Investigating Latitudinal-Dependence of the Response of the Ionosphere to Geomagnetic Activity

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Outline

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  - TEC
  - Geomagnetic Storms
- Objectives
- Data Analysis
- Results
- Conclusions

Introduction

The Ionosphere

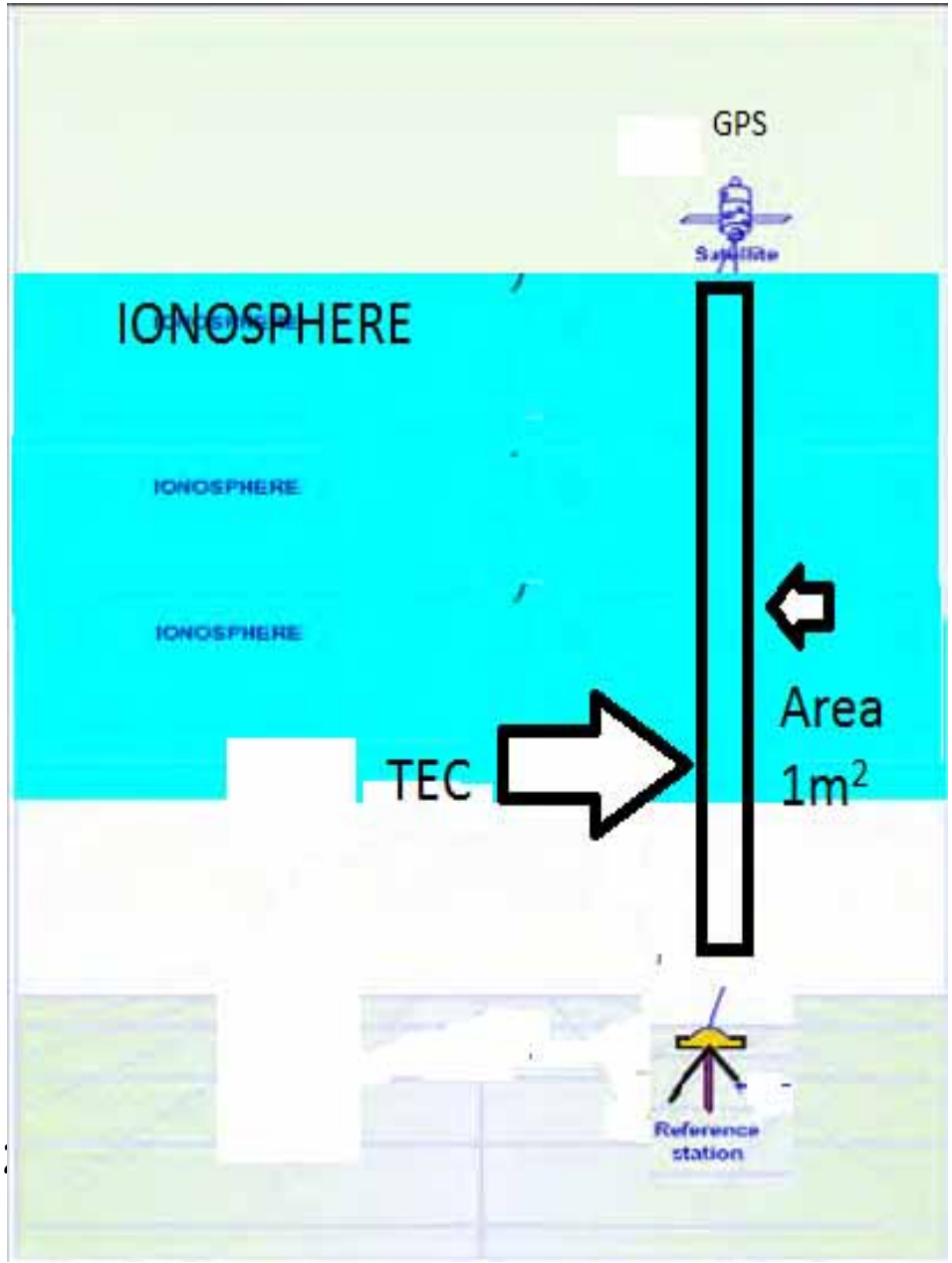
- It's the medium of transmission of radio waves
  - » long distance communication HF
  - » Earth-satellite transmission
- Home of Satellites
- Ionospheric conditions – proxy for space weather
- Imagine the dependence of global community of space based communication… internet, data, etc

