The GEMstone

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NOTES FROM THE NSF PROGRAM DIRECTOR

The Centerpiece for the Magnetospheric Physics Program

I pretty much say this every year and it's getting harder and harder to come up with a way of saying it differently. The GEM program continues to be the centerpiece for the Magnetospheric Physics program at NSF. The superb research being conducted by the GEM community is a great source of pride for me, and the envy of my colleagues at NSF. The GEM summer workshop continues to grow in size and the student participation grows more vibrant with every year. This year, the summer workshop will be held in Santa Fe simultaneous with the CEDAR workshop. I predict that we will have a new group of CEDAR attendees who come to GEM sessions and discover just what a great gem we have in GEM.

Last year (Fiscal Year 2004) 16 regular GEM proposals were submitted to NSF and an additional 22 proposals were submitted to the joint CEDAR/GEM Magnetosphere-Ionosphere Coupling competition. There were also 6 proposals submitted to the GEM postdoctoral competition. Of the 16 regular GEM proposals, 15 were submitted for the IMS campaign and 1 was submitted for GGCM development. Out of the 15 IMS proposals, 7 were funded and the single GGCM proposal was also funded. Out of the 22 CEDAR/GEM M-I coupling proposals, 7 were funded, with approximately half the money coming from the GEM program and half coming from the CEDAR program. The median award size is almost $90K/yr, an increase of nearly $10K from FY2003. The increased award size is both good and bad news. One of the NSF goals is to increase the size of awards, and that is certainly to the benefit of PI's who receive awards. In an environment of increasing NSF budgets it was quite possible to increase award sizes without decreasing the overall success rate. Unfortunately, as we all know, the 5-year plan for 15% annual budget increases only lasted 2 years and then only at a reduced level of ~10% increases. We are not going to go back to making smaller awards and forcing PI's to drastically cut their budget requests, but the obvious result is that the success rate is likely to go down.

The deadline for the FY2005 GEM proposals has just passed and the number of proposals stands at 40 (about the same as the GEM + M-I coupling proposals from last year).

IN THIS ISSUE

GEM Homepage URL

http://www-ssc.igpp.ucla.edu/gem/

The breakdown is 9 proposals for the Inner Magnetosphere/Storms campaign, 12 proposals for the Magnetosphere-Ionosphere Coupling campaign, 1 for GGCM development, and 18 for the new Global Interactions campaign.

The big news in the Upper Atmosphere Research Section (UARS) at NSF is that the solicitation for proposals for Faculty Development in the Space Sciences has been extremely popular. We are very proud of this program and the strong response from the space sciences community indicates that it was truly something that needed to be done. We have received 36 proposals (!) and they all appear to be very high quality proposals. Reviewing these proposals and determining which ones can be funded is going to be a very difficult job. Each of the discipline programs (Aeronomy, Magnetospheric Physics, Solar-Terrestrial Research) within the UARS section has set aside $400K/yr for the next 5 years to fund this effort. Since no new money was made available for this program, the money had to come from our research programs, and this translates to a loss of 6 or 7 normal research grants for each program. To the extent possible, I am trying to limit the impact this will have on GEM, but an impact there will nevertheless be.

Outlook for the Future

There appears to be no prospect for a return to significant increases in the NSF budget at least for the next few years. As I write this, we have been authorized to spend up to 95% of the FY2004 budget. The bills pending in the House and Senate could lead to having the 95% level being the final level for the year if the House markup is used. On the other hand, if the Senate markup is used we could see a very modest increase of about 1% at the program level. The most likely scenario lies somewhere between those two.

In such a constrained budget environment, it is important for everyone to take advantage of every funding possibility. Watch for special NSF programs such as Research in support of the National Space Weather Program, Collaborations in Mathematics and the Geosciences (CMG), Information Technology Research (ITR), Cyber-Infrastructure (CI), and Major Research Instrumentation (MRI). Watch for opportunities in the NSF/DOE Partnership in Basic Plasma Research and Engineering. If you have not done so already, go to the NSF web pages and look for opportunities in the cross-cutting programs that you might take advantage of. Find out what opportunities there might be for funding directly from the Dept. of Energy, the Office of Naval Research, and the Air Force Office of Scientific Research. And, obviously, be aware of the funding opportunities at NASA.

Although the funding situation for GEM (and the Magnetospheric Physics program in general) is not rosy, neither is it bleak. I will continue to do what I can to ensure that GEM remains a vibrant program.

A reminder to young GEM researchers: the next round of CEDAR/GEM/SHINE postdoctoral research proposals (see NSF 04-573) are due this coming February 7. Please read the announcement carefully before submitting a proposal, since postdoc proposals have different requirements from normal GEM proposals.

Summary

GEM has had another very successful year. Although funding for GEM is likely to be very tight for the next few years, I expect GEM to continue playing a vital role in the Magnetospheric Physics Program. I look forward to seeing everyone in the GEM community in Santa Fe this summer where we will be able to interact with the members of the CEDAR community. We are also looking for ways to enhance our interaction with the SHINE community in future years.

My thanks to Frank Toffoletto, Umbe Cantu and all the staff at Rice University, as well as all the students who work so hard to make the GEM workshops a success. And my thanks to Chris Russell, our institutional memory and archivist for all things GEM related.

Dr. Kile Baker
Program Director,
Magnetospheric Physics
National Science Foundation
Tel: (703) 292-5819, Fax: (703) 292-9023
`kbaker@nsf.gov`

Notes from the Chair

GEM Steering Committee Chair Report

The 2004 GEM Summer workshop was held from June 20 - 25, 2004 at Snowmass Village, Colorado. The meeting began on Sunday afternoon, June 20, with the student tutorials, organized by Michelle Reno, GEM student representative. The student consensus was that the tutorials were generally of extremely high quality and worth attending. Thanks are due to Michelle and the student presenters for the hard work they did in preparing the student tutorials. The GEM student representative for 2005 is Jichun Zhang of the University of Michigan.

For this workshop there were three active campaigns: Inner Magnetosphere/Storms (IM/S), Magnetosphere Ionosphere Coupling (MIC), and the new Global Interactions (GI) campaign. The Geospace General Circulation Model campaign has been recast as a Science Steering Committee (GGCMSSC) that works closely with the campaigns, co-sponsoring sessions and identifying topics that have direct bearing on the development of modules for a GGCM. The GGCMSSC also assists the campaigns in ensuring that they remain focused on the GEM goal of developing a Geospace General Circulation Model.

The IM/S campaign held its working group workshops in the first half of the meeting. This campaign has one full year to go and has defined an IM/S campaign challenge to complete the campaign's effort. A description of the challenge, as well as reports from the IM/S working groups was presented in the GEM Newsletter by the new Campaign Coordinator, Mike Liemohn, who has taken over for Anthony Chan. Thanks to Anthony for the hard work he has done in directing the campaign, and to Mike for taking on the continuing task of coordinating the campaign.

The other mature campaign is the MIC campaign. The MIC campaign held its workshops during the latter half of the week. This campaign addresses magnetosphere-ionosphere coupling from two aspects: electromagnetic coupling and mass coupling. The former specifically addresses the affects of small-scale processes on electromagnetic coupling, while the latter addresses the role of the ionosphere in supplying plasma to the magnetosphere. Both these efforts are at a crucial stage were they are determining how to parameterize the coupling processes in a way that is meaningful for global simulations.

The new GI campaign held its workshops during the middle of the week. David Sibeck and Tai Phan have been asked to serve as Campaign Coordinators, and they have done an excellent job in organizing the campaign and defining working groups for the campaign. The GI campaign workshops helped to further define the primary goal of the campaign, which David Sibeck summarized in a recent GEM Newsletter as being to determine the means by which solar wind plasma enters the magnetosphere and is energized and otherwise processed to contribute to the plasma sheet.

Many of the GI campaign workshops were well attended, with much discussion as to the scope of the new campaign. The overall scope is as noted above, investigation of the mechanisms for solar wind plasma entry into the magnetosphere, and how that plasma contributes to the plasma sheet. More specific goals will be defined by the working group chairs and the campaign coordinators. Both the goals and scope are expected to evolve throughout the campaign, being driven by the scientific interests of those who participate in the campaign.

The GI campaign specifically addresses solar wind plasma entry. The ionosphere is also a source of plasma for the magnetosphere, and should not be ignored. This plasma source, however, is currently under the auspices of the magnetosphere – ionosphere coupling campaign. Because the two plasma sources are of potentially equal significance, and further because some of the processes driven by solar wind – magnetosphere coupling in turn drive mass outflows from the ionosphere, there is an overlap of interest between the GI and MIC campaigns. At present the two plasma sources will be treated separately within their respective campaigns, but it is expected that the campaign coordinators and working group chairs will establish cosponsored sessions at the 2005 GEM summer workshop.

The 2005 GEM summer workshop will be held in Santa Fe, New Mexico. This meeting will be held at the same time as the Coupled Energetics and Dynamics of Atmospheric Regions (CEDAR) annual summer meeting. Although both meetings will be in Santa Fe, they will be held at separate locations. Since the two locations are reasonably close, at least one joint plenary session is being planned, with additional joint workshop sessions. The CEDAR and GEM representatives will meet at the Fall 2004 AGU meeting to finalize the details of the joint sessions. Topics likely to be included in joint sessions include polar ionospheric phenomena, contrasting the CEDAR and GEM perspectives on phenomena such as Joule dissipation and mass outflows. The MIC campaign is expected to be actively involved in this effort. The IM/S campaign may also be involved through the campaign's interest in sub-auroral phenomena such as Sub Auroral Polarisation Streams (SAPS), and plasmaspheric refilling, both of which are also of interest to the CEDAR community. Joshua Semeter is the CEDAR liaison with GEM.

Robert J. Strangeway
Chair, GEM Steering Committee
Phone: +1-310-206-6247
strange@igpp.ucla.edu

AGU GEM Mini workshop
December 12, 2004

This years fall AGU GEM mini-workshop will be held on the afternoon of Sunday December 12, 2004. Details will be posted on the GEM workshop website at http://gem.rice.edu/~gem

Next GEM Workshop
June 27- July 1, 2005
Santa Fe, New Mexico

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.

2004 WORKING GROUP REPORTS

Magnetosphere Ionosphere Coupling Campaign

Working Group 1: Plasma outflow

The Magnetosphere-Ionosphere Campaign WG 1 on plasma outflow sponsored a tutorial by Prof. Robert Schunk, Utah State University, entitled: "The Extended Ionosphere" and four breakout workshop style sessions, one of which was jointly sponsored by the GGCM Campaign.

