



The GEMstone

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NOTES FROM THE NSF PROGRAM DIRECTOR

It is certainly true that the mountains around Snowmass, CO are great, and the annual summer GEM workshops there have been highly productive as well as a lot of fun. That being said, I have to admit that I found the joint CEDAR/GEM workshop in Santa Fe this past summer to be a welcome change of scene. Not everything worked perfectly, and it seemed like I was constantly rushing from one hotel to the other, but there was plenty of interesting science to discuss, lots of good restaurants and interesting things to do and see when you needed a break from thinking about space science. I want to personally thank Frank Toffoletto, Umbe Cantu and Barbara Emery for all the hard work they put in to make sure it all went smoothly.

The fact that so many of us were running back and forth between hotels is a clear indication of how much the CEDAR and GEM communities have in the way of common interests. Of course, the magnetosphere is the portal that connects solar activity to Earth's atmosphere, and it is natural that the two communities should have much to say to each other. But what about the other end of the connection? Surely the magnetospheric physics community also has much in common with the solar and heliospheric community – the SHINE community. Now that the Global Interactions campaign is moving into full operation, it is time we considered how we want to interact with the SHINE program. The success of the joint CEDAR/GEM workshop certainly suggests that a joint GEM/SHINE workshop should be considered for the future.

And speaking of the new GI campaign, let me turn to the dull, but important programmatic information. As you probably know, the budget situation in fiscal year 2005 was not very good. The magnetospheric physics program ended up with a cut of about 3% compared with FY2004. In addition, the entire Upper Atmosphere Research Section at NSF was committed to making the Faculty Development initiative a success, and that unfortunately meant there were fewer dollars available for pure research activities. The new GI campaign also contributed to a renewed enthusiasm, which resulted in a striking increase in the number of proposals that were submitted to GEM - 40 proposals (35 independent projects). In the end, we were able to fund 8 proposals (7 projects). The breakdown by campaign was GI: 5 proposals (4 projects), MIC: 2 proposals, IMS: 1. The total first year funding was \$657K.

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GEM Homepage URL
<http://www-ssc.igpp.ucla.edu/gem/>

As usual, when I consult my crystal ball about what next year is going to be like it says, “cloudy, try again later.” But the speculation is that with luck we may get back to FY2004 levels. I expect to be giving GEM a high priority for funding in FY2006 and with no large commitments to other new programs (as we had last year) I expect the success rate for GEM will improve. By the way, since October 15 falls on a Saturday, the deadline for the GEM proposals this year will be Monday, October 17.

As always, I urge everyone to look for other sources of funding. I want to particularly draw your attention to two funding opportunities that have particular relevance to the GEM community. The first is the NSF/DOE Partnership in Basic Plasma Science and Engineering. As I write this, the announcement for this program has not come out, but it is likely that it will be out by the time your read this. The Dept. of Energy is expected to put over \$3M of new money into the competition, so if you have a project that involves a significant amount of basic plasma physics research you should strongly consider submitting a proposal to this program. I expect the deadline to be early January, 2006.

The other funding opportunity that the GEM community should be aware of is the NASA TR&T program. You will find the complete NASA announcement at <http://nspires.nasaprs.com/external/viewrepositorydocument/225/ROSES2005.pdf>. The specific item of major interest to GEM is the part of the focused TR&T program that is targeted toward solar wind plasma entry and transport in the magnetosphere. This focused research program is closely connected with the GEM GI campaign. I would urge you to consider submitting GI related proposals to both GEM and TR&T. **Note that the deadline for submission to TR&T is Sept. 9.**

A reminder to young GEM researchers: the next round of CEDAR/GEM/SHINE postdoctoral research proposals (see NSF 04-573) are due February 6, 2006. Please read the announcement carefully before submitting a proposal, since postdoc proposals have different requirements from normal GEM proposals.

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Notes from the Chair

GEM Steering Committee Chair’s Report on 2005 Joint GEM/CEDAR workshop

This year’s joint GEM/CEDAR workshop, held in Santa Fe, New Mexico from June 26 to July 1, 2005, was generally viewed as very successful. Much thanks for the success of the meeting should go to Frank Toffoletto and Umbe Cantu for their extremely hard work in coordinating the GEM program with the CEDAR program. Various compromises were required as the two workshops operate in a somewhat different manner from each other. Frank and Umbe were able to make the necessary compromises and allow the GEM component of the joint workshop retain much of the unique properties of GEM that have made the GEM summer workshop one of the most popular meetings within the magnetospheric community.

It is very important for the health of the GEM community that it be aware of the activities in our sister campaigns CEDAR and SHINE. This year’s joint summer workshop allowed the GEM community to learn more about CEDAR, with particular emphasis on the ground-based assets operated by members of CEDAR, as well as the

scientific concerns of the upper atmosphere community and how they relate to issues in magnetosphere-ionosphere-thermosphere-atmosphere coupling.

Because of the commonality of interests, the magnetosphere-ionosphere coupling (MIC) campaign and the inner magnetosphere/storms (IM/S) campaign acted as GEM hosts for the joint CEDAR/GEM workshops and plenary sessions. These plenary sessions and workshops occupied the first three days of the regular workshop, Monday through Wednesday. The joint plenary sessions and workshops covered topics that included: magnetosphere-ionosphere coupling at sub auroral and plasmaspheric altitudes; the polar ionosphere and new radar facilities such as the Advanced Modular Incoherent Scatter Radar (AMISR); the development of arrays of instruments (e.g., the Distributed Arrays of Small Instruments, DASI); and data assimilation and modeling.

The joint plenary sessions and workshops were scheduled along with the regular MIC and IM/S workshops. The first three regular days of the meeting were therefore extremely busy, while the last two days of the workshop were quieter, where the primary activities involved the Global Interactions (GI) campaign without any other campaigns running in parallel. This brings up an issue that I will discuss further below, as this summer's meeting showed a clear imbalance in the session load.

During the meeting I met with Jan Sojka, incoming CEDAR Steering Committee Chair, and we discussed matters of common interest between GEM and CEDAR that arose at the joint workshop, and that should continue to be addressed over the next few years. The first was that both GEM and CEDAR need to take advantage of the research opportunities provided by AMISR. NSF funding for AMISR research should become available in the next year or so. Second the DASI concept is still in

development. Both GEM and CEDAR need to be active in defining the program, as there are tensions between the needs of our communities and other scientific disciplines. Last, in terms of joint meetings, we both felt that the next joint GEM/CEDAR workshop should be in a about five years time. At the same time, we should be aggressive in identifying workshop sessions that would be of interest to our sister organizations. We could, for example, use the GEM Newsletter and the CEDAR Post to advertise specific workshop topics that would be of interest to CEDAR and GEM respectively.

Moving on now to topics specific to the GEM summer workshop, several topics of interest to the GEM community were discussed at the steering committee meeting at the end of the workshop. These topics included questions on the size of the GEM meeting, and how to balance the session load, issues concerning campaign termination, the role of the Geospace General Circulation Model Science Steering Committee (GGCM SSC), and planning for new campaigns.

Many of our colleagues in the CEDAR community commented on the vitality of the GEM workshop, specifically noting that the efforts of session chairs to maintain workshop mode led to good exchanges of information. Maintaining a workshop mode is a difficult task that requires a determined effort by session chairs and speakers to adhere to the workshop style of presentation. Speakers should avoid formal styles of presentation, and session chairs should encourage comments from the audience. Last, and perhaps most difficult, a workshop style of meeting requires a relatively small group of attendees. The larger the group the harder it is to encourage debate and discussion. The GEM meeting as a whole has to balance the popularity of the meeting with the size of the meeting. That the GEM workshop is centered on campaigns, and that the campaigns have a finite duration does allow for a natural turnover of attendees. This also emphasizes that campaigns must end. In addition,

I have been asked by the steering committee to provide some recommendations to session chairs that will help them maintain a workshop style of presentation.

We also discussed allowing more flexibility in defining the workshop program, so as to better balance the sessions. In the past we have restricted campaign sessions to either Monday through Wednesday, or Wednesday through Friday. This often results in two campaigns running in parallel, and workshops within a campaign running in parallel. By allowing one of the campaigns to occupy the central three days of the workshop, or even have campaigns run over the entire week, we hope to better balance the sessions. Since most workshop attendees stay for the entire week it was felt that this was not an undue hardship for the attendees to make this change, and it provides Frank Toffoletto with greater flexibility in planning the workshop schedule.

As noted above, GEM operates around campaigns, and the inner magnetosphere storms (IM/S) campaign is entering its last year. Next summer the IM/S campaign will report to the GEM community under the sponsorship of the GGCM SSC on the progress made during the campaign. At the steering committee it was decided that all campaigns should ultimately report to GEM via the GGCM SSC as they wrap up their activities. The GGCM SSC has been asked to take an active role in managing campaigns, helping campaigns to identify their goals in the context of a GGCM, cosponsoring sessions at workshops that discuss GGCM-related activities within a campaign, and as needed sponsoring GGCM specific workshops and plenary sessions. One of the plenary sessions to be sponsored by the GGCM SSC will be the plenary session at the end of the summer workshop, where the campaigns report back to the GEM community on activities during the workshop. (In accommodating the joint GEM/CEDAR sessions this plenary

session was inadvertently dropped from this year's workshop.) Last, if a specific working group is identified as needing to continue after the end of the parent campaign, then the GGCM SSC may wish to take over the working group. This option should be exercised with caution, and any working group desiring GGCM SSC support must have a clear role in furthering GGCM goals.

We have also established a process for turnover of the GGCM SSC membership. The campaigns have a limited time span, and the steering committee members serve for three years. It was decided that the GGCM SSC members should also serve for a three year term, but this will be extended for some members at this time so as to provide institutional memory.

As noted above, the IM/S campaign is terminating and now is the time to start the process of identifying new campaigns. While this may change, we intend to organize a session at the fall mini workshop that will solicit candidates for the new campaign. From the fall workshop we will select candidates to go forward to the summer workshop for a more detailed exposition. It is expected that the new campaign will be identified at this workshop, with the first campaign-sponsored sessions occurring at the 2007 Summer workshop. Preliminary sessions may also occur during the 2006 fall mini workshop.

The next summer workshop will be held in Snowmass, Colorado, from June 26 to 30, 2006. Recognizing the value of joint workshops, we are also pursuing possibilities for a joint GEM/SHINE workshop, although these plans are still uncertain. A joint GEM/SHINE workshop is particularly appropriate for the GI campaign, and also as part of the International Heliophysical Year and International Polar Year activities.

In closing, I wish to thank all the attendees of this summer's workshop. The vitality of the workshop is directly related to the enthusiasm of the session coordinators and attendees. As steering committee

chair I wish to maintain the consistency of the GEM workshop, allowing for this enthusiasm to continue. I welcome comments on the topics mentioned here, and also on any other topics that the GEM community may wish to raise. Do not hesitate to send comments to me via email.

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AGU GEM Mini workshop December 4, 2005

This years fall AGU GEM mini-workshop will be held on the afternoon of Sunday December 4, 2005. Details will be posted on the GEM workshop website at <http://gem.rice.edu/~gem>

Next GEM Workshop June 26- 30, 2006 Snowmass, CO

Tutorial Talks

It is traditional to collect the tutorial presentations from the GEM tutorial speakers and make them available on the web. This year is no exception and you may access these presentations (generally in power point or pdf files) at

<http://www-ssc.igpp.ucla.edu/gem/tutorial/index.html> .

Tutorials from previous years are also available at this site.

2005 WORKING GROUP REPORTS

Magnetosphere Ionosphere Coupling Campaign

Working Group 1: Plasma outflow

The Magnetosphere-Ionosphere Campaign WG 1 on plasma outflow co-sponsored with CEDAR a tutorial by Dr. Gang Lu, HAO/NCAR, entitled, "Auroral boundaries: finding them in data and models" and a joint GEM/CEDAR workshop on the same topic. WG 1 also sponsored one workshop on Global ion outflows and the polar wind, and co-sponsored with WG 2 a session entitled: "Investigating the auroral acceleration gap."

The Lu tutorial, available on the web at (<http://www-ssc.igpp.ucla.edu/gem/tutorial/index.html>) set the tone for a joint GEM/CEDAR workshop that followed. She discussed the physics associated with boundary formation and reviewed the work that has been done to use in-situ plasma observations, high frequency and incoherent scatter radar observations to elicit boundary locations. She also discussed techniques used to identify boundaries in MHD code outputs and gave a brief introduction to the enhanced boundary finding abilities of the new AMISER radar.

