



ABSTRACT BOOKLET



FIRST WORKSHOP ON SUN AND SPACE WEATHER

28 SEPTEMBER – 2 OCTOBER 2026
Antalya, Türkiye

Table of Contents

Day 1 Morning Presentations	4
SESSION 1: Cyclic behaviors of solar and geomagnetic activity	4
OPENING REMARKS	4
1.1 K. Mursula: What happens during a Gleissberg cycle and why?	5
1.2 V. Bezrukovs: Novel Approaches to Solar Flare Forecasting and Space Weather Monitoring: Results from the FLARE and IONEX Projects	5
1.3 H. S. Mohamed: Impact of F10.7 Flux and Proton Intensity on Delayed Ionospheric TEC Responses at Low Latitudes During Geomagnetic Storms Across Solar Cycles 23–25	6
LUNCH	6
Day 1 Afternoon Presentations	7
SESSION 2: Solar and geomagnetic activity prediction – I	7
2.1 J.-P. Rozelot: The crucial role of the leptocline in improving predictions of solar activity	7
2.2 K. Gerçeker: Assessing the Short-Term Predictability of Daily Space Weather Indices with Simplex Projection	8
Day 2 Morning Presentations	8
SESSION 3: Solar and geomagnetic activity prediction – II	8
3.1 K. Ryu: Korea's Space Environment Missions Advancing from LEO, GEO, Cis-Lunar, L4, and Beyond: Current Status and Future Plans	9
3.2 N. Karapınar: Automated Umbra–Penumbra Delineation and Machine-Learning-Based McIntosh Classification of Sunspot Groups	11
LUNCH	11
Day 2 Afternoon Presentations	11
SESSION 4: Eruptive solar phenomena (Flares, CMEs, SEPs, Shocks) – I	11
4.1 P. Devi: Relationship of prominence eruptions with CMEs and their dependence on Solar Cycle	11
4.2 N. Gopalswamy: Double-whammy Space Weather Events in the SOHO Era	12
TEA BREAK	12
4.3 S. Yashiro: White-Light Emissions in Gamma-Ray Solar Flares	13
4.4 P. Mäkelä: Durations of solar hard X-ray bursts with and without an associated coronal mass ejection	13
POSTER SESSION	13
Day 3 Morning Presentations	13
SESSION 5: Eruptive solar phenomena (Flares, CMEs, SEPs, Shocks) – II / Propagation of CMEs in the Heliosphere	13
5.1 N. Gopalswamy: The association rates of type II bursts and large solar energetic particle events in CME populations	14
5.2 M. Tirnakci: The Role of Impact Parameter in Forbush Decrease Profiles	15
5.3 H. Bhati: Study of ICME-ICME interactions, ICME-in-sheath and associated GLE 77 during 11-12th Nov 2025	16
TEA BREAK	16
5.4 S. Akiyama: A Comparative Study of CME and PEA Properties in Quiescent Filament Eruptions with and without SEP Events (1996–2025)	16
5.5 R. Joshi: Solar Flare Ribbons at Unprecedented Resolution	17
FREE TIME	17
Day 4 Morning Presentations	17
SESSION 6: Response of the Magnetosphere to the Impact of CMEs and Stream Interaction Region / Magnetosphere–Ionosphere–Thermosphere coupling – I	17
6.1 P. Koucká Knížová: Sporadic E Behavior over Central Europe during a Geomagnetically Quiet Period in 2019	18
6.2 S. O. Lomotey: First Results from a Low-Cost GNSS VTEC Monitoring Station: Evaluation Against IRI and AfriTEC over ACCRA, Ghana	19
TEA BREAK	19
6.3 O. Kryakunova: On solar sources of interplanetary disturbances before the high-energy magnetospheric electrons enhancements	19
LUNCH	19

Day 4 Afternoon Presentations	20
SESSION 7: Magnetosphere–Ionosphere–Thermosphere coupling – II	20
7.1 V. Truhlik: Performance of the IRI Model during Quiet Space Weather Periods at Swarm Altitudes and First Results on the Inclusion of Atmospheric Wave Indices	21
7.2 W. Ward: Knowledge Gaps in the Mesosphere and Lower Thermosphere: Potential Keystone Contributions . .	21
Day 5 Morning Presentations	21
SESSION 8: Space weather effects on technological systems – I	21
8.1 F. İnceoğlu: Space Weather and Machine Learning: What Works and What Does Not	22
8.2 K. Kazeem: Effects of Geomagnetic Storms on NmF2 over Ouagadougou during the Descending Phase of Solar Cycle 22	23
8.3 V.B. Belakhovsky: The analyses of the sources of extreme geomagnetically induced currents in power lines based on observations over 11 years	24
TEA BREAK	24
8.4 V. Dobrica: Assessing geoelectric hazard over Romania during extreme geomagnetic storms in March 1989, November 2003 and May 2024	24
8.5 F.O. Grodji: A study of solar flare effects on the geomagnetic field elements during solar cycles 23 and 24 . . .	25
LUNCH	25
Day 5 Afternoon Presentations	25
AFTERNOON SESSION	25
CLOSING REMARKS	25
Poster Abstracts	26
POSTER SESSION – Tuesday, 29 September 2026, 17:00–19:00	26
P1 E. Özüzenciler: Fine Structure of the Ellerman Bombs	26
P2 S. Aydın: Relationships Between Average Monthly CME Speed, Solar Wind Speed, and Galactic Cosmic Ray Counts During Solar Cycles 23, 24, and 25	27
P3 M. A. Calisir: Dependence of Umbral Dot Physical Properties on Magnetic Field Strength and Inclination in Eight Umbral Cores	27
P4 N. Karapinar: Quantifying sunspot group nesting with density-based unsupervised clustering	28
P5 Z. F. Bostancı: Long-term Solar Photospheric and H α Observations at Istanbul University Observatory	29
P6 H. Jain: Automated Multi-Wavelength Detection and Characterization of Solar Activity Features Using Kodaikanal Solar Observatory Data	29
P7 H. Jain: Long-Term Multi-Wavelength Solar Activity Datasets from the Kodaikanal Solar Observatory: Enabling AI-Driven Space Weather Research	30
P8 H. Atasoy: From Magnetic Reconnection to Geomagnetic Impact: CME–Shock-Driven Type II Radio Bursts and Their Space Weather Effects	31
P9 S. Makhtich: Stellar Space Weather and Its Impact on Exoplanetary Atmospheres and Habitability	32
P10 B. B. Seifullina: Comparative Analysis of the Large Forbush Decreases of June 2025 and January 2026 Using Data from the AATB Neutron Monitor	32
P11 V. Dobrică: Oscillatory features of the heliosphere-magnetosphere environment	33
P12 I. V. Despirak: Supersubstorms in strong magnetic storms of the 25th solar cycle	33
P13 D. Kouba: Peculiar Sporadic E Structures Observed during Enhanced Geomagnetic Activity	34
P14 A. Shafaani: Spatial and temporal variations of ionospheric irregularities over Africa using Swarm satellites . .	35
P15 A. A. Kassamba: Estimating the daytime vertical E $\times$ B drift velocities in the F-region of the equatorial ionosphere using the IEEY and AMBER magnetic data in West Africa	35

Day 1 | Morning Presentations

Sep 28th, 10:15 – 11:50

SESSION 1: Cyclic behaviors of solar and geomagnetic activity

Chair: XX YY

OPENING REMARKS

Time 10:15-10:30

What happens during a Gleissberg cycle and why?

ID: 1.1

Time 10:30–11:10

Invited Talk

Kalevi Mursula¹

¹ *Space Climate Group, Space Physics and Astronomy Research Unit, University of Oulu, Oulu, Finland*

Gleissberg cycle is a roughly centennial quasi-cyclicity, which has been observed, e.g., in sunspots, various solar lines and indices, auroras, geomagnetic activity, magnetic storms, ionospheric parameters and cosmogenic isotope data. The latest Gleissberg cycle (GC), now called the Modern Maximum (MM), was the strongest among the three GCs included in the sunspot number series, varying the sunspot cycle heights by a factor of more than 2.5. While the changes in the Sun during the solar cycle are mostly quite well known, the Gleissberg cycle is often not even considered to be a valid cyclicity, only a manifestation of rather randomly changing emerging magnetic fields, where the mutual relations between the various solar parameters would remain intact or depict random variation.

Although sunspots are regions of strongest magnetic fields, the weaker magnetic elements dominate by far the solar surface magnetism. Therefore, our view of long-term solar magnetic variability would be incomplete if it was only based on sunspots. Since solar EUV emissions are mainly produced in the moderately-strong magnetic elements of chromospheric plages, the proxies of solar EUV irradiance can give information about the long-term evolution of the chromosphere. Independent long-term measurements of solar magnetic fields of different strength can give new, interesting information about the evolution of the structure of solar magnetic fields over a Gleissberg cycle.

We have recently found systematic differences in the temporal evolution of several direct and indirect solar EUV proxies and sunspots during the last 130 years, covering the whole Modern Maximum. Our results show that the evolutions of strong (sunspots) and moderate (plages) magnetic field elements over the Modern Maximum are different so that relatively less of EUV was emitted in the MM growth and maximum phases than expected based on sunspots, while relatively more EUV was emitted during the last 3-4 solar cycles.

These results are further supported by a recent independent finding that CME storms were relatively more frequent than HSS/SIR storms in the MM growth and maximum phase, while the relative occurrence of HSS/SIR storms increased with respect to CME storms in the MM decay phase. All these changes indicate systematic differences in the relative amounts of sunspots and plages on solar surface over the Gleissberg cycle.

We review these results and discuss the consequences of our results to solar driving of the ionosphere and to the long-term variation of the spot-facula ratio and the stellar evolution of the Sun and Sun-like stars. We will also explain how the existence of the Gleissberg cycle can be understood in terms of relic or fossil magnetic fields in the Sun.

Novel Approaches to Solar Flare Forecasting and Space Weather Monitoring: Results from the FLARE and IONEX Projects

ID: 1.2
Time 11:10–11:30
Contributed Talk

Vladislavs Bezrukovs

Ventspils University of Applied Sciences, Engineering Research Institute "Ventspils International Radio Astronomy Centre" (VIRAC), Latvia

Reliable forecasting of solar flares and characterization of extreme space-weather events remain among the major challenges in contemporary solar-terrestrial physics. This presentation provides an overview of the ongoing Latvian Science Council project FLARE (Novel Proxies and Approaches for Solar Flare Forecasting, 2025-2027) and the newly launched project IONEX (Characterisation of Extreme Space Weather Effects on the Ionosphere, 2026-2029).

Within FLARE, we investigate novel observational, theoretical, and data-driven approaches for identifying short-term flare precursors. Particular attention is devoted to the analysis of EUV intensity fluctuations in active regions, application of machine-learning techniques to solar datasets, studies of magnetohydrodynamic wave phenomena, and development of new radio-astronomical diagnostics relevant for flare forecasting. Recent results demonstrate that statistical properties of EUV intensity variations and time-domain anomaly detection methods provide promising new tools for identifying flare-prone active regions.

