SM52E-08 1745h

Wave Contributions to Coupling Between the Ring Current/Plasmasphere and Subauroral Ionosphere

Louise C Gentile[1] (louise.gentile@hanscom.af.mil)

William J Burke[2] (bill.burke@hanscom.af.mil)

Evgenii V Mishin[1] (evgenii.mishin@hanscom.af.mil)

[1]Boston College, Institute for Scientific Research, Chestnut Hill, MA 02467, United States

[2]AFRL/VSBXP, 29 Randolph Rd, Hanscom AFB, MA 01731, United States

It has long been established that strong electric fields at subauroral latitudes in the post-sunset sector enable ionospheric closure of field-aligned currents generated in the stormtime ring current. Recent observations by the DMSP satellites of ∼10-km scale plasma density and electromagnetic oscillations, within the region of strong electric fields, indicate efficient M-I coupling in the ring current-plasmasphere overlap. It is demonstrated that a feedback instability may develop, analogous to that found in the auroral ionosphere. Enhanced electric fields and large-scale density troughs are the necessary conditions for the feedback to develop. Usually density troughs collocated with strong electric fields are viewed as consequences of frictional ion heating causing plasma outflow and increased rates of recombination stemming from charge exchange/transfer. This paper reports observations from DMSP satellites that are not fully described by this conventional model. During some strong subauroral wave-structure events, density troughs coincide with electron temperature enhancements, while the electric fields and ion temperatures are barely perturbed from background values. No significant ion outflows occur. Our observations suggest additional requirements for describing these subauroral dynamics. In addition to the conventional model, we account for strong electron heating in the ring current-plasmasphere overlap region. Resultant electron heat fluxes lead to the vibrational excitation of molecular nitrogen and support enhanced rates of charge exchange/transfer and recombination.

SM52F MCC: 2006 Friday 1600h

Magnetospheric Convection at Polar Latitudes *(joint with SA, AE)*

Presiding: **L Andersson,** Laboratory for Atmospheric and Space Physics, University of Colorado**; M W Dunlop,** Rutherford Appleton Laboratory

SM52F-01 1600h

Cusp Structures and the Location of the Reconnection Site

Karlheinz J Trattner[1] (650 424 2445; trattner@mail.spasci.com)

Stephen A. Fuselier[1] (650 424 3334; fuselier@mail.spasci.com)

Steve M. Petrinec[1] (650 354 5562; petrinec@mail.spasci.com)

[1]Lockheed Martin ATC, 3251 Hanover Str., L9-42, B255, Palo Alto, CA 94304-1191, United States

Ground-based observations (SuperDARN) together with multi-spacecraft observations (Polar, FAST, Interball and the Cluster satellites) reveal that structures observed in the cusp are both temporal and spatial phenomenon. While temporal cusp structures maybe the result of variations in the reconnection rate at the magnetopause, spatial cusp structures are thought to be due to spatially separated flux tubes emenating from multiple reconnection regions at the magnetopause. In this study we analyze a double cusp structure observed by the Cluster satellites. The analysis of the double cusp together with ionospheric convection information by the SuperDARN radar arrays show that these structures are associated with different convection cells, consistent with a spatial phenomenon. The distance to the reconnection line for both structures was calculated using the proven method of 3D cuts of the Cluster proton distribution function in the cusp to identify the low energy cutoffs of precipitating and mirrored ion populations. The calculated distance to the reconnection line is determined by tracing along the geomagnetic field to the reconnection site, where the draped IMF is used to estimate the magnetic field shear angle across the magnetopause. We find that double cusp precipitation originates in the anti-parallel reconnection regions in the northern and southern hemispheres, confirming the multiple reconnection line scenario.

