IEEC
Institut d'Estudis Espacials de Catalunya

Space Weather activities at the Institute of Space Studies of Catalonia (IEEC)

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Generalitat de Catalunya · Universitat de Barcelona · UAB Universitat Autònoma de Barcelona · Universitat Politècnica de Catalunya BarcelonaTech · CSIC Consejo Superior de Investigaciones Científicas · Centre de: CERCA Centres de Recerca de Catalunya

Institute of Space Studies of Catalonia (IEEC)

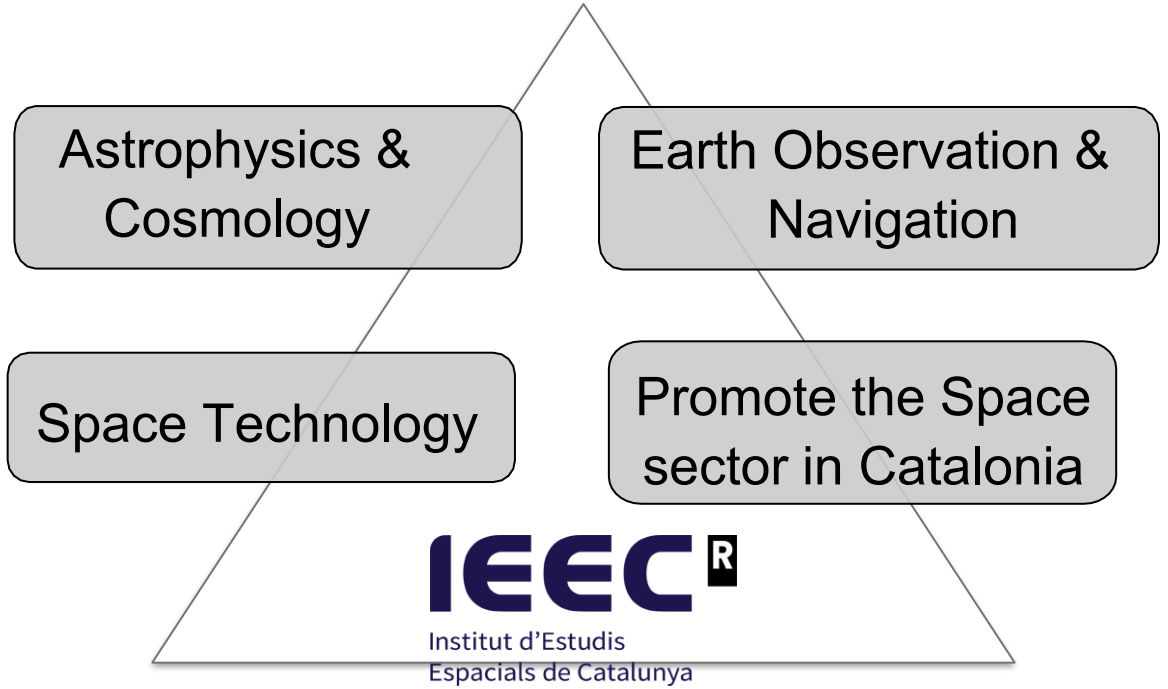
- Established in 1996 to promote the development of activities related to space in Catalonia in the fields of research, innovation and talent
- Studies the Cosmos and the Earth as a planet

- *Total members*: **290**
- *Productivity*: **500-650** peer-review articles per year; **~3x** more cited than average

