ionospheric altitudes. In the present study we expand on the previous work by moving the inner simulation boundary inward to 2 Re. The achieved increase in spatial resolution of the simulation grid results in a dramatically improved agreement of the simulated Region-1 currents with the observations. Moreover, the high-resolution MHD simulations lead to a better representation of the observed dayside Region-2 current system. However, the Region-2 currents show expectedly larger differences since ring current drift physics necessary to drive these currents in the magnetosphere is not implemented in the MHD evaluations. DMSP particle source identifications are used to compare source regions in the observed FAC maps with those in the MHD simulations.

SM72C-02 1345h

Observed relationship between rayed aurora and intense ion upflows near the polar cap boundary

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Ion outflow is truly a cross-scale phenomenon, where localized energy conversion in the ionosphere can have a fundamental impact the global magnetosphere. The morphology of outflowing ion distributions has been well characterized by satellites, but the physical coupling to the ionospheric source remains speculative. We have amassed a 12 year database of measurements made by the Sondrestrom incoherent scatter radar (ISR) from which we will characterized the morphology of ion outflows in detail from an ionospheric perspective. Because of its high latitude, Sondrestrom is primarily within the cusp, within the polar cap, or near the polar cap boundary - regions where the most significant ion outflows occur. The radar database is enhanced by the comprehensive set of permanent optical diagnostics at Sondrestrom, thus providing a window into the relationship between magnetospheric forcing and ionospheric response that is singular among ISR facilities.

The initial focus of this study has been on intense upflow events (Vi>500 m/s, flux>5e7/cm^{2}s at 700km) occurring when all-sky spectral imaging was available. Initial results suggest that ion upflows at the polar cap boundary are associated with soft (<100 eV) auroral rays. Prior analysis of such aurora has revealed an anomalously high altitude of the forbidden O^+(732nm) emission line (>500km) [Semeter, GRL 2002, in press]. This feature may be produced by the vertical transport of aurorally produced $O^+(^2P)$. If confirmed, this could lead to an optical diagnostic for ion outflow.

URL: http://isr.sri.com

SM72C-03 1400h

April 2000 storm: Energy transfer and dissipation in MHD

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We investigate both energy transfer and dissipation in a global MHD simulation. We have simulated a major magnetospheric storm that occurred on April 6, 2000, during which the Dst index reached almost -300 nT. For the energy transfer calculation, we first identify the magnetopause surface from the simulation results, after which we calculate the total energy flux incident to the surface. With this method we identify the locations on the magnetopause surface, where the energy transfer takes place and investigate the energy transfer location dependence on the solar wind parameters as well as the dependence of the total transferred energy on the empirical epsilon parameter. Furthermore, we calculate the Joule heating power and the precipitation power in the ionosphere, and determine the locations where the most significant ionospheric dissipation takes place. We find that during the main phase the energy is transferred in the plane of the IMF clock angle, and is dissipated mainly in the dayside ionosphere. Furthermore, we develop a relationship between the ionospheric dissipation power and solar wind parameters using similarity scaling laws. We discuss the implications of the found high correlation results both on magnetospheric dynamics and MHD simulation representation of the dynamics.

SM72C-04 1415h

Akebono satellite observations of Dispersive Alfven waves and the ionospheric Alfven resonator in the cusp region

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In the cusp region at altitudes of a few thousands of km, burst-like fluctuations of electric and magnetic fields are often observed in the ULF range of 0.2-5 Hz on the Akebono satellite. We have found that these bursts occasionally have clear harmonic structures in small-scale upward field-aligned current regions. The Alfven resonator between the bottom of the Auroral acceleration region and the ionospheric E layer is one of the candidates of these harmonic structures. The model of Lysak et al. [1991] calculated the phase shifts of electric and magnetic field as a function of frequency using the ionospheric Alfven resonator model. Grzesiak. [2001] succeeded in demonstrating that satellite measurements coincide with the model given by Lysak. Pilipenko et al. [2001] investigated the resonance condition of dispersive Alfven wave between the bottom of the auroral acceleration and the E layer.

Based on these previous results, we compared electric and magnetic field data obtained by the Akebono satellite with the Lysak model, using the cross-wavelet analysis method. Further, considering that small-scale upward and downward field-aligned currents would be produced by dispersive Alfven waves, we compared the measured ratios of electric and magnetic field with the resonance condition of dispersive Alfven waves.

SM72C-05 1430h

Ion Acceleration in Alfven Waves Above the Aurora From FAST

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In this presentation we examine the ion heating process that occurs in Alfven waves above the auroral oval from FAST. Observations show that outflowing fluxes of energized ionospheric ions as large as 10^{10} cm^{-2} s^{-1} are observed in conjunction with intervals of Alfvenic fluctuations in fields quantities at frequencies in the spacecraft frame up to the ion gyrofrequency. These ions may represent a significant portion of the density of ionospheric ions in the plasma sheet. Through the use of simulations and observations we show that this heating/acceleration process may be closely related to the process of electron acceleration in the observed Alfven waves and the subsequent feedback response of the ionosphere.

