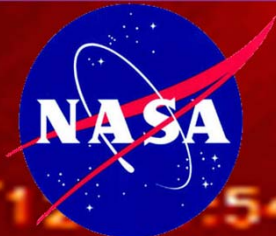


What potential science problem can we address using SAMBA- AMBER-MEASURE Network?

Endawoke Yizengaw

Senior Scientist and PI of AMBER

Institute for Scientific Research, Boston College

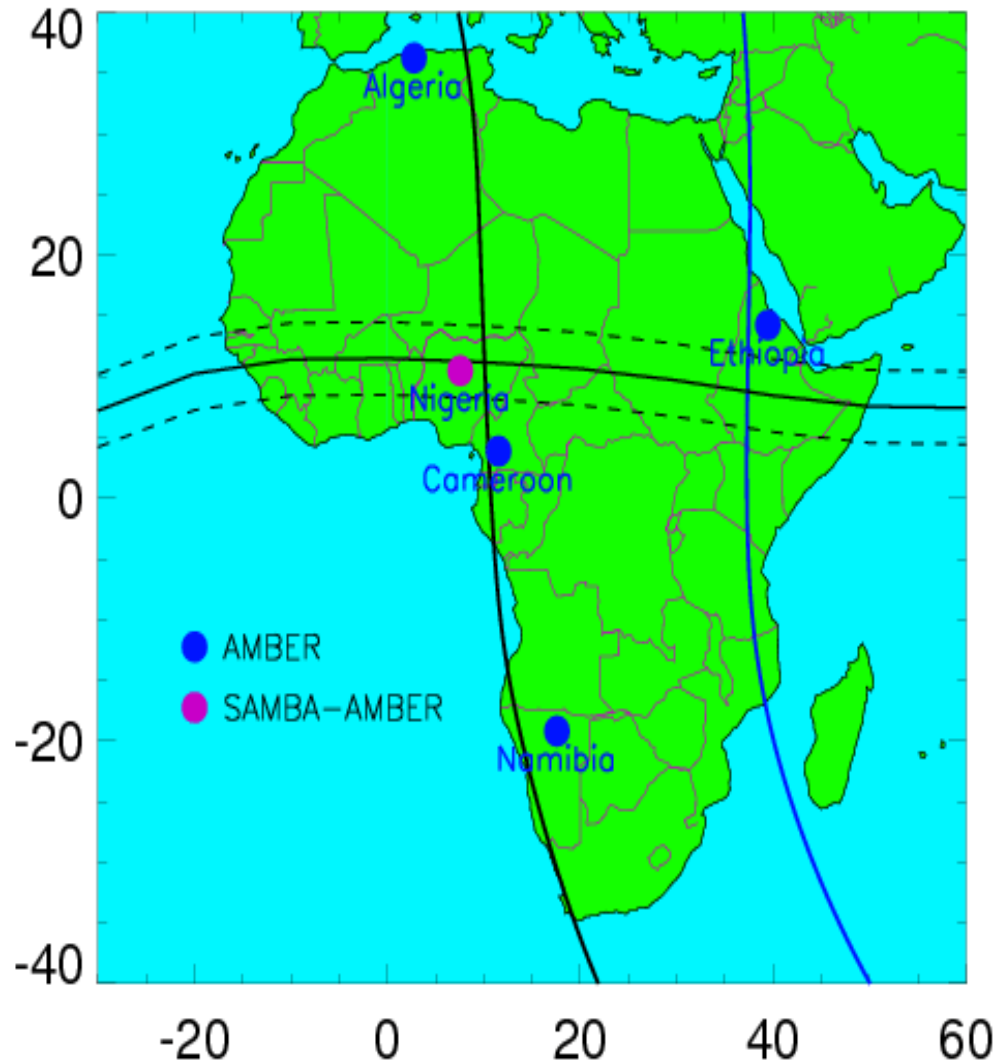


Outline

- Introduction and objective of AMBER network
- How SAMBA instruments we deployed in Chile is important to Chilean?
- Potential Science to be done
- What other instruments can we use to augment magnetometers' data?

Objective of AMBER Project

AMBER (African Meridian B-field Education and Research)

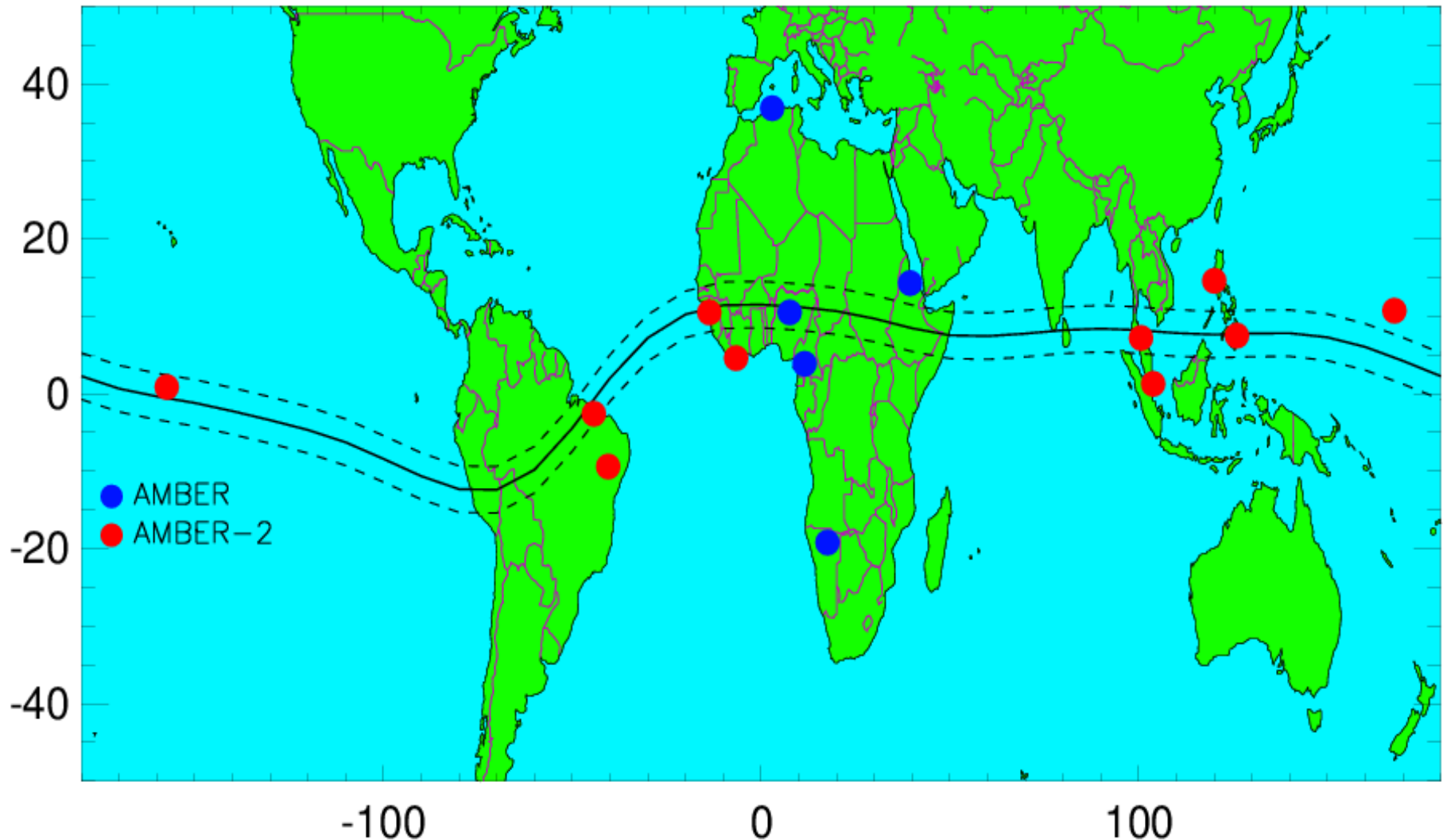


→ the processes governing electrodynamics of the equatorial ionosphere as a function of local time, longitude, magnetic activity, and season, and

→ ULF pulsation strength and its connection with equatorial electrojet strength at low/mid-latitude regions.

Current AMBER Magnetometer Network

Team Members: E. Yizengaw (BC, PI); M. Moldwin (UM); E. Zesta (NASA); M. Magoun (BC); K. Hector (UCLA)



Where to get more information about AMBER and the SAMBA-AMBER database

Detail Information About AMBER

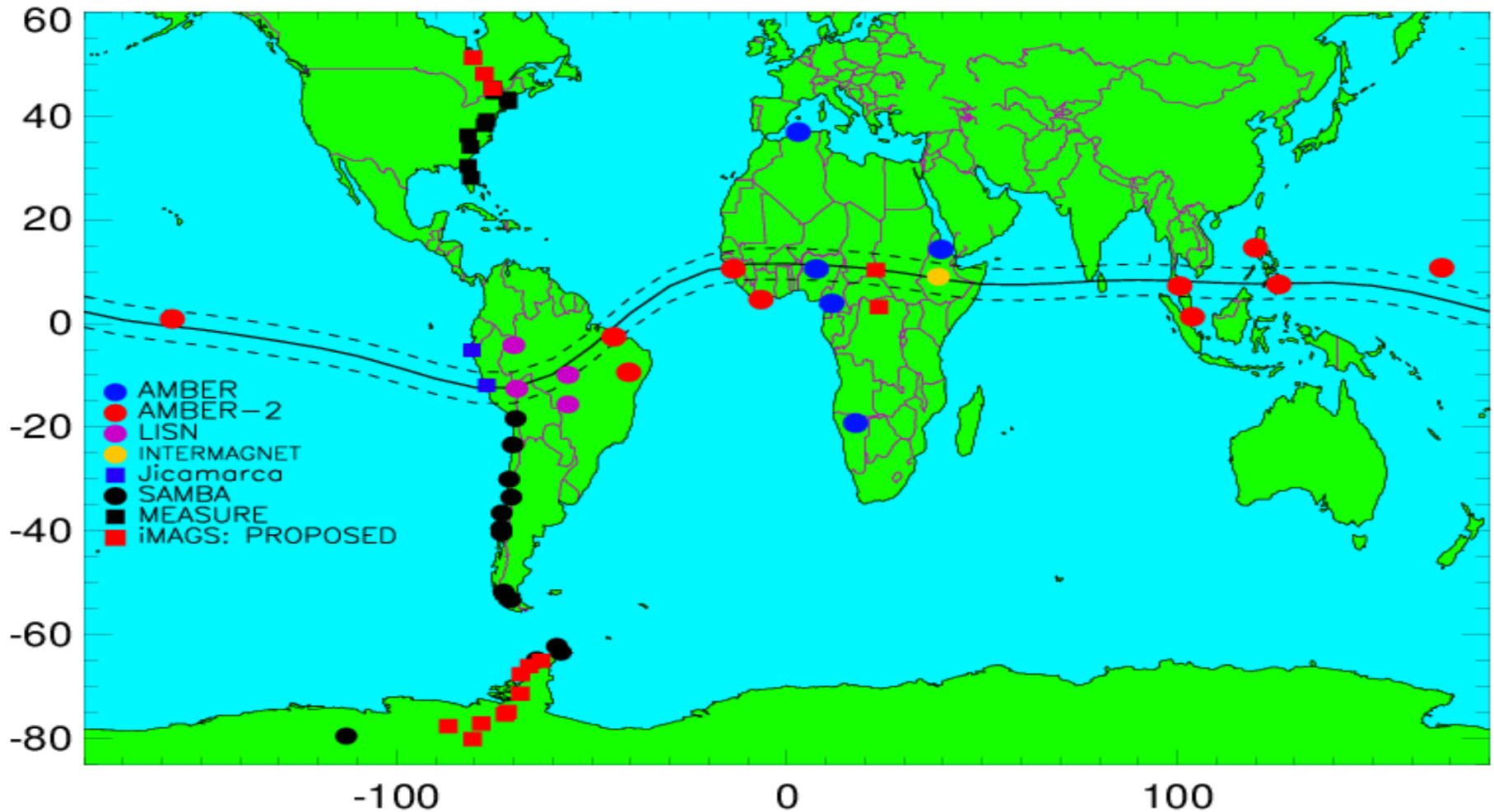
<https://www2.bc.edu/~kassie/AMBER.html>

New AMBER/SAMBA/MEASURE database

<http://magnetometers.bc.edu/>

Why we are here in Chile?

Team Members: M. Moldwin (UM); E. Yizengaw (BC); E. Zesta (NASA); A. Boudouridis (SSI); M. Magoun (BC); K. Hector (UCLA)



How SAMBA instruments we deployed in Chile is important to Chilean?

- First it trains and exposes young Chileans to science & technology**
- It measures space currents induced to the magnetic field which is dangerous to the power lines because Chile has facility/cities at high latitudes**
- It opens opportunities for Chilean scientists to participate in the global space weather research activities**

Potential Science to be done!

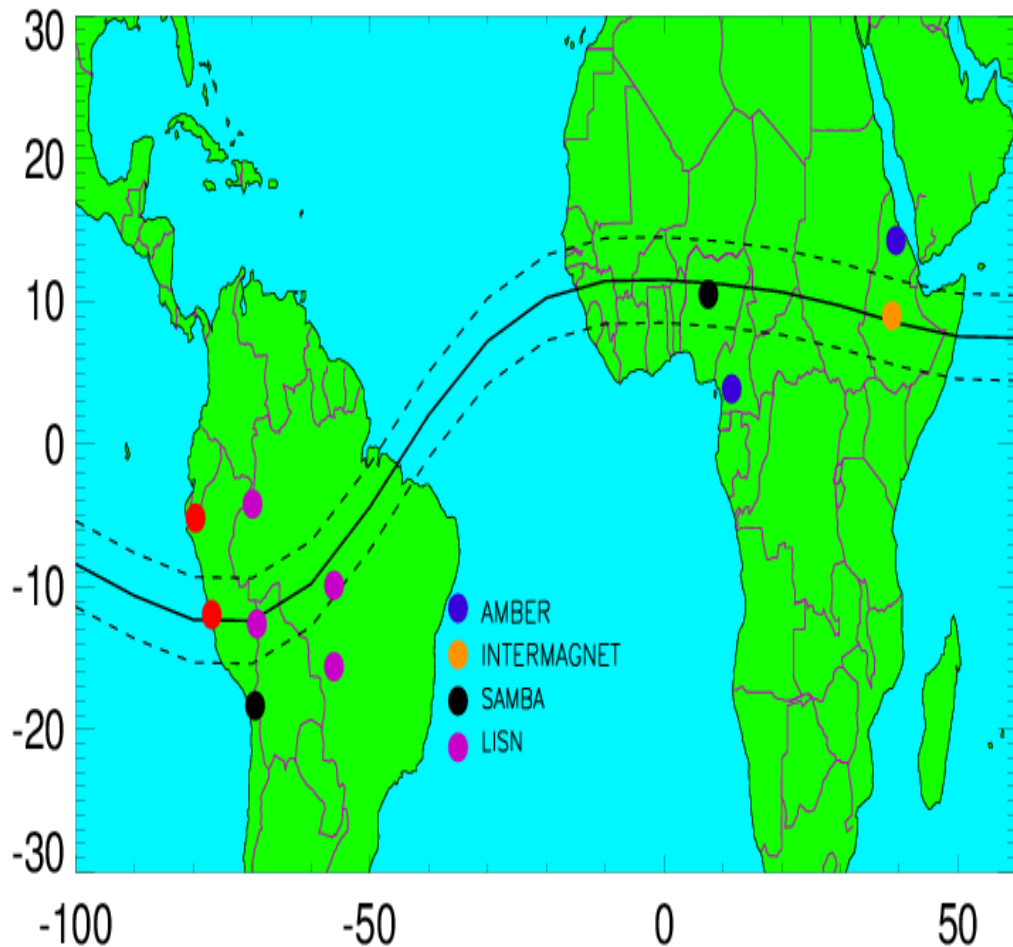
- **What is the longitudinal variability of the equatorial vertical drift?**
- **What is the impact of ULF wave penetration to lower latitudes? Is it related to scintillation activities?**
- **Remotely monitoring the plasmasphere boundary layer location. Key input for radiation belt acceleration.**
- **Is the magnetospheric plasma mass density and ionospheric electron density enhancements/depletion correlated? FLR studies?**
- **Why the ULF power and TEC have hemispheric asymmetries?**
- **How strong the GIC current in Chile and what can we do about it?**



