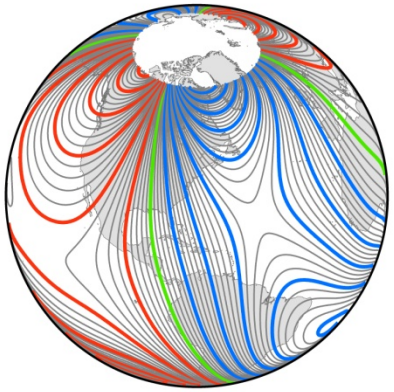
The NGDC/USGS Real-time Magnetospheric Disturbance Field Calculator



- Contributions to the geomagnetic disturbance field
- Description of the magnetospheric model
- Validation against observatory measurements

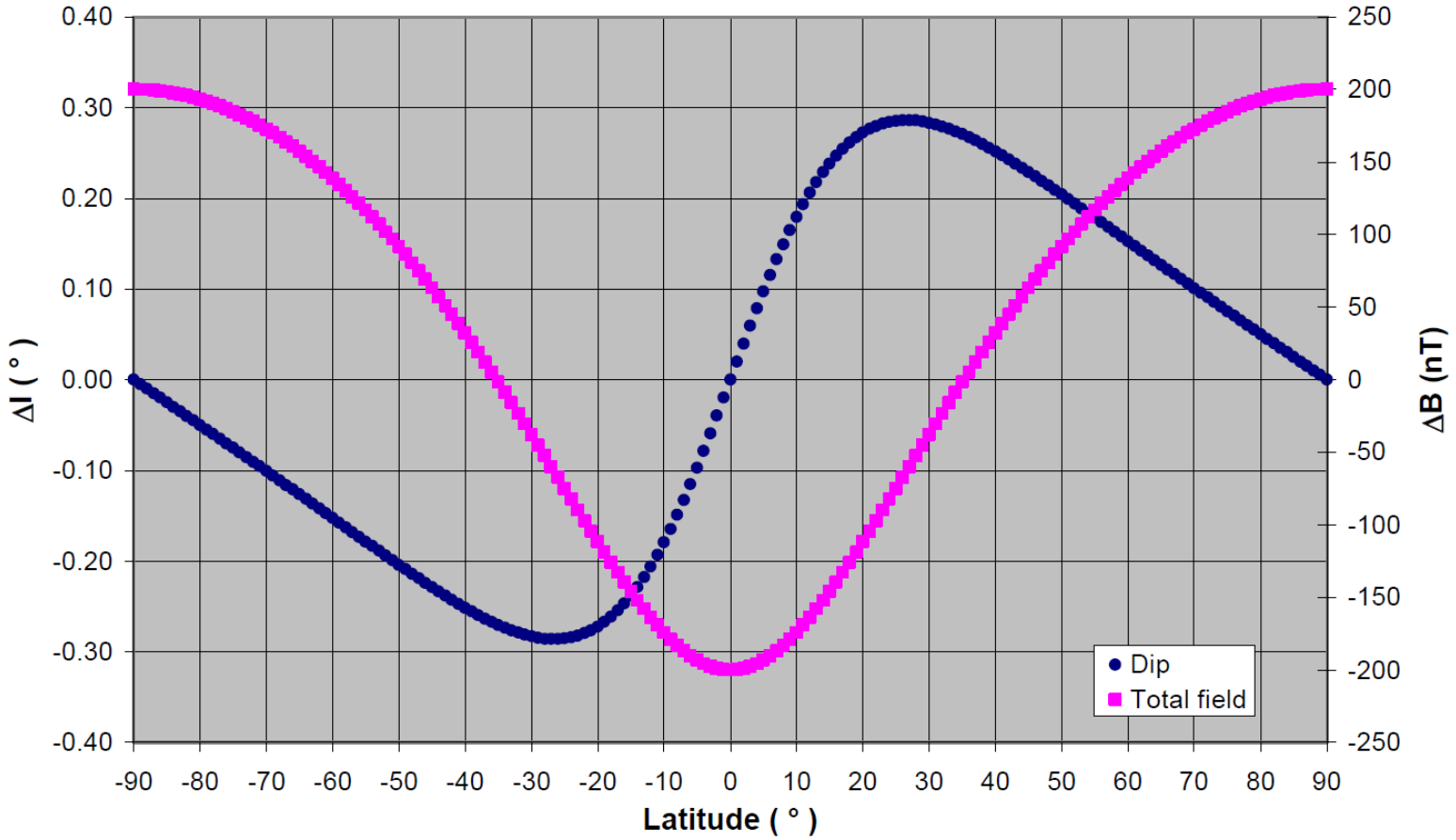
Stefan Maus, Manoj Nair, and Adam Woods (NOAA/NGDC)
Jennifer Gannon, Carol Finn and Jeffrey Love (USGS)

San Antonio, Oct-11, 2012

Background

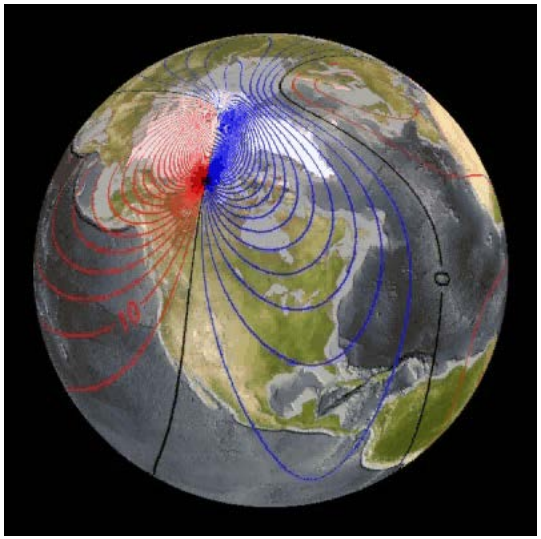
ISCWSA-32 (Florence, 2010):

Practical consequences of Earth's ring current and how to deal with them: Hansen (Univ Tromsø) and Edvardsen, Baker Hughes

