

ESA Space Weather Network of Federated Services



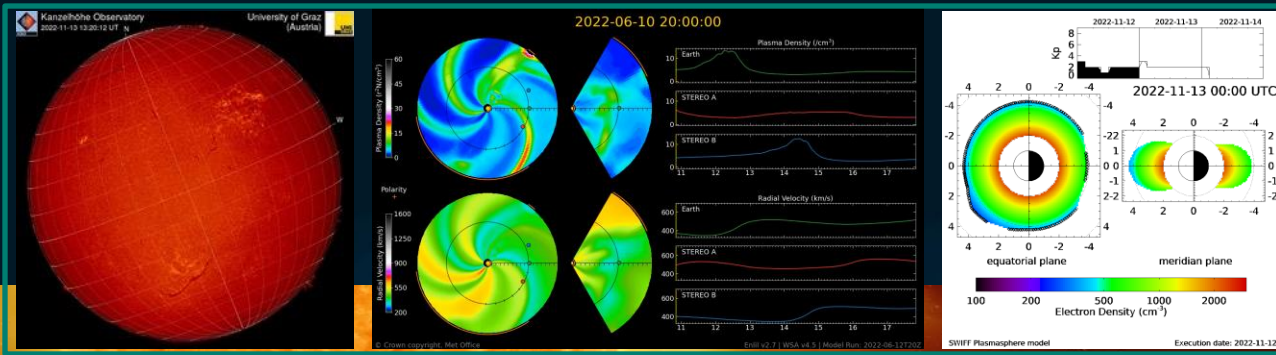
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Darmstadt, Germany

T-FORS Second Innovation Day

04.12.2024

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Service Network Provides:

- 29 services built on >300 data products & tools
- 95% availability & office hours helpdesk support
- Full Sun-Earth chain, coupled modelling
- Timely user tailored notifications & alerting

Who uses the services?

- >5000 registered users
- >2M hits on portal monthly
- All affected sectors, plus national & regional agencies

Who participates?

- >50 institutes, industry, academic groups
- Building on & strengthening European assets & expertise

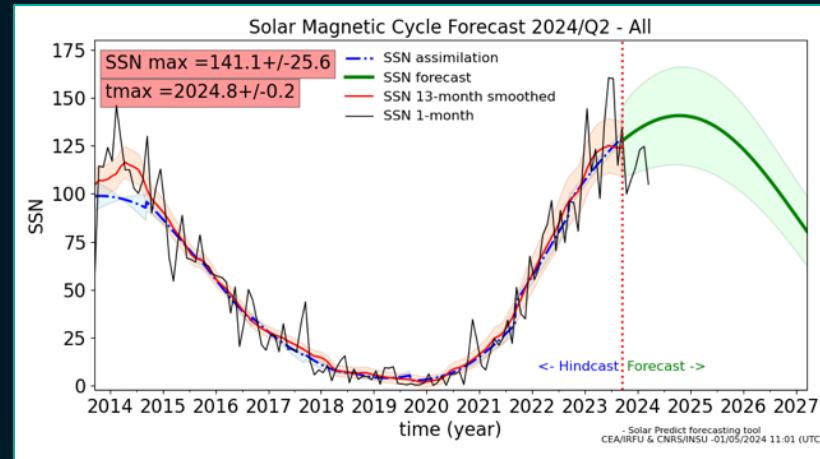


Service Enhancements



SWE portal releases 3.9.0 – 3.11.0

- New and updated products from the Expert Service Centres including solar cycle forecasting
- SWE Products for Southern Europe Phase 1 (P3-SWE-XXXVII) [Lead: UAH]
- P3-SWE-LII Plasmaspheric products for Space Weather Services [Lead: SSE ltd]
- New data from ICARE-NG instruments accessible via SWE Data Browser & API



Federated products from the Eötvös University (ELTE)

ESRGE PLASMA Plasmaspheric products for specification of Earth's plasma environment

Products: Compare Maps: Help

The Space Research Group (SRG) of the Eötvös Loránd University (ELTE, Budapest, Hungary) and the Institute of Earth Physics and Space Science (EPSS, Hungary) provide near real time specification for the current state of the plasmasphere and its outer boundary, related forecasts, as well as an archive of the products. The following federated products may be found by navigating to the 'products' tab on the horizontal menu:

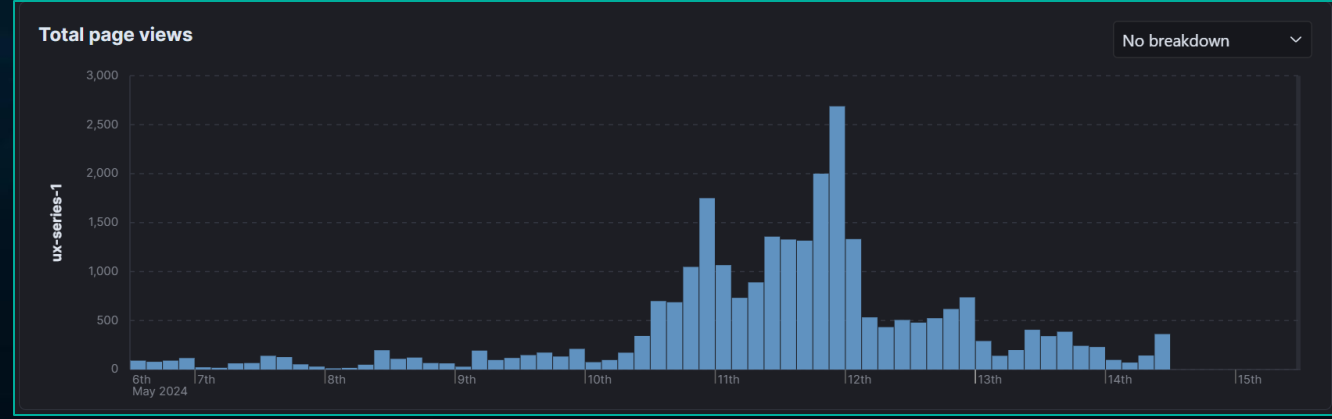
- PEDEM (Plasmaspheric Equatorial Electron Density Map) 2D equatorial electron density map of the plasmasphere derived by a 3D neural-network-based empirical model.
- PEM (Equatorial Plasmasphere Map) 2D equatorial plasmasphere maps derived by a 3D neural-network-based empirical model of the plasmasphere.
- PSI (Plasmasphere Index) A simple characterisation of the status and the evolution trend of the plasmasphere.
- LPP (Plasmasphere Limits) Lower and upper limits for the position of the plasmasphere derived from real-time observations.
- MPP (Midnight plasmasphere position proxy) Midnight plasmasphere proxy derived from the magnetic and plasma observation of the low Earth orbiting Swarm satellites.
- PD (Plasma Density) Real-time plasma (electron number and plasma mass) densities are obtained from ground-based observations.

Federated products from the Universidad de Alcalá (UAH)

Latest Archive Alert Subscription Help UAH-SYM-FOR & UAH-ASY-FOR

[G.176] Forecast of SYM-H and ASY-H indices

The SYM-H and ASY-H forecast product provides a one-hour and two-hour forecast for each index (red line), as well as the historical values of the previous indices for the last day, computed by the University of Alcalá (blue line). Monitoring metric assesses the Mean Absolute Error (MAE), absolute difference between the predicted value and the actual value of the index) for each prediction horizon and index in nT, providing the MAE for the last day and last month for each forecasting horizon.



- Excellent performance during events of May 2024!
 - Peak in page hits and new registered users
 - user feedback collection ongoing



Service Portal: Monitoring and Forecast of Ionospheric Disturbances



Provides estimates of the occurrence risk of ionospheric disturbances. **ntama** + THE EUROPEAN SPACE AGENCY

Welcome to the ESA Space Weather Service Network
Please note that all ESA-SWE Services are under review/construction

Space Weather Services / Transionospheric Radio Link / Monitoring and Forecast of Ionospheric Disturbances

Welcome to the *Transionospheric Radio Link - Monitoring and Forecast of Ionospheric Disturbances* service

Overview

The service "*Transionospheric Radio Link - Monitoring and Forecast of Ionospheric Disturbances*" aims to provide an estimate of the occurrence risk of ionospheric disturbances, including monitoring and detection of ionospheric phenomena causing local disturbances of electron density and detection of geomagnetic storms. This service is currently under development. The aim is to consider the following ionospheric phenomena:

- trough,
- Travelling Ionospheric Disturbances (TIDs),
- patches,
- depletions and
- D-region absorption.

Currently, this service provides vertical TEC maps, URSI ionospheric parameters and ionospheric perturbation products like the equivalent slab thickness and Rate Of Change of TEC Index (ROTI).

