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Article 1:

Exploring mesosphere and lower thermo-sphere mesoscale dynamics with SIMONe systems

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The mesosphere and lower thermo-sphere (MLT) region forms a bound-ary between Earth's weather and space weather. It is influenced by both lower atmospheric processes (terrestrial weath-er) and upper atmospheric or solar activi-ty (space weather). In turn, changes in the MLT can also affect near-space weather [1,2].

Understanding the MLT is essential not only for understanding space weather but also for monitoring climate change, pre-dicting the re-entry paths of objects into Earth’s atmosphere, and determining how material deposited into the Earth’s atmosphere is transported. These include both natural and human-made objects, as well as space vehicles [3,4,5].

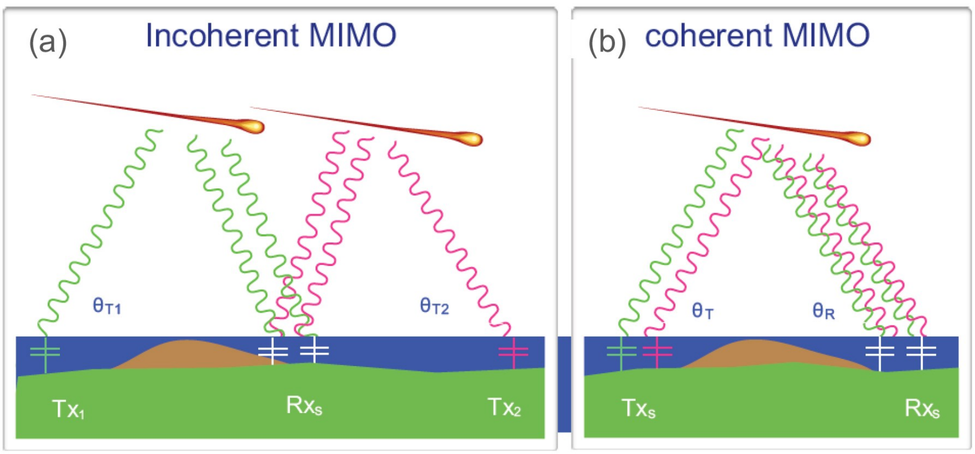

Figure 1. (a) Incoherent, and (b) Coherent Multiple-Input Multiple-Output (MIMO) meteor radars (adapted from Urco et al., 2019 [12]).

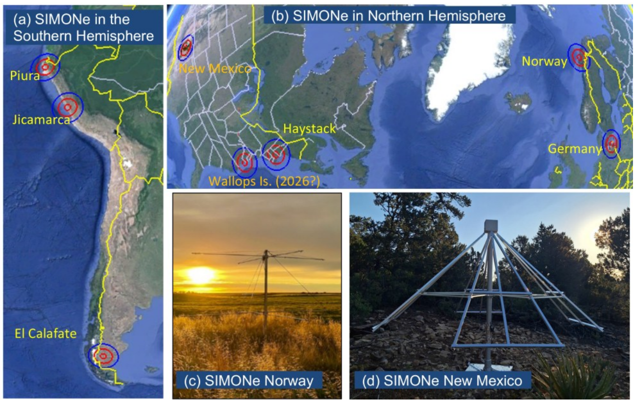

Figure 2. SIMONe installations in the (a) southern, and (b) northern hemispheres, and examples of receiving antennas using Yagis (e.g., Norway) or LWA antennas (e.g., New Mexico). A near real-time operation of the systems can be found at http://maarsy.rocketrange.no/MMARIA/index.html.

Recent global circulation models have extended their altitude coverage to include the MLT altitudes with different degrees of success [6]. However, these models struggle to resolve smaller-scale dynamics (called mesoscale processes) due to limitations in computing power and, more critically, a lack of observational data at these altitudes.

To address this key aspect, recently multistatic meteor radar approaches have been proposed. Figure 1, shows two multistatic configurations, (a) using two widely spaced transmitters and two closely spaced receivers (Incoherent MIMO), and (b) using two closely spaced transmitters and two closely spaced receivers (Coherent MIMO). The former was initially implemented with commercial radars [7,8], and the latter with our own design called SIMONe[1] [9].

