15th Int'l Ionospheric Effects Symposium

Alexandria, Virginia, USA

The Dependence of Nighttime Plasma Irregularities on Daytime Low-Latitude Electrodynamics

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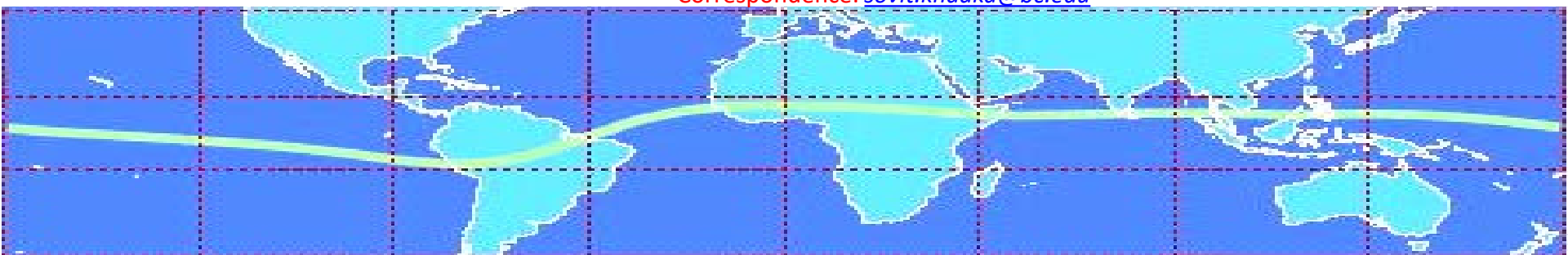

Outline

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  - Low-Latitude Electrodynamics
  - Ionospheric Parameters
- **Approach**
  - Instruments
  - Data Locations/ Selection
- **Analysis/ Results**
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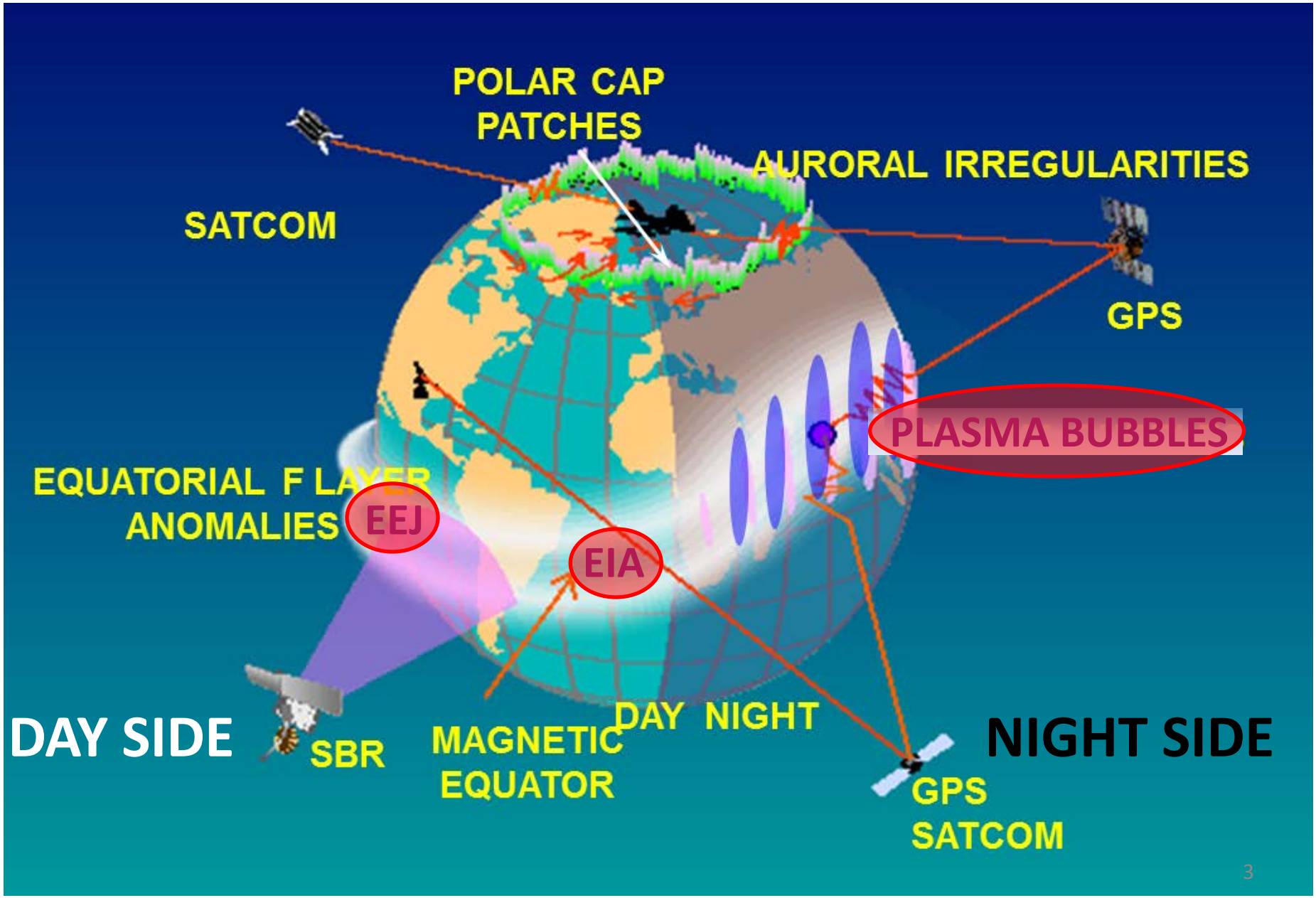
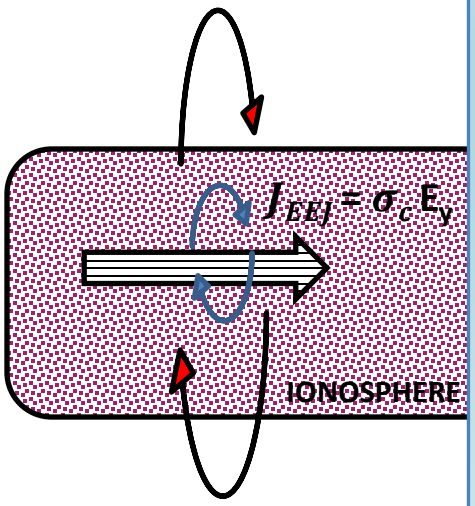
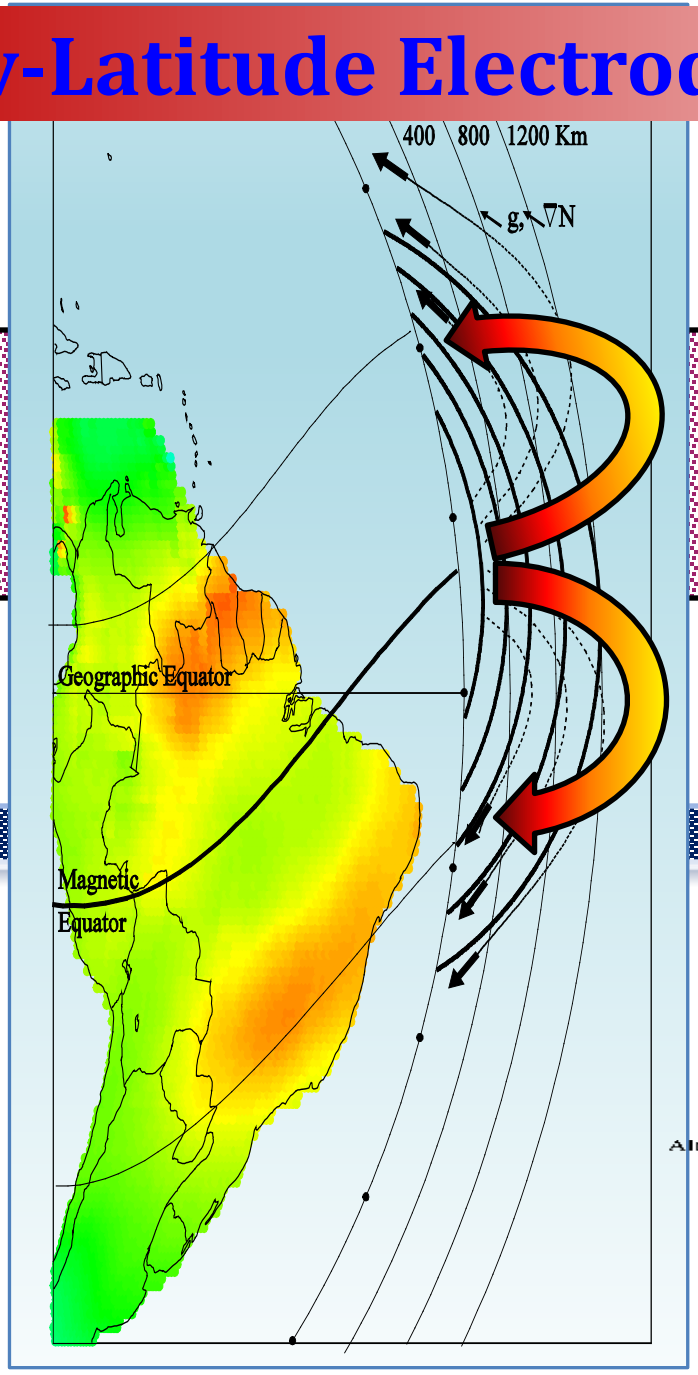
  - TEC & Equatorial Anomaly
  - Irregularities & Scintillation
- **Summary**

