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Article 1:

Long-term Solar Variability

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Theodosios Chatzistergos

Solar activity varies over a wide range of timescales, from days to millennia. Understanding this variability is essential for placing present-day solar activity in context, assessing its implications for space weather and space climate, and characterising the solar influence on Earth's system.

Understanding long-term solar variability requires the combination of historical observations, indirect proxies, and physics-based models, which together provide complementary information across a wide range of timescales. Direct solar observations have been collected at observatories around the globe for more than four centuries (Chatzistergos 2026), providing a rich record of solar activity. However, further back in time, these observations become increasingly sparse and less precise, with more limited temporal coverage and coverage of different layers of the solar atmosphere. The earliest records consist primarily of sunspot drawings, while photographic archives and spectroscopic observations extend back only a little more than a century.

Moreover, observations of the same quantities often differ between archives because of variations in instruments, observing conditions, and

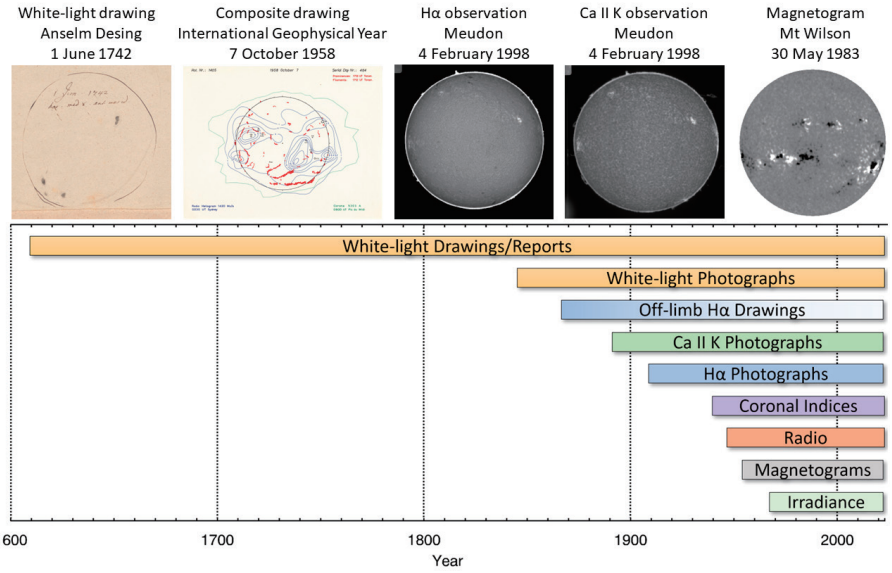


Figure 1. Timeline of the existing long-term archives of solar observations along with some example solar observations. Adapted from Chatzistergos 2026.

observational practices. Proper cross-calibration and homogenisation are therefore essential to combine these heterogeneous records and derive reliable, long-term measures of solar variability. Furthermore, many historical archives have yet to be digitised, while the whereabouts of others remain unknown (Pevtsov et al. 2019).

At the same time, indirect proxies, such as cosmogenic radionuclides, provide an opportunity to investigate solar activity and variability further back in time, beyond the period covered by direct observations. Recent advances in the recovery of high-temporal-resolution annual ^{14}C records, together with ^{10}Be measurements, are providing new insights into solar activity over millennia (Usoskin 2023).

Our Long-term Solar Variability Working Group (WG), operating under Focus Area 1: Sources of Space Weather and Space Climate, aims to foster collaboration among researchers investigating solar variability on long timescales through observations, proxies, reconstructions, and modelling. The WG supports the recovery, preservation, digitisation, and analysis of historical solar observations, as well as the development of improved approaches of cross-calibration, uncertainty assessment, reconstruction, and reanalysis. It also promotes the integration of historical and modern observations with long-term proxies and physics-based modelling, and facilitates the exchange of data, tools, and methodologies across the community. The WG collaborates with the Solar–Stellar Connections WG (see Newsletter number 48) and the Solar Energetic Particles and Extreme Solar Particle Events WG.

As part of these activities, the WG is organising session SCL1 at the European Space Weather Week-2026 as well as Focus Meeting 10, *"Solar variability across timescales: from magnetism to irradiance, models, and historical records"*, to be held during the 2027 International Astronomical Union (IAU) General Assembly (GA), which will take place in Rome over 10-19 August 2027. A session titled *"Long-term trends and variability in the Sun-planet system: solar, heliospheric, magnetospheric, and upper-atmospheric changes"* has also been proposed for the 2027 European Geosciences Union (EGU) GA, which will take place in Vienna over 4-9 April 2027. Initial discussions took place during SCOSTEP's 16th Solar-Terrestrial Physics Symposium.

We warmly invite researchers at all career stages interested in any aspect of long-term solar variability to join the WG and attend our meetings at the IAU and EGU GA.

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Article 2:

MOSAIC: From an Event Campaign to an International Multi-Observatory Community

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Lengying Khoo

The *Multi-Observatory for Solar Activity and Interplanetary Coordination (MOSAIC)* Working Group originated in 2022 as an informal international effort to coordinate observations and analyses of the remarkable 15-16 February 2022 CME/SEP event (Figure 1; Khoo et al. 2024; Palmerio et al. 2024; Wei et al. 2024; Sanchez-Cano et al. 2026). This SEP event was associated with a fast CME (~2376 km/s) and an estimated shock speed of ~2315 km/s. It represents one of the most intense and spatially extensive SEP events observed in Solar Cycle 25. This event was observed from Parker Solar Probe, BepiColombo, Solar Orbiter, STEREO-A, near-Earth assets (SOHO, ACE, Wind), and Mars-based missions (MAVEN, Mars Express, and the Curiosity rover), enabling a rare chance to examine the propagation of SEPs from the sun to the Martian atmosphere (Sanchez-Cano et al. 2026).

The success of this campaign highlighted the growing need for a platform where scientists could regularly exchange information across missions. What began as an event-focused collaboration gradually evolved into a broader community platform supporting multi-observatory heliophysics investigations. Today, MOSAIC is a formal working group within the SCOSTEP/COURSE Focus Area 2 (FA2), providing a venue for scientists to share mission updates, discuss coordinated observing opportunities, and develop collaborative studies using observations from throughout the heliosphere and their impact on planetary environments.

Now, MOSAIC constitutes of ~23 members working with a diverse range of missions, including Parker Solar Probe, Solar Orbiter, MAVEN, BepiColombo, and missions currently in cruise phases such as JUICE. Over the past year, MOSAIC has facilitated numerous

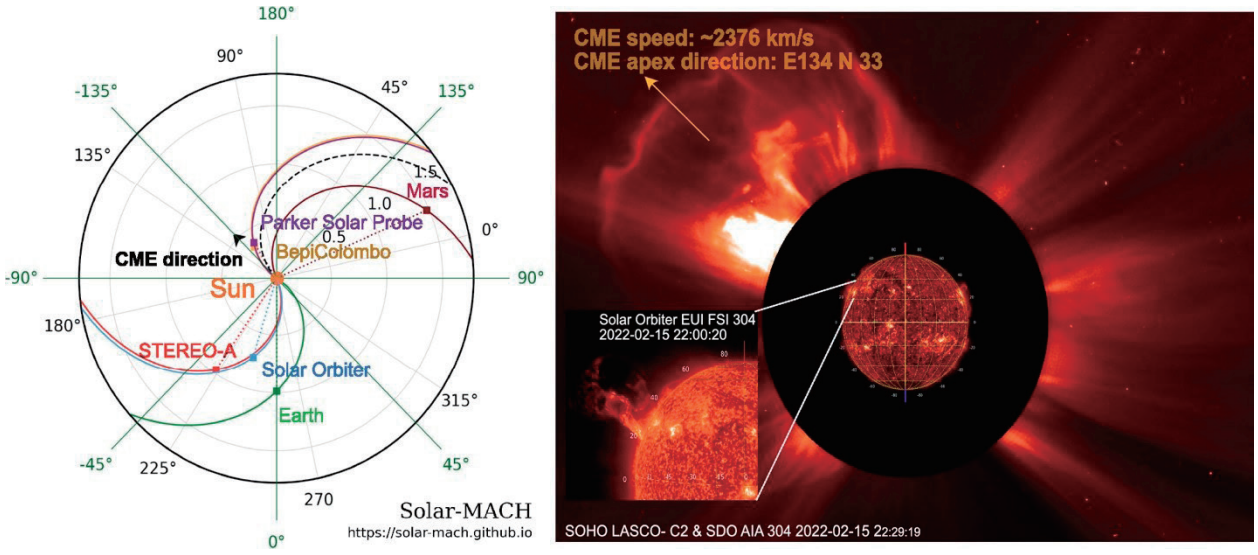


Figure 1. Overview of the spacecraft and planet configuration as well as solar activity on 2022 February 15. [From Khoo et al. 2024].

collaborative studies, including multiple solar energetic particles events during December 2024 (Khoo et al. in preparation; Carcaboso et al. in preparation), August 2025 (Lario et al. in preparation), and March 2025 (Xu et al. in preparation; Wei et al. in preparation; Khoo et al. in preparation). These efforts combined observations from multiple spacecraft and observing platforms to investigate particle acceleration, transport, and the evolution of large-scale interplanetary structures and their interactions with Earth/Mars. The multi-observatory perspective provided by these campaigns has enabled scientific insights that would be difficult to obtain from any single mission alone.

