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The GEMstone

Notes from NSF Program Director

Janet Kozyra

First, thank you to the members of Geospace community for making the GEM program into a completely unique environment for carrying out collaborative research. This is a grass roots effort in its finest form – there is no other venue quite like it. My commitment as program director is to support this effort by listening to the community, engaging with the community and being part of the community. In my view, the GEM experience has parallels to a "killer app". The benefits are so compelling that it becomes a priority to devote the resources and collective effort to maintain and structure the interaction. The synergies that develop in the focus groups feed back to enrich the individual research programs of the participants while pushing forward frontiers. The GE M program has a focused goal to define the physical processes that must be incorporated into models of the Geospace system and the technologies to make this happen. A strength of this program is that the course towards this goal continuously evolves, guided by the collective wisdom of the researchers in the broader GEM community. Nowhere is this clearer than in the recent white paper on GEM's future directions.

On the NSF front, the Geospace section is a very different place from when Ray Walker updated the GEM community in the 2013 newsletter. Ray finished his term as Program Director in late September 2014 (just as the GEM proposals were being submitted) and I arrived as an NSF rotator in late December, almost three months later. There were 45 projects (58 proposals) submitted to the GEM solicitation and due to a rather tight budget, I expect success rates will probably be below 20%.

Both Bob Robinson, GS Facilities Director, and Rich Behnke, GS Sec-

Inside this issue

tion Head, two positive driving forces in Geospace science at NSF, have now retired. Their experience and vision in supporting the current program and their tireless efforts at searching out new opportunities for Geospace science and the community are greatly missed. Hopefully they will take on new and exciting roles in the scientific community in the future. Volodya Papitashvili graciously stepped in to serve as Acting Section Head and Kile Baker returned from retirement to serve temporarily as Facilities Program Director. The search for a new Facilities Program Director is now in the final stages and will probably be concluded by July. The search for a permanent Geospace Section Head is underway.

With all these changes, I am working to return to a more rapid turn-around on GEM proposals with the aim of keeping the program vital. And, independent of this, I am committed to supporting the GEM meeting as a proven environment for scientific collaboration.

Janet Kozyra

2015 GEM Summer Workshop
June 14-19, 2015
Viceroy Hotels, Resorts & Residences
Snowmass, Colorado

The GEMstone Newsletter is edited by Peter Chi (pchi@igpp.ucla.edu) and Marjorie Sowmendran (margie@igpp.ucla.edu). The distribution of GEMstone is supported by the National Science Foundation under Grant AGS-1405565.

Solar Wind-Magnetosphere Interaction Research Area Report

Coordinators: Karl-Heinz Trattner and Katariina Nykyri

The Magnetosheath Focus Group

Co-Chairs: Katariina Nykyri and Steve Petrinec

The Magnetosheath Focus Group convened three sessions during the 2014 GEM workshop: two on Thursday and one on Friday. One session was combined with the Geospace System Science Focus Group; one was a joint session with the Magnetic Reconnection in the Magnetosphere Focus Group, and the final, Friday morning session was independent. Together, these three sessions represented the last of the five-year Magnetosheath Focus Group.

1. Magnetosheath joint session with GSS: "Origin of non-adiabatic heating from magnetosheath (MSH) into the magnetosphere (MSP)":

Joe Borovsky delivered opening words for this session: Specific entropy (non-adiabatic heating) increases by ~two orders of magnitude from the MSH into the MSP. Antonius Otto showed that significant non-adiabatic heating observed in MHD simulations associated with magnetic reconnection occurred only when MSH beta is very low ~0.01. Simon Wing showed that cold component ions are 30-40 percent hotter on the dawn-side plasma sheet compared to the dusk-side; however, because the dawn plasma sheet is also denser, no clear dawn-dusk asymmetry is observed in plasma sheet specific entropy. Ion to electron temperature ratio is pretty constant, although both species are heated in the MSP. Jay Johnson discussed how compressional waves such as Kelvin-Helmholtz waves can create kinetic Alfven waves (KAW) at the magnetopause boundary. KAW can heat ions effectively. More KAW are observed along the dawn-flank. Need to determine from observations the full k-vector of the KAWs. ERAU Ph.D student Thomas W. Moore identified (using multi-point Cluster observations) a high-frequency left handed polarized (in the plasma frame) wave packet inside a Kelvin-Helmholtz vortex during Parker-Spiral IMF at the dawn flank. This wave packet was observed during interval of plasma heating and mixing. An observational dispersion relation is currently being compared with theoretical dispersion relation of KAW and other plasma waves. Andrew Dimmock discussed development of statistical data analysis software for Solar Wind-Magnetosheath-Magnetosphere System Science that organizes data with respect to physical boundaries (bow shock and magnetopause). Katariina Nykyri discussed results of a statistical study of specific entropy using 7 years of THEMIS data: Regions of low β_i around the magnetopause correlate with enhanced ion entropy, S_i. Entropy is larger downstream quasi-parallel shock compared to dusk. MSH velocity fluctuations correlate with enhanced MSH entropy.

2. Magnetosheath joint session with Magnetic reconnection:

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 open flux. Joachim Birn discussed the energy budget during magnetic reconnection: how much goes into heating and does compression give irreversible heating? Andrii Lynnuk discussed how FTE motion over the dayside doesn't agree with anti-parallel or component reconnection model predictions. However, he did not consider shear flow**.** Katariina Nykyri showed results of her recently developed macro-scale MHD simulations of the KHI including magnetosheath velocity fluctuations at different frequencies and amplitudes. The frequency, amplitude and number of modes affect the growth of the KHI and when secondary reconnection in KHI

vortices starts. Homa Karimabadi's new 2D and 3D global hybrid simulations showed for the first time the generation of magnetic flux ropes and turbulence downstream of the quasi-parallel shock. Yongliang Zhang showed (using FUV and particle observations) that under a long (~4 hours) and strong northward IMF Bz (> 20 nT), the polar cap was filled with discrete arcs (including proton precipitations a few to ~10 keV). Possibly double lobe reconnection created new closed field lines on the dayside and extended to the night-side causing the polar cap (open field lines) to disappear. Rick Wilder showed (using MHD Simulations with DMSP and SuperDARN observations) that faster lobe circulation in the summer hemisphere occurs during northward IMF. Results suggest that reconnection between the IMF and the lobe field be more common in the summer hemisphere, while winter hemisphere lobe flux remains largely stagnant. This leads to hemispheric asymmetries in the ionospheric potential that are not dependent on ionospheric conductivity.

3. Magnetosheath session:

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 growth of Kelvin-Helmholtz instabilities) was also a major topic of this session. Studies of this phenomenon were presented by Kyoung-Joo Hwang and Brian Walsh. Lastly, a brief summary of observed high-speed jets in the magnetosheath and their influence on the magnetosphere was presented by Heli Hietala. These jets could be formed due to ripple-like bow-shock structures.

The magnetosheath 5-year focus group final report will be published in a separate GEMstone Newsletter.

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 19 presentations. The sessions were organized as follows: 1. Foreshock Phenomena 2. Magnetopause Phenomena 3. Ground Signatures

Session 1 – Wednesday, June 18, 1:30-3:00pm (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.

Turner et al. discussed particle acceleration in transient ion foreshock phenomena. They showed the evolution of the ion and electron pitch angle distributions inside an HFA and a foreshock bubble and concluded that transient ion foreshock phenomena are particularly efficient for both ion and electron acceleration. Liu et al. calculated the expansion speed of an HFA and a foreshock bubble using 5-point THEMIS observations. They found that the foreshock bubble is expanding at a speed of 168km/s, faster than that of the HFA (76km/s). However, the expanding rate of the foreshock bubble is much smaller than that of the HFA because the foreshock bubble is much larger than the HFA.

Great progress has been made on SHFA studies. Using global hybrid simulations, Omidi et al. investigated the parametric dependencies of SHFAs. They demonstrated that SHFAs are formed sporadically at M_A = 3 and SHFAs are formed frequently at higher Mach numbers. They also found

that the size of SHFAs and the level of ion heating increase with M_A. They also showed that SHFAs can form at cone angles as large as 90 degree as long as $M_A > 3$.

Statistical studies on HFAs have been done using Cluster and THEMIS datasets. 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 no HFAs or SHFAs were observed when the Mach number was less than 5, suggesting there is a minimum threshold Mach number for HFAs and SHFAs to form. Zong et al. identified more than 600 HFAs from Cluster-C1 observations from 2001 to 2012. 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" type HFAs are mature HFAs and most "-+" and "+-" type HFAs are young HFAs. They also found that mature HFAs are pressure balanced while the pressure is higher inside young HFAs than that outside.

Otto et al. investigated bow shock interaction with transient solar wind structures using an MHD simulation. They found that the interaction of the bow shock with a density depletion structure in the solar wind results in a sunward flow, which may provide an alternate mechanism for the formation of HFAs.

Session 2 – Wednesday, June 18, 3:30-5:00pm (Magnetopause Phenomena)

The broad topics of this session were (1) density enhancements 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 that density enhancements are mostly observed for small core and Theta BN angles. They also noted an anti-correlation between the density and ion temperature within these structures.

Connor et al. presented OpenGGCM-LTPT simulation results of cusp ion signatures and their relation to dayside reconnection during four IMF clock angles. They found that during northward IMF, both northern and southern magnetic reconnection produce ion precipitation into the northern cusp. They also found that during 120° clock angle, the coexistence of component and anti-parallel reconnection produces a flat and dispersed signature. During 60° clock angle, repetitive FTE formation on the southern magnetopause causes double reserve dispersions.

Lee et al. presented asymmetric ionospheric outflows observed at the dayside magnetopause by the Cluster spacecraft. They found that the cold ions are originated from the southern ionosphere and may affect the reconnection dynamics at the magnetopause.

Hwang et al. discussed the effect of plasmaspheric plume on magnetic reconnection and KHI. They pointed out that plasmaspheric plume may reduce the reconnection rate while it facilitates the excitation of the KHI, thus it may play an important role in controlling the competition between reconnection and KHI during southward IMF. They further pointed out that the plasmaspheric plume (mainly located on the dusk side) can lead to the dawn-dusk asymmetry of the KHI.

Kavosi et al. conducted a survey of KHI using THEMIS data. They found that KH waves are present at the magnetopause approximately 21% of the time. They also showed increasing KHI occurrences with increasing solar velocity and Mach number. They also found that KH waves were more frequently observed under southward IMF condition than they expected.

Session 3 – Thursday, June 19, 10:30 am - 12:15 pm (Ground Signatures)

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.

Zhang et al. presented THEMIS observa-

tions of an extreme HFA which lasted 17 mins near the prenoon bow shock. They showed that this HFA deformed the magnetopause by at least 4 RE. Observations of the IMAGE magnetometer network at 9 MLT show clear response to this extreme HFA. Cluster located in the dawnside magnetotail also observed a clear response to this extreme HFA. Hartinger et al. demonstrated that large, rapid magnetopause displacements are effective drivers of non-sinusoidal ULF waves in dayside magnetosphere. They pointed out that these perturbations are a substantial fraction of background values, therefore we cannot necessarily assume linear ULF response of magnetosphere during periods with substantial magnetopause motion (e.g., caused by HFAs, FBs, large solar wind pressure pulses). However, Murr et al. showed that not all foreshock transients cause ground signatures. This is not surprising but it means that we will now need to focus some effort on studying how different foreshock transients deform the magnetopause and which deformations are effective in driving field-aligned current systems in the MI system.

Chi et al. investigated the magnetospheric response to interplanetary field enhancements (IFE) using coordinated ground-based and space-based observations. They found that the IFE-induced ionospheric current vortices are opposite to those induced by sudden impulses.

Kim et al. presented conjugate observations of TCVs and EMIC waves associated with transient events at the magnetopause. They showed MIEs/TCVs observed by Greenland and Canadian magnetometers and their conjugate network in Antarctica in response to the solar wind pressure impulse events. They found that EMIC waves (identified as Pc1-2 on the ground) were also observed in conjunction with the TCV events from the ground network. In addition, SuperDARN observed enhanced convection associated with MIEs.

There were two talks on optical observations. Motoba et al. discussed the dayside transient aurora at South Pole Station. Mende showed that persistently occurring dayside transients in the aurora are Pole-ward Moving Auroral Forms (PMAF-s) which occur regularly regardless of the direction of the IMF Bz component.

Oliveira et al. investigated the geoeffectiveness of IP shock impact angles using global MHD simulations. They concluded that the Earth's magnetosphere and ionosphere respond to IP shocks in different ways depending on the shock impact angle.

Snapshots of 2014 GEM Summer Workshop
(Courtesy of Xia Cai)

Magnetotail and Plasma Sheet Research Area Report

Coordinators: Larry Kepko and Andrei Runov

Tail-Inner Magnetosphere Focus Group

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

The focus group had 3 breakout sessions on Tuesday, June 17 on a variety of topics related to the specific questions related to dipolarization fronts. Specifically speakers we asked to address 2 questions: (1) How is the formation of the substorm current wedge related to BBFs/dipolarization fronts? (2) What is the physics of the oscillations in the field and plasma seen ahead of the front?

In addition to the 3 sessions reported here there was also a joint session with the reconnection focus group, the report for which can be found in the reconnection focus group report.

Xiangning Chu looked at the poleward expansion of the aurora and its relation to the substorm current wedge in order to discriminate between two models for the poleward motion. One is a tail ward retreat of the flux pileup near the Earth; the other the change in mapping due to magnetospheric dipolarization. He studied in detail an event in Feb. of 2013 where there was THEMIS all sky data and the P3 and P4 satellites mapped to near the auroral arc. Each time the THEMIS satellites saw a flow burst, the arc on the ground brightened and made a small retreat Northward. The mapped arc position using a T96 model went from 10 R_E to 60 R_E in 20 minutes, requiring a speed in the tail much faster than the typical 50 km/s seen. By adding a substorm current wedge magnetic field model to T96, he was able to show good agreement with the mapped P3 and P4 positions and arc position on the ground. Thus, the magnetic dipolarization model is favored from this event.

Joachim Birn discussed the field-aligned currents associated with BBF's and the substorm current wedge. He broke down the currents in the large-scale wedge into a number of components: one associated with B_y on the sides of the BBF, another around the reduction of B_z at the head of the flow, another to dipolarization, and another from pressure buildup. He showed his simulation of a single entropy depleted flux tube to illustrate this picture. He noted, however, that his simulations show the simple picture with a single flux tube breaking up into multiple flow channels. In this case the single substorm current wedge is broken up into a number of "wedgelets". The net effect of this collection of wedgelets is to somewhat broaden the overall substorm current wedge.

