New Scientific Results Provided by the LISN Network

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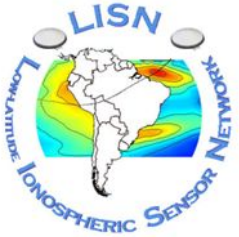
Outline

1. LISN instrumentation deployment – 2007-2008
2. TEC maps – TEC Depletion MAP
3. SSW event – Scintillation enhancement

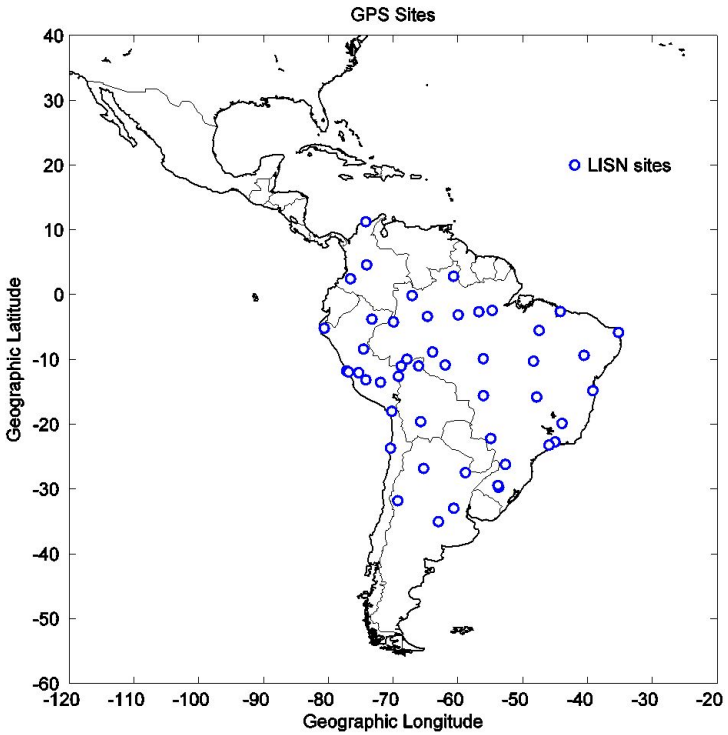


Session 1, July 25, 2022

UTD

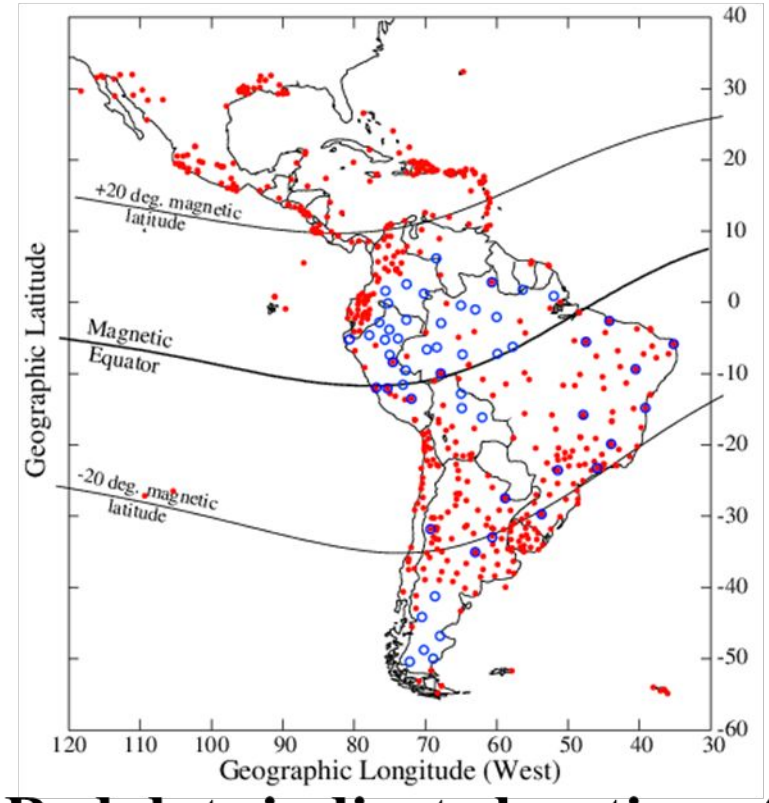
1. LISN instrumentation deployment

LISN GPS 2007-2016



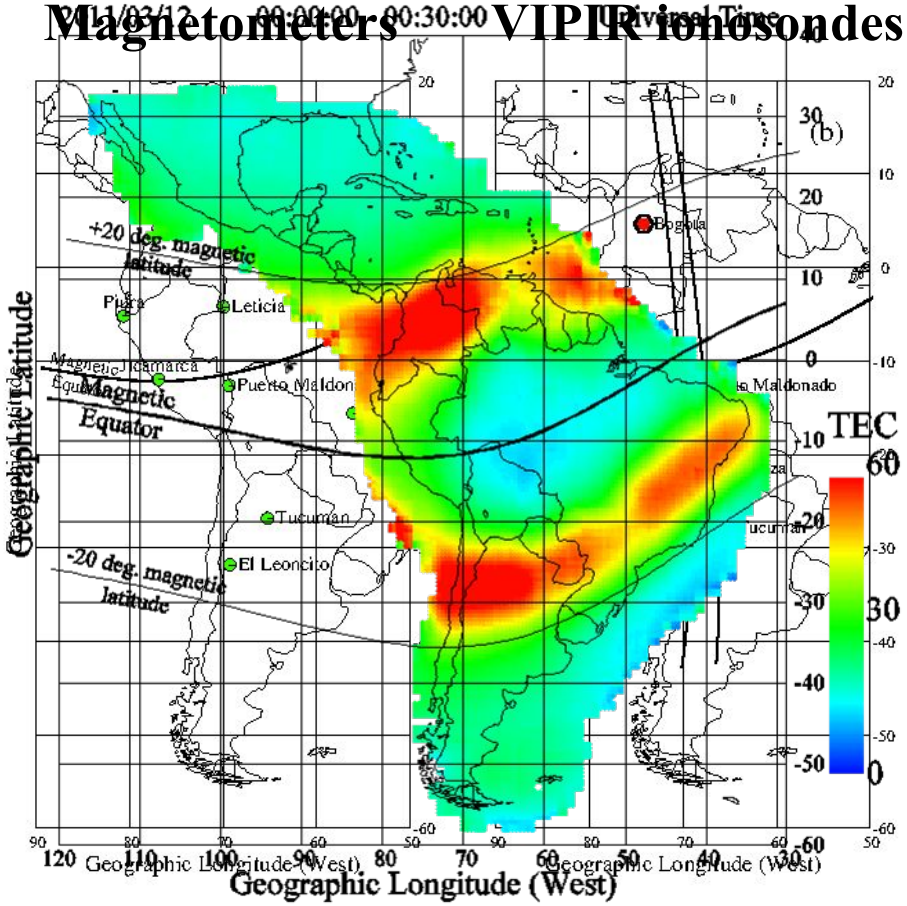
50 GPS Novatel rx

LISN + DURIP + 800 GPS



Red dots indicate location of 800+ receivers. Most of them provide data at UT=0.

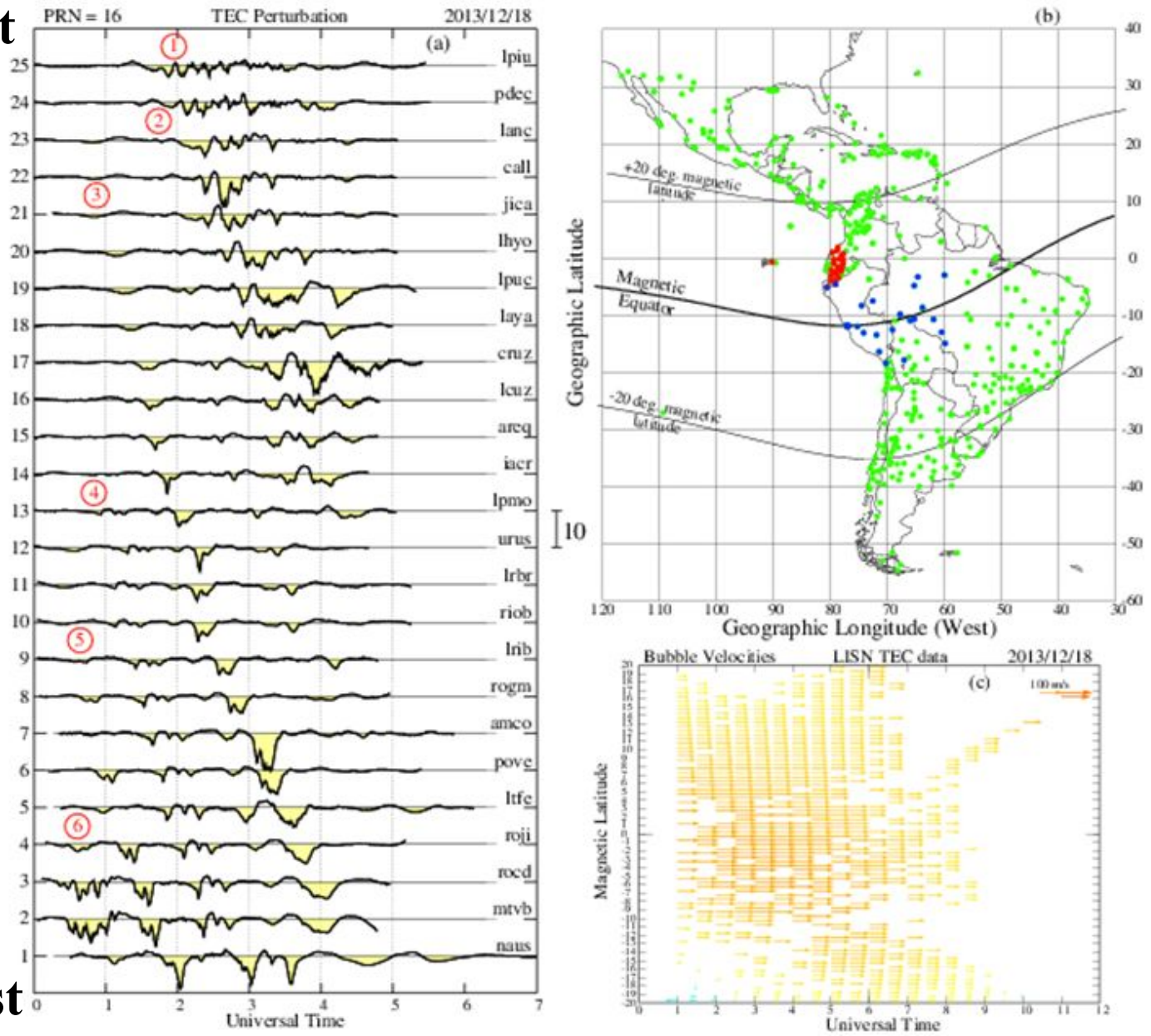
Magnetometers VIPIR ionosondes



2. TEC depletions and Equatorial Plasma Bubbles

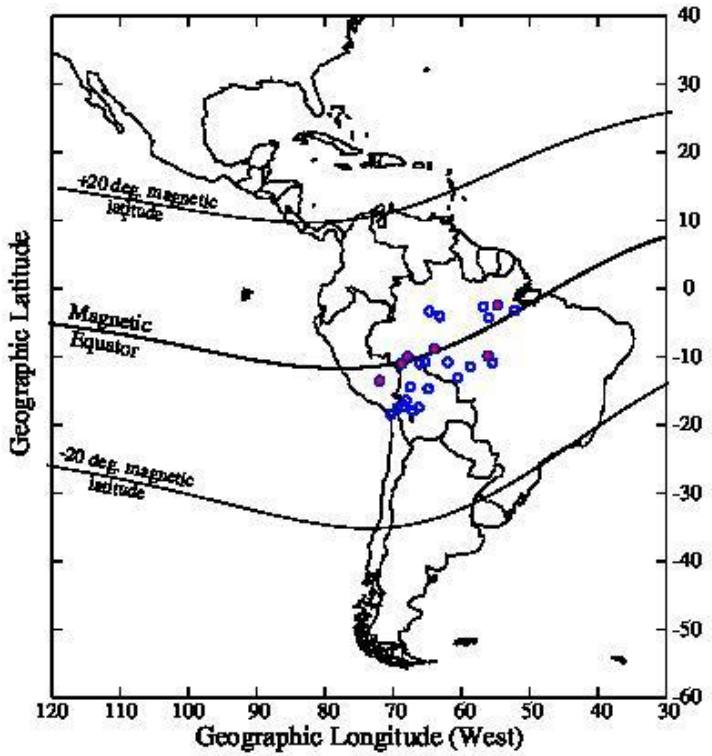
Difference TEC ➡

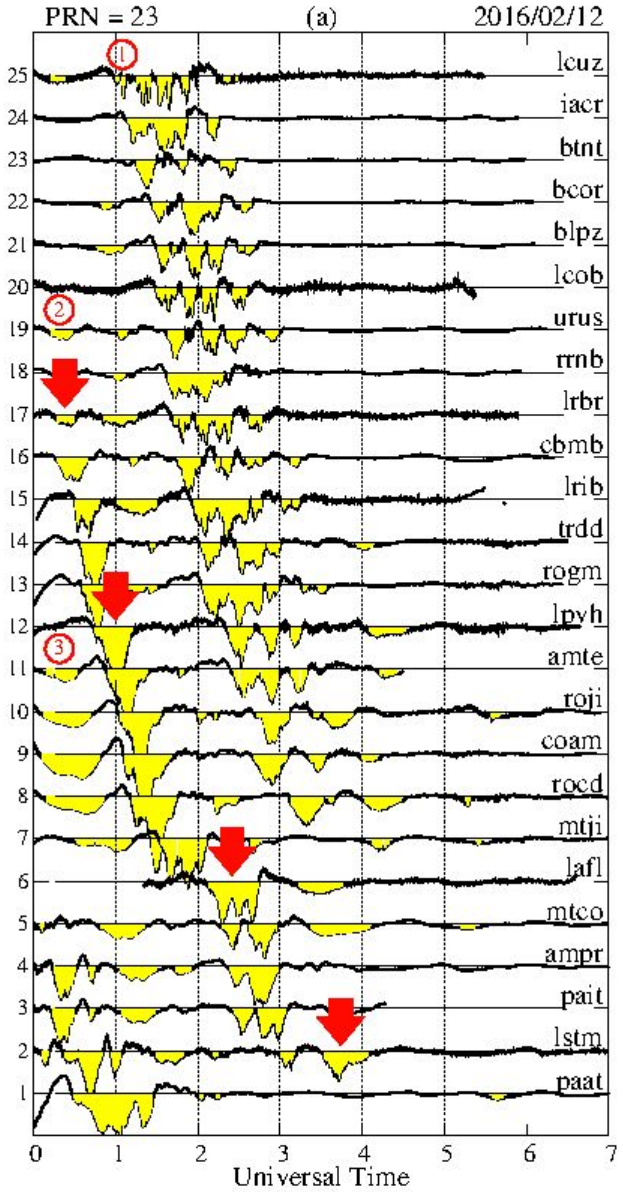
Display of TEC depletions observed ±6° from magnetic equator (blue dots in panel b) and cross-correlation analysis allow us to follow the transit of EPB/TEC depletions, study their evolution, observe the variability of L-band scintillations, estimate the bubble velocity, and forecast their appearance at stations located further East.

