GPS Scintillation over Vietnam on April 2006

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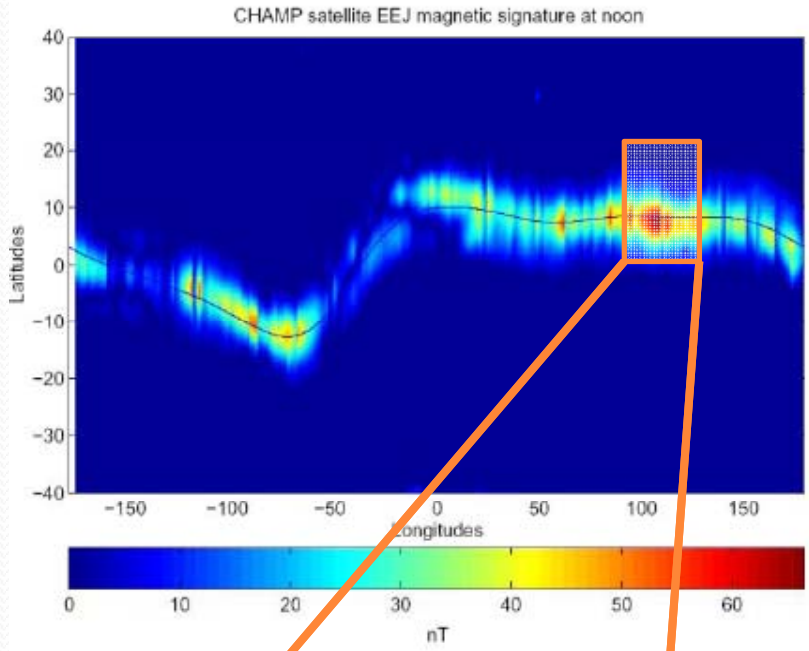
Outline

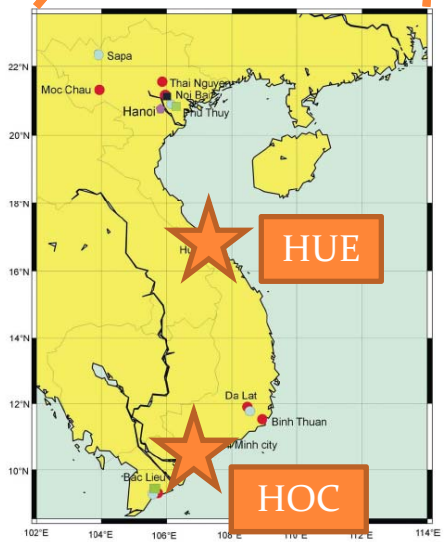
- Introduction
- Description and characterization of April 2006 events
- Data and Method
- Discussion of the results
- Summary and conclusions

Introduction

- Vietnamese ionosphere shows particular sensitivity to the Equatorial Electrojet
- Region poorly described in the open literature
- Two GISTM receivers
  - Hue (near the crest)
  - Hoc Mon (close to the equator)

From Amory-Mazaudier et al., Ann. Geophys (2006)

