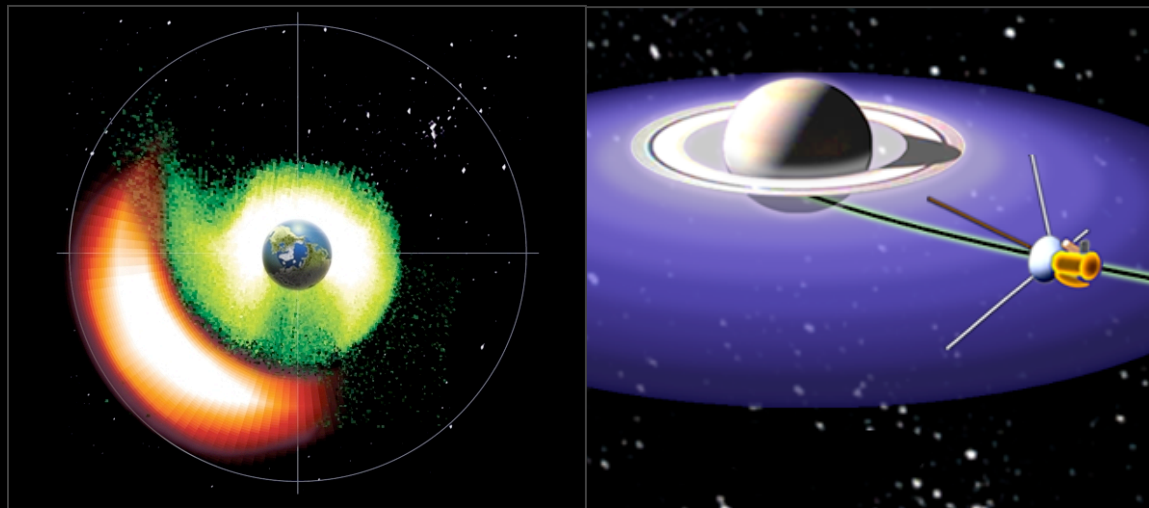




Images of the Invisible

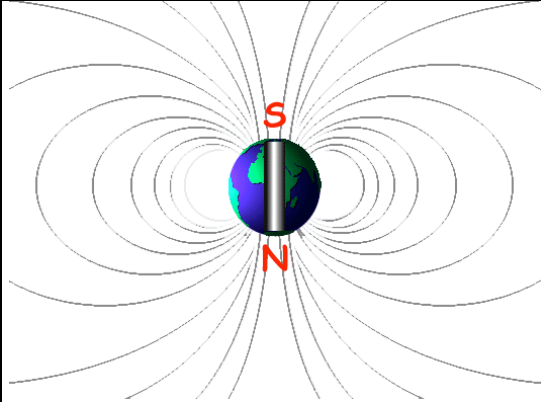
Planetary Space Plasma Environments



Jerry Goldstein

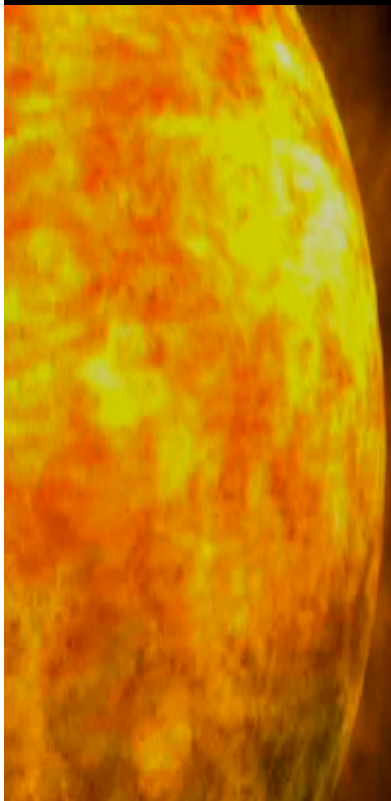
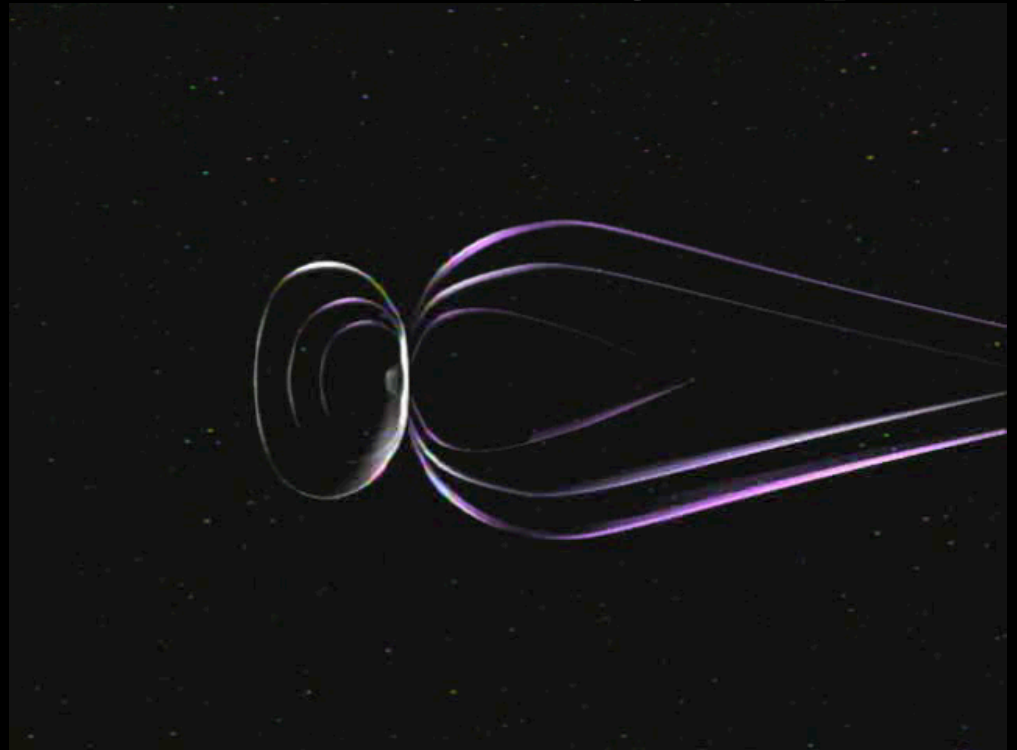
Southwest Research Institute (SwRI), San Antonio, TX

The Earth's Magnetosphere



Intrinsic Field: Dipole

Distorted Field: Magnetosphere



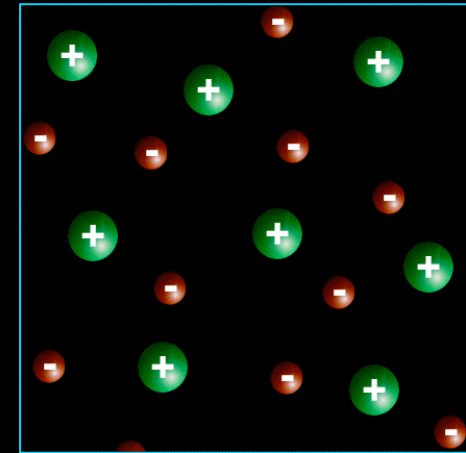
**Solar
Wind**



Full of Plasma!

The Ionosphere

Plasma: “4th state”



Ionized gas: **ions**
and **electrons**

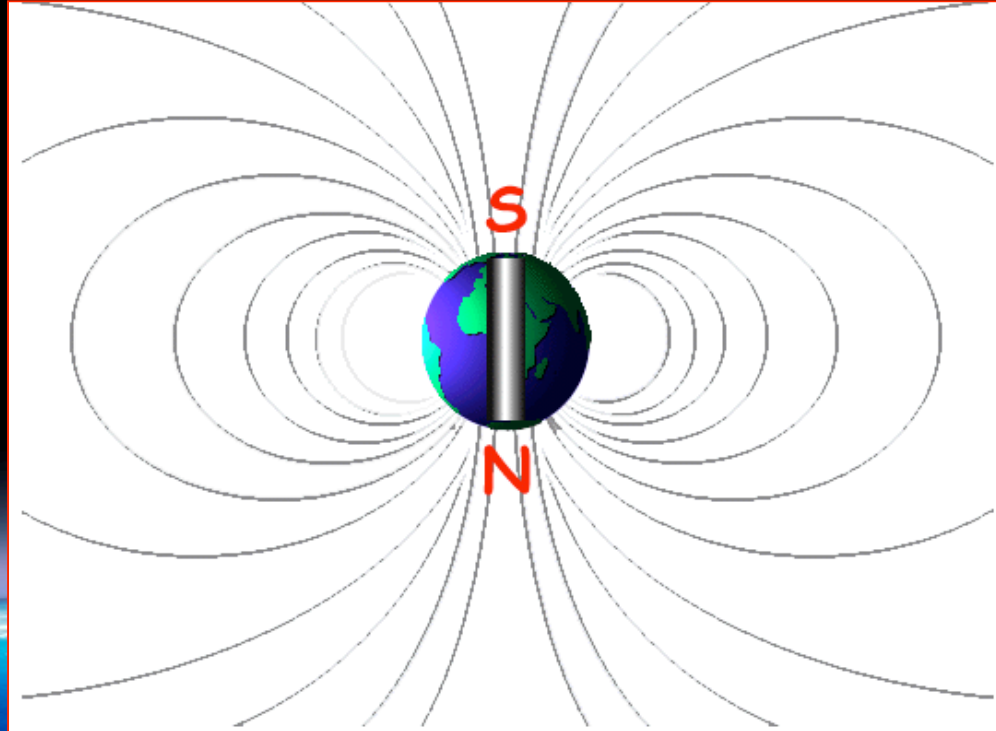
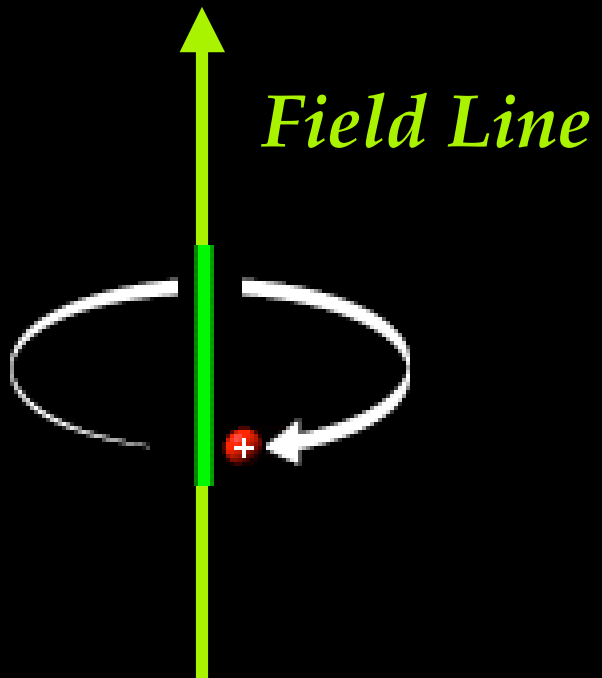
The Ionosphere