Fundamental & applied research

Frontier science

Space missions | Ground-based instruments



Catalonia Space 2030 Strategy

Mission 1

Catalonia, a hub of origin and connection for space economy

Mission 2

Contributing to the strengthening of Europe's space technology capabilities

Mission 3

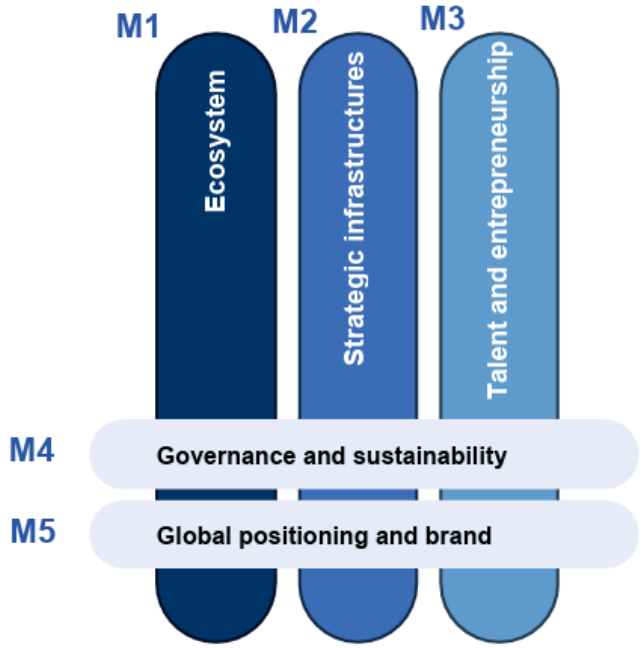
Fostering constellations of talent with Catalan DNA

Mission 4

A solid system that drives the sector and the country forward

Mission 5

Catalonia Space 2030: a global brand, a shared pride



*Space strategy being promoted by the Catalan Government since October 2020

Generalitat de Catalunya
Government of Catalonia

IEEC Institut d'Estudis Espacials de Catalunya

i2cat

ICGC Institut Cartogràfic i Geològic de Catalunya

https://politiquesdigitals.gencat.cat/ca/economia/espai/

Institutional Information

- The Institute of Space Studies of Catalonia (IEEC) was established in 1996
- It is a non-profit foundation of the Catalan public sector
- Board of Trustees: Generalitat de Catalunya, UB, UAB, UPC and CSIC
- CERCA centre – Centres de Recerca de Catalunya
- Four Research Units:
    - Institute of Cosmos Sciences (UB)
    - Center of Space Studies and Research - CERES (UAB)
    - Research Group in Space Sciences and Technologies - CTE (UPC)
    - Institute of Space Sciences - ICE (CSIC)

Generalitat de Catalunya

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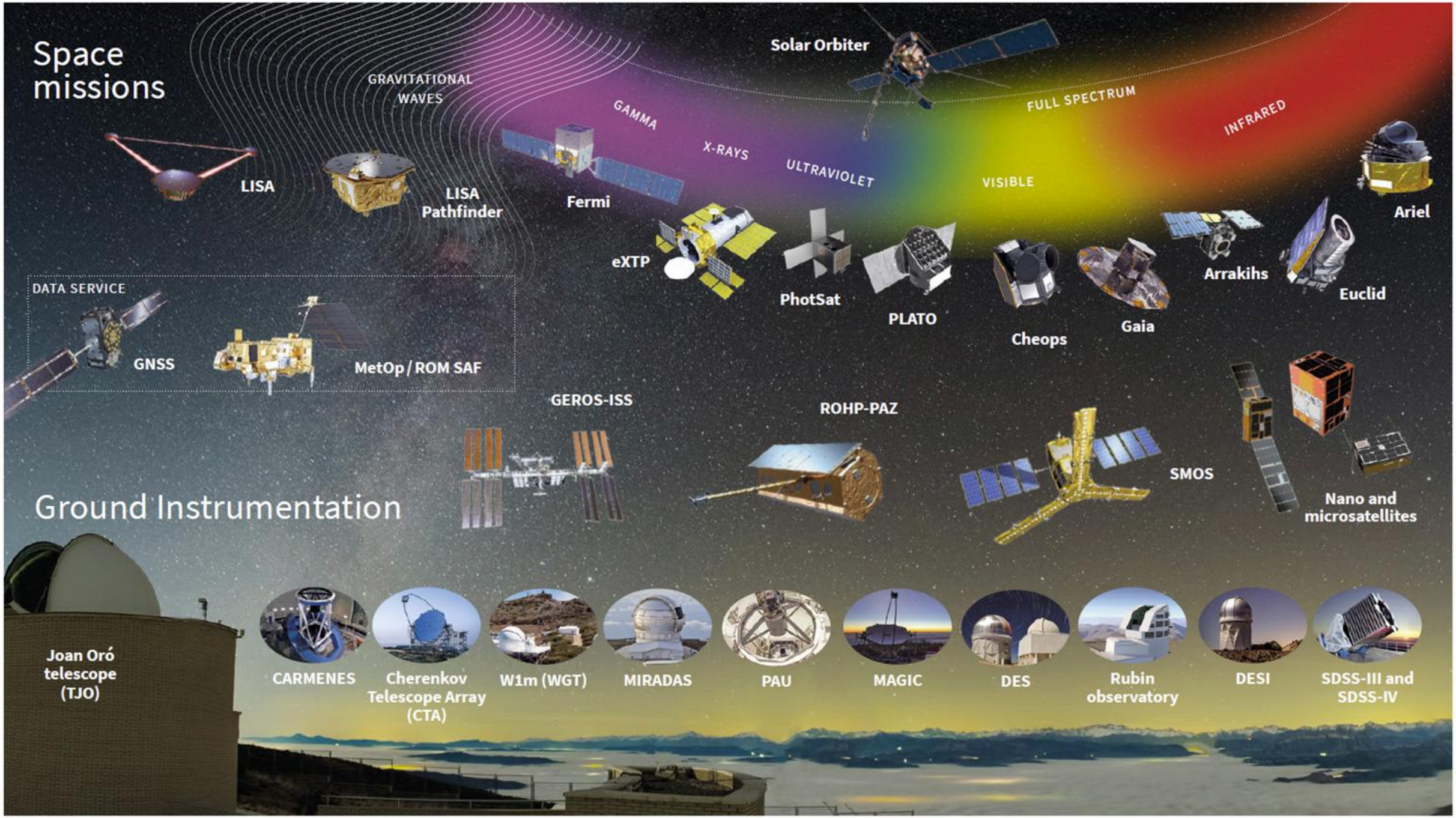
CSIC Consejo Superior de Investigaciones Científicas

