SCOSTEP
Scientific Committee on Solar-Terrestrial Physics

OCTOBER 2014

NEWSLETTER - SPECIAL ISSUE

In this issue:

1. Editorial – SCOSTEP Awards 2014

Recognizing the societal importance of studies in the field of solar-terrestrial physics and willing to give credit to scientists who contribute significantly to these studies and to SCOSTEP activities, the SCOSTEP Bureau has recently instituted three awards: SCOSTEP Distinguished Science Award, SCOSTEP Distinguished Young Scientist Award, and SCOSTEP Distinguished Service Award. The SCOSTEP Distinguished Young Scientist Award is given to young scientists who achieved considerable success in solar-terrestrial physics and took an active part in SCOSTEP-related activities. The SCOSTEP Distinguished Science Award is given in recognition of an outstanding contribution of a scientist to SCOSTEP science.

For its first installment, after a number of nominations from the solar-terrestrial community at large, the Awards Selection Committee unanimously selected and recommended to the SCOSTEP Bureau that Dr. Neel Savani and Dr. Jia Yue be the recipients of the SCOSTEP Distinguished Young Scientist Award for 2014. Prof. Gordon G. Shepherd was unanimously selected to be the recipient of the SCOSTEP Distinguished Science Award for 2014.

The SCOSTEP Distinguished Science Medals were presented to Dr. Jia Yue and Prof. Gordon Shepherd by the SCOSTEP President, Dr. Nat Gopalswamy al Solar-Terrestrial Physics Symposium (STP13), which took place during October 12 – 18, 2014, in Xi'an, Shanxi, China. Dr. Neel Savani was not able to attend. His award will be presented at a later date.

2. Message by the SCOSTEP President

Dear colleagues,

This Newsletter comes right after the successful Solar Terrestrial Physics symposium (STP13) held recently in Xi'an, China during October 12-18, 2014. Nearly 300 people attended the Symposium, which featured excellent keynote talks, overview talks, invited talks, and contributed presentations. Most of the presentations will be available online soon (http://www.yorku.ca/scostep/?page_id=1745 and http://stp13.csp.escience.cn) for the benefit of the SCOSTEP community members who could not attend STP13. I take this opportunity to thank Professor Chi Wang (LOC Chair) and Ms. Yanni Gao for the meticulous planning and smooth running of the symposium. I must thank the SOC members for the fantastic job they did in identifying world-class scientists as speakers at the symposium.

Arrangements are also being made to publish original-research and review articles presented at the symposium as special issues in international journals.

One of the important highlights of STP13 was the SCOSTEP 2014 awards. Two young scientists, Dr. Neel Savani and Dr. Jia Yue shared the 2014 Distinguished Young Scientist Award. The Distinguished Scientist award was given to Professor Gordon Shepherd. I take this opportunity to congratulate the award recipients again. When you see any of these next time, please congratulate them. This is one way to appreciate the contributions of our colleagues and celebrate their achievements. With these awards, we complete the first 2-year cycle of awards that includes SCOSTEP Service award (2013) and the Distinguished Scientist awards (2014). This means we should gear up to nominate deserving candidates for the next SCOSTEP Service Award in 2015. My sincere thanks go to the SCOSTEP sub-committee headed by Dr. Vladimir Kuznetsov in developing the modus operandi for the awards and the Awards selection committee chaired by Prof. Marvin Geller, Past President of SCOSTEP for the job well done.

The SCOSTEP Awards is one of the new initiatives designed to raise the profile of SCOSTEP, a fine organization I am proud to be President of. Some of the other recent initiatives are: SCOSTEP is now a Permanent Observer to the Science and Technology Subcommittee (STSC) of the United Nations Committee on Peaceful Uses of Outer Space (UNCOPUOS); The SCOSTEP Visiting Scholar (SVS) program recently launched will train young students and postdocs in advanced laboratories and institutes engaged in solar terrestrial physics; The new scientific program VarSITI (Variability of the Sun and Its Terrestrial Impact) was designed and finalized at the International Space Science Institute (ISSI) in Bern.

With all these activities, and the tremendous enthusiasm shown by the scientific community in carrying out various SCOSTEP activates, SCOSTEP will soon reach new heights. SCOSTEP will continue to strive for serving the community and realizing ISCU's mission of strengthening international *science for the benefit of society*.

Nat Gopalswamy
SCOSTEP President

Photo 2.1: SCOSTEP's President Dr. Nat Gopalswamy with the recipients of the SCOSTEP Distinguished Science Medal, Dr. Jia Yue and Prof. Gordon G. Shepherd, October 13, 2014.

