SCOSTEP
Scientific Committee on Solar-Terrestrial Physics

SCOSTEP/COURSE Newsletter

vol. 46, January 2026

Inside THE ISSUE

Article 1:

Launch of the SCOSTEP COURSE new scientific program for 2026-2030

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Abstract

The upcoming 2026–2030 scientific program of the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) is named COURSE (Cross-scale cOUpling pRocesses in the Solar–tErrestrial system). It aims to promote comprehensive and interdisciplinary research through coordinated international efforts adopting as the main overarching theme the cross-scale coupling processes within the Sun-Earth system. COURSE will be officially launched in January 2026. A core team of international experts has been formed to run the program for a period between 3 and 5 years. Preparatory activities have been already carried out such as the organization of the STP-16 symposium at Thessaloniki, Greece which will be the kick-off of the COURSE program; the COURSE website, which include the main information about the program; the COURSE logo contest has been announced; announcement of COURSE financial support for campaigns, databases, and meetings has been issued.

Overview of the COURSE program

The COURSE program (Laurenza et al., 2025a; Laurenza et al., 2025b) is structured (Figure 1) around three key scientific focus areas, each with distinct key questions and objectives, but all interconnected by other common themes such as societal impacts, extreme events, human and robotic exploration, and improving predictive capabilities. The three focus areas address the main topics in the solar-terrestrial system and are named: 1) Sources of Space Weather and Space Climate: 2) Solar wind, Magnetosphere, and Ionosphere coupling; 3) External impacts and Internal dynamics of the Earth atmosphere. Detailed complementary papers are published in this newsletter for each focus area.

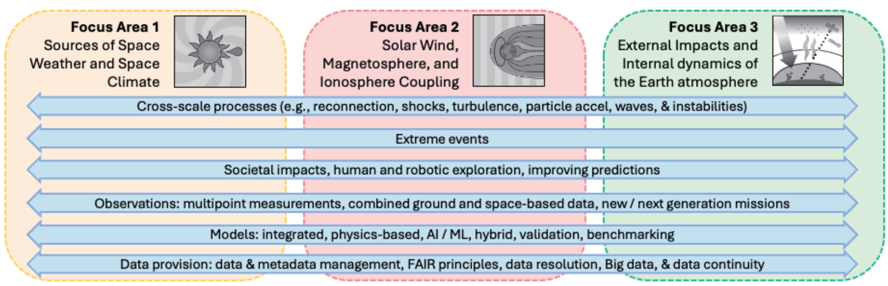

Figure 1. Overview of the COURSE program. The three focused areas are presented in the colored squares, whereas the overarching themes and the recommendations for the implementation of the program are explained in the horizontal bars.

The implementation of COURSE is recommended through the use of innovative techniques, including machine learning and artificial intelligence, integrated and validated models, new space missions, multi-point in-situ data combined with ground-based observations, enhanced metadata, and the adoption of Findable, Accessible, Interoperable, and Reusable (FAIR) principles. To successfully implement the program and tackle the proposed questions, it was also recommended (Laurenza et al., 2025b) to establish a core team of international experts (see next section). This team will focus on the specific question of interest with sustained effort over a period of 3 to 5 years, assuming that some members might be replaced for some reason during the 5 year duration of the program.

COURSE core team

The Steering Committee of the COURSE program is listed in Table 1 and includes two co-chairs as well as three co-leaders for each of the three Focus Areas. To date, the COURSE officers have held two virtual meetings on 4 August 2025 and 24 October 2025 to prepare for the launch of the program in January 2026.

The Steering Committee has identified the Working Groups (WGs) based on the objectives, properly combined, of the COURSE program, as described in Laurenza et al., 2025b. The individual WGs will aim to make progress on specific objectives of the COURSE program.

The focus area leaders, with the support of the co-chairs and president, have nominated the WG leaders and have the flexibility to form new WGs or disband existing ones as the program progresses. While "SCOSTEP/COURSE" can support WG activities through COURSE funding opportunities, the collaborative efforts of the team members will also support the ability of the participants to apply for additional research funding (such as grants) from their respective home countries. In addition to in-person meetings, virtual meetings will play a key role in maintaining ongoing collaboration among team members.

Table 1. Member List of the Steering Committee of the SCOSTEP's COURSE program.

role	name	short affiliation	country/region
COURSE Officers			
Co-chair	Monica Laurenza	INAF	Italy
Co-chair	Nick Pedatella	NCAR	USA
FA1 co-leader	Natalie Krivova	MPS	Germany
FA1 co-leader	Anil Raghav	Univ. of Mumbai	India
FA1 co-leader	Hannah Schunker	Univ. of Newcastle	Australia
FA2 co-leader	Yuki Harada	ISEE	Japan
FA2 co-leader	Rumi Nakamura	IWF/OEAW	Austria
FA2 co-leader	Yiqun Yu	Beihang Univ.	China
FA3 co-leader	Astrid Maute	IAP	Germany
FA3 co-leader	Maria Graciela Molina	FACET/UNT	Argentina
FA3 co-leader	Timofei Sukhodolov	PMOD/WRC	Switzerland
SCOSTEP Officers and Past President			
President	Kazuo Shiokawa	ISEE	Japan
Vice President	Bernd Funke	CSIC	Spain
Scientific Secretary	Odele Coddington	LASP, CU Boulder	USA
Past President	Nat Gopalswamy	NASA/GSFC	USA

COURSE information and opportunities

The COURSE kick-off will occur at the STP-16 symposium at Thessaloniki, Greece in the period 1-5 June 2026 (https://www.stp2026.org/).

Call for financial support based on the SCOSTEP funds has been announced on Nov. 7, 2025, with a deadline of Jan. 12, 2026, for (1) international campaigns, (2) meetings, and (3) database constructions (max $5K per event). For (1), publication support is also included. The COURSE Logo contest was announced on Oct. 14 with a deadline of Dec.15, 2025.

Information about the COURSE science program, Steering Committee, and grant opportunities can be found on the COURSE website (https://scostep.org/scostep-course/; Figure 2).

Figure 2. Home page of the COURSE Website.

We look forward to supporting and working with the international community to make progress towards the goals and objectives of the COURSE program in the coming years.

Acknowledgements

The COURSE website has been prepared by the SCOSTEP secretariat managed by the team at LASP, University of Colorado.