The presentation also highlights recent developments of the solar-monitoring infrastructure at the Ventspils International Radio Astronomy Centre (VIRAC), including automated observations with the RT-32 radio telescope, implementation of new solar imaging workflows, microwave monitoring of active regions and coronal holes, and exploitation of the LOFAR-Latvia station for studies of solar radio bursts and ionospheric effects.

The second part of the presentation introduces the IONEX project, which focuses on the investigation of extreme space-weather effects on the ionosphere using a multi-instrument approach combining LOFAR observations, geomagnetic measurements, and cosmic-ray data. Particular emphasis is placed on the response of the ionosphere to solar flares, coronal mass ejections, geomagnetic storms, and solar eclipses.

Together, these activities establish a new observational and analytical framework for studying the chain of processes connecting solar activity, heliospheric disturbances, ionospheric variability, and space-weather impacts on technological systems. The results contribute both to fundamental solar physics and to the development of future operational forecasting capabilities.

Impact of F10.7 Flux and Proton Intensity on Delayed Ionospheric TEC Responses at Low Latitudes During Geomagnetic Storms Across Solar Cycles 23–25

H. S. Mohamed^{a,b,}, Sampad Kumar Panda^c, O. M. Shalabiea^a, Christine Amory-Mazaudier^d, Hussein M. Farid^a, A. Mahrouse*

*^a Astronomy, Space Science and Meteorology Department, Faculty of Science, Cairo University, Giza, Egypt; ^b Canadian International College, Faculty of Engineering, Basic Science Department; ^c Department of Electronics and Communication Engineering, Koneru Lakshmaiah Education Foundation, Green Fields, Vaddeswaram, Andhra Pradesh-522302, INDIA; ^d Sorbonne Université, Ecole polytechnique, Institut Polytechnique de Paris, Université Paris Saclay, Observatoire de Paris, CNRS, Laboratoire de Physique des Plasmas (LPP), 75005, Paris, France; ^e Egypt-Japan University of Science and Technology, Egypt (*e-mail: heba.salah@aucegypt.edu)*

ID: 1.3

Time 11:30–11:50

Contributed Talk

There has been a growing interest in ionospheric delay as a crucial element in comprehending the impact of solar phenomena and geomagnetic storms on the ionosphere. This study investigates Total Electron Content (TEC) data collected from two International GNSS Service (IGS) stations: CUSV, Thailand (Geographic 13.74°N, 100.53°E), and COCO, Keeling Island (Geographic 12.19°S, 96.839°E). The investigation focuses on the geomagnetic storms during Solar Cycles (SC) 23, 24 and the early phase of Cycle 25. The ionospheric delay time is defined as the duration from the start of a geomagnetic storm to its peak effect on the deviation of TEC (DTEC) from the quiet time reference level. We found a relationship between the ionospheric delay time and the Disturbance Storm Time (Dst) index, with specific selection criteria applied to storm events to enhance the accuracy of this association. The lowest correlation is for COCO station during the declining phase of SC 23 with value 0.27 due to system errors and gaps. The highest value is CUSV station during the ascending phase SC 25 which is 0.89. High and statistically significant correlation values were observed across most cases and time periods, with the F10.7 flux imposing a direct influence on these relationships, which contradicts some prior research. Our research highlights the significant part that proton flux plays during these periods, as variations in logarithmic proton intensity across four distinct energy ranges (6.95 MeV, 16.40 MeV, 32.95 MeV, and 46 MeV) have influenced the correlation's linearity and its association with F10.7 flux at different stages of the Solar Cycle. Linear correlation equations were developed for each time period, revealing a linear relationship between the DTEC and the logarithm of the proton intensity across the four specified energy ranges. We report that the Lyman-alpha irradiance affects the DTEC linearly, characterized by a good correlation coefficient. The average ionosphere delay time varied by time period; the shortest delay time was observed during the declining phase of Solar Cycle 24, and the longest was during the early part of the declining phase of Solar Cycle 23.

LUNCH

Time 12:00-14:00

Day 1 | Afternoon Presentations

Sep 28th, 14:00 – 15:00

SESSION 2: Solar and geomagnetic activity prediction – I

Chair: XX YY

The crucial role of the leptocline in improving predictions of solar activity

ID: 2.1

Time 14:00–14:40

Invited Talk

Jean-Pierre Rozelot

Université Côte d'Azur, Nice, France

Understanding the subsurface dynamics of the Sun is crucial for building a complete picture of solar activity and developing new approaches to its monitoring. Observations from global and local helioseismology, combined with 3D radiative hydrodynamic simulations, reveal that the Sun's Near-Surface Shear Layer (NSSL), which spans the upper 35 Mm of the convection zone, has a distinct substructure known as the leptocline, in the first 8-10 Mm. This shallow layer is characterized by intensified turbulent convection and a sharp increase in rotational shear. We found that the radial gradient of solar rotation varies with the solar cycle, becoming more pronounced in regions of sunspot and active region formation. At mid- and low latitudes, these gradient enhancements below the leptocline align with the magnetic butterfly diagram, whereas within the leptocline itself, the latitudinal patterns are more complex, resembling the overlapping "extended" solar cycles observed in torsional oscillations. Understanding the leptocline's role in solar dynamics is crucial for refining models of solar magnetism and improving predictions of solar activity.

Assessing the Short-Term Predictability of Daily Space Weather Indices with Simplex Projection

ID: 2.2

Time 14:40–15:00

Contributed Talk

Kemalhan Gerçeker¹, Ali Kilcik¹

¹ Department of Space Sciences and Technologies, Faculty of Science, Akdeniz University, Antalya, Türkiye

Solar, heliospheric, and geomagnetic activity exhibit nonlinear and strongly time-dependent variations, making their short-term prediction challenging, particularly during rapidly changing conditions. In this study, we investigate the short-term predictability of daily space weather indices: the 10.7-cm solar radio flux (F10.7), interplanetary magnetic field (IMF) magnitude, and the geomagnetic aa index, using the Simplex Projection method. Each parameter was predicted independently using only its own historical record. The daily datasets extend from 1963 for F10.7, 1967 for IMF, and 1868 for aa. Model parameters were selected using a common 30-day validation period, and 7-day predictions were generated for 4–10 July 2026. The IMF predictions showed the most stable performance among the tested model configurations, whereas the aa predictions were strongly affected by the abrupt geomagnetic enhancement on 4 July. This event was substantially

underestimated by the selected aa model and accounted for a large fraction of the prediction error. A simultaneous sharp increase in IMF was also underestimated. For F10.7, the largest prediction errors occurred during the rapid decline following the high-activity interval rather than at a single isolated peak. Overall, the results indicate that Simplex Projection can reproduce gradual variations in daily solar, interplanetary, and geomagnetic activity, while abrupt changes and rapidly evolving conditions remain more difficult to predict.

Day 2 | Morning Presentations

Sep 29th, 10:30 – 11:30

SESSION 3: Solar and geomagnetic activity prediction – II

Chair: XX YY

Korea's Space Environment Missions Advancing from LEO, GEO, Cis-Lunar, L4, and Beyond: Current Status and Future Plans

ID: 3.1

Time 10:30–11:10

Invited Talk

Kwangsun Ryu

Satellite Technology Research Center, Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Republic of Korea (kwangsun@kaist.ac.kr)

Over the past two decades the Republic of Korea has extended its space environment programme outward, one orbital regime at a time. This presentation reviews the current status of the Korean missions that now populate low Earth orbit (LEO) and geostationary orbit (GEO), the first cis-lunar science mission under development, and the prospective Sun–Earth L4 observatory that would follow, together with the scientific rationale linking them.

At LEO, the Ionospheric Anomaly Monitoring by Magnetometer And Plasma-probe (IAMMAP) on board the Compact Advanced Satellite 500-3 (CAS500-3) has been in orbit since 27 November 2025 and has completed early operations. IAMMAP combines a Langmuir probe, an impedance probe that retrieves absolute electron density from the upper-hybrid resonance frequency independently of spacecraft potential and surface contamination, and the Adaptive In-phase Magnetometer (AIMAG), a low-noise fluxgate set. Flying a quasi-meridional sun-synchronous orbit, the suite is well matched to the joint study of the equatorial electrojet (EEJ) and the equatorial ionization anomaly (EIA); early data already resolve EIA electron density and temperature structures together with magnetic perturbations tracking EEJ intensity.

At GEO, the Korean Space wEather Monitor (KSEM) on GEO-KOMPSAT-2A has delivered continuous energetic particle, magnetic field, and spacecraft-charging measurements since 2018. Its successor KSEM-II is under development as the space weather payload of GEO-KOMPSAT-5 for launch in 2031, targeting both improved observational performance and domestic self-reliance in space weather instrumentation. It comprises proton and electron detectors, a charging monitor extended with a radiation dosimeter and a Segmented Electro-Static Analyzer for direct spacecraft-potential measurement, a magnetometer, a solar X-ray monitor

for early flare detection, and a data processing unit. The completed preliminary design consolidated requirements, sensor accommodation, spacecraft interfaces, and data architecture, with explicit traceability to operational warning indices.

Beyond GEO, Korea is planning its first deep-space science mission. The Space Science Explorer (< 500 kg) is to be injected directly into a lunar transfer orbit by the next-generation launch vehicle KSLV-III in 2031 and placed in an Earth–Moon 3:1 lunar resonant orbit (perigee $\sim 15 R_e$, apogee $\sim 50 R_e$, period ~ 9.1 days), an orbit class flight-proven by IBEX and TESS. Nine instruments — solar wind ion detector, low-energy electrostatic analyzer, heavy-ion composition analyzer, medium- and high-energy particle detectors, fluxgate and search-coil magnetometers, electric-field antenna, and EUV spectral imager — will deliver the first dedicated in-situ survey of the deep magnetotail beyond $40 R_e$, a region only sparsely sampled by MMS, Geotail, and ARTEMIS. Science goals address energy storage, release, and transport in the distant tail; Kelvin–Helmholtz growth at the magnetopause; heavy-ion entry and mass transfer; the cis-lunar plasma and radiation environment; cusp and polar-cap solar wind access; and remote EUV sensing of the corona. With 20–30% of each orbit in the undisturbed solar wind, driver and response are captured within a single revolution. After more than one year of magnetospheric survey the spacecraft transfers to a cis-lunar Lagrange point (L4, or alternatively L1/L2) to demonstrate deep-space navigation, communication, and long-duration operations.

A Korea-led Sun–Earth L4 mission has been studied as the natural continuation. Positioned 60° ahead of Earth and carrying a magnetograph, EUV imager, coronagraph, and heliospheric imager together with solar wind plasma, energetic particle, magnetic field, and dust instruments, it would offer a wide-angle view of the Sun–Earth line and, with existing and planned L1 and L5 assets, enable genuine multi-point heliospheric monitoring for CME and SEP forecasting in support of lunar and Mars exploration. The concept remains under study pending programmatic decisions, and the cis-lunar explorer is accordingly positioned as its technology demonstrator.

