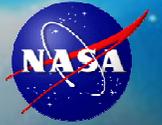




Biggest Breach of Earth's Solar Storm Shield Discovered

D.G. Sibeck

THEMIS Project Scientist

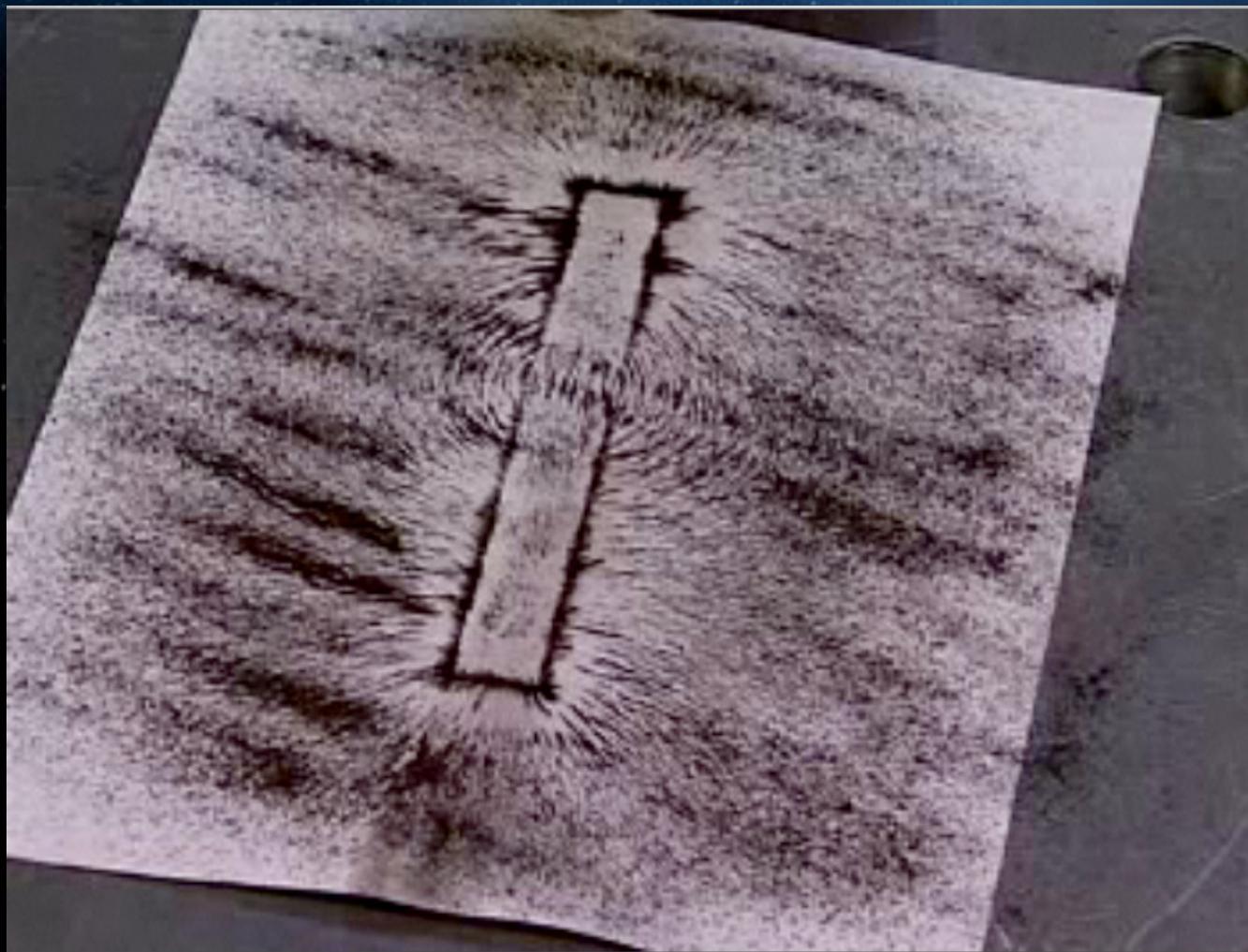


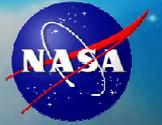
Earth's Magnetic Field Carves Out a Cavity Buffeted by the Solar Wind

Courtesy of C. Goodrich



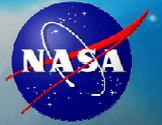
Southward Interplanetary Magnetic Field (IMF) Orientations Enable Solar Wind Energy to Enter the Earth's Magnetosphere



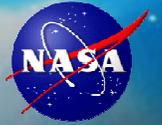


Southward Interplanetary Magnetic Field (IMF) Orientations Enable Solar Wind Energy to Enter the Earth's Magnetosphere

... but Northward IMF Orientations Enable
Solar Wind Plasma to Enter the Magnetosphere

