# The GEMstone

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## NOTES FROM THE NSF PROGRAM DIRECTOR

The 2008 GEM/SHINE joint summer workshop was – by most estimates – a real success. It provided an excellent opportunity for those of us involved with GEM to learn more about what was going on solar and heliospheric physics and *vice versa.* The reorganization of GEM is complete and I'll have more to say about that in a bit, but before going on I hope everyone will read the "Notes from the Chair" that Jimmy Raeder wrote. After you've read his comments come back here.

OK, you're back. One of the things that Jimmy mentioned is that the procedural rules of GEM have changed somewhat, and you may be wondering why. The U.S. federal government has some very strict rules about committees that provide advice to federal agencies. These rules are covered by the Federal Advisory Committee Act. It's very complicated and I don't pretend to understand it all, but basically the federal government doesn't like to have standing committees advising the government. Let's look at the GEM steering committee as a concrete example. If I appoint the members of the steering committee and rely on them to provide advice to me about what GEM should do, then it becomes a standing committee that is advising NSF. I'd have to get special permission to allow such a standing committee to exist and every meeting of the steering committee and all communications to/from members of the committee would have to be publicized and open to the public. On the other hand, if the GEM steering committee is a grass-roots organization that elects its own members and officers and determines its own agenda, then they are free to invite me to their meetings and may even allow me to have a vote in their meetings. I, on the other hand, am free to utilize the deliberations of the GEM steering committee as I see fit. Such a grass-roots committee is thus not an official advisory committee to NSF and does not need to be registered through FACA. Trust me, it's better this way.

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**GEM Homepage URL**

*http://aten.igpp.ucla.edu/gemwiki/index.php/GemWiki*

So, as Jimmy points out in "Notes from the Chair," his term as steering committee chair is coming to an end and the GEM community needs to select a new chair. I reiterate his call for suggestions of names. You will find the current membership of the GEM steering committee at the GEMwiki (http://aten.igpp.ucla.edu/gemwiki/index.php/GemWiki).

Returning now to the general topic of the reorganization of GEM it's also time to point out that the transition from Rice University running the GEM workshops to Virginia Tech is now complete. The transition was relatively painless and I think we're in safe hands with Bob Clauer and Scott Weimer. The other point that Jimmy raised is the fact that the MIC Electrodynamics focus group has officially ended (congratulations to the organizers) and 2009 should see the termination of two more focus groups, the Dayside Magnetopause Reconnection group and the Foreshock, Bowshock, Magnetosheath group. That will leave only one focus group (Cusp Physics) on the dayside and that group is scheduled to terminate in 2010. I'd like to see at least one new focus group starting on the dayside research area.

It's probably also useful to point out that the lead research area coordinators are all scheduled to rotate off and be replaced by the secondary coordinators in 2009. So in addition to a new chair, we need nominees (i.e. volunteers) for those positions as well. Again, please take a look at the "Organization and People" page of the GEMwiki for more information.

Finally, it's time for me to take out my crystal ball and look into the future budget situation for GEM. Hmm, it says "try again later – like in 6 months." I guess that's because congress has passed a Continuing Resolution that covers the first 6 months of fiscal year 2009. By the time the CR expires we will have a new congress and new president and it's very difficult to guess what they will do. If you twist my arm, I'll have to guess that a second CR will be passed keeping all agencies (except DoD and Veterans' Affairs) funded at last year's levels. This, of course, means that once again it is going to be impossible to increase the money available for GEM related research.

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## Notes from the Chair

The 2008 GEM summer workshop was one of the busiest ever. It was the second time that we met jointly with SHINE, and it was considered a successful meeting by most people I talked to. Congratulations to Bob Clauer, Scott Weimer, and Umbe Cantu for running a smooth meeting and overcoming the organizing challenges. We also started 3 new focus groups. Two of these FGs relate to tail and substorm science, which is getting a boost from new THEMIS data. The other new FG addresses the plasmasphere. All three focus groups got off to a great start. The MIC Electrodynamics focus group closed out in 2008, thus there will be room to start one new focus group in 2009. A solicitation for proposals for the new focus group will be posted on the GEM newsletter and the steering committee will decide on the new focus group at its Fall AGU meeting. Also, as we did last year, the proposers will have an opportunity to present their proposals at the pre-AGU mini-workshop. Two focus groups close out in 2009, and three more in 2010; thus there will be a larger turnover in the coming years.

After the busy 2008 summer workshop things will quiet down a bit in 2009. We will have the usual mini-workshop on the Sunday preceding the Fall

AGU meeting, December 14. In summer 2009 the workshop will return to Snowmass in the week of June 21 – 26. CEDAR meets the following week, Sun 28 June - Fri 3 July 2009, in Santa Fe, New Mexico. The meeting location for 2010 has not yet been decided; however, there seemed to be a strong preference to meet in Snowmass again, if possible. A joint meeting with CEDAR in 2010 was also proposed but the steering committee felt strongly that a joint meeting in 2010 would be premature. CEDAR has now decided to meet during "our" week in 2010, June 21 – 25. Thus we will have to make a tough decision, whether we should meet during the same week, or whether we should move our workshop by a week to have the GEM and CEDAR workshops back to back as usual. I'm sure everyone has strong opinions about the scheduling, so make sure to voice your opinion to your favorite steering committee member!

My term as steering committee chair will end with the summer 2009 workshop. In the past, the NSF program director (Kile, that is) would have appointed a new chair by that time. NSF's rules have changed a bit in the mean time such that this time around the steering committee needs to elect its next chair. The procedural details can probably be better explained by Kile than myself. A law degree might also be helpful. In any case, we would like to elect a new chair at this year's Fall AGU steering committee meeting so that the chair elect can benefit from 6 months transition time. Please feel free to suggest the names of candidates to the steering committee members.

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***Next GEM MINI WORKSHOP***
***December 14, 2008***
***San Francisco, CA***

***Next GEM Summer Workshop***
***June 21-26, 2009***
***Snowmass, CO***

GEM can provide support for a limited number of graduate students to attend the workshop. To apply for support, visit the Website for application instructions.

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### Tutorial Talks

Tutorials from previous years are available at this site: http://www-ssc.igpp.ucla.edu/gem/tutorial/index.html .

## 2008 FOCUS GROUP REPORTS

This year we have added three new focus groups: Plasmasphere-Magnetosphere Interactions (FG11); Substorm Expansion Onset: the First Ten Minutes (FG12); Modes of Solar Wind Magnetosphere Energy Transfer (FG13).

### FG1. GGCM Metrics and Validation

*Conveners: Aaron Ridley <ridley@ umich.edu> and Masha Kuznetsova <Maria.M.Kuznetsova@nasa.gov>*

Our group met for 1.5 hours, listening to talks on validation efforts by various groups (all of which have exceptionally good models). We further discussed having a modeling challenge focusing on inner magnetospheric dynamics - specifically, comparing geosynchronous (magnetic field, plasma, and magnetopause crossings) and ground-based magnetometer data with model results. The CCMC has volunteered to host the challenge, keeping track of both the data and model results. We have specifically allowed for modelers to enter more than one model result, so they can show what can be done in near-real-time and in a more science-grade production. It should also be noted that you don't have to participate in all aspects of the comparisons. For example, if you model only does magnetopause crossings, you can still participate. Four events have been chosen:

October 29 - 30, 2003
December 14-16, 2006
August 31 - September 1, 2001
August 31 - September 1, 2005

The details of the metrics challenge will be published at CCMC website and on the GEM wiki. The announcement will be made at GEM Messenger newsletter by mid-September.

We will have a session at the GEM mini-workshop at Fall AGU to discuss preliminary results from the challenge, so please, if you are interested in participating, try to do some of the simulations before Fall AGU.

## GEM 2008 MODELING CHALLENGE

Following the discussion at the Metric and Validation Session during the GEM 2008 Workshop at Zermatt, the GGCM Metrics and Validation Focus Group is organizing Modeling Challenge focusing on the inner magnetospheric dynamics and ground magnetic perturbations. Community Coordinating Modeling Center (CCMC) is supporting the Challenge.

**Four events have been chosen:**

Event 1: October 29th, 2003 06:00 UT - October 30th, 0600 UT
Event 2: December 14, 2006 12:00 UT - December 16, 00:00 UT
Event 3: August 31, 2001 00:00 UT - September 1, 00:00 UT
Event 4: August 31, 2005 10:00 UT - September 1, 12:00 UT
The Challenge involves the following model/data comparisons (metrics studies):

Metrics 1: Magnetic field at geosynchronous orbit (GOES)
Metrics 2: Magnetopause crossings by geosynchronous satellite (GOES and LANL)
Metrics 3: Plasma density/temperature at geosynchronous orbit (LANL)
Metrics 4: Ground magnetic perturbations (ground based magnetometers)

Details of the Challenge and instruction on how to participate can be found at the Community Coordinated Modeling Center (CCMC) web site: http://ccmc.gsfc.nasa.gov/

Challenge participants can upload model results using CCMC Web interface at http://ccmc.gsfc.nasa.gov/support/GEM_metrics_08/.

The CCMC will perform the model/data comparison for submitted simulation output. CCMC will keep track of both the data and model results.

Uploading the model results for one event simulated using certain model settings can be done in one submission. For each simulated event the modelers are invited to submit simulation results for one or more metrics studies (which can be selected during the submission procedure). For example, if your model calculates only magnetopause crossings or only ground magnetic perturbations, you can still participate.

Multiple submissions from the same participant for the same event and the same model but different model settings (e.g., for different model versions, different simulation grids, different ionosphere conductance models, different coupling options with inner magnetosphere, etc.)

are possible. This will allow us to demonstrate what can be done in near-real-time and in a more science-grade production, as well as to demonstrate the effect of model coupling.

The first results of the Challenge will be discussed at the GEM mini-workshop at the Fall AGU. Using the experience of these preliminary metrics studies we will discuss what modifications to the challenge procedure should be made and whether we should modify the list of events selected for the comparison.

To participate in this first round of the Challenge please submit your model results using CCMC's on-line submission interface prior to November 15, 2008.

Please send questions and comments to:
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## FG2. GGCM – MODULES AND METHODS

*Co-chairs: John Dorelli (john.dorelli@unh.edu) and Michael Shay (shay@udel.edu)*

**Michael Hesse's** talk addressed question Q2.3: What determines the aspect ratio of the electron diffusion region in open BC PIC simulations? In previous studies, the electron diffusion region was identified as the region where the electron frozen flux condition is violated. That is, the electron diffusion region was identified as the region where there are significant corrections to the UxB and Hall electric fields. Such an identification seems to imply that the aspect of the electron diffusion region is larger than that found in earlier PIC simulations (which used periodic boundary conditions). Hesse pointed out, however, that particles are actually losing energy (with the electron fluid simply drifting diamagnetically) to the electromagnetic fields throughout most of this large diffusion region. If one *defines* the electron diffusion region to be that region where particles gain energy from the fields (i.e., the dot product of current density and electric field is positive), then the electron diffusion region is much smaller.

**Kittipat Malakit's** addressed question Q2.4: Is the Hall effect necessary to produce fast reconnection? Malakit's work was motivated by recent so-called "Hall-less" hybrid simulations (in which the Hall term in Ohm's law is turned off), carried out by Homa Karimabadi, which seemed to demonstrate that fast reconnection was possible even in the absence of the Hall electric field. In his talk, Malakit provided a counterexample, demonstrating that in the case of reconnection of a double Harris sheet, turning off the Hall term effectively turns off fast reconnection (producing long Sweet-Parker-like current sheets).

**Mikhail Sitnov**, using an open BC version of the P3D code [Zeiler et al., 2002] that was modified by Divin et al. [GRL, 34, L09109, 2007], addressed the possible role of the ion tearing mode in producing secondary magnetic islands obsevered in open BC PIC simulations (thus potentially addressing questions Q2.1-Q2.5). Sitnov noted that the code differs from Bill Daughton's both in the particle part (maintaining continuity of only the two first moments at the boundary) and in the field part (eliminating any Bz change at the x-boundaries, mimicking magnetopause reconnection). Sitnov argued that in periodic BC PIC simulations, there are no "passing" electron orbits (i.e., electrons which leave the system, a population which is essential to the development of the ion tearing mode). Sitnov argued that open BC simulations allow for the existence of such passing orbits and, thus, the ion tearing mode may be responsible for secondary island generation in open BC PIC simulations. The effect of passing electrons suggests that the reconnection onset conditions in the magnetotail may be essentially non-local. Specifically, to be tearing- or reconnection-unstable, the tail current sheet not only must be thin enough (of the order of the ion gyroradius, to provide ion dissipation), but must also be sufficiently long to provide a sufficient number of passing electorns. There was some debate among focus group participant about the relevance of ion tearing in the secondary island generation process.

**Christopher Russell** presented an interesting statistical analysis of "reconnection efficiency" -- as measured by the ratio of the variation in geomagnetic activity to the variation in the z component of the Interplanetary Magnetic Field (IMF) -- at Earth's dayside magnetopause. Two results of this study were relevant to question Q1.3: How does dayside magnetopause reconnection work in global MHD codes? First, the dependence of reconnection efficiency on IMF clock angle is not as abrupt as one would expect from a simple "half-wave" rectifier model. Russell interpreted this result to mean that reconnection at a particular location on the magnetopause may depend sensitively on the local magnetic shear across the magnetopause; nevertheless, reconnection occurs simultaneously at multiple locations on the magnetopause, so that the integrated effect on geomagnetic activity may show a more gradual dependence on the IMF clock angle. Secondly, there was a dependence of reconnection efficiency on solar wind Mach number, suggesting that the solar wind exerts some control over the reconnection rate.

