Canadian Space Agency | Agence spatiale canadienne

Canadian Space Weather Activities in support to the International Space Weather Initiative

Forty-Seventh Session of the Scientific and Technical Subcommittee of COPUOS

February 15, 2010

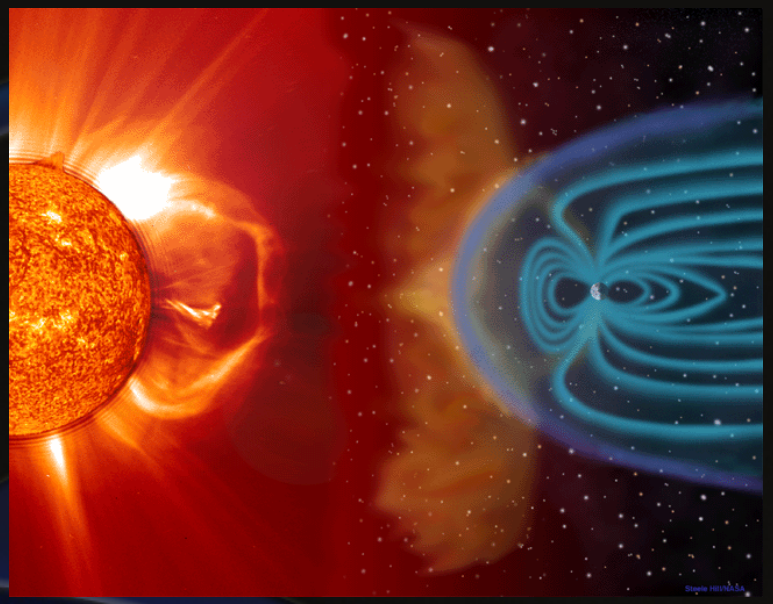
Dr. David Kendall
Canadian Space Agency

Canada

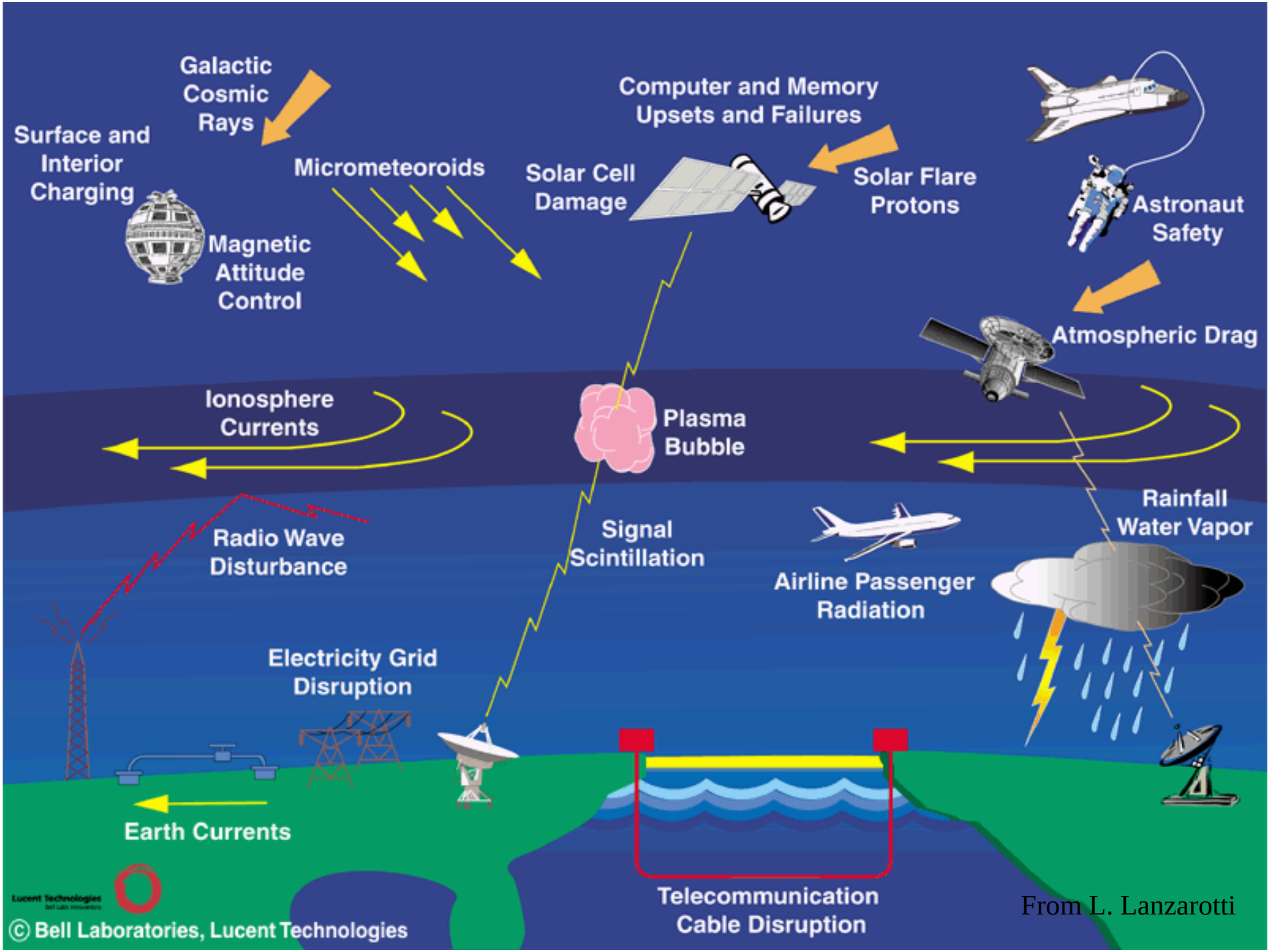
Canadian Space Agency | Agence spatiale canadienne