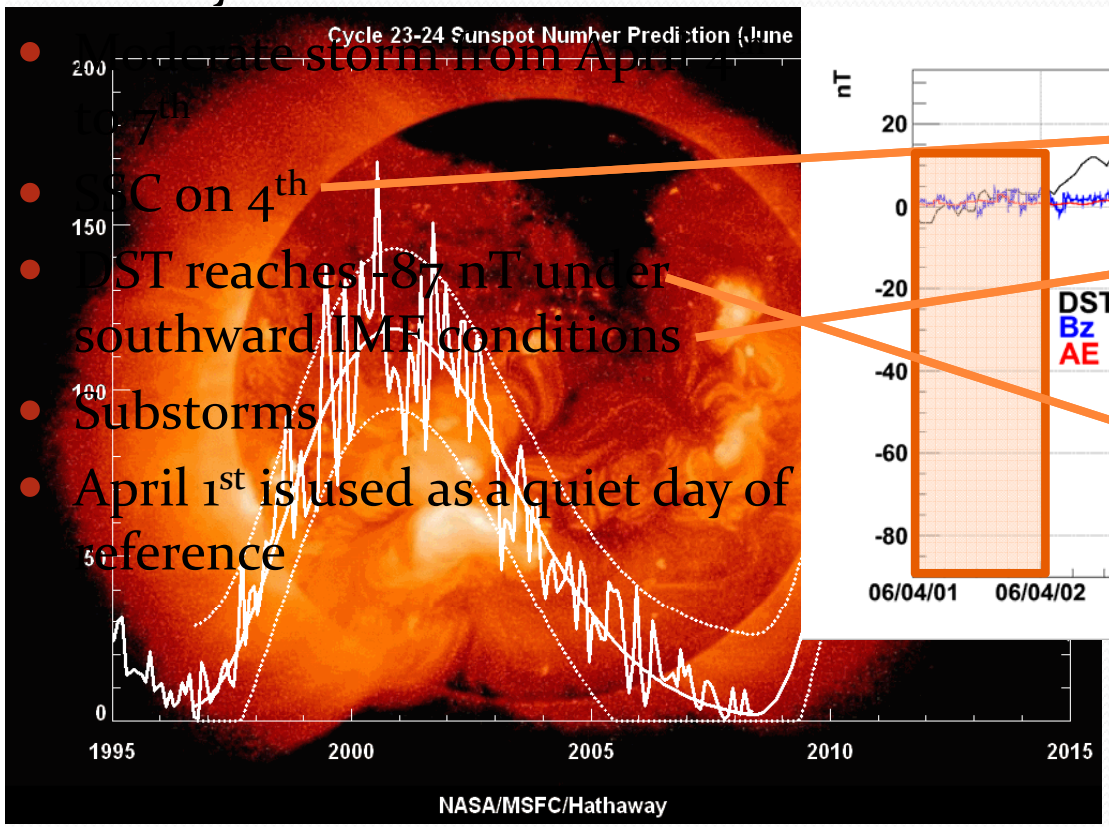


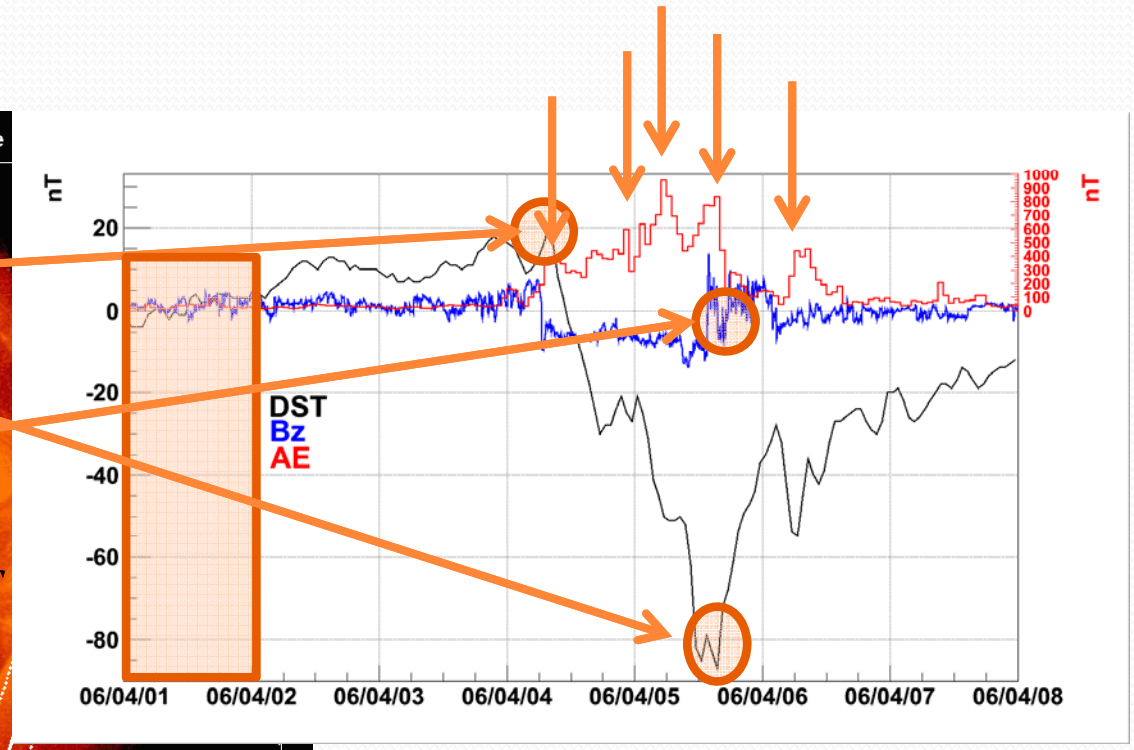


Location	ID	Latitude (°N)	Longitude (°E)
Hue	HUE	16.4	107.6
Hoc Mon	HOC	10.9	106.6

Geomagnetic conditions

- 2006: year of solar minimum
- Moderate storm from April 1st to 7th
- SSC on 4th
- DST reaches -87 nT under southward IMF conditions
- Substorms
- April 1st is used as a quiet day of reference





Data and Method

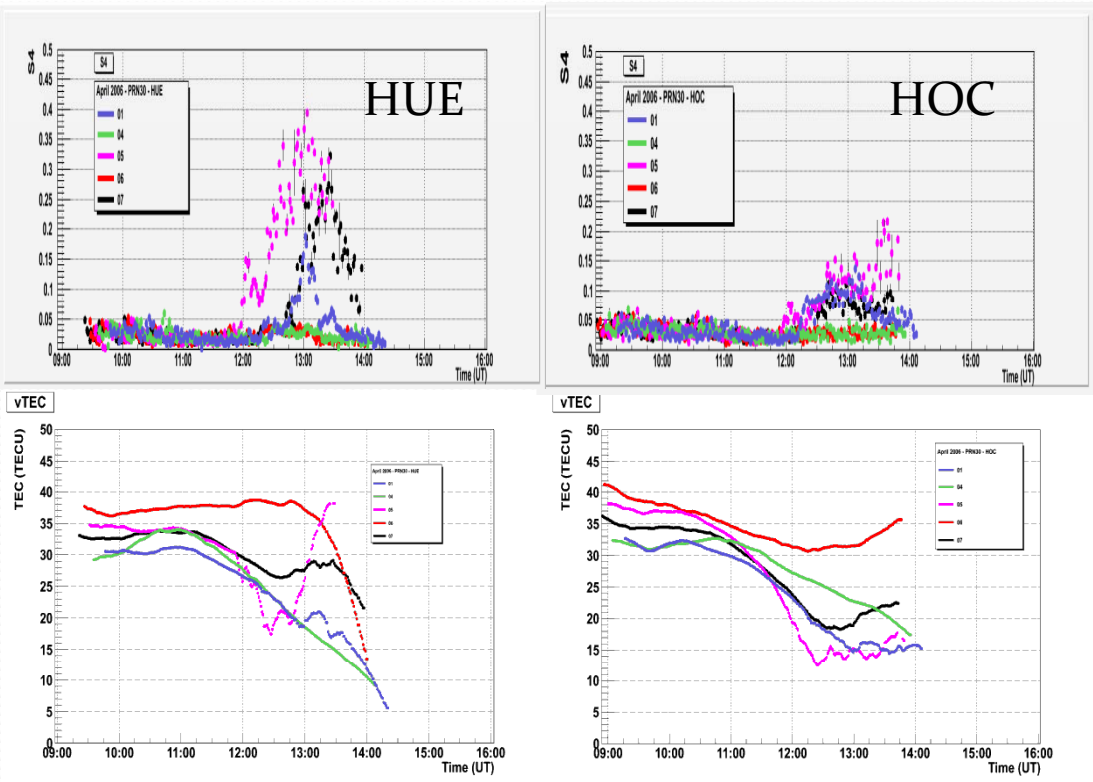
- **GISTM (GPS Ionospheric Scintillation and TEC Monitor)**
  - High sampling rate (50 Hz)
  - S4 and σ_Φ (1, 3, 10, 30 and 60 s)
  - TEC and ROT (15 s)
- **MIDAS (Multi – Instrument Data Analysis System)**
  - Ionospheric tomography to support the identification of irregularities
  - Dual frequency measurements from IGS network
  - Vertical TEC maps
- *ROT* (30 s), *ROTI* and Amplitude Scintillation index (S4) are used
  - ROTI is the std. dev. of ROT (5 minutes intervals)
- S4, ROT and ROTI gives information on the dimension of the irregularities
  - S4 is sensitive to scale below the Fresnel scale
  - ROTI>0.5 corresponds to scale lengths of few km
- No meaningful phase scintillation (as expected)

