Meeting on Operational and Research Capabilities for Better Understanding Solar-Terrestrial Interactions

September 29 – October 3, 2025, Belgrade, Serbia

BOOK OF ABSTRACTS AND CONTRIBUTED PAPERS

Edited by Vladimir A. Srećković, Aleksandra Kolarski, Milica Langović, Mihailo Savić and Nikola Veselinović

Belgrade, 2025

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SCIENTIFIC RATIONALE

Interactions between the Sun and Earth include solar radiation, solar wind, magnetic field variations, and their effects on Earth's magnetosphere, ionosphere, atmosphere, climate, technology, and human health. These interactions are both scientifically significant and practically important, making the "Meeting on operational and research capabilities for better understanding solar-terrestrial interactions" highly relevant.

The conference aims to bridge observational, theoretical, and operational efforts to deepen our understanding of solar-terrestrial phenomena, improve predictive models, and enhance preparedness for solar-driven events. Despite progress, current prediction capabilities remain limited, which hinders effective response. Solar activity influences satellites, communication systems, power grids, and climate patterns. Events like solar flares, coronal mass ejections, and geomagnetic storms can disrupt technology, while long-term solar variability impacts climate.

The interdisciplinary nature of these studies, combined with the explosion of observational data and advancing computational models, calls for integrated approaches. The conference will foster collaboration, promote real-time monitoring tools, explore topics like cosmic ray modulation and space weather effects, and encourage the use of AI and new theoretical frameworks. Ultimately, the event aims to drive innovation and international cooperation, strengthening both scientific understanding and practical readiness.

Participants will have the opportunity to share their work, attend keynote speeches, and engage in discussions about solar physics, space weather, and related topics.

Venue

Institute of Physics Belgrade

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Posters

Plenary Invited Lectures

[https://doi.org/10.69646/aob250901]
[Plenary Invited Lecture]

Slow changes in solar-terrestrial interaction and ice-ages. The work of Milutin Milanković

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Abstract: Slow periodical changes of eccentricity of the Earth's orbit around the Sun as well as of the precession and inclination of its axis influence the insulation of the Earh's surface, changing climate and even may induce an ice-age. The cause of a periodic massive cooling in Europe, when, in the greatest cold periods, in many places on the old continent it was like today in Antarctica, was a great scientific puzzle in the nineteenth and at the beginning of the twentieth century. Karl Friedrich Schimper (1803-1867) introduced in 1837 the term "Ice Age", supposing that in Europe there were periods of cold climate with formation of glaciers. The Swiss geologist Louis Agassiz (1801-1873) and Schimper developed a theory on a series of such periods of glaciation. Between two ice ages, there was a period when the ice retreated towards the Arctic, and the last glaciation period ended a little over ten thousand years ago. This theory imposed new important questions. Why did the ice masses spread and then retreat and will the ice will come in Europe again? Many theories have been formulated, attempting to solve the puzzle of ice-ages. Serbian scientist Milutin Milankovic (1879 - 1958) devoted his life to the solution of this mystery (Dimitrijević 1997, 2002, 2020). In this lecture we will review the basic facts of the Milanković's theory of variation of Solar irradiation of Earth's (and other planets) surface with time, due to astronomical reasons, and his work on the solution of ice-ages problem.

Keywords: Ice Ages, Solar-terrestrial Interaction, Milutin Milanković

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Invited Lectures

[https://doi.org/10.69646/aob250902]
[Invited Lectures]

Overview of the activities in Low-background laboratory at the Institute of Physics Belgrade

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Abstract: Since 1997. when a cavern was excavated, and positioned under 12m of soil, we could be referred to as the Low-background laboratory for Nuclear physics. Our main activities are, or could be branched from, studies of background radiation of measurements in underground cavern. Currently, most of the activities are in connection with Cosmic rays studies, with emphasis on atmospheric influence on measured Muon flux and, also, detection of neutrons resulting from Cosmic rays interactions with Lead shielding of HPGe detectors. Moreover, we were studying background radiation from Radon in air, radiation from concrete and soil and skyshine radiation. Studies were continued in several international collaborations and experiments, for example on Shine experiment at CERN, where we were studying hadron interactions in connection with Cosmic rays, than the MICE experiment at RAL, UK, which is an example of using our knowledge about Muon physics for Muon ionisation cooling. Our collaboration with IAEA enabled us to produce first Indoor Radon map of Serbia. There was also participation in several European experiments in connection to Nuclear physics. The newest example of participation in a collaboration is the gLOWCOST, a collaboration for building and operating a World network of small sandwich-type plastic scintillator detectors for monitoring of muon flux.

Keywords: Cosmic rays, Gamma spectroscopy, Underground laboratory

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[https://doi.org/10.69646/aob250903]
[*Invited Lecture*]

Cosmic Ray Studies Related to Space Weather in Türkiye

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Abstract: In this talk, we summarize the space weather related studies based in Türkiye, mostly at Istanbul University and Türkiye National Observatories. Daily sunspot and chromospheric narrow-band observations in H_alpha have been carried out continuously since 1951 at Istanbul University Observatory. These observations are conducted with two telescopes focused on the photosphere and chromosphere. Sunspots are monitored daily using a 13 cm, 200 cm focal length Photosphere Telescope (50′ FOV), while flares and prominences are observed with a 12 cm, 232 cm focal length Chromosphere Telescope. In addition to these efforts in 2024 we built the Mirya-m1 muon detector, which consists of two 1m^2 scintillators readout by eight photomultiplier tubes (PMTs) located on each side of the scintillators following a very similar design to muon impact tracer and observer (MITO, Ayuso et al. 2021). The Miyra-m1 detector is located in the

Türkiye National Observatories' Eastern Anatolia Observatory site at an altitude of roughly 3150 metres in Erzurum, Turkiye. We also acquired and installed an e-callisto radio spectrometer to monitor radio bursts. At the moment, a smaller cosmic ray detector has also been installed as a part of the gLOWCOST network. Finally, we are establishing a neutron monitor system based on three NM64 systems, from LND. We are hoping that by the time of the meeting the monitors will be shipped to Türkiye and by the end of 2025 Türkiye will be an active contributor to the Neutron Monitor Database.

Keywords: cosmic rays, space weather, solar activity

Acknowledgement
This project is being supported by the Turkish Republic, Directorate of Presidential Strategy and Budget project, 2016K121370.

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[https://doi.org/10.69646/aob250904]
[Invited Lecture]

Impact of Solar Activity on the Evolution of Positive and Negative Streamers in Sprite Phenomena

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Abstract: Sprites are large-scale transient luminous events occurring high above thunderstorm clouds, typically in the mesosphere at altitudes between 50 and 90 km. They are initiated by intense electric fields following lightning discharges and are characterized by rapidly propagating streamers. Streamers are thin filaments of weakly-ionised nonstationary plasma produced by an ionisation front that moves through non-ionised matter. Understanding the dynamics of sprite streamers is essential for modelling upper atmospheric electrical phenomena and their coupling to space weather. In this study, we present a classical fluid model for streamer inception and propagation, implemented using the AMReX software framework for adaptive mesh refinement and parallel computing (Simonović et al. 2024). We specifically investigated the influence of background ionisation on the evolution of positive and negative streamers. Background ionisation in the upper atmosphere is strongly dependent on galactic cosmic ray (GCR) flux, which is modulated by solar activity through the heliospheric magnetic field. Periods of low solar activity correspond to increased GCR penetration and higher ionisation levels, potentially

altering streamer morphology, velocity, and branching behavior. Our simulations reveal distinct differences in streamer dynamics under varying ionisation conditions, highlighting the sensitivity of sprite formation to space weather parameters. These findings contribute to a deeper understanding of the electrodynamic coupling between the troposphere and ionosphere and underscore the importance of solar-terrestrial interactions in shaping transient luminous events.

Keywords: sprites, streamers, fluid model, ionisation, solar activity

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[https://doi.org/10.69646/aob250905]
[Invited Lecture]

High Resolution in Situ observations at Lagrange 1 Point and Earth's Bow-Shock: past, present, and future

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Abstract: The terrestrial bow shock provides a unique laboratory for investigation of properties of collisionless shocks using in situ measurements under a wide range of conditions appearing over several solar cycles. The measurements at the bow shock and at L1 point upstream of the shock have amounted to a legacy of three full solar cycles at 4s resolution for electron, and a minimum of 92s resolution for ion measurements over several missions, proving a comprehensive database for space weather research. We review the current datasets capabilities, the major scientific outcomes, and provide an overview of current and future multi-point observations with missions such as Magnetospheric Multiscale (MMS) and Helioswarm missions.

