EFFECT OF GEOMAGNETIC STORM IN IONOSPHERE OVER NEPAL

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Outlines

- Introduction
- Datasets and Methodology
- Results and Discussion
- Conclusion
- Acknowledgements
- References

Introduction

Geomagnetic Reconnection

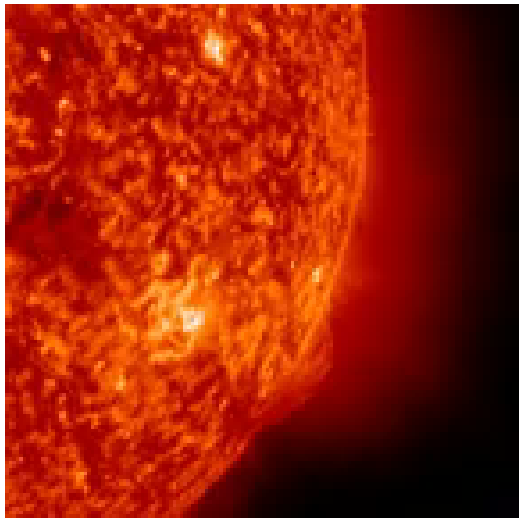


Figure: CME

https://www.youtube.com/shorts/p3luob5K3g4

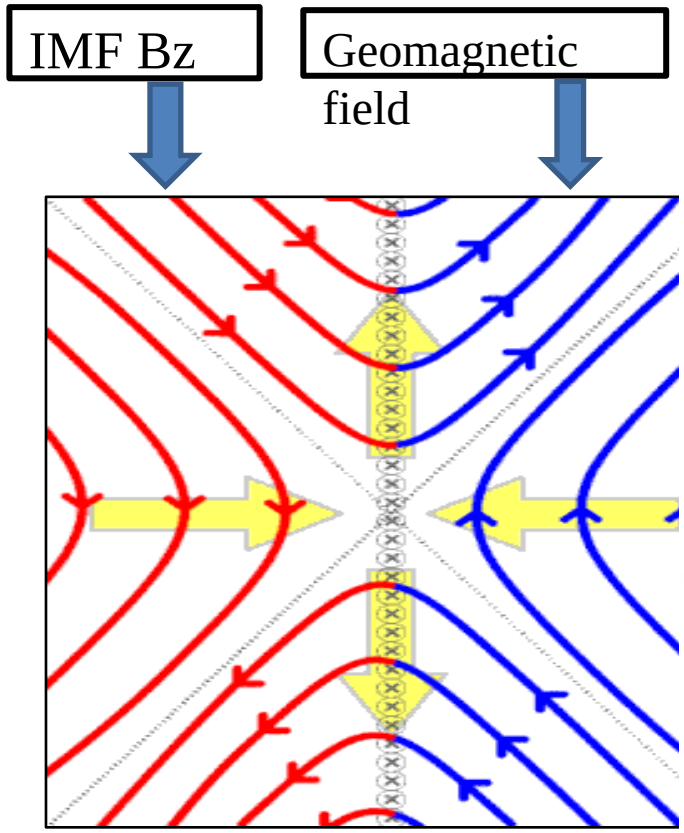


Figure: Magnetic reconnection between IMF Bz and geomagnetic field

Oieroset et al., 2001, *Nature*, 412 (6845): 414–417

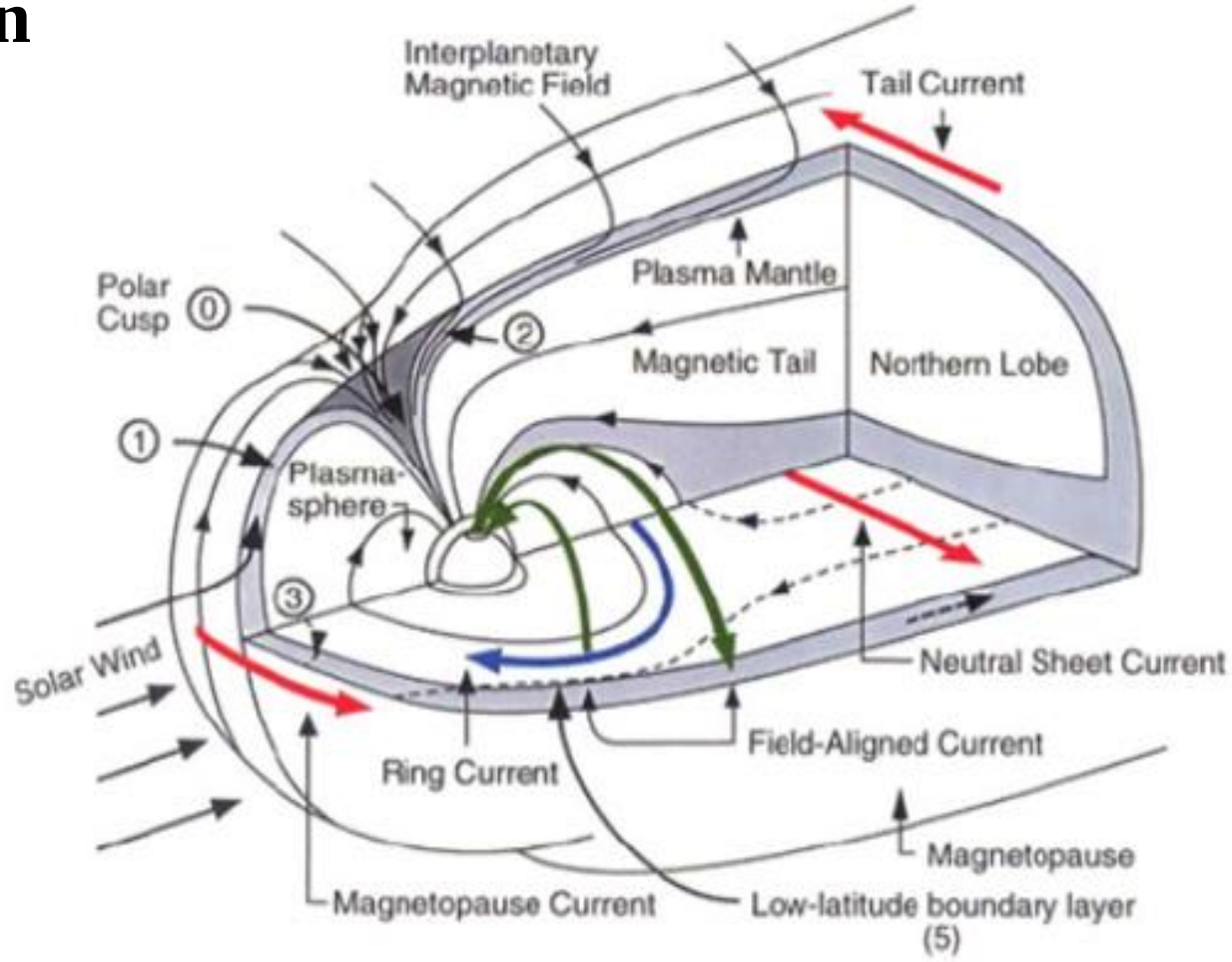


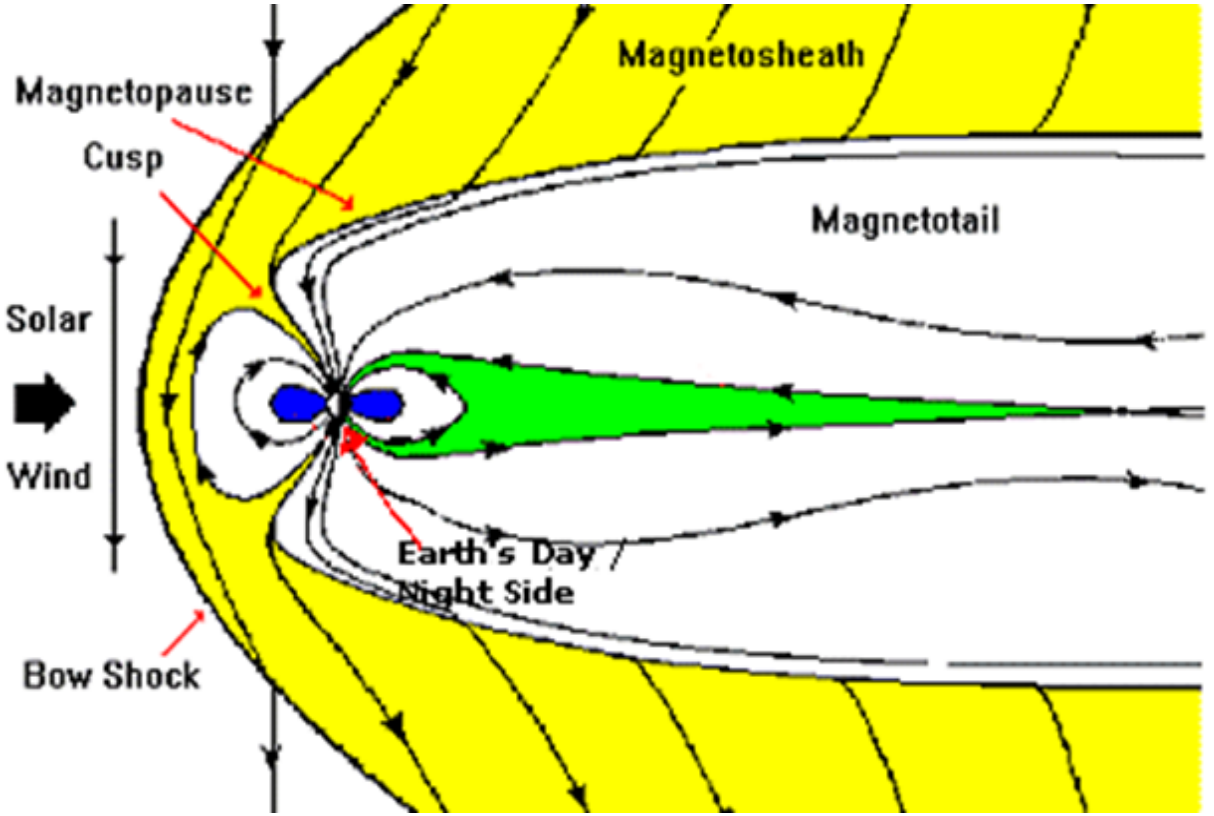
Figure: Illustration of Magnetosphere topology

Sandholt et al., 2006, *Dayside and polar cap aurora*, Germany

Introduction Contd…

Types of geomagnetic storms

- Storms (on the basis of Dst)
  - Weak storm (-30 to -50) nT
  - Moderate (- 50 to -100) nT
  - Strong storm (- 100 to -200) nT
  - Severe storm (-200 to -350) nT
  - Great (< -350) nT
- Substorm (short duration than storm)
- Super substorm (SML/AL < - 2500 nT
- HILDCAA (AE > 1000 nT, 2 days)



https://www.jpl.nasa.gov/nmp/st5/SCIENCE/disturbances.html#

Geomagnetic storms of solar cycle 24 are studied

(Loewe & Prölss, 1997)

Introduction

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Types of Geomagnetic Effects