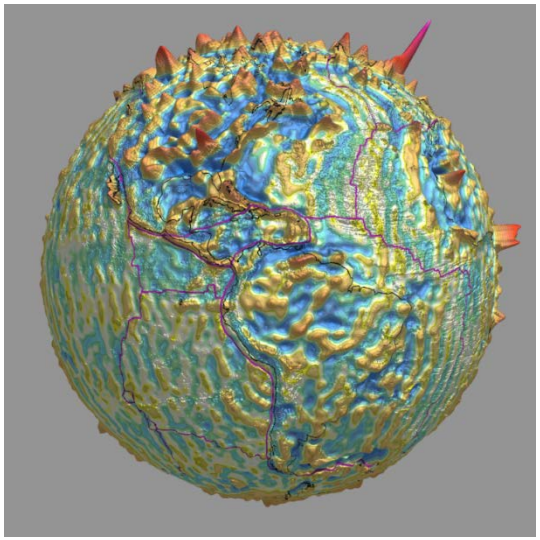


The Three Parts of the Geomagnetic Field

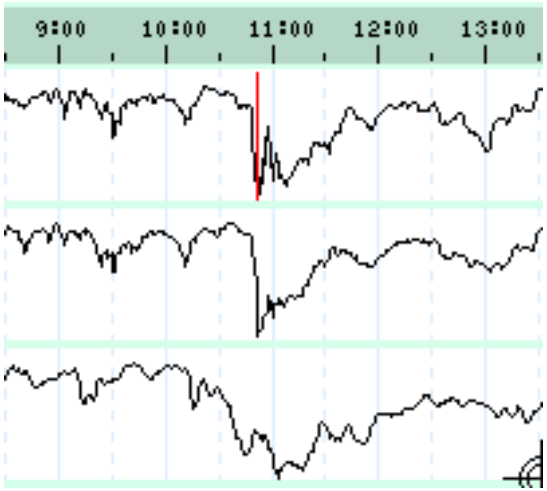
Main field

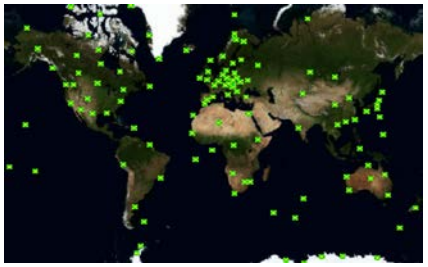


Crustal field

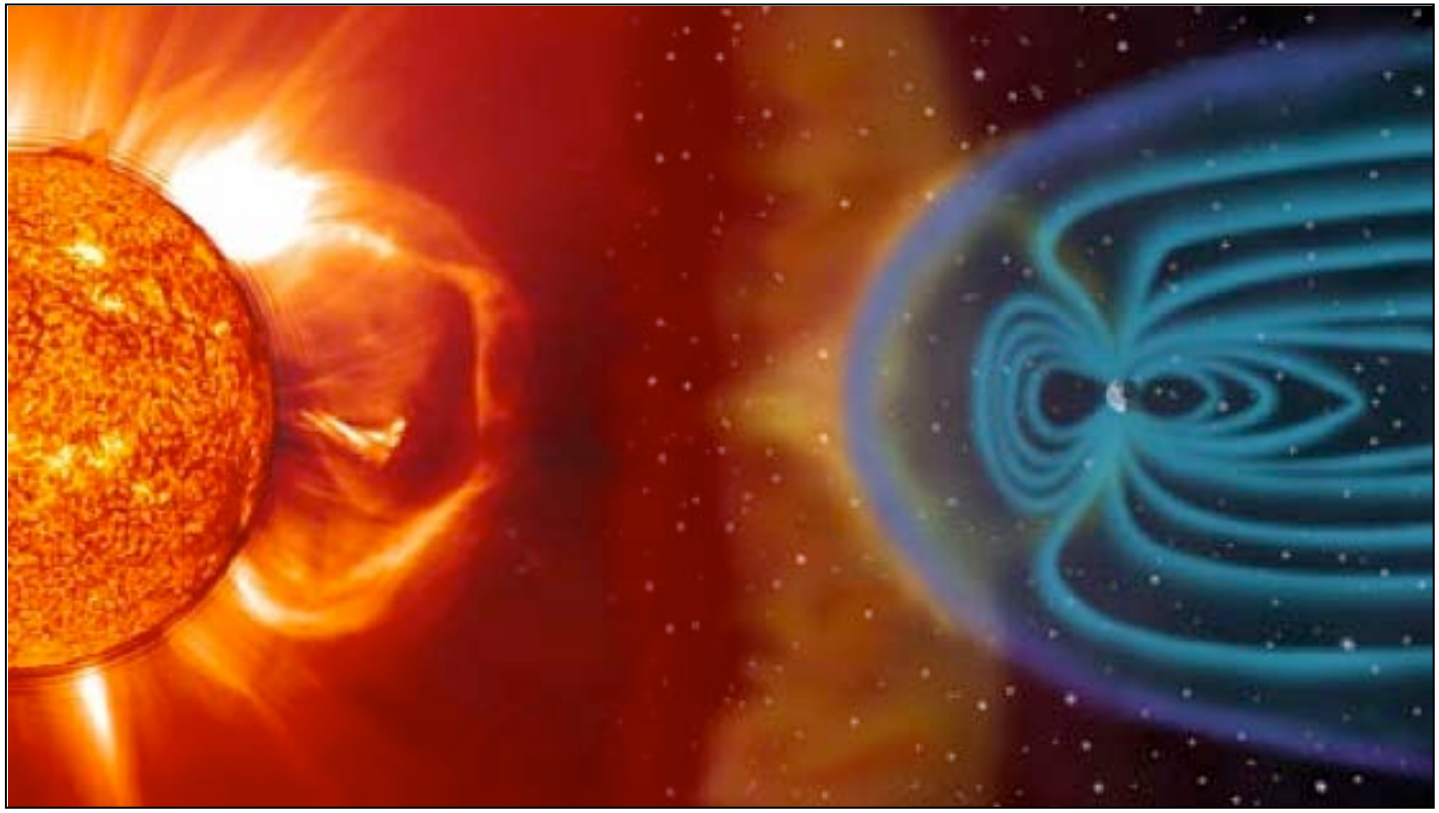


Disturbance field



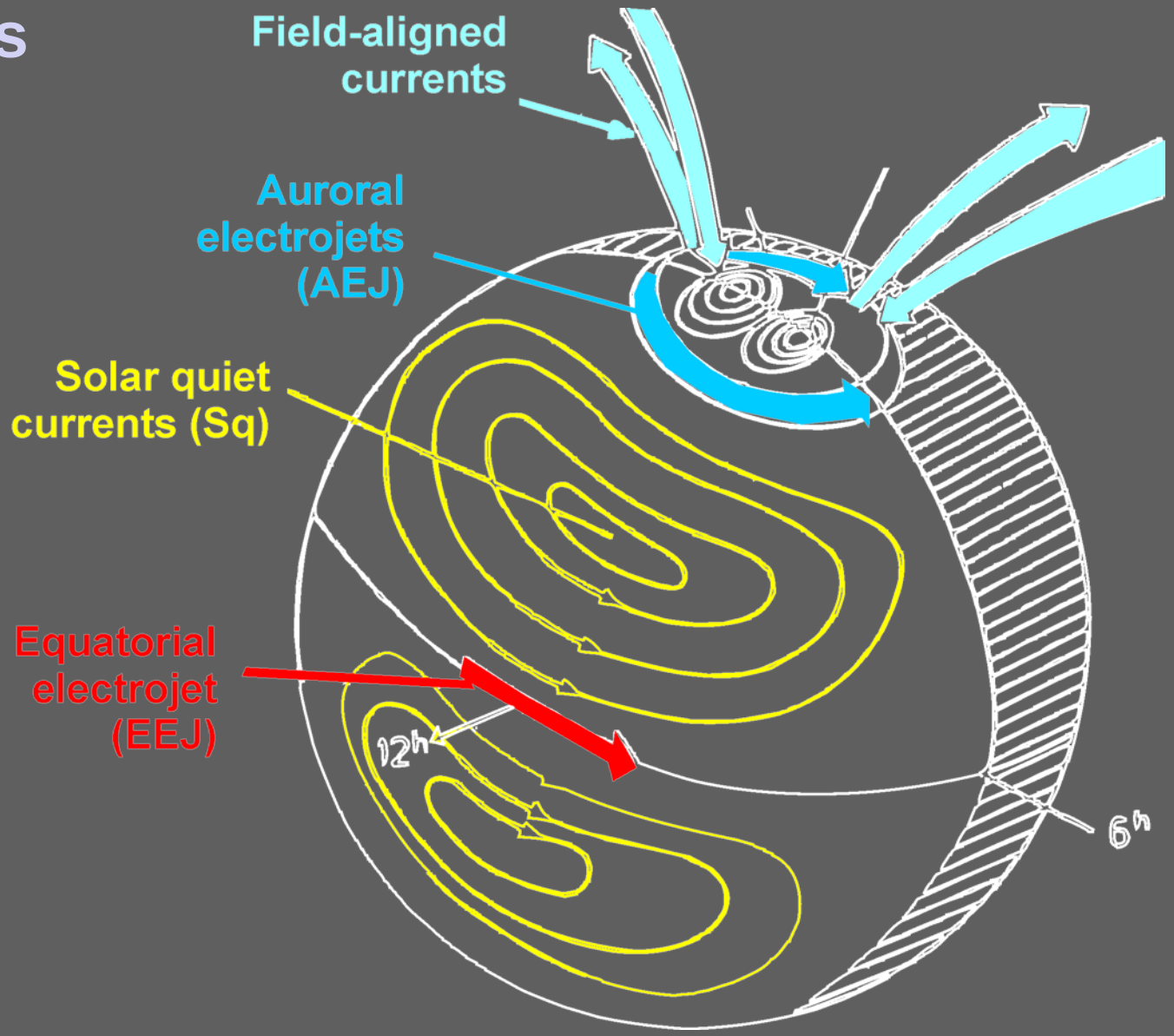


Disturbance Field



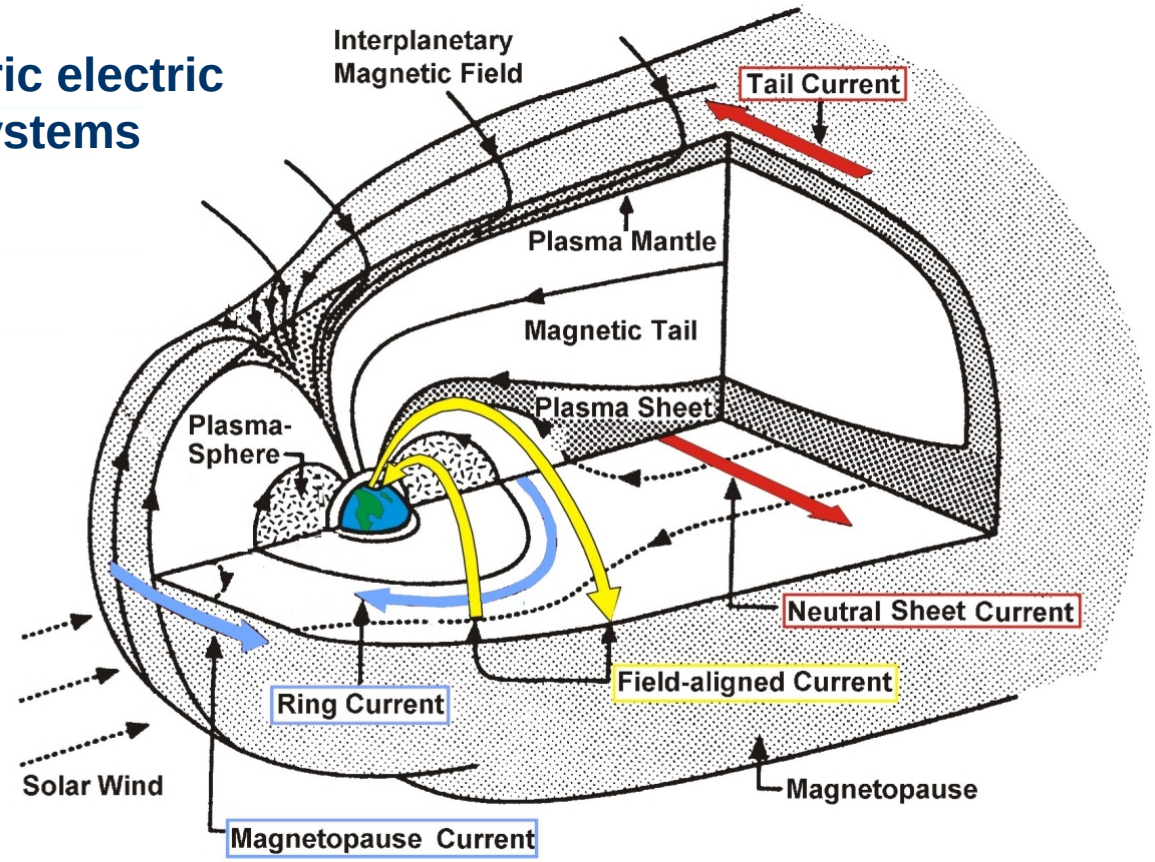
Mostly driven by the activity of the sun and solar wind
Plus minor contribution from winds in the upper atmosphere

