New Views of Magnetosphere-Ionosphere Dynamics From SuperDARN Radars at Middle Latitudes

*Joseph B. H. Baker[1,2], Nozomu Nishitani[2], Pavlo V. Ponomarenko[3,2], Tomoaki Hori[2], J Michael Ruohoniemi[1]

1. Virginia Tech, 2. Nagoya University, 3. University of Saskatchewan

In recent years, capabilities for monitoring ionospheric processes in the subauroral region have been significantly improved by expansion of the Super Dual Auroral Radar Network (SuperDARN) into middle latitudes. At the present time, 13 SuperDARN radars are operational at magnetic latitudes equatorward of 55 degrees. The collective coverage area of these radars in the northern hemisphere alone spans more than 12 hours of magnetic local time. Such measurements are valuable for monitoring coupled magnetosphere-ionosphere dynamics over hemispheric spatial scales, particularly when combined with other distributed datasets, such as ground magnetometers and imagers, AMPERE Field-Aligned Currents, and GPS Total Electron Content (TEC). In this presentation, the history of SuperDARN will be briefly reviewed with a particular emphasis on the new science investigations enabled by the radars at middle latitudes. Topics covered include storm-time expansion of auroral flows, large-scale structure of the Sub-Auroral Polarization Stream (SAPS), quiet-time subauroral convection, Traveling Ionospheric Disturbances (TIDs), and mid-latitude ULF pulsations.

Keywords: SuperDARN, Ionosphere, Mid-Latitude

Dynamics of the ionospheric convection during disturbed periods observed by the mid-latitude SuperDARN radars

*Nozomu Nishitani[1], Tomoaki Hori[2], Joseph B.H. Baker[3,1]

1. Institute for Space-Earth Environmental Research, Nagoya University, 2. Graduate school of Science, University of Tokyo, 3. Virginia Tech

Sub-Auroral Polarization Streams (SAPS) are one of the main disturbance signatures in the ionospheric convection at subauroral latitudes. Their generation is related to a wide variety of factors such as ring current distribution, solar wind / magnetospheric conditions, ionospheric conductivity etc. In this paper we discuss one event of the SAPS signature observed by the SuperDARN Hokkaido East radar on April 5, 2012. Simultaneously with the enhancement / decay of the SAPS, the mid-latitude SuperDARN radars in the North America observed the corresponding intensification / weakening of the convective flows in the postmidnight sector. There is no obvious solar wind / IMF condition changes, or substorm / storm developments directly related to the convection enhancements. This suggests that the SAPS might be generated in the framework of the global convection, not triggered by a simple factor. Results of detailed discussion / interpretation will be presented.

Keywords: SuperDARN Hokkaido Pair of (HOP) radars, ionospheric convection, geomagnetically disturbed periods, Sub-Auroral Polarization Streams (SAPS)

SECS reconstruction of flow fluctuations with SuperDARN data

*Tomoaki Hori[1], Nozomu Nishitani[2], Kunihiro Keika[1], J. M. Ruohoniemi[3], Mariko Teramoto[2], Akimasa Ieda[2], Shin'ya Nakano[4], Kanako Seki[1], S. G. Shepherd[5], W. A. Bristow[6]

1. Graduate school of Science, University of Tokyo, 2. ISEE, Nagoya Univ., 3. Virginia Tech, 4. Institute of Statistical Mathematics , 5. Dartmouth College, 6. Univ. of Alaska, Fairbanks

We further analyze detailed properties of two-dimensional (2-D) structures of the ULF-like, ionospheric flow fluctuations during a short (~2 hours) break of the main phase of the March 2015 storm. Line-of-sight (LOS) Doppler velocities observed by two SuperDARN radars in the early morning sector were used to deduce the 2-D horizontal flows by means of the spherical elementary current system (SECS) expansion. Similar to results deduced by the conventional map potential technique, the SECS reconstruction shows that ionospheric plasma in the subauroral region flows primarily in the geomagnetically eastward direction before and after the period of the ULF-like fluctuations. The reconstructed flow pattern shows that, during the first half of the ULF event interval, background convection subsides and circular/elliptically polarized flow fluctuations pass over the field-of-view of the radars as they propagate westward. Multiple flow bursts likely associated with small injections occur concurrently during the second half period, while the westward-propagating flow fluctuations still continue regardless of the bursts until a major substorm activity starts later on. Some eastward-propagating flow fluctuations are seen in the early morning sector upon onset of the major substorm, which is strongly suggested by the fact that multiple injections are seen around midnight by Van Allen Probes and the SYM-H and AL indices resume growing. A new finding from the reconstructed flow then is that the eastward-propagating structures are also dominated by a poloidal component. The common feature of poloidal-dominant fluctuations implies that the westward- and subsequent eastward-propagating fluctuations are both caused by a similar mechanism.

Keywords: ionosphere, ULF, SuperDARN

Propagation and evolution of electric fields associated with solar wind pressure pulses based on spacecraft and ground-based observations

*Naoko Takahashi[1], Yasumasa Kasaba[1], Yukitoshi Nishimura[2,3], Atsuki Shinbori[4], Takashi Kikuchi [4,5], Tomoaki Hori[6], Yusuke Ebihara[5], Nozomu Nishitani[4]

1. Dep. Geophysics Graduate School of Science Tohoku University, 2. University of California, Los Angeles, 3. Boston University, 4. Institute for Space-Earth Environment Research, Nagoya University, 5. Research Institute for Sustainable Humanosphere, Kyoto University, 6. Department of Earth and Planetary Science, Graduate school of Science, The University of Tokyo

We investigate spatial and temporal evolution of large-scale electric fields in the magnetosphere and ionosphere associated with sudden commencements (SCs) using multi-point equatorial magnetospheric (THEMIS, RBSP, GOES) and ionospheric (C/NOFS) satellites with radars (SuperDARN). A distinct SC event on March 17, 2013 and a statistical analysis of 130 SC events show that the magnetospheric electric field in the equatorial plane propagates from dayside toward nightside as a compressional wave. Estimated tailward propagation speed is about 1000–1100 km/s, which can be explained by a fast mode wave. The ionospheric electric field responds ~41 s after the onset of dayside magnetospheric electric field, which can be explained by the Alfvén wave speed. Tailward and downgoing field-aligned Poynting fluxes evaluated from THEMIS and RBSP data support these propagations. We also statistically derive a spatial distribution and time evolution of the magnetospheric electric field in the dawn-dusk direction (E_y). Our result shows that negative E_y (dawnward) propagates from noon toward the magnetotail, followed by positive E_y (duskward). At noon, negative E_y lasts for about 1 min, and positive E_y becomes dominant about 2 min after the SC onset. Negative E_y soon attenuates in the nightside region, while the positive E_y propagates fairly well to the pre-midnight or post-midnight regions while maintaining a certain amplitude. The enhancement of duskward electric field is affected by the evolution of the current system associated with the main impulse of SCs.

Investigation of ion composition of the inner magnetosphere from magnetosonic wave observations

*Yoshizumi Miyoshi[1], koji nomura[1], Satoshi Kurita[1], Shoya Matsuda[1], Kunihiro Keika[2], Masafumi Shoji[1], Yoshiya Kasahara[3], Naritoshi Kitamura[4], Shinobu Machida[1], Ondrej Santolik[5], Craig Kletzing[6], Scott Boardsen[7], John Wygant[8], Richard Horne[9]

1. Institute for Space-Earth Environmental Research, Nagoya University, 2. University of Tokyo, 3. Kanazawa University, 4. JAXA, 5. CAS, 6. University of Iowa, 7. NASA, 8. University of Minesota, 9. BAS

Magnetosonic waves (MSWs) (or equatorial noise) are electromagnetic emissions whose properties can be described by the cold plasma extraordinary mode. MSWs are typically observed between the proton cyclotron frequency and the lower hybrid resonant frequency generated by the ring distributions of energetic protons. We have investigated fundamental characteristics of MSWs using the data from EFW and EMFISIS of Van Allen Probes. MSWs propagate toward the Earth, and L=0 cut off at half-proton gyro frequency are sometimes found at L<2. This suggests the existence of ions with M/Q=2, i.e., H2+ or He++ which has been confirmed by previous studies (e.g., Matsuda et al.[2016]). Since L=0 cut off and cross-over frequencies depend on the ion composition of the ambient plasma, we can derive the ion composition ratio along the satellite orbit by investigation of L=0 as well as cross-over frequencies from the Van Allen Probes data. The results show that the maximum percentage of M/Q=2 ions at L<2 is less than 10%, and the oxygen ions is a primary component at the low altitudes. This method is a good diagnostic tool to investigate quantitatively ion composition in the inner magnetosphere, which may be applicable for the data from the Arase (ERG) satellite.