Ionized upper atmosphere

70-1000 km altitude

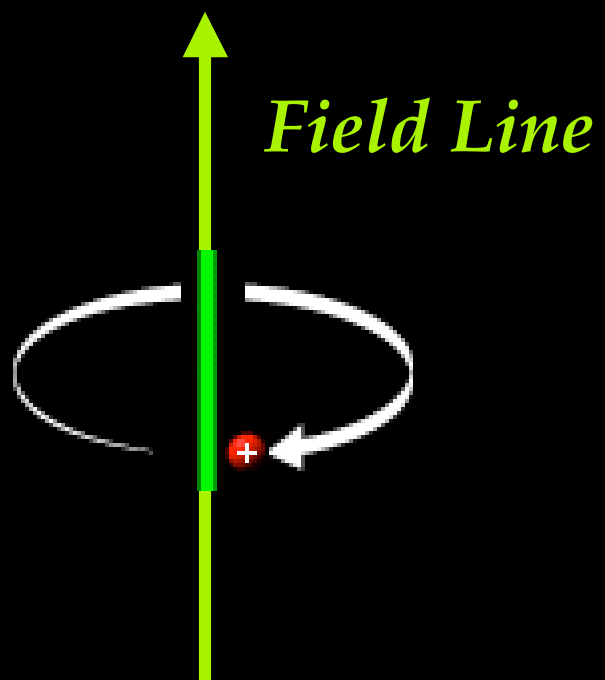


Charged Particles in Magnetic Field

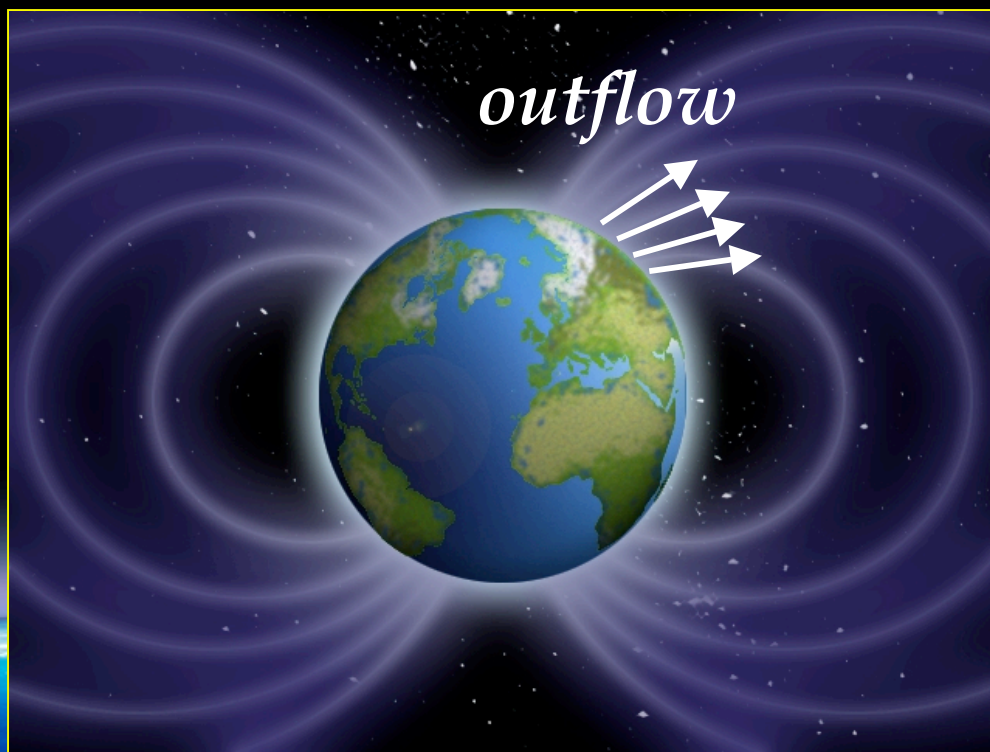


Ionospheric Outflow

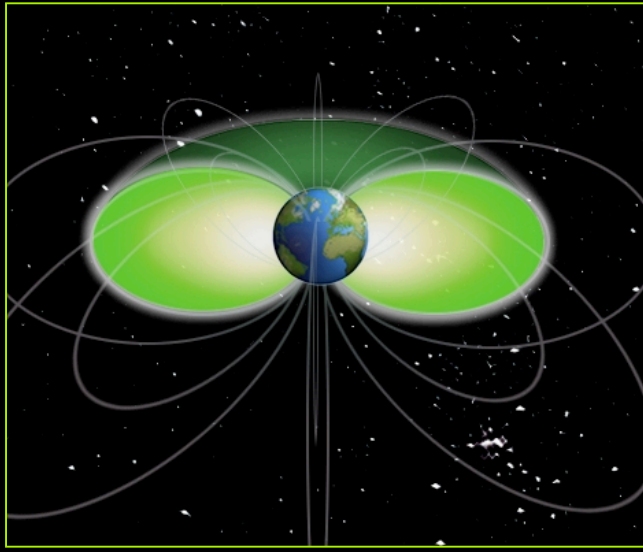
Plasma Source



The Ionosphere

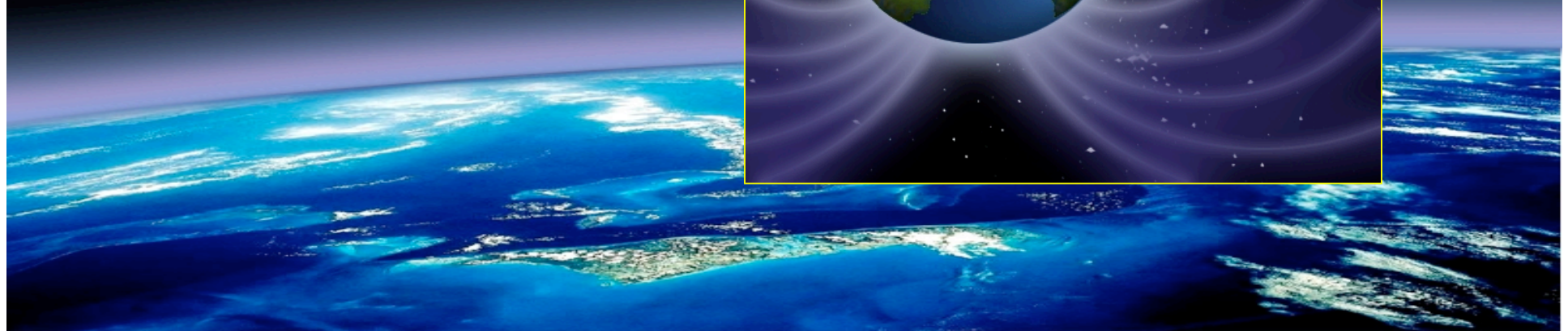
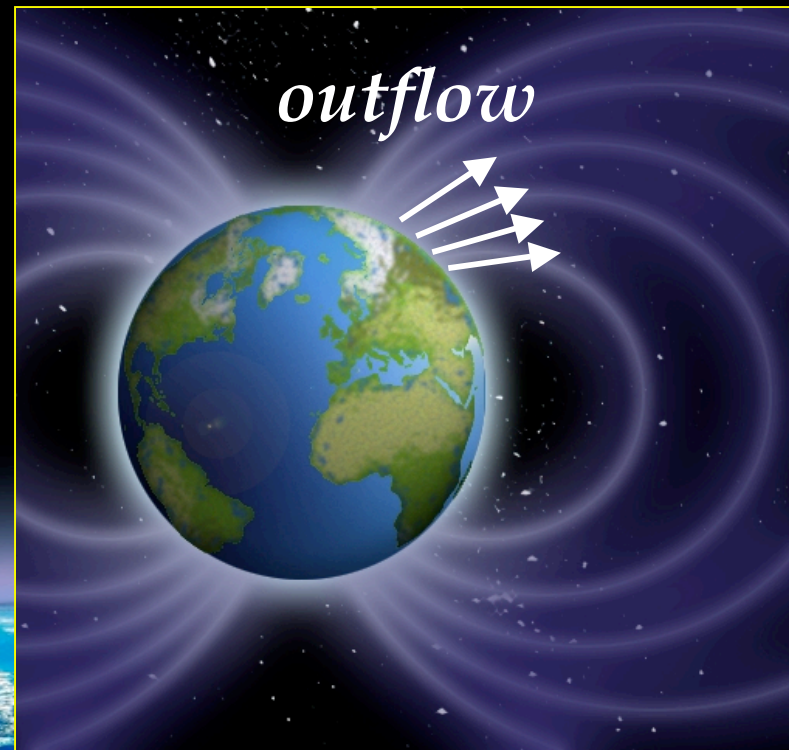


