

Opposite hemispheric asymmetries observed in the ionospheric F- and topside regions

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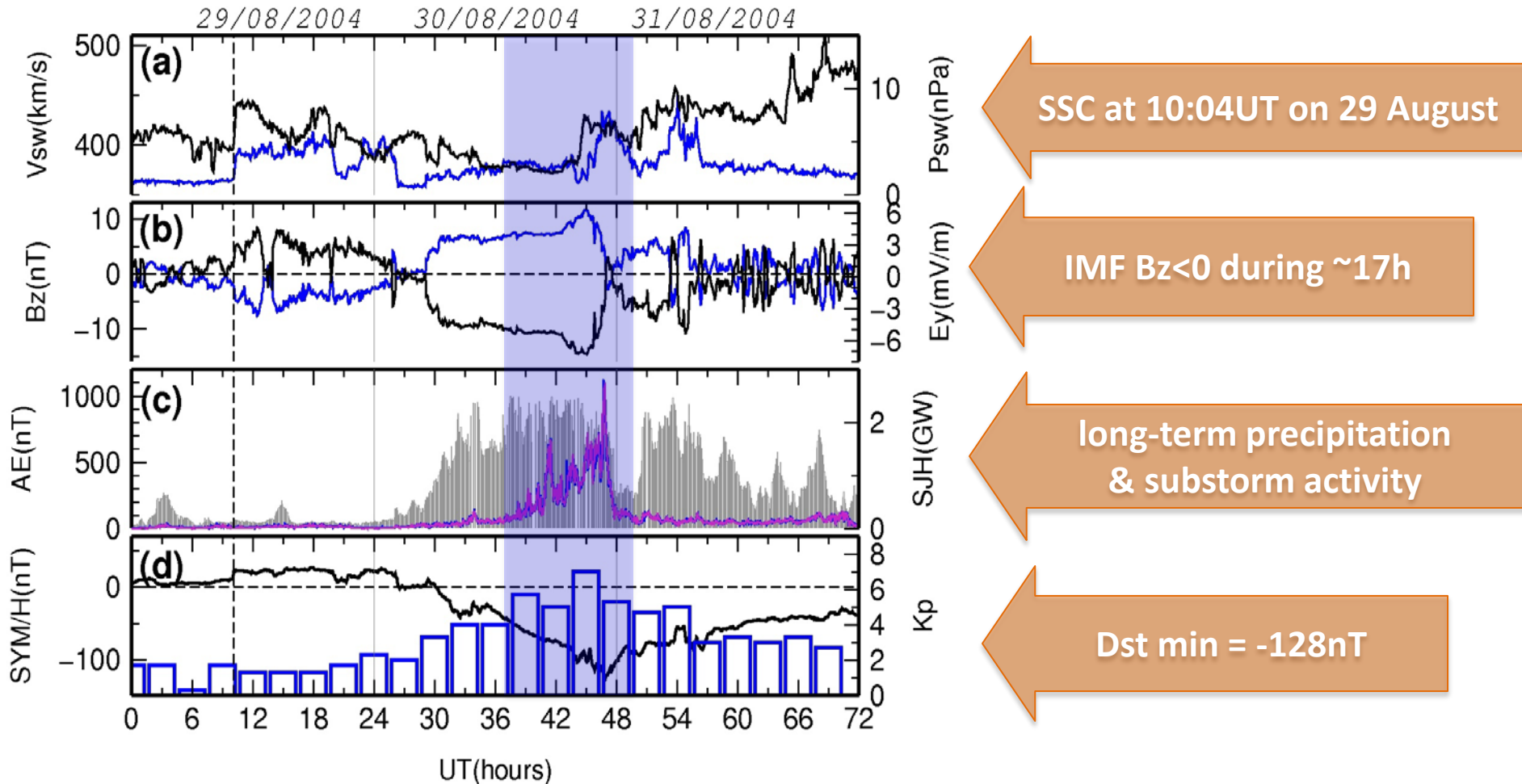
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Geomagnetic storm 29-31 August 2004



Astafyeva et al. (JGR, 2015)

**Moderately intense
geomagnetic storm**

Multi-instrumental study

GPS-satellites
($H \sim 20200$ km)