The lively joint GEM/CEDAR session had 11 speakers and quite a bit of discussion. Mervin Freeman (British Antarctic Survey) discussed the spectral width features in the SuperDarn radar that can be used boundary identifications. He showed that, except between 02 and 06 LT the agreement between boundaries identified by SuperDarn and DMSP plasma agree well. Josh Semeter (BU) discussed various representations of the polar cap boundary over Sondrestrom, Greenland, using

IMAGE, FAST, ISR, and spectral imagery. In particular, comparisons between sheared plasma flow in the ionosphere and optical auroral boundaries agree very well.

Dan Weimer (Mission Research Corp) showed pathological examples of open and closed boundaries with structure to illustrate that automatic boundary identification is a very challenging task indeed. Bob Strangeway (UCLA) made the same point using data from the FAST satellite.

Michelle Thomsen (LANL) noted that the success that K_p has in organizing magnetospheric phenomena follows from the locations of the magnetometer stations used to construct K_p being at latitudes near the auroral boundary where they are very sensitive to changes in the convection electric field which drives magnetospheric processes. Karen Remmick (USGS) made the same point but with the very extensive set of magnetometer data she has accumulated.

Joe Borovsky (LANL) made two major points, one unintended. First: he showed comparisons of all sky camera images at/near the magnetic foot points of geosynchronous satellites. Comparisons of plasma observed at geosynchronous altitude and auroral arcs showed that the diffuse aurora is associated with the displacement of the ion and electron plasma sheets. He unintended point was that the chairperson was so used to electronic projection, that old-fashioned view graphs were difficult to accommodate!

Erika Harnett (U of Washington) presented multi-stream MHD results demonstrating change in auroral boundary, field aligned currents, and outflow with increasing southward IMF – currents enhance and move to nightside. H^+ outflow increases in area while O^+ outflow increases particularly more on the dayside. Lutz Rastaetter (CCMS/GSFC) presented a polar cap

metric study for Feb. 18, 1999 event using the BATSRUS, Weimer-2K and OpenGGCM. The results showed substantial deviation of all models from data. He noted that field line tracing produced better results than using field-aligned currents.

Thomas Sotirelis (JHU/APL) showed examples of nightside boundary identifications using automated procedures on DMSP plasma data. He noted that the interval selected by the conveners did not have believable boundaries until instrumental degradation was accounted for. He noted that there are limits to correlations involving Dst and the stretching index because of relatively long magnetospheric response times

Bill Peterson (CU/LASP) argued that dynamic coordinates derived from plasma data provide better ordering than geomagnetic coordinates of invariant latitude and magnetic local time, but that their definition is instrument and platform dependant.

Global Ion Outflows and the Polar Wind.

The WG 1 sponsored workshop on Global ion outflows and the polar wind, had 4 speakers and lively discussion especially during Robert Winglee's comparison of multi-fluid model results with an interval identified by WG 1 with mass resolved ion outflow from Akebono, FAST, and Polar. A lot of the spirited discussion related to the fact that many in the audience were unfamiliar with the details and assumptions used in the code. Given the limitations of these assumptions the comparison between model and data agreed in location, relative intensity and energy spectra were quite good.

Jim Horwitz (UT Austin) reviewed the work of the Marshall group on the polar wind and suggested that O^+ is not a component of the polar wind, rather all thermal O^+ acquires its energy in the upwelling cusp region. Peterson pointed out that O^+ could be a component of the polar wind

and be further energized in the cusp/cleft and the observations could not tell the difference.

Bob Ergun (CU/LASP) discussed in this session and the following 'gap session' ion outflow in the downward current region. He noted that the current voltage relationship is robust in the upward current region, but not in the downward one. He noted a coherence time of 1-2 seconds in the downward region. Based on this and simulations he showed he suggested that the downward current region is characterized by random acceleration events with coherence times of a few seconds. In particular he noted that the data and simulations conflict with the pressure cooker model of the downward current region.

Bill Peterson (CU/LASP) reviewed the long term average O⁺ outflow rate reported from DE -1 (10 years), Akebono (12 years), FAST (1 year) and Polar (3 years) and characteristic energies. He concluded that the bulk of the upflowing O⁺ population, including thermals, acquires at least 3 eV at the altitude of 3,000 km, has characteristic energies of 100-500 eV at 6,000 km and 1 to 2 keV at Polar Apogee (4-9 Re)

Investigating the auroral acceleration gap.

Current models of electrodynamic decoupling between the magnetosphere and the auroral ionosphere (the so-called "auroral acceleration gap") rely on crude approximate relationships among bulk plasma properties. A joint WG-1/WG-2 session was convened with the goal of discussing how we might develop practical parameterizations of this region. Bob Strangeway (UCLA) discussed the correlation of ion outflow with pointing flux. His correlations were obtained near noon local time. Bill Lotko (Dartmouth) presented results of using the Strangeway relation of ion outflow vs. pointing flux with the LFM model to show the

resulting ion outflow pattern. These first results were very exciting but failed to replicate the MLT distribution of outflow, finding that most outflow as in the dawn/dusk sectors rather than the observed noon/midnight sectors. There was extensive discussion about the reasons for this difference, but no resolution.

Jim Horwitz (UT Arlington) presented a parametric study of wave heating from various modes in the gap region. Jay Johnson (Princeton) discussed feedback between the incident waves and the outflows which modify dispersion/damping of waves. Yan Song (U. Minnesota) discussed Alfvén waves in the gap region. Erik Lund reported on progress using the multi-moment fluid approach to modeling the gap region. Shin Ohtani (JHU/APL) presented data relevant to seasonal and tilt angle dependence of the magnitude gap acceleration.

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Working Group 2: Electrodynamic Coupling

Small scale structuring of the ionosphere and its influence on magnetosphere-ionosphere coupling.

The composition and structure of the polar ionosphere are altered not only by direct forcing (e.g., precipitation, wave heating, convection, solar production), but also indirectly as a result of plasma instabilities (e.g., gradient-drift, Farley-Buneman). This session explored the hierarchy of ionospheric structuring mechanisms, and possible consequences on M-I coupling. Bob Lysak (UM) opened the session by reviewing the status of feedback instability models, which remain a prime candidate to explain small-scale structuring in the aurora. Anatoly Streltsov (Dartmouth)

discussed Alfvén resonant modes, and their ability to locally deplete the ionospheric E-region. Such models have reached a level of sophistication where specific predictions about observable changes to the ionospheric state are possible. Joshua Semeter (BU) discussed how Incoherent Scatter Radars and spectral imagers might contribute to such model validation. Another approach to validating such models is through the use of space-borne particle and field measurements. Kristina Lynch (Dartmouth) presented measurements of the downward current region from FAST where observed E-field variability likely maps to the ionospheric E-region--i.e., not all divergent E structures need be associated with U-shaped potentials. E-field variability may also be produced by processes not directly connected with current systems. Lars Dyrud (CRS) proposed that the gradient-drift instability operating at E-region altitudes could lead to polarization electric fields that would affect M-I coupling. Finally, Miguel Larson (Clemson) summarized results from the JOULE rocket campaign, suggesting that neutral dynamics may also play an important role in M-I coupling at small scales.

The conclusion of this session might be stated as follows. It is difficult to evaluate the importance of small-scale processes on global-scale dynamics until we (1) identify what these processes are, and (2) develop predictive models of these processes. The results of this session suggest that these parallel experimental and theoretical efforts are still in a relatively immature state.

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Working Group 3: Global-Scale MI Coupling

Global MI Coupling: Energy deposition and partitioning

Two sessions were held on observations and modeling of global patterns of Poynting flux (at both DC and AC frequencies) and precipitating particle energy flux into the high-latitude ionosphere. These sessions included 13 contributed talks and spirited participation from an audience of more than sixty. The overall structure was broken down into three areas: existing observational and modeling capabilities with regard to these global patterns, MI coupling processes most directly affected or driven by these processes, and discussion and planning for an appropriate "GEM Challenge" in this area.

Brian Anderson (APL) and Haje Korth (APL) started the discussion by presenting observations based on the Iridium constellation of satellites. Global field-aligned current patterns derived from this constellation combined with SuperDARN or global imagers have provided the first quasi-instantaneous and quasi-global measurements of the Poynting flux flowing through the MI interface. Aaron Ridley (Michigan) and Jimmy Raeder (UNH) then presented corresponding results from global MHD simulations. Ridley highlighted the importance of global conductances in deriving these parameters and Raeder illustrated patterns of energy deposition by globally-driven ULF waves. Jo Baker (APL) demonstrated the ability to recover mesoscale patterns of energy deposition by combining observations from TIMED/GUVI and SuperDARN. Gang Lu (NCAR/HAO) showed AMIE results for Poynting flux given a variety of input datasets. Finally, empirical models for both Poynting flux and precipitating particle energy flux were presented by Tom Sotirelis (APL), Dan Weimer (MRC), and Astrid Maute (NCAR/HAO). This collection of talks clearly demonstrated an observational capability

sufficient to test the global MHD simulations with regards to energy deposition on global scales under a variety of conditions.

The session then explored how these patterns of energy deposition drive or influence MI coupling processes and discussed possible future directions of the new working group. Jeff Thayer (CU) and Alan Burns (NCAR/HAO) addressed how the deposited energy is processed as it flows into the ionosphere-thermosphere system. Additionally, Bob Strangeway (UCLA) and others discussed the role of Poynting flux in driving ionospheric outflow processes. At this point the group took full advantage of the "GEM workshop mode" and discussed how the working group should proceed forward. A consensus was reached that a "GEM pre-challenge" would be held at the GEM mini-workshop at the fall AGU meeting. This exercise will provide a venue for direct comparisons of observed and modeled (MHD and empirical) patterns of energy deposition for three or four intervals. It was also hoped that this "pre-challenge" process would aid in forming a more well-posed "GEM Challenge" that will have the explicit goal of advancing the state of global MHD simulations of the coupled magnetosphere-ionosphere-thermosphere system.

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Inner Magnetosphere/Storms Campaign

Session Summaries for the Inner Magnetosphere/Storms Campaign At the GEM 2005 Summer Workshop, Santa Fe, NM, June 27-July 1

The IM/S Campaign had another robust and active GEM summer Workshop this year. The campaign hosted 2 plenary tutorial sessions and

14 breakout sessions during the first half of the week. Working group 1 (Plasmasphere and Ring Current) and Working Group 2 (Radiation Belts) led the drive at this workshop, with Working Group 3 (ULF Waves) co-convening many of the sessions and providing valuable input to the discussions. Advancements and constructive dialogue occurred for several ongoing efforts of the campaign, including the IM/S Assessment Challenge, GGCM module development, and our understanding of the inner magnetosphere as a coupled system.

The two plenary tutorial presentations were joint with CEDAR, who was also meeting in Santa Fe the same week as GEM. Bob Spiro of Rice University gave a cogent review of electrodynamic coupling processes between the mid-latitude ionosphere and the inner magnetosphere, with a nice mix of observations and numerical modeling results on the subject. Janet Kozyra then discussed a variety of mass coupling issues between the thermosphere, ionosphere, and inner magnetosphere, with particular emphasis on phenomena emergent during the many recent superstorms. Below are individual summaries for each of the 14 sessions held at the GEM Workshop. A big thanks of gratitude is extended to all of the conveners, who devoted time to the organization, running, and summarizing of their sessions. These reports are followed by a brief update on the status of the IM/S Campaign. The campaign is slated to conclude after the GEM 2006 Summer Workshop. The IM/S community was very positive about the working relationship we have all developed because of our interactions under the GEM umbrella, and several ideas have been proposed to continue this momentum beyond the 2006 deadline.

IM/S Session 1 (Monday AM+): IM/S Assessment Challenge: Plasmasphere
Conveners: Dennis Gallagher and Brian Fraser

The objective of the plasmasphere challenge assessment session was to evaluate the current state of the art in our understanding of plasmaspheric physics. Further, we sought to put this evaluation in the context of the state of plasmaspheric physics at the start of the Inner Magnetosphere Storms (IM/S) Campaign. In the course of our discussion we were successful in identifying clear advances achieved during the IM/S Campaign. It was equally clear that the field of plasmaspheric research is in the midst of a renaissance. Rejuvenated activity in plasmaspheric study is being fueled by new, global observations of thermal and energetic plasma by the IMAGE Mission, by broadening use of the GPS satellites to calculate total electron content, and by the innovative analysis of global magnetic field oscillations and their propagation.

