



Activities and products of the  
Ebre Observatory in the field of space  
weather.

GICs and ionospheric irregularities.

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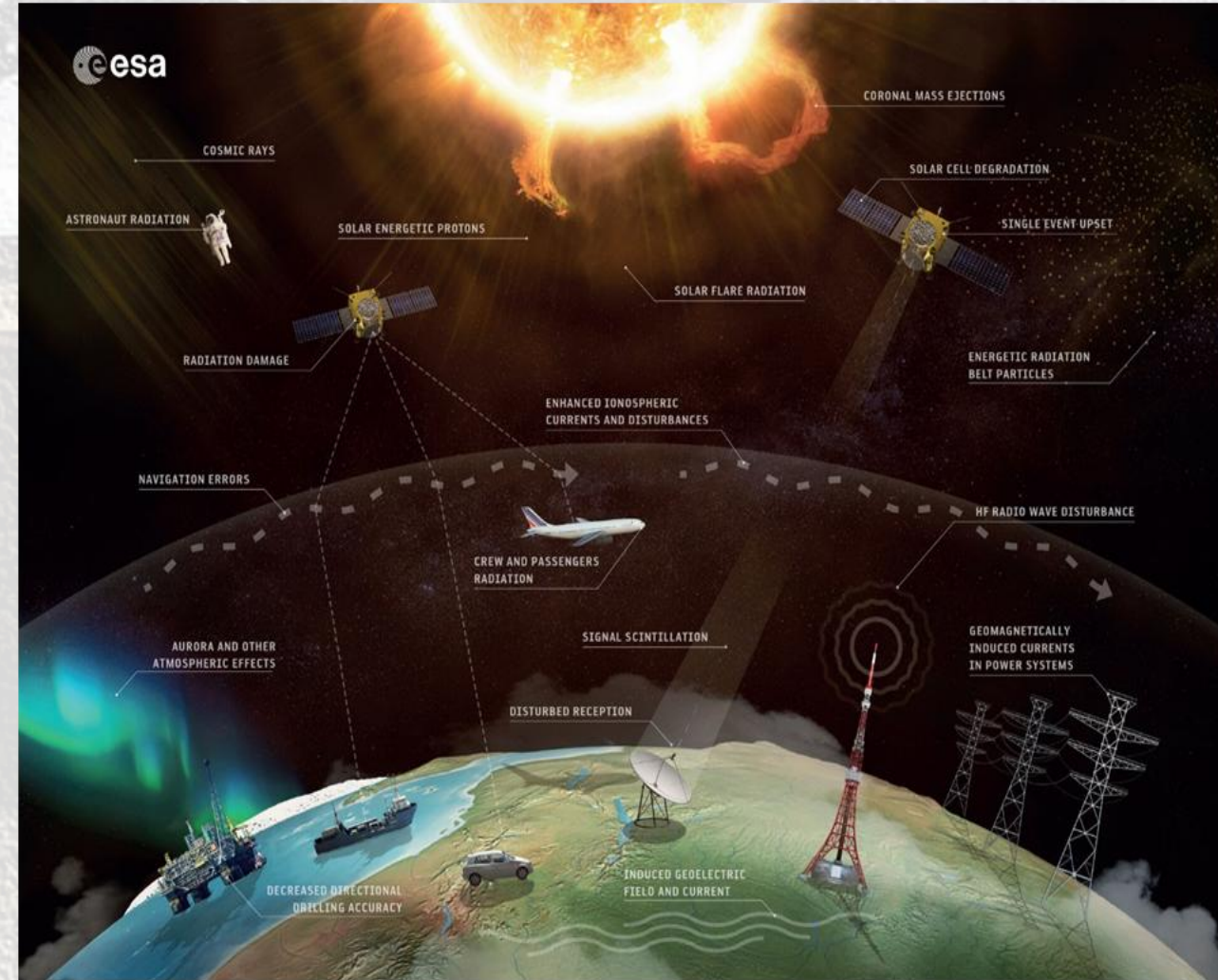
# The Ebre Observatory

- Foundation:
  - 1904/1905
  - Society of Jesus
- Main objective: **Sun-Earth** interaction
- Nowadays:
  - Research:
    - Geomagnetism and aeronomy
    - Hydrology and climate change
  - Observation:
    - Meteorology
    - Geomagnetism (in Spain and Antarctica)
    - Aeronomy (in Spain and Antarctica)
    - Solar
    - Seismic monitoring
  - Outreach (schools, high-schools and public)



# Research in Geomagnetism

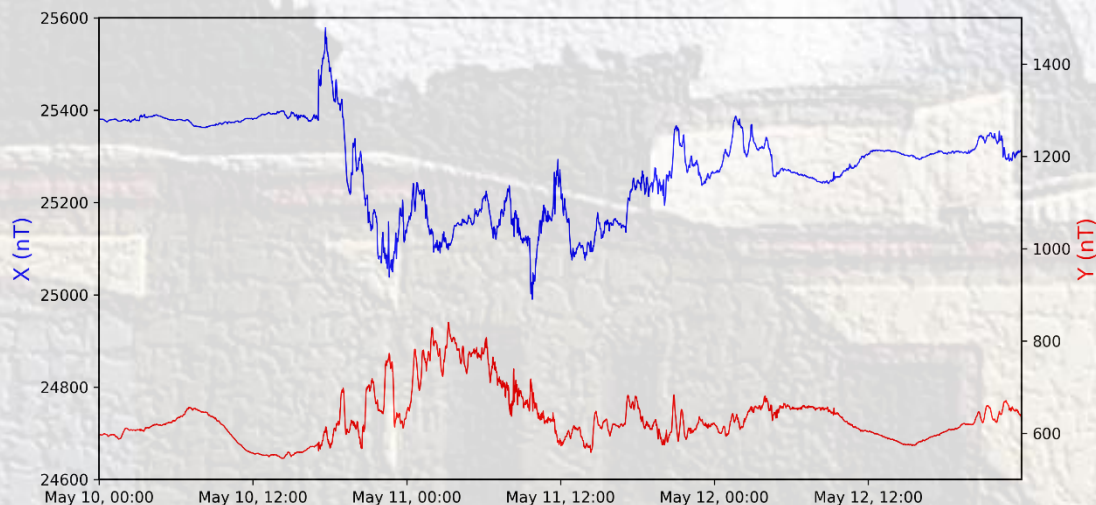
- Geomagnetic main field modeling in collaboration with UCM → IGRF candidates
- Geomagnetic instrumentation
- Space Weather → GIC modelling
  - Power Networks
    - REE, ENDESA
    - IBERGIC
    - IBERGIC-CAST
  - Gas pipelines
    - POWER-GAS-SW



