The GEMstone

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Notes from the NSF Program Director, Kile Baker

The transition from the GEM Campaign structure to the Focus Group structure has been completed successfully and, along with the return to Snowmass, helped make the 2009 summer workshop one of the best in many years. I felt the old energy and excitement was back and I enjoyed the meeting immensely. One complication of the transition to the Focus Group structure, however, is that the NSF Program Solicitation for the GEM proposals is now seriously out of date and I have been fielding a number of questions from new proposers who are confused about how to prepare a GEM proposal. So I will be working on a new GEM solicitation as soon as the new crop of GEM proposals has been received. If any of you have suggestions for improving the solicitation please let me know. You will find the current, but outdated, Program Solicitation at http://www.nsf.gov/pubs/2004/nsf04576/nsf04576.pdf. Since I will be preparing a new solicitation this is also an opportunity to change the date when GEM proposals are due each year, so let me know if you are happy with the current mid-October deadline or if you'd prefer to move the deadline to some other date.

The big news for NSF this past year was the American Recovery and Reinvestment Act that provided NSF with a large, but one time only, boost in funds. As a result of the ARRA funds we were able to fund half of the GEM proposals that we received for the Fiscal Year 2009 competition and the funded projects covered eight of the currently active Focus Groups. So what is the outlook for 2010? As I write this, we are about two weeks away from the deadline for the 2010 competition so I don't know how many proposals we will receive. But in any case it has to be recognized that the success rate will certainly drop back to more normal levels. We also don't know what the NSF budget will be for FY2010. I am nevertheless hopeful that the success rate

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for the GEM proposals will improve over what we were able to do in FY07 and FY08 when we were only able to fund about one proposal in five.

In looking to the future of GEM it is important for all of us to recognize that we need to show why the GEM program is valuable. To that end I would like to ask all of you who have received GEM awards to help me provide NSF with highlights of the successes that have come from GEM. Whenever you publish a paper, I would urge you to think about how you might make a short (one page) highlight of the results that would be of interest to a scientifically literate person who is not a space plasma physicist. You can send these highlights to me at any time. I am also wondering if there would be any interest in creating a GEM Working Group (as opposed to a Focus Group) that would be dedicated to the task of public outreach for magnetospheric physics.

In closing I would like to thank our outgoing Steering Committee Chair, Jimmy Raeder, for shepherding GEM successfully through the transition from campaigns to focus groups. He has left our new Chair, Mike Liemohn, with a stable and vital community. I'd also like to thank all the members of the steering committee, the research area coordinators and the focus group leaders for all the work they have put in to GEM. Thanks also to Bob Clauer and his team at Virginia Tech for taking the reins of the GEM workshops. The success of this past summer's workshop is a tribute to their efforts. I also hope that everyone will welcome Peter Chi as the new Communications Coordinator and I hope you will do your best to make his job of putting together the annual GEMstone as easy as possible. And finally, of course, thanks to all the participants in the GEM workshops, from students to senior scientists. It is you who make GEM "*the place* for magnetospheric physics" (as our new Chair puts it elsewhere in this issue of the GEMstone).

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Notes from the Outgoing Chair, Jimmy Raeder

When I started my tenure as the steering committee chair after the 2006 summer workshop in Snowmass, GEM was at the crossroads. The campaign structure that had served GEM well for more than 15 years had begun to crumble because the various campaigns had by then covered virtually all the magnetosphere regions and major processes. Furthermore, every time a campaign ended a large fraction of the GEM community lost their "home" when there was no other active campaign that was aligned with their interests. In true grassroots fashion the GEM community pondered the issues and came up with a new structure that still emphasizes continued renewal but in a more nimble way. The first workshop under the new format, 2007 at the Zermatt resort, probably still suffered from transition woes, and the location, which was not everybody's cup of tea. In 2008 we met jointly with SHINE, and that meeting was considered a success by most who attended. This summer we came around full circle at the "old" place in Snowmass, and from what I heard from several quarters, it was one of the most fruitful workshops ever. I believe this finally relieves the anxiety many in the GEM community may have had about the new way of doing business.

Along the way the GEM steering committee had to make some other changes. It used to be that the NSF program officer appointed

the members of the steering committee, however, federal rules no longer allow this, unless the steering committee acted as an official advisory committee to NSF. Since giving the steering committee such a role would not be desirable for many reasons, over the past years the steering committee elected its members internally, mostly as a matter of convenience. Of course, this procedure is not very democratic to begin with, so the steering committee decided that we would start to move towards a more open process in the 2009 workshop, where a number of steering committee positions had to be filled. There was not enough time to discuss and implement a fully democratic process, but at least we were able to solicit the nominations from the GEM community. I am sure the new steering committee will make this issue a priority in the coming year. We also changed the term of steering committee chair to two years, preceded by two years of "chair elect." Mike Liemohn became the first chair elect in early 2009 and took over from me as chair this summer, while David Sibeck became chair elect this summer and will tale over from Mike in 2011. I wish good luck to both of them!

Accounts about the exact birth date and place of GEM vary; "about 20 years after Woodstock" may be as accurate as it gets. There are tales of millions of dollars of funding that were originally expected and never materialized. Maybe that was not such a bad thing after all, because what we got was a workshop that has always tried to be different, not just from AGU style meetings, but even compared to our sister workshops of CEDAR and SHINE. I know of no other workshop that gives the young people, students and post-docs, as a much of a voice and a venue to present their ideas as GEM. Where else could a graduate student say that "if everyone over 40 left the room we could solve the substorm problem" (That person shall remain unnamed, he is about to turn 40!). I believe many a career has been started, or taken off, because of GEM, mine included. I am thus grateful to be part of the GEM community, and sitting at the wheel for a while has been a great privilege. However, it is time to move on now.

Jimmy Raeder
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Notes from the Incoming Chair, Mike Liemohn

The Summer GEM Workshop is my favorite meeting of the year. I have been coming to GEM since I was a postdoc, and it is a meeting I never get tired of attending. I am very happy that the transition to the new "Focus Group" structure of GEM has been successful, and I hope to see this structure continue and strengthen in the coming years.

First, I would like to extend a large thank you to Jimmy Raeder for serving so effectively as the GEM Steering Committee Chair for the last 3 years. He shepherded the transition from Campaigns to Focus Groups without a hitch, and has kept GEM a premier magnetospheric physics meeting. He has also initiated the development of by-laws for GEM, something the program badly needed but never formally had. This was part of the problem with the Campaigns; we all knew they should end after some time, but there was always one more thing for the Campaign to do and it was very hard to disinvite a segment of the magnetospheric research community (which is essentially what ending a campaign meant). Under Jimmy's leadership, we have a well-defined set of rules for the management of GEM. I strongly recommend that we continuously revisit and revise the GEM By-laws, but so far, they have proven to

be a rather elegant set of guidance for governing the GEM Program.

The GEM Program, and the summer workshop in particular, represents a number of things to me. First, as the name implies, it is a place for magnetospheric modelers to regularly gather and discuss the details and dirty secrets of their codes. It's a place for "nuts and bolts" discussions, where developers can congregate and talk shop about numerical schemes, flux limiters, grid configurations, and tricks to skirt computational obstacles. While there are other meetings devoted to scientific computing, the GEM workshop blends the computational discussions with the scientific interests of the group, often resulting a "challenge" relating to some magnetospheric phenomenon. I think that this combination of computational details with geospace application makes the GEM Workshop *the place* for magnetospheric modelers to get together.

On a related topic, the GEM Program also represents the place for the community to define and discuss the development of a Geospace General Circulation Model (GGCM). In the early days of blissful ignorance regarding the GEM funding levels, it was hoped that the GEM Program could finance the creation of one or more GGCMs. Instead, the direction of GEM morphed into something just as useful: it became the place for the geospace community to gather and talk about what should be included in a GGCM. It became a place to share your latest results of GGCM development and usage. I believe that GEM has been a critical catalyst in the large-scale computational efforts behind SWMF and CISM, serving as *the place* for these groups to build consensus and to express diverging views.

Which leads me to the next thing that GEM is to me, which is a meeting at which all can voice their opinion and challenge the norm. One of my favorite times during a GEM Workshop is the informal, open-schedule, discussion-dominated break-out sessions. Some sessions are dominated by AGU-style talks, and that's fine with me, as long as it is kept in moderation and followed up with a free-form session with few or no pre-planned talks. Most meetings are far more formal than GEM, and the sessions are so strictly regimented that there is no time to pause and contemplate a topic in more detail. GEM, I think, has maintained an informal atmosphere that allows for speaker lists to be shuffled or tossed out completely in order to spend an extra 20 minutes on a disputed point in someone's presentation. Not only that, we schedule entire sessions devoted to collegial argument about a controversial topic. Therefore, GEM is one of the few places for the community to gather to openly and seriously discuss an unresolved issue with a quorum of the interested researchers present. That is, the GEM Workshop is *the place* for building community consensus.

This community-oriented disposition of the GEM Program manifests itself in the organizational structure as well. With the shift to annual proposals for Focus Groups and elected steering committee members, the scientific direction and governance of GEM is highly driven by the magnetospheric science community. Regarding the GEM Steering Committee (SC) elections, the new SC members are as follows:

SC Chair-elect:	*David Sibeck*
GGCM Research Area Coordinator (RAC):	*Slava Merkin*
MI-Coupling RAC:	*Bob Lysak*
Dayside RAC (3-y term):	*Jean Berchem*
Dayside RAC (6-y term):	*Karlheinz Trattner*
Tail RAC :	*Larry Kepko*
Inner Magnetosphere RAC:	*Anthony Chan*
SC Member-at-large:	*Mike Wiltberger*

Congratulations to this crew, and I look forward to working with you of the next 2 years of my term as SC Chair. I would also like to thank all of those rotating off of the Steering Committee. Thank you very much for your service to the GEM Program.

To all of you who were nominated for an SC position and were not elected, thank you very much for agreeing to serve. I am very sorry that

you were not elected this time around, but I am very pleased that we had so much interest in GEM leadership and I sincerely hope that each of you will consider a GEM SC nomination in the future. Better yet, I strongly encourage you to talk with others in your field and propose a Focus Group idea for consideration at the Fall GEM Mini-Workshop.

I would like to expand on this topic of new FG proposals. With 2 of the Dayside RA groups ending this summer, we now have 10 active FGs. Here is the breakdown, according to research area (also available here <http://aten.igpp.ucla.edu/gemwiki/index.php/GEM_Focus_Groups>):

- GGCM: 2 (both ending next summer)
- MI-Coupling: 1 (with 2 years left)
- Dayside: 1 (ending next summer)
- Tail: 3 (ending 2-4 years from now)
- Inner Magnetosphere: 3 (also ending in 2-4 years)

We need more Focus Groups. I hope that the SC votes to start 3 to 5 new FGs next summer. I would especially like to encourage FGs in the MI-Coupling and Dayside research areas, as both of these RAs should have at least 1 more FG by next summer. This should not, however, stop anyone from the GGCM, Tail, or Inner Magnetosphere areas from proposing a FG idea. Please submit a proposal, as there is no upper limit to the number of active FGs within a research area. The SC will seriously and thoughtfully consider all proposals received before the submission deadline.

With the Fall GEM Mini-Workshop on December 13th (the Sunday before the Fall AGU Meeting), this year's deadline for submitting Focus Group proposals is Tuesday, December 1st. This will allow some time for the SC members to read the proposals before the Mini-Workshop. Please follow the proposal guidelines in the GEM By-laws (here < http://aten.igpp.ucla.edu/gemwiki/index.php/GEM_Bylaws>) and please keep the proposal to 2 pages. There will be a late-afternoon session at the Min-Workshop at which the FG proposers should present their idea to the GEM community. If you are proposing a FG, then please plan to give a 5-minute presentation in this session.

In summary, I love GEM, and I hope that you do, also. It's *the place* for magnetospheric physics. Thank you for the opportunity to serve the community as the GEM Steering Committee chair, and I look forward to working with you over the next 2 years to make the GEM program even better than it already is.