In order to evaluate the state of plasmaspheric physics near the end of the Campaign, answers to the following questions were sought during the session's presentations and discussion:

- Have modeling methods changed?
 - What physics is included now that wasn't included before?
 - Is there noteworthy modeling success?
 - Is there noteworthy modeling shortfall?
 - What will it take to do better? Theory-Experiment?
 - Is there physics not yet included, e.g. with use of a parameterized ionospheric conductivity?
 - What else can be said about plasmasphere modeling at the close of the IM/S campaign?
- Each of these questions was discussed at some length during the session. We closed our session without answers to these final questions. Perhaps it is fair to say that session participants found it easy to identify how far plasmaspheric research has come during the time of the IM/S Campaign and to identify the importance of maintaining the current upwelling of advancement and collaborative ties in this area of magnetospheric research. What was not clear

is how best to capitalize on everyone's enthusiasm to carry plasmaspheric research forward as a community of interest.

IM/S Session 2 (Monday AM+): Observational evidence for local acceleration and theoretical modeling
Conveners: Danny Summers and Richard Thorne

X.Li described the remarkable correlation between the inner edge of the outer radiation belt electrons and the innermost location of the plasmopause using long term SAMPEX measurements and CRRES measurements along with an empirical model of the plasmopause. Magnetic field fluctuations of large amplitude with frequencies comparable to the MeV electron drift frequency are observed through a large L-range but stop at the plasmopause, suggesting that inward diffusion of MeV electrons works until the plasmopause.

D.Summer presented quasi-linear diffusion coefficients for field-aligned electromagnetic waves with application to pitch-angle diffusion and energy diffusion of electrons in the outer radiation belt. The condition of field-aligned wave propagation need not unduly restrict the applicability of these easily computable results because first-order harmonic diffusion rates can provide an excellent approximation to diffusion rates for oblique waves calculated using additional higher-order harmonics.

L. Lyons discussed relativistic electron energization in association with high-speed streams, consistent with previous observations. Flux increases at geosynchronous do not begin until the solar wind density drops below about 5 cm⁻³. The Alfvén waves within the streams lead to multi-day periods of intermittent enhanced convection and repetitive substorms. Enhanced convection periods preceding onsets, not in substorm expansions, enhance the dawn-side chorus.

R. Thorne described the process of local electron acceleration during resonant interactions

with intense whistler-mode chorus emission. Waves are excited by plasma sheet electrons (10- 50 keV) injected into the inner magnetosphere during enhanced convection events. The waves are also able to resonate with relativistic electrons at large pitch-angles. Because such electrons maintain a quasi-isotropic distribution, scattering tends to preferentially occur towards higher energy where the electron phase space density is smaller.

Y. Shprits described the unprecedented events of the October-November 2003 magnetic storms, when the plasmasphere was drastically compressed down to 2 Earth radii for several days. This created preferential conditions (of strong magnetic field and low plasma density) for the local acceleration of electrons. Model results clearly show that the formation of a new belt during the recovery phase was produced by local acceleration. The extreme depletions can be explained by outward radial diffusion.

J. Albert discussed how recent quasi-linear diffusion calculations performed outside the plasmasphere show that energy and cross-diffusion rates can be comparable to that for pitch-angle diffusion. Jay described techniques for transforming to variables in which the cross diffusion term vanishes.

R.Sheldon noted that ULF waves constitute a synchronous or resonant way to accelerate MeV electrons, but asynchronous or non-resonant acceleration could also work, provided there exists a trap to hold the particles while they are being stochastically accelerated. The quadrupole cusp is just such a trap for low-frequency, stochastic, non-resonant ULF waves.

IM/S Session 3 (Monday PM): "IM/S Assessment Challenge: Ring Current"
Conveners: Vania Jordanova, Mike Liemohn, and Mark Moldwin

This session focused on ring current results for the IM/S Assessment Challenge events (April 22, 2001 and October 21-23, 2001). Data

analysts and modelers presented a variety of interesting findings from these two storms.

Mick Denton showed MENA observations and corresponding model results. Tracks of the location of the peak ENA emission during the October 21 storm were found in both the data and model results. Surprisingly, the Volland-Stern field better matched the MLT dependence than the Weimer-2001 field description. Mike Liemohn showed results from several simulations for each of the storms, comparing against numerous data sets. While, in general, the self-consistent E-field results were better than the analytical E-field models, the Volland-Stern field was best in a few categories and was shown to be decent overall. Sorin Zaharia showed results from his self-consistent magnetic field modeling with the Jordanova RAM code for the April event. Convergence was reached in 3 iterations, with the new pressure peak and anisotropy peak roughly half the original values. Finally, Vania Jordanova presented modeling results for the April storm, along with several data-model comparisons. The best agreement was achieved with the Weimer-2001 E-field, for both inner magnetospheric Cluster data and NOAA precipitation data.

The remainder of the session was devoted to an open-mike discussion of the issues that still need to be addressed and resolved regarding the storm-time ring current. It was a lively conversation, resulting in an "achievements and future directions" document, compiled by Margaret Chen later that week. Delivery of a near-complete draft of this and similar achievements documents to the Magnetospheric Physics Program Director at NSF (Dr. Kile Baker) is expected in mid-August 2005, with final versions next year at this time.

IM/S Session 4 (Monday PM): "Electron Variability Caused by Radial Diffusion"
Conveners: Yuri Shprits and Scot Elkington

This session was held Monday afternoon, June 27, and spanned the first PM breakout session,

with a few talks spilling over into the second quarter of the afternoon sessions. The focus of this session encouraged a broad range of contributions related to the quantification of the effect of radial diffusion in the outer radiation belts, and received contributions related to methods and results in radial diffusion modeling, calculation and characteristics of radial diffusion coefficients, and comparison of electron variability with ULF wave measurements.

Several talks in this session focused on the theory and simulation of the radial diffusion process, underscoring the vigorous level of modeling activity that has been undertaken in this area under the the GEM IM/S campaign. Xinlin Li modeled the inward transport of electrons during the October-November 2003 storm using empirical, solar wind-based diffusion coefficients and outer boundary conditions specified by geosynchronous observations. He reported that the filling of the slot region during the main phase of this event could be well-modeled by inward radial transport. Yuri Shprits looked at a contrasting possibility, namely outward radial diffusion contributing to the loss of radiation belt particles. Modeling efforts by Yuri suggested that this process can frequently account for flux dropouts observed during the main phase of a storm. Anthony Chan discussed the derivation of radial diffusion coefficients in the context of quasilinear theory, and showed numerical simulations confirming the physical characteristics of the resulting diffusion coefficients. Theodore Sarris presented modeling results showing the radial diffusion of electrons under the influence of an empirical representation of a series of impulsive variations in the solar wind. Sasha Ukhorskiy similarly examined the diffusive effects of impulsive variations in the solar wind, here using a modified version of the Tsyganenko-05 magnetospheric model to examine the global characteristics of the induced ULF waves. Sasha's work suggested that the symmetric and

partial ring currents could have a significant effect on the occurrence of ULF activity and the the resulting rates of radial diffusion.

The importance of ULF observations and the use of data in quantifying the radial diffusion problem was also the topic of several speakers in this session. Ian Mann analyzed ULF activity during the October-November 2003 storm, and found evidence for substantial ULF power penetrating into the slot region concurrent with the relativistic electron flux increases that were observed here during this event. Peter Chi presented long-term observations of global magnetospheric ULF activity as observed by Polar. Peter's observations were categorized according to solar wind conditions, and suggested aspects of the efficiency of the solar wind driver in causing diffusion-inducing ULF activity in different regions of the magnetosphere. Joseph Koeller spoke about the use of data assimilation techniques in radiation belt research. In particular, he showed how the Kalman filter could be used to give guidance in determining radial diffusion coefficients active in the real magnetosphere.

Due to the large number of talks contributed to this session, a few presentations relating to the radial diffusion problem were moved to the beginning of the second PM breakout session. Scot Elkington showed simulations of plasmashet electrons injected into the inner magnetosphere during the March 2001 event, and suggested that duskward-directed components of the global convection electric field could account for the strong access of very energetic electrons into the inner magnetosphere during this event. Simulations of trapped particles in the absence of a plasmashet source similarly suggested the extent to which radial diffusion could be counted as a loss process in this instance. Jacob Bortnik presented an analysis of HEO data and precipitation bands on SAMPEX. He concluded that there were 2 distinct possible loss mechanism indicated by the data: outward radial diffusion and precipitation due to EMIC scattering at lower L-values.

IM/S Session 5 (Monday PM+): “Recent Advance in Ring Current Understanding”
Conveners: Margaret Chen and Paul O’Brien

This session focused on recent advances in understanding the ring current from both observational and modeling studies. Shin Ohtani started the session by presenting statistical analysis of IMAGE/HENA data. He reported that the ENA-inferred O^+/H^+ ratio increased with increasing SYM-H and that the ring current O^+ content intensified during substorm injections. Jichun Zhang performed a superimposed epoch analysis of LANL geosynchronous (GEO) ion fluxes for 10 super storms that occurred during 1999-2004. He found higher ions fluxes on the dawn than dusk side and discussed possible reasons for this. Based on analysis of Polar/CAMMICE ion data, Paul O’Brien concluded that the ionosphere does not provide a significant direct outflow of ions to the ring current within GEO. However, he noted that there is direct ionospheric ion outflow beyond GEO and ring current modelers need to consider this source if the boundary of their models extend beyond GEO. Colby Lemon showed evidence from GEOTAIL ion pressure and magnetic field data that the specific entropy in the plasma sheet is reduced during storms. A reduction in the specific entropy was necessary for the build up of a ring current in his previous RCM-E modeling. From magnetically self-consistent simulations of the 19 October 1998 storm, Margaret Chen showed that the overall ring current pressure and magnetic perturbation are reduced when the feedback of the ring current is considered. However, especially later in the main phase, there can be places where the plasma pressure and magnetic perturbations are enhanced because of enhanced drift rates in regions of reduced B . From ring current simulations with self-consistent treatment of wave growth, George Khazanov demonstrated the importance of including the densities of the core and ring current plasmas

when calculating particle precipitation. Cheryl Huang presented DMSP observations of the Halloween storm that showed an enhancement of low-energy ion fluxes that coincided with enhancements in SYM-H. These ions originate from the ionosphere. Chin Lin discussed an explanation for Huang’s observations from considerations of ion drifts and ion and electron Alfvén boundaries. Wendel Horton described the analysis of the October 2000 storm from this WINDMI model. The WINDMI model predicted a sequence of substorms in the main phase and the Dst index.

IM/S Session 6 (Monday PM+): “IM/S Assessment Challenge: Radiation Belts”
Conveners: Reiner Friedel, Joe Fennell, and Sasha Ukhorskiy

R Friedel: Introduction to challenge

Yue Chen: The PSD radial distributions were calculated for GEM Assessment Challenge storms using the data from multiple satellites (LANL GEO, POLAR and Cluster) over two GEM IM/S selected storm periods. Temporal evolution of electron PSD radial distribution indicates that the decrease of electron fluxes during storm main phase is associated with non-adiabatic losses such as wave-particle interaction.

Zorin Zaharia: A self-consistent physics-based model of storm-time geomagnetic field was discussed in comparison with dipole and empirical models. It was shown that large field depressions (>100 nT) are different from the predictions of T89 model. Initial self-consistent results are significantly different from dipole runs of RAM. Lower plasma pressure, local narrow pressure peaks, and much higher values of β were observed.

Natalia Ganushkina / Reiner Friedel: Comparisons of T01s, T01 and event oriented B field modeling for challenge storms. No model captures main phase well, but all do reasonably well during recovery with the event orientated during better during some times only.

Sasha Ukhorskiy: A new self-consistent global

model of geomagnetic field was introduced. It was shown that strong variations in solar wind dynamic pressure during main phase of the storm induce large-scale oscillations of inductive electric field which violate the third adiabatic invariant of radiation belt electrons and result in their motion across the drift shells. Strong diamagnetic effect due to PRC leads to severe distortion of electron drift paths which in combination with nonadiabatic effects leads to rapid losses of radiation belt electrons through the magnetopause.

Athina Varotsu: Diffusion coefficients calculated from Salamambo code were used to calculate electron fluxes in radiation belts due to various diffusion mechanisms. The comparison of code calculations and Kp-averaged measurements show that radial diffusion is not enough to account for observed values of electron fluxes, i.e., additional diffusion terms improve the agreement.

