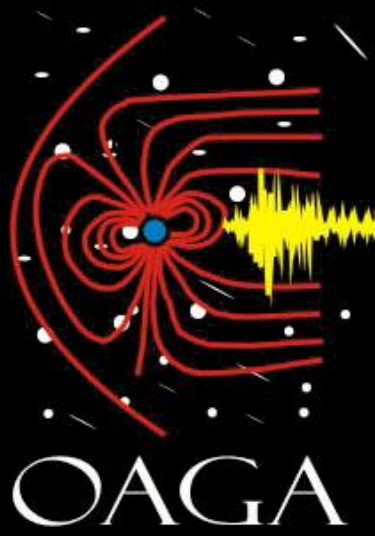
Monitoring the Geomagnetic field under the South Atlantic Magnetic Anomaly (SAMA)



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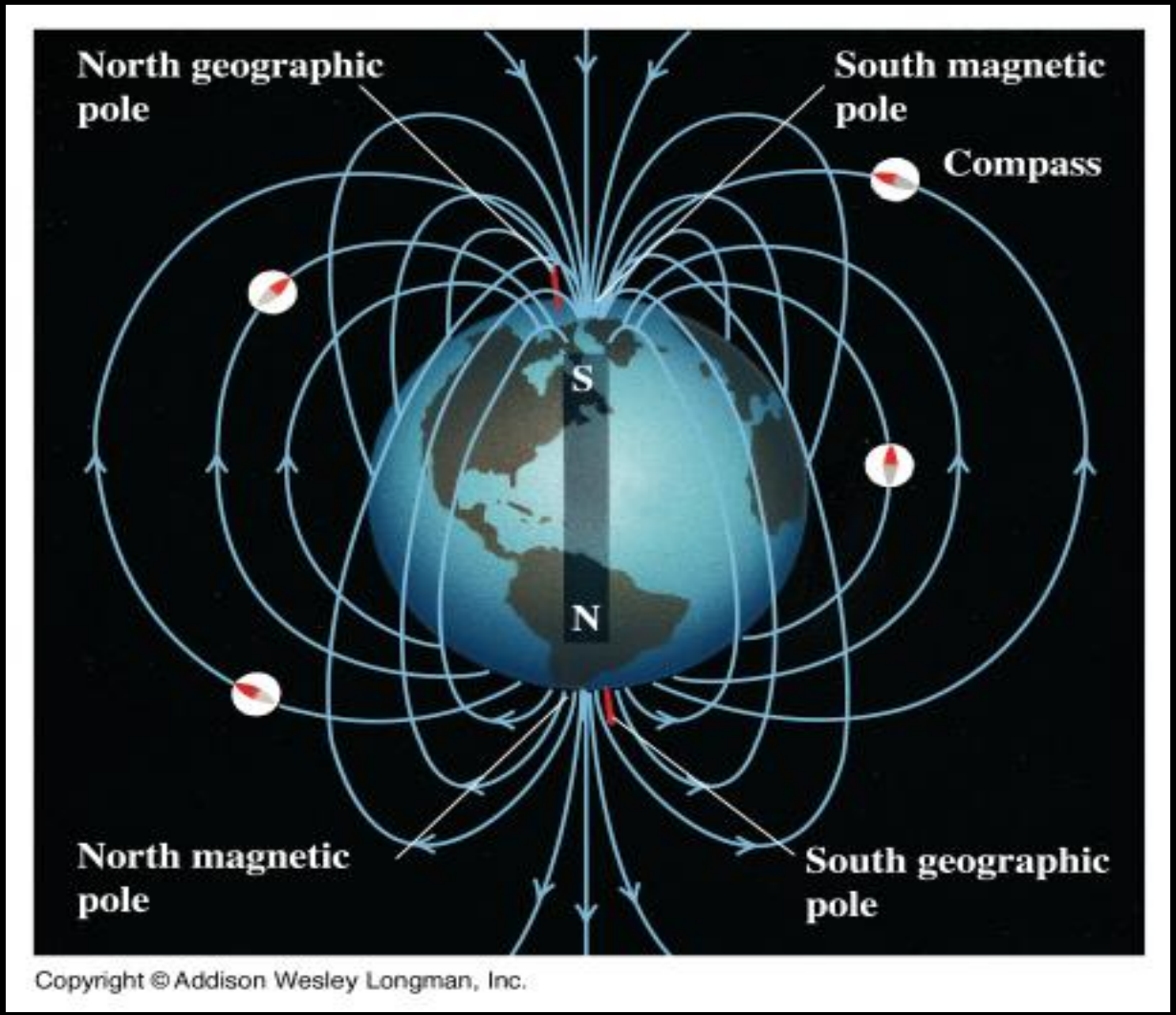
[1] Area Geofísica-Geotectónica, Instituto de Ciencias Geológicas, Facultad de Ciencias, Universidad de la República (leda@fcien.edu.uy)

[2] Observatorio Astronómico y Geofísico de Aiguá

[3] Departamento de Astronomía, Instituto de Física, Facultad de Ciencias, Universidad de la República (gonzalo@fisica.edu.uy)/ Observatorio Astronómico Los Molinos, DICYT – MEC

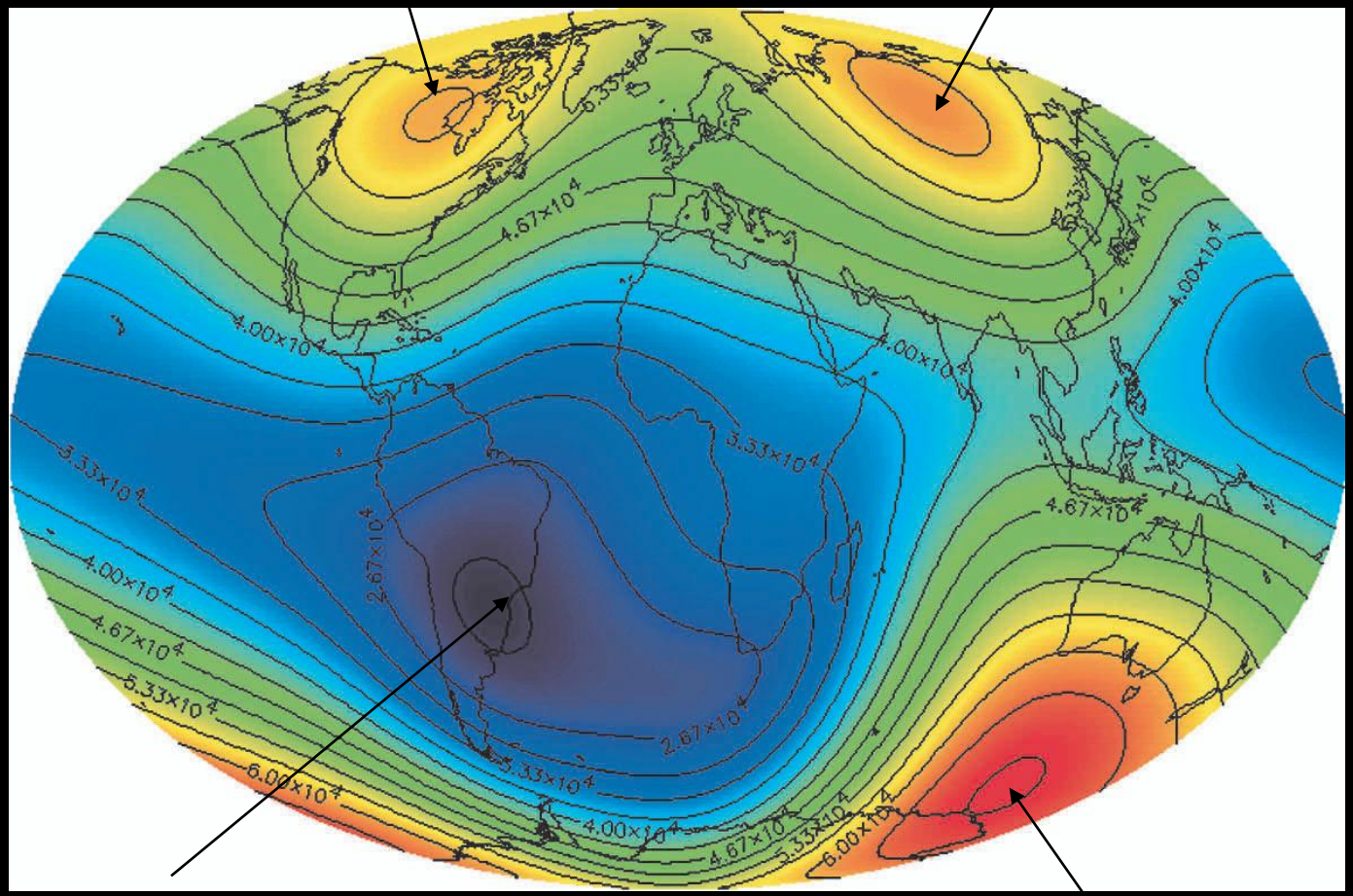
Geomagnetic field



GEOMAGNETIC FIELD

GEOMAGNETICO NORTH POLE

SECONDARY GEOMAGNETIC POLE?