The Schunk Tutorial set the tone for the discussions that followed. An electronic copy of the tutorial is available on the GEM tutorial web site:
http://www-ssc.igpp.ucla.edu/gem/tutorial/index.html

The tutorial was followed by extended presentations by Takume Abe and Matt Huddleston focused on recent polar wind observations from the Japanese Akebono and NASA Polar satellites. Abe summarized the extensive (14 year data set over the altitude range 500-11,000 km) polar wind mass-resolved density, temperature, and velocity observations from Akebono. He made the point that all the evidence shows that thermal O^+ escapes due to hydrodynamic expansion in response to plasma pressure gradients along magnetic field lines during quiet ionospheric conditions, which makes it an integral part of the polar wind. He also presented evidence in the extensive Akebono data set that solar illumination is responsible for generating the plasma pressure gradients driving the O^+ component of the polar wind. Huddleston summarized an extensive study of the polar wind intensity observed over many years at ~$1R_E$ during Polar perigee passes by the TIDE instrument. He used these data as an input to a transport model and showed that the observed polar wind intensity is strong enough to account for all of the plasma in the Earth's magnetosphere. In the discussion following these talks it was suggested by Huddleston and Peterson that reasonable estimates based on several data sets show that both the solar and polar wind are independently capable of supplying all of the plasma in the magnetosphere. The problem, then, seems to be that the sinks and escape routes for magnetospheric plasma are not well understood.

Other extended introductory talks were given by Mike Liemohn, Vahe Peroomian, Aaron Ridley, and Tony Lui addressing the subjects of where does ionospheric plasma go and what processes does it modify and/or control. Robin Coley, Karen Remic, Jay Johnson, Steve Mende, Robert Winglee, Bob Strangeway, Laila Andersson, Chris Mouikis, Shin Ohtani and many others made contributions.

The discussions in the break out sessions were lively. Topics included: What is the dominant source of magnetospheric plasma? What are the physical manifestations of ionospheric outflow? and what are the viable modeling approaches to addressing these questions?

On the topic of the dominant plasma source: Joe Borovsky, using LANL and ISEE data, made a very convincing argument that solar wind plasma dominates the magnetosphere at all times. Joe's presentation was made earlier in the week in the Global Interaction Campaign sessions. As noted above the presentations in the MI Coupling Campaign came to the conclusion that the outflow of ionospheric ions is intense enough at all times to account for all of the magnetospheric plasma. The conclusion seemed obvious at the end of the Working Group 1 discussions: More emphasis needs to be placed on loss, not source, processes.

On the topic of the physical manifestations of ionospheric outflows: The presentations and discussions identified modification of the reconnection rate (Ridley), reconnection structure (Winglee), and saturation of the cross polar cap potential as the most important physical consequences of the varying concentration of heavy ions in the magnetosphere.

On the topic of modeling approaches: The question is how to incorporate the ionospheric source into the model. Single particle tracing approaches presented showed remarkably different results when they focused on the solar wind source (Peroomian) and the ionospheric source (Liemohn/Moore). We had an extended discussion on the strengths and weaknesses of including ion outflow in single and multiple fluid MHD codes.

Working Group 1 held a joint session with the GGCM Campaign on Wednesday afternoon addressing the topic: Can ion outflows be reliably specified simulated or specified? Aaron Ridley was the GGCM Co-Convener and chaired the session.

An interval (14:30 on 3/18/97 to 02:00 on 3/19/97) with well defined solar wind conditions and mass resolved ion outflow data available from Akebono, Polar and FAST was selected as an example. Data for this interval is available at the URL:
ftp://willow.colorado.edu/pub/exchange/GEM/

Presentations were made by Bob Strangeway, Peter Chi, John Lyon, Robert Winglee, Aaron Ridley, J. Schoendorf (by Aaron Ridley), Jimmy Raeder, and Laila Andersson.

There was a spirited discussion of what is possible and what is wistful thinking in this well attended session. One conclusion was apparent after the discussion however. The “gap” region from the topside ionosphere to the region where global models start at, 2 or 3 R_E, is where ion acceleration occurs and where potential drops decouple magnetospheric and ionospheric electric fields. Processes occurring in the “gap” region therefore are important to global models in that they modify ion outflow trajectories and convection patterns. None of the current models attempt to address processes occurring in the gap region.

Tony Lui, in his extended talk on the last day, summarized the unresolved critical issues relating to the ionospheric plasma source in magnetospheric models. 1) What is the relative contribution of the polar and solar winds to the current sheet in the magnetic tail? 2) What are the effects of varying mass composition on the location and rate of reconnection? 3) What are the effects of varying mass composition on the distribution of pressures within the magnetosphere, and 4) How can we effectively use ionospheric components as tracers of transport in the magnetosphere.

Bill Peterson, Co-Chair
Pete@willow.colorado.edu
Robert Winglee, Co-Chair
winglee@ess.washington.edu

Working Group 2: Electrodynamic Coupling

MI Coupling Campaign Working Group 2 on the “Electrodynamics of MI Coupling” hosted a tutorial by Dr. Chris Chaston from UCB/SSL entitled "Alfvénic Acceleration Processes in MI Coupling” and the three breakout sessions described below.

Breakout 1. Beyond the Knight relation
(William Lotko, chair)

This breakout group is concerned with the physics governing the transition between thermal and nonthermal plasmas in the ionosphere and magnetosphere. Observational evidence suggests that several distinct mechanisms contribute to accelerating auroral particles (e.g., Alfvén waves, mirror force, electrostatic turbulence, transverse ion heating), but their relative importance in affecting electrodynamic MI coupling remains unclear. How such kinetic processes can be parametrically embedded within global models to give meaningful predictions of fluxes and rates also remains at issue. This year, the discussion focused primarily on acceleration in the downward current region, with the overarching goal of determining whether a parametric description (i.e., a Knight-type relationship) of this important return current region is possible.

E- and F-region density cavities form in downward current regions due to the exodus of upward flowing electrons required to carry the field-aligned current (Doe). Characteristic values include 50% depletion, 80-km average height, standard deviation of 25km, and 100-500s formation times. Doe's simulations assume a fixed exospheric potential and compute plasma evacuation. No enhancement in FAC is included in Doe's model. Evacuation time of ~15s is typical. Extreme density gradients near polar cap boundary would affect evacuation time and magnitude. As discussed in Breakout 2 below, this effect promotes feedback-unstable ionospheric resonator oscillations (IAR); the associated IAR Alfvén waves can give rise to electron acceleration and soft electron precipitation when the perpendicular wavelength of the Alfvén waves in the low-altitude magnetosphere approaches the electron inertial length there or when the field-aligned current of the Alfvén wave is sufficiently intense to promote current-driven micro-instabilities and anomalous resistivity and parallel electric fields.

The so-called pressure cooker effect (Gorney et al., 1985) occurs in downward current regions when a downward parallel electric field retards upflowing ions. In such regions, the confined ions are heated by microturbulence, which tends to enhance the perpendicular energy of the ions. When the resulting enhanced upward mirror force on the ions is sufficient to overcome the force of the downward parallel electric field, the ions are released to the magnetosphere. Although Alfvénic auroral regions near the polar cap boundary exhibit the highest number and energy flux of both up- and downflowing electrons and of outflowing ions resulting from enhanced ambipolar fields and transverse heating in the topside region, large-scale downward current regions typically persist for much longer periods than the substorm-related Alfvénic aurora, implying that the time-integrated ion outflow in downward current regions may exceed that in Alfvénic auroral regions (Lynch). An observational study of FAST Orbit 1626 by Lynch et al. (2002) shows that $J_{\|} \cdot E_{\|}$ (dc current) in an observed downward current region is well correlated with broadband ELF fluctuations, ion heating and outflow. We need to move from a case study of this effect to a statistical study.

The event reported by Lynch et al. (2002) has been modeled by Jasperse. The model includes a weak quasi-neutral parallel electric field effectively sustained by a parallel pressure gradient. This 1D model does not include Alfvénic $E_{\|}$ arising from electron inertial effects at transverse wavelengths < 10 km, nor does it include Debye scale $E_{\|}$ associated with double layers that have been observed by Andersson et al. (2002) in downward current regions. Test particle simulations suggest that these nonlocal double layers, which travel upward at 10-30 km/s (ion acoustic like) regulate on the ion outflow (Ergun). Double layers with downward directed $E_{\|}$ are presumably created when the ion upflow is strongly enhanced by transverse heating at low altitudes; double layers prevent ions from leaving the flux tube too quickly. Plasmasheet electron precipitation can stabilize such double layers at larger $E_{\|}$, giving rise to a larger parallel potential drop across the layer (Anderson). Ion conics observed below such double layers exhibit heating over an extended altitude; a localized heating model in the double layer itself doesn't explain observations.

This work raises several questions: What is the relation between quasistatic processes and highly dynamic processes involving Alfvén waves? How do return currents work? What is distribution of energy dissipation along the field line? What is distribution of potential drop along field line? Is there a knight relation in the return current region?

Schunk suggests that horizontal transport should be important in the test particle simulations of duration of ~ 2000s described by Ergun. The ion outflow may not be passing through the double layers$_{|}$, but "sneaking" between them. Recent work by Cattell shows that the occurrence probability of upflowing electrons in downward current region rises linearly from lower altitudes, in sharp contrast to the occurrence probability of upflowing ions in upward current regions, which exhibits a rapid rise starting at 2000km. This suggests that the acceleration processes and nature of $E_{\|}$ in downward and upward current regions is very different.

Breakout 2. Ionosphere-Magnetosphere Feedback (Joshua Semeter, chair)

Since Atkinson first proposed that positive feedback between the ionosphere and magnetosphere could contribute to auroral formation, much detailed modeling work has been done to refine and expand on this concept. Ionospheric feedback and, more generally, Alfvénic resonant modes have been used to address the complete hierarchy of spatial and temporal scales observed in auroras, field aligned currents, and Poynting flux. Observational evidence for these models, however, remains indirect and incomplete. This breakout focused on the state of research on feedback mechanisms in MI coupling, with specific emphasis on methodologies to link observations and modeling in a meaningful way. Similar to the previous breakout, we are ultimately interested in the extent to which such feedback interactions regulate large-scale processes.

The finite transit time of accelerated electrons traveling between the high-latitude ionosphere and low-altitude magnetosphere produces a phase difference between the field-aligned current at the E layer and ionization in the layer (Lysak). This effect modifies the synchronization required for the feedback instability. The ionosphere is currently treated as an electrostatic substrate in all global models. At transverse length scales of several hundred kilometers and on time scales less than about 10 seconds, the ionospheric response becomes inductive (Yoshikawa, 2002). This effect introduces a phase shift between the field-aligned current at the E layer and the field-aligned current. The kinetics of electron acceleration give rise to a nonlocal Ohm's law, as first described by Tikhonchuk and Rankin (2000) and extended by Lysak and Song (2003). This effect also introduces a phase shift in the current-voltage relation that is modeled more simply for > 10-sec time-scale phenomena in global models via the "Knight relation."

Theory and modeling show that the conditions in downward current field-aligned current channels are conducive to the development of the feedback instability (Streltsov and Lotko, 2003). As noted by Doe in the Breakout 1 report above, the upward exodus of upward flowing electrons in downward current channels is responsible for depleting the plasma density that promotes feedback instability. Low-altitude satellite observations, e.g., from Freja and FAST, record strongly enhanced fluctuations in downward current channels (primarily) in small-scale perpendicular electric fields, which are consistent with ionospheric Alfvén resonator (IAR) oscillations stimulated by feedback instability. Furthermore, the F0F2 density peak sets the maximum value of Σ_A (Alfvén conductivity) in the ionosphere. Simulations of feedback instability, including the ionospheric parallel inhomogeneity, show that when Σ_A is comparable to or greater than Σ_P (Pedersen conductivity), the feedback unstable IAR oscillations in downward current channels extend into the topside ionosphere and low-altitude magnetosphere where satellites can observe them. In the opposite case of $\Sigma_A < \Sigma_P$, the feedback unstable oscillations are confined primarily to the region below the F0F2 peak (Streltsov).

