EQUATORIAL ELECTROJET AND INTERPLANETARY MAGNETIC FIELD THROUGH NONLINEAR AND TIME SERIES ANALYSIS OF MAGDAS DATA

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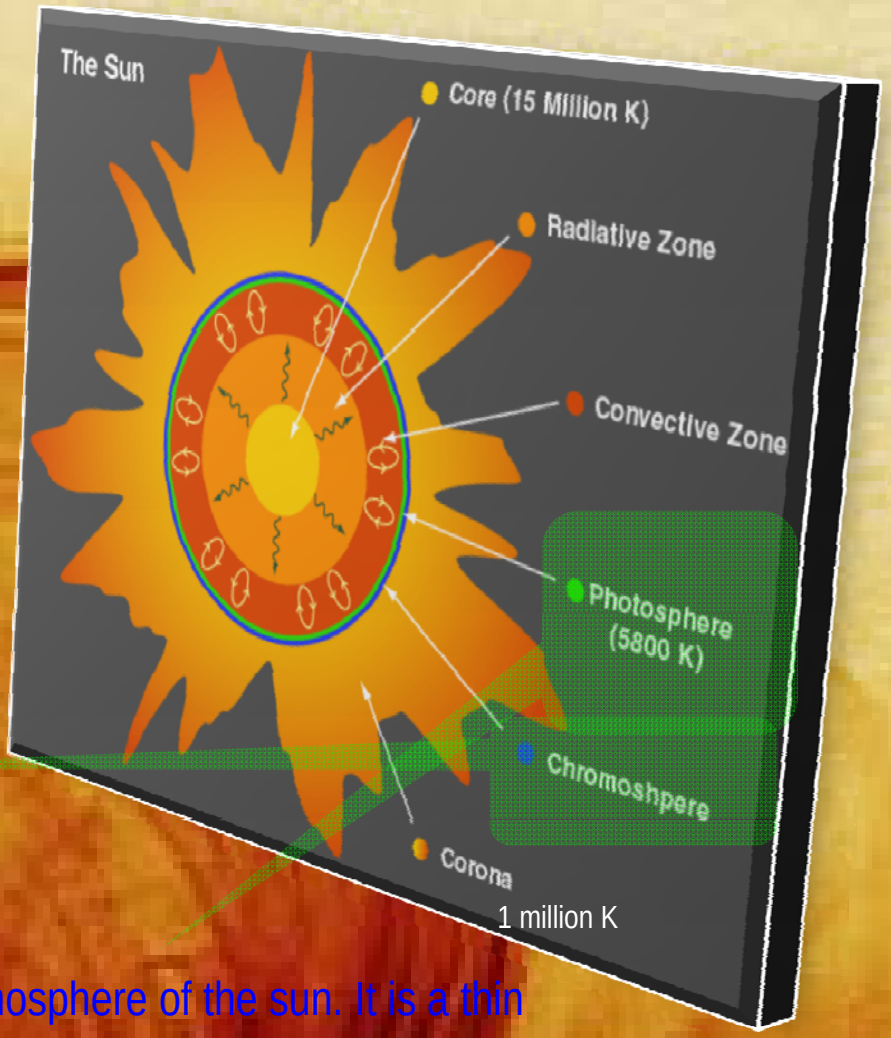
ISWI Philippines Logo

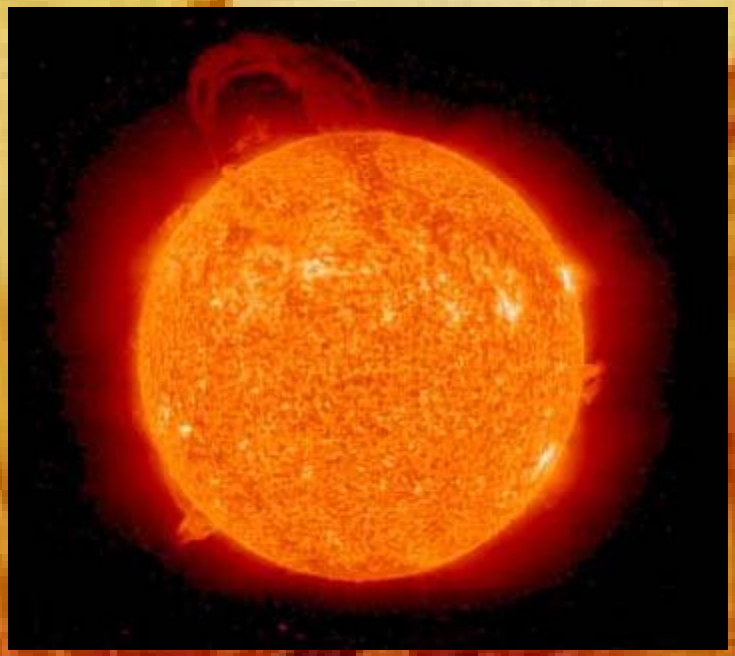
- The source of all energy (nuclear fusion) in the solar system
- mostly composed of hydrogen
- radius is about 700,000 km, 110 times the radius of the earth
- mass is $2X10^{30}$ kg about $3.3X10^{5}$ times the mass of earth

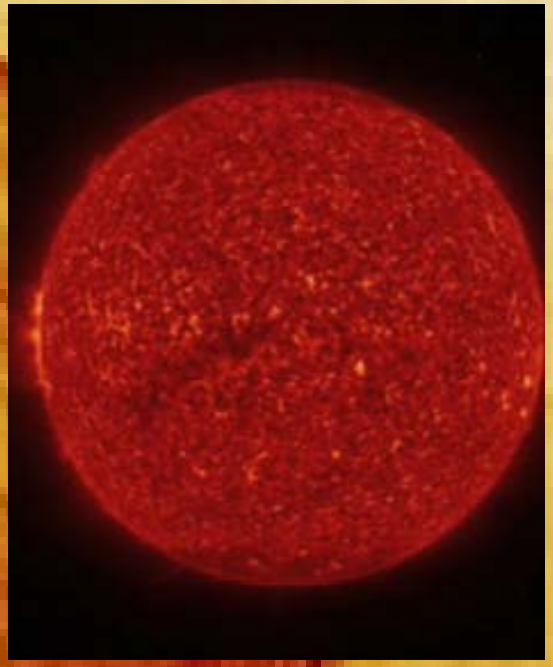


About 2000km thick, temperature is 10^{5} K

Defines the atmosphere of the sun. It is a thin layer, about 500km.