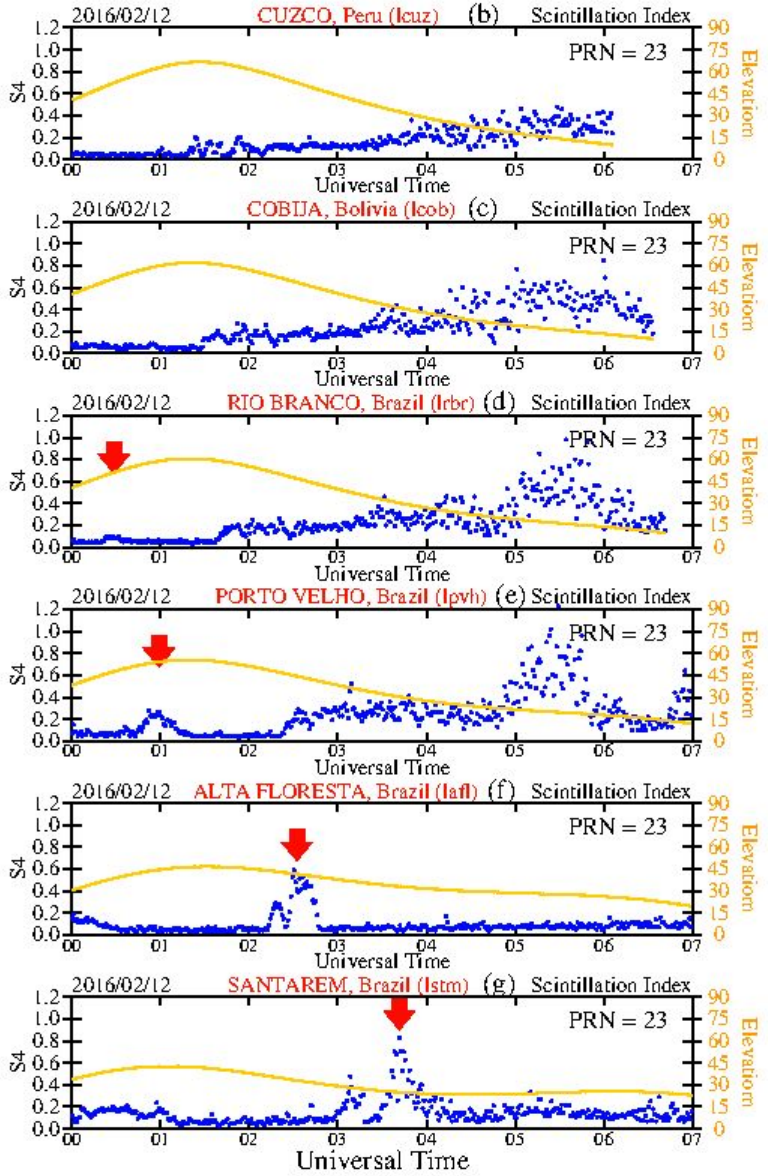


3. Scintillation enhancements: L1 S4 scintillations for February 12, 2016

Red arrows: point out times when bubble/TEC depletions are detected with LISN stations that measure scintillations.

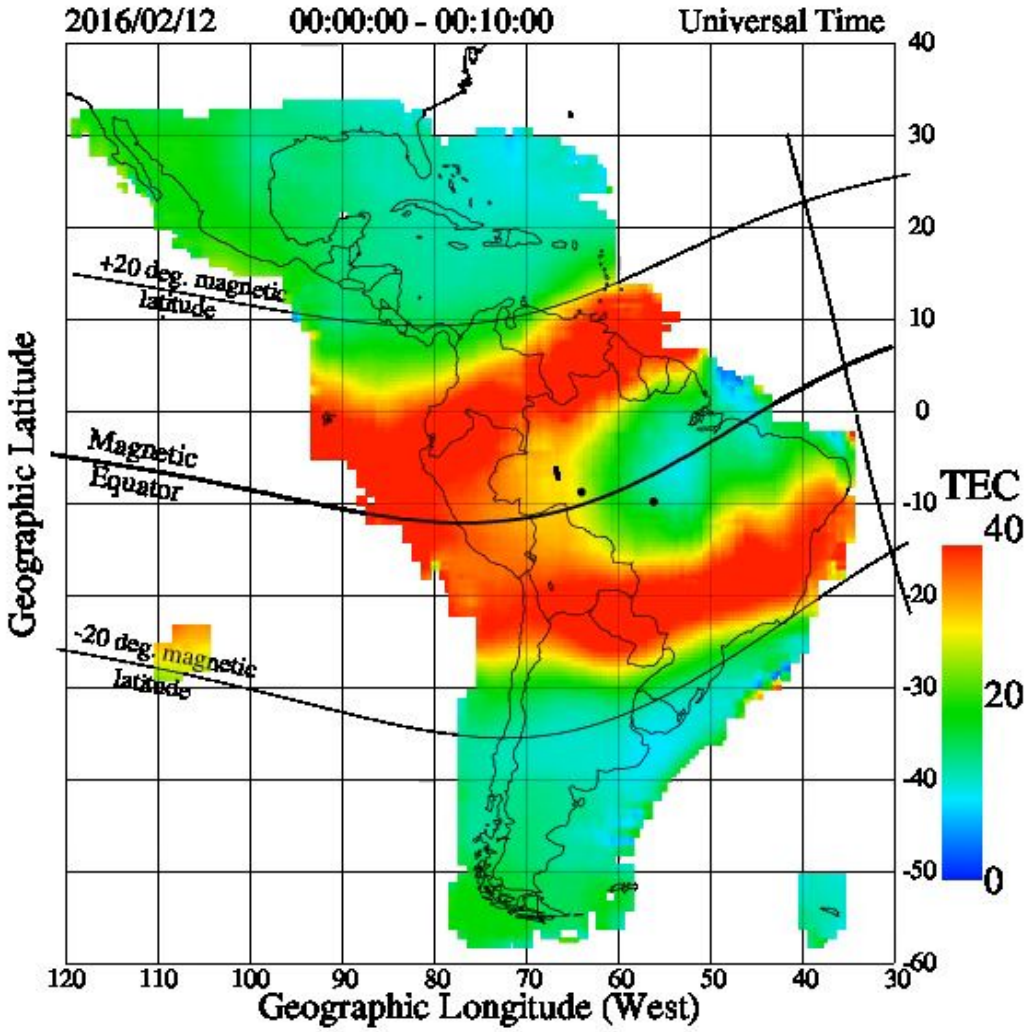


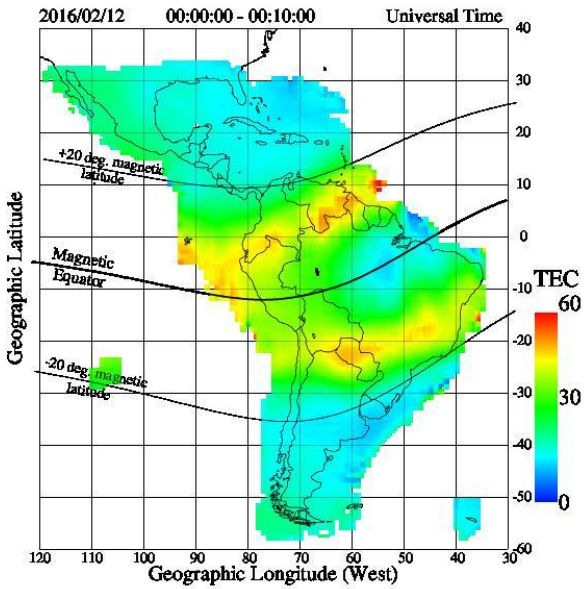


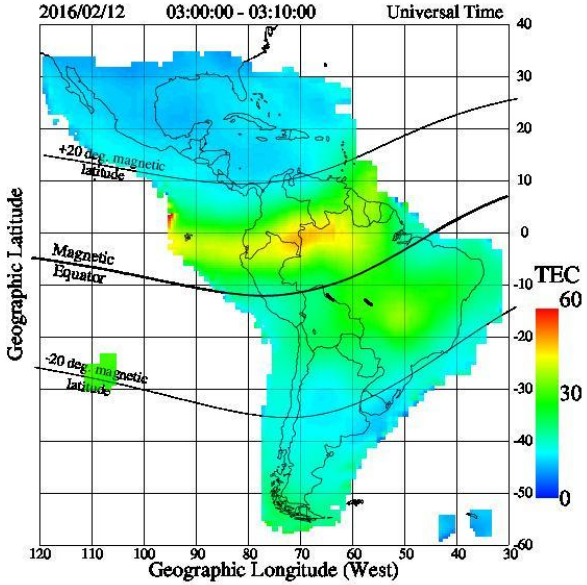


TEC observed on February 12, 2016

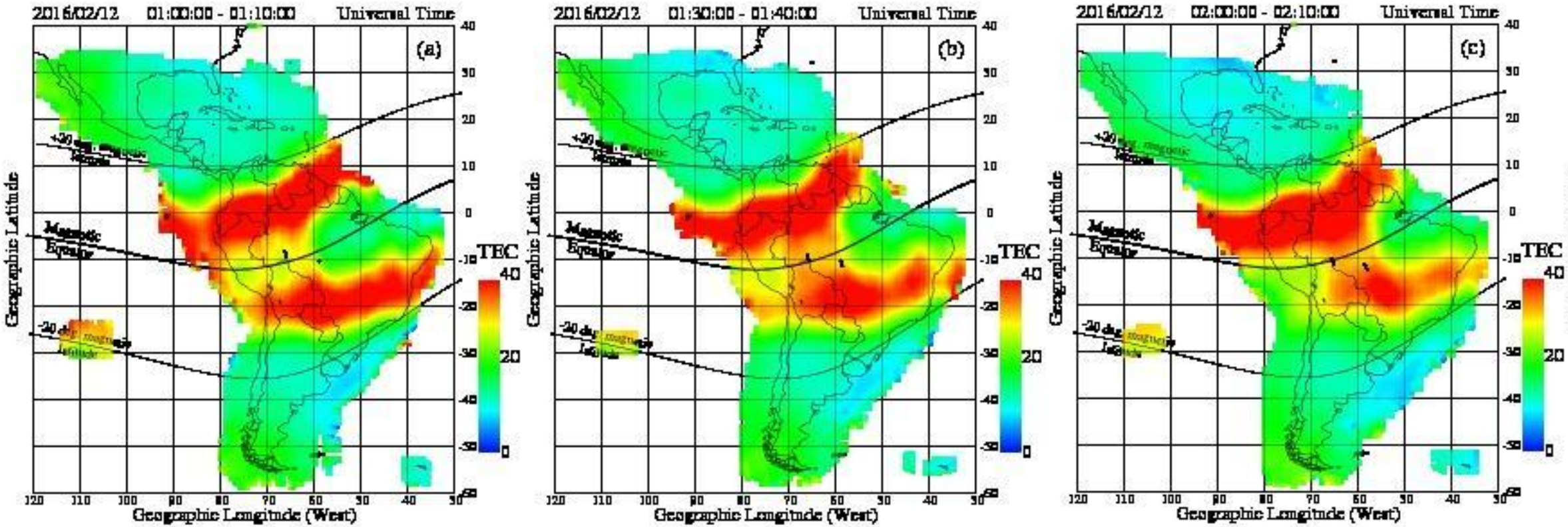
We observed sudden enhancements of the S4 scintillation index, 2-3 hour after bubbles were formed. The TEC values presented in the movie show the disappearance of the southern crest of the anomaly at 01:50 UT and the formation of a north-south aligned bridge that joined the Northern and Southern crests. A similar feature was also observed on February 13, 2016. After 02:00 UT the anomaly displays a circular cell.







