

# Imager for Magnetopause-to-Aurora Global Exploration

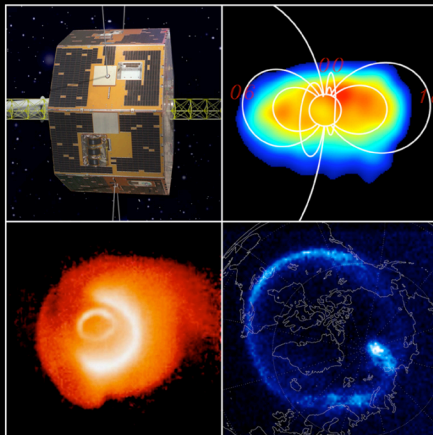
# IMAGE

Senior Review Presentation  
November 15, 2005

## Magnetospheric Imaging

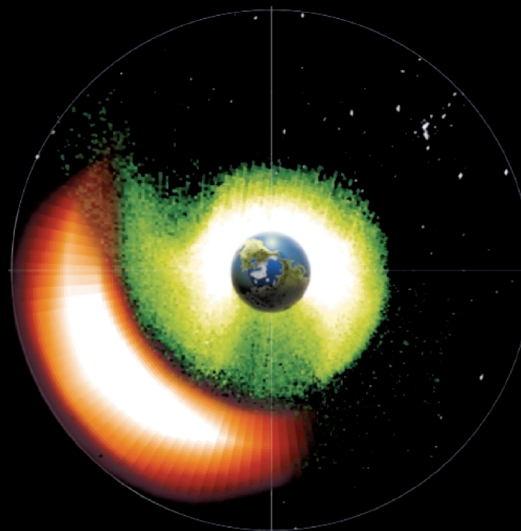
*The IMAGE Prime Mission*

Edited by  
J. L. Burch



Kluwer Academic Publishers

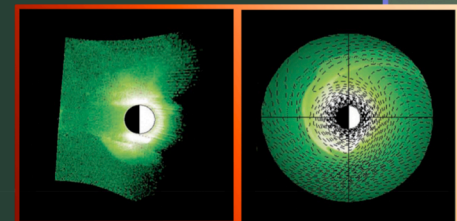
## The Inner Magnetosphere Physics and Modeling



Tuija Pulkkinen, Nikolai A. Tsyganenko,  
and Reiner H. W. Friedel, Editors

## Inner Magnetosphere Interactions

*New Perspectives from Imaging*

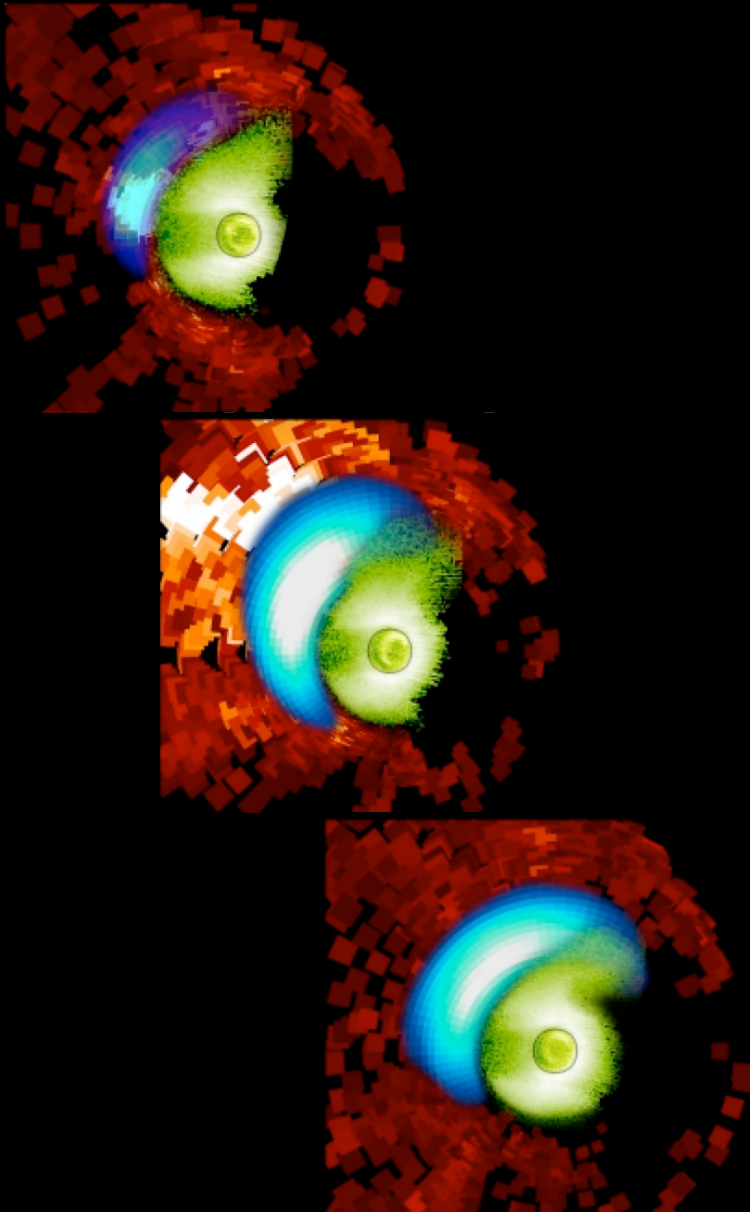
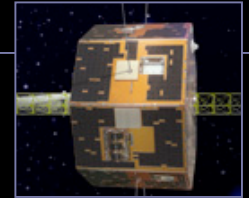


James Burch, Michael Schulz, and Harlan Spence,  
Editors

**J. L. Burch, Principal Investigator (SwRI)**  
**T. E. Moore, Mission Scientist (NASA/GSFC)**  
**J. Goldstein, Guest Investigator (SwRI)**

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## Key Topics

**IMAGE Science Themes 2007- 2010**

**Need for Continued IMAGE Mission**

**IMAGE and the S<sup>3</sup>C Great Observatory**

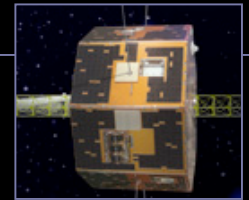
**Relevance to the S<sup>3</sup>C Roadmap**