SM52F-02 1615h

Semi-Global SuperDARN–Magnetometer Determinations of the Ionospheric Hall Conductance

Simon G Shepherd[1] (603.646.0096; simon.shepherd@dartmouth.edu)

David L Murr[1] (david.murr@dartmouth.edu)

[1]Thayer School of Engineering, Dartmouth College, 8000 Cummings Hall, Hanover, NH 03755, United States

The conductivity of the ionosphere plays a vitally important role in the electrodynamic coupling between the magnetosphere and ionosphere. The primary mode of coupling between these two regions is through field-aligned currents, which depend on spatial gradients in the conductivity. Despite its importance, values of ionospheric conductivity are not readily available, due mostly to the difficulty in measuring it, particularly over widespread regions. No technique exists to directly measure the conductivity over large regions of the high-latitude ionosphere. Using combined SuperDARN measurements of the ionospheric electric field and magnetometer measurements of the ground magnetic perturbation, it is possible to infer the height-integrated Hall conductivity (Hall conductance) in the localized region of the measurements. By using the extended nature of the SuperDARN and magnetometer networks it is possible to make localized inferences of the Hall conductance over a widespread region. Several periods with collocated measurements extending over many hours of local time are analyzed to determine the Hall conductance for varying geomagnetic conditions. The results are compared to other techniques and models commonly used to infer this quantity.

SM52F-03 1630h

The Effects of High Frequency ULF Wave Activity on the Spectral Characteristics of Coherent HF Radar Returns

Darren M Wright[1] (+44-116-252-3568; darren.wright@ion.le.ac.uk)

Timothy K Yeoman[1] (+44-116-252-3564; tim.yeoman@ion.le.ac.uk)

Emma E Woodfield[2]

[1]Department of Physics and Astronomy, University of Leicester, Leicester LE1 7RH, United Kingdom

[2]NCAR, P.O. Box 3000, Boulder, CO 80307-3000, United States

It is now a common practice to employ ground-based radars in order to distinguish between those regions of the Earth's upper atmosphere which are magnetically conjugate to open and closed field lines. Radar returns from ionospheric irregularities inside the polar cap and cusp regions generally exhibit large spectral widths in contrast to those which exist on closed field lines at lower latitudes. It has been suggested that the so-called Spectral Width Boundary (SWB) might act as a proxy for the open-closed field line boundary (OCFLB), which would then be an invaluable tool for investigating reconnection rates in the magnetosphere. The exact cause of the increased spectral widths observed at very high latitudes is still subject to considerable debate. Several mechanisms have been proposed. This paper compares a dusk-sector interval of coherent HF radar data with measurements made by an induction coil magnetometer located at Tromso, Norway (66° N geomagnetic). On this occasion, a series of transient regions of radar backscatter exhibiting large spectral widths are accompanied by increases in spectral power of ULF waves in the Pc1-2 frequency band. These observations would then, seem to support the possibility that high frequency magnetospheric wave activity at least contribute to the observed spectral characteristics and that such wave activity might play a significant role in the cusp and polar cap ionospheres.

SM52F-04 1645h

Determining the Relative Importance of Ionospheric Parameters to Ion Upwelling using Multivariate Analysis

Karen J Remick (907 474-7578; ftkjr@uaf.edu)

Geophysical Institute, PO Box 757320, Fairbanks, AK 99775, United States

The O+ content in the magnetospheric plasma sheet varies highly with magnetic activity. Because of the mass difference between H+ and O+, the plasma parameters that determine the behavior of the plasma in the magnetosphere, will also be highly variable. This O+ can only come from the earth's ionosphere. In order for the O+ to reach the magnetosphere from the ionosphere it must undergo heating in 2 different regimes: first bulk upwelling in the ionosphere, then filamentary heating at altitudes close to the auroral acceleration region. While H+ ions are light enough to easily boil off, O+ ions reside lower in the ionosphere and need to over come gravity and make it through the charge exchange region located at 800 Km. This study uses incoherent scatter radar and multivariate statistical analysis to look at the first step; the bulk upwelling in the ionosphere. It uses field-aligned data from 3 radar facilities to look at the 400-800 km altitude region, and multivariate analysis to determine the ionospheric parameters most associated with variation in upward ion flux. There are a whole zoo of mechanisms that could be responsible for the upwelling ions, each with their own effects on the ionospheric parameters. By determining which parameters are associated with upward ion flux, we can narrow down which mechanisms are dominant in each region. This is an important step in understanding both the mechanics of the ionosphere, and the ionospheric input into the magnetosphere.