Geomagnetic storm, Substorm, Super substorm, and HILDCAA

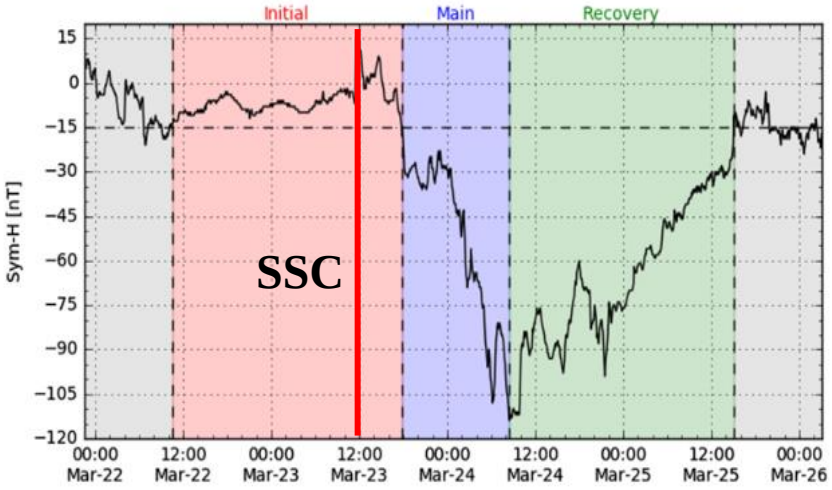

Figure: Geomagnetic storm

Wharton, 2020, *J. Geophys. Res.: Space Phys.*, 125

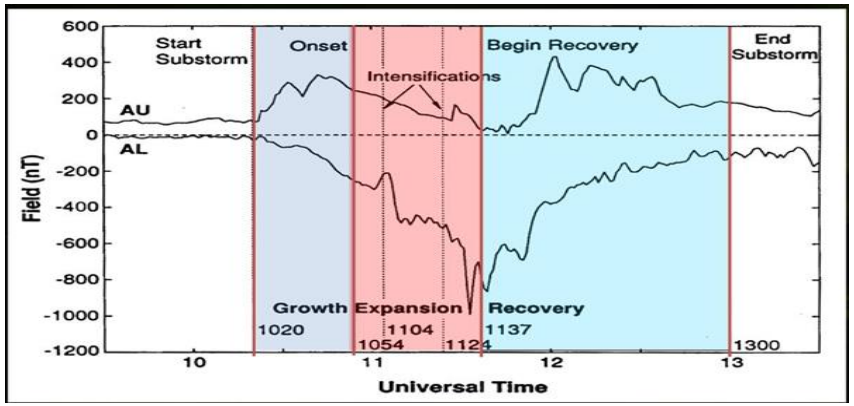

Figure: Substorm

McPherron, 1995, *Magnetospheric dynamics*, Cambridge Press

24 November 2001

AL or SML < -2500 nT

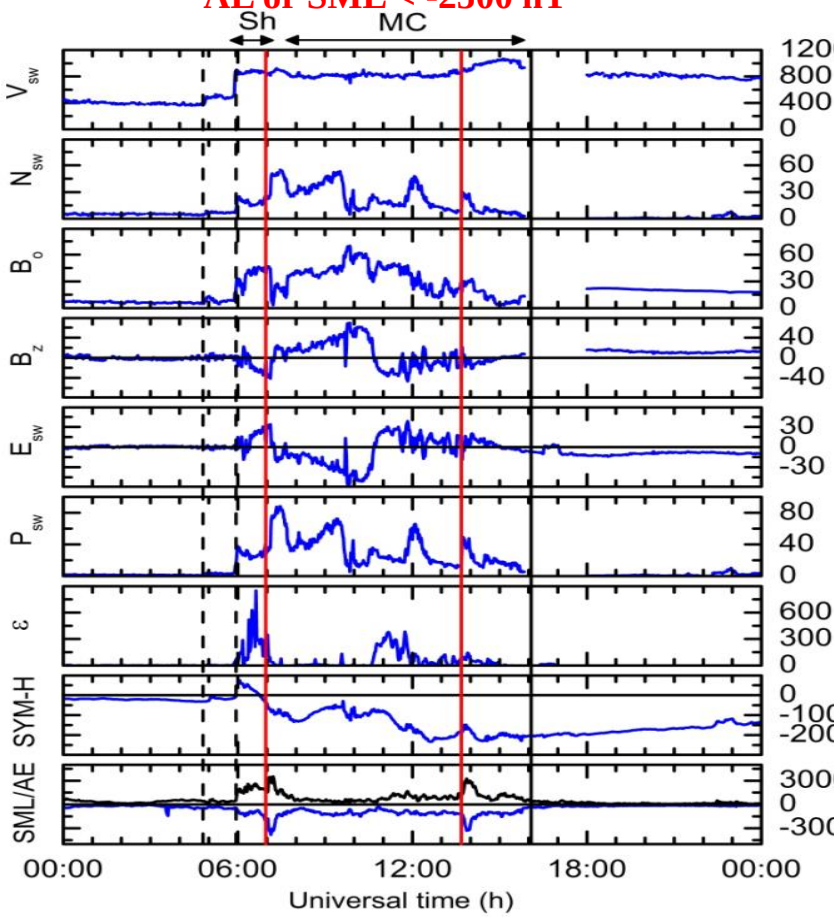

Figure: Super substorm

Tsurutani et al. 2015, *Annales Geophysicae*, 33(5), 519–524

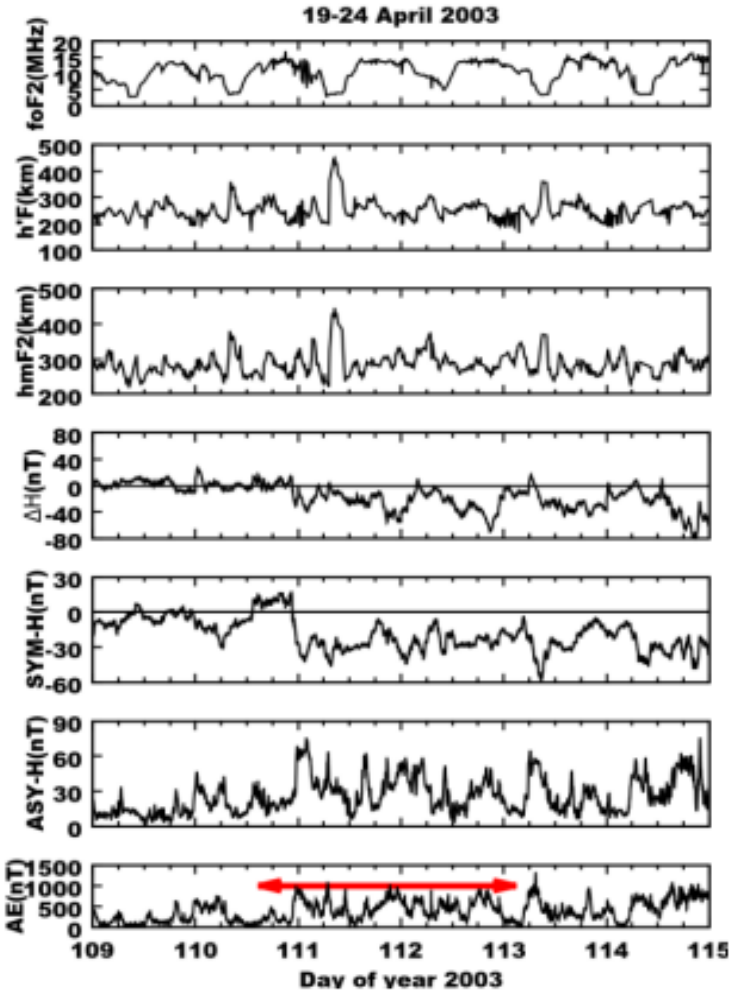

Figure: HILDCAA

Adhikari et al, 2017, *JIST*, 22(1), 34-40.

Introduction

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Ionosphere

A shell of partially ionized atmosphere surrounding the Earth

- Altitude ~ (60-1000) km
- Inner edge of magnetosphere
- Ionized by shorter wavelength of radiation
- Affect communication system

D-layer (60- 90) km
E-layer(90-140) km
F-layer(150-1000) km

Factors affecting ionosphere is related to

Location: latitude, longitude, altitude, and local time
