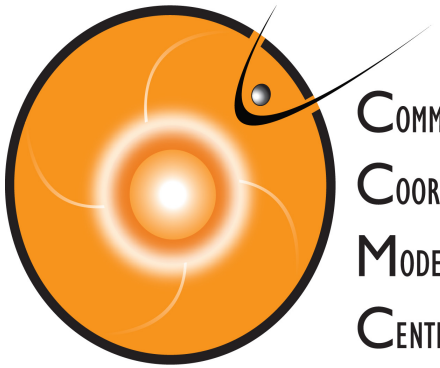
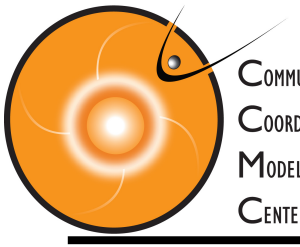


Earth's Magnetosphere

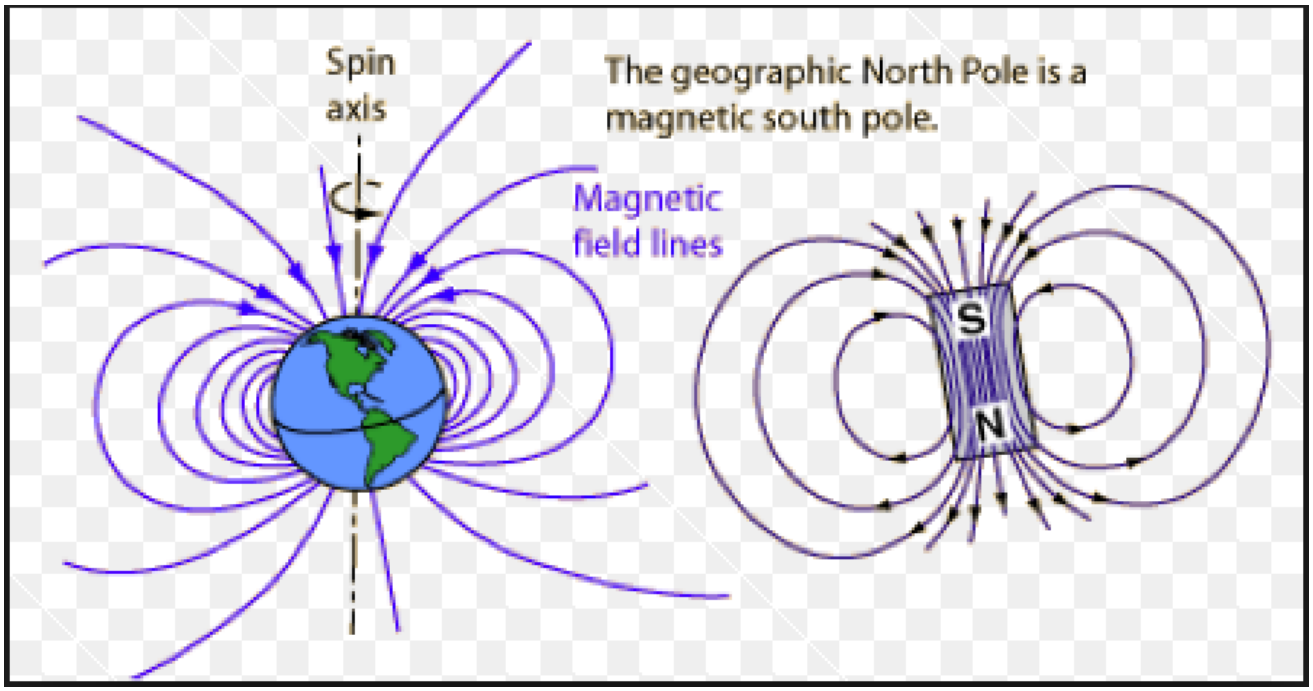
Presented by:
Dr. Yaireska (Yari) Collado-Vega

CCMC/SWRC SW REDI 2015

NASA Goddard Space Flight Center



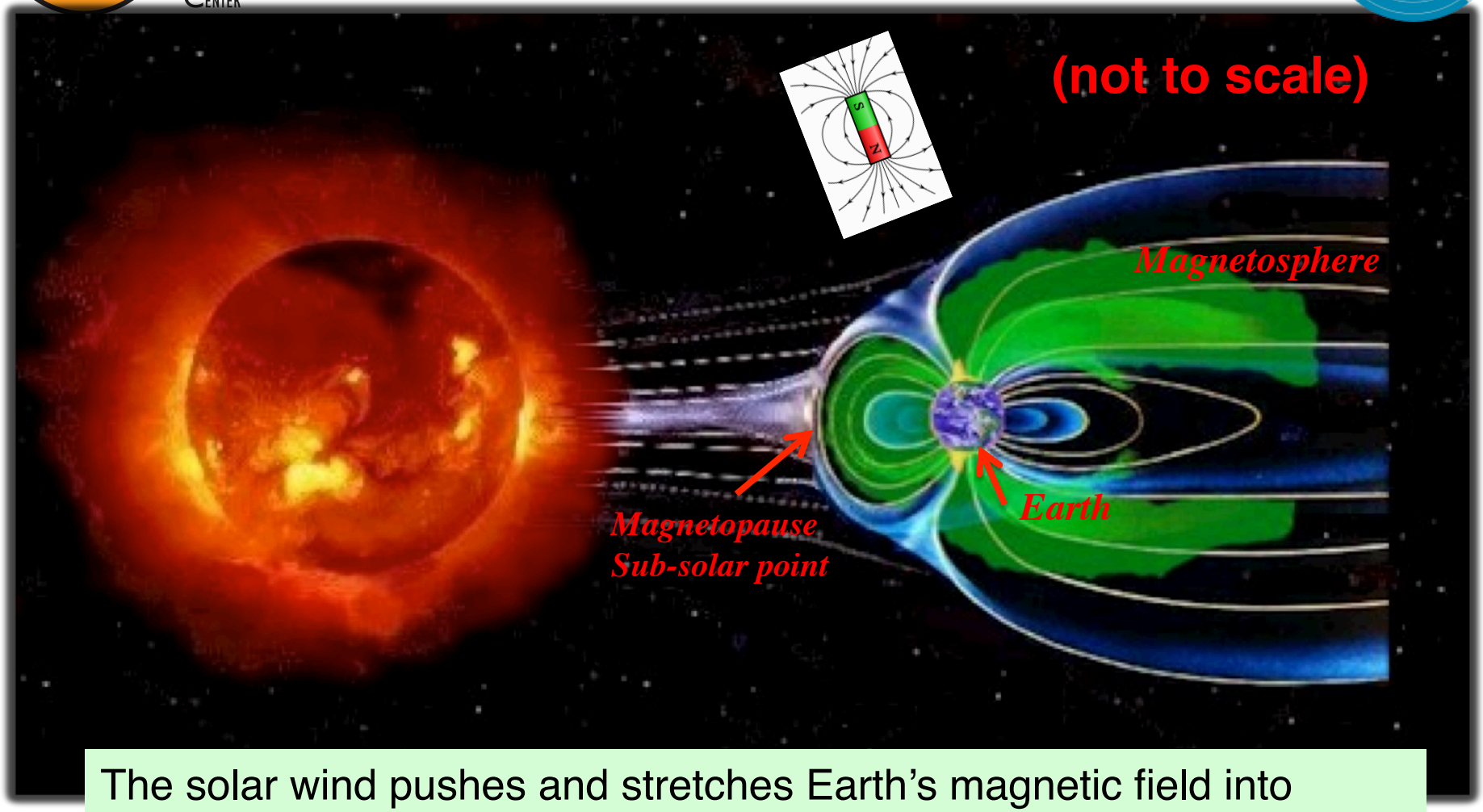
Magnetic Field of the Earth



The Earth's magnetic field is similar to that of a bar magnet. The magnitude varies over the surface of the Earth in the range 0.3 to 0.6 Gauss.

COMMUNITY COORDINATED MODELING CENTER

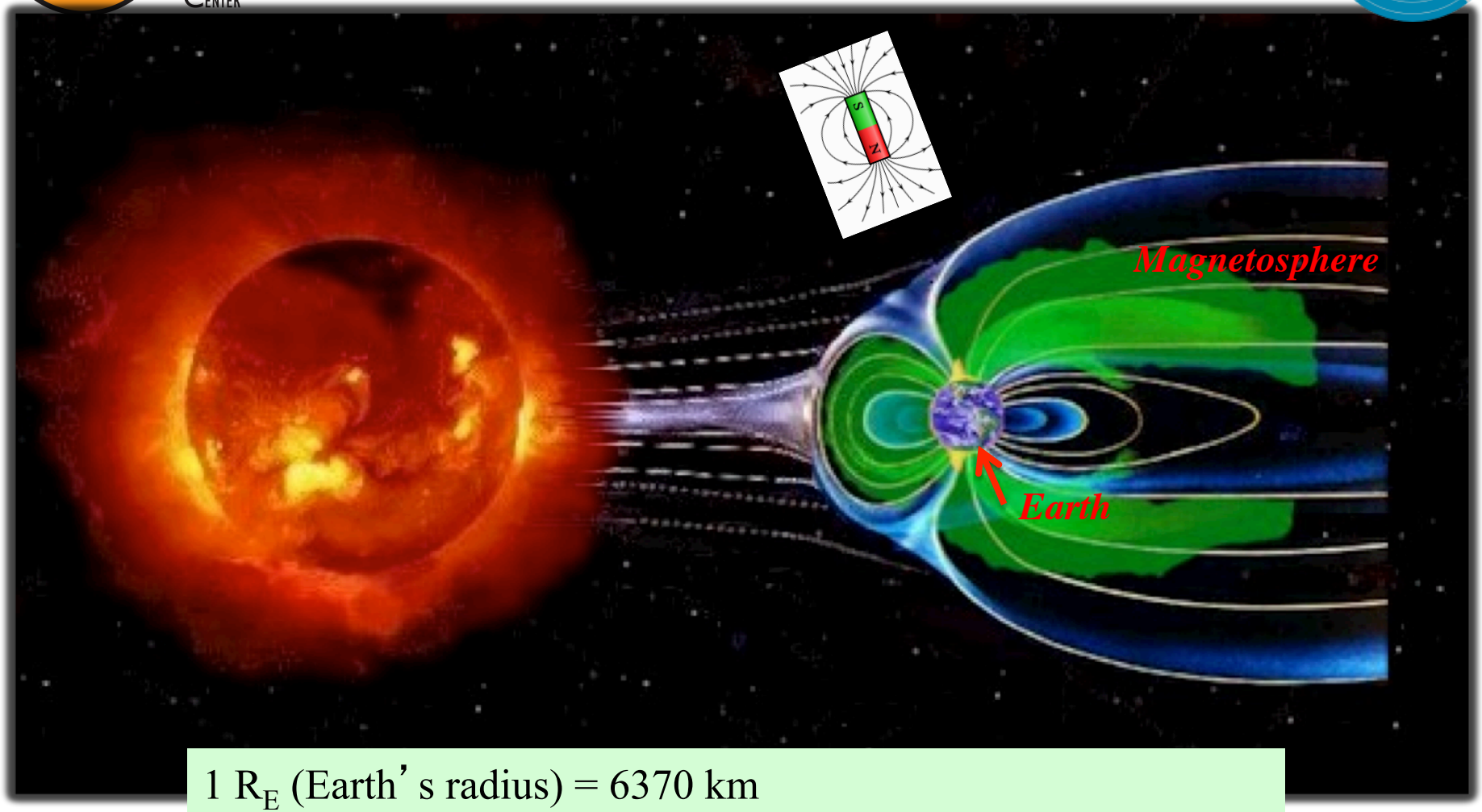
Earth's Magnetic Field



The solar wind pushes and stretches Earth's magnetic field into comet-shaped region called the magnetosphere. The magnetosphere and Earth's atmosphere protect us from the solar wind and other kinds of solar and cosmic radiation.