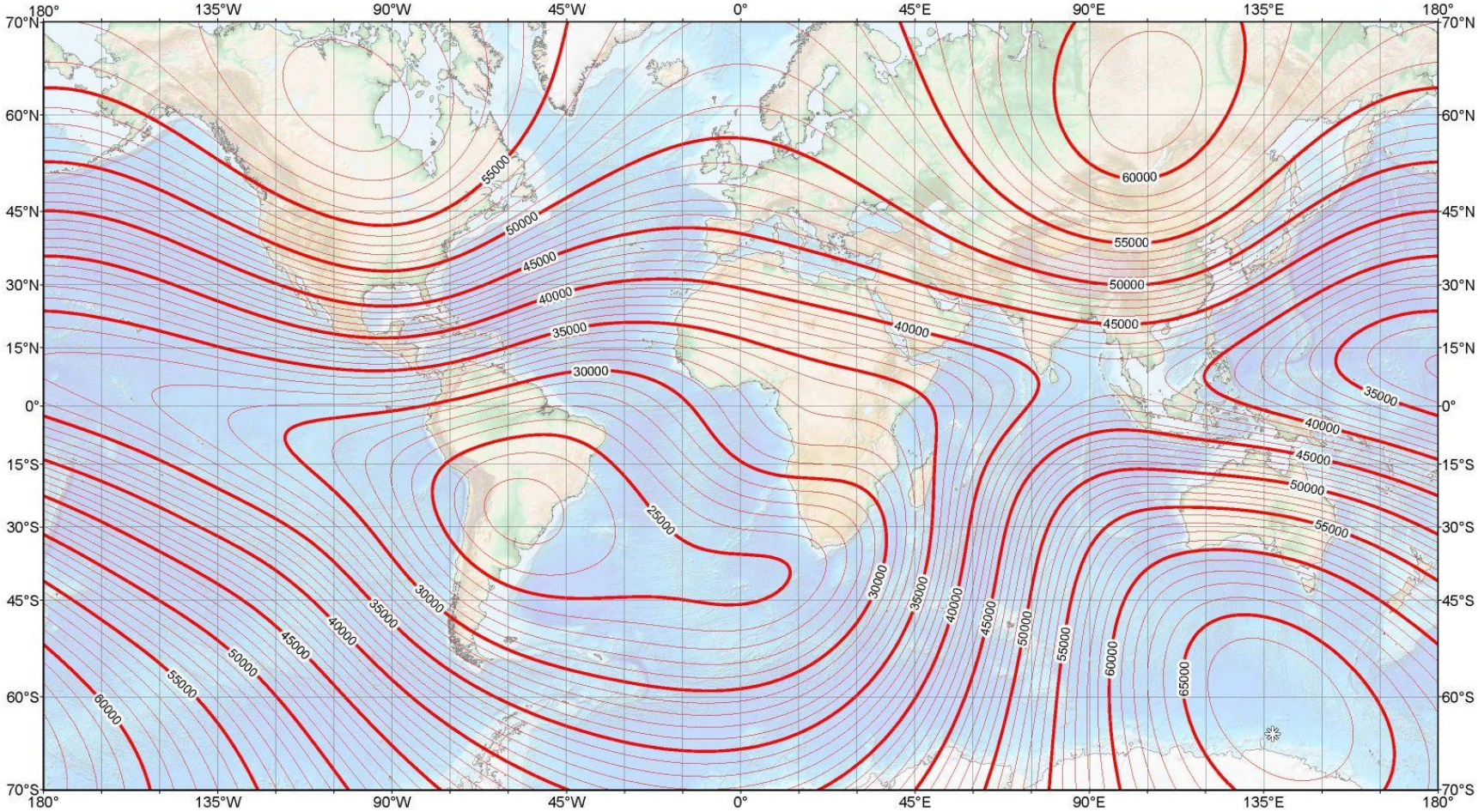


SOUTH ATLANTIC MAGNETIC ANOMALY (SAMA)

GEOMAGNETIC SOUTH POLE

The dipole strength is decreasing

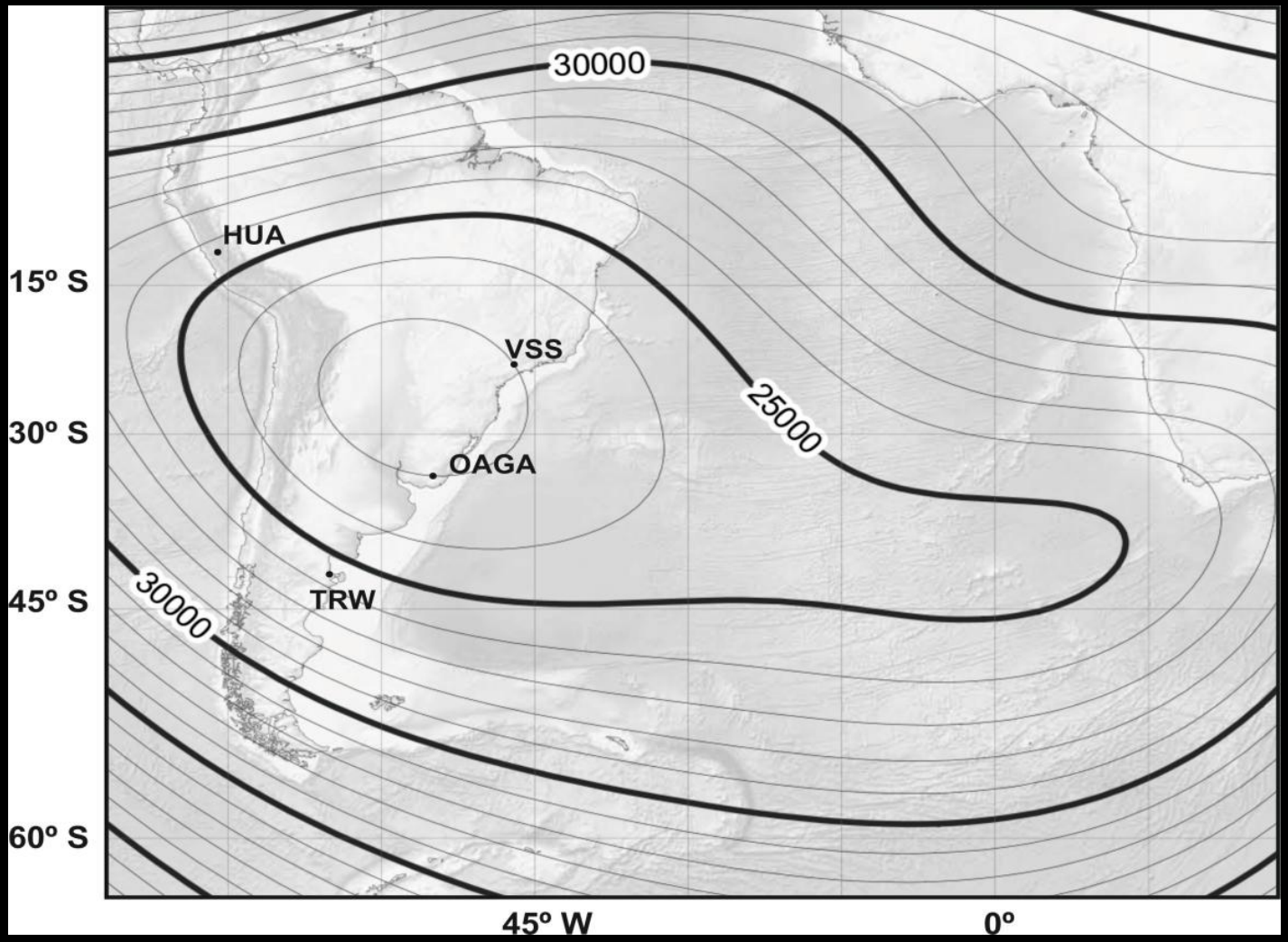
US/UK World Magnetic Model -- Epoch 2010.0
Main Field Total Intensity (F)



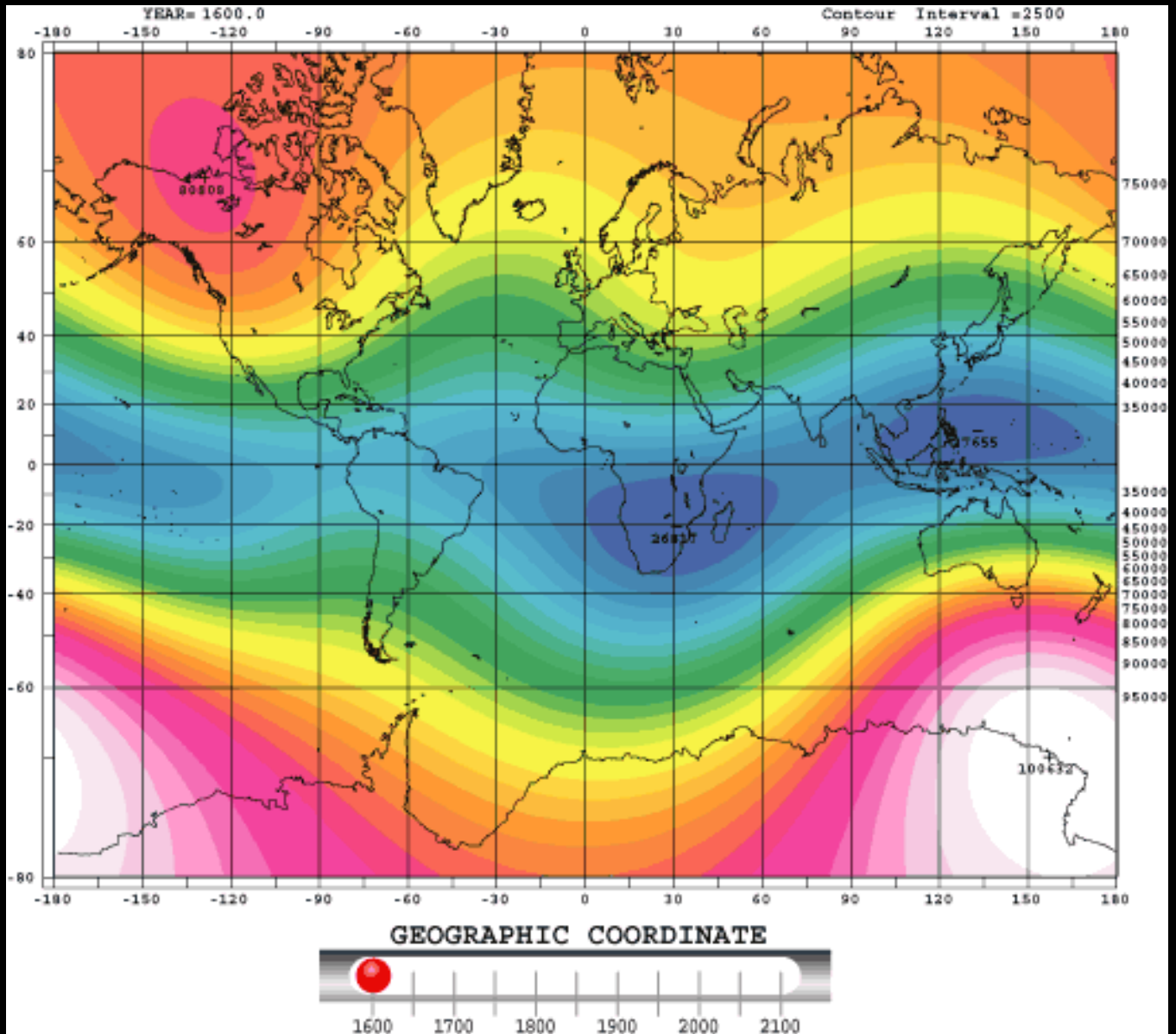
Main Field Total Intensity (F)
Contour interval: 1000 nT.
Mercator Projection.
: Position of dip poles

Map developed by NOAA/NGDC & CIRES
http://ngdc.noaa.gov/geomag/WMM/
Map reviewed by NGA/BGS
Published January 2010

