PITHIA-NRF
Access of facilities

Ingemar Häggström, PITHA Access Bureau
EISCAT Scientific Association
PITHA-NRF ESWW17 27Oct21

PITHIA TNA nodes

- 1. NOA, Palaia Penteli, Greece
- 2. OE, Roquetes, Spain
- 3. IAP, Prague, Czech Republic
- 4a. EISCAT Tromso ISR, Norway
- 4b. EISCAT Kiruna ISR, Sweden
- 5. LOFAR, ASTRON, Dwingeloo, The Netherlands
- 6. CBK/PAS, Warsaw, Poland
- 7. SGO, Sodankylä, Finland
- 8. INGV, Rome, Italy
- 9. ROB-GNSS, Brussels, Belgium
- 10. UPC-IonSAT, Barcelona, Spain
- 11. UPS-IRAP, Toulouse, France
- 12. DLR, Neustrelitz, Germany

Objectives

- Offer scientific users subsidized hands-on access
  - Conduct selected research projects
  - Learn how to access the observing facilities end-to-end
    - Set up a special campaign
    - Data collection & analysis
- Data exploitation
  - Usage of PITHIA tools and services
    - Live tests → improvements

Areas of science openings

- Validation & development of user models
- Developments of higher-level data products
- Plasma physics
- Development of analysis methods
- Small/large scale features and dynamics
- Magnetosphere-ionosphere-atmosphere coupling
- Usage of space models
- Global data analysis and modeling
- .....

User access

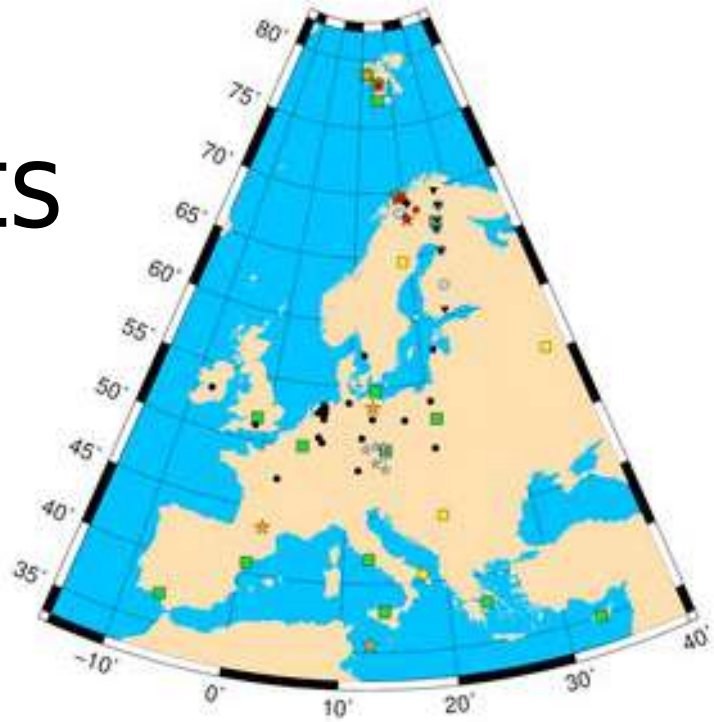
- Assessment
  - Follow H2020 TNA requirements
  - Scientific merit
  - Political preferences
    - New users
    - Max 20% outside of EU+
    - SMEs
    - Member states not well-endowed with RIs

Commitments

- Node
  - Physical
    - Travel to the site location and one week of accommodation
  - Remote
    - Weekly scheduled interactions during one month
  - Training at site for running experiments, analysing, database searching etc.
  - Remote support during the whole project
- User
  - Present scientific results and findings in a report within 6 months
    - Compiled by project into EU deliverables
  - Write an evaluation of the project experience

Instruments

- Ionosondes (■■)
- Doppler sounders, CDSS (★)
- GNSS scintillation receivers (★)
- Incoherent scatter radars (●)
- Riometers (●)
- Pulsation magnetometers (▲)
- LOFAR sites (●)
- GNSS sites of standard networks
  - EUREF and IGS
- Space models/global data
- Cameras and other radars/receivers



NOA node

The National Observatory of Athens (NOA) conducts ionospheric sounding measurements providing data and products to research community.

Athens Digisonde-Portable-Sounder-4D (DPS4D)

Location: Penteli (Athens) Greece (GEO 38.0° N, 23.5° E)

Geometry of the Athens DPS4D installation

Build-in Software

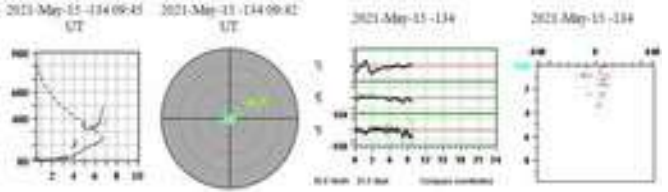
- ARTIST 5.0 – ionogram scaling
- DFT2SKY – Skymap calculation
- DDAV – Calculation of drift velocity
- DRGMaker – Calculation of directogram
- TILT – Calculation of ionospheric tilt
- Online image tools – production of images

NOA node

Products

Digisonde related data and products

- Ionospheric echoes parameters: Amplitude, phase, direction of arrival, virtual height, Doppler frequency & spread, ordinary & extraordinary wave polarization identification.
- Ionospheric electron density profiles; ionospheric characteristics including foF2, foF1, foE, foEs, MUF(3000)F2, hmF2, hmF1, hmE and the IRI parameters B0, B1 and more (49 in total). *Data archiving: SAO, SAOXML*
- Ionosphere visualization products:
  Ionograms; Skymaps; Drift velocity plots; Directograms
  Data archiving: RSF/SBF, SKY, DVL, TLT and PNGs



Athens DPS4D experiments

Standard mode

- Vertical soundings every 5 min (carried out routinely): scanning ionogram; F-region drifts

Special modes

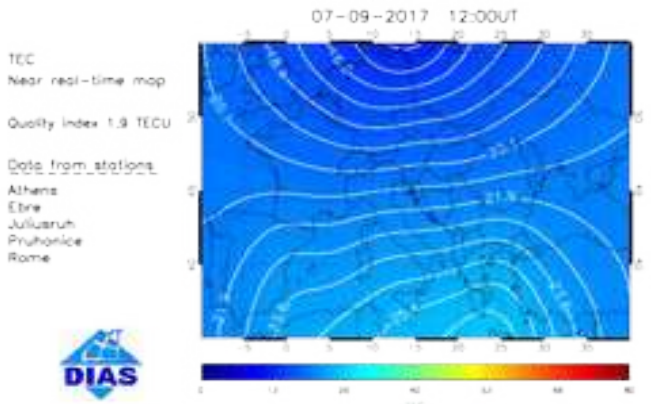
- Vertical soundings: fixed-frequency ionogram; E-region drifts.
- Bi-static oblique soundings jointly with one or more Digisonde systems (Digisonde-to-Digisonde operation)
- Programmable selection of frequencies or frequency bands
- Flexible scheduling of sampling cadence

NOA node

Models

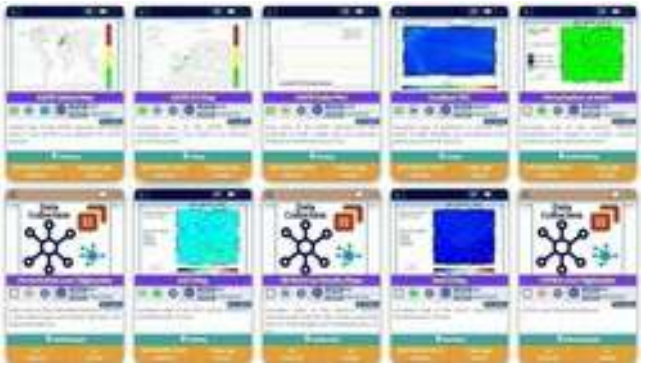
Ionospheric predictions

The **European Digital Upper Atmosphere Server (DIAS)** e-infrastrure operated by NOA delivers **nowcasts**, as well as short- and long-term **predictions** of ionospheric characteristics over Europe. The DIAS database contains data and model results from 2005 until today.