What is Space Weather?

Space Weather refers to conditions on the Sun and in the solar wind, magnetosphere, ionosphere and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health



Canada



From L. Lanzarotti

National and Global Concerns

- Space weather is a significant concern to Canada
  - Northern geographic location
  - Reliance on telecommunications
- Space weather is a global issue
  - Countries rely more and more on telecommunications and related technologies; e.g., Global Positioning Systems
- Space weather has potential effect on climate change
- Space weather processes continue to challenge the scientific community
  - Predicting solar eruptions
  - Understanding of solar wind disturbances
  - Potential effects of “super-storm” conditions

The best-known example of a space weather event is the collapse of the Hydro-Quebec power grid on March 13, 1989. It lasted more than 9 hours and affected 6 million people (estimated loss $2B).

A geomagnetic storm on January 20, 1994 knocked out two Canadian communications satellites, Anik E1 and E2 for eight months and the international communication satellite Intelsat K.

A Coronal Mass Ejection on January 7, 1997 caused the loss of the AT&T Telstar 401 communication satellite (a $200 million value).

Transpolar routes flown by airplanes are particularly sensitive to space weather, in part because of Federal Aviation Regulations requiring reliable communication over the entire flight.

"At least $30 billion in satellite revenue could be lost if an intense solar proton event, similar in magnitude to the historic flares of 1859, is unleashed during an upcoming solar cycle."

Canadian Space Agency | Agence spatiale canadienne

Canadian contributions

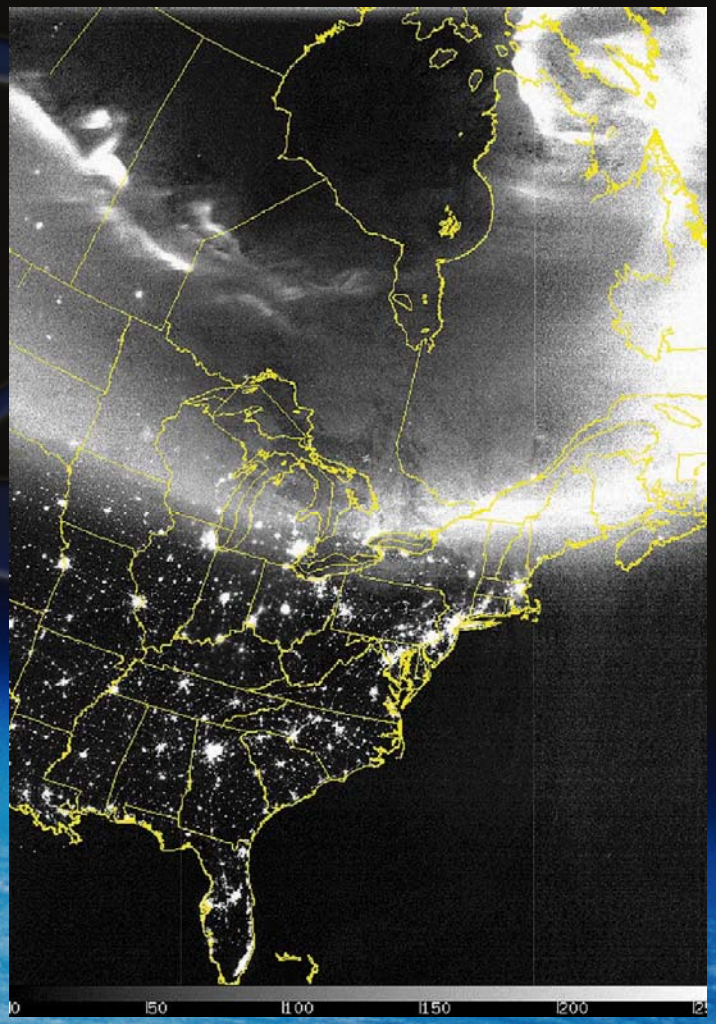
- Canada has a long history of studying Space Weather
- Canadian Geospace Monitoring Network
- THEMIS Ground-based Observatory (with NASA)
- Resolute Bay Incoherent Scatter Radar (with NSF/US)
- Enhanced Polar Outflow Probe satellite (e-POP)
- Canadian instrument onboard SWARM Satellites (ESA)
- Space Weather Forecasting Service
- Future: Global Auroral Imaging, SCOPE (with JAXA)