Keywords: solar wind, plasma instabilities, thermal noise

Lectures

[https://doi.org/10.69646/aob250906]
[Lecture]

Synergies of hydrology and space science: How cosmic-ray neutrons are used to detect water

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Abstract: Space weather observation with neutron monitors is based on the assumption that environmental conditions do not influence the local cosmic-ray signal. However, hydrogen in nearby snowpack or soils may be a nuisance even to highly shielded neutron detectors. This nuisance has been turned into a signal of major interest by scientists in hydrology and environmental research (Zreda et al., 2008).
Water in air, soil, snow, and vegetation determines the amount of ground-albedo neutrons from 1 to 10^5 eV, which can by efficiently monitored by neutron detectors with a thin moderation shield. Dedicated Monte Carlo modeling revealed a signal footprint that extends decimeters deep into the soil and over 10 hectares area due to the long-range neutron diffusion in air. Thereby detectors can capture root-zone soil moisture relevant for irrigation or drought analysis. Hence, the technology has the potential to bridge the scale gap between point-scale and remote-sensing products. Due to their low maintenance and non-invasive nature, the technology has been established worldwide as a reliable and continuous measurement of soil moisture in agriculture or snow in alpine environments. Neutron detectors can also be used in mobile mode on cars, trains, or airships

to facilitate on-demand soil moisture mapping at the field-, regional, or even national scales.
However, these measurements are based on the assumption of a constant incoming cosmic-ray flux, which poses the challenge of real-time corrections using the neutron monitor database, for instance (Hertle et al., 2025). Since their network is sparse, joint efforts are required across disciplines to ensure sustainable observations of cosmic-ray variations continuously in space and time (Franz et al., 2025). The presentation will demonstrate how ground albedo neutrons from cosmic rays are used in hydrology and discuss the strong links and potential synergies with space weather research and adjacent disciplines.

Keywords: cosmic rays, neutron detectors, sensor networks, soil moisture, snow

Acknowledgement: We acknowledge support by 21GRD08 SoMMet (Metrology for multi-scale monitoring of soil moisture), a Joint Research Project within the Programme 'European Partnership on Metrology' of EURAMET.

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[https://doi.org/10.69646/aob250907]
[Lecture]

Why a Minor Storm Did More Harm Than a Super One: Effects of the 2022 February G2 and 2024 May G5 Geomagnetic Storms

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Abstract: This study investigates the impact of minor geomagnetic storm of 03–04 February 2022 and super geomagnetic storm of 11 May 2024 on the variations of ionospheric responses across the low, mid, and high-latitudes while assessing potential connection of failure of Starlink satellites from variations of solar wind parameters (Bz, density, speed and plasma beta) perspective. The analysis utilizes Global Navigation Satellite System (GNSS) and Digisonde measurements, and models (International Reference Ionosphere, IRI 2020 and IRI-Plas 2017) to examine variations in the critical frequency (foF2) and height of peak electron density (hmF2) at F2-layer and Total Electron Content (TEC). The peak diurnal Digisonde-derived foF2 and GNSS TEC values observed on 01 February 2022 (a relatively quiet day) were significantly enhanced by about 61% and 70%, respectively on 04 February 2022 (recovery phase), near the Starlink satellite launch station (EG931). The substantial increases in foF2 and TEC values may be attributed to heightened solar wind parameters (notably 350% peak Bz decease and 638% plasma beta increase on 03 February 2022, 125% Bz decrease, 300% density and 95% plasma beta increase on 04 February 2022 compared to 01 February 2022). The 11 May 2024 storm produced reductions in both foF2 and TEC values on most of the time during the

main phase compared to the initial and recovery phases. However, compared to the quiet time variations the parameters show enhancements, with the highest (about 219%) being seen by the diurnal GNSS TEC values at the low latitude station of AS00Q.

Keywords: Geomagnetic storm, foF2, hmF2, TEC, low latitude, mid latitude, high latitude

[https://doi.org/10.69646/aob250908]
[Abstract]

Different Structural Elements of Corotating Interaction Regions: A Study on Characteristics and Geoeffectiveness 2008 – 2024

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Abstract: Corotating interaction regions (CIRs) arise in interplanetary space where high-speed and slow solar wind streams interact, leading to compressing plasma and magnetic fields. In this study, we investigate the properties of CIRs using *in situ* data from the WIND spacecraft, covering the period from January 2008 to December 2024. We analyze the correlation between basic solar wind (SW) parameters in different regions of CIRs specifically, ahead of and behind the stream interface (SI). Additionally, we also assess the associated variations in geoeffectiveness and cosmic ray neutron flux. For this purpose, we made a list of 832 solar wind disturbances incorporated into an online catalog for general use. After classifying these disturbances into CIRs, interplanetary coronal mass ejections (ICMEs), interactions, and complex events, we focused on 564 CIRs (68% of all SW events) with clearly identifiable SI. The correlation coefficients of magnetic field strength, $B_{\max}$, the proton thermal speed, $v_{th\max}$ and solar wind speed, $v_{\max}$, between the region in front and behind the SI are characterized by: cc = 0.85, 0.66 and 0.78, respectively. Notably, the proton density,

Np_{max}, exhibited two distinct CIR populations, with correlation coefficients of *cc* = 0.83 and 0.96. Furthermore, our results indicate that the most significant decreases in the Dst index and cosmic ray neutron flux typically occur between the SI and the reverse shock of the CIR.

Keywords: Corotating interaction regions, Solar wind disturbance, Stream interface, Cosmic ray

Acknowledgement
[The authors are grateful to the STEREO/SECCHI team (Goddard Space Flight Center, Naval Research Laboratory), the Wind team, the Moscow neutron monitor team, and SEVAN Cosmic Ray Division for providing the data].

[https://doi.org/10.69646/aob250909]
[Abstract]

Full-disk Solar Observations of the Solar Chromosphere (Hα) and Transition Region (CaII K) from the Rozhen National Astronomical Observatory

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Abstract: We present the initial results from the newly commissioned telescopes designed for solar observations in the Hα (6562.8 Å) and CaII K (3933.7 Å) spectral lines. The telescopes are refractors with free apertures of 130 mm and 100 mm, respectively, and are capable of imaging the full solar disk. The bandwidth of the Hα filter is <0.5 Å, and <2.4 Å for the CaII K line. We are presenting the technical parameters and resolution capabilities of the observational equipment. The system also includes 16-bit digital cameras capable of recording up to 20 fps, enabling the detection and analysis of rapidly evolving active events on the solar disk.

Keywords: Solar Chromosphere, Solar activity, Solar observations

Acknowledgement
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[Abstract]

Equipment and technical specifications for ground-based monitoring of solar radiation at the Rozhen National Astronomical Observatory

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Abstract: We present observational data from the newly established monitoring station for measuring solar radiation across various ranges of the electromagnetic spectrum (UVA, UVB, visible light, and infrared) at the Rozhen National Astronomical Observatory. The data is openly and freely accessible, with an updated archive that allows for the retrieval of past events. The main parameters and equipment of the station are described. Additionally, the station includes sensors for recording and building an online database of rainfall and snowfall measurements.

Keywords: Solar radiation, UV, Space Weather

Acknowledgement
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[https://doi.org/10.69646/aob250911]
[Abstract]

Exploration of AIR profile by meteorological balloons

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Abstract: Scientists have performed different kind of measurements with various experimental setups for more than 100 years in order to explore in detail the atmospheric ionizing radiation (AIR) profile. The common feature of all previous AIR measurements is the presence of continuous intensity increase of ionizing components along the atmospheric vertical profiles up to the well-known Regener-Pfotzer (RP) maximum appearing between 16-25 km altitudes.
In this study, peaking in ionizing radiation intensity in the atmosphere was registered below 10 km altitude, exceeding for more than 20 times the values at these heights from previous measurements by meteorological balloons (or in any other way lifted detectors into the atmosphere), as well as from simulations. We confirmed these findings by three independent measurements performed by detectors equipped with ultra-thin mica windows. The registered anomaly was

observed at altitude ranging from 5-8 km, in a very narrow altitude region (around 300 m).

