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Ionosphere-Thermosphere Disturbances at the Equator during Intense Magnetic Storms: Longitude and Local Time Dependences

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The ionosphere-thermosphere system of the earth's equatorial region is governed by coupling processes unique to the condition of low inclination/horizontal magnetic field lines connecting the dense plasma of the low latitude conjugate regions. Electric fields produced by wind driven dynamo, and penetrating electric fields originating from magnetosphere - Ionosphere interactions that becomes intense during magnetic storms/disturbances drive the dynamics and electrodynamics of this region. The storm time auroral heating that produces disturbance thermospheric winds and dynamo electric fields further modify the dynamics and the plasma distribution of the system. The prompt penetration electric field which is eastward during the day-evening sector causes large increase in the electrojet current as also large increase of the TEC (Total Electron Content) of the ionosphere as measured by GPS receivers. Forcing under very intense storms can cause expansion of the equatorial ionization anomaly (EIA) to midlatitude on the dayside and evening sector. The EIA can contract equatorwards under a westward electric field depending upon the storm activity phase. The development of Equatorial plasma bubbles/spread F irregularities, a nighttime phenomenon, can be intensified or suppressed depending upon the type of the penetration electric field, whether under-shielding or over-shielding type. The intensity of the penetrating electric fields and the disturbance dynamo electric fields and effects they produce in the equatorial ionosphere and thermosphere are found to depend on the longitude, the effects being more intense in the Atlantic longitude sector where the ionospheric conductivity appears to be generally higher than in other longitudes. This paper will present and discuss the most recent results on these aspects and related ones based on observational and model results.

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Equatorial Spread F development and day-to-day Variability due to Planetary Waves and Gravity Waves

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The spread-F /plasma bubble irregularity development in the post sunset equatorial ionosphere (ESF) is widely believed to arise from the generalized Rayleigh-Taylor (R-T) interchange instability mechanism. The instability is initiated from density perturbations at the bottomside gradient region of a rapidly rising F layer. Whether or not it could develop into flux tube aligned topside bubbles (plasma depletions) with cascading irregularity structures should depend upon: (a)-the intensity of the evening prereversal enhancement in the zonal electric field (PRE)/vertical plasma drift; (b) - the amplitude of the initial density perturbations and associated polarization electric fields possibly induced by upward propagating gravity waves (GWs). Observations by different technique show large degree of day-to-day and short term variabilities in the ESF strength and occurrence rate that could be caused the factors a and b, and possibly other factors such as the field line integrated conductivity. Recent results have shown that the PRE can be modulated by upward propagating Planetary Waves (PWs). We focus in this presentation on the competing/complementary roles of the PRE and GWs in the ESF development on the one hand and the variability in the PRE (and hence spread F) arising from the PWs on the other. The results to be discussed are based mainly on ground based radar, digisonde and optical measurements including results from some recent observational campaigns conducted in Brazil. Instability model results will discussed for a better understanding of the ESF variability.

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The position of Space Pollution and it's Potential Effects on Space Programs and the Environment.

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Since the beginning of the space programme in the late 1950s and the early 1960s by the former U.S.S.R. (Russian federation) and the United States of America(USA) there has been great achievements and developments in the areas of communication, remote sensing predicting climate change, disaster management, military operations as well as science and technology as a whole. Today there are 50 countries with satellites in orbit with the Malaysian Razak-sat and the United Arab Emirates Dubai sat-1 as the youngest as at September 2009.

However despite the above mentioned developments in space sciences, but yet there is a new ongoing negative impacts associated with this development in space sciences as a result of space programs.

This negative impact is best described as the "space pollution" this space pollution is caused by the introduction and the increasing numbers of debris in space as a result of human activities associated with space programmes like the destruction of satellites in the outer space for example like the destruction of the failed USA-193 satellite on- orbit by the United States, satellites that have completed their life spans in space or on-orbit collisions; such as the collision of the French military satellite Cerise with a portion of an ariane rocket in the year1996 among many others.

In view of the above there is a significant growing numbers of objects or debris in earth orbit .At present the US department of defense (DOD) using the Space Surveillance Network has tracked 19,000 objects approximatley10 centimeters in diameter or larger. It also estimated that there are over 300,000 objects with a diameter lager than one centimeter, and millions smaller.

Though there are continued efforts towards developing and implementing debris mitigation practice for example the spacefaring states including China, Japan, Russia, USA and the European Space Agency (ESA) developed the debris mitigation and the limited nations adopting voluntary guidelines with the supports of the UN Committees on the Peaceful uses of Outer Space (COPUOS), but yet the US department of defense (DOD) confirmed the increasing rate of debris in space in recent years.

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Onset of Sunspot Cycle 24 and Galactic Cosmic Ray Modulation

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The annual mean sunspot number (SSN) reached a minimum value in 2008, while the monthly mean SSN minimum was reached in August 2009. The galactic cosmic ray modulation for cycle 24 appears to have begun at earth orbit in January 2010. We study the characteristics of the new modulation cycle with the data from the global network of detectors. They respond to time variations in different segments of the galactic cosmic ray rigidity spectrum. The corresponding temporal variations in the frequency of the coronal mass ejections (CMEs), thesolar wind parameters B and V as well as the tilt of the heliospheric current sheet are also studied. We discuss the physical significance of our empirical results.

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A 3D magneto-hydrodynamic model of solar prominences

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We aim to model a solar prominence embedded in the upper solar atmosphere taking in account a fully 3D magnetic field, realistic thermodynamics, and energy sources, using a 3D MHD simulation. As initial condition for the magnetic field we use the analytical model of a bipolar active region by Titov & Demoulin (1999). This approximate force-free equilibrium consist of an arched and twisted magnetic flux tube embedded into an ambient potential field. This magnetic configuration contains "dips", i.e., locations where the field lines are concave upward (U-shaped) and can carry dense plasma against gravity. The thermodynamic model contains as initial condition a hydrostatic, pressure-balanced atmosphere that spans from the high chromosphere through the transition region to the solar corona. The energy equation includes radiative losses (Rosner, 1978), thermal conduction along the magnetic field (Spitzer, 1962), electric current dissipation, and an ad-hoc heating function for the corona (Serio et al, 1981).

Due to the spurious forces present in the magnetic field and the response of the atmosphere, the system develops a complex dynamic behavior from the very beginning of the simulation. The source terms of the energy equation seek to balance each other given the constraints imposed by the magnetic field. This evolution results in evaporation of chromospheric plasma that is expected to trigger a thermal instability and plasma condensation in the ongoing simulation, i.e., the formation of prominence material.

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Longitudinal distribution of sporadic E layers obtained from FORMOSAT-3/COSMIC GPS radio occultation measurements in the equatorial region

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The GPS radio occultation (RO) technique is used to study sporadic E (Es) layers on a global scale. Sporadic E layers are thin sheets of enhanced electron density occurring in the lower ionospheric E region, preferably between 95 and 120 km.

The data set is based on FORMOSAT-3/COSMIC (launched in April 2006) radio occultations and comprises about 2200 globally distributed measurements per day. Es layers cause strong fluctuations in GPS RO signals and can therefore be identified. In this study strong fluctuations of the signal to noise ratio are identified as signatures of Es.

The GPS RO data are used to obtain a global picture of sporadic E occurrence and its variability. In this study we focus on the equatorial region (20°N – 20°S) where we found a four-peaked longitudinal structure of sporadic E occurrence. It is widely accepted that Es formation is due to the wind shear mechanism when the ionised constituents of the E region interact with the lower thermospheric neutral wind field. The lower thermospheric neutral wind fieldin turn is strongly influencedby solar tides. Thus, we expect that the identified wave-4 structure in equatorial sporadic E occurrence can be attributed to tidal activity, e.g. nonmigrating diurnal tides.

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Three years of STEREO results

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Since their launch in october 2006, the suites of remote sensing and in-situ instruments on board the twin STEREO spacecraft have been providing strikingly new views of the Sun. Three dimensional reconstruction of active region loops and of flux-rope CMEs, direct imaging of the inner heliosphere or detection of interplanetary nanodusts are only a few of the many STEREO scientific highlight of the past years.
After a review of the most prominent results, I will outline a synthetic picture of their impact on heliophysics and propose some ideas for the future.

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Using Satellite Data in Detecting and Predicting Climate Change and Desertification in Africa.

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Desertification and climate change are two primary issues affecting the fertile lands of the Sahel and its people .This Sahel region stretches all the way from Senegal to Somalia or the Horn of Africa while cutting across over ten different African countries within the Sub-Saharan Africa. It borders the "Sahara desert" in the North and the "Sudan Savannah" in the South. This region has an annual rainfall of an average of 50-55 cm in the late 1960's and has drastically dropped to an annual average of 35-40 cm per annum since the late 1990's.While the Sahara desert of the region keeps expanding from an average 0.5 kilometers per annum in the late 1980's to 0.8 kilometers per annum since the last decade.

In view of the above mentioned desertification and climate change situations the agricultural out puts and pastoral activities as well as the sizes of lakes, rivers and ponds upon which the inhabitants of this region depends has drastically reduced significantly over the last two decades and further keeps increasing the rate of rural-urban migrations, job losses, poverty and land disputes.

Considering the above dynamic changes going-on in the Sahel region a faster, precise and reliable data are required by researchers conducting research in this field and such data can only come through space application such as applying the GNSS Technologies to water resource management as well as thematic mapping and forest management in the region.

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The Economic and Societal Impacts of Space Weather

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Vulnerability of society to space weather is an issue of increasing worldwide concern. For example, electric power networks connecting widely separated geographic areas may incur damaging effects induced by geomagnetic storms. Also, the miniaturization of electronic components that are used in spacecraft systems makes them potentially more susceptible to damage by energetic particles produced during space weather disturbances. Transpolar airline flights can be severely impacted by energetic solar particle events. Nations also are putting into place programs to expand human activities on the Moon and eventually plan a mission to Mars. However, despite all these potential space weather vulnerabilities, relatively few detailed studies of the socioeconomic impacts of severe space weather events have been carried out. Although cost/benefit analyses of terrestrial weather observing systems and mitigation strategies have a long history, similar studies for space weather are lacking. A committee, operating under the auspices of the Space Studies Board (SSB) of the U.S. National Academy of Sciences, was charged with making such an assessment. This study was to assess current and future ability to manage the effects of space weather events and their societal and economic impacts. The study effort included an analysis of the effects of historical space weather events, and used the record solar storms of October – November 2003 to focus the assessment and to provide data to project future vulnerabilities. The conclusion of the resulting National Academy study was that severe space weather events can cause tens of millions to many billions of dollars of damage to space and ground-based assets. The most extreme events could cause months-long power outages and could cost >$1trillion. In this presentation, I discuss broad socioeconomic impacts of space weather and also discuss the immense potential benefits of improved space weather forecasts. Such forecasts take advantage of our increased understanding of the Earth's space environmental conditions, especially as seen during extreme space weather episodes.

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Stratosphere-Troposphere Coupling in a Changing Climate

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Time-height cross-sections of the annular modes show the time-height development of stratosphere-troposphere coupling. However, there are challenges associated with the analysis of climate model projections as Earth's climate changes because the changing atmosphere projects (partially) onto the annular modes. I will discuss methods to define annular modes that are consistent across observations and models, and are not significantly affected by the time period used to define the annular mode spatial patterns. This involves defining a slowly-varying climatology, rather than a fixed climatology. Analysis of Chemistry-Climate Models (CCMVal) suggests that the timescale and variability of the annular modes are not projected to change appreciably during the rest of this century. Stratosphere-troposphere coupling is also projected to change little, as long as the climatology is allowed to vary slowly at the atmosphere evolves.

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On characteristic features of global, polar and equitorial temperature and its possible linkage with solar activities.

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The temperature of Land and Ocean, and Global Land -Ocean Temperature (GLOT) for the period 1880-2006 have been considered. Further, the Land and Ocean temperature during last century (1903-2006) for Polar region and Equatorial region have been analyzed and compared.

The analysis reveals (i) the temperature anomaly curve of GLOT has always positive gradient but the gradient during 1947 to 2006 is almost 1.7 times that of during the 1880-1946. (ii)Although the overall trend is increasing from 1880 onwards there exists an oscillatory trend in both Land and Ocean temperature anomalies separately and also in GLOT, but significantly in the last 26/ 27 years (i.e.1979/80 to 2006) the rate of increase of temperature for all three cases (Land, Ocean and GLOT), however, becomes much higher than that of previous 100 years. Consistently with this trend, the correlation coefficient (c.c.) between temperature anomalies and time during this period comes out to be quite high (+0.79 for both Land and Ocean, and +0.86 for GLOT).Clearly, these are all signatures of the so called Global Warming.

However, the comparison of the trend lines for temperature variation of Antarctic, Arctic and Equatorial regions during last 100 years(1903-2006) indicate that the rate of increase of temperature is positive everywhere but significantly it is maximum in Antarctic ,which is almost double that of Arctic, and almost four times that of Equatorial region. Further, in general, the nature of variation of Arctic and Antarctic temperature are opposite in character. e.g. Arctic temp. curve exhibits long period oscillation from 1913 to1963 and then continues to increase while Antarctic curve exhibits rapid fluctuation up to 1963/64 and then increase rapidly. This also implies Global Warming exist but not uniform everywhere.

When the trend of Global Land-Ocean Temperature (GLOT) is compared with that for Sun's Spot Number (SSN) for the period 1880-2006.It is found that the same monotonically increasing trend exists in the variation of SSN as well as in GLOT.Finally, the comparison of correlation coefficients between SSN and Temperature in different regions (Arctic, Antarctic and Equatorial) for different SSN ranges revel that SSN is most capable to influence in Eqatorial region. But always exist some critical value of SSN (≈120) exceeding which solar influence becomes more effective.

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Solar EUV Brightenings and Magnetic Reconnection Process

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Magnetic reconnections are considered as the main physical process which happen in many solar dynamical eruptions such as flares, prominences eruption. EUV brightenings may possibly one of the manifestations of magnetic reconnections in corona. In this paper, EIT brightenings in different scales were examined by using multiband data from spaceborne observations of SOHO TRACE and HINODE and from ground based Hα observations. The temperatures in and outside the EIT bright points were calculated from the HINODE data to explore how the magnetic reconnection was related to coronal heating. The EIT brightenings are divided into three types according their locations in: (1) active regions (with sunspots), (2) plage regions (without sunspot), (3) quiet regions. The analysis shown that there is a good correlation between variation of EUV flux and X-ray (0.1-0.8 nm) flux, especially during the flares larger than C-class. The first type of EUV brightenings are often accompanied by flares with magnetic strength larger than 1000 Gauss. The third type of EUV brightenings are usually correspondent to weak magnetic field with intensity less than 100 Gauss. The physical properties of EUV brightenings such as lifetime, magnetic strength and configuration were studied. Their dynamical evolutions and relations to their magnetic structures and possible magnetic reconnection process were discussed.

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Results from the C/NOFS Satellite obtained during the Current Deep Solar Minimum

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The multi-instrumented C/NOFS (Communication Navigation Outage Forecasting System) satellite was launched on April 16, 2008 with 13 degree orbital inclination to characterize and forecast outages in transinospheric communication systems in the equatorial region. The satellite launch corresponded to the deepest solar minimum period and its perigee of even 400 km was found to be inadequate at times for the forecast of the ionospheric turbulence and their deleterious effects on trans-ionospheric communication systems. However, the several on-board instrument packages comprised of a planar Langmuir probe, vector electric field instrument, ion velocity monitor, GPS occultation sensor and a multi-frequency radio beacon have provided many new results. Only the neutral wind meter has not been able to operate during this extreme quiet solar condition, but is expected to provide results when the solar flux exceeds 100 units.

Observations by various investigators will be presented Measurements using the ion velocity meter reported that the altitude extent of the ionosphere is significantly smaller than the present reference models would predict for these levels of solar activity. Moreover they found the transition height between O^+ and H^+ to reside near 450 km at night and at that time, this unusually contracted ionospheric shell around the equator had a temperature of only 600 K. Ion density data observed with the Planar Langmuir Probe (PLP) also yielded new findings, such as deep plasma depletions at sunrise and broad plasma decreases at nighttime. As far as plasma bubbles are concerned, several groups have analyzed the high resolution data of PLP plasma density and obtained spectral characteristics from 10km to 100 m. They suggested the possibility of two-slope spectra with a break at 70m scale length, which may be related to the long-lasting solar minimum condition. We have utilized the PLP data in conjunction with several ground-based instruments in the Jicamarca sector and have found great changes in the low-latitude electrodynamics from day-to-day. The interpretations of our C/NOFS ionospheric irregularity observations were greatly facilitated by the TEC data from the Low Latitude Ionospheric Sensor Network (LISN) and the incoherent scatter radar and Digisonde at Jicamarca.

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Polar surface air temperature variability in a chemistry climate model: Connections to geomagnetic activity?

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The atmospheric chemistry general circulation model ECHAM5/MESSy is used to simulate effects of geomagnetic activity variations using several different model setups. A transient model simulation was performed for the recent past and is shown to devlop polar surface air temperature patterns that depend on geomagnetic actvity strength, similar to previous studies. In order to eliminate influencing factors such as sea surface temperatures (SST), two further simulations were carried out, with strong and weak geomagnetic activity, respectively, while all other boundary conditions were repeated yearly. Statistically significant temperature effects that have been observed in reanalysis and model results are also obtained from this set of simulations, indicating that such patterns are indeed related to geomagnetic activity.
In the model, enhanced geomagnetic activity and the associated NO_x enhancements lead to polar stratospheric ozone loss. Compared to the simulation without geomagnetic activity, the ozone loss causes less longwave radiation from the surface to be absorbed in the stratosphere, leading to a cooling and thus a more stable vortex. A strong vortex is associated with a positive Northern Annular Mode (NAM) index, whereas a weaker vortex, as found in the low-geomagnetic-activity simulations, is associated with a negative NAM index. It has been shown that such NAM anomalies can propagate to the surface, and this is confirmed by the simulations. NAM anomalies are known to lead to specific surface temperature anomalies: a postive NAM is associated with a warmer than average northern Eurasia as well as a colder than average eastern North Atlantic, which is also found in the simulation with strong geomagnetic activity. Therefore, it appears that at least in the model the surface temperature effects can be explained by a consistent line of arguments.

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From the surface to space: First results from the new whole atmosphere model ECHAM5/CMAT2/MESSy

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Traditionally, different numerical models have been used to study the lower/middle atmosphere on the one hand, and the upper atmosphere on the other hand. However, these regions interact, and for example solar variability effects can propagate from the upper atmosphere at least down to the middle stratosphere. Whole atmosphere models are required for a full understanding of such processes. An innovative whole atmosphere model is currently being developed by coupling two existing models that in combination very well describe the lower, middle and upper atmosphere. This is achieved in the framework of the Modular Earth Submodel System (MESSy). MESSy already contains a comprehensive description of processes in the atmosphere from the ocean to the lower mesosphere including interactive atmospheric chemistry. For the region above we accomodated the CMAT2 model, which contains the dynamics, chemistry and physics from the stratosphere to the thermosphere, into MESSy. We present some of the technical aspects as well as first results with a focus on the chemistry and dynamics of the middle atmosphere.

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Modeling of Trends in PMC formation including Solar Cycle Effects

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The new circulation model called LIMA (Leibniz-Institute Middle Atmosphere) is used to study the trend behavior of the thermal state of the middle atmosphere . LIMA takes advantage of global ECMWF-ERA-40 data sets from troposphere/lower stratosphere regions which are processed through data assimilation techniques. This allows in middle atmosphere modeling to investigate in detail the effects of the lower atmosphere conditions on the upper atmosphere through upward wave activity propagation. On the other hand, solar variability (observed daily Lyman alpha fluxes since 1961) forces the LIMA middle atmosphere from above.

One example of LIMA studies is the simulation of the thermal state at the summer upper mesosphere since 1961 until 2009, and its impact on the morphology of ice particle related phenomena such as noctilucent clouds (NLC), and polar mesosphere clouds (PMC). LIMA allows to investigate inter-hemispheric differences as well as decadal long term trends in NLC/PMC formation. The NLC/PMC characteristics deduced from LIMA are validated with various data sets from different lidar (ground station ALOMAR), and satellite (SBUV) observations. LIMA reproduces the mean characteristics of observed ice layers, for example their NH/SH differences in variation with season, altitude, and latitude. Not only seasonal means, but also 11-y solar cycle effects and decadal long term behavior of PMC nicely agree with satellite data.

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Investigating the Influence of Solar Activity on the Arctic Polar Stratosphere using Nonlinear Statistical Methods

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A number of observational and modeling studies have shown that solar variability influences the radiation, chemistry and dynamics of the atmosphere. However, the detection of possible nonlinear interactions between the solar cycle and other atmospheric forcing factors such as the QBO, the El Nino Southern Oscillation or the northern annual mode and their impacts remains a difficult task. The main focus is on the influence of solar variations on the Arctic polar stratospheric vortex in reanalysis data as well as chemistry climate model output. In contrast to common linear statistical methods, this analysis aims at extracting nonlinear impacts of solar cycle variations via a neural network approach and a novel clustering method. The results are compared to commonly used linear methods.

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Solar-Wind/Magnetosphere Coupling: A Two-Step Process

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An examination of reconnection at the dayside magnetosphere finds that the solar-wind electric field vBz does not control the rate of reconnection. Yet, the level of geomagnetic activity has correlations with the electric field. The answer to this dilemma is that solar-wind/magnetosphere coupling is a two-step process: reconnection then coupling, with the solar-wind electric field playing a role in the second step. Calculation of the reconnection rate between the solar wind and the magnetosphere is treated as a fluid-flow problem and a Mach-number-dependent "reconnection function" is derived. The post-reconnection coupling is treated as an electrodynamics problem using the Goertz-Shan-Smith picture of current coupling to the ionosphere on connected field lines.

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Statistics on coexisting large scale oscillations in the middle atmosphere and ionosphere

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Signatures of planetary wave type oscillations (PWTO), with periods between 2 and 30 days and wavelengths exceeding 10.000km, can be observed in the ionosphere. While up to 50% of these PWTO can be allocated to variations in the solar radiation, others are supposed to be forced by waves from below.

Hourly maps of the total electron content (TEC), covering the northern hemisphere from 50°N to the North Pole, are used to analyse and describe PWTO in the ionosphere. Those PWTO probably forced by solar variations can be reduced by applying a filter method based on the wavelet transform. This paper presents statistics on the number of PWTO observed in the filtered TEC, classified by period ranges and wavenumber in midlatitudes during 2002 to 2008. Additionally statistics on the coexistence of PWTO found in the filtered TEC and planetary waves observed in NCEP stratospheric reanalyses are presented. It is found that about one third of the observed PWTO occurs at about the same time as planetary waves in the middle atmosphere. But, significance tests reveal that only few of the PWTO classes reach a 95% significant number of coexisting waves. Thus, statistical analyses can give hints but no evidence for atmosphere-ionosphere-coupling by planetary waves. Instead, case studies are suggested for further analyses.

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Line-core and line-wing features in the temperature-dependent MgHe emission/absorption spectra

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The present study deals with the collisional broadening of the monoatomic magnesium, evolving in a ground helium gas, in the wavelength and temperature ranges 260-310 nm and 100-3000 K, respectively. The emission and absorption spectral profiles, which might be generated from our theoretical computations, are based on the most recent potential-energy curves and transition dipole moments. The required interatomic Mg(3s2)-He and Mg(3s3p)-He potentials are constructed from two different sets.1 The purpose of this treatment is twofold. First, using the quantum-mechanical Baranger impact approximation,2,3 the width and shift of the line core of the spectra are determined and their variation law with temperature is examined. Then, the satellite structures in the blue and red wings are analyzed quantum mechanically.4-6 The calculations show especially that the free-free transitions are the most contributive in the MgHe photoabsorption spectra and a satellite structure is observable beyond the temperature 2000 K around the wavelengths 272 or 276 nm, depending on the used potential set. For both cases, the obtained results agree quite well with those already published.

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Measurements of Solar and Atmospheric Phenomena and Coupling using SCIAMACHY on board ENVISAT 2002 - present.

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The Scanning Imaging Absorption spectrometer for Atmospheric Chartography, SCIAMACHY, is a national contribution, funded by Germany, The Netherlands and Belgium to the ESA ENVISAT platform, which was launched on the 28th February 2002. SCIAMACHY has a variety of different scientific objectives makes measurements of the extra terrestrial solar emission and the upwelling radiance at the top of the atmosphere in a variety of viewing directions between 214 and 23800 nm. The limb and solar occultation measurements of SCIAMACHY yield unique information about the stratosphere, the mesosphere, and thermosphere. In this context we are able to investigate a diverse set of phenomena, including the impact of solar variability on the upper atmosphere, meteoritic ablation in the atmosphere and its consequences, polar mesospheric clouds and stratospheric ozone and aerosol chemistry and dynamics. This presentation describes selected highlights from our use of SCIAMACHY to investigate and understand these phenomena.

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Post Midnight Spread-F at Brazilian Low Latitudes under Solar Minimum Conditions

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At Brazilian low latitudes, the spread-F as seen by ionosondes or imaging systems is mostly associated with equatorial plasma bubbles (EPBs), mainly between September and April. On the other hand, during low solar activity and the June solstice periods, the observation of EPBs at low latitude sites is very rare, except during disturbed periods. In this work we present a study of a series of spread-F events observed at a low latitude site, Cachoeira Paulista (22.7^{o}S, 45.0 ^{o} W, mag lat: 16 ^{o} S, dip angle: -22.3^{o}), Brazil, during June solstice months, under solar minimum conditions. Analyzing a digital ionosonde database we have observed that the occurrence of spread-F at this station is frequently observed at midnight/post-midnight local times. By inspection of the digital ionosonde data obtained at equatorial site, São Luiz (2.33^{o} S, 44.2^{o} W, mag lat 1.6^{o} S, dip angle: -2.7^{o}) e airglow optical imaging we verified that the spread-F manifestations over Cachoeira Paulista are not associated to EPBs but to other ionospheric disturbances. We investigate the most probable sources.

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A theoretical model of torsional oscillations from a flux transport dynamo model

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Torsional oscillations, which appear as fast and slow rotating bands on the solar surface, provide observational evidence for the back reaction of the magnetic cycle on the solar flows. However, the faster rotating band is observed at the solar surface *2-3 years before* the first sunspots of the upcoming cycle appear on the solar surface. We conjecture that this apparent violation of causality can be resolved if the Lorentz stress is initiated at the high latitude tachocline due to production of strong toroidal fields there and are propagated upwards due to Alfven waves. We present below results from a mean field model coupled with an equation for the azimuthal velocity to support our claim. The reader is also requested to look at Chakraborty, Choudhuri and Chatterjee (2009, PRL, 102, 041102 and PRL, 103, .099902), where this work was originally published.

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Physics of Solar Coronal Mass Ejections

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Coronal mass ejections (CMEs) are the largest-scale eruptive phenomenon on the Sun, which involves many other solar activities with different scales and is the major driving source for geomagnetic disturbances. The large database of observations enables the statistics of many properties of CMEs, and provoked accumulating modelings. However, there are many controversies in our understanding, for example, whether there are two types of CMEs, what is the role of magnetic reconnection in CME eruptions, and what is the nature of the three-part structure of CMEs. In this talk, I review our understanding of the spectacular phenomenon, including their progenitors, the trigger mechanisms, and the final formation of the large-scale erupting structure. Emphasis is focused on the possible solutions to the existing controversies.

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The 11-years solar cycle in transient WACCM-3 simulations

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The whole atmospheric response to the 11-years Schwabe cycle was analysed in an ensemble of four WACCM-3.5 simulations covering 45 years (1965-2005, neglecting the initial five years for model spin-up). These experiments were carried out within the CCMVal-2 initiative to reproduce the past. The simulations were driven with the following forcings: (1) a time-varying solar cycle, (2) nudged QBO, (3) observed SSTs, (4) anthropogenic carbon and ODS emissions. All ensemble members show a statistically significant annual mean warming throughout the middle and upper tropical stratosphere, with a radiatively-driven maximum in the upper stratosphere, a relative minimum in the middle stratosphere and a secondary dynamically-driven strong maximum in the tropical lower stratospheric temperature and ozone response. The nudged QBO and the observed SSTs play an important role in amplifying the solar signal in the lower stratosphere. Moreover, a downward propagation of zonal wind anomalies from the stratosphere to the troposphere in the extra-tropics is found during the Northern Hemispheric winter, which appears to be a robust feature of the model simulations. On the other hand, the QBO modulation of the extra-tropical solar signal in late NH-winter (i), and the solar-cycle modulation of the Holton-Tan relationship (ii) are only evident in two of the four ensemble members, thus indicating that the two-way QBO-solar cycle dynamical interaction is not significant. Some features of these results are shown to be closer to observations than in previous WACCM modeling studies, thus certifying an improvement in the modeled whole atmospheric solar response in WACCM-3.5, which is brought by the implementation of a new GW-source parameterization.

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Middle Atmosphere Ozone Recovery and Climate Change

Chipperfield Martyn

Stratospheric ozone depletion has been observed over the past few decades. The dominant driver for this change has been increased loss from chlorine and bromine species, derived from source gases such as CFCs. Due to limits on production and emission of halogenated source gases the stratospheric abundance of chlorine and bromine is expected to return to 1980 levels (i.e. pre observed ozone loss) by about 2050. Therefore, stratospheric ozone is expected to recover on approximately the same timescale.

However, there is a strong 2-way coupling between stratospheric ozone and climate. Past depletion of stratospheric ozone has had an important impact on climate both locally in the stratosphere and at the surface. Other climate-induced changes in the stratosphere (e.g. cooling due to CO2 increases) have significant impacts. In the future these impacts will determine the rate and extent of ozone recovery.

In this talk I will discuss current science issues in ozone depletion/recovery. The talk will emphasise the interactions of ozone loss and climate change and will draw on 3D model results from the recent SPARC CCMVal activity.

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Solar dynamo and variability

Choudhuri Arnab

The sunspot cycle is believed to be produced by a flux transport dynamo, in which the toroidal field is produced from the poloidal field by stretching due to differential rotation, the poloidal field is produced by the Babcock-Leighton process and the meridional circulation plays an important role. I shall survey the important developments in the flux transport dynamo model and then discuss how this model can be applied to explain the irregularities of the sunspot cycle, leading to the possibility of predicting the strengths of future cycles.

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Could a full-halo CME coming from the limb be geoeffective?

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Fast halo CMEs coming from the solar central meridian are considered as the most geoeffective solar events. However, large disturbances at terrestrial environment have been also associated to halo CMEs from regions located far from central solar meridian, as Halloween storm. In this work we have selected all full halo CMEs from solar cycle 23, as observed by the LASCO coronagraph on board SOHO mission, with source at solar limb looking for the possibility of connection between solar limb and terrestrial environment. For this task, when the result of the limb halo CME might be a geomagnetic storm, we have analyzed every link in the Sun-Earth chain. In order to associate different links one to each other (as CME –ICME) we have not considered only the time window, but also we have carefully revised every candidate at solar surface.

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Meridional winds in the equatorial ionization anomaly observed by the Streak mission

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New analyses of thermospheric measurements from the ionization gauge on the Streak mission are presented and discussed. These measurements, returned from the dusk bottomside ionospheric F-layer, show strong signatures in the neutral gas impressed through the action of the equatorial ionization anomaly (EIA). These signatures are interpreted as being due to very rapid (several hundred meters per second) meridional winds associated with the equatorial ion fountain at dusk. The winds are shown to be consistent with a picture of the EIA at dusk developed from DE-2 measurements and discussed as the Equatorial Temperature and Wind Anomaly. The present measurements show how these winds depend on altitude. Furthermore, the wind structure exhibits a set of convection rolls that extends to high latitudes and is thus a form of coupling from low latitude to high latitude.

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Microburst storm characteristics: combined satellite and ground-based observations indicating the spatial extent of microburst activity regions

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Bursts of relativistic (>1MeV) electron precipitation from Earth's radiation belts are detected by the Solar Anomalous and Magnetospheric Particle Explorer (SAMPEX), a low Earth orbiting satellite. During periods of enhanced geomagnetic activity (Kp>6), burst-like perturbations can be found in very low frequency (VLF) signals received at Sodankyla, Finland, by the Antarctic-Arctic Radiation-belt (Dynamic) Deposition - VLF Atmospheric Research Konsortium (AARDDVARK). The VLF perturbations have been termed FAST events, which are characterised by their large perturbation amplitude, both positive and negative, their temporal brevity (t~<1s). These FAST events are observed to affect different locations of the D-region ionosphere during a series of events, and are therefore thought to be caused by a “rainstorm” of spatially small (tens of kilometres or less) bursts of precipitation striking the atmosphere. It is seen that periods of FAST event activity coincide with periods of SAMPEX detected microbursts. In this talk we discuss the interplay between the two sets of observations, and provide some indication of the spatial extent of the microburst/FAST activity region.

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The role of gravity wave effects and stratospheric sudden warmings in modelling solar signal propagation

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We used a troposphere-stratosphere model of intermediate complexity to study the atmospheric response to an idealized solar forcing in the subtropical upper stratosphere in early winter. Our analysis focuses on the poleward and downward propagation of the solar signal in the northern hemisphere, and we investigate two conditions that could influence this propagation: 1) the type of representation of gravity wave effects in the model, and 2) the presence or absence of Stratospheric Sudden Warming (SSW) events. Two sets of simulations were performed: one with a traditional Rayleigh friction representation of gravity wave effects (RF), and another with a Holton-Lindzen-type gravity wave scheme (GWS). Both control simulations produce similar climatologies, but substantially different distributions of SSW events, with the GWS distribution being most realistic. For the same forcing in the subtropical upper stratosphere, larger and longer-lasting responses, which propagated further poleward and downward, were obtained when the gravity wave scheme was used. The GWS version of the model thus has a higher sensitivity to external forcing than the RF version. When years with SSWs during early winter are excluded, the GWS results show an enhanced signal in the troposphere, which appears to be not directly connected to signals in the stratosphere, while signals appear to propagate more directly into the troposphere when examining SSW years only. This suggests that different mechanisms of troposphere-stratosphere coupling are active during disturbed (with SSW) and undisturbed (without SSW) conditions.

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Idealized 11-year solar cycle simulations using an AO-GCM

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Three idealized experiments are performed using forcings of total solar irradiance (TSI), spectral solar irradiance (SSI) and ozone representing the 11-year solar cycle. The model (EGMAM) used is a middle atmosphere version of ECHO-G with 39 vertical levels (top level 0.01 hPa) and including a detailed representation of middle atmosphere dynamics. The experiments are performed with a model version including the FUBRad radiation scheme with 49 spectral intervals in the UV/vis part of solar spectrum. Each experiment is carried out with an idealized sinusoidal solar forcing with a period of 11 years ranging over 21 solar cycles and 231 years respectively. To assess uncertainty due to ozone three different solar cycle dependent ozone anomalies are used. These long fully coupled simulations are used to identify the robustness of solar signals in the atmosphere and the ocean.

The temperature response shows a two peak structure in the tropical region with a warming of the lower stratosphere up to 0.8 K. Stronger warming occurs only in the stratopause region with an increase of more than 1 K during solar maximum conditions. The heating of the stratopause region is connected to both changes in short wave radiation and prescribed ozone anomalies. The dynamical response in the polar region of the middle atmosphere is well represented and similar to observations. The polar vortex is stronger and less disturbed during solar maximum. This signal becomes stronger and more significant after removing winters with sudden stratospheric warmings. Overall, the model response to solar variations in the middle atmosphere is similar to observed changes.

Beside the stratospheric response we investigate to what extent tropospheric circulation regimes are influenced, and the oceanic circulation. Averaged over all experiments, a La Nina like response is found in the tropical Pacific for solar maximum conditions. However, the average response is much weaker than in observations, because century long periods during which the amplitude of the response is comparable to observations are mixed with equally long periods during which hardy any response can be found. The reasons for this behavior have yet to be identified.

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GCR Flux and Dose Rate Increase in Geospace in the Declining Phase of the 23rd Solar Cycle

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The fluxes and absorbed dose rates from Galactic Cosmic Rays (GCR) and their secondary were continuously measured in Low Earth Orbit (LEO) and at aircraft altitudes with Liulin type spectrometers between March 2001 and September 2009. This period cover the unique maximum of GCR flux observed in the end of 23rd solar cycle. The measurements on aircraft were performed in cooperation with Czech Airlines (CSA). The detector was repeatedly placed in the cabin of airbus A310-300 for approximately 50 days. 24 runs were performed, with more than 2000 flights and 13500 flight hours on routes over the Atlantic Ocean mainly. Well seen increase of the dose rates from about 1.6 to 2.5 $uGyh^{-1}$ connected with flux increase from 0.485 to 0.576 $cm^{-2}s^{-1}$ is found at aircraft altitudes during the declining of the solar cycle. The obtained experimental data are compared with computational models like CARI and EPCARD. The fluxes and dose rates from GCR were also independently measured with analogical instruments onboard following spacecraft: International Space Station (ISS) in 2001 and 2008-2009; Foton-M2/M3 satellites in June 2005 and September 2007 respectively and on Indian Chandrayaan-1 satellite in 2008-2009. During the declining phase of the solar cycle the dose rates at L>4.5 increases in average from about 6.1 to 13.5 $uGyh^{-1}$. The flux increase in average from 1.64 to 3.23 $cm^{-2}s^{-1}$. The analysis of the GCR flux and dose rate latitudinal profiles gives the following: 1) The latitudinal profile at each vehicle shows similar shape with a minimum close to the geomagnetic equator, rising up part up to L=3.5 and knee followed by fixed values or smaller slope of the curve at high L values; 2) The fluxes and doses in the equatorial region don't show solar activity dependence; 3) The fluxes and dose rates in the range 1.5To reveal the shorter term (397 days) variations of the GCR on the ISS orbit we analyze about 3 million individual 10 seconds resolution measurements between February 2008 and June 2009. The finding is that for this period the global daily dose rate increase from about 85 to 90 $uGyh^{-1}$ per day, which is generated by average increase of the global GCR flux rate from 1.02 to 1.04 $cm^{-2}s^{-1}$.

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Models and observations of CME propagation to 1AU

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Coronal mass ejections (CMEs) are one of the main sources of the Space Weather variability. Propagation of these CMEs throughout the interplanetary space is still a challenge. A number of empirical and analytical studies have addressed this point so far, using observations from coronagraphs and interplanetary monitors, in order to correlate CMEs observed near the Sun and in-situ, at 1AU (Earth vicinity). Error bars in CME travel time predictions from the Sun to Earth are of the order of 1 day, which is considerably large for the typical travel time of 1 to 3 days. We found that the subset of interplanetary counterparts of CMEs, the ICMEs, with a well defined ejecta structure, are those with best predictable behaviour. The prediction of these interplanetary ejecta travel time to earth, using coronagraph observations is the one with lowest error bar among other sets of events, such as interplanetary shock. We present a statistical study of all the CME-ejecta events observed by the Large Angle and Spectrometric Coronagraph (LASCO), aboard the Solar and Heliospheric Observatory (SOHO) and by the Advanced Composition Explorer (ACE) satellite since 1997. Empirical models are used to predict travel time of the CMEs using CME expansion speed. Of special interest is the fact that extreme events (fast CMEs-ICMEs) are well predicted using our methodology.

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Simultaneous observation of quasi 16-day wave in the mesospheric winds and temperature over low-latitude with SKiYMET radar

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This paper presents for the first time the seasonal characteristics of 16 day planetary wave on mesospheric temperature and winds simultaneously over a low-latitude station Thumba (8.5^{o}N, 76.5^{o}E) using meteor radar. Four-years (2005-2008) of meteor winds and temperature data are used for the present study. It is observed that the amplitude of 16-day wave in zonal component is more than that of meridional. Further analysis shows that westerly phase of zonal wind is more favorable for the 16-day waves. The maximum amplitude in mesospheric temperature is observed during January-February and August-September. Climatology of 16-day wave shows the variability of semi-annual oscillation (SAO) on mesospheric temperature but not on winds. The vertical amplitude structure of zonal component shows the maximum amplitude at ~ 88-92 km with constant phase. It is also noticed that zonal and meridional wind are in phase, whereas as temperature leads zonal wind by 5±1 days. The significant of the present result shows the wave characteristics, effect of background wind and manifestation of SAO on their propagation behavior. It is envisaged that the present result will contribute to our understanding of the dynamics of the MLT region at low latitude in the northern hemisphere. The detail results will be discussed in the upcoming symposium.

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A Review on Lamb`s Atmospheric Oscillations Using Initial Value Problem Approach

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Waves at a surface of discontinuity in the atmosphere is analysed in 1910 by Lamb, who derived, using normal mode approach, an analytical dispersion relation for a discrete mode (surface mode). Lamb examined the case of waves propagated along a horizontal plane where the equilibrium temperature is discontinuous. For simplicity, the upper region and the lower region are considered incompressible.

