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Article 1:

The SafeSpace Project

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The "Radiation Belt Environmental Indicators for the Safety of Space Assets - SafeSpace" project was launched in January 2020 with a duration of 36 months [https://www.safespace-h2020.eu/]. This comprehensive space weather project has been funded by the European Union in the framework of the Horizon 2020 research and innovation funding programme. The objectives of SafeSpace are relevant and fully aligned with the SCOSTEP/PRESTO program and in particular with its first pillar of research (Sun, interplanetary space and geospace).

SafeSpace aims at advancing space weather nowcasting and forecasting capabilities and, consequently, at contributing to the safety of space assets through the transition of powerful tools from research to operations (R2O). To ensure an efficient and optimized transfer from science to applications, SafeSpace takes advantage of the strong, synergistic collaboration of academia (National and Kapodistrian University of Athens - NKUA, Office National d'Etudes et de Recherches Aérospatiales – ONERA, Katholieke Universiteit Leuven – KU LEUVEN, Institute of Atmospheric Physics Ustav Fyziky Atmosfery AV CR, v.v.i. – IAP, Institut royal d'Aéronomie Spatiale de Belgique Royal – BIRA-IASB, Centre National de la Recherche Scientifique - CNRS), a major European space industry (Thales Alenia Space España – TAS-E) and a space-oriented SME (Space Applications & Research

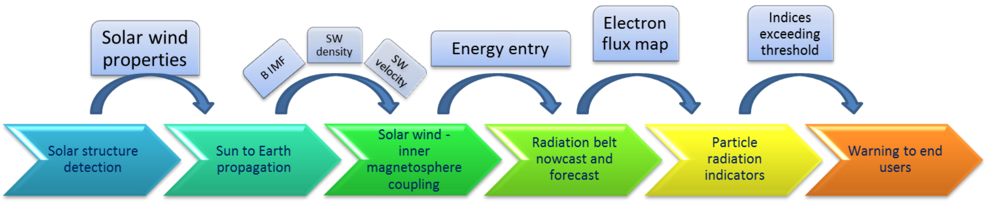

Figure 1. The overall project logic covers the complete Sun – interplanetary space – magnetosphere chain of space weather.

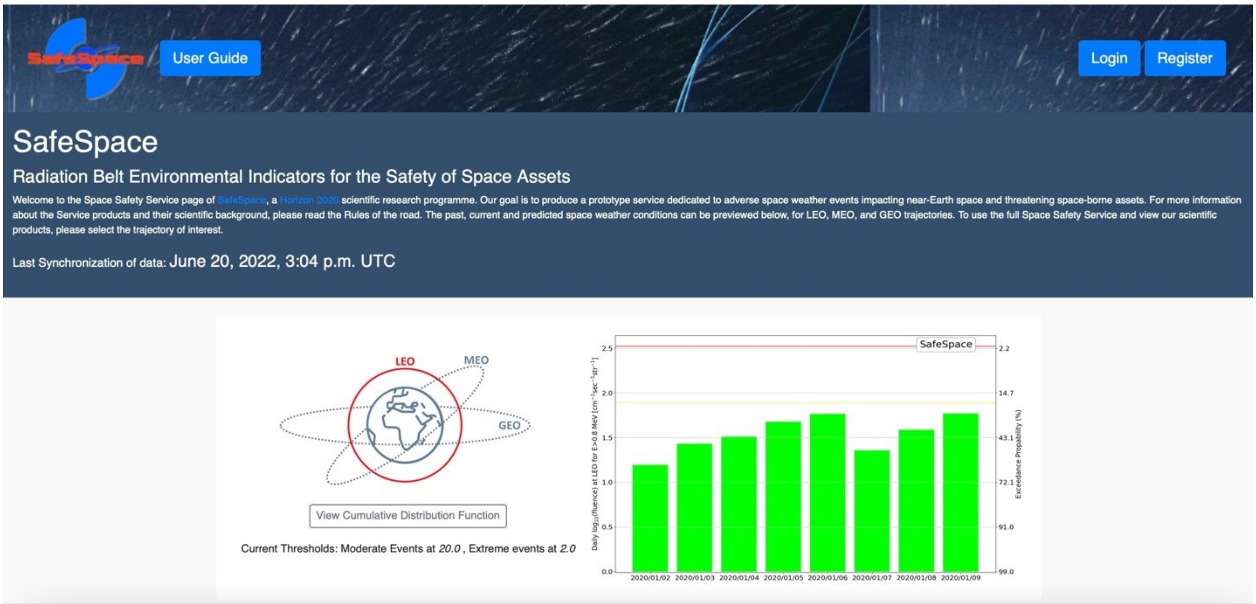

Figure 2. The SafeSpace service prototype is available at http://www.safespace-service.eu.