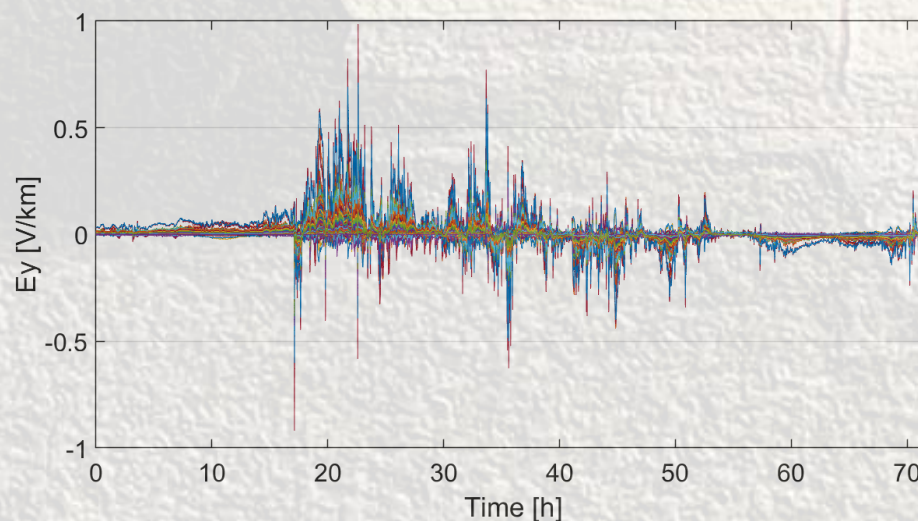
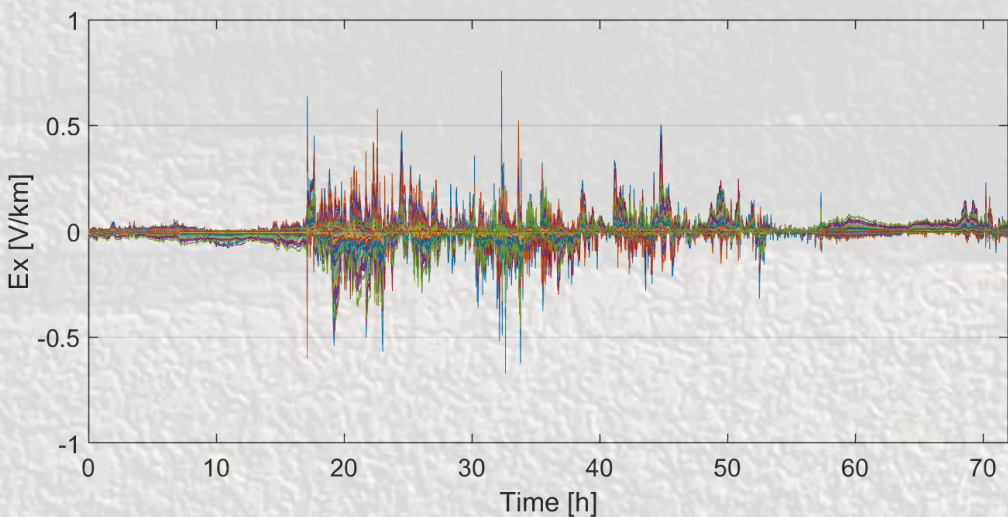
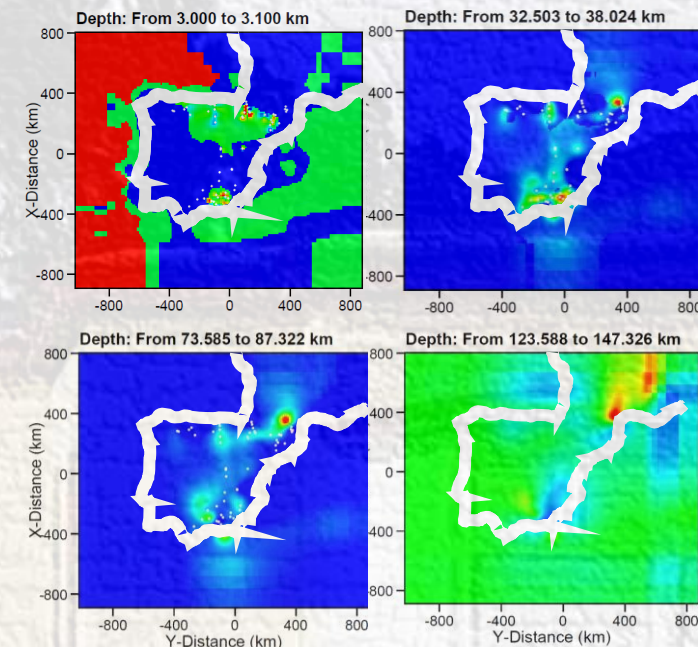
# Power network modelling

## 1. METHOD

ERMIL resistivity (v1.0) model (Torta et al., 2021)



(convolution)



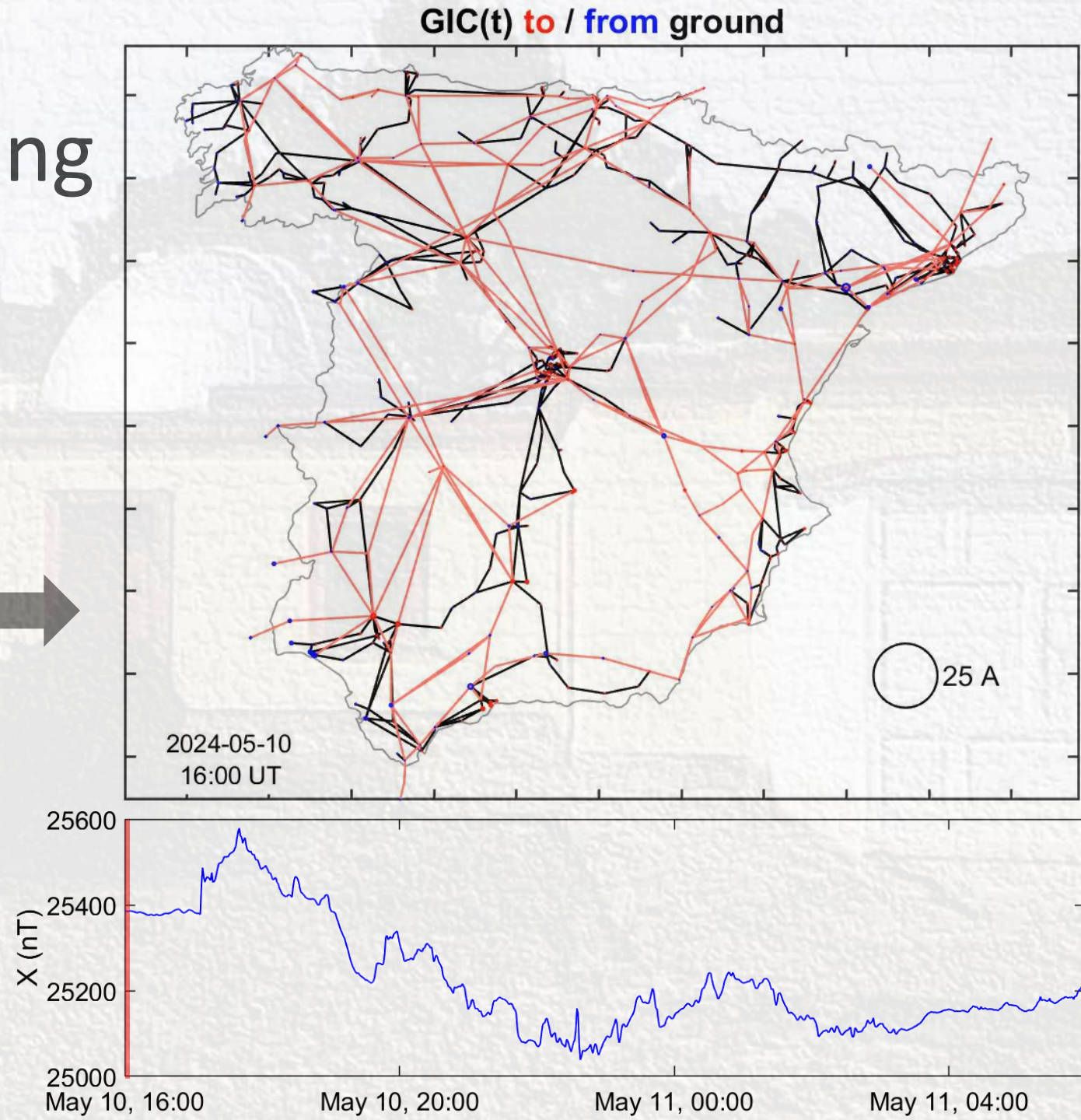
Bus admittance matrix (BAM)  
(Marsal et al., 2022)



