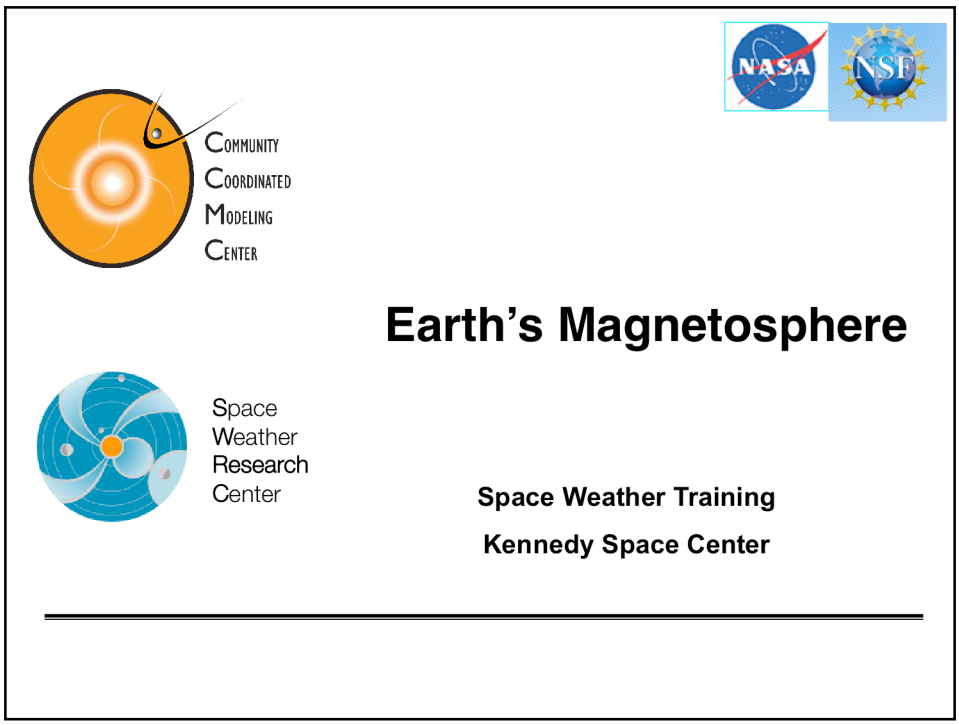
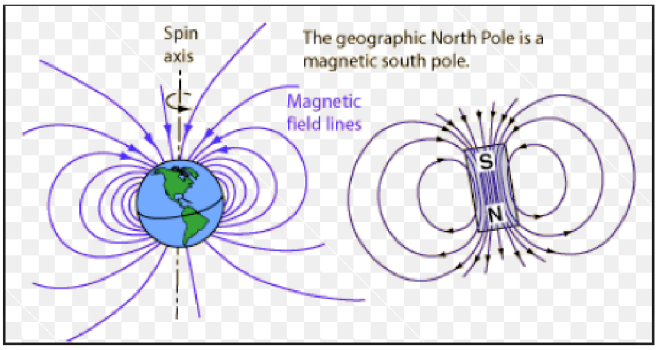


In this presentation I will be talking about the Sun and its activity in relations to the space weather

(http://iswa3.ccmc.gsfc.nasa.gov/wiki/index.php/Glossary/_space_weather)

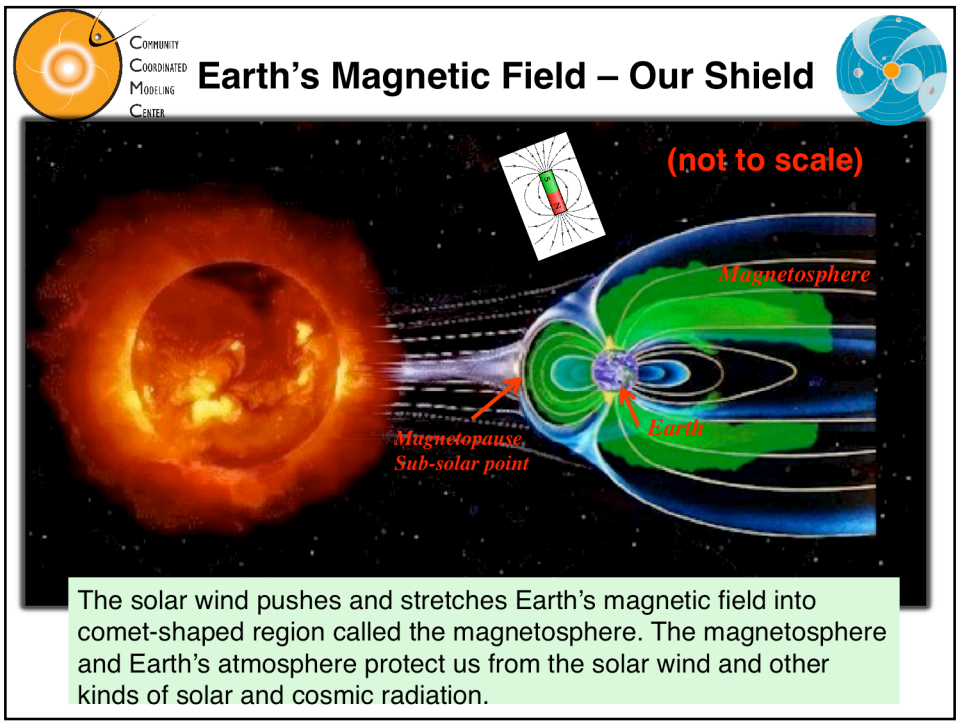
Magnetic Field of the Earth



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.

The Earth's magnetic field is similar to that of a bar magnet tilted 11 degrees from the spin axis of the Earth.

The magnitude of the magnetic field varies over the surface of the Earth in the range 0.3 to 0.6 Gauss.



The solar wind pushes and stretches Earth's magnetic field into a vast, 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.

Solar wind – Earth's magnetic field field interaction flatten the nose (dayside – towards the sun) and drag field lines to the tail (night-side – away from the sun).

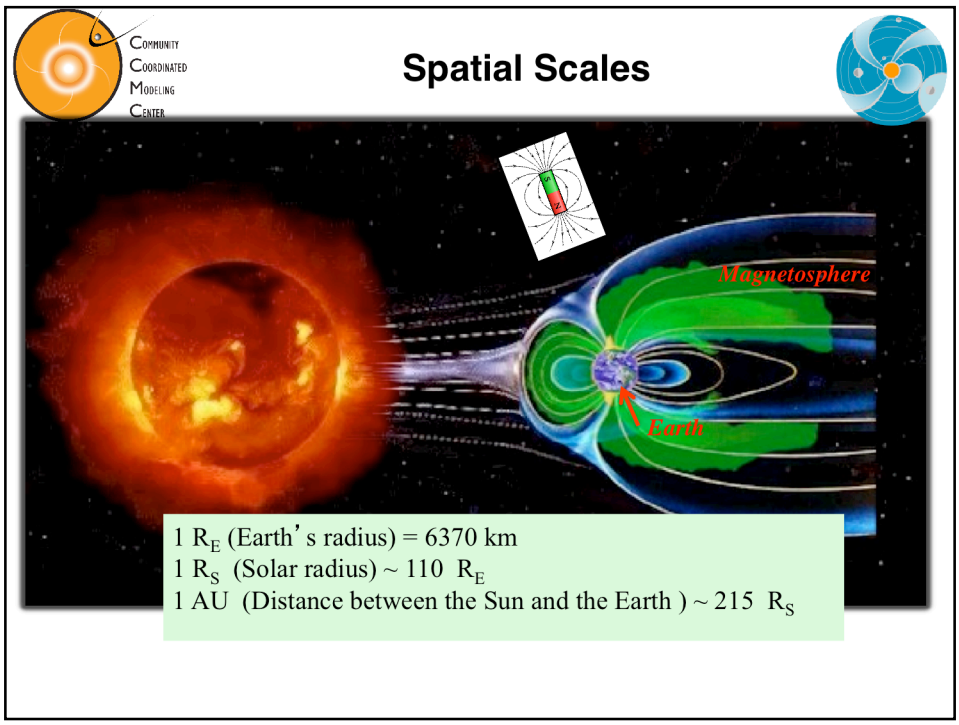
The magnetopause separates Earth's magnetic domain from the solar wind and its embedded interplanetary field (IMF).