Motion of the Earth: diurnal and seasonal
Sun: sunspot cycle, solar disturbances, geomagnetic activities
Lower atmospheric phenomena: gravity wave, earthquake

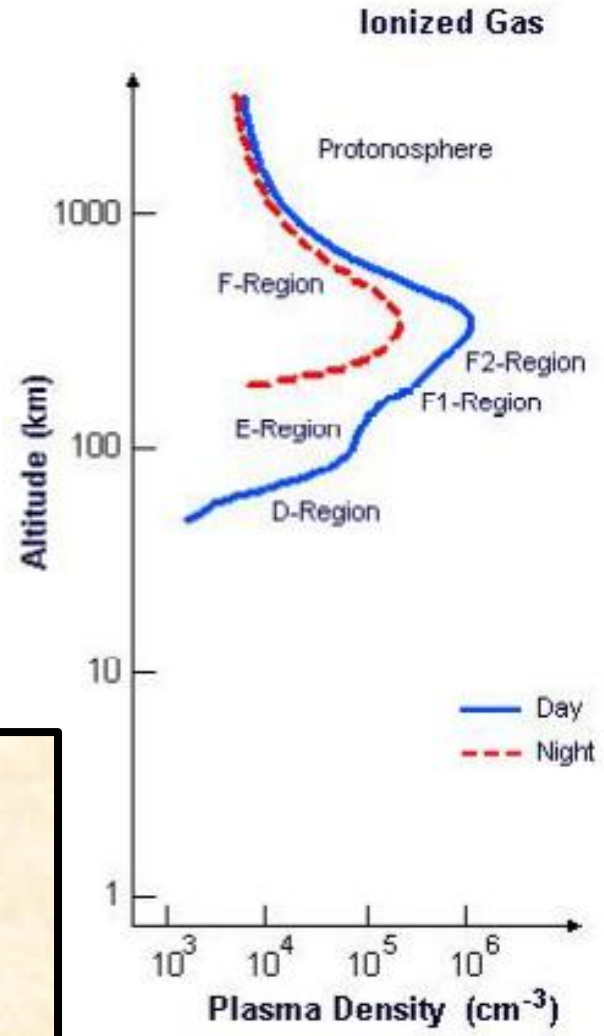


Figure: Ion density profile of ionosphere

Kelley, 1989, *Int. Geophys. Ser*, 43, 437–455.

Datasets and Methodology

Total Electron Content: Extraction and Analysis

- TEC is the number of electrons in a column of a cross section per meter square along a transionospheric path.

- TEC allows to determine the ionospheric delay and change in the direction of wave in the ionosphere.

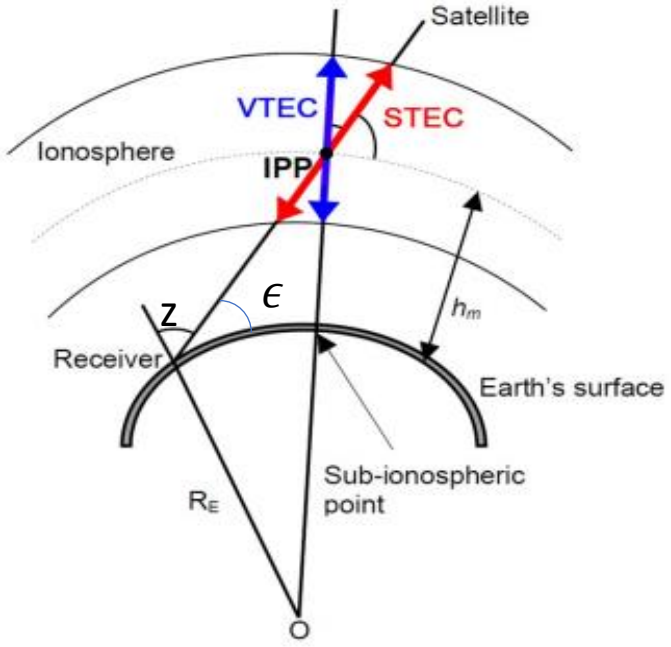
$$I_p = \frac{40.3\,TEC}{f^2}$$

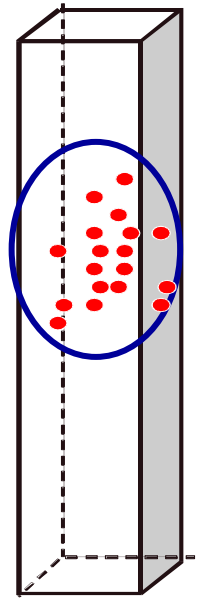
$$STEC = \frac{1}{40.3}\left(\frac{f_1^2 f_2^2}{f_2^2 - f_1^2}\right)(P_1 - P_2)$$

where f_1(1575MHz) and f_2 (1227.6 MHz) are frequencies and P_1 and P_2 are pseudo-ranges

$$VTEC = (STEC - B_s - B_u)\sqrt{1 - \left(\frac{R_E \times \cos\epsilon}{(R_E + h)^2}\right)}$$

where B_s and B_u are satellite and receiver biases.