Cheers,

Mike Liemohn
Incoming Chair, GEM Steering Committee
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Next GEM MINI WORKSHOP
December 13, 2009
San Francisco, CA

Next GEM Summer Workshop
June 20-25, 2010
Snowmass, CO

GEM can provide support for a limited number of graduate students to attend the workshop. To apply for support, visit the GEM Workshop Website at http://www.cpe.vt.edu/gem/ for application instructions.

Tutorial Talks

Tutorials from GEM Summer Workshops are available at the GemWiki site: http://aten.igpp.ucla.edu/gemwiki/index.php/GEM_Tutorials .

2009 Workshop Reports from Focus Groups

Geospace General Circulation Model Research Area

GGCM-1. GGCM METRICS AND VALIDATION (FG1)

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

Metrics and validation focus group serves, among other reasons, at as a place within GEM as a place for models developed in other focus group, to be compared and validated against each other as well as against observations. This focus group had two different emphases this year; therefore, the report is split into two parts.

1. GGCM Baseline Metrics Session Summary

The GGCM Baseline Metrics session at GEM (Monday@3:30) had five presentations by people showing model results and some data-model comparison. The main goal of the session was to highlight the fact that models, given the exact same driving conditions, can get very different results. This was clearly demonstrated. Presentations showing results from SWMF, OpenGGCM, and LFM had very different results of the ionospheric potential, currents, magnetopause currents, etc. for the same driving conditions. Indeed, when the same models were run with different numerics, different results emerged (LFM and SWMF were discussed in some detail).

A presentation was made that showed that penetration electric fields are present almost all of the time, and can be well modeled by extending the high latitude potential given a realistic conductance pattern and a disturbance dynamo wind pattern. It is clear that there is leakage from the high latitudes of about 10% all of the time. Another presentation was made, showing averaged Iridium field-aligned current patterns, and comparisons to the SWMF. The comparisons showed extremely high cross correlations, and so, there was much discussion on the flaws of such a comparison by other modeling groups.

It was decided that we would concentrate on determining how the numerics within the different models affects the solution of the dayside magnetopause as the magnetosphere enters saturation. In addition, we will examine how the ionospheric potential is affected by the numerics. The following steps will be taken between now and the fall mini-GEM:

1. We will directly compare the magnetopause and bowshock position, and current strength across the bow shock and magnetopause as a function of IMF Bz as it descends from -5 nT to -30 nT (given Vx=-400km/s, n=5/cc and T=100000K).
2. Given 1, we will each modify things like grid resolution, solvers, limiters, resistivity, etc., to determine how the numerics affect the simulation results.
3. We will each run an idealized ionospheric potential solve, given a specific field-aligned current pattern and boundary condition. We will then modify our boundary conditions, resolution, etc. to determine what the effects are on the solution of the potential.

2. GGCM Metrics and Validation Session

GGCM Metrics and Validation Focus Group met for 1.5 hours on Tuesday at 10:30 am to discuss the status of the GEM Modeling Challenge. The goals of the Challenge are to address differences between various modeling approaches, evaluate the current state of GGCM models, demonstrate effects of model coupling and grid resolution, encourage collaborations, and facilitate further model improvements. Events and

physical parameters for the Modeling Challenge were selected at the GEM 2008 Workshop.
Event 1: Oct 29, 2003 06:00 UT - Oct 30, 06:00 UT
Event 2: Dec 14, 2006 12:00 UT - Dec 16, 00:00 UT
Event 3: Aug 31, 2001 00:00 UT - Sep 01, 00:00 UT
Event 4: Aug 31, 2005 10:00 UT - Sep 01, 12:00 UT

CCMC staff introduced **Metrics Tools Suite** developed in support of the Challenge. The web-accessible Metrics Tools include interactive simulation results submission interface, on-line time series plotting tool, database of model settings, and configurable table of metrics results. Links to Metrics Tools can be found at the Challenge web site located at http://ccmc.gsfc.nasa.gov/support/GEM_metrics_08/index.php.

Antti Pulkkinen and Lutz Rastaetter presented reports on **Metrics Study 4 (Ground magnetic field perturbations)** and **Metrics Study 1 (Magnetic field at geosynchronous orbit)** based on simulation results submitted prior to the Workshop. The analysis demonstrated that different metrics (such as prediction efficiency and log spectral distance) that measure different aspects of the model performance provide quite different scores. Another important conclusion is that ranks of physics-based models are generally higher than ranks of statistical models for storm events selected for the Challenge.

An agreement was reached that there is sufficient material for joint publications on Metrics Studies 1 & 4. Antti Pulkkinen and Lutz Rastaetter will prepare drafts for two papers to be submitted to Space Weather Journal by GEM mini-Workshop at Fall AGU. All participants to the individual Challenge Metrics Studies will be co-authors. The final deadline for simulation results submission to be included in these papers is **September 1, 2009**.

Good progress is made in **Metrics Study 2 (Plasma parameters at geosynchronous orbit)** and **Metrics Study 3 (Magnetopause crossings by geosynchronous satellite)**. Michelle Thomsen provided LANL magnetopause in/out time series. GOES magnetopause crossing time series still have to be prepared. Following Michelle Thomsen's suggestion an agreement was reached to use plasma pressure as a primary parameter for the Metrics Study 2, however more work is needed to refine observational time series. Joe Borovsky made a point that the MPA measurements in energy range 1ev – 40 keV miss a lot of ion pressure and SOPA corrections are important. Tom Cayton agreed to make the Proton-Low fits to SOPA for the Challenge events. Joe Borovsky will provide corrected time series to CCMC by September 1. Reports on Study 2 and Study 3 will be presented at Fall mini-Workshop. To participate submit time series by **November 15, 2009**.

Comments were made that that there is a need to involve other Focus Groups model validation activities and to include more models. As a result of the discussion additional **Metrics Study 5 (Dst Index)** was suggested. CCMC will prepare submission interface for Dst time series by September 1, 2009. First results will be discussed at GEM mini-Workshop. Model output submission deadline**: November 15, 2005.**

Howard Singer made a presentation on NOAA SWPC metrics and validation needs. The metric study on ground magnetic perturbations is of primary interest. Experience of the GEM modeling Challenge can be utilized by the Operational community. **Operational metrics** must be defined by operational needs but tuned by working with model developers.

Possibility of arranging a **Special Issue of J. Atmospheric & Solar-Terrestrial Physics on Geospace Models Metrics and Validation** was discussed. The Special issue will include an introductory paper, 3-4 reports summarizing Challenge results, and a series of science papers with physics-based analysis. Expected primary focus of science papers are physical parameters addressed by Challenge metric studies. Events selected for metrics Challenge are preferable but

not required. Simulation results/visualization tools available at CCMC can be used for research analysis. Participation in the Challenge is not required to submit a paper for the special issue. If you are interested to submit a paper for the Special Issue on Geospace Models Metrics and Validation -- please send a title, authors, and an Abstract to Masha Kuznetsova (Maria.M.Kuznetsova@nasa.gov) before the **GEM mini-workshop at Fall AGU.**

GGCM-2. GGCM MODULES AND METHODS (FG2)

Chairs: *John Dorelli* <john.dorelli@unh.edu>, *Michael Shay* <shay@udel.edu> *and* *Brian Sullivan* <bsullivan@artemis.sr.unh.edu>

The overarching goal of this focus group is to understand the physics of collisionless magnetic reconnection on magnetospheric length scales (100-1000 ion inertial lengths). The methods and modules sessions included 8 speakers this year:

Yuri Shprits, Mikhail Sitnov, Lei Dai, Brian Sullivan, Aaron Ridley, Joe Borovsky, Joachim Birn, Paul Cassak, Masha Kuznetsova

The questions focused on were:

1. How does reconnection rate scale with dissipation region parameters, and what limits aspect ratio of the dissipation region? Specifically, how do the size and shape of localized resistive and viscous spots affect reconnection? Localized resistivity can produce high reconnection rates (such as those observed in nature) with Petschek-like open outflow geometries. A spatially localized resistive spot has the additional benefit for a numerical model of preventing magnetic gradients from steepening all the way to the grid scale. Merely localizing resistivity, however, does not prevent velocity gradients from approaching the grid scale. This difficulty can be alleviated numerically by using a region of localized enhanced viscosity. It has been found that:
   - Using a longer resistive spot can decrease the reconnection rate (Birn).
   - The aspect ratio of the dissipation region is not strongly influenced by a localized viscous spot (Borovsky et al.)
   - Electron viscosity does not appear to significantly change the reconnection rate in a 2-fluid model, although the length and thickness of the dissipation region do exhibit some dependence on the level of electron viscosity (Sullivan et al.)
2. How does dayside magnetopause reconnection work in Global MHD codes? Is reconnection locally controlled or externally driven?
   - The Cassak-Shay formula for asymmetric reconnection accurately predicts the reconnection rate at the dayside magnetopause.
   - The Axford Conjecture posits that the reconnection rate is controlled by global driving with no role being played by the diffusion region.
   - With regard to the Axford conjecture, the Cassak-Shay takes precedence; driving can change the reconnection rate only by changing the local plasma parameters.

The following are questions which need more attention in this focus group in 2009/2010:

3. What is the status of global Hall modeling? / What are the latest results of global Hall MHD modeling?
4. Status of other non-MHD approaches to global magnetospheric modeling (e.g. Hybrid models, embedded PIC regions, etc.)?
   - Is it even possible to couple an MHD code with a PIC code?
   - Is the region of MHD breakdown in a global MHD code sufficiently localized to make embedding computationally feasible?
5. What is the role of secondary magnetic islands in reconnection in the magnetosphere?

Other developments:

Masha Kuznetzova presented the following results on 3D reconnection in global MHD simulations:

- Flux ropes are not necessary tilted quasi-2D structures.
- Flux ropes have bends and elbows.
- Flux ropes internal structure and core magnetic field strength are changing on a spatial scale of the order of 1-2 Earth radii.

Yuri Shprits presented results from the Versatile Electron Radiation Belt (VERB) code. This radiation belt module for GGCM accounts for the dominant physical processes identified during Inner Magnetosphere, Storms Campaign. The module has been made available to the community: http://www.atmos.ucla.edu/~yshprits/VERB_code/

Lei Dai presented an analytic approach to the problem of collisionless magnetic reconnection, which he terms the "Alfvén-eigenmode approach." It was unclear what mechanism breaks the frozen in condition for electrons in this description of reconnection--an objection raised by several audience members. Additionally, several group members found the presentation to be a rehashing of ideas from the Furth, Killeen and Rosenbluth (1963) analysis of the tearing mode. Dai presented some evidence of agreement between his theoretical predictions and *in situ* observations by Mozer *et al*., Phys. Rev. Lett. 89, 015002 (2002).

Dayside Research Area

The following report summarizes the lively dayside science discussions held during the 2009 GEM meeting in Snowmass, Colorado. This meeting marked the conclusion of two dayside focus groups, those devoted to reconnection on the dayside magnetopause and to the effects of the foreshock and bow shock on the solar wind-magnetosphere interaction. The third focus group, that dealing with the cusp, will continue for another year. Overviews of the results obtained by the two concluding groups throughout the course of their existence will be presented elsewhere.

DAYSIDE-1. FORESHOCK, BOWSHOCK, MAGNETOSHEATH (FBM) (FG3)

Chairs: *Nick Omidi* <omidi@solanasci.com>, *David Sibeck* <David.G.Sibeck@nasa.gov> *and Karlheinz Trattner*<karlheinz.j.trattner.dr @lmco.com>

Suleiman Baraka addressed the question of whether a global EM PIC code can simulate the location of the bow shock. He showed results from runs with a system size of 105x55x55 R_E and answer in the affirmative. This led to a lively discussion with Omidi noting that the choices for the cell size (1 R_E) and plasma parameters (e.g. M_p = 16 m_e , V_{sw} = 0.25 c) mean that the answer is "No". *Hui Zhang* (GSFC) presented THEMIS observations of 7 HFAs during a 12 hour period. Both young (no shocks bounding the core region) and mature HFAs (core region bounded by shocks) were observed. Ion and electron distribution functions within HFA's are hotter in mature than young HFAs. The core region of young HFAs exhibits electrostatic (most likely lower hybrid) waves while the core regions of mature events does not. The role of these waves in ion and electron heating must be assessed. *Omidi* showed results from hybrid simulations that describe new structures called "Foreshock Bubbles" that form as a result of interactions between backstreaming ions and solar wind RDs. Foreshock bubbles exhibit a hot, tenuous core surrounded by a shock wave and shocked solar wind. Their dimensions transverse to the solar wind flow scale with the width of the ion

foreshock (10s of R_E), while their dimension along the flow increases with time. They convect antisunward with the solar wind and are highly effective particle accelerators. When they collide with the bow shock, they generate sunward magnetosheath flows and transient outward magnetopause expansions. This in turn disrupts plasma injection into the cusps due to reconnection and causes variations in the trapped radiation belt ion fluxes.