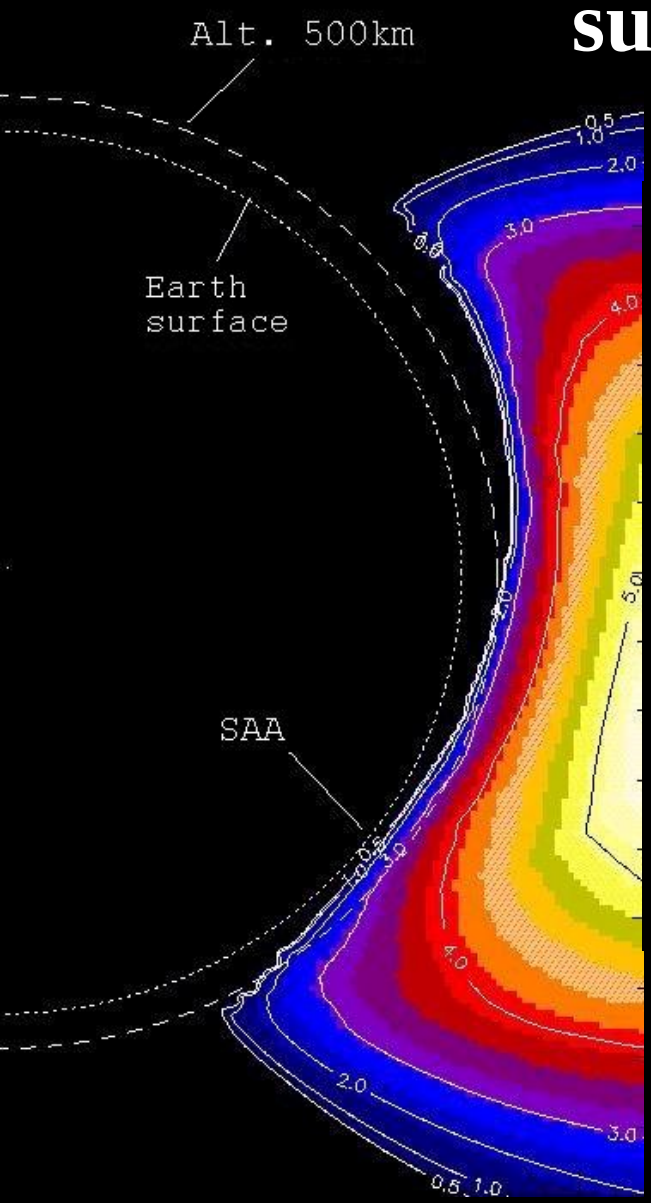
The total magnetic field under SMA

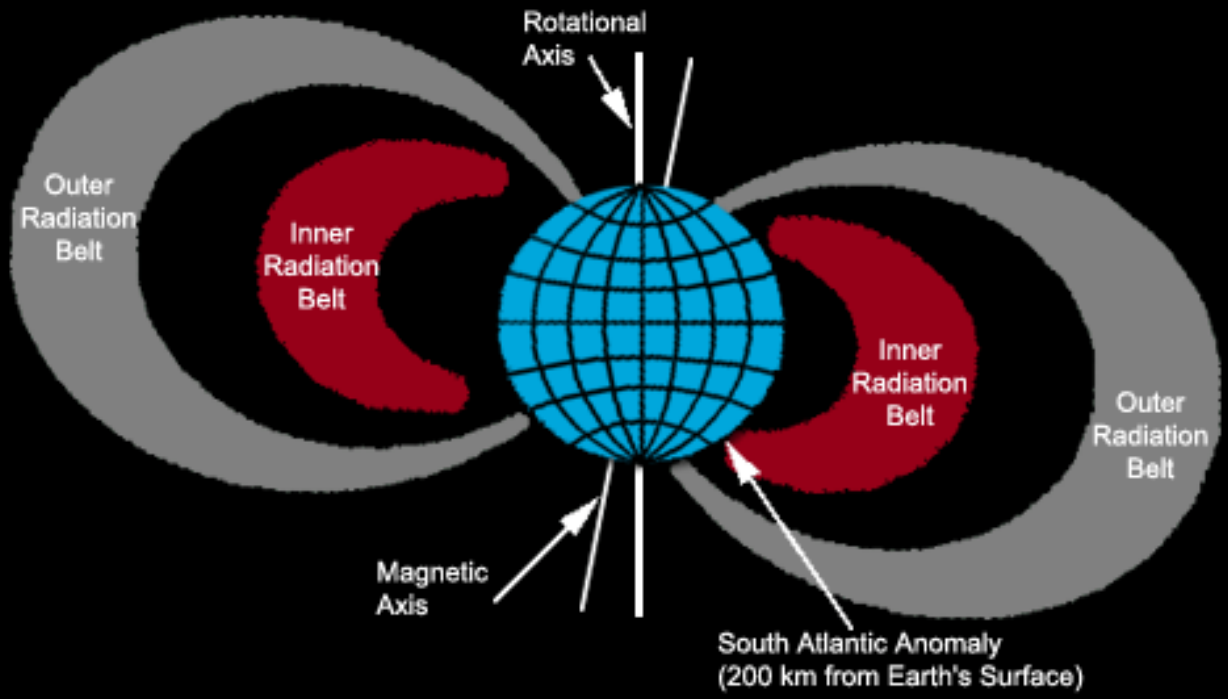


Time Evolution of SAMA

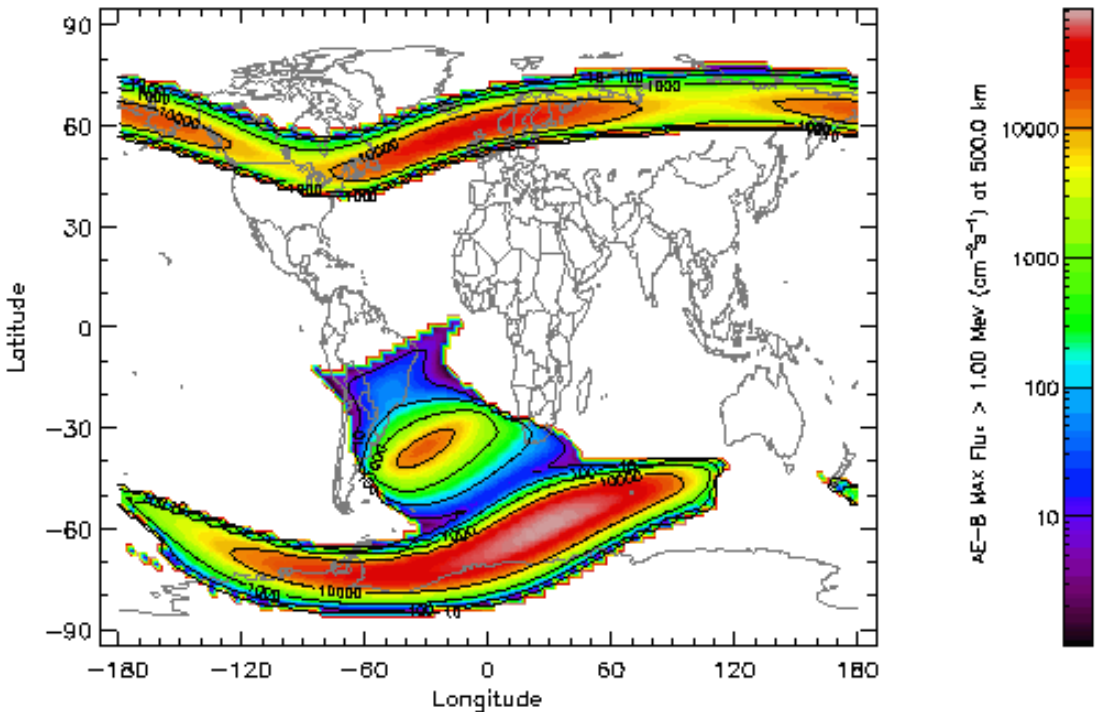


The inner Van Allen belt approachs the surface under SAMA

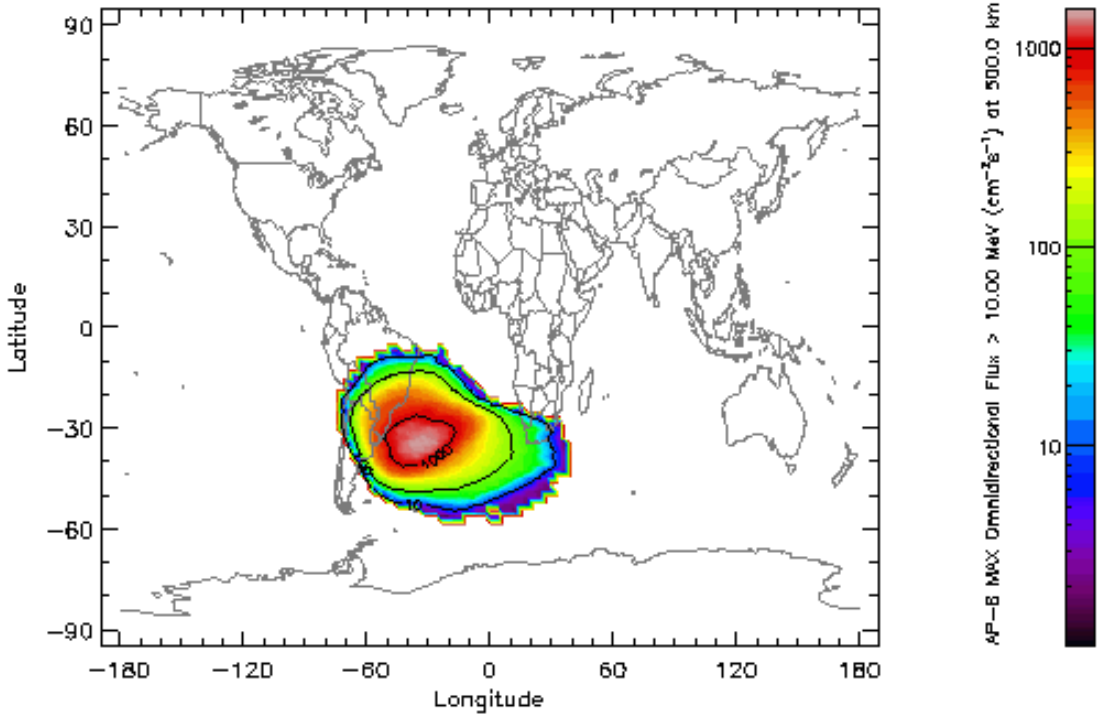


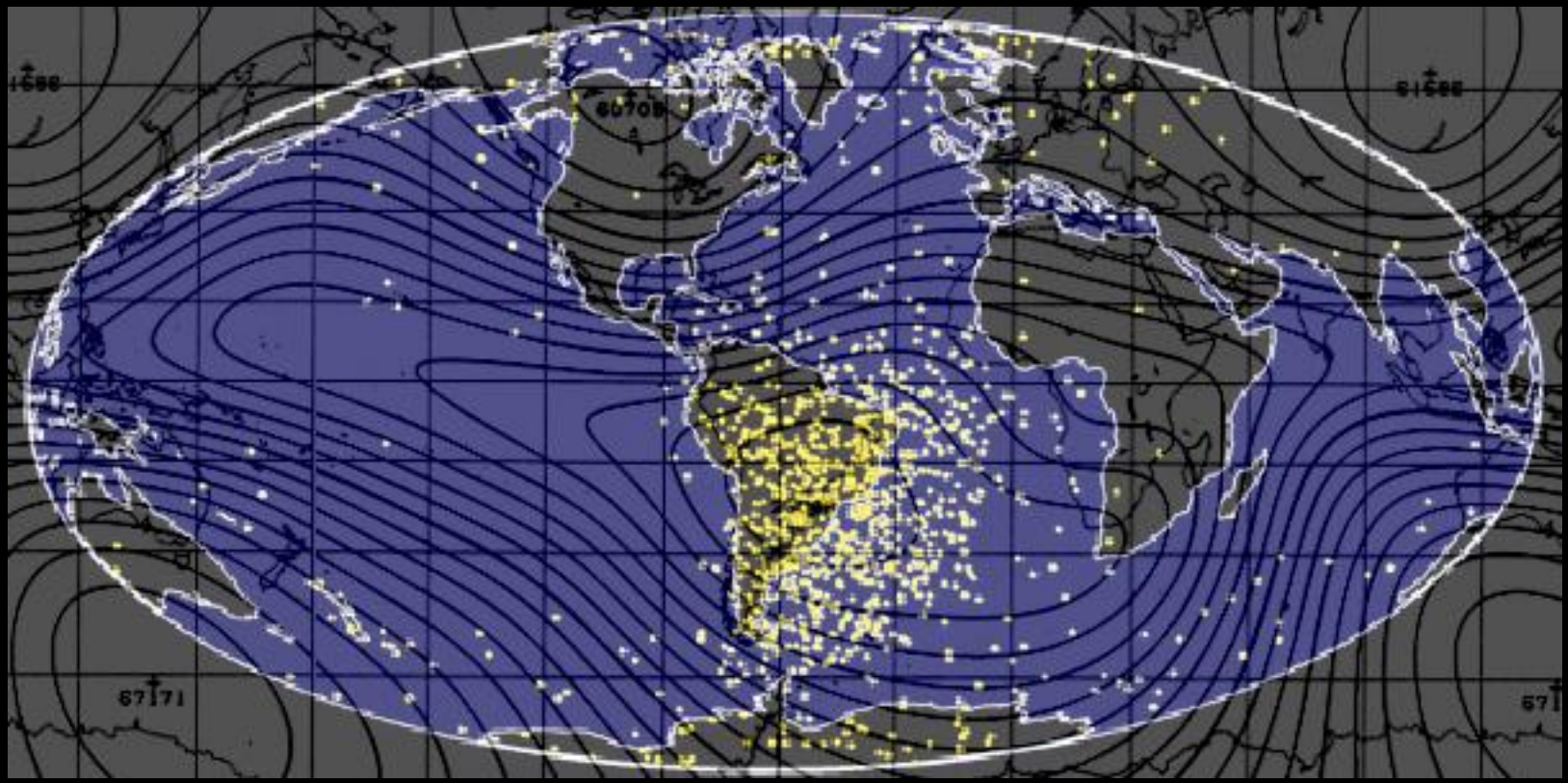


Energetic **electrons** flux at 500km over surface