Yan Song discussed the generation of field aligned currents and electric fields. She showed that their generation flowed naturally out of a formalism which directly concerned E and j, rather than the usual MHD approach which just really considers force balance.

Bob Lysak discussed a simulation model he developed with coworkers at Minnesota and Univ. of Newcastle to study ULF waves in the inner magnetosphere, particularly to study how waves can mode convert. The simulation uses a dipole grid going from L = 1.5 -10 and follows both compressional and Alfven waves. The model has a height resolved ionosphere as the inner boundary condition. Bob showed preliminary results driving the code with a 50 sec period compressional wave located mainly in the equatorial plane. The wave was able to excite a plasmaspheric resonance mode, showing the global effects of an external driver a on the inner magnetosphere and the mode conversion coming from the interplay of compressional between Alfven waves.

Testuo Motoba studied the correlation between auroral beading and the activity in the plasma sheet. The beading has been shown to be conjugate in the two hemispheres, so it is logical to look for a drive in the plasma sheet. It is very difficult to find good satellite conjunctions because of the small spatial scale of the beads. He did find a

sub-interval during a prolonged storm where he was able to identify pre-breakup signals in the satellite data in the inner magnetosphere that correlated with the auroral beading.

Toshi Nishimura showed a connection between auroral streamers and sub-auroral proton aurora. For the event he studied THEMIS A was in the plasmasphere and showed ring current ions. THEMIS D was in the plasma sheet and observed fast flows and enhanced ion fluxes. THEMIS A showed a bursty build up of the ring current during this time. Auroral streamers mapped to the magnetosphere connected the phenomena seen at both spacecraft. During the storm there were continuous PBI's and streamers only some of which made it to the equator-ward edge of the aurora. Those that did reach the edge were correlated with proton aurora that propagated into the sub-auroral region.

Ying Zou showed the temporal linkage of localized polar cap structures that propagate to the open-closed boundary at typical speeds of 600 km/s. The linkage of the polar cap structures to PBI's to streamers to, eventually, substorm onset seems to follow consistently from the data.

Doug Cramer discussed his work in modeling the flux into the inner magnetosphere during CME and CIR driven storms. He has extended the work he did using the CRCM and Tsyganenko models by using the OpenGGCM simulation model to look at the how continuous or bursty the energy flux into the inner magnetosphere is. He ran OpenGGCM without a coupled ring current model and looked at the nature of the flux across a L = 10 boundary. He found that the flux is bursty for both CME and CIR storms with both inflow and outflow in the equatorial plane with about a 2 hour periodicity. The CIR storms showed a greater variance in the flux across the boundary.

Xiaojia Zhang studied the relation of ECH waves to the diffuse aurora. ECH are one mechanism for the scattering into the loss cone. He used the Ovation model for a pattern of the ionospheric precipitation that was then mapped to the magnetosphere. He found that ECH is the dominant mechanism from the dawn side to near midnight.

Frank Toffoletto presented two studies from Jian Yang. In the first, the effects on a thin arc from a N-S aligned streamer were studied using a narrow depleted channel in the RCM-E. The model was first preconditioned through a growth phase. Then a channel had a reduced PV^{γ} for 10 minutes over a 1/2 hour LT width was introduced. The resulting simulation predicts both east and west moving arcs with a higher speed to the W (~2 km/s) than to the E (~0.5 km/s).

In the second presentation, the effects of field-line slippage were studied. The idea is that if plasma moves relative to its original position it changes the PV^{γ} distribution creating a bubble/blob pair. In the case studied, slippage was introduced near an auroral arc. The results were an enhancement of the arc.

Shin Ohtani discussed the O^+/H^+ ratio in the plasma sheet. The ratio depends on position in the plasma sheet. It is not clear whether there is energy dependent energization or whether there might be a velocity filter effect in action.

Christine Gabrielse gave two presentations. In the first, she looked at the statistics for ion and electron injections. She found a correlation between the injections and Al increases, B_z increases, flux pile-up, velocity flow bursts, and increased E_y. For a series of dispersionless electron injections the injections progress closer to the Earth and more dawnward.

In the second presentation she modeled the injection process. In her earlier work she used a narrow channel with a constant, enhanced E and found acceleration and injection. In the current study she used overlapping Gaussians rather than a step function to get a rapid rise in E with a slower decay. Once again she got energization and injection, but now was able to explain the observed depletion of particles below the highest energies injected.

Jacob Bortnik gave a progress report on his work to develop a self-consistent global model for the precipitating flux in the KeV range. His group is building a case-specific global, time-dependent chorus wave model, which will be linked to RAM-SCB, and the BATS'R'US MHD model. It will also include contributions from hiss. Estimates of the wave power will be obtained from inversion of the POES local precipitation measurements; these can then be mapped to RAM-SCB for a global picture.

Slava Merkin discussed his work on studying resistive reconnection using a Cartesian version of the LFM code, LFMBOX. He studied 2-D equilib-

ria relevant to tail configurations, one from Lembege and Pellat (LP) and another from Sitnov and Schindler (SS). The LP configuration should be stable to collisionless tearing while the SS - because of its enhanced B_z going tailward may be unstable. With zero resistivity, the SS configuration appears to be unstable to an ideal MHD instability, which may affect its stability to collisionless processes.

Mike Wiltberger showed his current work with simulating flow channels using the LFM code. He simulated a range in solar wind magnetic field strength and clock angle, as well as using different ionospheric conductance models. He found that the BBF/flow channels appear in almost all cases although the do seem to be quantitative differences between cases. He also showed preliminary work on creating a statistical picture of the BBF's using a superposed epoch analysis.

Janet Green discussed her work to get clean data sets that can be used to study the development of the ring current and radiation belts. In order to be able study this effectively, the satellite data must be converted to phase space density. She discussed the issues with both the GOES and POES data in terms of proton contamination and general errors. The actual satellite data are now available in NETCDF format rather than the idiosyncratic original form.

Jenny Kissinger showed data from the Van Allen Probes during the SMC phase of a storm. Chorus was seen all during the SMC phase. The RBSP data show that there was an injection before the SMC, During the SMC the flux level remained relatively high but was variable. After the SMC, the flux levels were much smoother.

There was a general discussion of where the focus group should concentrate its efforts. Two areas came to the fore.

Vassilis Angelopoulos suggested that the question of the linkage of the dayside to the nightside BBF's and flow channels shown by the propagation of polar cap structures from the dayside giving rise to auroral streamers should be given high priority. There is no current explanation for how these structures form and how they ultimately produce BBF's. There was an agreement to try to coordinate the dayside-nightside linkage with the dayside focus topic.

Andrei Runov brought up the issue that most dipolarization fronts/ flow bursts never get close to the inner magnetosphere. Yet, the presence of these midtail phenomena seem to be strongly correlate with, for example, the build-up of the ring current. There was general agreement that more work needs to be done to study how the energy is transferred across this gap region.

Snapshots of 2014 GEM Summer Workshop (Courtesy of Xia Cai)

Inner Magnetosphere Research Area Report

Coordinators: Anthony Chan and Scot Elkington

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

Co-Chairs: Joseph Baker, Stan Sazykin, Mike Ruohoniemi, Peter Chi, and Mark Engebretson

The overarching goal of the "Storm-Time Inner Magnetosphere-Ionosphere Convection" (SIMIC) focus group is to bring together experimentalists, theorists, and modelers to synthesize a new understanding of coupled magnetosphere-ionosphere dynamics during geomagnetic storms. At the 2014 GEM Summer Workshop the SIMIC focus group had three breakout sessions: two on Monday afternoon focused specifically on SIMIC science and a third on Tuesday morning joint with the new "Geospace Systems Science" (GSS) focus group. SIMIC speakers were asked to emphasize in their presentations: (1) shielding and penetration electric fields, specifically, and/or (2) science questions relevant to SIMIC that may have been overlooked in the original focus group proposal. A total of 14 scientific talks were given that collectively touched on the following 3 broad topic areas:

1. Large spatial scale observations of prominent mid-to-high latitude ionospheric features, such as, plumes of Storm Enhanced Density (SED) [Sasha Zou, Evan Thomas]; the Tongue of Ionization (TOI) [Evan Thomas]; the Sub-Auroral Polarization Stream (SAPS) [Larry Lyons, Evan Thomas, Jerry Goldstein]; and, penetration electric fields [Gang Lu]. Specific datasets analyzed included SuperDARN, AMPERE, GPS-TEC, THEMIS-ASIs, PFISR, IMAGE EUV and RPI.
2. Inner magnetosphere spacecraft measurements analyzed in terms of important observational features and processes, such as, excitation of EMIC waves [Jichun Zhang]; heavy ion dominance at low L shells [Christian Ferradas]; the role of substorm injections in buildup of ring current pressure [Matina Gkioulidou]; and, nonlinear electric field feedback after keV plasma injections [Mike Liemohn]. Specific spacecraft measurements analyzed included Van Allen Probes, DMSP, Cluster, and LANL.
3. Theoretical and simulation studies focused on a variety of topics, such as, coupling between middle and high latitudes via ULF waves [Bob Lysak]; assimilating substorm injection data into ring current simulations [Yiqun Yu]; energy interplay in the region of diffuse aurora [George Khazanov]; incorporating active ionospheric feedback in coupled ring current simulations [Margaret Chen, Stan Sazykin]; Thermospheric influences on the quiet-time plasmasphere [Jonathan Krall]; and, penetration electric field influences on Total Electron Content (TEC) [Gang Lu]. Specific numerical models discussed included RCM-E, RAM-SCB, RAM-RCM, RCM/SAMI3, TIMEGCM, and SAMI3/TIME_GCM.

In addition, Joe Borovsky gave a presentation explaining the rationale for the new Geospace Systems Science (GSS) focus group and highlighted the potential for future collaborative activities between the two groups.

Open discussion was primarily focused on narrowing the scope of SIMIC science questions and selection of a few events of common interest for future collective study. It was decided that these discussions should continue during early Fall 2014 using a collaborative web service called "Wiggio". Interested parties were encouraged to join the site and (1) make comments about science questions, events, and possible future directions for the focus group; (2) upload and download files for events of interest (i.e. share data and simulation results); and, (3) hold webex type meetings online for continued discussion. During the fall, the focus group leaders will use information collected on the website to select events and science questions appro-

priate for community-wide analysis ahead of the Mini-GEM workshop held in San Francisco the weekend prior to the 2014 Fall AGU Meeting.

Inner Magnetosphere Cross-Energy/Population Interactions Focus Group

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

The Inner Magnetosphere Cross-Energy/Population Interactions (IMCEPI) Focus Group began its first year at the 2014 GEM Summer Workshop in Portsmouth, Virginia. The broad scientific goals of the focus group are, through implementation of physics in existing models, to contribute to the physics-based understanding of the mechanisms responsible for the ring current growth and decay by exploring the interactions among the various particle populations and the feedback mechanisms that regulate them. Some specific questions to be addressed are:

1) How do the cold plasmasphere and hot ring current particles influence wave-particle interactions?
2) How do the cross-energy/population interactions alter the inner magnetospheric dynamics?
3) How does particle precipitation change ionosphere conductivity and feed back on the inner magnetosphere dynamics?

Two sessions were held on Thursday afternoon, and one on Friday morning. The first session targeted the influence of plasmasphere/ring current populations on wave excitation and particle distribution, and feedback on these populations. The purpose of this session was to build on what was learned from the past Focus Group "Plasmasphere-Magnetosphere Interaction" and apply that to couple the plasmasphere with the higher-energy populations, and continue the discussion on the coupling between the plasmasphere, waves, and ring current.

Eun-Hwa Kim reported a method to infer heavy ion concentration ratios from EMIC wave observations that result from ion-ion hybrid (IIH) resonance. The sensitive dependence of the frequency of a compressional wave driver on the heavy ion concentration makes it possible to estimate the heavy ion concentration ratio. Although wave absorption occurs for a wide range of heavy ion concentrations, it only occurs for a limited range of field-aligned wave numbers such that the IIH resonance frequency is close to, but not exactly the same as the crossover frequency. The wave absorption and observed EMIC waves from GOES-12 satellite are used to demonstrate how this technique can be utilized to estimate that the He+ concentration is around 4% near L=6.6.

Robert Allen presented an analysis of cluster data and statistical maps of EMIC occurrence rates, showing patterns interpreted as occurrence due to three primary source regions: dayside at high L-shells due to magnetospheric compressions, off-equatorial dayside regions due to Shabansky orbits, and regions where anisotropic ring current populations overlap with plasmaspheric plumes. In a separate talk the next morning, he presented a related analysis of plasma data showing linear theory derived wave growth parameters that predict EMIC instability in the same regions.

Anthony Saikin presented statistical results from Van Allen Probes magnetometer data that separated the H+, He+, and O+ EMIC bands. Their results showed that proton-band waves are observed in the dusk region, helium-band waves are relatively uniform in MLT, and Oxygen-band are primarily observed in localized pre-noon, pre-dawn, and dusk regions.

Justin Lee presented results from the application of THEMIS low-energy ion composition statistics to EMIC wave observations and modeling. Using measurements by multiple THEMIS spacecraft, they analyzed four typical EMIC wave events in the four MLT sectors and consider the properties of both cold and warm ions supplied from previous statistical studies to interpret the wave observations using linear theory.

Xiangrong (Sean) Fu presented PIC simulations of banded chorus excitation using RBSP HOPE data. Based on observed parameters, linear kinetic theory shows that with enhanced temperature anisotropies, both bands of whistler waves can be excited. PIC simulation results show whistler waves and “banded” electric field spectra are excited and late-time temperature anisotropies approach observed values.

Vania Jordanova presented recent results from the RAM-SCB model and comparisons with Van Allen Probes data, highlighting the effects of EMIC and Chorus wave-particle interactions on the energy and pitch-angle distributions. In a follow-up the next morning, she showed that RAM-SCB simulations predict strong EMIC wave amplitudes and proton precipitation in locations that agree well with IMAGE/FUV proton auroral data.

David Mackler showed statistical results from IMAGE MENA and suggested that precipitation of plasma sheet and partial ring current ions are the dominant driver of low altitude emission of ENAs.

The second session addressed the coupling of ring current plasma with electric and magnetic fields via MI coupling and self-consistent treatment of the magnetic field.

Raluca Ilie gave an update on the status of coupling between the HEIDI inner magnetosphere model and the BATS-R-US global MHD model, comparing results from idealized simulations with one-way and two-way coupling.