Ionospheric currents

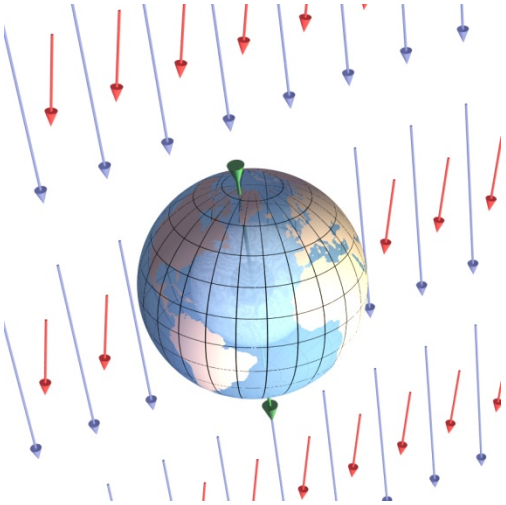


Magnetospheric currents and fields

Magnetospheric electric current systems

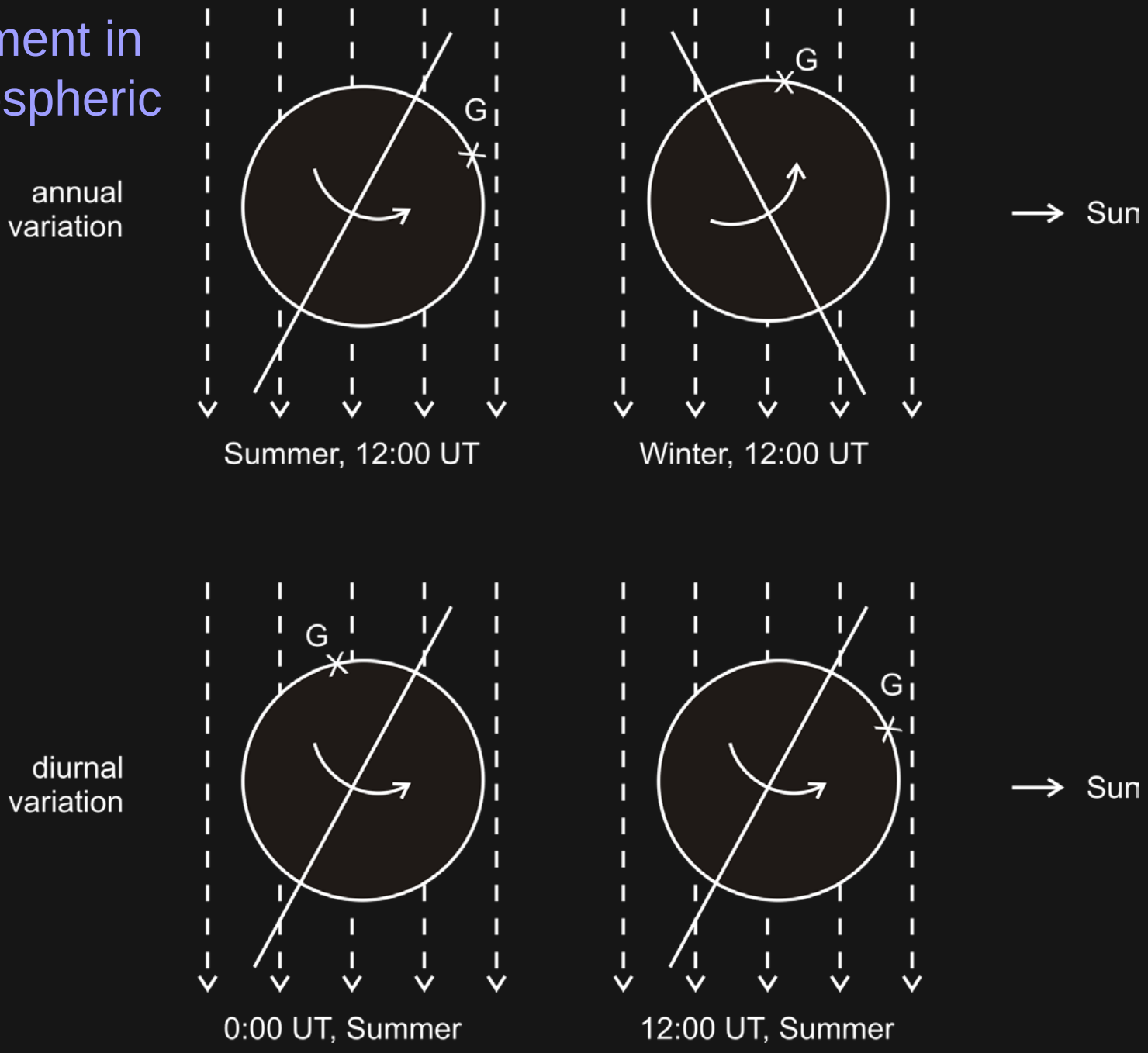


Resulting magnetic fields:



Use model of Maus & Lühr, 2005 & 2010

Earth movement in the Magnetospheric field



NGDC/USGS Real-time Calculator

Represented magnetospheric disturbance fields:

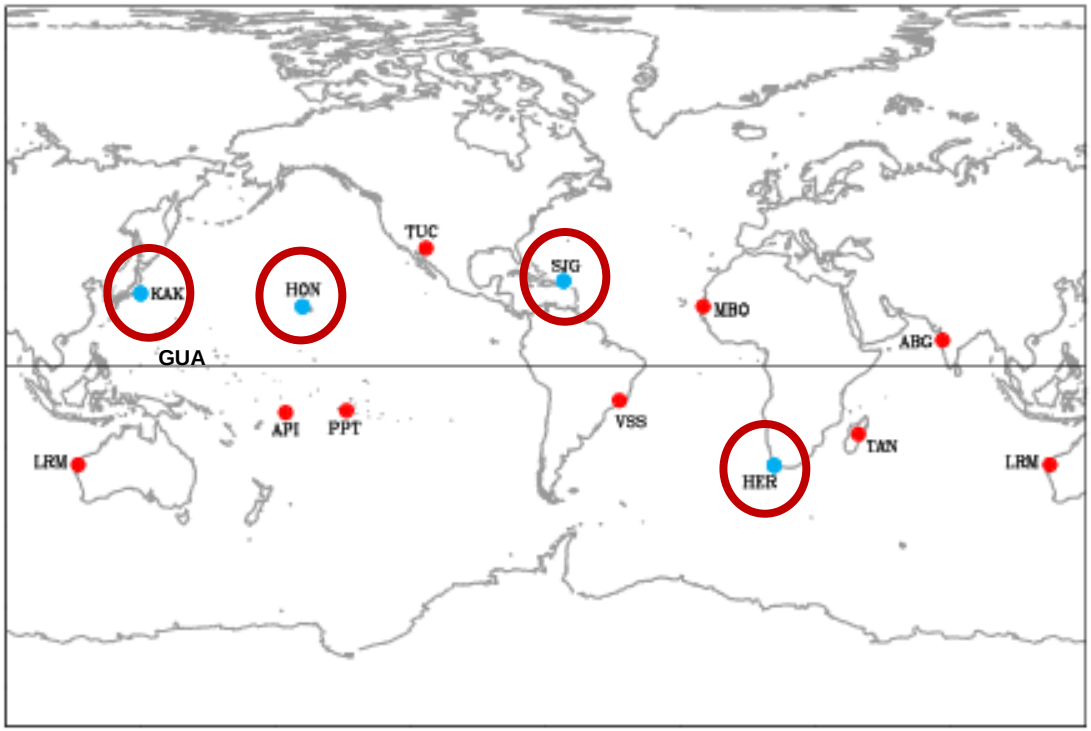
1) Magnetospheric variations caused by space weather
2) Rotation of the Earth in the magnetosphere
3) Secondary magnetic fields of electric currents, induced by time-varying magnetic fields in the conducting Earth and oceans

