The GEMstone

Volume 22, Issue 2 November 2012

Notes from NSF Program Director

Ray Walker

It had been a number of years since I last attended a GEM Summer Workshop. Then GEM was just starting so I looked to this year's workshop with great interest to see how GEM had evolved. I was not disappointed. I was very impressed by the organization of the workshop. In particular in all of the sessions I attended there were good presentations coupled with very active discussions. It was what I think a workshop should be.

GEM is now a mature project. It is the only focused research element in the NSF Magnetospheric Physics program. It has been over a decade since the goals of GEM were laid out formally. I believe it is time to revisit the GEM goals and take stock of where we are. One thing I am completely certain of is that the goals of GEM must be set by the community. Therefore I asked the GEM Steering Committee to write a white paper reexamining the goals and focus of GEM. To do that I believe they need to evaluate

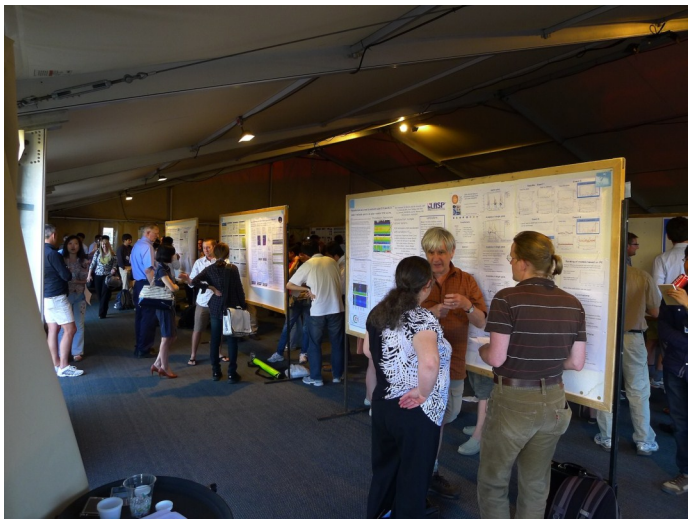
In this issue

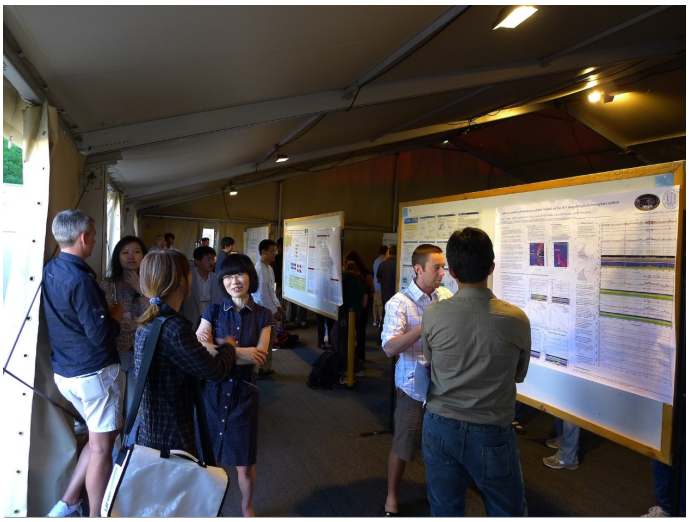
how the project has progressed in meeting the original goals and where GEM should focus in the future. I hope this white paper will form a strategic plan for GEM. Bill Lotko has agreed to lead this effort. He will be assisted by Jeff Hughes, Mike Liemohn and Katrina Nykyri. I want to thank them for volunteering. Their initial findings will be presented at the Steering Committee meeting at the AGU in December and the document will be written in 2013 in time for the next workshop.

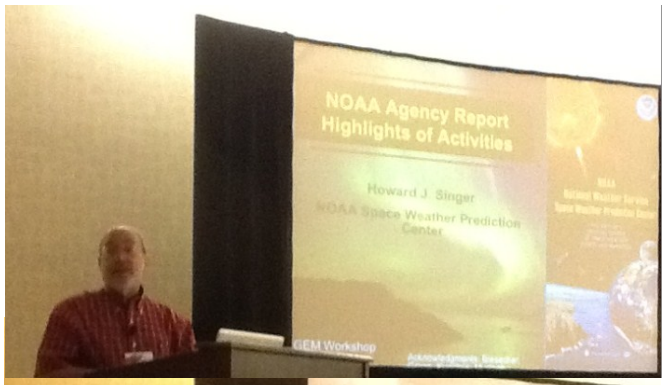
I look forward to working with you all over the next couple of years to keep the GEM program strong and dynamic.

Ray Walker

Snapshots of 2012 GEM Summer Workshop
(Photos provided by Xia Cai, Hyomin Kim, and Delores Knipp)







The GEMstone Newsletter is edited by Peter Chi (pchi@igpp.ucla.edu) and Marjorie Sowmendran (margie@igpp.ucla.edu).

Notes from GEM Chair

David Sibeck

Another action-packed GEM meeting has come and gone. From my perspective, this was one of the busiest GEM meetings ever, in part due to the duties of the chair but even more importantly thanks to the flurry of interesting results presented. GEM brings out the best in our community and highlights the vitality of magnetospheric physics. Imagine how exciting it will be when we enter the RBSP and MMS eras. Even the weather conspired to make it a great meeting, with hot sunny days one after the other.

The annual GEMstone bulletins provide an opportunity to take stock of where things stand within the GEM community. First, we have a new and very experienced NSF Program Manager, Ray Walker. Ray inherits the smoothly running enterprise that Kile Baker left behind, and has the strong interest in global simulations, system science, and observations needed to move us forward. Nevertheless, these are difficult times. Ray is going to need help from all of us to maintain a healthy GEM program. First and foremost, you can help by continuing to perform top-notch science. However, there are also other ways to help. Ray's first action as program manager was to request a white paper defining the mission, accomplishments, and objectives of the GEM program. Ray will be asking specific community members to help draft this white paper and we will be seeking comments and suggestions from everyone. Topics for consideration include the relationship of GEM to space weather (currently a high priority in the United states), forecasting and modeling, and NSF-supported ground-based assets. To start off the process of preparing this white paper, the GEM steering committee had an extensive discussion of GEM objectives, and eventually arrived at the following statement:

The overarching goal of the GEM program is to explore, understand, and ultimately predict geospace system dynamics by advancing increasingly realistic numerical simulations, including global and specialized regional models. This goal is achieved via a grass-roots collaborative engagement of the community, with a focus on the forefront issues of geospace science. The program supports observational, theoretical, and modeling developments, data archives, validation efforts, community campaigns and challenges, and sponsors and encourages student participation. The GEM program's semi-annual workshops substantially leverage NSF resources by providing an exceptionally energetic forum for a diversely funded community of US and international scientists to identify critical problems; to organize collaborative efforts in solving them; to disseminate research progress, to promote teaching, training and learning, and to integrate NSF-funded observations and modeling into other state-of-the-art research programs.

We welcome Margaret Chen as the newest regular (voting) member of the GEM Steering Committee. The steering committee then elected the following new research area coordinators: Katariina Nykyri (Dayside), Jerry Goldstein (Inner Magnetosphere and Storms), Sorin Zaharia (Tail), Marc Lessard (M-I Coupling), and Frank Toffoletto (GGCM). The steering committee recognized the need to broaden its contacts with other space-faring nations. I am happy to report that liaisons to South Korea

(Jaejin Lee), Taiwan (Lou Lee), and the People's Republic of China (Chi Wang) have now joined the steering committee, affording an opportunity to share information about current and future missions.

It is a pleasure to welcome Roxanne Catis from the University of Michigan as the new student representative on the Steering Committee. She will assist Nathaniel Frissell from Virginia Tech throughout the forthcoming final year of his term, and then take over as lead student representative. The student representatives on the Steering Committee offered many good suggestions to improve the GEM meeting. They ask that focus groups post their schedules on the WWW before the meeting, and that focus group leaders give their plans for the days activity just after the morning plenaries to enable participants to plan their schedules. Furthermore, to improve post-GEM communication, speakers should display their names and contact information on their presentations. Finally, we once again vowed to (and this time really must) award prizes to the best student posters at the forthcoming GEM meeting. David Murr and Colby Lemon will take on this task. Please assist them if asked.

The steering committee examined several locations for the next summer GEM meeting. We received a compelling offer from the mayor and other Snowmass community leaders. Consequently, next years meeting will be in Snowmass from June 16-21. Amongst other things, this affords an opportunity for joint sessions with CEDAR, whose meeting will be in Boulder from June 23-28. Details remain to be worked out, but the GEM side has established a planning committee which Larry Lyons has kindly agreed to lead. If you have suggestions on topics for a joint session or wish to help, please contact him.

It is also time to start thinking about new focus groups. Several just ended and two held their first meetings in Snowmass. Pontus Brandt (JHU/APL) will lead a group devoted to Tail-Inner Magnetosphere Interactions, while Hui Zhang (U. Alaska, Fairbanks) will lead a group addressing Transient Phenomena at the Magnetopause and Bow Shock. Those interested in proposing new focus groups should find appropriate partners, consult with the relevant Research Area Coordinators, prepare and submit a four page proposal to me that follows the bylaws on the GEM wiki pages by November 23. They should also prepare a short (~5 min) presentation of their plans to the GEM meeting on the Sunday before the Fall AGU.

Finally, I would like to take a moment to thank Peter Chi and Bob Clauer for their quiet work behind the scenes. They do the work that keeps GEM running smoothly.

See you at the Fall AGU mini-GEM meeting!

David Sibeck

2012 GEM Mini-workshop
Sunday, December 2
Westin San Francisco Market Street
50 Third Street
San Francisco, CA

Dayside Research Area Report

Coordinators: Karlheinz Trattner and Katariina Nykyri

The Magnetosheath Focus Group

Co-Chairs: Katariina Nykyri and Steve Petrinec

Magnetosheath FG held three sessions. Sessions had two invited speakers and eight contributed presentations allowing plenty of time for questions, discussion and planning. Research methodology of the session speakers utilized magnetosheath data from various spacecraft missions including Cluster, THEMIS, Geotail etc. The modeling efforts included global hybrid simulations, global and local MHD and Hall MHD simulations and support vector regression machine technique. Also a development of the new global scale Vlasov model with initial results was discussed. We have divided a discussion of the sessions into 1. *Highlights*, 2. *Where We Are Headed*, 3. *What we Have Accomplished* and 4. *Concluding Remarks.*

1. Highlights:

Heli Hietala showed Cluster observations of super magnetosonic magnetosheath jets and discussed their possibe generation mechanism to be related to the wavy structure of the bow shock, which could lead to formation of a secondary shock. Jets can have scale sizes 1-6 R_E and produce magnetopause perturbations, magnetospheric pulsations and short local ionospheric convection enhancements.

Nick Omidi showed observations and simulations of magnetosheath density cavities and how changes in IMF can lead to large-scale changes in magnetosheath properties: 1) Change from large cone angle to small and back to large results in cavities in time series data 2) Intrinsic cavities in quasi-parallel sheath due to shock dissipation processes 3) Cavities caused by IMF

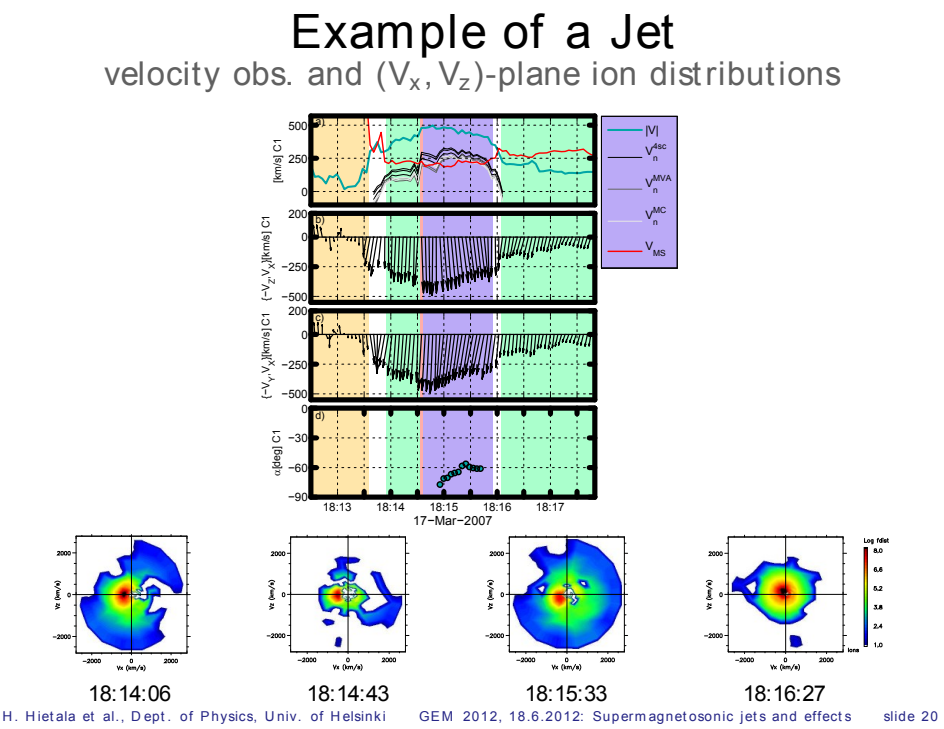


Figure 1 shows an example of velocity profile of supermagnetosonic jet and corresponding ion distribution functions observed by Cluster in the magnetosheath.

discontinuities and associated structures such as Foreshock Bubbles.

Antonius Otto used 2D MHD and Hall-MHD simulations and showed that there is a significant entropy (non-adiabatic heating) increase at the magnetopause only when magnetosheath beta is low. Entropy production in 2D reconnection occurs in i) in the diffusion region ii) sometimes through weak fast shock at the leading edge of the steady outflow region, iii) through shocks at the boundary between outflow and inflow region. However, the heating in the diffusion region is likely of small importance because of the small volume ~ ion inertia scale. Also, the nonadiabatic heating is significant in the outflow regions only for small plasma beta. Nonadiabatic heating occurs in Hall dynamics at the same rate (for the same conditions) as in MHD.

Katariina Nykyri used 15 Global MHD simulations (BATSRUS hosted at CCMC) to determine the magnetosheath properties during Parker Spiral (PS) and Ortho-Parker Spiral (OPS) IMF orientation for various solar wind plasma betas and solar wind Mach numbers. She then generated 30 local simulations at the dawn-dusk terminator at each flank corresponding to global simulations. Results showed that dawn-flank is more Kelvin-Helmholtz unstable for PS orientation which can lead into more plasma heating on dawn-side magnetopause due to reconnection and shocks generated by KHI and due to kinetic Alfven wave generation.

2. Where We Are Headed:

A) Need to identify the best method for the statistical studies of magnetosheath properties:

Several speakers performed statistical studies using spacecraft data of the magnetosheath properties. Interestingly some studies found dawn-dusk density asymmetry while others did not:

- Chih-Ping Wang used Themis data and showed dependence of the angle between the magnetosheath magnetic field and velocity vectors as a function of downstream distance: 1. THEMIS statistical results show that magnetosheath *Bxy* becomes more aligned with the magnetosheath *Vxy* with increasing downtail distance. 2. The sheath density and temperature observed within 3 Re from the model magnetopause do not show significant dawn-dusk asymmetry.

- Brian Walsh selected magnetopause crossings of the THEMIS data and performeda statistical study of the magnetosheath densities at the vicinity of the magentopause. He noticed that densities were higher on the dawn side magnetosheath agreeing with the previous study by Paularena et al (2001).

- Steven Petrinec showed statistical study of the magnetosheath properties using Geotail data. He did not observe any dawn-dusk density asymmetries, but the velocities were higher on dawn-flank magnetosheath.

- Jean Berchem showed couple of comparisons between global MHD simulation results and simultaneous observations made by Themis and Cluster in the magnetosheath. He illustrated that case studies will be needed to avoid misinterpreting results from statistical studies (e.g., orbital biases, seasonal effects) when comparing magnetosheath models with observations.

B) New Model Development:

- Arto Sandroos presented a new global Vlasov code under development at Finnish Meteorological Institute where protons are included as distribution fucntions and electrons as massless charge neutralizing fluid. The code has 10^{11} cells in total and computations are targeted to run on 100 000 CPU cores. First results applied to comparison of magnetsoheath and magnetospheric densities showed a good agreement with global MHD GUMICS model results.

- Yongli Wang presented a new three-dimensional magnetopause model with a sup-

port vector regression machine (SVRM) utilizing a large database of 15089 magnetopause crossings collected from multiple spacecraft. Using SVRM technique the magnetopause shape had more structure than the previous magnetopause models: clear cusp structure is seen and the whole magnetopause location changessystematically with different dipole tilts. The error sizes in the model correlate with missing data points. The model will be put into web server for community to use.

3. What have we accomplished:

Steve Petrinec/Katariina Nykyri have written a 'steady-state' magnetosheath white paper ('living document') describing the challenges involved in empirical, theoretical and numerical magnetosheath modeling. This paper also describes the Magnetosheath Challenge. There will also be repositories for model runs and results at the CCMC and at Lockheed Martin.