Keywords: equatorial noise, ion composition, inner magnetosphere

Generation of Alfvenic Electromagnetic Plasma Structures in the M-I Coupling Auroral Current System and a Unified Mechanism of Auroral Particle Acceleration

*Yan Song[1], Robert L Lysak[1]

1. University of Minnesota

Field-aligned potential drops are most powerful to accelerate auroral particles to high energy. However, once the parallel electric fields are produced, they will disappear right away unless the electric fields can be continuously generated and sustained for a fairly long time. Thus, the generation of a long-lasting parallel electrostatic electric field is needed for the acceleration of auroral particles to high energy and for the emission of auroral kilometric radiation (AKR).

Propagation and reflection of Alfven waves in the M-I coupling auroral current system can redistribute reactive stresses, which include mechanical and magnetic stresses, along magnetic field lines, producing localized stress concentration in the auroral acceleration region. We propose that the nonlinear interaction of incident and reflected Alfven wave packets in the reactive stress concentration regions can create Alfvenic electromagnetic (EM) plasma structures in the auroral acceleration region. The Alfvenic Double Layer (DL) is one of the Alfvenic EM plasma structures which consists of localized self-sustained electrostatic electric fields associated with charge separation, which are embedded in the low density cavities and surrounded by enhanced reactive stresses. The enhanced magnetic and velocity fields carrying free energy serve as the local dynamo. The generated electrostatic electric fields will quickly deepen the seed low density cavity, which can further rapidly enhance the generation of stronger electrostatic electric fields, causing auroral particle acceleration to high energy. The Poynting flux carried by Alfven waves can continuously supply energy from the generator region to the auroral acceleration region, supporting and sustaining Alfvenic DLs and constituting a powerful long-lasting electrostatic electric field.

We suggest that the Alfvenic EM Plasma structure is a new type of fundamental dynamical EM plasma states, which can be in quasi-stationary or time-dependent. The structure acts as powerful high energy particle accelerators for the formation of quasi-static and Alfvenic auroras, and as an important source of electromagnetic radiation in cosmic plasmas.

Keywords: Dynamical Theory of Auroral Particle Acceleration, Alfvenic Electromagnetic Plasma Structures: A New Type of Fundamental Dynamical EM Plasma State, Generation of Alfvenic Double Layers by NL Interaction of Incident and Reflected Alfven Wave Packets in Auroral Acceleration Region

Magnetosphere-Ionosphere coupling process produced by Ampere force forcing from the magnetosphere

*Akimasa Yoshikawa[1]

1. Department of Earth and Planetary Sciences, Kyushu University

The way of M-I coupling process through Ampere force forcing from the magnetosphere to the ionosphere is discussed. There are many kinds of electromagnetic coupling ways between magnetosphere and ionosphere, e.g.,
1. FAC forcing: map the FAC distribution from the magnetosphere to the ionosphere and calculate ionospheric electrostatic electric field (production of FAC-free polarization field),
2. Electric field forcing: map the electric field distribution from the magnetosphere to the ionosphere and calculate the FAC distribution at the ionosphere (production of polarization-free FAC distribution).
However, as discussed by Yoshikawa et al., [2010], both of above ways cannot simultaneously satisfy energy and current conservation. Alternatively the way of M-I coupling through shear Alfven wave can do that in local coupling. On the other hand, Alfvenic-coupling with electrostatic approximation cannot provide physical mechanism how a localized Alfvenic coupling phenomenon drives global ionbospheric current system.
In this study, we propose a new way of M-I coupling theory that formulating the M-I coupling process as subsequent process of ion dynamics produced by the Ampere force forcing from the magnetosphere, that is, 3. Ampere force forcing: map the Ampere force from the magnetosphere to the ionosphere and calculate ionospheric flow through the force balance equation, induced electric field through the generalized Ohm’s law, a new magnetic field perturbation through Faraday’s induction law, new current density through Ampere’s law, and new Ampere’s force as a result of this coupling process can feed back to the magnetosphere.
Some example of M-I coupling process, aurora streamer, WTS evolution during substorm process, and dynamical Cowling channel formation will be discussed.

Keywords: Magnetosphere-Ionosphere Coupling, Ampere force forcing, dynamical polarization process

Generation of auroral turbulence in the magnetosphere-ionosphere coupling

*Tomo-Hiko Watanabe[1]

1. Graduate School of Science, Nagoya University

The magnetosphere-ionosphere (M-I) coupling is unstable to the feedback instability, when the large-scale ExB convection flow velocity exceeds a critical value, where the shear (or kinetic) Alfven waves are amplified with enhancement of the field aligned current (FAC). The local development of FAC is related to enhancement of electron precipitation and spontaneous excitation of auroral arc structures with ionospheric density increase. The feedback instability has been investigated both in the linear and the weak nonlinear regimes while the full nonlinear study is limited so far. In the present study, we discuss a nonlinear evolution of the feedback instability and transition to turbulence.

Nonlinear saturation of the feedback instability growth has recently been discussed in terms of the secondary instability [2], where the Kelvin-Helmholtz type mode is generated by a sheared ExB flow. Then, one finds transition to turbulence through the M-I coupling [2], providing a theoretical understanding on spontaneous generation of Alfvenic turbulence observed in auroral regions.

[1] T.-H. Watanabe, Phys. Plasmas 17, 022904 (2010).
[2] T.-H. Watanabe, H. Kurata, and S. Maeyama, New J. Phys. 18, 125010 (2016).

Keywords: aurora, magnetosphere-ionosphere coupling, turbulence, Alfven waves

Conjugate Observations of Electromagnetic Ion Cyclotron (EMIC) Waves Associated with Traveling Convection Vortex (TCV) Events

*Hyomin Kim[1], C. Robert Clauer[2], Andrew Gerrard[1], Mark Engebretson[3], Michael Hartinger[2], Marc Lessard[4], Juergen Matzka[5], David Sibeck[6], Howard Singer[7], Claudia Stolle[5], Daniel Weimer[2], Zhonghua Xu[2]

1. Center for Solar-Terrestrial Research, New Jersey Institute of Technology, USA, 2. Center for Space Science and Engineering Research and Department of Electrical and Computer Engineering, Virginia Tech, USA, 3. Department of Physics, Augsburg College, USA, 4. Space Science Center, University of New Hampshire, USA, 5. GFZ, German Research Centre for Geosciences, Germany, 6. NASA Goddard Space Flight Center, USA, 7. Space Weather Prediction Center, NOAA, USA

We report on simultaneous observations of EMIC waves associated with traveling convection vortex (TCV) events caused by transient solar wind dynamic pressure (Pd) impulse events. The THEMIS spacecraft located near the magnetopause observed radial fluctuations of the magnetopause and the GOES spacecraft measured sudden compression of the magnetosphere in response to sudden increases in Pd. During the transient events, EMIC waves were observed by inter-hemispheric conjugate ground-based magnetometer arrays as well as the GOES spacecraft. The spectral structures of the waves appear to be well correlated with the fluctuating motion of the magnetopause, showing compression-associated wave generation. In addition, the wave features are remarkably similar in conjugate hemispheres in terms of bandwidth, periodic wave power modulation, and polarization. Proton precipitation was also observed by the DMSP spacecraft during the wave events, from which the wave source region is estimated to be 72-74 deg in magnetic latitude, consistent with the TCV center. The confluence of space-borne and ground instruments including the the inter-hemispheric, high-latitude, fluxgate/induction-coil magnetometer array allows us to constrain the EMIC source region while also confirming the relationship between EMIC waves and the TCV current system.