Ionospheric Outflow



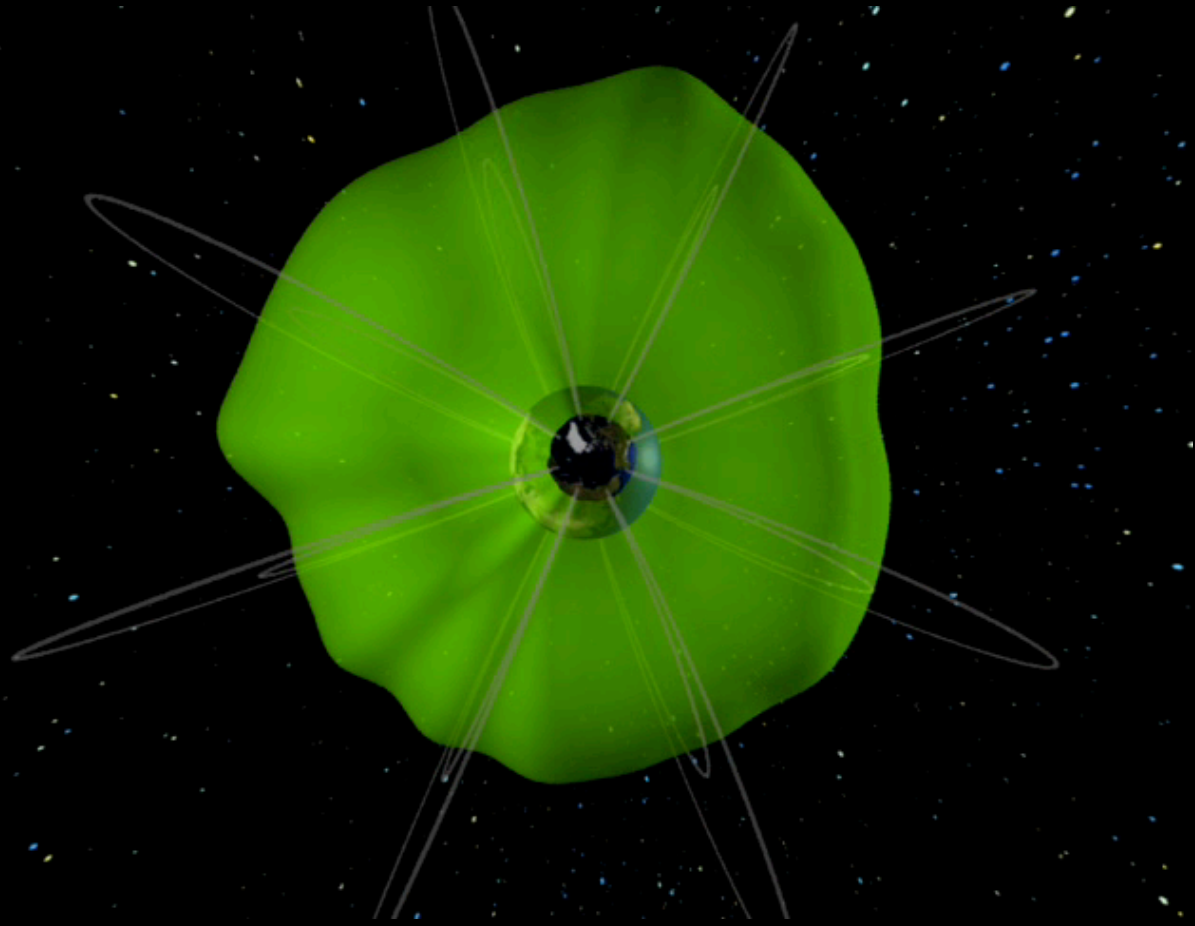
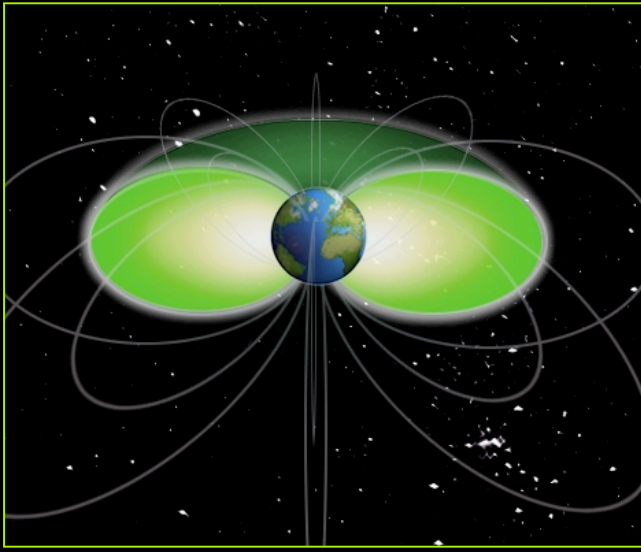
Plasmasphere
Torus of plasma
ionospheric origin

Plasma Source



The Plasmasphere

3D visualization



Torus of plasma

[animation courtesy W.T. Bridgman, GSFC]

