The Geomagnetic Field Observation

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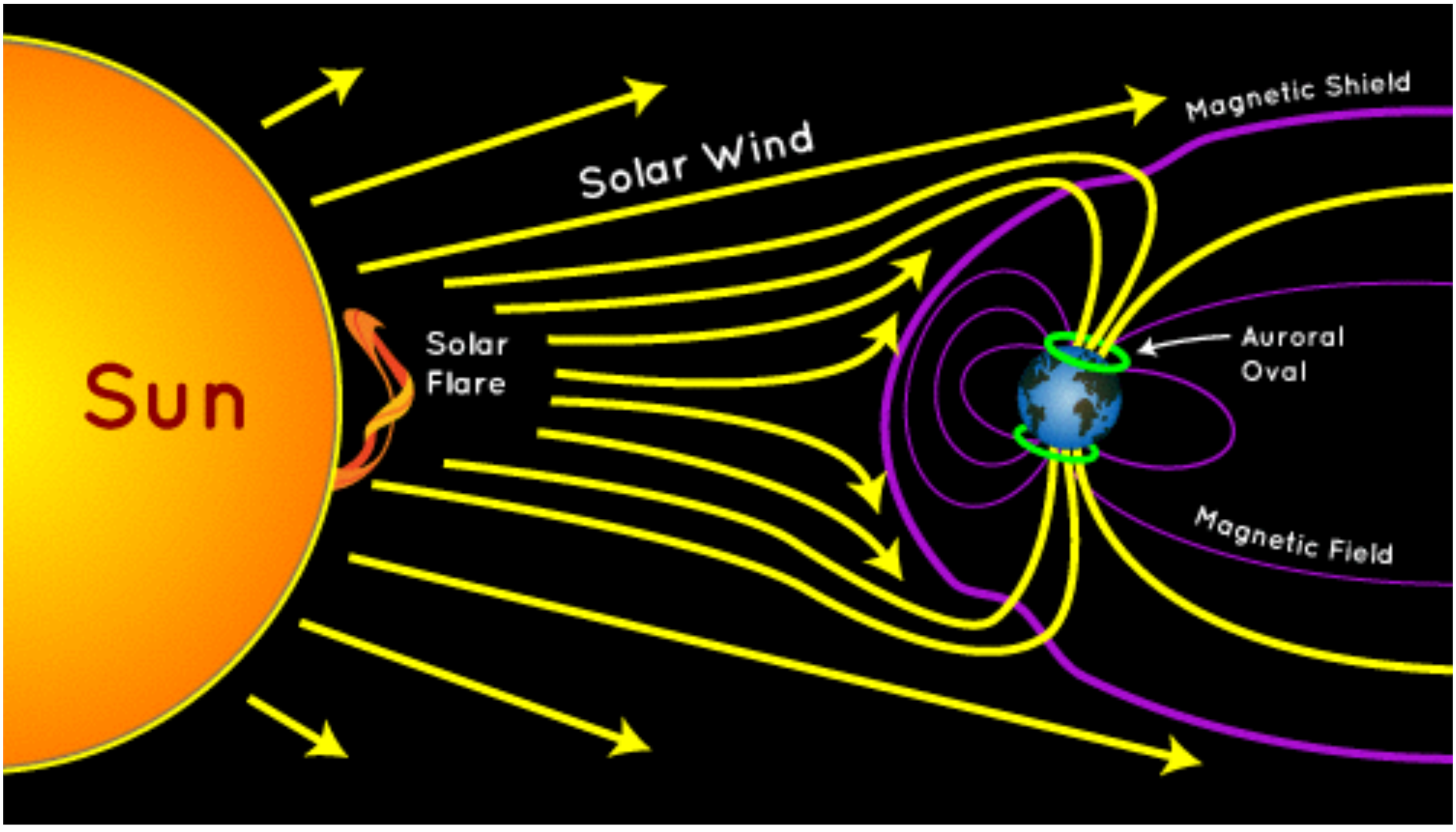
Solar wind+ Geomagnetic field+ plasma in space + = aurora!



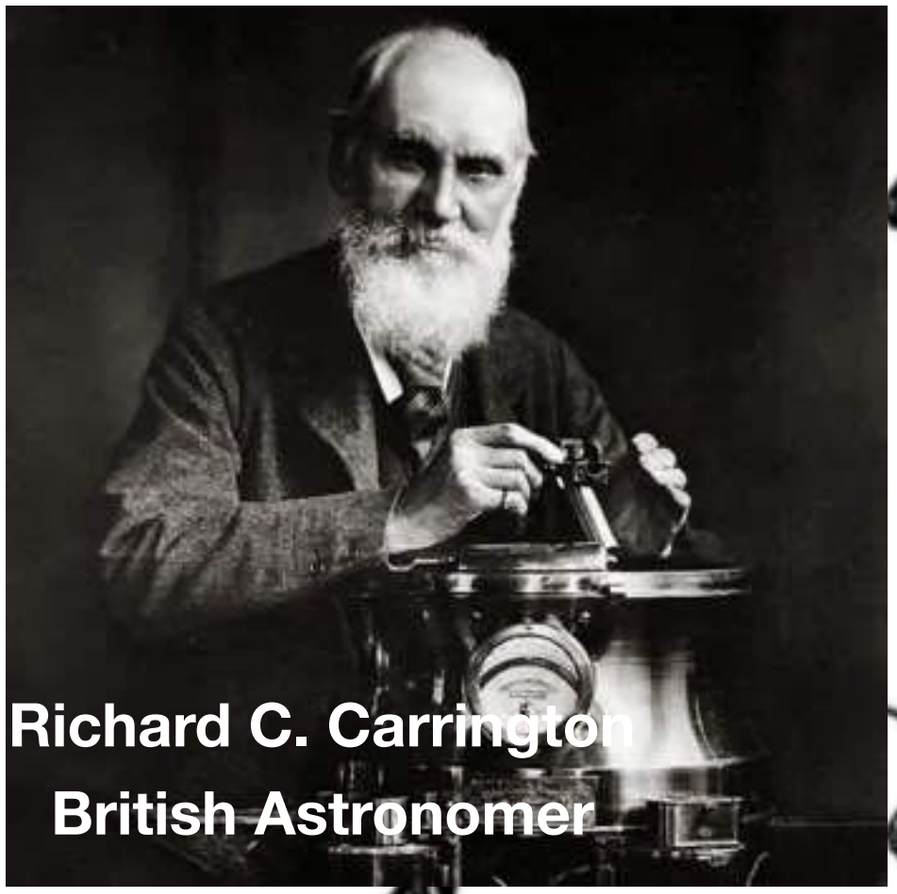
Role of geomagnetic field observations

- Geodynamo, paleomagnetism and archeomagnetism, magnetotellurics
- Aeronomy
- Magnetosphere, magnetic forms, and space whether