Very energetic **protons** Flux at 500km over surface





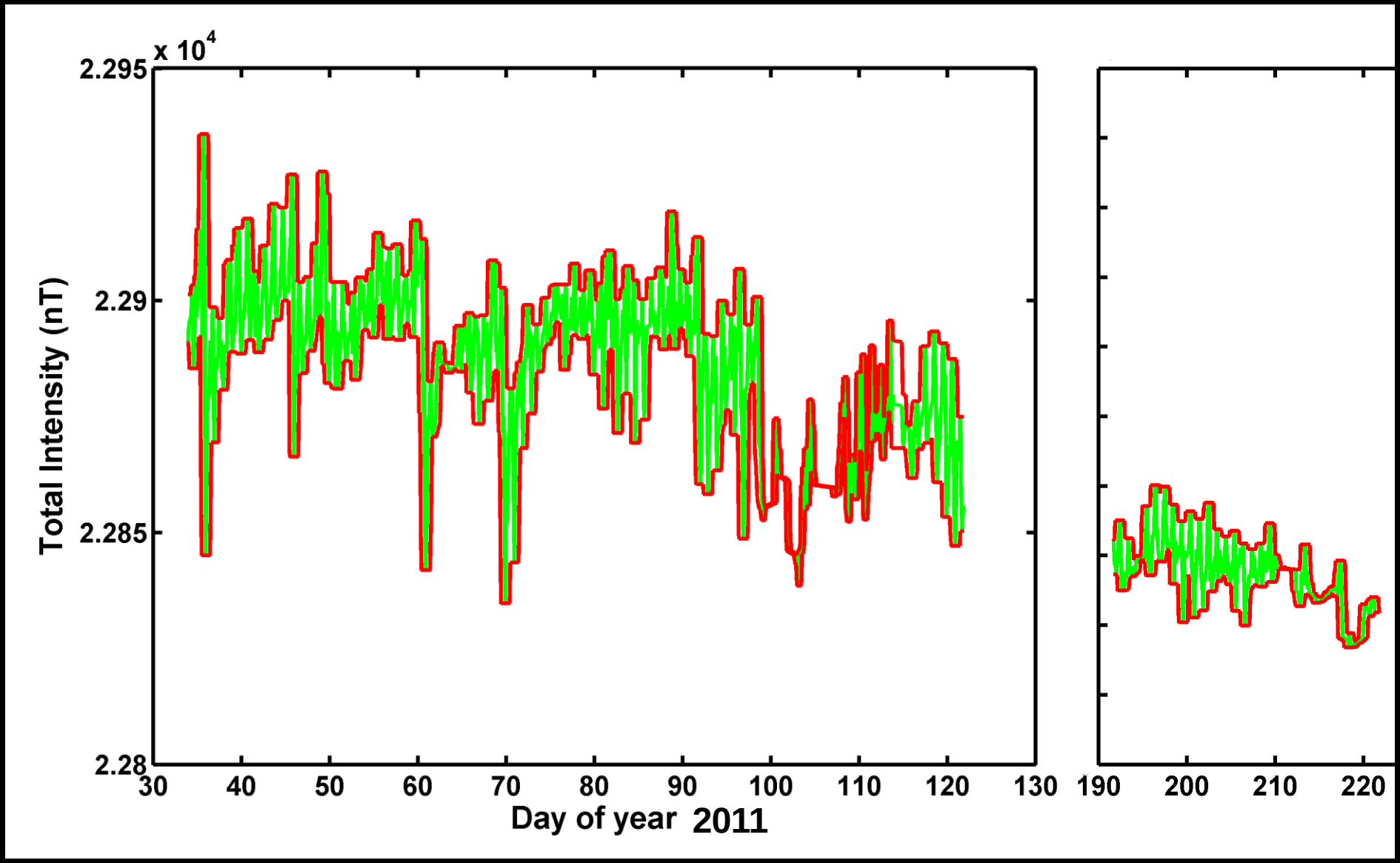
Memory upsets detected by UOSAT satellite. The magnetic field intensity levels are shown.

First monitoring of the magnetic field in Uruguay

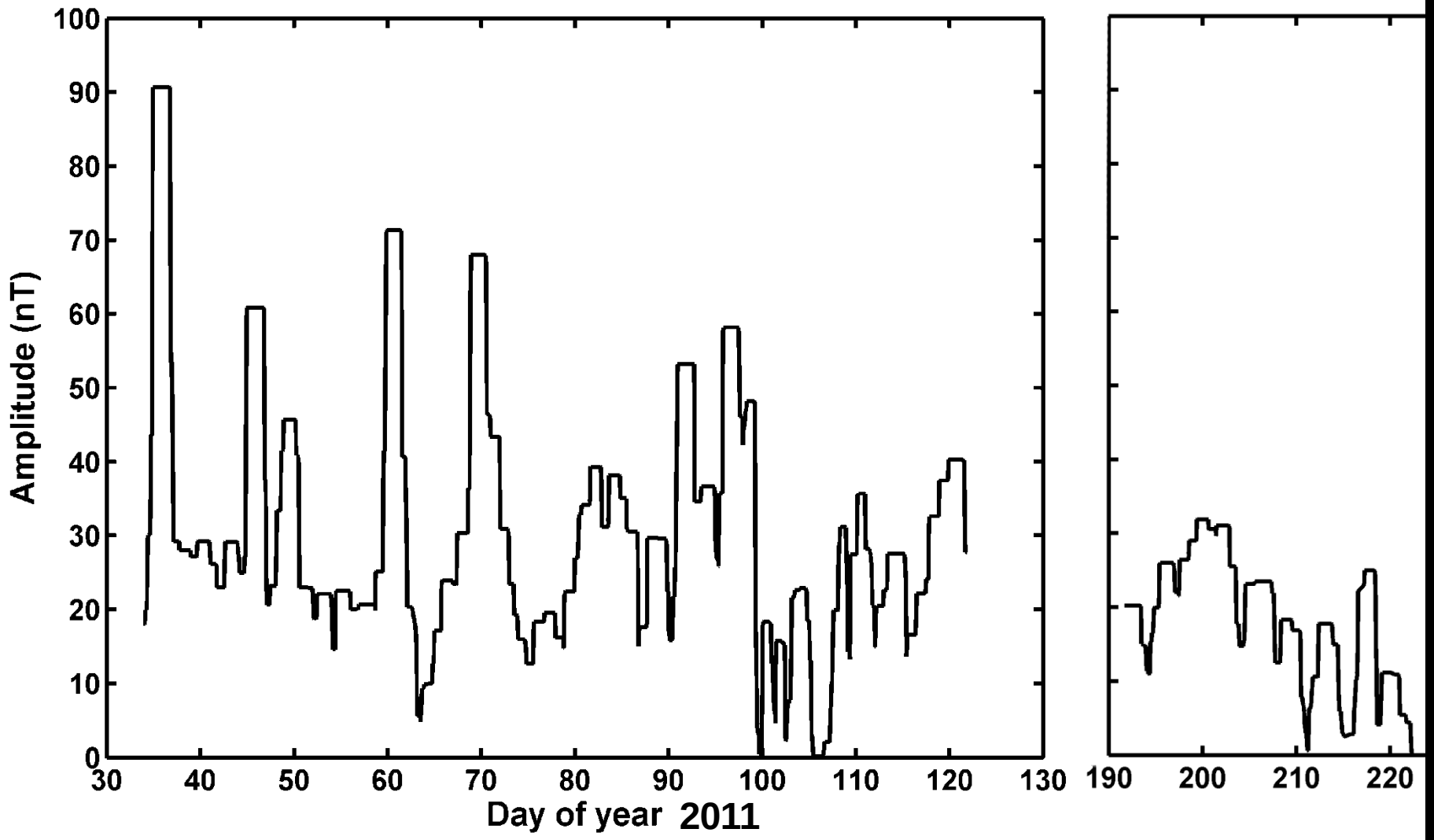
Done in 2011 from Observatorio Astronómico y Geofísico de Aiguá (Maldonado)

Instrument: Precision Proton Magnetmeter (Geometrics G856X)