Monte-Carlo simulations of propagation of cosmic rays through the atmosphere were performed, searching for possible increase in number of detected events at certain altitudes (10 km, 8 km, and 5 km) due to air-shower developments. Unlike our experimental results, the simulation results did not show an enhance in the number of cosmic ray produced secondary particles at certain altitudes (5 km or 8 km) relative to the 10 km altitude.

Results presented in this study will have broad impact on better understanding of the ionizing radiation production mechanism in the atmosphere, as well as on its dose consequences.

Keywords: atmospheric effects, atmospheric ionizing radiation, meteorological balloons, ultra-thin window GM tube, vertical ionization profile

[https://doi.org/10.69646/aob250912]
[Abstract]

Imaging via detection of cosmic muon induced secondary particles

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Abstract: Cosmic-ray muography has been used for the inspection of geological and industrial structures (e.g. fuel in nuclear reactors). However, the muon imaging of small structures with low atomic number and density was not yet solved appropriately. Completely new imaging method by cosmic-ray muons, based on the detection of secondary produced radiation in object material has been demonstrated by our research group. Taking advantage of the production rate of secondaries in the target materials, detected in coincidence with muons by plastic scintillator detectors, together with muon tracker, the first cosmic-ray muon images of bone and soft tissue

were created. These pictures represent the first radiographies of structures of organic origin ever recorded by cosmic rays. The research using Monte-Carlo (MC) simulations, done by Geant4 software, includes simulations of the interactions of cosmic-ray muons with different detectors and different target materials in order to optimize the experimental setups and further investigate the processes leading to image creation.

In this work, we will present two experimental setups in Novi Sad (MUCA) and Budapest (COMIS), used for muography of different test materials and the obtained images via those setups. MUCA- Muon Camera setup consists of 4 plastic scintillation detectors (50cm × 50cm × 5cm) and muon tracker (5 CCC boards 25cm x 25cm) placed above the object imaged. COMIS (Cosmic Muon Induced Secondaries) experimental setup is comprised of muon tracker (5 CCC boards 50cm x 50cm, with 2mm resolution) placed below the object imaged, 4 plastic scintillation detectors (50cm × 50cm × 5cm) positioned around the object and 4 plastic scintillation detectors (25cm × 25cm × 5cm) under the target volume. The aim of this research is to provide imaging and composition study of various objects, emphasizing low atomic number and density materials, using only natural omnipresent cosmic radiation.

Keywords: cosmic muon imaging; muon secondaries detection; low atomic number materials; Geant4 simulations; coincidence event detection

[https://doi.org/10.69646/aob250913]
[Abstract]

Thermospheric Response to Geomagnetic Storms and Impacts on Satellite Orbital Decay: A Comparative Analysis of the 2003 and 2024 Events

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Abstract: Geomagnetic storms inject significant energy into the upper atmosphere, increasing thermospheric temperature and density and, consequently, increase the atmospheric drag experienced by satellites in low Earth orbit (LEO). This study compares the effects of the October 2003 geomagnetic superstorm and the May 2024 storm on satellite orbital decay by quantifying changes in thermospheric density and their influence on drag force. Using analytical models combined with empirical density data from the NRLMSIS model, we calculated drag-induced decay rates for a representative LEO satellite at 400 km altitude. Results show that the decay rate increased from 73 m/day to 104 m/day in 2003, and from 155 m/day to 258 m/day in 2024, demonstrating a significant increase in drag on satellites which may affect their useful life. These findings highlight the critical importance of accounting for space weather conditions in satellite mission planning, particularly during solar maximum periods.

Keywords: Geomagnetic storms, Thermospheric density, Satellite drag, Orbital decay, Space weather, LEO satellites

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[https://doi.org/10.69646/aob250914]
[*Abstract*]

Lightning induced Electron Precipitation and related Ionospheric Electron Density Changes estimated from VLF Signal Perturbations recorded in Belgrade

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Abstract:
Energetic Electron Precipitation (EEP) events are of particular significance for dynamic of Earth's ionosphere (e.g. Prölss 2012; Silber and Price 2017; Mironova, Sinnhuber & Rozanov 2020). In this study, short-lived nocturnal phenomena related to Lightning induced Electron Precipitation (LEP) process taking place at altitude range corresponding to lower ionosphere were studied based on perturbations in propagation of Very Low Frequency (VLF; 3-30 kHz) radio signals recorded in Belgrade, Serbia. Multiple LEP events occurred over several years were inspected, with focus placed on amplitude and phase variations associated with selected LEP events, monitored and observed on two VLF signals with relatively close paths over Europe. Based on numerical simulations using LWPCv21 program (Ferguson 1998), regions of enhanced ionization along propagation paths of two signals (an European signal transmitted on frequency 22.1 kHz from UK towards Belgrade with relatively short path of approx. 2

Mm and an American signal transmitted on frequency 24 kHz from USA towards Belgrade with relatively long path of approx. 6.6 Mm) were determined, placing the zones of enhanced ionization over region corresponding to mid-latitude central European sector. Perturbed lower ionospheric electron density profiles related to analyzed LEP events were estimated, with main specifics and features presented in this research.

Keywords: VLF signals, ionospheric perturbations, lightning events, electron precipitation

Acknowledgement

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[Abstract]

Polarization Studies of the Solar Corona During Total Solar Eclipses: Results and Perspectives

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Abstract: Polarization studies during total solar eclipses (TSEs) provide essential insights into the physical conditions within the white-light solar corona, where many polarization-related problems remain unsolved. Polarized-light observations during TSEs allow direct determination of the electron density, enabling large-scale mapping of electron concentration in the corona and facilitating the separation of its K (electron-scattered) and F (dust-scattered) components. This separation is crucial, as the F-corona is practically unpolarized within 3 solar radii from the limb, allowing clearer characterization of the polarized K-corona. Despite their importance, systematic data on the dependence of the degree of polarization on wavelength, particularly within polar plumes, remain insufficient.

Our team has conducted white-light corona polarization experiments during TSE expeditions in 1999 (Bulgaria), 2006 (Turkey), 2017 (USA), 2019 (Chile), 2023 (Australia), and 2024 (Mexico). We aim to expand and repeat these measurements during the TSE on 2026 August 12 from Spain. In this presentation, we outline our polarimetric methodologies to determine the degree of polarization across different coronal regions reliably. These studies contribute to refining

coronal models and advancing our understanding of the distribution and dynamics of the solar corona during total solar eclipses.

Keywords: Solar corona; Polarization; Total solar eclipse;

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[Abstract]

3D Geophysical Vector Magnetometer: Installation and Calibration

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Abstract: In this work, we present a newly established three-axial magnetoresistive vector magnetometer for monitoring the Earth's magnetic field. The magnetometer is designed and developed by a team from the Institute of Astronomy and National Astronomical Observatory at the Bulgarian Academy of Sciences. This instrument provides the possibility of continuous monitoring and study of short-term changes (seconds) in the Earth's magnetic field. A dynamic database with open access is organized. This provides an additional opportunity for research and analysis of long-term geomagnetic dynamic processes related to various phenomena, solar activity, and space weather. The magnetometer shows a measurement accuracy of less than 1nT on every axis in combination with automatic internal

temperature stabilization of the sensor triad and most sensitive electronic components. Temperature accuracy is 0.003°C at sampling rate of one data measurement per second.

Keywords: Magnetometer; Geomagnetic Field; Magnetoresistance; Space Weather;

Acknowledgement

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[Abstract]

Urban Observatory of Belgrade

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Abstract: We present the three-year project Urban Observatory of Belgrade (UrbObsBel) funded through the Prisma call of the Science Fund of the Republic of Serbia which started in January 2024. We show our instruments and we discuss our first results related to the problem of the light pollution in Serbia. We also plan to perform observations which will provide information on the distribution of energy consumption, which has a major impact on the environment and ecosystems. We pay special attention to the instrument we have made,

but actually developed by Salazar-Vazquez and Mendez-Vazquez (2020), the visible and near-infrared (VNIR) hyperspectral imaging (HSI) detector mounted on the Tower of the Astronomical Observatory of Belgrade, and discuss its applications.

