MAGNETIC AND IONOSPHERIC OBSERVATIONS IN THE RUSSIAN FAR EAST REGION DURING THE MAGNETIC STORM OF 5 APRIL 2010

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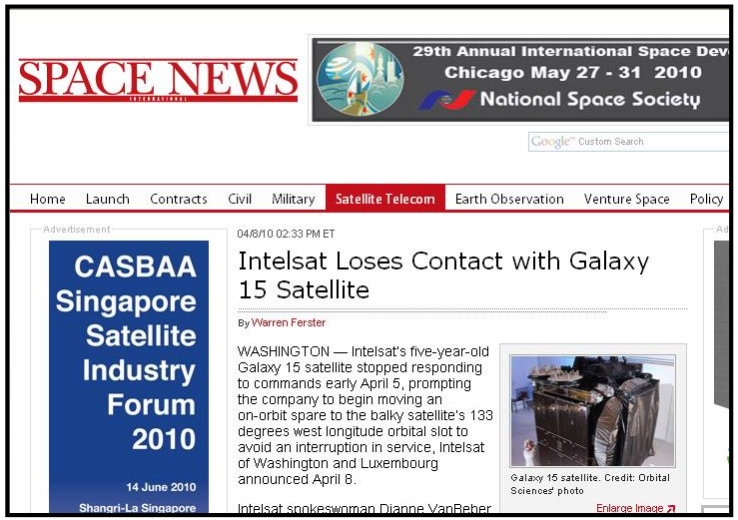
UN/Japan Workshop on Space Weather, Fukuoka, Japan, 5 March 2015

Introduction to the 5 April 2010 geomagnetic storm (the Galaxy substorm)

Background (1 of 2)
Galaxy 15 Satellite Anomaly - Impacts


SPACE NEWS

29th Annual International Space Dev
Chicago May 27 - 31 2010
National Space Society

Home Launch Contracts Civil Military Satellite Telecom Earth Observation Venture Space Policy

CASBAA Singapore Satellite Industry Forum 2010
14 June 2010
Shangri-La Singapore

04/8/10 02:33 PM ET

Intelsat Loses Contact with Galaxy 15 Satellite

By Warren Ferster

WASHINGTON — Intelsat's five-year-old Galaxy 15 satellite stopped responding to commands early April 5, prompting the company to begin moving an on-orbit spare to the balky satellite's 133 degrees west longitude orbital slot to avoid an interruption in service, Intelsat of Washington and Luxembourg announced April 8.

Galaxy 15 satellite. Credit: Orbital Sciences' photo

Enlarge Image

Intelsat spokeswoman Dianne VanReher

08 Apr 2010 – Intelsat reports that the Galaxy 15 stopped responding to ground commands (Anomaly time: 05 April @ 09:48 UTC)

10 Apr 2010 – FAA predicts erosion of WAAS capability due to Galaxy 15 failure

20 Apr 2010 – Orbital attributes the loss of Galaxy 15 to space weather

30 Apr 2010 – Intel reports Galaxy 15 still adrift and threatens nearby satellites (i.e. frequency interference)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04/20/10 02:05 PM ET

Orbital Blames Galaxy 15 Failure on Solar Storm

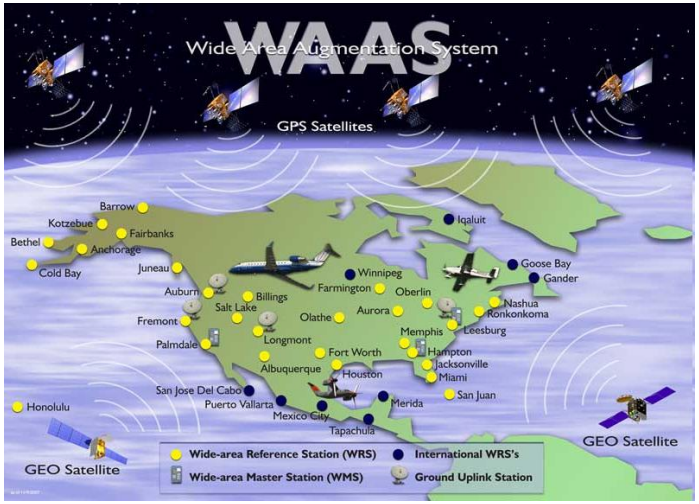
By Peter B. de Selding

PARIS — The in-orbit failure of the Orbital Sciences-built Intelsat Galaxy 15 telecommunications satellite April 5 was likely caused by unusually violent solar activity that week that damaged the spacecraft's ability to communicate with ground controllers, Orbital officials said April 20.

Galaxy 15 satellite. Credit: Orbital Sciences' photo

Enlarge Image

Similar events have occurred, if less severely, on other Orbital spacecraft



(From presentation by *Denig et al.* at the 2011 Space Weather Workshop)

Background (2 of 2)
Operational Timeline

```
:Product: 0404RSGA.txt
:Issued: 2010 Apr 04 2201 UTC
# Prepared jointly by the U.S. Dept. of Commerce, NOAA,
# Space Weather Prediction Center and the U.S. Air Force.
#
Joint USAF/NOAA Report of Solar and Geophysical Activity
SDF Number 094 Issued at 2200Z on 04 Apr 2010
IA.  Analysis of Solar Active Regions and Activity from  03/2100Z
to 04/2100Z:  Solar activity was very low. No flares were observed
during the past 24 hours. New Region 1060 (N24E58) was assigned
today and appears to be a small bipolar region.
IB.  Solar Activity Forecast:  Solar activity is expected to be very
low. However, there is a chance for an isolated C-class event during
the next three days (05-07 April).
IIA.  Geophysical Activity Summary 03/2100Z to 04/2100Z:
The geomagnetic field was mostly quiet to unsettled. However, there
was an isolated active period at mid-latitudes from 0600-0900Z which
was accompanied by storm level activity at some high latitude
stations. Solar wind speed observed by the ACE spacecraft were
elevated throughout the day, typically between 460-540 km/s. The
greater than 2 MeV electron flux at geosynchronous orbit reached
high levels during the past 24 hours.
IIB.  Geophysical Activity Forecast:  The geomagnetic field is
expected to be quiet with a chance for unsettled periods for the
first day (05 April) and partway through the second day (06 April).
An increase to mostly unsettled levels with a chance for active
periods is expected sometime late on the second day or early on the
third day (07 April) in response to a favorably positioned coronal
hole. Yesterdays halo CME appears to be primarily directed south of
the ecliptic plane. However, it is possible that the flank of the
CME could contribute to somewhat elevated activity on the third day.
III.  Event Probabilities 05 Apr-07 Apr
Class M    01/01/01
Class X    01/01/01
Proton     01/01/01
PCAF       green
IV.  Penticton 10.7 cm Flux
Observed         04 Apr 079
Predicted   05 Apr-07 Apr  080/080/085
90 Day Mean       04 Apr 083
V.  Geomagnetic A Indices
Observed Afr/Ap 03 Apr  005/008
Estimated Afr/Ap 04 Apr  010/010
Predicted Afr/Ap 05 Apr-07 Apr  005/007-007/010-012/012
VI.  Geomagnetic Activity Probabilities 05 Apr-07 Apr
A.  Middle Latitudes
Active             05/25/35
Minor storm          01/10/20
Major-severe storm    01/01/05
B.  High Latitudes
Active             10/30/40
Minor storm          05/15/30
Major-severe storm    01/01/10
```

