Ionospheric splinter

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BISA: Plasmaspheric studies.

RMI: Iono. local studies. Dourbes Observatory

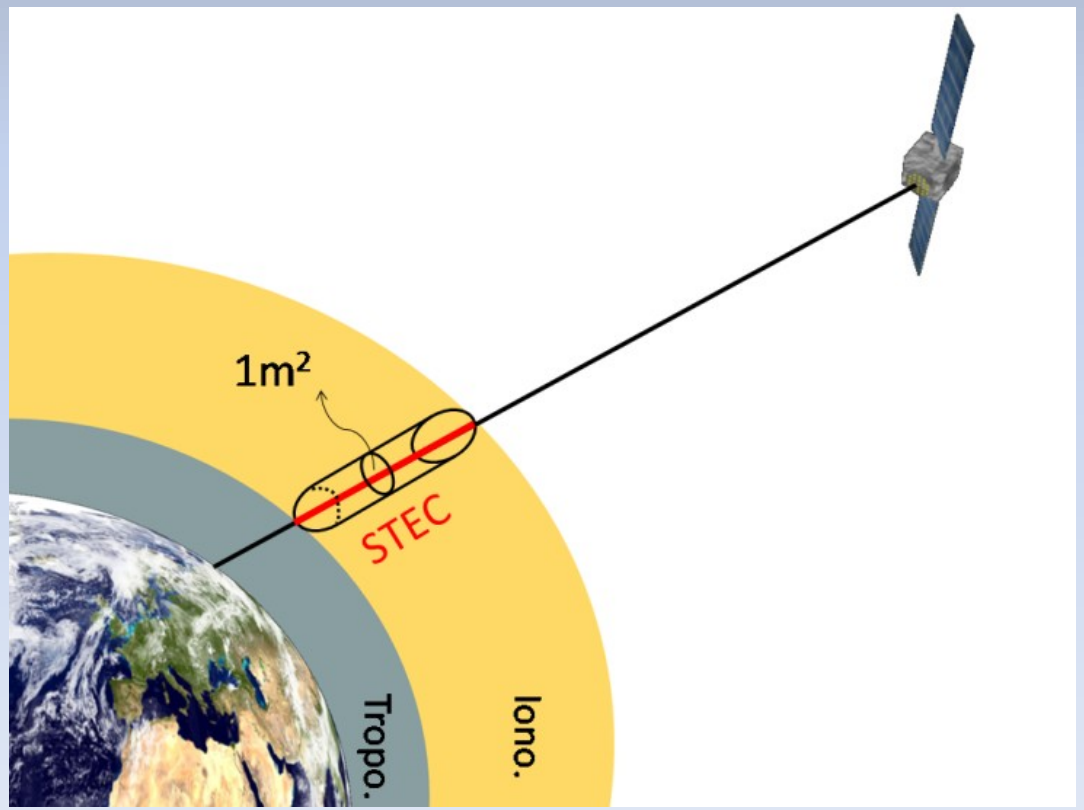
GNSS data + Ionosonde data + geomagnetic data

ROB: Iono. European studies.