In this work, in order to show how the modes appear in the response of a surface discontinuity to an initial perturbation, we consider the initial value problem (IPV). The main difference from the standard analysis is that solutions to the linearized equations of motion which satisfy general conditions are obtained in terms of Fourier-Laplace transform of the hydrodynamics variables .

These transforms can be inverted explicitly to express the fluid variables as integrals of Green´s functions multiplied by initial data. In addition to discrete mode (surface mode), a set of continuum modes due to a branch cut in the complex plane, not treated explicitly in the literature, appears.

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Initial Value Problem Approach of two Regions Model of System Solar: the Continuous Spectrum

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The standard mathematical procedures in Helioseismology field are based on normal mode approach for various models of solar interior and atmosphere.

We consider a two region model of a system solar interior and solar atmosphere. The two different regions are assumed quasi-isothermal and without magnetic fields and separated by a boundary z=0 .

In this work, in order to show how the modes appear in the response to an initial perturbation, we consider the initial value problem (IPV). The main difference from the standard analysis is that solutions to the linearized equations of motion which satisfy general conditions are obtained in terms of Fourier-Laplace transform of the hydrodynamics variables .

These transforms can be inverted explicitly to express the fluid variables as integrals of Green´s functions multiplied by initial data. In addition to discrete mode (f mode), a set of continuum modes due to a branch cut in the complex plane, not treated explicitly in the literature, appears.

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On the spatial and activity cycle variations of the relationship between different components of solar magnetic fields.

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Temporal variations of the different global parameters of the Sun, including such important as total solar irradiance, are strongly determined by evolution of magnetic fields. The question is which components of solar magnetism are responsible for changing of those or others physical values. In this study the solar cycle variations of magnetic strength ratios (MSR) in different combinations of spectral lines, an important diagnostics parameter which is considered as an informative indicator of correspondence between strong and weak magnetic components, are investigated. On the example of multi spectral lines Sun-as-a-star magnetic fields measurements it is shown that MSR's are practically constant with time despite of significant variations of sunspots number and average magnetic field strength. However, the existence of small changes in MSR center-to-limb variations for large-scale solar magnetic fields is discovered. Some possible explanations and consequences of the obtained results are briefly discussed.

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A cross-comparison of magnetograms in spectral lines NiI 676.77 nm, FeI 63.025 nm, FeI 617.33 nm, and calibration issue of solar magnetic field measurements on space missions SOHO, HINODE and SDO

Demidov Mikhail
Institute of Solar-Terrestrial Physics

Reliable information about distribution of magnetic fields across the whole solar surface is necessary for many scientific tasks. The existence of severe difficulties in this problem is proved, for an example, by several recalibrations of the widely used SOHO/MDI data sets. The main aim of this study is a cross-comparison of magnetic field observations made in different spectral lines used on space missions SOHO and Hinode, which measurements are available for several years already, and SDO, which data are expected in a nearest future. These lines are: Ni I 676.77 nm (SOHO/MDI), FeI 630.15 nm and FeI 63.025 nm (Hinode/SP), FeI 617.33 nm (SDO/HMI).
To do that, the full-disk high-precision Stokes-meter measurements on the STOP telescope at Sayan observatory are used basically, as well as some data from SOHO and Hinode. Besides, observations in other spectral lines having a great diagnostics impact, such as FeI 525.02 nm, FeI 523. 29 nm and FeI 532.4 2 nm are analyzed. The difference between simultaneous or quasi-simultaneous observations in different spectral lines on the STOP do not exceeds factor by 2-3 depending on combination of spectral lines and position on solar disk. This is significantly less then in some other studies devoted to cross-comparison of different data sets. Importance and consequences of the obtained results are discussed.

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Relations between CME, ICME and magnetic clouds

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Coronal mass ejections (CMEs) are the manifestation of magnetized plasma structures ejected from the solar atmosphere into interplanetary space where they are observed as ICMEs. Magnetic clouds (MCs) are a particular subset of ICMEs that have a twisted magnetic flux tube, or flux rope, as deduced from in situ magnetic field measurements. I will first describe how a coronal magnetic field could store enough free energy, and then how it could reach an instability to form a CME. In this process the build up of a flux rope via magnetic reconnection is occurring both in the pre-eruption and CME stage. Later, CMEs evolve considerably as they expand from the magnetically dominated lower corona into the advectively dominated solar wind. Their interaction with the solar wind is described by comparing the results obtained from in situ observations and with numerical simulations, focussing on MCs as they are the best understood sub-class of ICMEs.

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Variations of aurora emissions during substorms at Spitsbergen archipelago

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The variations of the intensities of the green 5577 Å auroral emission and the red 6300 Å one will be examined. The dynamics of these emission intensities during substorms, observed over the Spitsbergen archipelago will be studied. Data from simultaneous measurements of the photometer and the all-sky camera from the 2007/2008 and 2009/2010 winter seasons installed at the Barentsburg Observatory, plasma and solar wind magnetic field data from the WIND satellite and data from the ground-based magnetic stations from the IMAGE network have been used. It was shown that the precipitation of most energetic electrons occurs at the polar edge of the auroral bulge, and inside the bulge precipitation of less energetic electrons is observed.

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Nonstationary solar wind structures and its influence on substorm bulge development

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Solar wind streams, depending on the periods of solar activity, have different nature. There may be quasi-stationary streams (recurrent streams from coronal magnetic holes) and nonstationary streams (flare streams connected with coronal mass ejections (CME)). In this work was considered followed nonsationary solar wind structures - magnetic clouds (MC), Sheath and CIR regions (regions of interaction of Magnetic clouds and Recurrent Streams with undisturbed solar wind). This study is devoted to the investigation of the influence of nonstastionary solar wind structures on the auroral bulge development. Solar wind parameters were taken from the Wind spacecraft observations and the auroral bulge parameters were obtained by the Ultra Violet Imager onboard Polar. It was shown that auroral bulges "geometry" is different for these types of solar wind structures. The auroral bulges of substorms during magnetic clouds are, in average, wider in longitude and narrower in latitude. As consequence, the ratio between longitudinal and latitudinal sizes for substorms during MC is also larger. Auroral bulges are most extended in both latitude and longitude for CIR- and Sheath- situations. Perhaps, this is due to the influence of the compressed, highly dense solar wind plasma.

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The detection possibility of the neutrons from thunderstorm onboard low-orbit small satellites.

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The first experimental evidence, that neutrons are generated during thunderstorms, was found by Indian scientists [1]. Later, according to the analysis of experimental data on the neutron flux, obtained onboard the orbital station "MIR" (experiments "Ryabina-2",1990-2000) and microsatellite "Kolibri" (experiment "Kolibri", 2002) at the altitude of 400 km, it was concluded that possible correlation of the observed increase of neutron count with thunderstorm activity on the Earth can take place [2].

Recent studies show the principal possibility of neutron detection from the thunderstorms [3]. Confirmation of thunderstorm neutron detection on orbital altitudes has many difficulties [4]. In the experiment on microsatellite "Kolibri" the value of the observed increase of neutron flux was comparable to the background. The total flux of neutrons, detected at the satellite, is the amount of albedo neutron flux, local neutron flux, and neutron flux from other sources. In case of small satellites, the local neutron flux is faint [5] and makes no effect on the total flux. Unlike the local neutron flux, the albedo neutron flux does not depend on the mass of the satellite. Knowing the value and the characteristics (like latitude flux distribution) of the albedo neutron flux, we can separate the influence of other neutron sources on the total neutron flux.

In this work we analyze the contribution of the albedo neutrons on the neutrons detection rate onboard the satellite and discuss the possibility to single out the thunderstorm neutron flux. The neutron transport in the atmosphere from the Earth to orbital altitudes was calculated using the Geant4 Monte-Carlo simulation.

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Solar and Interplanetary sources of Anomalous Geomagnetic Event observed during Solar cycle 23

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In this study, we present the observations of solar and interplanetary sources of a very complex anomalous geomagnetic storm that is recorded during the start of the minimum phase of the solar cycle 23. It is the last major geomagnetic event occurred during the decline phase of solar cycle 23, this decline phase continued for few years up to 2009. During the observed event a very prominent and abrupt increase in He/proton density, and plasma dynamic pressure as well as depressed alpha/ proton ratio and low plasma beta, and more negative Bz is observed at the stream interface. Two days before of the event coronal hole associated high speed stream and 1 day before a halo earth ward directed CME, with its linear speed 1774 km/s at 2:54:04 on 13/12/2006 is observed. This CME is ICME which pushed the forward shock as sheath region producing a ring current in equator of the earth's magnetic field. For the reported study, the hourly values of interplanetary plasma and magnetic field parameters as well as geomagnetic disturbance index (Dst) and planetary index Ap have been used, for the period December 13-18, 2006. It is found that the major geomagnetic storm with a Dst~ -146 nT, which occurred on 15 December, 2006, had a more complex interplanetary structure with a X- class Solar flare and an ICME + Sheath. The geomagnetic event recorded by large Dst has a peculiar characteristic with complexity in nature, namely its association with CME and ICME, though it was expected to be associated with the CIR, because of its long recovery phase. These anomalous characteristics are discussed and will be highlighted in the detailed paper.

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Analysis of polar mesosphere winter echoes using the EISCAT VHF Radar

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Radar observations are a suitable tool to study the properties and dynamics of the atmosphere. During the polar winter radar echoes can be observed in the altitude range between 60 and 80 km using VHF radars which occur under certain circumstances. The occurrence of these echoes require a sufficient high volume reflectivity depending on the ionisation and on the turbulence strength. On several occations the EISCAT VHF radar (224 MHz) was measuring these echoes providing a set of data which is used to characterize the echoes. The spectral shape is used to determine the scattering mechanism and allows to identify the structures responsible for the backscatter. The analyses of the spectra concerning the signal power, the spectral width and shape as well as the altitude distribution provide interesting informations about the scattering mechanisms involved and the basic principles for the occurrence of mesospheric winter echoes.

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EISCAT-CAWSES-Copernicus Consortium to support German EISCAT user groups

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In the framework of the CAWSES priority program funded by the German Research Foundation (DFG) the German contribution to the European Incoherent Scatter Radar (EISCAT) is provided. Several research groups are actively using the possibility to obtain data from the EISCAT experiments. Current activities of German EISCAT users and future perspectives are presented to the community. Science and technical support will be introduced to provide successful usage of the available measurements and the results.

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Summary of German observational results obtained with EISCAT in the frame of the CAWSES priority program

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In the framework of the CAWSES priority program funded by the German Research Foundation (DFG) the German contribution to the European Incoherent Scatter Radar (EISCAT) is provided. Several research groups are actively using the possibility to obtain data from the EISCAT experiments. Current activities of German EISCAT users include the estimation of the spectral characteristics of polar mesosphere summer echoes observed at VHF and UHF frequencies and the estimation of microphysical parameters of mesospheric ice clouds derived from multiple frequency radar soundings. Furthermore, the characteristic features of the ionosphere and thermosphere in the cusp region were observed during a combined CHAMP-EISCAT campaign simultaneously and electron densities measured with EISCAT are compared to modelled data using HAMMONIA. The overview summarizes the contributions of EISCAT measurements to the atmospheric and ionospheric research activities in past few years and outlines the ongoing research.

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Climatologies of gravity wave parameters derived from HIRDLS and SABER satellite data

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Gravity waves (GWs) are mesoscale waves that play an important role in the dynamics of the stratosphere and the mesosphere. They are the main drivers of the mesospheric jets, play an important role in the dynamics of the QBO and SAO in the tropics, and recently it has been recognized that orographically forced GWs are responsible for a large part of the predicted trend of the Brewer Dobson circulation in the lower stratosphere.
Because the horizontal scales of GWs (about tens to 1000 km) are too short to be properly resolved in general circulation models (GCMs) their effect is usually parameterized. However, these parameterizations are only poorly constrained by observations. Therefore there is an urgent need for global observations of GW parameters, as well as their seasonal changes to improve those parameterizations. Especially global distributions of GW momentum fluxes are required because these can be directly compared to the values obtained by GW parameterizations.
The satellite instruments HIRDLS and SABER both provide high spatial resolution long-term data sets of temperature altitude profiles that allow parameters of mesoscale gravity waves like wave amplitudes, horizontal and vertical wavelengths, and, consequently, also absolute values of gravity wave momentum flux to be determined. We present estimates of GW momentum fluxes from both instruments. Seasonal, interannual, and spatial variations, as well as implications for GW parameterizations will be discussed.

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Evolution and Energization of Energetic Electrons in the Inner Magnetosphere

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We use more than a solar cycle of HEO observations to examine the inner magnetosphere's energetic electron response to both geomagnetic storms and extended quieting periods of solar cycle 23. We follow the penetration and enhancements of the electrons as a function of **L** value using HEO1 and HEO3 observations. HEO3 measures electrons of >130, >230, >450, >630, >1500 and >3000 keV and makes four traversals of the L=2-7 Re region each day. HEO1 measures electrons >130, >230, >1500, >4000, >6500, and >8500 keV down to L~4 every day and down to L~2.5 during some intervals . We show the relationship between high altitude and low altitude fluxes on the same L shells and demonstrate that often the High/Low flux ratios are relatively constant, evidence of a global coherence in the fluxes, irrespective of absolute flux levels. We find that small to moderate storms often caused enhancements in the <300 keV electron "seed" populations down to **L** ~3.0 which are not accompanied by enhancements in relativistic, >630 keV electron fluxes for **L**<5, indicating that the presence of the "seed" populations is not sufficient to lead to post storm enhanced reletivistic fluxes. The largest magnetic storms caused electron enhancements at energies up to >3 MeV at L values down to 2.5. For such events, the reletivistic electron fluxes peaked in the L~3.75-4.25 range depending on their energy.

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Solar Decimetric Fine Structures and the Flaring Loop Parameters

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In this work, we present the temporal/spectral analysis of five decimetric fine structures recorded in the frequency range of (950-2500) MHz by the Brazilian Solar Spectroscope (BSS), which is in regular operation at INPE, in Brazil. The five bursts were observed between June, 2000 and October, 2001. All events were associated with solar flares (classified as C, M or X flare in soft X-ray by GOES). For two events (June 06, 2000 and October 25, 2001) a CME was also reported associated with the recorded event. Based on the temporal/spectral morphologic features presented in the radio dynamic spectra, the fine structures were classified as type-U and type-J bursts. The data was recorded with high spectral (3-10 MHz) and high temporal (10-100 ms) resolutions. Considering the type-U burst as a signature of radio emission generated by the electron beam traveling along the closed magnetic structures in a flaring loop, the physical parameters of the source can be estimated. The high resolutions enabled us to determine the characteristics of the radio emission present in the dynamic spectra and then estimated the aspects of the magnetic morphology of the loops and the physical parameters of the sources. For each burst we estimated the velocity of the electron beam (0.15-0.45 c), the temperature of the coronal loop apex (of the order of 10^5-10^6 K) and also the low limit for the magnetic field strength (10-20 G) at the flaring region. The results will be presented and discussed in comparison with the previous results reported in the literature. Also, we will discuss the implication of high spatial solar imaging that will carried out in near future by the Brazilian Decimetric Array (BDA), a radio interferometer under development in Brazil, for more accurate determination of the loop size and the total length of ascending and descending branches of the flaring loop.

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Contributions of Brazilian Decimetric Array (BDA) for Chromospheric Evaporation and Plasmoid Ejection Investigations

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The basic scenario of chromospheric evaporation is based considering the particles accelerated during solar flares in the corona can be confined and move down along the magnetic lines. They can lose their energy by collisions with denser plasma at low chromosphere. Then, the heated plasma expands rapidly, but as it is confined by the magnetic loop structure, it can only flows upward. The up-flow of the hot plasma is known as chromospheric evaporation. The up-flowing plasma can be inferred in radio frequencies by the occurrence of the slowly drifting fine structures recorded in radio wavelengths, generated by electron beams traveling along to magnetic loop and crossing up-going evaporation front. With the high spectral/temporal resolution Brazilian Solar Spectrsocope (BSS), operating in the frequency range of 1.0 – 2.5 GHz, we have recorded decimetric fine structures with high-frequency edge slowly drifting from high to low frequencies, associated with eight solar flares. In this work we present details of these fine structures and their interpretation in terms of the plasma emission produced by accelerated particles and the chromospheric evaporation front. We discuss that the diagnostic and investigation of the chomospheric evaporation and also, of the plasmoids ejection and displacement in the solar atmosphere can be complemented, using high spatial solar radio images, as that will be provided by the Brazilian Decimetric Array (BDA), in the decimetric frequency range (1.2,-1.7, 2.8, 5.6 GHz). We also present the current status of the development of the BDA, and it potential contributions to space weather science and to investigations of solar flares and CMEs, related to location of energy release and particle acceleration regions and transport of energetic particles.

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The Hale Period and Climate Forcing

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From the presence of the 11-year Schwabe and the 22-year Hale period in numerous time series of climate indicators like tree rings, varves, precipitation, droughts or temperatures it has been concluded that solar activity has an influence on the terrestrial climate. While at present it is still unclear, however, whether this influence is direct (solar) or indirect (cosmic rays) and exactly which processes establish such relation, it is likely that the observed periods do contain valuable information. Here we follow up on our earlier suggestion that the Hale periodicity provides the ability to differentiate between climate forcings related to either solar electromagnetic or galactic cosmic radiation. We perform a detailed, comparative period analysis of solar irradiance and cosmic ray flux and we offer a hypothesis why the Hale period does occur in certain climate-indicative time series despite the insignificance or even absence of the Schwabe period.

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The multi-year NLC data set above ALOMAR.

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Noctilucent clouds (NLC), also called polar mesospheric clouds (PMC), are the visible manifestation of ice particles in the polar summer mesopause region and can be observed precisely by active laser remote sensing. Cloud parameters show variabilities ranging from minutes to decades, including tidal and solar cycle variations.

Between 1997 and 2009 NLC have been observed by the ALOMAR Rayleigh/Mie/Raman (RMR) lidar in Northern Norway at 69N, 16E. During a total of 4105 measurement hours, being well distributed over the 13 years, season and local time, NLC were detected for 1735 hours, which is the largest NLC data base acquired by lidar.

We will report on the variability of NLC parameters like occurrence, altitude, brightness and particle properties on different time scales.

For interpretation of our lidar NLC data we use multi-year data sets obtained by colocated radars and LIMA (Leibniz Institute Middle Atmosphere Model).

During the extended approach to the last solar minimum the occurrence rate of bright clouds did not follow the expected anti-correlation to solar radiation. Only since 2008, where the minimum was reached, this cloud class occurred more frequent again. This indicates that other processes than the widely assumed direct Lyman-alpha influence on water vapor have major impact on the NLC formation.

We will investigate the local time behavior of NLC parameters and address the question of year-to-year variability of their tidal amplitudes and phases. While the phases of the cloud occurrence are remarkable constant during each year, altitude and brightness show a different behavior. Possible implications for satellite observations of PMC will be discussed.

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Making the CAWSES Virtual Institute: escience and informatics at work

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Based on a successful pilot study during CAWSES I that utilized cyber infrastructure to organize and conduct science, CAWSES-II under the eScience and Informatics task group has created an International Virtual Institute. This institute is organized around the principles that progress in system-level investigations requires: researchers committed to the value of pursuing science at the interface between disciplines, strongly-focused science topics that provide a common theme around which disciplines are able to interact, means of educating researchers about the key scientific issues in other disciplines and the connections between disciplines, access to scientific publications in other discipline areas, new forms of scholarly publishing, and the structure needed to bring researchers into contact with data sets, models, and each other, across disciplines and national boundaries.

The presentation will introduce the concepts and capabilities of the Virtual Institute ranging from data resources via Virtual Observatories to web-based collaboration environments and indicate how CAWSES II Task groups may utlize this mechanism to further their research activities and outcomes.

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Secondary instabilities in breaking inertia gravity waves

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The breaking of inertia-gravity waves is an important process in the control of the structure and variability of the circulation in the middle atmosphere as well as contributing to the mixing of atmospheric constituents. Since inertia-gravity waves involve such a wide range of temporal and spatial scales, their effects must inevitably be parameterized in large-scale models. It is therefore critical that the conditions for breaking and the dynamics of the ensuing turbulence be well understood.

In this talk, the three-dimensionalization of turbulence in the breaking of vertically propagating inertia-gravity waves is investigated using singular vector analysis, whereby the initial perturbations whose energy grows by the largest factor in a given optimization time are found. It builds on earlier work in which the development of turbulence in a breaking inertia-gravity wave was investigated using a high-resolution nonlinear two-dimensional Boussinesq model initialized with a single inertia-gravity wave and one of its leading singular vectors or fastest growing normal modes. In practice, however, the flow becomes strongly three-dimensional. A tangent-linear model is used to find the leading singular vectors orthogonal to the plane containing the wave vectors of the breaking wave and primary perturbation and thus shed light on the dynamics of the initial three-dimensionalization of the flow.

The talk will focus on two cases: a statically stable wave perturbed by its leading singular vector and a statically unstable wave perturbed by its leading normal mode. In both cases, the secondary instabilities grow through interaction with the buoyancy gradient and velocity shear in the basic state. Which growth mechanism predominates depends on the time dependent structure of the basic state and the wavelength of the secondary perturbation. The singular vectors are compared to integrations of the tangent-linear model using random initial conditions, and the leading few singular vectors are found to be representative of the structures that emerge in the random integrations. A main result is that the length scales of the leading secondary instabilities are an order of magnitude smaller than the wavelengths of both the initial wave and primary perturbation, suggesting the essential dynamics of the breaking might be captured by tractable nonlinear three-dimensional simulations in a relatively small triply-periodic domain.

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Experimental evidence for dynamical coupling from the lower atmosphere up to the thermosphere during a major stratospheric warming from MIPAS observations

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Stratospheric sudden warmings (SSWs) represent dramatic meteorological disturbances which affect the polar winter atmosphere in a wide altitude range. While the mechanisms of SSWs are well understood in the middle atmosphere, little is known about the polar temperature responses to SSW above 120 km. We used temperature data from the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) on board ESA's Envisat satellite to analyze the temperature responses in the mesosphere and thermosphere up to 170km to a major stratospheric sudden warming (SSW) which occurred in January 2009. The observations show clear signatures of a mesospheric cooling and a thermospheric warming, the latter peaking at 120–140 km. From the analysis of the zonal temperature structure during the SSW a pronounced wave 1 pattern was found in the stratosphere and thermosphere. In the mesosphere, the wave amplitude is significantly damped. The wave amplification above is most likely produced by in situ forced planetary waves in the MLT region. Our observations represent, to our best knowledge, the first experimental evidence for dynamical coupling from the lower atmosphere up to the thermosphere by means of satellite data.

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Diagnosis of zonal asymmetries in stratospheric ozone and water vapor and their influence on circulation from tropo- to mesosphere

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We present a diagnosis of zonally asymmetric components in stratospheric ozone and water vapor and their long-term changes based on both assimilated data (ERA-40, ERA-Interim) and satellite data (SAGE, GOME, ODIN). Zonal asymmetries in strato- and mesospheric tracers are related to ultra-long quasi-stationary planetary waves, which increase during autumn, maintain during winter and decay during spring. For northern and southern hemisphere winter, we found pronounced wave one structures in both ozone and water vapor with maximum amplitudes up to about 20% of zonal mean values. Long-term changes include a nearly linear trend in amplitude and some pronounced variations which may partly be due to the 11-year cycle in solar radiation activity. Based on model simulations we investigate the influence of the related radiation perturbations and possible feedback processes between the planetary wave patterns in temperature, dynamics and chemistry. Sensitivity studies with the GCM MAECHAM5 and prescribed zonally asymmetric ozone show a significant increase in amplitude and a shift in phase of wave one structure in temperature and geopotential, accompanied by a longitudinal shift of up- and eastward directed quasi-stationary wave trains. Long-term equilibrium simulations with the CCM HAMMONIA show that the 11-year solar radiation cycle can lead to significant changes in the ultra-long planetary wave patterns in dynamics and chemistry. The results suggest that zonal asymmetries in ozone, water vapor and other absorbers may be an important factor in understanding observed long-term changes in dynamics and chemistry.

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Learning from Karin for Five Solar Cycles

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The year was 1960, and a young girl named Karin Behr wrote her Diploma thesis on the newly discovered phenomenon of the sudden stratospheric warming, with her advisor being Professor Scherhag, who wrote the first paper on this subject. Little did the world know that Karin Behr would go on (under her married name, Karin Labitzke) to be such an important contributor to middle atmospheric science, solar-terrestrial physics, and to SCOSTEP over the next five decades, hence the title of this talk. For several years, her research generally continued to be related to stratospheric warmings, and her work soon evolved to studies of the mutual interaction of the troposphere and stratosphere during periods of stratospheric warmings, now a subject of great current interest. By the 1970s, Karin was recognized as a leading authority on the meteorology of the stratosphere and mesosphere. In 1980, she published her first paper relating to solar influences on the atmosphere (with Adolf Ebel), and in 1987, she published her famous paper that separated solar influences on the middle atmosphere according to the phase of the quasi-biennial oscillation. This paper, along with her very important work with Harry van Loon, continues to exert great influence on the direction of research on solar influences on climate. Karin's science has been closely related to that of SCOSTEP, and Karin has been an active participant in several of SCOSTEP's major programs MAP (Middle Atmosphere Program), STEP (Solar-Terrestrial Energy Program, and CAWSES (Climate and Weather of the Sun-Earth System). In this talk, I will enlarge on all of these themes.

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Are we entering the next grand minimum?

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The present deep and prolonged minimum in solar activity gives rise to speculations whether this is the beginning of the next grand minimum, or just the minimum of the secular solar cycle, or neither. Different predictions have been made based on the same flux-transport solar dynamo model, but with different parameters. The most important parameters determining the operation of solar dynamo and therefore the amplitude and period of the sunspot cycle, are the large-scale solar meridional circulation and the diffusivity in the bulk of the solar convection zone. The direct measurements of these parameters are limited, and their long-term variations are not known. Here we present our method to estimate the long-term variations in solar surface and deep meridional circulation and the diffusivity in the solar convection zone, and link them to the long-term variations in solar activity. Further, we identify the combination of parameters which makes the dynamo switch to a different regime leading to grand minima in solar activity, and make a forecast for the evolution of solar activity in the next decades.

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Noctilucent cloud observations at mid-latitudes by lidar: mean state, variability, and relation to ambient conditions of temperatures and winds

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Temperatures in the polar summer mesopause region are low enough to form ice particles known as Noctilucent Clouds (NLC) or Polar Mesospheric Clouds (PMC). With decreasing latitude NLC occurrence is generally decreasing due to rising temperatures. Southward of 60°N average temperatures are near or even higher than the frost point temperature and NLC are only rarely observed. Therefore NLC occurrence is expected to change strongly with only minor variations in temperature and water vapour, i.e. it depends strongly on atmospheric waves, trends, and the solar cycle. Since 1997 NLC are observed at Leibniz Institute of Atmospheric Physics at Kühlungsborn, Germany (54°N, 12°E) during night by lidar at 532 nm wavelength. The altitude distribution centres at 82.9 km, i.e. similar to the polar NLC distribution even if the temperature structures are quite different at both latitudes. On average, the probability for NLC observations at 54°N is largest around day 180, which is about 10 days after the temperature minimum in the mesopause region. The NLC occurrence rate shows a strong interannual variation with a minimum in the early 2000s (roughly 0 %) and the highest rate near 20 % in 2009. The variation suggests a relation with the solar activity, but this mechanism does not explain the high variability observed between 2005 and 2009. We will compare the NLC occurrence rate to average temperatures and winds observed at out site by lidar and radar. During summer 2009 we have performed first observations with a daylight capable lidar at 532 nm, measuring NLC independent of solar elevation. By this the retrieval of diurnal variations of NLC occurrence and strength will be possible at our mid-latitude site, being one of very few stations in the world. Simultaneous observations of NLC and Mesospheric Summer Echoes (MSE) are limited to daytime since electron densities have to be sufficiently high. The new capabilities of the RMR lidar at Kühlungsborn together with the co-located OSWIN VHF radar and the K lidar allow first case studies from simultaneous NLC and MSE observations at mid-latitudes.

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In situ observations of stratospheric turbulence at sub-cm scales by new LITOS anemometer

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Leibniz Institute of Atmospheric Physics

Gravity waves often dissipate at least part of their energy in the stratosphere and generate layers of turbulence. Examinations of these small scale structures are not only important for the stratosphere itself but also for the understanding of gravity wave propagation into the middle atmosphere. Stratospheric turbulence has first been measured by balloon-borne sensors more than 20 years ago. However, in-situ soundings provide the only possibility for high-resolved soundings up to 35 km altitude, but these soundings are still technically challenging and the number of soundings is sparse. We have developed a compact balloon-borne payload called LITOS (Leibniz Institute Turbulence Observations in the Stratosphere). LITOS is designed for wind turbulence soundings from the ground up to 35 km altitude by use of a constant-temperature anemometer (CTA, also called hot-wire anemometer). For the first time a vertical resolution of ~2.5 mm is achieved for stratospheric soundings. The balloon payload has been launched several times since autumn 2007 from our site at Leibniz-Institute of Atmospheric Physics (IAP) at Kühlungsborn, Germany (54°N, 12°E). Two additional soundings are carried out in 2008 and 2009 at Kiruna, Sweden (67°N, 12°E) as part of the BEXUS program. We observed thin turbulent layers of 20-100 m thickness, partly up to 500 m in a mainly non-turbulent atmosphere. Power spectral densities of vertical wavenumbers reveal slopes of $m^{-5/3}$ and m^{-7}, indicative of the inertial and viscous subrange. Energy dissipation rates are determined from the best fit of a theoretical model to the measured spectrum. Within the turbulent layers dissipation rates strongly vary between 0.05 mW/kg (weak turbulence) and 20 mW/kg (strong turbulence). These energy dissipation rates deviate by a maximum factor of 100 from earlier indirect measurements. We will show examples of turbulent layers and the corresponding altitude-resolved energy dissipation rates. We will discuss the occurrence of these turbulent layers and their relation to atmospheric background parameters as observed simultaneously by radar, lidar and radiosondes

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Study of characteristic appearance of TEC enhancement at mid-latitude using TEC data of LEO satellite

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The characteristic appearance of Total Electron Content(TEC) enhancement at mid-latitude was clarified by TEC data. Enhancement of TEC in topside ionosphere was detected with TEC data. TEC data between GRACE and GPS satellites is the integration value of the electron density in the plasmasphere and the topside ionosphere. GRACE satellites observed the enhancement of TEC between 50 degree and 70 degree latitude in the geomagnetic latitude. It tends to appear during geomagnetic storm period and to appear dawn side and dayside.It clarified that the enhancement of TEC in dayside caused by the storm enhanced density (SED) and other phenomena and that occurred above the topside ionosphere. The characteristic appearance of TEC enhancement was studied statistically. The north-south asymmetry of TEC enhancement at mid-latitude was observed. The longitudinal dependence of TEC enhancement in dayside was observed. In the north hemisphere, it tends to appear from 230 degrees longitude to 310 degrees longitude, and in the south hemisphere, it tends to appear from 100 degrees longitude to 220 degrees longitude. On the other hand, the seasonal variation of TEC enhancement at mid-latitudes was observed in dawn side. The night of the midnight sun cause the seasonal variation of TEC enhancement at mid-latitudes. These results indicate it was different that the characteristic appearance of TEC enhancement between in dayside and in dawn side. This difference suggests the physical process of enhancement is not same between in dayside and in dawn side. The ionospheric plasma in low-latitude could make the TEC enhancement in dayside as the phenomena with equatorial ionospheric anomaly. The ionopheric plasma in high-latitude could make the TEC enhancement in morning side by solar irradiation in polar region near midnight.

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Middle Atmospheric Water Vapour Above the Zugspitze

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Water vapour is a key species of the middle atmosphere with respect to its radiative and chemical effects. It also serves as a tracer to study stratosphere-troposphere exchange and changes in global atmospheric circulation. The influence of solar irradiation on water vapour distribution forms an important topic of mesospheric research, as well as the existence of planetary wave signatures in the observations. This contribution investigates middle atmospheric water vapour above the Zugspitze (46°N, 10°E, 2650 m a.s.l.). The data have been taken with a ground-based microwave spectroradiometer, MIRA 5, in the first half of 2009. The instrument records the 22 GHz emission of water vapour. Optimal estimation retrievals from the spectrally resolved data yield water vapour profiles throughout the middle atmosphere. The measurements cover the occurence of a major sudden stratospheric warming (SSW) in January 2009, caused by anomalous dissipation of planetary waves in the stratosphere. The observed event is studied in some detail. Comparisons with satellite and ECMWF data complement the analysis. The ground-based measurements also bear the potential to study diurnal variations in water vapour which are caused by atmospheric tides. However, the magnitude of this effect in water vapour is small and difficult to detect. A comparison with 3D chemical-transport model output informs about the capacity of such analyses.

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Studying the Inter-hemispheric Coupling during Polar Summer Mesosphere Warming in 2002

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It has been found that the northern summer polar mesopause region in 2002 was warmer than normal and of shorter duration than for other years analyzed. Theoretical studies have implied that the abnormal characteristics of this polar summer were generated by unusual dynamical processes occurring in the southern polar winter hemisphere. We have used data from the SABER instrument aboard the NASA TIMED Satellite to study these processes for polar summer periods of 2002-2009. For background, SABER is a broadband limb scanning radiometer that measures a large number of minor atmospheric constituents as well as pressure and temperature in the 13-110 km altitude range over most of the globe.We will use SABER temperature data to illustrate the correlated heating seen between the southern and northern hemispheres during June and July 2002. We will then describe the approach to study the wave characteristics of the atmospheric temperature profiles and demonstrate the features that were unique for 2002 compared to the other years.

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Influences of the driver and ambient medium characteristics on the formation of shocks in the solar atmosphere

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Traveling interplanetary (IP) shocks were discovered in the early 1960s, but their solar origin has been controversial. Early research focused on solar flares as the source of the shocks, but when coronal mass ejections (CMEs) were discovered, it became clear that fast CMEs clearly can drive the shocks. Type II radio bursts are excellent signatures of shocks near the Sun. The close correspondence between type II radio bursts and solar energetic particles (SEPs) makes it clear that the same shock accelerates ions and electrons. A recent investigation involving a large number of IP shocks revealed that about 35% of IP shocks do not produce type II bursts or SEPs. Comparing these radio quiet (RQ) shocks with the radio loud (RL) ones revealed some interesting results: (1) there is no evidence for blast waves, in that all IP shocks can be attributed to CMEs, (2) a small fraction (20%) of RQ shocks is associated with ion enhancements at the shocks when they move past the observing spacecraft, (3) the primary difference between the RQ and RL shocks can be traced to the different kinematic properties of the associated CMEs and the variation of the characteristic speeds of the ambient medium, and (4) the shock properties measured at 1 AU are not too different for the RQ and RL cases due to the interaction of the shock driver with the IP medium that seems to erase the difference.

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The International Space Weather Initiative

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The International Space Weather Initiative (ISWI) is a program of international cooperation aimed at understanding the external drivers of space weather. The ISWI program has its roots in the successful International Heliophysical Year (IHY) program that ran during 2007 – 2009 and will continue with those aspects that directly affect life on Earth. The primary objective of the ISWI program is to advance the space weather science by a combination of instrument deployment, analysis and interpretation of space weather data from the deployed instruments in conjunction with space data, and communicate the results to the public and students. Like the IHY, the ISWI will be a grass roots organization with key participation from national coordinators in cooperation with an international steering committee. This presentation outlines the ISWI program including its organizational aspects and proposed activities. The ISWI observatory deployment and outreach activities are highly complementary to the CAWSES II activities of SCOSTEP.

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Solar Influences on Climate

Gray Lesley

In this tutorial lecture, the influence of solar variability on climate will be discussed. Examples of climate variability associated with the 11-yr solar cycle and century-scale solar variations will be presented. Observational variations will be restricted to the atmosphere below approximately 100 km, which is the region of the atmosphere known to impact the surface, and will include variations in temperatures, winds, ozone, clouds, precipitation and regional modes of variability such as the monsoons and the North Atlantic Oscillation. A summary of the various proposed mechanisms for these solar variability influences will be given, including the effects of variations in solar irradiance and charged particles. Long term solar variations will also be discussed in the context of recent observations of global climate change.

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Response of ozone photochemical pathways to a doubling in CO2

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We present results from a new diagnostic tool which sheds light on ozone photochemistry in the atmosphere. The tool - the Pathway Analysis Program (PAP) - automatically identifies and quantifies chemical pathways for ozone production and loss based on output from a coupled climate-photochemical model. We have analysed modern-day and doubled carbon dioxide conditions. Results are a valuable aid to understanding the potentially complex catalytic processes which affect atmospheric ozone and their response to carbon dioxide increases. The PAP tool (Lehmann, 2004) has already been applied with success to modern Earth conditions in the stratosphere (Grenfell et al. 2006).

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Trends and stability in the MLT-region - a model study

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The height of the NLC has not noticeably declined since the time of first observation. The term “equithermal submesopause” was introduced in 1996 and reflects the significant repeatability of the mean mesopause temperature during the last 40 years. The microwave measurements of water vapor at high latitudes (ALOMAR, 69°N) during last 14 years do not show significant positive trends in MLT-region. These facts motivate us to study the mechanisms of stabilization in the atmosphere and precisely in the summer mesopaus region which is astonishingly stable in spite of the anthropogenic changes.

We investigate the influence of the rising concentrations of methane, nitrous oxide and carbon dioxide since 1961 on the chemistry of the mesosphere. We use our global 3D-model LIMA (Leibniz-Institute Middle Atmosphere) designed for the investigation of the MLT-region and particularly the extended mesopause region. LIMA uses real tropospheric and lower stratospheric temperature and horizontal wind up to 35 km altitude from assimilation of ECMWF/ERA-40. Realtime Lyman-α flux values are employed to determine the water vapor dissociation rate. The analysis of the long-term behavior of water vapor also utilizes real methane measurements. The solar influence on the water vapor mixing ratio is insignificant below about 75-80 km within high latitudes in summer, but becomes increasingly important above this domain.

Three calculations were carried out and analyzed. 1. We use a constant annual variation of the model dynamics for all years according to the dynamics of the solar minimum in 1964 and employ a realistic growth of the anthropogenic gases. 2. We use constant concentrations of the anthropogenic constituents at the lower border but employ the varying dynamics. 3. The realistic case considers both, the increase of the anthropogenic minor constituents and yearly varying dynamics. The analyses of these 3 cases show, that the effect of dynamics reduces the influence of anthropogenic changes in the upper mesosphere-mesopause-lower thermosphere region. This probably occurs due to non-linear feed backs effect between dynamics and chemistry. Therefore, models with climatologically mean dynamics, apparently, overestimate anthropogenic impact. We also discuss the long-term behavior of water vapor with regard to the potential impact on NLC. Additionally, we estimate influences on the thermal regime of MLT-region.

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Wave mixing effects on minor chemical constituents in the MLT-region: Results from a global CTM driven by high-resolution dynamics

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The dynamical fields a high-resolution mechanistic general circulation model (GCM) with resolved gravity waves are used to drive a chemistry-transport model (CTM) of the mesosphere/lower thermosphere (MLT). Both models have been used in previous studies. Here, they are coupled in off-line mode in order to study the explicit effects of gravity waves on the transport and photo-chemistry of minor constituents of the MLT. This is done on the basis of sensitivity experiments. In our control simulation the CTM is driven with the full dynamical fields from an annual cycle simulation with the GCM, where mid-frequency GWs down to horizontal wave lengths of 350 km are resolved and their wave-mean flow interaction is self-consistently induced by an advanced turbulence model. A perturbation simulation with the CTM is defined by eliminating all mesoscale variations with horizontal wavelengths shorter than 1000 km from the dynamical fields by means of spectral filtering before running the CTM. This means, both CTM-simulations are driven by the same large-scale dynamics. For reasons of consistency, we apply the same numerical grid and time step in both CTM simulations.

The response of the CTM to gravity wave perturbations reveals strong effects on the trace-gas concentrations. In particular, minor chemical constituents with large photochemical life-time are strongly affected by vertical wave mixing, while constituents with short life-time reflect the dependence of their reaction rates on meso-scale temperature perturbations and on the changed distribution of long-living constituents. The mean model response varies with latitude and season, but is strongest around the mesopause. We present detailed discussions of the simulated gravity waves on the photo chemistry and highlight the consequences for our understanding of the general circulation of the MLT.