Yoshizumi Miyoshi: UNH-RAM model was used to examine October 21-23 storm. It was concluded that the convection is effective transport mode for only lower energy part, while higher energy part is subjected to radial diffusion. Total energy gain from convective transport is much larger than that of radial diffusion. Calculations show that there is a strong growth of whistler mode outside of the plasmapause.

Reiner Friedel / Tom Cayton: "LANL GEO pitch angle observations for the Challenge Storms"

IM/S Session 7 (Tuesday AM+): GEM (IM/S WG1,3)/CEDAR Joint Workshop:
Electrodynamical M-I coupling at sub-auroral latitudes
Conveners: Phil Erickson, Bob Lysak, Stan Sazykin

The workshop was an opportunity for both CEDAR and GEM scientists to compare notes and exchange data and ideas on the subject of electrodynamic coupling between the sub-

auroral/mid-latitude ionosphere and the inner magnetosphere. Although the "focus" topic was Sub-Auroral Polarization Stream (SAPS) electric field phenomena, the 14 speakers addressed a broader range of issues in this very active research topic from the theoretical, modeling and observational points of view. The workshop was oversubscribed, and although there was no time left for a separate open discussion, many talks were followed by multiple questions and brief discussions.

Opening the workshop, John Foster presented an ionospheric perspective of the SAPS phenomena, based on Millstone Hill incoherent radar measurements of subauroral electron densities and convection velocities combined with GPS TEC maps, emphasizing that the magnetosphere drives SAPS but the ionosphere controls SAPS characteristics, including narrow structuring.

Anatoly Streltsov presented his theoretical/modeling work that gives one possible explanation of this effect in terms of Alfvén waves resonator effect. Mike Liemohn showed structured inner-magnetospheric electric fields calculated with the self-consistent version of the RAM ring current model. Mike pointed out that R_E-scale structures are not found in IMAGE HENA particle flux maps of the ring current region, and challenged experimentalists to reconcile model results with HENA observations. Austrid Maute gave a short update on her work in developing an electrostatic potential solver to be used with the LFM global MHD code as part of the CISM project. Bob Lysak described his current work in first-principles magnetosphere-ionosphere modeling extending his model to mid-latitude regions of low conductivity. All of these modeling talks indicated that we are still quite far from being able to explain the observations.

The need for modeling was evident as there was an abundance of observations presented at the session. Jerry Goldstein, in his talk, used IMAGE EUV and HENA observations to point out the close relation of the (cold) plasmaspheric and (hot) ring current particle populations. An emerging role of meter scale (HF and VHF)

coherent radar measurements in deducing convection electric fields at subauroral latitudes was evident from three talks by Ray Greenwald (initial observations of SAPS with the newest SuperDARN Wallops Island HF radar). Murray Parkinson (Australian TIGER HF radar observations of SAPS during substorms, talk given by Stan Sazykin), and Melissa Meyer (University of Washington MRO passive radar VHF coherent scatter SAPS and SAID observations). In-situ electric field measurements by CLUSTER spacecraft presented by Pamela Puhl-Quinn indicate the presence of SAPS in the dusk-side inner magnetosphere.

On the subject of observations of broader M-I coupling at mid-latitudes, Attila Komjathy gave an overview of ionospheric electron density global changes during the initial phases of “superstorms” based on TEC maps derived at JPL. Ian Mann talked about another global aspect of M-I coupling during superstorms— observations of intense ULF (Pc5-band) waves at mid-latitudes. Chin Lin described his recently-published work on modeling ionospheric low-latitude effects of storm-time magnetospheric electric fields.

In summary, there is a clear need for continuation of the very productive discussion started at this workshop.

IM/S Session 8 (Tuesday AM+): Quantitative Analysis of Precipitation Loss during Storms
Conveners: Jacob Bortnik and Terry Onsager

This session focused on the loss of energetic radiation-belt electrons during geomagnetically disturbed conditions. This session turned out to be extremely popular, with a total of twelve speakers addressing a wide range of topics such as:

- relativistic electron flux dropout events, associated loss time-scales, and evaluation of various potential mechanism responsible for such events.

- Electron loss due to interaction with a variety of waves such as hiss, lightning-generated whistlers, electromagnetic ion cyclotron waves, ultra-low-frequency waves as well as the associated observations of wave and X-ray bursts associated with electron precipitation.

- The influence of the plasmasphere, ring-current, and magnetopause in contributing to electron loss during storms.

The session was characterized by lively discussion and stimulated active debate and new ideas about radiation-belt loss mechanisms and their respective roles.

IM/S Session 9 (Tuesday PM): Joint GEM/CEDAR Workshop: M-I Mass Transfers and Storm Time Plasmasphere
Conveners: Dennis Gallagher, Bob Schunk, and Fred Menk

This joint CEDAR/GEM session on ionosphere/plasmasphere coupling was focused on storm-time plasma redistribution, heating, and other mass coupling topics. Several speakers presented their recent results in a relaxed atmosphere, allowing for plenty of question and answer time between talks and discussion at the end of the session. It was felt to be a successful dialogue between the ionospheric and magnetospheric communities regarding mid-latitude/inner-magnetospheric mass coupling.

IM/S Session 10 (Tuesday PM): "Radial profiles for electron PSD during different phases of a storm"
Conveners: Janet Green and Geoff Reeves

The GEM Inner Magnetosphere/ Storms working group devoted one session at the 2005 GEM/CEDAR workshop to discussing the evolution of electron phase space density (PSD) gradients in the Earth’s radiation belts. In theory, the observed evolution of these gradients can be used to differentiate between the many acceleration and loss processes proposed to explain the extreme temporal variation of

relativistic electron flux. However, in practice, studies comparing electron PSD gradients to theoretical expectations have reached contradictory conclusions due to large errors in PSD estimates and ambiguities in model predictions. The goal of the session was to synthesize the various PSD estimates obtained from different satellites and methods, and to clarify theoretical predictions for comparison.

The session began with a review of electron PSD gradients obtained from different satellites. Off-equatorial PSD estimates obtained from the Polar satellite show peaks at low L indicative of processes which locally accelerate electrons present in the inner magnetosphere. However, it is not clear whether these peaks are formed by acceleration or just local scattering of equatorial electrons at constant energy to off-equatorial regions. Equatorial PSD estimates are uncertain. Estimates from the GOES and SCATHA satellites show nearly flat gradients in the range from $L \sim 5-7$ indicative of rapid radial diffusion. However, the methods currently employed to transform these data to PSD are subject to errors and require some refinement. A careful analysis of estimates from LANL geosynchronous satellites combined with Polar equatorial data at large L shows that, for a range of energies and pitch angles (μ and J values) negative radial gradients are observed in the L-range from 5-9 consistent with the presence of a PSD peak inside geosynchronous orbit.

The presentations of observed PSD density gradients were followed by new developments in modeling expected gradients produced by various physical processes. More precise analytical forms for diffusion coefficients in a non-dipolar magnetic field geometry have been developed. These coefficients are necessary for accurately modeling radial transport. Additionally, parametric studies of a 1-dimensional radial diffusion model highlighted how variations in outer boundary conditions can dramatically change PSD gradients. More specifically, a decrease at the outer boundary can cause rapid outward radial diffusion and

electron loss which may be significant during the main phase of storms.

IM/S Session 11 (Tuesday PM+): Recent advances in plasmaspheric understanding
Conveners: Maria Spasojevic and Mark Moldwin

The GEM Inner Magnetosphere/Storms campaign held a session at the 2005 GEM/CEDAR workshop devoted to recent results on the plasmasphere. There were a total of 10 speakers covering a wide range of topics. The first several talks focused on studies of plasmaspheric mass including discussion of improvements to ULF mass density determinations through the use of non-dipole field models; using ion cyclotron wave frequencies to determine ion composition; and diurnal plasmasphere refilling using global EUV images. There was also considerable discussion of the importance of understanding the coupling between the plasmasphere and other magnetospheric populations including talks on the correlation between the plasmopause location and 1) the mid-latitude ionospheric trough, 2) the equatorward auroral boundary. Sub-corotation of the plasmasphere was discussed by several speakers including studies of the relationship between subcorotation and the auroral ionospheric disturbance dynamo. Also, new global electric field patterns derived from Cluster EDI were presented.

IM/S Session 12 (Tuesday PM+): "Statistical and empirical models for the radiation belts"
Conveners: Reiner Friedel and Paul O'Brien

This session was motivated by the October 2004 Radiation Belt modeling Workshop held by NASA's LWS program and the subsequent formation of a new COSPAR Panel on Radiation Belt Environment Modeling (PRBEM). Its intent was to solicit input from the GEM community on issues associated with building statistical and empirical models of radiation belt particle fluxes and to directly give input to outstanding COSPAR PRBEM working group actions:

1. Agree on a set of user needs definition
2. Select standard methods for data

processing/analysis

The session consisted of a few presentations with mainly open discussions.

R. Friedel: "COSPAR Panel on Radiation Belt Environment Modeling intro"

PRBEM,

http://www.onecert.fr/craterre/prbem/Working_group.html#progress). The working group consists of the following members:

- B. Blake, Aerospace Corp., USA
- C. Underwood, Univ. of Surrey, UK
- S. Bourdarie, ONERA, France (Chairman)
- R. Friedel, LANL, USA
- M. Panasyuk, MSL, Russia
- J. Cao, CSSAR, China
- Y. Mijushi, Stelab, Japan

Discussion: Statistical models serve as boundary conditions to science models. Need to define user needs first. Real time models may not be needed for engineering purposes. Statistical models use methods to map sparse observations to whole of radiation belts. Use internal model coords flux v. pitch angle rather than traditional omni v. B/Bo and provide to interfaces – one for science and one for engineering communities. Need to wrap new model in a new ISO standard to gain wide acceptance.

Paul O'Brien: "How to build statistical specification models"

Presented a new Framework for statistical specification models. Uses joint probability distribution In L, Eq pitch and energy - solar cycle dependent. New capabilities – propagation of errors, worst case analysis, possibility of filling in missing data from models.

Discussion: GEO electron model based on GOES is available, uses a "database" approach to produce maximum flux prediction and likely error distribution. Need to make sure the model gives the same results to all contractors, cannot tolerate Monte Carlo simulations that only

sometimes give "March 1991" event. Need to use coordinate system that minimizes the variance. Divergence of user needs and science needs, because scientists (and real-time users) want best magnetic coordinates and preflight user wants deterministic mapping between magnetic and geographic coordinates. Need to build models that combine multiple spacecraft and are easily extendable to new spacecraft. Maybe start with model in best physical coordinates, then run it to build environment specifications in more static coordinates for "design" users. Suppose we get 6 months of data from a new orbit in a region we haven't measured before. Can we use the other knowledge we have to extrapolate those 6 months to the whole solar cycle? Some disagreement in the audience, but the comment is basically right, as long as we don't extrapolate too far.

IM/S Session 13 (Wednesday PM):

'Requirements for the development of inner magnetosphere modules for the GGCM'

Conveners: Aaron Ridley, Mary Hudson, Richard Thorne, and Richard Denton

This was a very full session discussing various aspects of inner magnetospheric modules for a geospace general circulation model (GGCM). The following is a brief summary of the presentations.

Frank Toffoletto, discussing RCM-LFM coupling under steady southward IMF with constant ionospheric conductivity. Jimmy Raeder the fact that hemispherical asymmetry in conductivity will be a challenge for such efforts to couple RCM to global MHD models. Vania Jordanova described incorporation of results from a LANL Monte Carlo code description of diffusion in L, energy and pitch angle into her kinetic ring current – radiation belt model. Rob Sheldon discussed the problem of diagonalizing diffusion in the three adiabatic invariants Phi, J and M. The outer zone is not azimuthally symmetric as assumed in most radial diffusion calculations, while at ring current energies the convection electric field introduces

non-azimuthal asymmetry. An alternative formulation, which transforms from a Lagrangian to Hamiltonian coordinate system, was briefly presented.

Richard Thorne described rapid pitch angle scattering at low energies and energy diffusion at higher energies, and in general, five wave modes which must be considered in the ELF/VLF range for localized radiation belt electron acceleration. Erlandson and Ukorsky have a statistical model for EMIC waves, which play an important role in electron losses on the dusk side, including wave normal angles distinct from parallel propagation. Yuri Shprits described a 3D radiation belt Fokker-Planck description of diffusion neglecting cross terms between radial, energy and pitch angle diffusion. Brian Kress described the formation of a transient proton belt lasting two years in terms of Lorentz trajectory calculations of Solar Energetic protons in time dependent MHD (LFM) fields for two events in November 2001.