The three-dimensional location of the magnetopause represents a balance of pressures: Pressures of solar-origin (predominantly solar wind flow ram pressure) balance pressures of Earth-origin (predominantly outward magnetic pressure) at the magnetopause.

The magnetic field is the shield that protects the Earth from the solar plasma particles because they have difficulty in moving across the magnetic field lines.

If the Earth did not have the magnetic field, continuously blowing solar wind and CMEs would most likely wipe out all the life forms on the Earth. Scientists speculate that something like this could have happened on Mars, who lost its magnetic field over the time.

The Sun-Earth line cross the magnetopause at the Sub-solar point. Magnetopause stand-off distance is the distance to the magnetopause sub-solar point.



Distances in Solar Corona are expressed in Solar radii: 1 – 20 R_S

Solar radius is approximately 100 times larger than the Earth's radius.

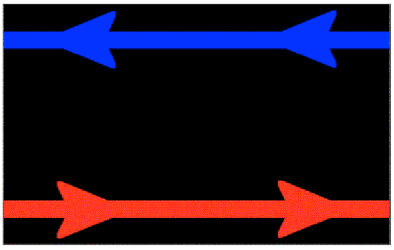
Distances in magnetosphere are expressed in Earth radii.

During quit solar wind conditions the sub-solar point of the magnetosphere boundary is at about 10 R_E from the Earth.

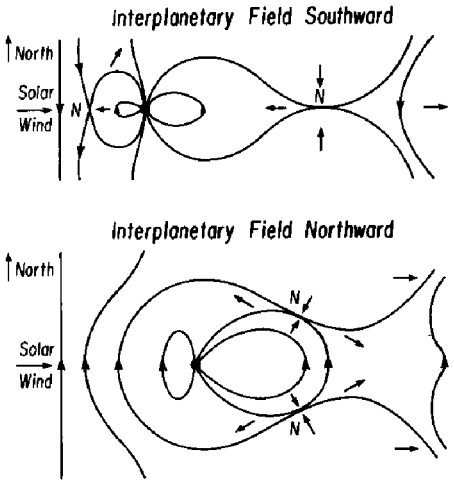
The tail width is about 30-40 $R_{E,}$ The tail length is 1000s R_E

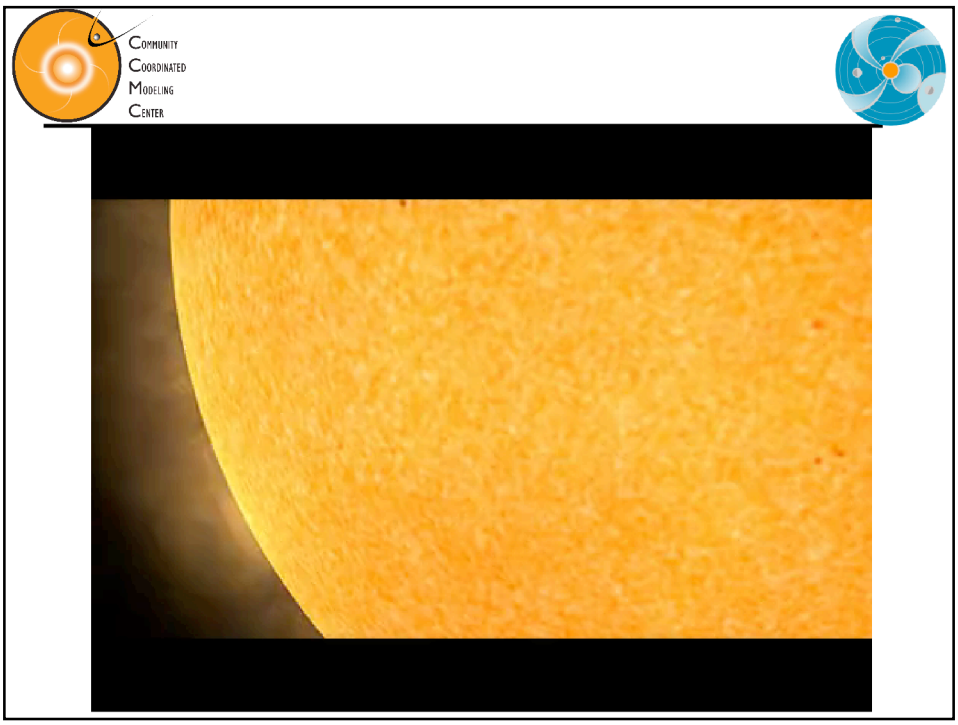
The distance to the moon is about 60 $R_{E,}$

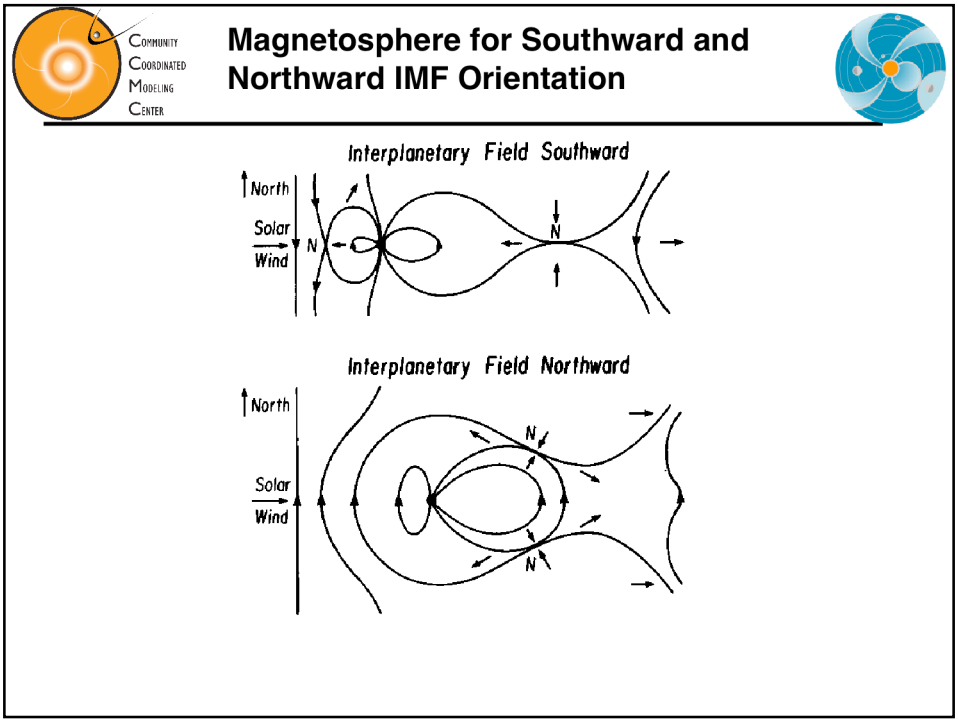
Magnetosphere for Southward and Northward IMF Orientation