TOPEX/Jason-1
 $H = 1336$ km
vTEC

DMSP F13/F15
 $H = 840$ km
 N_i, O^+

GRACE
 $H = 485$ km
vTEC, N_e, ρ

CHAMP
 $H = 385$ km
TEC, N_e, ρ

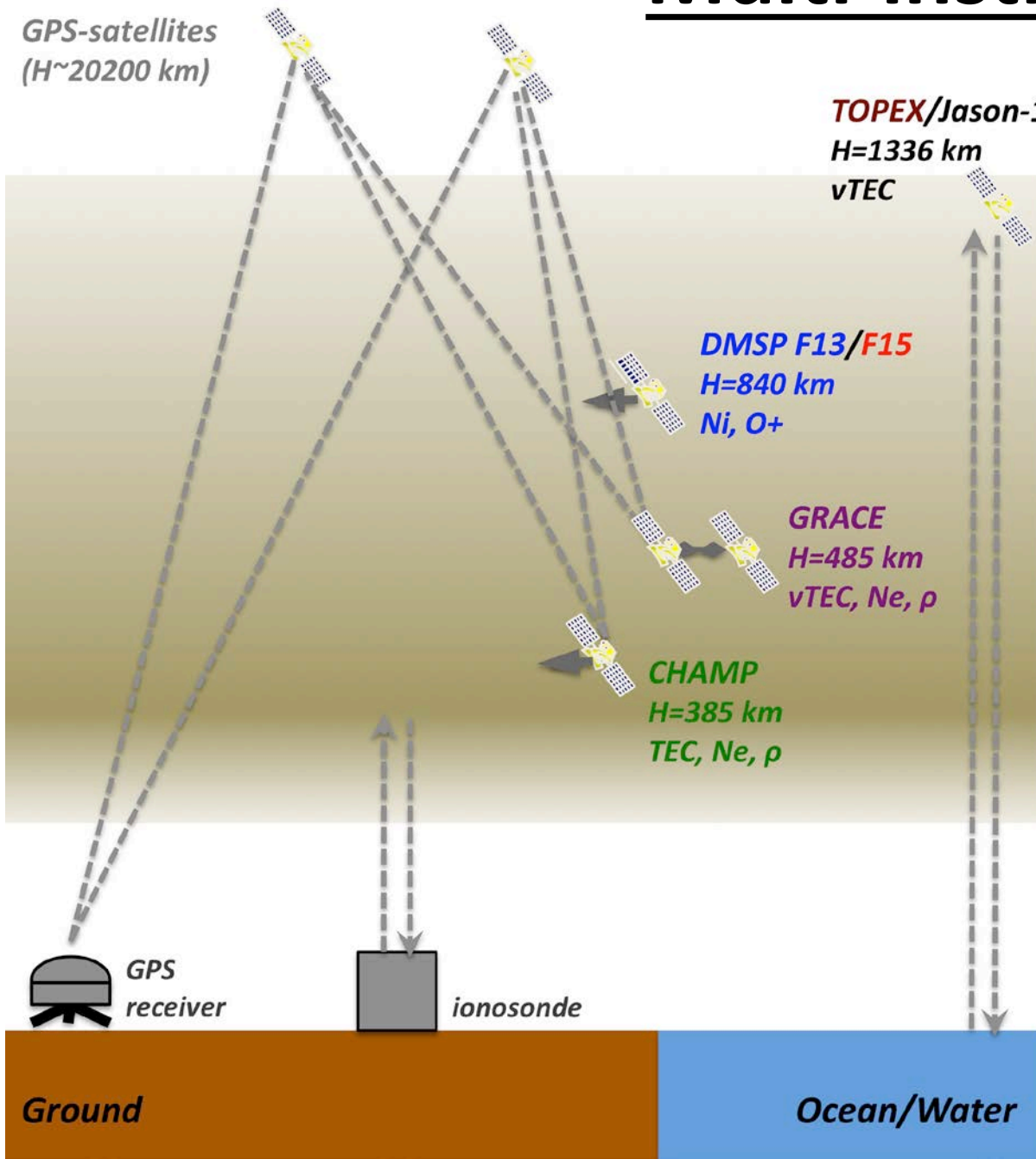
GPS
receiver

ionosonde

Ground

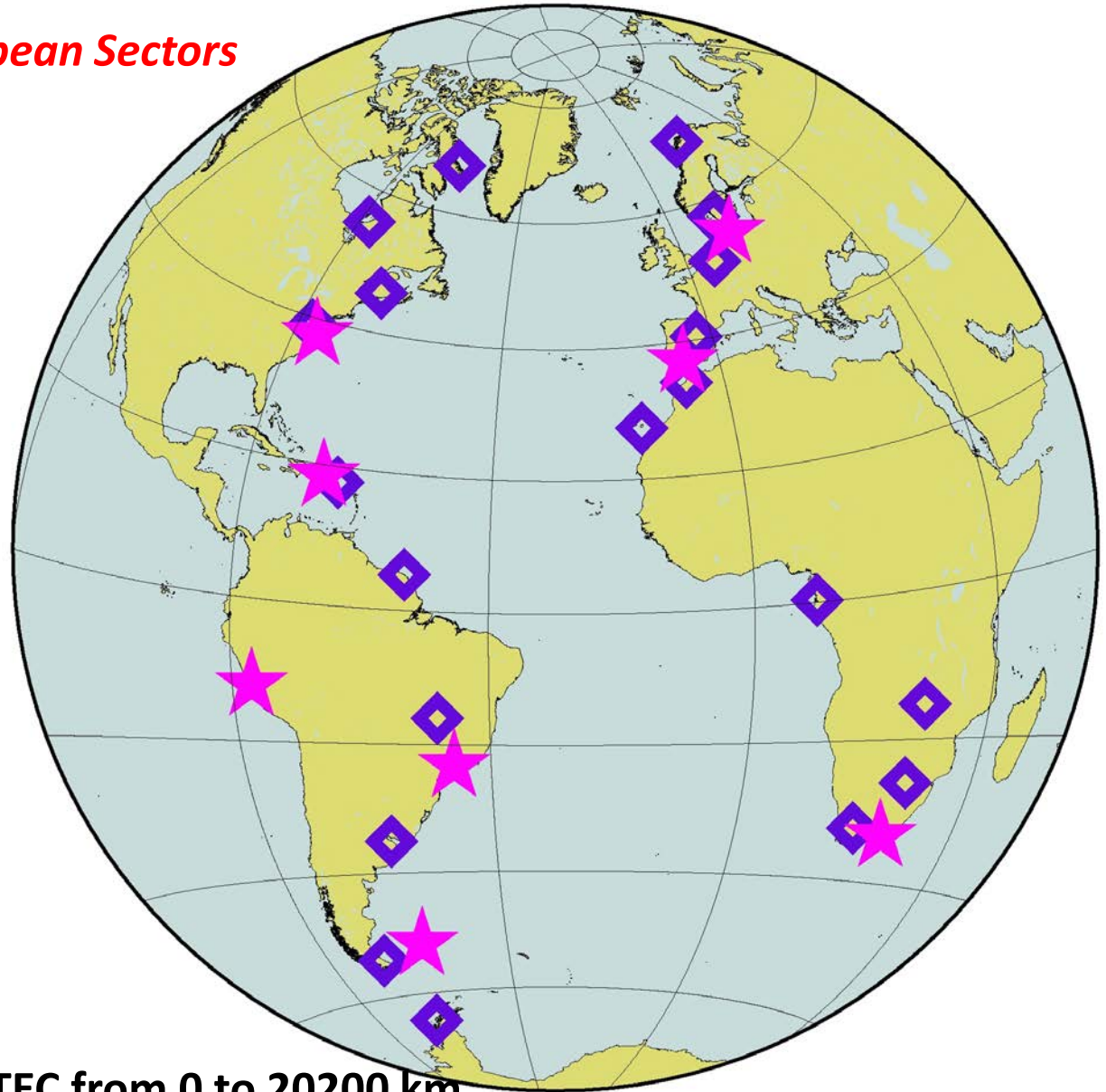
Ocean/Water

Ground-based
+
space borne



RESULTS I: Ground-based observations

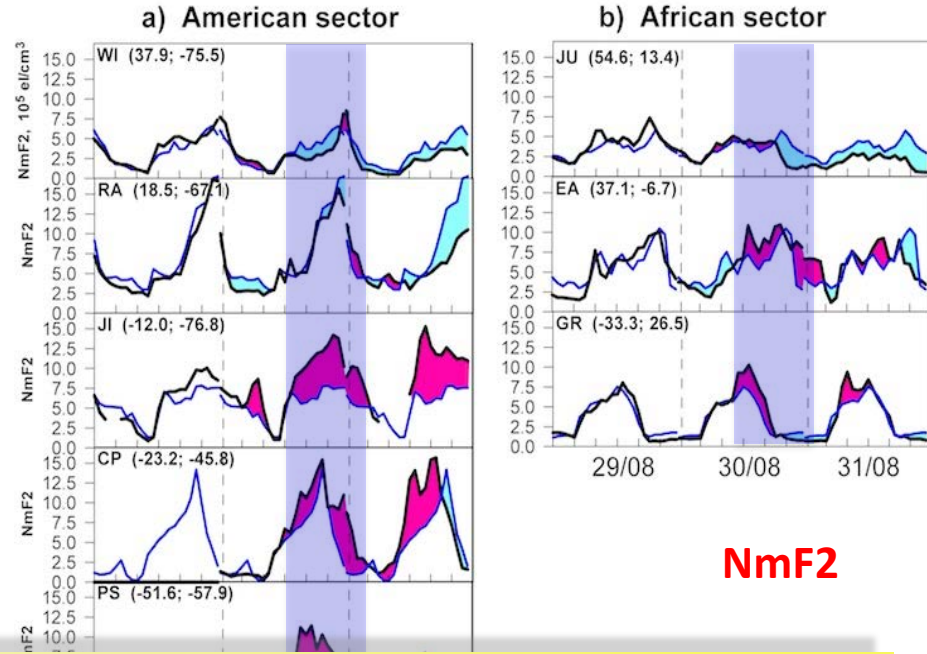
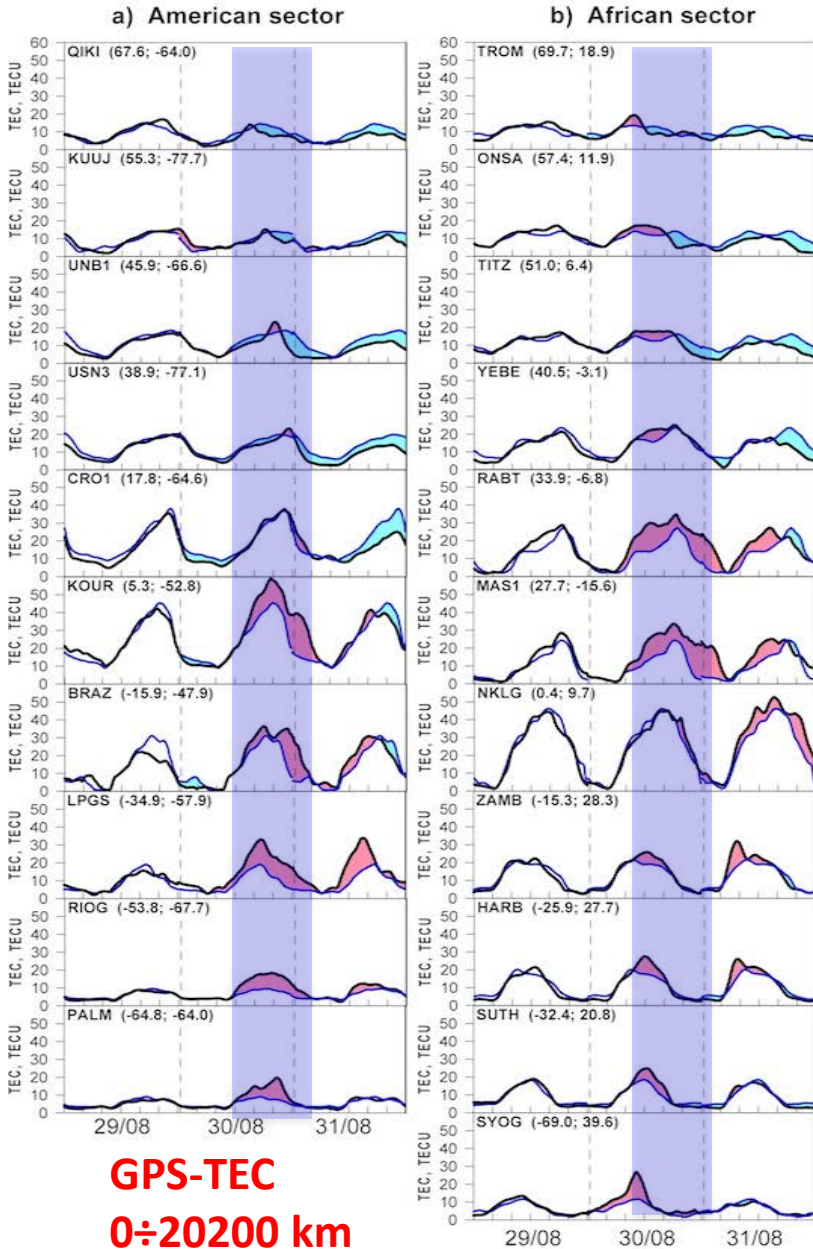
American & European Sectors



