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Inside this issue

Article 1:

The Dimmest State of the Sun

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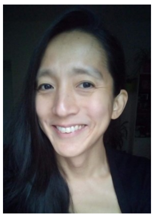

Kok Leng Yeo

How the amount of solar electromagnetic radiation entering the Earth system, described in terms of Total Solar Irradiance (TSI), varied since pre-industrial times is an important consideration in the climate change assessment. The industrial revolution is preceded by the Maunder minimum, an extended peri-

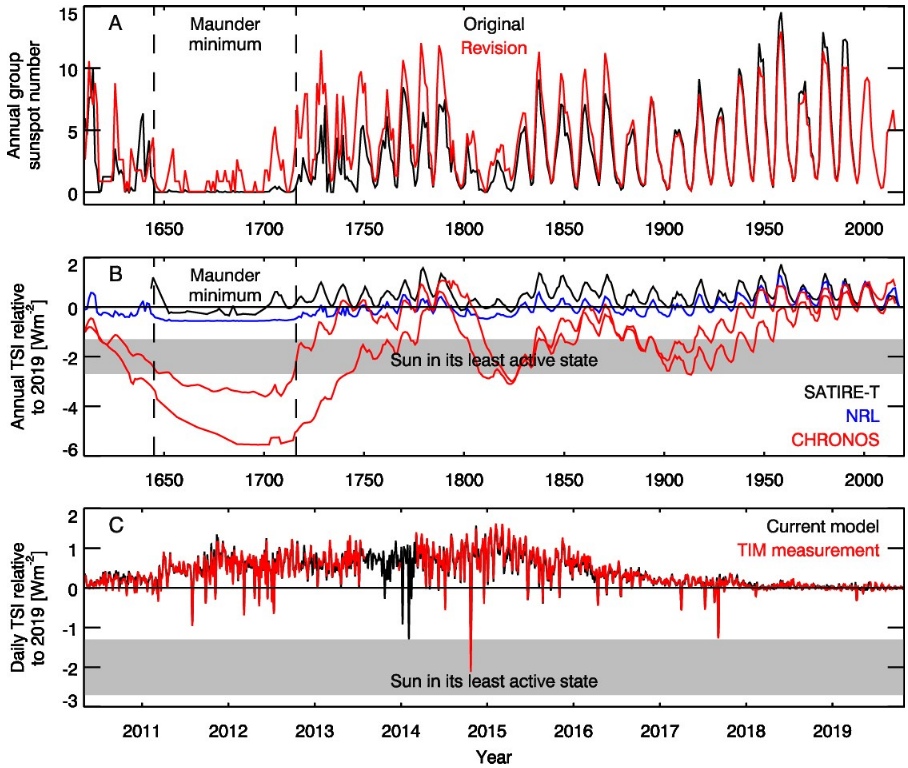

Figure 1. A) Solar activity since the Maunder minimum as indicated by the group sunspot number (black: Hoyt and Schatten 1998; red: Svalgaard and Schatten 2016). B) The reconstruction of TSI over the same period from the SATIRE-T (Wu et al., 2018, black), NRL (Coddington et al., 2016, blue) and CHRONOS models (Egorova et al., 2018, red). C) The reconstruction of TSI since 2010 from SATIRE-3D (black Yeo et al., 2020) and the measurements from SORCE/TIM (Kopp et al., 2005, red). We established, with this model, that the TSI level of the Sun in its least-active state is 2.0±0.7 Wm^{-2} below the 2019 level, indicated by the shaded range.

