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The GEMstone

Notes from NSF Program Director

Janet Kozyra

There have been some major changes in the Geospace Section at NSF since the last newsletter. Therese Moretto Jorgenson has been appointed as Geospace Section Head effective November 1. Please join us in welcoming her into this new position. Therese has been working to move Geospace science forward at NSF for more than 10 years playing key roles in such remarkable successes as the development of the CubeSat program, and the GS space weather program, and garnering NSF support for the innovative first-of-its-kind AMPERE program. She continues to contribute to strategic planning for the National Space Weather Program. We look forward to more exciting advances as she takes on this new role at NSF. With this change, I have been able to step down from Acting Section Head to focus much-needed attention on the Magnetospheric Physics Program and GEM. Finally, John Meriwether has joined NSF as the Upper Atmosphere Facilities Program Director. John is a rotator with background in optical instrumentation and aeronomy on leave from Clemson University, where he is a Professor in the Physics and Astronomy Department.

There is an open Dear Colleague Letter to recruit program directors for Aeronomy and Space Weather as well as a "floating" GS program director with broad geospace background to help out in all the programs. We ask for your help in identifying energetic and knowledgeable candidates for these very important positions.

Focusing on the latest GEM solicitation, 50 proposals (total of 44 projects) were submitted in October 2015. With this number, we expect a

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success rate around 20%. Plans are underway to hold the GEM panel review in late February or early March 2016. Please note: Last year, PIs were notified shortly after the GEM panel review of the status of proposals and were supplied with individual and panel reviews in hopes of informing plans for upcoming submissions. However, due to temporary understaffing in the GS section, the *official* paperwork for the declines is only now being submitted and processed through the Division of Grants and Awards at NSF. This paperwork automatically generates an official notification. These notifications have no connection to the present GEM solicitation.

There are also a number of ongoing challenges. The first draft of the Geospace Portfolio Review (PR) is expected in late November. The draft will be provided to NSF GS Section to confirm all the numbers and facts used in constructing the report and to the Geosciences Advisory Committee (AC GEO) for approval. The PR group is a subcommittee of the AC GEO. Because this report addresses the balance in the Geospace research portfolio, it has direct relevance to GEM and other Geospace programs. By some time in January, it is anticipated that a completed report will be submitted to the NRC with aim of reviewing the process used in developing the recommendations in the report as well as assessing how well they support recommendations in the Solar and Space Physics Decadal Survey.

An NSF Atmospheric and Geospace Science strategic plan is also being formulated. There are plans to hold a town hall meeting about the strategic plan in early January at the upcoming AMS Annual Meeting in New Orleans, Louisiana. A completed draft is expected to be delivered for NRC review by Summer 2016.

With all of these developments, it promises to be an interesting year for GEM moving forward into 2016.

2015 GEM Mini-workshop

Sunday, December 13

Holiday Inn Golden Gateway
1500 Van Ness Avenue
San Francisco, CA

http://www.cpe.vt.edu/gem-mini/index.html

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Notes from GEM Chair

Michael Wiltberger

My career in space physics began with attending the GEM meetings. I fondly remember the drives up to Snowmass from Denver to attend the student tutorial workshops before the main workshop began. The GEM workshop was and remains a jewel in the scientific meeting scene because of its open sessions with plenty of time for discussion, focus areas that are organized by active community members, and its willingness to let all members of community whether they are just starting their careers or well established give talks, lead sessions, and participate in advancing our science. It's my plan to make sure that GEM and its corner stone meeting continue to remain a driving force within the solar and space physics community.

Before discussing the future of GEM let me take moment to tell those of you who do not know me a little bit about my background. I got my Ph.D. in 1998 from the University of Maryland. My thesis topic was using global magnetohydrodynamic simulations to model substorms. The substorm focus group and the substorm modeling challenge heavily informed my thesis research. After graduate school I took a research scientist position at Dartmouth College and remained active with GEM serving on the Geospace General Circulation Model (GGCM) Science Steering Committee. The ideas developed within GEM for the GGCM helped form the basis for the Center for Integrate Space Weather Modeling (CISM) supported by NSF Science and Technology Center program. Other groups within the community found support outside of GEM to develop their own GGCMs. These models are now made available to the entire research community through Community Coordinated Modeling Center. After five productive years at Dartmouth, I took Scientist position at the High Altitude Observatory (HAO) within the National Center for Atmospheric Research (NCAR) where I continue to do research developing numerical models of geospace.

The strength of the GEM program comes from the community's utilization of the latest geospace observations to inform the development of the next generation of geospace models. We currently have 12 active Focus Groups covering all-regions within the magnetosphere. As commonly happens within GEM several of these groups are ending this year and the steering committee will select new Focus Groups using goal of research programs that advance the development of a GGCM with predictive capability as our guide post. In addition, it is my intention that we will continue to use the GEM meeting as a way of bring our community to together to not only to do basic research, but help to define the next set of key science questions that our community can and will solve. GEM has always been a grassroots program and I encourage everyone to think about serving as either a leader of a Focus Group or as a member of the GEM steering committee. A call for volunteers for steering committee members will come out shortly before next year's annual meeting.

The 2016 GEM Meeting will be held in Santa Fe, New Mexico and will be held in conjunction with annual meeting of the CEDAR community. Josh Semeter, CEDAR chair, and I have formed a planning committee with members from both groups to ensure that we have truly joint meeting focusing on the connections between our communities. I look forward to seeing you at the GEM mini meeting before this year's Fall AGU meeting. Note that this year's meeting is being held at Holiday Inn Golden Gateway, which is a bit further away from the convention center then last year, but may take those of you with long memories back to the early days of AGU. If you ever have questions or concerns about GEM and its future please feel free to contact me directly. My email address is wiltbemj@ucar.edu and my phone number is 303-497-1532.

My thanks to all of you that make GEM a great program and I look forward to working with you in the coming years.

Solar Wind-Magnetosphere Interaction Research Area Report

Coordinators: Katariina Nykyri and Steve Petrinec

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

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

The "Transient Phenomena at the Magnetopause and Bow Shock and Their Ground Signatures" focus group held three sessions with 14 presentations covering the following research areas: 1. Foreshock Phenomena 2. Magnetosheath and Magnetopause Phenomena 3. Ground Signatures

1. Foreshock Phenomena :

Various foreshock phenomena including hot flow anomaly (HFA), spontaneous hot flow anomalies (SHFAs), and foreshock bubbles (FBs) were investigated by this focus group using both in-situ observations and global hybrid simulations.

Liu et al. presented a hypothesis about the tangential discontinuity (TD)-driven FB formation and supported their hypothesis by THEMIS observations. They suggested that a statistical study should be applied to compare rotational discontinuity (RD)- vs. TD-driven FBs in order to fully understand how FBs are formed. In addition, their observational results should be examined with global hybrid simulations to further validate the premise and the process of FB formation by TDs.

Statistical studies on HFAs have been done using Cluster and THEMIS datasets. Zhang et al. identified 199 classical HFAs from Cluster observations from 2001 to 2010. These HFAs were classified into four categories ("-+", "+-", "M", and "W") according their dynamic pressure profile. HFAs were classified as young and mature according to the ion distributions. They found that most "W" and "M" type HFAs are mature HFAs and most "-+" and "+-" type HFAs are young HFAs, indicating that "M" and "W" type HFAs may be the later evolution stages of "-+" and "+-" type HFAs. They also found that variations of plasma parameters and magnetic field of mature HFAs are more dramatic than those of young HFAs, except for temperature. They suggested that the four categories of HFAs may also be due to the fact that the spacecraft crossed an HFA structure along different paths. Chu et al. presented a statistical study of both HFAs and SHFAs using THEMIS data. They showed that both mature and young HFAs are more prevalent when there is an approximately radial interplanetary magnetic field. They also found that HFAs were observed up to 6.3 R_E upstream from the bow shock and their occurrence decreases with distance upstream from the bow shock.

Using global hybrid simulations, Omidi et al. investigated impacts of SHFAs on the magnetosheath and magnetopause. They demonstrated that in addition to the formation of Magnetosheath Filamentary Structures (MFS), SHFAs results in the formation of large-scale cavities in the magnetosheath which are associated with decreases in density and magnetic field strength and an increase in ion temperature. They also showed regions of high flow speeds form as a result of SHFAs which may correspond to magnetosheath jets observed by spacecraft. They also showed that SHFAs can cause in and out motion of the magnetopause.

2. Magnetosheath and Magnetopause Phenomena :

Xuanye Ma discussed 3D simulation results of the Kelvin-Helmholtz Instability showing that the 3D growth of KHI is similar for northward/southward IMF and that patchy reconnection in KH vortices does not contribute to the majority of the The broad topics of this session were (1) phenomena in the magnetosheath, (2) plasma transport into the magnetosphere due to Kelvin-Helmholtz instabilities (KHI) and magnetic reconnection, and (3)

the effect of cold ions (plasmaspheric plume or ionospheric outflow) and cusp ions on reconnection and KHI at the magnetopause.

Gutynska et al. investigated the density enhancements in the magnetosheath using THEMIS observations and compared their results with those from global hybrid simulations. They found an anticorrelation between the density and ion temperature within these structures which are consistent with the MFS in hybrid simulations.

Ahmadi et al. investigated effects of electron anisotropy on mirror instability evolution in the magnetosheath using PIC simulation. They found that electron distribution becomes isotropic before proton instabilities can grow, because electron whistler instability grows much faster than proton cyclotron or proton mirror instabilities. They also found that in expanding box simulations, electrons become anisotropic same as protons but electron whistler instability starts growing quicker than proton instabilities and keeps electron distribution close to equilibrium.

Sibeck introduced a recently selected mission called Solar wind Magnetosphere Ionosphere Link Explorer (SMILE). This is a joint mission between European Space Agency and Chinese Academy of Sciences studying interaction between Earth's magnetosphere and solar wind. SMILE will be able to simultaneously capture images and movies of the magnetopause, polar cusps, and aurora.

Wang et al. presented ARTEMIS observations of the hot electron enhancement in mid-tail magnetosheath and its dawn-dusk asymmetry. They found that hot electron enhancements occur 3-4 times more often on dawnside magnetosheath than duskside magnetosheath and fluxes of hot electron enhancements are twice larger on the dawnside than on the duskside. They suggested that the dawn-dusk asymmetry may be caused by processes at quasi-parallel bow shock.

Walsh et al. proposed a new theory to explain the dawn-dusk asymmetry (more at dusk) of the Kelvin-Helmholtz waves at the dayside magnetopause. They proposed that the high plasma density associated with the plasmaspheric plumes at the dusk side of the dayside magnetosphere make the Kelvin-Helmholtz waves more likely to occur at the dusk side magnetopause.

Hartinger et al. investigated the global structure and time evolution of dayside magnetopause surface eigenmodes. They found that magnetopause surface eigenmodes are a potential source of ULF waves below 2 mHz and magnetopause surface eigenmodes can seed tailward propagating surface waves via the Kelvin-Helmholtz instability.

Lee et al. presented statistical studies on the characteristics of the cold dense ions observed at the dayside magnetopause by using the Cluster spacecraft datasets. They found that the occurrence rate of plasmaspheric plume or ionospheric plasma strongly depends on the solar wind/IMF conditions. In particular, plasmaspheric plumes tend to occur during southward IMF, whereas ionospheric outflows tends to occur during northward IMF. The occurrence rate of the plasmaspheric plumes is significantly higher on the duskside than that on the dawnside.

3. Ground Signatures :

During the Friday session, a 6+year statistical study of THEMIS magnetosheath ion temperature observations was presented by Andrew Dimmock. Although a slight dawn/dusk asymmetry in temperatures was found (slightly higher temperatures along the dawn flank as compared to dusk), no significant change in asymmetry was observed when the large data set was filtered by solar wind speed or by IMF Bz. An observations-based study of magnetic field fluctuations in the magnetosheath was also presented. In this case, dawn/dusk asymmetry were more pronounced for slow solar wind as compared to fast solar wind. Filtering by IMF Bz resulted in much less dawn/dusk asymmetry of field fluctuations.

Plasmaspheric plumes and their influence on physical processes at the magnetopause (the occurrence and rate of magnetic reconnection and The foreshock phenomena may have significant impacts on the Earth’s Magnetosphere-Ionosphere System. Presentations in this session used a variety of space- and ground-based measurements to examine the response of the magnetosphere to solar wind transients and various foreshock phenomena.