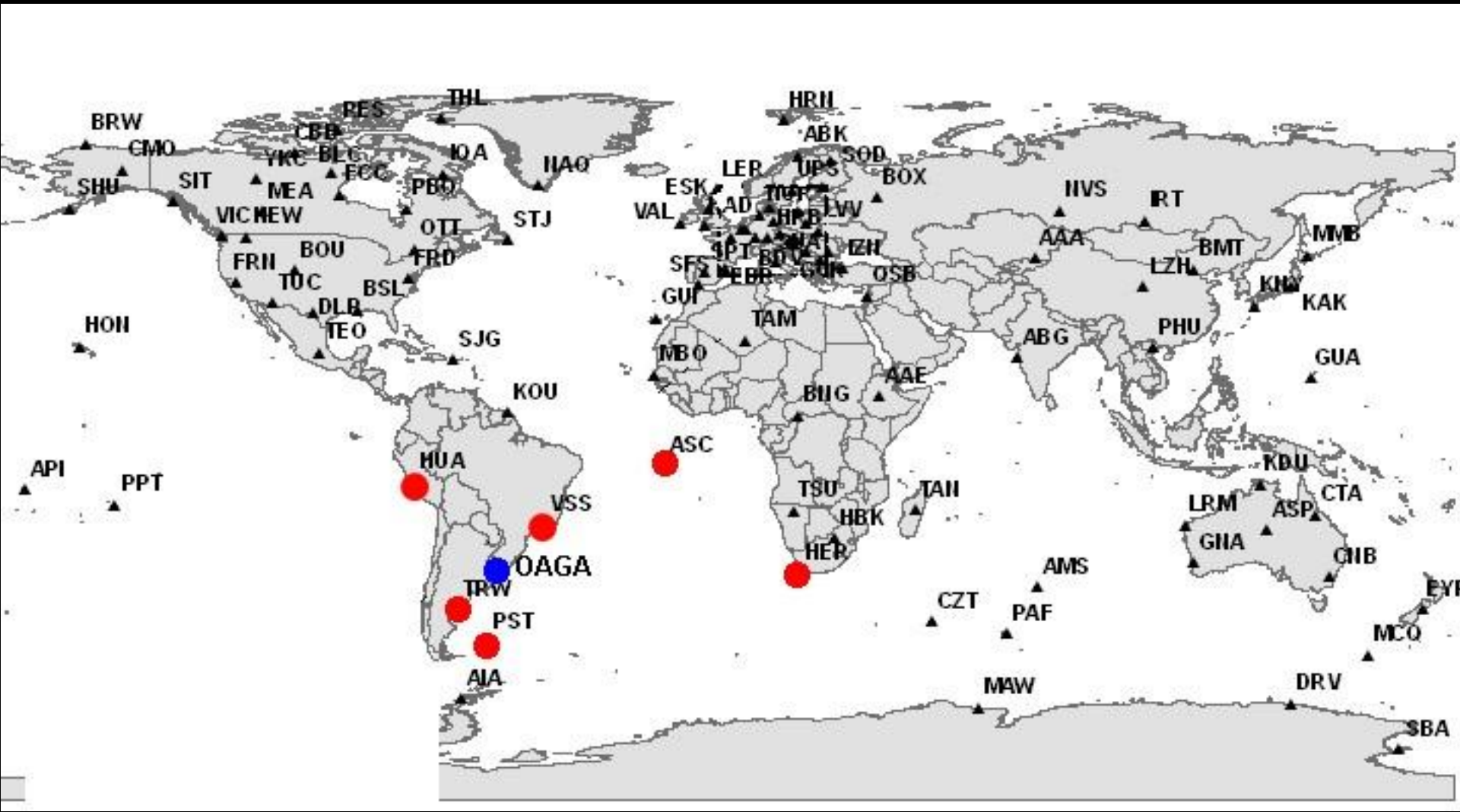
Evolution of the total intensity of the magnetic field from OAGA during 2011



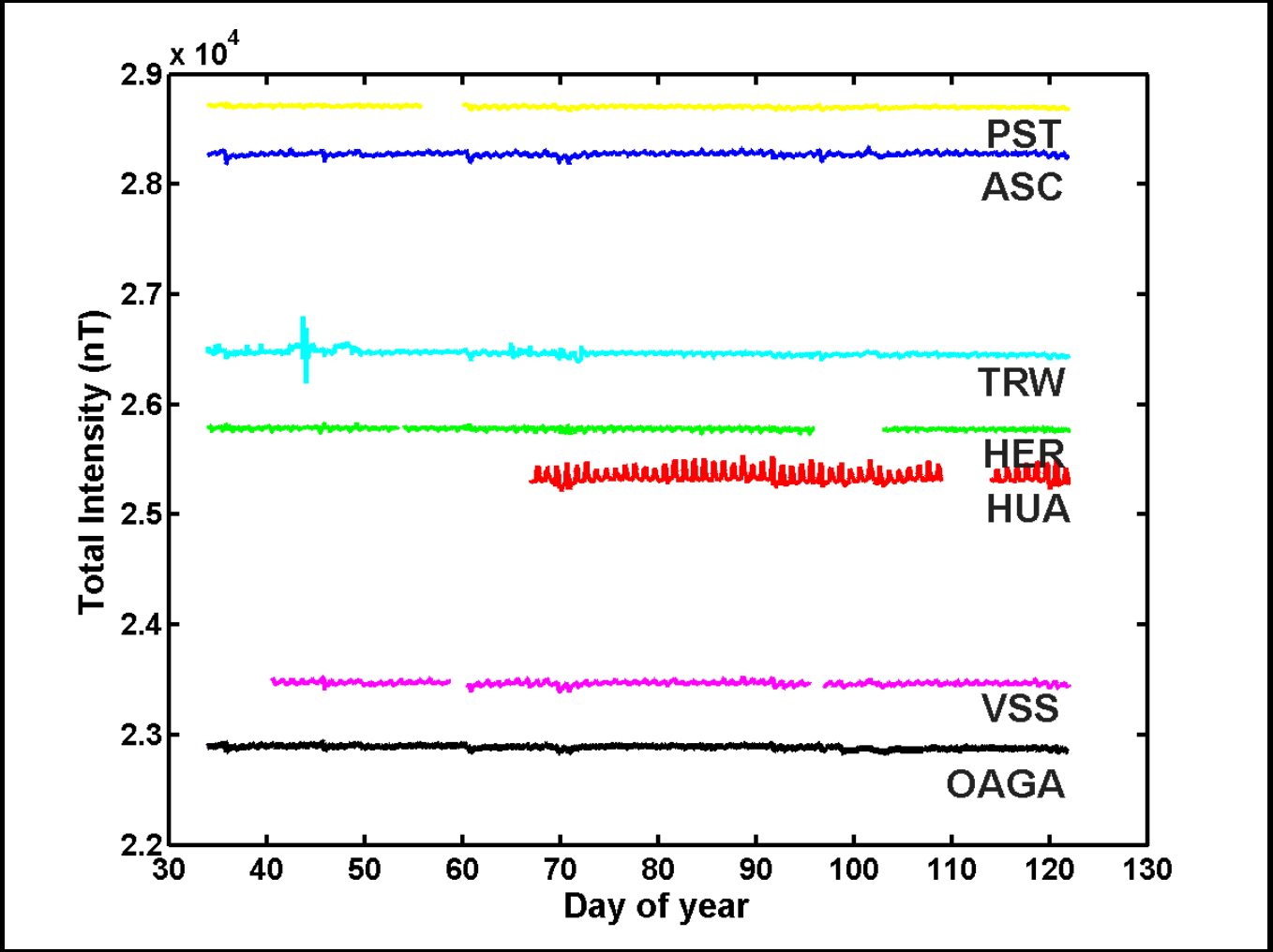
Daily amplitude of the total intensity



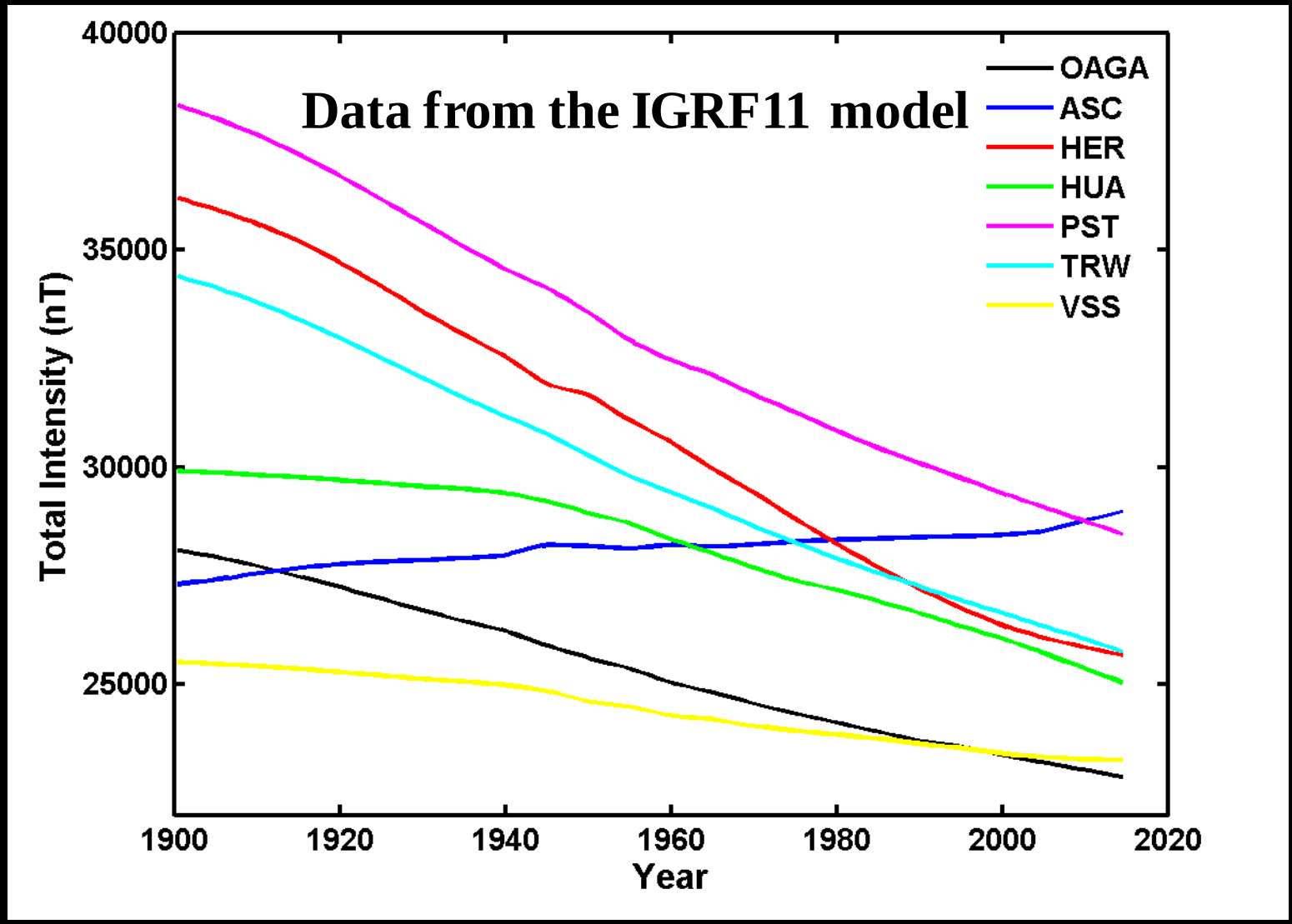
Comparative analysis with other geomagnetic observatories (Intermagnet)