An analysis of the ion production rate by precipitating electrons shows that tall columns of O^+ ionization are produced at altitudes of ~ 400km by soft electron precipitation associated with Alfvénic aurora (Semeter). This effect gives rise to sharp transverse gradients in both Σ_A and Σ_P in the F region, which regulate the development of feedback-unstable Alfvén waves via the mechanism described above by Streltsov.

Hemispherical asymmetry in the conductivity can regulate the development of the feedback instability of fieldline eigenmodes, giving rise to a large $E_{||}$ that accelerates electrons preferentially in the winter hemisphere, for example, where Σ_P is strongly depleted relative to that in the summer ionosphere (Pokhotelov et al., 2002). Another, and possibly more important, effect that regulates electron acceleration in both quasistatic and feedback unstable field-aligned currents is the density distribution along the field line. In the winter hemisphere, the topside density scale height is much lower than in the summer ionosphere. The resulting depleted density in the low-altitude magnetosphere requires a larger electron parallel drift to sustain a given field-aligned current. Therefore, one expects current-driven instabilities, microturbulence, and anomalous $E_{||}$ to be more prevalent in the low-altitude winter magnetosphere. Inclusion of this effect in simulations of feedback instability shows that while the hemispheric asymmetry in Σ_P determines whether and in which hemisphere feedback instability will occur, it is actually the topside density scale height that determines whether such feedback unstable oscillations will produce $E_{||}$ and the magnitude of the accelerating potential (Lotko).

Breakout 3. Global-scale asymmetries in MI coupling (Nikolai Ostgaard, chair)

Synoptic measurements of high-latitude electromagnetic fields, currents, and auroras have revealed both longitudinal and hemispheric asymmetries. Such global-scale MI coupling effects should be predicted by global models, yet many fundamental questions remain. For example, can asymmetries in auroral intensity and morphology be accounted for as the IMF influence on the magnetospheric configuration and tilt angle? How well are these effects incorporated in magnetic field models? Does the state of the ionosphere play a role, for example, in observed dayside/nightside asymmetries in Joule heating? Which is more important in the development of non-conjugate phenomena, seasonal conductance differences or interplanetary magnetic field orientation? This year the breakout group focused on longitudinal and hemispherical asymmetries that are observed in polar cap potentials, field aligned currents and aurora, and how well models can reproduce/predict these findings.

Ostgaard opened by showing simultaneous imaging data of substorm onsets and nightside auroral features and how the relative displacements (up to 2 MLT – 30 degrees) of the features are organized by the IMF clock angle. He interpreted this to result from the tension force acting on newly opened field lines as they convect from dayside to nightside. When IMF has a By component, only field lines with asymmetric footprints can ‘find each other’ and reconnect in the tail. A secondary effect (maximum 1 MLT) controlled by the tilt angle was explained by the strongest FACs appearing in the sunlit hemisphere. The asymmetries are not predicted by Tsyganenko models.

The IMF controlled spatial asymmetries of the substorm onset were supported by conjugate observations from one camera (VIS Earth camera on Polar) presented by Nicky Fox. She also showed the expected changes in convection patterns inferred from SuperDARN data overlaid the images.

Gang Lu showed AIME results in the conjugate hemispheres for different IMF orientations. For southward IMF, the polar cap potential drop was very similar in the two hemispheres, while for northward IMF the differences could be a factor of 2, with the largest potential drop in the hemisphere where tail lobe reconnection is most efficient due to the IMF Bx and By components. She also showed that the intensities of FACs were strongly controlled by tilt angle, where FACs in the sunlit hemisphere could be a factor 2 of the FACs in the dark hemisphere.

Bill Lotko showed how one can model the difference in field aligned electric fields when the larger scale height of the upper atmosphere due to solar illumination is taken into account. His results showed larger field aligned potential drops in the darker hemisphere than the sunlit hemisphere providing an explanation to statistical results by e.g., Newell et al.

H Korth presented Iridium results of FACs in the two hemispheres. For southward IMF, he showed that the FACs in the conjugate hemispheres are mirror-symmetric around a fixed (i.e., not IMF dependent) axis tilted towards pre-noon. The symmetry implies that the high-latitude FACs near noon are located on open field lines and are consistent with the IMF By dependent reconnection driven on opposite “flanks” of the magnetosphere. As the spatial resolution of the Iridium FAC distributions is limited to the spatial separation of the orbit planes (~30 degrees), no spatial asymmetries in the nightside ionosphere due to IMF orientation could be observed.

Shin-Ichi Ohtani presented seasonal statistical results of large-scale FACs based on magnetometer DMSP data. The dayside FAC latitude was found to shift poleward (equatorward) in the summer (winter), while nightside FACs have the opposite seasonal dependence. Over the entire range of tilt-angles, the dayside (nightside) shift is 5 (4) degrees. In the flank sectors the average FAC latitude is higher around solstice and can be explained in terms of the semiannual variation of geomagnetic activity Jimmy Raeder was the first to present how global models can predict the hemispherical differences. His model clearly demonstrated the tilt effects for northward IMF where FACs was predicted to be a factor of ~2 stronger in the sunlit hemisphere (compared to the dark hemisphere). Contrary to observations (G.Lu) he found significant hemispherical differences in the potential drops for southward IMF.

Ostgaard examined a Northern Summer Solstice condition with the global MHD code BATSRUS using a realistic solar EUV driven conductance. There was an approximately factor of 2 difference in the ionospheric potentials. For the same time period and IMF conditions, the Weimer [1996] electric potential patterns showed only a 20% difference. When the exact same conditions were run with a constant ionospheric conductance, the cross polar cap potential was approximately the same between the Northern and Southern hemispheres, although the shape of the field-aligned current pattern shows differences in structure.

Matt Fillingim showed Polar UVI and IMAGE FUV results of non-conjugate dayside afternoon aurora. Multiple spots were seen in one hemisphere while only diffuse aurora was seen in the other. He attributed this to stronger flow-shears and Region-1 currents in one hemisphere, due to a significant IMF By component, that could drive Kelvin-Helmholz instability in only one hemisphere. He also presented a statistical analysis of several hundred substorm intensifications observed by Polar UVI in the northern hemisphere by Damien Chua where substorms were found to be (1) more intense and (2) to last longer in the winter (dark) hemisphere as opposed to the summer (sunlit) hemisphere.

Based on imaging data from the conjugate hemispheres Tim Stubbs showed how IMF Bx and By control the location of the auroral oval. For negative By, the northern oval was duskward of the southern oval. He also showed that the IMF Bx can dominate the tilt-angle effect and give a tailward shift of the oval in the northern hemisphere for positive Bx, as is consistent with expectations [Cowley et al., 1991]. The asymmetries are not predicted by Tsyganenko models. Also, there was evidence that lobe reconnection can occur in only one hemisphere.

From conjugate imaging with only one camera John Sigwarth showed several events where the intensities and/or timing of substorm onsets in the two hemispheres showed unexpected differences. These observations may indicate hemispherical differences in MI coupling, particularly, in the time required for generation of parallel potentials in the auroral acceleration region in each hemisphere and the maximum acceleration potential achieved.

Finally, Brian Fraser presented VLF results that showed By dependent asymmetries consistent with the auroral results presented by Ostgaard and Fox.

The session clearly demonstrated that there are a lot of new observational results on both spatial, intensity and even temporal differences of FACs potential drops, polar cap potentials and aurora. The models seem to do a good job regarding the tilt-angle (seasonal) control on FAC intensities, while the results on polar cap potentials differed somewhat from observations.

If we want to pursue the conjugacy of MI coupling at next years GEM meeting, we should select a few events (with different IMF orientation and tilt-angles) where we have good observational coverage (images, Iridium, DMSP etc) and compare with model predictions. We could then compare quantitatively not only FAC intensities and polar cap potentials but also hemispherical differences in potential drops and spatial asymmetries due to tilt-angles and IMF orientation. We should restrict the number of speakers to allow for more discussion.

Joshua Semeter
Joshua.semeter@sri.com
Bill Lotko
William.lotko@dartmouth.edu

Inner Magnetosphere/Storms Campaign

Report on Inner Magnetosphere/Storm Campaign Activities At the GEM 2004 Workshop, Snowmass, CO, June 21-25

The Inner Magnetosphere/Storms Campaign held 13 quarter-day oral sessions at the GEM 2004 Workshop in Snowmass, CO, in late June. The IM/S Campaign also had two invited tutorial presentations and dozens of presentations at the Tuesday evening poster session.

The IM/S Campaign is focused on understanding the physics of the inner magnetosphere and defining the key elements necessary for simulating the near-Earth plasma populations as part of a Geospace General Circulation Model (GGCM). The campaign has 3 working groups: Plasmasphere and Ring Current (WG-1), Radiation Belts (WG-2), and ULF Waves (WG-3). The IM/S Campaign officially began in 1999 and is expected to end with the 2006 summer workshop. The climax of the IM/S Campaign is the IMS Assessment Challenge, in which several time intervals have been chosen for intensive data-model comparisons. Working groups 1 and 2 are each conducting their own versions of this challenge. Initial results for the WG-1 challenge were presented at this workshop, and the planning for the WG-2 challenge was discussed in detail in Snowmass as well. WG-3 is intimately involved with both the WG-1 and WG-2 challenges.

The following is a summary of each of the sessions, in the order in which they occurred during the workshop. For the most part, these were written by the session conveners.

Report on Inner Magnetosphere/Storm Campaign Invited Tutorials

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The IM/S session had two invited tutorial presentations: on Monday and Tuesday mornings by Jerry Goldstein and Geoff Reeves, respectively.

Jerry discussed "Plasmasphere/Plasmapause Dynamics", posing the question of what is needed in a plasmaspheric model for the GGCM. In particular, he examined IMAGE EUV data to explain how convection fronts alter the distribution of cold plasma in the inner magnetosphere, first impacting the midnight region and then propagating toward the dayside. He also showed that the quiet time plasmasphere tends to develop more small-scale structure that during active times.

Geoff Reeves presented "Progress and Challenges in the GEM Radiation Belt Investigations". Opening with the GEM Invited Tutorial Filter, he then proceeded to discuss what has been learned about the radiation belts in recent years. The concluded by presenting some new directions in radiation belt analysis, particularly emphasizing global modeling and data assimilation. He emphasized that knowledge of the inner magnetospheric magnetic field topology is still a large source of uncertainty in understanding radiation belt observations.