DIAS TEC maps

Detection and prediction of TIDs



The **TechTIDE-EC** warning system provides detection and prediction of Travelling Ionospheric Disturbances (TIDs) over Europe and Africa. The TechTIDE database contains data and model results from 2017 onwards.

http://www.tech-tide.eu/

Observatori de l'Ebre node

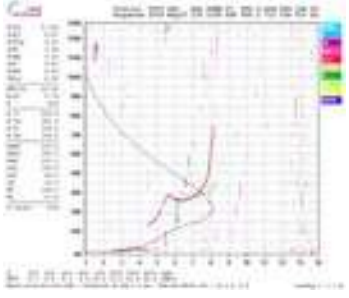
Observatori de l'Ebre (OE) is a research institute born in **1904** to study Sun-Earth relationship. We study, analyze and measure the variability of the Earth's magnetic field and ionosphere.

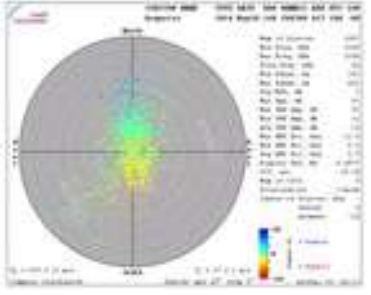
Located in Roquetes, Catalonia, Spain
www.obsebre.es

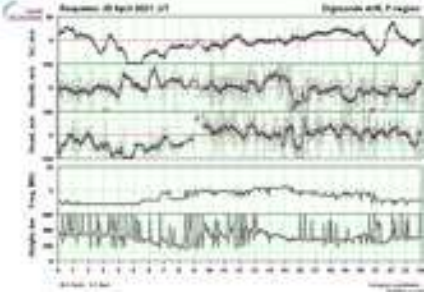
Description of the infrastructure:
OE team operates a DPS4D ionosonde system, providing routine vertical incidence (VI) and bi-static oblique incidence (OI) ionospheric measurements in synchronous operation with other European DPS4D systems.

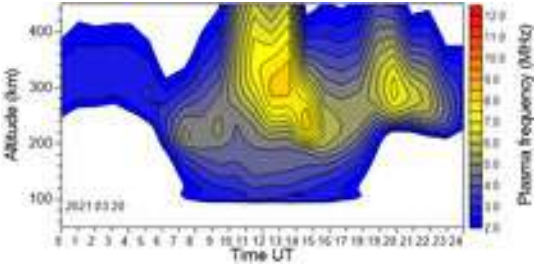
Observatori de l'Ebre node

Physical measurements: Amplitude, phase, direction of arrival, virtual height, Doppler frequency & spread, ordinary & extraordinary wave polarization identification.
Real-time: ionospheric electron density profiles; vertical ionospheric total electron content (ITEC); classical ionospheric characteristics (foF2, foF 1, foE, foEs, MUF(3000)F2, hmF2, hmF1, hmE, and the IRI parameters B0, B1)
A**dded value product**s: VI and OI ionograms, skymaps, digsonde drift velocity, ionospheric tilts and directograms



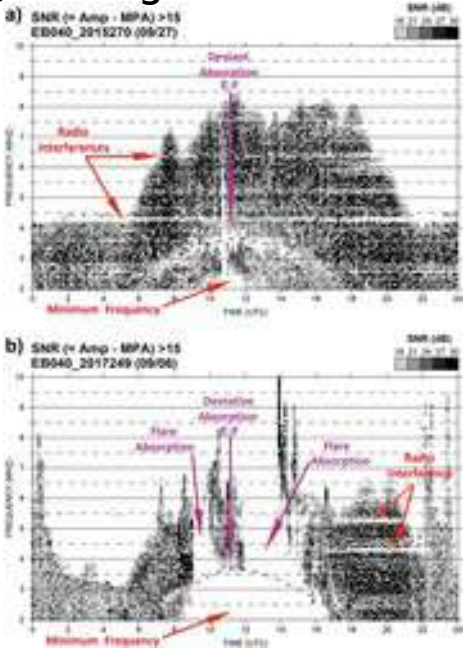






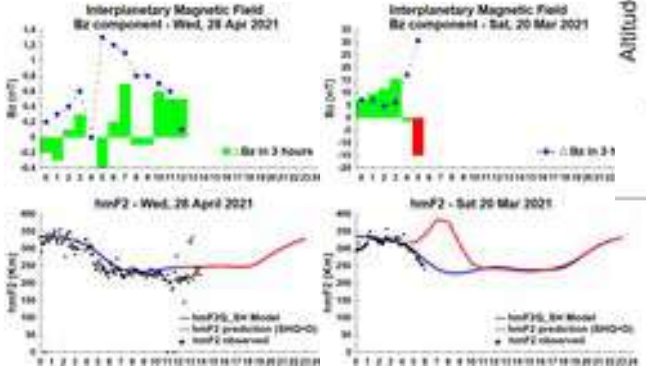
Observatori de l'Ebre node

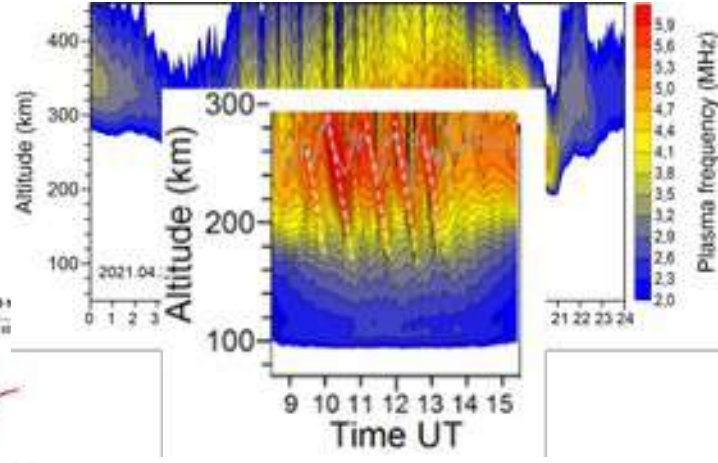
-Absorption study effects produced by Solar flare emissions Study of the absorption signal observed in the signal noise ratio (SNR) during Solar flare emissions.



-hmF2 Model

Model of the response of the electron density peak hmF2





IAP Node

Analysis of ionospheric variability, wave coupling processes and consequences in the whole atmosphere and ionosphere using **CDSSs**, **DPS 4D,**and electrostatic field measurements (**EFM**):

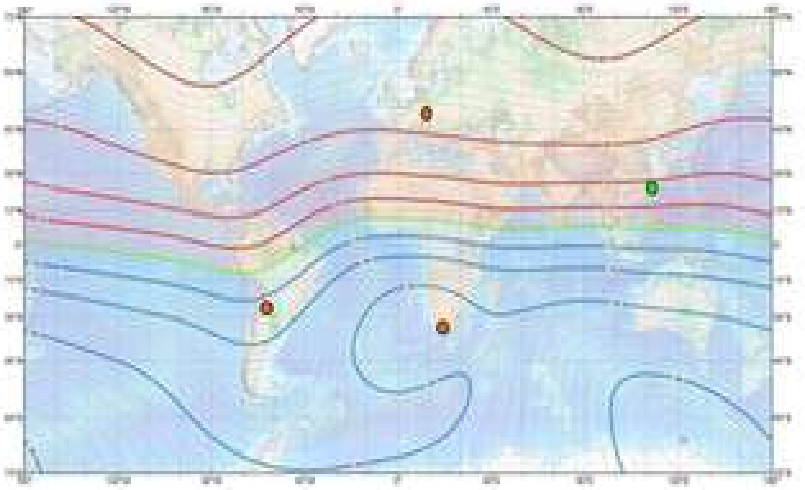
- Validation of medium scale TIDs (MSTID) detection techniques
- Ionosphere/gravity wave climatology
- Troposphere – upper atmosphere – solar wind coupling studies exploiting atmospheric electricity
- Providing access to the IAP experimental infrastructure, offering observatory infrastructure for installation of measuring instruments for long- or short-term campaigns) and to our archives of high quality ionospheric data.

IAP Node: CDSS

Continuous Doppler Sounding System (CDSS)

- Doppler shift measurements
- Monitoring of AGW propagation
- Detection of infrasound signatures in the ionosphere

Central Europe, South Africa, Argentina and Taiwan



Multi-point continuous Doppler sounding makes it possible to investigate **propagation of atmospheric waves** (direction, velocity, periods, amplitudes) and disturbances of the upper atmosphere and ionosphere such as **spread F, ionospheric response to solar flares, to geomagnetic and seismic activity, disturbances related to severe tropospheric convection, solar eclipse, solar terminator, man-made explosions.**
CDSS do **continuous sounding** and a **high time resolution** (around 10 s).