**What is the longitudinal
variability of the
equatorial vertical drift?**

2009/09/12 11:54

Electrodynamics Variability



→ **Disturbances due to geomagnetic impact**

On H-components at the equator and off the equator

→ **Disturbances due to EEJ**

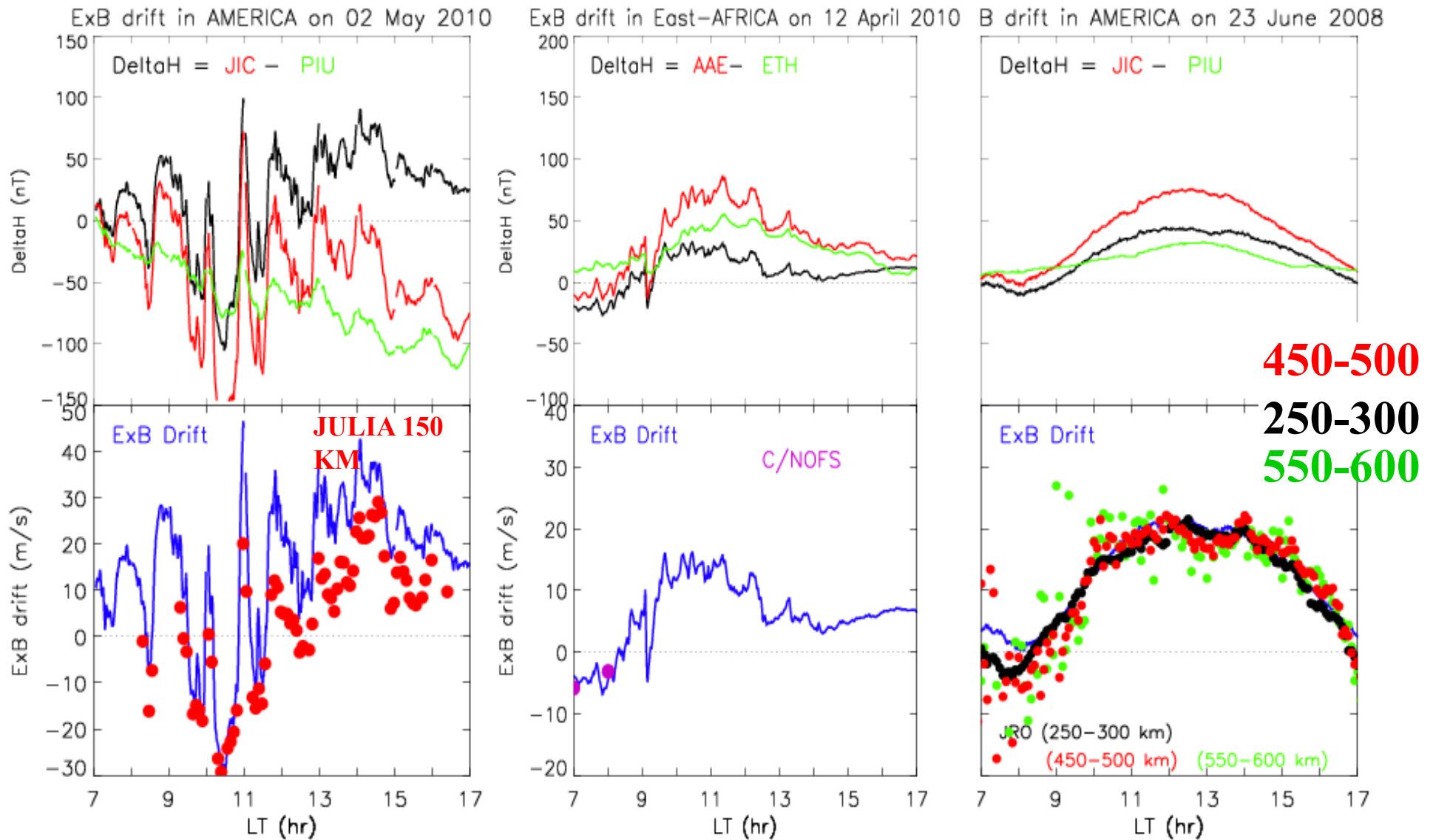
Only on H-component at the equator

Comparison with other observations

with **JULIA**

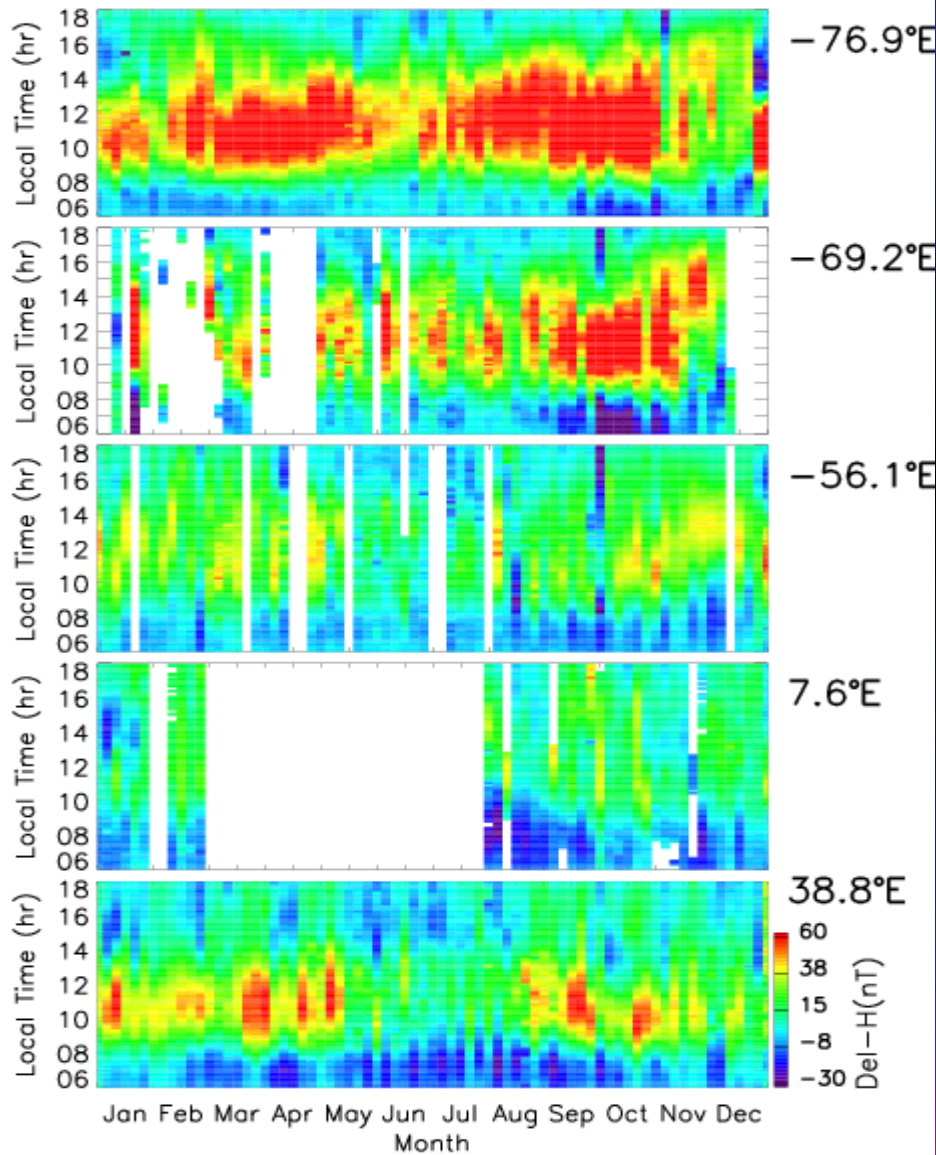
C/NOFS - Africa

ISR - America

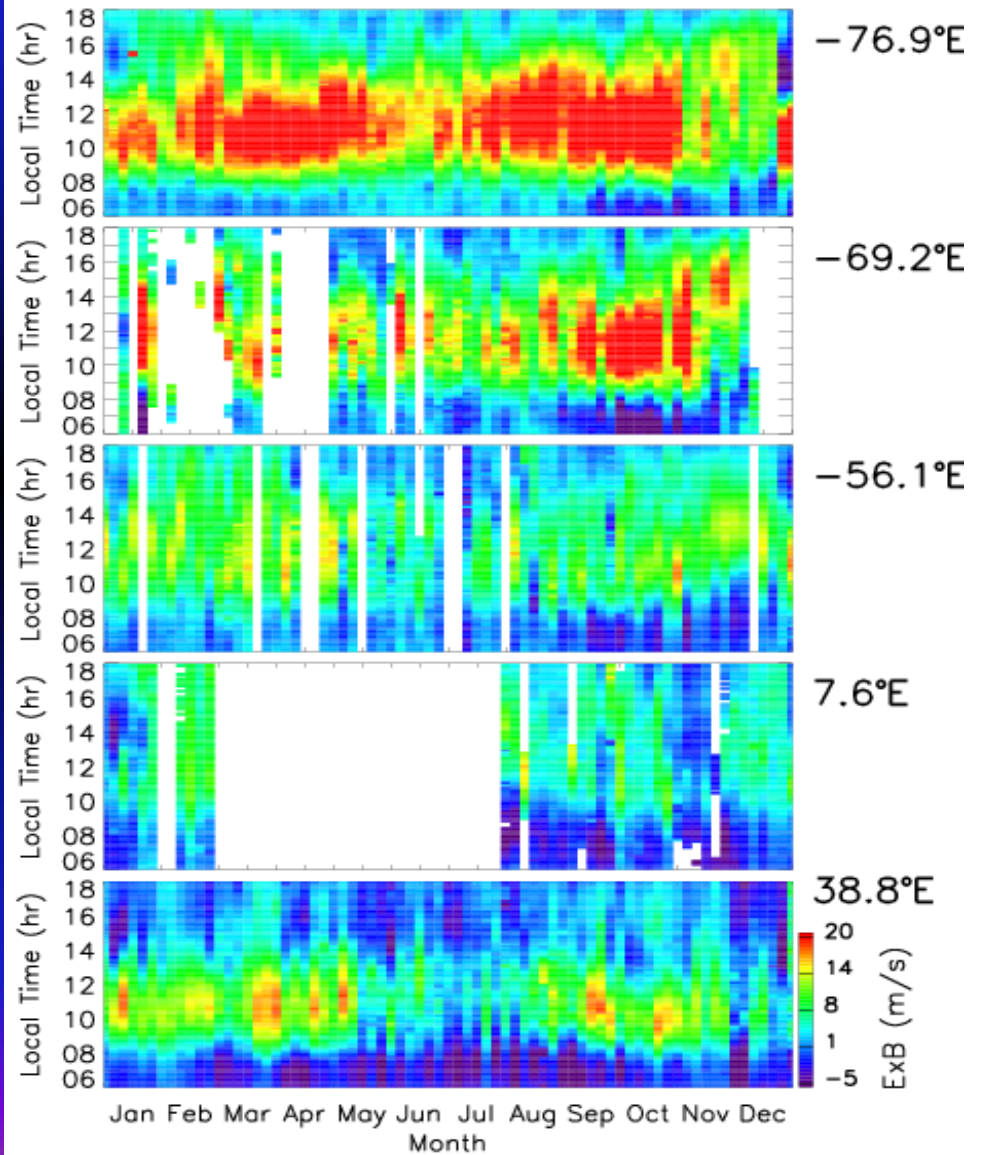


Longitudinal EEJ Variations

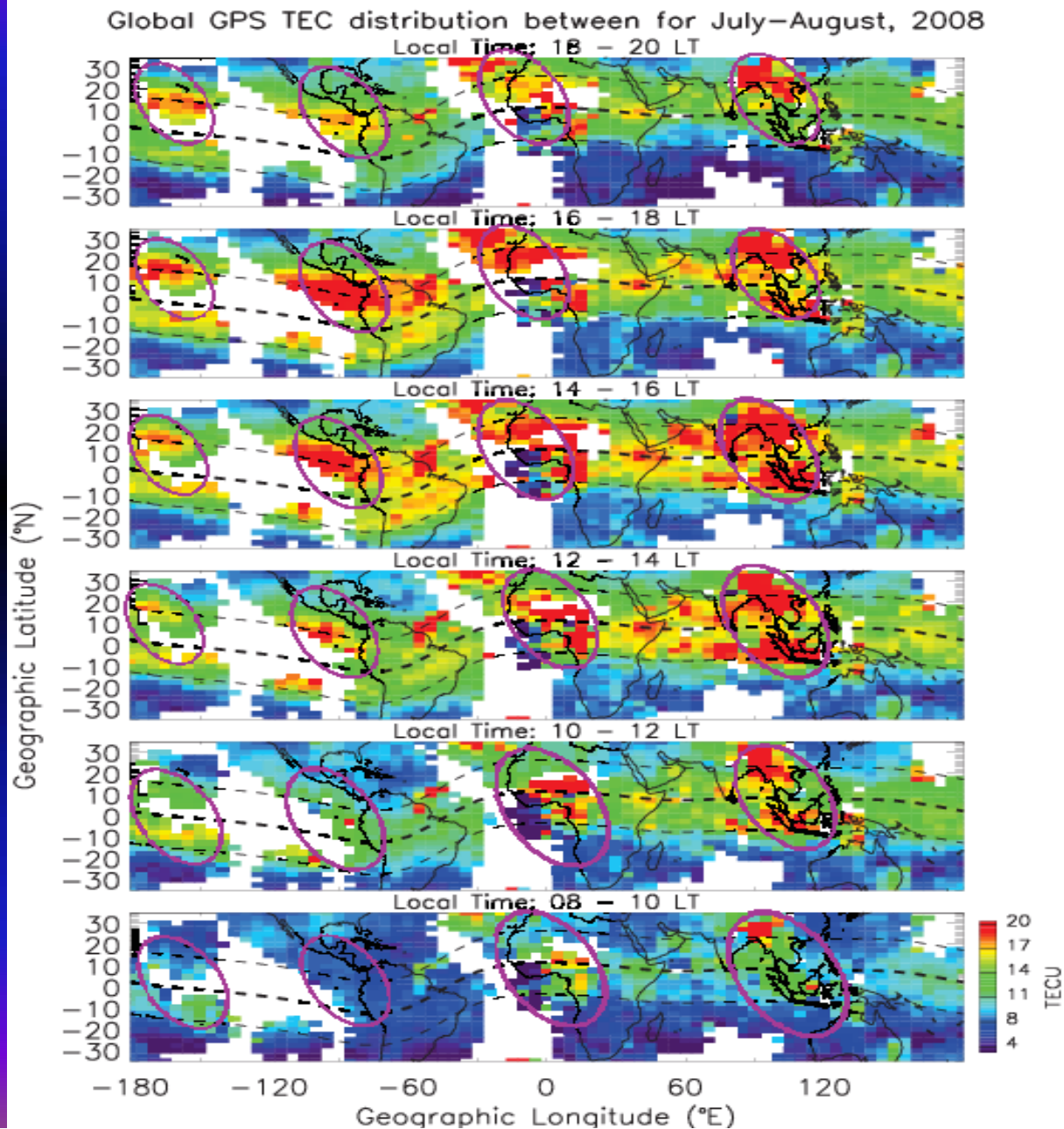
Longitudinal and Seasonal EEJ difference
for 2010 - 2013