**Recent IMAGE Results**

**IMAGE's Continuing Public Visibility**

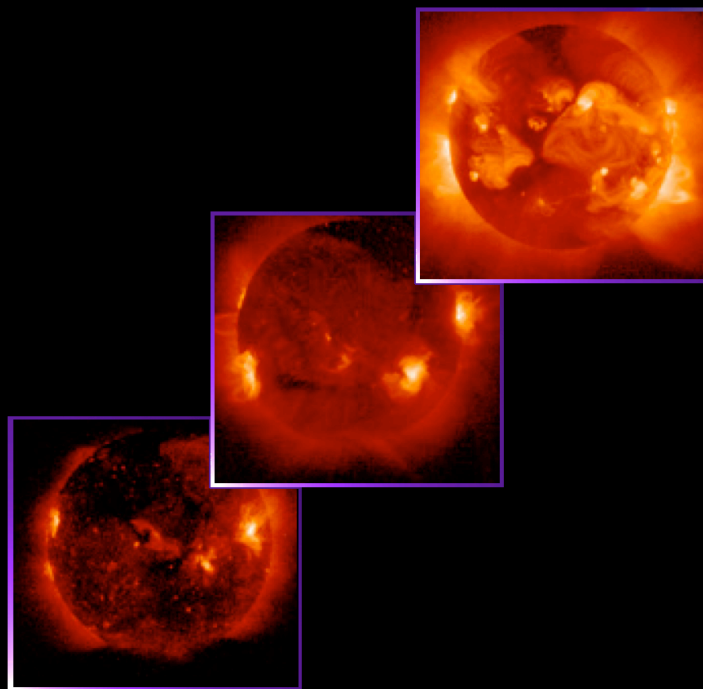
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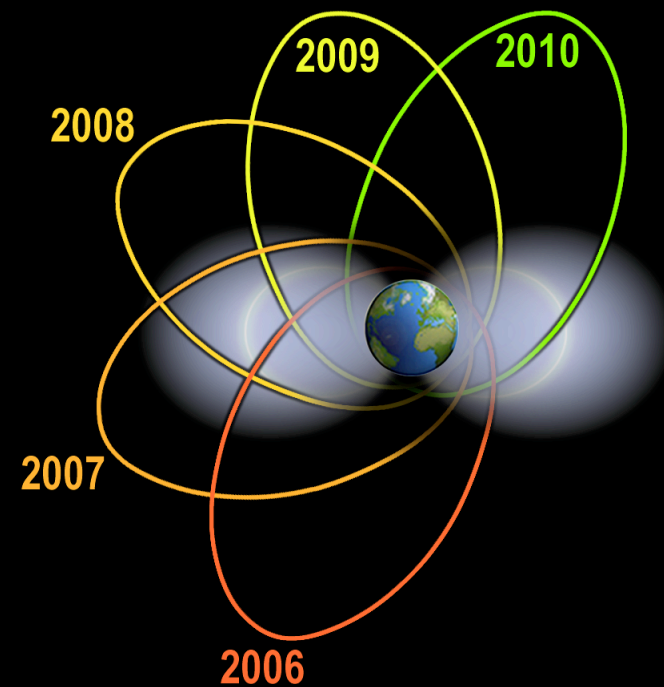
## IMAGE Extended Mission 2007 - 2010

### Solar Cycle



ascending phase

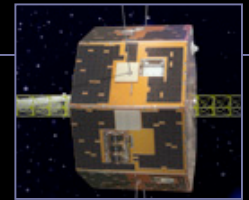
### IMAGE Orbit



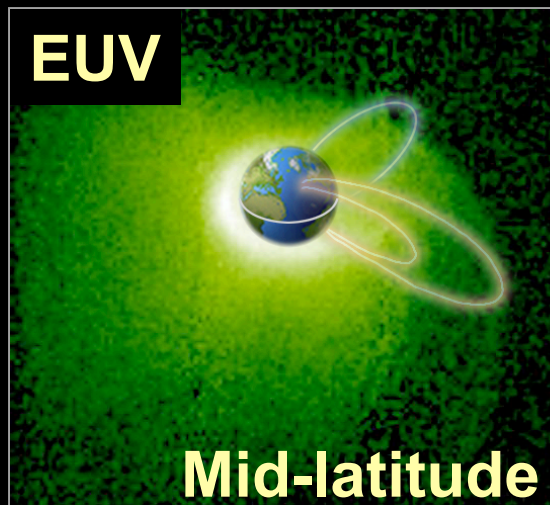
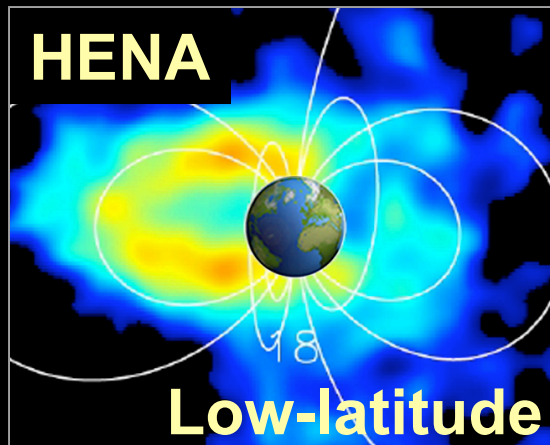
viewing from low to  
high north latitudes

# IMAGE

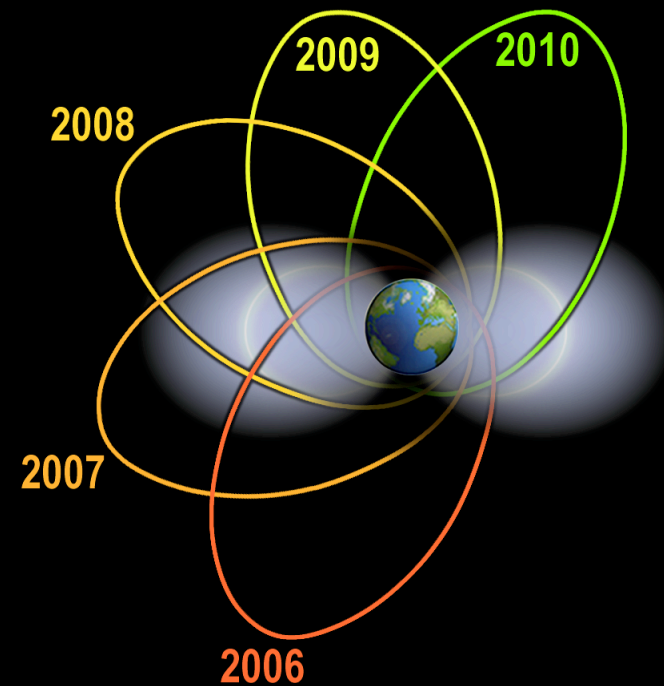
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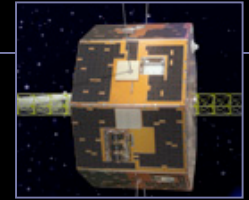
## IMAGE Extended Mission 2007 - 2010



