Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM13-01 Room:103 Time:May 22 09:00-09:15

The ionospheric convection response to different modes of geomagnetic activity

GROCOTT, Adrian[1*]

[1]University of Leicester

The dynamics of the coupled magnetosphere-ionosphere (M-I) system are predominantly driven by reconnection between the terrestrial magnetic field and upstream interplanetary magnetic field (IMF). The nature of the M-I response to this driving depends largely on the strength and orientation of the IMF and the speed and density of the solar wind in which it is embedded. In the ionosphere, the most immediate response to a change in interplanetary conditions is usually observed on the dayside, where convection can be excited by changes in the topology of newly reconnected magnetic flux. On the nightside convection can also be excited by reconnection occurring within the magnetotail. The nature of this nightside convection is, however, greatly varied and dependent on the magnetospheric conditions under which the reconnection occurs. One process often associated with magnetotail reconnection is the substorm, which has been shown to excite strong convection in the coupled M-I system. However, recent studies have also shown that substorms occurring under different magnetospheric conditions can exhibit starkly different characteristics. In addition, reconnection occurring in the magnetotail during intervals of no substorm activity has also been shown to drive characteristic convection patterns in the ionosphere. I will discuss these different modes of magnetospheric activity and what can be learned about their underlying physics from their associated ionospheric convection signatures.

Keywords: Magnetotail, Ionosphere, Convection

PEM13-02 Room:103 Time:May 22 09:15-09:30

On the importance of the Cowling/polarization mechanism for the electrodynamics of the ionosphere and magnetosphere

AMM, Olaf[1*], FUJII, Ryoichi[2], YOSHIKAWA, Akimasa[3], Heikki Vanhamaki[1]

[1]Finnish Meteorological Institute, Helsinki, Finland., [2]Solar-Terrestrial Environmental Laboratory, Nagoya University, Nagoya, Japan., [3]Department of Earth and Planetary Sciences, Kyushu University, Fukuoka, Japan.

The mechanism of charge polarization is a basic process in electromagnetism and plasma physics. For the ionospheric physics, it is mostly known from the Cowling channel situation. However, this mechanism is not limited to the specific Cowling channel geometry in the ionosphere nor to substorm situations, but can appear at any type of situation when significant ionospheric conductance gradients are present. In this presentation, we will briefly review some theoretical foundations of the polarization mechanism and its effects on ionospheric electrodynamics in a 3-dimensional ionosphere, and present a statistical analysis that shows when situations with a high Cowling efficiency are most likely to occur. Further, we will analyse in detail an event case during a substorm interval, and from the results discuss the relative relevance of current closure via the Cowling mechanism as compared to local current closure for this case, as well as the impacts on magnetosphere-ionosphere coupling.

Keywords: ionosphere, current systems, electric field, M-I coupling, Cowling effect

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PEM13-03 Room:103 Time:May 22 09:30-10:00

Changes in the magnetotail configuration before near-Earth reconnection

SNEKVIK, Kristian[1*], TANSKANEN, Eija[1], OSTGAARD, Nikolai[2], JUUSOLA, Liisa[1], LAUNDAL, Karl Magnus[3], GORDEEV, Evgeniy[4], BORG, Anette Lauen[5]

[1]Finnish Meteorological Institute, Helsinki, Finland, [2]Department of Physics and Technology, University of Bergen, Bergen, Norway, [3]Teknova AS, Gimlemoen 19, 4639 Kristiansand, Norway, [4]St Petersburg State University, St Peterburg, Russia, [5]ESTEC/European Space Agency, Noordwijk, The Netherlands