Longitudinal and Seasonal ExB drift difference
for 2010 - 2013

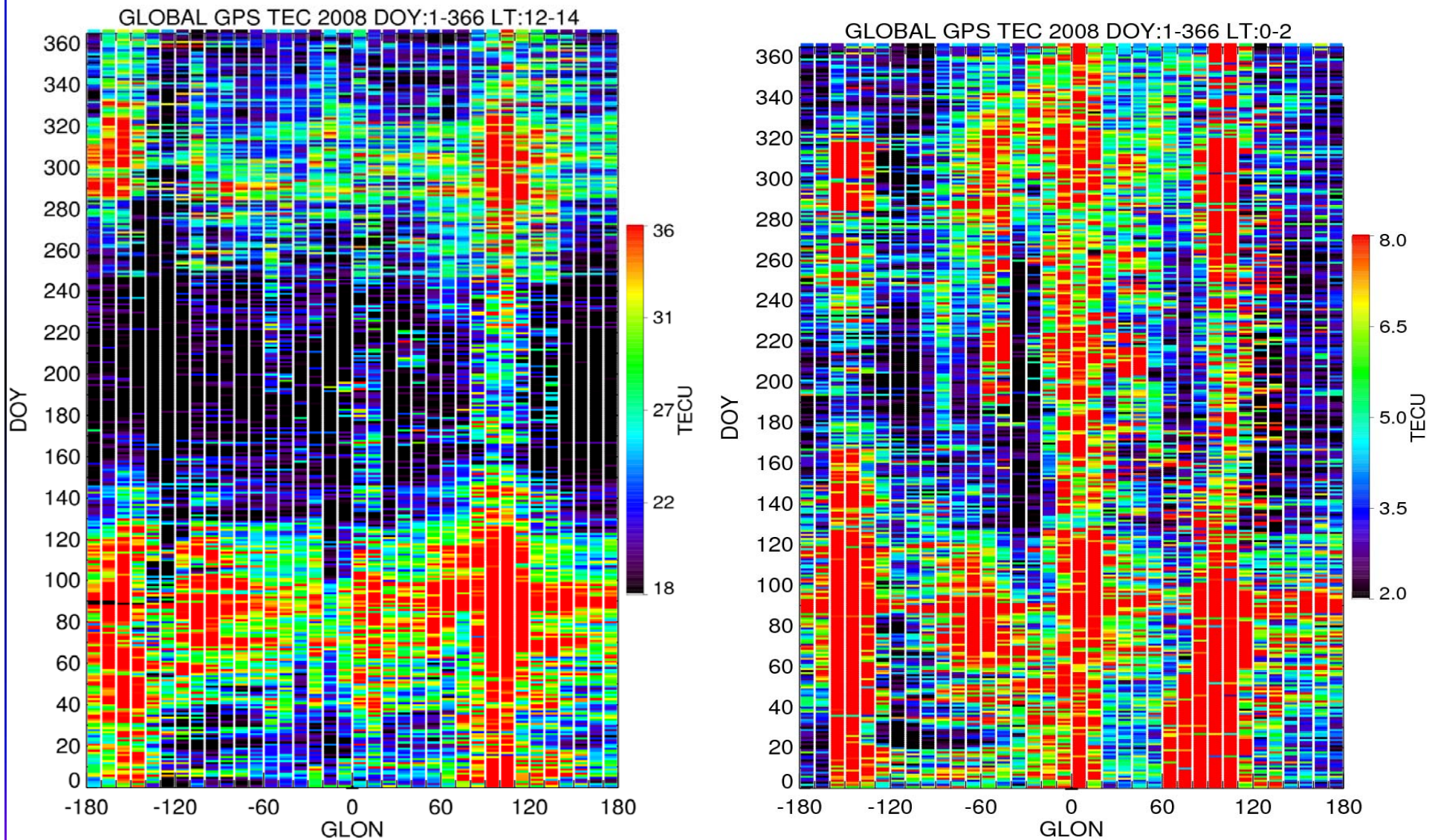


Global TEC map for July-August 2009



Yizengaw, IJG, 2012

Day-to-day wave number-4 structure at different local time

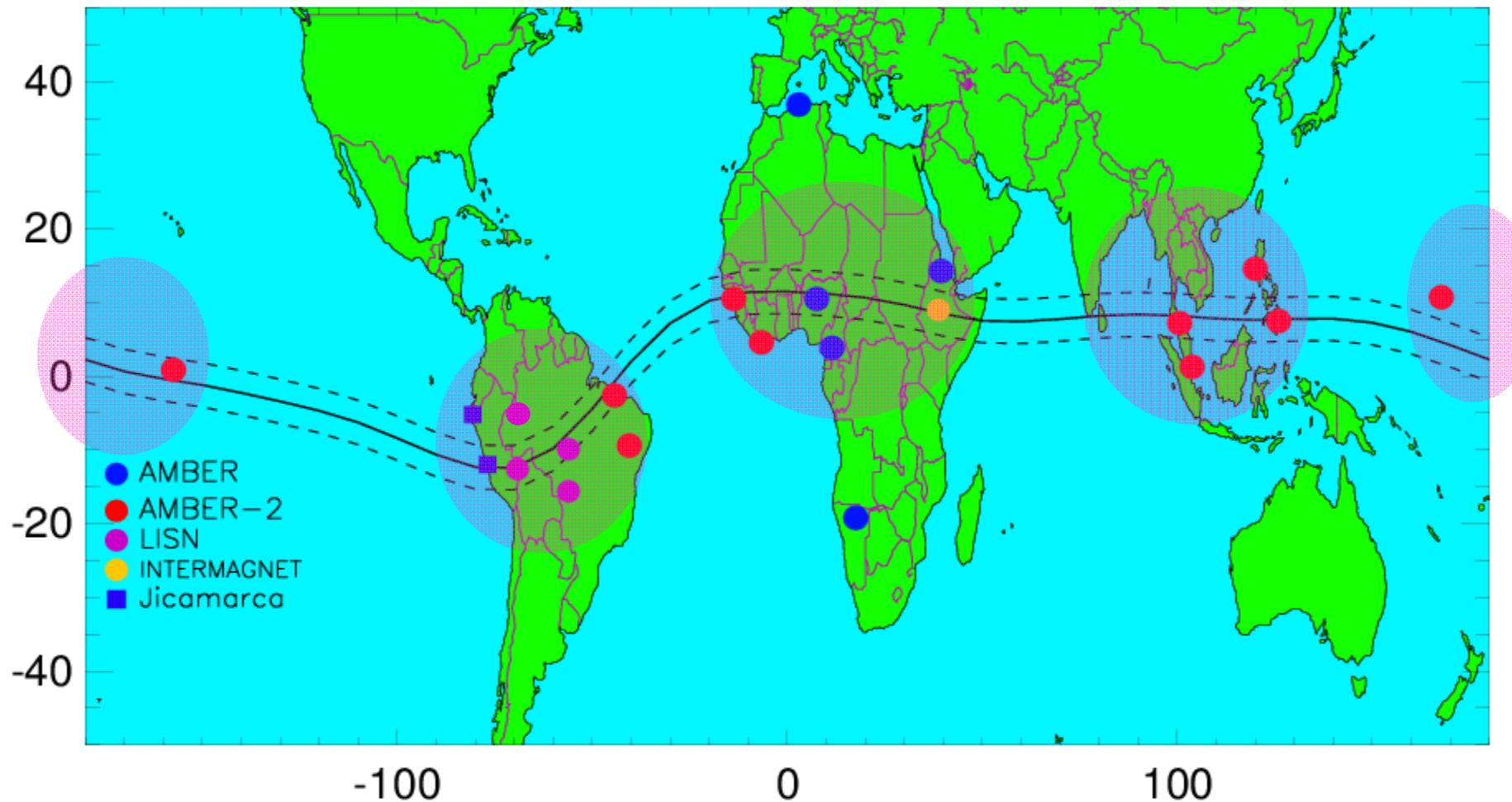


Yizengaw and Pacheco, JGR, 2013

AMBER and other magnetometer networks

→ AMBER PI: **Endawoke Yizengaw**

→ LISN PI: **Cesar Valladeres**





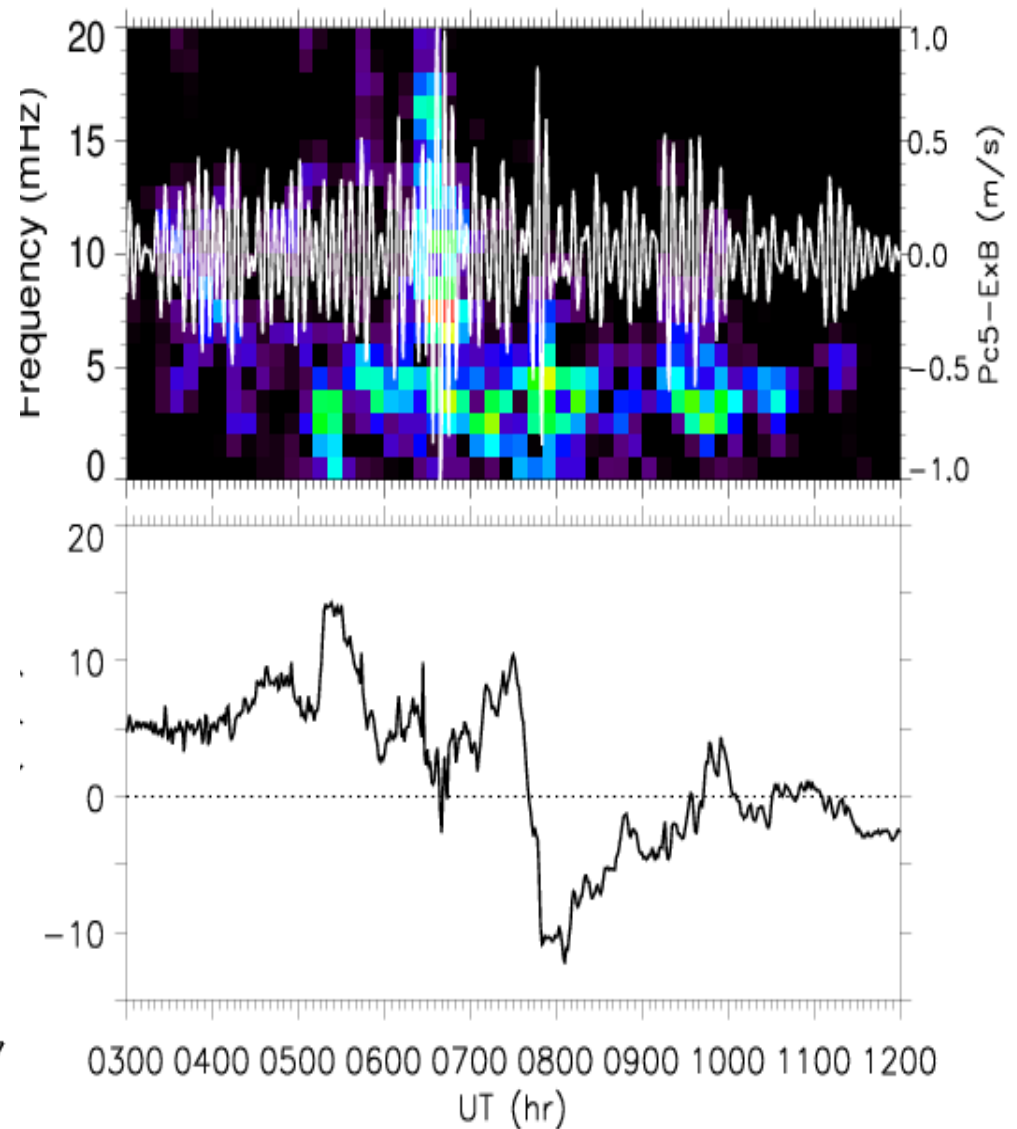
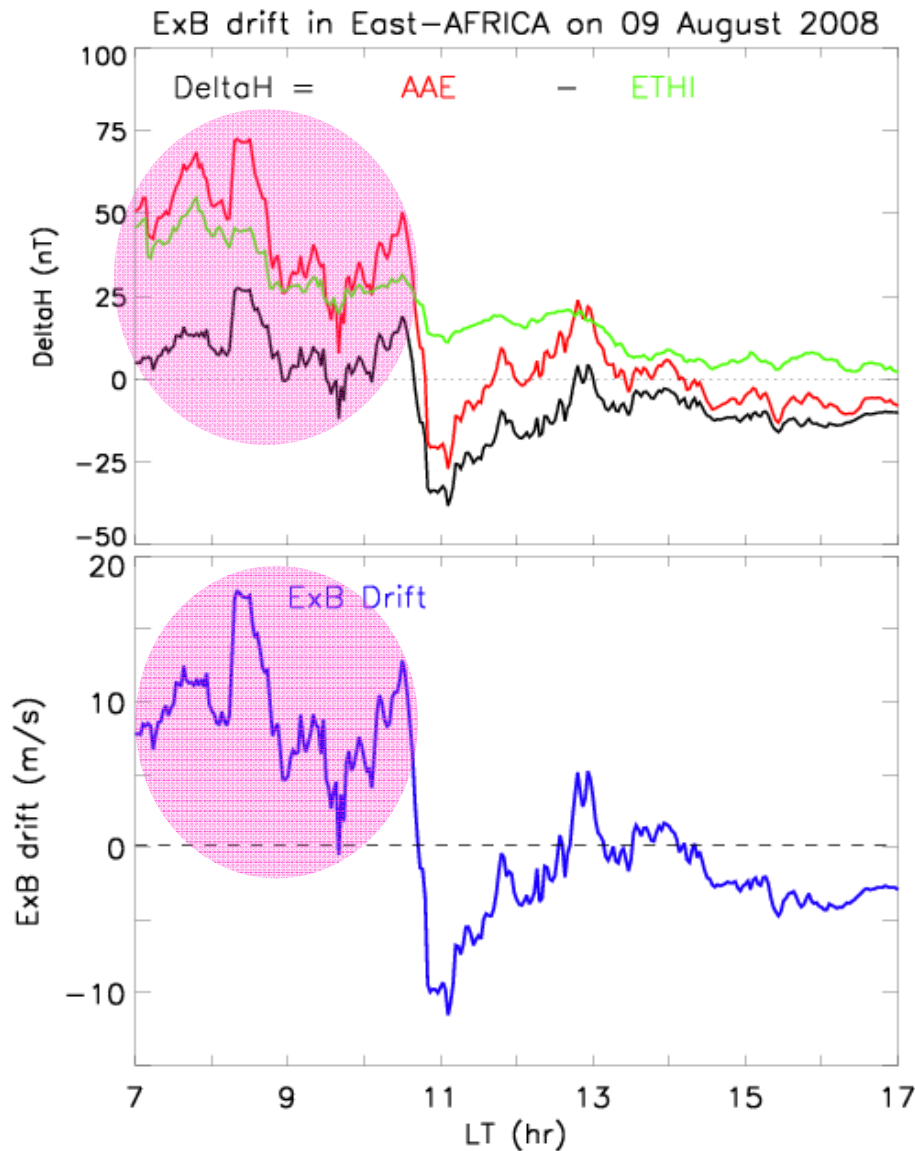
**What is the impact of ULF
wave penetration to lower
latitudes? Is it related to
scintillation activities?**