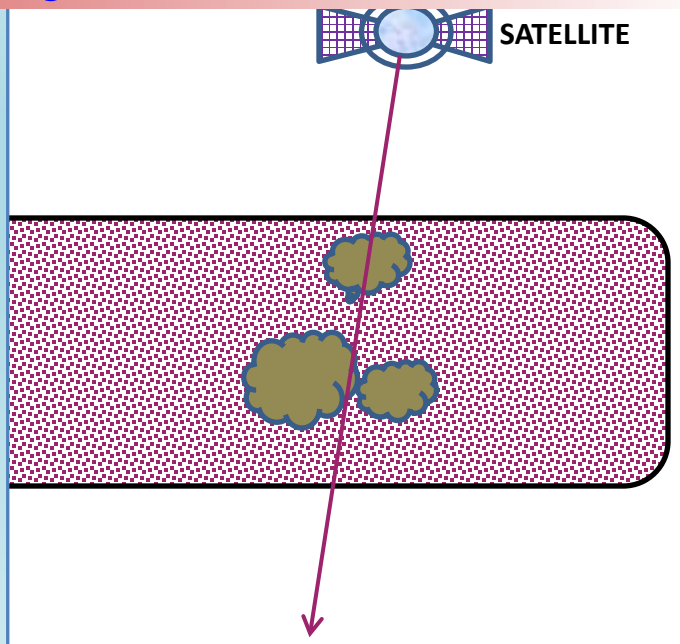
Introduction

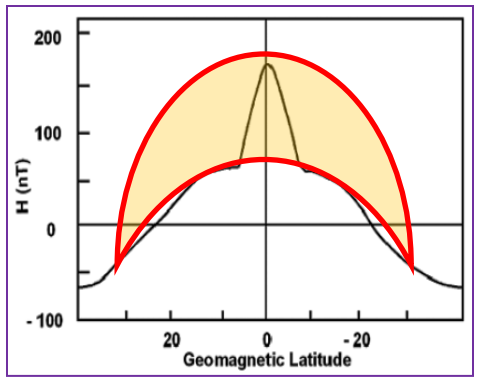


Low-Latitude Electrodynamics









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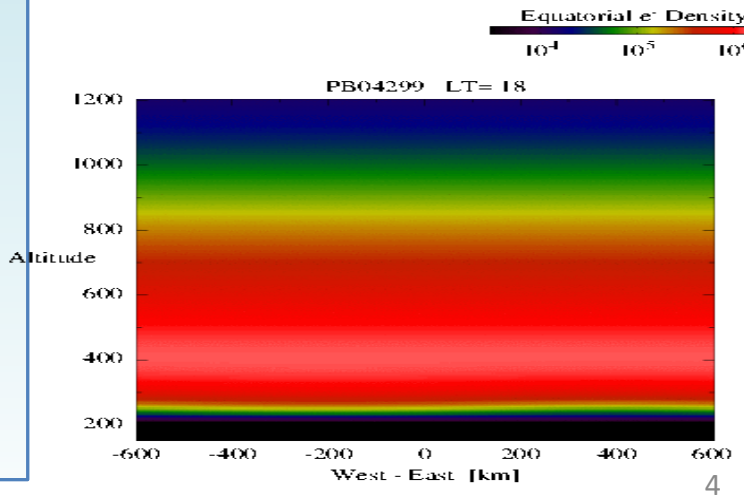


Retterer, [2008a, b]

Ionospheric Parameters: EEJ, TEC & S_4 Index

Equatorial Electrojet (EEJ) Measurement

- Eastward Current due to streaming movement of laterally limited (±3°) charged particles in the lower ionosphere during day along magnetic equator.

$$EEJ = H_{Equator} - H_{offEquator}$$

Total Electron Content (TEC) Measurement

- Number of free electrons in a rectangular solid with a one-square-meter cross section extending from the receiver to the satellite.

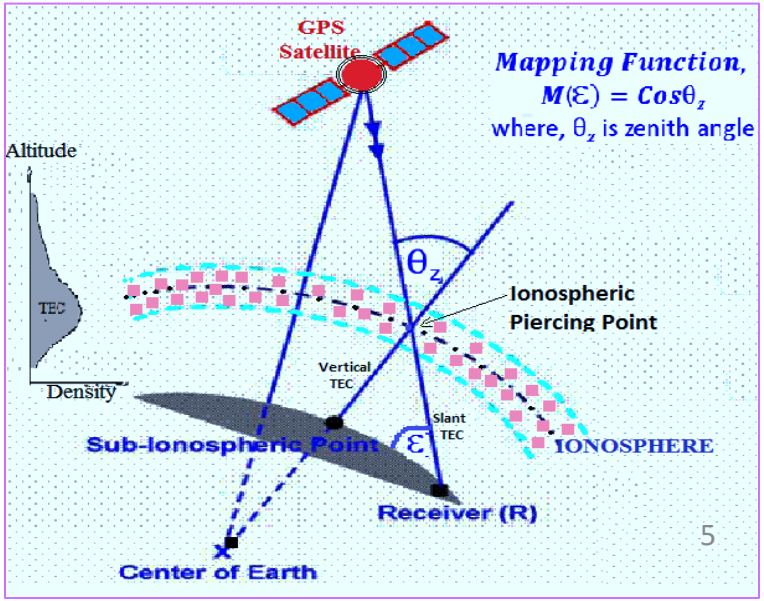
$$TEC = \int_{Receiver}^{Satellite} n(h)dh$$