Christian Ferradas presented Cluster CODIF data of events in which He+ or O+ ions were the dominant ion species, and explained these observations by using drift trajectories in simple field models, including charge exchange losses.

Yiqun Yu simulated ring current particle injections using the Space Weather Modeling Framework with the RAM-SCB model, emphasizing the importance of a self-consistent treatment of substorm injections that includes the dipolarization of the magnetic field and the induced electric fields.

Jiang Liu discussed the physics of dipolarizing flux bundles (plasma bubbles) and demonstrated their identification inside of geosynchronous orbit with THEMIS magnetometer data (where they can be difficult to identify using only flow speed).

The third session, on Friday morning, aimed to improve the full self-consistent link between the wave-particle interactions, particle precipitation, and ionospheric conductivity models.

Mike Liemohn presented a statistical analysis of plasmapause location data during storms from 2000-2002 that were obtained through an automated analysis of IMAGE EUV data. Superposed epoch analyses were used to contrast plasmapause behavior during Magnetic Cloud, ICME-Sheath, and CIR-Driven storms, and these responses were related back to the properties of the upstream drivers.

Binzheng Zhang presented numerical experiments with the LFM model that compared different ionospheric conductance models in an effort to explain the clockwise tilt of the ionospheric convection cells, and suggested that the typical meridional gradients in the Hall conductance drive the clockwise rotation and a duskward shift of the nightside reconnection region and flow channels.

Hyunju Connor simulated a storm with the OpenGGCM coupled with the CTIM model, and showed that they were able to reproduce high-latitude neutral density peaks seen in CHAMP and GRACE observations caused by neutral upwelling of the thermosphere due to joule heating.

Colby Lemon compared the effects of different electron pitch-angle scattering models in RCM-E simulations of a magnetic storm, demonstrating significant differences in the ring current buildup for both electrons and protons due to feedback on the electric field caused by auroral conductance enhancements.

Because of the focus on extensive coupling processes, and the interconnectedness of those processes, many of the talks and the resulting discussion during each session touched on multiple subjects and highlighted the complexities involved in quantitatively modeling a coupled system with so much feedback.

After the talks, there was discussion of how to communicate throughout the year by creating an IMCEPI email list and posting information to the GEM Wiki. We also discussed some challenge events for the GEM Mini-Workshop, such as the 17 March 2013 and 1 June 2013 magnetic storm. Finally, we discussed holding a joint session at the 2015 Summer Workshop with the Quantitative Assessment of Radiation Belt Modeling focus group, focusing on the wave-particle interactions and coupling with the radiation belts.

Quantitative Assessment of Radiation Belt Modeling Focus Group

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

The 2014 GEM Summer Workshop marked the start of a new Focus Group on "Quantitative Assessment of Radiation Belt Modeling". The overarching goals of this FG are to bring together the current state-of-art models for the acceleration, transport, and loss processes in radiation belts, develop event-specific and global wave, plasma, and magnetic field models to drive these radiation belt (RB) models, and combine all these components to achieve a quantitative assessment of radiation belt modeling by validating against contemporary radiation belt measurements. Five breakout sessions were held on Tuesday June 17th and Wednesday June 18th and all of the sessions were well-attended. There were a total of 35 scheduled talks and a few walk-in talks over the 5 sessions, covering a wide range of topics which are listed below:

Session 1 - "Joint Session with Radiation Belts & Wave Modeling focus group"

The new FG started with a joint session with the outgoing Radiation Belts and Wave Modeling (RBWM) FG (finishing in 2014). In this session, the RBWM FG wrapped up their activities and accomplishments in the past 5 years. Then the four co-conveners of the new FG Quantitative Assessment of Radiation Belt Modeling gave a tag-team presentation to introduce the new FG to the GEM community, lead discussions on the remaining open questions in radiation belt modeling, and connect them to the goals and challenges of the new FG. A lot of interesting discussions took place in this session and valuable experiences and lessons were learned from the outgoing FG.

Session 2 - "Review existing RB models and discuss where we are and what is needed"

In this session eight talks were presented to review and discuss the existing models for the acceleration, transport, and loss of radiation belt particles. They include the convection-diffusion type RAM [V. Jordanova] and RBE [A. Glocer] models, the diffusion-type VERB [Y. Shprits], DREAM3D [G. Cunningham], and UCLA 2D [R. Thorne] codes, the Rice SDE [A. Chan] and LASP K2 [S. Elkington] codes, and the UCLA reanalysis model [A. Kellerman]. Questions were discussed such as "what are "standard" RB codes not doing well enough?" and "What are we not doing at all but probably should be?".

Session 3 - "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. Ten short talks were presented, with the topics covering ULF waves [L. Ozeke; P. Chi; M. Hartinger], chorus and hiss [W. Li; M. de Soria-Santacruz; K. Orlova], EMIC waves [K. Min; R. Denton], magnetosonic waves [Q. Ma], etc., and their effects on RB particles. We reviewed the available wave models and discussed what are still missing for RB modeling. For example, a global and event-specific EMIC wave model will be directly useful to RB models but it is still missing, and we do not yet have a comprehensive understanding on the role of magnetosonic waves on RB particles.

Session 4 - "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. The covered topics include seed populations for radiation belt electrons [J. Birn; N. Ganjushkina; D. Turner; A. Boyd], source population for plasma waves [R. Denton; J. Lee], magnetic field models [N. Ganjushkina; A. Kellerman], last closed drift shell [C. Huang], etc. In the discussions we also reviewed what are currently available and discussed what are still missing. For example, there were interesting discussions on how practical and critical it is to implement event-specific magnetic field models into RB modeling.

Session 5 - "Wrap-up discussion and plan for future FG activities"

This final session was a planning session. Due to the large number of presentation requests, a few

short talks on empirical radiation belt studies were scheduled at the beginning of this session [B. Johnston; Y. Su; L. Lyons; H. Zhao]. These empirical RB models are useful for specifying the initial/boundary conditions for RB modeling. Then we wrapped up this year's FG with more big-picture discussions, and planned for future FG activities for the upcoming mini-GEM and next year's GEM workshop. Important future activities include the 'RB dropout' and 'RB buildup' Challenges. Short talks were presented in this session to propose interesting dropout/buildup events for our future challenges. A preliminary event list was developed but further planning for the challenges will be discussed in the upcoming mini-GEM in December 2014.

Magnetosphere-Ionosphere Coupling Research Area Report

Coordinators: Bill Lotko and Marc Lessard

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

The initial years of focus group presentations, discussion and planning have brought us to the point of merging models of the ionospheric outflow with models of the magnetosphere and bringing these merged models together with ionospheric and magnetospheric measurements for a first selected storm period. Results from a variety of model and measurement studies were presented at the Portsmouth GEM meeting and a planning discussion was held regarding our next set of activities.

Ionospheric outflow models include the Generalized Polar Wind (GPW) from Utah State, the Polar Wind Outflow Model (PWOM) from Michigan and the Ionosphere Polar Wind Model (IPWM) from NCAR. The magnetosphere models used to date are the BATSRUS from Michigan, the LFM from NCAR and the LSK from UCLA. There are also ion trajectory tracing models from GSFC. Merged models for the ideal storm example have been run for GPW/BATS, PWOM/BATS and IPWM/LFM and initial comparisons of the different model results have begun.

For comparisons between models and between models and measurements, a storm which took place on Sept 27-Oct 4, 2002 was chosen last year. A merged model run using initial GPW results combined with BATS has been carried out. These results are available for comparison with the spacecraft Cluster, Polar, LANL and FAST. Storm measurements from these missions were shown for a variety of instruments and initial comparisons with the merged model have begun. In addition to the GPW/BATS run, a GPW/LFM run is planned this year with results scheduled for the Mini-GEM meeting at AGU in December. Further development of the IPWM/LFM merged model will take place at NCAR with results planned for the GEM summer meeting in 2015. Results from the GPW runs can be obtained from USU by contacting Bob Schunk at schunk@cc.usu.edu. Results from the BATSRUS merged models and copies of the presentations from the 2014 GEM meeting can be found at: http://aoss-research.engin.umich.edu/projects/outflowmmm/. NCAR merged modeling results can be obtained by contacting Mike Wiltberger at wiltbermj@ucar.edu.

Our challenge now is to continue the model development and comparison and to add the spacecraft orbit tracks through the models so that the model and measurements can be directly compared throughout the storm period. Cluster and

LANL orbits have already been added to BATSRUS and the Polar and FAST orbits will be added. All of these spacecraft orbits need to be added to the merged LFM models for comparison. In addition, BATSRUS needs to be run in a multi-fluid version to enhance the comparison effectiveness. The GPW outflow model run for the complete first selected storm needs to be completed and the spacecraft orbit tracks should be added to it. All of this is in work and the schedule below will identify the projected completion times.

The focus group needs to select a second storm period to study. Clearly, we need to select a period in which there is good satellite coverage as in the first storm, both in the tail of the magnetosphere at high altitude and in the ionosphere at low altitude. It was suggested that we should consider selecting a period near solar minimum winter in order to contrast with the first storm which occurred nearer solar maximum summer. Although both Polar and Cluster were not operating together during a solar minimum period, one possibility for a storm to study with Cluster, FAST and other spacecraft is the period around August 20, 2005. This is not wintertime, but it is near solar minimum and should have Cluster data in the magnetotail. Other suggested storm periods that have been identified are: April 6/7, 2000, October 24, 2002, and August 18, 2003. **We are asking the experimentalists in the focus group to take a look at their measurement coverage during these four time periods and send their order of preference for the second storm to** rick.chappell@vanderbilt.edu **by August 15, 2014 so that we can make the selection of the second storm period to be studied.**

Note that in addition to the regular Mini-GEM focus group meeting at the AGU in December, 2014, there will be a special session on Ionospheric Ion Outflow as a Source of Magnetospheric Plasma: Observations vs. Modeling chaired by Abdallah Barakat. Please consider contributing papers to that session. Abstract deadline for contributed papers is August 6, 2014.

Schedule of Upcoming Activities for the Focus Group:

—Completion of the GPW results for 4 days of the first storm period—Early September, 2014
—Selection of the second real storm period—Experimenter's input—August 15, 2014
—Selection—End of August, 2014
—Add spacecraft orbits to merged models—August 15, 2014
—Make layered plots to compare model results & measurements along orbit—November, 2014
—Completion of the GPW results for the second real storm period—December, 2014 (AGU)
—Completion of merged GPW/BATS and GPW/LFM for first storm—December, 2014 (AGU)
—Completion of merged GPW/BATS and GPW/LFM for second storm—June, 2015 (GEM)
—Completion of merged IPWM/LFM for first storm—June, 2015 (GEM)
—Comparison of Model Results with each other and with measurements—June, 2015 (GEM)

We appreciate the participation of all in the focus group who have contributed to the group's activities in modeling the ionosphere-magnetosphere system and comparing the model results with measurements.

Scientific Magnetic Mapping & Techniques Focus Group

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

The Scientific Magnetic Mapping and Techniques group held three sessions at the GEM meeting in Portsmouth, Virginia. The topics covered in the three sessions focused on an open-closed boundary challenge (focusing on Nov. 14, 2012 storm), tail mapping techniques, and a joint session with the metrics and validation focus group. Talks have been archived on the Wiki: bit.ly/gem_mapping.

For the first session Liz MacDonald offered an overview of the Nov. 14th event with boundary observations from the RBSP spacecraft and LANL-GEO as well as BATSRUS model run predicting the open-closed boundary. Joo Hwang offered additional conjunctions and a more global view from GOES, THEMIS, and GEOTAIL. She also offered an alternate explanation for the dropout features. Grant Stephens presented on the topic of the TS07D magnetic field model, its derivation, comparison to earlier models, and utility for the

inner magnetosphere. Misha Sitnov showed further evaluation of TS07D for the Nov 14, 2012 event. Kevin Urban presented work with the AGO data testing of auroral boundaries, in particular focusing on a proxy for the open-closed boundary derived from ground-based magnetometer data. Shasha Zou also presented an assessment of a technique using SuperDARN spectral width boundaries in predicting the OCB for Nov. 14. This showed a promising comparison to the in situ data for the northern hemisphere. She also discussed the effect of IMF By as seen in different modeling runs.

In the second session, a variety of mapping techniques and challenges were discussed. E. Donovan presented optical observations, focusing on images taken at 630 nm (Oxygen "redline"), from which one can sometimes infer the ionospheric signature of the open-closed boundary. He suggested a study using redline images from Rankin Inlet Canada, and magnetometer time series from the "Churchill Line" to test the efficacy of Urban's proxy for the OCB (see above). Chao Yue presented for Jun Liang on the topic of using energy-latitude dispersion of ion precipitation to test the accuracy of geomagnetic models, especially comparison to an event-adaptive model approach. Bea Gallardo-Lacourt presented an analysis of ionospheric flow structures associated with beading at substorm auroral onset and how they map to fast moving structures in the tail. Ted Fritz presented an analysis of energetic ion pitch angle distributions and magnetopause mappings focusing on two types of butterfly pitch angle distributions and showing supporting single particle ray tracing for distinct source mechanisms. Dmitri Kandrashov presented a reconstruction of large gaps in solar wind parameters for empirical magnetic field modeling using a single spectrum analysis technique.

In the last joint session, there were technical talks and extensive discussion on how to quantify mapping metrics. Chao Yue showed empirical modeling of the 3D force-balanced pressure and magnetic field structure during substorm growth phase. She applies this analysis to magnetic field mapping of the ion isotropic boundary and proton aurora. Jo Baker for Simon Shepard presented problems with ACGM Coordinates. The CCMC presentation by Rastaetter focussed primarily on the use of CCMC empirical model implementations to carry out magnetic field mappings for individual events and for "batches" of large numbers of events.

In the wrap-up discussion, the conveners and other attendees agreed on a number of key points moving forward. For one example, it is clearly important for collective ability to "map" between the ionosphere and magnetosphere in general and in specific cases that we have a much better understanding of the validity of a number of physical proxies we use in this regard. How reliable are proxies of the OCB and ionospheric signature of the equatorward boundary derived from auroral "redline" boundaries? Does improving "fit" of models to B-field observations at a few disparate locations in the magnetosphere improve mapping with event-specific empirical models? What are the best (in terms of resultant mappings) ways of fitting empirical models to large data sets (see Sitnov, Yue, Liang, Birn, etc)? How can the ability to serve "batch" requests for large numbers of mappings with a wide range of models be optimized and assessed? Ultimately, how can we test mapping capabilities in general given that we cannot "see" or directly observe magnetic field lines?