2000/09/12 11:54

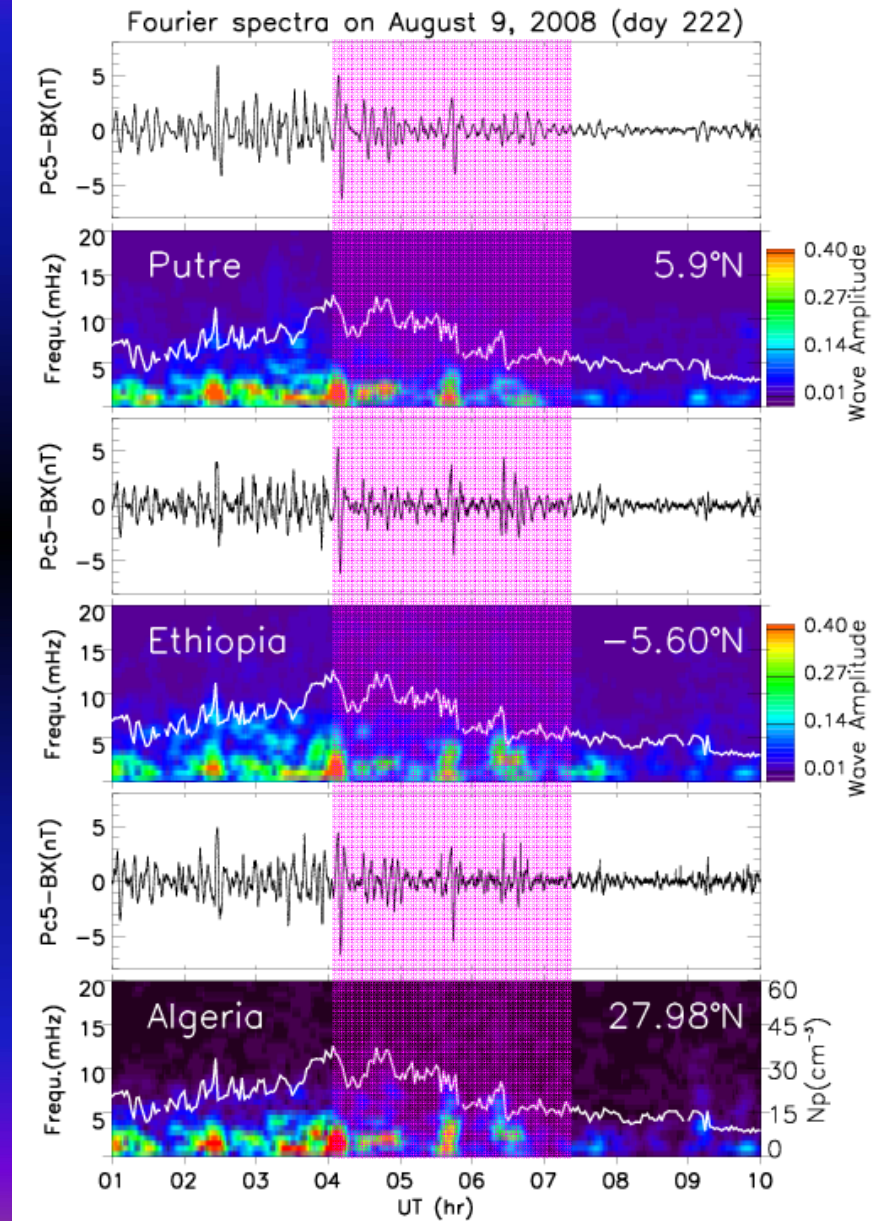
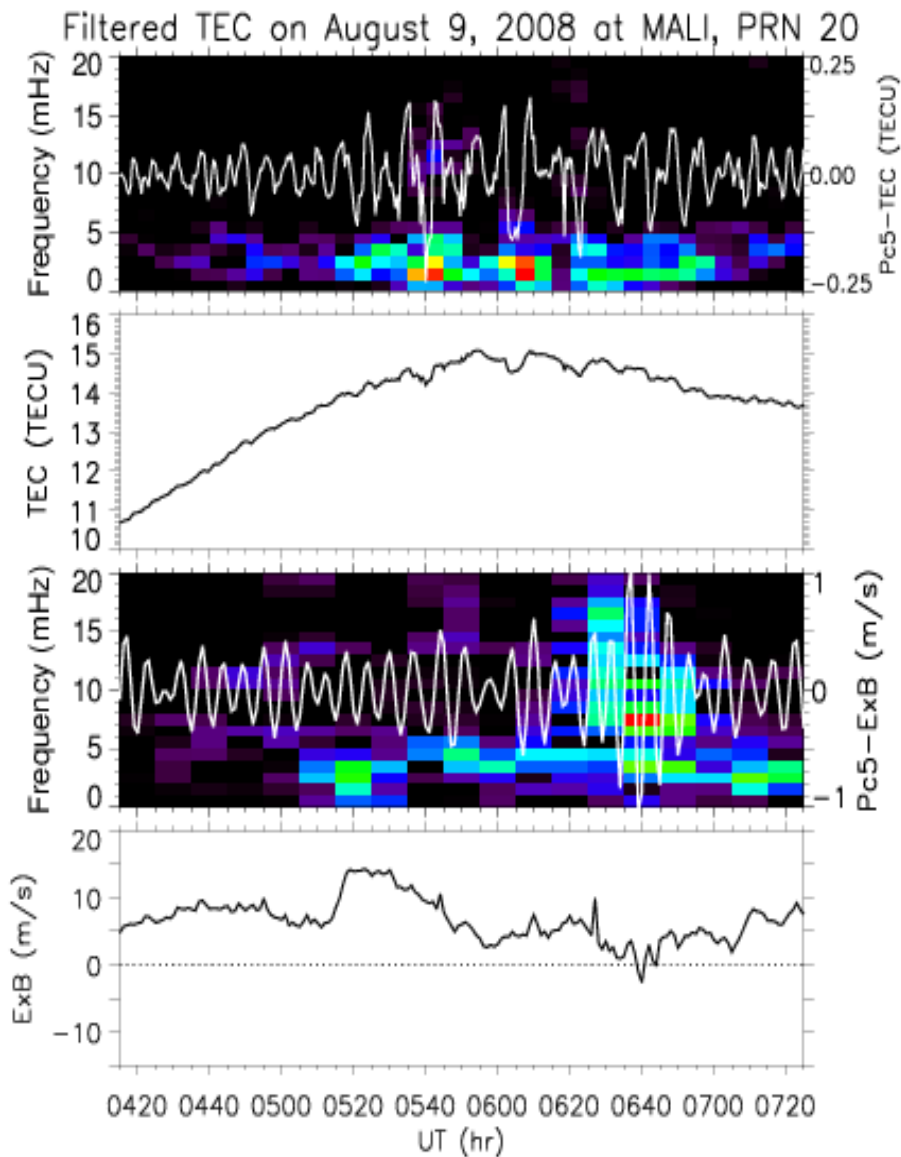
Equatorial Vertical Drift Fluctuation

African sector

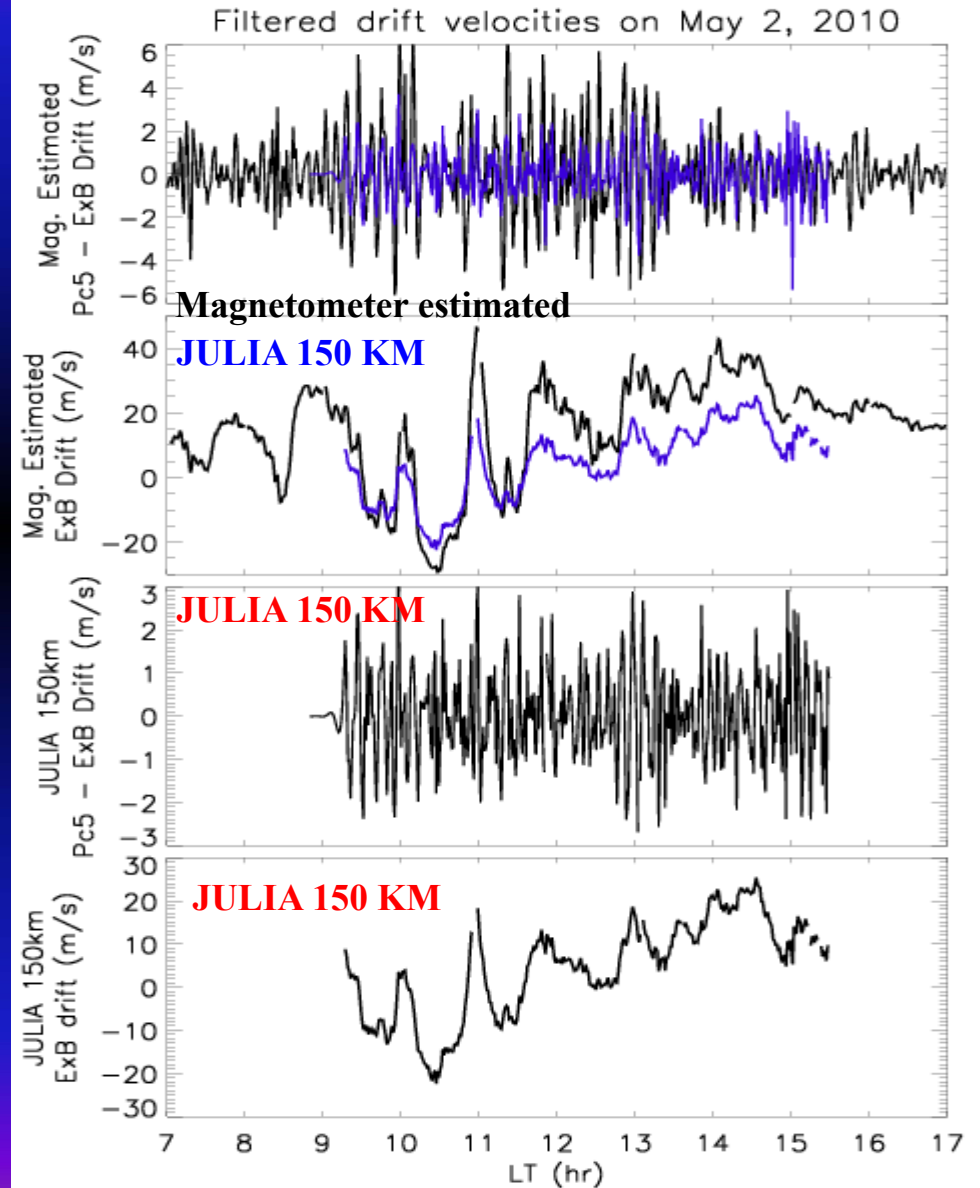
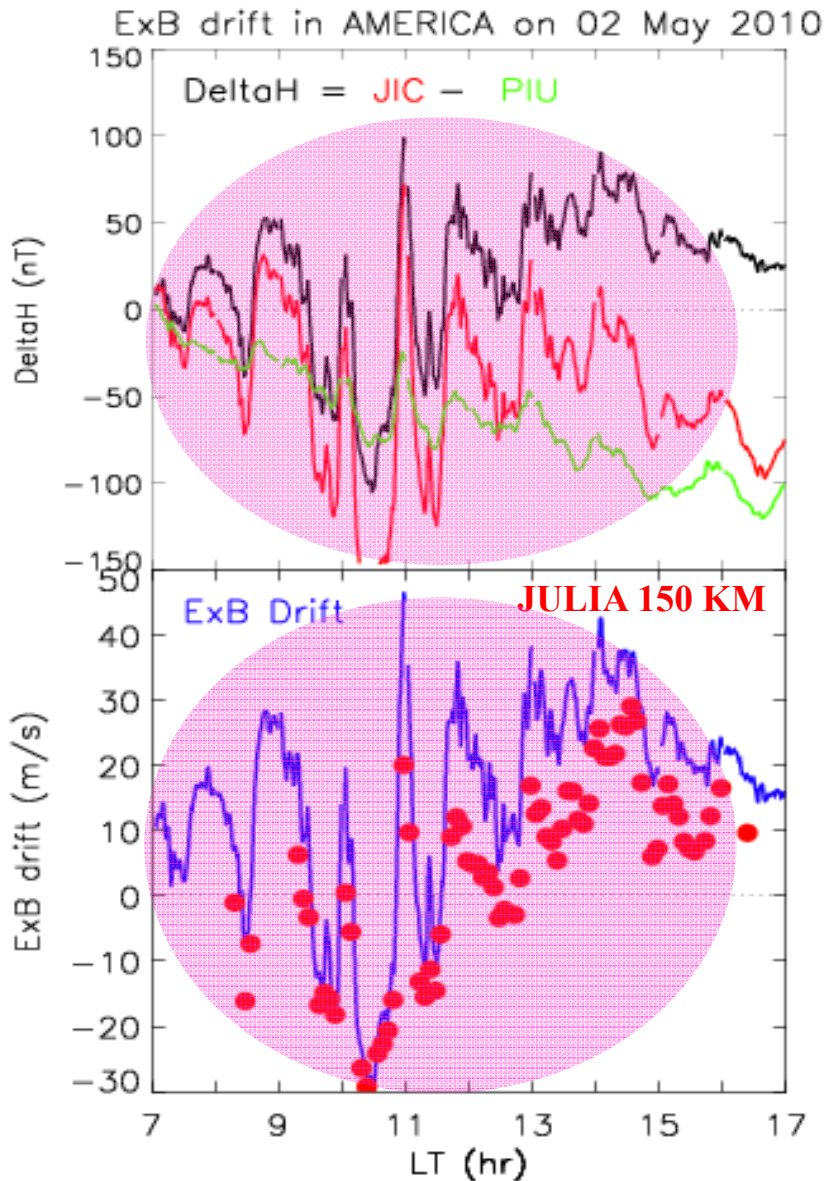
Band-pass filtered drift shows ULF wave