Next slide



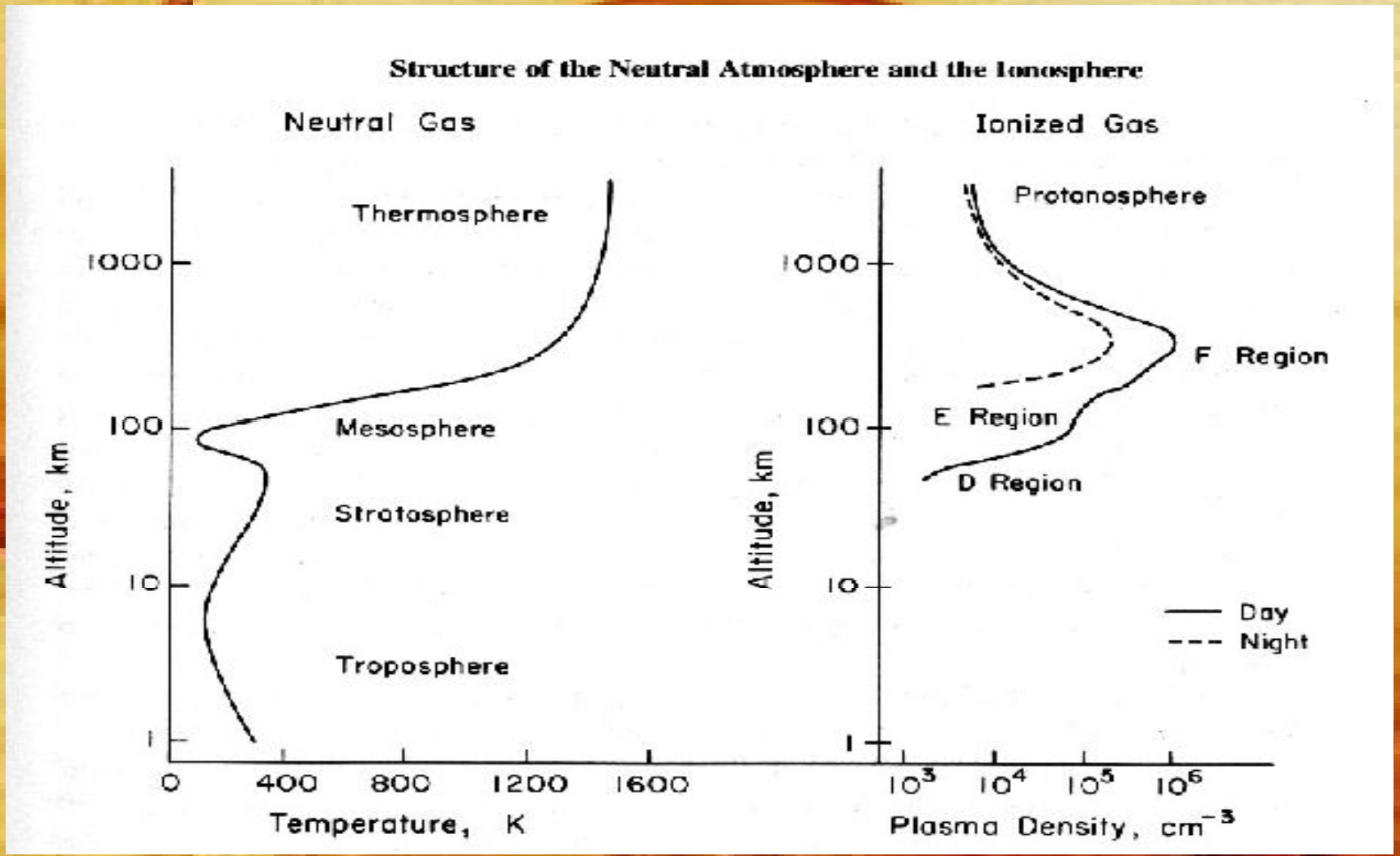


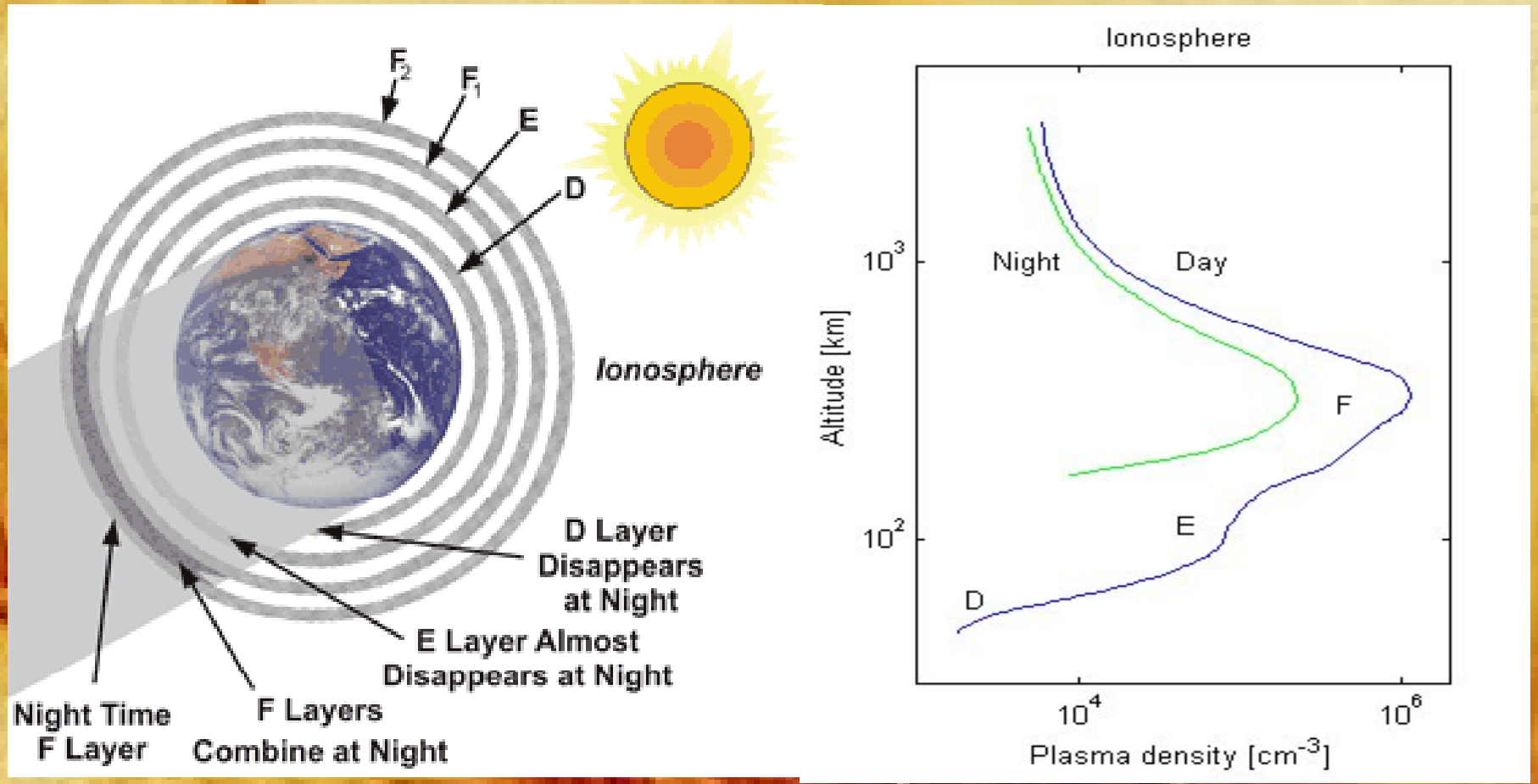
Prominence April 12-13, 2010.

