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The large shock of 24 March 1991 rapidly created a new radiation belt in the slot region consisting of electrons and protons with energies of tens of MeV. Remnants of this injection persisted for years. This event took the community by surprise and led to a search for others. Since that time smaller injections were seen with sensors aboard SAMPEX, Polar, and 1997-068 (HEO orbit) that also were associated with the presence of energetic solar particles and a shock striking the magnetosphere. However a long-lasting ion injection, persisting for over a year, was not observed until 6 and 24 November 2001. Trapped ions as heavy as Fe were seen. It appears that in order for an ion injection to persist for a long time, the injection must be inside of L = 2.5. Outside, loss processes including a breakdown of adiabatic motion seem to prevent long life. A key question is: What are the characteristics of the shock and perhaps the source population that leads to a deep injection? We have examined the records of the 210 Magnetometer Chain, that stretch back to before the March 1991 event, to look for features in the magnetometer records of SSCs, such as amplitude, rise-time, and frequency content, that might determine the geoeffectiveness of a shock for creating a long-lasting, new belt of radiation.

SM41D-04 1105h

The Role of Post-shock Streams and Sheath Regions in Driving Magnetospheric Activity

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Post-shock streams and sheath regions are efficient drivers of magnetic disturbances in the Earth's magnetosphere. Characteristics for these structures are high solar wind dynamic pressure and fluctuations in the solar wind electric field. We present statistics indicating that post-shock streams and sheath regions caused almost the half of intense magnetic storms (Dst < -100 nT) during the six-year interval 1997-2002, covering rising, maximum and early declining phases of solar cycle 23. For example the third largest storm of the present solar cycle (determined by the Dst index), that took place on Apr 6-7, 2000, was caused by a sheath region whereas the magnetic cloud appears to have missed the Earth almost entirely. Apart from causing a substantial fraction of large Dst storms, post-shock streams and sheath regions seem to drive more strongly the high-latitude activity than magnetic clouds. We compare in more detail the evolution of two intense magnetic storm periods: One event, Apr 17-18, 2001, was caused by sheath region fields and the other, Apr 21-22, 2001, was driven by a magnetic cloud. We have investigated the geomagnetic response using various magnetic indices. The different behavior of the indices during these two storms suggests the different response of magnetospheric current systems at low and high-latitudes.

SM41D-05 1120h

Increased geoeffectiveness of high solar wind dynamic pressure fronts under southward IMF orientation

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It is well known that a persistent southward IMF produces increased geomagnetic activity. We have found that southward IMF conditions combined with high solar wind dynamic pressure lead to an even greater coupling between the solar wind and the terrestrial magnetosphere, dramatically increasing the geoeffectiveness of solar wind dynamic pressure events on the Earth. We illustrate this with satellite and ground measurements of various magnetospheric parameters during solar wind pressure front events occurring under steady southward IMF conditions. We show the effect of pressure enhancements on the auroral oval size and precipitation, ionospheric convection, and field-aligned and ionospheric currents. We find an increase in auroral precipitation and a dramatic poleward expansion of the oval and closing of the polar cap at all MLTs following the arrival of a pressure front. A simultaneous enhancement of ionospheric convection all over the polar cap leads to a further increase of an already high cross-polar-cap potential, despite the fact that the magnetosphere is compressed, revealing a substantial increase in the coupling of the solar wind electric field to the Earth's magnetosphere under the high-pressure environment. Finally, an intensification of both field-aligned and ionospheric currents is observed over a wide range of MLTs during the high pressure regime, pointing to increased magnetosphere-ionosphere coupling. This global magnetospheric response to solar wind dynamic pressure enhancements under southward IMF is compared with the weaker response under near-zero IMF B_z prior to the pressure front impact.