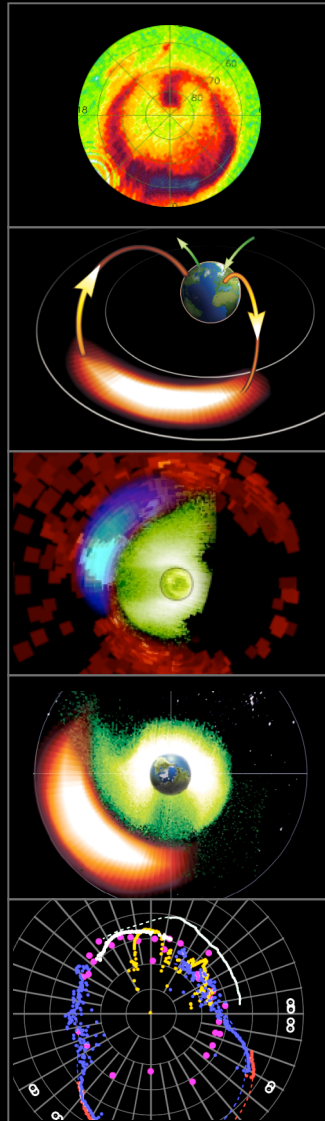
## IMAGE Orbit



viewing from low to  
high north latitudes



## Scientific Themes



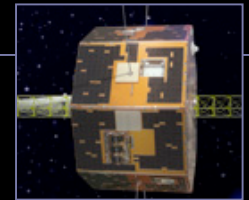
**Reconnection**

**Electrodynamic Coupling**

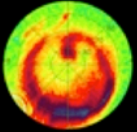
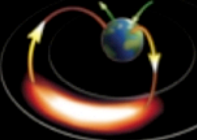
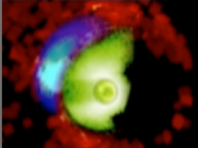
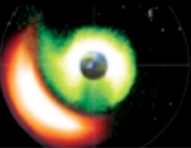
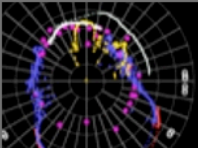
**Plasma Injection, Transport, and Loss**

**Hot-Cold Plasma Interactions**

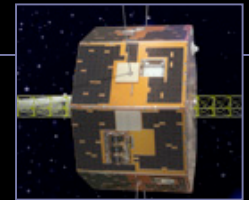
**Remote Sensing of the Heliosphere**



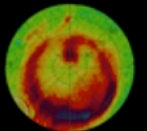
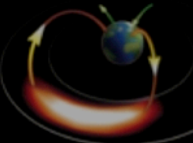
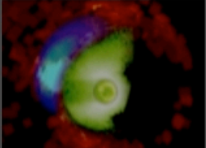
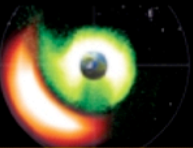
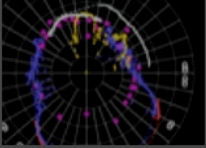
## *Application of the Scientific Method:* **From Discovery To Understanding**

	<b>Reconnection</b>	Proton aurora spot	Confirmation of continuous reconnection	Antiparallel and component recon.
	<b>Electrodynamic Coupling</b>	Plasmasphere corotation lag	Association with ionospheric lag	Auroral heating and other neutral winds
	<b>Plasma Injection, Transport, and Loss</b>	Post-midnight RC injection	Identification of IMF By dependence	Connection to skewed E-fields
	<b>Hot-Cold Plasma Interactions</b>	Subauroral proton arcs & role of IMF	Connection to EMIC waves in plumes	Wave-Particle Loss Processes
	<b>Remote Sensing of the Heliosphere</b>	Second interstellar neutral stream	Support from numerous in situ measurements	Solar-cycle dep.

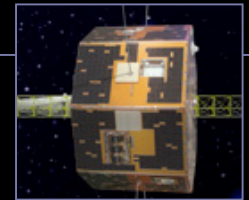
**Discovery** → **Hypothesis Testing** → **Prediction & Verification**



## *Application of the Scientific Method:* **From Discovery To Understanding**

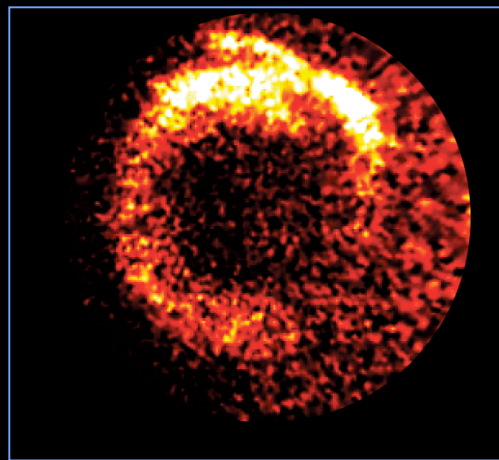
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**Discovery** → **Hypothesis Testing** → **Prediction & Verification**



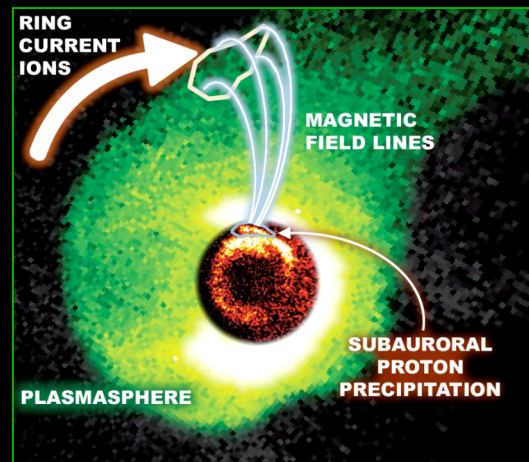
## Hot-Cold Plasma Interactions:

*From Discovery to Understanding*



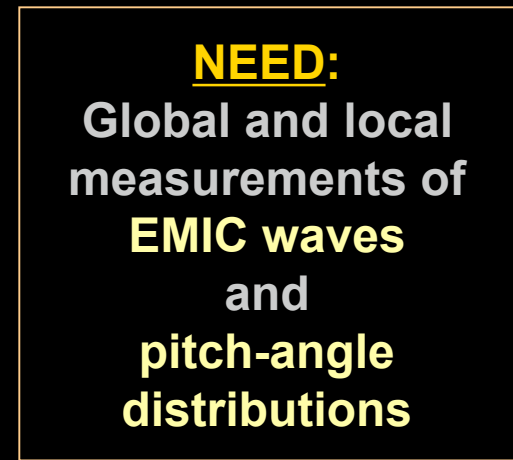
### Discovery

Detached subauroral proton arcs and the role of the IMF



### Hypothesis Testing

Connection to plumes and observation of EMIC waves in plumes



### NEED:

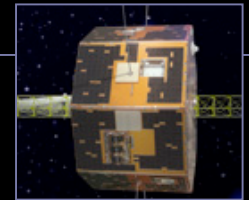
Global and local measurements of EMIC waves and pitch-angle distributions



### Prediction & Verification

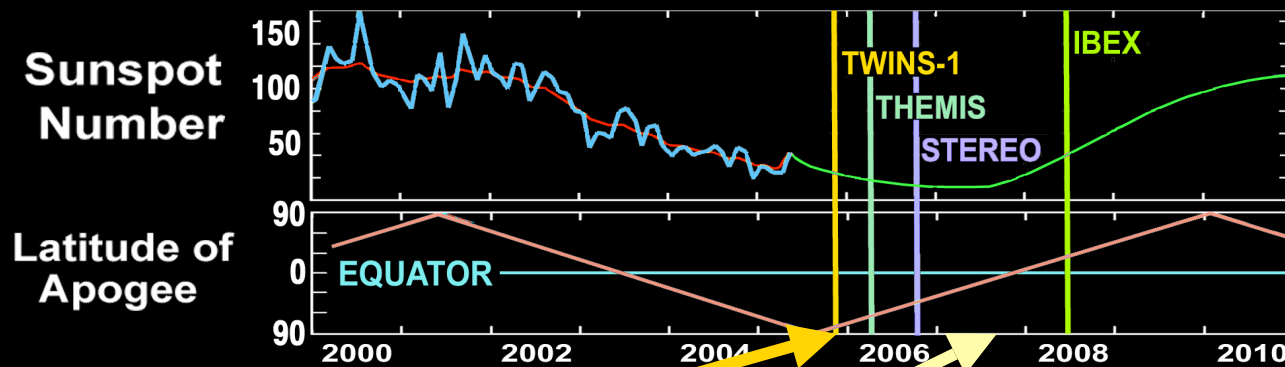
FUTURE:  
Confirmation of wave-particle loss processes & their global effect





## Understanding Wave-Particle Interactions:

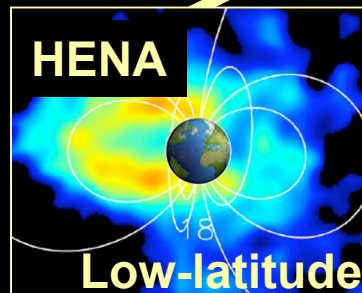
*Achieving Closure on Science Questions*



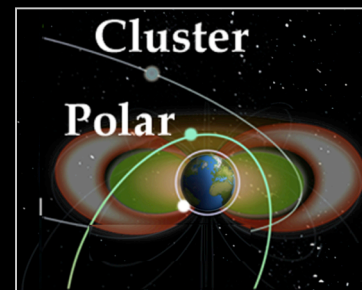
Scientific progress accelerates via collaborations with other missions of the S<sup>3</sup>C Great Observatory



Global RC pressure & pitch angles



+

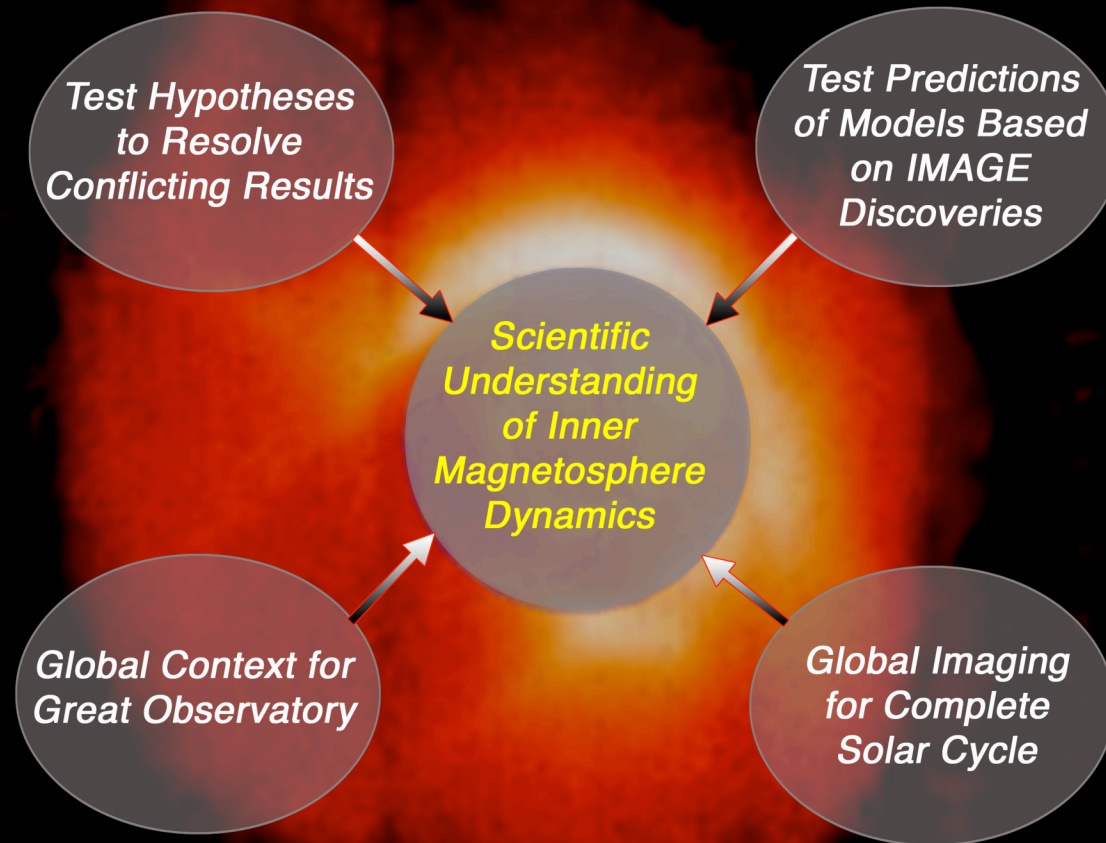
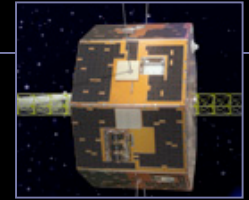