COMMUNITY COORDINATED MODELING CENTER

Spatial Scales

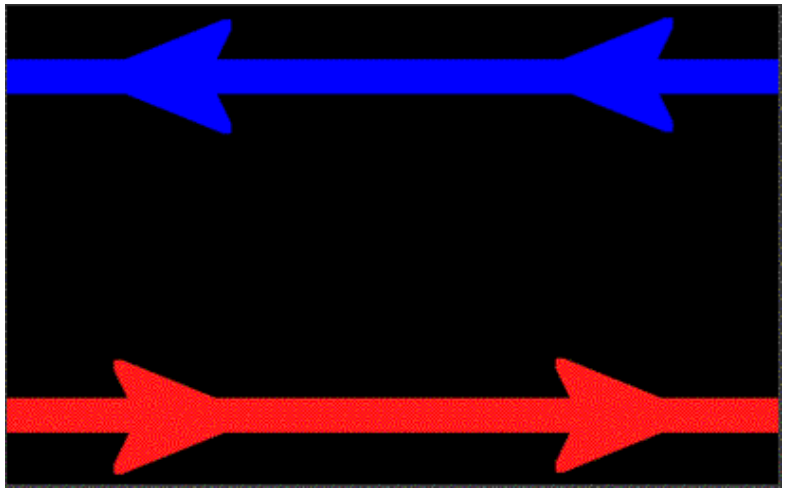


1 R_E (Earth's radius) = 6370 km

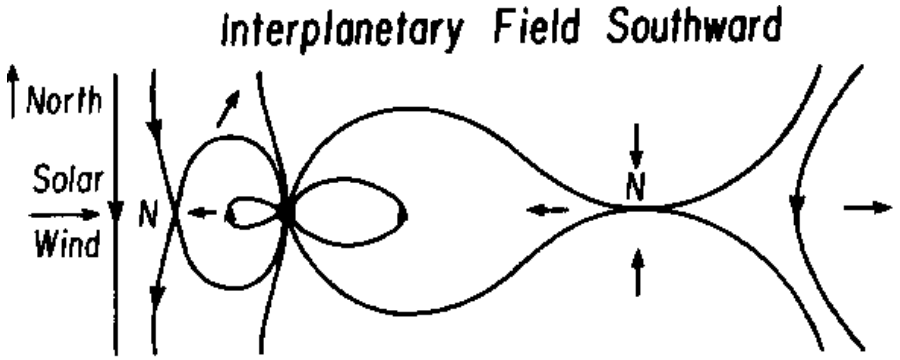
1 R_S (Solar radius) ~ 110 R_E

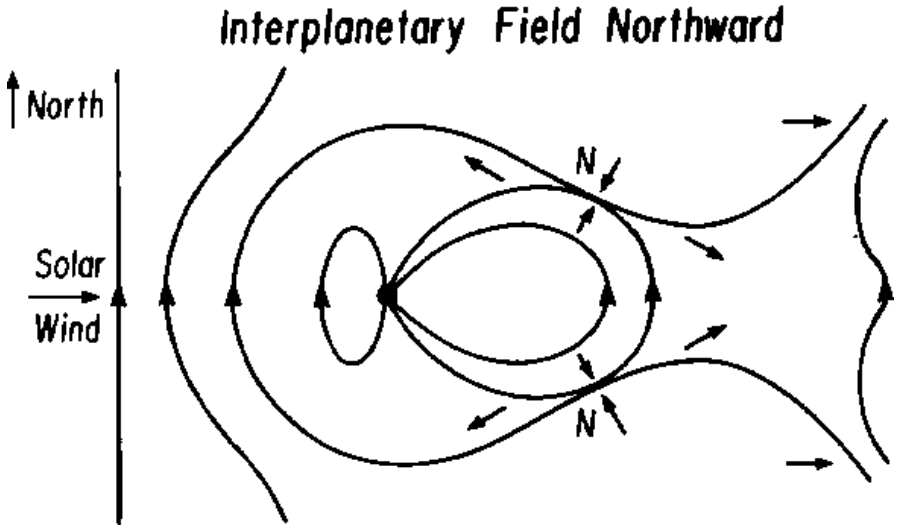
1 AU (Distance between the Sun and the Earth) ~ 215 R_S

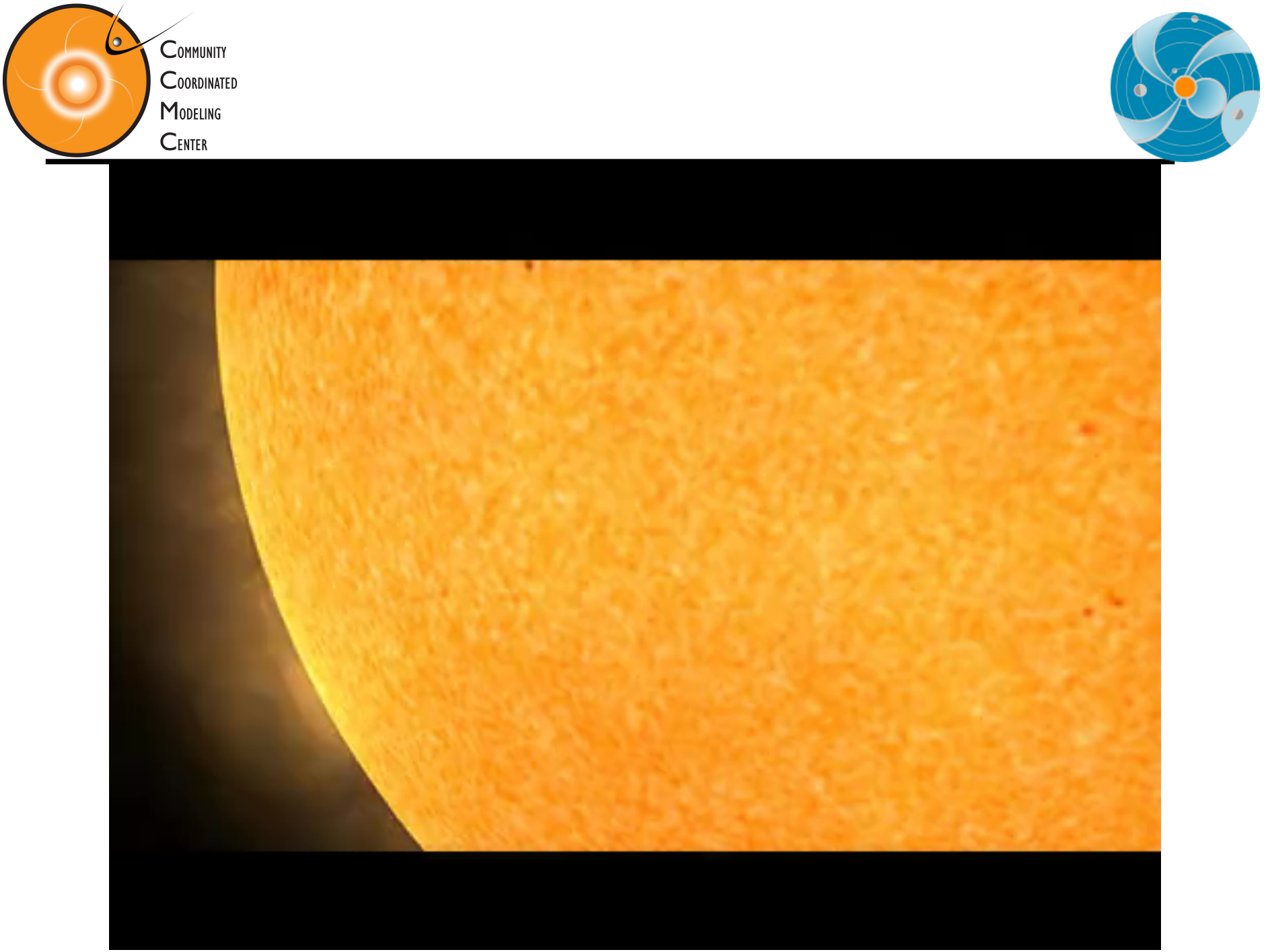
Magnetosphere for Southward and Northward IMF Orientation