Taken together these missions describe a coherent national trajectory — from ionospheric monitoring at LEO, through operational space weather observation at GEO, to independent exploration of the cis-lunar magnetosphere and onward to heliospheric vantage points. In this talk, I summarize the development status of each element, the collaboration opportunities they open with MMS, SMILE, IMAP, and Vigil, and the technical and programmatic challenges ahead.

Automated Umbra–Penumbra Delineation and Machine-Learning-Based McIntosh Classification of Sunspot Groups

ID: 3.2
Time 11:10–11:30
Contributed Talk

Nurdan Karapınar

Department of Astronomy and Space Sciences, Graduate School of Natural and Applied Sciences, Ankara University

Sunspots are dark photospheres structures associated with strong magnetic fields and constitute fundamental observational tracers of solar activity. Reliable identification of their two principal morphological components—the darker umbra and the surrounding penumbra—is essential for quantitative measurements of sunspot area, morphology, and active-region complexity. Such measurements are also directly relevant to the automated classification of sunspot groups according to the McIntosh classification scheme.

In this work, an image-processing approach previously developed using the R programming language and the EBLImage package is revisited and proposed for implementation within a modern Python-based pipeline. The original implementation includes a Laplacian-based two-dimensional convolution, Gaussian blurring, grayscale conversion, adaptive thresholding, morphological opening, convex-hull filling, connected-component labeling, and intensity-propagation-based masking. These operations provide a foundation for separating sunspot structures from the photospheric background. The Python implementation will preserve this algorithmic core while adding explicit contour extraction, umbra–penumbra segmentation, and conversion of pixel areas into physical or standard solar area units.

In the second stage, quantitative image-derived descriptors—including total sunspot area, umbral area, penumbral area, the umbra-to-penumbra area ratio, perimeter, eccentricity, circularity, elongation, spot multiplicity, and within-group spatial descriptors—will be supplied to machine-learning models. The objective is to automatically estimate the Z, p, and c components of the McIntosh classification. The resulting framework therefore integrates image segmentation and supervised classification in a single reproducible pipeline.

The scientific relevance of the proposed approach is supported by recent developments in automated solar-image analysis. The 2023 SunSCC framework combined mathematical morphology and thresholding for segmentation, mean-shift clustering for grouping individual spots, and a multitask CNN for predicting the Z, p, and c components of the McIntosh scheme. Recent 2024 studies have addressed automated sunspot/umbra/penumbra delineation and the temporal behaviour of the penumbra-to-umbra area ratio. In 2025, a study published in *Astronomy and Computing* proposed SungDC, a deep-learning framework designed to classify all 60 valid McIntosh classes directly from SDO/HMI continuum images. These developments demonstrate that automated morphological characterization and McIntosh classification remain active research topics.

The principal contribution proposed here is therefore not a simple translation of an R program into Python. Instead, the earlier R/EBLImage methodology is reconstructed as a reproducible computational baseline, quantitatively validated, and extended with physically interpretable morphological feature extraction and machine-learning-based McIntosh classification. The resulting framework is intended to establish a transparent link between solar-image processing, umbra–

penumbra morphology, quantitative feature extraction, and automated sunspot-group classification.

LUNCH

Time 12:00-14:00

Day 2 | Afternoon Presentations

Sep 29th, 14:00 – 19:00

SESSION 4: Eruptive solar phenomena (Flares, CMEs, SEPs, Shocks) – I

Chair: XX YY

Relationship of prominence eruptions with CMEs and their dependence on Solar Cycle

ID: 4.1

Time 14:00–14:40

Invited Talk

Pooja Devi

Rosseland Center for Solar Physics, University of Oslo, Norway

Solar prominences are cool, dense plasma structures embedded in the solar corona and are frequently associated with eruptive events such as coronal mass ejections (CMEs). Understanding their connection with CMEs is important for their space-weather implications. In this study, we investigate the association between prominence eruptions (PEs) and CMEs using observations from the Solar Dynamics Observatory (SDO) and the Large Angle and Spectrometric Coronagraph (LASCO). We investigate the spatial and temporal evolution of PE-associated CMEs to determine how prominence material contributes to the development of CME structure. Our results show that during solar minimum, CMEs tend to deflect towards the equator, possibly due to the influence of the stronger polar magnetic field. Of the 662 CMEs associated with PEs, 78% exhibit a clear bright-core structure. Analysis of the morphological and temporal evolution of these CMEs indicates that the prominence material evolves into the CME bright core at higher coronal altitudes. This suggests that the prominence and CME bright core represent the same structure observed at different stages of the eruption, providing important insights into the formation and evolution of CME cores.

Double-whammy Space Weather Events in the SOHO Era

ID: 4.2
Time 14:40–15:00
Contributed Talk

N. Gopalswamy, S. Akiyama, S. Yashiro, and P. Makela

N. Gopalswamy — NASA/GSFC; S. Akiyama, S. Yashiro, P. Makela — The Catholic University of America

It is well known that the solar sources of coronal mass ejections (CMEs) causing geomagnetic storms generally originate close to the disk center of the Sun. On the other hand, CMEs responsible for solar energetic particle (SEP) events originate from the western hemisphere (including some behind the limb events). However, there is a population of CMEs that are responsible for both a geomagnetic storm and an SEP events. These are called double-whammy (DW) space weather events. These are important because they have wide ranging space weather consequences in the interplanetary space and geospace. Starting with the routine coronagraphic observations since 1996 by the Solar and Heliospheric Observatory (SOHO) and the NOAA GOES proton data, we identified 37 DW events until the end of January 2026. We report on the speed, width, and the solar source locations of the DW CMEs. The average sky-plane speed of DW CMEs is much larger than that of storm-producing CMEs and marginally larger than that of SEP-causing CMEs. All DW CMEs are halos (100%) compared to 68% for all storm-producing CMEs and ~80% for all SEP-associated CMEs. The source locations are distributed near the disk center with a western bias (10:27). The farthest eastern CME (S15E56 on 2024 September 14) has a speed of 2366 km/s and resulted in an energetic storm particle event. The farthest western CME from S20W85 on 2001 April 15 has a speed of ~1200 km/s and resulted in a 1000-pfu SEP event. The geomagnetic storms in these two cases are caused by sheath regions because of the glancing blow.

TEA BREAK

Time 15:00-15:20

White-Light Emissions in Gamma-Ray Solar Flares

ID: 4.3
Time 15:20–16:00
Invited Talk
(Online)

Seiji Yashiro^{1,2}, Nat Gopalswamy², Satoshi Masuda³, Kyoko Watanabe⁴, Nariaki V. Nitta⁵, Pertti Mäkelä^{1,2}, and Sachiko Akiyama^{1,2}

¹ The Catholic University of America, Washington, DC, USA; ² NASA Goddard Space Flight Center, Greenbelt, Maryland, USA; ³ Nagoya University, Nagoya, Aichi, Japan; ⁴ National Defense Academy of Japan, Yokosuka, Kanagawa, Japan; ⁵ Lockheed Martin Solar and Astrophysics Laboratory, Palo Alto, California, USA

The Fermi Large Area Telescope identified 45 gamma-ray (GR) solar flares during Solar Cycle 24. We investigate their white-light (WL) counterparts using continuum intensity data from the Helioseismic and Magnetic Imager onboard the Solar Dynamics Observatory. Among 18 flares with confirmed prompt GR emission, 17 (94%) exhibit WL enhancement during the impulsive phase, indicating a strong

temporal association between prompt GR and WL emission. This correspondence is observed even in moderate M-class events. In contrast, no WL enhancement is detected during sustained gamma-ray emission (SGRE) intervals in any of the 27 sustained GR flares analyzed, including three behind-the-limb events. Despite the strong occurrence association, no significant correlation is found between GR flux (100–10,000 MeV) and WL intensity. Weak positive correlations are observed between hard X-ray flux (25–300 keV) and WL intensity. These results suggest that WL emission is primarily related to impulsive-phase electron energy deposition, whereas sustained GR emission likely reflects a distinct proton acceleration process.

Durations of solar hard X-ray bursts with and without an associated coronal mass ejection

ID: 4.4
Time 16:00–16:40
Invited Talk
(Online)

Pertti Mäkelä

The Catholic University of America / NASA Goddard Space Flight Center

Sustained gamma-ray emission (SGRE) events at energies >100 MeV have been observed to be associated with hard X-ray (HXR) bursts that last longer than those without SGREs. SGRE events are produced by >300 MeV protons propagating down to the solar photosphere and producing neutral pions that decay into >100 MeV gamma rays. It has been suggested that the protons are accelerated in the shocks driven by coronal mass ejections (CMEs). We have studied durations HXR bursts with and without a CME using Fermi Gamma-Ray Burst Monitor (GBM) and Wind Konus measurements at energies around and above 100 keV. We found out that although the distributions overlap, they look different. The distribution of the HXR bursts with CMEs appears to be more skewed towards longer durations. We are investigating possible reasons for this difference.

POSTER SESSION

Time 17:00–19:00

Day 3 | Morning Presentations

Sep 30th, 09:00 – 12:10

SESSION 5: Eruptive solar phenomena (Flares, CMEs, SEPs, Shocks) – II / Propagation of CMEs in the Heliosphere
Chair: XX YY

The association rates of type II bursts and large solar energetic particle events in CME populations

ID: 5.1
Time 09:00–09:40
Invited Talk

Nat Gopalswamy, Pertti Makela, Sachiko Akiyama, and Seiji Yashiro
Nat Gopalswamy — NASA/GSFC; Pertti Makela, Sachiko Akiyama, Seiji Yashiro
— The Catholic University of America

We investigate the type II (metric and or DH) burst association rate as a function of CME speed, width and solar-source location. In the past we found a steady increase in the association rate with increasing speed and width of the CME speed and width. We have revisited this problem using an expanded data set over the past two decades. As special population of CMEs, we consider halo CMEs and fast and wide CMEs. In the general CME population of CMEs, the association rate of interplanetary type II bursts increases rapidly for the fast-and-wide CMs and attains 100% at a speed of ~ 2000 km/s. We also investigate the effect on the association rate when only m-km type II bursts are considered. Finally, we investigate the association rate of solar energetic particle events when western hemispheric type II bursts are considered.