GNSS data

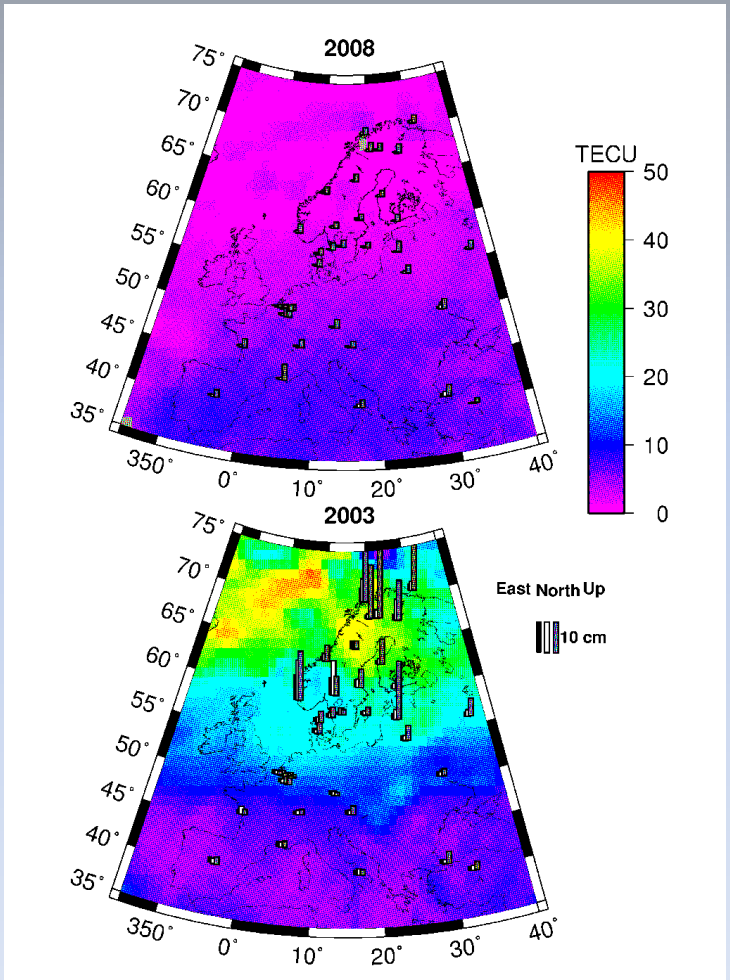
Total Electron Content

- GNSS = Global Navigation Satellite Systems
- TEC = Total Electron Content
- TECU = TEC Units with 1 TECU=10^{16} electrons m^{-2}



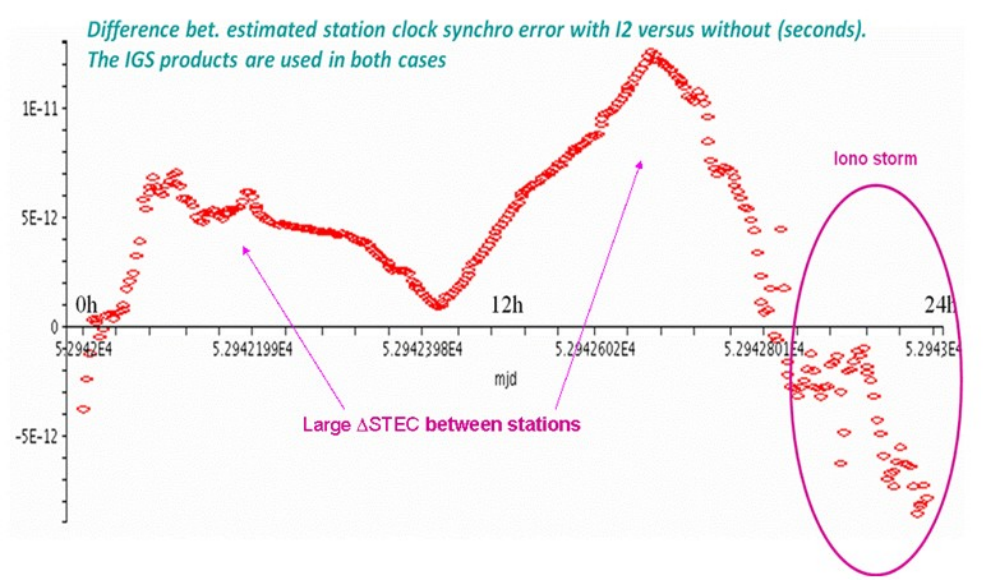
Research

Link Ionosphere/Positioning (ROB)
Link Ionosphere/Time-transfer (ROB)