Andrey Samsonov showed results from MHD simulations for the interaction of oblique interplanetary shocks with the magnetosphere. He showed that the associated signatures (fast shocks, contact discontinuities) are very different in the dawn and dusk magnetosheath. The interaction of these structures with the magnetopause is therefore expected to cause asymmetric ground signatures (sudden impulses), which should typically be far stronger at post-noon than pre-noon local times. The propagation time for these signatures through the magnetosheath and magnetosphere should be larger (~3.1 minutes) for oblique interplanetary shocks than radial shocks (~ 2.4 minutes). *David Sibeck* reviewed forthcoming missions relevant to dayside science. These include MMS, Cross-scale and STORM. While studies of the foreshock and bow shock do not fall within the primary objectives of MMS, the extended mission should observe these regions. By contrast, Cross-scale is intended to study processes occurring at the bow shock and in the foreshock in detail. It is currently in an ESA down-select competition with a nominal launch date in 2017. STORM (Sheath Transport Observer for the Redistribution of Mass) is a notional NASA mission to image the foreshock, bow shock and magnetosheath and their response to solar wind variations in soft X-rays. Currently, attempts are being made to secure funds for instrument development and feasibility studies.

DAYSIDE-2. DAYSIDE MAGNETOPAUSE RECONNECTION (FG5)

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

The Reconnection at the Dayside Magnetopause Focus Group met on Monday afternoon. The session focused mostly on large-scale structures and dynamics of reconnection at the dayside magnetopause. ***Karlheinz Trattner*** reported the results of a study related to the formation of magnetic islands at the dayside magnetopause. Motivated by results from ***Omidi's*** hybrid simulation, he searched Polar/TIMAS observations in the cusp to identify remote signatures of their occurrence. In particular, he looked for double reconnection events since the reconnection of an already opened flux tube could create a magnetic island. He showed several examples of overlapping parallel ion beams observed in the cusp that suggest that magnetic islands do occur at the magnetopause. The question is now how common they are and what are the controlling factors for their formation. ***Jean Berchem*** presented the results of a global MHD/large-scale kinetic simulation of a rapid change in ion dispersions observed by Cluster. The goal of the study is to use the interaction of solar wind discontinuities with the magnetopause to investigate the large-scale dynamics of reconnection at the dayside magnetopause and its impact on ion dispersions observed in the cusp. Solar wind particles were launched upstream from the shock and then followed in time using the MHD fields in order to compute ion dispersions in the cusp. Comparisons with the Cluster data show that the ion dispersions computed from the simulation results reproduce very well the structures observed by the spacecraft. Analysis of the magnetic field topology indicates that the rapid evolution of the merging region creates several simultaneous reconnection sites that are not topologically connected. As shown by the particle computation results, such an evolution of the reconnection topology implies that different

plasma sources contribute to the ion dispersions observed by the spacecraft as they cross the cusp.

Karlheinz Trattner presented the results of a study that uses THEMIS magnetopause crossings to test the reconnection location model derived from Polar/TIMAS observations in the cusp. He found a remarkably good agreement with the prediction of reconnection occurring along the line of maximum magnetic shear across the dayside. However, the study showed that a better description for the transition between the line of maximum magnetic shear and the anti-parallel solution is needed around local noon. ***David Sibeck*** used the Cooling model to understand why FTEs observed on the dayside magnetopause tend to occur for southward IMF orientations whereas they don't show such a tendency on the flanks. His method was to generate series of FTEs along the subsolar component reconnection curves parallel to magnetopause current vector and then to use the Cooling model to track their subsequent motion. He found that FTEs retain the orientation of the reconnection line; as a consequence plasma velocities and event velocities generally differ. FTEs for southward IMF orientations exhibit stronger signatures than those for northward IMF orientations, but never reach the flanks, i.e. events for IMF $B_z < 0$ dominate the dayside magnetopause, not the flanks. ***Nick Omidi*** investigated time-dependent and patchy reconnection using planar hybrid simulations for southward IMF. His main goal is to measure the impacts of the magnetosheath waves on reconnection at the magnetopause. Simulation results indicate that the presence of magnetosheath waves results in time-dependent reconnection and the formations of FTEs that move along the magnetopause surface and coalesce into larger FTEs. However, time-stationary magnetic islands are formed in some cases. This different regime could correspond to patchy reconnection at the dayside magnetopause near the nose where sheath velocities are small and phase-standing waves may exist.

DAYSIDE-3. CUSP PHYSICS (FG6)

Chairs: *Karlheinz Trattner* <karlheinz.j.trattner.dr@lmco.com>, *Nick Omidi*<omidi@adelphia.net> *and* *David Sibeck*<david.g.sibeck@nasa.gov>

Following up on questions from earlier GEM's about the generality of 2.5D simulations in which FTEs interact with the cusp, ***D. Sibeck*** investigated the fate of 20 R_E long FTE's originating along component reconnection X-line through the subsolar point, and how they are (or are not) convected into the cusp regions for various IMF orientations. The Cooling et al. (2001) model for the motion of reconnected magnetic field lines was used to track the motion of the FTE's to determine if they reach the cusp. The probability that FTE's can reach the cusp is far higher for southward than northward IMF conditions and is also more likely for weak than strong IMF strengths. The chance of an FTE reaching the cusp increases as the length of the reconnection line increases.

K. Nykyri investigated the Cluster cusp crossing on Feb. 14, 2003 using data from the RAPID, PEACE and FGM instruments. The crossing exhibits two cusp diamagnetic cavities (CDC) filled with high-energy electrons, protons and alpha particles. The investigation concluded that the high-energy particle flux decreases as a function of distance from the CDC. Because conservation of the first adiabatic invariant requires particles entering the weak field region within the CDCs from some external source to exhibit small pitch angles, some re-processing of the particles within the CDC is required to explain particles with 90° pitch angles. The highest power in the magnetic field fluctuations is significantly below the ion cyclotron frequency. This interesting result caused several discussions throughout the GEM meeting and will be

addressed in subsequent GEM meetings. ***V. Coffey*** used Polar TIDE observations to study the rate at which Alfvénic turbulence heats oxygen in the cusp. The ion heating rate shows a strong correlation with BB-ELV emissions, which are consistent with Alfvénic turbulence and meet the criteria for stochastic ion acceleration. Three heating mechanisms were investigated, and a combination of two of the mechanisms is most applicable for the observed TIDE heating rate. *D. Knipp* investigated the Poynting flux in the low altitude cusp using Champ and DMSP observations. There was extensive heating in the thermosphere from dawn to dusk for hours during an interval of large northward or ecliptic IMF orientation.

A. Otto presented results from an MHD simulation of a cusp diamagnetic cavity. Test particles were used to investigate ion acceleration in the funnel shaped, low magnetic field region. The test particles mirror in the Z direction and drift in the X-Y direction, producing a combination of gradient/curvature drifts in the electric field direction. With time, the energies of the test particles reach ~50 keV, consistent with the cusp reconnection 'potential' (~50 keV). The resulting energetic population is highly anisotropic, with pitch angles peaking at 90°+/-45°. Predicted spectra match those observed, suggesting that this is a potential energization mechanism for electrons and ions. Using a combination of simultaneous Cluster and Polar satellites in the cusp, *B. Walsh* estimated the size of the CDC in the high altitude cusp. For the range covered by the satellites, the CDC seems to attain a thickness of 1.9 R_E thickness and a length of 9 R_E. Following up on a presentation by S. Fuselier at the Mini GEM in San Francisco last December, *T. Fritz* reported examples of energetic ion anisotropies just outside the magnetopause in the magnetosheath. The distributions invariably showed an antisunward convection anisotropy and provided no evidence for particles streaming sunward along magnetic field lines draped against the magnetopause. T. Fritz noted that the observations contradict a picture presented by S. Fuselier, which indicated that ions energized at the pre-noon bow shock might cross the magnetosheath and then flow sunward. K. Trattner noted that S. Fuselier showed in his presentation that the energetic ion population in the cusp behaves the same way as the bulk of the plasma and is therefore not accelerated in the cusp. He added that IMF field lines draped around the magnetopause provide a connection between the reconnection region (and therefore the cusp) and the quasi-parallel bow shock region which should therefore allow shock accelerated ions to stream into the cusp and that ISEE-2 observed these ions in the magnetosheath during an event adjacent to the magnetopause (Phillips et al., 1993, Plate 1).

Tail Research Area

TAIL-1. PLASMA ENTRY AND TRANSPORT INTO AND WITHIN THE MAGNETOTAIL (FG4)

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

The plasma entry and transport (PET) focus group organized three sessions at the 2009 GEM workshop focusing on (a) plasma entry, (b) transport within the plasma sheet, and (c) magnetosphere-ionosphere coupling and magnetotail transport. We also summarize the PET09 workshop held in March 2009 in Fairbanks Alaska.

Plasma Entry

The session on plasma entry focused on global studies of the formation of the plasma sheet, studies of Kelvin-Helmholtz waves at the magnetopause boundary, and constraints on plasma entry.

Jimmy Raeder presented recent evidence from THEMIS of a thick boundary layer on the dayside consistent with dayside reconnection. **John Lyon** showed global simulations with Kelvin-Helmholtz instability operating for both northward and southward IMF. Transport for northward IMF appeared to involve interchange instability along the flanks, while transport for southward IMF involved transient earthward flows (BBFs) and/or substorms. **Dan Welling** showed global simulations where the ionosphere was the primary source of the plasma sheet for southward IMF, while the solar wind was the primary source for northward IMF. **Vahe Peroomian** examined the entry points of the plasma sheet and ring current populations using test particle simulations during a storm event.

A couple talks focused on observations of Kelvin-Helmholtz instability in the boundary layer. **Joo Hwang** showed evidence of vortex structure during southward IMF conditions with evidence of reconnection in the particle signatures. **Katariina Nykyri** showed observations of three component distributions (cool population energized along the field, cool population energized across the magnetic field, and nominal hot plasma sheet population) during a crossing of the flank magnetopause. Parallel energization could result from reconnection in Kelvin-Helmholtz vortices and perpendicular energization could be related to kinetic Alfven waves. **Katariina Nykyri** also discussed the importance of understanding whether dawn-dusk asymmetries in the plasma sheet result from the entry process or from asymmetries in the magnetosheath.

The importance of constraints on plasma entry and transport processes (entropy, phase space density, ion to electron temperature ratio) was stressed in the PET tutorial given by **Jay Johnson.** Several additional talks in this session discussed these issues in more detail. **Joe Borovsky (for Benoit Lavraud)** showed that the ion to electron temperature ratio in the sheath and plasma sheet (which is well known to be similar for high Mach number) is also similar even for low Mach number shocks. This result suggests that the temperature ratio is probably preserved by the entry process rather than caused by it. **Joachim Birn** presented a study showing that entropy could increase by 20-30% in a reconnection geometry when there is a guide field; however, such increases in entropy are rather modest compared with observed increases in entropy from the magnetosheath to the plasma sheet.

Plasma Sheet Transport

Entropy constraints were also considered in the plasma sheet transport session. **Joachim Birn** showed that entropy depleted bubbles convect earthward entraining surrounding plasma in the earthward motion. **Antonius Otto** presented an exciting new result showing that convection of flux to the dayside (subject to the constraint of entropy conservation) leads to the formation of intense, thin current sheets.