Hartinger et al. presented observational results on the effect of northern-southern hemisphere conductivity asymmetries on ground magnetic responses during a large solar wind transient.

They showed that magnetic perturbations excited by a solar wind pressure increase were observed at magnetically conjugate stations in the northern and southern hemispheres. These perturbations have essentially the same amplitude and timing, contrary to expectations for solstice conditions – i.e., ionospheric conductivity does not appear to affect the properties of the magnetic perturbations, which differs from previous studies showing large interhemispheric differences.

Connor et al. presented OpenGGCM-CTIM simulation results of thermospheric heating in the high-latitude dayside regions after the sudden enhancement of solar wind pressure. They showed that the coupled MIT model produces localized increase of electric field and aurora precipitation in the high-latitude dayside region after the solar wind dynamic pressure impact, which in turn effectively heat the thermosphere and causes the neutral density increases at 400 km altitude. Their model results demonstrate that the physics-based magnetospheric energy input is critical to improve ionosphere-thermosphere model predictions.

Oliveira et al. investigated the geoeffectiveness of IP shock impact angles using global MHD simulations and observations. They found that the Earth's magnetosphere and ionosphere respond to IP shocks in different ways depending on the shock impact angle. In general, strong (high speed) and almost frontal (small impact angle) shocks are more geoeffective than inclined shocks with low speed. They attribute this result to the fact that frontal shocks compress the magnetosphere symmetrically from all sides, which is a favorable condition for the release of magnetic energy stored in the magnetotail, which can produce moderate to strong substorms and magnetic field perturbations observed by ground-based magnetometers.

Finally, we discussed post summer work group plan. This focus group is supposed to end in the summer of 2016. Considering that MMS-Cluster -THEMIS conjunctions in 2016 will provide excellent opportunities for this focus group, people suggest that we ask for a 1-year extension.

Tail Environment and Dynamics at Lunar Distances Focus Group

Co-Chairs: Chih-Ping Wang, Andrei Runov, David Sibeck, Viacheslav Merkin, and Yu Lin

The Tail Environment and Dynamics at Lunar Distances FG held its first and only session at the 2015 GEM summer workshop on Monday (June 15th) morning. This session was devoted to open discussion on mid-tail science questions and how they can be answered. The objective is to establish specific scientific questions to be addressed in the following years. There were nine speakers, including leaders from three other FGs. For achieving the two goals of this FG (to establish fundamental understanding the mid-tail and to develop model to evaluate the underlying physical processes), the speakers pointed out many fundamental but critical questions, including: (1) How do solar wind conditions (IMF discontinuities, interplanetary shocks, IMF change from northward to southward) change the mid-tail magnetosheath and magnetosphere and what are the resulting dynamics? (2) What do we know about the various boundary processes? (3) How is the mid-tail environment affected by the Moon? (4) What are characteristics of the current sheet structure and dynamics? (5) What are the connection of the mid-tail to the ionosphere and near-Earth tail? (6) What are the time scale and time lag of the connection to the solar wind and other regions?

The presentations are available at http://people.atmos.ucla.edu/cat/FG/2015-GEM-talks/

Hui Zhang discussed transient phenomena at the tail bow shock and magnetopause. She showed that a Hot Flow Anomaly (HFA) can deform the magnetopause, such as by creating a magnetopause bulge. The bulge can convect tailward with magnetosheath flow. For a lifetime of ~18 min estimated from the ionosphere signatures (traveling convection vortices) and convection speed of 100-500 km/s, a HFA is expected to travel to 17-85 R_E down the tail. She pointed out two main questions for this FG: What do HFAs look like in the mid-tail? What is the tail response to HFA?

Sheng-Hsien Chen presented observations of waves in the mid-tail LLBL and lunar wake. He found that there is a lack of periodicity in ULF (~1–60 min) surface waves in the LLBL. However, there is a presence of kinetic waves in the LLBL and lunar wake. He pointed out two main questions for this FG: (1) How is the interaction of LLBL plasma with the Moon in the mid-tail subjected to kinetic Kelvin-Helmholtz instability, lower-hybrid instabilities, kinetic ballooning/interchange instability, and reconnection? (2) What are the typical values for plasma scale lengths (L), anomalous resistivity due to lower-hybrid drift waves (η), associated diffusion coefficients ($D_{\alpha\alpha}$), and Lundqvist number ($\mu_0 L V_A / \eta$) across the interfaces?

Denny Oliveira presented Open GGCM MHD simulations of a shocked magnetotail due to an interplanetary shock on 2012-03-08 and compared with the ARTEMIS observations at 60 R_E . He found that enhanced current density in the current sheet due to shock compression and the center of the magnetotail shifted to Y = -–20 R_E due to the strong Vy shear, which are consistent with the observations. MHD predicts interesting features of R-1 FACs that need to be compared with ground magnetometers. He suggested that more event simulation-observation comparisons with ARTEMIS observations are needed to understand the mid-tail response to sharp solar wind/IMF changes.

Rob Fear discussed magnetotail structure associated with transpolar arcs. He showed an event with Cluster in the lobe at X ~ –8 R_E and Z ~ -12 R_E, which saw perpendicular electron fluxes indicating closed field lines at very high latitudes, and IMAGE saw a transpolar arc, which supports that magnetotail reconnection during northward IMF can be a candidate for transpolar arcs. Newly reconnected field lines map sequentially deeper into the polar cap. Thus when a transpolar arc extends across fully to the dayside, this closed field line structure will extend a long way downtail. He suggested to use ARTEMIS data to investigate the connection between mid-tail structures and transpolar arcs.

Peter Chi presented ion cyclotron waves at the Moon and their connection to the plasma sheet and the lunar exosphere. He showed that the tail environment at lunar distances can be influenced by the presence of the Moon. The Moon can be a dominant particle source in the tenuous magnetotail. He suggested to identify the generation mechanism(s) of ion cyclotron waves at the Moon (through studying the morphology of ICW and the wave/particle data). Also if the pickup ions are the source of ICW, the amount of exospheric particles (and their escape) can be estimated by the measurements of ICW.

Ivan Vasko presented current sheet observations by Geotail in the mid and distant tail. He found quite often thin and intense current sheet in the 30-50 and 80-100 R_E regions; more intense near midnight. Intense current is found to be associated with fast ion flow and electrons likely the main current carrier. He suggested that ARTEMIS separated in space can provide better understanding of the formation of thin current sheet and electron dynamics.

Andrei Runov pointed out that lunar orbit in the magnetotail is in-between the statistically most probable Near Earth Neutral Line (NENL) and Distant Neutral Line (DNL) locations. Thus, in the framework of magnetotail reconnection and related phenomena, including BBFs, dipolarization/jet fronts, particle energization and transport, observations there are greatly important. He suggested to propose a joint session with the Reconnection in the Magnetosphere FG.

John Lyon showed LFM simulations at lunar distances for growth phase and sawtooth event. He found that for growth phase conditions (IMF changes from northward to southward), bubble initiates at lunar distance. For the sawtooth event driven by O^+ outflow, the X-line is seen to move between the near-Earth neutral line and lunar distance. He suggested to increase resolution in the mid-tail region and compare simulations with statistical observational results.

Joe Borovsky discussed mid-tail and systems science in terms of what affects the mid-tail, what the mid-tail affects, and whether there are ‘complex-systems behaviors’ in the mid-tail. He suggested a potential joint session with the Geospace Systems Science FG to access the mid-tail and to figure out time scale and time lags for those connections.

Magnetotail and Plasma Sheet Research Area Report

Coordinators: Andrei Runov and Matina Gkioulidou

Tail-Inner Magnetosphere Interactions Focus Group

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

The TIMI focus group had 4 breakout sessions during the 2015 workshop. 2 sessions were joint with other focus groups. The first session was joint with the Magnetic Reconnection in the Magnetosphere focus group was held on Tuesday June 16. The report for this session was kindly provided by the reconnection focus group and can be found in their report. The second session was also joint with the Storm-Time Inner Magnetosphere-Ionosphere Convection (SMIC) focus group was held on the morning of Thursday, June 18.

Joint SMIC/TIMI session – Thursday, June 18

Co-Chairs: Stan Sazykin (Rice), Joe Baker (Virginia Tech) and Frank Toffoletto (Rice).

Mike Wiltberger (NCAR/HAO) presented published (in press, JGR) analysis of bubbles (BBFs) in LFM simulations. He traces these flow channels back to originating reconnection spots in the tail and also did statistics using simulations to compare with Geotail data published by Shin Ohtani and found quite good agreement.

Mike Henderson (LANL) made a presentation on PBIs and the evolution of north-south aligned forms-auroral streamers and showed that omega bands were related to flow bursts. Sometimes injections at geosynchronous and can be related to streamers but this is uncommon.

George Khazanov (GSFC) presented a new self-consistent model of auroral precipitation that emphasizes the importance of superthermal electrons and interhemispheric flows.

Natalia Ganushkina (U. Michigan) presented a new empirical model for plasma sheet electron fluxes using THEMIS data between 6 and 10 Re. Motivation is to specify outer boundary conditions for magnetospheric electrons. Data includes ESA (up to 30 keV) and SST (50 keV—a few MeV) instruments as well as electron temperature as a function of L and solar wind velocity.

Sean Chen (GSFC) along with Mei-Ching Fok looked at the penetration of large electric fields into the inner magnetosphere using Van Allen Probes data between 9/18/2012 and 12/31/2014. He showed statistical patterns of Ey (dawn to dusk) in corotating frame for various Kp levels. Results seem similar to Rowland and Weygant 1998. Some simulations from the comprehensive inner magnetosphere ionosphere (CIMI) model were also presented.

Matina Gkioulidou (JHU/APL) show observations for 3/17/2013 event when she finds multiple injections in the ring current from using Van Allen Probe ring current ion data. Lower energy particles (pressure) are correlated with Dst, but higher-energy particles are not. Pitch-angle distributions were found to be mostly isotropic.

Shin Ohtani (JHU/APL) discussed adiabatic transport in the plasma sheet and reported that the Harang discontinuity is the solution to the pressure balance problem.

X. Shu (Virginia Tech) showed SuperDarn observations of Pi2 pulsations in the SAPS region. He suggested that this is a response to a BBF, showing THEMIS flow data to support this.

Bing Yang (U. Calgary) showed GRL (in press) results using auroral patches to estimate convection flows.

Doug Cramer (UNH) Doug showed OpenGGCM-RCM simulations of 3/17/2013 and 11/01/2012 events, both appear to show a SAPS channel and electric field penetration in the inner magnetosphere.

Jian Yang (Rice) Showed RCM-E idealized simulations indicating that bubbles are important for ring current injection.

TIMI Focus group, Thursday June 18.

The final two TIMI Focus sessions were held on the afternoon of Thursday, June 18. Co-chairs: Vassilis Angelopoulos (UCLA), John Lyon (Dartmouth) and Frank Toffoletto (Rice)

Doug Cramer (UNH) Found that using the OpenGGCM-RCM coupled model, they have identified SAPS events in the March 17, 2013 and November 1, 2012 geomagnetic storms. During these events, the peak of the poleward electric filed was found to be near a magnetic local time of 17.

Jian Yang (Rice) Using RCM-E simulations, he showed that bubbles can contribute about 60% of the ring current energy for intense storms. He also showed an RCM-E simulation without bubble injections through the tailward boundary, which produced roughly the same large-scale ring current pressure distribution as the run with bubbles.

Drew Turner (Aerospace): Presented results from his recently published GRL article (2015) of Van Allen Probes observations of energetic electron injections deep into the inner magnetosphere. Their evidence apparently link sudden injections of 10s to 100s electrons into the slot region and inner radiation belt to classic substorm injections and activity at higher L-shells, though the injection mechanism at such low L remains an open question.

Sasha Ukhorskiy (JHU/APL) Reported on recent analysis of ion measurements from the RBSPICE experiment of the Van Allen Probes mission showed that the buildup of plasma pressure in the inner magnetosphere largely occurs in the form of localized discrete injections similar to dipolarization fronts observed in the magnetotail. His analysis is based on three-dimensional test-particle simulation in an analytical model of the electric and magnetic field perturbations associated with the injection fronts showed that the proton acceleration is produced by stable particle trapping and subsequent earthward propagation along with the front.

