SCOSTEP
Scientific Committee on Solar-Terrestrial Physics
VarSITI

Variability of the Sun and Its Terrestrial Impact (VarSITI)
SEE / ISEST-Minimax24 / SPeCIMEN / ROSMIC
http://www.varsiti.org/

Vol. 19, October 2018

VarSITI Newsletter

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VarSITI

Article 1:

Project for Solar-Terrestrial Environment Prediction (PSTEP)

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Although solar activity may significantly impact the global environment as well as socio-economic systems through variety of processes (Fig. 1), the mechanisms for solar activities and the subsequent processes have not yet been fully understood. Thus, modern society, which is supported by advanced information systems, is at a risk from severe space weather disturbances and the long-term variation of solar-terrestrial environment. Project for Solar-Terrestrial Environment Prediction (PSTEP) was launched in order to improve this situa-

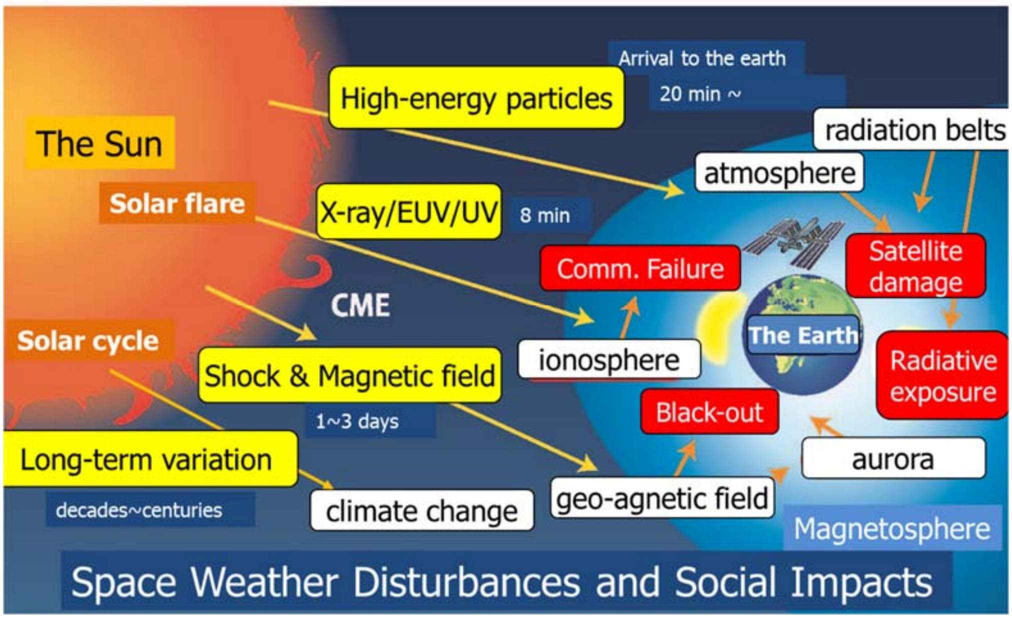


Figure 1. The subject of PSTEP study. The objective of PSTEP is to improve the feedback between the scientific research and the operational forecast of space weather disturbances and social impacts.

tion through synergy between the basic science research and the forecast operation. PSTEP is a nation-wide research collaboration supported by a Grant-in-Aid for Scientific Research on Innovative Areas from MEXT/ Japan. In this project, we seek to answer some of the fundamental questions concerning the solar-terrestrial environmental system and aim to contribute to building a next-generation space weather forecast system to prepare for severe space weather disasters. More than twenty institutes and hundred researchers join to PSTEP, and PSTEP is operating for five years since 2015 April.

The organization of PSTEP is composed by four research groups (A01–A04), proposal-based research units, and the steering committee (Fig. 2). Group A01, lead by Dr. Ishii (NICT), aims at constructing next-generation space weather forecast system by joining the other groups of PSTEP. Groups A02 and A03, lead by Prof. Ichimoto (Kyoto University) and Prof. Miyoshi (Nagoya University), respectively, improve our capability for predicting the solar-terrestrial environment by understanding the physical mechanism of solar explosions and the consequent disturbances to the geo-space using physics-based models and the state-of-the-art observation facilities, e.g., Arase (ERG) Geospace Prove and the solar observing satellite Hinode. Group A04, lead by Prof. Yoden (Kyoto University), aims to develop a prediction scheme for the activity of the next solar cycle and also to improve the scientific understanding of solar influence on climate by implementing the solar related effect into the atmospheric part of the Meteorological Research Institute Earth system model. In addition to the Research Groups, seventeen research units are selected for topical subjects and work with the related research groups. PSTEP also organizes the series of international conferences for space weather and space climate studies (see Fig. 3) and publishes the PSTEP Newsletter and the PSTEP Science Nuggets for each research subject, periodically.