The plasma sheet transport session also focused on transport processes within the plasma sheet including mechanisms of transport related to fluctuations and timescales. **Chih-Ping Wang** showed that the observed fluctuations in the plasma sheet could lead to diffusion from the flanks on the relevant timescales. **Colby Lemon** modeled the evolution of phase space density for filling of the northward IMF plasma sheet using a Lorenz particle tracking code. **James Weygand** discussed the correlation scales of fluctuations in the plasma sheet showing that for quiet times they are aligned with the magnetic field, while at active times they are isotropic. Finally, **Joe Borovsky** found that storm transport timescales are similar to non-storm transport timescales into and within the magnetosphere.

Several talked also focused on convective transport. **Larry Lyons** presented examples of strong convection and substorms for mostly northward IMF associated with fluctuating IMF conditions related mostly (but not entirely) with high speed streams. **Rick Wilder** also showed that the reverse convection saturation potential is

larger in the summer than the winter indicating a seasonal dependence on transport.

Magnetosphere-Ionosphere Coupling and Magnetotail Transport

Another important source for plasma sheet material is the ionosphere. This session focused on parameterizing outflows of source populations, understanding the distribution of the ionospheric particles in the plasma sheet/magnetosphere, and using ground-based observations of currents and aurora to understand transport in the plasma sheet.

Erik Lund discussed parameterization of ion outflows using a kinetic model for wave-particle interactions. **Victoria Coffey** presented observations of ion heating associated with BBELF wave activity and compared the observations with theoretical heating rates based on wave observations. **Robert Redmont** presented a parameterization of ionospheric ion outflow in auroral coordinates: polar cap (PC) fluxes almost balanced and enhanced fluxes near PC boundary. **Bill Peterson** discussed the importance of 'In Transit populations' for ionospheric outflow: Up to 4000 kg in store for plasma sheet and up to 300 kg for Ring current.

Particle distributions in the magnetosphere were also considered. **Jing Liao** presented O+ occurrence frequency maps in the magnetosphere discussing north-south and dawn-dusk asymmetries. There is an energy increase in the populations from the cusps to the lobes to the plasma sheet. **Vahe Peroomian** also presented LSK simulations of the event shown in the plasma entry session, but in this case focused on ionospheric sources of the ring current and plasma sheet populations comparing densities and energies of the LSK and MHD models. **Xinlin Li** examined energetic (40 keV) electrons in plasma sheet. For northward IMF there was a reduction/absence of energetic electrons. There were also large changes in electron fluxes for a substorm.

Studies were also presented using ground/satellite measurements to understand current systems and transport processes. **Xiaoyan Xing** used THEMIS observations to determine azimuthal pressure gradients and from this derived field-aligned currents. **Andrey Samsonov** presented Global MHD simulations of shock interaction for northward IMF. Field-aligned current developed when there was a sudden impulse & a transient generator region for NBZ currents was identified. Finally, **Gang Lu** mapped the aurora and convection to equatorial plane using the modified T96 model. While the aurora mapped to different regions throughout the substorm, it mapped to the dusk side at the substorm peak.

PET09 Workshop in Fairbanks

The Plasma Entry and Transport (PET09) workshop was held March 8-15, 2009 in Fairbanks, Alaska.(web site: http://how.gi.alaska.edu/pet09/) The main focus of the workshop was the origin and the transport paths of the plasma that populates the Earth's plasma sheet. The workshop was attended by about 30 researchers and 10 students from national and international institutions. The workshop included 34 presentations with considerable time for discussion addressing the following main topics

- Ionospheric sources
- Solar wind sources
- Plasma circulation within the plasma sheet
- Special questions for global models
- Special issues for observations

with detailed lists of specific subtopics as outlined on the workshop topics web page http://how.gi.alaska.edu/pet09/topicspet09b.html. There was a good balance of theorists and observers who addressed these questions through respective presentations and detailed discussion. The discussion addressed ion outflow from the ionosphere, the solar wind entry into the cusp and the plasma sheet, plasma sheet morphology and time scale, the physical mechanisms (reconnection, KH instability, kinetic Alfven waves) that facilitate the plasma entry and the redistribution of the plasma within the plasma sheet, entropy, electron to ion ratio, etc. One of the key questions in this discussion is the

dependence of the entry and transport on the orientation of the IMF and other solar wind properties and the conserved quantities.

Particularly noteworthy results

- There was general agreement that cusp reconnection, Kelvin Helmholtz waves, and kinetic Alfven waves contribute to the plasma entry for northward IMF.
- There were good arguments that plasma transport within the plasma sheet is consistent with diffusion caused by plasma sheet turbulence.
- We have made excellent progress in numerical models of plasma entry processes for northward IMF.
- Plasma entry for southward IMF is not well understood, i.e., mantle vs flank boundary source.
- An important consideration for ionospheric sources is the rather large amount of ionospheric material the is en-route at any given time.
- Particularly important unresolved questions of the plasma entry are (1) the observed dawn-dusk plasma sheet asymmetry, (2) the increase in local entropy by two orders of magnitude from the magnetosheath to the plasma sheet, (3) the fairly constant ion to electron temperature ratio between the magnetosheath and the plasma sheet.

In view of these results and the clear focus on unresolved questions that was developed during the workshop, there was general agreement that entropy (both local and flux tube entropy) play a critical role as an organizing agent for physical processes in the plasma sheet and can also be used to examine observations in relation to specific entry mechanisms. In summary the workshop was highly helpful (a) to clarify our current understanding of plasma sheet entry and (b) to formulate a clear focus of the main unresolved issues of plasma entry.

TAIL-2. NEAR EARTH MAGNETOSPHERE: PLASMA, FIELDS, AND COUPLING (FG8)

Chairs: *Sorin Zaharia* <szaharia@lanl.gov>, *Stan Sazykin* <sazykin@rice.edu> *and* *Benoit Lavraud* <Benoit.Lavraud@cesr.fr>

The Near Earth Magnetosphere focus group held 3 breakout sessions at the 2009 GEM Summer Workshop in Snowmass, CO. The main goal of the focus group is to improve physical knowledge and modeling of the near-Earth magnetosphere and its coupling with the outer magnetosphere. The focus group is coordinated by Sorin Zaharia, Stan Sazykin and Benoit Lavraud.

The sessions, held on Wednesday, June 24, featured short presentations and discussions of progress on the two main research fronts selected for the present phase of the focus group, as well as results from the recently initiated Near-Earth Magnetosphere Challenge.

1. Observations/empirical models

Short presentations addressed the following topics:

- Empirical electric field specification: overview of improvements in the UNH Inner Magnetosphere Electric Field (IMEF) model based on Cluster data (P. Puhl-Quinn), now being extended to include extreme periods; CLUSTER study of Poynting flux associated with the convection E-field (Y. Nishimura); induced E-fields were shown to be very important for inner magnetosphere particle transport (Gang Lu).
- Empirical magnetic field model TS07D (M. Sitnov); dramatic increase in spatial and temporal resolutions; model is now available on APL website; model shows that in some events the storm-time magnetosphere can be dominated by the tail current).
- During storms with low Mach number solar wind, the dayside B-field can be reduced instead of compressed (due to external

Region-1 type currents near the open-closed boundary; Joe Borovsky)

- Empirical plasma pressure model of the inner magnetosphere (P. Brandt, presentation by M. Sitnov – obtained by combining in-situ with global ENA observations)
- First results from the TWINS mission (J. Goldstein, M.-C. Fok); stereo ion inversion leads to improved accuracy; validation vs. THEMIS data.
- Radar observations of ionospheric convection (J. Baker, mid-latitude SuperDARN; 8 new mid-latitude radars coming online in the next 4 years, providing more spatial coverage for model-data comparisons.)
- Pc4, Pc5 wave observations (THEMIS data); correlation with solar wind (Liu et al.)

2. Physics-based numerical Models

Presentations discussed the following issues:

- The recent extension of the magnetofriction code to anisotropic equilibria (for future use e.g. in CRCM); the issue of mirror/firehose instabilities - F. Toffoletto
- CRCM model runs vs. TWINS observations (M.-C. Fok); while ENA (and 12 keV fluxes) peak at post-midnight, the ion pressure peak is still at pre-midnight local times
- The correlation between plasma sheet local time peak density and ring current pressure peak location vanishes when a self-consistent E-field formulation is used (Yihua Zheng, CRCM).
- Effect of models used to drive ring current formation (Vania Jordanova, RAM/RAM-SCB); the self-consistent B-field moves anisotropic regions farther from Earth; N. Ganushkina/M. Liemohn: Dst calculation with the DPS formula vs. Biot-Savart for non-dipole field leads to different results
- 1-way coupling of RAM-SCB with the Space Weather Modeling Framework (SWMF) shows strong ring current and Region-2 currents in RAM-SCB, and good agreement w/ Iridium observations (S. Zaharia)
- Inner magnetosphere physics – Hall MHD not sufficient to produce ring current (Dan Welling, BATS-R-US Hall MHD vs. vanilla MHD)

3. Near-Earth Magnetosphere Challenge

One session was devoted to presentation of results from the recently initiated Near Earth Magnetosphere Modeling Challenge. The challenge has brought together researchers from all major inner magnetosphere modeling groups: RAM-SCB (V. Jordanova, S. Zaharia, LANL), HEIDI (M. Liemohn, Michigan), RCM (S. Sazykin, Rice), RCM-E (S. Sazykin, Rice; C. Lemon, Aerospace), CRCM (N. Buzulukova, GSFC; Y. Zheng, JHU/APL), M. Chen's model (Aerospace), IMPTAM (N. Ganushkina, FMI). The first step in the Challenge, Phase 0, involved an idealized event, with simple inputs/physics (with the goal of setting a baseline for all models). Phase 0 results were discussed; the total energy (or, equivalently, Dst) values from the different models were found to be close enough (within max. 10% of one another) considering the model differences (e.g. anisotropic vs. isotropic), so Phase 0 is about to be concluded. The results have been posted on a dedicated Challenge website: http://rcm.rice.edu/~sazykin/GEM/challenge/ A mailing list for the Challenge has been established as well.

The remainder of the session involved a community discussion ironing out details about the next stage in the Challenge (Phase 1). Phase 1 will involve full-physics modeling of an idealized storm, with the goal of finding out the relative role of different physics features in the models. An updated table with the idealized storm parameters will soon be published on the Challenge website.

Some preliminary results from Phase 1 were shown by M. Liemohn (work of N. Ganushkina, IMPTAM) and S. Zaharia (RAM-SCB). The focus group plans to have a session at Mini GEM

2009 where more extended Phase 1 results will be discussed; then, Phase 1 will be wrapped up at Summer GEM Workshop 2010.

The last stage of the Challenge will be Phase 2 (one or a suite of real event simulations), in which both modelers and data analysts will be involved. The focus group is investigating the possibility of a joint effort with GGCM Metrics Modeling Challenge at this stage.

TAIL-3. SUBSTORM EXPANSION ONSET: THE FIRST 10 MINUTES (FG12)

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

This is the second year for this focus group. We had four breakout sessions for the following subjects:

(1) Onset Timing
(2) Onset Signature Propagation
(3) M-I Coupling
(4) Mapping.

1. Onset Timing

For the timing session the primary question we set was "What is the time sequence of onset-related phenomena observed in space and on the ground, and what are the implications for substorm initiation?" The valuable dataset obtained during the THEMIS era makes it possible to investigate the time difference among the ground, near-Earth tail, and mid-tail region. Their timing differences have been the key issue for the THEMIS project. We asked two speakers to make status reports and review of recent progress on this timing issue. Christine Gabrielse reported a preliminary analysis of timing difference using ground auroral onset as T=0 with introducing more than 80 parameters to define the timings and discuss accuracy and limitations of the substorm timing study. Kyle Murphy introduced timing contour map with epicenter of substorm initiation on the ground using Pi1/2 wave propagation features with periods of 10-50 s observed by CARISMA chain.