# Power network modelling

## 2. PRODUCTS

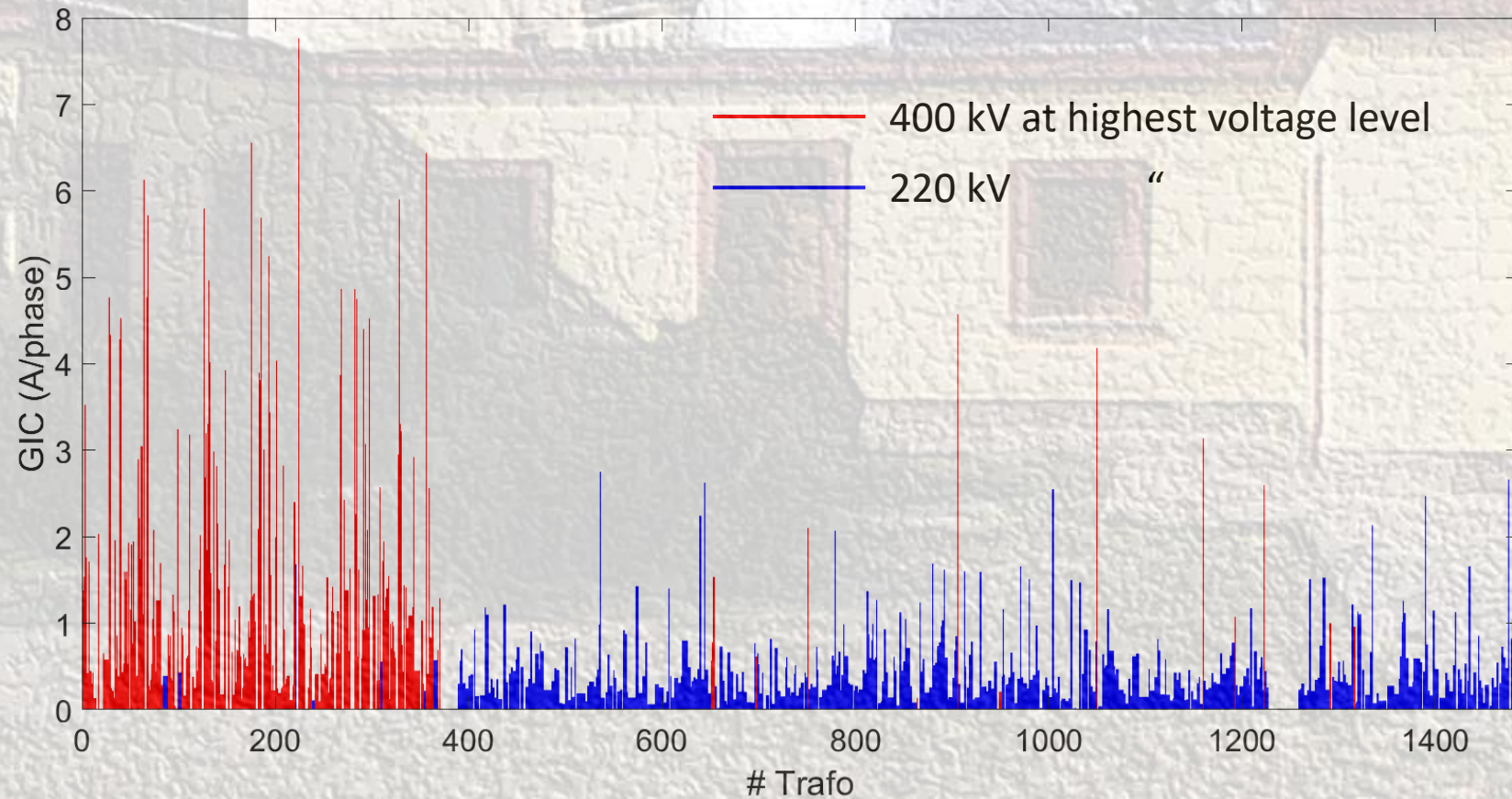
GIC to/from ground through  
substation neutral points



# Power network modelling

## 2. PRODUCTS

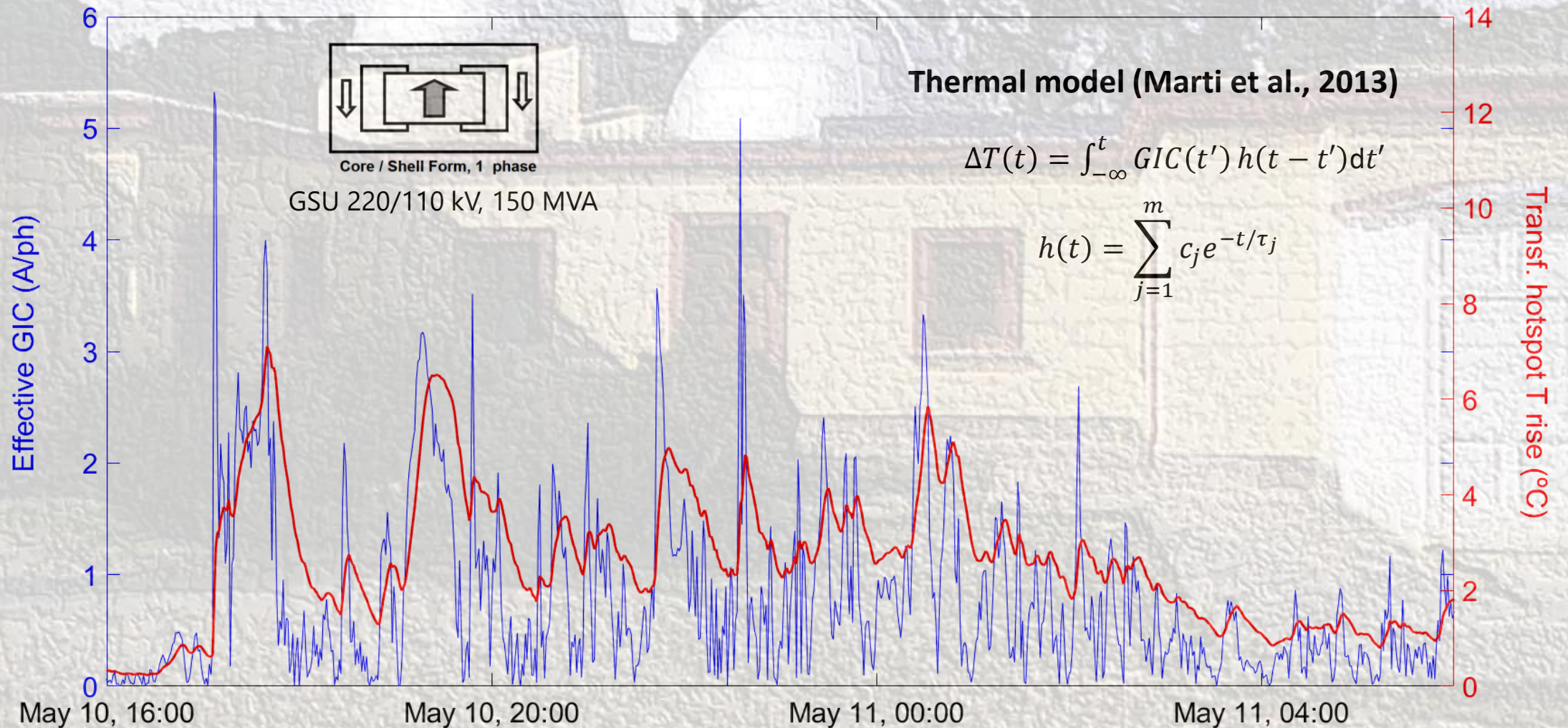
GIC flowing in each transformer winding of the grid



# Power network modelling

## 2. PRODUCTS

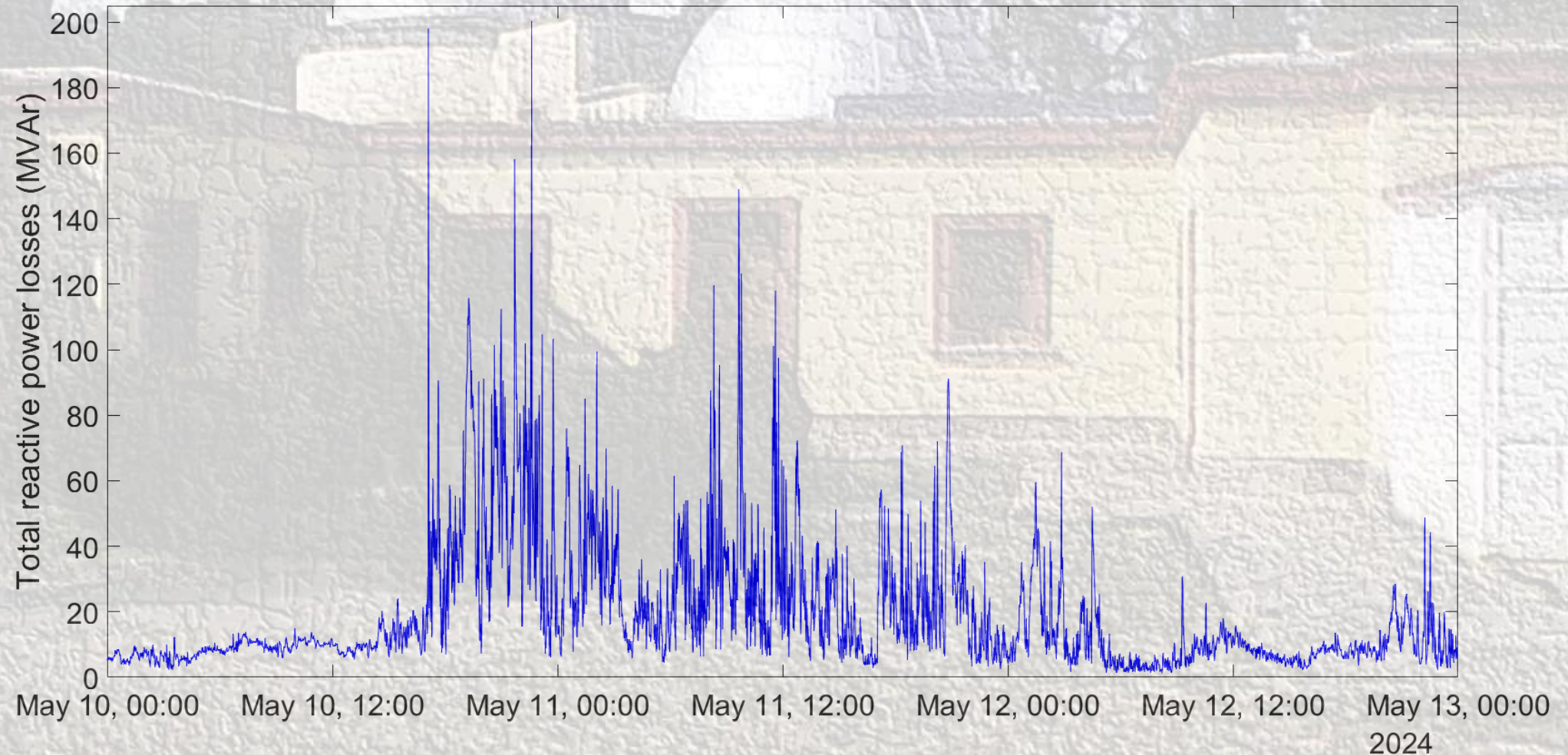
Effective GIC & hotspot temperature rise at each transformer