Results

PRN 30

- Scintillation between 1200 and 1400 (local post-sunset)
  - 1st , 5th and 7th
  - Pre-reversal activity
- Inhibition on 4th and 6th.
- vTEC
  - Smooth during inhibited days
  - Steep changes during scintillating days

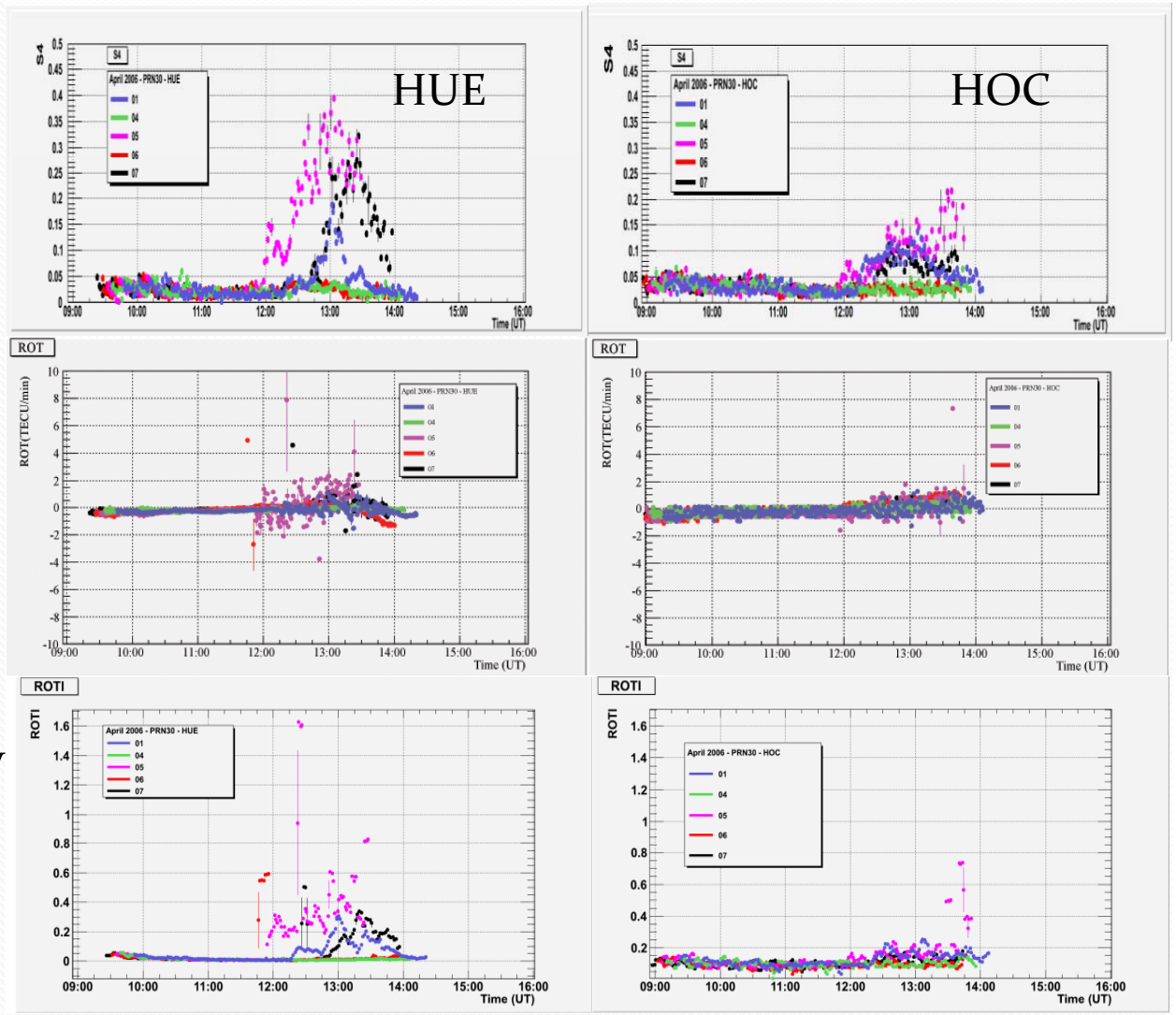