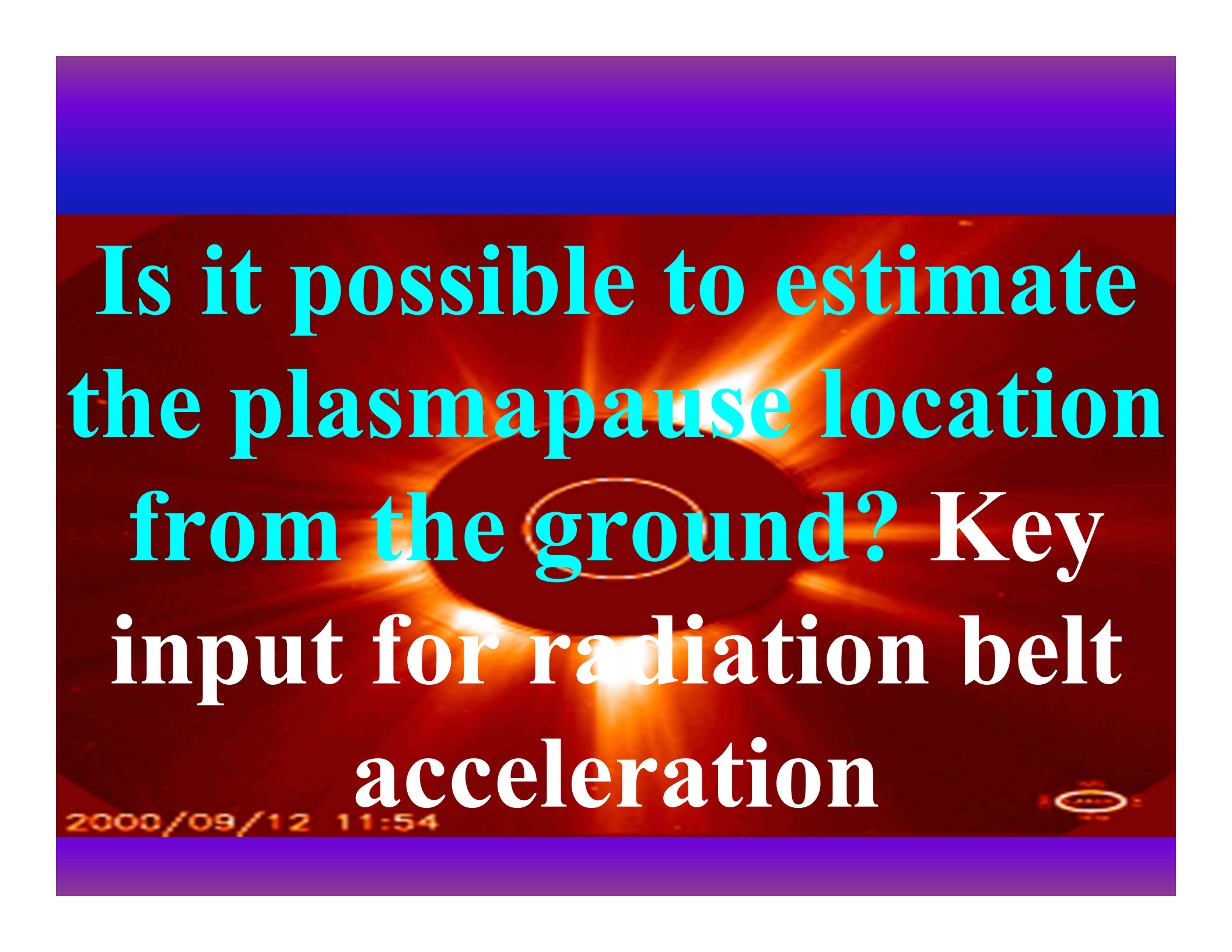


Vertical Drift and Density Fluctuation



Vertical Drift and Density Fluctuation



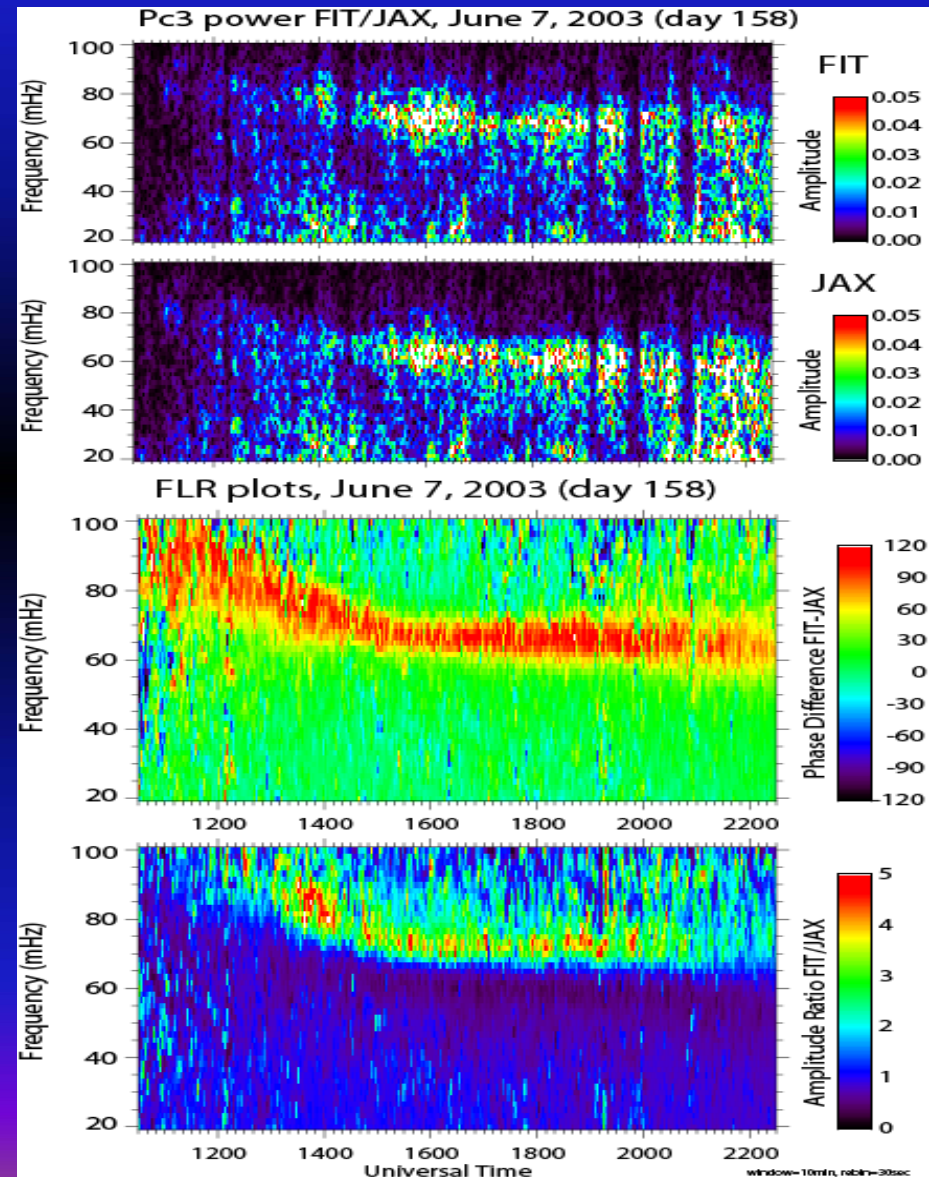
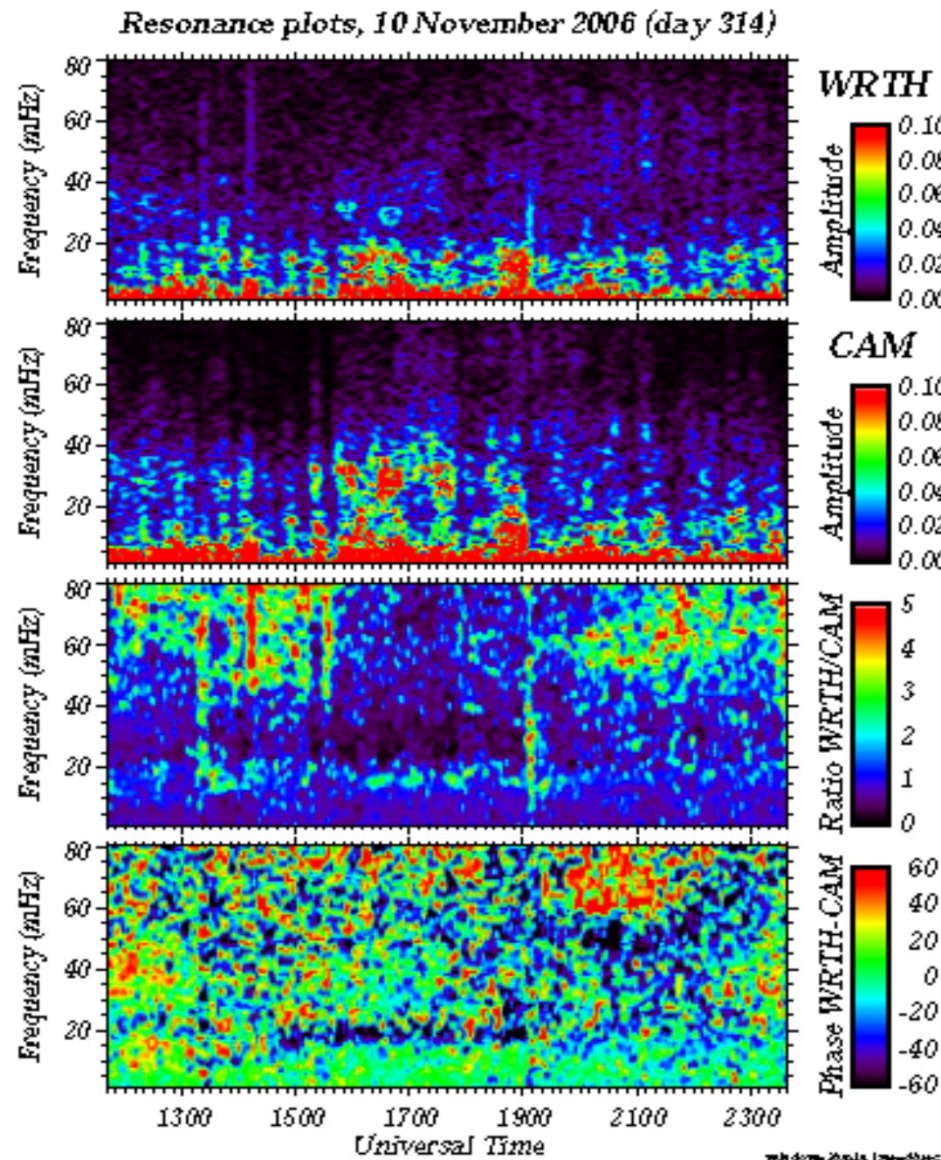


**Is it possible to estimate
the plasmapause location
from the ground? Key
input for radiation belt
acceleration**

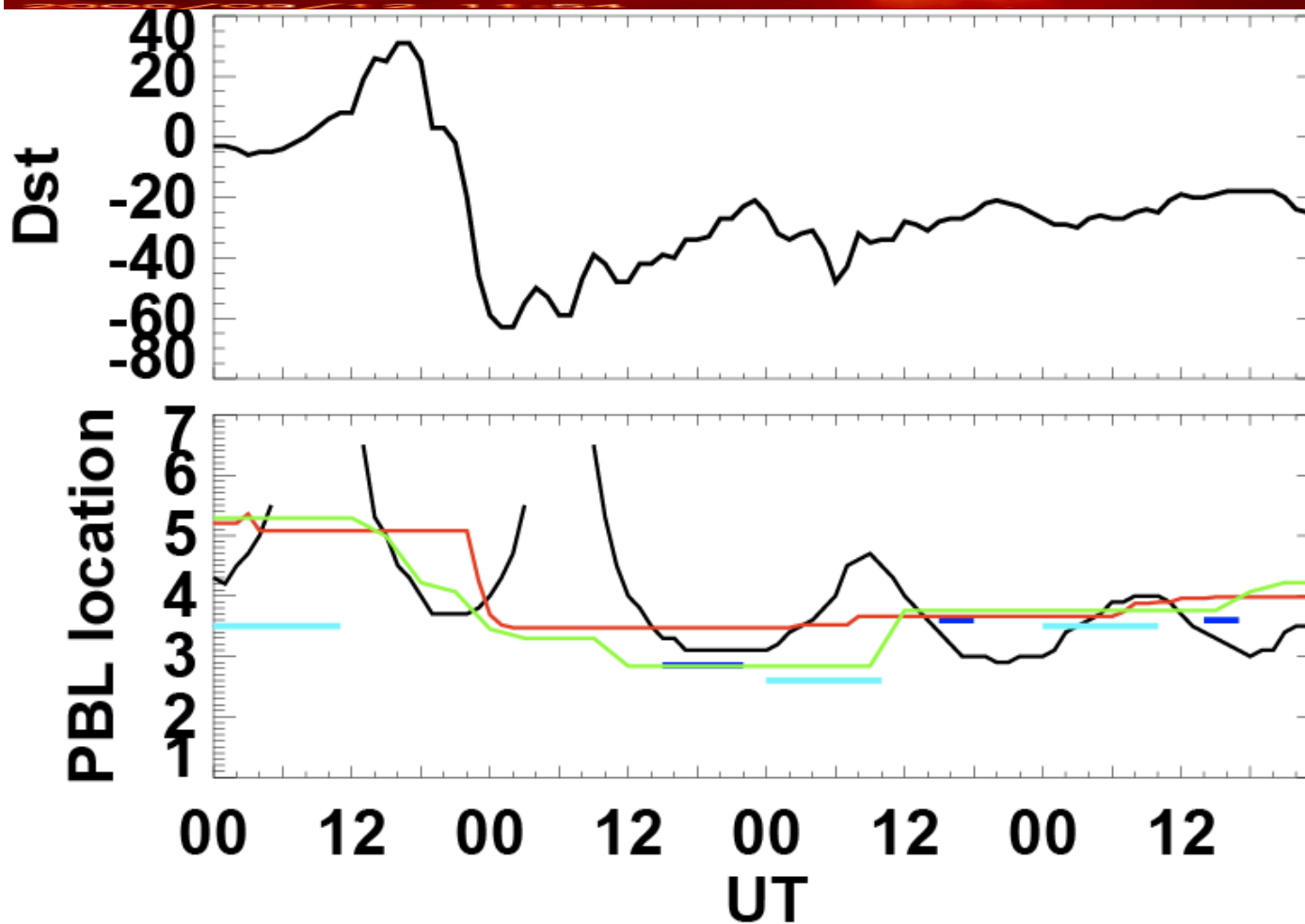
2000/09/12 11:54

Lpp from reverse Phase Difference

Reported before by Menk et al. [2004]

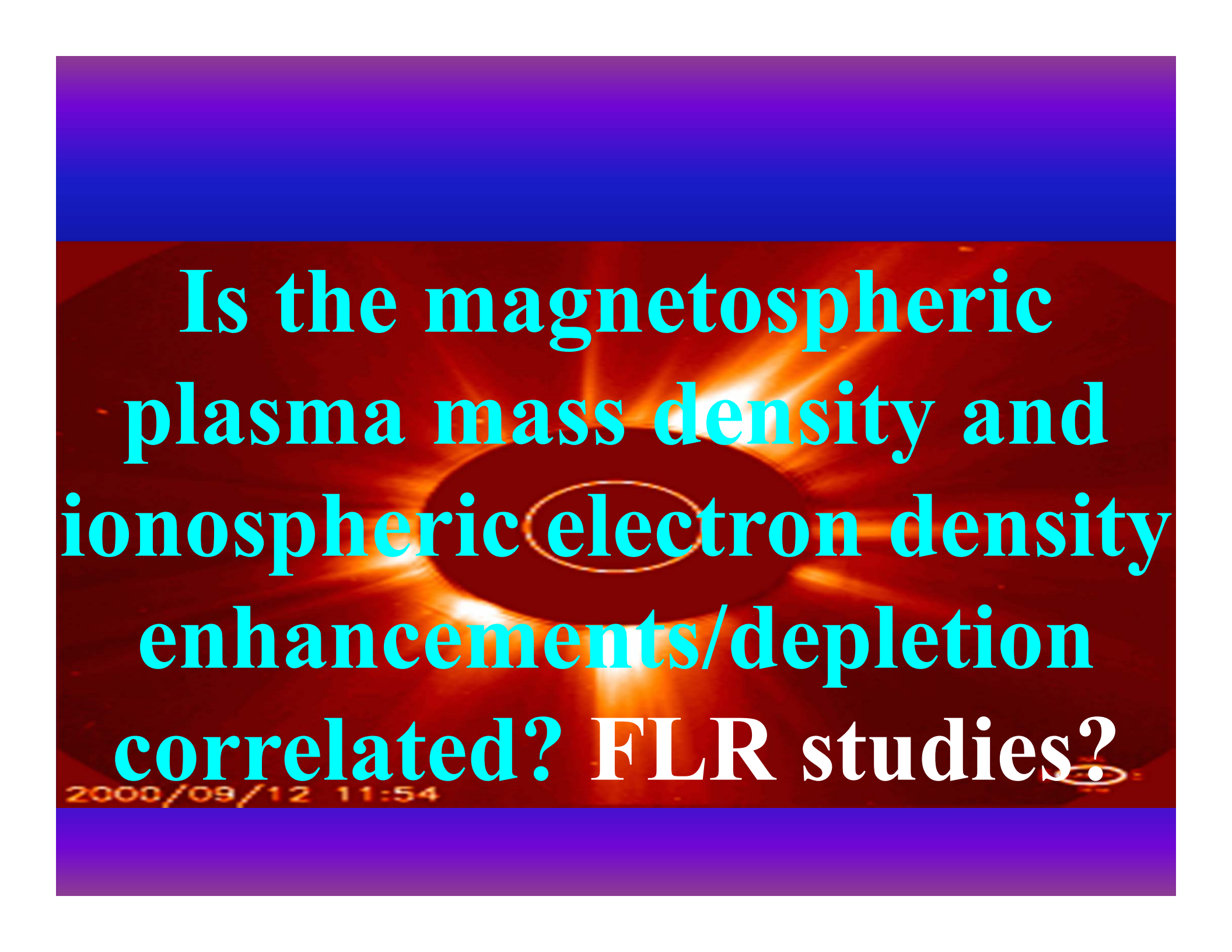


PBL determination comparisons



- Carpenter and Anderson [1992], Kp
- O'Brien and Moldwin [2003], Dst
- Reverse PD from ground mags
- TEC profile from ground GPS receivers

— Dynamic Global Core Plasma Model (DGCPM), [Ober, 1997]. DGCPM is a 2D single-species model

