

Identification of ionospheric anomalies
by fusion of ionosonde & GNSS TEC data

HANDS-ON

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DISPEC

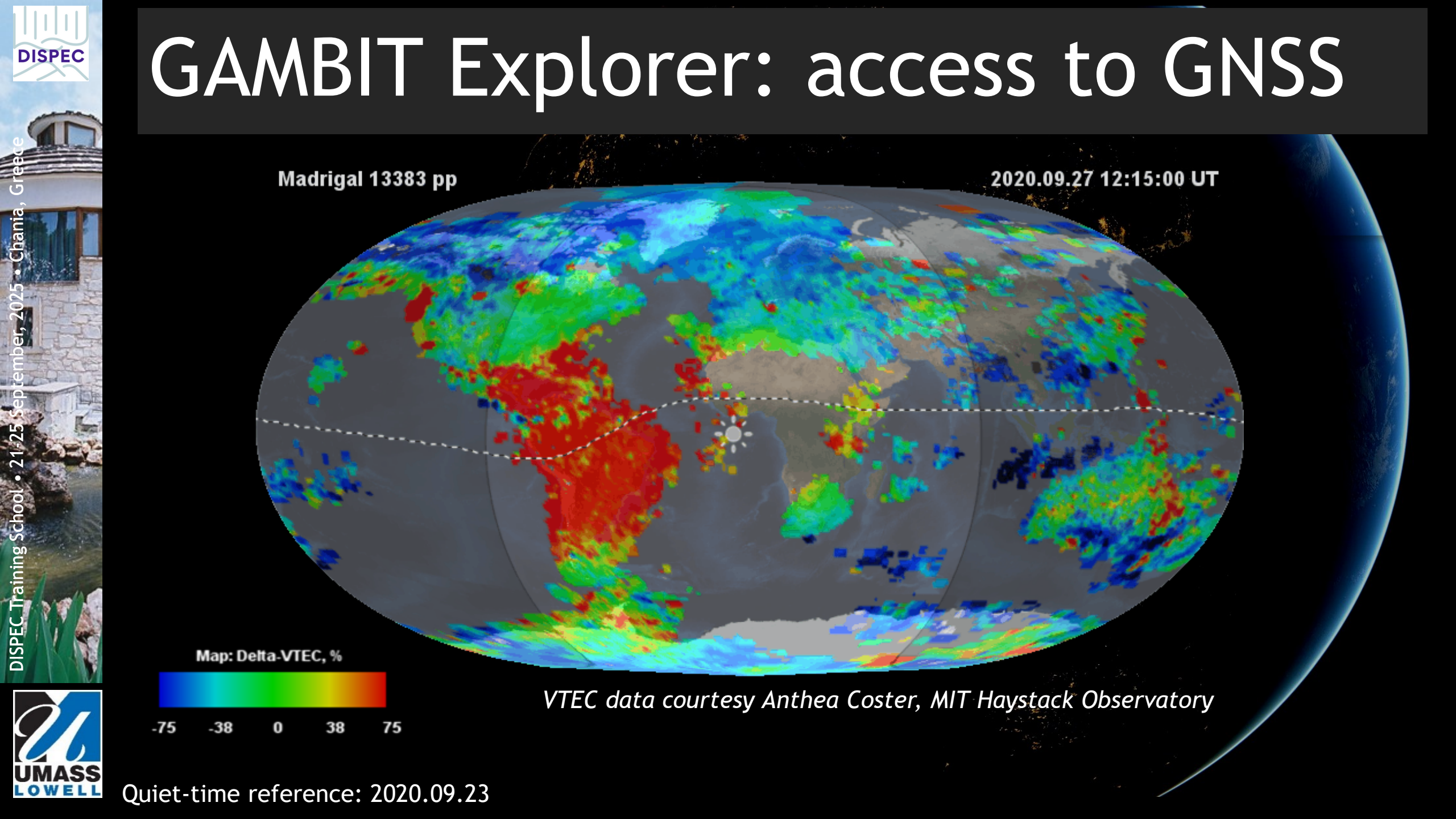
Chania, Greece
21 September 2026



COOPERATION OF GIRO AND GNSS

EFFECTIVE IONOSPHERIC SLAB THICKNESS

GAMBIT Explorer: access to GNSS

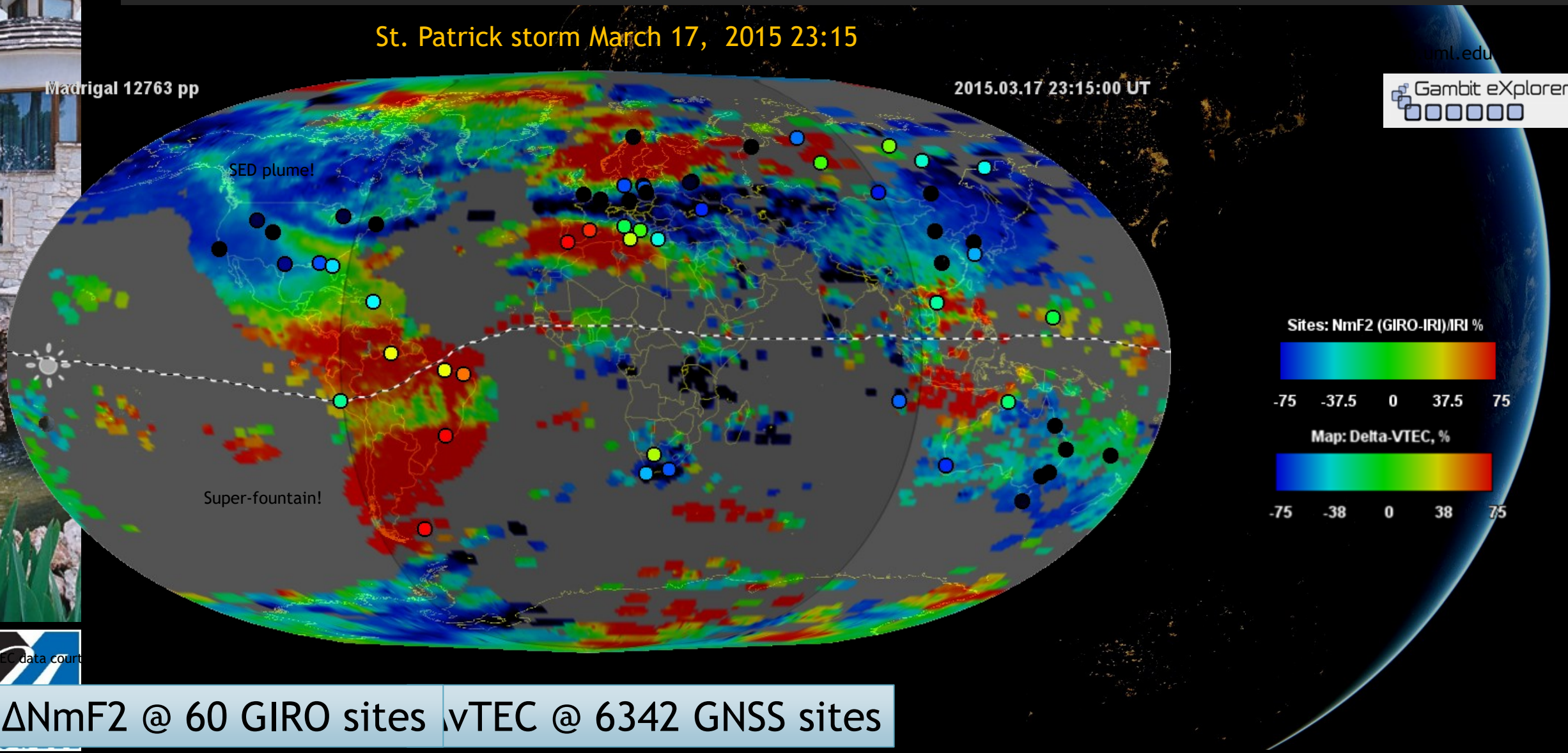