Cold, *dense* torus of
1 eV, 100-10,000/cc

H^+ , He^+ ,
80% 15-20%

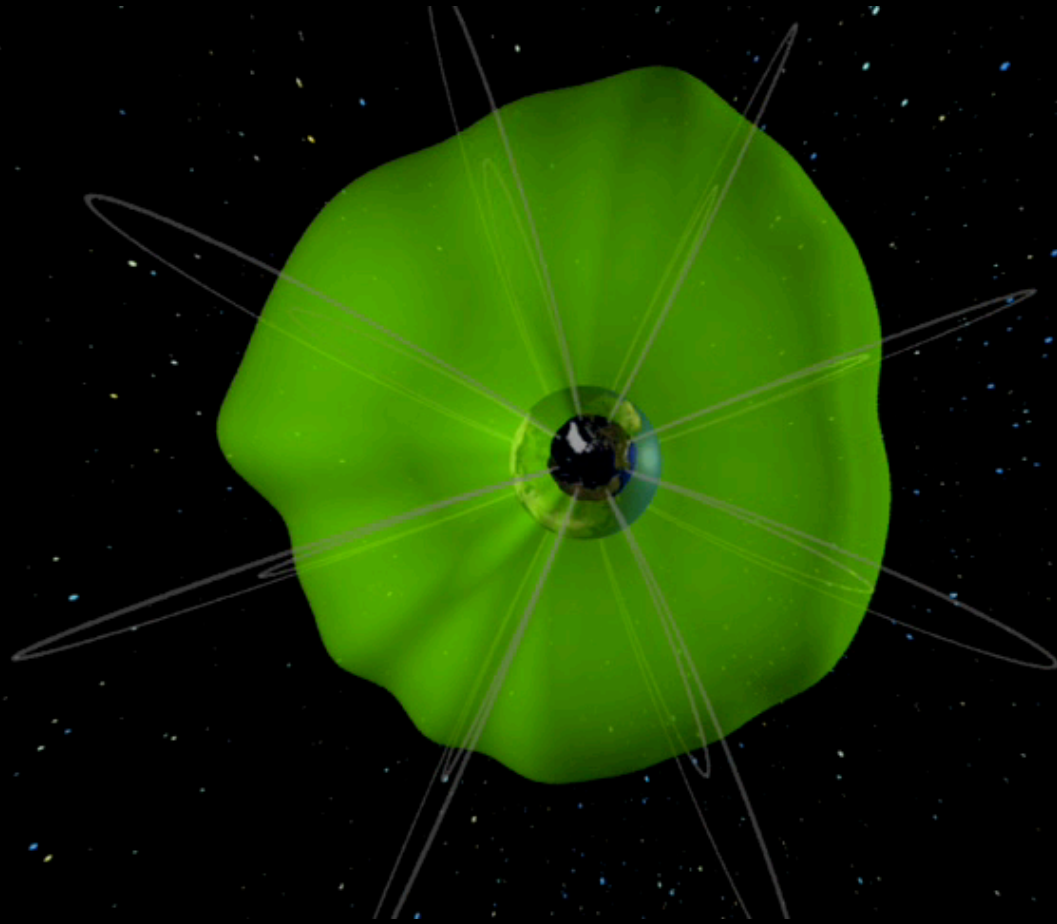
O^+
few %

Plasmasphere Observations

March 25, 2000
Vandenberg AFB



IMAGE
satellite

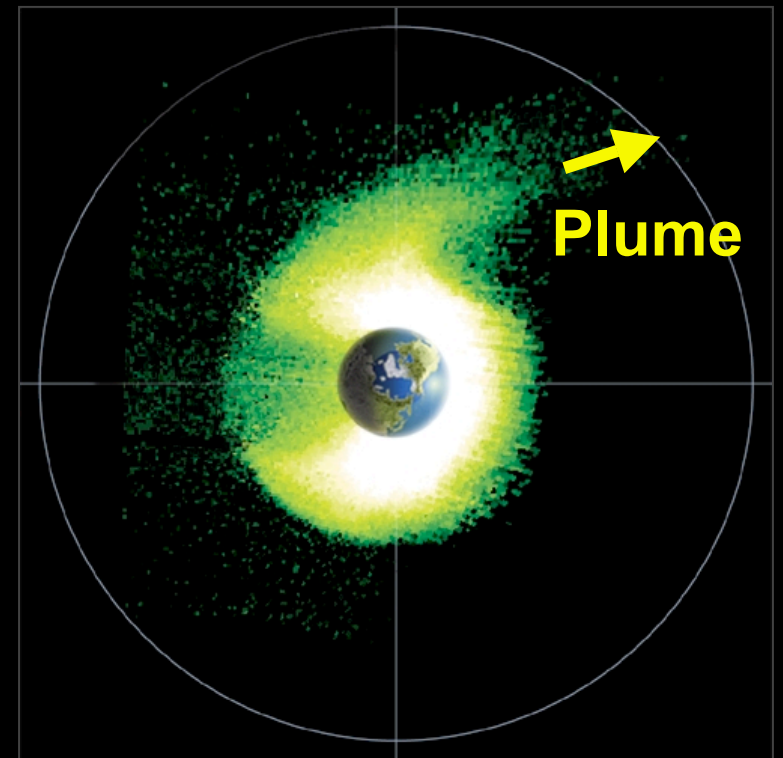
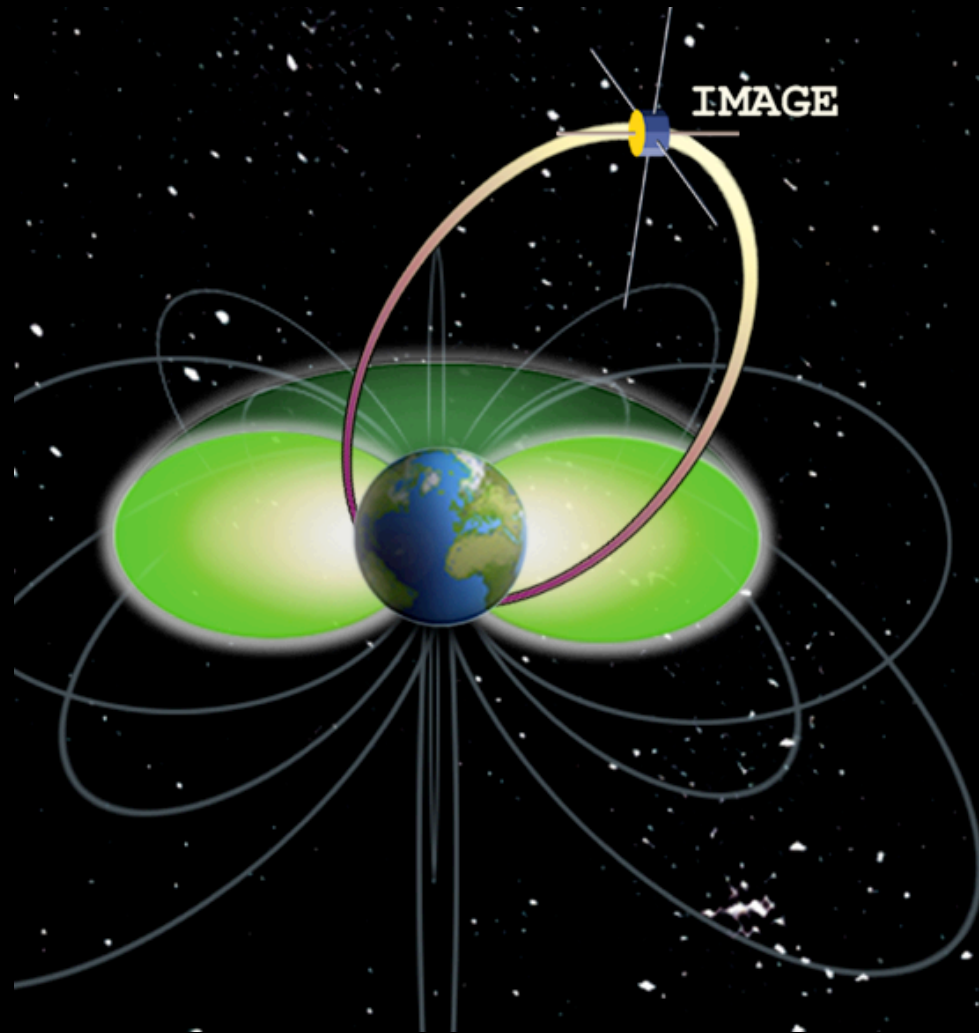


[animation courtesy W.T. Bridgman, GSFC]

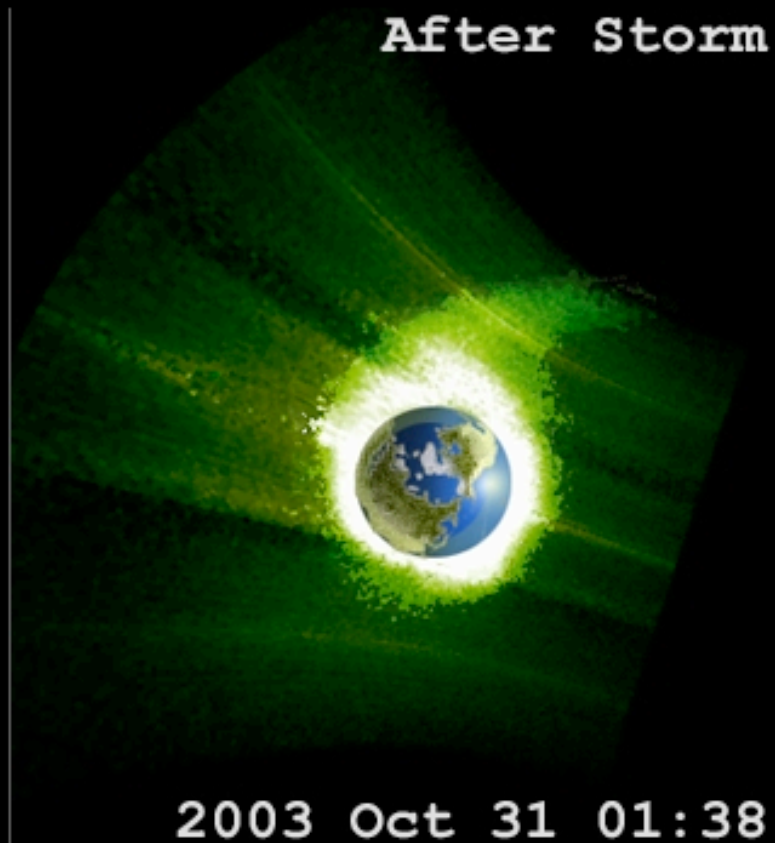
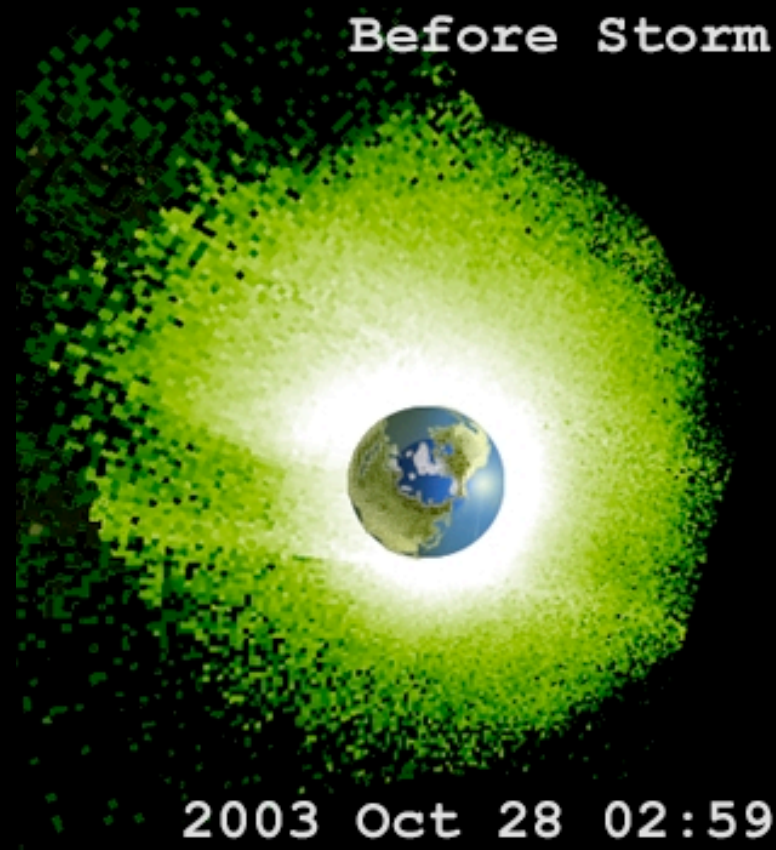
The Plasmasphere

IMAGE

EUV He⁺ ultraviolet glow



Plasmaspheric Erosion... by Space Storms!