IM/S Session 14 (Wednesday PM+): "GEM IM/S Campaign: What Is Left To Do?"
Conveners: Mike Liemohn and the IM/S WG chairs

In this session we examined where we have come over the last 6 years during this campaign, and we explored the possible directions we could take to continue the discussion.

Several informal presentations were made. Mike Liemohn showed an outline of the IM/S Assessment Challenge progression and status. There will be a JGR special section for results from this challenge, with a submission deadline of November 30. A show of hands revealed that at least 20 papers plan to be submitted to this special section. Dennis Gallagher summarized the achievements of the plasmasphere efforts within WG-1. Reiner Friedel reported on WGs-2 and -3 relativistic electron research and related

plasma wave studies. Richard Thorne then gave an update on advances in radiation belt modeling.

These presentations were followed by a lengthy general discussion touching on several topics. One topic was on the inner magnetospheric science that still needs to be done and understood. It was concluded that one of the most important issues still to be adequately addressed is the interaction between the various plasma populations and plasma wave classes. Further, there was some consensus on the realization that progress in deciphering competing mechanisms for the dynamics of relativistic electrons will depend on a close coupling of modeling and observations, as observations by themselves can in principle not lead to unambiguous answers as they only ever measure the net superposition of all processes that are acting.

There was also a discussion on the future of the IM/S Campaign. It was generally agreed that this community likes meeting together and collaboratively addressing the issues. We also agreed that we really like the GEM Workshop venue, for its informal style, its support of students, and its reputation as an outstanding meeting. Several options were discussed about how to continue meeting together.

This discussion led into another one about how to approach the GEM Steering Committee, particularly at its end-of-the-week meeting. Three options were seriously considered: (1) ask that the IM/S community/campaign continue with the same objectives; (2) reinvent ourselves as a new campaign or working group within GEM; and (3) reinvent ourselves outside of the GEM umbrella. Option 1 seemed to be the most popular, but it was not expected to succeed with the Steering Committee. Option 3 was seen as the least popular because it would require the creation of the logistical framework already in place for GEM. Option 2, therefore, seemed the most reasonable. Options for new campaigns were discussed, as well as the possibility of becoming a

working group within either or both of the MI-Coupling or GI Campaigns. It was agreed that this conversation should continue at the GEM Mini-Workshop in December.

Whither IM/S? Feedback from the Friday Night GEM Steering Committee Meeting

These three options for continuing the IM/S campaign were brought to the GEM Steering Committee on Friday. Option 1 (continue as we are) was frowned upon, and option 3 (continue outside of GEM) was not discussed. Option 2 (continue differently within GEM) was discussed quite a bit. Bob Strangeway seemed happy with how the IM/S Campaign is proactively wrapping up. He recognizes the need and desire of the IM/S community to continue talking with each other, and is sympathetic to having IM/S research continue within GEM. Continue, somehow, but not as the current IM/S Campaign. There was a brief conversation about the next new campaign. This discussion did not get serious, though, and it was tabled until the December steering committee meeting. All of the other campaign chairs expressed an interest in absorbing some part of the IM/S Campaign. Jeff Hughes (MIC) would like to absorb those aspects of IM/S that couple with the ionosphere, Dave Sibeck (GI) would like to absorb those aspects of IM/S that couple to the plasma sheet, and Jimmy Raeder (GGCM) would like to absorb the code development and code coupling aspects of IM/S. The climate is favorable for IM/S research to continue within the GEM umbrella, either as part of a new campaign or as part of the existing campaigns.

Note that the IM/S Campaign will have sessions at both the December 2005 GEM Mini-Workshop and at the Summer 2006 GEM Workshop. Next summer is the end, however. The number of sessions will be small and the topics will be limited to those that bring closure to ongoing studies within the IM/S Campaign.

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With contributions from Dick Wolf, Margaret Chen, and J.-M. Jalen

Global Interactions

Global Interaction Campaign Report

The Global Interaction Campaign completed its second workshop at the annual GEM meeting in Santa Fe, New Mexico from June 29 to July 1, 2005. The campaign represents a fusion of two separate proposals to study the "solar wind interaction with the magnetosphere" and "geospace transport". The scope of this campaign is to follow fields and particles from the solar wind to the plasma sheet, with an emphasis on processes that mediate their transport. The campaign consists of two closely-linked working groups: Reconnection Dynamics, Cusp, and LLBL (RDCL) and Plasma Acceleration and Transport within the Magnetotail (PATM). Campaign coordinators are D. G. Sibeck and T.D. Phan. RDCL chairmen are J. Berchem, N. Omidi, and K.-H. Trattner. PATM chairmen are T. Onsager and A. Otto.

The first two RDCL sessions concerned solar wind pre-conditioning in the foreshock, bow shock, and magnetosheath. Thomsen and Sibeck reviewed previous observations and generation mechanisms for foreshock cavities and hot flow anomalies (HFAs). Fennell showed Cluster observations of an HFA associated with the arrival of an interplanetary shock and a current layer. Omidi showed results from global hybrid simulations indicating that for some IMF directions, a large (~ 25%) portion of the bow shock may be replaced by a solitary fast magnetosonic shock followed by a heated and deflected plasma with large amplitude ULF waves. Comparisons with HFA observations are

currently under way. The session also dealt with the role played by ULF waves in the foreshock and magnetosheath. Blanco-Cano analyzed waves predicted by global hybrid simulations in the foreshock and magnetosheath for comparison with ISEE observations. The predicted and observed properties of transverse and compressional 30 sec waves in the foreshock, as well as ion cyclotron and mirror mode waves in the magnetosheath, agreed well. Gary reviewed the properties of the latter two waves and their effects on the parallel and perpendicular temperatures of the magnetosheath in considerable detail and showed that the predicted dependencies upon plasma beta agree well with observations. Eastwood reviewed recent Cluster observations of upstream and magnetosheath waves and demonstrated how future studies using Cluster will contribute to the campaign objectives. Hesse showed results from full-particle simulations of shocks and electron acceleration due to shock surfing. He noted that this phenomenon might explain solar X ray observations. Sigsbee showed Cluster observations of electron plasma oscillations in the electron and ion foreshocks and the contrasts in their spectral properties due to large amplitude density fluctuations in the ion foreshock. Maynard presented observations indicating that pressure pulses modulate reconnection at the magnetopause. Moretto showed Cluster observations of a plasma depletion layer during southward IMF and suggested its existence as a possible future challenge for modeling.

Thursday began with a tutorial lecture by Masaki Fujimoto on the formation of the plasma sheet. He asked whether the situation is well understood. In the standard model for southward IMF orientations, the plasma sheet occupies a region of closed field lines filled by heated plasma of solar wind origin. Because the plasma sheet pressure must balance that in the lobes, and that in the lobes balances the pressure

in the magnetosheath, we expect and observe certain relationships between the plasma sheet and solar wind densities, and between the plasma sheet temperature and the solar wind kinetic energy. During periods of northward IMF, we expect plasma entry into the magnetotail to be less efficient. May be other modes of interaction in addition to reconnection. Densities are higher, temperatures lower, and pressures about the same. Simon Wing has used DMSP observations to study these relationships. Temperature falls with time after a northward IMF turning. The observations indicate that any successful model must explain flank entry, little heating, and the presence of cold dense plasma extending over a large distance from the boundary during periods of northward IMF orientation. Possible explanations include reconnection poleward of both cusps, the diffusion or reconnection enhanced by the Kelvin-Helmholtz instability, or enhanced mixing.

Hasegawa has reported Cluster observations of rolled up vortices on the magnetotail flanks and interpreted them in terms of the KH instability. Kinetic Alfvén wave diffusion may also play a role. These mechanisms are not mutually exclusive. The cold dense plasma within the plasma sheet may move earthward, leading to a dawn-dusk asymmetry at inner edge of PS.

Fujimoto's presentation was followed by a session on the origin and transport of plasma in the plasma sheet. A more detailed report on this session will be included here at a later date.

The session on the origin and transport of plasma in the plasma sheet focused on characterizing the observed properties of the plasma sheet and distinguishing among the different source processes. A number of presentations provided important constraints on the properties of the plasma sheet that should be reproduced by models, such as the dependence of plasma sheet density and temperature on IMF and the dawn-dusk asymmetry of the plasma sheet.

Comparisons of source processes, such as high-latitude northward IMF reconnection and the Kelvin-Helmholtz instability, were made, helping to constrain the dominant plasma entry mechanisms. Presentations in this session also investigated the transport of plasma from the plasma sheet into the inner magnetosphere and its consequences for the ring current and radiation belt. An important challenge for the future will be to determine how well our existing models of the magnetosphere can reproduce the major properties of the plasma sheet and their dependencies on the IMF and ionosphere.

Friday afternoon attention turned to the magnetopause. During a well attended and very lively session, most of the discussions focused on both micro and macroscopic aspects of reconnection at the magnetopause and the occurrence and role of other processes such as the Kelvin Helmholtz instability and to a lesser degree, transient phenomena such as FTEs and plasmoid-like structures, in the global transport of solar wind plasma to the magnetotail. Dorelli reported that both component and antiparallel merging can occur within global MHD simulations, while Berchem reinterpreted observations previously taken as evidence for component merging in terms of antiparallel merging. Wendel/Reiff used Cluster observations to define reconnection topology at the magnetopause, while Maynard used Cluster observations of the separatrixes to remotely sense reconnection and determine its location on the magnetopause. Wenhui Li reported that models which invoke double reconnection poleward of the cusps successfully account for Cluster boundary layer observations during prolonged periods of northward IMF. Lavraud reported work by Seki which also invokes the Kelvin-Helmholtz instability to explain the boundary layer properties under these conditions. Otto explored the generation of a sequence of bipolar magnetic field signatures normal to the magnetopause by

the Kelvin-Helmholtz instability. The contrasting results indicate that determining the mechanisms and regions of entry of plasma at the magnetopause remains an outstanding issue to be addressed by the GI campaign. Although no formal resolution was taken, members of the GI campaign agreed that to make new progress the working group has now to converge on specific problems (e.g. theoretical/simulation challenges) and events.

Vahe Perroomian presented the second invited lecture of the GI campaign on Friday morning. He began by defining the characteristics of large scale kinetic models. He and his group follow the orbits of a large number of particles in specified global models for the electric and magnetic fields that include the Lorentz force. Their objective is to determine the effect of remote processes on local plasma distribution functions. These are not particle-in-cell codes or self-consistent simulations, but they do allow us to examine ion dynamics and kinetic effects on a global scale. Their success can be determined via comparison with observations. Researchers provide an observed outflow or input solar wind distribution, and get in return something to compare with observations. Now the group uses 3D, MHD based, solar wind drivers. Ions are traced forward and backward for comparison with observations of distribution functions. Recently they successfully reproduced velocity-dispersed structures seen by Cluster within the PSBL. These features originated in a weak field region just earthward of the near earth x line. From these results, we can conclude that the loss of self-consistency is a price we can afford. The group has also been studying the entry of plasma into the magnetosphere. They launch drifting Maxwellian ion distributions at $X = 17$ RE, upstream from the bow shock, compare the regions where they enter the magnetosphere with the predictions of Luhmann's antiparallel merging model and demonstrate that the ions ultimately form a theta-structure magnetotail cross section. The model can also be used to

study individual events, such as the geomagnetic storm from September 24 to 28, 1998. The location of the magnetopause was determined using the output of an MHD model driven by time-varying Wind solar wind input provided. Particle energies increased with depth into the magnetosphere at locations just tailward of the cusp. The reconnection region was on the dusk flank, but field lines draped over towards dawn. This is not tailward of the cusp reconnection but rather entry via an antiparallel reconnection site on the duskside. One can conclude that hot plasmas may not always be locally accelerated.

The final RDCL session concerned observations and modeling of the cusp. Special attention in this session was given to a long standing controversy, the occurrence of energetic ions and electrons in the cusp and their possible source regions. One explanation put forward in the session was that these energetic particles are accelerated locally in the cusp which would make the cusp an important source for energetic ions in the magnetosphere. The other explanation discussed was that these energetic ions are accelerated elsewhere, e.g. the well know acceleration region upstream of the quasi parallel shock, and subsequently transported into the cusp along interconnected magnetic field lines. In a series of talks, contributors presented events which were interpreted either as evidence for local acceleration or transport into the magnetosphere from the quasi-parallel shock region. Both groups agreed to exchange their finding and event lists for review and intend to report their results at the next GEM meeting. Preliminary results can be expected for the GEM workshop in December as part of the Fall AGU. In addition several modeling groups have joint the effort to apply global magnetospheric models or specialized tools to simulate that region and the path of the energetic ions.

