

2003. GPS TEC mapping observed the rapid enhancement of the EA and the formation of a concentration of enhanced plasma in the Caribbean sector. This co-rotating enhancement provided a continuing a source for the dusk-sector plasmaspheric drainage plume. The down-looking IMAGE FUV instrument can map enhancements in the equatorial emissions associated with the EA and observed the spatial extent and evolution of the co-rotating low-latitude ionospheric features in the American sector during this event. Simultaneous DMSF overflights provide in situ observations of topside plasma density at 880 km altitude. Pixel by pixel intercomparison of GPS TEC maps with the FUV observations determine the sensitivity characteristics of the FUV instrument for such studies (features with > 60 TECu are well imaged by the FUV instrument).

SM22A-06 1145h

### Potential of a Sensitive Low Frequency Radio Telescope for Heliospheric Studies

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A sensitive low frequency radio telescope array introduces a new generation digital aperture synthesis interferometer. A possible design could cover the 80-240 MHz frequency range and provide up to 32 MHz of observation bandwidth. Groups of orthogonal dipoles will serve as receptors and the collecting area will be distributed in a centrally condensed manner. The instrument will be optimised for high dynamic range snap shot imaging. The conversion of the receptor signal to the digital domain at the earliest available opportunity makes it possible to form multiple independent beams simultaneously. The current design allows up to 8 beams using the entire collecting area of the array and 256 beams per polarisation using only the part of the array lying within the central 2 km of the array (core). The instrument will also feature an *All Sky Monitor*, which will use the array core and will provide an image the entire field of view about every second. These unprecedented capabilities makes the instrument very effective for a variety of solar and heliospheric studies, in addition to its astronomical and astrophysical objectives. The high dynamic range imaging capability of the instrument makes it very useful for imaging the Sun. Due to steep spectral nature of the emission and the low frequencies of observation the instrument, it will be able to image the emission from the CMEs to distances beyond the fields of view of existing coronagraphs. When the CMEs become too faint to be imaged directly, interplanetary scintillation (IPS) techniques can be used to study them, allowing their evolution to be tracked till beyond 1 AU. The large multi-beaming capability of the array core makes it very attractive for IPS tomographic reconstruction of the velocity structure of the entire inner heliosphere. The full polarisation capability of the instrument allows us to exploit the effect of Faraday rotation (FR) to study the distribution of magnetic field and electron density along lines of sights to distant polarised sources. IPS and FR studies will yield information about both the quiescent and transient heliosphere. The use of IPS and FR data-sets from this instrument along with data from Thompson scattering imagers like SMEI and STEREO will provide much more complete information about the heliosphere. These data-sets when combined with good MHD solar wind propagation models will provide the opportunity for a tomographic reconstruction of the velocity, density, turbulence structure and magnetic field in the heliosphere. A very useful by-product of the calibration of this instrument will be exquisitely detailed information about the total electron content (TEC) of the ionosphere at the telescope site. The instrument will have about 5000 lines of sight piercing the ionosphere over a radius of 400 km, providing a very fine spatial sampling of the ionosphere. This information can be used to construct for the first time a 4D (3 spatial and 1 temporal) TEC model of the ionosphere at these spatial scales.