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Study of 5577Å and 6300Å emissions by simultaneous measurements during substorms

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The behaviour of the auroral emissions 5577Å and 6300Å and the ratio I_{6300}/I_{5577} during substorms occurred at the time of recurrent streams (RS) at different latitudes has been examined. The development of the substorm bulge is followed up. The variations of the emissions during the substorm movement towards North, at the polar edge of the auroral bulge and inside it have been studied.
For the study, simultaneous measurements from the All-Sky Imagers at Andøya Rocket Range (ARR), Andenes, Norway, at Longyearbyen and New Alezund, Svalbard have been used.
Additional data concerning the solar wind parameters, IMF and the magnetic field are used from WIND satellite and the IMAGE magnetometer network to determine the recurrent streams, the substorms onsets and their further development.
Data access has been provided under the Project "ALOMAR eARI" (RITA-CT-2003-506208), Andenes, Norway. This Project received research funding from the European Community's 6th Framework Program.

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Longitudinal development of low-latitude ionospheric irregularities during the geomagnetic storms of July 2004

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During the period 22–28 July 2004, three geomagnetic storms occurred due to a sequence of coronal mass ejections. In this paper we present and discuss the ionospheric observations from a set of in situ satellites and ground-based GPS total electron content and scintillation receivers, a VHF radar, and two chains of ionosondes (300°E and 120°E, respectively) that provide the evolutionary characteristics of equatorial and low-latitude ionospheric irregularities versus longitude during these storm periods. It is found that the irregularities occurred over a wide longitudinal range, extending from around 300°E to 120°E on storm days 25 and 27 July 2004. On 25 July plasma bubbles (PBs) began premidnight in America and postmidnight in Southeast Asia. On 27 July the occurrence of irregularities followed the sunset terminator and was observed sequentially after sunset from American to Southeast Asian longitudes. Past studies have reported that storm□time low□latitude ionospheric irregularities are mostly confined to a narrower longitude range, <90°, after sunset hours and are associated with the prompt penetration of eastward electric fields (PPEFs) into low latitudes. In June solstice months the occurrence of range-type spread F or PBs is very low in Southeast Asian and South American sectors. In contrast, the present results indicate that geomagnetic storms triggered the wide longitudinal development of PBs. In the American sector this was probably due to the effects of PPEFs on both storm days. However, in the Southeast Asian sector the PBs on the 2 days probably arose from disturbance dynamo electric field (DDEF), PPEF, and gravity wave seeding effects. This study further shows that under complex storm conditions, besides the long duration or multiple penetrations, the combined effects of PPEFs and DDEFs could result in a wide longitude extent of ionospheric irregularities at times.

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Atmospheric Wave Effects in the Equatorial MLT

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The low latitude atmospheric and ionospheric regions are unique in many ways. Intense tropical convection sets up a variety of atmospheric waves that propagate up and through their interactions with the background flow produce alternating easterly and westerly winds in the middle atmosphere. The Coriolis frequency is small in the low latitude region and that allows long-period equatorially trapped waves to propagate from their source regions in the lower atmosphere to higher altitudes. Within the mesosphere-lower thermosphere (MLT) region, the sun-synchronous atmospheric tides are the dominant dynamical features and owe their existence to the absorption of solar radiation by water vapour in the troposphere and ozone in the stratosphere. In recent years, the presence of non-migrating tides in the MLT region has been demonstrated by satellite observations and its importance in producing the longitudinal redistribution of ionization within the low latitude F-region has been emphasized. There have been studies that examined the signatures of planetary waves and tides in the low latitude ionosphere but none could provide experimental evidence for any planetary wave or tidal component to directly modulate the ionospheric parameters. It is firmly believed that much of the quiet-time space weather in the upper atmosphere is contributed by upward propagating waves of lower atmospheric origin but what spectrum of waves penetrate the MLT region and produce observable effects in the upper atmosphere is not known. These aspects emphasize the complexities in the interplay of several dynamical and electrodynamical processes in the low latitude MLT and ionospheric (MLTI) regions. This talk will present the state-of-the-art in our understanding of the role of dynamical processes in MLTI coupling with highlights from recent results obtained using ground-based radar and magnetometer data sets and some new insights revealed by satellite observations on non-migrating tides.

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The effect of nonmigrating tides on the upper thermospheric zonal wind observed by CHAMP

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Measurements performed by the accelerometer onboard the CHAMP satellite have revealed unexpected results about thermospheric dynamics. Concerning the equatorial zonal wind at 400 km altitude, a discovered four-peaked longitudinal structure was related to the eastward propagating diurnal tide with zonal wavenumber 3 (DE3). It was demonstrated that DE3, excited by latent heat release in tropical deep convective clouds, propagates directly from the troposphere into the upper thermosphere. The eastward propagating diurnal tide with zonal wavenumber 2 (DE2), the westward propagating diurnal tide with zonal wavenumber 2 (DW2), and the standing diurnal tide (D0) are further strong nonmigrating tides present in the CHAMP zonal wind. While DE3 and DE2 amplitudes are increasing with decreasing solar flux, DW2 and DO amplitudes are decreasing. For our study an extended data set of wind readings is now available starting from June 2001 to December 2007 as compared to the previous four years of measurements from 2002 – 2005. We show tidal spectra for this time period and compare it to the results of a physics-based empirical fit model based on Hough Mode Extension fits to TIMED tides. The observed solar cycle dependencies of the various tides are discussed.

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Solar influences on climate through stratosphere-troposphere coupling

Haigh Joanna
Imperial College London

This presentation will consider two different aspects to how solar activity may influence the climate of the lower atmosphere.

The first aspect concerns the dynamical coupling processes whereby changes in tropospheric circulation and temperature are produced in response to solar heating of the stratosphere. A simplified general circulation model has been used to investigate the chain of causality. Spinup ensemble experiments have been performed to examine the evolution of the tropospheric circulation in response to heating perturbations. The study focuses on a perturbation which is largest in the tropical lower stratosphere, as found previously to be the solar 11-year cycle signal in observational data, but the mechanisms discussed have wider relevance for the impact of stratospheric perturbations on the troposphere. The results demonstrate the importance of changing eddy momentum fluxes in driving the tropospheric response; it is apparent that feedback between the tropospheric eddy fluxes and tropospheric circulation changes is required to produce the full model response. The latitudinal distribution of the stratospheric heating determines the direction of displacement of the tropospheric jets and storm tracks: heating of lower latitudes produces poleward shifts, as observed in analyses of the response of zonal winds to solar cycle variability.

The second aspect concerns solar radiative forcing of climate and its dependence on the spectrum of solar irradiance variability. A 2D (latitude-height) radiative-photochemical-transport model is used to investigate the response of the atmosphere to changes in solar spectral irradiance between 2004 and 2007. The results obtained using spectra measured by SORCE/SIM are compared with those obtained using data from an established multi-parameter model of spectral irradiance. The latter produces a broad structure of increased ozone (2004 relative to 2007) with maximum values of around 0.8% near 40km altitude while the SIM data produce a peak increase of over 2% in low latitudes around 35km along with significant decreases above 45km. This unanticipated structure is also detected in the profile of ozone change in contemporaneous measurements of ozone from the MLS instrument on EOS-Aura. The decreases are due to enhanced destruction by the HO_x which results from increased $O(^1D)$ from O_2 photolysis. Taking into account the stratospheric effects it is found that with the SIM data solar radiative forcing at the tropopause is out of phase with solar activity. If this type of spectral variability has occurred over previous solar cycles, or on longer timescales, an entire revision would be necessary of the attribution of causes to observed variations in temperature throughout the atmosphere.

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Solar cycle signals in sea level pressure and sea surface temperature.

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Imperial College London

We identify solar cycle signals in 155 years of global sea level pressure (SLP) and sea surface temperature (SST) data using a multiple linear regression approach. In SLP we find in the North Pacific a statistically significant weakening of the Aleutian Low and a northward shift of the Hawaiian High in response to higher solar activity, confirming the results of previous authors using different techniques. We also find a weak but broad reduction in pressure across the equatorial Pacific. In SST we identify a weak El Nino-like pattern in the tropics for the 155 year period, unlike the strong La Ni˜na-like signal found recently by some other authors. We show that the latter have been influenced by the technique of compositing data from peak years of the sunspot cycle because these years have often coincided with the negative phase of the ENSO cycle. Furthermore, the date of peak annual sunspot number (SSN) generally falls a year or more in advance of the broader maximum of the 11-year solar cycle so that analyses which incorporate data from all years represent more coherently the difference between periods of high and low solar activity on these timescales. We also find that studies of the solar signal in SST over the second half of the 20th century may alias as ENSO signal if this is not properly taken into account.

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Solar flare effects on ionospheric electron densities as measured by the Arecibo incoherent scatter radar

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The explosive emission of electromagnetic radiation from solar flares is confined mostly in the X-ray and EUV bands of the solar spectrum. This energetic radiation is capable of causing pronounced changes on ionospheric electron densities, which then become responsible for a range of well-known phenomena classified as "sudden ionospheric disturbances" or SID. Although the study of SID, that uses mostly radio wave propagation and absorption techniques, can arrive at some indirect inferences on the modified electron densities in the lower ionosphere, direct measurements of flare-induced ionospheric electron density profiles for most of the ionosphere are rather limited. Surprisingly, there are only very few direct electron density measurements during solar flare events reported in the open literature that have been made with incoherent scatter radars (ISR), particularly the powerful ISR at Arecibo. Here, we take advantage of an existing data base to report on solar flare-related electron density measurements made with the Arecibo radar which monitored the ionosphere from 60 to 430 km altitude with a height resolution of ~600 m and a time resolution of ~ 1.8 min. The results to be discussed refer to several solar flares in the range from about C50 to X50, that is, the X-ray fluxes in the 1.0 – 8.0 Å band range from 5 $\mu W/m^2$ to 5 mW/m^2, as measured and classified by the GOES satellite space environment X-ray monitor. The emphasis is placed on the structure of the modified electron density profiles and the temporal altitudinal variations of electron densities relative to the radiation changes measured by GOES in the long (XL) and short (XS) X-ray bands of 0.5 to 4.0 Å and 1.0 to 8.0 Å, respectively. These results can be useful in the validation of existing D region photochemical models as well as VLF (very low frequency) and HF (high frequency) radio wave propagation models. In addition, they can provide a judgement on the significance of ionospheric TEC (total electron content) changes anticipated during solar flare events of different magnitude.

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Observations of tidal behavior in mesospheric water vapor at mid- and high latitudes.

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Water vapor is a good tracer of the middle atmosphere dynamics due to its long chemical lifetime. Observed tidal variability in the amount of water vapor can therefore be assumed to be caused by different transport mechanisms. Gravity waves are known to be of importance for the momentum balance in the MLT region. However they can be affected by the tides. A comprehensive understanding of all aspects of tidal behavior in the upper mesosphere is therefore of importance. Tidal behavior in accordance with current models are regularly observed in the different wind-fields by radars. Satellites can readily detect water vapor in the MLT region with a high temporal resolution but are burdened by orbital constrains and the continuous observational record of tidal behavior in water vapor is small. Ground based detections of water vapor in the MLT region have until now been sparse due to the weak signal.

In May 2008 we installed a microwave spectrometer sensitive enough to observe tidal behavior in the mesospheric water vapor on a monthly basis at ALOMAR (69 N, 16 E). A similar instrument was installed at Schneefernerhaus on Zugspitze (47 N, 10 E) in January 2009. We measure water vapor at 22.235 GHz which set the upper limit of the resolvable profile to approximately 80 km. We will here present observations of tidal behavior in mesospheric water vapor from two different measurement locations, one polar location (ALOMAR) and one mid-latitude location (Zugspitze). By applying a moving time-frame integration scheme where each month is integrated and rebinned to a monthly-mean represented by one day we are able to resolve variability within that day. The variability is fitted by a cosine function with two components, one diurnal and one semidiurnal. Both locations indicate tide-like behavior according to the fit-function.

The behavior at each location will be described and compared to each-other. It will also be compared to models describing tidal effects in mesospheric water vapor. The daily variations in water vapor do not follow any single wind field, but is most probably the result of a superposition of the different mesospheric dynamical fields. The diurnal component above ALOMAR show a distinct behavior of amplitude maxima at the equinoxes, something which is not observed above Zugspitze. These equinoctial maxima show the largest amplitude of all components, although the diurnal component above Zugspitze do in general have a larger amplitude than the ALOMAR.

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Global study of CMEs and of their effects in the Earth environment

Hanuise Christian [1], *GMI-PNST Group* [2]
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The aim of the GMI (Multi-Instrument Group) of the French National Solar-Terrestrial Physics program is to study the physical processes in, and the relations between, the various regions on the path from the Sun to the Earth. Are successively involved the formation mechanism of solar flares and CMEs, the propagation within the solar wind, the interaction with the Earth's magnetosphere and the coupling between the magnetosphere, the ionosphere and the neutral atmosphere.To that effect, we use the CME database published at www-solar.mcs.st-and.ac.uk/~stephane/PNST/ and select several events chosen among the 233 halo CMEs in order to study their geoeffectiveness. We look successively at the origin of the CMEs at the Sun, at the characteristics of the associated ICMEs and of the solar wind, at the interactions between CMEs and the magnetosphere, as seen on the polar cap potential derived from SuperDARN radars and magnetic indices, and at the CMEs effects down in the thermosphere, as seen on a disturbance thermospheric coefficient. The variations of these parameters are studied during five-day intervals starting on the day of a CME.

The polar cap potential, obtained from the APL database for the northern hemisphere radars, shows a noticeable response to the arrival of the CME only in a very limited number of cases (about 10% of the database). The other indices also show that there are some long periods without any geoeffective CME. For halo CMEs propagating backwards from the Sun or on the eastward limb of the Sun, the lack of terrestrial effect is quite normal. But, in addition, halo CMEs with a negative acceleration seem also to lack of effectiveness. Moreover, the direction of B and the orientation of B_z might play a role in the geoeffectiveness of a halo CME.

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Observations of the Phase-Locked Two day Wave Over the Australian Sector Using Medium Frequency Radar and Airglow Data

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The quasi two day wave (QTDW), with a nominal mean period just above 50 hours, is a significant feature of the 80 to 100 km altitude region in both hemispheres. It becomes particularly prominent in the southern hemisphere summer at mid latitudes where, a short time after summer solstice, its amplitude rapidly increases and its mean period is found to be approximately 48 hours, producing an oscillation phase locked in local time. This lasts for a few weeks. Presented here are observations of the meridional winds and airglow over two sites in Australia, for four years during the austral summers of 2003 to 2006. We show that during those times when the large-amplitude phase-locked two-day wave (PL-TDW) is present the diurnal tide greatly decreases. This is consistent with the Walterscheid and Vincent (1996) model in which the PL-TDW derives its energy from a parametric excitation by the diurnal tide. These data also show that the diurnal tide is more suppressed, and the PL-TDW amplitude is larger, in odd-numbered years, suggesting a biannual effect. The airglow data indicated that, for the PL-TDW, the winds and temperature are close to out of phase. When the PL-TDW is present airglow amplitudes can become quite large, a result dependent on the local time of the PL-TDW maximum. The airglow intensity response was in general much larger than what would be expected from the airglow temperature response suggesting that the PL-TDW is causing a significant composition change possibly due to minor constituent transport.

Walterscheid, R., and R. Vincent (1996), Tidal generation of the phase-locked 2-day wave in the southern hemisphere summer by wave-wave interactions, J. Geophys. Res., 101(D21), 26567-26576.

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Production Rate of cosmogenic nuclides in the Earth's atmosphere

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Galactic cosmic rays which interact with the Earth's atmosphere produce a cascade of secondary particles. These secondary particles are able to generate cosmogenic nuclides, in particular ^{7}Be, ^{10}Be, ^{14}C and ^{37}Cl, by spallation reactions between secondary neutrons as well as protons and atmospheric gases like nitrogen and oxygen. Complex atmospheric processes lead to the fact that these nuclides are stored in natural archives such as tree rings and ice cores. In order to model these concentrations the production rate as well as loss processes have to be simulated. The first step is to determine the production rate, which will be presented here using the GEANT4 tool PLANETOCOSMICS to model the radiation field, i. e. neutrons and protons in the atmosphere and the corresponding production rate of the cosmogenic nuclides ^{7}Be, ^{10}Be, ^{14}C and ^{37}Cl.

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On the Importance of the Local Interstellar Spectrum for the Solar Modulation Parameter

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Here we compare several local interstellar proton spectra often used in literature, and show that the modulation parameter ϕ, which parametrizes the modulation of the local interstellar spectrum (LIS) in the heliosphere, strongly depends on the LIS itself. Taking the LIS dependency of ϕ into account, we first derive linear equations to convert the modulation parameter between the different LIS and afterwards apply these conversions to a long-term reconstruction of ϕ from a derived cosmogenic nuclide ^{10}Be record. For some LIS models occasionally negative values are obtained, a fact which is impossible from the physical point of view. Despite inner-heliospheric effects such as uncertainties in the geomagnetic field and climate influences on the ^{10}Be production, one possible reason may also be the choice of the LIS. We show that the reconstruction of ϕ provides the potential to derive the lower intensity limit of the LIS, keeping in mind that first the inner-heliospheric effects have to be removed from the data.

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QBO influences on the polar mesosphere and lower-thermosphere

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Long-term ground-based radar observations have been used to investigate the influence of the equatorial stratospheric quasi-biennial oscillation on the dynamics of the polar mesosphere and lower thermosphere. When the variance in the 12-30 day band-passed horizontal wind is used as a proxy for long-period planetary wave activity, it is found that during winter (summer) planetary wave activity is enhanced (reduced) in the Antarctic MLT when the QBO around 40 hPa is positive. Furthermore, when a QBO-driven enhancement in planetary wave activity is observed in the high latitude southern hemisphere, a corresponding reduction is observed in the opposite hemisphere. The QBO is also shown to influence the zonal wind in the Antarctic MLT, especially around the time of the polar vortex break up, and to modulate the Antarctic semidiurnal tide through changes in the amplitude of the S=1 non-migrating component.

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Atmospheric coupling through wave activity changes associated with recent stratospheric sudden warming events

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Stratospheric sudden warmings (SSWs) are caused by enhanced planetary waves propagating from the troposphere and are the most spectacular planetary-scale events in the wintertime stratospheric circulation. The polar vortex is highly distorted and breaks down within a few days and the westerly polar night jet is quickly changed to easterlies with an accompanying large-scale warming of the circumpolar regions. In addition, poleward shifts of the polar night jet core are often observed prior to the occurrence of SSWs; such poleward shifts are known as the 'preconditioning' for SSWs. Thus, dramatic changes of wind and temperature fields would occur in mid- and high-latitudes in association with SSWs, which could bring about activity changes of gravity waves depending on selective damping effects of background atmosphere. While quasi-planetary waves cannot propagate vertically due to the appearance of easterly winds, gravity waves propagate vertically and their changes may influence the MLT region. In this study, observed changes of wind and temperature fields associated with recent SSW events are shown and possible dynamical coupling processes due to wave activity changes are discussed.

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Observation of Descending Mesospheric Air above the Arctic during the Winters of 2007 to 2010 by Ground-based Microwave Radiometry

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In the mesosphere and lower thermosphere (MLT), NO_x is produced by solar high-energy radiation. It can then be transported into the polar winter stratosphere by the large-scale circulation of the middle atmosphere.
In this region, NO_x acts as catalyst for ozone destruction. Parts of the ozone variability can therefore be induced by either the varying NO_x production in the MLT region or the varying strength of the downward transport into the stratosphere.
For the quantification of the latter, the influence of dynamics, observations of the respective descent rates are needed. They can be obtained from measurements of CO profiles, since CO is a tracer for dynamics in this region.
We have been performing ground-based microwave observations of CO since 2007 above Kiruna, Sweden (67.8°N), covering an altitude range of 40 km to 80 km. We present the analysis of the measured timeseries for the three winters from 2007/2008 to 2009/2010 together with an estimation of the descent rates. In addition to the analysis of the vertical motion, the measurements might be used to investigate meridional mixing across the vortex border in the upper stratosphere. That is because the data set contains features that indicate a weakening of the polar vortex in the upper stratosphere, while it remains stable in the lower stratosphere.

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Seasonal and interannual variation of mesospheric waves at middle and high latitudes

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The seasonal and interannual variation of the wave activity in the mesosphere/lower thermosphere (MLT) at middle and high latitudes is presented on the basis of nearly identical wind measurements with meteor and MF radars at Juliusruh (55°N, 13°E) and Andenes (69°N, 16°E). The annual cycle of winds and waves at both latitudes is discussed with simulations using the mechanistic general circulation model KMCM which reproduces the main observed features very well.

For the observations, proxies for the activity of mid-frequency gravity waves (GWs) and waves with longer periods are computed from their variances estimated as sum of wavelets for defined bandwidths. The corresponding proxy for the simulated GWs is the non-rotational kinetic energy due to the resolved mesoscales. Both observational and computational results show the strongest GW energy during winter and a secondary maximum during summer. This semi-annual variation is consistent with directional GW filtering by the annual cycle of the mean zonal wind. The latitudinal dependence during summer is characterized by stronger GW energy below about 82 km at middle latitudes than at polar latitudes, and a corresponding upward shift of the wind reversal towards the pole which is also reflected by the simulated GW drag.

Mesospheric wind measurements are available at Juliusruh since 1990. First results of long term investigations at middle latitudes indicate a negative trend of the zonal winds below 80 km during summer. This increase of the observed westward directed winds during July goes along with an enhanced gravity wave activity at altitudes above 80 km. These results for middle latitudes will be compared with the data derived at Andenes since 1999.

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Comparison of Observed 11-Year Signals in Stratospheric Ozone and Temperature with CCM Simulations Including a Coupled Ocean and Troposphere

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Observational studies of stratospheric ozone and temperature records since the onset of continuous global satellite measurements (1979) indicate the existence of responses to 11-year solar UV forcing at tropical and subtropical latitudes. In addition to an upper stratospheric response that is attributable to direct photochemical and radiative forcing, a significant variation is also observed in the lower stratosphere that appears to be dynamical in origin and is much less well understood. The latter variation has not yet been fully simulated by chemistry climate models that consider only stratospheric processes with fixed sea surface temperatures. Observational studies have also identified 11-year surface climate signals in the tropical Pacific that resemble those observed during cold ENSO events (van Loon et al., JGR, 2007). The latter signals have recently been approximately simulated using the WACCM model coupled to the ocean, land, and sea ice components of an ocean-troposphere model (CCSM3) (Meehl et al., Science, 2009). Here, we report an initial comparison of the latter coupled WACCM/CCSM3 model output for stratospheric ozone and temperature (with and without a modeled QBO) to observed 11-year responses derived using a multiple regression statistical model. The purpose of the comparison is to better determine the origin of the tropical lower stratospheric response, especially whether the response may be amplified by feedbacks from the ocean-troposphere response. The statistical model includes a lagged ENSO term and two lagged QBO terms to minimize any aliasing of the solar regression coefficients by internal sources of stratospheric interannual variability. A number of qualitative agreements are found. For example, the observed geographical dependence of the total column ozone response in NH winter (characterized by low values in the equatorial eastern Pacific and higher values in the subtropical eastern Pacific) is similar to that obtained from the model ozone data. A more detailed comparison of the observed and modeled tropical ozone and temperature responses and their dependences on season, altitude, latitude, and longitude (with and without including a QBO in the WACCM model) will be presented.

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Solar extreme flare events: definition, origin, occurrence and their forecast.

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For the past of 8 solar cycles from the beginning of solar flares regular observation extreme flare events, as a rule, were occurred on growth phases and, more often, cycle declining. The exception was made by solar cycle 22 when both intervals of such events realization had on a maximum phase. The first known instances of these flare events associated with "Space Weather's" effects occurred on August, 28 and Sept. 1, 1853. In cycle 17 possible similar flare event occurred on the end of Feb. – beginning of March 1942, at ~ 4.8 year after maximum. In cycle 18 – Nov., 1949 (~ 2.3 y.); in cycle 19 – November, 1960 (~ 2.7 y.) and may be July, 1961 (~3.3 y.); in cycle 20 – August, 1972 (~3.7 y.); in cycle 21 – June, July, December, 1982 (~3 y.) and the end of April, 1984 (~4.8 y.), in cycle 22 – March, August 1989 (~ max.), June 1991 (~2.5 y). In cycle 23 it is registered only four flares with a X-ray class X≥10 (for example, for interval 1 – 15 June, 1991 only, its was 5): and three of them were the main one during the concerned 19.10 – 04.11.2003 (~ 3.5 y.). First extremal flare was observed in the beginning of April, 2001. Last extremal flare occurred at September 2005 (5.5 y after maximum of cycle 23). The question of definition solar extreme flare events and their attitude to severe disturbed of space weather condition is discussed. The comparative analysis of AR – generators powerful flare events is lead. The opportunity of forecasting extreme flare events as result of interaction of new emerging magnetic fluxes and with already existing magnetic structures is considered. The process of new magnetic flux emergence, its evolution and its interaction with already existing magnetic flux is sufficiently determined that allows us to predict as a period of flare energy release (PFER) so an importance of most solar flare in the flare set of this period. The method of the large solar flare event prediction has been put to successful test on Russian scientific satellites such as GRANAT, GAMMA, CORONAS-I. Computer version this forecast techniques has been developed on the base of real-time solar data. The forecasts are accessible via http://www.izmiran.rssi.ru/space/solar/forecast – Russian version and http://titan.wdcb.ru/virbo_rus/viewlast.do?section=RBBulletin – English version.

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About existence of physical boundaries between structures of one polarity on the Sun.

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To one of the basic consequences active regions complexes (CAR) studying became opening existence of boundaries between magnetic "unipolar" structures of the same polarity. These boundaries are not defined on magnetogram received at observations of AR. Such borders inside of active regions can be revealed at studying the dynamic phenomena, especially in flare processes. These boundaries, in case of realization of large solar flares, interfered with propagation of H_α flare emission to penetrates in the neighboring area. On an example of the large solar flare in AR3804 on July, 12th, 1982 it is possible to see, that the emission ribbon of N-polarity even during a maximum of flare does not penetration into areas of active region laying to the north of some boundaries.. The second example gives us active region AR4263 on August - September, 1983 in which such boundaries passed between two space closely spots of one polarity. Umbra of spots all over again settled down in one penumbra, and then dispatch noticeably, and more east umbra, was noticeably turned counter-clockwise. If both umbra were in one "unipolar" structure (one system), should turn there were both umbra, however the physical border which is passed between spots, interfered with it. At the analysis of the flares occurred in these AR, their spatial independence is well looked through: emission of flares carried out in one system under no circumstances does not get into another. The modern analysis shows, that coronal holes arise just in a place of “physical” boundaries existence. From this point of view it is possible to assume that coronal holes are always formed in unipolar magnetic structures when such structures consist of two magnetic areas of one sign, but various origin and between them necessarily there is a "physical" boundaries. In the solar corona where electrodynamic forces are weakened, there is a pushing away of these parts from each other and magnetic field lines appear opened in interplanetary space.

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Small scale magnetic fluctuations in middle and low latitudes as observed by Oersted satellite and their possible source in the lower atmosphere

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Large scale lower atmospheric disturbances caused by typhoon, earthquake, volcanic eruption etc. are supposed to influence the ionosphere. Such ionospheric effects have been detected by geomagnetic observation on the ground, and the proposed mechanism which generates the geomagnetic variation is the ionospheric dynamo. In this paper, the global distribution of geomagnetic field fluctuations in mid- and low-latitude ionosphere observed by the Oersted satellite is analyzed. The fluctuations having a few nT in amplitude are orthogonal to the ambient magnetic field suggesting that they are Alfvenic phenomena or artifacts caused by the attitude problem. The results indicate a hemispheric asymmetry of the small scale magnetic fluctuations at the Oersted altitudes, i.e., they are larger in the northern hemisphere than those in the southern hemisphere. A tendency that the amplitude is larger over the North American and Eurasian continents suggests the lower atmospheric effects. That is, the ionospheric wind caused by the acoustic mode and/or gravity mode waves could generate such Alfvenic fluctuations through the ionospheric dynamo.

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Geomagnetic and ionospheric response to vertical acoustic resonance caused by lower atmospheric disturbances

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A large scale disturbance with short time scale in the lower atmosphere may generate acoustic waves, and they propagate not only in a horizontal direction but also to the upper atmosphere. Because of exponential decrease of atmospheric mass density with height, a small pressure variation in the lower atmosphere is amplified to appreciable vertical wind at the ionospheric height, and the vertical wind may cause electric currents or Alfvenic fluctuations in the ionosphere through dynamo process. The geomagnetic variation generated by the ionospheric current could be detected on the ground. As the source of lower atmospheric disturbances with large horizontal scale, large earthquakes, strong volcanic eruptions, typhoons, total eclipses etc. are expected. The amplitude of the magnetic effects on the ground is in general very small and difficult to distinguish from external (i.e., magnetospheric) effects. However, if we limit to the cases of the vertical resonance of the acoustic waves between ground and ionosphere, it is possible to find the cases because of the theoretically expected resonance frequency. In this paper, we summarize the cases where the magnetic and pressure variations with the acoustic wave resonance frequencies are detected and discuss their characteristics.

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The Solar Mass Ejection Imager (SMEI) Web Database and 3-D Analysis at UCSD

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The Solar Mass Ejection Imager (SMEI) has been operating nearly continuously since "first light" on the Coriolis spacecraft in early February, 2003. We present the current state of the SMEI database maintained and stored on UCSD/CASS Web servers. The up-to-date UCSD database includes individual SMEI CCD data frames from each of the three SMEI cameras since launch as well as single-orbit full-sky maps in a sidereal reference frame that preserve the original resolution and photometric precision. Further processing of the SMEI data for the whole data set has allowed the removal of zodiacal cloud brightness, auroral signals, bright stars, and the sidereal background. A Web interface to this latter data set describes the database and allows display of these maps in sun-centered ecliptic coordinates, either directly or as running differences. "Quick-look" skymaps are now displayed as real-time difference images on the UCSD website within a few hours of their arrival from the instrument. Further processing provides these data free from planetary-, moon-, and auroral-light contamination so that they can be used in tomographic 3-D analyses. These 3-D analyses are presented on the Web as up to date as possible (usually within a month of their being available). Current plans are to provide these higher-level products additionally in "forecast" mode, allowing real-time updates of in-situ density measurement forecasts at Earth up to a few days ahead of the present.

Presented by: **Jackson, B.V.**

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An index to describe global ionospheric variability using satellite-borne solar EUV measurements

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Primary ionisation of major ionospheric constituents is calculated from SolACES and TIMED-SEE solar EUV measurements in the wavelength range 16-135 nm, and number densities of the background atmosphere taken from the NRLMSIS-E climatology. From the calculated ionisation rates, a global EUV-TEC index is derived, which describes the ionospheric response on solar EUV and its variability from the last solar maximum to date. The index is compared against global mean ionisation values taken from TEC maps. The index describes global TEC variability better than other indices like F10.7 do. The EUV-TEC index may be used for scientific research, and to describe the ionospheric effects on radio communication and navigation systems.

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Long-term trends and their changes in midlatitude MLT winds

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Long-term variability of mesosphere/lower thermosphere (MLT) winds, tidal amplitudes and phases, and long-period oscillations has been analyzed using three ground-based wind data series obtained at Collm (52°N, 15°E), Obninsk (55°N, 37°E) and Saskatoon (52°N, 107°E). Applying piecewise linear trend analysis with a priori unknown number and positions of breakpoints shows that trend models with breakpoints are partly preferred against straight lines. Differences between the three wind time series and their trends are found, which are partly connected with stratospheric stationary planetary waves, indicating an influence of stratospheric circulation on MLT trends.

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Possible connection between stratosphere and ionosphere through modulation of gravity waves by planetary waves

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A possible mechanism of vertical coupling between stratospheric planetary waves (PW) and observed ionospheric planetary wave type oscillations (PWTO) is studied analyzing the modulation of gravity waves (GW) by PW. Information of GW with vertical wavelengths <6km are obtained from SABER temperatures potential energy (30-130km). This is used to study the connection through the modulation by PW at midlatitudes. Proxies of travelling PW, obtained by combining mean and standard deviation in the longitude-time domain, are applied to the GW data, which deliver a nearly continuous picture of the PW modulation effects from the stratosphere to the lower thermosphere. In relation to Traveling Ionospheric Disturbances (TID) derived from Total Electron Content (TEC) of GPS covering the European sector a transmission path of PW signals from the stratosphere to the ionosphere can be indicated.

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Modulation of the 'stratospheric bridge' by the Pacific Decadal Oscillation, Quasi-Biennial Oscillation and the 11-year solar cycle

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Analysisof the monthly mean three-dimensional Eliassen-Palm fluxes indicated the existence of the "stratospheric bridge" forming by the upward planetary wave propagation from the troposphere over northern Eurasia in early winter and the downward wave signal from the stratosphere over North Atlantic in late winter (January-February). In early winter (December), the interannual changes of the planetary wave activity control partly the variations of the stratospheric circulation in subsequent January. The interannual and decadal variations of the upward wave flux in December are strongly associated with the sea surface temperature (SST) anomalies in the North Pacific (Pacific Decadal Oscillation - PDO) in early winter during 1958-1979 and 1992-2007. A decadal period from the mid- 1970s to mid-1990s of the Holton-Tan (HT) relationship violation corresponds well to that of the positive PDO phase (anomalously cold SSTs in the central North Pacific). The absence of the modulation of the stratospheric circulation by the 11-year solar cycle in early winter can be connected with this oceanic forcing on the thermal excitation of the stationary planetary waves.

In contrast with early winter, the large role in the wave-zonal flow interaction plays the downward wave flux from the stratosphere to the troposphere over Canada and North Atlantic in January-February. The sink of the eddy energy from the stratosphere occurs in this "stratospheric wave hole" region. One can suggest that there are two dominant regimes in the stratosphere-troposphere coupling in late winter: 1) the "ventilation regime" with the strong penetration of planetary waves from the troposphere over north Eurasia and their strong downward propagation over Canada and North Atlantic, and 2) the "blocking regime" with the weak those.

It is shown that the decadal HT relationship violation from the mid- 1970s to mid- 1990s is associated with an exchange of these regimes for the west/east QBO years in late winter. This simple physical mechanism can also explain why the stratospheric warmings are observed more often for the west QBO (wQBO) years during high solar activity (HS/wQBO) and east QBO (eQBO) years during low solar activity (LS/eQBO) than for LS/wQBO and HS/eQBO years.

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Analysis of the Effect of Geomagnetic Storm on Nigeriasat-1

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The earth's magnetic field alters the flow of charged particles supplied by the Sun for many hundreds of Earth's radius out into space. These charged particles are trapped by magnetic field of the Earth; the region affected is called the Earth's magnetosphere. The magnetosphere act like a buffer between the earth and solar wind, which flows over and around it, the solar wind compressed the earth's field on the day- side and stretches it on the night side in a long magnetic field.

The NigeriaSat-1 is a sun-synchronous satellite and Sun-synchronous orbit satellite trails the Earth's shadow and never enter into the Earth's shadow(Night-time), The Satellite always have Solar wind perpetually striking it, because it received the Sun-light at all time. The satellite is perpetually at the day side of the Earth which always prone to the effects of compression of the Earth's magnetic field by solar wind resulting to Geomagnetic storms. Therefore Sun-synchronous orbital satellite may suffer from effects that are predominantly during geomagnetic storm, so an investigation of the intense geomagnetic storms effects and the ionospheric storms was carried out on Nigeria Sat-1

The ionospheric data used in this study consists of hourly values of foF2 obtained from some of the National Geophysical Data Center's SPIDR (Space Physics Interactive Data Resource). The interplanetary parameters data are the Proton Number Density, Proton pressure, the Solar Wind Flow Speed, Plasma Temperature, the Interplanetary Magnetic Field Bz and Geomagnetic index Dst.

The result of this study shows that Nigeriasat-1 is immune against the atmospheric drag, gravitational pull and electrostatic discharge.

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Reconstruction of solar photospheric and heliospheric magnetic field since 1700 with a physical model

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Based upon the group sunspot number and the previous studies about the features of the sunspot emergence including the area, latitude, longitude and tilt angle, we reconstruct the solar photospheric and heliospheric magnetic field since 1700 with the coupled solar surface flux transport model and current sheet source surface extrapolation. The open flux results from our model agree well with geomagnetic-based reconstruction. We also get the temporal evolution of the heliospheric current sheet tilt angle, which is important for cosmic ray modulation.

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Comparative observations of gravity waves in MLT region using the Kunming MF radar and Meteor radar

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An all-sky meteor radar and a MF radar had been installed at Kunming station (25.1°N, 102.7°E) since July 2008, and begun routine observations subsequently after a short test operation. The data from these two radars in November and December 2009 have been used to analyze gravity wave activities in mesosphere and lower thermosphere (MLT) over Kunming. For MF radar the wind variances of gravity waves during 12-180-min periods between 80-100 km are used to calculate frequency spectra of wind velocity, then estimate variances $<u'^2>$, $<v'^2>$, and $<w'^2>$ by integrating the spectra. For meteor radar, a technique for measuring gravity-wave activity has been proposed, in which the variance of horizontal wind velocities measured by individual meteors is accepted as a proxy for the activity of the gravity-wave field, and am also able to investigate the vertical structure of the gravity-wave field at heights between 80 and 100 km. In this study a general comparison between gravity waves derived from these two techniques are given.

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Peculiarities in the start of solar cycle 24

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The long-waited start of cycle 24 has arrived but some differences from previous cycles can already be identified. The present work is primarily based on Debrecen sunspot data. These data are detailed enough to study statistically the Spörer diagram of the individual cycles and it turns out that the present cycle starts at unusually low latitudes in both hemispheres. Some hints of the north-south phase lag are also scrutinized. Further properties of the minimum periods can also be compared, such as the number of spotless days, mean spot sizes and mean lifetimes of sunspot groups. At the present moment the recently available properties promise a fairly weak cycle.

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Nine years of coincident measurements of PMSE and NLC above ALOMAR

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Polar Mesospheric Summer Echoes (PMSE) and Noctilucent Clouds (NLC) are both layered phenomena of the cold summer mesopause. While NLC consist of ice particles large enough to be observed optically, the generation mechanism of PMSE requires also, but in a more subtle way, the presence of ice particles. PMSE are observed by different radars employing the backscatter on structures in electron density at the Bragg scale. At the ALOMAR research facility in Northern Norway (69N, 16E) different radar and lidar instruments are in operation since more than 10 years. We merge observations of PMSE by the ALWIN radar and observations of NLC by the ALOMAR Rayleigh-/Mie-/Raman lidar. We have analyzed about 2900 hours of lidar data and 13900 hours of radar data of the years 1999 to 2008. This unique dataset allows for simultaneous and common-volume studies of both phenomena. We present statistics on joint and sole occurrence of PMSE and NLC and its implications for cloud altitude and brightness. We find an increased probability for joint occurrence, confirming the supposed link between both phenomena, which is also strengthened by the cumulated coincidence of PMSE and NLC lower boundaries. However, we also observe NLC while PMSE is absent in the same volume. Comparison of occurrence rates with solar zenith angle reveals that NLC without PMSE mostly occur during night hours indicating that the ice particles were invisible to the radar due to the reduced electron density. We will present the joint observations on different time scales and quantify the link between PMSE and NLC. By this, we will assess the suitability of PMSE and NLC measurements as a tracer for parameters of the background atmosphere.

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Activity of planetary waves at the stratosphere heights during 2007-2009 winters

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Planetary wave activity is studied in the boreal winter stratosphere on the basis of the UK Met Office temperature and geopotential height data. Decomposition of standing and travelling amplitudes according to the recalculation procedure produced the following results. During 2007-2009 winters, at the stratospheric higher-middle latitudes the amplitudes of eastward traveling waves having period near 32 days dominate the westward ones according to analysis of the temperature and geopotential height data. Amplitudes of the eastward travelling waves at the 20 days period are comparable with the westward wave amplitudes or higher. Well pronounced 5- and 7-10-day westward waves are characterized with maximal amplitudes. While at the lower-middle latitudes the westward components of traveling planetary waves are predominant both at the temperature and geopotential height data. The amplitudes of stationary (standing) and traveling planetary waves are comparable in values within 30N-40N area. It is obtained that, at 1 hPa height westward wave amplitudes are close to standing wave amplitude values and having maxima within 7 and 22-day periods. UK Met Office data were used to estimate intra-seasonal variability of the zonal mean planetary waves in the stratosphere and allowed to clarify a dominance of eastward waves at higher latitudes than at the lower ones. The described dominance of eastward waves within 60N-70N could be explained with the coincidence to their generation area at the stratospheric heights. Another line for a discussion is the amplification of stationary planetary waves during winters 2007-2009 and their connection with the sudden stratospheric warming events.