Magnetic Reconnection

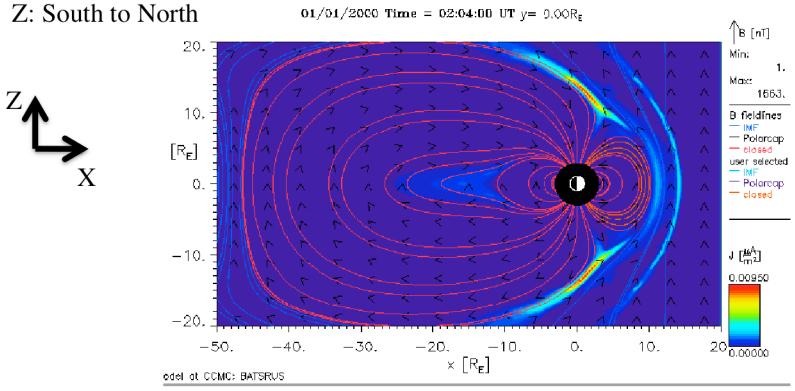



Community
Coordinated
Modeling
Center


Community Coordinated Modeling Center
Magnetosphere for Southward and Northward IMF Orientation
Interplanetary Field Southward
North
Solar Wind
N
N
Interplanetary Field Northward
North
Solar Wind
N
N

Magnetosphere:
Northward IMF

X: Earth to Sun
Z: South to North



Z
X

Sun

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

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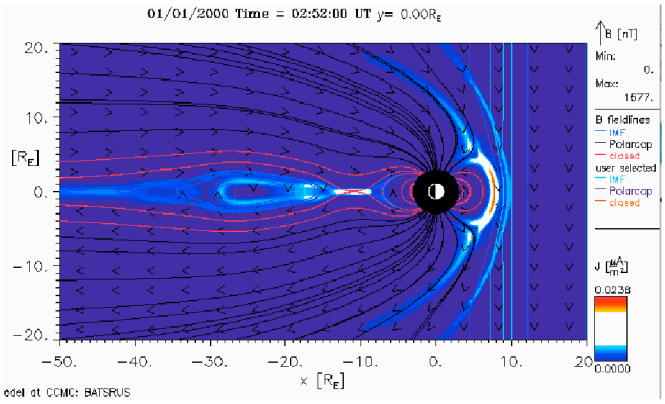
Magnetosphere:
Southward IMF



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

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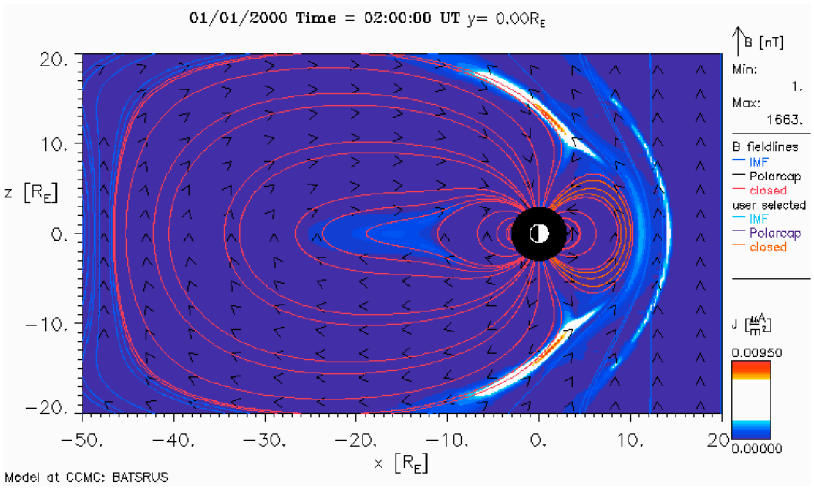
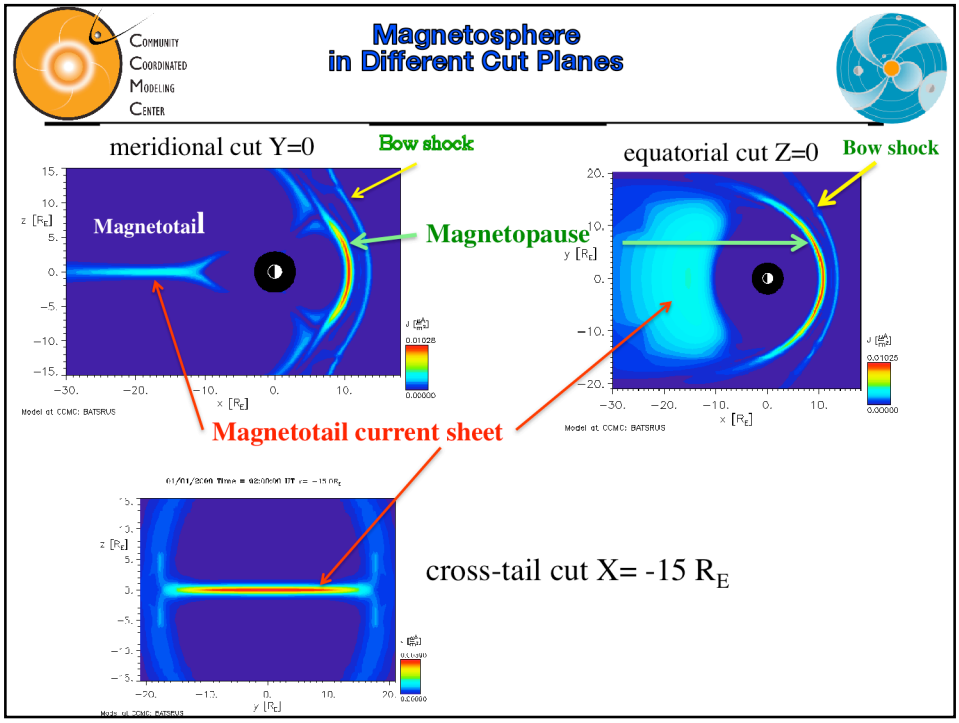
Magnetosphere:
North to South Turning