4. Concluding Remarks

Magnetosheath is both a place for rich plasma physical processes and a filter between solar wind and the magnetospheric plasma and magnetic field enviroments. The magnetosheath properties are crucial determining the growth rates of various instabilities at the magnetopause determining the efficiency of solar wind mass, momentum and energy transport into the magnetosphere.

Interesting 'new' phenomena are the super magnetosonic magnetosheath flows and there was lot of discussion on the possible generation mechanisms of these jets.

A lot of discussion was also devoted on hybrid simulations of the magnetosheath. One concern was the scale size of the structures in hybrid simulations vs. the real system size: e.g how many ion inertial lengths is the magnetosheath in hybrid simulation vs. in real magnetosphere.

There was a lot of discussion of how extreme care must be taken when statistical studies are done: where data is collected, orbital biases, seasonal effects, and how data is binned can affect the conclusions of the study. In this session two speakers arrived at opposite conclusions on the density asymmetry of the magnetosheath probably due to data selection: other speaker choose THEMIS data closer to the magnetopause and other further away from the magnetopause.

The purpose of the white paper is to describe the challenges in methodology for doing magnetosheath research, collect and document various model and statistical data-analysis results into repositories and understand how differences in methodology can lead to different results in statistical and modeling studies. Many publications documenting bow-shock, magnetopause and magnetosheath modeling and analysis leave out important details. Unfortunately the devil is in the details and everything needs to be documented, so that results can be reproduced by a third party. The white paper gives also examples of header files both for observational and numerical magnetosheath modeling that can assist in this quest.

Transient Phenomena at the Magnetopause and Bow Shock and Their Ground Signatures Focus Group

Co-Chairs: Hui Zhang, Q.-G. Zong, Michael Ruohoniemi, and David Murr

The "Transient Phenomena at the Magnetopause and Bow Shock and Their Ground Signatures" focus group held four sessions with 25 presentations. The sessions were organized as follows: 1. Foreshock Phenomena 2. Magnetopause Phenomena 3. Ground Signatures 4. Planning session.

Various foreshock phenomena including hot flow anomaly (HFA), foreshock compressional boundary (FCB), and foreshock bubbles were investigated by this focus group using both in-situ observations and global hybrid simulations. Turner et al. gave an overview of these foreshock phenomena.

Speakers presented results illustrating that HFA is a universal phenomenon. HFA has been observed at the bow shock of the Earth, Mars, Sat-

urn, and Venus. Wang et al. (presented by Zong) investigated 87 HFAs with large flow deflection (with the magnitude of *Vy* or *Vz* in GSE coordinates greater than 200 km/s) from Cluster-C1 observations from 2003 to 2009 and found that the large flow deflections in HFAs are location dependent and that the ions are near-specularly reflected at the bow shock. In addition, both in-situ observations by NASA THEMIS spacecraft and global hybrid simulations demonstrate that HFAs can be generated spontaneously (in the absence of any current sheets) at quasi-parallel bow shocks where the interplanetary magnetic field lies nearly parallel to the shock normal. Omidi et al. showed that the simulated SHFAs form as a result of the interaction of foreshock cavitons with the bow shock. Simulations show the formation of large numbers of SHFAs and demonstrate that they are an inherent part of quasi-parallel shock dissipation processes. Cluster observations show that magnetic flux rope can form within a magnetosheath HFA. Multiple THEMIS spacecraft observations have been used to investigate the propagation and expansion speed of an HFA.

Omidi et al. demonstrated the dynamic nature of the foreshock compressional boundary and its relation to foreshock cavities. Using global hybrid simulations with steady and time varying IMF conditions, they showed that even during steady IMF conditions, the FCB is highly dynamic and in practice will likely not reach an equilibrium state. Simulations also show that FCBs are part of foreshock cavities and should be detected at their edges regardless of which mechanism is responsible for the formation of foreshock cavities. Rojas-Castillo et al. presented Cluster observations of FCBs and showed that they form either downstream of the ion foreshock boundary or coincide with it. Observations show the presence of FCBs during steady or time varying IMF. They also show the presence of FCBs under a wide range of solar wind speeds and IMF cone angles.

The foreshock phenomena may have significant impacts on the Earth's Magnetosphere-Ionosphere System. Presentations in the second and third sessions used a variety of space- and ground-based measurements to examine the response of the magnetosphere to solar wind transients and various foreshock phenomena.

Turner et al. showed that 23 transient foreshock events (including HFAs, FCBs, and foreshock bubbles) were identified from one day's THEMIS C data (July 14, 2008) when the solar wind is steady (~700 km/s). These foreshock events resulted in significant magnetopause disturbances observed by THD and THE just inside of the magnetopause. They also showed that foreshock activity correlates with enhanced ionospheric convection, based on equivalent ionospheric currents (EICs) derived from GMAGs and SuperDARN radar signatures. Global PC3-5 wave activity ob-

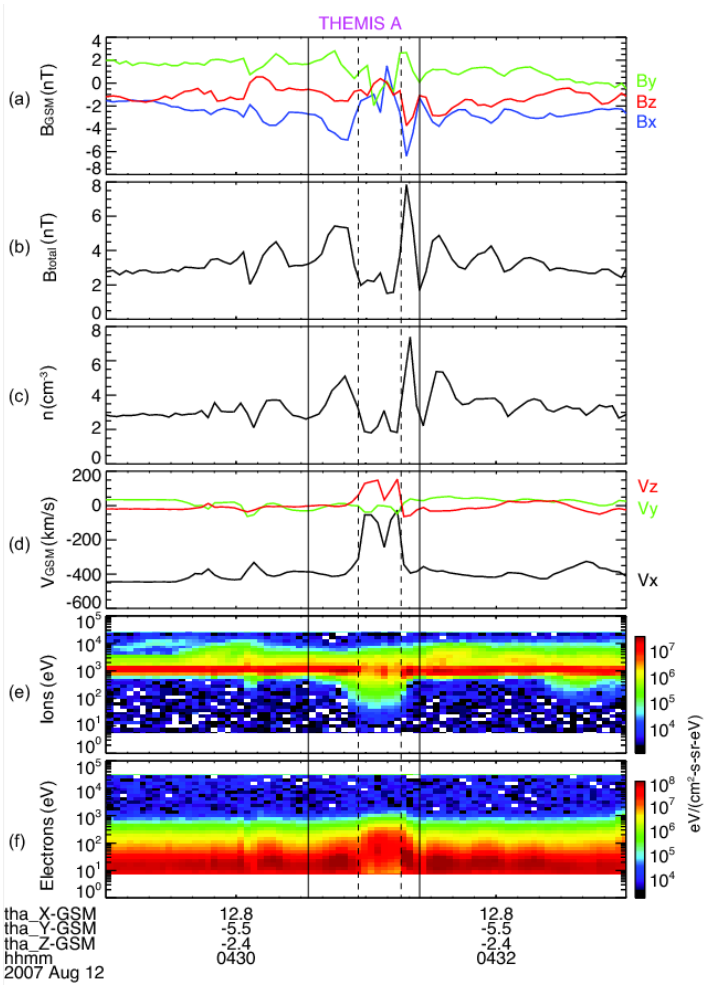


Figure. An overview plot of THEMIS A observations of an SHFA upstream from the bow shock. From top to bottom: (a) components of the magnetic field in GSM coordinate system, (b) magnetic field magnitude, (c) plasma ion density, (d) components of plasma flow in GSM coordinate system, (e) plasma ion spectrum, (f) plasma electron spectrum. The vertical solid lines mark the beginning and the end of the the event. The vertical dashed lines mark the time interval when the solar wind flow is significantly deflected from the the Sun-Earth direction.

served by Cluster, THEMIS, and GOES is also correlated with foreshock transient activity.

Korotova et al. presented THEMIS observations of an unusual bow shock motion attending a magnetospheric transient event. Ferdinand Plaschke used MHD theory to show that THEMIS observations of a magnetopause surface wave were inconsistent with the Kelvin-Helmholtz instability.

Yari Collado-Vega gave two presentations. In the first, the motion of FTEs observed by the Cluster spacecraft were found to be consistent with both component and anti-parallel merging, depending on the IMF conditions. In the second, the rotation axis of magnetopause vortices in MHD simulations during dynamic solar wind conditions was found to be mainly aligned with the *z*-direction, whereas for fixed solar wind conditions it was in the *x*-*y* directions.

Wenhui Li showed OpenGGCM-CTIM simulations of magnetic reconnection at the dayside cusp region when IMF *Bz* ~ 0. The simulations reproduce both Poynting flux and neutral density "hot spots" which are consistent with observations. Xuanye Ma presented 3D local MHD simulation results of anti-parallel magnetic reconnection with a perpendicular shear flow. The simulation results showed that the development of reconnection changes the onset conditions for KH modes, allowing waves of different wavelength to develop in different regions of the reconnection geometry. Subsequently, the magnetic diffusion regions are twisted and strongly modified by KH modes.

Rick Wilder showed DMSP observations of fast sunward flow channels on open field lines under northward and *By*-dominant IMF conditions. Sunhee-Lee presented Cluster observations of asymmetric reconnection at the dayside magnetopause. Lee et al. identified the separatries, flow boundaries, and central current sheet on the magnetospheric side and magnetosheath side by sharp boundaries in wave spectrogram, particle differential energy flux, flow, field, and density gradient. Then they deduced the geometry of the asymmetric reconnection based on the different separatrix angles. Shi et al. presented Cluster observations of a transition layer equatorward of the cusp, which contains both magnetosheath and magnetospheric populations, during northward IMF conditions. This transition layer is possibly formed by dual-lobe reconnection when the IMF is northward.

Michael Hartinger presented a case study of global Pc5 ULF waves and argued their characteristics were more consistent with a transient foreshock driver rather than upstream wave activity. Nathaniel Frissell presented a new analysis technique for extracting ULF wave signatures from high time resolution SuperDARN "camping beam" data and David Murr showed how transient features can be extracted from GPS/TEC measurements. Mark Engebretson presented Svalbard observations of a post-noon EMIC wave burst associated with an outward motion of the bowshock measured by the Cluster spacecraft. Bob Clauer talked about an unusual class of event in which a solar wind pressure increase produces a decrease in the low latitude magnetic field, rather than an increase. Finally, Juan Rodriguez presented an overview of "crewcuts" which are quiet-time auroral features extending equatorward from the dayside oval during negative *Bx* and *By*-dominated conditions.

During the planning session, we discussed outstanding questions to be answered by this focus group and post summer workshop plan. We revised the outstanding questions proposed in the original proposal such that we shortened the list of outstanding questions, more clearly identified the regions that should be studied in response to transient solar wind and foreshock phenomena, and broadened the types of phenomena that could be studied. We also set up tasks immediately following GEM. The focus group wants to have a list of events that can be analyzed by the entire community from different perspectives. These events are initially going to be provided by Drew Turner and Hui, and then posted on the wiki. We plan on compiling a list of phenomena known to cause different types of disturbances, post them on the wiki, and link them to the events that we have posted. The focus group will also be joining the GSFC Monday Dayside science teleconference (supported by THEMIS) at noon as a mechanism for continued communication and presentation of science topics.

Tail Research Area Report

Coordinators: Larry Kepko and Sorin Zaharia

Substorm Expansion Onset: The First 10 minutes Focus Group

Co-Chairs: V. Angelopoulos, A. Runov, S.-I. Ohtani and K. Shiokawa

This year this focus group covers the following four topics.

- Relative timing between onset signatures in space and on the ground
- Substorm signatures propagation from tail toward the inner magnetosphere and to the ground
- Substorm-related processes in the tail-dipole transition region
- Substorm signatures beyond –30 R_E, including Lunar orbit and distant tail

We had three sessions on June 20, 19, 2012. The third session (starting at 3:30) was joint with the Magnetic Mapping Focus group and discussed problems of late growth phase mapping. Here are notes on the presentations and discussions made during the sessions.

Session 1 (10:30-12:15)

- Faifai Jiang discussed what is the cause of the pre-existing arc? Faifai showed FAST statistics of 210 events of pre-existing arcs before subtorm onset in 1998 using E-field measurements. Most equatorward electron acceleration structures observed within one hour before the substorm onset are considered as the pre-existing arcs. Most of the pre-existing arcs are located within 1 degree of the boundary of the region 1 and 2 field-aligned currents (FACs). Equatorward E-field increases significantly from lower to higher latitudes of the preexisting arc in the postmidnight. In the pre-midnight, such enhancement was not seen. Relation between flow shear associated with the arc and large-scale convection flow should be clarified. This result is consistent with the kinetic ballooning model, since ballooning instability becomes most unstable near the boundary of R1/R2 currents (Cheng and Zaharia, 2004).
- Eric Donovan reported results reported by Motoba et al. (*GRL*, 2012) which show clear conjugacy of onset auroral beads at conjugate stations in northern and southern hemispheres. The beads move eastward with a maximum speed of~5 km/s in the ionosphere. This high speed is difficult to be explained by the ballooning instability (too fast). There are some evidences that these beads occur after the flow bursts. Drift-mirror instability can also make similar structure.
- Larry Lyons showed three unexpected suggestions: 1) current wedge response on ground magnetic field data delayed to the auroral brightening, and responds much stronger to auroral streamers (plasma sheet flow channels); 2) flow channels leading to pre-substorm onet PBIs and streamers can extend from well within the polar cap towards the polar cap boundary; 3) polar-cap boundary streamers after onset make additional poleward expansion and brightening of aurora when they touch the brightening aurora. As the low-entropy plasma of flow burst touches the equatorward arc, instability in the inner magnetosphere seems to develop further. Questions arises how the low-entropy plasma makes precipitation? Does the instability necessary? Just a braking process may be enough to cause aurora brightening. The issue 3) can be explained either by the idea that the flow braking causes auroral brightening, or the idea that the flow burst causes near-earth plasma instability.

- Toshi Nishimura showed correspondence between aurroal signatures and midlatitude Pi2 pulsations to separate different Pi2 models (directly driven by BBF, ballooning instability, or cavity mode resonance). Quasi-periodic auroral streamers (brightenings) appear repeatingly after onset. The on/off of these streamers corresponds to the Pi2 pulsations at middle and low latitudes, consistent with the model that multiple BBF creates Pi2. However, the correspondence between repeating streamers and flow burst in the tail is not so clear.
- Vassilis Angelopoulos showed that an earthward flow burst (FB) causes a pair of upward/downward currents. Tailward FB causes an opposite pair of upward/downward currents. The currents are inferred from ground magnetic field data.
- Misha Sitnov showed accumulation of magnetic flux at the tailward end of the thin tail current sheet. It was theoretically expected. Geotail observation by Machida et al. (2009) show such a signature of *Bz* increase before the onset. A particle simulation shows that the accumulation (tearing instability, slippage) accelerates particles earthward before the reconnection (Sitnov and Swisdak, 2011), consistently with the idea of catapult slingshot scenario for substorms by Machida et al. (2009). Time difference between non-reconnection flow and reconnection start seems to be too short in the model (less than 1 min) to explain the Machida's observation (more than a few min).

Session 2 (13:30-15:00)

- Joe Baker showed suppression of westward ionospheric convection for a few minutes at subauroral latitudes during auroral substorm onset in the onset meridian. Currently there is no good explanation on this phenomenon.
- Jiang Liu showed measurements of current sheet at the dipolarization front (DF) using a THEMIS statistics at X= −6 to −13 Re. Current at DF is more field aligned at higher latitudes, and more perpendicular to the field at lower latitudes. $Jx > 0$ in morning and $Jx < 0$ in evening, which is consistent with the region-1 FAC sense.
- Joo Hwang showed tailward-moving dipolarization front (DF) followed by an earthward-moving DF observed by Cluster at X= −14 R_E. Tailward flow causes stretching of plasma sheet and may initiate X-type lobe reconnection that causes subsequent earthward flow. Flow velocity is earthward during tailward-moving DF. What does it mean? DF may be just an enhancement of Bz.
- Joachim Birn showed two issues; 1) a few-min timing delay from reconnection to the substorm current wedge formation, and 2) energetic electron/proton motion in the simulated BBF. The particle has two source regions, one from tail frank side (early, higher energy), and the other from the reconnection region (later, lower energy). They have anisotropic pancake distribution at low latitudes, and cigar (field-aligned) distribution at high latitudes.
- Xuzhi Zhou studied ion beams in the PSBL using THEMIS observation at two satellites (P4 and P5) for 18 events. PSBL ion flow bursts are followed by adjacent CPS flow bursts and dipolarization fronts for 16/18 events.
- Stefan Kiehas showed several examples of ARTEMIS observation during substorm-like phenomena. P1 and P2 are separated about 7 R_E in X or in Y. The scale size of the substorm signature (TCR/flux ropes/plasmoid) in the near-Earth tail at $X \sim -60$ R_E does not extend over the entire tail.