3. SCOSTEP Awards 2014 - Citations

3.1 Distinguished Young Scientist – Dr. Neel Savani

Dr. Neel Savani of the Naval Research Laboratory is the recipient of SCOSTEP's **Distinguished Young Scientist Award** for 2014 in recognition of his innovative research and prolific publication record on solar-terrestrial physics in the first four years of his career.

Dr. Neel Savani's research interests focus on the solar-terrestrial relationships, the SCOSTEP core science, through the study of coronal mass ejections (CMEs) and their impact on Earth. Exceptionally for such a young scientist, in his research Dr. Savani employs a well-rounded arsenal of expertise in the analysis of both remote and in-situ observations as well as in the deployment of complex high-performance computing simulations. The appeal of his work to the broad research community is best summarized by his impressive h-index of 11 within 4 years of graduation. He has published 8 peer-reviewed articles as first author and contributed to 21 articles over all. During this time, he has won two highly competitive fellowships; the JSPS research fellowship at Nagoya University, and the Jack Eddy LWS Postdoctoral Fellowship at the Naval Research Laboratory, and has developed international collaborations with a large number of researchers. In addition to his modeling and data analysis capabilities, Dr. Savani has demonstrated a very creative mind, which has led him to key insights into the problem of the CME propagation in the inner heliosphere. He has created a flux rope model implemented extensively in several high impact publications and has suggested a radical change in the underlying theory of CME propagation by mathematically showing that the eccentricity of CMEs will reach a steady state under self-similar expansion. This is contrary to the outputs of the typical integrated space weather forecasting tools, which implement a hydrodynamic solar wind (i.e., ENLIL model) and hence result in extremely elliptical CMEs. This research has been followed by an insightful comparison between the morphology of Earth's magnetosphere and the magnetic obstacle of a CME. The results suggest that CMEs may have an even lower eccentricity. More recently, Dr. Savani has made two important far-reaching contributions. First, he has extended his earlier work on CME ellipticity by using high performance computing facilities in Japan to investigate the magnetic topology of simulated CMEs, solving the well-known disparity between remotely observed CMEs and those measured in situ upstream of Earth. His simulations have proven that the popular cylindrical topology inferred from in situ measurements could co-exist with remotely observed

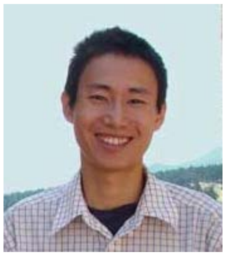
CMEs that appear stretched or 'pancaked'. Second, Dr. Savani has changed how the community views the solar winds parameters that influence the Earth's environment. Previously, the majority of the space weather forecasting research focused on understanding and correlating the Bz component of the solar wind magnetic field to the direct effects measured on Earth's environment. The paradigm shift in the research performed by Dr. Savani has shown that the effects of ram pressure of a CME can be isolated and shown to have a significant effect on geomagnetically induced currents measured on the ground. This work has also opened a potential forecasting capability by providing a proof of concept for measuring the ram pressure using remote observations. His current work focuses on improving these techniques to create a more reliable data set, which can be used as input into magnetospheric forecasting simulations for space weather predictions.

Dr. Savani has demonstrated rare skill in branching out of a single research domain in order to attack key scientific questions such as predicting Southward Bz, quantifying the influence of various solar wind parameters on Earth, and understanding the morphological changes occurring within a CME arriving at Earth. This ability to repeatedly perform significant contributions in scientific literature with a large variety of scientists across the world demonstrates his ability to work within large, cross-continental teams and disseminate scientific discoveries.

Overall, Dr. Neel Savani has performed innovative research on CMEs, one of the key components of the solar-terrestrial relationship. His research is influential as evidenced by his high h-index. He maintains an active role within the SCOSTEP community as a member of the working committee of ISEST (International Study of Earth-affecting Solar Transients), one of the four elements of the SCOSTEP VarSITI program, and outstanding ambassador for the Solar-Terrestrial Physics community and SCOSTEP as a young scientist.

3.2 Distinguished Young Scientist – Dr. Jia Yue

Dr. Jia Yue of Hampton University is the recipient of the SCOSTEP **Distinguished Young Scientist Award** for 2014 for his significant contribution to solar-terrestrial physics through his study of vertical coupling by atmospheric waves between the troposphere and the upper atmosphere.



Dr. Jia Yue's work deals with the broad topic of atmospheric waves and their variability in the mesosphere, thermosphere and ionosphere. He has utilized experimental techniques including both passive and active optical remote sensing from ground-based narrowband sodium temperature-wind lidars and all-sky airglow imagers, as well as satellite-borne instruments such as the TIMED/SABER, AIM, Aura, Suomi NPP etc. He also performed theoretical simulations of the mesosphere, thermosphere and ionosphere using general circulation models such as the NCAR/TIME-GCM.