# Power network modelling

## 2. PRODUCTS

### Storm-time reactive power losses at each transformer

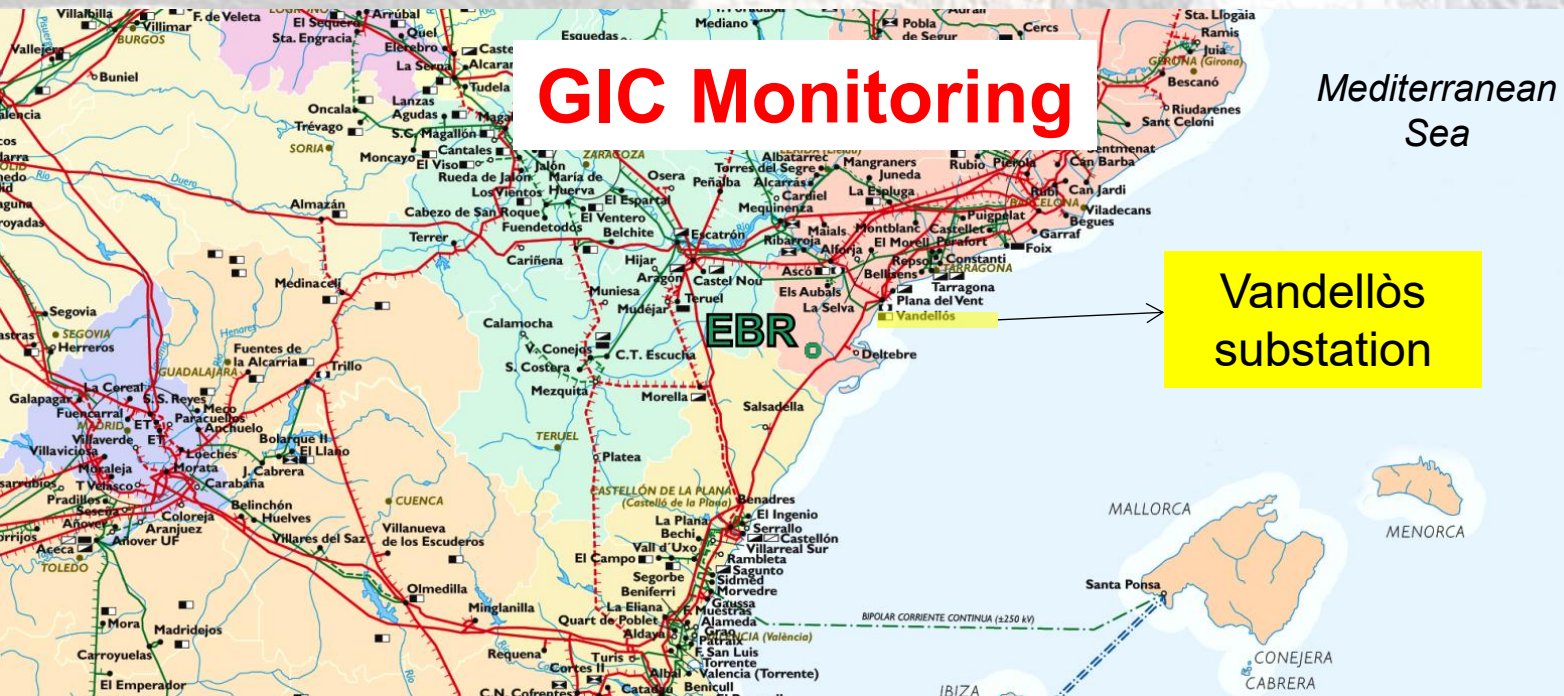


# Power network modelling

## 3. MODEL VALIDATION

In transformer neutrals ...

Measuring system



Neutral

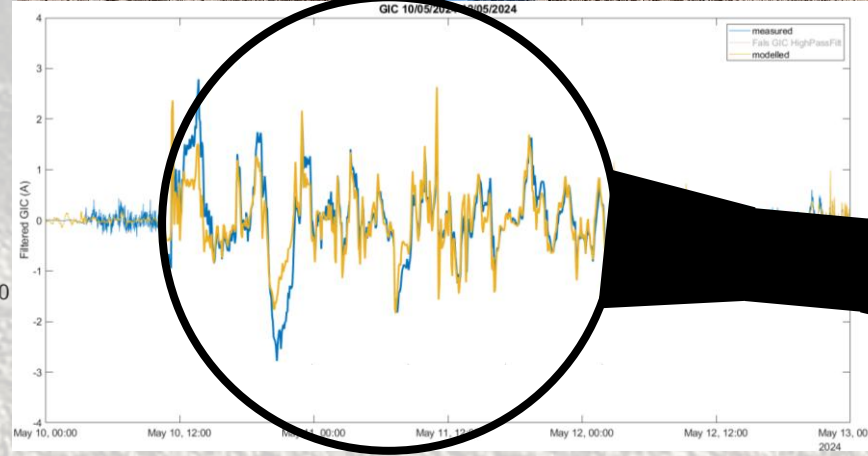
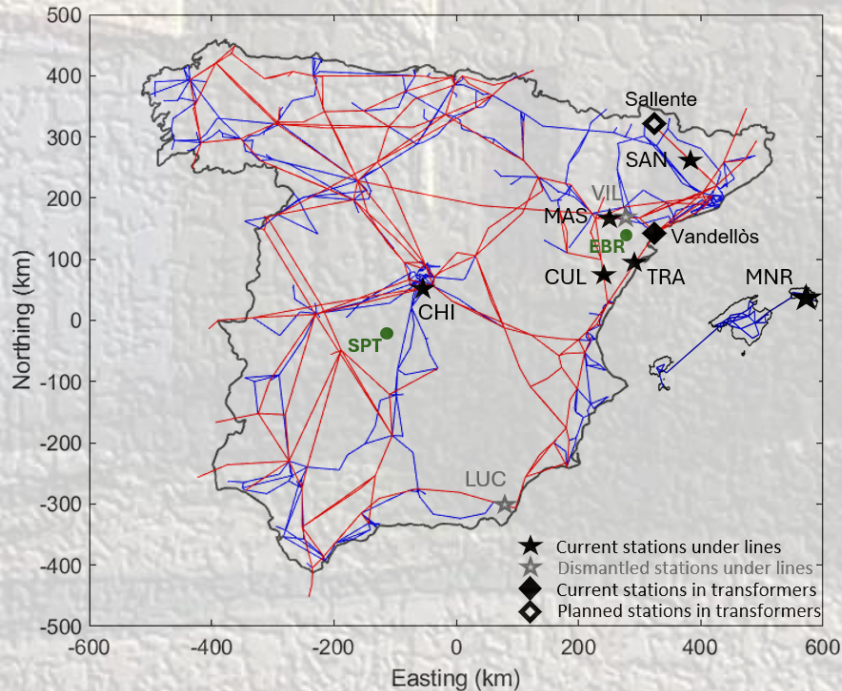