Four speakers made brief comments. Tony Lui raised 5 questions on the timing analysis reported by Angelopoulos et al. (Science, 2008) based on his comment published recently in Science (2009). Jiang Liu presented an extended analysis of THEMIS observations previously reported by Lui et al. JGR 2008 resulting in a different interpretation of the observations. Yan Song showed a timing chart pointing out that the time difference between mid-tail and near-tail signature is too small to explain by fast Alfven speed in the plasma sheet and proposed unstable Alfven wave coupling in the growth phase plasma sheet. Jim LaBelle showed their MF wave observations associated with auroral initial brightening, which is a new parameter which can be used to signal substorm onset on the ground.

2. Onset Signature Propagation

The questions we set for the propagation session were: "How do onset-related signatures propagate in the magnetosphere? How does the uncertainty of propagation time affect our understanding of substorm initiation?" This propagation topic is closely related to the timing issue. We asked two speakers for status report. Misha Sitnov reported the current status of new reconnection modeling that shows detailed structures of a dipolarization front propagating earthward and tailward ahead of fast flows. Peter Chi showed application of magnetoseismology technique to calculate the fastest onset signature propagation, known as Tamao path, in the tail with global distribution of Alfven and magnetosonic waves.

Four speakers followed to make comments. Bob Lysak reported calculation of Alfven wave propagation in the tail, pointing out that the fastest path for Alfven wave from the mid-tail is not plasma sheet but the PSBL. He also report M-I coupling simulations including Landau damping.

Kaori Sakaguchi reported detailed analysis of 30-Hz sampled auroral images at two substorm brightening events, showing rapid (20km/s) longitudinal propagation of brightening aurora and their inverse-cascade features from larger to smaller scales. Shin Ohtani reported explosive growth phase and superposed epoch study of onset features at near-Earth tail. Nathaniel Frissell reported Pi2 features in the SuperDARN radar echoes giving possibility to obtain 2-dimentional propagation features of substorm-associated waves on the ground.

3. M-I Coupling

For this session, we asked the questions: "How does the aurora evolve around substorm onsets? How are magnetospheric and ionospheric onset signatures connected in terms of auroral precipitation and currents, and what can we learn about substorm initiation from simultaneous ground-satellite observations?" So correspondences of substorm signatures between ground and tail are a key for this session. Two speakers presented status reports: Eric Donovan reported on recent events observed by THEMIS ground all-sky cameras and meridian scanning photometers for details of spatial and temporal development of substorm brightening aurora. Toshi Nishimura presented Poynting flux measurements by THEMIS showing that electromagnetic energy comes from the tail to the high-latitude ionosphere and then back to the inner magnetosphere.

Four speakers commented: Larry Lyons made a brief presentation of the connection between Toshi Nishimura's and Shasha Zou's work. Shasha reported more than 60 % of auroral brightening occurs in the pre-existing Harang discontinuity. Next, James Weygant reported modeling of ionospheric equivalent currents and their curls as a proxy for field aligned currents, already utilized by numerous studies. Larry Kepko presented an event in which the auroral breakup was preceded by the equatorward motion of a region of 630.0-nm emission from poleward latitudes.

4. Mapping

The question we set for the mapping session was: "How does the presence and evolution of pre-onset and expansion-phase current systems affect the link between auroral and plasma sheet locations and processes?" We asked two speakers to make comments on mapping from empirical and global modeling points. Andrei Runov reported results by Marina Kubyshkina regarding field-line mapping using empirical magnetic field model like those by Tsyganenko and using adjusted field-line model which utilize in-situ magnetometer data for adjustment. For both types of models, the field-line mapping becomes quite ambiguous above 68 deg MLAT and beyond X=-15 Re. Jimmy Raeder followed to show mapping of proton precipitation using global MHD models for the "first light" THEMIS event (March 23, 2007; SSR Angelopoulos et al. 2008). The MHD-based mapping showed good agreement with observations. Jimmy pointed out that global MHD modeling provides a good platform for more sophisticated physical mapping, like "Liouville" mapping using particle observations in the tail, at geo-synchronous orbit, and in the ionosphere.

Three other speakers made brief comments. Frank Toffoletto presented for Jian Yang showing a mapping technique based on RCM. Misha Sitnov discussed the limitations and future directions of field-line modeling for the mapping of substorm features around the onset. Eric Donovan reported on the ambiguity of field-line mapping, pointing out that "physical" mapping of magnetospheric boundaries (for example, isotropy boundaries, polar cap boundaries, etc…) are needed to verify any magnetic field model.

5. Future directions

At the end of sessions we had time to discuss the future direction of this focus group which lasts three more years. Continuation of the propagation/timing session and introduction of a new session about near-Earth tail processes, were

proposed. Two additional suggestions were made:

(1) We need to evaluate of various physical processes proposed as the carriers of substorm onset signals from space to ground (particle motion or waves, what type/speed) and (2) we need a phenomenological mapping of various observables occurring at onset (using e.g., Liouville mapping, or isotropy boundary mapping). These issues are closely connected with each other and also with the subtopics of the Focus Group. It was also proposed to make an X-Y matrix of our current understanding of the associations between various onset phenomena and their physical mechanisms. Other suggestions were to study the tail state prior to onset and the explanation of the longitudinal location of substorm onset. Finally it was noted that we should have time for more discussion during the sessions. Having a discussion-only session and/or strictly limiting the number of presentation slides are proposed.

TAIL-4. MODES OF MAGNETOSPHERIC RESPONSE (FG13)

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

The modes of magnetospheric response focus group met for the second year. We had 2 breakout sessions this year. In the first we collected all the speakers (7) for short talks. Most talks were in the 5 slide range, and there was plenty of time for discussion.

Session 1 Agenda:
During this first breakout we had 7 contributed talks, covering a wide range of topics related to magnetospheric modes of response. Bob McPherron presented the work of Benoit Hubert which indicate that pseudo-breakups are associated with flux closure. Jenny Kissinger examined SMC intervals observed by THEMIS, and concluded SMC occur preferentially prior to CIR. Noora Partamies discussed solar wind coupling, and Vsw as an ordering parameter. Yong Shi discussed the difference between BBFs PBIs, and concluded that PBIs do not penetrate as deeply into the near-Earth magnetosphere. Yasong Ge showed examples of plasmasheet kinks/oscillations observed by THEMIS. Meghan Mella showed initial results of the Cascades II PBI measurements. Jian Yang discussed RCM and entropy, and concluded entropy may control the response mode.

Session 2 Agenda:
During the second session we had no talks planned and instead sought community input on the outstanding questions of magnetospheric mode response. Everyone who attended seemed to appreciate the informal discussion, and we feel as if we made great progress in identifying topics for next year's GEM. For the GEM mini-workshop, we will work to identify datasets to be used in answering our focused questions, and work to include the modeling community. We will likely also have a session discussing the role of entropy, and how that might be used, calculated, etc. For GEM next year, we have identified the following topics, each of which will likely have its own breakout session:

1. Non-linear coupling analysis:
We had a nice discussion about the limitations of linear analysis in studying mode transitions, and it was agreed that we need to examine non-linear coupling of, e.g., solar wind parameters with measurements of magnetospheric activity

2. Energy partitioning:
It is not clear if our reliance on (often) single indices is sufficient to identify mode transitions. If energy is deposited into a different magnetospheric region, it may be missed by the

particular index. How do we overcome this limitation?

3. What role does pre-condition/time-history play in determining the response mode?

4. Solar minimum response:
We are taking measurements during a unique solar minimum. The radiation belts seem to be further out, the magnetopause is further out, substorm activity seems to be occurring at higher latitudes than normal, the Earth's atmosphere is much lower than we have ever seen, etc. Do these changes alter the response modes? This would likely be a joint session with dayside, rad belts, ionosphere coupling.

5. Ion outflow:
What effect does ion outflow have on the response mode? This would likely be a joint session (and perhaps include PET/entropy)

Inner Magnetosphere and Storms Research Area

IMS-1. SPACE RADIATION CLIMATOLOGY (FG9)

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

At the summer 2009 GEM workshop, the Space Radiation Climatology focus group held 2 days (6 sessions) of meetings jointly with the Next Generation Radiation Specifications Consortium. A detailed agenda, many of the talks, and links to data and models can be found at http://www.virbo.org/GEM_NGRSC_2009.

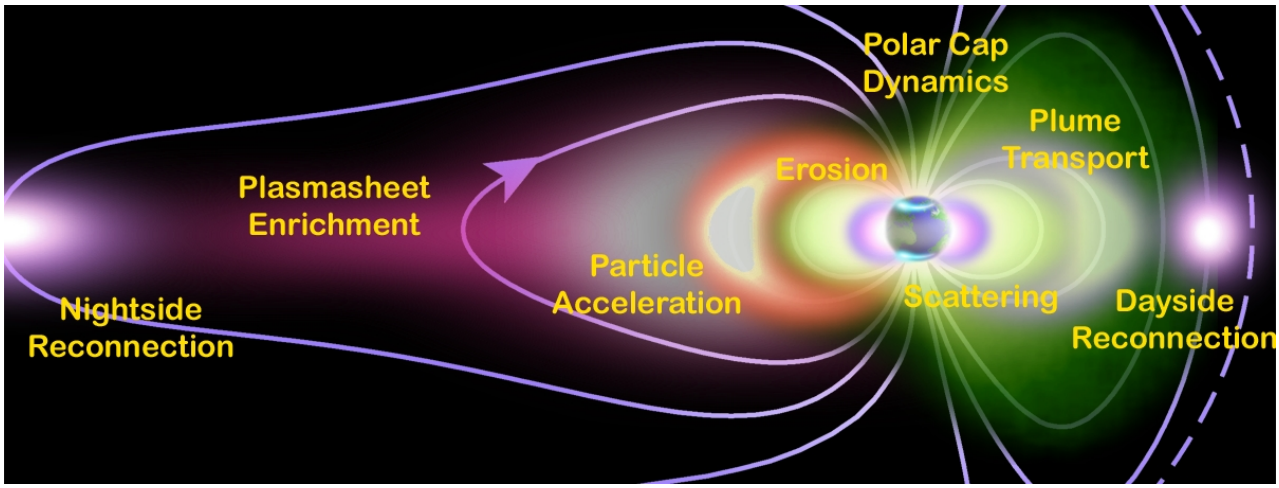
On the first day (Wednesday), we held 3 sessions. First, we heard updates from LANL, Aerospace, ONERA, AE9/AP9, and UCLA. There is a *lot* of radiation specification modeling going on. A beta version of AE9/AP9 will become available in early 2010. Next, we heard tools updates. The VERB and RBE codes are available on-line. The IRBEM-LIB (formerly ONERA-DESP-LIB) is becoming a widely used tool. Finally, we had a discussion of options for open source. Most of the group seemed not quite ready to jump in whole hog, but could benefit from a "closed" source site for collaborative sharing/updating of codes. We suggested that NASA and NSF "encourage distribution of tools and codes via open or closed source version control repositories." ViRBO (Bob Weigel) has offered to provide "subversion" service in both open and closed-source forms for the community. NASA, at least, has defined a NASA Open Source Agreement, that is valid for any open source effort funded by the US Government.

On the second day (Thursday), we held more GEM-like sessions on the science of space radiation and plasma climatology. We learned from LASP that the quiet Sun has led to several effects on the radiation belts, most noticeably a widening of the slot, as seen by SAMPEX. LANL and UCLA are working together to get their reanalyses to match. A UCLA reanalysis using CRRES, Akebono, GPS, and LANL GEO is available on a UCLA website and will be a useful resource for understanding radiation belt dynamics. Paul O'Brien demonstrated principal component analysis on a statistical reanalysis of the electron belts, and how to use it to determine Kp-dependent pitch-angle diffusion coefficients. Binbin Ni showed that switching among the various Tsyganenko field models used to compute L* didn't have a huge impact on the reanalysis solutions when electron data is combined from multiple satellites. Another presentation from UCLA showed a method to fill in temporal gaps in the solar wind time series, which helps us get more science out of CRRES and other missions with limited solar wind coverage. Bob Weigel teased out a statistically robust role for solar wind density in the driving of the ring current (Dst).