Keywords: EMIC waves, Traveling Convection Vortex, Transient phenomena

Estimation of source region of pulsating proton aurora

*Tomohiro Inoue[1], Mitsunori Ozaki[2], Satoshi Yagitani[2], Kazuo Shiokawa[3], Yoshizumi Miyoshi[3], Ryuho Kataoka[4], Yusuke Ebihara[5], Reiko Nomura[6], Kaori Sakaguchi[7], Yuichi Otsuka[3], Martin G Connors[8]

1. Graduate School, Kanazawa University , 2. Institute of Science and Engineering, Kanazawa University, 3. ISEE, Nagoya University, 4. National Institute of Polar Research, 5. RISH, Kyoto University, 6. ISAS / JAXA, 7. NICT, 8. Athabasca University

Pulsating proton aurora (PPA) is caused by pitch angle scattering of high-energy (several keV ~ tens of keV) ions via the electromagnetic ion cyclotron (EMIC) waves at the magnetic equator. EMIC waves propagate along the magnetic field line from the source region and are observed as Pc1 geomagnetic pulsations on the ground. We have been investigating the source region in the magnetosphere from the traveling time difference between PPA and Pc1 geomagnetic pulsations observed on the ground. We estimated the source region using the simultaneous ground-based observations of PPA and Pc1 geomagnetic pulsations at Athabasca, Canada (L value=4.3). The PPA events were observed by using an all-sky EMCCD camera (110 Hz sampling), and the geomagnetic pulsations were measured by an induction magnetometer (64 Hz sampling). In this study, we analyzed the source region for the two events of simultaneously observed PPA and Pc1 geomagnetic pulsations on 12 November, 2015 and 2 January, 2016. The observed Pc1 geomagnetic pulsations consist of rising-tone elements having the subpacket structures. The repetition period for the rising-tone element was approximately 100 seconds. The time variation for the subpacket structures was a few tens of seconds. The PPA intensity showed the same repetition period and fast modulation. In order to estimate the source region of PPA, we calculated the time difference between PPA intensity and Pc1 amplitude taking the cross-correlation between them. The observed time difference between PPA and Pc1 geomagnetic pulsations showed that the Pc1 geomagnetic pulsations arrived at the ground station faster than the PPA. We theoretically calculated the time difference between EMIC waves and energetic ions using the group velocity of EMIC waves and the resonance energy at each magnetic latitude. The source region was estimated by comparing between the observed and theoretically calculated time differences. The estimated results showed that the source region was in the magnetic latitudes around the equator. All of the obtained results are consistent with the scenario that the high-energy ions responsible for triggering the PPA was generated at the magnetic equator.
In the presentation, we will discuss the estimation results of source regions of PPA observed at Athabasca in detail.

Keywords: Pulsating proton aurora, Pc1 geomagnetic pulsations, EMIC waves

Space-ground coordinated observations of subauroral ion drifts (SAID)

*Toshi Nishimura[1,2], Bea Gallardo-Lacourt[1], Larry Lyons[1], Eric Donovan[3], Vassilis Angelopoulos[1]

1. University of California, Los Angeles, 2. Boston University, 3. University of Calgary

Duskside plasma convection is often enhanced at narrow latitudes just equatorward of the electron auroral oval (subauroral polarization streams or SAPS). The latitudinal extent of the flows can occasionally become less than a degree with the peak speed exceeding a few km/s. Those are called subauroral ion drifts (SAID), and their formation mechanism and differences from SAPS have been key issues in subauroral magnetosphere-ionosphere coupling.

We aim at understanding occurrence timing and magnetospheric drivers of SAID by using optical imaging, radars, and low-altitude and magnetospheric satellites. Interestingly, although SAID is a subauroral phenomenon where we do not generally expect localized precipitation, all-sky imager data during a subset of SAID events showed a latitudinally narrow (~0.5 deg) auroral arc adjacent to SAID. This unique auroral feature allowed us to optically trace evolution of SAID. We found that SAID was preceded by substorm injections and SAPS, and that subsequent injections without strong proton injection resulted in SAID. This different injection behavior was confirmed by the NOAA and DMSP satellites. DMSP also showed that the bulk of the region-2 field-aligned currents (FACs) are confined to the SAID latitudinal extent. In one of the events, one of the THEMIS satellites crossed the earthward boundary of the electron plasma sheet and detected SAID with much narrower L-shell separation between electron and ion inner boundaries.

These observations indicate that SAID has a similar quasi-steady structure to SAPS both in the ionosphere and magnetosphere except for the latitudinal extent, but the type of particle injection is quite different from SAPS events; namely the injections are dominated by electrons and give much smaller separation with the ion inner boundary.

Keywords: SAPS/SAID, ring current and plasma sheet, auroral imaging and radar

Equatorial Magnetic Field of the Near-Earth Magnetotail: THEMIS Observations

*Shinichi Ohtani[1], Tetsuo Motoba[1]

1. The Johns Hopkins University Applied Physics Laboratory

The equatorial magnetic field on the night side is critical for understanding not only the configuration of the magnetotail but also its state and dynamics. The present study observationally addresses various aspects of the equatorial magnetic field such as its equatorial distribution, spatial gradient, and the occurrence of extremely weak magnetic fields using measurements made by the THEMIS satellites. An emphasis is placed on the transition region between dipolar and stretched magnetotail configurations. The results are summarized as follows: (1) within 9 R_E from Earth the magnetic field is statistically organized to a noticeable extent by the radial distance, but at a given distance it is weaker closer to midnight suggesting that it also organized by the X distance; (2) At 9-12 R_E, however, the spatial variation is less systematic suggesting that the magnetic field changes more dynamically; (3) in general, the equatorial magnetic field increases earthward steeply in the near-Earth region and far more gradually farther down the tail, and the transition takes place at r ~ 9-12 R_E; (4) the gradient of the equatorial magnetic field is predominantly earthward, but it can be transiently directed tailward in association with the dipolarization of local magnetic field; (5) the equatorial magnetic field becomes extremely weak (< 2 nT) in the transition region during the substorm growth phase as well as during prolonged quiet intervals, but any clear association can be found with the steady strong driver of the magnetosphere possibly because of its rare occurrence.

Keywords: Equatorial Magnetic Field, Near-Earth Magnetotail, Plasma Sheet, Bz Minimum, Tailward Gradient of Bz, Magnetospheric Configuration

Mechanics and energetics of substorm expansion onset

*Yusuke Ebihara[1], Takashi Tanaka[2]

1. Research Institute for Sustainable Humanosphere, Kyoto University, 2. Kyushu University

Substorm expansion onset is a long-standing unsolved issue in magnetospheric. Processes taking place in the equatorial plane have been paid much attention for many years, but the connection between the equatorial plane and the ionosphere remains unclear. We focus on abrupt intensification of upward field-aligned current (FAC) that is central to this issue. That is because the upward FAC is responsible for accelerating electrons downward and emitting bright aurora and development of auroral electrojet. Here, on the basis of results of the global MHD simulation (REPPU), we show that the abrupt intensification of the upward FAC is reasonably explained by magnetohydrodynamics (MHD) processes. First of all, we focused on the magnetic field line from the onset position to the equatorial plane. The upward FAC is intensified along the magnetic field line except near the equatorial plane. The generation of the upward FAC (as a function of vorticity) takes place primarily at off-equator, not equatorial plane. The value of J.E is negative in the middle of the magnetic field line where the upward FAC is generated. This implies that the plasma moves against the Lorentz force to twist the magnetic field line and generate the FAC. These results may suggest that the abrupt intensification of the upward FAC results primarily from processes taking place at off-equator, not the equatorial plane. We will discuss the causality between the formation of the near-Earth neutral line (NENL) and the onset in terms of mechanics and energetics.