Looking ahead, MOSAIC aims to continue serving as a platform for international collaboration, maximizing the scientific return of current and future heliophysics missions. As spacecraft become increasingly distributed throughout the heliosphere, coordinated observations will play an essential role in advancing our understanding of solar activity and space weather. MOSAIC provides the community framework needed to make these investigations possible.

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Article 3:

Introducing COURSE Focus Area 3 Working Group: Drivers, Variability, and Forecasting Challenges in Space Weather (ChaS)

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Garima Malhotra


Claudio Cesaroni

The Earth's middle and upper atmosphere is driven from above by solar and geomagnetic activity, and from below by the terrestrial weather system, whose tides, planetary waves and gravity waves propagate upward. The region is therefore highly complex and intrinsically multi-scale, and its daily weather- the day-to-day variability of the thermosphere-ionosphere (T-I) system is hard to predict.

ChaS is one of three working groups under Focus Area 3, 'External impacts and internal dynamics of the Earth's atmosphere,' within the current Cross-scale Coupling Processes in the Solar-Terrestrial System (COURSE) program. It takes up COURSE question G3.4 (Laurenza et al. 2025): how do couplings of different regions, drivers and scales impact the predictability and forecast skill of the upper atmosphere? Figure 1 puts this in forecasting terms: skill is measured against climatology, and persistence (yesterday carried forward) beats it only while the system still remembers. Our first phase has two complementary studies.

Study 1- Memory and predictability of the T-I system. Forecast horizons are set by how long, and over what distances, the system remembers its own state. We measure that memory directly, as decorrelation timescales and spatial decorrelation lengths, in whole-atmosphere models and in ground- and space-based observations, contrasting quiet periods with SSWs and geomagnetic storms to isolate and quantify the contributions of forcing from below and from above (COURSE research objective O3.3, Laurenza et al. 2025). A focus case is the pre-reversal enhancement around dusk which governs whether plasma bubbles and GNSS scintillations develop that night. Preliminary work with ICON's Ion Velocity Meter shows that the PRE anomaly on one evening predicts the next with r = 0.61 (Figure 2a), and the correlation decays with an e-folding time of 2.1 days (Figure 2b), so persistence outperforms climatology for about a day and a half.

Study 2-Enhancing ionospheric forecasting and understanding physical drivers. Progress here depends on the fusion of observations with advanced numerical models and machine learning. We are building a benchmark for AI-based ionospheric modelling on a curated dataset from ground-based (GNSS, ionosondes) and space-based (radio occultation) observations across all longitudes (COURSE research objective O3.5, Laurenza et al. 2025). By establishing this standardized baseline, the working group aims to systematically evaluate machine learning algorithms, assess data quality limitations, and optimize data utilization.

Three questions frame our work:

1. How can the contributions of forcing from below and from above be isolated and quantified to space weather predictability?
2. What is the intrinsic predictability of the T-I system, and how do models and observations differ in the memory they encode?
3. How can machine learning be evaluated fairly against physics-based baselines?

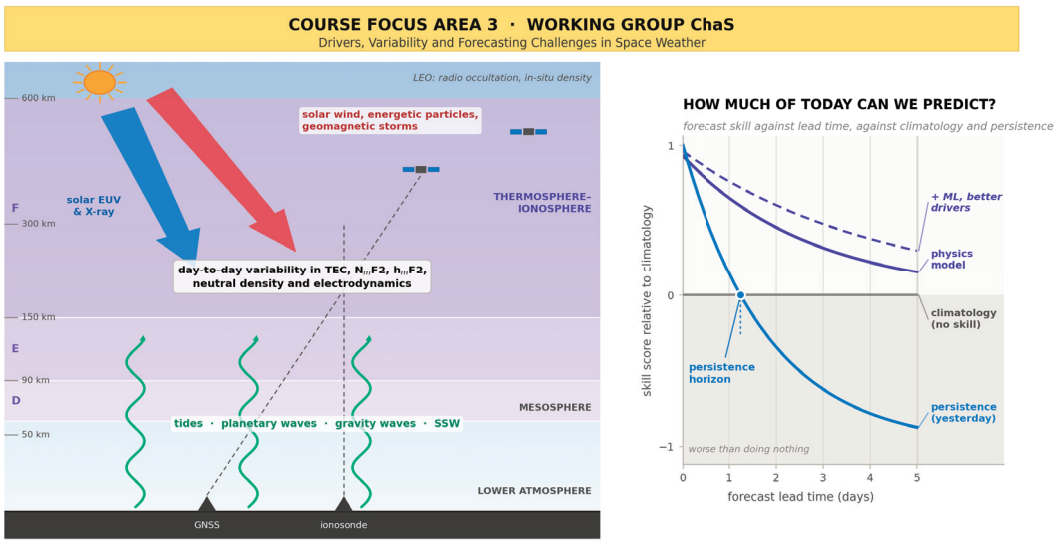


Figure 1. Schematic of Working Group ChaS. Left: forcing from above and from below acting on the thermosphere–ionosphere system, sampled by ground- and space-based instruments. Right: the consequence for prediction. Skill is measured against climatology (the zero line); persistence drops below it at the persistence horizon, while models stay useful further out. The curves are illustrative, not model output.

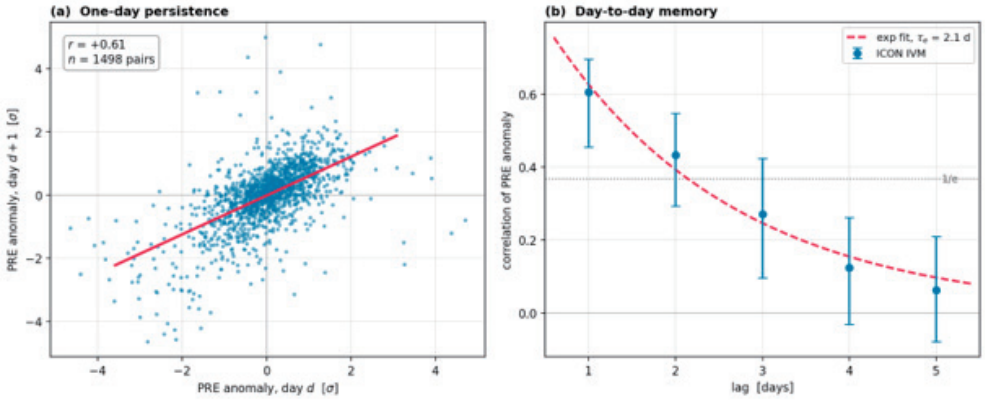


Figure 2. Day-to-day memory of the equatorial pre-reversal enhancement from ICON Ion Velocity Meter drifts (October 2020 - November 2022, |magnetic latitude| < 8°, 17.5–19.5 LT). (a) PRE anomaly on successive days, pooled across 30° longitude sectors and 35 observing windows (r = +0.61, n = 1498 pairs). (b) Correlation against lag, with bootstrap uncertainties and a fitted e-folding timescale of 2.1 days. Anomalies are relative to a fitted local-time, longitude, seasonal, F10.7 and Ap climatology. Preliminary analysis contributed by Garima Malhotra.