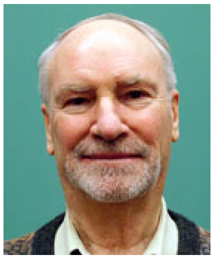
Dr. Yue's investigations have encompassed the full range of wave phenomena including gravity waves, tides and planetary waves. His first major contribution was the discovery that concentric gravity waves are routinely produced by tropospheric convective activity. Although isolated observations of concentric gravity waves had been reported in the past, Dr. Yue's breakthrough was to systematically compile a database of these waves from 6 years of airglow imagery in Colorado and then characterize these waves by comparing with tropospheric radar charts and satellite images. He also collaborated with scientists to model these waves, and clarified the mechanisms by which these concentric waves are generated and propagate into the thermosphere. Such concentric gravity waves are now more commonly observed with satellite imaging (e.g. ISS/IMAP, Suomi NPP etc.) and ground based imager networks, as the number of researchers involved in this research field is rapidly increasing. Dr. Yue himself has recently shown these waves to reveal themselves in ice cloud imagery acquired by the CIPS instrument on the NASA/AIM satellite.

Subsequent to his initial work on gravity waves, Dr. Yue has made contributions also in tidal and planetary wave studies. Using both satellite and model results, Dr. Yue mapped out the global distribution of the migrating terdiurnal tide and linked its morphology to the (3,3) Hough normal mode. Most recently Dr. Yue has become interested in the quasi two-day planetary wave and his work has contributed to a recent explosion of interest in this topic amongst aeronomers. Using simulations with the TIMEGCM, Dr. Yue has shown that this wave, previously understood to be primarily a mesospheric phenomenon, can propagate into the thermosphere and ionosphere, ultimately modulating the peak F2 region electron density. He has also shown how this wave may contribute to the rapid transport of exhaust plumes from the space shuttle. Taken together, these studies and publications on gravity waves, tides and planetary waves represent a prodigious research output, covering the entire range of middle and upper atmospheric dynamical variability.

With over 70 citations in 2013 alone (Web of Science database), Dr. Yue's work has made an immediate and important impact on the aeronomic community. The focus of his work relates to the topic of "What is the geospace response to variable inputs from the lower atmosphere?" (TG4) of SCOSTEP's Climate and Weather of the Sun-Earth System (CAWSES-II) program (2009-2013) and is highly relevant to the ROSMIC "Coupling by Dynamics " Working Group (Working Group 2) of the VarSITI (Variability of the Sun and its Terrestrial Impact) program (2014-2018). Dr. Yue has shown that concentric gravity waves are not rare, but rather are common phenomena associated with deep convection in the troposphere. As a result of his work and publications, various studies on strong vertical coupling due to such gravity waves are now being carried out more extensively by the aeronomy community utilizing both ground-based and satellite observations, theoretical works and modeling. Since gravity waves are one of the primary ways in which momentum is transferred vertically in the earth's atmosphere, Dr. Yue's work is directly relevant to the improvement of whole atmosphere modeling. In addition to his immediate research Dr. Jia Yue is very active in organizing collaborations with many researchers from the Solar-Terrestrial Physics community, especially with scientists in the USA and Asia (e.g. China (both main land and Taiwan) and Japan).

Dr. Jia Yue's accomplishments as a young scientist indicate a potential for him to become a very visible international presence representing SCOSTEP science.

3.3 Distinguished Scientist – Prof. Gordon G. Shepherd



Dr. Gordon Greeley Shepherd, Distinguished Research Professor Emeritus of Earth and Atmospheric Science at York University, is the recipient of the **SCOSTEP Distinguished Scientist Award** for 2014. Prof. G. Shepherd's seminal accomplishments and sustained contributions in upper atmosphere physics, chemistry, energetics, and dynamics, have significantly impacted the field of solar-terrestrial research. To date he has published more than 260 refereed journal publications resulting in 4504 citations, 3454 without self-citation. This places him in the top 1% in his field, according to Thompson Reuters Essential Science Indicators, and quantifies the impact of his scholarly research. His extraordinary scientific accomplishments and qualifications for the SCOSTEP Distinguished Science Award are summarized below.