Chih-Ping Wang (UCLA) He examined how far BBFs can transport high-energy electrons (~100 keV) earthward using simultaneous measurements from 3 THEMIS probes and one RBSP probe aligned along similar Y from X ~ –12 to –5 Re. BBFs preconditioned by stronger large-scale convection, thus larger ring current and lower magnetic field strength in the inner magnetosphere, can transport high-energy electrons (~100 keV) further earthward.

Christine Gabrielse (UCLA) Presented results from analytical modeling of electron injections via localized, transient dipolarizing flux bundles demonstrated that the source of electrons depends on the spacecraft location relative to the DFB front as well as the DFB properties. In many scenarios, the electron source is the plasma sheet; however, if the field magnitudes are large and the spacecraft crosses the dawnside of the front, electrons may arrive from the reconnection region due to enhanced earthward transport via sharp, localized gradients in the DFB's magnetic field.

Larry Lyons (UCLA). Showed that localized channels of enhanced polar cap flow are traceable in red line via polar cap arcs and patches. Tracing indicates that the flow channels not only drive plasma sheet/auroral oval flow channels, PBIs, streamers, and substorm onset, but they also feed the westward surge and poleward expansion of the substorm bulge. Features are traceable across the polar cap for up to ~1-1.5 hr.

Yin Zhou (UCLA). Showed that based on ground-based observation, nightside auroral oval

disturbances are found to be preceded by localized and fast flows in the polar cap traced by polar cap arcs. These disturbances are major disturbances within a few hours and they only initiate after the impingement of polar cap arcs on the auroral poleward boundary and right at the impinging longitude, suggesting them to be triggered by mesoscale flows from polar cap.

Toshi Nishimura (UCLA) presented MHD simulation results of driven reconnection by localized flow channels impinging on the plasma sheet. He suggested that magnetotail reconnection can be triggered by fast flow channels originating in the dayside.

Jodie Barker Ream (UCLA) show that using both the UCLA and LFM global MHD models, they find that as flows slow down in the braking region a Pi2 period compressional wave begins to run ahead of the flows into the inner magnetosphere. However, the ionospheric conductance models play a large part in determining how far earthward those compressional waves are able to travel.

Aaron Schutza (Rice) gave a presentation describing his thin filament simulations of interchange oscillations in the Earth's magnetotail. His simulations show evidence of mode coupling between tail flapping and interchange oscillations.

Roxanne Katus (Univ. Michigan) presented initial result of a 10 minute resolution magnetospheric ion temperatures derived from TWINS MENA flux data. The ion temperature data were examined statistically as a function of storm time.

Zhengwei Chen (UNH) performed a case study with in situ magnetic field and plasma measurements from the Cluster to examine the FAC carriers in the magnetotail during a substorm recovery phase. This study provides a method to study the FAC carriers in a feasible way by using Cluster multi-instrument (FGM, PEACE, CIS) data.

Jiang Lu (UCLA) showed results of a statistical study, where he found that dipolarizing flux bundles (DFBs) in the magnetotail carry asymmetric region-1-sense field-aligned currents (FACs). These asymmetric FACs allow ~10 DFBs to comprise the substorm current wedge (SCW), so that each DFB acts as a "wedgelet", the building element of the SCW.

Plans for the coming year

2016 will final year for the TIMI focus group. We hope to use the final year to recap the progress that has been made during the existence of the TIMI focus group and map out future plans that can be taken on by existing or future focus groups. This is a focus area that continues to attract a lot of interest and with the recent MMS mission along with the recently formed Heliophysics/Geospace System Observatory (HGSO) group we expect more exciting science to come.

Testing Proposed Links between Mesoscale Auroral and Polar Cap Dynamics and Substorms Focus Group

Co-chairs: Kyle Murphy, Toshi Nishimura, Emma Spanswick, and Jian Yang

Motivated by the recent controversy over auroral streamers, flow bursts and possible connections to substorm triggering, we introduced a new focus group (FG), "Testing Proposed Links between Mesoscale Auroral and Polar Cap Dynamics and Substorms", intended to elucidate connections between auroral structures and their magnetospheric counterparts, and to bring closure to the question of substorm triggering. We had four sessions including one jointly with the Scientific Magnetic Mapping & Techniques FG. The first three talks reviewed current understanding and open questions, and subsequent talks in session 1 and 3 discussed a selected event and discussed how much the community can agree on the event sequence. Modelers also presented works on key issues on substorms. Session 2 discussed methods and techniques to quantify auroral signatures, and session 4 was for magnetosphere-ionosphere map-

ping of substorm signatures.

1. Event discussion

Larry Lyons gave a review of precursor streamer scenario, presented his view of the Kepko et al. [2009] event, and raised outstanding issues. If the Nishimura et al. [2010] scenario is very common, as he believes will turn out to be the case, then a number of quite interesting questions, including (1) How do flow channels do and do not lead to onset relate to entropy gradient changes from intruding low entropy flow channels? (2) How does substorm onset instability relate to entropy gradient changes caused by the intruding flow channels? (3) How are flow channels related to DNL/NENL and polar cap flows? (4) How is a current wedge involved in these?

Mike Henderson reviewed a historical aspect of substorm triggering by IMF orientation changes. Then he commented on substorm pre-onset scenarios and near-Earth instability. He noted that the November 21, 2002 event in Henderson [2009] also shows streamer-like features prior to onset. The onset has characteristics of ballooning instability and precedes mid-tail X-line formation. He also raised questions why only some of the streamers trigger onset, how the magnetosphere is different compared to streamers that lead to other types of responses (e.g., torches and omega bands).

Larry Kepko discussed similarities and differences of existing scenarios and raised key questions (presented by Toshi Nishimura). He pointed out that there is no quantitative definition of streamers, and that different types of auroral activities have been used in the past statistics. Depending on how people identify each auroral signature, the occurrence probability of precursors may vary substantially, resulting in the lack of consensus about substorm precursors in the community. The community should establish quantitative definition of each auroral signature, and have a community-wide discussion of individual events and occurrence statistics.

Shin Ohtani and Tetsuo Motoba examined Kepko et al. event with a focus on the initial location and propagation of auroral beads using the polar distribution of equivalent currents as a reference for global convection. They found that an auroral structure propagating from poleward touched the auroral oval around the demarcation between the dawn and dusk convection cells and then, the auroral beads started to form without any noticeable delay. The timing is consistent with the idea that the auroral breakup is caused by the penetration of a plasma flow into the near-Earth region. However, they also found that the beads formation started noticeably dawnward of the convection demarcation and expanded dawnward toward the demarcation. In addition, auroral beads themselves propagated dawnward. They therefore suggested that the auroral activation is not a direct consequence of the flow penetration, but there is an additional process, for which the ion dynamics might be important.

Larry Lyons and Toshi Nishimura gave their view of Kepko et al. event. They agree that a streamer formed and contacted the growth phase arc prior to the onset. However, in contrast to Kepko et al.'s suggestion, they found that the streamer did not originate in the middle of the auroral oval but from a poleward boundary intensification (PBI). The PBI was preceded by a polar cap airglow, suggesting that the precursor of this substorm initiated in the dayside polar region, propagated across the polar cap and nightside open-closed boundary, and then reached the near-Earth plasma sheet prior to the substorm onset.

Kyle Murphy analyzed Kepko et al. event using his technique of tracing auroral structures. His method automatically identifies streamers and growth phase arc, and shows that streamers contacted the growth phase arc prior to the onset. In this event, his analysis supports Kepko et al.'s conclusion that the substorm onset is preceded by plasma sheet flows.

Yukinaga Miyashita suggested that for making discussions about the substorm triggering mechanism clear, it is essential to determine the timings of the three steps of the auroral develop-

ment, i.e., initial brightening, enhancement of wave-like structure, and poleward expansion. For the 25 February 2008 substorm event, he pointed out that the pre-onset auroral streamer reached the auroral onset arc away from the initial brightening site after the initial brightening already occurred. He also showed that near-Earth reconnection possibly began 4 min before the initial brightening.

Joachim Birn presented results from test particle tracing in an MHD simulation of near-tail reconnection and flow bursts, demonstrating the formation of field-aligned ion beams in the PSBL. The ion beams were generated by direct non-adiabatic acceleration in the vicinity of the neutral line, consistent with PIC simulation results, but adiabatically deformed into crescent shaped velocity distributions from propagation toward higher magnetic field. The energy dispersion of the beams permits a remote identification of the acceleration site.

Phil Pritchett showed results from a 3D PIC simulation of a portion of the magnetotail indicating that the ballooning/interchange instability should produce structuring of auroral streamers similar to THEMIS ASI observations. He emphasized that 3D PIC simulations have evolved to the point where they can be used to investigate other issues relevant to the Substorm focus group such as the influence of dayside flow channels in initializing localized tail reconnection.
Misha Sitnov discussed PIC simulations of dipolarization fronts and their ionospheric implications. Pritchett, Coroniti and Nishimura (JGR, 2015) first noticed that while equatorward portion of the streamer showed multiple arcs, the poleward portion of the streamer might stay essentially as a single arc. This observation is consistent with his 3D PIC simulations of fronts. Sitnov showed that, in contrast to flapping and buoyancy-driven perturbations of the dipolarization front causing its modulation in the dawn-dusk direction, the region well behind the front, including the new X-line forming in its wake, remains largely unstructured in the dawn-dusk direction, except relatively long wavelength flapping motions.

Vassilis Angelopoulos presented plans of the upcoming Heliophysics/Geospace System Observatory (HGSO). Although satellite missions are generally driven by their own mission goals, he proposes to coordinate satellites as well as ground observatories for studying cross-scale and cross-regional coupling processes in a broader scale than previously possible. HGSO will conduct simultaneous observations in the dayside and nightside reconnection regions by MMS and THEMIS, and coordinate with other satellite missions and ionospheric measurements for investigating (1) global effects of dayside transients, (2) cusp-dayside connections, (3) nightside reconnection and tail-inner magnetosphere coupling, (4) global processes, and (5) cross-scale coupling.

2. Tools and Methods Session

Bob McPherron presented a detailed overview on point processes and how this analysis could be applied to substorm research. Using data from ground-based magnetometers B. McPherron compared and contrasted different substorm lists including the SuperMAG, IMAGE, mid-latitude positive bay and Nishimura substorm lists. B. McPherron demonstrated that the SuperMAG, IMAGE and mid-latitude positive bay list were all in excellent agreement while the Nishimura list was poorly correlated with the others.

Emma Spanswick and Eric Donovan presented an overview of the circle gram substorm aurora analysis technique. The circle gram determines whether onset occurs spontaneously with in a discrete region or is triggered by aurora outside of the region. The analysis technique is ideal for characterizing substorm triggering by auroral streamers.

Nadine Kalmoni presented a new analysis technique for characterizing the auroral bead observed at substorm onset. The technique is able to determine both the auroral wave length and growth rates observed at substorm onset. These wavelengths and growth rates can then be compared to theoretical values to determine the

most likely instability leading to development of auroral beads.

Kyle Murphy presented a new analysis technique for auroral tracking. The quantitative algorithm track aurora and is able to determine whether streamers are a necessary condition for substorm onset.

3. Mapping Session

Emma Spanswick presented observations from riometers and red line imagers in the mapping session. E. Spanswick demonstrated that the riometer signature of substorm onset is highly correlated with in-situ observations of the substorm injection. With an array of ground-based riometers the development of the substorm injection can be track in latitude, longitude and time. E. Spanswick also showed new 2D red line auroral imagers, new work is being done to determine if these imagers can routinely track the polar cap boundary across MLT and in time.

Shin Ohtani gave two talks in the mapping session. In the first S. Ohtani discussed the overlap region of R1 and R2 currents where substorm onset can occur and which can be driven unstable by the interchange instability. In the second talk S. Ohtani discussed the mapping of R1 and R2 current relative to electron and ion plasma sheets.

Jian Liu presented detailed observations of the substorm current wedge from the THEMIS constellation.

Chao Yue presented a new mapping technique for mapping the growth phase auroral arc from the ionosphere to equatorial plane. C. Yue's mapping suggests that substorm onset occurs in the inner magnetosphere in a region that is characteristically unstable to a ballooning instability.

4. Future work

In a wrap up session the focus groups leaders discussed outstanding questions and ways to move forward with the focus group. Outstanding questions included:

1. What is a streamer?
2. What are the conditions for onset?
3. What is the timing between streamers and auroral onset? And how close do streamer need to get to trigger onset?
4. Is the association of streamers and onset coincidental?
5. What information can we derive from optical/ground data that directly connects to satellite measurements?