**Joachim Birn** substituted for Joe Borovsky, who could not attend the meeting. Borovsky addressed question Q1.3: How does dayside magnetopause reconnection work in global MHD codes? Essentially, Borovsky argued that under pure southward IMF conditions in the BATSRUS code, the subsolar magnetopause reconnection electric field is well predicted by the Cassak-Shay formula. Borovsky went on to derive a solar wind-magnetosphere coupling function, using the Cassak-Shay formula as a starting point. Borovsky further argued, based on the agreement between the Cassak-Shay prediction with the simulated reconnection electric field, that reconnection is controlled by local plasma parameters and not "driven by" (which, for Borovsky, means "matched to") the solar wind electric field. Borovsky presented three pieces of evidence for this (from BATSRUS simulations): 1) reconnection rate didn't "match" the solar wind electric field (it's more consistent with the Cassak-Shay formula), 2) magnetic flux pileup didn't depend on the IMF clock angle, 3) a "plasmasphere" effect was observed, in which the reconnection electric field was observed to drop as a plasmaspheric density plume arrived at the dayside magnetopause.

**Paul Cassak** presented his latest results on asymmetric reconnection, extending previous resistive MHD work to the collisionless regime. Using conservation laws, Cassak derived an analytic expression for the reconnection electric field in a two-dimensional, steady state, asymmetric (i.e., different densities and magnetic field strengths on either side of the current sheet). The resulting expression predicts that the reconnection electric field depends only on the upstream and downstream plasma mass densities and magnetic field strengths. The Cassak-Shay formula also predicts that when the plasma resistivity is constant, the reconnection electric field scales like the square root of the resistivity. Thus, the Cassak-Shay provides a potential answers to questions Q1.2 and Q1.3.

**John Dorelli** presented a critique of the application, by Joe Borovsky, of the Cassak-Shay formula to the dayside magnetopause. In this talk, Dorelli addressed questions Q1.2 and Q1.3, arguing that: 1) magnetopause reconnection is "driven by" the solar wind in the usual sense: the solar wind electric field imposes a constraint on the local reconnection electric field such that local conditions adjust to accommodate the imposed external electric field. In 2D, this implies a matching of the solar wind electric field to the magnetopause electric field. In 3D, however, imposing zero curl on the electric field (steady state) does not imply such an exact matching; therefore, Borovsky's observation that the BATSRUS magnetopause reconnection electric field does not "match" the solar wind electric field does not imply that reconnection is controlled by local plasma parameters, as Borovsky argues. 2) when the plasma resistivity is constant, reconnection occurs via a flux pileup mechanism such that a) the amount of magnetic energy pileup is independent of the IMF clock angle (consistent with Borovsky's BATSRUS observations), and b) the reconnection electric field scales like the fourth root of the plasma resistivity (which contradicts the Cassak-Shay formula). Dorelli concluded by deriving an analytic expression (based on the Sonnerup-Priest 3D stagnation flow equations) for the flux pileup reconnection electric field at the dayside magnetopause. Dorelli further suggested that a simple way to test Cassak-Shay vs. the Sonnerup-Priest electric fields would be to look at the dependence of the reconnection electric field on the plasma resistivity: Cassak-Shay predicts a square root dependence; Sonnerup-Priest predicts a fourth root dependence.

**Masha Kuznetsova** presented results which addressed the effects of collisionless physics on magnetotail dynamics (specifically, substorm onset and expansion), thus addressing questions Q1.4 (How does magnetotail reconnection work?) and Q3.3 (What is the status of "embedding approaches," in which kinetic physics is added locally to an MHD code (either via code coupling or via local modification of the equations)). Kuznetsova used analytic expressions for the nongyrotropic corrections to the electron pressure tensor to locally modify the resistive MHD Ohm's law in the BATSRUS code. These modifications result in a collapse of the Sweet-Parker current sheet to microscopic size (of the order of the ion gyroradius) as well as a dramatic increase in the reconnection rate (consistent with fast reconnection observed in PIC simulations).

**Amitava Bhattacharjee** presented results from Hall MHD simulations (in which constant resistivity, hyper-resistivity and/or electron inertia break the frozen flux theorem), addressing question Q2.3 (What determines the aspect ratio of the electron diffusion region in collisionless reconnection?). Bhattacharjee presented a critique of recent analytic work by Luis Chacon in which Chacon argued that extended electron current sheets are possible in electron MHD. According to Bhattacharjee, Chacon's analysis neglected a term which should not have been neglected.

**Vadim Roytershteyn** presented new large-scale PIC simulations in collaboration with Bill Daughton & Homa Karimabadi. The main points of the presentation were:

These PIC simulations were NOT with open boundary conditions - but rather with two standard periodic test problems (1) single Harris and (2) double Harris sheet. We realize that the open boundary model is somewhat complicated and controversial, so our approach in this study was to fall back to very simple boundary conditions and use brute force to make the system size large enough to give the layer a chance to develop over longer time scales.

Both of these periodic test problems were worked with two completely different PIC codes (NPIC vs VPIC) that use very different numerical methods. However, the results from these two codes are in excellent agreement on the question of electron sheet elongation + secondary island formation.

We furthermore used both of our PIC codes to work exactly the same double Harris sheet problems as the recent PRL by Shay et al. Both of our PIC codes show multiple secondary island formation (even at late time) in clear contradiction to the results obtained by Shay et al. Furthermore, the reconnection rate in our PIC simulations is modulated in time with the length of the electron layer, while the results from Shay are "steady". This is not a matter of a "different interpretation". The simulation results are clearly different. We welcome further comparisons from anyone in the community who is interested in resolving this discrepancy. It would seem crucial to understand these very real code differences, in order to move forward on the "role" of secondary islands.

Secondary-island formation cannot be the whole story - but we believe it clearly offers one mechanism to control the length of the electron layer. The fact that reconnection rates are similar to Hall MHD does not prove the physics is the same - especially when the time-dependence and macroscopic structure are quite different. Kinetic simulations of pair plasma (mi=me) gives precisely this rate, even in small systems where there are no plasmoids and no Weibel instability. Two-fluid simulations of pair plasma have also demonstrated this same rate without plasmoids or Weibel [Chacon, PRL, 2008].

**Brian Sullivan** presented results from 3D resistive Hall MHD simulations of driven reconnection. Starting from a double Harris sheet equilibrium, reconnection was driven by a three-dimensionally localized inflow. Thus, a three-dimensional stagnation flow was produced, making this study relevant to Earth's dayside magnetopause. Thus, this study addressed questions Q1.3 (How does dayside magnetopause reconnection work in global MHD codes?). An attempt was made to define and identify a three-dimensional "magnetic island" and determine the dependence of the reconnection rate on the aspect ratio of the dissipation region. Interestingly, the three-dimensional nature of the forcing function resulted in the addition of a "geometrical factor" (resulting from the fact that plasma flows out in all directions downstream of the reconnection current sheet) to the familiar two-dimensional expression.

### Plans for the Future

- **Global MHD Axford Conjecture Challenge**
- **Open BC Reconnection Challenge**
- **Global Hybrid/MHD Comparison**

## FG3. Foreshock, Bowshock, Magnetosheath

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**Russell et al.** addressed the structure and evolution of weak collisionless shocks. In regards to the evolution of the shock, STEREO A-B observations show examples of shock steepening by coalescence of two weaker shocks where the trailing shock overtakes the leading shock. Regarding shock structure, the original theory of weak shocks suggested that their structure was due to dispersive waves whose damping provide the necessary dissipation at the shock. According to this theory these waves are present upstream of the shock layer for oblique cases and downstream of the shock for perpendicular cases. STEREO observations, however, show that waves are present both upstream and downstream of the shock.

**Krauss-Varban et al.** addressed the question of whether observed energetic ion fluxes at CME-driven shocks can be understood and quantified for the purpose of space weather forecasts. Previous attempts at ordering fluxes with Mach number and shock normal angle were not successful. To address this problem 2.5-D hybrid simulations were performed to compare fluxes of energetic ions to observations. The results show that in the case of quasi-parallel shocks both fluxes and the power law index agree well with observations without the presence of seed population of ions. In the case of the oblique shocks, the simulated fluxes are 5 orders of magnitude below the observed levels and lead to a soft power law. Addition of 1% seed population with a kappa distribution function and running for much longer times enhance the fluxes by 2 orders of magnitude. This enhancement is due to generation of fast waves in the upstream and their convection back into the shock causing the undulation of the shock surface. To account for the missing 3 orders of magnitude in the fluxes the effects of particle mirroring in the sunward converging field lines was included by reflecting the energetic ions back into the simulation box leading to larger fluxes and harder spectrum. However, additional mechanisms are still needed and under consideration for future studies.

**Zhang et al.** reported on THEMIS observations of a weak interplanetary shock interacting with the bow shock and its magnetospheric consequences. The interaction results in the earthward motion of the magnetopause at the speed of ~ 40 km/s. In addition, ground stations observed compressions over a wide range of MLTs and latitudes. It was also found that the transmitted IP shock took the form of a discontinuity associated with enhancement of B and N and a decrease in T. The field rotation associated with this structure is similar to that of the IP shock prior to its encounter with the shock. However, the fast shock expected to form based on fluid theory was not present.

**Eastwood et al.** reported on THEMIS observations of an HFA and comparisons to global hybrid simulations. During this event, THEMIS A was upstream of the bow shock while B,C,D and E were in the downstream region. THEMIS E observed the signatures of the HFA which consisted of a series of fast and slow magnetosonic waves and the remnants of the discontinuity whose interaction with the bow shock resulted in the formation of the HFA. In addition, THEMIS ground based observatories tracked the progress of the associated magnetic impulse event across the magnetosphere. An interesting aspect of these observations was that while the HFA was formed on the dusk side the associated magnetic impulse was observed on the dawn side. To compare these observations with hybrid simulations two runs using different upstream conditions guessed at based on observations were performed. In the first run, an HFA was formed on the dawn side but not on the dusk side. The lack of an HFA on the dusk side is due to the quasi-perpendicular nature of the simulated bow shock. In second run, the IMF was mostly radial leading to quasi-parallel geometry at the dayside bow shock. The interaction of the backstreaming ions with the incoming discontinuity resulted in the formation of a large structure in the foreshock which was subsequently convected back towards the shock. While the results show some similarities to the THEMIS observations no true HFA were formed. These results indicate the sensitivity of the solutions to the upstream conditions and the difficulties in deciphering the “true” upstream conditions from the observations due to the turbulent nature of this region during the event. Further work is planned for future.

**Omidi et al.** reported on the properties the ion foreshock boundary using global hybrid simulations. This new boundary was first detected in a global hybrid run with radial IMF geometry which led to a new model for foreshock cavities by Sibeck et al. (2008). According to this model, foreshock cavities correspond to spacecraft going from solar wind through the foreshock boundary into the foreshock and back into the solar wind. This accounts for the isolated nature of foreshock cavities. The results of simulations show that the ion foreshock boundary is weak at low Mach numbers and is enhanced with increasing Mach number. By performing a series of local hybrid simulations it was found that this Mach number dependence is in turn tied to the properties of the backstreaming ions where both beam velocity and density lead to the strengthening of the ion foreshock boundary. The results also show that while for small IMF cone angles the ion foreshock boundary forms on both sides of the foreshock, at larger cone angles (e.g. $20^o$) an asymmetry forms where the boundary is present only on one side of the foreshock.

**Blanco-Cano et al.** reported on the properties of foreshock ULF waves in global hybrid simulations and their dependence on the IMF cone angle and comparisons with CLUSTER observations. At intermediate cone angles the simulations show the presence of sinusoidal waves which propagate at small angles to the magnetic field and shocklets which propagate at larger wave normal angles. These waves are present in different parts of the foreshock. On the other hand, during small cone angles the two types of waves generated by the backstreaming ions correspond to parallel propagating sinusoidal waves and highly oblique fast magnetosonic waves. The properties of the excited waves were compared to linear theory which showed very good agreement. In contrast to intermediate cone angles, both types of waves are generated in the same regions of the foreshock and interact strongly during their nonlinear evolution. As a result, structures associated with large (~ 50 %) drops in solar wind density and magnetic field are formed which have been named foreshock cavitons. The size of the foreshock cavitons is of the order of 1 RE and they are convected back across the shock and into the magnetosheath leading to a highly turbulent plasma. A search through the CLUSTER data was conducted where a number of foreshock cavitons were observed. Comparisons between properties of the simulated and observed foreshock cavitons show very good agreement.

**Scholer et al.** reported on Cluster observations in the quasi-parallel foreshock region of the Earth bow shock. They investigated the association of the intensity of the diffuse ion population with the intensity of the compressional and tangential magnetic field wave intensity. They found that although the intensity of the diffuse ion population increases with decreasing distance to the Earth bow shock the wave intensity stays constant. This effect cannot be explained by existing theories and there is some evidence that this effect is associated with field-aligned ion beams originating at the perpendicular region of the Earth's bow shock.

**Desai et al.** reported on abrupt enhancements in the intensities of ions in the energy range of a few 10s of keV to 100s of keV upstream of the Earth's Bow Shock – upstream ion events – are characterized by short durations (~1-2 hours), steeply falling spectra, large (>100:1) field-aligned sunward anisotropies, and positive correlations with the solar wind speed and geomagnetic activity indices. Despite the wealth of information available, it is still not clear whether these ions are accelerated at the bow shock or somewhere inside the Earth's magnetosphere. Furthermore, such events are also often observed simultaneously at two or more spacecraft, indicating that a large source region perhaps covering the entire size of the bow shock fills large spatial structures in the upstream region. In this paper we use simultaneous measurements of >40 keV upstream ions observed at ACE, Wind, and STEREO-A between 2007, day 1 through 2007, day 181 to calculate the occurrence probability of upstream events as a function of lateral and radial separation between L1 and STEREO-A. During the end of this ~6-month period, Wind (or ACE) and STEREO-A were separated by ~1750 RE in the radial direction and laterally in YGSE by ~3800 RE. Despite this large separation, STEREO-A continued to observe upstream events right up until the end of our survey period. More surprisingly, we found that the occurrence probability for measuring simultaneous upstream events at Wind or ACE at L1 and STEREO-A was ~20-30%, i.e., far greater than that expected from accidental coincidences. We discuss the implications of these results for the size of the source region, the conditions under which upstream events occur, and the size and nature of the spatial structures in which these ions populate and propagate in the upstream region.