Session 3 (15:30-17:00) joint session with the mapping FG

- Shin Ohtani showed that the DMSP FAC/particle data (large data set) show b3a (equatorward boundary of monoenergetic electron precipitation) occurs at the R1/R2 current boundary. B3b (poleward boundary of monoenergetic electron precipitation) occurs at poleward boundary of the R1 current. (Ohtani et al., 2010). Caution was made that the growth-phase arc will be only a very small fraction of the used dataset.
- Toshi Nishimura showed using CHAMP FAC and THEMIS ASI that the pre-onset arc was

located (event 1) at the peak of the R1 currents, (event 2) at the middle of the R2 currents, (event 3) at the middle of the R2 current, and (event 4) at the poleward edge of R2 current. The onset arc is in the R2 current in the onset meridian, while it is at the boundary of R1/R2 current at dusk/dawn side of the onset meridian. These observations seem to be inconsistent with the kinetic ballooning model, since ballooning instability becomes most unstable near the boundary of R1/R2 currents (Cheng and Zaharia, 2004). But they assume symmetric magnetosphere in the model.

- Jun Liang showed using THEMIS E and A difference that the tailward boundary of upgoing quasi-parallel electron beam (QPEBs) in the CPS can be used to map the equatorward boundary of auroral arc region to the magnetosphere. The pre-breakup arc region is found as situated in the near-tail region, i.e., a transition region from quasi-dipolar to stretched current sheet topology, inferred by estimating the magnetic field curvature.
- Larry Lyons showed mapping implications of the very thin auroral oval in the late growth phase. The sequence of "PBIàeqauatorward-moving streamer à auroral brightening onset" was investigated for thick oval cases (typical, 97%) and thin oval cases (rare, 3%). THEMIS data show difference in Ptot increase. Thin case: less PBIs, streamers, flow channels. Thick case: stronger, monotonic increase of Ptot at growth phase, and more thinning of tail.
- Jian Yiang showed development of a substorm-time magnetic field model based on the equilibrium version of RCM (SUMMER). He also showed that even one has a very good empirical model, the equatorial crossing *X*-distance is very different.

All these presentation and relevance to the various substorm models are summarized as a substorm onset matrix which is uploaded on the GEM Wiki page.

At the end, we agreed to have a similar joint session with mapping FG next year. Caution was made to distinguish morphological mapping and field-line mapping. A possibility was also suggested to have a joint session with inner magnetosphere-Tail FG.

Modes of Magnetospheric Response Focus Group

Co-Chairs: Larry Kepko, Robert McPherron, Jenni Kissinger

At the 2012 GEM Workshop the Focus Group on Modes of Magnetospheric Response convened two sessions. The first in the morning of Monday June 18 was devoted to new results related to steady magnetospheric convection (SMC) events. The second immediately after lunch considered sawtooth events and other phenomena.

In the SMC session N. Ganushkina used Tsyganenko models to demonstrate that during SMC the inner edge of the tail current is located near 10 Re and that there is very little ring current inside of this distance. J. Yang used the Rice Convection Model driven by different boundary conditions in the tail to simulate conditions during an SMC. He found the best match to observations was with a model that has a broad region across the tail where there are localized and transient bursts of reconnection. This suggests that SMC are anything but steady in the tail. A. DeJong described "active SMC" and contrasted them with "classic SMC". During active SMC the level of disturbance in the westward electrojet is much stronger than in typical SMC, and the fluctuations of this electrojet are proportionally elevated. However, the steadiness defined as the ratio of fluctuation amplitude to mean value remains low. Such active SMC can explain the absence of substorm expansions during strong activity. R. McPherron presented an analysis of the synchronous magnetic field during SMC demonstrating that the synchronous field inclination is steadily tail-like throughout the night sector. This result is consistent with the idea that there is a steady current at the inner edge of the plasma sheet distorting the magnetic field. J. Kissinger examined the relation between substorm onset and SMC.

She finds that more than 90% of all SMC are immediately preceded by an obvious expansion phase. A more detailed examination reveals that of the remaining 10% all but 1% is preceded by some form of disturbance that may be a poorly observed weak substorm. The small fraction of SMC that cannot be associated with a substorm expansion appear to begin from very quiet conditions. Furthermore, these grow very slowly compared to SMC starting after an expansion phase. The result suggests that for a typical SMC to occur an x-line must form close to the Earth so that continuous transient and localized reconnection at points on the line can balance dayside reconnection.

In the afternoon session X. Cai described her extension of the list of sawtooth events to a complete solar cycle. She finds that sawtooth events can occur in both CME and CIR driven storms. The properties of *AL* and *Sym-H* during sawtooth events are very different from those during more common types of activity. Jeremy Ouellette relayed results obtained by Oliver Bramble on how sawtooth events can be produced in simulations. Under strong solar wind driving ionospheric O^+ is injected into the magnetosphere slowing the reconnection rate. This leads to reduced emission and faster reconnection (substorm expansion). The feedback loop modulates the tail behavior producing a quasi-periodic sequence of substorms. If no O^+ is emitted the tail settles into the SMC response mode. It is the combination of strong driving and oxygen emission that converts the SMC mode to the sawtooth mode. J. Baker described new observations from the AMPERE experiment obtained by L. Clausen on the size of the polar cap. During weak solar wind driving the size of the polar cap defined by the ring of Region 1 current expands and contracts in the classic loading-unloading sequence producing a sequence of isolated substorms. In contrast during strong driving the polar cap expands to cover a large area and the changes in its area are small and cannot be identified as individual substorms. A statistical comparison of isolated substorms to SMC events showed the R1 oval size and flux during SMC events were stable compared to the expansion seen at substorm onset. R. Wilder argued that a different mode of activity may occur when the magnetosphere is driven by very strong IMF *By*. He reported that during these times there is extremely strong Joule Heating in the ionosphere. A. Kellerman reported on his work using Stereo data to predict the arrival of a CIR at the Earth from observations at a spacecraft trailing the Earth in its orbit. Naively one expects that a stream interface will arrive at the speed of corotation of the Sun. In fact the interface may be tilted relative to the ecliptic and may also evolve as the Sun rotates. Errors as large as one day in an expected 3-4 day travel are seen. This makes it very difficult to use the known climatology of a CIR to predict the response of the magnetosphere. A report on the use of magnetometer arrays at opposite end of a field line to study sudden impulses was presented by H. Kim. He found a constant difference between the disturbances in opposite hemispheres that was surprising because it did not depend on day of year. C. Yue carried this theme to the tail where he used Themis data to study the propagation of interplanetary shocks in the tail.

GEM Tail-Inner Magnetosphere Interactions (TIMI) Focus Group

Co-Chairs: Pontus Brandt, John Lyon and Frank Toffoletto

The focus group profited from two excellent tutorials related to focus group concerns: the first presented by Harry Warren who discussed supra-arcade down flows and comparative solar/geospace systems, and the second by Dick Wolf on the physics of bubbles and BBFs.

The first breakout session on Wednesday consisted of invited presentations reviewing the state of our understanding of interactions between the tail and the inner magnetosphere interactions.

Vassilis Angelopolous (UCLA) gave an overview of the status of observations and theory/simulations relating to depolarization fronts (DF). He noted the importance of force balance and the associated Birkeland currents both as observed and simulated —ahead of the front the currents are characterized as having a region-2 sense while within the bubble itself the currents have a region-1 sense.

John Lyon (Dartmouth College) gave a review on the properties of BBFs and bubbles seen in recent high-resolution LFM simulations. At the current resolution of the code, the LFM is able to resolve BBFs in the tail and is close to resolving their impact in the ionosphere.

Jian Yang (Rice) described causes and effects of DF as seen in the RCM-E; his results suggest that the westward electrojet peaks at the equatorial edge of bubbles and that bubble injection can increase ring current pressure by 10 nPa in RCM-E simulations.

Jimmy Raeder (UNH) discussed several related topics. He has found that the breakdown in force balance before reconnection is associated with a KY0 ballooning mode although the exact nature of this instability is not clear. He noted the appearance of other ballooning structures in the tail about 1 Re in scale size. These structures look like beads in the aurora, consistent with some observations. He presented slides from a recent talk by Tetsuo Matoba *et al.* who observed auroral beads from the ground and concluded that they are not local ionospheric effects since they are conjugate between hemispheres.. These beads drift with speeds of about 5 km/s; such motion is difficult to explain with ballooning. He also reported on simulation work by Ping Zhu on bubble formation mechanisms, starting from a Harris sheet and developing an axial-tail instability. Zhu [2011] also found entropy minima/maxima (bubble/blob) pairs forming, consistent with the recent work of *Hu et al.,* [2011].

Vahe Peroomian (UCLA) gave a brief presentation of large-scale kinetic simulations of the 8-9 March 2008 storm, launching H+ in the solar wind and O+ from the ionosphere. He found that the geoeffective entry region was 40-90 Re down tail.

The first session on Thursday focused on observation-based presentations.

Andrei Runov (UCLA) looked at transient dipolarizations. Taking advantage of a unique configuration in April 2009 when all five THEMIS spacecraft had favorable radial conjunction he found a strong DF *Bz* signature in all of the spacecraft except the inner one at 8 R_E. GOES and THEMIS-B saw oscillations in both particle velocity and magnetic field which he concluded were diamagnetic oscillations from mirror-mode-like waves.

Larry Lyons (UCLA) discussed mesoscale flows aligned with streamers. Flow channels from as high as 85° MLAT are seen together with PBI (Poleward Boundary Intensifications).

Toshi Nishimura (UCLA) discussed PBI streamers associated with substorm onset. His results suggest that reconnection causes the streamers, and the associated flow bursts lead to intensification of the diffuse aurora and onset.

Bea Gallardo (UCLA) looked at mesoscale flow channels associated with auroral streamers, showing that flow channels and streamers appear almost simultaneously with flow enhancements east of the streamers. Poleward flows appear (~24% of the time).

Ying Zou (UCLA) showed statistics of the relationship between mesoscale polar cap flows and PBIs/streamers. 82% show occurrence of equatorward flow before a poleward boundary intensification with a delay of around 0-3 minutes.

Shin Ohtani (APL) showed examples of DF bouncing/overshoots at 9 R_E, as well as evidence of dipolarization inside geosynchronous orbit. He also showed statistical plots of delta H (N-S component of the magnetic field) versus delta *V* (radial component) and the electric-field inside geosynchronous (Cluster perigee) where dipolarizations show a dawn-dusk Electric-field.

Pontus Brandt (APL) showed global ENA intensifications and timing during storm-associated substorms. Around substorm onset a rapid decrease of ENAs occurs outside geosynchronous orbit, followed by dipolarizations and particle enhancements at GEO. He also showed coherent fine-structure/indentations at the outer edges of the bright ENA emissions from sequences of independent ENA images, which are statistically significant.

Jerry Goldstein (SWRI) talked about TWINS stereo ENA observations of the anisotropy of injected ions. Results from two events show a clear dawn-dusk asymmetry, where the PADs at dusk are more pancake than at dawn.

Natasha Buzulukova (GSFC) showed results comparing HENA images and CRCM runs of protons in the 60-119 keV range during a substorm injection. Clear enhancements of protons in the ring current were noted.

Xiaoyan Xing (UCLA) looked at the bubble precursor effect in the near-Earth plasma sheet where it was found that the currents were ring current in front of the DF and R1-like behind.

Yongli Wang (Univ. Maryland) reported on a statistical survey of magnetotail properties from X_{GSE} = –10 to –80 Re using THEMIS/ARTEMIS data

Eric Donovan (Univ. Alberta) advocated increasing the density of ground based stations in a focused region with imaging riometers, magnetometers, spectrometers, and VLF receivers.

Jichun Zhang (UNH) discussed ion spectral dynamics at the inner edge of the ring current. He focused on nose features that are multiple bands of plasma sheet particles that occur in the ring current. He found that RCM and RCM-E modeling can reproduce some spectral features seen but multiple nose structures are difficult to reproduce.

The second session on Thursday consisted of modeling-based presentations.

Aleksandr Ukhorskiy (APL) looked at mechanisms of proton energization on dipolarization fronts. Using a simulation, he found that protons in the magnetotail can be accelerated up to ~100 keV in the DF, but that the level of energization depends on how long the particle can stay in phase with the front.

Bill Lotko (Dartmouth) discussed influence of ionospheric conductance on cross-tail asymmetry in nightside reconnection and plasmasheet fast flows seen in LFM simulations.

Bin Zhang (Dartmouth) discussed the magnetotail origins of auroral Alfvénic power.
Jeremy Ouellette (Dartmouth) discussed sawtooth oscillations driven by ionospheric outflows as seen in the LFM global MHD code.
Joachim Birn (SSI) described his MHD results on bubbles, blobs and particle acceleration. The earthward transport of bubbles result in region-1 Birkeland currents and the depth of penetration into the inner magnetosphere depends on their reduction in the entropy. Bubbles that make it to the inner magnetosphere produce a substorm-current-wedge-like signature.
Regions of enhanced entropy (blobs) generate region-2 sense currents.

Misha Sitnov (APL) discussed the roles played by magnetic reconnection and buoyancy in the formation of mesoscale structures such as plasma bubbles.

Natalia Buzulokova (GSFC) discussed the cause and effect relation between DF and reconnection using 2.5 D PIC simulations.
Roxanne Katus (University of Michigan) discussed a statistical study of several storms between 1970-2011, binning *Dst*, IMF *Bz*, and *AL*. She found that intense events show two-step/inflection main phase *AL* and *Dst* development implying that substorms play a strong role in intense events.

Antonius Otto (Univ. Alaska) noted that entropy is conserved when flux is circulated from the nightside to the dayside as demonstrated by MHD simulations. In these simulations, the MHD

boundary conditions is outflow on the nightside. The growth phase simulations see a major reduction of closed magnetic flux in the near-Earth tail and increased thinning of the near Earth tail current along with a strong reduction of the gradient of the flux tube entropy and a sharp transition to the inner edge.

The final session on Thursday consisted of spillover from the previous sessions and discussion of plans for upcoming meetings.

David A. Mackler (SWRI) described his work with observations of the energetic neutral storm (ENA) geomagnetic emission cone (GEC).

Yasong Ge (UNH) Talked about ion dynamics from an analysis of the Feb. 27, 2007 DF event using observations from THEMIS and all sky imagers. Proton precipitation was enhanced following a DF, which suggests that the magnetotail DFs can accelerate and re-distribute plasma sheet ions into an earthward or field-aligned distribution.

Natalia Ganushkina (Univ. Michigan) showed inner magnetosphere model results — with different energies and temperatures — depend on where and how one applies the boundary conditions.

In addition, the final session also consisted of a discussion of several open questions/suggestions on what to tackle during the course of the focus group.

Roughly speaking, the discussion could be categorized as inner magnetosphere issues versus tail questions. In fact it was suggested that these categories were a way to organize our understanding. On the tail side, questions revolved around the formation of bubbles, the causes of their fast Earthward flow, and what causes the flows to be concentrated in limited regions of the nightside open closed boundary. Other important issues were the role of DF's in accelerating particles in the tail and the effect of the ionosphere on bubble formation and propagation.

The inner magnetosphere discussion centered on two broad areas: the transition from tail to inner magnetosphere and the capabilities of ring current models to reproduce the RC with and without the effects of bubbles. On the first issue, the role of bubbles in substorm expansion at L <10 was considered since most bubbles do not penetrate inside of 9 R_E. Are there violations of adiabatic convection associated with the bubbles? On the second issue there was a general discussion of the current state of ring current models. No firm conclusion was reached about whether bubbles were required to form the ring current and whether variations of $PV^{5/3}$ along the outer boundary were necessary and could be accommodated in the various models.

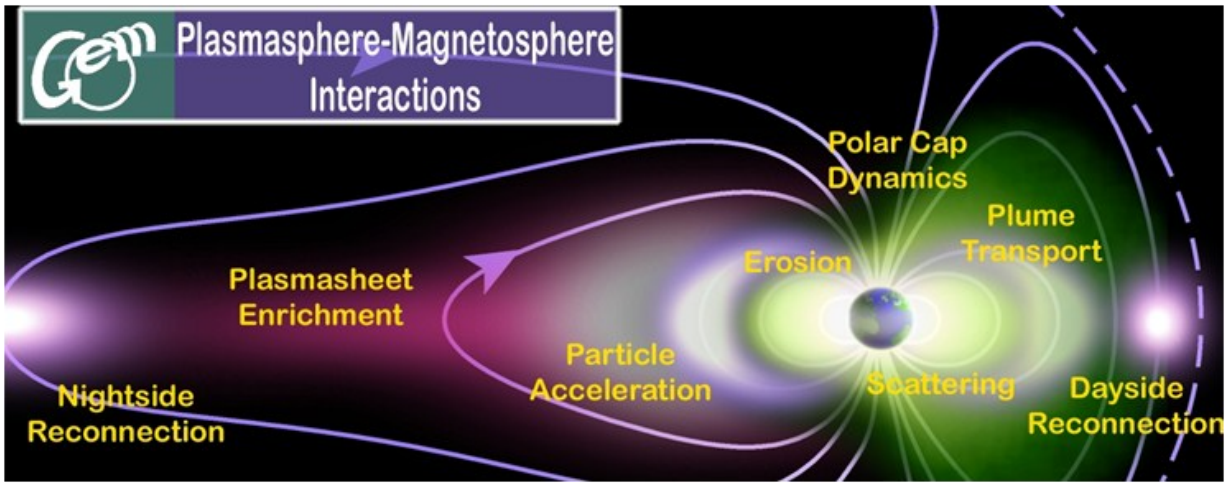
New observations and analyses were discussed. RBSP figured prominently to look at DF interactions with inner magnetosphere: RBSP-ASI-SD to determine relation between streamers, PBIs, and ring current pressure. Ion spectral features will also be available over a wide range of L. The full range of THEMIS capabilities (ground and satellite) were discussed for statistical analysis of Auroral streamers, flows, and PBI's. Global ENA imaging from IMAGE and TWINS should be used to determine the global nature and context of the fine-scale structure/indentations. Low altitude emission can also be used to resolve acceleration mechanisms.