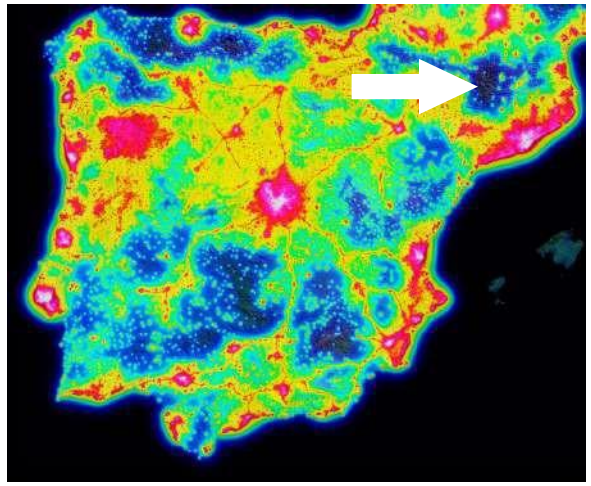
Headquarters

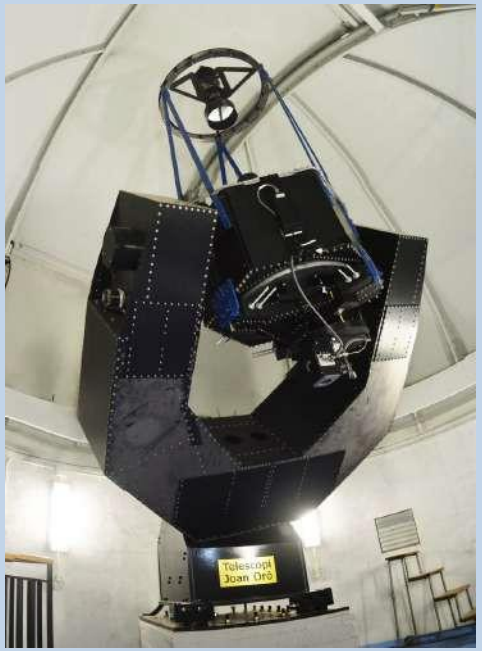
IEEC


Space missions
GRAVITATIONAL WAVES
LISA
LISA Pathfinder
Solar Orbiter
GAMMA
X-RAYS
ULTRAVIOLET
VISIBLE
INFRARED
FULL SPECTRUM
Fermi
eXTP
PhotSat
PLATO
Cheops
Gaia
Arrakihs
Euclid
Ariel
DATA SERVICE
GNSS
MetOp / ROM SAF
GEROS-ISS
ROHP-PAZ
SMOS
Nano and microsatellites
Ground Instrumentation
Joan Oró telescope (TJO)
CARMENES
Cherenkov Telescope Array (CTA)
W1m (WGT)
MIRADAS
PAU
MAGIC
DES
Rubin observatory
DESI
SDSS-III and SDSS-IV

Montsec Observatory (OdM)

MONTSEC OBSERVATORY





Innovation

Innovation and transfer projects

- Astronomy
- Earth Observation
- Navigation
- **Space Safety - Space Situational Awareness**
- Telecommunications
- Quantum communications
- Space transportation
- Commercialisation & transference
- Talent & education

Space Weather research activities at IEEC

IEEC

Coordinates world-class research across its units. Core focus on operational 24/7 services.