Keywords: Light pollution, instruments, visible and near-infrared hyperspectral imaging detector

Acknowledgement
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[https://doi.org/10.69646/aob250918]
[Abstract]

Machine Learning for Space Weather: Overview of Research Efforts at Georgia State University

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Abstract: Over the past decade, the Heliophysics community has increasingly explored machine learning (ML) techniques, as reflected in the exponential growth of peer-reviewed publications, conference presentations, and funding opportunities. Among the key areas of ML application, space weather forecasting stands out as a field with tremendous potential for data-driven decision-making. This contribution highlights some of the ongoing ML research efforts at Georgia State University, including: (1) ML-driven forecasting of solar transient events (STEs) such as solar flares, coronal mass ejections, and solar energetic particles; (2) intertwining the ML with physics-based simulations for further enhancement of predictions of STEs; (3) the development of ML-ready datasets and data exploration tools for improved forecasting of STEs, radiation exposures at aviation altitudes, and other applications.

Keywords: Space Weather, Machine Learning, Data Mining

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[https://doi.org/10.69646/aob250919]
[*Abstract*]

Alertissimo: orchestrating LSST broker alerts for scientific workflows

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Abstract: Alertissimo is a framework in development for coordinating astronomical alerts from multiple LSST brokers. Its aim is to standardize common broker concepts while also making broker-specific features accessible, using a modular architecture based on an intermediate representation (IR). Alertissimo will provide a domain-specific language (DSL) for defining scientific workflows, helping astronomers combine broker outputs and follow up on events of interest. Future plans include natural language processing (NLP) features, allowing researchers to interact with alerts and workflows through conversational queries. While still at the demonstration stage, Alertissimo is intended as a practical tool for collaborative and reproducible exploration of the dynamic sky.

Keywords: LSST, astronomical alerts, scientific workflows

Acknowledgement

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[Abstract]

Balkan, Black Sea, and Caspian Sea Regional Network for Space Weather Studies

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Abstract: 50 years after the International Geophysical Year (IGY) in 1957-1958, one of the most successful international science programs of all time, the "International Heliophysical Year" (IHY) was organized in 2007-2008. The term "Heliophysical" emphasized studying the interconnectedness of the entire solar-heliospheric-planetary system, thus broadening of the concept of "geophysical," extending the connections from the Earth to the Sun and interplanetary space.
The IHY had the following science goals for 2007-2008:

- Develop the basic science of heliophysics through cross-disciplinary studies of universal processes.
- Determine the response of terrestrial and planetary magnetospheres and atmospheres to external drivers.
- Promote research on the Sun-heliosphere system outward to the local interstellar medium – the new frontier.
- Foster international scientific cooperation in the study of heliophysical phenomena now and in the future
- Communicate unique IHY results to the scientific community and the general public.

To coordinate the IHY-related activities, several regional networks were organized. Only one of them is still active: the Balkan, Black Sea, and Caspian Sea Regional Network (known as the "BBC Network") for Space Weather Studies which was created in 2005 and earlier this year it celebrated its 20th

anniversary. In this presentation I will highlight the history, activity, and opportunities for joint research.

[https://doi.org/10.69646/aob250921]
[Abstract]

Influence of the D-region electron density on modeled ionospheric Wait's parameters in quiet conditions – case study

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Abstract: In this paper, we show the difference in the ionospheric D-region electron density depending on two sets of parameter values in the quiet period before the influence of the solar X-ray flare. These data sets are obtained on the basis of the Quiet Ionospheric D-Region (QIonDR) model and its modification for the current period determined using analysis of the time evolutions of ionospheric parameters. We study D-region perturbation induced by the solar X-ray flare of class M1.4 that occurred on 1 July 2014. The obtained results show that the deviations increase with height and the highest value is reached during the maximum of the perturbation, but that in the observed example, the difference is greater than one order of magnitude only during intense perturbation for altitudes above 80 km.

Keywords: Solar X-ray flare, ionospheric D-region, VLF signal

Introduction

Modelling the atmosphere is very complex both in quiet and disturbed periods. At the same time, modelling in quiet conditions also affects the determination of parameter variations during perturbations.

In this paper, we show the impact of modelling the ionospheric D region in quiet conditions on the determination of the electron density during the perturbation caused by a solar X-ray flare. We analyze differences in calculations of the D-region electron density using the QionDR model and its modification by the procedure described in Nina (2022). The QionDR model provides general dependences of Wait's parameters on quiet conditions on the sunspot number and day of year in the midday periods (relevant for this study). The procedure given in Nina (2022) relates to the observed time period and it is based on the analysis of evolution of the Wait parameters sharpness β and reflection height H' during the impact of a solar X-flare. Here we consider the solar X-ray flare of class M1.4 that occurred on July 1, 2014.

Observations, data and modelling

The considered solar X-ray flare is recorded by GOES satellite in period 11:05 to 11:59 UT with maximum intensity corresponding to class M1.4 on 11:23 UT. To analyze ionospheric D-region electron density we process a very low frequency (VLF) signal used for monitoring of this atmospheric layer. We consider VLF signal emitted by the DHO 23.4 kHz transmitter located in Germany and received by the (AWESOME) receiver in Serbia. The recorded data in the considered period is shown in Fig. 1.

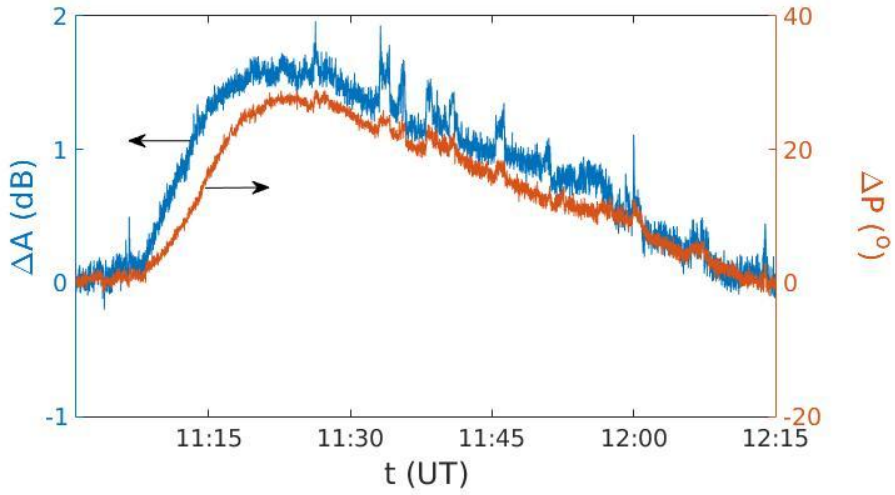

Figure 1. Differences of the recorded amplitude ΔA and phase ΔP during perturbation with respect to the corresponding values during quiet condition before influence of the considered X-ray flare.

The ionospheric Wait's parameters sharpness β and reflection height H' are modelled using procedure described in details in Nina et al., 2020. This procedure requires knowledge of the values of these parameters in quiet conditions before the considered perturbation period. To calculate them we apply two procedures based on the QIonDR model. First procedure is based on the basic QIonDR model (Q), and the second one use the modification of this model described in Nina (2022) (mQ).

The electron density Ne in both procedures is calculated using equations (Thomson 1993)

$$N_e(h,t) = 1.43 \cdot 10^{13}\, e^{-\beta(t)H'(t)} e^{(\beta(t)-0.15)h},$$

where h is height.

Results and discussion

According the QionDR model, the initial values (e.g. values in quiet

conditions) of parameters βQ and H'Q are 0.483 km-1 and 71.1 km. Applying the procedure described in Nina 2021, the obtained corresponding modified values βmQ and H'mQ are 0.450 km-1 and 70.0 km, respectively..

The modelled time evolutions of Wait's parameters, presented in Fig. 2, show that β is higher and H' lower in the second case during the whole considered time period. The absolute values of the differences Δβ=βmQ - βQ and ΔH'=H'mQ - H'Q (shown in the bottom panel) are the largest in the period of maximum perturbation and have values approximately from 0.1 km-1 to 0.2 km-1, and from 1 km to 2 km, respectively.