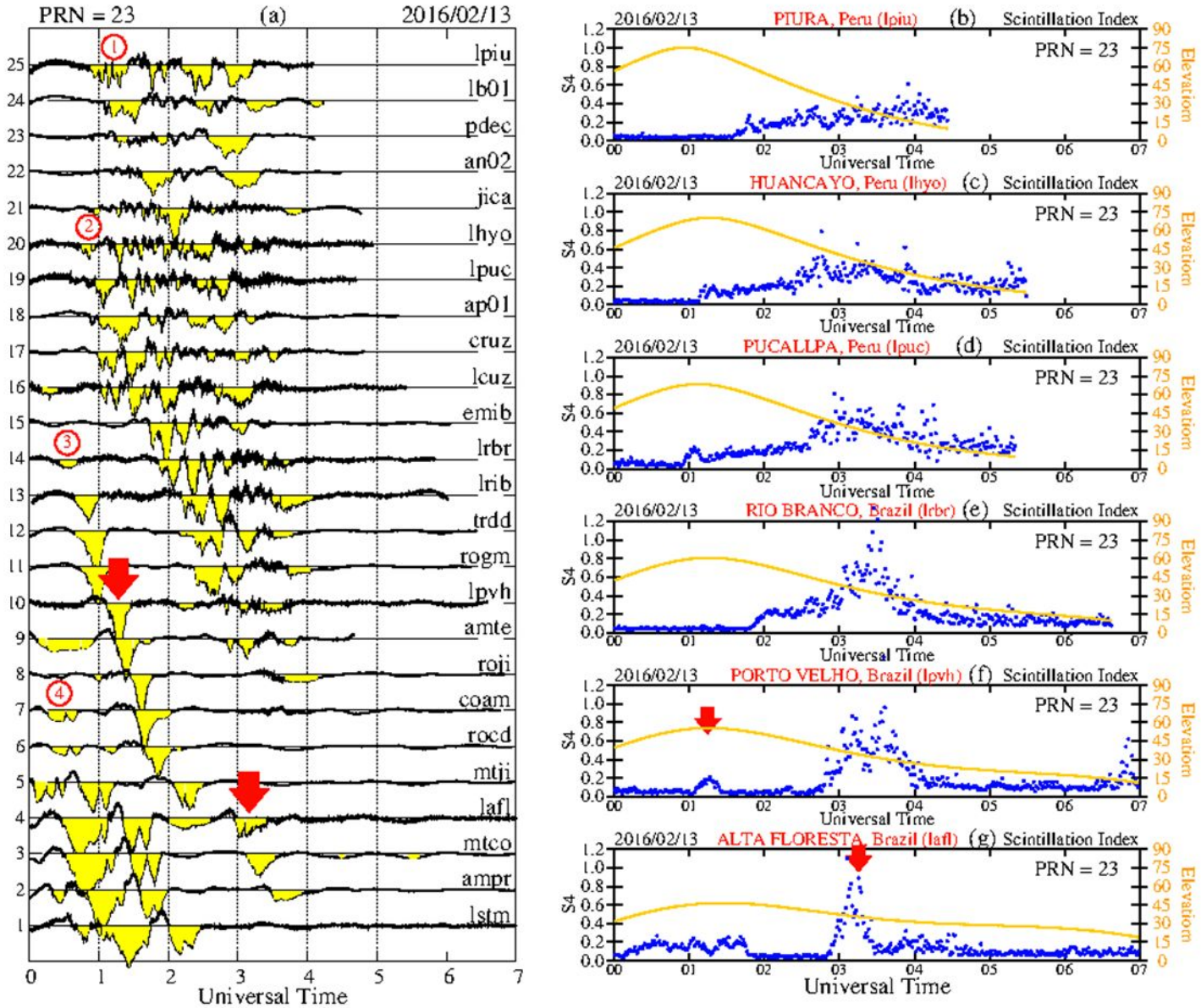
Summary of the Evolution of the EIA during the SSW event (February 12, 2016)



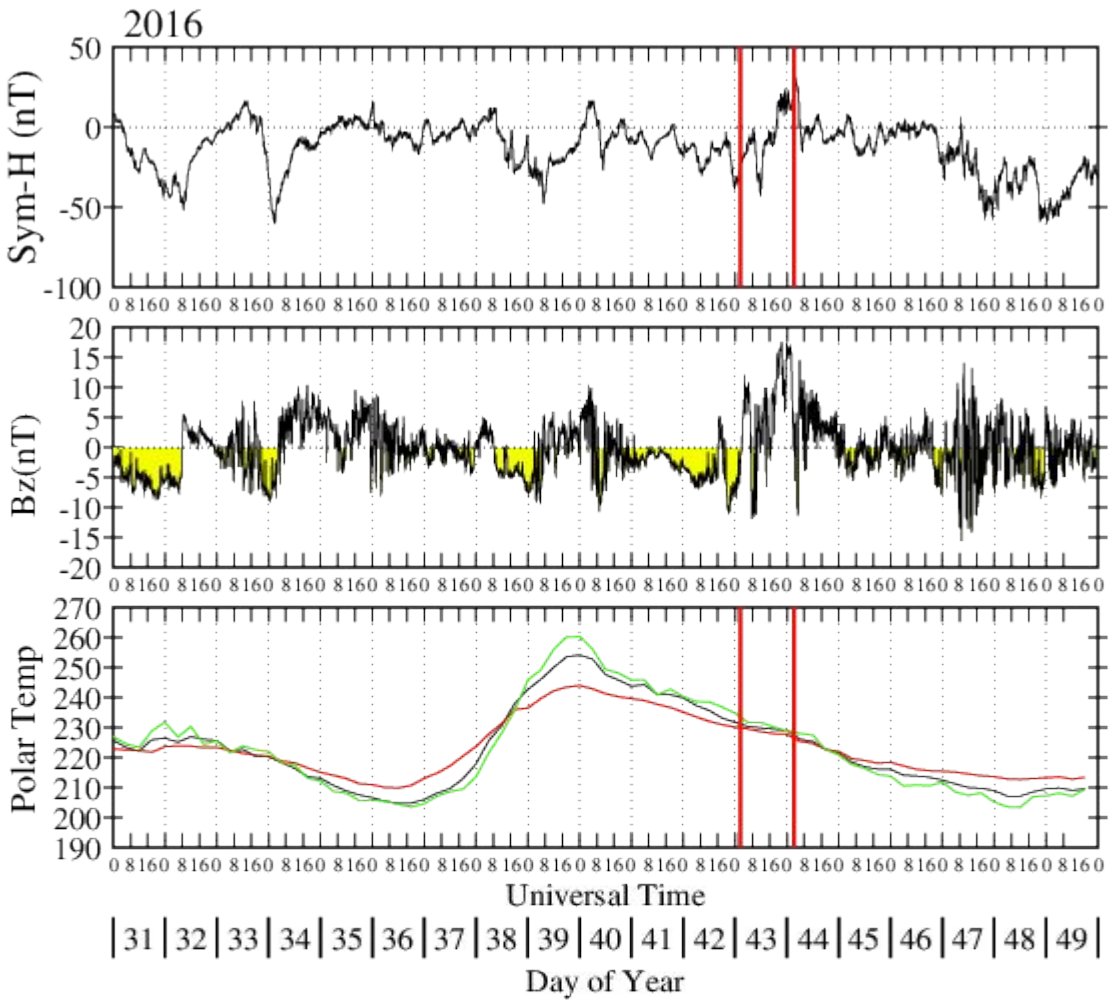
TEC depletions and L1 S4 scintillations for February 13, 2016

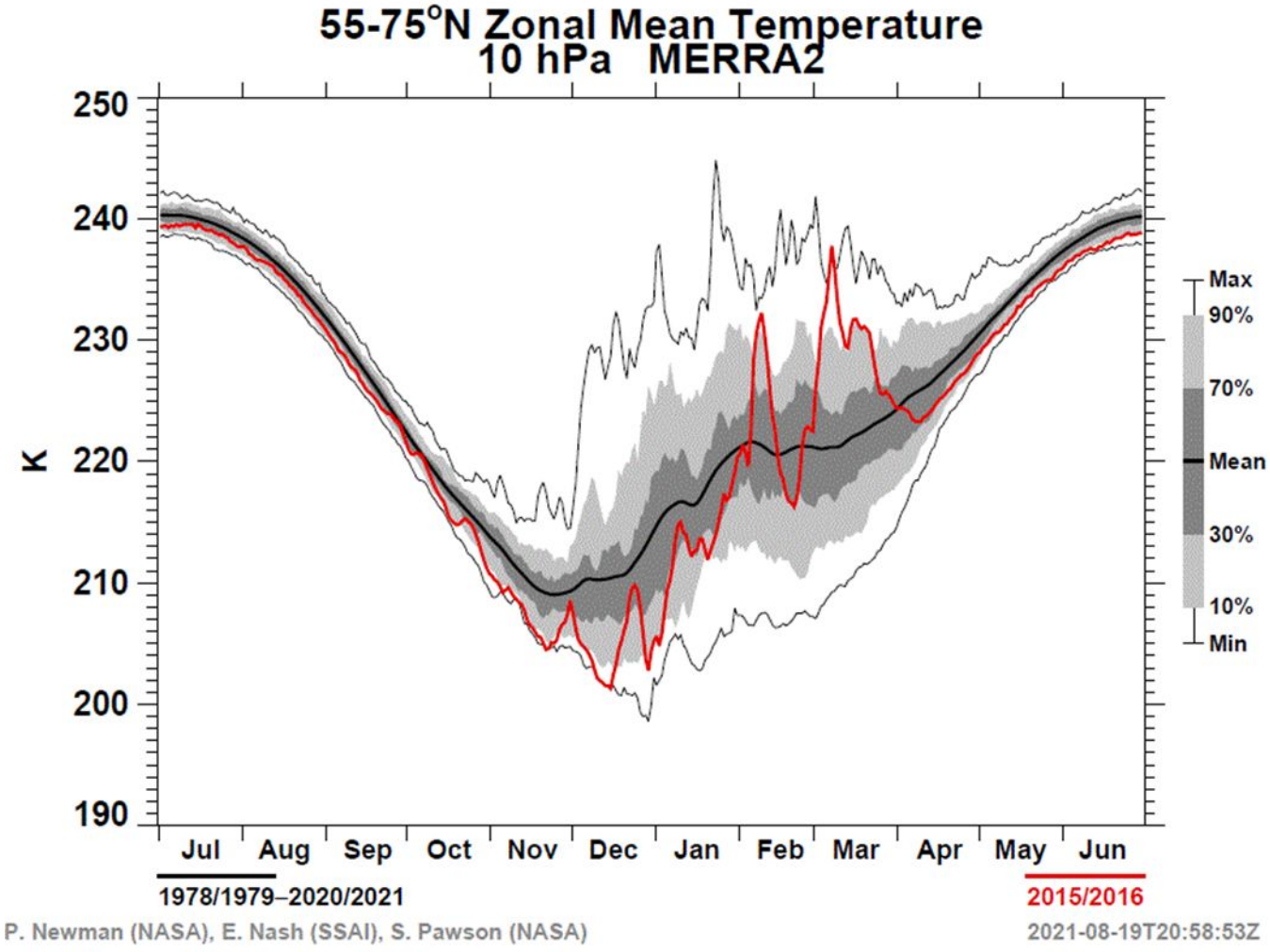
Red arrows: point out times when bubble/TEC depletions are detected with LISN stations that measure scintillations.

Note the increase of the S4 scintillation index after 03 UT for the four stations that measured scintillations located in the eastern part of Peru and Brazil.



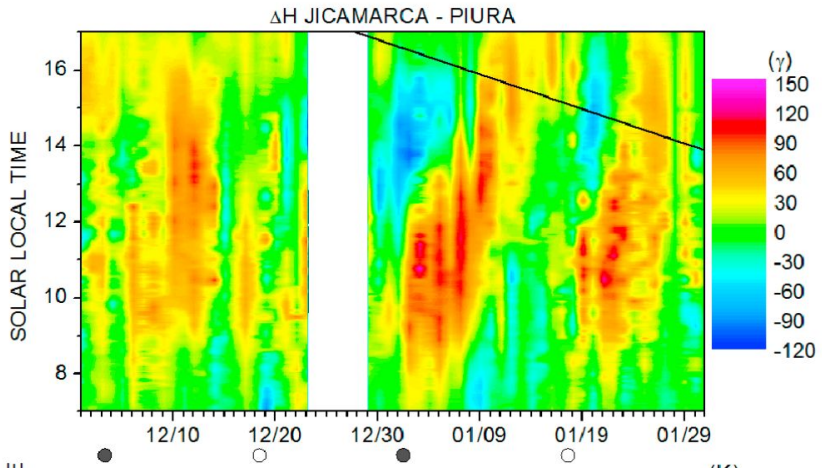
What mechanism can produce these effects? Magnetic storms or Sudden Strat warming?