SM41D-06 1135h

EFFECTS OF THE SOLAR WIND AND IONOSPHERIC CONDUCTANCE ON THE TRANSPOLAR POTENTIAL AND MAGNETOSHEATH FLOW: GLOBAL MHD MODELING

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The behavior of the magnetosphere-ionosphere system under the influence of a strong solar wind electric field is studied using global MHD simulations. The simulations indicate the saturation of the transpolar potential for high values of IEF. However, the saturation level is strongly affected by the level of ionospheric conductance. A mechanism of the ionospheric conductance feedback on the magnetosheath flow is presented. The mechanism describes a chain of events from the ionosphere to the magnetopause and to the magnetosheath and shows that the dayside reconnection potential, and consequently the transpolar potential, are determined by the interplay between the ionospheric conductance, magnetopause shape, magnetosheath flow and bow shock stand off distance. Effects of the solar wind dynamic pressure are discussed along with the effect of the ionospheric conductance, and the latter is shown to be dominant.

SM41D-07 1150h

Probabilistic Forecasting of Geomagnetic Indices Using Solar Wind "Air Mass" Analysis

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Measurements of the sun's photospheric magnetic field can in principle be used to predict geomagnetic activity one to three days in advance. The accuracy of such predictions is low, however, because they do not include the north-south component of the interplanetary magnetic field (IMF Bz), which is the most geomagnetically relevant parameter. Aside from that carried by large-scale transients, IMF Bz is mainly a product of small-scale, in-transit turbulence and, so, is inherently unpredictable from solar measurements. Routine one-to-three day forecasts of geomagnetic activity based on deterministic algorithms are, therefore, not possible. Probabilistic forecasts offer the next best thing to deterministic forecasts, and air-mass climatology offers a way to develop the advantages inherent in probabilistic forecasts for space weather applications. Here we address the IMF Bz indeterminacy problem (or better, get around it) by applying the concept of air mass climatology to the solar wind. We give criteria and statistics for solar wind air masses, which provide poof of concept for routine, mid-range (one to three day) probabilistic air-mass forecasts of daily levels of geomagnetic activity.

SM41D-08 1205h

Storm-time Energetic O+ Flux Variations in the Ring Current and the Plasmasheet: A Study of the April 2002 Storm Event

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The development of the ring current during intense magnetospheric storms is often discussed in terms of the energization of single-charged oxygen ions. Although it is generally accepted that the ionosphere is the ultimate source of such O+ ions, it still remains to be understood where and how they are accelerated in the magnetosphere. The present study examines global changes of oxygen ENA fluxes measured by the IMAGE/HENA instrument. A focus is placed on a storm event that took place in April 2002. When the IMAGE satellite was at vantage points during this storm event, it occasionally observed the oxygen ENA flux to increase globally within 10 min or less in the ring current region. This timescale is too short for those O+ ions to be transported from the plasmasheet. In situ measurements of magnetic field and energetic particle fluxes at geosynchronous orbit reveal simultaneous occurrence of dipolarization and particle injection. The Geotail satellite, which was located in the post-midnight magnetotail, also observed an increase of the O+/H+ ratio in the energy density in association with substorm activity. The present result indicates that the substorm-associated local acceleration is crucial for the energization of the ring-current O+ ions at storm time.

SM42A MCC: Level 1 Thursday 1330h

Is a New Lexicon Required for High-Latitude Field-Aligned Current Systems? I Posters *(joint with SA, AE)*

Presiding: **N Ostgaard,** Space Sciences Laboratory, University of California, Berkeley**; J W Gjerloev,** NASA Goddard Space Flight Center

SM42A-0590 1330h INVITED POSTER

IMF-Dependent Maps of High-Latitude Field-Aligned Currents Derived From Ørsted and CHAMP High-Precision Magnetic Field Measurements

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Since their launch time, the Ørsted (1999-02-23) and CHAMP (2000-07-15) satellites have provided a bulk of high-precision geomagnetic field measurements made over both the northern and southern polar caps and covering all magnetic local times. As these observations now go for more than four years, these data are available for all variations in the Earth's dipole tilt (i.e., smoothly transitioning between the summer, equinox, and winter seasons) and for a variety of interplanetary magnetic field (IMF) conditions. In this study, we show a revised field-aligned currents empirical model (FACEM) for high-latitudes that was derived from the satellites data for quiet and moderate (but non-storm) IMF conditions. The model is mainly parameterized by the IMF strength and direction, as well as the Earth's dipole tilt angle. The model's detailed maps of the high-latitude field-aligned currents allow a researcher to follow evolution of the major field-aligned current systems (e.g., R0/R1/R2 and cusp currents) as the IMF vector rotates in the GSM Y-Z plane and the dipole tilt changes. Since the 23rd solar cycle shows a double maximum in 2000-2002, we attempt to deduce the solar activity effects on statistical distributions of the high-latitude field-aligned currents from 1999 and up to present time.