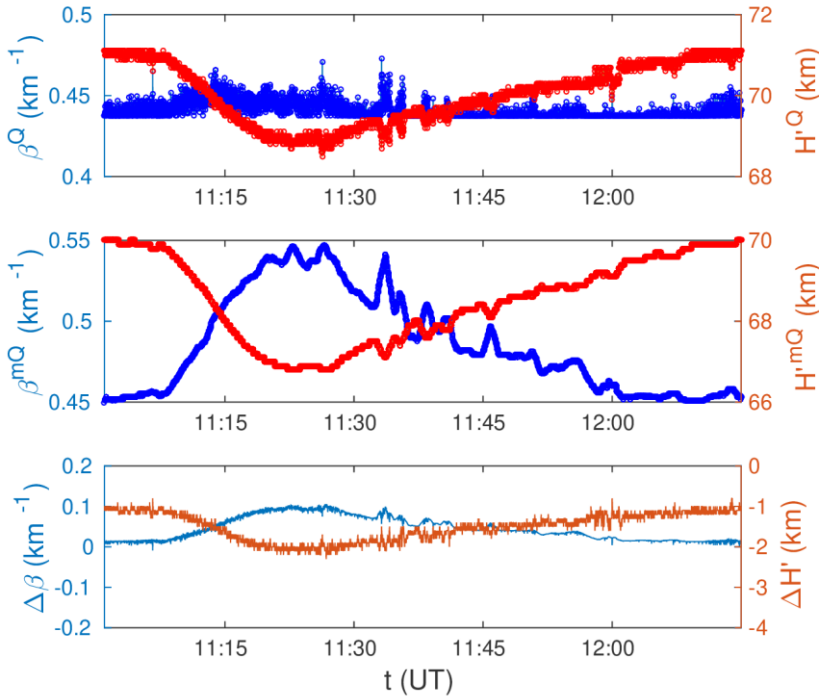

Figure 2. Time evolutions of Wait's parameters for initial values obtained by the QionDR model (upper panel) and modelled by procedure given in Nina, 2021 (middle panel). Time evolutions of differences of these parameters Δβ and ΔH' are given in the bottom panel.

Dependencies Ne(t,h) for both sets of Wait's parameters are presented in Fig. 3. The calculations based on the QionDR model (NeQ) are shown in the upper panel, while the results obtained using this modified model (NemQ) are given in the bottom panel. As one can see the electron density has higher values in the second case.

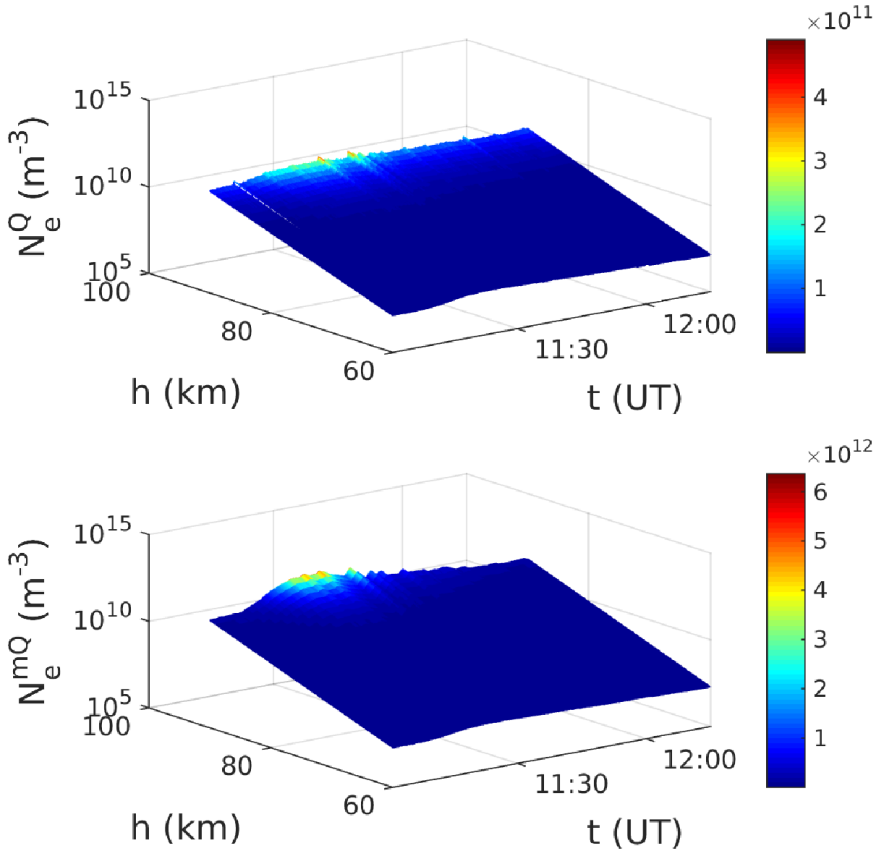

Figure 3. The electron density dependencies on the time t and height h for the initial Wait's parameters calculated by basic (upper panel) and modified (bottom panel) model.

The ratio r=NemQ/NeQ (shown in Fig. 4) is the most pronounced in the period of maximum perturbation and rise with height. It indicates that difference of the obtained electron density is within one order of the magnitude except in the period of the most intense perturbation for altitude larger than 80 km.

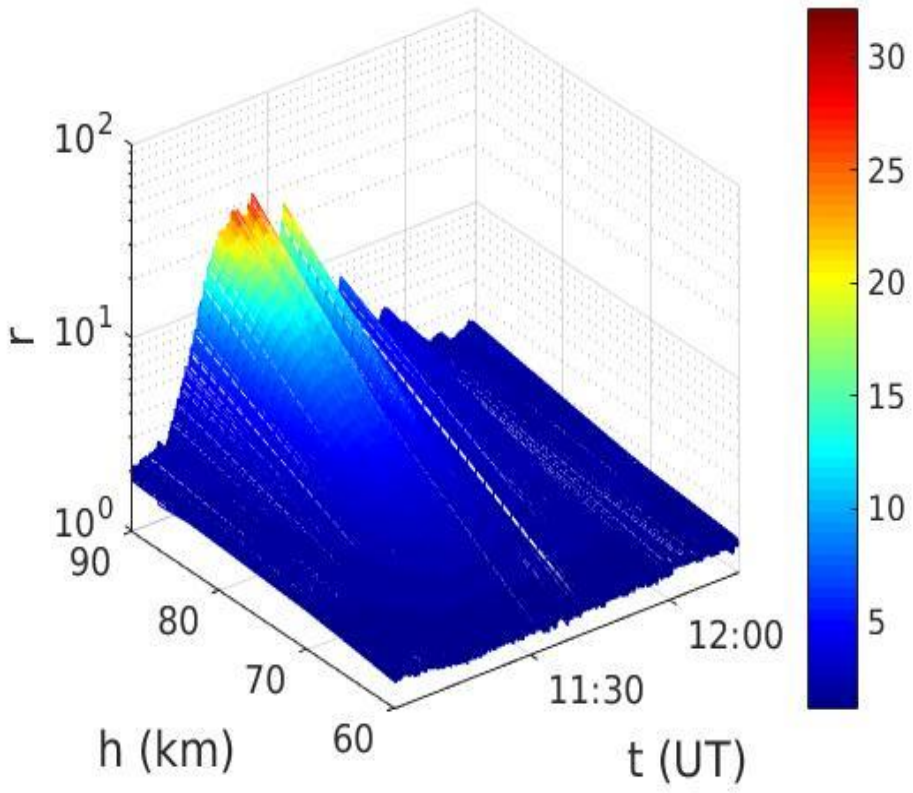

Figure 4. Dependencies of the ratio r=NemQ/NeQ on the time and height.

This results indicate that the considered modification is important for strong perturbations at the upper D-region part.

Summary

In this study we show difference in modelling of the ionospheric D-region electron density applying two procedures for determination of initial ionospheric Wait's parameters in quiet condition. To calculate them we apply QionDR model and its modification which give the time evolutions of Wait's parameters during perturbations that best match the shapes of signal amplitude and phase. We consider an example of perturbation induced by a solar X-ray flare of class M1.4 that occurred on 1 July 2014. The obtained results show that differences are within one order of magnitude except during intense perturbation above 80 km.

Acknowledgement

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[https://doi.org/10.69646/aob250922]
[Abstract]

Mini-neutron monitor ROZHEN: technical parameters and capabilities

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Abstract: Since neutron monitors were first developed in the 1960s, their fundamental design principles have remained largely unchanged. However, in the past two decades, there has been increasing deployment of smaller, lighter versions of standard neutron monitors—mini-neutron monitors (MNMs). This paper presents a compact and cost-effective MNM deployed at Rozhen Observatory. We describe our new mini-neutron detector (MNM-ROZH), which utilizes gas-filled proportional counters (LND2043 BF_3). These detectors serve as effective cosmic ray monitors by measuring the secondary neutron flux produced by cosmic ray interactions in the atmosphere. We present the technical specifications of the MNM design, electronics systems, and software implementation, along with background measurements and initial results. The system is purposed for long-term cosmic ray monitoring and investigation of correlations between cosmic ray variations and solar activity.