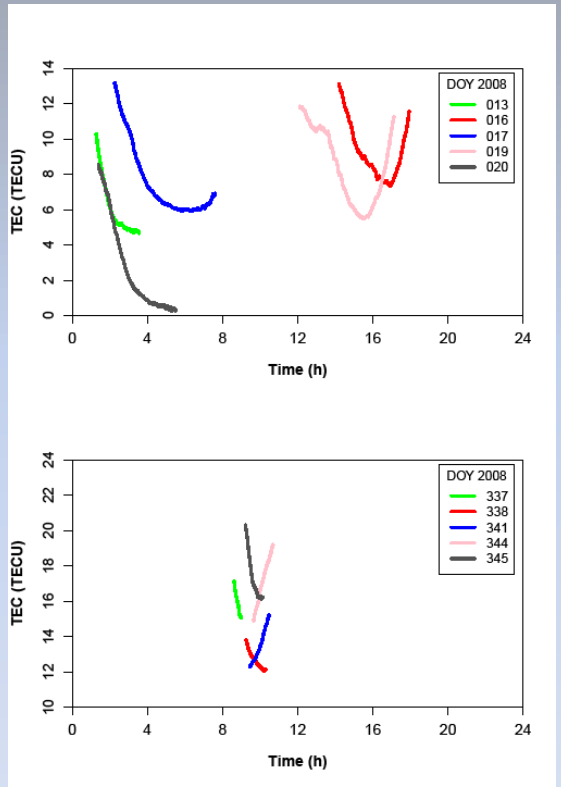
Position : ~dm effect

Time-transfer: 1ns effect



GNSS-based TEC reconstruction RMI

- Development of a TEC reconstruction technique which exploits the added value of Galileo and modernized GPS (availability of additional carrier frequencies):
  - Accuracy of classical methods : 3-5 TECU
  - Accuracy of the new technique = 1 TECU (additional improvements are expected)



Example of Galileo TEC

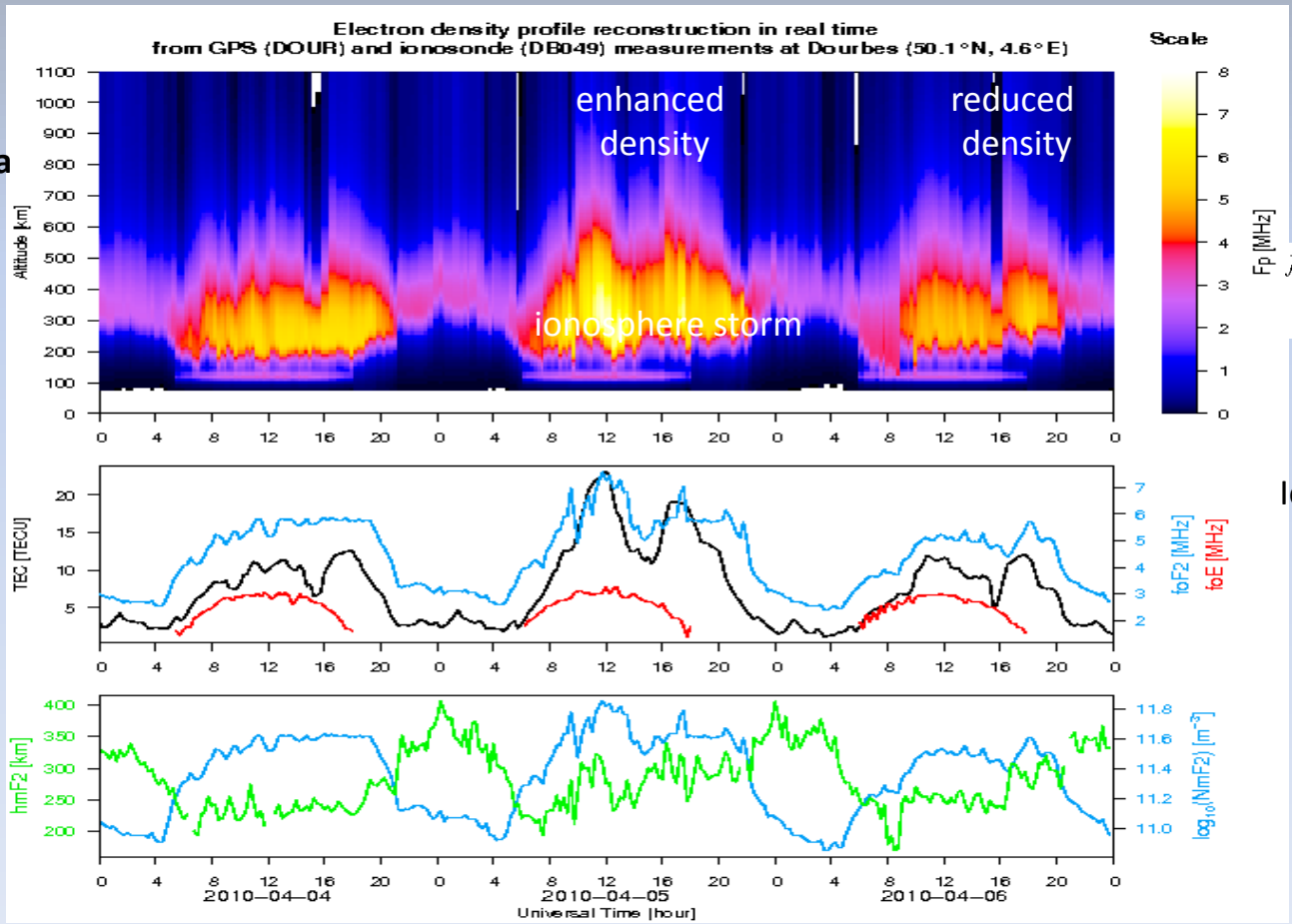
Ionospheric plasma density specification in real time (RMI)

Objective: Development of operational procedure for reconstruction of the local ionospheric electron density distribution on a real-time basis using GNSS and vertical incidence sounding measurements.