Measuring sensors

# Power network modelling

## 3. MODEL VALIDATION

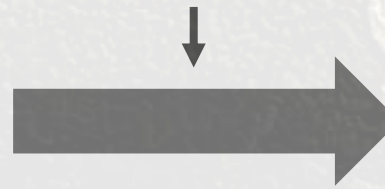
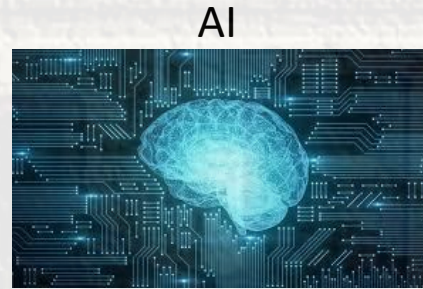
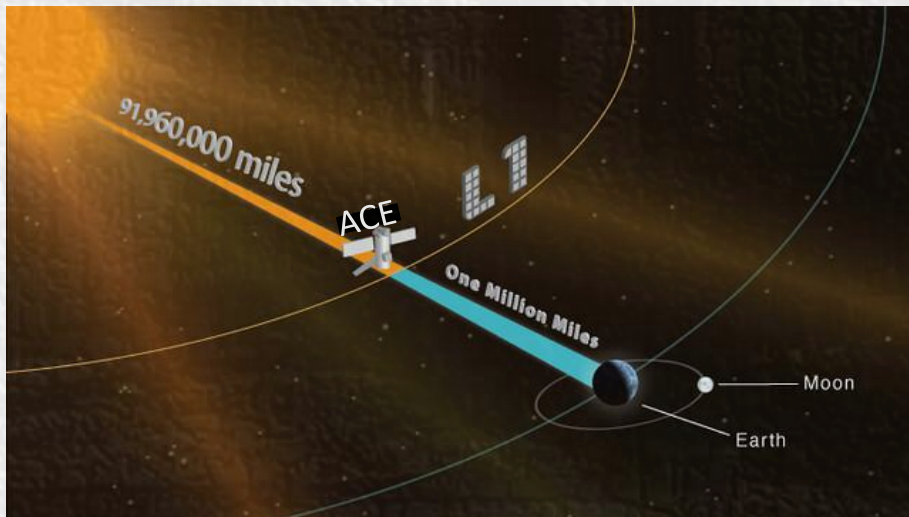
... and under power lines