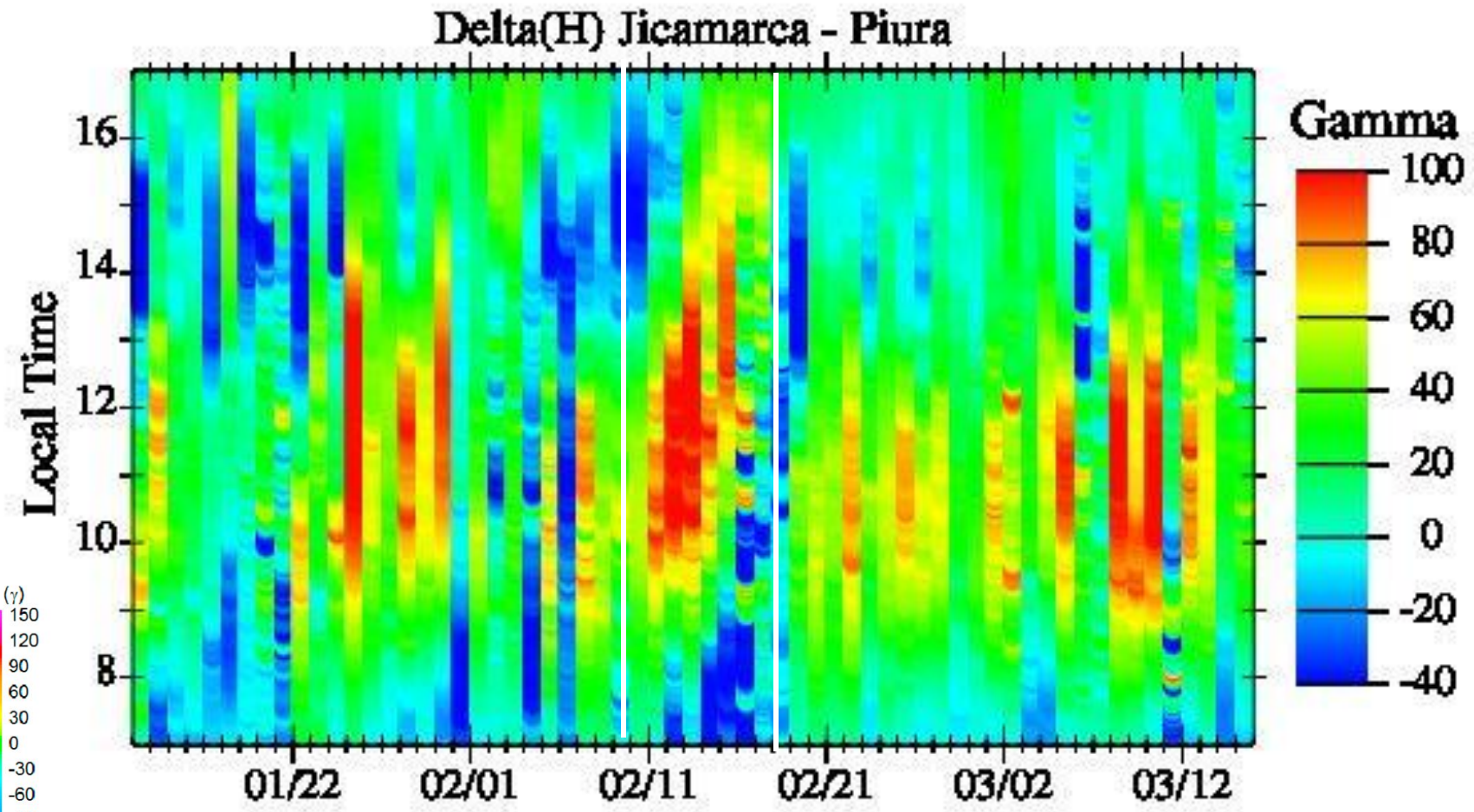




Differential Magnetic Field Variation: ΔH = Jicamarca(H) – Piura(H)

This plot shows that between February 09 and 16, 2016, there was a linear displacement of the γ values on later days. It is pointed out that during the period of interest, the new moon period occurred on February 08, 2016, at 14 UT.

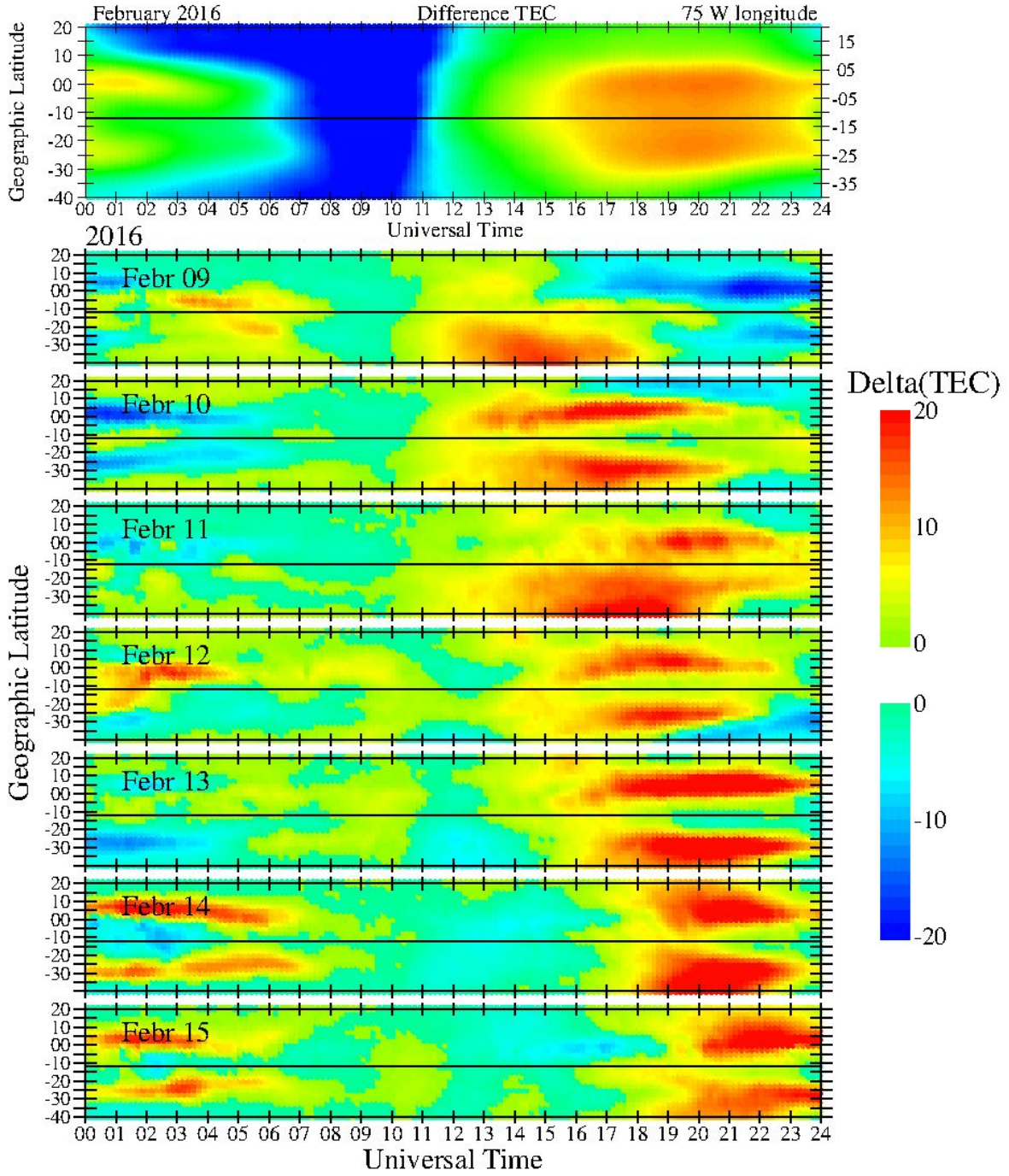




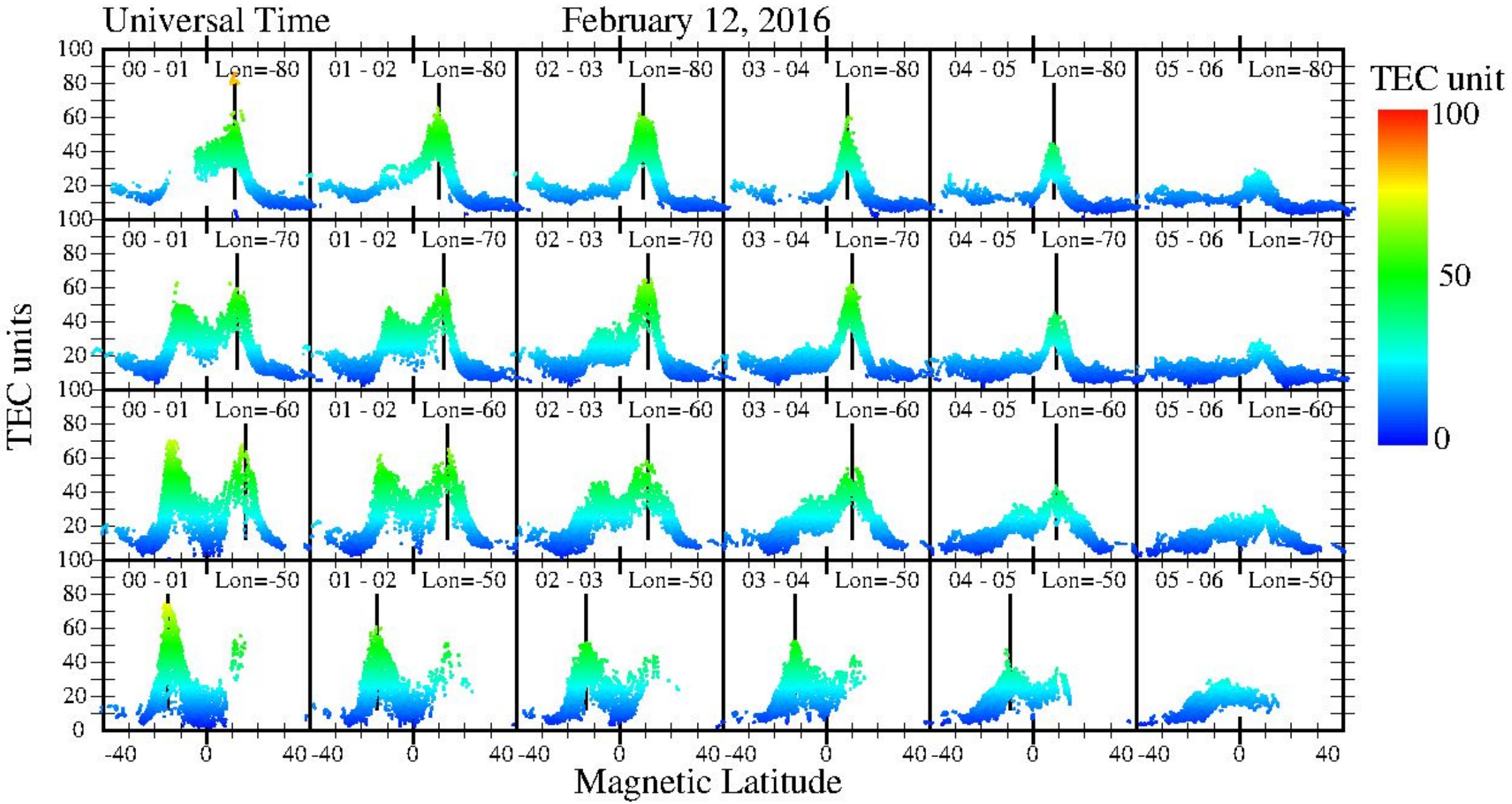
Fejer et al., JGR 2010

Lunar Tide Phase Progression

Differential TEC after subtracting TEC values measured along a magnetic field line that intersects the magnetic equator at 75° W longitude and the TEC monthly average along the same field line (top panel). TEC enhancements associated with the EIA develop ~1 hour later every day between 09 and 15 February 2016. This plot endorses our statement that the lunar tide was enhanced after the minor SSW event of February 2016.

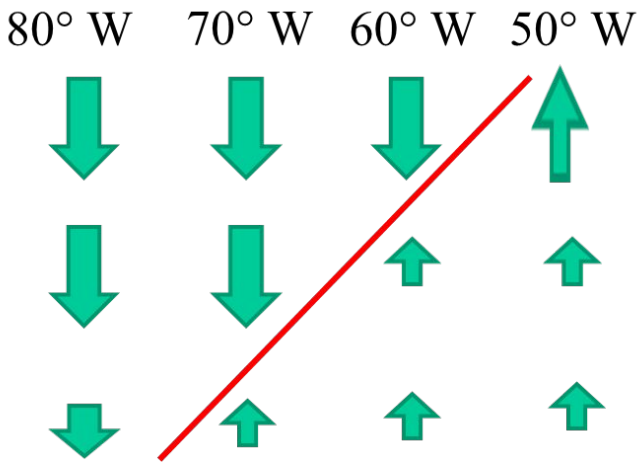


TEC latitudinal profiles for 12 February 2016 for different Longitudes



Conclusions

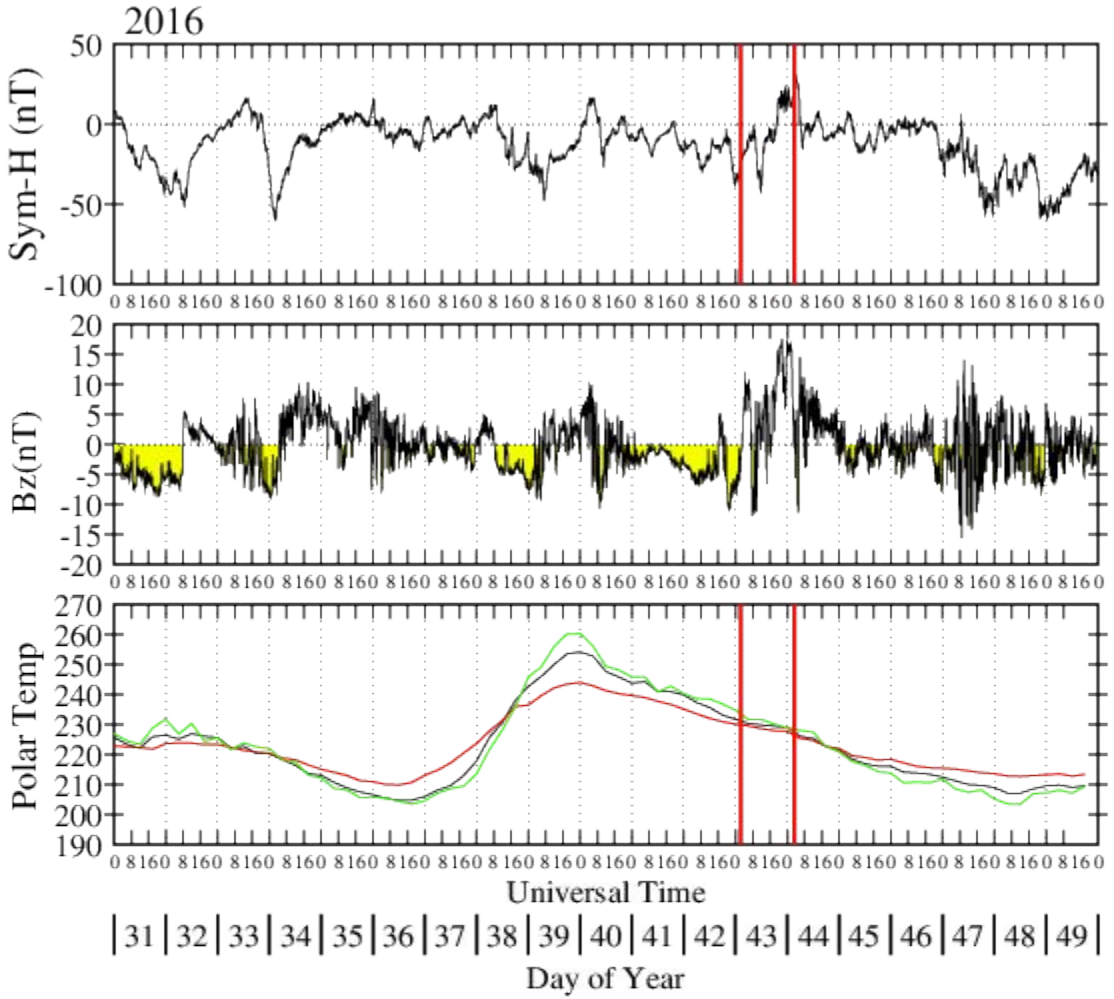
We observed the formation of a loop-like anomaly due to the meridional wind and an intensification of the S4 index two hours after TEC depletions were formed. Although both events (February 12 & 13, 2016) were detected under Kp = 3 conditions, we believe that these events are not related to a prompt penetration electric field or disturbance dynamo effects but instead to an enhancement of the semidiurnal lunar tide propitiated by the onset of the minor SSW event during the winter of 2015-2016.