Magnetic Reconnection



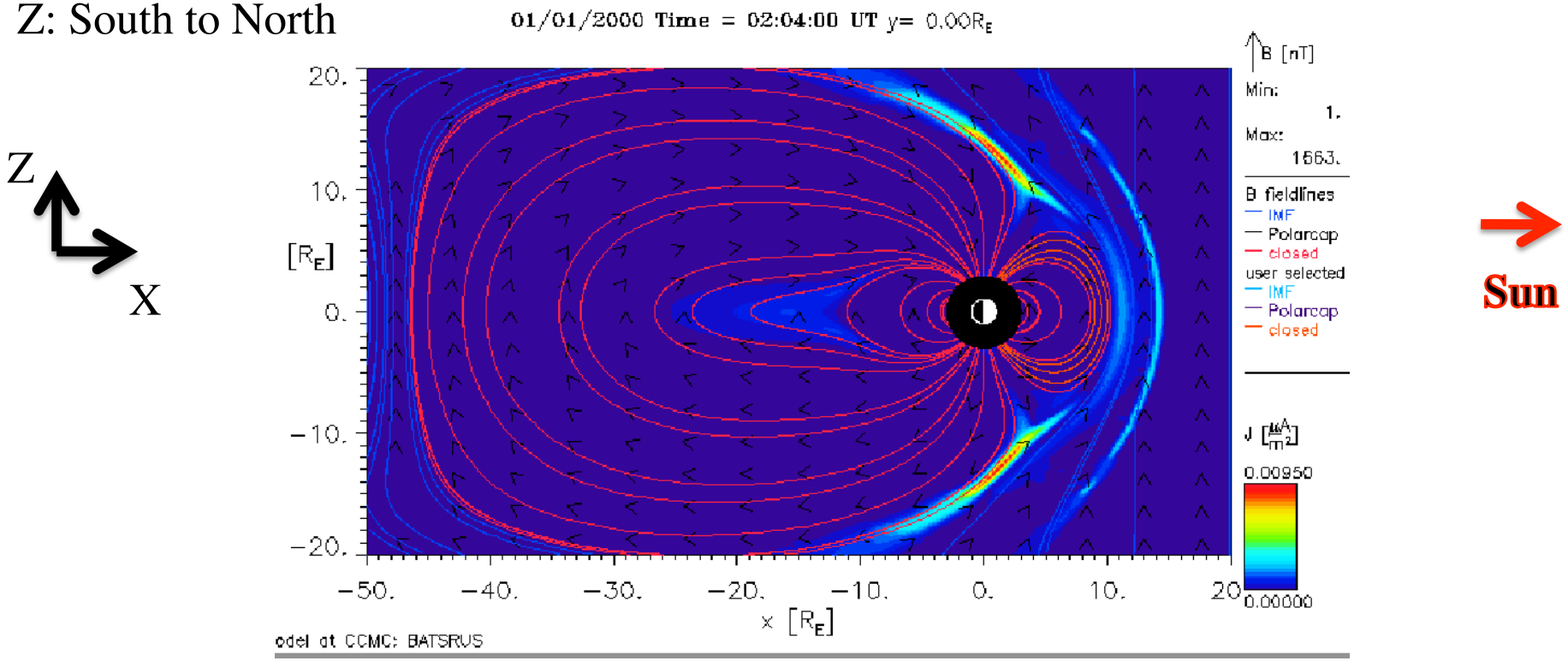



Community
Coordinated
Modeling
Center

COMMUNITY COORDINATED MODELING CENTER

Magnetosphere:
Northward IMF

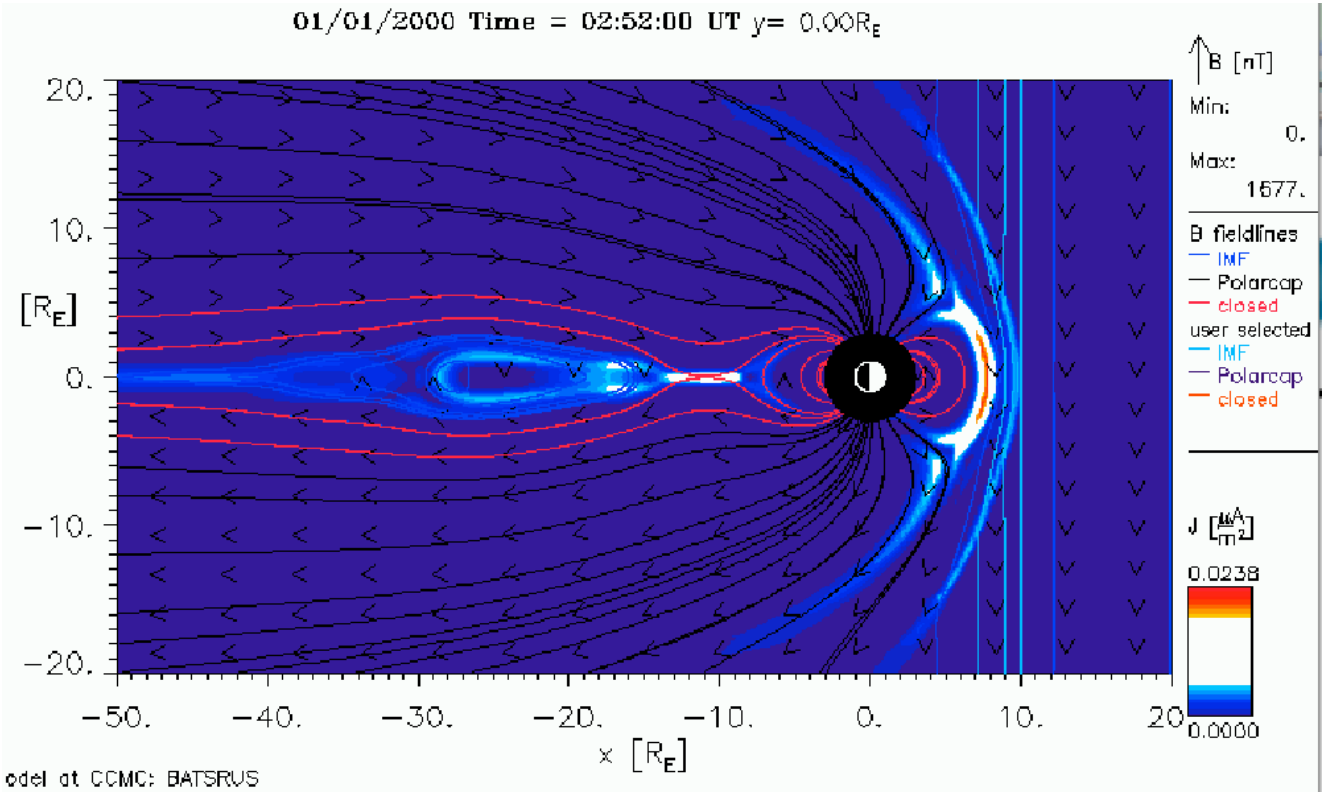
X: Earth to Sun
Z: South to North



Red lines (closed): Magnetic field (MF) lines with both ends connected to the Earth
Black lines (open): MF lines with only one end a the Earth
Blue lines (interplanetary): MF lines with both ends in the interplanetary space

COMMUNITY COORDINATED MODELING CENTER

Magnetosphere:
Southward IMF



Red lines (closed): Magnetic field (MF) lines with both ends connected to the Earth

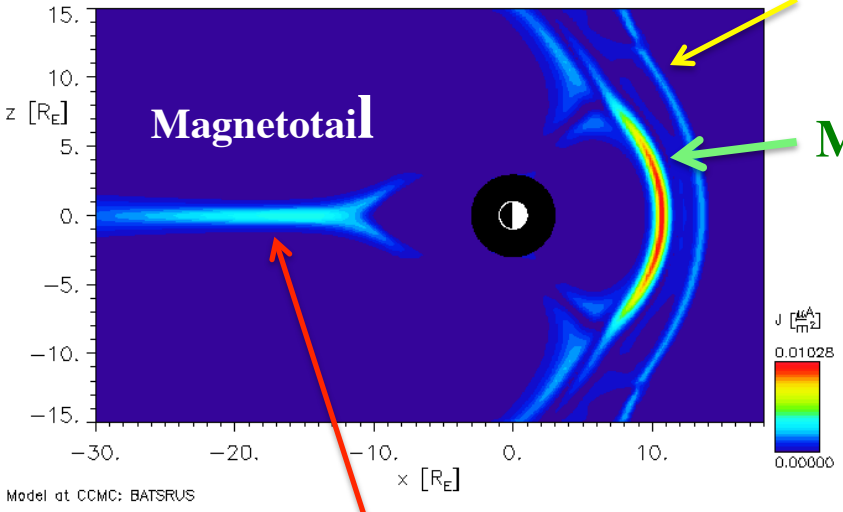
Black lines (open): MF lines with only one end a the Earth