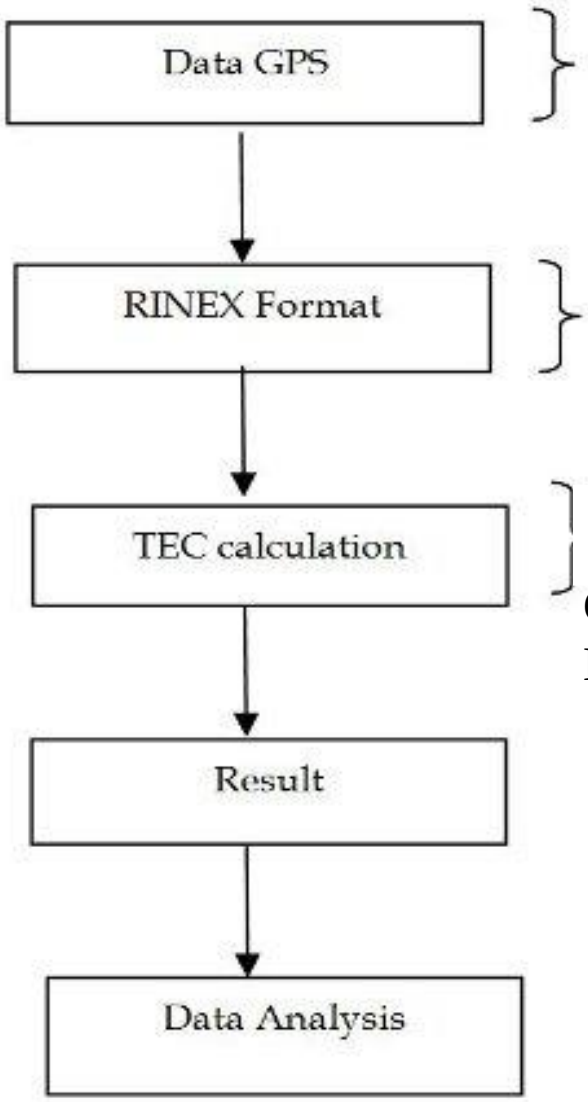
1 TECU = 10^{16} m^{-2}

Figure: Measurement of TEC
Ya'acob et al., 2008, *Int. J. Netw. Secur*, 8(9), 154–160.

Datasets and Methodology

Contd…

Total Electron Content: Extraction and Analysis



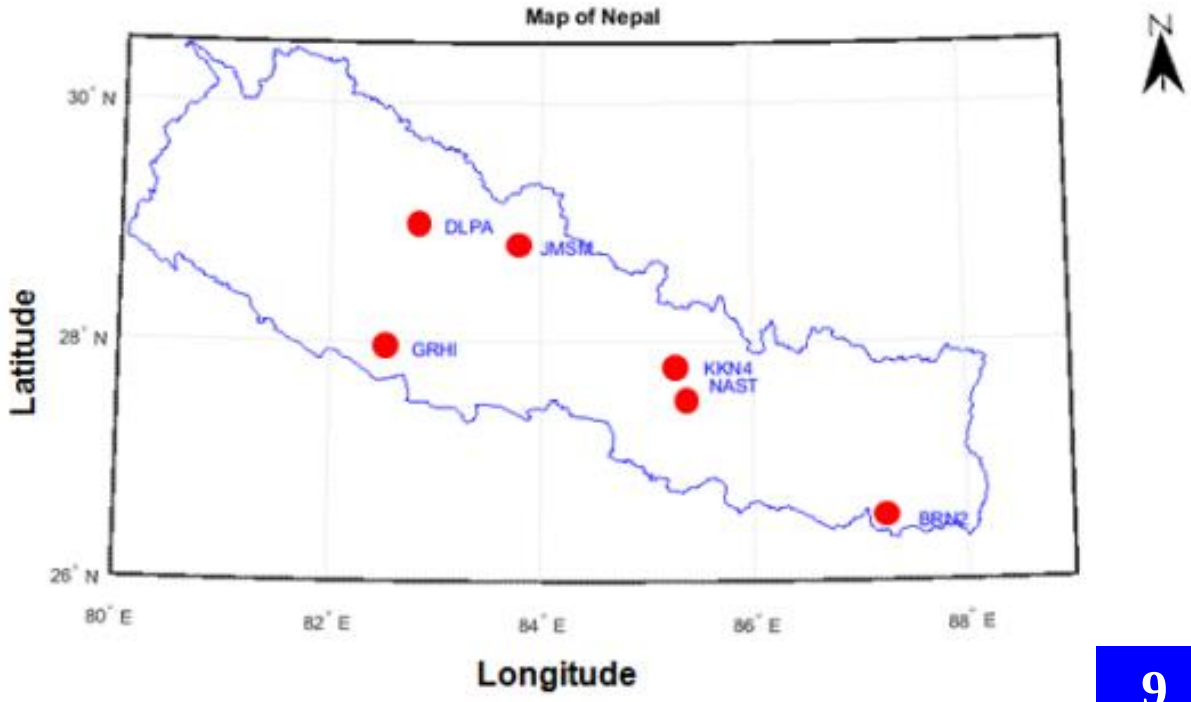
Data collection (e.g~JUPEM)

