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Inside this issue

Article 1:

How Small-Scale Current Sheets and Magnetic Islands in the Solar Wind Help Understanding the Nature of Large-Scale Processes Behind Space Weather

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Current sheets (CSs) occur in the solar wind ubiquitously, owing to both local dynamical processes and dipole/multipole nature of the solar magnetic field. Their typical elongation size ranges from many AUs, e.g. in the case of the quasi-stable heliospheric current sheet (HCS) and CSs formed within high-speed flows/streams, to several proton gyroradii in the case of CSs involved in the turbulent cascade. The width of CSs is about several proton gyroradii independently of their origin, therefore, in this term, CSs are very small-scale structures.

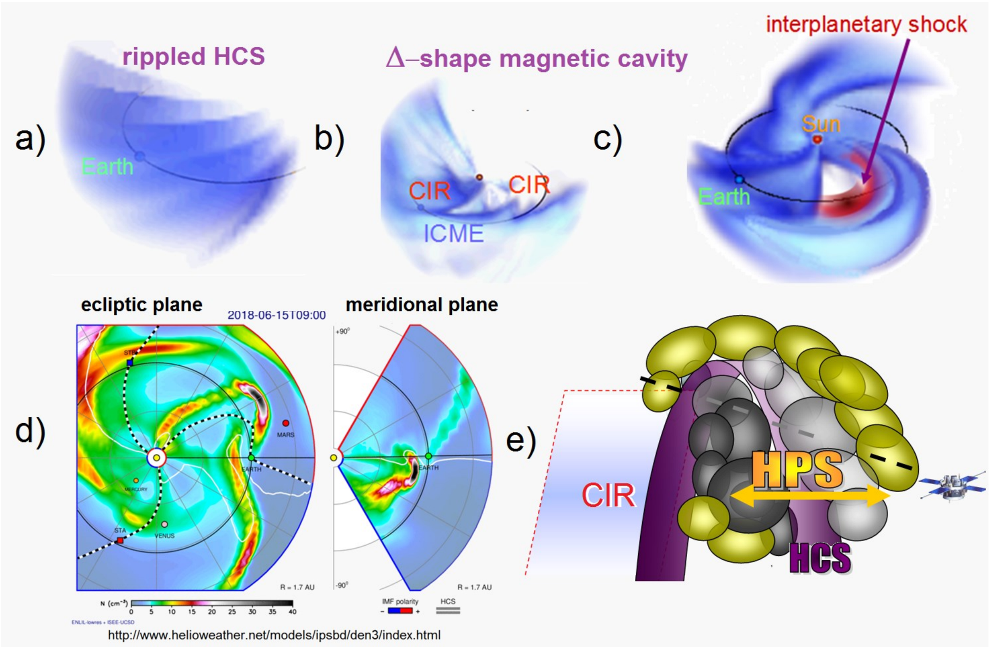

Figure 1. Magnetic cavities in which magnetic islands and CSs are intensively formed in the interplanetary space. a) Cavities inside the HCS ripples. b) Cavities formed by co-existing streams/flows. c) HCS distorted by an approaching ICME-driven interplanetary shock. Magnetic cavity can be formed between the HCS and the shock. Panels a)-c) are based on STEL reconstructions of the solar wind speed from http://smei.ucsd.edu/new_smei/index.html (Khabarova et al. 2015, 2016). d) ENLIL reconstructions of the HCS (white line) distortion by propagating streams (green and yellow areas), see http://www.helioweather.net/ for details. In the meridional plane, it is seen that the HCS is crossed twice – before and after the stream passage. Magnetic cavities are formed between the stream and the HCS. e) Sketch illustrating a complex distortion of the HCS/HPS-magnetic island system by an approaching CIR. Magnetic islands within the HPS are grey and outside are yellow. Since the HCS/HPS is strongly bended by the CIR, some of magnetic islands are located inside the ripple representing a semi-closed magnetic cavity (Adhikari et al. 2019).