Richard Denton showed a long-term mass density reconstruction from GOES wave data, which extends the widely-used Young et al. models of O+/H+ ratios. THEMIS/SST data has enormous potential, but still needs work to perform in the intense trapped radiation environment. LANL and UCLA are working on inter-calibrating SST with other satellites. ViRBO is evolving to a long-term service, so we can all start to "rely" on it more.

We are making good progress on the data, simulations, and tools that are essential for reanalysis and other climatology investigations. We are starting to see a variety of scientific results, as the approach matures.

IMS-2. PLASMASPHERE-MAGNETOSPHERE INTERACTIONS (PMI) (FG11)



Chairs: *Jerry Goldstein* <jgoldstein@swri.edu>, *Joseph Borovsky* <jborovsky@ lanl.gov>

Topic Chair: *Maria Spasojevic* <mariaspasojevic@stanford.edu> *(Wave-Particle Interactions)*

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

This is a report of activities of the Plasmasphere-Magnetosphere Interactions (PMI) Focus Group (FG) at the Geospace Environment Modeling (GEM) Workshop which took place 21-26 June 2009 in Snowmass, Colorado. This document presents a broad overview of the physical ideas discussed rather than a detailed summary of each and every presentation.

Other Documents, Posted on the PMI Wiki Page (http://tinyurl.com/pmiFGwiki):

Detailed information about the presentations is available on the PMI Wiki Page, as follows.
PMI09_Session_Notes.doc - Detailed notes from the various PMI sessions.
GEM_PMI09-actual.pdf - The schedule of presentations for all PMI sessions.
PMI09_*[N]*.zip - PMI Presentations (.ppt or .pdf); *[N]* identifies the session from which the talk came (1A, 1B, 2, 3, or CEDAR; see **PMI Breakout** list below.)

Format of the 2009 GEM PMI Sessions
Presenters were encouraged (both in advance and at the sessions) to keep their presentations brief and informal, leaving time for questions and discussions, fostering an atmosphere of active exchange of ideas among speaker and audience.

PMI Breakout Sessions

To address the PMI FG's central question, "*How Are Magnetospheric Processes Regulated By Plasmaspheric Dynamics (and Vice Versa)?*" we hosted five (5) sessions at the 2009 GEM

Summer Workshop. The detailed schedule is posted on the PMI Wiki as indicated above.

In this next section of the PMI Focus Group Report, each PMI Breakout Session is listed with its Topic, Top-Level Science Question(s), and Purpose, followed by a brief summary of what was discussed and accomplished at the session.

Monday, 22 June 2009
PMI Breakout 1A: 10:30am - 12:15pm.

Topic: "Wave Growth and Propagation"
How does the evolving global distribution of cold plasma govern the growth and propagation of waves that control energetic particle distributions & dynamics?

This topic addresses the influence of ambient plasma upon how waves are produced, and how they propagate. To be examined are the conditions for growth and propagation of various waves including EMIC, whistlers (hiss, chorus), ULF, especially the influence of ambient plasma properties (such as density, composition, and spatial structure on various scale sizes).

Several presentations elucidated the theoretical quantitative effect of background plasma upon wave development and propagation. Ray tracing simulations indicate that VLF whistler waves spend more time in the plasmasphere than in regions with more tenuous plasma, and the whistler wave growth rate is heavily dependent upon the background density. Complementing these theoretical studies were several presentations highlighting the observational evidence that background density is a crucial influence upon wave growth and propagation. ULF waves are severely attenuated inside the plasmasphere. There is certainly a correlation between plumes and electromagnetic ion cyclotron (EMIC) waves (as revealed both by direct in situ cross-comparison and in situ plasma proxies for EMIC growth). However, it has become clear that there is a second process (besides growth in plume plasma) of the temperature anisotropy that favors EMIC growth: magnetic compression by solar wind pressure pulses, leading to EMIC wave growth in the outer magnetosphere. This systematic organization (by physical process) of EMIC wave growth has emerged from all observations: in situ, ground-based, and global imaging.

Monday, 22 June 2009 (continued)
PMI Breakout 1B: 1:30 - 3:00pm.
Topic: "Plasma Influence on Wave Particle Interactions"
How do ambient plasma properties such as temperature, density, and composition influence wave particle interactions?

This topic focuses on how ambient plasma influences the wave-particle interactions themselves, examining how various plasma properties (such as density, composition, and spatial structure on various scale sizes) help govern the effectiveness of various waves in changing the energy or pitch angle of energetic particles.

Again, theoretical and observational studies were used hand-in-hand to examine the influence of ambient plasma upon wave particle interactions. The wave normal angle clearly influences the scattering rate. EMIC energization of He+ seems concentrated in the afternoon sector but close to the magnetopause, which could arise from either of the two EMIC-generation processes listed above; more study is clearly needed. Because EMIC waves are believed to scatter ions effectively, two imaging tools have emerged as possible proxies for EMIC waves: proton aurora seen by IMAGE FUV and low altitude ENAs observed by the two TWINS spacecraft.

Monday, 22 June 2009 (continued)
PMI Breakout 2: 3:30 - 5:00pm.
Topic: "Plume Transport, Evolution, and Influence"

How does eroded plasmaspheric material get transported, evolve, and influence reconnection?

This topic examines the formation, dynamics, and fate of plasmaspheric plume plasma. Specific concepts to be addressed include (but are not limited to): observation or modeling of cold, dense plasma mixed with magnetospheric plasma, plume plasma at reconnection sites or on open field lines, recirculation or redistribution of cold, dense plasma into the cusp and plasmasheet.

Numerous observations were presented that illustrate that plume plasma is highly structured, both in flow field and in density, with indications of fine structure on scale sizes below what instruments have ever measured. The creation of this fine structure is still an outstanding question: does it arise from turbulent electric/magnetic fields, or does ExB-drifting plume plasma spontaneously shred itself as it convects? The global structure is better understood and quantified: during storms and substorms plume plasma convects sunward inside a corridor whose shape, size, and location vary with epoch time and disturbance level.

The influence of plumes was also examined. Observations were shown that illustrate a measurable control of plume plasma upon the reconnection rate. An invited "crossover talk" by Cassak (from the Dayside Magnetopause Reconnection focus group) presented a theoretical analysis quantifying how asymmetric reconnection (i.e., reconnection in which inflow and outflow regions have different properties) is applicable to the plume influence on DMR. Observations also show that super dense plasmasheet (possibly enriched by plumes) may influence the stormtime level of relativistic electrons.

Tuesday, 23 June 2009

PMI Breakout 3: 10:30am - 12:15pm.

Topic: "Plasma Density Structure and Evolution"

How do density structures of various spatial and temporal scales form and evolve? How does plasmaspheric filling vary spatially and on time scales from hourly to solar cycle?

This session addresses outstanding questions about the dynamics of density structures in the plasmasphere. Ideas to be covered include plume fine structure & turbulence, plasma instabilities, refilling, ionosphere-thermosphere-plasmasphere interactions, and subcorotation.

New observational capabilities were explored, such as the burgeoning field of plasmaspheric tomography using GPS signals and analysis of ultra-low-frequency (ULF) waves observed by ground magnetometer stations. Tomography is now allowing us to obtain a global snapshot of the entire (or the majority of the) dayside cold density distribution. These new and developing observational techniques can augment the already extensive cold plasma measurment database used by the GEM community.

Much discussion was devoted to how cold plasma density features can be used to diagnose inner magnetospheric (IM) electrodynamics. For example, by using correlation analysis (both manual and computer-automated), notches and other sublte features can be tracked to help quantify (and ultimately, explain) the rate at which IM plasma subcorotates; i.e., lags behind strict corotation with the rigid Earth. Modeling of undulatory ripples that travel across the duskside plasmapause has revealed a new type of region-2 current system, i.e., traveling pairs of filamentary region-2 currents that arise from interchange unstable ring current plasma and modulate the cold background density/

Thursday, 25 June 2009

Joint PMI-CEDAR session: 3:30 - 5:00pm.

Topic: "Plasmasphere, Magnetosphere, Ionosphere: Overall System Response"

How do PMI processes influence the overall system response to storms?

This session was held jointly with scientists who attended CEDAR the following week. This topic investigates the effects of redistribution of

thermal ions (ionospheric and plasmaspheric) on the stormtime response of the overall magnetospheric system. The goal is to develop our understanding of the interaction among components of the larger system.

Several presentations examined how various subsystems (e.g., ionosphere, ring current, neutral winds, etc.) fit together into the larger magnetospheric system, and how these various components interact as part of the overall system response during stormtime. Some discussion focused upon what concrete progress has been made in understanding specific subsystems or their interrelationship. For example, the relationship between plasmaspheric plumes and ionospheric storm-enhanced density (SED) tongues was explored at length, with the conclusion that the dynamics of SED tongues and plumes are clearly linked during stormtime, indicating strong M-I coupling along the entire flux tube. Several key plasmaspheric effects upon the magnetosphere-ionosphere system were also scrutinized as to whether they have been confirmed or not. All in all, concrete progress has indeed been made, and our methodology promises that progress will continue in the coming years.

Planned Activities: 2009 – 2010. There are numerous ongoing studies by researchers participating in the PMI FG. Coordination of these various studies will be via the PMI Wiki page (http://tinyurl.com/pmiFGwiki) and via the PMI Mailer List, which includes 60 people as of the writing of this report (with several joining after this year's workshop).

The goal is to promote synthesis of the various studies into a system-level conceptual framework; PMI is by its very nature a system-level FG. We also plan to continue to recruit participation (in the form of crossover talks) in PMI from other focus groups whose topics overlap ours, including

FG 5. Dayside Magnetopause Reconnection
FG 8. Near Earth Magnetosphere
FG 9. Space Radiation Climatology
FG 10. Diffuse Auroral Precipitation.

We also will continue to solicit and encourage participation from other non-GEM disciplines such as CEDAR, thus promoting the system-level view of the geospace environment.

Magnetosphere-Ionosphere Coupling Research Area

MIC-2. DIFFUSE AURORAL PRECIPITATION (FG10)

Chairs: *Richard Thorne*<rmt@atmos.edu> *and Joe Borovsky*<jborovsky@lanl.gov>

There were four separate breakout sessions devoted to the Diffuse Auroral Precipitation Focus Group at the 2009 GEM workshop. Each session was well attended with an average of 30-40 participants.

Tu, 23 June, 1:30 p.m. - 3:00 p.m.
DAP 1: " Understanding Diffuse Auroral Structure "
Co-chaired by Marilia Samara and Robert Michell

Tu, 23 June, 3:30 - 5:00 p.m.
DAP 2: "Magnetospheric Dynamics Associated with the Diffuse Aurora"
Co-chaired by Eric Donovan, Marilia Samara and Robert Michell

The first two sessions of the Diffuse Aurora Focus group dealt with observations and included initial attempts to infer useful quantities from those observations for the modeling efforts currently underway.

In the first session the wide range of observable auroral structures, from both ground and space, was discussed. We had talks covering the smallest (sub-km) scale using narrow-field

imagers, the medium (1-10 km) scale using both narrow-field and all-sky imagers, the large (10-100 km) scale using all-sky imagers, rockets and satellites and the very large (> 100 km) scale from satellite observations. The variety of structure, both small and large, present in the aurora illustrated how the term "diffuse aurora" has biased us to expect an unchanging fairly uniform optical manifestation, which is far from what observations show.

Marilia Samara presented several examples of narrow-field movies from a recent campaign at Poker Flat, AK. The advances in imaging technology, specifically the EMCCD imagers, have made it possible to quantify the very fine scale structures within the diffuse aurora. The sensitivity and dynamic range are such that temporal frequencies can be regularly measured (up to 16 Hz most often, ~ 50-60 Hz is also possible.).

Elizabeth MacDonald showed an example of a rocket flight over pulsating aurora (PARX, 1997 PI: G. Parks) and discussed the speed and spatial extent of the pulsating aurora. The in situ particle data revealed the presence of high energy electron precipitation, associated with the region of pulsating aurora.