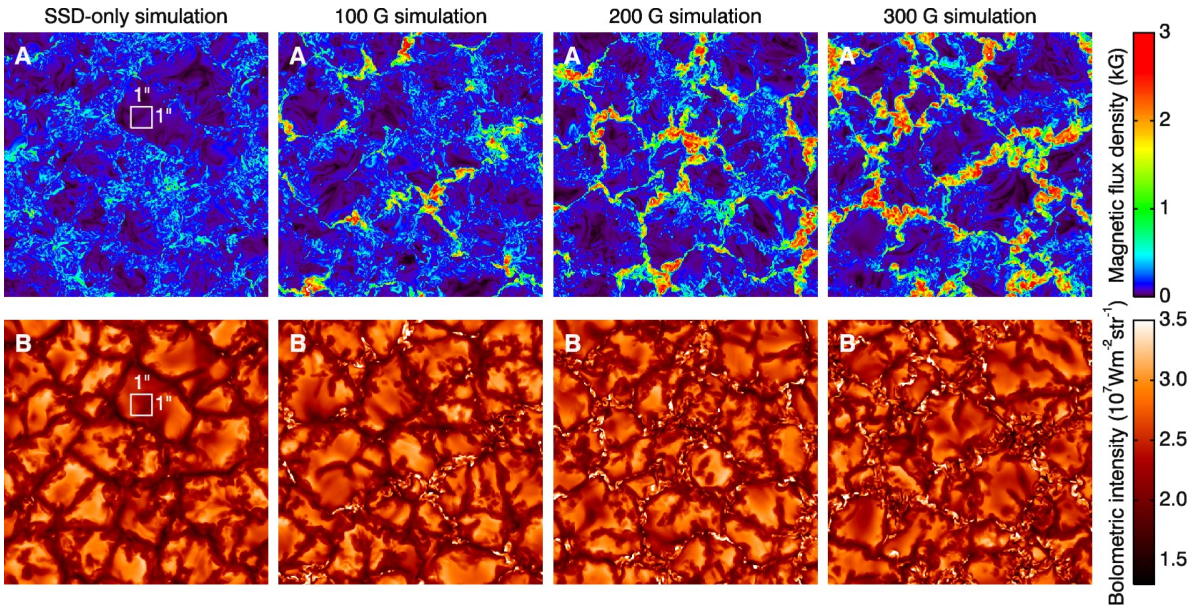

Figure 2. Three-dimensional magnetohydrodynamics simulations of the solar surface and atmosphere. A) Magnetic flux density at the solar surface in a snapshot of each simulation run and B) the corresponding bolometric image, calculated using a radiative transfer code. The simulation runs were set up to emulate the small-scale turbulent dynamo. Three of the four runs were initiated with a uniform vertical magnetic field of 100, 200, and 300 G, producing the magnetic aggregations in the intergranular lanes. The white box in the left column denotes 1×1 arcsec, corresponding to an area of approximately 725×725 km on the Sun.

od of weak solar activity (Fig. 1A). Detrimental to the climate change debate, current estimates of the rise in TSI since the MM differ markedly, ranging from 0.1 Wm^{-2} to 6 Wm^{-2} (Fig. 1B). This is one of the reasons why the exact contribution by solar forcing to the rise in global temperatures over the past centuries remains controversial. To address this issue, we adopted a novel approach, based on state-of-the-art solar imagery and numerical models, to establish the TSI level of the Sun in its least active state (Yeo et al., 2020). Since this corresponds to the dimmest the Sun can be during grand activity minima such as the MM, the difference to the present level represents the greatest possible rise in TSI since the MM.

This work built on the groundbreaking model of TSI variability presented by Yeo et al. (2017), SATIRE-3D. Models of solar irradiance variability account for the effect of solar surface magnetism on the brightness of the Sun. For simplicity, other models estimate this effect from plane-parallel approximations of the heterogeneous solar atmosphere or, even more crudely, from the linear regression of indices of solar magnetism to solar irradiance observations. Such approaches cannot capture the relevant physics fully, with the result that these models require calibration to measured solar irradiance variability. SATIRE-3D employs realistic three-dimensional models of the solar atmosphere (Fig. 2) generated with a state-of-the-art magnetohydrodynamic (MHD) code (MURaM, Vögler et al., 2005). By establishing how these model solar atmospheres would appear to the HMI solar telescope onboard SDO (Scherrer et al., 2012), SATIRE-3D is able to reproduce TSI variability from HMI observations while not requiring any calibration to measured TSI variability (Fig. 1C), and remains the only reported model to achieve such a feat.

Taking into consideration the dearth of sunspots during the MM (Fig. 1A), the timescale of stellar evolution and the findings of recent studies into the small-scale turbulent magnetic field on the solar surface, we argued the least active state of the Sun is where the global dynamo is dormant and the entire solar surface resembles the present-day internetwork. (The internetwork refers to the solar surface outside of sunspots, faculae and network.) By incorporating newly-available realistic MHD simulations of the internetwork into SATIRE-3D, we established the TSI level of the least active Sun to be 2.0±0.7 Wm^{-2} below the 2019 minimum level (Fig. 1C). This upper limit on the rise in TSI since the MM, only one-third of the existing cap of 6.0 Wm^{-2}, greatly restricts the possible role of solar forcing in global warming.