 Ionosondes – NmF2

 Ground-based GPS – vTEC from 0 to 20200 km

Ground-based observations → F-layer



F-layer effects:

- 1) Positive storm at low-latitudes;
- 2) Negative storm in the NH
- 3) Strong positive storm in the SH mid- and high-latitudes (winter hemisphere!);

RESULTS II: Satellite observations

Evening sector:

+ GRACE A&B (vTEC + Ne + ρ) ~17LT

+ DMSP F13 (Ni + O⁺) ~18.5LT

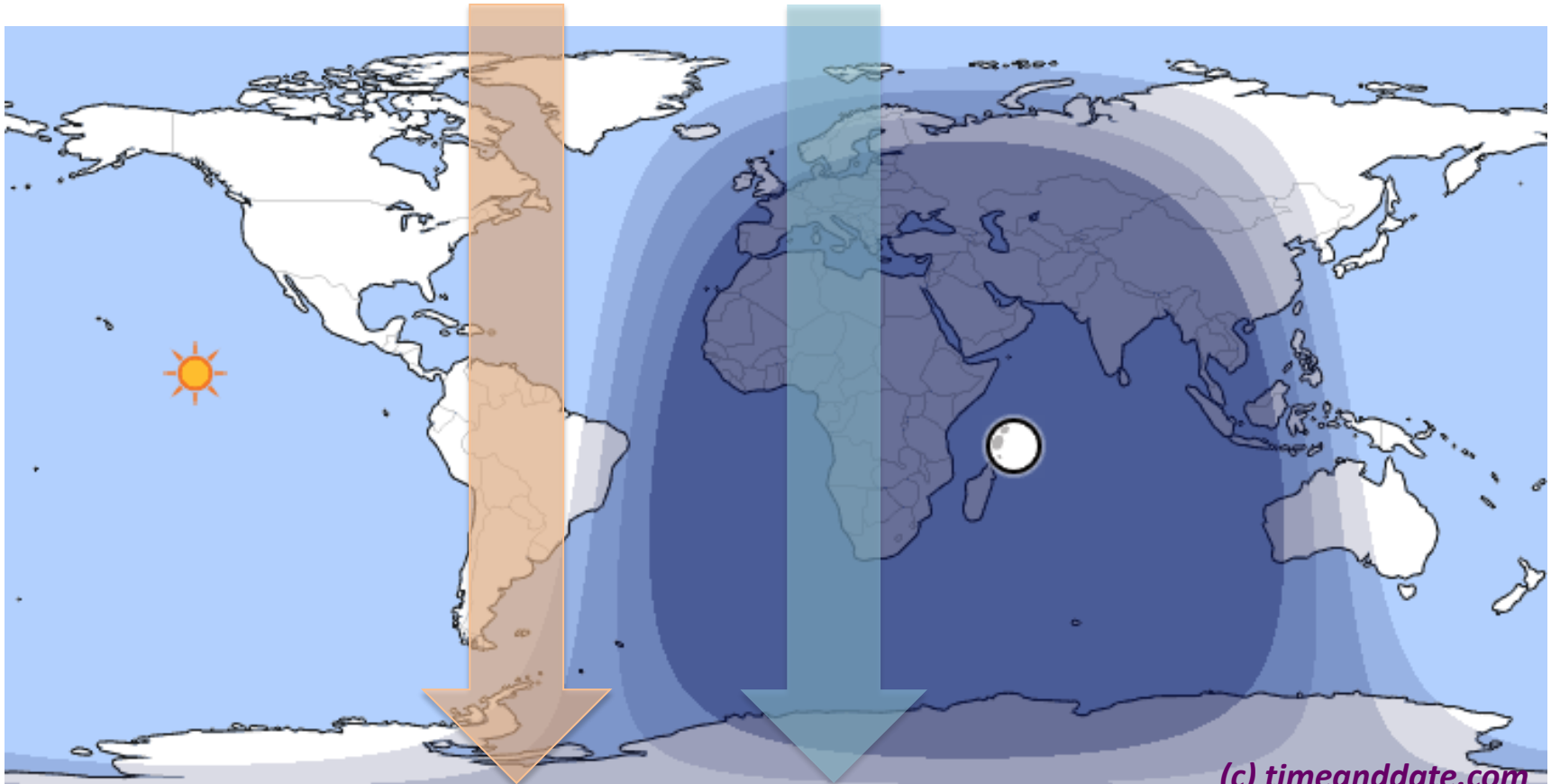
Post-sunset sector:

+ TOPEX/Jason-1 (vTEC) ~20.56LT

+ CHAMP (vTEC + Ne + ρ) ~21LT

+ DMSP F15 (Ni + O⁺) ~21.1LT

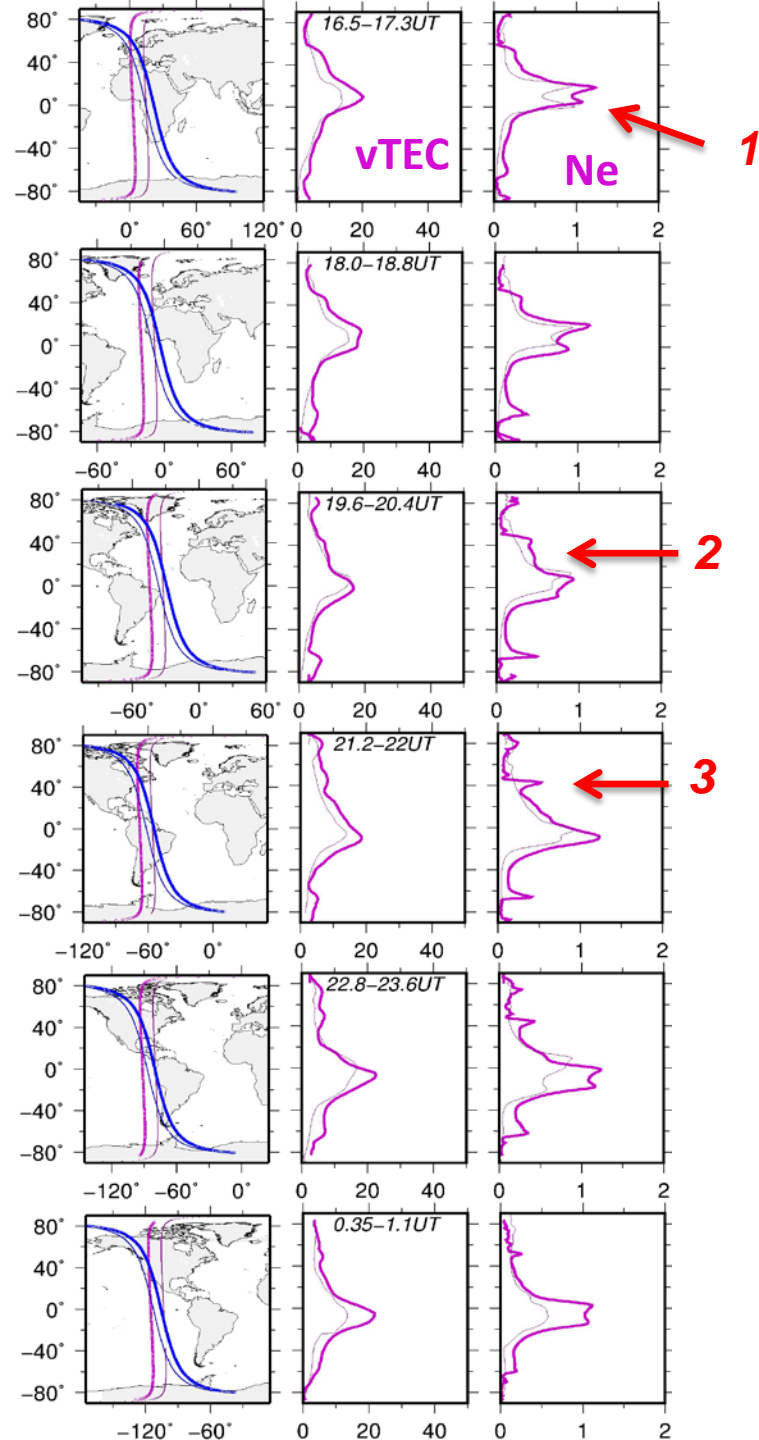
Map for 30/08/2004 -- 21UT



Evening sector (~17LT)

30/08 16UT – 31/08 1UT

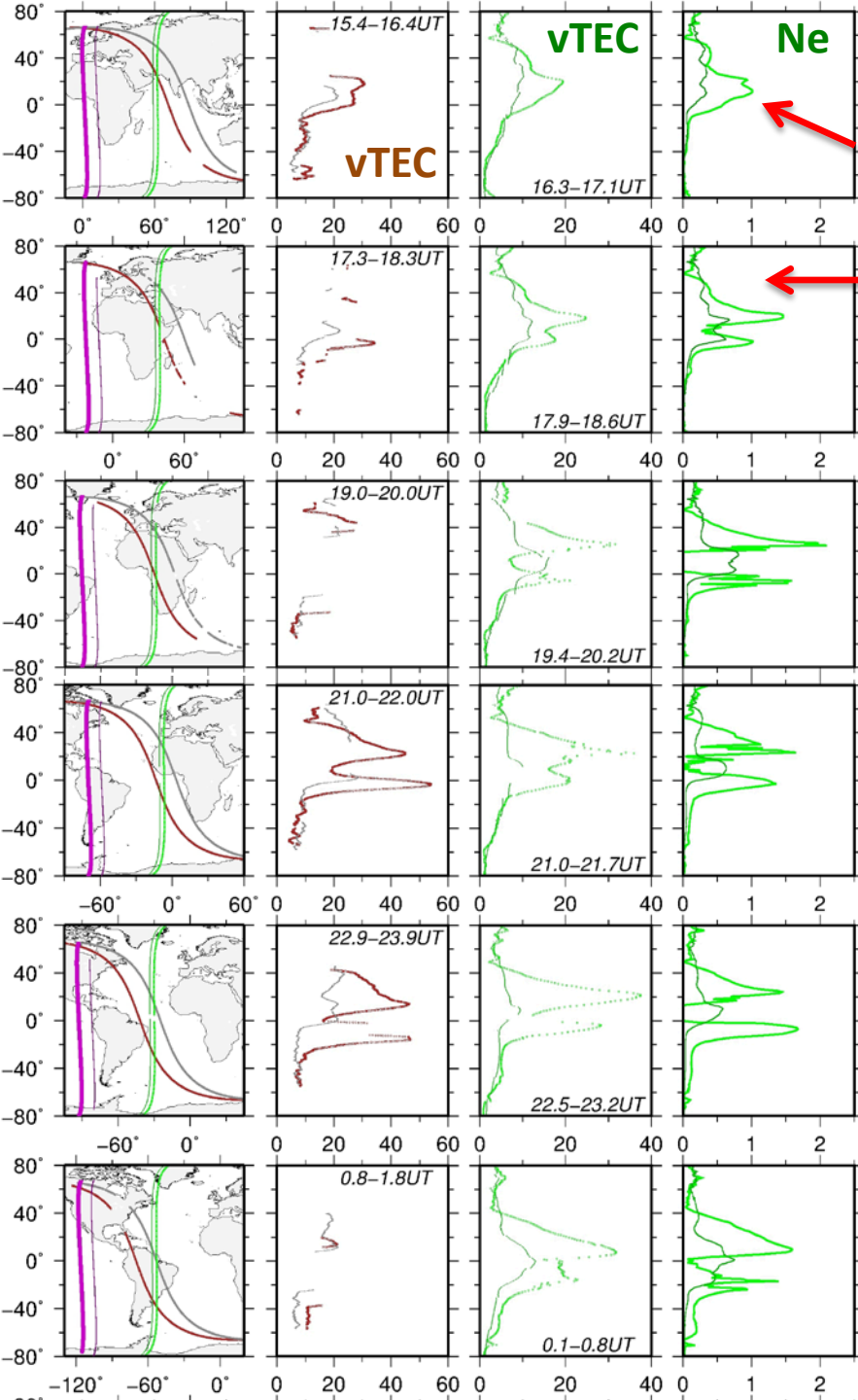
GRACE:
485 km - 17 LT



Evening sector (topside):

- 1) Low-latitude increase
- 2) Increase in the NH (*Contrary to the F-layer observations!*)
- 3) TIDs at high-lat in NH & SH

Post-Sunset sector (~20.5-21LT)



1

2

3

4

Super-fountain

Post-sunset sector (topside):

- 1) NH-SH asymmetry (**contrary to the F-layer**)
- 2) Strong SFE from 18 UT; ~250-400% vTEC increase
- 3) Topside irregularities

RESULTS II: Satellite observations

Evening sector:

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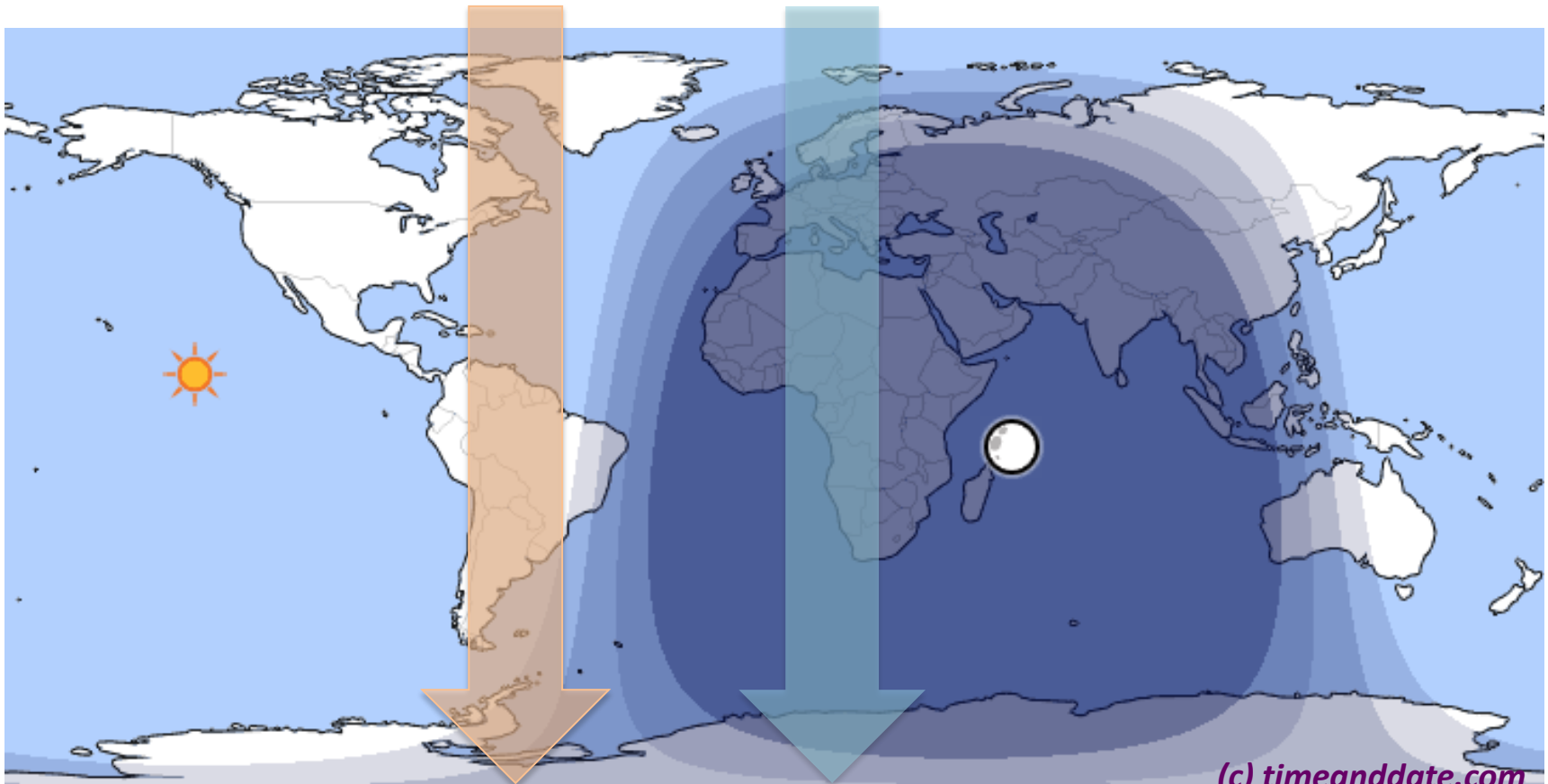
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Map for 30/08/2004 -- 21UT

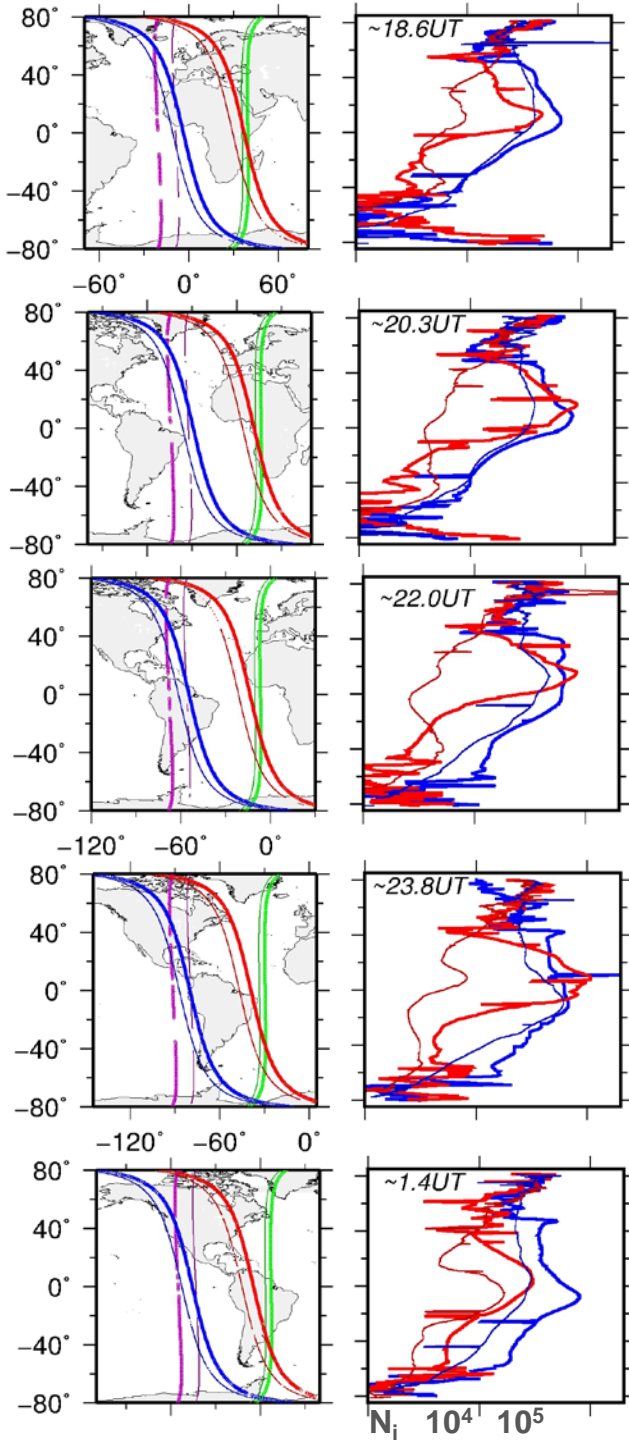


DMSP observations 840km

30/08 ~17UT --- 31/08/2004 ~3UT

F13
(18UT)

F15
(21UT)



Ni & O+ at 840 km height:

- 1) Uplift till 840 km at low-latitudes
- 2) Asymmetry in both sectors
- 3) Significant uplift in the PS sector

Known

1) Positive storm at low-latitudes in all longitudinal sectors;

2) positive storm in the winter hemisphere;

3) Ionospheric uplift up to at least ~840 km; observations of the dayside super-fountain effect



New (questions)