Session Summary: "GEM Storms Analysis" (WG-1, 2, and 3)
Conveners: Ian Mann and Mike Liemohn

This session was dedicated to the analysis of the GEM-Storms events: May 15, 1997; September 25, 1998; October 19, 1998; October 4-6, 2000; March 31-April 2, 2001; October 21-23, 2001; and April 17-24, 2002. The recent “Halloween” superstorms were also added to the list of preferred events. The full slate of speakers and the rich and lively discussion demonstrated the vitality of the community-wide effort to examine and understand the GEM-Storms events. The interest was so high that several talks had to be rescheduled to other sessions later in the week.

Here is a brief synopsis of the session. Wendell Horton presented a very fast, simple model to predict the magnitude of several current systems during substorms, and applied it to all of the GEM-storm events. Zoe Dent examined field-line resonance cross-phase analyses for some of the events, finding that the predicted mass density is sensitive to the assumed B-field model and that much of the diurnal variation is due to local-time-dependent stretching. Joe Fennel showed pitch angle distributions for some of the GEM-storm events, concluding that field-aligned ions appear deep within the inner magnetosphere at energies below 10 keV, but are separate from the main ring current peak. In analyzing the April 2002 event, Shin Ohtani found that dipolarizations are well correlated with oxygen ENA enhancements. Gang Lu then showed AMIE results for the GEM-storms events, highlighting the relationships between IMF and geophysical quantities extracted from AMIE. For the Halloween storms, the polar cap potential reached 400 kV and the Joule heating exceeded 5 TW, which are some of the largest values Gang has seen in the AMIE results. The rest of the talks focused on the Halloween storms. Dan Baker presented SAMPEX data of the radiation belts, noting that these storms had fluxes 2 orders of magnitude bigger than anything else in the SAMPEX database at L=2. Xinlin Li then shoed his prediction model results, showing that the March 2001 superstorm actually had a more dramatic and longer lasting inner belt than the Halloween storms. Richard Thorne showed diffusion modeling results that predict chorus wave interactions can fill the slot region within 1 day. Cheryl Huang presented a detailed study of the DMSP observations of cold ions at low L shells, seen more dramatically in the morning sector. The talks by Peter Chi, Sebastien Bourdarie, and Ian Mann were moved to other relevant sessions later in the week.

Session Summary: "Plasma Transport into the Inner Magnetosphere: SMC Conditions Versus Other Conditions" (WG-1 and WG-2)
Conveners: Ennio Sanchez and Joe Borovsky

Preliminary evidence indicates that the transport of plasma into the inner magnetosphere during SMC (Steady magnetospheric convection) events is unusually efficient. This could be caused by more-efficient transport of plasma or by stronger sources of plasma. In this session, data analysis and theory presentations were given to explore this issue. In particular the session focused on the following four questions. (1) Can we quantify the transport of plasma into the inner magnetosphere for SMC versus other conditions? (2) Is convection in the magnetosphere higher than "normal" during SMC times? (3) If convection is higher, is it because BBFs are occurring more frequently or is it because the underlying slow convection is stronger than "normal". (4) Are the sources of plasma (solar wind entry, ionospheric outflow, plasmasphere, etc.) enhanced during SMC events. After several presentations, an open discussion was conducted to further examine these questions and the SMC phenomenon.

Session Summary: "GEM IMS Challenge: Data" (WG-1 & WG-3)
Conveners: Mark Moldwin and Dennis Gallagher

The intent of the data session was to draw together available measurements for the IM/S GEM Challenge storms for the purpose of supporting quantitative evaluation of the state of inner magnetospheric modeling. While the approach to establishing the contribution of the IM/S campaign to the GEM program was decided at the previous December mini-GEM at Fall AGU, relatively few observations of the inner magnetosphere have been assembled. A description of the IM/S challenge with links to relevant Internet sites can be found at http://csem.engin.umich.edu/GEM_IMS/. Measurements and empirically derived physical properties of inner magnetospheric plasma are being made available on originating institution web sites and on a common FTP site at ftp://ftp.nsstc.nasa.gov/GEM.

While not complete, a variety of measurement sources and analysis techniques were presented in this session. Richard Denton presented a Polar spacecraft derived power-law model for the distribution of thermal plasma along magnetic field lines. He also showed evidence from the CRRES spacecraft for increasing density toward the magnetic equator along field lines. Jerry Goldstein presented an overview of plasmapause determinations for the challenge storms. These results and information that can be used to estimate a component of the convection electric field during the events are available on the WG1 FTP site. Michael Denton discussed the results of comparing IMAGE spacecraft MENA (medium energetic neutral atom) ring current observations with models by Jordanova and Liemohn. The comparison was done using MENA images and simulating MENA images from the theoretical models. Peter Chi described a relatively new technique that is now starting to be applied. Field line resonances are inverted in order to derive mass density distribution. The method has been coined magnetoseismology. Another useful source of magnetic field measurements that was presented is from the Polar (or other) spacecraft, which can be used to obtain magnetic field perturbations, hence currents, and magnetic field oscillations from waves. The spatial and temporal variations of currents and wave amplitudes are important measures of energetic plasma processes. Dave Berube described a new automated process for obtaining the same magnetoseismology results that may replace the labor-intensive method now being used. Howard Singer described the availability of GEOS satellite measurements for obtaining field line currents in the tail, ring current, and magnetopause. Bob Clauer discussed how the axial component of the magnetic field would be used to "see" the partial ring current development.

Shortly after the June GEM workshop Tony Mannucci provided global ground-based TEC data in support of GEM storm October 21-22, 2001. Files and documentation are now available on the challenge FTP site.

Session Summary: "GEM IMS Challenge: Modeling" (WG-1 & WG-3)
Conveners: Margaret Chen and Jerry Goldstein

This IM/S GEM Challenge Modeling Session focused on comparing ring current, plasmaspheric, and ionospheric model results with observations for the two storm challenge events. Vania Jordanova presented results from her version of the Ring-Current Atmospheric Model (RAM) that used both the Volland-Stern and Weimer models of electric field convection for the 21-23 October 2001 storm. With the Weimer electric field her model produced better agreement with the observed Dst and with the high altitude NOAA-15 data than with the Volland-Stern electric field. With either of these electric field models, she found good agreement between her model ion fluxes and in-situ Polar and Cluster fluxes but not good agreement with the proton fluxes inferred from HENA images. Natalia Ganushkina showed calculations of the energy density of ring current protons with energies ranges of 1-20 keV, 20-80 keV, and 80-200 keV from her ring current model that takes into account the effect of substorm-associated electric and magnetic field pulses. Often she finds that during the storm recovery phase that the higher energy protons contribute more to the energy density than the lower energy ions. However, the high-energy protons did not dominate the contribution to the energy density during the recovery phase of the 21 October 2001. Xinlin Li described his Dst prediction model. The

Dst index for the two challenge storms are quantitatively reproduced by using solar wind parameters. Mike Liemohn performed simulations of the ring current and plasmasphere using his version of the RAM model with 4 different electric field models: (1) Volland-Stern, (2) modified McIlwain, (3) self-consistently computed cross polar cap potential with field-aligned currents from RAM, and (4) self-consistently computed cross polar cap potential with double the auroral oval conductance. He compared his model results to Dst, mid-latitude magnetic field perturbations, LANL/MPA data, and EUV, MENA, and HENA images. A red, yellow, green light scale to indicate how well the model agreed with all the data sets was displayed in a matrix. Overall, he found that the Volland-Stern model is not bad. However, the self-consistent electric field generally produced model results that were in better agreement with the observations. Steve Naehr illustrated how synthetic ENA images can be produced from the Rice Convection Model–Equilibrum (RCM-E) and compared with HENA images. He emphasized that forward modeling can be very useful because it avoids image inversion difficulties. Naomi Murayama described a new model that she is developing that includes both plasmaspheric refilling and the evolution of the plasmapause. She has found good agreement of the electron densities from her model with Carpenter's measurements. Her model will be used to evaluate the refilling time scale, the required heating rates, flux tube depletion, zonal plasma motion, and the details of the plasmapause formation process. Jerry Goldstein very briefly showed a simulation of the 22-33 April 2001 plasmasphere erosion, using a Volland-Stern E-field normalized to 20% of the solar wind E-field. The simulation agreed with EUV images on a global scale, but indicate the need for more complete understanding of the sub-global E-field.

Session Summary: "Analysis of Electron PSDs During Storms" (WG-2)
Conveners: Janet Green and Reiner Friedel

The flux of relativistic electrons (>~100keV) in the outer radiation belts varies dramatically on timescales of less than a day. Many theoretical mechanisms have been developed to explain the rapid acceleration of electrons to these high radiation belt energies but as of yet none has been definitively confirmed by observations. The various mechanisms proposed make specific and testable predictions about how the electron phase space density is expected to evolve as a function of both time and L-shell as electrons are accelerated. However, any comparison to these predictions requires transforming electron flux measured as a function of position, energy, and pitch angle to phase space density (PSD) expressed as a function of the three adiabatic invariants, mu, K, and L*. The results of such comparisons are often ambiguous because of large errors introduced by the transformation of the data. In this session, work was presented showing new methods for calculating PSD, phase space density gradients obtained from a variety of datasets, and new theoretical modeling results.

The session began with an introductory talk from Geoff Reeves who reviewed past work and highlighted how errors are introduced by the transformation of the data to PSD. All PSD calculations suffer from errors introduced by the necessary reliance on magnetic field models of unknown accuracy to calculate the electrons second and third adiabatic invariants.

Terry Onsager showed a new method for calculating the radial gradient of PSD using the two geosynchronous GOES satellites. The model relies on the fact that the two satellites, located at the same radial distance (6.6), actually sample different *L* shells because of their differences in local time and latitude. Using deduced pitch angle distributions, an outward radial gradient was obtained for one time period during fairly quiet magnetospheric conditions.

Yue Chen showed PSD gradients obtained from the LANL geosynchronous data using a variant of the method described by Onsager. Pitch angle distributions were obtained by using lower energy particle measurements to determine the direction of the magnetic field. The results of this careful work showed that during two events the PSD increased first with an outward radial gradient and then developed into a peak at L~6 as electrons were lost at higher L.

Joe Fennell showed PSD gradients obtained from the SCATHA satellite in a low inclination orbit covering L ranges from ~4.5 to ~7. Surprisingly, the results showed the electron PSD increases rapidly and uniformly at all L values sampled with an approximately flat gradient.

Some modeling work was presented by both Sebastien Bourdarie and Sasha Ukhorskiy. Sebastien showed some of the new improvements made to the Salammbo code which solves a diffusion equation that includes both pitch angle and radial diffusion. The model has been adapted to include a simple form of data assimilation. Sasha showed progress with the development of a new radial diffusion code.

A comprehensive explanation for the myriad of PSD observations is still elusive but will likely come as a result of the new GEM challenge which will be a coordinated effort to calculate PSD during one or two events using all data available and implementing the new more precise calculation methods.

Session Summary: "ULF Heating and Transport" (WG-2 and WG-3)

Conveners: Mary Hudson and Brian Fraser

John Freeman opened the session discussing the response of the magnetosphere to an idealized synthetic oscillatory solar wind driver at 3mHz sustained for some 2500s. It was concluded that the simulation of large-scale ULF waves from a variety of solar wind drivers can provide insight into energy transmission processes and wave structure in the magnetosphere.