OAGA: the observatory with the lowest values of the magnetic field in the world



OAGA: the observatory with the lowest values of the magnetic field in the world



Global lightning

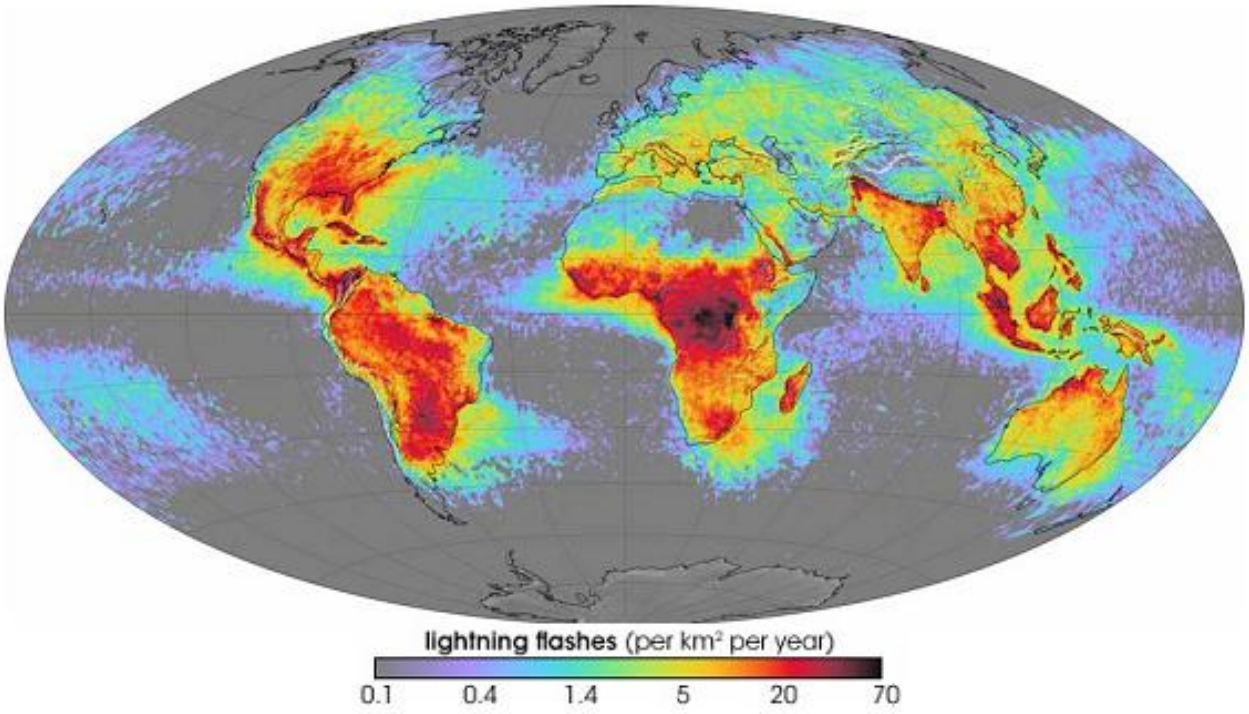
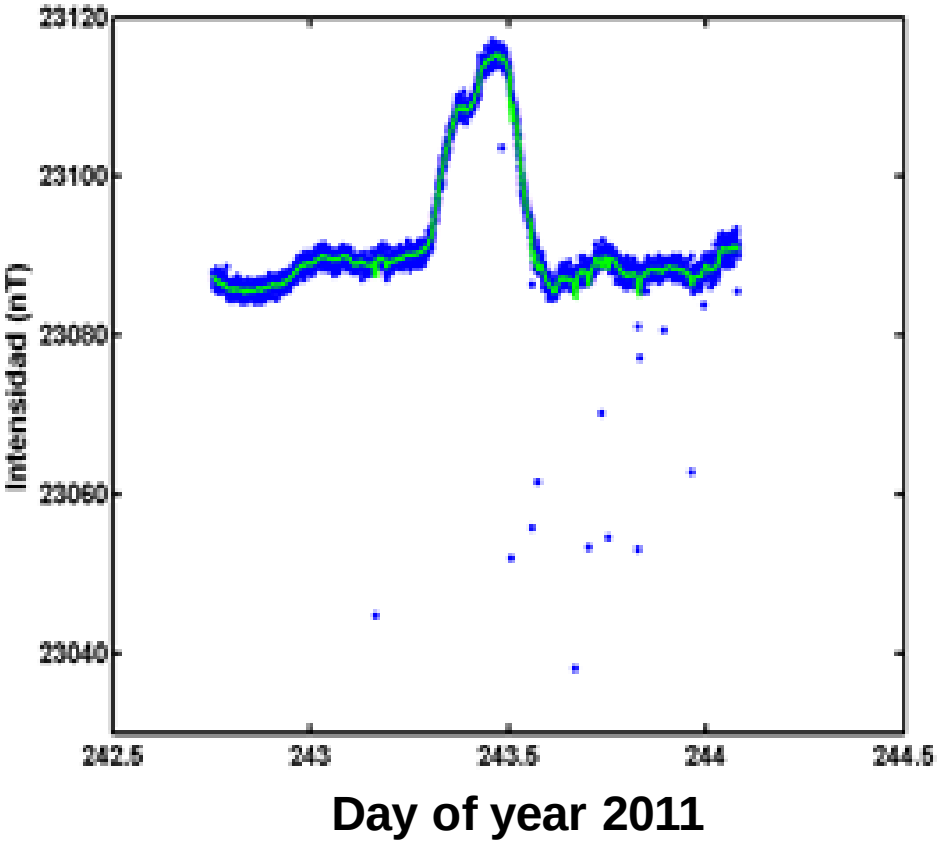
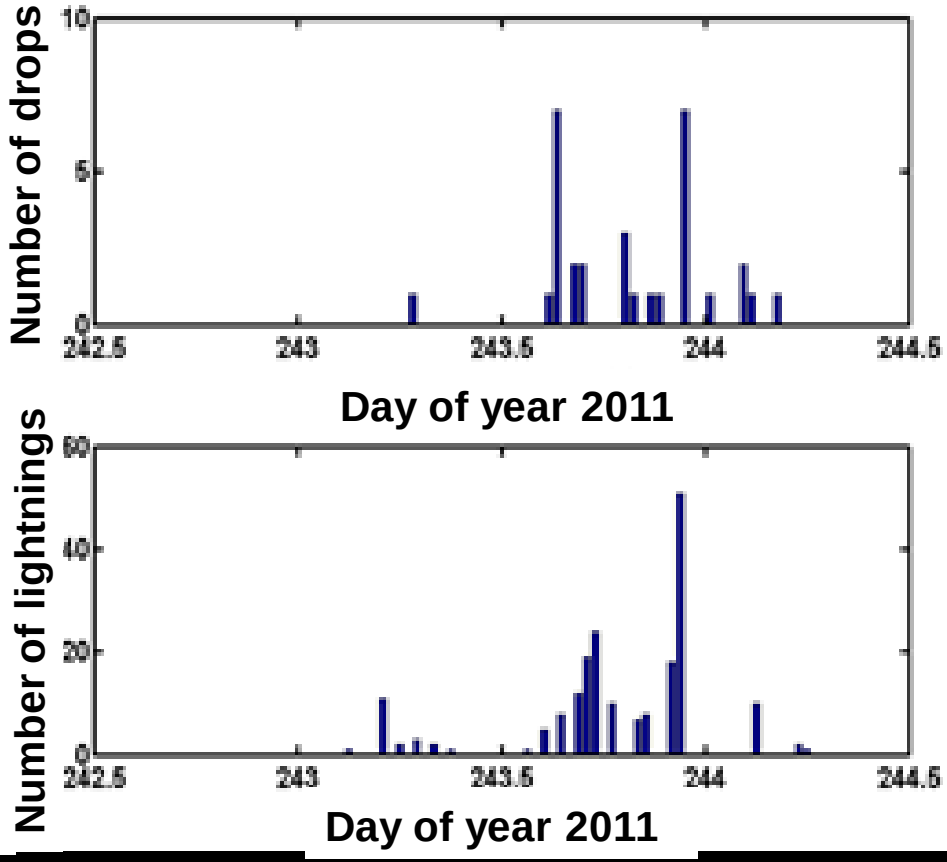


Fig. 9. Global distribution of annually averaged lightning flash frequency density derived from data of LIS between 1997 and 2002, and OTD between 1995 and 2000 (from NASA's Global Hydrology and Climate Center at Marshall Space Flight Center, 2006). The maximum and global mean flash density values are $\sim 80\,\mathrm{km}^{-2}\,\mathrm{a}^{-1}$ and $2.7 \pm 0.3\,\mathrm{km}^{-2}\,\mathrm{a}^{-1}$, respectively.

Schumann and Huntrieser (2007)



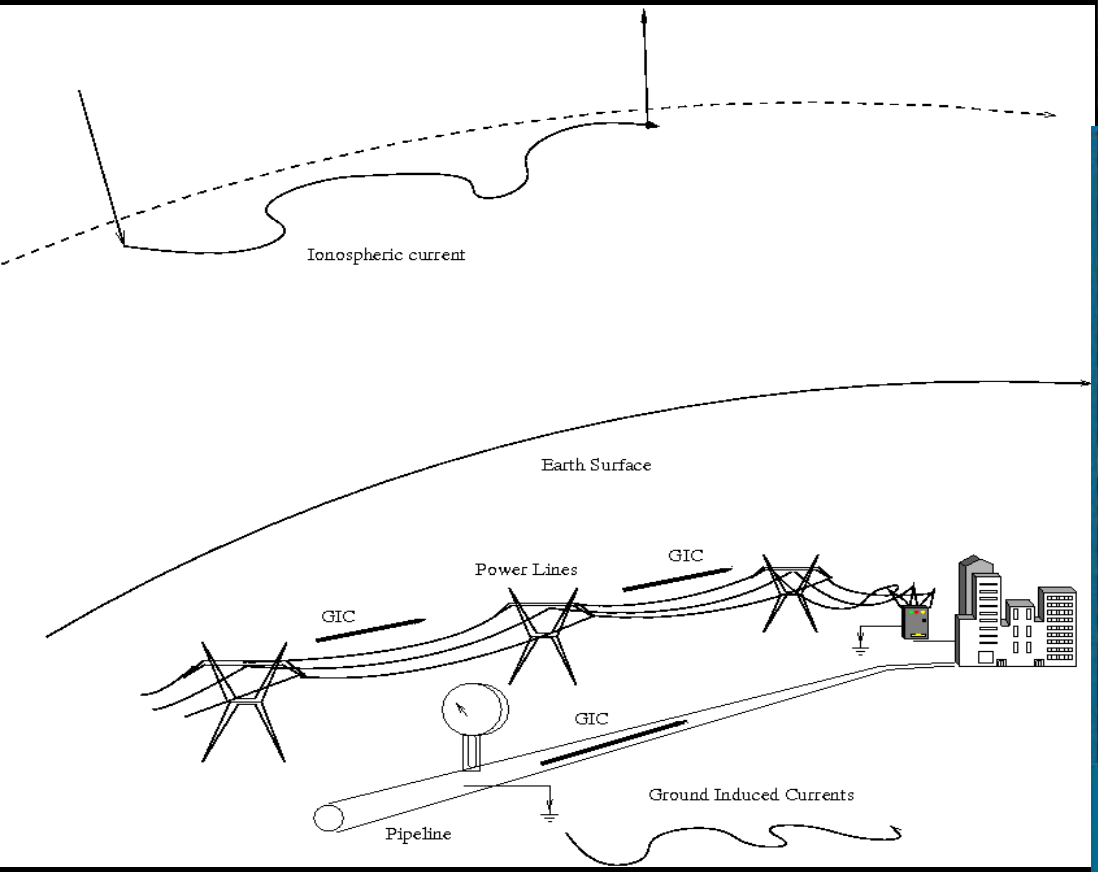


Total magnetic field from OALM during a thunderstorm in days 242 to 244.