GEM on the Internet

GemWiki: http://aten.igpp.ucla.edu/gemwiki/
GEM Workshop Website: http://www.cpe.vt.edu/gem/
GEM Messenger (Electronic Newsletter):

- To subscribe or update subscription: E-mail gemeditor@igpp.ucla.edu
- To post announcements: Fill out the online request form at http://aten.igpp.ucla.edu/gem/messenger_form

Inner Magnetosphere Research Area Report

Coordinators: Scot Elkington and Seth Claudepierre

Inner Magnetosphere Cross-Energy/Population Interactions (IMCEPI) Focus Group

Co-Chairs: Yiqun Yu, Colby Lemon, Mike Liemohn, Jichun Zhang

Our focus group started its second-year in 2015, receiving a lot more interests from the community since a year ago. We organized one joint session with "Quantitative Assessment of RB modeling" and three individual sessions focusing on "wave-particle interactions", "plasma-field coupling" and "magnetosphere-ionosphere coupling", respectively. We had a good number of speakers and attendance in each session, and positive inputs from the discussion with the audience.

1. Joint session with "Quantitative assessment of radiation belt modeling" FG:

The two FGs shared the same audience and speakers to jointly address the wave particle interactions in the inner magnetosphere populations. A variety of research topics were presented, such as establishing a global time-dependent EMIC amplitude distribution using RAM-SCB outputs (X. Fu) and spatial distributions of EMIC wave from Van Allen Probes observations (A. Saikin). Other studies looked at the excitation of chorus waves in a laboratory plasma (J. Bortnik, X. An) and whistler waves from particle simulations (S. Wu). W. Li modeled the acceleration of radiation belt electrons due to chorus waves in a 3D diffusion model, and C. Wang reported ULF waves from multi-point observations. Y. Shprits presented VERB-4D simulations that can combine the transport of convection and diffusion for radiation belt electrons.

2. "Wave-particle interactions" Session:

We had a variety of contributions on various waves, including EMIC, ULF, and Chorus waves. We focused on a challenge event on Feb 23, 2014 from coordinated space- and ground- measurements. This included intense EMIC wave activity across a wide range of L-shells and MLTs and subsequent scattering of energetic particles (M. Engebretson), and delayed EMIC activity following tail plasma injections within GEO (J. Lee). We had contributions on ULF waves and their dependence on azimuthal wave number m, and an extension of a previous statistical study from new database (M. Hartinger). Topics on chorus waves included their global distribution as functions of solar wind conditions (A. Homayon), and statistical studies of shock-associated chorus excitation in the dayside magnetosphere due to more homogeneous magnetic field configuration (C. Zhou). In addition to observational contributions, we also had discussions on the modeling effort of global chorus and EMIC wave distribution from the RAM-SCB model (V. Jordanova), as well as forecasting effort on the electron radiation belts (A. Kellerman).

3. "Plasma-field coupling" Session:

We had again a variety of research topics for the inner magnetosphere coupling between the plasma and electric/magnetic fields. Presentations included investigation of the cause of the post-midnight flux minimum in the near-Earth eV electrons (L. Smith) by examining the correlation with the equatorial noise, discussion on the subauroral polarization streams (SAPS) electric fields observed by Van Allen probes and their relation with plasma sheet boundaries (S. Califf), and estimation of ring current energy densities using Van Allen Probes observations during geomagnetic storms (H. Zhao). Investigations of the characteristics and formation of heavy ion "trunk" structures (J. Zhang) and the spatial distributions of proton 'nose' structures as functions of species and geomagnetic activities (C.

Ferradas) were also presented. In addition to these observational studies, we also had contributions of modeling efforts, including the improvements in global models of the inductive electric fields (R. Ilies), the test particle simulations on Landau accelerations of low energy electrons following substorm injections (J. Woodroffe), as well as discussion of an apparent inconsistency between improved diffuse auroral precipitation models (C. Lemon) and their resulting effects on electric feedback between the ionosphere and magnetosphere.

4. "Magnetosphere-ionosphere coupling" Session:

We focused on the connection between the ionosphere and magnetosphere, by looking into the effects of magnetospheric dynamics in the inner magnetosphere on the ionosphere and vice versa, such as the development of an ionospheric conductivity model from statistical DMSP measured precipitation spectra (R. McGranaghan), ionospheric electron precipitation due to pitch angle scattering in the magnetosphere by plasma waves (Y. Yu), and modeling the feedback loop of ionospheric outflow and its effects on the ring current (D. Welling). Observational studies are devoted to new measurements on pulsating aurora at low energies (M Gillies), and multi-instrument coordination on the waves and associated radiation belt precipitation (A. Janyes). A challenge event on Jan 25, 2015 was extensively discussed by several speakers from different perspectives, such as BARREL observations of energetic electron precipitation by A. Halford, Van Allen Probes analysis of EMIC waves by J. Zhang, and modeling effort on the coupling between the ionosphere and inner magnetosphere by Y. Yu. The audience also provided suggestions to the focus group, including adding more challenge events while elaborating their challenges, and planning a website/server for sharing data with colleagues.

Quantitative Assessment of Radiation Belt Modeling (QARBM) Focus Group

Co-Chairs: Weichao Tu, Jay Albert, Wen Li, and Steve Morley

In the 2015 GEM Summer Workshop, "Quantitative Assessment of Radiation Belt Modeling" (QARBM) Focus Group held five sessions on Monday June 15th and Tuesday June 16th. All of the sessions were well-attended with helpful discussions. There were 39 scheduled talks in total and a few walk-in talks over the 5 sessions, covering a wide range of topics, as listed below:

Session 1 - "Radiation Belt (RB) observations and modeling results"

In the first session eight talks were presented on the observational and modeling results of the acceleration, transport, and loss of radiation belt particles. There were four talks discussing the radiation belt responses during the recent "super storm" on Mar 17, 2015, including the fast diffusion and impenetrable barrier for ultra-relativistic electrons observed by Van Allen Probes, the LFM test particle simulation for ULF waves and electron transport, and the VERB code simulating the MeV electron dynamics. The additional four talks reported, respectively, LFM test particle simulations of RB electron precipitation response to ULF waves, modeling of the "peculiar" pitch angle diffusion of relativistic electrons in the inner belt and slot region using a 2D diffusion code, deep injections of 10s-100s keV electrons observed by Van Allen Probes, and statistics of storm-time RB enhancements vs. depletions showing detailed E and L dependence.

Session 2 - "Various magnetospheric wave characteristics and their global distribution required in RB modeling"

This session focused on characterizing various wave properties that are required as inputs to RB models. Nine short talks were presented, covering ULF waves, chorus and hiss, EMIC waves, magnetosonic waves, and their effects on RB particles. There were three ULF-related talks, covering quan-

tification of the radial diffusion coefficients using Van Allen Probes field data, discussion of the relation between ULF waves and radial diffusion, and an advertisement for the ULF Wave Challenge organized by the Validation&Metrics FG. One talk discussed the relationship between EMIC waves and RB electron precipitations based on data from multiple missions including BARREL, Van Allen Probes, CARISMA, CSSWE, POES, etc. The two magnetosonic (MS) wave talks focused on observational and numerical studies of the electron scattering due to MS waves and the bounce resonance with MS waves. Additional topics covered in the session included global chorus wave distributions using statistical and event-specific models, nonlinear wave-particle interactions, and the effects of wave obliquity on RB energization and losses.

Session 3 - "Seed populations, plasma density, and magnetic field configuration required in RB modeling"

Nine talks were presented in this session focusing on specifying other required inputs for driving RB simulations. There were four talks on the quantification and modeling of the seed populations for radiation belt electrons, including the IMPTAM model, an empirical model based on LANL/GEO data, the quantification using Van Allen Probes data, and the RCM-E simulation. In addition, two talks discussed the Time Domain Structures and the Double Layers associated with electron/ion acoustic waves, and the three talks by the end reported updates and results from the DSX mission, FIREBIRD II, and the CSSWE mission.

Session 4 - "RB "dropout" and "buildup" challenges and Planning for future activities"

In the final independent session of our FG we had a great discussion on the RB "dropout" and "buildup" challenges that we are planning. Due to the large number of presentation requests, a few short talks were scheduled at the beginning of this session. The topics included: recent results from the UCLA reanalysis code, 3D LFM test particle simulations on the October 2012 storm and March 2013 storm respectively, and Van Allen Probes observations of the electron bursts during the March 2015 storm.

After those talks, we started the discussion on the RB "dropout" and "buildup" challenges by proposing candidate events under four different categories: "storm-time enhancements", "non-storm enhancements", "storm-time dropouts", and "non-storm dropouts". Three to four candidate events were presented and discussed under each category including details of solar wind drivers, geomagnetic activities, and RB responses. The goal is to select one event from each category based on inputs from the community. After the summer workshop, we sent out an email to the community to collect votes for the challenge events. Based on the responses that were received, we found the votes were exceptionally clear-cut for the storm-time events. While voting was less one-sided for the non-stormtime events, a clear consensus emerged in the votes as well. We will soon announce the final selections for the four challenge events and encourage people to simulate these events with their own models and/or provide data or model inputs that are required to simulate these events. To establish a common basis for simulations and testing, we will also provide a common point of access to the model inputs and data for each of the selected events. By mini-GEM in December 2015, we look forward to seeing results of modeling and quantitative assessment of these selected challenge events.

Session 5 - "Joint session with "Inner Magnetosphere Cross-Energy/Population Interactions" FG"

We finished with a joint session with the IMCEPI FG, since the two FGs have common interest in understanding how plasma waves are generated and how they influence the radiation belt dynamics. In this session, we had eight talks in total, with two talks discussing the quantitative simulations of RB electrons using a 3D diffusion model and the VERB-4D convection-diffusion model respectively, two EMIC-related talks on the generation of EMIC waves and the statistical distribution of EMIC waves from Van Allen Probes data, three talks on the generation of whistler waves using experimental or numerical approaches, and an additional talk on the multi-point observations of ULF waves.

Magnetosphere-Ionosphere Coupling Research Area Report

Coordinators: Marc Lessard and Shin Othani

The Ionospheric Source of Magnetospheric Plasma—Measurement, Modeling, and Merging into the GEM GGCM Focus Group

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

Our focus group had an active set of presentations and discussions at the GEM Snowmass Workshop in June. The sessions covered progress in merged modeling of the ionospheric outflow and magnetospheric dynamics and comparison of these merged model results with the observations for specific magnetic storm periods that had been selected by the focus group participants. The two storm periods are Sept 27- Oct 4, 2002 and Oct 22- 29, 2002. Measurements for the two selected GEM storm periods as well as for a third storm period in April 6 -7, 2000 are available from instruments on Cluster, Polar, LANL and FAST spacecraft. In addition, there was a session specifically to do an inter-comparison between different model results and a final general session that included an open discussion regarding the closing activities of the focus group at the end of this calendar year. The papers and presenters for these four sessions are shown in Appendix A.

In a general sense, there has been continued progress in both the ion outflow models and their merger with the magnetospheric MHD models, both BATS-R-US and LFM. The outflow models have been completed for the two selected storm periods and there have been merged model runs for these two storms as well. The ion outflow has been modeled using the Generalized Polar Wind model at Utah State University, the Polar Wind Outflow Model at the University of Michigan and Goddard Space Flight Center and the Ionosphere Polar Wind Model at NCAR. The model inter-comparisons show very interesting results, which match the observations in a variety of ways. In some instances one merged outflow model can give a better match to the Dst and the cross-polar cap potential and another can match the O+ outflow more effectively. Merging the ion outflow to the MHD model leads to the release of a plasmoid in the tail of the magnetosphere whereas the lack of explicit input from the ionosphere results in no plasmoid release.

Additional discussion of modeling results and observations from these two events led to a short list of key features that must be investigated in the future. Cluster observations of outflow in the northern and southern hemispheres showed strong asymmetry in terms of density and composition. Further studies will be required to determine if this feature manifests in the model results. Many noted that the lack of embedded ring current model in the MHD models might be an important limitation, especially when performing data-model comparisons within geosynchronous distances. Finally, experimental results from the LFM model when many fluids are used illustrates the necessity for 3 or more dedicated fluids in order to properly capture the complicated outflow dynamics throughout the magnetosphere. These additional modeling steps will be taken under consideration as the teams prepare for Fall AGU.