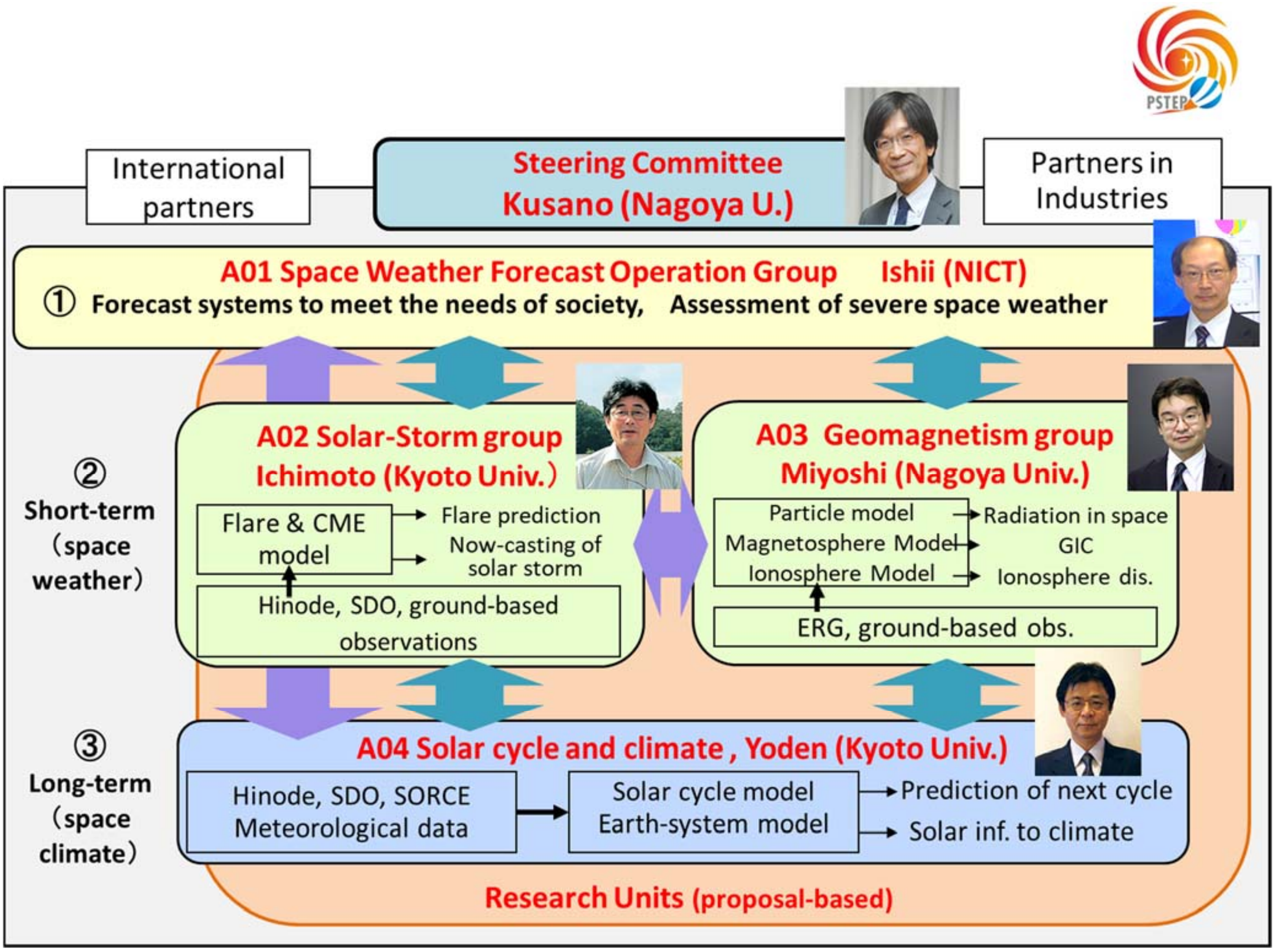
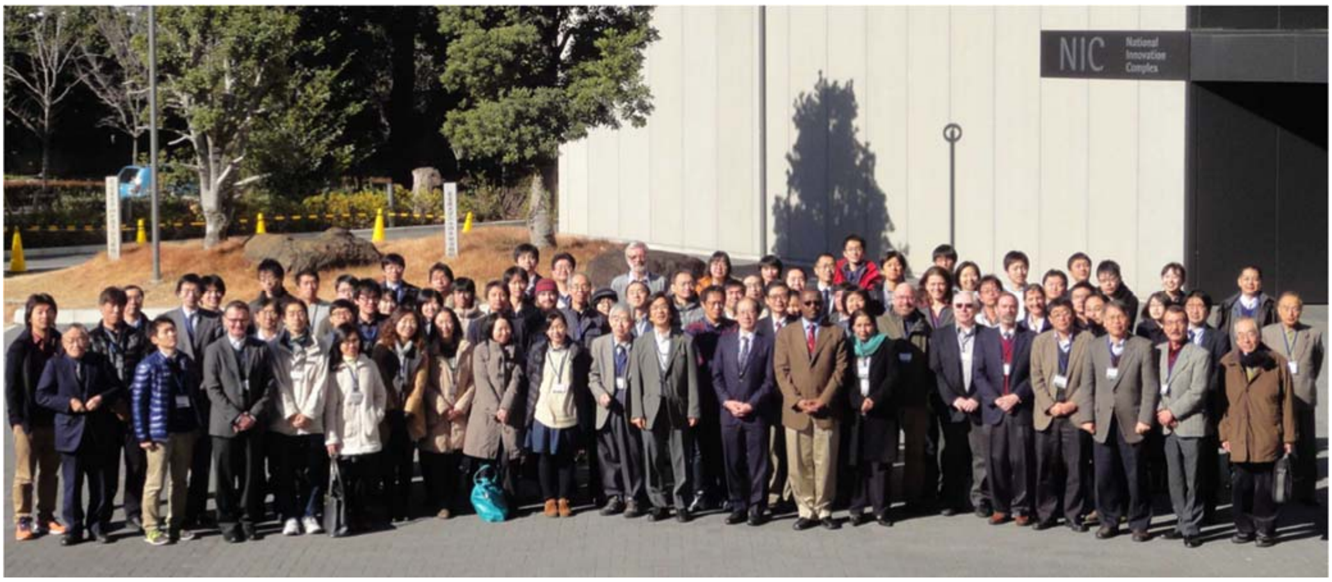


Figure 2. The organization of PSTEP and the aim of each research group A01-A04.



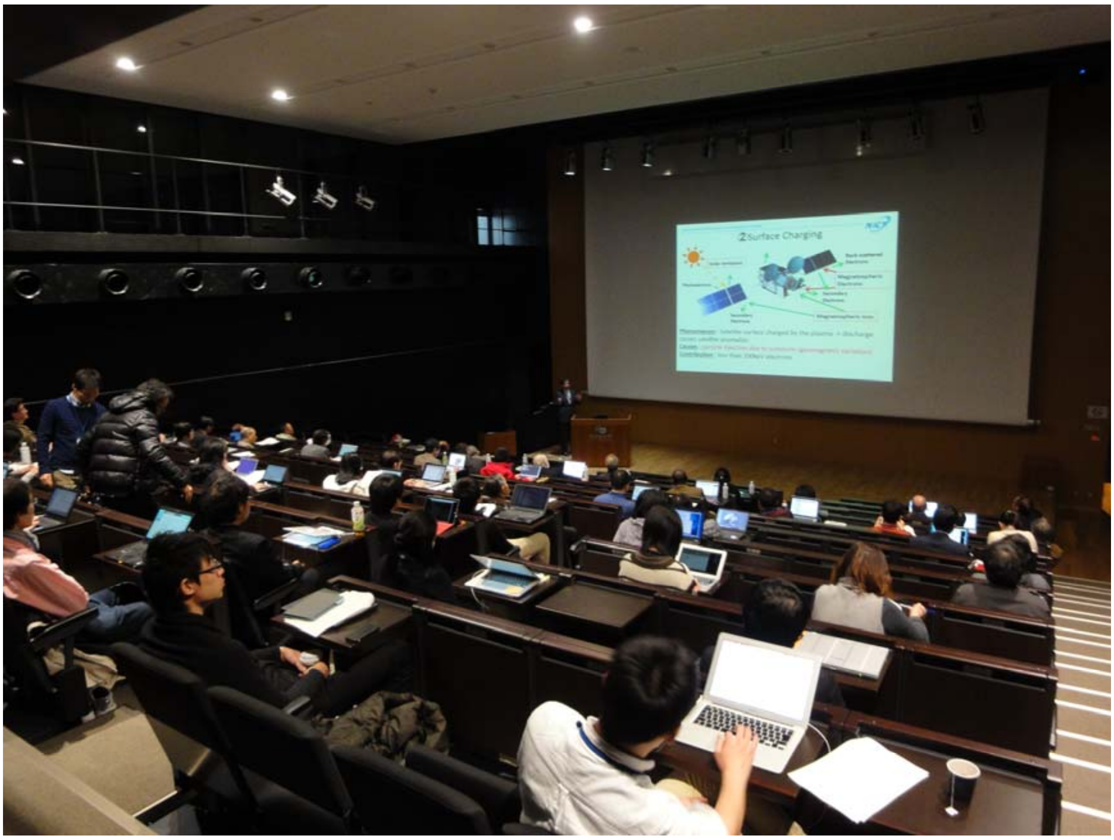


Figure 3. International Symposium PSTEP-1 held at Nagoya University on Jan 13-14, 2016.