Led by the Leibniz Institute of Atmospheric Physics (Germany) in partnership with the University of Tromsø (Norway) and MIT-Haystack Observatory (USA), SIMONe uses advanced signal processing techniques from modern telecommunications [10,11,12]. Being multistatic, SIMONe allows for more measurements and different viewing angles, and its modern design allows for more robust, easier-to-operate and extendable systems compared to commercial systems. In SIMONe systems the hardware complexity is reduced, however, the software complexity is increased.

Since its first deployment in July 2018, seven SIMONe systems have been installed across diverse geographic and meteorological regions in both hemispheres. These sites were selected for their unique environmental conditions and are supported by local partnerships. Figure 2 shows the current location of SIMONe systems. In the case of Germany and Norway, the SIMONe systems are complemented by other pulsed radar systems working at different frequencies.

SIMONe measurements from these systems are being used in a variety of studies involving planetary-scale MLT dynamics [13], MLT dynamics induced by a volcano eruption [14] as well as MLT mesoscale dynamics. Figure 3 shows selected examples of mesoscales dynamics: (a) 4D wind fields obtained with a physics informed neural network approach called HYPER [15]; (b) Helmholtz decomposition of MLT mesoscales winds [16], (c) average vertical gradients of the zonal momentum fluxes over central and northern Peru [17]; and (d) dissipation rates of mesospheric stratified turbulence over Northern Norway [18].

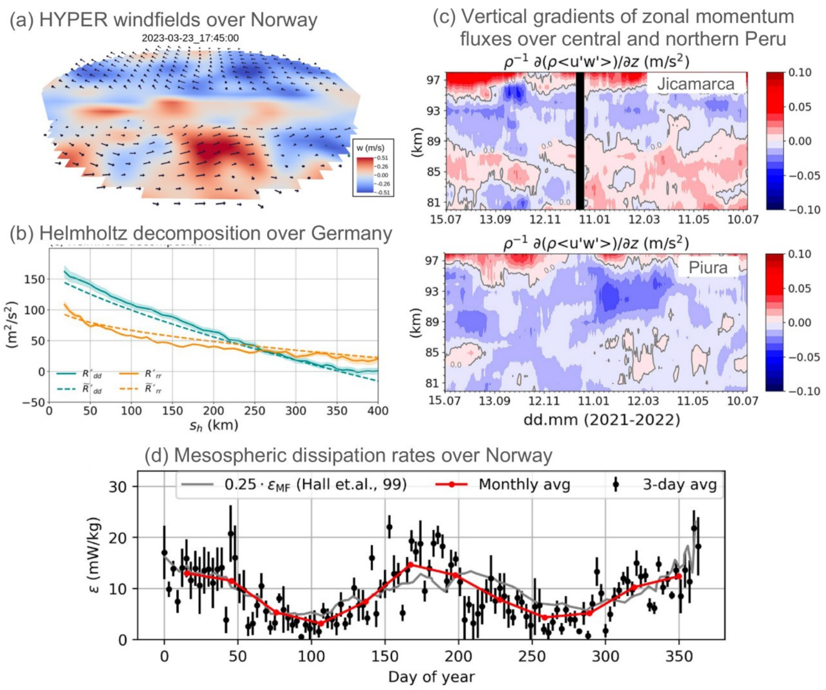

Figure 3. Examples of measurements enabled by SIMONe systems. (a) 4D Wind fields using HYPER (after [15]), (b) Second-order statistics of wind fields from second-order statistics one-dimensional wind projections (after [16]), (c) Average vertical gradients of zonal moment fluxes over central and northern Peru (after [17]). (d) estimates of eddy dissipation rates (after [18]).

[1]Spread Spectrum Interferometric Multistatic meteor radar Observing Network

In addition to MLT dynamics, SIMONe systems are capable of observing E-region irregularities, polar mesospheric summer echoes, large bolides and their associated non-specular meteor echoes, as well as airplanes and space debris with relatively large radar cross-sections.

With its innovative design and growing global reach, SIMONe is addressing critical observational gaps in the MLT region. The data it provides are advancing our understanding of MLT dynamics and hold significant potential for improving space-weather forecasting, as well as predicting the behavior of metal layers influenced by meteors and space debris entering the atmosphere. We welcome collaboration and invite colleagues interested in contributing to the expansion of the SIMONe network to get in touch.

Acknowledgements

We thank the principal investigators and collaborators of all SIMONe systems, without their support, the continuity and quality of the data would not be possible.