Select the appropriated RINEX data File

Calculate STEC and VTEC using Matlab software

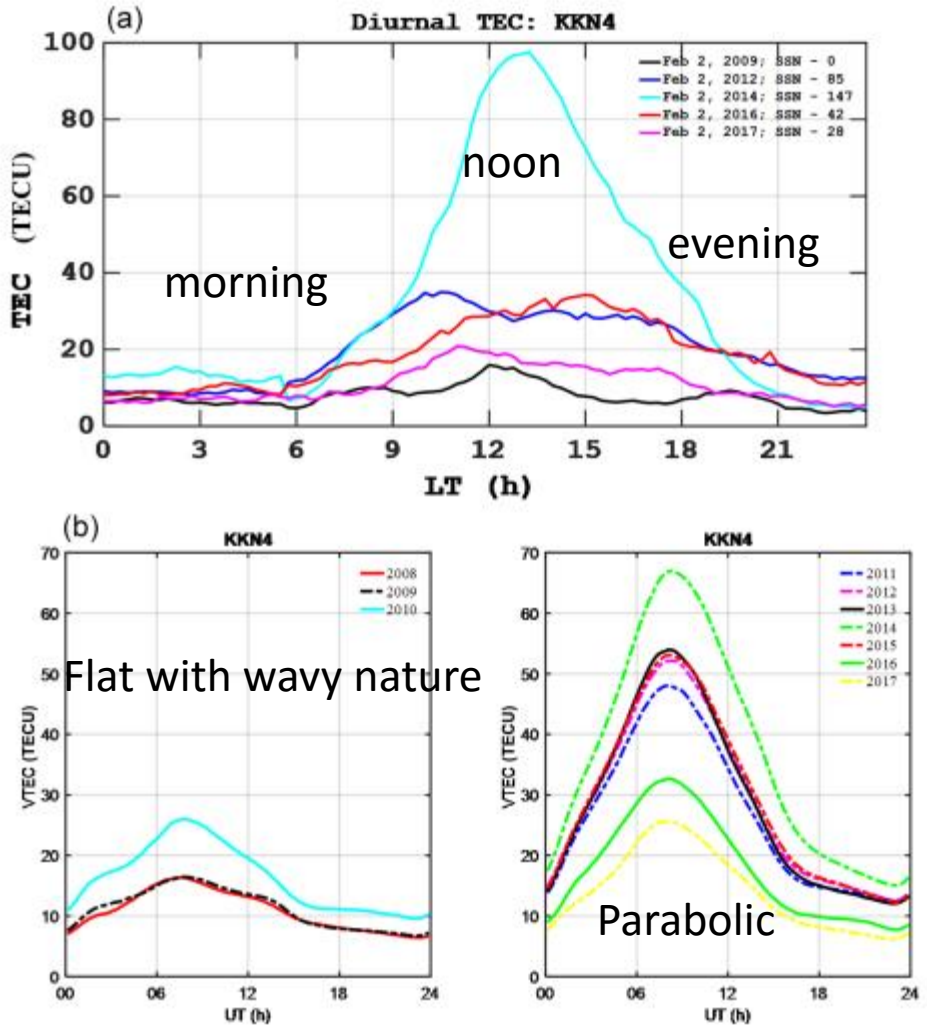
List of GPS stations

1. KKN4 (Kakani, 27.80°, 85.27°)
2. GRHI (Gorahi, 27.95°, 82.49°)
3. JMSM (Jomsom, 28.80°, 83.74°)
4. DLPA (Dolpa, 28.98°, 82.82°)
5. BRN2 (Biratnagar, 26.51°, 87.27°)
6. NAST (Kathmandu, 27.65°, 85.32°)

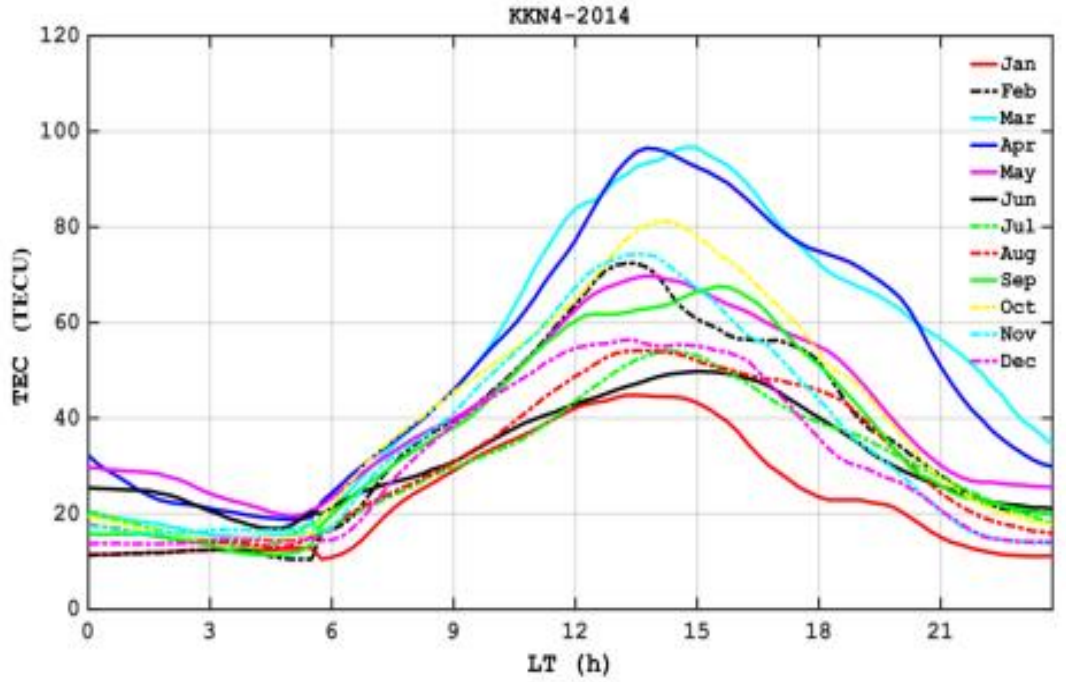


Results and Discussion

Diurnal variation of VTEC



Monthly variation of TEC of year 2014

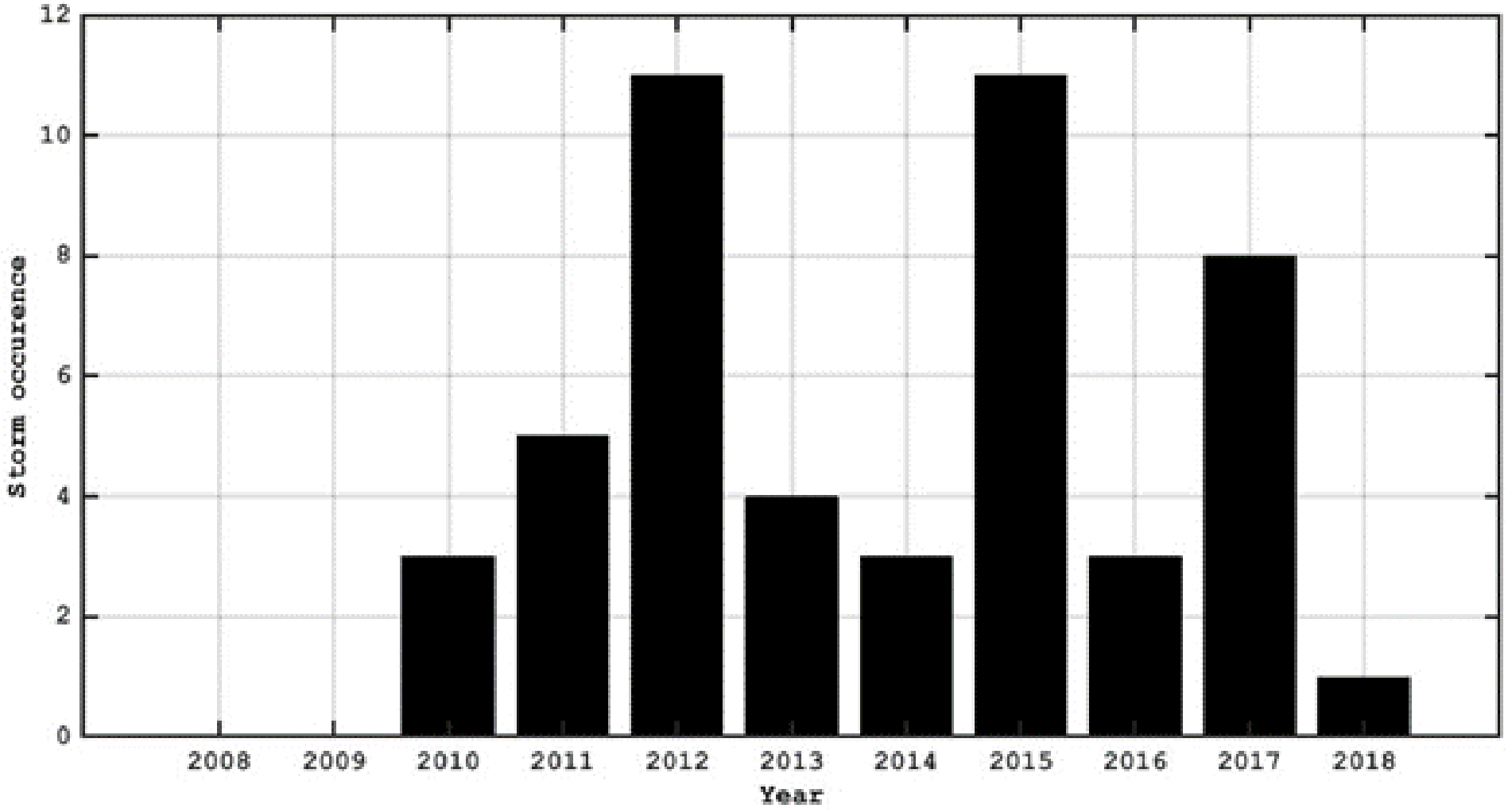


Pandit et al., 2021, *Ann. Geophys.*, 39(4), 743-758.