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Laurenza M. and the SCOSTEP's Next Scientific Program committee, SCOSTEP/PRESTO Newsletter, Vol. 42, January 2025, 2025a. https://scostep.org/wp-content/uploads/2025/01/SCOSTEP_PRESTO_Newsletter_Vol42_high_reso.pdf

Laurenza et al., COURSE: Cross-scale cOUpling pRocesses in the Solar-tErrestrial system - SCOSTEP's new program for 2026-2030, Earth, Planets and Space, 77, 180, 2025b. https://doi.org/10.1186/s40623-025-02283-w

Article 2:

Focus Area 1: Sources of Space Weather and Space Climate

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Natalie Krivova | Anil Raghav | Hannah Schunker

Focus Area 1 (FA1) of SCOSTEP/COURSE addresses the solar origins of the disturbances and long-term variations that shape the heliosphere. Within COURSE (Cross-scale Coupling Processes in the Solar–Terrestrial System) the central idea is that the Sun–Earth system is governed by cross-scale coupling: interactions that connect processes across a broad range of spatial and temporal scales. FA1 focuses on identifying, characterising, and modelling the solar processes that initiate and modulate both space weather and space climate.

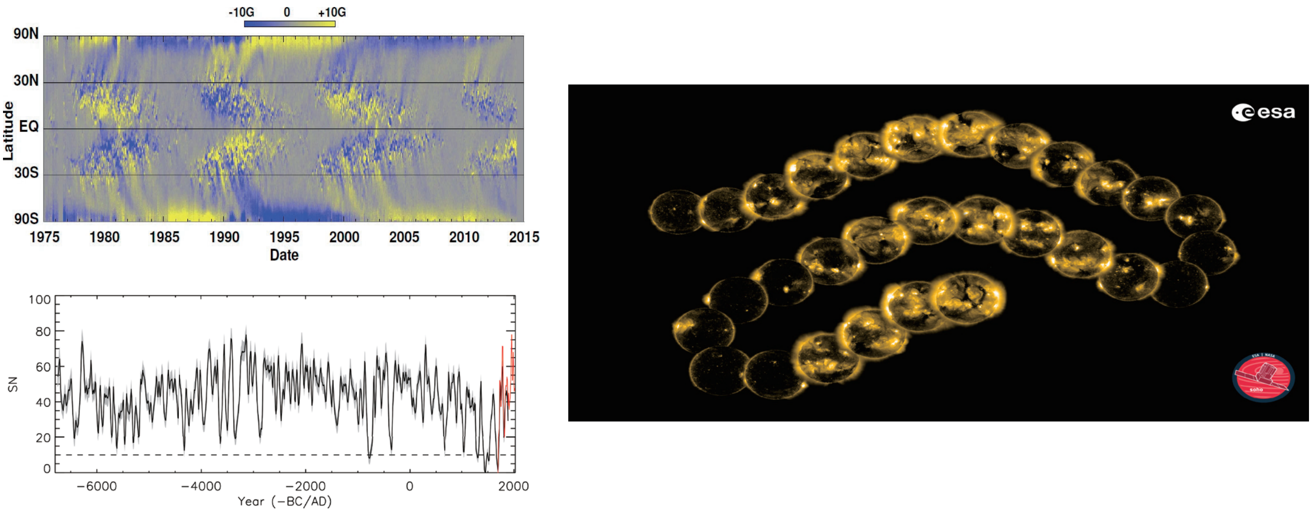

Figure 1. SCOSTEP/COURSE FA1: Cross-scale coupling in the sources of space weather and space climate. (Top left) Butterfly diagram highlighting the latitudinal migration of surface magnetic fields throughout the last four solar cycles (adapted from Hathaway, 2015, *Living Rev. Sol. Phys.*, 12). (Bottom left) Reconstruction of sunspot number from cosmogenic ^{14}C and ^{10}Be archives over the Holocene, illustrating long-term evolution of solar activity (Wu et al. 2018 A&A, 615, A93). (Right) Composite of SOHO/EIT 284Å observations showing the evolution of large-scale coronal structure across multiple solar cycles (image credit: SoHO, ESA & NASA, F. Auchère & ATG Europe). Together, these panels demonstrate how solar magnetic-field generation, long-term variability, and coronal structuring across a wide range of spatial and temporal scales shape the sources driving space weather and space climate.

A central goal of FA1 is to coordinate and support efforts to understand how solar magnetic fields are generated, structured, and evolve. Magnetic flux at the surface of the Sun originates from the Sun's local and global dynamos and is shaped by rotation, convection, differential rotation, and local turbulence. It appears in a hierarchy of scales: from small-scale dynamo fields and ephemeral regions to large, complex active regions, to the global dipole field. FA1 aims to facilitate research that clarifies how these multi-scale processes interact to form, transport, and concentrate magnetic fields in ways that set the stage for energy storage and release.

Energy build-up in the corona is the cumulative result of processes coupling the photosphere, chromosphere, and corona over timescales from minutes to weeks. FA1 therefore supports coordinated observing campaigns – of the magnetic field at the surface of the Sun, helioseismic observations to probe the interior, as well as EUV and X-ray imaging of the outer atmosphere, of the magnetic field in the outer atmosphere and corona – combined with advanced modelling at a broad range of temporal and spatial scales to interpret the observations.

Long-term variability and space climate are equally central themes. FA1 includes efforts to connect short-term eruptive behaviour with variability in solar magnetism and irradiance on solar-cycle to millennial timescales. This also links naturally to the solar–stellar connection: observations of solar-like stars provide crucial context for understanding the range of magnetic activity the Sun can exhibit, placing both contemporary variability and rare extreme events into a broader astrophysical framework.

A wide range of solar instruments, missions, and modelling tools are driving progress on the FA1 research topics. Space missions such as Solar Dynamics Observatory, Solar Orbiter, Hinode, and Parker Solar Probe together with DKIST and other ground-based facilities, including long-duration synoptic facilities, provide detailed measurements of the solar atmosphere, magnetic fields, and solar wind. Next-generation missions, including Vigil, SOLAR-C, the ground-based network ngGONG, and proposed multi-point heliospheric constellations, will add crucial multi-perspective coverage and improved continuity. Complementary models capture magnetic fields from their generation and emergence to their heliospheric impacts: global dynamo simulations, radiative MHD models of convection and sunspot formation, surface flux-transport models, coronal field extrapolations, magnetofrictional approaches, and full MHD heliospheric models of the corona and solar wind.