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A possible explanation of the Maunder minimum from a flux transport dynamo model

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We propose that the poloidal field at the end of the last sunspot cycle before the Maunder minimum fell to a very low value due to fluctuations in the Babcock--Leighton process and also due to the stochastic fluctuations of meridional circulation. With this assumption, a flux transport dynamo model is able to explain various important features of the historical records of the Maunder minimum (e.g., sudden initiation but gradual recovery, periodic but weaker oscillation and North-South asymmetry observed during the last phase of Maunder minimum) remarkably well on choosing the parameters of the model suitably to give the correct growth time.

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Why are relativistic electrons persistently quiet at geosynchronous orbit in 2009?

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Relativistic electrons at geosynchronous orbit (GEO) were persistently quiet in 2009 for almost a whole year. The solar wind speed, which has been known as a primary parameter controlling the outer belt electrons, was very slow in 2009 as expected, and at a comparably low level as of 1997 when we did not observe such a persistently quiet condition. Since the interplanetary magnetic field (IMF) was quite different between 1997 and 2009, the difference in IMF is a possible cause of the difference in the electron flux levels, providing an important clue to understand the complex source and loss process of relativistic electrons at GEO. We suggest that the extremely weak IMF of the very slow solar wind plays an essential role in diminishing the source processes themselves such as magnetic storms and substorms, and in turn to suppress the relativistic electron flux at GEO over the time scale of a year, as an inevitable consequence of extremely weak open magnetic field of the Sun associated with the extremely weak current solar minimum.

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Solar cycle 23 in SCIAMACHY Atomic Oxygen and Hydrogen Data

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Several mesospheric species such as atomic hydrogen, oxygen and ozone as measured by Sciamachy and Gomos on Envisat show a pronounced dependence on the solar flux during the 23rd solar cycle. This dependence is analysed and compared to model simulations of the HAMburg Model of the Neutral and Ionized Atmosphere. Differences are discussed with respect to dynamical and photochemical effects.

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The long-term variations of temperatures in the stratosphere-lower thermosphere and electronic concentration in F2-region of ionosphere

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A lot of experimental results have confirmed the existence of detailed correlations between the parameters of the ionosphere and atmosphere below. The middle atmosphere affects the ionosphere with upwardly propagating waves. Using data of vertical radiosounding of the ionosphere and temperature measurements at stratosphere heights (30 km) and in the lower thermosphere (80 km), the interrelation of occurrence of fluctuations with the periods of planetary waves in temperature variations at different heights and in variations of critical frequency of layer F2 (foF2) in the conditions of a minimum of solar activity in 2006-2007 are investigated. The features of occurence of the common periodicities of the considered wave structures are discussed. The statistically significant periods of fluctuations of temperature in the stratosphere and mesosphere vary from 11days to 49 days while for foF2 periodograms there are also more high-frequency fluctuations with the periods in 8 days, 9 days and 10 days. The significant correlation between the occurrence of fluctuations with the periods of planetary waves in variations of stratosphere/lower thermosphere temperatures and foF2 is revealed. The similarity of periodic structures for the variations of considered parameters is found: correlation coefficients between periodograms are positive and high (r> 0.8), especially in the winter, in December.

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Characteristics of energetic particle precipitation determined by incoherent scatter measurements and modelling

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Recently there have been several studies concerning the effects of solar activity on tropospheric and stratospheric variability through chemical changes induced by energetic particle precipitation [Randall et al., 2005; Rozanov et al., 2005; Seppälä et al., 2009]. The key issue of this approach is the quantification of the actual precipitating particle spectrum since the particle detectors onboard the current satellites generally struggle to measure accurately the precipitation fluxes in the high energies.

Traditional ground based radio wave techniques, such as radars, riometers and VLF receivers, monitor changes in the ionospheric electron density as a consequence of various ionisation sources including the particle precipitation. This provides opportunities to invert the precipitation characteristics from existing long-term datasets in comparison with the satellite observations.

In this study, the electron density profiles measured by the EISCAT radars are investigated against the MEPED particle detector data onboard the POES satellites. Markov-Chain-Monte-Carlo (MCMC) methods together with the Sodankylä Ion Chemistry model (SIC) are used to construct a statistical model between the datasets.

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Nonlinear Interactions between Solar Tides

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Atmospheric solar tides are large-scale waves driven by the absorption of solar radiation, mainly due to water vapour and ozone, in the troposphere and stratosphere. Because tidal amplitudes increase inversely proportional to the square root of densitiy, tides play a major role in the dynamics of the mesosphere/lower thermosphere region.
In the present work a linearised primitive equation model is used to describe the tidal signal. We take a linear regression approach for determining optimal profiles of Rayleigh friction, newtonian cooling and horizontal diffusion to account for interactions with small-scale structures, mainly gravity waves, which cannot be resolved by our model. The nonlinear interaction between stationary planetary waves and solar tides is also included. The amplitude and phase structure of the diurnal tide is shown to be reproduced in accordance with the state-of-the-art general circulation model HAMMONIA if we take the imaginary parts of Rayleigh friction and newtonian cooling into consideration. The results for the diurnal tide are shown to be further improved by adding a forcing term to the linear model that contains nonlinear contributions to the diurnal signal from the semidiurnal and terdiurnal tides. The annual cycle for the diurnal tide will be discussed with an emphasis on the role of gravity wave-tidal and tidal-tidal interactions.

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Choice of effiscient Carrier wave combination for GPS surveys

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The establishment of geodetic reference frames which are an essential foundation for all surveys related to geodetic works and land management is not a simple task and expects more attention to avoid an error blemished results.
Large country like Algeria cannot afford a dense, nation-wide control GPS network without minimsation of these errors.
In order to perform this task, we need to establish an observation strategy taking in account all the correction which will be bring to the GPS data treatment.
GPS reference works done in the framework of my master thesis have provided interesting results for the modeling concept of survey errors.
Carrier phase based GPS measurements was not sufficient, if we have not taken in consideration the different parameters (GDOP, Atmosphere , Elevation mask,..) to control the three dimension positions measurement which required a sub centimeter accuracies that could not be reached without bringing several corrections to the patterned errors.
For those applications requiring sub meter or even centimeter-level accuracy in position the working radius of a field station is limited to less than 1000 km for the long baselines station (Arzew-Constantine baseline).
To overcome this unsatisfactory situation, the spatial and temporal correlations of GPS measurement errors introduced by ionosphere, troposphere, and satellite orbit need to be modelled in a real time multi station solution.
A concept for such a local GPS reference network covering only densely control point and benchmark areas can be concerned by this study because reduction of errors propagation effect where an efficient algorithms such as geodetic lines, Levenberg Marquardt and many others has been developed in order to minimize accuracy loss. Therefore the effort agreed in order to improve accuracies on networks computations has been reduced drastically.
In the paper, we discuss the carrier receiver wave combination choose in order to conjugate it with different algorithms cited above to establish an accurate GPS reference network that can be operated, for geodetic works and positioning results for control and cadastral surveys.

KEYWORDS: Geodetic, Gps, Gdop, Levenberg M arquardt, cadastral surveys.

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Acoustic gravity waves of troposphere/seismic origin that may trigger the collision interchange instability in the ionosphere.

Kherani Esfhan

Acoustic Gravity waves (AGWs) are launched in the Atmosphere during convective activity at the troposphere heights. They are also launched prior and during an Earthquake owing to the energy deposition at the Earth's surface. The interactions of AGWs with the Ionosphere may manifest in varieties such as density and electromagnetic signatures in the E and F region of Ionosphere. These waves may also act as a seeding for the excitation of Collisional-Interchange Instability (CII) which gives rise to the plasma irregularities in the Ionosphere. In the present theoretical work, the possibility of excitation of CII by seeding of AGWs of troposphere/seismic origin will be explored. To do so, numerical simulations of AGWs in atmosphere and CII in the Ionosphere are carried out.

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The influence of precipitating solar and magnetospheric particles on the entire atmosphere - Simulations with HAMMONIA

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When energetic charged particles of solar and magnetospheric origin precipitate into the Earth's atmosphere they can affect atmospheric chemistry, energy budget, and dynamics. The occurence, composition, and energy of such precipitating energetic particles are highly variable in time and space but crucial for the location where they deposit their energy and initialize atmospheric processes.
To study the influence of precipitating solar and magnetospheric particles on the entire atmosphere during the solar and magnetospheric storms in October/November 2003 and the following months we use the 3-D chemistry and climate model HAMMONIA (Hamburg Model of the Neutral and Ionized Atmosphere) [Schmidt et al., J. Climate, 2006]. The model treats atmospheric dynamics, radiation, and chemistry interactively for the height range from the Earth's surface to the thermosphere (approximately 250 km). 3-D sets of ion pair production rates for precipitating solar and magnetospheric protons, electrons, and alpha-particles are provided by AIMOS (Atmospheric Ionization Module Osnabrück) [Wissing and Kallenrode, J. Geophys. Res., 2009].
Our model computations point out the substantial impact of precipitating energetic particles on the polar middle and upper atmosphere. Simulations show significant enhancements in middle and upper atmospheric NO_x content and thermospheric ion concentrations during the period of very intense particle storms which happened in October/November 2003.
Further, our model results indicate a noticeable influence of precipitating electrons in the lower mesosphere during individual events. Generally, electrons play the major role in NO_x production in the auroral upper mesosphere and lower thermosphere. It can be shown that downward transport events carry large amounts of NO_x from the mesopause to the stratopause region. This illustrates that neglecting electrons in studies of precipitating particles may lead to a significant error in the assessment of chemical background conditions.
Besides their influence on atmospheric chemistry we also study the effects of particles on energetics and dynamics. A temperature decrease in the sunlit middle atmosphere is associated with a particle induced ozone depletion. In the thermosphere precipitating particles control a couple of energy relevant processes leading, in general, to a net warming. However, a net cooling caused by particle influence in a small altitude range in the polar summer thermosphere can be shown.

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The roles of stratospheric dynamics and chemistry for polar ozone anomalies in a 29 year assimilated ozone dataset

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We introduce a 29-year dataset of stratospheric ozone which has been created from sequential assimilation of Solar Backscatter UV (SBUV) satellite ozone profile observations into a chemistry transport model (CTM). Our assimilated dataset shows excellent agreement with ozone profile data from independent observations (satellite instruments and sondes), including during polar night when no SBUV observations are available. The dataset can thus be viewed as a consistent long-term dataset closing the gaps in satellite observations in order to investigate high-latitude ozone variability.
We use the assimilated dataset to analyze the development and persistence of ozone anomalies in the Arctic stratosphere, and their relation to stratospheric dynamics and chemistry. Anomalies in the stratosperic circulation, expressed by the Northern Hemisphere Annular Mode (NAM) index, are shown to have a large influence on ozone anomalies. In particular, extreme phases of the NAM index (strong and weak vortex events) lead to the creation of distinctively shaped ozone anomalies, which first appear in the upper stratosphere and rapidly descend to the lower stratosphere, where they remain visible for up to five months. Using budget terms from the assimilation as well as regression analysis of CTM sensitivity runs, we further quantify the contributions of gas-phase chemistry, heterogeneous chemistry and dynamics to polar ozone anomalies, and their impact on mid-latitude ozone trends.

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Particle tracing within noctilucent clouds in the polar summer mesosphere

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We use the LIMA/ICE Lagrangian model for NLC simulation to investigate the history of large mesospheric ice particles prior to and after observation and to look into the origin and development of noctilucent clouds. To that end, we scan given NLC events for large particles (e.g., > 20nm) and then trace those backward in time to their nucleation and forward to their evaporation. From this, characteristic properties like mean radius, growth rate, local water vapor (super-)saturation etc. are plotted in time series to characterize NLC particle development.

As validation for the trajectory modeling, modeled winds from LIMA are compared to measurements of radar data from Andenes (69°N) and Juliusruh (55°N).

We observe a generally good agreement of modeled winds with radar winds for the Andenes latitude, so the focus of trajectory tracing are NLC oberserved near 69°N. Higher and lower latitudes are also considered, but those results are used more cautiously, as validation for the winds used in modeling is not as conclusive in this case.

Particle lifetime is dependent on latitude, with NLC particles observed near the pole remaining small and close to the mesopause much longer than those at lower latitudes. At 69°N, the typical growth and sedimentation process may take a day or longer, while ice particles observed at the very edge of the NLC latitude range tend to grow within hours before being observed. This may be explained with much more variability in saturation ratios of air carrying ice particles in mid-latitudes compared to higher latitudes.

With few exceptions, ice particles growing to visible size evaporate within ~6h of observation, since they sediment to warmer regions and evaporate quickly once there. Thus, ice particle lifetime is almost entirely determined by the time the NLC particles take to grow to visible size.

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Variations in global temperature: anthropogenic or natural factors

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The observed increase in the surface air temperature during the last century has aroused a heated debate about the causes for this increase. General circulation models include as input parameters the variations in both anthropogenic greenhouse gases and solar radiation, but not in other manifestations of solar activity. In the present paper, the variations in the surface air temperature on different time-scales are studied. Special attention is paid to the last 100 years, and especially to the temperature decrease in the period 1940-1970 when the concentration of CO2 increases, and to the temperature increase in the period 1970-2000 when solar radiation decreases but for some time geomagnetic activity continues growing.

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Ground Magnetic Characteristics of the Solar Diurnal Variations: A Case Study Based on Records from Vassouras Observatory (Brazil)

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A recently developed method is used to perform a spectral analysis study of global quiet geomagnetic field variations via a principal component analysis. It is well known that the solar quiet variation measured on the Earth's surface presents characteristic frequencies with 24, 12, 8 and 6-hour periods. Those typical kinds of oscillations are primarily due to the global thermotidal wind systems which conduct currents flowing in the "dynamo region" of the ionosphere, the E-region. In this study, the horizontal component amplitude observed by ground-based observatories belonged to the INTERMAGNET network have been used to analyze the global pattern variance of the Sq variation. The methodological approach is based on Principal Component Analysis (PCA). The PCA is a mathematical tool useful to transform a number of correlated variables into a number of uncorrelated variables called principal components. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible. By applying the PCA to datasets of geomagnetic quiet days, we determined the global dominant patterns of the geomagnetic field variance. The purpose of this work is to describe the global dominant patterns of variance in the time series of Vassouras (VSS) and other magnetic stations reasonably well-distributed over the whole Earth's surface.

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Electric Field in the Earth's Ionosphere

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Thermal plasma in F-region of the Earth's ionosphere is magnetized. Therefore, the electric field causes transport of plasma in F-region of ionosphere due to electromagnetic drift. The main mechanism of formation such large-scale irregularities in distribution of thermal plasma in the ionosphere as equatorial ionization anomaly and main ionospheric trough is the electric field. Equatorial electrojet and the additional F3-layer at geomagnetic equator also are formed by electric field. The electric field in the ionosphere is generated by two sources: thermospheric and magnetospheric. The dynamo electric field generated by thermospheric winds in the lower ionosphere brings the main contribution to the electric field at low latitudes in quiet geomagnetic conditions. However, during the geomagnetic disturbances the magnetospheric convection and Alfven layer electric fields can penetrate to the low latitudes. In high latitudes the magnetospheric convection electric field plays the main part. We have carried out the research of influence of electric field on the ionosphere of low and high latitudes. Researches were carried out with use of the numerical model GSM TIP, developed in the West Department of IZMIRAN. We have considered the influence of the electric field on behavior of the main ionospheric trough and equatorial ionization anomaly. The influence of the dynamo electric field on auroral electrojet is considered. It is shown, that the electric field of magnetospheric origin influences on equatorial electrojet. We have carried out the research of influence of electric field of magnetospheric convection and Alfven layer on formation of additional F3-layer in the equatorial ionosphere. We also considered the ionospheric effects of the modeling substorm and storm sequence. Recently the researches of local changes of such ionospheric parameters as foF2 and TEC in quiet geomagnetic conditions got the special popularity. Separate cases of such changes some researchers connect with the action in the ionosphere of the electric field of seismogenic origin. We show the results of modeling calculations of such situations with the additional zonal and penetrated vertical electric field, presumably seismogenic origin.
The present work was done under support of the Russian Foundation of Basic Research (Grant No. 08-05-00274).

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Solar influence on the stratosphere

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Stratospheric influence of the solar cycle due to the change in solar UV heating in the stratopause region becomes evident through observational and modeling studies. Solar response in the lower stratosphere is considered to be created by a dynamical response to the solar forcing in the stratopause region. This process involves the interaction between the planetary waves propagating upward in the winter stratosphere. Due to a processes similar to the polar-night jet oscillation, the solar signal penetrates downward to the troposphere. This process is highly non-linear and still models have a difficulty to reproduce a realistic response. It should be noted however that we do not have a consistent observational data set covering many solar cycle. So, in fact, we do not know what is “realistic”.

Therefore, it is important to have a conceptual model of solar response which indicates essential feature of the solar response. Here we present a conceptual model of the solar dynamical response in the stratosphere taking account for the structural evolution during the winter.

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Response of the high-latitude magnetosphere to complex interplanetary driving

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On 22 November 1997 a magnetic cloud reached the earth magnetosphere and produced a storm with Dst=-75 nT. While the magnetosphere was still in its recovery, a new magnetic cloud hit the magnetopause, causing the development of a new storm with Dst reaching -108 nT. In the course of this complex two-step storm several substorms developed with AL down to –1400 nT. The sheath region of the first cloud reached the Earth at ~ 9:50 UT and a pulse in SW dynamic pressure hit the magnetopause. The high-apogee Interball-1 satellite was in the tail at ~ -10.6 R_E, heading towards perigee. It registered a two times increase of the magnetic flux about 1.5 – 2 min later. Interball-2 made two scans over the northern polar hemisphere and observed the development of filed-aligned currents in the dusk sector. Peculiar magnetopsheric events were observed on 23 November 1997, during the second step of the storm. While Dst minimum, in the high-latitude magnetosphere Interball-1 registered intense tailward convection of mantle-like plasma, together with intense bi-directional fluxes of electrons with magnetosheath energies. Later in the recovery phase in the northern lobe, within the bi-directional electron fluxes, tailward electrons accelerated near the earth were identified. Interball-2 registered the development of highly structured intense field-aligned currents. We compare the observations with the results from Tsyganenko'96 and Tsyganenko'2005 storm models.

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Variations of proton temperature and density during magnetic storm: modeling and comparison with experimental data.

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INTERBALL 2 and MAGION 5 measurements in the Earth's inner magnetosphere revealed that during magnetic storm main phase, plasmaspheric ion temperature mostly fell down while ion density either increased or stayed at the level typical for undisturbed conditions. A physical mechanism describing outward proton drift which causes ion temperature decreasing during magnetic storm is considered. It is shown that for the thermal plasma in the equatorial plane the third adiabatic invariant is conserved even in the processes with characteristic time less than charged particle drift time around the Earth. Model temperatures well agree with experimental data.

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Three-dimension numerical parametrization of the orographic gravity waves impact in the middle and upper atmosphere.

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Internal atmospheric waves play an important role in the formation of variations of wind and other parameters in the atmosphere. Interpretation of observations of atmospheric waves requires the development of simple numerical schemes, which provide a satisfactory description of wave oscillations with minimum computer time. One important source of atmospheric waves is the topography of the Earth's surface. Wind interacts with the irregularities of the relief and the result is a stationary atmospheric wave. In our study the method developed by Scinocca and McFarlane is used as a basis. In this method a concept of so called "subgrid" topography is used, which involves variations of the heights of the terrestrial surface with horizontal scales smaller than a step of the horizontal grid, which is used in atmospheric dynamical models. In the vicinity of each grid point the “subset” orography is characterized by elliptical mountain barriers. After that, the horizontal force acting on an elliptical mountain by the incident horizontal flow is calculated. Then, using the polarization ratio for stationary gravity waves, one may obtain expressions for the total wave-energy transfer, wave-amplitudes and wave acceleration in the case of stationary waves.

The main new feature of the developed method is usage of the theory of stationary waves propagation in an inhomogeneous atmosphere for calculating orographic wave amplitudes and other parameters at different altitudes up to the middle and upper atmosphere. Using the dispersion equation and polarization relations for stationary waves in a rotating atmosphere we obtained the equation of wave action (or energy) change in the inhomogeneous atmosphere similar to that one obtained previously for nonstationary waves. This equation is solved to obtain wave parameters for different atmospheric applications. Results we achieved show important wave fluctuations that should be taken into account in atmospheric dynamic models. Developed method may be useful for interpretation of for laser radar measurements of atmospheric dynamics.

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Same pattern of connection between space-time variations of precipitation and geomagnetic activity

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Authors proposed a physical mechanism of solar activity effects on climatic characteristics and the atmospheric circulation through the atmospheric electricity. A model of the solar activity effect on climatic characteristics of the Earth's troposphere was elaborated on the basis of the mechanism under consideration. The model key concept is the heliogeophysical disturbance effect on the Earth climatic system's parameters, which influence energy flux going from the Earth to space in high-latitude areas. Precipitation is a quantitative and the most sensitive indicator of the atmospheric circulation change.

NCEP/NCAR Reanalysis, CMAP and GPCP data were used to analyze particularities and regularities of long-term variations in amount of precipitation in 1950-2007. Global decrease in amount of precipitation was found to dominate till late 1990s. It started increasing only 10 years ago. Peculiarities of distribution and long-term variations in amount of precipitation in different latitudes and longitudes were also considered.

Correlation analysis of connection between the amount of precipitation and the geomagnetic activity and atmospheric circulation was carried out. Peculiarities of the space-time distribution of correlation coefficients were studied. The connection was found out to depend on a season, and is spatially no homogeneous. Cold periods in the northern hemisphere were characterized by a direct relationship between the geomagnetic activity and amount of precipitation in high latitudes, whereas a negative relationship was observed in subequatorial latitudes. It was found the greatest sensitivity region of the precipitation to geomagnetic activity is the tropical North Pacific at all seasons. The intertropical convergence zone is intensified at the periods of the increased geomagnetic activity, at that the amount of precipitation rises in tropical North Pacific, but falls in tropical South Pacific.

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Storm-time dayside ULF activity: CIR and CME driven storms comparison

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The dayside ULF-pulsation activity has been analyzed during the selected succession of 10 recurrent magnetic storms (CIR-driven storms), which repeated with the periodicity of about 27 days in 2006. The ULF-index, as a measure of the wave level activity in the frequency range of 2-7 mHz, was calculated according to the ground-based 1-min observations at the morning (03-12 MLT) and afternoon (12-18 MLT) sectors for auroral (60-70º) and polar (70-90º) latitudes. It was found that in all phases of the magnetic storms under consideration, the enhanced ULF-activity was found at the auroral as well as at the polar latitudes. In the studied CIR-driven storms, the value of the solar wind velocity was very large (more 600 km/c) providing the Kelvin-Helmholz instability progression and, correspondingly, the ULF wave generation. The daytime polar zone ULF intensity was of the same order or even higher then at the auroral zone. The ULF-index, calculated for the fluctuations in the Interplanetary Magnetic Field (IMF), indicated the enhancement of the strong ULF waves in the initial and main phases of the analyzed magnetic storms. We assume that some of these fluctuations could penetrate into the open polar cap and provide an enhancement of the dayside ULF geomagnetic pulsations at the high latitudes. The ULF-index, based on the geostationary GOES data, demonstrated increasing of the intense ULF pulsations in the magnetosphere in the storm main and recovery phases, but not in the storm initial phase. The comparison of the ULF-activity during the CIR-driven storms (typical for the solar activity minimum) and CME-driven storms (typical for the solar activity maximum) showed that the ULF-activity associated with the CIR-driven storms was observed at the higher latitudes then in the CME-driven storm.

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Polar cap ULF waves as a result of solar wind and magnetosphere interface

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The ground multi-stations geomagnetic data have been analyzed during several selected magnetic storms associated with interplanetary magnetic cloud passages. Strong ULF geomagnetic pulsations have been found at the daytime polar cap latitudes caused by magnetosphere impact with high turbulent and compressed plasma of the magnetic cloud front edge (sheath region. The spectra of ground ULF pulsations were compared with the spectra of the wave observed in the different components of the interplanetary magnetic field (IMF) and in the solar wind dynamic pressure. Some similarity of these waves spectral structure was found. This finding suggests a possibility of the direct penetration of the solar wind wave fluctuations into the Earth polar cap. A cloud leading edge arrival and magnetic storm main phase onset shifted this Pc5-6 geomagnetic pulsation activity into the inner magnetosphere.

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Comparison of the 11-year solar signal in coordinated SPARC/SOLARIS experiments using filtered forcings

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The origin of the observed maximum in temperature and ozone response to the solar cycle in the tropical lower stratosphere is currently under discussion. It is unclear whether it is related to non-linear interactions between the solar cycle, the QBO and ENSO or due to aliasing effects. To further investigate this, we present results from coordinated chemistry-climate model (CCM) simulations, performed with the ECHAM5/MESSy (EMAC-FUB), NCAR's Whole Atmosphere Community Climate model (WACCM3) and the MRI models within the SPARC SOLARIS initiative. The CCM simulations are similar to the reference simulations for the past within the SPARC CCMVal initiative for the period 1960 to 2005 with observed greenhouse gases, ozone depleting substances, and daily varying spectrally resolved solar irradiances but use prescribed filtered QBO and filtered SST and sea ice forcings instead. The SSTs and the sea ice time series have been filtered to remove QBO (2-3 years) and solar cycle (> 10 years) signals, while the observed equatorial mean zonal mean wind data have been filtered to retain QBO signals only (9-48 months) and exclude ENSO and solar cycle signals explicitly. All three CCMs use the same filtered SST and sea ice forcings. WACCM3 and EMAC-FUB use the filtered QBO forcing to nudge a QBO, whereas the MRI model produces a self-consistent QBO and does not use the filtered QBO forcing data.

The results are analysed by means of a correlation and state-of-the-art multiple linear regression model analysis. Special emphasis is placed on the response of ozone volume mixing ratio and related radiative heating, temperature and zonal wind to the 11-year solar cycle. The results are compared to CCMVal reference simulations with unfiltered forcings for the same time period.

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Ionospheric response to the space weather events during December 2006 in the South Pacific Region

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We study the VLF perturbations on subionospheric signals from NWC (19.8 kHz), NPM (21.4 kHz), VTX3 (18.2 kHz), NLK (24.8 kHz) VLF transmitters monitored at Suva, Fiji, due to solar flares that occurred during 5-14 December 2006. A series of solar flares with classes from C1.7 to X9.0 occurred during 5-14 December that produced VLF perturbations on above VLF signals. An intense storm associated with coronal mass ejections and solar flares of X class occurred at 14:14 UT on 14 December with a minimum *Dst* value of -145 nT at 0800 hrs on 15 December. A solar flare of class X1.5 occurred on 14 December 2006 at 21:07 UT and ended at 22:26 UT with its peak flux at 22:15 UT, during the main phase onset of this storm. Enhancements in the amplitude (*DA*) of above VLF transmissions were determined. The values of *DA* were found to be in the range of 3.6 - 8.8 dB for solar flares of C1.7 to X9.0 classes.The enhancement in the amplitudes of VLF signals is due to the increase in the D-region electron density due to ionization enhancements produced by the solar flares. An intense storm associated with coronal mass ejections and solar flares of X class occurred at 14:14 UT on 14 December with a minimum *Dst* value of -145 nT at 0800 hrs UT on 15 December. The storm-time effects in the F2-region during at Niue (19.06.2^{o}S, 169.93^{o}W) and Townville (19.63^{o}S, 146.85^{o}E), low latitude stations near at the ionization anomaly crest, will be presented.

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Influence of the solar cycle and QBO modulation on the Southern Annular Mode

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Influence of the 11-year solar cycle and the stratospheric equatorial Quasi-Biennial Oscillation (QBO) on the Southern Annular Mode (SAM) in late winter/spring is examined through the analysis of combined reanalysis data of ECMWF. It is found that the signal is strongly affected by both the solar cycle and the QBO. Regarding the effect of the solar cycle, the signal extends to the upper stratosphere and persists into the following summer in years with high solar activity, but it is restricted to the troposphere and disappears very quickly in years with low solar activity. For the QBO, the signal extends to the upper stratosphere in late winter/spring but disappears in the following summer in QBO-west years. On the other hand, the signal extends vertically as the time evolution and tends to persist into the following summer in QBO-east years. When both the solar cycle and the QBO are considered, the effects from the solar cycle dominate and those from the QBO work as linearly superimposed factors. Role of ozone on the solar cycle and QBO modulation is also discussed.

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Data-driven Modeling of Solar Storm

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Solar storm caused by solar flare and/or coronal mass ejection (CME) is major source of heliospheric and geo-magnetospheric disturbance. However, the onset mechanism of that is not well understood yet. Aiming at revealing the initiation mechanism of solar storm, we have recently developed a new data-driven simulation model based on the observation by Solar Optical Telescope (SOT) onboard Hinode solar physics satellite. Our model consists of the following three different magnetohydrodynamic (MHD) simulations for solar flare, CME, and ICME, respectively. For the flare model, we first calculated the nonlinear force-free field (NLFFF) of active region NOAA 10930 using the vector magnetogram observed by Hinode/SOT as the boundary condition, and carried out the three-dimensional MHD simulation by imposing photospheric variation which corresponds to the magnetic flux emerging activity seen in the active region prior to the flare occurred on December 13, 2006. As a result, we have successfully simulated a solar eruption, in which magnetic reconnection drives super Alfvenic plasma jet from the flaring site. It was also shown that magnetic reconnection may initiate the transfer of magnetic helicity out of the active region into a large scale magnetic loop. Second, we handed over the result of the flare model into the global corona model, and restarted the simulation for CME formation process. As a result, it was shown that the magnetic loop, which was subject to the magnetic helicity injection due to the flaring reconnection, could expand to a CME. Finally, we have performed the interplanetary space simulation, in which the CME with magnetic helicity was set on the inner boundary. The model successfully tracked the propagation of ICME up to the orbit of earth, and simulated the variation of magnetic field and velocity consistent with the in-situ observation by ACE satellite. All the results indicate that the series of data-driven simulations is a powerful tool for understanding the entire process of solar storm. It also suggests that the process from flare to ICME should not be explained as a result of simple plasmoid ejection but is constituted of several stages, which might be governed by different processes of resistive and ideal MHD.

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Solar cycle by helicity of magnetic fields: observations and theory.

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Using the data obtained by systematic solar vector-magnetographic observations carried out at Huairou Solar Observing Station in China within 1988-2005, we have calculated current helicity and twist of magnetic field, and so we have constructed departure from mirror-symmetry of the solar magnetic field as a 2D function of latitude and time over the two solar cycles. These enable us to characterise the solar cycle by a new observational proxy which is not immediately related to either the magnetic field strength, nor to sunspot number. We have found that while polarity of sunspots alternates between odd/even cycles, forming the overall cycle with period of about 22 yr, the sign of helicity and twist is reproduced in each cycle the same way, so these quantities have approximately 11 yr period, although they are not immediately quadratic with respect to the magnetic field. We have found that the so-called "hemispheric rule" for helicity is obeyed over the most of the solar cycle, giving negative (positive) sign of helicity and twist in the Northern (Southern) hemisphere. We have established specific latitudes and times in the beginning and the end of each cycle when the sign of helicity and twist is systematically (based of statistically significant observations) inverted with respect to the "hemispheric rule". We have also noticed some difference between the cycles 22 and 23 in the onset of the sign inversions in Northern and Southern hemispheres which may be pronounced in the context of the long minimum of solar activity over the years 2006-2008. We are challenged to confront the found properties with existing solar dynamo models using magnetic helicity as additional constrain.

Presented by: **Kuzanyan, Kirill**

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Space Weather Forecasting in IZMIRAN

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The Geophysical Forecast Center has been operating at IZMIRAN for 11 years. It provides the customers with the different-term daily forecast of various aspects of the space weather, such as the solar and geomagnetic activity, radiation conditions, etc.

The on-line forecast is based on the bulk of data from various heliogeophysical information resources. These are the optical, X-ray and UV solar images and movies; the images and movies obtained with coronagraphs; measurements of photospheric magnetic fields and solar radio emission; helioseismic data; spacecraft and ground-based measurements of X-rays, gamma-rays, solar, and galactic cosmic rays; velocity, density, and temperature variations of interplanetary plasma; variations in three components and absolute value of the interplanetary magnetic field; and real-time ground-based measurements of geomagnetic field variations. These data, together with our previously built up databases, are used to analyze the present-day situation and tendencies in the evolution of heliogeophysical processes.

Most of the space weather forecast methods created at IZMIRAN and are partly automated. Usually, the forecast issued by an automatic program is considered to be preliminary and is liable to appraisal by a group of experts. These people take a decision of whether a correction of the input data and a new cycle of automatic treatment are necessary or the forecast can be adopted as final and delivered to the users.

The space weather forecast is delivered to the customer (various departments of the Russian Space Agency, Ministry of Extreme Situations, medical institutions, and mass media) using all available communication facilities: Internet, e-mail, fax. The forecast and information on the current geomagnetic situation and main meteorological parameters can be obtained via the automatic answerback phone, (unique service of the kind in the world).

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Influence of solar variability on rotation and climate of the Earth

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The paper presents results of our study of connection between changes of solar activity (sunspot numbers W), rotation rate (w) and global temperature (Tgl) to understand their connection on different time scales in the past, present and close future. We use W for the period 1700-2005, proxy data of north hemisphere temperature Tnh and global temperature Tgl for the last 1000 yrs and also w for the last 335 yrs. We apply MGM method of spectral analysis elaborated by us that can quantitatively describe both trends and non-stationary oscillations to evaluate their input in data. Trend in Tnh shows rise since Maunder minimum with present rate ~0.5 deg.C/100yr correlated with trend in W. High-amplitude 200-yr cycles in W and in Tgl have passed their maxima and show decrease of their parameters accompanied by acceleration of Earth for now. The 200-yr cycle variation extracted from data of interplanetary magnetic field (IMF) measured at the Earth's orbit also shows the IMF decline. Moreover, the 200-yr solar cycle contributed to the Tgl rise since ~1890. We suggest a possible explanation of observed unexplained increasing in the Tnh for the interval 1905-1940 and its subsequent decrease for 1940-1976 with rate 0.75 deg.C/100yr by variation in w with period of ~72 yr. Characteristics of the other cycles in Tgl, w and W with the same periods are also discussed. Based on our results we suggest a possible mechanism for the 22-yr variation in W, Tgl and w derived in our study to be explained. Basic idea of the mechanism is electromagnetic interaction of the solar wind with magnetosphere and subsequent entry of the solar wind electro-magnetic flux into polar caps. We used measurements of the IMF and the solar wind velocity for 1964-2005 to calculate value and direction of necessary electromagnetic parameters. The flux coming to polar cap leads in the end to heating of polar ionosphere and atmosphere, temperature contrast between two caps, intensification of the inter-hemisphere heat machine in the upper atmosphere, change of angular moment of atmospheric zonal winds (and consequently angular velocity of the Earth w). The mechanism successfully reproduces the 22-yr variations in W, Tgl and w.

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Spectrum of plasma density fluctuations in photospheric plage regions

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Differences in the morphology of magnetic fields at photospheric level lead us to divide the solar surface into active and quiet regions. Individual active regions produced most of variability of the Sun on times-cales of weeks to months. It is also well established by observations that motions in the solar photosphere are in fully developed turbulent state. In this report we consider formation of plasma density fluctuations in turbulent flows of photospheric plage regions. Plage is the part of active region outside sunspots which contains a mean magnetic field of a few hundred gauss. The plage regions are associated with strong photospheric downflows and last about an hour. Because of a low degree of gas ionization at the photosphere level we use a three-fluid model to describe generation of the fluctuations. We also assume that ion-electron plasma is submerged in the turbulent flow of incompressible gas and its motions are not affected by electrically charged particles. From data of observations it is also known that the statistics of chaotic velocity field of photospheric gas obeys a Kolmogorov power law. A mean plasma-density gradient and a uniform magnetic field are taken into account. It is shown that plasma density fluctuations have to be appeared in turbulent flows of the plages. We obtain an expression for the spectrum of plasma fluctuations with length-scales corresponding to the inertial range of turbulence. Using the expression we show that the large-scale fluctuations result from destruction of mean plasma density gradient by turbulent mixing of the gas while the small-scale ones are formed by interaction of plasma embedded in the turbulent flow with the magnetic field. The expression allows us to estimate changes in the shape of horizontal fluctuation spectrum at altitude of 350 km under increase in the magnetic field strength B from 0.2 to 1.5 kG. We consider two cases: the vertical magnetic field (parallel to the gradient in mean plasma density) and the horizontal field (perpendicular to the gradient). If the spectrum is approximated by a simple power law k^{-d}, then the power index d decreases from 1.41 to 1.17 with increasing B in the first case and from 1.51 to 1.27 in the second. We also calculate the rms level of the fluctuations. The increase in B results in the rise of the level from 8.27 to 10.73% relative to the local mean plasma density.

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Irregular structure of the mid-latitude sporadic-E caused by neutral turbulence

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The neutral air turbulence plays an important role in the dynamics of the ionospheric D and E regions. Above an altitude of 80 km a source of the turbulence may be destruction of the atmospheric gravity waves and tides propagating from the lower atmospheric layers and also the nonlinear interaction of planetary waves and tides. These large-scale atmospheric motions are responsible for a vertical shear in the neutral wind that is necessary for the production of mid-latitude sporadic-E. The sporadic-E is an example of the ionosphere-atmosphere interaction. The neutral turbulence exerts an essential influence on sporadic-E parameters and generates its irregular structure. Intensification of the turbulence may decrease the peak amplitude of the layer and increase the sporadic-E thickness. Main steps needed to derive analytic expressions for the spatial spectrum of sporadic-E plasma irregularities caused by the neutral turbulence and for evaluation of the RMS fluctuation level of irregularities are described in the present report. The derived formulae are used to analyze the dependence of sporadic-E irregular structure on the ion composition of the layer under unchanged intensity of the turbulence. The dependence of the irregular structure on intensification of the turbulence under the fixed ion composition is analyzed too. Changes in the ion composition is taken into account through changes in the mean ion mass, mi, whereas intensification of the turbulence through increase in the mean rate of turbulent energy dissipation (TED). Calculations were made for the mid-latitude sporadic-E (magnetic dip angle about 44°) near height of 100 km. An increase in mi caused by heavy metallic ions that are known to exist in the night-time sporadic-E results in the reduction in the RMS fluctuation level of the irregular structure and in decrease of the slope of irregularity spectrum that can be measured during rocket flights. The change in mi from 31 to 51 AMU results in the fluctuation level decrease from 7.7 to 4.1% and change in the power index from -3.0 to -2.6 under the TED rate 10 mW/kg. It is also shown that enhancement of the turbulence (the TED rate changes from 5 to 20 mW/kg) results in the reduction in the fluctuation level form 6.9 to 4.4% and change in the power index from -2.7 to -2.3 for the sporadic-E composition with mi=41 AMU. Results of this report can be tested in rocket experiments that include measurements of parameters of the sporadic-E and the turbulent neutral wind.

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On the remarkable Arctic winter in 2008/9

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It is well known that the interannual variability of the stratospheric winters over the Arctic is very large. On the basis of data for more than 60 winters, this variability has been studied with the aim of understanding and possibly forecasting the type of the coming winter, in the stratosphere and also in the troposphere.Today, there is general agreement that the variability of the stratospheric circulation during the Arctic winters is influenced by different forcing mechanims: by the tropospheric planetary waves which penetrate into the stratosphere, by the Quasi-Biennial Oscillation (QBO) and the Southern Oscillation (SO) in the tropics which influence the stratospheric polar vortex, and by the 11-year sunspot cycle which interacts with the QBO and probably also with the SO. For the winter 2008/2009, all of the known signals pointed to a stable, cold stratospheric vortex throughout the winter, but in the real atmosphere a major midwinter warming (MMW) developed in January and February with record-breaking temperatures. The synoptics of this winter will be discussed in the context of all of the above-mentioned forcing mechanisms, and with the last winter, 2009/2010.

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Berlin and the Stratosphere: Why is Berlin the place for STP-12?

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Berlin is the "Capital for Science" and this year we celebrate 350 years of the Royal Library and 300 years of the Charité (central hospital). Also, 300 years ago Leibniz founded the "Academy of Sciences", and Wilhelm von Humboldt initiated 100 years later the "Berliner Universität" which is named today "Humboldt Universität".
In this short historical review we try to show which part Meteorology and Aerology were playing during these active times. For example: the discovery of noctilucent clouds in 1885 by Otto Jesse; the discovery of the stratosphere in 1901, simultaneously by two carefully working scientists, Richard Assmann and L.Teisserenc de Bort; the unexpected westerlies in the equatorial lower stratosphere in 1908, discovered by Arthur Berson, which were against the present conceptions at that time; and about the discovery of the "Major Midwinter Warmings" by Richard Scherhag in 1952, which later led to the discovery of the influence of the 11-year solar cycle in the stratosphere, in 1987.

