2013 Workshop: Geospace system science

Long title
Geospace system science during storms and substorms
Conveners
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Description

Main science topics include:

(1) Energy flow in the disturbed M-I-T system: what are the prime characteristics and relationships during storm-time processes promoting energy flow and exchange between the magnetosphere and the I-T system?,

(2) How do energetic particle precipitations (EPPs) affect the energy distribution, chemistry and transport of the upper/middle atmosphere?,

(3) What are the effects of EPPs on ionospheric structure, atmospheric heating, the formation of irregularities, and the generation of atmospheric gravity waves?,

(4) How do shielding processes in the inner magnetosphere and current feedback mechanisms between the magnetosphere and ionosphere impact ionospheric electrodynamics (e.g. subauroral electric fields – SAPS) and mesoscale ionospheric plasma and temperature structure (e.g. storm enhanced densities – SEDs)?,

(5) What are the controlling influences on field aligned mass coupling and flows linking the plasmasphere and ionosphere?

The above questions will be addressed by emphasizing participant discussions which bring new views of the M-I-T system made available by expanded observation capabilities available from various ground-/space-based measurements.

Furthermore, we will encourage participants to combine and synthesize resources from observations, modeling, theory, and data assimilation. We invite short, workshop style presentations with ample time allocated for discussion. We particularly welcome “big picture” (or system level) perspectives that motivate science questions and their relevance to the understanding of coupling processes within the magnetosphere-ionosphere-thermosphere.

We envision this workshop as part of a multi-year series with steady progress on specific questions within the main topics. Identification of these questions during discussion is an expected and ongoing outcome of workshop activities. We encourage proposals for how these specific science questions can be addressed using various modern and historical resources, and we expect our activities to motivate new cross-disciplinary collaborations and new observational capabilities. To facilitate these aims, we will allocate time within the workshop for discussion of metrics and quantification of progress on identified science topics.

Summary

The overarching goal of the session is to improve our understanding of the geospace system response to storms and substorms. Two breakout sessions were held on Monday afternoon to maximize the likelihood of attracting participants from the GEM community. The talk was in short presentation style in order to facilitate the free flowing informal discussions, while allocating enough time for wrap-up discussions at the end of the session. The speaker list was in order of the five topics identified in our session proposal.

The session was initiated by the former CEDAR president, Jeff Thayer (Univ. of Colorado). As the architect of the new CEDAR strategic plan, he introduced the overall CEDAR picture and the “systems perspective”. He emphasized that it is time to do implementation of the CEDAR strategic plan. The meaning of the “New Dimension” was explained: it was added to traditional “coupling ” approach. It is “complexity” including such as feedback, instability, and emergent behavior etc. Storms and Substorms are one of the good examples of such “complexity”. He also clarified “systems perspective”: it is not necessarily “big” since internal processes are important.

New observation capabilities that would contribute to our science challenges were introduced. The Dave Rucsh/Laila Anderson (LASP) introduced the new mission, Global-scale Observations of the Limb and Disk (GOLD, PI Richard Estes). The mission was selected as Explorer mission of opportunity and is planed to launch in Fall 2017 on a GEO satellite. The main objectives of the mission will include storm effects on thermosphere, global response to EUV variability, significance of lower atmospheric waves and tides, and formation/structure of equatorial irregularities. GOLD will contribute to this group by information on energy deposition (topic1,2,5), evolution of thermosphere (topic3), and solar wind effect (topic4). It is important for the mission to coordinate with ground based observations.

Bill Bristow (U-Alaska) showed new exciting results from PINOT. The PINOT is an observation campaign over Alaska to addresses the three main themes: Magnetosphere drivers of I-T state variables, Waves and turbulence, and Magnetosphere dynamics inferred from I-T, by integrating PFISR, Optical Instruments, SuperDARN, and Modeling. Dramatic event with propagation of disturbance to mid-latitude were shown during first two campaigns during 20121113-14, demonstrating great capability of the integrated observations. Winds (SDI) vs. ion convection (SDARN+PFISR) showed fantastic correspondence, with appropriate time-lagged response of the winds.

New challenges were presented on energy flow in the distributed MIT system (topic1). John Meriwether (Clemson U) clearly pointed out in his talk on Global thermospheric response to geomagnetic storms that the “Big Picture” we suggested is incomplete: neutral transport from high-low latitudes is missing. He illustrated an example of sustained upwelling of neutral air during a storm, and challenged us with a question “where does the air go?”, by combining measurements by Svalbard ISR, NATION FPI network, and C/NOFS. He emphasized a need for a global observing system to piece this puzzling picture together.

Art Richmond (NCAR/HAO) briefly summarized three studies relevant to energy flow into atmosphere (topic1) as follows: (1) Changing the conductivity or FAC distribution can dramatically change E-field morphology but leave very similar B-Field morphology, in performing Pointing flux calculation; (2) Using AMPERE FACs as input to TIEGCM and adjusting auroral precipitation produces good agreement with ground based magnetometers; (3) Height-integrated heating is inadequate: effect of heating varies considerably with altitude.

Cheryl Huang (AFRL) showed a case when Poynting flux doesn’t account for thermospheric heating (i.e. missing something in the energy budget). She suggested that polar cap is more important than auroral and cusp regions in energizing IT by showing an observation that neutral density spikes occur predominantly in polar cap.

Yansi Huang (Univ. of NM) compared ionization rates of three models for the polar cap precipitation observed by DMSP. The F-region ionization reproduced by the new Fang2010 that is the first parameterization based on first principles models and covers wider energy range, was not captured by TIEGCM and GITM (assuming maxwellian energy distribution, and narrower energy range).

Asti Bhatt (SRI) presented new results of Broad incoherent scatter plasma lines during auroral precipitation, as a new independent measurement of precipitating particle energies. She suggested its great potential by coordinated experiments with THEMIS/RBSP and other ISRs.

New results on substorms were introduced by integrating recent observations. Ying Zou (UCLA) demonstrated that meso-scale fast polar cap flows, optically traced by airglow patches have an association with PBIs and streamers preceding substorm onset, by combining radar, ASI, and airglow measurements. The meso-scale polar cap flows can be associated with large scale features including triggering magnetotail reconnection, earthward flow channels in plasmasheet, and auroral disturbances.

Beatriz Gallardo-Lacourt (UCLA) suggested auroral beading might be a manifestation of substorm instability, based on the study of the ionospheric flow patterns associated with the substorm auroral onset using ASI and SuperDARN.

Wrap-up discussions: Phil Erickson took the note while projecting onto another screen (M. Buonsanto workshop style). There was general agreement that our effort to address the science questions identified in our session proposal should be continued as a multi-year effort. We plan to coordinate joint campaigns with the GEM Focus Group: Storm-Time Inner Magnetosphere-Ionosphere Convection (SIMIC) led by Baker, Ruohoniemi and others.

Summary (pdf)

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