$1\,\mathbf{TECU} = 10^{16}$ electrons/m^2

Ionospheric Scintillations Measurement

- Rapid fluctuation of the phase and intensity of signal that passed through ionosphere.
- **S4 index**: Normalized standard deviation of signal intensity,

$$S_4 = \frac{\sqrt{(< I^2 > - < I >^2)}}{< I >}$$



Approach

Magnetometer Locations

Jicamarca:-

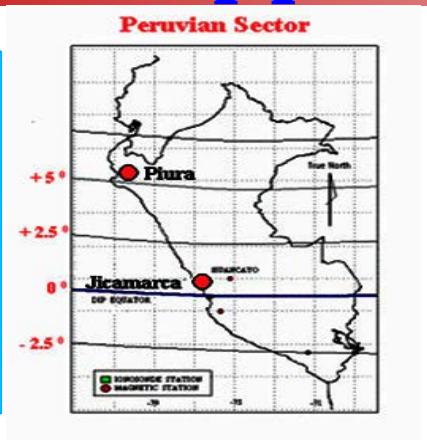
Geographic: 11.92°S; 283.13°E

Geomagnetic: 0.8°N

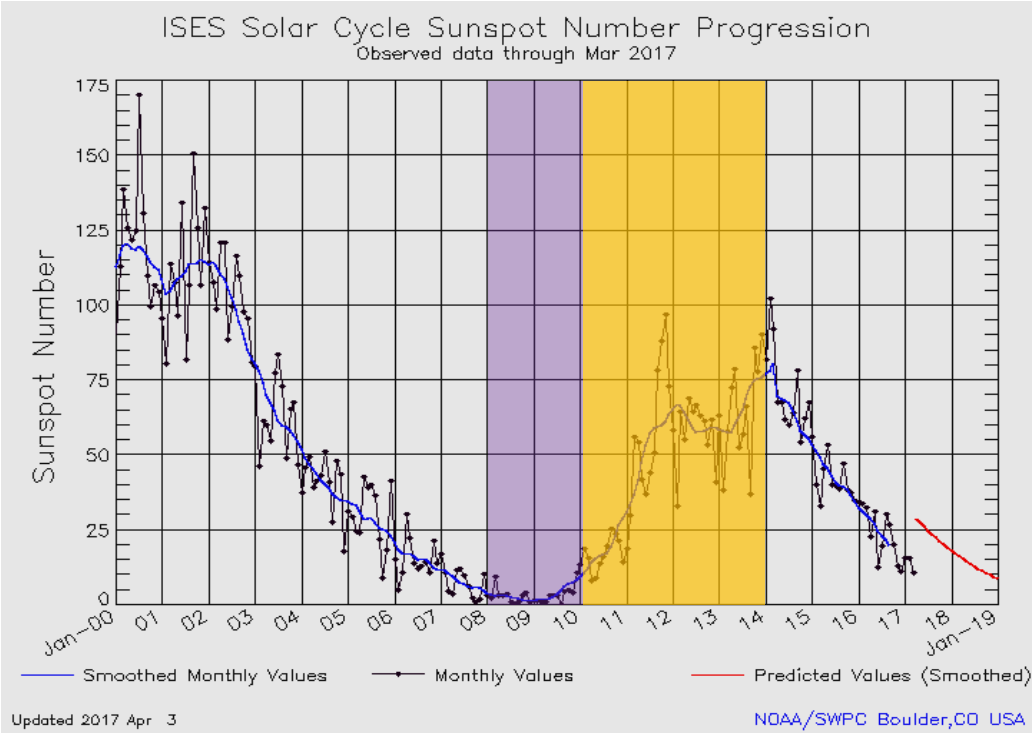
Piura:-