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Stratospheric Ozone Changes and their Influence on Weather and Climate

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Ozone is an important trace gas in Earth's atmosphere. 90% of the ozone is found in the stratosphere; highest ozone mixing ratios are measured at ~35 km, while most of the ozone mass is found in the lower to middle stratosphere at ~25 km altitude. Stratospheric ozone protects life on Earth as it absorbs harmful ultraviolet radiation from the sun.

Since the mid 1980s, when Antarctic measurements showed unexpected, strong, recurring ozone losses in spring, stratospheric ozone concentrations have been continuously decreasing due to chemical destruction as a result of anthropogenic emission of chlorofluorocarbons (CFCs) and other ozone depleting substances (ODSs). To avoid further damage to the ozone layer, the Montreal Protocol and several adjustments to control the production and consumption of ODSs were implemented, with the effect of a measurable reduction of CFCs in the lower atmosphere and a stop of the increase of CFCs in the stratosphere by now. Recent measurements indicate a slowing of the global ozone decrease. New model predictions of the future evolution of the ozone layer indicate a recovery of stratospheric ozone in most regions during the 21st century, however with large local differences in the speed of recovery.

In this talk an overview of past stratospheric ozone changes, their impact on the thermal and dynamical structure of the stratosphere, and their possible influence on climate and weather will be given. Future projections of stratospheric ozone change from chemistry-climate models will be presented, and the interaction between ozone recovery and climate change will be discussed.

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Long-term changes and trends in the upper atmosphere and ionosphere

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The anthropogenic emissions of greenhouse gases influence the atmosphere at nearly all altitudes between ground and space. The greenhouse gases are the main driver of trends in the upper atmosphere (mesosphere and thermosphere) but other factors, namely stratospheric ozone depletion, middle atmosphere water vapour, long-term changes of geomagnetic activity and secular change of the Earth's magnetic field play some role as well. The first scenario of long-term trends (and/or global change) in the upper atmosphere and ionosphere has been constructed in 2006. The scenario consists of mutually consistent trends in mesospheric temperatures, thermospheric densities, upper ionosphere ion temperatures, and electron densities and heights of F1, E and D ionospheric layers. However, there were three areas, characterized by key words F2 region, MLT (mesosphere and lower thermosphere) dynamics, middle atmosphere water vapour, which did not fit this scenario. I will deal with the overall pattern of trends in the upper atmosphere and ionosphere with special emphasis to possible effects of solar/geomagnetic activity, to impact of changing trends in stratospheric ozone, and to the three exceptional areas. According to recent model calculations and observational analyses, F2 region parameters foF2 and hmF2 could be at present dominantly controlled by geomagnetic activity and increasing concentration of greenhouse gases, respectively, or even only by greenhouse gases, which removes part of contradictions. Relatively little progress has been reached in mesospheric dynamics; new data on trends in planetary wave activity remain controversial but indications of positive trend in the MLT region turbulence, which is thought to be produced by gravity wave dissipation, have been reported. As for mesospheric water vapour, there is strong indication that after considering different latitudes of satellite and ground-based NLC observations the difference between trends deduced from ground- and satellite-based data remains within limits given by the accuracy of observations, i.e. these measurements need not differ as it was thought earlier. Two key questions for future investigations are trends in MLT (or middle atmosphere) dynamics and links between trends in the upper atmosphere and stratosphere/troposphere.

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Lidar investigation of the middle atmosphere over Buckland Park, Australia, 35°S

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The middle atmosphere is a key link to understand dynamical processes such as tidal, planetary and gravity waves because they change their characteristics (e.g. wavelength, amplitude) when propagating through the atmosphere from their source regions in the lower atmosphere to their breaking altitudes. The characteristics of these waves are still under scientific discussion as they vary significantly with geographical location, season and altitude (Fritts and Alexander 2003). With ground based lidar measurements, various wave characteristics can be observed directly e.g., vertical wavelength, temperature amplitude, potential energy and spectral power density. Nowadays investigating the middle atmosphere by lidar is a well established experimental method and utilised at many sites around the world. However, these sites are predominately in the northern hemisphere and there are very few lidar stations in the southern hemisphere. The southern subtropics is in particularly important as there is significant demand for measurement with high spatial and temporal resolution.

This presentation reports the ongoing development of the lidar facility at Buckland Park (35°S, 138°E), the second in the world at this latitude and the first in Australia. Within The University of Adelaide, the Atmospheric Physics Group, in collaboration with the Optics and Photonics Group, is setting up a facility to host three lidar systems. The aim of this facility is to measure atmospheric temperature and dynamical processes with high spatial and temporal resolution from 15 to 110 km altitude. The current work focuses on the development of a Rayleigh/Mie/Raman (RMR) backscatter lidar for measurements in the altitude range from 15 to 80 km. The derived temperature profiles will be used to study dynamical processes and to establish a climatology at this unique latitude.

The lidar facility completes the Buckland Park site as a unique atmospheric research location as a number of co-location radars and passive optical instruments are in operation since decades. The co-located Stratospheric-Tropospheric (ST) and Medium-Frequency (MF) radars can measure winds and dynamical processes up to 20 km and upwards of 60 km, respectively. The lidar will close this observational gap between 20 and 60 km and provide various parameters for the investigation of dynamical processes. The scientific outcomes of this project will greatly enhance our understanding of the middle atmosphere and will contribute to the evaluation of meteorological satellites and models in this southern subtropical region.

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Kinetic instabilities in the solar wind plasma with suprathermal Kappa anisotropies

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The kinetic instabilities are presently actively invoked in a large variety of astrophysical scenarios because of a wide-spread existence of kinetic anisotropies in space plasmas. The present abundance of data from observations and in-situ measurements in the solar wind reveal not only deviations from isotropy in the velocity space of plasma particles but also a constant presence of suprathermal populations. These are non-Maxwellian distributions with high-energy (suprathermal) tails very well fitted by the Kappa functions. Moreover, the intense electromagnetic fluctuations of the interplanetary fields are traces of the kinetic instabilities which arise in the solar wind and compete with other constraints (adiabatic expansion, Coulomb collisions) for maintaining a relatively small anisotropy. Here we present the main results of the stability analysis for anisotropic distributions modeled with Kappa functions. The new threshold conditions are shown and the growth rates are plotted numerically for typical conditions encountered in the solar wind. The essential phyiscal properties of the kinetic instabilities are retained but both the thresholds and the growth rates are markedly changed by the presence of suprathermal populations. Such analysis including nonequilibrium plasmas is the first step for developing a new transport theory and providing better estimates for the physical parameters characterizing the solar wind plasma.

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Short term variability of the high and mid latitude ionosphere as a result of coupling between the solar wind and magnetosphere

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Ionospheric variability occurs on a range of time scales from days to years and probably centuries. In this talk we focus on the variability which is introduced by the coupling between the solar wind and magnetosphere. This coupling introduces variability on time scales of hours, due to magnetospheric substorms, and days, due to magnetic storms. The changes in the ionosphere are due to enhanced energy deposition into the ionosphere in the form of particle precipitation which results in heating of the plasma and also enhanced electric field resulting in Joule heating of the plasma. At high latitudes the changes in the ionospheric plasma result from the enhanced ionisation from particle precipitation, which can lead to enhanced absorption of radio waves should the particles penetrate to altitudes of 100 km and less. Joule heating on the other hand leads to enhanced temperatures in the ionosphere resulting in enhanced ion loss from either ion upflow or from enhanced recombination. This tends to occur at altitude above about 250 km. At mid-latitudes the variability during substorms may be more related to the propagation of atmospheric gravity waves stimulated by the heating at cusp latitudes or auroral latitudes on the nightisde. These waves propagate to mid and low latitudes resulting in variation in the ionospheric plasma density on time scales of hours. Mid-latitude variations due to storms are extremely complex due to transport of plasma due to winds. In this presentation we shall concentrate on observations of the ionosphere made by the Super Dual Auroral Radar Network (SuperDARN) which extends from the poles to about 40 degrees of latitude in both hemispheres. These radars provide information on the electric fields responsible for Joule heating, ionospheric plasma distributions, in particular enhanced absorption and changes in the F region peak density, and gravity waves. With the continued extension to mid latitudes particularly in the American sector, these radars now provide critical information on the ionospheric variability on the short term.

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Energetic Particle Precipitation in the Upper Atmosphere: Sources and Consequences

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Energetic particles, namely electron and ions, released from the Sun and from the Earth's magnetosphere are important sources of ionization of neutral gases in the upper atmosphere. Owing to their different characteristic energies and energy fluxes, there are distinctive differences in geoeffectiveness among solar energetic protons (SEPs), ring current energetic particles, and auroral particles in terms of their energy deposition in the ionosphere and atmosphere. While precipitating electrons with an average energy <30 keV are mostly responsible for producing auroras above 100 km, precipitating protons contribute about 15% of the total energy input in the auroral zone. Furthermore, the distributions of auroral protons are often different from precipitating electrons both spatially and temporally. Higher energy electrons and ions from 30 keV to a few MeV originating from the ring current can significantly increase electron density as well as NOx and HOx in the upper and middle atmosphere between 50 and 100 km. Solar energetic protons of energies > 1 MeV can penetrate deep into the atmosphere, causing ionization at altitudes below 100 km. SEPs can also significantly alter the neutral composition in regions between the lower thermosphere and upper stratosphere. This paper will demonstrate the effects associated with the energetic particles from the various sources based on numerical simulations from the NCAR TIMEGCM, with an emphasis on the inter-comparison amongst the different source populations.

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Sunspot databases of Debrecen

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The Heliophysical Observatory is the source of the most detailed sunspot data. The DPD (Debrecen Photoheliographic Data) is made by using ground-based observations, it is the continuation of the Greenwich Photoheliographic Results. The SDD (SOHO/Debrecen sunspot Data) is based on space-borne observations, its resolution is lower in space and higher in time than those of DPD. The digitized historical material will later serve as a basis of a long-term catalogue. We give an introduction of these materials and some comparisons with other sunspot datasets concerning data types, precision, biases (with emphasis on area data) and solutions of presentation. Secondary datasets are also derived (e.g. sunspot group tilts, recurrent active regions) or planned (classification of active region types).

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Highlights of the CAWSES priority program in Germany

Lübken Franz-Josef

The German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) has created a priority program for the period 2005-2011 closely linked to the international CAWSES project of SCOSTEP. The aim is a better understanding of the influence of the Sun on the terrestrial atmosphere on time scales from hours to centuries. The focus is on absorption of solar radiation and particles, the generation and modification of photochemically active trace gases, and the generation of waves, including tides. Medium and long term variation of solar activity and its influence on the terrestrial atmosphere is also studied to assess the importance of natural processes in long term trends in comparison with anthropogenic influences. Topics being investigated in the scope of this priority program include: 1. characterisation of the variability of solar forcing by electromagnetic radiation and by particle impact, 2. analysis of solar forcing impact on the thermal, dynamical, electro-dynamical, and compositional structure of the atmosphere in the height range from the upper troposphere to the lower thermosphere and on time scales from hours to centuries (including neutral gas, plasma, and aerosols), 3. investigation of the coupling mechanisms in the atmosphere, including transport of trace gases, and the generation, propagation and destruction of waves, 4. identification and understanding of solar signals in atmospheric parameters which are not directly influenced by the Sun, including a study of the relevant physical and photochemical processes, 5. comparison of solar induced long term variations with anthropogenic climate change (mainly above the troposphere), 6. laboratory studies of physical processes which are relevant for the coupling mechanisms mentioned above. Approximately 80-100 scientists at 25-30 research institutes in Germany are involved in this program. Some scientific highlights of the first phase of this program will be presented.

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Studies of the upper atmosphere using CHAMP

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The recent near-Earth satellite missions carrying high-resolution accelerometers, like CHAMP and GRACE provided a global view of thermospheric features and dynamics. A comprehensive picture of temporal-spatial variability of mass density and winds could be achieved. One of the surprising discoveries is the influence of the geomagnetic field on the neutral particle distribution. Examples are the low-latitude density bulges aligned with the dip-equator and the cusp-related mass density anomaly.

The CHAMP satellite, in orbit since July 2000, has gathered during the past 10 years a continuous data set covering the whole time span from solar maximum to solar minimum. This long time series is particularly valuable for distinguishing between the role of solar flux and magnetic activity in controlling the thermosphere. Magnetic storms play a special role in that context.

Thermospheric winds play a particular role in the ion-neutral coupling. Due to the sparseness of wind measurements, many of the proposed coupling processes could only be investigated theoretically. CHAMP observations changed this situation at least for the zonal wind component. The local time and seasonal distribution of that wind component has been revealed on global scale. A particular interesting result is the longitudinal dependence of the wind velocity. And here it is especially the signature of non-migrating tides at 400km altitude. So far it had been assumed that tidal signals propagating upward are dissipated at about 120km. This new finding made necessary significant adaptations of coupled ionosphere-thermosphere models.

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Solar cycle dependence of ionospheric irregularities, as deduced from CHAMP and GRACE

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The low-latitude ionosphere in the post-sunset time sector is known to be susceptible to instabilities. The resulting electron density irregularities cause severe degradations of communication and navigation signals. Systematic surveys of irregularities over the past decade by the satellites CHAMP and GRACE provide unprecedented insights into the distribution of these phenomena. We show the seasonal/longitudinal distribution of the occurrence rates and how it varies during the declining solar cycle 23. As we have measurements at two different altitudes, the upward propagation manifests itself in the difference in local time distributions at the two spacecraft. Also the very few observations of plasma bubbles by GRACE during the late years suggest that the irregularities do not reach 490km altitude at low solar flux levels.

Our observations further confirm the existence of neutral density depletions accompanying plasma bubble. These, although small, undulations in neutral mass density play an important role in the pressure balance between the magnetic, plasma and neutral particle pressure. Besides the plasma depletions there are also enhancements called plasma blobs. Both, plasma bubbles and blobs are generally accompanied by field-aligned currents which manifest the electrodynamic nature of these phenomena.

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Long-lived and Large-scale Structures Caused by Interacting iCMEs and Their Influence on the Earth and Planetary Magnetospheres

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The interaction of successive interplanetary coronal mass ejections (iCMEs) on their way to Earth (and other planets) has been a leading cause of large-scale and long-lived structures resulting in intense geo-magnetic storms during past solar cycles. Associated with the interaction, the merging of shock waves, which creates denser sheaths and the compression of the magnetic field in ejecta are expected to result in unusal responses of the magnetosphere. Here, we present results of magneto-hydrodynamic (MHD) simulations of geo-effective events from the past solar maximum with the Space Weather Modeling Framework (SWMF). Our focus is on the propagation and interaction of successive iCMEs from the Sun to the Earth and the understanding of the mechanisms which may result in larger and more geo-effective structures. We will also present simulations showing how the Heliospheric Imagers part of SECCHI onboard STEREO can help predicting complex ejecta during solar cycle 24, in particular by determining the direction of iCMEs and even by directly imaging the collision of iCMEs.

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What can we learn about planet Earth by studying other magnetospheres and ionospheres?

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The science of the Earth's magnetosphere and ionosphere has made major progress in the last fifty years, the "Space age". In-situ measurements, i.e. measurements performed by instruments on board Earth orbiting satellites, have been of vital importance for the understanding of the Earth's near space environment. Improved understanding is a product of advanced scientific instruments on dedicated and successively more complex satellite missions. Considering the impressive fleet of scientific satellites that has orbited the Earth and produced a large amount of information, one may therefore raise the relevant question: What can we learn about the Earth by studying the environment of other planets? Considering the cost, complexity and limitations involved in space missions to other planets, that question may seem highly relevant. However, there are at least three important reasons for why comparative planetology and space missions to other planets are important.

The first is that in-situ results have been the most important guide on our way towards progress in the physics of the planetary (e.g. Earth) space environment. Space physics is still in many ways an exploratory field of science. The second reason is that the planets in our solar system, e.g. the Terrestrial planets, are in different stages of their evolution. The Sun is a variable and evolving star, its impact on the planetary environment different from one planet to the other. The third reason is the issue of habitability of planets near a central star, factors leading to and controlling the evolution of life. For instance, in what way does Space Weather have an impact on the habitability of a planet in our solar system?

The gamma-ray source input for the numerical simulation of the lightning neutron generation

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There exist a number of experimental data favoring to the idea of correlation between the thunderstorm discharge activity and growth of the neutron count rate in on-ground as well as space detectors [1,2]. Furthermore, registered are the flashes of the gamma-ray photons in the atmosphere (TGFs) also associating with thunderstorm discharges [3]. These are usually accounted for by the bremsstrahlung radiation of the relativistic run-away electron avalanches moving in the generated during thunderstorms electromagnetic fields. According to the theory first proposed by Babich [4], in interaction of the TGF photons with the atmospheric nuclei the neutrons are born. The question of possibility to detect such neutrons at orbital altitudes is still disputed and various authors get opposite results (see [5,6] and references therein).

Though there appeared a lot of works devoted to these phenomena, the complete enough account of the neutron source is lacking. This is, mostly, due to the fact, that for simulation of the neutron source formation extremely simplified models of gamma-ray source are usually used. However the spatial shape of the source (first of all its vertical size) can play rather crucial role for the formation of neutrons and, possibly, for the total neutron flux at low satellite orbits.

In the present study, we give corresponding analysis of the characteristics of bremsstrahlung photons, generated by relativistic run-away electron avalanche. Using the Monte-Calro numerical simulation package Geant4 we perform modeling of neutron generation process owing to photonuclear reactions that take place during the thunderstorm discharges in the atmosphere. At that, we take into account the most important features of the energetic and spatial distributions of the gamma-ray photons, as well as atmospheric conditions. It is, in particular, shown that the neutrons source can span up to several tens of kilometers, that leads to some re-estimation of the neutron flux at low orbits.

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Flares, coronal mass ejections, and magnetic clouds from a mixed helicity active region

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On 18 and 20 November 2003, active region (AR) 10501 produced a series of M flares all of them associated with coronal mass ejections (CMEs), some of which were identified as the source of subsequent magnetic clouds at 1 AU.
The particularity of this AR is that while observational tracers of the magnetic helicity sign indicate that the large scale field in the region had negative magnetic helicity, the MC associated to the most intense flare/CME on November 18 showed the opposite sign. Furthermore, the filaments observed on November 20 present morphological characteristics that correspond to a negative magnetic helicity sign, the rotation of the polarities of an emerging bipole indicate negative magnetic helicity sign injection; however, the flare ribbons observed after two homologous events can be connected either by field lines computed using a positive or a negative helicity sign magnetic field.
We combine Halpha, EUV, hard X-rays, and magetic field data analysis with magnetic field modeling, topology, and magnetic helicity injection computations to understand the origin of the helicity sign discrepancies and the initiation scenario of the ejective events.

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Formation of shock waves in the solar corona and near-Sun interplanetary space

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At the Sun, shock waves are produced either by flares and/or by coronal mass ejections (CMEs). They are regarded to be the source of solar energetic particle events. In the solar corona, shock waves generate solar type II radio bursts. The propagation of a disturbance away from an active region through the corona into the interplanetary space is considered by evaluating the radial behaviour of the Alfven speed. The magnetic field of an active region is modelled by a magnetic dipole superimposed on that of the quiet Sun. Such a magnetic field structure leads to a local minimum of the Alfven speed in the range 1.2-1.8 solar radii in the corona as well as a maximum of about 740 km/s at a distance of 3.8 solar radii. The occurrence of such a local minimum and maximum has important consequences on the formation and development of shock waves in the corona and the near-Sun interplanetary space and their ability to accelerate particles. That leads to a temporal delay of the onset of solar energetic particle events with respect to both the initial energy release (flare) and the onset of the solar type~II radio burst.

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Response of the whole atmosphere to solar cycle changes in radiative and geomagnetic forcing

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This talk presents a model study of the atmospheric response from the surface to the lower thermosphere to changes in solar and geomagnetic forcing over the 11-year solar cycle. The study utilizes the latest version of the NCAR Whole Atmosphere Community Climate Model (WACCM4), a chemistry climate model with coupled ocean, sea ice and land components. The model is run with observed variability in solar radiation, auroral activity and trends in radiatively active chemical species. Multiple linear regression is used to separate secular changes in chemistry and dynamics from those correlated to the periodic solar forcing. The extent to which 11-year solar cycle variability leads directly or indirectly to changes in the troposphere is investigated.

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Solar Influence on Climate: top down or bottom up?

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To further investigate solar influence on climate via the recently proposed combined effects of the stratospheric "top-down" and the tropospheric "bottom-up" mechanisms, we present a detailed analysis of experiments carried out with NCAR's Whole Atmosphere Community Climate Model (WACCM3), a chemistry-climate model that incorporates the whole atmosphere up to the lower thermosphere. The simulations span 10 solar cycles with realistic time-varying solar forcing, a synthetic time-varying QBO, and an interactive ocean. We analyze in detail the impact of UV variations on the stratosphere, and their indirect circulation changes throughout the atmosphere, as well as changes in the tropical troposphere, with special focus on changes in the tropospheric circulation patterns, cloud formation and precipitation. The results will be compared to a similar WACCM experiment without a QBO to highlight the role of the QBO in modulating the solar signal.

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Non-Migrating Tidal Effects in the Ionosphere as simulated by TIME-GCM

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The ionosphere and the electrodynamics of the atmosphere are closely intertwined. Although the ionosphere is ionized mainly by solar radiation it is also influenced from below. Space-borne observations of ionospheric densities and derived ExB/B^2 drift at low and mid latitude show longitudinal variations even during geomagnetic quiet times. Studies have confirmed that many of these variations can be connected to the propagation of non-migrating tides which are excited in the troposphere.

The National Center for Atmospheric Research (NCAR) Thermosphere-Ionosphere-Mesosphere-Electrodynamics General Circulation model (TIME-GCM) can reproduce part of the longitudinal variation if forced with the Global Scale Wave Model (GSWM) at the lower boundary (ca. 30 km). We will use an updated GSWM-09 tidal climatology to force TIME-GCM from below in order to examine the tidal effects in the ionosphere. We will focus on geomagnetic quiescent conditions and report on the seasonal variability of the electrodynamic effects of the tides. Comparisons with space-borne observations can show how realistic these effects might be. Model studies like this can help to understand if certain tides are more effective in varying the ionosphere.

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Gravity waves and their effects in the thermosphere during low and high solar activity

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Propagation of internal gravity waves (GWs) from the lower atmosphere into the upper thermosphere, and their dynamical and thermal effects have been studied under low and high solar activity described by the $F_{10.7}$ cm parameter. A nonlinear spectral parameterization accounting for different dissipation mechanisms of GW harmonics in the thermosphere has been used in offline calculations with typical wind and temperature distributions from the HWM and MSISE-90 models, and in simulations with the University College London Coupled Middle Atmosphere-Thermosphere-2 (CMAT2) general circulation model (GCM) under solstice conditions. GW harmonics with horizontal phase speeds less than 100 m s^{-1} have been utilized with an appropriate distribution of initial wave momentum fluxes at the source level (15 km). GW drag and wave-induced heating/cooling turned out to be smaller below ~170 km at high solar activity, and larger above, compared to the low solar activity case. The maxima of GW momentum deposition occur much higher in the upper thermosphere, but their peaks are half as strong in the winter hemisphere when the solar insolation is large. Instead of strong net cooling in the upper thermosphere, GWs produce a weak heating at high solar activity created by fast, high-frequency waves that are less affected by attenuation. Molecular viscosity increases with solar activity at fixed pressure levels, but seen in the Cartesian altitude coordinates it can either increase or decrease in the lower thermosphere, depending on the height. Therefore, in pressure coordinates, in which most GCMs operate, the influence of larger temperatures on GWs can be viewed as a competition between the enhanced dissipation and vertical expansion of the atmosphere.

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A 22-yrs Hurricane Cycle and its Relation to Geomagnetic Activity

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Applying spectral analysis to the Atlantic and Pacific hurricane time series, we found periodicities that coincide with the main sunspot and magnetic solar cycles. To assess the possibility that these periodicities could be associated to solar activity, we obtain correlations between hurricane occurrence and several solar activity-related phenomena, such as the total solar irradiance, the cosmic ray flux and the Dst index of geomagnetic activity. Our results indicate that the highest significant correlations are found between the Atlantic and Pacific hurricanes and the Dst index. Most importantly, both oceans present the highest hurricane-Dst correlations during the ascending part of odd solar cycles and the descending phase of even solar cycles. This shows not only the existence of a 22yrs cycle but also the nature of such periodicity. Furthermore, we found that the Atlantic hurricanes behave differently from the Pacific hurricanes in relation to the solar activity-related disturbances considered.

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Equatorial ionospheric irregularities observed with C/NOFS satellite and occurrence of VHF scintillation during the current deep solar minimum

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Communication Navigation Outage Forecasting System (C/NOFS) was launched in order to monitor and forecast ionospheric scintillation. In early October 2008, the C/NOFS satellite orbited near the magnetic equator at its perigee altitude of ~400 km at dusk in the Peruvian sector. This provided an ideal opportunity for a comparison between plasma density disturbances measured by the Planar Langmuir Probe (PLP) instrument on the C/NOFS satellite at perigee and VHF scintillation activity at Ancon on the magnetic equator. Two extreme cases are shown in this study: one in which severe in-situ disturbances was accompanied by mild scintillation on a particular day, namely, 10 October while there was little in-situ disturbance with strong scintillation on 5 October. This apparent contradiction was diagnosed further by a latitudinal ground-based GPS network at Peruvian longitudes, a digisonde, and the incoherent scatter radar (ISR) at Jicamarca. The crucial distinction was provided by the behavior of the equatorial ionization anomaly (EIA), which was well-developed on the day (Oct 10) having severe in-situ disturbance. However, this led to lower equatorial plasma density and total electron content (TEC) at the equator and consequently reduced scintillation at Ancon. The NRL SAMI2 model was utilized to gain a greater understanding of the role of neutral winds and electric fields in reproducing the TEC as a function of latitude. Spectral studies with hi-resolution in-situ PLP data were also performed. The power law spectra within the plasma bubbles showed two slopes: the low frequency slope being ~ -5/3 and the high frequency ~ - 5 with a break around wavelength=70 m. This particular type of two-slope spectra may be related to the extremely low solar activity and its impact on neutral composition and temperature. It is important to know that during the sustained solar minimum strong VHF scintillations could be accompanied by bottomside irregularities below the perigee of C/NOFS, thus making them difficult to predict. We will investigate the occurrence probability of the bottomside irregularities that causes VHF scintillations in absence of in-situ disturbances statistically.

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Effect of Major Solar Energetic Particle Events on Polar Stratospheric Aerosols for Cycle 23

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The present work is focused on evaluation of the possible influence of the greatly enhanced ionization caused by extremely strong solar energetic particle (SEP) events likes ground level enhancement events upon formation of new and growth of pre-existing aerosol particles in the low stratosphere over the polar region. A detailed analysis of variations of the daily profiles of aerosol extinction, obtained by space-borne POAM instrument in different wavelengths, for both Arctic and Antarctic polar regions during periods of major SEP events was done. We found statistically significant changes in the aerosol parameters associated with the SEP events. This means that increasing of solar cosmic rays induction ionization rate in the polar atmosphere leads to changes of physical-chemical properties (specifically the mean size of aerosol particles) in this area. A statistical test confirms that the observed changes of the chemical and physical properties of the polar troposphere are significant and are unlikely to be related to a spatial or temporal independent meteorological fluctuation of the aerosol and others contents.

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The atmospheric response to solar cycle variability simulated by MAECHAM5 with and without ocean coupling

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The 11-year solar cycle variation has a well demonstrated impact on the Northern Hemisphere winter stratosphere. During early winter of maximum solar activity years the stratospheric vortex tends to be stronger and colder in contrast to minimum activity. While there is a relative consensus on the stratospheric response, the pathways through which the solar signal is propagated into the troposphere are still under debate. The surface response in particular regions, as in the Equatorial Pacific, further perplexes our understanding. In this work, we explore the inseparable troposphere-stratosphere response of the 11-yr solar cycle with the aid of fully coupled atmosphere-ocean general circulation model (GCM).

Simulations with the MAECHAM5 GCM with a realistic time varying solar forcing (as observed from 1955 to 2006) and prescribed ozone anomalies are carried out. No other external forcing is considered. The quasi-biennial oscillation (QBO) is spontaneously generated in the model. We conduct 9 ensemble runs over 52 years each with MAECHAM5 coupled to the MPI ocean model (MPIOM) and compare the results to another 9 member ensemble with prescribed sea surface temperature (SST).

In this study, the domain of interest is the equatorial and subtropical stratosphere and troposphere with a special focus on the Pacific region. Our analysis reveals that the tropospheric response in the coupled runs differs substantially from the uncoupled. The prescribed SSTs damp the temperature solar signal and statistically significant results are obtained only in the experiments with time varying SSTs. Both coupled and uncoupled simulations show a pronounced secondary maximum in the lower equatorial stratosphere which is somewhat stronger in the coupled ensemble. In the equatorial Pacific a tongue of weak negative temperature anomalies can also be found. In our presentation, we further elaborate on the mechanisms that may explain the simulated solar response.

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Variability of solar activity and cosmic rays, and their influences on climate change

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In this paper, we discuss the long-term variation of solar activity during the last 6000 years, based on the frequency analyses of annually measured carbon-14 content in tree rings. The long-term variations of solar activity are often reconstructed based on decadal data of cosmogenit nuclides, however, it is difficult to eliminate the variations caused by the changes in climate change, anthropogenic effect and the geomagnetic field intensity. So far, multiple scenarios for the long-term variation of solar activity level have been derived based on the data sets of cosmogenit nuclides. Our previous studies have shown that the actual length of solar decadal cycle may be another independent reference for the absolute level of solar activity. Our records obtained so far indicate that the lengths have varied within 8-15 years depending on the level of long-term solar activity.

In this paper, we also discuss the variability of the flux of galactic cosmic rays at the earth related to the variation of solar magnetic activity since the Early Medieval Maximum Period. We apply the records of multiple cosmogenic nuclides with annual resolution to derive the information on the variation of incident cosmic rays in the past. The reconstructed variation of cosmic rays shows that the components of the 11-year and 22-year variations in cosmic rays vary in time depending on the long-term level of solar magnetic activity. These characteristic variations of cosmic rays have been also detected in the reconstructed northern hemispheric temperatures and the humidity change in Japan, and thus it is suggested that cosmic rays are playing important role in climate change at the hemispheric scale.

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Solar-Terrestrial Effects in the Mesosphere and Thermosphere Observed by the TIMED/SABER Instrument

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Solar-terrestrial effects in the mesosphere and thermosphere are readily observed in the data from the TIMED/SABER instrument now in orbit nearly 8.5 years. The effects are evident in the energy balance, the thermal structure, the chemical composition, and by inference, the atmospheric dynamics. Effects are evident on time scales ranging from 1 day to the 11-year solar cycle. Of particular interest is the study of the thermospheric cooling during the prolonged solar minimum and the relative response of cooling by carbon dioxide and nitric oxide. We observe the latter to have decreased by an order of magnitude in the last 8 years. During geomagnetic storm events the emission from NO may increase by an order of magnitude over a day and then rapidly revert back to pre-storm conditions. In the mesosphere the effects of solar and geomagnetic variability are less pronounced, but still quite evident, for example in cooling by carbon dioxide. In this talk we will present an overview of the solar-terrestrial effects observed by SABER as well as future plans as the instrument heads towards 11 or more years of observations.

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The Relation Between Coronal Holes and CMEs During the Rise, Maximum and Declining Phases of the Solar Cycle 23

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We investigate the influence of coronal holes on the propagation of CM Es through considering both ICM Es categories with and without flux rope structures, i.e. magnetic clouds (M Cs) and non magnetic clouds (non-M Cs), during the three phases of the solar cycle 23 and compare the results obtained with that of the driverless shocks reported previously by Gopalswamy et al., 2009b. The results show that the correlation coefficient in the case of M C events is very high at the rise phase (~0.99), while it is for declining phase ~-0.62. This result confirms the correspondence between the non-radial motion during the rise phase of the solar cycle and the existence of the higher magnetic field strength in the solar regions of the polar coronal holes during this phase. For the maximum phase the correlation coefficient in case of magnetic clouds is ~-0.30. The correlation coefficient values are found to be much less for non magnetic clouds during the three phases; with the highest value turned to be for the declining phase (ccd=-0.2). The difference between measured position angle (M PA) and the influence position angle (FPA) s pointing, ($\Delta\psi$), is found to be in the case 3 where the CH is located between the eruption region and disk center ~35o for the non-M Cs in the maximum phase and in case 2 where the disk center is located between the CH and eruption region ~34o for the non-M Cs events in the rise phase which is consistent with the value of $\Delta\psi$ for driverless shocks given by Gopalswamy et al., (2009b) (where $\Delta\psi \leq$ 37o). These results together with the average influence parameter value (Favd=2.5 G) which is found to be the highest compared to the other two phases and also to the M Cs average values suggest that the non M Cs is resembling in their behavior the driverless shocks (which have been proven by Gopalswamy et al., (2009a,b) to be deflected by the near by CH s away from the Sun-Earth line) and that the non M Cs may have flux rope structure as the M Cs do have but this structure is hidden from observation due to the deflection by CH s. This finding may have bearing on the idea that all CM Es may be flux ropes and the difference is only due to the viewing angle variation.

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Influence of Solar Activity on Stratosphere Troposphere Interactions

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Studies on the influence of solar activity in 11-year cycle on wind and temperature pattern at various altitude levels in the troposphere and stratosphere have been carried out based on the ECMWF global reanalysis data. The study covers all latitude zones at 10 degree latitude by 30 degree longitude areas over the entire globe and in the vertical levels, lower-, middle- and upper-troposphere, tropopause, lower-, middle- and upper- stratosphere. The long-term trend and short period fluctuations were removed from the data series. Solar radio flux at 10.7 cm has been selected as the indicator of solar activity. Stratospheric temperature shows a strong association with solar activity in the 11-year cycle, especially in the upper stratospheric region. Tropical stratosphere gives a consistent and steady link to the changes in solar activity. Temperature in the lower troposphere shows large spatial variability with the solar changes and the effect is seen to be less compared to that of the stratosphere. Increase in the solar radio flux tends to strengthen winter westerlies in the upper stratosphere over the mid-latitude and summer easterlies in the middle stratosphere over tropics. Larger variability in the zonal wind is noted near stratopause height. Results obtained from the study indicate that changes of mean zonal wind in the stratosphere are usually associated with changes in wave forcing, and feedbacks which provide a mechanism for coupling between the highly dense and convectively active troposphere and less dense and radiatively driven stratosphere. These results can be incorporated for further understanding on the dynamics interaction between the stratosphere and troposphere in association with the changes in solar activity.

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The solar and geomagnetic activity influence on long-term change of troposphere characteristics

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Mechanisms of solar activity effects on weather and climate have been discussed. Authors proposed a physical mechanism of solar activity effects on climatic characteristics and the atmospheric circulation through the atmospheric electricity. A model of the solar activity effect on climatic characteristics of the Earth's troposphere was elaborated on the basis of the mechanism under consideration. The model key concept is the heliogeophysical disturbance effect on the Earth climatic system's parameters, which influence energy flux going from the Earth to space in high-latitude areas. According to our model, when the solar activity increases, radiation cooling of high-latitude regions decreases, thermobaric field restructures, average meridian gradient of temperature between polar and equatorial regions decreases, defining the atmospheric circulation. The energy outflow from low latitude regions falls as a result of the decrease of meridional temperature gradient; it results in the temperature increase at middle and low latitude.

In the framework of the model considered, the analysis results are presented and discussed of regularities of variations in geomagnetic activity and troposphere thermobaric characteristics for 1900–2007. It was shown that observable long-term changes in troposphere characteristics are generally caused by changes in the underlying surface. It can be explained by the fact that the accumulation of individual heliogeophysical disturbance effects occurs in the underlying surface (mainly in the ocean).

The continuous increase of the Earth climatic system heat content has been observed from 1910 till now. Under the model, we made analysis of regularities, which underlie variations of geomagnetic activity and troposphere thermobaric characteristics. These results and changes of the global circulation in the atmosphere and ocean allow the conclusion that the warming observed in the 20^{th} century can be mostly explained by variations of the solar activity level.

Scenario for long-term changes of physical processes in the Earth atmosphere, cryosphere and ocean is presented on the basis of the model of the solar activity effect on the troposphere circulation and thermobaric characteristics.

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Long-Term Changes in Sunspot Activity, Occurrence of Grand Minima and Their Future Tendencies

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Long-term changes in magnetic activity of the Sun were studied in terms of the empirical mode decomposition that revealed their essential modes. Occurrence of the grand minima was also studied in their relation to long-term changes in sunspot activity throughout the past 11000 years. Characteristic timescales of long-term changes in solar activity manifest themselves in the occurrence of grand minima. A quantitative criterion has been defined to identify epochs of grand minima. This criterion reveals the important role of secular and bicentennial activity variations in the occurrence of grand minima and compares their amplitudes with the current activity level that is variable on a millennial timescale. We have revealed specific patterns in the magnetic activity between successive grand minima which tend to recur approximately every 2300 years but occasionally alternate with irregular changes. Such intermittent activity behaviour indicates a low dimensional chaos in the solar dynamo due to the interplay of its dominant modes. The analysis showed that in order to forecast activity level in forthcoming cycles, one should take into account long-term changes in sunspot activity on a ~2300-yr timescale. The regularities revealed suggest solar activity decrease in the foreseeable future.

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Local Dst/Dcx indices: New space weather products from the SOTERIA project

Mursula Kalevi, Holappa Lauri, Karinen Arto, Leikanger Tore

The Dst index is one of the most used geomagnetic indices that is constructed to monitor the most dramatic events in the near-Earth space, the geomagnetic storms. The Dst index is calculated as an average of disturbances observed at four low-latitude stations, roughly equally distributed in longitude. However, in addition to the ring current, other current systems like the tail current, magnetopause current and partial ring current contribute to the Dst index. Therefore, the local disturbances at the four stations are very often quite different. Moreover, because of the problematic Dst recipe, the different Dst stations contribute to the Dst index with systematically different weights.
We have calculated a revised version of the Dst index, the so called Dcx index, where the different stations contribute with equal weights. So far, the Dst/Dcx indices have been based only on four stations. Such a coarse longitudinal accuracy does not allow for a detailed study of the local time structure of storm time disturbances due to asymmetric current systems like the partial ring current and the tail current. Therefore, we have increased the number of stations used to calculate the Dcx index to 16 stations. This longitudinally enhanced index is called Dcx16. Within the FP7 SOTERIA project both the Dcx and Dcx16 indices, together with all the 16 local Dcx indices observed at each contributing station will be made available. This offers an ample range of new possibilities for detailed studies of storm time disturbances and currents.

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The Heliospheric Current Sheet During the Peculiar Solar Minimum 23/24

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The heliospheric magnetic field (HMF) has long been hemispherically asymmetric so that the field dominant in the northern hemisphere is weaker and the area larger than in the south. As a consequence, the heliospheric current sheet (HCS) is shifted southwards. This asymmetry, also called the bashful ballerina, has existed during roughly three years in the late declining to minimum phase of solar cycles 16-22.

We study here the asymmetry and thickness of the HCS during the exceptional declining phase of cycle 23 using ecliptic (low-latitude) and high-latitude observations. We find that the latitudinal ordering of HMF sectors at low latitudes is exceptional in SC 23: While the typical latitudinal variation was attained in the north in 2008, it did not take place in the south until Spring 2009, implying that the Rosenberg-Coleman rule is abnormally delayed or broken for the first time. Comparing the low-latitude HMF observations at 1 AU with the coronal source surface field, we find that the HCS is considerably less asymmetric at low latitudes during SC 23 than in earlier cycles. However, the Ulysses perihelion observations in 2007 show that the field asymmetry at high latitudes is as large in SC 23 as earlier. Ulysses also shows that the HCS region is considerably wider during SC 23 than in SC 22, which is likely due to the exceptionally large tilt angles and weak polar fields in Sc 23. Thus, the HCS is indeed southward shifted even during the exceptional solar cycle 23 but the exceptionally thick HCS makes this difficult to be observed by low- latitude observations. We also note that the exceptional properties of SC 23 (weak dynamo, wide HCS, small HCS asymmetry in low-latitude observations) agree with the historical evidence that the active Sun leads to a greater asymmetry in low-latitude observations.

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Long-term variability in geomagnetic activity and storminess: Implications for solar and heliospheric structure and development

Mursula Kalevi
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Geomagnetic activity forms one of the most reliable and versatile ways to study the long-term change in the Sun and heliosphere. Continuous measurements of geomagnetic activity exist since the mid-19th century, covering nearly 170 years. In addition to the long-term trend, geomagnetic activity depicts persistent patterns and periodicities, the most dominant of which are the solar cycle variation and the semiannual variation. Other significant periodicities include the annual variation, 1.3-1.8-year variation and the 22-year variation. All these variations reflect fundamental properties of the Sun and the Sun-Earth connection. Interestingly, although some of these patterns are known for nearly 150 years, they are properly appreciated and understood only since recently. In this contribution I review the present status of the traditional and new indices of geomagnetic activity, discuss the present understanding of the systematic patterns reflected in geomagnetic activity, including the centennial change of geomagnetic activity and their implications on the long-term change of the Sun.