Total Electron Content (TEC)

- TEC is the number of electrons in a tube of $1m^2$ cross section extending from the receiver to the satellite
- TEC along the signal path is given by

$$TEC = \int_{path} N_e ds$$

- Where N_e is the electron density along the signal path



Geomagnetic Storm

- Geomagnetic activity manifests as disturbances in the ionosphere.

- Disturbance Time index (Dst) is a parameter used to measure the level or severity of Geomagnetic storm

objective

- to investigate the latitudinal –dependence of the Ionospheric Response to Geomagnetic Activity

5-7 April 2010 geomagnetic storm

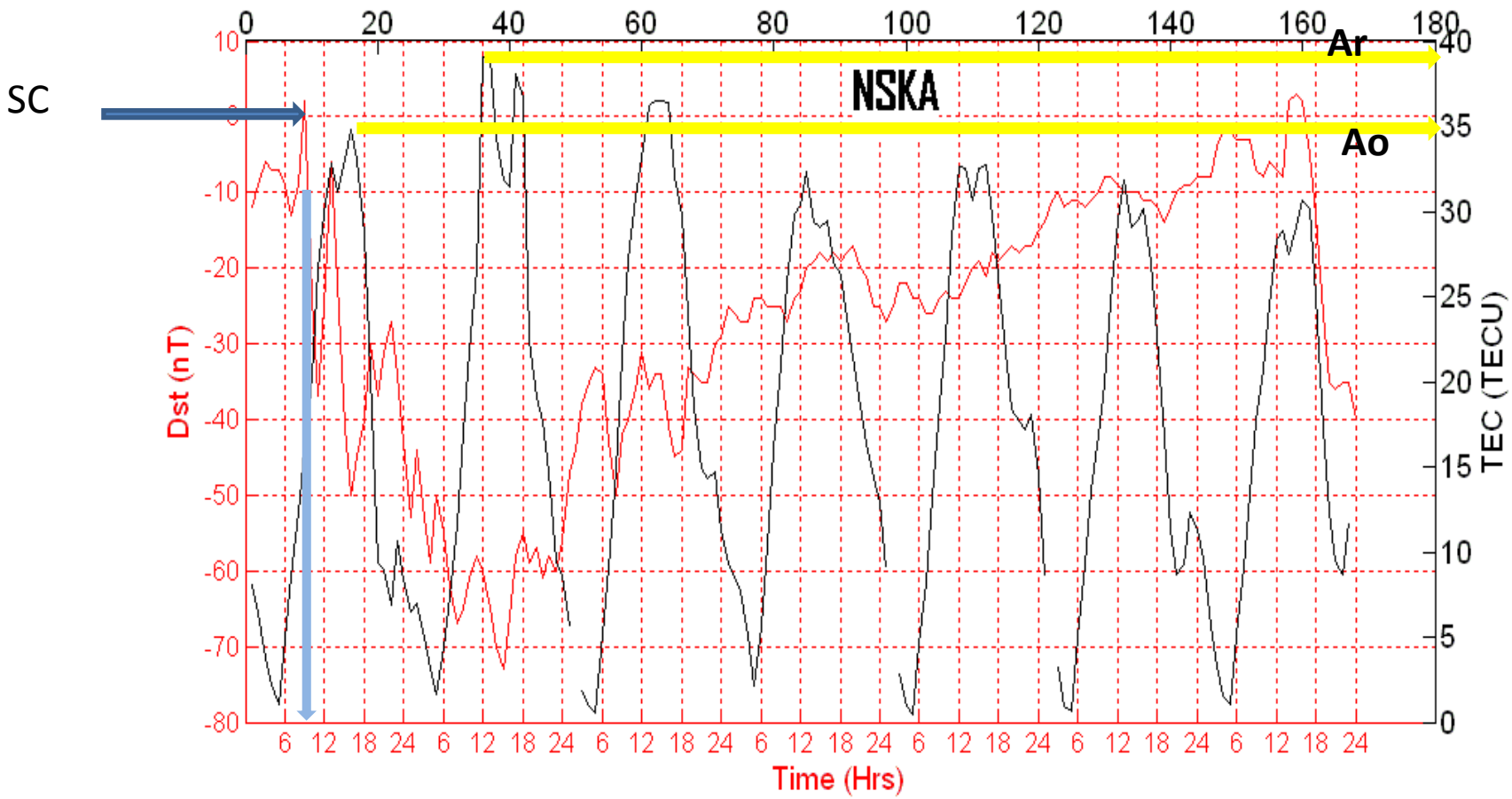
- Period of Focus
- first major storm to be recorded in the solar cycle # 24
- Storm commenced at about 0900 UT on 5th April
- The minimum Dst recorded on 6th April was -73 nT.