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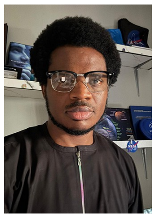
Highlight on Young Scientists 1:

Impact of Large-to-Meso-Scale-Wave-Structures on the Intra-seasonal variation of the occurrence of Range Spread F and Scintillation



Brians Chinonso Amadi

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There is an intra-seasonal variation in the occurrence of Equatorial Plasma Bubbles (EPBs) or Spread F (SF), for instance, between December and January, as shown in Table 1 (Amadi et al., 2025). The number of days with Range Spread F (RSF) occurrence in December 2021 and January 2022 is 21 and 9 respectively. RSF are the most severe SF on the severity scale. These months are also characterized by proportional numbers of scintillations (S4). A question this study aims to answer is if Large-to-Meso-Scale-Wave-Structures (LSWS) play a role in intra-seasonal variation.

SF	December 2021	January 2022
RSF	19	7
MSF	0	8
FSF	0	1
S4 > 0.8 after 22 UT	87	42

Table 1. Number of Spread F (SF) types including Range-Spread F (RSF), MSF, FSF, and Scintillation Index (S4) exceeding 0.8 for December 2021 and January 2022.

The mean vertical drift obtained from digisondes for the months of December and January is 38 and 48 m/s respectively. Thus, the vertical drift did not explain the difference in the number of RSF. The TEC and ΔTEC (difference between TEC and the 90-minute running average) were obtained with GNSS receiver at São Luis from satellites having trajectories whose ionospheric piercing point (IPP) lies within 5° of geomagnetic latitude and whose duration is longer than 120 minutes. Oscillations between 18 – 22 UT, with periods and speeds of about 72 minutes and 60 m/s respectively, and exhibiting time-lag with distance, were observed (Amadi et al., 2025). These oscillations and phase propagations are more distinct in December than in January. Additionally, the time lag with distance in iso-phase oscillations is more coherent in December than in January. These characteristics are typical of LSWS.

To ascertain the impact of electric field contributions from background neutral wind (E_{LS}) and meso-scale wave structures (E_{WS}), two numerical experiments denoted as E1 and E2, were conducted. Values of E_{LS} and E_{WS} in cases E1 and E2 were chosen in accordance with the features observed in December and January respectively. The value of E_{LS} in case E1 was three-fourth its magnitude case E2. On the other hand, E_{WS} was kept constant in case E1 but varied with altitude in case E2 such that its magnitude was reduced by a reducing factor at altitudes > 325 km. Figure 1 shows the variation in electron density for each case, with severe undulations and continous advection of plasma observed in case E1 at 22:43 UT, reflecting the severity observed in December scenario.

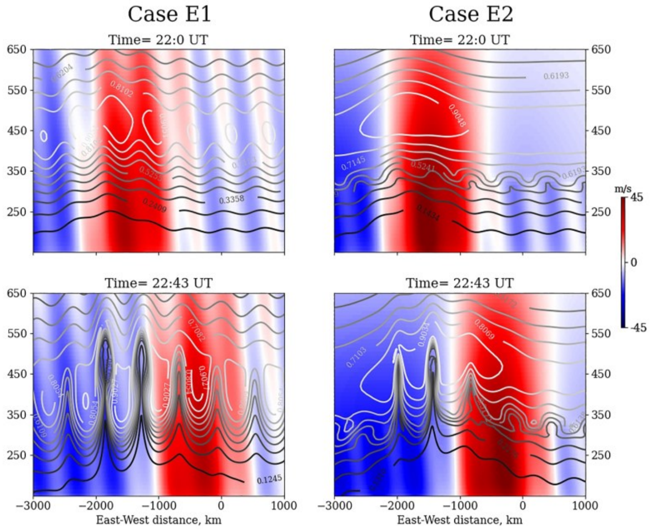

Figure 1. Snapshots of Iso-Density Contours for E1 (in left-panels) and for E2 (in right-panels).

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This work was carried out under the supervision of Professor Alam Kherani and Eurico R. de Paula while a PhD graduate student at Instituto Nacional de Pesquisas Espaciais (INPE), and supported by National Council for Scientific and Technological Development (CNPQ), Brazil.