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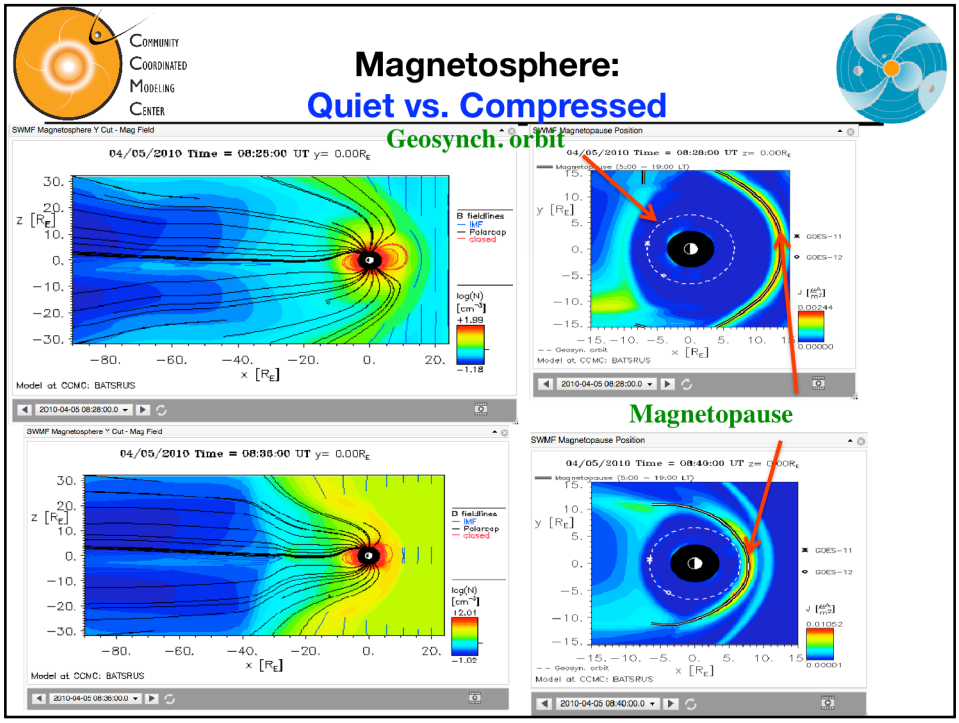
Magnetosphere in Different Cut Planes
meridional cut Y=0
Bow shock
Magnetotail
Magnetopause
equatorial cut Z=0
Bow shock
Magnetotail current sheet
cross-tail cut X= -15 R_E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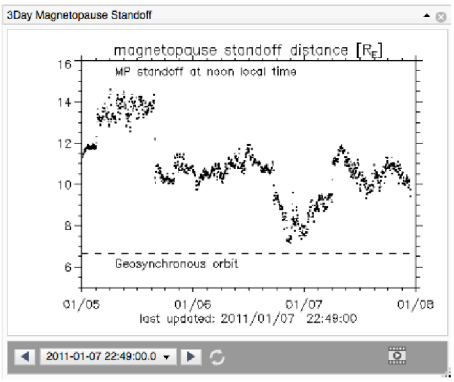
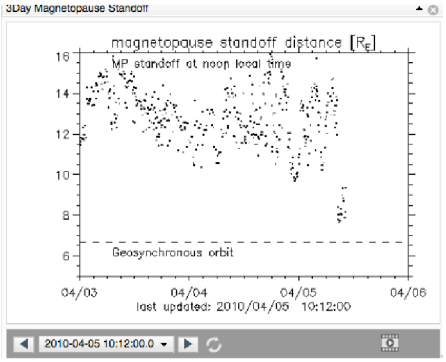
Magnetosphere:
Quiet vs. Compressed
Geosynch. orbit
Magnetopause
SWMF Magnetosphere Y Cut - Mag Field
04/05/2010 Time = 08:25:00 UT y= 0.00R_E
SWMF Magnetopause Position
04/05/2010 Time = 08:28:00 UT z= 0.00R_E
SWMF Magnetosphere Y Cut - Mag Field
04/05/2010 Time = 08:35:00 UT y= 0.00R_E
SWMF Magnetopause Position
04/05/2010 Time = 08:40:00 UT z= 0.00R_E
B fieldlines
IMF
Polarcap
closed
log(N) [cm^-3]
GOES-11
GOES-12
Model at CCMC: BATSRUS
Geosyn. orbit
x [R_E]
y [R_E]
z [R_E]

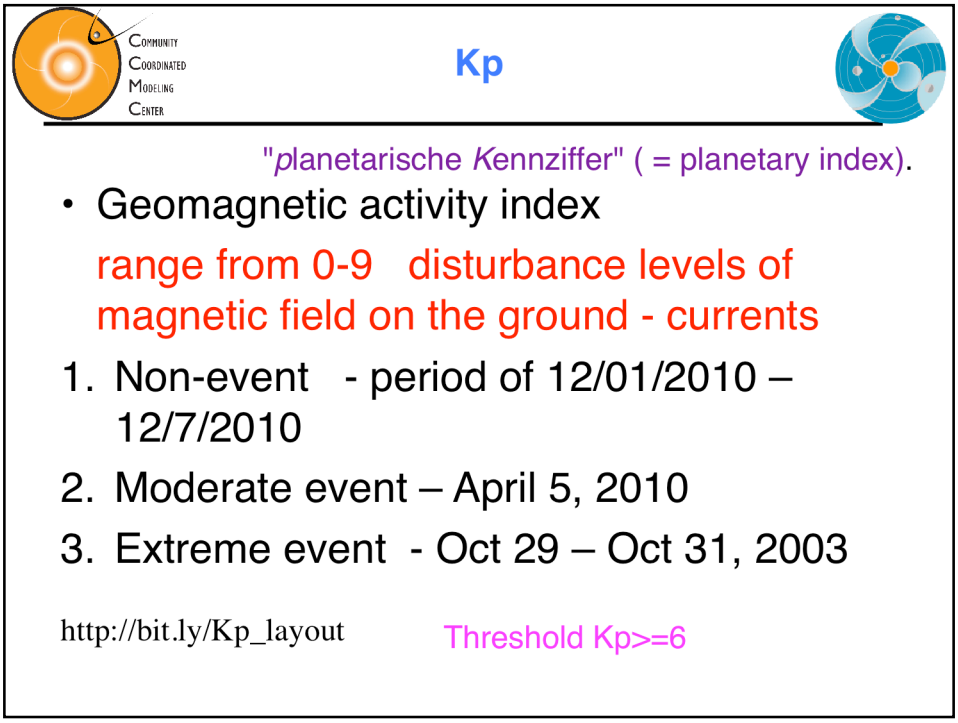
Magnetopause Stand-off Distance

Degree of compression of MP
Due to Pdyn of solar wind
(interplanetary shock or HSS)

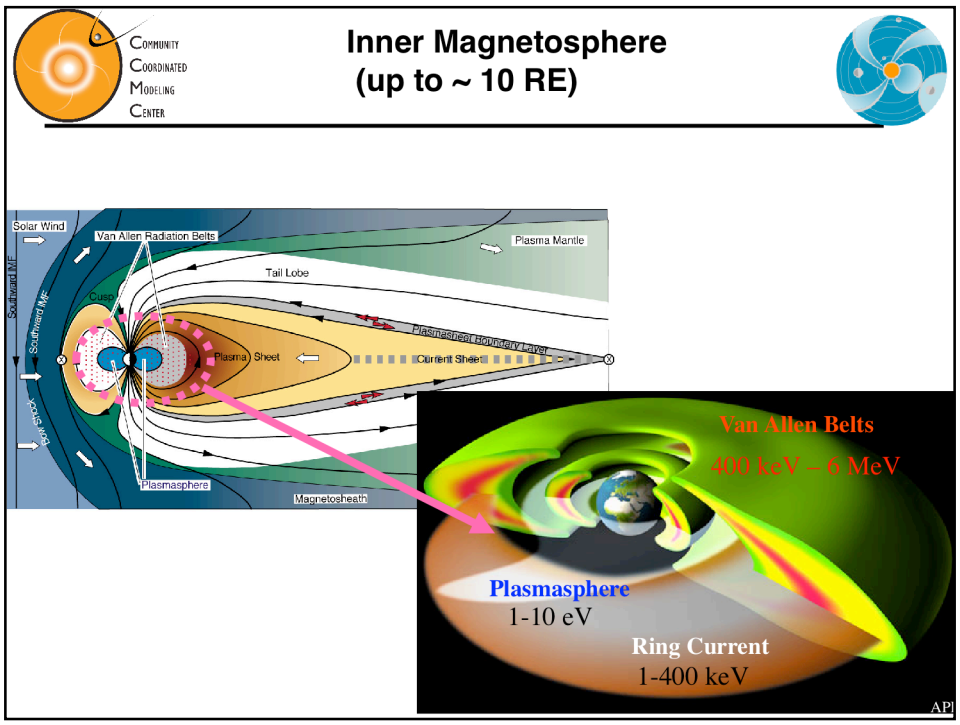
r0 <=6.6 Re – model product
Events: Apr 5, 2010,
Dec 28, 2010
Jan 6, 2011, 22:30 UT
Non-event: Dec 1 – 7, 2010







The Kp index indicates the magnitude of geomagnetic disturbance on a 0-9 scale, with zero being very quiet and 9 indicating a major geomagnetic storm. The index has a three-hour cadence. Higher values of Kp are associated with geomagnetic storming