Operational Timeline – Universal Time (UT)

April 3, 2010

09:54 B7 solar flare (sunspot region 1059)

10:33 CME first visible

22:04 SWPC Daily Forecast issued

- *Notes Flare and Coronal Mass Ejection (CME)*
- *Geomagnetic quiet expected: 04-05 April*

April 4

22:01 Daily Forecast issued (left text)

- *Flank of CME may contribute to elevated activity on April 7*

April 5

05:33 Warning issued: K=4

05:44 Alert issued: K=4

08:04 Warning issued

- *Sudden Impulse (CME hits ACE @ 07:56 UT)*

09:16 Warning issued: K=5

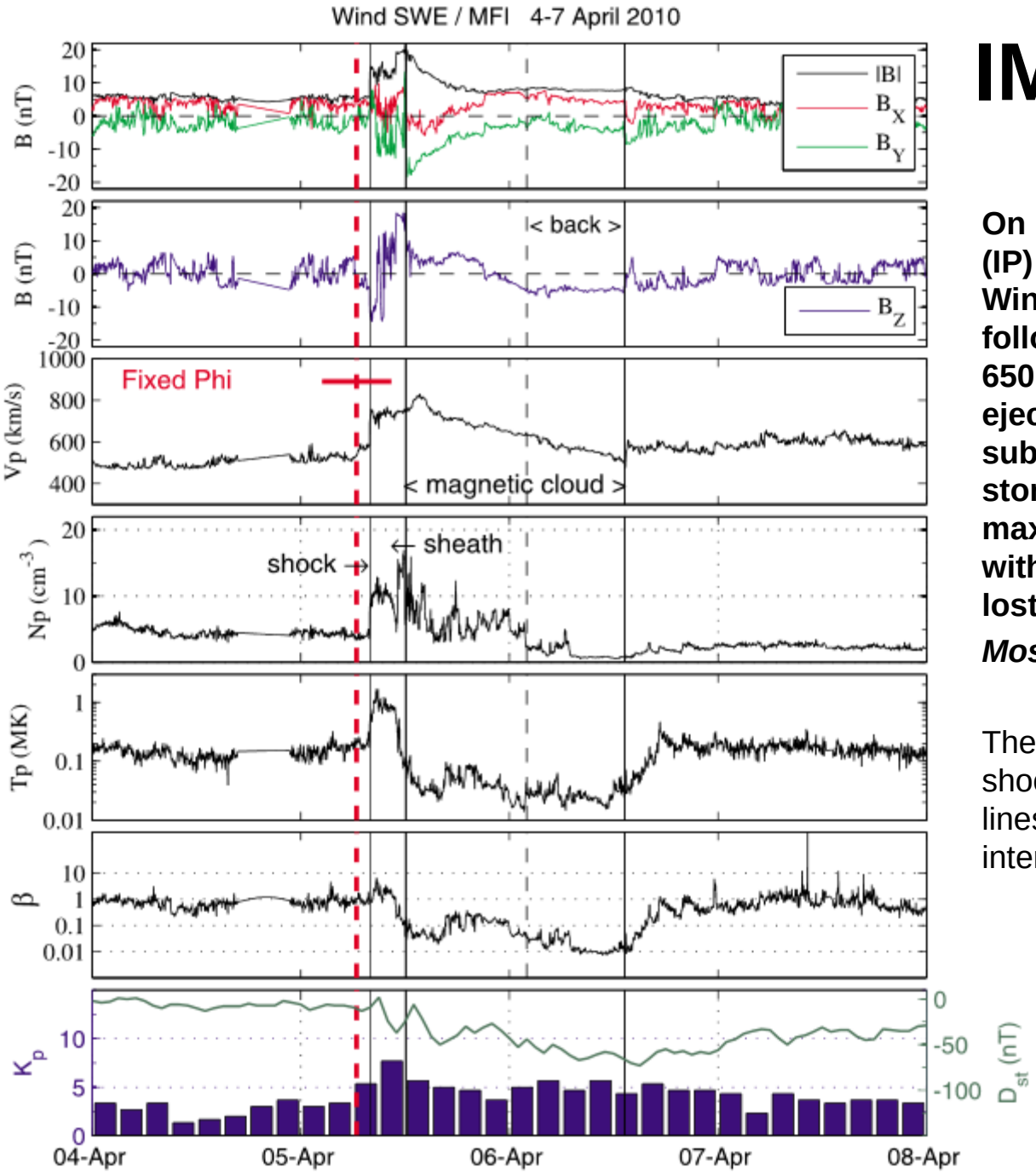
09:17 Alert issued: K=5

09:22 Alert issued: K=6

09:48 *Galaxy 15 anomaly* 

09:56 Alert issued: K=7

(From presentation by *Denig et al.* at the 2011 Space Weather Workshop)