Highlight on Young Scientists 2:

Research on Magnetospheric Processes Corresponding to Afternoon Detached Auroral Arcs

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Most auroras occur within the main auroral oval; however, some special types of auroras appear outside the auroral oval region. One of these is the afternoon detached aurora, which is located equatorward of the main auroral oval and often connects to the noonside auroral oval [1], as indicated in Figure 1. Previous studies have shown that this aurora mainly occurs during geomagnetic disturbances and is suggested to have a close link to the plasmaspheric plume [2]. Another key characteristic is that its precipitating particles are primarily composed of ring current ions with energies greater than 10 keV [3], which are usually thought to be associated with the resonant scattering process between Electromagnetic Ion Cyclotron (EMIC) waves and energetic particles [4].

In this project, we aim to conduct a systematic analysis of the possible physical processes behind the afternoon detached aurora using observations from the Arase and DMSP satellites. We present a joint observation event that occurred during 07:00-08:00 UT on December 5, 2017. As shown in Figure 1(a), DMSP/SSUSI observed a clear afternoon detached auroral structure, and both Arase and the Zhigansk station happened to pass through this region, as indicated by the green and red arrows. Figures 1(b)-(c) show the distribution of precipitating particles recorded by DMSP. In this region, we observed precipitating ring current ions with energies exceeding 10 keV, accompanied by relatively weak electron precipitation. Figure 2 shows detailed observations from Arase, including magnetic field, plasma density, electron and ion measurements, as well as wave spectra. The results show that Arase was located in the plume region, where wave activity was observed. Therefore, our initial joint observations confirm that this afternoon detached aurora corresponds to the plasmaspheric plume in the magnetosphere. The detailed relationship between these waves and the aurora requires further analysis.

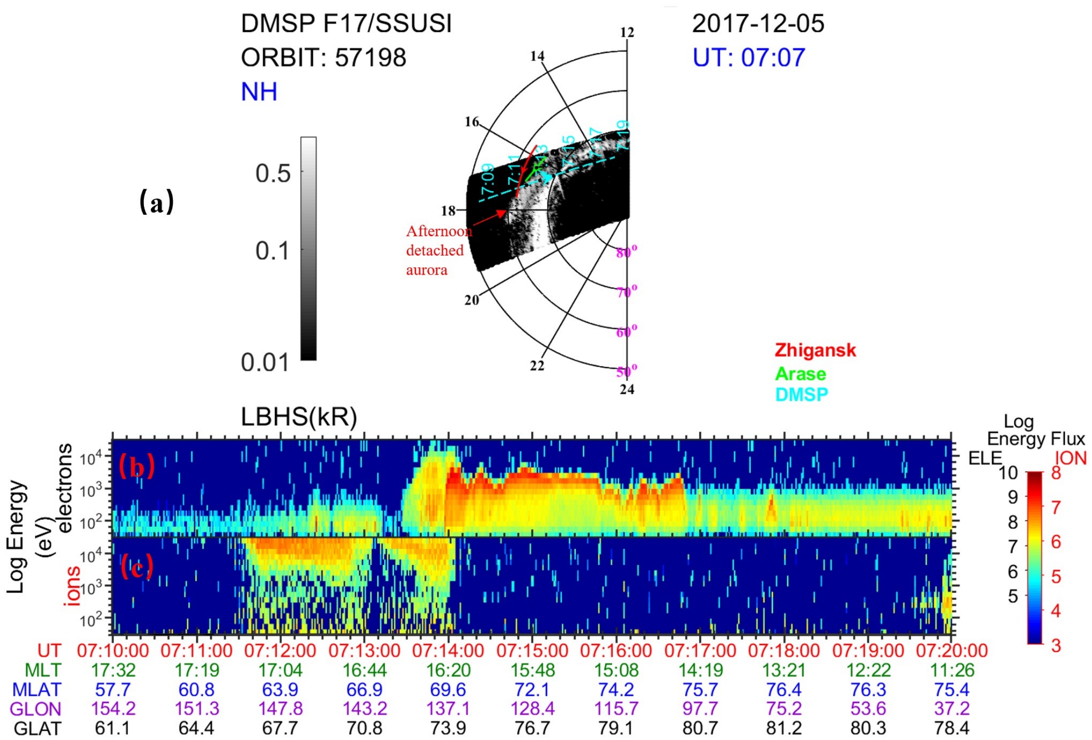

Figure 1. Joint observations of the afternoon detached aurora by DMSP, Arase, and Zhigansk station. (a) Afternoon detached aurora observed by DMSP/SSUSI. (b)-(c) Distributions of precipitating electrons and ions.