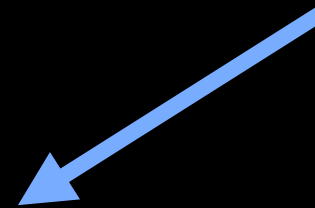
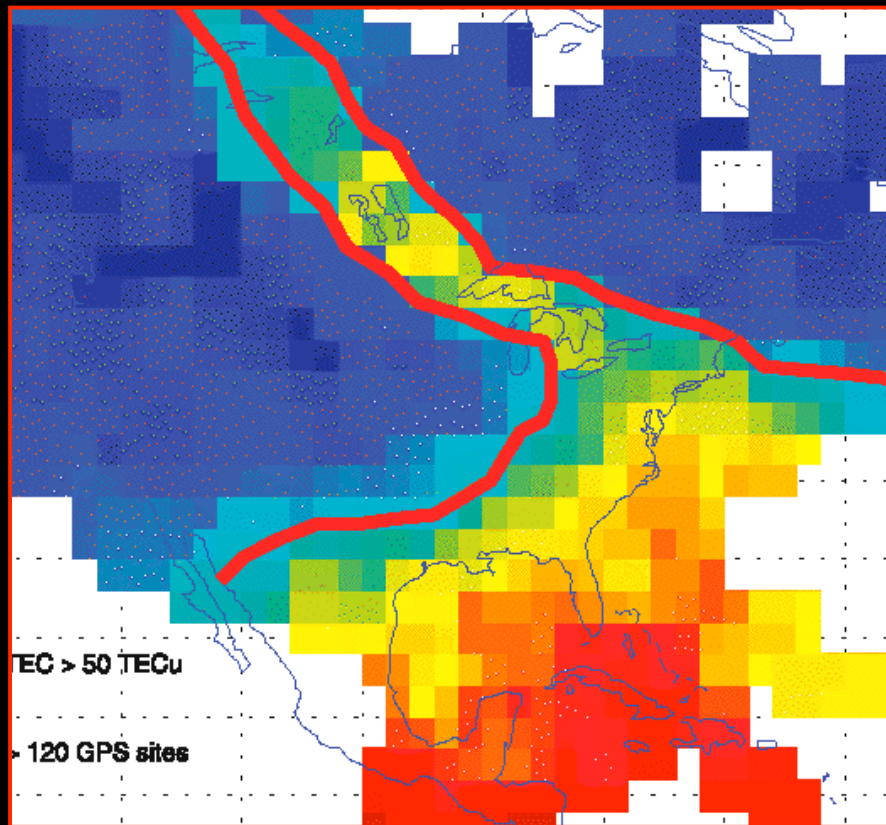
The Great "Halloween" Storm

31 October 2003

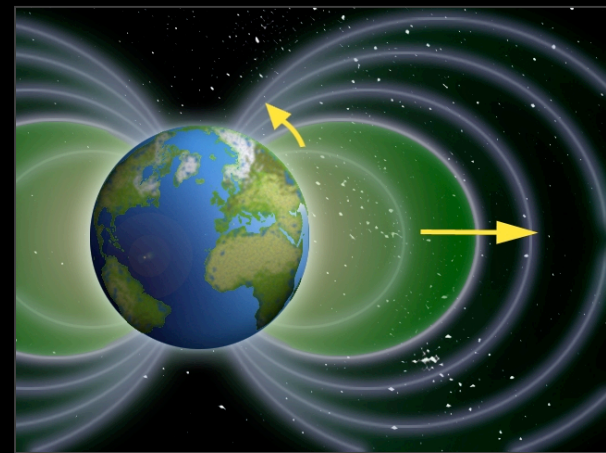
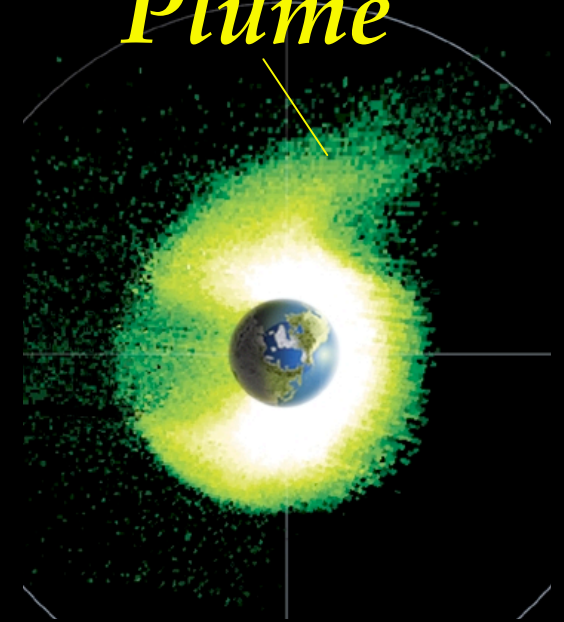
30 to 50 kV