ChaS will also contribute to COURSE seminars and STP sessions, and work with the other FA3 groups on shared metrics. We invite colleagues at all career stages, and particularly encourage students and early-career researchers in keeping with COURSE's capacity-building mission.

To join, complete our sign-up form at https://forms.gle/woG1iJ7qtaPDjX9K9 or contact us at garima.malhotra_at_colorado.edu and claudio.cesaroni_at_ingv.it.

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Article 1-3 introduce new WGs of the COURSE program. The latest list of Working Groups under the three Focus Areas of the COURSE program is available at https://scostep.org/scostep-course/.

Article 4:

Ionosphere Monitoring and Studies with the "Ionosonde" Space Mission

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S. A. Pulinets


A. A. Chernyshov

The Russian **"Ionosonde"** project is designed for comprehensive monitoring and studies of the Earth's ionosphere, magnetosphere, and solar–terrestrial interactions using four **"Ionosfera-M" ("Ionosphere-M")** satellites. The first pair of satellites was launched on November 5, 2024, and the second on July 25, 2025. The "Ionosfera-M" spacecraft were developed by VNIIEM Corporation. Space Research Institute of the Russian Academy of Sciences (IKI RAN) is responsible for the scientific payload of the "Ionosfera-M" spacecraft. Four spacecraft operate in two sun-synchronous orbits at an altitude of approximately 820 km and local times of 03:00–15:00 and 09:00–21:00. Two spacecraft are placed in each orbital plane at approximately opposite points. The collection and processing of data are carried out using the ground infrastructure of the Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet), with the participation of scientific organizations. The data are delivered to Roshydromet for monitoring purposes and to Institutes of the Russian Academy of Sciences for scientific use. A data flow is about ~60 GB per day from the four spacecraft.

The main instrument tasks are to peform remote sounding of ionosphere, detect electromagnetic and plasma waves, measure energetic particles and cosmic radiation. A separate research direction is experiments on the artificial modification of the ionosphere using ground-based facilities. The "Ionosfera-M" scientific payload is briefly described below [1].

The **LAERT topside sounder** (developed by VNIIEM) performs remote ionospheric sounding from low-Earth-orbit. In passive mode, it operates as a 0.1–20 MHz radio spectrometer for recording natural emissions, while in active mode it provides the

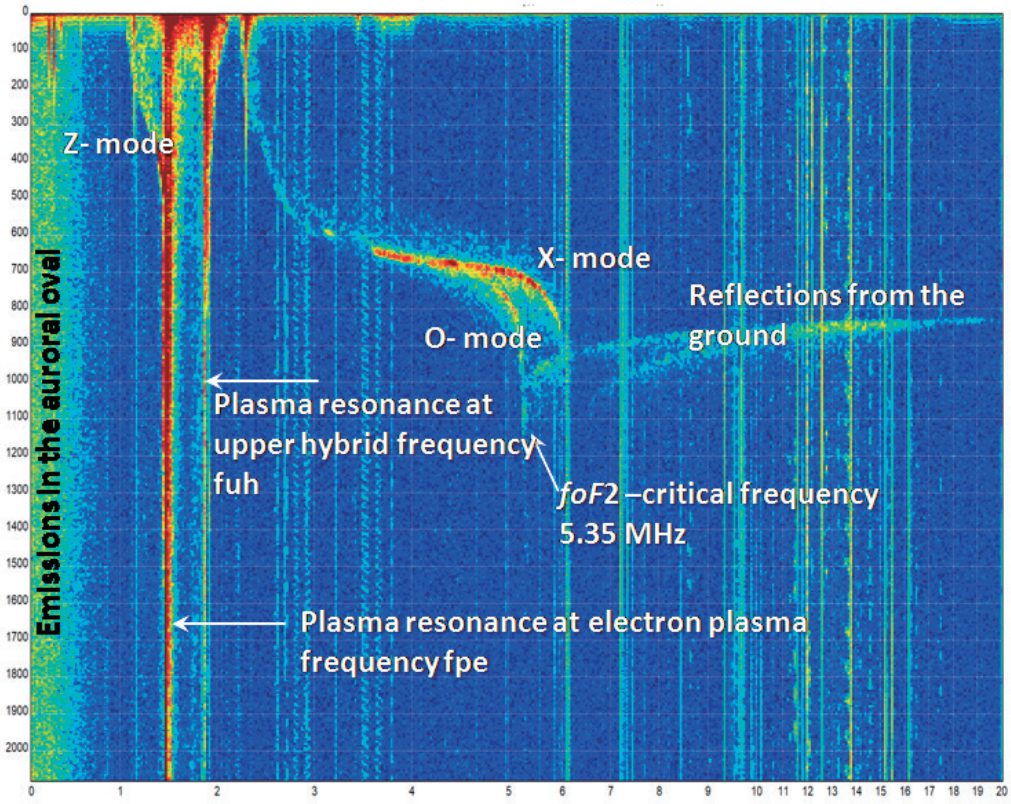


Figure 1. Example of a topside ionogram (LAERT ionosonde, "Ionosfera-M1"). The main ionospheric parameters are marked on the figure: plasma resonances at the local plasma frequency and upper-hybrid frequency, reflection traces from the ionosphere for the ordinary and extraordinary modes, the critical frequency, and ground reflection traces.

electron density profile above the F-layer maximum, inaccessible to conventional ground-based ionosondes. Figure 1 shows an example of an external-sounding ionogram.

The **MAYAK instrument**, beacon, (IZMIRAN) is a transmitter of two coherent radio signals at frequencies of 150 and 400 MHz. The signals are received by a network of ground stations and are used to reconstruct the spatial distribution of electron density in the ionosphere by means of low-Earth-orbit radio tomography. The **PES instrument** (IZMIRAN) receives signals from global navigation satellite systems. Analysis of signal propagation and refraction provides information on the spatial distribution of electron density.

The wave instrumentation, including the low-frequency wave complex - NVK (IZMIRAN), magnetic (NIRFI of Nizhny Novgorod State University), and electric-field (LLC Astron Electronics NPP) sensors, is designed to measure the electric and magnetic components over the frequency range from 1 Hz to 20 kHz. This range includes major characteristic frequencies of the ionospheric plasma (Figure 2).

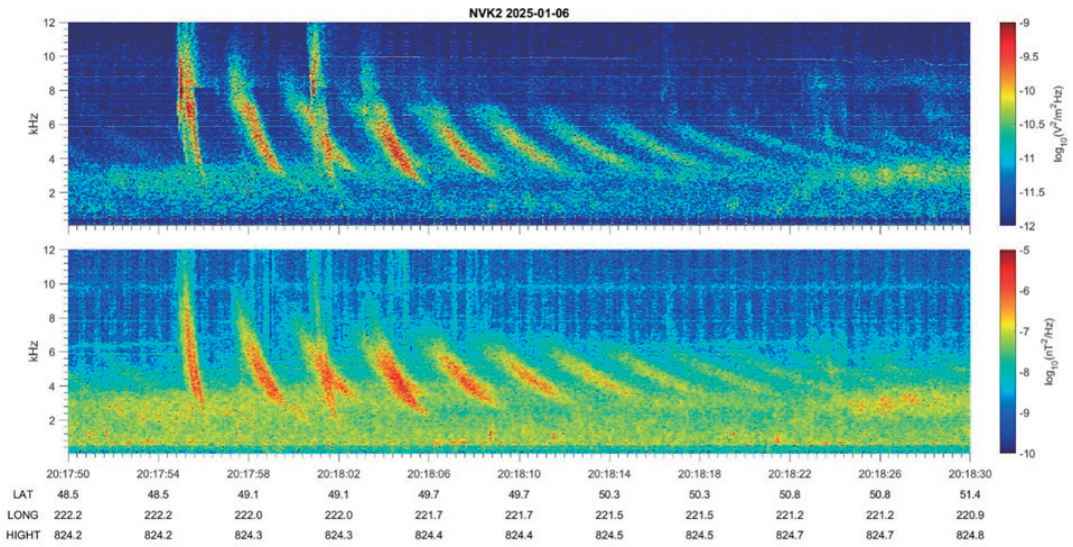


Figure 2. Example of NVK measurements on "Ionosfera-M2" from 6 January 2025: top panel: electric component, bottom: magnetic component. Series of sequential reflections of a whistler (13 reflections) propagating in a mid-latitude channel (duct). Time between reflections – 2.5 sec. A long series of reflections and repeating echo sequences indicates the stability of the duct.