Histogram of the number of intensity drops

Number of lighting measured in data provided by INPE (Brasil)

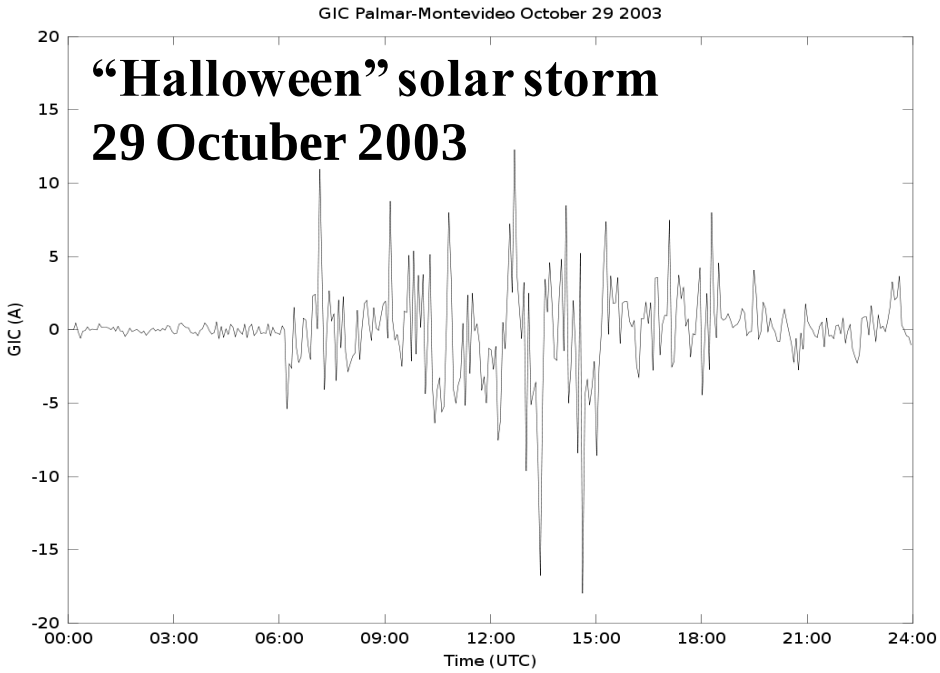
Geomagnetic Induced Currents

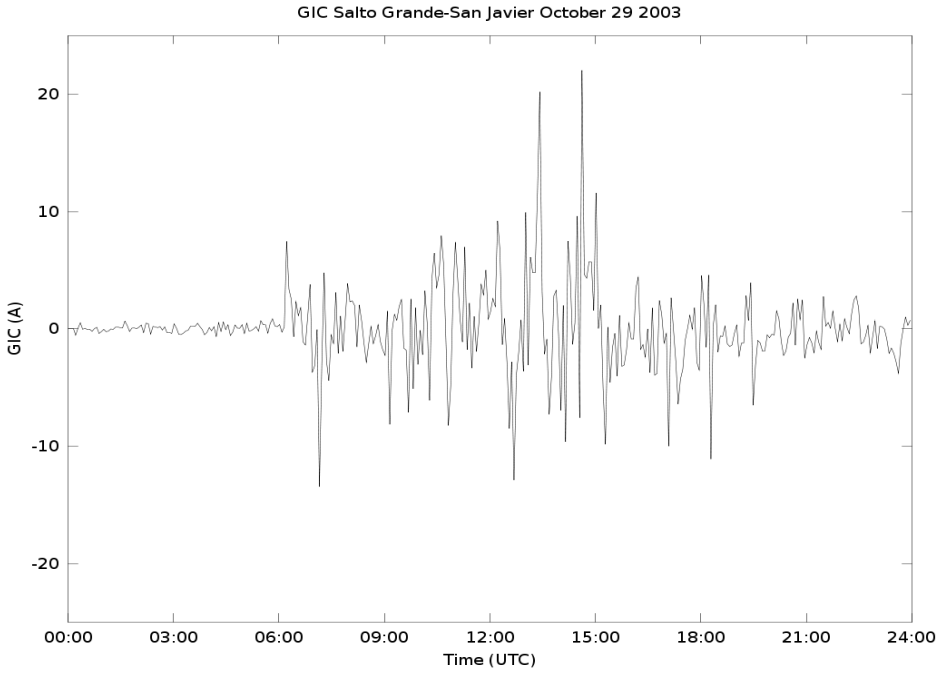


Failure in a large South African generator transformer, three weeks after the Halloween storm of 2003.

Geomagnetic Induced Currents in electric power lines in Uruguay

Caraballo, Sánchez, Tancredi (2012)





Observatorio Astronómico y Geofísico de Aiguá

	Lat.	Long.
Geographic	34.3S	54.7W
Geomagnetic	24.7S	16.0E

OAGA

SOUTH AMERICA
Caribbean Sea
North Atlantic Ocean
South Pacific Ocean
South Atlantic Ocean
VENEZUELA
COLOMBIA
GUYANA
SURINAME
French Guiana (FRANCE)
ECUADOR
PERU
BOLIVIA
BRAZIL
PARAGUAY
CHILE
ARGENTINA
URUGUAY
A M A Z O N B A S I N
B R A Z I L I A N H I G H L A N D S
G U I A N A H I G H L A N D S
A N D E S
MATO GROSSO PLATEAU
ATACAMA DESERT
P A M P A S
P A T A G O N I A
Caracas
Bogotá
Quito
Lima
La Paz
Brasília
Asunción
Santiago
Buenos Aires
Montevideo
Georgetown
Paramaribo
Cayenne
Stanley
Falkland Islands (Islas Malvinas) (administered by U.K., claimed by ARGENTINA)
South Georgia and the South Sandwich Islands (administered by U.K., claimed by ARGENTINA)
Cerro Aconcagua (highest point in South America, 6962 m)
Península Valdés (lowest point in South America, -40 m)
Strait of Magellan
Tropic of Capricorn
Equator
Scale 1:35,000,000
Azimuthal Equal-Area Projection
500 Kilometers
500 Miles
Boundary representation is not necessarily authoritative.
802636AI (R02108) 6-99

Uruguay
International boundary
Department boundary
National capital
Department capital
Railroad
Road
0 25 50 Kilometers
0 25 50 Miles
Lambert Conformal Conic Projection, SP 31S/34S
ARGENTINA
BRAZIL
ARTIGAS
SALTO
RIVERA
PAYSANDÚ
TACUAREMBÓ
RÍO NEGRO
CERRO LARGO
TREINTA Y TRES
DURAZNO
SORIANO
FLORES
FLORIDA
LAVALLEJA
ROCHA
COLONIA
SAN JOSÉ
CANELONES
MALDONADO
MONTEVIDEO
Montevideo
Río de la Plata
SOUTH ATLANTIC OCEAN
Laguna Merín
Lagoa Mirim
Lago Artificial de Rincón del Bonete
Lago Artificial de Paso del Palmar
Embalse de Salto Grande
Buenos Aires
La Plata
Punta del Este
Maldonado
Minas
Melo
Tacuarembó
Paysandú
Salto
Artigas
Rocha
Boundary representation is not necessarily authoritative.
Base 802398 (R01687) 5-95

Observatorio Astronómico y Geofísico de Aiguá

A plataform for the development of Space Sciences in Uruguay

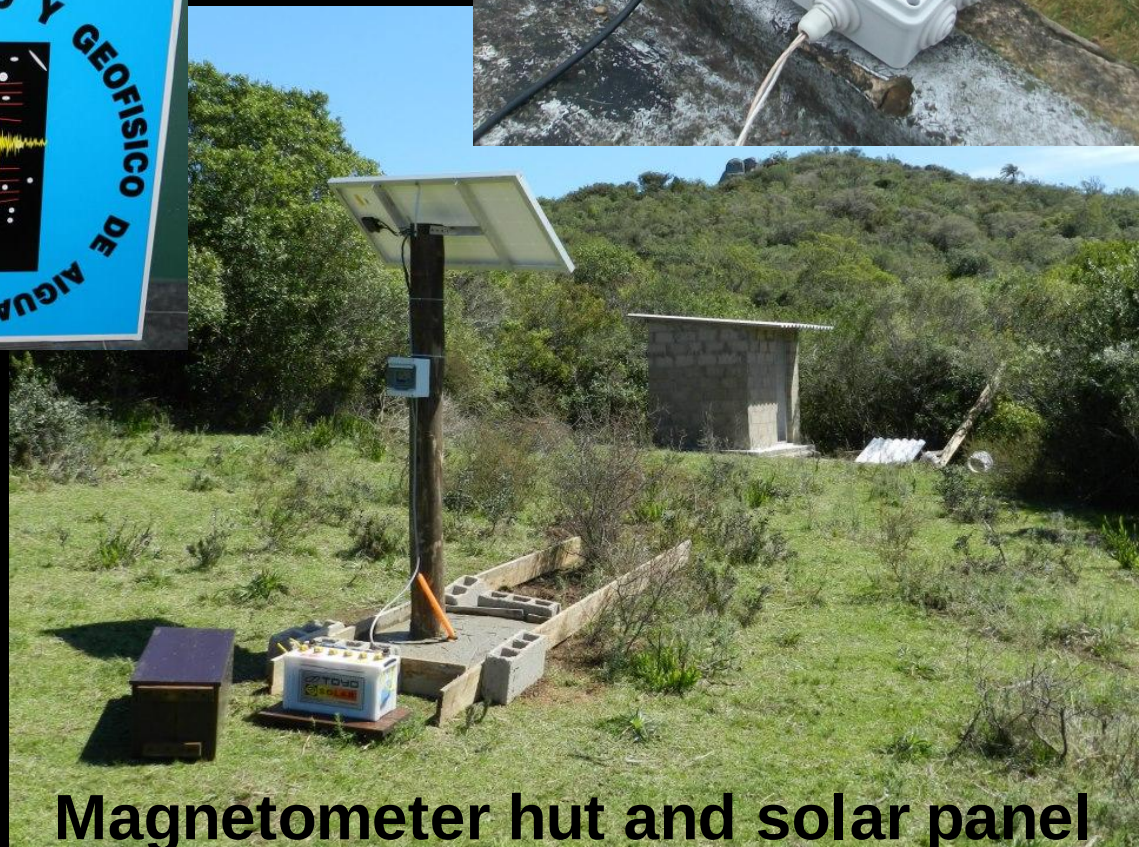
- **Magnetometers**
- **Solar activity sensors**
- **Telescope for asteroids and comets follow-up**
  All-sky cameras for bolides and cloudiness
- **Meteorological station**
- **Sismometer**
- **GPS station**
- **Lightning detector**
- **Low-energy cosmic rays detector**
- **…...**