Keywords: Neutron monitor; Cosmic rays; Space Weather;

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[https://doi.org/10.69646/aob250923]
[*Abstract*]

Gaseous Muon Trackers in Muography

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Abstract: Muography is a novel imaging technology to reveal the internal density structure of hill-sized objects. The cosmic muons lose slowly their energy and penetrate hundreds of meters into the ground, thus their differential local flux correlates with the density-length they have passed through.

Combining this information with surface- or geological data density-anomalies could be located, that benefits eg. speleology, mining, volcanology, and cultural heritage research.

Detecting and tracking of each passing muon is crucial, while the main challenges for used detector technology are the portability, low power consumption, and robustness against the out-of-the-laboratory environment. Our portable gaseous tracking detector system has been designed and built, and successfully used in several locations, like caves, mines, or near volcanoes.

The presentation will focus on the designed portable tracking system, the main requirements, used detector technology, issues and

solutions; and show results from several muography campaigns in peculiar scenarios.

Keywords: muography, detector physics, gaseous detectors, geophysics

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[Abstract]

Atmospheric Effects on Secondary Cosmic Ray Muons: A Comparison Between Simulation and Observations

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Abstract: The propagation of cosmic-ray muons through the atmosphere is strongly influenced by changing atmospheric conditions. Accurately modeling these effects requires considering the entire atmospheric profile. Correlations can arise not only between different atmospheric parameters but also within the same parameter across multiple atmospheric layers. As a result, disentangling the precise contributions of these effects is nontrivial, particularly when using empirical correction models (Dorman 2004).

To address this, we employed the CORSIKA Monte Carlo package (Heck et al. 1998) to simulate muon count rate time series in which all observed variations originate solely from changes in atmospheric conditions. Our focus was on assessing how well the two dominant effects, the barometric effect (linked to variations in atmospheric

pressure) and the temperature effect (caused by atmospheric temperature fluctuations) are represented in the simulated data. For this purpose, we applied standard correction procedures (Savic et al. 2016) to both simulated and real muon flux datasets and compared the resulting time series.

The analysis showed that the annual variation in the simulated data is effectively removed after temperature correction, suggesting that CORSIKA most likely models the temperature effect with good accuracy. In contrast, the significant residual variations that remains after both barometric and temperature corrections could indicate potential issues in the way the barometric effect is implemented in the simulation framework. This result highlights the importance of carefully evaluating the accuracy of atmospheric corrections in simulations before applying them as benchmarks for empirical or theoretical models.

Keywords: [Cosmic rays, muons, atmospheric effects, CORSIKA]

Acknowledgement

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[Abstract]

gLOWCOST: Establishing a Distributed Network of Portable Muon Detectors for Space Weather Studies

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Abstract: Monitoring both space and terrestrial weather is crucial for protecting lives, infrastructure, and technology, while supporting agriculture, transportation, energy systems, and public safety, particularly during extreme solar activity events. Muon flux variations, influenced by atmospheric factors like pressure and temperature, are also sensitive to space weather phenomena. The Global Low-Cost

Observation of Weather and Space weather with Cosmic Rays and Terrestrial Sensors (gLOWCOST) is a network of affordable, portable cosmic ray muon detectors designed to monitor cosmic ray flux changes with high precision and near real-time capability, offering a powerful tool for observing dynamic shifts in both space and terrestrial weather (Mubashir et al., 2023). Additionally, the network promotes international STEM outreach and collaboration. This work presents an ongoing interdisciplinary initiative led by Georgia State University to establish a global network of these detectors, currently deployed in nine countries, with plans for further installations across diverse environmental and geophysical conditions. We discuss the detector hardware setup (He et al., 2021) and preliminary global measurements during extreme events of the ongoing solar cycle 25 (Mubashir et al., 2025).

Keywords: Worldwide network, Cosmic rays, Muon detectors, Space weather

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[Abstract]

Temperature correction of neutron monitor count rates

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Abstract: The worldwide neutron monitor network is engaged in studies of cosmic ray variations caused by interplanetary and geomagnetic conditions.
A proper understanding of variations of atmospheric origin is an important component of these studies. While the correction of neutron monitor count rates for atmospheric pressure changes is routinely performed today, most neutron monitors do not perform temperature correction at all. In this paper, we introduced a completely empirical correction method, based on Principal Component Analysis (PCA), utilizing available temperature data from the GDAS database.

Keywords: Cosmic rays, Neutron monitors, Atmospheric effects, Principal component analysis

Posters

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[Abstract]

A Generalization of the PINN Approach for Solving Selected Problems in Astrophysics

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Abstract:
We apply the methods recent generalizations of the **Physics-Informed Neural Networks (PINNs)**, based on Kolmogorov-Arnold Networks and other interpolations, for the computation of **magnetohydrodynamic (MHD)** equilibria in the solar corona. Equilibrium **curved-magnetic** structures are an important topic in solar physics. They are described by solutions of the Grad–Shafranov (GS) equation, derived in the axisymmetric approximation. For example, the GS equation and its solutions are often used for magnetic-cloud reconstruction (e.g., to determine their geometries from observations, as studied by Isavnin et al. in 2011). GS-like solutions are also important for modelling the **coronal mass ejection (CME)** phenomenon, for which a simple force-free spheromak solution is used, as studied by Shiota & Kataoka in 2016 and Verbeke et al. in 2019. Hence, particular solutions of the GS equation, called **Soloviev solutions**, can also be implemented as **time-dependent** boundary conditions, as done by Linan et al. in 2023, which leads to a better, self-consistent CME evolution model. As another example, we consider the Lane–Emden (LE) equations, which are widely employed in astrophysics and relativistic mechanics.

Our approach is general and may be exploited as an alternative to the standard PINN methodology as developed by Raissi et al. in 2019 and later.

Keywords: PINN in Deep Learning, PINN for solution of PDEs, Astrophysics,
Computational modelling

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[https://doi.org/10.69646/aob250928]
[*Abstract*]

Using Machine Learning to Predict Geomagne4c Varia4ons for GIC Applica4ons

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Abstract: Extreme space weather events can perturb Earth's magnetic field and generate enhanced geo-electric fields that result in the flow of large Geomagnetically Induced Currents (GICs) through infrastructures such as transmission lines (Gaunt 2016). These disturbances underscore the vulnerabilities and interdependencies of critical infrastructure and key resources. For example, the loss of power could also affect water, food, transportation, communication, banking, and finance. Thus, predicting geomagnetic variations is paramount to better understanding GICs to safeguard critical infrastructure. Research on GICs is starting to benefit from comprehensive data-intensive approaches such as machine Learning (ML) neural networks that are both computationally efficient and inexpensive (Baily et al. 2022). In this study, we train the multi-variate Long-Short Term Memory (LSTM) neural networks for time series analysis to ingest solar wind and interplanetary magnetic field from the OMNI dataset and geomagnetic field observations obtained from ground magnetometer recordings, with a future goal of predicting geomagnetic field disturbances for GIC applications. Neural Networks are best trained with clean and validated data sets. However, both OMNI and ground station data have

unexpected values (spikes) and/or data gaps. To address those, we present preliminary results using
the LSTM model for the following: 1) Data validation - to know how much data is missing, as well as size of data; 2) Interpolation - to reduce large data gaps. Additionally, we will also implement other neural network models, including a multi-layer perception such as the feed-forward artificial neural network (ANN) or a convolutional neural network (CNN). The results will inform the decision as to the best
neural network model to use to predict geomagnetic variations for GIC applications.

Keywords: GICs, AI/Machine Learning, Extreme space weather

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[*Abstract*]

Influence of solar activity in the middle atmosphere

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Abstract: Variations in solar activities are evident through solar cycles.These cycles can occur on millennial, centennial, and decadal timescales, although solar activity also changes on yearly (seasonal), monthly, and daily scales. Milutin Milanković, in his well-known cycles, described the millennial-scale changes in the Sun–Earth relationship and laid the foundations of mathematical climatology. Valentina Zharkova proposed that the centennial solar cycle may result from the interference of two magnetic waves with similar but not identical frequencies. According to her findings, the Sun has entered a modern Grand Solar Minimum, which is expected to lead to a significant reduction in the solar magnetic field. This article focuses on decadal solar activity, specifically the 11-year solar cycle. Changes in this cycle affect temperature and atmospheric circulation, thereby influencing the conditions for the propagation and reflection of gravity waves (GWs) in the Earth's middle atmosphere. These effects are most pronounced in the stratosphere, where variations in solar UV radiation can increase temperatures by up to 3 K and alter ozone concentration by approximately 2%. Additionally, during extreme solar minima, the lower thermosphere becomes relatively cold, with temperatures around 500 K. In contrast, during periods of high solar activity,

temperatures in the thermosphere can reach up to 2000 K. In this study, we examined the characteristics and propagation of gravity waves under these varying conditions.