The Role of Impact Parameter in Forbush Decrease Profiles

ID: 5.2
Time 09:40–10:00
Contributed Talk

Melike Tirnakci, Mateja Dumbović
University of Zagreb, Faculty of Geodesy, Hvar Observatory, 10000 Zagreb, Croatia

A Forbush decrease (FD) is a temporary decrease in the galactic cosmic ray intensity observed in connection with the passage of a coronal mass ejection (CME). The typical FD profile can contain two distinct decreases. While the first is generally associated with the shock and sheath ahead of the CME, the following decrease is linked to the magnetic structure inside the ICME, called a flux rope. Here, we are interested in this latter contribution and, in particular, in whether the location at which a spacecraft crosses the flux rope can influence the measured FD. For this purpose, we apply ForbMod (Dumbović et al., 2018; 2020), an analytical model describing the diffusion of cosmic rays into an expanding flux rope. As the structure propagates away from the Sun, cosmic rays gradually diffuse into the initially depleted flux rope. The resulting cosmic ray distribution can be used to model the decrease measured during a spacecraft passage. The spacecraft does not necessarily cross the flux rope close to its axis. Its crossing location is represented by the impact parameter, p , with smaller values corresponding to passages closer to the axis and larger values to more distant passages. We use ForbMod to explore how this crossing geometry may be reflected in the depth and shape of the modeled FD, while considering the individual properties of each flux rope. The model results are then examined together with selected observed events to evaluate the role of the spacecraft trajectory in shaping the measured FD. This research was funded by the European Union (project SPEARHEAD, No 101135044). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency (HaDEA). Neither the European Union nor the granting authority can be held responsible for them.

Harsh Bhati¹, Mani K Chettri², Hemam Dinesh Singh¹

¹ Netaji Subhas University of Technology, Delhi, India; ² Sikkim University, Gangtok, Sikkim, India

We investigate the propagation, interaction, and turbulence characteristics of multiple CME events that erupted during 9–11 November 2025. The analysis utilizes in situ measurements from spacecraft positioned near the Sun-Earth L1 point, including Aditya-L1 (MAG and ASPEX), WIND (SWE), and MMS (FGM), together with ground-based neutron monitor observations. In situ observations from Solar Orbiter were also incorporated from the MAG and EPD payloads. During 11–12 November, Solar Orbiter was situated at 0.83 AU at an inclination of 13.5°.

On 9 and 10 November, two solar flares, X1.7 and X1.2, erupted at 07:36 and 09:48 UTC, respectively. The associated CMEs propagated at speeds of 625 and 1644 km/s, respectively, with the faster, later CME overtaking the earlier one to form a complex ejecta. The arrival of the complex ejecta shock at the L1 point around 23:48 UT on 11 November 2025 triggered an intense geomagnetic storm, resulting in a minimum Dst index of 217 nT. Quasi-perpendicular shock properties were inferred from peak ion flux observations by both Aditya-L1/ASPEX and Solar Orbiter/EPD at the time of shock arrival. The shock region was identified through a spike in all three components of the magnetic field observed by Aditya-L1/MAG, with earlier signatures detected by Solar Orbiter/MAG, followed by the turbulent sheath region. Plasma and magnetic field signatures reveal clear evidence of ICME-ICME interaction through secondary enhancements in solar wind velocity, density, proton temperature, energetic ion flux, and interplanetary magnetic field (IMF) fluctuations.

On 11 November at 10:04 UTC, an X5.1 solar flare erupted from AR 14274, associated with a fast CME propagating at 1845 km/s. The leading edge of this CME interacted with the trailing part of the magnetic cloud of the slower 10 November CME. This interaction resulted in the formation of an ICME-in-sheath structure, characterized by enhanced turbulence and compressed plasma regions. An ICME-in-sheath structure occurs when a faster CME overtakes a preceding, slower ICME: the faster CME's shock compresses and traps the slower ICME, pushing it into the turbulent, shock-compressed sheath region between the primary ICME's shock front and its main magnetic ejecta. The ICME-in-sheath turbulent signatures were observed in the plasma beta ratio, proton number density, proton bulk speed, and plasma temperature, along with major fluctuations in the magnetic field. Unexpected spikes associated with the ICME-in-sheath structure were observed for approximately two hours, between 10:00 and 12:00 UTC on 12 November. The interacting ICME subsequently arrived at the L1 point, accompanied by major fluctuations resulting from the preconditioned, heightened solar wind environment left behind by the slower ICME.

Power Spectral Density (PSD) analysis of magnetic field fluctuations using MMS observations reveals a kinetic-scale spectral slope of approximately 2.602, lying between the characteristic slopes of kinetic Alfvén wave (KAW)-like and

whistler-like turbulence. This indicates enhanced kinetic-scale dissipation and turbulent energy transfer within the interaction region. The study also investigates energetic particle signatures associated with the event. Ground-based neutron monitor observations confirmed the occurrence of Ground-Level Enhancement GLE 77, one of the strongest events of the past two decades, exhibiting a rare double-peak structure and strong anisotropic behavior during its impulsive phase. The ENLIL simulation further supports the formation of complex ejecta resulting from ICME-ICME interaction and demonstrates the subsequent interaction of a third fast CME with the preconditioned heliospheric medium.

These results highlight how interacting ejecta restructure amplify turbulence, and create efficient particle acceleration environments relevant to Solar Energetic Particle (SEP) generation and extreme space weather conditions.

TEA BREAK

Time 10:20-10:50

A Comparative Study of CME and PEA Properties in Quiescent Filament Eruptions with and without SEP Events (1996–2025)

ID: 5.4
Time 10:50–11:30
Invited Talk
(Online)

S. Akiyama^{1,2}, N. Gopalswamy², P. Mäkelä^{1,2}, S. Yashiro^{1,2}, and H. Xie^{1,2}
¹ The Catholic University of America; ² NASA/GSFC

Coronal mass ejections (CMEs) that produce solar energetic particle (SEP) events are generally characterized by high speeds, large angular widths, and solar sources associated with intense flares. Although uncommon, SEP events originating from CMEs associated with quiescent filament eruptions (QFEs) have been reported (Gopalswamy et al. 2015; 2016). In this study, we compare the physical properties of QFE-associated CMEs with and without SEP events using an extended analysis period from January 1996 through December 2025 and restricting the solar source locations to the well-connected longitudes between W00 and W120. Under these selection criteria, we identified 8 QFE-associated CMEs accompanied by SEP events and 27 that did not produce SEP enhancements. All SEP-associated CMEs exhibited DH type II bursts and showed notably higher reconnection flux, magnetic field strength, area, and X-ray intensity compared to the non-SEP group. Additionally, SEP-associated CMEs displayed higher leading-edge speeds and accelerations, as well as larger and more tilted post-eruption arcades (PEAs). These results indicate that energetic CMEs are more likely to drive shocks and generate SEP events. We present a comprehensive thirty-year analysis focusing on the CME and PEA properties that distinguish SEP-producing QFE-CMEs from those without SEP events.

Solar Flare Ribbons at Unprecedented Resolution

ID: 5.5
Time 11:30–12:10
Invited Talk

Reetika Joshi, Jonas Thoen Faber, Luc Rouppe van der Voort, Sven Wedemeyer, Lyndsay Fletcher, Guillaume Aulanier, Daniel Nóbrega-Siverio
Reetika Joshi — Rosseland Centre for Solar Physics, University of Oslo, Norway

Solar flares release most of their luminous energy in the chromosphere. These luminous signatures, known as flare ribbons, act as the footpoints of the released energy and are crucial for the interpretation of reconnection processes causing these events. We explored the fine structures in flare ribbons at the chromospheric level using high-resolution observations with imaging and spectral techniques. In this talk I will show the capabilities of Swedish 1-m Solar Telescope observations in the $H\alpha$, Ca II 8542 Å, and $H\beta$ lines, to analyse the flare ribbons. The fine structures followed by the SST observations in flare ribbons supports the theory of a direct link between fine-structure flare ribbons and current sheet tearing. We believe our observations represent the highest resolution evidence of fine-structure flare ribbons to date.

FREE TIME

Time 12:10 onward

Day 4 | Morning Presentations

Oct 1st, 10:00 – 11:50

SESSION 6: Response of the Magnetosphere to the Impact of CMEs and Stream Interaction Region / Magnetosphere–Ionosphere–Thermosphere coupling – I

Chair: XX YY

Sporadic E Behavior over Central Europe during a Geomagnetically Quiet Period in 2019

ID: 6.1
Time 10:00–10:40
Invited Talk

Petra Koucká Knížová¹, Csilla Szárnya², Christina Arras^{3,4}, Sunil Kumar Ramath-eerthan^{1,5}, Carsten Schmidt⁶, Patrick Hannawald⁶, Jaroslav Chum¹, Kateřina Podolská¹, Kateřina Potužníková¹, Jaroslav Urbář¹, Zbyšek Mošna¹, Daniel Kouba¹, Šimon Mackovjak⁷, Vladimír Truhlík¹, Veronika Barta^{2,8}, Dalia Bu-rešová¹, Michal Kozubek¹, Sahar Sobhkhiz-Miandehi³

¹ Institute of Atmospheric Physics, Czech Academy of Sciences, Prague, Czech Republic; ² HUN-REN Institute of Earth Physics and Space Science, Sopron, Hungary; ³ GFZ Helmholtz Centre for Geosciences, Section Space Geodetic Techniques, Potsdam, Germany; ⁴ TU Berlin, Institute for Geodesy and Geoinformation Science, Germany; ⁵ Department of Atmospheric Physics, Faculty of Mathematics and Physics, Charles University; ⁶ Department of Space Physics, Institute of Experimental Physics, Slovak Academy of Sciences, Košice, Slovakia; ⁷ German Remote Sensing Data Center (DFD), German Aerospace Center (DLR), Oberpfaffenhofen, Germany; ⁸ University of Sopron, Institute of Geomatics and Civil Engineering, Sopron, Hungary

This study examines sporadic E (Es) variability over Central Europe during August–September 2019, focusing on the geomagnetically super-quiet interval of 18–28 August. Ionosonde, Continuous Doppler Sounding System (CDSS), radio occultation, OH airglow, SABER, and MERRA-2 observations were combined to investigate atmosphere–ionosphere coupling. Despite low geomagnetic activity, pronounced variability occurred in Es occurrence, foE, foF2, and hmF2, together with wave-like structures in the E and F regions. Wavelet analysis revealed significant oscillations in the gravity-wave (1.5–6 h), semidiurnal (8–14 h), and planetary-wave (6–18 days) ranges. Enhanced CDSS Doppler fluctuations and spread echoes on 20, 23, and 25 August provided further evidence of short-period gravity-wave activity (15–40 min). Radio occultation measurements showed Es occurrence rates above climatological levels during Days of Year 230–240, accompanied by increased Es altitude variability. Mesospheric observations indicated enhanced gravity-wave activity and persistent warming, coinciding with intensified planetary-wave activity and weakening zonal-mean zonal winds during the developing 2019 Southern Hemisphere sudden stratospheric warming. The results suggest that Es variability was primarily driven by neutral-atmospheric dynamics through two mechanisms: gravity waves generated by frontal and convective activity over Central Europe, and planetary-wave modulation associated with interhemispheric coupling during the sudden stratospheric warming.