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Article 2:

Ionospheric Equatorial Scintillation in Southern Crest over Kinshasa (DRC)

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The Equatorial ionosphere is the turbulent fluctuations of electronic density that cause rapid variations ionosphere refraction index. The ionospheric scintillation is amplitude and phase perturbation of radio signals up to 12 Ghz [ITU-R, 2012] traversing these variations. The data used come from the GPS SCINDA Kinshasa site obtained from May 2011 to October 2012.

Studies of ionospheric scintillations at equatorial latitudes reveal the existence of an intense belt of ionospheric irregularities in the night time F-region covered by about ± 20º magnetic latitudes around the magnetic equator include where the electrojet current controls equatorial anomaly in the F2 region and the region of the strongest ionization encompassing southern crest of equatorial anomaly (~20°-25°S) with Magnetic inclination 23°S including Kinshasa with 4.41°S, 15.30°E The F-layer equatorial irregularities is vital for the design and operation of satellite communication systems affected up to microwave bands.

The Vtec is solar flux dependent, during the nighttime Vtec values are below 20 tecu. During the day time, two equinoxes maximum for 80 tecu at 14 TU are coding from red to black colors. The first maximum of solar activity cycle 24 in November 2011 the second maximum stronger than the first in the beginning of 2012.The weakest period is in summer solstice with about 35-45 tecu. The Tec symmetry of seasonal behavior relatively to the magnetic equator was shown. The blue code means nighttime not affected by solar flux almost 22.00 to 10.00 (Fig.1).

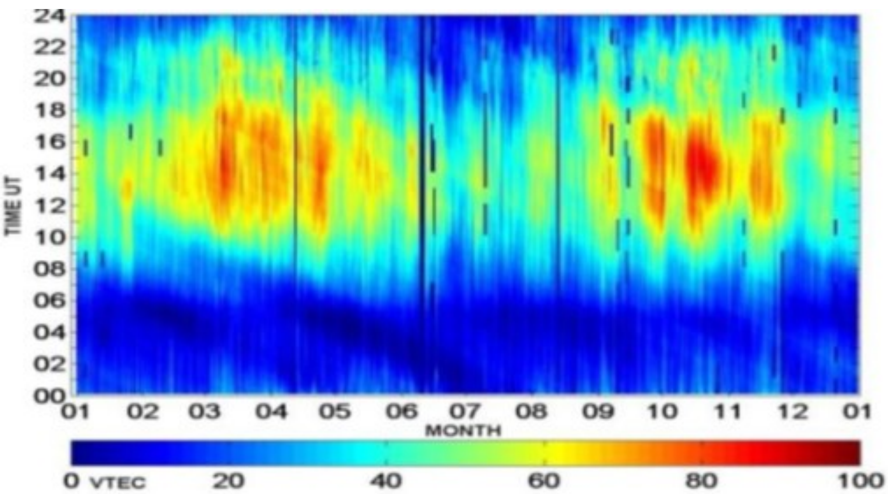

Figure 1. Three-dimensional VTEC Diurnal variation at DRC, 2012 (TEC Unit:1tecu=10^{16} electrons / m^2) (Kahindo et al.2017).