We have examined three typical substorm growth phase signatures in the magnetotail two hours before near Earth reconnection; namely current sheet thinning, field line stretching and increase in the lobe magnetic pressure. The reconnection events were identified from in situ measurements in the plasma sheet by the Cluster spacecraft. The events were signified by high speed plasma flows, often lasting more than one hour. The list of events contains time intervals with high solar wind driving and strong intensification in the auroral westward electrojet, and other intervals with weak driving and no intensification in the electrojet. Irrespective of the amount of driving, there was usually a significant thinning of the current sheet prior to the reconnection onsets. Multi-spacecraft measurements of the magnetic field revealed that the average thinning was from 24000 to 12000 km, lasting about an hour. In those events without thinning, the current sheet was thin for an extended period before reconnection. Furthermore, the thinning happens even when there is no increase in the lobe magnetic pressure in the same time interval. The magnetotail is often stretched for a long time before reconnection onset, and reconnection seems to commence only when the current sheet is thin enough. In those events with large increase in the lobe magnetic pressure before onset, there is also significant field line stretching.

Keywords: Magnetic reconnection, Magnetospheric configuration and dynamics, Magnetotail, Plasma convection, Substorms

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PEM13-04 Room:103 Time:May 22 10:00-10:15

Whistler, Lower Hybrid and Alfvenic Wave Emission from Magnetically Reconnecting Current Layers

SYDORA, Richard[1*], FUJIMOTO, Keizo[2], Konrad Sauer[1]

[1]University of Alberta, Canada, [2]RIKEN, Japan

Analysis of whistler mode and Alfven-whistler emissions from magnetically reconnecting current layers can serve as a useful remote-sensing probe of plasma conditions in the vicinity of the electron diffusion region. Whistler waves associated with magnetic reconnection are frequently observed in the Earth magnetosphere (recent examples: Geotail and Cluster satellites; Wei et al., 2007, Eastwood et al., 2009, Le Contel, et al., 2009, etc.) and in laboratory experiments. From the observations, electron beams and electron thermal anisotropy have been identified as possible free energy sources for the whistler/electron cyclotron emission. In addition, kinetic Alfven waves have also been observed to propagate outwards from the reconnection X-line and that these waves may drive significant transport through the diffusion region (Chaston et al., 2005, 2009). Further analysis by Huang et al., 2010 using the Cluster spacecraft indicates highly oblique propagating modes consistent with the Alfven-whistler branch which seem to interpret the measurements. More recently, Khotyaintsev et al, 2011 have analyzed wave-particle interactions in the flux pile-up region of reconnection jet outflows in the magnetotail using Cluster spacecraft. Their analysis shows whistler waves and lower hybrid fluctuations and suggest they play a role in energy conversion during plasma jet breaking. In light of these observations we make comparisons with kinetic simulations. In our previous work, using 2D electromagnetic particle-in-cell model with adaptive mesh refinement in a Harris-type current sheet (Fujimoto and Sydora, Geo. Res. Lett., vol. 35, L19112 (2008)), we found that whistler modes driven by electron temperature anisotropy transiently formed in the downstream region of the electron outflow where the magnetic field is intensified due to pileup of the field lines. The maximum wave power from the unstable electromagnetic fluctuations ranged from 0.1 to 0.6 of the local electron cyclotron frequency and the quasi-parallel propagating (right-hand polarized) whistler modes were found to contribute weakly to the electron momentum transport. In this presentation we extend our previous results and analyze electron and ion beam-generated whistler fluctuations and Alfven-whistler modes in the vicinity of the outflow regions. A theoretical analysis of the maximally unstable modes and wave polarization properties are presented based on parameters consistent with Cluster spacecraft X-line encounters. We find that whistler mode fluctuations are capable of increasing the phase space density up to 2keV and higher within a second time scale and play a role in beam generation. Implications of these results to future missions, such as MMS, will also be presented along with possible laboratory experiments.