Keywords: Substorm, MHD simulation

Global MHD simulation study on substorms: Influence of low altitude boundary condition

*Naoki Kamiyoshikawa[1], Yusuke Ebihara[1], Shinichi Ohtani[2], Takashi Tanaka[3]

1. RISH, Kyoto University, 2. APL, The Johns Hopkins University, 3. SERC, Kyushu University

A substorm is one of the most drastic disturbances taking place in the magnetosphere. The substorm is known to occur frequently when the interplanetary magnetic field (IMF) is southward and solar wind speed is high. It is believed that a substorm is essentially driven by the external condition, that is, the solar wind and IMF. Recently, some simulation results have shown that the ionospheric condition may affect the global magnetospheric convection. This may imply that in addition to the external condition (solar wind and IMF), the internal condition (ionospheric condition) is also a control factor to the characteristics of substorms. We investigated the characteristics of substorms by using global magnetohydrodynamics (MHD) simulation [Tanaka et al., 2010]. For given parameters of the solar wind and IMF, we repeated the simulation by changing the inner boundary of the simulation. In the global MHD simulation, the inner boundary is located at 2.6 Re. In the original setting, plasma pressure at the innermost grid was determined by $P_1=AP_2$, where P_1 and P_2 are the plasma pressures at the lowest grid and the second lowest grid, and A is a factor. When A is 1, the plasma pressure is the same at the lowest and the second lowest grids. This means that the pressure gradient force does not exist in between. When A is less than 1, there is a pressure gradient between them, and the plasma is accelerated toward the Earth. Finally, the plasma will be lost when it encounters the innermost boundary of the simulation. In the real situation, it represents the plasma loss process due to a recombination or charge exchange in the ionosphere. We obtained the following results. For given solar wind condition, the near-Earth reconnection region as identified by earthward and tailward plasma flows occurred at ~12 Re near the equatorial plane regardless of the value A. However, the earthward flow speed increases with decreasing the value A. When the value A is 0.6, the earthward flow speed was about 650 km/s, whereas when the value A is 1.0, it was about 260 km/s. As the value A increases, it became clear that high-pressure regions in the near-Earth plasma sheet extended toward the Earth after the reconnection, and that the magnitude of the current density and the magnetic field before the reconnection at ~12 Re increased. In this simulation, the magnetic diffusion takes place when the anomalous resistivity is large. The anomalous resistivity is a function of the current density and the magnetic field. It is thought that the condition at the inner boundary of the simulation may change the force balance that is responsible to the anomalous resistivity and the subsequent substorm dynamics. We will discuss the detail mechanism for the dependence of A on the earthward-tailward flow speed as well as the magnitude of auroral electrojets and field-aligned current.

Keywords: substorm, global MHD simulation, inner magnetosphere

Response of the Earth' s magnetosphere and ionosphere to the small-scale magnetic flux rope in solar wind by the MHD simulation

*Kyung Sun Park[1], Myeong Joon Kim[1], Dae-Young Lee[1], Kyungsuk Cho[2], Rok Soon Kim[2], Tatsuki Ogino[3]

1. Chungbuk National University, Korea, 2. Korea Astronomy and Space Science Institute, Korea, 3. ISEE, Nagoya University, Japan

We have studied the response of the Earth' s magnetosphere and ionosphere to two cases of small-scale magnetic flux ropes in solar wind by using a three-dimensional global MHD simulation. (1) the case of +Z axis of magnetic flux rope, the IMF is northward with a dawn to dusk B_Y components as right-handed, (2) the case of +Y axis of magnetic flux rope, the IMF is north to southward with a duskward B_Y as right-handed and solar wind dynamic pressure is normal (1.3 nPa).
The simulation results show that the bow shock is located at about 14.6 R_E and the magnetopause is located at about 10.24 R_E in both cases. However, ionospheric phenomena show the different feature for two cases. The cross polar cap potential becomes small during the northward even though magnitude of magnetic field becomes large for +Z axis of magnetic flux rope. And the cross polar cap potential increase that is governed by magnitude of magnetic field as well as southward B_Z for +Y axis of magnetic flux rope.

Keywords: small-scale magnetic flux rope, magnetosphere and ionosphere , cross polar cap potential

Dayside plasma blob: a different high-density structure from patches in the polar cap

*Qing-He Zhang[1], Yu-Zhang Ma[1], P. T. JAYACHANDRAN[2], J. Moen[3], M. Lockwood[4], Yong-Liang Zhang[5], Yong Wang[1], D. R. Themens[2]

1. Institute of Space Sciences, Shandong University, Weihai, China, 2. Physics Department, University of New Brunswick, Fredericton, New Brunswick, Canada, 3. Department of Physics, University of Oslo, Blindern, Oslo, Norway, 4. Department of Meteorology, University of Reading, Earley Gate, Post Office Box 243, RG6 6BB, UK., 5. The Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, USA

A new nomenclature of “dayside plasma blob/dayside blob” has been introduced to differentiate another type of enhanced density structures from polar cap patches in the polar ionosphere based on the *in situ* and ground based observations, by learning from the terminology of auroral blob, a plasma structure within the night-time auroral oval on the closed field lines. Comparing with the polar cap patches, which transported from dayside sunlit region with dense and cold plasma, the dayside blobs are associated with particle precipitations and aurora arcs in the polar cap with dense and hot plasma and strong field-aligned current. Notably, the dayside blobs cause more severe disturbances in the polar cap ionosphere for navigation signals than patches, which will be very useful to grade the importance of space weather phenomena in the polar cap.

Keywords: Polar cap patches, Dayside plasma blobs, Polar Ionosphere, Polar ionosphere-magnetosphere coupling

Spatiotemporal variations of the electron precipitation producing moving cusp aurora

*Satoshi Taguchi[1], Keisuke Hosokawa[2], Yasunobu Ogawa[3]

1. Department of Geophysics, Graduate School of Science, Kyoto University, 2. Department of Communication Engineering and Informatics, University of Electro-Communications, 3. National Institute of Polar Research

A moving mesoscale aurora at a wavelength of 630.0 nm (red line) is a typical phenomenon in the dayside cusp of the high-latitude ionosphere and is thought to be caused by enhanced fluxes of soft magnetosheath electrons in the moving flux tube driven by intermittent reconnection. In this paper we examine the spatiotemporal variations of the electron precipitation in the moving reconnected flux tube by analyzing red-line aurora image data from a ground-based all-sky imager. An analysis taking into account a long radiative time of red-line emission was performed. The long radiative time is the dominant cause of the difference between the extent of the moving red-line aurora and that of the moving electron precipitation. Estimating this difference quantitatively in the aurora image obtained at a time resolution of approximately 10 s reveals the dynamic features of the electron precipitation in the moving reconnected flux tube.

Keywords: Aurora, cusp, electron precipitation

The Earth's Magnetopause: Force Balance and Topology Revealed by High Cadence Plasma Measurements

*Christopher T Russell[1], Robert J Strangeway[1], Cong Zhao[1], Brian J Anderson[2], Wolfgang Baumjohann[3], Kenneth R Bromund[4], James A Slavin[5], Larry Kepko[4,6], Guan Le[4], Werner Magnes[3], Rumi Nakamura[3], Roy B Torbert[6], William R Paterson[4], Thomas E Moore[4], Barbara L Giles[4], Stephen A Fuselier[7], James L Burch[7]

1. Earth Planetary and Space Sciences, University of California, Los Angeles, CA 90095, USA., 2. Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723-6099, USA, 3. Space Research Institute, Austrian Academy of Sciences, Graz, Austria, 4. NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA, 5. University of Michigan, Climate and Space Sciences and Engineering, Ann Arbor, MI 48109-2143, USA, 6. University of New Hampshire, Durham, NH 03824, USA, 7. Southwest Research Institute, Boulder, CO 80302, USA.