**Kucharek et al.** reported on intensity variations of suprathermal ions at interplanetary discontinuities such as shocks, shocks associated with CIR's, and compression regions. Observation from ACE/SPEICA and STEREO PLASTIC in the energy range of 250 – 800keV were used to investigate the enhancements of $He^{+}$, $He^{2+}$, $3He^{2+}$ at CIRs. Numerical (test particle) simulations have been used to explain why $3He^{2+}$ is less enhanced the pickup helium and solar wind alpha particles. Reasonable agreement has been achieved and there is evidence that the enhancements of the various species are controlled by the local turbulence at the shock ramp as well as local shock parameters. Future observations as well as simulations are planned to investigate not only the reflection and accelerations properties of the different interplanetary discontinuities for the various species but also the impact of these structures on the (far) downstream region of the Earth's bow shock.

## FG4. Plasma Entry and Transport into and within the Magnetotail

*Conveners: Antonius Otto <ao @ how.gi.alaska.edu>, Jay R. Johnson <jrj @ pppl.gov>, and Simon Wing <Simon.Wing @ jhuapl.edu>*

At this workshop, PET had two sessions: 1. southward IMF and 2. northward IMF. In addition, PET had a joint session with the MI coupling FG that focuses on ion outflow and its effects on the magnetotail transport and solar wind entry. The summaries of the northward and southward IMF sessions are given below while the summary of the joint session is to be given by the MI coupling FG.

PET : Southward IMF

**a. Electric field mapping and convection**

**Larry Lyons** reviewed the two main issues in mapping the convection pattern from the ionosphere to the magnetosphere: the potential and induced electric field. The potential electric field concerns with the particles crossing the field line whereas the induced electric field concerns with the changing magnetic field which has no significant effect in the ionosphere.

**Jo Baker** compared the results of mapping Cluster EDI electric field observations with T96 with SuperDARN convection pattern. He found that 24% of EDI measurements are not accounted for by SuperDARN, but generally there was good agreement. The convection patterns for duskward, dawnward, and northward IMF were considered.

**Yukitoshi Nishimura** examined a storm event with Themis in which the convection is weak in the plasma sheet, but strong in the flanks and inner magnetosphere. Only one out of five spacecraft observed steady convections. He found that the dawn-dusk electric field $E_y = (VxB)_y$.

**b. Plasma sheet driving of the inner magnetosphere**

**Matina Gkioulidou** presented a simulation that examines the roles of plasma sheet cold ions. She found that enhanced cold ions near midnight increases shielding while enhanced cold ions in the flanks enhances fast flow near midnight.

**Vahe Peroomian** presented a simulation of a storm event where most particles only enter from the dawn flank and there was a path for cold ions to move from dawn magnetopause all the way to the inner magnetosphere. Simulation results show qualitatively similar features with HENA observations. In comparison, fewer paticles enter from the deep tail, although this occurs in his simulations for different events.

**c. Solar wind entry**

**John Lyon** showed that KH waves are present in the flanks for both northward and southward IMF. The plasma sheet density increases with the solar wind speed. Curiously the plasma sheet refilled from the flanks rather than traditionally thought through lobe/mantle reconnection. The cold ions are transported toward the midnight meridian through the instability interchange. There is no dawn-dusk asymmetry.

**d. Entropy**

**Gary Erickson** showed that $PV^{\gamma}$ exhibits characteristic differences for substorms, convection bays, and pseudo breakups. In the latter $PV^{\gamma}$ returns to earlier levels (Bubbles), but $PV^{\gamma}$ stays depressed in the substorm expansion for a few 10 minutes and in convection bays for hours.

**e. Solar wind and magnetic activity influences**

**Yiqun Yu** presented a storm main phase simulation (BATSRUS) that shows that solar wind Vx but not solar wind ram pressure, linearly drives with thermal pressure in the plasma sheet. At other The observed density and pressure agree with the simulation. IMF Vx has stronger influences than IMF Bz on dayside reconnection.

**Chih-Ping Wang** showed Geotail data that suggest that, when AE is increasing, the density peaks at the flanks, but when AE is decreasing, density decreases at all LT. The velocity shows a dawn-dusk asymmetry that is consistent with the dawn-dusk asymmetry.

**PET : Northward IMF**

**a. Solar wind entry**

**Benoit Lavraud** showed observations of plasma distributions with three different populations: two cold components and one hot component associated with Kelvin-Helmholtz modes at the flank boundary for northward IMF.

**Chris Chaston** showed wave spectra as evidence for kinetic Alfven waves at the dayside flank boundary. The wave were associated with parallel electron and perpendicular ion heating and the diffusion coefficient was estimated to $10^{10}$ $m^2/s$.

**Wenhui Li** showed that MHD simulation for double cusp reconnection which leads to thick boundary layer on the dayside during northward IMF. The density and velocity agree with Themis observations, but the temperature and magnetic field do not agree as well. He discussed also that in the boundary layer, plasma flows southward for a summer dipole tilt.

**Margaret Chen** presented an analytical magnetosheath model that agrees with the Spreiter gasdynamic model. Particle tracing shows that more energetic ions, having larger gyro radii, can enter the magnetosphere more easily.

**Antonius Otto** presented analytical estimates of the relation of mass transport and entropy mixing for double reconnection and KHI. Differences in the plasma transport for cusp and three-dimensional KH were addressed.

**Jay Johnson** illustrated how perpendicular ion and parallel electron heating is consistent with kinetic Alfven dynamics as for instance observed by Chaston.

**b. Transport of cold ions to the midnight meridian**

**Simon Wing** shows that cold ion entropy increases by a factor of 5 going from the flanks to the midnight meridian, suggesting that as yet unidentified transport mechanism would heat the cold ion nonadiabatically.

**c. Solar wind influences**

**Xinlin Li** showed that solar wind speed highly correlates with the LANL energetic electron fluxes and that the correlation is better for southward IMF than northward IMF. Solar wind electrons do not correlate with these energetic electrons. Hence, it is not clear how and where these electrons are accelerated.

**d. Outstanding questions**

**Jay Johnson** summarized the outstanding questions

- What is the cause of dawn-dusk asymmetries observed at the magnetospheric flanks? How do they depend on solar wind velocity, IMF orientation (Parker spiral), mechanism (Cusp reconnection, Kelvin-Helmholtz, Kinetic Alfven waves)?
- How does plasma transport from the flanks to the center of the plasma sheet? What is the role of convection verses turbulence?
- How do kinetic-Alfven waves couple with velocity driven (KH) waves and how does it affect transport?
- What are the mechanisms, fluxes, energies, and spatial distributions of ionospheric material in the magnetotail and their impact on the transport into and within the tail?

## FG5. DAYSIDE MAGNETOPAUSE RECONNECTION

*Conveners: Jean Berchem <jberchem@igpp.ucla.edu> and Nick Omidi < omidi@adelphia.net>*

The dayside magnetopause reconnection focus group met on Monday afternoon. The session was very well attended. Between 30 and 40 people were present. As decided during the San Francisco meeting last December, the group focused on the three following topics:

Large-scale properties of reconnection at the magnetopause. **Jeremy Ouellette** from Dartmouth College presented results from the LFM code. He has run a series of simulations for constant solar wind conditions and a different IMF clock angles. He found that reconnection is predominantly an anti-parallel process. For 45° and 90° IMF clock angles, reconnection occurs in two small regions on the upper dusk and lower dawn sides, whereas for 135° and 180° angles it extends across the subsolar region. Reconnection rates at the magnetopause grow linearly with IMF clock angle from 45° to 135°and then saturate, increasing only slightly from 135° to 180° clock angles. Cross polar potential drops increase linearly from 50 to 225 kV, where they saturate.

Subsequently, observations of polar rain aurora were presented by **Yongliang Zhang** from JHU/APL. Data from the FUV experiment onboard the IMAGE spacecraft and DMSP measurements reveal the occurrence of polar rain aurora across the polar cap for periods of southward IMF and strong By. The energy range of the polar rain electrons was about 1 to 2 keV. In both cases presented, the polar rain auroras were dawn-dusk aligned and drifted anti-sunward at 200 m/s. Yongliang suggested that these polar rain auroras could result from reconnection over an extended area of the dayside magnetopause.

The physics of reconnection at the dayside magnetopause. **Vadim Roytershteyn** from LANL gave a presentation about the influence of sheared parallel flows on the onset of reconnection. He has built several equilibrium models of a jet embedded ($k \parallel B_0$) in a Harris-type current sheet. Results from the kinetic studies differ significantly from those for fluid treatments. The kinetic studies show that the instability persists in super-Alfvènic flows and produces reconnection. The thickness of the sheet was found to be one of the factors determining the transition to a fluid-like behavior. For thin sheets ($<\rho_i$) the mode behavior is determined by kinetic effects (ion anisotropy in their model) whereas the qualitative features appear to be independent of the details of the equilibrium distribution for thicker sheets.

We then discussed the properties of asymmetric reconnection when the magnetic field strengths and densities on either sides of the dissipation region differ, a situation particularly relevant to reconnection at the dayside magnetopause. **Paul Cassak** from the University of Delaware started by presenting results from a generalized Sweet-Parker type scaling analysis of 2D anti-parallel asymmetric reconnection. He showed that the outflow speed scales like the Alfven speed based on the geometric means of upstream fields and the density of the outflow ($V_{out}\ \alpha\ (B_1B_2/\rho_{out})^{1/2}$ , $\rho_{out} = (B_1\rho_2+B_2\rho_1)/(B_1+B_2)$ ) and the reconnection rate is a product of the aspect ratio of the dissipation region, the outflow speed, and an effective magnetic field strength given by the "reduced" field ($E\ \alpha\ (2\delta/L)V_{out}\ B_r$ where $B_r = B_1B_2/(B_1+B_2)$). These results are independent of dissipation mechanism and numerical simulations agree with the theory for collisional and collisionless (Hall) reconnection. The location of the x-line differs from the location of the stagnation line.

Subsequently, **Joachim Birn** (LANL) presented some results for asymmetric reconnection in resistive MHD. He showed that the scaling was similar to that for fast reconnection (Cassak-Shay) when using the outflow density from x-line ($V_{out} = (B_1B_2/\rho_x)^{1/2}$). Fast flows occur preferentially into the high Alfven speed region and the flow stagnation line was displaced toward the high-field side. An investigation of the energy flow and conversion in the vicinity of the reconnection site revealed the significant role of enthalpy flux generation (compressional heating) in addition to the expected conversion of Poynting flux to kinetic energy flux.

Time-dependent reconnection and impacts of transients. **Masha Kuznetsova** from NASA/GFSC reported results from a global MHD simulation (BATSRUS) with high grid and temporal resolution run at CCMC to explain the occurrence of the flux transfer events (FTEs) observed by THEMIS near the flank of the magnetosphere. She found that individual extended flux ropes formed by component reconnection near the subsolar region (strong core field), but antiparallel reconnection at the flanks (weak core field). The flux rope had bends and elbows reminiscent of those invoked by Russell and Elphic to explain the occurrence of FTEs at the dayside magnetopause. The simulation showed also the formation of plasma wakes (field-strength cavities) as the ropes move over the magnetopause and that different parts of the flux rope moved in different directions.

**Jean Berchem**, IGPP, UCLA used an actual Cluster event to discuss the effects of a rapid northward turning of the IMF on the topology of magnetic reconnection at the magnetopause. A global MHD simulation of the event was run and solar wind ions launched upstream of the shock were traced in the time-dependent electric and magnetic fields of the MHD simulation. Ion dispersions calculated from particles collected at Cluster's location in the simulation were found to be in very good agreement with those measured by Cluster in the cusp. In particular, the simulation reproduced very well the change in the slope of the ion dispersions observed by the spacecraft. Analysis of the simulation results indicates that reconnection occurs mostly in the subsolar region as the discontinuity interacts with the magnetopause, and then moves tailward as the field completes the rotation.

**Nick Omidi** from Solana Scientific Inc. reported the results of a study showing the influence of magnetosheath turbulence on magnetic reconnection at the magnetopause. He presented two global hybrid simulations in which the dayside magnetosheath exhibited waves associated with dissipation at the quasi-perpendicular shock (e.g., mirror and ion cyclotron waves). Both runs had the same solar wind plasma and southward IMF conditions. However, the resistivity was increased in the second run to damp magnetosheath waves. Comparison of the results showed that the number of FTEs formed at the magnetopause was reduced from 20 to 9 in the second run, indicating that the presence of turbulence in the magnetosheath enhances considerably time-dependent reconnection.

## FG6. CUSP PHYSICS

*Conveners: Conveners: K.J. Trattner <karlheinz.j.trattner.dr@ lmco.com>, N. Omidi<omidi@adelphia.net> and D. Sibeck<david.g.sibeck@nasa.gov>*

The last breakout session of the Dayside Research Area held on Monday afternoon addressed the cusp region and its processes. In addition to a poster session later on Monday evening, 6 speakers had been scheduled who covered the following subjects:

- Sounding of the cusp ion fountain. (Rocket observations)
- Pc 3-4 pulsations at cusp latitudes.
- Simulations of the cusp diamagnetic cavities and particle motions.
- Cluster observations in the cusp and magnetosheath (Fields and RAPID).
- Cluster observations in the cusp and magnetosheath (CIS).
- CEP ions in the cusp (ISEE observations).

**M. Lessard** presented first results from a study on the cusp ion fountain using SCIFER rocket observations (apogee 1500 km) on Jan 18, 2008 following launch at 07:30:08 UT. The launch occurred from Norway over the EISCAT radar on Svalbard during the occurrence of a Poleward Moving Auroral Form (PMAF). Investigated were the relative significance of Joule heating, soft electron precipitation and waves in ion outflow processes including the altitude dependency of these processes. The observations showed ion outflow with the EISCAT radars during the event, in conjunction with soft electron precipitation. The Japanese spacecraft REIMEI took images during the launch. Additional results were presented during the poster session.