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

Global System Modeling Research Area Report

Coordinators: Slava Merkin and Frank Toffoletto

Metrics and Validation Focus Group

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

The GGCM Metrics and Validation Focus Group held three well-attended sessions at this past GEM workshop in Portsmouth, VA, on Thursday and Friday, June 19-20, 2014. The first session was held jointly with the Scientific Magnetic Mapping and Techniques focus group and is reported on by that group as well as briefly below. The second session was "Model Uncertainty: Dealing with Uncertain Physical Processes and Boundary Conditions." In this session, modelers reported on their models and there are plans to extend validation efforts that measure models' sensitivity to inner boundary conditions. The final session was on "Validating Models under Extreme Geomagnetic Conditions." In this session, results were presented from simulations that attempt to extend model results to storms like the 1859 'Carrington' event that brought auroras and geomagnetically induced currents to extremely low magnetic latitudes (i.e., tropical and subtropical geographic latitudes). The results from these studies will help to guide our understanding of model capabilities, where improvements are needed, and to identify gaps in our understanding of physical processes. During the last year we completed a community-wide modeling challenge by calculating K-index values from magnetic perturbations at selected magnetometer stations using 5 models and 6 challenge events. A paper on an earlier dB/dt study was published (Pulkkinen et al, 2013), a paper on the calculation of magnetic perturbations from first-principles magnetosphere–ionosphere models was submitted (L. Rastaetter et al., 2014) and the K-index paper is in preparation (A. Glocer et al, 2014).

Plans for the next year include:

- Conduct challenges evaluating how different model inner boundary conditions affect comparisons with magnetopause observations (Y. Collado-Vega, L. Rastaetter, A. Glocer, modelers).
- We also will address models' resiliency when faced with extreme solar wind inputs and study model recovery after extreme inputs subside.
- The Metrics and Validation focus group is also collaborating with the Scientific Magnetic Mapping & Techniques and the Radiation Belts and Wave Modeling focus groups. We are developing automatic validation of run-requests at the CCMC that will aid users to study models' outputs.

Publications:

A. Pulkkinen et al., "Community-wide validation of ground magnetic field perturbation predictions of geospace models to support model transition to operations", Space Weather 11 (6), 369-385, doi:10.1002/2013SW000990 (2013).

L. Rastaetter, et al., "CalcDeltaB: An efficient post-processing tool to calculate ground-level magnetic perturbations from global magnetosphere simulations", submitted to Space Weather (2014).

A. Glocer, et al., "Community-wide validation of K-index calculations from geospace models o support model transition to operations ", in preparation for Space Weather (2014).

Joint session with Scientific Magnetic Mapping and Techniques Focus Group

The Scientific Magnetic Mapping and Techniques focus group and the Metrics and Validation focus groups had a joint session that solicited contributions relevant to both the magnetic mapping and metrics and validation themes. More details on the joint session can be found in the Scientific Magnetic Mapping and Techniques focus group report. The following presentations stood out as being of particular interest to the Metrics and Validation focus group:

Results from improved altitude adjusted corrected geomagnetic coordinates (AACGM) coefficients were presented. The AACGM coefficients are able to perform more accurate magnetic mapping near the South-Atlantic Anomaly.

M. Sitnov reported on the capabilities of the Tsyganenko-Sitnov 2007 model. Use of more inner magnetosphere observations improves spatial resolution near the Earth.

G. Chisham reported on SuperDARN observations that can determine the open-closed magnetic field (polar cap) boundary. With the existing radars and new radars being built the coverage may become sufficient to perform routine comparisons with global models.

Session on Model Uncertainty: Dealing with Uncertain Physical Processes and Boundary Conditions

One of the necessary metrics used in data assimilation and ensemble modeling is a thorough understanding of model uncertainty. It is also, however, a quantity which has been the subject of few studies and is currently poorly understood for many of the GEM community models. Therefore, in this session we solicited contributions discussing how model uncertainties and uncertain boundary conditions affect model results and validation. Specifically solicited were strategies to accommodate uncertainty in modeled physical processes (e.g. uncertain radiation belt diffusion coefficients), uncertainty in boundary conditions (e.g. upstream solar wind), or the validation of models at their boundaries (such as ground-based magnetometers).

We had six contributions (R. Weigel, A. Glocer, R. Walker, L. Rastaetter, D. DeZeuw and Y. Collado-Vega) and a discussion of two upcoming GEM Challenge ideas. CCMC resources were used to compare differences in the magnetopause shape between different global MHD models depending on preconditioning (startup) and internal model parameter settings. During extreme driving, the inner boundary conditions of a global MHD model can affect the pressure and shape of the ring current. Differences in the solar wind observations between two solar wind monitors can be used to infer the uncertainty in a global MHD simulation, especially in storm recovery phase. The Virtual Model Repository is developing tools to facilitate comparison and validation of CCMC archived runs, which is searchable by event. We had two discussions of GEM Challenges – one testing models for performance in predicting the magnetopause crossing of geosynchronous satellites and the other testing global MHD model's ability to accurately reproduce the ULF wave power in the magnetosphere. Both challenges are expected to be highly relevant to understanding the dynamics of the radiation belts.

Session on Validating Models under Extreme Geomagnetic Conditions

Extreme events in the geospace environment are among the most interesting scientifically as well as important for their space weather consequences. The goals for this session were: to show model results for extreme events in the magnetosphere, to share information about the range of conditions where models have been validated, to assess methods for validating model performance with limited observations (such as for early historical events), and to assess the reliability of a model outside the range in which it has been validated. These results will guide our understanding of the magnetosphere under extreme conditions, and provide insight into what physics needs to be incorporated into models so that they perform better during extreme events. This work is at the heart of the M&V focus group, attempting to understand data/model differences from validation studies to improve the underlying physics of geospace models, and thus enabling a more complete GGCM with improved prediction efficiencies.

In this session we had contributions from J. Raeder, M. Wiltberger, D. Welling, V. Jordanova (given by Welling), R. Weigel (including B. Curtis), Y. Shprits, C. Ngwira, and A. Glocer (including M-C. Fok). Participants discussed the lack of extreme events during the modern era of multi-satellite and ground-based observations, although we've heard that in July 2012, Earth escaped what likely would have been an extreme event that instead was aimed at STEREO ahead. While we can test models on a few historic events, when we don't have critical observations, some speculation is needed to understand how models will perform under extreme conditions. Concerns were expressed about

how well the ionosphere portions of the coupled magnetospheric MHD models will perform, e.g. how well will they deal with extreme precipitation and high temperatures, issues related to capturing well the cross polar cap potential, coupling to inner magnetosphere models, and modeling ionospheric ion outflow. There is also a need for developing data assimilation techniques for use with coupled magnetosphere/ionosphere models. It was pointed out that the physics-based numerical models have a better chance for representing extreme conditions since empirical models don't have many of these events in their database. It was suggested that models need improvements related to features such as model resolution and the specification of ionospheric conductance. Some model runs have resulted in negative pressures and density errors during extreme conditions, illustrating the need for a more systematic evaluation of extreme events. One modeler mentioned the need for improved physics in inner magnetosphere models, such as how to handle open field line regions, and poor results that can come from inconsistent inputs. Another modeler showed significant differences between models for the same events and talked about the need for more uncertainty analysis. Attempts are being made to artificially construct the solar wind for historic events and try to match some of the few ground-based observations. These tests can try to isolate which current systems might have been important for producing the few observed ground-based observations. A better description of ionospheric outflow of O+ seems to be critical to reproduce the Dst response in storms. Discussions of results and challenges, such as those mentioned above, will help to define future studies that can better assess where emphasis is needed on future model development.

The Magnetic Reconnection in the Magnetosphere Focus Group

Co-Chairs: Paul Cassak, Andrei Runov, and Homa Karimabadi

In year two for the focus group on Magnetic Reconnection in the Magnetosphere, four sessions were convened. Two were independent sessions with close to 100 people in attendance. Two joint sessions with other focus groups were also convened - one with the "Tail-Inner Magnetosphere Interactions" focus group and one with the "Magnetosheath" focus group. Each session 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 to guide discussion. Summaries of each session follow, with a discussion of future plans.

Session 1 - What controls the rate of dayside reconnection? - Monday, June 16, 10:30am-12:15pm

The first set of scene-setting talks had researchers with opposing views on what controls the rate of dayside reconnection, which sparked interesting discussion. Joe Borovsky argued that the reconnection rate at the dayside magnetopause is controlled by the local plasma parameters on both sides (magnetosheath and magnetosphere) of the reconnection site. The solar-wind flow pattern around the magnetosphere largely controls those critical plasma parameters. Meanwhile, Ramon Lopez argued that the rate of magnetic merging on the dayside between the solar wind magnetic field and the geomagnetic field is identically the rate that flux is transported across the dayside merging line by the magnetosheath flow. This global transport is controlled by the net force acting on the flow in the magnetosheath (which is in turn dependent on the solar wind conditions as well as ionopsheric conductivity) and not by the local microphysics. For example, changes in plasma density at the magnetopause due to phenomena such as plasmaspheric plumes may reduce the local merging rate, however the flux being pushed into the merging line by the solar wind will simply pile up in adjoining sectors, increasing the merging rate in those sectors so that the integrated global merging rate does not change.

Shan Wang used Cluster observations to show that the local reconnection rate of the dayside magnetopause generally follows the Cassak-Shay formula. For individual events, the contribution of O+ and cold ions from the magnetosphere can be comparable with that of the magnetosheath

H+, but statistically the variation of the local reconnection rate is dominated by the variation of the magnetosheath/solar wind conditions. Alex Glocer presented a new, efficient algorithm for tracking magnetic separators in global magnetosphere simulations. The method does not require the presence of magnetic nulls and can handle very complex topologies (e.g., Flux Transfer Events). John Dorelli derived an expression for the subsolar magnetopause reconnection rate showing how Faraday's law in the steady state limit weakens the dependence of the reconnection electric field on the state of the magnetosphere. The essential physics is that magnetic flux pileup in the sheath compensates for decreases in the Alfven speed just upstream of the diffusion region.

Session 1 - General Contributions - Monday, June 16, 10:30am-12:15pm

Michael Hesse showed PIC simulations of planar, asymmetric reconnection. He showed that the reconnection electric field is provided by electron inertia effects; yet, pressure tensor nongyrotropies are essential to obtaining a viable reconnection electric field distribution. Particle distributions are composed of meandering and rather simple, drifting populations. Jason Shuster showed electron distributions from the electron diffusion region (EDR) of a collisionless, symmetric, antiparallel particle-in-cell simulation of magnetic reconnection, which were discovered to exhibit intricate spatiotemporal evolution. Moving from the X-line to the end of the electron outflow jet, he reported that (1) the discrete, striated populations of X-line distributions retain their discrete structure as they coherently rotate through velocity space, and (2) the discrete striations fade in time as reconnection proceeds, predictions which are immediately relevant to the Magnetospheric Multi-Scale mission to observe and understand the electron-scale physics of magnetic reconnection.

Colby Haggerty showed that electrons in anti-parallel reconnection are heated through a Fermi bounce mechanism at the point of sharpest magnetic curvature. This mechanism is enhanced by a parallel electric potential, which results in a mass independent scaling of the change in temperature which is proportional to the upstream Alfvén speed squared. Ruilong Guo analyzed Cluster data, finding two spiral magnetic null points connected by their common spine line, which has not been studied before. During the formation of the two-spiral-null-point structure, a secondary island was generated, which were flux ropes that magnetic field lines rotated around the spine line.

Session 2 - How is magnetotail reconnection modulated by dayside reconnection? What is the nature of magnetotail reconnection onset and transients? - Monday, June 16, 1:30pm-3:30pm

Toshi Nishimura showed simultaneous day and night observations by all-sky imagers; radars revealed that a dayside poleward-moving auroral form (PMAF, an ionospheric signature of dayside reconnection) evolved into a polar cap airglow patch that propagated across the polar cap and was then followed by nightside poleward boundary intensifications (PBIs, nightside reconnection). The propagation across the polar cap and the subsequent PBIs suggest that the flow channel originated from dayside reconnection and then reached the nightside open-closed boundary, triggering localized nightside reconnection and flow bursts within the plasma sheet.

Ying Zou found localized polar cap flow enhancements are found to colocate and propagate with airglow patches, indicating that these mesoscale flows can be traced by airglow patches in an all sky imager. Using airglow patches as flow tracers, we found that as airglow patches propagate across the polar cap and approach the nightside auroral poleward boundary, they are followed by and connected to PBI/streamers. Vassilis Angelopoulos discussed plans for the THEMIS mission to be in the magnetotail when MMS is at the dayside, potentially giving an unprecedented opportunity to study both simultaneously.

Session 2 - What determines the cross-tail scale of reconnection jets? - Monday, June 16, 1:30-3:30pm

Phil Pritchett reviewed what is known from a theoretical perspective regarding the cross-tail extent of reconnection jets in the magnetotail. While many 3D models, including fully kinetic, hybrid, two-fluid, and MHD, are able to produce structure on the scale of 15 - 30 ion inertial lengths,

there is little consensus regarding the physics that determines these scales. Clearly, additional work is needed to provide a more definitive understanding of the jet width.

Jiang Liu showed observations showing that dipolarizing flux bundles expand in the cross tail direction as they propagate earthward. This expansion allows them to cause global effects. Yi-Hsin Liu showed that the ion-ion kink instability seems to be unavoidable in tail equilibria. He demonstrated that the imprint of pre-existing kink structure under slow driving can produce a patchy onset of reconnection and hence patchy outflows, which may explain the cross-tail size of BBFs.

Session 3 - Joint with "Tail-Inner Magnetosphere Interactions" Focus Group - Monday, June 16, 3:30-5:00pm

Misha Sitnov showed results from 3D PIC simulations with open boundaries showing that spontaneous reconnection, including the formation of new large-scale X-lines in the dawn-dusk direction, is possible in the magnetotail. However, it is manifested primarily by the formation and acceleration of dipolarization fronts rather than by the X-line formation. Buoyancy and flapping motions significantly disturb the dipolarization front but neither destroy it nor change the near-2D picture of the front evolution critically.