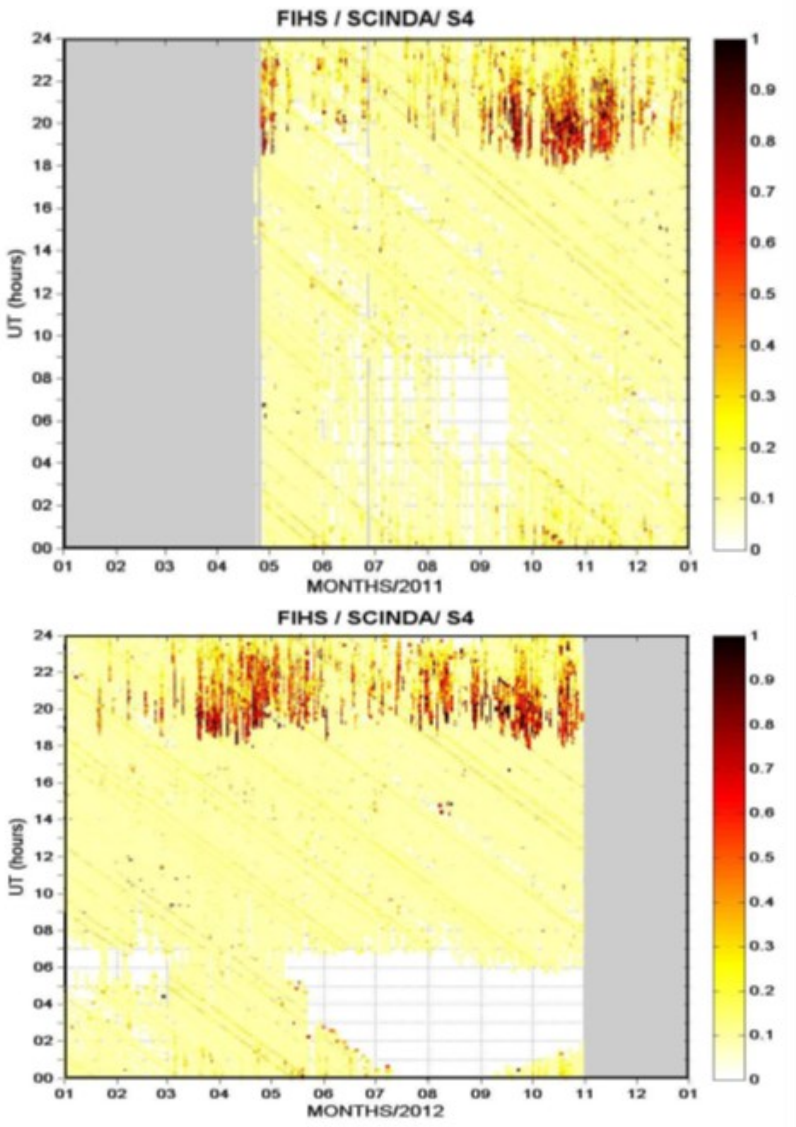

Figure 2. Scintillations of Scinda GPS Kinshasa (2011-2012) [Kahindo et al, 2017].

The development of high amplitude scintillations was (S4 > 1.0) after 18UT (19.00 LT) and maximum during the equinoxes but few scintillations in solstices (Fig. 2). The interest of these observations is occurring in the southern crest of equatorial anomaly where are very few measurements.

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Highlight on Young Scientists 1:

Evidence of high-to-low latitude coupling in the daytime thermopheric gravity wave activity during geomagnetically disturbed periods

Subir Mandal

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My research is focused on understanding the effects of solar and geomagnetic forcing on the vertical propagations of gravity waves (GWs) over the low-and-equatorial latitudes. We have arrived at a new approach to derive vertical propagation characteristics (time periods, speeds, wavelengths) of GWs by monitoring the phase-offsets in height variations of multiple iso-electron density contours as obtained using digisonde measurements (Mandal et al., 2019). Such analyses over a two-year duration from Ahmedabad, India, showed that the vertical propagations of GWs in the daytime thermosphere exist only 40% of the time and they are strongly influenced by the solar flux variability (Mandal et al., 2020). During geomagnetically quiet times, we found a double-humped structure in the magnitudes of vertical phase speeds (C_z) of these upward propagating GWs with maxima during equinoxes and minima during solstices (figure-1a). Further, they