**F. Lu** studied multi-instrument observations of Pc 3-4 pulsations at cusp latitudes in Svalbard on September 18, 2006. The study of combined magnetometer, radar and satellite data shows that the strongest Pc 3-4 signal on the ground occurs 4-5 degrees equatorward of the cusp, whose location can be accurately determined from the radar backscatter. The study contradicts the direct cusp entry theory, which predicts strongest ground signal right under the cusp, but supports the ionospheric transistor theory by Engebretson et al. [1991].

**A. Otto** presented results from an MHD simulation of a cusp diamagnetic cavity where they used test particles to investigate ion acceleration in the funnel shaped, low magnetic field region. With time, his test particles reached about 50 keV, consistent with the cusp reconnection ‘potential’ (~50 keV). The particles remained trapped in the cavity while a combination of gradient/curvature motion in the reconnection potential was reported as the acceleration mechanism. The resulting energetic population is highly anisotropic with pitch angles peaking at 90 +/- 45 degrees. Predicted spectra match those observed.

**K. Nykyri** investigated the Cluster cusp crossing on Feb. 14, 2003 using data from the RAPID and FGM instruments. The cusp crossing exhibits two diamagnetic cavities filled with high energy electrons, protons and helium. By using the four Cluster satellites Katariina reported for the first time an actual spatial size of a diamagnetic cavity (about 1 RE in the direction normal to the magnetopause). The turbulence in the cavity, thought to be one of the methods for accelerating ions, was identified as partly the back and forth motion of the cavity boundary over the satellite while most of it exhibits an FTE-like structure.

**K. Trattner** investigated the same Cluster cusp crossing as K. Nykyri, using data from the CIS instrument. Applying analyzing tools to pinpoint the location of the reconnection site and IMF field line draping around the magnetopause revealed a reconnection site located poleward of the cusp and a quasi-parallel bow shock region in the southern hemisphere which is magnetically connected to the northern hemisphere cusp region. The 3D capability of the CIS instrument provided observations in the cusp cavity and the magnetopause boundary layer and showed an energetic particle distribution streaming into and towards the cusp, respectively, consistent with a bow shock source for cusp energetic particles.

**T. Fritz** presented an ISEE-1/2 cusp crossing with orders of magnitude flux increase within the depressed and very turbulent diamagnetic cavity. The energetic particles seem to originate from below the observing spacecraft streaming upward/outward. The electrons demonstrated a distribution peak at 90 degree pitch angle, indicative of being confined within a cusp minimum field trap. The observations were interpreted as being consistent with a local acceleration source.

## FG7. M-I Coupling Electrodynamics and Transport (MICET)

*Conveners: Joshua Semeter <jls@bu.edu> and Bill Lotko <william.lotko@dartmouth.edu>*

"M-I coupling" constitutes a broad range of topics that are important to both the GEM and CEDAR initiatives. The MICET focus group was born in 2006 from the M-I coupling campaign in order to maintain continuity in this topical area. The MICET focus group hosted two breakout sessions at the 2008 workshop. As demonstrated in the highlights below, progress in M-I coupling continues to be strong in both the theoretical and observational domains. In particular, the emergence of new diagnostic capabilities associated with the THEMIS and AMISR projects, and new models capable of making predictions that may be directly compared with these measurements, underscores the need to continue M-I coupling activities in some form after the completion of the MICET focus group in 2009.

**Session 1 - "M-I coupling: New measurements, new models, new methods"**

The modeling and observational characterization of M-I coupling is complicated by the fact that M-I coupling processes are locally enabled while being globally regulated and impressed. This breakout session explored various manifestations of this dichotomy from both the theoretical and observational perspectives. With the MICET focus group coming to a close, much of the discussion focused on strategies for moving forward on these topics. Also, due to the overlap with the CEDAR meeting, the session also served as a forum to highlight new developments in observational capabilities, in addition to highlighting new developments and challenges emerging from theoretical work. A brief summary of the individual presentations follows.

**Paul Song** presented results of a one-dimensional, time-dependent model of M-I coupling driven by a change in magnetospheric flow at the top boundary. Steady state required ~20 Alfven transit times, but during the transition, the flows and currents were significantly enhanced and varied in both magnitude and direction with altitude. He concluded that using Ohm's law in the neutral wind frame for M-I coupling will miss important electrodynamics at the beginning, and important neutral wind dynamics later.

**Eric Lund** discussed the physical origin of the parallel electric field in the auroral acceleration region. He compared the E-parallel contribution of various individual components of the momentum equation. The dominant terms are the pressure gradient and mirror force (although their signs are opposite), with anomalous resistivity accounting for only 10% of the total E-parallel.

**Bob Lysak** described the limitations of treating the ionosphere boundary in terms of current continuity imposed on height-integrated conductivities—namely, Hall conductivity introduces magnetic compressibility, tilt of field lines can couple curl-free electric fields to compression even in absence of Hall conductivity, and finite frequency and small perpendicular wavelength limit penetration of Alfvén wave into ionosphere. He proposed a more general model for the ionosphere, which requires a determination of the magnetic potential in the lithosphere-ionosphere region.

On the observational end, **Phil Erickson** described constraints on M-I coupling derivable from the Millstone Hill incoherent scatter radar (ISR). He focused on mid-latitude physics associated with the plasmasphere boundary layer (PBL), at the interface between the auroral magnetosphere and the onosphere/thermosphere dominated inner region. He discussed specific outstanding questions regarding SED, SAPS, wave/particle interactions, and optically driven hallmarks of magnetosphere/ionosphere coupling such as stable auroral red (SAR) arcs. He also presented a wide list of unanswered questions concerning PBL dynamics that require consideration of the full range of magnetosphere-ionosphere-thermosphere coupling effects. These topics highlight the need for close collaboration between the GEM and CEDAR communities.

**Joshua Semeter** discussed new opportunities for studying auroral M-I coupling enabled by the recently completed Poker Flat ISR (or PFISR). A component of the AMISR project, PFISR has an electronically steerable antenna, enabling the construction of volumetric images of ionospheric densities, temperatures, and motions. A movie was presented, showing the evolution of ionospheric densities in the 90-to130-km altitude range at 14-s cadence during an auroral activation, highlighting features that would be ambiguous using traditional line-of-sight ISR measurements. (The movie is available for download at http://heaviside.bu.edu/~josh/PFISR/11Nov2007/PFISR_11Nov2007.mpg)

Lastly, **Frederick Wilder** discussed observations of potential saturation associated with reverse convection cells. The study was based on combined analysis of ACE solar wind data and SuperDARN measurements between 1998 and 2005.

**Session 2 - "MI coupling and magnetotail transport" (joint with the PET)**

Heavy ions of ionospheric origin can at times be the dominant contributor to the mass density in the plasma sheet. Plasma sheet transport processes also exhibit signatures in the ionosphere that can be used to constrain plasma sheet transport models. This breakout focused on addressing the following core topics: (i) the ionosphere as a source of plasma sheet populations and determining the heavy ion distribution in the plasma sheet for various IMF conditions; (ii) signatures of plasma sheet transport processes in the ionosphere (e.g. are there signatures of plasma sheet turbulence in the ionosphere?); and (iii) the effect of ionospheric/heavy ions on plasma sheet transport and solar wind entry.
Discussion leaders included **Jay Johnson, Bill Lotko, Matthew Zettergren, Bill Peterson**, and **Paul Kintner**.

## FG8. NEAR EARTH MAGNETOSPHERE: PLASMA, FIELDS, AND COUPLING

*Co-chairs: Sorin Zaharia <szaharia @ lanl.go>, Stan Sazykin <sazykin @ rice.edu> and Benoit Lavraud <Benoit.Lavraud @ cesr.fr>*

The Near Earth Magnetosphere focus group held 3 breakout sessions in its 2nd year of activity at the 2008 GEM Summer Workshop in Zermatt, UT. The main goal of the focus group is to improve physical knowledge and modeling of near-Earth magnetosphere and its coupling with outer magnetosphere. The focus group is coordinated by Sorin Zaharia, Stan Sazykin and Benoit Lavraud.

The three focus group sessions, held on Tuesday and Wednesday (06/24-25) were well attended and featured short presentations and discussions of progress on the two main research fronts the focus group has concentrated to achieve its goals:

1. Data-based/empirical models - short presentations described both continuing progress on empirical modeling (such as the UNH IMEF E-field model), as well as a significant number of new research efforts on this front, from new magnetic field to plasma pressure models; below is a synopsis of the main topics discussed:

- Empirical plasma sheet specification – either for use in models (C. Lemon, a plasma sheet property database for geosynchronous orbit) or validating model results, e.g. observational verification of ring current injection from the plasma sheet (C.-P. Wang, Themis observations)
- Empirical E-field specification: overview of improvements in the UNH IMEF model based on Cluster data - the model is now publicly available (H. Matsui, P. Puhl-Quinn); its first use in a physics-based ring current model (V. Jordanova, RAM); dichotomy between convective electric field dependence on IMF southward turning in the plasma sheet vs. earthward of it (Y. Nishimura)
- Empirical B-field: M. Sitnov, new dynamical model (with a dramatic increase in spatial resolution); J. Zhang, T89GS - model constrained by spacecraft observations that satisfies force balance near spacecraft; R. Denton – adjusting TS05 model to better fit GOES observations; N. Ganushkina - event-oriented B-field model – modification of Tsyganenko model (good for studying detailed magnetic field variations for a specific event, time period, or magnetospheric region)
- Empirical plasma pressure model of the inner magnetosphere (P. Brandt – obtained by combining in-situ with global ENA observations)
- Radar observations of ionospheric convection (L. Lyons, Poker Flats AMISR; J. Baker, mid-latitude SuperDARN); qualitatively similar features observed in model results (Lyons, RCM)

2. The second research area, physics-based modeling, tackled mostly the coupling between different elements in the models (plasma, electric and magnetic fields); highlights from the presentations include:

- Modeling many events with simple setup (model works better for one storm type, i.e. sheath-driven storms, suggesting different storm drivers lead to more or less complex inner magnetosphere physics) (**M. Liemohn**, HEIDI - Michigan RAM)
- Ballooning instability in RCM-E; continued driving, simulating a growth

phase, pushes the magnetosphere toward both MHD and fast MHD unstable states (**F. Toffoletto**)

- Substorm simulations: with RCM-E (**J. Yang**, using Geotail data to set up boundary; results consistent with observations); with a "bubble" imposed (RCM with new T89GS force-balanced model - **J. Zhang**; injection of bubble leads to higher pressure in the near-Earth magnetosphere)

- Wave studies: analytical pitch-angle diffusion - three lowest eigenvalues for the pitch-angle diffusion coefficient (**M. Schulz**; results could be used in ring current models); connection theory/observations - whistler modes (derived from LANL plasma observations + linear theory; enhanced growth rates found in the recovery phase; **E. MacDonald**)

- Effect of plasma boundary on RC injection (cold dense plasma more geoeffective; local time boundary distribution also very important - **B. Lavraud**, RAM; in simulations with self-consistent E-field, higher plasma sheet pressure causes quicker shielding of the penetration E-field - **M. Gkioulidou**, RCM)

- 1-way coupling of RAM with self-consistent B-field with SWMF (using SWMF pressure on RAM boundary) reconfirms previous results that cold, dense plasma sheet –a common feature in MHD models – is more "geoeffective," i.e. leads to higher inner magnetosphere plasma pressure) (**S. Zaharia**)

The second half of the 3rd breakout session was devoted to a community discussion in which a future modeling challenge relevant to Focus Group goals emerged. The challenge will entail several near-Earth/inner magnetosphere models simulating, with same (or equivalent) input, both an idealized and a real event (geomagnetic storm). The challenge will bring together researchers from all major near-Earth magnetosphere modeling groups : RAM-SC B (LANL); HEIDI (Michigan RAM), RCM, RCM-E, CRCM, M. Chen's model. The challenge will involve 3 stages: First an idealized event, with simple inputs/physics (with the goal of setting a baseline for all models). The second and third stage will involve full-physics modeling of an idealized and real event, respectively (thus the 3rd stage will involve both modelers and data analysts). More details about the challenge/model setup will be communicated to the community via e-mail and the new Focus Group Wiki. It is expected that the first stage be completed by and results presented at the 2008 GEM Mini-workshop (Sunday before AGU Meeting) in December, where the focus group plans to have a session. The 2009 Summer Workshop will then see initial results from the simulation of an idealized event with full model capabilities, with the goal of finding out the relative role of different physics features (e.g. plasma/fields self-consistency) present in the models.

## FG9. SPACE RADIATION CLIMATOLOGY

*Conveners: Paul O'Brien<paul.obrien@ aero.org>, Geoff Reeves <reeves@lanl.gov>*

Focus Group Topic Description: Climatology is typically defined as the study of the long-term (seasonal, decadal, etc.) variability of the atmosphere, as opposed to weather, which is typically defined as the short term variations associated with storms, fronts, air masses, etc. There is a direct analogy in space weather and space climate, and it influences how we pursue knowledge about the space environment. Space weather is often pursued in the form of observations and physics-based simulations of individual storm events, while space climate has, until recently, been characterized almost exclusively by long-term empirical studies. These empirical climate studies have revealed some terrific insights into the physics of the magnetosphere: e.g., the Russell-McPherron effect demonstrated the importance of southward IMF and dayside reconnection, while the Solar cycle seasonality of intense ring current and radiation belts revealed the different magnetospheric response to CIRs and CMEs, and a Paulikas and Blake survey of interplanetary conditions and trapped electrons revealed a significant role for solar wind speed in driving the radiation belts. However, only recently have data assimilative methods begun to be applied to the inner magnetosphere, paving the way for physics-based climatology.

The objectives of the GEM Focus Group on Space Radiation Climatology (SRC) will be to discover those geospace relationships that are primarily manifest on long time scales (months to years) and apply that knowledge to the development of inner magnetospheric components of a GGCM (including internal and solar wind driving conditions). Specifically the campaign will focus on (1) application of data assimilation and statistical techniques to modeling magnetospheric dynamics over approximately 1 solar cycle or more; (2) "reanalysis" of climate model outputs to determine driving factors, missing processes in the models, and coupling to other parts of geospace; (3) event and "interval" studies on time scales from storms to solar cycles to determine the relationship between weather and climate in the inner magnetosphere; and (4) application of the knowledge gained in this focus area to space weather problems and the further evolution of GGCMs.