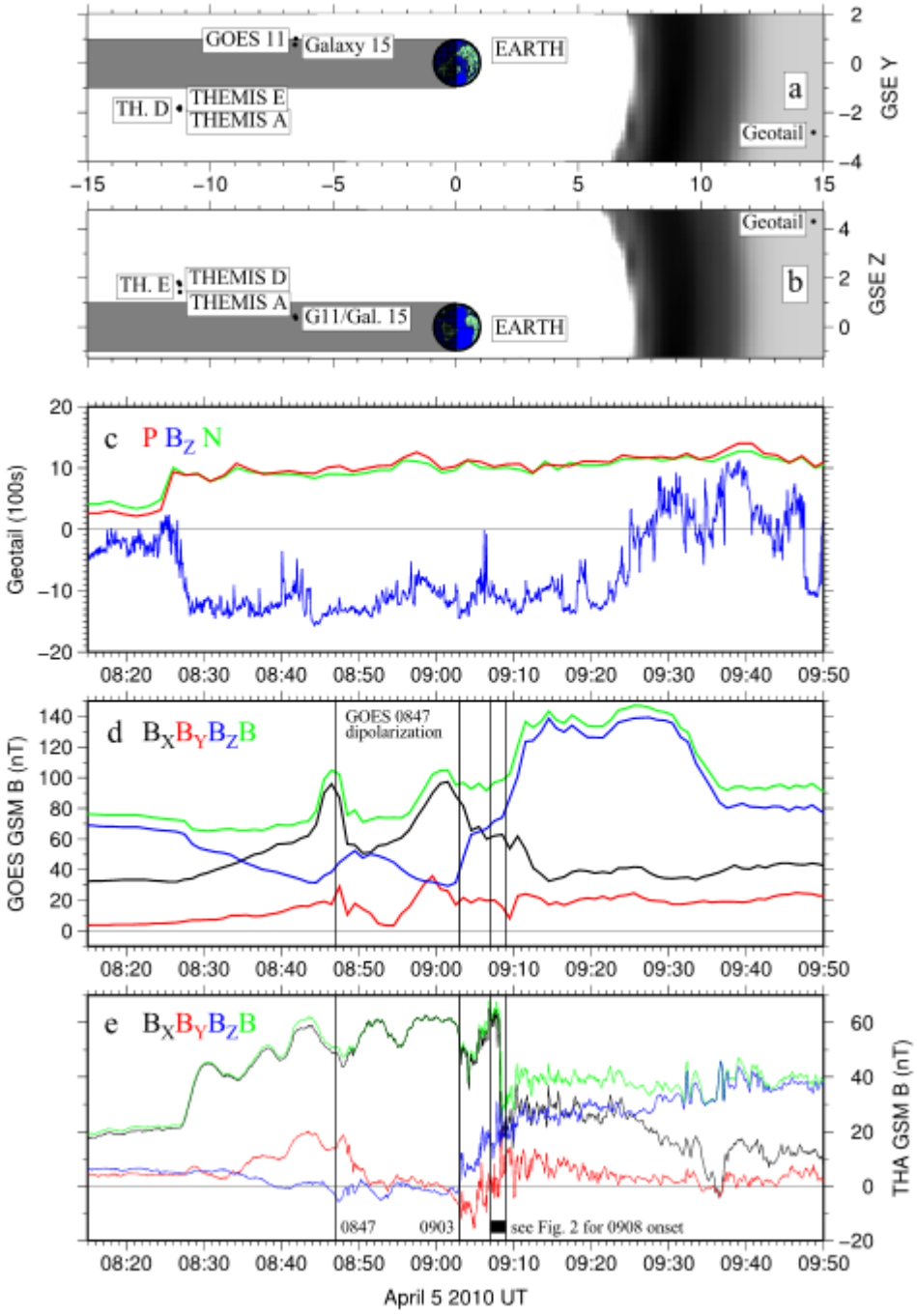
IMF/SW

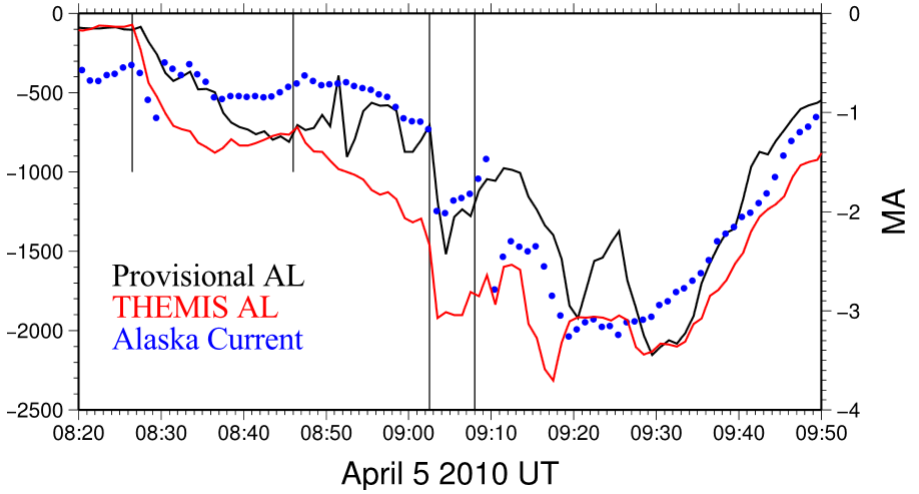
On 5 April 2010 an interplanetary (IP) shock was detected by the Wind spacecraft ahead of Earth, followed by a fast (average speed 650 km/s) IP coronal mass ejection (ICME). During the subsequent moderate magnetic storm (minimum Dst =-72 nT, maximum Kp=8-), communication with the Galaxy 15 satellite was lost.

Mostl et al. (GRL, 2010)

The first solid line from left is the shock arrival. Second and third solid lines indicate the Magnetic Cloud interval.