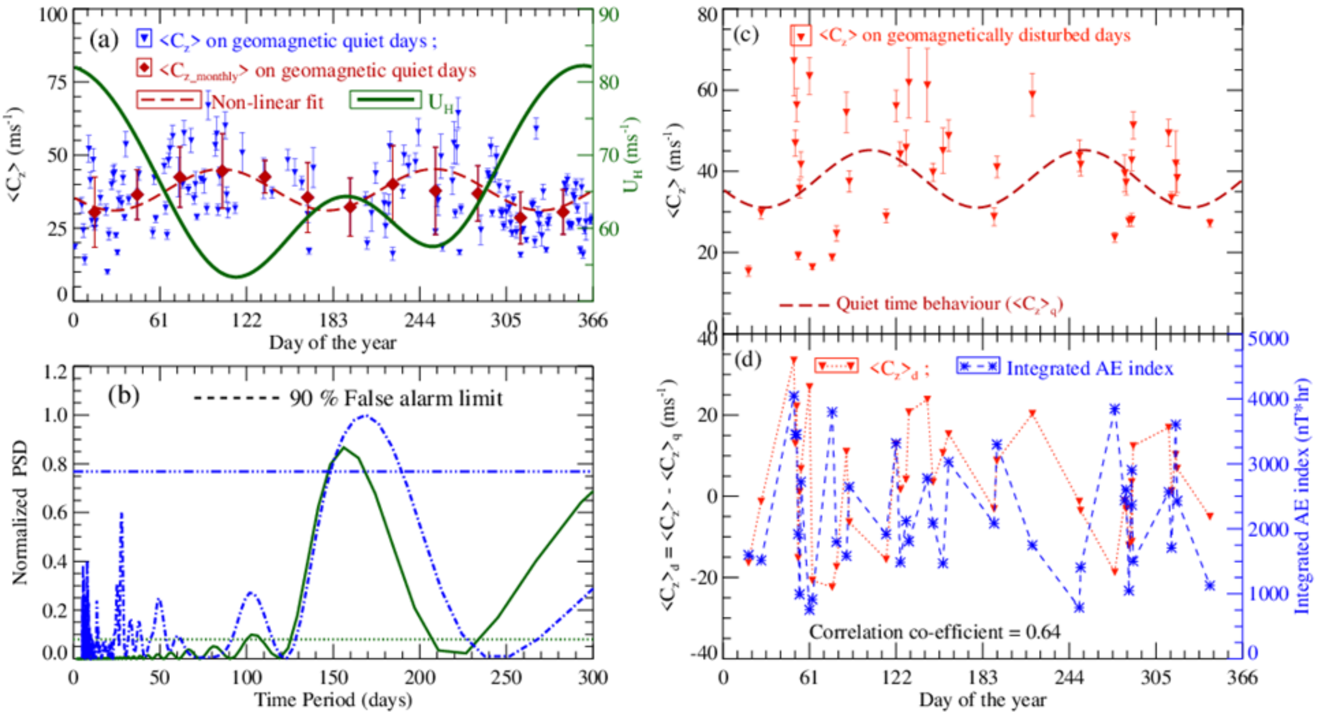

Figure 1. (a) Seasonal variation in the vertical phase speeds of GWs for geomagnetically quiet days (blue triangles) and HWM-14 model-derived winds (green curve). Monthly averaged values of C_z (red diamonds) and the least-square fit (dashed curve) of these are shown. (b) Periodograms obtained from the Lomb-Scargle analyses of winds (green) and GW speeds (blue) are depicted, which show a nearly similar periodicity in them which is anti-correlated with their temporal behavior shown in (a). (c) Disturbed time vertical phase speeds of GWs (red triangles) along with the quiet time average behavior (dashed curve). (d) Changes in $C_z$values (red triangles) during disturbed times compared to quiet days, and the integrated values of the AE index (blue asterisks) are shown as a function of day of the year.

show anti-correlation and similar periodic variation with the thermospheric model winds (figure-1b), suggesting a strong influence of background winds on wave propagations (Mandal and Pallamraju, 2020). The vertical propagation speeds of GWs on geomagnetically disturbed days are found to be significantly different from the average quiet time behavior (figure-1c), represented by least-square curve fitting. These differences in the vertical phase speeds ($< C_z >_d$) for geomagnetically disturbed days have been found to show variation similar to those in the integrated values of the auroral electrojet (AE) index, which is a measure of Joule heating in the auroral region due to energetic particle participations. We propose that these changes in the propagation speeds of GWs are brought in by the equatorward winds generated due to heating in the high latitudes and hence, present an evidence of high-to-low latitude coupling.

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Highlight on Young Scientists 2:

Insights from the study of 3D evolution of CMEs in inner and outer corona

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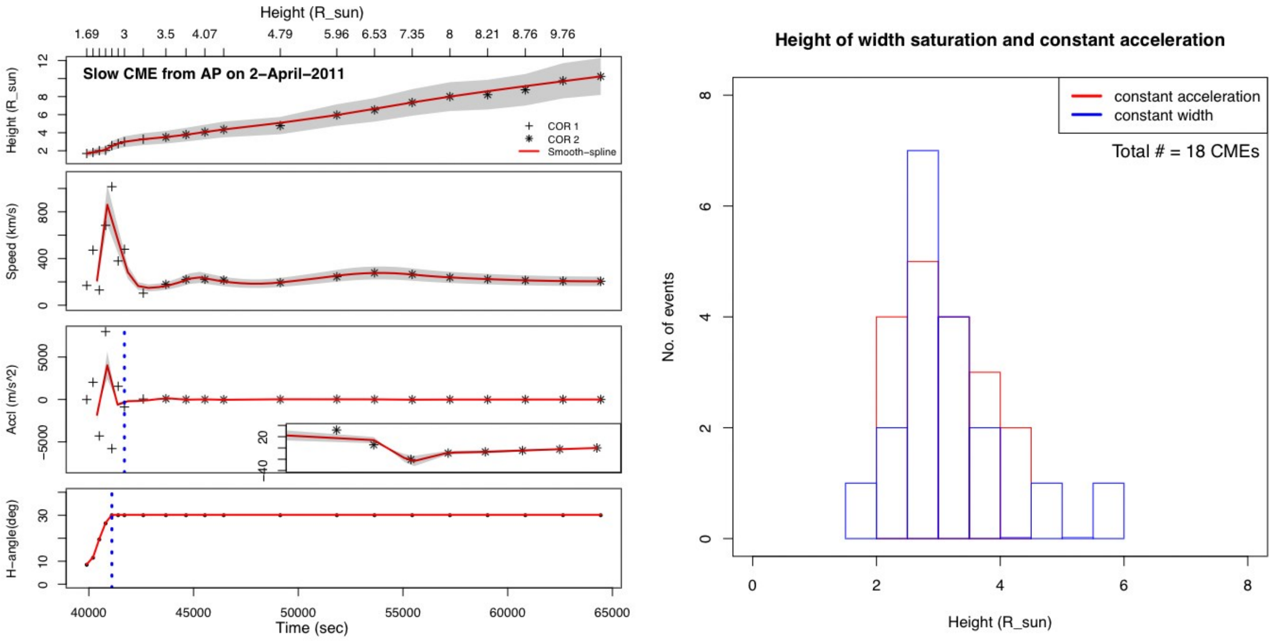
Despite studying Coronal Mass Ejections (CMEs) for the past few decades, the major challenges faced are projection effects, and paucity of data in the inner corona (< 3R). As a consequence of the later, Extreme UltraViolet observations are seldom combined with white light observations but unfortunately at the cost of questioning the consistency in the tracked physical feature.

Thus, in Majumdar et al. (2020), we studied the 3D kinematics of 59 CMEs in inner and outer corona by implementing the Graduated Cylindrical Shell (GCS) model (Thernesien et al. 2009) to the combined observations of COR-1 and COR-2 on-board the twin spacecraft STEREO-A/B.

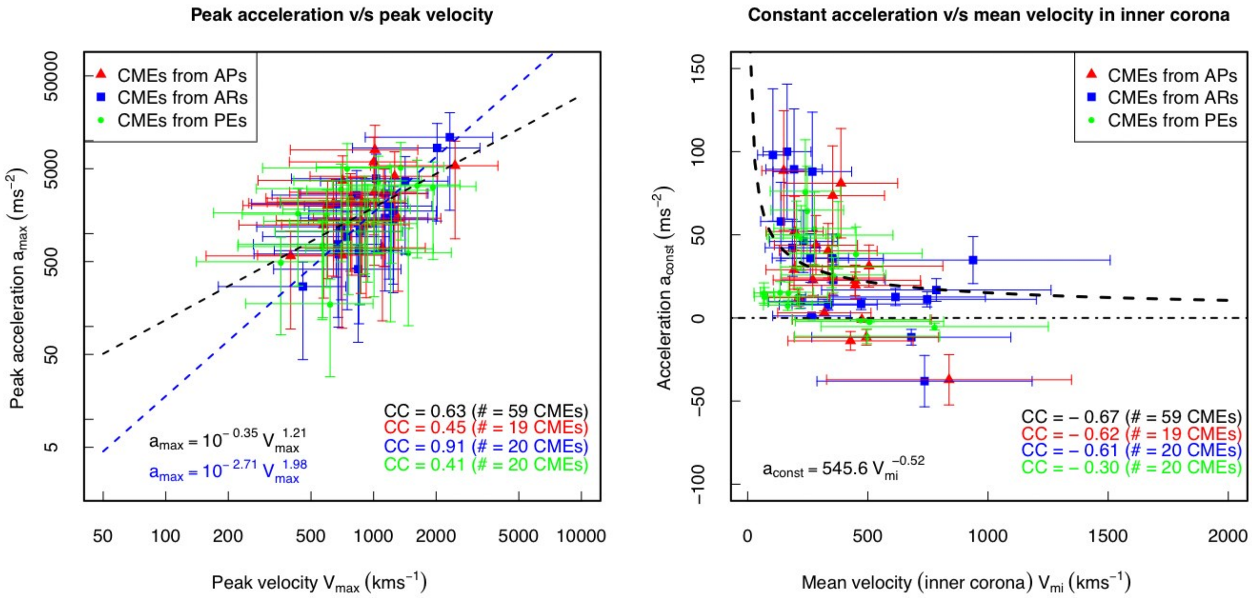
In Figure 1(a) we see a complete kinematic profile of a CME. In the third and fourth panel, we mark the heights of ceasing initial impulsive acceleration and rapid width expansion and find the two heights to lie close to each other. Thus providing the observational evidence in support of a width acceleration equivalence as nothing but a veritable manifestation of the same Lorentz force. We further noted these two heights for several events and found that the distribution of these heights (Figure 1(b)) are largely overlapping, with both distributions peaking at 2.5 - 3 R. Thus further asserting that the imprint of Lorentz force statistically stays dominant till 2.5-3R.