Canada

Canadian Space Agency | Agence spatiale canadienne

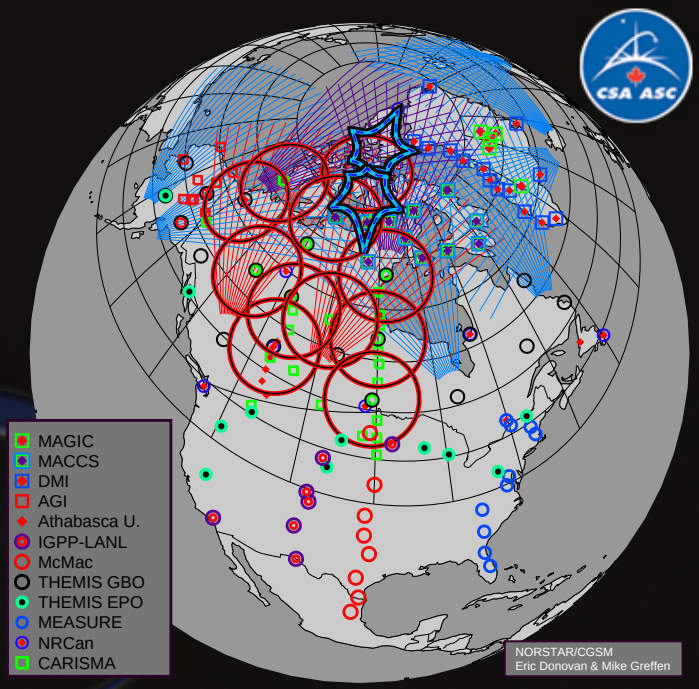
Canadian Geospace Monitoring

- World's largest and most advanced ground-based network:
  - More than 100 scientific instruments (magnetometers, radiometer, HF radars, Ionosondes, GPS receivers).
- Operated by the Canadian Space Agency and Natural Resources Canada.
- Forecast service with more than 300 users



Canadian Space Agency | Agence spatiale canadienne

Canadian GeoSpace Monitoring Program



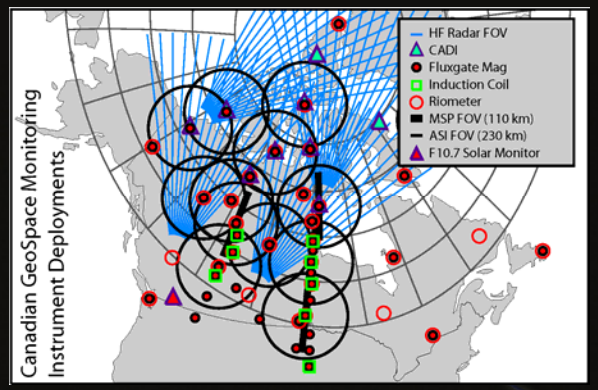
Networked monitoring of near-Earth space

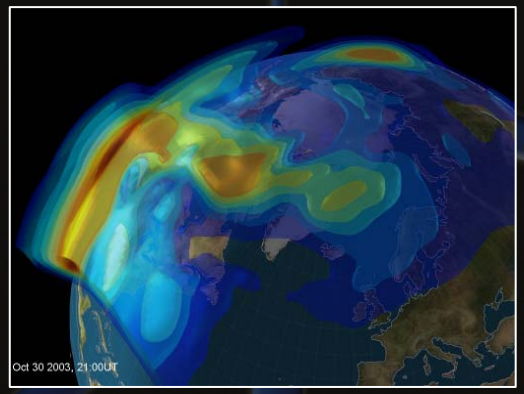
- Solar monitoring
- Magnetic observations
- Ionospheric plasma observations
- Energetic particle precipitation observations
- Numerical modelling and data assimilation
- Space weather modelling and forecasting

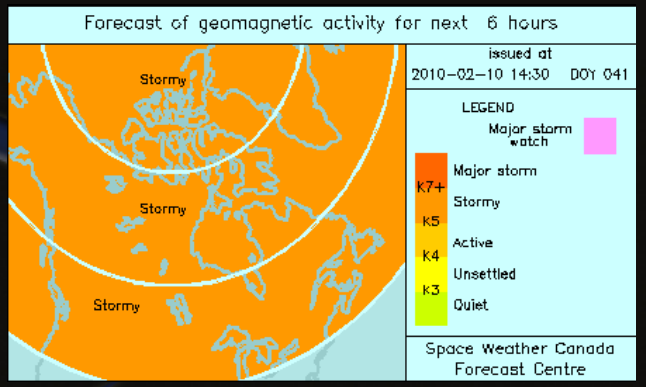
…a major contribution to international space science