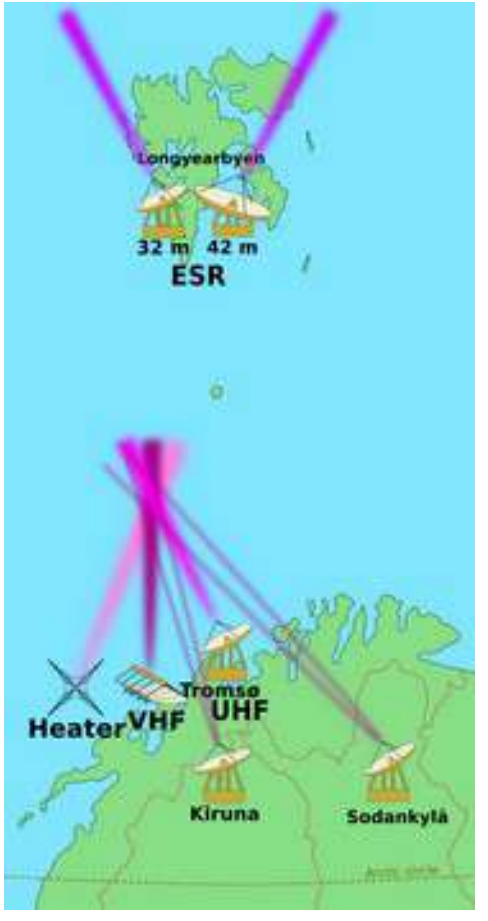
EISCAT nodes

EISCAT Scientific Association (EISCAT) conducts upper atmosphere radar measurements, providing data for the research community.
The **incoherent scatter radar system** (ISR) is distributed on four sites in northern Scandinavia/Svalbard, with the addition of a **heating facility** and a **dynasonde** in Tromsø. A next-generation radar system **EISCAT_3D** is under development and construction.

The EISCAT Tromsø site.

Operating Sites:

- **Tromsø**
  - **VHF** transmitter/receiver 224 MHz
  - **UHF** transmitter/receiver 929 MHz
  - **Dynasonde**
  - **HF** High power transmitter/receiver 4-8 MHz
- **Longyearbyen**
  - **ESR** double transmitter/receiver 500 MHz
- **Kiruna & Sodankylä**
  - **VHF** receivers

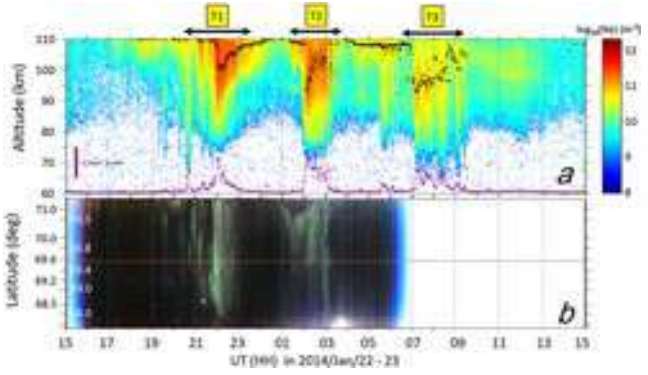


Access to EISCAT nodes

Products/models

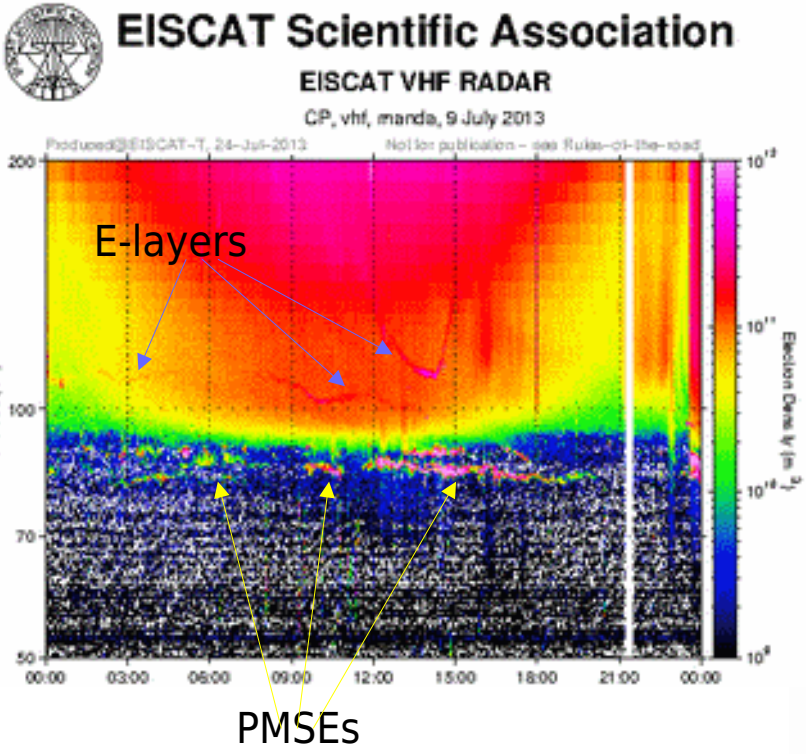
Physical parameters:
ISR: Profiles of electron density, electron and ion temperature, ion drift velocity, ion composition, etc.
Dynasonde: Critical frequencies, electron density profiles, drift vector fields, angle of arrival, etc.

Aurora:

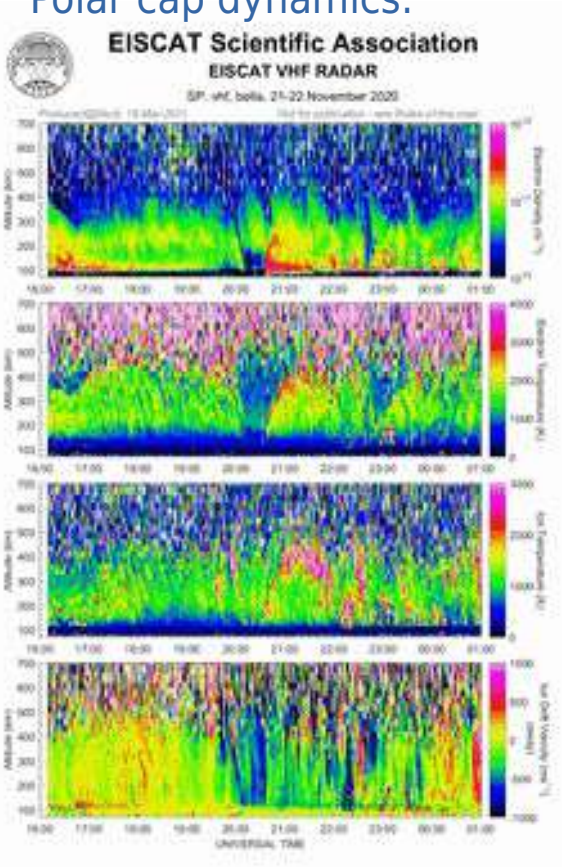


Oyama et al. 2017, doi:10.1002/2016JA023484.

Polar mesospheric summer echoes (PMSE) and induced E-layers:



Polar cap dynamics:

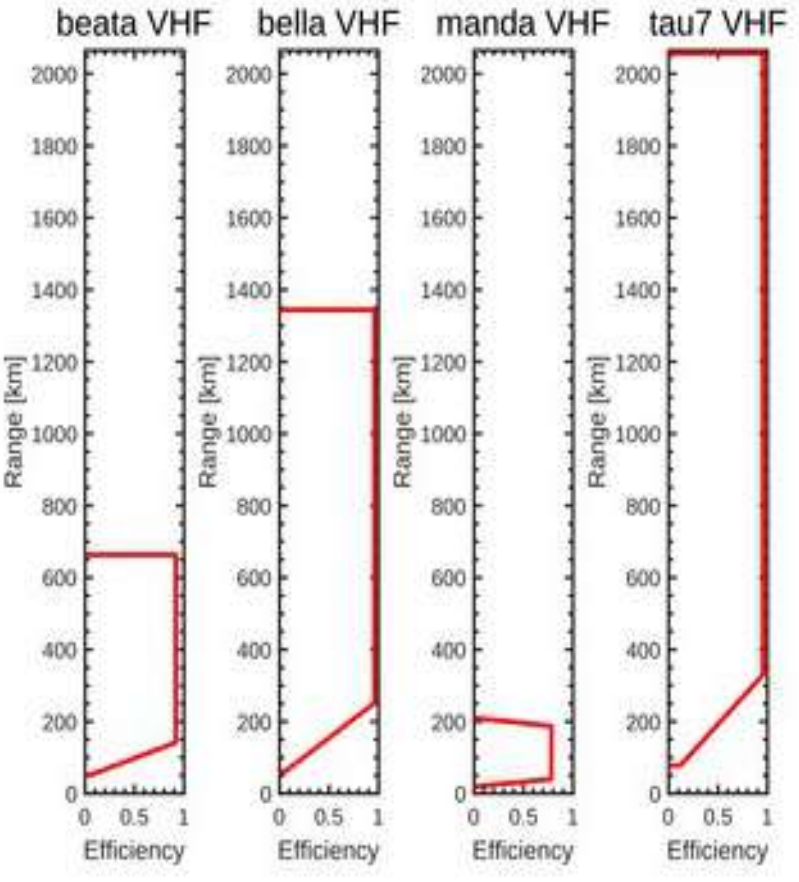


Access to EISCAT nodes

WP7: Access to PITHIA-NRF facilities

EISCAT node is open to experiment proposals in the following fields:

- Polar cap dynamics
- Ionospheric phenomena such as aurora, polar mesospheric clouds and summer echoes (PMC and PMSE), sporadic E-layers and naturally enhanced ion-acoustic lines (NEIAL)
- ISR/HF experiments
- Magnetosphere-ionosphere-atmosphere coupling
- Auroral electrodynamics statistical models
- Space environment-atmosphere coupling at the statistical southern edges of the polar vortex and the auroral oval
- Meteoroids, dust particles and near-Earth objects detection experiments
- Ionospheric 3D imaging



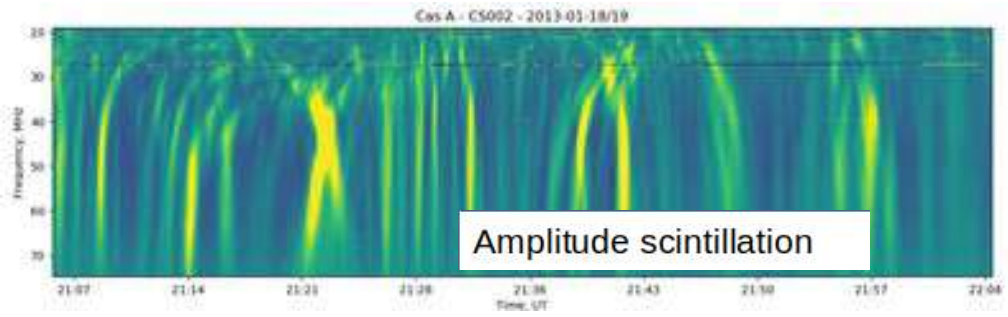
Netherlands Institute for Radio Astronomy

<u>Infrastructure</u>: LOFAR: low frequency radio telescope, operating at frequencies between **10-80 MHz and 110-250 MHz.** Several stations, each consisting of many (48/96) dipole antennas. Dense core (baselines <3km, 24 stations) and 14 remote stations (baselines <100km) in the North East part of the Netherlands. Several international stations throughout Europe

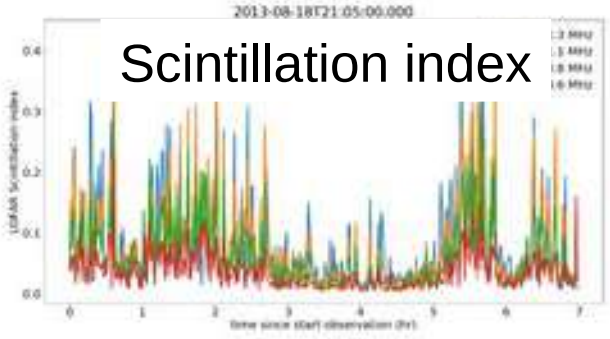
LOFAR: World's largest and most flexible low frequency radio telescope

Designed for radio astronomy, **very suitable for ionospheric research.**

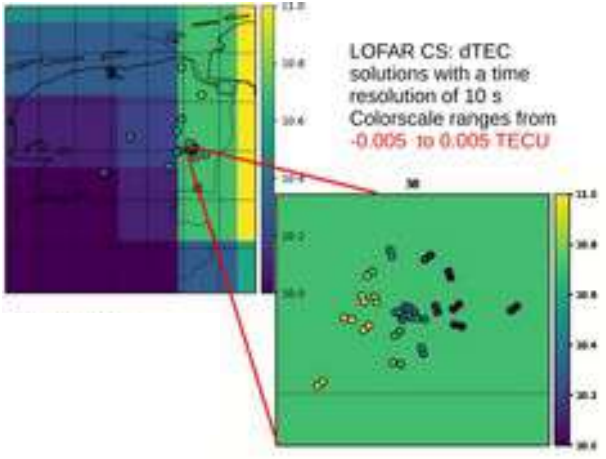
Netherlands Institute for Radio Astronomy



<u>Products</u>: database of **i**onospheric amplitude scintillation data of a bright radio source. Single station data of multiple stations. Access to small scale structures and velocities thereof, by combining data from multiple core stations



Other data products:
TEC gradients (mTECU accuracy)
Direct fast (1 min) imaging of large ~500km FOV TEC gradient structures, including mTIDs/field aligned wavelike structures



CENTRUM BADAN KOSMICZNYCH
POLSKIEJ AKADEMII NAUK (CBK/PAS)

Ground based infrastructures

Heliosphere

Planetary Research

Solar Physics

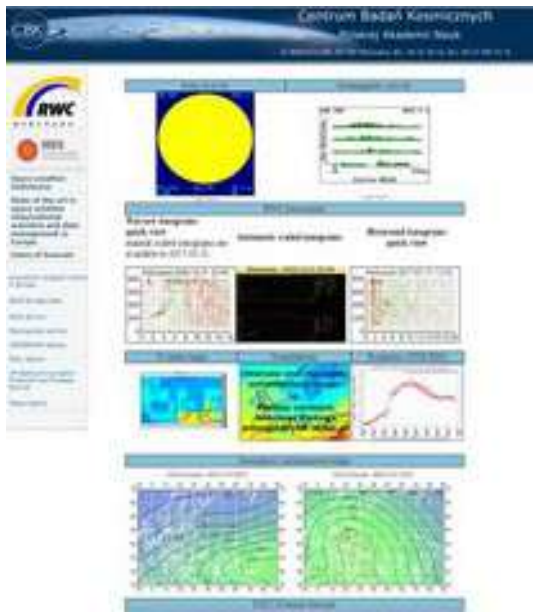
Space Plasma Physics

Geodynamics, Time Reference Systems

Remonte Sensing

Instrumentation

LOFAR SITE, IONOSONDES, RIOMETERS, GNSS receivers



Sodankylä Geophysical Observatory

Finnish Pulsation Magnetometer Chain, 6 stations: 60-69N, since 1999, in-house build.

Finnish Riometer Chain, 7 stations: 60-69N, since 1970 (KIL, IVA, SOD, ROV, OUL, JKL, NUR).

KAIRA broad-band VHF radio receiver **default mode observations:** since 2013.

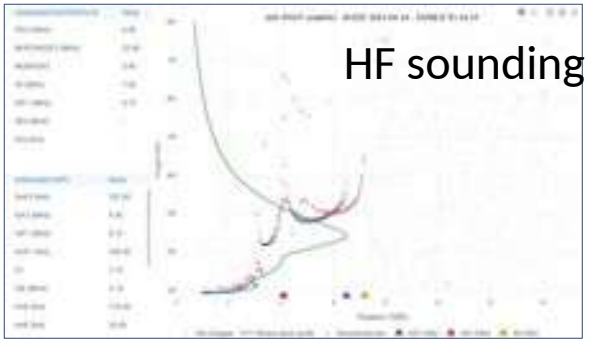
Jyrki Manninen

Tero Raita

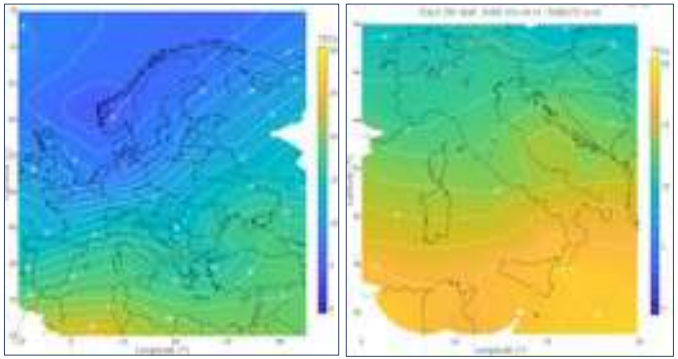
Products and Models: Pc5 pulsations and pulsation power, Pc5 oval, latitudinal variability and local inhomogenities. Identification of auroral substorms by AI method Sseeker and inter-annual and annual substorm variability. Electron precipitation from KAIRA.