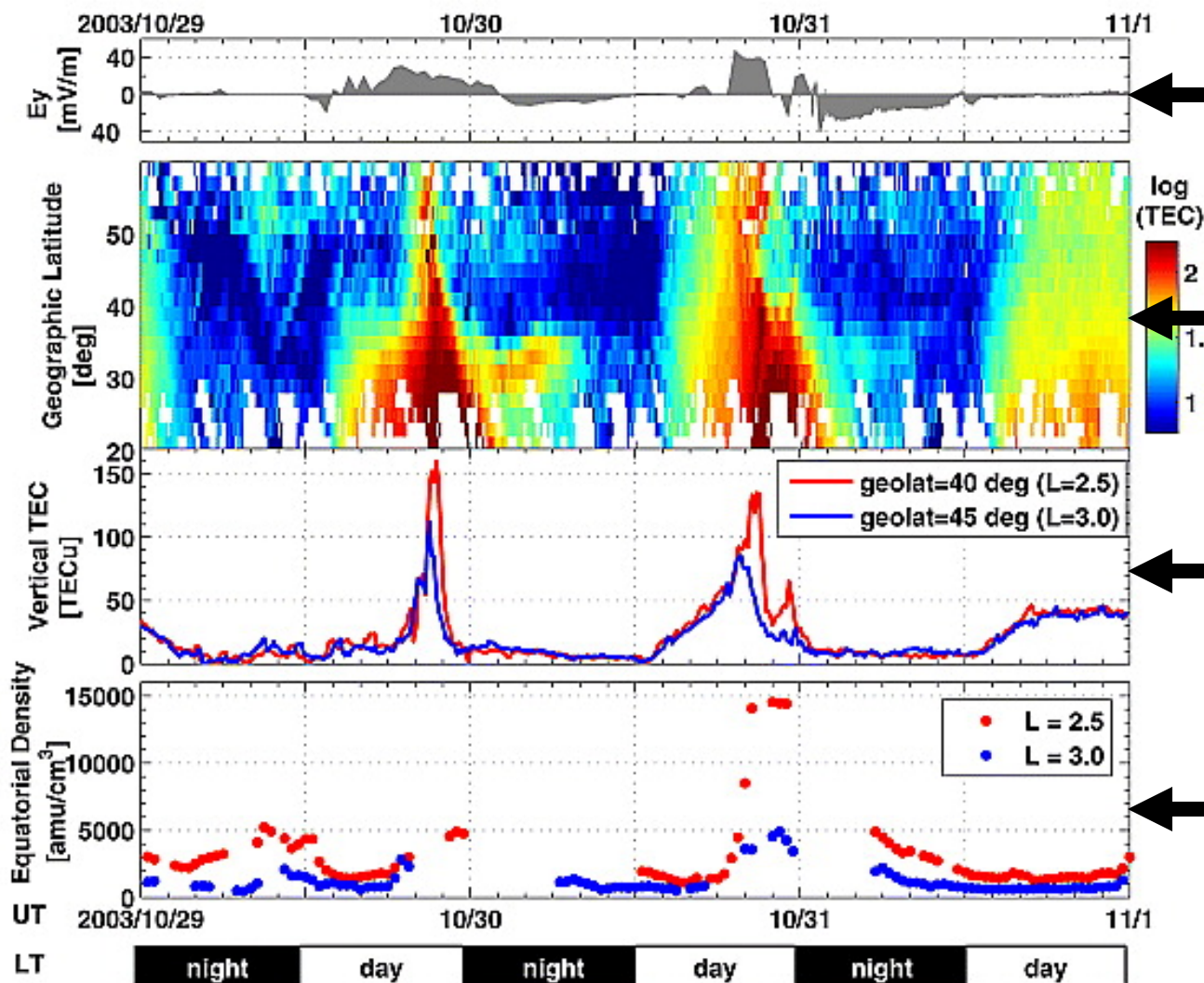


**Is the magnetospheric
plasma mass density and
ionospheric electron density
enhancements/depletion
correlated? FLR studies?**

2000/09/12 11:54

Simultaneous density enhancement in the plasmasphere and ionosphere

Chi et al., GRL, 2005

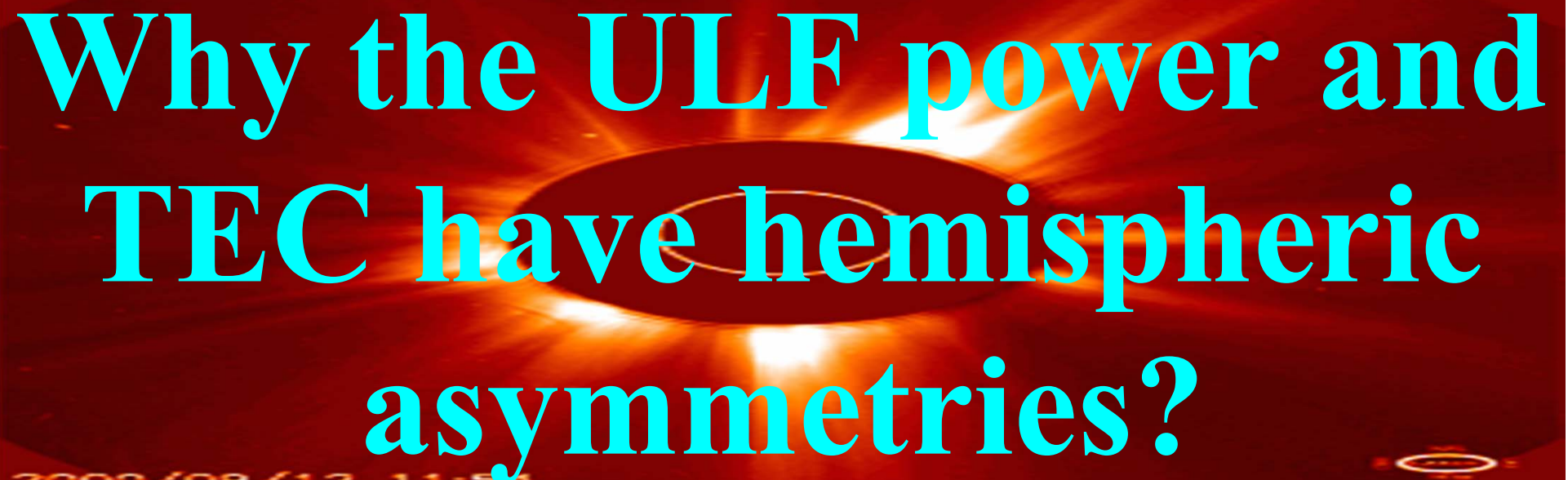


East-west electric field ($E_y = V_x \times B_z$)

The vertical total electron content (TEC) along 255°E geographic longitude

The vertical TEC values at $L = 2.5$ and 3.0

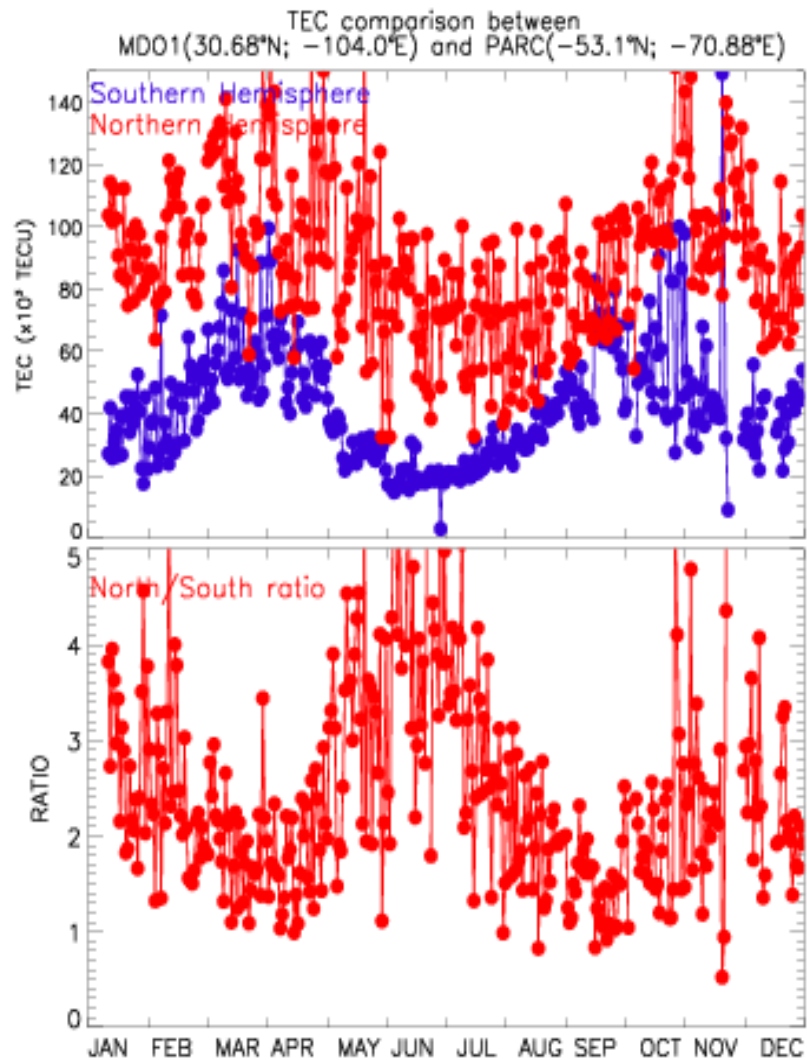
Mass density inferred by field line resonance measurements



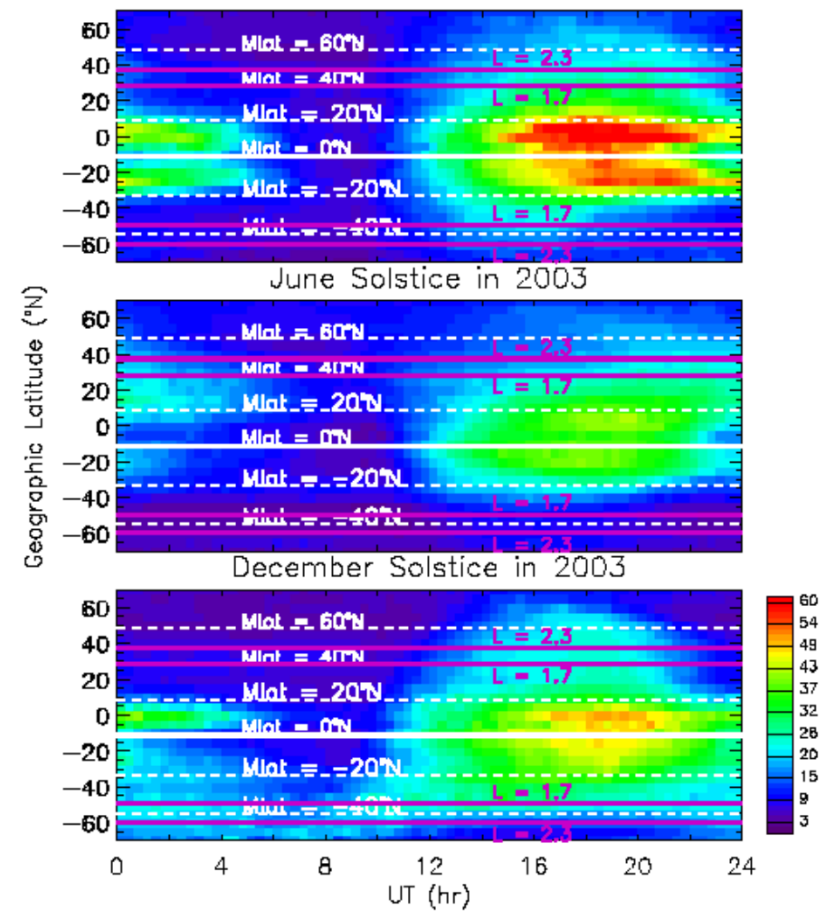
**Why the ULF power and
TEC have hemispheric
asymmetries?**

2000/09/12 11:54

ULF power and TEC asymmetry



Diurnal Variation of GPS TEC between -80 and -60°E
September Equinox in 2003



ULF power and TEC asymmetry

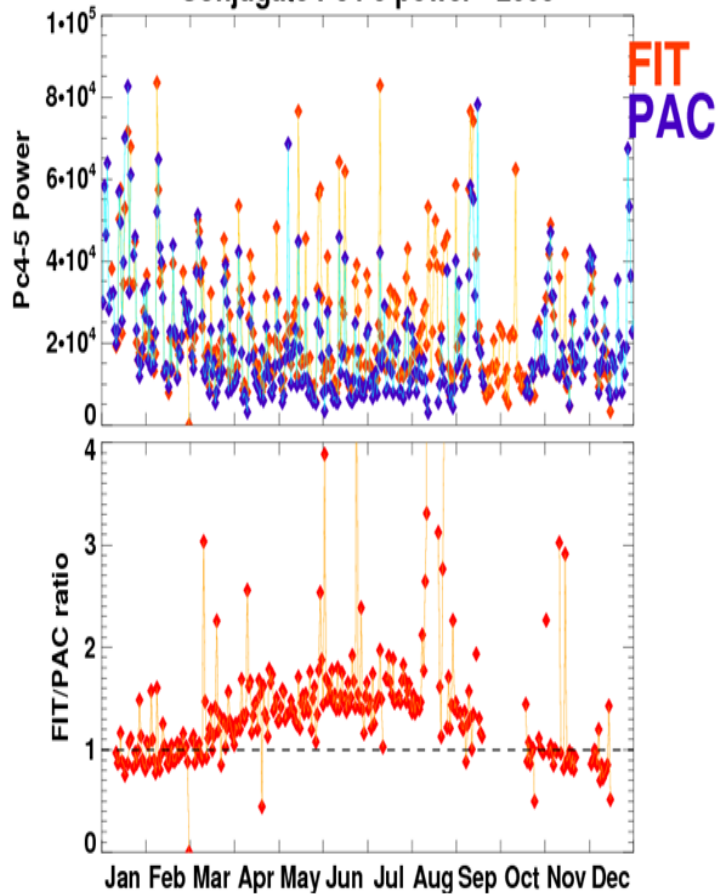
AMER (N) and OHI (S)

FIT (N) and PAC (S)