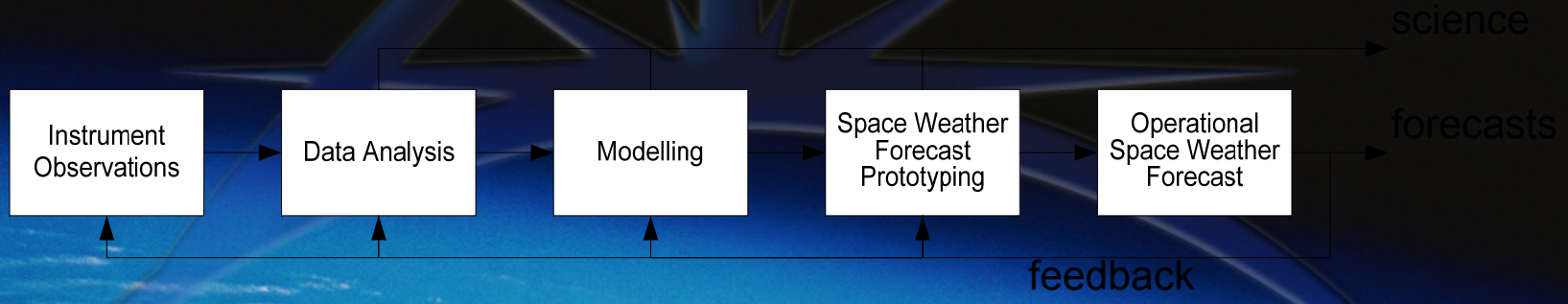
Canada

Program Elements









Canadian Space Agency | Agence spatiale canadienne

CGSM Phase 2 (2007-2012)

12 Science Contracts & Agreements (2007)

1 Operations, Maintenance & Engineering Services Contract (2008)

1 Information Technology Services Contract (2010)

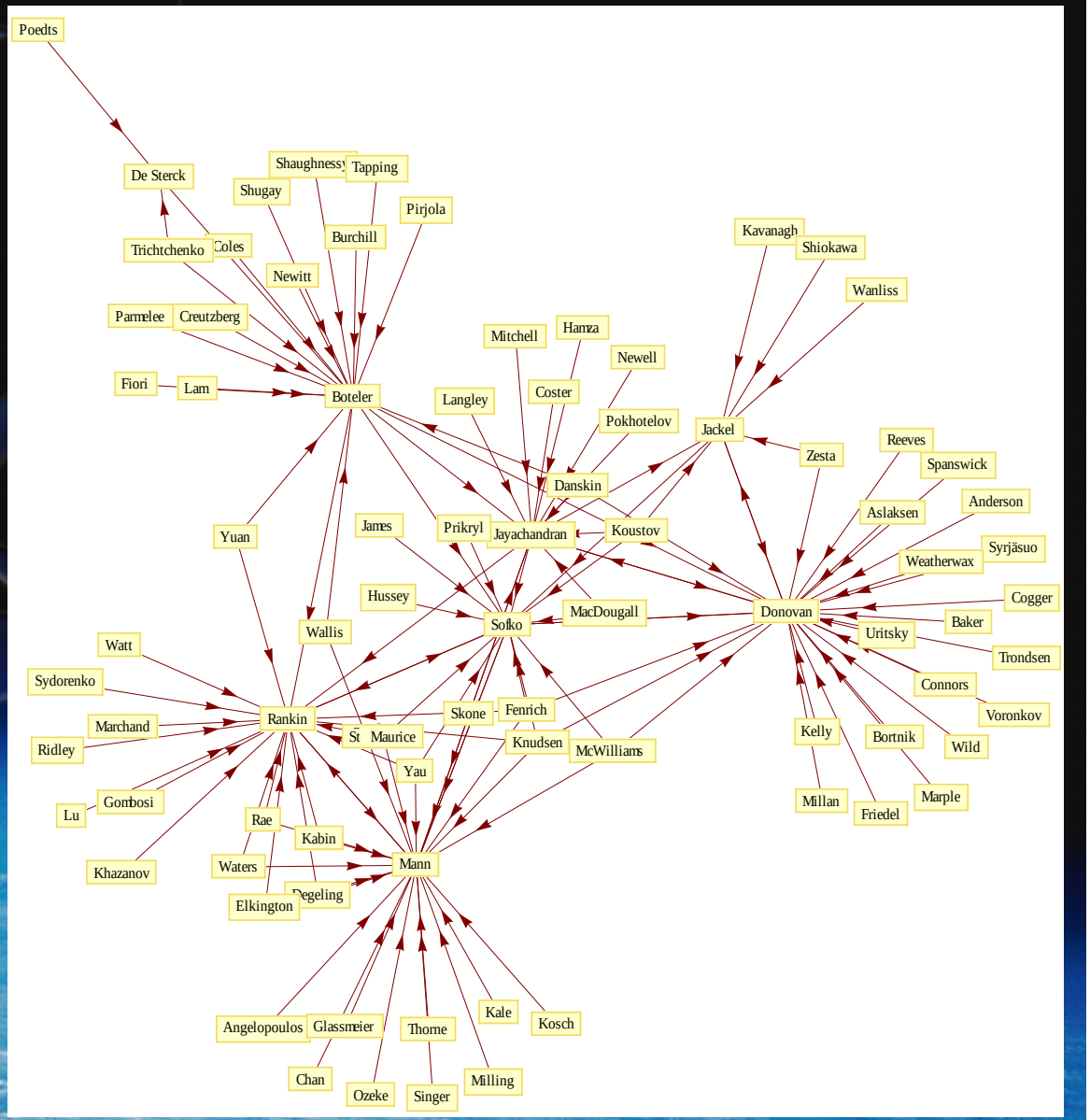
Module 1 Magnetic	Module 2 Ionospheric	Module 3 Particles	Module 4 Solar	Module 5 Modelling	Module 6 Forecasting
U Alberta CARISMA FGM	UNB CHAIN	U Calgary Multi-Spectral Auroral Imaging	NRC Solar Radio Flux Monitoring	U Alberta FDAM	NRCan Operational Forecasting
U Alberta CARISMA ICM	U Sask SuperDARN / PolarDARN	U Calgary Multi-Spectral Auroral Photometry			U Alberta Forecasting with ULF Models
		U Calgary Riometer Network			U Waterloo Solar Drivers of Space Weather