Plasmaspheric Erosion

Ionospheric Density Enhancements

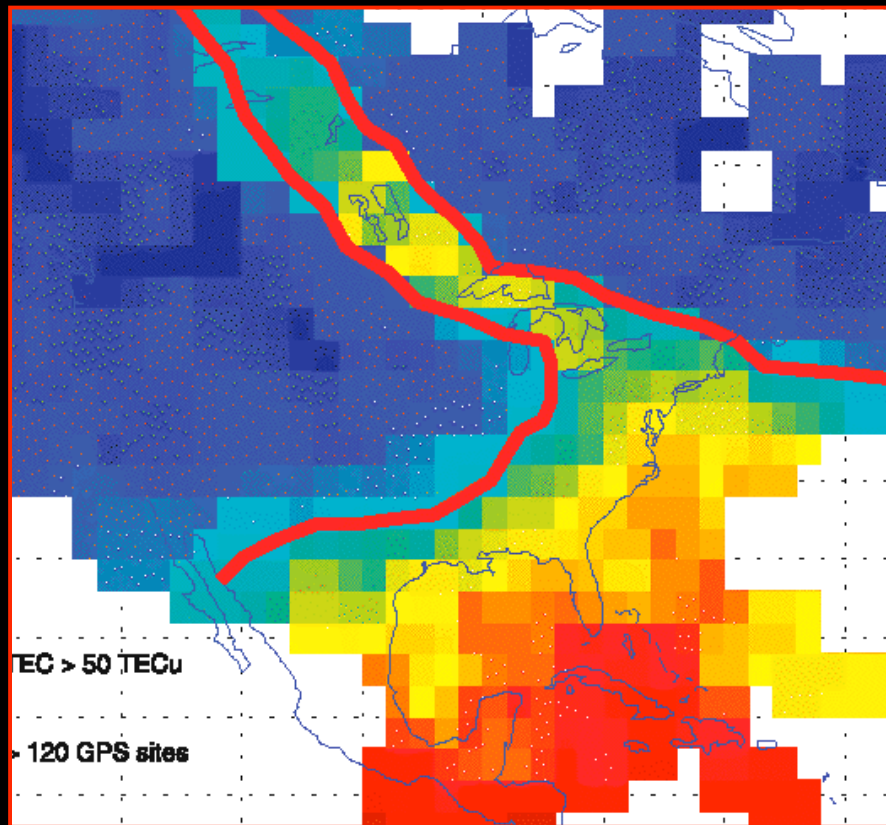


Plume

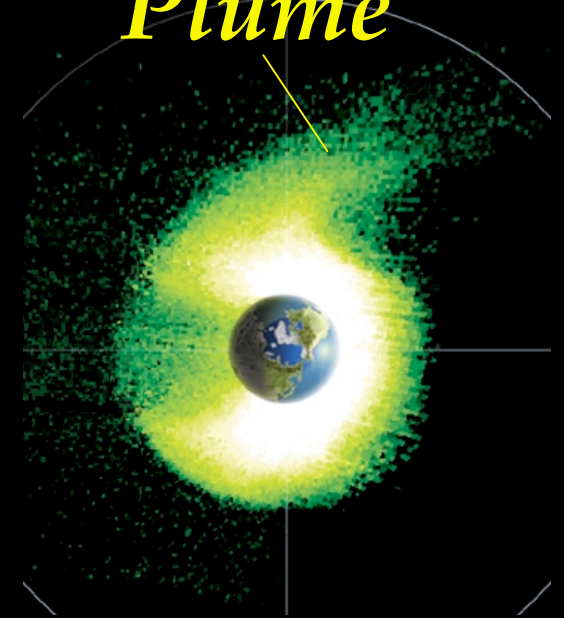


Plasmaspheric Erosion

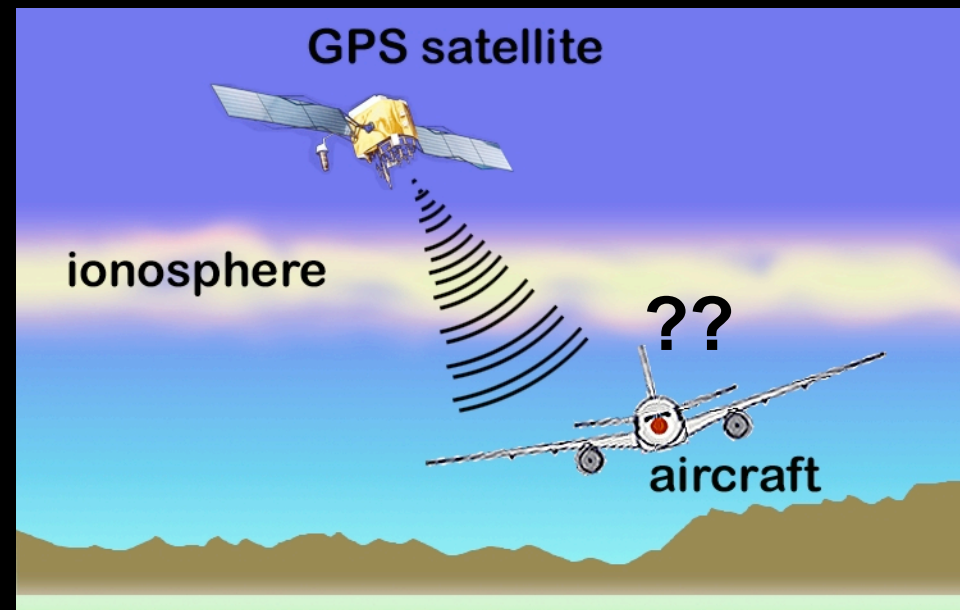
Ionospheric Density Enhancements



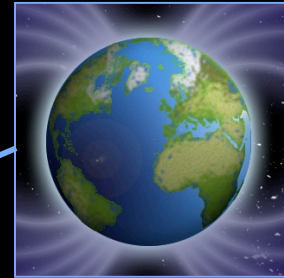
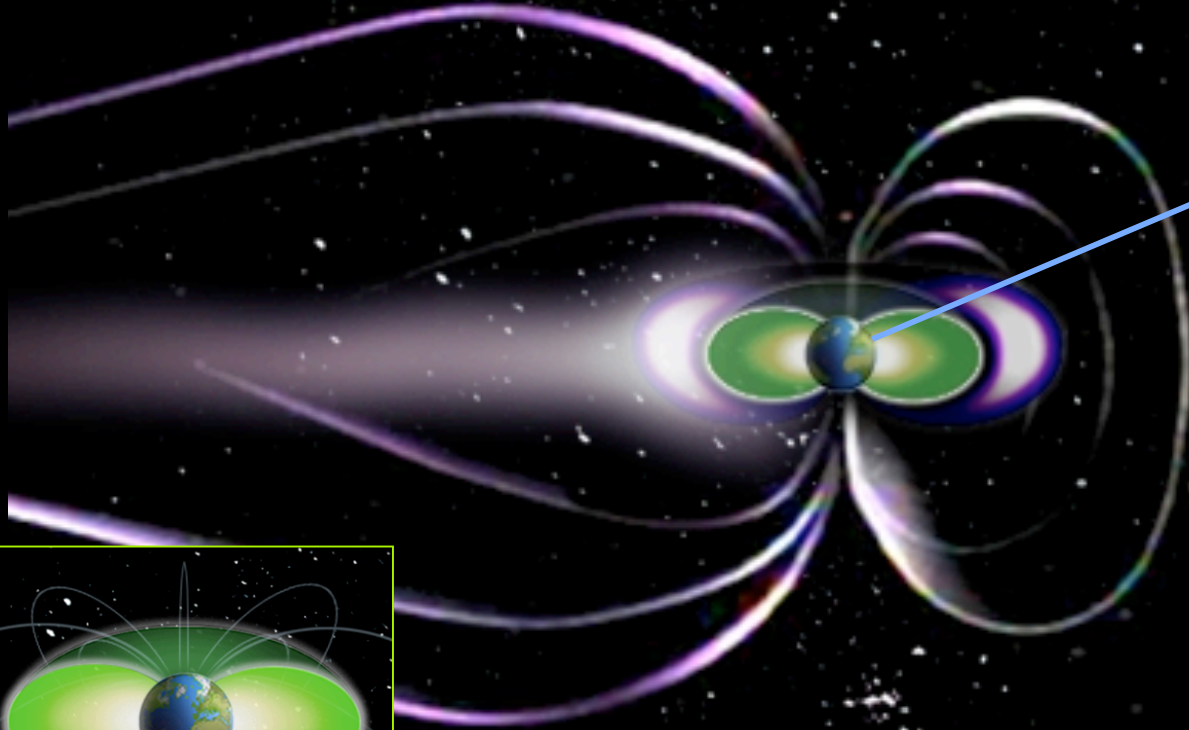
Plume



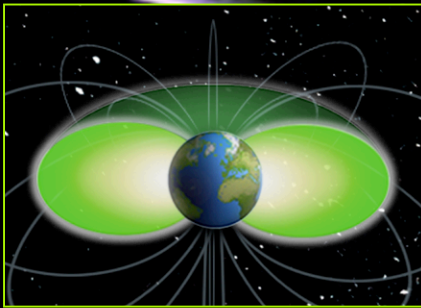
GPS Errors: Tens of Meters



The Earth's Magnetosphere



ionosphere



plasmasphere

The Aurora

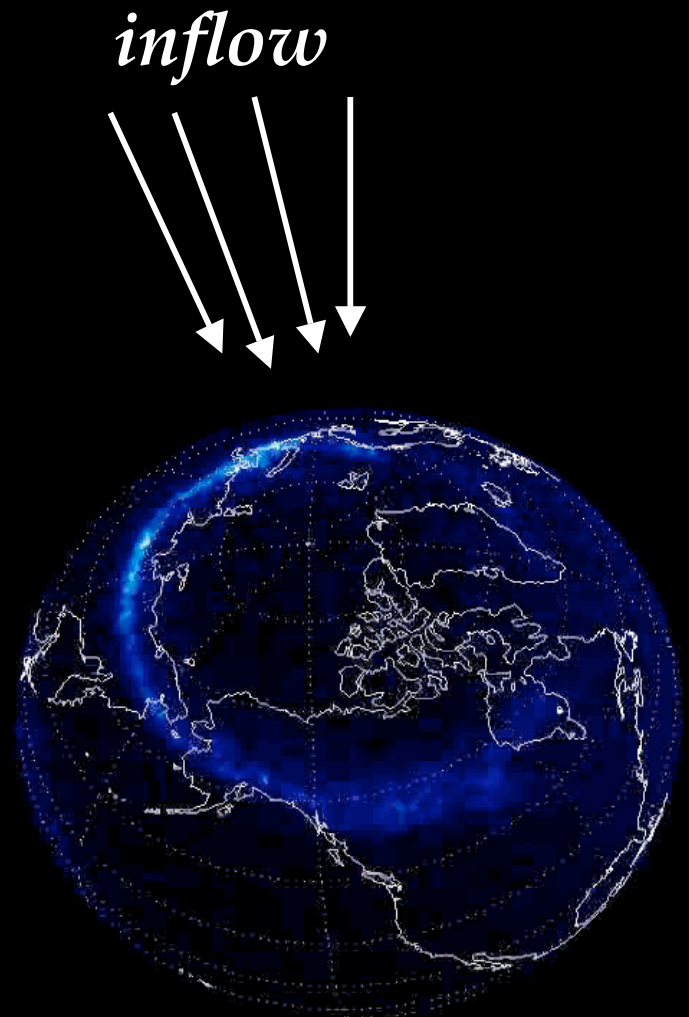
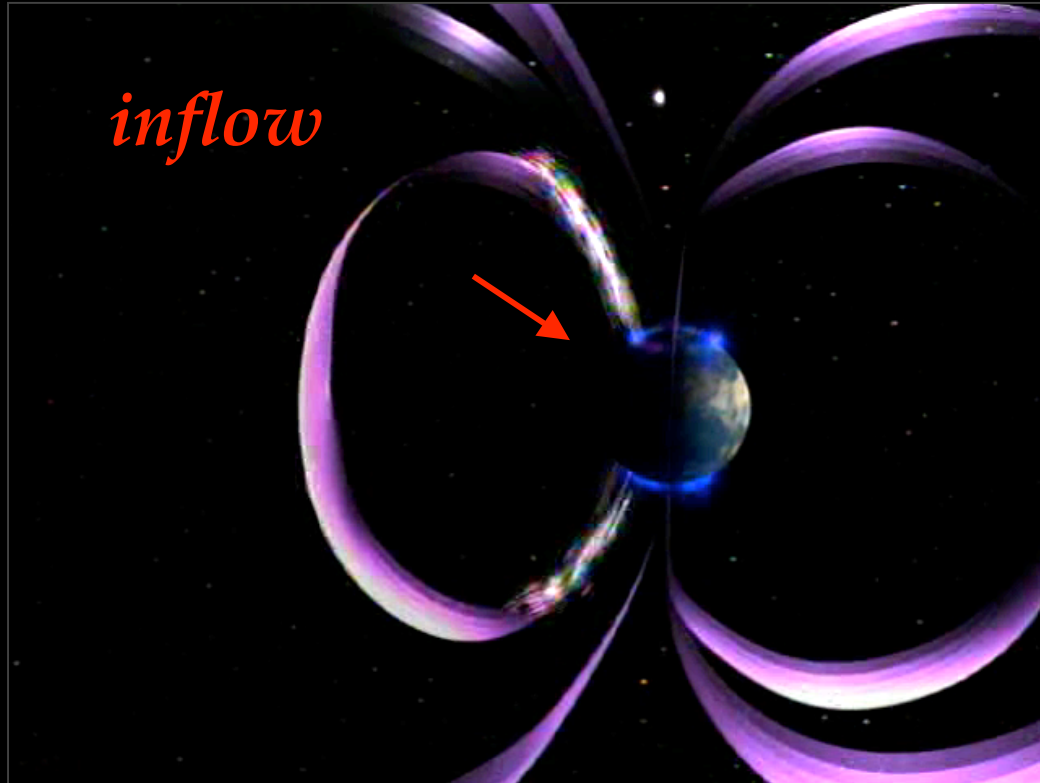
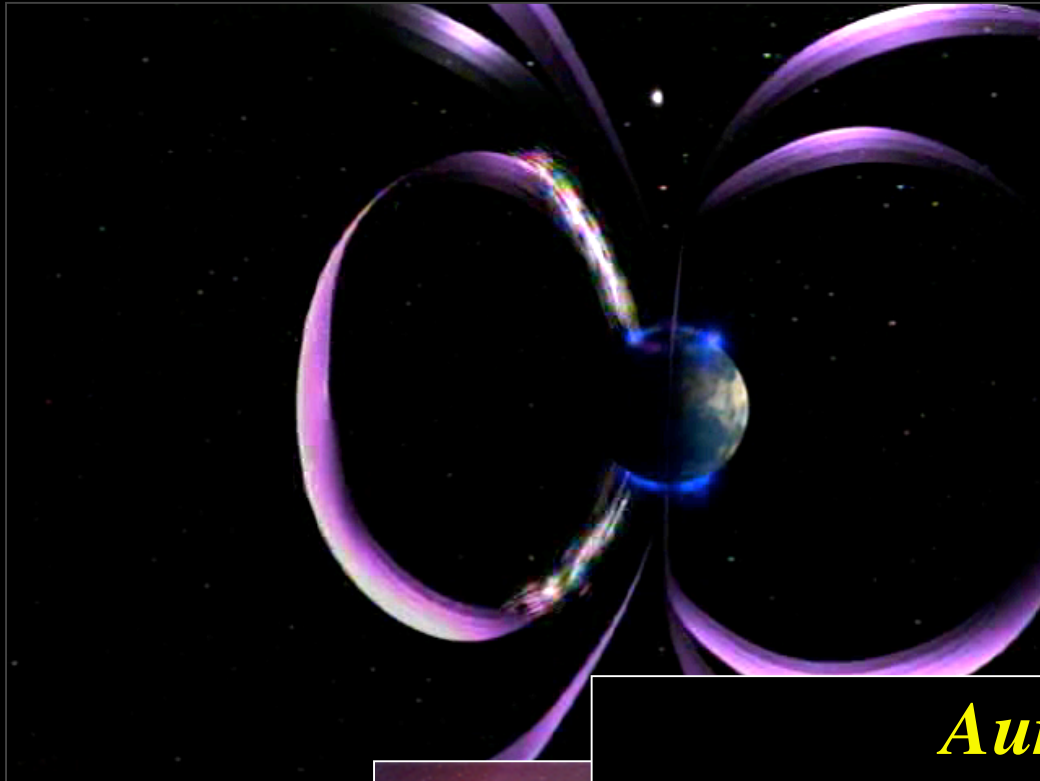


