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DISPEC NEWSLETTER

Scientific exploitation of space Data for improved Ionospheric SPECification

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Dear Reader,

Welcome to the fourth issue of the DISPEC newsletter series!

DISPEC (2024-2027) is a European Union funded project under the Horizon Europe Research and Innovation Programme.

The DISPEC project offers new high-level data products based on advanced data processing techniques that improve data quality, provides estimates of ionospheric characteristics based on the joint processing of space and ground data, provides results from post-processing of data for improved ionospheric specification, and exploits long-term time series for the study of long-term trends in the ionosphere in connection to atmospheric long-term dynamics and geophysical phenomena.

Join us to stay informed about the latest project developments.

The DISPEC Consortium

PROJECT EXTENSION AND FINALISATION ACTIONS

The DISPEC project has been granted a three-month extension, moving its completion date from 31 December 2026 to 31 March 2027.

The additional time will enable the consortium to complete the remaining scientific activities, finalise the associated publications and incorporate the results into the outstanding project deliverables. According to the revised work plan, verification analyses are expected to be completed by January 2027, followed by the preparation, review and submission of the remaining deliverables by March 2027.

The extension does not affect the project's objectives, scientific scope or budget, ensuring sufficient time for the completion of the planned activities and delivery of DISPEC's final results.

DISPEC DEMONSTRATOR: FROM SCIENTIFIC DATA APPLICATIONS TO OPERATIONAL WORKFLOWS

A major outcome of the DISPEC project is the development of the DISPEC Demonstrator, a platform providing access to DISPEC raw data, high-level data products and scientific workflows. Its functionalities are based on four Scientific Data Applications (SDAs), developed throughout the project and further tailored to address stakeholder requirements.

The four SDAs address complementary aspects of ionospheric specification:

SDA1 “Digisonde data-driven electron density reconstruction model”

SDA1 provides two workflows: single-ionogram processing and electron density profile reconstruction, including comparisons between the ARTIST and DISPEC processing chains, and the generation of time series of ionospheric characteristics over user-selected intervals. It also introduces the hybrid NeQuick-Digisonde-TaD (HyNT) model, which reconstructs electron density profiles from the bottomside to the topside ionosphere using ionogram-derived input profiles.

SDA2 “Modeling trans-ionospheric radio signal propagation”

SDA2 evaluates radio signal propagation through the ionosphere using two ray-launching approaches: numerical solutions of the Haselgrove equations and the analytical Multiple Quasi-Parabolic (MQP) technique. Dedicated workflows enable comparisons under different propagation conditions and validation against observational data. A graphical user interface has also been developed to support practical training activities.

SDA3 “Specification of slab thickness anomalies”

SDA3 investigates ionospheric anomalies and their relevance to high-frequency (HF) radio communications. Particular attention is given to the effective ionospheric slab thickness (τ), derived from vertical total electron content (VTEC) and peak electron density (NmF2), and its relationship with variations in the Maximum Usable Frequency over a 3000 km radio link MUF(3000). The developed workflow supports the evaluation of relevant ionospheric proxies and the monitoring of MUF depression.

SDA4 “Proxies for geophysical phenomena and long-term trends”

SDA4 exploits long-term ionospheric observations to identify proxies for geophysical phenomena and investigate ionospheric variability. The project has completed the computation of extensive historical datasets spanning more than 2.5 solar cycles, from the end of 1996, comprising more than 10 billion values. These include VTEC Global Ionospheric Maps (GIMs), Differential Code Biases (DCB), VTEC gradients, Ionospheric Storm Scale Index GIMs (IsUG), Global Electron Content (GEC) time-series and electron density gradient datasets. Supporting tools and a RESTful API facilitate access to and exploitation of these data.

Accessing the DISPEC Demonstrator

The four SDAs provide complementary capabilities, ranging from electron density reconstruction and radio propagation modelling to the identification of ionospheric anomalies and long-term geophysical trends.

In the final phase of DISPEC, the project's data collections and software tools will be hosted in the PITHIA e-Science Centre, supporting their open use by the scientific community and facilitating the exploitation of the project's results beyond its lifetime.

Explore the **DISPEC Demonstrator** and discover the individual Scientific Data Applications.

TRAINING ACTIVITIES

DISPEC Training School

From 21 to 25 September 2026, the DISPEC Training School brought together 21 MSc, PhD students and early-career researchers from 10 countries, alongside lecturers and scientific experts, at CIHEAM-MAICh in Chania, Crete, for five days of intensive scientific training, practical activities and knowledge exchange.