Canada

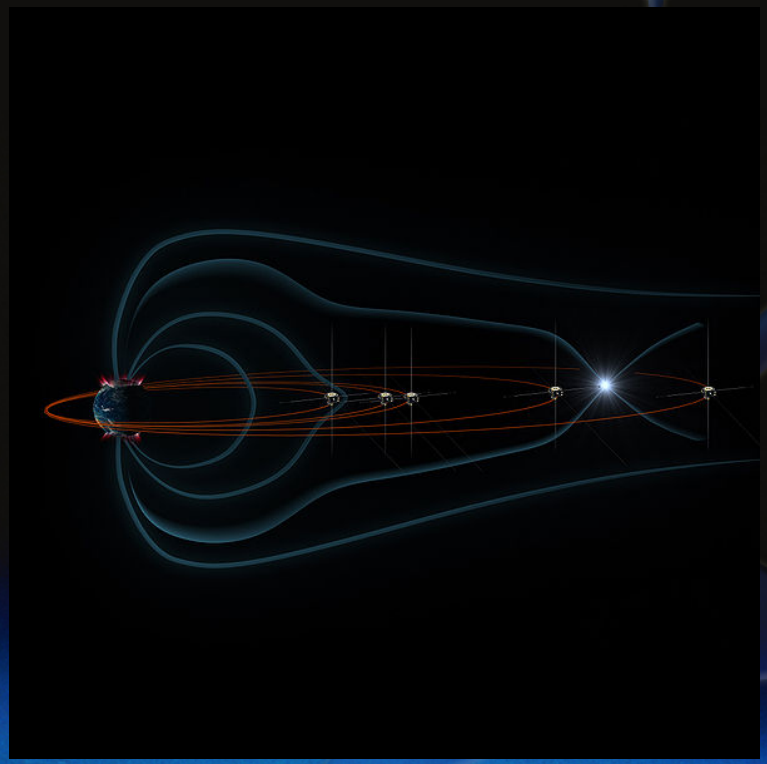
Canadian Space Agency | Agence spatiale canadienne