Geographic: 5.18°S; 279.36°E

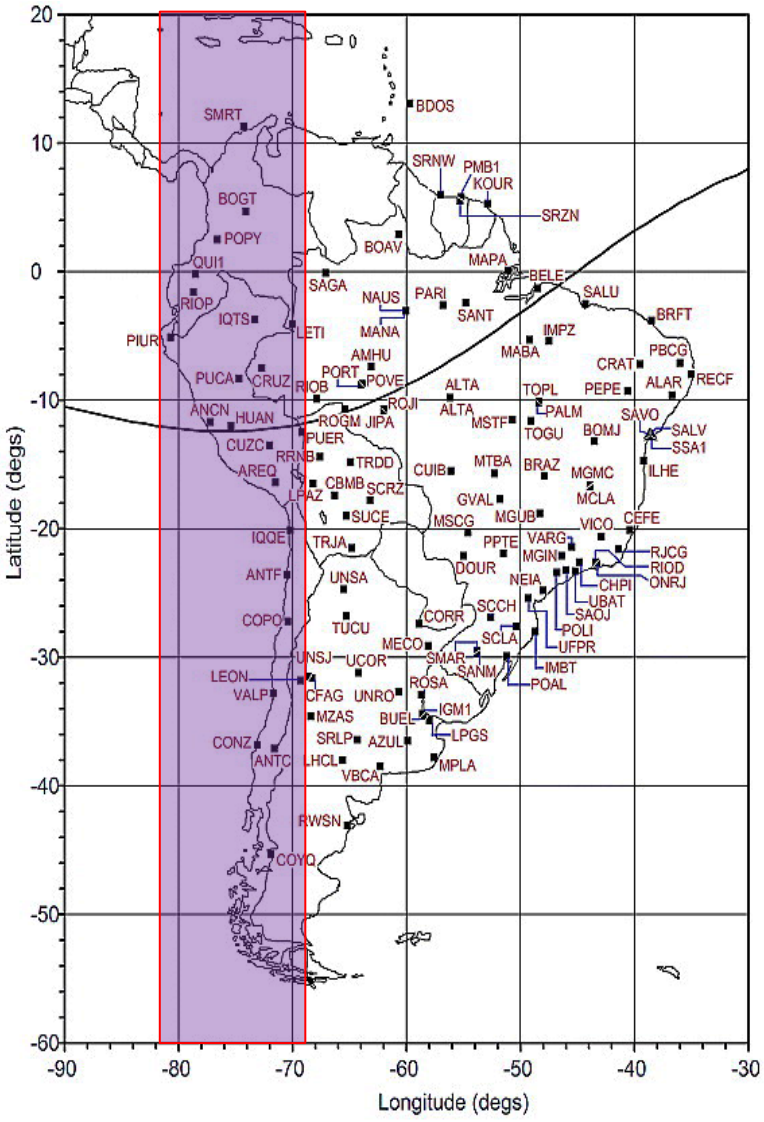
Geomagnetic: 6.8°N



Data Selection



GPS Locations



Analysis: EEJ

Magnetometer Locations

Jicamarca:-
Geographic: 11.92°S; 283.13°E
Geomagnetic: 0.8°N

Piura:-
Geographic: 5.18°S; 279.36°E
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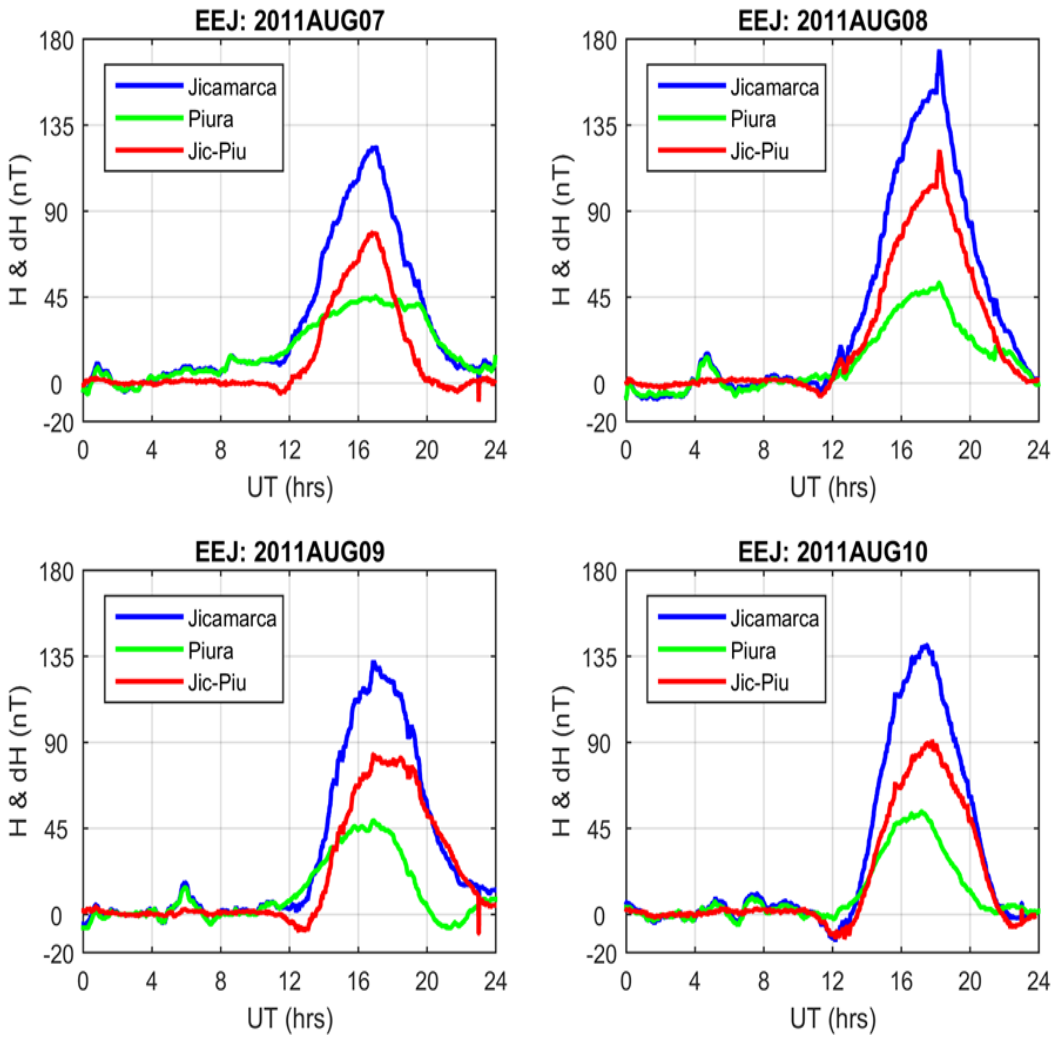
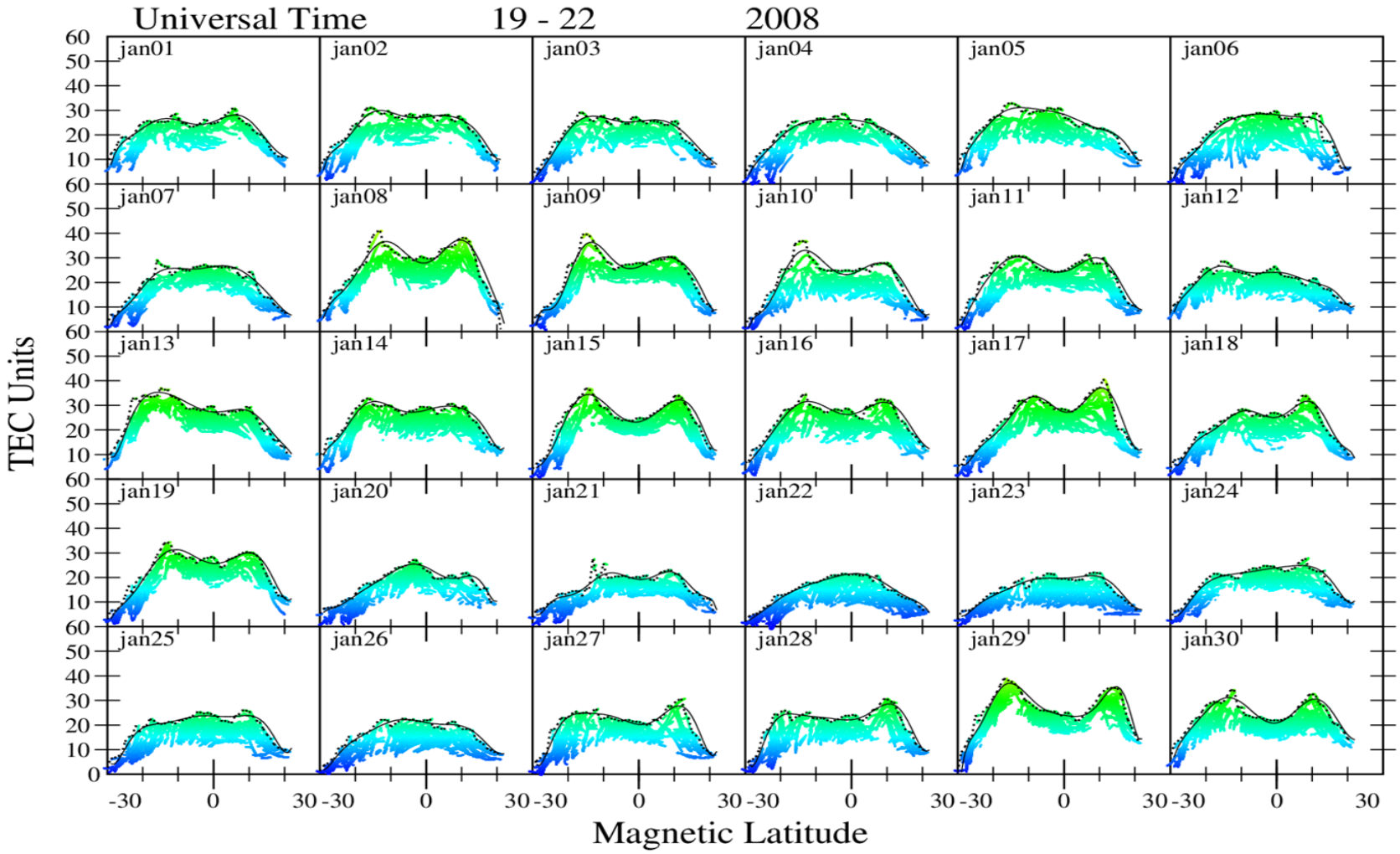


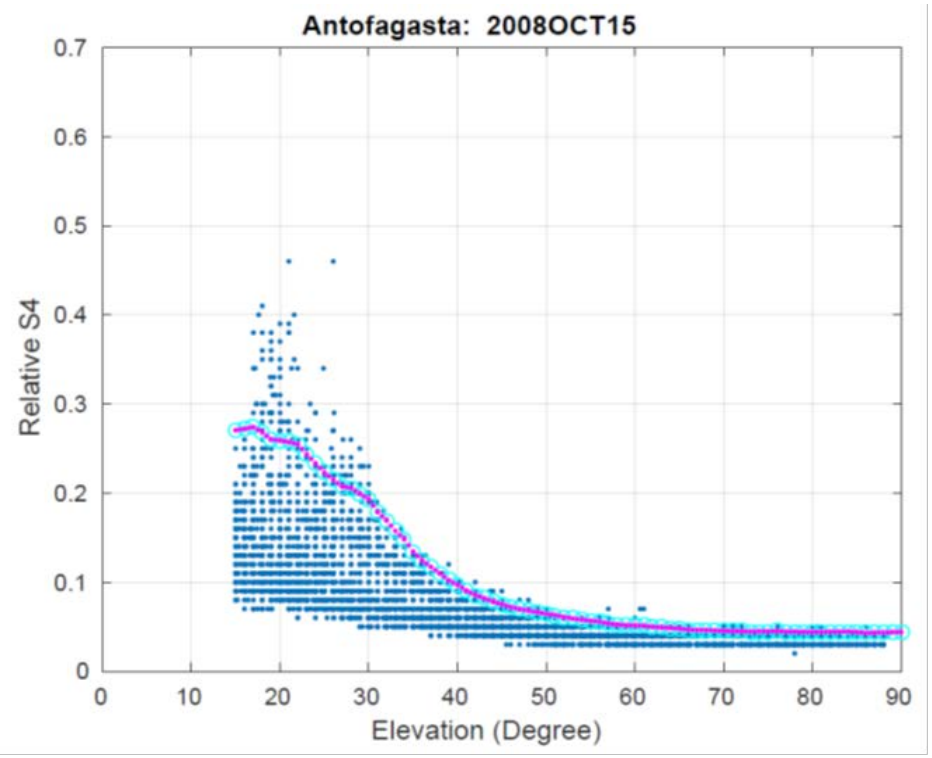
Evaluated EEJ during ramp up phase of solar cycle 24.