URL: http://maggy.engin.umich.edu/mist/limie.html

SM42A-0591 1330h INVITED POSTER

High Latitude Current Systems: FAST and Polar Observations

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The polar-orbiting FAST and Polar spacecraft have provided extensive observations of the field-aligned current (FAC) systems that flow into and out of the high latitude ionosphere. These FACs flow in response to the forces that act on the magnetospheric and ionospheric plasmas; the classical Region-1, -2 current sheet model is the analog to the twin cell convection pattern associated with steady southward Interplanetary Magnetic Field. The FAST and Polar observations have demonstrated both the strengths and weaknesses of the Region-1, -2 current sheet model. Large statistical databases show that the Region-2 current system is closed within the inner magnetosphere by a partial ring current, while investigations of the large scale current system in the dawn-dusk meridian show that 70% of the Region-1 currents are coupled to the Region-2 currents, as required to provide the return flow over a narrow latitude range. On the other hand FAST and Polar observations in the dayside cusp region demonstrate some of the problems with the simple Region-1, -2 model. The cusp currents are strongly dependent on IMF orientation, but it is by no means clear what the field-aligned current morphology actually is in this region. Models of cusp currents include overlapping Region-1 currents, separate polar cap DPY currents, and hybrid current sheet models, where one of the cusp currents is part of the Region-1 system, and the other is a polar cap FAC. Understanding the morphology of these currents requires knowledge of the underlying magnetic field topology, including both the transition from open to closed field-lines, and the mapping of open field lines to the magnetopause, as the magnetic field topology relates the FACs to the drivers of convection. Similar problems manifest themselves when considering observations of multiple FAC sheets in the dawn-dusk meridian. Are the additional FACs structures within the Region-2 currents, or structures within the Region-1 currents? Or is trying to place these currents into the Region-1, -2 model misleading, if not simply wrong? Again knowledge of the magnetic field topology is essential in resolving these questions. Several resources are available to address this issue, including in situ particle observations, ground-based ionospheric observations, and MHD models.

SM42A-0592 1330h POSTER

Simultaneous Inter-hemisphere Comparison of Birkeland Current Magnetic Perturbations: Quantitative Tests of Conductivity Control

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The Iridium system key parameters are used to compare the magnetic perturbations in the northern and southern hemisphere simultaneously. By using simultaneous data from the north and south the variations in currents due to changes in the solar wind-magnetosphere drivers of current are greatly reduced revealing true hemispherical differences for identical driving conditions. Three full years of data are used to characterize the seasonal and diurnal dependence of FACs. Strong seasonal and diurnal variations in the relative intensity of the Birkeland currents are found on the dayside and much smaller effects on the nightside. In a given hemisphere the net current is a factor of 1.6 larger in summer than in winter. The diurnal variation is nearly as large and the amplitude of the diurnal variation changes with season having the largest amplitude near the equinoxes. Both the seasonal and diurnal variations are modeled by comparing the relative ionospheric conductances modeled as the combination of solar EUV and particle contributions evaluated using empirical relations between solar zenith angle and conductivity and average Polar UVI auroral emission distributions. The observations can all be accounted for in terms of EUV and auroral conductances if the maximum auroral conductivity is near 10 mhos. In addition to the variations there is a persistent bias toward the northern hemisphere. After removing seasonal and diurnal effects, the magnetic perturbations are consistently 15 percent larger in the northern hemisphere than in the south. The uncertainty in the bias is less than 2 percent. The bias can be attributed to the combined effects of auroral zone geometry and magnetic field between the northern and southern hemispheres.

SM42A-0593 1330h POSTER

Estimation of field aligned currents from combined Iridium, DMSP, Oersted and CHAMP Data.