PSTEP activity is now at its midway point and already produced a variety of scientific productions, e.g., the development of new scheme for predicting the onset of solar flares, the prediction of next solar cycle activity, the new warning system for aviation exposure to solar energetic particle, and the prediction of occurrence of equatorial plasma bubbles using a whole atmosphere-ionosphere coupled model. At the final stage of PSTEP, we will try to summarize the results of the PSTEP studies and create a space weather hazard map. The details of PSTEP activities and scientific results are reported on the PSTEP Website (http://www.pstep.jp/).

Article 2:

VarSITI Discussion on "Solar Variability and Sunspot Indices"

Katya Georgieva

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The number of sunspots is the solar activity proxy with the longest record, and widely used to evaluate both solar variability and its terrestrial impacts.

Two sunspot indices were used until recently:

- The "Wolf number" (Wolf, 1851) defined by the number of observed sunspots S and sunspot groups G: R_Z=10G+S

- The group sunspot number based on only the number of sunspot groups G (Hoyt and Schatten, 1998), calculated as R_G=12.08G to bring it to the same scale as R_Z.

The R_Z series provides yearly/monthly/daily sunspot index values from 1700/1749/1818, respectively, to May 2015, and the R_G series – from 1610 to 1995. To quantify the long-term solar variability, some researchers have used R_Z, others R_G, and still others a combination of the two because R_Z is not available before 1700, and R_G – after 1995.

R_Z and R_G are closely correlated, however their long-term trends differ (Fig.1), and so do estimates of solar variability and its terrestrial impacts based on the one or the other. In particular, using R_G leads to higher estimated past solar forcing on the Earth's climate than using R_Z.

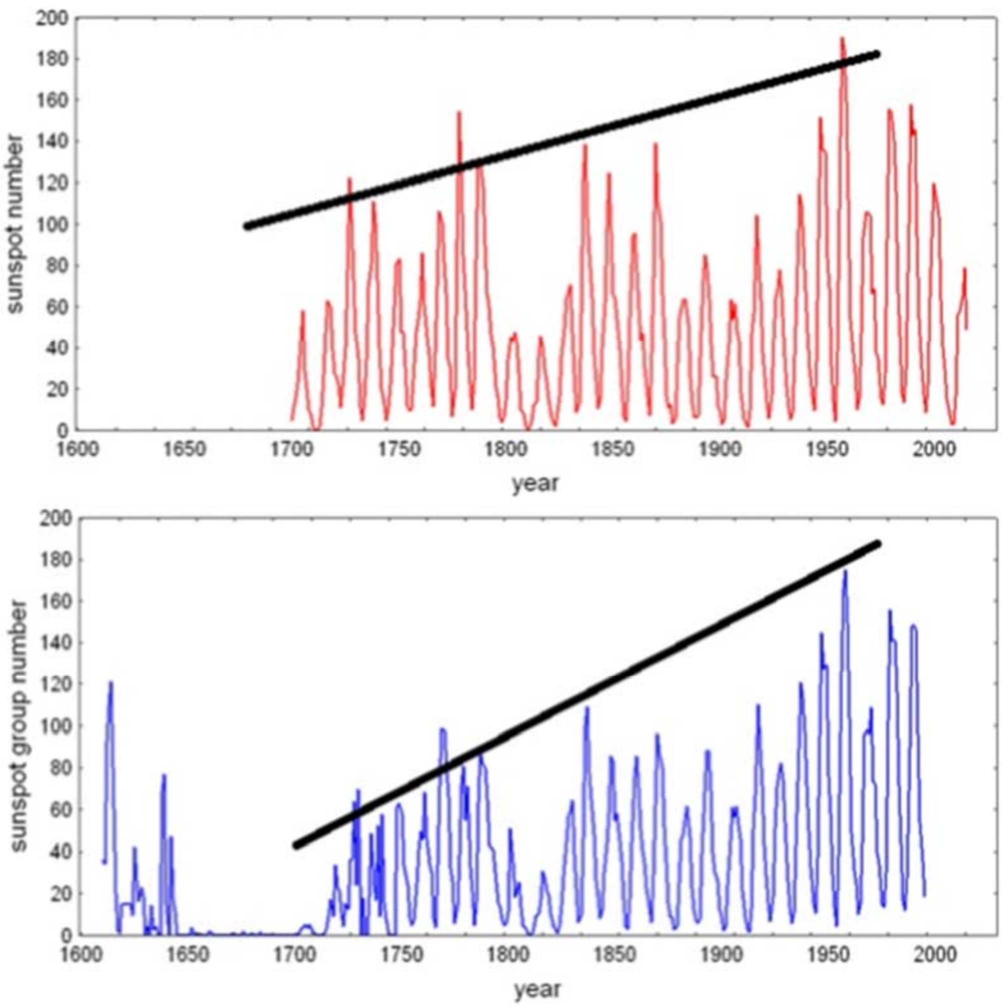

Figure 1. Trends in R_Z (upper panel) and R_G (lower panel).

In 2011, a group of scientists united around the idea that, "given the importance of the sunspot time series, the coexistence of two conflicting series is a highly unsatisfactory situation that should now be actively addressed" (Clette et al., 2014). To address the situation, a series of Sunspot Number Workshops was held with the goal "to rectify the discrepancies" between R_Z and R_G, and "to publish a single consensus sunspot data series" (Cliver et al., 2013).

Recalibrations of both indices were accordingly undertaken, and as a result, two new indices were constructed to replace R_Z and R_G. The goal "to rectify the discrepancies" between them was achieved, and the new sunspot and group sunspot numbers (S_N and G_N) match very well (Clette et al., 2014) – Fig.2. However, the goal to come to "a single consensus sunspot data series" totally failed, as the publication of S_N and G_N triggered a number of other alternative new sunspot and group sunspot series (Cliver, 2016). Nevertheless, since July 2015, R_Z was terminated and replaced by S_N (http://www.sidc.be/silso/datafiles).