Modeling results for GPW, BATS and merged GPW/BATS are available to the community at the following website: http://aoss-research.engin.umich.edu/projects/outflowmmm/. Contact Dan Welling for information on obtaining or sharing your modeling results on the website (dwelling@umich.edu).

Based on the focus group discussion in our fourth session we have planned a continuation of

our GEM focus group activities in a special session at the upcoming Fall AGU meeting. The session title is **Ionospheric Outflow from Earth and Other Terrestrial Planets and It's Importance as a Source of Plasma for Magnetospheres.** The Session ID is SM003 and the conveners are Vince Eccles, Rick Chappell, Lukas Maes and Bill Peterson. Our goal is to continue the momentum of the focus group with presentations addressing both the merged modeling results and the observations that are now in progress. We have invited four speakers for this session and 8 papers have been contributed. A list of the invited and contributed papers is shown in Appendix B.

We are also considering organizing a special section for the Journal of Geophysical Research on the role of the ionospheric source in driving magnetospheric plasma and dynamics. This special JGR section would be built around the papers that will be presented at fall AGU as well as the papers that have been written in connection with the work of the focus group over the past years. This special section should be an excellent compendium of the work of our GEM focus group.

In addition to the special JGR section, the focus group was involved in creating the Yosemite Chapman Conference in 2014 on our research focus. An AGU monograph is being written based on the papers given at the Yosemite conference and an HD video of the Yosemite conference is available online at Utah State University. In order to view the Yosemite video go to http://digitalcommons.usu.edu/yosemite_chapman/2014/. A second book on the focus group topic based on an ISSI conference held in Bern Switzerland in October, 2013 is in press. At the conclusion of our focus group activities we expect to have an comprehensive collection of material that captures the new research results that have been stimulated by our GEM focus group over the past 5 years.

Thanks to all of the focus group members who have contributed to the merged modeling activities and to the analysis of the spacecraft measurements that are being used for comparisons with the modeling results. Please contact Rick Chappell at rick.chappell@vanderbilt.edu if you have any questions. We look forward to seeing you at the Fall AGU meeting!

Rick Chappell, Bob Schunk, Dan Welling.

Appendix A
Focus Group Sessions at the 2015 GEM Meeting

The Ionospheric Source of Magnetospheric Plasma—Measurement, Modeling and Merging into the GEM GGCM

Agenda for the Focus Group Sessions at GEM 2015

Merged Ionosphere-Magnetosphere Models

Monday, June 15: 10:30am-12:15

—Generalized Polar Wind Models of GEM Storms, 1—Bob Schunk 20 min

—Generalized Polar Wind Models of GEM Storms, 2—Vince Eccles 20 min

—Merged Ionosphere-Magnetosphere Models—Dan Welling 20 min

—Overview of Recent LFM Modeling and Thoughts for the Future—Bill Lotko 20 min

—Discussion

Merged Ionosphere-Magnetosphere Models Compared to Observations

Monday, June 15: 1:30-3:00pm

—Merged BATS Iono-Magnetosphere Models for GEM Storms—Dan Welling 15 min

—Merged LFM Iono-Magnetosphere Model for GEM Storm—Katie Garcia-Sage 20 min

—Cluster Measurement/Model Comparisons During GEM Storms—Lynn Kistler 20 min

—LANL Measurement/Model Comparisons During GEM Storms—Joe Borovsky 20 min

—The Estimation of Cold Plasma Outflow During Storms—Stein Haaland 20 min

Inter-Model Comparison for GEM Storm Periods and New Measurements

Monday, June 15: 3:30-5:00pm

—Continued Discussion of Merged Models and Measurements Comparison

—Ion Outflow Topics—Naritoshi Kitamura 20 min

—Hysteresis Effects in Coupled MFLFM-IPWM

Models—Roger Varney 15 minutes
—Initial Plasma Measurements from MMS—Barbara Giles 20 min
—Ion Fluxes Into and Out of a Model Plasmasphere During a Storm—Jonathan Krall 20 min

General Discussion of Modeling and Observations and Focus Group Planning

Tuesday, June 16: 10:30am-12:15

—Global Multiscale Magnetospheric Simulations: HYPERS—Yuri Omelchenko 15 min
—The Powering of Highly Efficient Poynting Flux-Driven Wind Using Polar Spacecraft Measurements—John Wygant 15 min
—Ion Upflow Dependence on Ionospheric Density and Solar Photoionization—Bruce Fritz 15 min
—From SED Plume to Dayside Trough: Role of Ion Upflow—Shasha Zou 15 min
—A New Look at DE-1 Escaping Ion Observations at Non-Storm Times—Bill Peterson 10 min (Accompanying poster by Kristina Lu)
—Discussion involving entire Focus Group

In addition to the focus group sessions, there was a Plenary Tutorial Talk at GEM by Stein Haaland on "Cold Ion Outflow from the Polar Cap."

Appendix B
Presentations at the Fall AGU Session on Ionospheric Outflow from Earth and Other Terrestrial Planets and Its Importance as a Source of Plasma for Magnetospheres

Invited Papers:

Estimation of cold plasma outflow during geomagnetic storms
Stein Haaland, Max-Planck Institute, Goettingen, Germany; Birkeland Centre for Space Science, Bergen, Norway

High-resolution Multi-instrument Observations of Ion Outflows in the Topside Ionosphere on the Enhanced Polar Outflow Probe (e-POP)
Andrew W Yau, University of Calgary, Calgary, AB, Canada

Stormtime Ionospheric Outflow Effects in Global Multi-Fluid MHD
Katherine Garcia-Sage, NASA Goddard Space Flight Center, Greenbelt, MD, United States; Catholic University of America, Washington, DC, United States

Data-Model and Inter-Model Comparisons of the GEM Outflow Events Using the Space Weather Modeling Framework
Daniel T Welling, University of Michigan, Ann Arbor, MI, United States

Contributed Papers:

Comparing the O+ and H+ Escape Fluxes from Fluid and Particle-in-Cell Solutions of the Polar Wind— J Vincent Eccles, Center for Atmospheric and Space Sciences, Logan, UT, United States

Comparison Between the Integrated Ion Outflow Fluxes from the North and South Hemispheres Under Sustained Geomagnetically Active Conditions
Abdallah R Barakat, Utah State University, Logan, UT, United States

Low-Energy Ions as a Major Source of Magnetospheric Plasma: Statistics and Consequences
Mats Andre, IRF Swedish Institute of Space Physics Uppsala, Uppsala, Sweden

Influence of Causally Regulated Ion Outflow on Coupled Magnetosphere-Ionosphere Dynamics
Roger H Varney, SRI International Menlo Park, Menlo Park, CA, United States

Is Substorm Onset Seeded by Cross-Tail Current Enhancement Resulting from Parallel Energization of Oxygen Ion Polar Cap Outflow?
George J Sofko, University of Saskatchewan, Saskatoon, SK, Canada

Modeling the O+ Transit from Ionosphere to Plasmasheet
Thiago V Brito, Laboratory for Atmospheric and Space Physics, Boulder, CO, United States

The Cusp Ion Outflow up to 6 Re: Statistical Study on Polar and FAST Conjunction Events
Sheng Tian, University of Minnesota Twin Cities, Minneapolis, MN, United States

On contribution of energetic and heavy ions to the plasma pressure: Storm Sept 27 - Oct 4, 2002
Elena A Kronberg, Max Planck Institute for Solar System Research, Gottingen, Germany

The Storm-Time Inner Magnetosphere-Ionosphere Convection (SIMIC)

Co-Chairs: Joseph Baker, Michael Ruohoniemi, Stanislav Sazykin, Peter Chi, and Mark Engebretson

During the 2015 summer GEM workshop, the Storm-Time Inner Magnetosphere-Ionosphere Convection (SIMIC) Focus Group chose to concentrate its attention on 2 selected intervals. Our goal is to use ground- and space-based observations in conjunction with numerical simulations during these intervals to understand how plasma distributions, convection electric fields, and current systems emerge and evolve in the inner magnetosphere and conjugate ionosphere during geomagnetic storms. The two storm intervals are March 17th, 2013 (a CME-driven storm) and November 1st, 2012 (a storm produced by a sheath). We had two sessions with 18 presentations.

SIMIC FG uses a web-based collaboration site (http://www.wiggio.com) for sharing of results and discussions, and we refer the readers to that web site for more detailed examples of presentations during the workshop. Interpretation and analysis of the March 17th, 2013 and November 1st, 2012 events will continue at the upcoming mini-GEM workshop prior to the Fall AGU Meeting in San Francisco.

The presentations included event simulations with global MHD models (LFM and OpenGGCM), ring current/inner magnetosphere models (RCM-E, HEIDI, CIMI), coupled ring current-ionosphere models (SAMI3-RCM), ring current-global MHD (RAM-BATS-R-US) models, and the ionospheric TIEGCM model. The datasets brought to the discussions included AMPERE Birkeland currents, ground-based magnetic field perturbations, geosynchronous energetic particle fluxes from GOES and LANL spacecraft, THEMIS all-sky images and in situ spacecraft data, DMSP topside ionospheric measurements, SuperDARN ground-based radar data, various particle and fields measurements from Van Allen Probes instruments, and energetic neutral atom (ENA) TWINS data.

The following are some of the specific science questions that shaped the discussions:

1. What are the observational signatures of bursty -bulk flow/entropy bubbles predicted by global MHD simulations (M. Wiltberger)?
2. How do main-phase substorms contribute to the Dst index (S. Ohtani)?
3. Is it possible to separate different types of storm-time penetration electric fields (impulsive changes due to solar wind pressure pulses, smooth global convection changes, and flow bursts) (L. Lyons)?
4. What is the temporal and causal relationship between auroral streamers, bursts of convection, and intensification of SAPS flows (B. Gallardo)?
5. Is there a consistent pattern in the relative locations of the plasmapause and the SAPS channel as seen by the Van Allen Probes instruments (F. Wilder)?
6. What is the role of electron precipitation in the diffuse aurora and can the electron ring current fluxes be predicted with improved electron precipitation models (M. Chen)?
7. What is the storm-time response of the ionospheric Total Electron Content (TEC) caused by penetration electric fields (G. Lu)?
8. Can storm-time TEC structuring and plasmaspheric structuring be predicted with first-principles modeling (J. Krall)?
9. What is the location of the ring current pressure peak as a function of MLT and storm phase (L. Smith)?
10. What is the role of enhanced convection in the storm-time ring current formation (A. Glocer)?

11. What are the relative roles of enhanced convection versus flow bursts in the formation of storm-time ring current (M. Liemohn)?
12. Can observed SAPS be predicted with modeling (Y. Yu)?
13. What is the role and occurrence characteristics of whistler waves (E. MacDonald)?
14. What are viable mechanisms of prompt-penetration electric fields (R. Lysak)?
15. Dynamics of ENA during storms (P. Valek)?
16. What creates observed multiple sheets of Birkeland currents (B. Anderson)?

These science questions will continue to form the main scope of the focus group.

In addition, the SIMIC group had one session joint with the Tail-Inner Magnetosphere Interactions (TIMI) focus group. The primary focus of that session was on ionospheric signatures of transient flow features flows and entropy bubbles. The summary of this session was included in the report of the TIMI focus group distributed separately.

Scientific Magnetic Mapping & Techniques Focus Group

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

The Scientific Magnetic Mapping and Techniques focus group held three sessions at the 2015 GEM summer meeting, including one joint session.

The first session, joint with the *Testing Proposed Links between Mesoscale Auroral and Polar Cap Dynamics and Substorms* focus group, investigated, "What is a streamer and how does it map?" Speakers in this session included Shin Ohtani, Emma Spanswick, Elizabeth Roy, Jiang Liu, and Chao Yue. For details about this session, please refer to the workshop report of the *Testing Proposed Links* focus group.

The second session focused on progress on the mapping challenge to map the open-closed boundary and other mapping techniques. Peter Porazik showed an analysis of using an electron gun to probe the structure of the loss, which works well up to 500 keV for gun stability. Liz MacDonald showed results from the November 14, 2012 boundary crossing event which was used to probe the open-closed boundary by comparing Van Allen and LANL observations with model results. Kristie Llera discussed a new model to show the source of low altitude emissions observed by TWINS. Alexa Halford presented BARREL observations of an SEP event and discussed using the different balloon observations to determine which balloons were on open field lines. Eric Donovan discussed proton aurora, and informed the group about an extensive riometer array planned for installation in Canada.