IMAGE-FUV-S112, 2000-07-15-13:30:06

The Aurora



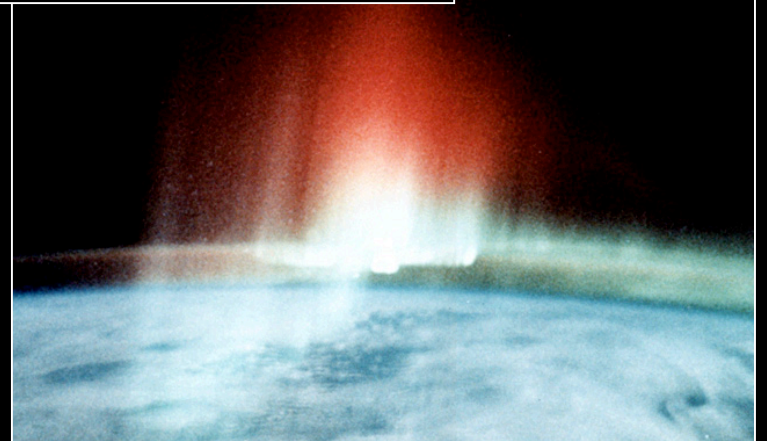
13 MARCH 1989 0745 UT



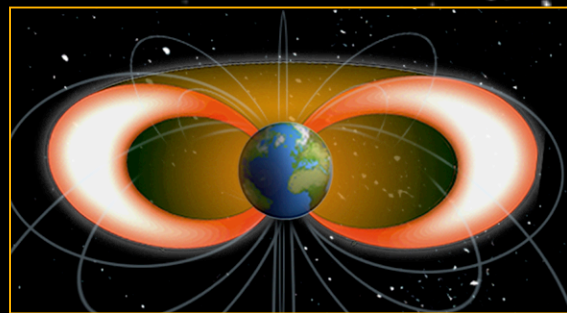
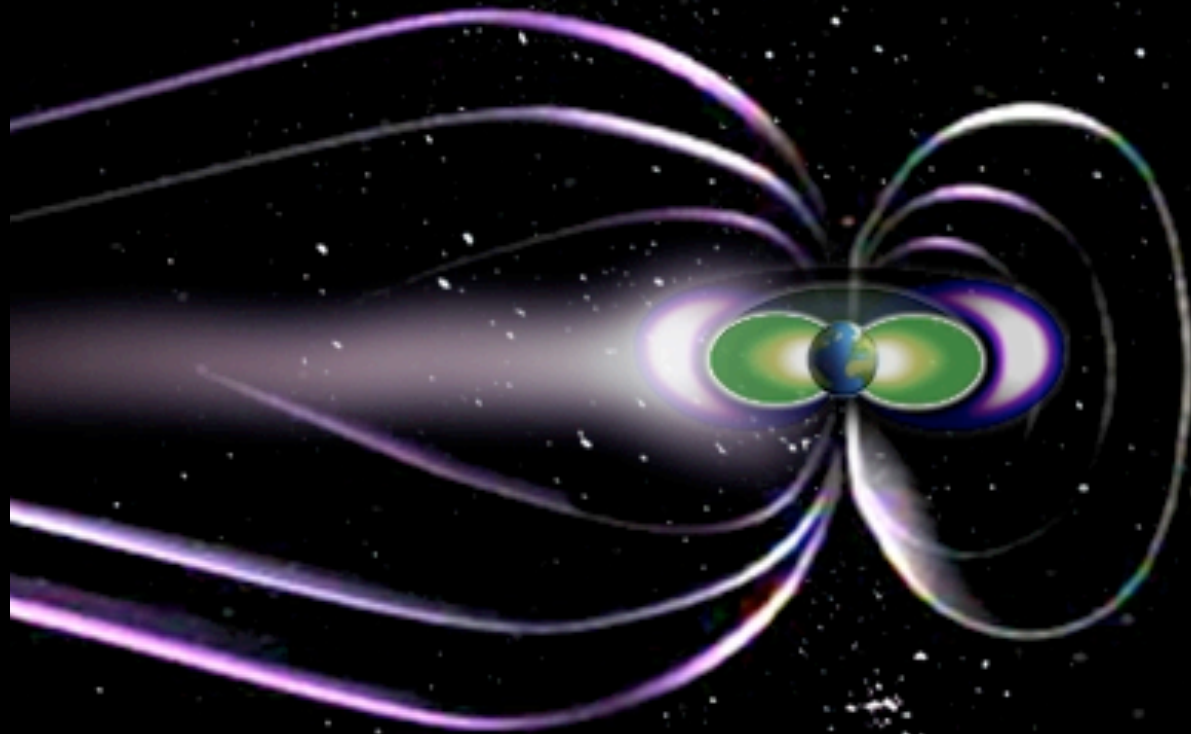
Copyright M. A. Sval, Geological Observatory, McGill University

Power outages!