Local RC & wave observations

# IMAGE

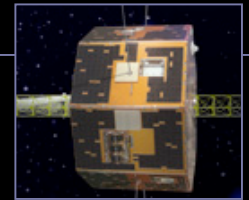
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## Need for New IMAGE Data During 2007 - 2010



# IMAGE

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## IMAGE: Cornerstone of the S<sup>3</sup>C Great Observatory

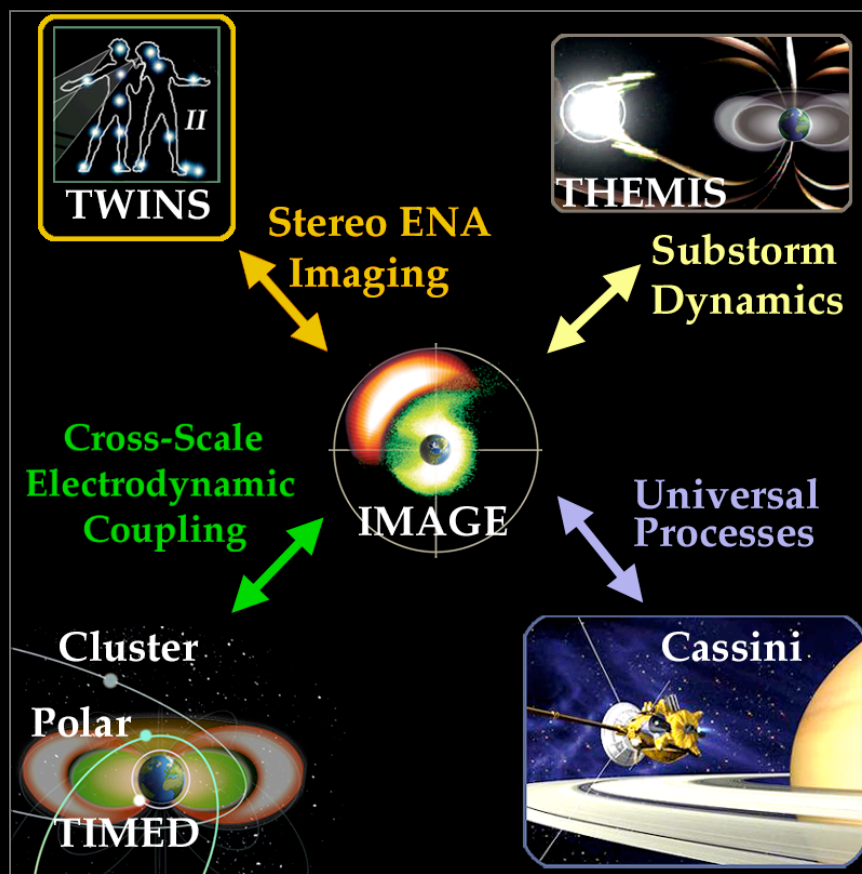


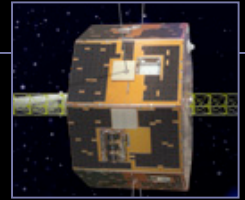
IMAGE is NASA's primary tool for auroral and magnetospheric imaging.

IMAGE will continue to add significant value to collaborative studies.

IMAGE provides the global imaging needed to constrain global simulations.

# IMAGE

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**IMAGE contributes to every major science objective in the S<sup>3</sup>C Roadmap.**

## **F: Open the Frontier to Space Environment Prediction**

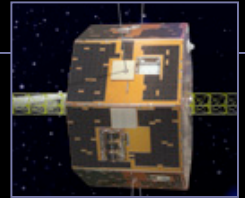
*Global monitoring of the inner magnetosphere and aurora by IMAGE plays a vital role in efforts to understand, model, and predict space weather.*

## **H: Understand the Nature of Our Home in Space**

*IMAGE provides unique global-scale data on plasma injection and transport, which will provide important tests of theories of solar wind, magnetosphere, ionosphere interactions.*

## **J: Safeguard the Journey of Exploration**

*IMAGE provides global observations that improve models and understanding of the acceleration and loss of energetic charged particles.*