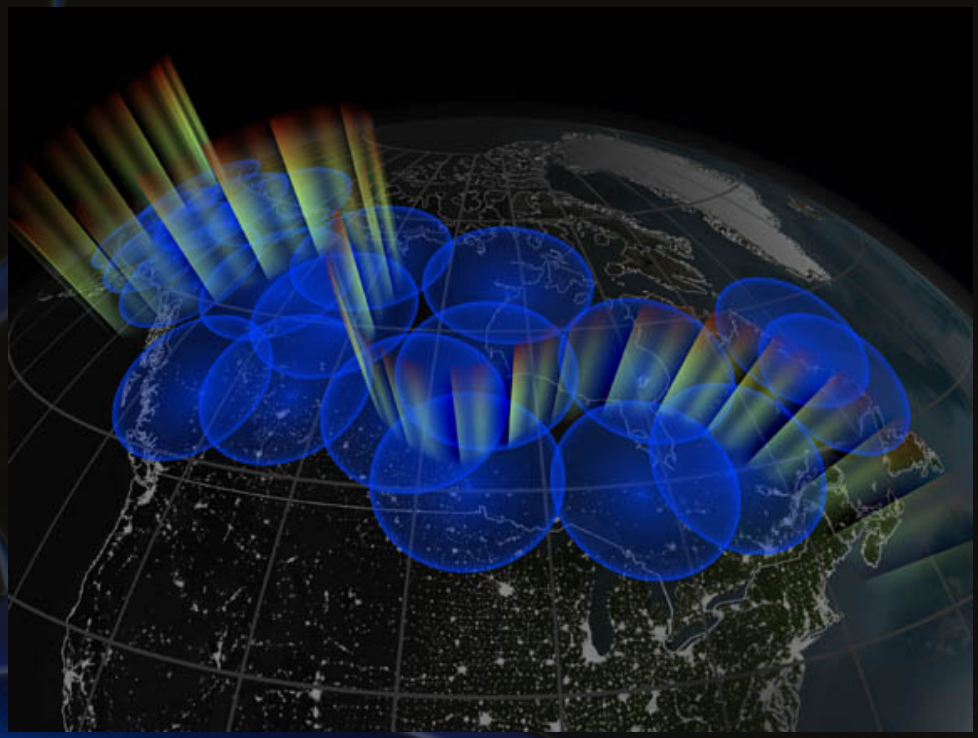
Science Team

- 85 scientists
- 9 PIs
- 7 countries
- 5 provinces



THEMIS Ground-Based Observatory





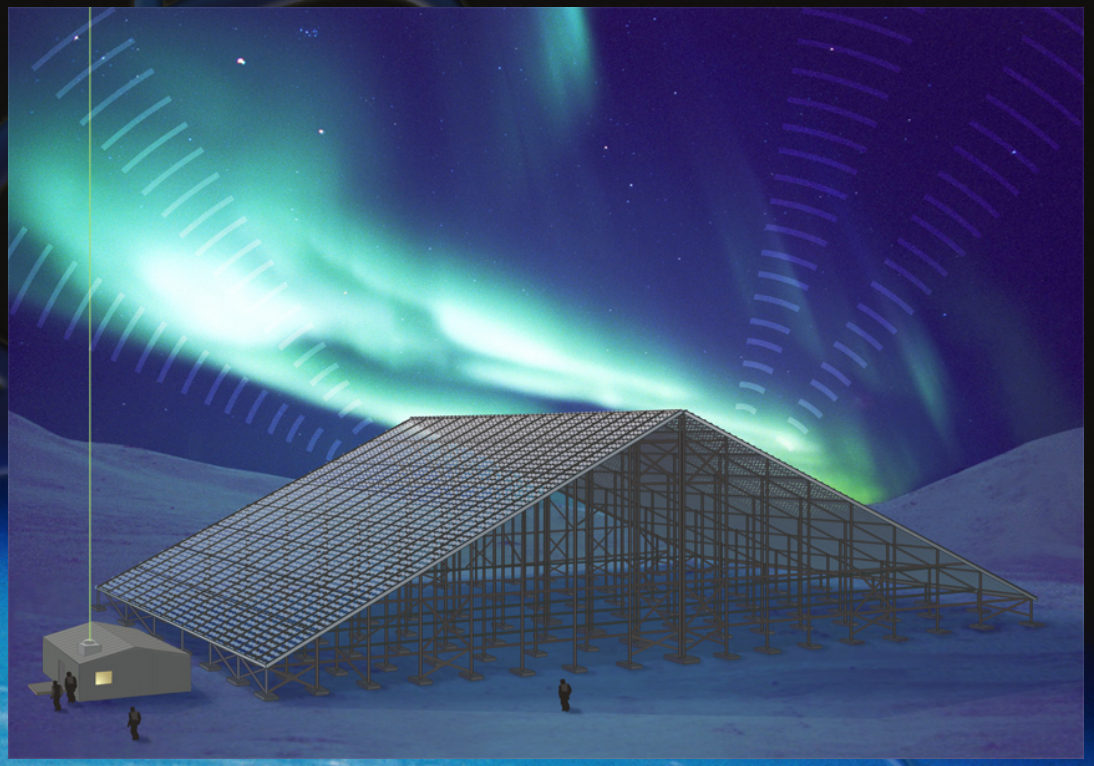
- Contribution to NASA's THEMIS 5 satellite mission (launch 2007)
- Canadian ground-based observatory:
  - significant progress in understanding of how substorms occur and develop

Canadian Space Agency | Agence spatiale canadienne

Resolute Bay Incoherent Scatter Radar

The Resolute Bay Incoherent Scatter Radar is a modular, mobile radar facility that will be used by scientists and students from around the world to conduct studies of the upper atmosphere and to observe space weather events.

The radar will help to improve satellite and aircraft communication, as well as navigation systems. The radar will also look at the impact of space weather on climate change.