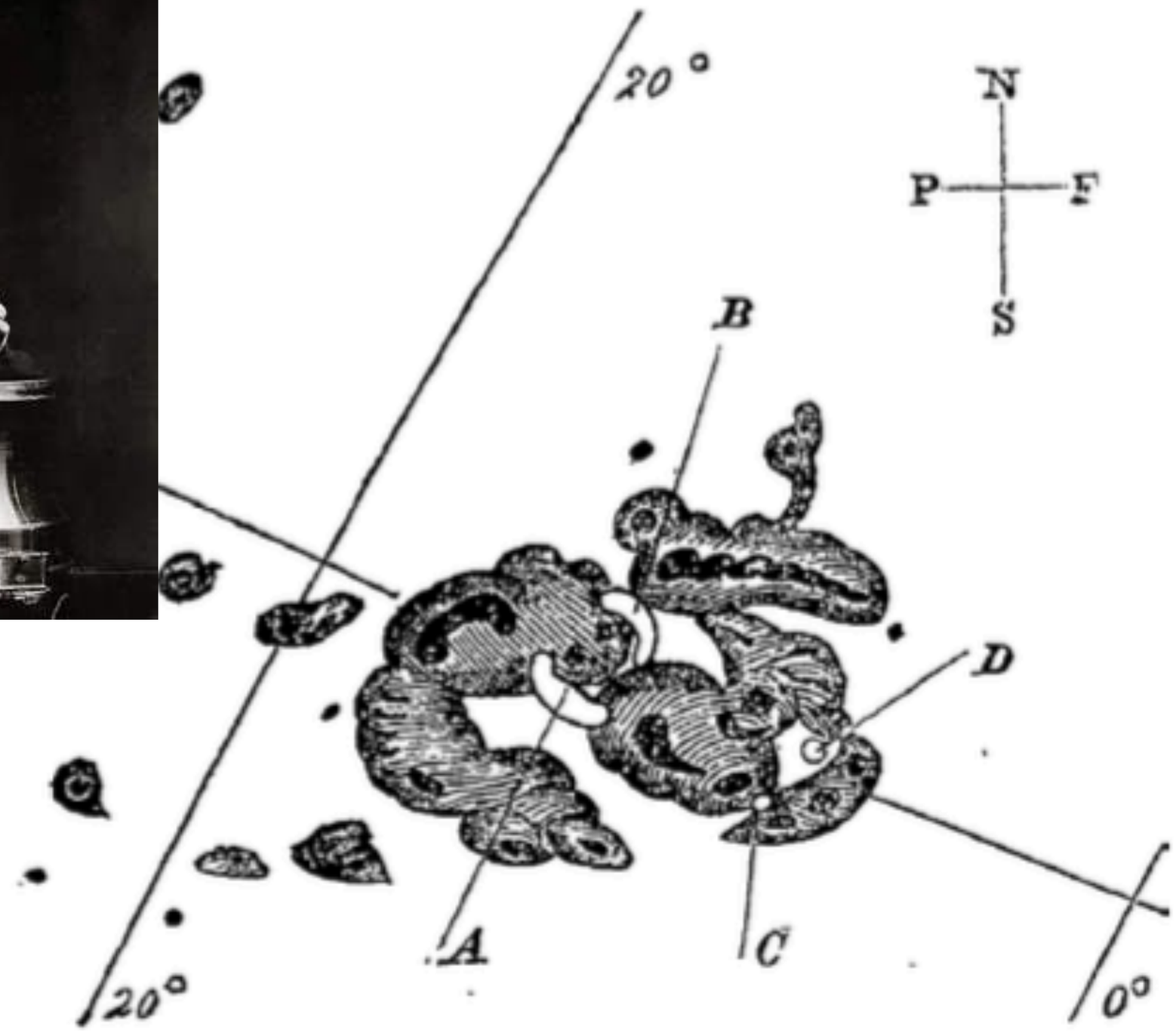
The greatest magnetic storm in recorded history

- The greatest magnetic storm in recorded history occurred on September 1859. The storms referred to as Carrington Event (Carrington, 1860)
- In retrospect, this great storm is caused by a major coronal mass ejection (CME).
- Aurora were seen around the world, as far south as the Caribbean. In Japan, aurora were observed even in Wakayama.