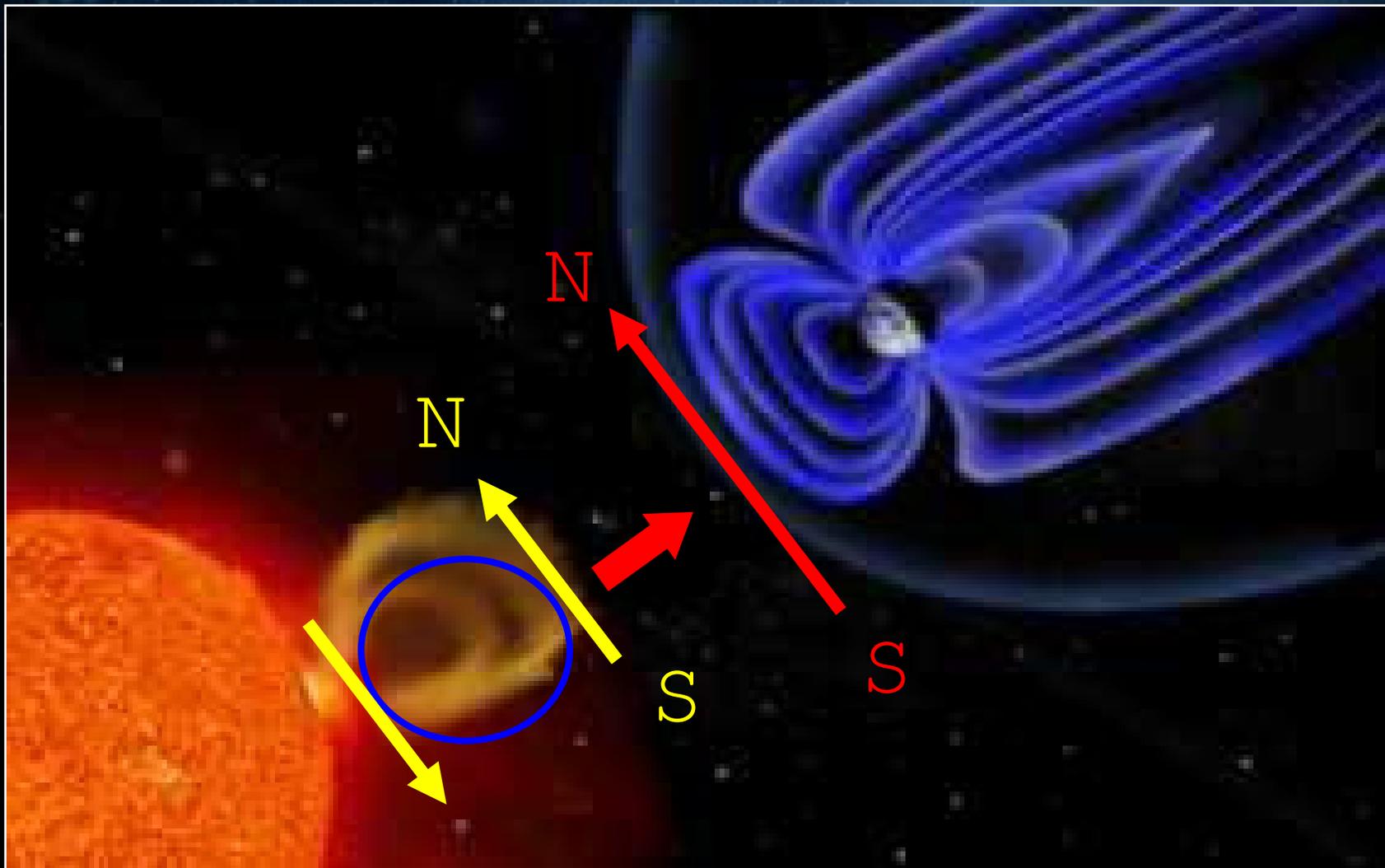


... but Northward IMF Orientations Enable
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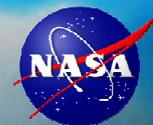


Significance of These Discoveries: Bigger Geomagnetic Storms in the Next Solar Cycle