UPC-IonSAT members (IEEC-UPC)

HPSWG members (IEEC-UB)

CommSensLab members (IEEC-UPC)

MNT-Solar m. (IEEC-UPC)

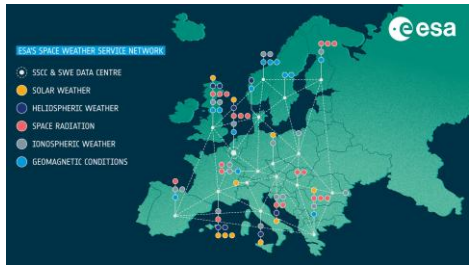
gAGE/UPC m. (IEEC-UPC)

Space Weather research activities at IEEC

IonSAT. Ionospheric determination and navigation based on Satellite And Terrestrial systems (IEEC-UPC)

Main contacts: Manuel Hernández-Pajares, Alberto García-Rigo, Germán Olivares-Pulido

- **R&D Excellence:** Experts in Space Weather monitoring via precise ionospheric determination (RT, PP, Forecast).
- **High Reliability PNT:** Developing high-reliability GNSS positioning and navigation algorithms.
- **Disaster Mitigation:** Monitoring seismic signals, earthquakes, and tsunamis via accurate ionospheric determination.
- **Global Reach:** Services provided through ESA SWE Service Network, EUSPA, International GNSS Service (IGS), the Galileo Reference Center (GRC) and the International Civil Aviation Organization (ICAO) - ACFJ Cons. (via ESSP).
- **Industrial Adoption:** Products used by major global and regional industry leaders such as Google, Indra and GMV



ICAO · OACI · ИКАО 国际民航组织 · الإيكاو

IGS INTERNATIONAL GNSS SERVICE

EUSPA

Google

Space Weather research activities at IEEC

IonSAT. Ionospheric determination and navigation based on Satellite And Terrestrial systems (IEEC-UPC)

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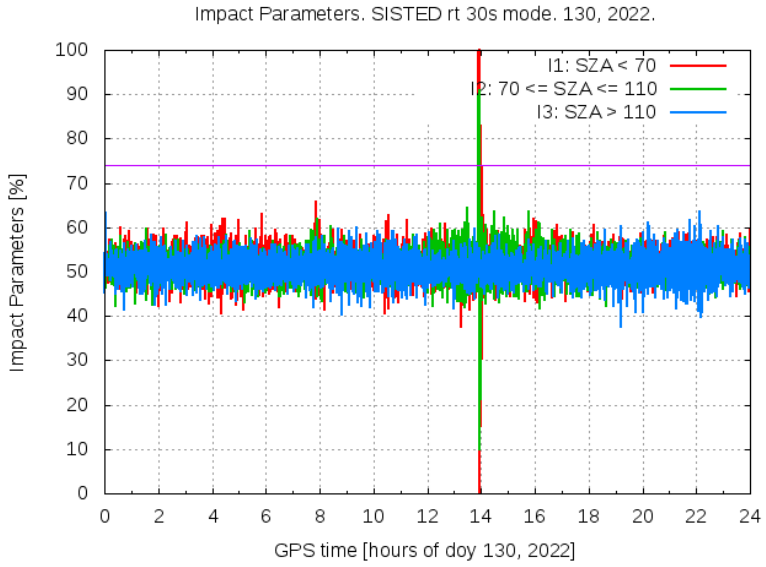
Products integrated into the ESA SWE Network 24/7 and ICAO civil aviation applications (ACFJ consortium):