Consultancy Sandberg & Co Private Company - SPARC).

SafeSpace aims to improve radiation belt modelling through the incorporation into an existing physical model of processes and parameters that are of major importance to radiation belt dynamics. In order to set up a prototype of a new space weather service dedicated to Earth-orbiting satellites, end-user requirements related to space weather hazards have been defined by TAS-E in consultation with other end-users.

The main goal of the SafeSpace project is to design and produce the Space Safety Service, i.e., a service prototype dedicated to adverse space weather events impacting near-Earth space and threatening space-borne assets. The *Space Safety Service* is devoted to the prediction of hazardous – for Earth-orbiting satellites – enhancements of outer Van Allen belt electron fluxes/fluences. Effective mitigation of the detrimental effects of such electron enhancement events is possible with reliable warnings and could result in cost avoidance of several billion dollars globally per decade.

The design and output of the SafeSpace prediction service is based on the requirements of space industry partners and considers the full cause-to-effect sequence, from precursors on Sun's surface to radiation belt variability. We have achieved this through the synergistic combined use, for the first time, of the following complementary models: the solar wind acceleration model MULTI-VP (CNRS), the heliospheric solar wind propagation models Helio1D (CNRS) and EUHFORIA (KU Leuven), the ONERA Geoffectiveness Neural Networks, the IASB plasmasphere model, the NKUA EMERALD model for the prediction of the radial diffusion coefficients, the IAP model for the estimation of the VLF diffusion coefficients and the ONERA Salammbô radiation belts code, covering different regions of the complete Sun – interplanetary space – magnetosphere chain of space weather (see Figure 1). The coupling of these complementary models enables a holistic approach of radiation belt forecasting, incorporating the study of plasma and energy flow from the Sun to the near-Earth environment, the transfer into the terrestrial magnetosphere, and the effects on cold plasma density and electromagnetic wave properties, driving radiation belt dynamics.

The SafeSpace service prototype is available at: http://www.safespace-service.eu (Fig. 2). Please visit the WebSite and use the service! We would very much appreciate your feedback through this short questionnaire: https://forms.gle/gA9oBfPmKJdC1QJg9.

The SafeSpace project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870437.

*SafeSpace Team: I.A. Daglis, S. Bourdarie, J. Cueto, F. Darrouzet, B. Lavraud, S. Poedts, I. Sandberg, O. Santolik, S. Aminalragia-Giamini, G. Balasis, E. Botek, A. Brunet, I. Bueno, N. Dahmen, J. De Keyser, L. De Pablo, S. Doulfis, G. Eiguren, V. Génot, M. Georgiou, O. Giannakis, B. Grison, Z. Iqbal, J.M. Jimenez, C. Katsavrias, R. Kieokaew, I. Kolmasova, V. Maget, F.-A. Metallinou, K. Moutsouroufi, A. Nasi, J. Oliveros, C. Papadimitriou, V. Pierrard, R. Pinto, D. Pisa, E. Samara, A. Sicard, J. Soucek, Highlight on Young Scientists 1:

A Statistical Study on the Causes and Consequences of Magnetic Complexity Changes within Interplanetary Coronal Mass Ejections

Camilla Scolini

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Coronal Mass Ejections (CMEs) are gigantic eruptions of plasma and magnetic fields from the Sun. Their interplanetary counterparts (ICMEs) are the main drivers of strong-to-intense geomagnetic disturbances (Kilpua et al. 2017), and understanding their Sun-to-Earth evolution is critical to advance our knowledge of the heliospheric environment and take prompt protective measures against hazardous space weather events. ICMEs are generally depicted as highly magnetized structures with a flux-rope-like magnetic topology, known as magnetic ejecta (ME), connected to the Sun by two “legs” and often preceded by shocks and turbulent sheaths. Such a picture (Figure 1), developed through decades of observations (e.g. Burlaga et al. 1981; Luhmann et al. 2020), describes a widely accepted paradigm for a low-complexity ICME state. Yet, ICMEs observed near 1 au exhibit different levels of complexity in terms of similarity/deviation from that configuration (as shown by the two examples in Figure 2).