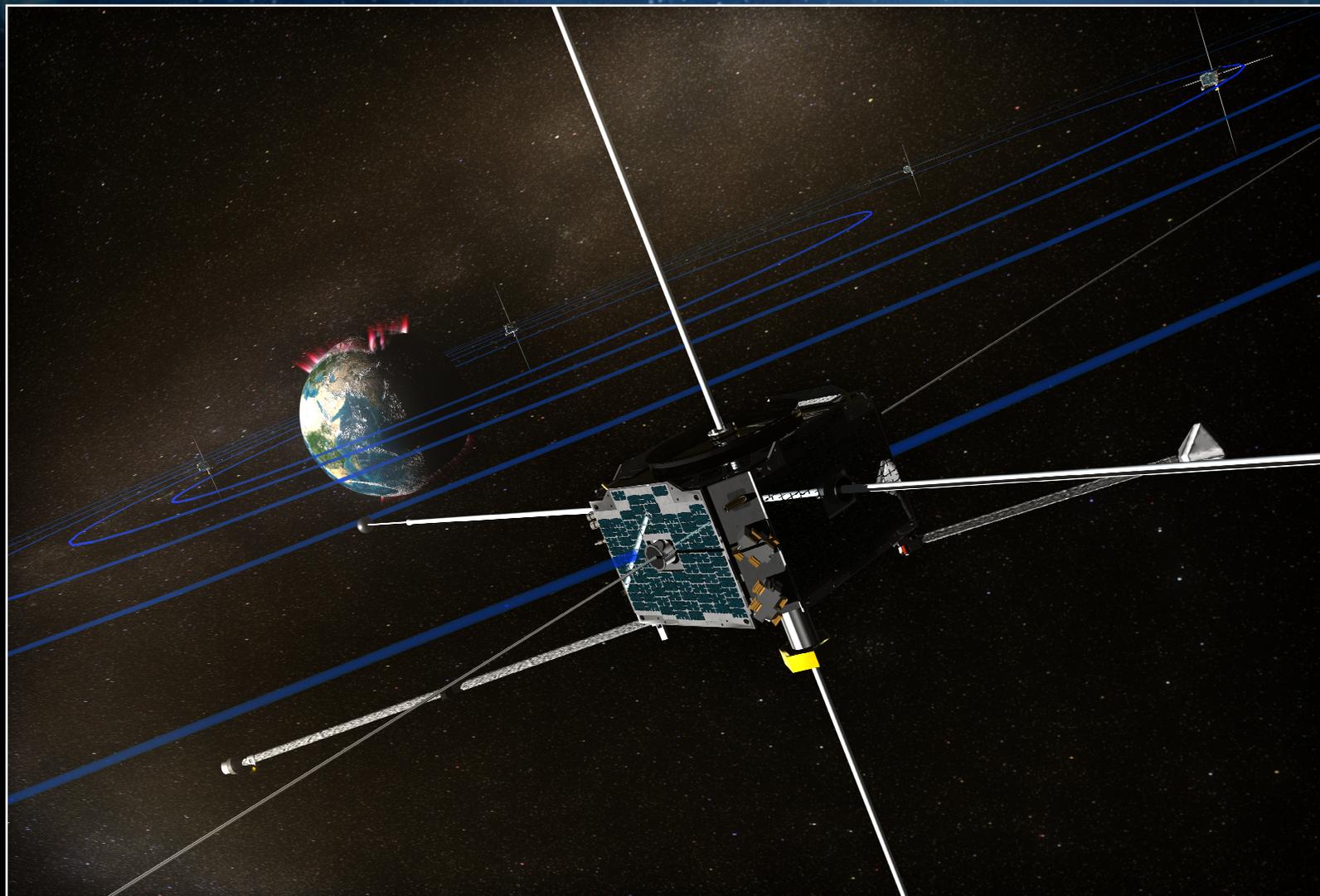


Marit Øieroset
THEMIS researcher
University of California at Berkeley



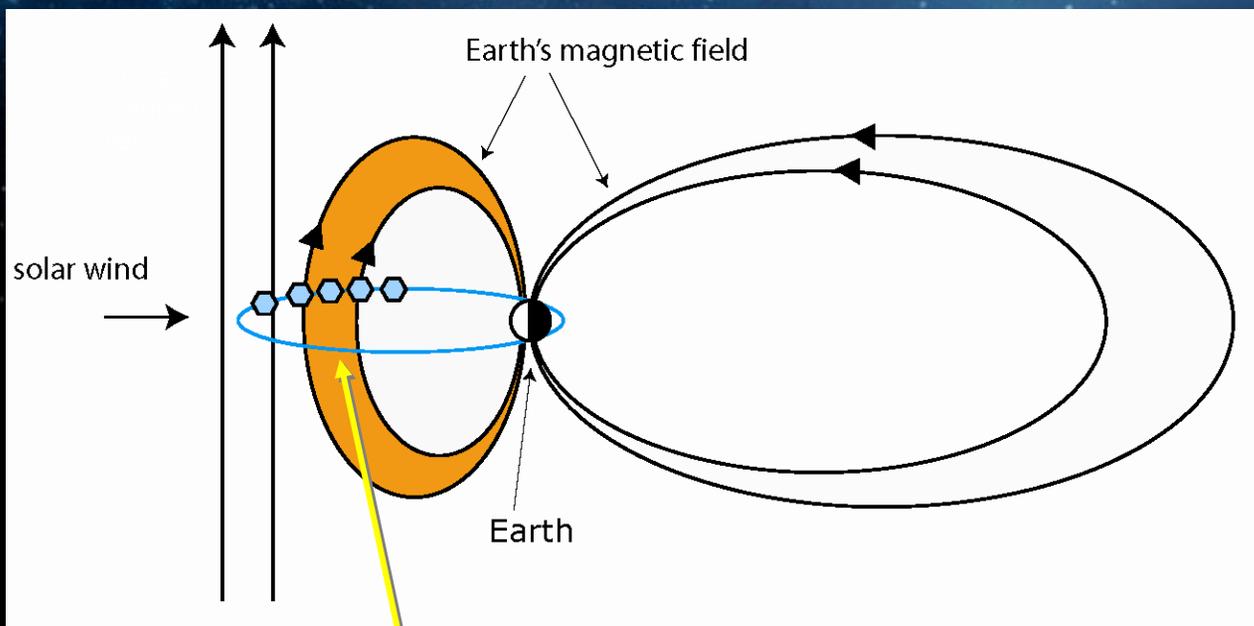
THEMIS: five-spacecraft NASA mission launched Feb. 2007

<http://themis.ssl.berkeley.edu>





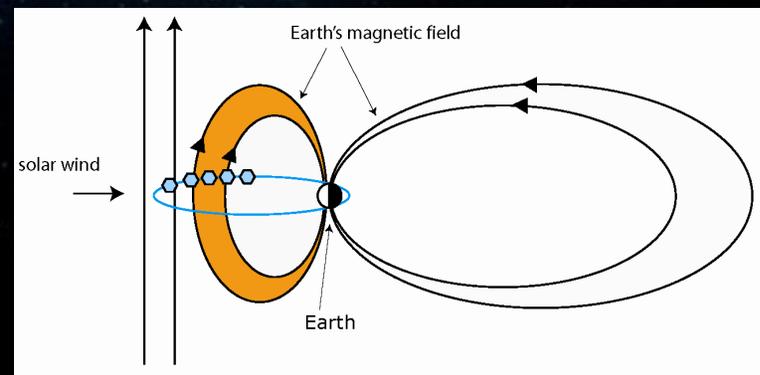
Thick layer of solar particles inside Earth's magnetosphere discovered