Keywords: solar activity, stratosphere, thermosphere, gravity waves

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[Abstract]

New molecular data for planet formation chemistry and modeling

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Abstract: Astrochemical models play a crucial role in interpreting studies of interstellar and circumstellar molecules, providing insight into the gas's physical properties and evolution. Advances in astrochemical models are linked to changes in databases and rate coefficient estimations, both experimental and theoretical (see e.g. Iacob et al. 2019; Albert 2020; Srećković et al. 2022; Srećković et al. 2023; Vujčić et al. 2023). The science community requires access to preferred molecular data for modeling and understanding the chemistry of planet formation. Atomic and molecular datasets, such as VAMDC, are essential for developing models and simulations. The examination of studied rates offers useful insights into the occurrence of species. Research should focus on both radiative and concurrent

processes involving molecular ions, including dissociative recombination. Our goal is to calculate, evaluate, and analyze cross sections and rate coefficients for molecular ions like hydrogen and helium using different model parameters.

Keywords: data, modeling, planets

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[Abstract]

New Molecular Datasets for Modeling: Radiative Processes Involving Some Non-Symmetric Systems

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Abstract: This work explores radiative processes, namely photodissociation, in non-symmetric molecular systems with hydrogen and silicon. We provide computed molecular data, define electronic states, and derive cross-sections and spectrum absorption rate coefficients based on temperature and EUV/UV wavelengths. We provide a simple fitting formula for photodissociation cross-sections and spectral rate coefficients. Data can be used for improved photochemical modeling in laboratory plasmas and astrophysical settings (see e.g. Gnedin et al. 2009; Iacob et al. 2019; Albert et al. 2020; Srećković et al. 2022).

Keywords: data, modeling, molecules

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Ions Relevant for Astrochemistry and Laboratory Investigation, *Data*, *7*(9), 129.

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[Abstract]

Geomagnetic storms and historical vulnerabilities: A solar perspective on World War II events

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Abstract: The influence of solar activity on Earth extends beyond modern technological systems, with potential implications for historical events. This study explores the possible connection between solar storms and unexplained terrestrial incidents that occurred during World War II (1938–1941). By compiling over 50 documented cases—including industrial explosions, communication failures, and infrastructure disruptions—from newspapers, wartime reports, and institutional archives, we examine whether geomagnetic disturbances could have played a role in events traditionally attributed to sabotage or accidents.

Statistical and geographical analyses of magnetometer data and space weather indices reveal striking temporal correlations between intense solar storms and several unexplained incidents, such as widespread power failures and accidental detonations. Notably, the geomagnetic storm of November 1940 coincided with multiple industrial accidents across Europe and Asia, while the September 1941 storm aligned with

a large-scale explosion in Kansas City that affected over 400,000 people.

These findings suggest that geomagnetically induced currents and associated space weather phenomena may have inadvertently triggered or exacerbated sensitive terrestrial failures during this critical period. Beyond offering a new lens on historical events, this research underscores the broader significance of solar–terrestrial interactions for both past and present, highlighting the need for interdisciplinary approaches that integrate heliophysics, history, and societal resilience to space weather.

Keywords: Solar activity, Geomagnetic storms, Space weather, World War II, Technological disruptions.

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[Abstract]

Sunspot Activity in Solar Cycle 24 from Istanbul University Observations

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Abstract: This study presents a preliminary analysis of sunspot activity during the 24th Solar Cycle based on daily observations conducted at Istanbul University Observatory. Since 1951, systematic sunspot observations have been carried out using the University's historical meridian telescope, resulting in one of Turkey's most extensive long-term solar observation archives. The data used in this analysis were compiled from daily records maintained by researchers at the Department of Astronomy and Space Sciences. Butterfly diagrams were constructed to investigate the latitudinal distribution of sunspot groups. As in previous cycles, a clear north–south asymmetry was identified. In particular, sunspot groups in the southern hemisphere were found to cover a broader range of latitudes compared to those in the northern hemisphere. Moreover, the time series based on monthly averaged relative sunspot numbers reveals a distinct double-peaked maximum phase in Cycle 24, a characteristic also observed in Cycles 22 and 23, but more pronounced in the current cycle. These initial findings highlight the dynamic structure of the solar cycle and reflect the complexity of the Sun's magnetic field evolution. They also

emphasize the scientific value of Istanbul University's long-term observational data for contemporary solar physics research.

Keywords: Solar activity, Solar observations, Butterfly diagram, Long-term monitoring, Solar Cycle 24

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[Abstract]

Solar Observations from Ground and Space: A Comparative Study of Data from Istanbul University Observatory and SOHO

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Abstract: In this study, ground-based solar observations conducted at Istanbul University Observatory and space-based data obtained from the SOHO (Solar and Heliospheric Observatory; Domingo et al. 1995) spacecraft were comparatively analyzed over a defined time interval. The analysis utilized photospheric images and sunspot counts from both data sources. The ground-based observations from Istanbul University provide a valuable long-term dataset for monitoring solar activity, while SOHO's space-based observations offer high spatial and temporal resolution, enabling detailed tracking of short-term and dynamic solar phenomena. The study focused on the temporal distribution, morphology, and relative counts of sunspots from both datasets. Results indicate that ground and space-based observations complement each other effectively. The combined use of historical ground-based data and modern space telescope measurements offers significant advantages in solar activity studies. This integrated approach enhances understanding of solar magnetic field variations and contributes to improved modeling of solar-terrestrial interactions.

Keywords: Solar observations, Sunspots, SOHO, Ground-based telescopes

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[Abstract]

Space weather and satellite anomalies

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Abstract: Space weather phenomena, driven by solar activity and its interaction with Earth's magnetosphere, pose significant risks to satellite operations across various orbital regimes. This paper provides a comprehensive overview of the primary space weather factors—including solar flares, coronal mass ejections, high-speed solar wind streams, solar proton events, cosmic rays, and radiation belts—and their mechanisms of impact on spacecraft. We examine the orbit-dependent nature of these anomalies, highlighting the distinct vulnerabilities of low-Earth orbit (LEO), medium-Earth orbit (MEO), and geostationary orbit (GEO) satellites. Statistical analyses reveal clear dependencies on local time, geomagnetic activity, and solar cycle phase, with anomaly rates often peaking during the rising and declining phases of solar cycles. The paper also discusses mitigation strategies, including design hardening, operational responses, and advanced forecasting techniques, emphasizing the need for probabilistic, environment-aware risk management to enhance satellite resilience in an increasingly space-dependent world.

Keywords: space weather phenomena, impact on spacecraft, orbital dependence

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[Abstract]

Morphological Comparison of the Quiet and Active Sun

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Abstract: The solar atmosphere exhibits clear morphological differences between the widespread coronal network structures dominant during quiet phases and the bright loop systems, flares, and coronal mass ejections (CMEs) characteristic of active phases (Shibata & Magara, 2011). In this study, single-frame observations from SDO/AIA at 171 Å (Fe IX, ≈0.7 MK) are used to compare a low-activity period with a high-activity period (Lemen et al., 2012; Pesnell, Thompson & Chamberlin, 2012). Visual inspection shows that on the quiet day the corona appears more homogeneous, with lower contrast and small-scale structures, whereas on the active day it is dominated by intense loop bundles, nearly saturated bright cores, and extended brightness tails, producing a higher-contrast morphology. Quantitative assessments indicate that both the mean brightness and the variability of the intensity distribution increase significantly during the active period, with the coronal emission evolving toward a more clustered configuration. The results obtained in the 171 Å band can be extended to multi-wavelength analyses (94/131/193/211/304 Å) to demonstrate how activity levels leave measurable imprints across different thermal components of the solar atmosphere (Lemen et al., 2012; Pesnell, Thompson & Chamberlin, 2012).