Through interdisciplinary (and international) collaboration, observational campaigns and modelling developments, data sharing, and capacity-building activities, FA1 strives to advance an integrated view of the Sun as the driver of space weather and space climate, in line with the broader goals of SCOSTEP/COURSE.

Article 3:

Focus Area 2: Solar Wind, Magnetosphere, and Ionosphere Coupling

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Yuki Harada


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Background

The solar wind supplies energy, momentum, and mass to the plasma environments around the Earth and planetary magnetospheres and ionosphere. A number of in situ measurements performed in the past decades from near-Earth plasma missions led to significant advances in our understanding of the solar wind–magnetosphere–ionosphere coupling processes. Yet, fundamental questions still remain, in particular the coupling processes among the different scales leading complex interaction processes among these different plasma regions governing plasma energization and energy transport in the solar wind–magnetosphere–ionosphere coupling system. These include active times with southward interplanetary magnetic field (IMF) manifested as substorms or geomagnetic storms, but also during all IMF intervals including quiet times. The importance of understanding the cross-scale coupling of the solar wind with the magnetosphere and ionosphere is not only for Earth, but also for other planets and moons where the solar wind coupling with (induced) magnetospheres or with surfaces can be relevant.

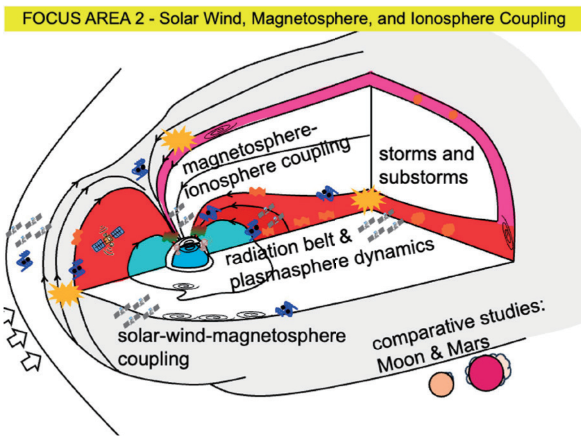

Figure 1. Schematics of Focus Area 2 main topics (Laurenza et al., 2025).

Terrestrial solar wind-magnetosphere-ionosphere coupling

The terrestrial solar wind-magnetosphere-ionosphere system is highly integrated via a rich variety of processes such as magnetic reconnections, plasma injections, magnetic drifts, wave-particle interactions, particle precipitation, and aurora emissions. Energy being transported from the solar wind into the terrestrial magnetosphere is further dissipated via joule heating and ionization in the upper atmosphere, which subsequently provides feedback effects on the magnetospheric dynamics. The cross-scale nature of this coupling is fundamental, intrinsically linking global, meso-, and micro-scale processes. Understanding the plasma energization and multi-scale energy flow during geomagnetic storms and substorms is essential for near-Earth hazardous space weather alerts.

Comparative studies: Moon, Mars, and beyond

Comparative studies with other planetary systems offer unique opportunities for studying cross-scale couplings in solar wind interactions. For example, the Moon has no global magnetic field or dense atmosphere, allowing direct solar wind interactions with the lunar surface and localized crustal magnetic fields. Multiple spatial scales are involved in the Moon-solar-wind interaction, including individual dust grains, regional topography, sub-ion-scale mini-magnetospheres around lunar magnetic anomalies, and the global wake structure. Mars also lacks a dipole magnetic field of internal dynamo origin but possesses crustal remanent magnetization. The solar wind interaction with the Martian upper atmosphere and crustal magnetic fields forms a unique hybrid magnetosphere of both induced and intrinsic nature, which also hosts rich cross-scale coupled processes. For safe and sustainable human exploration at the Moon and Mars, it is essential to characterize and understand the space environments, including radiation environments at Mars and the Moon, electrostatic environments on the lunar surface, ionospheric effects on radio communications and navigation at Mars, and their responses to extreme solar events. Last but not least, other magnetospheres of magnetized planets, such as Mercury and Jupiter, enable us to gain insights into the universality and diversity of magnetospheric processes and to construct a more general understanding of solar wind couplings with planetary systems.

Open questions and directions

The scientific questions in Focus Area 2 include:

- How are particles energized in near-Earth space through cross-scale coupling processes?
- How do micro-physical processes, such as wave-particle interactions and turbulence, "feedback" to control the macroscopic properties of the system (like large-scale current closure or global convection)?
- Can we develop a unified, multi-scale model that accurately represents the coupling from the magnetosphere to the ionosphere? Can we develop a predictive understanding of this complex system?
- How can comparative studies on different planetary plasma environments improve our general understanding of solar wind–magnetosphere-ionosphere coupling?

To address these questions, we can combine effectively the current fleet of spacecraft of upstream solar wind, geospace, near-planet, and ground-based observations (e.g., SoHO, Hinode, SolO, STEREO, SDO, PSP, DKIST, THEMIS, MSS, TRACERS, Arase, FengYun-3E, BepiColombo, MAVEN, Tianwen-1, MESSENGER, JUICE) as well as upcoming missions (e.g., SMILE, ESCAPADE, MMX), along with recent advances in the development of numerical models. Working groups addressing specific topics relevant to Focus Area 2 will be formed, and active participation from the international community is encouraged.

Article 4:

Focus Area 3: External Impacts and Internal Dynamics of the Earth Atmosphere

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Astrid Maute


Maria Graciela Molina


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The Earth's middle and upper atmosphere is shaped by solar radiation and its coupling to the solar wind and the magnetosphere, while also responding to dynamical forcing from below. Gravity waves, planetary waves, and atmospheric tides—generated among others by solar radiation absorption, weather systems, convection, and topography—propagate upward and, in a stratified atmosphere, can break, interact nonlinearly, generate secondary waves, and modify the background state. Moreover, long-term changes in anthropogenic forcing alter how solar variability influences the system across scales at different altitudes. As a result, the coupled middle and upper atmosphere forms a highly dynamic, multi-scale environment governed by photochemical, dynamical, and electrodynamical interactions.

