2014 Workshop: Understanding Conjugacy

Long title
Grand Challenge: MEGI - Multi-element Earth and Geospace Investigation
Grand Challenge
Conveners
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Description

GRAND CHALLENGE: How conjugate are the Northern and Southern Hemispheres?

The next step in our ability to model the coupled Earth-Sun system is to understand the detailed partitioning of energy between the Northern and Southern Hemispheres. Our parameterizations of the energy input are expressed in terms of the total energy. We have a fairly good understanding of the energy input into the Northern hemisphere and an inkling of the geographic distribution of particle and Joule heating. Our understanding of the Southern Hemisphere inputs is much less well defined. This is due, in part, to the lack of facilities on the Antarctic continent and, in no small share, the fact that the Southern auroral oval is often mostly over open ocean. In this grand challenge we seek to elucidate not only the issues associated with the energy partitioning of the upstream component, but the partitioning into the two hemispheres, and their subsequent electrodynamic and neutral response during quiet and disturbed times. There is abundant evidence that the aurora is seldom conjugate. The response of the upper atmosphere and ionosphere are not conjugate.

We propose a workshop that will elucidate the Grand Challenge and consider the questions we must address. What are the fundamental limitations on our ability to understand these processes? What measurements and model developments must we make in our to understand conjugacy from the viewpoint of: 1) coupling to the solar wind 2) energy inputs into the hemispheres 3) the electrodymanic response 4)

the neutral/ion coupling and response 5) the response to active experiments (heaters and chemical release, etc) 6) the role of top-down forcing in the two hemispheres on the lower atmosphere 7) the role of the respective polar circulation pattern, particularly the polar vortex, on these processes.

We propose that in order to adequately address these issues we must develop a MREFC proposal that develops community-wide support for a large facility in Antarctica and a cohesive plan for addressing these questions on a global, international, cooperative basis. In this workshop we seek contributions from the community as to the formulation of such a major research facility as well as how existing and planning US and international research efforts can be folded into this MREFC proposal.

For convenience we call this proposal MEGI – Multi-element Earth and Geospace Investigation. The begin the discussion we propose several elements of the facility and a scope that includes the GEM and CEDAR community with potential input from the SHINE community as well as participation from the NSF Polar Programs and Atmospheres program. The key elements are: 1) An Antarctic Incoherent Scatter Radar 2) A small satellite program managed by NSF to support new and long-term spacebased measurements of key parameters on international, commercial and US rides and rideshares 3) A satellite Command and Data Handling Facility in Antarctica 4) A sea-launched buoy facility for distributed measurements of key parameters, such as magnetic field and/or TEC, around the Antarctic continent 5) A small/medium scale balloon assembly and launch facility to support use of balloon platforms in Antarctica balloon payloads e.g. lidars, FPIs, imagers, etc 6) A facility for the construction, repair, deployment and analysis of UAV-borne instruments e.g. imagers, TEC measurements for novel measurements such as tomographic reconstruction of features within the ISR field of regard. 7) Facilities for researchers to test and deploy additional instruments in the Antarctic region (land, sea and air) as well as to analyze data from all instruments (including the space segment) and the model output visualization capability for analysis and planning of new and ongoing investigations into conjugacy issues. Note that MEGI takes advantage of the continued global presence in the Arctic region to enable a fuller understanding of the implications and manifestation of “conjugacy” as well as investigations at mid- and low- latitudes that enable us to understand the coupled Earth-geospace system. MEGI provides context for the continued NSF Cubesat program. The Cubesat program will now have a technology path forward to implementation of the lessons

learned from that investment as some of the cubesats may be replicated and flown as part of an evolving constellation that will address part of this over-arching theme. MEGI provides context and support for existing CEDAR and GEM investigations. Individual investigators will now be able to take advantage of a global view of the system whether or not they are focused on conjugacy issues.

This workshop solicits inputs from the community as to the principal aspects of this problem that must be addressed and potential approaches. The outcome of this workshop will be a community-wide, community-driven MREFC proposal. The workshop will consist of invited overviews of the science and technology issues, contributed talks and moderated discussion. We plan to develop working groups to focus on particular aspects of the problem.

Organizers: Larry Paxton Rick Doe Lars Dyrud Janet Kozyra Patrick Newell Aaron Ridley Anja Stromme

Justification

How similar are the Northern and Southern Hemispheres? To what extent are they conjugate? What can we learn from studying the two hemispheres as a connected system? What does this tell us about the impact of a planetary magnetic field on the evolution/protection of a planetary atmosphere?

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See description for context and approach. **The goal is to develop a community-wide MREFC proposal for an Antarctic Observatory.** Therefore, this session addresses our future and how we achieve it.

We intend to produce an MREFC proposal that will address the issues associated with the conjugacy of the Northern and Southern Hemispheres. All elements of the CEDAR strategic plan are addressed. This is, inherently, a systems approach. We will explore and quantify the exchange across the boundaries.We understand that there are two important external forcing terms: forcing from above and forcing from below. Both of these terms are fundamentally different in the Northern and Southern Hemispheres. Forcing from above is driven by the magnetic field configuration. Forcing from below is driven by differences in atmospheric circulation and composition, orographic features, and albedo among others. We will be able to explore how changes in the lower atmosphere affect the upper atmosphere and whether there is a top-down and bottom-up coupling that is important to the other research communities (i.e. atmospheres and oceans). This connects us to the whole of the NSF Geosciences Directorate. A key element in the MEGI is the development of new instrument strategies especially ones that build on and incorporate existing activities (such as existing small satellite activities, ISR technology development, and new techniques using distributed autonomous platforms and incorporate assimilative modeling). We will fuse data across disciplines and the platforms we develop may be useful and important for other disciplines (i.e. oceans, atmospheres, polar programs). We will develop new data collection techniques including for example, the use of ocean buoys, balloon platforms, remote autonomous observatories, and the development of autonomous UAVs that can "flock" to enable autonomous configuration for auroral and ionospheric tomography. This will provide our community with the opportunity to exercise innovative approaches to data collection and reinvigorate the research community.

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