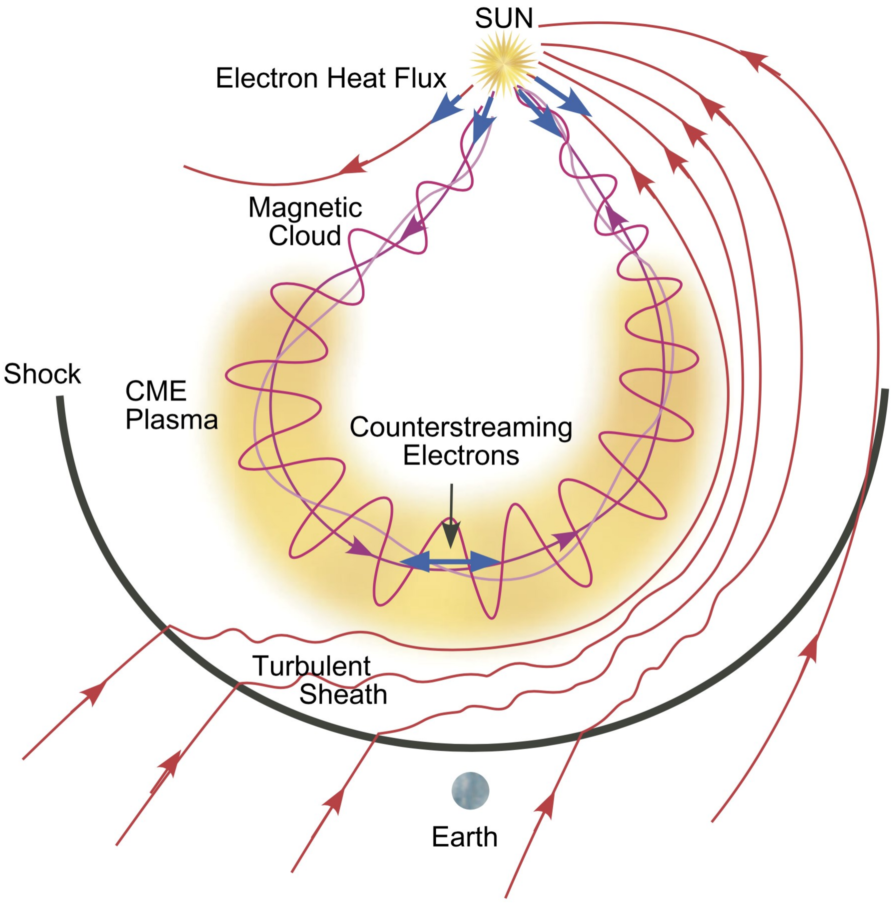

Figure 1. Schematics of an ICME in the standard model, including a magnetic ejecta/cloud with a flux-rope-like magnetic field structure, and preceding shock and turbulent sheath structures. The common detection of counter-streaming suprathermal electron beams is commonly interpreted as evidence of a closed magnetic topology connected to the Sun by two “legs”. From Luhmann et al. (2020) based on Zurbuchen & Richardson (2006).