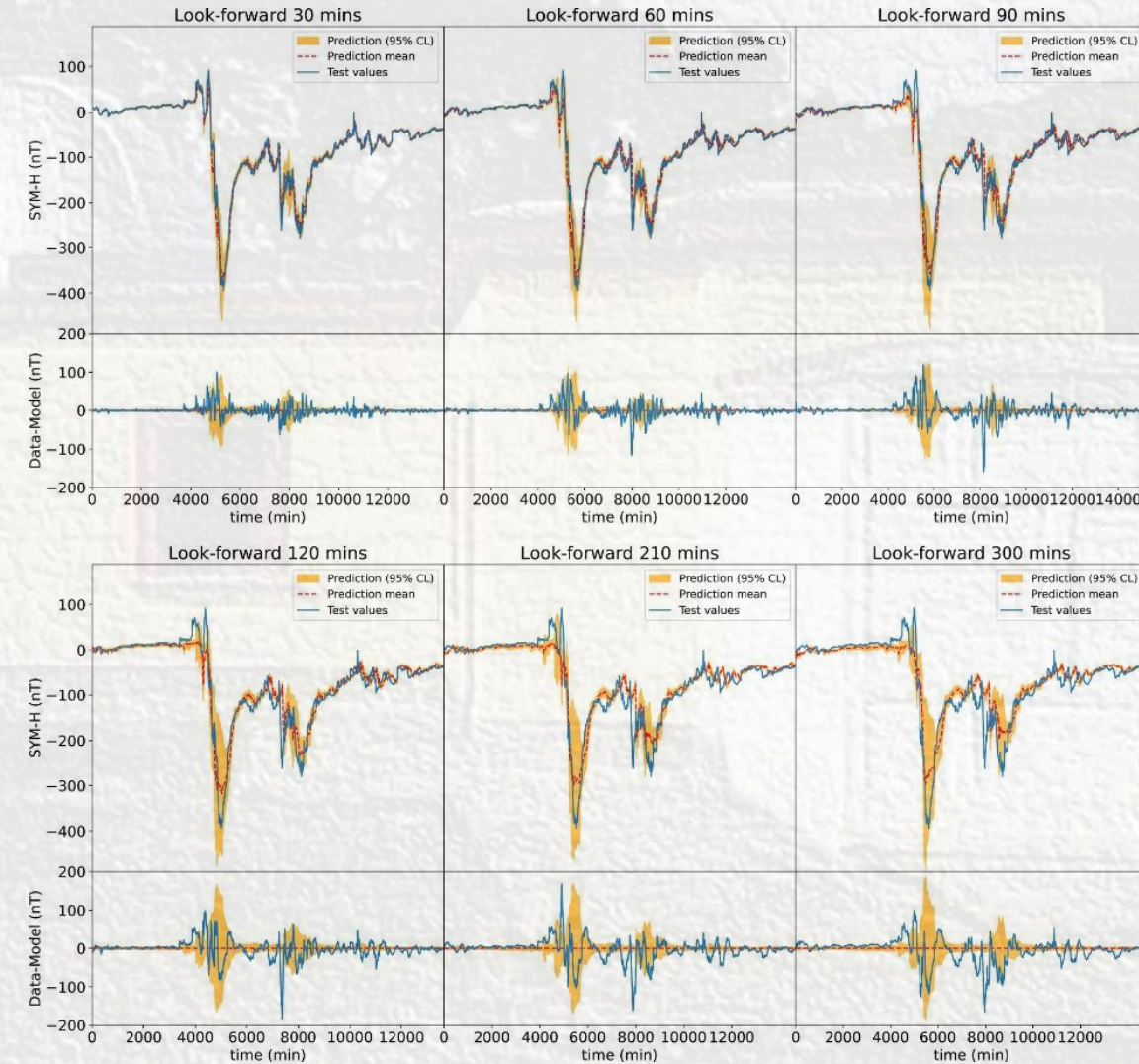
# Power network modelling

## 4. IN DEVELOPMENT

- Objective: GIC forecasting



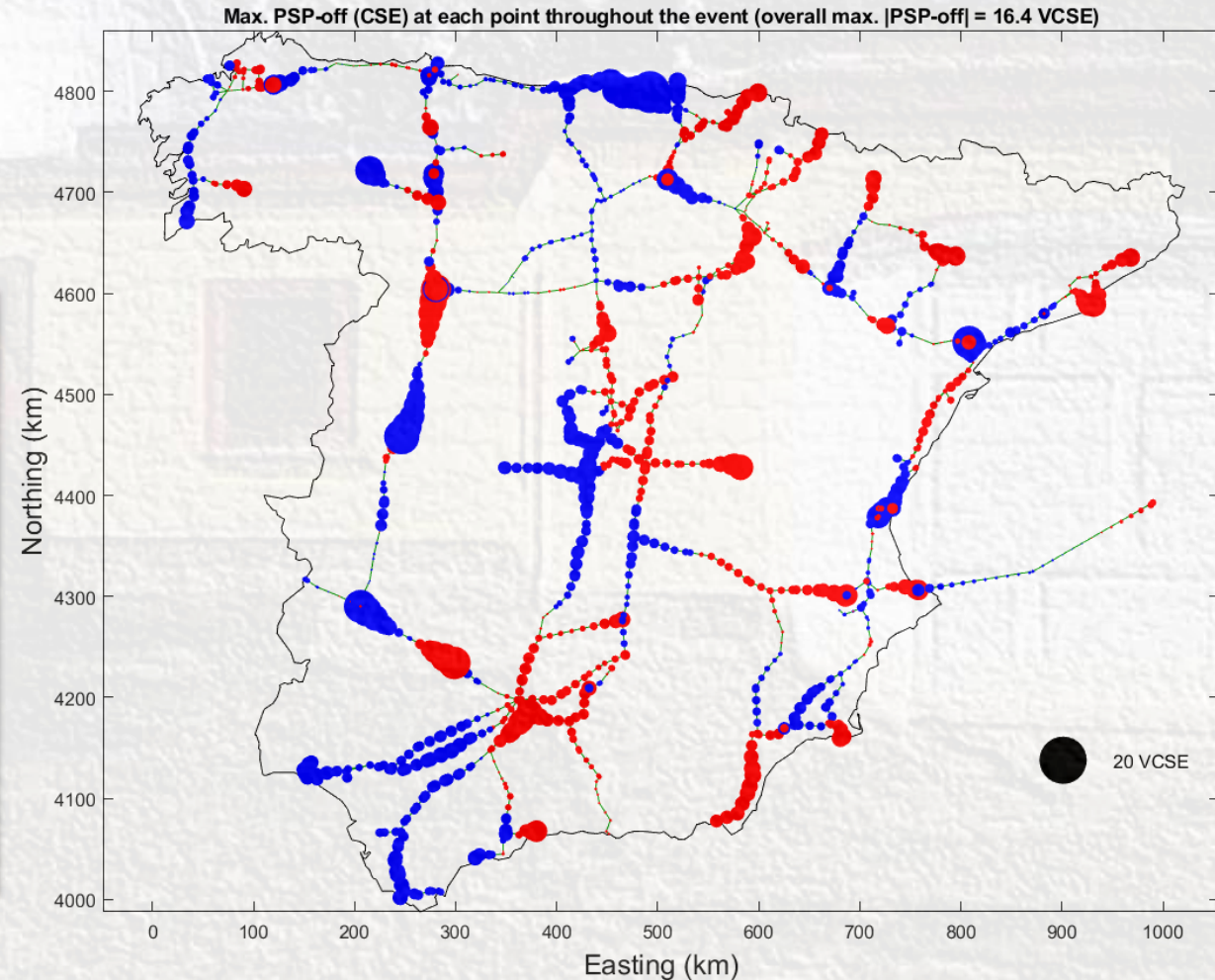
## SYM-H prediction



# Gas pipeline modelling

## PRODUCTS

Storm-time Pipe-to-Soil Potential (V)  
along the pipeline network



# Research in Aeronomy

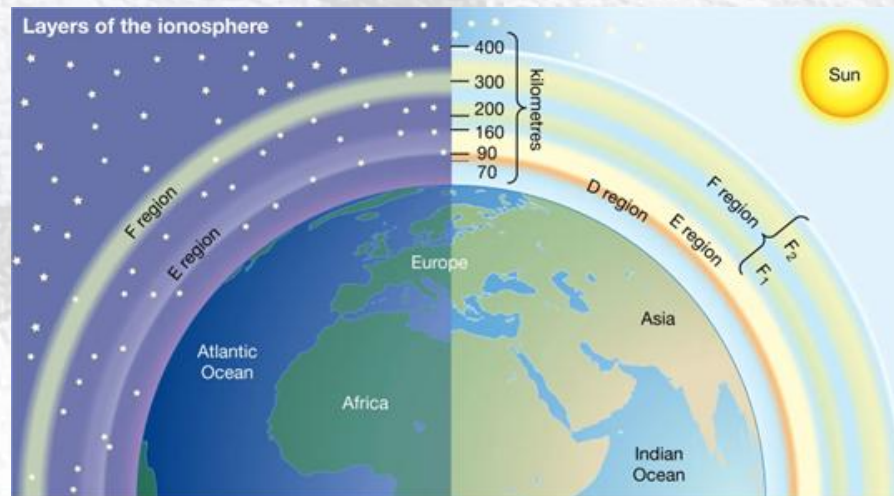
## Study of the Ionosphere:

- Ionospheric climatology (participating in the IRI model).
- Ionospheric meteorology (transitory events).

## Model and tool generation:

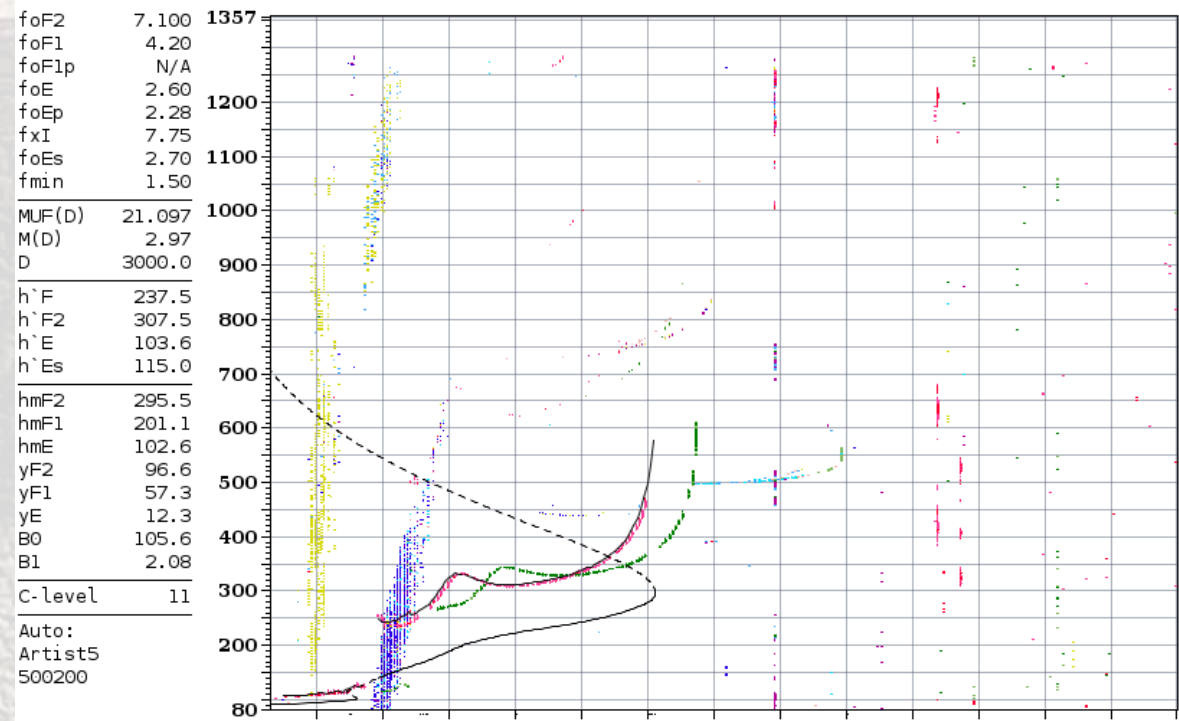
- Tools for detecting, monitoring, alerting, and predicting irregularities.
- Support for disturbance mitigation.

Access to observational and research assets for other researchers, both on-site and remotely.



Lowell GIRO Data Center

Station YYYY DAY DDD HMMSS P1 FFS S AXN PPS IGA PS  
Roquetes 2026 Jun01 152 174001 RSF 1 712 100 03+ 00



D 100 200 400 600 800 1000 1500 3000 [km]  
MUF 7.7 7.8 8.1 8.6 9.3 10.3 13.4 21.1 [MHz]  
db eb040 20260601 174001.rsf / 275fx512h 5 kHz 2.5 km / DPS-4D EB040 41 / 40.8 N 0.5 E