Model drivers:

1) USGS real-time Dst* index (ground observatories)
2) NASA solar wind measurements (ACE satellite)

*Dst = Disturbance Storm Time

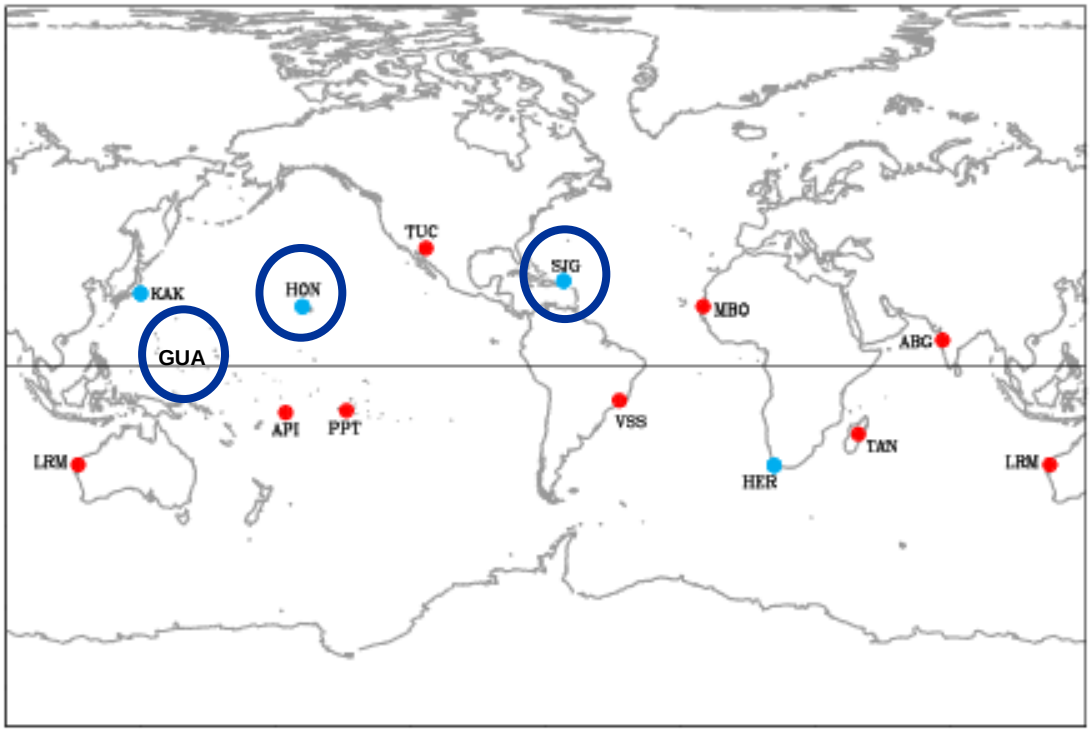
USGS Near Real-time Dst index



USGS Dst (4-station version):

- HON and SJG data transmitted by satellite and internet
- HER and KAK data transmitted by internet only

USGS Near Real-time Dst index



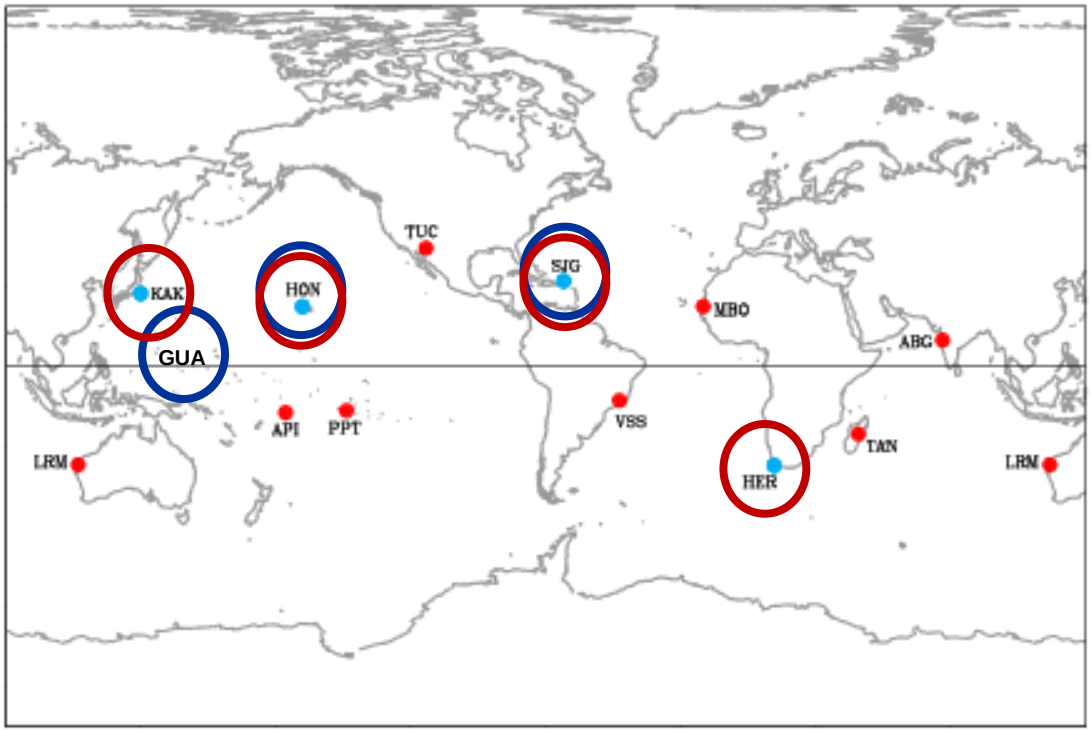
USGS Dst (4-station version):

- HON and SJG data transmitted by satellite and internet
- HER and KAK data transmitted by internet only

Backup-1: USGS Dst (3-station version), USGS-only:

- HON, SJG and GUA transmitted by satellite and internet

USGS Near Real-time Dst index



USGS Dst (4-station version):

- HON and SJG data transmitted by satellite and internet
- HER and KAK data transmitted by internet only

Backup-1: USGS Dst (3-station version), USGS-only:

- HON, SJG and GUA transmitted by satellite and internet

Backup-2: Kyoto Dst (based on KAK, HER, HON, and SJG)

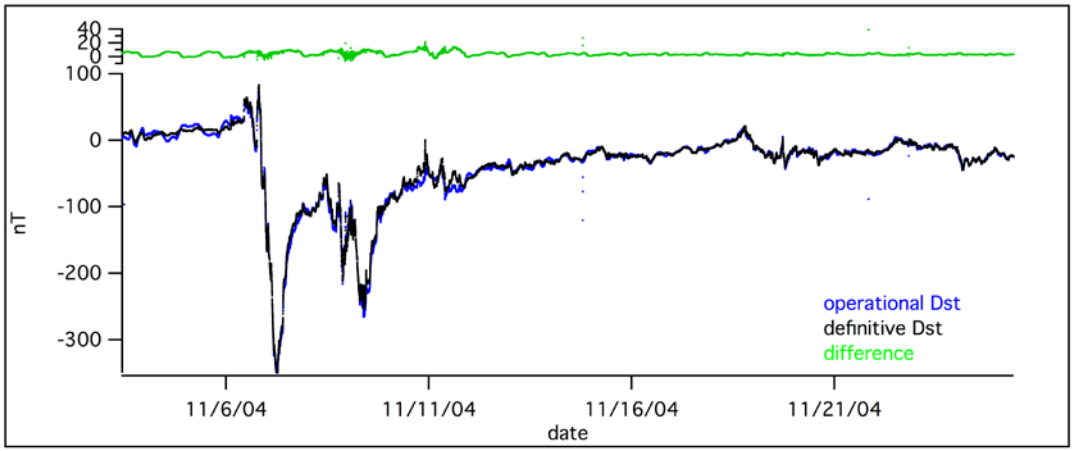
- By internet from http://wdc.kugi.kyoto-u.ac.jp/