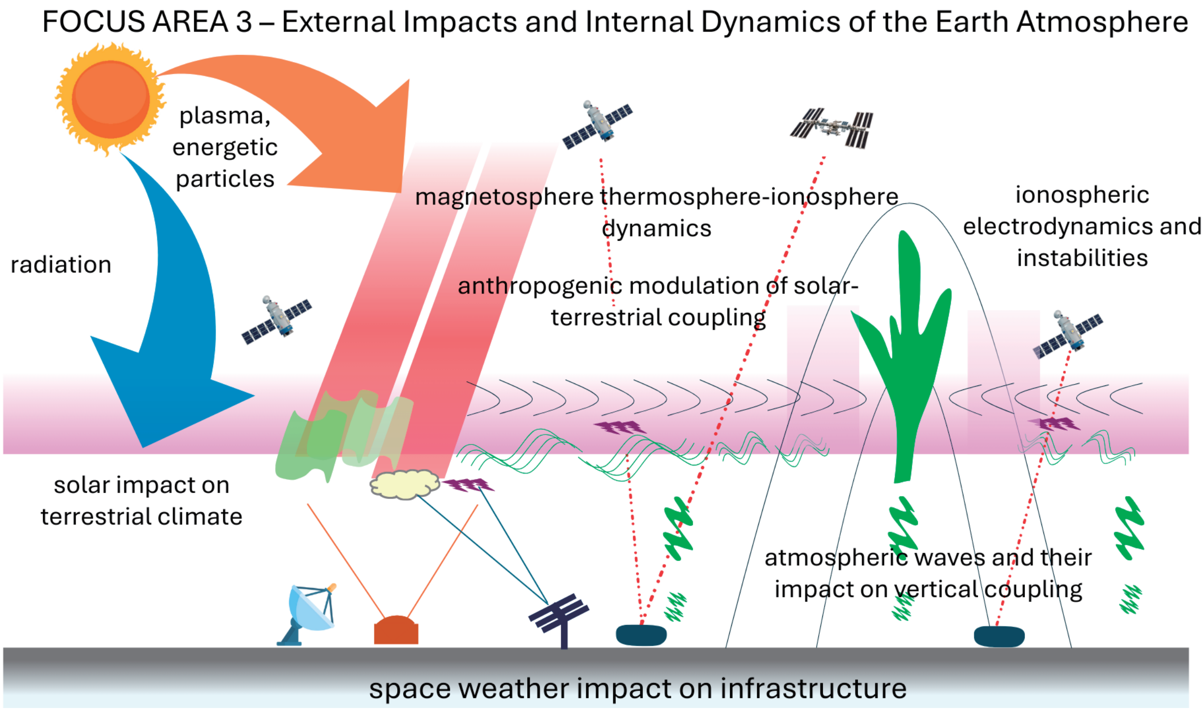

Figure 1. Schematic of the whole atmosphere-ionosphere system illustrating the Focus Area 3 main topics.

Understanding these cross-scale couplings is essential for predicting the atmosphere–geospace system, supporting human exploration, safeguarding space-based assets, and protecting ground infrastructure. Although continuous monitoring across scales remains challenging, progress can be made through new satellite missions, expanded ground-based networks, and the integration of numerical models, data assimilation, and machine learning.

Key science questions include:

1. How do external drivers and internal dynamics interact?
2. What role does the middle and upper atmosphere play in coupling the atmosphere–geospace system?
3. How do cross-scale interactions shape variability?
4. How do regional and global couplings affect predictability?

Advancing this field requires coordinated use of diverse datasets, rigorous model–observation benchmarking, and emerging physics-AI approaches to capture nonlinear dependencies. Three working groups have been established to guide progress.

1. **Data Integration for Atmospheric Linkage (DIAL)** Leads: Fabrizio Sassi (NASA-GSFC, USA), Dr. Yenca Migoya-Orue (ICTP, Italy): A broad set of datasets already supports this effort, including empirical models like MSIS and IRI, NASA reanalysis products, and extensive ground-based networks such as ionosondes, HF radars, and GNSS receivers. Reviewing these resources can clarify their strengths, limitations, and gaps in coverage or accessibility. Collaboration between modelers and observationalists is essential: observations benchmark models, while models help interpret sparse or noisy measurements. Traditional data assimilation remains vital, requiring new frameworks that integrate novel and non-traditional data with numerical simulations. Machine-learning and AI methods also depend on well-curated datasets, making benchmarking crucial. Finally, regional observations must be harmonized and effectively incorporated into global models to capture localized phenomena.

2. **Advancing Whole Atmosphere Modelling: Intercomparison (WAMI)** Leads: Prof. Claudia Stephan (IAP, Germany), Dr. Chih-Ting Hsu (NSF NCAR, USA): WAMI offers a platform to evaluate how different models treat coupling between the lower and upper atmosphere. Comparisons between whole atmosphere models and thermosphere–ionosphere models highlight the importance of interactive lower-upper atmosphere processes and the trade-offs between physical complexity and computational cost and model agility. Intercomparison studies shed light on necessary model configuration and physics to capture key coupling mechanisms. Geomagnetic storms, sudden stratospheric warmings, and equinox transitions provide natural test cases. Hybrid approaches that combine physics-based models with AI methods are emerging as promising tools to capture nonlinear processes while retaining physical interpretability and reducing computational demands.

3. **Drivers, Variability, and Forecasting Challenges in Space Weather (ChaS)** Leads: Dr. Garima Malhotra (Uni. Colorado Boulder, USA), Dr. Claudio Cesaroni (INGV, Italy): Space weather remains a central challenge, with specific events such as solar flares, coronal mass ejections, and geomagnetic storms serving as natural laboratories for testing models and forecasts. Day-to-day variability and latitudinal differences complicate prediction, while long-term trends linked to climate change and solar activity variability add further complexity. The upper atmosphere is shaped both by forcing from below, through terrestrial climate variability, and from above, through solar and geomagnetic inputs. Disentangling these drivers is critical for advancing forecasting skills. Machine learning offers new opportunities to assimilate diverse datasets and improve predictive capability, but robust benchmarking and interpretability remain essential.

Highlight on Young Scientists 1:

Traveling Ionospheric Disturbances Interaction with Equatorial Plasma Bubble over Brazil

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[2]State University of Paraiba (UEPB), Campina Grande, Brazil

Luiz Fillip Rodrigues Vital

Equatorial Plasma Bubbles (EPBs) are large-scale F-region ionospheric irregularities, initiated by a perturbation in the bottom side F-region controlled by the Rayleigh-Taylor Instability (Kelley, 2009). Medium Scale Traveling Ionospheric Disturbances (MSTIDs) are wave-like perturbations in ionospheric plasma with periods from minutes to hours and horizontal wavelengths up to thousands of kilometers (Hines, 1960).