DIDBasePortal\_Servlet 0.1

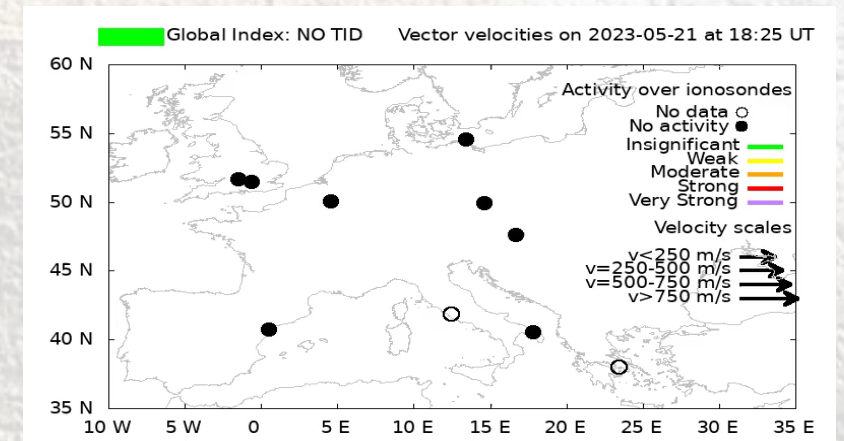
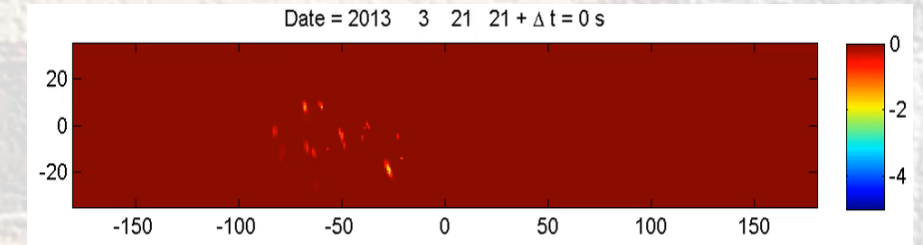
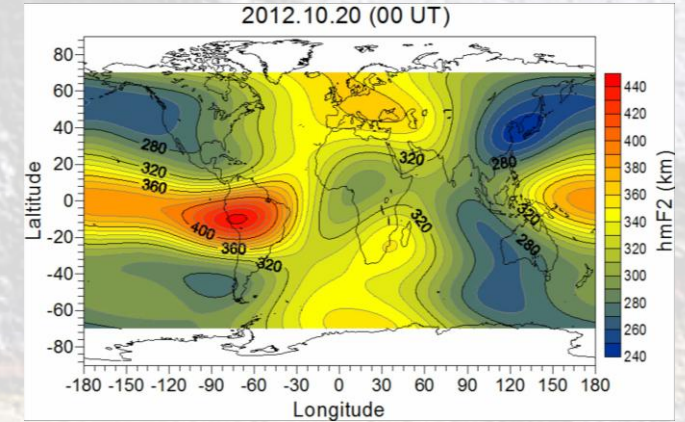
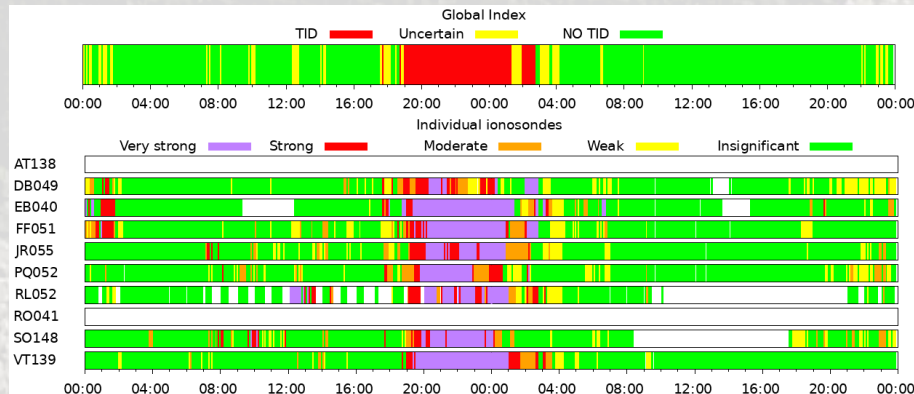
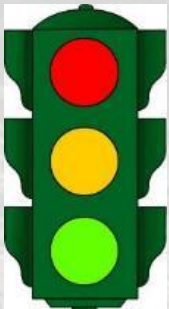
# Research in Aeronomy

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- Support for disturbance mitigation.



# Research in Aeronomy

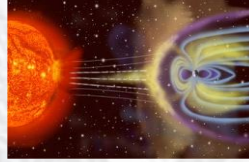
Solar Flares



Solar eclipses



Solar Storms



External impact – Sun – Atmosphere Coupling

IONOSPHERA

Internal impact – Earth – Atmosphere Coupling



Earthquakes



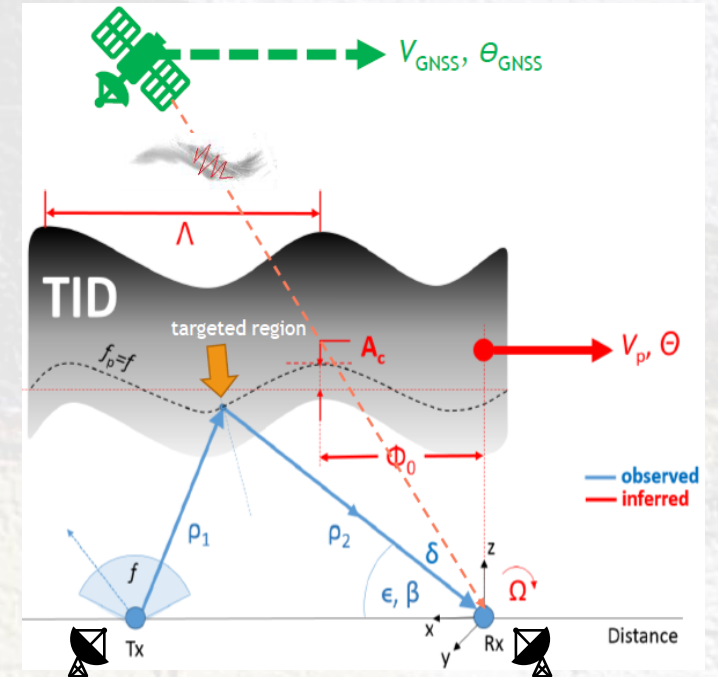
Tsunamis



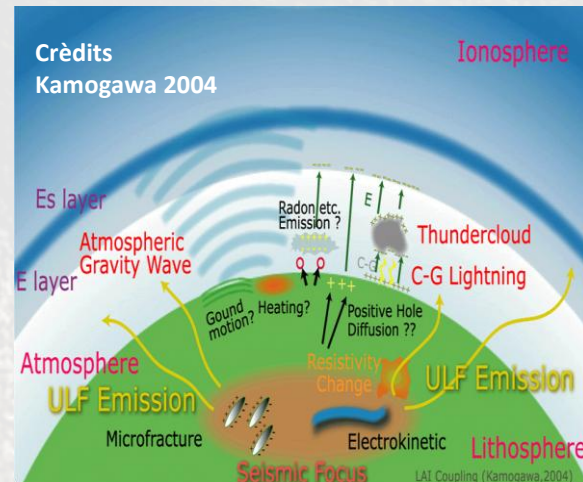
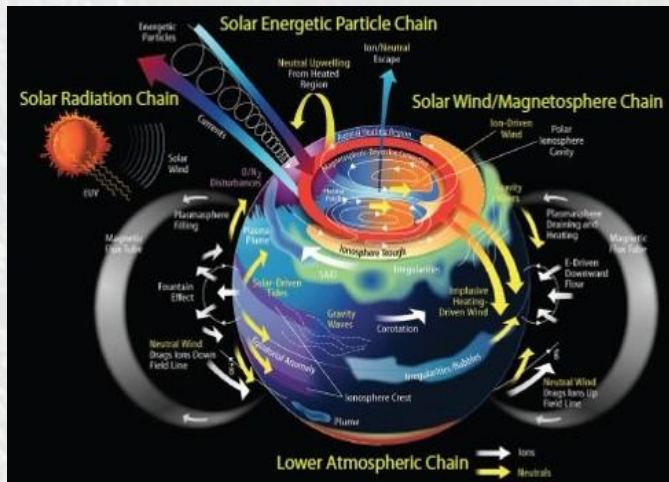
Eruptions



Rockets, Explosions



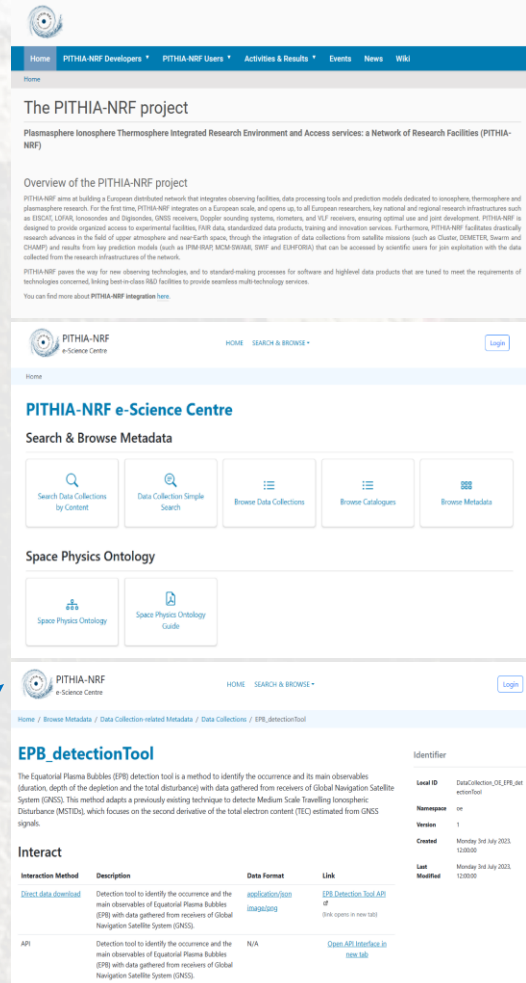
- Degradation of the regular propagation of radio- electrical signals
- Potential loss of reception
- Compromise accuracy in precision navigation systems
- Cause short-range catastrophe in radiocommunications systems
- It is necessary to evaluate and disseminate corrections
  - It is not always possible.