Andrei Runov showed average properties of dipolarizing flux bundle (DFB) plasma revealed from statistical studies of 271 events observed by THEMIS. He was found that the average temperature in DFBs increases with respect to the background value by ~1.2 - 1.5 for ions and ~1.5 - 1.7 for electrons, with larger values closer to the Earth. The Ti/Te-ratio depends on distance and reaches ~1 at R < 12 R_E and T > 10 keV. Average ion energy spectra show power-law (J~W^-k) energetic tails with k ~ 3 to 4. Average electron spectra show kappa-like distributions with kappa ~4 to 6.

Mike Shay examined the basic properties of 3D reconnection in the magnetotail using a Sweet-Parker-like theory and two-fluid simulations. He found that for a three-dimensional X-line, the "ends" act as an energy sink, reducing the free energy available to create fast outflows. For X-lines smaller than around 10 ion inertial lengths, reconnection is no longer energetically favorable. This minimum length is consistent with typical cross-tail scale sizes of BBFs.

Jim Drake presented the results of 3D PIC simulations of the structure of reconnection-driven flow bursts relevant to the magnetotail. He found that for reconnection jets that are around 3 R_E in cross-tail extent that (1) the jets are deflected in both the dawn and dusk directions at the front and (2) the body of the jet behind the front breaks up, producing large variations in Bz as seen in most of the satellite observations. The mechanism for the breakup is presently being explored.

Heli Hietala discussed ion temperature anisotropy profiles across reconnection exhausts using both ARTEMIS observations from the Earth's magnetotail at lunar distances and 2.5 dimensional Particle-In-Cell simulations. She found excellent agreement between the observations and simulations: the temperature parallel to the magnetic field dominates at the edges of the exhaust and the firehose instability threshold is often greatly exceeded, yet the perpendicular temperature dominates at the neutral plane.

Session 4 - Joint with "The Magnetosheath" Focus Group - Thursday, June 19, 3:30-5:00pm

Please see the summary in the Magnetosheath section.

Future Directions

The discussions at the 2014 GEM Workshop exposed interesting and important areas where a consensus has not yet been formed. Future work on what sets the rate of dayside reconnection, what sets the scale of transient structures in the magnetotail, and the relative importance of reconnection vs. interchange type modes in magnetotail dynamics will continue to be discussed at future GEM meetings. In 2015, we expect exciting sessions on the kinetic physics of reconnection in conjunction with the launch of MMS in early 2015. Outstanding questions such as heating and particle acceleration at electron scales will be addressed.

Geospace Systems Science Focus Group

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

The Geospace Systems Science (GSS) Focus Group had its first sessions at the 2014 GEM Summer Workshop in Telluride: three sessions plus two joint sessions.

The first sessions was entitled "*Timescales, Time Lags, and Feedback Loops in the M-I System*", the second session was entitled "*Long-Running Measurements of the State of the System: What Can Be Done?*", and the third session was entitled "*Planning Session for the Systems Science Focus Group*". All three sessions were audience-participation discussions and no slides were shown. These three sessions are reviewed below.

The two joint sessions were "*The Origins of the Non-Adiabatic Heating from Magnetosheath into Magnetosphere*" joint with the Magnetosheath Focus Group and "*Shielding*" joint with the SIMIC Focus Group. These two sessions have been reviewed in the reports from the other two focus groups.

Session 1: "Timescales, Time Lags, and Feedback Loops in the M-I System"

The first purpose of this session was to identify, catalog, and quantify the known timescales and time lags in the M-I system associated with reactions to the solar wind, with plasma transport, with morphological evolution, with the evolution of plasma populations and radiation belts, with ionospheric outflows, etc. The second purpose was to identify and catalog the feedback loops in the driven M-I system.

The session was an audience discussion aimed at filling out Table 1 below: naming a time lag (L) or a timescale (T) of the magnetosphere-ionosphere system and providing, if possible, an estimate of that timescale or time lag. The name of an expert on the timescale or time lag has been added to the table: some of the experts were present for the session discussion and some were drafted by the audience.

Session 2: "Long-Running Measurements of the State of the System: What Can Be Done?"

To quantify the state of the magnetosphere-ionosphere system and to gauge the reaction of the system to the solar wind, we chiefly rely on geomagnetic indices. However, geomagnetic indices only characterize a small fraction of what goes on the magnetosphere-ionosphere system. The purpose of this GSS session was to identify other measures of the system that could be used. To be practical, the measures must be in the form of a simple index, one number that is a function of time. The audience-participation discussion was summarized in Table 2, which is a list of potential or already existing indices that characterize the various aspects of the magnetosphere-ionosphere system, the name of an expert (present or suggested) who would know about making such an index, and brief notes about the feasibility of that index. The conclusion of the discussion was that there are many more indices available that would describe many aspects of the magnetosphere-ionosphere system.

Session 3: "Planning Session for the Systems Science Focus Group"

The new GSS Focus Group met at the 2014 GEM Summer Workshop without having any prior audience input as to the direction the focus group should take and the session topics that the focus group should host. A session was held to get some of that input from the GEM community. A wide variety of issues and topics were discussed. Some of the discussion topics are summarized in Table 3. That discussion will be continued and solidified at a session at the 2014 Mini-GEM Workshop in San Francisco where a call will be made to the GEM community for presentations about suggestions for session topics for 2015 and beyond.

Table 1. Time lags and timescales identified for the magnetosphere-ionosphere system.

#	time lag or timescale	value	expert
L01	reconnection response to solar wind	few min	Joachim Birn
L02	reaction of geomag indices to solar wind	10-30 min	Bob McPherron
L03	Alfven transit times	minutes	Bill Lotko, Bob Lysak
L04	magnetosphere reaction to pressure pulses	10-50 min night 5 min	Thanasis Boudouridis
L05	Ionospheric convection onset	4-6 min	Bob Clauer
L06	LLBL entry timescales		Steve Fusilier
L07	Circuit reaction to solar wind	several hours in tail	Shin Ohtani
L08	Current startup timescales	1.25 hr	Rick Wilder, Haje Korth
L09	Magnetotail growth and stretching	several hour full time, 55 min to disrupt	Joachim Birn, Shin Ohtani, Bob McPherron
L10	Polar cap expansion		De Jong
L11	Substorms: time to onset	55 s	Bob McPherron, Dan Weimer
L12	Plasma transport timescales from solar wind	2 - 15 hr	Mick Denton
L13	Cloak appearance		Joe Borovsky
L14	Ionospheric circulation timescales	5-30 hr circulation 1.5-2 hr pc transit	Dan Weimer
L15	Cool dense plasma sheet timecales		Mick Denton
L16	Ring current growth timescales	3 hr - 12 hr	Vania Jordanova
L17	Time lag of ionospheric outflows	variable, multiple	Dan Welling, Rick Chappell, Alex Glocer
L18	Composition time lags		Lynn Kistler
L19	Time lag for plasmaspheric plume to dayside		Walsh, Goldstein
L20	M-I coupling timescales		Bill Lotko, Aaron Ridley, Lysak
L21	Radiation belt dropout + recovery		Steve Morley
L22	Substorm injections to create waves	very short	Richard Thorne
L23	Outer radiation belt growth	chorus few hr,	Richard Thorne
L24	NOX	minutes to start, hrs, 8-11 hr peak	Marty Mlynczak, Gang Lu
T01	Substorms: recovery time	size dependent 1.8-2.4 hr	Dan Weimer, Bob McPherron
T02	Periodicity of the magnetosphere		Larry Kepko
T03	Eienfrequencies		Anaoly Streltsov
T04	Plasmaspheric refilling		Denton or Denton
T05	Decay of geomagnetic indices	180 min	Bob McPherron
T06	Relaxation of magnetotail inflation		Joachim Birn
T07	Radiation-belt decay	days, weeks, months	Richard Thorne
T08	Ring-current fadeout	7 hr or longer or shorter	Mike Liemohn
T09	Ionosphere recovery	flywheel 5-6 hr, density hourish, neutral	
T10	Plasma sheet decay		Mick Denton
T11	polar cap shrinking		

Table 2. Potential indices (measures of the system) that could be obtained.

#	Index to Measure What	Expert	Feasible?
1	obscure geomagnetic indices we should use	Bob McPherron	iridium, supermag
2	cross polar cap / polar-cap convection	Bob Clauer	PCI already exists
3	midlatitude magnetic change (not envelop)	Xiangning Chu	substorms, soon available , see superdarn (envelope)
4	plasmasphere	Jerry Goldstein, Brian Walsh	TEC-based needs validation, whistler ground based something is feasible, magnetoseizmology limited
5	Joule heating	Gang Lu	Dan Weimer has Poynting flux long term
6	ion plasma sheet	Mick Denton	geosynchronous index available with 1 hr cadence, DMSP feasible
7	electron plasma sheet	Simon Wing	DMSP feasible
8	ion composition	Lynn Kistler, Richard Denton, Shin Ohtani	validate and use MPA electron-ion mismatch, use MPA-GOES, Geotail 1992-present, PLASMON coming
9	total radiation-belt electron content	Chia-Lin Huang, Alex Boyd	available for 2013 onward every 4.5 hr, available POES rad belt indices inner outer and slot
10	inner radiation belt	Mary Hudson	
11	outer electron radiation belt	Mick Denton	geosynchronous density and hardness available 1-hr cadence 1990-2008, GOES pitch angles
12	polar-cap outflow	Alex Glocer	Aggregate index: proxy with UV, electron precip. Poynting flux index
13	auroral outflow	Tom Moore	
14	dayside plasma	Brian Walsh	look at TEC,
15	substorms: Wp index	Steve Morley	Pi-2 multistation feasible
16	substorm-injected particles	Mick Denton	1-hr cadence available 1990-2008
17	ring current (beyond Dst)	Mike Liemohn	derivative (time) of Dst, LT-UT maps, local time of mag perturbation, ENA imaging
18	magnetotail size, currents	Joachim Birn	
19	auroral monitoring open flux	Eric Donovan	need space assets that are not yet available
20	AARDVARK ionosphere	Craig Rodger	relativistic precip monitor, 2005-2013 coming, D-region state
21	Schumann cavity Q		needs to be pursued
22	riometers	Mark Lessard	not feasible
23	geosynchronous anisotropy	Lauren Blum	feasible if there is interest
24	hemispheric power precip	Pat Newell	
25	NOX	Marty Mlynczak	
26	ULF dawn-dusk / KH	Mike Hartinger, Mark Engebretson	feasible ground-GOES combo

27	ULF	Mark Engebretson	1991-2013 Pilepenko ground geo imf nsw
28	ULF compressive	Mike Hartinger	
29	EMIC	Mark Lessard, Mark Engebretson	challenging, localized,
30	chorus	Wen Li	get pitch-angle scattering rate from POES anisotropy, feasible index
31	ionospheric density	Rob Redmon	GPS regional disturbance indices, global TEC maps, available in future
32	DMSP index ideas	Rob Redmon	
33	magnetopause and magnetosheath	Steve Petrinec	magpause standoff distance from solar-wind data, model reconnection rate, KH growth rate dawn and dusk
34	boundaries	Pat Newell	
35	dayside reconnection rate	Thanasis Boudouridis	not great
36	magnetotail stretching index	Simon Wing	DMSP isotropy boundary, already available
37	state of ionosphere		
38	ion radiation belt		POES index available
39	polar cap size	Dan Weimer	convection reversals, look at DMSP boundaries, Ampere will supply index (haje)
40	TEC		
41	thermospheric density	Gang Lu	
42	Ampere open flux	Shin Ohtani	feasible
43	ovation series-- open flux	Rob Redmon, Mitchell	
44	local time of AL	Howard Singer	can get this
45	POES index	Janet Green	will be available
46	total hemispheric current	Haje Korth	is available
47	scinilaion likelihood index	Rob Redmond	

Workshop Coordinator Report

Xia Cai

1. Report on Workshop Participants

At GEM 2014 Summer Workshop, we have 280 participants including 206 scientist participants and 74 student participants. Among them, there are 25 international participants (20 scientists and 5 students) from 11 countries: Norway, UK, Finland, Canada, Australia, China, Japan, Germany, South Korea, France and New Zealand.

The geographic information for scientist, scientist and student participants from US are shown in Figure 1 (a) and (b). It clearly shows that there are two clusters of all participants. One cluster has 111 participants from northeastern states and a few middle states, NH, MA, NY, NJ, DE, MD, DC, WV and VA. The other cluster has 97 participants from CA, UT, CO, KS, NM and TX. The top three states are CA, MD and NH with 41, 38 and 38 participants respectively. Students mainly

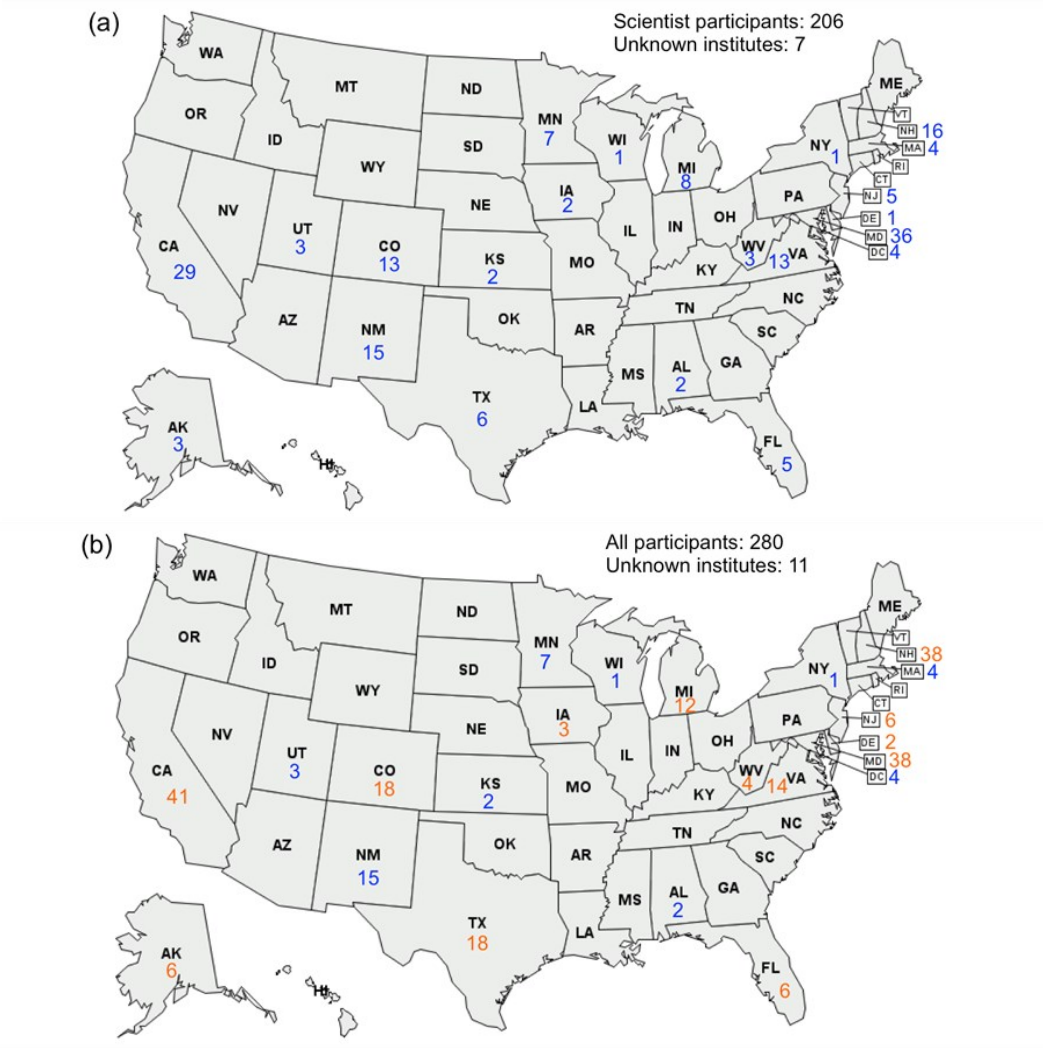

Figure 1. The geographic information of scientist participants (a), scientist and student participants (b). The numbers of participants from each state are presented under the acronym of each state. In (b), if there are students coming from the same state, the new total numbers are shown in orange.

come from NH, CA and TX, which have 22, 12 and 12 respectively. Note there are 7 scientists and 4 students with missing or incomplete institute information.