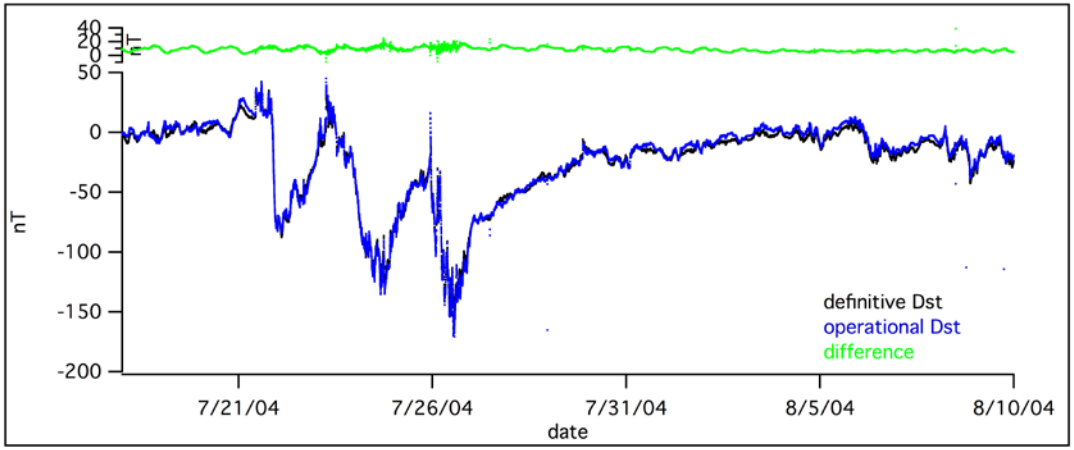
USGS Operational Dst

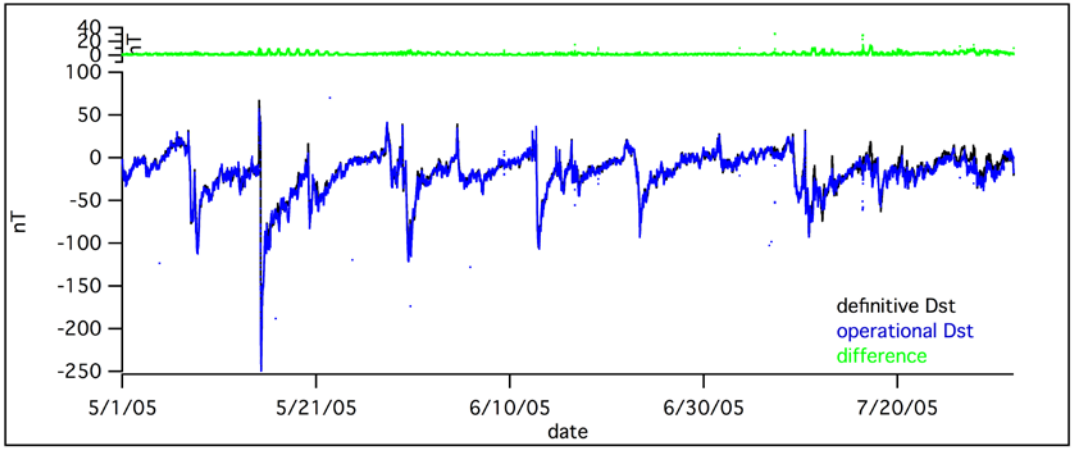
References:

Gannon, J.L., Love, J.J., Friberg, P.A., Stewart, D.C. & Lisowski, S.W., 2011. U.S. Geological Survey Near Real-Time Dst Index, USGS Open-File Report, 2011–1030, 10 p.

Gannon, J. L. & Love, J. J., 2011. USGS 1-min Dst index, J. Atmos. Solar-Terr. Phys., 73, 323-334.







USGS Dst Index Summary

Definitive Index for the past

- Uses definitive (clean) magnetic field data
- 25 year processing span

Near Real-time Index

- Uses preliminary (near real-time) magnetic field data
- 5-15 minute latency

USGS versus Kyoto Dst

- Better time resolution (USGS: 1-minute, Kyoto: 1-hour)

Screen shot of calculator

Geomagnetism

Home | Magnetic Field Overview | Model and software downloads | Online Calculators | Magnetic Data Sources | Geomagnetic Tutorials

Real-Time Disturbance Field Calculator

	Degree	Minute	Second	Elevation
Lat: ◉ North ○ South	31	20	0	25
Lon: ◉ East ○ West	20	25	10	○ Feet ○ Meters ◉ Kilometers

Start Date:

Day	Month	Year	UTC
5	October	2012	21

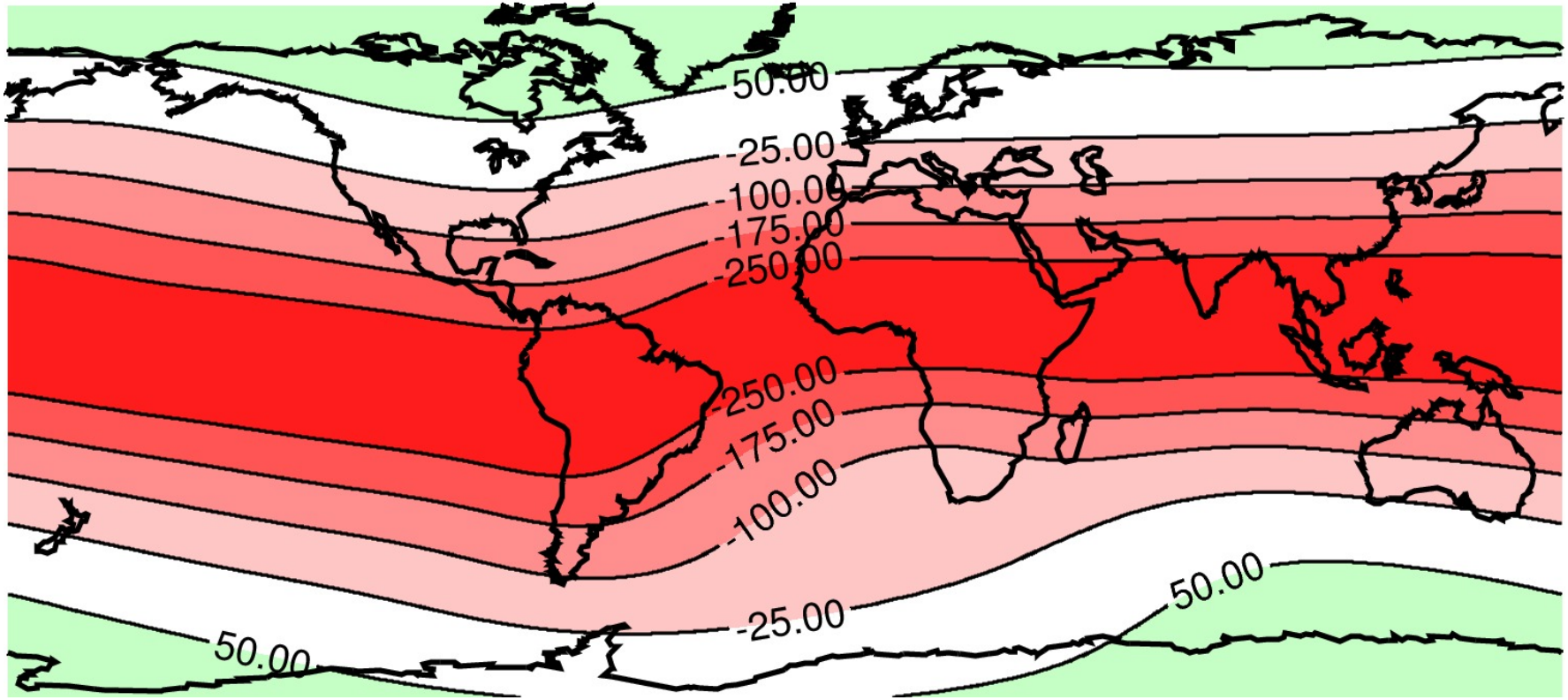
Compute Magnetic Field Values

Lat: 31.33 Lon: 20.42 Elev: 25.00	ΔDeclination: -0.01 minutes (+E|-W)	ΔInclination: 0.66 minutes (+E|-W)	ΔF: -0.34 nT	ΔH: -5.95 nT	ΔX: -5.93 nT (+N|-S)	ΔY: -0.40 nT (+E|-W)	ΔZ: 5.50 nT (+Down|-Up)