The **SPER instrument** (SINP Moscow State University) is designed to measure fluxes of charged particles of magnetospheric origin, including electrons, protons, and alpha particles, over a broad energy range from 0.1 keV to 160 MeV. The **GALS instrument** (IPG of Roshydromet) detects electrons and protons with energies 0.15-600 MeV, while the **SG instrument** (SINP MSU) measures hard X-ray and gamma-ray radiation in the 0.02–10 MeV energy range associated with solar flares. The **Ozonometer instrument** (IKI RAN) is installed on the "Ionosfera-M3" and "Ionosfera-M4" to determine the distribution of ozone in the atmosphere. The **BKUSNI** (IKI RAN) is control and data-transmission unit for all scientific instruments.

Thus, the "Ionosonde" project provides a unique four-satellite system for studying the ionosphere and magnetosphere, including plasma processes, electromagnetic waves, energetic particles, and cosmic radiation. Scientific investigations based on "Ionosfera-M" data are coordinated by IKI RAN and have both fundamental and applied significance [2,3].

A public database is under development. Currently, "Ionosfera-M" data are available as case studies upon request from the project PI, M.M. Mogilevsky (mogilevsky_at_cosmos.ru).

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Article 5:

Beyond Detection: Mapping the Magnetic Field of the Sun's Far Side



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Operational space-weather forecasting requires magnetic information over the entire Sun. While the Earth-facing hemisphere is continuously monitored by magnetographs, the far-side has remained largely limited to indirect indicators of active regions (ARs). Helioseismic imaging can detect strong far-side ARs through phase perturbations of acoustic waves, but these measurements do not directly provide magnetic-field strength or polarity.

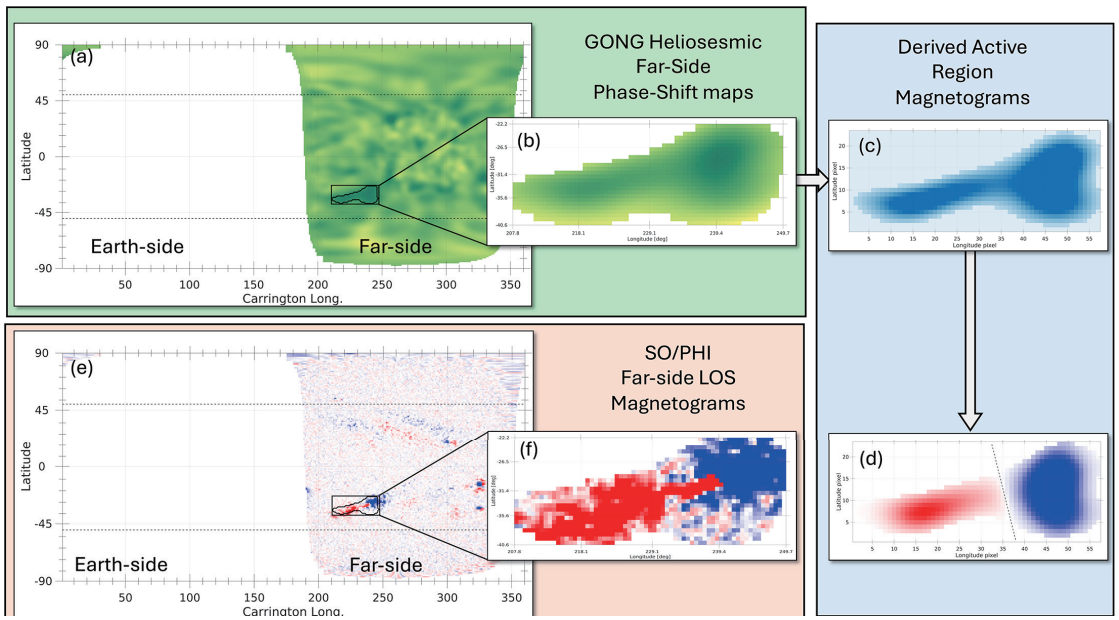


Figure 1. Reconstruction of polarity-resolved far-side magnetic-field maps from helioseismic observations. (a) GONG helioseismic phase-shift map showing the far-side coverage; (b) zoomed-in phase-shift signal for an active region; (c) estimated unsigned magnetic field derived from the calibrated phase-shift signal; (d) reconstructed signed magnetic field, with polarities assigned using the inferred bipolar structure and Hale's law; (e) co-temporal Solar Orbiter/PHI far-side line-of-sight magnetogram; and (f) a zoomed-in view of the corresponding region for observational comparison.

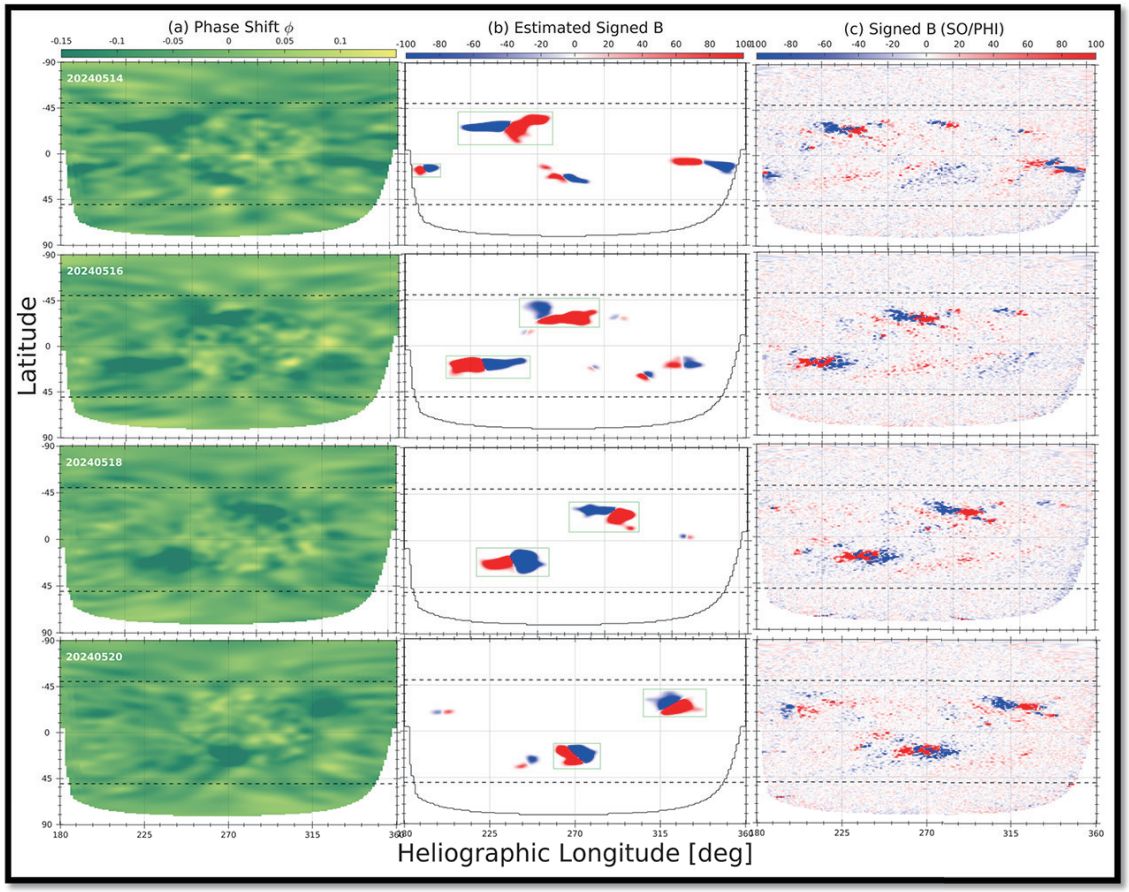


Figure 2. Evolution of the May 2024 active-region complex during its passage across the solar far-side. Each row compares the GONG helioseismic phase-shift map (left), the reconstructed polarity-resolved magnetic field derived from the helioseismic measurements (middle), and the corresponding co-temporal Solar Orbiter/PHI signed magnetogram (right). The sequence demonstrates that the helioseismic-based reconstruction can track the large-scale magnetic configuration and evolution of strong active regions while they are hidden from Earth.