One may think that such objects have nothing to do with space weather and large-scale streams or flows that impact the terrestrial magnetosphere causing a chain of effects potentially dangerous for human beings and the technosphere. Meanwhile, recent observational studies show that CSs are intensively produced (i) in the turbulent region downstream of shocks, (ii) in corotating/stream interaction regions (CIRs/SIRs), and (ii) in magnetic cavities formed either by the HCS and an approaching high-speed stream/flow or by interacting SIRs and interplanetary coronal mass ejections (ICMEs). Such CSs are associated with so-called magnetic islands that represent 2-D sections of 3-D plasmoids/blobs/flux ropes originating from magnetic reconnection considerably intensified in turbulent plasmas and magnetic cavities compressed from at least one side (Khabarova et al. 2015, 2016; Khabarova & Zank, 2017; Adhikari et al. 2019; Malandraki et al. 2019). **Figure 1a-c** shows typical situations in which magnetic cavities filled with CSs and magnetic islands can be formed, and **Figure 1a-c** illustrates distortion of the HCS that leads to confinement of CSs and magnetic islands.

A new method of automated identification of CSs based on the analysis of three key parameters reflecting sharp variations in the solar wind plasma and the interplanetary magnetic field at CS crossings has been recently created (Khabarova et al. 2021). An open access database of CSs identified at 1 AU can be found at https://csdb.izmiran.ru . Compiling of the database has allowed carrying out both case studies and a comprehensive statistical analysis of CS properties in different streams/flows. In particular, it is found that a number of CSs per day (*R*) is determined by variations of the solar wind thermal and kinetic energy density. The second important point is that variations of *R* may be used for prognostic aims. Preliminary results show that *R* increases well before both ICME- and SIR/CIR-caused geomagnetic storms (see **Figure 2**). Similar features are found for magnetic islands (see Fridman 2020 and references therein). Therefore, understanding properties of smalls-scale structures in the solar wind opens wide opportunities for the improvement of mid-term prognoses of geomagnetic storms.

Last but not the least is the ability of dynamical CSs and magnetic islands accelerate particles to MeV energies locally in the solar wind, which may be treated as a potentially hazardous but unaccounted effect of space weather (Zank et al. 2015; Khabarova et al. 2015, 2016, 2018, 2020; Khabarova & Zank, 2017; le Roux 2019, 2020; Adhikari et al. 2019; Malandraki et al. 2019).

The study is supported by RSF grant No. 20-42-04418.

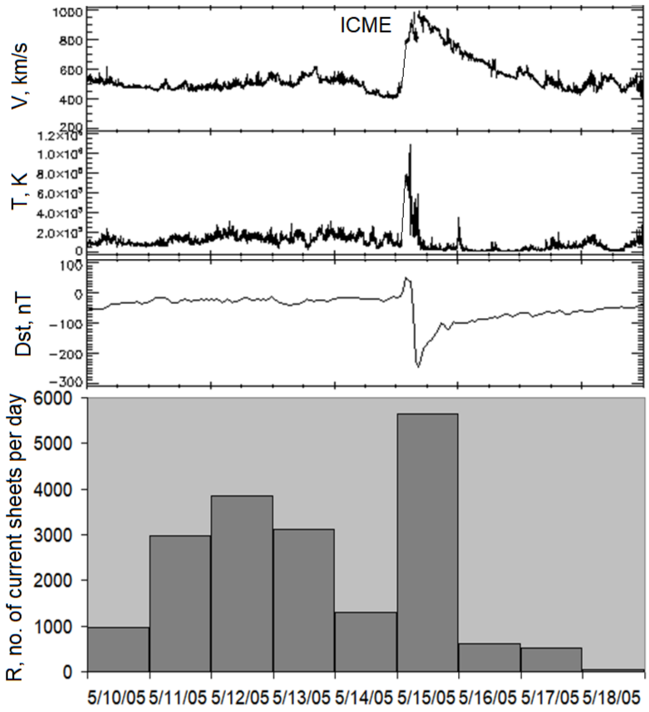

Figure 2. Typical behavior of the CS daily number (*R*) associated with the ICME approach. From top to bottom: the solar wind speed, the solar wind temperature, the *Dst* index of geomagnetic activity, and *R*. Modified from Khabarova et al. (2021). *R* increases twice: one time in the magnetic cavity formed by the HCS and the approaching ICME, and the second time - in the ICME sheath. The CS database: https://csdb.izmiran.ru .

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Highlight on Young Scientists 1:

Relative Contribution of ULF and Whistler-Mode Chorus to the Radiation Belt Variation

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University of Tokyo, Japan

Naoko Takahashi

The Earth's radiation belt exhibits a dramatic variation during magnetic storms. Regarding how energetic particles accelerate up to relativistic energies, interaction with ULF waves and/or whistler-mode chorus makes a significant contribution. Over the past decade, multi-point observations and simulations have separately demonstrated evidence for the wave contribution. However, the global picture of wave contribution to the total radiation belt content with relative comparison has not been extensively studied yet.