The sunspot in Carrington Event

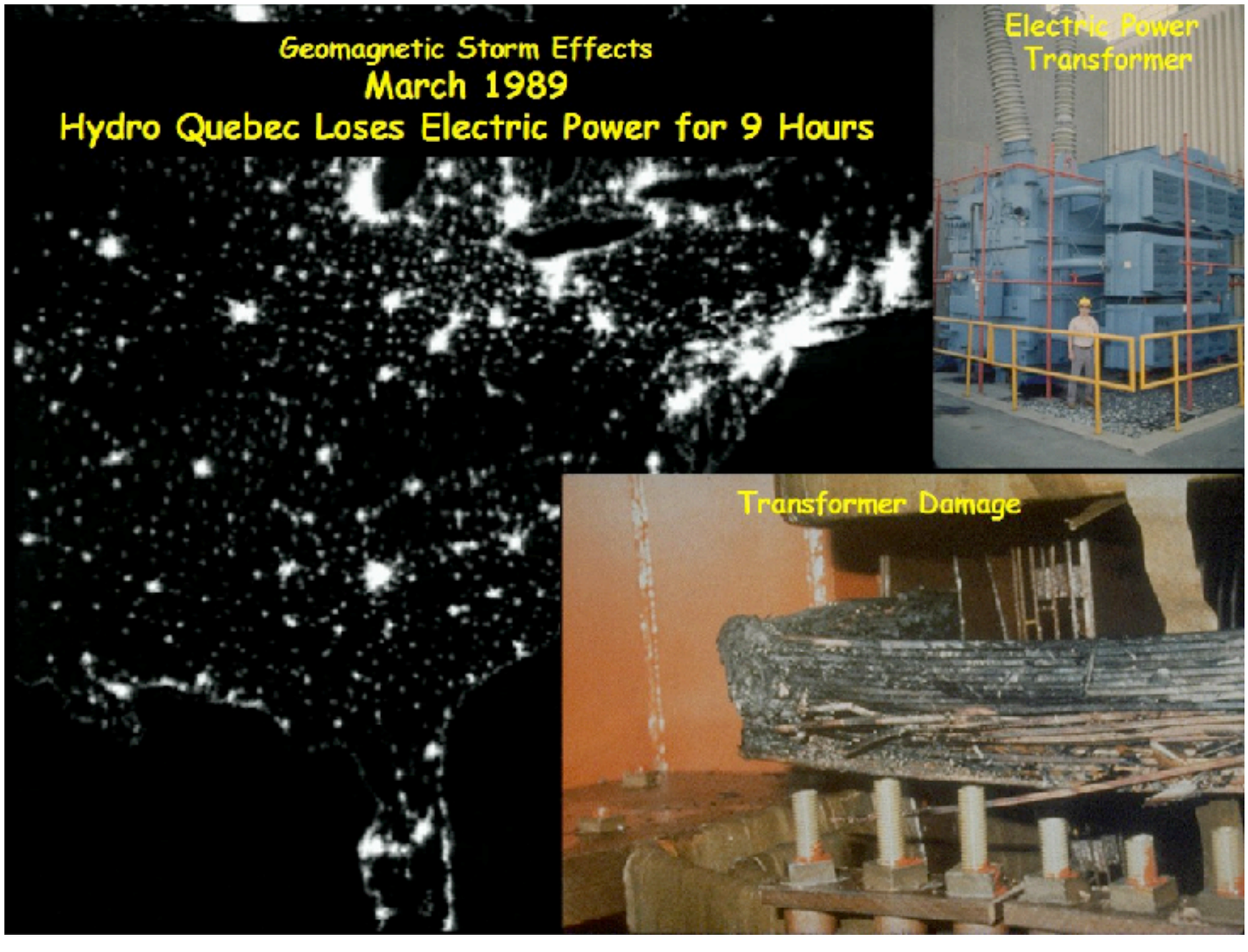


Richard C. Carrington
British Astronomer



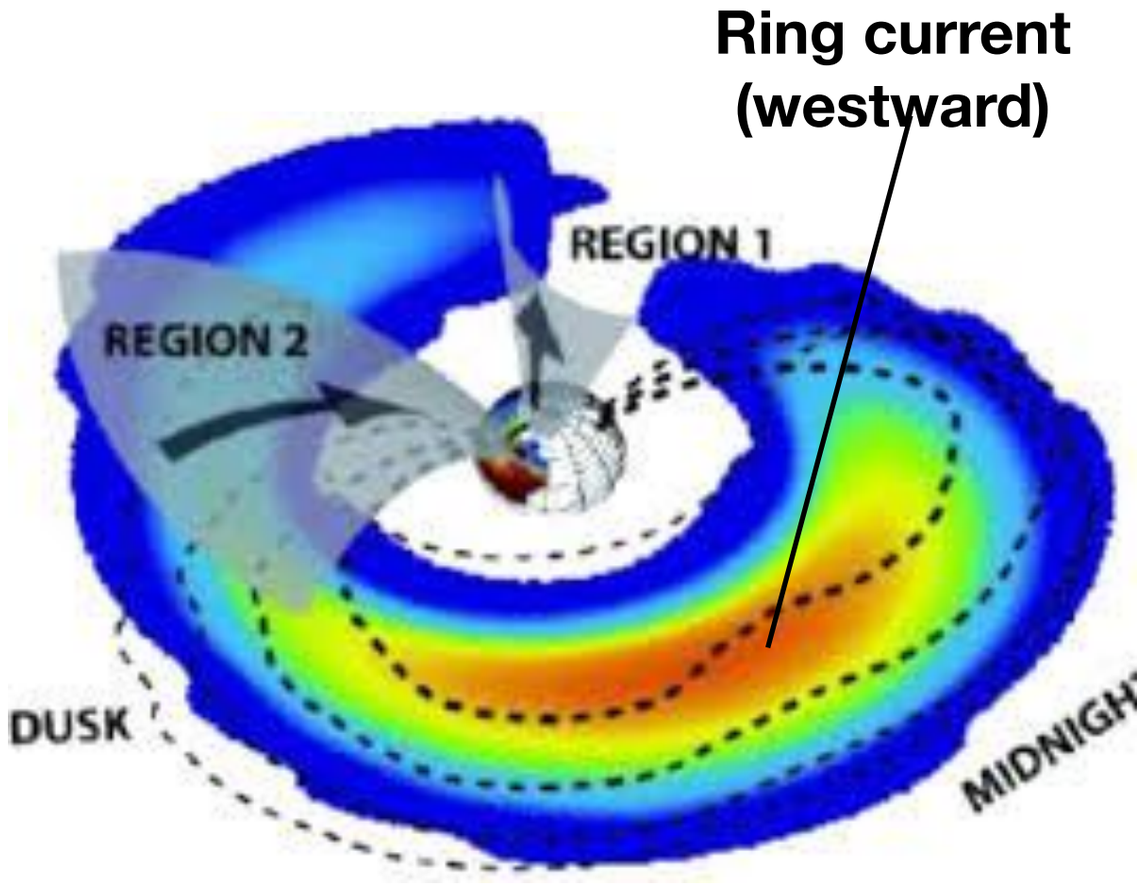
What happen in the magnetic field?