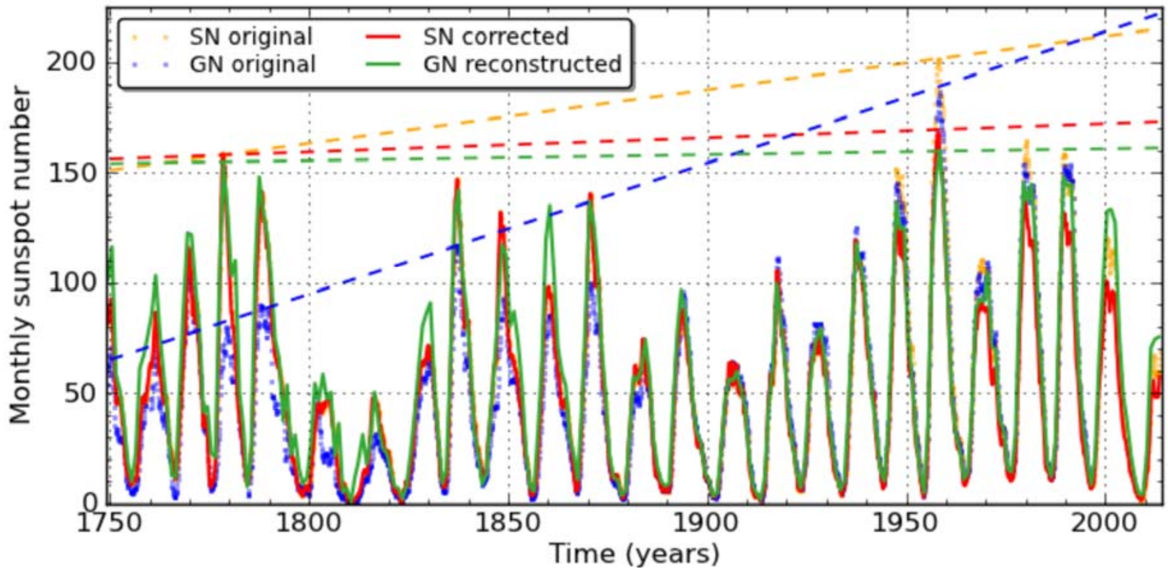

Figure 2. Original and recalibrated sunspot and group sunspot numbers, from Clette et al. (2014) .

Thousands of studies are based on R_Z and R_G. Their termination affects a number of topics like constraining dynamo models, solar cycle predictions, reconstructions of solar irradiance, ionospheric models, calibration of long-term proxies like cosmogenic isotope abundances, etc. Their replacement by a number of new indices makes past results incomparable to recent ones, and recent results using alternative indices incomparable to each other.

As the research in the framework of the VarSITI program critically depends on the quantification of the solar variability, VarSITI's Steering Committee decided to start a discussion on the "Solar variability and sunspot indices". The questions to be discussed include, but are not limited to:

- Is it necessary to continue the production of the Wolf sunspot number, even if new indices are being created?

- Is it justified to try to rectify the discrepancies between different indices and to develop a single time series of sunspot numbers, or do these discrepancies have physical reasons?

- While the number of sunspots constitutes the longest solar activity record, it is not the most informative index. What additional indices can and should be maintained to estimate the variations of different solar activity manifestations (sunspot areas, sunspot group areas, others)?

- Which observatories can and are ready to provide the continuation of the terminated Wolf number, and which observatories can and are ready to provide the maintenance of other indices? What are the requirements that such observatories must answer (long-term records, few gaps, possibility to reproduce and verify the data, others)?

- What can VarSITI do to have the contributing observatories authorized to maintain these indices, and how to ensure the continuity of long-term time series in the current funding "climate"?

To join the discussion, please visit VarSITI's website www.varsiti.org.

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Highlight on Young Scientists 1:

Vertical Coupling by Gravity Waves: What Do We Learn from Satellite Observations?

Thai Trinh

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Satellite observations of atmospheric gravity waves (GWs) are important for improving our physical understanding and for constraining models. Among different observation techniques, limb sounding provides a large part of GW spectrum. Comparison of observed and modeled GW spectra, however, is only possible by applying a comprehensive observational filter, which mimics the observation geometry and instrument sensitivity [2]. One application is, for example, the verification of the free parameters of a GW source model [3].

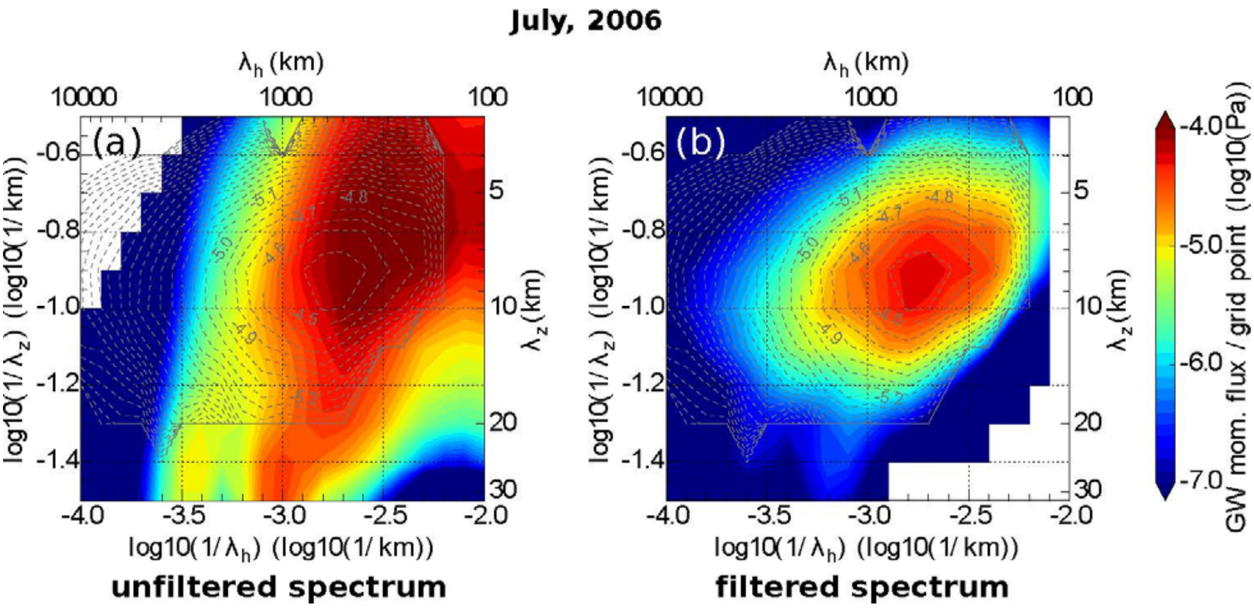

Figure 1. GW momentum flux spectra with respect to horizontal wavenumber and vertical wavenumber for July 2006: (a) original (unfiltered) spectrum generated by a convective GW source model and (b) spectrum after applying the observational filter (filtered spectrum). Dashed lines show the spectrum observed by satellite instrument HIRDLS. Figure is adapted from Trinh et al. [3].

