# Factsheet - CGSM Science Objectives

Canadian GeoSpace Monitoring (CGSM) involves research into the inter-connected space physical phenomena that are driven by solar magnetic activity. These include solar wind processes, solar wind-magnetosphere coupling, magnetospheric dynamics, magnetosphere-ionosphere coupling (including ion outflow), auroral physics, ionospheric physics, and the substorm and storm. In this rich scientific area, classical mechanics, statistical physics, electrodynamics, fluid dynamics, nonlinear dynamics, information theory and sophisticated computational methods are all brought to bear on questions that are important not only to space science, but also to cosmology, magnetohydrodynamics, and plasma physics. The goal of CGSM is to understand the transport of mass and energy across multiple scales through the entire solar-terrestrial system [see also the “CANOPUS 2000” and “Space Weather in Canada” documents for more background to CGSM science]. While CGSM will enable scientists in Canada and around the world to address a wide range of fundamental questions at the forefront of space physics, CGSM research will focus on five *grand challenge* themes.

Dayside reconnection and shear-flow viscous interaction at the magnetopause directly drive anti-sunward flows of magnetospheric plasma and ultimately power magnetospheric convection. These processes are inherently time-dependent: changes in the solar wind affect dayside merging and the spatial profile of the viscous interaction. Understanding these processes and their geospace consequences is the focus of grand challenge theme I. Nightside reconnection closes field lines which have been transported into the magnetotail, allows excess magnetic flux to be ejected during substorms, and completes the cyclic global convection process. Observations show that reconnection and night-side convection are often episodic and violent, and are important in the magnetospheric mass and energy budget. Understanding these processes forms the focus for CGSM grand challenge theme II. Magnetosphere-Ionosphere coupling is achieved through numerous electrodynamic, particle, and plasma physical processes, some of the most interesting of which involve active feedback. Energy transport to the ionosphere and atmosphere below manifests itself through auroral processes, specifically via field aligned currents, energetic particle precipitation, as well as through the propagation of a range of Alfvénic and magnetohydrodynamic waves. These auroral processes form the focus of CGSM grand challenge theme III. Global and local wave modes in the magnetosphere provide a pathway for energizing energetic particle populations in the magnetosphere. They can also be used to monitor the fundamental processes governing the structuring and dynamics of cold plasma population in the magnetosphere, the dynamic evolution and structure of the plasmapause. Understanding the energy and mass transfer associated with these processes is the goal of CGSM grand challenge themes IV and V. In summary these five CGSM grand challenge themes are

- *I* *Driving and control of magnetospheric convection.*
- *II* *Triggering and development of magnetotail instabilities and flows.*
- *III* *Generation, modulation, and multi-scale structure of auroral processes.*
- *IV* *Acceleration, transport and loss of energetic particles in the magnetosphere.*
- *V* *Cold plasma injection, transport, and loss in the global magnetosphere.*