Organised within the Horizon Europe-funded DISPEC project, with the support of the ESA Academy, the school aimed to strengthen participants' theoretical knowledge and practical skills in the observation, modelling and interpretation of ionospheric variability and disturbances.



From observations to advanced modelling

The five-day programme combined expert lectures with hands-on sessions, progressively introducing participants to the physical processes governing the ionosphere and the methodologies used to investigate its behaviour.



The first day focused on ionospheric disturbances and irregularities, ground- and space-based monitoring systems, and data analysis techniques, including ionogram scaling, identification of ionospheric structures and RINEX-to-TEC processing.

The second day explored ionospheric weather models, electron density reconstruction and signal propagation, with practical exercises on the fusion of ionosonde and GNSS-TEC observations for identifying ionospheric anomalies, as well as the application of ray-tracing models to ionogram modelling.

On the third day, attention turned to Machine Learning and its applications in ionospheric research, covering time-series forecasting and the identification of ionospheric irregularities.

The fourth day focused on the spatio-temporal characteristics of ionospheric maps, combining theoretical lectures with practical exercises.

Putting knowledge into practice: the hackathon

A major highlight of the school was the hackathon, which began on Thursday afternoon and continued throughout Friday.

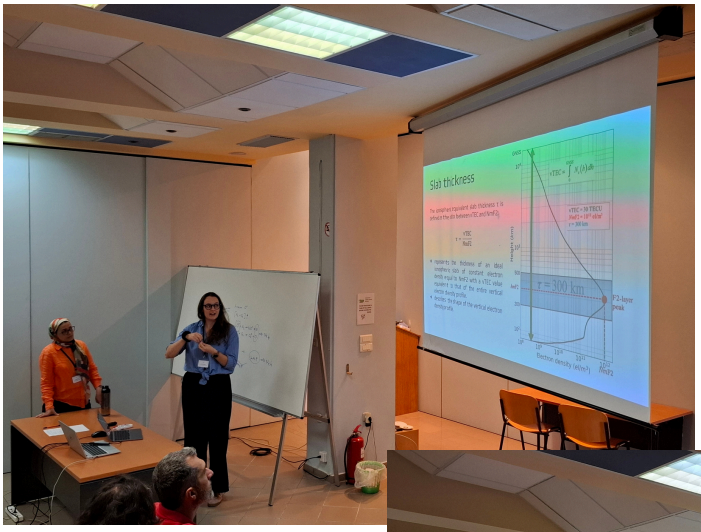
Working in teams, participants selected research challenges and developed their own solutions.

The hackathon addressed several research challenges, reflecting the diversity of DISPEC's scientific activities. Participants worked on topics including:

- ionogram inversion using ray tracing,
- multi-instrument investigation of ionospheric storm-time anomalies and their vertical and spatial 2D structures,
- AI-based forecasting of data time-series,
- detection and forecasting of ionospheric disturbances using AI classifiers,
- sporadic E-layer identification using vertical and oblique incidence echoes,
- modelling the impact of travelling ionospheric disturbances (TIDs) on radar systems.

Through these assignments, participants applied the methods and tools introduced during the Training School to practical problems in ionospheric research.

The teams presented their projects, sharing their approaches, solutions and results.















The programme also included a dedicated session on open-access scientific publishing by EDP Sciences.

Building skills and strengthening the scientific community

Beyond its scientific content, the Training School provided a valuable opportunity for networking, interdisciplinary exchange and the development of new professional connections. Participants shared experiences, collaborated on common challenges and strengthened links within the wider ionospheric and space-weather research community.

By combining scientific foundations, practical training and collaborative problem-solving, the DISPEC Training School contributed to the project's broader objectives of advancing the scientific exploitation of space- and ground-based observations and supporting the development of improved methodologies and high-level data products for ionospheric specification.

The DISPEC consortium warmly thanks all participating students, lecturers and mentors, the Programme, Evaluation and Local Organising Committees, CIHEAM-MAICh for hosting the event, and the ESA Academy for its support.

More information and training materials are available on the DISPEC website.



OUTREACH ACTIVITIES

NOA 31st Summer School of Astrophysics

The National Observatory of Athens (NOA) team contributed to the 31st Summer School of Astrophysics organised by NOA's Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS) on 1-3 September 2026.

The school was attended by 69 high school students (49 on-site and 20 online) in their first two years of high school (16-17 years old). The students participated in nighttime/solar observations and attended general lectures on astrophysics, space physics, and the ionosphere.