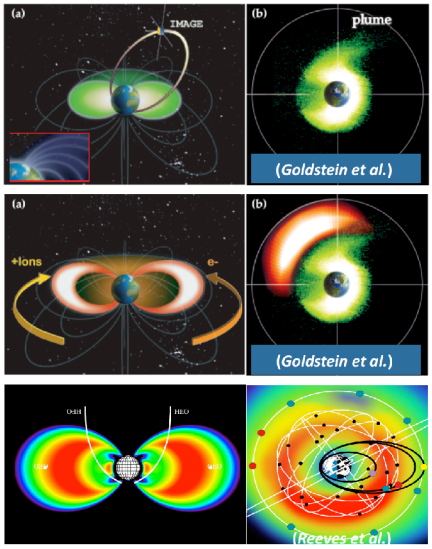


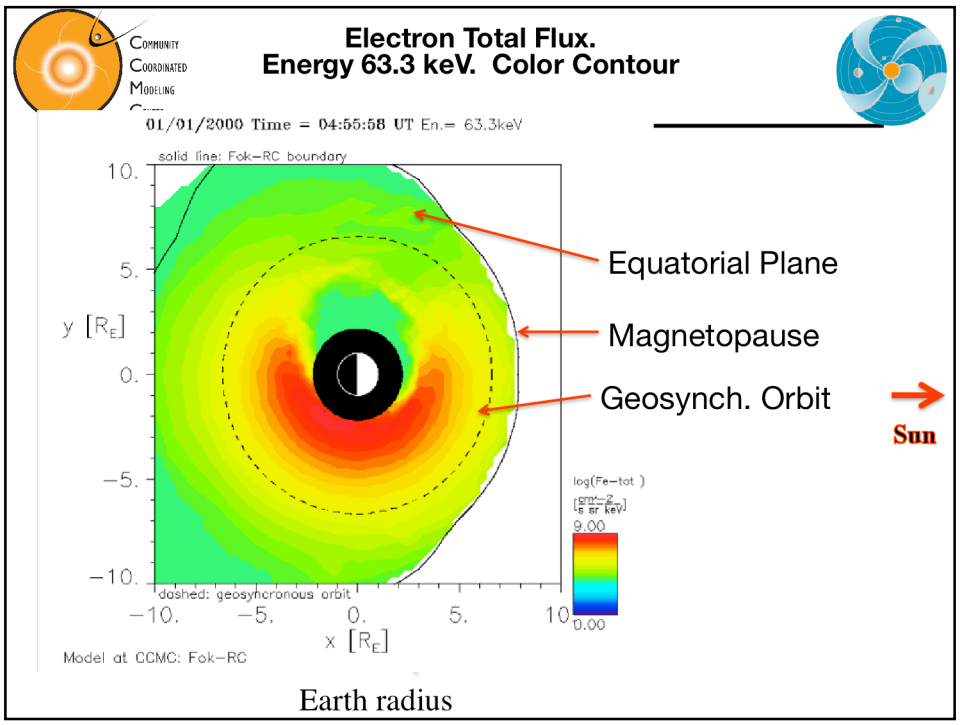
1 nT = 10^{-5} Gauss

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





Earth radius

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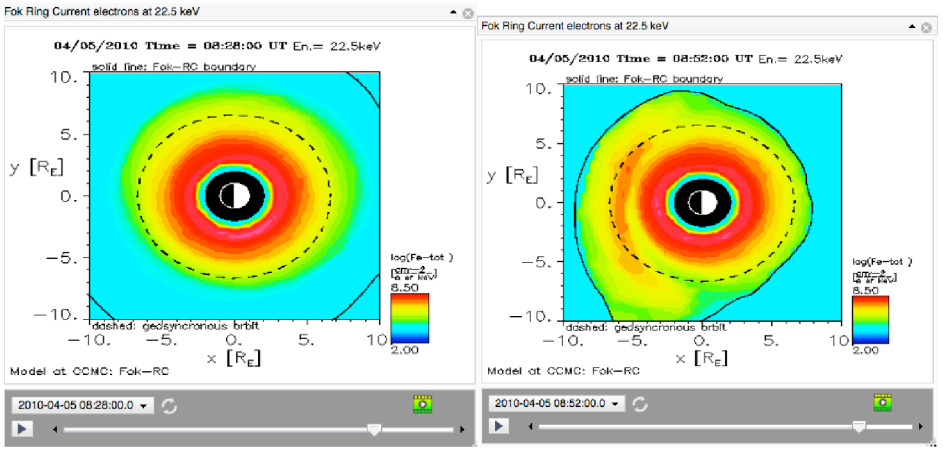
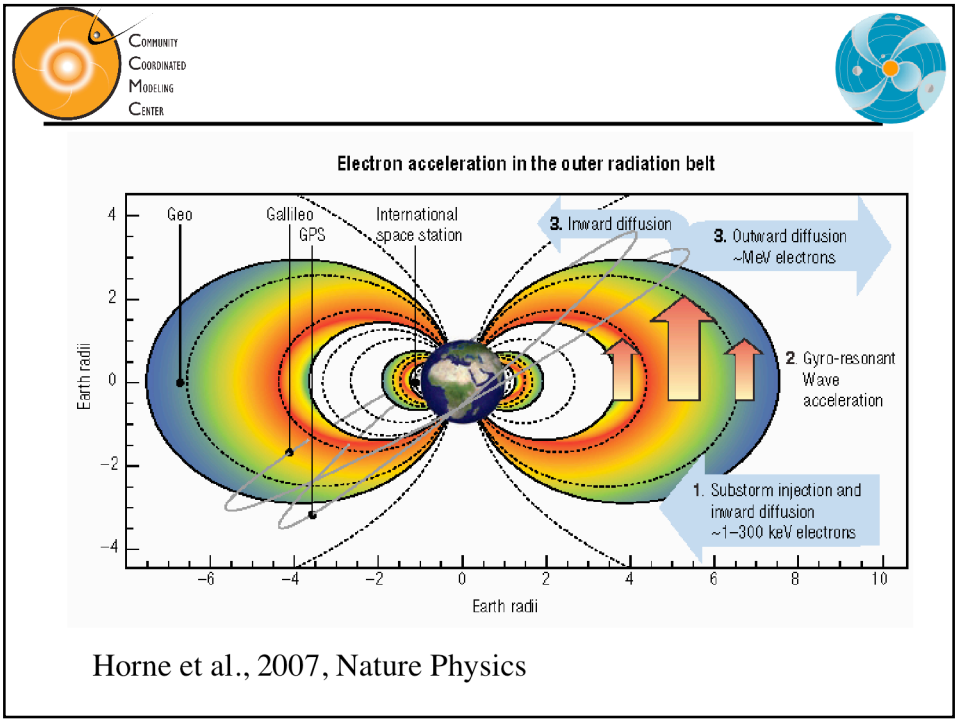
Ring Current:
Quiet vs. Active





Horne et al., 2007, Nature Physics

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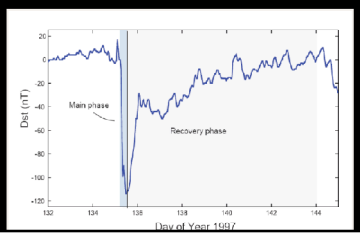
Magnetic Storms