[Read more about this service](#)

Highlights

SISTED warning	Swarm Rate Of change of TEC Index (ROTI)	Nowcasting of MUF(3000)F2 ratio over Europe
GIVE maps (Northern Europe)	Global Scintillation Indices	EIS Nowcast European maps of foF2
TechTIDE TID Activity Report	Equivalent slab thickness, Juliusruh	

Announcements

Update: New Service Page design for release 3.7! Let us know what you think about our services in our Survey.

Products and Alerts

The following products are associated with this service:

Products

- ▶ Ionospheric Disturbances Nowcast
- ▶ Ionosphere, Nowcast
- ▶ Ionosphere, Forecast
- ▶ Solar Indices Nowcast
- ▶ Solar indices, Forecast
- ▶ Geomagnetic indices, Nowcast
- ▶ Geomagnetic indices, Forecast

Alerts

- ▶ Ionospheric Disturbance Detection

Tools

TEC map (Global), current

Total Electron Content (TEC) 2024-12-03T02:10:00 UT

Ionospheric Range Error (L1) / m

TEC/TECU

Full product Provided by: German Aerospace Center

σ_p maps (Northern Europe)

Scintillation index σ_p for L1 frequency 2024-12-03 11:10 UTC

Latitude (degrees) Longitude (degrees)

Full product Provided by: Norwegian Mapping Authority

SOLERA-drift

drift / TECUs

The TechTIDE is provided by the National Observatory of Athens.

View TID Activity | Reference Date: 2024-12-03T11:12:00 UTC

TID Indicators	Date	Critical Characteristic	Current value of critical characteristics	Activity level	Activity icon
AATR	2024-12-03T11:00:00	AATR at polar, high, medium and low latitudes	0.083	LOW	
GNSS TEC Gradient	2024-12-03T10:55:30	TEC gradient amplitude in high latitudes	4.768	STRONG	

LSTID Detection	Date	Critical Characteristic	Current value of critical characteristics	Activity level	Activity icon
HF Interferometry (HF-INT)	2024-12-03T11:05:00	Spectral Energy Contribution	0.1	LOW	
LSTID _{dx}	2024-12-03T10:40:00	Relative Std Dev of Ne	0	LOW	

MSTID Detection	Date	Critical Characteristic	Current value of critical characteristics	Activity level	Activity icon
CDSS	2024-12-03T09:30:00	Doppler shift detected in the Czechia network	0.165	STRONG	
MSTID _{dx}	2024-07-11T06:40:00	MSTID _{dx} at polar, high, medium and low latitudes	0.309	STRONG	

Legend

Low Activity Level

Medium Activity Level

Strong Activity Level

No Data

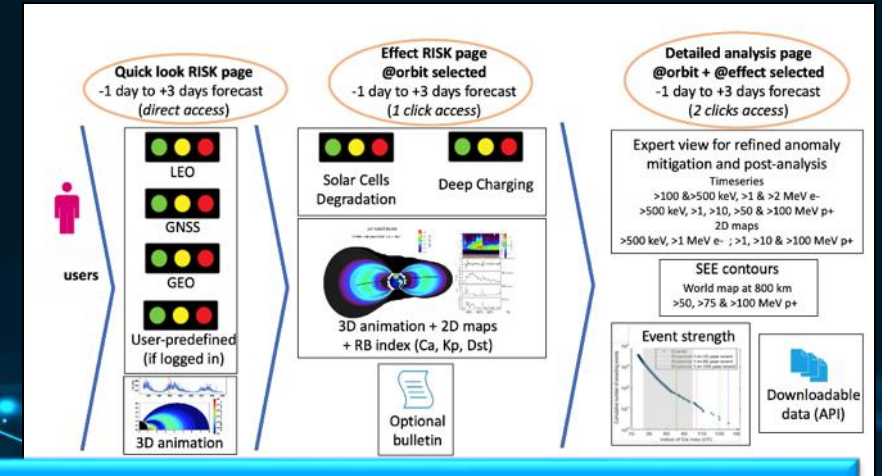
S2P Period 2: Upcoming Developments

- Currently preparing Evolutionary Maintenance (S2-SW-05) and pre-operational extension (S2-SW-07) with SWESNET project team
- S1-SW-19 Virtual Space Weather Modelling Centre (ITT just closed)
- S1-SW-21 Space Weather Impact on GNSS Performance (ITT to be released soon)
- ITTs in Q1/Q2 2025 (total budget 3,610kEuro):
 - S2-SW-06.A Virtual Space Weather Modelling Centre
 - S2-SW-06.B Space Environment Characterisation, Nowcast and Forecast
 - S2-SW-06.C Space Weather Capability Development for Ionospheric and Geomagnetic Conditions
 - S2-SW-06.D Solar and Heliospheric Weather Toolkit Development
 - S2-SW-06.E Advanced Validation for the SWE Service Network
- New and improved service component deployments throughout 2025 as ongoing projects mature