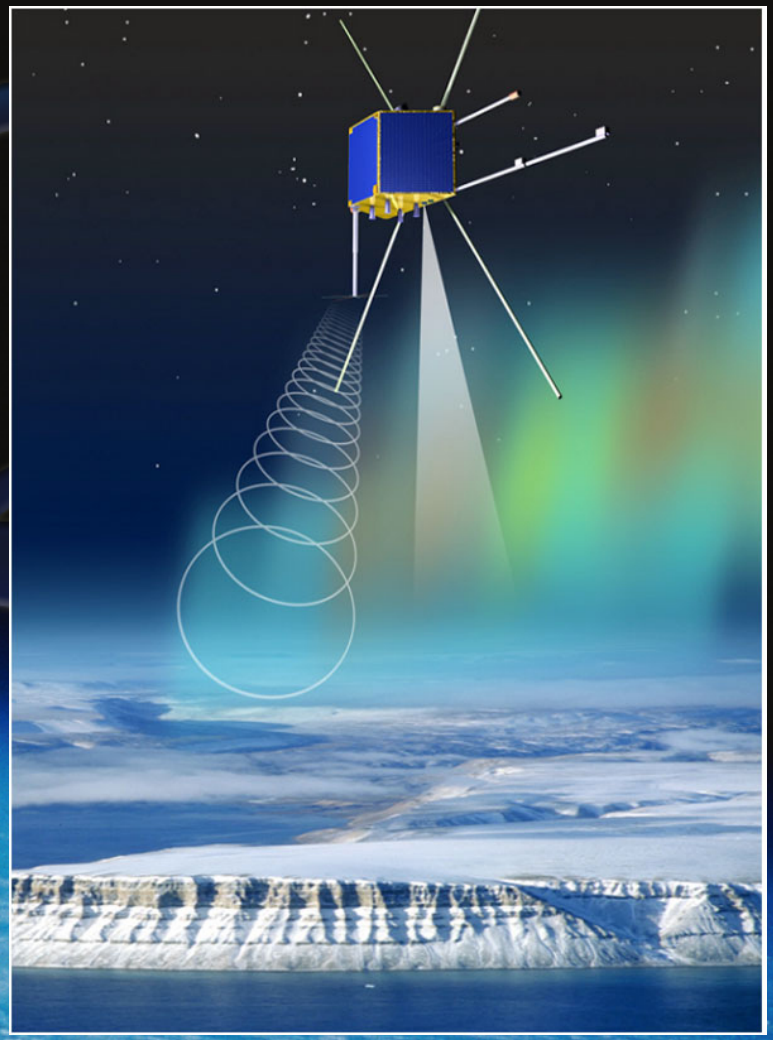
Canada

Canadian Space Agency | Agence spatiale canadienne

Enhanced Polar Outflow Probe

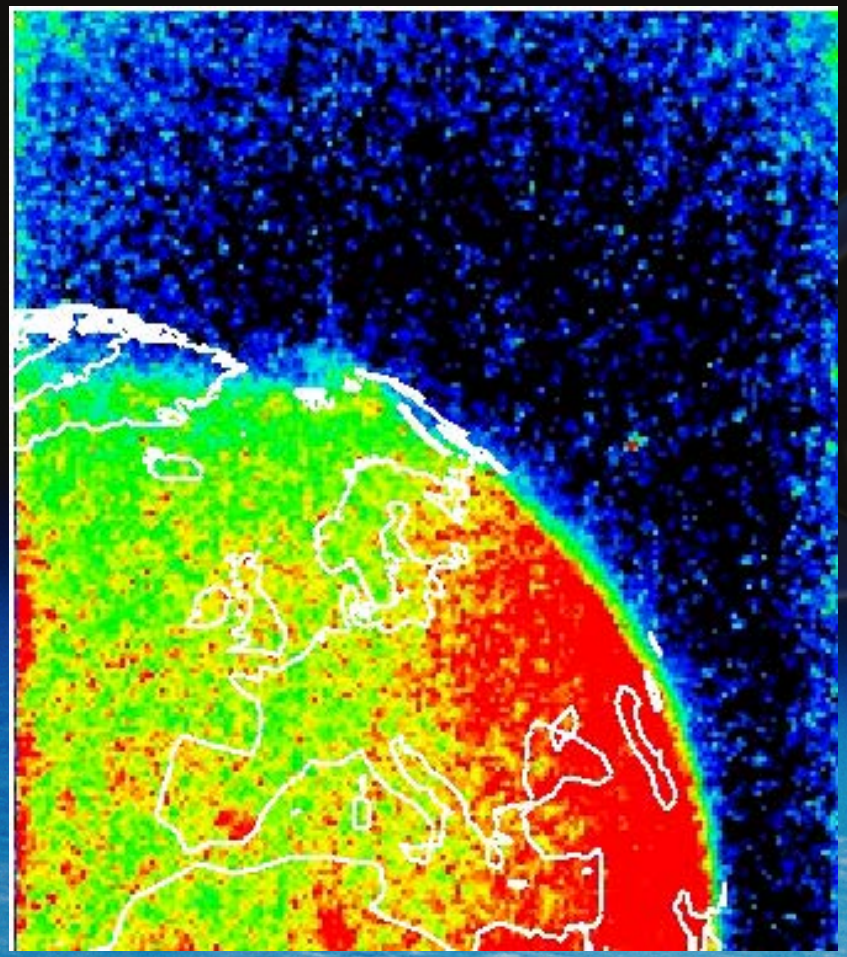
Canadian small satellite mission to study mass outflow from Earth