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The Iridium system consists of more than 70 satellites in circular, polar, 780 km altitude orbits in six equally spaced planes. This configuration provides a unique opportunity to obtain in-situ measurements of the global distribution of field aligned currents and associated magnetic perturbations on time scales of the order of about an hour. The technique uses the cross track components of the magnetic field measurements from the Iridium satellites and makes no assumptions regarding ionospheric conductivity or global magnetic activity parameters (e.g., AE, Kp or Dst). The availability of magnetometer data from Oersted, CHAMP and DMSP, spacecraft allows (i) a direct test of the Iridium fitting results and (ii) estimation of field aligned currents using the combined data sets. In this paper we describe the method used to combine the Iridium data with higher quality, vector magnetometer data from DMSP, Oersted and CHAMP. The combined data sets are used to investigate the field aligned current configurations for various IMF and solar wind conditions.

SM42A-0594 1330h POSTER

IMF control of the theta aurora and substorm onset location in the conjugate hemispheres

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Based on simultaneous imaging data from IMAGE FUV and Polar VIS Earth Camera, we examine the IMF control of the occurrence and location of auroral features in the conjugate hemispheres. The imaging data have revealed that transpolar arcs during northward IMF can exist in one hemisphere but not in the other. We attribute this occurrence of non-conjugate theta aurora to the sign of the IMF B_x component, which controls the hemisphere in which lobe reconnection is favored. Examining auroral substorm onsets in the conjugate hemispheres, we find that the onset locations are displaced in one hemisphere compared to the other, meaning they have different geomagnetic coordinates (e.g., apex, CGM). We find that the relative displacement of onset locations in the conjugate hemispheres are controlled by ratio of B_y/B_z or the IMF clock-angle. These results indicate that the magnetic tensions force is acting on open magnetic field lines before reconnecting in the magnetotail. This leads to a twisted magnetotail and can explain why conjugate field lines have different geomagnetic coordinates in the northern and southern hemispheres.

SM42A-0595 1330h POSTER

Conditions Governing High-Latitude Dayside Aurora During IMF $B_y > 0$

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In a recent study of IMAGE FUV data, Frey et al. (2003) examined cases of high-latitude dayside aurora caused by precipitating electrons predominantly during northward IMF with a strongly positive IMF By component. Analysis of FAST data showed that the auroral spots coincide with regions of localized upward field-aligned currents (FACs). In order to determine the conditions that control these auroral emissions, we examined field-aligned currents observed by the Iridium constellation for 25 events of prolonged steady IMF orientation with clock angles between $+60^{\circ}$ and $+90^{\circ}$. We find that localized FACs are observed under all solar wind conditions but that the occurrence of high latitude aurora are restricted to solar wind proton densities below $4\,\mathrm{cm}^{-3}$ and peak current densities higher than $1.0\,\mu\mathrm{A/m}^2$. These conditions were met for the 11 events with auroral emissions while emissions are not observedduring the remaining 14 events for which these conditions are not met. Our findings can be qualitatively explained with the Knight relation [Knight, 1973], which states that the field-aligned potential drop is directly proportional to the field-aligned current density and inversely proportional to the energy density of the precipitating population. Auroral emissions are generated, if the field-aligned potential drop, which accelerates electrons into the ionosphere, is sufficiently large whereas either low current density or high particle density leads to lower potential and correspondingly weaker aurora. The results also indicate that the particle density on field lines mapping to the upward current region is largely governed by the solar wind density.

SM42A-0596 1330h POSTER

Transient Sheets of Field-Aligned Currents Observed During a Superstorm

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During the main phase of the superstorm on 6 April 2000 (Dst < -200 nT), multiple DMSP satellites observed large sheets of field-aligned currents (FACs) in both hemispheres and at local times ranging from dawn to 09:00 and from dusk to 21:00 LT. FAC intensities (J > 1 A/m) are amongst the largest ever observed by DMSP, yet produced no commensurate magnetic signatures on the ground beneath or magnetically conjugate to the satellites. The event empirically confirms Fukushima's theorem. In addition, Pedersen conductances required by Ohm's law are much larger than values estimated with Robinson's formula. Particle and field observations during the event show that precipitating low-energy electrons and ring-current ions are the primary FAC carriers in the upward and downward sheets. Neglect of their contributions can lead to significant underestimates of conductance. Our results have profound relevance for understanding magnetosphere-ionosphere coupling and the dissipation of ring-current energy under highly stressed geomagnetic conditions.