Keywords: magnetic reconnection, plasma waves, kinetic simulation, particle acceleration, energy transport

PEM13-05 Room:103 Time:May 22 10:15-10:30

Wave activity around the X-line observed in Magnetotail

SHINOHARA, Iku[1*], KOJIMA, Hirotsugu[2], NAGAI, Tsugunobu[3], FUJIMOTO, Masaki[1]

[1]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, [2]Research Institute for Sustainable Humanosphere, Kyoto University, [3]Tokyo Institute of Technology

We have examined plasma wave activity observed in the near Earth magnetotail reconnection events. Geotail encountered several reconnection sites in 20 years observation where the enhanced cross-tail electron current layer was detected in association with the simultaneous plasma flow and magnetic field reversals. The intense plasma wave activity in wide frequency range is observed in the electron-ion decoupling region around the X-line. However, surprisingly, wave intensity right in the center of the electron current layer, that is a possible X-line, is much weaker than that in its surrounding region. The observed wave power at the X-line cannot explain the anomalous resistivity sufficient to the energy dissipation for fast magnetic reconnection. The Geotail observation suggests that the magnetic diffusion region of the near Earth magnetotail reconnection site is mainly controlled by the physics of the collisionless reconnection process.

PEM13-06 Room:103 Time:May 22 10:45-11:15

Galileo observations of Jovian tail reconnection

KASAHARA, Satoshi[1*], Elena Kronberg[2], KIMURA, Tomoki[1], TAO, Chihiro[1], Sarah Badman[1]

[1]ISAS/JAXA, [2]Max Planck Institute

Magnetic reconnection in planetary magnetospheres plays important roles in energy and mass transfer in the steady state, and also possibly in transient large-scale disturbances. Our detailed case study has shown that a reconnection jet front in Jovian magnetotail was associated with the front thickness of the order of ion inertial length, sub-Alfvenic ion flow, density depletion, and particle energisation. Although these characteristics are similar to the terrestrial jet fronts, their generality in the Jovian magnetosphere has not been clarified, since the above result was based on a single event study. Therefore we examined strong north-south magnetic field events in the Jovian outer magnetosphere. Through the analyses with plasma velocity and density data, we found the clear dawn-dusk asymmetry; both northward and southward magnetic events in the dawn side show reconnection jet front signatures (tailward and sunward popagating, respectively), whereas dusk side events do not. This result suggests that the Jovian tail X-line is absent in the dusk side or located much further down tail compared to the dawn side.

Keywords: Jovian magnetosphere, tail reconnection

PEM13-07 Room:103 Time:May 22 11:15-11:30

Jovian Magnetospheric Response to Solar Wind Dynamic Pressure

KITAGAWA, Hirotaka[1*], KASAHARA, Satoshi[2], TAO, Chihiro[2], KIMURA, Tomoki[2], FUJIMOTO, Masaki[2]

[1]Department of Earth and Planetary Science, The University of Tokyo, [2]Institute of Space and Astronautical Science/ Japan Aerospace Exploration Agency

Past observations have revealed the typical structures of the Jovian magnetosphere. However, the magnetospheric response to the variable solar wind is still unclear, due to the absence of the solar wind monitor at the Jovian orbit. We approach this issue by using the calculated solar wind parameters via MHD equations whose input parameters are based on the observation at Earth's orbit. Referring the propagated solar wind parameters, we investigated the variability of the Jovian magnetotail observed by the Galileo spacecraft. Through multi-event analyses, we found that the energetic particle fluxes tend to enhance responding to the increase of the solar wind dynamic pressure. In order to understand the cause of the particle flux enhancement, we examined a particular event in detail. The pitch angle distribution of energetic protons (around 100 keV) was almost isotropic during quiet times, whereas it became more field-aligned (mono-directional, parallel or anti-parallel to the magnetic field) after the increase of the solar wind pressure. This suggests that the observed flux enhancement is consistent with the acceleration through magnetotail reconnection, rather than by the simple betatron acceleration associated with the magnetospheric compression, which is caused by the increased solar wind pressure.