Amplitude Response

- TEC was estimated for the days 5-11 April from GPS observables.
- Let A_o be the daily TEC amplitude just after the SC
- A_r be the next daily TEC amplitude within the storm period
- We defined "amplitude response as difference between A_o & A_r"

$$\text{i.e. } \Delta A = A_r - A_o$$

hourly variations of Dst index and TEC from 5 – 11 April 2010



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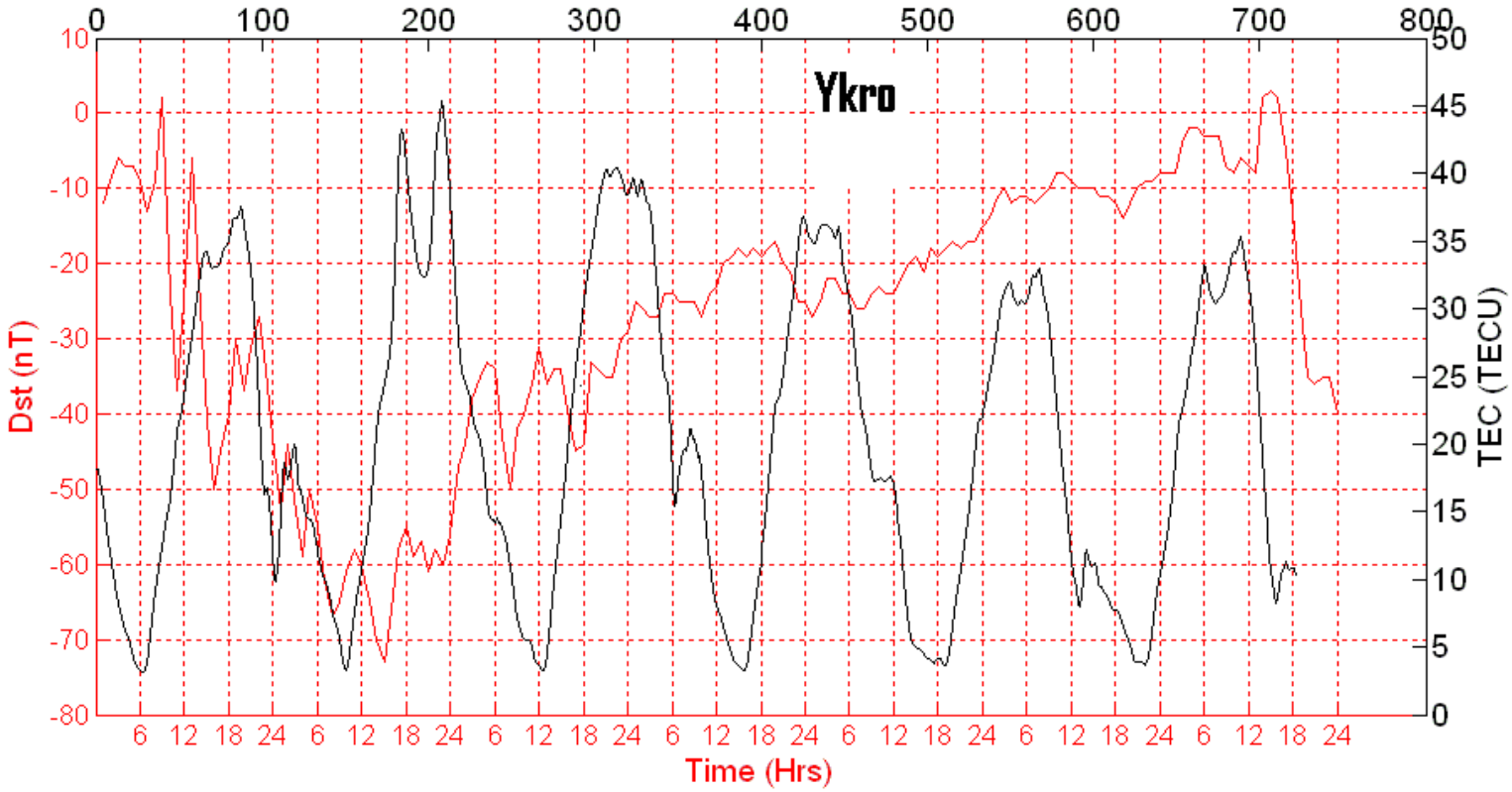