This year we received 71 requests for student support. Among them, 2 applications were incomplete. For the rest 69 students, we managed to provide them full support due to slightly cheaper airfare comparing to other years. Students pay reduced registration fee regardless whether receiving funding or not. We have supported 5 students from international universities/institutes. They were considered equally as students from US institutes once they entered the US border. They took care of their international flights. Figure 2 shows the number of supported graduate students form US and international institutes. The numbers range from 1 to 16. The top three domestic universities are UNH, UCLA and UTSA. We consider the diversity of the student body. So students from universities with smaller space science research groups receive slightly more consideration than those from universities with larger groups. The numbers shown here might be slightly different from those in Figure 1(b) as 5 students coming to the workshop with other financial recourses such as awards from NASA CCMC competition or research funding.

Figure 3 shows the detailed information about the year of graduate school and gender information of student participants. Following the suggestions of the GEM Steering Committee, we support graduate students doing research. The rationale is that those students will benefit most from discussing the frontier research topics with our prominent scientists and professors. From the left pie chart, we see the majority students are in the 2nd, 3rd and 4th of graduate school. The numbers are 16, 15, 22 respectively. Moreover, the number of students in 4th graduate school year is approximately 1/3 of total students. There are 16, 15, 22 students in. We found more students in 4th year graduate school than those in 2nd year graduate school. This is probably due to the fact we started to request evaluations of students' readiness from their advisors.

Although we see more female students in recent years than in 10 and 20 years ago, there is still a large imbalance as shown in the right pie chart in Figure 3. This year we supported 47 male students and 22 female students. The number of

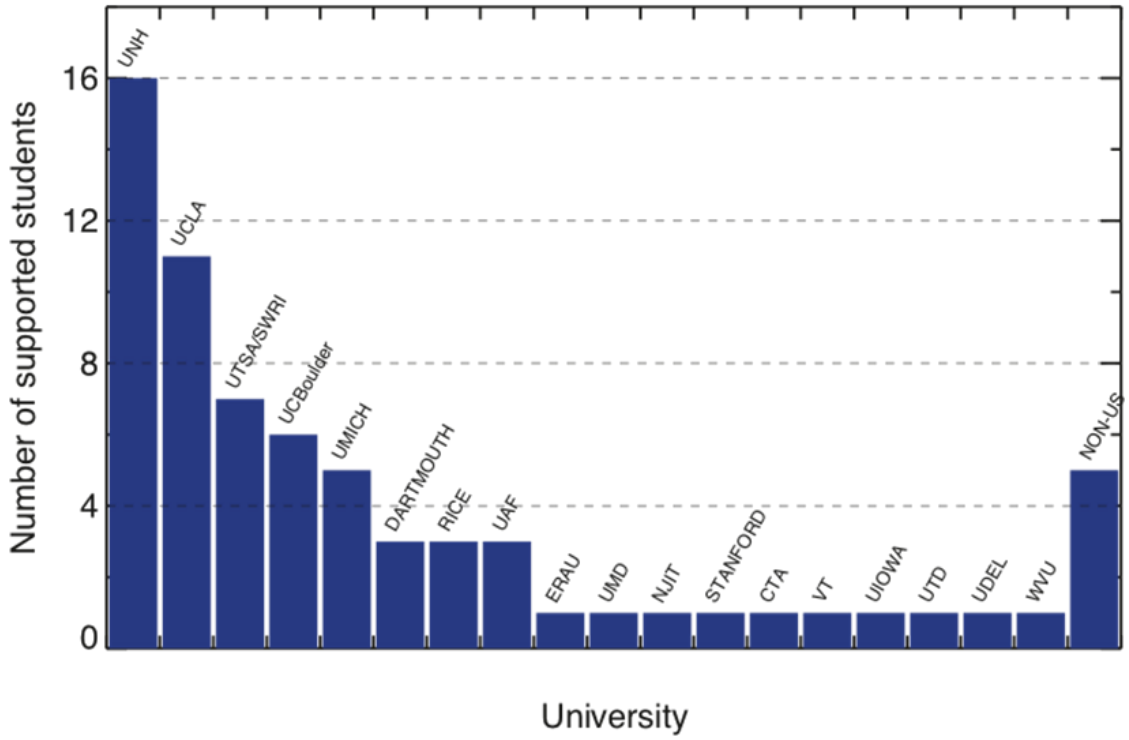

Figure 2. Numbers of supported graduate students. Those from US universities are arranged from high to low. 5 students from international universities are illustrated as the last bar.

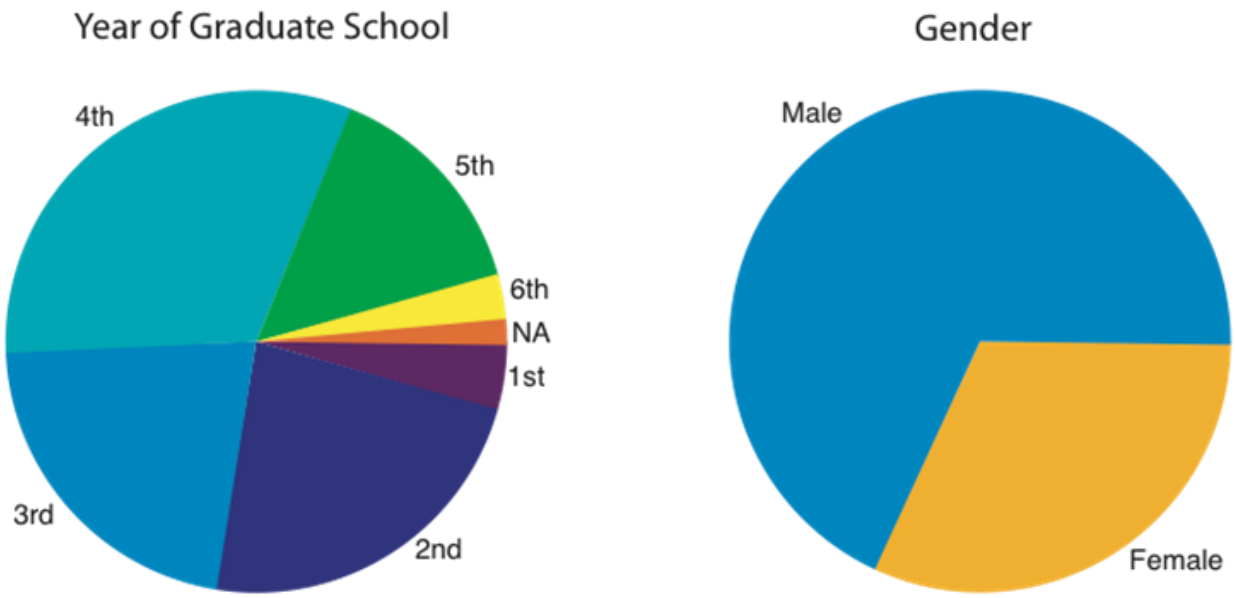

Figure 3. Pie charts showing the years of graduate school of student participants and gender information of them.

male of students is more than twice as many as that of female students. Needless to say, this imbalance will make the existed imbalance in Space Science even worse as those students represent our future workforce. So our community should improve the awareness of this issue and provide encouragements and support to female students.

2. GEM Steering Committee Meeting Minutes

Location: Portsmouth, Virginia
Date: June 20, 2014

Members present: Ray Walker, Eric Donovan, Mike Wiltberger, Jacob Bortnik, Magaret Chen (dialed in), Robyn Milan, Drew Turner, Therese Moretto, Howard Singer, Joe Borovsky, , Masha Kuznetova, , Chi Wang, Brian Fraser, Robert Clauer, Xia Cai, Ian Cohen, Robert Allen, Peter Chi, Andrei Ronov, Scot Elkington, Bill Lotko, Slava Merkin, Frank Toffoletto
Members not present: Mona Kessel, Josh Semeter, Robert Rankin, Xochitl Blanco-Cano, Laura Morales, Benoit Lavraud, Hedi Kawano, Jaejin Lee, Lou Lee, Karl-Heinz Trattner, Katariina Nykyri, Larry Kepko, Anthony Chan, Marc Lessard

1. Introductions (going around the room)

2. Brief Agency/Liaison Reports

NSF (By *Ray Walker*): NSF put more money into GEM this year than previous years. The chairs of GEM, SHINE and CEDAR were all invited to the NSF review.

Since it is the last year Ray Walker served as the NSF GEM program manager, the group also briefly discussed the candidates of the replacement. The candidate should not only know the GEM community well, but also the SHINE and CEDAR community. S/he is willing to do the job. S/he must handle to deliver negative messages to people.

NOAA (By *Howard Singer*): Howard announced the tentative dates for 2015 Space Weather Workshop. It is from April 13th to 17th in Boulder. A detailed NOAA report is found in the NOAA Liaison Report in this issue.

China Liaison (By *Chi Wang*): Good news: The Meridian Project has been running smoothly for 1.5 years. The data is available to public; the group lead by Chi secured financial support to build 2 SuperDARN; the group proposed International Meridian Circle Project to the Ministry of Science and Technology of China, the proposal has been approved.

Bad news: The Kuafu mission is on hold because of no international partner.

CCMC (By *Masha Kuznetosov*): CCMC is doing very well and it is doing almost too much. There will be an advisory group to help them focus activities. They need to form advisory group, seeking people who are not necessarily giving them money.

Canada (By *Eric Donovan*): The SWARM workshop went well. The constellation has 3 satellites. It will go in space for 10 years providing electric field and magnetic field measurements. EPOP is now in orbit, and will go for more than 2 years. RISER will turn on in August or September. THEMIS is still supported by CSA. Go-CANADA will have AO for science activities.

Australia (By *Brian Fraser*): The 3 Superdarn radars are now all working very well. The modelling community is developing 2.5 or 3 D global MHD models. The conductivity model of the ionosphere works. Now there are ground-based magnetometers in conjunction with Japanese and Chinese in Antarctica. There are some cubesats that are "on their way". For example, Brioche and QB50. Funding is currently "bad". There is less funding for graduate students and postdocs.

Discussion: Whether the ending focus groups should deliver both annual and final reports? A suggestion is to waive the need for an annual report in the last year of the FG, as well as a final report. The committee approved this suggestion after unanimous vote.

(Based on students' suggestion), most of FGs started posting agenda for meetings. The SC hope this will carry on.

3. Student Report (By *Ian Cohen*)

There are 76 students coming to the GEM Summer Workshop this year. This number is over 1/3 of total attendees. On Sunday we had students tutorials and ice breakers. Eric and Ray came and spoke and answer questions in informal setting. Students really appreciated that. Students enjoyed the dinner cruise. There were lots of activities to do such as games and dancing. Feedbacks on the venue: climate control in rooms, lack of outlets in session room. The poster session is crowded. It is not good to have posters on back of boards. Some students complained that the schedule of sessions was hard to get. Most of sessions were not real workshop style. Students prefer being able to know where they need to be at a given time. BUT- also "loose" sessions were well received, e.g., geospace systems session.

Robert Allen replaced Roxanne Katus as new GEM student representative.

Discussion: The communication coordinator Peter Chi will be provided with a student list before workshop. Students prefer communicating by emails over FB or twitter.

4. Feedbacks on this meeting

The SC discussed how to keep workshop style and avoid AGU meeting style, how to increase students' involvement, how to acknowledge international liaisons, etc.

a. Suggestions to keep workshop style

- The convenors should ask questions and (encourage to) have a debate in the room, as a discussion. They could choose a few representatives, decide why it is important, the controversy, then ask for formal presentations/talks.
- The convenors could specify a topic for a session, (encouraging) collaborative discussion.
- If a presenter also has a poster, he could have 1 -2 minutes to present the results of the poster (at oral sessions). So the participants will have some time for a round-table discussion.
- Pushing people towards posters will not help as the poster sessions were already oversubscribed.
- Eric Donovan proposed a handbook of suggestions or techniques to instruct FG leaders on how to run sessions. He identified four volunteers: Robyn, Drew, Ian, and Andrei to work on a document. Research area coordinators should instruct FG leaders.

b. The meeting rooms were very long and deep.

c. Students were less involved in the breakouts than they used to be. A suggestion is to have at least one student directly tied to the focus groups. New FG proposals may also consider including a young scientist as part of their team.

d. SC should also provide suggestions for students on how to give talks.

e. International liaisons should write a brief report to be included in GEMstone. They

will also be introduced at the beginning plenary sessions.

f. Collect more demographic information such as institutions, participation and nationality.

5. Collaboration with CEDAR/SHINE

Eric brought up Bill Lotko's suggestion that we should collaborate more with CEDAR and SHINE.

A suggestion is not to leave SHINE in the dark, for example, don't schedule (the two meetings) over the same week. Our GEM community should try having some more system science joint with CEDAR.

One solution is just informing each other (CEDAR and SHINE) about meetings, etc. And hold meetings close by geographically so there can be an overlap.