1st 4th 5th 6th 7th



Results

PRN 30

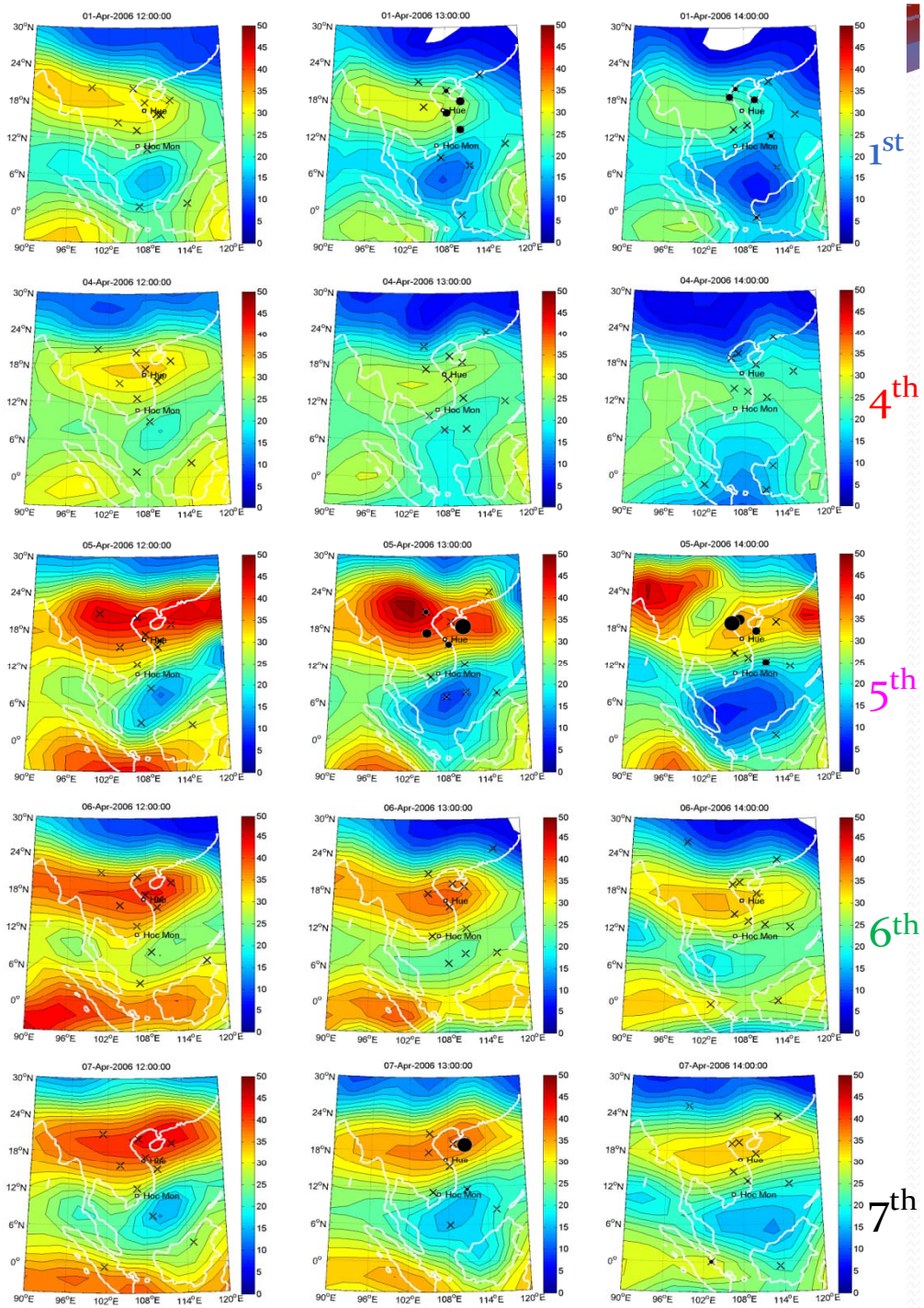
- ROT and ROTI
  - Stable values during inhibited days
- ROTI>0.5 for 6th (HUE @ 1200 UT)
  - Irregularity scale < few km
  - BUT not sufficient to produce scintillation