All-sky camera

OBSERVATORIO ASTRONOMICO Y GEOFISICO DE AIGUA

OAGA

Internet Radiolink



Magnetometer hut and solar panel

Magnetometers in installation

GEM Systems Magnetometers

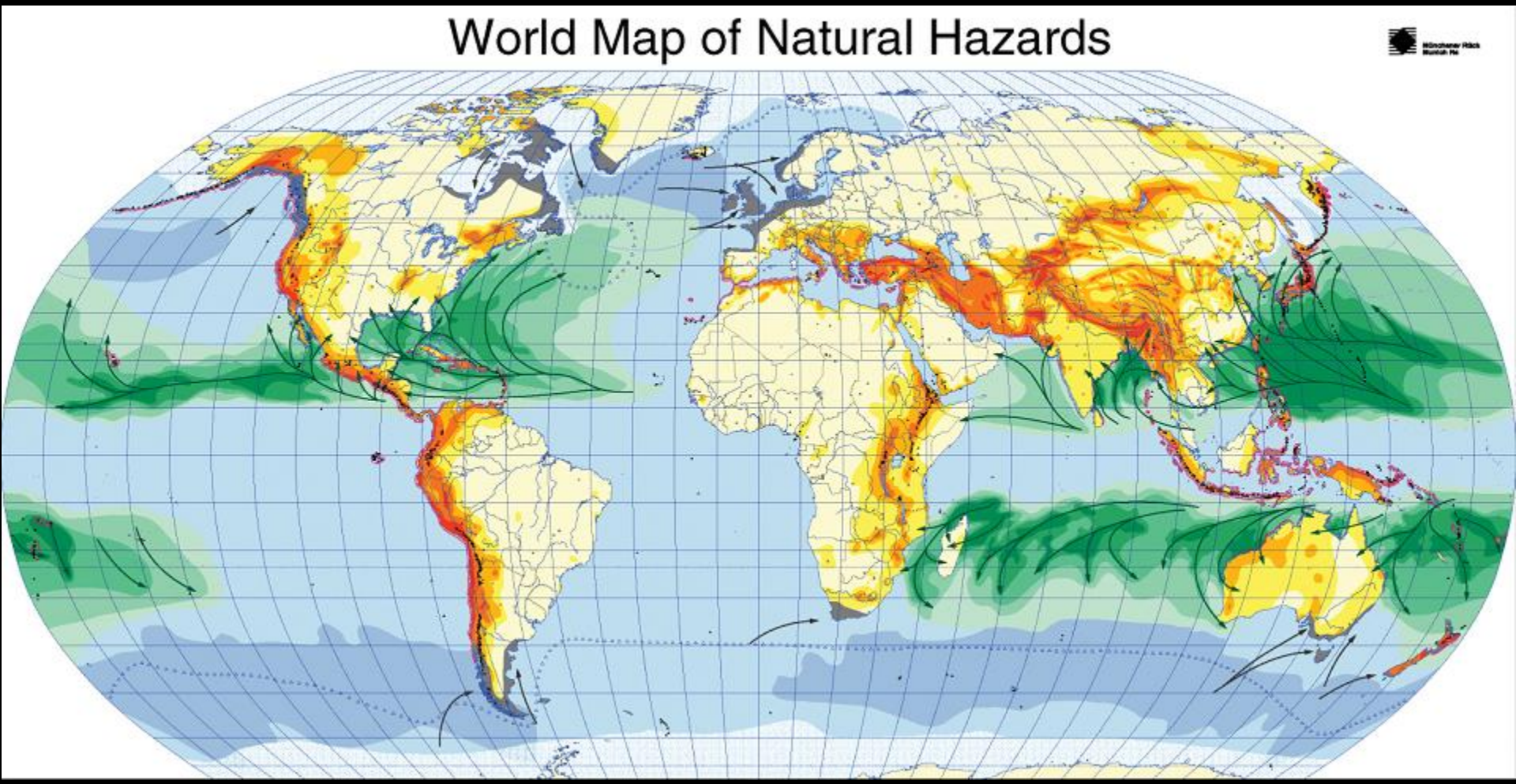
GSM-90F5D
Overhauser dIdD (delta Inclination/delta Declination)
A fully integrated 3-component
Overhauser vector magnetometer for continuous monitoring of the inclination,
declination and total intensity of the earth's magnetic field

GSM-90 v7.0 T Overhauser EUROMAG scalar magnetometer
- long term stability and high accuracy;
- high resolution and low noise (0.022nT).

The possible social impacts of SAMA

- In space:
  - Memory upsets and failure of satellites
  - Exposure of astronauts
  - Problems with telecommunications and GPS
- In the atmosphere and on the surface
  - High flux of energetic particles in the ionosphere
  - Biological consequences for the exposure at a low magnetic field
  - Consequences to flights passengers and crew
  - GICs?
  - …..

Social impacts depends on the location on the Earth



Earthquakes, volcanoes, tsunamis, weather storms

What is the distribution on Earth of the social impacts of Space Weather?

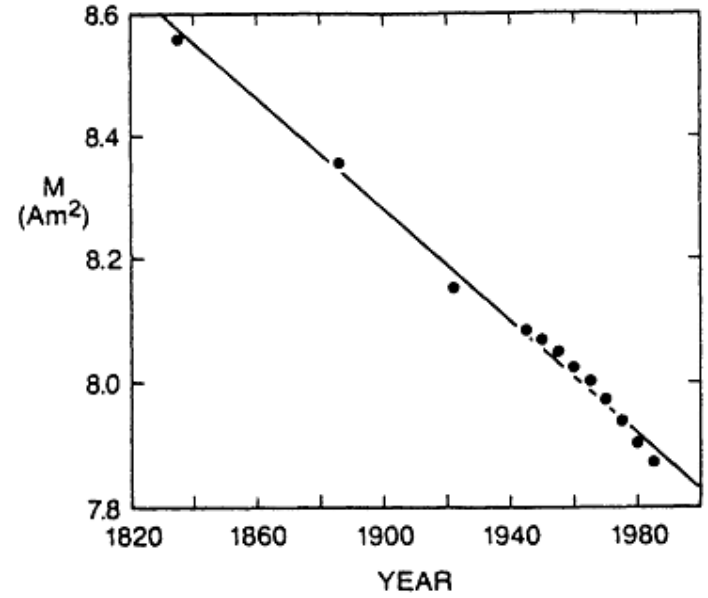


Figure 29 Decay of the dipole moment from 1835 to 1985 (after Fraser-Smith 1987).

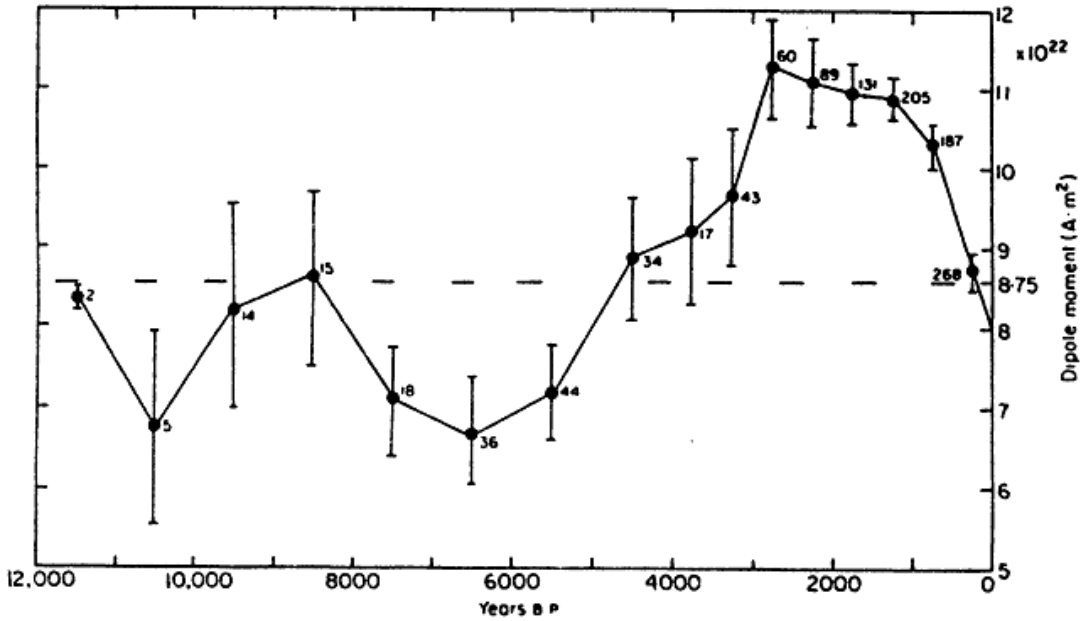
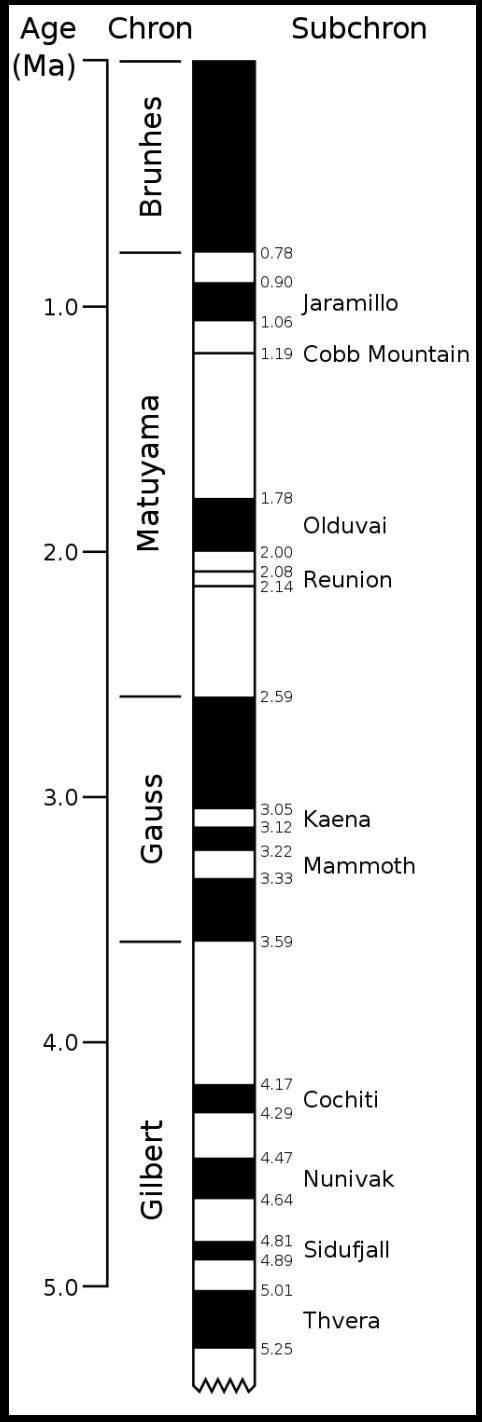


Figure 38 Global mean dipole moments with 95% confidence limits for 500-yr intervals (to 2000 BC) or 1000-yr intervals (prior to 2000 BC) from archaeomagnetic data (after McElhinny & Senanayake 1982).



Secular variation of total intensity (nT/yr) for 2005.0-2010.0.