SM72C-06 1445h

Observations from the Polar and Cluster Spacecraft of the Structure and Dynamics of Strong Poynting Flux in the Plasma Sheet During Periods of Strong Magnetic Activity

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This paper presents observations from the Polar and Cluster spacecraft of wave and steady state Poynting flux in the plasma sheet at radial distances of about 9 and 18 Re when both spacecraft were with in several hours of the same magnetic local time position on the night side during magnetically disturbed intervals. The data indicates that strong Poynting flux is associated with passage of the outer boundary of the plasma sheet over the spacecraft, the the Poynting flux is directed predominately Earthward along the magnetic field line, and that Poynting flux magnitudes at Polar locations (9 Re) are larger than at Cluster (18 Re) but scale with the magnitude of the magnetic field strength. The last observation suggests that parallel Poynting flux maps along magnetic field lines inversely as the cross section area of the flux tube. Cluster inter-spacecraft timing indicates that layers of strong wave Poynting flux exist over typical scale sizes 1-2 Re (with plasma sheet normal velocities of 10-100 km/s and durations of Poynting Flux of 2 minutes). This spatial scale implies the region of strong wave Poynting flux observed by Cluster, when mapped along magnetic field lines to altitudes of 100 km in the auroral ionosphere, has typical scale sizes of 1-3 degrees in latitude with amplitudes of 10-50 mW/m . Instances of strong steady state parallel Poynting flux at distances of 9 Re will also be presented. These observatons strongly suggest that Poynting flux can be a major mechanism for transferring energy along plasma sheet field lines and powering low altitude acceleration processes. Comparisons to the kinetic energy flux in ion beams will also be presented. A survey of auroral images from the Polar UVI and VIS instruments and the WIC imager on the IMAGE spacecraft indicates the existence of strong Poynting flux in the tail near radial distances of 9 Re in the PSBL is often associated with the formation and dynamics of intense auroral structures at the pole ward boundary of the auroral oval.

SM72D MCC: 105 Sunday 1530h

Aurora and Auroral Processes I *(joint with SA)*

Presiding: **P T Newell,** Applied Physics Laboratory**; K A Lynch,** Dartmouth College

SM

SM72D-01 1530h

The Distribution of Auroral Power Increases and Decreases

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The auroral substorm was originally identified as a large increase in auroral power. There does not seem to be any investigation of just how large a power increase is needed to identify a substorm. It is not clear

whether auroral brightenings and fadings form a continuous spectrum, or even whether large decreases in auroral power likewise occur over a short time scale (which could be considered a negative, or inverse substorm). We used Polar UVI images of global auroral power to investigate these and related questions. Specifically we considered the distribution of dP/dt and (dP/dt)/P, that is, the distribution of absolute and relative changes in auroral power. At small values of —dP/dt—, negative changes are much more frequent than positive changes. In fact, a small negative change in auroral power is by far the most common type of change. Hence the typical behavior of the aurora is a slow decline in power from one image to the next. Large magnitude changes are rare, but turn out to be almost exclusively positive (i.e., inverse substorms do not exist). Beyond about 0.2%/s relative change in auroral power (amount to a 20% change over 100 s), only positive events occur, within the measureable noise levels. However no clear boundary exists which divides substorms from other types of auroral boundaries: the spectrum of large positive changes in auroral power is continuous, without any apparent inflection point.

SM72D-02 1545h

Multipoint Magnetic and Electric Field Measurements in the Auroral Ionosphere

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In this study, we examine magnetic and electric field data taken from the NASA SIERRA multiple-payload rocket mission, which flew into a 100 nT auroral substorm at altitudes up to 735 km over the Poker Flat Research Range in Alaska on January 14, 2002. The SIERRA experiment was composed of three payloads synchronized with GPS and employing a new COWBOYS (COrnell Wire BOom Yo-yo System) electric field boom configuration. First we give an overview of the deployment, rough attitude, and geometry of our three-spacecraft system. We then show that the magnetic variations found on all three spacecraft magnetometers is consistent and that a field-aligned current interpretation of the magnetic variations is believable. The measured magnetic field gradients are shown to be correlated with precipitating electrons in typical inverted-V structures. Using accurate GPS positioning and timing and the magnetometer data from these multipoint observations, we infer current densities, assuming a static interpretation. We also examine the magnetic field variations for the presence of Alfvénic activity. Future work will be enabled once a full attitude solution is obtained for all three payloads, permitting the calculation of $\nabla \times B$ and the DC-electric fields.

URL: http://sierra.ece.cornell.edu/

SM72D-03 1600h

Auroral Precipitation and Quasi-Trapped electrons

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The visual auroral takes on a bewildering variety of forms ranging from the discrete, highly structured to the diffuse glow. There is a similarly large variety of electron distribution functions associated with aurora precipitation ranging from the field-aligned monoenergetic to the broad spectrum, nearly isotropic. An enormous conceptual simplification can be obtained by assuming that auroral electrons are accelerated as spatially narrow, field-aligned beams, which are immediately scattered. The scattering leaves the bulk of electrons in quasi-trapped orbits. The trapped electrons are subject to a rapid pitch-angle scattering process that maintains pitch-angle isotropy and continued auroral luminosity after the acceleration event has passed. Gradient and curvature drift of electrons acts to spatially diffuse the forms.