Scientifically, early experiments with data assimilation in the radiation belts have shown how the amount and nature of "adjustment" needed in the data assimilation stage can be used to identify physical approximations that need to be improved in the underlying physics-based simulation. Development of a Space Radiation Climatology will also provide a valuable service to society: existing space climate models (e.g., AE-8 and AP-8) are quantitatively inaccurate, they do not capture the natural variability of the space environment, nor do they cover ring current energy ranges. Considerable resources are squandered every year to hedge against the unquantified shortcomings of existing climate models.

In the terrestrial weather community, the concept of reanalysis is fairly mature. The NCAR/NCEP climate reanalysis project [*Kalnay et al.*, 1996] has demonstrated the value of long term (decades) continuous global specifications of the climate for numerous scientific applications: climate studies, seasonal climate prediction, climate variability studies, initial/boundary conditions for regional/sub-grid-scale models, diagnostic studies, verification of climate models, and test beds for operational models. In the space science community, the reanalysis approach is still in its infancy [*Kihn et al.*, 2002]. Presently, the space science community is developing data-assimilative numerical simulations of the ring current, electron radiation belts, and proton radiation belt. As these models mature, it will soon be appropriate to run them over a long, coordinated 11-year interval to obtain a reanalysis of a complete solar cycle. Finally, by providing continuous coverage on a fixed, global grid, a reanalysis opens the door for more sophisticated system-identification studies and the generation of meaningful "indices" than is possible with orbital data that is limited in time and constrained to the varying orbit tracks of satellites (e.g., comparison of the Southern Oscillation Index and terrestrial climate reanalysis has revealed the regional and global impacts of El Nino).

This focus area would leverage complementary programs that are in development outside GEM. Those include: NASA's Living With a Star program, and the NRO's AE-9/AP-9 initiative, DOE's DREAM program and, of course, NSF's Space Weather Program. The GEM program can play a lead role in the development of new understanding of space climate and ensure close cross-pollination between global models and inner magnetosphere models.

Relationship to other Focus Groups: The strongest relationship between a Space Radiation Climatology Focus Group would be with the GGCM Focus Groups. In essence the data-assimilative numerical simulation models developed by the SRC focus group would constitute the ring current and radiation belt modules of a future GGCM. The SRC focus group would also collaborate closely with tail/transport focus groups, with solar wind/magnetosphere coupling groups, and with magnetosphere/ionosphere coupling focus groups – all of which are coupled intimately with the drivers, sources, and sinks in the inner magnetosphere.

Specific Goal: The specific goal of the SRC Focus Group is to distribute a "Standard Solar Cycle," which will be a specification of the complete global radiation environment, from ring current plasma to relativistic electrons and protons, on a spatial grid that covers the inner magnetosphere at a time cadence appropriate to each particle population. As a means of developing this product, the SRC Focus Group also plans to develop and validate three data-assimilative numerical simulation models: the ring current, electron radiation belts, and proton radiation belt.

Term: The term of the Space Radiation Climatology Focus Group shall be 5 years: 2007-2012. This term will allow time for development of high quality data-assimilative numerical simulations in anticipation of NASA's RBSP launch in 2012.

Expected Activities

Expected Session Topics:
- Data assimilation into ring current simulations: Plasmas, Magnetometers
- Data assimilation into relativistic electron simulations: Particles, ULF Waves
- Data assimilation into inner belt simulations: Particles, Magnetometers

Event study challenges for data-assimilative numerical simulations:
- Estimation of magnetic field along Polar spacecraft track
- Estimation of electron fluxes observed by a GPS vehicle
- Estimation of electron and proton fluxes observed by SAMPEX

References:

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## FG10. DIFFUSE AURORAL PRECIPITATION

**There were four separate breakout sessions devoted to the Diffuse Auroral Precipitation Focus Group at the 2008 GEM workshop**

### DAP 1: "Electron Pitch-Angle Scattering: Wave Observations and Theory"

*Co-chaired by Richard Thorne <rmt@ atmos.ucla.edu> and Nigel Meredith<nmer@ bas.ac.uk>*

This session was well attended (30-40 participants) and examined the global morphology and variability electrostatic electron cyclotron harmonic (ECH) and electromagnetic whistler mode chorus plasma waves, which are capable of interacting with plasma sheet electrons, leading to precipitation into the atmosphere. Theoretical calculations of pitch-angle scattering rates from each class of wave, under different levels of geomagnetic activity, were also presented to assess their potential contribution to the global pattern of diffuse auroral precipitation.

**Nigel Meredith** presented a statistical analysis of ECH and upper band chorus from CRRES wave observations.

**Binbin Ni** presented plasma sheet electron scattering by upper and lower band chorus and showed that such waves could induce strong diffusion scattering over the energy range between 100 eV to a few keV.

**Richard Thorne** presented ECH scattering rates and showed that such waves could contribute to the scattering of lower energy electrons.

**Richard Quinn** presented Jay Albert's approximate calculations for chorus scattering and showed that this could lead to far more rapid computation.

**Eric Donavan** presented observations for Laila Andersson, which showed evidence for two difference mechanisms for electron scattering.

**Ted Fritz** presented evidence for butterfly distributions of energetic electrons in the auroral zone.

Over the next year much better observational models for the global distribution of each class of scattering wave will be made available, which can be used to better quantify the rate of plasma sheet electron scattering.

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## DAP 2: "The Origin of Diffuse Auroral Structure"

*Co-chaired by Eric Donovan <edonovan@ ucalgary.ca>, Mike Henderson< mghenderson @lanl.gov>*

This session was well attended (30-40 participants) and explored the origin of spatial structure and temporal variability of the diffuse aurora.

**Eric Donovan** presented evidence for patches of diffuse auroral emissions, which exhibit temporaly pulsations at a variety of time scales ranging from >1 Hz to Pi2 frequencies.

**Mike Henderson** showed observations of Giant Undulations on the equatorward edge of the diffuse aural zone, and suggested that these were associated with SAPs flows in the dusk sector.

**Sarah Jones** presented evidence (for Mark Lessard) of pulsating aurora with ~ 10 sec period, and suggested that this was associated with modulation of the cyclotron resonant instability.

**Tom Sotirelis** described the global distribution of precipitating electrons observed on low altitude satellites.

**Eric Donovan** presented evidence for Harlan Spence of Omega bands observed in the inner magnetosphere.

The talks highlighted three important aspects of diffuse aurora structure: 1) the spatio-temporal evolution of boundaries; 2) the spatio-temporal modulation of precipitation, particularly in the case of patchy-pulsating aurora; 3) the importance of global models of the precipitation due to diffuse aurora that would incorporate some information about structure. In addition, it was decided that we are uncertain as to whether pulsating aurora are always embedded in larger-scale diffuse aurora, nor whether or not patches in the diffuse aurora may be formed as a consequence of parallel acceleration.

It was agreed by those present that activities in the near future should focus in particular on global models of diffuse auroral precipitation, and on advancing our understanding of patchy and pulsating aurora. It was asserted that these two themes offer promise for better quantifying, for example, global distributions of conductivity that are used in global simulations.

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## DAP 3 (Joint with FG on Near Earth Magnetosphere): "Plasma Sheet Ion Scattering"

*Co-chaired by Shawn Young< Shawn.Young@ kirtland.af.mil> and Marc Lessard<marc.lessard@unh.edu>*

The equator-ward edge of the diffuse proton aurora provides information on current sheet scattering associated with stretching of the magnetic structure in the magnetotail. Ion precipitation can also be associated with features of the ring current.

**Yongliang Zhang** presented evidence of ion precipitation observed in TIMED/GUVI and DMSP/SSUSI data. The data provides global information on equatorward boundary of proton current sheet scattering and on the scattering process for ring current ions.

**Simon Wing** discussed observational information on the b2i boundary of isotropic ion precipitation.

**Eric Donovan** described the use of FAST satellite data to determine the transition from isotropic scattering to weak scattering near the edge of the proton diffuse aurora. He also showed that there was some inconsistency between the isotropic boundary location and the expectations from energy-dependent current sheet scattering on the dayside.

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## DAP 4: "Planning session for 2008-2009 activities"

*Co-chaired by Jacob Bortnik< (jbortnik@gmail.com> and Tom Sotirelis< tom.sotirelis@jhuapl.edu>.*

In this session **Jacob Bortnik** and **Tom Sotirelis** discussed available data sources on waves and precipitating particles. This information will be place on the GEM/Wiki web site. Plans and objectives for the next year of the campaign were also formulated.

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## FG11. PLASMASPHERE-MAGNETOSPHERE INTERACTIONS (PMI)

*Conveners: Jerry Goldstein< jgoldstein @swri.edu>, Joseph Borovsky< jborovsky@ lanl.gov>*
*Topic Chair: Maria Spasojevic< mariaspasojevic @ stanford.edu> (Wave-Particle Interactions)*

**Overview:**
At the 2008 GEM Meeting in Zermatt Resort, Midway, Utah, the Plasmasphere-Magnetosphere Interactions (PMI) Focus Group held four breakout sessions and hosted one tutorial:

<u>Science Breakouts (PMI 1 and 2)</u>: The two kick-off science breakouts were extremely well-attended. At the encouragement of the PMI conveners, speakers kept their presentations fairly brief and informal. Following each talk, the questioning and discussion was allowed to continue until it naturally led into the next presentation, rather than cutting off discussion to make room for AGU-style talks. This approach fostered much free-form discussion, and generated a list of science questions to attack in the coming years of our new focus group. These science questions are listed in a Word document (***PMI-ScienceQuestions.doc***) that is linked on the GEM Wiki Page (see URL above).

<u>Planning Breakouts (PMI 3 and 4)</u>: The first planning breakout (PMI 3) began with several "overflow" presentations, i.e., brief talks contributed to the PMI FG this year, but which did not fit into the two science breakouts (either because the subject matter was not specific to

PMI 1 or 2, or because there wasn't enough time in these sessions). These overflow presentations were mostly concerning plasmaspheric refilling or outflow, with a few talks discussing future capabilities or facilities that might benefit the PMI FG. Because there were so many overflow talks, a second planning breakout (PMI 4) was scheduled on the spot for the following morning. The planning sessions produced additional science questions in support of future PMI activities. At PMI 4 session, a sign-up sheet was passed around for people interested in being on the PMI mailer list. The mailer list comprises (as of 1 July 2008) 31 scientists most of whom listed on the sign-up sheet their planned PMI-related activities for the coming year.

Tutorial: **Maria Spasojevic** gave an excellent, very well received tutorial that introduced the basic concepts of the plasmasphere-magnetosphere interaction, reviewed work that has been done, and listed unsolved science puzzles which the PMI FG will hope to address. A day before the tutorial, Goldstein and Spasojevic met and hashed out the science/conceptual structure of the PMI investigation, as enumerated in detail in the Word document ***PMI-ScienceQuestions.doc*** linked on the GEM Wiki Page. The PMI investigations are grouped into four Main Topics (I through IV in ***PMI-ScienceQuestions.doc***), each of which has two main questions (A. and B. in ***PMI-ScienceQuestions.doc***). Each Main Topic will have a Topic Chair assigned to guide the science investigations; Maria Spasojevic has accepted the request to chair *Wave-Particle Interactions (Topic I)*; Joe Borovsky will be acting chair of *Plume Dynamics & Recirculation (Topic II).* It is planned that every year at GEM, each Main Topic would host one or more breakout sessions; the planned breakout session sub-topics are also listed in the linked Word document.

**Science Summary:**

I. WAVE-PARTICLE INTERACTIONS:

The PMI investigation of this topic will be organized by two main questions:

A. How does the evolving global distribution of cold plasma govern the growth and propagation of waves, specifically those that control energetic particle distributions & dynamics? and (B)
B. How do ambient plasma properties such as temperature, density, and composition influence wave particle interactions?

Stated simply, these break up into "Wave Growth & Propagation" and "Wave Influence (on Energetic Particles)", and they both require knowledge and understanding of the ambient plasma properties, especially of the plasmasphere.

Discussion (in the PMI 1 breakout session) of this topic was quite lively, with a consensus yielding the following observations:

1. The "important" waves (i.e., those that influence energetic particles) appear to be *EMIC, hiss, chorus, and magnetosonic*.
2. To really solve the wave particle interactions problem, we would ideally like to know the amplitude of all "important" waves at all locations. Understanding the impossibility of this ideal, the following practical approaches were discussed:
    a. One approach to characterizing waves is to perform several case studies and attempt to draw general conclusions. Illustrating this approach with case studies of EMIC waves, Mark Engebretson demonstrated how sparse, temporally-separated observations can yield (apparently) conflicting rules for occurrence and amplitude.
    b. Another approach is to use a large database of wave observations (e.g., a mission's worth) and attempt to produce an empirical model parameterized by various activity indices. Nigel Meredith has adopted this approach, using CRRES

data in several studies of hiss, EMIC, chorus, etc. Despite their universal appeal, the weaknesses of the currently available empirical characterizations seem to be

i. "averaged" amplitudes will smooth out extrema and blur the spatial-temporal relationship (and obscure the presence or absence of plumes), and
ii. because plasmaspheric properties are so important to wave growth (and influence), what we really need is some way to characterize wave amplitude & occurrence based on the presence or absence of plumes or plasmasphere. With the knowledge that plumes follow a predictable dynamical pattern according to the most recent change in convection, perhaps a superposed epoch characterization (rather than Kp or Dst, etc.) would yield a better emprical wave model.

c. It has also been suggested that the best way to get the global dynamic view we seek is to just use self-consistent models (such as Vania Jordanova's). However, we are still working on addressing important limitations of these models.
   i. For example, and most relevant to EMIC wave growth, we believe that the internal fine structure of plumes can generate EMIC waves throughout the plume, rather than just at the global boundaries (as is the case in the current formulation of these models, which have "smooth" density profiles inside the plume). Vania volunteered to examine whether or not internal fine structure could be simulated in a simple (and perhaps not self-consistent) way.
   ii. Also related to this point, the discussion focused for quite some time upon the generation mechanism for the fine structure within plumes. Joe Borovsky, who likes to call this fine structure "plume lumpiness", has for some time advocated an inherent tendency for ExB drift to become turbulent, this opinion apparently based on satellite-based experiments that dumped plasma into space. Whatever the name or cause, it is clear that no measurement has ever fully resolved the fine structure of the apparently turbulent and/or filamentary density variations within plumes. A truly self-consistent treatment must understand the genesis of this structure.