First Results from a Low-Cost GNSS VTEC Monitoring Station: Evaluation Against IRI and AfriTEC over ACCRA, Ghana

ID: 6.2
Time 10:40–11:00
Contributed Talk

*Solomon Otoo Lomotey*¹, *Bruno Nava*², *Rabiu Babatunde*³, *Anton Kashcheyev*⁴, *John Bosco Habarulema*⁵, *Ebenezer Agyei-Yeboah*⁶, *Daniel Okoh*⁷, *Christine Amory-Mazaudier*⁸, *Sam-Quarcoo Dotse*¹, *Valence Habyarimana*⁹, *Golekamang Thaganyana*¹⁰, *Patrick Essien*¹¹, *Nana Ama Browne Klutse*¹²

¹ University of Environment and Sustainable Development (UESD), School of Natural and Environmental Sciences (SNES), Department of Physical and Mathematical Sciences, PMB, Somanya, Eastern Region, Ghana; ² The Abdus Salam International Centre for Theoretical Physics (ICTP) T/ICT4D, Trieste, Italy; ³ Space Environment Research Laboratory, National Space Research and Development Agency, Abuja, Nigeria; ⁴ University of New Brunswick, Fredericton, NB, Canada; ⁵ South African National Space Agency (SANSA) Space Science, 7200 Hermanus, South Africa; ⁶ Laboratory of Physics and Astronomy, UNIVAP, São José dos Campos, Brazil; ⁷ Department of Astronomy and Space Science, Technical University of Kenya, Nairobi, Kenya; ⁸ Laboratoire de Physique des Plasmas, Université Pierre et Marie Curie Sorbonne Universities, 75252, Paris Cedex, France; ⁹ Department of Physics, Mbarara University of Science and Technology, Mbarara, Uganda; ¹⁰ Centre of Space Research, North-West University, Potchefstroom, South Africa; ¹¹ Department of Physics, University of Cape Coast, Cape Coast, Ghana; ¹² Department of Physics, University of Ghana, Accra, Ghana

Ionosphere monitoring and forecasting can be challenging due to gaps in ground-based Global Navigation Satellite Systems (GNSS) receiver coverage over West Africa, particularly in Ghana. Our recent results on the monthly and seasonal variations of Vertical Electron Content (VTEC) derived from a Low-Cost GNSS

receiver in Accra, Ghana (Geographic: 5.70 N, 0.040 E; Geomagnetic: 7.00 S) are presented in this paper. The features of VTEC were examined between 2023 and 2025, and the VTEC from the African regional total electron content (AfriTEC) and International Reference Ionosphere (IRI-2020) models were compared. The VTEC showed a semiannual variation with a major maximum during the March equinox, a minimum during the June solstice, and a secondary maximum during the September equinox. The results show better agreement (i.e., VTEC values) with the AfriTEC model than with the IRI-2020 VTEC model predictions. Overall, over- and underestimations of VTEC (~ 10 TECU) were observed in both model predictions across all seasons. The correlation coefficients between the low-cost VTEC and predicted VTEC from the two models are mostly greater than 0.9. Results from the Mother's Day storm, the most intense geomagnetic storm in the past two decades, which occurred between May 10–15, 2024, are also presented. Following the sudden storm commencement (SSC) on 10 May and the storm main phase extending into 11 May, positive ionospheric storm effects were observed between $\sim 11:00$ LT and $\sim 18:00$ LT on 10 and 12 May. In contrast, a negative ionospheric storm effect occurred on 11 May. Another notable feature of the storm was the observation of a high rate of change in TEC index (ROTI) values ($\text{ROTI} > 0.4$ TECU/min) on days 10, 12, 13, and 14, respectively. These results indicate that the low-cost GNSS receiver is suitable for ionospheric TEC studies.

TEA BREAK

Time 11:00-11:30

On solar sources of interplanetary disturbances before the high-energy magnetospheric electrons enhancements

ID: 6.3

Time 11:30–11:50

Contributed Talk

O. Kryakunova (1), B. Seifullina (1), I. Tsepakina (1), M. Abunina (2), N. Nikolayevskiy (1), N. Shlyk (2), R. Koichubayev (1)

(1) Institute of Ionosphere, Kazakhstan; (2) IZMIRAN, Russia

Based on measurements of magnetospheric electron fluxes with energies > 2 MeV in geostationary orbits, solar wind velocity, and geomagnetic activity for the period 1995–2025, a catalog of electron enhancements in which the electron fluence exceeds dangerous level has been compiled. For the events of this catalog, disturbances of interplanetary space have been determined, after which enhancements in high-energy electrons begin, and their solar sources have been determined. It has been found that in more than half of the events of electron enhancements, the solar sources of disturbances are high-speed solar wind streams (HSSs) from coronal holes. In 97.2% of the events, HSSs from coronal holes were one of the solar sources of disturbances, in the formation of which coronal mass ejections after solar flares and the disappearance of solar filaments also participated. The average behavior of the electron flux, cosmic rays, solar wind velocity and geomagnetic activity was obtained.

This research is funded by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP23489700).

LUNCH

Time 12:00-14:00

Day 4 | Afternoon Presentations

Oct 1st, 14:00 – 15:00

SESSION 7: Magnetosphere–Ionosphere–Thermosphere coupling – II

Chair: XX YY

Performance of the IRI Model during Quiet Space Weather Periods at Swarm Altitudes and First Results on the Inclusion of Atmospheric Wave Indices

ID: 7.1

Time 14:00–14:20

Contributed Talk

V. Truhlík(1), J. Urbář(1), Š. Mackovjak(2), C. Schmidt(3), P. Hannawald(3), J. Chum(1), Petra Koucká Knížová(1), L. Küchelbacher(3), and S. Wüst(3)

(1) Department of Ionosphere and Aeronomy, Institute of Atmospheric Physics of the Czech Academy of Science, Czech Republic; (2) Department of Space Physics, Institute of Experimental Physics, Slovak Academy of Sciences, Slovak Republic; (3) German Remote Sensing Data Center, German Aerospace Center, Federal Republic of Germany

Quiet-time ionospheric variability can remain substantial even when solar and geomagnetic forcing is minimal. We evaluated how well the International Reference Ionosphere (IRI) (Bilitza et al., 2022) represents electron density (Ne) at Swarm altitudes during strictly solar- and geomagnetically quiet periods between 2014 and 2025, as defined in Mackovjak et al. (2026) to establish a baseline for characterizing this variability. We found systematic biases compared with average conditions and thus we proposed a correction method. Swarm A, B and C in-situ plasma densities are treated as a reference after careful quality selection and calibration. For calibration, we used the approach of Smirnov et al. (2024). We tested IRI-2020 (both COR2 and NeQuick topside options) (a) with the climatological URSI foF2 option and (b) with IRTAM (Real-Time Assimilative Mapping) coefficients representing ionospheric weather conditions and quantified performance using statistics of the calibrated Ne(Swarm)/Ne(IRI) ratio for the quiet periods and the whole interval 2014–2024. Over Europe, IRI performs best at Swarm A/C altitudes (~450 km), while a systematic underestimation is found at the Swarm B altitude (~510 km). In our quiet-period analysis, including IRTAM does not lead to a consistent improvement at Swarm altitudes. To correct these biases, we modeled the common logarithm of the quiet-period ratio of Ne as a smooth multidimensional correction function F depending on magnetic local time, invdip (Truhlik et al., 2001), magnetic longitude, and season. The corrected Ne at Swarm altitude is then used as an additional anchor point to improve the IRI topside profile shape for both topside options (COR2 and NeQuick). Case studies for the super-quiet interval in August 2019 and other quiet intervals demonstrate that the correction reduces systematic offsets and improves the latitudinal trend at mid-latitudes and local-time dependence. Finally, we tested a residual, disturbance-related correction using a neural network driven by regional ground-based parameters (foF2, Doppler sounding proxies, TEC/ROTI (Total Electron Content/Rate of Total Electron Content Index), and selected airglow wave indices). Feature importance tests confirm foF2 and ionospheric proxies as dominant predictors of Ne and its variability at Swarm altitudes, while wave indices show a weaker impact. The results support a stepwise IRI proposed correction: (i) a climatological quiet-time correction for the

topside ionosphere, and (ii) an additive regional residual correction where dense coverage by ground-based measurements is available.

Knowledge Gaps in the Mesosphere and Lower Thermosphere: Potential Keystone Contributions

ID: 7.2
Time 14:20–15:00
Invited Talk
(Online)

William Ward¹, Dan Gerber² (Mission PI) and the Keystone Team

¹ University of New Brunswick, Canada; ² DLR, Germany

In spite of contributions by several missions over the past couple of decades, there remain a number of gaps in our understanding of the mesosphere and lower thermosphere and its response to coupling from above and below. Issues with its chemistry (the role of atomic oxygen and its variability) and energetics (non-local thermodynamic equilibrium effects associated with CO₂ cooling, with atomic oxygen again playing a role) which were recognized decades ago remain partially understood. The thermospheric/ionospheric response to variations in forcing from above and below on shorter timescales remains unvalidated by observations. The variability of atomic oxygen, the major constituent in the thermosphere remains poorly characterized even though its variability results in density variations affecting satellite drag.

The Keystone mission has been developed to help resolve these issues. It consists of three instruments: a heterodyne terahertz instrument, an infrared radiometer (IR) and an ultra-violet/visible spectrometer (UV/Vis) flying in a sun-synchronous orbit. The terahertz instrument takes advantage of recent technological advances to provide height profiles of atomic oxygen and other species, temperature and line-of sight wind directly. The UV/Vis and IR instruments are based on proven technologies and provide information on the emissions of various species which play a role in the chemistry and energetics of this region. These view the same parcels of air simultaneously so that the chemistry and energetics can be analysed cleanly.

In this talk, the outstanding issues associated with this region of the atmosphere will be reviewed and the proposed Keystone mission described and its potential contributions to our understanding of this region discussed.

Day 5 | Morning Presentations

Oct 2nd, 09:30 – 12:20

SESSION 8: Space weather effects on technological systems – I

Chair: XX YY

Space Weather and Machine Learning: What Works and What Does Not

ID: 8.1
Time 09:30–10:10
Invited Talk
(Online)

Fadil Inceoglu^{1,2}

¹ CIRES, University of Colorado Boulder; ² NCEI, NOAA

In the era of booming space technology and exploration, space-based systems have become critical infrastructure for governments and industries. Space weather phenomena can disrupt these systems and produce cascading effects across sectors, including navigation, agriculture, oil and gas operations, and electric power grids. Continuous observations of the Sun and near-Earth geospace are therefore essential. Observations of the heliosphere as an integrated system extending from the Sun to Earth's magnetosphere, ionosphere, and upper atmosphere are traditionally made by government agencies and universities worldwide generating vast and continuously growing volumes of data. Recent advances in machine learning have greatly expanded our ability to extract scientific and operational value from these data. Yet the availability of big data and increasingly powerful models does not, by itself, establish that machine learning "works" in space weather science and operations. To answer the question "What works and what does not?" we must first answer several others: Works for what purpose? On what evidence? Under what conditions? Compared with what? And by what standard? Using a few selected scientific and operational examples, I will examine how purpose, data quality and standards, model selection, validation, and operational constraints determine whether an ML method actually works. I will also identify why models that appear successful in retrospective evaluation may fail to provide scientific or operational value.