We investigate when and where ULF waves and whistler-mode chorus contribute to the net flux of relativistic electrons during the May 2017 storm. ULF waves mainly contribute to the global enhancement of relativistic electron flux during the early recovery phase. In contrast, whistler-mode chorus contributes to the flux enhancement confined in L-value during the late recovery phase. We simulate the global distribution of ULF waves and some parameters related to the excitation of whistler-mode chorus using BATS-R-US – CRCM simulation. The simulation qualitatively reproduces the global evolution of ULF waves. For the excitation of whistler-mode chorus, the region where the anisotropy of hot electrons is large shifts toward dusk during the recovery phase. We also find that whistler-mode chorus in the nightside is predominantly excited by the anisotropic distribution of hot electrons, whereas the enhancement of dayside chorus is affected by the magnetic field line configuration. The present study provides the global picture of wave contribution to the radiation belt variation, which have a significant impact on understanding how much ULF waves and whistler-mode chorus accelerate electrons up to the relativistic energies.

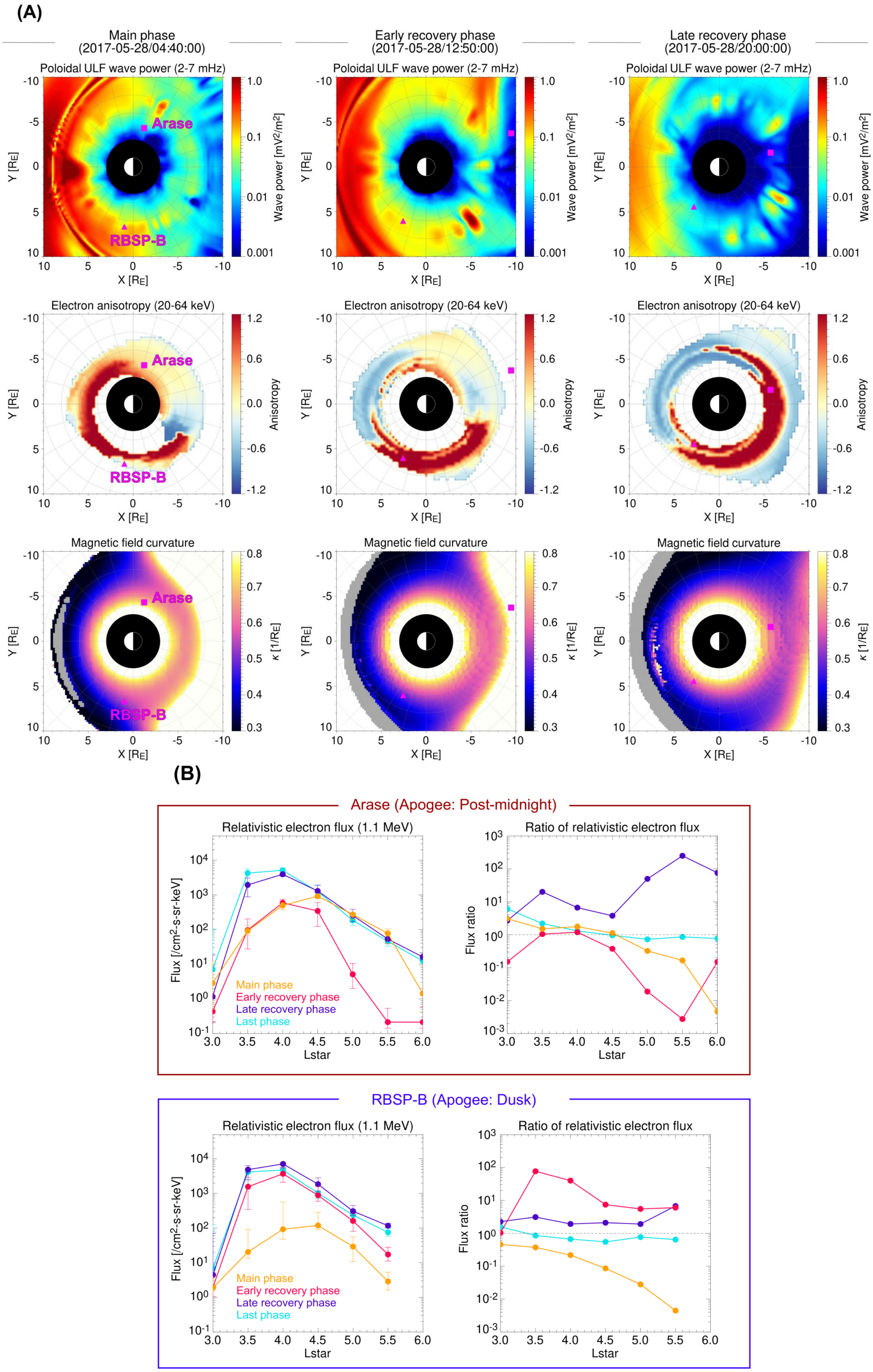

Figure 1 (A) Global distributions on the equatorial plane (Z_{SM}=0 plane) estimated from BATS-R-US−CRCM simulation. (B) Net flux of relativistic electrons (1.1 MeV) observed by Arase and RBSP-B. Right panels show the ratio of electron flux compared to the previous phase.

Highlight on Young Scientists 2:

Direct Influence of Solar Spectral Irradiance on the High-Latitude Surface Climate

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Not only total solar irradiance (TSI) but the spectral solar irradiance (SSI) matter for the Earth's climate. Nevertheless, the SSI used by the climate modeling community is not as well constrained as the TSI, especially for the visible (VIS) and near-infrared (NIR).

The recent TSIS-1 mission has provided unprecedentedly accurate observations of the SSI over the VIS and NIR [1], which provides us a chance to evaluate the modeling community SSI used for their most recent IPCC assessment [2].