As an extension, in Majumdar et al. (2021), we found that the correlation of peak 3D speed and acceleration is different for CMEs originating from active regions (ARs) than those from quiescent and active prominences (PEs and APs) (Figure 2(a) and (b)). Further, the correlation between average acceleration and average speed (Figure 2(c)) showed that the drag experienced by CMEs are also different for different sources. Thus these results hint towards the possibility of different ejection and propagation mechanisms for CMEs connected to these different sources.



(a) (b)

Figure 1. (a) A complete kinematic profile of a CME. The height time data is fitted with a smooth spline (in red) and the speed and acceleration profiles (with an inset for a zoom in to the residual acceleration phase) are plotted by taking and first and second order derivative of the height-time data and the spline fit to it. The fourth panel shows the evolution of the half-angle parameter of the GCS model that communicates the angular width expansion of the CME. The blue vertical line (in third and fourth panel) markes the height at which the impulsive acceration and rapid angular width expansion ceases. (b) The distribution of heights of ceasing impulsive acceleration and width saturation.



(a) (b)

Figure 2. (a) Plot of peak acceleration versus peak speed. (b) Plot of the mean constant acceleration versus mean speed in inner corona. The data points are color coded with respect to the source region they are coming from, and the corresponding correlation coefficients are shown. The dashed line is the fitted emperial profile to the data.

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Meeting Report 1:

The Hinode-14/IRIS-11 Joint Science Meeting

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Jie Zhang

The Hinode-14 / IRIS-11 Joint Science meeting took place virtually on October 25-29, 2021 and was hosted by George Mason University (Fairfax, VA, USA). The meeting highlighted the most recent achievements of the IRIS and Hinode missions together with the latest research on topics related to the missions' goals. The science program was organized around four themes: (1) Hinode/IRIS connection to inner heliospheric platforms (PSP, SolO and other instrumetnts), (2) photospheric convection and solar magnetic field, (3) atmospheric heating: chromosphere to corona and (4) Flares, jets, CMEs and others. The fifth day was dedicated to a tutorial to the usage of data from EIS, XRT and SOT, and SunPy and IRISpy software packages.

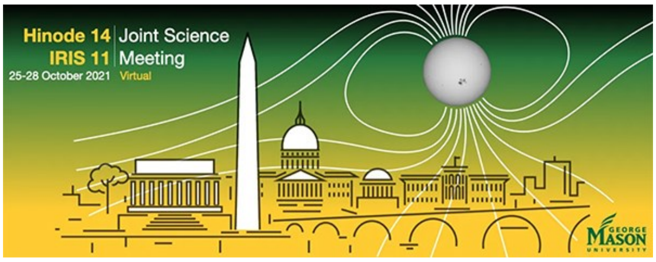

Figure 1. The logo of the Hinode-14/IRIS-11 Joint Science Meeting.

There were 350 registrations from 26 countries. There were 138 abstracts submitted, distributing in 50 oral presentations (14 invited) and 88 posters. The meeting acknowledges support from GMU, NSO, NSF, NASA and SCOSTEP/PRESTO. The full meeting information can be accessed at http://hinode14.org.