March 17-27, 2007

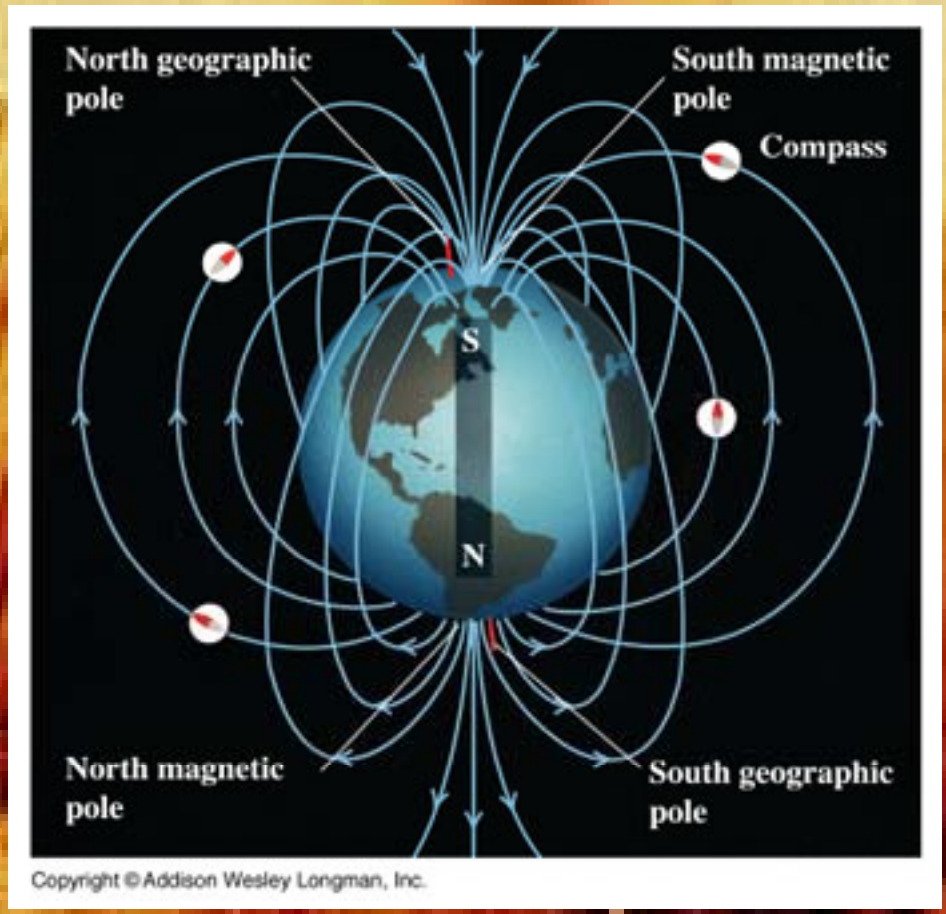
Image above: STEREO's (Solar Terrestrial Relations Observatory) Extreme Ultraviolet Imaging Telescope captured these images of the sun
Courtesy: NASA

THE EARTH'S ATMOSPHERE AND IONOSPHERE

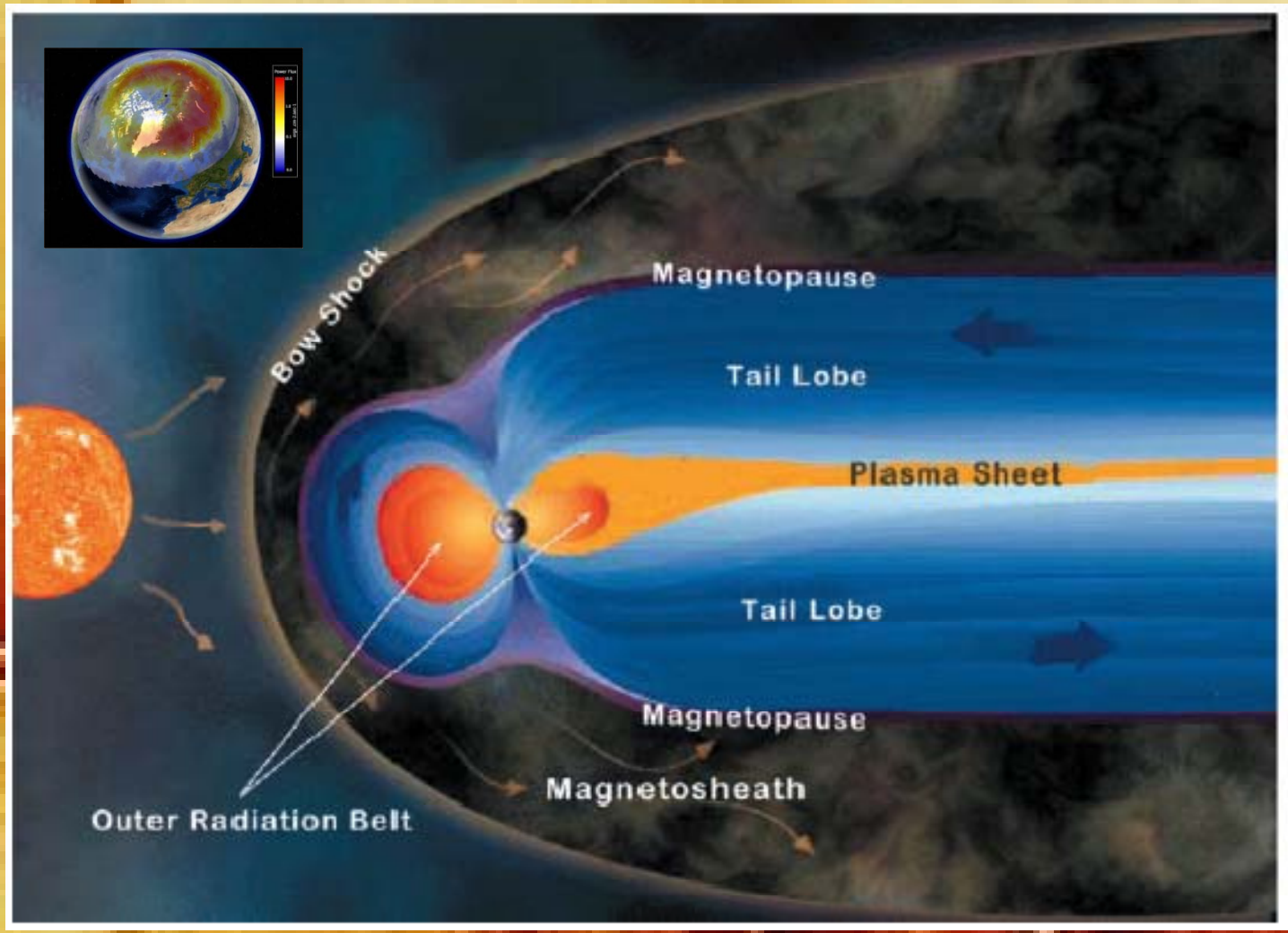



F2
F1
E
D
Ionosphere
D Layer
Disappears
at Night
E Layer Almost
Disappears at Night
F Layers
Combine at Night
Night Time
F Layer
Ionosphere
Night
Day
F
E
D
Altitude [km]
10^3
10^2
10^4
10^6
Plasma density [cm^-3]