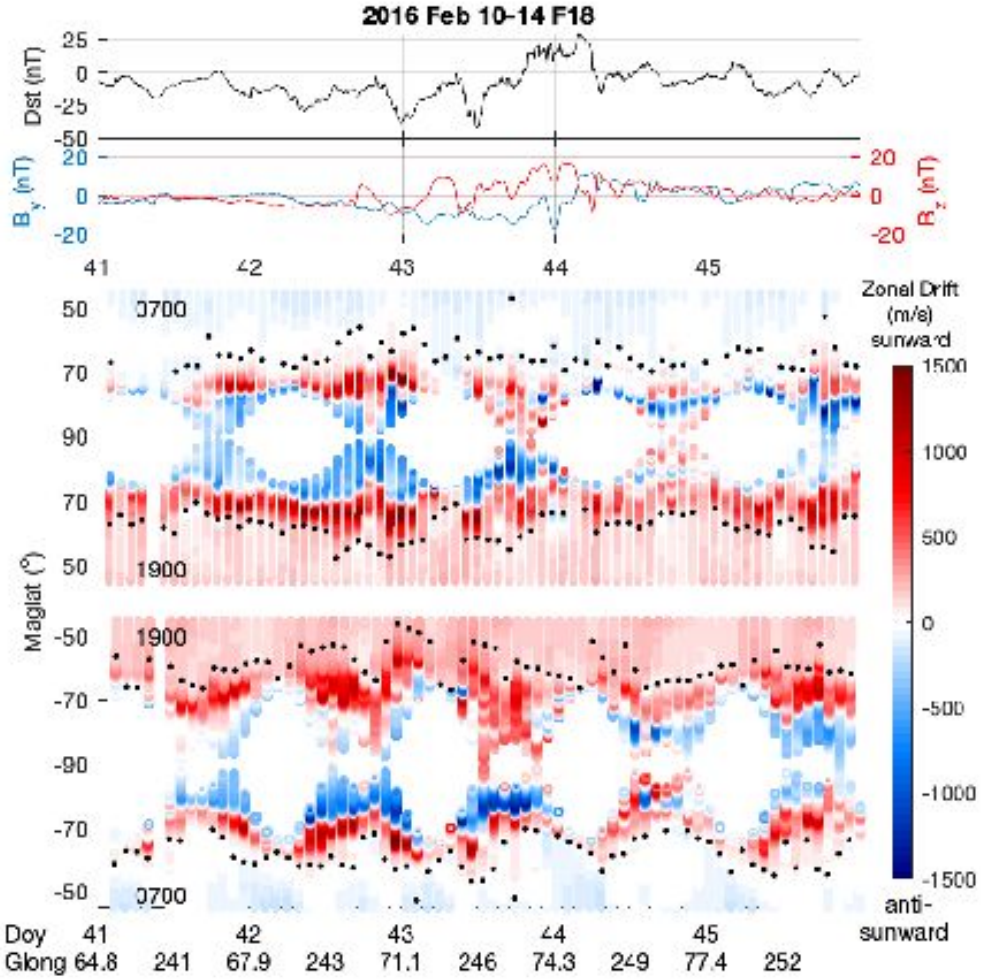


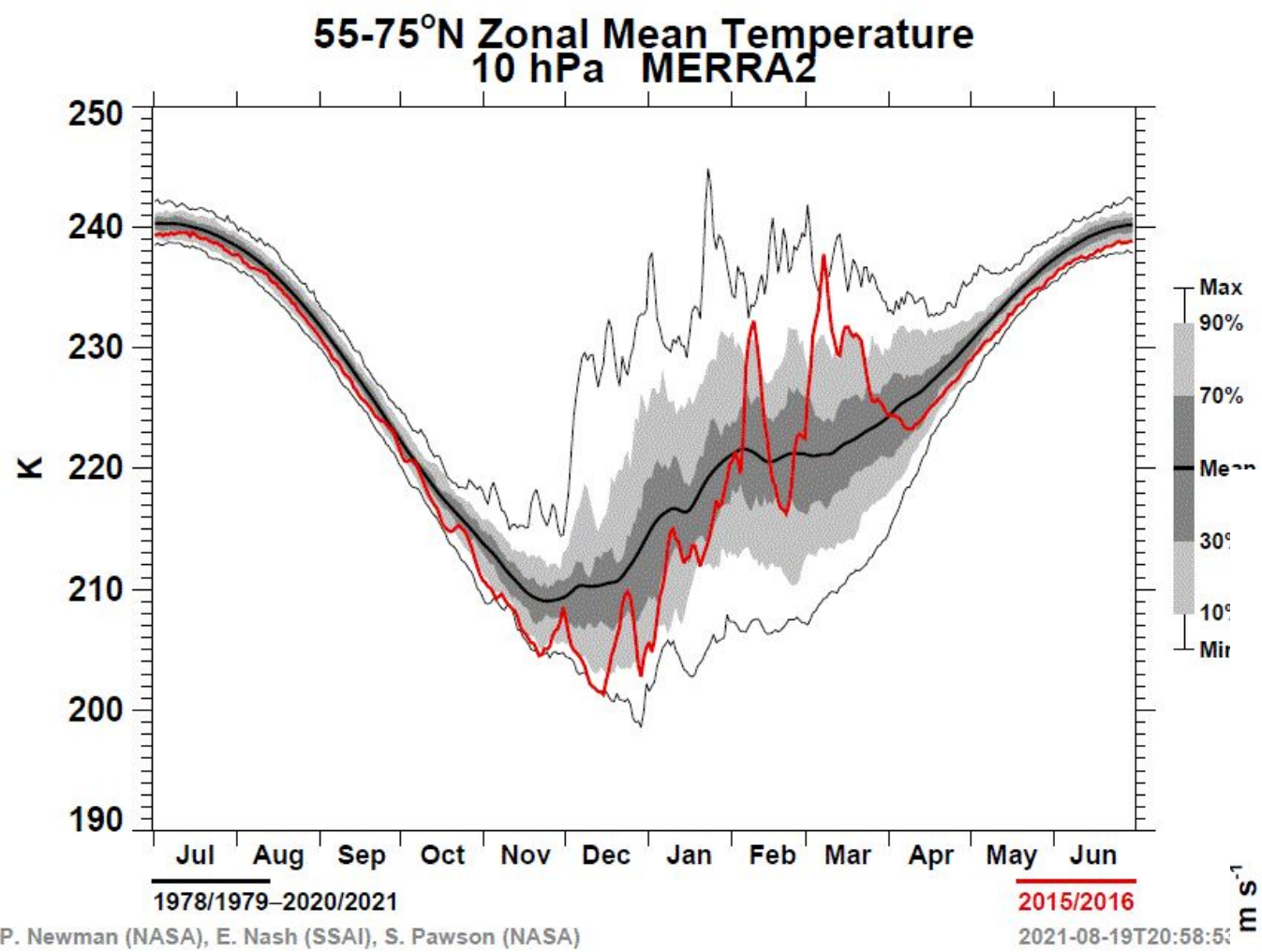
Sketch of the meridional winds on 12 February 2016 near 02 UT.

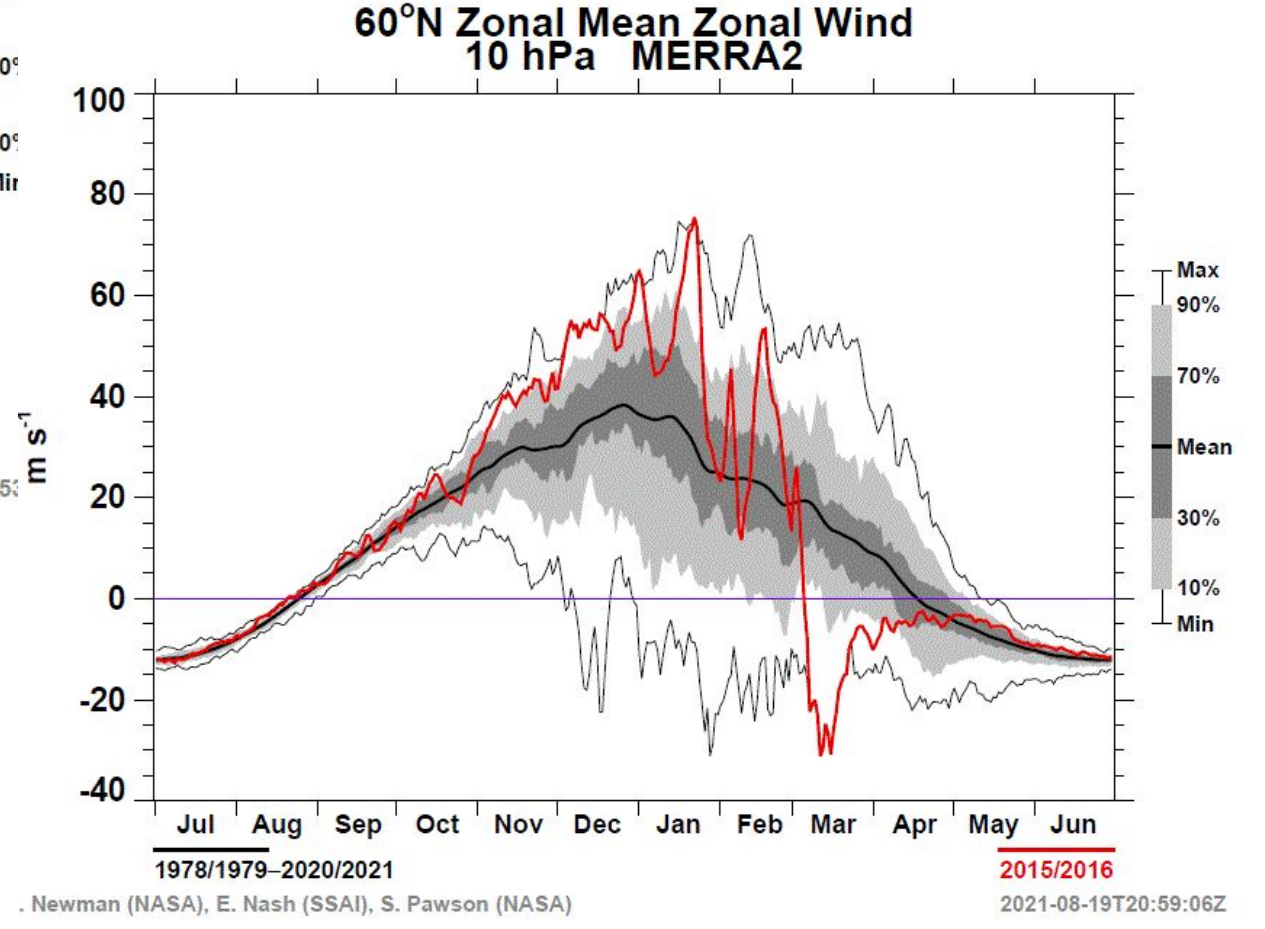
We found that depending on the lunar tide phase cycle, the neutral wind's meridional component can augment sub-km scale irregularities and enhance L-band scintillations (through $U \cdot \nabla n$; $\nabla U \cdot n$) via the wind-driven gradient instability.

What mechanism can produce these effects? Magnetic storms or Sudden Strat warming?