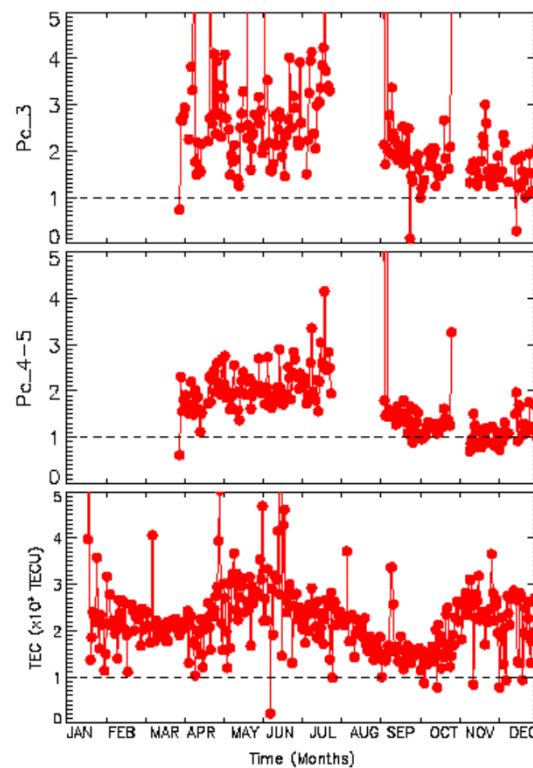
2006

2007

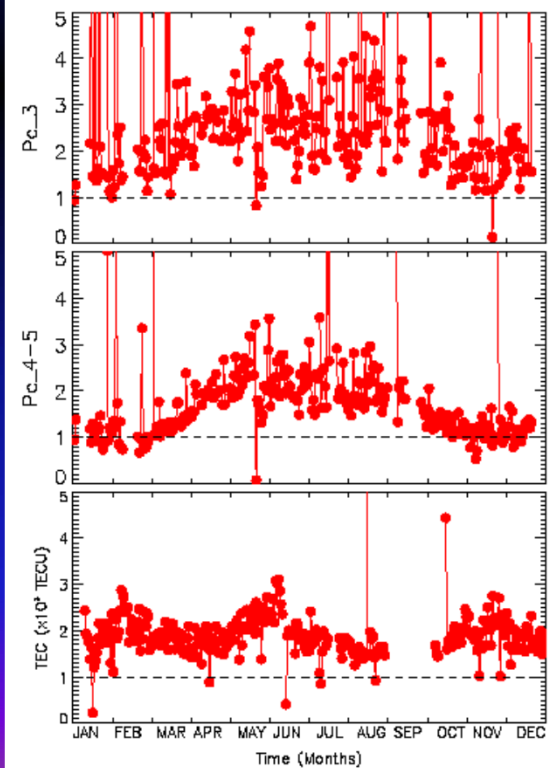
Conjugate Pc4-5 power - 2005



Conjugate Pc3 and Pc4-5 Power and TEC Ratios in 2006



Conjugate Pc3 and Pc4-5 Power and TEC Ratios in 2007





**How strong the GIC
current in Chile and
what can we do about it?**

2000/09/12 11:54

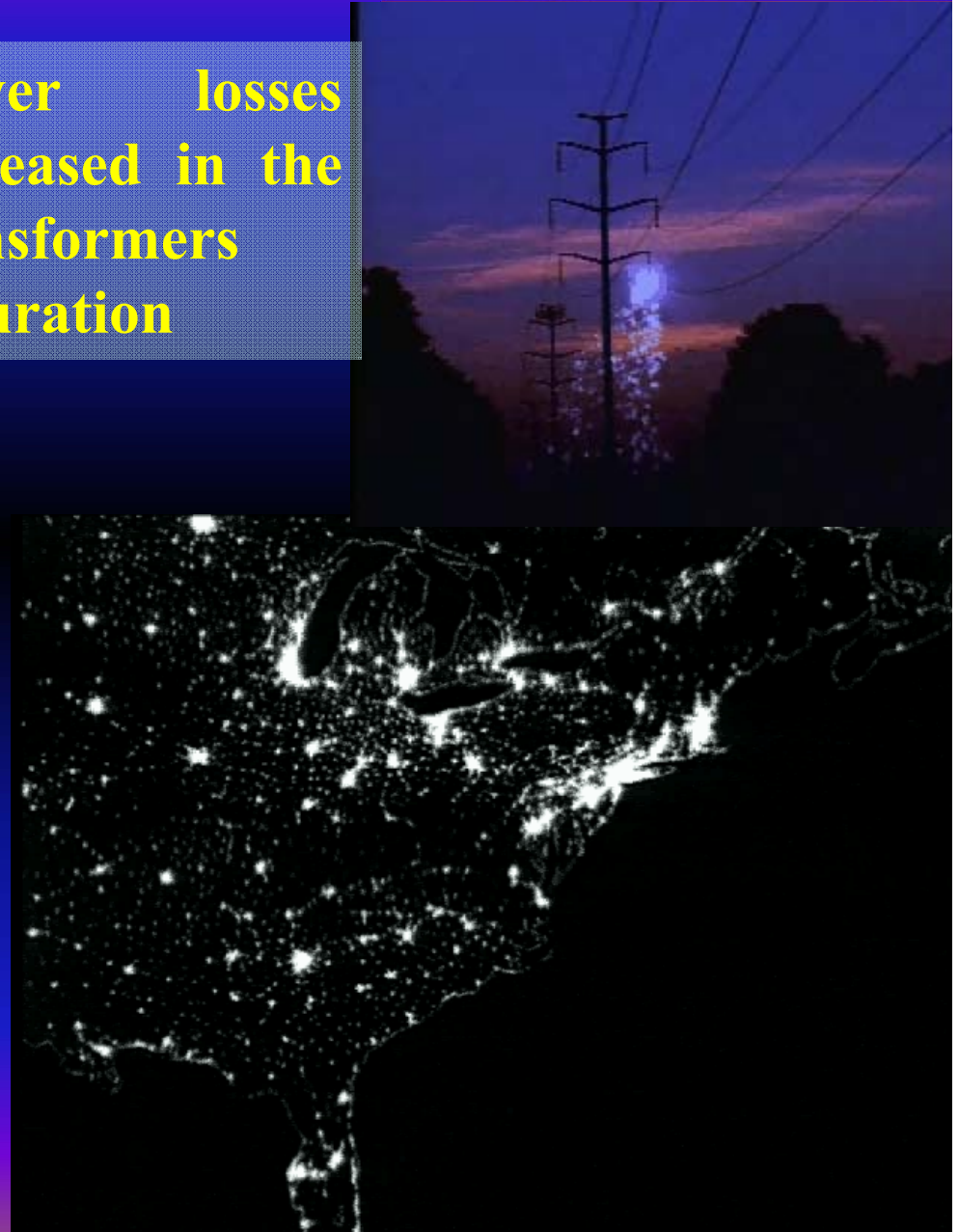
GIC induction on long conducting cable

1956 trans Atlantic cable
(yet metallic)

Power losses
increased in the
transformers
Saturation



Corrosion quicker than 25 μ /yr



Other large economic events

- San Francisco Earthquake 1906\$ 500B
- Hurricane Katrina 2005\$ 120B
- Annual loss from Electric interruption\$ 80B
- **North American Power Grid Blackout\$ 30B/day**
- **GEO satellite revenue loss> \$25B**
- GEO satellite revenue loss\$ >25B
- Blackout of East Coast 1955\$ 10B
- Mt Lassen Volcanic Eruption .. 1915\$ 5B
- Quebec Blackout 1906\$ 2B

Baker et al.



**What other instruments
can we use to augment
magnetometers' data?**

2000/09/02 11:54

Where can we get calculated GPS TEC?

Madrigal data base (developed by MIT group) provide global calculated GPS TEC, interpolated 2 x 2 degree latitude and longitude. The calculated TEC is averaged every 5 minutes.

Madrigal calculated TEC data base

<http://madrigal.haystack.mit.edu/cgi-bin/madrigal/madInvent.cgi>

**TOPEX and JASON altimeter
TEC can be used to augment GPS
TEC that you have been
discussing so far?**

**TOPEX and JASON provide altimeter TEC (i.e, vertical
TEC below 1360 km altitude) over the ocean.**

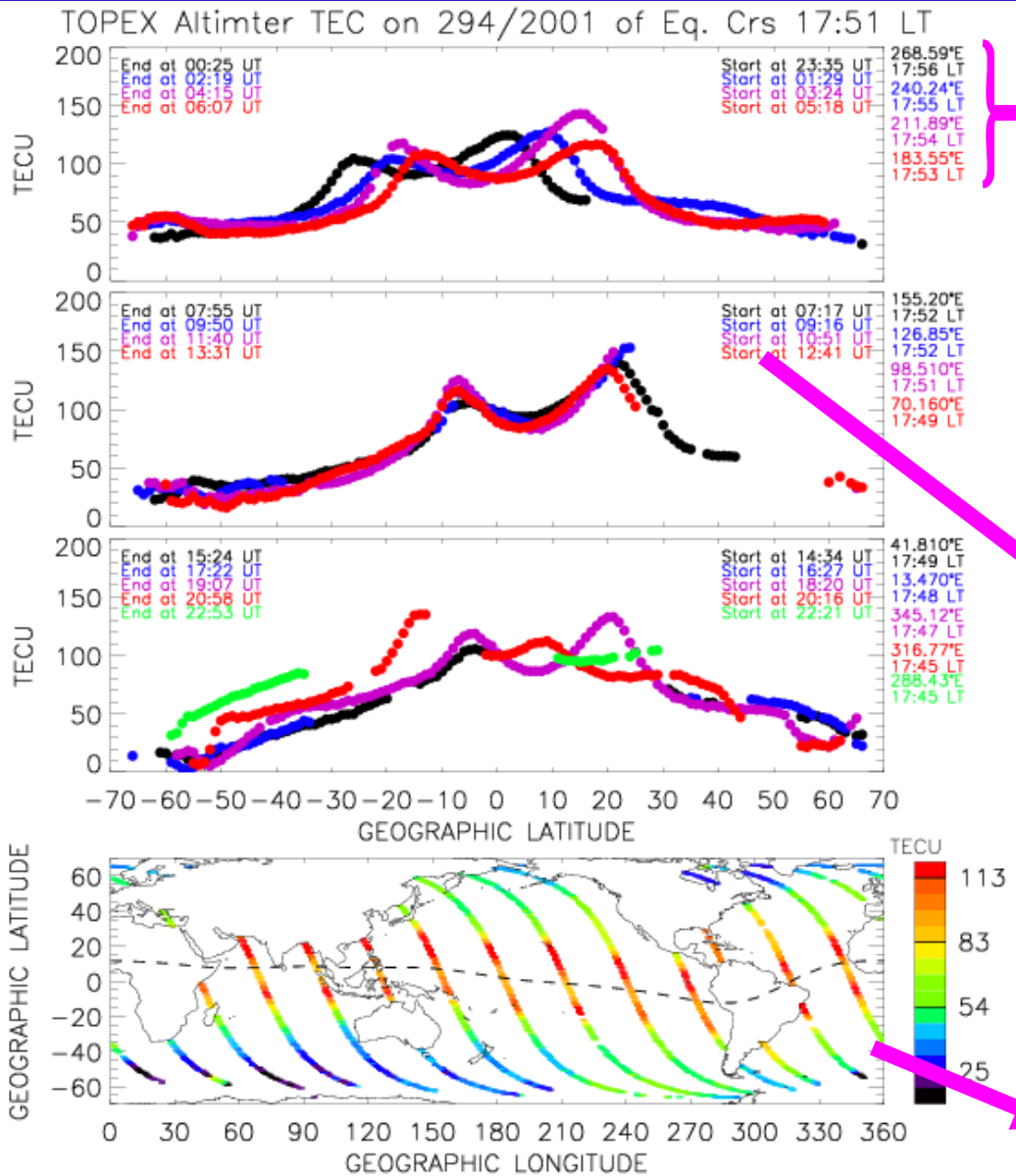
TOPEX Altimeter TEC

ftp://podaac.jpl.nasa.gov/SeaSurfaceTopography/topex/L2/tp_ssha/

JASON Altimeter TEC

ftp://podaac.jpl.nasa.gov/SeaSurfaceTopography/jason1/L2/j1_ssha/

TOPEX altimeter TEC plot

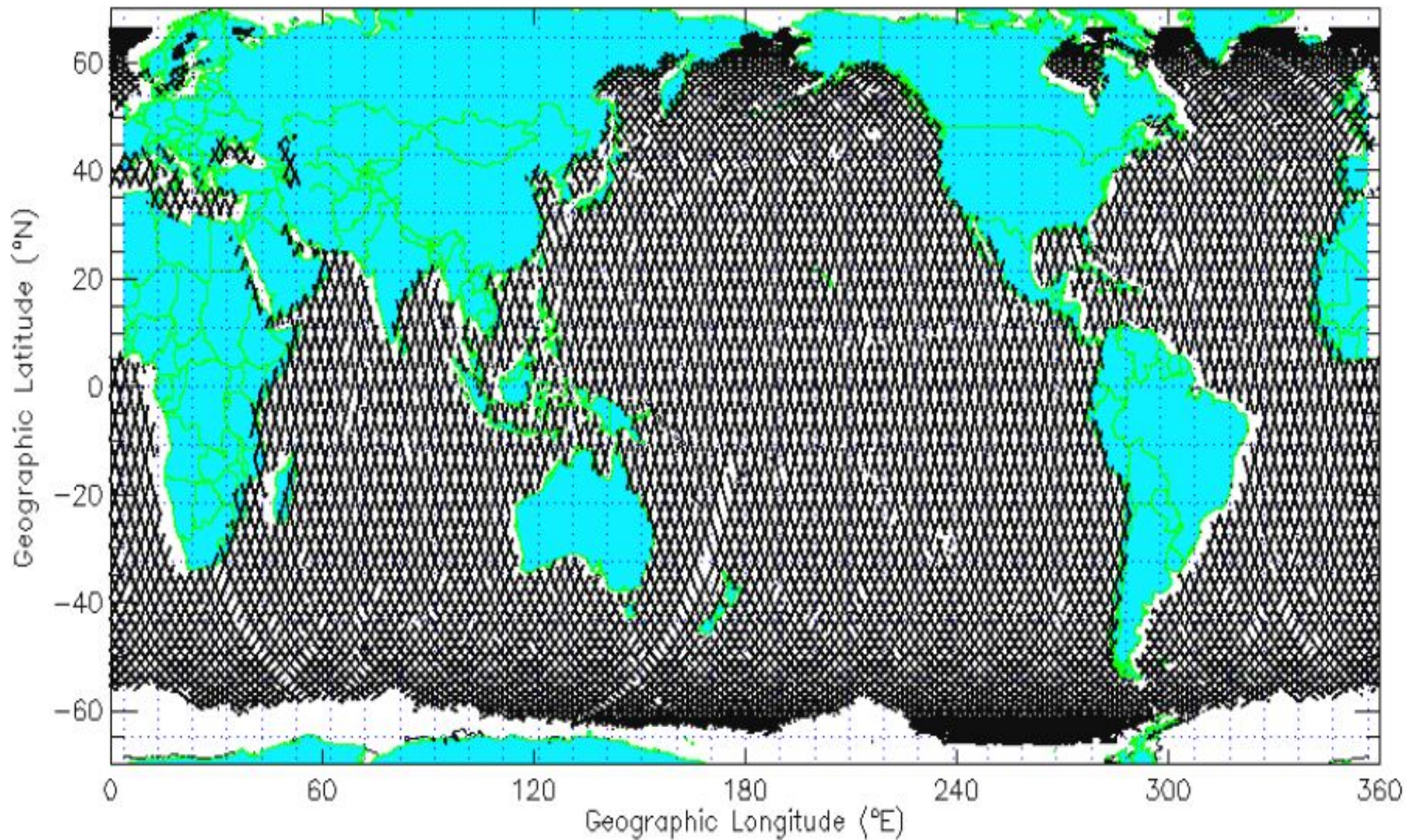


Equatorial crossing longitudes

Topex passes start and end times

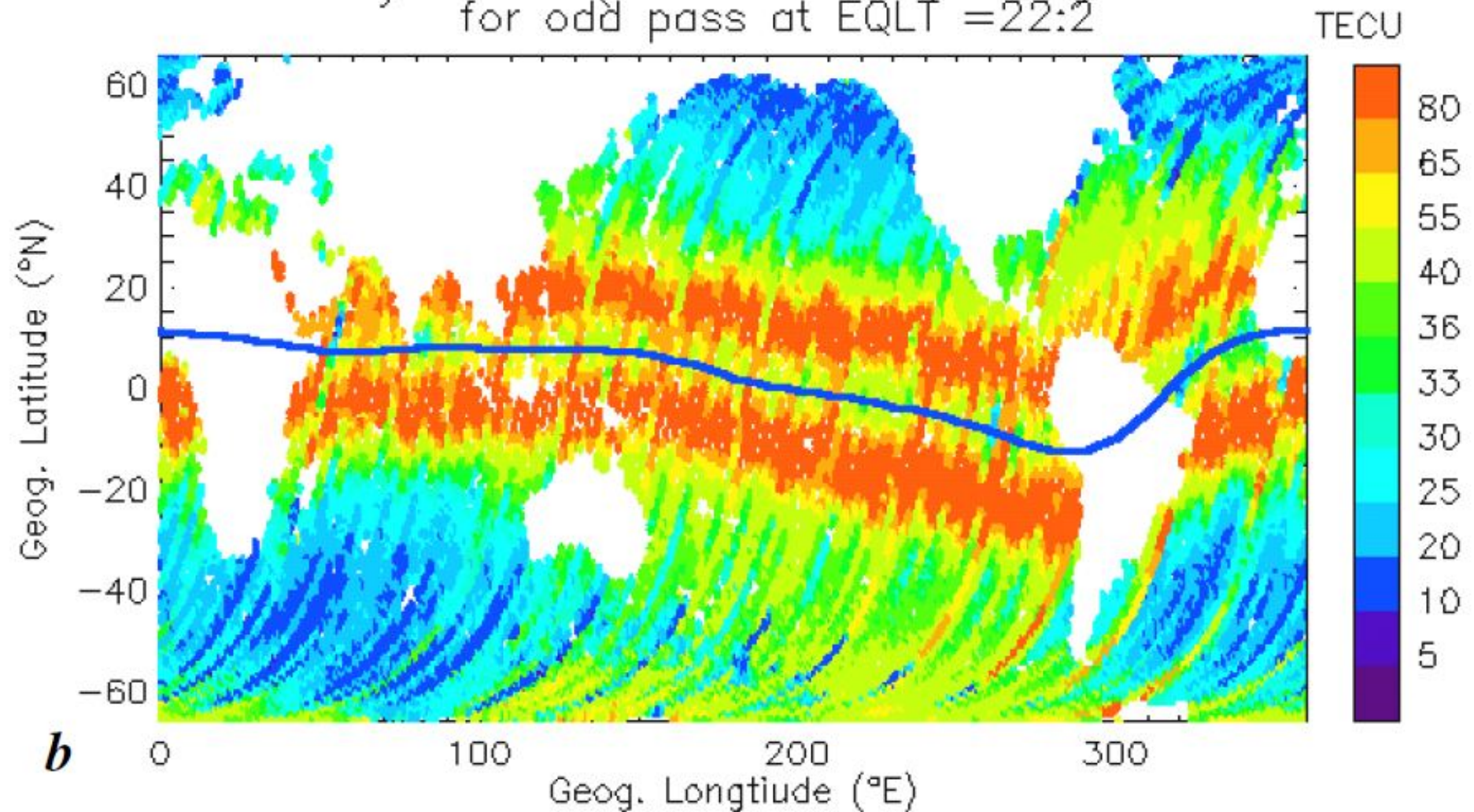
Topex TEC contour plots along its ground tracks

One cycle TOPEX Passes (10 days)



One cycle TOPEX TEC (10 days)

Cycle 315 (DOY 092–102, 2001)
for odd pass at EQLT = 22:2



How about data from other LEO satellites?