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High-speed solar wind streams influence on relativistic electrons in the outer earth's radiation belt during the solar activity minimum.

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SINP MSU

One of the goals of the experiment on board Russian space solar observatory CORONAS-Photon is the investigation of the space weather, in particular the relativistic electron flux dynamics in the radiation belt of the Earth's behavior. Although, geomagnetic activity during whole 2009 was very low, sometime radiation conditions demonstrated variations typical for moderate magnetic storms. The increased (about two order) fluxes of the relativistic electron with the energy 1-4 MeV were measured after the small magnetic disturbance on 13 March 2009. This enhancement was caused by high-speed solar wind stream incoming to the Earth's orbit. The next enhancement of the relativistic electron flux was observed on April, 9, after the next high-speed stream's coming to the Earth. During the September, October and November 2009 the similar electron flux enhancements were observed also, but their amplitudes were significantly lower. Electron-M-Pesca is the semiconductor telescope was created for the detection of electrons with the energy 200 keV- 1 MeV, 1-4 MeV and > 4 MeV. These observations show that near-Earth's environment is strongly caused by the solar wind during solar minimum.
This work was partly supported by RFBR foundation grants 07-02-92004-HHC_a.

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Dynamo Model Based Solar Cycle Predictions

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Predicting the amplitude of future sunspot cycles is important for assessing it's forcing on planetary atmospheres, including climate and mitigating the adverse effect of space weather on our technologies based in space and here on Earth. The origin of the sunspot cycle and its fluctuations is governed by a magnetohydrodynamic dynamo mechanism in the solar interior. Ultimately therefore, physics based predictions of the solar cycle can only be achieved if we understand the processes that contribute to this dynamo mechanism. Such dynamo based predictions of the upcoming Solar Cycle 24 has however generated completely different results (from very high to very low predictions). Moreover, the NOAA-NASA international solar cycle prediction panel charged with coming up with a forecast failed to arrive at a consensus early on, and later revised its prediction for Solar Cycle 24. In this talk, based upon some recent work, I will argue that we are just beginning to understand the interplay between different processes that determine the physics of solar cycle prediction. I will also present results that may help discriminate between the different (physics based) solar cycle predictions, and which may eventually lead towards a more physically well-founded forecast for the upcoming Solar Cycle 24

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Assimilation of Earth Orientation Parameters to Constrain Natural Variability in an Atmospheric Model

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It has been known for some time that global-scale atmospheric modes of variability, such as ENSO, affect the global atmospheric angular mometum (AAM). The vector components of AAM can furthermore be inferred from the parameters which define the earth's rotational rate and axis. These earth orientation parameters (EOPs) are regularly observed by a variety of methods and intruments, and provide a new constraint for the simulation of natural climate signals in earth system models.
Here we discuss the problem of formally assimilating observed EOPs, most notably the rate of rotation of the Earth (i.e. the length of day) into the global atmosphere model ECHAM5/MESSy. Using a conceptual model, we illustrate and discuss the problem of assimilating a global integral quantity in order to infer information about individual components of a model state. We also present a full diagnosis of the representation of AAM in the ECHAM/MESSy atmosphere, as well as a discussion of our progress towards an operational assimilation system.

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Indonesian Climate Variability due to Solar Terrestrial Interaction

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Since a long time ago Sun as the main source of energy of the Earth has been considered to influence the climate. Various data and methods have been used to show the relationship between solar activity and climate. This influence may be globally, locally, or regionally, with or without delay time. Indonesia, as located in equator, between two continents and two oceans become very important in global atmospheric convection affecting climate by induces and controls the atmospheric and oceanic circulations.

To ensure the solar activity affecting in cloud cover over Indonesia we compare the period of both cloud cover all over Indonesia and solar activity parameter, f10.7 by using wavelet analysis. We found a declining period about 11 years indicating the solar signal especially for dry seasons (June-August) from 1976-1995 cloud cover satellite data and other signal with the period of about 6 years down to 3 years. We suggested that eastern Indonesia is dominantly influenced by ENSO and western by IOD. Pontianak, which represent middle Indonesian region is suggested correlated strongly with solar activity cycle.

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On large-scale wave coupling into the upper atmosphere

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A variety of new evidence suggests that large-scale atmospheric waves such as tides and planetary waves driven in the lower and middle atmosphere are an important ingredient in geospace variability and space weather. Atmospheric tides due to persistent tropical rainstorms produce large longitudinal and local time variations in bulk ionosphere-thermosphere-mesosphere (ITM) properties, i.e., temperature, wind, composition, airglow and plasma density, to name a few. Oscillations of F-region plasma density and other ITM properties at planetary wave periods at least partly reflect the planetary wave activity and variability in the stratosphere. All theses waves may further interact with each other, with gravity waves, and the background atmosphere when propagating upward through the stratosphere to the thermosphere and ionosphere, hence producing additional variability and/or secondary waves.

This paper gives an overview of the relevant physical processes including wave sources, propagation, dissipation and their effects. What are they? Why do we care? What is the state-of-the-art? What are the future challenges? Diagnostics from various satellites and ground-based stations will be presented along with modeling results and put into the context of SCOSTEP's Climate and Weather of the Sun-Earth System (CAWSES)-II program 2009-2013.

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Sensitivity of the 11-Year Solar Signal in the Atmosphere to Spectral Solar Irradiance Data and Ozone

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The effect of solar variability on the atmospheric radiation budget as simulated in chemistry climate models (CCMs) strongly depends on the capability of the broad-band radiation schemes used by the CCMs to account for the spectral variations of solar irradiance. Another aspect influencing the amplitude of the simulated solar signal are the spectral solar fluxes that need to be prescribed at the top of the model atmosphere. The purpose of this study is to quantify the effects of prescribing different solar flux data sets on the simulated atmospheric response, and to compare these to the atmospheric effects of the 11-year variations in both the solar flux and the ozone, respectively. We will present results obtained with the FUBRad short-wave radiation parameterization (Nissen et al., 2007) that was run in offline-mode and as short-wave (SW) radiation module in the ECHAM5-MESSy (EMAC) CCM. SW heating rate differences between a minimum (September 1986) and a maximum phase (November 1989) of the 11-year solar cycle will be compared. They are calculated using observed spectral solar flux variations from three different data sets: (a) daily spectral data from UARS/SOLSTICE described in Lean et al. (2005), (b) spectral solar irradiance reconstructed from the SATIRE model based on SOHO MDI imaging (Krivova and Solanki, 2005), and (c) scaled solar variability data derived from SCIAMACHY (Pagaran et al., 2009). The effect of solar induced ozone variations are taken into account by prescribing two ozone climatologies for solar maximum and minimum conditions respectively, taken from offline calculations with a chemical transport model and the EMAC CCM.

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Solar cyclicity and global magnetic fields

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The nature of large-scale magnetic fields (LSMF) and their coupling with local fields are discussed. The results of helioseismic studies are used to investigate the problem of LSMF generation, taking into account their meridional drift. During an activity cycle, the global field never goes to zero, but only changes its direction. The LSMF data are shown to be important for long-term (5-10 years) prediction of solar activity. The heating of the solar corona is simulated using the intensity and structure of LSMF. It is shown that the velocity of high-speed streams depends both on the area of coronal holes and on their contrast. The background fields consist of fine elements with the predominantly transversal field. The active longitudes arise at intersection of the heliospheric and geographical equators. A forecast is produced expecting low activity in the first third of the XXI century.

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General Circulation Changes Seen in the Mesosphere

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Temperature measurements at two OH stations (Wuppertal, 51°N, 7°E; Hohenpeißenberg, 48°N, 11°E) cover almost two solar cycles (#22, #23) and are analyzed for long-term trends and solar influences on an annual basis.

The seasonal variations of OH temperatures (high values during winter, low values during summer) are counter-intuitive and are closely linked to the atmospheric circulation. The width of the "summer-valley" is monitored for long-term changes by means of the "Equivalent Summer Duration" (ESD) which is defined as the time span with temperatures lower than 198 K. A long-term increase of ESD is found with a rate of about one day per year. Temperature trends have also been analyzed on a monthly basis. They are quite different in different parts of the year which explains the ESD trend. Summer duration in the stratosphere has been determined from zonal wind turn-around in spring and autumn. A long-term change is observed here, too. Its sign is, however, opposite to that in the mesosphere, i.e. summer duration becomes shorter. These summer length changes are interpreted as long-term changes of middle atmosphere general circulation. They appear to be linked to changes of the Eliassen-Palm flux from the troposphere to the lower stratosphere.

Recent analyses of Quasi Two-Day Waves (QTDW) in the summer mesosphere have found a triple maximum of amplitudes. This triplet has changed its form during the last 21 years. Thus the dynamical stability of the mesosphere has changed. This is supported by corresponding changes of the baroclinic instability that has been derived from wind measurements at Juliusruh (54°N, 13°E). In summary there are quite a number of different parameters measured by different methods and at different altitudes that consistently support the idea of a circulation change in the mesosphere.

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The 3-4-Day wave effects on the Brazilian equatorial ionospheric region. Observation and modeling.

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We investigate effects of planetary scale waves on the ionospheric parameters, h´F and foF2, in the equatorial ionosphere. In order to find out planetary wave oscillations in the mesopause region, temporal variations of the mesospheric wind structure measured by meteor radar at São João do Cariri (7.4 ^{o}S, 36.5 ^{o}W) were used. For the ionospheric parameters ionosonde data at Fortaleza (3.9 ^{o}S, 38.4 ^{o}W) were used. The wavelet analysis was used to identify the 3-4-Day Kelvin wave oscillations in the observational data, and some coincidence between the parameters was analyzed. The effect of winds induced by the planetary waves in the ionospheric parameters was tested using the ionospheric model "CODB2005" (Codigo de Batista 2005). Some relevant results in comparison of the model calculation and observed oscillation amplitude will be presented.

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Study of recent delta-D time series from Antarctica, Andes and Greenland ice cores.

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The relative abundance of fractioned stable isotopes in the water molecule allows the reconstruction of past climate, which improves the actual knowledge on the terrestrial climate dynamics. Analysis of the ice-cores isotopic composition, through the measurements of the ratio between the hydrogen and its isotope deuterium (H/D or delta-D) and between the stable oxygen and its isotope ($^{16}O/^{18}O$ or delta-^{18}O) may allow information on physical process involved in the global hydrological cycle, considering their sensitivity to each step of this process (evaporation from the sea surface, air mass mixture and long range transport, water vapour condensation and snow freezing). Identify the main source of its temporal variations could be the key of the climatic changes studies. Through the spectral and coherence analysis of five recent delta-D time series measured at di
fferent locations, we discuss the solar cycle information inside its spectral features, as well as the imprints of large-scale atmospheric circulation on the isotopic data.

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Variation of the Mesospheric Ozone above the Arctic caused by solar influence observed by ground-based millimeterwave radiometry

Palm Mathias, Wieters Nadine, Hoffmann Christoph, Sinnhuber Miriam, Golchert Sven, Notholt Justus

We present measurements of strato- and mesospheric O3 with a time resolution of 1 hour and an altitude range from 25 to 90 km. The instrument is located in the high Arctic at 79N.

Ground based millimeterwave radiometry offers the opportunity to measure O3 at a narrow and well defined spot in the mesosphere. Because of the slowly moving sun in the high Arctic, the state of the mesosphere regarding to solar illumination can be assumed to be constant throughout the measuring time of about 1 hour.

The measurements are compared to the model output of a 3D chemical-transport model which is developed at the IUP. The model is appended using mesospheric chemistry and includes solar forcing of the atmosphere.

The VMR of O3 strongly depends on the solar illumination. The strongest variation is due to the equilibrium reaction O3 + nu <-> O + O2, which creates the diurnal variation. There are, however, other variations which do not follow this scheme and are less well understood.

The qualitative agreement of the model and the measurement is good, the quantitative agreement ranges from excellent to rather poor. It is assumed that variation of the O3 content in the mesosphere due to solar illumination strength is not well represented. Possible sources for the observed variation and the underlying mechanisms are discussed and quantitavely studied.

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Atmospheric Tides and Planetary Waves in the MLT and their Role in the Atmosphere-Ionosphere Coupling

Pancheva Dora , Mukhtarov Plamen
Geophysical Institute

With the recent accumulation of the satellite ionospheric measurements some attention is now being directed towards investigating the impact of wave forcing from the lower atmosphere. Recently when the level of solar activity is very low and when there is not a flare or geomagnetic storm in progress it is particularly appropriate for investigating the vertical coupling of the atmosphere-ionosphere system by atmospheric tides and planetary waves. The six-satellite Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC) mission makes routine ionospheric measurements over the entire globe using occultation techniques. These observations have been used in to develop global-scale maps of the electron density for altitudes between 100 km and 800 km and for the period of time between January 2008 and March 2009. The temperature measurements from the Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) instrument on the Thermosphere-Ionosphere-Mesosphere-Energetics and Dynamics (TIMED) satellite have been analyzed in order to derive the global spatial structure and temporal variability of the atmospheric tides (migrating and nonmigrating) and planetary waves (stationary and zonally propagating) from the lower stratosphere to the lower thermosphere (20-120 km). For a given altitude and latitude the COSMIC electron density is analyzed in the same way as that used for the SABER temperatures. In this way it is possible to extract ionospheric disturbances with a given period and zonal structure. The presentation will be focused mainly to the global distribution and temporal variability of the ionospheric response to the eastward propagating diurnal tides with zonal wavenumbers 2 and 3.

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Superposition Effects in the Mesosphere and Lower Thermosphere Associated with Tides

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Geophysical Institute

Atmospheric tides often constitute the dominant dynamical component of the mesosphere and lower thermosphere (MLT). Tides observed in neutral wind or temperature in the MLT are measured from the ground using different type of radars and lidars, providing excellent temporal and vertical resolution of the tidal fields. A major disadvantage of ground-based methods is their inability to distinguish between global and local signatures hence the measured tides are superposition of all migrating and nonmigrating tides for a given geographical point. Satellite-borne remote sensing instruments however afford the opportunity to measure the global distribution of the tidal fields, i.e. to separate and determine the migrating and nonmigrating tidal components. The measurements from the SABER instrument on the TIMED satellite have provided global temperature data from the lower stratosphere to the lower thermosphere since 2002. The continuous temperature data for 6 full years (2002-2007) and for altitudes between 20-120 km and latitude between 50^oN-50^oS are used in order to obtain the climatological features of the diurnal and semidiurnal tides with zonal wavenumbers up to 4. The effects originated from the superposition of diurnal and semidiurnal tides are demonstrated particularly for a geographical point (40^oN, 105^oW). A detailed comparison between the climatological features of the diurnal and semidiurnal tides seen in the SABER/TIMED temperatures at a point (40^oN, 105^oW)and the Na lidar observations over Fort Collins, Colorado (41^oN, 105^oW) will be presented.

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On the contribution of black carbon radiative forcing to the total aerosol radiative forcing over an urban environment

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In this paper we discuss the extent of Black Carbon (BC) radiative forcing in total aerosol atmospheric radiative forcing over Pune, an urban site in India. Collocated measurementsof aerosol optical properties, chemical composition and BC were carried out for a period of six months (during October 2004 to May 2005) over the site. Chemical composition data sets of water soluble, insoluble and BC components were used in Optical Properties of Aerosols and Clouds (OPAC) to derive aerosol optical properties for composite aerosols. The BC fraction alone was used in OPAC to derive optical properties solely for BC aerosols. The aerosol optical properties for composite aerosols and BC aerosols were separately used in SBDART model to derive aerosol radiative forcing due to composite aerosols and solely due to BC aerosols. The atmospheric radiative forcing for composite aerosols were found to be +35.5, +32.9 and +47.6 Wm^{-2} during post-monsoon, winter and pre-monsoon seasons respectively. The average BC mass fraction found to be 4.83, 6.33 and 4 μgm^{-3} during the above seasons contributing around 2.5 to 6% to the total aerosol load. The atmospheric radiative forcing estimated due to BC aerosols was +18.8, + 23.4 and +17.2 Wm^{-2}, respectively during the above seasons. The study suggests that even though BC contributes only 2.2 to 6% to the total aerosols load; it is contributing an average of around 55% to the total lower atmospheric aerosol forcing due to strong radiative absorption, and thus enhancing greenhouse warming.

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Formation of Interstellar Bubbles due to Asymptotic Giant Branch Wind: Eight New Bubbles Purposed

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I present the results of numerical simulations for the first 10^4years of the development of spherically symmetric interstellar bubble formed by the Asymptotic Giant Branch (AGB) wind. Assuming three phase interstellar medium (ISM) model we estimate the size of the interstellar bubbles. Our result will be based on 10^6virtual stellar wind particles and discussed in the context of early and late AGB star. In addition to the numerical simulations, we systematically searched the bubble like structure in the 60 μm and 100 μm IRASS (Infrared Astronomical Satellite Survey) and measured their sizes. A comparison between the results of the numerical simulations and the observations is discussed. It is found that the size of the interstellar bubble lie in the range 1.48 pc to 39.20 pc if the stellar wind speed is 15 km s^{-1}(early AGB wind). The size of the bubble ranges 2.82 pc to 74.64 pc if the stellar wind speed goes to 75 km s^{-1} (i.e., late AGB phase). The cold ISM forms small-sized bubble whereas the hot ISM produces large-sized bubble. However the stability of cold interstellar bubble is higher than that of the hot interstellar medium. As a preliminarily investigation we propose 8 interstellar bubble candidates, probably shaped by the White Dwarf and the Pulsar. The first four candidates are relatively small-sized (major diameter < 0.88 pc) because of the low speed stellar wind emitted during the evolution of White Dwarfs. The last four bubble candidates are intermediate sized, probably shaped by the relativistic wind of the Pulsar. The emission feature of the outer shocked region should be studied in the future in order to justify the nature of the interstellar bubble.

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Characteristics of Intense Space Weather Events as Observed with GPS from a Low Latitude Station

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Space Weather, a relatively new terminology, loosely defines the hierarchy of all phenomena within the Sun-Earth environment that may impact systems that reside within that environment. The Earth's ionosphere acts as a perturbing medium on transionospheric radio signals coming from a radio source or a satellite. Scintillations of transionospheric signals constitute one of the most intense Space Weather related propagation effects. Phase scintillation measurements have been few over the world and no records of GPS phase scintillations during intense Space Weather events have been reported from the geophysically sensitive Indian longitude sector. A dual frequency high resolution software based GPS receiver capable of measuring TEC with an accuracy of 5×10^{-4} TEC units and providing phase of the GPS L1 and L2 signals is operated round the clock at the Institute of Radio Physics and Electronics (IRPE), University of Calcutta, Calcutta, India. GPS TEC sampled at 1 minute interval and phase measurements at 17 Hz have been simultaneously monitored using this receiver for studying some Space Weather events during 2008-2009, a period of extremely low solar activity level, when post-sunset scintillations were observed on GPS links from Calcutta (22.58^{o} N, 88.38^{o} E geographic; magnetic dip: 32^{o} N) situated virtually underneath the northern crest of the Equatorial Ionization Anomaly. Data from a dual frequency Ionospheric TEC and Scintillation Monitor operational at IRPE under the international SCINDA program of the US Air Force was used in conjunction with the software based receiver for studying the S_4 indices on different GPS links mapped on a polar plot. On February 2, 2008, the GPS SV16 link located almost due south of Calcutta exhibited fluctuations in CNO with a maximum of 6 dB-Hz and associated bite-outs of nearly 15 TEC units around 1540 UT. Patches of scintillations were noted on the amplitude (maximum S_4~0.5) and phase of the GPS L1 signal around the same time. On October 8, 2009, GPS SV12 link located south of Calcutta exhibited sharp depletions in TEC during 1330-1415 UT. CNO fluctuations of about 10 dB-Hz were noted at 1350 UT on GPS L1 frequency. Well-defined patches of phase scintillations occurred during 1340-1440 UT. The amplitude scintillation patches were intense with maximum S_4~0.6 at 1340 UT. This paper presents some cases of intense Space Weather events occurring in the equatorial latitudes even under magnetically quiet conditions and low solar activity levels.

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The response of a dynamic ocean model to different natural forcings.

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Solar influence on climate has been recently proposed to work as a combination of the stratospheric "top-down" and the tropospheric "bottom-up" mechanisms. To further investigate these mechanisms and understand the role of the ocean, a set of model experiments with the Ocean Model for Circulation and Tides (OMCT) from the GFZ German Research Centre for Geosciences will be analyzed. Two multi-decadal sensitivity experiments with the OMCT forced with atmospheric data from NCAR's Whole Atmosphere Community Climate Model (WACCM3), which incorporates the atmosphere up to the lower thermosphere, will be investigated. The WACCM3 simulations include either a realistic time-varying solar cycle only, or a solar cycle and a synthetic, prescribed time-varying QBO. Special attention will be paied to the role of the QBO on the ocean response.

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Analyses of gravity waves using simultaneous measurements of winds and temperatures

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MF and Meteor radar measurements are excellent tools for the continuous monitoring of upper mesospheric winds between about 70 and 95 km. In particular, wind fluctuations caused by atmospheric waves can be identified and studied over extended time periods. However, the investigation of their vertical propagation is obviously limited to the height range where radar observations are feasible. With lidar measurements, wave-induced temperature fluctuations can be studied from the ground up to the MLT region. Here, however, the temporal coverage is limited especially to nighttime and cloud-free atmospheric conditions. Therefore, the combination of radar and lidar techniques allows the investigation of vertical wave structures over an extended altitude and time range.

The present study is based on wind observations using the MF and Meteor radars at Juliusruh (54.6°N, 13.4°E) and on temperature measurements using the RMR and Potassium lidar at Kühlungsborn (54.1°N, 11.8°E). Common volume and simultaneous measurements are used to identify wave packages using the polarization relations between temperature and wind fluctuations. Finally, the results are compared to the characteristics of gravity waves over an extended altitude range derived from simulations with the wave-resolving mechanistic general circulation model KMCM.

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The Geophysical Impacts and ENA Signatures of Ring Current Ion Precipitation into the Thermosphere and Ionosphere

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We present observations from NASA's IMAGE and TWINS missions of the intense ENA emissions emanating from the foot points of geomagnetic field lines connected to the Earth's ring current during geomagnetic storms. We describe analyses performed using these observations to specify the spatial and pitch angle distributions of the emitted ENAs and present the results of these. We also describe progress on an effort, recently begun, in which in-situ observations of ion precipitation are analyzed and compared with simultaneous observations of ENAs emitted from precipitation foot points, in order to estimate the distribution of ENAs resulting from an element of ion precipitation. Finally, we describe future observations that may be used to constrain the relationship between precipitating ions and the resultant ENA signatures, with the ultimate goal of being able to specify the ion precipitation using ENA observations.

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Emission and magnetic structure of solar sources of geomagnetic disturbance

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In the solar minima the most known source of geomagnetic disturbances is high-speed streams of a solar wind from low latitude coronal holes. We investigated microwave, UV emission and magnetic structure of coronal holes at chromospheric and coronal levels, and compared them with solar wind and geomagnetic disturbance characteristics. We have found the connection of high-speed solar wind streams velocities at L1 point according to ACE satellite data obtained during the first half of 2007 with plasma density and microwave emission flux at levels of chromosphere and a low corona. But strong dependence between amplitude of geomagnetic disturbances and magnetic flux of coronal holes wasn't found. However, we noticed the velocities of solar wind were higher when magnetic flux at chromospheric and coronal levels was connected with south polarity of magnetic structures. The most intensive and long duration storms (Dst and Kp indexes) and sub-storm (Ae-index) activity was observed for the same moments. The results of potential extrapolation of photospheric magnetic field to coronal levels demonstrate that noted cases have been connected with the especial configuration of a coronal holes magnetic field which included combination open components of a magnetic field with high (up to solar radius) loops closed out of the coronal hole. In this work was investigated solar "quasi-open" magnetic field configuration contributing geomagnetic disturbances.

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Impact of energetic particle precipitation on the middle atmosphere

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Research into the effects of energetic particle precipitation (EPP) on the atmosphere has expanded significantly in recent years. This is due to a combination of factors, including the availability of more observations, improvements in models, and intriguing occurrences of EPP effects, beginning with the 2003 "Halloween" storms. This talk will summarize our current understanding of the middle atmosphere response to EPP, and will highlight some of the recent advances in this field. In particular, emphasis will be placed on vertical coupling in the polar regions, and the so-called "indirect effect" of EPP. In three of the last seven Arctic winters, extraordinary meteorology in the SMLT (Stratosphere-Mesosphere-Lower-Thermosphere) led to unusually strong descent of air from the mesosphere into the stratosphere. In each of these three years (2004, 2006, 2009), the descent led to enhancements in polar NO_x mixing ratios that were larger than ever before recorded. These enhancements have been attributed to EPP even though, in 2006 and 2009, geomagnetic activity levels were lower than average. This talk will describe the observational evidence for this coupling, and will put the results into the context of current modeling efforts.

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Multi-frequency radar studies of PMSE: statistical properties, microphysical results and electron densities

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It is now common belief that polar mesosphere summer echoes (PMSE) originate from turbulence-induced scatter in combination with a large Schmidt number due to the presence of charged ice particles. It provides us opportunity to achieve deep insight of PMSE to apply this theory on simultaneous observations of PMSE at two well separated frequencies. In this study, we first present the statistical properties of PMSE obtained from simultaneous observations with the EISCAT Svalbard radar and the SOUSY Svalbard radar (collocated near Longyearbern (78^{o}N, 16^{o}E), with frequencies of 500 and 53.5 MHz, respectively) in June 2006 and also with the EISCAT VHF and UHF radars (collocated near Tromso (69^{o}N, 19^{o}E), with frequencies of 224 and 930 MHz, respectively) from the years 2003 through 2007. According to the above mentioned theory, the ratio of the volume reflectivities of PMSE simultaneously observed at two frequencies can be used to calculate the Schmidt number and hence the radii of the charged ice particles involved. The resulting particle radii display excellent agreement with expectations from microphysical models and independent observations of microphysical ice parameters using optical techniques. Finally, we use UHF-radar measurements of incoherent scatter in the presence of VHF PMSE to study the electron density dependence of PMSE. Statistical distributions of the ratio $|Z_A|N_A/n_e$ will be presented (where Z_A is the average aerosol charge, N_A the aerosol number density, and n_e the free electron number density) revealing that in the majority of cases $|Z_A|N_A/n_e << 1$.

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The Role of Meteoric Smoke Particles in the Polar Middle Atmosphere

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Meteoric smoke particles (MSPs) are thought to be formed as secondary meteoroid ablation products when part of the meteoric material deposited in the altitude range from 70 - 100 km recondenses to form nanometer-scale particles which may then further develop by coagulation and transport. It is current belief that MSPs play an important role in several middle atmosphere phenomena such as the nucleation of mesospheric ice clouds, the metal layers, the transport of meteoric material to the ground, and even the formation of polar stratospheric clouds which in turn play a significant role in the context of ozone destruction during polar spring. While MSPs have long been deemed important for all these processes, solid experimental results on their properties have only recently been acquired with the availability of new rocket-, radar- and satellite-techniques. This paper reviews our current knowledge regarding MSPs taking into account all these new experimental sources as well as recent model results and closes with suggestions for future work.

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Differences in the atmosphere-ocean system response to solar activity variations of various time scales

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Responses of atmospheric and climatic processes to solar forcing are analyzed. It is shown that in the case of short-term solar activity variations (hours, days) the structure and dynamics of atmospheric processes exhibit an almost real-time response. In the case of long-term solar activity variations (years and longer) an important role is played by the atmospheric circulation, and the atmosphere-ocean system as a whole begins to react to solar forcing. This leads to regional responses to global solar forcing. In addition, in the case of decadal variations (11- and 22-year solar cycles) the solar signal can interact with internal noises of the atmosphere-ocean system in the same frequency range. Experimental data indicate that this interaction can enhance the solar signal by a factor of 2-3.

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Modelling solar induced disturbed stratospheric Chemistry for the Period 2002 - 2005

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Model simulations of disturbed chemistry in the middle atmosphere following energetic particle precipitation for the period 2002 - 2005 are presented. Several realisations of the KASIMA model using a Bethe-Bloch ionization rate module using GOES proton flux data or precalculated ionization rates from the AIMOS data set including also effects from relativistic electrons are compared with detailed observations taken with MIPAS/ENVISAT of NO2, CO, and other species, allowing to evaluate the direct effects through ionization and indirect effect through transport on the chemistry. As none of these versions is able to simulate the strong intrusions in the Northern winters 2003/2004 and 2005/2006, also different dynamical modes of the model are tested where the relaxation terms to the analyses are varied. Including a GCR component of the ionization rates is found to have effects on the NOy budget in lower and middle stratosphere.

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Long period variation in the nightglow

Reid Iain

This work presents 13 years of measurements of two airglow emission intensities from the Buckland Park (*34.9°S, 138.6°E*) field site near Adelaide, Australia, and adds to a number of recent studies which have greatly improved our understanding of the global morphology of the Mesosphere Lower Thermosphere (*MLT*) region airglow. The close link between the underlying chemistry, dynamics and temperature structure of the MLT-region and the clear interdependence of the parameters make this a particularly important topic. In this paper, we consider the seasonal variability of the *730 nm OH (8,3)* and *558 nm OI* nightglow emission intensity over a period covering one solar cycle and compare them with *OH (6,2)* and O2 *(0,1)* measurements from an imager located the same site and TIME-GCM results reported by Gelinas et al (2008), and with WINDII measurements of OI and OH intensity reported by Liu et al. (2008). These results form a baseline for future intercomparison with the other instruments at the Buckland Park (*BP*) field site, which provide measurements of winds and rotational temperatures and with satellite and model results. We do this as a first step to better understanding the aeronomy of the *MLT* region at a lower middle latitude site.

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Using observations of subsurface helicity to predict flare occurrence

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Solar flares are responsible for a number of hazardous effects on the earth such as disabling high-frequency radio communications, interfering with GPS measurements, and disrupting satellites. However, forecasting flare occurrence has been very difficult. One possible means for predicting flare occurence lies in helioseismology, i.e. analysis of the region below the active region for signs of an impending flare. Time series helioseismic data collected by the Global Oscillation Network Group (GONG) has been analyzed for a subset of active regions that produce large flares and a subset with very high magnetic field strength that produce no flares. A predictive parameter has been developed and analyzed using discriminant analysis as well as traditional forecasting tools such as the Heidke skill score. Preliminary results indicate this parameter, combined with surface magnetic field measurements, predicts active region flaring probability with a higher success rate than any currently used method.

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The German Swarm Project Office

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In order to provide the best ever survey of the geomagnetic field and its temporal evolution ESA is planning a constellation mission of three satellites. The Swarm mission, as one of the Earth Explorer Missions within the Living Planet Programme, will provide new insights into the processes that generate the various parts of the magnetic field in and near the Earth. The satellites will monitor with high resolution the scalar and vector magnetic field, the electric field, plasma density, electron /ion temperature, air density and thermospheric winds. These observations, and the derivation of field models, play also an important role in predicting space weather activity within the near-Earth environment. The German Swarm Project Office was initiated to distribute information about this mission and its wide application spectrum. It acts as an interface of the German Aerospace Center (DLR) to ESA and the main contractor EADS Astrium (Friedrichshafen) . The Project Office will coordinate the scientific and technical use of the expected results at German companies and research institutions as part of a comprehensive concept for Swarm data exploitation. The home page of the Swarm Project Office is www.swarm-projektbuero.de. The Swarm Project Office at GFZ is sponsored by the Federal Republic of Germany, Initiator: German Space Agency of the German Aerospace Center (DLR) through funds of the German Federal Ministry of Economics and Technology based on a decision of the German Federal Parliament (FKZ 50EE0916).

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Ground-based estimates of outer radiation belt energetic electron precipitation fluxes into the atmosphere

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Currently there is intense debate as to the ultimate effects of solar activity on tropospheric and stratospheric variability, particularly through direct and indirect effects of chemical changes induced by energetic particle precipitation. However, there are key unresolved questions concerning the understanding of the effects of energetic particle precipitation on the lower atmosphere, one of which is magnitude and temporal variability of precipitating radiation belt energetic electrons. Definitive answers are very difficult to provide from satellite measurements alone because of the complexity in measuring electron fluxes unambiguously in the whole bounce-loss cone without contamination from fluxes in the drift-loss cone or trapped fluxes.

In this study we have used AARDDVARK data from a radiowave receiver in Sodankylä, Finland to monitor transmissions from the very low frequency communications transmitter, NAA, (24.0 kHz, 44°N, 67°W, L=2.9) in USA since 2004. The transmissions are influenced by outer radiation belt (L=3-7) energetic electron precipitation. In this study we have been able to show that the observed transmission amplitude variations can be used to routinely determine the flux of energetic electrons entering the atmosphere. Our analysis of the NAA observations shows that electron precipitation fluxes can vary by three orders of magnitude during geomagnetic storms. Comparison of the ground-based estimates of precipitation flux with satellite observations from DEMETER and POES indicates a broad agreement during geomagnetic storms, but some differences in the quiet-time levels, with the satellites observing higher fluxes than those observed from the ground. Typically when averaging over L=3-7 we find that the >100 keV POES 'trapped' fluxes peak at about 10^6 el.cm^{-2}s^{-1}str^{-1} during geomagnetic storms, with the DEMETER >100 keV drift loss cone showing peak fluxes of 10^5 el.cm^{-2}s^{-1}str^{-1}, and both the POES >100 keV 'loss' fluxes and the NAA ground-based >100 keV precipitation fluxes showing peaks of ~10^4 el.cm^{-2}s^{-1}str^{-1}. The analysis of NAA amplitude variability has the potential of providing a detailed, near real-time, picture of energetic electron precipitation fluxes from the outer radiation belts.

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Observations of Polar Mesospheric Clouds from Space and Their Scientific Implications

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Observations of Polar Mesospheric Clouds (PMCs), also called Noctilucent Clouds, were first reported in 1885 by the amateur astronomer Robert Leslie. Since that time there has been a growing public and scientific interest in these beautiful, iridescent clouds. This is most probably because they can be easily seen from the ground at latitudes above about 55 degrees and in addition numerous papers have reported quantitative cloud properties from space borne measurements. In recent years the focus on PMCs has intensified as a result of satellite measurements that show increasing cloud brightness and frequency of occurrence over the last ~ 27 years. Also, while not conclusively shown, it seems that there are more frequent cloud sightings at lower latitudes, e.g. 40 N, than have been reported in the past. Finally, there is the unproven but plausible theory that the observed changes in cloud properties are connected with global change due to the buildup of the greenhouse gases, CO2 and CH4, in the atmosphere.

This paper will present an overview of space-based observations of PMCs and scientific implications of the data. The clouds have been extensively observed by a number of satellite experiments including SME, HALOE, SNOE, SCHIAMACHY, OSIRIS, SBUV, OMI and AIM. The latter mission, AIM, is the first mission dedicated to the study of PMCs with the overall goal being to understand why they form and vary. PMC temporal variability on time scales of a solar cycle and the 27-day solar rotation have been reported. We also now know that PMCs are highly variable from orbit-to-orbit and day-to-day with significant complex structure. Other analyses show that temperature change is a dominant factor in controlling season onset, variability during the season and season end. Rising water vapor levels at the beginning and falling values at the end also play a key role in season initiation and cessation. Structures seen in the clouds look very much like complex features seen in tropospheric clouds including large regions of near circular ice voids. Planetary waves modulate PMC occurrence and can effectively extend the PMC season by providing several days of localized regions of saturated air in the troughs of the waves. By contrast, gravity waves appear to locally diminish PMC frequency even though global scale gravity wave drag is acknowledged as the prime cause of the cold polar summer mesopause. Satellite results also provide evidence that interhemispheric coupling, from the winter hemisphere to the summer hemisphere affects PMC variability.

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Microphysics of electrified aerosols and cloud droplets: Laboratory experiments

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The global electric circuit is one of the candidates for a coupling of terrestrial climate with solar activity [1]. It has been suggested that the vertical electric currents in the atmosphere, which are carried by ions, ionic clusters and electrified aerosol particles can modify the cloud microphysics and thereby can link the atmospheric layers [2]. In the framework of the DFG priority program *CAWSES* we conduct laboratory experiments which quantify the interaction between electrified aerosol particles and cloud droplets in order to assess the atmospheric relevance of this link between the higher and lower atmosphere.

More specific, we quantify the influence of charges, electrical fields and ionizing radiation on the heterogeneous and homogeneous freezing nucleation in cloud droplets, their evaporation behaviour and their scavenging efficiency for aerosol particles. The latter are relevant for contact freezing rates in clouds and therefore cloud development and lifetime. The experiments are carried out under realistic atmospheric conditions on individual particles in electrodynamic levitation within a miniaturized climate chamber [3, 4]. The main methods of investigations are microscopy, microspectroscopy and light scattering analysis [5].

In our contribution, we present an overview of the effects analyzed so far, demonstrate charge dependent evaporation and scattering efficiencies and estimate their atmospheric relevance.

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Gravity Wave Generation and Propagation in the Middle Atmosphere Revealed by a High-Resolution GCM

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Gravity waves are one of primary components of the atmospheric dynamics, in particular, in the middle atmosphere. A lot of observational studies using radars, lidars, radiosondes, and satellites have been made to elucidate various aspects of dynamical characteristics of gravity waves so far. However, because observable quantities and observable frequency and wavenumber ranges are limited depending on the sounding instruments, overall characteristics of gravity wave generation and propagation has not been fully understood. With the aid of recently available super-computer technique, we developed a gravity-wave resolving GCM having T213 spectral horizontal resolution and 256 vertical levels extending from the surface to a height of 85 km with a uniform vertical spacing of 300 m. Analyzing hourly data over three model years obtained by our simulation, we make reinterpretation of the gravity wave characteristics fragmented in a real or spectral space that shown by previous observation studies. According to our analysis, important gravity sources penetrating into the middle atmosphere are steep mountains and strong tropospheric westerly jets i n winter and vigorous monsoon convection in summer. It is also shown that poleward propagation of gravity waves from the source region is important, which is not included in gravity wave parameterizations used in most climate models.

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Program of the Antarctic Syowa MST/IS Radar (PANSY)

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Syowa Station is one of the distinguished stations, where various atmospheric observations for research purposes by universities and institutes as well as operational observations by Japan Meteorological Agency and National Institute of Information and Communications Technology are performed continuously. National Institute of Polar Research plays a central part in the operations. The observation of the Antarctic atmosphere is important in two senses. First, it is easy to monitor weak signal of the earth climate change because contamination due to human activity is quite low. Second, there are various unique atmospheric phenomena in the Antarctic having strong signals such as katabatic flows, the ozone hole, noctilucent clouds, and auroras. The middle atmosphere is regarded as an important region to connect the troposphere and ionosphere. However, its observation is sparse and retarded in the Antarctic compared with the lower latitude regions; nevertheless the vertical coupling is especially important in the polar region.

Since 2000, we have developed an MST/IS radar to be operational in the Antarctic and have made feasibility studies including environmental tests at Syowa Station. Various significant problems have been already solved, such as treatment against low temperature and strong winds, energy saving, weight reduction, and efficient construction method. A current configuration of the planned system is a VHF (47MHz) Doppler pulse radar with an active phased array consisting of 1045 yagis.

The value of the PANSY project has been approved internationally and domestically by resolutions and recommendations from international scientific organizations such as IUGG, URSI, SPARC, SCOSTEP, and SCAR. The scientific research objectives and technical developments have been frequently discussed at international and domestic conferences and at a scientific meeting at NIPR organized by the PANSY group every year. Special sessions of PANSY were organized at related scientific societies such as Meteorological Society of Japan and SGEPSS to deepen the discussion with an eye to submission of our proposal to Japanese government. As a result, the PANSY project was authorized as one of main observation plans for the period of JARE52-57 in 2008, and funded by Japanese government in 2009. We will start the radar construction at Syowa Station in the Antarctic this year. After a one year for initial test observations, MST/IS observations will be made over 12 years which covers one solar cycle.

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Tracking intense geomagnetic storms to the interplanetary medium and solar sources.

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On May 15, 2005, at 02:38 UT an interplanetary shock was recorded by ACE. The following interplanetary structure produced an important geomagnetic storm (minimal value of the Dst index -263 nT). Analysis of interplanetary (plasma and magnetic) observations has shown that these disturbances could correspond to the arrival of magnetic clouds.
The main trigger of the geomagnetic storm is definitively the fast halo CME of May 13 (LASCO) observed consequently to the flare occurring at 17:22 UT in the active region 10759. However, the analysis of the complexity of the magnetic cloud parameters (ACE) leads us to different possible scenarios for the interpretation. The existence of two clouds produced by two different solar events on May 13 (two different filament eruptions) is the more probable scenario.
The agreement between the magnetic helicity sign in the source region and the magnetic clouds, together with the agreement between the MC axis orientations and the polarity inversion line directions, support this view.