## I. PLUME DYNAMICS & RECIRCULATION:

The PMI investigation of this topic will be organized by two main questions:

A. How is eroded plasmaspheric material transported throughout the magnetosphere, and how does it evolve?
B. How do plumes influence the reconnection process, and what are the implications for solar-wind-magnetosphere coupling?

These two main questions will be attacked in several breakout session sub-topics:

1. *Dayside/Flank Plume Circulation*
2. *Plume Plasma and Dayside Reconnection*
3. *Plumes in the Polar Cap*
4. *Nightside Cold Plasma Circulation*

At the PMI 2 breakout, discussion was once again quite lively. We spent most of our time on subtopic 3 (*Plumes in the Polar Cap)*, with substantially less time on subtopic 2 (*Dayside/Flank Plume Circulation*). The discussion yielded the following consensus obsevations:

1. To understand how plume plasma reaches the dayside magnetopause:
   a. In the coming year, we need to work out a model that predicts the MLT-vs-UT-vs-*L*-

   shell dependence of plumes. Specifically, in the recovery phase, when the plume is wrapping, where/when does the plume cross geostationary orbit? How "wrapped up" are the plumes? Etc.
   b. We also should look into any means of determining how much plasma gets stranded in the dayside afternoon sector during recovery, and how much plasma that does reach the magnetopause remains on closed field lines and gets recirculated by the antisunward flow along the flanks.
2. By examining polar cap observations, we might hope to get a handle on how much plume plasma is heated or lost during its passage through the dayside reconnection site, and how much cold plasma is retained on the open field lines.
3. Yi Jiun Su's outstanding study of polar cap observations of what appears to be plume plasma convecting toward the nightside illustrated the following issues:
   a. It is critical to distinguish between plume plasma and ionospheric outflow plasma.
   b. Polar cap field lines are probably not in diffusive or thermal equilibrium; therefore, the ionospheric footpoint (e.g., as seen in ionospheric TEC or radar) may not be a robust proxy for the rest of the field line.
   c. Not all "polar patches" seen in radar are plumes. It also appears that not all plumes produce polar patches.

## FG12. Substorm Expansion Onset: The First 10 Minutes

*Conveners: Vassilis Angelopoulos <vassilis @ucla.edu>, Shin Ohtani <Shin.Ohtani @ jhuapl.edu> and Kazuo Shiokawa <shiokawa@ stelab.nagoya-u.ac.jp>*

This is the first year for our new focus group, "Substorm Expansion Onset: The First 10 Minutes". We had 3 breakout sessions for three topical areas, that is, substorm onset timing, breakup aurora, and mapping. The following is a brief summary of each session.

For the timing session the primary question we discussed was:
"What is the time sequence of onset-related phenomena observed in space and on the ground, and what are the implications for substorm onset processes?"
The substorm trigger in the magnetotail is generally addressed in terms of two different ideas, that is, outside-in and inside-out models. The outside-in model proposes that the near-Earth neutral line (NENL) is formed before substorm onset, and that the braking of the ejected fast earthward flow causes the reduction of tail current in the near-Earth region. In contrast, the inside-out model proposes that the tail current reduction is the very initial process of substorm trigger, and the model considers the formation of a NENL as its consequence. The distinction of the two models is also one of the primary objectives of the THEMIS mission.

**Dave Sibeck** gave a summary review of these two substorm models explaining how this issue can be addressed with THEMIS satellite and ground observations as well as with other existing data sets. For this session we pre-selected two substorm events, one on January 29, 2008 (07-09 UT) and another on March 1, 2008 (01-05 UT). For both events the THEMIS satellites were in major conjunction in the magnetotail allowing us to address radial propagation of onset signatures with their footpoints well covered by networks of ground observations, which provide unambiguous onset timing; those two events may be browsed at http://www.igpp.ucla.edu/public/THEMIS/SCI/events/.

**Stephen Mende** presented the January 29 event on behalf of Tony Lui. For this event THEMIS satellite observation indicates that the main onset took place in the near-Earth region, between $X$ = -8 and -11 $R_E$. Since there was no fast flow detected before the onset and also because ground auroral images show no disturbance with arcs poleward of the onset arc, they concluded that this onset can be explained in terms of the inside-out model. There was another substorm period later on the same day.

**Benoit Lavraud** (on behalf of Christian Jacquey) discussed the propagation of substorm-related signatures for three events during this later period. The preliminary result suggests the near-Earth initiation of a substorm followed by the tailward propagation of an active region (NENL or current disruption).

**Vassilis Angelopoulos** presented the March 1 on behalf of Andrei Runov. In this event, particle acceleration, FACs, and plasma bulk flow were detected at $X$ = -15 ~ -17 $R_E$ before the ground onset, while the tail current continued to build up in the near-Earth region. Dipolarization/current disruption was observed later in association with the major onset. Thus they concluded that the sequence is consistent with the outside-in model. The initiation of reconnection prior to a substorm onset was also reported for the February 28, 2008 event by Jiang Liu.

As for the propagation of fast plasma flow, **Tung-Shin Hsu** presented a superposed epoch analysis based on the THEMIS data set. The result shows that the fast flow is decelerated as it approaches Earth and accordingly, magnetic flux is piled up in the near-Earth region. In addition, onset-related wave signatures were discussed for THEMIS events by Joe Baker (Pi2 observed by SuperDARN) and Peter Chi (Pi2 and magnetoseismology).

In the "breakup aurora" session, we addressed the following three questions:

1) How does aurora evolve around substorm onsets?
2) Is the onset arc formation an outcome of the M-I coupling, or is it a manifestation of a tail process?
3) Is the breakup arc Alfvenic or inverted-V? For the former, how is the associated process related to the formation of the substorm wedge system?

**Stephen Mende** made an overall review of recent observations of high-time resolution ground all-sky imaging. The auroral emission starts to increase gradually 1-2 min before the sharp enhancement. The structuring of aurora arcs and formation of a new arc occur during this 2-min interval. He also presented that auroral breakup occurs in the central region of the pre-existing proton precipitation.

**Eric Donovan** also presented based on recent ground observations the sequence of auroral breakup, including auroral fading prior to the onset. He also pointed out that arcs poleward of the breakup arc are not disturbed before onset. **Mark Lessard** discussed PiB waves in the context of Alfven aurora. **Mike Henderson** addressed substorm dynamics with Polar auroral image data.

**Bob Lysak** reviewed and discussed the role of Alfven wave in auroral breakup focusing on its temporal and spatial scales. An Alfven wave is trapped between the ionosphere and the peak of the altitudinal peak of the Alfven velocity, which creates Alfven resonator with resonant periods of 1-10 s. This is the typical period range of waves commonly observed on the ground. He also showed that in the presence of perpendicular density gradient, the phases of Alfven waves are mixed creating small-scale structures, which may explain the scale of the onset arc. **Yan Song** addressed the role of Alfven waves in substorm processes with an emphasis of the break down of the frozen-in condition.

The target question of the "mapping" session is:

How does the presence and evolution of pre-onset and expansion-phase onset current systems affect the link between auroral and plasma sheet locations and processes?
Three possible approaches are discussed, that is, physical mapping, field-line modeling, and phenomenological mapping.

**Joachim Birn** theoretically addressed whether the thin current sheet in the tail can be detected at the ionosphere. He suggested that in a thin current sheet, in which a current is carried by the ExB drift of electrons, the magnetic field lines are dragged dawnward along with electron motion. Thus the rapid thinning causes an Alfvenic pulse, which propagates toward the ionosphere and therefore may be detected at the ionosphere.

**Misha Sitnov** presented the update of a dynamical field-line model, which he has been developing with Kolya Tsyganenko. Their current model follows the sequence of magnetospheric storms, and its extension to substorms is the target of their future efforts.

**Larry Lyons and Shasha Zou** addressed the mapping of auroral breakup using measurements of various quantities as references. They reported that auroral breakup takes place at the center of convection shear (Harang discontinuity) and that the breakup arc is located just poleward of SAPS, from which they inferred that the substorm onset takes place near the inner edge of the electron plasma sheet. Based on these results they suggested that the physics of the R2 current system is important for substorm trigger.

## FG13. Modes of Solar Wind – Magnetosphere Energy Transfer

*Conveners: Larry Kepko <larry.kepko@unh.edu> and Bob McPherron <rmcpherron@igpp.ucla.edu>*

The response of the magnetosphere to the solar wind is manifested in variety of ways. We used to think there were substorms and storms, and storms were simply a superposition of substorms. Today we know the situation is more complex. It is possible to identify at least three main modes: substorms, steady magnetospheric convection (SMC), and sawtooth injection events. In addition during these events we can identify pseudo breakups and poleward boundary intensifications (PBI). We are still in the process of identifying the characteristic behavior that identifies these various events as separate phenomena. We do not completely understand the solar wind conditions or internal state of the magnetospheric that allows a particular mode. We do not know what causes a transition from one to another, although solar wind velocity seems to play an important role. This focus group had two breakout sessions to discuss these phenomena. Most of the contributions dealt with sawtooth injection events, SMC, and PBI

This was the first year of the focus group. Speakers were particularly encouraged to address one or more aspects of the particular transport mode: (1) The particular state of solar wind conditions associated with the response mode; (2) The internal state of the magnetosphere during the response mode; (3) What causes the transition into or out of a mode.

The focus group held 2 breakout sessions. The first session examined both large scale and long duration magnetospheric convection events. This includes steady magnetospheric convection, Sawtooth events, and High-Intensity, Long Duration, Continuous Auroral Activity (HILDCAA) events. The second session discussed small scale and/or short duration convective events, such as poleward boundary intensifications and pseudo breakups.

**Mike Henderson** presented a tutorial on sawtooth events. In the course of discussing the properties of sawtooth events, two points generated significant discussion. It was noted that the period of sawtooth events varies greatly, and that it was unknown how this period was established. Rather than a single period, sawtooth events exhibited a continuum of periods. Mike also discussed the commonly held belief that injections during sawtooth events were dispersionless over most local times. He pointed out that this wasn't the case; dispersion was observed away from midnight. The consensus opinion is that sawtooth injections penetrate deeply into the inner magnetosphere, and therefore appear less dispersed at different local times. That is, the commonly held belief that sawtooth events are global dispersionless injections is not correct.

The majority of the discussion centered on the primary question of what forces the magnetosphere into the quasi-continuous steady magnetospheric convection events or quasi-periodic sawtooth injections. Several speakers (**Borovsky, DeJong, Cai**) discussed the solar wind conditions during SMCs and sawtooth events, and noted that given the same solar wind IMF, the solar wind velocity dictates which of the two modes is dominant. It was not clear, however, what the physical mechanisms were that dictated the magnetospheric behavior. There was further discussion on what determined the period of sawtooth injections. It was generally agreed that the periodicity occurred over a continuum from approximately 1 to 4 hours, with a peak in the distribution near 2 hours. Most participants believed the period was determined by internal magnetospheric properties. **Larry Lyons** presented work suggesting the periodicity was not internal to the magnetosphere, and was driven by periodicities in the solar wind and IMF.

Near the end of the second breakout we discussed the role of global MHD simulations in answering the 2 main questions brought up during the discussions: (1) What are the solar wind conditions that determine the SMC vs. sawtooth mode of response; (2) What determines the periodicity of sawtooth injections? Both LFM and Open GGCM representatives agreed to simulate events for the next GEM meeting, in particular events observed by THEMIS. Furthermore, events lists compiled by different speakers (in particular McPherron and DeJong) will be collected and available to the GEM community for further studies.

The Focus Group leaders and Dr. Tung-Shin Hsu have organized a special session SM06 at the December 2008 meeting of the American Geophysical Union in San Francisco. The title of this session is "Modes of Solar Wind-Magnetosphere Energy Transfer". Thirty eight papers will be presented at this session.

## Joint GEM-SHINE Sessions

### 1. "Multiple-Dip Geomagnetic Storms: Solar-Wind Drivers or Internal Magnetospheric Processes"

**Monday, June 23, from 1:30 to 5:00 pm**

*GEM co-convener: Vania Jordanova*
*< vania@lanl.gov>*
*SHINE co-convener: Ian Richardson*
*<ian.g.richardson@ nasa.gov>*

A classic geomagnetic storm (as measured for example by the Dst index) consists of a rapid fall to minimum Dst (the main phase) and a slower recovery to near pre-storm conditions (recovery phase). However, some storms show a more complex development, with more than one local minimum in Dst (“dip”). The main objective of this session was to use observations, theory, and modeling to assess the current status and establish collaborative efforts towards understanding the physical processes of geomagnetic storms. In particular, the session explored the solar-wind drivers of multiple-dip storms and whether the associated reintensification of geomagnetic activity produced any unusual signatures in the magnetosphere.

The session included two presentations discussing the interplanetary drivers of multipledip storms. **Jie Zhang** (GMU) & **Ian Richardson** (GSFC/UMD) presented a survey of the solar and interplanetary drivers of all the 165 "dips" in the 90 intense (Dst< -100 nT) geomagnetic storms during 1996-2006 and concluded that multiple-dip storms are common, including ~70% of these intense storms, consistent with the earlier results of Kamide et al. [1998].