Results and Discussion

Contd…

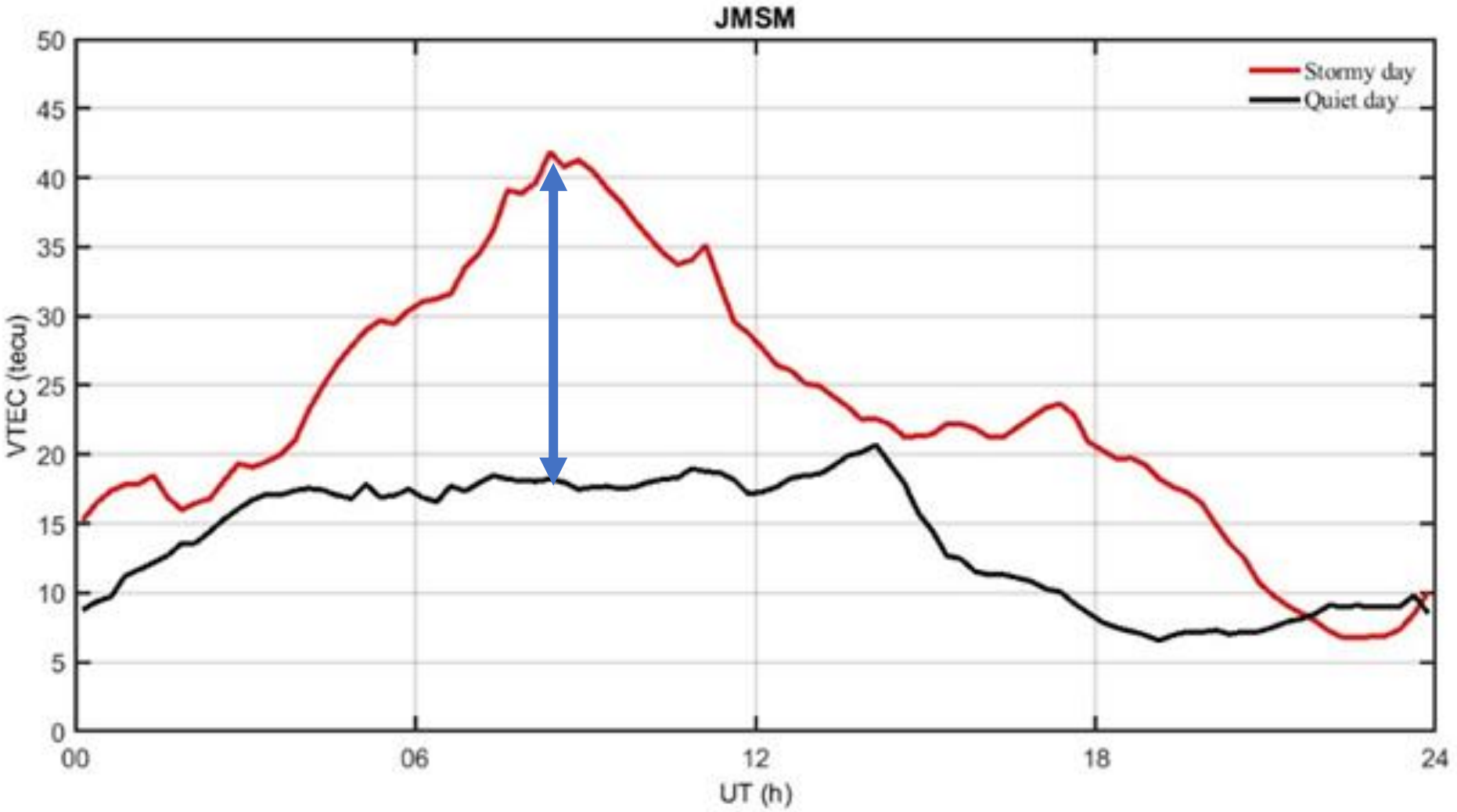
Yearly occurrence of storm of in solar cycle 24 with Kp > 6



Results and Discussion

Contd…

VTEC during stormy day (2010-08-04) and quiet day (2010-08-30) at JMSM station.

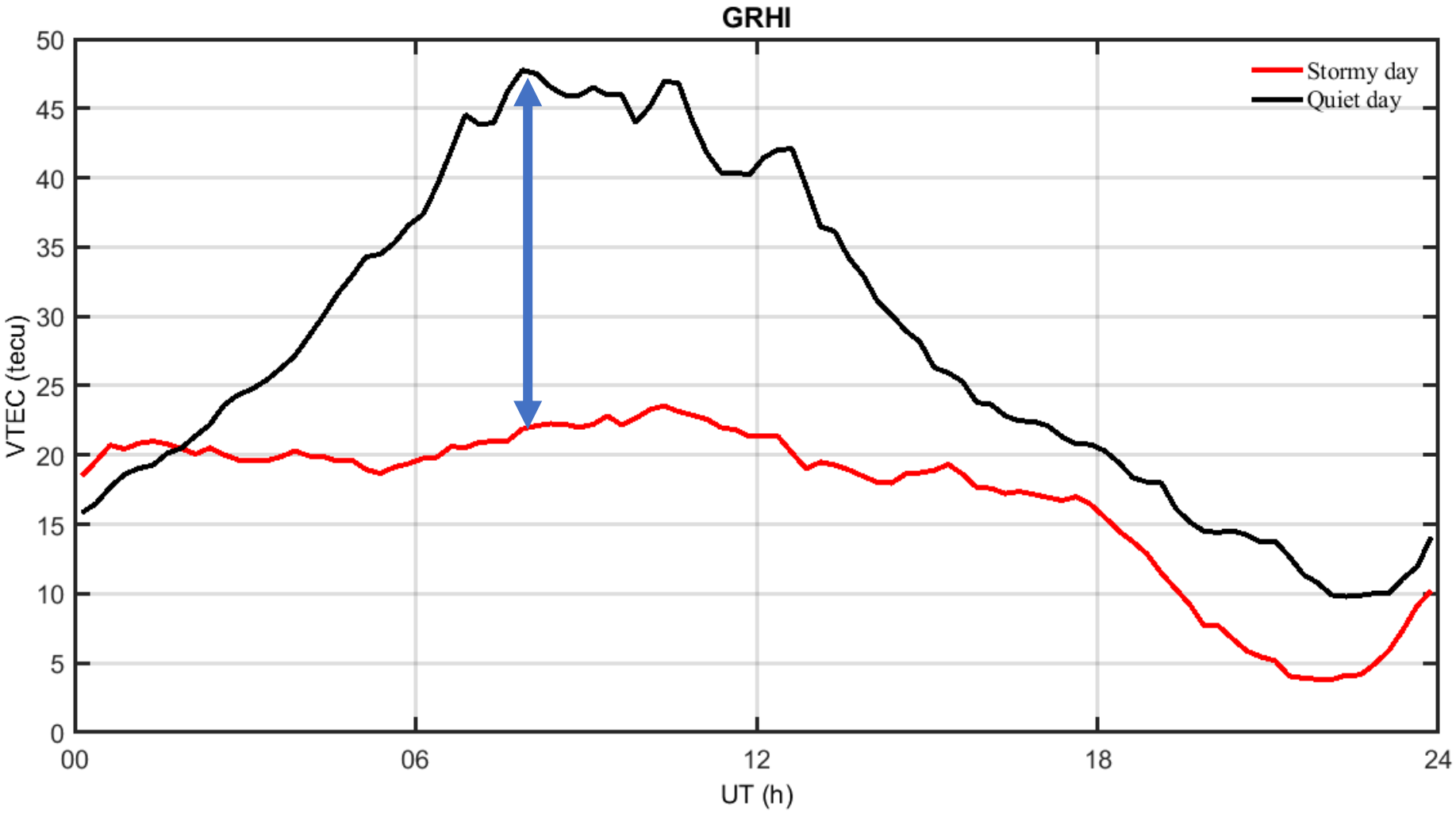


In a study carried by Trivedi et al, 2011 noted that the deviation in VTEC (upto −90%) for the geomagnetic storm occurred on July 17, 2005.