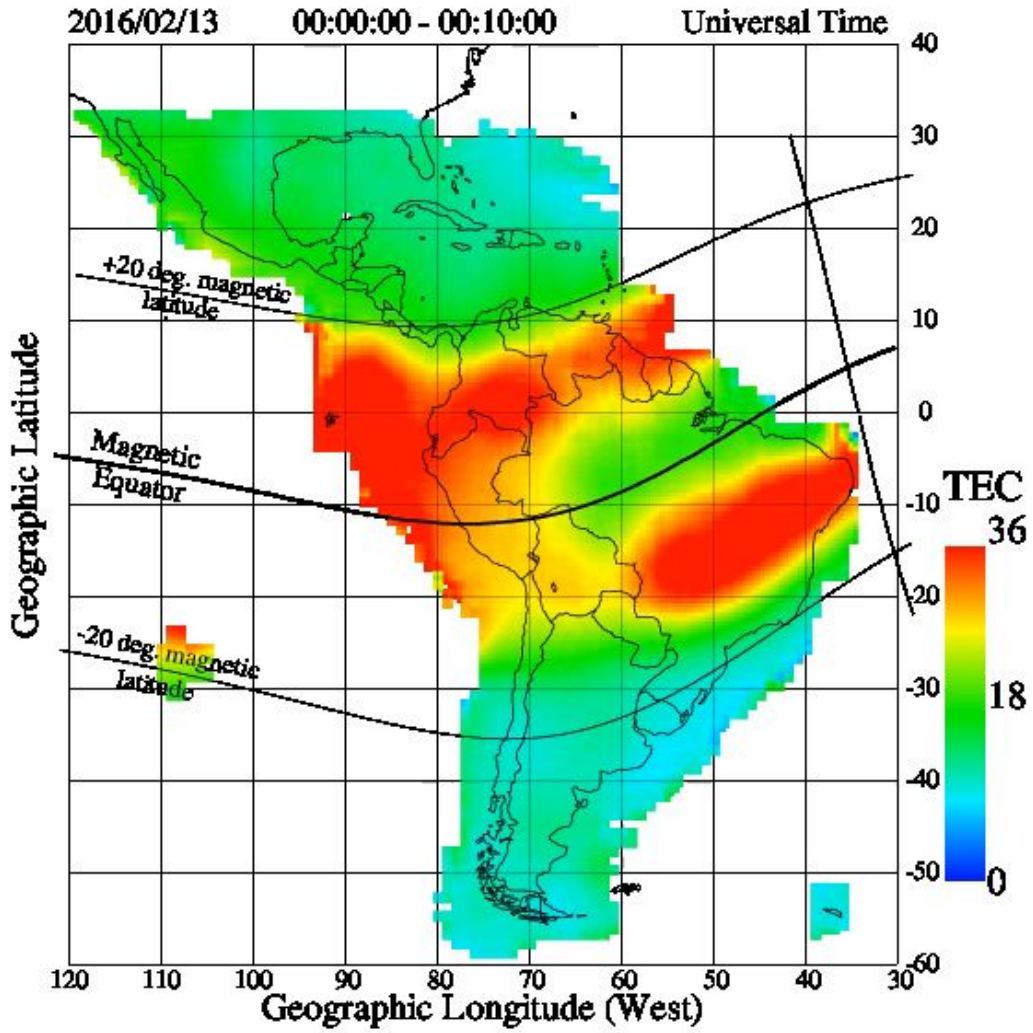



55-75°N Zonal Mean Temperature
10 hPa MERRA2
250
240
230
220
210
200
190
K
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
1978/1979–2020/2021
2015/2016
Max
90%
70%
Mean
30%
10%
Min
P. Newman (NASA), E. Nash (SSAI), S. Pawson (NASA)
2021-08-19T20:58:53

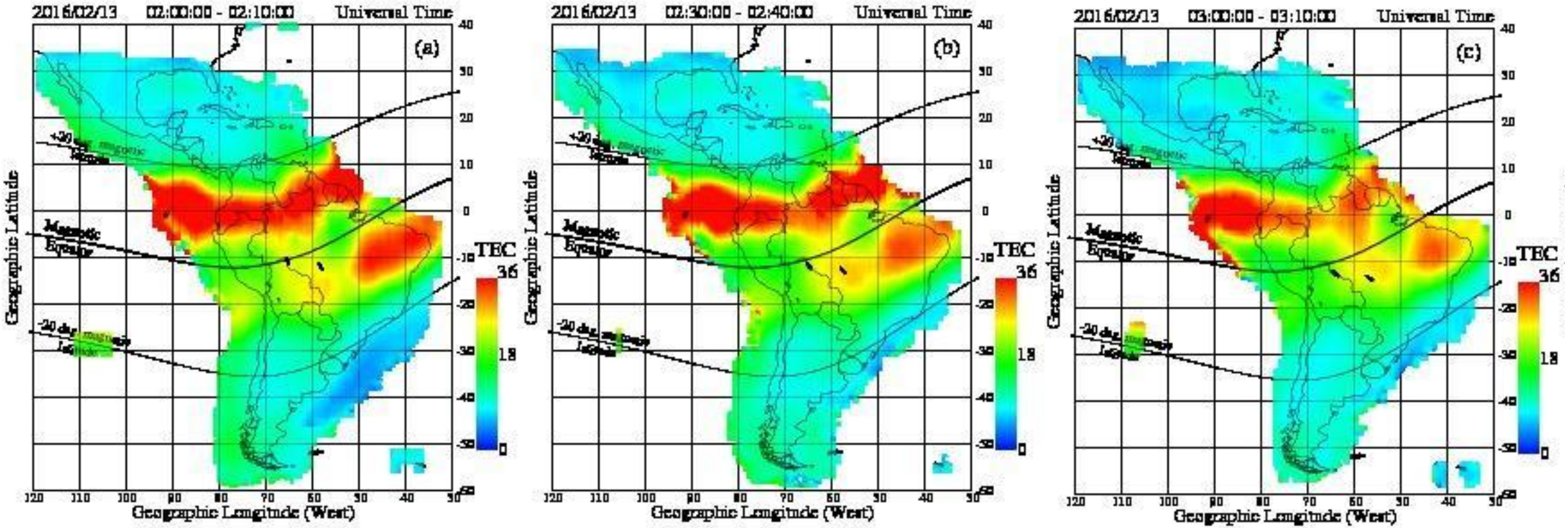

60°N Zonal Mean Zonal Wind
10 hPa MERRA2
100
80
60
40
20
0
-20
-40
m s-1
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
1978/1979–2020/2021
2015/2016
Max
90%
70%
Mean
30%
10%
Min
. Newman (NASA), E. Nash (SSAI), S. Pawson (NASA)
2021-08-19T20:59:06Z

TEC observed on February 13, 2016

Break of a continuous and nearly symmetric equatorial ionization anomaly and the formation of a new cell on 13 February 2016.



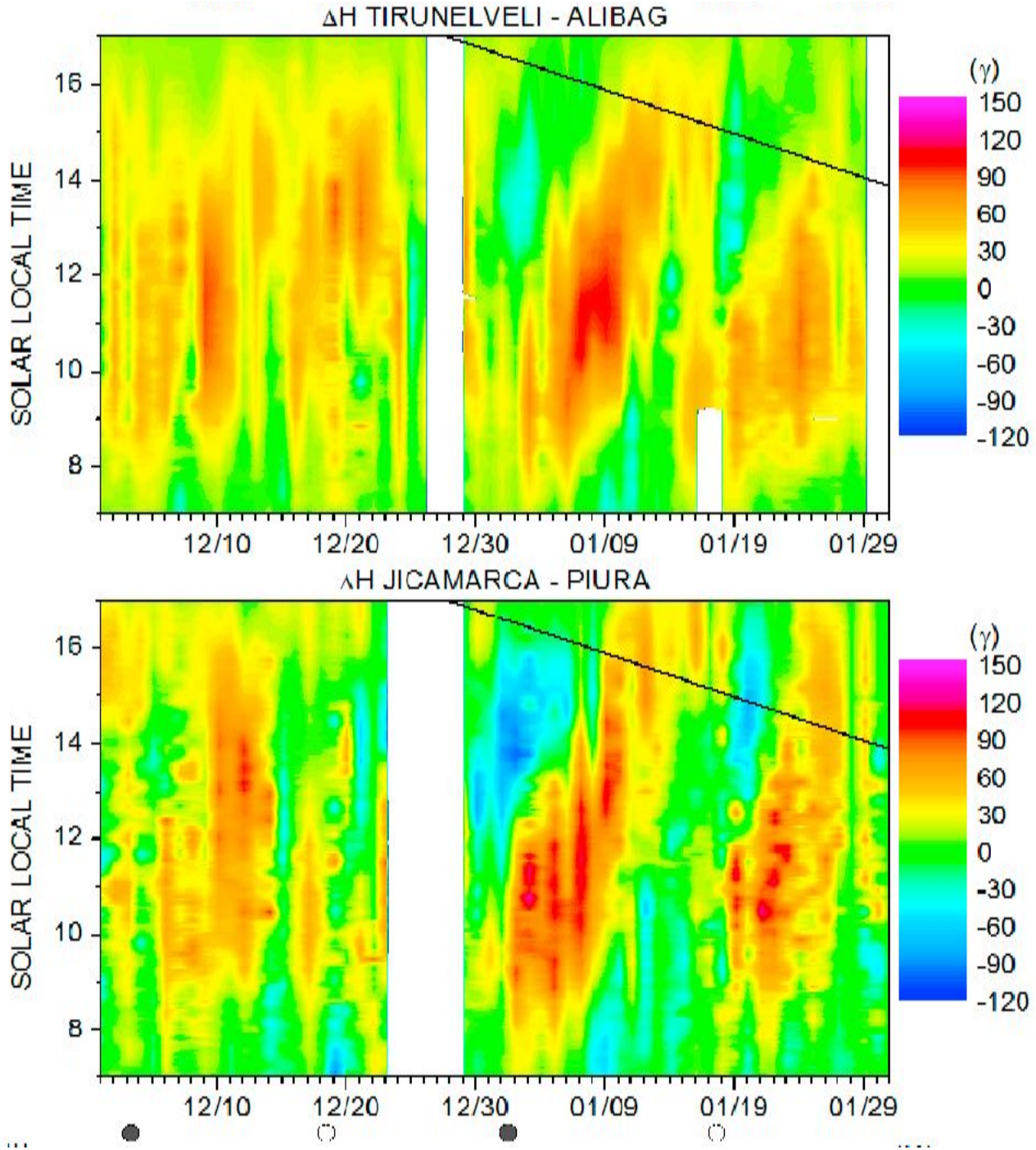
Summary of the Evolution of the EIA during the SSW event (February 13, 2016)



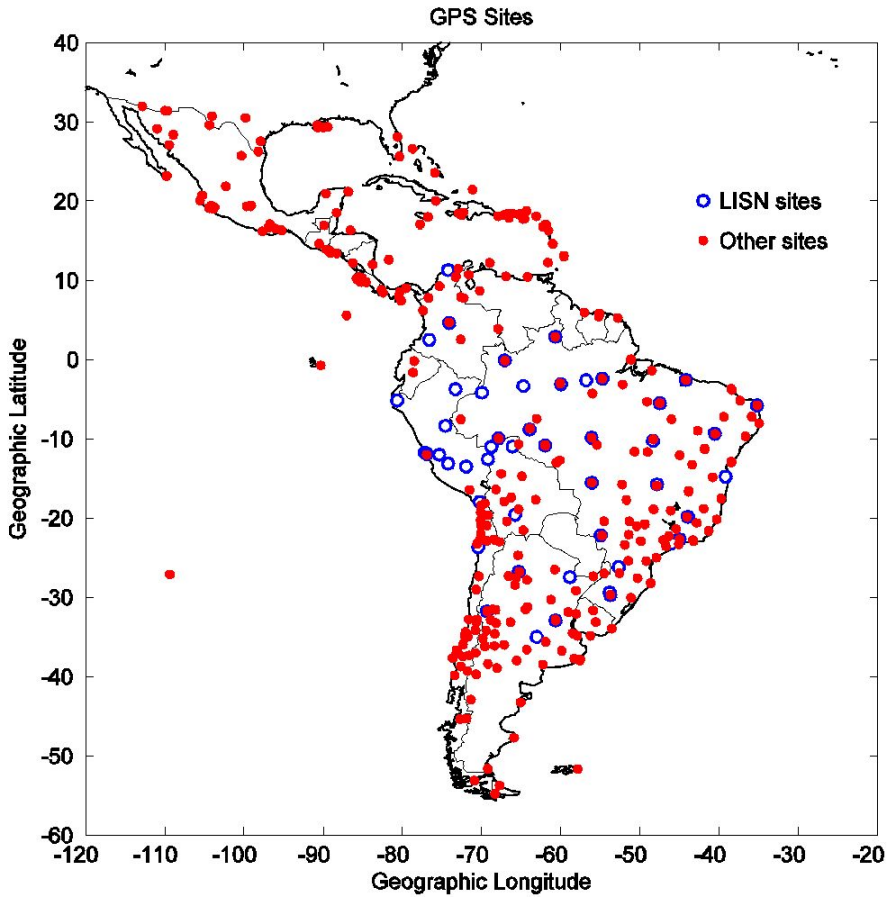
Fejer et al., JGR, 2010

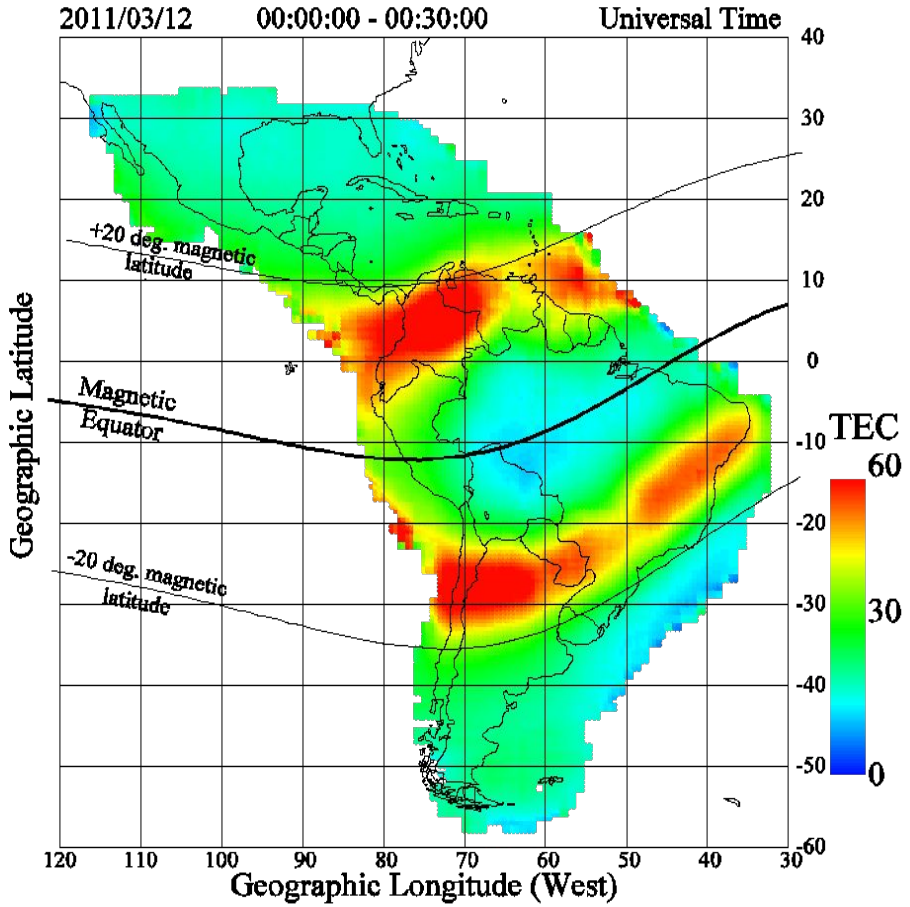
Lunar-dependent equatorial ionospheric electrodynamic effects during sudden stratospheric warmings