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SM42A-0597 1330h POSTER

One-Dimensional Upward Continuation of the Ground Magnetic Field Using Spherical Elementary Current Systems

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The method of spherical elementary current systems (SECS) has been successfully applied to derive ionospheric equivalent currents from ground magnetometer data. Its one-dimensional variant (1D SECS) is now introduced especially for situations with data available only from a chain of magnetometers. We compare equivalent currents obtained by the 2D and 1D SECS methods and by 1D Fourier method using synthetic 1D current models. Then we study real situations with data from a 2D (IMAGE) and 1D (MM210) magnetometer network. We show that the 1D SECS reveals the integrated eastward and westward current densities very reasonably compared to the 2D SECS, also during clearly non-1D situations. It also follows that the 1D SECS can be applied in a routine manner to replace the commonly used local electrojet proxies (local AL and AU indices) by a direct quantitative estimate of the ionospheric currents.

SM42B MCC: Level 1 Thursday 1330h

Dynamic and Global Aurora II Posters *(joint with SA, AE)*

Presiding: **P L Rothwell,** Air Force Research Laboratory/Space Vehicles Directorate**; R E Ergun,** University of Colorado

SM42B-0598 1330h POSTER

Conjugate and Same-Scene Auroral Imagery

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Conjugate studies of high-latitude geomagnetic activity are central to understanding the global magnetospheric response to external perturbations, i.e. the solar wind, and the role of the ionosphere in modulating and coupling with the magnetosphere. Interhemispheric asymmetries as manifested in auroral emissions have been observed for over 40 years. Unfortunately, the nature of the problem has limited the type and extent of studies that can be performed to either conjugate ground based observations or comparison of space based images with all-sky cameras. Recently Frank and Sigwarth (2002) published results using unique simultaneous images from Polar of the northern and southern aurora, but these are necessarily limited to the nighttime and at oblique angles. However, images made with the cameras from the Polar and IMAGE missions contain simultaneous conjugate images as well as same-scene images of the large-scale aurora under many and varying conditions. This rich data set provides an opportunity to study interhemispheric auroral asymmetries and investigate their occurrence as a function of solar wind conditions and ionospheric parameters such as conductivity. In order to use images of different scenes from each of these cameras, knowledge of their relative response to a common scene is required. To that end, this paper will present preliminary results of comparing images with emphasis on data from the Polar UVI LBH filters and the IMAGE FUV WIC.

SM42B-0599 1330h POSTER

Local Time Displacement of Substorm Expansion in Conjugate Hemispheres

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Because the Earth's magnetic field is largely dipolar and symmetric, many auroral features are conjugate between the northern and southern hemispheres. However, previous work has shown that the aurora can be nonconjugate. Most previous optical conjugacy studies have been limited to ground based observations or ground based and space based imager comparisons. In both cases at least one observation point is restricted to viewing only small scale features. Conjugate observations of the large scale behavior of the aurora have been confined to rare, serendipitous space based imager conjunctions and single spacecraft viewing of both hemispheres which is tempered by large oblique viewing angles. As the Polar spacecraft's apogee has descended in the the southern hemisphere, the Polar Ultraviolet Imager (UVI) has spent an increasing amount of time viewing the southern aurora. Simultaneously, the Wideband Imaging Camera (WIC) onboard the IMAGE spacecraft has been observing the northern aurora. By using image data from both spacecraft, we are able to systematically analyze the degree of auroral conjugacy on synoptic scales and over a wide variety of geomagnetic conditions. In this work, we focus on the conjugacy of the region of intense auroral emission during substorm onset and expansion. We find a persistent displacement in local time of the region of active aurora during substorm expansion; features in the northern hemisphere are shifted westward (duskward) relative to the conjugate point of the southern hemisphere aurora by up to a few thousand kilometers. Often there is a shift in the opposite direction observed before and at substorm onset. The same sense of displacement has been reported in earlier work. The sense or magnitude of the displacement showns no obvious correlation with the interplanetary magnetic field orientation or strength as suggested in previous studies. Therefore, we suggest that the displacement in local time of the region of intense auroral emission is a result of the asymmetric distortion of the magnetic field by the large scale field-aligned currents associated with substorms.