Magnetic field variations



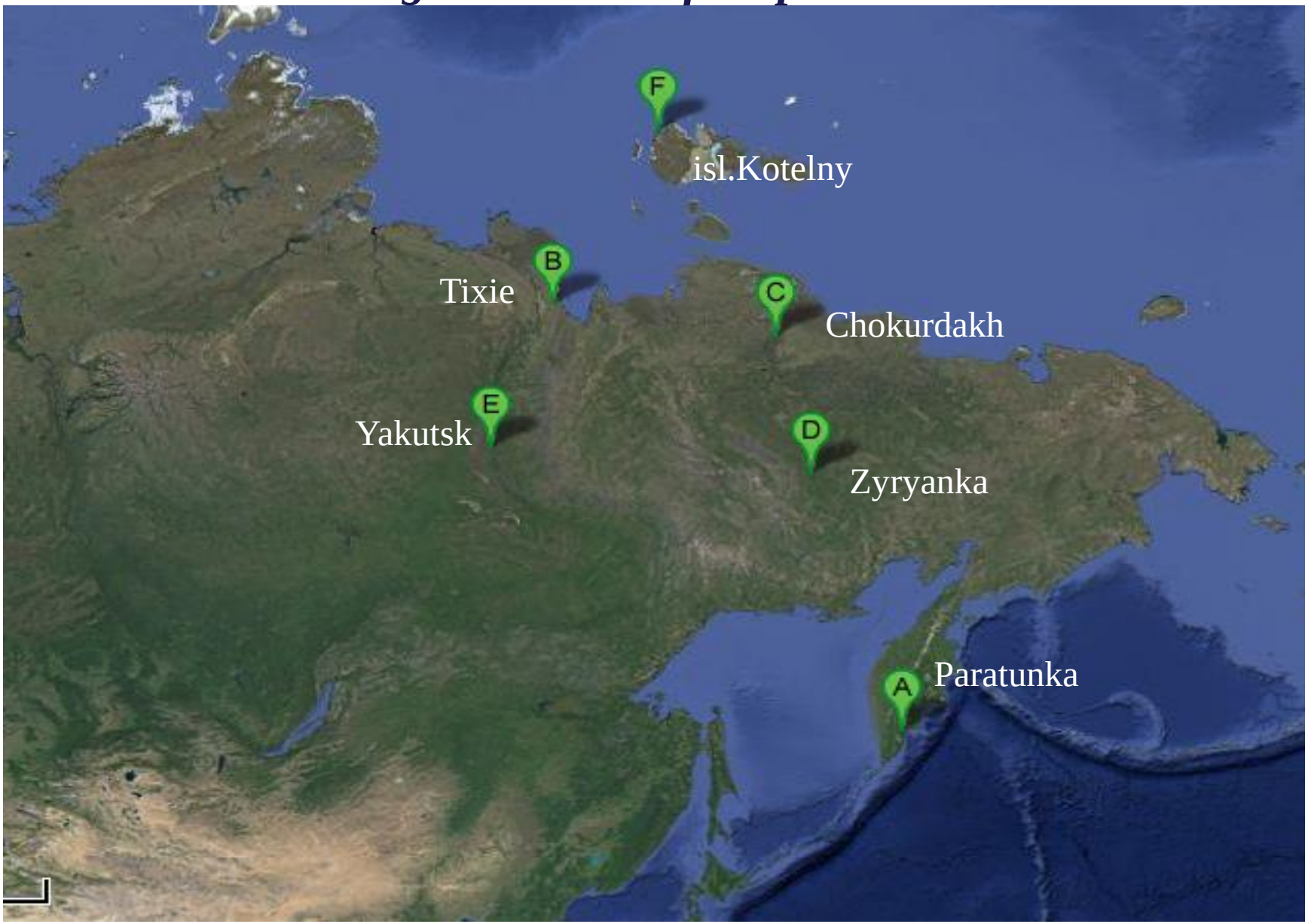


A substorm growth phase and localized dipolarization at 08:47 UT were followed by large dipolarizations at 09:03 UT and 09:08 UT, observed by GOES 11 in the midnight sector, and by three THEMIS spacecraft near X=−11, Y=−2Re.

Connors et al. (Ann. Geophys., 2011)

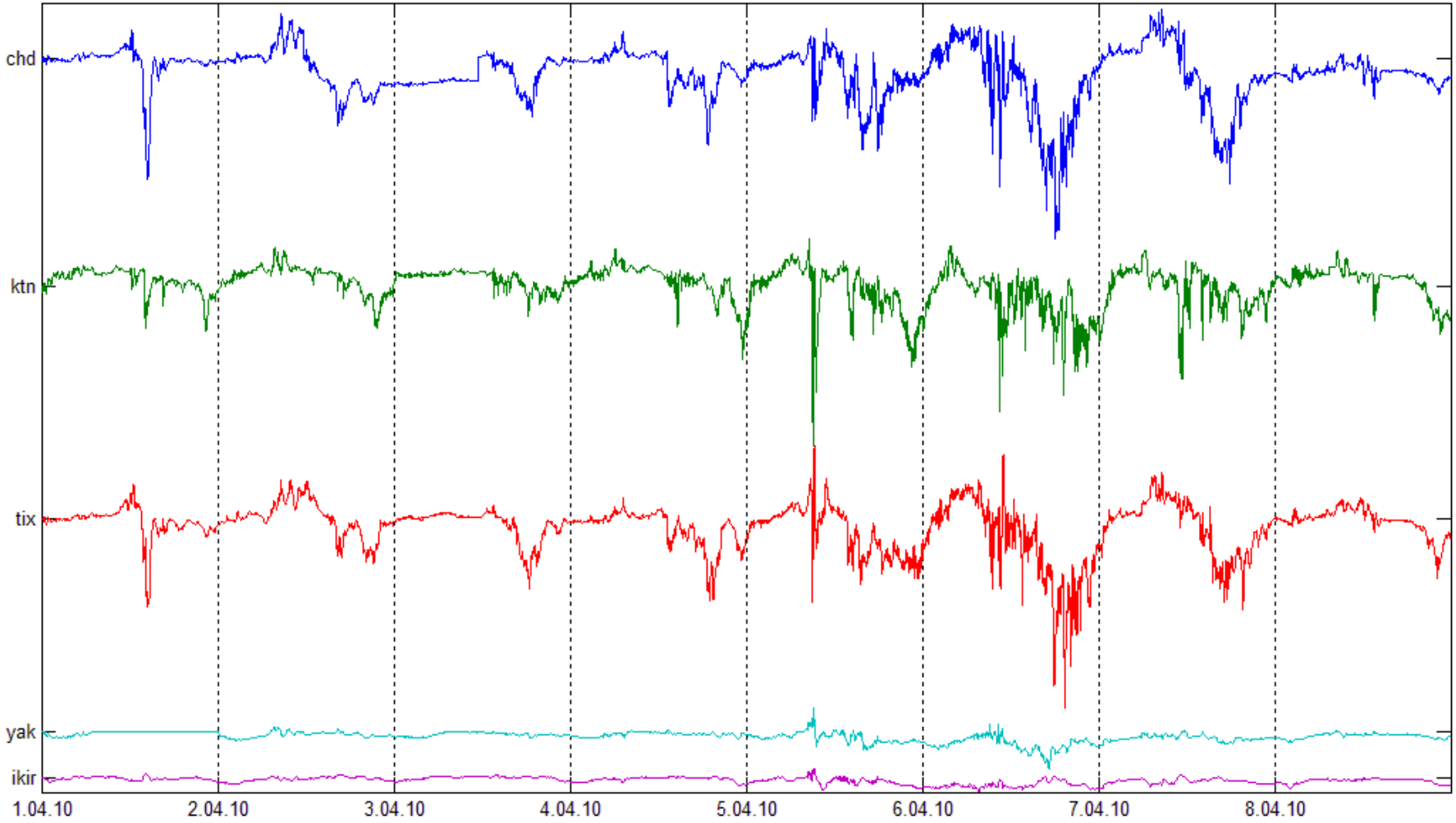
Magnetic and ionospheric observations by IKFIA and IKIR