Satellite observations also provide significant insights into vertical coupling processes [4]. In Fig. 2, SABER GW momentum flux in the middle atmosphere [e.g. 1] and GOCE density fluctuations in the thermosphere show many similarities. In the winter hemisphere, a hotspot of mountain waves over the southern tip of the Andes are seen clearly in both datasets. In the summer hemisphere, convective GWs move poleward while propagating upwards (Fig. 2a, b, c). A similar latitude band-like structure with 3 main maxima are seen in summer midlatitudes in both datasets. Good spatial correlation between 2 datasets are found above the winter polar jet and summer midlatitudes (Fig. 2e). These findings likely indicate that GWs with origins in the lower atmosphere can directly and/or indirectly propagate to the thermosphere.

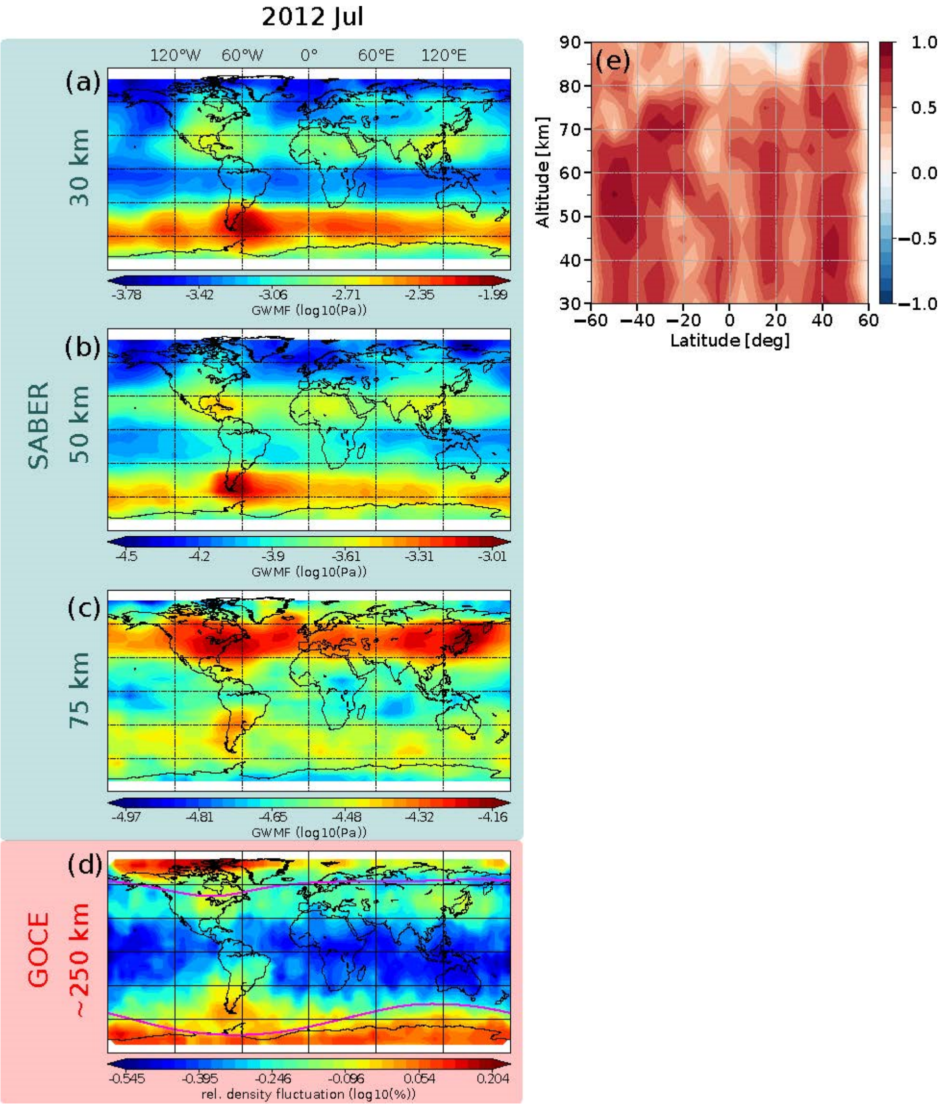

Figure 2. GW momentum flux observed by SABER (Sounding of the Atmosphere using Broad- band Emission Radiometry) at 30, 50, 75 km (a, b, c) and GW density fluctuations observed by GOCE (Gravity Field and Steady-State Ocean Circulation Explorer) at 250 km (d) show many similarities. Good correlations between 2 datasets are found, especially above the polar jet and summer midlatitudes (e). Figure is adapted from Trinh et al. [4].

References:

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Influence of Equatorial Electrodynamics on Low-latitude Thermospheric Dayglow Emissions and Gravity Wave Characteristics

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Space and Atmospheric Sciences Division, Physical Research Laboratory, Ahmedabad, India

Deepak K. Karan

The upper atmospheric behavior over equatorial- and low-latitudes are affected by both neutral and electrodynamics. Optical neutral dayglow emission intensities at OI 777.4, 630.0, and 557.7 nm wavelengths are obtained over a low-latitude location in India using a large field-of-view high spectral resolution optical spectrograph, called MISE (Multi-wavelength Imaging Spectrograph using Echelle grating). Considering purely photo chemical nature of production mechanisms, a symmetric diurnal pattern in the dayglow with respect to local noon is expected. However, on several days asymmetric patterns in the dayglow were observed (Figure 1). The extent of asymmetricity was characterised by a parameter, called Asymmetricity in Time (AT), which showed similar variations with the integrated (from 7-12 h) equatorial electrojet (EEJ) strength demonstrating the dominance of equatorial electrodynam-