Scot Elkington explained how drift resonance driven by fluctuations in the convection electric field might accelerate electrons in a compressed dipole. Whether acceleration can occur is dependent on the propagation characteristics of the waves.

Following on from the previous paper, Ian Mann discussed the need for a ULF wave index for use in statistical studies of radiation belt dynamics and electron acceleration. He pointed out that Dst is a poor indicator and it is important to determine the appropriate ULF waves to monitor. ULF wave power and Vsw were shown to be better indicators. Further work is needed to cross-calibrate in situ and ground based measurement techniques.

Frank Cheng considered the topic of proton heating during substorms, including stochastic wave growth. In particular, diffusion and perpendicular heating were discussed. Modeled radial diffusion computations were compared with CRRES results by Yuri Shprits. For a time dependent radial diffusion model it was found that the 1-10 day lifetimes were important. The model reproduces 0-150 days of CRRES data and follows the lower electron flux edge in L quite well. It reproduces some storms well, but not all.

Theodore Sarris considered compressional oscillations propagating into the magnetosphere and the magnetic field response at synchronous orbit. He investigated diffusion in particle populations for various levels of magnetic activity and found that D_LL calculations followed the earlier results of Falthammar.

Kara Perry introduced a 3-dimensional radiation belt model with diffusion included to characterize ULF wave observations. The slope of ULF wave power dependence on frequency and L value were found to have important effects on D_LL. A much stronger L dependence results when L-profiles of ULF wave power measured by ground magnetometers are used in the model.

CRRES electric field ULF wave data with both high and low wave numbers were analysed by Sasha Ukhorskiy. Wave-particle interaction involving poloidal mode waves and particle tracing at the equator provided diffusion coefficients for the poloidal mode and the toroidal mode.

Session Summary: "Sawtooth Events" (WG-1 & WG-2)
Conveners: Mike Henderson and Bob Clauer

Sawtooth events are quasi-periodic, large-amplitude flux oscillations with a periodicity of 2-4 hours observed globally at geostationary orbit. The oscillations have been termed 'sawtooth events' because their shape -- a series of slow flux decreases followed by rapid increases – resemble the teeth of a saw blade. The 'sawtooth' shape is particularly well-defined in energetic proton fluxes. They occur during storms when the ring current is enhanced and they appear to be driven by steady, moderate to strong, southward IMF conditions (magnetic clouds). The plasma sheet appears to be unusually close to the Earth at the time of sawtooth events and the inner magnetospheric plasma convection is strong.

Although each 'tooth' of a sawtooth event exhibits many of the characteristics that one would normally associate with substorms (e.g. field stretching and dipolarization, particle injections, auroral onsets, etc.), the disturbances rapidly engage a wider than usual range of magnetic local time sectors and the dipolarization and dispersionless injection signatures can extend past the terminators into the dayside. This and other considerations have raised issues regarding the nature of substorms, storm-time substorms, steady magnetospheric convection events, direct driving vs. unloading, the inner magnetospheric pressure catastrophy, magnetospheric convection and energy dissipation.

This session focused on the following issues: (1) establish more fully the observational characteristics of sawtooth events and to (2) address theoretical physical mechanisms that might explain their occurrence. Among the questions that need to be addressed more fully are: Do sawtooth events form a specific class of substorms? How does the tail behave during sawtooth events? What does the ring curent look like (asymmetry, composition, radial structure, etc.) during sawtooth events?
Why doesn't the steady solar wind conditions that drive sawtooth events not produce steady magnetospheric convection (SMC) events instead? What current systems are responsible for the observed field changes on the ground and in space? Why are the injections so energetic (especially in protons)?

Several presentations were made, showing data and modeling results of sawtooth oscillation events. Many different opinions exist regarding these events, and a lively discussion concluded the session. Resolution on the issues was not reached, but additional sessions, and GEM and other workshops, are planned to continue the debate.

Session Summary: "Quantification of Electron and Ion Loss Rates from the radiation Belts" (WG 2&3), chaired by Richard Thorne and Paul O'Brien

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Janet Green discussed the sudden loss of relativistic electrons: drops by a factor of 100 in >2 MeV electron flux at GEO. Similar dropouts are also seen down to L=4 on HEO satellites and occur down to energies of 300 keV. POES sees electron precipitation at 17-4 MLT. Several mechanisms were discussed as possible causes for the sudden loss. The analysis suggests that EMIC are the most likely mechanism, but local time inconsistency must be resolved.

Reiner Friedel presented a superposed epoch analysis of the rapid dropouts, using GPS data. The dropout were found to extend down to L=4.8. The dropout appears to occur slower at higher energy and lower L.

Robyn Millan considered the relation ship between microbursts (caused by chorus), MeV X-ray bursts observed on MAXIS balloon observations, GOES rapid dropouts, and SAMPEX precipitation bands all seen at the same time during the MAXIS flight. She asked whether they are they related. She questioned whether drift dispersion can smear out the rapid microburst and other temporal signatures in the precipitation flux.

Dan Baker presented data on the Halloween storms and showed that the post-storm decay occurred on timescales comparable to 3-5 days for two penetration events that injected energetic electron into L=2.5 (the normal location of the quiet time slot).

Richard Thorne described how the microburst loss rates depend on pitch-angle scattering rates near the edge of the loss cone. He presented data from SAMPEX observations, which suggest that microburst loss rates during the main phase of a storm occur with a lifetime comparable to 1 day. He presented theoretical calculations which also indicated a lifetime comparable to a day gives about 1 day for low density conditions expected outside the plasmapause during the main phase of a storm.

Recent work by Jay Albert (presented by RMT) on the scattering of energetic electrons by storm-time enhanced plasmaspheric hiss can reduce MeV electron lifetimes to a few days. When additional scattering due to EMIC waves during main phase are included the combined lifetime can drop below 1 day.

Brian Fraser discussed GOES observation of EMIC waves associated with detached proton arcs and cold plasma seen by LANL. Such waves provide an important ring current loss process.

Vania Jordanova described results from her kinetic code, which indicated that EMIC induced ion scattering losses maximize during the main phase of a storm, and can remove ions at a comparable rate to charge exchange during the main phase.

Session Summary: "Radiation Belt Ideas for the GEM Challenge" (WG-2)
Conveners: Richard Thorne and Reiner Friedel

This session was for the Radiation Belts working group to discuss ideas regarding the implementation of a relativistic electron IMS Assessment Challenge. Presentations were made regarding the best course to follow and the interval to select, but much of the session was devoted to an open discussion to formulate a proposed plan. A tentative schedule for the year ahead was designed, with the following elements: (1) an email discussion in late summer/early fall to decide on time intervals; (2) magnetic field modeling of the events during the fall; (3) magnetic field modeling results and initial data analyses presented at the mini-workshop in December; (4) a WG-3 only special workshop in late winter/early spring to present initial results and decide future plans; and (5) presentation of final results at next summer's GEM workshop. The timeframe might slip into the next year, but the deadline of June 2006 for the end of the IMS Campaign is impetus to proceed as scheduled with this phase of the IMS Challenge.

Session Summary: "ULF Diagnostics" (WG-3)
Conveners: Mark Moldwin and Brian Fraser

This break-out session was sponsored by the new ULF Waves working group within the Inner Magnetosphere/Storms Campaign. WG 3 is devoted to the study of the role of ULF waves in particle acceleration, loss, and transport. The session on "ULF Diagnostics" discussed the different techniques that can be used to infer important properties (e.g., mass density, the location of the plasmapause, etc.) of the inner magnetosphere from both ground-based and space-based instruments. The international effort to develop a ULF wave index was also discussed. This session showed that the techniques are maturing and that there is considerable potential for routine monitoring of the mass density and plasmapause location using meridional arrays of magnetometers.

Specifically, Jerry Goldstein presented a talk titled, "Plasmaspheric Density Distribution Determined by Cross-Comparison of EUV Images and LANL or RPI In Situ Measurements" in which he showed the first steps of calibrating the IMAGE EUV images to in situ observations. In general, IMAGE EUV has a threshold of approximately 30 ions per cc.

Peter Chi presented a talk titled, "Observations of Field Line Resonance Properties and Magnetospheric Density by Joint Operation of Magnetometers at the 330th Magnetic Meridian" in which he showed results from the Halloween storm using the APGM method.

Zoe Dent presented a talk titled, "Monitoring Heavy Ion Dynamics via Comparison of Ground-Based Magnetometer and IMAGE RPI Observations" where she estimated the contribution of heavy ions in the plasmasphere following storms.

Dave Berube gave a presentation titled, "Plasmaspheric Mass Density Response to GEM Storms Determined from ULF Resonance Measurements" where he compared the different field line resonance techniques. He found that the combination of the cross-phase and amplitude method works as well as the APGM method with the advantage of a quantitative uncertainty of the estimate.

Richard Denton spoke on the "Mass Density Determination using Spacecraft Data." Richard presented CRRES data of multi-harmonic ULF resonances that were used to constrain the field line distribution of mass density.
Hedi Kawano described results regarding the "Remote Sensing the Plasmasphere with the CPMN Japanese Chain." By using a meridional chain of stations, the location of the plasmapause can be estimated using field line resonance observations.

Finally, Brian Fraser presented work of Fred Menk's showing ULF resonance observations that were used to track mass density behavior and the motion of the plasmapause.

Session Summary: "IMS Theory and Modeling" (WG-1, 2, 3, and GGCM)
Conveners: Vania Jordanova and Scot Elkington

This session was held in collaboration with the

GGCM campaign. It spanned two quarter-day sessions on Tuesday afternoon and Wednesday morning.

The first part of this session focused on new theory and modeling applications in the inner magnetosphere. New results from storm time magnetic field modeling were presented by Margaret Chen, Sorin Zaharia, and Natalia Ganushkina. They indicated that the inner magnetosphere magnetic field differs significantly during storm time from a dipolar configuration and strongly influences both the ion and electron ring current evolution. A new relativistic quasilinear diffusion tensor for arbitrary-frequency electromagnetic perturbations was presented by Anthony Chan, while Bob Lysak showed new results from global modeling of ULF waves in the inner magnetosphere. Richard Thorne and Yuri Shprits showed simulations of the energy and pitch-angle diffusion by chorus emissions and the subsequent filling of the slot region during the Halloween storms, in good agreement with observations. The SEP injection in the inner zone proton belts during storms was discussed by Brian Kress, and Austin Baker presented relativistic electron fluxes obtained with a radial diffusion model.

During the second part of this session, which focused on how the current state of inner magnetospheric modeling fits in with the goals of developing a GGCM, Frank Toffoletto discussed the coupling of the RCM to the LFM models and Aaron Ridley showed the recent development of the CSEM model. The session ended with a general discussion on what advances or directions need to be taken for further improvement of our modeling efforts. It was indicated that the global MHD models are fairly robust and can implement various inner magnetospheric modules, like models of the ring current, the plasmasphere, and the radiation belts. Comparing results from such investigations will help identify various models' strengths and weaknesses.