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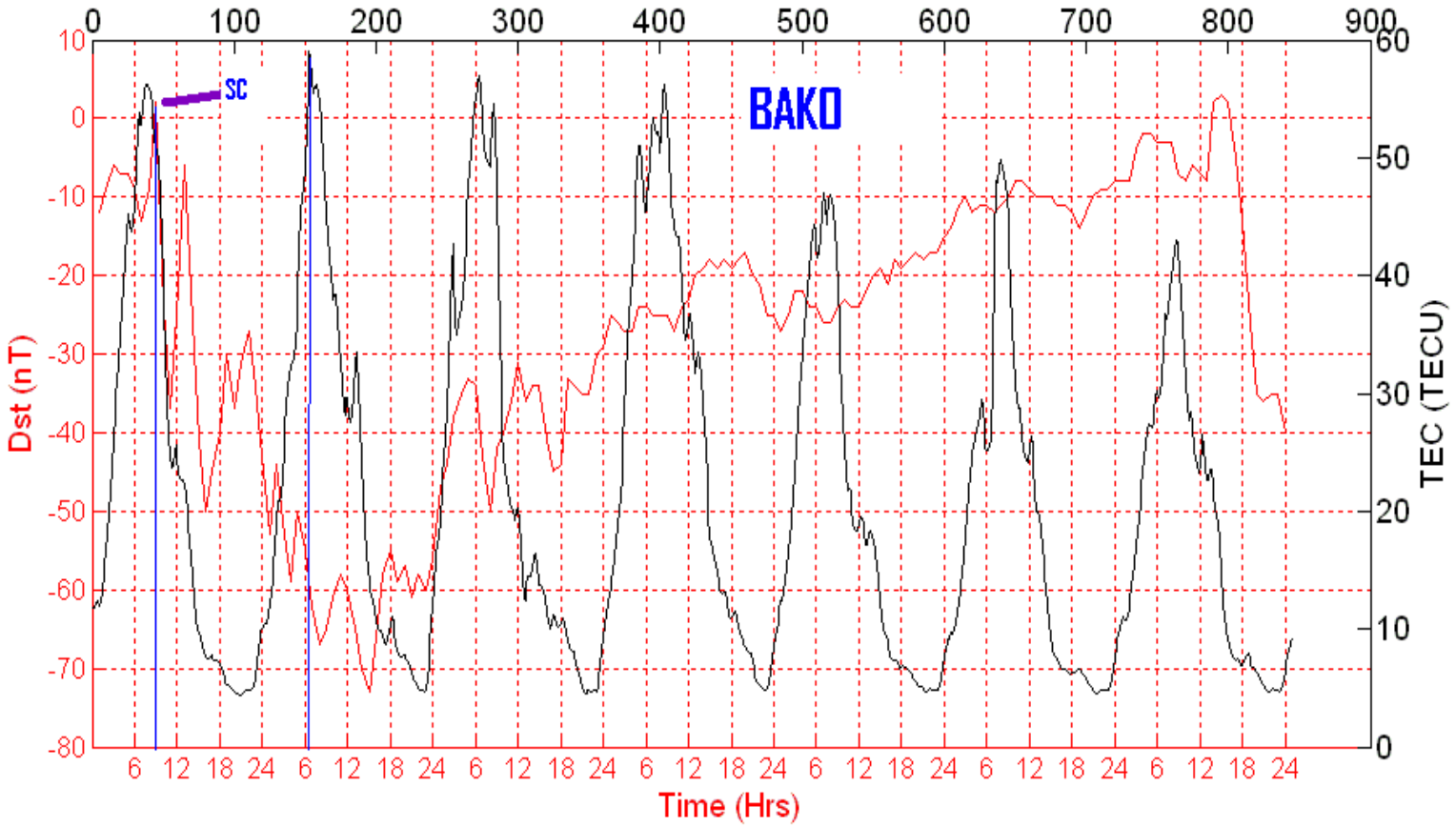