Dr Anna Belehaki delivered a lecture entitled "Understanding the Ionosphere: from Earth to Space" and supervised a group of students participating in a laboratory activity entitled "Broadcasting radio waves into space".

RECENT PUBLICATIONS AND PRESENTATIONS

Papers under revision:

- Jarmolowski, W., Belehaki, A., Wielgosz, P., Krypiak-Gregorczyk, A., Hernandez-Pajares, M., Olivares Pulido, G., Galkin, I., Milanowska, B., Rapinski, J., Fabbro, V., Baumann, X., "Time-frequency Fourier analysis and filtering of Global Ionosphere Maps for space weather applications", Annals of Geophysics, 2026.

Selected published papers:

- Adil, M. A., Hadas, T., Senturk, E., & Pajares, M. H., "Sensing the ionosphere under varying electrodynamics during extreme cyclogenesis using real-time/near real-time satellite observations", IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2026, https://doi.org/10.1109/JSTARS.2026.3689567
- Liu, A., Wang, N., Li, Z., Brack, A., Hernández-Pajares, M., Krankowski, A., Gini, F., Ghoddousi-Fard, R., Liu, Q., Wang, L., Fron, A., Li, A., Liu, R., Xie, M. "FAIRS: a factor-adjusted ionospheric residual statistics approach for global ionospheric RMS mapping", Satellite Navigation, 7(1), 20, 2026, https://doi.org/10.1186/s43020-026-00209-9

- She, H., Hernandez-Pajares, M., Olivares-Pulido, G., Huang, G., Wang, L., Zhu, Z., & Lai, W., “Analysis of Tonga eruption-induced disturbances in the upper thermosphere based on atmospheric drag accelerations from LEO satellites”, GPS Solutions, 30(4), 186, 2026, https://doi.org/10.1007/s10291-026-02150-5
- Smirnov, A., Asamoah, E. N., Navas-Portella, V., Kronberg, E. A., Lühr, H., Liu, Q., & Hernández-Pajares, M., “Global IsUG index maps for tracking ionospheric variability: a case study of the 4–5 November 2023 geomagnetic storm”, Journal of Space Weather and Space Climate, 16, 17, 2026, https://doi.org/10.1051/swsc/2026008
- Zhang, Y., et al., "IonoMoni: ionospheric monitoring based on dual-frequency data from single GNSS station.", GPS Solutions, 30.2 (2026): 100, 2026, https://doi.org/10.1007/s10291-026-02059-z

Delivered presentations:

- Wojciech Jarmolowski, Anna Belehaki, Pawel Wielgosz, Anna Krypiak-Gregorczyk. "Different several-day TEC variations over different regions at the same geomagnetic latitude", EMSEV2026, Kumamoto, Japan, 24-28 August 2026.
- Manuel Hernández-Pajares, David Roma-Dollase, Alberto García-Rigo, Raul Orús-Pérez, Germán Olivares-Pulido, Qi Liu, J. Maria Aroca-Farrerons, Victoria Graffigna, Heng Yang, Enric Monte-Moreno, Anna Belehaki, Angeliki Thanasou, Ivan Galkin, Wojciech Jarmolowski, Pawel Wielgosz, Vincent Fabbro, Xavier Baumann. "Three decades of continuous monitoring of ionospheric electronic content on a global scale and new derived products", URSI 2026, Krakow, Poland, 15-22 August 2026.
- Wojciech Jarmolowski, Pawel Wielgosz, Anna Krypiak-Gregorczyk, Beata Milanowska. "Total electron content anomalies over tectonic plate boundaries indicating lithosphere-ionosphere coupling", URSI 2026, Krakow, Poland, 15-22 August 2026.
- Wojciech Jarmolowski, Anna Belehaki, Pawel Wielgosz, Anna Krypiak-Gregorczyk, Beata Milanowska, Manuel Hernandez-Pajares, German Olivares-Pulido, Ivan Galkin, Vincent Fabbro, Xavier Baumann. "Different frequency-time characteristics of total electron content anomalies over different tectonic plate boundaries", URSI 2026, Krakow, Poland, 15-22 August 2026.

Published technical reports:

- Anna Belehaki. “Results from manually scaled ionograms”, Zenodo, June 2026, https://zenodo.org/records/20845638

A full list of publications, presentations and reports related to DISPEC can be found on the project website.

DISPEC PARTNERS

ABOUT

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Scientific exploitation of space Data for improved Ionospheric SPECification (DISPEC)

Topic
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