Keywords: Solar physics, Corona, Solar activity, SDO/AIA

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[*Abstract*]

Radiation Pressure Effects in Main-Sequence Stars for Interstellar Mission Applications

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Abstract: In this study, the dynamic effects of radiation pressure—varying with spectral type—on main-sequence stars and their potential applications for interstellar space missions are investigated. High-resolution spectral data from the UVES Paranal Observatory Project (UVES-POP), obtained using ESO's Very Large Telescope (VLT), were used to determine the effective temperatures, surface gravities, and luminosities of the target stars. Astrometric parameters from Gaia DR3 were utilized to derive distances and confirm the stars' positions on the main sequence. Mass-loss rates were calculated using the method of de Jager, Nieuwenhuijzen, and van der Hucht (1988), and stellar wind parameters were derived based on these rates. The resulting radiation pressure (Prad) values were modeled as the radiative force acting on an idealized low-mass light sail positioned near the stars. Consequently, the acceleration and orbital deviations of the light sail were evaluated in a comparative manner based on spectral type. The results suggest that main-sequence stars of different spectral types could serve as potential "propulsion sources" or "navigation waypoints" in future interstellar missions. In this context, the study is considered to contribute to the optimization of trajectories for light sail-based interstellar missions.

Keywords: Stellar radiation pressure, main-sequence stars, light sail, stellar winds, interstellar missions.

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[Abstract]

The role of excited states in Solar-Terrestrial Interactions: MOLESs consortium

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Abstract: Particles from the solar wind interact with molecules from the Earth's atmosphere creating ionized species (Marinković et al. 2025) and species with excited states. These states are responsible for Auroral formation, atmospheric chemistry and chemical species production or ozone depletion. The interactions involving excited states affect the overall energy balance and heating/cooling of the atmosphere (Campbell & Brunger 2018, Kirillov 2012). Long ago, the excited states of molecules have been reviewed in the three-volume series by Melvin Robin (1974, 1975, 1985). We are establishing the consortium of researchers aiming to rewrite the classic series and update data. New collection should include new laser methods, spectra in the solid (ice) phase and new theoretical calculations. These data have become so important in recent years for astronomical and space studies, whilst data for biomolecules are largely missing. We have established a webpage of MOLESs consortium (MOlecular Excited

State spectroscopy) https://www.moless-spectroscopy.org/project/ The MOLESs consortium will meet annually in Belgrade. Our intention is to publish data in both e-book format and on-line with recommended data sets. Data-sets will be uploaded and curated in specified databases within VAMDC (Virtual Atomic and Molecular Data Centre) portal https://vamdc.org/structure/databases/ (Dubernet et al. 2916, Albert et al. 2020, Vujčić et al. 2023, Srećković et al. 2025).

Keywords: molecules, excited states, MOLESs consortium

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[Abstract]

Geomagnetic Storm Impacts on the Ionosphere in Solar Cycle 25

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Abstract: Interactions between the Sun and Earth play a critical role in shaping the near-Earth space environment, particularly during periods of enhanced solar activity. Geomagnetic storms, triggered by solar eruptions such as coronal mass ejections (CMEs), can significantly disturb Earth's magnetosphere and ionosphere. In this study, we investigate the ionospheric response to selected geomagnetic storm events that occurred during Solar Cycle 25. Hourly Kp and Dst geomagnetic indices are analyzed alongside global Total Electron Content (TEC) maps obtained from GNSS-based products. The results

demonstrate clear ionospheric anomalies correlated with storm intensity, highlighting short-term increases and irregularities in electron density. These findings emphasize the importance of continuous space weather monitoring, as ionospheric disturbances can impact navigation and communication systems. This work provides a regional perspective by focusing on the mid-latitude ionosphere, contributing to the understanding of Sun–Earth interactions during periods of heightened solar activity.

Keywords: Solar activity, Solar observations, Solar Cycle 25

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[Abstract]

Preliminary Characterization of Forbush Decreases in June 2025 from Ground-Based Measurements

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Abstract: In 2025, the solar cycle reached its maximum, driving significant solar activity characterized by intense events from active regions and coronal holes. On May 30, 2025, a powerful M8.1 solar flare triggered a fast coronal mass ejection (CME), impacting Earth on June 1, 2025, and escalating geomagnetic activity to G4 (severe) storm levels [South African National Space Agency, 2025]. This interplanetary CME induced a notable Forbush decrease, a transient reduction in cosmic ray flux caused by heliospheric disturbances [Belov et al., 2022]. The event was recorded globally by a network of ground-based neutron monitors and at the Belgrade Muon Station, Serbia, which continuously measures secondary cosmic ray muon fluxes with distinct median rigidity [Veselinović et al., 2023]. In this work we present a

comparative analysis of neutron monitor and muon detector data that enabled the determination of the rigidity spectrum. Linear regression was applied to derive power indices, facilitating a comprehensive evaluation of large-scale CME impacts on galactic cosmic ray modulation. These findings allows more comprehensive assessment of how large-scale coronal mass ejections influence the modulation of galactic cosmic rays, and also can enhance our understanding of solar-terrestrial interactions and improve space weather forecasting capabilities.

Keywords: Forbush decrease, Rigidity spectrum, Cosmic rays modulation

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SECTION (MINI PROJECTS)

M1 Monitoring and Operational Activities

M2 Analysis and Data Preparation

M3 Application and Outreach

PROGRAMME

Meeting on Operational and Research Capabilities for Better Understanding Solar-Terrestrial Interactions

September 29 – October 03, 2025, Belgrade, Serbia

Monday (day 1) September 29, 2025		
Start	End	Session
13:30	15:00	Registration
15:00	15:30	Opening ceremony
15:30	16:00	Lectures Chairs: Aleksandra Kolarski and Nikola Veselinović
		Kristina Demirhan Lecture
16:00	16:30	**Kristina Demirhan** Lecture
16:30	17:00	**Lecture** Dimitrije Maletić
17:00	18:00	Welcome cocktail

Tuesday (day 2) September 30, 2025		
Start	End	Lectures Chairs: Dimitrije Maletić and Vladimir Srećković
10:00	10:30	Openining Day 2 and Welcome speeches from Director of IPB and

		Director of Astronomical Observatory Belgrade
10:30	11:00	**Milen Minev** Lecture
11:00	11:30	**Tsvetan Tsvetkov** Lecture
11:30	**12:00**	**Coffee break**
Start	End	Lectures Chair: Nicolina Pop
12:00	12:30	**Konstantin Krastev** Lecture
12:30	13:00	**Gergő Hamar** Lecture
13:00	13:30	**Aleksandra Nina** Lecture
13:30	15:00	Lunch break
15:00	15:30	Lectures Chair: Ognyan Kounchev
		C. V. Pena Lecture
16:00	16:30	**Mihailo Martinović** Lecture
16:00	16:30	**Yekoye Asmare Tariku** Lecture
20:00	22:00	Conference Dinner
15:30	16:00	**Boyan Benev** Lecture
16:00	16:30	**Viacheslav M Sadykov** Lecture

Wednesday (day 3) October 01, 2025		
Start	End	Lectures Chair: Nikola Petrov
10:00	10:30	**Tolga Güver** Lecture
10:30	11:00	**Vergil Yotov** Lecture
11:00	11:30	**Aleksandar Dragić** Lecture
11:30	**12:00**	**Coffee break**
Start	End	Lectures Chair: Aleksandar Dragić
12:00	13:00	**Saša Dujko** Lecture
13:00	13:30	**Darije Maričić** Lecture
13:30	15:00	Lunch break
15:00	17:00	Poster Session Chair: Nikola Veselinović

Thursday (day 4) October 02, 2025		
Start	End	Lectures Chair: Srđan Samurović
10:00	10:30	**Milan S. Dimitrijević** Lecture
10:30	11:00	**Rade Pavlović** Lecture
11:00	11:30	**Veljko Vujčić** Lecture
11:30	**12:00**	**Coffee break**

Start	End	Lectures Chair: Mihailo Savić
12:00	12:30	**Martin Schrön** Lecture
12:30	13:00	**Nikola Veselinović** Lecture
13:00	13:30	**Katya Georgieva** Lecture
13:30	15:00	Lunch break
		Lectures Chair: Dejan Joković
15:30	16:00	**Mihailo Savić** Lecture
16:00	17:00	**Work on mini projects**
15:00	15:30	**Aleksandra Kolarski** Lecture

Friday (day 5) October 03, 2025		
Start	End	Session
10:00	11:00	Discussion about future projects and collaborations
11:00	11:30	Organizing committee Meeting
11:30	12:00	**Closing ceremony and departure**

AUTHORS' INDEX

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