SM52F-05 1700h

Magnetospheric Compression Signatures of Traveling Convection Vortex Events

Therese Moretto[1] (301-286-2574; tmoretto@lepvax.gsfc.nasa.gov)

David G Sibeck[1] (301-286-5998; David.G.Sibeck@nasa.gov)

[1]NASA Goddard Space Flight Center, Code 696, Greenbelt, MD 10771, United States

Most dayside, high-latitude ionospheric traveling convection vortices (TCVs), as observed in ground based magnetometer measurements, are accompanied by variations in the magnetic field strength at geosynchronous orbit. Similar compressional signatures in Equatorial ground-based magnetic observations have also been reported for many cases. A comprehensive understanding of these signatures and their relation to the TCV events, however, is still lacking. We present here the results of a systematic analysis of these relationships. The geosynchronous and low-latitude ground-based magnetic signatures for more than 40 TCV events identified in the Greenland and MACCS magnetometer data during 1998 have been analyzed. The results are compared to theoretical predictions for the relationships based on field aligned current generation by propagating localized compressions at the magnetopause. Further, the upstream solar wind conditions for the events are analyzed and interpreted in terms of predictions for occurrence, propagation direction and speed of magnetopause oscillations.

SM52F-06 1715h

MHD Simulations of SIs observed by Polar

Galen J Fowler[1] (310-206-1208; gfowler@igpp.ucla.edu)

Chris T Russell[1] (310-825-3188; ctrussell@igpp.ucla.edu)

Joachim Raeder[2] (603-862-3412; J.Raeder@unh.edu)

[1]UCLA - IGPP, 3845 Slichter Hall, Los Angeles, CA 90095, United States

[2]UNH - Dept. of Physics & Space Science Center, 245G Morse Hall 39 College Rd., Durham, NH 03824, United States

We use the UCLA MHD Geospace General Circulation Model (GGCM) to simulate Sudden Impulses (SI) observed by the Magnetic Field Experiment (MFE) onboard Polar. SI's are observable on the surface of the Earth as abrupt changes in the magnetic field magnitude caused by thin solar wind discontinuities across which the solar wind dynamic pressure abruptly and significantly increases. They compress the magnetosphere as they move past the Earth. The empirical T89 and T96 models developed by N. Tsyganenko can be used to predict the steady state changes in field magnitude but an MHD model can also resolve the temporal evolution of the SI signal. Since the rise time of an SI is used to determine the distance a shock travels along the length of the magnetosphere the MHD model is more useful for predicting such an occurrence. By varying the speed of a shock, and other solar wind parameters, we investigate the respective effect that various parameters have on the rise time and magnitude of an SI.

SM52F-07 1730h

The Magnetospheric Convection System in the Sudden Impulse

Shigeru Fujita[1] (x81-4-7144-7185; sfujita@mc-jma.ac.jp)

Takashi Tanaka[2] (tatanaka@geo.kyushu-u.ac.jp)

Takashi Kikuchi[3] (kikuchi@crl.go.jp)

[1] Meteorological College, Asahi 7-4-81, Kashiwa 277-0852, Japan

[2] Department of Earth and Planetary Sciences, Kyushu University, 6-10-1, Hakozaki, Higashi-ku,, Fukuoka 812-8581, Japan

[3] Communications Research Laboratory, Nukui-Kita machi, Koganei 184-8795, Japan