Similar to GEM-CEDAR challenges, GEM probably could have GEM-SHINE challenges.

A concern is the audience do not want to hear the same talk presented three times: GEM, GEM-CEDAR and CEDAR.

6. Future GEM Workshops

a. For GEM 2015 Summer Worekshop, Bob Clauer described that CEDAR told us about their meeting in Seattle and we could be next to them. (Unfortunately) We couldn't sign the contract and lost it.

Our team found an alternate venue in Portland, but price for scientists is $200/night for scientists. The poster room is small, but we can do it in the banquet hall. (To hold this venue), we need to (sign a contract) by June 30th. Do we want to have an expensive meeting to be near CEDAR? Or do we want to look at other places?

This meeting we had 283 people. For the next meeting, maybe Portland won't be that big. The rate of the original hotel was $159/night. In Embassy Suites, they would put 3 students in a room.

b. Students would prefer staying all together.

c. The SC agreed upon skipping Portland. The SC voted and approved the following two options: Snowmass, Santa Fe.

7. Other businesses

a. The SC voted and accepted the following suggestions:

i. Remove the FG report sessions;

ii. The Summer Workshop ends at noon on last day;

iii. Move the student award in the Friday morning plenary session.

b. Xia Cai talked about GEM meeting 2016-2017. GEM and CEDAR will want to coordinate meeting sites. They sent a call for proposals. We received three proposals. The first one is from VA tech. The participants will fly to Roanoke airport. All GEM and CEDAR will be in one single hotel (Hotel Roanoke) with CEDAR using one floor and GEM using another floor. The estimate meeting cost is comparable (to what we had this year at Snowmass). The second one is from Penn state. Participates could fly to Harrisburg then take 1.5 shuttle to the campus. Another option is to fly to State College, PA but could be very expensive. It's a hard place to get to. The third proposal is from the University of Michigan. There are no details at this moment. What we have now is we will use the university facilities and have to pay overhead rate that is roughly 20%. The overhead may be waived if a faculty member sponsors it. Students will be in dorms.

c. Mike Wiltberger concluded that we don't have enough info to make a decision at this time, but CEDAR cant make a decision unilaterally. A suggestion is gathering information on each of these and sending out to everyone. The decision will be probably made at the coming GEM 2014 Mini-Workshop.

(The minutes are based on notes from Xia Cai and Jacob Bortnik. Special thanks to Jacob Bortnik for sharing his notes generously!)

Student Representative Report

Ian Cohen

The GEM students very much enjoyed the week in Portsmouth. This year we had 76 students, more than 35% of the total GEM attendees. As in the past, we kicked the week off with a Student Forum on Sunday. This featured several icebreakers and a series of tutorials covering every aspect of GEM from basic structure to dynamics to highlights of new focus groups. The audience judged each tutorial presenter and Lois Smith from Michigan was voted as having given the best student tutorial. The day closed with a visit from Eric Donovan, Chair of the GEM Science Steering Committee, and Ray Walker, NSF Program Manager. Many students commented that they really enjoyed the informal comments that Eric and Ray made and hope that such student access to GEM leadership continues.

On Monday, we capitalized on the fortuitous simultaneity of the GEM Student Dinner and the US-Ghana World Cup match. We took the opportunity to eat dinner together in the amphitheatre while watching the game. This was a great bonding experience for the students. Another highlight of the week was the GEM banquet/dinner cruise. This year's venue allowed for a great dinner and socializing but also additional activities such as dancing and games.

We received quite a large amount of feedback from students this year. They ranged from complaints about temperature control to the lack of power outlets. Many concerns were raised over the difficulty of accessing the schedule of talks within each focus group. Although GEM constantly claims to want to avoid AGU-like structured sessions, the reality is that many sessions tend to be oriented that way and having access to the session schedules would be helpful for students to best utilize their time at GEM. That being said, students' comments indicated that the few sessions that did adhere or at least attempted to maintain a more workshop-like feeling were better received.

Finally, we thank the newly minted Dr. Roxanne Katus for her two years of service as GEM Student Representative and welcome her newly elected successorRobert Allen from UTSA.

CEDAR Liaison Report

Joshua Semeter

The 2014 CEDAR workshop was held at the University of Washington, June 22 - 26. The traditional Sunday student session focused on "Aeronomical Instrumentation," featuring tutorials on Fabry-Perot Interferometry, LIDAR, Incoherent Scatter Radar, Global Navigation Satellite Systems (GNSS), and instrumentation on the forthcoming NASA Ionospheric Connection (ICON) mission.

The regular meeting included 18 separate workshop sessions, covering a range of themes as proposed by the community. Two of these were selected as Grand Challenge topics, to be pursued as community-wide initiatives over the coming 4 years. These were "The High-latitude Geospace System" and "Coupling and Transport Processes from the Upper Mesosphere through the Middle Thermosphere." Over the past several years, CEDAR has been organically moving toward initiatives that combine space-based and ground-based measurement of the coupled "geospace system," in line with the community's 2012 strategic planning document, "CEDAR, The New Dimension." In addition to the attention paid to the ICON mission, the 2014 workshop included several science highlights in support of this thematic path. Brian Anderson presented recent results from the NSF AMPERE project, Harlan Spence presented results from the NSF Frontiers in Earth Systems Dynamics project concerning "Sun-to-Ice" connections, and the "CEDAR Prize Lecture" by Jeffrey Forbes included perspectives on neutral dynamics derived from coupled ground- and space-

based measurements. A further plenary session focused on future NASA ITM programs, including the selected GOLD and ICON missions, in addition to other missions recommended in the NRC Decadal Strategy for Solar and Space Physics (in particular, GDC and Dynamic). At the end of the 2014 meeting, Joshua Semeter formally took over as steering committee chair, replacing Dave Hysell.

The next CEDAR workshop will be returning to the beautiful University of Washington campus, June 21-25, 2015. Plans are underway for a full joint CEDAR-GEM meeting in 2016, which will take place at the Santa Fe Convention Center, NM. Discussions continue on a sustainable strategy for exploiting deep synergies between the GEM and CEDAR communities through summer meeting planning and other fora.

NASA Liaison Report

Mona Kessel

NASA's Science Mission Directorate (SMD) Heliophysics Division has adopted the 2013 Heliophysics Decadal Survey and the 2014 Roadmap as the foundation to foster the next decade of heliophysics research. These ideas are captured in the 2014 NASA Science Plan. The Heliophysics Roadmap defines recommendations for implementing the Decadal Survey, including technology development requirements. The first priority is to complete the current program on time and on budget. The next priority is to strengthen our Research program, including Research & Analysis, MO&DA, Guest Investigator, and Technology elements; we are working towards rebalancing the research program (DRIVE) as recommended by the Decadal Survey. We plan for more frequent, lower cost missions. NASA has a new CubeSat Initiative for $5M per year beginning in FY2014, managed by the SMD/Heliophysics Division. An Explorer AO will be out no earlier than FY2017 – for a Small Explorer (SMEX) and a Mission of Opportunity (MoO).

The Heliophysics System Observatory has 18 operating missions (on 29 spacecraft): Voyager, Geotail, Wind, SOHO, ACE, Cluster, TIMED, RHESSI, TWINS, Hinode, STEREO, THEMIS/ARTEMIS, AIM, CINDI, IBEX, SDO, Van Allen Probes, IRIS. Five of these missions (SOHO, ACE, Stereo, SDO and Van Allen) contribute to operational Space Weather efforts. Four missions are in implementation (SET, MMS, SOC, SPP) and two more are in formulation (ICON and GOLD). This represents over $5.5B total investment in Heliophysics space assets (excluding launch costs) with an $110M annual operating budget.

NASA's four Magnetospheric MultiScale (MMS) mission spacecraft are undergoing final preshipment tests at the Goddard Space Flight Center, before being shipped to Cape Canaveral this year in preparation for a March 12, 2015 launch. The 4 identical satellites will fly in formation: a tetrahedron with separations as close as 10 km during its 2 year prime mission. MMS is a highly focused mission with the goal of observing reconnection to provide the observational evidence we need to understand the basic physics.

NASA SMD/Heliophysics has undergone some changes in personnel this year. Jeffrey Newmark became the interim director; he has been at HQ for 6 years, where he was the Solar Discipline Scientist, and also ran the Sounding Rocket Program and the Explorer Program. Sandra Smalley is now Deputy Director; she joins SMD/Heliophysics with twenty-five years of experience in program management and engineering. She formerly served in the Office of the Chief Engineer as the Director for Engineering, Program and Project Management. Elsayed Talaat is now the Ionosphere-Thermosphere-Mesosphere Discipline Scientist; he is working with the ICON and GOLD Explorer Missions, the Planetary Science Division MAVEN mission to Mars, and is also a liaison for Space Weather related activities. He served as an IPA at NASA HQ for the past two years while working at JHU/APL.

NOAA Liaison Report

Howard Singer

Howard Singer reported on NOAA topics relevant to the Geospace Environment Modeling (GEM) community. He presented several examples of recent space weather impacts where GEM research and modeling is especially important. These included the North American Electric Reliability Corporation's efforts to determine a "geomagnetic disturbance benchmark" for describing a rare extreme event, a recent launch delay related to a large solar flare and solar proton event, and an ionospheric storm that, in parts of the continental US and Alaska, resulted in the temporary loss of the Wide Area Augmentation System Service (WAAS) used by airlines and the Federal Aviation Administration (FAA).

The rise to solar maximum is following predictions to be below average intensity. While there was an initial solar cycle peak in February 2012 with sunspot number 67, we are now headed for a second slightly larger peak with sunspot number over 80. This second peak, resulting mostly from significant activity in the sun's southern hemisphere, demonstrates the importance for predicting solar activity by hemisphere. It is also important to keep in mind that, historically, some of the largest geomagnetic storms have occurred during weak solar cycles. In spite of the recent low activity, there is huge growth in new space weather customers. One indicator, NOAA SWPC's subscription service, has grown to over 43,000 subscribers as of June 2014 (7,000 more than last year). In addition, international interactions continue to flourish with over 22 Nations represented at this year's Space Weather Workshop. Also, there is a growing visibility for space weather at the highest levels in the US Government, including agreements with partners in many nations. These examples are not only important for NOAA, but demonstrate the importance of the work being carried out by the entire space science community.

This year's Space Weather Workshop, carried out in partnership with NASA and NSF, had 275 registered attendees from 22 nations. Next year's meeting is scheduled for April 14 to 17, 2015 in Boulder with side meetings planned for Monday April 13. With regard to NOAA satellite data, used by many GEM scientists, the geosynchronous satellites GOES-13 and -15 are operational, with GOES-14 in storage and ready to be called up when needed. The next series of GOES spacecraft, beginning with GOES-R, are scheduled for a first launch in March 2016. The low-altitude, polar-orbiting POES satellites, NOAA - 15, 16, 18, and 19 are currently operational, along with METOP- A and-B (European satellites with NOAA energetic particle sensors.) METOP -C is in development and planned for launch in 2017. The follow-on to the POES satellites, the Joint Polar Satellite System (JPSS) will not carry space environment monitors. Many of the functions for GOES and POES satellites that were carried out in the past by NOAA SWPC have been transferred to NOAA's National Geophysical Data Center (NGDC) where one can obtain satellite data. In addition, NOAA NGDC is enhancing its support for understanding and resolving satellite anomalies caused by space weather. The NOAA Space Weather Prediction Center provides real-time measurements of space radiation intensity and issues alerts, warnings and watches. And the NOAA National Geophysical Data Center complements this effort by providing additional data, products, and expertise for post-satellite anomaly assessment and improved satellite design.

SWPC, benefiting from work by the scientific community and many other partners, has transitioned to operations the Wang-Shelley-Arge Enlil model for predicting the background solar wind and the arrival at Earth of coronal mass ejections (CMEs). Of particular interest to the GEM community, SWPC work with modelers and the Community Coordinated Modeling Center (CCMC) to evaluate Geospace model(s) for transition into operations resulted in the selection of the University of Michigan's Space Weather Modeling Framework

and Virginia Tech's Weimer empirical model. Our initial emphasis is with transitioning the Michigan MHD model to operations. We look forward to continuing collaborations with NASA CCMC and modelers of the geospace system, and we continue to encourage progress on geospace models and to pursue opportunities to work with the broader modeling community

Space Weather Prediction Center is one of the National Centers for Environmental Prediction within the National Weather Service. Since the GEM meeting in June, a new SWPC Director was announced. I'm pleased to report that our new Director is Dr. Tom Berger. Tom comes to us from the National Solar Observatory where he was the Project Scientist of the Daniel K. Inouye Solar Telescope under construction on Haleakalā, Maui, Hawaii. Before that, he spent 15 years working solar physics at the Lockheed Martin Solar and Astrophysics Laboratory. For additional information about Tom's views and background, see recent articles in the Space Weather Journal and Space News.

ESA Liaison Report

Benoit Lavraud and Vincent Maget

This report only concerns "GEM-related news" regarding major recent ESA missions and upcoming programmatic calls.

1. SWARM

The SWARM mission was launched successfully on 22 November 2013. It consists of a constellation of three satellites in different low altitude polar orbits to study the Earth's magnetic field. Although not its prime objective, SWARM is well geared for the study magnetosphere-ionosphere coupling, in particular in conjunction with the ongoing Cluster and THEMIS missions.

2. Medium-size mission M4 call

ESA has issued its call for a medium class mission (M4) on August 19, 2014. The mission proposals are due on January 15, 2015. Selection is expected a couple months later. Unlike previous medium size calls, the total budget is limited to 450 M€ for this call. There are several missions of interest to GEM which are expected to be proposed, including:

- Alfvén+: a dual spacecraft mission in rather low Earth Orbit for the study of auroral physics including both in situ measurements and imagers.
- THOR: a single spacecraft mission dedicated to the study of solar wind and magnetosheath turbulence at kinetic scales, with very high resolution wave and particle measurements (beyond MMS).
- NITRO: a single satellite on rather low-Earth orbit to study escape processes to the Earth's magnetosphere, with strong emphasis on composition measurements (Nitrogen/Oxygen).
- Ravens: a dual spacecraft mission on Molnya type orbits, dedicated primarily to continuous and simultaneous auroral imaging (related to KuaFu-B).