Gordon Shepherd received his Ph.D. in physics from the University of Toronto in 1956. The early part of his research career was at the University of Saskatchewan, applying newly developed interferometric spectroscopy techniques to studies of aurora and airglow. Gordon initially deployed ground based instruments to measure a host of phenomena, including mesospheric sodium concentrations, pulsating aurora, auroral proton velocities deduced from hydrogen Balmer beta emission, and Doppler temperatures within the aurora and airglow. He subsequently developed new versions of these instruments for rocket flights, which allowed the first ever in-situ measurement of the Balmer beta emission in a proton aurora and led to his role as Principal Investigator for the Red Line Photometer (RLP) on the second International Satellites for Ionospheric Studies (ISIS-II) satellite. Gordon moved to York University in 1969 and ISIS-II was launched in 1971. RLP successfully mapped daytime red aurora associated with the cusp, tropical red arcs, conjugate photoelectrons, and mid-latitude stable red auroral (SAR) arcs. Following the RLP cusp work, Gordon led a team to Cape Parry on the Arctic coastline, and launched rockets to make the first in-situ measurements of the daytime aurora. Prof. Shepherd has consistently pursued international collaborations with scientists from Asia, the United

States and Europe. Gordon's visit to the Laboratoire Aimé Cotton in Paris in 1961 inspired the configuration of a ground based instrument, the Wide Angle Michelson Interferometer (WAMI) for measuring Doppler temperatures in the aurora and airglow. Gordon subsequently demonstrated the crucially important step of extending WAMI to include wind observations from the Doppler shifts by making those measurements.

In 1987 Gordon was co-investigator in the establishment of the Institute for Space and Terrestrial Science (ISTS), a Centre of Excellence based at York University. ISTS became the Centre for Research in Earth and Space Technologies (CRESTech), and Gordon became the Director of the Solar Terrestrial Physics Laboratory within that centre. He was also Director of the Centre for Research in Earth and Space Science at York University from 1996 to 2009. During this period Gordon and his colleagues developed a ground-based Spectral Airglow Temperature Imager (SATI) and provided instruments to Japan, China, Korea, Kazakhstan, Bulgaria, Spain, as well as Canada. Perhaps the most successful SATI was one of two Korean instruments operated collaboratively at Resolute Bay, yielding eight years of Arctic mesospheric temperatures and establishing their relationship to stratospheric sudden warmings. Gordon subsequently evolved the WAMI instrument into the Wind Imaging Interferometer (WINDII), launched on NASA's Upper Atmosphere Research Satellite (UARS) in 1991. Because WINDII measured winds from airglow during both day and night, it definitively characterized the diurnal tide at the equator and demonstrated that it was much larger than previously thought. WINDII also measured atomic oxygen airglow and concentrations, showing a systematic relationship between airglow altitude and emission rate with higher airglow emission peaking at lower altitude. This relationship was interpreted as a dynamical influence on the airglow (i.e., downward advection of atomic oxygen from above increasing the emission rate), and shown to be a dominant influence on airglow variability. Gordon and the WINDII Science team also investigated many other phenomena with WINDII, including wind enhancements during geomagnetic storms, polar mesospheric clouds, the quasi two-day wave, the springtime transition, longitudinal wind variations, tropical arcs, and the influence of the Sun on airglow and atomic oxygen concentrations. Gordon's role as the principal investigator of WINDII involved the leadership of a large team of French and Canadian scientists, and work with CNES, CSA and NASA personnel. Although it has been more than twenty years since WINDII was launched, its capability has yet to be reproduced. Gordon's ongoing research efforts include investigations of non-migrating tides, polar spirals in winds that appear to be related to traveling ionospheric disturbances (TIDs), airglow "bright nights", solar cycle variability, thermospheric atomic oxygen concentrations, the O^+ airglow, and hydroxyl rotational temperatures. Gordon proposed the SCOSTEP Planetary Scale Mesopause Observing System (PSMOS) project and co-chaired PSMOS from 1997 to 2002. PSMOS involved more than 100 scientists from 21 countries. The basis of the PSMOS project was the large and then unresolved longitudinal variations observed by WINDII, along with radars and small instruments like SATI. By all measures PSMOS was a success. Under its auspices the scientific community conducted global ground-based measurement campaigns, and reported their results at international symposia and in a 2010 special issue on the Ionosphere/Thermosphere in the Journal of Atmospheric and Solar-Terrestrial Physics. Gordon's SCOSTEP contributions also include his six-year term on the Bureau from 2004 to 2010. During roughly the same period he was a member of the COSPAR Bureau and was chair of the Executive Committee that hosted the 2008 Scientific Assembly in Montreal.

Gordon Shepherd is an outstanding scientist who has made seminal contributions to our understanding of the ionosphere-thermosphere system through the development of innovative instruments and the subsequent analysis of their observations over the course of a research career that is approaching 60 years duration. He is a scientific leader and innovator, and a modest person of integrity.

4. Research Highlights – SCOSTEP Awardees

4.1 Neel Savani – *Predicting the magnetic vector within coronal mass ejection arriving at Earth*

Dr. Neel Savani began his career shortly after the launch of the NASA STEREO spacecraft, and has proceeded to take full advantage of the new observational capabilities of the inner heliosphere.