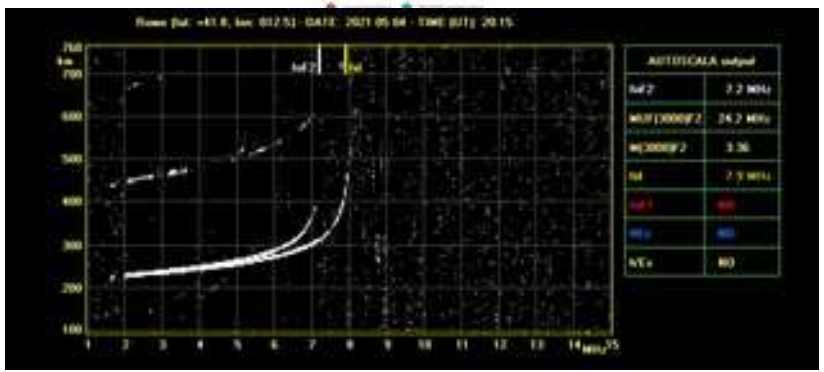
INGV node overview

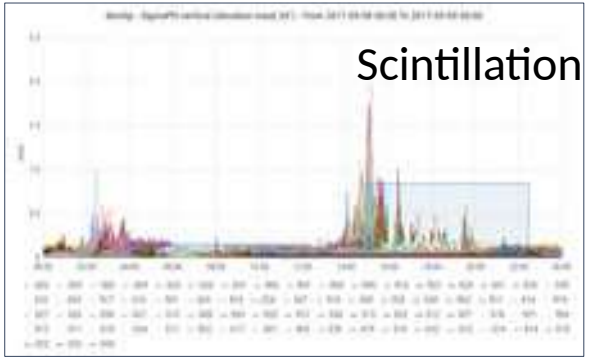
Real-time data

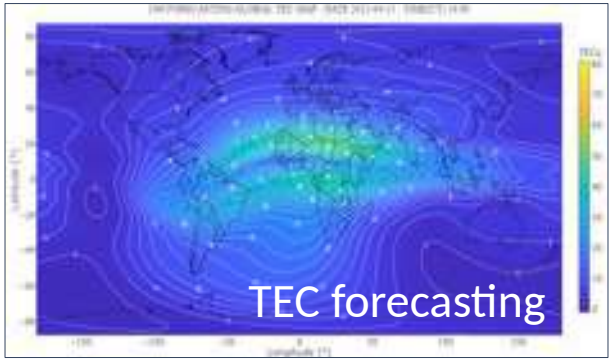


TEC nowcasting









INGV developed its own ionograms scaling software named AUTOSCALA

INGV performs continuous HF soundings since 1950 and GNSS ionospheric scintillation measurements since 2003.

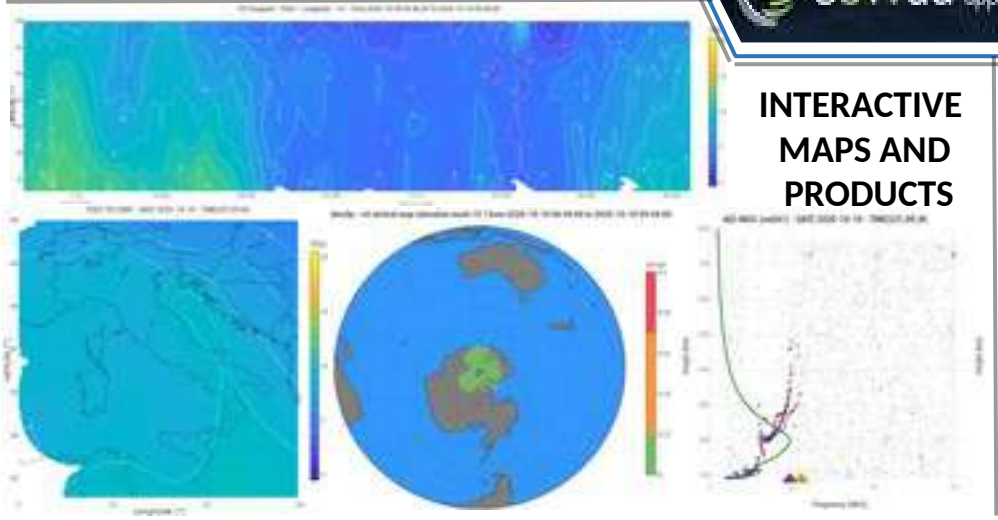
The front-end: eSWua website (eswua.ingv.it)

NEAR-REAL TIME ALERTS AND MONITORING

ARCHIVE DATA TIME-SERIES

eSWua electronic Space weather upper atmosphere

INTERACTIVE MAPS AND PRODUCTS



Royal Observatory of Belgium

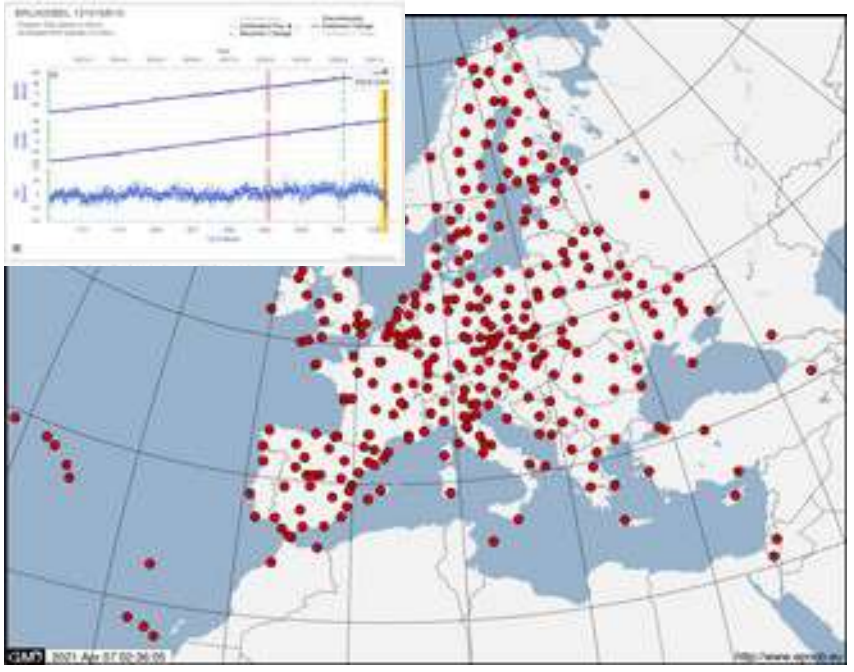
ROB hosts the **EUREF Permanent GNSS Network (EPN)** (~360 stations).

Data centres providing access to the station data.

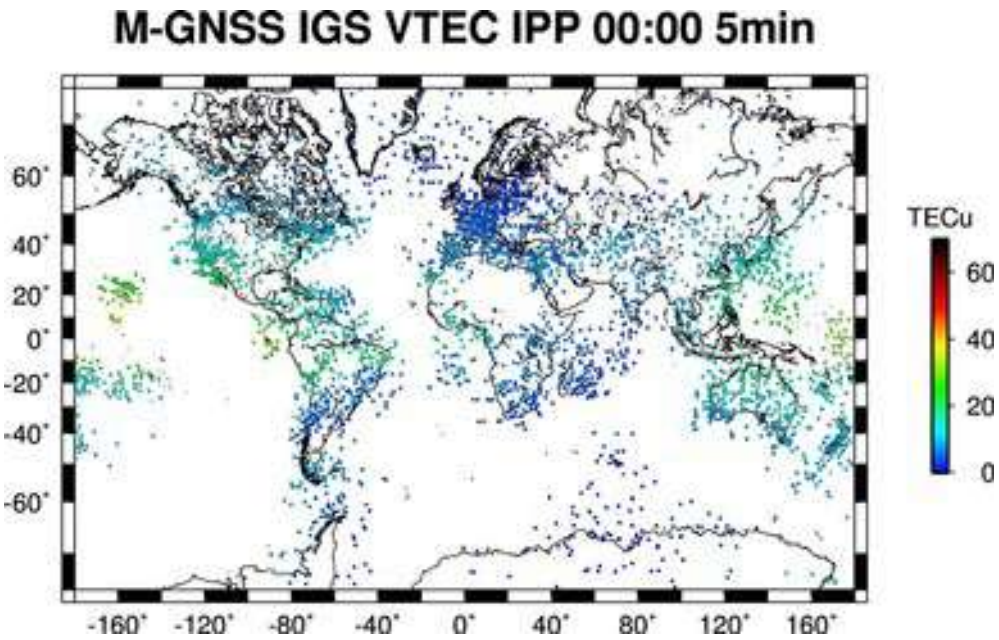
Analysis centres that analyze the GNSS data,