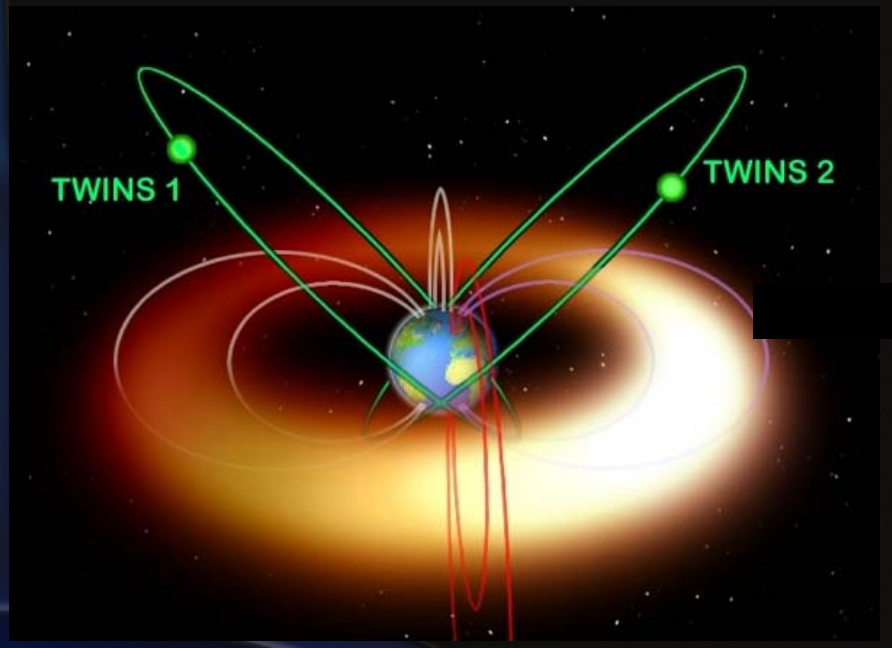
e-POP's eight scientific instruments will collect new data on space storms and associated plasma outflows in the upper atmosphere and their potentially devastating impacts on radio communications, GPS navigation, and other space-based technologies.



Canadian Space Agency | Agence spatiale canadienne

Global Auroral Imaging





Auroral imaging from space was pioneered by Canada.
24/7 imaging capability is essential to understanding long-term Space Weather behavior.
Currently two options are being considered:
Molniya orbit on the Canadian twin Satellites PCW, or
Polar orbit on the Chinese Kuafu-B mission

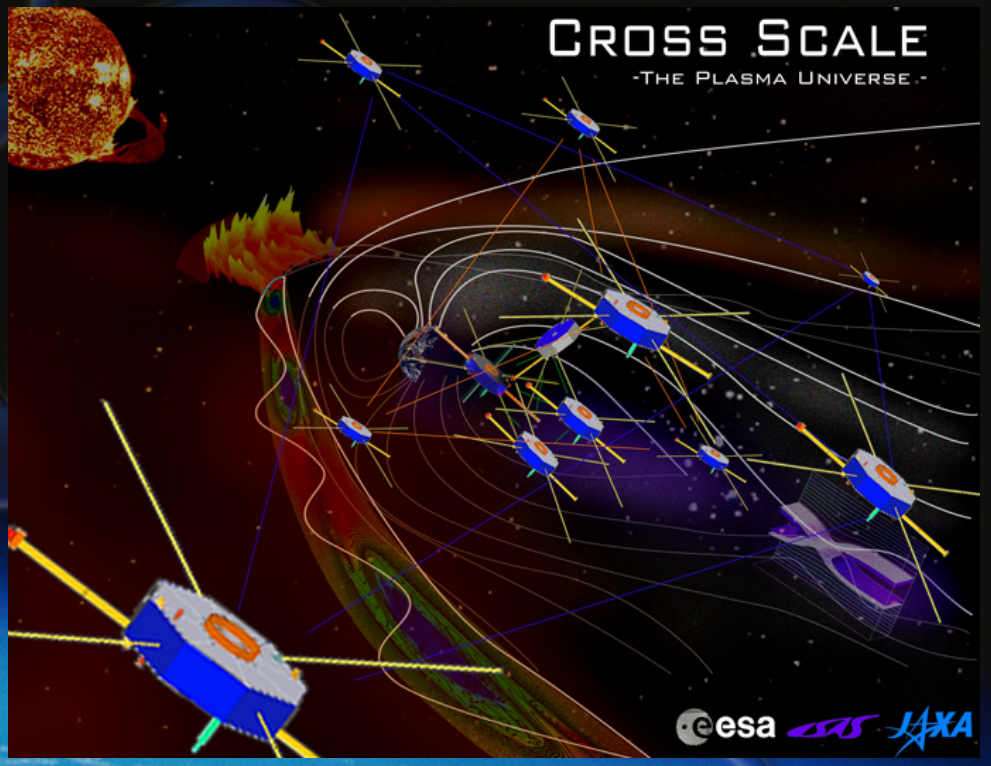
Canada

SCOPE

Energy in the space weather system comes from the magnetic field.

SCOPE is a proposed 5-satellite mission to investigate how energy is tapped from the magnetic field to power space weather

A potential collaboration between CSA and JAXA



Conclusion

International Space Weather Initiative offers a timely opportunity to:

- Coordinate global monitoring of space weather using space- and ground-based assets
- Combine global resources to consolidate knowledge and develop forecast capabilities
- Increase preparedness, develop procedures of damage control, and establish a system of mutual assistance, in case a major event does occur