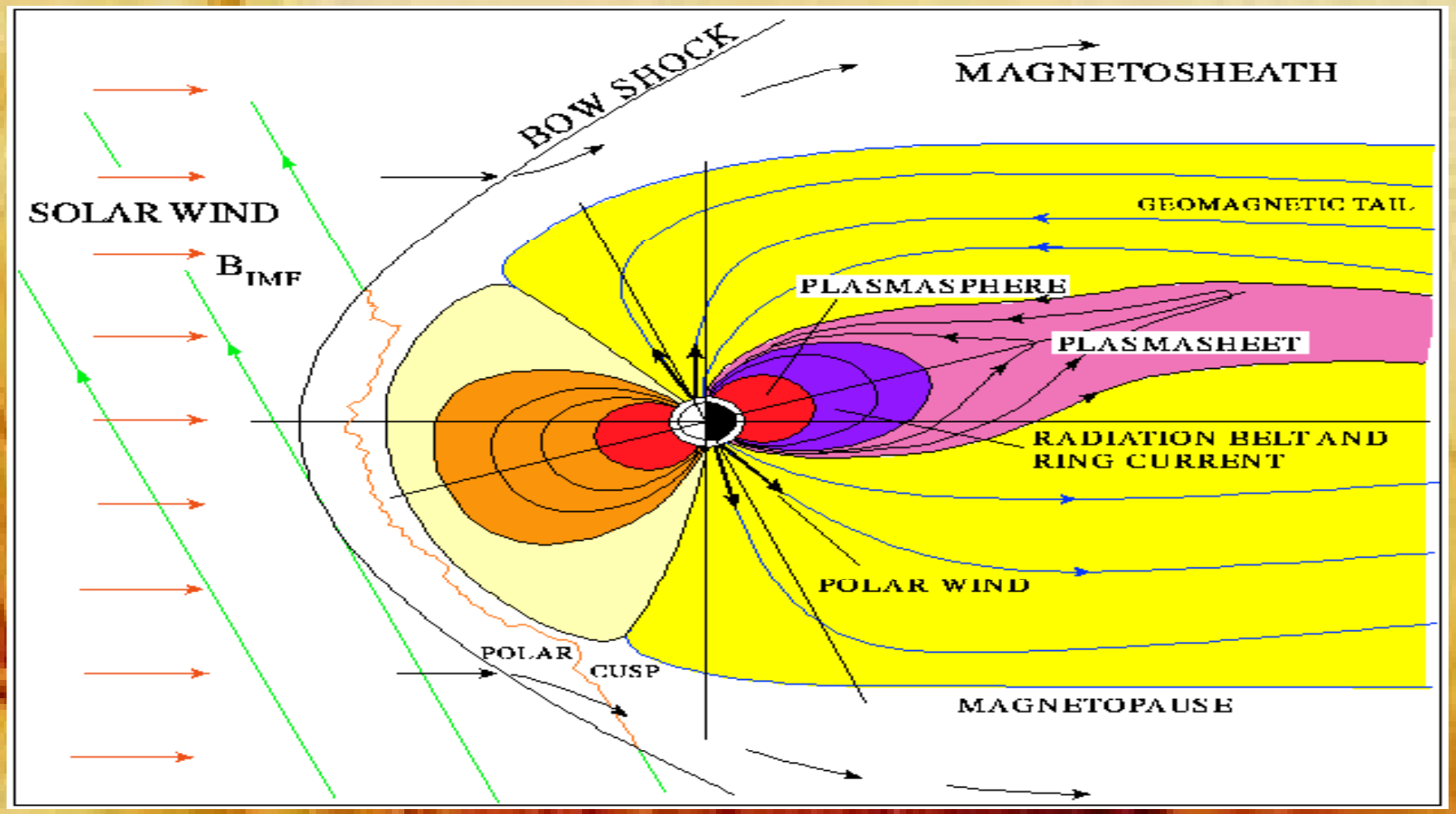
THE EARTH'S MAGNETIC FIELD



THE SOLAR WIND



Lyon, J. G., The solar wind-magnetosphere-ionosphere-coupling, *Science*, 288(5473), 1987-1991, 2000.



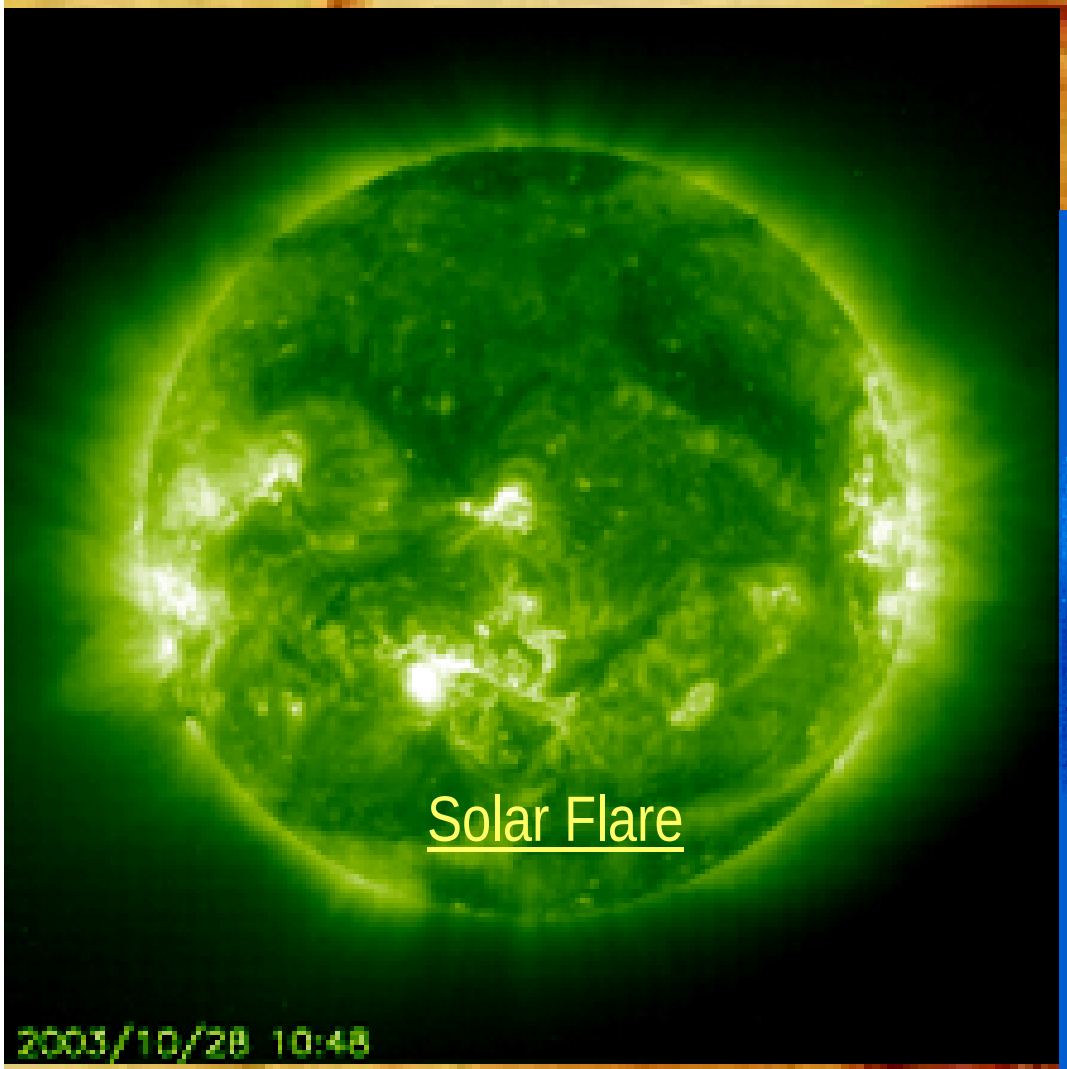
http://www.uaf.edu/asgp/hex/ionosphere.htm