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2005 GEM Student Report

GEM Student Facts

GEM provided financial support for 61 students this year. In 2002, 2003, and 2004, the supported students totaled 44, 56, and 62, respectively. Because of higher living expenses in Santa Fe than in Snowmass, the GEM student community did not grow this time.

No undergraduate student attended the 2005 GEM workshop. 22%, 20%, 33%, 8%, 8%, 4%, and 4% of the GEM students are first, second, third, fourth, fifth, and sixth-year graduate students, respectively. One of the goals of the Sunday GEM Student Tutorials was to equip those low-grade students (>70%) with enough knowledge to understand what's going on at GEM.

Sunday Student Workshop

Jichun Zhang (GEM Stud. Rep.) and Carlos Martinis (CEDAR Stud. Rep.) worked together to plan for the Student Workshop on Sunday.

In the morning session (10:10 – 12:30), Prof. Robert McPherron at UCLA, the GEM speaker, talked about the Magnetosphere-Ionosphere Coupling (MIC) from a magnetospheric perspective. Dr. Rod Heelis from University of Texas, Dallas, the CEDAR speaker, introduced MIC from an ionospheric point of view.

In the afternoon, CEDAR and GEM students had separate tutorials in two different meeting rooms at the same time (2:00 – 4:15). The GEM split afternoon session had two sections: IM/S and GI, which also included “modeling” (GGCM). All GEM tutorial speakers are graduate students. The detailed schedule is as follows:

Section I: Inner Magnetosphere/Storms (IM/S)

1. Introduction to the plasmasphere: Dave Berube (UCLA) - 15 minutes
2. The Earth's radiation belts: William Peter (Stanford) - 15 minutes
3. The ring current: observations, theory and modeling: Alexander Varpirev (UNH) - 15 minutes
4. ULF Waves in the magnetosphere: John Niehof (BU) - 15 minutes

Section II: Global Interactions (GI)

1. Magnetic reconnection: Pin "Penny" Wu (BU) - 15 minutes
2. The magnetospheric cusp: Hui Zhang (BU) - 15 minutes
3. Magnetospheric boundary layers: Katherine Garcia (BU) - 15 minutes
4. The plasma acceleration and transport within the magnetosphere: Xai Cai (UMich) - 15 minutes

Workshop Evaluation Results

At the end of the student tutorials, all attendees were asked to evaluate both morning and afternoon sessions by filling out an evaluation form. The evaluation results show that the GEM Sunday Student Workshop was successful: 62% (75%) of the attendees voting to keep the morning (afternoon) tutorials at the same level; 60% (57%) choosing 4 or 5 as the usefulness rating of the morning (afternoon) session, which is on a scale of 1 ("least helpful") to 5 ("most helpful").

A/V Helpers for Session Settings

To show their contribution to the GEM workshop, 18 student volunteers helped audio/video settings and light control. Each volunteer was assigned to 2 -3 sessions. Here is the list of the volunteers: Xia Cai, David Galvan, Katherine Garcia, Alex Glocer, Mark Golkowski, Salvador Hernandez, Brian Hicks, Chia-Lin Huang, Wenhui Li, Elizabeth MacDonald, Aramis Martinez, Paul Ontiveros,

William Peter, Daniel Welling, Jesse Woodroffe, Pin Wu, Jichun Zhang, and Shasha Zou.

Student-Sponsored Tutorials

This year, GEM students asked two senior scientists to give tutorials. One is Robert McPherron at UCLA. He introduced the magnetosphere-Ionosphere Coupling (MIC) from a magnetospheric point of view on the Sunday morning. The other speaker is Dr. Janet Kozyra from the University of Michigan. On the Tuesday morning, she gave the student-sponsored tutorial, "Mass and energy flows into the ionosphere from the plasmasphere-ring current interface: New views from superstorms". This talk was also one of the joint CEDAR/GEM tutorials.

New Student Representative

7 GEM students were willing to be the student representative next year. In the end, William Bill Peter, a fourth-year student at Stanford University, was selected as the 2006 GEM student representative.

Jichun Zhang (Student Representative)

jichunz@umich.edu

GEM Steering Committee Minutes

July 1, 2005 Santa Fe, NM, Friday July 1, 4:00 – 9:00 PM

Present:

Aaron Ridley, University of Michigan
Brian Fraser, University of Newcastle
Christopher Russell, UCLA
Dan Weimer, MRC
David Sibeck, NASA
Ennio Sanchez, SRI
Eric Donovan, University of Calgary
Frank Toffoletto, Rice University
Gang Lu, HAO
Hideaki Kawano, Kyushu University
Howard Singer, NOAA

Jichun Zhang, University of Michigan
Jimmy Raeder, UNH
Kile B Baker, NSF
Mike Liemohn, University of Michigan
Robert Strangeway, UCLA
Vania Jordanova, UNH
W. J. Hughes, Boston University
Xochitl Blanco-Cano, UNAM

1. Chair Issues – Bob Strangeway, UCLA
Bob Strangeway started the meeting by addressing several issues included questions related to the overall workshop program and the role of the GGCM within GEM. In the past, the workshop program was structured to have no more than two campaigns running in parallel with each campaign program running for 3 days. This had the advantage of allowing participants to attend the workshop for a little as 3 days and only attend sessions of interest. In this years workshop the, this structure resulted in a program that was very full at the beginning of the week and sparse at the end. However, the majority of participants in this year’s meeting registered for the full 5 day workshop. Strangeway suggested that a better way to set the workshop program might be to run all campaigns in parallel for the full 5 days. It was noted that in order to do this, some degree of flexibility on the part of the session organizers will be required.

Chris Russell observed that one problem that has crept into the meeting over the past few years is that the sessions consist of too many formal ‘AGU-style’ talks. Part of the reason for this is that the number of participants in each session has grown to the point where informal discussion-based sessions are difficult to do. He suggested that in some cases there would be some benefit in splitting a working group into 2 parallel sessions. The two groups would later reconvene in a working group plenary to compare notes. This would have the additional benefit of forcing people to report back to the GEM community and the GGCM. In order to

address this and other workshop structure issues, Bob Strangeway volunteered to develop a guiding document for the working group chairs and conveners on how best to plan sessions.

Strangeway brought up for discussion the role of the GGCM within GEM. He reminded everyone that the GGCM is expected to exist as long as GEM. He also suggested that all the campaigns are expected to report back to the GGCM Steering Committee (GGCMSC) at the end of the campaign. It was also noted that in the summer 2007 workshop that the Inner Magnetosphere/Storms (IM/S) campaign will not have any specific sessions identified as IM/S but will instead have GGCM-sponsored sessions to present its wrap-up to the community. He also raised the question whether the GGCMSC membership should have a finite duration and it was suggested that 3 years would be a reasonable time. Membership turnover would have the benefit of increasing community ownership of GEM and would act to bring in new ideas. Jimmy Raeder pointed out that the since committee has been in existence for 2 years, a reasonable approach would be to stagger the committee turnover. He mentioned the he plans to step down as chair after the 2006 summer workshop. Jeff Hughes asked about the lack of GGCM-sponsored sessions in this year’s meeting. It was noted that this year’s joint meeting with CEDAR made planning for these sessions difficult.

Chris Russell also suggested that each campaign should be reporting back to the GEM community at a GGCM-sponsored plenary. Another roles for the GGCM are as a repository for models as well as informing the community what the outstanding problems that need to be addressed that would improve our understanding of the magnetosphere. Such feedback would provide important information on what the new campaigns should be.

Strangeway addressed the issue of whether certain groups should be allowed to continue after the

end of a campaign. It was noted that if a case could be made that GEM as a whole would suffer by ending a working group then it could be incorporated within the GGCM or some other campaign. The GEM steering committee would consider such proposals from working groups and its approval would depend on whether either the sponsoring campaign or the GGCM would be willing to adopt the working group.

There was some discussion of what role GEM should have in the upcoming IHY program. A vote was taken and it was decided that the GEM steering committee should write a letter to endorse this program. It was also noted that some members of the GEM community, headed by Robert Clauer of the University of Michigan and Ennio Sanchez of SRI, have put forward a proposal to the upcoming World day radar coordinating committee; this was done in collaboration with CEDAR.

There was some preliminary discussion of what new campaign should replace the outgoing IM/S campaign. So far, a couple of suggestions have been put forward; 1. the Physics of Space Weather; 2. and Acceleration Processes. It is expected that calls for further campaign ideas will be solicited from the community, perhaps via a GEM/AGU newsletter and that such proposals will be discussed at the fall GEM mini-workshop. As was done in the planning process that led to the Global Interactions (GI) campaign, it is likely that tutorials will be presented at the 2006 workshop to advocate their respective proposed campaigns. It was noted that the GGCMSC should play a role in the decision process and a report is being written that will form the basis for the new campaign. It is anticipated that the new campaign will start in 2007.

2. Future meeting plans – Frank Toffoletto, Rice University

The total participants for the 2005 meeting was 226, which included 60 students. It was noted

for the 2005 joint meeting some participants felt that the distance between the Eldorado and La Fonda hotels made some joint parallel sessions difficult. In the future, there should be more careful attention to scheduling sessions of joint interest. Since the interactions between GEM and CEDAR were beneficial, future meetings should be set aside one day at each meeting where sessions of mutual interest should be scheduled (GEM/CEDAR day).

Frank Toffoletto outlined plans for the upcoming Fall 2005 AGU mini-workshop in San Francisco, to be held on Sunday December 4 in with the steering committee meeting following later in the evening. GEM will be returning to Snowmass for the 2006 summer workshop during the week of June 26. (The 2006 CEDAR meeting will take place one week earlier in Santa Fe; the 2007 CEDAR meeting will be the week of June 23 in Boulder.) Chris Russell suggested that GEM should consider a possible joint meeting with SHINE. Strangeway indicated that if a joint GEM-SHINE meeting were scheduled, it would most likely be held on the mainland. Frank Toffoletto told the committee that 2006 will be his last year as workshop coordinator and a replacement should be sought. It was suggested that GEM return to Snowmass in 2007 in order to ease the transition for the replacement workshop coordinator. However, if a joint meeting with SHINE is to be considered, a meeting at Snowmass may not be feasible.

3. NSF – Kile Baker

With the exception of the AMISR facilities budget, the NSF budgets have been decreasing. Kile Baker reported on the 2005 GEM competition where there were 40 proposals, after borrowing money from the facilities program, \$657 K was made available; with a 20% success rate. The breakdown for submitted/funded proposals was: 1/0 for GGCM, 8/1 for IM/S (funded for 2 years), 12/2 for Magnetosphere ionosphere coupling (MIC) and 15/4 for Global interactions (GI). It was noted by several people

that any GEM funded investigator should be encouraged to attend the GEM workshop and present their results. For the GEM/CEDAR/SHINE postdoc competition, 14 proposals were received, the breakdown for submitted/funded proposals was; 6/1 for CEDAR, 2/2 for CEDAR/GEM and 3/1 for SHINE (1 was withdrawn at the last minute).

4. NOAA – Howard Singer.

On Jan 9, 2005, NOAA Space Environment Center officially became part of the National Weather Service's (NWS) National Centers for Environmental Prediction (NCEP), which has proved to be a very positive move. Howard Singer noted that one benefit of becoming part of the NWS is that SEC has been able to make a few new hires. Janet Green will be joining NOAA; he also noted that approval has been requested for an opening for a person to aid in model transition. As of July 31st, Ernie Hildner has retired and a national search for his replacement will be undertaken. Space weather week was again a very successful meeting in 2005. The 2006 the meeting will be April 25-28 at the Boulder Millennium Hotel. Howard mentioned that there was a successful POES launch last month and that GOES-N, which will become GOES 13 on orbit, is scheduled to launch around 7/20/2005 (update: now waiting for launch mid August). Finally, he mentioned that there is a Broad Agency Announcement for a solar wind monitor and coronagraph and that there has already been one meeting with prospective proposers. He noted that the links between the operational weather community and the atmospheric science community are often viewed to be similar to the links between the magnetospheric science community and the SEC operations. He pointed out for example that the National Centers for Environmental Prediction will use the Earth System Modeling Framework and that there will be extensive opportunities for synergies between research and operations. Jimmy Raeder noted that an

external advisory committee on such issues would be beneficial.