1) opposite hemispheric asymmetries in the ionospheric F- and topside regions

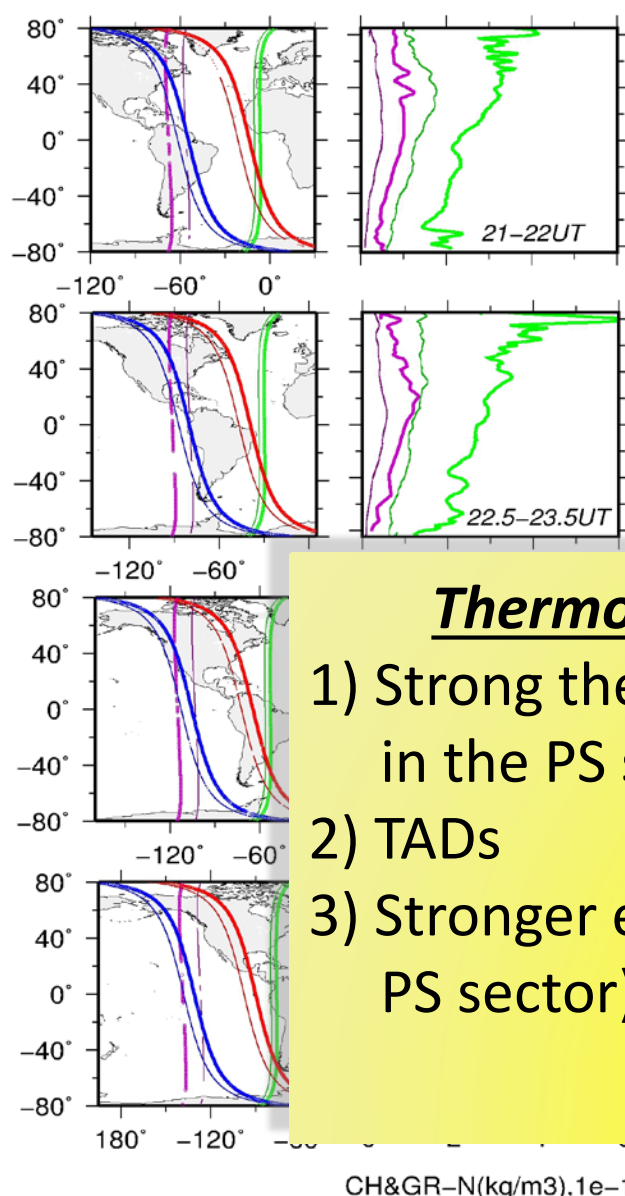
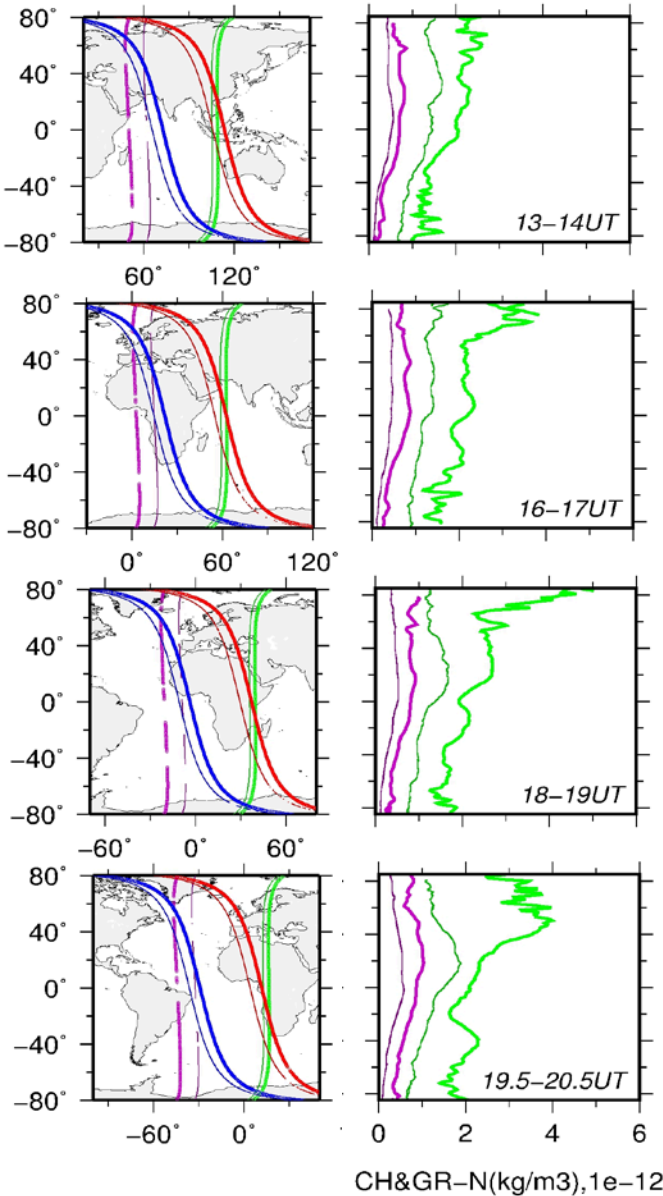
2) Post-sunset super-fountain effect. What is the "ionization source" in the ~21 LT sector (in absence of solar irradiance)?

Thermospheric storm (eve & PS sectors)

30/08/2004 @13-20UT

30/08 @21UT – 31/08/2004 @~3UT

GRACE (ρ) – 17LT
CHAMP (ρ) – 21LT

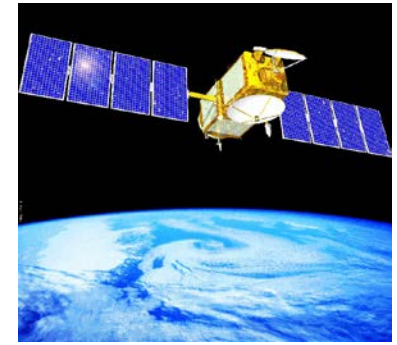
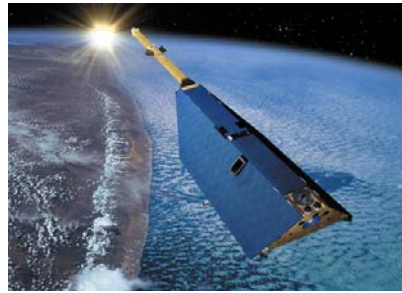
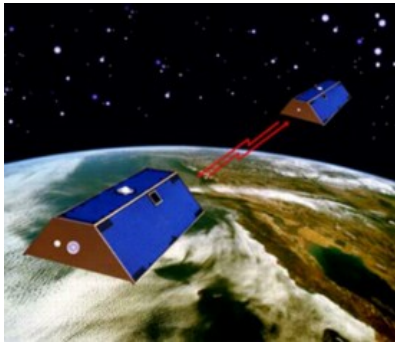


Thermospheric storm:

- 1) Strong thermospheric storm in the PS sector
- 2) TADs
- 3) Stronger effects in the NH (in PS sector)

CONCLUSIONS

- **Weaker storms can produce strong effects**
- **Ionospheric F-layer and the topside ionosphere may not respond in the same way**
- **Ionospheric response in the post-sunset sector can be the strongest**

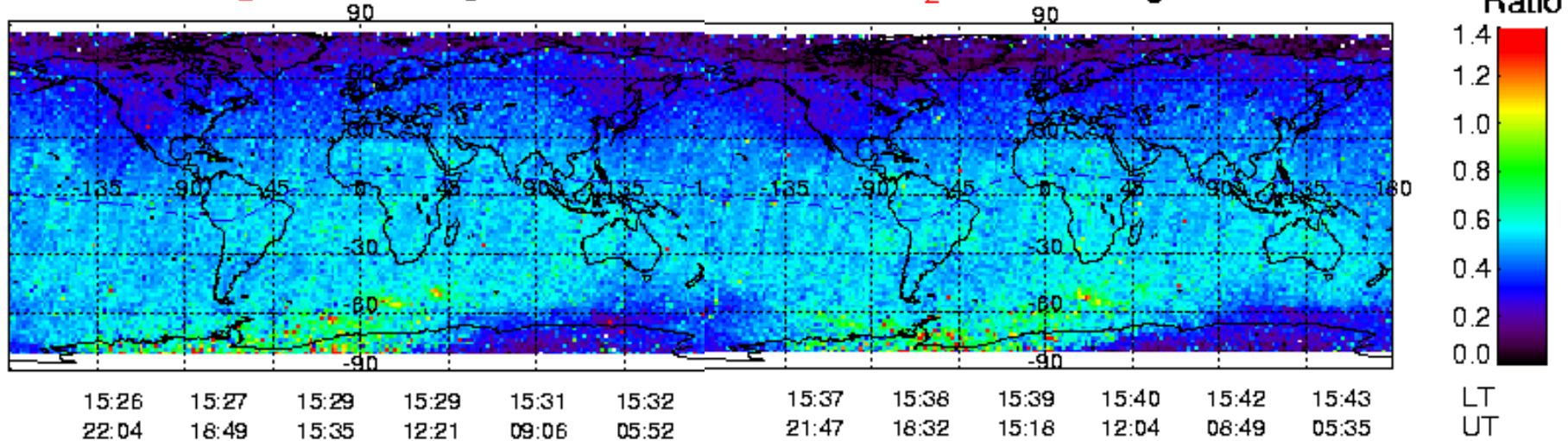


Thank you!