Session Summary: "IMS Challenge: Assessment and Future Plans" (WG 1,2,3)
Conveners: Mike Liemohn and Dennis Gallagher

This session was devoted to recapping the progress made at the workshop towards defining and conducting the IM/S Assessment Challenge, and to discuss the plans for the year ahead regarding this endeavor. Reiner Friedel gave a summary of Tuesday's discussion to plan out the radiation belt phase of the challenge. Mike Liemohn also gave a very brief review of the plasmasphere and ring current results presented on Monday. This was followed by several talks focused on quantitative metrics for data-model comparisons, given by Elly Huang, Lutz Rastaetter (for Kristi Keller), and Joerg-Micha Jahn. There was also a discussion of what to do by next December (at the GEM Mini-Workshop prior to the Fall AGU Meeting) and by next June (the summer 2005 Workshop). It was decided that most of the effort this year would go towards the radiation belt phase of the challenge, with definitive plans agreed upon by December, initial results at a dedicated workshop (sponsored by IGPP?) in late winter/early spring, and refined results for all phases of the challenge presented in Santa Fe next June. Time was also spent discussing the specific data sets to "officially" include in the challenge. In a brief meeting after the session, the data sets for the ring current were agreed upon. Data for the plasmasphere and radiation belts will be decided during the year ahead.

Mike Liemohn, Co-Chair
liemohn@umich.edu
Dennis Gallagher, Co-Chair
Dennis.gallagher@nsfc.nasa.gov
With contributions from Dick Wolf, Margaret Chen, and J.-M. Jalen

Global Geospace Circulation Model SSC

Report from the GEM GGCMSSC (Geospace General Circulation Model Science Steering Committee)

The GEM program has traditionally been organized into campaigns. One of these campaigns had been the GGCM campaign, in effect since 1998. At last year's (2003) GEM steering committee's meeting the status of the GGCM campaign was discussed and SC decided to form an ad-hoc committee to evaluate whether or not the CCGM campaign should continue as a campaign or whether it should be replaced by something else.

The ad-hoc committee met in Fall of 2003 at Dartmouth College (Mary Hudson hosted the meeting and Dietmar Krauss-Varban, George Siscoe, Michael Hesse, Jeff Hughes, Tamas Gombosi, Dick Wolf, Bob Strangeway, Jimmy Raeder participated). The committee decided that it would be best to dissolve the GGCM campaign and replace it with a Science Steering Committee, i.e., the GGCMSSC, that would coordinate the GGCM efforts with the campaigns.

The GGCMSSC was established in Spring 2004 and it's initial members include Kile Bake (ex officio), Bob Clauer, Michael Hesse, Mike Liehmohn, Bill Lotko, Nick Omidi, Jimmy Raeder (chair), Bob Strangeway (ex officio), and Michael Wiltberger. Its members should be rotated every 3 years.

For the 2004 summer workshop the GGCMSC invited 2 tutorial speakers (Stanislav Sazykin from Rice University presented "Coupling the Rice Convection Model to Global MHD Codes" and Cecilia DeLuca from NCAR presented "Architecture of the Earth System Modeling Framework".) The GGCMSSC also co-sponsored several sessions. Some of these session concerned issues that are mainly of concern for GGCM developers and users, while other sessions were organized together with the campaigns.

In the future the GGCMSSC will continue to sponsor two tutorials at the summer workshops. It also solicits suggestions for sessions, either for GGCM related issues, such as metrics, transition to operations, computing frameworks, or visualization, as well as for joint sessions with the campaigns, for example to address specific science issues, for the study of events or model challenges. Below is a list with the current GGCMSSC members with contact information.

Bob Clauer, UMich - CSEM
rclauer@umich.edu
734-763-6248
Bill Lotko, Dartmouth - M-I campaign
William.Lotko@Dartmouth.edu
603-646-3485
Mike Liemohn, UMich - IM/S campaign
liemohn@engin.umich.edu
734-763-6229
Michael Hesse, NASA/GSFC - CCMC
michael.hesse@nasa.gov
301-286-8224
Nick Omidi, UCSD - G-I campaign
nomidi@ece.ucsd.edu
858-755-5801
Michael Wiltberger, NCAR - CISM
wiltbemj@ucar.edu
303-497-1532
Kile Baker, NSF (ex officio)
kbaker@nsf.gov
703-292-8519
Bob Strangeway, UCLA (ex officio)
strange@igpp.ucla.edu
310-206-6247
Jimmy Raeder, UNH - Chair
J.Raeder@unh.edu
603-862-3412

Jimmy Raeder, Chair
J.Raeder@unh.edu

Global Interactions

The Global Interaction Campaign just completed its first workshop at the annual GEM meeting in Snowmass, Colorado on June 22 and June 23, 2004. The campaign represents a fusion of two separate proposals to study the "solar wind interaction with the magnetosphere" and "geospace transport". The scope of the new campaign is to follow fields and particles from the solar wind to the plasma sheet, with an emphasis on processes that mediate their transport. Substorms, although important for the plasma sheet and magnetosphere, lie outside the scope of the campaign. Similarly, the role of the ionosphere is left to the M-I coupling campaign. As befits a fusion of two proposals, 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 RDCL session began with a tutorial lecture from George Siscoe, who advocated a global view integrating processes in the foreshock, magnetosheath, at the magnetopause, in the cusp/cleft, and the LLBL and HLBL, and the ionospheric contribution to understand the source(s) of the plasma sheet. His talk then focused upon three unresolved dilemmas: the manner in which the cusp depends upon the IMF orientation, the role of the cusps in supplying plasma to the plasma sheet, and the role of the cusp in generating energetic particles.

While antiparallel reconnection models predict the cusps to be the focal point for reconnection on the magnetopause, component models frequently predict reconnection near the geomagnetic equator. Siscoe proposed a GEM challenge to both modelers and data analyzers to determine the locus of reconnection sites on the magnetopause as a function of IMF orientation. As a corollary, we should seek to determine why all the models produce relatively good cross polar cap potential drops despite the fact that they do not include the correct reconnection physics. Curiously, although the IMF By strongly controls the characteristics of the cusp in simulations and low-altitude observations, it has little or no effect on the location or dimensions of the high-altitude cusp in the vicinity of the magnetopause. Siscoe noted that numerical simulations also fail to predict the depth of the magnetic field depression observed within the cusp.

Global MHD simulations confirm a suggestion by Song and Russell that reconnection poleward of both cusps provides a good explanation for the formation of a cold dense plasma sheet during periods of northward IMF orientation. However, neither global MHD nor hybrid models provide good explanations for the hot, tenuous plasma sheet seen during periods of southward IMF orientation. Hope for understanding the formation of the plasma sheet under these conditions lies in the Rosenbauer model for particles entering into and bouncing out of the cusp, rather than the Coroniti/Kennel model for a slow mode expansion wave HLBL in the magnetotail. Finally, there remains an intriguing, and potentially fundamental, possibility that processes as yet unknown accelerate incoming solar wind plasma to very high energies within the cusp.

A number of the presentations that followed focused on local processes at the magnetopause and the properties of the cusp. Michael Hesse discussed results of kinetic models of reconnection at the dayside magnetopause highlighting the physics of guide-field magnetic reconnection. Fritz presented Polar observations of particle entry and energization in the cusps. Tai Phan reported the results of a Cluster survey of reconnection tailward of the cusp indicating that cusp-region merging only occurs for strongly northward IMF Bz, but neither he nor Ted Fritz noted any evidence for its location to depend upon the sign of IMF By. Phan noted that the depletion layer observed for northward IMF orientations was required to enable steady merging on the high-latitude magnetopause. Although Phan had not found a depletion layer at high latitudes for southward IMF orientations, Therese Moretto reported observing one during an interval of greatly enhanced solar wind dynamic pressure. Mona Kessel presented the results of a study of vortices near the magnetopause using MHD simulations along with Geotail and Cluster observations during periods of high speed solar wind streams and northward IMF.

Benoit Lavraud reported the results of a statistical study of Cluster plasma flows in the cusp as a function of IMF orientation. Flows on the equatorward edge of the cusp are poleward and Earthward during intervals of southward IMF. They are stagnant and Earthward on the poleward edge of the cusp for northward IMF. Dawnward flows were seen for duskward IMF orientations, but the situation was not so clear for dawnward IMF orientations. Field strengths were weaker than those predicted by the Tsyganenko model. Berchem reported similar flows in his simulation results.

Double and even triple cusps were a topic of interest. Berchem presented results of a global MHD case study showing that for strong IMF By multiple successive reconnection events occurring in the flanks can explain some of the multiple proton injections observed simultaneously by Cluster CIS in the cusp and by Image FUV in the dayside auroral region. Wing presented observations and discussed a model for the double cusp. He argued that it could be a spatial or a temporal feature, and noted that observationally it is most common for large By and small Bz Zong reported a triple cusp encounter in Cluster observations on April 18, 2002 from 1600 to 1900 UT . He attributed the repeated encounters to variations in the solar wind flow direction, although there were also substantial fluctuations in the solar wind dynamic pressure. Berchem has simulated this event. Despite the low solar wind pressure, he gets reconnection jets and crossings near the standard magnetopause location, not far out as seen.

The origins of the LLBL continued to be discussed. Russell noted that leakage, acceleration, and heating are common at boundary layers (and in the foreshock). He noted that the presence of sharp transitions excludes an explanation in terms of diffusion, although Frank Cheng argued forcefully that wave-particle interactions at the magnetopause were important. Results from 2- and 3-D hybrid code simulation runs were presented. Omidi focused on boundary layer while Blanco-Cano examined the influences of quasi-parallel shock on the magnetopause. The hybrid simulations indicated a density peak at the magnetopause, a possible magnetic field pile-up in the inner magnetosheath, slow mode waves in the quasi-parallel sheath. The magnetopause was most easily interpreted as an intermediate shock for some IMF orientations. Fuselier used results from global MHD simulations to interpret Polar's observations of counterstreaming O+ on field lines that connect the high latitude to the flank magnetopause for northward IMF. He explained that successive reconnection near the southern cusp and then in the northern hemisphere provides a viable mechanism to capture energetic ions generated in the foreshock on closed field lines and populate the flank plasma sheet. The second reconnection closes off the flank field line solar wind and quasi parallel bow shock source but opens the other hemisphere ionospheric source. Fuselier also reported that the flank plasma sheet is colder and less dense than the magnetosheath during periods of Bz > 0. Whereas O+ is not correlated with H+, He2+ is. Density ratios change across the magnetopause. During the course of a study of sawtooth Kelvin-Helmholtz waves (period ~3 min, wavelength ~ 6 R_E), Fairfield estimated the thickness of the flank LLBL as greater than 0.5 R_E during an interval of northward IMF orientation. Finally, Lavraud reported that unidirectional, heated magnetosheath electrons are often observed outside the magnetopause under northward IMF and that a preliminary survey of Cluster Data indicates that when reconnection occurs in both cusp regions, the dipole tilt is the major factor controlling which hemisphere may reconnect first.

The debate over the origin of the energetic ions observed in the cusp (and elsewhere) continued. Three sources were suggested: wave-particle interactions in the cusp, wave-particle interactions in the foreshock, and leakage from the magnetosphere. Participants were unable to reach a consensus.