Before the existence of wide angle heliospheric imagers (HI), the assumed morphology of CMEs in the interplanetary medium were predominately estimated from results of simulated CMEs under 3D MHD conditions. These simulations would often observe a continually stretching (aka. 'pancaking') of a CME during propagation. Coronagraphs were capable of defining the CME morphology close to the Sun's surface, while simplistic models fitted onto interplanetary in situ data were used to infer the CME structure at planetary distances.

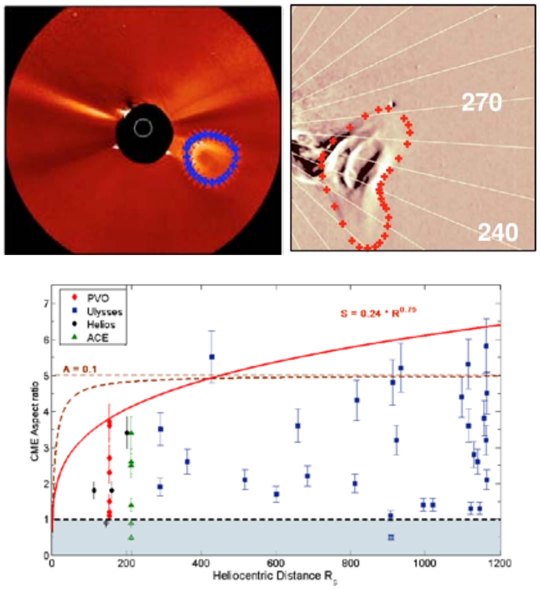


Figure 4.1.1: The deformation of a CME during propagation, observed with STEREO B spacecraft on 15th November 2007 (upper panels)Savani et al. 2010). Aspect ratio of a CME estimated at various heliocentric distances from in situ data (lower panel) (Savani et al. 2011).

The STEREO HI imagery (Figure 4.1.1, 1upper panel) were used to demonstrate that a CME is capable of undergoing extreme deformation due to the structure propagating through a bi-modal fast/slow solar wind stream (*Savani et al*. 2010). While the aspect ratio of the CME cross section appears to stretch and pancake during propagation, a study to estimate the aspect ratio at interplanetary distances proved less conclusive. The aspect ratio was estimated from in situ data and by identifying a correlation between a CME shock morphology with Earth's bow shock (Figure 4.1.1, lower panel). This interplanetary study of CMEs showed the aspect ratio is able to vary considerably between events, but always remain significantly more circular in cross section than the theoretically estimated pancaking structure (*Savani et al.* 2011a,b).

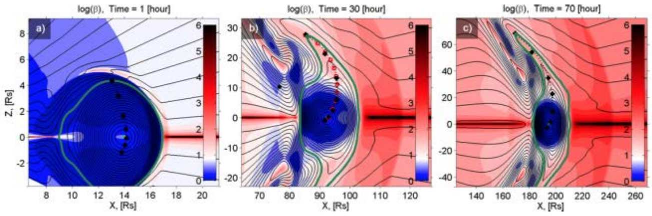


Figure 4.1.2: (a)-(c) 2.5D simulation of a CME propagating through the heliospshere. The drastic change in the magnetic behavior of the CME from a quasi-circular cross section to a 'pancaked' shape is displayed with a plasma beta color scale. The use of computational simulations enables studies of the forces undergone by the CME; namely the kinetic energy density of the shocked solar wind plasma ahead of the magnetic obstacle and the poloidal field energy density, which describes the tendency for the flux rope structure to remain quasi-circular. (Savani et al. 2013a)

To understand how the magnetic topology of the internal CME structure evolves, computational simulation results still remain the primary techniques for discovery until verification of these objects will be measured in the inner heliosphere by Solar Orbiter and Solar Probe Plus. A simulation below (Figure 4.1.2) displays a solution that shows the pancaking hallmarks of a CME displayed by heliospheric imagers while capable of reproducing a strong magnetic field rotation (with quasi-circular cross section) from a hypothetical spacecraft trajectory though the CME central region (*Savani et al.* 2013). This two-region nature of a CME, in part, goes towards explaining the reasons of such high degree of success that in situ modelers have with a fixed circular cross section flux rope model and towards the debate if all CMEs contains a magnetic flux rope.