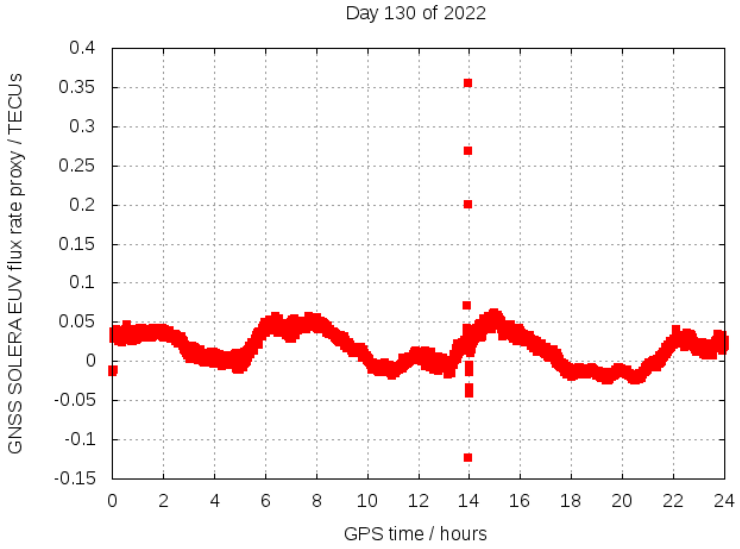
SISTED Detector/Alerts

Real-time detection of GNSS-derived sudden TEC enhancements indicating solar flares with high sensitivity.



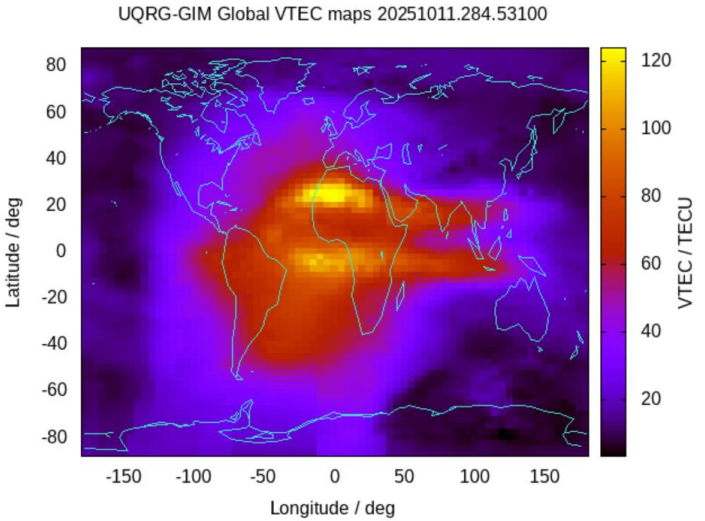
SOLERA Proxy/Detector/Alerts

GNSS-based proxy for the time derivative of Solar EUV flux impacting the ionosphere.



Global VTEC Ionospheric Maps

UQRG-GIM / RT-GIM high-precision VTEC global maps. Monitoring of polar ionospheric states and geomagnetic storm indices in NRT.



Space Weather research activities at IEEC

HPSWG - Heliospheric Physics and Space Weather Group at ICCUB (IEEC-UB)

Main contact: Àngels Aran

- **R&D Excellence:** Solar Energetic Particle (SEP) events analysis, modelling and prediction.
- **Mission Support:** Co-Investigator of the energetic particle detector suite of Solar Orbiter mission.
- **SEP Environment Models:** Predicting particle radiation for satellites in interplanetary orbits.
- **Modelling SEPs:** Modeling the acceleration and transport of energetic particles in the inner heliosphere.

Space Weather research activities at IEEC

CommSensLab (IEEC-UPC)

Main contact: Adriano Camps

- **R&D Excellence:** Experts in ionospheric irregularities monitoring and modeling using GNSS data. Detection and quantification of Scintillation (S4 index) and Equatorial Plasma Bubbles (EPBs).
- **Global coverage:** Use of GNSS-R to expand global monitoring coverage (over the oceans)
- **Simulation tools for signal mitigation:** Advanced ray-tracing tool using ionospheric models (IRI/NeQuick, NRLMSISE-00, IGRF) to predict Space Weather effects such as refraction, signal delays (in SAR, GNSS-R or HF radar missions).
- **Lithosphere-Ionosphere Coupling:** correlations between ionospheric anomalies and seismic activity (analyzing data from 2017–2021), identifying subtle ionospheric correlations under specific geophysical conditions.