The disaster caused by geomagnetic storm:
Québec power outage

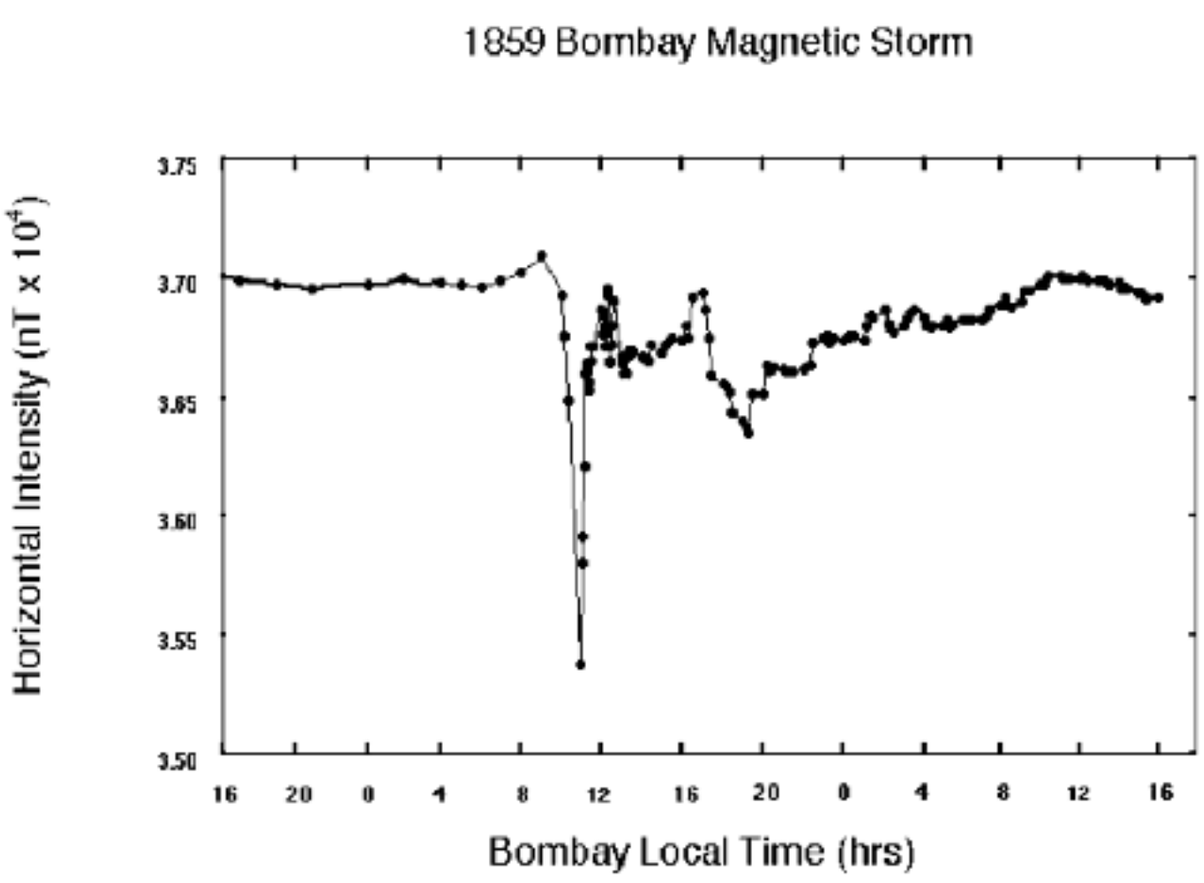


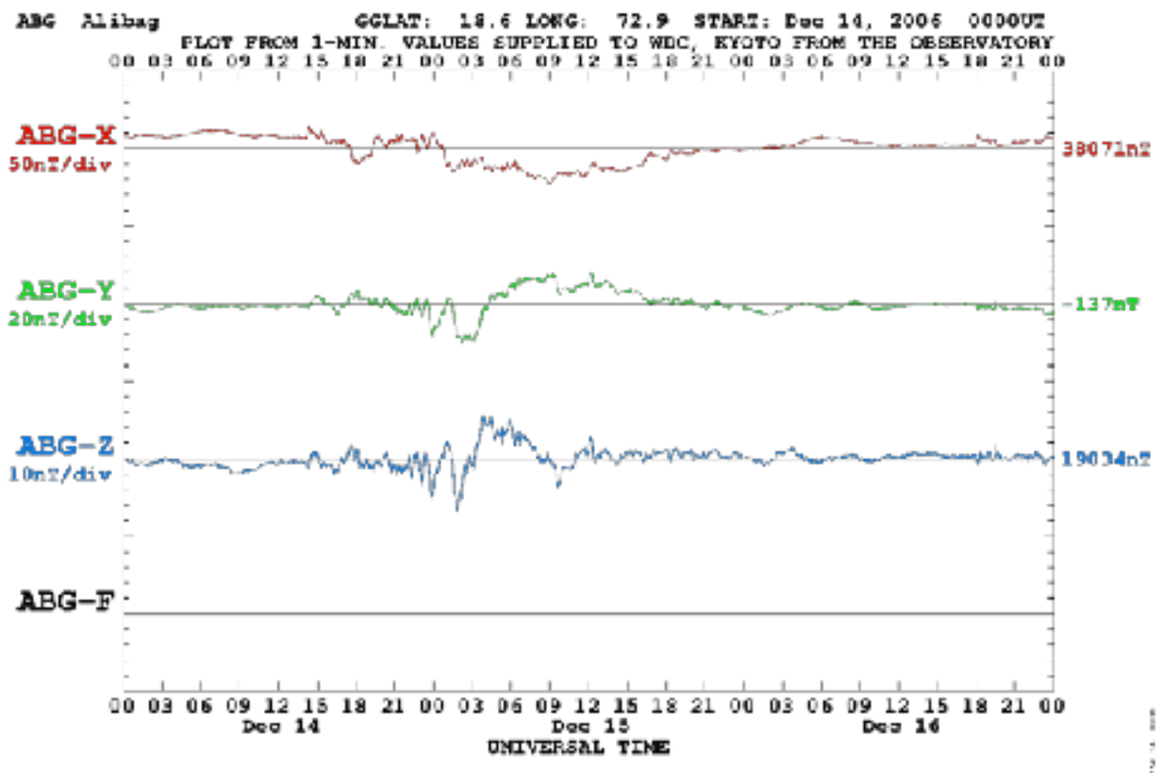
The geomagnetic storm

- During geomagnetic storm, the night side geomagnetic field at mid- and low-latitude decrease due to the ring current.
- In Carington event, the geomagnetic field at low latitude (Bombay) incredibly decrease.