1st 4th 5th 6th 7th

Results

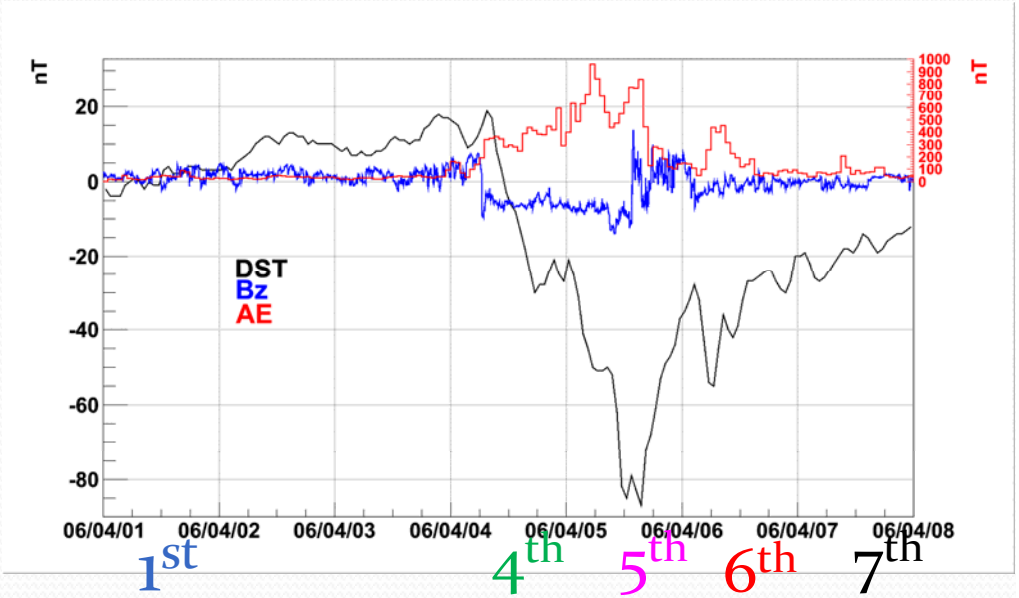
- vTEC profiles (MIDAS)
- Scintillation 1200-1400 UT
- Dots indicates S4
  - Scint. co-located with TEC gradients
- Crests recognizable on 1st , 5th and 7th
- 4th and 6th crest approaches equatorial lat.
  - No sufficient fragmentation (?)



Results

Possible explanation

- IMF:
  - southward on early 4th
  - northward on late 5th
  - southward on early 6th
- Southward turnings associated with AE activity enhancements: substorms possibly causing penetrating electric fields
  - Suppression of spread F
- On 7th the F layer goes back to the unstable conditions
  - Expected local post-sunset scintillation enhancement