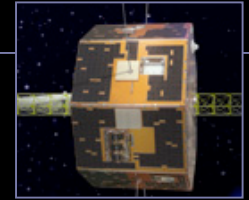


## **Examples of New Science Results**

*Since Proposal Submission*

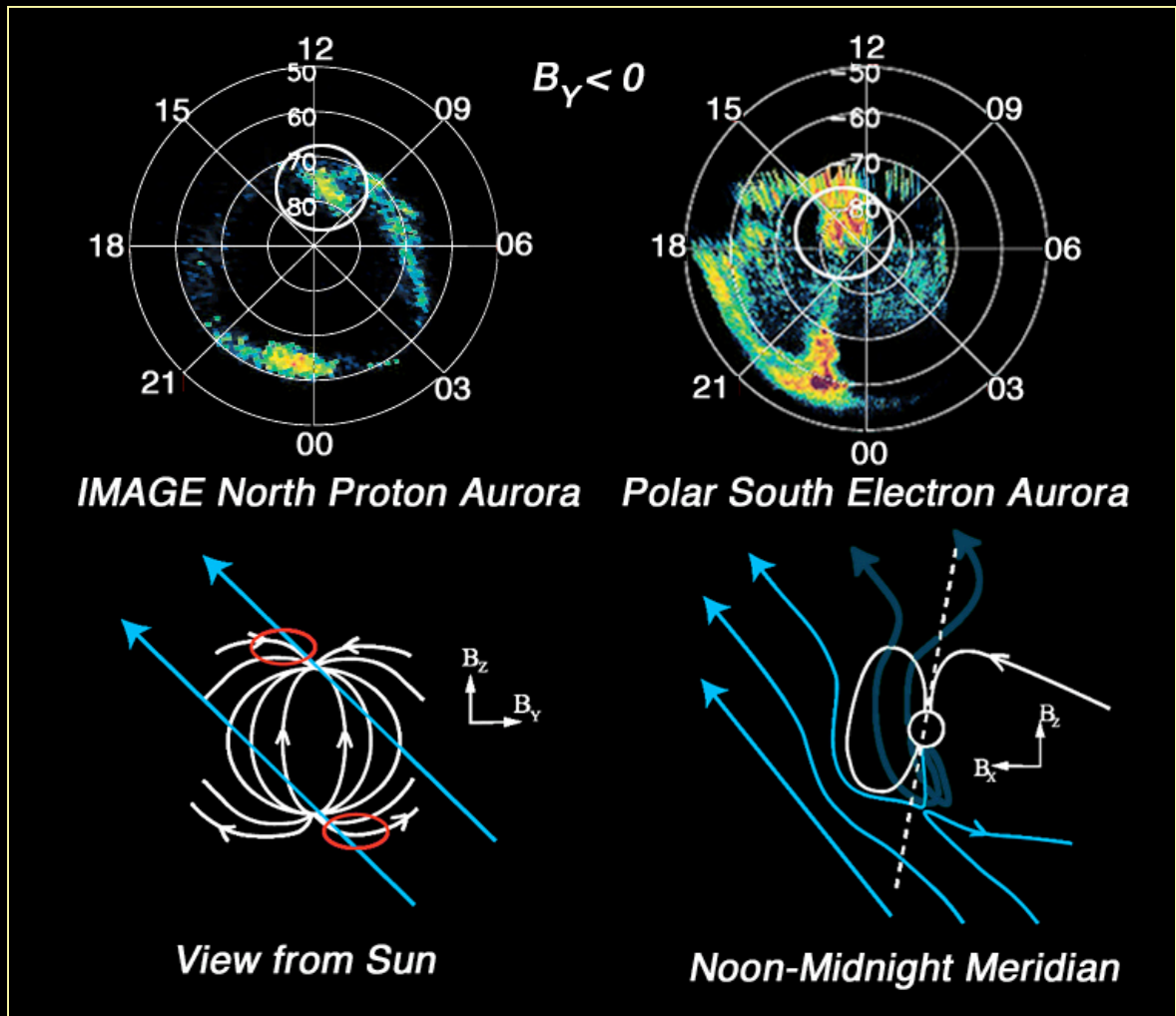
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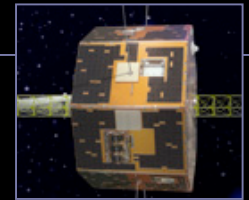
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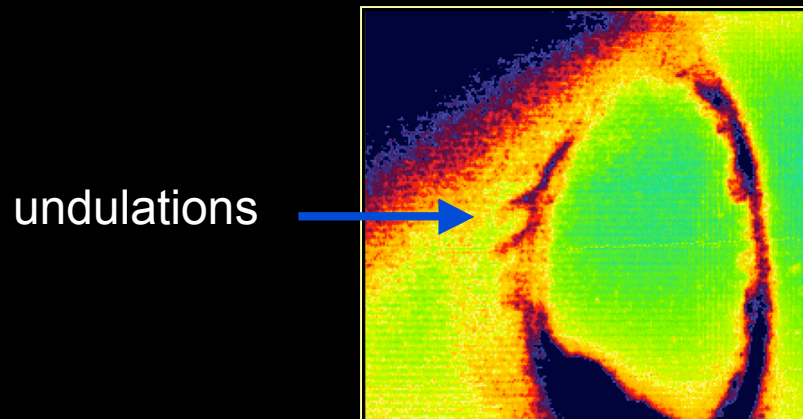
Simultaneous imaging of the reconnection spot in the opposite hemispheres during northward IMF, Østgaard, et al., in press, GRL, 2005.

- IMAGE-FUV and Polar-VIS observed reconnection spots simultaneously in North and South.
- Consistent with IMF negative  $B_y$ , the spot was in the morning sector in the N and in the afternoon sector in the S.
- Spot was several degrees higher in latitude in the S, and was connected to a theta aurora in the S but not in the N (suggested to result from tilt-angle and IMF  $B_x$  effects).

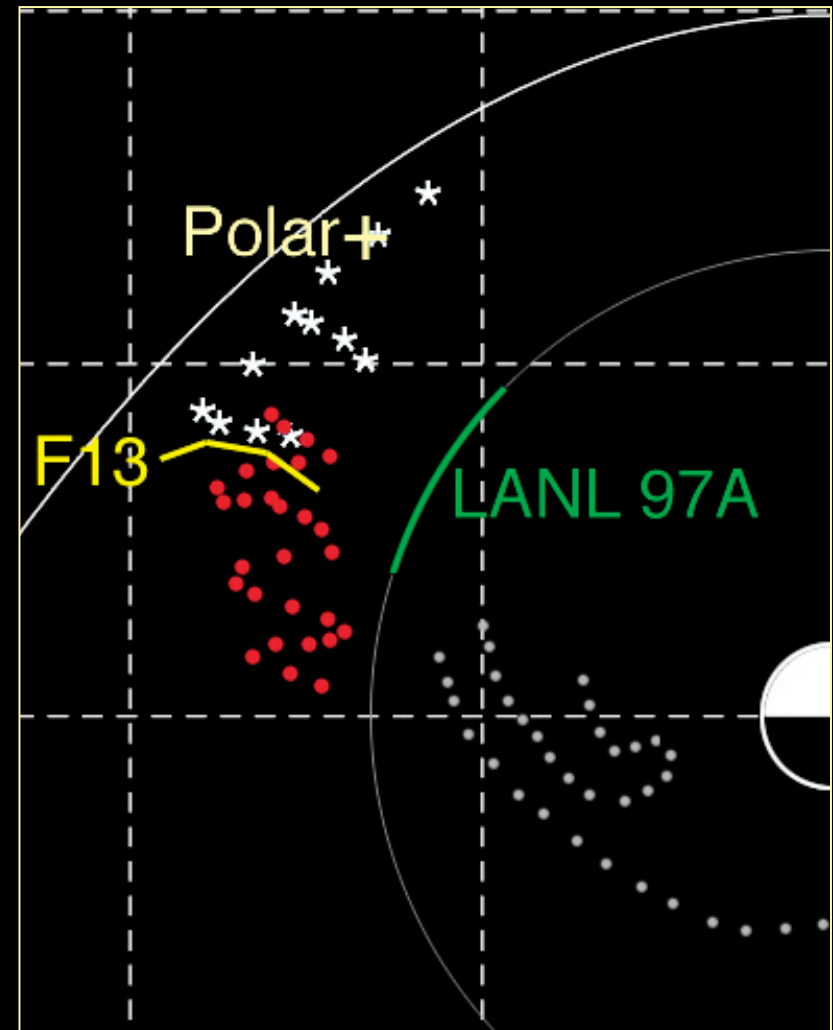




Duskside auroral undulations observed by IMAGE and their possible association with large-scale structures on the inner edge of the electron plasma sheet, W. Lewis, et al., in press, GRL, 2005.