5. NASA – Bob Strangeway, UCLA (for Craig Pollock)

NASA's Sun-Solar Systems Connections (S³C), Geospace Science Program, and Earth Science will be separated. The new NASA administrator Mike Griffin places a high value on science as an integral part of the NASA mission. The administrator has made personnel changes at NASA headquarters, returned funds to MO&DA and STP, and hinted that MMS and GEC may occur earlier. It was further reported that the associate administrator for Science, Al Diaz, is to retire. The current personnel consist of: Mary Cleave as the Sun-Earth System Division Chief; Richard Fisher as the Sun-Earth System Deputy Division Chief; Lika Guhathakurta as the LWS Program Scientist, Barbara Giles as the LWS/Geospace Program Scientist; Mary Mellott is the Geospace Discipline Scientist, Phil Richards as the ITM Discipline Scientist (IPA) and Craig Pollock as the Magnetosphere Discipline Scientist (IPA).

The FY 05 and FY 06 budgets included deep cuts to Explorer, STP, and MO/DA. However, sufficient funds were made available to maintain most operating satellites. A new S³C Roadmap is nearing completion and the MOWGs are to meet August 9-11 to review the roadmap. The advisory committee structure is to be re-formed in the fall. It was noted that four new Graduate Student Research Program (GSRP) proposals were funded in FY05 and that Supporting Research and Technology Program (SR&T) will proceed as presented in ROSES 2005, but the Guest Investigator Program 2005 competition is on hold and unlikely to occur. It was reported that solar terrestrial probes were expected to have significant funding restored. The Magnetospheric MultiScale (MMS) Instrument suite has been selected, with launch likely to be moved up from the current 2013 date. Global Electrodynamics Connections (GEC) possibly will start as early as

2009, and Magnetospheric Constellation (MC) will follow. Solar Terrestrial Relations Observatory (STEREO) development is proceeding well. In addition while Solar B has had some problems with the optics it is also proceeding well. The Living With a Star program Solar Dynamics Observatory (SDO) development is on track for launch in August of 2008. For the Geospace Missions, the Radiation Belt Storm Probes (RBSP). Notice of Intent is out and an AO is coming soon; the Ionosphere Thermosphere Storm Probes (ITSP) is next on the roadmap. The Inner Heliospheric Sentinels (IHS) is on next the roadmap after ITSP. In addition, the targeted Research and Technology (TR&T) Program amendment to ROSES 2005 is out. The International Living With a Star (ILWS) Steering Committee and working group meetings were held in Vienna, Austria, April 23-24, 2005. For the MO&DA, there were substantial cuts absorbed in both 2005 and 2006 and numerous missions were facing termination. Partial budgetary restoration has been realized. It was noted that the Senior Review Proposals are due October 4, 2005 and the Panel is to convene November 14-19, 2005, with results to be announced on or about February 6, 2006.

6. CCMC – Kile Baker, NSF (for Michael Hesse)

Kile started by reminding everyone that the CCMC is a collaborative interagency project that includes support from: NASA, NSF, AFOSR, AFMC, AFRL, AFWA, ONR, and NOAA. The CCMC runs of numerous space weather models on request, and has done over 500 runs to date. Geospace models include: the Open GGCM, Bats-r-us MHD code, and the Fok Ring Current model. Ionospheric models include the SAMI2 and CTIP ionosphere/thermosphere models and the Weimer ionosphere electrodynamics model. Solar models include the MAS model and the PFSS. Heliospheric models include ENLIL, heliospheric tomography models and the exospheric solar wind models. Many of the models included in

the CCMC come from either CISM or CSEM modeling efforts, including a new frameworks version of BATS-R-US model that is coming online. The Utah state GAIM model is also expected to be available soon. Future plans include more CCMC participation in education and it is hoped that there will be close collaboration with modelers. It was noted that George Mason University has added several space physics faculty positions and that there is expected to be close collaboration with the CCMC. The CCMC is also building a data infrastructure, along the lines of a virtual observatory.

7. CEDAR– Bob Strangeway, UCLA (for the CEDAR liaison Josh Semeter)

Based on discussions at the joint CEDAR/GEM lunch that was hosted by CEDAR on June 30, the joint meeting was deemed to be very successful and a reasonable timeline for another joint meeting would be 5 years.

8. SHINE – Chris Russell, UCLA (for SHINE liaison Dave Webb).

Pete Riley of SAIC is the chair, and David Alexander from Rice University will be the new workshop coordinator starting in 2006. Unlike GEM, SHINE does not work in campaign mode; SHINE has 3 working groups: solar sources, heliosphere and energetic particles. The SHINE student population is ~27 out of a total participation of 200. SHINE is anticipating ~\$1.4M in grants for FY 2006 and a total funding of ~\$2M for 2007, which would bring SHINE in line with GEM. Since GEM is planning on returning to Snowmass in 2007, the earliest time for a joint meeting would be 2008. Chris also mentioned that there is the possibility of smaller joint meetings focused on specific topics of mutual interest, such as numerical simulation techniques and reconnection. Strangeway suggested that IHY could help coordinate such a joint activity.

9. Campaign reports

Global Interactions (GI) – David Sibeck, NASA
Dave reported that the GI campaign had a ‘very interesting’ meeting that resulted in a working meeting over lunch on July 1 in order to resolve a few issues related to the focus of the campaign. It was determined that initially campaign sessions focused on regional issues but wanted to be process oriented. However, the participants enjoyed the meeting and several interesting presentations were made. The GI campaign would like to seek some connection to the IM/S campaign. He also noted that the anticipated launch of Themis in 2006 should invigorate the campaign. Jimmy Raeder suggested that a startup report for the GI campaign should be written.

Magnetosphere Ionosphere Coupling (MIC) – Jeff Hughes, Boston University
The Magnetosphere Ionosphere Campaign (MIC) had a very good meeting as a result of the interaction with CEDAR. The campaign is further enhanced by a new working group on Global MI-coupling led by Mervyn Freeman and David Murr. They ran 2 sessions: the first on global MIC, looked at the Iridium-based global field aligned current structure. This will probably lead to a modeling challenge to look at field aligned currents and global energy dissipation in the ionosphere. The second session was devoted to looking at multipoint correlations. This also will probably will lead to a modeling challenge to see if models produce similar correlations. He mentioned that there were sessions on auroral boundary outflows and noted that models are now attempting to model outflow, an activity that was not present a couple of years ago. There were other IM/S sessions on the auroral boundaries and the auroral acceleration gap.

Global Geospace Circulation Model Steering Committee (GGCMSC) – Jimmy Raeder, UNH
The GGCMSC had 2 tutorials at the 2005 workshop as well as a cosponsored session with

IM/S. Jimmy said he had wanted to have a GGCM-only session on GGCM issues, but that the joint meeting made planning rather difficult.

Inner Magnetosphere/Storms (IM/S) – Mike Liemohn, University of Michigan
The IM/S campaign had 14 sessions over 3 days at this year’s workshop. There were several sessions on the challenge. Mike reminded all that there will be a special issue of JGR for IM/S; the deadline for submissions is November 30. Based on feedback from meeting participants, approximately 25 papers are expected to be submitted. It is expected that the number of IM/S sessions in 2006 will be substantially reduced and will consist of wrap-up and joint sessions. He pointed out that one thing that has occurred in GEM is that it has brought together a substantial fraction of the GEM community working on the same science topic, often resulting in collaborations. He suggested that one thing remaining to be done is to bring the various plasma populations together as a whole. Bob Strangeway indicated that GEM would consider a proposal from the IM/S community that would put forward a scientifically compelling reason to continue or expand a working group. In order to be continued and an ongoing effort under GEM the working group would need to address specific GEM needs. Discussion on this topic was tabled for the December 2005 steering committee meeting.

10. International reports

Japan, JAXA/ISAS – Hideaki Kawano, Kyushu University

Both the Akebono and GEOTAIL satellites are still healthy, and the most of their instruments are still working with the exception of the electric field instrument on board Akebono and the Japanese high-energy particle instrument on board GEOTAIL. The GEOTAIL data is available at a website called DARTS (<http://www.darts.isas.ac.jp/stp.html>); it provides 3-second and 16Hz magnetic field data up to the end of 2004, and will soon provide plasma

moment data up to the end of 2001. Hideaki also mentioned that the proposals for support of the deep space network are due Oct. 5 and that it may be useful to have any GEOTAIL related papers submitted before this deadline; those who would like recent GEOTAIL data for their papers are welcome to contact Dr. Mukai for plasma moments and Dr. Nagai for magnetic field data.

Australia – Brian Fraser, University of Newcastle

While FedSat is still operating, the funding for the research center that provides ground support will be shut down after 7 years. Brian is also involved with the University of Alberta ORBITALS satellite search coil magnetometer payload in collaboration with Ian Mann and UCLA. The FedSat ground station at the University of South Australia in Adelaide will start gathering IMAGE data, with the possibility of providing real time IMAGE data. He reported that the TIGER radar is still operating and that the Unwin radar in New Zealand has been commissioned. The National Committee on Space Science is writing a decadal plan. A space advisory group including representatives from research institutions, industry and government agencies is coordinating a plan to present to government regarding space-related activities. Brian mentioned the possibility of having an AGU Western Pacific Meeting in 2008 in Cairns.

Canada – Eric Donovan, University of Calgary
The Canadian Space Agency's CANOPUS program has been superceded by Canadian GeoSpace Monitoring (CGSM, <http://cgsm.ca/>). CGSM includes NORSTAR (optical/riometers), CARISMA (magnetometers), NRCan (spaceweather.ca and CANMOS magnetomers), CADI (digital ionosondes), SuperDARN Canada (and the upcoming PolarDARN Canada), and the F10.7 cm solar radio monitor, as well as a dedicated modelling (FDAM) and data portal (ssdp.ca) program element. One of

the PolarDARN radars has been funded and they are awaiting funding for the other radars. For the THEMIS ground based observatories, there are plans for 16 ground based observatories, 5 of which are in place. The rest will be deployed by fall 2006. The ePOP satellite will be launched in the 2007-2008 timeframe and is designed to look at ion outflow in an 800 km/65° orbit. David Knudsen is carrying out Phase-A work for the electric field instrument on ESA's Swarm. The Canadian part of the ILWS currently comprises 2 proposed missions: 1. Orbitals which is led by Ian Mann that is now in moving into phase A and 2. the Ravens mission led by Eric Donovan. There is interest in absorbing Ravens into the planned Chinese KuaFu mission. There is a new space physicist at the University of New Brunswick (Thayyil Jayachandran). Eric reminded everyone that the upcoming 8th international conference on substorms (ICS-8) will be from March 27 to March 31 2006. The meeting is being held at the "Banff Centre" in Banff Canada (ics8.ca).

It was noted by Xochitl Blanco-Cano that the Spring 2007 AGU meeting will be in Cancun, Mexico and that proposals for sessions are encouraged.

11. Student report – Jichun Zhang, University of Michigan

In 2005, GEM supported 61 students, as compared to 62 students in 2004. Originally GEM had planned to support 65 students, however 4 students pulled out at the last moment, three as the result of one student (Austin Barker) who was tragically killed in a climbing accident in the Spring. He also gave the committee a report on the survey given to students concerning Sunday student tutorials. Next year's student representative will be William ("Bill") Peter from Stanford University.

12. GEM communications – Chris Russell, UCLA

Chris reported that there have been 47 issues of the GEM Messenger this year, up 7 from last

year. They plan to move the archive from an ftp server to an http server. As a result of feedback, they plan to issue no more than one GEM Messenger per day, combining several messages within each email. He urged everyone to get their reports in as soon as possible as he would like to get the GEMstone out by early September. Strangeway pointed out there are several members of the steering committee who have rotated off and that the web page needs to be updated.

The meeting adjourned at 9pm.

Frank Toffoletto, GEM workshop coordinator, July 29, 2005.