Robert Michell presented results from those who wanted to contribute but did not make it to the workshop. Multi-spectral observations of black aurora from Björn Gustavsson revealed the differences between the emissions in the black aurora and the background diffuse aurora. All-sky FPI observations from Mark Conde reveal the changes in intensity and temperature caused by the aurora. The changes in neutral temperature are an indicator of joule heating and energy input and dissipation. Trond Trondsen sent an example of large-scale periodic black structures that formed within diffuse aurora, observed with multiple imagers using different fields of view (looking both at the smallest and largest structures). There was a specific example showing, on a small scale, the transformation of an unstructured boundary to a structured boundary. Kaori Sakaguchi explored the event presented by Trondsen in detail. She extracted the periodicity and wavelength of the pulsating structures, verifying that they are curl features much larger that what had been observed previously. She asserted that they are caused by an interchange instability.

Geoff Mcharg presented work relating to flickering aurora observations from Toolik Lake, AK using a high speed PHANTOM intensified CCD imager that can easily detect frequencies up to 1 KHz. He quantified the frequencies as a function of time and wave number. These frequencies can be associated with ion cyclotron wave scattering of electrons into the loss cone.

The second session started with the three presentations that remained from the first session and then continued with some overlap of observation and modeling. The goal of the second session was to focus more on using the aurora as a tool for remote sensing the magnetosphere.

Eric Donovan presented observations of pulsating aurora with the THEMIS all-sky network. He focused on observations from Athabasca, following the motions of patches to determine whether they are really consistent with ExB motion. He discussed the need for figuring out what causes patchy pulsating aurora and suggested an auroral workshop for sometime in the near future.

Thanasis Boudouridis showed results from 77 passes of twin DMSP satellites where he correlated the particle data from the two satellites with varying time lags. It was found that the ions were more correlated over time than the electrons indicating that the ion structures where longer lived. He also found that the small-scale electron features were less correlated over time, indicating that the small-scale features are more variable in time. This is the kind of analysis that we should be taking into consideration for future work.

Marianne Daae presented results primarily from IMAGE WIC. She quantified scale sizes of auroral giant undulations that occur at the equatorward edge of the diffuse aurora during very active times.

Jerry Goldstein presented TWINS as a new

data source available for examining where the high-energy ion precipitation is occurring, based on stereo ENA observations.

Sarah Jones presented pulsating aurora work from one of the students in Marc Lessard's group. The aim of that work is to identify the particle population responsible by first ordering pulsating events according to MLT and MLAT. The work utilizes THEMIS ASI observations and offers hope of, within a year or so, quantifying the spatial extent and spatio-temporal morphology of the region containing pulsating patchy aurora.

Matt Gilson explored (bright) proton aurora, presenting initial results wherein the proton precipitation (assuming strong pitch angle diffusion when Kappa for the appropriate energy protons is < ~3) is inferred from a self-consistent global simulation.

Aaron Ridley presented three different modeling attempts. The last one, using the Rice Convection model contains the most accurate physics of diffuse aurora. It produced the best looking precipitation patterns but did not seem to provide enough conductance to shunt the current, resulting in a very large cross polar cap potential.

Mike Liehmon presented modeling results that highlighted that the ring current can be very different just by shifting the auroral conductance a little bit. Implications discussed included the suggestion that dynamic arcs require large current, while diffuse 630.0 nm structures do not, and that any process that scatters plasmasheet electrons into the loss cone should produce 630.0 nm emissions, which could be used as a sensitive indicator of plasmasheet flows.

One of the objectives of the Focus Group is to determine how aurora in general, and diffuse aurora in particular, can be utilized to remote sense Geospace processes. The THEMIS mission makes this particularly timely. Larry Kepko presented work to that end, using images of diffuse aurora, as seen in oxygen "redline" emissions, to remote sense central plasmasheet (CPS) dynamics during the late substorm growth phase. These initial results indicate that fast flows might be seen as disturbances of the diffuse low energy CPS precipitation.

The final discussions for these two sessions centered on ways that the observations can be used to constrain or provide input for the models and the shortcomings of the current methods of modeling conductivity. It was decided that the ground observation researchers should attempt to come up with quantifiable information that modelers in the GEM community can use to advance the objectives of the GEM program. For example, the medium and large-scale structures give the latitudinal extent and location of the diffuse auroral precipitation and ULF wave frequencies can be extracted from pulsating auroral structures. That in turn will likely be useful in verifying the spatio-temporal evolution of a specific magnetospheric region in global models and simulations, or in constraining MI coupling as invoked in those models.

Wed, 24 June, 10:30 a.m. - 12:15 p.m.

DAP 3 "Modeling Electron Scattering Rates by ECH waves and Chorus"

Co-chaired by Richard Thorne and Binbin Ni

This session concentrated on the global morphology, spectral properties, and variability of two classes of magnetospheric plasma waves, electrostatic electron cyclotron harmonic (ECH) and electromagnetic whistler mode chorus plasma waves, which are capable of scattering plasma sheet electrons, leading to diffuse auroral precipitation. Theoretical calculations of pitch-angle scattering rates from each class of wave were presented to assess their potential contribution to the global pattern of diffuse auroral precipitation.

Richard Thorne presented the global distribution of electromagnetic whistler-mode chorus waves and electrostatic electron cyclotron harmonic (ECH) waves based on the available wave observations of CRRES and THEMIS spacecraft. The presentation showed that the patterns of the chorus waves, ECH waves, and low-energy (100 eV ~ 30 keV) are similar to the

global morphology of the diffuse aurora, suggesting that both wave modes play roles in the occurrence of diffuse aurora.

Mike Schulz, starting from the diffusion operator and Jacobian, discussed the importance of inclusion of diffusion in both energy and pitch angle while dealing with wave-particle interactions. He suggested that both energy diffusion and energy-pitch angle mixed diffusion should be included for modeling accurately the radiation belt dynamics by solving numerically the Fokker-Planck equation.

Binbin Ni presented initial results of bounce-averaged diffusion coefficients for diffuse auroral precipitation due to chorus and ECH waves, using the statistical wave power distributions obtained from CRRES and the latitudinal wave normal variations computed from HOTRAY code. The presentation showed that chorus waves play much more important roles than ECH waves in driving diffuse aurora.

Richard Denton presented the results of 2-D modeling of whistler-mode chorus waves and suggested three options to investigate the generation and propagation of chorus waves in the magnetosphere, including a full particle method, conventional hybrid code, and hybrid-like simulation.

In addition Gang Lu presented modeled height-integrated ionospheric conductivities with and without proton precipitation. The presentation showed that the losses of protons to the upper atmosphere can contribute to changes by up to 38% for Pederson conductivity and by up to 36% for Hall conductivity, which suggests that proton precipitations make a difference for the buildup of the profile of ionospheric conductivities.

Wed, 24 June, 1:30 - 5:00 p.m.

DAP 4: "Required Inputs for Global Modeling: Plans for 2009-2010 Activities"

Co-chaired by Margaret Chen and Richard Thorne

In this session Pat Newell presented data from the DMSP (F7) satellite of ion and electron precipitation flux, separating out the contributions from discrete and diffuse auroral precipitation. He demonstrated that the diffuse auroral precipitation contributes the dominant source of precipitation energy flux into the atmosphere (83%-75% depending on solar wind driving). The diffuse auroral precipitation triples during stronger solar wind forcing and the global pattern of diffuse electron precipitation (which dominates over diffuse ion precipitation) is similar to that anticipated from scattering by chorus emissions.

Vania Jordanova presented RAM model simulations of the global pattern of chorus excitation during the October 2002 magnetic storm. The RAM simulations followed the transport of plasmasheet electrons into the inner magnetosphere under the influence of enhanced convection electric fields, and evaluated the amplification of whistler-mode chorus waves due to the simulated electron distributions. The simulations showed a preference for chorus excitation on the dawn side similar to the statistical properties obtained earlier from CRRES data.

Margaret Chen presented modeling of the global distribution of electron precipitation using her ring current model with various assumptions on the electron scattering lifetimes. She was able to reproduce the general features of electron precipitation using a scattering model that assumed a rate of scattering less that that of strong diffusion. This is consistent with the scattering calculations presented in the earlier session by Binbin Ni.

The session was finally opened up for inputs from the participants on how the Diffuse Auroral Focus group could best provide information on particle precipitation to Global MHD modelers and other members of the GEM community. It was determined that our group should develop global models of electron and ion lifetimes as a function of geomagnetic activity.

MIC Research Area: New Focus Group Discussions

Coordinators: *Jeffrey Hughes* <hughes@bu.edu> *and David Murr* <murrdl@augsburg.edu>

Magnetosphere-Ionosphere research is alive and well at GEM. During the 2009 Workshop well over half the breakout sessions used the phrase "M-I coupling" in their session description which shows how pervasive coupling is in the overall geospace system. However, in spite of all this activity, at this workshop there were no active Focus Groups whose primary affiliation is in the M-I coupling research area. Accordingly, the research area's focus was on discussions about possible new focus groups. The M-I Research Area sponsored two tutorials each of which was immediately followed by a breakout session to discuss ideas about a proposal for a new focus group.

"Does Geospace Exercise Self Control?" was the question posed by Bill Lotko in his tutorial on Thursday morning which complemented the student tutorial "The Historical Road to the Dungey-Alfven Magnetosphere" given the previous day by George Siscoe. Lotko's tutorial was followed by a session "Geospace System: Coupled SW-Magnetosphere-Ionosphere-Thermosphere" to discuss the formation of a focus group that would approach geospace as a system. The twin objectives of the study would be to guide the development and application of global models and to advance empirical understanding of the system. The focus group could identify and coordinate observations applicable to understanding system behavior, formulate empirical tests and validations, and use models to explore geospace system problems and hence discover the new physics needed to improve model fidelity in describing system behavior. A lively discussion centered on possible problems on which to focus attention. The group discussed the saturation of the reconnection and transpolar potentials and whether the 3-hour repetition period observed in the so-called saw-tooth convection events represents a fundamental system period as two possible problems for a new group to address.

On Friday Brian Anderson gave a tutorial on "Near term New Observational Capabilities in M-I Coupling: AMPERE and the Midlatitude SuperDARN Chain." Both these systems will be providing unparalleled new global convection data by next summer's workshop, AMPERE a complete global picture of the field aligned currents linking the magnetosphere and ionosphere on a 9-minute cadence, while SuperDARN will give a more comprehensive image of ionospheric plasma velocities (and hence electric field) at a higher time resolution than AMPERE. Together these two systems provide a global view of the Poynting flux flowing between the magnetosphere and ionosphere and when combined with ground-based magnetometer data, a more complete description of electromagnetic M-I coupling than has ever been possible empirically. This tutorial was followed by a session discussing what new opportunities these new data sets provide for studying the coupled M-I system globally, and a new focus group devoted to this. Much of the discussion centered on the global distribution of ionospheric conductivity, a critical modeling parameter that is notoriously difficult to measure or estimate.

At the conclusion of both break-out sessions, plans were made to write a proposal for a new focus group for the GEM Steering Committee to consider in December.

GEM 2009 Student Report

Student Representative: *Raluca Ilie* <rilie@umich.edu>

About 46 students attended the Sunday student tutorials, of which 3 undergraduate students, 8 1st-year graduate students, 12 2nd-year

graduate students, 8 3rd-year graduate students, 9 4th-year graduate students and 6 5th-year or higher.

The day was split in three parts: first part was an introduction to the magnetospheric physics, meant to target the first and second year students. The second part focused on challenges and approaches in modeling the magnetosphere, while the last section was a review of literature and the newest results coordinated with the focus groups to follow during the week at GEM. According to the feedback forms, most students found the tutorials very helpful. The CCMC tutorial during the modeling session was very well received. The student website provided information for the schedule of the tutorials, the speakers for each tutorial and logistics of the meeting concerning the students. The students found it very helpful.

This year, for the first time, we had a 'Best Student Tutorial Award', meant in encourage students to give high quality tutorials and provide a good incentive for the undecided to participate in the student day. All students got to vote the best talk, according to the several criteria, similarly to the AGU student competition. Rick Wilder was the winner and the award was announced during the Wednesday banquet. Brian Walsh from Boston University is the new student representative for 2010.