doi:10.1029/2010JA015273



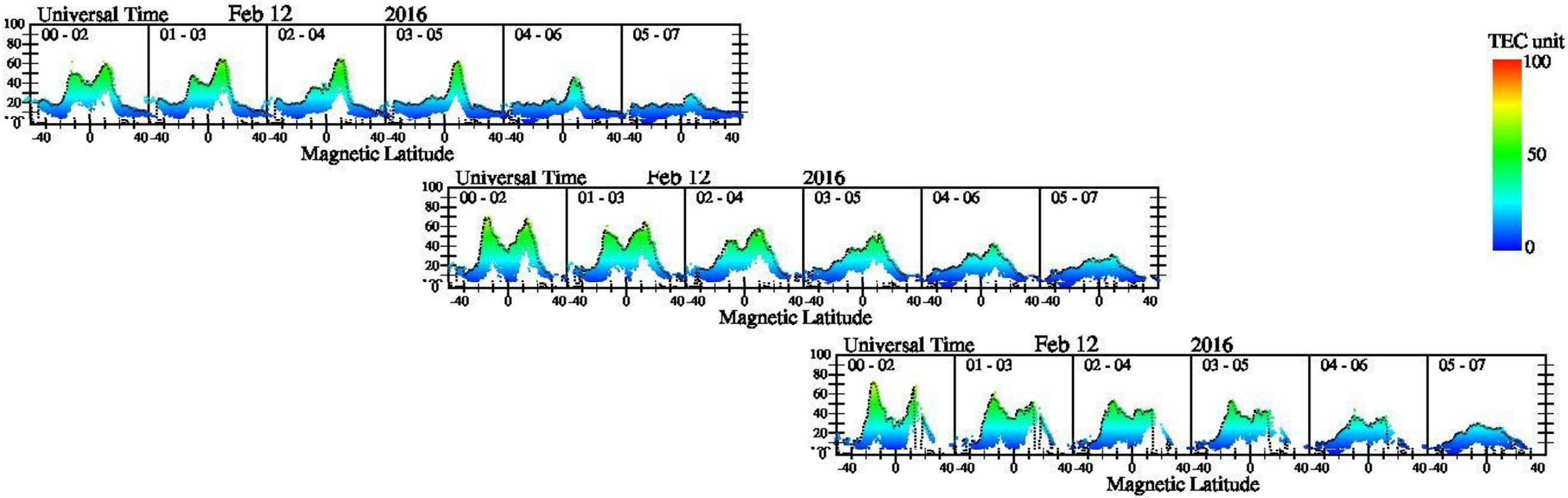
LISN GPS receivers and basic measurements





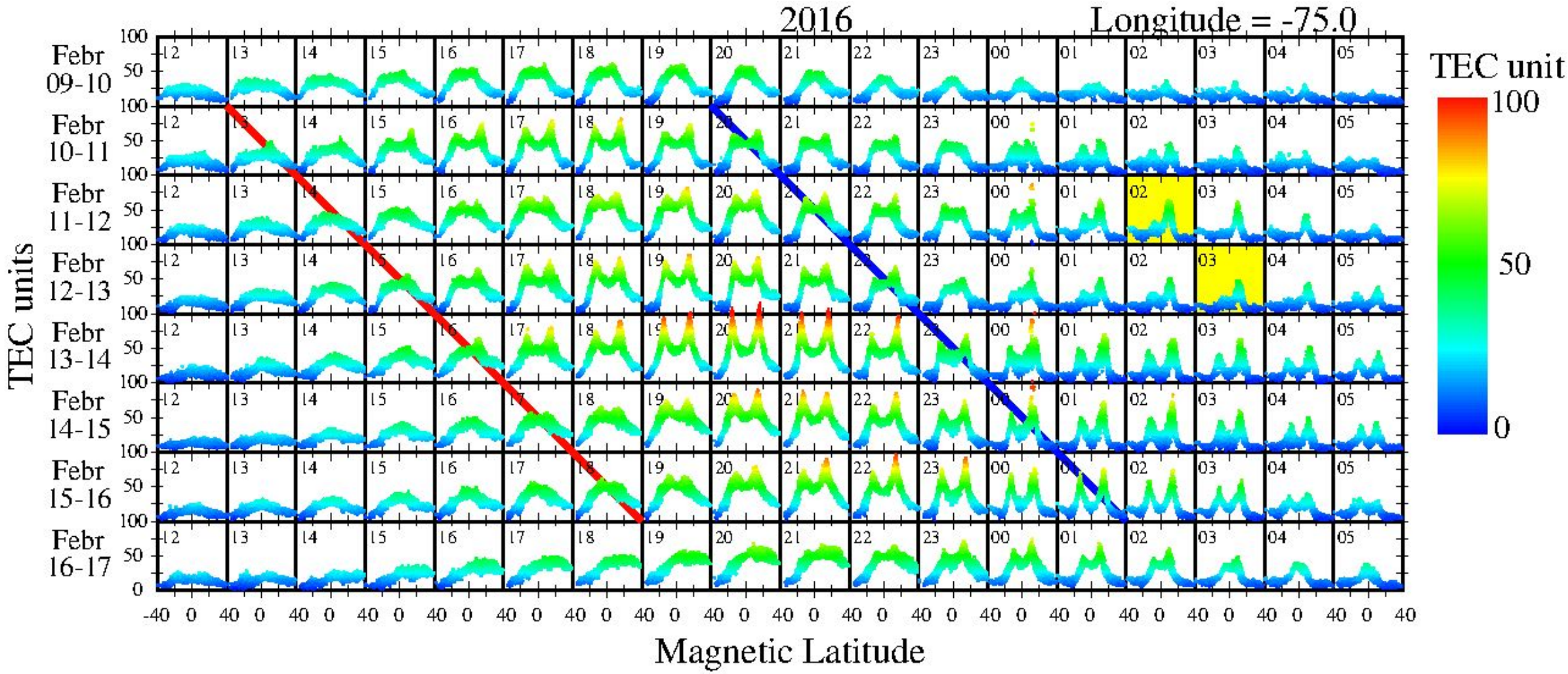
TEC Latitudinal Profiles at three longitude sectors for February 12, 2016

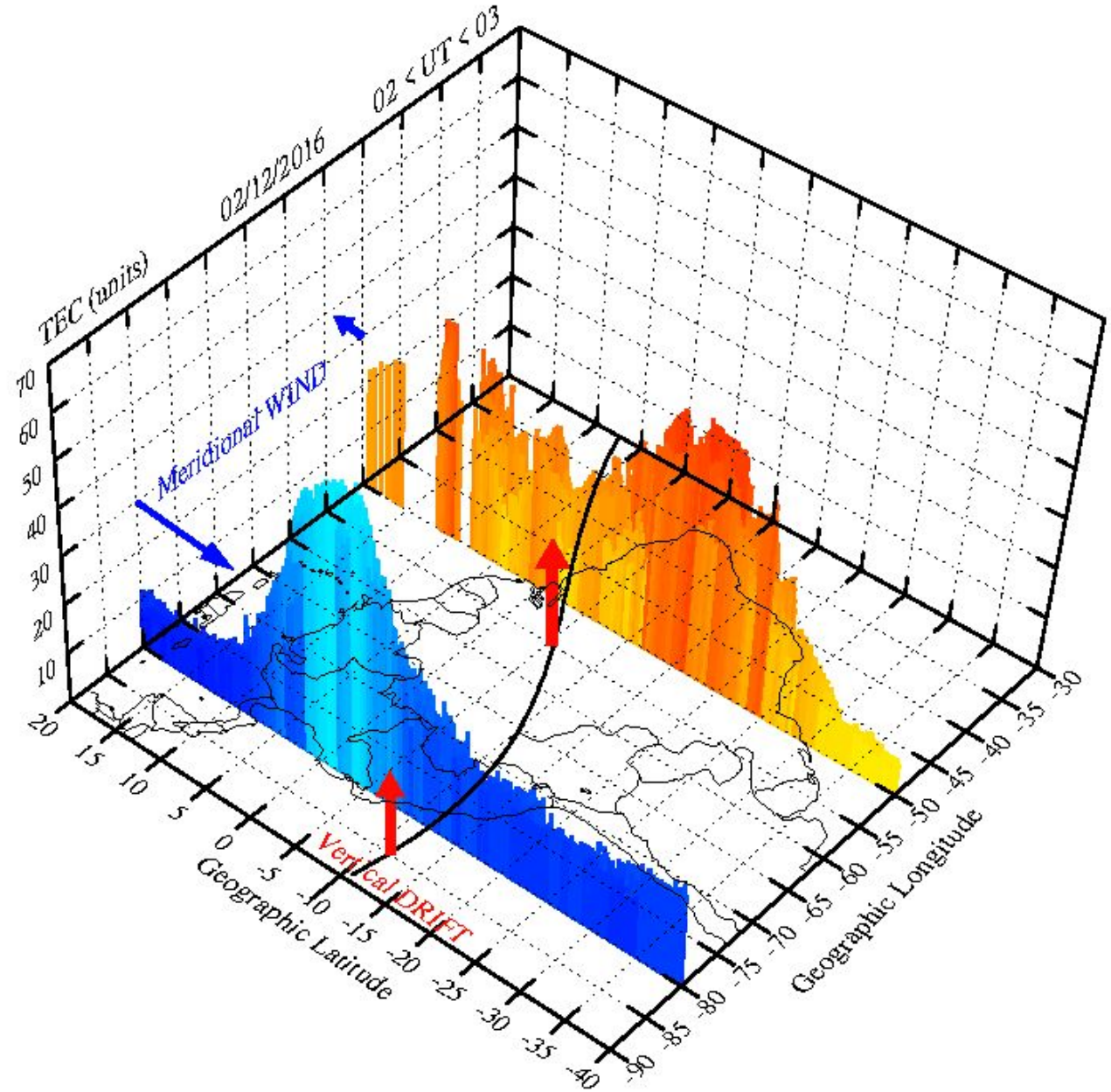
70° W **60° W** **50° W**



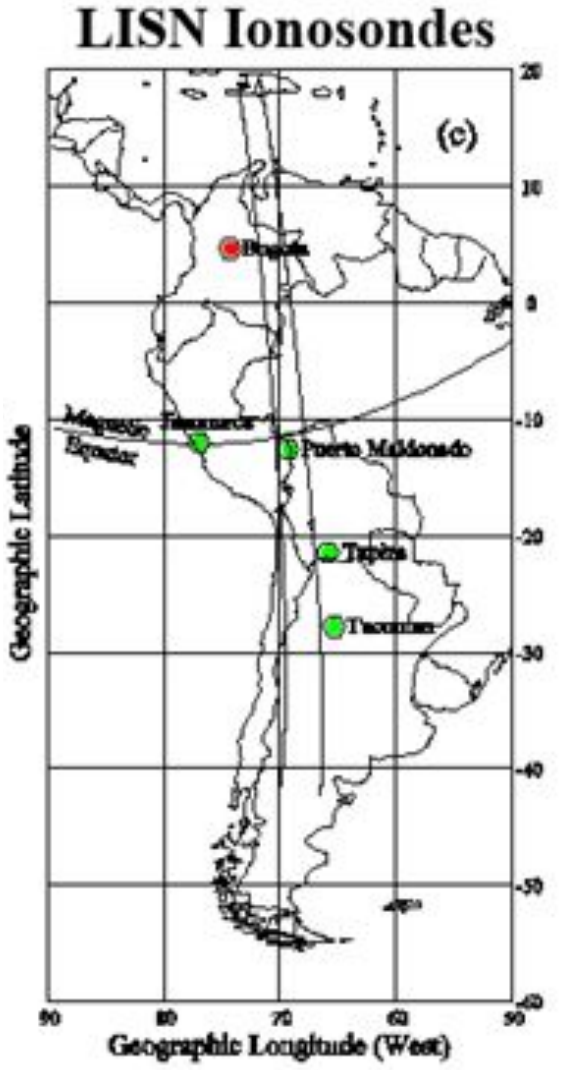
The high value of the northern (southern) crest at 70° (50°) is an indication of a southward (northward) meridional at 06 UT. The result is a shear of the meridional wind.