- 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



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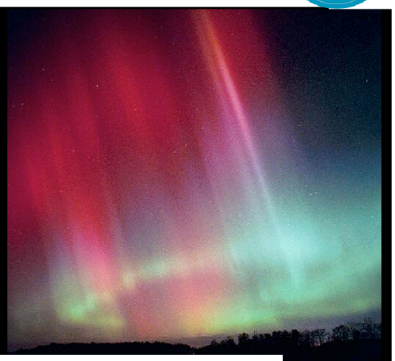
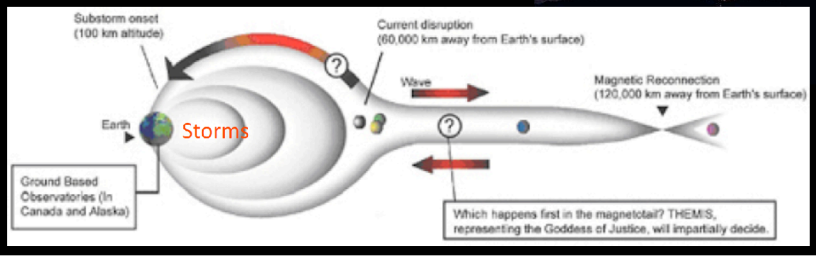
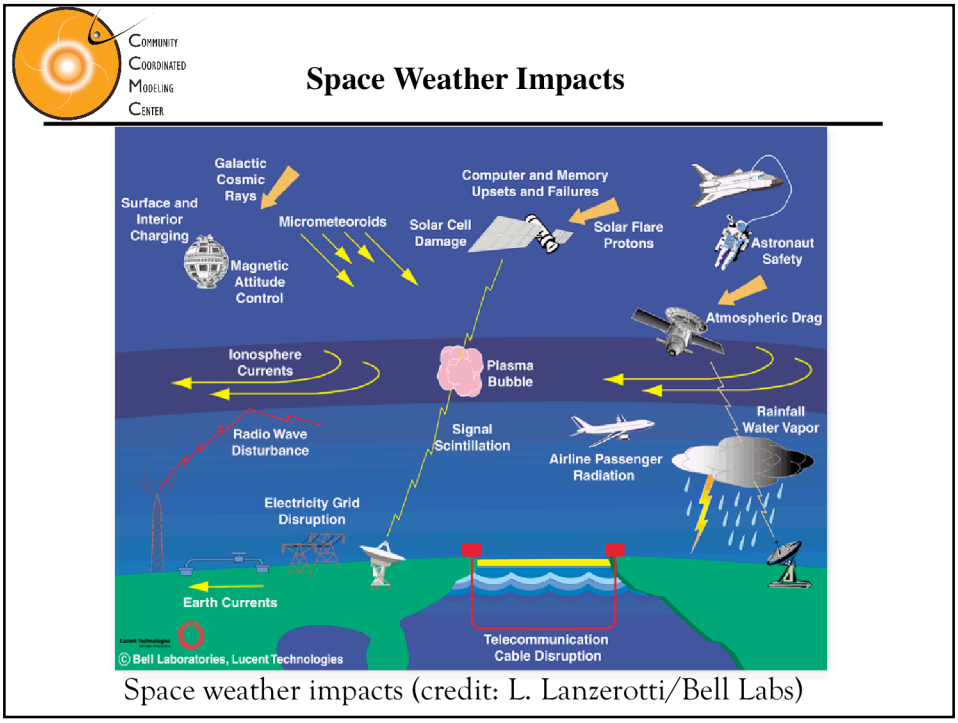
Substorms

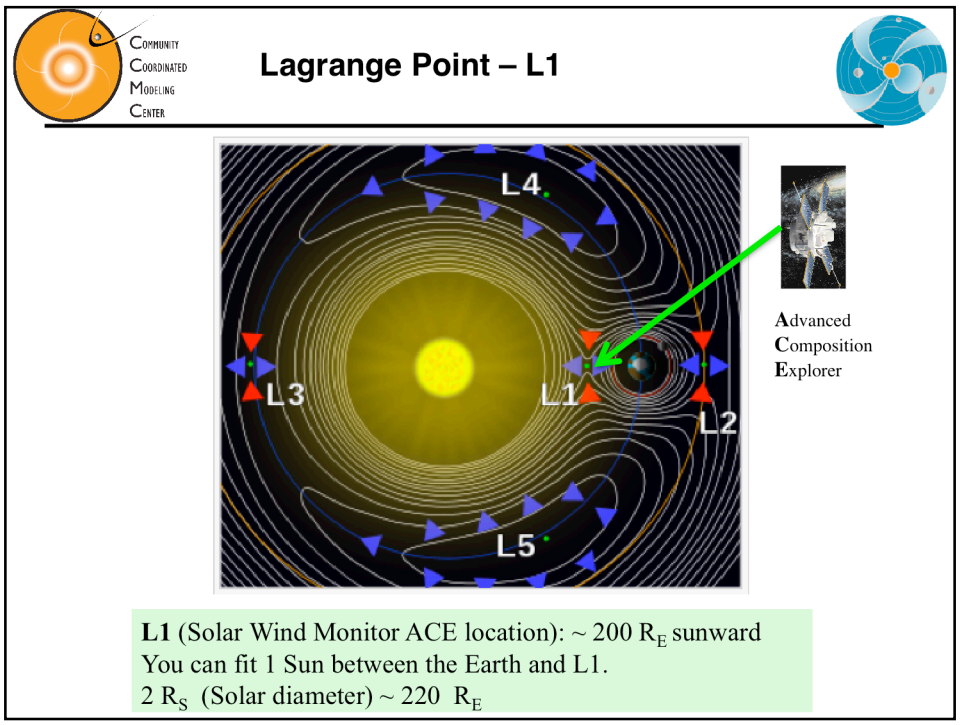
- Instabilities that abruptly and explosively release solar wind energy stored within the Earth's magnetotail.
- manifested most visually by a characteristic global development of auroras
- Last ~ hours







Space weather impacts (credit: L. Lanzerotti/Bell Labs)



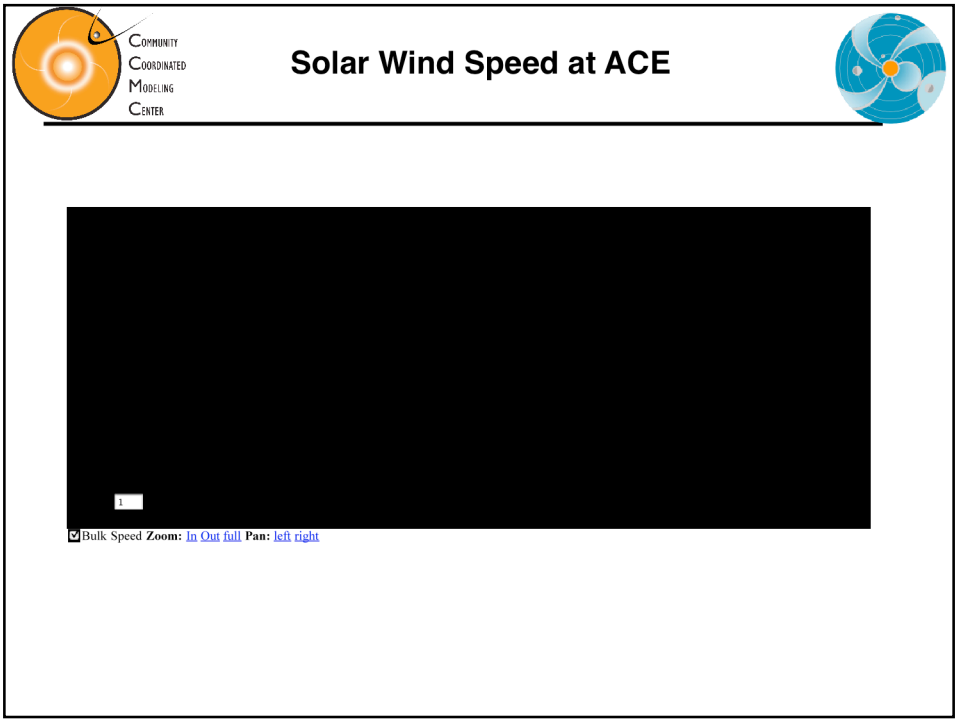
The **Lagrangian points** (**L-points**) are the five positions in an orbital configuration where a spacecraft affected only by gravity can