hourly variations of Dst index and TEC from 1 to 15 April 2010

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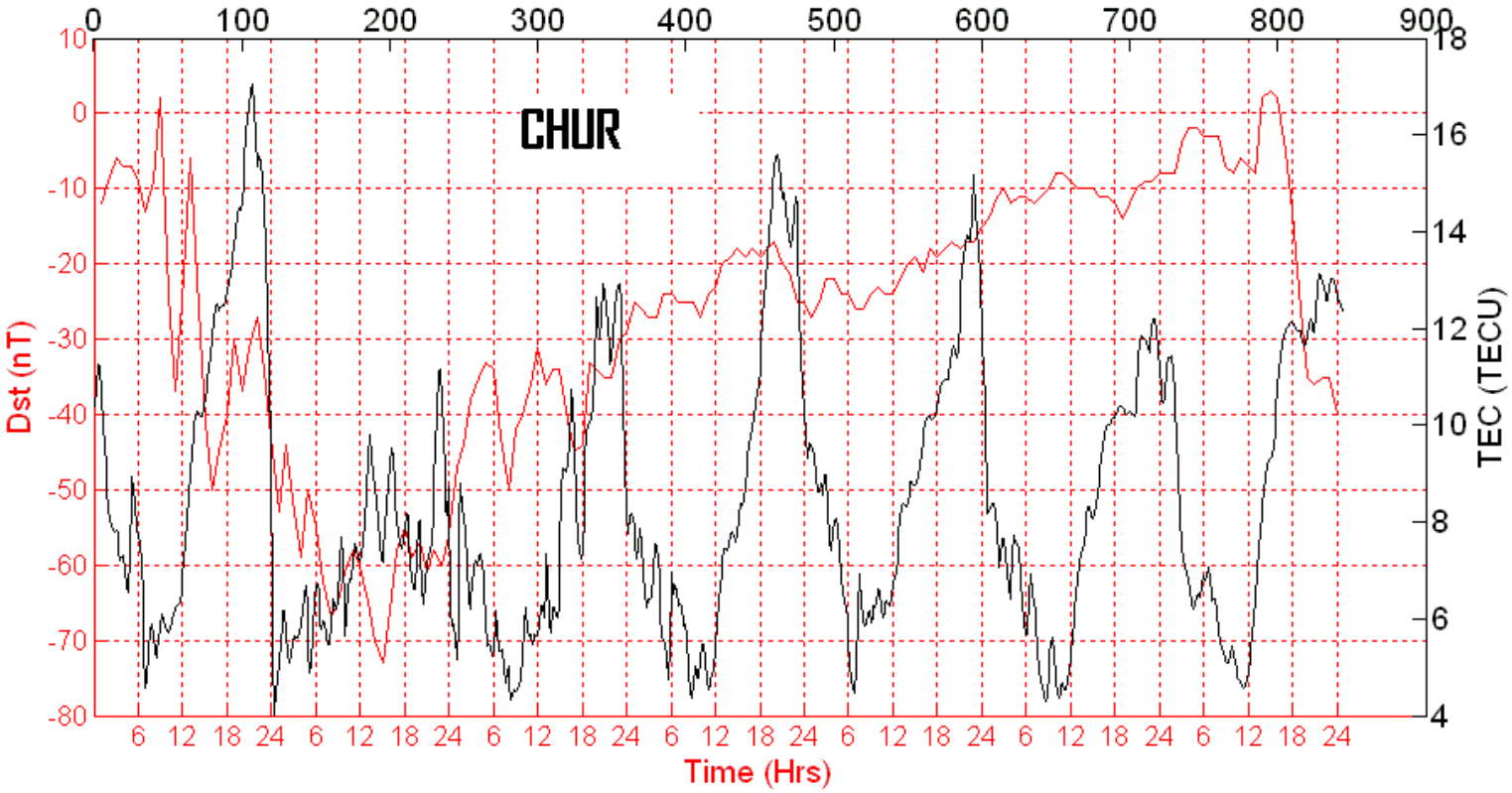
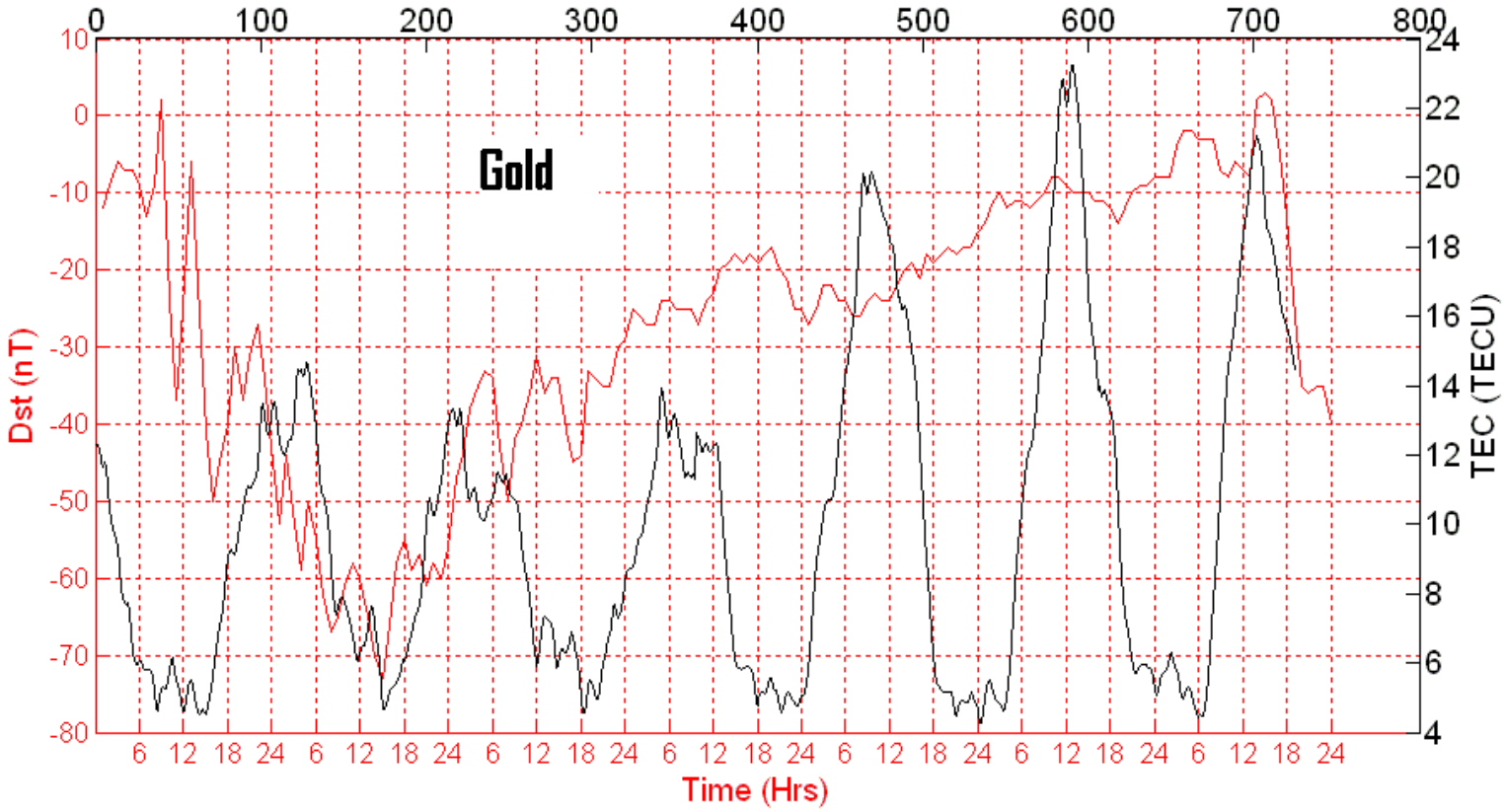