The third and final session was a wrap-up session for the Magnetic Mapping focus group, which is ending this year. In this session, we surveyed the progress in magnetic mapping, and discussed the path forward. Raluca Ilie discussed how to map isotropic boundaries to the tail. The group as a whole discussed future plans including the possibility of writing an EOS article. It is anticipated that the subject of magnetic mapping will continue to be discussed by the *Testing Proposed Links between Mesoscale Auroral and Polar Cap Dynamics and Substorms* focus group.

As this focus group comes to and end, we'd like to thank everyone for their participation. This focus group was an import forum for discussing issues of magnetic mapping which are so critical to many areas of space physics research, particularly as we continue to combine different ground- and space-based observations to investigate the coupled MI system. In particular, this focus group proved to be cross-disciplinary, bringing together researchers from a wide range of sub-disciplines. We look forward to participating in the *Testing Proposed Links between Mesoscale Auroral and Polar Cap Dynamics and Substorms* focus group sessions at mini-GEM and beyond.

Global System Modeling Research Area Report

Coordinators: Frank Toffoletto and Alex Glocer

Metrics and Validation Focus Group

Co-Chairs: Timothy Guild, Lutz Rastaetter, and Howard Singer

The GGCM Metrics and Validation Focus Group convened two sessions during the GEM Summer Workshop in Snowmass, Colorado. The first session was held in the morning on Wednesday, June 17, 2015 and focused on the magnetopause modeling challenge, included some additional contributions, and discussed the wrap-up of the focus group that is coming to an end this year.

Session on magnetopause modeling challenge, other contributions and focus group wrap-up:

Community Coordinated Modeling Center staffpresented plans to augment and finalize the magnetopause modeling study that was begun at the CCMC and modelers contributed model assessments that included past event analyses and statistical approaches to evaluating real-time model results.

One of the model validation studies is the specification of the magnetopause location and comparisons with the prediction of when satellites at geosynchronous orbit could be located in the magnetosheath under storm-time solar wind conditions. Lutz Rastaetter presented recent advances in the automated calculation of skill scores using results from GEM modeling challenge events. Skill scores based on contingency tables derived for magnetopause crossings can be compiled in a similar manner as was used in a previous study for determining model skill at predicting the crossing of various dB/dt threshold levels for ground-magnetic perturbations.

Yaireska Collado Vega's presentation suggested ways to select and analyze magnetopause crossing events during steady solar wind conditions to constrain possible magnetopause standoff values through multi-spacecraft observations and to determine lag times inherent in each of the magnetosphere models.

Mike Wiltberger showed the analysis for LFM modeling of a storm event with the skill scores based on successful forecasts (both when events are predicted and are occurring and when they are not predicted and are not occurring) and failed forecasts (events predicted but not occurring or events occurring and not predicted).

Rob Redmon reported on the future of GOES missions with plasma and magnetic field instrumentation supporting magnetopause determination. He listed magnetopause models that may soon enter operations at SWPC and emphasized that magnetic field measurements at GOES alone are not sufficient to identify magnetopause crossings (the usual criterion of $Bz < 0$ may occur in the magnetotail inside the magnetopause or may not occur when the dayside magnetosheath field is nearly parallel to the geomagnetic field).

Mike Liemohn presented results from an analysis of outputs of the SWMF magnetosphere model that is being run in real-time at the CCMC. His analysis included daily minimum values of magnetopause standoff on the Sun-Earth line and compared them to the Shue magnetopause model driven by OMNI solar wind inputs.

Dan Welling presented statistical distributions of errors between model results and observations and organized averages and errors by solar wind drivers to reveal systematic biases and trends not seen in other analyses. He used magnetic perturbations at magnetometer stations calculated by the SWMF model during six events in the recently completed GEM magnetosphere modeling challenge.

Concluding the session, Howard Singer presented a review of the activities and accomplishments of the M&V focus group, and led a discussion to explore ideas about the future role of M&V in GEM. Some past studies included the validation

of models, such as the GEM magnetosphere modeling challenge that studied magnetic fields at geosynchronous orbit, predicting Dst index values, and predicting magnetic perturbations at magnetometer station locations, and regional and planetary K index values. In the future, model-observation comparison studies will remain an integral part of any development within the GEM community. The preference voiced in the discussion was toward a Modeling and Measurement focus group with some suggesting the group should work mostly embedded in other focus groups, and others suggesting the need for continuing a distinct focus group. The conveners closed by encouraging attendees to propose follow-on focus groups as the community sees fit for evaluation at the mini-GEM meeting in December, 2015.

Session on ULF wave modeling challenge:

We had ten contributions starting with Seth Claudepierre's introduction on the motivation of modeling ULF wave fields by global magnetosphere models. The goal is to ultimately understand many aspects of how ULF pulsations in the global field can radially diffuse energetic electrons in the outer radiation belt. Since this is a complex goal, the modeling challenge will first focus on how well MHD models can specify the ULF wave field in terms of distribution and intensity of ULF power. A second component will address the ability of the ULF power distribution to affect the outer radiation belt as observed by the Van Allen Probes during March 1–15, 2013. A presentation by Ian Mann (given by Kyle Murphy) reported on time periods from ground magnetometer data and THEMIS satellite observations when capabilities of global magnetosphere models can be tested. Peter Chi spoke about global observations of ULF power by the ULTIMA (Ultra Large Terrestrial International Magnetometer Array) network of ground magnetometers. He noted that the solar wind parameters can explain only up to ~60% of Pc5 power and that for understanding the effects on radiation belt electrons, one needs to consider the importance of observed ULF wave activity in contrast to using ULF climatology. He also spoke about needing to consider the importance of high-m poloidal waves on radiation belts. Ashar Ali reported how one can obtain radial diffusion coefficients from Van Allen Probe measurements of electric and magnetic fields. Chih-Ping Wang reported on RBSP and THEMIS and Geotail observations and LFM modeling of a 2-hour ULF wave interval. Lutz Rastaetter reported on progress made in ULF field modeling at the CCMC in support of the ULF challenge. Coli Komar presented SWMF/BATSRUS model results and electron resonance conditions and Bob Lysak presented his inner magnetosphere model of ULF wave power distributions. Slava Merkin presented ULF modeling results obtained by the LFM model and Scot Elkington presented ULF mode structure calculations. Finally, Qianli Ma presented a radial diffusion model applicable to the March 2013 interval featuring a quiet-time slow inward diffusion event.

Presentations given at the two sessions are available on the web site of the Community Coordinated Modeling Center (http://ccmc.gsfc.nasa.gov) under "Metrics and Validation" (check for "GEM Magnetopause Challenge" and "GEM ULF Wave Modeling Challenge").

Recent Publications:

- Rastaetter, L., G. Toth, M. M. Kuznetsova, and A. A. Pulkkinen (2014), CalcDeltaB: An efficient postprocessing tool to calculate ground-level magnetic perturbations from global magnetosphere simulations, Space Weather, 11, doi:10.1002/2014SW001083.
- Rastaetter, L., J.-S. Shim, M. M. Kuznetsova, D. J. Knipp, L. M. Kilcommons, M. Codrescu, T. Fuller-Rowell, B. Emery, D. R. Weimer, R. Cosgrove, M. Wiltberger, J. Raeder, W. Li, G. Toth D. Welling (2015), "GEM-CEDAR challenge: Poynting flux at DMSP and modeled Joule heat", submitted to Space Weather
- Glocer, A. et al. (2015), Community-wide validation of geospace modeling challenge: regional and planetery K-index, to be submitted to Space Weather.

The Magnetic Reconnection in the Magnetosphere Focus Group

Co-Chairs: Paul Cassak, Andrei Runov, Brian Walsh, and Yi-Hsin Liu

In year three for the focus group on Magnetic Reconnection in the Magnetosphere, we welcomed two new co-chairs – Yi-Hsin Liu and Brian Walsh. We thank Homa Karimabadi for his efforts the first two years of the focus group. At the summer workshop, four sessions were convened. Three sessions were joint with other focus groups - one with the "Tail-Inner Magnetosphere Interactions" (TIMI) focus group (approximately 60 attendees), one with the Community Coordinated Modeling Center (CCMC) (40 attendees), and one with the "Geospace Systems Science" (GSS) focus group (60 attendees). The TIMI and GSS sessions had two "scene-setting" talks to provide an overview of the relevant topics, followed by discussion and shorter contributed presentations on both observations and theory/simulations. The individual session had a number of short presentations. The purpose of the CCMC joint session was to solicit community input on developing infrastructure for particle-in-cell simulations at CCMC. One session was independent with close to 30 people in attendance. Summaries of each session follow, followed by a brief discussion of future plans.

Session 1 – Joint session with Tail-Inner Magnetosphere Interactions (TIMI) - Tuesday, June 16, 1:30pm

The first two presentations were scene setting talks. Jim Drake presented an overview of the properties and issues related to magnetotail flow bursts, emphasizing that ion reflection at the front leads to dissipation of bulk flow kinetic energy. Open issues include the role of electron dissipation at the front, whether and how the front breaks up, the potential for secondary reconnection along the flanks of the flow burst and the mechanisms that initiate and terminate flow bursts. Joachim Birn first presented a brief summary of particle-in-cell (PIC) and magnetohydrodynamic (MHD) modeling results concerning the competition between tearing and the ballooning/interchange instability related to substorm onset, suggesting that adiabatic deformation of the magnetotail does not change stability against ballooning modes, whereas the onset and progression of reconnection causes entropy loss, enabling ballooning which in turn can accelerate reconnection and cause cross-tail structures. He also presented results from test-particle tracing in an MHD simulation of tail reconnection and field collapse, demonstrating the formation of ion beams in the plasma sheet boundary layer (PSBL) as a consequence of near-tail reconnection; the test-particle simulations, consistent with PIC simulations, indicate that the crescent shape of the ion distribution results from propagation toward higher magnetic field, rather than from the direct acceleration mechanism.

In other talks, Phil Pritchett addressed two aspects of magnetotail reconnection using PIC simulations. In 2D he showed that the B_z hump configuration considered by Sitnov and Schindler (2010) is indeed unstable, but the growth rate is an order of magnitude smaller than seen in previous open simulations and does not have the characteristics of a tearing instability. In 3D he discussed the structure of exhaust jets from a finite length (in y) X -line and found that the dawnward portion travels faster than the remaining wider duskward portion of the front; both parts tend to break up on scales of several d_i. Then, Misha Sitnov showed 3D PIC simulations with open boundaries of dipolarization fronts, where the ion and electron temperatures increase by the factors less than ~2 and 4, respectively, consistent with THEMIS observations published by Andrei Runov. In contrast to ions, electrons are heated within a relatively short region (~ 5 ion inertial scales) behind the front, and variations of their temperature along the front correlate with the northward magnetic field B_z and anti-correlate with the corresponding ion temperature variations.

Further on the topic of dipolarization fronts (DFs), David Sibeck, presenting for Joo Hwang, identified both typical (earthward-propagating) and atypical (tailward-propagating) dipolarization fronts observed by MMS. Four MMS spacecraft provide exciting observations of tail magnetic topology changes. Hoaming Liang argued that pre-existing current sheets having a significant concentration of O+ can determine the thickness of DFs and encumber the propagation of DFs. The force contribution on DFs provided by the pre-existing current sheet O+ is not only determined by the density gradient but also ion temperatures, which means that ion heating, acceleration, and reflection near DFs need to be considered self-consistently for the force balance.

Mike Wiltberger presented results from high resolution LFM simulations to examine BBFs in the magnetotail. They found that, in the simulation, the BBFs are caused by magnetic reconnection and have statistical properties in agreement with observations made by Geotail. Yu Lin presented a 3D global hybrid simulation of magnetotail reconnection under a southward IMF. The evolution of 3D flux ropes as dipolarization fronts, the ion acceleration and injection, and their impacts to wave turbulence at global diplolarizations were discussed.

Ying Zou discussed ground-based observations revealing nightside magnetic reconnection and subsequent disturbances in the magnetotail are preceded by localized and fast flows in the polar cap. These flows are well traced by polar cap arcs and as they impinge on the auroral poleward boundary, they are followed by and spatially connected to major intensifications within the auroral oval. Toshi Nishimura presented MHD simulation results of driven reconnection by localized flow channels impinging on the plasma sheet. He suggested that magnetotail reconnection can be triggered by fast flow channels originating at the dayside.