Results and Discussion

Contd…

VTEC during stormy day (2012-07-16) and quiet day (2012-07-13) at GRHI station.



Results and Discussion

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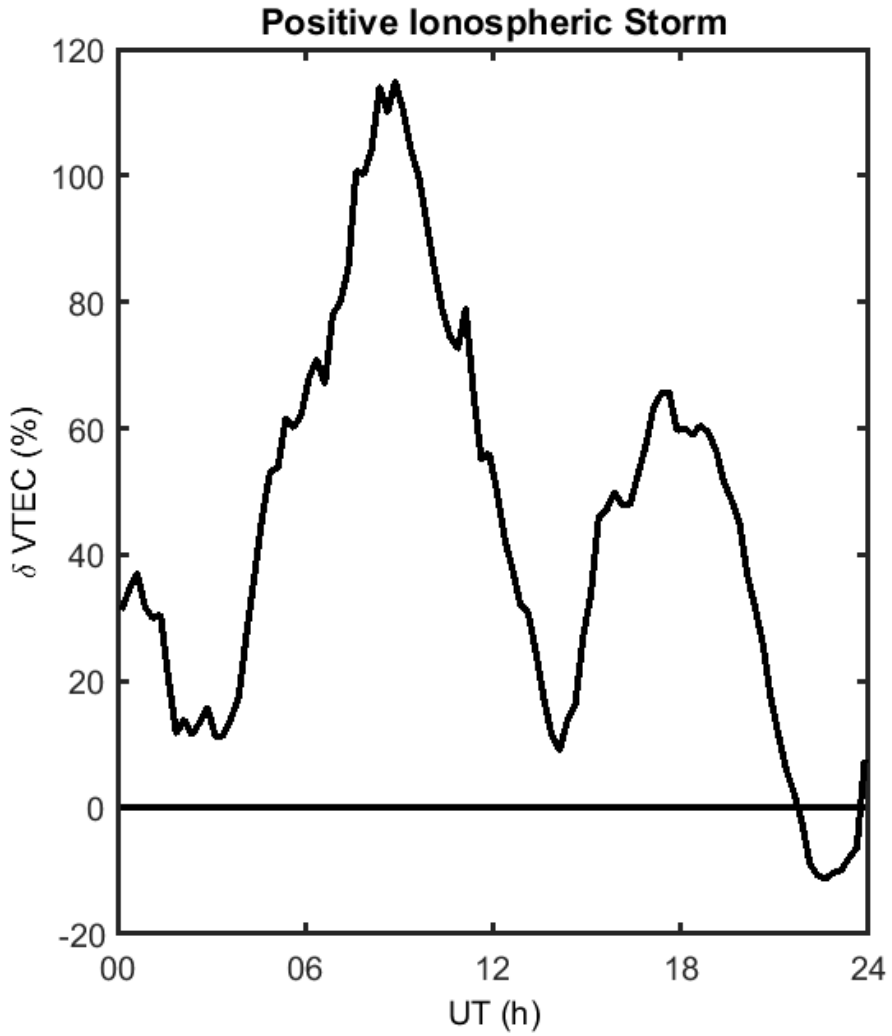
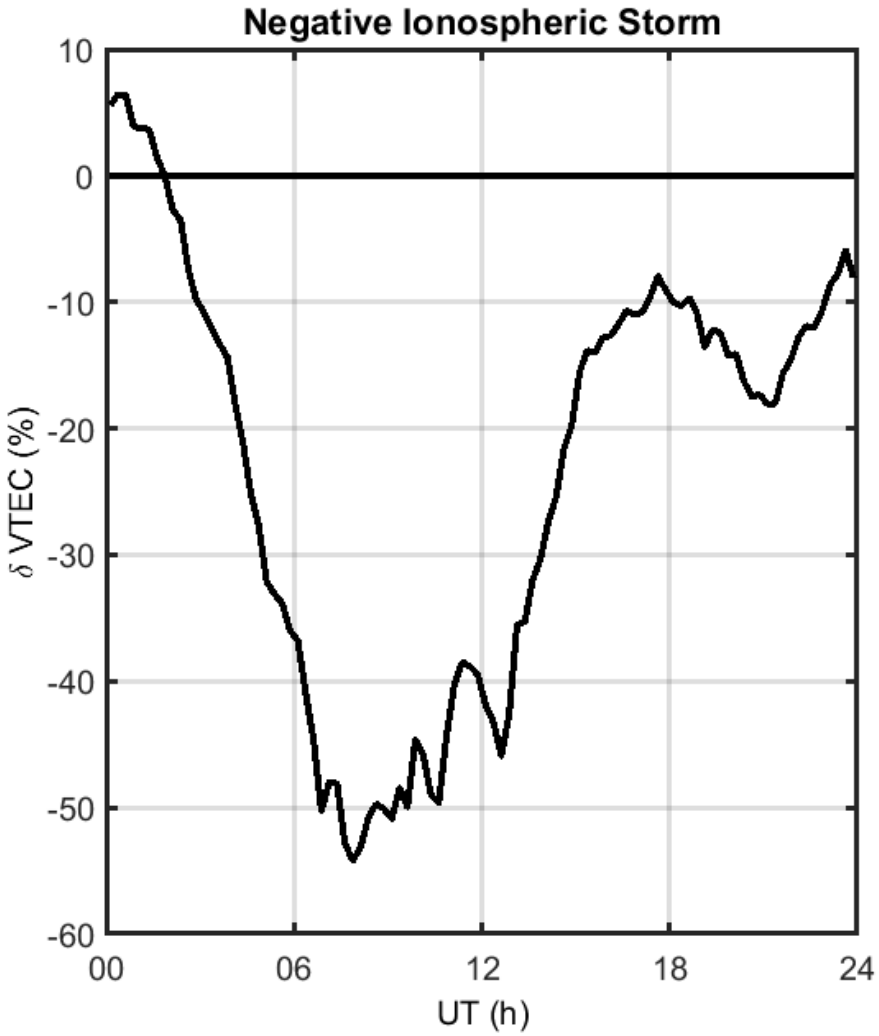