[Brandt et al., 2008]





Magnetic field Observation Ground or Satellite?

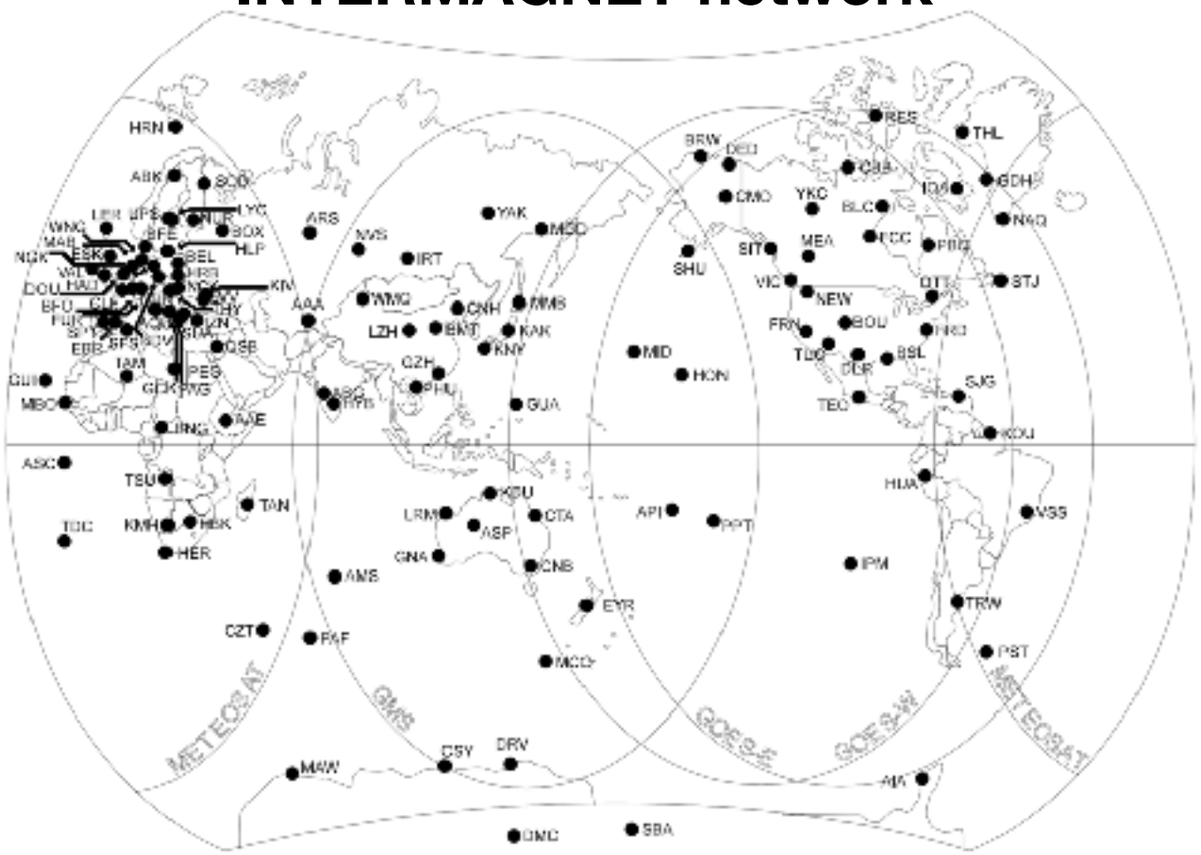
	Ground	Satellite
Advantage	• Easy to maintain • Cheaper than satellite magnetometer • Continuous observation	• In-situ observation in the ionosphere or the magnetosphere • Collaborative measurements with particle instruments in
Disadvantage	• Difficult to separate the source into effects in the ionosphere and the magnetosphere • Affected by the human activity	• Maintenance is difficult after launch • Takes ages to develop

Global network of magnetic observation

Now, the geomagnetic data in the world are available.