We discussed what new model runs/improvements are needed. Major questions: How are bubbles created by reconnection or violation of frozen-in-flux? How can the transition to instability be properly handled and what impact does the presence of a ring current have on this? What is the best way to self-consistently model the transition region?

Future plans include a joint session with the "First 10 Minutes FG" in 2013. We will invite key "anchor" speakers, schedule plenty of discussion time, and require walk-ons to be strictly relevant to the specific topic.

IMS Research Area Report

Coordinators: Anthony Chan and Jerry Goldstein



Plasmasphere Magnetosphere Interactions (PMI) Focus Group

How Are Magnetospheric Processes Regulated By Plasmaspheric Dynamics (and Vice Versa)?

Co-Chairs: Jerry Goldstein, Maria Spasojevic, Joe Borovsky

Wiki: http://aten.igpp.ucla.edu/gemwiki/index.php/FG11._Plasmasphere-Magnetosphere_Interactions
ABRIDGED LINK: http://tinyurl.com/pmiFGwiki

Purpose of This Report

This is a report of activities of the Plasmasphere-Magnetosphere Interactions (PMI) Focus Group (FG) at the 2012 Geospace Environment Modeling (GEM) Workshop in Snowmass, Colorado. This report includes a broad overview of PMI scientific progress. The report is posted online at the GEM PMI Wiki page: http://tinyurl.com/pmiFGwiki.

Format of the 2012 GEM PMI Sessions

Presenters were encouraged (both in advance and at the sessions) to keep their presentations brief and informal, leaving time for questions and discussions, fostering an atmosphere of active exchange of ideas among all attendees and speakers.

PMI Breakout Sessions

To address the PMI FG's central question, "*How Are Magnetospheric Processes Regulated By Plasmaspheric Dynamics (and Vice Versa)?*" we hosted five (5) Breakout sessions at the 2012 GEM Summer Workshop, listed below. There were two topics covered:

A. ***Density, Waves, and Fields Sessions:*** These sessions highlighted recent research on: the spatial and temporal dependence of plasma properties (density, temperature, composition), growth and propagation of waves, and electric, magnetic, and convection flow fields in the inner magnetosphere.

B. ***GEM PMI Challenge Sessions:*** In these sessions, speakers presented data and modeling results for the GEM PMI Challenge, which is described below (see PMI Breakout 2)

List of Sessions:

PMI-1 [Mon, 18 June, 3:30p]: Density, Waves, & Fields I
PMI-2 [Tue, 19 June, 10:30a]: GEM PMI Challenge I
PMI-3 [Tue, 19 June, 1:30p]: GEM PMI Challenge II
PMI-4 [Tue, 19 June, 3:30p]: Density, Waves, & Fields II
PMI-5 [Wed, 20 June, 1:30]: Density, Waves, & Fields III

The detailed schedule (GEM_PMI12_final.pdf) is posted on the PMI Wiki. These PMI Breakout sessions drew (on average) ~25 people per session, with significant (and at times quite animated) discussion. Directly below, each PMI Breakout Session is listed with its Topic, followed by a brief summary of what was discussed and accomplished at the session.

Notes from PMI Breakout Sessions:

Monday, 18 June 2012
PMI Breakout 1 [3:30p]
Topic: "Density, Waves, & Fields I".
Session Chairs: Claudepierre, de Soria-Santacruz Pich

This session focused on the density features of the plasmasphere, the dependence of wave growth and propagation on the presence or absence of cold plasma, and the fields that influence cold plasma evolution. The session featured seven (5) scheduled presentations by Chappell, Claudepierre, de Soria-Santacruz Pich, Golden, and Matsui. Chappell's analysis of OGO-5 ion density data produced the first reported observation of a possible minimum scale size of under 250 km (0.04 R_E) for the fine-scale structure within plasmaspheric plumes, hinting at the mechanism responsible for the structure. Simulations using the LFM-RCM coupled model by Claudepierre, including a static plasmasphere, show a significant effect of the plasmasphere upon the ULF wave mode structure: the frequency of FLRs is lowered, and spectral power is shifted inward in *L*-shell by the presence of the inner cavity. de Soria-Santacruz Pich showed results of modeling EMIC wave growth, propagation, and dispersion relation in order to study radiation belt remediation (RBR), and found that wave-particle interactions of interest to RBR occur for <400 MeV protons, within the oxygen band in the inner belt, and for <10 MeV electrons, within the proton band in the outer belt. Golden (presented by Goldstein) used regression analysis to produce a THEMIS-based empirical model of chorus emissions, keyed to indices (*Sym-H*, *AE*, *Pdyn*, and the Newell coupling function), binned in *L* and MLT, with RMS errors of <3 pT. Matsui (presented by Goldstein) has updated the 2008 Cluster+ground-based global electric field empirical model: the updated model (valid from *L*=2-10 at all MLT) gives electric potential versus *X* and *Y* (SM coordinates), and with newer Cluster data to include active periods not part of the original model.

Tuesday, 19 June 2012
PMI Breakout 2 [10:30a]
Topic: "GEM PMI Challenge I".
Session Chairs: Chi, Chen

The goal of the **PMI Modeling Challenge** is to evaluate the current state of modeling of the evolution of cold plasma density, and the impact of this distribution on specific magnetospheric processes. In collaboration with the NASA LWS plasmasphere FST, two Challenge events were selected: **(A)** a disturbance interval, 8-11 June 2001; and **(B)** a quiet interval, 2-5 February 2001. The results are to be published in JGR space physics, with authors to include "GEM PMI Challenge" in the manuscript title.

PMI Breakout 2 was the first of two sessions dedicated to the sharing of first results from the PMI Modeling Challenge. To kick off the session, an overview of the two PMI Challenge events (provided by Spasojevic) was presented. For event **A**, both manual and automated extractions of plasmapause locations show a two-phase erosion coincident with two

corresponding negative excursions in Dst on 9 June and 10 June; the recovery was marked by a double plume (one per erosion phase) and the growth (0.2-0.4 R_E/h) of a dayside shoulder. For event **B**, multiple density traces by IMAGE RPI, from successive perigee passes of the spacecraft were used to characterize refilling at 4 MLT and 16 MLT.

The session then featured five (5) scheduled presentations by Spasojevic, Maruyama, Lunjin Chen, Fraser, and Chi. Spasojevic (presented by Goldstein) showed correlation between regions of cold, dense plasma (from IMAGE EUV and LANL MPA) and EMIC waves, either directly observed by GOES magnetometers, or inferred using the *Blum et al.* [2012] LANL plasma-based proxy. Maruyama presented Challenge results from the coupled CTIP-RCM model, illustrating how ionosphere-thermosphere (IT) coupling (i.e., neutral wind effects) enhances SAPS, and extends it to lower latitudes. Chen modeled the propagation characteristics of EMIC waves, showing large wave growth for the guided mode, and within 10 degrees of the equator, and finding O+ band growth only during recovery, and H+ band growth throughout the storm, preferred for the guided mode and inside the plasmaspheric plume. Fraser presented GOES data for Event B, in which EMIC waves were unstructured in the outer magnetosphere, and structured closer in with dominant power in the He band and with polarization characteristics indicating propagating left-handed waves. Chi used field line resonance (FLR) sounding to obtain ground-based remote-sensing measurements of the mass density distribution from 2006-2007, finding a dependence consistent with L to the -4 power, higher mass weighting at lower L, higher mass density in winter (consistent with a winter helium bulge), and a dayside density rise (presumably from ionospheric filling) that begins at noon MLT, rather than at the dawn terminator.

PMI Breakout 3 [1:30p]
Topic: "GEM PMI Challenge II".
Session Chairs: Zaharia, Maruyama

This was the second of two sessions dedicated to the sharing of first results from the **PMI Modeling Challenge.** The session featured six (6) scheduled presentations by Ozhogin, R. Denton, Takahashi, Zaharia, Buzulukova, and Krall. Ozhogin (presented by Denton) showed active RPI sounding measurements for the PMI Challenge, including 97 active traces, and the fitting parameters that specify the density inversion for both PMI Challenge events (and one additional LWS FST event); these fitting parameters are indexed at http://goo.gl/MmMqb. The Ozhogin density fits specify a field-aligned dependence; for intervals with multiple sounding within a 1-R_E distance, an L-shell dependence was also inferred. Denton presented global refilling rates inferred from analysis of passive RPI data, for Event B, and the LWS FST event 26 Nov-1 Dec 2001, finding respective L-dependent refilling rates of 56,000 L^(–5.1) cm^{-3} per day, and 24×10^(1.8–0.42L) cm^{-3} per day. Takahashi (presented by Denton) used GOES 8 and 10 data to obtain mass density measurements for 2001 day 32-38, showing a gradual increase from 10 to 100 amu per cm^3 that is consistent with a 2-phase refilling, and for Event A (8-11 June 2001), showing increased O^+ in the plasmatrough to produce an apparently L-independent mass density. Zaharia presented RAM code plasmasphere simulations from 9 June 2001 (Event A) for three different electric fields (Volland-Stern, Weimer, and RCM-embedded), finding the strongest plumes occurred in the self-consistent (embedded RCM) E-field run. Buzulukova presented CRCM simulations of Event A, with self-consistent E and dynamic Tsyganenko B, finding fairly reasonable agreement with the IMAGE EUV observations: although no dayside shoulder was observed, the wrapped plume from the recovery phase was fairly well reproduced. Krall showed SAMI3 preliminary (no neutral wind) model runs including a multi-species plasmasphere (H, O, He, and others), interhemispheric interactions, a Weimer E-field (plus corotation). Sazykin presented RCM runs for Event A, in which the ring cur-

rent injection caused nightside inflation of the cold plasma.

PMI Breakout 4 [3:30p]
Topic: "Density, Waves, & Fields II".
Session Chairs: Baker, Blum

PMI Breakout 4 was the second session focused on the density features of the plasmasphere, the dependence of wave growth and propagation on the presence or absence of cold plasma, and the fields that influence cold plasma evolution. The session featured four (4) scheduled presentations by Erickson, Eun-Hwa Kim, Jo Baker, and Engebretson. Erickson (presented by Goldstein) showed observations of strong spatial and temporal E-field gradients and variability in the subauroral ionosphere within SAPS channels, seen in both low-altitude orbiting spacecraft and ground-based radar. Kim showed the results of an finite element method (FEM), cold linearlized plasma wave modeling code with adaptive resolution, in which a plasmapsheric plume provided boundaries that confined wave energy, and using different wave perturbation methods (point source, field-aligned, and north-south asymmetric). Baker showed conjugate (SuperDARN, north and south) mid-latitude radar observations from the plasmasphere boundary layer (PBL) illustrating the determination of SAPS flow channels. Engebretson presented and discussed ground-based and satellite (AMPTE, CRRES) observations to determine whether cold plasma is a preferred site for EMIC waves, finding modest agreement with a superposed epoch approach.

Wednesday, 20 June 2012
PMI Breakout 5 [1:30p]
Topic: "Density, Waves, & Fields III".
Session Chairs: Denton, Zhang

PMI Breakout 5 was the final PMI session, and the third session focused on the density features of the plasmasphere, the dependence of wave growth and propagation on the presence or absence of cold plasma, and the fields that influence cold plasma evolution. The session featured six (6) scheduled presenters: Zhang, Allen, R. Denton, Blum, Krall, and Brito. Zhang showed EMIC wave observations from Cluster for two events, (Z1) a weak main phase on 30 March 2002 and (Z2) the recovery phase of a super storm on 22 November 2003, extending the observations to higher energies using both CODIF and RAPID instruments. Allen compared observed Cluster (CODIF and RAPID) EMIC observations with the predictions of linear theory using the *Blum et al.* [2012] plasma proxy parameters, finding key differences between the two events. Event Z1 had strong anisotropy, consistency with theory, and waves locally generated and still in the source region. Event Z2 had weak anisotropy, inconsistency with theory, and the observations suggested non-local generation. Denton presented statistical analysis of bulk H^+ vs O^+ composition using GOES Alfven waves and LANL MPA data, finding that with increased F10.7 and *Dst* magnitude, there is increased mass density and fractional O^+ composition, but lower light ion density, and finding that both mass density and ion density increase in the afternoon MLT sector. Blum presented a statistical comparison of the predictions of the LANL-MPA-based plasma proxy parameters, and directly-observed waves in GOES data, showing good correlation (in MLT and epoch time) between the two quantities. Krall presented a preliminary "proof-of-concept" SAMI3 simulation including a Volland-Stern potential. Brito showed 3D test particle simulations of the response of relativistic radiation belt electrons to shock-induced ULF wave oscillations, finding that the ULF waves can cause electron precipitation on short time scales. The simulation results, consistent with MINIS balloon data from 21 January 2005, finally explain these observations as resulting from ULF modulation of the loss cone angle, which can widen by as much as 40% from the large-amplitude ULF waves.

Conclusions and Activities for the Coming Year

This year, several main science results were collectively presented. In the area of **ion composition**, several studies of mass density were presented, yielding new insight into the spatial relationships of the O^+ torus, and of its effects on the growth and propagation of EMIC waves. It was found that **fine scale structure within plumes** may have a measurable lower limit in scale size, hinting at the generation mechanism for this fine structure. In the area of fields, updated **electric field** empirical models and observations, and the effect of **self-consistent magnetic fields**, were explored. Finally, multiple case studies, simulations, and statistical results are explaining **wave mode structure** and its importance for hot particles, and are starting to converge on a consensus system-level picture of EMIC and chorus wave occurrence, growth, and propagation.

The **PMI Modeling Challenge** will feature reproduction of plasmaspheric dynamics for two selected events (see PMI Breakout 2 above), and modeling and observations of EMIC waves. Led by Maria Spasojevic, all data and modeling/simulation results and participants are and will be found at two locations:

http://vlf-sharealike.stanford.edu/~gem/
http://tinyurl.com/gempmi

The results of the GEM PMI Modeling Challenge will be presented at GEM 2013, and published in a coordinated, linked series of papers, most likely in Journal of Geophysical Research.

Near-Earth Magnetosphere: Plasma, Fields, and Coupling Focus Group

Co-Chairs: Sorin Zaharia, Stan Sazykin, and Benoit Lavraud

The goal of this focus group is to improve physical knowledge and modeling capability of the near-Earth magnetosphere (inner magnetosphere and the inner plasma sheet). The focus group held 2 sessions at the 2012 Summer GEM Workshop, its final year of activity. Both sessions took place on Monday, June 18. The first session saw speakers present their latest research results on various topics relevant to the focus group, while the second session was dedicated to short summaries describing research spanning the whole focus group duration, as well as to a discussion of open questions and plans for documenting the focus group activity between 2007 and 2012.

Latest Research Results

In this session both data-based results and model-derived findings were presented.

On the data front, Chih-Ping Wang described near-Earth plasma sheet properties (a crucial driver of inner magnetosphere dynamics), specifically plasma anisotropy, as obtained by a statistical observational study using THEMIS spacecraft data from 2007 to 2010. Focusing on a region closer to Earth, Jerry Goldstein presented remote Energetic Neutral Atom (ENA) imaging from the TWINS satellites. TWINS data (including the low-altitude emission) is an important tool for model validation. Among the questions that the data poses for both theorists and modelers, a prominent one is the physical reason for the observed dawn-dusk asymmetry in pitch angle anisotropy. Finally, Jo Baker analyzed large-scale ionospheric convection features (sub-auroral polarization streams, or SAPS) from SuperDARN HF radar observations. His presentation showcased the unprece-

dented coverage and resolution of SAPS events observed by mid-latitude radars, making SAPS an excellent opportunity for testing inner magnetosphere models. In fact, his presentation was immediately followed by model results presented by Stan Sazykin, who used the Rice Convection Model (RCM) to simulate several of the observed features.

The second part of the session had several model-derived findings presented. Frank Toffoletto and Jian Yang concentrated on the role of entropy "bubbles" and the interchange instability in plasma injection to the inner magnetosphere, using global MHD models (LFM) and the equilibrium version of RCM (RCM-E). Their results reconfirm the crucial role entropy bubbles (whose observed counterpart are the substorm injections) have in ring current formation, as a mechanism for sidestepping the "pressure balance inconsistency." Matina Gkioulidou's presentation highlighted, through simulation results using RCM (with a force balance solver), the importance of ionospheric conductivity (through the e- loss rate/precipitation) in ring current dynamics. A more realistic, MLT-dependent loss rate was also found to lead to better agreement between precipitating electron energy fluxes and statistical DMSP observations. As part of the ongoing quest of improving global MHD model physics, 2 presentations investigated different approaches to this end: 1). Vahé Peroomian presented results using test particles launched in a global MHD code and traced through its fields, results that showed greatly improved agreement with observations during a high speed stream (HSS) geomagnetic storm; 2). Xing Meng presented the latest results in relaxing the isotropy criterion in the BATS-R-US MHD code (anisotropic MHD) and coupling the code with an inner magnetosphere model (CRCM). Finally, Dan Welling's presentation focused not only on the strong effect of ionospheric outflows on near-Earth magnetosphere dynamics, but also on their impact on the magnetosphere shape and the cross polar cap potential (CPCP). While partly verifying the role that a strong ring current has on "inflating" the magnetosphere and reducing CPCP, the results also showed a fundamental difference when ion outflow is introduced, implying that factors other than the magnetopause shape also play a role in the CPCP variation.