Product centres generate the EPN products

Central Bureau the daily monitoring and management of the EPN

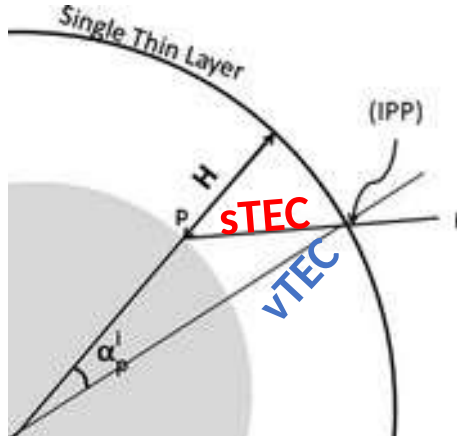


Royal Observatory of Belgium



Products and models:

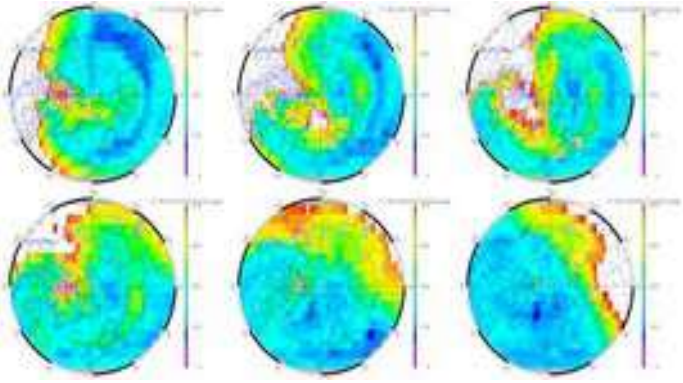
ROB provide daily (less 1 day latency) vTEC estimation at Ionospheric Pierce Point from a selection of IGS stations (#220). The output consist in GNSS sTEC and vTEC, as well as the DCBs for the different signal combinations every 30s.

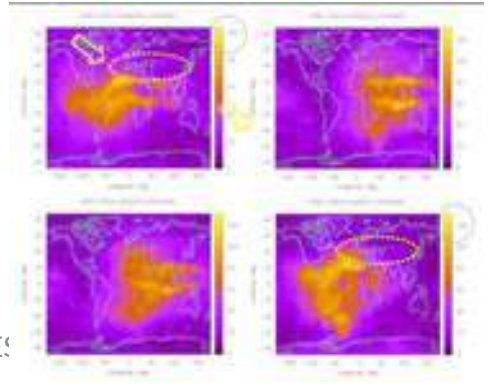


UNIVERSITAT POLITÈCNICA DE CATALUNYA (UPC-IonSAT)

UPC is a public Spanish University @ Barcelona on technology. **UPC-IonSAT res.** group has more than 30 years of experience in GNSS research (photogrammetry, new models for ionospheric modeling, space weather and precise positioning) including GNSS teaching

Products, Models & Dissemination
Final, rapid, RT and predicted Global Ionospheric Maps
GNSS-based solar flare indices and EUV flux rate estimation
inversion of challenging ionospheric ionospheric
Experience in international teaching.



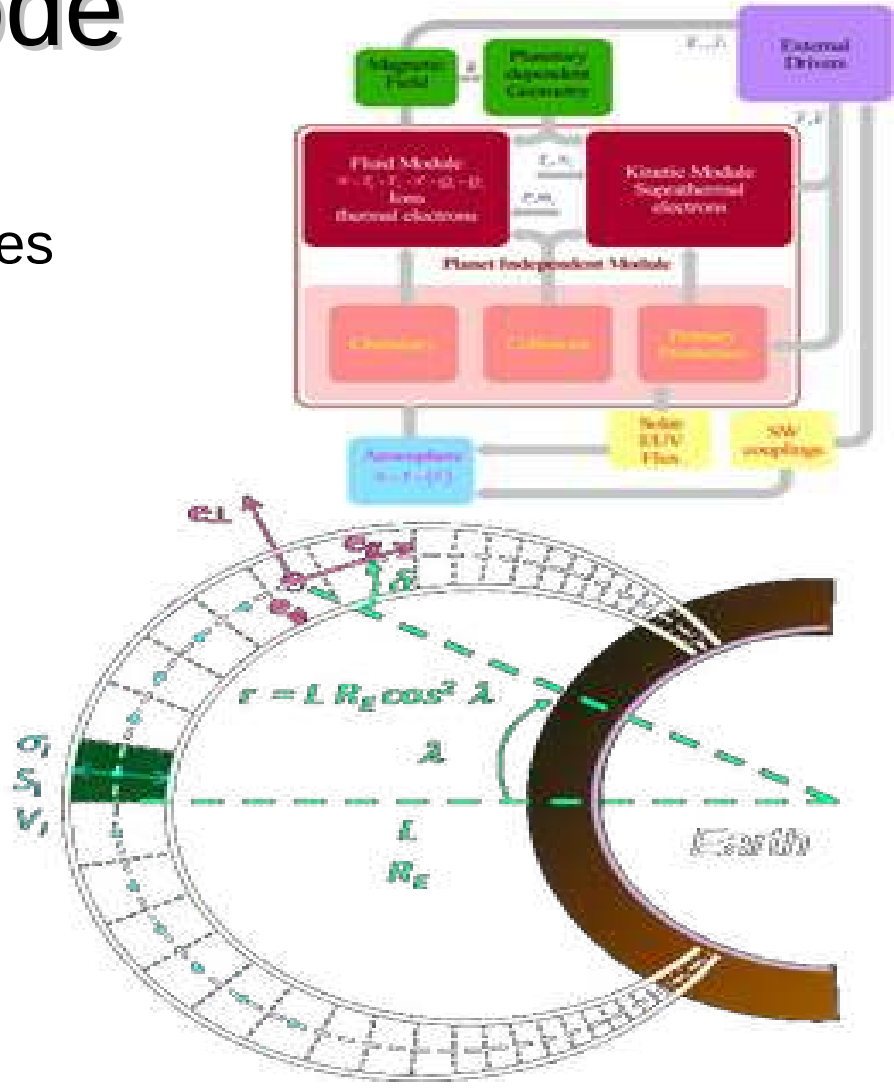


IRAP Node

- TRANSPLANET
  - http://transplanet.irap.omp.eu/
- Online access to IPIM model
  - Available for planets
  - Restricted access
    - Photoionization
    - Species
      - Neutrals (not solved)
      - Ions
- Multiple flux tubes
- Batch runs
  - Email for completion
- Data in different formats
  - Open data access
  - Full parameters
    - Binary IPIM format
  - Main parameters
    - NetCDF
    - CDF

IRAP Node

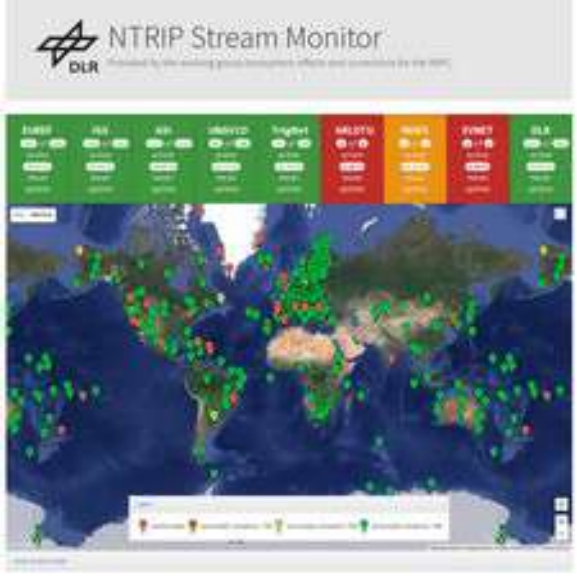
- IPIM Interhemispheric model
  - ionosphere-plasmasphere description
  - transport equations solved along flux tubes
    - closed magnetic field line :Interhemispheric
    - open magnetic field line : High latitude
  - Coverage
    - latitudes
      - Interhemispheric: 10° < |Mlat| < 60°
      - High latitude: >60°
    - Altitudes
      - Minimum: 80-90 km
      - Interhemispheric 6 Re
      - High latitude ≤ 6 Re
  - Magnetic field lines
    - Tilted and eccentric dipole