S2P P3: Service Portal Evolution and Targeted Application Developments

SWE portal evolution

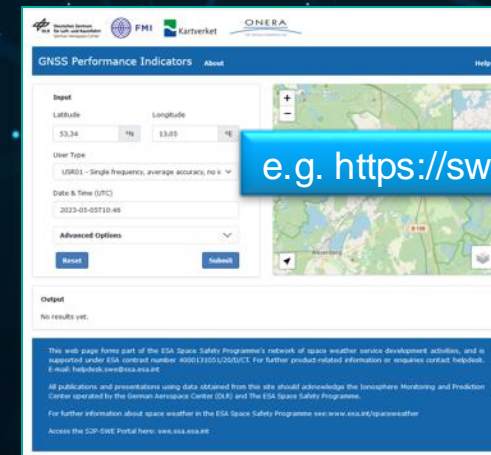
- Layered approach portal-wide catering for different levels of user expertise
- Technology upgrade enabling interactive, customisable presentation
- Leverage underpinning data system improvements for API data access
- Improved SWE Portal navigation and search for better usability



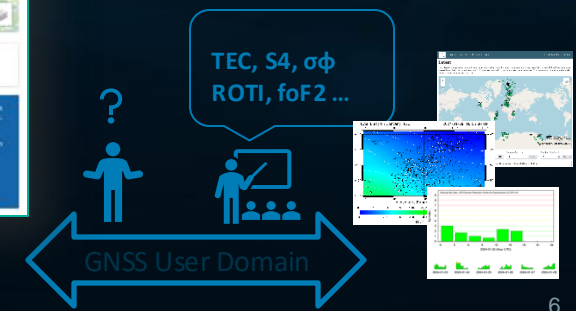
e.g. <https://swe.ssa.esa.int/onera-rb-fan-federated>

Targeted Application & Tool Development

- Combining individual products into overarching user-driven consolidated product/applications.
 - Target domains including Spacecraft Operators, GNSS, electricity transmission grid operators & others.
- SWE Data Utilisation: advanced Level-2 processing pipelines and toolkits including preparation for Vigil.



e.g. <https://swe.ssa.esa.int/GPI-federated>



S2P P3: World Class R2O(2R) Framework Targeting End User Needs

- Demonstration and testing space weather service capabilities with end users: pre-operational service model
- Continuous evolution with opportunities to include new and improved products every 3 months
- Continuous reliable provision with user in the loop enables:
 - Understanding of user workflows and terminology
 - Feedback on products and tools, understanding of highest priorities for users (O2R process)
 - Identification of promising business cases
- **Performance assessment** establishing community standards
- Fostering commercial solutions



Virtual Space Weather Modelling Centre (VSWMC)

- End-to-end Space Weather modelling, simulation and NRT data processing
- Verification and validation of end-to-end simulation with further models
- Support for OSSEs and OSEs
- Advanced user interfacing and data visualisation

Enhancement of space weather models

- Empirical, physics based, DL, AI and combined models
- Utilisation of data from space weather system
- Advanced onboard data processing
- Feasibility studies for new technologies

Software development

- Phase 2 of the Space Weather Payload Data Centre
 - Implementation of Vigil Level 1 data processing
 - Enhancement of the Data Hub
- One-stop-shop for space weather data

Instruments and mission studies

- New instrument developments/procurements
 - => instrument pipeline
 - => utilisation of advances in sensor technology
- OSSEs and OSEs
- Operationalisation of ground based observations

Space Weather Training Course – Third Edition!

- One week residential course targeting Master/PhD students organised by SWE Office together with ESA Academy team, ESEC-Galaxia, Belgium 24-28th March 2025
- Lectures delivered by internationally recognised experts
 - Fundamentals of space weather science through modelling, forecasting, different application areas and socio-economic impacts
- Hands-on tutorials using the SWE portal and key tools
- Group project to design a space weather service concept
- Tours of the operations centre at ESEC-Redu with introduction to PROBA mission operations and visit to Space Pole in Brussels including the SSCC premises
- Applications deadline for students: 6 January 2025.





THANK YOU

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