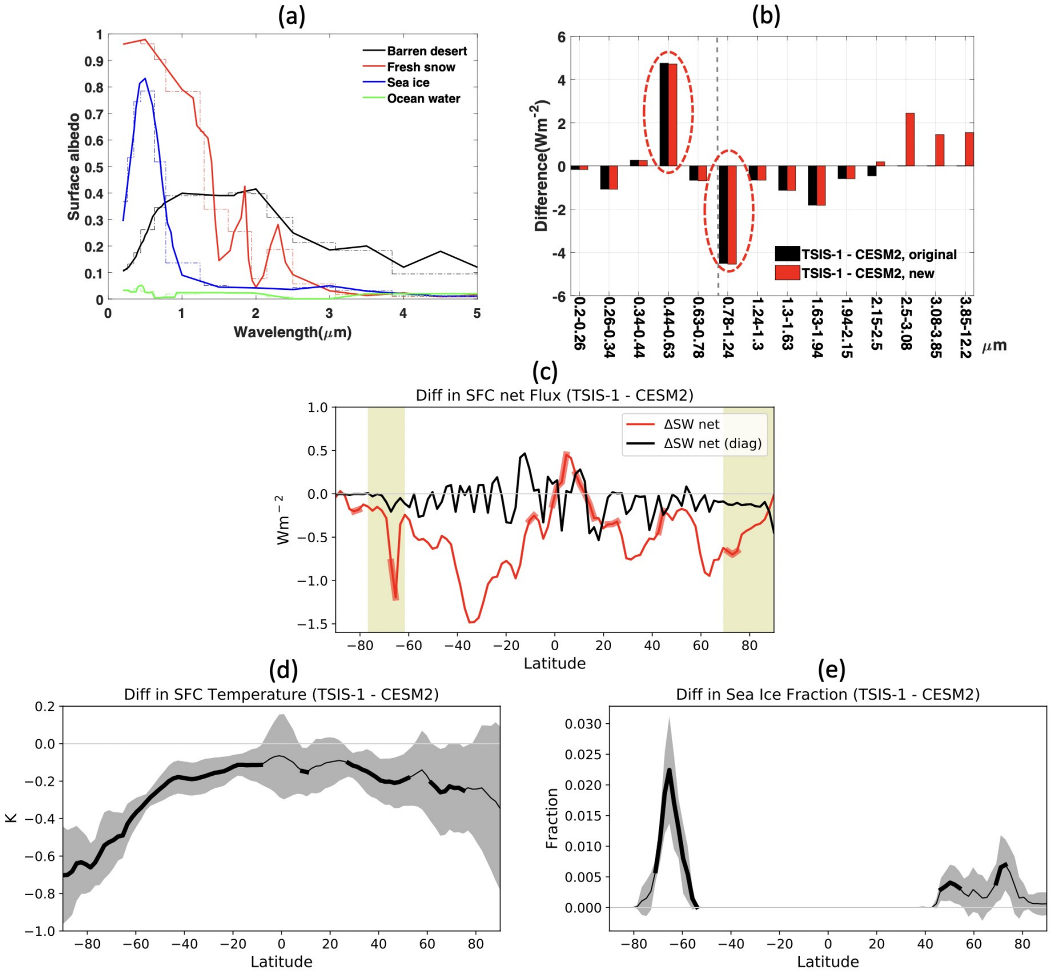

Figure 1 (a) Spectral albedo of different surface types, based on the surface spectral albedo database used in the MODTRAN5. Solid lines are the spectral albedo at their native spectral grids and the dash-dotted lines are the averages on the RRTMG-SW bands. (b) The difference between the TSIS-1 SSI and the CESM2 SSI for each RRTMG-SW band. The original difference is shown in black and only available for 0.2–2.4 μm (the actual TSIS SSI spectral coverage). The difference after the adjustment for utilization in simulations is shown in red for all the bands. (c) The difference in zonal-mean net surface SW flux (downward positive) between the TSIS-1 and CESM2 experiments. Five-day diagnostic run difference (no effect from surface coupling) is in black and the long-term ensemble mean difference (including surface coupling) in red. The yellow shades indicate latitudes where zonal mean sea ice fraction > 0.1. (d) The differences in zonal-mean surface temperature climatology between the TSIS-1 and CESM2 simulations. Shaded areas denote ±1σ of the annual-mean temperature differences. Thickened portions of the line indicate statistically significant differences (5% significance level). (e) The same as (d), but for sea ice fraction.

Traditionally, the SSI impact on climate has been mostly studied from a "top-down" perspective (i.e., how UV radiation affects the radiative heating by stratospheric ozone, which then affects the troposphere by stratosphere-tropospheric exchange) [3]. However, SSI can also affect climate through a "bottom-up" mechanism: some types of surfaces (especially sea ice and snow) have different spectral albedos for the VIS and NIR (Fig. 1a), implying different surface response to varying SSI partitioning.