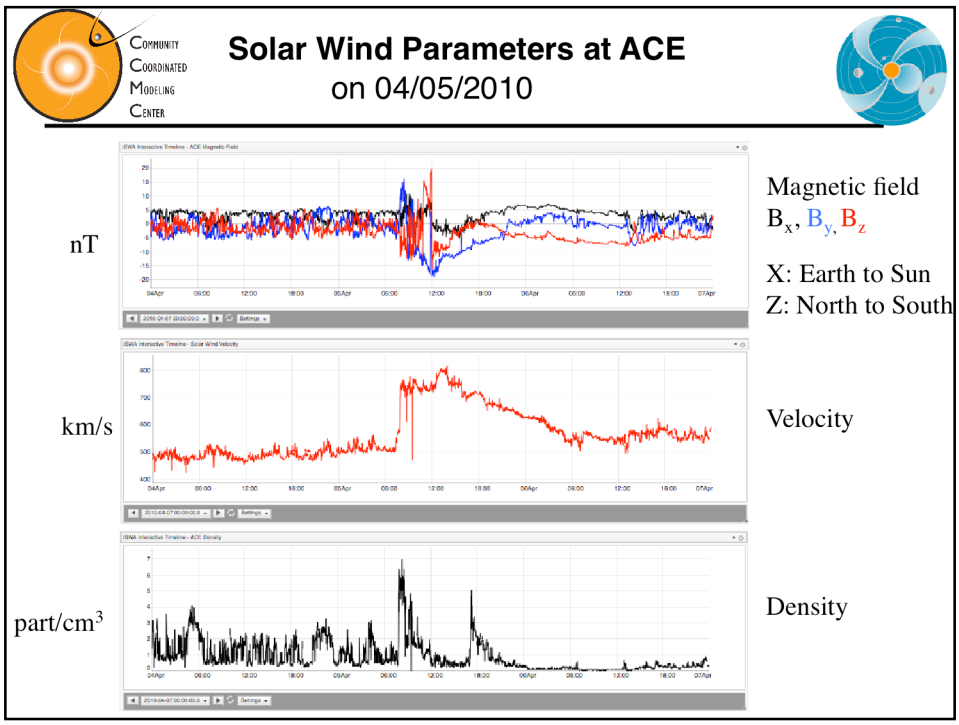
maintain its position relative to the two massive bodies (the Earth and the Sun).

You can almost fit 1 solar diameter (~ 200 R_E) between the Earth and L1.

Solar wind monitor ACE is positioned at L1 point.

It takes about 30 – 60 min (depending on the speed of the solar wind) for the disturbance observed at L1 to reach the Earth.


Community
Coordinated
Modeling
Center
Solar Wind Speed at ACE
1
Bulk Speed Zoom: In Out full Pan: left right



1 nT = 10^{-5} Gauss

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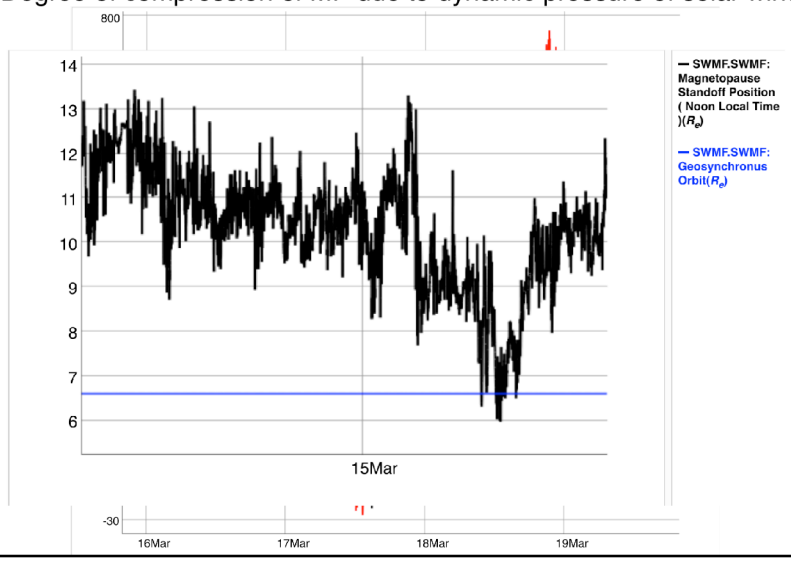
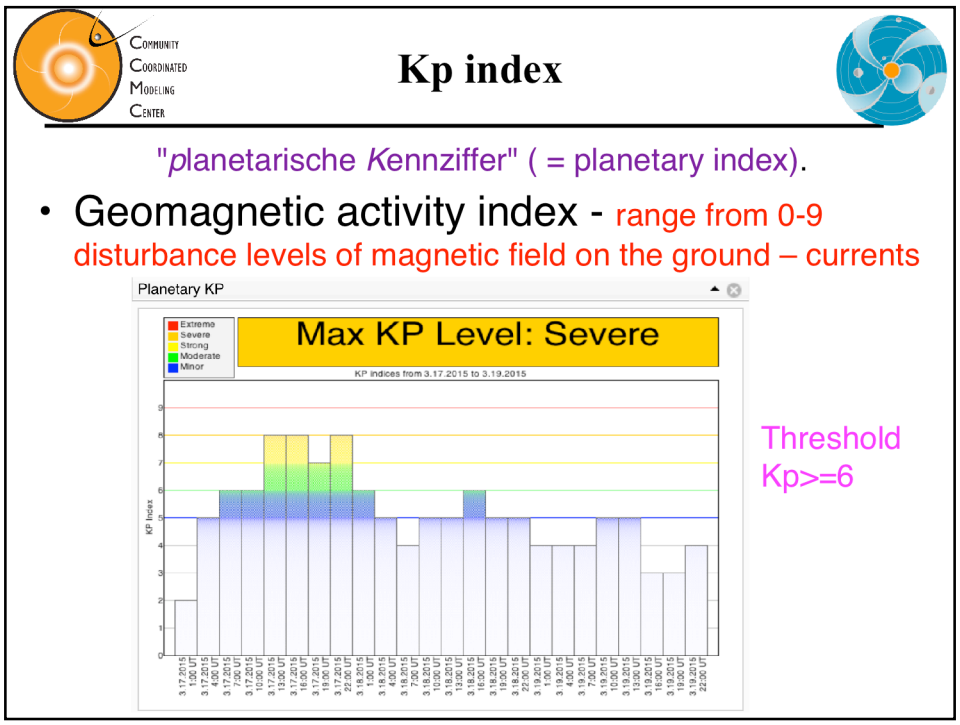
Magnetopause Stand-off Distance