Figure 1 shows a sequence of OI 630.0 nm all-sky airglow images acquired at (a) São João do Cariri (7.37°S, 36.5°W) and (b) Bom Jesus da Lapa (13.3°S, 43.5°W), used to investigate the interaction between a post-midnight EPB ("B") and a dark-band MSTID ("M") on 25 July 2022 under geomagnetically quiet conditions (Kp < 3). Figure 1a shows the development of EPB around 02:40 UT (local time = UT-3 hours). The EPB exhibits latitudinal expansion without

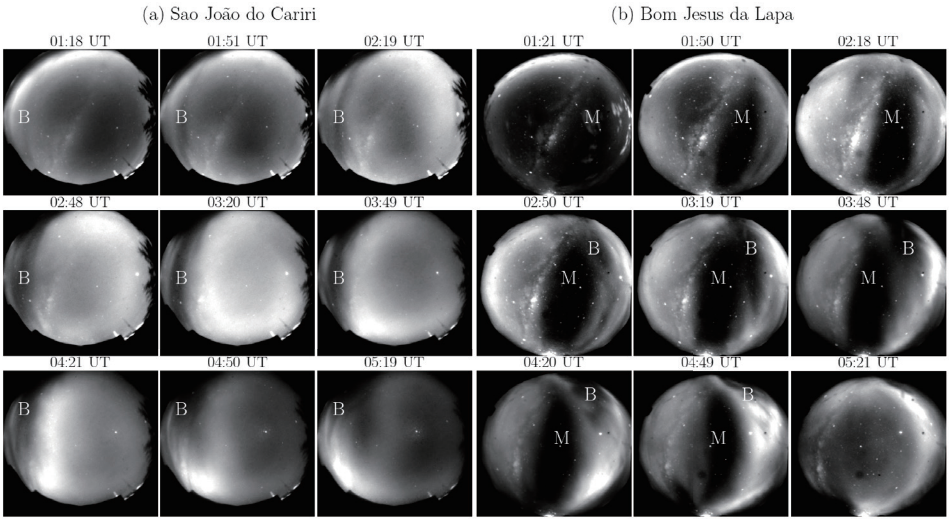

Figure 1. Time sequence of OI 630.0 nm airglow all-sky images obtained at (a) São João do Cariri and (b) Bom Jesus da Lapa on the night of 25 July 2022. The letters "B" and "M" indicate the EPB and the dark-band MSTID, respectively. The time of acquisition of each image are displayed above each image in universal time.

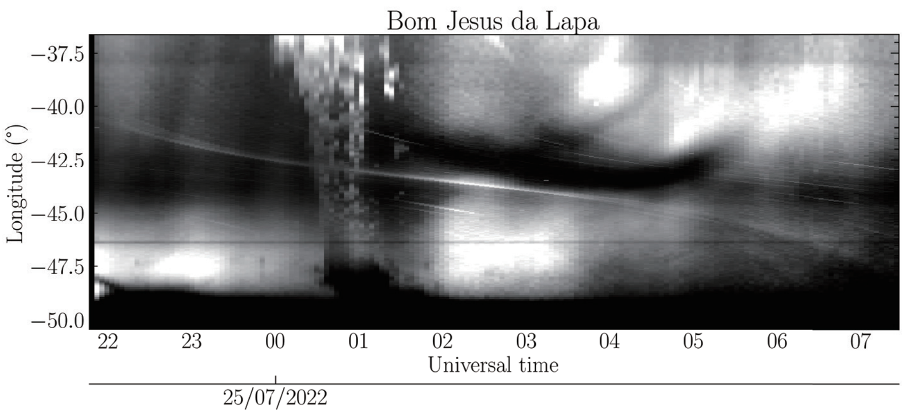

Figure 2. Longitudinal keogram derived from OI 630.0 nm airglow images along the zonal direction at Bom Jesus da Lapa on 25 July 2022. The images were mapped over a horizontal distance of 1536 km, corresponding to a zenith angle of ~75°, assuming an emission altitude of 250 km.

significant zonal propagation on the western side of the Cariri imager and subsequently appears in the central field of view of the Bom Jesus da Lapa imager. Figure 2 presents the zonal keogram (longitudinal cross section) derived from the OI 630.0 nm airglow images at Bom Jesus da Lapa, after linearization and mapping into geographic coordinates. The keogram shows the onset of an MSTID around 01:00 UT, with wavefronts aligned from southeast to northwest and propagating northwestward, the EPB emerges on the keogram around 03:00 UT with eastward gradient.

Notably, after the interaction with the EPB a brief reversal in the MSTID propagation direction from northwestward to eastward is observed around 04:30 UT. The disappearance of EPBs following interaction with MSTIDs has been widely reported in previous studies (e.g., Shiokawa et al., 2015; Otsuka et al., 2012) and may be attributed to plasma refilling throughout the EPB driven by MSTIDs polarization electric fields. In contrast, the mechanisms responsible for the observed reversal in MSTID propagation remain under investigation.

Acknowledgements:

The author gratefully acknowledges the support of the SCOSTEP Visiting Scholar (SVS) Program and the Institute for Space-Earth Environmental Research (ISEE), Nagoya University and to Professor Yuichi Otsuka for the supervision. The author also thanks Embrace/INPE Space Weather Program for providing All-Sky imager data. This research was supported by the China-Brazil Joint Laboratory for Space Weather (CBJLSW), the National Space Science Center (NSSC), and the Chinese Academy of Sciences (CAS) through a postdoctoral fellowship. Additional support was provided by the Overseas Science and Education Cooperation Center Deployment Project, Bureau of International Cooperation, Chinese Academy of Sciences (Grant No. 119GJHZ2024027MI).

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Highlight on Young Scientists 2:

Characteristics of Field-Aligned Low-Energy Oxygen (FALEO) Events Based on Arase LEP-i Observations

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Trunali Anil Shah

Heavy ions of ionospheric origin, particularly O^+, play a crucial role in shaping Earth's magnetospheric dynamics, yet their transport pathways and spatial distribution remain incompletely understood. In this study, we investigate Field-Aligned Low-Energy Oxygen (FALEO) ions using four years (2020–2023) of observations from the Arase satellite. By analyzing data from the Low-Energy Particle experiment (LEPi) and the Magnetic Field Investigation (MGF), we identified 90 energy-dispersed FALEO events and examine their spatial distribution, flow direction, and dependence on geomagnetic activity.