Effects of Geomagnetic Storms on NmF2 over Ouagadougou during the Descending Phase of Solar Cycle 22

ID: 8.2
Time 10:10–10:30
Contributed Talk

K. Kazeem

Department of Physics, Edo State University, Iyamho, Edo State, Nigeria

This study investigates the effects of geomagnetic storms on the F2-layer peak electron density (NmF2) over Ouagadougou (12.4° N, 358.5° E; dip latitude +1.45°), an equatorial station in the African sector, during the descending phase of Solar Cycle 22 (1992-1995). The F2 layer is crucial for high-frequency radio wave propagation, and its variability during geomagnetic disturbances is a key focus of space weather research. Hourly ionosonde observations from Ouagadougou are used to derive NmF2 values, while the Disturbance Storm Time (Dst) index is used to identify and characterise geomagnetic storm events. Due to the lack of interplanetary magnetic field and solar wind parameters during the study period, storm analysis is based exclusively on Dst measurements.

Geomagnetic storms are classified by their minimum Dst values, and storm-time NmF2 variations are evaluated relative to quiet-time reference conditions. The investigation focuses on the occurrence of positive and negative ionospheric storm effects, their dependence on storm intensity, and their temporal evolution

during the main and recovery phases of geomagnetic storms. Statistical analyses assess the relationship between geomagnetic activity and NmF2 variability.

The results are expected to provide insight into the behaviour of the low-latitude African ionosphere under disturbed geomagnetic conditions and to improve understanding of ionosphere–magnetosphere coupling processes during the declining phase of solar activity.

The analyses of the sources of extreme geomagnetically induced currents in power lines based on observations over 11 years

ID: 8.3

Time 10:30–10:50

Contributed Talk
(Online)

Belakhovsky V.B.¹, Pilipenko V.A.², Selivanov V.N.³, Sakharov Y.A.¹

¹ Polar Geophysical Institute, Apatity, Russia; ² Schmidt Institute of Physics of the Earth, Russian Academy of Sciences, Moscow, Russia; ³ Northern Energetics Research Centre, Kola Science Center, Russian Academy of Sciences, Apatity, Russia

This study analyzes cases of extreme geomagnetically induced currents (GICs) in power transmission lines in northwestern Russia (Murmansk region and Karelia) and considers the mechanisms of their excitation within the ionosphere, Earth's magnetosphere, and the solar wind.

A database of extreme GIC values in power transmission lines has been created based on 11 years of observations (2012–2022). The GIC monitoring system was established by the Polar Geophysical Institute and the Northern Energetics Research Centre and comprises 5 stations.

The analysis of events utilized GIC data from the Vykhodnoy (VKH) auroral station and the Kondopoga (KND) sub-auroral station. The database includes 95 events recorded at the VKH station ($|GIC| > 20$ A) and 45 events recorded at the KND station ($|GIC| > 5$ A). Geomagnetic field variations were monitored using data from the PGI Lovozero (LOZ) observatory and the Mekrijärvi (MEK) station, part of the IMAGE network.

The number of extreme GICs is higher during the declining phase and at the maximum of the solar cycle. According to data from the VKH station, GIC values reach extreme levels more frequently during CME storms (~55%) than during CIR storms. Data from the KND station show that extreme GIC values are observed during CME storms in 80% of cases.

Analysis shows that for both the VKH and KND stations, extreme GIC events are primarily caused by substorms (>80% of cases), which occur with roughly equal probability in the post-midnight and evening MLT sectors. Furthermore, the development of vortex current systems during a substorm (Pi3–Ps6/Pi2 pulsations) can contribute significantly to the growth of GICs for a north-south oriented power transmission line. Extreme GIC events are accompanied by discrete auroral forms exhibiting a vortex structure in the green line (557.7 nm). Daytime and morning GIC events are caused by positive magnetic bays, Pc5 geomagnetic pulsations, and SSC impulses.

On average, GIC amplitude increases with the intensity of the magnetic storm ($|\text{SYM} - H|$), the rate of change of the magnetic field (dB/dt), and the IE index. However, the relationship between GIC amplitude and solar wind parameters, the interplanetary magnetic field (V , B_z , E_s , Akasofu parameter), and geomagnetic activity indices (SYM-H , AE , IE) is highly nonlinear. This highlights the difficulty of forecasting GICs based on these parameters, as GIC amplitude is determined primarily by local ionospheric currents rather than global magnetospheric characteristics.

For dB/dt , the correlation with interplanetary medium parameters and geomagnetic activity indices is noticeably higher than for GIC, especially at the subauroral station KND. To calculate GIC amplitude, it is necessary to consider not only dB/dt but also the configuration of ionospheric current systems and the signal frequency.

The study was supported by Russian Science Foundation grant No. 25-17-20038 (<https://rscf.ru/project/25-17-20038/>) and a grant from the Ministry of Education and Science of the Murmansk Region.

TEA BREAK

Time 10:50-11:20

Assessing geoelectric hazard over Romania during extreme geomagnetic storms in March 1989, November 2003 and May 2024

ID: 8.4

Time 11:20–12:00

Invited Talk

V. Dobrica, C. Stefan, C. Demetrescu
Institute of Geodynamics, Romanian Academy

The extreme geomagnetic storms that occurred in the satellite era, March 1989, November 2003 and May 2024, are investigated from the point of view of the associated hazard over Romania, described in terms of the surface geoelectric field, which in turn can result in geomagnetically induced currents. The surface electric field at the country scale, produced by the variable magnetic field of geomagnetic storms, is determined on the basis of available geomagnetic observations and information on the electrical conductivity of the underground. The comparative analysis of the three events shows that the amplitude of geoelectric field depends on the morphology rather than the amplitude of the geomagnetic disturbance, and is significantly higher in case of March 1989 than in case of the other two events. The spatial distribution of the surface electric field amplitude on the Romanian territory is presented, providing the geoelectric hazard map at the country scale and contributing to a better understanding of vulnerability to extreme space weather events.

A study of solar flare effects on the geomagnetic field elements during solar cycles 23 and 24

ID: 8.5
Time 12:00–12:20
Contributed Talk
(Online)

GRODJI Oswald Didier Franck¹ (F.O. GRODJI), Vafi DOUMBIA¹ (V. DOUMBIA), Paul Obiakara AMAECHI² (P.O. AMAECHI), Amory-Mazaudier Christine³ (C. Amory-Mazaudier), N'Guessan Kouassi¹ (N. Kouassi), Tuo Zie¹ (Z. Tuo), Aziz Diaby Kassamba¹ (A.A. Kassamba)

¹ Université Félix Houphouët Boigny; ² University of Lagos, Nigeria; ³ Institut de physique du globe, Paris, France

In this paper, we investigated the impact of solar flares on the horizontal (H), eastward (Y) and vertical (Z) components of the geomagnetic field during solar cycles 23 and 24 using a chain of magnetometers measurements on the sunlit side of the Earth. We examined the relation between sunspot number and solar flare occurrence of various classes during both cycles. We obtained a positive linear relation with correlation coefficient of 0.93/0.97, 0.96/0.96 and 0.60/0.56 for C-class, M-class and X-class flare, respectively during SC23/24. The three geomagnetic components of the geomagnetic field exhibited a peak few minutes after the solar flare occurrence. Generally, the magnetic crochet of the H component was negative at mid-latitudes in both hemispheres and positive at low-latitudes. The peak amplitude of solar flare effect (sfe) on the various geomagnetic components depended of many factors including the local time at the observing station, the solar zenith angle, the position of the station with respect to the magnetic equator and the intensity of the flare. Thus, these peaks were stronger for the stations around the magnetic equator and very low when the geomagnetic field components were close to their night values. Both cycles presented similar monthly variations with the highest sfe value ($\Delta H_{\text{sfe}} = 48.82$ nT for cycle 23 and $\Delta H_{\text{sfe}} = 24.68$ nT for cycle 24) registered in September and lowest in June for cycle 23 ($\Delta H_{\text{sfe}} = 8.69$ nT) and July for cycle 24 ($\Delta H_{\text{sfe}} = 10.69$ nT). Also the sfe was generally higher in cycle 23 than in cycle 24.

LUNCH

Time 12:30-14:30

Day 5 | Afternoon Presentations

Oct 2nd, 14:30 – 15:30

AFTERNOON SESSION

Chair: XX YY

CLOSING REMARKS

Time 14:30-15:30

Poster Abstracts

Tuesday, Sep 29th, 17:00 – 19:00

POSTER SESSION

Tuesday, 29 September 2026 | 17:00 – 19:00

Fine Structure of the Ellerman Bombs

ID: P1
Time 17:00–19:00
Poster Presentation

Emel Özdüzenciler¹, Seray Şahin^{1,2}, Vasyl Yurchyshyn²

¹ Department of Space Sciences and Technologies, Faculty of Science, Akdeniz University, Antalya, Türkiye; ² Big Bear Solar Observatory, New Jersey Institute of Technology, Big Bear City, CA, USA

Ellerman bombs (EBs) are small-scale brightenings in the lower solar atmosphere that are commonly associated with magnetic reconnection. We analyse a long-lived EB observed on 2024 May 3 with high-resolution $H\alpha$ observations from the Goode Solar Telescope (GST) at Big Bear Solar Observatory. Multi-wavelength light curves reveal a structured evolution lasting approximately 40 min, with broadly similar behaviour in the blue and red wings and a modest blue-wing excess during the enhanced phase. The EB contains several compact blob-like substructures. Focusing on a representative plasmoid-like feature, we measure apparent propagation speeds of approximately $7\text{--}15\text{ km s}^{-1}$ and an increase in apparent transverse width from about $60\text{--}65\text{ km}$ to $\sim 90\text{ km}$. The feature was also tracked across the $H\alpha$ wavelength scan to characterize its wavelength-dependent intensity. These observations reveal pronounced fine-scale dynamics within the EB and are consistent with a highly structured, reconnection-driven environment.

Relationships Between Average Monthly CME Speed, Solar Wind Speed, and Galactic Cosmic Ray Counts During Solar Cycles 23, 24, and 25

ID: P2
Time 17:00–19:00
Poster Presentation

Sunay Aydın¹, Muhammed Ali Calisir¹, Ali Kilcik¹

¹ Department of Space Sciences and Technologies, Faculty of Science, Akdeniz University, Antalya, Türkiye

Cosmic rays are high-energy particles traveling at relativistic speeds in space. They are of great importance in space weather studies due to their effects on Earth's atmosphere and the near-space environment. In this study, the possible relationships between average monthly sunspot number (SSN), coronal mass ejection (CME) speed, solar wind speed, and galactic cosmic ray (GCR) counts were investigated during solar cycles 23, 24, and 25. To identify potential relationships between the used data sets, cross-correlation analyses were applied to both raw and first-differenced time series. The following results were obtained: (i) CME speed consistently shows a strong negative correlation with GCR counts across all three solar cycles. (ii) During Solar Cycle 23, the relationships between GCR counts and both CME speed and solar wind speed occurred simultaneously (lag = 0) in both the raw and first-differenced data. (iii) During Solar Cycle 25, solar wind speed was

found to affect GCR counts within the same month in both data. (iv) Considering the entire period (1996–2025), GCR counts show a simultaneous relationship with solar wind speed and a four-month lagged relationship with SSN in both the raw and first-differenced data. (v) Long-term GCR trends are driven by sunspot numbers, while short-term monthly variations are simultaneously controlled by solar wind and CME speeds.