We investigate numerically simulated disturbances of plasma convection in the magnetosphere-ionosphere system during a geomagnetic sudden commencement (SC) interval. The disturbance is excited by the solar wind density impulse impinging on the dayside magnetopause. Before the impulse arrives at the magnetopause, the magnetospheric convection essentially exhibits steady plasma shear motion that induces the field-aligned current. It is also noted that the magnetospheric current is the diamagnetic current that flows along the equi-contour lines of pressures. Divergence and convergence of the magnetospheric current is associated with the field-aligned current. It is noteworthy that the magnetospheric convection and current is connected self-consistently with the ionospheric convection and current through the field-aligned current in the stationary state. In the first stage of the SC, the compressional plasma disturbance is dominant in the dayside magnetosphere. On the other hand, the compressional disturbance does not arrive at the ionosphere because the ionospheric disturbance is essentially incompressible. This compressional disturbance appears in the first 3 - 4 min. of the SC interval. The ionospheric convection pattern is not corresponding to the magnetospheric convection pattern in this stage. After the compressional disturbance disappears, the magnetospheric convection flow exhibits a shear-like pattern. The ionospheric convection becomes consistent with the magnetospheric convection in the second stage. However, there appears a peculiar transient convection system in the nightside magnetosphere. This convection, driven by compression of the magnetospheric flank when the solar wind impulse is passing the flank, is moving to midnight magnetosphere. When the convection arrives at the midnight, it disappears. In the final stage of the SC when the transient convection disappears, a new steady convection in the magnetosphere-ionosphere system is established. This convection corresponds to the new condition of the solar wind after the impulse.

SM52F-08 1745h

Transmission of the convection electric field to the inner magnetosphere

Takashi Kikuchi (81-42-327-7526; kikuchi@crl.go.jp)

Communications Research Laboratory, 4-2-1, Nukui-kitamachi, Koganei, Tok 184-8795, Japan

Low latitude magnetometer observations revealed that the partial ring current started to develop within several minutes after the onset of growth of the polar cap potential (PCP), and decayed simultaneously with the decrease in the PCP (Hashimoto, Kikuchi and Ebihara., JGR 2002). The magnetometer observations also indicated that the DP2 ionospheric currents were driven by the convection electric field at mid latitudes as well as at high latitudes. These observational facts suggest that the ionospheric electric field plays a crucial role in driving the convection in the inner magnetosphere. A probable model for the electric field transmission should explain both the convection in the inner magnetosphere and the ionospheric currents at mid latitudes. The instantaneous transmission of the ionospheric electric field and currents from the polar ionosphere to the equator was explained by Kikuchi and Araki (JATP 1979) based on the TM0 mode in the Earth-ionosphere waveguide. In this paper, we attempt to explain the transmission of the convection electric field to the inner magnetosphere by applying the Earth-ionosphere waveguide. However, two issues remained unresolved in the paper by Kikuchi and Araki (1979). One is the excitation of the TM0 mode in the Earth-ionosphere waveguide, and the other is the attenuation under the nighttime ionospheric condition. To examine the excitation of the TM0 mode, we couple the Earth-ionosphere waveguide (transmission line) with a magnetospheric transmission line composed of a pair of field-aligned currents (e.g., R1 FACs). A fraction of the electromagnetic energy carried from the magnetosphere is transmitted into the Earth-ionosphere waveguide, although substantial energy is dissipated in the polar ionosphere intervening between the two transmission lines. The transmitted electromagnetic energy excites the TM0 mode in the Earth-ionosphere waveguide. We then evaluate the attenuation of the TM0 mode by calculating upward flow of energy from the waveguide into the conducting ionosphere and the magnetosphere. It is shown that the attenuation of the TM0 mode is not significant even for the nighttime condition, when compared to the geometrical attenuation due to the finite size of the polar electric field. Furthermore, it is shown that the ionospheric electric field carried by the TM0 mode is transmitted by Alfven waves upward into the inner magnetosphere along the magnetic field lines, supplying energy for the convection in the inner magnetosphere. It should be stressed that the ionosphere never creates electromagnetic energy but acts as a transmission line for the convection electric field. We conclude that the Earth-ionosphere waveguide connected with the magnetospheric transmission line explains both the instantaneous propagation of the electric field and currents in the ionosphere and of the convection electric field into the inner magnetosphere.