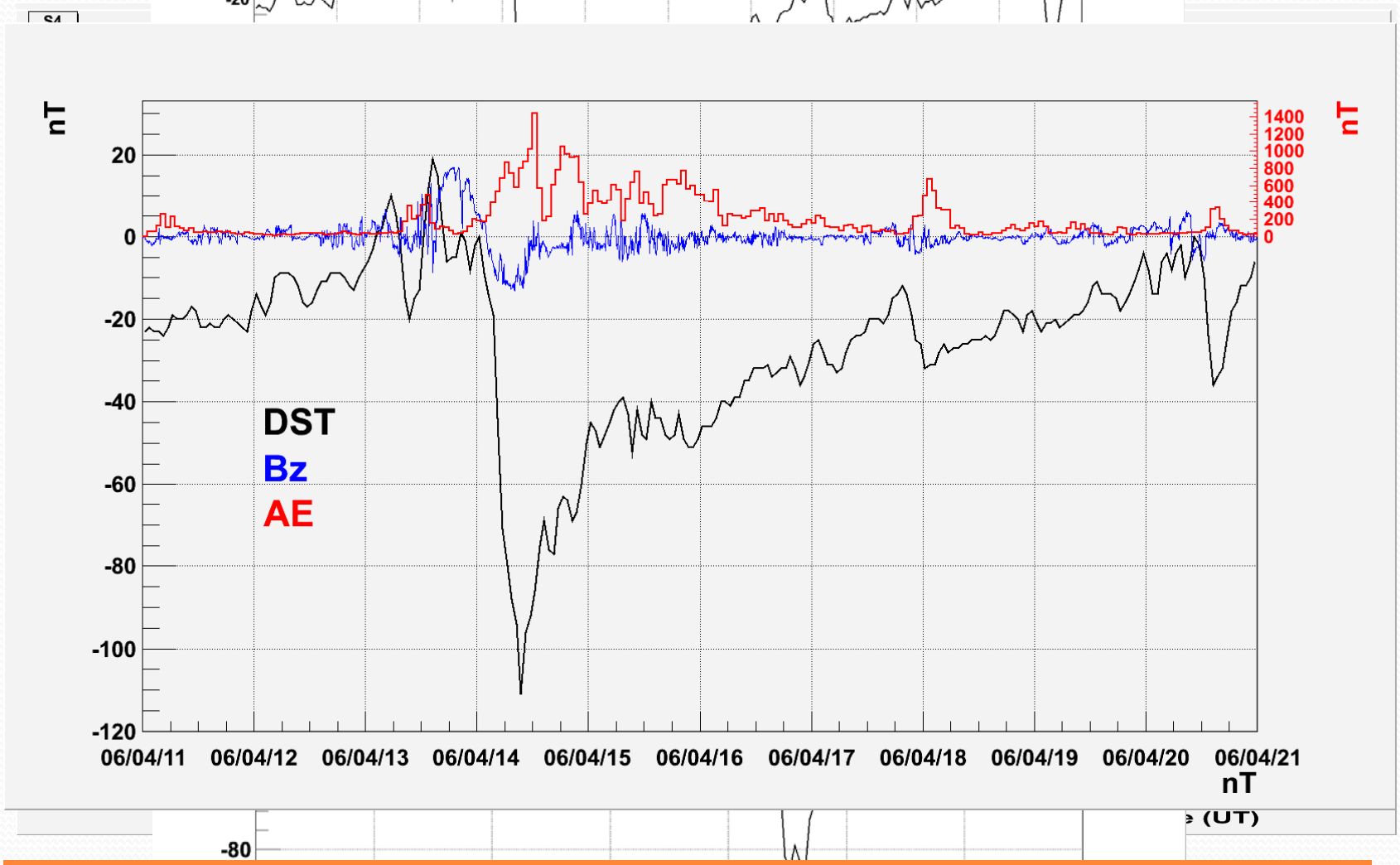
Summary

- Identification of scintillation inhibition during different phases of the storm development (PRN 30)
- vTEC, ROT and ROTI indicates that amplitude scintillation is due to steep changes in vTEC
- vTEC time evolution is smooth under inhibited conditions
- The MIDAS maps indicate that the crest configuration is lost on 4th and 6th
  - IMF turns southward on 4th, comes back to northward on 5th and turns southward again on 6th:
    - IMF South often associated with AE activity intensification (penetrating E fields?)
- IMF Bz and AE critically contribute to the suppression of the spread F generating ionospheric scintillations.

L. Alfonsi, L. Spogli, J.R. Tong, G. De Franceschi, V. Romano, A. Bourdillon, M. Le Huy, C.N. Mitchell, *GPS scintillation and TEC gradients at equatorial latitudes on April 2006*, Advances in Space Research, In Press, Accepted Manuscript, ISSN 0273-1177, DOI: 10.1016/j.asr.2010.04.020.

Similar inhibitions happen during a storm occurred few days later…

The 2006



A comparative study with the previous event is in preparation

Thanks for your attention!

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