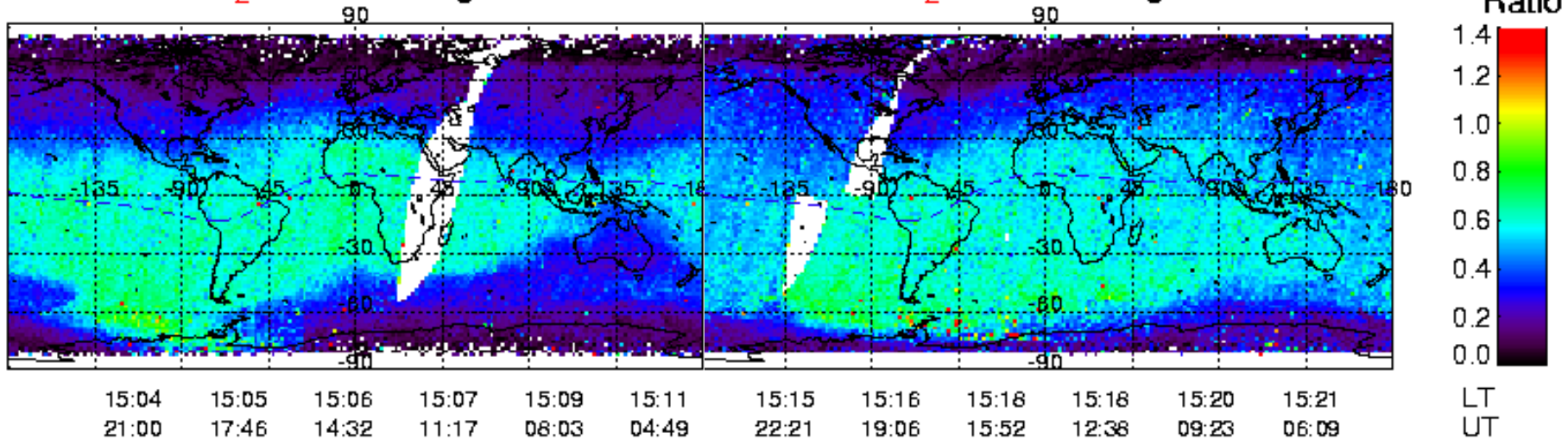


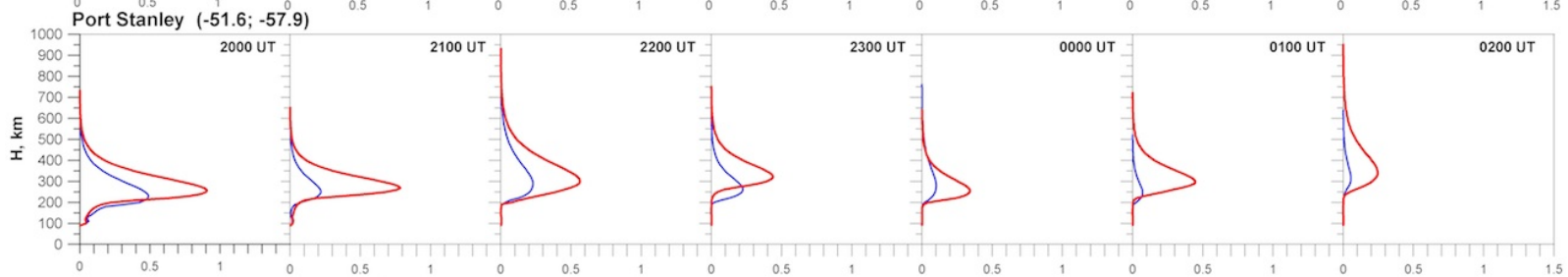
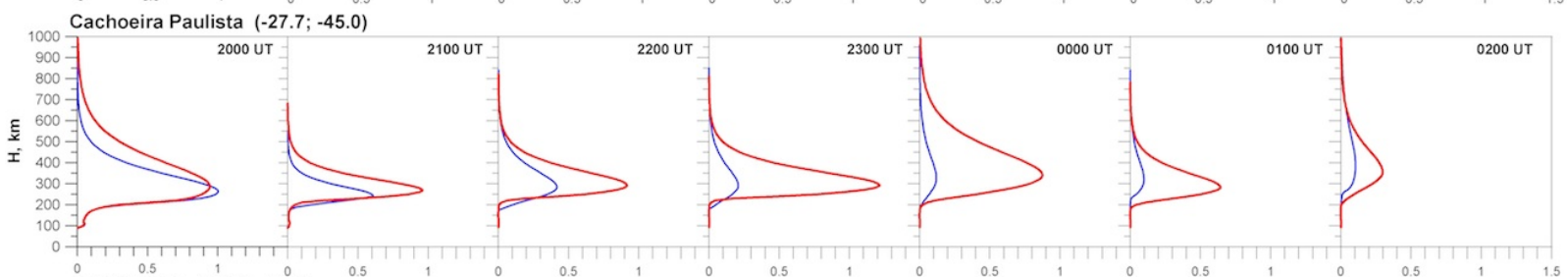
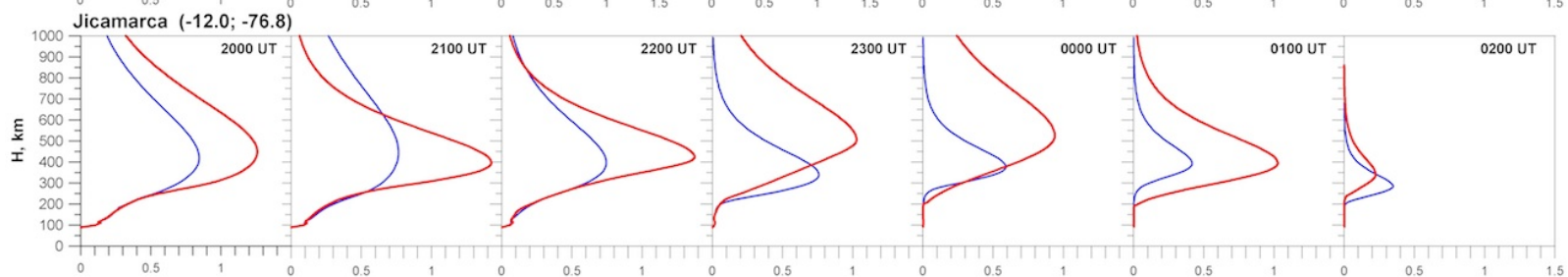
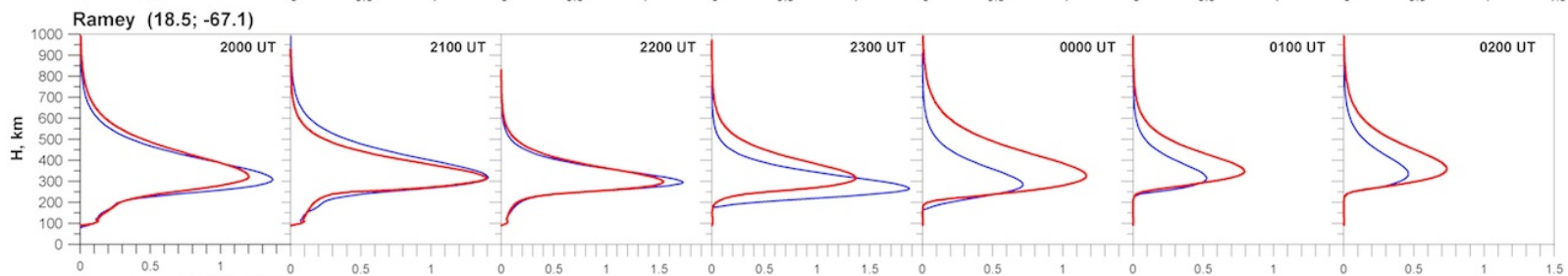
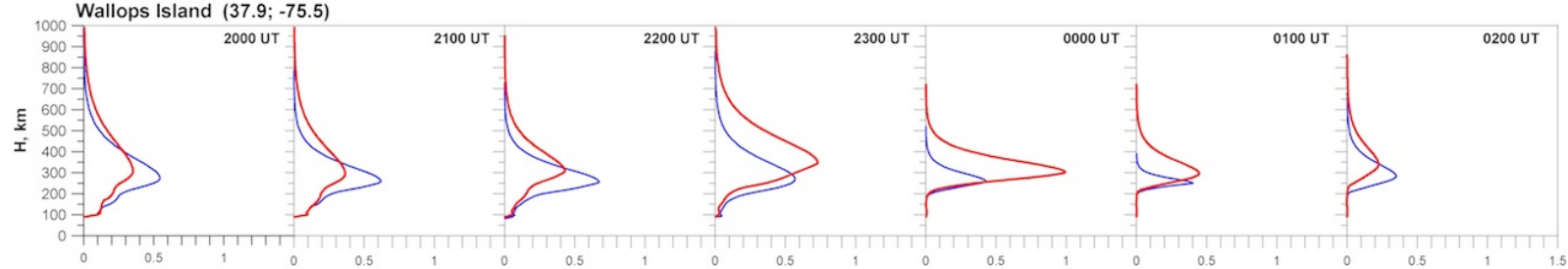
GUVI/TIMED measurements