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





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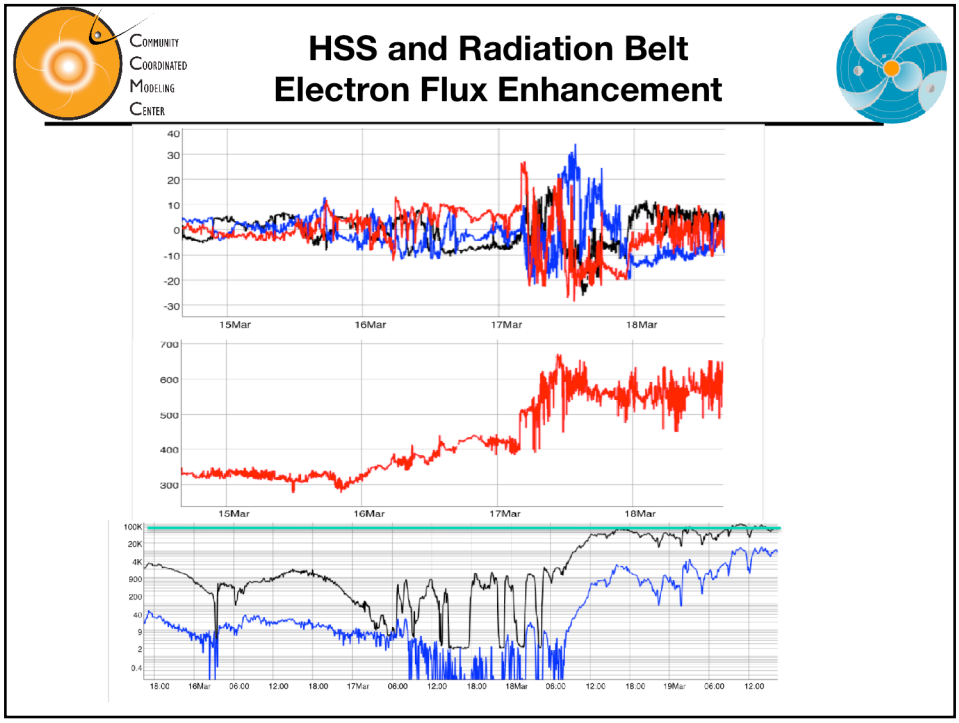
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HSS and Radiation Belt Electron Flux Enhancement
40
30
20
10
0
-10
-20
-30
15Mar
16Mar
17Mar
18Mar
700
600
500
400
300
15Mar
16Mar
17Mar
18Mar
100K
20K
4K
900
200
40
9
2
0.4
18:00
16Mar
06:00
12:00
18:00
17Mar
06:00
12:00
18:00
18Mar
06:00
12:00
18:00
19Mar
06:00
12:00

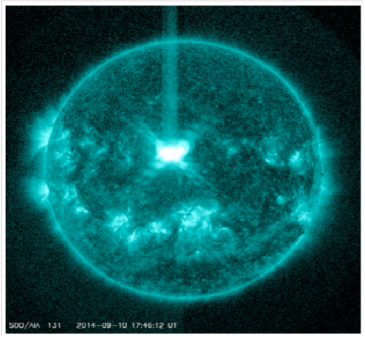
Energetic Proton Flux

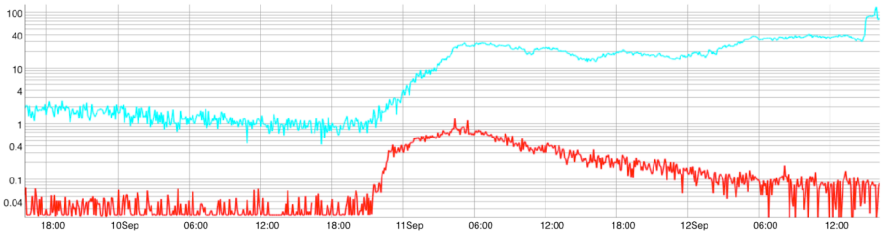
- >10 MeV flux by GOES spacecraft

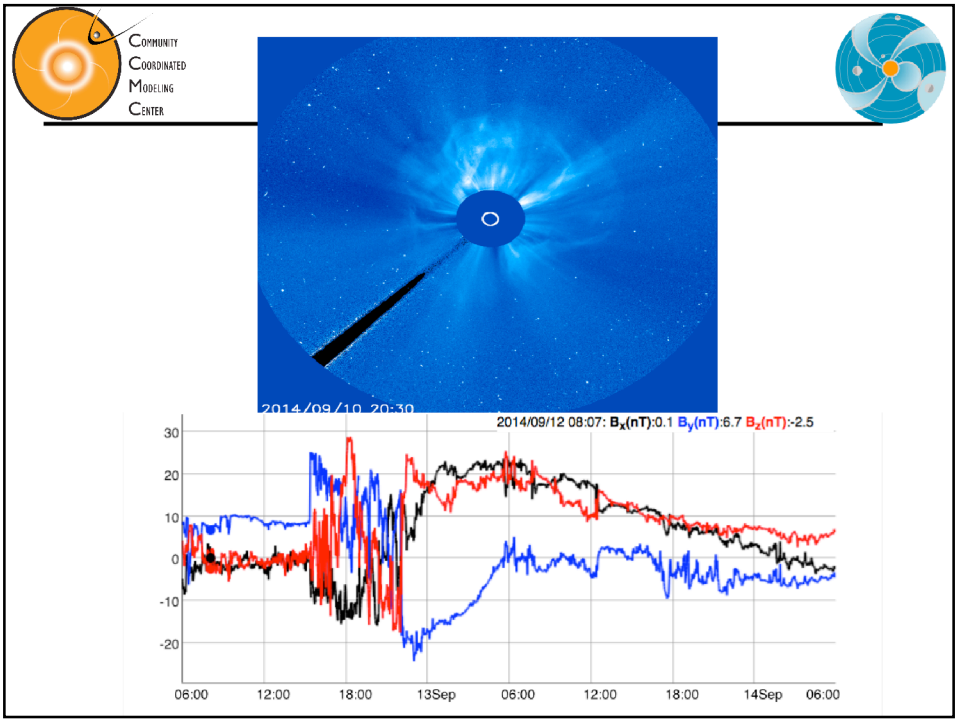
Threshold: 10 pfu

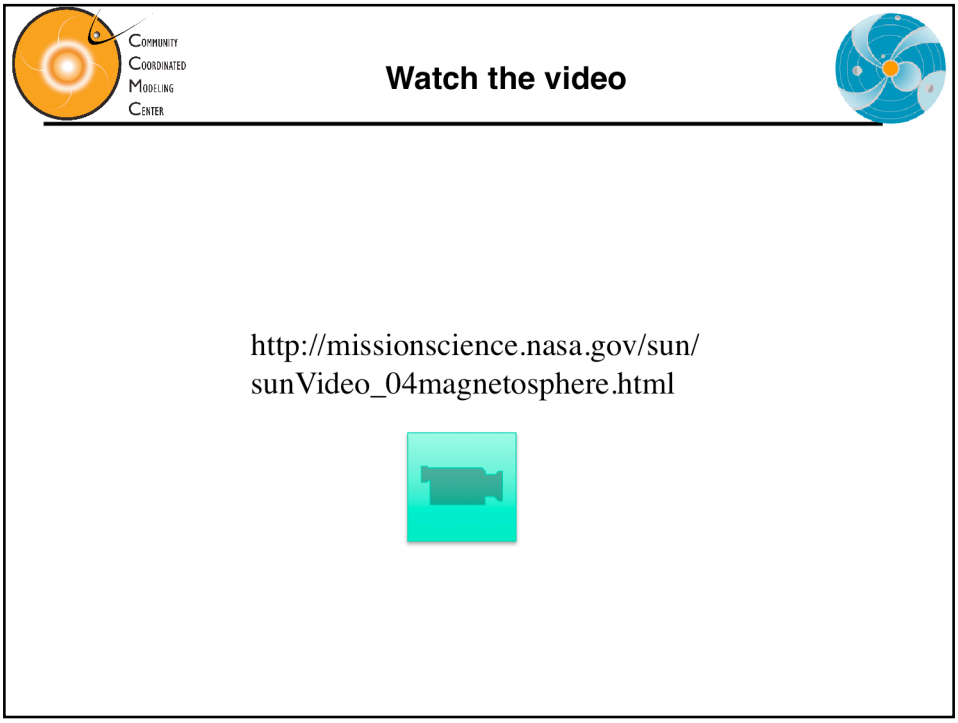
- >100 MeV flux by GOES spacecraft

Threshold: 1 pfu






Community
Coordinated
Modeling
Center
2014/09/10 20:30
2014/09/12 08:07: Bx(nT):0.1 By(nT):6.7 Bz(nT):-2.5
30
20
10
0
-10
-20
06:00
12:00
18:00
13Sep
06:00
12:00
18:00
14Sep
06:00



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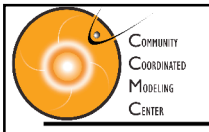

iSWA Layout:
07/12/2012