Geographical locations of magnetic stations used for analysis of the magnetic storm of 5 April 2010



Analysis of magnetic data

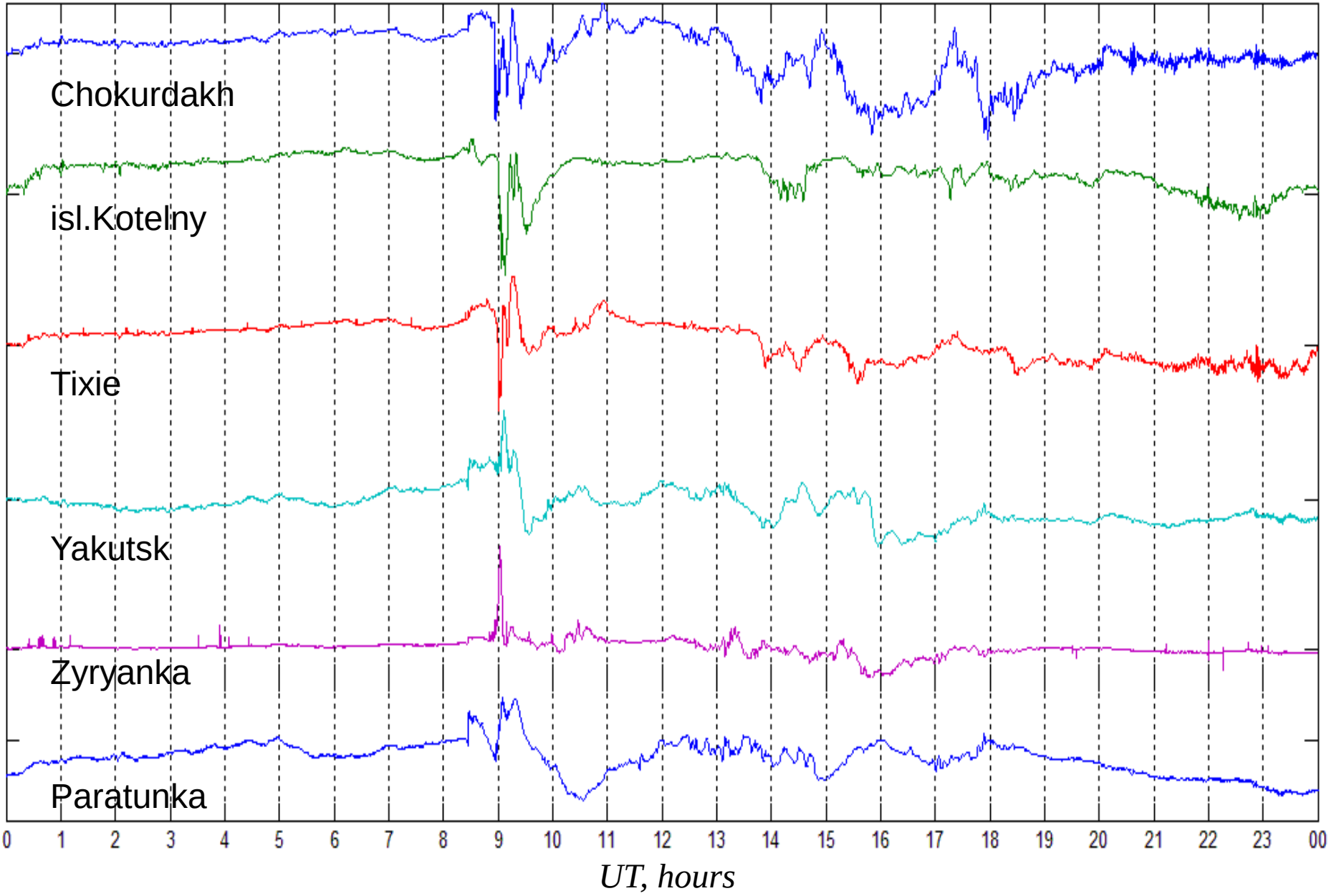
Variation of H-component of the geomagnetic field on 1-8 April 2010