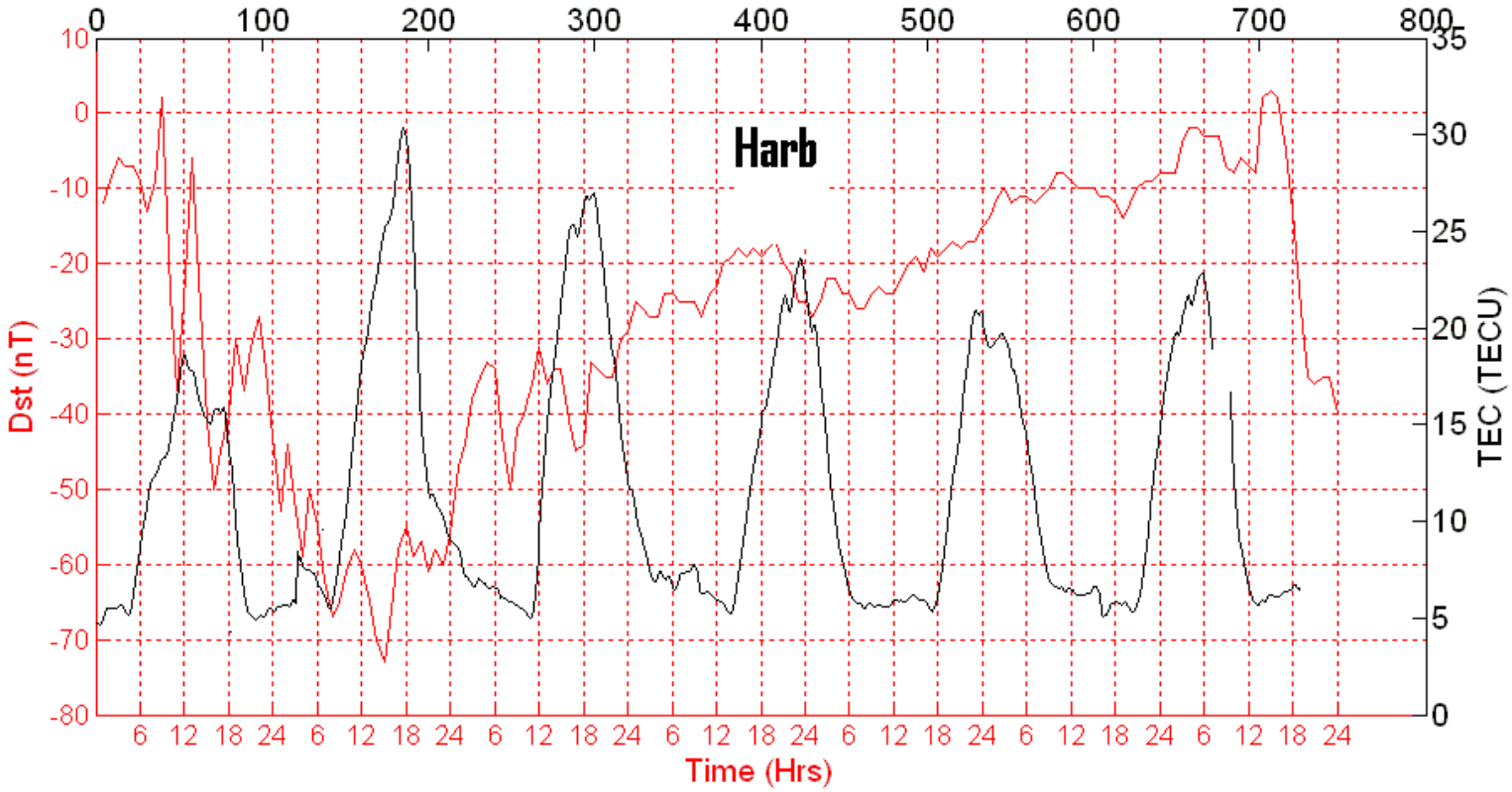
hourly variations of Dst index and TEC from 5 – 11 April 2010