In our recent study [1], we developed a framework for reconstructing **polarity-resolved far-side magnetograms from helioseismic measurements**. We combined far-side phase-shift maps from the Global Oscillation Network Group (GONG), AR masks identified by the machine-learning FASTARR model [2], and co-temporal line-of-sight magnetograms from Solar Orbiter/PHI during 2022–2024. Solar Orbiter provided the unique opportunity to directly validate magnetic structures on the hemisphere hidden from Earth.

We first established an empirical nonlinear calibration between the helioseismic phase shift and the unsigned line-of-sight magnetic field. Applying the inverse relation converts seismic signatures into estimated unsigned magnetic-field maps. To recover polarity, we analyzed the longitudinal variability within each FASTARR-detected far-side AR. We found that strong bipolar regions frequently exhibit a bimodal variance profile corresponding to two dominant magnetic concentrations. A tilt-aware Gaussian decomposition identifies their large-scale separation, while Hale's polarity law establishes the expected leading–trailing polarity ordering for Solar Cycle 25.

Applying this procedure automatically to the 2022–2024 dataset identified **190 polarity-ready far-side ARs**. For a representative region, the reconstructed signed magnetic field showed a **Spearman correlation of 0.718** with the co-temporal SO/PHI magnetogram, while the recovered magnetic polarity reached **90.8% accuracy** for pixels with $|B| \geq 20$ G. These results demonstrate that helioseismic observations contain information about the large-scale magnetic organization of strong far-side ARs, rather than merely revealing their presence.

We also examined the far-side passage of AR 13663 and ARs 13664/13668 following the extreme solar activity of May 2024. The reconstructed maps tracked the persistence and magnetic organization of these regions while they were invisible from Earth, as well as their subsequent fragmentation and reappearance.

This work represents an important step toward **continuous 360° magnetic monitoring of the Sun**. Our longer-term goal is to generate low-latency, polarity-resolved far-side maps from the ground-based GONG network at six-hour cadence and combine them with near-side magnetograms. Such full-Sun magnetic boundary conditions could provide improved inputs for coronal and solar-wind models and, ultimately, more complete information for operational space-weather forecasting.

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Highlight on Young Scientists 1:

Understanding the Role of Source Surface Height and Magnetograms in Solar Wind Forecasting



Sandeep Kumar

Sandeep Kumar[1]
[1]**Udaipur Solar Observatory/ Physical Research Laboratory, Ahmedabad, India**

The potential field source surface (PFSS) model forms the basis of many state-of-the-art space weather forecasting frameworks (Kumar et al. 2025). Essentially, PFSS takes the photospheric magnetic field, and uses it to extrapolate the magnetic field into the solar corona. This requires the assumption of only a single parameter: the radial distance of the "source surface", a fictitious sphere that separates the radial magnetic field of the solar wind from the structured magnetic field of the photosphere. Traditionally, a fixed SS height of 2.5 $R_\odot$ has been adopted in most studies.

Our recent study has demonstrated that the SS height in the PFSS model plays an important role in solar wind velocity forecasting at L1 (Kumar et al. 2025). This study employed two types of Global Oscillation Network Group (GONG) synoptic magnetic field maps, namely, standard (STD) and zero-point-corrected (ZPC) maps, over selected periods of solar cycles (SCs) 24 and 25. We also reported that the improved performance of the framework for ZPC maps as compared to the STD full Carrington maps, can be attributed to its capability to capture the global magnetic field. This was further confirmed by comparing the extrapolated global magnetic field structures with the large-scale corona observed in the extended field of view of the PROBA2/ SWAP images as shown in Figure 1.

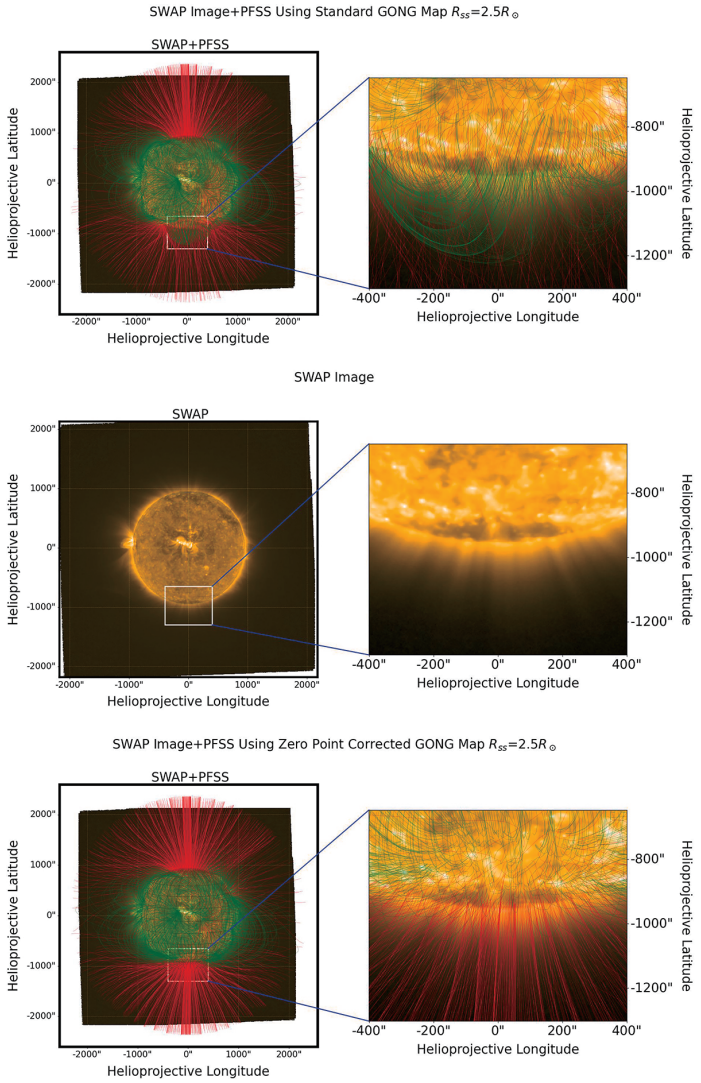


Figure 1. PFSS extrapolated magnetic field lines overlaid on the SWAP (top and bottom panel) image of 20 August 2017, 10:45 UT. The middle panel shows the SWAP mosaic without PFSS extrapolation. The top left panel shows PFSS extrapolation with HU STD map, and the bottom left panel with HU ZPC map (on 20 August 2017, 12:14 UT). The right column shows the zoomed-in version of the white rectangle on the left panels.