SPACE STORM

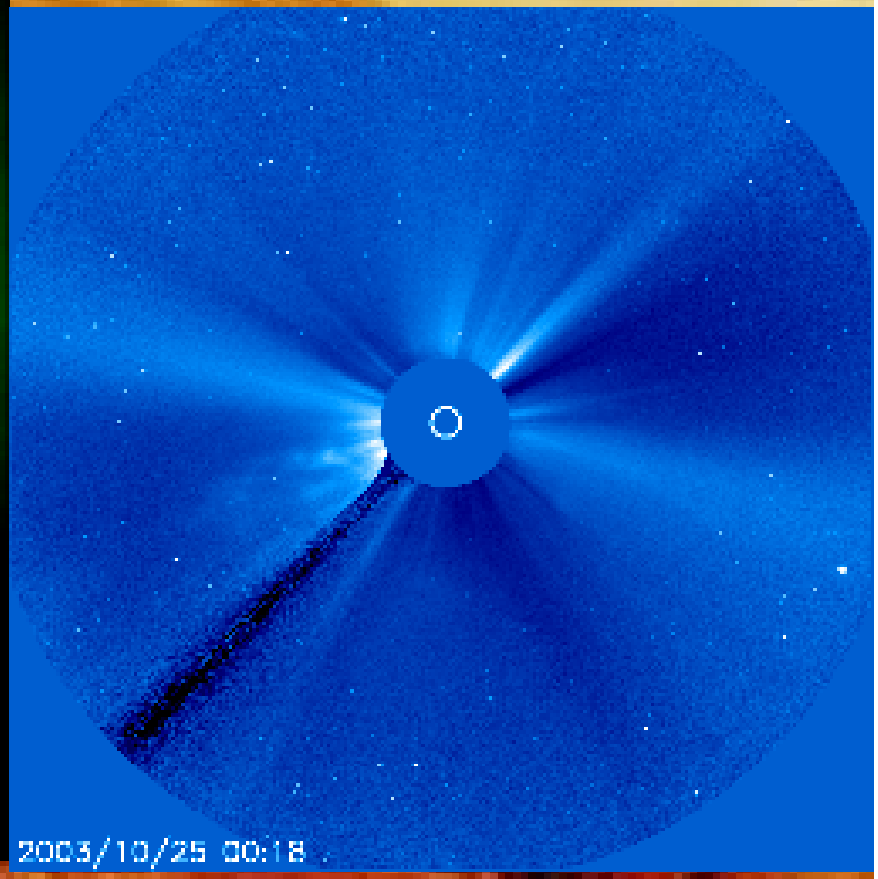
First detected by Alexander von Humboldt

2003,10/28 Event
10UT ～X17.2

10/29 Event
21UT～X10.0



Solar Flare



Coronal Mass Ejection

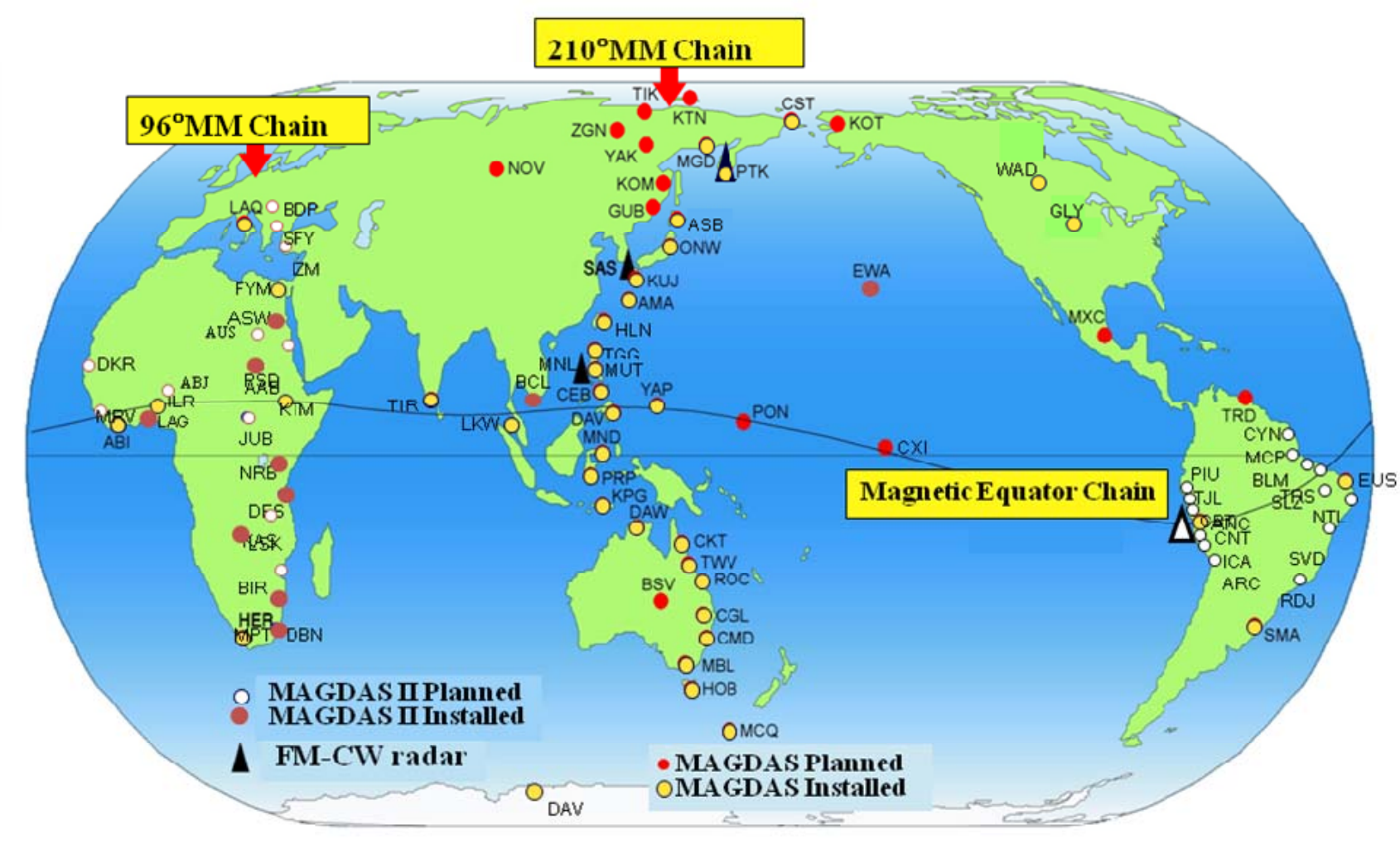
Harmful effects of space storms:

- geomagnetically induced currents can damage power stations (Brazil and Canada)

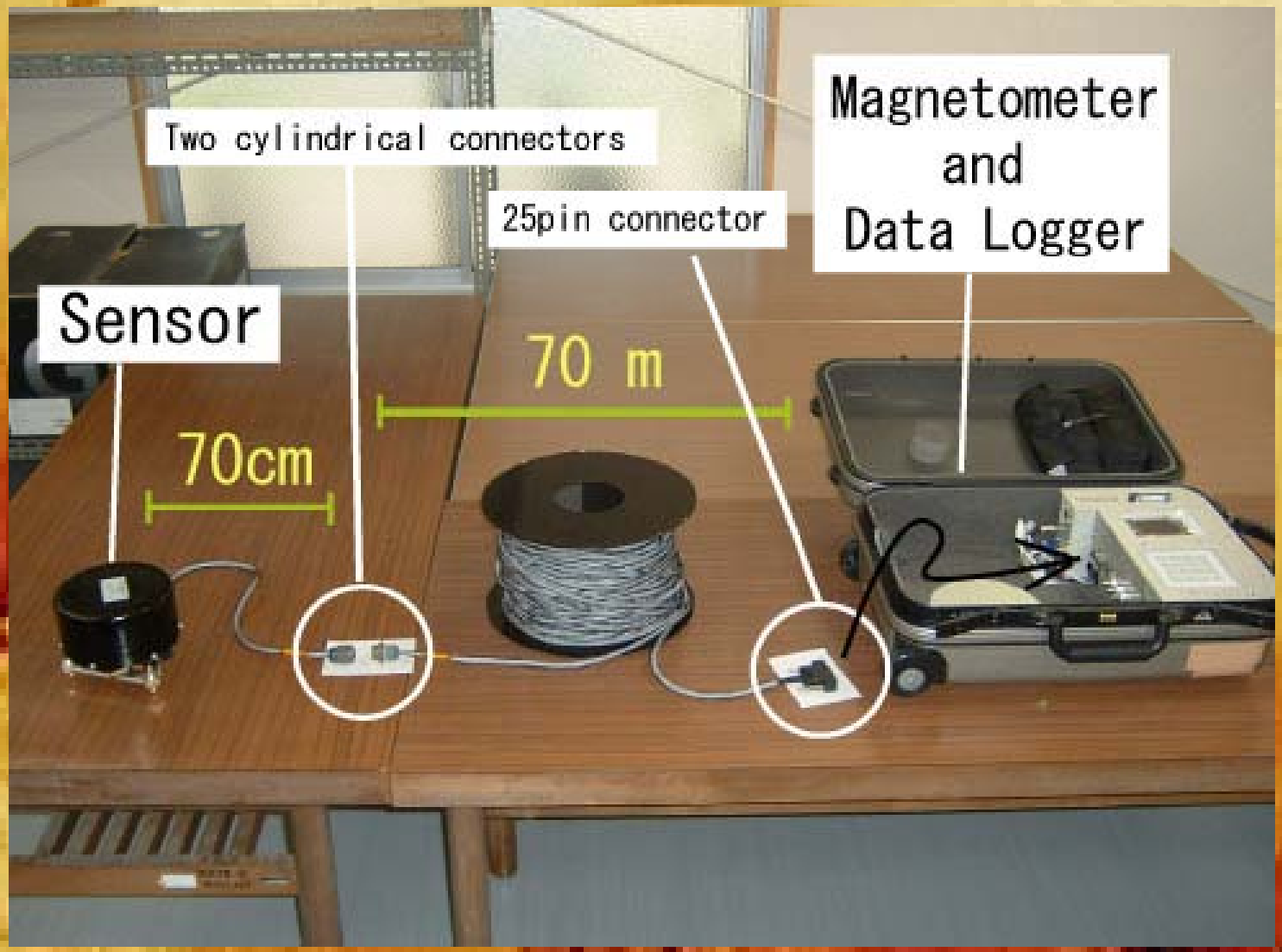
(Boteler, D.H., R.M. Shier, T. Watanabe and R.E. Horita, Effects of geomagneticlly induced currents in the B.C. Hydro 500 kV system, *IEEE Trans. Power Delivery*, 4, 818-823, 1989.)