*Aurorae
on the ground... and in space*

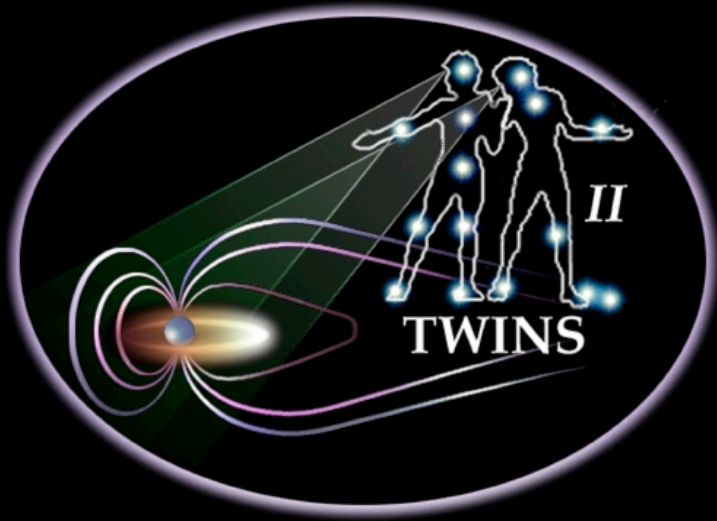


The Earth's Magnetosphere



ring current

The TWINS Mission



3D imaging: 2 spacecraft

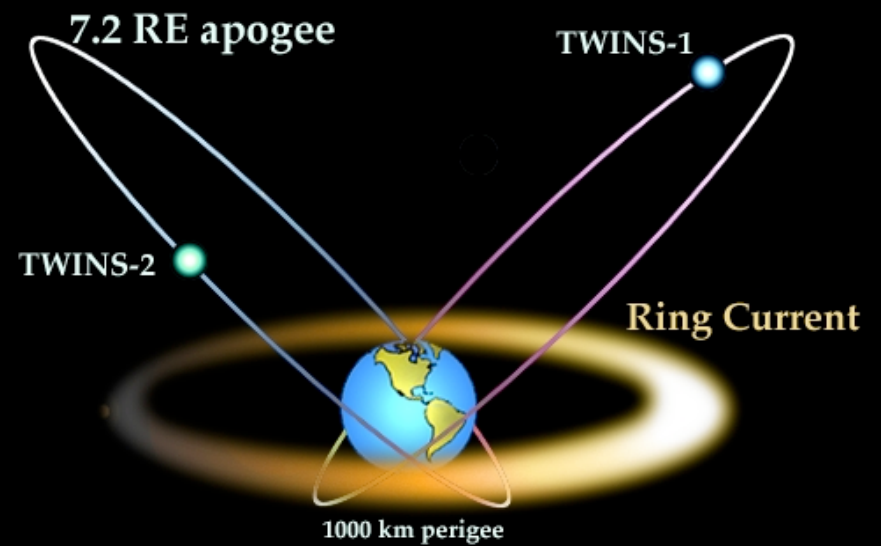
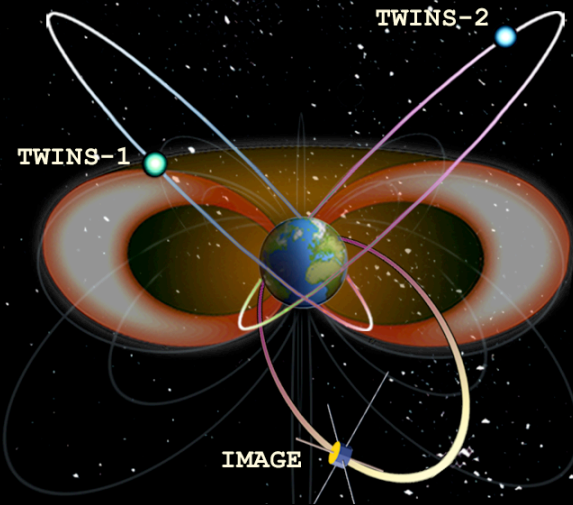
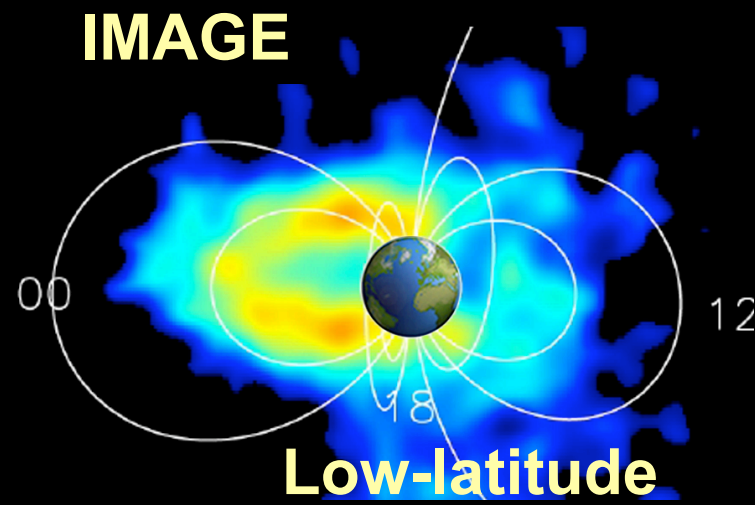
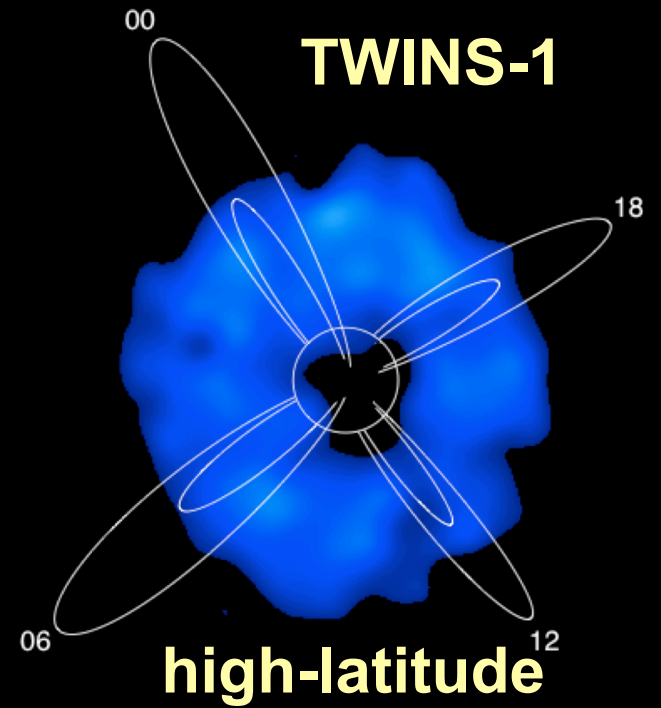


IMAGE and TWINS:
Improved 3D imaging



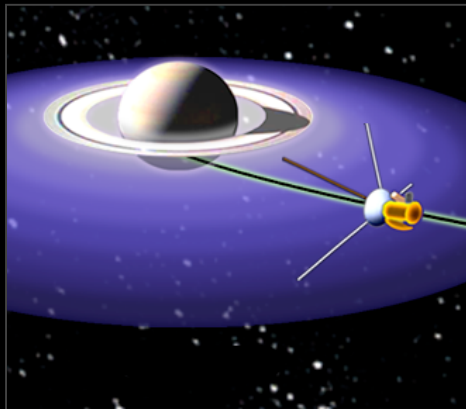
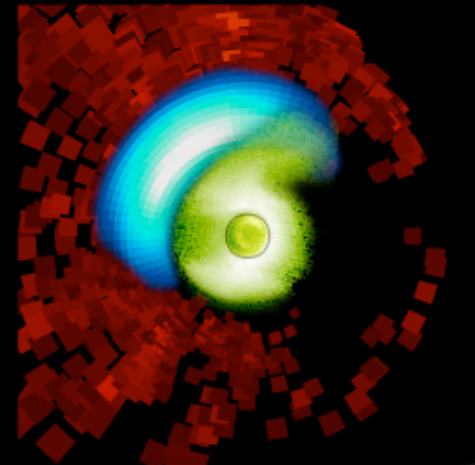
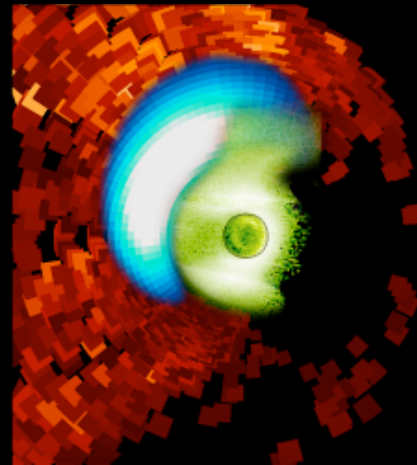
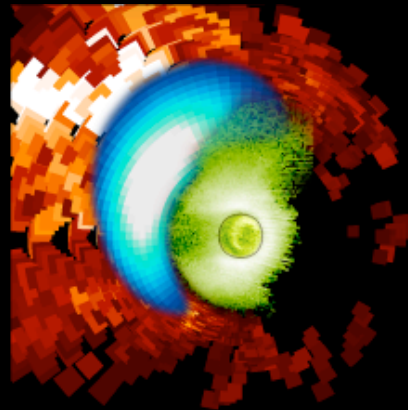
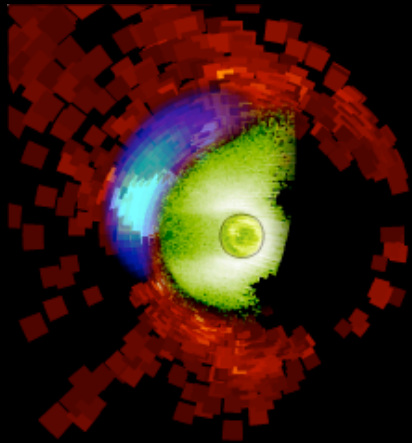
3 imagers!



Research Opportunities *Magnetospheric Physics*

Earth

IMAGE TWINS



Saturn!

Cassini