The magnetopause is strongly influenced by properties of the flowing plasma that it deflects. The Magnetospheric Multiscale Mission has enabled this interaction to be probed in intimate detail. We combine the magnetic measurements of the four spacecraft to demonstrate how the magnetic forces affect the boundary between the shocked solar wind and the Earth's magnetic field. We compare these forces with the plasma pressure, confirming the accurate intercalibration of the plasma and magnetic forces but draw attention to the tradeoff between spatial resolution and accuracy of the gradient measurements so governed by the spacecraft separation. We use the electron distribution function to examine the topology of the magnetic field. Small pockets of low magnetic field strength, small radius of curvature magnetic field lines and high electric current mark the electron diffusion region.

Keywords: Magnetopause, Reconnection, Topology

The azimuthal extent of magnetopause reconnection

*Ying Zou[1], Brian Walsh[1], Toshi Nishimura[1,2], Vassilis Angelopoulos[2], John Micheal Ruohoniemi[3], Kathryn McWilliams[4], Nozomu Nishitani[5]

1. Boston Univeristy, 2. University of California Los Angeles, 3. Virginia Tech, 4. University of Saskatchewan, 5. Nagoya University

Although the dayside magnetopause reconnection is shown to occur in localized regions or over an extended X-line, a systematic understanding of what is the prevailing scale size and how this depends on IMF conditions has not been achieved. Multi-point observations by spacecraft tend to be separated either too small to cover the reconnection site, or too large that the assumption of a continuous X-line between satellites becomes questionable. Radars and imagers can broadly monitor the ionospheric signatures of magnetopause reconnection around the cusp as fast anti-sunward flows and auroras, and can thus provide a large-scale context of the reconnection scale size given by the flow channel size. We combine multi-point THEMIS spacecraft observations with SuperDARN measurements to statistically determine the width of magnetopause reconnection and its IMF dependence. We require nearly simultaneous magnetopause crossing by at least two spacecraft and determine the occurrence of reconnection based on the Walen test and the D-shape distribution of ion phase space density. This is compared with the occurrence and the azimuthal width of ionospheric fast flows at the spacecraft footprint. Our preliminary results show that when the two spacecraft are separated by a few Re and both detect reconnection signatures, their footprints are located within or close to the same ionospheric flow channel. When one misses reconnection, its footprint is located away from the ionospheric flow channel. Such conjunctions ensure the physical connection between ionospheric flow channels and magnetopause reconnection extents, and thus enable a reliable interpretation of the reconnection width. We observe the reconnection width to be 200-600 km in ionosphere, which corresponds to 2 Re up to 8 Re in the equatorial plane, although more events are under survey.

Keywords: Magnetopause reconnection, Multi-point observation, Magnetosphere-ionosphere conjunction

Seasonal and solar wind control of the reconnection line location at the Earth’ s dayside magnetopause

*Yasuto Hoshi[1,2], Hiroshi Hasegawa[2], Naritoshi Kitamura[2], Yoshifumi Saito[2]

1. Graduate School of Science, The University of Tokyo, 2. ISAS/JAXA

Geomagnetic disturbances in the geospace such as aurora and geomagnetic storm are driven by solar wind energy transported into the Earth’ s magnetosphere. Magnetic reconnection at the dayside magnetopause is the most important process by which solar wind energy enters the magnetosphere. This is a phenomenon in which the interplanetary magnetic field (IMF) in the solar wind and the Earth’ s magnetic field re-connect. Under southward and/or predominantly dawn-dusk IMF conditions, magnetic reconnection takes place along an extended reconnection line at low latitudes, called the X-line. Geomagnetic flux connected to the IMF is transported to, and is stored in, the nightside magnetosphere. The amount of solar wind energy that flows into the magnetosphere is controlled by the efficiency of reconnection occurring at the dayside magnetopause. The efficiency of reconnection may depend on the X-line location. When the X-line location shifts from the subsolar point, where the sun is at the zenith, the boundary conditions around the X-line can change. Therefore, the amount of solar wind energy flowing into the Earth’ s magnetosphere can change because of the changed efficiency of the reconnection. In recent years, some models and observations showed that finite dipole tilt or IMF B_X controls the X-line location by moving it northward or southward from the subsolar point. Although the X-line location is an important parameter in solar wind energy transport, its dependence on dipole tilt and IMF Bx is not yet made clear based on statistical observational studies. We statistically estimated the X-line location by investigating the occurrence pattern of reconnection jets observed at the dayside magnetopause. Used here are plasma and magnetic field data taken in the dayside magnetopause region within the magnetic local time range of 10 to 14 hours from 10 years of observations by the THEMIS spacecraft.

Among full magnetopause crossing events, flows with a speed tangential to the magnetopause exceeding 150 km/s, which is of the order of the Alfvén speed in the magnetosheath, are chosen as candidates of the reconnection jets. The Walén relation is used to test whether the flow was generated by reconnection, and a total of 715 jets were identified. We estimated the X-line location by the direction and position of the identified jets. The present analysis assume that the northward jets are observed on the northern side of the X-line and the southward jets are observed on the southern side. The average X-line location was estimated by determining a linear discriminant function that minimizes the occurrence probability of the southward jets on the northern side of the estimated X-line or the northward jets on the southern side. It was found that the X-line location shifts about 6 Earth radii from the subsolar point toward the winter hemisphere under the largest dipole tilt. This is also the first study that reveals that the X-line location shifts about 2.5 Earth radii from the subsolar point when the IMF B_X component is large. The results demonstrate that the effect of dipole tilt on the X-line position is larger than that of the IMF B_X component. To summarize, the dipole tilt dependence of the X-line location suggests that efficiency of energy transport into the magnetosphere by dayside magnetic reconnection during southward IMF may decrease when the dipole tilt is large. This suggests that the well-known geomagnetic activity decrease under larger dipole tilts may be partially due to the X line position displaced from the subsolar point for large dipole tilt.

Keywords: magnetopause, magnetic reconnection

Subsidence of Ionospheric Fast Flows Triggered by Magnetotail Magnetic Reconnection During Transpolar Arc Brightening

*Motoharu Nowada[1], Robert C. Fear[2], Adrian Grocott[3], Quan-Qi Shi[1], Chun-Feng Zhang[1], Yong-Fu Wang[4], Qiu-Gang Zong[4], Yong Wei[5], Sui-Yan Fu[4], Zu-Yin Pu[4]

1. Center for Space Weather Sciences, Institute of Space Science, School of Space Science and Physics, Shandong University at Weihai, 2. Department of Physics and Astronomy, University of Southampton, 3. Space and Planetary Physics Group, Department of Physics, Lancaster University , 4. Institute of Space Physics and Applied Technology, School of Earth and Space Sciences, Peking University , 5. Key Laboratory of Earth and Planetary Physics, Institute of Geology and Geophysics, Chinese Academy of Sciences