hourly variations of Dst index and TEC from 5 – 11 April 2010



hourly variations of Dst index and TEC from 5 – 11 April 2010



Amplitude response

Station	Latitude (°)	$A_{0\ (TECU)}$	$A_{r\ (TECU)}$	ΔA
Bako	-6.49	56	59	3
Chur	58.76	17	9	-8
Gold	35.43	15	11	-4
Harb	-25.89	18	29	11
NSKA	7.3	34	39	5
YKRO	6.87	36	45	11

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Discussions and Conclusion

- Daily TEC amplitude at the middle and high latitudes reduces as the storm progresses
- There is an enhancement of daily TEC amplitude at low latitudes
- Ionosphere at different latitudes responds differently to geomagnetic activity

Discussions and Conclusions

- The storm time behavior of the Midlatitudes ionosphere's TEC is in concert with all past case studies.

- This can be accounted for by the expansion of the magnetospheric convection pattern at ionospheric heights [Lanzerotti et al., 1975] ; &

- by a competition between solar production, winds, and magnetospheric influence as a function of latitudes [Mendillo et al., 1992]

Discussions and Conclusions

TEC Storms at Equatorial and Low Latitudes

- The region spanned by the equatorial ionization anomaly (EIA) is governed during storms by the same mechanism (electric fields) that accounts for its daily occurrence

- The difference is that the locally induced E field can be enhanced or reversed by external E fields of direct magnetospheric origin (penetration) or indirect magnetospheric sources (disturbance dynamo).

- Throughout this region the TEC pattern responds to three fundamental storm time processes, each linked ultimately to magnetospheric input: (1) prompt effects, (2) delayed effects, and (3) composition changes.

(Mendillo, 2006)

THANK YOU FOR YOUR ATTENTION!