- Increase drag of satellitess
- Disrupt satellite communications
- Highly energetic charged particles may harm

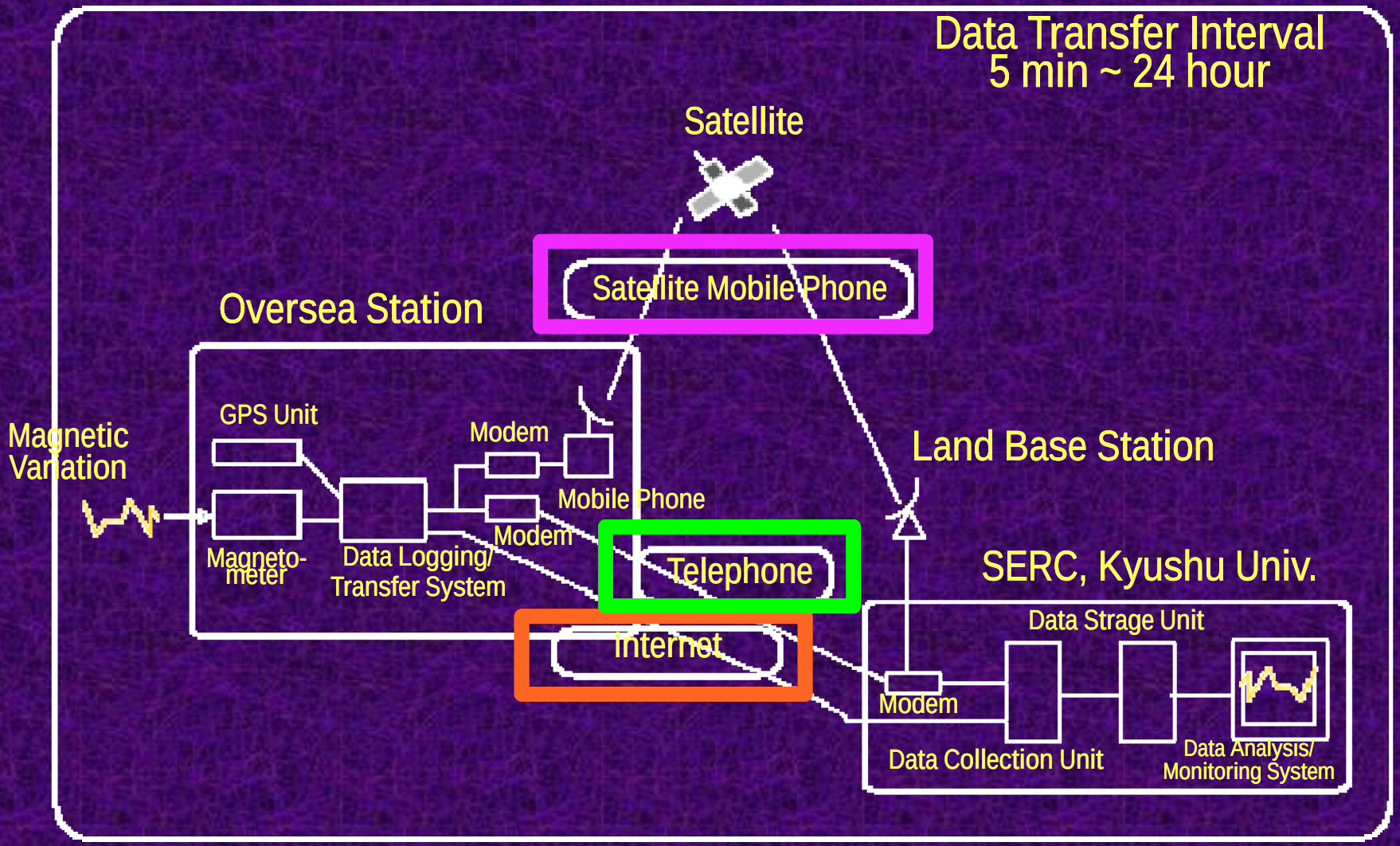
MAGNETIC DATA ACQUISITION SYSTEM (MAGDAS)