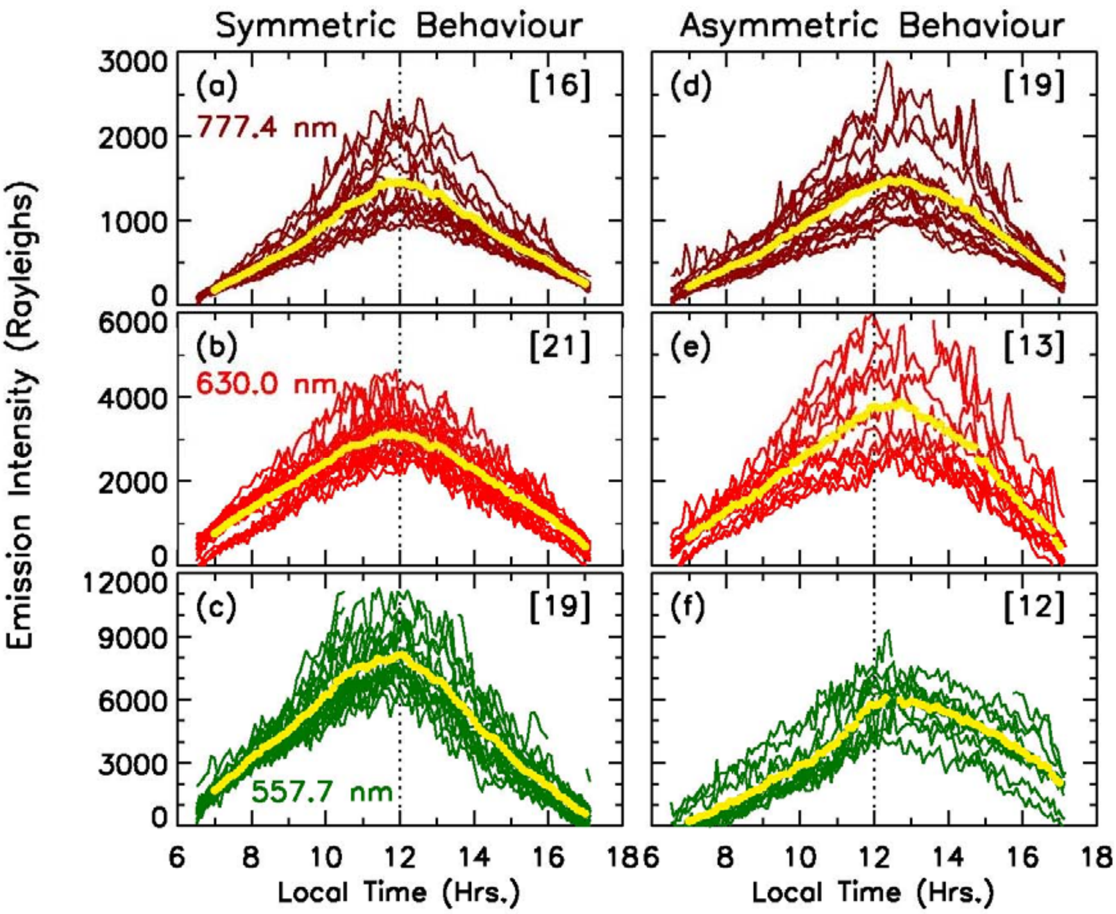

Figure 1. The figure depicts the symmetric (left panel) and asymmetric (right panel) diurnal pattern observed in the dayglow emission intensities at 777.4 (upper), 630.0 (middle), and 557.7 (lower) nm wavelengths during December 2013 to March 2014. In each panel, number of days considered are shown on the top right corner and the yellow line is the mean diurnal pattern on those days.

ics on the variation of dayglow emissions over low-latitudes. Independent ionospheric measurements from digisondes also supported this finding. As the EEJ strength varies with respect to solar activity, diurnal pattern of the OI 630.0 nm dayglow was considered for over 25 years from the published literature, and it was found that the AT values show commensurate changes as that of solar activity (Figure 2) [1]. Further, on days when the diurnal pattern was asymmetric, it was found that longitudinal differences in neutral gravity wave (GW) dynamics exist in as small as 3^0 separations [2]. This is the shortest separation on the existence of such longitudinal differences in equatorial electrodynamic processes ever reported in the published literature. GW propagation characteristics were also found to be different on days with and without the presence of longitudinal differences [2]. Further, special bi-directional mode of observations were conducted in order to investigate the neutral dynamics in three dimensions [3], which showed the neutral GW scalesizes to be shorter in the day compared to the night.

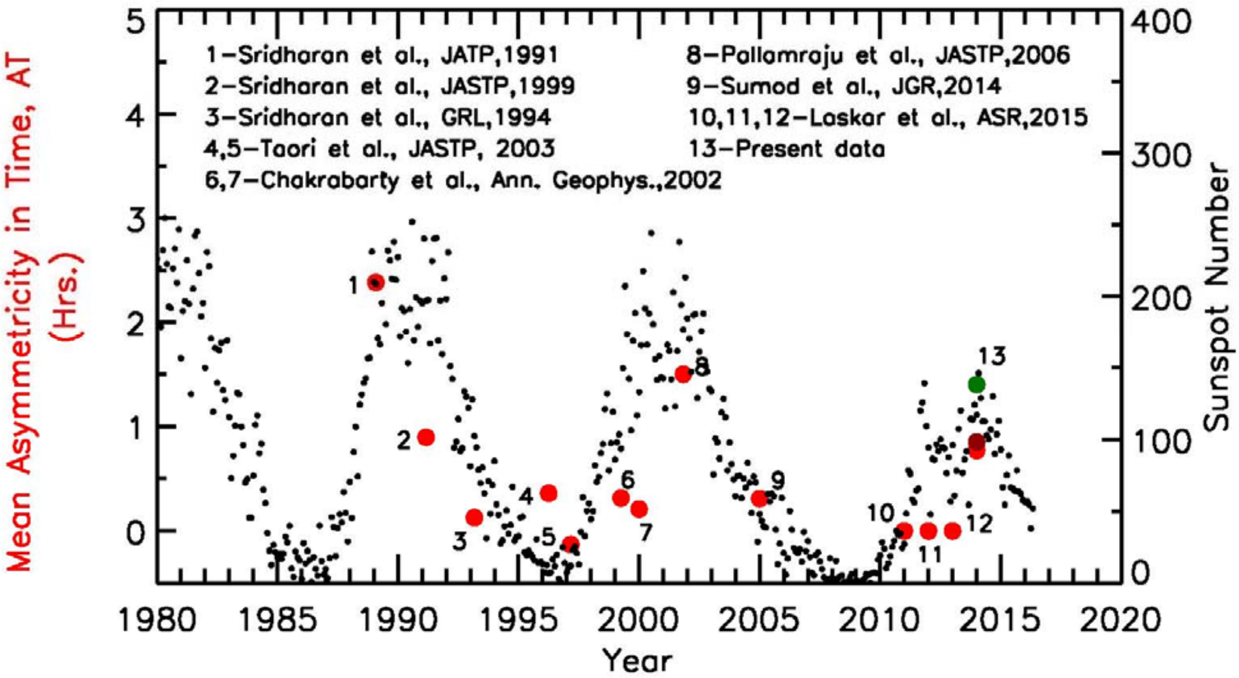

Figure 2. Similar variation between the AT values obtained from the diurnal pattern of the dayglow (as published in the literature as mentioned in the figure) and the sunspot number shows the solar activity dependence of the asymmetricity in the diurnal pattern of dayglow emissions.

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Highlight on Young Scientists 3:

Kinematics and Geoeffectiveness of Interacting Successive CMEs


Chenglong Shen

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Coronal mass ejections (CMEs) are one of the most energetic phenomenon in the heliosphere. When multiple CMEs continuously erupted, they may interact with each other in the heliosphere, and then significantly change their kinematic properties and space weather effects.