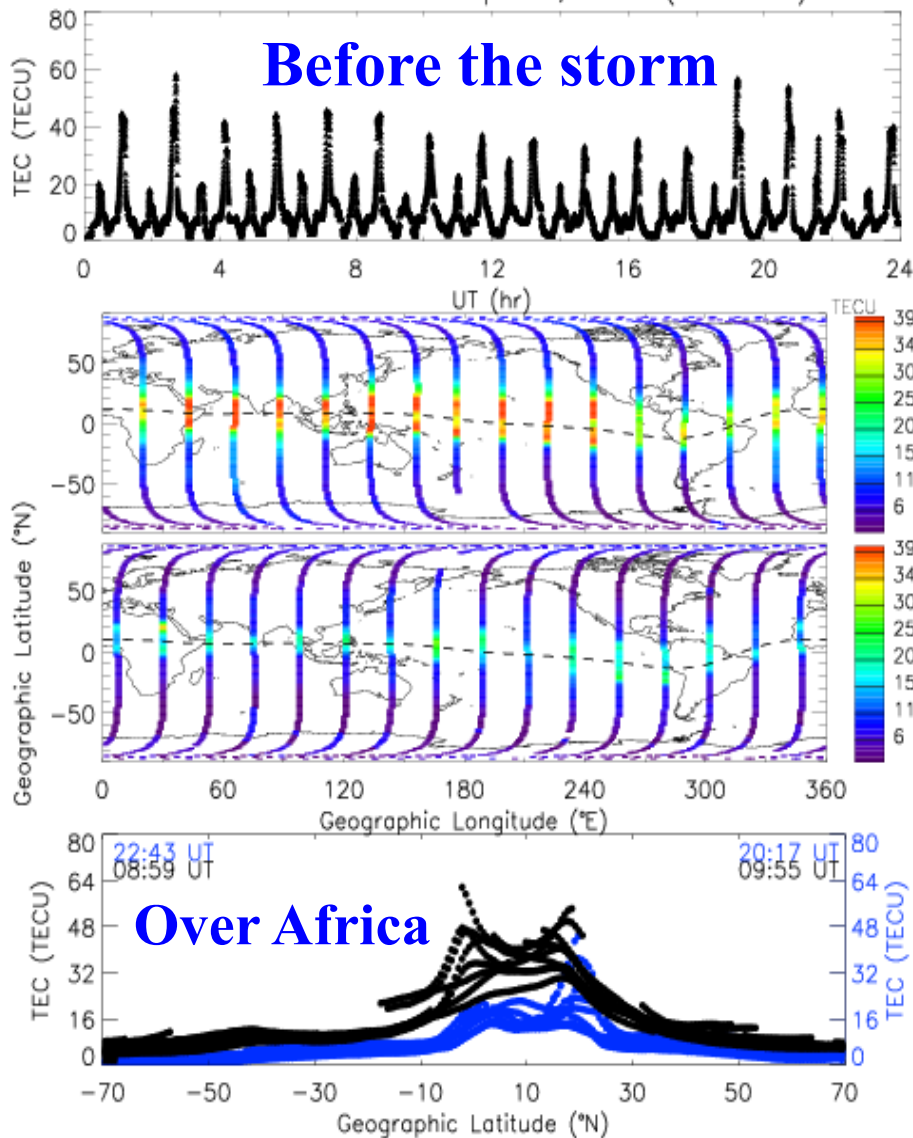
The COSMIC (six LEO satellites) and CHAMP LEO satellites provide two sets of very important data. (1) topside ionospheric and plasmaspheric GPS TEC (2) Occultation ionospheric density profiles (from about 70 km upto the altitude of the spacecraft).

COSMIC and CHAMP data base

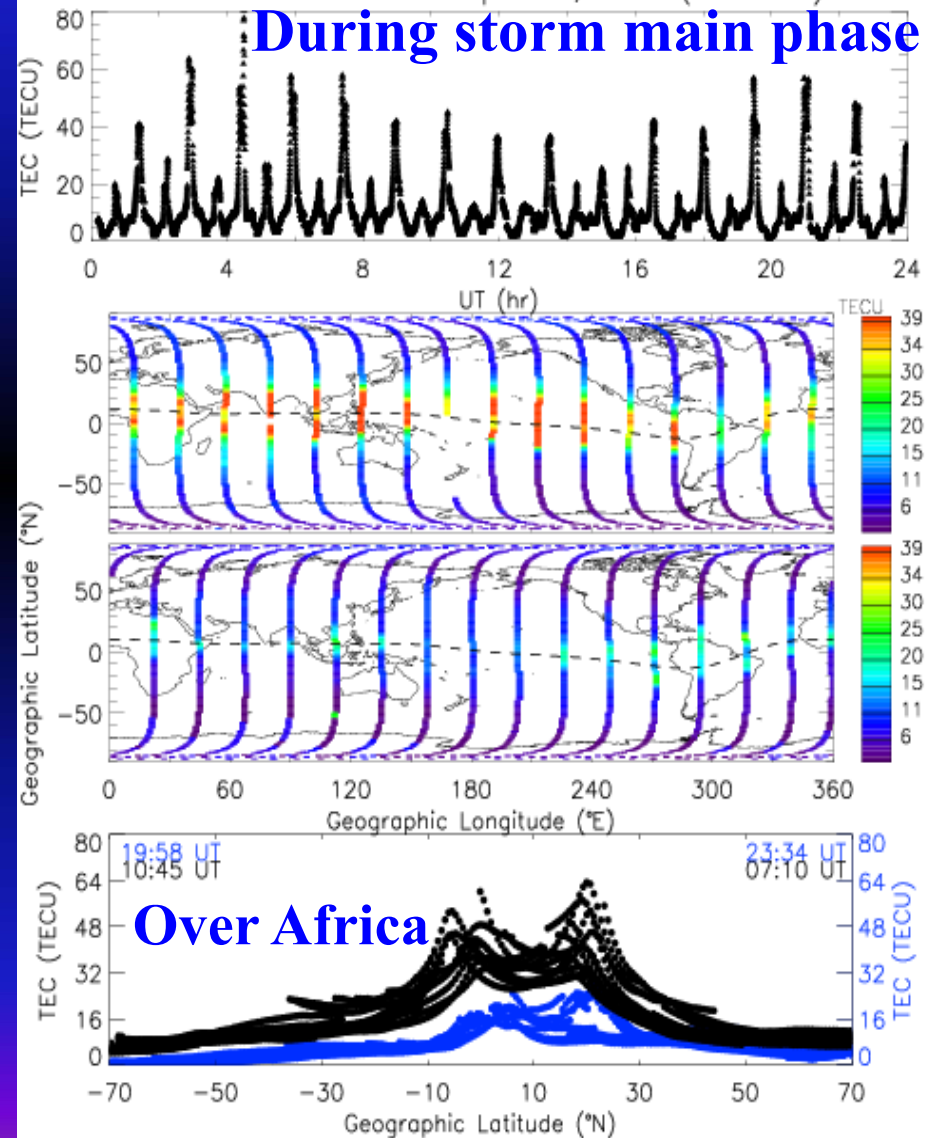
<http://cosmic-io.cosmic.ucar.edu/cdaac/>

Examples of LEO TEC data

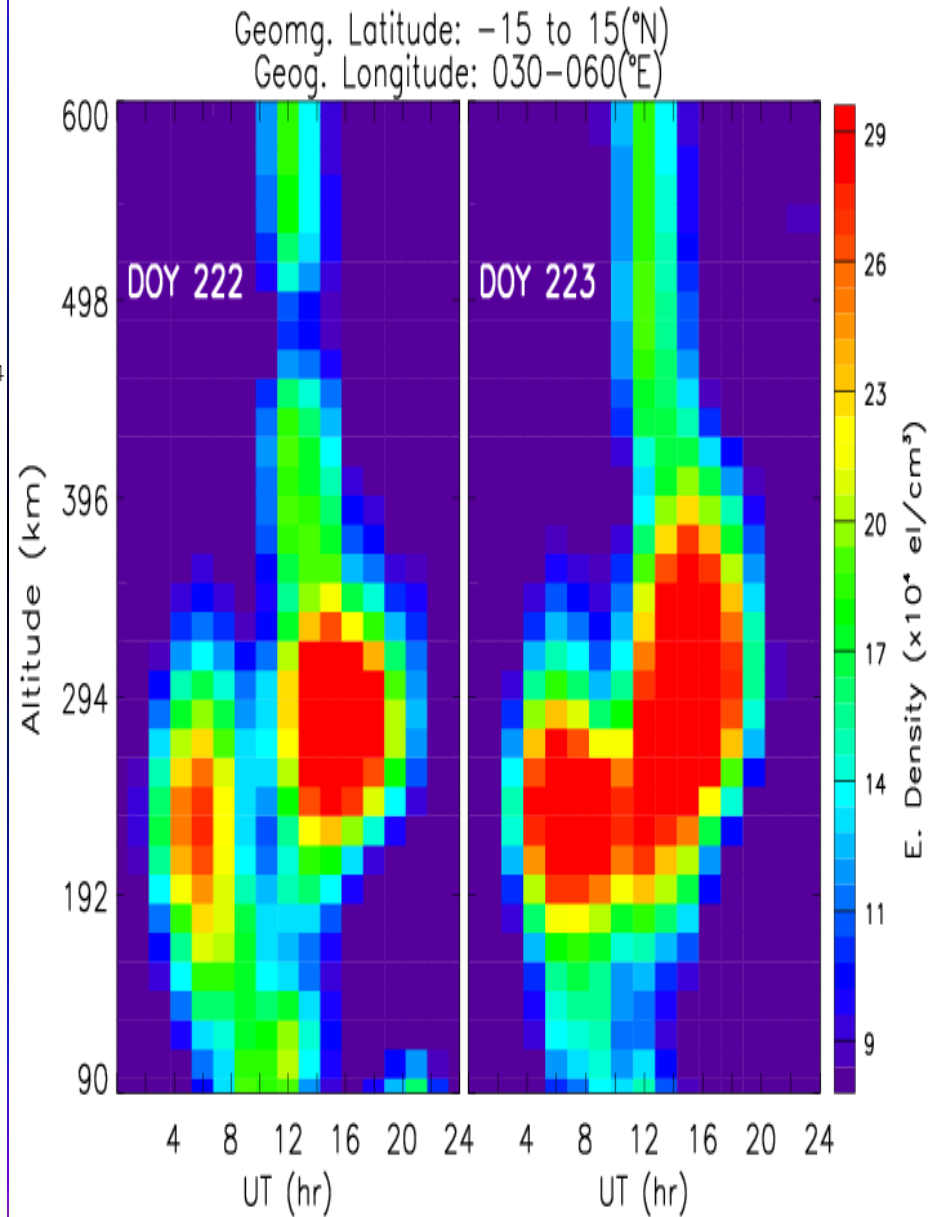
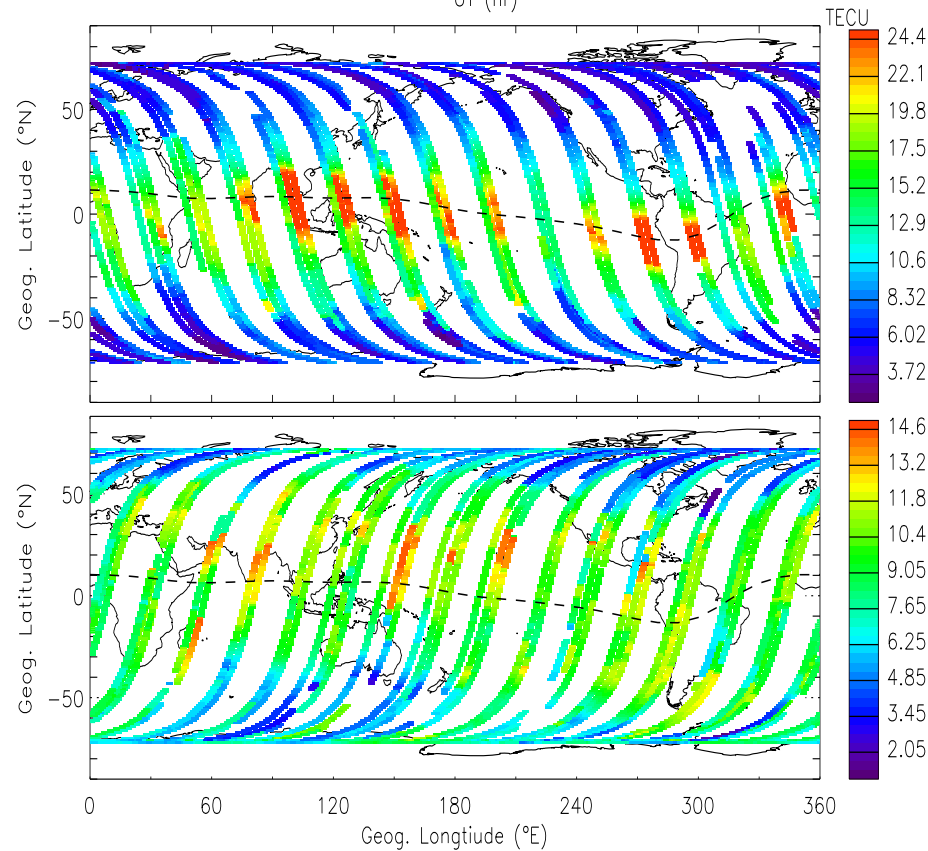
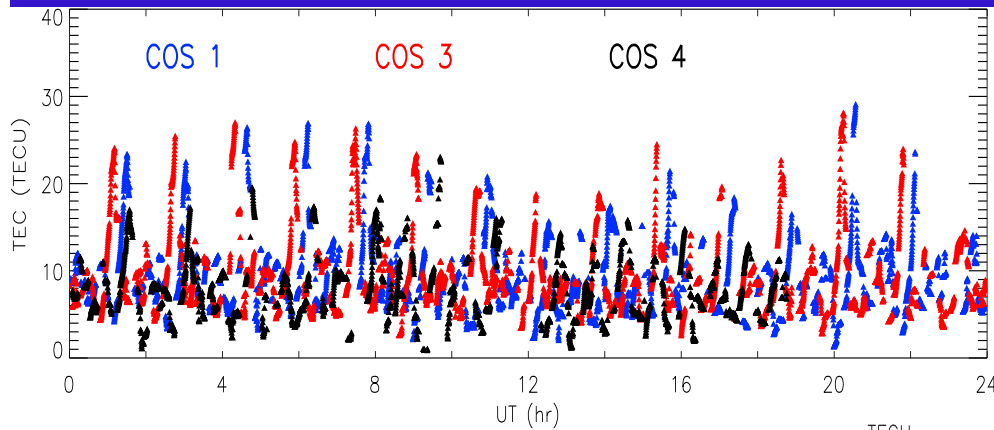
CHAMP TEC data on April 9, 2010 (DOY 100)



CHAMP TEC data on April 12, 2010 (DOY 103)



Examples of LEO TEC density profile data





**More In situ density and drift
observation also available
from various space crafts?**

2000/09/12 11:54

**DMSP satellite also provide various
important data sets, including in situ density.**

MDMASP database (organized by UT Dallas)

http://cindispace.utdallas.edu/DMSP/dmsp_data_at_utdallas.html

More space weather data can also be available

Here are some of the publicly available data bases.

Coordinated Data Analysis Web (CDAWeb)

http://cdaweb.gsfc.nasa.gov/cdaweb/istp_public/

OMNI data base

http://spdf.gsfc.nasa.gov/data_orbits.html

Where to find model run outputs?

Here are some of the publicly available model run data bases.

Community Coordinated Modeling Center (CCMC)

<http://ccmc.gsfc.nasa.gov/>

Thank you!

E-Mail: kassie@bc.edu

URL: <http://www2.bc.edu/~kassie>