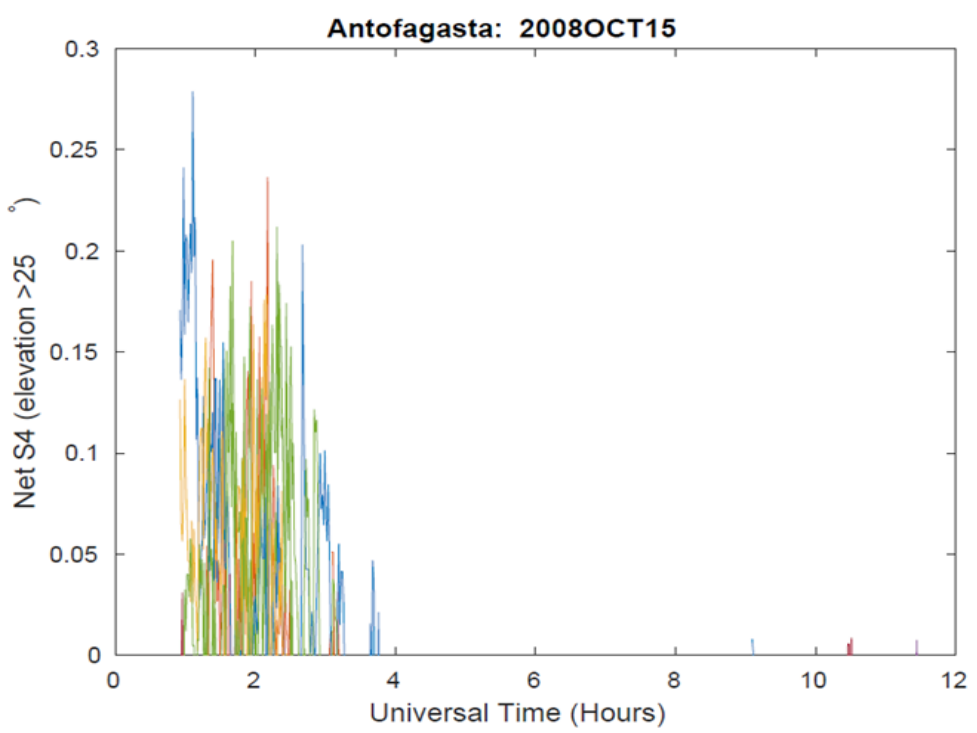
Analysis: TEC Strengths



- Dotted line:- Maximum values of TEC data
- Continuous curve:- Fitted data points of Maximum TEC.

Analysis: S_4 Index

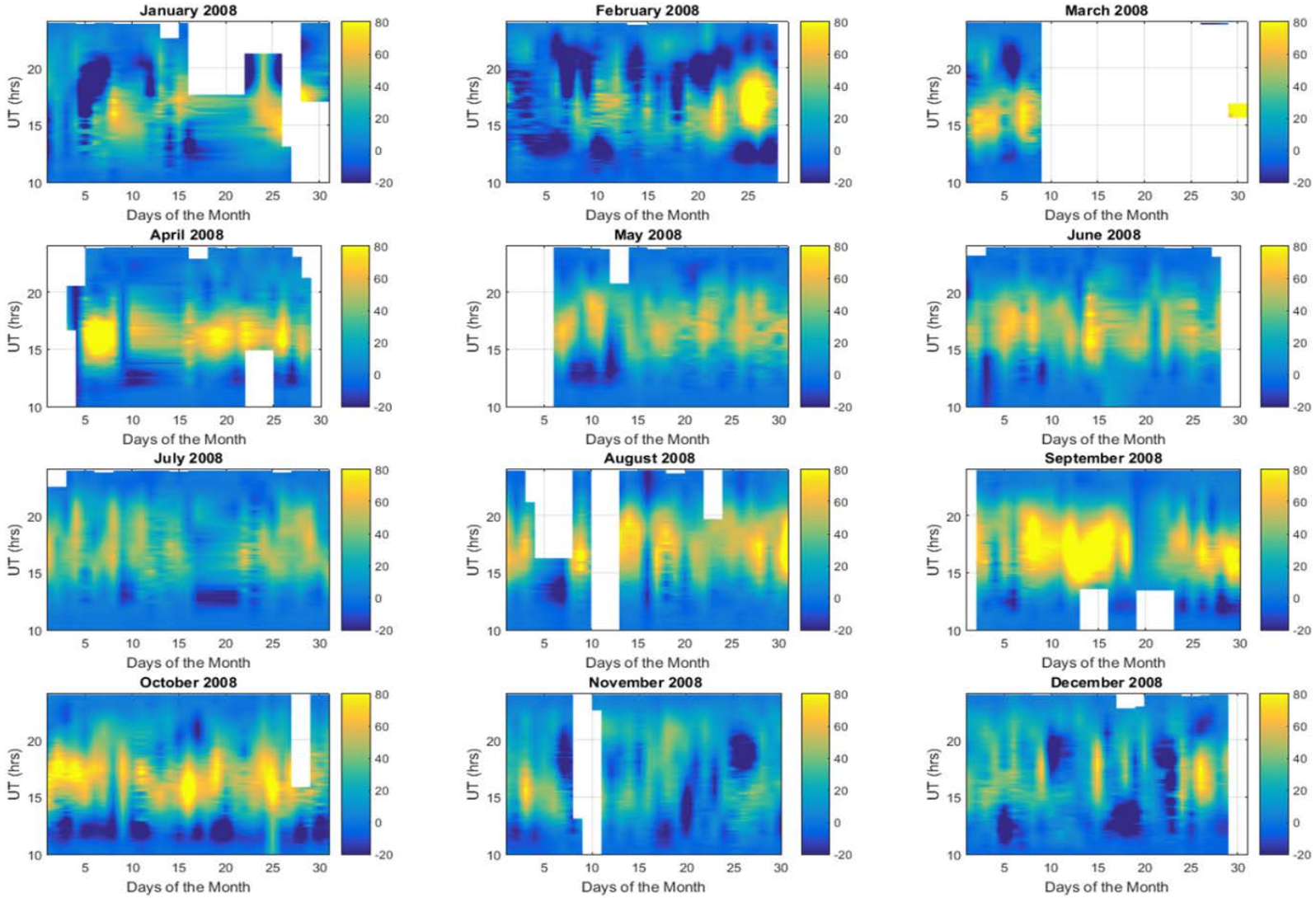




Left: Relative S4 index observed at Antofagasta GPS station and threshold line (pink) against elevation.