Geospace Environment Modeling: A New Way of doing Business: Invited Paper at Joint Session

Abstract

The GEM and CEDAR programs were responses to the establishment of the Global Change Program in the early 1980's. The objectives of the CEDAR program were more clearly relevant to Global Change and it was established first. GEM developed its objectives over a 4-year period culminating in a program start in September 1991 with its first annual summer meeting in June 1992. The work of GEM is accomplished in a series of campaigns whose working groups focus on solving specific problems and contributing the results to an improved Geospace General Circulation Model of the magnetosphere. A campaign has a finite lifetime (nominally 6 years). Two campaigns are usually in full swing at any time with a third campaign starting up or winding down. This process of renewal brings in new people, new approaches and new solutions to the problems of the magnetosphere.

A Brief History of GEM

The Global Change Program was a mid-1980's multidisciplinary, multiagency response to concerns about threats to the environment

from anthropogenic activities. In 1986 Juan G. Roederer proposed "that aspects of solar terrestrial research relevant to the total Earth system be incorporated as integral components of the Global Geosciences Program of the National Science Foundation". The program that was to become GEM was the magnetospheric community's proposed contribution to the Global Change Program. With the help of S.M. Krimigis, L. J. Lanzerotti and G. C. Reid, Juan Roederer met with NSF Director, E. Bloch, in September 1986. A proposal to hold a workshop was approved for funding and in August 1987 a workshop was convened at the University of Washington in Seattle to develop a focus for the fledgling GCP/STP program. Two options were examined: a narrowly focused study of solar irradiance and a thorough study of the general circulation of the magnetosphere. The latter objective had near unanimous support.

The 1988 defining document that emerged from the workshop described a series of three-year campaigns with up to three campaigns running in parallel to solve specific problems in the magnetospheric physics. In turn the campaigns formed working groups to concentrate on aspects of problems that appeared ripe for resolution. These working groups could be centered on observations, theory or numerical models. The output of the campaign was increased knowledge of how the magnetosphere worked, especially knowledge that could be incorporated into one or more Geospace General Circulation Models or GGCMs. A novel aspect was that the campaigns were to have finite lifetimes. Once the window of opportunity for a campaign had passed, the baton was given to a new campaign. This plan was instituted to keep GEM fresh, and to enable it (ultimately) to cover all of magnetospheric physics, despite its inability to address everything at once.

The blueprints for the first GEM campaign were laid down in a series of three workshops in 1989 and 1990. These were workshops on

magnetopause and boundary layer physics, on the ionospheric signature of the cusp, magnetopause and boundary layer processes, and on intercalibrating cusp signatures. Proposals for funding were solicited in early 1991 and selection occurred late in the summer of that year. The grantees met at UCLA on September 23-25, 1991 and immediately took steps to broaden the participation and leverage funding to achieve the purposes of GEM. A series of mini workshop on the day preceding the December AGU meeting were arranged followed by the first of the annual summer meetings in June 1992.

Plans Versus Reality

Originally each campaign was to be funded at between \$500K and \$1000K annually with three campaigns running simultaneously. Campaigns would run three years with funding coming from the Global Change program. The reality was that only about \$300K of new money could be found with eventually that total arising to \$500K. Thus there was only about 20% of the funding that was expected and only a few awards could be made. It was necessary to leverage other programs and agencies in order to be successful. In addition individual campaigns had to remain active longer to achieve their goals. Six years was chosen as the target duration of the campaigns. It was made clear to all that GEM was to be inclusive of everyone in the community who had an interest in these problems. Meetings were to be conducted in a forum that led to the ready exchange of ideas and friendly debate. The December mini-workshops and annual summer meeting soon became community traditions.

The Boundary Layer Campaign

The first campaign, the Boundary Layer Campaign, began in June 1992 and ran through June 1997 being treated in 6 summer meetings. It had working groups on the boundary magnetic and electric fields, on particle entry, boundary structure and transport, and on current systems

and mapping. It invented the grand challenge where modelers were invited to test these models against a well documented observation. At the beginning of the campaign, boundary layers were generally attributed to diffusive processes at the magnetopause, perhaps powered by the Kelvin-Helmholtz instability. However, the boundary layer campaign marked the ascendancy of reconnection as the key process in the magnetosphere for plasma, momentum and energy transport, not only on the nightside but also on the dayside.

The Magnetotail and Substorm Campaign

The Boundary Layer Campaign had the advantage of three workshops that helped define its objectives prior to the start of GEM proper. The magnetotail and substorm campaign used the first two GEM summer meetings to plan its directions and then in June 1994 ran its first full blown campaign sessions. There were working groups on onset signature, phenomenological models, quantitative models, and the tail/substorm challenge. The study of substorms is almost as old as the field of magnetospheric studies and many of the early substorm practitioners were still active during the GEM campaign. Thus the field had much historical baggage. In addition a “competing” series of international meetings on substorms (The International Substorm Conferences) were begun, drawing off some of the energy of the community. The campaign tried to reinvent and reinvigorate itself in June 1999 with new blood and working groups on observations, on quantitative models, on triggering, and on steady convection but no clear consensus emerged on substorm processes. After ten years the campaign was terminated and no report on the results of the campaign has yet been written.

The Inner Magnetospheres/Storms Campaign

The Inner Magnetospheres/Storms Campaign was also given two years to define itself and in June 1998 it held its first full campaign meeting: It established working groups

on the plasmasphere and ring current, on injection and recovery mechanisms, on energetic electron variability, on the radiation belts and on ULF waves (in 2003). The campaign has had its last full meeting this year and will summarize its findings and close off its program in the 2006 meeting. Thus the Inner Magnetospheres and Storms campaign will have run a total of nine years, not including the two planning years. This campaign also reinvented itself in midstream but principally because the original lead coordinator (A. Chan) had other organizational responsibilities that demanded most of his time so a new lead (M. Liemohn) was selected.

Magnetosphere–Ionosphere Coupling Campaign

GEM's fourth campaign, the Magnetosphere Ionosphere Coupling Campaign began in June 2001 and now is in the middle of its campaign. It has working groups on mass exchange, on electrodynamics and on global M-I coupling (in 2005).

Global Interactions

Global Interactions, GEM's fifth campaign, is an amalgamation of two competing ideas for campaigns on solar wind interactions and on plasma transport. This year (2005) was the first year of the campaign with a planning year in 2004. It has working groups on reconnection dynamics, cusp and low latitude boundary layer and on plasma acceleration and transport within the magnetotail. This campaign brings new communities into GEM.

Geospace General Circulation Model

The original concept of GEM was to develop modules that would be assembled into one large model of the magnetosphere. It was eventually realized that such an effort would be impractical and that one would need instead a "spine" model which might then be augmented by submodels for specific processes or regions. In addition, it was also realized that one GGCM might not be sufficient but that multiple

competing GGCMs would be desirable which may have different strengths and weaknesses. In the mean time several spine models have emerged and they are all based on the MHD approximation. None of these models were primarily an outgrowth from the GEM program since GEM could not provide sufficient funds for model development, which came mostly from different sources. However, GEM played a crucial role in formulating "challenges" that tested the models' capabilities and limitations. GEM and NSF also played a crucial role in the establishment of the Community Coordinated Modeling Center, which at present houses multiple magnetosphere models for use by the community. Current GGCM work, pursued by several groups, focuses on coupling the MHD spine models with submodels, in particular models that cover the ionosphere/thermosphere, the ring current, and M-I coupling.

Originally the development of the GGCM was overseen by a steering committee. After several years the GGCM Steering Committee requested Campaign status and received it. Soon it was appreciated that the GGCM development is not suited for a campaign mode attack. Rather the other campaigns feed results to it. Thus the GGCM is managed by a steering committee once again.

Workshops

GEM holds two regularly scheduled meetings each year. One set, referred to as the mini-workshops, is scheduled the day before the December AGU meeting. Any working group that requests a session is afforded a 2-hour session. Generally about half the working groups request a session. This allows the more interactive working groups to maintain momentum. The GEM Steering Committee meets in the evening after the mini workshops.

The main annual meeting is usually held on one of the last two weeks of June. This meeting runs six days and all working groups are expected to participate. The first day of the

summer meeting is reserved for student-run tutorials. This day is organized by and for the students. In the evening a reception is held at which old acquaintances are renewed and the work of the conference begins. To minimize the cost of the meeting for participants the agenda has been structured so one campaign was emphasized over the first two days and a second campaign over the last two days with the middle day for campaigns that were starting up or winding down, plus the activity of the GGCM. This allows attendees to choose to participate profitably in a three-day meeting if they chose to focus on only one campaign. A smaller registration fee is charged for those attending three days. The banquet is held on Wednesday night and is included in the registration for Monday-Wednesday or Wednesday-Friday groups. Recently few have been utilizing this option. Tuesdays and Thursday evenings are reserved for poster sessions associated with the campaign(s) active on that day. The Steering Committee meets on Friday evening.

A typical day at a summer GEM meeting begins with a plenary session for all attendees. Generally at 0815 AM there are two tutorials followed by announcements. In particular the working group meeting organizers describe their sessions and invite interested participants to them. After the break there are two or more working groups. The idea is to break up the attendees into smaller groups that are small enough to have real working sessions. Formal presentations are discouraged. After the lunch break there are two more sessions, in each of which parallel meetings of different working groups are held. There is a conscious attempt to ensure that the same two working groups are not always in parallel so that attendees can sample the work of other teams. Often working groups have joint meetings on a topic of interest. Splitting up into smaller groups works best if the working group then reports back to a committee of the whole. There has not been enough of that in recent years and we encourage that more

summarizing and reporting at the meeting takes place. The posters (on Tuesdays and Thursdays) take place after the dinner break.

Communication

GEM maintains two newsletters. The GEM Messenger conveys brief messages of relevance to the entire GEM community. These might be notices of sessions scheduled at the December or June meetings; an issuance of a GEM challenge; a job opening or a research opportunity. The newsletter is sent to the GEM mailing list at the first opportunity. These messages are sent electronically only and are maintained on line at UCLA. The second newsletter is the GEMstone, an annual newsletter that attempts to capture all the deliberation of the summer workshops. These serve as the main archive of the GEM program. The GEMstone's ftp site is sent out electronically to the GEM mailing list. The GEMstone is available on request in paper form.

GEM Steering Committee

The membership on the GEM Steering committee consists of a chair and about six regular members each selected for 3 years term. The terms are staggered to retain some corporate memory. The selections are made so as to have expertise on the Steering Committee in each of the active campaigns. The rotation of committee members ensures that a significant number of members of the GEM community can participate in the running of GEM. In addition to the regular members there are liaison members from other organizations and countries as well as the current student representative.

The student representative is generally elected by the students and given the responsibility of running the student day at the following meeting. This student then reports on the student activity at the steering committee meeting following his session. Liaisons have been set up with other programs such as CEDAR and SHINE; with organizations such as NASA and NOAA; and with countries such as Canada and

Mexico. Also attending the meeting are NSF's Program Director for GEM and the GEM meetings and communications coordinators.

Concluding Remarks

This year's meeting was GEM's 14th annual meeting. Over this period it has been able to renew itself by faithfully following its campaign mode of doing business. It has brought in fresh communities of scientists, fresh topics and new ideas. GEM has been successful despite having been underfunded since its inception. It has leveraged activities and funding from other programs and organizations, and per force it has had to work at a slower pace. GEM has struggled to avoid being another "AGU" meeting. It has split itself into manageable working groups, and worked in parallel sessions with reportage back to the other working groups when conclusions were drawn. The amount of

this reporting back has dropped in recent years. We need to reinvigorate this process. Ending campaigns has been difficult. A firm date must be set when a campaign is approved. Finally, a high level of satisfaction has been expressed by the GEM community. The attendance of the meetings continues to grow.

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

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Current GEM Structure	
GEM Steering Committee Chair: Bob Strangeway	
Inner Magnetosphere/Storm Campaign:	Convener: Mike Liemohn/Dennis Gallagher
<i>Working Groups:</i>	Plasmasphere and Ring Current - Dennis Gallagher and Margaret Chen
	Radiation Belts – Reiner Friedel and Richard Thorne
	ULF Waves – Brian Fraser and Mark Moldwin
GGCM Science Steering Committee	Convener: Jimmy Raeder
Magnetosphere-Ionosphere Coupling Campaign	Conveners: Ray Greenwald and Jeffrey Hughes
<i>Working Groups:</i>	Mass Exchange - Bill Peterson and Robert Winglee
	Electrodynamics – Josh Semeter and Bill Lotko
	Global MI Coupling – David Murr and Mervyn Freeman
Global Interactions Campaign	Conveners: David Sibeck and Tai Phan
<i>Working Groups:</i>	RCOL - Jean Berchem and Nick Omid
	PATM - Terry Onsager and Antonius Otto

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