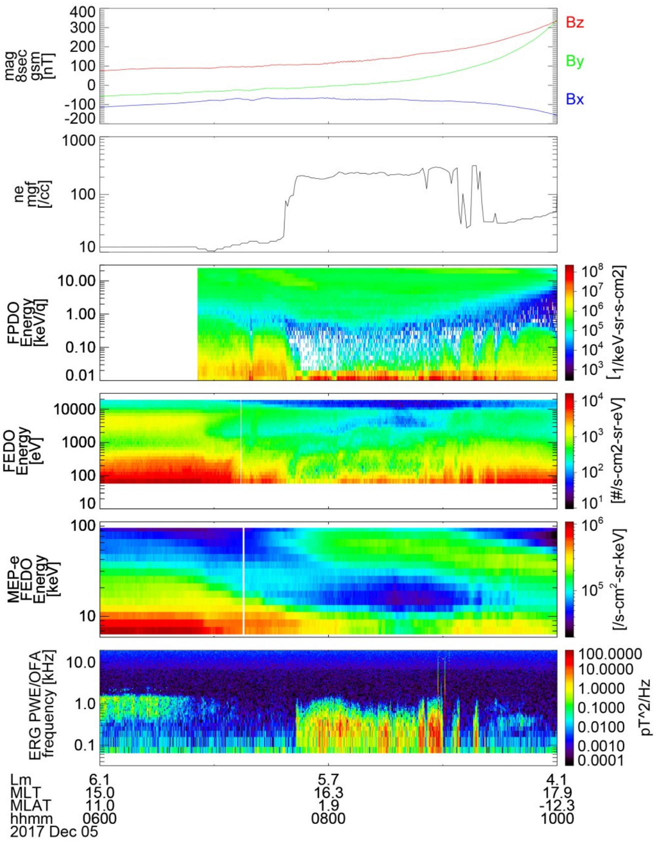

Figure 2. The detailed observations from Arase are shown from top to bottom as follows: magnetic field, plasma density, proton and electron distributions, and the wave spectrum from OFA.

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This work was supported by the SCOSTEP Visiting Scholar (SVS) program and the Space Physics and Space Weather group at GFZ. I sincerely thank all the members for their efforts. I sincerely thank Professor Yoshizumi Miyoshi for his invaluable guidance and support throughout my stay in Nagoya University. I am also grateful to the Arase team for their assistance and valuable suggestions.

Highlight on Young Scientists 3:

Impact of Major Sudden Stratospheric Warming Events on the Upper Atmospheric Radiative cooling

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The upper atmosphere is influenced by both solar–magnetospheric and lower atmospheric forcings. Understanding its response to these drivers is pivotal for advancing space weather prediction. Upward-propagating waves and tides, especially during Sudden Stratospheric Warming (SSW) events, play a crucial role in vertical coupling, resulting to significant changes in composition and thermal structure (Baldwin et al., 2021).

SSWs can alter the concentration of key trace species such as atomic oxygen (O), nitric oxide (NO) and carbon dioxide (CO_2) which play a vital role in the upper atmospheric energetics. Variations in radiative emissions from NO and CO_2 during major SSWs have been analysed in recent studies (Kumar et al., 2024a, 2024b). Figure 1 shows the daily-averaged NO volume emission rates (NO-VER), temperature, NO, and O densities at high latitude mesosphere–lower thermosphere (MLT),