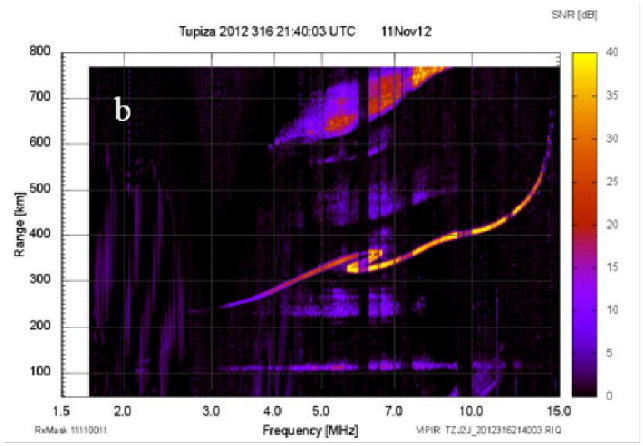
Meridional Wind:

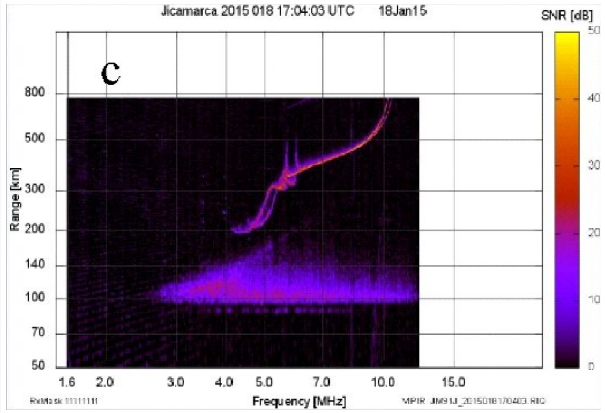

2016
Longitude = -75.0
TEC unit
100
50
0
TEC units
Magnetic Latitude
Febr 09-10
Febr 10-11
Febr 11-12
Febr 12-13
Febr 13-14
Febr 14-15
Febr 15-16
Febr 16-17

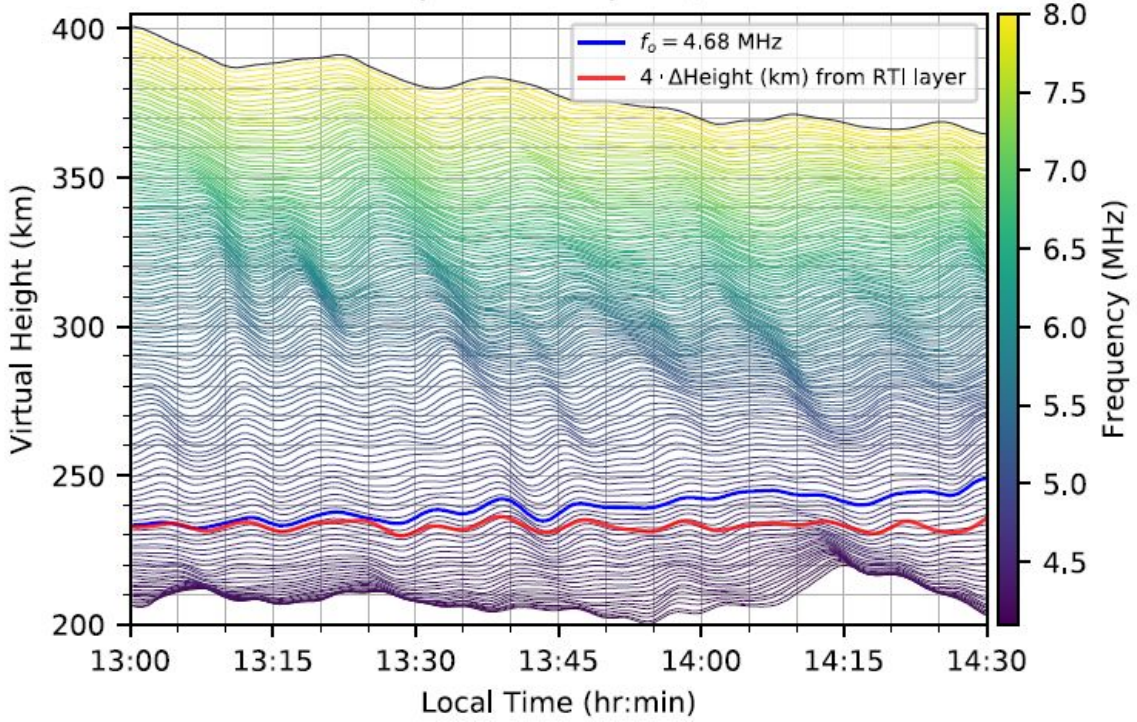

TEC (units)
02/12/2016
02 < UT < 03
Meridional WIND
Vertical DRIFT
Geographic Latitude
Geographic Longitude

Four VIPIR ionosondes and measurements of TIDs



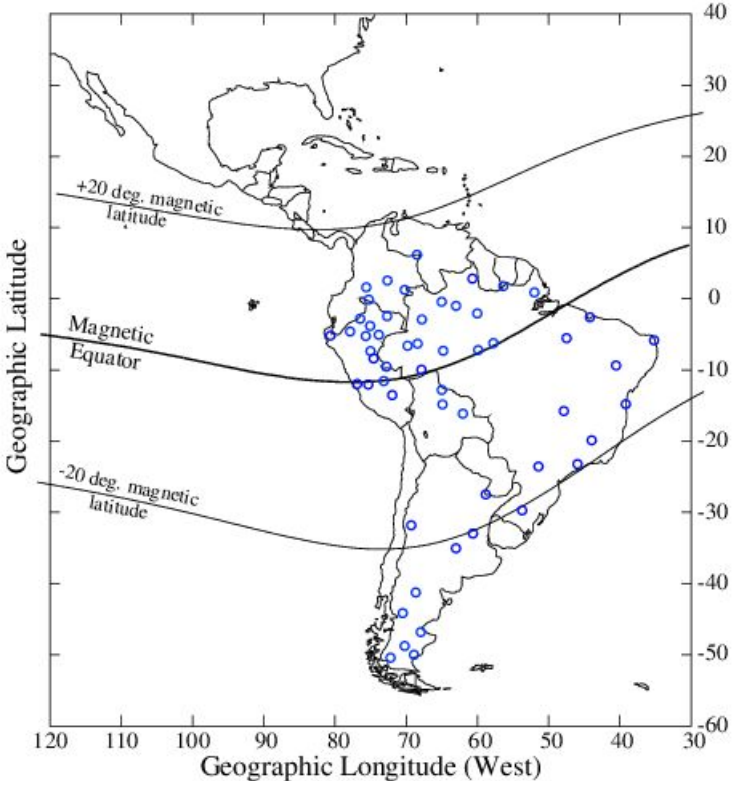






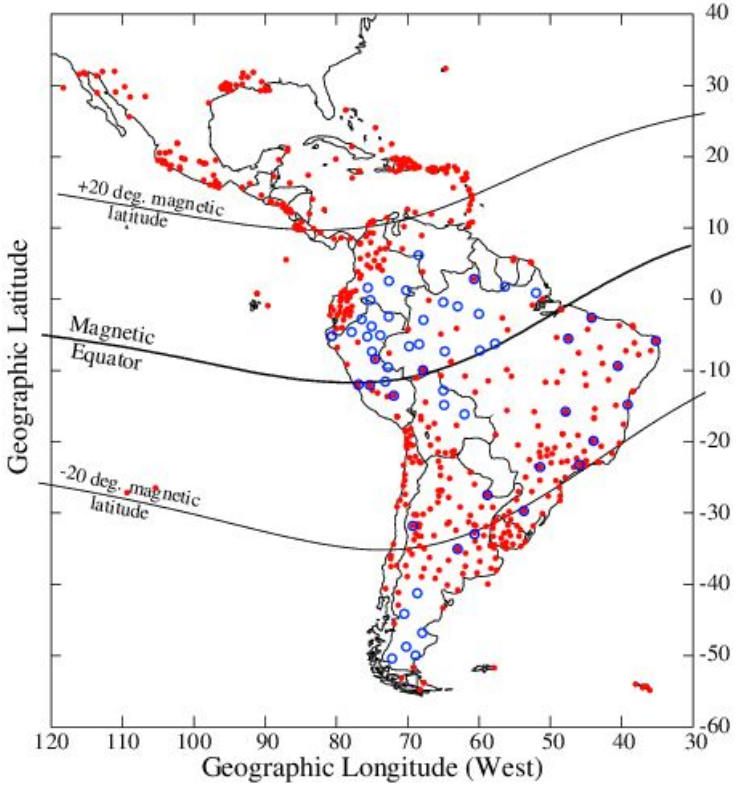
Joint Operations of GPS & GNSS receivers will start in May 2022

GNSS+GPS 2022



Real-time data to be upload every 15 min.

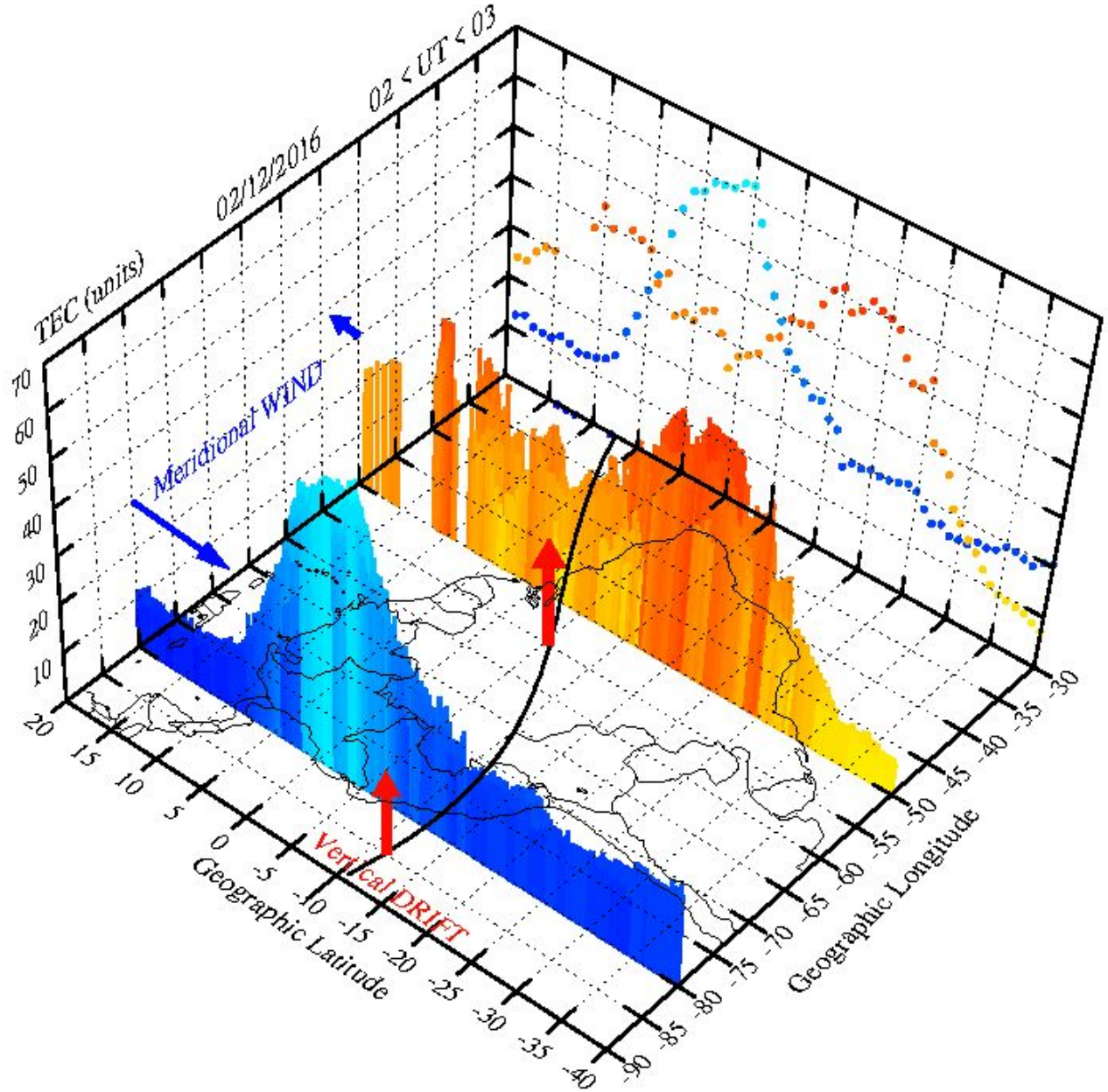
LISN + DURIP + 800 GPS

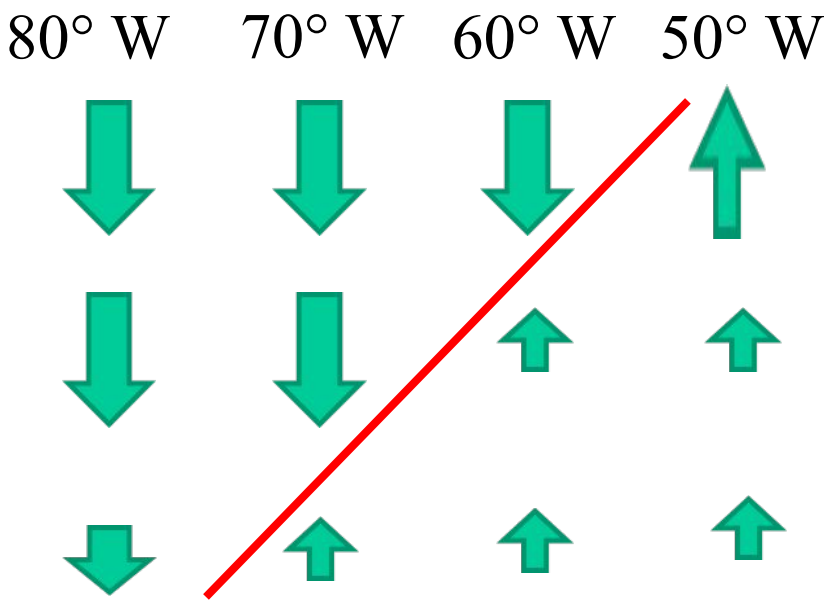


Red dots indicate location of 800+ receivers. Most of them provide data at UT=0.

Networks:

SOPAC https://garner.ucsd.edu
UNAVCO: https://data-out.unavco.org
CDDIS: https://cddis.nasa.gov/archive/
CHILE: gps.csn.uchile.cl
BRAZIL: ftp://geoftp.ibge.gov.br/informacoes_sobre_posicionamento_geodesico/rbmc/dados/
ARGENTINA: 186.33.227.179
LISN: lisn.igp.gob.pe
Other networks at Peru, Ecuador, Bolivia, and Colombia.


TEC (units)
02/12/2016
02 < UT < 03
Meridional WIND
Vertical DRIFT
Geographic Latitude
Geographic Longitude


80° W
70° W
60° W
50° W