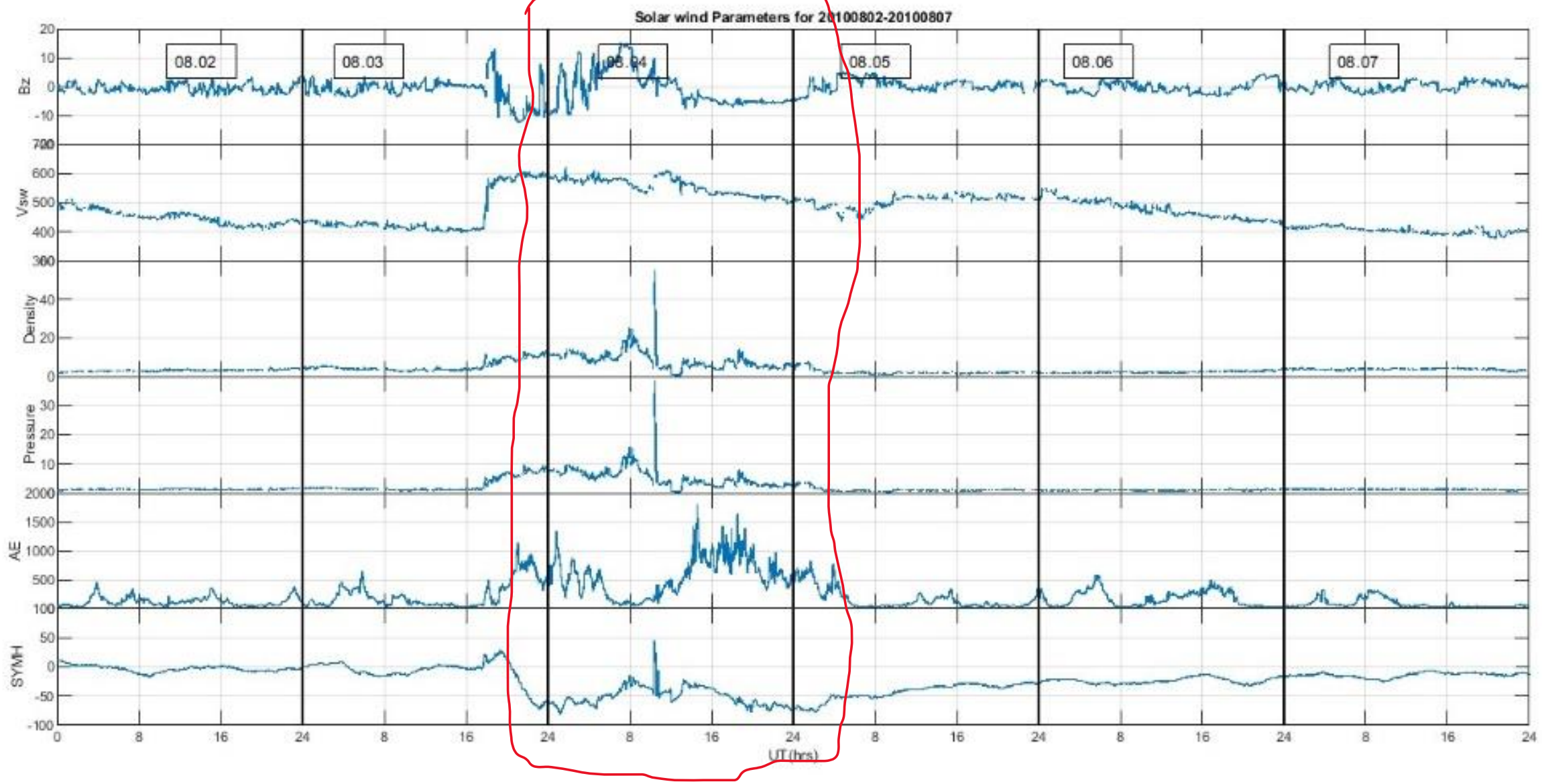


Trivedi et al, 2011 noted that the deviation in VTEC (upto −90%) for the geomagnetic storm occurred on July 17, 2005 [5].

Results and Discussion

Contd…

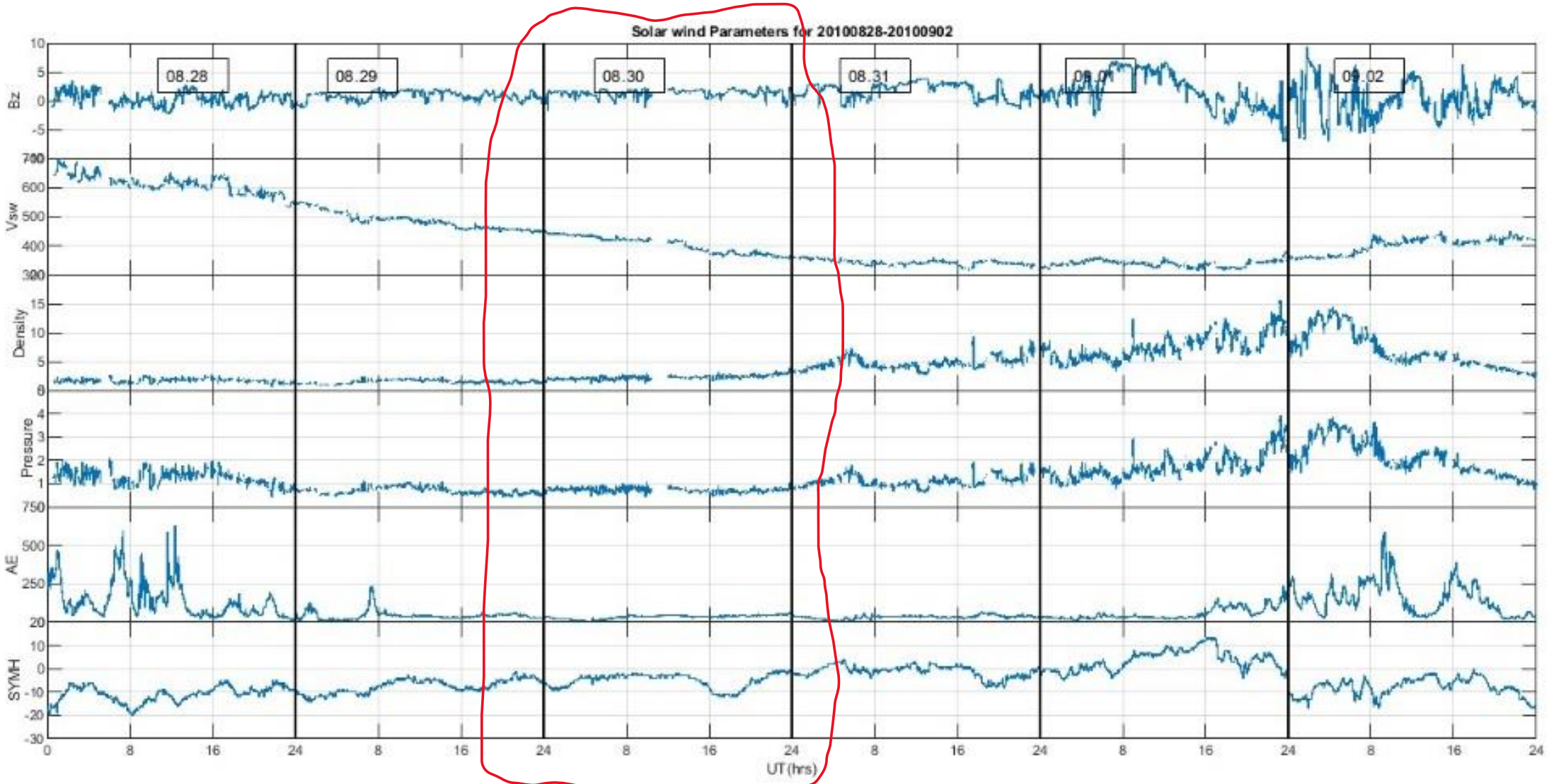
Solar wind and geomagnetic parameter during geomagnetic storm of 2010-08-04



Results and Discussion

Contd…

Solar wind and geomagnetic parameter during geomagnetic storm of 2010-08-30



Conclusions

- Both positive and negative ionospheric has identified during the impact of geomagnetic storm.
- The maximum increase in TEC during positive ionospheric storm on 2010-08-04 obtained is more than 100%.
- During negative ionospheric storm the maximum decrease in TEC noticed is more than 50%.

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https://www.jpl.nasa.gov/nmp/st5/SCIENCE/disturbances.html#

THANK YOU.....