THEMIS spacecraft flew through thick layer of solar particles inside Earth's magnetosphere



Multiple THEMIS spacecraft can measure thickness of layer

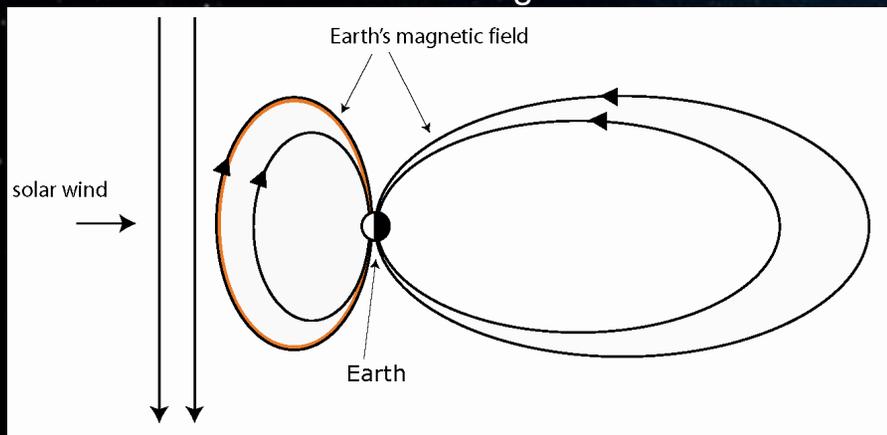


Solar particle layer one Earth radius (4000 miles) thick and growing rapidly

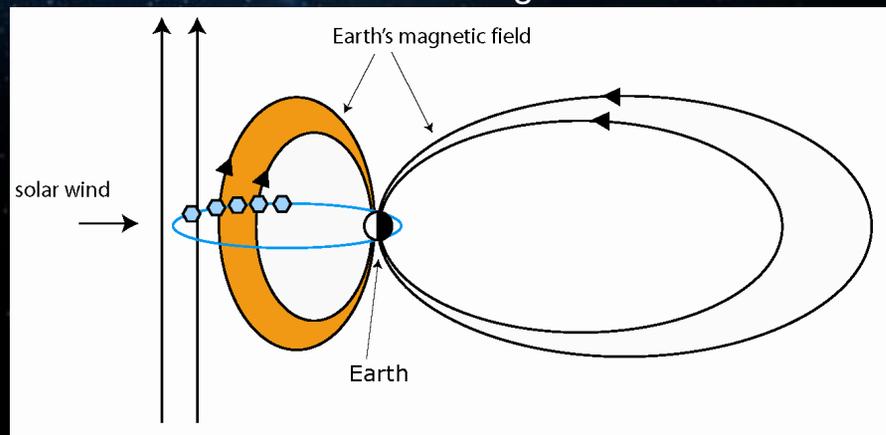


Solar particle layer much thicker when Sun's and Earth's magnetic fields are aligned

solar wind magnetic field
not aligned
with Earth's magnetic field



solar wind magnetic field
aligned
with Earth's magnetic field



20 times more particles enter when the magnetic fields are aligned

How is the thick layer formed?