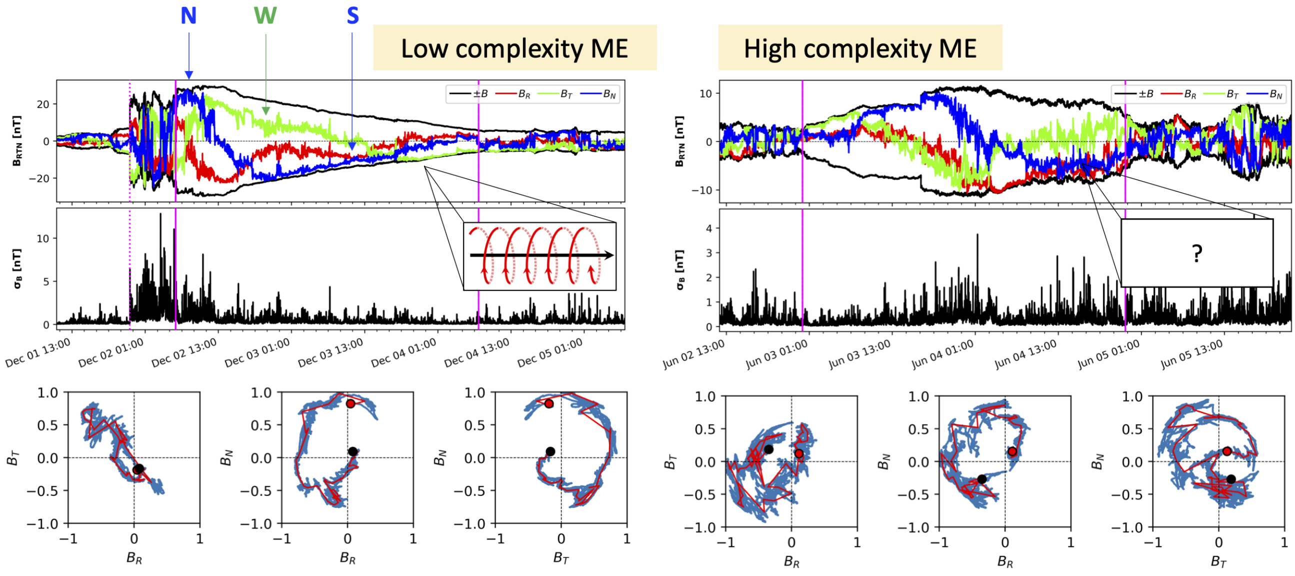

Figure 2. Example of two ICMEs observed by STEREO-A in 2013 (left) and 2009 (right). Right: low-complexity ICME (between the solid vertical lines) exhibiting a preceding shock (marked by the dotted vertical line), a turbulent sheath, and an ME with smooth rotations in the magnetic field components, compatible with a NWS low-inclination flux rope structure (Bothmer & Schwenn, 1998). Left: high-complexity ME interacting with an interplanetary shock lacking a clear flux rope structure. Adapted from Scolini et al. (2022).

In a recent study (Scolini et al. 2022), we addressed the question of why some ICMEs are more complex than others, focusing on the evolution of complexity within ME magnetic structures during interplanetary propagation. We analyzed the complexity of 31 MEs detected between 2008 and 2014 by radially aligned spacecraft between 0.3 and 1 au, based on their similarity/deviation from the schematics in Figure 1. For each ME, we compared observations at the inner and outer spacecraft to determine complexity changes during propagation. We found that the majority of MEs increased their complexity with heliocentric distance, and that complexity changes were closely associated to the presence of large-scale solar wind structures in the ICME propagation space, highlighting the key role of interactions with high speed streams, stream interaction regions, and the heliospheric current sheet in the development of ME magnetic complexity during propagation. Complexity changes also correlated with reduced periods of bi-directional suprathermal electron flows within MEs, indicative of major alterations to their magnetic topology and connectivity to the Sun.

Our results suggest that magnetic complexity changes are likely a consequence of ICME interactions with large-scale solar wind structures, rather than intrinsic to ICME evolution during propagation, complementing previous evidence by Winslow et al. (2021) and Scolini et al. (2021). New magnetic field and plasma observations in the inner heliosphere (e.g. from Parker Solar Probe and Solar Orbiter) are opening up new opportunities to explore the physical mechanisms mediating magnetic complexity changes within MEs from local to global scales. Future initiatives aimed at increasing the number of missions monitoring the solar wind conditions at different distances from the Sun will also be critical to broaden our knowledge on the evolution of ICMEs throughout the inner heliosphere.

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Highlight on Young Scientists 2:

Reconstruction of the two-dimensional precipitating electrons and the three-dimensional structure of the pulsating aurora from auroral images obtained with all-sky cameras

Mizuki Fukizawa

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Auroras begin to blink quasi-periodically from midnight to morning. These auroras are called pulsating auroras (PsAs). Rocket and satellite observations revealed that electrons precipitate from the magnetosphere to the ionosphere in synchronization with PsA emission intensity modulation (e.g., Miyoshi et al., 2015; Sandahl et al., 1980). However, rocket and satellite observations can only obtain one-dimensional data along their orbits. In this study, we reconstructed the two-dimensional (2-D) precipitating electrons and the three-dimensional (3-D) volume emission rate (VER) of a PsA patch from auroral images.