Kushu University

INTERMAGNET network



THEMIS GEO network

Structure of the fluxgate magnetometer

GPS antenna

MAG-03TB
TIERRA TECNICA

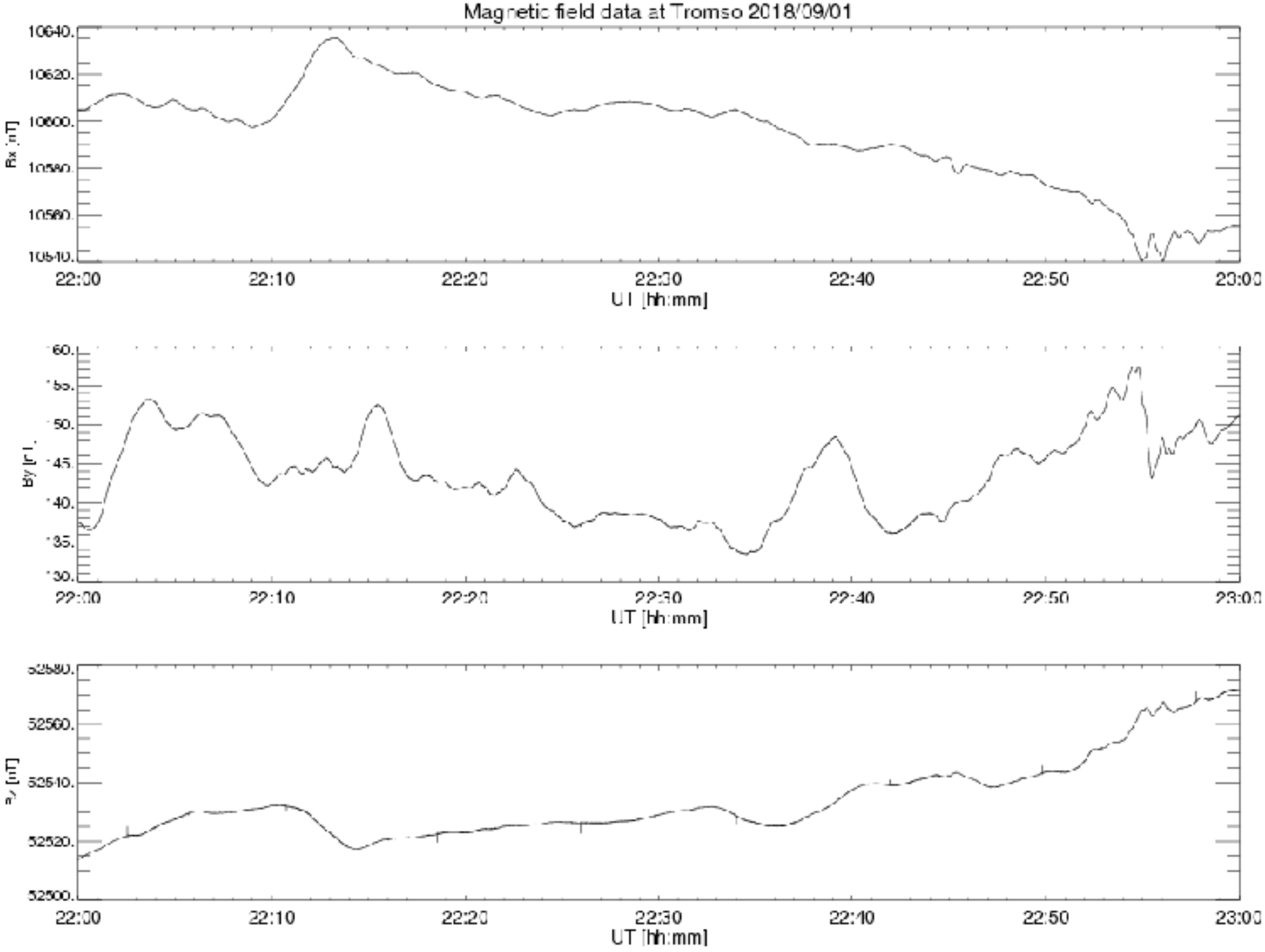
Three-Axis sensor

Data logger
DCA500BA
TIERRA TECNICA

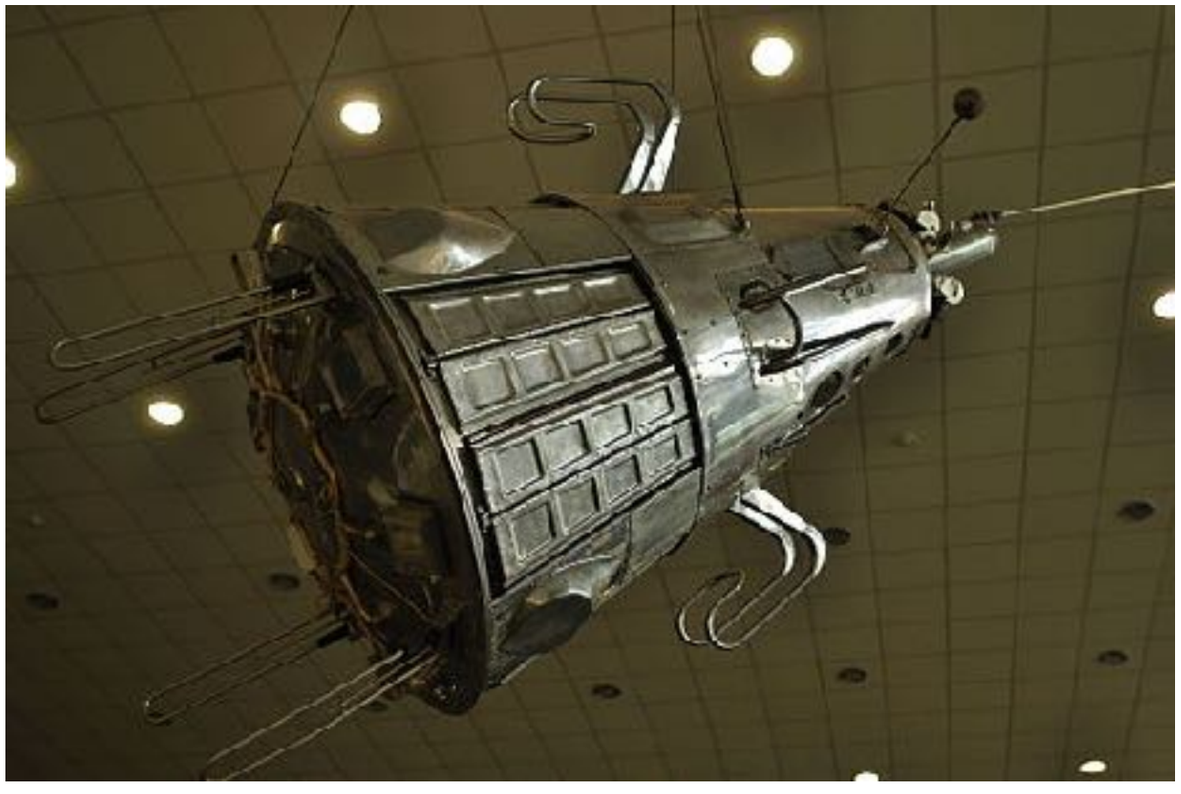
Things to pay attention to setup the fluxgate magnetometer on the ground

- **Check no artificial objects around the sensor.**
- **Find the best do-it-yourself store.**
- **Protect the cables and connectors against animals and human beings.**
- **Consider the power-supply and data transfer systems.**