**Charles Farrugia** (UNH) & **Vania Jordanova** (LANL) described examples of how mergers of interplanetary coronal mass ejections (ICMEs, also known as "ejecta") can lead to two-step geomagnetic storms. They emphasized that a major factor in severe, long-duration, double-dip storms is the very elevated plasma sheet density (Nps) of solar wind origin (Nps ~ Nsw1/2). It was discussed that multiple-dip storms are caused by interplanetary structures that include regions of southward Bz separated by less geoeffective solar wind. Storms driven by a single ICME can have double dips if there are southward fields in the sheath and ICME, as also discussed by [Kamide et al. 1998]. Multiple dip storms can also result from ICME-ICME interactions, as discussed by Farrugia et al. [2006], sheath regions formed by multiple ICMEs, shocks moving through a preceding ICME with a southward field that is intensified by the shock compression, by corotating interaction regions, and by combinations of these various scenarios. Interestingly, the occurrence rate of multiple-dip storms does not depend on whether the driver is a single ICME, involves multiple ICMEs, or is a CIR. Hence, the complexity of a storm profile is not necessarily a reflection of the complexity of the solar/interplanetary driver. Magnetospheric dynamics during multiple-dip storms were discussed by several GEM participants. To motivate collaboration between the SHINE and GEM communities, the event list of Zhang and Richardson was made available to likely participants in the session before the meeting.

**Michelle Thomsen** (LANL) presented an overview of plasma sheet dynamics in double-dip storms using data from geosynchronous satellites, while **Chris Mouikis** (UNH) discussed ion composition variations in double-dip storms from Cluster data. It was noted that 1) high plasma sheet densities persist after the first dip, but not after the second one; 2) the ion and electron temperatures in the plasma sheet are not significantly affected by the second dip; and 3) O+ is enhanced throughout the storm; there is some indication of a further O+ enhancement in the second dip but more ion composition measurements are needed to confirm this.

Some unusual plasmasphere dynamics and wrapping of drainage plumes during the second dip were presented by **Jerry Goldstein** (SWRI) using data from IMAGE satellite. **Mikhail Sitnov** (JHU/APL) presented simulation results obtained using a dynamical empirical magnetic field model with enhanced spatial resolution (TS07D) and showed that the second dip is often provided by an anomalously strong tail current, approaching close to the Earth, rather than by the conventional ring current closed through the Region 2 Birkeland system.

An analysis of ring current simulations for single- and multiple-dip storms with a kinetic ring current model presented by **Mike Liemohn** (UMI) showed that single-dip storms are well reproduced, but ring current injection during multiple-dip storms is underestimated, indicating that internal feedback may be important for these storms. Global SWMF simulations of multiple-dip storms from the Sun to the Earth were presented by **Tamas Gombosi** (UMI) and the results were compared with observations.

**Noe Lugaz** (UHI) discussed the Solar-Heliospheric and space weather perspectives of geoeffective sheaths in intense multiple-dip geomagnetic storms. It was concluded that several challenges remain for modeling/forecasting multiple dip storms including understanding the CME initiation process, modeling ICME-ICME interactions, and including realistic magnetic fields.

**2. "Creation and Propagation of CMEs and Plasmoids: Loss of Equilibrium and Subsequent Evolution"**

*Organizers: Kathy Reeves - Harvard (SHINE)< kreeves@cfa.harvard.edu> and Joachim Birn - LANL (GEM)< jbirn@lanl.gov>*

Analogies between substorm features in the Earth’s magnetic tail and CME/flare releases have been invoked for some time: In both cases, there is a slow energy build-up leading into a rapid release of primarily magnetic energy which is then converted to kinetic energy in the form of bulk flow, and thermal and non-thermal particle energy. This process is associated with the ejection of a magnetic bubble, plasmoid, or flux rope from closed magnetic field lines into open space.

In this session we focussed on similarities and differences between the two scenarios, particularly on large scales, including release mechanisms, loss of equilibrium or large-scale instability, formation, topology, evolution, momentum gain, and energy partitioning. The session consisted of four invited presentations stimulating very lively discussions.

**Mark Linton** compared the formation and evolution of flux ropes in CMEs and magnetotail plasmoids. He reviewed several mechanisms proposed for forming flux ropes and initiating eruptions in the corona, including flux cancellation, breakout reconnection and the helical kink instability. He pointed out that in the magnetotail, the flux rope forms when the current sheet thins (although during the discussion period, it was mentioned that the situation in the magnetotail is actually somewhat more complicated). Once formed, flux ropes can deform upon interaction with other structures (i.e. each other, surrounding media), making it difficult to reconstruct their geometry from 1D spacecraft measurements.

**Michael Hesse** presented results from 3D resistive MHD simulations of reconnection and plasmoid formation in the geomagnetic tail. The initial state included a guide magnetic field (across the tail in the direction of the main current) of a few percent of the the main field, as is typical for the tail. The main results can be summarized as follows. The plasmoid formation and ejection is a continuous process that involves a changing mix of field lines with different toplogy (connected with or disconnected from Earth at one or both ends). The accumulation of mass, momentum, and energy is primarily due to the continuous addition of newly reconnected flux to the plasmoid.

**Nancy Crooker** presented work lead by George Siscoe, attempting to find a universal framework that covers the processes of coronal mass ejections as well as plasmoid ejection in the Earth's magnetic tail. Applying the commonly accepted CME/flare eruption scenario to the geomagnetic tail, she pointed out the potential relevance of plasma flow generated by force imbalance prior to the onset of reconnection.

**Jun Lin** examined the consequences of magnetic reconnection in the two different environments of the solar corona and the Earth's magnetosphere. He presented several examples of similar post-reconnection behavior in the two environments, including dipolarizing (shrinking) reconnected loops, reconnection inflows and evidence for multiple X-points.

**3. "Small-Scale Structure in the Solar Wind and Its Effect on Earth"**

*SHINE co-convener: Joe Borovsky <jborovsky @ lanl.gov> GEM* *co-convener: Beniot Lavraud <Benoit.Lavraud @ cesr.fr>*

On Tuesday June 24, between 1:30 – 3:30 pm, was held one of the several Coordinated GEM-SHINE sessions. This session was devoted to "Small scale structure in the solar wind and its effect on Earth". It was proposed by J. E. Borovsky and chaired B. Lavraud and J. Steinberg. The aim of the session was to promote discussions between experts that address topics which, though often studied separately, all eventually act together in the driving of magnetospheric activity. The topics that were addressed during the session, and the experts that discussed those, included:
- The propagation of solar wind structures in the solar wind;
(**Dan Weimer, Chris Russell**)
- Periodic variations and turbulence in solar wind;
(**Nicky Viall, David Ruffolo**)
- Magnetospheric reaction to solar wind structures (e.g., substorms);
(**Nicky Viall, Tung-Shin Hsu, Raluca Ilie**)
- Structure during High-Speed Streams and influence on Earth.
(**Steinberg** for Borovsky)
- Current sheets hitting Earth and foreshock influence;
(**Xochitl Blanco-Cano, Larry Lyons**)

**4. "Is there a Need for More-Detailed Solar-Wind Models"**

*SHINE co-convener: Nick Arge <Nick.Arge @ Kirtland.af.mil>*

*GEM co-convener: Bob McPherron <rmcpherr @ igpp.ucla.edu>*

**McPherron** and **Pizzo** both took the position that it would be impossible to view the Sun from the Earth and predict the wave form of Bz at the Earth.

The major response to this view was "who cares" about substorm prediction?

The contrary view was that it is only necessary to predict large scale structures such as CMEs and CIRs. It was claimed that this would eventually be possible.

However, the US military does worry about 5-day, 3-day, and 24 hour forecast of the probability of certain types of disturbance.

It was pointed out that current MHD models of the solar wind have a grid size of 500 Re corresponding to two-hours of solar wind travel. Details of the solar wind at a smaller scale are not contained within these models.

Current (and probably future) observations of the solar wind from the Earth are inadequate to initialize models at the Sun.

It was argued that we need solar sentinels in both equatorial and polar orbits around the Sun to provide necessary input.

**Dan Weimer** presented comparisons of ACE data propagated to Stereo A and B with his method. There was surprisingly good agreement out to 1000 Re separation.

**Tamas Gombosi** pointed out that a 1-D MHD model of solar wind from ACE could be developed but would not do much better than the Weimer empirical method.

**Justin Kasper** described efforts to produce very high time and space resolution maps of the properties of the inner heliosphere using Faraday rotation and tomography. This may eventually provide the data required for model initialization.

**5. "What Determines When Reconnection Turns On? Chromosphere,Corona, Solar Wind, Magnetopause, and Magnetotail"**

*SHINE co-convener: Spiro Antiochus <spiro.k.antiochos @ nasa.gov>*
*GEM co-convener: Mike Shay <shay @ UDel.Edu>*

This session presented a forum for the discussion of what determines when reconnection turns on in the Sun, the Solar Wind, and the Magnetosphere. The focus of this session was on the more general aspects of onset as they relate to the particular physical systems, and especially on determining the physical processes that may be common to many observed forms of activity. We invited contributions from all solar, heliospheric, and geomagnetic physicists with observations, theories, or models, that address the question posed in the title to this Session.

**Amitava Bhattacharjee** opened the session with a review presentation on reconnection onset in the magnetosphere. He noted that both CMEs and substorms are highly impulsive, with reconnection growth rates that change extremely quickly. He emphasized that any successful reconnection onset model must show these timescales of change. He showed that including the Hall term in fluid simulations of reconnection greatly increases the speed of onset, but it is still too slow to match observations. He discussed the ballooning instability as an onset mechanism, but pointed out that its growth is not explosive enough. He finished with the question that if Hall onset is not sufficient to explain onset in the Earth's magnetosphere, would it be sufficient for the sun?

**Chris Russell** presented observations of magnetic reconnection in the Earth's magnetosphere as well as that of Jupiter and Saturn's. He stated that onset in the magnetotail primarily occurs because the high density current sheet becomes eroded, leading to extremely fast reconnection of the lobe magnetic field due to the low plasma density.

**Michael Hesse** presented simulations of reconnection onset in the magnetotail. His main point was that compression of the magnetotail eventually leads to a strong reduction in Bz, which allows the electrons to demagnetize at that point, leading to reconnection onset. In the case with the guide field, the current sheet must compress to a thickness comparable to an electron larmor radius, which requires considerable driving.

**Ron Moore** presented an overview of observations of CME eruptions with a focus on reconnection onset. His bottom line was that the configuration of the preeruption field is critical for determining where reconnection onset will occur. The explosive growth of a CME occurs when reconnection releases a flux rope, which drives yet more reconnection.

**Misha Sitnov** presented his kinetic onset theory in which passing electrons due to mirroring in the Earth's strong dipole field allows reconnection ton onset even when the electrons are still magnetized. Simulations were shown using kinetic PIC with open boundary conditions. When particles are reflected at the boundaries, there are no secondary islands formed. When the boundaries are open, there are secondary islands even though the electrons are magnetized.

**Paul Cassak** presented a theory that solar flare reconnection onset is caused by a catastrophe in which the slow reconnection solution ceases to exist (due to bifurcation), leading to an explosive onset of reconnection. If this theory is playing a critical role, it is postulated that the average coronal conditions will tend towards values at the critical bifurcation point. Data from the solar corona and extrasolar flares was shown which provides support for this theory.

**Illa Roussev** presented magnetograms from the most complicated flare events studied to date. A total of 10 flux systems were playing a role in the active region dynamics. The erupting field had a much larger separation than originally though, and they are still trying to understand the complex dynamics.

### 6. "SEPs from Heliosphere to Magnetosphere"

*Candidate SHINE co-convener: Janet Luhmann <jgluhman @ ssl.berkeley.edu>*

*Candidate GEM co-convener: Mary Hudson <mary.hudson @ dartmouth.edu>*

A brief but productive discussion of the problem of SEPs (Solar Energetic Particles) from their production in the heliosphere to their geospace effects, was held on Thursday, June 26. This is a particularly rich and appropriate GEM/SHINE topical area because it involves connecting a chain of processes occurring in the solar corona and interplanetary medium to responses in the middle atmosphere, via the magnetosphere.

The large solar proton events that are of most interest were the main focus of the discussion, which was kicked off with an overview of the heliospheric end by **David Lario** (JHUAPL). David described the still outstanding problems of a lack of understanding of the details of the particle production, energization and transport. This was followed by a more specific discussion by **David Ruffolo** (Mahidol Univ.) of the most energetic of SEP events, GLEs or Ground Level Events, which are detected on the ground by Neutron Monitors. The major events which represent the deepest penetrations of SEP event effects typically occur only once or twice per solar cycle, and the reason for their particularly great fluxes of protons at high energies reaching into the GeV range is still a subject of investigation. These events have certain properties such as prompt arrival and high antisunward, field-aligned anisotropies that affect the way they are perceived on the ground.

**Brian Kress** (Dartmouth) spoke on the magnetospheric access of the SEPs, and coincidentally, on the effect of the particle flux anisotropy on access to high latitudes along open field lines. Simulations of the proton access in MHD magnetosphere models show geomagnetic cutoffs will appear different in measurements when significant anisotropies exist. Thus ground (and LEO and atmosphere) exposure to SEP effects for the most energetic events is somewhat less predictable using cutoffs computed for isotropic incident fluxes.

**Tamitha Mulligan** (Aerospace) spoke on several recent large SEP events observed in both the heliosphere and magnetosphere. She showed that there were features in the magnetospheric time profiles not present in the interplanetary time profiles, suggesting magnetospheric modulation of the intrinsic time profiles, perhaps.

Finally, **Stan Solomon** (HAO) spoke on the recent modeling of SEP event effects in the atmosphere using the WACCM (Whole Atmosphere Community Climate Model). This model can trace the 3D dynamical and chemical effects of SEP events from the top of the thermosphere to the ground. Stan showed some results from Jackman and coworkers for some previous large proton events. The NO and ozone chemistry effects can be seen to last for months after the event, and to make their way well into the middle atmosphere- and occasionally into the stratosphere. The potential for tracing this full chain of SEP physics from end to end has never been greater.