We used auroral images obtained with all-sky cameras at Abisko, Kilpisjärvi, and Skibotn (Figure 1a). Each camera had a common field of view (Figure 1b). We reconstructed the electron flux ($\boldsymbol{f}$) from the auroral images ($\tilde{\boldsymbol{g}}$) by maximizing the posterior probability ($P(\boldsymbol{f}|\tilde{\boldsymbol{g}})$). Details of the analysis method are explained in Fukizawa et al. (2022).

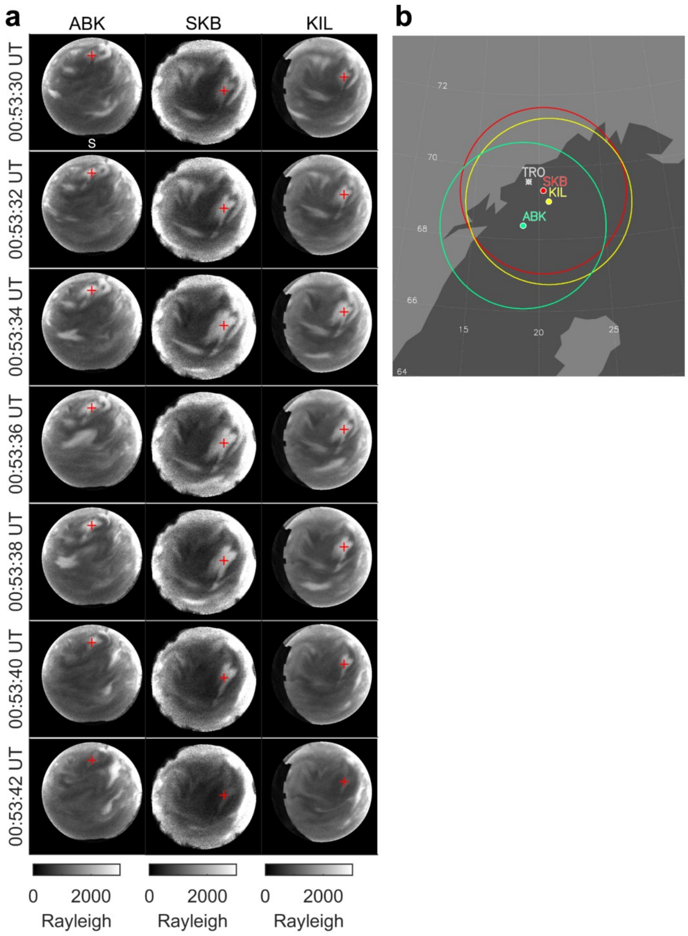

Figure 1. Observation data (Fukizawa et al., 2022). (a) Auroral images at Abisko (ABK), Skibotn (SKB), and Kilpisjärvi (KIL) from 00:53:30 UT to 00:53:42 UT on 18 February 2018. (b) Locations and fields of view of all-sky cameras at ABK (green), SKB (red), and KIL (yellow) at an altitude of 100 km. The location of Tromsø (TRO) is shown by a gray asterisk.