Development: Type – operational nowcast, Output – ionospheric plasma density/frequency, Altitude range – from 90 to 1100 km, Time resolution – 15 min, Latency – less then 3 min.

Applications: Research, verification of ionospheric models, ionospheric tomography, etc.

Ionosphere Plasma Frequency



$$f_p[MHz] \approx c_p \, N_e^{0.5}[el/m^3]$$

$$c_p = 0.898 \times 10^{-5}$$

Ionosphere Total Electron Content (TEC)

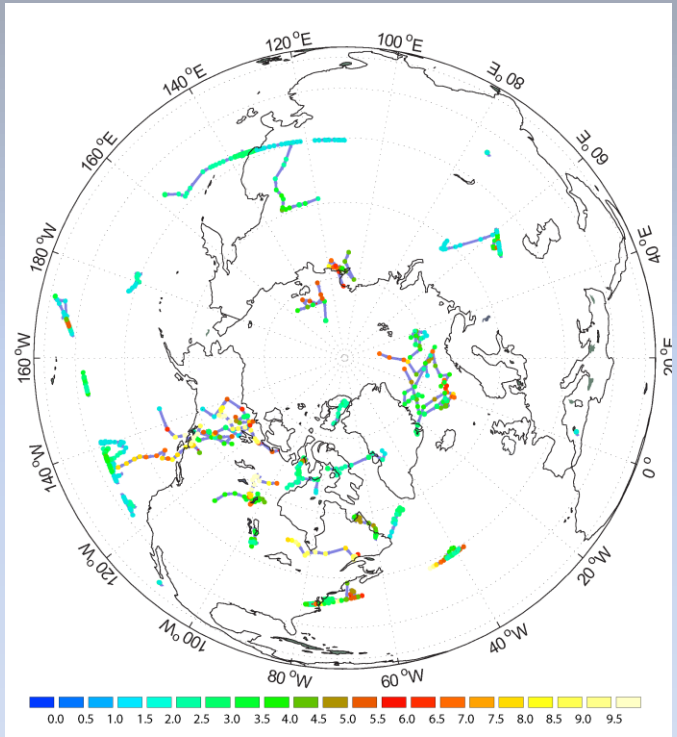
Ionosphere Critical Frequencies (F2 layer - foF2 , E layer - foE)

Ionosphere peak density altitude (hmF2)

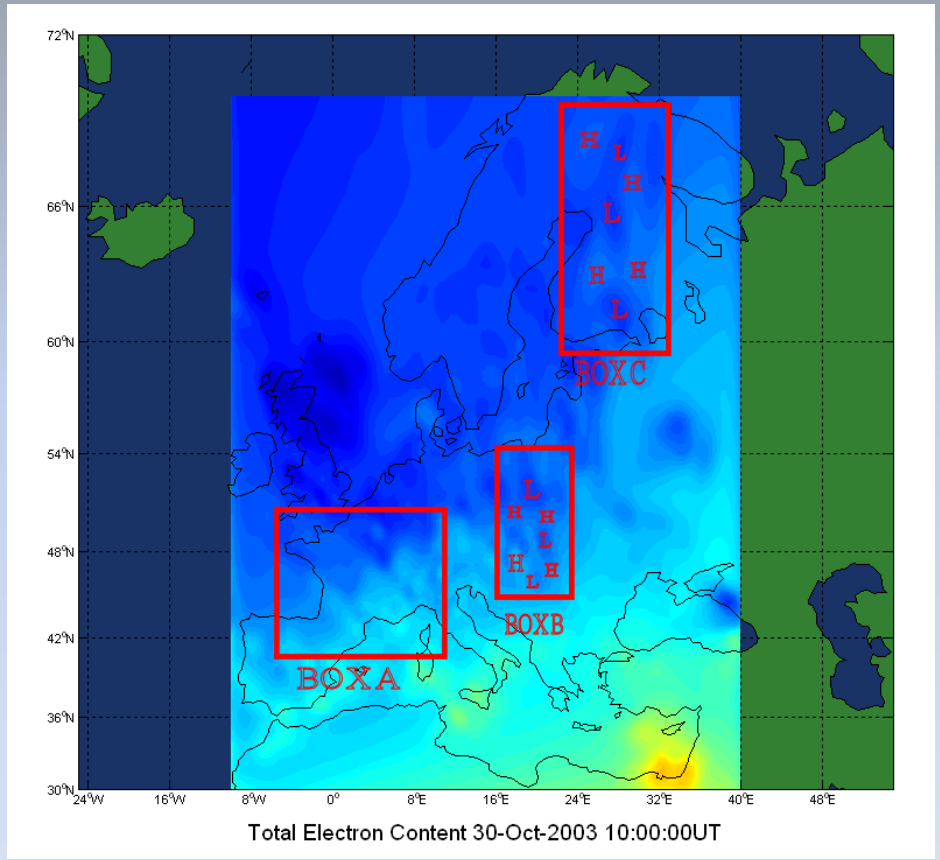
Ionosphere Peak Density (NmF2)