VTEC data courtesy Anthea Coster, MIT Haystack Observatory

Quiet-time reference: 2020.09.23

Anomaly maps by IGS and GIRO networks

St. Patrick storm March 17, 2015 23:15



ΔNmF2 @ 60 GIRO sites vTEC @ 6342 GNSS sites

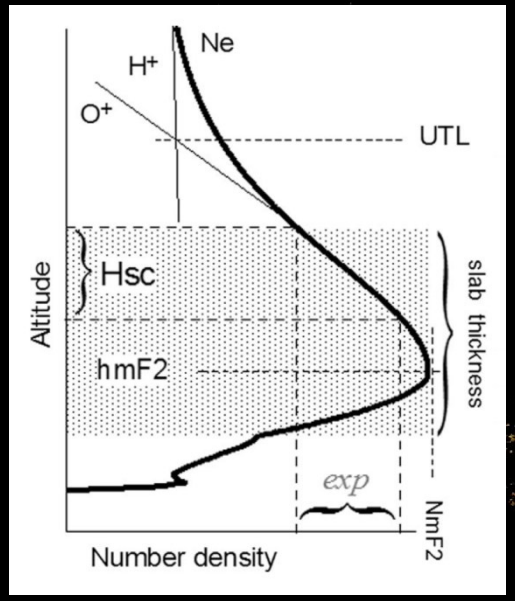
Cooperation of GNSS and GIRO

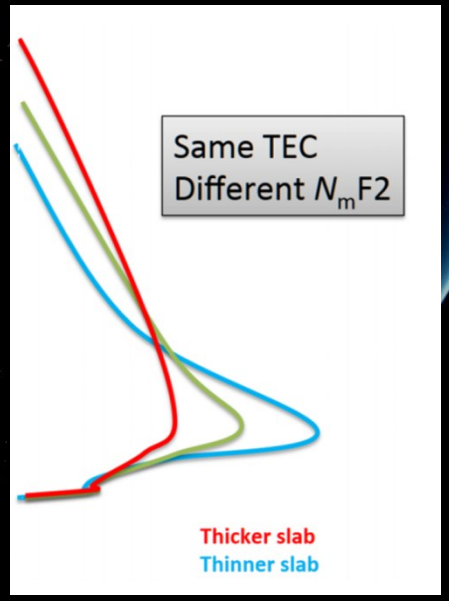
OTHERS:

- 2D: use observed ΔvTEC to derive corrections to NmF2 over no-coverage areas
  - T. Gulyaeva et al.
  - A. Pignalberi et al.
- Assimilate GIRO and GNSS data simultaneously in a 3D model
  - 6000 vs 60 problem
    - GIRO input is insignificant
  - GPSII: weighted assimilation
    - Fridman *et al.*, NWRA/HFGeo

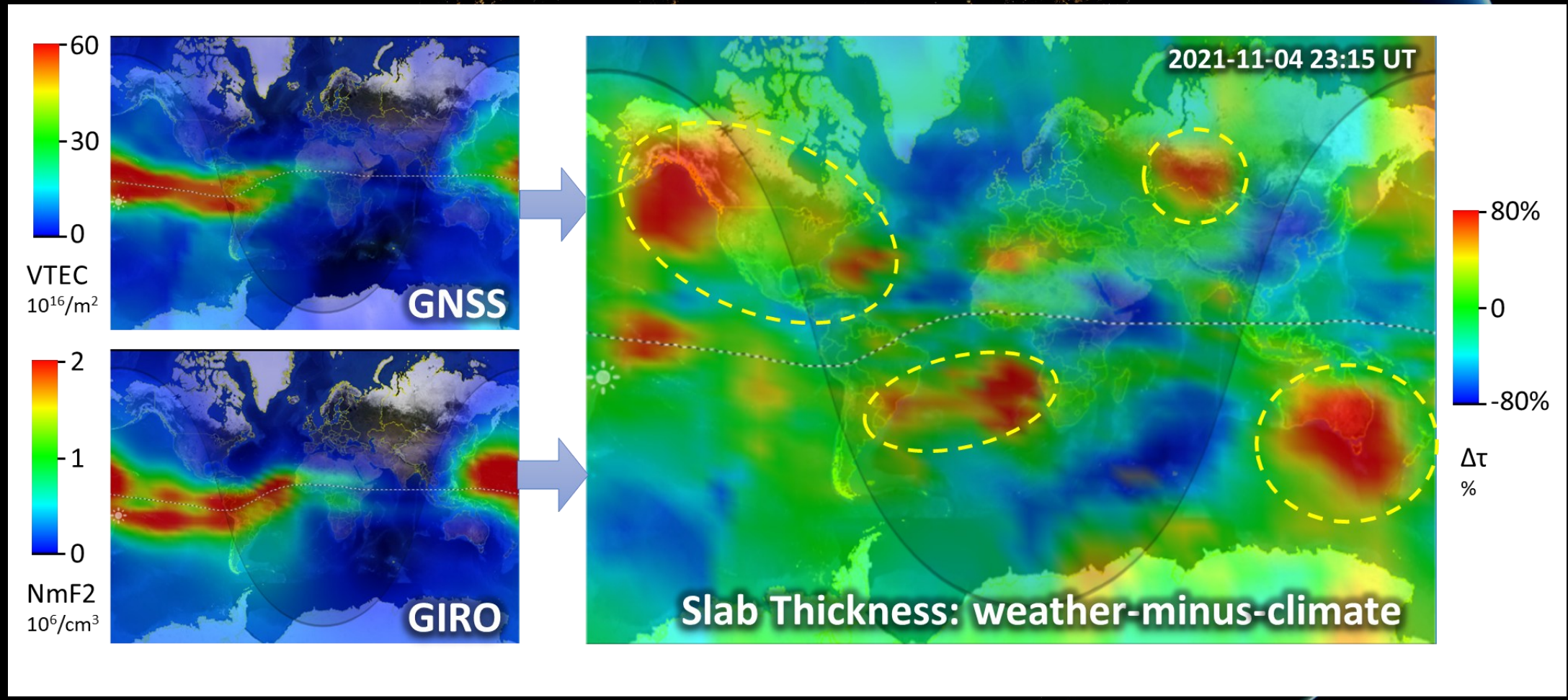
THIS WORK:

- DATA FUSION PROJECT
  - Combine NmF2 and vTEC measurements to reason about slab thickness τ

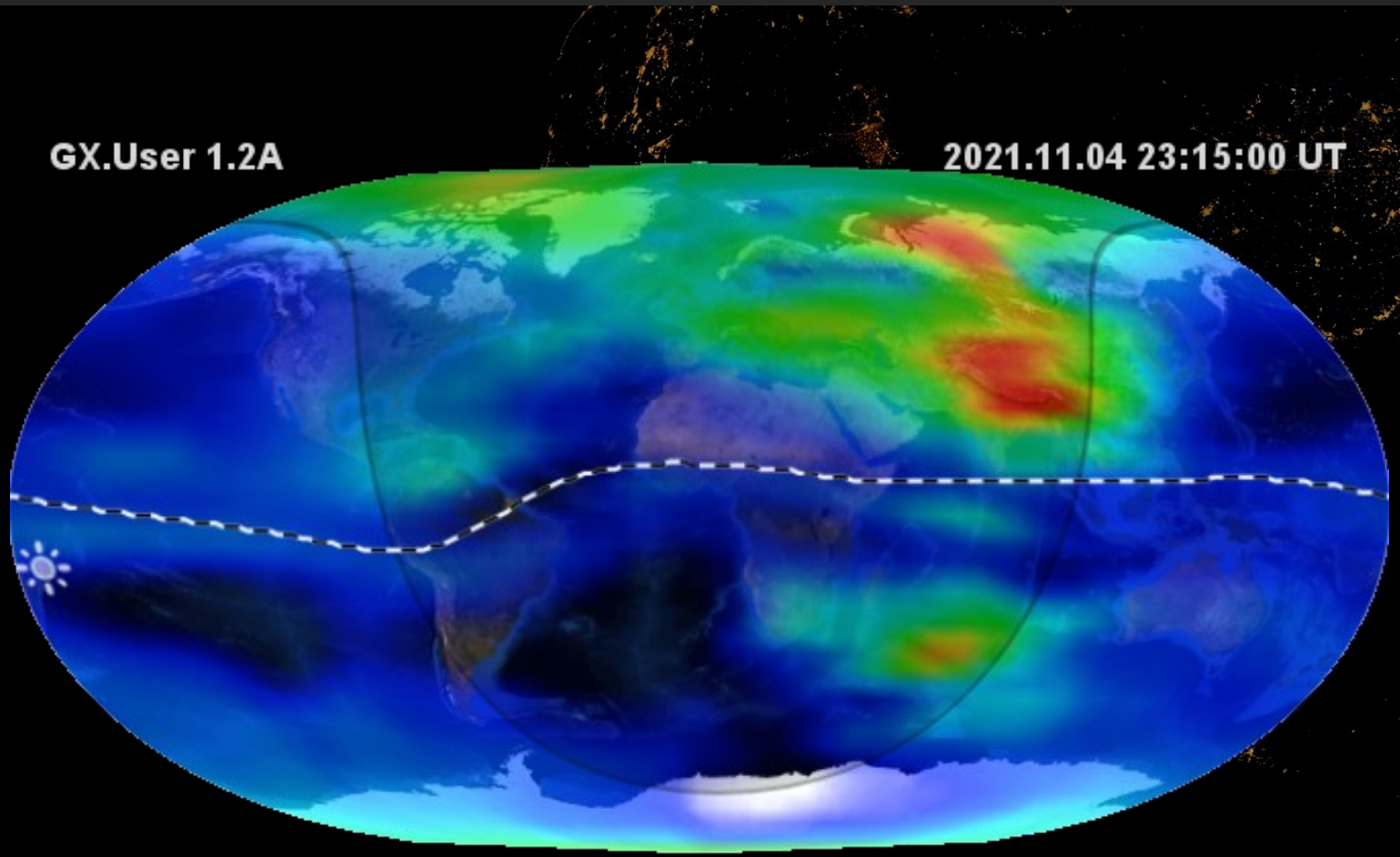




Real-time Anomaly Slab Thickness



Slab Thickness Climatology

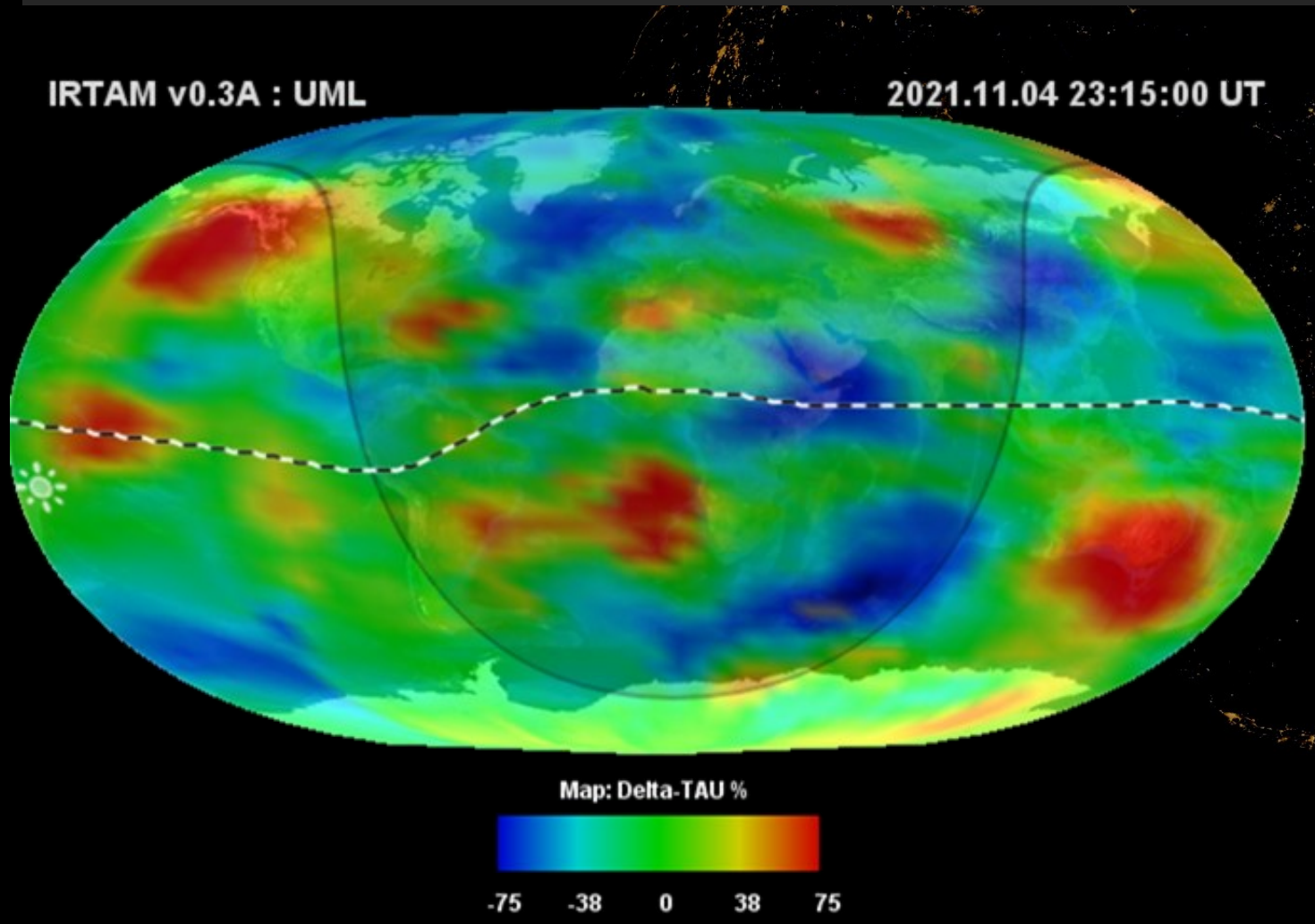


NmF2: IRI foF2 model (climate)
VTEC: IGS 30-day median VTEC

[Fron *et al.*, 2020]

Slab Thickness *Anomaly* Map

2021 Nov 04 storm example



NmF2: IRTAM NmF2 weather

VTEC: IGS VTEC Weather

Tau-anomaly vs MUF anomaly (storm-time)

No VTEC

$\Delta\tau$

ΔMUF