A static transpolar arc (TPA), which extended from post-midnight to pre-noon, was seen on 16th September 2001 in the northern hemisphere. The orientations of the Interplanetary Magnetic Field-B_z and -B_y components were dominantly northward and weakly dawnward, respectively, when the TPA began to brighten. Associated solar wind velocity, density and dynamic pressure were almost stable. The SuperDARN radars detected westward plasma flows whose range was between 0.4 km/s and 0.75 km/s along the poleward edge of the midnight-sector main auroral oval, suggesting that they were confined within closed field lines and identified as the ionospheric plasma flows associated with Tail Reconnection during IMF Northward Non-substorm Intervals (TRINNIs). These TRINNIs' ionospheric fast plasma flows persisted for at least 50 minutes prior to an appearance of the TPA. Often, TRINNIs are observed even during the period when the TPA is present, but, in this case, the flows associated with TRINNIs subsided beforehand. Additional slower plasma flows, which might cross the open/closed polar cap boundary, were seen at the time of the TPA onset in the same magnetic local time sector as the nightside end of the TPA. These ionospheric flows suggest that magnetotail reconnection significantly contributed to the TPA formation, which is proposed by Milan et al. [2005]. We investigate how magnetotail reconnection actually occurred before and during the TPA appearance by calculating the Joule heating (E・J) based on a global MHD simulation. Evidence for heating associated with magnetotail reconnection was seen during an interval of TRINNIs' fast flows on the midnight-sector main auroral oval prior to the TPA appearance, but no significant Joule heating due to nightside magnetic reconnection was found during the TPA brightening. This result suggests that the fate (absence or presence) of the TRINNIs' fast flows on closed field lines (the midnight-sector main auroral oval) during the TPA brightening would depend on a scale of magnetic reconnection, that is, the width of the reconnection line.

Reference:

Milan, S. E., B. Hubert, and A. Grocott (2005), Formation and motion of a transpolar arc in response to dayside and nightside reconnection, J. Geophys. Res., 110, A01212, doi:10.1029/2004JA010835.

Keywords: Transpolar Arc, Magnetotail Reconnections, Ionospheric Flows, TRINNIs

Simultaneous observation of auroral substorm onset in Polar satellite global images and ground-based all-sky images

*Akimasa Ieda[1], Kirsti Kauristie[2], Yukitoshi Nishimura[3], Yukinaga Miyashita[1], Shinobu Machida[1], Yoshizumi Miyoshi[1], George K. Parks[4], Matthew O. Fillingim[4], Kawashima Takahiro[1], Miura Tsubasa[1]

1. Institute for Space-Earth Environmental Research, Nagoya University, 2. Finnish Meteorological Institute, 3. University of California, Los Angeles, 4. University of California, Berkeley

Substorm onsets have originally been defined as longitudinally extended sudden auroral brightening ("Akasofu initial brightening") followed a few minutes later by auroral poleward expansion in ground-based all-sky images. In satellite global images, in contrast, such a clearly marked two-stage development has not been observed, and instead substorms have often appeared to start in a localized area. To resolve these differences, optical substorm onset signatures in global images and all-sky images were compared for a substorm that occurred on 7 December 1999. We have used the Polar satellite ultraviolet global images with a fixed filter (170 nm), enabling a high time resolution (37 s), and have used the 20 s resolution green line (557.7 nm) all-sky images at Muonio in Finland for comparison.

We first identified the substorm onset brightening at 2127:49 UT in the global images and then searched for corresponding signatures in the all-sky images. The Akasofu initial brightening (2124:50 UT) and the poleward expansion (2127:50 UT) were observed in the all-sky images, indicating that the onset in global images was not simultaneous with the actual onset but rather with the poleward expansion in the all-sky images. The Akasofu initial brightening was not observed in the global images, which may possibly be attributed to the limited sensitivity of global images for thin auroral arc brightenings. This result suggests that substorm onset identified in global images does not necessarily represent the Akasofu substorm onset, but rather corresponds to the poleward expansion a few minutes later.

Keywords: substorm, auroral breakup, aurora, global image, all-sky image

Study on Effects of Ionospheric Polarization Field and Inner Boundary Conditions on Magnetospheric Dynamics and Substorm Processes in Global MHD Simulation

*Aoi Nakamizo[1], Akimasa Yoshikawa[2,3], Takashi Tanaka[3]

1. Applied Electromagnetic Research Institute, National Institute of Information and Communications Technology, 2. Faculty of Science, Kyushu University, 3. International Center for Space Weather Science and Education (ICSWSE)

Global MHD simulation is an effective way to investigate the Solar Wind-Magnetosphere-Ionosphere system. Among various handlings and parameterizations in the global simulations, they are related to processes which cannot be described by MHD or which have not been fully understood, we especially place importance on the descriptions for low-altitude region (the M-I coupling part and inner boundary conditions) and we expect that they largely control the dynamics of the M-I system. In order to advance our physical understanding of the M-I system from the viewpoints of the above interests, we investigate the responses of magnetosphere and substorm processes for different treatments of low-altitude region.

Our investigation is generally classified into two categories; (A) the one in the context of the M-I coupling algorithm and (B) the other in the context of the inner boundary conditions imposed on MHD variables.
As for (A), the currently and commonly used algorithm is as follows; the FACs (rotB) of the MHD region are inputted to a potential solver embedded at the ionosphere altitude with prescribed conductance distribution, then calculated electric field is mapped back to the MHD region as the velocity field. In the present study, as the first step, we investigate the effect of inhomogeneity of ionospheric Hall conductance distribution. The background of this direction is the recently proposed concept of ionospheric control [Yoshikawa et al, 2008; 2013a, Nakamizo et al., SGEPSS, 2013] based on generalized theory for ionospheric polarization/Cowling channel formations [Yoshikawa et al, 2008; 2013b]
As for (B), normally either the Neumann or Dirichret conditions are selected for MHD variables (plasma density/pressure, velocity, deviation components of magnetic field from the intrinsic field). Other adjustments, representing particle precipitations, neutral wind friction, polar wind, and so on, are included. In the present study, we perform simulations with different pairs of boundary conditions for MHD variables.
In this presentation, we compare and discuss the obtained results.

Keywords: M-I Coupling, Ionospheric Polarization Field, Hall Conductance Inhomogeneity, Substorm, Global Magnetosphere MHD Simulation, Inner Boundary Conditions

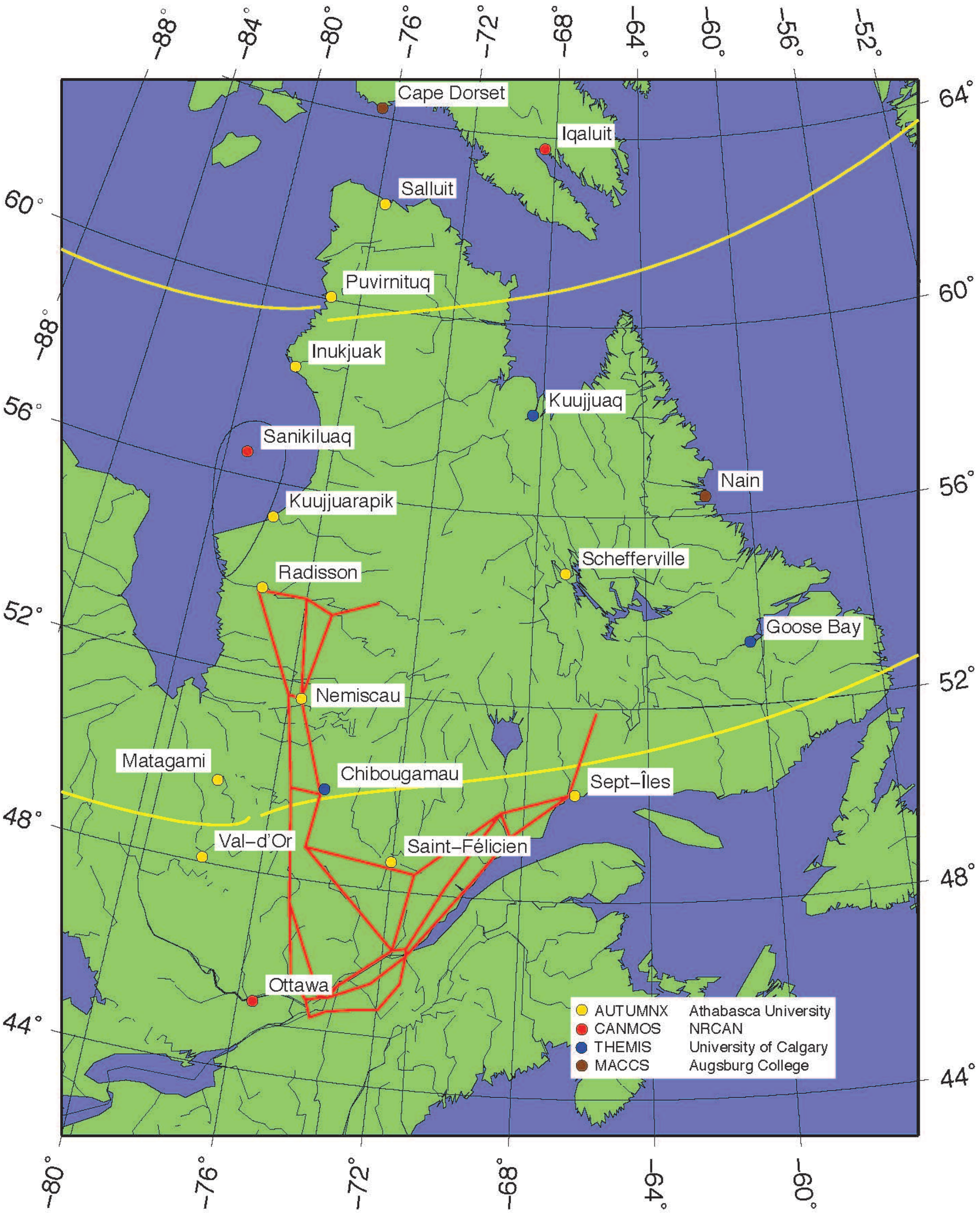
Geomagnetic Phenomena near the AUTUMNX Magnetic Array in Qué bec, Canada