Ionospheric Imaging (ROB)

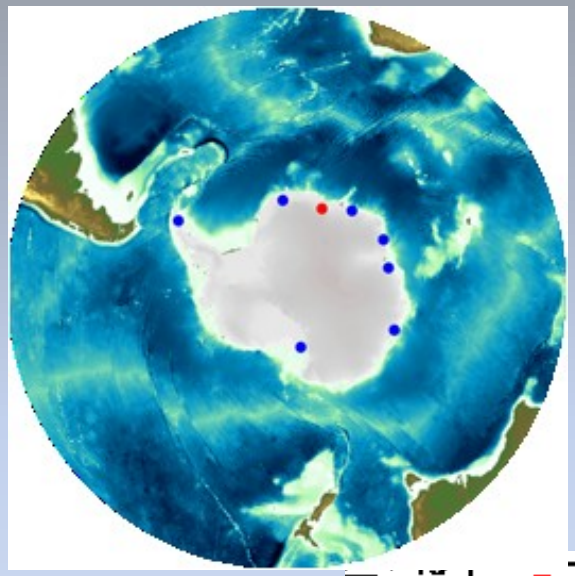
Polar-cap Plasma Patches

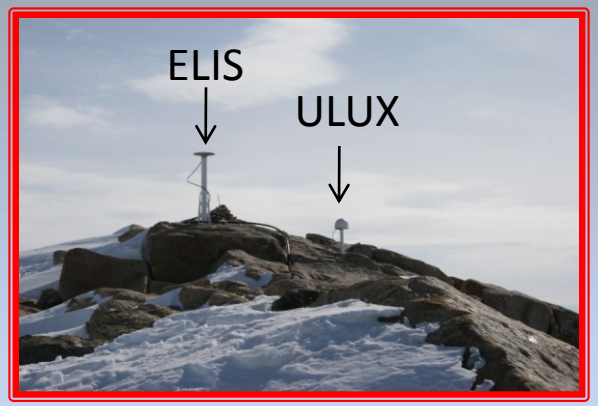


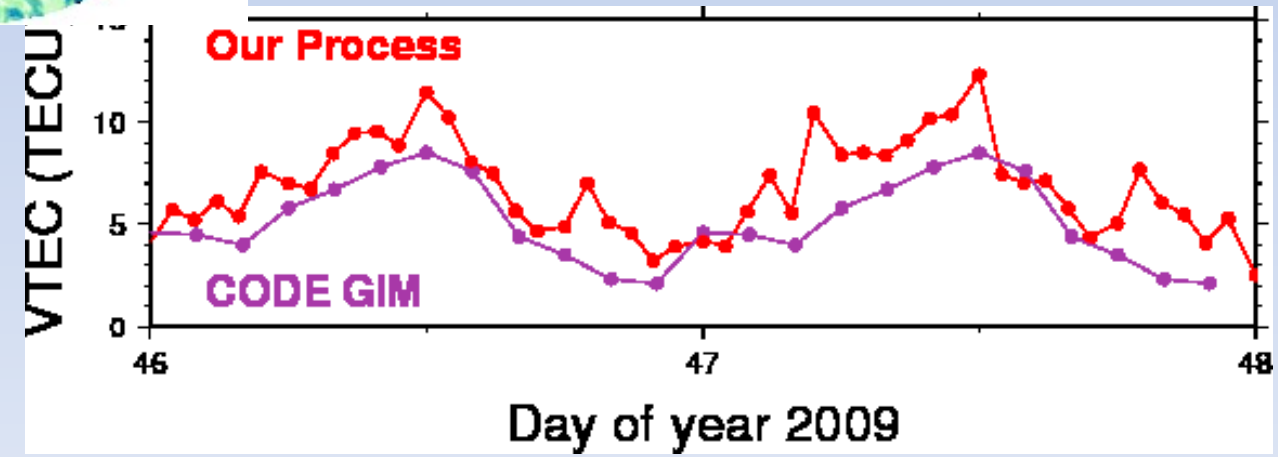
Ionospheric physics applications