Success! Date Used: 10/5/2012 21:00

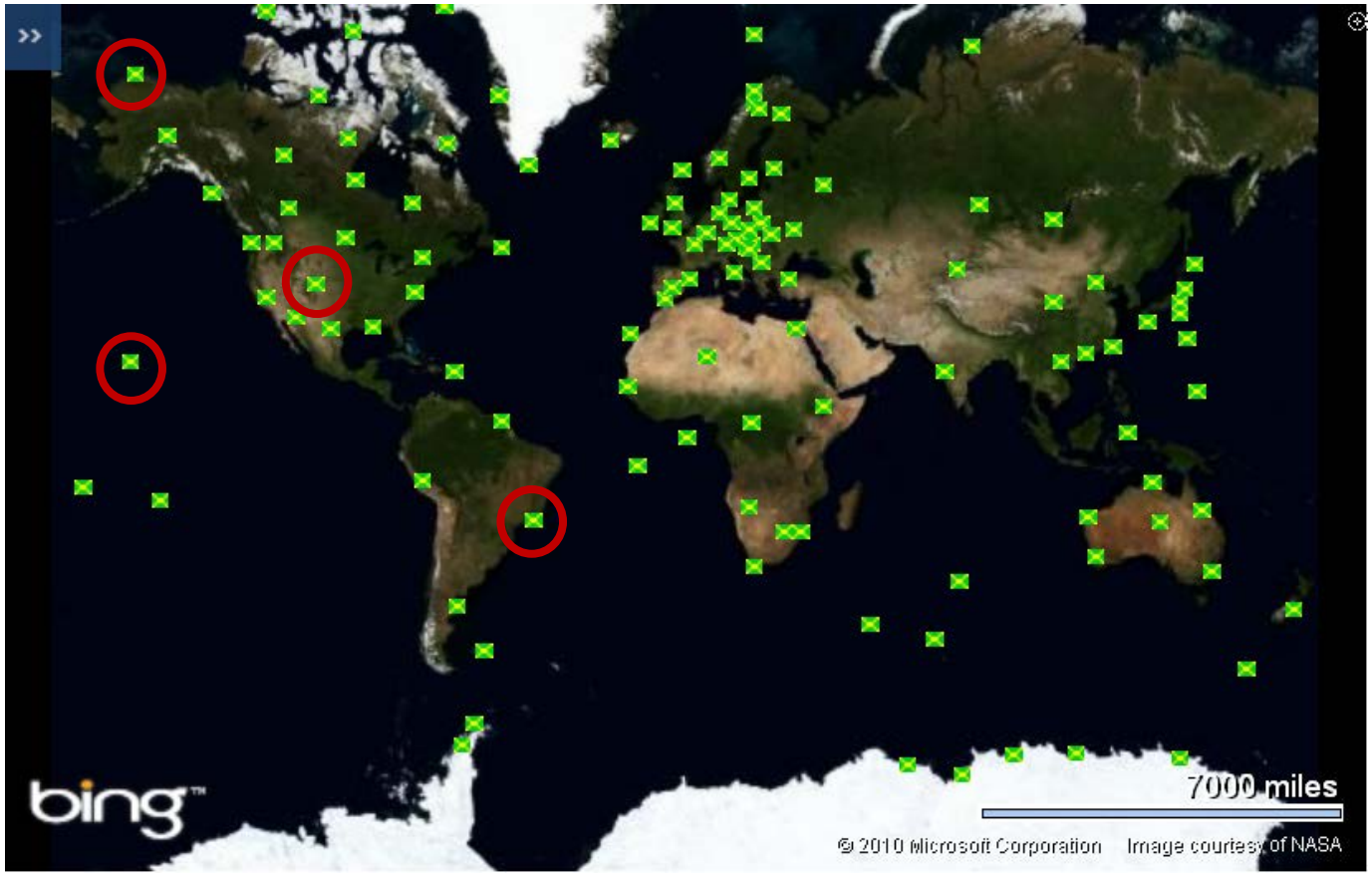
Real-time Map

Calculator will show real-time maps of the declination, dip and total field



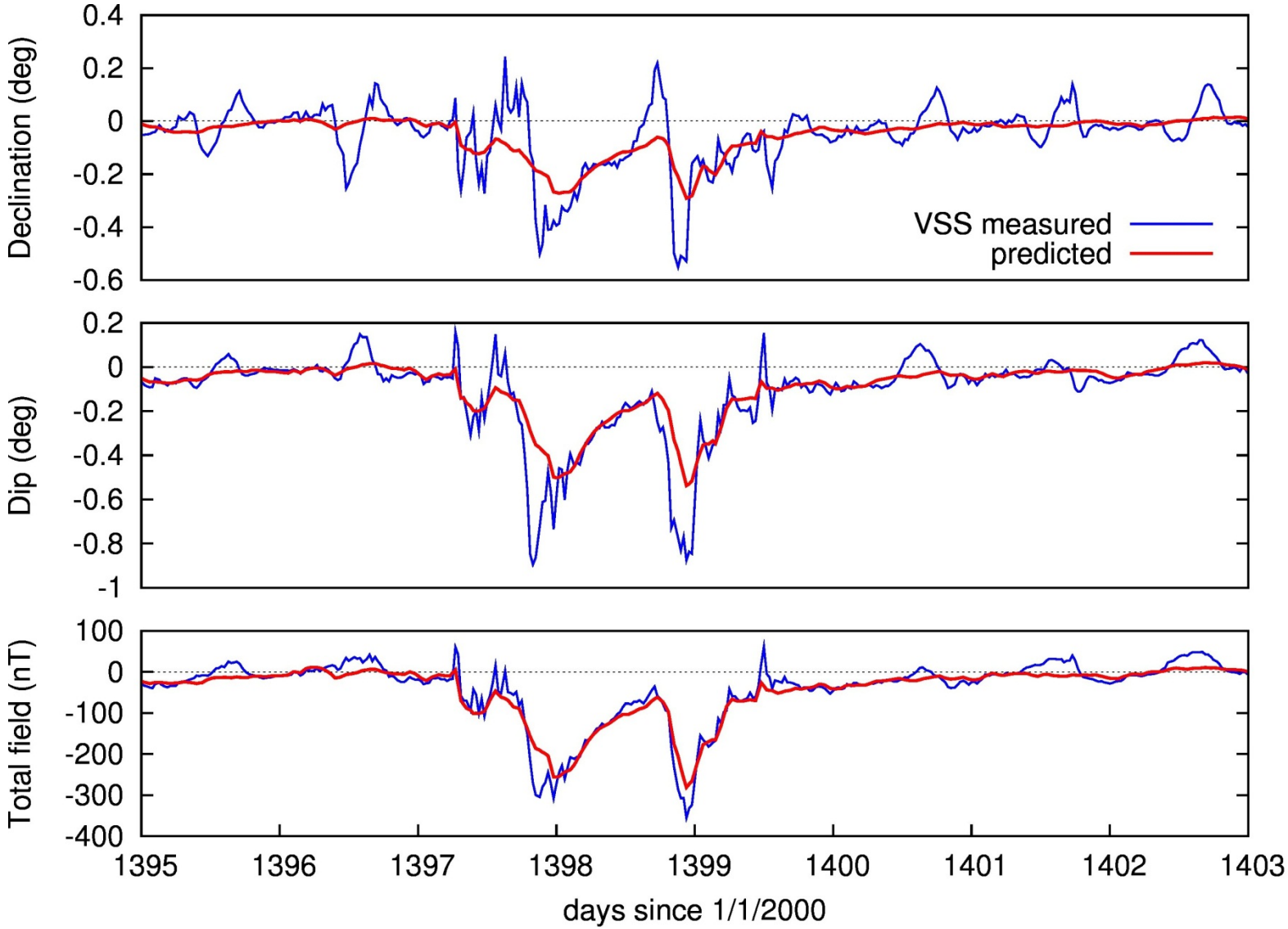
Total field at the Earth surface for a magnetic storm in October 2003