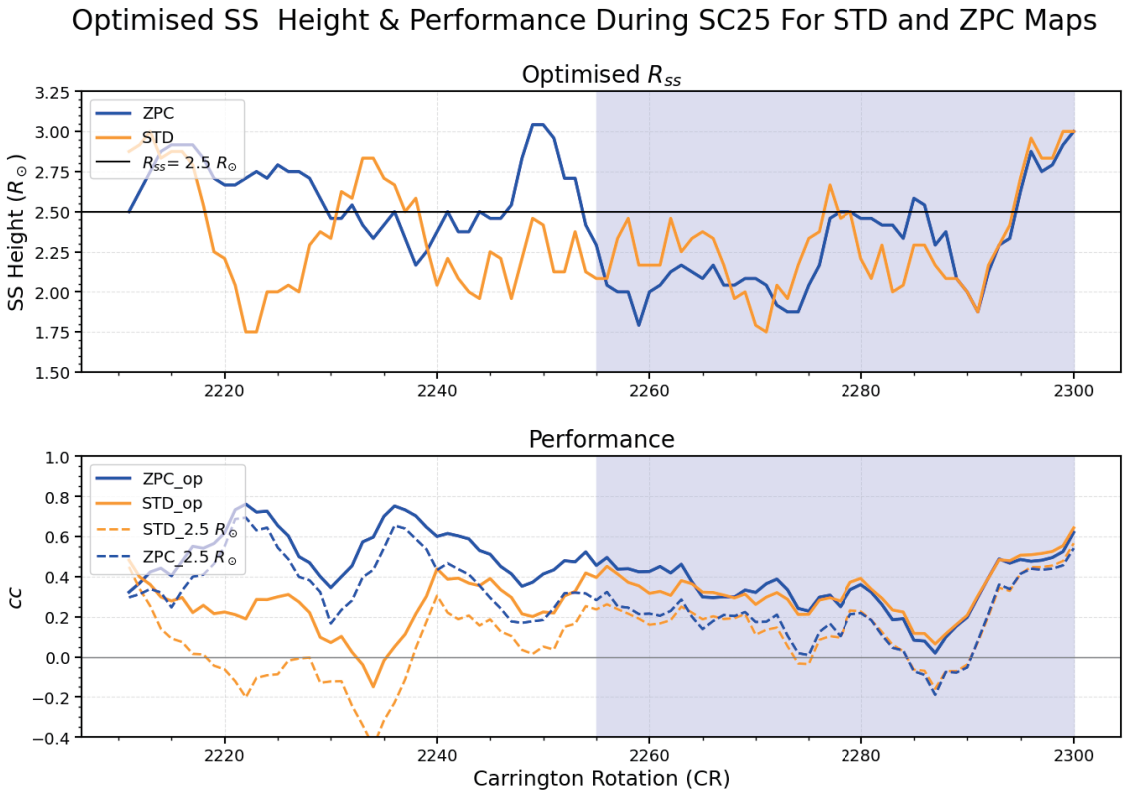


Figure 2. Optimized SS height and the corresponding performance (cc), given by Pearson's correlation coefficient between observed and simulated SW velocity profile at L1, of the framework for ZPC and STD maps during SC25. Top panel shows running average of 6 CR of the optimized SS height. Bottom panel shows the 6 CR running average of the performance of the framework. The solid blue and orange lines correspond to the performance of the optimised SS height for ZPC and STD maps, respectively, and the dashed lines show the corresponding performance for conventional SS height.

In the subsequent study, we did a comprehensive analysis of SC 23, 24, and 25, using 254 CRs from GONG magnetograms and 204 CRs from SDO/HMI magnetograms (Kumar et al. 2026). For each CR, eight SS heights ranging from 1.5 to 3.25 $R_\odot$ are tested using a PFSS–WSA–HUX modelling framework, and the predicted solar wind speeds are compared with OMNI observations at L1 using the Pearson correlation coefficient.

The results show that the optimal SS height varies systematically with solar activity. During the ascending and declining phases of the solar cycles, higher SS heights, generally above 2.5 $R_\odot$, provide better agreement with observations, whereas lower SS heights are preferred during solar maximum (Figure 2). Further our results show that GONG ZPC and HMI provide comparable solar wind forecasting performance and generally outperform the GONG STD maps.

Our adjusted PFSS radii clearly improve solar-wind speed forecasts. However, the assumption of a spherical source surface limits further improvements. Future models that move beyond this assumption could provide substantially greater forecast improvements.

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1. Kumar S, Srivastava N, and Talpeanu D, 2026, Source Surface Height Optimization for Improved Solar Wind Velocity Forecasting across Solar Cycles 23, 24, and 25, ApJ 1006 26, DOI 10.3847/1538-4357/ae7bf7

2. Kumar S, Srivastava N, Talpeanu D, Mierla M, D'Huys E, et al. 2025. On the role of source surface height and magnetograms in solar wind forecast accuracy. J. Space Weather Space Clim. 15, 24. https://doi.org/10.1051/swsc/2025021.

Highlight on Young Scientists 2:

A Multi-Instrument Approach to Low- to High-Latitude Ionospheric Coupling: EIA–Auroral Oval Interaction During the May 2024 Storm

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Yamila Daniela Melend

During my research stay at NASA's Goddard Space Flight Center (GSFC), as part of the SCOSTEP Visiting Scholar (SVS) Program, I focused on combining observations from ground-based instruments and satellite missions to investigate ionospheric dynamics across a broad range of latitudes. As a case study, we selected the 10–12 May 2024 geomagnetic storm, one of the most intense events of Solar Cycle 25, which has been extensively studied due to its extreme intensity and wide range of ionospheric responses. Among the phenomena observed during this event, the apparent interaction between the southern crest of the Equatorial Ionization Anomaly (EIA) and the auroral oval provides an opportunity to examine coupling between low- and high-latitude ionospheric structures. Here, we focus on the observational signatures and temporal evolution of this apparent merging over South America.

Figure 1 shows one of the multi-instrument observations considered in this study. At 23:23 UT, GOLD observations show an enhanced ionospheric density structure extending over southern South America. This is followed by an enhanced TEC region at 23:40 UT, identifying the southern EIA crest across central Argentina (upper arrow). Simultaneously, the Río Grande all-sky imager records intense 630.0 nm emission extending to unusually low latitudes, with the signature remaining active at 00:04 UT (lower arrow), consistent with the equatorward expansion of the auroral oval. Together, GOLD, TEC, and the all-sky imager provide complementary views of the same evolving ionospheric configuration, offering evidence of the apparent EIA–auroral oval merging and its evolution over South America.

We thank NASA/GOLD and the GOLD mission science team, and Carlos Martinis (Center for Space Physics, Boston University), for providing the GOLD and Río Grande all-sky imager data, respectively.

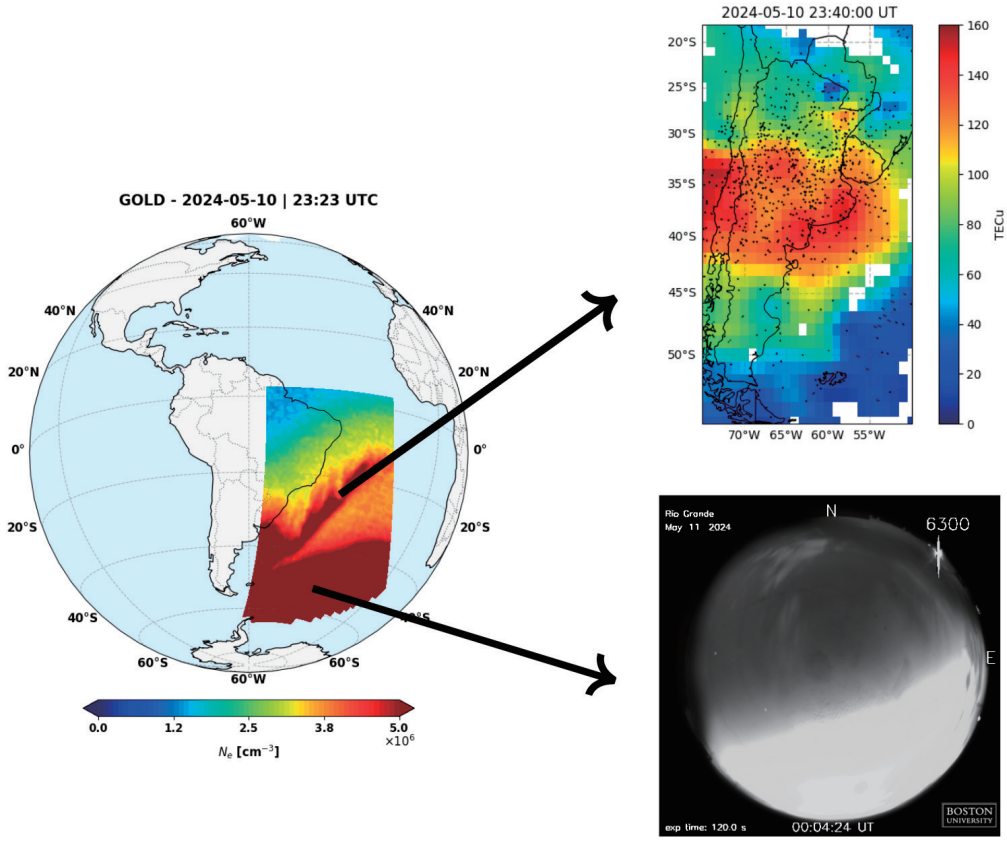


Figure 1. GOLD observations showing the interaction between the Equatorial Ionospheric Anomaly (EIA) and the auroral oval. Top right: EIA visualization using Total Electron Content (TEC). Bottom right: Auroral oval imaged by an All-Sky Imager in the red-light filter located at Río Grande (Argentina).