In this study, we showed that, in certain VIS and NIR bands, the modeling community SSI differs from the TSIS-1 SSI observation by as much as ~4 Wm^{-2}, but with opposite signs (Fig. 1b). Using the NCAR CESM2 model, we assessed to what extent such spectral differences can affect the simulated climate, given the identical TSI. It was demonstrated that, because sea ice and snow surface reflects more VIS than NIR, the simulations with more energy in the VIS had less solar absorption by the high-latitude surfaces (Fig. 1c), resulting in colder polar surface temperature and larger sea ice coverage (Figs. 1d and 1e). Our results suggest that, even for the identical TSI, the sea-ice spectral albedo feedback can be triggered by different SSI partitions between the VIS and NIR. The results underscore the importance of monitoring SSI (in addition to TSI) and the usages of correct SSI in climate simulations.

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Upcoming meetings related to SCOSTEP

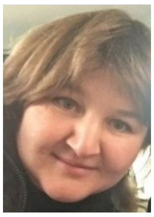
Conference	Date	Location	Contact Information
43rd COSPAR Scientific Assembly	Jan. 28-Feb. 4, 2021	Sydney, Australia	https://www.cospar2020.org/
School on Describing and Analyzing Solar Data for a better prediction of Space Weather	Feb. 14-18, 2021	Kigali, Rwanda	https://ur.ac.rw/?School-on-Describing-and-Analyzing-Solar-Data-for-a-better-prediction-of-
EGU General Assembly 2021	Apr. 25-30, 2021	Vienna, Austria	https://www.egu2021.eu/
AOGS 2021	Aug. 1-6, 2021	Suntec, Singapore	https://www.asiaoceania.org/aogs2021/public.asp?page=home.html
IAU 2021 General Assembly	Aug. 16-27, 2021	Busan, Korea	http://www.iauga2021.org/
IAGA 2021	Aug. 22-27, 2021	Hyderabad, India	http://www.iaga-iaspei-india2021.in/
The 30th IUPAP General Assembly	Oct. 20-22, 2021	Beijing, China	
AGU Fall Meeting 2021	Dec. 13-17, 2021	New Orleans, LA, USA	https://www.agu.org/fall-meeting
SCOSTEP's 15th Quadrennial Solar-Terrestrial Physics Symposium (STP-15)	Feb. 21-25, 2022	Alibag, India	https://scostep.org/stp-symposia/
EGU General Assembly 2022	Apr. 3-8, 2022	Vienna, Austria	
COSPAR 2022	Jul. 16-24, 2022	Athens, Greece	http://www.cosparathens2022.org/
AOGS 2022	Aug. 14-19, 2022	Melbourne, Australia	
AGU Fall Meeting 2022	Dec. 12-16, 2022	Chicago, IL, USA	https://www.agu.org/fall-meeting
IUGG 2023	In July, 2023	Berlin, Germany	
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.