The geomagnetic field data



Satellite observation



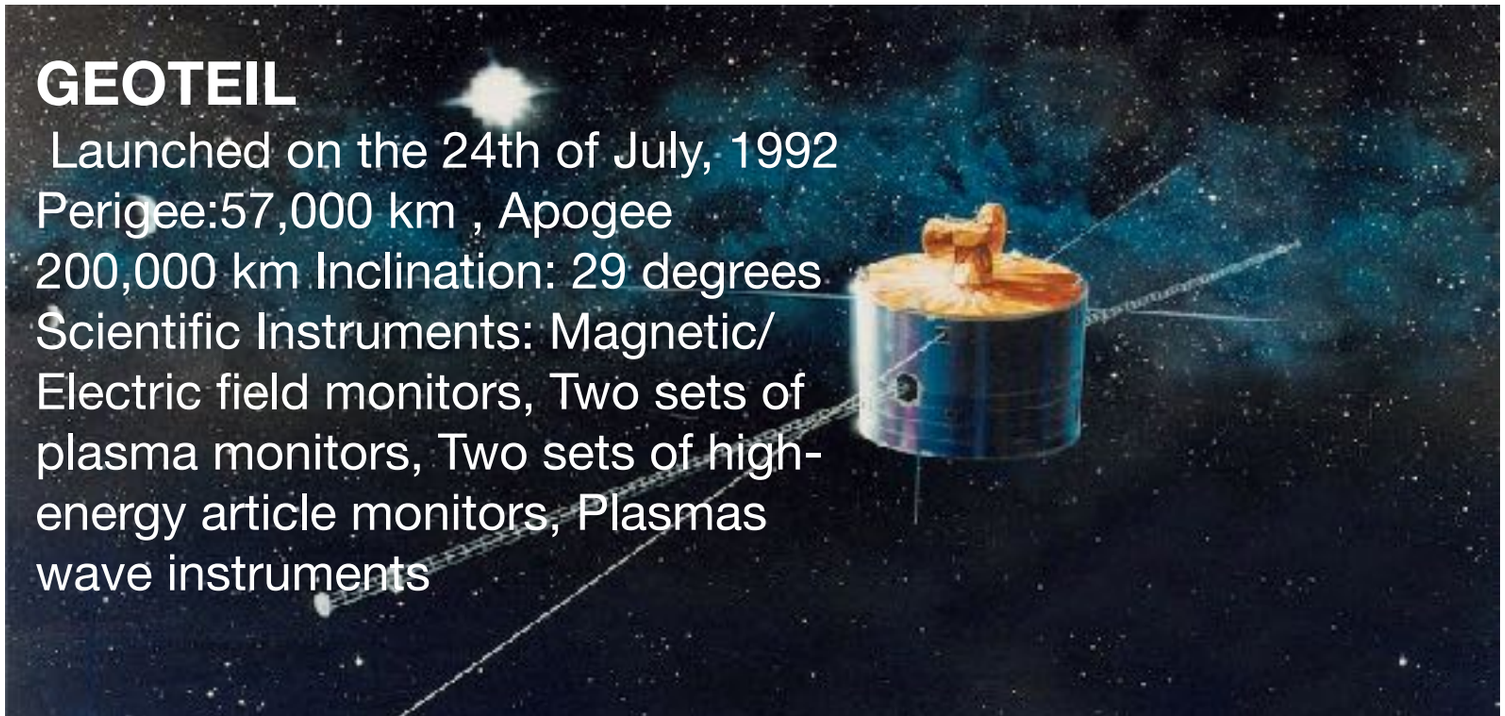
- Suptnik 3, launched in May 1958, the fist spacecraft carrying a magnetometer.

- Following the Russian achievement, the NASA series satellite POGO and OGO 2,4,6 satellite carried out global magnetometers of scalar field from October 1965 thorough June 1971.

Japanese satellite for International Solar-Terrestrial Physics

Akebono satellite

Launched on the 22nd of Feb., 1989
Perigee:275 km , Apogee 10,500 km Inclination: 75 degrees
Scientific Instruments: magnetometer, electric field detector, low energy ion detector, suprathermal ion spectrometer, thermal electron detector, VLF wave detector, HF wave detector, topside sounder, visible and UV auroral imager, and radiation monitor.