Jimmy Raeder

THEMIS Co-Investigator

Wenhui Li

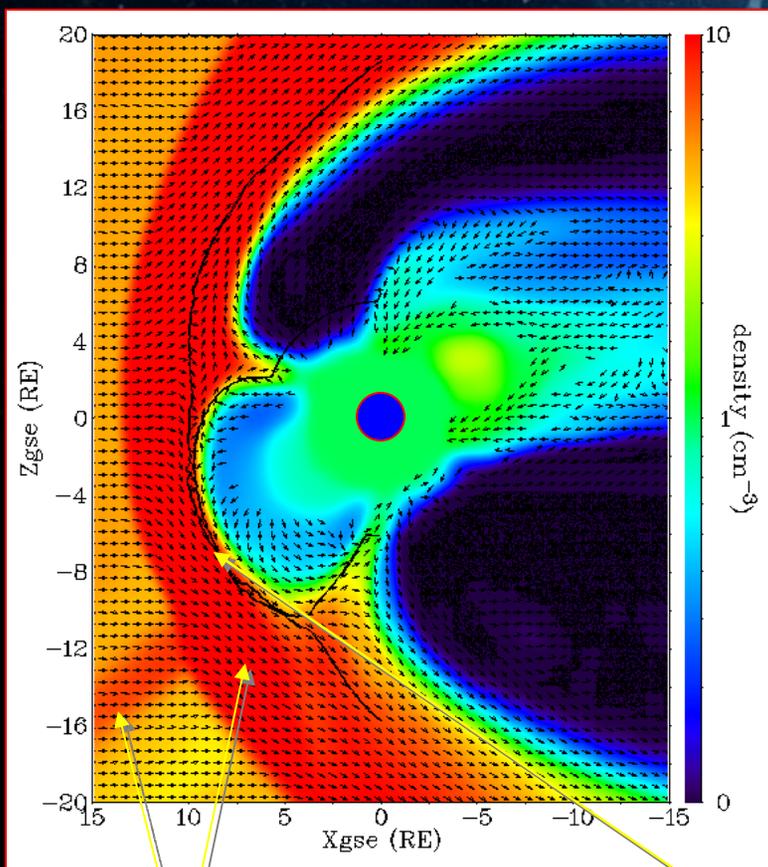
THEMIS researcher

Space Science Center
University of New Hampshire

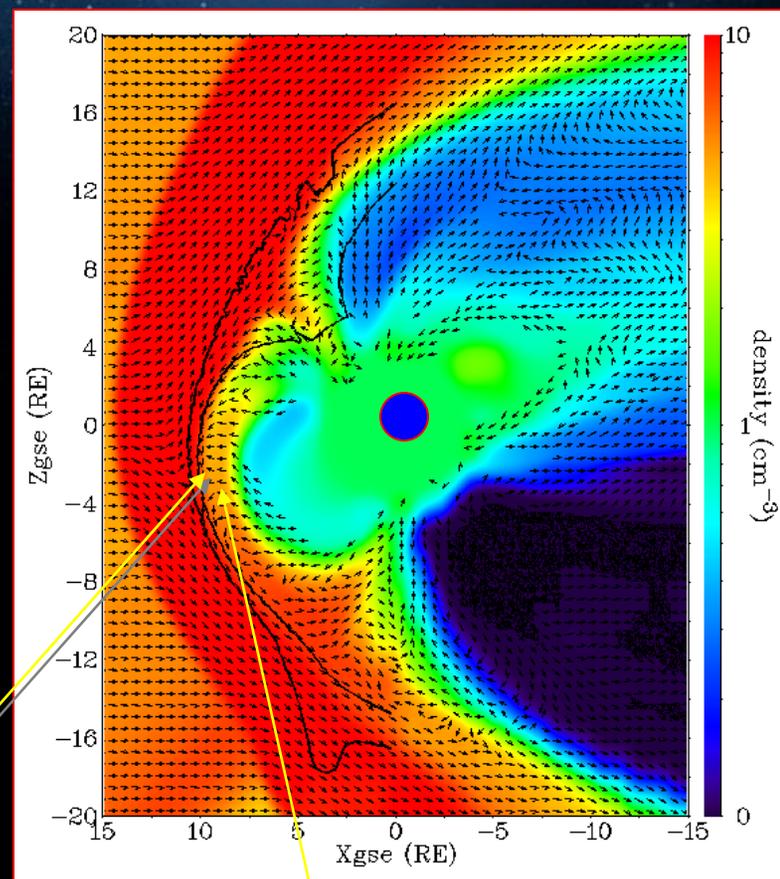


How big is the breach?

not aligned



aligned



Earth's magnetic shield

Thicker and denser layer

dense solar wind

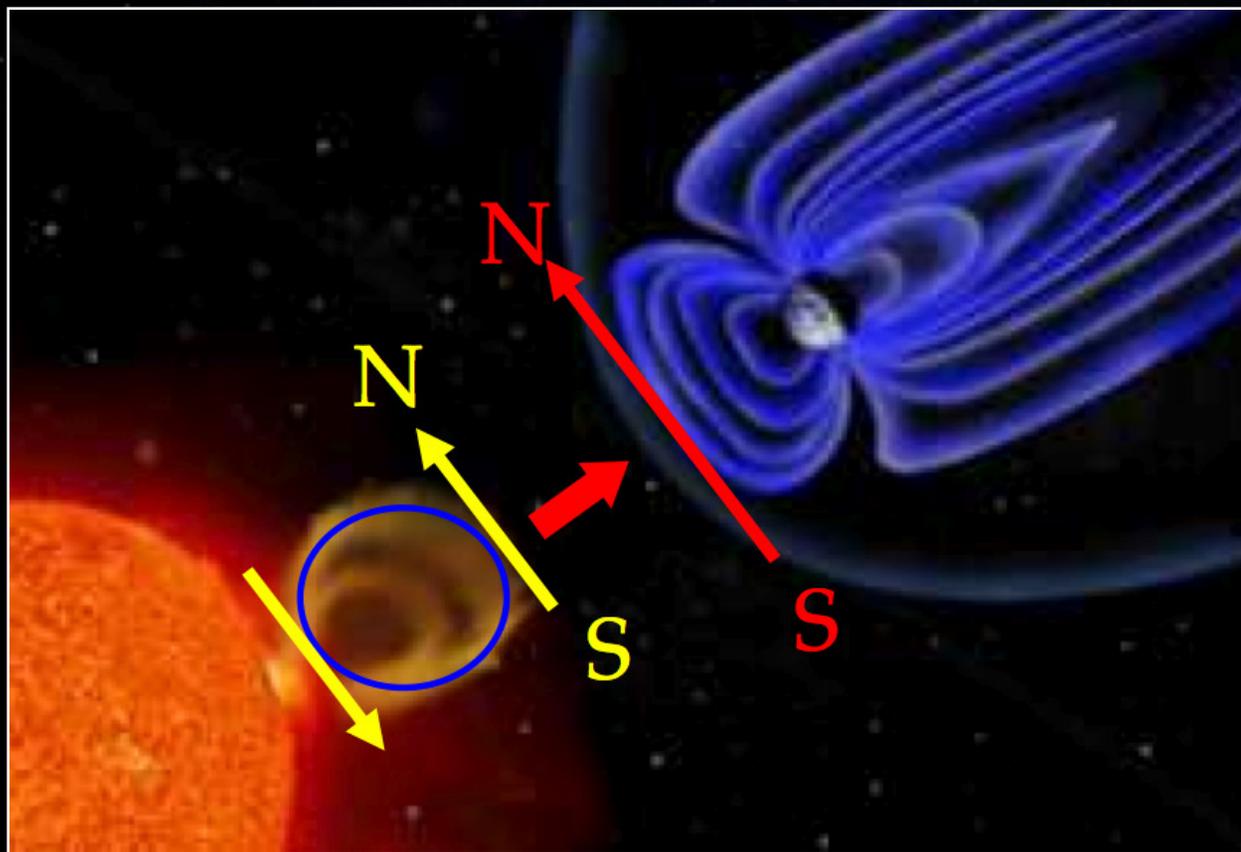
How do the particles get in?