MAGDAS Magnetometer Components



Real-time Data Transfer System



MAGDAS **Magnetometer Array-Philippines**

Tuguegarao 2005/05/15

Muntinlupa 2005/05/15

Davao 2005/06/28

Magnetic Equator

LGZ

2009 07/24

Fr. Cordero

Cebu, 2005/06/26

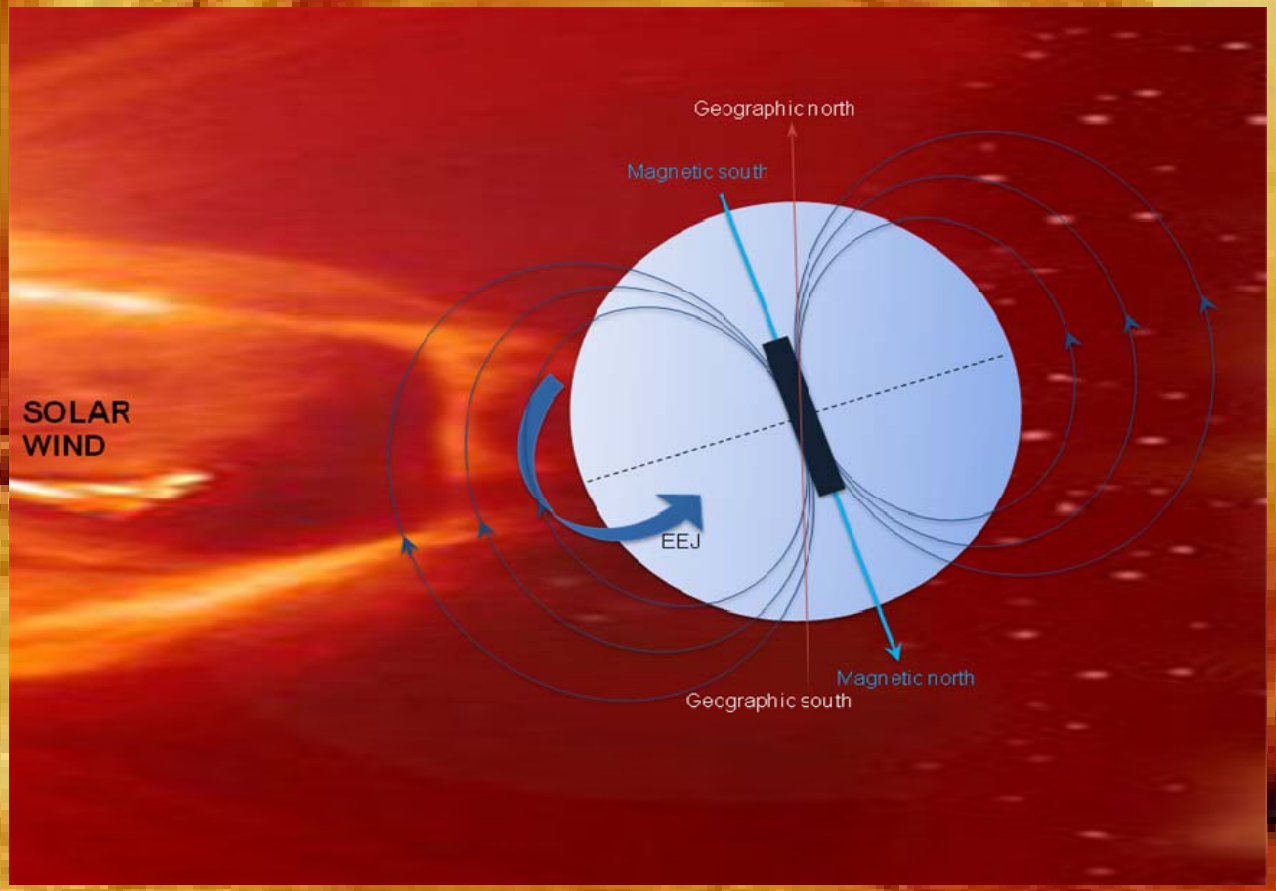
CDO

2009 07/27

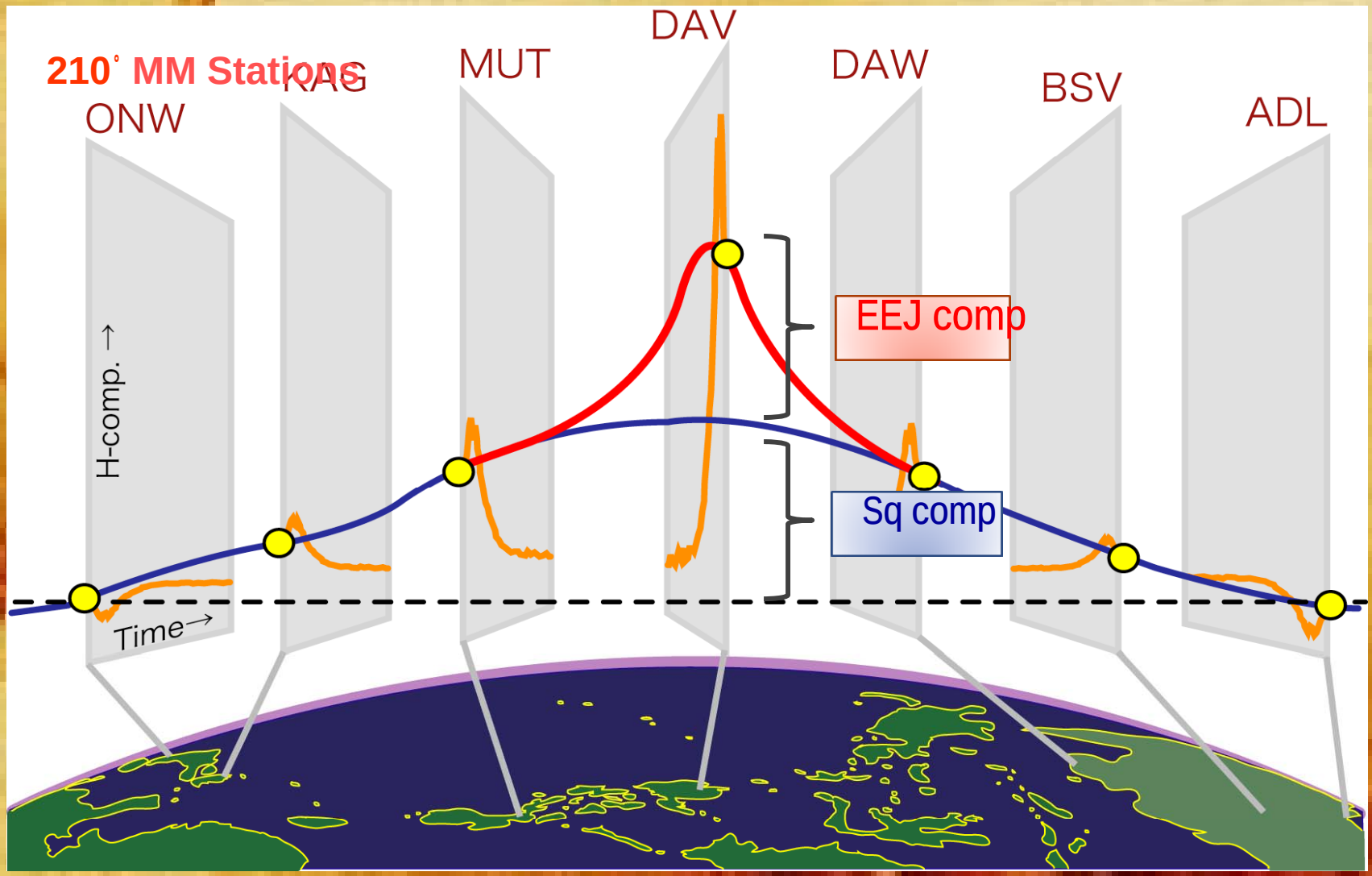
Fr. Villarian

EQUATORIAL ELECTROJET

- The equatorial electrojet or EEJ (Chapman 1951) is a narrow band of current at the E-region of the ionosphere flowing eastward along the dayside dip equator.
- It is caused by the enhancement of east-west Pedersen conductivity and manifests as an enhancement of the daily variations of the northward component *H* of the geomagnetic field with the maximum occurring at the dip equatorial latitudes.
- It was first detected at Huancayo, Peru in 1922.