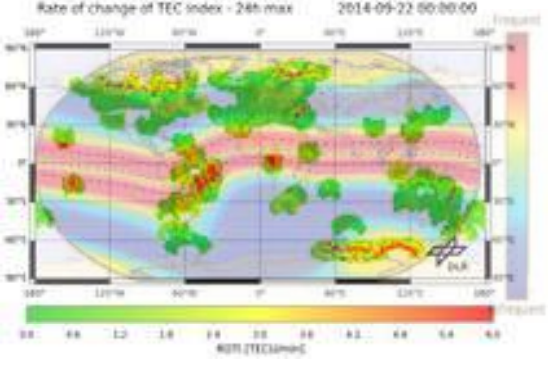


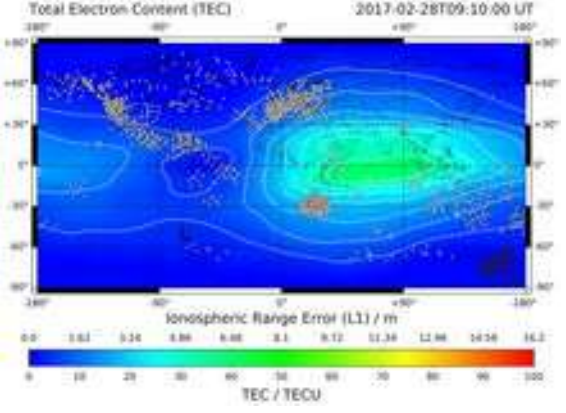
German Aerospace Center – Institute for Solar-Terrestrial Physics
Products and Models

IMPC Real-Time GNSS Processing System

Characterization of the actual state of the ionosphere by using the Neustrelitz TEC Model (NTCM)
Real time high rate GNSS data (1Hz) of several hundred GNSS receivers from GNSS-reference networks (e.g. IGS, EUREF, UNAVCO, ASI, TrigNet) to calculate important key observables e.g. TEC, ROTI, DIX.







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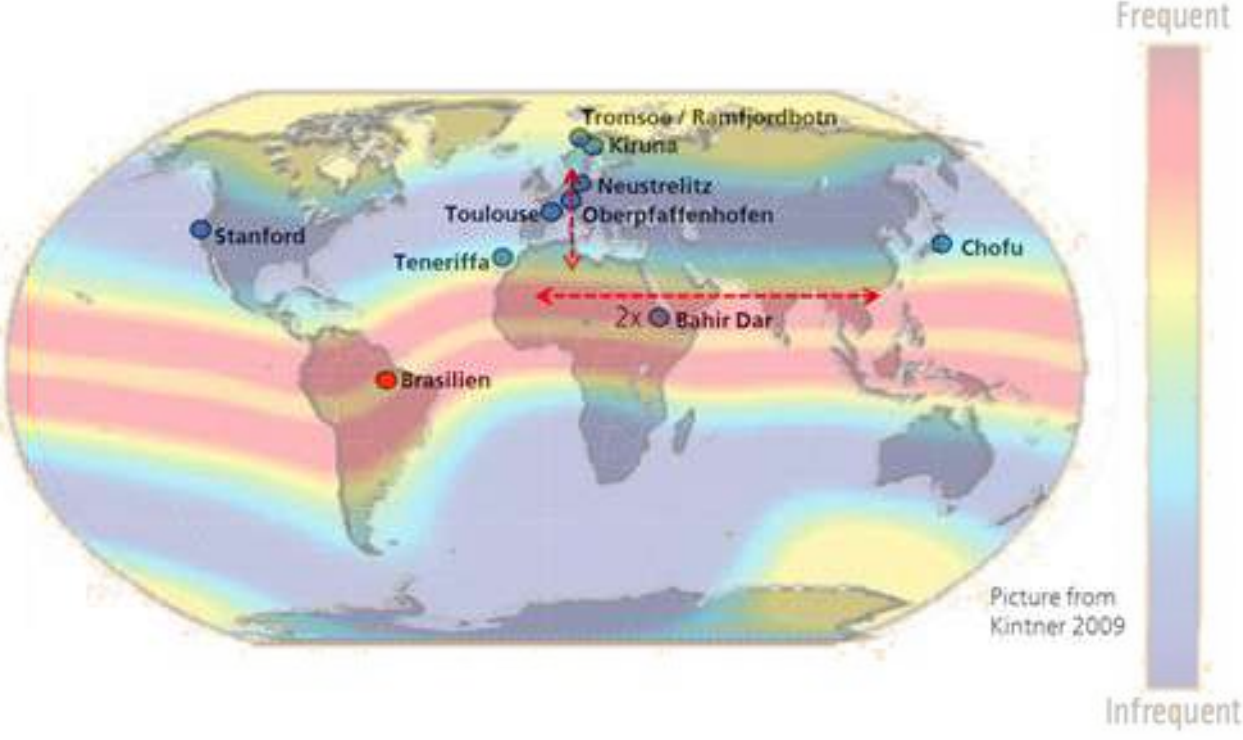
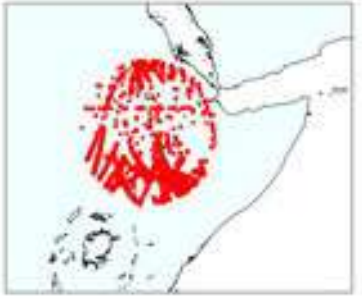
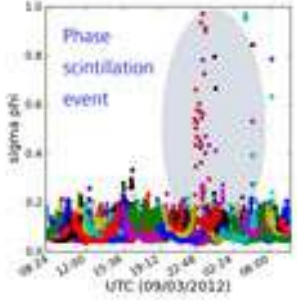
Products and Models (2)

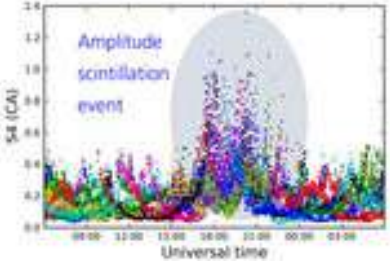
EVNET: High Rate GNSS Receiver Network

The EV-NET is a network of high rate GNSS receivers (50-100 Hz) for the detailed investigation of small-scale ionospheric disturbances and related phase and amplitude









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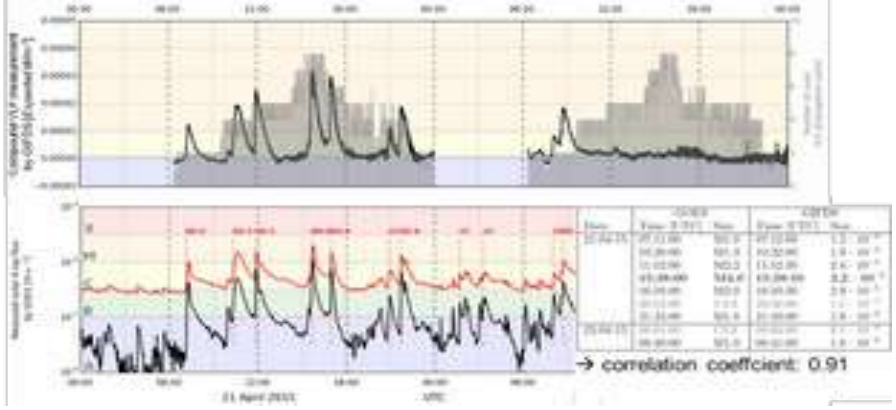
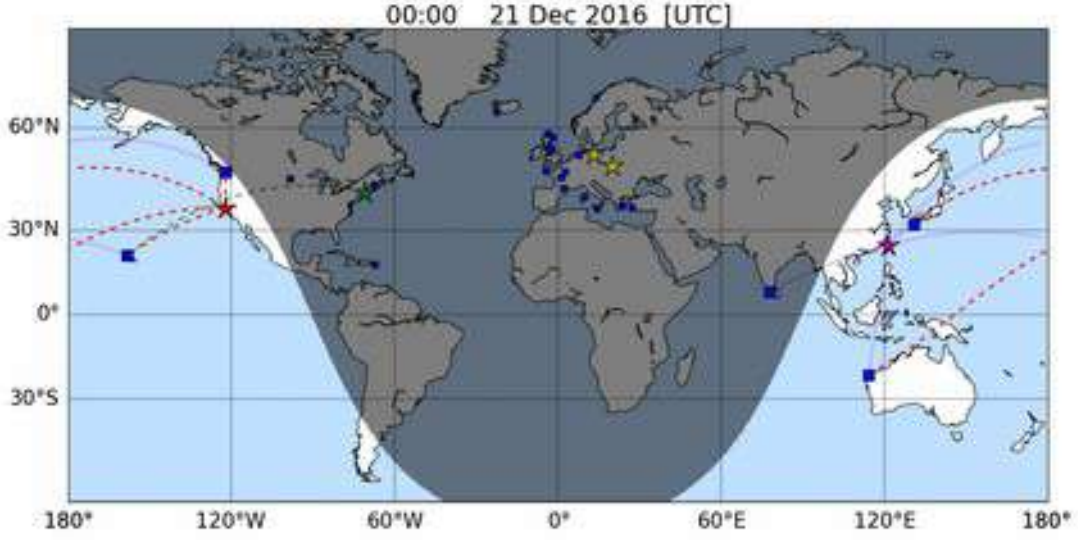
GIFDS: Global Ionospheric Flare Detection System

Global system to measure sudden ionospheric disturbances (SIDs) in the D-layer Ionosphere caused by solar X-ray flares in near real time.