Using the imaging data from the STEREO (Solar Terrestrial Relations Observatory), we found that the collision between two CMEs in early November, 2008 (Figure 1) was super-elastic with a likelihood of 73%. Such a super-elastic collision led notable changes in their propagation directions and velocities [1].

Shock-embedded interplanetary CME (ICME) structure is a special resultant structure of multiple-CME interactions. It is formed due to a following fast forward shock propagating into and compressing the ejecta region of a preceding ICME. Through establishing a Wind ICMEs catalogue [2], we statistically confirmed that shock-embedded ICMEs tend to have strong geoeffectiveness due to the shock compression [3].

To quantitatively study the enhancement of the geoeffectiveness caused by the shock compression, we developed a method to recover the uncompressed state of a shocked-MC from in-situ measurements [4]. By applying the method to the event in early September, 2017, we for the first time showed a real observed case that the shock compression enhanced the geoeffectiveness by a factor of ~2 (Figure 2) [5].

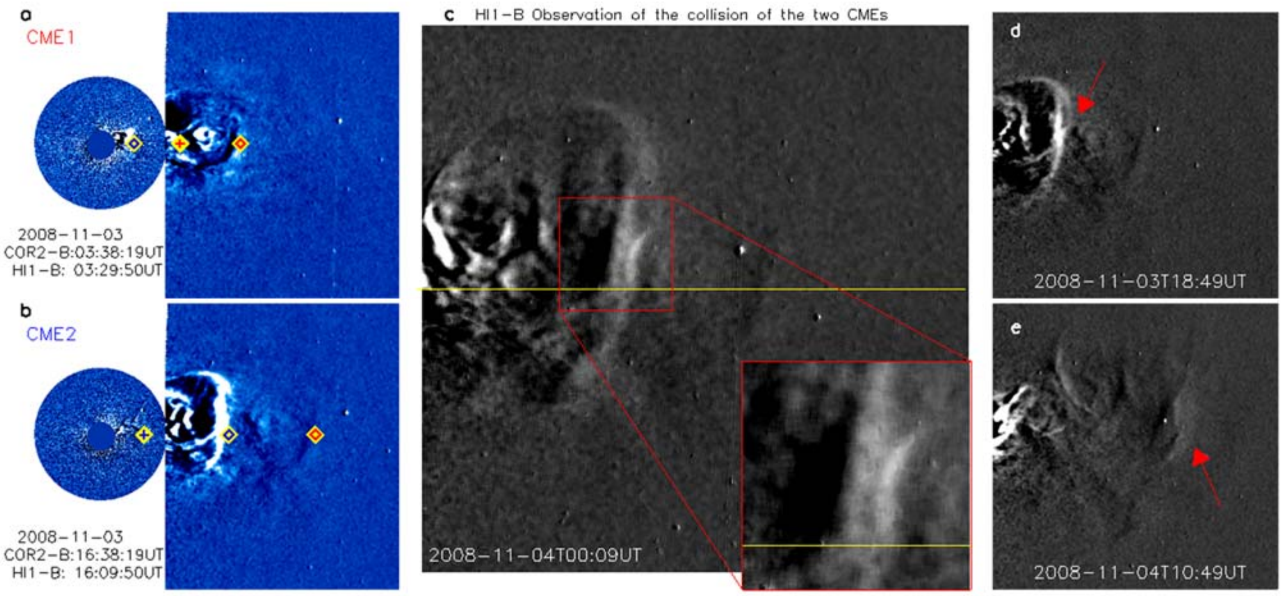

Figure 1. The STEREO/SECCHI images of the two CMEs and their collision in the heliosphere. Panel (a) and (b) show the running-difference images of CME1 and CME2. The red diamond and plus symbols mark the front and rear edges of CME1, respectively, and the blue symbols are for CME2. Panel (c) shows the running-difference image of the collision between these the two CMEs. Panel (d) and (e) show the beginning and end of the collision. The red arrows indicate the collision region.

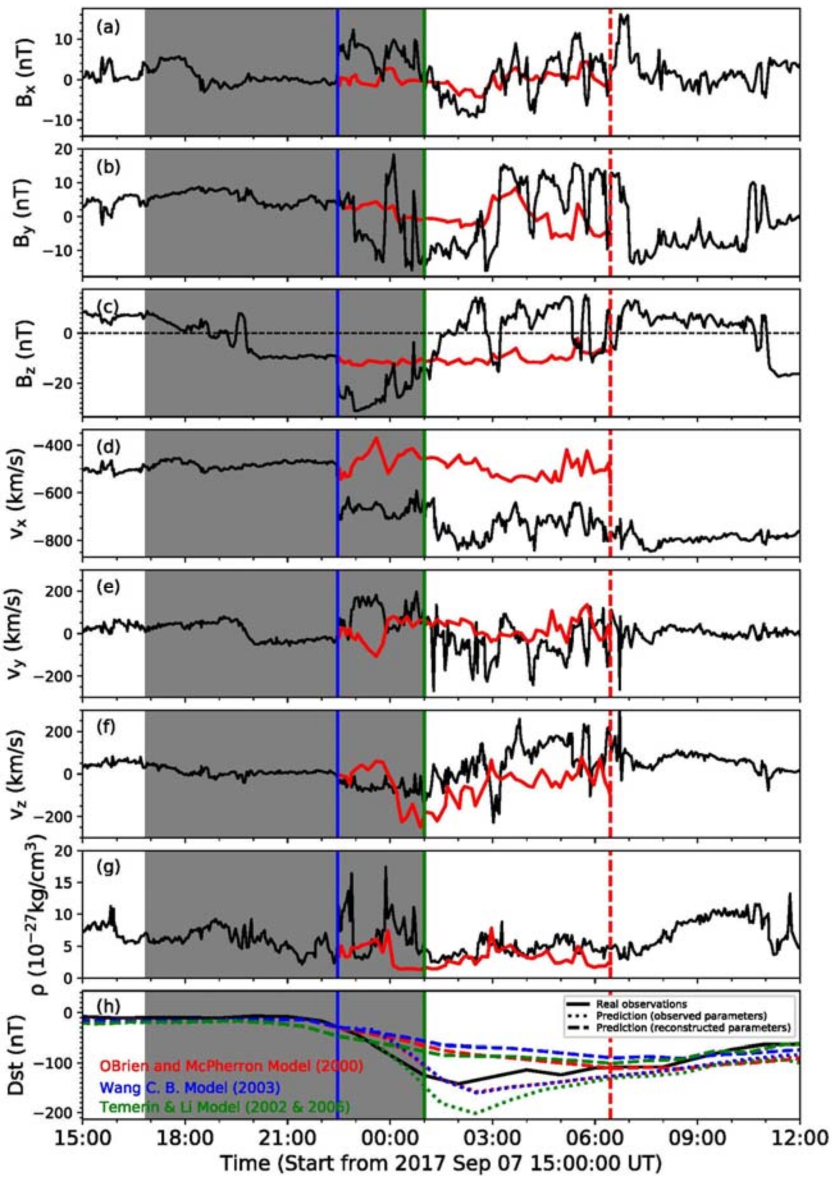

Figure 2. The observational data and recovered uncompressed state of magnetic field, solar wind speed, total plasma density, and Dst index from 2017 September 6 12:00 to 2017 September 8. The shaded region shows the period of the MC and the blue vertical line shows the time of the shock arrival. The black lines in panels (a) to (h) between the first two vertical lines (blue and green vertical lines) show the original observations, and the red lines between the first and third vertical lines (blue and red vertical lines) represent the recovered parameters. Panel (h) shows the real data (black line) and the prediction results based on the observed (dashed lines) and recovered (dashed–dotted lines) parameters of the Dst index. Different colors represent different prediction methods.