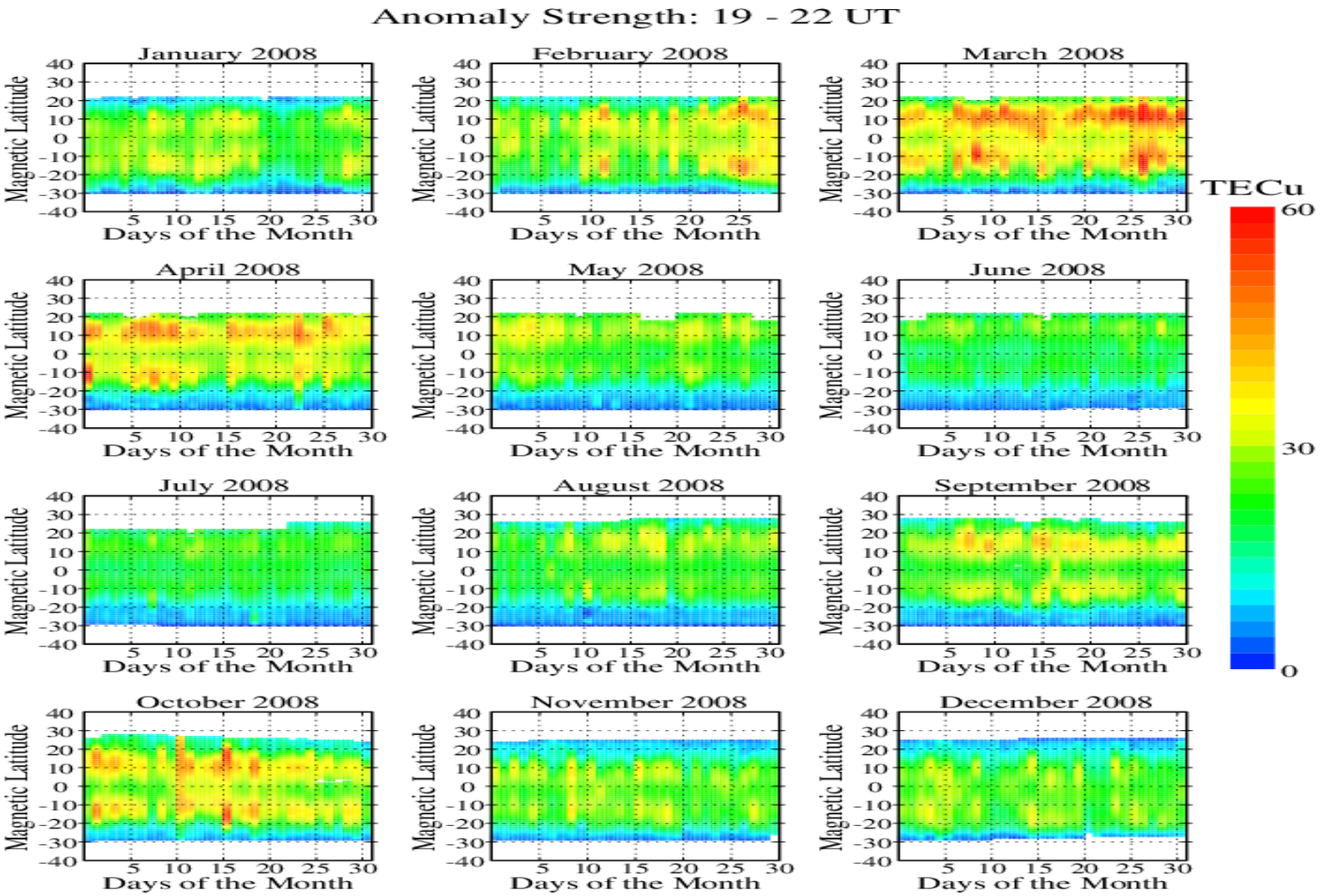
Right: Net S4 index against UT after subtracting the background and low elevation contribution.

Results: EEJ



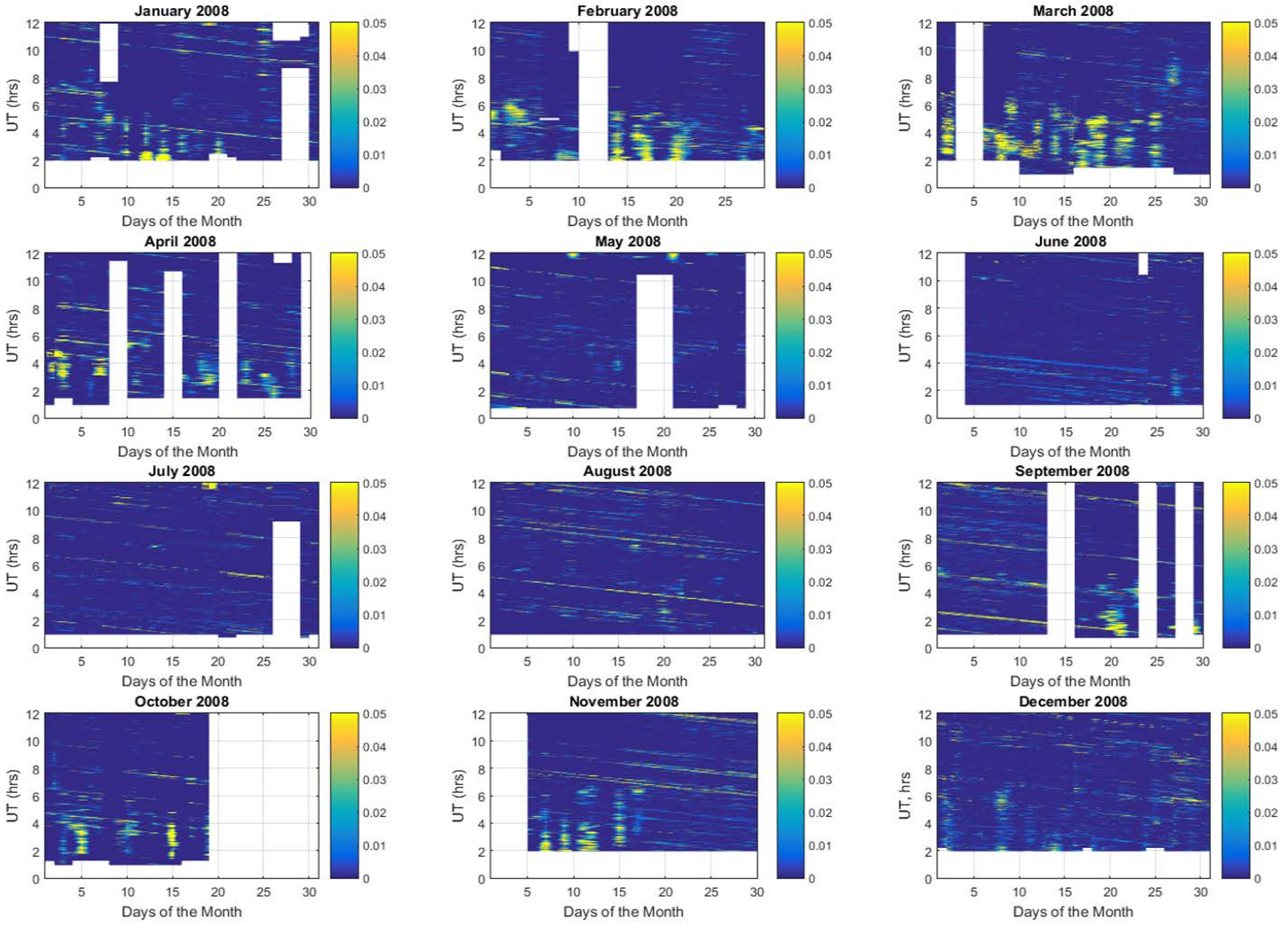
Day-to-day variability of EEJ during 10 - 24 UT of the day observed using magnetometers located at Jicamarca and Piura stations during solar minimum 2008

Results: TEC Anomaly Strength



Latitudinal distribution of day to day variability TEC profiles with ±30˚ from magnetic equator in the Peruvian sector

Results: S_4 Index



Day-to-day variability of S4 index during 00 - 12 UT obtained from GPS receivers spread on magnetic equator to either sides of anomaly region during solar minimum 2008.