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Geomagnetic Activity and Polar Surface Air Temperature Variability

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ERA-40 and ECMWF operational surface level air temperature (SAT) data sets from 1957 to 2006 were used to examine polar temperature variations during years with different levels of geomagnetic activity, as defined by the A_p index. Previous modelling work has suggested that NO_x produced at high latitudes by energetic particle precipitation can eventually lead to detectable changes in polar SATs. We find that during winter months, ERA-40 and ECMWF polar SATs in years with high A_p index are different than in years with low A_p index; the differences are statistically significant at the 2-sigma level and range up to about ±4.5 K, depending on location. The temperature differences are larger when years with wintertime Sudden Stratospheric Warmings are excluded. Solar irradiance variations were taken into account in the analysis.

Although using the re-analysis and operational data sets it was not possible to conclusively show that the polar SAT patterns are physically linked by geomagnetic activity, we conclude that geomagnetic activity likely plays a role in modulating polar wintertime surface air temperature patterns. The SAT results were tested against variation in the Quasi Biennial Oscillation (QBO), the El Niño Southern Oscillation (ENSO) and the Southern Annular Mode (SAM). The results suggested that these were not driving the observed polar SAT variability. However, significant uncertainty is introduced by the Northern Annular Mode (NAM) and we could not robustly exclude a chance linkage between sea surface temperature (SST) variability and geomagnetic activity. We have further extended the SAT analysis and will in this presentation discuss the vertical propagation and extent of the temperature signals as well as wind anomalies from the ERA-40 and ECMWF data sets.

The physical mechanism linking the SAT variability and geomagnetic activity has recently been examined using atmospheric models and the results will be discussed in another presentation during this conference.

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Study of Mesospheric Temperature Inversions and their Generation Mechanisms using Rayleigh Lidar and Satellite observations over a Sub-tropical Location

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Characteristics of Mesospheric Temperature Inversions (MTIs) have been studied using more than 250 nights of Rayleigh Lidar data collected at Gurushikhar, Mt. Abu (24.5^{o}N, 72.7^{o}E, msl 1.7 km) from 1997 to 2003. Strong MTI event on 30 December 2003 and two episodes of mesospheric temperature inversion during December and March 2000 are described along with a detailed statistical analysis of MTI characteristics. Case studies revealed that MTI persists for few days and its amplitude increases gradually. Both the episodes exhibit different characteristics viz., height of occurrence, magnitude of inversion and the separation between upper and lower levels of MTIs. Mesospheric zonal winds observed by TIMED Doppler Interferometer (TIDI), onboard Thermosphere Ionosphere Mesosphere Energetics and Dynamics (TIMED), were also found to be strongly perturbed on 30 December 2003 over Mt. Abu. Ozone, observed by Halogen Occultation Experiment (HALOE) onboard Upper Atmospheric Research Satellite (UARS), shows significantly higher variability during strong MTIs. Statistical study revealed that the frequency of occurrence of MTIs is maximum during winter months and minimum during summer. These features are in contrast to the low-latitude observations. The average magnitude of MTI is about more than 20 K and has prominent seasonal variability and the average height of occurrence of MTIs has been found to be lower over Mt. Abu than that observed over low-latitudes. Furthermore, using NCEP wind data, we have found a good correlation between occurrence of MTI events and strong wave activity in the troposphere over Mt. Abu. These observed features are discussed in terms of possible source mechanisms and impact on mesospheric processes.

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Middle Atmospheric Gravity Wave Activity over a Sub-tropical Location, Mt. Abu (24.5oN, 72.7oE): Implication on Coupling Processes

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Gravity Waves (GWs) play an important role in energy and momentum transport from troposphere to the upper atmosphere. Strong convective activity over tropical and sub-tropical regions plays an important role for the generation of GWs. Mt. Abu (24.5°N, 72.7°E) is located in sub-tropical, hilly region where a large number of convective phenomena occur. GWs study at Mt. Abu may contribute to a better understanding of middle atmosphere on seasonal and long term scales and in delineating vertical coupling between lower, middle and upper atmosphere. Rayleigh lidar is in operation at Mt. Abu since 1997. We make use of ~11 years (1997-2008) of high resolution Rayleigh lidar measurements for the present study. Temperature profiles are derived from raw data (photon count profiles) in the height range of 30-65 km with a vertical resolution of ~480 m. Temperature profiles are further analyzed to extract and delineate the GWs features. The present study is focused on the GWs characteristics in terms of time (frequency) and height (wave-number), associated Potential Energy (P.E.) and their seasonal dependences. The frequency and wave-number spectra are obtained, where continuous data sets of ~4 hours are available. Generally, the temporal evolution of temperature profile illustrates the downward phase propagation indicating that the energy is propagating upward. The dominant time period of GW is found to be greater than 2.3 hours in the mesosphere at the 60-65 km height region. The lower periodicity of less than ~2 hours are found in the upper stratosphere (30-45 km). The P.E. for 3 different height regions (35-40 km, 45-50 km and 55-60 km) are calculated and analyzed. The seasonal variation of GWs characteristics and associated P.E. has also been investigated. It shows two distinguished maxima during May and November months. Further, the obtained results are compared with models and the other reported results from different locations.

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Winter mesopause dynamics observed in airglow emission rates and temperatures at Resolute, 74 N.

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Airglow emission rates and rotational temperatures have been observed for the OH Meinel (6,2) band and the O2 Atmospheric (0,1) band for eight winters at Resolute, 74 N, in Northern Canada, using a Spectral Airglow Temperature Imager (SATI). The winter dynamics at the mesopause are dominated by the downwelling associated with the large-scale circulation that keeps the mesopause region warm in winter. However, this downwelling is modulated by extreme variations during 1) short-term variations such as mesospheric coolings, 2) variations over the course of the winter and 3) variations from winter to winter. These variations, on all time scales, show strong positive correlation between the temperature and emission rate, consistent with adiabatic temperature increases arising from enhanced downwelling, and contemporaneous airglow enhancements through the transport of atomic oxygen from the oxygen-rich region above to the oxygen-poor region below. These mesospheric (OH airglow) temperatures are compared with lower stratospheric temperatures obtained from radiosonde observations at the same location and a strong correlation is found for the westerly phase of the QBO. In addition, the OH rotational temperatures are correlated with the solar flux, but only during the westerly phase of the QBO. These results are reviewed and compared with other observations.

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Coupling between the stratosphere, mesosphere and ionosphere during the major stratospheric warming of January 2009

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Temperature and electron density data from the COSMIC GPS-RO satellite constellation together with temperatures from the MLS-Aura satellite in the Arctic are used to study the response of the mesosphere/ lower thermosphere (MLT) and ionosphere to changes in the stratosphere during the major sudden stratospheric warming (SSW) event from January 2009. Ground-based observations of hydroxyl and O_2(0,1) Atmospheric band airglow emission rates and rotational temperatures are also considered. In the low to mid-stratosphere (15-40 km) eastward wave activity was significantly reduced during the early part of the 2008-09 winter and immediately prior to the major SSW. A westward wave with zonal wavenumber two, with distinct peaks at 22 km and 35 km and period of ~16-24 days, as well as a stationary wave two were associated with the 2009 major SSW. In the MLT region at the time of the SSW the airglow emissions and the temperatures appear depleted and decreased, followed by an enhancement of the airglow emission rates during the SSW recovery phase, while the temperatures returned to their pre-event state. The analysis has shown atomic oxygen depletion by a factor of ~ 5 during the SSW which lasted about 5 days. During the SSW recovery phase the atomic oxygen volume mixing ratio giving rise to the observed O_2 (0,1) airglow emission rates increased by a factor of 3.5 from its pre-SSW level and 17 times from the peak of the SSW. Perturbations in the OH and O_2(0,1) airglow layers with periods of 4-, 6-, 8- and 12-h indicate non-linear interaction between zonally symmetric semidiurnal tides and planetary waves. These perturbations are followed into the ionosphere and compared with the planetary wave signatures observed in the stratosphere and mesosphere examining the dynamical coupling between these atmospheric regions.

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A new view of the Sun from Hinode

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The recent space solar mission, Hinode, revealed amazingly dynamic features of the solar atmosphere, ranging from the photosphere, chromosphere, to the corona. That is, it has been revealed that not only the chromosphere but also coronal holes are full of nanoflares, jets, and Alfven waves. We can now say that there are ubiquitous reconnection and ubiquitous Alfven waves in the solar atmosphere. Here we review such newly discovered dynamic features in the solar atmosphere and its implication to the long standing puzzle of the chromospheric and coronal heating.

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Effect of sea surface temperature on the solar signal in the stratosphere and troposphere as revealed by chemistry-climate model simulations from 1960 to 2006

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Simulations on the past atmosphere were made with the chemistry-climate model (CCM) of Meteorological Research Institute (MRI), MRI-CCM. Several runs with slightly different initial conditions were performed for about 47 years from 1960 to 2007 under different forcings. Major difference in the forcing is in the sea surface temperatures (SSTs). The first and second SSTs are the observed one with and without filtering of the solar 11-year cycle, and the third SST is the one simulated by the ocean-atmosphere coupled general circulation model of MRI. Solar signals are obtained by a multiple linear regression model and their differences stemming from the SSTs are analyzed in detail.

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Imaging observations of coupling processes in the thermosphere-ionosphere-magnetosphere system at high and low latitudes

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This paper provides some recent observations of coupling processes of the thermosphere, ionosphere, and magnetosphere, on the basis of optical measurements of aurora and airglow. The imaging capability of multi-point all-sky imagers enables us to visualize the coupling processes at various latitudes. At high latitudes, auroral energy input from the magnetosphere causes significant disturbances in the thermosphere both on local and global scales. We show examples of large-scale traveling ionospheric disturbances (LSTIDs) during a magnetic storm and intense vertical winds during an auroral substorm. Penetration of magnetospheric electric field associated with storm/substorm also causes global and local disturbances of the ionosphere. At middle and low latitudes, gravity waves from the lower atmosphere and plasma instabilities are two major causes of small-scale disturbances in the thermosphere and the ionosphere. We show examples of medium-scale traveling ionospheric disturbances (MSTIDs) observed at middle and low latitudes and their relation to gravity waves, ionospheric instabilities, and penetrating electric field. These recent imaging observations give new insights and further questions on the coupling processes in the thermosphere-ionosphere- magnetosphere system, which are the new challenge for the task group 4 of CAWSES-II "What is the geospace response to variable inputs from the lower atmosphere?"

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Topside ionosphere plasma bubbles: season/longitudinal and solar activity dependence

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He^+ density depletions, considered as originating from equatorial plasma bubbles, or as fossil bubble signatures, were involved in this study. He^+ density depletions were detected from ISS-b spacecraft data (1978-80, $F_{10.7}$~200) in the topside ionosphere (~1000 km) deeply inside the plasmasphere (L~1.3-3) (Sidorova, ASR, 2004, 2007). (1) It is suggested that the equatorial F region irregularities (EFI), their post sunset development, evolution, and decay processes are controlled by the sunset electrodynamics of the equatorial region. He^+ density depletion peculiarities were considered in connection with EFI, equatorial F-spread (ESF) and plasma bubbles (PB). Seasonal and longitudinal (s/l) variations of their statistics (McClure, JGR 1998) were compared with the same statistics of He^+ density depletions obtained under winter, summer, equinoctial condition within 25-50° INVLAT for the both hemispheres. It was revealed that the main statistical maxima of the mentioned above equatorial F-region irregularities are well enough reflected in s/l statistical plots of He^+ density depletions of the both hemispheres. The best conformity was obtained during the equinox periods, the worst one was revealed during solstice periods, when the most dramatic insolation differences take place for the different hemispheres. (2) According to publications He^+ density depletions were also revealed on OGO-4, OGO-6, Oreol-1 and DE-2 data. They occur during high/maximal solar activity when He^+ density layer is very well developed in the topside ionosphere (Wilford et al., JGR, 2003). Using the plasma bubble formation model (Woodman, La Hoz, JGR, 1976), it was concluded that topside plasma bubbles seen in He^+ density are rather typical phenomena for the topside ionosphere for high solar activity epoch.

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Topside ionosphere plasma bubbles: characteristic times of evolution and decay processes

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There are some questions about the survival possibilities of plasma bubbles at the altitudes of the upper topside ionosphere (1000 km and more). The study deals with the evaluation of life time of the plasma bubbles, seen as He^+ density depletions in the topside ionosphere. He^+ density depletions (or subtroughs) are usually observed during a high solar activity at the topside ionospheric altitudes (~1000 km) deeply inside the plasmasphere (L~1.3-3). They are considered as originating from equatorial plasma bubbles phenomena or as possible fossil bubble signatures. The estimation of the characteristic times of a life, diffusion and vertical drift transport of helium ions (He^+) at the topside ionosphere heights of the low-/mid-latitude region was made. It is suggested, that the plasma bubbles are produced by Rayleigh-Taylor instability at the bottomside of ionosphere and transported up to the topside ionosphere/plasmasphere. It takes about 3-4 hours for plasma bubbles to reach the topside ionosphere altitudes. It is revealed, that the diffusion transport process is the fastest one (some minutes). Since the ionosphere plasma is magnetized plasma at the topside ionosphere heights, the diffusion processes are field-aligned. Plasma bubbles spread (due to diffusion processes) along the magnetic tubes. Their spreading becomes more and more significant in process of their uplifting. So extended bubbles look like “banana” (or tilted “aneurysm”) with the extremities reaching the ionosphere heights in both the hemispheres. This scheme is also correct if the separate components are under considerations, namely He^+. Also it is well known that the magnetic tube, partially “devastated” by a plasma bubble, is replenished extremely slowly. The tube replenishment time is proportionally L^4 (for example, Badin, JATP, 1994). It takes ~10 hours for refilling the tube (L=2, ~45ºINVLAT), partially "devastated" or depleted by plasma bubble. It was concluded, that, if some plasma bubbles can reach the topside and plasmashere heights, they can exist here (may be as “dead” bubbles) during some hours. It was also concluded, that there is enough time to register the plasma bubbles at the topside ionosphere heights.

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The solar cycle 24 peak

Silbergleit Virginia
FIUBA-CONICET

By considering the technique of Gumbel's first asymptotic distribution it is estimated the maximum solar activity for the next solar cycle. A maximum value not smaller than 68.4 and not greater than 187.4 monthly mean sunspots is predicted. Only a small number of sunspot predictions for solar cycle 24 peak are out of this interval. According to these values the solar cycle 24 could be smaller or higher than the prior one but not more than a 56% percent The interest to study the sun's cycles is based on the possibility to protect our environment, technological systems and human activity affected by solar aggressions.

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Mesospheric/lower thermospheric winds and tides at low, middle, and high latitudes during the CAWSES Global Tidal Campaign observations in 2005-2010

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Winds at mesospheric/lower thermospheric altitudes between 80 and 100 km and temperatures around 90 km are derived from all-sky meteor radar observations at latitudes between 22°S and 69°N. Wind tides are determined using 4-d, 10-d, and 60-d composite days. The seasonal variability of mean winds, diurnal, semi-diurnal, and ter-diurnal tides is presented. In addition, the seasonal variation of the migrating tides at 22°S has been derived using radar observations at three sites well separated in longitude (Learmonth, 114°E; Rarotonga, 200°E; Cachoeira Paulista, 315°E). The radar observations of the diurnal tidal signatures at 22°S are characterised by a strong longitudinal variability in good agreement with the results of the global circulation model HAMMONIA (HAMburg Model of the Neutral and Ionized Atmosphere). Comparisons are made between the tidal wind fields obtained from meteor radar observations and by superposing the tidal components from satellite analyses (TIMED). Both data sets are in good agreement and show that satellite and ground based observations are consistent with each other. The depicted strong longitudinal variability at 22°S is also seen in the reconstructed tidal wind fields of the HAMMONIA model.
The dynamical response of the MLT region on solar activity phenomena is presented for severe solar proton events in October 2003, January 2005, and December 2006 with a reversal of the meridional winds down to about 75 km and a moderate reduction of zonal winds. Particular attention is devoted to the events in 2003 and 2005 in respect to enhanced turbulence related with changes of the background wind field and gravity wave propagation.

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The contribution of electron precipitation to middle atmosphere composition

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Precipitating radiation belt electrons are a well known source of NOx (N, NO, NO2) in the lower thermosphere. There is mounting evidence of a strong indirect impact of precipitating electrons especially on the polar middle atmosphere due to downwelling of NO from the lower thermosphere during polar winter. However, not much is known about a direct impact on middle atmosphere composition, though during geomagnetic storms, electron energies are sufficient that electrons can precipitate well down into the middle atmosphere.

We investigate possible direct and indirect impacts of precipitating electrons onto the middle atmosphere in two ways. On the one hand, we analyse long measurement records of middle atmosphere NOx, i.e., from HALOE / UARS, MIPAS/ENVISAT or SCIAMACHY / ENVISAT; on the other hand, we carry out and analyse model runs with the Bremen 3-dimensional chemistry and transport model of the stratosphere and mesosphere which are driven by AIMOS ionisation rates including atmospheric ionisation due to protons and electrons.
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Quasi-equilibrium current sheet and the onset of impulsive bursty reconnection

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A two-dimensional reconnecting current sheet is studied numerically in the MHD approach. Different simulation setups are employed in order to follow the evolution of the formed current sheet in diverse configurations: Two types of initial equilibria, Harris and force-free, two types of boundary conditions, periodic and open, with uniform and non-uniform grid set, respectively. All the simulated cases are found to exhibit qualitatively the same behavior in which a current sheet evolves slowly through a series of quasi-equilibria; eventually it fragments and enters a phase of fast impulsive bursty reconnection. In order to gain more insight on the nature and characteristics of the instability taking place, physical characteristics of the simulated current sheet are related to its geometrical properties. The aspect ratio of the current sheet is observed to increase slowly in time up to a maximum value at which it fragments. Additional turbulence introduced to the system is shown to exhibit the same qualitative steps, but with the sooner onset of the fragmentation and at smaller aspect ratio. Comparison with observed solar current sheets is discussed.

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Reconstructing solar activity with applications in climate change.

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The Sun is a variable star, with all aspects of solar activity displaying a distinct cyclic variation as well as changes on other time scales. E.g. since 1978 measurements have revealed that the Sun varies in brightness on time scales from minutes to the solar cycles. With the current minimum a new aspect has been revealed: the fact that the solar brightness is not always the same at solar activity minimum, i.e. there irradiance also displays a secular variation.
The magnetic field is most likely responsible for the variation of solar irradiance, just as it is for other aspects of solar activity. Models have been increasingly successful in reproducing the measured solar irradiance. In some respects, measurements have even lagged behind the models, a rarity in solar physics. Thus, models have been predicting for years that solar irradiance displays a significant secular variation. During the current activity minimum these predictions have finally been borne out by measurements.
In order to detect the influence of solar variability on climate, longer time series than, e.g., the solar irradiance record are needed to complement studies on shorter time-scales. This requires models computing essential quantities, such as irradiance or open magnetic flux from sunspot numbers (available since 1610). At earlier times, even sunspot numbers or other measures of solar activity are not available and need to be reconstructed from cosmogenic isotopes.
Finally, reconstructed solar activity/irradiance can be compared with climate records either directly, or via a GCM or other climate model.
This talk will give an introduction to such activities.

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Transient climate simulations from the Maunder Minimum to present day including a detailed stratosphere

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Transient climate simulations are performed covering the period from 1630 to 2000. A vertically extended version of a coupled atmosphere-ocean general circulation model is used, including a detailed representation of the stratosphere. One simulation is driven by changes in total solar irradiance due to solar activity as well as volcanic eruptions and changes in greenhouse gas (GHG) concentrations. A second simulation additionally includes changes in short-wave heating due to prescribed photochemical changes in ozone. A third simulation includes higher resolved changes in the UV/visible part of the solar spectrum combined with lower changes in TSI. The simulations are compared with reconstructions and other simulations employing less resolved stratosphere. The inclusion of the higher resolved stratosphere does only play a moderate role for the simulated climate variability on the hemispheric scale. By contrast the use of lower TSI changes combined with the higher resolved changes in short wave fluxes results in a clear reduction of changes in annual NH mean near surface temperature. All three simulations reveal a shift of the North Atlantic Oscillation toward a more positive phase from the Maunder Minimum to present day, mainly attributed to the anthropogenic increase in concentration of well-mixed GHG. The increase in GHG is related to a more disturbed stratospheric polar vortex resulting in an only moderate strengthening of tropospheric westerlies over Europe compared with the tropospheric version of the model. On multidecadal to centennial time scales the stratospheric solar forcing substantially contributes to the climate change signal in the stratosphere, and there is clear evidence for an impact on the tropospheric circulation.

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A partial review of current progress with our understanding of small scale ionospheric irregularities and of some of the remaining challenges.

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The advent of increasingly high temporal and spatial resolution instruments coupled with a growing global perspective on the subject has meant that even some very basic properties of ionospheric irregularities have continued to challenge our understanding, this in spite of impressive progress in our capability to perform sophisticated numerical simulations. A brief presentation on the subject can only cover a limited range of topics. Here we will only look at some of the challenges associated with short scale irregularities accessible to ground-based radars. Even then, there is a long list of questions to choose from such as: the age-old question of what causes the saturation of E region irregularities at something comparable to the ion-acoustic speed of the medium; how aspect angles have to grow as individual structures evolve and how these same aspect angles relate to saturation and to electron heating at high latitudes; the possible role played by anomalous diffusion; the possible origin of very low altitude E region echoes; the possible origin of up-down and east-west asymmetries seen in E region echoes below 105 km at low latitudes; the non-local character of gradient-drift irregularities higher up; what we know we don't know about so-called 150 km echoes; `wall echoes' in the lower F region at mid-latitudes; the origin of the systematic lower Doppler shifts seen by HF radars in comparison to drifts determined from other techniques; the question of what seeds equatorial spread F and the possible connection with the pre-reversal enhancement in the low latitude electric field.

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Analysis of Solar Flare Activity from Empirical Time Series of Soft X-ray Solar Emission

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A time series of soft X-ray emission observed on 1974-2007 years (GOES) is analyzed. We demonstrate how self-similar models driven by Levy stable noise can be useful for modeling X-ray solar data. In the periods of high solar activity 1977-1981, 1988-1992, 1999-2003 the energy statistics of soft X-ray solar flares for class M and C is well described by a FARIMA time series with Pareto innovations. The model is characterized by two effects. The first creates a random number of strong bursts on a background, and the second forms their persistence between each other.Their parameters are statistically stable enough during the periods. We suggest a statistical model for predicting the flare energy statistics.

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Global variability of mean age of stratospheric air from MIPAS observations since 2002

Stiller Gabriele [1], Von Clarmann Thomas [1], Glatthor Norbert [1], Funke Bernd [2], Linden Andrea [1], Grabowski Udo [1], Hoepfner Michael [1], Kellmann Sylvia [1], Kiefer Michael [1], Lopez-Puertas Manuel [2], Wiegele Andreas [1], Versick Stefan [1]
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MIPAS provides spectral information on the atmospheric trace constituent SF_6. SF_6 is produced purely anthropogenically, and has a pronounced trend in the troposphere of about 0.2 pptv/year (about 3%/year). Since its only atmospheric sink is in the mesosphere, it can be used to determine the so-called stratospheric mean age of air, i.e. the time an air parcel needs to travel from the tropopause to a certain position in the stratosphere. This is a quantity under vivid discussion currently, since many climate chemistry models predict an intensification of the Brewer-Dobson circulation due to climate change. This would lead to reduced mean age of air in the stratosphere and impact the stratospheric chemical composition, which would, in turn, provide feedback on climate change and impact the recovery of the ozone hole.

SF_6 and age-of-air global distributions for the full-spectral-resolution period of MIPAS (September 2002 to March 2004) have already been published (Stiller et al., ACP, 2008). Here we present global distributions of SF_6 for the whole mission lifetime of MIPAS/Envisat (2002 to present) and derive global distributions of mean age of stratospheric air from this quantity. We analyse the time series of mean age of air in terms of its temporal and spatial variability for various latitude bands and link the results to observed and modelled atmospheric coupling.

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Equatorial-to-Middle Latitude Ionospheric Irregularities: Studies Using ROCSAT Data

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Equatorial-to-middle latitude topside ionospheric ion density variations observed by ROCSAT-1 at the 600-km altitude have been studied to construct the global/seasonal/local-time distributions of the equatorial plasma depletion (plasma bubble) occurrence rates, and the low-to-middle latitude plasma enhancement (plasma blob) occurrence rates from 1999 to 2004 when the solar activities were moderate to high. The occurrence distributions of the two contrasting density irregularity structures indicate some complementary pattern in the latitudinal distribution. The seasonal/longitudinal (s/l) distributions of the equatorial density depletions have been studied extensively in the past and the causes of such distributions have been proposed due to (1) the magnetic declination angle to affect the longitudinal gradient of the ionospheric conductivity across the sunset terminator, (2) the geographic location of the dip equator to affect the ionospheric seasonal density variation, and (3) the strength of the geomagnetic field at the dip equator to drive the over-all electrodynamics. In contrast, the study of the low-to-middle latitude density enhancements has just been started and the occurrence distribution only indicates that the maximum occurrence rates appear during the June solstice in both northern and southern hemispheres. Some occurrence dependence is noticed at longitude of large magnetic declination region, but the causal relationship between the equatorial density depletion and the density enhancement irregularities needs further investigation. Details of the global/seasonal/local-time distributions between the two different density irregularities are compared and the causes of the plasma enhancement irregularity structures are discussed.

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Modeling of 630.0 nm dayglow under varying solar activity conditions

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The atomic oxygen airglow emission at 630.0 nm emission is the most extensively observed emission feature in the dayglow and twilight glow. This emission is prominent feature in the thermosphere between 150-300 km. This paper presents the model resutls of the atomic oxygen redline dayglow emission. The solar Extreme Ultra Violet (EUV) radiation flux plays a very important role in the production of airglow emission. To study the redline emission a comprehensive model is developed including all the possible source and loss mechanisms. This model uses solar EUV flux from Solar2000 model. The model results are tested by comparing with the observations of Wind Imaging Interferometer (WINDII). It has been observed that the model produces a fairly good agreement with the observed results in comparison to the earlier model studies. Zhang and Shepherd (2004) have proposed an empirical formula for the calculation of peak emission rate and the intensity of redline emission based on the entire set of WiNDII observations during 1991-1995. These empirical formulae can calculate the peak emission rate and intensity as a function of the solar activity expressed in terms of the F10.7 solar index and solar zenith angle. The present model is used to obtain peak emission rates during the period of 2001-2005 on a fixed date. A comparative study is presented between the results obtained from the empirical formula and the model. It has been observed that the empirical formula produces low emission rates at high solar activity conditions in comparison to the model results and the agreement between the two is better during the low solar activity period. The possible reasons for the lower estimation of peak emission rate by the empirical formula during the peak activity conditions along with a correction factor to the empirical formula is presented in this paper.

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Morphology of 557.7 nm dayglow emission under varying solar activity conditions

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The atomic oxygen emission at 557.7 nm is the most widely observed airglow feature in the upper mesosphere and lower thermospheric regions. The approximation of solar irradiance fluxes is very crucial in the modeling of this emission. The recently introduced Solar2000 EUV flux model is a suitable candidate to provide the solar EUV flux for any level of solar activity on any given day. The Solar2000 EUV flux model has not been tested for its applicability in the airglow modeling studies. In the present study a comprehensive model has been developed to study the 557.7 nm dayglow emission using Solar2000 EUV flux model. This study presents the model results of diurnal and yearly variations of 557.7 nm dayglow emission under equinox conditions. The effect of varying solar activity on this emission is studied for a period of five years (2001-2005) at a fixed date of April 3. This date is chosen due to the fact of large variations in the solar activity during the period of five years. The volume emission rates obtained from the model in the upper mesospheric region are found higher than the observed results. This discrepancy is due to the extremely high values of solar EUV flux generated by the Solar2000 EUV flux model at 102.5 and 103.7 nm wavelengths. The model is found in good agreement with the measurements in the thermospheric region. The morphology is presented as a function of F10.7 solar index for five years (2001 – 2005) equator and 45◦ N at a fixed longitude.

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Middle atmosphere sources of non-migrating tides, and non-linear interaction of tidal components

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The tidal oscillations of the wind and temperature are one of the basic processes which are responsible for the formation of dynamical and thermal regimes in the mesosphere and lower thermosphere (MLT) region. The study of the variability of atmospheric tides and their sources is the key for understanding of the energetics and dynamics of this atmospheric region. On the base of simulation with the Middle and Upper Atmosphere Model (MUAM) the relative role those sources of nonmigrating tides is considered that are situated in the middle atmosphere. It is shown that when planetary waves are strong in the stratosphere (for instance, during sudden stratospheric warming events), the main middle atmosphere contribution into the generation of nonmigrating tides is nonlinear interaction between migrating tides and the stationary planetary wave with zonal wave number m=1. Largescale longitudinal ozone inhomogeneities lead to additional sources of nonmigrating semidiurnal (m = 1) and diurnal (m = 2) tides. Filtration of the thermal sources of the different tidal components in the MUAM allows us to investigate the generation of secondary migrating tides due to nonlinear interaction between the primary thermal tides and estimate the contribution of the diurnal and semidiurnal tides to the formation of the zonally averaged circulation in the MLT region.

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The Multi-solar Cycles with Long Periods and Some Extrapolations

Tan Baolin
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Based on analysis of the annual mean values of relative sunspot number during 1700 -- 2009, there are 3 components of solar cycles are confirmed: the first one is the usually well-known 11-yr cycle which has the strongest power; the second strongest solar cycle has the period of 103 years which can be named as Grand Cycle (marked as G1, G2, G3, and G4, respectively since 1700); the third component of solar cycle has a period of 51.5 years which is possibly the relatively weak second harmonic of the Grand Cycle. By using the similarity assumption, the author made an extrapolation of the forthcoming solar cycles after the cycle 23, and point out that solar cycle 24 will be in the vale between G3 and G4, it will be a relative long and weak solar active cycle, which may reach to its apex in about 2012-2014. As for the origin of solar cycles, the author believes the dynamo theory may be the best one to explain the 11-yr solar cycle, and speculates that the Grand Cycle is possibly resulted from the thermonuclear instability of the solar core which modulated the global energy releasing processes.

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Study of Quiet Solar Radio Emission at 1.0-7.6 GHz Band

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The quiet solar radio emission at 1.0-7.6 GHz band was studied with synthesis analysis of the observed data of Chinese solar broadband radio spectrometers and the numerical model of quiet solar radio emission.

First, by analyzing the daily calibration data recorded by the solar radio spectrometers of China in the period of 1997-2007, some results were obtained. 1), the daily calibration coefficients were found in good correlation with local air temperature for most frequencies of 2.6-3.8 GHz band. 2) a set of constant calibration coefficient were fitted for three bands (1.0-2.0 GHz, 2.6-3.8 GHz, 5.2-7.6 GHz) of the spectrometers. 3) At 2.6-3.8 GHz band, a correction factor that varied with local air temperature was added to the constant coefficient calibration. For good channel (80 percent), the result shows the calibration error of correction coefficient and constant coefficient is 5-15 s.f.u and 5-20 s.f.u

Then, with the analysis of calibration, the observed result of quiet solar radio emission flux at 1.0-7.6 GHz band was obtained. On the other hand, the numerical simulation of quiet solar radio emission is calculated in using of theory model. But the solar atmosphere parameter between the chromospheres and corona is still not quite certain. This work gave an appropriate result with the numerical simulation by adjusting the parameters properly.

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Climatology of Ripple-Type Instability Structures Imaged in the Mesopause Region over Maui, Hawaii

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Utah State University

Airglow image measurements of the mesospheric and lower thermospheric nightglow emissions provide a powerful technique for quantifying short-period (<1 hour) gravity wave and instability processes that occur in the ~80-100 km height range. In this study, we present new results on the frequency of occurrence, characteristics and seasonal variability of small-scale ripple events using two years of high-quality OH and O_2 nightglow measurements obtained by the Utah State University Mesospheric Temperature Mapper (MTM). The observations were made from the summit of Haleakala Crater, Maui (20.7°N, 156°W, 2970 m) which afforded excellent night-sky observing conditions. This rich data set has enabled us, for the first time, to establish strong evidence for cyclic variations in their frequency of occurrence as well as seasonal changes in their observed motions. Our results provide knowledge on the climatology of ripples present in the low-latitude mesopause region and their potential association with larger scale gravity waves will be discussed.

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The writhe of helical structures in the solar corona

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Helicity is a fundamental property of magnetic fields, conserved in ideal MHD. In flux rope topology, it consists of twist and writhe helicity. Despite the common occurrence of helical structures in the solar atmosphere, little is known about how their shape relates to the writhe, which fraction of helicity is contained in writhe, and how much helicity is exchanged between twist and writhe when such structures erupt. Here we present a quantitative investigation of these questions relevant for coronal flux ropes. The decomposition of the writhe of a curve into local and nonlocal components greatly facilitates its computation. We use it to study the relation between writhe and projected S shape of helical curves and to measure writhe and twist in numerical simulations of flux rope instabilities. The results are discussed with regard to sigmoids, stable and eruptive filaments, and coronal mass ejections (CMEs).

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Theoretical and numerical modelling of solar eruptions

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LESIA, Observatoire de Paris

Large-scale solar eruptions are the most violent energy release processes in the solar system and the main driver of Space Weather disturbances. They are observed as flares, CMEs, and filament (or prominence) eruptions. It is now widely accepted that these three phenomena are not independent, but constitute different observational manifestations of a more global process, namely a sudden large-scale disruption of the coronal magnetic field. While a "standard model" for the main (flare) phase of such eruptions is now well established (often referred to as CSHKP Model), the mechanisms which trigger and drive eruptions in the first place are still not fully understood. In this talk, I will review current theoretical models for the initiation and acceleration of solar eruptions, with emphasis on the considerable progress obtained by numerical MHD simulations in recent years. In particular, I will discuss to what extent the models overlap, and briefly outline how they might converge in the coming years to a "standard model" for the initiation and acceleration of solar eruptions.

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Evolution of 3D solar wind structure during cycles 22 and 23

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Interplanetary scintillation (IPS) measurements made with the 327-MHz multi-station system of the Solar-Terrestrial Environment Laboratory of Nagoya University were analyzed to study long-term variation of the global solar wind structure during cycles 22 and 23 (1985-2008). In this analysis, the computer-assisted tomography method was applied to retrieve three-dimensional distribution of the solar wind speed from IPS observations. The result clearly demonstrated that the solar wind structure evolved drastically with the solar cycle; the source surface areas of fast (slow) wind increased systematically as the solar activity declines, reaching the maximum (minimum) value at the minimum phase. In addition, the spatial distribution of fast and slow winds showed different latitude preference. High latitude regions were mostly dominated by the fast wind except for a few years around the maximum phase, while low latitude regions were occupied with the slow wind throughout the cycle. These behaviors of fast/slow winds are regarded as manifestation of the solar cycle change of Sun's magnetic field. An excellent correlation between fast/slow wind areas and polar magnetic field is demonstrated here. The important point to note is that the solar wind speed distribution for the current minimum significantly differs from that for the previous minimum. This difference is considered as a consequence of weaker polar fields in the current minimum, and may be a part of secular variation of the solar activity.

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Outer radiation belt of relativistic electrons in 2006-2010: GLONASS data

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We analyze a dataset of 1 MeV electrons measured on GLONASS in 2006-2010. Radiation doze under 2 g/cm^2 Al is also presented. The orbit is circular, 20000 km height, 65 degrees inclination; it well covers the outer radiation belt. Semiannual-mean doze shows unprecedented decrease by ~20 times, from 2007 to 2009. This gives more than order of magnitude deviation from the model-based (AE8) prediction. Generally, fluxes of relativistic electrons become lower and lower along these years, with yet rather high individual peaks. Seldom and weakening storms leave quiescent periods in which diffusion waves of earthward moving belts of newly injected electrons can be easily observed. Wave velocity well corresponds to the theory of L-diffusion of electrons driven by sudden geomagnetic impulses. Seasonal variation (with maxima around equinoxes) is seen but not in all periods and not so well as we saw on GLONASS in 1994-1996. A most prominent breaking of the seasonal cycle is a high-amplitude peak in Dec 2006, resulted from injection by the strong geomagnetic storm; this storm also breaks seasonal variation of geomagnetic indices.

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CHAIN Project and Capacity Building

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The Flare Monitoring Telescope (FMT) was constructed in 1992 at Hida observatory in Japan to investigate the long-term variation of solar activity and explosive events. It has been part of the international coordinated observations program (STEP) since 1991. It has five solar imaging telescopes that SIMULTANEOUSLY observe the full-disk Sun at different wavelengths around H-alpha absorption line or in different modes. Therefore, it can measure the 3 dimensional velocity field of gas motion of active phenomena on the full solar disk with suppressing the seeing effect. Moreover, it can detect Moreton-waves (shockwaves on the chromosphere) that accompany solar flares. Observations of physical properties of such solar explosive phenomena play a very important role for the space-weather research.

We want to monitor all geoeffective solar flares, erupting filaments and shock waves as much as possible by using several of such characteristic telescopes. Then, we started to execute "Continuous H-alpha Imaging Network (CHAIN)-project" as part of the CAWSES, CAWSES-II project. In the CHAIN-project, we intend to install the FMT-type telescopes in foreign appropriate sites, so that we achieve 24 hr continuous observational network.

As for the station for the 1st oversea FMT, we selected Ica University in Peru and we already installed it there in March 2010 with cooperation of Peru/IGP* and Ica Univ. Moreover, we are planning to install the 2nd oversea FMT to Algeria in around 2012 with cooperation of Algeria/CRAAG**.

Through such distributions of instruments under the CHAIN-project, we aim to advance international cooperative studies, education and popularization of space weather research and solar physics. These are also important purposes of the CHAIN-project. Therefore, this project is quite fit for not only the scientific purpose of CAWSES-II, but also the purpose of capacity building.

In this talk, we would like to introduce characteristics of the CHAIN-project, current status and plans in the next several years.

(*) IGP: Instituto Geofisico del Peru
(**) CRAAG: Centre de Recherche en Astronomie Astrophysique et Geophysique

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VHF radar observed characteristics of convectively generated gravity waves during wet and dry spells of Indian summer monsoon

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A powerful VHF radar observed characteristics of convectively generated gravity waves (CGW) excited during the wet and dry spells of Indian summer monsoon over a tropical station Gadanki (13.5^0N, 79.2^0 E) are discussed. The characteristics of gravity waves in the lower stratosphere during these two spells are discussed in terms their wavelet spectra along with height-time sections of vertical velocities. In most of the cases, the lower stratospheric gravity wave amplitudes were found to be relatively more in dry spell compared to wet spell. The wavelet analysis of lower stratospheric vertical velocities showed a dominant periodicity of about ~20- 40 min in wet spell and ~15-20 min in dry spell. The analyses also showed clearly that wet spell is found to be more conducive for the generation of gravity waves. However, the propagation of these waves to the stratosphere is found to be more efficient during dry spell of monsoon. The strengthening/weakening of the tropical easterly jet during wet/dry spell of monsoon is found to be the main reason for the inhibited/enhanced wave activity in the lower stratosphere during wet/dry spell. The present analysis also suggests that the static stability of the mid and upper troposphere during dry and wet spell have implications in the observed frequency of the CGW. Thus, the present analyses brought out for the first time the features of CGW during two distinctive regimes of convective systems and emphasized the importance of prevailing background conditions in exciting them.

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Study of Greenline Dayglow Emission

Upadhayaya Arun

The study deals with the reanalysis of morphological (volume emission rate as a function of altitude and latitude) study of greenline dayglow emission under equinox conditions in light of Solar 2000 V2.25 model. The morphology is obtained from the emission profiles of greenline dayglow emission using the updated glow model. The glow model is updated by incorporating temperature dependent rate coefficient of the reaction $N_2(A^3\sum_u^+)$ +O. The proposed correction for the atomic oxygen density in MSIS-90 neutral atmosphere model is also included at mesospheric altitudes to achieve the consistency with the WINDII measurements. The modeled morphology of greenline dayglow emission is presented between 50˚S and 50˚N latitudes for the months of March and April using Solar 2000 V2.25 model. It has been found that this emission shows less asymmetry between the northern and the southern hemispheres in comparison to previous study which was carried out using Hinteregger Solar EUV flux model. The Glow model is further updated to study the influence of geomagnetic activity on this emission and it has been simulated and influence of the activity is clearly seen on thermospheric peak intensity. The intensity of greenline thermospheric peak can hence be considered as a potential candidate for thermospheric proxy.