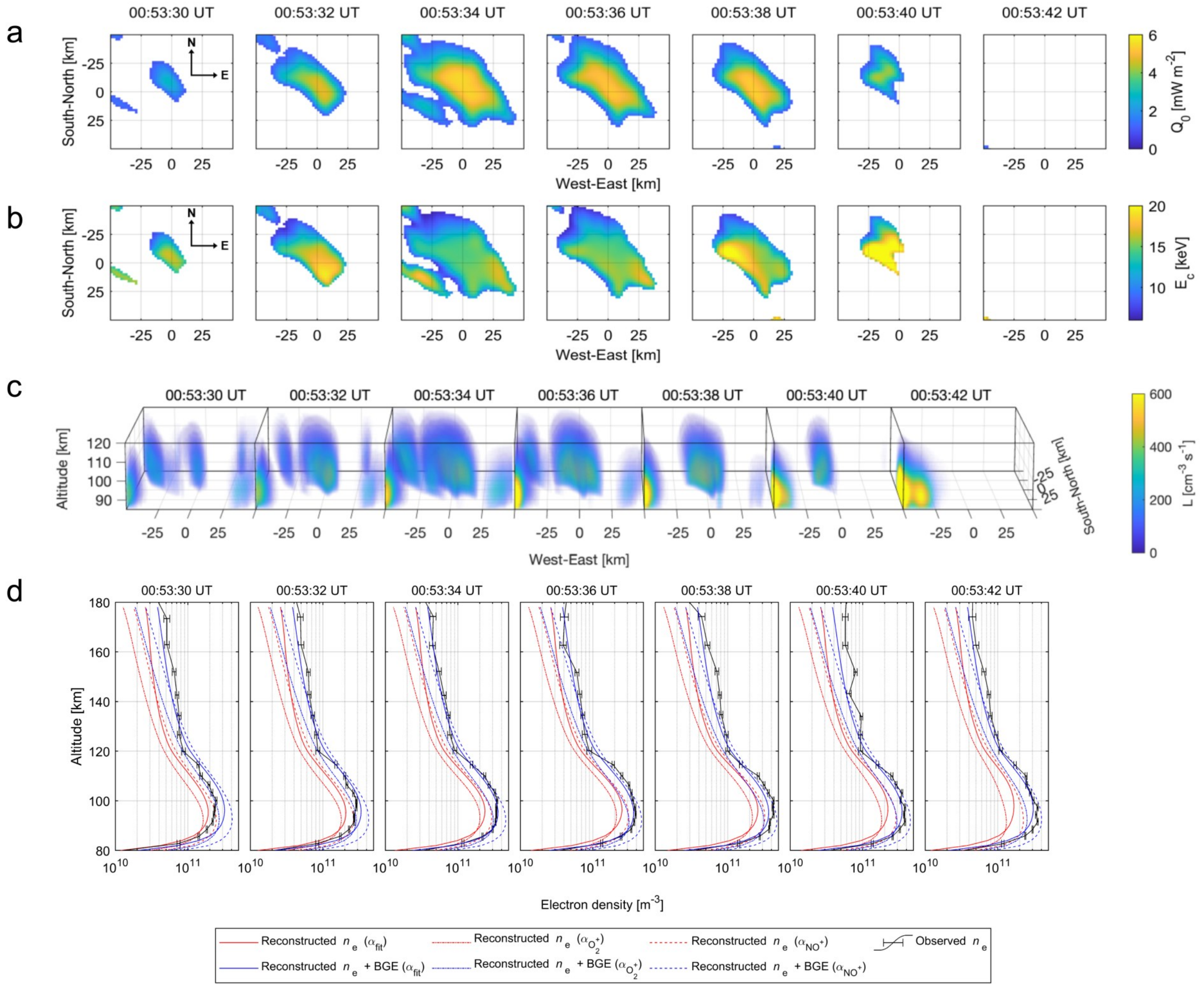

Figure 2. Reconstruction results (Fukizawa et al., 2022). (a) Total energy (Q_0) and (b) characteristic energy (*Ec*) of the reconstructed electron flux. (c) Reconstructed 3-D distribution of volume emission rates (VERs) (*L*). (d) Electron density altitude profiles (n_e) converted from the reconstructed VERs with the subtraction of the background emission (BGE) (red lines), those without the BGE subtraction (blue lines), and those observed by the EISCAT radar (black lines). Details of effective recombination coefficients α_{fit}, $\alpha_{O_2^+}$, and α_{NO^+} are explained in Fukizawa et al. (2022). The measurement uncertainties are represented by error bars.

The reconstructed results are shown in Figure 2. Figures 2a and 2b show the total and characteristic energy of the reconstructed electron flux, respectively. We found that the characteristic energy (*Ec*) was high near the edge of the PsA patch and that *Ec* had both spatial and temporal changes. These spatiotemporal variations imply changes of the plasma and magnetic field environment in the magnetosphere.

Figure 2c shows the reconstructed 3-D VER. The VER was converted to the electron density to validate the reconstruction accuracy using the continuity equation (Figure 2d). We confirmed that the reconstructed electron density was consistent with that obtained with the European Incoherent Scatter (EISCAT) radar.

The results of this study suggest that the spatiotemporal changes of the 2-D precipitating electrons and 3-D VER of PsAs can be investigated only using ground-based cameras.