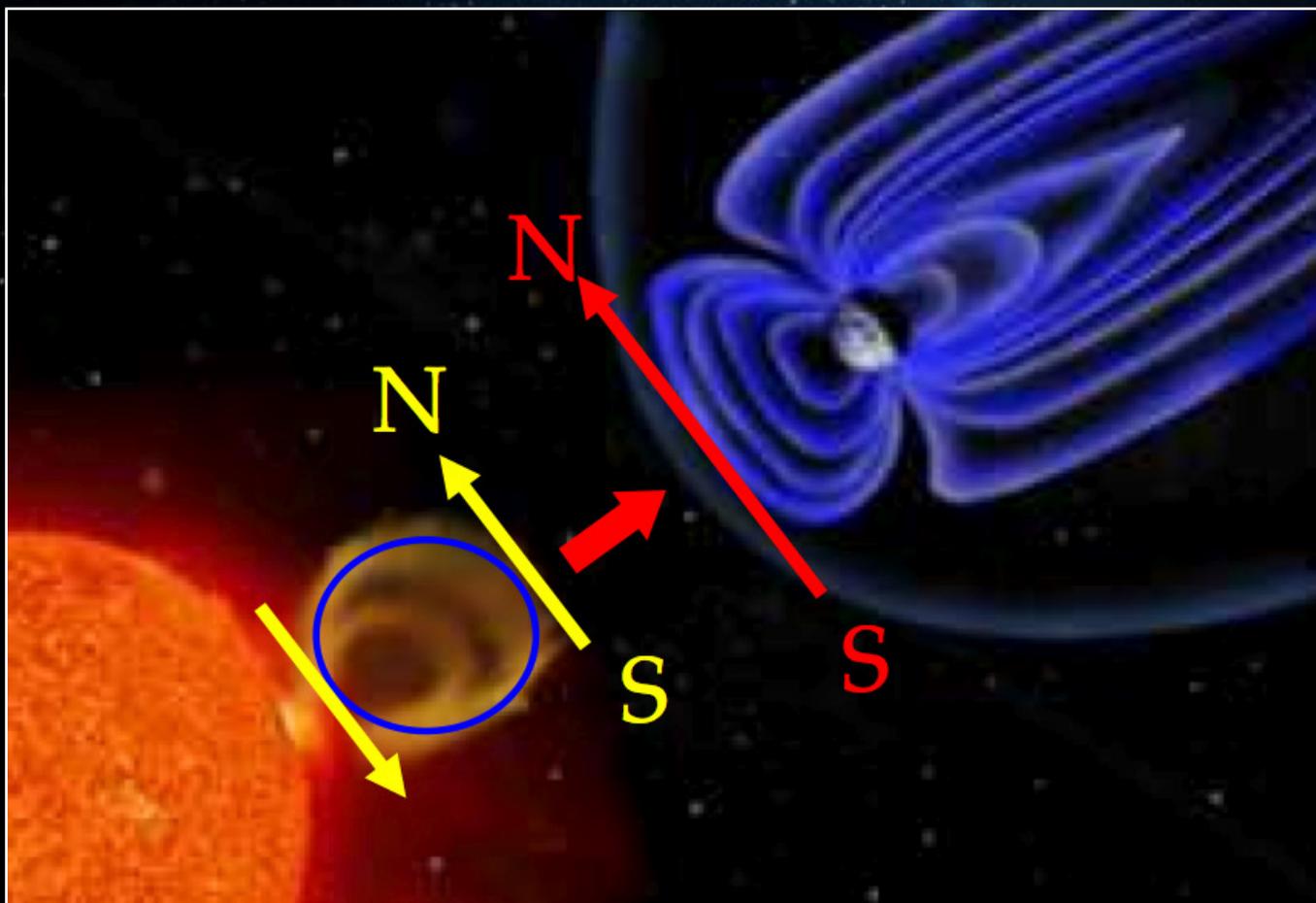
Why is this important?

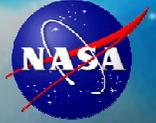
- The Sun has an 11 year activity cycle. The last one ended in 2006. Next cycle maximum expected ~2012.
- Every new cycle the sun changes the polarity (direction) of its magnetic fields.
- Eruptions on the sun (so-called Coronal Mass Ejections, CMEs) cause magnetic storms on the Earth.





- Next solar cycle will bring mostly north-south CMEs.
- These will first bring plasma into the magnetosphere (northern part) and then energize it (southern part) stronger storms are expected because the plasma in the magnetosphere acts like a fuel for the storm.