Summary and Open Questions

The second session of the focus group had several groups in the community present, through their representatives, short summaries of their work spanning the focus group duration, and distilling major themes and findings that came up from their work. The strongest such theme, prevalent in all summary presentations, was the importance of including self-consistency between magnetic field and plasma in models of the inner magnetosphere. With one notable exception, the presentations found a self-consistent magnetic field to be a very strong factor in altering inner magnetosphere dynamics, in most cases leading to better agreement with observations.

Margaret Chen and Colby Lemon summarized, in 2 separate presentations, inner magnetosphere research at the Aerospace Corporation using the RCM-E model. Their results showed the ring current to be weaker when magnetic (and electric) self-consistency is taken into account, and they also found that the self-consistent RCM-E field compared better than TS04 with observations. Sorin Zaharia summarized inner magnetosphere research performed at Los Alamos in the 2007-2012 timeframe using the self-consistent RAM-SCB model. His results included magnetic field "shielding" (lower ring current pressure) when self-consistency is taken into account, qualitatively similar to the Aerospace RCM-E results. Other RAM-SCB results presented showed a strong dependence of the ring current on the plasma sheet parameters and ion composition, as well as the important effect of the induced electric fields. Matina Gkioulidou presented a summary of her Ph.D. thesis research,

which overlapped temporally with the focus group. Using the RCM code with a two-dimensional force balance solver, she also found a strong effect of the self-consistent magnetic field, in particular a weakening of the inner magnetosphere pressure. Of these presentations, Natalia Ganushkina's was the one that did not see significant changes in the computed *Dst* index with the inclusion of self-consistency. Yet, there were other changes observed: while without self-consistency the tail current had a very strong contribution to the *Dst*, this relative contribution diminished with the addition of a self-consistent magnetic field.

Among the remaining open questions raised and discussed in the context of the summary presentations, the most prominent were: 1). How to include effects of faster time scale processes (e.g. substorms)? 2). How to create, with ever-increasing computational power, more cohesive simulation tools (i.e. replace "coupled" models with global models that take into account relevant physics), and 3). How important exactly is a better model of auroral precipitation?

Finally, the final session of the Near-Earth Magnetosphere focus group ended with a discussion about documenting the outcome of the focus group activities between 2007 and 2012. It was agreed that an optimal course of action would be, in addition to the final focus group report, the publication of a review paper detailing the research results obtained under the aegis of the focus group (such a review paper would cite the individual papers published in the relevant timeframe, but could also be accompanied by new papers that would be linked to it).

Radiation Belt and Waves (RBW) Focus Group

Co-Chairs: Yuri Shprits, Scot Elkington, Jacob Bortnik, and Craig Kletzing

The GEM Radiation Belt and Waves Focus Group began the week with a discussion of the ongoing RBW Particle Challenge, whereby GEM radiation belt modelers undertake simulations of the radiation belt dynamics for a specified period from the CRRES era. We had two presentations summarizing results from the UCLA and LANL modeling efforts. In both cases, modelers noted substantial heating associated with the introduction of chorus waves in the simulations, far exceeding observed heating rates. The UCLA model noted that the introduction of appropriate cross terms in the diffusion tensor reduced the rate of heating to be more in line with observations, while the LANL group assumed a lower level of chorus wave activity than statistical models suggest, pending inclusion of cross terms in their model. We also discussed relevant physical processes that may be included in future models participating in the challenge. Magnetopause shadowing was noted as an important process governing loss at high altitudes, with ring current activity playing a role in concert with magnetopause position. Seed populations of energetic electrons injected from the tail were modeled in the context of a low energy and high-*L* boundary conditions for dynamic models of the belts.

The group devoted a session to general radiation belt modeling efforts, with a focus on preparing radiation belt models for RBSP data. Data assimilation methods were used in efforts to determine the source location for radiation belt heating, with separate efforts focused on the outer zone electron and the inner zone proton belts. A study of radial diffusion coefficients used in radiation belt modeling underscored similarities and differences in transport rates inferred from a variety of sources including previous empirical estimates, those obtained from recent global MHD simulations, in situ, as well as ground observations of magnetospheric ULF wave activity. Work was presented regarding the probability distribution of radiation belt fluxes as associated with solar wind speed, where it was shown that normalizing the observations by solar wind speed occurrence frequency made flux dependence on solar wind activity much more apparent. There was discussion of the appropriate basis

functions used to describe radiation belt pitch angle diffusion. Radiation belt loss mechanisms were discussed in the context of observed radiation belt decay times, and additional discussion focused on the effects of magnetopause shadowing on radiation belt losses.

Wave-particle interactions are a key part of the dynamics of the outer zone electron belt. EMIC wave growth and propagation was the focus of modeling efforts examining an event observed by Cluster, and a separate study examined "microburst" precipitation of electrons observed at LEO. A study of the evolution of the outer zone phase space density profile in response to a high speed stream showed the dynamics of the radiation belts in the context of typical solar wind conditions for such events, and investigations of the injection of electrons into the slot region likewise looked for associations between solar wind conditions and slot populations. We discussed non-linear wave particle interactions, both in the context of structured chorus waves, and with global ULF waves. In the latter case, global models of the magnetosphere suggest that radial diffusion may not be an adequate descriptor of the transport process in the outer zone.

The group devoted two sessions to discussions of wave excitation, propagation, and distribution, focusing on both ULF and ELF/VLF waves. Initial results from the coupled LFM/RCM global were analyzed for Pc-5 ULF wave activity, showing the significant effect of the plasmasphere on supported resonant wave modes within the magnetosphere. Statistical studies of Pc-5 ULF waves observed by THEMIS suggested the existence of global cavity/waveguide modes, most easily observed during periods of relatively calm solar wind, with most events being observed in the noon sector. There was extensive discussion on the characteristics and physics of magnetospheric EMIC waves, with event studies contrasting the polarization state, heavy ion heating, and source regions associated with different levels of warm ion anisotropy and solar wind conditions; persistent, localized EMIC waves were reported in association with pressure increases in another event observed by ground magnetometers during a high speed solar wind event. There were also reports of active modeling efforts devoted to understanding the physical origins and characteristics of EMIC waves. Separate numerical studies of the effect of O^+ concentrations indicated that oxygen ion concentrations can have a significant effect on wave generation regions, oxygen heating, and wave polarization and propagation. Simulations of Pc-1 waves in the ionospheric Alfvén resonator suggested the effect of ionospheric conductivity on ground-based signatures of these waves.

Numerical models of wave excitation and propagation at VLF frequencies looked at whistler propagation and amplification as a function of wave frequency and local density variations, including ducting effects along gradients in the plasma density and confinement of waves within the plasmasphere. Nonlinear processes including mode-mode wave coupling were considered in the context of wave excitation and particle heating. Statistical analyses of the source locations of magnetospheric chorus were seen to be consistent with numerical simulations of electron temperature anisotropies induced in the off-equatorial magnetic minima near the dayside cusps, while studies of THEMIS observations of magnetosonic and discrete hiss-like chorus worked to improve our understanding of the occurrence and characteristics of these wave populations.

The Radiation Belt and Waves Focus Group is undertaking a challenge in the numerical modeling of the magnetospheric waves relevant to radiation belt transport, loss, and acceleration, with a goal of identifying the relevant physics and numerics important for reproducing real observations. The framework of this challenge will be worked out over the coming weeks and announced at the Fall AGU GEM Miniworkshop, and will include efforts to model wave activity under both observed and idealized magnetospheric conditions, covering important wave populations at VLF/ELF and ULF frequencies. We welcome thoughts from the wider GEM community on issues such as boundary and initial conditions for the simulations and relevant observations and metrics for validation, and encourage participation of all those with an interest in modeling aspects of the magnetospheric wave environment.

MIC Research Area Report

Coordinators: Bill Lotko and Marc Lessard

Dayside Field Aligned Currents and Energy Deposition (FED) Focus Group

Co-Chairs: Delores Knipp, Geoff Crowley, Stefan Eriksson, and Ramon Lopez

The Field Aligned Currents and Energy Deposition (FED) Focus Group held two sessions at the 2012 GEM Meeting. The primary aspects of the ten presentations focused on:

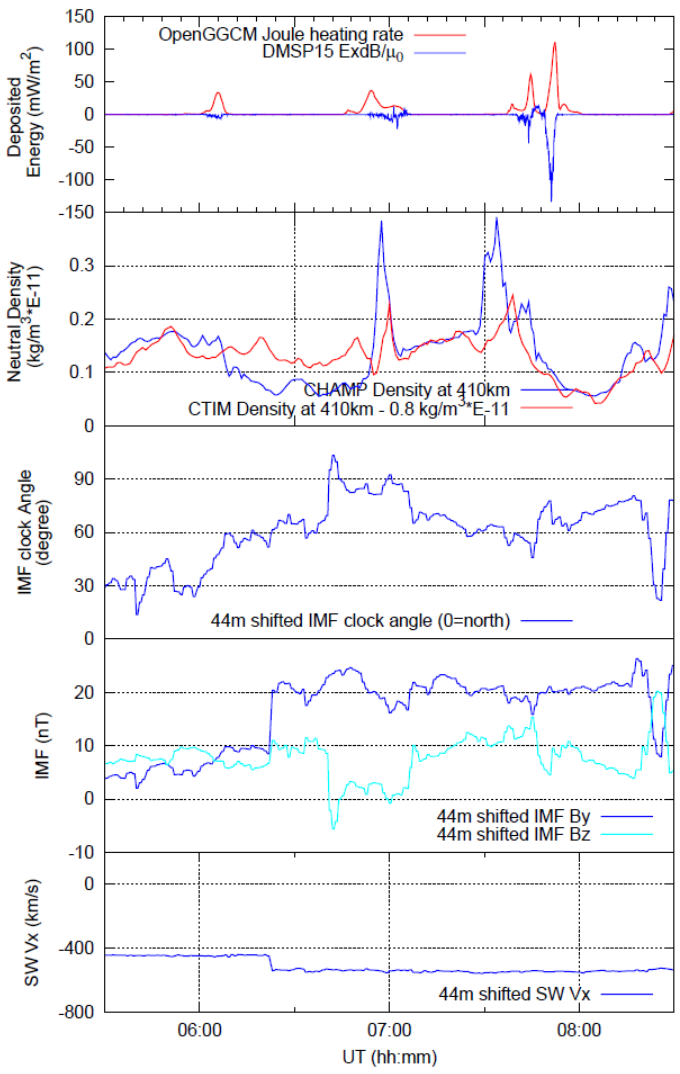
1) Data-model comparisons for dayside energetics: (a) AMPERE, DMSP, CHAMP, GRACE, SuperDARN; (b) LFM, OpenGGCM, TIMEGCM, AMIE, HASDM and JB2008
2) Relative role of dayside Poynting flux and particle deposition in creating dayside neutral density perturbations
3) The data-model comparisons for field aligned currents and associated dynamics reveal improving agreement. Model sophistication is increasing and data sets are providing better global coverage. Getting to agreement with the neutral density response to energy deposition is still a challenge, although recent efforts to include both dayside Poynting flux and particle deposition as a source of energy is showing promise. The relative roles of these energy sources were discussed at length.

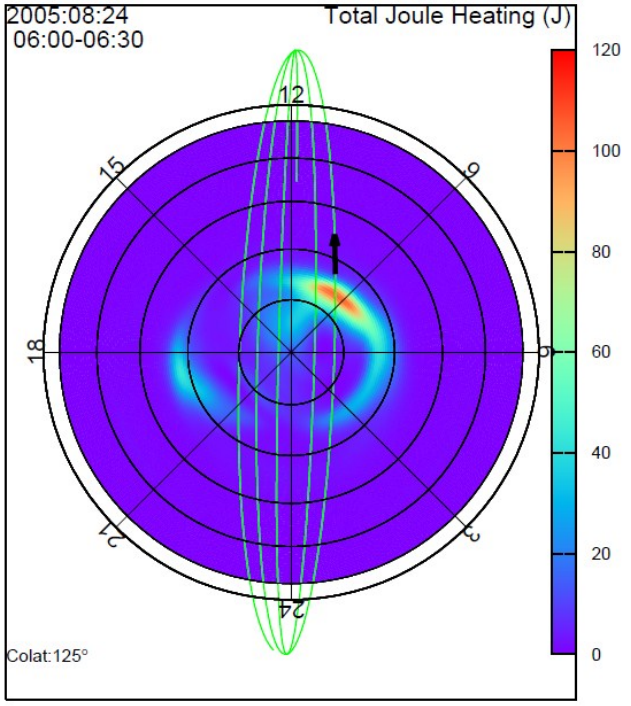
Slava Merkin compared Active Magnetosphere and Planetary Electrodynamics Response Experiment (AMPERE) data and an ultra-high resolution (~60 km in the ionosphere) Lyon-Fedder-Mobarry (LFM) global MHD simulation for an interval during the August 3-4 2010 storm, wherein there was a solar wind dynamic pressure jump and a south to north rotation of the IMF *Bz* component with $By < 0$.

The LFM and AMPERE current patterns showed remarkable agreement during this period. The dayside peak of the upward current moved from post-noon to pre-noon in response to the IMF *Bz* rotation. He showed that the magnetic perturbations underlying AMPERE patterns were very consistent with the simulated response. He also noted that, particularly during northward IMF conditions, if the orbit crossing point is far from the locus of the NBZ current system, the AMPERE fit may not capture the true geometry of the currents because the pole of the inversion basis functions is at the orbit crossing point rather than the magnetic pole. The new generation of AMPERE inversions fixes this problem by putting the basis function pole at the magnetic pole.

Athanasios Boudouridis presented a case study of the effect of solar wind dynamic pressure fronts on dayside field-aligned currents and thermospheric density for April 5, 2010 using Challenging Minisatellite Payload (CHAMP) data and TIMEGCM simulations. The challenge is to separate pressure pulse effects from IMF effects and determine their relative importance, since often both happen at same time. The pressure and IMF front passed ACE at ~ 0830 UT. The first responses were in the post-noon/afternoon MLT sector; these appear to coincide with intense FACs and Joule heating as produced in the AMIE procedure. The CHAMP and TIMEGCM results enhanced neutral density in the same general region, but the magnitudes of the perturbations are not yet in agreement. The associated traveling atmospheric disturbance traveled to the equator in ~ 3.5 hr. More effort will be devoted to determining how common the response is and to determining the relative roles of the IMF and dynamic pressure.

Wenhui Li discussed Thermospheric Density Enhancements in Dayside High latitude Region. He showed comparisons between OpenGGCM-CTIM





and CHAMP observations for three cases. Lühr et al. [2004] showed that, under relatively quiet geomagnetic conditions, the CHAMP satellite often observes regions of enhanced density at ~ 400 km altitude in the noon sector at high latitudes correlated with small scale field-aligned currents (FACs) associated with the dayside cusp. Knipp et al., [2011] reported localized Poynting flux in the near cusp region, during northward IMF with strong *By* component (quiet magnetosphere, *Kp*<2). This study looked at large Poynting flux and Joule heating during NBZ with large By. The CHAMP neutral enhancements are matched by OpenGGCM/CTIM but quantitative differences exist and are being explored. He is exploring effects of soft electrons and is varying the IMF clock angle to determine its effects.

Rick Wilder investigated intense Joule heating, thermospheric upwelling, and large- scale gravity waves and their association with reverse convection under northward IMF for April 5, 2010. He showed that the TIMEGCM output agrees better with CHAMP data when the high latitude driver (AMIE) ingests AMPERE data. During intervals of strong northward IMF there can be intense reverse convection that produces vertical winds and enhanced thermospheric density. Large-scale

Figures on Left. The images illustrate model-data comparisons of southern hemisphere energy deposition during an interval on Aug 24, 2005, when the IMF was northward, but also had a large east-west component. During a 90 min interval the high latitude neutral density, sensed by the CHAMP satellite in a narrow band, changes from undisturbed to extremely disturbed. The stack plot shows times lines of: 1) deposited energy along the CHAMP track compared to DMSP estimates; 2) CHAMP density compared to model output; 3) the IMF clock angle; 4) IMF By and Bz and 5) solar wind speed. The polar plot shows the location and intensity of model Joule heating in the southern hemisphere. To keep the presentation geometry consistent with that normally used for the northern hemisphere, the view is from inside the Earth, looking outward. The outer ring is located at co-latitude 125°. The center of the polar plot is at co-latitude 180° or –90°) The location of the neutral density disturbance is consistent with the location of intense energy deposition modeled by OpenGGCM-CTIM in association with flank/lobe merging driven by the large east-west IMF component. The CHAMP track is shown by the green arcs. The color bar is in units of mW/m².

gravity waves with 700 m/s wave speed and 1000 km wavelength can arise from the density perturbations. Again the challenge for this event is separating solar wind dynamic pressure effects from IMF change effects.