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Meeting Report 1:

2nd Iberian Space Science Summer School (i4s)

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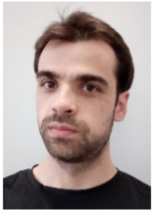
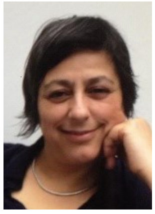
[1]University of Alcala, Madrid, Spain
[2]University of Coimbra, Coimbra, Portugal


Antonio Guerrero


Consuelo Cid


Manuel Flores-Soriano


Teresa Barata


Anna Morozova

The second edition of the i4s school 2022 was held in-person between 6th June and 10th June 2022 at the University of Alcala in Spain. The local organization was carried out by the SWE-UAH research group (Spain) and IA (Portugal) with the support from SCOSTEP. 28 students from 16 different countries from Africa, America, Europe, and Asia participated, attending lectures from 17 scientists covering specializations in all stages of the Sun-Earth interaction. Grouped in five projects they worked on specific space weather events. They also presented their research work with talks and posters. Travel and accommodation for some students were possible thanks to SCOSTEP, ISWI, JSPS and ISEE. Participants had the opportunity with two tours to know more about UAH, one of the oldest universities in Europe, and about ESAC, the host for science operation centres and mission's archives of ESA.


Figure 1. A group photo of the participants of i4s summer school.

Meeting Report 2:

Workshop on Extreme Solar Events

Stepan Poluianov[1]
[1]University of Oulu, Finland


Stepan Poluianov

The workshop on Extreme Solar Events was held in Rokua, Finland on 27-30 March 2022. It was organized by early-career scientists as an in-person event and brought top-tier experts and doctoral researchers from Finland, Switzerland, Japan, and Germany to discuss the recent progress in a very rapidly developing field of extreme solar events. Three major topics were addressed: (1) the statistics of occurrence of extreme events (energetic particle storms, flares, coronal mass ejections) on the Sun and solar-like stars, (2) the search for and reconstructions of past extreme events, (3) effects induced by the storms in the Earth's environment. The event was supported by projects ESPERA and QUASARE of the Academy of Finland, as well as by a SCOSTEP/PRESTO meeting grant. The website of the event: https://cosmicrays.oulu.fi/espera_2022.


Figure 1. A group photo of the participants of the workshop.

Meeting Report 3:

The 2nd Summer School on Space Research, Technology & Applications for young scientists and PhD students

Rositsa Miteva[1]
[1]Institute of Astronomy with National Astronomical Observatory, Bulgarian Academy of Sciences, Sofia, Bulgaria

Rositsa Miteva

The second summer school on Space research, technology and applications was held in the National Astronomical Observatory (NAO) – Rozhen, Bulgaria from 3rd to 10th July 2022 in a hybrid mode. It was organized by Branch 'Cosmos' of the Union of Physicists in Bulgaria. 16 on-site and 51 online participants from about 20 different countries could access the event. Variety of topics were offered to the students: from gravitational waves and exo-planets, to space weather, Earth observations and machine learning. The program comprised morning hybrid lectures and afternoon on-site-only or online practice sessions covering topics from Sun and space weather, Gravitational waves, Machine learning to Astrophotography. Workshops on Risk analysis and management of space missions and Earth observations were provided too as a standalone one-day activity. At the end of the school, three teams presented the results from their practice work led by the lecturer or/and experienced mentors. Transferable skills were trained too, in sessions dedicated to communications in astronomy and developing space-related SMEs and start-ups. In addition, each participant gave a short overview on their PhD topic during a dedicated PhD session.

Figure 1. A group photo of the on-site participants, lecturers and summer school organizers in front of the dome of the 2-m telescope in NAO-Rozhen.

The summer school received financial support from the America for Bulgaria foundation, SCOSTEP and Karoll knowledge foundation. The event was held under the auspices of the Ministry of Innovation and Growth of Bulgaria.

More details, open-access lectures, presentations and videos can be found at the summer school web-site: https://bulgarianspace.online/second-summer-school_2022/.

Announcement 1:

In Memorium

Patricia Helen Doherty (1950-2022)

I have to share the sad news that Patricia (Pat) Helen Doherty, the SCOSTEP Scientific Secretary, suddenly passed away on July 14, 2022, from a heart attack. I do not have words to express my thoughts on this really sad news. I can only pray for her peaceful rest.