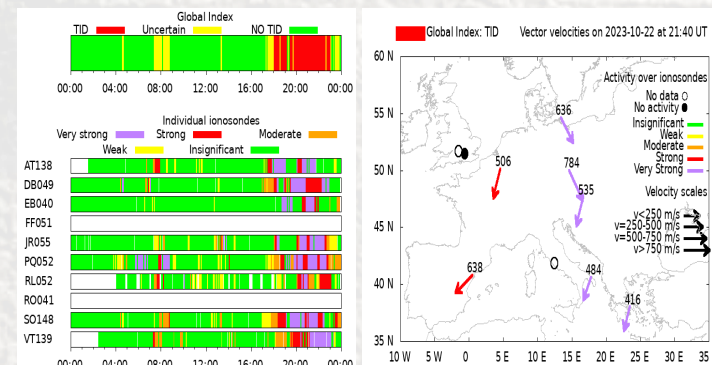
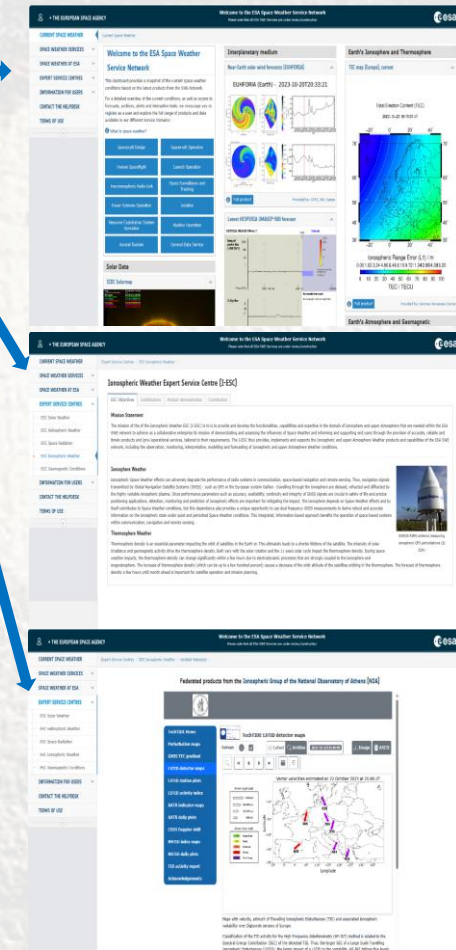


Observatori  
de  
l'Ebre

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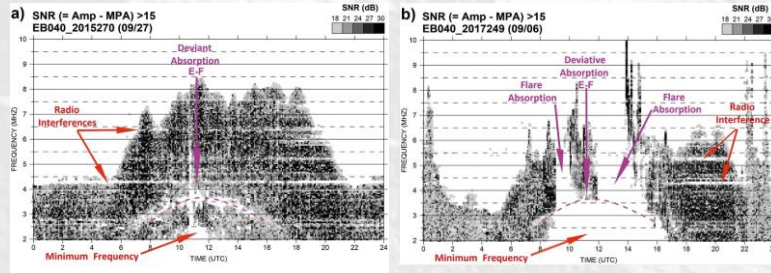
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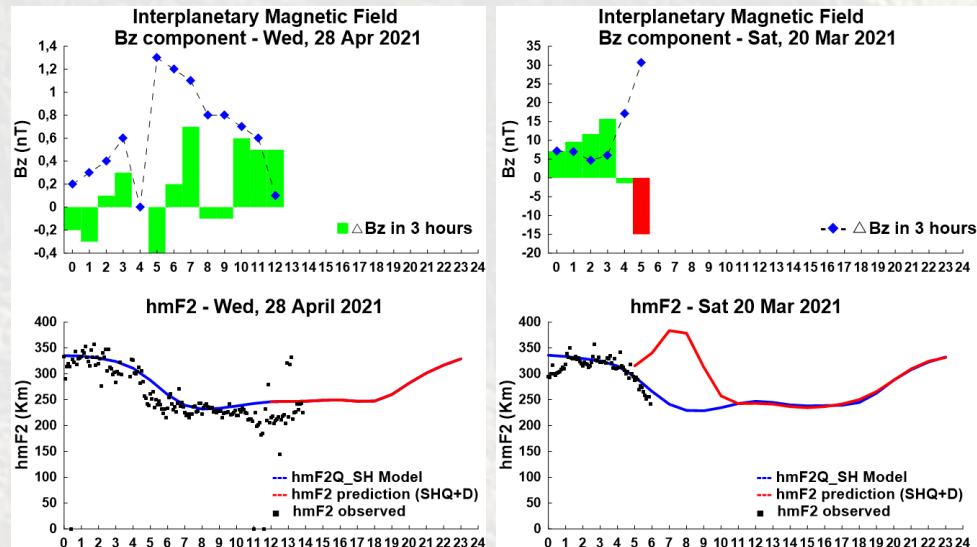
# Research in Aeronomy

- **Upgrades of generated products**

- Model of radio signal absorption produced by solar flares.

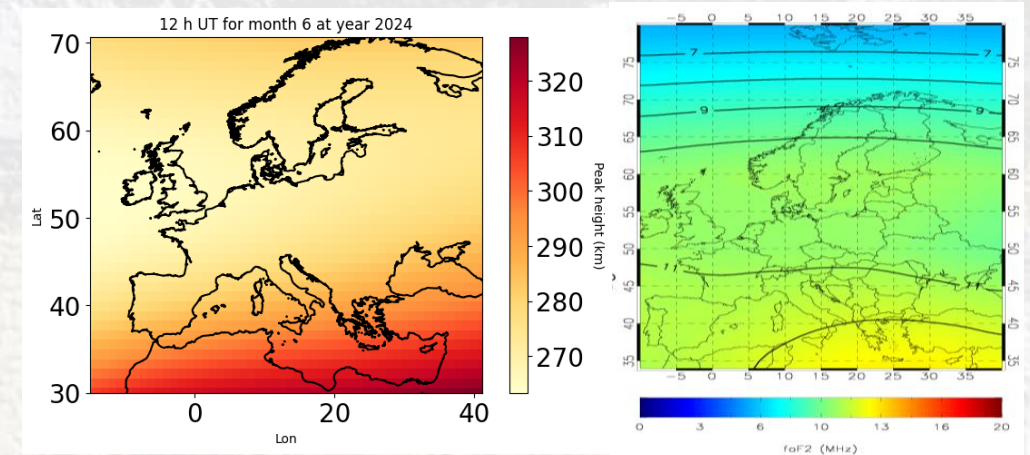


- Local model of ionospheric height disturbance caused by severe solar storms.

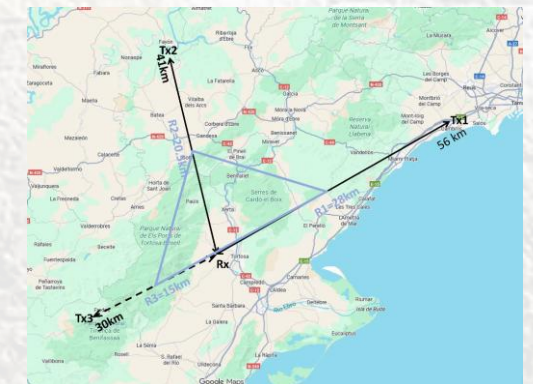
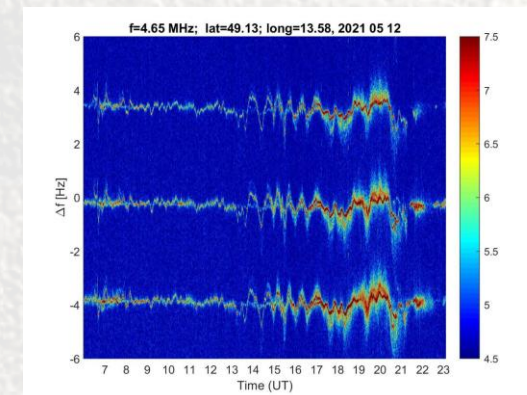


- **New products generation**

- Existing model combination (**Workflows**).



- New sensors/infrastructure for ionospheric irregularities detection.





Thank you !!

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