Keywords: Jovian Magnetosphere, Solar Wind

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PEM13-08 Room:103 Time:May 22 11:30-11:45

Roles of the near-Earth tail in energy storage and release processes during substorms

SAITO (HASEGAWA), Miho[1*]

[1]NASA Goddard Space Flight Center

The magnetic energy in the lobe is $P_b V$, where P_b is the magnetic pressure in the lobe and V is the volume encircled by the tail current. A change in the magnetic energy as a result of energy storage and release is possible in two ways: (1) both P_b and V are changed, which is the traditional view of the growth phase of substorms and plasma sheet thinning for energy storage, and (2) only V is changed. The latter way of the energy storage and release was recently found by five-point THEMIS observations on 8 April 2009 substorm. By estimating a radial profile of the plasma pressure during the plasma sheet thinning, it can be shown that with no increase in the total pressure, the energy storage is possible by the inward penetration of the current sheet. In addition to that, this new type of the thinning can explain the formation of the near-Earth neutral line or the weak magnetic field region. Detailed analyses of this new type of thinning and extended case studies using THEMIS, Geotail and GOES were performed to understand the role of the near-Earth tail in the growth phase of substorms. It should be stressed that some of widely adapted presumptions for the near-Earth tail analysis and understanding require severe cautions. First, the assumption of one dimensional geometry or a pressure balance, i.e. negligible tension force, are not appropriate, while isotropic MHD force balance is valid. Second, spatial profiles of the magnetic field and current requires cautions: the equatorial field has a local minimum and current density is non-uniform. Finally, when the traditional thinning was observed during the growth phase, the plasma sheet evolved in a non-monotonic way. In the late growth phase, the increasing trend in the total pressure ceased and became constant in time. Overall, this study suggests that the new type of the current sheet thinning is a leading factor for the substorm onset.

Keywords: substorm, magnetotail, plasma sheet, multi-spacecraft analysis

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PEM13-09 Room:103 Time:May 22 11:45-12:00

State of the magnetotail during disturbed and calm neutral sheet crossings

TANSKANEN, Eija[1*], James A. Slavin[3], Kristian Snekvik[1], Pyry Peitso[4], Gabor Facsko[1], Harri Laakso[5], Laura Degener[1]

[1]Finnish Meteorological Institute, Helsinki, Finland, [2]University of Bergen, Department of Physics and Technology, Norway, [3]Ann Arbor University, Michigan, US, [4]Aalto University, Espoo, Finland, [5]European Space Agency, ESTEC, Netherlands

Magnetotail neutral sheet crossings were identified for the Cluster tail seasons since 2001. Neutral sheet crossings were divided to calm and disturbed crossing according to the number of neutral sheet passes during the crossing. Single neutral sheet crossings are called calm and multiple crossings are defined to be disturbed crossings. The year-to-year variation of calm and disturbed crossings are analyzed and the role of different solar wind drivers (e.g. high-speed streams and interplanetary coronal mass ejections) will be studied. The state-of-the magnetotail is analyzed during different crossings by using plasma sheet velocity, total pressure and (JxB)x. The x-component of the cross product of total current and magnetic field characterizes the stress level of the magnetotail during the crossing. Furthermore, we compare the magnetotail disturbances to the geomagnetic activity at auroral and equatorial latitudes during the neutral sheet crossings.

Keywords: Magnetotail, Neutral sheet, plasma sheet, space weather, substorms, storms

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PEM13-10 Room:103 Time:May 22 12:00-12:15

Changes in the rapid flux transport rate in magnetotail

NAKAMURA, Rumi[1*], BAUMJOHANN, Wolfgang[1], VOLWERK, Martin[1], PANOV, EVGENY[1]

[1]Space Research Institute, Austrian Academy of Sciences

A major part of the flux transport in the magnetotail is associated with transient and localized plasma flows, called bursty bulk flows or flow bursts. Occurrence of such rapid flux transport signatures has been reported to be reduced significantly Earthward of 15 Re, which has been interpreted as being due to flow braking. Recent event studies using different multi-point spacecraft constellations, however, showed that the flows can be deflected and even bounced back in the near-Earth region, suggesting that the flow braking process involves complicated evolution, which still needs to be understood. In this study we surveyed the local changes in the rapid flux transport rate obtained by Cluster multi-point observations from the midtail as well as the near-Earth region in order to discuss the evolution of the flux transport process between these two regions and how the flow braking process take places.