GEM 2009 Steering Committee Report

Workshop Coordinator: *Bob Clauer*
<rclauer@vt.edu>

There were 153 scientist participants and 61 student participants for a total of 214 attendees at the June, 2009 GEM workshop in Snowmass, CO. At the present time the GEM workshop is devoted to the following Major Research Areas and their associated focus group:
(* indicates that the focus group lies within multiple research areas.)

Dayside including boundary layers and plasma Entry:
Coordinators: David Sibeck, John Dorelli
Focus Groups:
1.Foreshock, bowshock, magnetosheath (2004 – 2009)
N. Omidi
2.Component versus Anti-parallel Reconnection (2004 – 2009)
J. Berchem
3. Cusp Physics (2006 – 2010)
K-H. Trattner

Inner magnetosphere and Storms
Coordinators: Mike Liemohn, Reiner Friedel
Focus Groups:
1. Near Earth Magnetosphere: plasma, fields and coupling *(2007 – 2012)
S. Zacharia, S. Sazykin, B. Lavraud
2.Space Radiation Climatology (2006 – 2011)
Paul O'Brien, Geoff Reeves
3.Diffuse Auroral Precipitation * (2006 – 2011)
R. Thorne, J. Borovsky
4. Plasmasphere-Magnetosphere Interactions (2008 – 2013)
Jerry Goldstein, Joe Borovsky

Tail, including plasma sheet and substorms
Coordinators: Frank Toffoletto, Mike Henderson
Focus Groups:
1.Plasma entry and transport into and within the magnetotail (2006 – 2011)
S. Wing, J. Johnson, and A. Otto
2.Near Earth Magnetosphere: plasma, fields and coupling * (2007 – 2012)
S. Zacharia, S. Sazykin, B. Lavraud
3. Modes of Solar Wind-Magnetosphere Energy Transfer (2008 – 2013)
R. McPherron, L. Kepko
4.Substorm Expansion Onset: (2008 – 2013)
V. Angelopoulos, S. Ohtani, K. Shiokawa

Magnetosphere - Ionosphere Coupling, Aurora
Coordinators: Jeff Hughes, David Murr

Focus Groups:
1.MIC Electrodynamics (2003 – 2008)
J. Semeter, Bill Lotko
2.Diffuse Auroral Precipitation * (2006 – 2011)
R. Thorne, J. Borovsky

GGCM
Coordinators: Mike Wiltberger, Stan Sazykin
Focus Groups:
1.GGCM Metrics and Validation (2005-2010)
M. Kuznetsova, A. Ridley
2.GGCM Modules and Methods (2005-2010)
M. Shay, J. Dorelli

While several focus groups have concluded their activity at the 2009 workshop, there were no new focus group proposals submitted at the summer workshop. The next opportunity to review proposed new focus groups will be at the GEM mini-workshop to be held on Sunday December 13, prior to the AGU meeting in San Francisco. Focus group proposals are sought and encouraged. Significant time will be devoted to the discussion of future focus groups at the December 2009 mini-workshop.

Jimmy Raeder completed his term as GEM Steering committee chair at the 2009 summer workshop and Mike Liemohn takes over as the chair for 2009 – 2011. The chair elect is David Sibeck (2011 – 2013).

Future scheduled GEM workshops are:

- December 13, 2009 mini-workshop, San Francisco (prior to AGU)
- June 20 – 25, 2010 in Snowmass, Colorado
- December 12, 2010 mini-workshop, San Francisco (prior to AGU)
- June 19 – 24, 2011, joint with CEDAR, in Santa Fe, New Mexico

There was also a Steering Committee meeting on Friday afternoon, at which the joys and concerns of the workshop were discussed and new steering committee membership was voted.

It was discussed and concluded that the Focus Group format is working well and should be continued. It was agreed that RAs should have more responsibility to direct the FG leaders to stay on course with their 5-year plan, working towards a scientific or software deliverable by the scheduled FG end date.

There will be a concerted push for new FG proposals this fall. An optimal number of active FGs was discussed, but no resolution was reached. It was agreed that there will be room for at least 3 new FGs.

New GEM Steering Committee Members:

- SC Chair-elect: David Sibeck (2009 – 2011)
- GGCM Research Area Coordinator (RAC): Slava Merkin (2009 – 2015)
- MI-Coupling RAC: Bob Lysak (2009 – 2015)
- Dayside RAC: Jean Berchem (2009 – 2012)
- Dayside RAC (6-y term): Karlheinz Trattner (2009 – 2015)
- Tail RAC: Larry Kepko (2009 – 2015)
- Inner Magnetosphere RAC: Anthony Chan (2009 – 2015)
- SC Member-at-large: Mike Wiltberger (2009 – 2012)

The Steering Committee would like to thank all of those who agreed to be considered for a steering committee position, and encourages those not selected to be on the steering committee to become active in GEM leadership through the Focus Group process.

SHINE Report

Liaison to SHINE: *Christopher T. Russell* <ctrussel@igpp.ucla.edu>

The 2009 SHINE meeting was held in Wolfville, Nova Scotia on August 3, 2009. Topics considered on day one included modeling CMEs from their eruption to 1AU, reconnection

in large, high-Lundquist number coronal plasmas and ^{3}He rich solar energetic particle events. On day two SHINE had sessions introducing community models, examined the late phase of solar flares and non-balanced solar wind turbulence. They also examined the coronal and heliospheric magnetic field and corotating interaction regions. On day three they debated whether or not the Sun was headed for a Maunder minimum. The evidence points more to a Dalton type minimum as characterized by solar cycles 5 and 6 at the beginning of the 19th century. They also examined tests of particle acceleration theories and also unsteady reconnection. On day four they examined active region magnetic fields, the slow solar wind and the source region and mechanism for anomalous cosmic rays. On the closing day they studied the relationship between flares and CMEs, shock formation by CMEs and the structure of the solar wind. There is much being learned about the solar wind at present, especially with the STEREO mission. The weakness of the current solar minimum was viewed as unfortunate by some and very helpful by others. Most felt invigorated by the continuing decline in activity, for the Sun was clearly doing something it had not done for a very long time.

CEDAR Report

Liaison to CEDAR: *Mike Ruohoniemi* <mikeruo@vt.edu> (with contributions from Barbara Emery)

Like GEM, CEDAR (Coupling, Energetics, and Dynamics of Atmospheric Regions) is a research program sponsored by NSF that brings together researchers and students to address common interests and societal needs. The ambit of CEDAR includes coupling of the upper atmosphere to the ionosphere and magnetosphere and the connections to the solar wind, and so there are important overlaps with GEM objectives. Both programs feature annual week-long workshops which have occasionally been held jointly to general acclaim. Planning is now well-advanced to hold the next joint meeting in Santa Fe in 2011.

The CEDAR workshop this year was held in Santa Fe the week June 28 – July 2, i.e., the week after the GEM workshop. A discussion was joined as to where exactly to hold the 2011 joint meeting. GEM and CEDAR representatives (including Jimmy Raeder and Barb Emery) visited one suggested site, a casino-based resort located about a 15 min drive from the Santa Fe downtown. In the end it was decided to keep the meeting in Santa Fe itself. The CEDAR representatives visited the new Santa Fe convention center, which is very pleasant and not more than a 5 min walk from the Eldorado hotel. Between the convention center and the nearby hotels, it should be possible to combine the two workshops in a way that allows some leeway for each to observe its distinctive traditions. Discussions are continuing about the allocation of meeting and hotel rooms. The dates for the joint meeting are June 26 – July 1, 2011 (Sunday – Friday).

The 2010 CEDAR workshop will be held in Boulder at the University of Colorado on June 20-25, unfortunately, during the same week as the GEM meeting. Hopefully there will be room to schedule sessions of common interest so that cross-over people can attend both.

Finally, the GEM community should be aware that the CEDAR Science Steering Committee is formulating a new strategic plan. Particular elements have been defined and lead persons identified. Participation by GEM persons is desired. Jeff Thayer, the current Chair of CEDAR SSC, is leading this effort. John Foster is the Chair-elect of the CEDAR SSC, and he will become the Chair after the 2010 Workshop.

Current GEM Structure

NSF Program Manager
- Baker, Kile

Steering Committee Regular Members (Voting Members)
- Liemohn, Mike (Chair, 2009 - 2011)
- Sibeck, David (Chair-elect, 2011 - 2013)
- Onsager, Terry (2007 - 2010)
- Spasojevic, Maria (2007 - 2010)
- Omidi, Nick (2008 - 2011)
- Wiltberger, Mike (2009 - 2012)
- Research Area Coordinators (see below)
- Meeting Organizer (see below)

Steering Committee Liaison Members
- Baker, Kile (Liaison to NSF)
- Blanco-Cano, Xochitl (Liaison to Mexico)
- Donovan, Eric (Liaison to Canada)
- Fraser, Brian (Liaison to Australia)
- Hesse, Michael (Liaison to CCMC)
- Kawano, Hedi (Liaison to Japan)
- Kessel, Ramona (Liaison to NASA)
- Lavraud, Benoit (Liaison to Europe)
- Moldwin, Mark (Liaison to DASI)
- Moretto, Therese (Liaison to NSF)
- Russell, Chris (Liaison to SHINE)
- Ruohoniemi, Michael (Liaison to CEDAR)
- Singer, Howard (Liaison to NOAA)

Meeting Organizer
- Clauer, Bob (2007 - 2010)

Communications Coordinator
- Chi, Peter (2009 - 2014)

Student Represenatives
- Ilie, Raluca (2009 - 2010)

Research Areas

Research Area Coordinators
- Dayside, including boundary layers and plasma/energy entry. (Dayside)
  - Berchem, Jean (2009 - 2012)
  - Trattner, Karl-Heinz (2009 - 2015)
- Inner magnetosphere and storms. (IMS)
  - Friedel, Reiner (2006 - 2012)
  - Chan, Anthony (2009 - 2015)
- Tail, including plasma sheet and substorms. (Tail)
  - Henderson, Mike (2006 - 2012)
  - Kepko, Larry (2009 - 2015)
- Magnetosphere - ionosphere coupling, aurora. (MIC)
  - Murr, David (2006 - 2012)
  - Lysak, Bob (2009 - 2015)
- GGCM
  - Sazykin, Stan (2006 - 2012)
  - Merkin, Slava (2009 - 2015)

Focus Groups

Focus Groups and Their Research Areas (RA)
1. GGCM Metrics and Validation (2005 - 2010, M. Kusnetzova & A. Ridley, RA: GGCM)
2. GGCM Modules and Methods (2005 - 2010, J. Dorelli, M. Shay, B. Sullivan, RA: GGCM)
3. Foreshock, bowshock, magnetosheath (2004 - 2009, N. Omidi, RA: Dayside)
4. Plasma Entry and Transport into and within the Magnetotail (2006-2011, S. Wing, J. Johnson, and A. Otto, RA: Tail)
5. Component versus Anti-parallel Reconnection (2004 - 2009, J. Berchem, RA: Dayside)
6. Cusp Physics (2006 - 2010, K-H. Trattner, RA: Dayside)
7. MIC Electrodynamics (2003 - 2008, J. Semeter & B. Lotko, RA: MIC)
8. Near Earth Magnetosphere: plasma, fields, and coupling (2007 - 2012, S. Zaharia, S. Sazykin, B. Lavraud, RA: IMS, Tail)
9. Space Radiation Climatology (2006 - 2011, P. O'Brien and G. Reeves, RA: IMS)
10. Diffuse Auroral Precipitation (2006 - 2011, R. Thorne and J. Borovsky, RA: MIC, IMS)
11. Plasmasphere-Magnetosphere Interactions (2008 - 2013, J. Goldstein and J. Borovsky, RA:IMS)
12. Substorm Expansion Onset (2008 - 2013, V. Angelopoulos, S. Ohtani, K. Shiokawa, RA:Tail)
13. Modes of Magnetospheric Response (2008 - 2013, B. McPherron, L. Kepko, RA:Tail)

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GemWiki (GEM website): http://aten.igpp.ucla.edu/gemwiki/
GEM Workshop website: http://www.cpe.vt.edu/gem/
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