Investigations into CMEs and how they evolve prior to arrival at Earth has predominately been driven by the need to better forecast their effects on the terrestrial environment; often called space weather. It has long been known that a southward magnetic field orientation is the primary driver for strong geomagnetic storms. However, significantly less emphasis has been focused towards large and sudden compression of the magnetosphere due to drastic changes in solar wind ram pressure. Figure 4.1.3 displays an example CME seen by STEREO-A cameras in a mass-image format with minimal image processing (*Savani et al.*, 2013a,b). This event was specifically chosen for its significant northward directed field orientation, thus enabling isolated studies into the effects of ram pressure. Through the use of CCMC simulation tools based at NASA Goddard, the rate of magnetic field fluctuations at ground stations around Earth were estimated and compared to observations to prove that the ram pressure of a CME has a significant impact on geomagnetically induced currents.

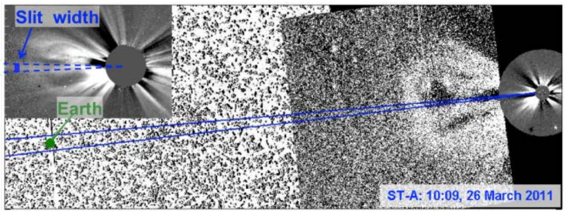


Figure 4.1.3: Excess mass images for an event seen by STEREO–A cameras. Blue cone displays the small region of interest for Earth. (Inset) Expanded view of the COR2 camera when the CME remains within the field of view. The rectangular blue block (slit width) displays the area in each frame used to create a density time series. (Savani et al. 2013b)

References:

Savani, N. P., M. J. Owens, A. P. Rouillard, R. J. Forsyth, K. Kusano, D. Shiota, R. Kataoka: Evolution of coronal mass ejection morphology with increasing heliocentric distance: I. Geometrical analysis, ApJ, 731, 109, 2011a.

Savani, N. P., M. J. Owens, A. P. Rouillard, R. J. Forsyth, K. Kusano, et al.: Evolution of coronal mass ejection morphology with increasing heliocentric distance: II. In situ analysis, ApJ, 732, 117, 2011b.

Savani, N. P., A. Vourlidas, A. Pulkkinen, B. Lauvard, T. Nieves-Chinchilla, M. J. Owens: Tracking the momentum flux of a CME and quantifying its influence on geomagnetically induced currents at Earth, Space Weather, 11, 4, 2013a.

Savani, N. P., A. Vourlidas, D. Shiota, M. Linton, K. Kusano, N. Lugaz, A. P. Rouillard: A plasma β transition within a propagating flux rope, ApJ, 779, 2, 142, 2013b.

4.2 Jia Yue – *New satellite observations yield clear evidence of lower to upper atmosphere coupling*

Dr. Jia Yue's recent research effort involves bringing in new spaceborne sensors to study the coupling of the lower and upper atmosphere via the propagation of gravity waves. Two science highlights are summarized below.

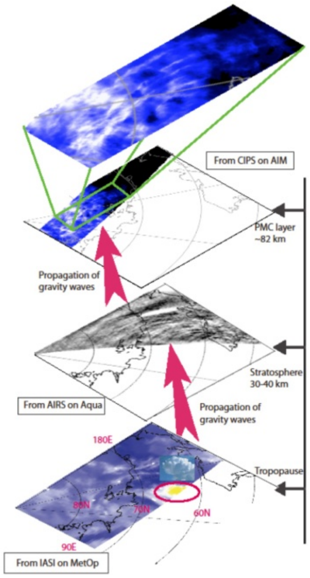


Figure 4.2.1: Upper tropospheric cloud disturbances occurring ~8 miles above the surface are traced through the atmosphere to the edge of space at ~50 miles altitude using three satellite instrument systems: IASI, AIRS and CIPS.

Noctilucent clouds (NLCs) or polar mesospheric clouds (PMCs) are the highest clouds in Earth's atmosphere, occurring ~50 miles above the ground. The NASA Aeronomy of Ice in the Mesosphere (AIM) mission has been monitoring the morphology of these clouds with an unprecedented 5km by 5km horizontal resolution since 2007. This ultra-high resolution has enabled the discovery of many new features of PMC properties. For example, the curvatures found in PMC images (top enlarged panel, Figure 4.2.1) are shown to align with very similar curvatures in temperature contours simultaneously observed by the NASA Aqua satellite almost 30 miles below the clouds. These interesting curved patterns in PMCs are formed from the upward passage of atmospheric gravity waves. What is being seen here is like a stone tossed into a lake. An atmospheric disturbance occurs at a point and is propagating upward. The "stone" is the occurrence of a strong storm that creates intense convection and perturbs the atmosphere starting ~8 miles above the surface. The excited waves travel away from the thunderstorm and reach the PMC layer changing the cloud shapes. Through propagation of gravity waves (the curved structures), the upper and lower atmospheres are coupled together. The combined observation of upper tropospheric and mesospheric clouds is more relevant than was previously expected. PMCs reside in the mesopause region which is a gateway between geospace and the neutral atmosphere. This research also serves to stimulate comprehensive investigations that consider Earth's atmosphere as a whole.