Announcement 1:

Climate Implications of the Sun Transition to High Activity Mode


T. Egorova


A.V. Shapiro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It was recently suggested that the Sun could go through epoch of high magnetic activity which would lead to unexpected behavior of the solar irradiance. A noticeable 0.9% drop in the total solar irradiance (TSI) will be accompanied by a large increase of the UV irradiance. The response of the terrestrial climate and ozone layer state is very hard to predict because a multitude of the physical and chemical processes and their nonlinear links will be disturbed by such a change of the irradiance. General cooling due to smaller TSI could be partially compensated by the ozone enhancement and warming in the tropical stratosphere followed by extensive warming of the northern landmasses during the cold season. The evaluation of the possible consequences can be performed only with a fully interactive ocean-atmosphere-chemistry climate model. Therefore, in this project, we are going to use recently developed Earth System Model SOCOLv4.0 to analyze possible consequences of the Sun's high activity on the terrestrial atmosphere. This study will be performed in the framework of the new project CISA (Climate Implications of the Sun transition to high Activity mode) supported by Swiss Karbacher Fonds and Max Planck Institute for Solar System Research, Germany. We invite climate modeling groups worldwide to join this activity using scenarios of solar irradiance change utilized in this project.

Announcement 2:

PRESTO Town Hall at AGU Fall Meeting

Ramon E. Lopez[1] and Patricia Doherty[2]
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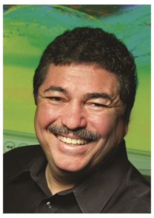
[2]SCOSTEP Scientific Secretary, Institute for Scientific Research (ISR), Boston College, Boston, MA, USA


Ramon E. Lopez


Patricia Doherty

The PRESTO Town Hall at the AGU Fall Meeting was held on Wednesday, December 16, 2020. Approximately 35 participants attended to hear presentations about the scope of PRESTO science initiatives, and current activities. Of particular interest was PRESTO financial support for virtual meetings and other activities that support PRESTO science goals. More details about this may be found on the SCOSTEP/PRESTO website at https://scostep.org/.

Announcement 3:

Memorandum of Understanding Between SCOSTEP and ISEE, Nagoya University

Kazuo Shiokawa
SCOSTEP President,
Center for International Collaborative Research (CICR),
Institute for Space-Earth Environmental Research (ISEE), Nagoya University,
Nagoya, Japan

Kazuo Shiokawa

The Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) and the Institute for Space-Earth Environmental Research (ISEE), Nagoya University, have exchanged a Memorandum of Understanding (MoU) on January 8, 2021. This MoU is to define the conditions under which the ISEE will contribute to the SCOSTEP by supporting to publish SCOSTEP's newsletters and to organize SCOSTEP's online seminars and capacity-building lectures. ISEE has already supported editing and publishing SCOSTEP's CAWSES-II/TG4 newsletters (2010-2013), VarSITI newsletters (2014-2019) and SCOSTEP/PRESTO newsletters (2019-). ISEE has also supported hosting SCOSTEP/PRESTO online seminars since 2020 and will support hosting SCOSTEP online capacity-building lectures from 2021. The MoU authorizes the conditions of these various supports from ISEE to SCOSTEP. The SCOSTEP President and the director of ISEE (Professor Kanya Kusano) signed the MoU form on January 8, 2021, and the MoU has become effective since then.

Figure 1. Professor Kanya Kusano (left), the director of ISEE, Nagoya University, and Kazuo Shiokawa (right), the SCOSTEP President, with the signed MoU.

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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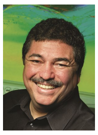

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