## 7. "Comparing the Properties of Magnetic Reconnection in Various Environments"

*SHINE co-convener: Jack Gosling <Jack.Gosling @ lasp.colorado.edu>*
*GEM co-convener: Michael Hesse <Michael.Hesse @ nasa.gov>*

Magnetic reconnection is a ubiquitous plasma transport and energy release process in space plasmas. Magnetic reconnection is understood to be a key ingredient in solar eruptions and other solar processes, has recently been detected in the solar wind, facilitates energy transfer into the magnetosphere, drives magnetospheric circulation, and produces the dynamical evolution associated with magnetospheric substorms. Owing to this breadth of applications, magnetic reconnection is perhaps the most important fundamental process in space plasmas. This session aimed at analyzing observations and
models of magnetic reconnection in different heliosphefric environments, with the specific goal to understand commonalities and differences in the way reconnection operates in different space plasmas. The session included a small number of invited presentations and brief (2 viewgraph) presentations from the audience, with an emphasis on discussion, not on AGU-style series of presentations.

The topic and goals for the session were introduced by **Michael Hesse**.

Invited speakers were **Joachim Birn, Terry Forbes, Bob Lin,** and **Mike Shay**.

Contributed talks were given by **Jon Eastwood, Jack Gosling** (filling in for Benoit Lavraud), **Dietmar Krauss-Varban, Yu Lin,** and **Chris Russell.**

It was a relatively lively session and was moderately successful in focusing attention on comparative aspects of magnetic reconnection in different space environments.

## 8. Transverse Ion Heating: Observations on Earth and Theory at the Sun

*SHINE co-convener: Ben Chandran*
*< benjamin.chandran@unh.edu>*

*GEM co-convener: Bob Lysak*
*<bob@aurora.space.umn.edu>*

This session, somewhat misnamed since solar observations and auroral ion heating theories were also discussed, took place on Friday morning, June 27, in the Matterhorn room. Six presentations were made in this session, which was rather well attended considering its late placement in the week's schedule. The session began with reviews of auroral zone heating observations and theory by **Eric Lund** (UNH) and **Chris Chaston** (UCB). Eric discussed heating at the ion cyclotron resonance by a variety of wave modes in the auroral zone, while Chris focused on stochastic ion heating by kinetic Alfvén waves of short perpendicular wavelength (comparable to the ion gyroradius) and large amplitude. This distinction between resonant and stochastic heating was a common theme that ran throughout the session.

**John Kohl** (CfA) followed with a presentation on observations from the SOHO UVCS instrument, which measures resonant line widths of the $O^{+5}$ ion, which is considered a proxy for protons. These observations indicate remarkably rapid acceleration of these ions to solar wind speeds, reaching 400 km/s by 2-3 RS. His observations, using a maximum probability technique, also indicated that the oxygen ions were predominantly heated perpendicular to the field, with temperature anisotropies ranging up to about 10.

This talk was followed by two theoretical talks, the first from **Tulasi Parashar** (UDelaware), who presented hybrid simulations of perpendicular ion heating in turbulent plasmas, concluding that resonance was not necessary and that heating was stochastic. The second theoretical talk was from **Liu Chen** (UCI), who discussed a detailed theory of sub-harmonic resonant heating. This talk seemed to be at odds with the results of Chaston, which was possibly due to the distinction between Chaston dealing with short perpendicular wavelength kinetic Alfvén waves while Chen was discussing the pure shear Alfvén wave.

Finally, **Lan Jian** (UCLA) discussed very recent STEREO observations at 1 AU of ion cyclotron waves presumably generated closer in to the Sun that propagated both Sunward and anti-Sunward in the solar wind frame, with the anti-Sunward propagating waves showing a right-handed polarization due to being convected outward in the solar wind flow.

Overall, the discussion illustrated the similarities and differences between the two plasma environments. It was suggested that the auroral environment was possibly similar to the colder plasma environments in coronal holes, although it was realized that one major difference is the strong, static background magnetic field in the Earth's magnetosphere in contrast with the more variable magnetic fields in the corona. In general, however, the universality of the plasma physics phenomena was nicely demonstrated.

## NSF CEDAR-GEM-DASI Report

DASI - the 'distributed array of small instruments' - is described in the NRC report (http://books.nap.edu/openbook.php?record_id=11594&page=43) and was the topic of a joint CEDAR-GEM-DASI workshop in Santa Fe NM in 2007 and a GEM Special Session in Zermatt UT in 2007. There were no DASI activities within GEM at the summer 2008 workshop. Other events and initiatives (such as the NSF small satellite program) and the development of new focus groups have taken the community's time. CEDAR is working to develop a more comprehensive science plan to move the DASI concept forward. Since the CEDAR-DASI workshop last year and into the coming year, CEDAR is focused on developing a future science plan that will undoubtedly need an instrument deployment strategy like DASI. The CEDAR science plan is called Integrative Aeronomy and was discussed in the latest CEDAR Post Issue 53

http://proxy.cedarweb.hao.ucar.edu/wiki/index.php/Community:CEDARPost
The GEM and CEDAR communities will work together to keep each community involved and informed of the progress of this initiative.

**Mark Moldwin**
*<mmoldwin@igpp.ucla.edu>*

## GEM 2008 Student Report

*Student Representative : Katie Garcia ksgarcia@bu.edu*

About 60 GEM students and 35 SHINE students attended a joint GEM/SHINE student day. Joint sessions focused on basic magnetospheric, solar, and heliospheric physics, comparative processes, and SW-M coupling. Separate GEM sessions focused on GEM research area topics. A students-only poster session followed the student tutorials. The student website provided the schedule of student tutorial speakers, and tutorials will be posted on the GEMWiki. Drew Turner (CU Boulder) is the new student representative for 2009.

## GEM 2008 Steering Committee Minutes

GEM Steering Committee Meeting, 2008 Summer Workshop, June 27, 2008

Attendance: Jimmy Raeder, Bob Clauer, Hideaki Kawano, Chris Russell, Mark Moldwin, Frank Toffoletto, Brian Fraser, Therese Moretto, Katherine Garcia, Michael Hesse, Eric Donovan, Mike Liemohn, Michael Wiltberger, David Sibeck, Stan Sazykin, Howard Singer, Simon

Shepherd, Maria Spasojevic, Jeff Hughes, Jerry Goldstein, Kile Baker, Chuck Goodrich

1. 2009 Summer Workshop Planning
   a. Potential sites in Snowmass, Columbia river, Annapolis, Santa Fe
   b. CEDAR 2009 June 27-July 3 in Sante Fe
   c. GEM 2009 will meet June 21 – 26. These dates are available at Snowmass.
   d. Snowmass is our first choice. We will try to negotiate a 2-year deal. (June 20 – 25, 2010). Terry Onsager will visit Snowmass to see first hand the changes since construction and report back to Clauer.
   e. Santa Fe is second choice – need to look at the El Dorado hotel and La Fonda hotel.
   f. We prefer that GEM meet alone 2009 and 2010. Perhaps CEDAR can book in Boulder adjacent to GEM in 2010.
2. 2008 December Mini-Workshop – we need to explore with AGU early regarding meeting rooms. We may be better off negotiating independently. We will look at alternative hotels for meeting rooms.
3. We will explore meeting jointly with CEDAR in 2011.
4. Ramona Kessel rotates off the SC following the meeting. The SC thanks Ramona for her service. Candidates were discussed and Jimmy will make an appointment accordingly. (Note: Nick Omidi has accepted to replace Ramona. – JR)
5. Do we need agency reports at the workshop?
   a. 5-minute reports are still desirable, we prefer not to have them on Monday morning.
6. Should we change the summer workshop to have SHINE-style morning wrap-ups of the previous day sessions instead of the Friday wrap-up?
   a. EXCELLENT IDEA. – will be implemented in the 2009 workshop – given in the spirit of the 'sessions today descriptions'.
   b. Jimmy will provide a template format for wrap-ups – Statement of Goals and Progress report with request to all group leaders to follow the format.
7. Should we implement a GEM Post-Doc plenary talk? No decision made.
8. Poster Sessions (should identify Student Posters – maybe indicate expected graduation date.) Continue the poster session from 5:00 – 7:00. Posters should be left up longer if possible.
   a. Are there other ways to mix faculty and students? Poster sessions seemed to be the best method. Maybe we should identify or segregate student posters.
9. We should consider having the steering committee meeting during an evening mid-week.
10. Agency Reports:
    a. SHINE – **Chris Russell** reported that there was general satisfaction with the joint meeting but some regret that the organization of the meeting had not been coordinated better.
    b. GEM Communications – **Chris Russell** reported that he hopes to issue the GEMStone newsletter earlier this year and requests that all focus group leaders submit reports for the newsletter to him as soon as possible. UCLA has set up a Wiki that can be used by the focus groups and general GEM information. Peter Chi will assist. This is the final year of their support for GEM communications at UCLA. The effort will be re-competed. Chris will not propose but it is likely that Peter Chi at UCLA will

submit a proposal. Others are encouraged to also compete.

c. NSF – Basic information about NSF budgets has been posted on the UCLA GEM Web site. **Kile Baker** reported on upcoming funding opportunities, including Cyber-enabled Discovery and Innovation (CDI), Petascale Applications, Career, and the GK12 program. **Michael Wiltberger** indicated that NCAR computer time is available and he can assist with information regarding the application process and available facilities. The NSF Small Satellite competition received 29 proposals that are under review.
d. NASA – **Chuck Goodrich** encouraged people to submit proposals to upcoming opportunities.
e. CCMC – **Michael Hesse** reported that CCMC is accumulating more models. Runs on request are being filled on average of 2 per day. The CCMC encourages people to use their facilities and to provide feedback.
f. NOAA – **Howard Singer** reported that the next Space Weather Workshop will be held Apr. 27 – May 1. SWPC has a new emphasis on putting out tools and prediction services. Feedback and ideas for Space Weather Workshop are encouraged.
g. CEDAR – **Simon Shepherd** reported on the CEDAR workshop sessions and discussions. A new thrust is to look at coupled system science so there is increased interest to meet jointly with GEM. New GEM liason will be Mike Ruohoniemi. CEDAR will meet next year in Santa Fe June 27 – July 3. In 2010, they could meet in Boulder during the week adjacent to GEM if GEM were held in Snowmass.
h. Australia – **Brian Fraser** reported on funding issues in Australia. The new Australian government may be more favorable to science. Two SuperDARN radars are operating and a third has been proposed. The Western Pacific meeting will be held in July.
i. Canada – **Eric Donovan** reported on the availability of ground data for Themis related studies. He will supply information to be posted on GEM Wiki.
j. Japan – A written report was submitted and will be available on the GEM website (**http://www-ssc.igpp.ucla.edu/gem/pdf/Kawano_report_2008Jun27.pdf),** primarily concerning the timely accessibility of Geotail data.
k. DASI – **Mark Moldwin** reported on the 'distributed array of small instruments' effort. There was a DASI workshop at GEM last year. Other events have overtaken DASI and efforts seems to have stalled. There need to be more coordinated discussions between GEM, CEDAR, and NSF.
l. GEM Student Report – **Katherine Garcia** reported on the student sessions that were held jointly with Shine. They would have liked to have lists of participating students updated more often so that they could contact students in the program planning prior to the meeting. Information did not seem to get back to all students. We need to be more pro-active in contacting students and providing information about their arrangements and lists of participating students to student leaders for their planning purposes. The incoming student

representative will be Drew Turner (Colorado University).

m. **Kile Baker** reviewed the problems for ground based space science in England. At the present time funding for most ground based facilities have been zeroed out. People are fighting this.

n. Increased costs of air fares may impact the number of students that can be supported for future meetings. We may need to negotiate partial support with advisors in order to maintain support for about 60 students. We were able to support about 42 students and fortunately Rice had residual funds that supported another 18 students.

Meeting Adjourned.

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For the GEM Messenger send any news items to editor @igpp.ucla.edu

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| **2008 GEM Structure** | |
|---|---|
| **GEM Steering Committee:** | **Focus Groups:** |
| **Jimmy Raeder (2006-2009) : Chair**<br>Nick Omidi (2008-2011) [Dayside]<br>Bob Ergun (2006-2009) [MIC]<br>Terry Onsager (2007-2010) [GGCM]<br>Maria Spasojevic (2007-2010) [IMS] | **1. GGCM Metrics and Validation**<br>– M. Kuznetsova and A.Ridley<br>**2. GGCM Modules and Methods**<br>– M. Shay and J. Dorelli<br>**3. Foreshock, Bowshock, Magnetosheath**<br>– N. Omidi |
| **Research Areas Coordinators:** | **4. Plasma Entry and Transport into and within the Magnetotail**<br>– S. Wing, J. Johnson and A. Otto |
| **1. Dayside, including boundary layers and plasma/energy entry (Dayside)**<br>– David Sibeck and John Dorelli | **5. Component versus Anti-parallel Reconnection**<br>– J. Berchem<br>**6. Cusp Physics**<br>– K-H Trattner |
| **2. Inner magnetosphere and storms (IMS)**<br>– Mike Liemohn and Rainer Friedel | **7. MIC Electrodynamics and Transport**<br>– J. Semeter and B. Lotko<br>**8. MIC Global Coupling**<br>– D. Murr |
| **3. Tail, including plasma sheet and substorms (tail)**<br>– Frank Toffoletto and Mike Henderson | **9. Near Earth Magnetosphere: plasma, fields and coupling**<br>– S. Zaharia, S. Sazykin, B. Lavraud |
| **4. Magnetosphere – ionosphere coupling, aurora (MIC)**<br>– Jeff Hughes and David Murr | **10. Space Radiation Climatology**<br>– P. O'Brien and G. Reeves<br>**11. Diffuse Auroral Precipitation**<br>– R. Thorne and J. Borovsky |
| **5. GGCM**<br>– Mike Wiltberger and Stan Sazykin | **12. Substorm Expansion Onset: The First 10 Minutes**<br>– V. Angelopoulos, S. Ohtani, K. Shiokawa<br>**13. Modes of Solarwind – magnetosphere Energy Transfer**<br>– R. McPherron; L. Kepko |

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