Highlight on Young Scientists 3:

Investigating Seeding of Postmidnight Irregularities in the South Asian Sector


B Gayathri

B Gayathri[1] and Yuichi Otsuka[2]
[1]Indian Institute of Geomagnetism, Navi Mumbai, India
[2]Institute for Space-Earth Environmental Research (ISEE), Nagoya University, Japan

Ionospheric irregularities are large scale plasma density depletions that develop mostly in the equatorial region. These irregularities play a crucial role in adversely affecting the satellite-based communication and navigation systems. Recent studies primarily interested in identifying the seed perturbations responsible for the initiation of post-midnight field-aligned irregularities (FAIs). These irregularities have been observed predominantly during the summer months under low solar activity conditions in the equatorial and low-latitude region (Otsuka et al., 2018).

In this study, we investigated the seed perturbations associated with post-midnight FAIs near the magnetic equator as a case study. FAI observations were obtained using the 47 MHz Equatorial Atmosphere Radar (EAR), located in West Sumatra, Indonesia (0.20°S, 100.32°E; dip latitude 10.36°N). The post-midnight FAI backscatter structures extending from approximately 200 to 400 km in altitude were observed between 01:30 and 05:00 LT on 11 August 2019. Simultaneous Total electron content (TEC) perturbations were observed by a network of Global Position System (GPS) receivers distributed across Sumatra, Indonesia, known as Sumatran GPS Array (SuGAr) near the EAR site as shown in Figure 1(a). Figure 1(b) illustrates the TEC perturbations are observed between 00:00 and 01:00 LT just prior to the occurrence of post-midnight FAI structures.

Two-dimensional (2D) detrended total electron content (DTEC) maps were used to investigate the propagation characteristics of these TEC wave-like perturbations. The results show that the TEC perturbations propagated in the northeastward direction as shown in Figure 1(c). This propagation direction is distinct from the southwestward propagation commonly reported for FAIs and medium-scale traveling ionospheric disturbances (MSTIDs) (Otsuka & Ogawa, 2009). The distinct propagation characteristics, together with the occurrence of the TEC perturbations prior to the FAI structures, suggest that these perturbations may serve as seed perturbations for the freshly generated post-midnight irregularities. However, the physical mechanism responsible for the generation and propagation of these wave-like TEC perturbations require further investigation.

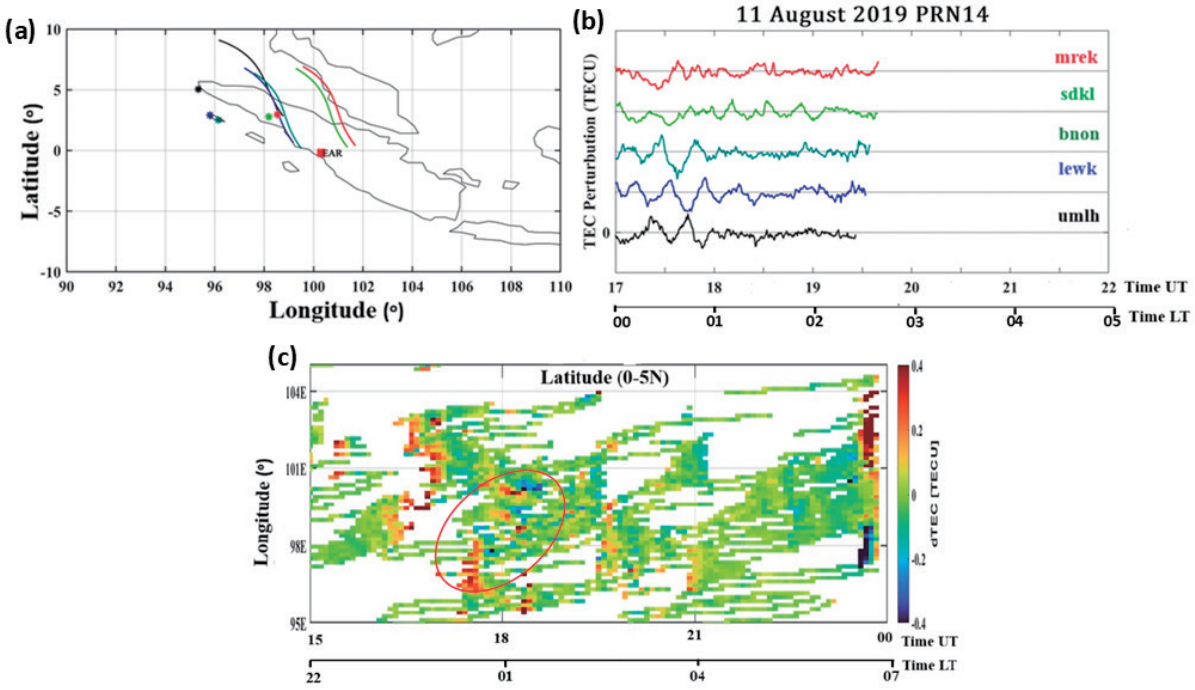


Figure 1. (a) shows the satellite passes observed from the northern receivers located near the EAR site. (b) shows the wavy TEC perturbations observed by all five receivers during 17:00 – 18:00 UT (00:00 – 01:00 LT) on 11 August 2019. (c) TEC perturbations at a fixed northern latitude. The eclipse shows the northeastward propagation.

References:

Otsuka, Y., & Ogawa, T. (2009). VHF radar observations of nighttime F-region field-aligned irregularities over Kototabang, Indonesia. I*n Earth Planets Space* (Vol. 61).

Otsuka, Y. (2018). Review of the generation mechanisms of post-midnight irregularities in the equatorial and low-latitude ionosphere. In Progress in *Earth and Planetary Science* (Vol. 5, Number 1). Springer Berlin Heidelberg. https://doi.org/10.1186/s40645-018-0212-7

Acknowledgements:

I sincerely thank SCOSTEP and ISEE, Nagoya University, for funding this visit and providing the necessary infrastructure and support for this work. I would like to express my special thanks to Professor Yuichi Otsuka for his valuable guidance, support, and encouragement throughout this work.

Meeting Report 1:

The 7th IMAOC School on "Artificial Intelligence for Space Weather," Tunis, June 15–26

Ahmed Ammar[1], Mohamed Hedi Riahi[1] and Mme Manel Madhioub[1]
[1]ESPRIT School of Engineering, Tunis, Tunisia


Ahmed Ammar


Mohamed Hedi Riahi


Mme Manel Madhioub

The 7th edition of IMAOC brought together participants from 3 European countries and 11 African countries. *21 students from Algeria, Burkina Faso, Cameroun, Côte d'Ivoire, Guinea, Morocco, Senegal, RDC, Tchad and *26 students from Tunisia and 2 from Egypt.

The training was conducted by professors from Burkina Faso, France, Italy, Senegal, and Tunisia.

Three scientific topics were primarily selected :

1.Solar activity and geomagnetism

2.Solar wind, magnetosphere, ionosphere coupling

3.Variations in ionospheric ionization (TEC)

The second major component focused on artificial intelligence and machine learning.

*Mornings were devoted to lectures, and afternoons to lab work. The students worked in small groups on assigned topics. The groups consisted of physicists of GIRGEA (www.girgea.org), mathematicians and computer scientists from the ESPRIT school.



Photo 1. Group photo from the IMAOC7 school

*In addition to the main scientific programme of the summer school, a complementary workshop entitled **"Fundamental Deep Learning"** was organized during the IMAOC 7 programme

Outreach :

* June 21st : Public conference on Space Weather at the City of Science of Tunis

* June 23rd : Radio on Climate and Intelligence artificial

Meeting Report 2:

The 18th workshop "Solar influences on the Magnetosphere, Ionosphere, and Atmosphere" in Primorsko, Bulgaria


Katya Georgieva

Katya Georgieva[1]
[1]**Space Climate Department, Space Research and Technology Institute of the Bulgarian Academy of Sciences, Sofia, Bulgaria**

The 18th workshop "Solar influences on the Magnetosphere, Ionosphere, and Atmosphere" was held in Primorsko, Bulgaria during June 8-12, 2026. 81 participants from 16 countries made 54 oral and 29 poster presentations, most of which (after the authors' consent) will be freely available online at the meeting's website https://www.spaceclimate.bas.bg/ws-sozopol/. Papers based on these presentations have been published after peer review in the Workshop's Proceedings which are freely available online from the meeting's website, and already have SJR (0.19) and Q4-range. 12 young scientists took part in the Workshop, all of which made presentations


Photo 1. A group photo of the participants.