Blue lines (interplanetary): MF lines with both ends in the interplanetary space

Magnetosphere in Different Cut Planes

meridional cut Y=0

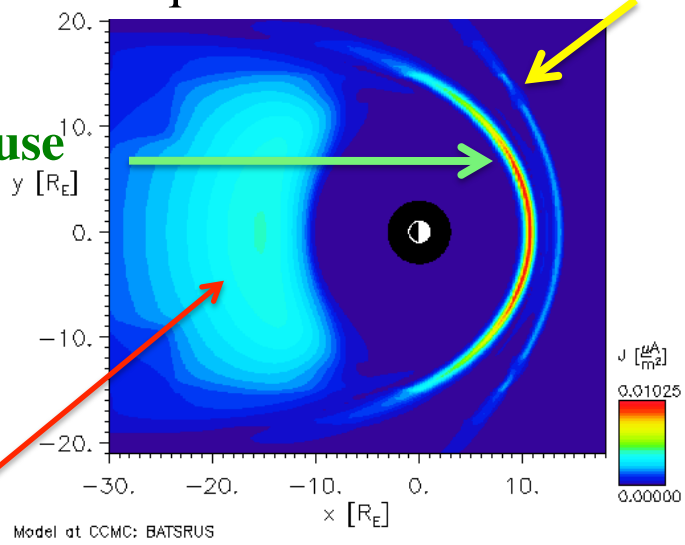
Bow shock



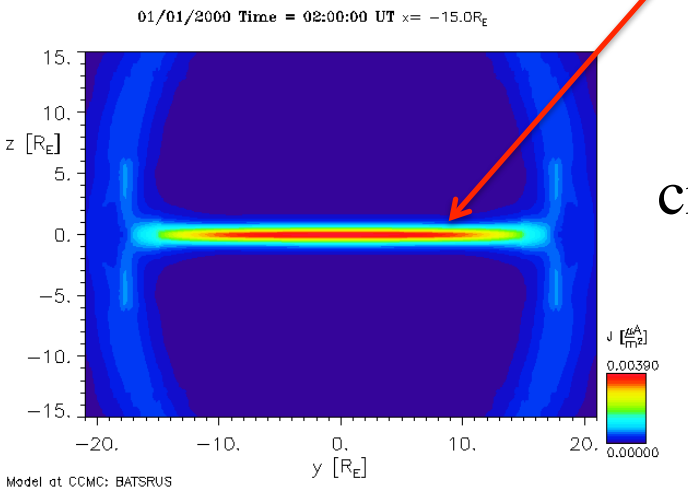
Magnetopause

equatorial cut Z=0

Bow shock

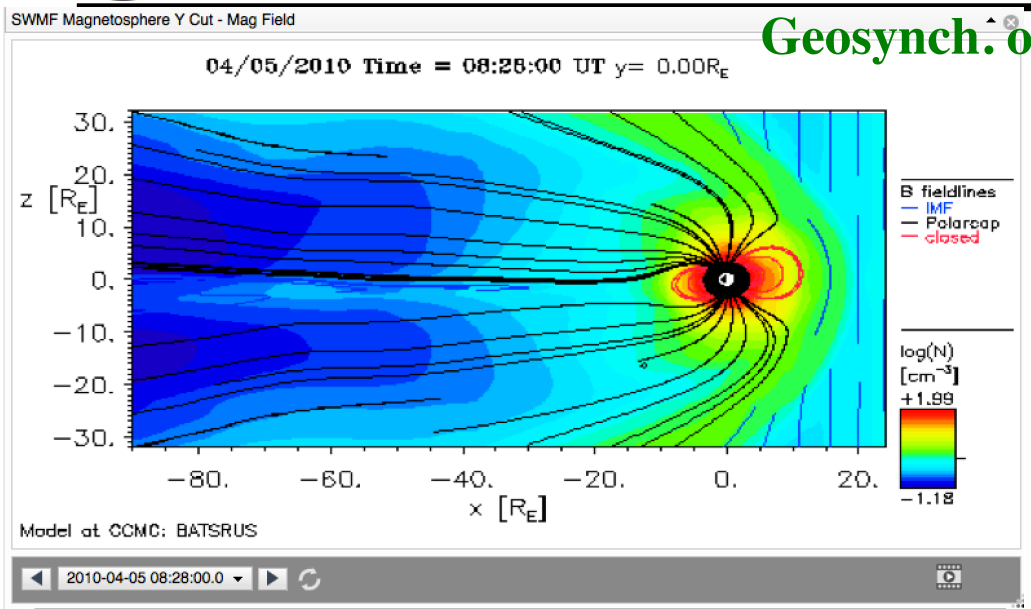


Magnetotail current sheet

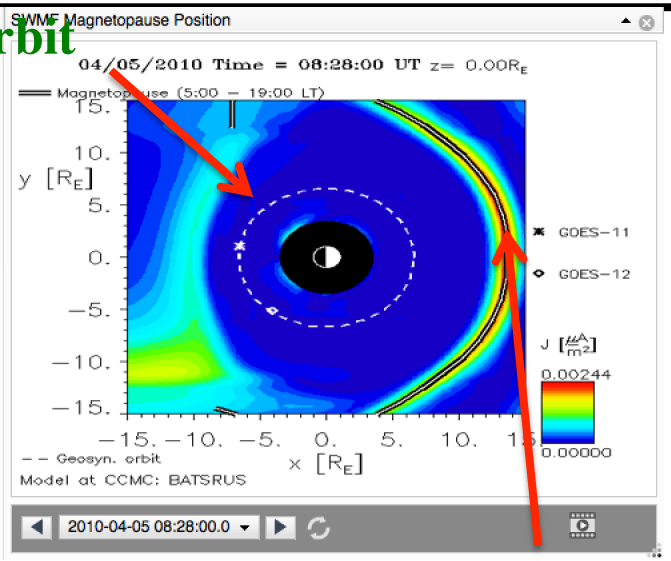


cross-tail cut X= -15 R_E

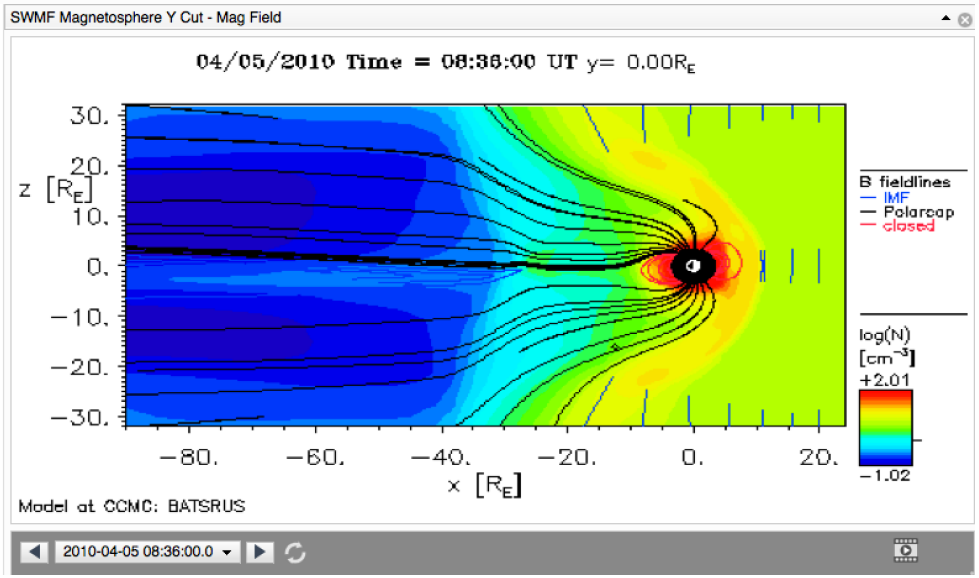
Magnetosphere:
Quiet vs. Compressed

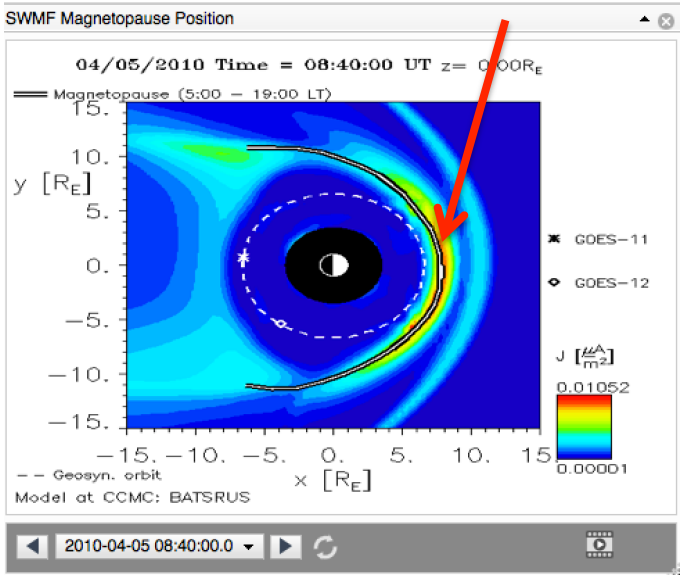


Geosynch. orbit



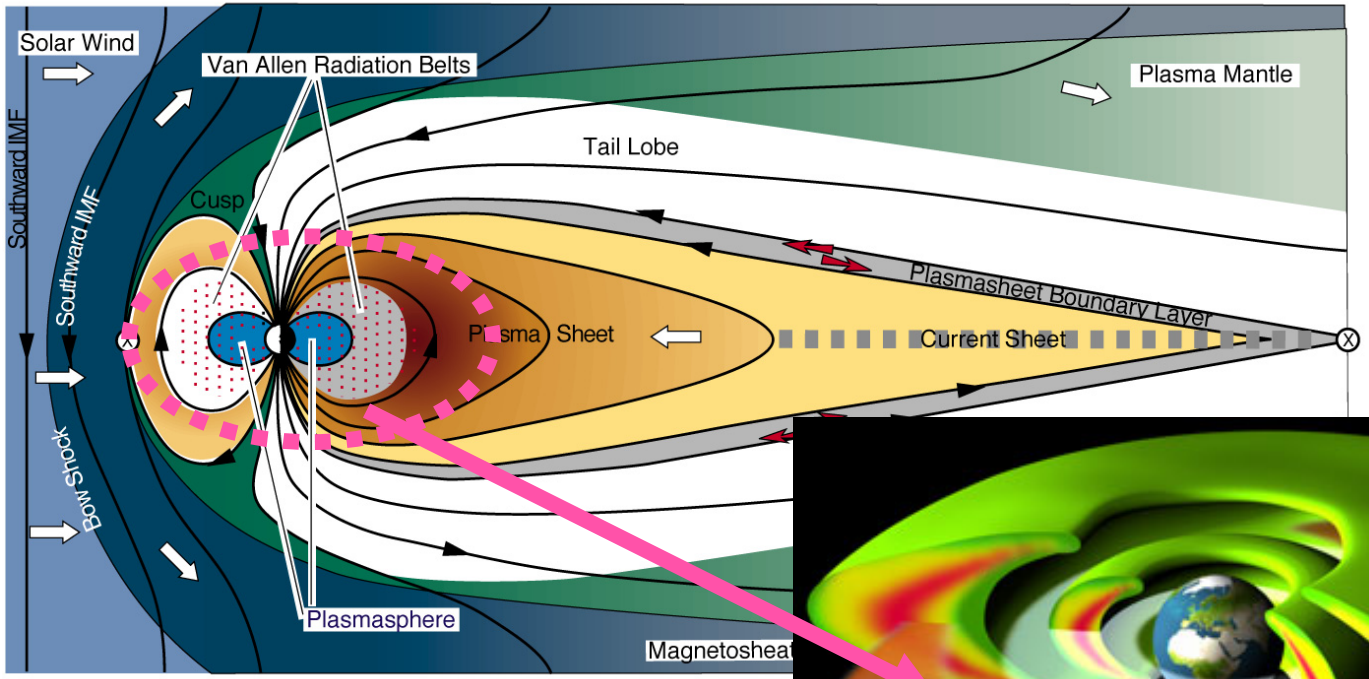
Magnetopause

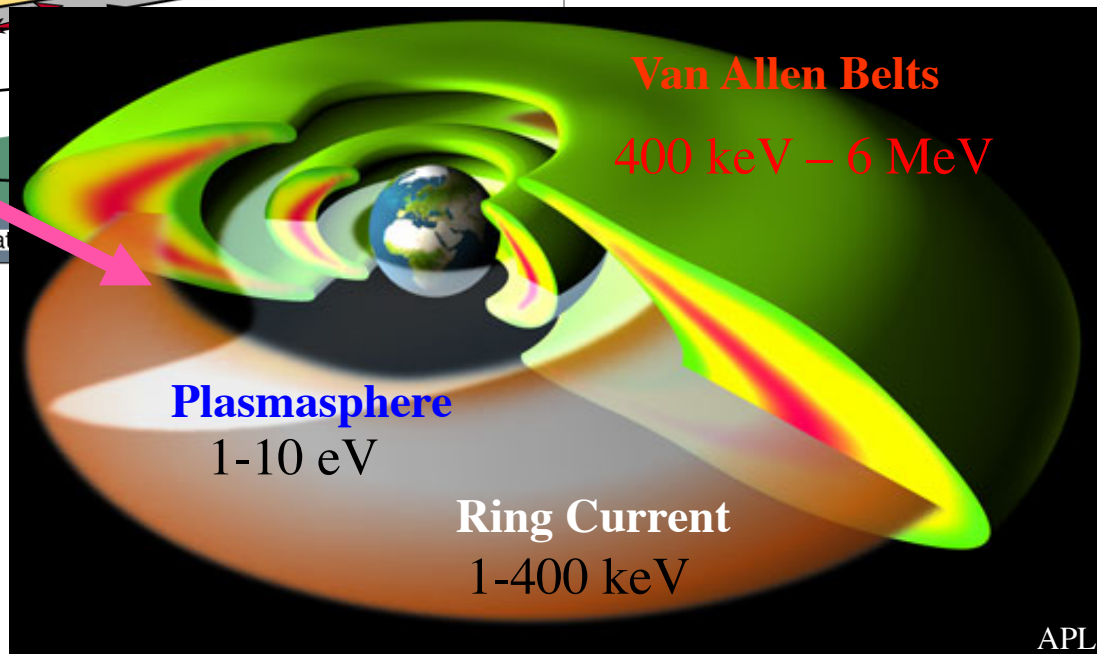


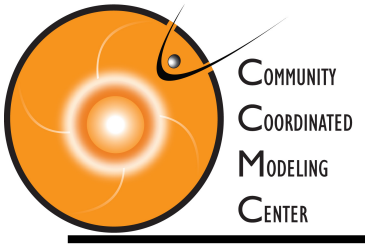


COMMUNITY COORDINATED MODELING CENTER

Inner Magnetosphere (up to ~ 10 RE)



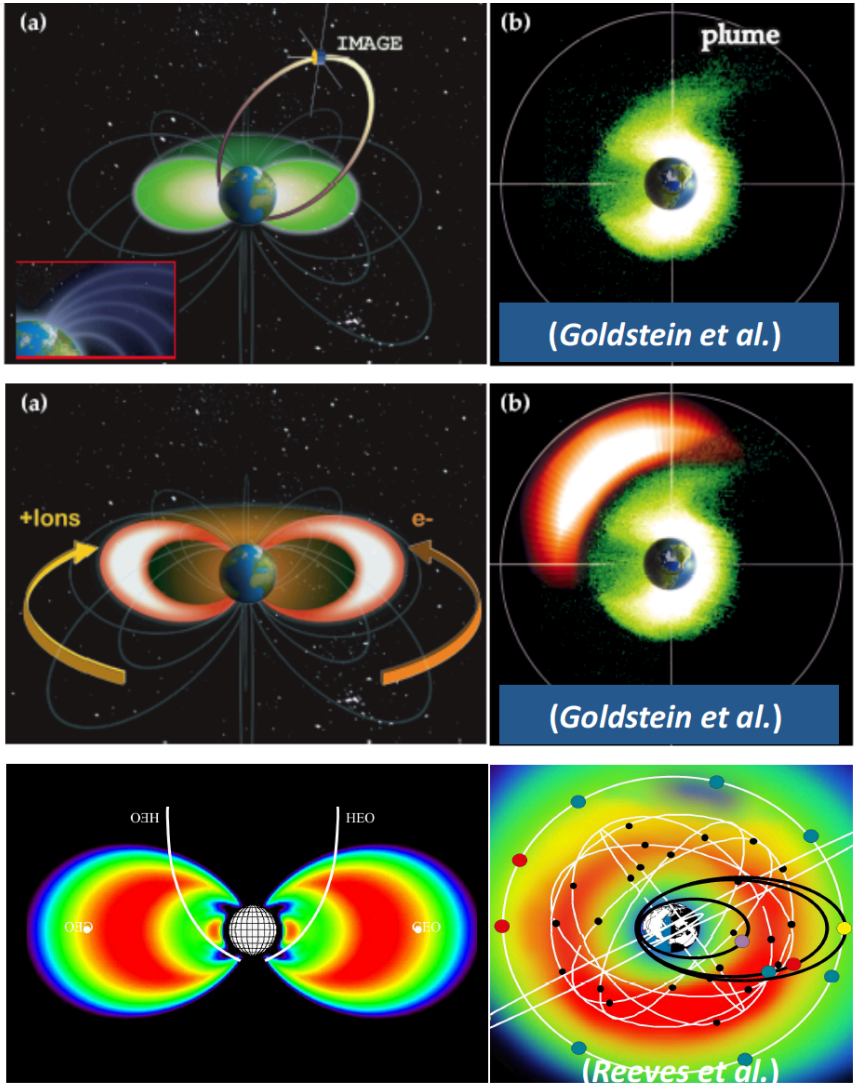




Inner Magnetosphere Plasmas

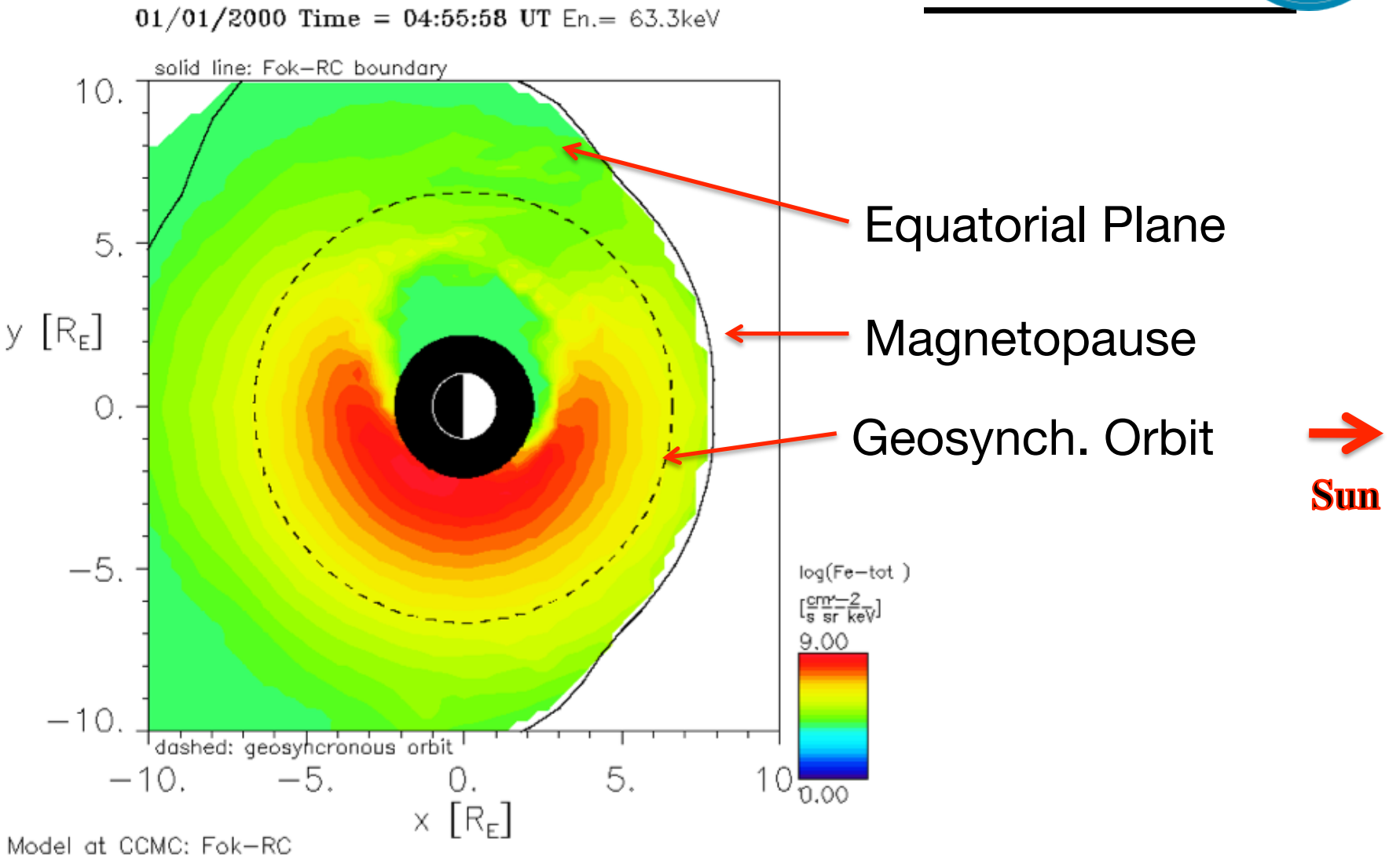
- Plasmasphere
  - 1-10 eV ions
  - ionospheric origin
- Ring current
  - 1-400 keV ions
  - both ionospheric and solar wind origin
- Outer radiation belt
  - 0.4-10 MeV electrons
  - magnetospheric origin