Our results show that FALEO ions move along magnetic field lines, appearing parallel to the magnetic field below the equator and anti-parallel above it, confirming their ionospheric origin. On the nightside, FALEO events are most common near midnight and typically occur during geomagnetically quiet periods. The minimum "stop" energy of these ions increases with radial distance (L-value). During enhanced geomagnetic activity, lower-energy ions penetrate to smaller L-values, highlighting the role of storm-time convection (Figure 1).

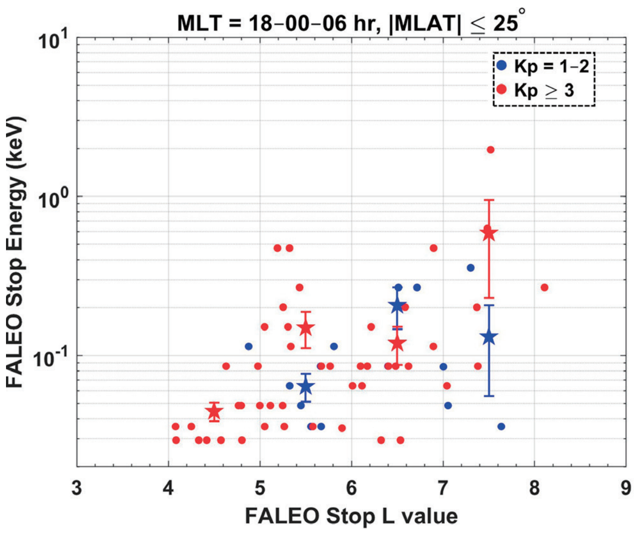

Figure 1. The Figure presents the dependence of FALEO stop energy on L value and Kp index.

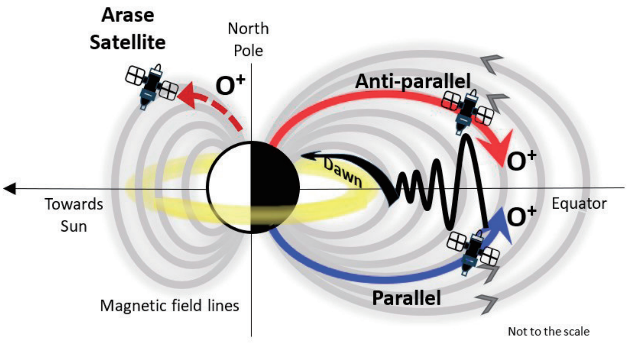

Figure 2. Schematic overview of the key results derived from the FALEO event analysis presented in this study.

A key new finding of this study is the first systematic observation of bidirectional FALEO events on the dawnside (06–10 MLT). These dawnside events are predominantly associated with geomagnetic storms, suggesting that enhanced convection and storm-time ionospheric outflows enable oxygen ions to access regions previously thought to be dominated by nightside sources. The main results and conceptual interpretation of these findings are summarized schematically in Figure 2.

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Acknowledgement:

This work was supported by the International Exchange Program of the National Institute of Information and Communications Technology (NICT), Japan. I sincerely thank Prof. Masahito Nosé and Prof. B. Veenadhari for their supervision.

Highlight on Young Scientists 3:

Tracing Universal Turbulence Scaling in ICMEs through Kinetic-Scale Current Sheets

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Zubair Ibrahim Shaikh[1]
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Interplanetary coronal mass ejections (ICMEs) are large-scale eruptions of magnetized plasma from the solar corona that propagate through the heliosphere and strongly influence planetary magnetospheres and the heliosphere. Our research focuses on identifying and characterizing kinetic scale structures that mediate this cross-scale coupling (Zhdankin et al., 2012; Vech et al., 2018), using in situ observations of ICMEs. ICMEs provide a unique laboratory with a wide range of plasma beta (β) values from as low as 0.001 to above 100, creating conditions rarely found in the ambient solar wind (Shaikh et al., 2022; ICME example in Fig. 1: left), making them ideal for investigating current sheets (CSs): thin, localized regions where magnetic fields and current densities vary sharply (Vasko et al., 2022; example in Fig. 1: right).

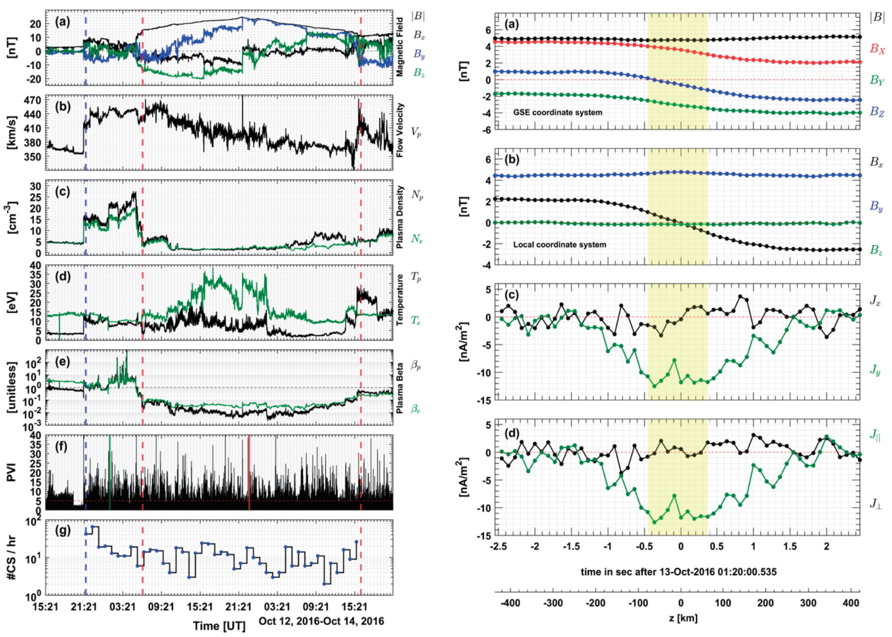

Figure 1. The Figure presents the dependence of FALEO stop energy on L value and Kp index.