URL: http://sprg.ssl.berkeley.edu/~matt/AGU2003/

SM42B-0600 1330h POSTER

Conjugate auroral observations under various interplanetary conditions

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Recently, it has been possible to observe the entire auroral oval in both the northern and southern hemispheres simultaneously with the IMAGE FUV imagers and Polar VIS Earth camera, respectively. These rare opportunities allow us to study conjugate and non-conjugate effects between the two hemispheres under various interplanetary conditions. This enables us to better understand the transfer of mass and energy from the solar wind to the magnetosphere/ionosphere system. The events we study here are from late 2002 with periods of simultaneous observation lasting between about 35 and 60 minutes. Most events are associated with a steady IMF B_X component, where the IMF B_Y and B_Z components vary.

SM42B-0601 1330h POSTER

Comparison of Rice Field Model to Simultaneous Conjugate Auroral Images

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We examine simultaneous conjugate satellite images of the north and south hemispheres from a two-hour time period on August 17, 2001. IMF conditions during this time show a strong B_y component and a negative B_z component, with geomagnetic indices indicating that this time period took place in the middle of a magnetic storm, as well as during the growth phase and onset of a substorm. As a result of these conditions, the satellite images show a large polar cap size shifted toward dawn in the north and dusk in the south. We use the Rice Field Model to map field lines from one hemisphere to the other in order to determine the polar cap size and the positions of conjugate features in the auroral zone. This comparison between model output and data allows us to optimize the adjustable parameters of the model, resulting in greater accuracy for the field model. The angle of rotation of the magnetotail was increased in order to match the polar cap shape and position to the satellite images. The final output of the model successfully described to first order the polar cap size, shape, and position and the direction of shift of various features from one hemisphere to the other. The model fell short, however, in its attempt to model the more dynamic substorm effects. In general, simultaneous images of the aurora allow for a better understanding of how magnetic field lines and polar cap boundaries map from one hemisphere to the other, as well as aid in determining which auroral features are real and are most likely to be seen in model outputs.

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Local time propagation of electron and proton auroras in substorms

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Latitudinal expansion of substorm auroras is explained by the poleward motion of the dipolarization region during the expansive phase. However the cause of the expansion of the aurora in local time is not fully understood and we used IMAGE FUV observations of 154 substorms to investigate it. Images of the Wideband Imaging Camera and the SI-12 proton auroral imager were re-projected to a rectangular magnetic latitude local time coordinate grid during 154 substorms. A representative function of the intensity distribution as a function of magnetic latitude, composed of two Gaussian peaks, was fitted to the projected images and the fitting parameters were obtained for all magnetic local times (MLT-s). This fitting permitted the effective removal of dayglow and other non auroral artifacts and yielded simple parameters to examine the properties of the aurora. The integrated intensity of the fitted double Gaussian functions were used to represent the intensity of the aurora at a particular MLT. Using this, intensity MLT-keograms were produced to examine the MLT development of the proton and electron aurora. These keograms show that the nightside aurora expands after substorm onset, but in addition to the expansion, the luminosity exhibits a bulk motion in the (MLT) direction towards dawn or dusk. No regular trends were derived in the direction or speed of the luminosity of the aurora in either the proton or the electron case. The MLT motion of the post substorm aurora therefore does not represent the drift motion of the injected particles in the magnetosphere but rather it represents a gradual drift of the particle injection source region. In previous case studies, comparison of energetic neutral atom (ENA) data with FUV showed that there is good agreement between lower energy trapped and precipitating fluxes. From our study therefore we propose that the substorm expansion in local time is a motion of the source of the particle injection during the process of the substorm.