Inner magnetosphere: Gigantic Particle accelerator



COMMUNITY COORDINATED MODELING CENTER

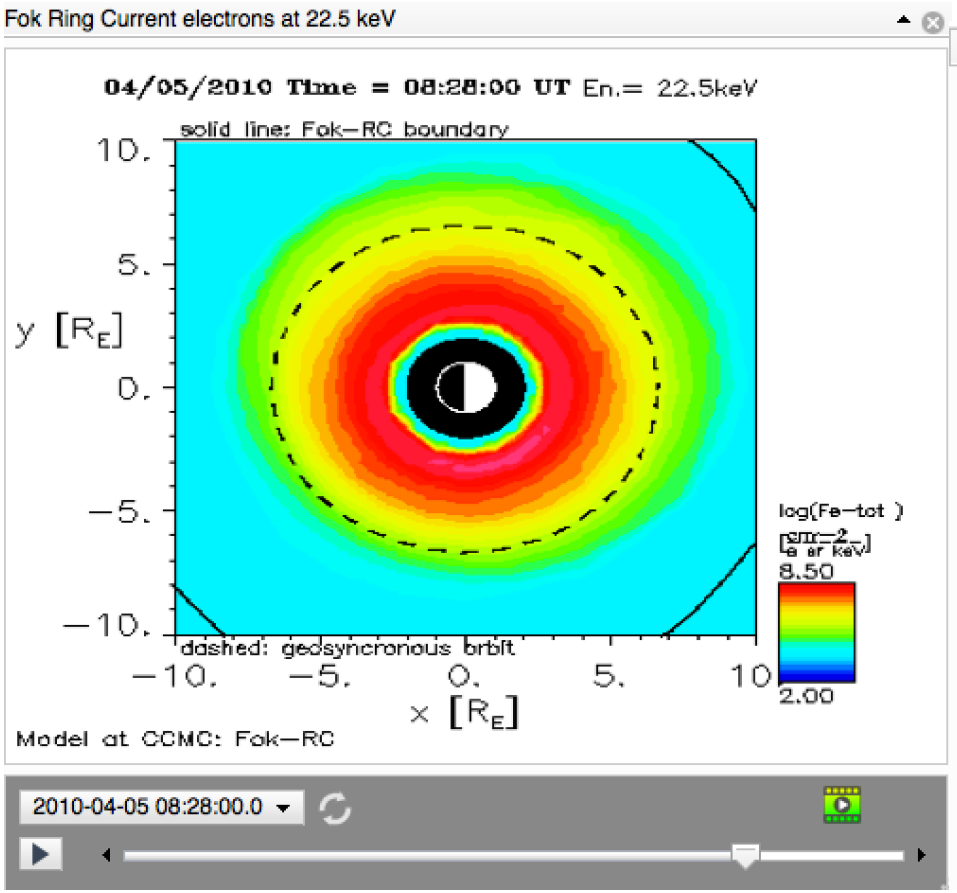
Electron Total Flux. Energy 63.3 keV. Color Contour

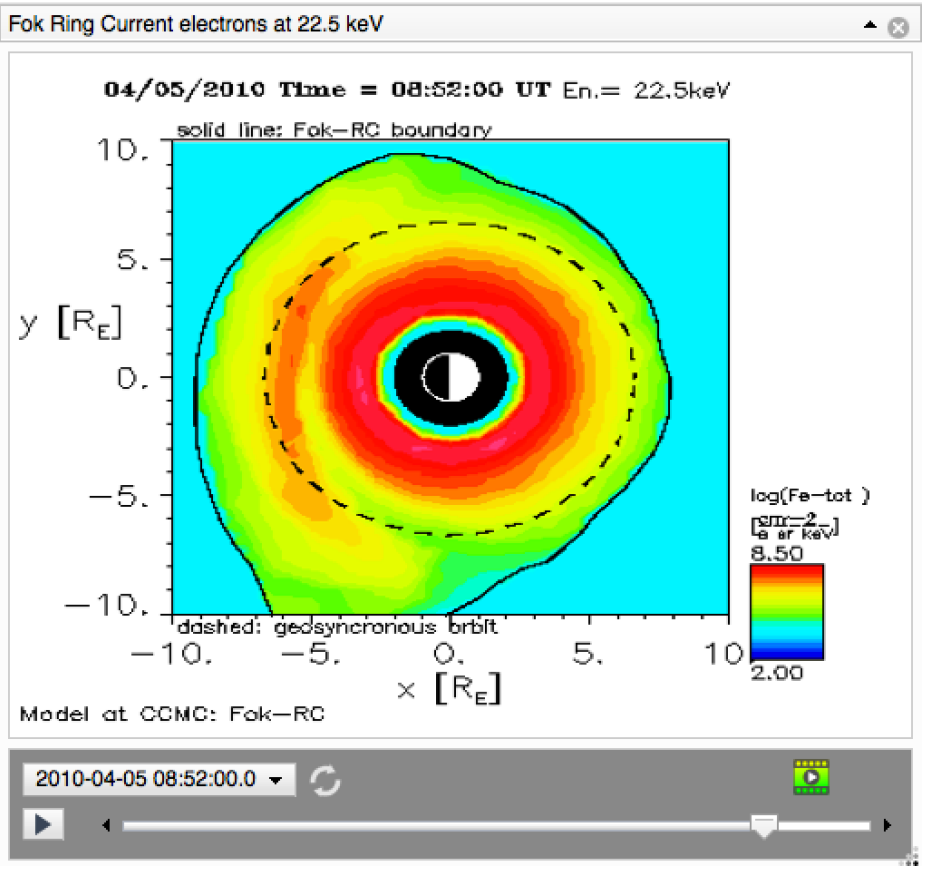


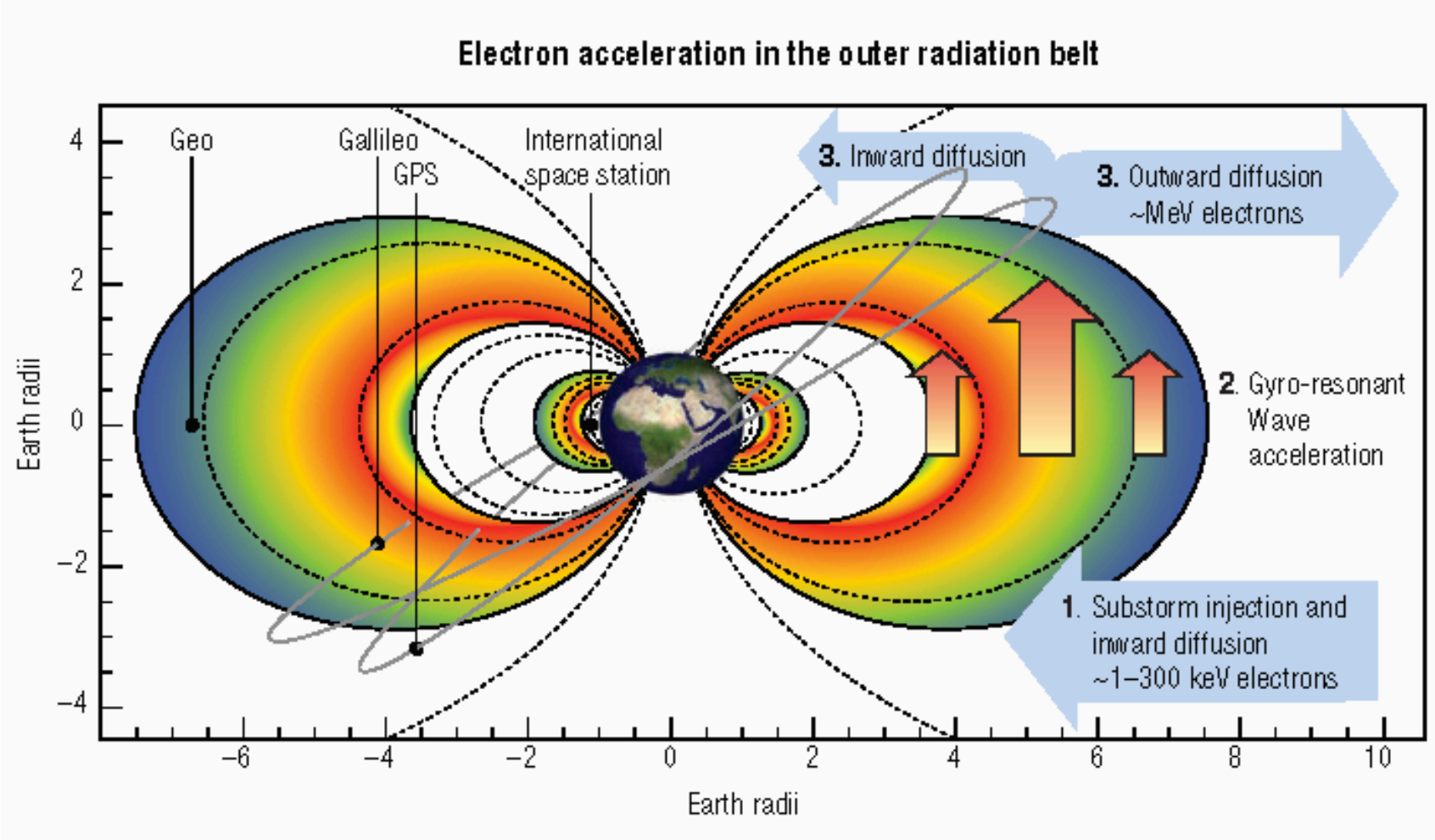
Earth radius

COMMUNITY COORDINATED MODELING CENTER

Ring Current:
Quiet vs. Active



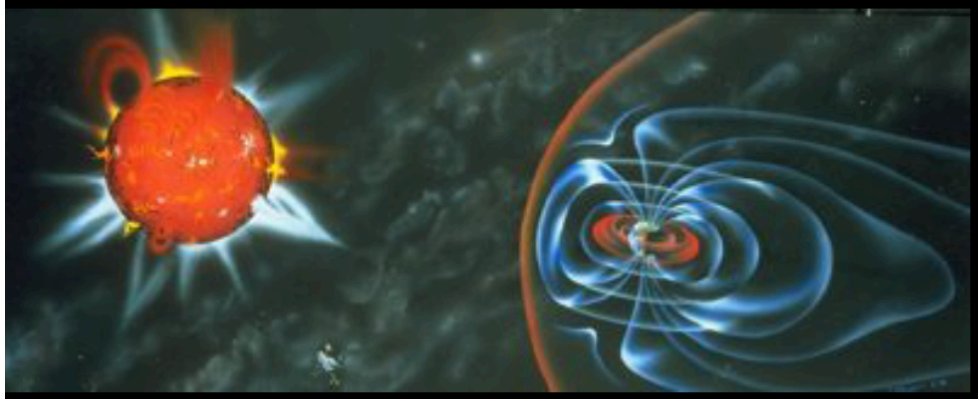




Horne et al., 2007, Nature Physics

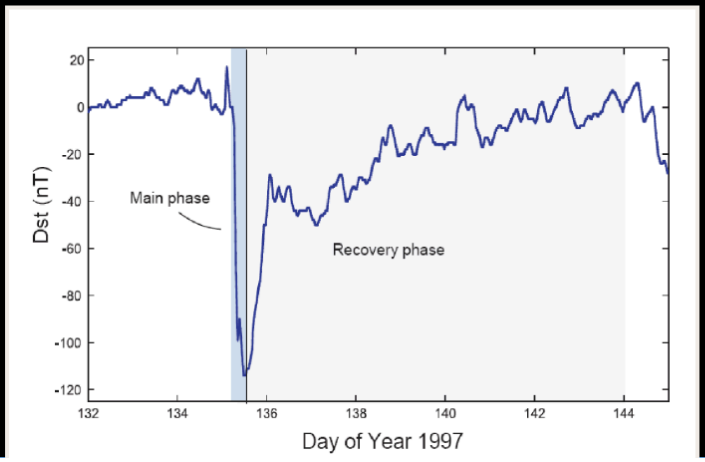
Community Coordinated Modeling Center

Magnetic Storms



- Most intense solar wind-magnetosphere coupling
- Associated with solar coronal mass ejections (CME), coronal holes HSS
- IMF Bz southward, strong electric field in the tail
- Formation of ring current and other global effects