Real-time calculator validation using magnetic observatory minute values

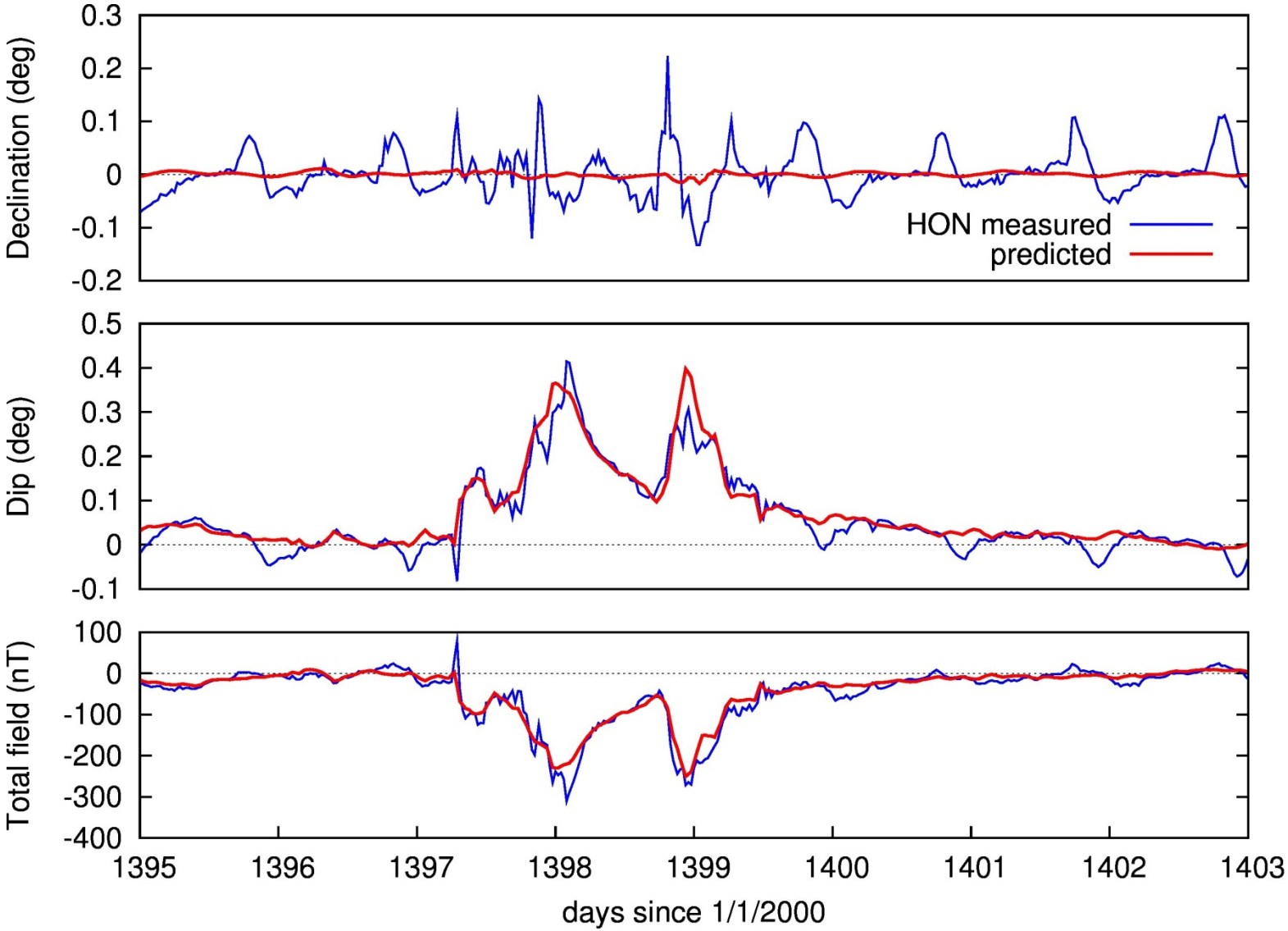


http://spidr.ngdc.noaa.gov/spidr

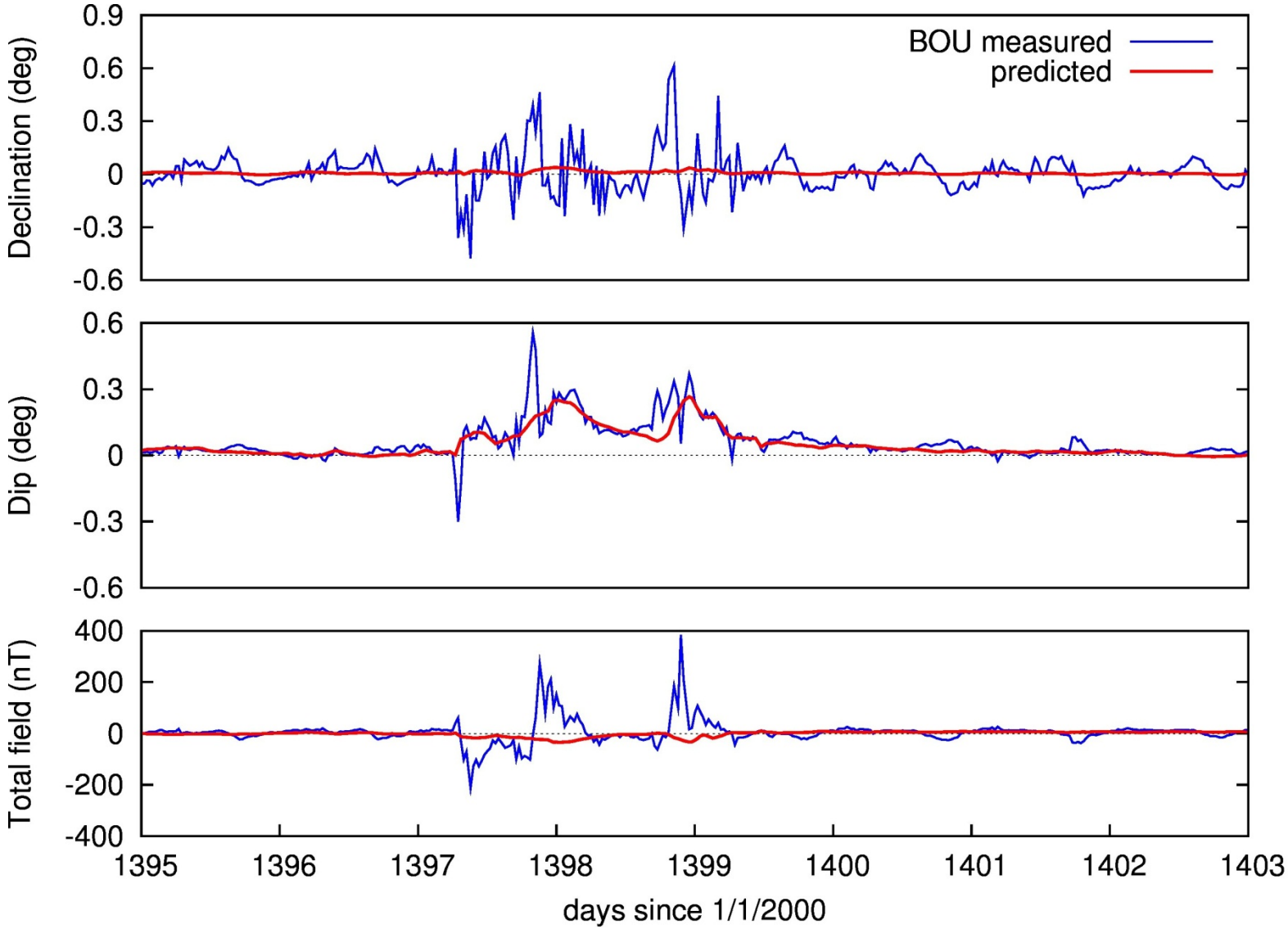
Vassouras, Brazil (-22° Latitude)



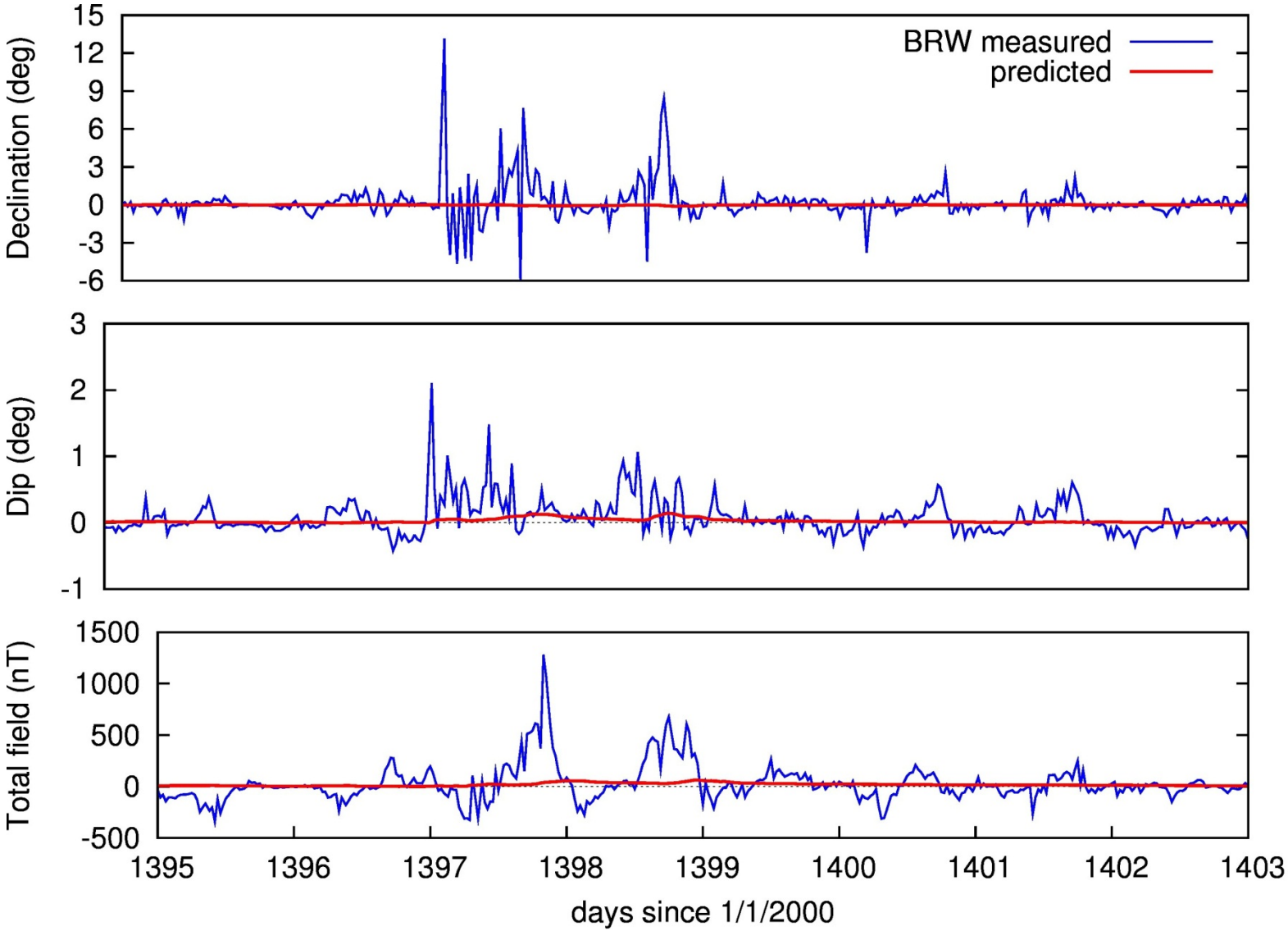
Honolulu, Hawaii (21° Latitude)