Days

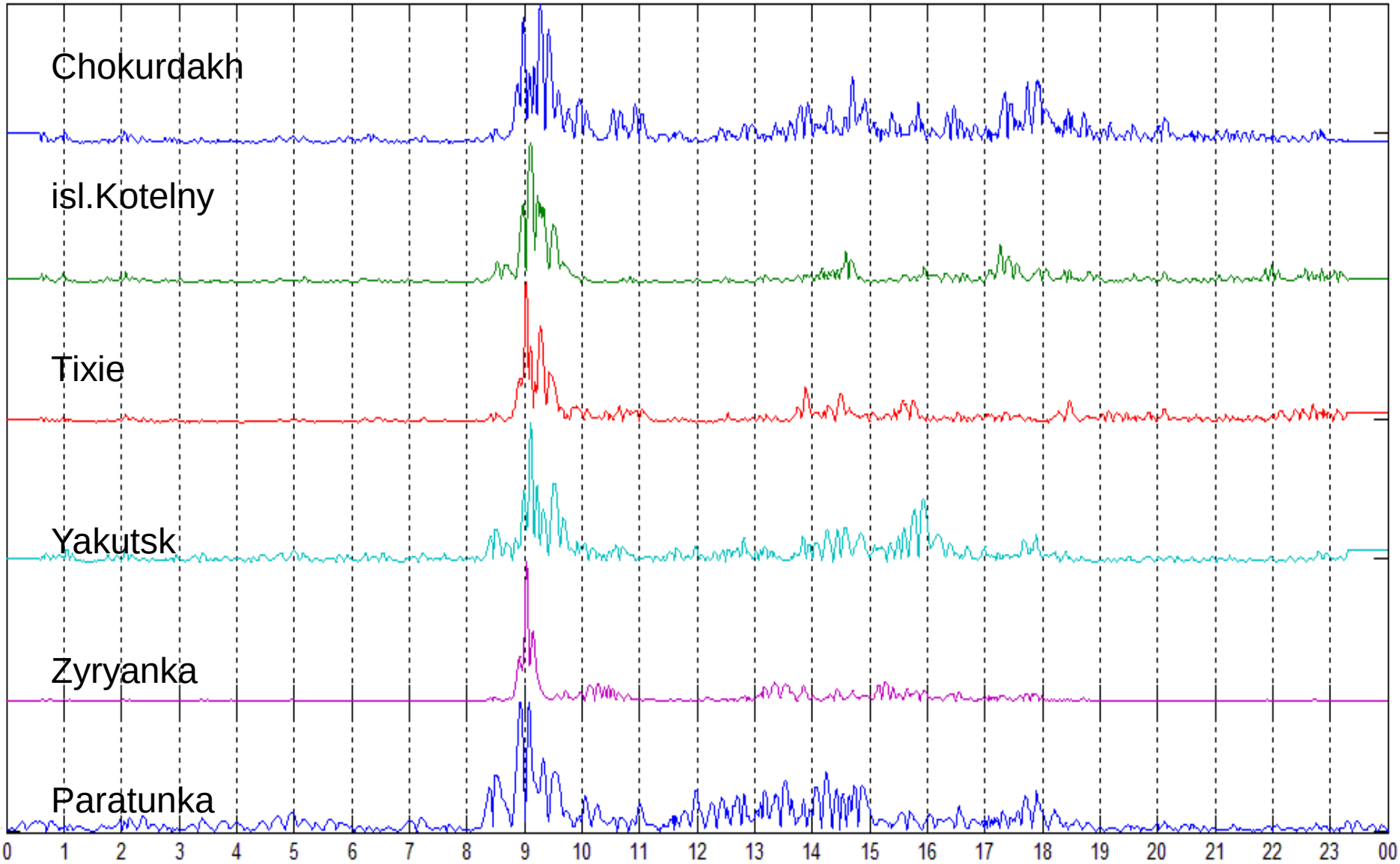
Analysis of magnetic data

Variation of geomagnetic field H-component on 5 April 2010 the (calibration to max)



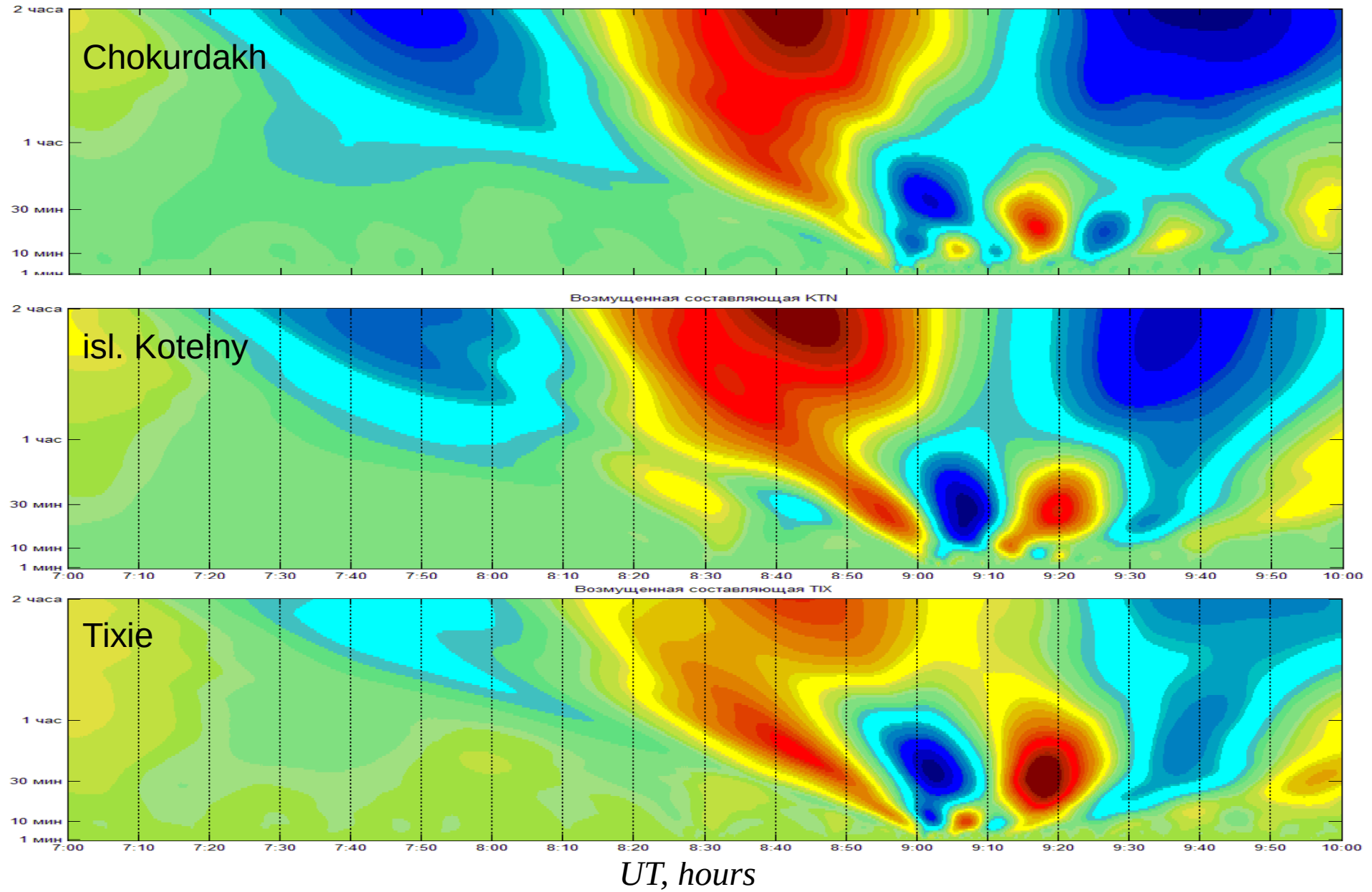
Analysis of magnetic data

Estimation of intensity of geomagnetic disturbances (calibration to max)