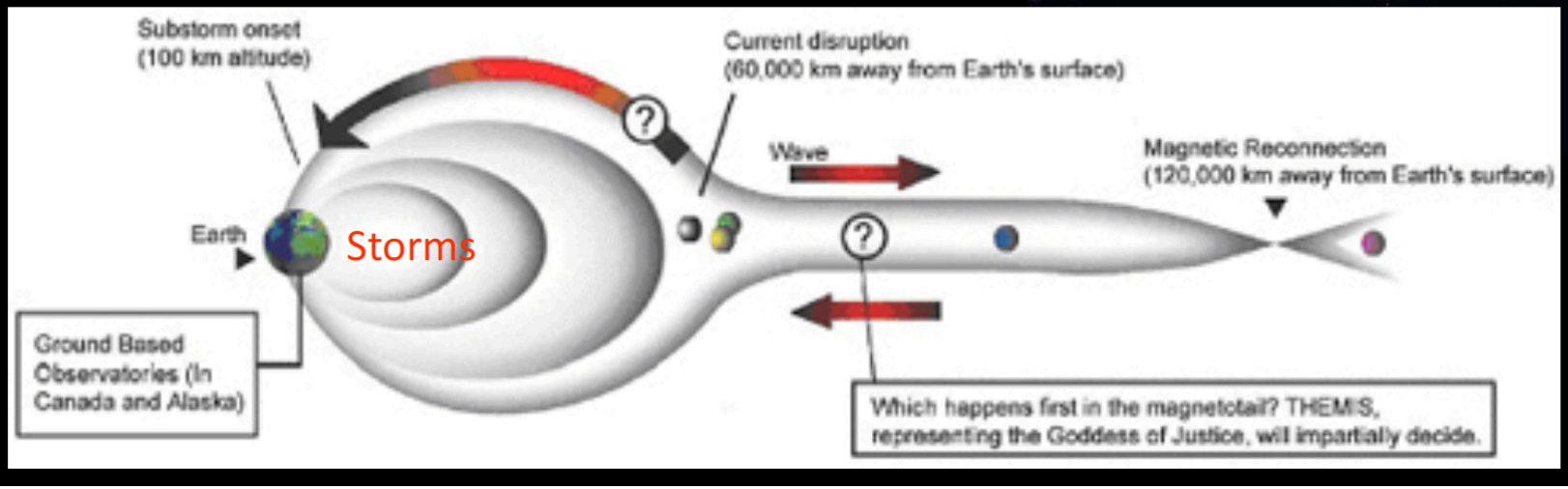
- Dst measures ring current development
  - Storm sudden commencement (SSC), main phase, and recovery phase
  - Duration: days



Community Coordinated Modeling Center

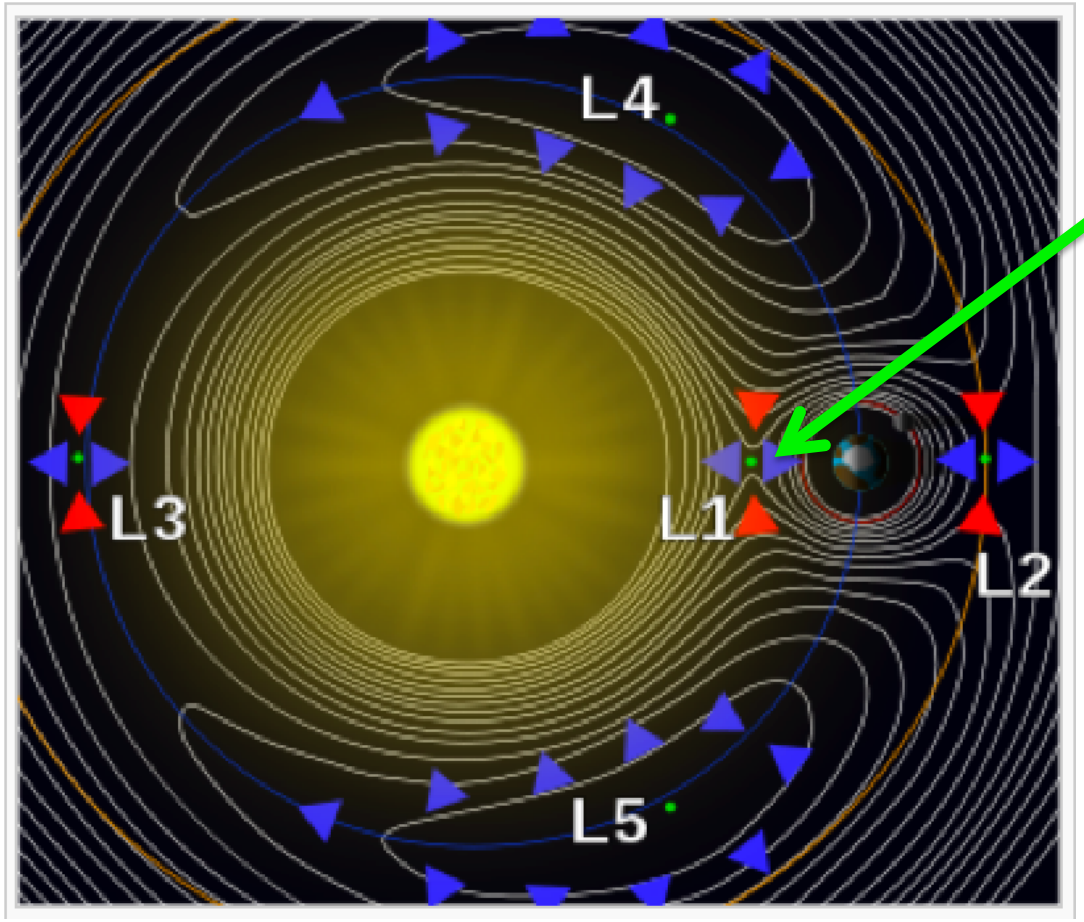
Substorms

- Instabilities that abruptly and explosively release solar wind energy stored within the Earth's magnetotail.
- manifested most visually by a characteristic global development of auroras
- Last ~ hours



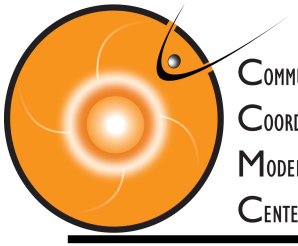
Community Coordinated Modeling Center

Lagrange Point – L1

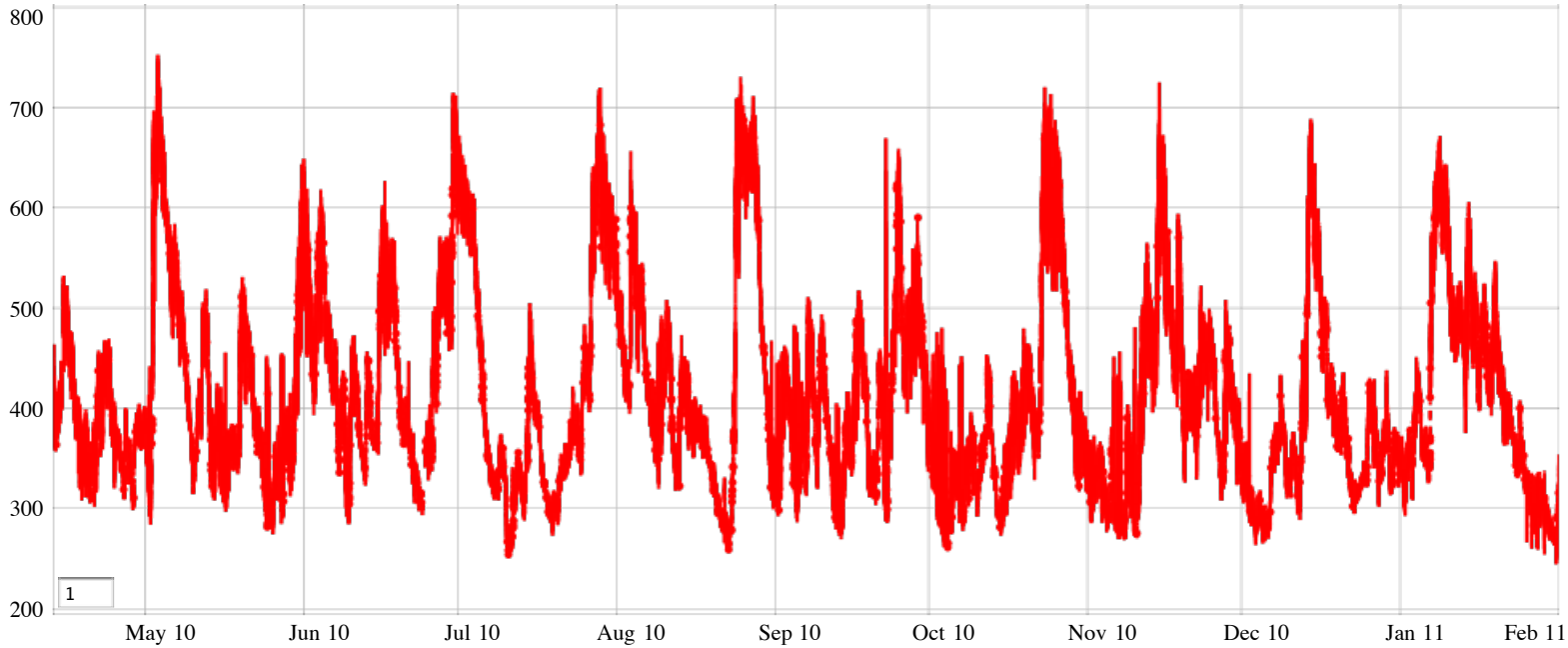


Advanced
Composition
Explorer

L1 (Solar Wind Monitor ACE location): ~ 200 R_E sunward
You can fit 1 Sun between the Earth and L1.
2 R_S (Solar diameter) ~ 220 R_E