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Solar and cosmic-ray flux variability on different time scales: Keynote lecture

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An overview of the present state of the art in studies of variability of various solar and cosmic-ray indices on different time scales is presented: from daily and shorter time scale, related to solar energetic particle events and Forbush decreases of cosmic rays; through interannual 11-year cyclic variability; to secular changes. Special emphasis is given to the possible reflection of these temporal variations in the terrestrial climate.

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Thermospheric response to gravity wave coupling from the lower atmosphere

Vadas Sharon
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In this talk, we discuss the response on the thermosphere to gravity waves from the lower atmosphere. In particular, we examine the spectrum of gravity waves excited by deep convective overshoot near the tropopause and by wave breaking near the mesopause. We examine which portion of these wave spectra can survive dissipative filtering and propagate into the thermosphere. We then calculate the horizontal body forces which result when these waves dissipate in the thermosphere. We examine their altitudinal, spatial, and temporal characteristics. We then determine the "mean" wind and secondary gravity wave responses which occur from these forcings using models and simulation. We then review the literature which shows evidence of these responses. This includes PFISR, CHAMP satellite, EISCAT, and TIDBBIT sounder published data.
We also review recent global model simulations showing the effects of parameterized gravity wave dissipation on the thermosphere. Finally, we calculate the thermospheric response to 6 hours of deep convection in Brazil using a global model. We find that these forces create a ``mean" eastward wind perturbation at z=150 km as large as 200-340 m/s. We find that these forces also excite large-scale secondary GWs for at least 3 hours with horizontal wavelengths of 4000 km and horizontal phase speeds of 600 m/s. We also show the scale and speeds of the medium scale secondary gravity waves that are excited by thermospheric body forces using our new compressible solutions.

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Statistical tests for possible solar particle detection with the Mexico City neutron monitor

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We performed a search for ground level enhancements in the 5 minute data of the Mexico City neutron monitor from 1989 to 2006. We used Daubechies filters to renormalize the data, and then applied Student's test in search of signicant increases which could correspond to solar particle signals. Of the 31 events which occured in that time span, we found signicant signals for eight of them. Due to the high cutoff rigidity of the site (8.28 GV) and mean response energy of the instrument (25 GeV), these results provide evidence of the acceleration of high energy particles by eruptive phenomena in the solar atmosphere; they may also help to establish an upper bound for the particle acceleration power of the Sun.

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Transmission the influence of solar wind to middle atmosphere and troposphere via high-latitudinal ionospheric potential pattern

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Space weather influences the earth's atmosphere in different ways. One way of mapping of such influences down to the middle atmosphere and below is due to the field-aligned currents which are generated in the magnetosphere by the solar wind and are determined by the IMF. These currents determine the electric potential pattern in the ionosphere in both polar caps, where a potential difference of magnitude 40-160 kV (80-100 kV in average) is formed between the dawn and dusk sides. Because of that, while the ionospheric potential at geomagnetic (gm) latitudes below about 600 remains uniform (~250 kV with respect to the ground), at higher gm latitudes it is modified by up to ±80 kV. Because of the large horizontal scale of the trans-polar potential difference (~3000 km), the fair-weather currents which flow from the ionosphere to the ground in the global atmospheric electrical circuit at polar and high latitudes are modified, and this modification spreads downward to the surface. We evaluate theoretically the relative variations of the currents flowing in the global electrical circuit, as a function of altitude, gm coordinates, and gm local time, depending on IMF carried by the solar wind. For this goal we create a 3D numerical steady-state model based on the continuity equation for the electric current density. The dawn-to-dusk difference, as well as the pattern of the ionospheric potential distribution, which are related to specific IMF parameters, are evaluated by the Weimer model. A relatively simple global model of the atmospheric conductivity is used. We examine by our model the role of different factors in the formation of the electric currents and related electric fields which are superimposed to the global atmospheric electrical circuit at different gm locations and altitudes and under different conditions - these factors concern the solar wind and the atmospheric conductivity and their variations. Our study can be important in estimation of the ways of transmission of space weather influence to the Earth's atmosphere.

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Computational Analysis of Solar Radio Bursts Associated with Geoeffective X-Class Flares

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High temporal resolution solar observations in the decimetric range (1-3 GHz) can provide additional information on solar active regions dynamics and thus to contribute to better understanding of solar geoffective solar events as flares and coronal mass ejections. The June 06, 2000 flares are a set of remarkable geoeffective eruptive phenomena observed as Solar Radio Bursts (SRB) by means of the 3 GHz radiometer at the Ondrejov Observatory. We selected and analyse, applying the Dentrended Fluctuation Analysis (DFA), three decimetric bursts associated to X1.1, X1.2 and X2.3 flare-classes, respectively. The association with the geomagnetic activity is also reported. The DFA method is performed in the framework of a radio burst automatic monitoring system. Our results may characterize the SRB evolution, computing the DFA scaling exponent, scanning the SRB time series by means of short windowing before the extreme event. For the first time, the importance of the DFA in the context of SRB monitoring analysis is presented.

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Evolution of the total and spectral solar irradiance during the Holocene

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The Earth's coupled atmosphere-ocean system responds to the variability of the solar radiative energy input, which is its main external heating source. However, there is still large uncertainty on the level of changes because most of the reliable observations of geophysical and solar parameters are limited to the last decades. During this period, changes of the atmosphere's composition and of Earth's surface features due to human activity were already disturbing the thermal structure of the atmosphere. Consequently, in order to quantify the influence of solar variability on Earth's climate it is necessary to search for its influence in the time prior to the increase of human activity. Here we present a reconstruction of the total and spectral solar irradiance during the Holocene employing a simple, but consistent physical model. The model was derived from the spectral and total irradiance reconstruction (SATIRE) models employed to study the solar irradiance on time scales from days to centuries. The model uses the solar open flux, which can be computed using physics-based models from the cosmogenic isotopes recorded in natural archives, as the input parameter. The reconstruction and its implications are discussed.

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Evidence of high-energy particle precipitation effects on the atmosphere composition and dynamics in the Southern Hemisphere Magnetic Anomaly region

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Observations of atmospheric and oceanic parameters indicate that the climate is changing on global and regional scales. The changes of the solar energy output (e.g. total and spectral solar irradiance), atmospheric composition, oceanic dynamics, and Earth's surface properties are the main causes of the observed climate change. In order to assess the causes of changes on regional scales, it is necessary to distinguish the mechanisms responsible for changes in semi-permanent atmospheric systems such as the Intertropical Convergence Zone (ITCZ), subtropical high-pressure centers, and jet streams. The region encompassing the South America and adjacent oceans provides a unique scenario to investigate the role of natural drivers of climate change. From the point of view of atmospheric-oceanic sciences, the variability of climatic phenomena such as the El Nino-Southern Hemisphere Oscillation (ENSO) is crucial to understand the evolution of several atmospheric systems. From the point of view of space sciences, the presence of the southern hemisphere magnetic anomaly (SHMA) provides the opportunity to investigate the coupling between the neutral and ionized components of the atmosphere. However, we noted that the energetic coupling between phenomena observed in the neutral and ionized components of the atmosphere in the SHMA has not been extensively investigated. Here we show that the stratospheric patterns in the southern hemisphere tropical and subtropical regions match the pattern of the Southern Hemisphere Magnetic Anomaly (SHMA). We found that during the austral winter and spring, in the subtropical region (below 30o S), the reduction of the lower stratosphere temperature occurs systematically in the magnetic anomaly area. The differences between the temperatures inside the magnetic anomaly (60o W) and outside the anomaly (150o E) for 42.5o S from June to November are higher than 2 K. The maximum difference at this latitude is approximately 5.9 K and occurs in October during the austral spring.

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Gravity Wave Coupling into the Tropical MLT

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Gravity (buoyancy) waves play an important role in transferring momentum from source regions in the lower atmosphere to the middle and upper atmosphere. Body forces produced by breaking waves lead to residual circulations that profoundly affect the state of the atmosphere. This talk summarizes results from a campaign held near Darwin in northern Australia in January-February 2006 to measure wave generation and propagation and the associated momentum fluxes. The project used a variety of radars to study the spatial and temporal variability of rainfall and the associated latent heat release during large convective storms. A high-resolution numerical model utilized the latent heat release to compute the spatial and geographic variation of gravity wave generation and propagation into the lower stratosphere. Gravity wave ray-tracing techniques were then used to estimate the wave flux penetrating to heights near 90 km, where the results were compared with direct measurements made using a meteor radar. It is shown that there is excellent agreement between the direct and indirect estimates of wave activity. Wave fluxes show a high degree of temporal variability, with consequent variability in momentum flux deposition and wave drag

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All-sky imaging observation of interacting mesospheric frontal systems

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On the night of February 8, 2007, mesospheric OH imaging observations from low latitude Indian site, Tirunelveli (8.7^{o}N, 77.8^{o}E), revealed development of a frontal system moving approximately towards North (designated as Front 1). About an hour later, it collided with another frontal system (Front 2). Front 2 had entered from northwest and was moving towards Southeast. The collision also involved a third frontal system (Front 3) which was relatively weaker and moving almost exactly opposite to front 1. Interestingly, the measured wavelengths and time periods indicate a loss of energy for Front 1 and gain of energy for the other two systems. Especially the parameters appear to get almost exchanged between front 1 and front 2. The background wind information revealed wind reversal during the event. The temperature information obtained approximately two hours before the interaction of fronts from SABER snapshot measurements shows an inversion layer partially covering the OH emission heights. In this work an attempt is made to understand the event. This is a very rare observation that appears analogous to collision of particles. Hence, understanding of such events is expected to improve our conceptions on the different types of atmospheric wave processes and their interactions especially at high frequency limit.

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Global distribution and seasonal variations of convective instabilities occurring in the mesosphere

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Convective instabilities are important short scale features occurring during the cascade of energy from larger to smaller scales. Their presence is inferred in the Mesosphere Lower Thermosphere region with the help of rocket soundings, lidar observations and optical imaging techniques. Such observations provide information about convective instabilities only over a few selected locations. Their global distribution, seasonal variations, occurrence frequency and maximum occurrence altitudes are not well known. In this study, we have utilized SABER\TIMED temperature measurements for the years 2003 and 2008 (corresponding to solar maximum and minimum respectively) to infer the occurrence frequency, global distribution, day night, seasonal, solar cycle variations and any local time dependence of convective instabilities occurring in the mesosphere. The occurrences of convective instabilities are more or less equal during day and night time. It is found that the occurrence of convective instabilities peak at 94 to 96 km altitudes with presence of instabilities for about 16% of observation time. In summer high latitude mesosphere, the peak occurrence decreases to a height of 80 to 81 km. Winter and equinoctical periods show more or less similar pattern. Overall occurrence is high at low latitudes followed by mid latitudes and high latitudes. No significant longitudinal differences are seen in the occurrence of such instabilities. No definitely attributable solar cycle dependence is deduced from this study.

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Solar UV and the predictability of climatic zonation

Vita-Finzi Claudio
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UV emission fluctuates much more markedly than the rest of the irradiance spectrum over the ~11 year (Schwabe) cycle and it triggers temporary shifts in components of the global circulation, including the Hadley cells, the jet streams and the intertropical convergence zone. Better understanding of the origins of this and other UV periodicities thus offers scope for improved forecasting of terrestrial and space weather. For example, a 27-day effect which is conventionally attributed to the Sun's rotation, and hence viewed as primarily a photospheric effect, may in fact derive primarily from steady rotation of the Sun's radiative zone rather than the vagaries of sunspot and facula distribution. In addition, advances in the analysis of cosmogenic isotopes reveals cumulative effects which overshadow more flamboyant but shortlived events. Thus the ^{14}C and ^{10}Be evidence of ice cores and marine sediments appears to indicate a progressive increase in solar irradiance over the last 30,000 years which was repeatedly subject to century-scale reversals, including the Maunder Minimum, and which, like the Schwabe, may be manifested in the disposition of the atmospheric circulation rather than in a mean global temperature. As the 27-day signal shows, fossil and documentary records of UV fluctuations may in turn serve as windows into the solar interior.

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The Study of Atmospheric Gravity Waves and Travelling Ionospheric Disturbances using EISCAT Svalbard Radar IPY-data

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Internal Atmospheric Gravity Waves (AGW) play an important role in upper and middle atmospheric dynamics. Such waves can propogate far away from their origin up to hundreds of kilometers verticaly and many thousands of kilometers horizontaly. AGW are also known for causing Traveling Ionspheric Disturbances (TID) when they reach ionosphere. Already for couple of decades Incoherent Scatter Radars (ISR) have been successfully used in AGW/TID studies. A big step forward in ISR measurements was made when EISCAT Svalbard Radar (ESR) was operated allmost continuosly for a whole one year period within the "International Polar Year" (IPY) programme. It has been found that AGW/TID is common phenomenon above ESR especialy during spring and summer. We are going to present the results of our statistical study including annual and duirnal variability of AGW/TID occurance frequency and parameters (especially, periods and amplitudes). The impact of geomagnetic activity will be also discussed.

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Possible role of internal climatic oscillation in the relationship between Sun and cloud cover

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During the last decade accumulating statistical evidence of solar effects on climate has emerged. Significant global correlations between different types of cloud cover and ultraviolet irradiance (UVI), and respectively cosmic ray induced ionization (CRII) have been found. In our previous work we have shown that different solar drivers play different roles in the occurrence of clouds at different altitudes. Since clouds play an important role in climate changes as a major contributor to the Earth's radiation budget, it is important to study as thoroughly as possible the degree of correlation and the background conditions when such a correlation must be taken into account when evaluating the climate change. Among these we focus on the possible link between ultraviolet irradiance (UVI) or cosmic ray induced ionization (CRII), and low or high clouds, respectively. Because of some variability modes in teleconnection indices (e.g., NAO) which are close to the solar 11-yr cycle, they can interfere in the climate response. We investigate here the possibility that the observed link in the complicated chain that relates Sun and climate could be a mixed relationship between teleconnection indices (NAO), cloud cover and solar variability (CR or UVI based).

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The ionospheric trough and associated ionosphere-magnetosphere coupling, possible indicator of space weather status

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There are ionospheric phenomena that can be the result of the coupling between near Earth plasmas. One of these is the density depletion occurring in the F region, known as the ionospheric trough. Using satellite and ground based data some different types of troughs have been selected for a thorough analysis of their characteristics. We have chosen those ionospheric troughs where experimental results are available from more than a single instrument. This allows a detailed investigation of electron density, plasma temperatures and ion drifts within the trough and its neighborhood. Moreover, data from the top ionosphere and from the inner magnetosphere based on in situ observations or empirical and/or physical models are used for identifying specific background conditions (convection electric fields, IMF structure) with different types of troughs, and, consequently, contribute to a better understanding of the formation and evolution of the trough.

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Solar wind turbulence and production of proton beams

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Super-Alfvénic proton beams are a common observation in the fast solar wind, but their origin is still uncertain. We consider the possibility that these beams are generated by the dissipation range of the solar wind turbulence. In accordance to modern turbulence theories, the spectral energy transport in the solar wind is dominated by the perpendicular cascade towards small perpendicular length scales. When the cross-field wavelengths become of the order of ten ion gyroradii or less, kinetic effects come into play initiating wave-particle interactions and plasma energization. In this case the dissipation range of the solar wind turbulence is formed by highly oblique kinetic Alfvén waves (KAWs). We study the field-aligned electric potential well created by the KAWs in the dissipation range and its effect on the solar wind protons. The average KAW potential propagates with the super-Alfvén velocity that depends on the KAW spectral index and spectral breaks in such a way that it is larger in the old (developed) turbulence than in the young (under-developed) turbulence. We show that the protons trapped by the potential well closer to the Sun, where the turbulence is younger, can be accelerated to 1.5-2 Alfvén velocities at larger heliocentric distances, where the turbulence is older, building up the proton beam with the relative number density about 0.1.

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Inhomogeneous currents and anomalous resistivity along auroral field lines

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Field-aligned auroral currents are intrinsically inhomogeneous across the background magnetic field, which may have a significant influence on the physics of magnetosphere-ionosphere coupling. We study effects of current inhomogeneity on current-driven micro-instabilities that could result in the anomalous resistivity along auroral field lines. We show that the current shear, even with relatively small cross-field gradient, highly reduces the thresholds of kinetic ion sound (KSW) and kinetic Alfvén waves (KAWs) micro-instabilities. The KAW instability dominates for relatively high plasma $\beta \sim 0.1$, whereas the KSW instability dominates for $\beta <\sim 0.01$ (β is the gas/magnetic pressure ratio). For intermediate plasma β the aperiodic growth rate of both instabilities is about 0.1 of the electron velocity shear $\partial V/\partial x$. These instabilities produce the anomalous resistivity that limits currents and builds up voltage drops along the auroral field lines. Observations of mainly electrostatic KSWs in regions $\beta < 0.01$, and mainly electromagnetic KAWs in regions $\beta \sim 0.1$, on the background of field-aligned currents, could provide an indirect observational evidence for these effects.

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Compositional and Dissipative Effects on Wave Propagation in a Diffusively Separated Atmosphere

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We present results from a new model that simulates acoustic-gravity wave propagation in a binary gas mixture of atomic oxygen and molecular nitrogen. The model includes the effects of molecular viscosity and thermal conduction. Compositional effects include the collisional transfer of heat and momentum between gases and the effects that one gas has on the viscosity and thermal conduction of the other. The individual constituents have different phase and amplitude dependencies with altitude owing to the individual characteristics of the gases (scale heights and vertical wavelengths). We find that dissipation reduces the phase differences between constituents relative to those with thermal and momentum coupling acting alone [del Genio et al., 1978]. Compositional effects reduce the effective dynamic viscosity and thermal conduction for individual constituents in proportion to their mixing ratios; the less abundant the constituent the weaker the dissipation. This has a significant effect on the amplitudes of wave quantities for the individual gases relative to each other. At altitudes where thermal and momentum coupling is small the upward flux of energy and momentum is partitioned between the constituents. The total gas result gotten by summing over the individual gases differs significantly from the results of a single gas model with compositional effects included by means of height-variable time-independent mean molecular weight (the usual approach). The accuracy of single gas models can be significantly improved by allowing the mean molecular weight M to be conserved following parcel displacement, whence the perturbation value of M is nonzero. We discuss the implications of these results for gravity wave propagation in the thermosphere.
Del Genio, A. D., J. M. Straus, and G. Schubert, Effects of wave-induced diffusion on thermospheric acoustic-gravity waves, Geophys. Res. Lett., 5, 265, 1978.

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High Latitude Thermal Cells Induced by Ion Drag Driven Gyres

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Under typical conditions, the ions driven into motion by the high latitude electric field generates a pair of counter-rotating anticyclonic and cyclonic gyres in the neutral wind circulation. When viscous and ion-drag forces are not too strong dynamical adjustment of the atmosphere acts to bring the winds into an approximate gradient wind balance between the inertial forces (Coriolis and centrifugal) and the pressure gradient. These forces act in the same direction for cyclonic gyres and in the opposite direction for anticyclonic gyres. When the flow is not too strong or too curved the Coriolis force is dominant and dynamical adjustment gives a pair of high (warm) and low (cold) pressure cells, associated respectively with the anticyclonic and cyclonic gyres. However, when the flow is sufficiently rapid the centrifugal force dominates and both gyres give relatively cold low pressure cells. The thermal changes induced by dynamics are adiabatic and are in addition to the changes induced by the diabatic heat sources.

We have examined the balance of forces with a 3-D general circulation model of the upper atmosphere (TIME-GCM). We infer the balance of forces normal to the motion (centrifugal, Coriolis and pressure gradient) forces. We have examined the balance of forces and the pressure and thermal response to these forces during quiet and active times.

The quiet-time structure is radically changed when the atmosphere is spun up into rapid motion during active periods. During active periods structures form that are more complicated than the structure of the forcing itself. Centers of relative low density air are found on both the dawn and dusk sides with a trough of low density air over the pole connecting them. The intrusion of low density air over the pole splits the region of high density air that exists under quiet conditions giving two high density centers, one toward the midnight side and other toward the noon side. This gives the four cell pattern simulated by Crowley et al., 1989, 1996. We find that this structure evolves when the flow is too rapid to sustain the quiet-time warm high-pressure anticyclonic cells.

Crowley, G., B. A. Emery, R. G. Roble, H. C. Carlson, and D. J. Knipp (1989), Thermospheric dynamics during September 18 – 19, 1984: 1. Model simulations, J. Geophys. Res., 94, 16,925– 16,944.

Crowley, G., J. Schoendorf, R. G. Roble, and F. A. Marcos (1996), Cellular structures in the high-latitude thermosphere, J. Geophys. Res., 101, 211–223, doi:10.1029/95JA02584.

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Impacts of solar disturbances on the heliosphere and magnetosphere

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Interplanetary disturbances, including interplanetary shocks and ICMEs, disturbance not only the magnetosphere-ionosphere system but also the heliosphere. This talk will be divided into two parts, the first part will discuss the impacts of solar disturbances on the heliosphere. We present a multi-fluid MHD model, which takes into account the effects of pickup ions, to describe the solar wind in the outer heliosphere, since the solar wind in the outer heliosphere is fundamentally different from that in the inner heliosphere, with the influence of the local interstellar source becomes significant. Using observations from multiple spacecraft distributed throughout the heliosphere, we traced the propagation of ICMEs and their driven shocks from 1 AU to the location of Voyager 2. The Bastille Day, 2000 event and April 2001 event are modeled in detail.

Interplanetary (IP) shocks disturb the magnetosphere-ionosphere system resulting in geosynchronous magnetic field changes and sudden impulses observed by ground-based magnetometers. We perform a statistical survey of geospace magnetic field responses to IP shocks. The magnitude of the geosynchronous magnetic field (dBz) responses to IP shocks depends strongly on local time, which peaks near the noon meridian, however the relative magnitude of the responses depends only weakly on local time. Negative responses (where dBz is negative) were sometimes observed in the nightside of the magnetosphere even though the IP shocks always caused increases in the solar wind dynamic pressure. The 3D global MHD simulations reproduce the main characters of the observations. The dBz at the geosynchronous orbit near local noon and the amplitude of sudden impulses (dSYM-H) on the ground are highly correlated. We show that sudden impulses (SIs) can be used to estimate key parameters at L1 point and geosynchronous orbit, including the change of square-root the solar wind dynamic pressure across the shock, and the associated geosynchronous magnetic field changes near the sub-solar region. Empirical formulae deduced from observations can be used to estimate certain IP shock characteristics and geosynchronous magnetic field changes from observed sudden impulse data observed on the ground with prediction efficiency as high as 89%.

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Tidal coupling: Recent insights and challenges

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It is now close to 20 years since the launch of the UARS satellite and the topic of atmospheric tides, which was considered close to being solved at that time, is still a very active area of research. Where significant advances have been made over the past couple of decades, is in the recognition of the complexity of the tidal wave system and the extent to which they permeate the middle and upper atmosphere. Non-migrating tides (in addition to the migrating tides) are now recognized as providing substantial contributions to the energetics and dynamics of the atmosphere and interference effects between components result in strong longitudinal variations in tidal amplitudes. The CAWSES 1 tidal campaigns which included data from satellites (TIMED in particular), ground based observations and tidal analyses of extended general circulation models have been a contributing factor in developing this understanding. However, the remaining questions are substantial. Source and dissipation mechanisms of the various components, how they influence mixing processes and gravity wave propagation and dissipation, what their internal interactions are, and what their dynamical, chemical and ionospheric effects are, remain uncertain and still need to be determined. Research into these questions remains challenging since a global and whole atmosphere perspective is required to find solutions. In this talk, progress in our understanding of tides is reviewed and the outstanding problems are summarized.

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Modulation of the 'stratospheric bridge' by the quasi-biennial oscillation and 11-year solar cycle in late winter

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Analysisof the three-dimensional Eliassen-Palm fluxes indicated the existence of the "stratospheric bridge" forming by the upward planetary wave propagation from the troposphere over northern Eurasia in early winter and the downward wave signal from the stratosphere over North Atlantic in late winter. It is shown that the causesof the decadal violation of the Holton-Tan relationship of the extra-tropical stratospheric circulation with the equatorial quasi-biennial oscillation and the 11-year solar cycle impact can be associated with decadal changes of the "stratospheric bridge" modulation in January-February. The simple mechanism explaining the link of the eddy energy exchange between the troposphere and stratosphere with the stratospheric circulation on the interannual and decadal timescales is proposed.

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Three dimensional model simulations of the impact of ion-chemistry induced by solar particle precipitation onto chlorine species

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Solar Energetic Particle Events and geomagnetic storms can produce fluxes of high-energy protons and electrons, which can enter the Earth's atmosphere especially in polar regions. These particle fluxes primarily cause ionisation and excitation in the upper atmosphere, and thereby the production of HO_x and NO_x compounds, which are catalysts for the reduction of ozone.
Besides the increase of HO_x and NO_x , the abundance of other species like chlorine are effected by solar particle induced ion-chemistry, as observations indicate.
To simulate such particle events and their effect on chlorine species, ionisation rates calculated by the Atmospheric Ionization Module Osnabrück AIMOS (University of Osnabrück) have been implemented into the Bremen 3D Chemistry and Transport Model. The model is driven by meteorological data provided by the Leibniz-Institute Middle Atmosphere Model LIMA (IAP Kühlungsborn), to cover altitudes up to the mesopause. To account for the ion-chemistry regarding chlorine species in the neutral chemistry scheme of the Bremen 3D CTM, parameterised production rates calculated by the University of Bremen Ion-Chemistry model UBIC are included into the model.
Model calculations for the solar proton event in October/November 2003 have been carried out and results will be presented and compared to measurements by the Michelson Interferometer for Passive Atmospheric Sounding MIPAS (ENVISAT) instrument.

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Effects of solar particle events on the middle atmosphere's chlorine chemistry

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It is well established that solar proton events (SPEs) are sources of distinct chemical disturbances in the Earth's polar atmosphere. While the SPE caused production of NOx and HOx and the subsequent destruction of ozone can be reproduced quite well by atmospheric models using basic parameterizations for NOx and HOx release as a function of the particle impact ionization rate, there are significant differences between measurements and model predictions concerning chlorine compounds. Satellite measurements (HALOE, MIPAS, MLS/Aura) have shown that there is also chlorine activation in the stratosphere and mesosphere, and an increase of chlorine nitrate in the lower and middle stratosphere during SPEs. This cannot be explained by the NOx and HOx increase alone. Atmospheric models with standard parameterizations of NOx and HOx production due to SPEs fail to reproduce the magnitude of the observed chlorine disturbances.

Numerical simulations using the University of Bremen ion chemistry (UBIC) model show a much better agreement with measurements if full negative ion chemistry is considered additionally to the NOx and HOx production. The UBIC results in combination with atmospheric models indicate that reactions of negative cluster ions can have a significant impact on the middle atmosphere's chlorine chemistry during SPEs. There is a transformation of HCl into active chlorine via anion cluster chemistry. Additionally, the release of O(1D) through $N(2D) + O_2 \rightarrow NO + O(1D)$ has a considerable impact on chlorine species.

Results of UBIC simulations for different SPEs (July 2000, October 2003, January 2005) are presented. They are compared with the observed changes of chlorine compounds – HCl, HOCl, ClO and $ClONO_2$ – from the satellite instruments HALOE, MIPAS and MLS/Aura.

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Modeling electron density in E- and F-layer: Comparison of the model chain AIMOS-HAMMONIA and ISR measurements

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Ionization due to particle precipitation is the main forcing of the electron density in E- and F-layer during night times.
Therefore incoherent scatter radar (ISR) measurements show electron densities exceeding model simulations without particle forcing by up to a factor of 1000.

We now implemented a model chain for the Atmospheric Ionization Module OSnabrück (AIMOS), modeling spatially resolved ionization due to particle precipitation, and the climate model HAMMONIA with extended ion chemistry in the E- and F-layer up to approx. 200 km. This presentation will focus on the comparison of modeled electron density in the upper atmosphere and ISR measurements from Sondrestrom, Tromsø, Svalbard and Millstone Hill. As the time period covers October 2003 to April 2004 the results represent geomagnetic quiet as well as active periods (October event 2003). Special interest will also be given to local variations since the ISR stations cover the geomagnetic latitudes from 53 to 76°N. According to the altitude range in this comparison the effect of magnetospheric particles will be discussed in the first instance.

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Magnetohydrodynamic Simulation of the Correspondence of an EIT Wave, CME and ICME

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The accumulated observations of SOHO/LASCO/EIT, STEREO and ACE showed that coronal mass ejections (CMEs) are often accompanied by EIT waves. When a CME propagates out to the heliosphere it evolves to an Interplanetary Coronal Mass Ejection (ICME). We use a composite 3D magnetohydrodynamic (MHD) model to simulate the sequence features according to the May 12, 1997 event. This composite model consists of two regions; the 3D coronal model (Feng et al. 2007) which covers from the solar surface to 0.08 AU (18 solar radii (R_s)) and a fully 3D, time dependent compressible MHD model which covers from 0.08 AU to Earth and beyond. The results to be presented include the following: (i) the initial equilibrium state of solar interplanetary atmosphere, (ii) the evolution of 3D magnetic field configuration, (iii) CME induced shocks, and (iv) the properties of ICME.

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Statistical Properties of the Most Powerful Solar and Heliospheric Events Related to Strong Magnetospheric Disturbances

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The study of space weather and solar-terrestrial relations remain important from scientific and practical points of view. The investigation of extreme solar and hemispheric events is related with following difficulties: 1) the library of extreme events is small: extreme events are rather rare by definition; 2) the reliable theoretical models of extreme events are still not available. Nowadays various indexes are used for the description of parameters and a prediction of space weather condition. In our work we took the NOAA classification. The critical parameters were the X-ray flux (parameter R), solar proton flux (parameter S) and geomagnetic disturbance level (parameter G). The number of disturbances increases exponentially with a decreasing of a level of S and G parameters. Probability of events with a small occurrence frequency is overstated for data set in comparison with the theoretical von Neumann model of a random process for all parameters, especially for R.

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Study of equatorial Spread-F with ground-based large network observations in Asia and Pacific regions

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Equatorial spread F (ESF) is intense ionospheric irregularity that occurs around the geomagnetic equator. It can cause intense scintillation to satellite-ground communications, and serious error in the GPS measurements. The ESF has been a hot research topic of the equatorial/low-latitude ionosphere for long time. However, its day-to-day variability is not well understood. In the southeast Asian region, Japanese researchers developed a network of ground-based observations with the Equatorial Atmosphere Radar (EAR) of RISH, Kyoto University, the ionosonde network SEALION (SouthEast Asia Low-latitude IOnospheric Network) of NICT, and optical instrument network OMTI (Optical Mesosphere Thermosphere Imager) of STEL, Nagoya University. SRI International deploys a VHF radar, an ionosonde and several satellite beacon receivers on Pacific islands. In addition to this, we are deploying a network of the digital satellite beacon receiver named "GNU Radio Beacon Receiver (GRBR)" to fulfill observation gaps. Multi-beam observation of ESF with the EAR have shown strong evidence that occurrence of the ESF is very close to the sunset of F-region at the dip equator. Our GRBR-TEC measurements with C/NOFS from Vietnam and Indonesia successfully showed longitudinal large-scale wave structure of the ionosphere is in good relationship to the ESF occurrence. From 2010 we further expand the network in Asia and Pacific regions, and tackle yet-unknown day-to-day variability of the ESF.

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The dynamical response of ozone and temperature in the lower stratosphere to the 11-year solar cycle simulated by the CCSR/NIES CCM

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The variation of ultraviolet (UV) radiation with the 11-year solar cycle has been suggested to affect temperature and ozone in the upper stratosphere [e.g., Chandra and McPeters, 1994; Marsh et al., 2007]. While, in the lower stratosphere the direct effect of the UV radiation change with the 11-year solar cycle is considered to be small, and the lower stratospheric ozone is possibly affected by the solar cycle forcing and the sea surface temperature (SST) variations through the circulation change [e.g., Kodera and Kuroda, 2002; Austin et al., 2008]. The three dimensional chemistry climate model (CCM) is able to provide better description of these processes than two dimensional model, and it is especially important for explicit calculation of the planetary wave propagation in the extratropics. It is useful to perform sensitivity experiments using a three dimensional CCM to estimate these processes. Here we show the results which exclude the volcanic eruption, because the CCSR/NIES CCM used in this study overestimates the effects of the volcanic aerosol, which causes unrealistically large solar response in the lower stratosphere with the multiple regression analysis. The control run in this study includes the solar cycle forcing and observed SST and excludes the volcanic forcing.

The results is that the contribution of the solar cycle forcing to the solar term is about 1% per 100 units F10.7 in ozone concentration solar response and 0.2 K per 100 units F10.7 in temperature solar response in the lower stratosphere. We show that a change in ozone transport may be the main factor for the solar signal of ozone concentration in the lower stratosphere. The magnitudes of ozone and temperature solar responses in the lower stratosphere are smaller than the observations (about 4% in ozone and 0.5 K in temperature) which implies that some other factors such as the SST, may be included in results based on observations.

Another sensitivity experiment with observed SST and fixed solar cycle forcing shows a small solar response in the lower stratosphere, suggesting that the interannual variability of the SST could contribute to the solar term in the lower stratosphere through troposphere-stratosphere processes and/or have an effect as an artifact of interference due to the insufficient period for analysis.

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New Observational Windows on Flares and CMEs --- On Chinese Spectral Radioheliograph in cm-dm Wavelength Range

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The radio observations with high temporal, spatial and spectral resolutions simultaneously will open new windows on flares and CMEs. The FASR and Chinese Spectral Radioheliograph (CSRH) aim at these goals and will provide first images of solar flares over an extended spectral range. The CSRH dm-wave and cm-wave arrays I and II are under construction and due to operate in 2011 and 2013 respectively. We discuss the scientific objectives of CSRH.

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Range Imaging Results from Polar Mesosphere Summer Echoes

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The range resolution of pulsed radars is usually limited by the transmitting pulse length and the sampling time. The so-called range imaging (RIM) has been developed to reduce these limitations. To apply this method the radar operates alternately over a set of distinct frequencies. Then the phase differences of the receiving signals can be used for optimization methods to generate high-resolution maps of reflections as function of range insight the pulse length.

The technique has been implemented on the ALWIN VHF radar in Andenes (69°) and the OSWIN VHF radar in Kühlungsborn (54°N). Here we present results of the RIM method from measurements in polar mesosphere summer echoes – PMSE. These strong radar echoes are linked to ice particle clouds in the mesopause region.

The dynamic of the PMSE can be reflected very well by RIM. The movement of PMSE and the edges of the extension can be tracked with a high altitude resolution. Comparisons between simultaneous measurements by RIM and by standard radar techniques demonstrate the advantages of RIM. Wave structures can be identified with RIM whereas they are not detectable with the lesser resolution of the standard measurements. Gravity wave parameter associated with these echo variations are estimated using the simultaneous measured velocity field.

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Features of Spatial Structure of Tropospheric Response to Solar and Geomagnetic Activity Level Variations

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We have carried out a multifactor correlation analysis of the connection between the heat content of various tropospheric layers and solar (f 10.7 cm) and geomagnetic (AA-index) activity level variations over the period of 1950–2007. To calculate the heat content, we used NCEP/NCAR reanalysis data. We analyzed the influence of volcanoes, El-Nino, and Arctic sea ice area on characteristics of the connection under study.

The degree of the connection between tropospheric heat content changes and solar and geomagnetic activity variations was demonstrated to depend essentially on the period of smoothing of time series. When the time scale is increased to 5 years, the correlation coefficient rises considerably (to 0.6–0.7) in most regions.

We have found that the heat content correlates with geomagnetic activity in most of the troposphere. But in some regions one can see a significant anticorrelation decreasing with distance from the underlying surface.

The tropospheric heat content response to the geomagnetic activity influence is characterized by a significant spatial inhomogeneity which is most pronounced near the underlying surface and considerably changes with height. The spatial structure of the response enlarges with increasing height, and the region of the peak positive response shifts to low latitudes.

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Solar Activity Signals on Annual Precipitation Records (1912-2008) from Santa Maria (29°41'S, 53°48'W), Southern Brazil

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In recent years, there is a great interest in trying to understand and quantify the solar influences on Earth's climate. However, on the global scale, the correlation between solar activity and meteorological parameters may be positive, negative, or even zero. In this study, we investigate the effects of solar activity (Rz and Rz_{22}) on the rainfall time series (1912 to 2008) from Santa Maria (29°41'S, 53°48'W), Southern Brazil. Classical spectral analysis for rainfall has shown significant periods of 12.3, 21.0 and 82.5. Cross-wavelet between Rz (11yr) and rainfall was significant in the 11 year signal after 1930, but it was intermitted around 1960–1970. Furthermore, it was also observed a high and continuous cross correlation between rainfall and Rz_{22} (22yr) for the analyzed period. The linear correlation between annual rainfall and solar activity was $r < -0.10$ for Rz and $r = -0.19$ for Rz_{22}. These results suggest that, regarding the rainfall variability, minor than 10% can be associated with a linear dependency to 11 year solar cycle and around 19% to 22 year magnetic cycle. Therefore, it is possible that the effect of Hale cycle on climate may be stronger than the Schwabe cycle effect.

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Berlin, 12 - 16 July 2010
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Solar Activity Signals on Centennial Temperature Time Series from Santa Maria (29°41'S, 53°48'W), Southern Brazil

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Many attempts have been made to connect climatic changes with variation in solar activity parameters, which has showed increased levels at the present compared with the Maunder Minimum period. In this study we investigate the possible effects of solar activity (Rz and Rz_{22}) on the surface air temperature (1912 to 2008) from Santa Maria (29°41'S, 53°48'W), Southern Brazil. Classical spectral analysis for temperature has shown significant periods of 11.8, 19.1 and 64.3. Cross-wavelet between Rz (11yr) and temperature was significant in the 11 year signal after 1935, but it was weak around 1970–1980. Furthermore, it was also observed a high and continuous cross correlation between temperature and Rz_{22} (22yr) for the analyzed period. The linear correlation between annual temperature and solar activity was $r < -0.10$ for Rz and $r = -0.19$ for Rz_{22}. These results suggest that, regarding the temperature variability, minor than 10% can be associated with a linear dependency to 11 year solar cycle and around 19% to 22 year magnetic cycle. Therefore, it is possible that the effect of Hale cycle on climate may be stronger than the Schwabe cycle effect.

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Electromagnetic signatures inside the ionospheric equatorial plasma bubble: CHAMP observation and theoretical framework.

Kherani Esfhan

The equatorial ionospheric F region often becomes unstable during evening-time and gives rise to large plasma depletion or plasma bubble. In this work, CHAMP observations of electromagnetic fluctuations inside the plasma bubbles will be presented. To study the possible cause for these fluctuations, hydro-magnetic framework is adopted where growth equation for polarization electric field and density fluctuation will be derived. To excite the magnetic fluctuation inside the plasma bubble, the possible contribution from current driven by polarization electric field and density gradient will be examined.

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The influence of the 11 yr solar cycle on the interannual-centennial climate variability.

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The monthly sunspot number (SSN) for January 1749-August 2004, the global sea-surface temperature (gmSST) and the regional SSTs in the northern N. Pacific (npSST) and the Nino3.4 (ninoSST) areas for the winters of 1870-2004 are analyzed by a wavelet transform to show their multi-scale nature. On the interdecadal timescales, both gmSST and npSST have similar variation tendencies with that of the intensity and cycle-length of the 11 yr SSN, with slight phase differences. The npSST and ninoSST are often out of phase on the decadal-interdecadal timescales. The ninoSST is predominated by the interannual timescales peaking around 3.8yr. Moreover, the ninoSST exhibits an apparent 80-90 yr signal that is almost out of phase with that observed in SSN. Numerical experiments using a simple nonlinear system illustrate that the intensity of the seasonal forcing, modulated by the 11 yr solar activity, is likely an important factor causing different dominant timescales in regional SSTs. Even a small change in the solar constant by 0.04% on the 11 yr timescale may result in a regime change in the response (e.g. SST) with various dominant timescales, including the 77 and 88 yr signals that are similar to those of the Gleissberg cycle in observed SSN. The results show that part of the energy of the internal variability of the system is transferred to the forced variability that may have richer timescales than those in the forcing itself due to nonlinear resonance. This suggests that observed interannual-centennial climate signals are not purely internal, but also external because of the existence of the 11 yr solar activity cycle, which has changed the solar constant in the past and will continue doing so in the future. It also suggests that if the solar Gleissberg cycle is included in the forcing term, the 77 and 88 yr interdecadal signals and their subharmonics on centennial timescales may be more significant than what is shown here, which might have some implication to global warming research.