Session 2 – Joint with Community Coordinated Modeling Center - Wednesday, June 17, 3:30pm

Lutz Rastaetter and Masha Kuznetsova announced plans to incorporate particle-in-cell simulations at CCMC. The goal is to make it possible for researchers to look at distribution functions on request for comparison with data from existing missions or especially the Magnetospheric Multiscale (MMS) mission. This session was to brainstorming to see what community members desired in such resources and what issues need to be overcome.

Two-dimensional cuts of three-dimensional distribution functions should be readily possible. The desire is to allow the user to choose where to take data and to output the distribution functions. A number of logistic issues were discussed, including normalization and how much data can be made available given storage constraints. Andrei Runov showed observations of distribution functions and Jim Drake and Jason Shuster showed distribution functions in simulations to get a feel for the comparison.

Finally, Alex Glocer and Colin Komar spoke about the development of separator (X-line) finding techniques in global magnetospheric simulations and their implementation at CCMC. They have begun the task of allowing the user to request separator locations at run time.

Session 3 – Joint with Geospace Systems Science - Thursday, June 18, 1:30pm

The first two presentations were scene settings talks. Bin Zhang showed global simulation results based on multi-fluid MHD revealing that: 1) a small amount of mass loading at the dayside magnetopause only redistributes local reconnection rate without a significant change in the integrated reconnection rate and 2) a large amount of mass loading reduces both local reconnection rates and the integrated reconnection rate on the dayside, with corresponding changes in the shape of the magnetopause, in the properties of the magnetosheath and the geoeffective length in the solar wind. Simulation results suggests that the dayside reconnection potential may be controlled by both local and global processes. Then, Colin Komar discussed the longstanding debate over whether reconnection is a local or global process. Advances in locating three-dimensional X-lines, or separators, in global simulations were discussed with an emphasis on quantifying reconnection local to these structures in order to develop a comprehensive understanding of magnetospheric reconnection.

In other talks, Bill Lotko discussed LFM simulations including the effects of auroral field-aligned potential drops which show that they affect nightside reconnection by 1) enhancing the rate (and accompanying fast exhaust flows) along the pre-midnight X-line relative to that in the post-midnight plasma sheet and 2) cause the pre-midnight X-line to move earthward relative to that in the post-midnight sector. The enhanced pre-midnight reconnection is evidently required to power the extra Joule dissipation associated with the low-altitude, field-aligned potential drops occurring there and is enabled by the earthward displacement of the X-line where the lobe flux of the reconnection inflow and, therefore, the reconnection rate, is larger. Yi-Hsin Liu discussed 3D PIC sim-

ulations demonstrating that the X-line bisects the total magnetic shear angle in the large ion-to-electron mass ratio limit, consistent with the idea of maximizing the peak reconnection rate in corresponding 2D oblique planes.

Slava Merkin analytically investigated the kinetic and MHD tearing stability of 2D magnetotail current sheets as a function of their length, level of stretching and amplitude, as well as the scale size and direction of the magnetic field B_z gradient. He showed that not only "hump" equilibria have a potential for instability, but also equilibria possessing a tailward B_z gradient; however, instability requires the current sheet to be sufficiently long and stretched and tailward B_z gradient to be sufficiently steep. Misha Sitnov emphasized the inherently multi-scale nature of the Lembege-Pellat ion tearing stability criterion that depends on the global parameter, the flux tube volume, and local parameters, particularly the current sheet thickness. It was shown that the formation of thin current sheets further from Earth can be provided by a generalization of the 1972 class of equilibrium models described by Schindler if the effect of the dipole field is taken into account.

Session 4 –Individual Reconnection Session - Thursday, June 18, 3:30pm

In this session, there were a number of contributed talks as well as discussion. Colby Haggerty showed that long range, weak amplitude parallel electric fields are present in magnetic reconnection exhausts as a result of electron pressure balance along a magnetic field line. These parallel electric fields form a repulsive potential for ions entering the exhaust, reducing their counter-streaming velocities and thus reducing ion heating during reconnection. Shan Wang proposed an electron velocity distribution function model based on the electron diffusion region energization process to obtain the electron bulk heating coefficient. The coefficient is found to be ~2% in magnetotail observations, where the substorm unloading causes large variations in upstream conditions. Jason Shuster discussed PIC simulations of collisionless magnetic reconnection, showing the spatiotemporal evolution of electron velocity distributions in the electron diffusion region (EDR) to elucidate how electrons are accelerated and heated. The multicomponent non-gyrotropic distributions may serve as "smoking-gun" observables to identify the EDR based on spacecraft measurements.

Liang Wang suggested a multi-fluid moment model to address several needs of modern global codes: 1) including full electron pressure tensor in a fluid-based framework, 2) operation without an artificially specified resistivity, 3) efficient incorporation of the Hall term, and 4) straightforward handling of multi-ion species. This model has been coupled to OpenGGCM as an optional time integrator, and realistic problems like Ganymede and Earth's magnetosphere are in progress. In the context of a discussion on temperature anisotropy and ion-to-electron temperature ratio within reconnection jets, Andrei Runov showed recent statistical results from THEMIS that revealed the absence of the pronounced anisotropy and vanishing correlations between ion and electron temperatures in the dipolarizing flux bundles detected in the near-Earth plasma sheet ($R < 15$ R_E).

Rick Wilder showed dual-spacecraft observations of a high-latitude moving X-line using data from the Cluster mission. He observed that the X-line retreats at approximately the magnetosheath speed. Paul Cassak discussed theory and simulations of asymmetric reconnection with flow shear. A new prediction of the drift speed of isolated X-lines and the reconnection rate for arbitrary upstream flow speeds and upstream parameters was given and confirmed with simulations and comparisons to Rick Wilder's observations.

Future Directions

Undoubtedly, next year's sessions will include discussion of data from MMS and what it means for reconnection in the magnetosphere. As the observations will be at the dayside, this will likely dominate some of the discussion, including kinetic dissipation physics and particle acceleration in asymmetric systems, and the 3D structure of dayside reconnection. As warranted, conjunctions with THEMIS will be discussed. For the magnetotail, we expect continued interest in the nature of dipolarization fronts and what causes reconnection onset.

Geospace Systems Science (GSS)Focus Group

Co-Chairs: Joe Borovsky, Bill Lotko, Vadim Uritsky, and Juan Valdivia

At the 2015 GEM Summer Workshop the GSS Focus Group held four sessions, plus one joint session. The Joint session (with the Reconnection Focus Group) was titled What is the interplay between local and global processes in regulating reconnection?: a summarization of that joint session appears in the Reconnection Focus Group's summary.

In the Summer of 2014 GSS held 3 sessions at the summer workshop and no talks were presented in any of those sessions; rather they were entirely dedicated to audience-participation discussions. At the 2015 Summer Workshop the 4 GSS sessions were instead dominated by presentations, with audience discussion during and after the presentations.

Session 1 was entitled "Time Lags in Solar Wind-Magnetosphere-Ionosphere Interactions". The purpose was to discuss in some detail the major time lags of the M-I system. The speakers were Mick Denton, Bob McPherron, Roger Varney, Shin Ohtani, and Bob Clauer. It was pointed out (Mick Denton) that mass-transport timescales into and through the magnetosphere are roughly known, but the variance of those timescales on particular geomagnetic conditions is not known. It was also pointed out that the timescales for Dungey-cycle magnetospheric convection are considerably slower than the ionospheric two-cell convection timescales. Examinations of the response of geomagnetic indices to the solar wind (by Bob McPherron) yield various systematic time lags for the different indices examined. In particular, the responses show delays and durations, which are different quantities, akin to a time-delayed low-pass filter. Examining the timescales associated with ionospheric ion outflows into the magnetosphere (Roger Varney) it was pointed out that the outflow commence very quickly (~1 min) when electron precipitation into the atmosphere commences, but that there are much longer time scales for the ion outflows to propagate downtail from the cusps. There was a discussion about the ion outflows in the mantle being drawn into the near-Earth magnetotail by substorm reconnection. Theoretical analysis of the timescales in the nightside current systems (Shin Ohtani) found multiple timescales of 10 sec, a few minutes, and a few hours. A discussion followed about a periodicity timescale for the magnetospheric reaction to the solar wind governed by the magnetotail-current timescales: two possibilities are inductive timescales of magnetotail current systems versus ion-outflow timescales into the magnetotail. Timescales of the reaction of ionospheric convection to changes in the solar wind were examined (Bob Clauer). Two major reaction times are (1) the time to initiate a change in the ionospheric convection pattern and (2) the time to reconfigure the convection pattern. The time to initiate the convection change was stated to be ~6 minutes after a solar-wind change, with that time probably representing electric-signal propagation at the Alfven velocity in the magnetosphere. Citing studies by Dan Weimer, it was judged that the second timescale (reconfiguration of the convection pattern) was probably on the order of 45 minutes.

Session 2 was entitled "Extreme Events". The purpose was to discuss statistical analysis and prediction of large-sized geomagnetic events. The speakers were Surja Sharma, Jeff Love, Slava Merkin, Bob Clauer, Allison Jaynes, and Delores Knipp. Surja Sharma was asked to give an overview of methods of analyzing complex nonlinear systems. For the magnetosphere Surja considered extreme events to be storms and substorms. Several concepts for statistically examining event sizes and event waiting times were overviewed, including detrended fluctuation analysis, return intervals analysis, and extreme value theory. A statistical analysis of the Dst index (Jeff Love) found log-normal statistics rather than power-law statistics. Power-law statistics would point to the possibility of self-organized critical processes as the origin of extremely large events. Instead, log-normal statistics points to the possibility of multiple multiplicative processes as the origin of extremely large events. The modification of ionospheric conductivities in MHD codes associated with microscale ionospheric processes was discussed (Slava Merkin). Specifically, the Farley-Buneman drift instability was considered and its complex effects on ionospheric conductance was considered. A case of no saturation of the polar cap potential under strong

driving of the magnetosphere by the solar wind was considered (Bob Clauer). The event was chosen as a test of whether saturation would be caused by a reduction of the dayside reconnection rate or caused by active ionospheric processes. Instead, a lack of saturation was found. Allison Jaynes discussed the concept that substorm injections produce the seed particles for the electron radiation belt and also give rise to the chorus waves that energize the seed particles into the radiation belt. A radiation-belt depletion during a northward-IMF event showed no recovery of the radiation belt (a long-lasting depletion). The lack of the occurrence of substorms during this event was blamed for both the absence of injected seed electrons and the lack of production of chorus waves. Delores Knipp discussed a set of geomagnetic storms that had many manifestations of strong driving by the solar wind but that had anomalously weak amounts of thermospheric heating. It was found that these "problem storms" have an overproduction of NO in the upper atmosphere caused by enhanced low-energy particle precipitation. A mystery called out was "what is the source of these low-energy particles?". In this session and in others, the audience showed interest in future GSS sessions focusing on the systems science of these "problem storms".

Session 3 was entitled "Systems Science Tools, Methodologies, and Results". The speakers were Jacob Bortnik, Misha Balikhin, Konstantin Gamayunov, Delores Knipp, Lutz Rastatter, and Mikhail Sitnov. Jacob Bortnik was asked to give an overview talk on machine-learning techniques. One result that he showed was a neural network trained to look at time series spacecraft measurements of the Earth's plasmasphere along with the Dst time series. The result was a dynamical model of the growing and shrinking plasmasphere as Dst varied with time. In this case nothing new was revealed to the audience, since we are already familiar with the dynamical behavior of the plasmasphere. However, it was suggested that spacecraft measurements of the warm plasma cloak be giving to the neural net: in this case such a machine model could be very enlightening since we have no idea what the evolution of the warm plasma cloak is. In this session Misha Balikhin showed a new model, Konstantin Gamayunov spoke about a systems science approach to EMIC waves, Delores Knipp discussed estimating the uncertainty of DMSP Poynting flux values, Lutz Rastatter talked about modeling Joule heating in the ionosphere, and Mikhail Sitnov discussed empirical models.