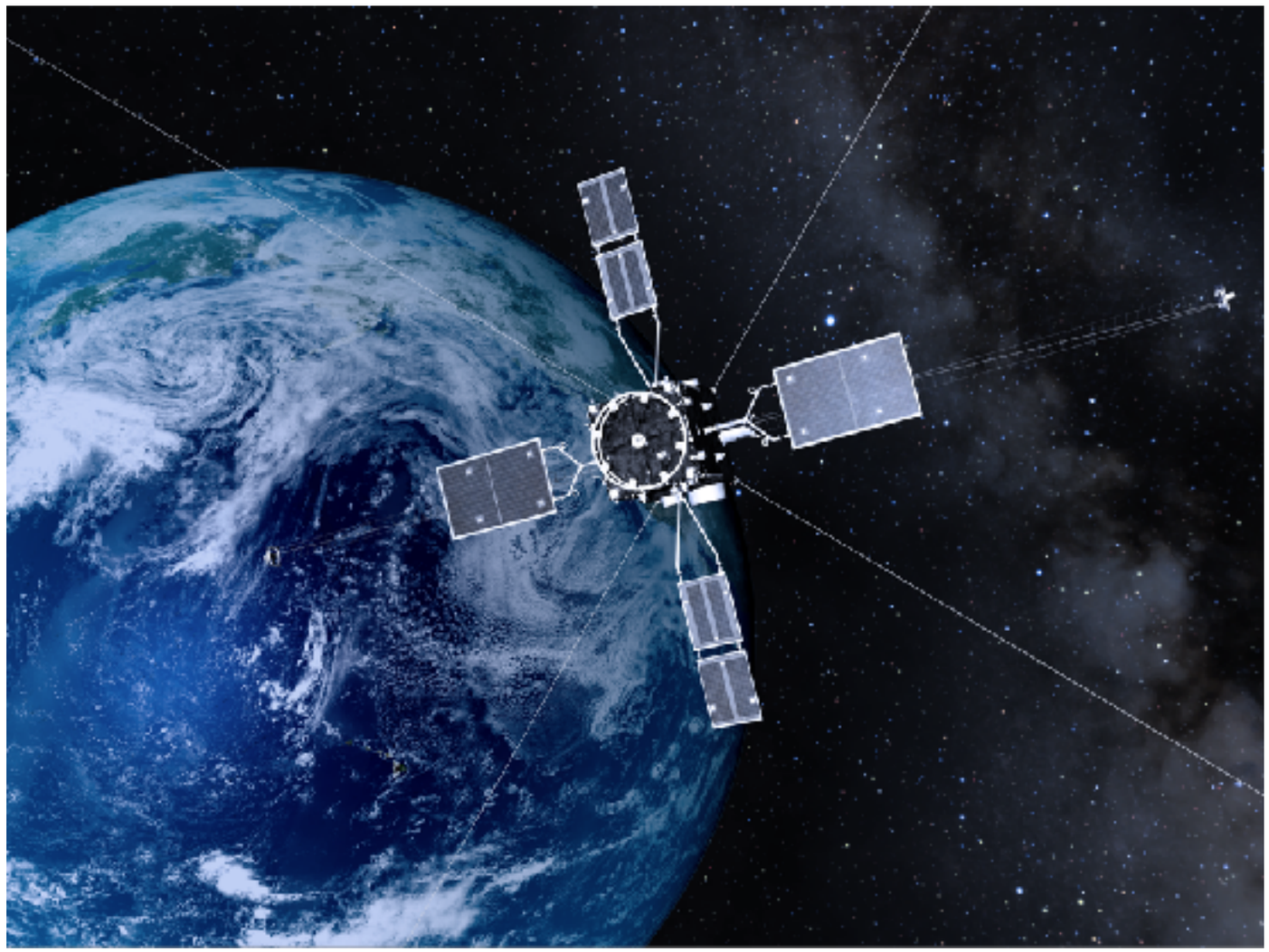


GEOTEIL

Launched on the 24th of July, 1992
Perigee:57,000 km , Apogee 200,000 km Inclination: 29 degrees
Scientific Instruments: Magnetic/ Electric field monitors, Two sets of plasma monitors, Two sets of high-energy article monitors, Plasmas wave instruments

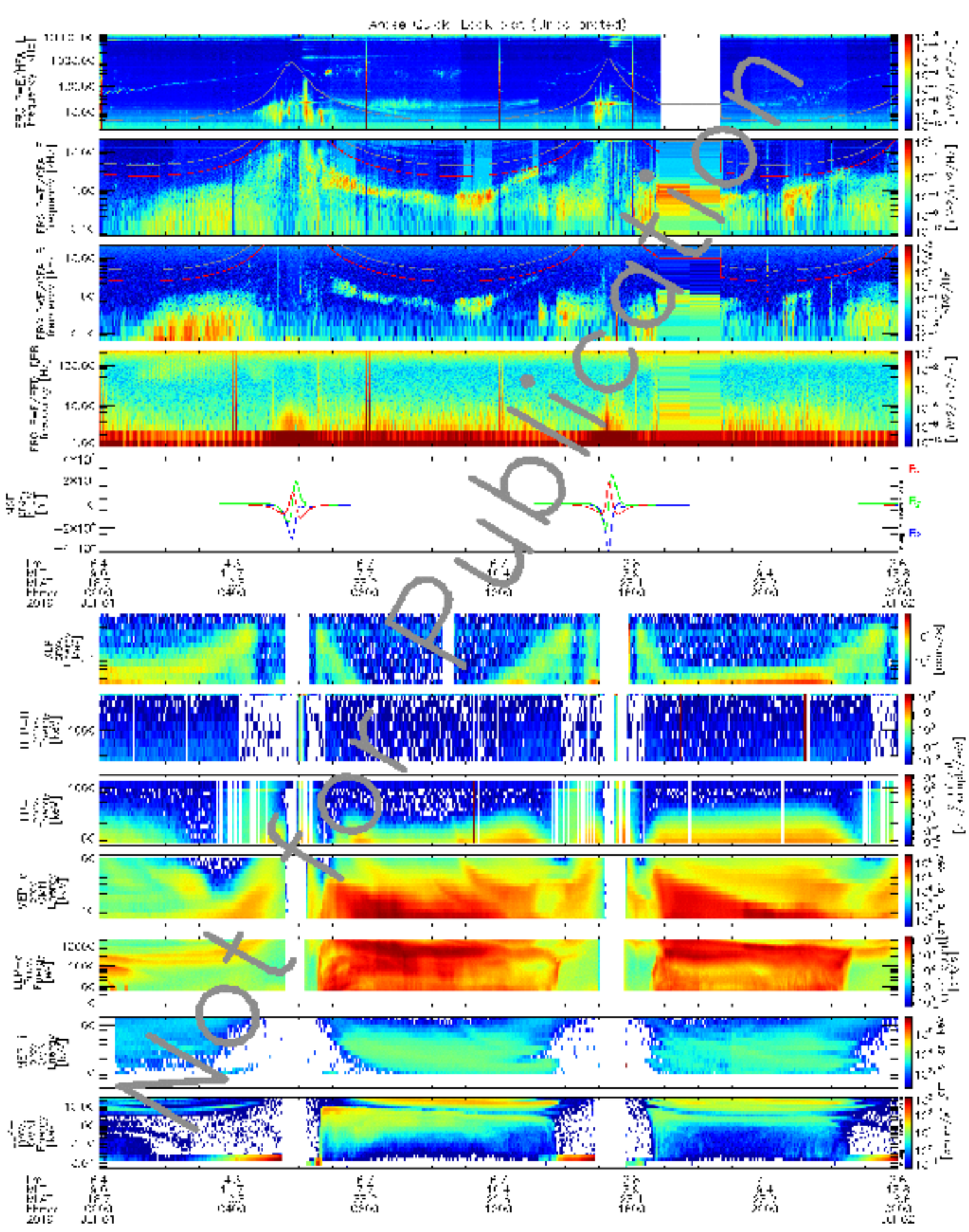
Things to pay attention to setup the fluxgate magnetometer onboard the satellite for scientific purpose

- **Consider instrument structure for noise reduction**
- **Do severe calibration and alignment tests for high-accuracy data**
- **Get attitude data with high accuracy.**



Arase satellite

Launched on the 20th of Dec., 2016
Perigee:440 km , Apogee 32,000 km
Inclination: 31 degrees
Scientific Instruments: Magnetic field experiment,Plasma Wave Experiment,Software-type wave particle interaction analyzer,Low-energy particle experiments - electron analyzer,Low-energy particle experiments - ion mass analyzer,Medium-energy particle experiments - electron analyzer,Medium-energy particle experiments - ion mass analyzer,High-energy electron experiments,Extremely high-energy electron experiments



Arase satellite can observe plasma and magnetic field

Summary

- The geomagnetic field data are globally observed in space and on the ground for space weather.
- Ground observation sites of the geomagnetic field easily were maintained.
- Satellite can detect magnetic field data and plasma data via in-situ observations to study plasma physics in space.
- The setup of ground stations and calibration of the fluxgate magnetometer of satellite are required with higher accuracies.