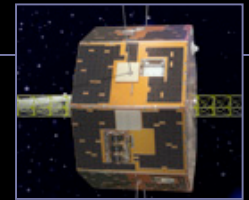


- Data from IMAGE-EUV, Polar, and DMSP showed source was beyond the plasmasphere plume at the inner edge of the electron plasma sheet.
- Simulation results suggest that undulations result from coherent, large-scale density fluctuations driven by drift wave instability.



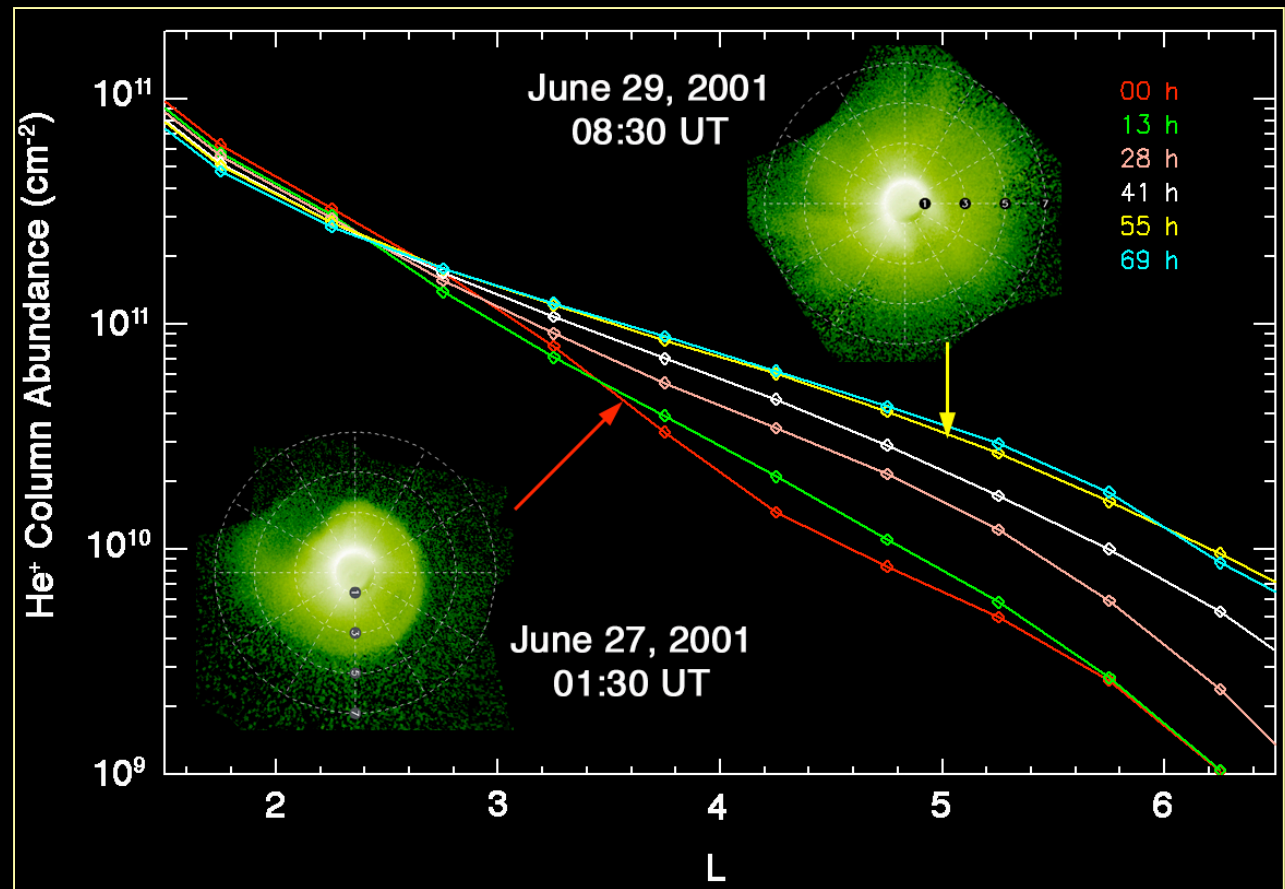
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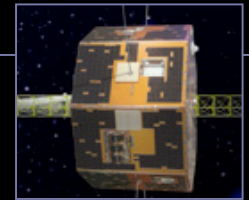


Plasmasphere refilling measurements using IMAGE-EUV data, B. R. Sandel and M. Denton, in preparation, 2005.

- Supply of plasma from the ionosphere to the plasmasphere is a fundamental aspect of MI coupling.
- IMAGE EUV can contribute a global view, and sample many radial profiles simultaneously.
- Previous studies assumed strict corotation (which IMAGE has shown does not hold) to track refilling of plasmasphere flux tubes.



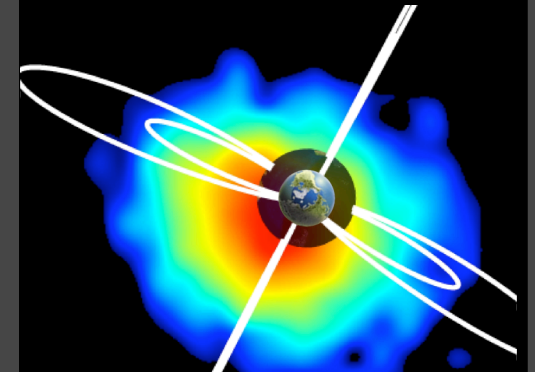
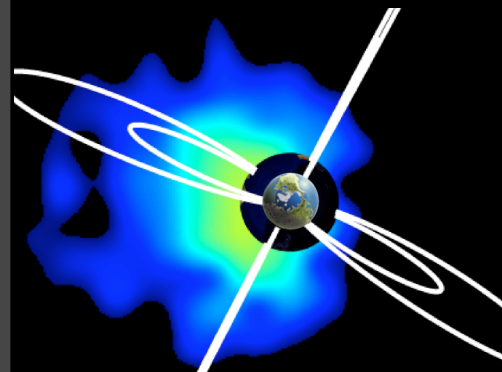