3. Small-size mission call with China

Unlike its S1 call (for which the CHEOPS mission dedicated to extrasolar planets search), the second S-type mission of ESA will be undertaken in cooperation with China. Two preparatory workshops have been organized in February and September 2014. The call is expected to be issued late 2014 and the proposal submission in Spring 2015. Several mission concepts of interest to the GEM community include:

- AXIOM-Jian: a single spacecraft primarily composed of an X-ray imager for global imaging of the Earth's magnetosphere (based on Xray-emmision from charge exchange with highly charged solar wind ions).
- BEADS: A dual spacecraft mission concept for the study of auroral substorms and radiation belts dynamics.
- INSTANT: A single spacecraft mission concept at the L5 Lagrangian point to measurement coronal magnetic fields and Solar-Terrestrial propagation of CMEs.

Australia Liaison Report

Brian Fraser

Currently there are three Tiger SuperDARN radars operating in Australasia, Bruny Island Tasmania, Bluff New Zealand and Adelaide South Australia. The Adelaide radar recently made national news as it used rugby goalposts for the antennas! Currently the radars are being used at 9sec resolution to study ULF waves near the plasmapause.

The University of Sydney under Iver Cairns is building a CubeSat under the QB50 Project. Other CubeSat projects are underway at the University of New South Wales, but no details.

The Murchison Wide Field Array (MWA), a precursor to the SKA, is operational in Western Australia in collaboration with MIT. An exciting new result using MWA data observes the drift of density ducts between the magnetosphere and ionosphere (*Loi et al.*, 2015, *Geophys. Res. Lett., 42*, doi:10.1002/2015GL06369.).

In general space science funding is currently difficult in Australia due to government policy and astronomy pushing the SKA.

Canada Liaison Report

Robert Rankin

1. Geospace Observatory (GO) Canada

The Canadian Space Agency continues to provide funding (until 2018) for the operation of ground-based instrumentation across Canada that is designed to improve understanding of physical processes that generate space weather. The overarching objective of GO Canada is to observe and understand geospace as a coupled system. This high-level objective is further divided into two secondary objectives: (1) to understand how coupling across geospace influences system-level structure and dynamics; and (2) to understand the response of the ionosphere and thermosphere to magnetospheric drivers. In late summer 2014 the CSA issued an AO that has the stated goal ÒTo develop and improve models for operational use in mitigating the impact of space weatherÓ. The space science community in Canada is awaiting the outcome of the evaluation of the AO, which is a major source of scientific support of space science activities in Canada.

2. ePOP and SWARM Satellite Missions

There were two successful satellite launches in 2013 that each have a geospace component. These are the Canadian CASSIOPE (Cascade, SmallSat, and Ionospheric Polar Explorer) and European Space Agency (ESA) Swarm missions, each of which carries Canadian instrument payloads (ePOP on CASSIOPE and EFI on Swarm). The PI's are Andrew Yau (ePOP) and David Knudsen (EFI), both of whom are faculty members at the University of Calgary. The combination of CASSIOPE, Swarm, and GO Canada and their complementary observations of the same region of geospace are being utilized to improve understanding of physical processes controlling the space environment. The electric field instrument on SWARM is performing to specifications. The technical team at Calgary are developing procedures to process and analyze data from the mission. The CASSIOPE/e-POP payload was launched on September 29, 2014, 51 years to the day after the Alouette I launch. It recently celebrated the completion of its first year in orbit. All instruments on the e-POP payload are continuing nominal operations, albeit at reduced duty cycles due to recurring telemetry subsystem issues. Science data for individual instruments are being posted on the University of Alberta Canadian Space Science Data Portal (cssdp.c) as they are processed.

3. Athabasca Observatory

Athabasca University Geophysical Observatory (AUGO, founded in 2002, and located about 25 km WSW of Athabasca in a dark site) continues to operate as a test site for new equipment. It currently houses a 3-axis set of induction coils from STELAB, while auroral and noctilucent cloud imaging is done with low-cost camera equipment. A THEMIS GBO camera is also located at AUGO although there is no associated THEMIS magnetometer due to the proximity of NRCan station Meanook. AUGO is the main site for auroral optical work, with six 1.5 meter domes now all occupied. A recently developed H-beta FESO scanner and numerous other instruments complement the main KEO EMCCD imager. AUGO also houses VLF receivers run by STELAB, Tohoku University, and the University of Calgary. It offers a residential facility capable of hosting visiting small groups for campaigns, and is often conjugate to the NASA Van Allen probes. The AUTUMN magnetometer array in western Canada continues to operate and is being expanded with the deployment of 10 magnetometers in Quebec in eastern Canada to fill a gap spanning the auroral zone. It will have several subauroral sites in addition. The new array is called AUTUMNX and has open data as part of GO Canada. For more information, contact Martin Connors at martinc@athabascau.c.

4. Other Programs

Undergraduate students at the University of Alberta (UofA) launched a balloon in September 2013 containing a sensor that is being tested for inclusion in NASA's BARREL (Balloon Array for Radiation-belt Relativistic Electron Losses) project. The sensor may be used as a high-resolution tool between the larger BARREL balloons because it uses crystals that are much smaller and inexpensive. The BARREL balloons, together with the NASA Van Allen Satellite Probes, will measure X-rays in the Van Allen radiation belts. The CARISMA magnetometer array operated by UofA is fully operational and providing ground context for THEMIS and Van Allen Probes observations. The THEMIS ground elements are also fully operational with the optical element maintained by the University of Calgary and magnetometers maintained by the UofA.

Mexico Liaison Report

Xochitl Blanco-Cano

The creation of the Space Weather Service in Mexico (SIESMEX) has been recently approved. SIESMEX will be operated by the Institute of Geophysics, UNAM and endorsed by the Mexican Space Agency (AEM). The SIESMEX will apply to become a Regional Warning Center (WRC) of the International Space Environment Service (ISES). The SIESMEX will operate a Web Application (www.siesmex.unam.mx) to collect and share real time data, information, and alerts to users and general public on space weather events and geomagnetic activity. The SCIESMEX will operate also a Virtual Earth-Sun Observatory (VESO; http://www.veso.unam.mx) to collect and distribute data from the network of the UNAM ground instruments related to space weather, including data from the Geomagnetic Service which participates in INTERMAGNET. VESO will follow open access policies. SCIEMEX will also operate a HPC server (hpc.sciesmex.unam.mx) for data analysis and numerical modeling of space weather phenomena including topics relevant to GEM.

South Korea Liaison Report

Jaejin Lee

1) The Ministry of Science, ICT and future Planning (MSIP) and Korea Astronomy and Space Science Institute (KASI) study the government policy for space science missions in the fields of Astrophysics, Solar Physics and Magnetosphere/ Ionosphere physics. As a result of this study, we would expect a small satellite (about 100 kg) to be launched for the research of Magnetosphere and Ionosphere coupling in 2020. In addition, Korean government will increase the investment of the long-term plan for science missions.
2) The Magnetosphere-Ionosphere joint workshop was successfully held last summer in Daejeon. The goal of this workshop is to share scientific outputs and discuss the future direction of the Korean space physics community. About 70 participants including students attended the workshop.
3) Kyunghee University was selected as main contractor developing space weather instruments aboard Korean meteorological satellite, GK-2A on the geo-synchronous orbit. The space weather instruments consist of three detectors, energetic electron spectrometer, magnetometer and spacecraft charging monitor. The GK-2A satellite funded by KMA(Korea Meteorological Administration) is scheduled to be launched in 2017. Prof Jong-ho Seon is the PI of the payload.
4) KAIST(Korea Advanced Institute of Science and Technology) passed Preliminary Design Review (PDR) for developing space physics instruments, ISSS (Instruments for the Study of Space Storms) on board the microsatellite, NEXTSat-1 that is planned to be launched into polar orbit in 2016. The ISSS is an instrument suite consisting of five particle detectors; High Energy Particle Detector (HEPD), Medium Energy Particle Detector (MEPD), Langmuir Probe (LP), Retarding Potential Analyzer (RPA) and Ion Drift Meter (IDM). Prof Kyung-Wook Min is the PI of the science payload.

Taiwan Liaison Report

Lou Lee

1. "Space Weather Research Office" in Taiwan

The "Space Weather Research Office" has been established at the Institute of Earth Sciences of Academia Sinica in Taiwan. This office serves as a center for development of space weather models, including prediction model of magnetopause location and ionosphere forecast models assimilating ground-based GPS and FORMOSAT-3/ COSMIC observations.

2. Status of FORMOSAT-3 (Cosmic-1) and FORMOSAT-7 (Cosmic-2)

(a) FORMOSAT-3 is the first major Taiwan/US collaboration of the space program on the weather and space weather satellites. The primary mission is to implement an advanced instrument using radio occultation technology to establish a near real-time global Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC). The 6-satellites of FORMOSAT-3 were launched and deployed into an evenly global distributed constellation in 2006. As of the end of September 2014, there are more than 2,515 global users including all major national weather forecast centers in 74 countries. FORMOSAT-3 constellation is still providing 1,200 profiles of the retrieved radio occultation soundings today, compared to 2,500 profiles at the beginning of mission in 2006.

(b) The FORMOSAT-7/COSMIC-2 Program is another Taiwan/US collaboration mission based on the successful deployment of FORMOSAT -3/COSMIC mission. The goal of the FORMOSAT-7/ COSMIC-2 is expected to be a much improved operational system consisting of a new constellation of 12 satellites. The constellation is comprised of 6 satellites at 24 degree inclination and 6 satellites at 72 degree inclination. The mission payload is a TriG GNSS-RO receiver (TGRS) and will retrieve Russian GLONASS navigation system in addition to the retrieval of the U.S GPS navigation system. As a result of these improvements, the expected daily retrieved radio occultation profiles will be more than 8,000, while all 12 FORMOSAT-7 satellites are deployed in orbits. The plan is to launch the first set of 6-satellites in the 2nd Quarter of 2016. However, the 2nd launch set is currently underdetermined pending on the U.S. budgetary challenges in the coming year.

3. An electric coupling model for the lithosphere-atmosphere-ionosphere system

Observations from both ground-based instruments and satellite data showed the presence of related electromagnetic perturbations in the atmosphere and ionosphere over the earthquake fault region several days before the main shock of earthquake. The related ground-based observations of earthquake precursors include amplitude and phase anomalies of subionospheric VLF/LF signals, thermal anomaly and TEC (total electron content) variations before strong earthquakes. We have proposed an electric coupling model for the lithosphere-atmosphere-ionosphere system and simulated the dynamics of the ionosphere [Kuo, Lee and Huba, J. Geophys. Res., 119, 3189, 2014]. Variations of TEC and nighttime plasma bubbles near the source region can be generated as results of this coupling. The results of ionosphere simulations show that the TEC variations and formation of single or double plasma bubbles depend on the magnetic latitude of the dynamo source, the flowing direction of dynamo current or the direction of zonal electric field.

4. The role of enhanced thermal pressure in the earthward motion of the Earth's magnetopause

The magnetopause is the thin boundary between the solar wind and the Earth's magnetic field. The magnetopause moves earthward as the total pressure just inside the magnetopause is reduced or the total pressure just outside the magneto-

pause is enhanced. It has been suggested for more than four decades that field-aligned currents, created by magnetic reconnection for southward interplanetary magnetic field, reduce the magnetic pressure just inside the magnetopause. Under the assumption of a constant total pressure just outside the magnetopause, the magnetopause consequently moves earthward. It is shown that the reduced magnetic pressure just inside the magnetopause is insufficient to account for its earthward motion to its real location. For this to happen, an enhancement in the total pressure just outside the magnetopause is required. Satellite observations reveal that the enhanced thermal pressure is the major contributor to the total pressure enhancement [*Shue and Chao, J. Geophys. Res. 118*, 3017, 2013].

GEM Steering Committee

NSF Program Manager

- Janet Kozyra

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- Mike Wiltberger (Chair-elect, 2015-2017)
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- Margaret Chen (2012-2015)
- Robyn Millan (2013-2016)
- Drew Turner (2013-2016)
- Research Area Coordinators (see below)
- Meeting Organizer (see below)

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- Xochitl Blanco-Cano (Liaison to Mexico)
- Lou Lee (Liaison to Taiwan)

Meeting Organizer

- Xia Cai, Robert Clauer (2005-2018)

Student Represenatives

- Ian Cohen (2013-2015)
- Robert Allen (2014-2016)

Research Area Coordinators

Solar Wind-Magnetosphere Interaction (SWMI)

- Karl-Heinz Trattner (2009-2015)
- Katariina Nykyri (2012-2018)

Magnetotail and Plasma Sheet (MPS)

- Larry Kepko (2009-2015)
- Andrei Runov (2014-2018)

Inner MAGnetosphere (IMAG)

- Anthony Chan (2009-2015)
- Scot Elkington (2013-2018)

Magnetosphere-Ionosphere Coupling (MIC)

- Bill Lotko (2011-2015)
- Marc Lessard (2012-2018)

Global System Modeling (GSM)

- Slava Merkin (2009-2015)
- Frank Toffoletto (2012-2018)

Communications Coordinator

- Peter Chi (2014 - 2019)

List of GEM Focus Groups

Focus Group	Duration	Co-Chairs	Associated Research Areas				
			SWMI	MPS	IMAG	MIC	GSM
The Magnetosheath	2010-2014	S. Petrinec K. Nykyri	•				
Transient Phenomena at the Magnetopause and Bow Shock and Their Ground Signatures	2012-2016	H. Zhang Q.-G. Zong M. Ruohoniemi D. Murr	•				
Tail-Inner Magnetosphere Interactions	2012-2016	V. Angelopoulos P. Brandt J. Lyon F. Toffoletto		•			
Storm-time Inner Magnetosphere-Ionosphere Convection (SIMIC)	2013-2017	J. Baker M. Ruohoniemi S. Sazykin P. Chi M. Engebreston			•	•	
Inner Magnetosphere Cross-Energy/Population Interactions	2014-2018	Y. Yu C. Lemon M. Liemohn J. Zhang			•		
Radiation Belts and Wave Modeling (RBWM)	2010-2014	Y. Shprits S. Elkington J. Bortnik C. Kletzing			•		
The Ionospheric Source of Magnetospheric Plasma	2011-2015	R. Schunk R. Chappell D. Welling				•	•
Scientific Magnetic Mapping & Techniques	2011-2015	E. Donovan E. MacDonald R. Millan				•	
Metrics and Validation	2011-2015	T. Guild L. Rastaetter H. Singer					•
Magnetic Reconnection in the Magnetosphere	2013-2017	P. Cassak A. Runov Y.-H. Liu B. Walsh					•
Geospace Systems Science	2014-2018	J. Borovsky W. Lotko V. Uritsky J. Valdivia					•