During the Workshop, a Special Session on the China Space Station (CSS) was organized during which the participants were informed about the program and the possibilities to participate with instrumentation and experiments in it. Dr. Babatunde Rabiu from Nigeria, who is the African coordinator for ISWI, discussed the possibilities for more African scientists to participate in the future editions of the Workshop.

Meeting Report 3:

The 12th SCAR Open Science Conference in Oslo, Norway


Wojciech J. Miloch

Wojciech J. Miloch[1]
[1]**University of Oslo, Oslo, Norway**

The SCAR Open Science Conference was held between 10-14 August in Oslo, Norway. SCAR stands for Scientific Committee on Antarctic Research. The conference had more than 1400 registered participants from all disciplines related to the Antarctic research. The Antarctic Geospace and ATmosphere reseArch (AGATA) Scientific Research Programme of SCAR organized several dedicated sessions and two workshops to gather community working within the topic. More than 100 scientists participated in the AGATA events, and many of them were early career researchers. During the AGATA related sessions, results from recent upper atmosphere and space studies over the polar regions were discussed. We have also started planning future activities within the geospace research, in particular for the International Polar Year 2032-33. AGATA thanks SCOSTEP / COURSE for providing support to several young researchers and for helping in making this meeting a successful one.



Photo 1. A group photo of the participants.

The group photo was taken spontaneously after the AGATA Business Meeting on 9 August, on Sunday evening before the start of the main conference.

Upcoming meetings related to SCOSTEP

Conference	Date	Location	Contact Information
Alliance Meeting	Oct. 19-21, 2026	Rome, Italy	https://indico.ict.inaf.it/event/3628/overview
The XXIst IAGA Workshop on Geomagnetic Observatory Instruments, Data Acquisition and Processing	Oct. 25-30, 2026	Ishioka, Japan	https://kakioka2026.org/
European Space Weather Week 2026	Nov. 2-6, 2026	Florence, Italy	https://esww2026.eswan.eu/
The 9th Asia-Oceania Space Weather Alliance meeting	Nov. 8-11, 2026	Tainan, Taiwan	https://aoswa.nict.go.jp/meetings/index.html
Sun-Earth connection through stellar analogs	Nov. 9-12, 2026	Graz, Austria	https://lively-stars.uni-graz.at/de/neuigkeiten/upcoming-event-scostep-course-nov-2026/
AGU Fall Meeting 2026	Dec. 7-11, 2026	San Francisco, CA USA	https://www.agu.org/annual-meeting
10th HEPPA-SOLARIS Workshop	Jan. 11-15, 2027	Dunedin, New Zealand	https://events.hifis.net/event/4134/
IUGG General Assembly (with SCOSTEP General Council meeting)	Jul. 16-22, 2027	Incheon, Korea	https://iugg2027korea.org/
AOGS2027	Jul. 25-30, 2027	Marina Bay Sands, Singapore	https://www.asiaoceania.org/AOGS2027/default.aspx

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

Announcement 1:

SCOSTEP 2026 Distinguished Scientist Award

SCOSTEP is pleased to announce that the
2026 Distinguished Scientist Award is given to


Michael Lockwood

Prof. Michael Lockwood, FRS
University of Reading, UK

Citation: His research has fundamentally advanced our understanding of the coupled Sun-Earth system, from the basic physics of magnetic reconnection and magnetosphere-ionosphere coupling to long-term solar variability, space climate, and the influence of solar activity on the Earth's environment. At the same time, he has provided outstanding scientific leadership, mentored generations of researchers, and made lasting contributions to the international solar-terrestrial community

Prof. Michael Lockwood is one of the worldwide leaders in solar-terrestrial physics. His research has fundamentally advanced our understanding of the coupled Sun-Earth system, from the basic physics of magnetic reconnection and magnetosphere-ionosphere coupling to long-term solar variability, space climate, and the influence of solar activity on the Earth's environment. Many of his discoveries have become so deeply embedded in solar–terrestrial physics that they are now part of the way the subject is routinely taught and understood. Across multiple fields, he has consistently combined physical insight, rigorous analysis, innovative use of observations, and last but not least, a remarkable ability to connect phenomena across the entire Sun-Earth system.

One of the first major discoveries of Prof. Lockwood was the identification of the cleft ion fountain using observations from the Dynamics Explorer spacecraft. Then he fundamentally changed the interpretation of incoherent scatter radar observations (including EISCAT) by demonstrating the importance of non-Maxwellian ion velocity distributions produced through ion-neutral collisions during strong plasma convection. His influential pioneering contributions to understanding magnetic reconnection and the transfer of solar-wind energy into geospace were of primary importance. Among others he played a leading role in establishing the observational basis for the modern understanding of transient magnetic reconnection through flux transfer events. His work identified their ionospheric signatures, quantified the magnetic flux transferred during individual events, and developed methods to infer reconnection rates directly from cusp ion observations. Another important contribution was his work, together with S. Cowley and colleagues, on what has become known as the Expanding-Contracting Polar Cap (ECPC) paradigm This elegant framework fundamentally changed how the community interprets ionospheric convection. In the area of solar/heliospheric variability, he demonstrated that the Sun's open magnetic flux approximately doubled during much of the twentieth century, fundamentally changing scientific understanding of long-term solar variability. This discovery stimulated an entirely new generation of investigations into secular solar change and its implications for heliospheric conditions. He also developed physically based methods for reconstructing the heliospheric magnetic field, open solar flux, and solar-wind properties over centuries by combining geomagnetic observations, cosmogenic isotope records, and modern spacecraft measurements. He has played a leading role in establishing what is now recognised as the field of space climate. His work has always been characterised by careful physical reasoning and, particularly, by a talent for extracting new insight from diverse observations.

It is necessary to mention his dedication to mentoring the next generation of scientists. He has supervised or co-supervised more than thirty doctoral students, the overwhelming majority of whom have gone on to successful scientific careers, many now occupying senior leadership positions in universities, research institutes, and space agencies around the world. Colleagues and former students know him as an exceptionally generous collaborator, an insightful mentor, and a scientist who combines intellectual rigour with genuine enthusiasm for discovery.

Announcement 2:

SCOSTEP 2026 Distinguished Young Scientist Award

SCOSTEP is pleased to announce that the
2026 Distinguished Young Scientist Award is given to


Dai Koshin

Dr. Dai Koshin
International Research Center for Space and Planetary Environmental Science,
Kyushu University, Fukuoka, Japan

Citation: Dr. Dai Koshin is a very talented young scientist. He played a key role in generating the first whole atmosphere reanalysis JAWARA. Prior reanalyses had upper boundaries at no more than ~60 km, preventing their use for studying the mesosphere and lower thermosphere (MLT), whereas JAWARA goes all the way from surface throughout the lower thermosphere. Also his scientific contributions to advancing understanding of middle and upper atmosphere variability is important.

Dr. Koshin developed already as a PhD student JAGUAR-DAS, a whole atmosphere data assimilation system; only a few groups worldwide developed such systems due to their complexity. Then he generated JAWARA, the first whole atmosphere reanalysis, and made it publicly available to the research community in the early 2025 (https://doi.org/10.17592/002.2025010407). JAWARA represents a milestone community resource, and it is thanks to Dr. Koshin's efforts that the scientific community now has a reanalysis that extends from the surface all the way to the lower thermosphere. JAWARA filled a critical community gap, and is already having a significant impact that is only going to grow in the future. However, he not only developed JAWARA. He has significantly advanced knowledge of interhemispheric coupling between the stratosphere and the mesosphere and lower thermosphere (MLT region), developing new understanding of the dynamical processes that couple variability in the high-latitude stratosphere to MLT variations in the opposite hemisphere. He has also elucidated the role of gravity waves in driving the lower thermosphere circulation, an important circulation that impacts upper thermosphere composition and dynamics. He showed that gravity waves generated at higher altitudes, which are typically neglected in low-resolution simulations, play a role in driving the lower thermosphere circulation, demonstrating the need to account for wave generation at higher altitudes to accurately capture the lower thermosphere circulation.

Dr. Koshin received the Meteorological Society of Japan Matsuno Award in 2020, and Japan Society for the Promotion of Science Overseas Research Fellowship in 2024.

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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