Pat's research has been focused on space weather and ionospheric conditions on Global Navigation Satellite Systems. Pat has been the Scientific Secretary of the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) since 2019. Since then, Pat has provided various administrative supports for the SCOSTEP activities. In addition, Pat has made great efforts to support students and early-career scientists by organizing capacity building schools and workshops and by providing administrative supports for their travel to overseas institutions under the SCOSTEP visiting scholar program. Pat has also managed translation of SCOSTEP's comic books on solar-terrestrial physics for kids to various languages and developed a new SCOSTEP website (https://scostep.org/) and the SCOSTEP-related mailing list under the Boston College mailing system.

SCOSTEP will miss her deeply and send our sincere condolences to her family and friends.

Kazuo Shiokawa, SCOSTEP President

Upcoming meetings related to SCOSTEP

Conference	Date	Location	Contact Information
AOGS 2022	Aug. 1-5, 2022	Online	https://www.asiaoceania.org/aogs2022/public.asp?page=home.asp
International Beacon Satellite Symposium	Aug. 1-5, 2022	Boston, MA, USA	https://www.bc.edu/bc-web/research/sites/institute-for-scientific-research/events-conferences/bss2022.html
16th International Symposium on Equatorial Aeronomy (ISEA-16)	Sept. 12-16, 2022	Kyoto, Japan	http://www2.rish.kyoto-u.ac.jp/isea16/
8th International Space Climate Symposium (SC8)	Sept. 19-22, 2022	Krakow, Poland	https://spaceclimate8.uph.edu.pl/
European Space Weather Week 2022	Oct. 24-28, 2022	Zagreb, Croatia	https://www.stce.be/esww2022/
Summer Space Weather School - Physics and use of tools	In October, 2022	Houphouët Boigny University, Abidjan, Côte d'Ivoire	
AGU Fall Meeting 2022	Dec. 12-16, 2022	Chicago, IL, USA	https://www.agu.org/fall-meeting
IUGG 2023	Jul. 11-20, 2023	Berlin, Germany	https://www.iugg2023berlin.org/
AGU Fall Meeting 2023	Dec. 11-15, 2023	San Francisco, CA, USA	https://www.agu.org/fall-meeting

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

The purpose of the SCOSTEP/PRESTO newsletter is to promote communication among scientists related to solar-terrestrial physics and the SCOSTEP's PRESTO program.

The editors would like to ask you to submit the following articles to the SCOSTEP/PRESTO newsletter.

Our newsletter has five categories of the articles:

1. Articles— Each article has a maximum of 500 words length and four figures/photos (at least two figures/photos).
   With the writer's approval, the small face photo will be also added.
   On campaign, ground observations, satellite observations, modeling, etc.
2. Meeting reports—Each meeting report has a maximum of 150 words length and one photo from the meeting.
   With the writer's approval, the small face photo will be also added.
   On workshop/conference/ symposium report related to SCOSTEP/PRESTO
3. Highlights on young scientists— Each highlight has a maximum of 300 words length and two figures.
   With the writer's approval, the small face photo will be also added.
   On the young scientist's own work related to SCOSTEP/PRESTO
4. Announcement— Each announcement has a maximum of 200 words length.
   Announcements of campaign, workshop, etc.
5. Meeting schedule

Category 3 (Highlights on young scientists) helps both young scientists and SCOSTEP/PRESTO members to know each other. Please contact the editors if you know any recommended young scientists who are willing to write an article on this category.

TO SUBMIT AN ARTICLE

Articles/figures/photos can be emailed to the Newsletter Secretary, Ms. Mai Asakura (asakura_at_isee.nagoya-u.ac.jp). If you have any questions or problem, please do not hesitate to ask us.

SUBSCRIPTION - SCOSTEP MAILING LIST

The PDF version of the SCOSTEP/PRESTO Newsletter is distributed through the SCOSTEP-all mailing list. If you want to be included in the mailing list to receive future information of SCOSTEP/PRESTO, please send e-mail to "patricia.doherty_at_bc.edu" or "sean.oconnell.2 at bc.edu" (replace "_at_" by "@") with your name, affiliation, and topic of interest to be included.