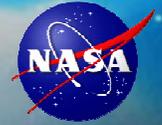
Summary

- THEMIS observes a large breach in Earth's magnetic shield that allows solar particles to enter at a large rate.
- Contrary to common belief And to many scientists' surprise this breach occurs when the magnetic fields from the sun and the Earth align. Previously it was thought that more particles enter when the fields are in opposite directions.
- Simulations show that the plasma entry occurs across the entire sunward side of the magnetosphere.
- This discovery means that magnetic storms during the next solar cycle maximum (~2012) could be stronger than the storms of the previous cycle.

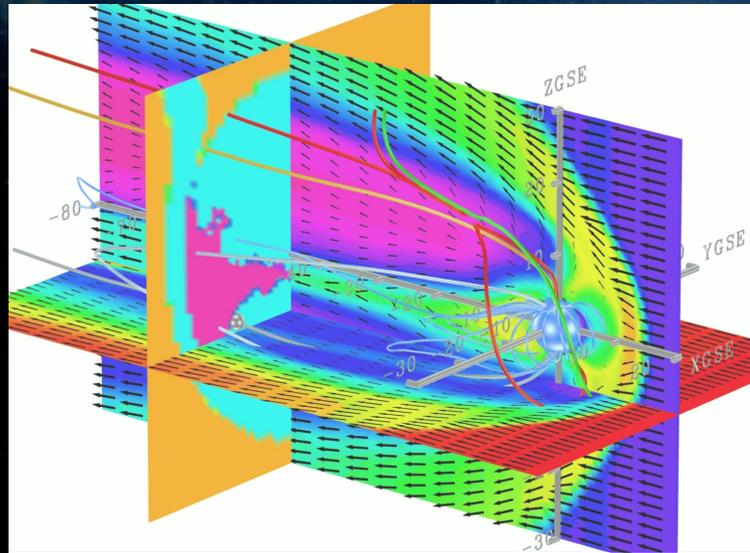
This research was sponsored by NASA and the
National Science Foundation (NSF)



Extra Slides

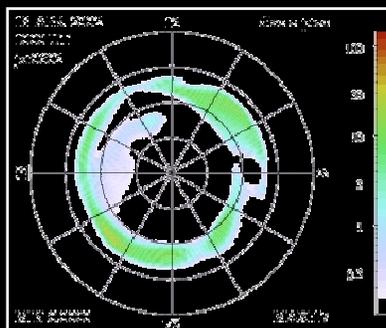


Computer simulation model

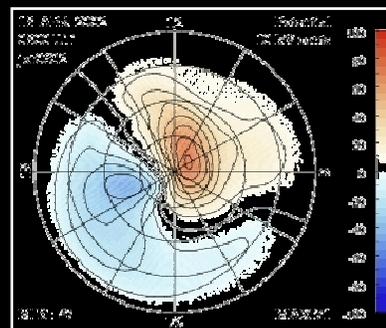


The Open Geospace General Circulation Model (OpenGGCM):

- A community model of Earth's space environment.
- Like a model for terrestrial weather prediction, but for space.
- In the figure global the sun is to lower right.
- The solar wind flows to the left and creates a bow shock wave.
- Plasma from the sun flows around the magnetosphere.



Aurora



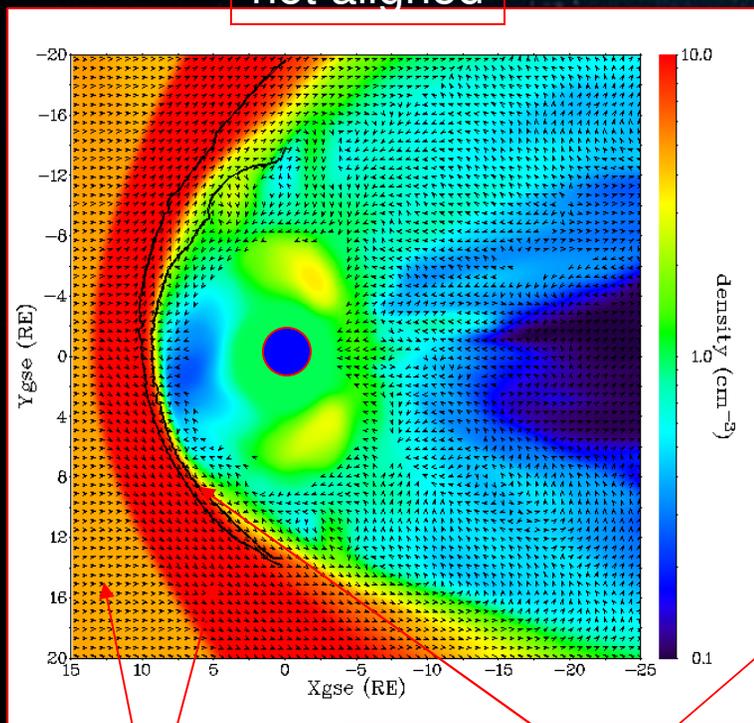
Ionosphere Potential

Personnel: J. Raeder, D. Larson, W. Li, A. Vapirev, K. Germaschewski, L. Kepko, H.-J. Kim, M. Gilson, B. Larsen (UNH), T. Fuller-Rowell, N. Muriyama (NOAA/SEC), F. Toffoletto, A. Chan, B. Hu (Rice U.), M.-C. Fok (GSFC), A. Richmond, A. Maute (NCAR)