*Martin G Connors[1,2,3], Ian Schofield[1], Kyle Reiter[1], Christopher T Russell[5], Sebastien Guillon[4], Paul Prikryl[6,7], Kazuo Shiokawa[2], Mark Engebretson[8], Peter Chi[5], Jesper Gjerloev[9]

1. Athabasca University, 2. ISEE, Nagoya University, 3. Department of Physics and Astronomy, University of Calgary, 4. Hydro Quebec, 5. IGPP, UCLA, 6. University of New Brunswick, 7. Geomagnetic Laboratory, NRCan, 8. Augsburg College, 9. Applied Physics Laboratory, Johns Hopkins University

The AUTUMNX Magnetic Array’ s main chain has a closely-spaced set of UCLA THEMIS-class magnetometers along the east coast of Hudson Bay. Stations at Sept-Îles and Scheffervill, Québec, along with the THEMIS station at Kuujuaq and the NRCan Iqaluit observatory on Baffin Island make a looser second chain. This chain may be extended by a proposed new partner site in Fredericton, New Brunswick, and there are several other subauroral stations near the Hydro-Québec power grid. AUTUMNX magnetic data is freely available with one minute and 2 Hz cadence at http://autumn.athabascau.ca/autumnxquery.php?year=2017&mon=02&day=02 and pages easily accessed from there. It is also distributed widely, and in near-real time, to the THEMIS project, and quickly accessible through CDAWeb. More than one year of baselined one-minute cadence data (to the end of 2015) is now available through SuperMAG at http://supermag.jhuapl.edu/mag/. Since its establishment in late 2014, AUTUMNX has had a high rate of reliability and gathered nearly continuous data. For dates through mid-2016, however, potential users are urged to contact the PI about initial data quality issues at some sites. AUTUMNX is complemented by other arrays in eastern North America to now give good coverage in this region, which before 2014 had few magnetometers. AUTUMNX also improves magnetic data coverage near the footpoint of GOES East. It has magnetic conjugate points on land/ice in Antarctica, where the PRIMO project hopes to put new magnetometers.
The dense coverage of the Eastern Hudson Bay part of AUTUMNX allows magnetic inversion studies to be done well. Here we use techniques based on forward modelling to analyze cross meridian and regional currents. In addition to substorms, some of small total current, we find that steady convection is common. The currents in the March 17, 2015 storm attained 3 MA. A new finding relevant to space weather is that impulsive events are common. The Hydro-Québec utility measures harmonic distortion in the grid, and we find a close correlation with impulsive events. Our first detection of a pulse subsequently found to cause GIC in the Hydro-Québec network was on February 2, 2017 (link given above). In approximately 50 other cases, we have verified that GIC pulses initially detected in the grid had associated magnetic impulses. These are sometimes associated with substorms, but those which are not often show direct correlation with solar wind changes.
The AUTUMNX array has distinct advantages for ground magnetic studies in which high data rate, coverage of a large region, at least one closely spaced meridian chain, and conjugacy to geosyncronous satellites are important. We have also compared magnetic data with that from nearby GPS stations to show colocation of the auroral electrojets with scintillation during a storm. To these we currently add proximity to the major Hydro-Québec power grid servicing eastern North America for studies on space weather effects. There is further the potential for interhemispheric studies both on the conjugate magnetic footpoints in Antarctica at latitudes interesting for substorm studies, and along the meridian overlapping with Asia for day/night studies.
AUTUMNX was built with support from the GO Canada programme of the Canadian Space Agency, which now supports its operation.

Keywords: geomagnetism, magnetometer, data inversion, GIC, substorm, magnetic conjugacy



Application of Global Three-Dimensional Current Model for Dayside and Terminator Pi2 Pulsations

*Shun Imajo[1], Akimasa Yoshikawa[1,2], Teiji Uozumi[2], Shinichi Ohtani[3], Aoi Nakamizo[4]

1. Earth and Planetary Science, Kyushu University, 2. ICSWSE, Kyushu University, 3. APL, Johns Hopkins University, 4. AERI, NICT

We tested the magnetospheric-ionospheric current system for Pi2 magnetic pulsations on the dayside and near the terminator using a numerical model. We estimated the spatial distribution of the ground magnetic field produced by the three-dimensional magnetospheric-ionospheric current system for Pi2 consisting of field-aligned currents (FACs) localized in the nightside auroral region, the magnetospheric closure current flowing in the azimuthal direction, and horizontal ionospheric currents produced by the FACs in the electrostatic approximation. The calculated magnetic field reproduced the observational features reported by previous studies; (1) the sense of the H component is not changed over the wide local time sectors in low latitudes; (2) the amplitude of the H component on the dayside is enhanced at the equator; (3) D-component magnetic fields are reversed near the dawn and dusk terminators; (4) the meridian of the D-component phase reversal around the dusk terminator shifted more sunward than that around the dawn terminator; (5) the amplitude of the D component in the morning was larger than in the early evening. The separation of contributions to magnetic fields produced by each current part provides information on what contributes to these features. The phase reversals of the D component around dawn and dusk terminators are explained by a change in the contributing currents from the FACs on the nightside to the meridional ionospheric currents on the sunlit side of the terminator, and vice versa. The contribution of the ionospheric current on the dayside at middle-to-low latitudes is about 90%, suggesting that the spatial pattern of equivalent currents, which are magnetic field vectors rotated by 90 degrees, reflects that of ionosphere currents on the dayside. The different features between dawn and dusk regions can be attributed by the skewed dayside ionospheric current that has more intensive meridional currents in the morning than in the early evening. The model results indicated that the oscillation of the magnetospheric-ionospheric current system is a plausible explanation of Pi2 pulsations on dayside and near the terminator.