GUVI O/N₂ Ratio August 29, 2004 GUVI O/N₂ Ratio August 28, 2004



GUVI O/N₂ Ratio August 31, 2004 GUVI O/N₂ Ratio August 30, 2004

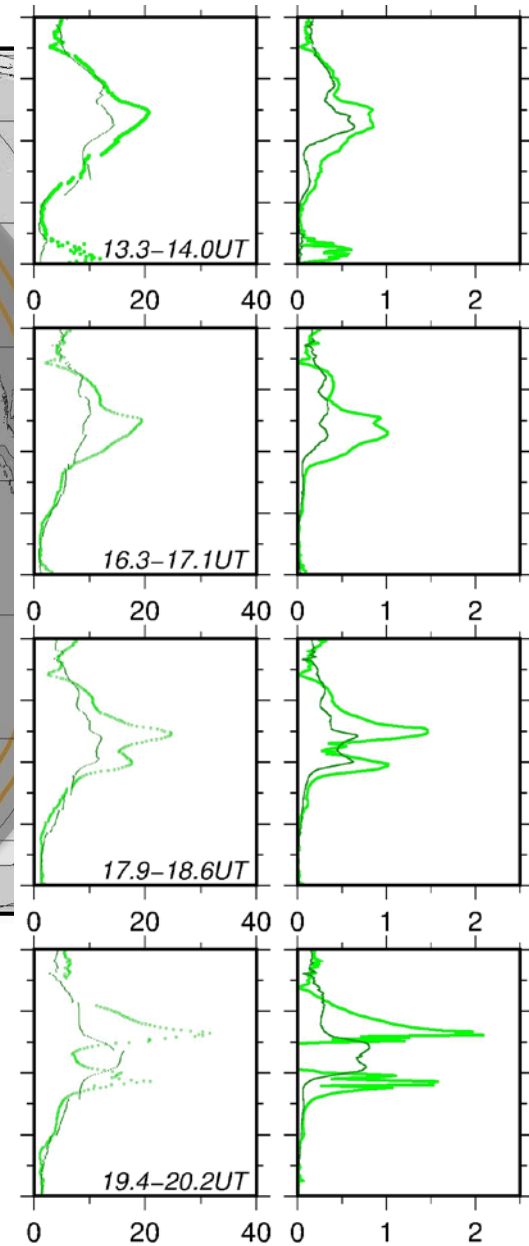
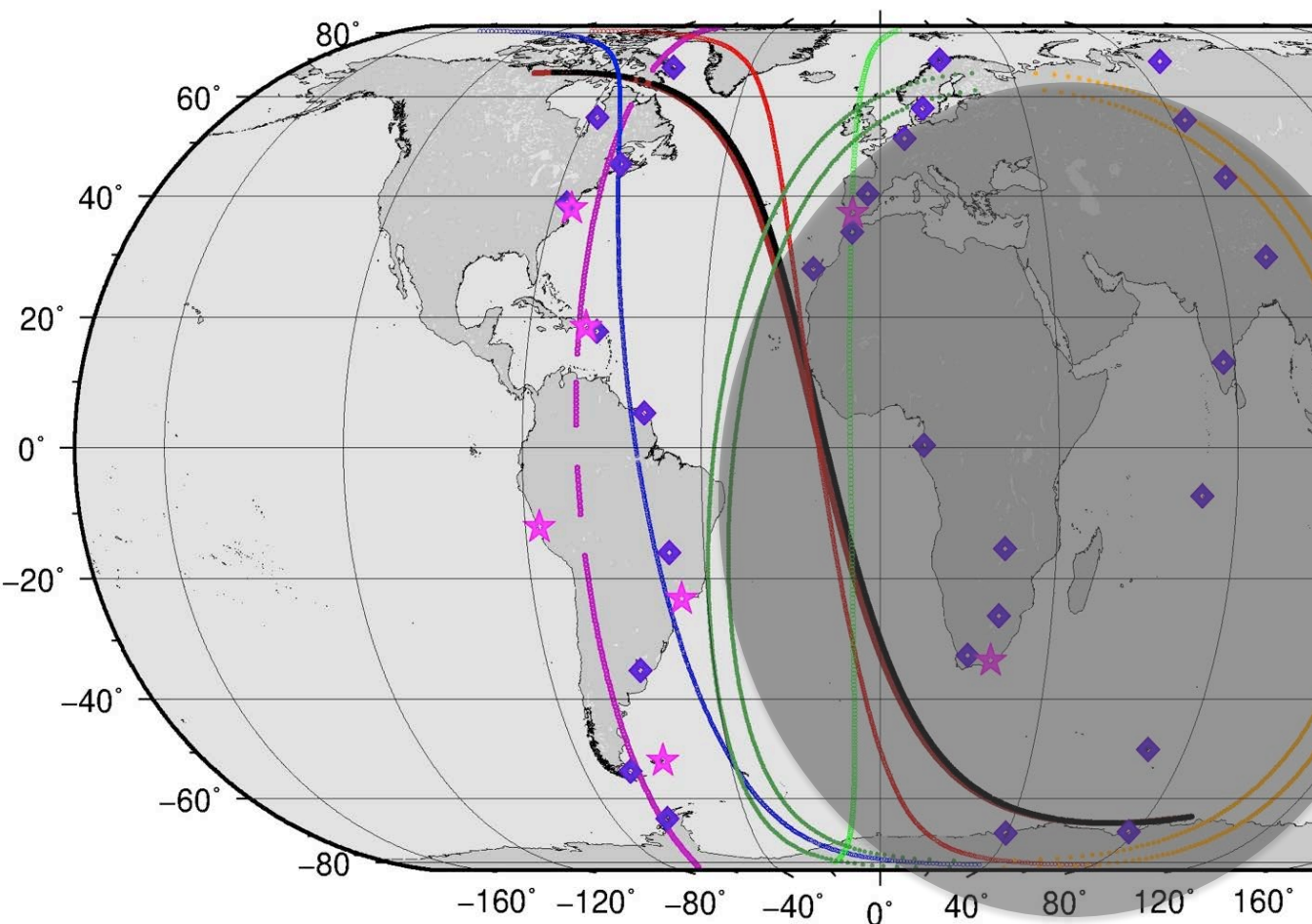




Electron Density (10^6 el / cm^3)

— 28(29) August 2004
— 30(31) August 2004

PS sector: ionization source?



- 1) *Pre-reversal enhancement EF -- <22LT => the uplift*
- 2) *Ionization ? ... neutrals !*

CH-VTEC(TECU) CH-Ne(m-3),1e12

SUMMARY

- Opposite hemispheric asymmetries in the F-layer and in the topside ionosphere/plasmasphere;
- Very strong thermospheric and ionospheric reaction in the post-sunset sector; development of the super-fountain effect;
- Occurrence of the topside plasma irregularities in the post-sunset sector during the main phase.