Wavelet spectrum of disturbed geomagnetic constituents on 5 April 2010

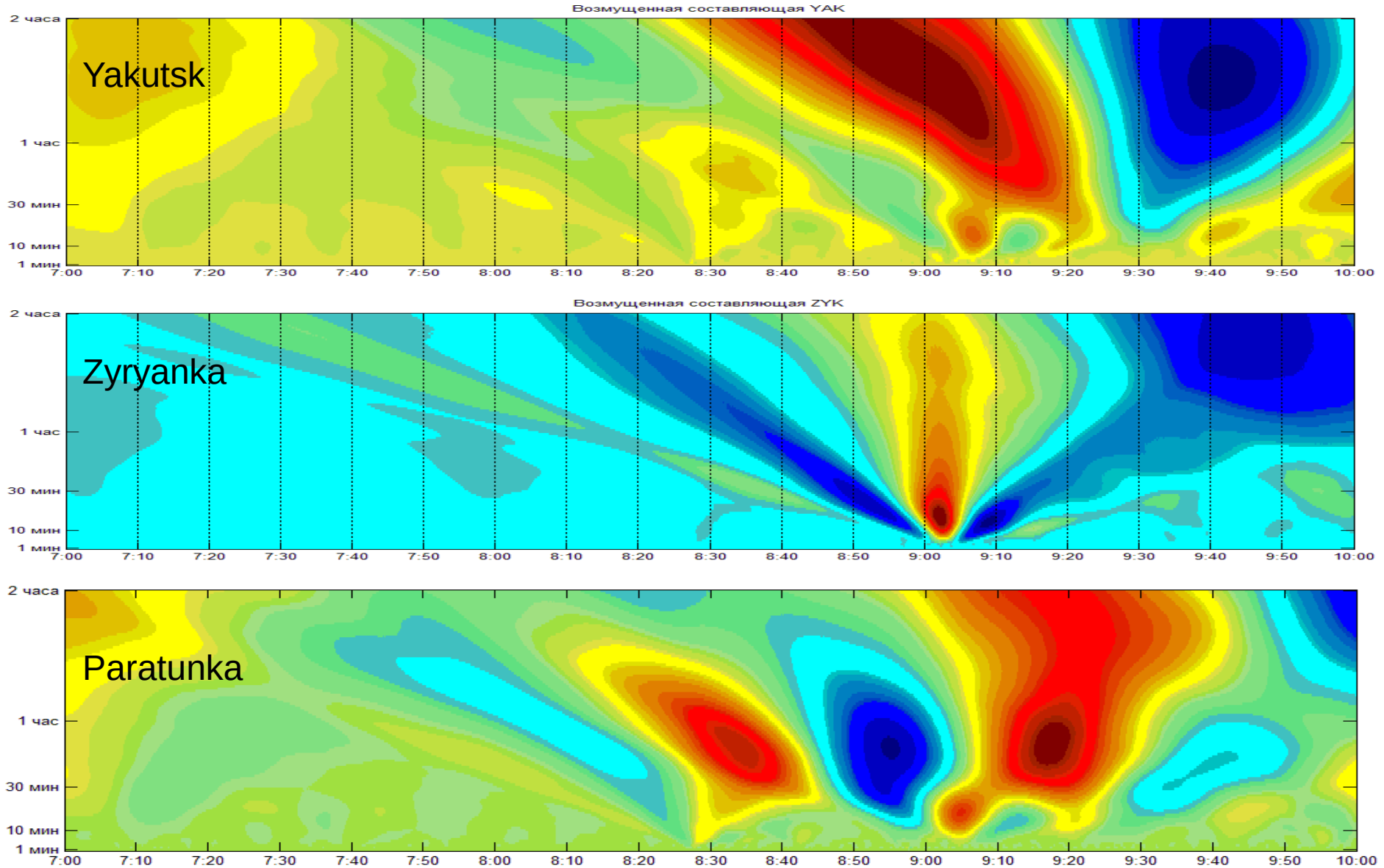
Estimation of intensity of geomagnetic disturbances (calibration to max)