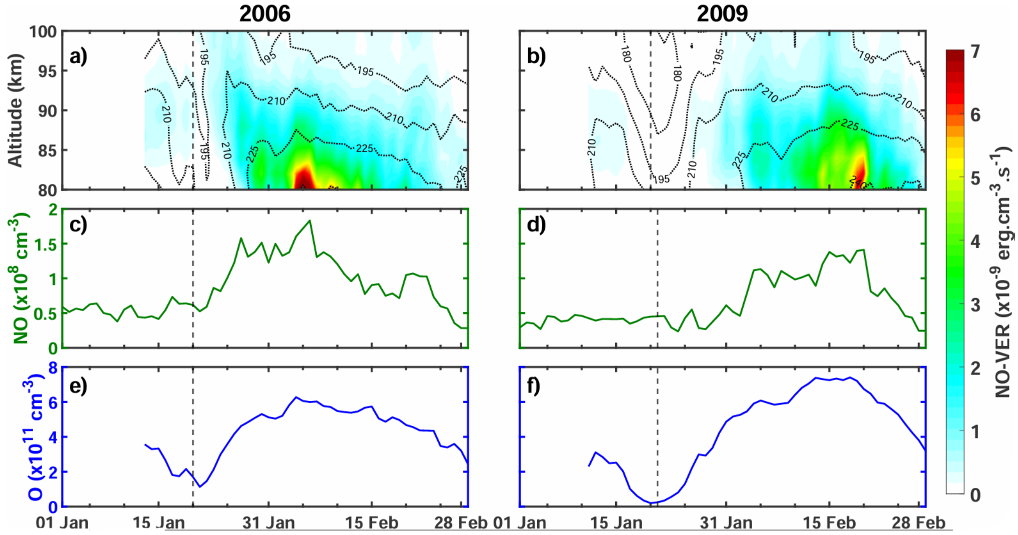

Figure 1. Daily averaged zonal mean NO-VER (a–b), NO density derived from SCIAMACHY (c–d), and O density measured by SABER (e–f) between 70° and 80° N at MLT altitudes (80–100 km) during 2006 and 2009 SSW events, respectively. The dashed contour lines (a–b) indicate the temperature variations. The vertical lines indicate the zonal wind reversal at 1 hPa.

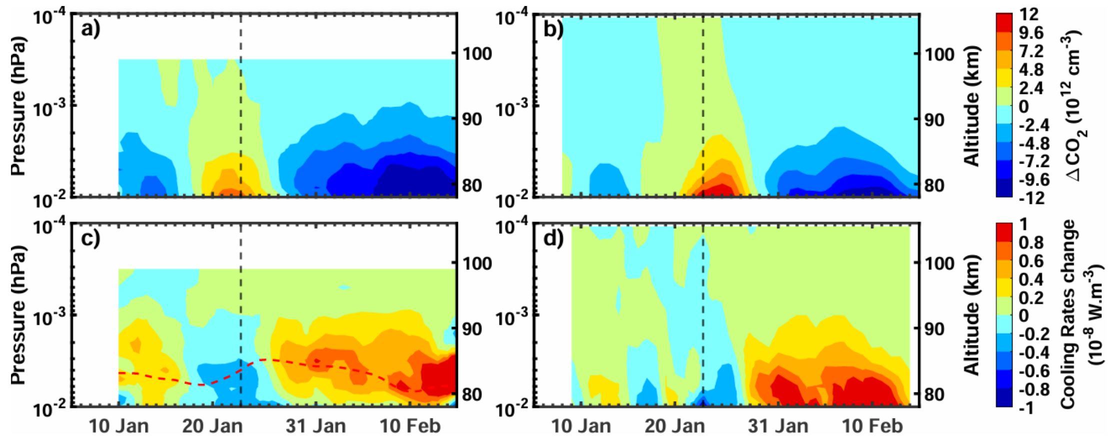

Figure 2. The anomalies in the CO_2 density (upper panels) measured by ACE-FTS (a), and calculated from SD WACCM-X (b), and radiative cooling by CO_2 fundamental band at 15 µm (lower panels) observed by SABER (c), and calculated from SD WACCM-X (d), during the 2009 SSW. The red-dashed line indicates the altitude of peak CO_2 cooling. The vertical dashed line indicates the peak warming time over the polar stratosphere.

during the 2006 and 2009 SSWs. The NO-VER variations closely correlate with temperature changes in the MLT. The initial decrease in NO-VER during the onset of the SSWs is attributed to reduced temperatures and O densities, while the enhancement during the recovery phase is primarily driven by increases in temperature, NO, and O densities.

During the 2009 SSW event, an anticorrelation between CO_2 density and CO_2 radiative cooling was observed in both measurements and model estimates, as shown in Figure 2. These cooling patterns are consistent with variations in temperature and O density, which critically influence CO_2 infrared cooling in the MLT. Changes in temperature and O density affect the collisional excitation of CO_2 to higher energy states, thereby modulating the radiative cooling rates during the SSW.

Changes in radiative cooling influence the temperature, dynamics, and chemical composition of the upper atmosphere. Studying these processes is essential for improving our understanding of upper atmospheric energetics and enhancing space weather forecasting capabilities.