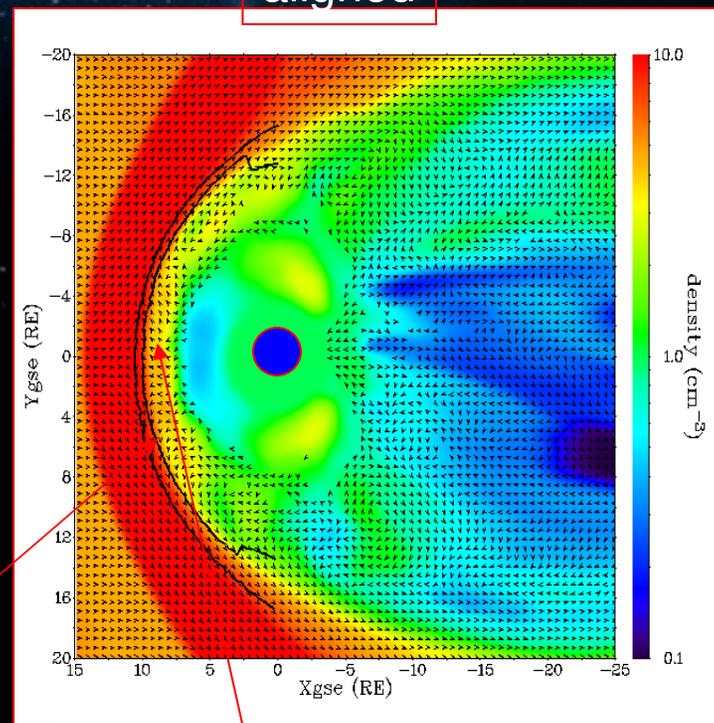


The computer simulation shows that the layer extends over the entire sunward side of the magnetosphere

not aligned



aligned



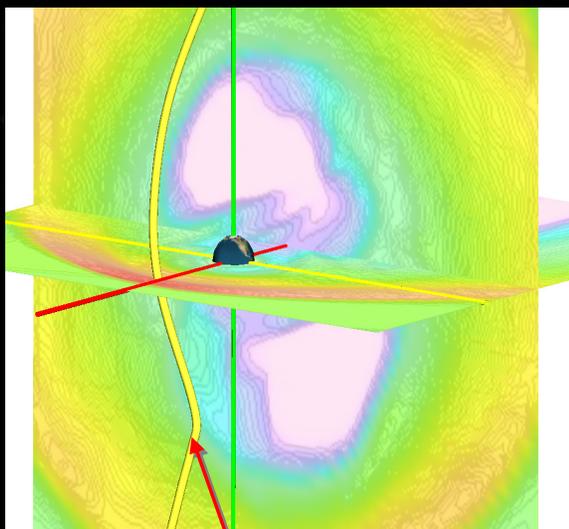
Earth's magnetic shield

Thicker and denser layer

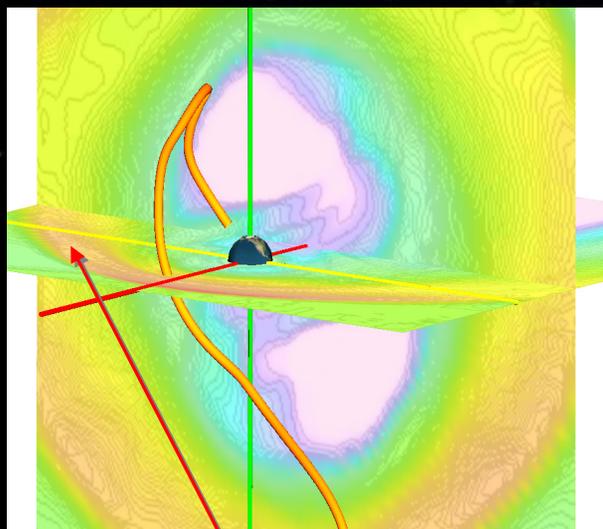
dense solar wind



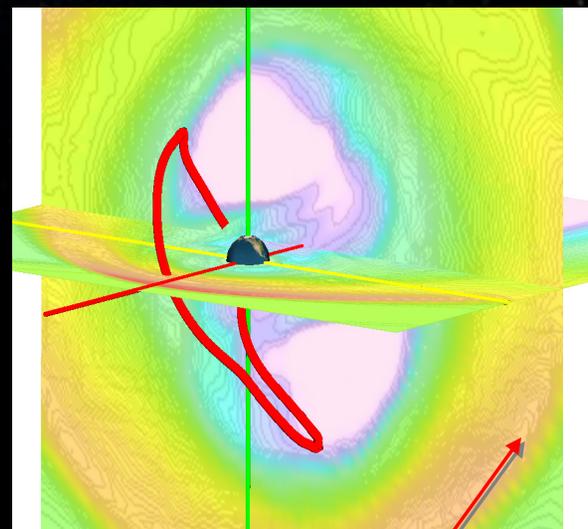
- The solar wind carries magnetic field from the sun to the magnetosphere.
- This magnetic field drapes over the magnetosphere and connects to the Earth's field above the north pole.
- About a minute later it connects with the Earth's field over the south pole: The solar wind field line has now become one of Earth's and the plasma that came with it is in the magnetosphere.



solar wind
Magnetic field line



plasma density on
equatorial plane



plasma density on a cross
plane behind the Earth



Magnets Attract



Magnets Repel



Magnetic Lines