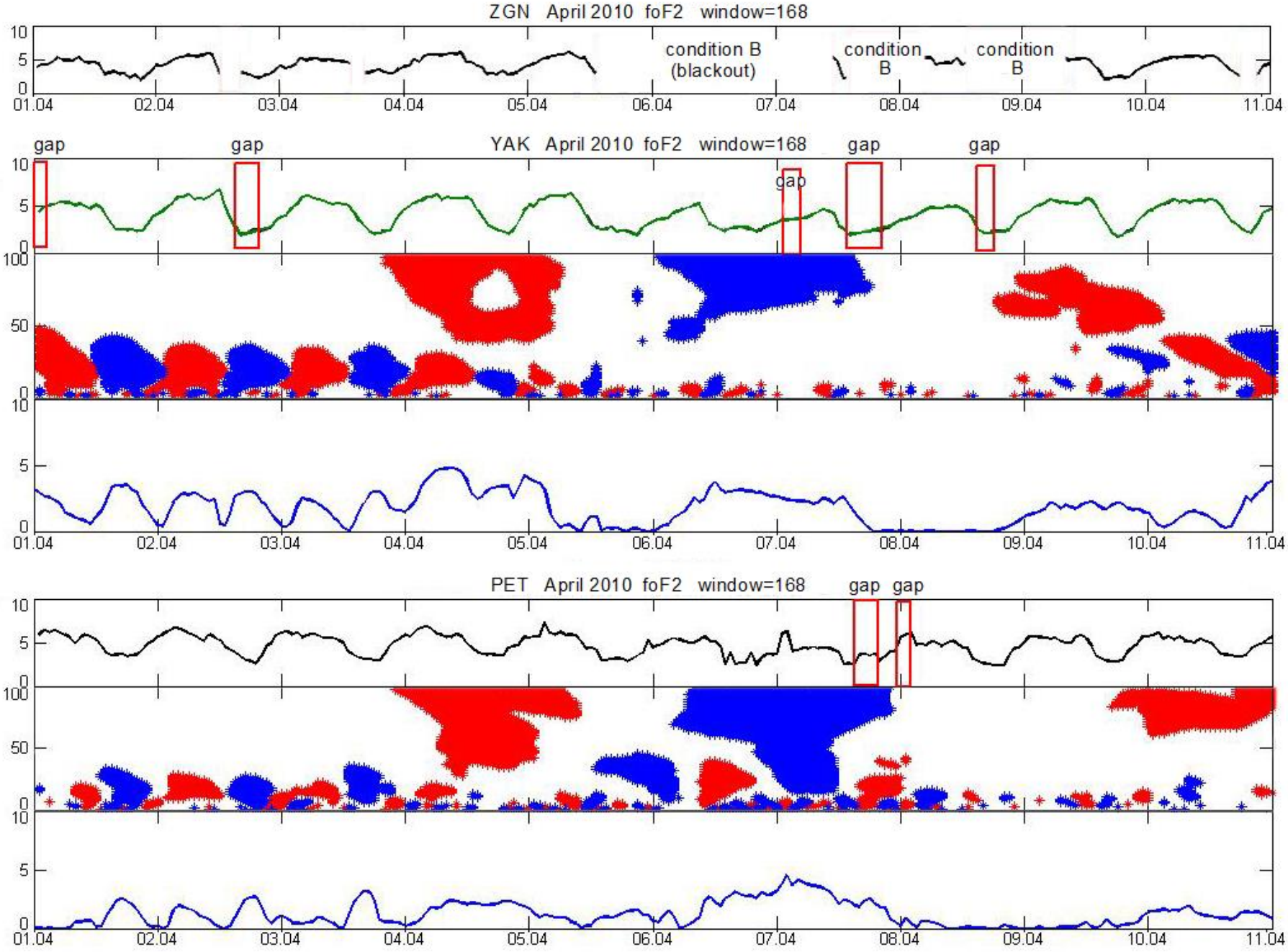
UT, hours

Wavelet spectrum of disturbed geomagnetic constituents on 5 April 2010

Estimation of intensity of geomagnetic disturbances (calibration to max)



Wavelet analysis of the F2 layer critical frequency



Variations of magnetic and ionospheric parameters in Egypt

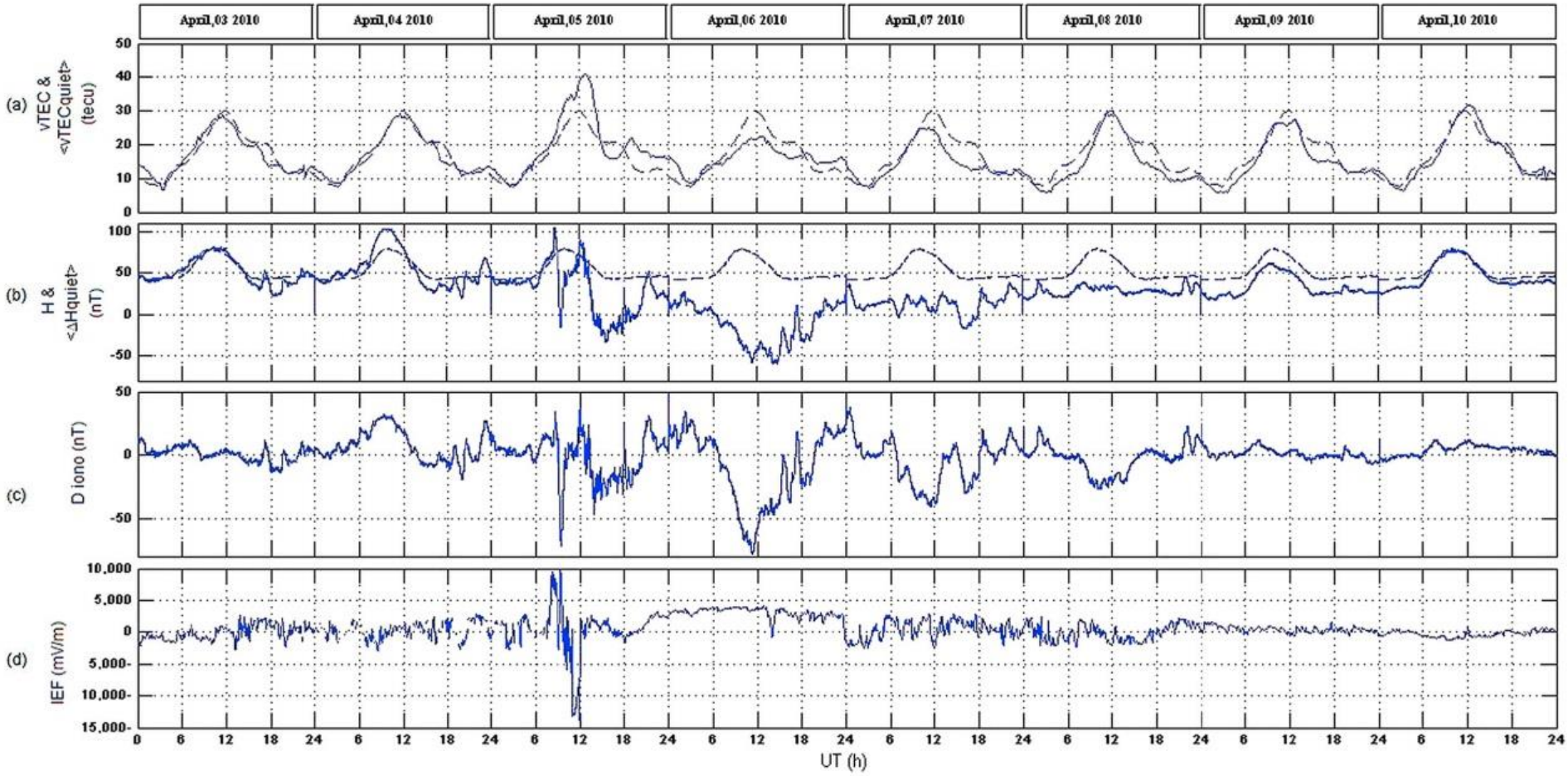


Figure 3. The daily variations for the whole period: (a) vertical total electron content (vTEC), (b) horizontal component of Earth's magnetic field (H) where the dashed curve for most quiet days (sunspot number (Am) ≤4), (c and d) ionospheric disturbance (Diono) and interplanetary electric field (IEF).

Shimeis et al. (JGR, 2012)

Conclusions

Magnetic and ionospheric disturbances in the Russian Far East region during the magnetic storm of 5 April 2010 are studied. The highest intensity of magnetic disturbances in period of interplanetary shock contact with the Earth's magnetosphere was observed at isl.Kotelny (L~8), while during the HILDCAA event observed on 6 April 2010 the highest magnetic intensity occurred at Tixie and Chokurdakh. Ionospheric conditions during the magnetic storm were characterized by radiowave blackouts (condition B) at Zhigansk (L~4) for ~2.5 days after a beginning of the magnetic storm and a sharp decrease in the electron concentration in the day hours during the main storm phase at Yakutsk (L~3.2) and Paratunka (L~2.2), which were kept on the same level for ~3 days. It can be noted that at Yakutsk and Paratunka were observed an enhancement of critical frequency foF2 before a beginning of the magnetic storm.

Thanks for attention!