Keywords: Pi2 pulsation, magnetospheric-ionospheric current system, solar terminator, numerical model

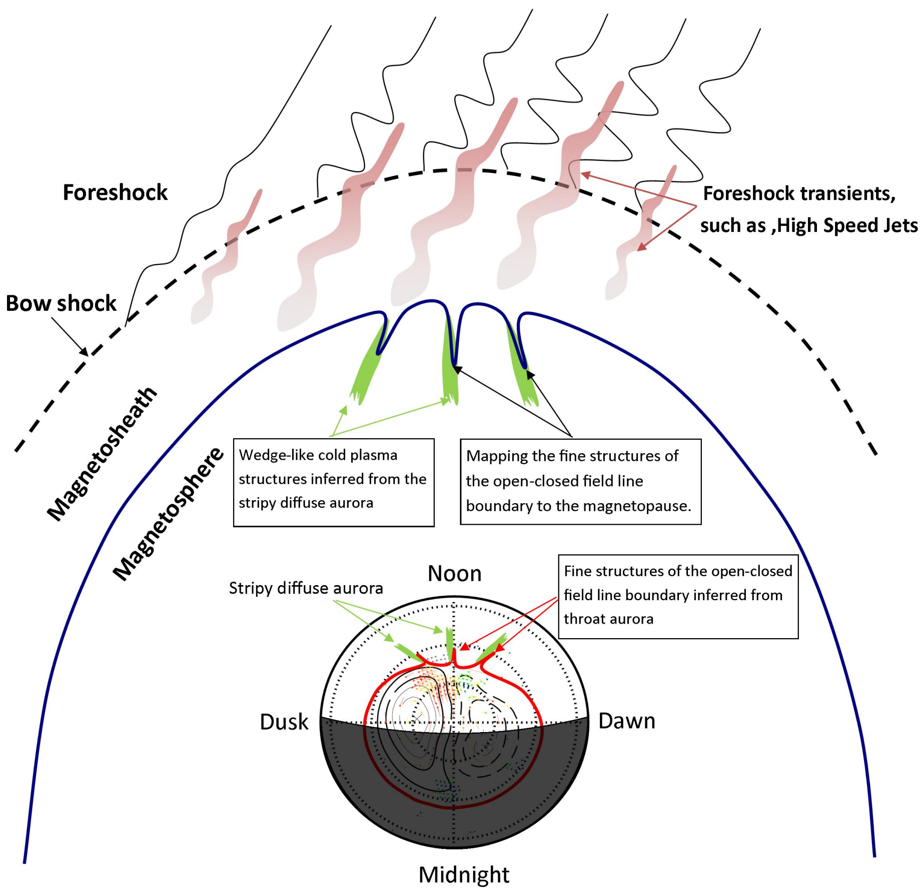
Throat aurora and the important implications on solar-wind/magnetosphere coupling

*Han Desheng[1]

1. Polar Research Institute of China

Observational properties of throat aurora are investigated in detail by using 7-year continuous auroral observations obtained at Yellow River Station (magnetic latitude 76.24°N). From our inspection, throat aurora is often observed under the condition of stripy diffuse aurora contacting with the persistent discrete auroral oval, and the long-period throat aurora observations generally consist of intermittent subsequences of throat aurora brightening followed by poleward moving auroral form (PMAF) and throat aurora dimming. We also noticed that the orientation of throat aurora is aligned along the ionospheric convection flow and its local time distribution shows clear dependence on the interplanetary magnetic field (IMF) *By* component. These observational results indicate that factors inside the magnetosphere may play important role on occurrence of throat aurora. We thus suggest that throat aurora may present the ionospheric signature of redistribution of reconnection rate on the magnetopause by cold magnetospheric plasma flowing into the reconnection site. In addition, we also found that the occurrence rate of throat aurora clearly decreases with increase of the IMF cone angle ($\arccos(|Bx|/B)$), which is very similar with the occurrence rate of high-speed jet (HSJ) observed in magnetosheath depending on the IMF cone angle. This is suggested as that the HSJs occurred outside the magnetosphere may also play important role for generation of throat aurora by triggering magnetopause reconnection or by direct impacting. Although further studies are needed to clarify how the throat auroras are generated in detail, the relevant observations about throat aurora have presented important implications on a variety open questions, such as, distribution and generation of cold plasma structures in the outer magnetosphere, magnetopause deformation, and possible relation between HSJ and reconnection.

Keywords: throat aurora, convection, ionospheric outflow, cold plasma, magnetic reconnection


Foreshock
Foreshock transients,
such as ,High Speed Jets
Bow shock
Magnetosheath
Magnetosphere
Wedge-like cold plasma structures inferred from the stripy diffuse aurora
Mapping the fine structures of the open-closed field line boundary to the magnetopause.
Stripy diffuse aurora
Noon
Fine structures of the open-closed field line boundary inferred from throat aurora
Dusk
Dawn
Midnight

East-west band poleward moving long period (T˜2-10 min) auroral pulsations

*Natsuo Sato[1,2], Akira S Yukimatu[1,2], Yoshimasa Tanaka[1,2], Tomoaki Hori,[3,4], Akira Kadokura[1,2]

1. National Institute of Polar Research, 2. SOKENDAI, 3. Institute for Space-Earth Environment Research, Nagoya University, 4. Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo

Using the ground-based all-sky imagers we examined the long period (T˜ 2-10 min) east-west band type auroral pulsations which are completely different from well-known pulsating auroras with period of ˜ 10 second. Fundamental characteristics of this type of auroral pulsations are as follows: 1) East-west band auroras extending more than 3000km in some cases, 2) Recurrently poleward moving auroral forms, 3) Recurrent periods are ˜ 2-10 min, 4) Auroral intensity enhancement, not intensity modulation, 5) Occurrence region is just poleward side of common pulsating aurora, 6) Occurrence local time is post-midnight sector, 7) Aurora luminosity is rather high, sometimes comparable to discrete auroral arcs in the evening sector. We will examine the generation characteristics and mechanisms of this type of auroral pulsations using the multi-instrument ground-based observations and also the date simultaneously observed with instruments onboard spacecraft.

Keywords: aurora, east-west band aurora, auroral pulsation, pulsating aurora, magnetosphere-ionosphere coupling, polar region

Energetic electron precipitation and auroral morphology at the substorm recovery phase

*Shin-ichiro Oyama[1], Antti Kero[2], Craig J Rodger[3], Mark A Clilverd[4], Yoshizumi Miyoshi[1], Noora Partamies[5,6], Esa Turunen[2], Tero Raita[2], Pekka T Verronen[7], Shinji Saito[1]

1. Institute for Space-Earth Environmental Research, Nagoya University, 2. University of Oulu, 3. University of Otago, 4. British Antarctic Survey, 5. The University Centre in Svalbard, 6. Birkeland Centre for Space Science, 7. Finnish Meteorological Institute

It is well known that auroral patterns at the substorm recovery phase are characterized by diffuse or patch structures with intensity pulsation. According to satellite measurements and simulation studies, the precipitating electrons associated with these aurorae can reach or exceed energies of a few hundred keV through resonant wave-particle interactions in the magnetosphere. However, because of difficulty of simultaneous measurements, the dependency of energetic electron precipitation (EEP) on auroral morphological changes in the mesoscale has not been investigated to date. In order to study this dependency, we have analyzed data from the European Incoherent Scatter (EISCAT) radar, the Kilpisjärvi Atmospheric Imaging Receiver Array (KAIRA) riometer, collocated cameras, ground-based magnetometers, the Van Allen Probe satellites, Polar Operational Environmental Satellites (POES), and the Antarctic-Arctic Radiation-belt (Dynamic) Deposition-VLF Atmospheric Research Konsortium (AARDDVARK). Here we undertake a detailed examination of two case studies. The selected two events suggest that the highest energy of EEP on those days occurred with auroral patch formation from post-midnight to dawn, coinciding with the substorm onset at local midnight. Measurements of the EISCAT radar showed ionization as low as 65 km altitude, corresponding to EEP with energies of about 500 keV.

Keywords: aurora, ionosphere, EISCAT, KAIRA, energetic electron precipitation