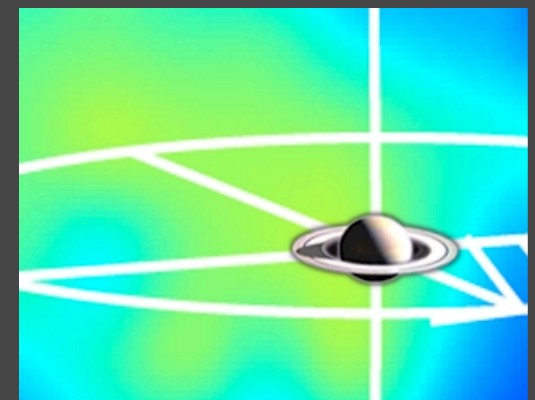
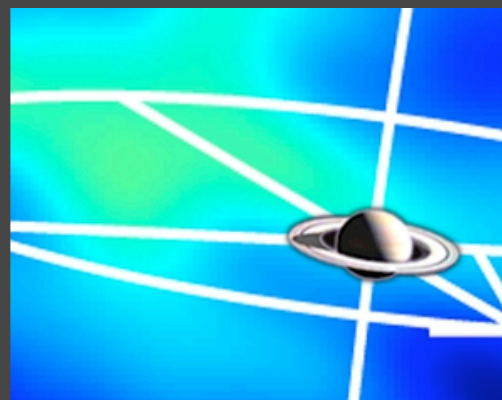
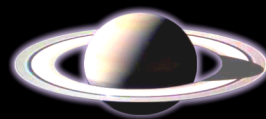
## Lessons from IMAGE HENA Reveal Oxygen Substorms at Saturn In preparation, 2005

- IMAGE HENA: Energization and injection of oxygen by substorm
- Cassini INCA: Similar global behavior observed at Saturn.
- Identification facilitated by experience with terrestrial ENA observations.
- Universal processes of transport and loss of plasma

### EARTH

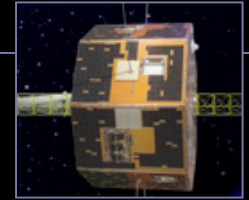


### SATURN



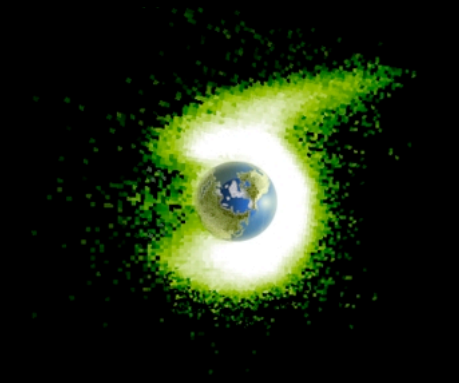
### SUBSTORMS

Sudden brightening of oxygen ENAs indicates substorm energization

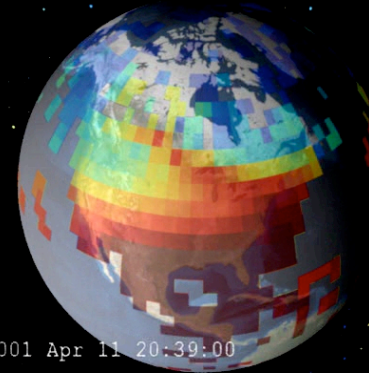
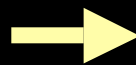


## Keeping S<sup>3</sup>C Science in the Public Eye: *IMAGE Space Science Updates & Press Conferences Since the Last Senior Review*

Stormy Space Weather Slips Through The Cracks	03 Dec 2003
An Unusual Light Show	10 Nov 2004
Earth's Safe Zone Became Hot Zone During Legendary Solar Storm	15 Dec 2004
Lightning Maintains Safe Zone Between Radiation Belts	08 Mar 2005
Scientists Find Earth's Auroras Aren't Mirror Images	04 Apr 2005
<b>NASA - NSF Team Discovers Space Weather "Cold Fronts"</b>	<b>05 Dec 2005</b>



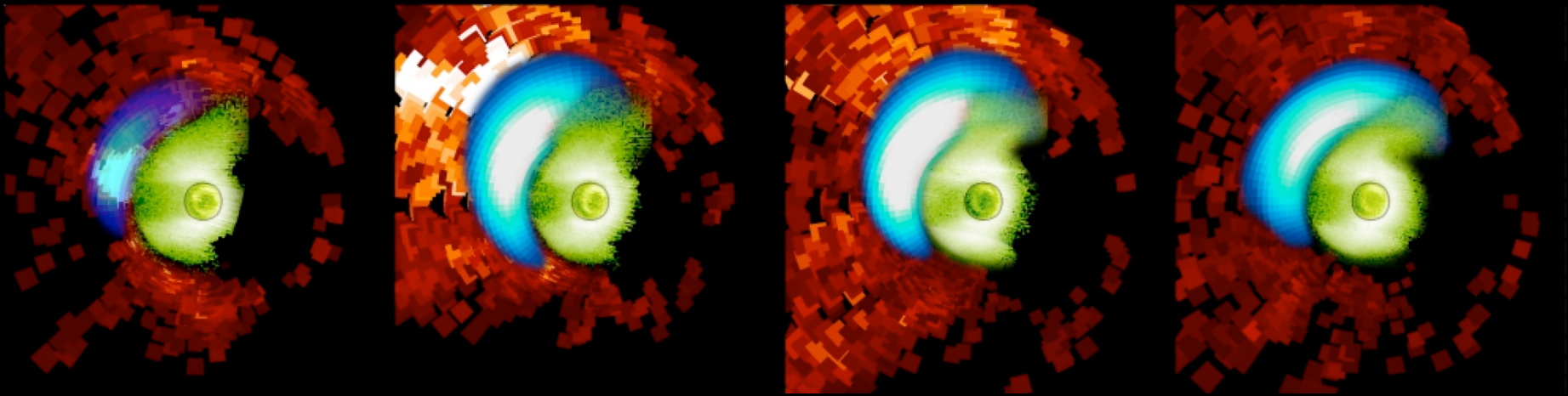
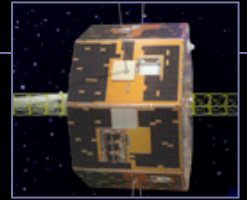
New Understanding  
of Space Storms



Predicting GPS Disruptions

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*Questions?*