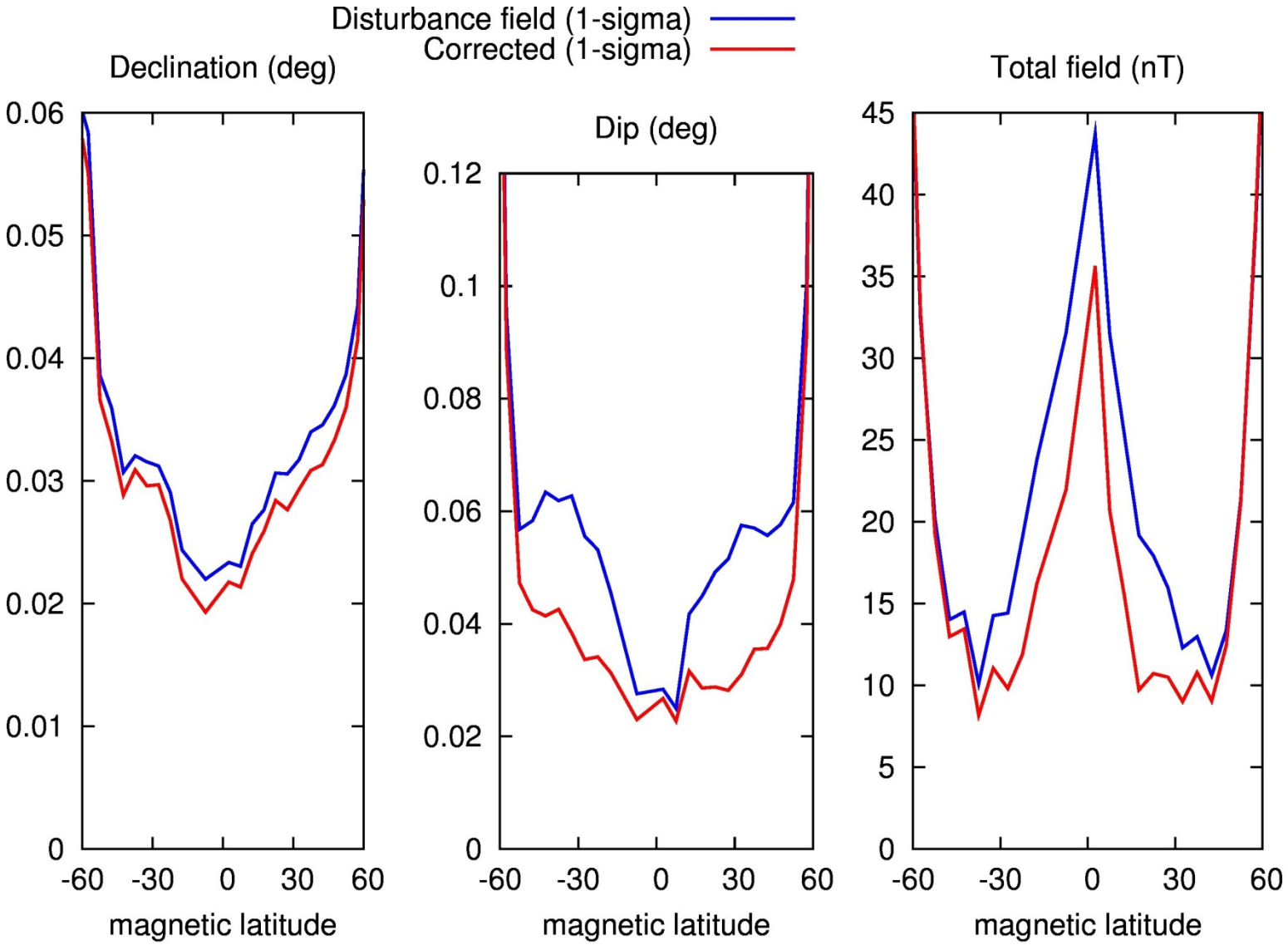
Boulder, Colorado (40° Latitude)



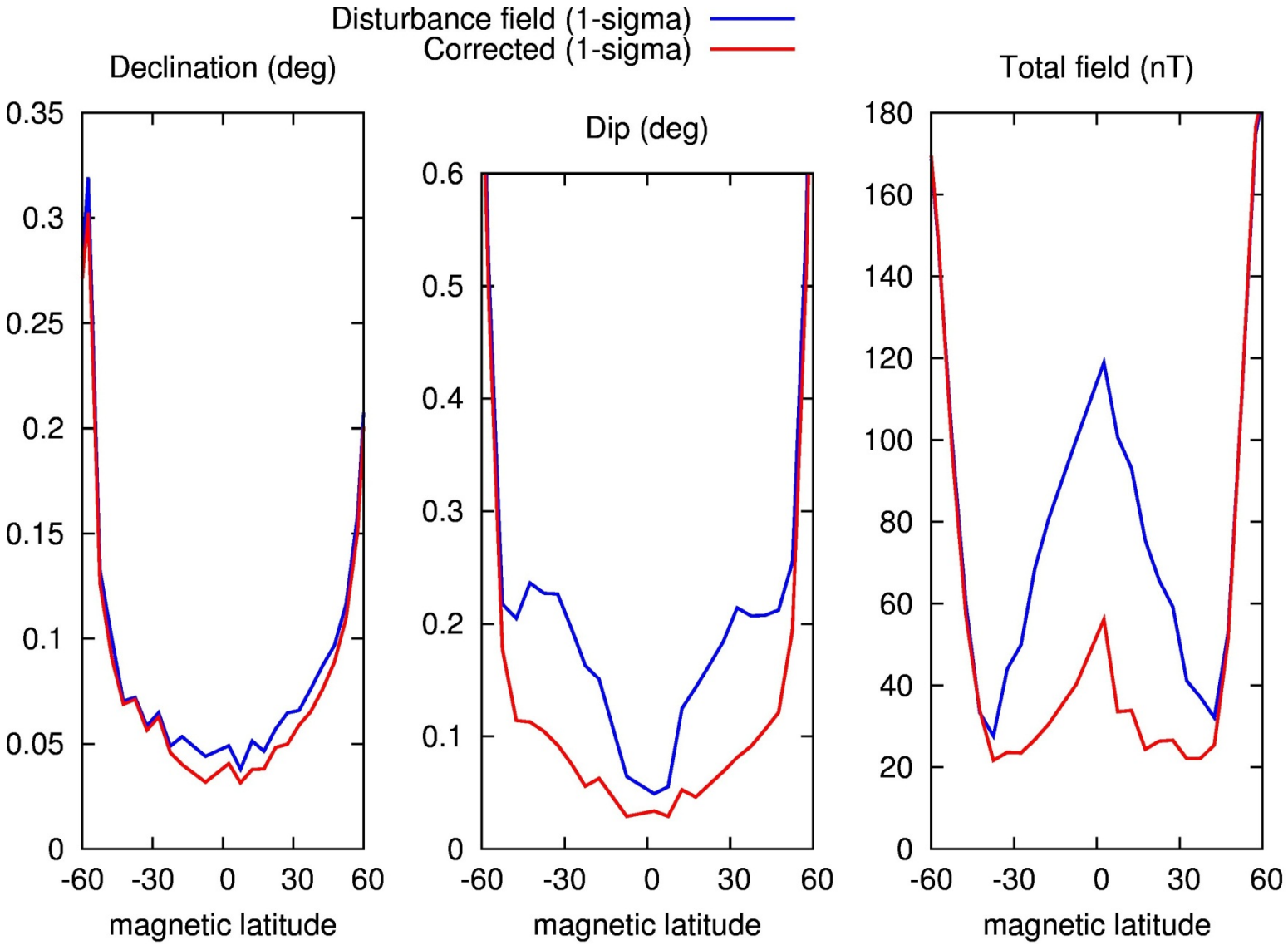
Barrow, Alaska (71° Latitude)



Disturbance Field Strength against latitude



Disturbance During Magnetic Storms (Kp≥6)



Conclusions and Outlook

- **Real-time magnetospheric disturbance field prediction:** http://geomag.org/models/RTDFC.html
- **Works best at low latitudes**
  - Upto 50% reduction in total field and dip residuals
  - → Investigate reasons for failed surveys
  - → Correct total field and dip for magnetic ranging
- **Calculator will be enhanced**
  - Use minute-value USGS Dst
  - Include further parts of the disturbance field