Dependence of Umbral Dot Physical Properties on Magnetic Field Strength and Inclination in Eight Umbral Cores

ID: P3
Time 17:00–19:00
Poster Presentation

Calisir, M.A.¹, Kilcik, A.¹, Yurchyshyn, V.²

¹ Department of Space Science and Technologies, Akdeniz University Faculty of Science, Antalya, Turkey; ² Big Bear Solar Observatory, New Jersey Institute of Technology, Big Bear City, USA

Umbral Dots (UDs), the bright features within sunspot umbrae, serve as fundamental indicators of magneto-convective energy transport in the deep layers of sunspots. In this study, we investigated the relationship between the physical parameters of UD (area, brightness, diameter, and eccentricity) and their local magnetic properties (field strength and inclination). High-resolution data from the Goode Solar Telescope (GST) at Big Bear Solar Observatory (BBSO) were used to analyze six sunspots and eight different umbral cores at various morphological stages. To obtain UD characteristics at the same locations, simultaneous continuum, magnetic field, and magnetic inclination images were used. Our results reveal a strong negative correlation between mean UD brightness and the local magnetic field strength. This inverse relationship shows that convective flux is stronger in regions where the magnetic field is locally weakened. Conversely, a weak correlation was found between mean UD magnetic inclination and their area, diameter, or brightness, suggesting that UD morphology is mostly controlled by the magnetic field strength rather than its magnetic orientation.

Quantifying sunspot group nesting with density-based unsupervised clustering

ID: P4
Time 17:00–19:00
Poster Presentation

Nurdan Karapınar

Department of Astronomy and Space Sciences, Graduate School of Natural and Applied Sciences, Ankara University

Sunspot groups emerge in spatial–temporal clusters known as activity nests, reflecting the persistence and spatial organisation of solar magnetic flux emergence. We present a fully automated, data-driven method to identify sunspot-group nests in the longitude–time domain and to quantify the fraction of sunspot groups participating in these structures. The method combines kernel density estimation with density-based spatial clustering (DBSCAN), is validated using synthetic solar-like cycles, and accounts for variations in observational data density.

We apply the method to 151 years of sunspot-group observations from the Royal Greenwich Observatory Photoheliographic Results (RGO; 1874–1976) and

Kislovodsk Mountain Astronomical Station (KMAS; 1955–2025). Across all solar cycles and latitude bands, we find a mean nesting degree of $\langle D \rangle = 0.61 \pm 0.12$, indicating that approximately 61% of sunspot groups emerge within activity nests. Nesting exhibits a pronounced latitude dependence, reaching its highest values at 10° – 20° , while the two independent datasets show consistent behaviour over their overlapping period.

A key result of this study is the significant positive correlation between nesting degree and the overall level of solar activity. The nesting degree correlates with the total sunspot-group area, with Pearson correlation coefficients of $r = 0.60$ for RGO and $r = 0.73$ for KMAS. Moreover, this relationship becomes stronger when small sunspot groups are excluded, indicating that the observed correlation is not simply a consequence of the increasing number of small groups during active periods. This provides the first quantitative evidence, to our knowledge, that the degree of sunspot-group nesting systematically increases with the strength of the solar activity cycle.

Our results demonstrate that activity nesting is not merely a spatial property of sunspot emergence, but is systematically coupled to the amplitude of solar magnetic activity. The identified nests range from compact clusters to long-lived, longitudinally drifting structures, providing new quantitative constraints on the persistence and spatial organisation of solar magnetic activity.

Long-term Solar Photospheric and $H\alpha$ Observations at Istanbul University Observatory

ID: P5
Time 17:00–19:00
Poster Presentation

Z. Funda Bostancı, Tolga Güver, Korhan Yelkenci, Burcin Öztürk, Süleyman Fişek, Olcay Plevne, Ergün Ege, Tuğba Boztepe, Emre Yılman, Melike Eryılmaz
Istanbul University

Istanbul University Observatory Research and Application Center has conducted systematic solar photospheric and chromospheric observations since 1945 as part of its long-term solar monitoring program. The observational archive currently preserves records dating back to approximately 1950, representing one of the long-standing regional solar datasets in Türkiye.

The archive includes full-disk solar observations obtained in both photospheric and chromospheric wavelengths, including ongoing $H\alpha$ observations. These observations provide valuable information for investigating long-term solar variability, solar cycle evolution, active region development, filament activity, and changes in solar magnetic activity over decadal timescales.

In this study, we present an overview of the historical and ongoing solar observation program at Istanbul University Observatory together with the current status of the available archive. Representative examples from the observational material are presented, and ongoing efforts related to preservation, organization, and future digitization of the archive are discussed. The scientific potential of the dataset is evaluated in the context of long-term solar variability studies, including possible cross-calibration with other historical solar archives and future applications to solar activity reconstruction studies.

The Istanbul University solar archive constitutes an important regional historical dataset and may contribute to international efforts focused on the preservation and scientific exploitation of long-term solar observations for studies of solar variability and space climate.

Automated Multi-Wavelength Detection and Characterization of Solar Activity Features Using Kodaikanal Solar Observatory Data

ID: P6
Time 17:00–19:00
Poster Presentation

Hanshika Jain¹, Shashanka R. Gurumath¹, Hiremath K. M.²

¹ Department of Physics and Electronics, Jain University, Bengaluru, India; ² Indian Institute of Astrophysics (IIA), Bengaluru, India

The advancement of AI-based space weather forecasting depends critically on the availability of large-scale, standardized, and physically validated solar observational datasets, yet such resources remain scarce for the historically significant Kodaikanal Solar Observatory (KSO) archive, which spans more than a century of continuous solar monitoring. This work presents an automated multi-wavelength analysis pipeline that converts KSO's historical observations into standardized, machine-learning-ready datasets for solar activity analysis and space weather research.

The pipeline processes high-resolution (4096×4096) Ca II K spectroheliograms to detect and characterize chromospheric plage regions using adaptive thresholding, edge detection, and contour-based segmentation. Accurate solar disk localization through circle-fitting algorithms and orientation correction ensures consistent spatial referencing across the full observational record. The methodology is extended to white-light and H-alpha observations for automated detection of photospheric sunspots and chromospheric filaments, providing a unified multi-layer framework covering more than 100 years of daily solar observations. Heliographic coordinates and physical areas are computed for all detected features after applying limb-darkening and foreshortening corrections, yielding reproducible measurements across wavelengths.

The pipeline outputs structured FITS-format datasets containing feature identifiers, locations, timestamps, and area measurements, validated through comparison of computed feature areas with reference measurements and manual inspection of representative observations. These datasets are designed for direct integration into machine learning workflows for solar feature classification, activity cycle characterization, and operational space weather forecasting. The resulting datasets improve the accessibility and reproducibility of one of the world's longest continuous solar observation archives, providing a standardized resource for machine learning applications, long-term solar activity studies, and future operational space weather forecasting. The framework further demonstrates a scalable approach for transforming archival solar observations into standardized datasets that support AI-enabled space weather research.

Long-Term Multi-Wavelength Solar Activity Datasets from the Kodaikanal Solar Observatory: Enabling AI-Driven Space Weather Research

ID: P7
Time 17:00–19:00
Poster Presentation

Hanshika Jain¹, Shashanka R. Gurumath¹, Hiremath K. M.²

¹ Department of Physics and Electronics, Jain University, Bengaluru, India; ² Indian Institute of Astrophysics (IIA), Bengaluru, India

Understanding and predicting space weather requires long-term observations of solar activity spanning multiple solar cycles. The development of data-driven and artificial intelligence (AI)-based approaches depends on the availability of standardized, physically meaningful, and machine-learning-ready solar datasets. The Kodaikanal Solar Observatory (KSO) in India provides one of the world's longest continuous records of solar observations, with daily observations extending back to 1904 across Ca II K, white-light, and H-alpha wavelengths.

We present an automated multi-wavelength processing pipeline for systematically detecting and characterizing solar activity features from the KSO archive at full resolution (4096×4096). Chromospheric plage regions, photospheric sunspots, and chromospheric filaments are detected using adaptive thresholding, edge detection, and contour-based segmentation. Solar disk localization and orientation correction provide consistent spatial referencing across observations, while limb-darkening and foreshortening corrections enable the derivation of heliographic coordinates and physical feature areas.

The detected features are stored in structured FITS-format datasets containing feature identifiers, observation timestamps, locations, and physical areas. The detection and area-estimation procedures are evaluated through comparison with reference measurements and manual inspection of representative observations. The resulting datasets provide a standardized observational resource for studying solar activity across multiple wavelengths and solar cycles.

By transforming more than a century of KSO observations into machine-learning-ready datasets, this work establishes a foundation for AI-driven studies of solar-cycle variability and solar activity patterns relevant to space weather forecasting. The framework can support future investigations connecting photospheric and chromospheric activity with eruptive solar phenomena and heliospheric space weather, demonstrating a scalable approach for integrating historical solar observations into modern data-driven space weather research.

From Magnetic Reconnection to Geomagnetic Impact: CME–Shock-Driven Type II Radio Bursts and Their Space Weather Effects

ID: P8
Time 17:00–19:00
Poster Presentation

Hasret Atasoy, Z. Funda Bostanci
Istanbul University

Type II solar radio bursts are key observational signatures of propagating coronal shocks and are closely associated with fast coronal mass ejections (CMEs). However, how CME–shock formation links to magnetic energy release during flares, and whether Type II-associated CME–shock systems produce stronger geomagnetic responses, remain incompletely understood. In this study, magnetic reconnection parameters provided by Kazachenko (2023), the Type II classification by White, Kazachenko & Cliver (2026), and CME catalogs are combined to statistically analyze the physical chain: magnetic reconnection → CME dynamics → coronal shock/Type II emission → geomagnetic response.

Eruptive flares with and without Type II emission are compared across magnetic reconnection parameters (reconnected flux, maximum reconnection rate, and reconnected flux fraction) as well as CME characteristics (speed, acceleration, angular width, mass, and kinetic energy). This analysis tests whether the relationship between magnetic reconnection and Type II emission is direct or primarily mediated through reconnection’s influence on CME dynamics and subsequent shock formation.