The newish Suomi NPP satellite's next-generation low-light sensor can observe gravity waves in nightglow (mainly infrared OH Meinel bands) with an unprecedented resolution of~0.75 km from space. The first simultaneous spaceborne observations of concentric gravity wave patterns in the stratosphere and mesosphere over the Indian Ocean excited by Tropical Cyclone Mahasen are made using both the NASA Suomi NPP and Aqua satellites. These look like ripples of glowing atmosphere whose structure is the result of a train of gravity waves that is passing through a thin layer of the atmosphere that produces a very faint veil of light called 'nightglow'. These are not clouds (although they were forced by the thunderstorms below), and they do not occur in the troposphere, where our 'weather' is. They are much higher up — at the interface between the mesosphere and the thermosphere — about 90 km (55 miles) above the surface. The Tropical Cyclone was proven to be a powerful engine of exciting gravity waves that could propagate into space. Concentric ring patterns in nightglow were observed in close-proximity to Mahasen by the Day/Night Band (DNB) of the Visible/Infrared Imager/Radiometer Suite (VIIRS) on the Suomi NPP satellite (Figure 4.2.2). The waves exhibited horizontal wavelengths of 40–60 km. Meanwhile, long concentric waves of ~500 km wavelength were also seen west of India, far away (~1500 km) from their estimated center near Mahasen. Concentric gravity waves in the stratosphere were observed nearly simultaneously by the Atmospheric Infrared Sounder on the Aqua satellite. These multi-level observations provide a clearer picture of the complex three-dimensional structure of tropical cyclone-generated gravity waves than a single instrument alone.

References:

Yue, J., B. Thurairajah, L. Hoffmann, M. J. Alexander, A. Chandran, M. Taylor, J. M. Russell III, C. Randall, S. M. Bailey, Concentric gravity waves in polar mesosphere clouds from the Cloud Imaging and Particle Size (CIPS) experiment (2014), J. Geophys. Res. Atmosphere, 119, doi: 10.1002/2013JD021385.

Yue, J., S. Miller, L. Hoffmann, and W. Straka III (2014), Stratospheric and mesospheric gravity waves over Tropical Cyclone Mahasen: joint AIRS and VIIRS satellite observations, J. Atmos. Solar Terra. Physics, 119, 83-90.

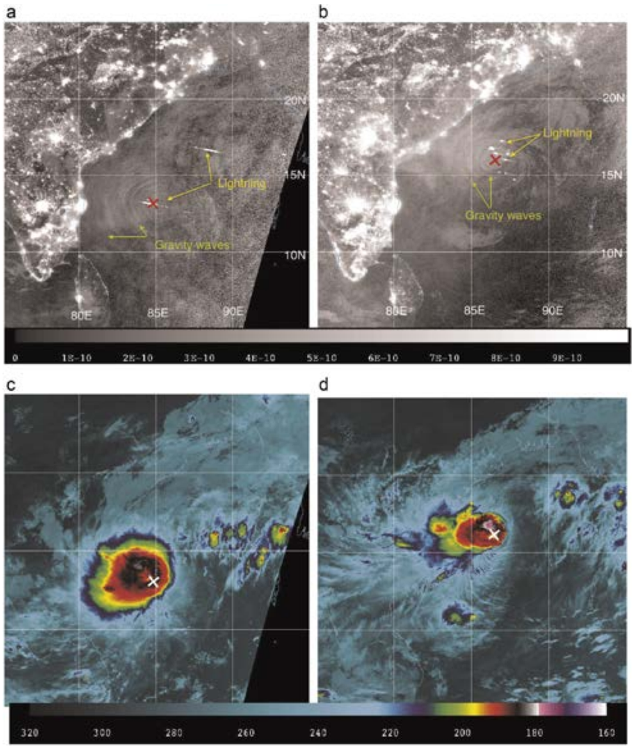


Figure 4.2.2: DNB observations of the Tropical Cyclone Gravity Waves in nightglow (upper panels) and corresponding infrared (brightness temperature in K) observations of TC Mahasen (bottom panels). Red and white crosses denote the estimated centers of the concentric TGW structures.

4.3 Gordon Shepherd – <u>*Reflections on the first SCOSTEP Distinguished Scientist Award*</u>

I want to deeply and sincerely thank SCOSTEP for selecting me for their first Distinguished Scientist Award. Being the first is unique and is particularly treasured. Most of all, having the award come from one's colleagues brings warm feelings about the community in which we all live and work. I attended my first SCOSTEP assembly in Ottawa, in 1982, and have been to many since then. As well, I co-chaired PSMOS, a small but very rewarding project, from 1997 to 2002. Although I have not been active in SCOSTEP since then, I feel very much a part of it again now.