Ceren Kalafatoglu (student at Istanbul University) compared Joule heating outputs from IRI/SuperDarn/BATSRUS for two isolated substorms and will do future validation with DMSP.

Marc Lessard presented for Brent Sadler: "Auroral Precipitation / Ion Upwelling as a Driver of Neutral Density Enhancement in the Cusp" [Sadler et al., 2012]. He investigated soft electron precipitation effects at higher altitude using the Otto model. The line of reasoning is: Auroral precipitation and Joule heating heat ambient electrons. The electron gas expands upward and the ions are pulled upward by the electric field. Ion momentum drags the neutrals upward. The estimated "cooking time" for this effect is 10-30 min: Electron temperatures rise in 1-3 min and upward ion velocity increases in 3-5 min. This should drive ion outflow. Much discussion on this soft electron cause – effect followed.

Yi-Jiun Su discussed the high-altitude energy input to the thermospheric dynamics: for the August 4-7, 2011 storm event. She compared density from DMSP and GRACE sensors and the HASDM, JB2008 and JB2008-with-Weimer-2005 models. She reported that the thermosphere responded immediately as the solar wind energy began to deposit energy into the high-latitude region; however, it took 6 hours to reach the maximum of the thermospheric energy. The thermosphere does not return to pre-storm level for a very long time. She estimated that the high latitude system transferred 3×10^{16} J of energy to 2.5×10^{16} J of heat—very efficient heat transfer.

Jo Baker discussed SuperDARN / IMF *By* asymmetries. He reported that strong IMF *By* penetrates the dayside magnetosphere and produces interhemispheric field aligned currents [Kozlovsky et al, 2003]. For strong *By* <0 in the northern hemisphere there is a downward FAC in the polar cap and an outward FAC on closed field lines which drives eastward convection in the auroral zone. The opposite situation exists in the southern hemisphere. Thus there will be a velocity mismatch between hemispheres when IMF *By* <0. In the winter southern hemisphere the FAC reinforces afternoon convection; in the summer northern hemisphere the FAC counteracts afternoon convection. The width of the FAC channel is 3-6 deg. He presented evidence for a unipolar current in/out FAC and interhemispheric current.

Delores Knipp showed dayside DMSP Poynting flux and soft particle asymmetries and compared those to CHAMP neutral enhancements. For all years and most conditions the enhancements were stronger in northern hemisphere cusp than in southern hemisphere cusp. In many instances the cusp energy deposition overwhelms the nightside energy deposition. Temporal variability of this effect is under investigation.

Delores Knipp also presented for Yue Deng on the relative roles of particles and Poynting flux in dayside energy deposition. She used the Global Thermosphere Ionosphere Model (GTIM) to investigate soft particles (~100 eV) and their roles in direct heating and ionization that leads to Joule heating redistribution. The investigation compares the result to strong driving by Poynting flux. The result is a non-linear enhancement of particle influence. She also showed spatial distribution of neutral density changes at 200 and 400 km. Model density changes were consistent with those reported by CHAMP.

Binzheng Zhang presented the Roles of Particles in Heating in Dayside Near Cusp Region. He used the coupled magnetosphere-ionosphere thermosphere model (LFM+TIEGCM = CMIT) to investigate the effects of precipitating soft electrons. The study included two types of causally specified soft electron precipitation - direct-entry cusp precipitation and Alfvén-wave induced, broadband electron precipitation - the effects of which are self-consistently included for the first time in a coupled global simulation model. Simulation re-

sults show that while both types of soft electron precipitation have relatively minor effects on the interaction between the magnetosphere and ionosphere, they can significantly modify the plasma distribution of the F-region ionosphere and the neutral density of the thermosphere. Enhancements in F-region electron density and temperature and bottomside Pedersen conductivity caused by soft electron precipitation are shown to enhance the Joule heating per unit mass and the mass density of the thermosphere at *F*-region altitudes. The simulation results provide a causal explanation of CHAMP satellite measurements of statistical enhancements in thermospheric mass density at 400 km altitudes in the cusp and premidnight auroral region.

Subsequent Open discussion focused on:

- Defining a modeling challenge? —Depends on whether the Focus Group is extended
- Community effort to develop a PF index?—How could we create and verify a local vs global index?
- Extending focus group? Some interest, but will need a volunteer to take this forward
- Writing a final report? Will be done at year's end if no extension

The Scientific Magnetic Mapping & Techniques Focus Group

Co-Chairs: Eric Donovan, Liz MacDonald, and Robyn Millan

The Scientific Magnetic Mapping & Techniques focus group held three lively sessions at the recent GEM. The first was dedicated to presentations of new mapping techniques. Mike Henderson presented a review of event-based modeling techniques and Chia-Lin Huang presented a comparison of different empirical models at GEO. Several others presented techniques from different perspectives ranging from DMSP & FAST to GOES & THEMIS to different modeling techniques.

Long talks and discussion were the focus of the joint substorm session focusing on the late growth phase. Speakers included Toshi Nishimura, Jun Liang, Larry Lyons (for Shasha Zou) and Jian Yang. Future plans include more joint sessions focusing on mapping.

The plenary session by Misha Sitnov was also very relevant and a bold reminder of considerations with using empirical field models. Questions were raised about the time resolutions and dynamics resolvable with empirical field models and also the key differences between different versions.

We ended by encouraging participants to get together and propose challenges for GEM funding. Several ideas were discussed including taking a Nishimura wave-mapping event and comparing other mapping techniques, or focusing on particular ionospheric signatures and looking at their magnetospheric conjugates. As a next step we intend to gather lists of available events (from Nishimura, Ganjushkina, and others) and compare the availability of model inputs and in situ data. There seemed to be significant interest from modelers and the CCMC group which has been supporting numerous challenges lately (http://seeccmc.gsfc.nasa.gov/ challenges). A mapping challenge presents a learning opportunity regardless of a null or positive result; however, results may be difficult to interpret and apply metrics to. Our plan for mini-GEM is to compare challenge ideas with preliminary looks at the datasets and models available and additional consideration of the format and metrics.

We are also planning to begin a review paper and looking for volunteers. For more information including complete speaker lists, notes, and talks please see http://bit.ly/gem_mapping.

GGCM Research Area Report

Coordinators: Slava Merkin and Frank Toffoletto

Mertrics and Validation Focus Group

Co-Chairs: Masha Kuznetsova, Aaron Ridley, Tim Guild, Lutz Rastaetter, and Howard Singer

The Metrics and Validation Focus Group held two sessions at the summer workshop focusing on recent progress in the GGCM Modeling Challenge (session 1) and "Measuring Models Climatologically" (session 2). Both sessions were held on Wednesday, June 20th, were well attended and included lively audience participation.

The first session, titled "GGCM Modeling Challenge" focused on scientific geospace models under evaluation for use in space weather operations. This activity aids the transition of models from research to operations, but is also effective for validating models, discovering where new physics needs to be included, and accelerating the installation of new model versions at CCMC for use by the scientific community. Lutz Rastaetter opened the session by introducing the project. This geospace model validation project is built upon the ground magnetic perturbations (delta-B) community-wide metrics study initiated in the summer of 2008. Phase I of the project focused on the time derivative of the horizontal magnetic field vector dB/dt at a set of preselected ground stations. NOAA SWPC is planning to utilize the results of this geospace model validation project in their selection of operational geospace model. Three global MHD magnetosphere models (SWMF v20110131, OpenGGCM v4.0, and LFM-MIX vLTR-2_1_1) and two empirical delta-B models (Weimer and Weigel) participate in this activity. Lutz described the tool developed at CCMC that extracts the ground magnetic field perturbations from the global MHD model outputs (through integration over magnetospheric and ionospheric current systems). The sensitivity of the results to methods of *dB/dt* calculations (e.g.,the CCMC post-processing tool vs. run-time calculations implemented in SWMF); and to ground station locations were discussed. Everybody agreed that all time series to be used in the final metrics study should be made available for download at the CCMC ftp site and for on-line ploting using an interactive on-line ploting tool. It was also agreed that the results will be used as a basis for the second round of the delta-B metrics study that will illustrate models' progress over time (2011 vs. 2008). Antti Pulkkinen described the process of metrics format selection and presented the final results of the threshold-based metrics with crossings of thresholds (0.3, 0.7, 1.1 and 1.5 nT/s) detected using 20-min analysis window length. The first draft of the joint paper on geospace model validation to be prepared by September 1st. Information in the paper will be included in the CCMC report to NOAA SWPC. The second half of the session was focused on another important parameter – the regional K index. Several new metrics that could be used for this study and would be useful for SWPC, were proposed and presented by Howard Singer. Dan Welling presented his approach on how to extract region K from model outputs. It was agreed to build upon D. Welling's study and continue the discussion at the GEM mini-workshop in San Francisco.

M&V Focus group leadership transition and midterm report preparation were discussed. The following GEM metrics studies were recommended for continuation:

- Regional K (in support of operational geospace model selection and model scientific capability)
- A second round of the delta-B metrics study to trace models' improvement over time

It was also agreed to continue the Joint GEM-CEDAR Challenge initiated at the 2011 Joint Workshop and to arrange an additional session at the next GEM-CEDAR session. Metrics studies

to addressed by the GEM-CEDAR Challenge will include:

- Auroral Oval Boundaries
- Joule Heating in the Ionosphere
- Role of magnetosphere drivers on the ionosphere.

The second session, titled "Measuring Models Climatologically" was intended to solicit some new ideas about model validation from the GEM community. Historically, the majority of model validation exercises have been focused on comparing model output to short time-series of observations, such as geosynchronous magnetic field observations or Dst during a storm. This session solicited ideas and presentations devoted to non-standard methods of model validation, especially over "climatological" intervals (weeks to years). Climatological validation of a model is complementary to validating the dynamics during a storm, ensuring that the model performs well "on average," and also aids in identifying missing physics in models where there is a difference between model and observation. Despite this call for long-term (climatological) validation presentations, the contributed presentations focused more on "global" or "statistical" validation exercises, a good example of the GEM community steering the topic to their interests.

Tim Guild opened the session by summarizing what climatology means for space science, and what science questions long-term modeling is well-positioned to answer. Slava Merkin described some comparisons between simulated high-resolution LFM field-aligned current (FAC) patterns and globally-distributed field aligned current patterns derived from Iridium observations under the AMPERE project. These global patterns are derived from delta-B measurements by ~70 Iridium satellites in 6 orbital planes via a spherical harmonic fitting procedure. In many cases there is good agreement between the Birkeland current patterns in the LFM simulation and AMPERE inversions. In some cases (e.g. a northward IMF case) however, the patterns do not agree as well even though the AMPERE magnetic perturbations seemed highly consistent with the simulated currents, possibly reflecting limitations in the initial version of AMPERE inversions. Slava emphasized that though global validation is now possible and may be extremely valuable, it needs be done carefully understanding the strengths, limitations, and uncertainties of models, data sets, and derived data products. Colby Lemon discussed how we could use statistical validation exercises to mine geospace models for physical understanding. For instance, we can run a variety of simulations and test their agreement (or not) with data-based empirical models, and determine what modeled physical processes are responsible for that agreement (or not). The audience contributed many good empirical models which are well posed for statistical validation exercises. Some include the Young et al., 1981 composition of the tail, many Newell et al., 2007 empirical relations, and the Thomsen et al., 1998 relation showing the ring current strength (Dst) is best correlated with VBsouth times the plasma sheet density averaged over the previous 12 hours. Tim Guild, Amy Keesee and Mike Wiltberger showed a unique comparison of simulated (LFM) plasma sheet temperatures in the equatorial plane during a storm and temperatures inferred from TWINS ENA observations in the plasma sheet. Both model and observations showed a suggestive hotter dusk-side plasma sheet. Vahe Peroomian suggested that this hotter dusk side plasma sheet was due to direct entry of sheath plasma under strong negative IMF By. Pontus Brandt discussed the need for and progress toward developing an empirical model of inner magnetosphere pressure derived from inverting ENA observations and combining them optimally with in-situ observations. This was followed with good discussion of how physics-based simulations could be used to understand the functional dependencies of a number of empirical models or well-known geophysical relations.

The Ionospheric Source of Magnetospheric Plasma: Measuring, Modeling, and Merging into the GGCM (OutflowMMM) Focus Group

Co-Chairs: Bob Schunk, Rick Chappell, and Dan Welling

The Ionospheric Source of Magnetospheric Plasma: Measuring, Modeling, and Merging into the GGCM (or, simply, OutflowMMM) Focus Group held four sessions at this year's GEM Summer Workshop: one for each of the "M"s in the title and a planning session to organize future tasks. The key concluding points from these sessions are as follows:

1) It remains unclear what the most important energization mechanisms are under different circumstances.
2) There remains a great deal of contention on what modeling approach best captures outflow dynamics.
3) The merging community is slowly shifting from examining the immediate and basic effects of adding outflow to global systems to investigating potential improvements of merging techniques to enhance simulation accuracy.
4) Future activities will work to homogenize the three sub-groups and audiences with focus-group-wide projects.

Session Summaries:
The Measuring session had 5 speakers with an audience of approximately 50. Dr. Tom Moore began the session by reviewing what is known and what remains unanswered. Unknowns included the core ion velocity distributions, ion-neutral relative velocities, and the distinct roles of heat and electromagnetic flux on outflows. Dr. Andrew Yau followed with a presentation on the importance of quiet time O^+ outflow. He noted that these fluxes can take 5 hours to reach the plasma sheet, but the source remains a point of uncertainty: is this population the result of the classical polar wind, or are other energization mechanisms playing lead roles? Dr. Naritoshi Kitamura then presented work on field aligned potential drops and their role in outflowing populations. He noted that such drops could accelerate hydrogen and oxygen to 20eV. Rob Redmond presented an investigation on the apparent dawnward bias of escaping O^+, which reduces with activity. His current conclusion is photoheating at sunrise causes this bias. Finally, Dr. Anatoly Streltsov presented simulation work on ionospheric electron density voids. He found that these could be driven by small-scale waves produced by downward flowing field-aligned currents. The discussion for this session was lively and involved. It is clear that there are very limited observational data on the ion outflow that have been taken from spacecraft with potential control and by instruments that have large enough geometric factors to successfully characterize both the ionospheric source and the fate of these upward flowing particles in the magnetosphere. Measurements such as these will be required as the magnetosphere-ionosphere community works toward the merged models that include the coupling of these two regions.

Dr. Bob Schunk was the first of five speakers at the Modeling session, which was attended by approximately 30 people. He reviewed the important physical processes that must be accounted for in numerical models, and then showed results from his modeling team. He emphasized the importance of capturing the full velocity distribution of each species, the polar rain contact potential at high altitudes, and energization mechanisms not captured by simpler fluid-based models. Dr. Alex Glocer presented comparisons of his Polar Wind Outflow Model (PWOM) results to various observational and empirical databases and found good agreement for various solar zenith angles. Next, Paul Song introduced a new model for ionospheric electrodynamics that receives electromagnetic waves as input rather than an assumed imposed electric field or field-aligned currents. He emphasized that this

methodology takes much longer to reach equilibrium than conventional ionospheric electrodynamics models. Dr. Uri Omelchenko presented arguments for the use of full 3D hybrid magnetosphere models. He discussed the physics of the model, the technology required to perform the resource-intensive simulations, and the increased detail that can only be captured using this approach. Finally, Vahé Peroomian used results from his Large Scale Kinetic model to introduce two key questions: how do global modelers constrain outflow during storms, and how do modelers benchmark results when there are no observations of composition? Again, the discussion of this session was lively with an emphasis placed on understanding the differences between the different modeling approaches and determining which approach best captures outflow dynamics.

The third session, Merging, saw a similar audience to the previous session but had an additional speaker (6 total). Dr. Daniel Welling began by reviewing the various effects outflow has on the magnetosphere ionosphere system; from changes to the cross polar cap potential to the interdependent relationship outflow has with the ring current. This presentation was followed by Dr. Raluca Ilie, who showed comparisons of TWINS satellite measurements with multifluid MHD simulations that included outflow (via the PWOM). TWINS has observed substorm-driven O^+ enhancements; Dr. Ilie showed similar behavior in her MHD model. Dr. Yiqun Yu, using the same model, but with a constant and prescribed outflow, showed how outflow can effect the formation of Kelvin-Helmholtz (KH) vortices by expanding the region along the flanks that is KH unstable. Dr. Alex Glocer then presented a potential coupling mechanism that would include high altitude wave-particle interaction (WPI) acceleration. His concept was to use an empirical WPI acceleration term in a non-anisotropic MHD model to continue parallel outflow acceleration deeper into the magnetophere. Yanhua Liu moved the discussion from acceleration to reconnection by presenting data from the Cluster constellation that showed how outflow of heavy ions affects the tail. He found that the ratio of O^+ to H^+ correlates negatively with tail flare angle size, implying that as O^+ increases, reconnection and tail stability also increase. Finally, Dr. Bill Lotko reviewed the extensive work by the CISM team to tackle the issue of coupling outflows to their global model. The use of the Strangeway relationship was discussed, as was outflow's role in producing sawtooth oscillations in the magnetosphere. The approach of the CISM team was contrasted against the use of PWOM and the additional methodology proposed by Dr. Glocer.