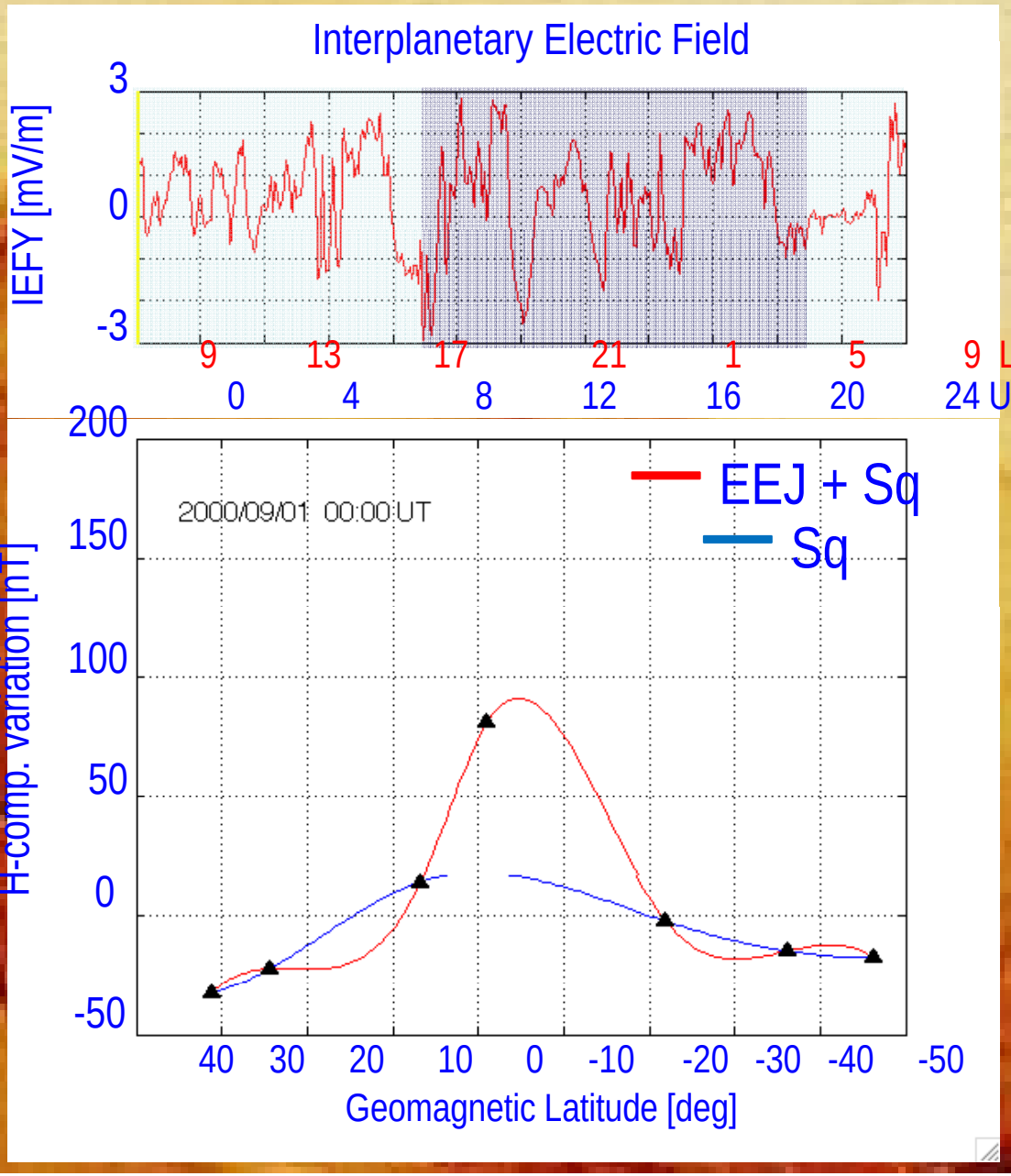


Ueno et al.(2008)



It is well known that IMF will reverse southward during space storms

2001/09/01

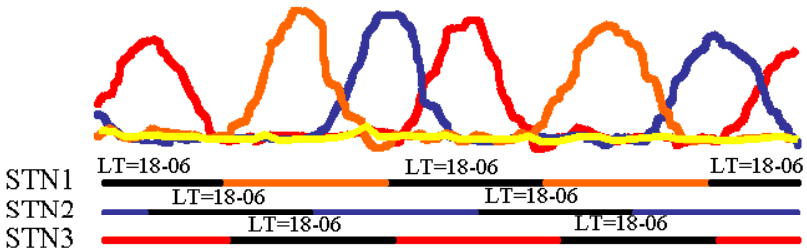


Ueno et al.(2008)

EE-Index (*EDst, EU, EL*)

Uozumi et al. (2009)

Definition of *EDst*



$$EDst(m) = \sum_{S|_{\mathrm{LT=18\text{-}06}}} ERs(m)\big|_{\mathrm{LT=18\text{-}06}} \,/\, N(m)\big|_{\mathrm{LT=18\text{-}06}}$$

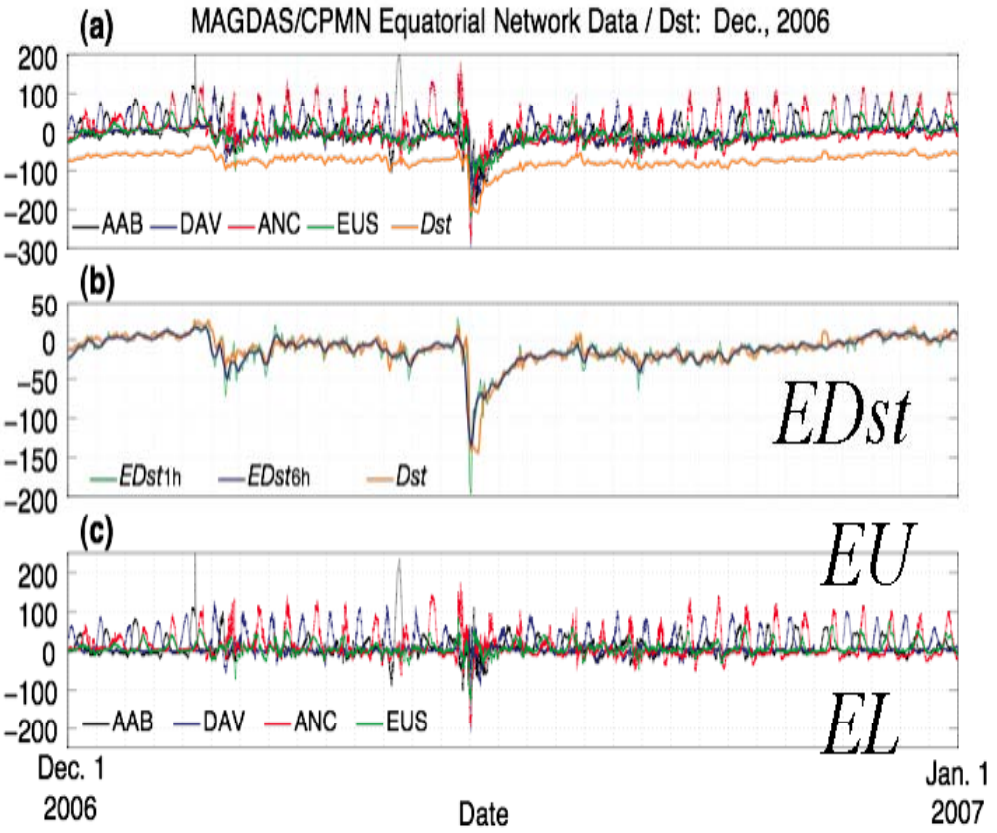
S: index of station

m: point of time in UT

EDst : the mean value of magnetic fields at night side.

EU: Amplitude of EEJ

EL: Amplitude of CEJ



A new *EE*-index to monitor short- and long-term variations of the equatorial electrojet by adopting the MAGDAS/CPMN real-time data.

What we will do?

Nonlinear measures to characterize and detect sudden changes in IMF and EE-index:

- Fractal/Multifractal structures-fractal dimensions
- Hurst coefficients
- Algorithmic complexity

To characterize correlations and information transfer between IMF and EEJ:

- cross-correlation coefficients
- Mutual information
- Transfer entropy


A workshop on nonlinear and time series analysis will be organized on June 23-30, 2011 by Dr. Alfonso Albano.


Thank You
INTERNATIONAL SPACE WEATHER INITIATIVE
ISWI
PHILIPPINE SECTOR