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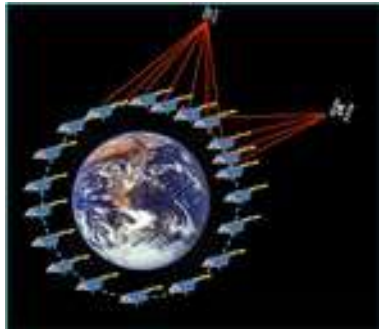
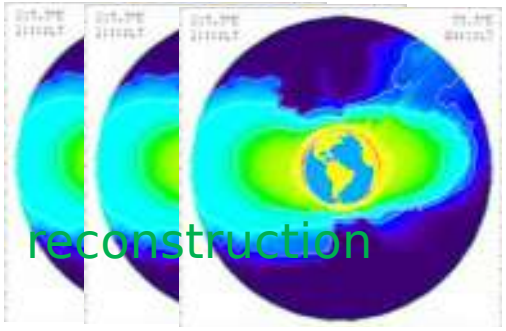
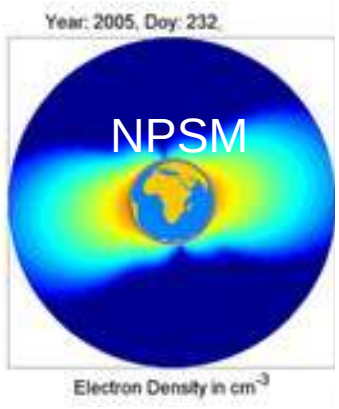
NPSM: Neustrelitz Plasmasphere Model



GNSS navigation data abroad LEO satellites



topside ionosphere /plasmasphere



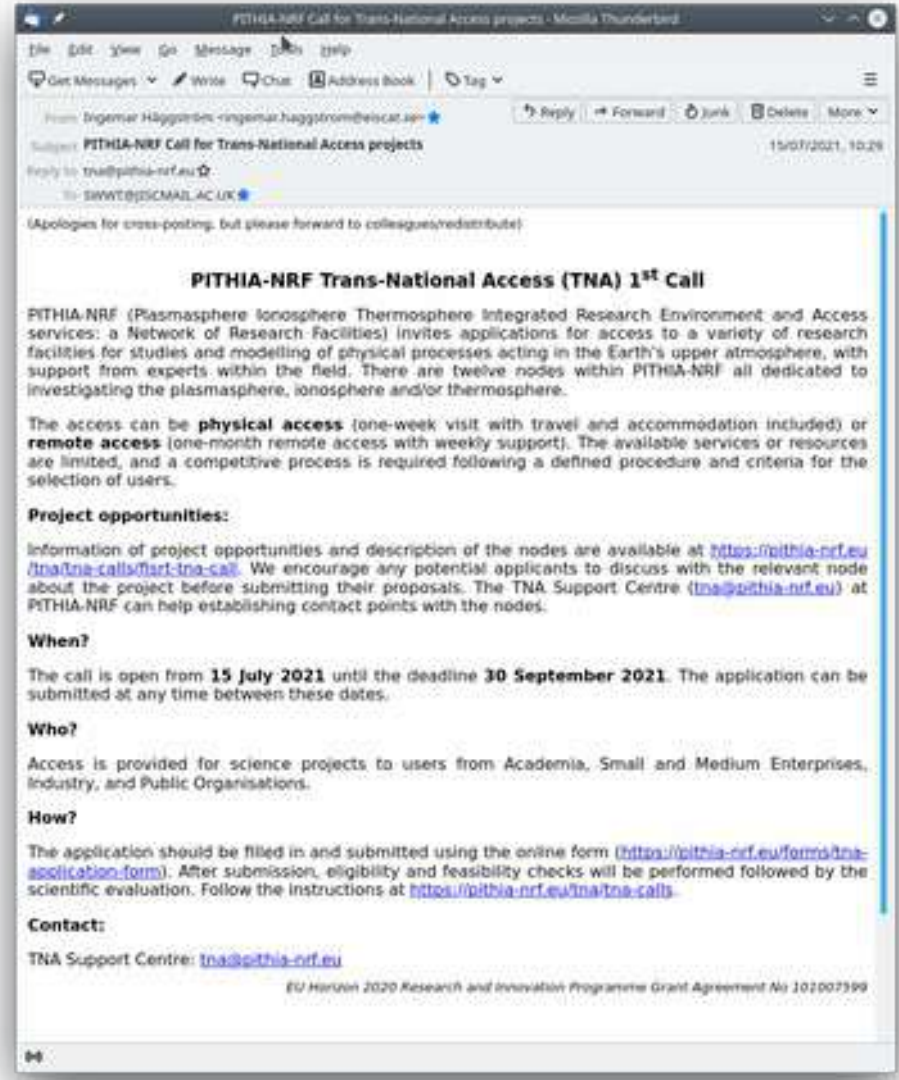
Model output

- Using the solar radio flux index F10.7 as the only external parameter, the operation of the model is robust and fast to be used as a background model for estimating TEC or electron density profiles in near real time applications and services.

- NPSM includes a high altitude part where plasmaspheric processes related to plasmapause and magnetosphere dominate and a lower part where ionospheric coupling is taken into account. The resultant is the plasmaspheric electron density

TNA Calls

- Twice per year
- 15Jul-30Sep 2021
  - Execute 1Nov-1Aug
- 1 Jan-15Mar 2022
  - Execute 1May-1Mar



PITHIA-NRF Call for Trans-National Access projects - Mozilla Thunderbird

File Edit View Go Message Tools Help

Get Messages Write Chat Address Book Tag

Reply Forward Junk Delete More

From: Ingemar Häggström <ingemar.haggstrom@eiscat.se>

Subject: **PITHIA-NRF Call for Trans-National Access projects** 15/07/2021, 10:29

Reply to: tna@pithia-nrf.eu

To: SWWT@JISCMAIL.AC.UK

(Apologies for cross-posting, but please forward to colleagues/redistribute)

PITHIA-NRF Trans-National Access (TNA) 1st Call

PITHIA-NRF (Plasmasphere Ionosphere Thermosphere Integrated Research Environment and Access services: a Network of Research Facilities) invites applications for access to a variety of research facilities for studies and modelling of physical processes acting in the Earth's upper atmosphere, with support from experts within the field. There are twelve nodes within PITHIA-NRF all dedicated to investigating the plasmasphere, ionosphere and/or thermosphere.

The access can be **physical access** (one-week visit with travel and accommodation included) or **remote access** (one-month remote access with weekly support). The available services or resources are limited, and a competitive process is required following a defined procedure and criteria for the selection of users.

Project opportunities:

Information of project opportunities and description of the nodes are available at https://pithia-nrf.eu/tna/tna-calls/1st-tna-call. We encourage any potential applicants to discuss with the relevant node about the project before submitting their proposals. The TNA Support Centre (tna@pithia-nrf.eu) at PITHIA-NRF can help establishing contact points with the nodes.

When?

The call is open from **15 July 2021** until the deadline **30 September 2021**. The application can be submitted at any time between these dates.

Who?

Access is provided for science projects to users from Academia, Small and Medium Enterprises, Industry, and Public Organisations.

How?

The application should be filled in and submitted using the online form (https://pithia-nrf.eu/forms/tna-application-form). After submission, eligibility and feasibility checks will be performed followed by the scientific evaluation. Follow the instructions at https://pithia-nrf.eu/tna/tna-calls.

Contact:

TNA Support Centre: tna@pithia-nrf.eu

EU Horizon 2020 Research and Innovation Programme Grant Agreement No 101007599

Thank you for your attention!

WEB:
https://www.pithia-nrf.eu

The PITHIA-NRF project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101007599