Antarctic – Princess Elisabeth base (ROB)







Vertical Total Electron Content (VTEC) in the ionosphere from ELIS and ULUX data (red) from global models (purple).

Services

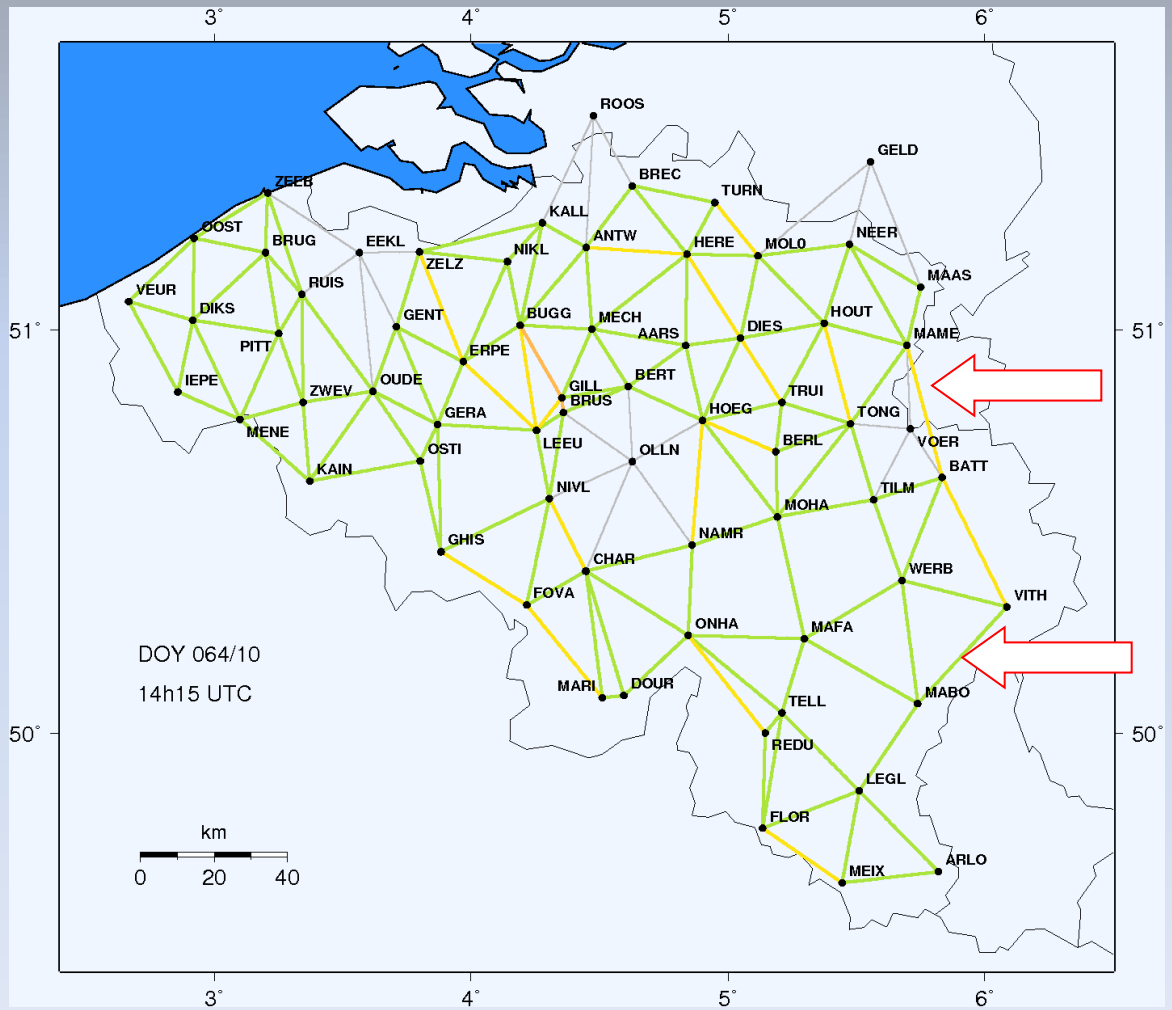
Web site (RMI-SIDC)