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Meeting Report

Project ROSMIC

Meeting Report 1:

HEPPA-SOLARIS Workshop 2018

Figure 1. Group photo of participants.

Scott Bailey

S. Bailey and B. Thurairajah
Bradley Department of Electrical and Computer Engineering, Virginia Tech., Blacksburg, VA, USA

The 7th HEPPA-SOLARIS Workshop was held June 11-14 2018 in Roanoke, Virginia, USA. The focus of the workshop was on observational and modeling studies of the influences of solar radiation and energetic particle precipitation on the atmosphere and climate. Sessions were held on: solar and precipitating particle variability; solar photon and particle effects on the stratosphere and above; dynamical processes influencing the coupling of altitude regions; solar and particle effects on the troposphere and climate system; and tools for assessing solar and precipitating particle influences. There were 35 presentations including 7 posters. Participants represented 8 countries (USA, Norway, Spain, Finland, United Kingdom, Germany, Japan, Brazil). An open process for nominating invited talks led to a broad set of presentations with many new results and many stimulating discussions. In addition to VarSITI, support was provided by Virginia Tech (the host institution) as well as SPARC. Further information can be found at http://www.cpe.vt.edu/heppa.solaris.2018/.

Project ROSMIC

Meeting Report 2:

7th IAGA/ICMA/SCOSTEP Workshop on Vertical Coupling in the Atmosphere-Ionosphere System

Figure 1. Group photo of participants.

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The traditional 7th IAGA/ICMA/SCOSTEP Workshop on Vertical Coupling in the Atmosphere-Ionosphere System was held in the campus of the GFZ German Research Centre for Geosciences, Helmholtz Centre Potsdam from July 2 – 6, 2018. Audience at the Workshop included 60 scientists from 30 institutions across 18 countries spanning Asia, Europe, Africa, North and South America. During five days of workshop over 50 oral contributions and 16 posters were presented, among them 5 solicited talks. This meeting offered an excellent opportunity for scientists of broad research area, from lower, through middle and upper atmosphere and ionosphere and magnetosphere, to present and discuss their recent results. Communication between scientists has been very fruitful and initiated further cooperation. The following meeting is planned for 2020. The organizers appreciate substantial financial support provided by VarSITI (project ROSMIC) together with IAGA and IUGG that allowed twelve scientists to participate.

Meeting Report 3:

45th Annual European Meeting on Atmospheric Studies by Optical Methods

Tima Sergienko

Tima Sergienko
Swedish Institute of Space Physics,
Kiruna, Sweden

The 45th Annual European Meeting on Atmospheric Studies by Optical Methods (45AM) was organized by the Swedish Institute of Space Physics in Kiruna, Sweden. The meeting lasted for one week (August 27-31) at the end of the summer 2018. More than 50 participants took part in 45AM, presenting 50 oral and 10 poster presentations.

Although the meeting has the title "Annual European Meeting" it attracts scientist from all parts of the world, especially from North America, Japan and former Soviet Union countries. This annual meeting aims to bring together scientists and graduate students from Europe as well as from other parts of the world to exchange experiences, share scientific results, and plan and coordinate future experiments.

Figure 1. Group photo of participants.

The meeting programme covered a wide range of phenomena where optical techniques are used to learn about processes in the atmosphere. It included seven sessions: aurora and ionosphere-thermosphere interaction; noctilucent clouds and mesospheric aeronomy; transient luminous events; aerosol and clouds; meteors; active experiments in the upper atmosphere; ground-based, in-situ and space-based instruments, new facilities; and EISCAT_3D and optical instruments.

The VarSITI program was a co-sponsor of 45AM and partially supported the attendance of some young scientists, students and invited speakers. The conference program, abstracts and photos are available at http://45am.irf.se.

Upcoming meetings related to VarSITI

Conference	Date	Location	Contact Information
15th International Symposium on Equatorial Aeronomy	Oct. 22-26, 2018	Ahmedabad, India	http://www.prl.res.in/isea15
7th Symposium of Brazilian Space Geophysics and Aeronomy Society (SBGEA)	Nov. 5-9, 2018	Santa Maria-RS, Brazil	http://www.sbgea.org.br/en/vii-sbgea-2/
2018 AGU Fall Meeting	Dec. 10-14, 2018	Washington, D.C., USA	https://fallmeeting.agu.org/2018/
Chapman Conference on "Scientific Challenges Pertaining to Forecasting Space Weather Includ-	Feb. 12-15, 2019	California, USA	https://chapman.agu.org/
2019 URSI Asia-Pacific Radio Science Conference (AP-RASC 2019)	Mar. 9-15, 2019	New Delhi, India	http://aprasc2019.com/
EGU General Assembly 2019	Apr. 7-12, 2019	Vienna, Austria	https://egu2019.eu/home.html
Japan Geoscience Union Meeting 2019 (JpGU)	May 26-30, 2019	Chiba, Japan	http://www.jpgu.org/en/index.html
27th IUGG General Assembly	Jul. 8-18, 2019	Montreal, Canada	http://iugg2019montreal.com/
AOGS 2019 16th Annual Meeting	Jul. 28-Aug.2, 2019	Singapore	http://www.asiaoceania.org/

The purpose of the VarSITI newsletter is to promote communication among scientists related to the four VarSITI Projects (SEE, ISEST/MiniMax24, SPeCIMEN, and ROSMIC).

The editors would like to ask you to submit the following articles to the VarSITI 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 VarSITI
3. Highlights on young scientists— Each highlight has a maximum of 200 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 VarSITI
4. Short news— Each short news has a maximum of 100 words length.
   Announcements of campaign, workshop, etc.
5. Meeting schedule

Category 3 (Highlights on young scientists) helps both young scientists and VarSITI 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. Ayumi Asai (a-asai_at_isee.nagoya-u.ac.jp). If you have any questions or problem, please do not hesitate to ask us.

SUBSCRIPTION - VarSITI MAILING LIST

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