Solar Wind Speed at ACE

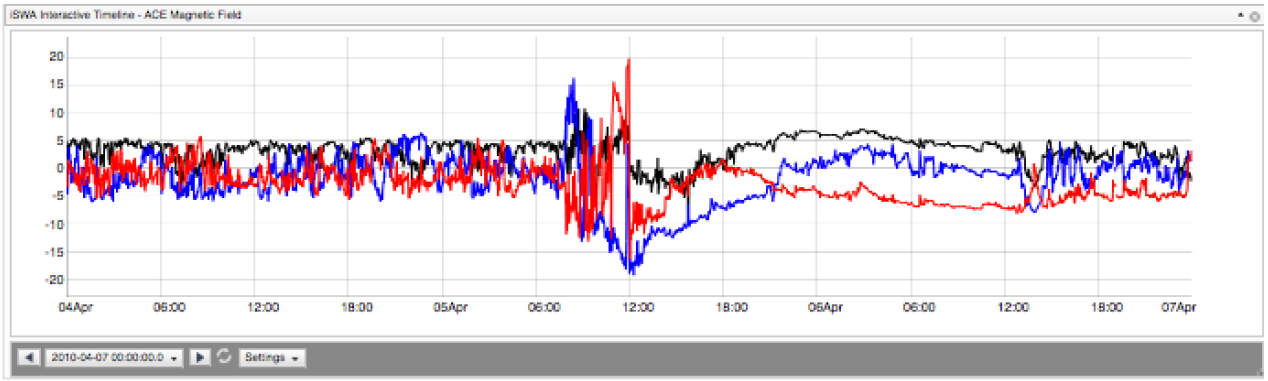


☑ Bulk Speed **Zoom:** In Out full **Pan:** left right

Community Coordinated Modeling Center

Solar Wind Parameters at ACE

on 04/05/2010



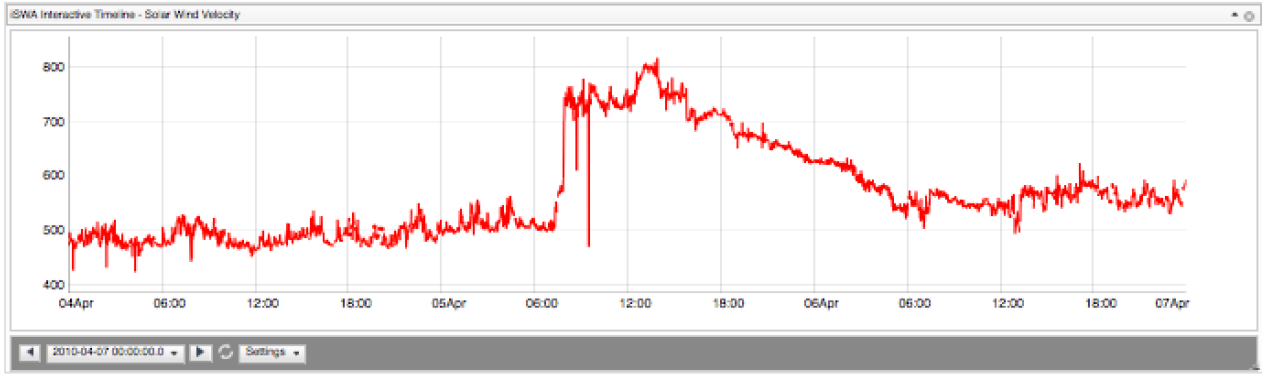
nT

Magnetic field

B_x, B_y, B_z

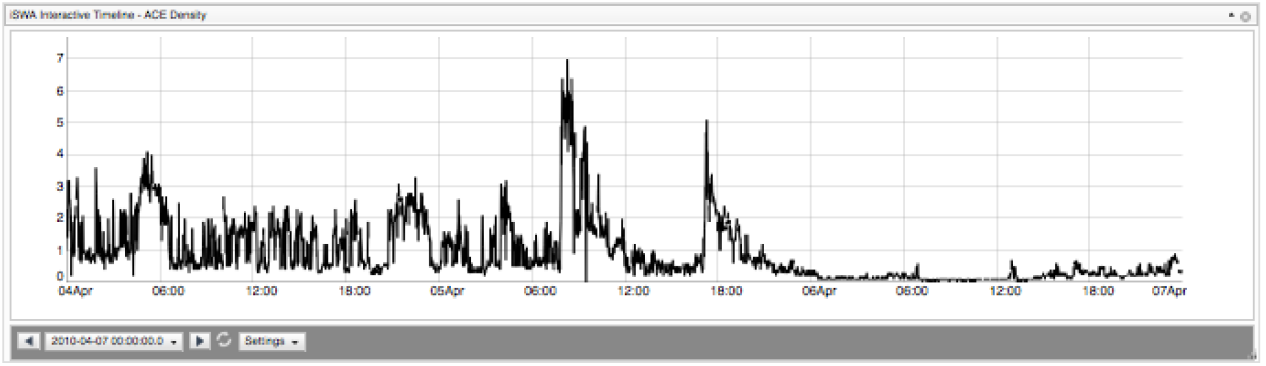
X: Earth to Sun

Z: North to South



km/s

Velocity



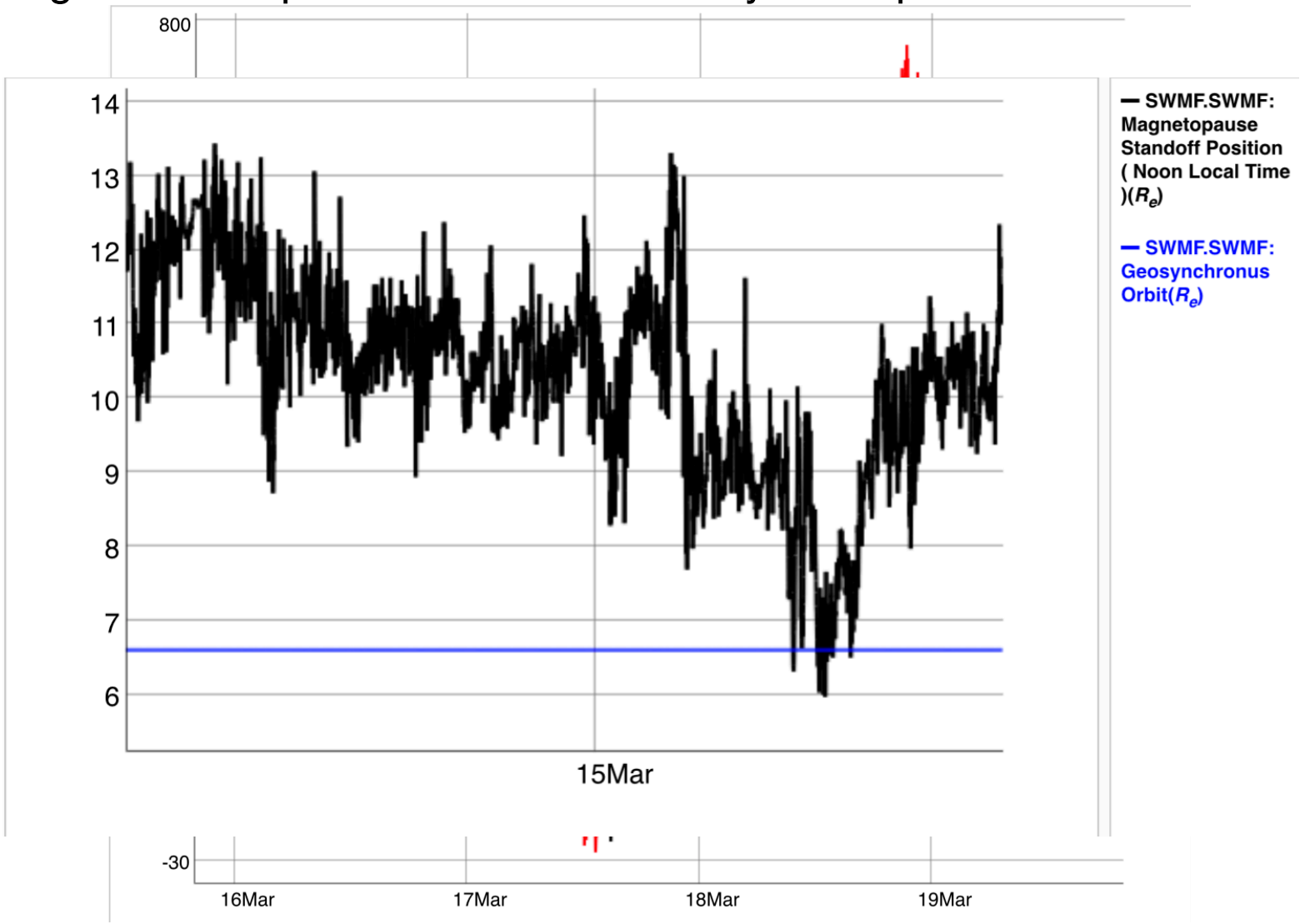
part/cm^3

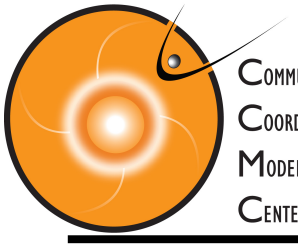
Density

Community Coordinated Modeling Center

Magnetopause Stand-off Distance

Degree of compression of MP due to dynamic pressure of solar wind

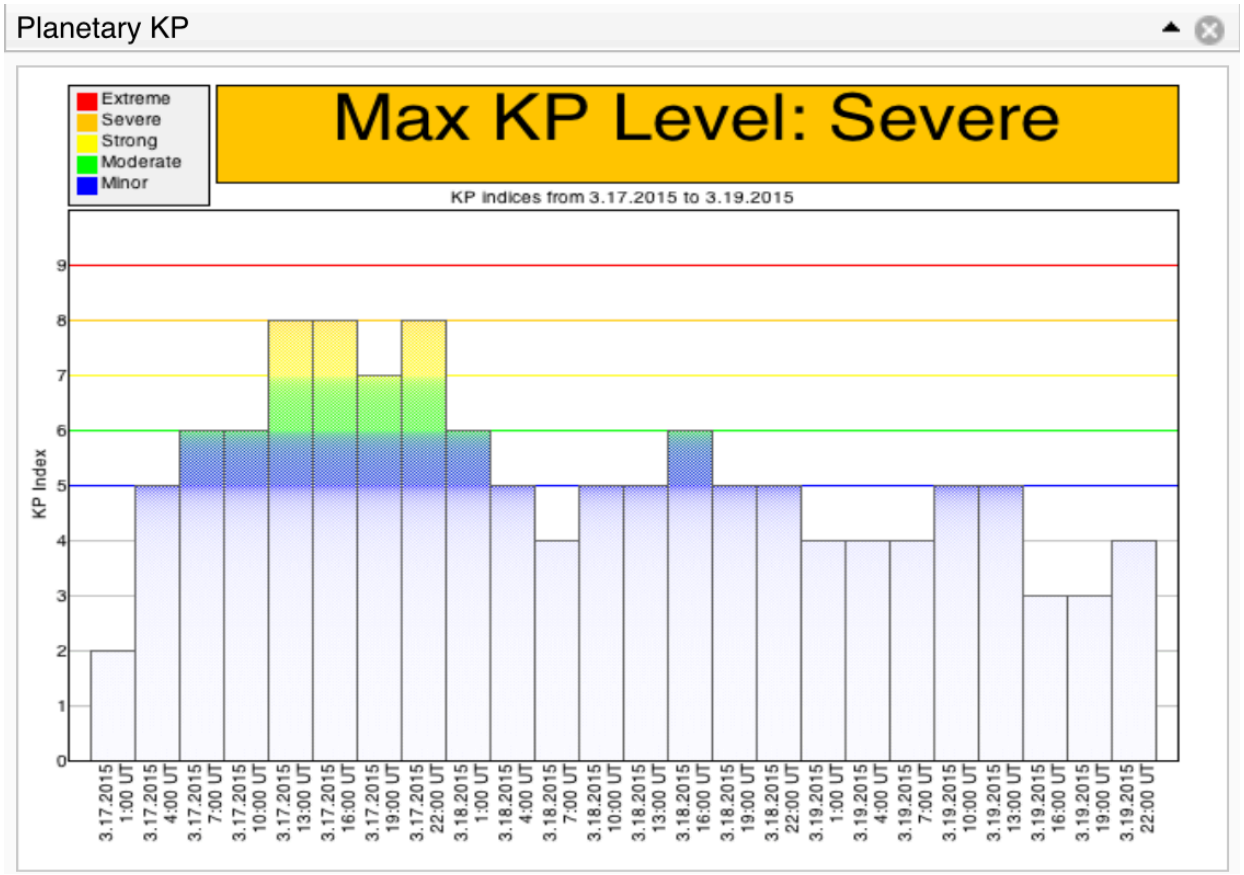




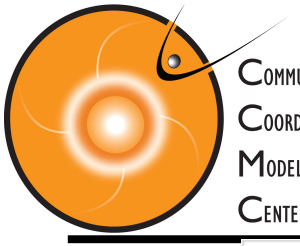
Kp index

"*p*lanetarische *K*ennziffer" (= planetary index).