Meeting Report 2:

The International Space Weather Initiative (ISWI) Workshop

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Tarun Kumar Pant

The 2021 online International Space Weather Initiative workshop on 'Space Weather: Science & Applications' was jointly organized on November 2-3, 2021 by UNOOSA and the Space Physics Laboratory, Vikram Sarabhai Space Centre (VSSC), of the Indian Space Research Organization (ISRO), India. The Workshop was supported by International Committee on Global Navigation Satellites (ICG), Boston College, National Aeronautics and Space Administration (NASA), and Scientific Committee on Solar Terrestrial Physics (SCOSTEP). Over 340 participants from 52 different countries attended the workshop. The faculties comprised both national and International experts on Sun, Space Weather, its science and applications. Various important aspects of the "Space Weather: Science and Application" were discussed in four sessions, titled as (1) Sun, Solar Wind and Extreme Solar Eruptions, (2) Space Weather - Sources, Consequences, Observations and Modeling, (3) Space Weather Impacts on Magnetosphere - Thermosphere - Ionosphere System, and (4) Space Weather Instrumentation, Data, Outreach and Education.

The talks addressing topics concerning solar exploration, new payloads and probes, new and ongoing solar missions provided a modern perspective to the participants. The workshop also familiarised the participants with available data resources. The participants also got exposed to the new niche and emerging areas of solar - terrestrial science and modelling thereof. In addition, this workshop has been an important prelude to the forthcoming 15th Quadrennial Solar Terrestrial Physics Symposium, under the aegis of SCOSTEP, in India in February, 2022. This initiative is planned to continue in future too.

All the details and open-access lectures can be found at the web-site: http://www.unoosa.org/oosa/en/ourwork/psa/schedule/2021/2021-iswi-workshop.html.

Upcoming meetings related to SCOSTEP

Conference	Date	Location	Contact Information
SCOSTEP's 15th Quadrennial Solar-Terrestrial Physics Symposium (STP-15)	Feb. 21-25, 2022	Online	https://stp15.in/
EGU General Assembly 2022	Apr. 3-8, 2022	Vienna, Austria	https://www.egu22.eu/
The Second Summer School on Space Research, Technology and Application	Jul. 3-10, 2022	Rozhen, Bulgaria	https://bulgarianspace.online/second-summer-school_2022/
COSPAR 2022	Jul. 16-24, 2022	Athens, Greece	http://www.cosparathens2022.org/
AOGS 2022	Aug. 1-5, 2022	Online	https://www.asiaoceania.org/society/public.asp?page=home.asp
16th International Symposium on Equatorial Aeronomy (ISEA-16)	Sept. 12-16, 2022	Kyoto, Japan	
Summer Space Weather School - Physics and use of tools	In October, 2022	Houphouët Boigny University, Abidjan, Côte d'Ivoire	
AGU Fall Meeting 2022	Dec. 12-16, 2022	Chicago, IL, USA	https://www.agu.org/fall-meeting
IUGG 2023	Jul. 11-20, 2023	Berlin, Germany	https://www.iugg2023berlin.org/
AGU Fall Meeting 2023	Dec. 11-15, 2023	San Francisco, CA, USA	https://www.agu.org/fall-meeting

Please send the information of upcoming meetings to the newsletter editors.

The purpose of the The purpose of the SCOSTEP/PRESTO newsletter is to promote communication among scientists related to solar-terrestrial physics and the SCOSTEP's PRESTO program.

The editors would like to ask you to submit the following articles to the SCOSTEP/PRESTO newsletter.

Our newsletter has five categories of the articles:

1. Articles— Each article has a maximum of 500 words length and four figures/photos (at least two figures/photos). With the writer's approval, the small face photo will be also added. On campaign, ground observations, satellite observations, modeling, etc.
2. Meeting reports—Each meeting report has a maximum of 150 words length and one photo from the meeting. With the writer's approval, the small face photo will be also added. On workshop/conference/ symposium report related to SCOSTEP/PRESTO
3. Highlights on young scientists— Each highlight has a maximum of 300 words length and two figures. With the writer's approval, the small face photo will be also added. On the young scientist's own work related to SCOSTEP/PRESTO
4. Announcement— Each announcement has a maximum of 200 words length. Announcements of campaign, workshop, etc.
5. Meeting schedule

Category 3 (Highlights on young scientists) helps both young scientists and SCOSTEP/PRESTO members to know each other. Please contact the editors if you know any recommended young scientists who are willing to write an article on this category.

TO SUBMIT AN ARTICLE

Articles/figures/photos can be emailed to the Newsletter Secretary, Ms. Mai Asakura (asakura_at_isee.nagoya-u.ac.jp). If you have any questions or problem, please do not hesitate to ask us.

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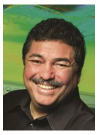

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