The PATM session began with an invited talk from Joe Borovsky, who described the entry of solar wind plasma into the plasma sheet. He began by describing the plasma characteristics of the various regions, noting that turbulent flows reach magnitudes comparable and greater than steady flows. He argued that the solar wind is the dominant source- as demonstrated by correlations and composition (except during highly active times), also the nearly steady ion/electron temperature ratio. The best correlations are for solar wind and plasma sheet densities then for solar wind dynamic pressures and plasma sheet temperatures. Lag times for density variations to reach the plasma sheet are: 2 hrs in the magnetotail, 4 hrs to midnight geosynchronous, 8 hrs to dusk geosynchronous, and 15 hrs to noon geosynchronous. Less time is required during geomagnetic storms. The flow of ions required to supply the observed densities at geosynchronous is on the order of several 10^{25} protons/s. The required entry area on the dayside magnetopause is 1.3 x 10^7 km^2. A larger area would be required to account for the downtail flow of ions.

Borovsky identified the key questions as: (1) the mechanism by which plasma enters the magnetosophere, the path it follows, the manner by which solar wind conditions control the entry, the reason for such stable temperature ratios, and the destination for plasmaspheric plasma. He requested modelers to explain: the plasma sheet location, convection, density and temperature profiles, density pulses, cold dense plasma sheet, ionospheric outflow, and plasma sheet composition.

Mick Denton reported results from a study of 283 storms to identify the dependences of geosynchronous plasma on Dst and Kp. The density rises at the start of storms. Electron densities peak near dawn. Low densities occur at solar minimum, higher at maximum. Michelle Thomsen described how the IMF controls geosynchronous densities. The cold dense plasma sheet is a separate population with characteristics similar to those of the LLBL. It does not reach geosynchronous orbit for low Kp, but does reach geosynchronous when long periods of Bz > 0 are followed by either a southward Bz or a solar wind compressions. Peroomian confirmed this with a report that large scale kinetic (LSK) simulation results indicate that a northward IMF turning sends plasma Earthward. Mouikis reported the results of a superposed epoch analysis of the substorm plasma sheet H+ and O+ densities, temperatures, and pressures during and outside of geomagnetic storms. Whereas H+ temperatures remain flat, O+ heats up a bit. Wing reported that an ensemble of DMSP observations indicates that plasma sheet densities rise and temperatures fall with time following a northward IMF Bz turning. The dusk flank is colder than the dawn flank.

Whereas Peroomian noted that the plasma sheet in the LSK model is too thick, Siscoe report that the ISM code generates a plasma sheet that is too thin. Borovsky noted that the hot plasma sheet is always present, but that the cold only appears for Bz > 0. He asked where the hot plasma sheet came from: the ionosphere or left over cold plasma sheet. Lyons responded that it was supplied by the cusp. Winglee maintained that the ionosphere could make a significant contribution. The influence of the ionosphere leads to a dawn/dusk asymmetry in plasmoid/flux ropes, which stretch from sunward dusk to antisunward dawn. The ionospheric plasma slows down reconnection in the magnetotail. His simulations indicate plasma entry from the magnetotail boundaries during periods of southward IMF, but a lot of ionospheric plasma in the central magnetotail during periods of northward IMF.

Peroomian, Lavraud, and Borovsky were tasked with identifying several case studies for model and data analysis prior to discussion at the mini-GEM meeting in December at the Fall AGU.

David Sibeck, Co-Chair
David.g.sibeck@nasa.gov
Tai Phan, Co-Chair
phan@ssl.berkeley.edu

Student Tutorials

2004 GEM Student Report

2004 GEM Workshop Student Tutorials

The GEM student community continues its trend of growing and diversifying each year. Some general statistics of this year's student population are as follows, with last year's numbers in parentheses.

This year the GEM Workshop hosted 63 (56) students from 19 (13) different institutes. Campaign affiliation break down was:
- 33% Inner Magnetosphere/ Storms (43)
- 10% Magnetosphere-Ionosphere Coupling (21)
- 7% Global Interactions
- 4% Geospace General Circulation Model (17)

The student tutorials were geared towards introducing the newer students to the basics of the topics they would encounter at the meeting. In an effort to keep the level of the talks introductory, most student speakers presented a topic that was not the primary focus of their research. This approach proved successful, with 72% of the students voting to keep the talks at the same level, 24% preferring an increase in level and 2% preferring a decrease. The average usefulness rating was 4 on a scale of 1 to 5. (Last year's figures were 57%, 28%, 15% and 4 respectively.) There was no correlation between the year of study and the tutorial level rating or the usefulness rating.

The tutorials were arranged in four sections, each corresponding to one of the GEM campaigns. Within each section three 15-minute tutorials were given, addressing three key aspects of the campaign. After an introduction to the meeting in which I outlined the goals of each campaign and working group and highlighted when on the schedule each group convened, the tutorials were as follows.

1. Introduction to the Magnetosphere (Elly Huang)
2. Magnetosphere-Ionosphere Coupling
   a. Introduction to MIC (John Sample)
   b. Electrodynamics of MIC (Deirdre Wendel)
   c. Ion Outflow (John Gagne
3. Inner Magnetosphere/Storms
   a. Plasmasphere (Daniel Main)
   b. Ring Current & Storms (Jichun Zhang)
   c. Radiation Belts (Dave Berube)
4. Global Interactions
   a. Magnetospheric Boundary Layers & Cusp (Bill Peter)
   b. Magnetic Reconnection (Manish Mithaiwala)
   c. Plasma Transport & Acceleration (Mike Chevalier)
5. Geospace General Circulation Model
   a. Global MHD Models (Tim Guild)
   b. Radiation Belt Models (Kara Perry)
   c. Hybrid Models (Michelle Reno)

Dr. Steven Fuselier of Lockheed Martin gave the student-sponsored tutorial entitled "What do Spacecraft Observations Tell Us About Magnetic

Reconnection". The talk gave an overview of what is currently known about magnetic reconnection as well as what remains to be investigated, highlighting techniques used to study the Cusp region using available data sets.

In addition to students speaking about topics that differ from their research, a few other changes were implemented at this year's tutorials. Unlike previous years, no PhDs were asked to give tutorials, which helped assure that the talks did not focus on personal research. At the request of many students in last year's evaluation forms, additional brief breaks were added after each set of campaign talks. A new GEM student website was created with links to a new Acronym Dictionary, useful information and graphics sites, and a Photo Directory (currently under construction).

The GEM student representative for 2005 is Jichun Zhang, a fourth year student at the University of Michigan. In addition to giving a remarkable tutorial, he has offered insightful ideas for the improvement of the student tutorials for this upcoming year.

Michelle Reno, Student Representative
mreno@swri.edu

GEM Steering Committee Minutes

June 25, 2004, Snowmass, Colorado

Minutes from the GEM steering committee meeting, June 25, 2004, Snowmass, Co.

Present
Robert Strangeway, UCLA (GEM chair)
Aaron Ridley, University of Michigan
Bill Peterson, NASA
Brian Fraser, Univ. Newcastle (Australia)
Chris Russell, UCLA (Communications coordinator)
Dan Weimer, Mission Research Corporation
David Sibeck, NASA
Frank Toffoletto, Rice, (GEM Workshop coordinator)
Gang Lu, NCAR
Hedi Kawano, Kyushu University (Japan)
Howard Singer, NOAA
Jeff Hughes, Boston University
Josh Semeter, Boston University
Kile Baker, NSF
Martin Connors, Athabasca University (Canada)
Michael Hesse, NASA/CCMC
Michelle Reno, University of Michigan (Student representative)
Mike Liemohn, University of Michigan (IM/S)
Ray Greenwald, Johns Hopkins University
Teresa Moretto, (Europe)
Vania Jordanova, University of New Hampshire
Xochitl Blanco-Cano, UNAM (Mexico)

Frank Toffoletto (GEM workshop coordinator) outlined plans for upcoming GEM workshops. The next mini-workshop will be held the day before the Fall AGU meeting in San Francisco on the afternoon of Sunday December 12. A GEM steering committee meeting will follow that evening. The next Summer Workshop will be in Santa Fe, New Mexico, June 27 – July 1, 2005 and will be held jointly with CEDAR. For 2006, the tentative dates for the Summer Workshop are June 26-30, 2006; returning to Snowmass in 2006 appeared to be the preference.

Kile Baker (NSF) reported on the status of NSF programs. He indicated that the next major NSF program is 'Cyber Infrastructure', the details of which have not yet been announced. He also described the timeline of the Advanced Modular Incoherent Scatter Radar (AMISR) program, which it is expected to be operational in the early Spring of 2005, with availability for use by Summer or Fall of 2005. Kile encouraged anyone who has a magnetosphere-ionosphere coupling project that would use AMISR to send their proposals to the GEM solicitation of 2004 and possibly to the CEDAR solicitation in 2005. He

also mentioned that since the GEM IM/S campaign is winding down, proposals for the 2004 solicitation of only 1-2 year duration will be encouraged. He encouraged submission of proposals that would seek to produce modules related to the inner magnetosphere for the GGCM. He also encouraged the GEM community to be aware of and to participate in the upcoming DASI (Distributed Array of Small Instruments) initiative.
Howard Singer (NOAA/SEC) updated the GEM committee on the status of the Space Environment Center. He reminded everyone that Space Weather Week will be held at NOAA April 5-8, 2005. Information on the meeting will be posted on the NOAA website (http://www.sec.noaa.gov/). They are also expecting to have the NRC postdoc competition in January, 2005. He also mentioned that Mary Hudson has been asked to be the GEM liaison for the International Heliophysical Year (IHY) in 2007, information on the IHY can be found at http://ihy.gsfc.nasa.gov/.

Bill Peterson (NASA) reported that NASA is undergoing a major reorganization. A Senior Review is planned to decide the future of 8 of 14 NASA SEC missions. The report will be due in the Spring of 2005. NASA is also redoing the roadmap, and community participation is encouraged. SAMPEX is slated to be turned off, however there are efforts to find alternative funding in order to keep the mission operational.

Michael Hesse (CCMC) reported that they currently have 4 magnetospheric models (UNH-OpenGGCM, BATSRUS, and 2 Fok Ring current models), several ionosphere models (SAMI-2, CTIP, and Weimer-2K), 2 heliospheric models (Heliospheric Tomography Model and an Exospheric Solar Wind Model) and 2 solar models (MAS and PFSS). As of the end of June, the CCMC has received 244 requests for runs. The CCMC has received NSF support to do solar modeling and Peter McNeice has joined the CCMC team. The CCMC is also working on a memorandum of understanding with the CISM and CSEM programs and well as a 'rules of the road' document for the use of CCMC models that is scheduled to appear on the CCMC website (http://ccmc.gsfc.nasa.gov/). Michael pointed out that that the CCMC is really the brianchild of George Siscoe. He also welcomed community input to the CCMC. The CCMC is planning to expand their relationship with both model developers and NOAA/SEC.

Josh Semeter (Coupling Energetics Dynamics of Atmospheric Regions - CEDAR liason) brought up the question of the plans for the joint GEM-CEDAR meeting in 2006. He suggested that one possible structure for the meeting would have at least 1 joint plenary and a couple of joint sessions.