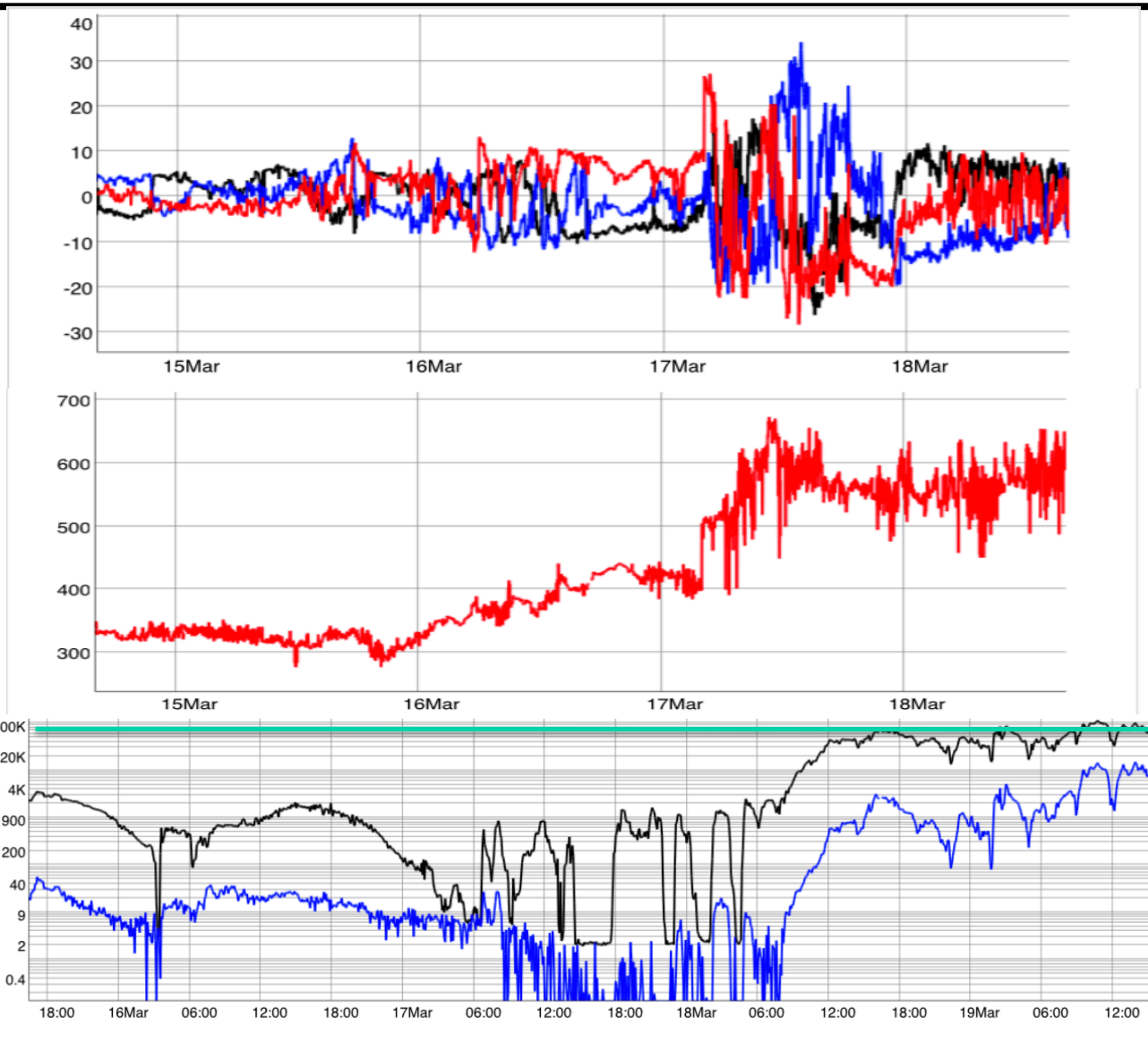
- Geomagnetic activity index - range from 0-9
  disturbance levels of magnetic field on the ground – currents



Threshold
Kp>=6



HSS and Radiation Belt Electron Flux Enhancement



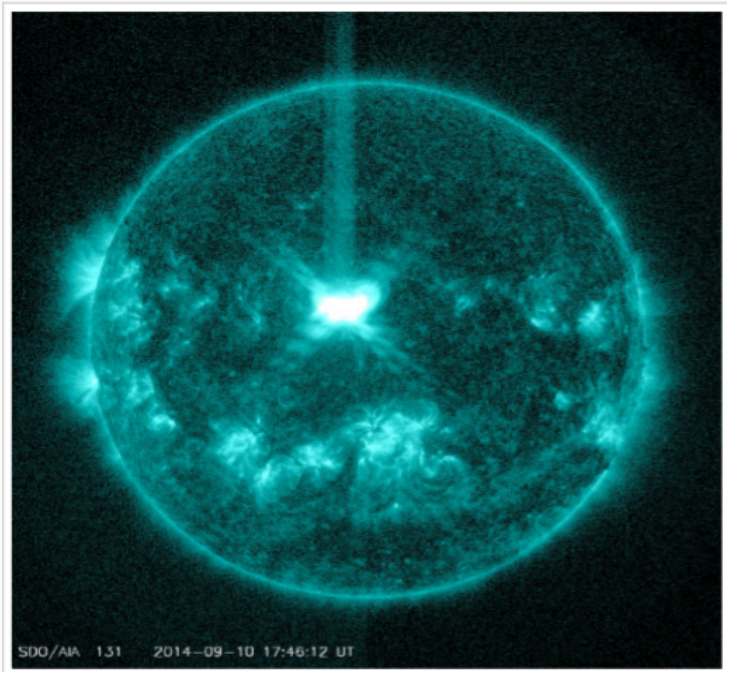
Energetic Proton Flux

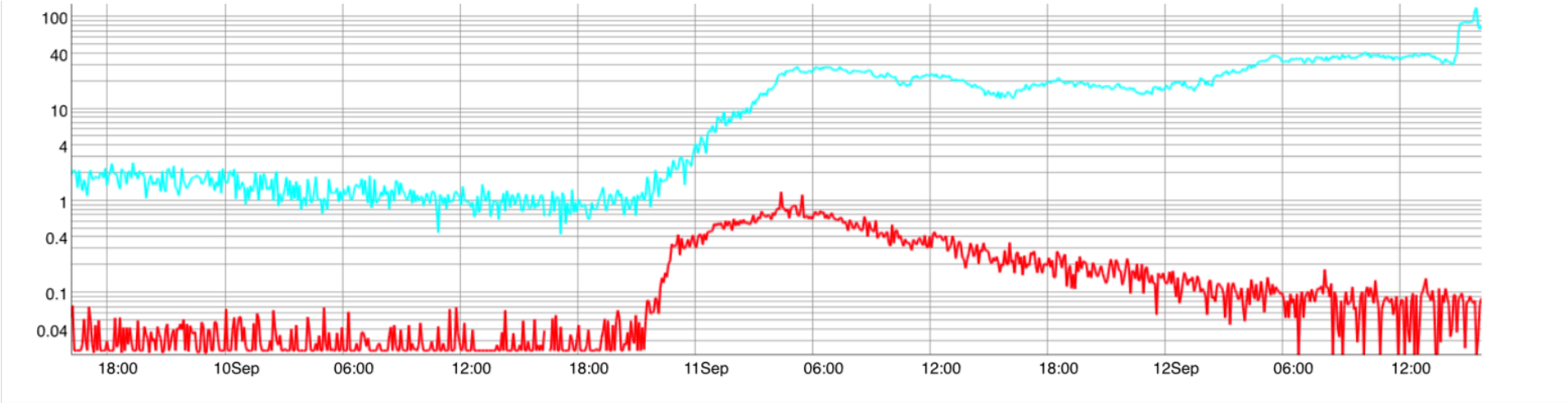
- >10 MeV flux by GOES spacecraft

Threshold: 10 pfu

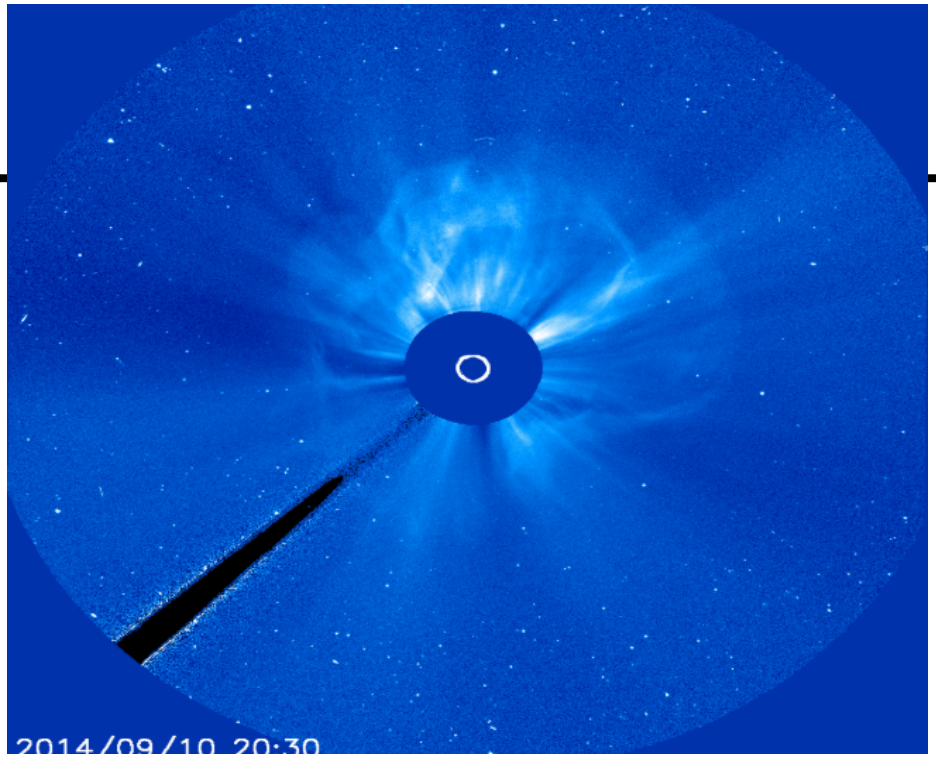
- >100 MeV flux by GOES spacecraft

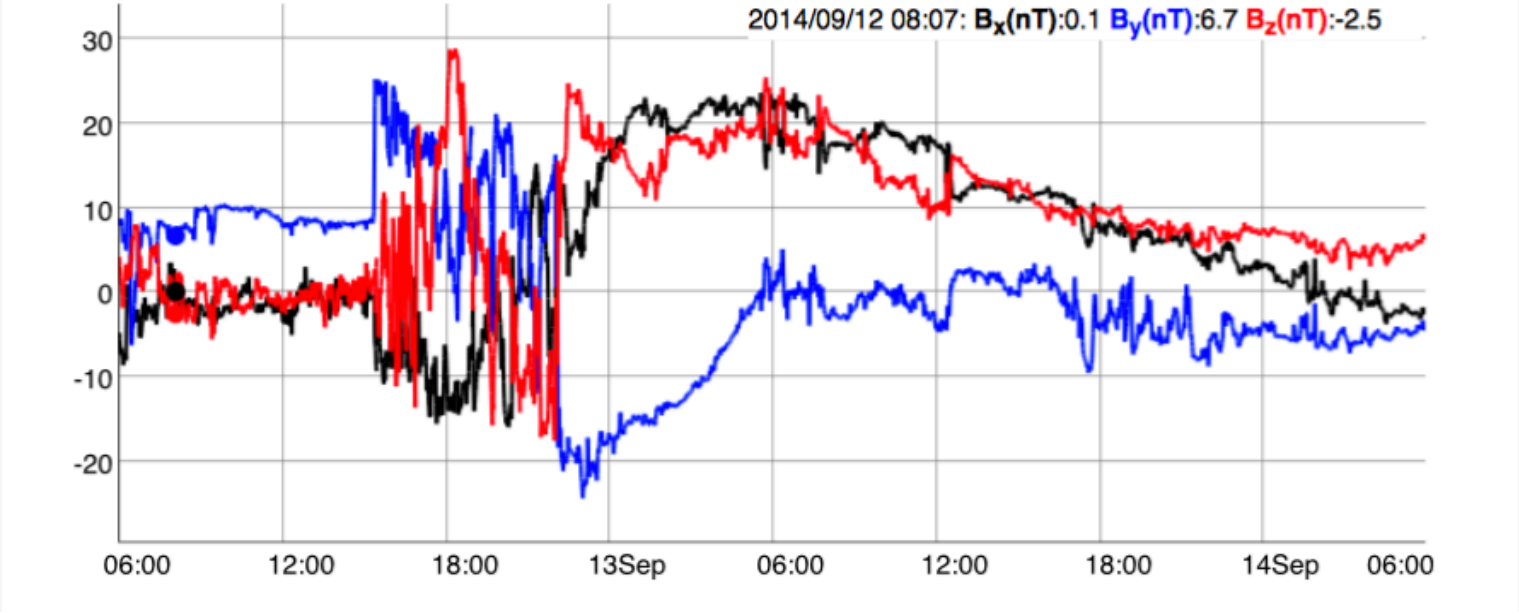
Threshold: 1 pfu

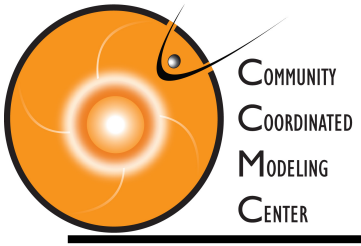




Community Coordinated Modeling Center

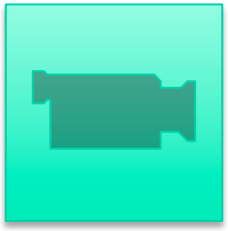


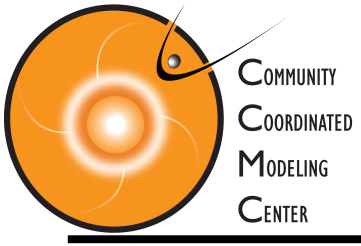




Watch the video

http://missionscience.nasa.gov/sun/sunVideo_04magnetosphere.html





iSWA Layout:
07/12/2012

http://goo.gl/V0JjxV