Results: Relationship of EEJ, TEC & S_4 Index

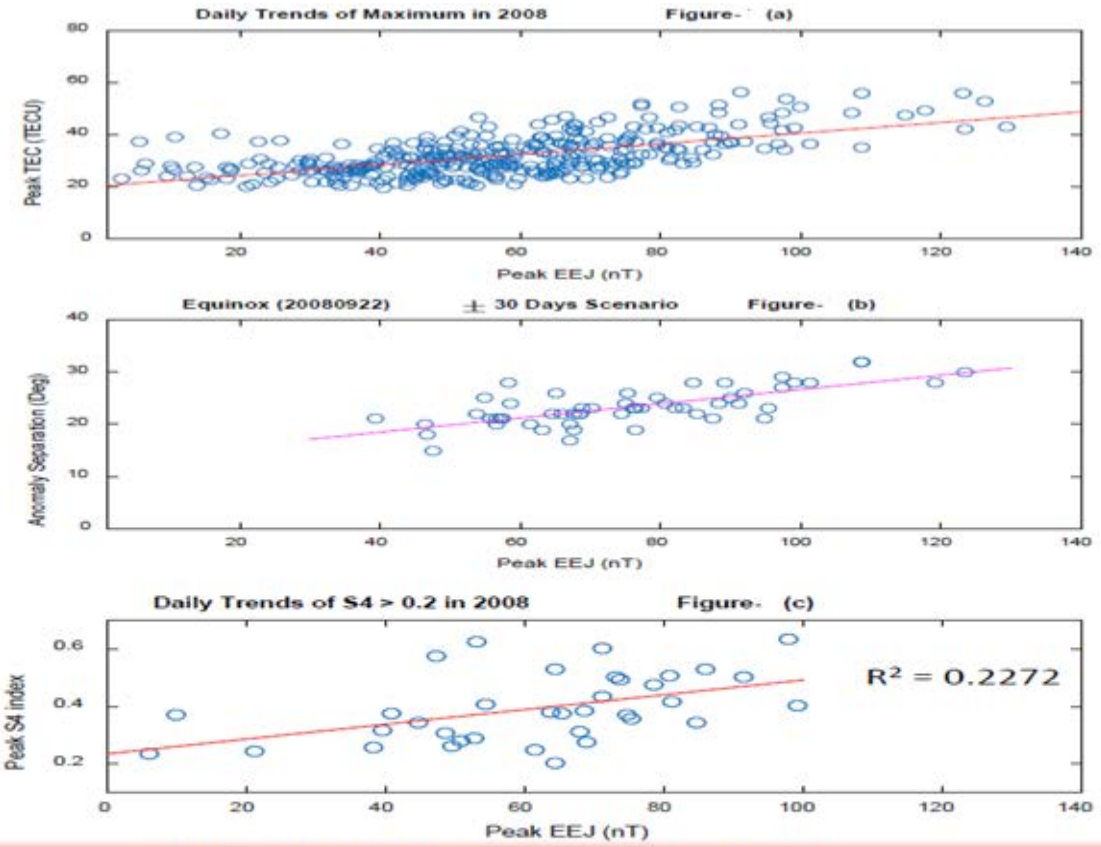
Correlation analysis of the daily trends of the peak value of EEJ in the year 2008 with

(a) maximum TEC during 19 - 22 UT

(b) the separation of the anomaly crests on equinox (September - 22) ± 30 days

(c) S4 index greater than 0.2

(d) S4 less than 0.2 observed during 00-12UT.



AGU PUBLICATIONS

Radio Science

RESEARCH ARTICLE
10.1002/2016RS005966

Special Section:
Ionospheric Effects Symposium 2015

On the mutual relationship of the equatorial electrojet, TEC and scintillation in the Peruvian sector

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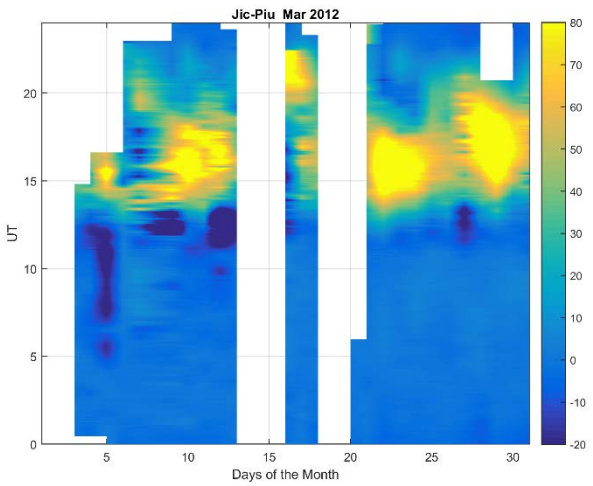
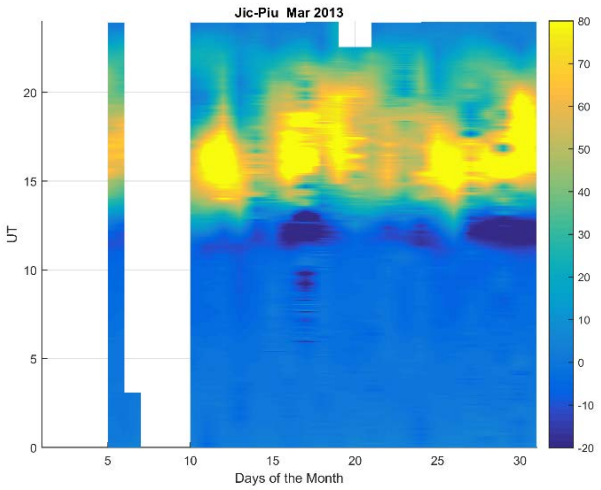
[1]Physics Department, Boston College, Chestnut Hill, Massachusetts, USA, [2]Institute for Scientific Research, Boston College, Newton, Massachusetts, USA, [3]Radio Observatorio de Jicamarca, Instituto Geofísico del Perú, Lima, Peru

Key Points:

EEJ During Solar Maximum

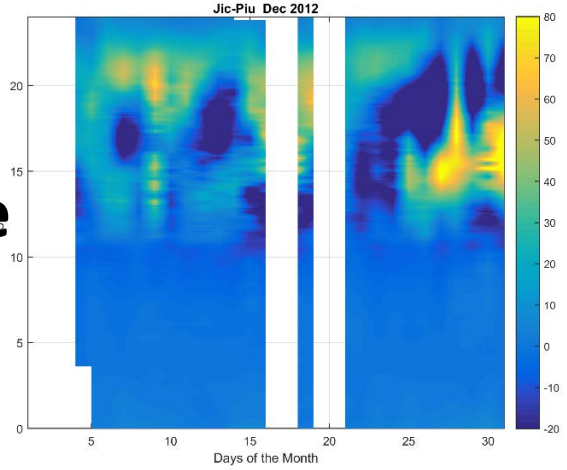
March Equinox

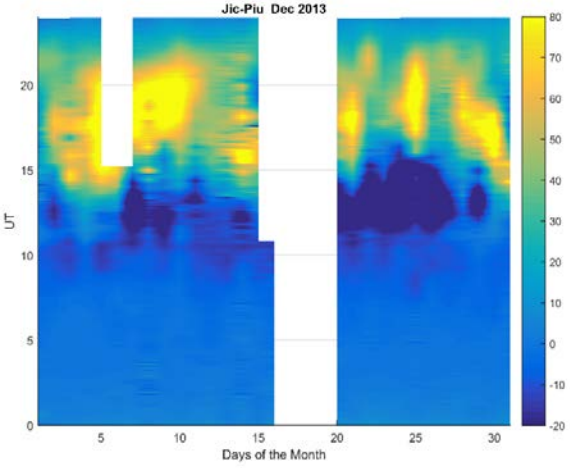




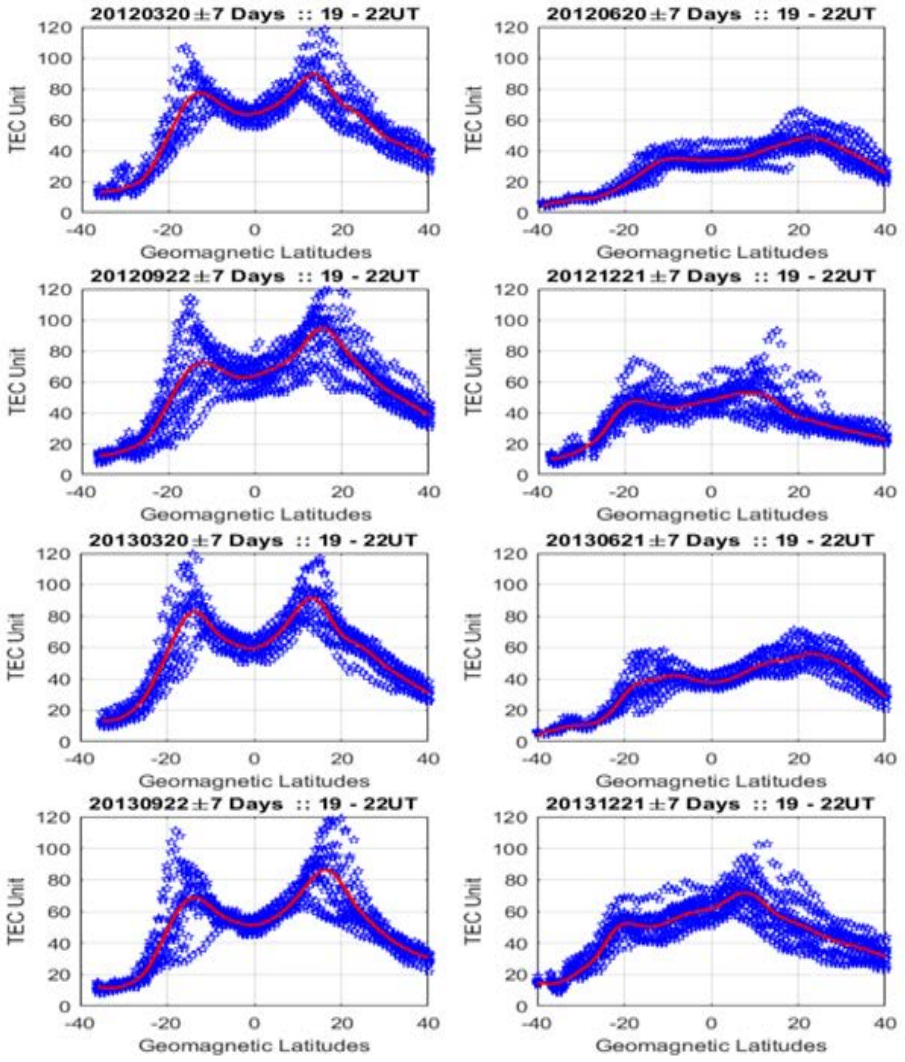
Day-to-day variability of EEJ during 00 - 24 UT of the day observed using magnetometers located at Jicamarca and Piura stations during solar maximum years 2012 & 2013.

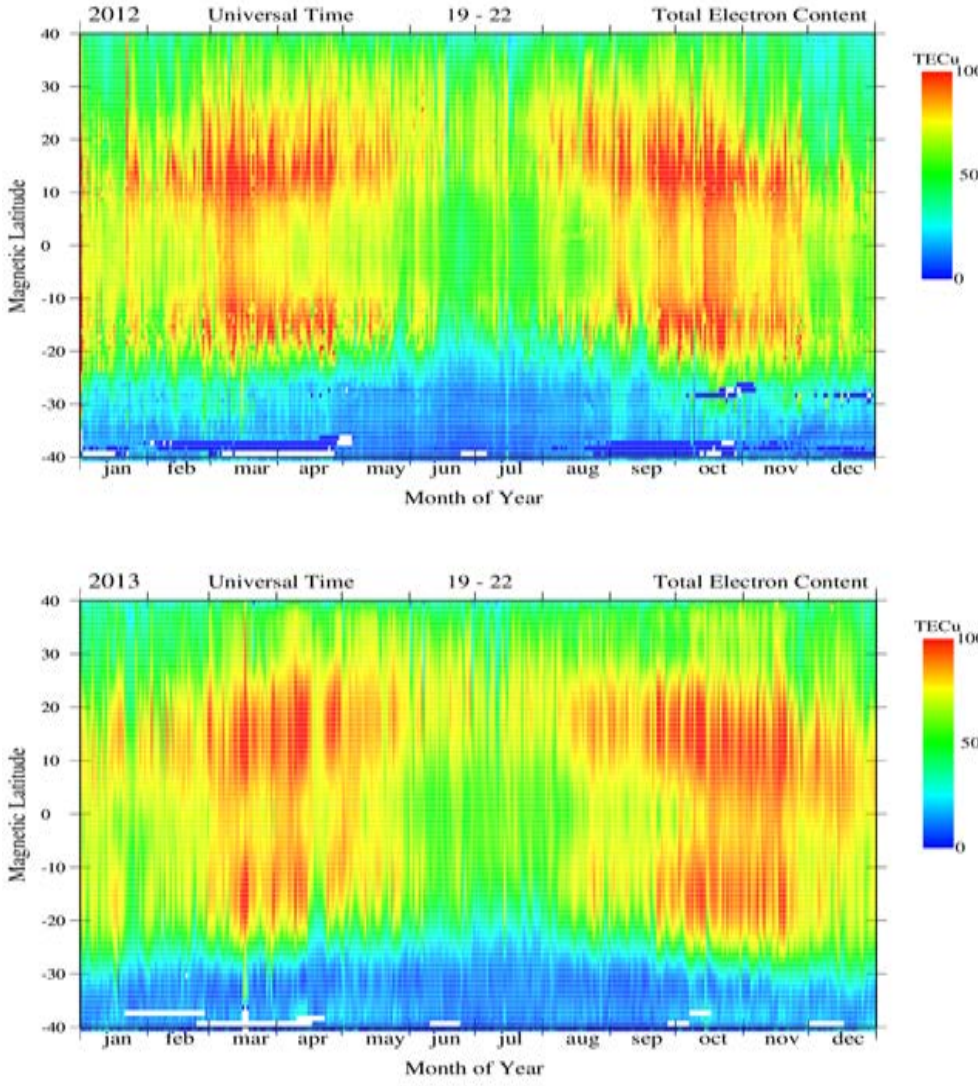
December Solstice





Equatorial Anomaly During Solar Maximum

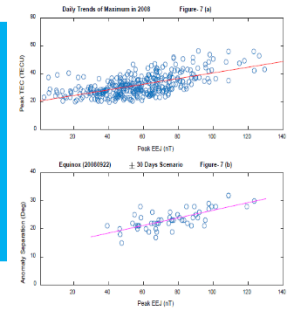




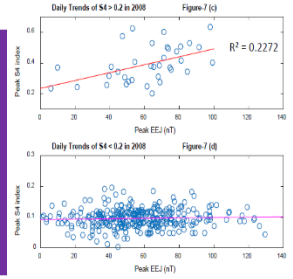
Left:-*Fifteen days scatter plots of latitudinal and seasonal variation of EIA crests.*

Right:- *EIA crests of TEC in the western longitudes (70°W-80°W) in the year 2012 and 2013*

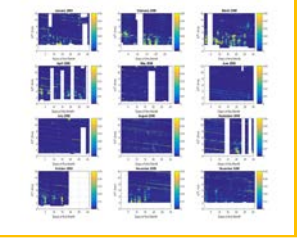
Summary



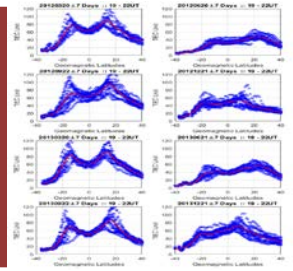
A clear picture of the linear dependence of peak values of afternoon TEC and anomaly separation is seen on noontime EEJ strengths in the low latitude ionosphere.



Minor correlation of peak value of EEJ with net S4 index greater than 0.2 likely exists, but there is no correlation at all below 0.2 for the solar minimum year 2008.



Noontime EEJ strengths is not a good predictor for the nighttime scintillation during solar minimum period in the low latitude ionosphere.



Extending this analysis to solar maximum with larger database of nighttime S4 index will certainly be worthwhile project in accessing correlations with peak values of daytime EEJ.

Thank You!