A radiation transport code is used to test this hypothesis. Auroral imagery from the Polar Satellite is used to define an initial radiation distribution, assuming pitch angle isotropy. The radiation transport code, is used to compute subsequent precipitation patterns, due to rapid pitch angle diffusion between a prescribed set of altitudes. These precipitation patterns can be compared with subsequent Polar images. It is found for a particular isolated substorm event that the luminosity decay time of about a half hour can be accounted for with the radiation transport code, assuming rapid pitch angle scattering occurs between the altitudes of 6,000 and 30,000 km. Eventually, the trapped electron population will fall to the point that it will no longer sustain the instability responsible for rapid pitch-angle diffusion. This will leave a residual population more permanently trapped. The role of the aurora in replenishing the radiation belts will be discussed.

SM72D-04 1615h

Electron distributions produced by kinetic Alfven waves on auroral field lines

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A non-local kinetic theory has been developed to describe the interaction between electrons and Alfvn waves on auroral field lines, including the mirroring of electrons by the dipole magnetic field. Calculations of the relative wave power converted to particle acceleration have been performed. For the model density profile considered, the peak power dissipated occurs for a plasma sheet temperature of 1 keV, a frequency of 0.2 Hz, and a perpendicular wavelength of about 10 km. At frequencies above 0.1 Hz, the power dissipated has a sensitive dependence on the frequency due to the effect of the ionospheric Alfven resonator. At lower frequencies, the wave reflects from the region of large parallel electric field, and so the ionospheric conductivity does not affect the results. The variations in the electron distributions will be considered, with emphasis on the energy flux of electrons precipitating into the ionosphere. The effective current-voltage relation as a function of the frequency of the Alfven waves will be determined.

SM72D-05 1630h

Cluster Observations of Banded fine Structure in AKR Burst Emission

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We have detected banded fine structure in dynamic spectra of auroral kilometric radiation (AKR) from the WBD instrument on multiple Cluster spacecraft. The banded structure consists of periodic amplitude modulation of AKR burst emission with a frequency separation close to the local proton cyclotron frequency. We have analyzed ten examples of this fine structure in the 250-262 KHz and 500-512 KHz frequency bands. The modulated AKR bursts were received on multiple Cluster spacecraft during six epochs from 20 June to 27 July 2002. The banded structure is similar to that reported by Grabbe (1982) from ISEE-1 observations, but detailed measurements of the frequency spacing show that it is systematically lower than the local proton cyclotron frequency by 5-20% at 250 KHz and 20-40% at 500 KHz. This systematic difference appears to rule out the three-wave model proposed by Grabbe. We discuss an possible alternative mechanism in which the banded structure is caused by a diffracting screen located above the AKR region.

URL: http://phobos.physics.uiowa.edu/rlm/research/

SM72D-06 1645h

Enhanced Auroral Proton and Electron Precipitation Immediately Following Rapid Magnetopause Compressions

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Sudden increases in the solar wind dynamic pressure compress the magnetopuase, leading to significantly enhanced Chapman-Ferraro currents, and a corresponding increase in the magnetic field strength throughout most of the magnetosphere. This is the dominant magnetic effect during the initial phase of storms, particularly so when the IMF is northward at the time of the solar wind dynamic pressure increase. At least four times during the past decade, a sudden, significant step in solar wind pressure occurred when the viewing conditions at Gillam (Canada) were good enough to allow for observations of the proton aurora, and the CANOPUS Gillam Meridian Scanning Photometer was operating. In each case, a virtually instantaneous increase in the proton auroral brightness occurred simultaneously with the ground magnetic signature of the dynamic pressure increase. Here, we focus on one of these three events, for which there is excellent supporting in situ and ground-based observations. Based on FAST satellite transits of the auroral oval before and after the pressure step, it is clear that the enhanced proton auroral intensity results from adiabatic energization, and not an increased effectiveness of the pitch angle scattering process that causes the precipitation. The sudden step in dynamic pressure leads to a sudden change in the magnetospheric topology. This change is communicated to the ionosphere by a transient Alfven wave, the passage of which is clearly detected by the magnetic and electric field instruments on Polar. This Alfven wave causes a brief burst of electron precipitation that results in a transient (3 min.) enhancement of the electron aurora. This "shock aurora" was recorded by the CANOPUS All-Sky Imager and MSP at Gillam. Events such as this provide us with an excellent opportunity to quantify one way that the solar wind provides energy to the magnetosphere, and to elucidate some important aspects of auroral electron acceleration, and auroral proton pitch angle scattering.

SM11A MCC: 134 Monday 0830h

Nicolet Lecture *(joint with SA, SH)*

Presiding: **D N Baker,** University of Colorado, Boulder

SM11A-01 0830h INVITED

Aeronomy: From Exploration to Data Assimilation

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Please see paper number SA11A-01 for abstract.