The final session opened discussion to all in order to plan the future of the OutflowMMM focus group. It was quickly decided that upcoming activities should aim to homogenize the measuring, modeling, and merging subcommunities in order to cross pollinate ideas and further fold observations rapidly advancing modeling and merging efforts. Next, many ideas for group-wide research activities were raised and discussed, ranging from the specification of WPI acceleration rates and their potential application to outflow and global models to creating a set of idealized magnetospheric simulations that capture the various "modes" of outflow activity. After much discussion, it was decided that the simplest and most productive path forward would be to challenge both outflow and global modelers to simulate situations without any ionosphere contribution, then turn on outflow and compare and contrast the two magnetospheres. These activities will be organized through the upcoming OutflowMMM email list. The first simulations will be presented at the upcoming Fall AGU Mini-GEM. All interested researchers should contact Dr. Daniel Welling (dwelling@umich.edu) to sign up for the OutflowMMM email list.

GEM Steering Committee Report

Bob Clauer

GEM Steering Committee Minutes
Snowmass, Colorado
June 22, 2012

Attending: David Sibeck, Eric Donovan, Mike Wiltberger, Liz MacDonald, Emma Spanswick, Ray Walker, Masha Kuznetsove, Hedi Kawano, Mona Kessel, Joe Borovsky, Howard Singer, Nathaniel Frissell, Roxanne Katus, Peter Chi, Jon Berchem, Karl-Heinz Trattner, Mike Henderson, Larry Kepko, David Murr, Bill Lotko, Stan Sazykin, Slava Merkin, Bob Clauer, Xia Cai.

Future Meeting Planning

- Meeting began with a presentation from Snowmass Westin regarding proposal to host GEM Workshop during June 2013 at same rates as we had this year.
- Discussion of process to determine location of GEM Workshop. Workshop coordinator provides options. Steering Committee discusses and makes selection.
- Clauer presents option for GEM Workshop in Portsmouth, VA.
- Discussion of the need to coordinate with CEDAR and SHINE and to hold meetings during adjacent weeks. General feeling is that ties between GEM and CEDAR should be strengthened.
- Following further discussion, committee voted to accept the proposal from Snowmass to hold the GEM Workshop there in June 2013 and to explore holding in Portsmouth, VA in 2014 (possibly with SHINE). Need to arrange visit to look at facilities. Clauer should coordinate with Joe Borovsky to explore interest in holding GEM and SHINE during adjacent weeks in Portsmouth. Could also look at Annapolis – THEMIS meeting was held there with reasonable expense. Student opinions was that most people were indifferent —somewhere else would be ok, see somewhere else in the country.

Student report

- 74 students at the meeting
- Students were particularly pleased with the meeting.
- Tutorials – added 'hot topics' tutorial and tutorials specific to the two new focus groups.
- Students really like the Condo's.
- Student funding process was much better this year.
- Students are still interested in having a student poster judging competition.
- 2/3 of students were new this year. Many unfamiliar with 'gem' informality.

Recommendations:

1. Good to post schedules on wiki at the beginning of the week so students know what will be happening (maybe this could be done each morning) Wiki can be edited by focus group leaders. Need to advertise this. Still, want to avoid AGU style of meeting. Topics, perhaps, should be the emphasis. If focus group leaders are preparing information for workshop – it should be posted somewhere (probably on the wiki). Must be coordinated with Peter Chi to do this in a timely way. Maybe advertise at end of Plenary Session – announce focus group activities for each day.
2. Students don't know names of senior scientists – have presenters put name on bottom of each slide
3. Could coffee be available all day?
4. Participant lists before meeting made available.
5. In redefining the purpose of GEM, it is important to stress the importance of developing the relationship between students and more senior researchers as the students to transition from student to colleague.
6. Students like the CEDAR model of poster judging.
7. Roxanne Katus introduced as new student representative to SC.

David Murr and Colby Lemon volunteered to organize the student poster competition for the next GEM summer workshop. We need to supply a list of students coming to the workshop to Murr/Lemon.

Replacing people leaving the steering committee.

This year we anticipated this and have contacted a number of people who could fill a role on the steering committee.

- Margaret Chen elected member at large
- Jerry Goldstein elected to Inner Magnetosphere and Storms research coordinator
- Katariina Nykyri elected to Dayside research coordinator
- Sorin Zaharia elected to Tail research coordinator
- Marc Lessard elected to Magnetosphere-Ionosphere Coupling research coordinator
- Frank Toffoletto elected to GGCM research coordinator

Announcements from liaisons.

- Shine: Joe Borovsky is new liaison – will look into establishing more coordination between GEM and SHINE
- Canada (Rankin sent a written report): (a) Themis will be supported at least until end on 2013. (b) ESA Swarm satellite & Knudsen instrument (drift meter) should be launched in Fall. (low altitude magnetometers, drift meter to get convection). (c) E-POP hopes to launch in January. (d) RISER (Canadian southward facing radar in Resolute – starting operations). (e) 3 polarDARN radars operating now.
- CCMC: want to do more tutorials – did one at this workshop. GEM/CEDAR challenge being supported. Request to have session at mini-workshop to continue progress on this. We can do this. New versions of models being received and implemented. Supporting education during summer schools will continue. Masha is acting director at CCMC.
- SWPC: Space weather workshop next year is April 16-19. Also anticipate that SWPC will be hiring someone who is adept at transitioning MHD models to operation. Hope to hire postdoc in January (National Research Council support)

Development of White Paper to Redefine and Promote GEM program

- Next is discussion of White Paper to support NSF program manager to promote the GEM program. *Peter Chi taking more detailed notes on this.*
- Audience for paper are upper management at NSF, Public affairs people at NSF, partners at other agencies, other Divisions and Programs at NSF (physics, high performance computing, education). Need 2-page executive summary.
- Purpose: define a program that can withstand budget buffeting, define GEM (establish new GEM goals)
- How are we part of the decadal survey.

Various ideas presented and discussed:

- Education is a fundamental component; GEM has an important baring on space weather; desire to partner with other agencies (e.g. NOAA); Need to state: what we do, why we do, how we do. Also, somewhere key achievements made by past GEM program.
- Modular GGCM —Is this still our purpose? Provide a List of deliverables – some done, some still working on – ties future to past accomplishments.
- A previous report was prepared by Tom Hill (Rice) with some NSF funding…. Some parts of this could be exerpted for this new report….perhaps.
- Jeff Thayer recently presented the new CEDAR document. (strategic plan) We might want to query people about this CEDAR report.
- GEM Wiki has links to early GEM documents and plans.
- We need to establish a time table – Ray would like to have by April 2013. Therefore like to have a good outline or preliminary draft by Fall AGU.

Discussion of what GEM is now:

- Development of GGCM no longer primary goal. Goal is to 'understand' how geospace works – to enable prediction… What is deliv-

erable? Modeling should remain key aspect of GEM – models express our understanding. Modeling distinguishes us from other groups. Coordination is another aspect that distinguishes us from others. System level view locates GEM between solar wind and atmosphere. This also distinguishes us. Specific GEM focus activities examine particular processes that can be developed into modules for GGCMs.

- Bring together data/observations and models and theory – very important aspect of GEM
- There is a need to further advance the models and GEM plays a key role.
- GEM is a vehicle to organize community to focus efforts toward understanding aspects of geospace in order to improve models that express our understanding. GEM brings together data/observations, model, theory to develop this understanding.
- Propose that Anthony and Slava wordsmith purpose of GEM – send to Sibeck.
- Ray will call upon someone and put together a small team to do this.
- Note that in the next phase of GEM greater effort in the utilization of observations to constrain and feed models (data assimilations).

Meeting adjourned.

Student Representative Report

Nathaniel Frissell

Over 70 students from 25 institutions attended the 2012 GEM Summer Workshop. Once again, students played an active role in GEM activities through through scientific presentations given in all focus group sessions and at both poster sessions.

The GEM Summer Workshop began with a special Student Tutorial day held on the Sunday before the main workshop. Tutorials were written and presented by students, and the tutorial session was divided into three sessions. During the first session, speakers presented an introduction to the GEM community and an overview of major topics in magnetospheric physics. The second session focused on certain types of ground-based instrumentation, data assimilation, and modeling techniques and resources. The final session provided and introduction to GEM "Hot Topics," including talks introducing the two newest focus groups, "Transient Phenomena at the Magnetopause and Bow Shock and Their Ground Signatures" and "Tail-Inner Magnetosphere Interactions." David Sibeck, GEM Steering Committee Chair, addressed the students at the end of the day. Slides from all tutorials may be found at http://aten.igpp.ucla.edu/gemwiki/index.php/GEM_Student_Forum#2012_GEM_Workshop_Student_Tutorials.

The GEM student community was also pleased to invite Harlan Spence of the University of New Hampshire to present as the GEM Student Sponsored Tutorial Speaker. Harlan presented a talk on RBSP (now the Van Allen Probes) during a GEM plenary session Monday morning. Harlan is the principal investigator of the Energetic Particle Composition and Thermal Plasma Suite (ECT) instrument on the Van Allen Probe mission.

In addition to scientific activities, a number of social activities were also arranged to encourage community development among GEM students. These activities included a GEM sponsored student dinner. The GEM student community would like to thank the GEM Steering Committee and the National Science Foundation for continuing to provide support and opportunities for students to participate in the GEM program.

The GEM students would like to welcome Roxanne Katus as the new student representative for the 2012-2015 term. Roxanne is a Ph.D. student from the University of Michigan.

NOAA Agency Report: Highlight of Activities

Howard J. Singer, NOAA Space Weather Prediction Center (SWPC)

Howard Singer reported on NOAA topics relevant to the GEM community. Considering the importance of upstream solar wind observations for both space weather operations and the GEM community's science, he provided an update on the Deep Space Climate Observatory (DSCOVR). DSCOVR is being readied for launch to L1 in 2014. NASA is transferring the satellite and sensors to NOAA, and NOAA received significant funding this year to support the NASA refurbishment of DSCOVR. The USAF is in the process of acquiring a launch vehicle, and beyond DSCOVR, NOAA is investigating long-term commercial solutions for follow-on solar wind observations.

The rise to solar maximum is pretty much following predictions to be below average intensity. A peak sunspot number of about 90 is predicted for around May 2013. It is important to keep in mind that, historically, some of the largest geomagnetic storms have occurred during weak solar cycles. In spite of the recent low activity, there is huge growth in new space weather customers. NOAA SWPC's subscription service has grown to over 25,000 subscribers as of June 2012. There is also a large increase in global interactions as indicated by over 18 Nations being represented at this year's Space Weather Workshop. Also, there is a growing visibility for space weather at the highest levels in the US Government, including agreements with partners in many nations. Furthermore, space weather is now included in the Strategic National Risk Assessment from the Department of Homeland Security. These examples are not only important for NOAA, but demonstrate the importance of the work being carried out by the entire space science community.

SWPC, benefiting from work by the scientific community and many other partners, has transitioned to operations the Wang-Sheeley-Arge Enlil model for predicting the background solar wind and the arrival at Earth of coronal mass ejections (CMEs). Of particular interest to the GEM community, SWPC is working with modelers and the CCMC to evaluate Geospace model(s) for transition into operations, following the successful transition of WSA-Enlil.

This year's Space Weather Workshop, carried out in partnership with NASA and NSF, with 353 registered attendees, was the largest ever. Next year's meeting is scheduled for April 16 to 19, 2013 in Boulder. With regard to NOAA satellite data, used by many GEM scientists, the geosynchronous satellites GOES-13 and -15 are operational, with GOES-14 in storage and ready to be called up when needed. The next series of GOES spacecraft, beginning with GOES-R is scheduled for a 2015 launch. The low-altitude, polar-orbiting POES satellites, NOAA - 15, 16, 17, 18, and 19 are currently operational, along with METOP- A, a European satellite with NOAA energetic particle sensors. Two more METOP's are in development. The follow-on to the POES satellites, NPOESS, is now the Joint Polar Satellite System (JPSS) for NOAA, but these satellites will not carry space environment monitors. Many of the functions for GOES and POES satellites that were carried out in the past by NOAA SWPC have been transferred to NOAA's National Geophysical Data Center where one can obtain satellite data. In addition, NOAA is enhancing its support for understanding and resolving satellite anomalies caused by space weather. The NOAA Space Weather Prediction Center provides real time measurements of space radiation intensity and issues alerts, warnings and watches. And the NOAA National Geophysical Data Center will complement this effort by providing additional data, products, and expertise for post-satellite anomaly assessment and improved satellite design.

SWPC anticipates an NRC Associateship opportunity for the January 2013 application interval. When that is available, an announcement will be placed in the GEM newsletter. And, as a final note, Dr. Tom Bogdan, SWPC Director, moved in January 2012 to lead the University Corporation for Atmospheric Research (UCAR). The selection of a new SWPC Director is underway.

CEDAR Liaison Report

Joshua Semeter

The 2012 CEDAR workshop was held at the El Dorado Hotel in Santa Fe, New Mexico,
The new strategic plan, entitled "CEDAR: The New Dimension," was formally released at the 2011 joint CEDAR-GEM workshop. The agenda of the 2012 workshop was organized around specific themes represented in the document, with the intention of providing perspective and guidance as we begin the "implementation" of this vision.

CEDAR research has always embraced a close coordination between science and technology, and the value of this synergy is reinforced by the "system science" approach advocated in our new strategic plan. The Advanced Modular Incoherent Scatter (AMISR) radar program continues to expand in global coverage. In addition to the first AMISR installation at Poker Flat (PFISR), SRI has now completed construction of two collocated radars at Resolute Bay, offering broad latitudinal coverage of the unexplored polar-cap ionosphere. RISR-North (or RISR-N) was developed under the auspices of the NSF, while RISR-Canada (or RISR-C) has been developed through joint project with the Canadian Foundation for Innovation. New AMISR systems are still planned for La Plata, Argentina (magnetically conjugate to Arecibo) and Antarctica, with discussions moving forward to place an AMISR system in Ethiopia. In recognition of this new generation of ISR activity, a CEDAR Distinguished Lecture was given by ISR pioneer Don Farley entitled "Incoherent Scatter Radar: Early History and Further Thoughts."

CEDAR has been moving steadily into space. Small satellite programs are now embraced by NSF, AFOSR, and NASA as a strategic approach to training young space technologists, as well as a new vehicle for creative coordination of scientific and technological innovation. A number of other larger-scale missions currently under development are focused on science topics of direct interest to CEDAR. A tutorial by Larry Paxton, called "Creating a Future for Aeronomy," provided some perspective for the community as we continue our trend toward space-based observation.

The CEDAR strategic plan also highlights the value of understanding how our own outer atmosphere compares and contrasts to those of other solar system bodies. A tutorial by Andrew Nagy reviewed work on "Comparative Planetary Aeronomy," another emerging discipline within the CEDAR community.
Understanding the coupling between the ITM (ionosphere-thermosphere-mesosphere) system and lower atmospheric regions was emphasized in the recently released Decadal Survey on Solar and Space Physics as well as the CEDAR strategic plan. Our 2012 CEDAR Prize Lecture was given by Larissa Goncharenko, who described her work on a critical aspect of this coupling: "Stratospheric Warmings and Their Effects in the Ionosphere."

The proper interpretation of the rapidly expanding global network of geospace measurements will require sophisticated models and a solid understanding of their uncertainties. The topics were addressed by a tutorial by Jan Sojka on "Inferring Limitations of Numerical Models."

The 2013 CEDAR workshop will be at the University of Colorado at Boulder, June 22-28, 2013. The location of the 2014 workshop has not yet been determined.

SHINE Liaison Report

Joseph Borovsky

NSF SHINE program is dedicated to promoting enhanced understanding of, and predictive capabilities for, solar disturbances that propagate to the Earth. Full information about SHINE can be found at the website http://shinecon.org.

The annual SHINE Workshop was held this year in Maui June 25-29, the week after GEM. The SHINE Workshop Coordinator is Ilia Roussev and the Conference Administrator is Umbe Cantu.

Active session at the SHINE Workshop that might be of interest to members of the GEM community are:

- Advances in Understanding the Solar Wind through Spectroscopic Observations.
- Interaction of CMEs with Coronal and Heliospheric Structures.
- Fast reconnection in large, high-Lundquist number coronal plasmas mediated by plasmoids: Implications for reconnecting current sheets and supra-arcade downflows.
- The need for high accuracy, high time resolution plasma and electromagnetic field measurements in the solar wind.
- Causes of the wide longitudinal signatures of Solar Energetic Particle (SEP) events.
- Origin of CIR-associated suprathermal and energetic particles at 1 AU.
- Assessing the Contribution of Heliospheric Imaging, IPS and other remote sensing observations in Improving Space Weather Prediction.
- Sympathetic and Homologous Eruptions in the Solar Corona.
- What do prominence and cavity activation tell us about the magnetic structure and triggering of the CME?
- Data driven MHD modeling of CME events.
- Community wide validation study of models of the corona and inner heliosphere.