- Development of a web site which provides users with information about:
  - Ionospheric and geomagnetic activity
  - Ionospheric effects on GNSS

SIDC website

SoDIPE-RTK (RMI)

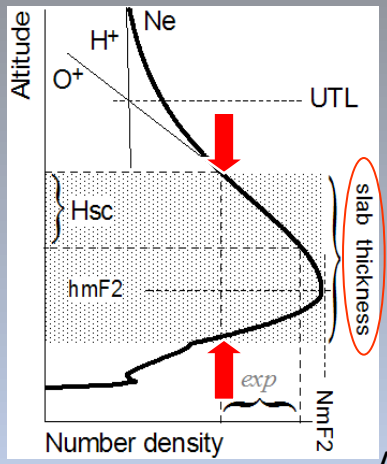
- Positioning error is “translated” into a map where the colors (from green to red) give the magnitude of the ionospheric error depending on the region



Yellow, orange
➔ Iono disturbance

Green
➔ No disturbance

Ionospheric slab thickness monitoring (RMI)



The ionospheric slab thickness (τ) is the depth of an idealized ionosphere which has the same electron content (TEC) as the actual ionosphere but uniform electron density equal to the maximum electron density (NmF2),

$$\tau = TEC/NmF2$$

Objective: Explore the capability of this ionosphere parameter for monitoring and estimating the level of ionosphere disturbances.

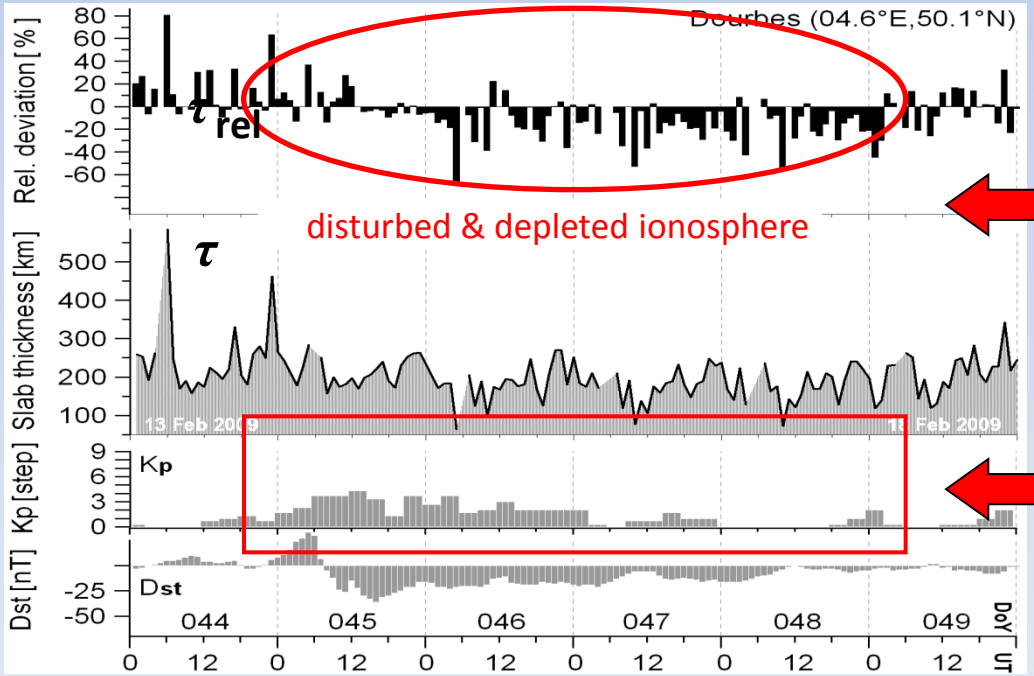
Development: Type – operational nowcast, Output – slab thickness [km], relative deviation from monthly medians, Update rate – 15 min, Latency – 3 min.

Applications: Research, modelling, ionosphere disturbance monitoring, etc.