Session 4 was entitled "Behavior of the System". The speakers were Wen Li, Jonathan Krall, Vania Jordanova, and Joe Borovsky. A presentation of the conditions under which radiation-belt dropouts occur (Wen Li). A statistical link between dropouts and the occurrence of chorus waves was seen a discussion followed about whether the chorus waves play a role in the dropout or whether chorus waves and the dropout were both consequences of another factor. Simulations of structure on the plasmapause were presented (Jonathan Krall) that changed when thermospheric winds in the simulation were on versus off. The simulations raised the possibility of an ExB wind-driven dynamo. Jonathan made a call for data that could help to clarify this simulation. The initial findings of a research program at Los Alamos to multiply connect various elements of the magnetosphere and ionosphere systems together via computer codes were presented (Vania Jordanova). The research effort is called the SHIELDS Project. It attempts to include all of the relevant system elements needed to describe the transport and energization of plasmas and energetic particles throughout the dynamically evolving system. This stimulated an audience discussion of the merit of getting substorm physics correct in global modeling. A system science technique developed for the solar-wind-driven magnetosphere-ionosphere system was described (Joe Borovsky). The technique is called global correlation analysis and it is based on the information contained in the cross correlations of all variables in the solar wind and all variables in the magnetosphere. Preliminary results found that it was capable of uncovering various different modes of reaction of the magnetosphere to the solar wind.

Future plans for the GSS Focus Group were briefly discussed at the 2015 GEM Summer Workshop. A preliminary plan is to have a regular session on system science techniques and the results of those techniques. A strong suggestion was to have the GSS Focus Group look at the "problem storms" of Delores Knipp (see discussion above). A plan was made to have a session at the 2015 Mini-GEM in San Francisco to discuss suggestions for upcoming focus group sessions and focus group campaigns.

Workshop Coordinator Report

Zhonghua Xu and Robert Clauer

Participants

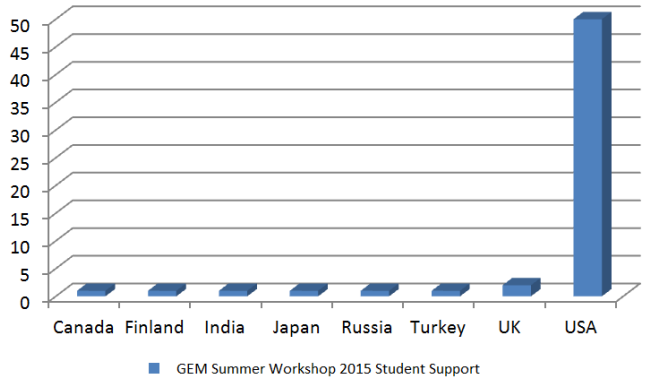
At GEM 2015 Summer Workshop, 223 participants including 148 scientist participants and 75 student participants, from over 50 institutions attended. Among them, there are 25 international participants (17 scientists and 9 students/young scientist) from 13 countries: Australia, Canada, China, Finland, France, Germany, India, Japan, Norway, Russia, South Korea, Turkey, and UK. The registration information for scientist and student participants from the US shows that the top five groups of participants are from NASA, University of California Los Angeles, University of New Hampshire, University of Colorado Boulder, and the University of Michigan.

This year, the GEM funding supported 57 student/young scientist from 20 institutions in 9 countries. This is the most diverse group of the student participants in recent GEM Summer Workshops. We managed to provide full support, including air-tickets and lodging for most students. Students paid a reduced registration fee regardless whether receiving funding or not. In addition, 9 students/young scientist from 8 international universities/institutes, including Canada, Finland, India, Japan, Russia, Turkey, and UK. For these international participants, GEM supported their travel and lodging inside the US. International flights were not supported. The top three domestic universities with student participants are UNH (13), UCLA (9) and UTSA (7). There were also 21 students using their own funding to participate the workshop. All received the registration fee support from GEM in the amount of $225/student.

Although we see more female students in recent years than in the previous 10 and 20 years, there is still an imbalance. This year we supported 37 male students and 20 female students. Our community should improve the awareness of this issue and provide encouragement and support to female students.

Multi-media Resource of Student Tutorials and Training Sessions

As previously requested by the participants, the GEM student tutorial and training sessions are now recorded with video-camera for the first time. The presentation slides and video are shared via Google Drive and YOUTUBE to all the GEM participants with the permission of presenters. If possible, the GEM workshop will continue to provide this service to the community. Also new this year, the students had a proposal training session with some senior scientists after the student dinner. The session was so successful that it was extended to more than two hours.



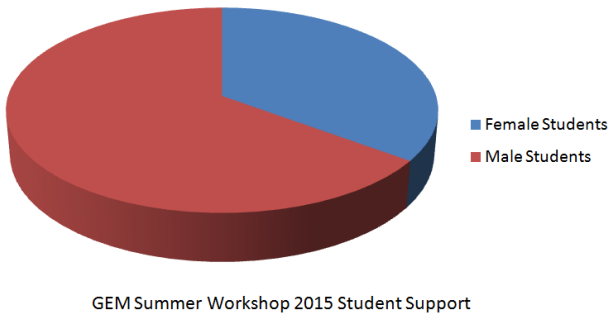


Figure 1. The demographic information of supported students for the 2015 Summer Workshop.

GEM Steering Committee Minutes

Location: Snowmass, Colorado

Date: June 19, 2015

Members present: Mike Wiltberger, Jacob Bortnik, Robyn Milan, Drew Turner, Eric Donovan, Howard Singer, Janet Kozyra, Vladimir Papitashvili, Joe Borovsky, Masha Kuznetova, Brian Fraser, Robert Clauer, Lois Keller Sarno-Smith, Robert Allen, Peter Chi, Andrei Ronov, Bill Lotko, Slava Merkin, Frank Toffoletto, Jaejin Lee, Katariina Nykyri, Larry Kepko, Hui Zhang, Lutz Rastaetter.

1. Introductions:
- Going around the room;
- Thanks to Eric for his great service;
- Welcome the new steering committee.

2. NSF Discussion:
- Space Weather funding' Who is eligible; "System science", what is the science of space weather;
- 50-50% ration between BASE and GEM funding; Encouraging BASE program application.

3. Feedbacks on GEM 2015:
- Web page agenda should be finalized two weeks prior to the GEM workshop;
- Radiation group requests a large room;
- New projectors;
- Reduce break time to increase lunch time;
- Don't provide for the first hour of poster session;
- More speakers than the FG convenors during individual sessions.

4. Discussion for MiniGEM 2015, GEM-CEDAR 2016 and future GEM workshops:
- MiniGEM will hold workshop style;
- MiniGEM will be hold at Holiday Inn Golden Gateway;
- Collaboration with CEDAR for the joint workshop 2016;
- Location discussion for future GEM, regarding to CEDAR locations.

5. FG Disscussion:
- Vassilis' letter for requesting support to HSO;
- How could CCMC help GEM better?
- Transient group extension for 2016;
- Elections (As shown at http://aten.igpp.ucla.edu/gemwiki/index.php/Organization_and_People)

Student Representative Report

Robert Allen and Lois Sarno-Smith

Student Day and student activities went well this year at GEM. Student Day featured 20 minutes talks from 14 students with different levels of experience and from several different universities. Topics covered in the tutorials ranged from ground-based observational techniques, to magnetic reconnection, to basics about the Sun and the solar wind.

This year at GEM we also introduced a Student Proposal Writing Panel dinner. The panel consisted of a NSF representative, three senior scientists, and an early career scientist in the GEM community and discussed grant writing tips and strategies. The panelists were Mike Wiltberger, Drew Turner, Phil Valek, Lynn Kistler, and Janet Kozyra. The workshop was structured in an open-question style, resulting in most of the discussion focusing around student questions.

The GEM students concluded the GEM Workshop with a student-organized hike through the beautiful mountains around Snowmass. Approximately 20 – 30 students joined in on the several hour hike, and all seemed to have a really great time! We plan on continuing to have this type of student bonding activities for future GEMs.

The students also introduced a GEM Community Facebook page this year. The goal of the Facebook page is to allow for open communication and information sharing amongst the GEM community throughout the year. We hope that everyone will join the Facebook group and use it as a way to share useful information and achievements within our community.

In summary, this past year was a very successful year for the GEM student community. We all look forward to our joint meeting with CEDAR this summer.

GEM Steering Committee

NSF Program Manager

- Janet Kozyra

Steering Committee Regular Members (Voting Members)

- Mike Wiltberger (Chair, 2015-2017)
- Jacob Bortnik (Chair-elect, 2017-2019)
- Robyn Millan (2013-2016)
- Drew Turner (2013-2016)
- Paul Cassak (2015-2018)
- Weichao Tu (2015-2018)
- Research Area Coordinators (see below)
- Meeting Organizer (see below)

Steering Committee Liaison Members

- Joe Borovsky (Liaison to SHINE)
- Josh Semeter (Liaison to CEDAR)
- Teresa Moretto (Liaison to NSF)
- Mona Kessel (Liaison to NASA)
- Howard Singer (Liaison to NOAA)
- James McCollough (Liaison to AFRL)
- Masha Kuznetsova (Liaison to CCMC)
- Benoit Lavraud (Liaison to ESA)
- Laura Morales (Liaison to Argentina)
- Brian Fraser (Liaison to Australia)
- Robert Rankin (Liaison to Canada)
- Chi Wang (Liaison to China)
- Yoshizumi Miyoshi (Liaison to JAXA, Japan)
- Jaejin Lee (Liaison to Korea)
- Xochitl Blanco-Cano (Liaison to Mexico)
- Lou Lee (Liaison to Taiwan)

Meeting Organizer

- Robert Clauer, Zhonghua Xu (2005-2018)

Student Represenatives

- Robert Allen (2014-2016)
- Lois Sarno-Smith (2015-2017)

Research Area Coordinators

Solar Wind-Magnetosphere Interaction (SWMI)

- Katariina Nykyri (2012-2018)
- Steve Petrinec (2015-2021)

Magnetotail and Plasma Sheet (MPS)

- Andrei Runov (2014-2018)
- Matina Gkioulidou (2015-2021)

Inner MAGnetosphere (IMAG)

- Scot Elkington (2013-2018)
- Seth Claudepierre (2015-2021)

Magnetosphere-Ionosphere Coupling (MIC)

- Marc Lessard (2012-2018)
- Shin Ohtani (2015-2021)

Global System Modeling (GSM)

- Frank Toffoletto (2012-2018)
- Alex Glocer (2015-2021)

Communications Coordinator

- Peter Chi (2014 - 2019)

List of GEM Focus Groups

Focus Group	Duration	Co-Chairs	Associated Research Areas				
			SWMI	MPS	IMAG	MIC	GSM
Transient Phenomena at the Magnetopause and Bow Shock and Their Ground Signatures	2012-2016	Hui Zhang, Q.-G. Zong, Mike Ruohoniemi, and David Murr	●				
Tail Environment and Dynamics at Lunar Distances	2015-2019	Chih-Ping Wang, Andrei Runov, David Sibeck, Slava Merkin, and Yu Lin	●	●			●
Tail-Inner Magnetosphere Interactions	2012-2016	Vassilis Angelopoulos, Pontus Brandt, John Lyon, and Frank Toffoletto		●			
Testing Proposed Links between Mesoscale Auroral and Polar Cap Dynamics and Substorms	2015-2019	Toshi Nishimura, Kyle Murphy, Emma Spanswick, and Jian Yang			●	●	
Storm-time Inner Magnetosphere-Ionosphere Convection (SIMIC)	2013-2017	Josoph Baker, Mike Ruohoniemi, Stan Sazykin, Peter Chi, and Mark Engebreston			●	●	
Inner Magnetosphere Cross-Energy/Population Interactions	2014-2018	Yiqun Yu, Colby Lemon, Michael Liemohn, and Jichun Zhang			●		
The Ionospheric Source of Magnetospheric Plasma	2011-2015	Bob Schunk, Rick Chappell, and Dan Welling				●	●
Scientific Magnetic Mapping & Techniques	2011-2015	Eric Donovan, Liz MacDonald, and Robyn Millan				●	
Metrics and Validation	2011-2015	Tim Guild, Lutz Rastaetter, and Howard Singer					●
Magnetic Reconnection in the Magnetosphere	2013-2017	Paul Cassak, Andrei Runov, Yi-Hsin Liu, and Brian Walsh					●
Geospace Systems Science	2014-2018	Joe Borovsky, Bill Lotko, Vadim Uritsky, and Juan Valdivia					●