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Meeting Report 1:

PRESTO Summarizing Workshop

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Ramon Lopez


Odele Coddington


Jie Zhang


Kazuo Shiokawa

PRESTO Summarizing Workshop was held as an ISEE international workshop in the Institute for Space-Earth Environmental Research (ISEE), Nagoya University, Japan, on June 16-19, 2025. This workshop was designed to summarize the 5-year scientific achievements of the SCOSTEP's PRESTO (Predictability of the variable solar-terrestrial coupling) program (https://scostep.org/presto/) of 2020-2024. Ten scientists (chair, co-chairs of the program, Pillar co-leaders, and invited writers of PRESTO) were joined from Finland, Greece, India, Japan, Switzerland, and USA, and draft of four review papers were written. These review papers will be submitted to Progress in Earth and Planetary Science (PEPS) for the special issue of PRESTO.

During this workshop, Ramon Lopez, the PRESTO chair, presented a glass plaque to Ms. Mai Asakura, SCOSTEP newsletter secretary in ISEE for recognition of 5-year editorial support of SCOSTEP/PRESTO Newsletter. Nat Gopalswamy, the Past President of SCOSTEP, presented a glass plaque to Dr. Claudia Martinez-Calderon of ISEE, for recognition of 5-year organization of the SCOSTEP online capacity building seminar series since 2020.

Figure 1. Participants of the PRESTO Summarizing Workshop (left) and plaque presentations (bottom right: Ms. Mai Asakura, bottom right: Dr. Claudia Martinez-Calderon)

Meeting Report 2:

European Space Weather Week, Coimbra (Portugal), 4–8 November 2024

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Rui F. Pinto


Teresa Barata

The 20th edition of the European Space Weather Week was held in Coimbra, Portugal, in November 2024 (eswww2024.org). As in previous editions, the ESWW2024 aimed at bringing together the diverse groups in Europe working on different aspects of Space Weather and Space Climate, from research scientists to privates companies and operators. The meeting gathered more than 650 participants (both on-site and online), who contributed with a very high number of good quality orals and posters to the plenaries and splinter sessions, with exhibit booths at the Fair, and held several business meetings at the venue. Two satellite events took place immediately before and after the core of the meeting: an ISWAT working meeting and an ESA Vigil Workshop. An outreach initiative about auroral phenomena received a significant number of visitors. This ESWW sponsors - including the SCOSTEP/PRESTO programme - funded a larger number of participants (about 20).

Figure 1. ESWW2024 Opening Address and participants.

Meeting Report 3:

The 17th workshop "Solar influences on the Magnetosphere, Ionosphere, and Atmosphere"

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Katya Georgieva

The 17th workshop "Solar influences on the Magnetosphere, Ionosphere, and Atmosphere" was held in Primorsko, Bulgaria during June 2-6 2025. 80 participants from 16 countries made 53 oral and 35 poster presentations, most of which will be freely available online at the meeting's website https://www.spaceclimate.bas.bg/ws-sozopol/. Papers based on these presentations will be published after peer review in the Workshop's Proceedings which already have SJR and Q-range.

During the Workshop, the 20th anniversary of the Balkan, Black sea, and Caspian sea Regional Network for Space Weather Studies (known as the BBC-network) was celebrated. It was created to coordinate the activities in the 11 member states in the International Heliophysical Year, and continued as a network for space weather studies. At the special BBC session, organizational problems were discussed, a co-chair was elected, the national representatives and the editorial board on the network's scientific journal Sun and Geosphere (https://sungeosphere.org/) were updated.


Figure 1. A group photo of the participants.

Meeting Report 4:

Course on "Cross-scale Coupling of Heliophysics Systems" [May 12-16, 2025, L'Aquila, Italy]

Simone Di Matteo

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[2]Goddard Space Flight Center, NASA, Greenbelt, MD, USA

The school was directed by Simone Di Matteo (*The Catholic University of America/NASA–GSFC*), Marco Romoli (*Università degli Studi di Firenze*), and Ioannis Daglis (*University of Athens*) with local organization by the *Consorzio Area di Ricerca in Astrogeofisica, INGV, INAF, University of L'Aquila, Department of Physical and Chemical Sciences* and support from *SCOSTEP, SWICo, E-SWAN, ESA, IUGG, IAGA, ISEE at Nagoya University*.

The lessons provided an overview of the interconnectivity between heliophysics systems mediated through cross-scale processes, including discussions of universal phenomena, hands-on activities, and useful resources for students at different career levels on how to get involved in current international efforts to advance research of "system of systems" phenomena in heliophysics. All lessons will be available at https://www.astrogeofisica.it/cchs.