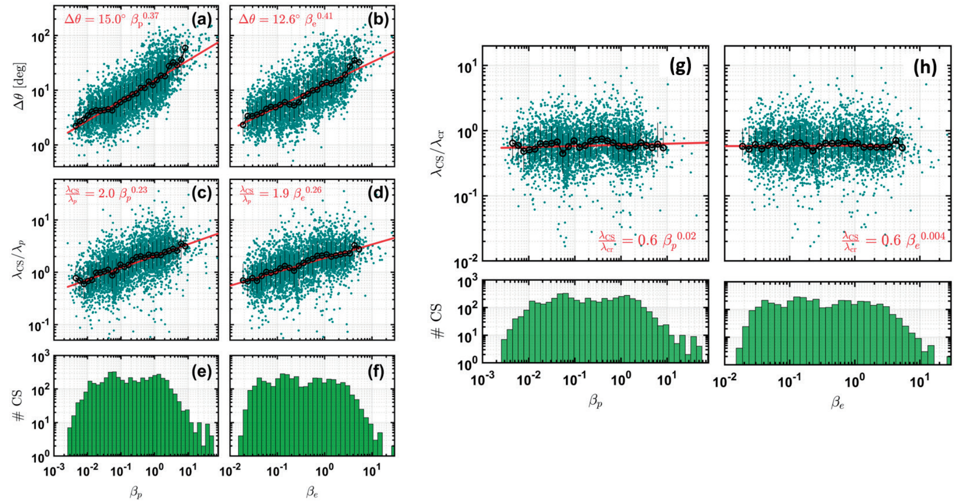

Figure 2. Panels (a-f): Shear angle Δθ and normalized current sheet thickness λ_{CS}/λ_p as functions of proton and electron plasma beta. Panels (g-h): Current sheet thickness λ_{CS} normalized by the disruption scale λ_{cr} versus proton and electron beta. Black circles show bin medians with 15th–85th percentile ranges, and red lines indicate power-law fits.

In a recent study (Shaikh et al., 2026), using 11 Hz magnetic field measurements from the Wind spacecraft, we analyzed about 4600 CSs embedded within 13 distinct ICMEs at 1 AU. We showed that these CSs are predominantly kinetic scale structures, with thicknesses λ_{CS} comparable to the ion inertial length λ_p, and that their properties systematically depend on plasma beta (Fig. 2). Specifically, CSs become thicker and exhibit larger magnetic shear $\Delta\theta$ at higher beta, while remaining thinner and more intense in low beta environments. Remarkably, when normalized by the theoretically predicted disruption scale associated with electron tearing instability (Loureiro & Boldyrev 2017), the beta dependence disappears (Fig. 2), suggesting a universal scaling in controlling turbulence dissipation in collisionless plasmas. This observation supports the theory suggesting that CSs mediate the transition from the inertial to the kinetic cascade through the electron tearing mode. Moreover, turbulence amplitude scales with β, and shear angle scales with turbulent amplitude. These results link observations and turbulence theory, showing how microscale processes shape large-scale structures and control cross-scale coupling (Uzdensky et al., 2016).

Acknowledgements:

I sincerely thank my co-authors Ivan Y. Vasko, Tai Phan, and Stanislav Boldyrev for their valuable contributions and insights.

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Highlight on Young Scientists 4:

Robust Ionosonde Surrogate for foF2 and hmF2 Estimations based on Machine Learning Routines

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Critical frequency (foF2) and virtual height (hmF2) of the ionospheric F2-layer are parameterized using vertical radio sounders (Tx, Rx) or ionosonde echoes [1]. Ionosondes are very crucial, supporting GNSS based total electron content (TEC) mapping. However, they exhibit diverse limitations including cost, coverage and mode of operation. Though interlinked, coverage presents the greatest challenge for scientific and operational grade applications.

We present a machine learning (ML) surrogate that leverages GNSS piercing point (IPPs) passes in co-located Ionosonde-GNSS receiver regions, the solar zenith and space weather conditions to determine the foF2 and hmF2. The approach is significant for reducing spatial inaccuracies in empirical models that utilize ionosonde inversions to estimate TEC (e.g. ML-TEC models), knowing the ionospheric spatio-temporal variability. Figure 1 is a schematic description.

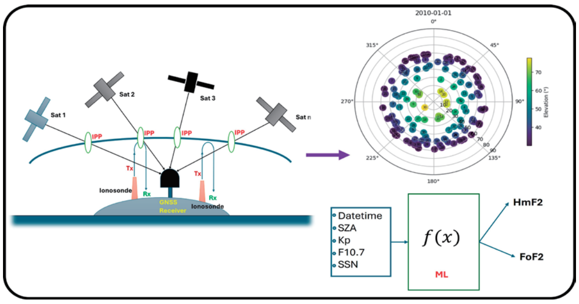

Figure 1. Schematic description of the problem and ML snapshot used for estimating foF2 and hmF2. The method's-UI is refactored such that the user may not require location covariates.

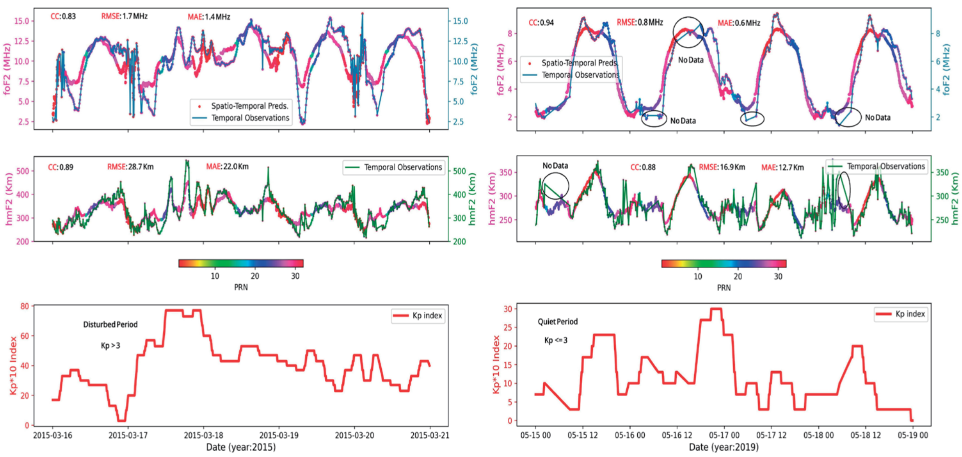

Figure 2. Top panels show the temporal evolution of foF2 from ionosonde inferences overlayed with determinations from the ML model color-coded with the satellite PRNs at each IPP location. The same is true for the middle panels but for hmF2 dynamics. The bottom panels are the Kp index for the storm-time (left) and quiet time (right) conditions of 2015 (solar maximum) and 2019 (solar minimum).