In the second stage, the geomagnetic impacts of events with suitable Earth-directed propagation geometry and identified interplanetary counterparts are evaluated using the Kp index. Maximum Kp distributions of CMEs with and without Type II emission are compared while controlling for CME speed, width, and energy. This determines whether Type II bursts provide diagnostic value beyond CME dynamics alone. Overall, this work establishes the physical chain from flare energy conversion to geomagnetic response, treating Type II bursts not as a direct driver of geomagnetic activity, but as an early coronal diagnostic of powerful CME–shock systems.

Stellar Space Weather and Its Impact on Exoplanetary Atmospheres and Habitability

ID: P9
Time 17:00–19:00
Poster Presentation

Salma Makhtich
LPHEA, Faculty of Sciences Semlalia, University Cadi Ayyad, Av. Prince My Abdellah, BP 2390 Marrakech, Morocco

The increasing discovery of exoplanets around active stars has highlighted the importance of stellar space weather in understanding their atmospheric evolution and potential habitability. In this work, we present a theoretical overview of the effects of stellar eruptive phenomena, including flares, coronal mass ejections, and energetic particles, on the atmospheres of exoplanets. We discuss how enhanced stellar radiation and particle fluxes can drive atmospheric heating, ionization, chemical changes, and atmospheric escape, particularly for planets located close to their host stars. The role of magnetic fields and atmospheric properties in protecting planetary environments is also considered. By comparing these processes with those

observed in the Sun–Earth system, we discuss how solar space weather physics can provide a framework for understanding space weather conditions around other stars. This study emphasizes the importance of stellar activity when assessing the long-term atmospheric stability and habitability of exoplanets.

Comparative Analysis of the Large Forbush Decreases of June 2025 and January 2026 Using Data from the AATB Neutron Monitor

ID: P10

Time 17:00–19:00

Poster Presentation

Seifullina B.B.^{1,2}, Kryakunova O.N.¹, Tsepakina I.L.¹, Nikolayevskiy N.F.¹, Koichubayev R.Ye.^{1,3}

¹ Institute of Ionosphere, Almaty, Kazakhstan; ² Al-Farabi Kazakh National University, Almaty, Kazakhstan; ³ Satbayev University, Almaty, Kazakhstan

This study compares two large Forbush decreases registered during 1–10 June 2025 and 19–25 January 2026 by the AATB neutron monitor (Almaty, Kazakhstan; 3340 m above sea level; geomagnetic cutoff rigidity $R_c = 5.9$ GV). Variations in galactic cosmic ray intensity are analyzed together with solar wind parameters, the interplanetary magnetic field, and geomagnetic activity indices.

The June 2025 Forbush decrease had an amplitude of approximately 12%. It was associated with fast coronal mass ejections (CMEs) accompanying M-class solar flares in active region AR 14100. An interplanetary shock arrived on 1 June, followed by a sheath region and interplanetary CME (ICME) ejecta.

The January 2026 Forbush decrease had a larger amplitude of approximately 18%. It was associated with a fast CME accompanying the X1.9-class solar flare on 18 January. The interplanetary disturbance reached Earth on 19 January. Both events were accompanied by strong geomagnetic activity.

The amplitudes, main phase durations, and recovery profiles of the two Forbush decreases were compared. The timing of the cosmic ray intensity minima was examined relative to the passage of the sheath regions and ICME ejecta. Differences in solar wind speed, interplanetary magnetic field strength and fluctuations, and geomagnetic activity were analyzed. The possible influence of high-speed solar wind streams on the main and recovery phases was also assessed.

This research is funded by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP23489700).

Oscillatory features of the heliosphere-magnetosphere environment

ID: P11
Time 17:00–19:00
Poster Presentation

Venera Dobrică, Crișan Demetrescu
Institute of Geodynamics, Romanian Academy

Building on our earlier work on the presence and similarity of signals at the solar magnetic (MC) and solar Gleissberg (GC) timescales in the evolution of solar, heliospheric, magnetospheric and ionospheric parameters, we investigate oscillatory features of the coupled heliosphere – magnetosphere system over approximately the past two centuries. By applying the Hodrick-Prescott analysis and Butterworth filtering, the medium- and long-term variations at inter-decadal (22 years) and sub-centennial (80-90 years) timescales can be distinguished in time series characterizing media such as the Sun, the heliosphere and the magnetosphere. The results suggest that the evolution of the entire system is given by the superposition of the two variations associated to the magnetic and Gleissberg solar cycles on the long-term inter-centennial trend. It highlights the oscillatory and predictable nature of solar-terrestrial interactions and their role in determining the long-term evolution of space weather.

Supersubstorms in strong magnetic storms of the 25th solar cycle

ID: P12
Time 17:00–19:00
Poster Presentation

I.V. Despirak, N.G. Kleimenova, A.A. Lubchich
1 Polar Geophysical Institute, Apatity, Russia; 2 Schmidt Institute of the Physics of the Earth RAS, Moscow, Russia

The current 25th solar cycle began in December 2019 and peaked in 2024–2025, and is characterized by very strong magnetic storms, during which geomagnetic disturbances were observed at unusually low geomagnetic latitudes. Strong magnetic storms are often accompanied by intense and very intense substorms, so-called supersubstorms (SSS), which were identified as a separate substorm type relatively recently. Supersubstorms were defined as substorms with very high values of the SML index of geomagnetic activity (< -2500 nT). Although this value was chosen arbitrarily, it is still used as an estimate, since it is important to have a quantitative description of the phenomenon. Until recently it was found that SSS are a relatively rare phenomenon observed mainly during intense, major storms and superstorms, when high values of the southward IMF and solar wind dynamic pressure are recorded. Besides supersubstorms, unlike regular substorms, have been shown to have a different auroral evolution and a specific character of magnetic disturbances, including convective magnetic bays development. It was also found that the supersubstorms are mainly observed during magnetic storms caused by CME. The features of supersubstorms during some strong storms during the 25th solar cycle are examined, and their various possible solar wind and IMF drivers are discussed.

Peculiar Sporadic E Structures Observed during Enhanced Geomagnetic Activity

ID: P13
Time 17:00–19:00
Poster Presentation

Daniel Kouba, Petra Koucká Knížová, Zbyšek Mošna
Institute of Atmospheric Physics, Czech Academy of Sciences, Dept. of Ionosphere and Aeronomy

We investigate the response of sporadic E (Es) layers to enhanced geomagnetic activity during Solar Cycle 25, focusing on the extreme geomagnetic storms of May 2024 (“Mother’s Day Storm”) and November 2025 (“Veterans Day Storm”). High-temporal-resolution Digisonde observations from several European mid-latitude stations, including Průhonice and Sopron, reveal changes in Es occurrence, variability, and structural complexity during geomagnetically disturbed periods. Enhanced Es activity frequently coincided with intensified auroral and geomagnetic forcing. However, the nature of this relationship remains unclear, as other observational studies have reported reduced Es activity during geomagnetic disturbances. Nevertheless, both enhancement and suppression indicate that storm-time thermospheric processes substantially affect ionospheric dynamics. Pronounced variations in Es critical frequency and virtual height further demonstrate the sensitivity of mid-latitude Es layers to geomagnetic activity, most likely through storm-induced changes in neutral winds and ionospheric plasma transport.

Spatial and temporal variations of ionospheric irregularities over Africa using Swarm satellites

ID: P14
Time 17:00–19:00
Poster Presentation

Ankwatsa Shafaani

Fluctuations in the ionosphere, often referred to as irregularities, can disrupt Global Navigation Satellite Systems (GNSS) by causing scintillation, signal loss, and positioning errors. These effects are especially significant over Africa, where the geomagnetic configuration is unique and observational infrastructure is still limited. In this study, we investigate the spatial and temporal variations of ionospheric irregularities across the African continent using measurements from the Swarm satellite constellation. The analysis made use of Swarm-derived electron density and the Ionospheric Plasma Irregularities (IPIR) index to detect and characterize irregularity events. Data were examined across different longitudes, seasons, and local times to capture both seasonal and temporal patterns. The results reveal a clear longitudinal dependence: irregularities are more frequent and intense in the western sector, particularly during the equinoxes and solstice months, while the eastern sector generally experiences fewer disturbances. Irregularity activity peaks during equinox periods, coinciding with the pre-reversal enhancement (PRE) of the eastward electric field. Seasonal and local time variations further demonstrate the combined role of geomagnetic latitude, thermospheric dynamics, and ionospheric instabilities in shaping these patterns. The study further demonstrates a strong positive relationship between the absolute electron density gradient and ionospheric irregularity indicators, showing that regions with steeper electron density gradients consistently exhibit stronger plasma fluctuations and higher irregularity occurrence.

These results identify the electron density gradient as a reliable diagnostic of top-side ionospheric irregularities observed by the Swarm constellation. Overall, the study provides new insights into the climatology of ionospheric irregularities in Africa, highlights the challenges posed by limited observational coverage, and emphasizes the need for expanded monitoring to improve GNSS reliability and space weather forecasting in the region.

Estimating the daytime vertical $E \times B$ drift velocities in the F-region of the equatorial ionosphere using the IEEY and AMBER magnetic data in West Africa

A.A. Kassamba, V. Doumbia, O.K. Obrou, F.O. Grodji, Z. Tuo, N. Kouassi, E. Yizengaw

1 Laboratoire de Physique de l'Atmosphère, UFR-SSMT, Université Félix Houphouët Boigny, Abidjan, Côte d'Ivoire; 2 Space Science Application Laboratory, The Aerospace Corporation, El Segundo, CA, USA

In this paper the daytime vertical $E \times B$ drift velocity in the F-region of the equatorial ionosphere was estimated from the magnetic effect of the equatorial electrojet (EEJ) in the West African sector for September equinoxes in 1993 during solar cycle 22 and in 2013 during solar cycle 24. Geomagnetic data recorded during the International Equatorial Electrojet Year (IEEY) from 1993 to 1994 and the ongoing AMBER (African Meridian B-field Education and Research) program since 2008 were used. The vertical drift velocity was inferred from the EEJ contribution (ΔH) in the geomagnetic field horizontal component. The IEEY data were used to examine the seasonal variations of the daytime vertical drift velocity. The noontime seasonal averages are $V_d = 10.95$ m/s and $V_d = 9.46$ m/s respectively for March and September equinoxes, and $V_d = 8.75$ m/s and $V_d = 8.27$ m/s for December and June solstices. The daytime vertical drift velocity was found to be larger in equinoxes than in solstices. The dependence of the daytime vertical drift velocity on solar cycle was also shown by comparing the results of September equinox in 1993 and 2013. The drift velocity of 9.5 m/s in 1993 is significantly weaker than that of 24.5 m/s in 2013. This strong difference in V_d reflects the level of the solar cycle between 1993, when the mean $F_{10.7} = 109.86$ sfu, and 2013, when the mean $F_{10.7} = 122.55$ sfu.

ID: P15

Time 17:00–19:00

Poster Presentation