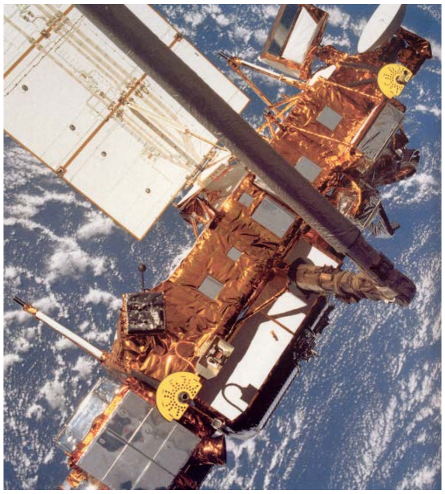


Photo 4.3.1: The Upper Atmosphere Research Satellite at the end of the Canadarm, about to be released into space. This was shuttle flight STS-48, the date was September 15, 1991.

There are three things that I have particularly enjoyed during my career. The first is to see new concepts in instrument development, mainly interferometers, come into being. I like to tell non-scientists that I am an "interferometric spectro-scopist". To me, such a new instrument is a beautiful thing. The second is to see new data from new instruments, some feature of the atmosphere that no one else has seen before. This is a particularly wonderful experience, and happily one that goes on and on as one delves more and more into the data. There is no end to that and I am still finding new things today. I have learned so much from these data. The third thing is working in collaboration with colleagues; students, post-docs, research associates and faculty members from my own institution and others around the world. I have learned so much from all of them.

The late Skip Reber, Principal Scientist for the NASA's Upper Atmosphere Research Satellite, told the team that UARS was NASA's last great atmospheric science experiment. By this he meant that future large atmospheric missions would be more applied, and that the UARS instrument PIs were given all the resources they asked for, that there was no limit to what had to be done to make the best possible measurements. The same was true of the Canadian and French support for the Wind Imaging Interferometer (WINDII). That is what made WINDII so successful, based of course on a simple but novel concept for wind measurements, along with the emission rates of the airglow emissions, both at night and during the daytime. The data reinforced my earlier convictions that one should trust ones data (if the instrument is well conceived, well fabricated and well calibrated).

Thus the tidal experts on the WINDII team told us we would not be able to characterize the migrating tides. Wrong, this tide was the dominant feature in the data. This is not a criticism of those individuals; they were predicting on the basis of previous knowledge. However, to see these tides we had to use zonal averaging, smoothing out the non-migrating tides which we could have seen from the beginning, but did not, for another 20 years. We studied the quasi two-day wave, the seasonal variation of the mean winds, and most surprising, the incredible influence of the observed winds on the emission rates. The whole atmosphere was in motion and it was the vertical motions that informed us about the airglow variability that has puzzled aeronomers for decades. We also saw the impact of solar flares on airglow, and we saw polar mesospheric clouds, as WINDII was an imager as well as a wind-measuring device.

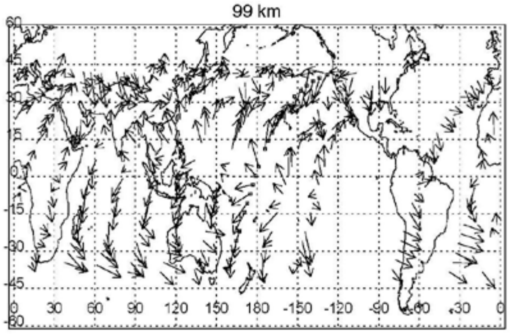


Figure 4.3.1: WINDII winds measured for day 95 of 1992 with each measurement shown as a vector. Note the changes in wind for different longitudes for a fixed latitude, also the large wind perturbation at high latitudes near the longitude 150 degrees, perhaps cause by the aurora.

During the UARS mission the pace was frantic. Now, the work continues, at a slower pace, but led by new revealed insights, with no schedule to meet. The most recent work has been to extract the O^+ (^2P) 732 nm emission from the data. This offers the opportunity for accurate determinations of the atomic oxygen concentrations in the thermosphere. More optimistically, it offers the possibility of the measurement of ion winds and their influence on the neutral winds. The enjoyment and surprises continue, indefinitely.

5. General Information about SCOSTEP

5.1 SCOSTEP Web Site

Information on SCOSTEP can be found at:
http://www.yorku.ca/scostep/

5.2 SCOSTEP Contact

The Scientific Secretary is the main point of contact for all matters concerning SCOSTEP.

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