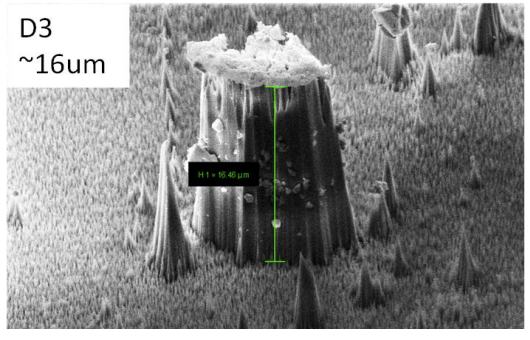
Space Weather research activities at IEEC

MNT-Solar (IEEC-UPC)

Main contact: Manuel Domínguez Pumar

Miniaturized sensor for long term monitoring of atomic oxygen degradation processes in VLEO

- Sensor technology for the long term monitoring of atomic oxygen degradation processes of protective materials and coatings in VLEO (even in case of thick layers).
- With this type of sensors it is possible to monitor also total cumulative ATOX fluence.
- Space weather—specifically solar activity and geomagnetic storms—directly dictates how much ATOX a satellite encounters due to photodissociation of atomic molecules. Atmospheric Swelling pushes denser layers of the atmosphere (and thus more atomic oxygen) up into the path of VLEO satellites / Increased fluence leading to faster material degradation.
- Interested in miniaturized sensors for monitoring the VLEO environment: atmospheric density, ionospheric components (species densities and temperatures) and optionally, ion drift.



Space Weather research activities at IEEC

Research group of Astronomy and GEomatics (gAGE/UPC)

Main contacts: Jaume Sanz, Miguel Juan Zornoza, Guillermo Casado

- **R&D Excellence:** Experts in tracking and modeling the ionosphere, specifically focusing on electron density profiles obtained via radio-occultation, variability of total electron content (TEC), GNSS performance analysis, and Fast-PPP (high-precision navigation).
- **Space Weather Products:** Development of specialized products designed to detect and mitigate the impact of Travelling Ionospheric Disturbances (TIDs) on GNSS users.
  - High-precision Fast-PPP navigation
  - Polar and Equatorial scintillation studies

Space Weather research activities at IEEC

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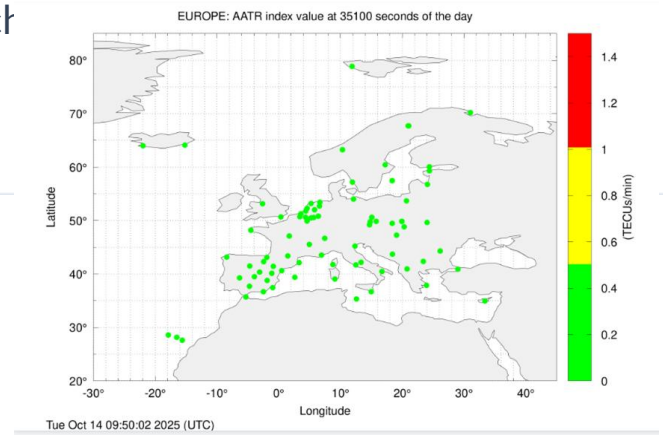
Products integrated into the ESA SWE Network:

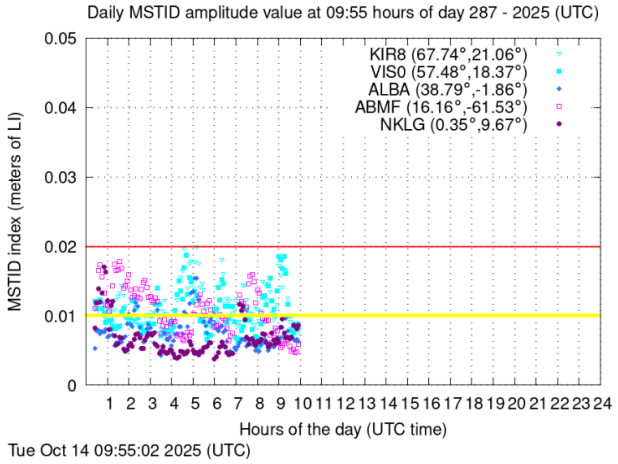
AATR Index

Identifies ionospheric conditions degrading SBAS/EGNOS system performance. Adopted as the metric for EGNOS operational



MSTID Index

Tracks Medium-Scale Travelling Ionospheric Disturbances. Categorizes activity as Low, Medium, or High for GNSS users.

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Thanks for your attention!
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