More information about these sessions and their organizers can be found on the SHINE website.

ISAS/JAXA Liaison Report

Hedi Kawano, Masaki Fujimoto, and Iku Shinohara

(1) Currently-running space-physics satellites of ISAS are Akebono, GEOTAIL, and REIMEI.

(2) Akebono is a monitor of the inner magnetosphere. Akebono is planned to continue until the rise of the next solar max is firmly confirmed so that full two solar cycles will be covered. The issue will be subject to review by the science steering committee of ISAS every year.

Requests of Akebono data are to be sent to Dr. Matsuoka (Project Manager): matsuoka [at] stp.isas.jaxa.jp

(3) It is for sure that GEOTAIL will continue until the end of Mar. 2016.

(4) The year 2012 marks the 20th year from the launch of GEOTAIL on July 24, 1992. Thus, an international symposium will be held in Tokyo on Nov. 12-14, 2012 to celebrate its 20th anniversary. Details will be announced soon.

(5) NASA is continuously supporting GEOTAIL (tracking by DSN (Deep Space Network), and making level-1 data), and THEMIS-GEOTAIL conjunctions are a reason; thus, when you analyze THEMIS data, please also use simultaneous GEOTAIL data.

To help it, ISAS has been making efforts to further facilitate access to GEOTAIL data; for ex-

ample, the THEMIS TDAS software will be able to directly read GEOTAIL data in the near future.

(6) At the same time, you can easily browse data plots of both GEOTAIL and THEMIS at a website called CEF (Conjunction Event Finder): http://darts.isas.jaxa.jp/stp/cef/cef.cgi.

At CEF, GEOTAIL data can be browsed about two weeks after the acquisition of the data. (To be more specific, magnetic field data, electric field data, and low-energy plasma data, can be browsed.)

(7) GEOTAIL digital data are open to public at a website called DARTS at http://darts.isas.jaxa.jp/stp/index.html.en.

When you have used the GEOTAIL data in your paper, please tell that to ISAS, for the record. The DARTS website shows where to contact.

Requests of GEOTAIL digital data that are not found at DARTS are to be sent to both

Prof. Fujimoto (Project Scientist):
Fujimoto @ stp.isas.jaxa.jp and
Dr. Shinohara (Project Manager):
iku @ stp.isas.jaxa.jp

(8) REIMEI is at 600km height and provides high-resolution data on auroral dynamics. High cadence electron and imagery data are available until 2007. Only imagery data are available after 2008.

Since the REIMEI camera zooms-in to a 100km × 100km region possibly embedded in the THEMIS GBO field of view, there is a chance of performing cross-scale coupling science in the context of auroral physics.

Science operation of REIMEI might be terminated at the end of this FY (March 2013).

The Point of Contact for REIMEI is Dr. Asamura at ISAS, JAXA: asamura @ stp.isas.jaxa.jp.

(9) SCOPE is a mission for simultaneous multi-scale observations of space plasma. It consists of multi satellites, and international collaborations are in its vision. The mission proposal of SCOPE was submitted to ISAS in September 2008, and it has passed the mission definition review (MDR). Collaborative study with Canadian CSA had been in progress, but in Oct 2011, CSA told ISAS that they cannot continue the study any more.

The planned launch year of SCOPE had been 2019, but now, without any international partner, it is open.

While the original plan of collaborating with European Cross-Scale was terminated, there still is a strong interest from both sides in collaborating via one shape or another.

Strong interest from the US community is acknowledged, and in that sense, it is very regrettable that we cannot be very encouraging at this time.

(10) ERG is a satellite to explore the inner magnetosphere. It will utilize the spacecraft bus system built for "small scientific satellite program" at ISAS.
The planned launch year of ERG is FY2015.

Collaborations with RBSP and RESONANCE are in its vision.

(11) In addition to the above-stated Earth-orbiting missions, the Mercury mission Bepi-Colombo MMO [Mercury Magnetospheric Orbiter] (launch 2015) is put together in a unified framework. This everything-linked-together style is the strength of the Japanese community. Indeed, recent exciting plasma measurement results from the lunar orbiter Kaguya are elevating the mood of the MMO team. With the help from two JAXA's International Top Young Fellows, the community is expanding its research horizon towards the magnetospheres of outer planets.

ESA Liaison Report

Benoit Lavraud (IRAP, Toulouse, France)

This report concerns recent news regarding space plasma missions in Europe. Note that points 1 and 2 about current and upcoming missions from the 2011 report are still valid, and are not repeated here.

1. Large-size call L1 selection

The Jupiter JUICE mission was recently selected by ESA for implementation. It is planned for launch in 2022. It will study in part the ionized environment of Jupiter and its moons. It is characterised by a 7.6 years cruise and 3.5 years operation in the Jovian system. The call for payload proposal was just released and responses were submitted in 2012.

2. Medium-size call M2 selection

Solar Orbiter was selected last year. Launch is planned in 2017.

3. Small-size call S1 proposals

76 letters of intent were submitted in March, but only 26 proposals were apparently submitted. This comes from the fact that ESA was asking for a very strong support from member state agencies for the proposed mission (i.e., ESA was in fact only offering to pay for a third to half of the total mission cost). There have been a number of space plasma missions relevant to GEM submitted, of which the main ones are:

- TOR: it plans to use a Sun-pointing spinner together with new measurement techniques to study solar wind turbulence with unprecedented abilities (i.e., at highest frequencies).
- AXIOM-C: the purpose is to make Advanced X-ray Imaging Of the Magnetosphere and Cusp and thus study the magnetopause and cusp response to changes in solar wind. Charge exchange between solar wind highly-ionized heavy ions and geocorona neutrals leads to emissions in soft X-ray lines that can be observed in particular in the cusp where neutral density is high.
- NITRO: the mission is focused on the study of ionospheric outflows and specifically plans to distinguish Oxygen from Nytrogen thanks to appropriate, new composition measurement techniques.
- SELMA: the mission targets the origin of water on the moon but will also study plasma processes near the moon (i.e., solar wind reflection, magnetic anomalies, etc.)

The mission which was selected on October 19th 2012 is CHEOPS. Its main goal is to characterize transiting exoplanets on known bright and nearby host stars. Of the GEM-related mission, TOR was very positively evaluated.

4. KuaFu-B mission

The Chinese space agency contacted ESA last year to study the possibility of contributing to the KuaFu mission. China would build the solar wind L1 orbiter (i.e., KuaFu-A), while ESA would contribute 2 magnetospheric spacecraft (i.e., KuaFu-B). ESA put in place a SST (Science Study Team) over the last 6 months, which wrote a proposal for Kuafu-B. The proposed concept consists in 2 satellites on the same orbit, but in opposition of phase, with only two UV auroral imagers (one wide and one narrow field-of-view) on each spacecraft, in order to (1) continually measure the northern aurora and (2) simultaneously measure the northern and southern hemisphere aurorae on a frequent basis. The proposal will be examined by ESA committees in the fall 2012.

5. ESA Space Weather Programme

ESA's space weather programme — part of the Space Situational Awareness (SSA) programme — is currently studying various opportunities to embark space weather-oriented particle instruments onboard various platforms (e.g., geosynchronous telecom satellites).

6. European Union Space programme

In addition to ESA and member state agencies efforts, the European Union also issues calls to supports space-related sciences (not only space plasmas, of course, but several magnetospheric and heliospheric proposals were selected in the last round). The official 2013 FP7 Space Work Programme and Call for Proposals will be published on July 10th 2012, and the deadline for proposals is expected to be November 21st. The total amount of EU funding expected to be available for projects is EUR 126 million, compared with EUR 84 million last year.

Mexico Liaison Report—Space Plasmas Observatories operating at present in Mexico

Xochitl Blanco-Cano

Below we present a brief report of the observatories related to the study of the influence of solar activity on the Earth environment operating at present in Mexico.

Schumann Detector. In 1952 Schumann proposed that the earth and the ionosphere form a resonant cavity which "breaths" at very low frequencies (~8 Hz). We are interested in the detection of these extremely low frequency waves to study the effects in the atmosphere of the solar variability. We have constructed a suitable detector (a coil with 3000 turns) sensible to the magnetic part of the electromagnetic waves, which has shown a good response to the Schumann resonance. This detector is in Mexico City. A second station to detect the Schumann resonance is being built in Michoacan.

LAVNet-Mex. The "Latin American Very Low Frequency Network" station at México (LAVNet-Mex) is part of a major project called SAVNet of the Brazilian University Mackenzie. We have designed and built a system that is working since 2010 and detects signals in the 10 - 40KHz range emitted by stations situated around the world. In particular, it detects the VLF waves traveling through the earth-ionosphere waveguide and therefore, is able to measure the response of the lower part of the Ionosphere to the solar quiescent and transient inputs.

Radio Jove is a 20 MHz Receiver with a dipole antenna intended to support and help a high school project at UNAM.

CALLISTO is a solar radio spectrometer and is part of the network ETH in Switzerland. Our station operates at the 200 – 800 MHz frequency range. Since 2009.

The Short Base Solar Radio Interferometer (RIS). The RIS detects the total Intensity, polarization and position of the center of emission (interferometric channels) of the solar radiation at 7.5 GHz.

The millimeter Radio telescope (RT5) is in construction at Sierra Negra Volcano (4200 m of altitude), it has a primary mirror diameter - 5 m in the initial phase will work at 4, 7.5, 12 and 43 GHz, but we are planning to cover higher frequencies up to 400 GHz.

Cosmic Ray Observatories: There are two cosmic ray observatories in Mexico; one is located at the UNAM campus in Mexico City registering low energy cosmic rays (from 8.2 to 100GV) by means of two detectors: a neutron monitor (6NM) and a muon telescope. This observatory has been working continously since 1990.

There is another cosmic ray detector at the top of the Sierra Negra volcano at 4600m asl, it is a Solar Neutron Telescope, dedicated mainly to study the high energy particles emmited from the Sun in large flares.

Micropulsations Observatories: There are two micropulsations observatories in Mexico; one is located at the UNAM Campus Juriquilla, Queretaro, and other with the same kind of instrument in Nuevo Leon University, Campus Linares, Monterrey, both registering Ultra Low Frequency geomagnetic pulsations (from 0.001 to 2 Hz) by means of flux gate magnetometers. The first observatory has been working continously since 2002.

The second one since 2005, these instruments are dedicated mainly to study of magnetospheric storms and low latitude geomagnetic micropulsations, and the relation with solar activity.

GPS stations: We control two GPS stations for ionospheric studies, one locate at UNAM, Campus Juirquilla, Queretaro, and one at Coeneo, Michoacan. Both instruments are expected to be integrated to the Mexican GPS network, to improve upon the continuous monitoring of the total electron content (TEC) of the ionosphere over Mexico.

MEXART. The Mexican Array Radio Telescope consists of a 64x64 (4096) full wavelength dipole antenna array, operating at 140~MHz, with a bandwidth of 2~MHz, occupying about 9,660 square meters (69m × 140m) (http://www.mexart.unam.mx). This is a radio array for Interplanetary Scintillation (IPS) observations located at: latitude 19° 48' N, longitude 101° 41' W.

The main objective of the MEXART is to perform studies of solar wind disturbances employing the IPS technique. The IPS technique can be applied to track solar wind disturbances between the Sun and the Earth and it is a useful tool for space weather surveys. The operation of MEXART will allow us a better coverage of solar wind disturbances, complementing the data provided by other instruments.

Snapshots of 2012 GEM Summer Workshop
(Photos provided by Xia Cai, Hyomin Kim, and Delores Knipp)

2012 GEM Mini-workshop Schedule

Sunday, December 2, 2012
Westin San Francisco Market Street
50 Third Street, San Francisco, California

Room\Time	9 AM	10	11	12 PM	1	2	3	4	5	6	7	8
City	RBSP Meeting			Outflow MMM FG			PMI FG					
CIVIC	ULTIMA-GEM Forum for Ground Magnetometers											
Common-wealth				Magne-tosheath FG		B				Steering Commit-tee Dinner		
Concordia				Substorm Onset FG		R	Magnetic Mapping FG					
Cornell				Transient Phenomena FG		E	TIMI FG		New FG Proposals (SC)			
Francisco I	LWS Focus Team			RBW FG		A	RBW FG	RBSP Interactive Data Analysis / THEMIS Data Analysis Software / Space Environment Data Analysis Software Tutorial				
Francisco II				GGCM-Metrics & Validation FG		K	GEM-CEDAR Modeling Challenge					

FG: Focus Group
GGCM: Geospace General Circulation Model
LWS: Living With a Star
OutflowMMM: The Ionospheric Source of Magnetospheric Plasma--Measuring, Modeling and Merging into the GGCM
PMI: Plasmasphere-Magnetosphere Interactions
RBSP: Radiation Belts Storm Probes
RBW: Radiation Belts and Wave
TIMI: Tail-Inner Magnetosphere Interactions
ULTIMA: Ultra Large Terrestrial International Magnetometer Array

GEM Steering Committee

NSF Program Manager
- Ray Walker

Steering Committee Regular Members (Voting Members)
- David Sibeck (Chair, 2011 - 2013)
- Eric Donovan (Chair-elect, 2013 - 2015)
- Liz MacDonald (2011 - 2013)
- Emma Spanswick (2011 - 2013)
- Jacob Bortnik (2012 - 2014)
- Margaret Chen (2013 - 2015)
- Research Area Coordinators (see below)
- Meeting Organizer (see below)

Steering Committee Liaison Members
- Joe Borovsky (Liaison to SHINE)
- Josh Semeter (Liaison to CEDAR)
- Mona Kessel (Liaison to NASA)
- Howard Singer (Liaison to NOAA)
- Teresa Moretto (Liaison to NSF)
- Masha Kuznetsova (Liaison to CCMC)
- Benoit Lavraud (Liaison to Europe)
- Robert Rankin (Liaison to Canada)
- Xochitl Blanco-Cano (Liaison to Mexico)
- Hedi Kawano (Liaison to Japan)
- Jaejin Lee (Liaison to Korea)
- Chi Wang (Liaison to China)
- Lou Lee (Liaison to Taiwan)
- Brian Fraser (Liaison to Australia)

Meeting Organizer
- Bob Clauer (2007 -)

Student Represenatives
- Nathaniel Frissell (2011 - 2013)
- Roxanne Katus (2012 - 2014)

Research Area Coordinators
- ◊ Dayside, including boundary layers and plasma/energy entry (Dayside)
  - Karl-Heinz Trattner (2009 - 2015)
  - Katariina Nykyri (2012 - 2018)
- ◊ Inner magnetosphere and storms (IMS)
  - Anthony Chan (2009 - 2015)
  - Jerry Goldstein (2012 - 2018)
- ◊ Tail, including plasma sheet and sub-storms (Tail)
  - Larry Kepko (2009 - 2015)
  - Sorin Zaharia (2012 - 2018)
- ◊ Magnetosphere - ionosphere coupling, aurora (MIC)
  - Bill Lotko (2011 - 2015)
  - Marc Lessard (2012 - 2018)
- ◊ GGCM
  - Slava Merkin (2009 - 2015)
  - Frank Toffoletto (2012 - 2018)

Communications Coordinator
- Peter Chi (2009 - 2014)

GEM on the Internet

GemWiki:
http://aten.igpp.ucla.edu/gemwiki/

GEM Workshop Website:
http://www.cpe.vt.edu/gem/

GEM Messenger (Electronic Newsletter):
To subscribe GEM Messenger, send an e-mail to majordomo@igpp.ucla.edu with "subscribe gem" (without quote) in the body of your message.

List of Focus Groups

Focus Group	Duration	Co-Chairs	Association with Research Areas				
			Day-side	IMS	Tail	MIC	GGCM
Dayside FACs and Energy Deposition	2010-2012	D. Knipp G. Crowley S. Erikson R. Lopez	•			•	
The Magnetosheath	2010-2014	S. Petrinec K. Nykyri	•				
Transient Phenomena at the Magnetopause and Bow Shock and Their Ground Signatures	2012-2016	H. Zhang Q.-G. Zong M. Ruohoniemi D. Murr	•				
Near Earth Magnetosphere: Plasma, Fields, and Coupling	2007-2012	S. Zaharia S. Sazykin B. Lavraud		•	•		
Plasmasphere-magnetosphere Interactions	2008-2013	J. Goldstein M. Spasojevic J. Borovsky		•			
Radiation Belts and Wave Modeling	2010-2014	Y. Shprits S. Elkington J. Bortnik C. Kletzing		•			
Substorm Expansion Onset	2008-2013	V. Angelopoulos S. Ohtani K. Shiokawa A. Runov			•		
Modes of Magnetospheric Response	2008-2013	R. McPherron L. Kepko			•		
Tail-Inner Magnetosphere Interactions	2012-2016	P. Brandt J. Lyon F. Toffoletto			•		
The Ionospheric Source of Magnetospheric Plasma	2011-2015	R. Schunk R. Chappell D. Welling				•	•
Scientific Magnetic Mapping & Techniques	2011-2015	E. Donovan E. MacDonald R. Millan				•	
Metrics and Validation	2011-2015	M. Kuznetsova A. Ridley T. Guild L. Rastaetter					•

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