In Figure 2, we have compared direct ionosonde foF2 and hmF2 inferences with the ML model's estimations under solar maximum and solar minimum periods during disturbed and quiet space weather conditions. The ML model accurately determined foF2 levels at about 83% (RMSE: 1.7 MHz) and hmF2 at 89% (RMSE: 28 Km) accuracies during the Patrick's day Storm conditions whereas a 94% and 88% were recorded during the quiet time conditions.

The figure matches up temporally for satellite PRNs that appeared spatially in the field of view of the receiver and the co-located ionosonde radar color-coded at the IPP positions. The approach adopted makes the model spatially robust and can be used to estimate the ionospheric properties during full radio frequency absorption.

Reference

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Meeting Report 1:

The European Space Weather Week (ESWW 2025)

Audrey Schillings

Audrey Schillings[1]
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The European Space Weather Week (ESWW 2025) took place in the north of Sweden, Umeå, from October 27–31, preceded by a space weather training for early-career professionals in Kiruna (October 23–26). Organized by Umeå University with the support from the Solar-Terrestrial Excellence Centre in Belgium and the Swedish Institute for Space Physics, the conference gathered over 550 on-site participants and more than 600 in total. The program offered several social activities such as aurora sightseeing and a conference dinner. Thanks to the strong community involvement, around 600 abstracts were submitted, and over 35 sessions were held. The NOC team extends sincere thanks to sponsors, the space weather and climate community, and the volunteer students whose efforts made ESWW 2025 a great success. We look forward to welcoming you to ESWW 2026 in Firenze, Italy!

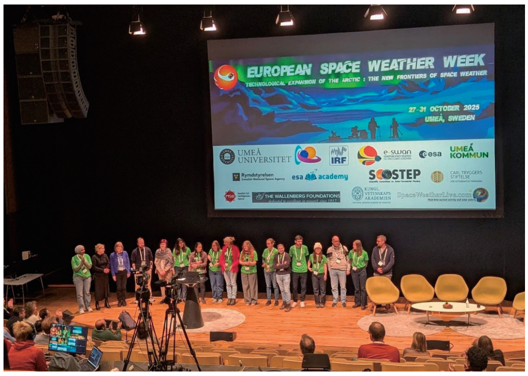

Photo 1. The National Organization Committee (NOC) and volunteers during the Closing Ceremoning of ESWW 2025 in Umeå.

Meeting Report 2:

2025 IMCP Space Weather School

Jiuhou Lei

Liwen Ren

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The International Meridian Circle Program (IMCP) is dedicated to conducting full-latitude, all-weather observations of the Sun–Earth space environment, investigating the global characteristics and propagation patterns of space weather and its interactions with global change, and providing scientific support for mitigating space weather hazards. IMCP successfully conducted its second Space Weather School from November 10 to 16, 2025, in Haikou, China. A total of 42 young scholars from 19 countries participated in the school. Accompanying them were 15 esteemed lecturers from 6 countries.

The theme of the school was "Space Weather Observation and Research Based on the International Meridian Circle Program." The program aimed to cultivate young scholars' understanding of the full-chain physical processes of space weather through a structured curriculum that combined scientific lectures, field trips, and hands-on assignments requiring data analysis and practical operation. Students worked in groups and engaged in extensive interactions with lecturers during the assignment sessions. Based on the final project presentations, the scientific organizing committee selected three groups for the Excellent Student Award.

2025 IMCP school was sponsored by SCOSTEP, Institute for Space-Earth Environmental Research (ISEE) and the Chinese Academy of Sciences (CAS).

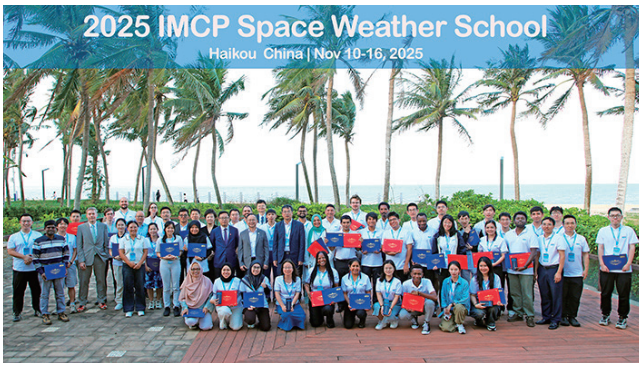

Photo 1. 2025 IMCP Space Weather School Group Photo.

Upcoming meetings related to SCOSTEP

Conference	Date	Location	Contact Information
The International Symposium for Equatorial Aeronomy 17 (ISEA-17)	Feb. 9-13, 2026	Liberia, Costa Rica	https://www.iap-kborn.de/isea17/home
United Nations/Costa Rica Workshop on Machine Learning applied to Space Weather and Global Navigation Satellite Systems (GNSS)	Feb. 16-20, 2026	San José, Costa Rica	https://www.unoosa.org/oosa/en/ourwork/psa/schedule/2026/united-nations-costa-rica-workshop-2026.html
ESPD Summer School 2026	Apr. 27-May 1, 2026	Dubrovnik, Croatia	https://oh.geof.unizg.hr/index.php/en/meetings/espd-school-2026
13th TREND Workshop	May 18-22, 2026	Beijing, China	https://trends2026.casconf.cn/
SCOSTEP's 16th Quadrennial Solar-Terrestrial Physics (STP-16) Symposium	Jun. 1-5, 2026	Thessaloniki, Greece	https://scostep.org/events/stp-symposia/
Space Climate 10 Symposium	Jun. 9-12, 2026	Åland/Ahvenanmaa, Finland	https://cosmicrays.oulu.fi/space_climate2026/
7th IMAOC School	Jun. 15-26, 2026	Tunis, Tunisia	
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/COURSE newsletter is to promote communication among scientists related to solar-terrestrial physics and the SCOSTEP's COURSE program.

The editors would like to ask you to submit the following articles to the SCOSTEP/COURSE 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/COURSE
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/COURSE
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/COURSE 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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The PDF version of the SCOSTEP/COURSE Newsletter is distributed through the SCOSTEP-all mailing list. If you want to be included in the mailing list to receive future information of SCOSTEP/COURSE, please send e-mail to "scostep_at_lasp.colorado.edu" (replace "_at_" by "@") with your name, affiliation, and topic of interest to be included.

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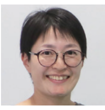

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