Figure 1. Attendees at the Congress Center "Luigi Zordan", University of L'Aquila, Italy.

The course was attended by 43 students from Azerbaijan, Chile, China, Croatia, Egypt, Finland, France, Greece, India, Italy, Kenya, Marocco, Mexico, South Korea, Spain, Thailand, United Kingdom, United States of America.

Meeting Report 5:

The Solar Physics International Network for Swirls

Viktor Fedun

Suzuna Silva

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The Solar Physics International Network for Swirls (SPINS) meeting took place at the University of Sheffield between 2 - 4 June 2025 (https://pdg.sites.sheffield.ac.uk/research/vortex-community/spins-meeting). Organised by the Plasma Dynamics Group (https://pdg.sites.sheffield.ac.uk/home) and supported by SCOSTEP, the primary goal of SPINS was to deepen our understanding of vortical motions and their role in solar plasma dynamics. This was the first-ever scientific meeting dedicated exclusively to the study of solar vortices.

The event featured three focused sessions covering various aspects of vortex identification, analysis, and theoretical modelling in the solar atmosphere. Key topics included the observational signatures of plasma vortical motions and their associated communities, methods of vortex identification and the relationship between observed vortices and their representation in numerical models.

Figure 1. Attendees at the SPINS meeting held in the University of Sheffield, Sheffield, UK.

The meeting was highly successful, bringing together over 20 participants from seven countries. It fostered engaging discussions among leading scientists, early-career researchers and PhD students, encouraging collaboration and new ideas in this emerging field of solar physics.

Upcoming meetings related to SCOSTEP

Conference	Date	Location	Contact Information
The 22nd Annual Meeting of the Asia Oceania Geosciences Society (AOGS)	Jul. 27-Aug. 1, 2025	Singapore	https://www.asiaoceania.org/aogs2025/
International Colloquium on Equatorial and Low Latitude Ionosphere (ICELLI) 2025	Jul. 28-Aug.1, 2025	Abuja, Nigeria	https://nspee.org/icelli/
IAGA / IASPEI Joint Scientific Meeting 2025	Aug. 31-Sep. 5, 2025	Lisbon, Portugal	https://iaga-iaspei-2025.org/
Partially ionized plasmas in astrophysics (PIPA2025)	Sep. 1-5, 2025	Bergen, Norway	https://www.uib.no/en/ift/173827/partially-ionized-plasmas-astrophysics-pipa2025
ICTP PHYSICS WITHOUT FRONTIERS UGANDA: East African Training Workshop on Machine Learning and Data Science Applications in Space Weather and Ionospheric Research	Sep. 8-12, 2025	Mbarara, Uganda	https://www.must.ac.ug/event/eastafrican-training-workshop-on-machine-learning-applications-in-space-weather-and-ionospheric-research/
XVIIIth Hvar Astrophysical Colloquium From the Sun to the Heliosphere and beyond	Sep. 15-19, 2025	Hvar, Croatia	https://oh.geof.unizg.hr/index.php/en/meetings/xviii-hac
The 2025 Sun-Climate Symposium	Sep. 15-19, 2025	Fairbanks, Alaska	https://lasp.colorado.edu/meetings/2025-sun-climate-symposium/
European Space Weather Week in Umeå	Training: Oct. 23-26, 2025 ESWW: Oct. 27-31, 2025	Umeå, Sweden	https://esww.eu/
6th Symposium of the Committee on Space Research (COSPAR): Space Exploration 2025: A Symposium on Humanity's Challenges and Celestial Solutions	Nov. 3-7, 2025	Nicosia, Cyprus	https://cospar2025.org/
2025 IMCP (International Meridian Circle Program) Space Weather School	Nov. 10-16, 2025	Hainan, China	http://school2025.imcp.ac.cn/
The International Symposium for Equatorial Aeronomy 17 (ISEA-17)	Feb. 9-13, 2026	Liberia, Costa Rica	https://www.iap-kborn.de/isea17/home
SCOSTEP's 16th Quadrennial Solar-Terrestrial Physics (STP-16) Symposium	Jun. 1-5, 2026	Thessaloniki, Greece	https://scostep.org/events/stp-symposia/
46th Scientific Assembly of the Committee on Space Research (COSPAR) and Associated Events	Aug. 1-9, 2026	Florence, Italy	https://www.cospar2026.org/

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

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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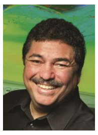

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