Chris Russell (Solar Heliospheric and Interplanetary Environment - SHINE representative) represented the SHINE liaison Dave Webb. A new SHINE competition will be announced for 2005. Chris reminded everyone that SHINE has 3 working groups: solar sources, interplanetary connections, and solar energetic particles. The dates of the 2005 SHINE meeting are July 10-15 (site still TBD). Invited presentations from the 2004 (and 2003) meeting are online at http://www.shinegroup.org/ under "Presentations". The 2004 Meeting summaries will be posted soon. He also mentioned the possibility of a joint GEM-SHINE meeting, the earliest date for that being 2006.

Michelle Reno (Student Representative) gave the student report. For the 2004 summer workshop, GEM supported 63 students from 19 different institutions. This year Michelle initiated a survey rating the quality of the meeting, the average rating was 4/5 with 5 being the highest and has also developed a GEM student website that includes photos and contact information of all the GEM students (http://www-personal.engin.umich.edu/~renom/). In the student tutorials, each presenter was asked to make a presentation on a subject out of their research area, that had the effect of keeping the talks accessible to all the students. Michelle's replacement for 2005 will be Jichun Zhang on the University of Michigan. Michelle also reported that the room used for the student tutorials was too small.

Mike Liemohn (Inner Magnetosphere Storms (IM/S) campaign) reported that the campaign is conducting the IM/S assessment challenge. Working group-1 conducted phase-1 of the challenge where the initial results from the ring current and plasmasphere models where presented. Working group 2 on radiation belt modeling had discussions during the workshop on plans for the challenge. They expect that by fall of 2004 the inputs from WG-1 would be available and that there may be a separate workshop in the spring of 2005 on the challenge. He noted out that 2005 will be the final year as a full campaign. Kile Baker suggested that a collection of JGR papers on the challenge would be appropriate. Strangeway pointed out that given that the campaign is planning on ramping down, that some thought should be given to the planning of the ramp down and to presenting the final results of the campaign in 2005. The 2004 fall mini-workshop would be a potentially useful time to do the planning. Chris Russell pointed out that summary sessions at the end of each activity is no longer reported back to the GEM community. The possibility of having the GGCMSSC being responsible for the reporting was raised, but it was thought that it would be more appropriate that each campaign should undertake that task. Jeff Hughes suggested that there should be more interaction of the campaign with the GGCMSSC.

Jeff Hughes (Magnetosphere Ionosphere Coupling (MIC) campaign) reported that the campaign has 2 working groups; each group had 3 sessions in the 2004 meeting. One question that was raised when this campaign was started was whether there was a need for an outflow model in the GGCM. He pointed out that one measure of the success of the campaign is that such questions are now taken for granted. Aaron Ridley suggested that there was some disconnect between the small scale and large scale models that should be reconciled. There was extensive discussion about how to best schedule the meeting, it was felt that during the days in which the IM/S campaign was held, that having only one session running did not make efficient use of the time and facilities. Part of the reason for this was the request that MIC not have parallel sessions. This could be mitigated by having MIC sessions run in parallel with other campaigns.

David Sibeck (Global Interactions (GI) campaign) noted along with co-organizer Tai Phan that there are 5 working group chairs. Of all the organizers and chairs of this new campaign, only one was a regular GEM attendee. As a result, there was a lot of discussion about how to best organize the campaign. David reported that the GI campaign now has a mission statement that says that the campaign will try to understand the processes in which solar wind plasma is transported into the magnetosphere to form the plasma sheet. The campaign was the result of the forced merger of several different proposals: substorms, steady magnetospheric convection and cusp energization. David pointed out that they are hoping to have the opportunity to establish links to the other campaigns. He noted that 10 years ago GEM was dominated by ground based observers which is no longer the case; plans are afoot to get more of this part of the community involved with GEM again. David questioned whether the goal of the campaign model is to improve our physical understanding or to improve models. Jeff Hughes pointed out that perhaps a better way to look at the goals of the campaign is to ask is: What are the physics questions we need to answer in to build better models? Bob Strangeway noted that THEMIS will in some sense dictate the new campaign. Discussion for the new campaign will likely start in 2005.

Jimmy Raeder (GGCMSSC), noted that Global Geospace Circulation Model Science Steering Committee (GGCMSSC) is not a campaign. The GGCMSSC came into being on April of 2004 and comprises members from each campaign as well as participation from CISM, CSEM and NSF. He plans to have the whole committee together in the fall 2004 meeting.

Brian Fraser (Australia) reported that FEDSAT has been up for 18 months and that all systems are working normally, with the exception of some disruption during the October 2003 storms. Magnetometer data is now starting to come in. The other big instrumentation program is the Tasman International Geospace Environment Radar (TIGER) radar in Tasmania which is to be complemented by the UNWIN radar on the South Island of New Zealand that should be operational by the end of 2004. Brian pointed out that the IMAGE spacecraft is precessing its orbit into the southern hemisphere and there are plans to use the FedSat ground station in Adelaide to download the data from the IMAGE spacecraft. He also reported that the CRC for Satellite Systems, which built and operates FedSat, renewal was not successful

Hedi Kawano, Kyushu University (Japan) reported that ISAS and NASDA were merged last October into a new institute called JAXA (Japan Aerospace eXploration Agency. There are no major changes in the functions of ISAS. ISAS continues to operate two magnetospheric satellites: Akebono and GEOTAIL, both of which are healthy. He noted that GEOTAIL data is available at a website called DARTS where it will soon have all the 3-sec magnetometer data up to the end of 2003. 16-Hz magnetometer data will also be available soon. All the Geotail 3-sec magnetometer data and all the Geotail plasma moment data available at DARTS will soon be made available at CDAWeb, also. For recent GEOTAIL data that is not yet available at DARTS, Prof. Mukai (mukai@stp.isas.jaxa.jp) should be contacted for plasma moments and Prof. Nagai (nagai@geo.titech.ac.jp) for magnetic field data. Bill Peterson noted that GEOTAIL will be participating in the next senior review; Don Fairfield is the US PI on this program. NASA's major support role is in the tracking of the spacecraft.

Xochitl Blanco-Cano (Mexico) reported that there will be a Sun-Earth Connection meeting in Merida, Mexico, November 8-12, 2004 (http://www.lanl.gov/csse/merida/). She noted that this meeting would be an experiment in getting GEM and SHINE participants in a joint meeting. NSF is expected to provide funds for student travel to the meeting.

Martin Connors (Canada) who was standing in for Eric Donovan reported that concept studies underway for ORBITALS and Ravens and that the study is expected to take 18 months. The AMISR program that has been formally approved by NSF is expected to have a significant impact on Canadian space science in that PolarDARN is very likely to be strongly linked to AMISR. He also reported that SWARM was approved by ESA and that David Knudsen will be the PI of EFW instrument (a low-energy ion drift meter) on each of the three low-altitude satellites. Launch is expected in 2009. Athabasca University Geophysical Observatory is now open for business and that the Canadian Geospace Monitoring (CGSM) is now underway, with 6 contracts in place, and current development of new real time data recovery system. THEMIS-Canada is also underway with one complete ground based observatory in the field, and three more to be deployed this summer. He also noted that J. -P. St. Maurice is moving to join the University of Saskatoon radar group and that Kathryn McWilliams is a new faculty hire in Saskatoon.

Teresa Moretto (Europe). She noted that the SWARM mission has been funded. It is scheduled to be launched in 2009 and will be a direct follow-up to the German CHAMP mission. The SWARM mission is currently in the design phase; the plans call for 3 spacecraft, one at 450 km altitude and two at 530 km altitude all separated in local time. The mission is currently geared towards magnetic field measurements, but it is expected to have other instruments on board such as an ion drift meter and Langmuir probe.

Chris Russell (GEM communications) Started in October 1991, GEM Messenger is in its 14th year of online circulation. It currently has 459 subscribers. In 2003, the GEM Messenger published 50 regular issues in addition to GEMStone Newsletter issued on September 18, 2003. As of June 15, GEM Messenger has published 31 issues in 2004. In each year several announcements from the GEM Program, including the distribution of GEMStone, are also disseminated through the SPA Newsletter. The subscription to and removal from the GEM mail list can be done by e-mail following the instruction at the end of the Newsletter or simply contact the Editor at editor@igpp.ucla.edu.

The meeting adjourned at 9:40 pm.

Recorded by Frank Toffoletto

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

GEM Contact List			
Contact	**E-mail Address**	**Contact**	**E-mail Address**
Kile Baker	kbaker@nsf.gov	Nick Omidi	nomidi@ece.ucsd.edu
Jean Berchem	jberchem@igpp.ucla.edu	Terry Onsager	Terry.Onsager@noaa.gov
Joachim Birn	jbirn@lanl.gov	Antonius Otto	Ao.why.gi.alaska.edu
Joe Borovsky	jborovsky@lanl.gov	Bill Peterson	pete@willow.colorado.edu
Anthony Chan	anthony-chan@rice.edu	Tai Phan	phan@ssl.berkeley.edu
Margaret Chen	mchen@aero.org	Jimmy Raeder	J.Raeder@unh.edu
Peter Chi	pchi@igpp.ucla.edu	Michelle Reno	mreno@swri.edu
Brian Fraser	Brian.fraser@newcastle.edu.au	Aaron Ridley	ridley@umich.edu
Reiner Friedel	friedel@lanl.gov	Chris Russell	ctrussel@igpp.ucla.edu
Dennis Gallagher	Dennis.Gallagher@msfc.nasa.gov	Ennio Sanchez	ennio.sanchez@sri.com
Ray Greenwald	ray.greenwald@jhuapl.edu	Josh Semeter	jls@bu.edu
Jeffrey Hughes	Hughes@bu.edu	David Sibeck	david.g.sibeck@nasa.gov
Mike Liemohn	liemohn@umich.edu	George Siscoe	siscoe@bu.edu
Bill Lotko	william.lotko@dartmouth.edu	Bob Strangeway	strange@igpp.ucla.edu
Gang Lu	Ganglu@hao.ucar.edu	Frank Toffoletto	toffo@rice.edu
John Lyon	John.G.Lyon@dartmouth.edu	Richard Thorne	rmt@atmos.ucla.edu
Mark Moldwin	mmoldwin@igpp.ucla.edu	Robert Winglee	winglee@ess.washington.edu

Current GEM Structure	
GEM Steering Committee Chair: Bob Strangeway	
Inner Magnetosphere/Storm Campaign:	**Convener:** Mike Liemohn/Dennis Gallagher
Working Groups:	**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
Working Groups:	**Mass Exchange** - Bill Peterson and Robert Winglee
	Electrodynamics – Josh Semeter and Bill Lotko
Global Interactions Campaign	**Conveners:** David Sibeck and Tai Phan
Working Groups:	**RCOL** - Jean Berchem and Nick Omidi
	PATM - Terry Onsager and Antonius Otto

UCLA/IGPP
C.T. RUSSELL - GY-79
THE GEMSTONE
BOX 951567
LOS ANGELES, CA 90095-1567

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