Ionospheric **slab thickness relative deviation** from non-disturbed behaviour

Ionospheric **slab thickness**

Geomagnetic activity indices Kp and Dst



Ionospheric slab thickness behaviour during geomagnetically disturbed conditions

Geomagnetically disturbed Conditions

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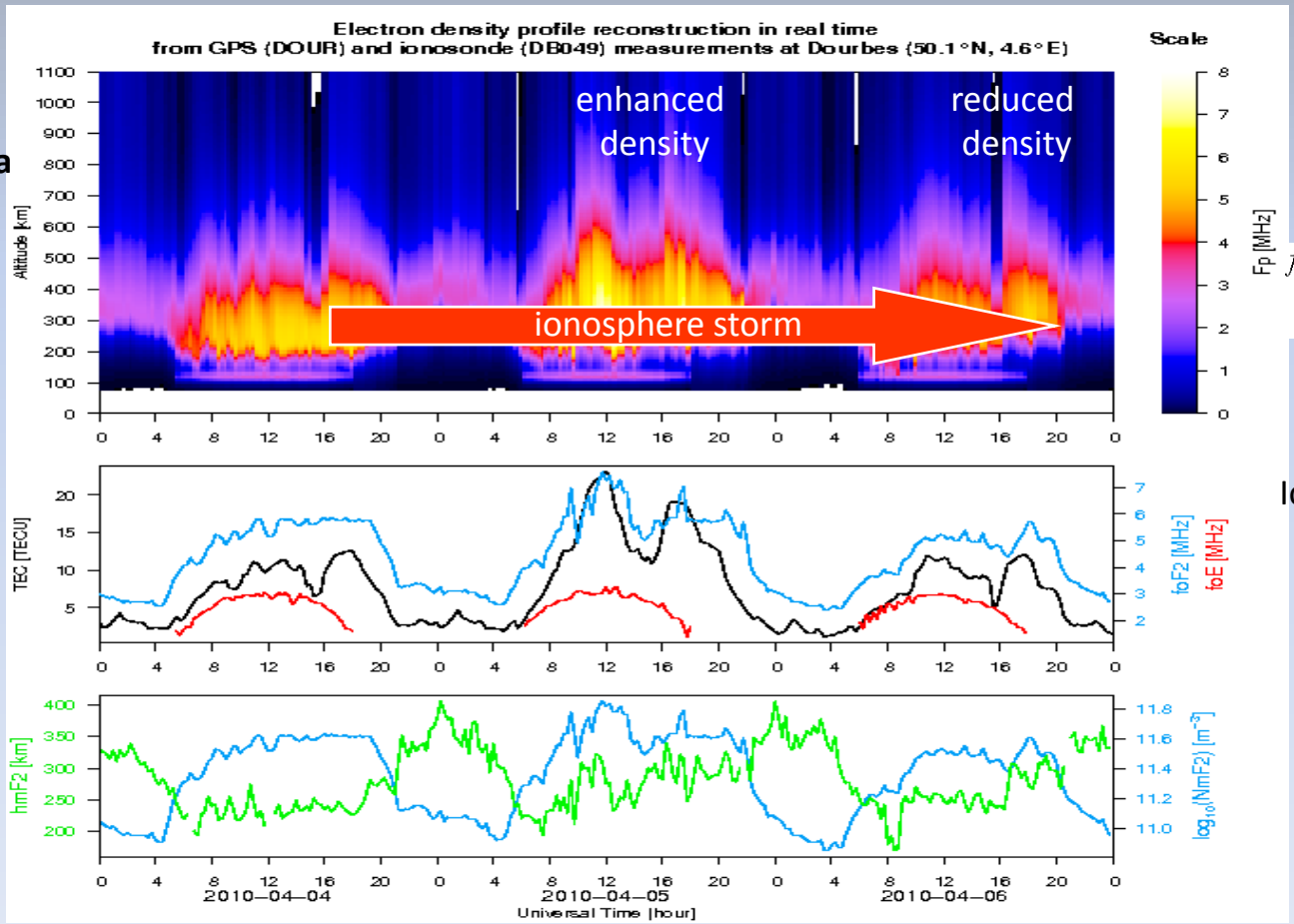
Ionosphere Plasma Frequency



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Ionosphere Peak Density (NmF2)

Future collaborations

Comparison of TEC to improve the accuracy from different techniques (ROB/RMI)

TEC maps over Europe to compare with plasmasphere content. (ROB/RMI/BISA)

Link plasmaspheric model and ionospheric model (ROB/RMI/BISA)