SM23A CC: 518 A Tuesday 1330h

### What Controls the Degree of Conjugacy in Auroral Phenomena? I (joint with SA)

**Presiding:** N Ostgaard, University of California, Berkeley; J F Spann, NASA Marshall Space Flight Center

SM23A-01 1330h INVITED

### Conjugacy and non-conjugacy of auroral breakup observed by the Syowa-Iceland conjugate observatories

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Syowa Station in Antarctica and Japanese stations in Iceland provide an ideal set of observatories to study geomagnetically conjugate optical auroras. A campaign of auroral conjugate observations using all-sky TV cameras has been carried out since 1984 during the equinox periods when simultaneous optical observations are possible under enough darkness in both hemispheres. In this paper we will briefly review these conjugate auroral observations and give an outline of what we have learned regarding asymmetries, and to what extent these are controlled by the IMF or magnetospheric internal causes. Then we will focus on the examples of conjugacy and non-conjugacy of auroral breakup phenomena, which have been recorded during the last few years. An excellent conjugate event, which occurred on 26 September 2003, showed that the evolution of an auroral substorm from the growth phase through expansion phase to recovery phase was observed at the conjugate-pair observatories. Auroral breakup occurred at lower latitudes, and then the active auroral region expanded rapidly poleward. Afterwards, north-south (N-S) structured auroral forms appeared from higher latitudes and extended to lower latitudes several times. The sequence was concluded by N-S structured pulsating auroras. This excellent conjugate event allowed us to trace the conjugate point with high time- and spatial resolution. On the other hand, three non-conjugate auroral breakup events we examined showed that the start time of the auroral breakup (sudden luminosity enhancement and followed by poleward expansion) and the shape of the auroral forms were completely different in the conjugate hemispheres. During two of the three events, the poleward expansion started earlier at Syowa than that at the observatory in Iceland, but for one event the opposite was true. We will discuss these features in order to clarify how the IMF parameters and/or ionosphere-magnetosphere coupling processes control the conjugacy or non-conjugacy of auroral breakup.

SM23A-02 1350h INVITED

### What do Empirical Field Models Tell us on the Geomagnetic Conjugacy ?

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Empirical magnetospheric magnetic field models are natural tools for studying the geomagnetic conjugacy, since they are based on large amounts of spacecraft data and, by their construction, are supposed to faithfully represent the actual magnetospheric geometry as a function of the geomagnetic disturbance and characteristics of the incoming solar wind, as well as its asymmetry due to seasonal and diurnal changes of the Earth's dipole tilt. The very notion of geomagnetic conjugacy makes sense only for closed magnetic field lines, whose footpoints lie equatorward from the poleward boundary of the auroral oval. On the other hand, the field lines originating progressively equatorward from the auroral zone, map into the inner magnetosphere, where the total field rapidly increases earthward and becomes essentially dipolar, so that the location of conjugate points in that region is virtually unaffected by the external factors and the dipole tilt. Therefore, when studying the conjugacy, our region of interest is limited within a relatively narrow interval of geomagnetic latitudes. During strong geomagnetic storms, the combined effect of the increase of the ring and tail currents can result in a dramatic deformation of the previously quasi-dipolar nightside magnetic field, so that the tail-like stretch of the field lines (and, hence, the amplitude of the conjugate footpoint shift) can greatly increase and penetrate

deeper into the inner magnetosphere. Another storm-time effect, distinctly revealed by the models, is the development of a strong partial ring current on the dusk side, manifested in a remarkable dawn-dusk asymmetry of the magnetic field depression at low latitudes. Finally, empirical models persistently indicate a significant penetrated component of the IMF inside the magnetosphere. All these factors can affect the location of conjugate points, and it is the purpose of this talk to present a survey of most important effects.

SM23A-03 1410h

### IMF Control of Auroral Phenomena in the Conjugate Hemispheres

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Based on simultaneous imaging data from IMAGE and Polar, 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 and we have attributed this to the sign of the IMF Bx component, which controls in which hemisphere lobe reconnection is most efficient. Examining auroral substorm onsets in the conjugate hemispheres, we have found that the onset locations are systematically displaced in one hemisphere compared to the other, meaning they have different geomagnetic coordinates (e.g. apex, CGM). Our results indicate that the relative displacement of onset locations in the conjugate hemispheres is controlled by the IMF clock-angle. These findings are used to examine how well these asymmetries in the nightside magnetosphere are included in existing magnetic field models. In this paper conjugate observations of dayside cusp precipitation during northward IMF will be presented and examined as well.

SM23A-04 1425h

### Simultaneous Observations of Conjugate Northern and Southern Auroras from a Single Camera.

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Most studies of the solar wind-magnetosphere-ionosphere system assume that the northern and southern auroral ovals are symmetric. However, evidence has been steadily accumulating for interhemispheric differences in the nature of the northern and southern auroras at magnetically conjugate locations. From late September to early November of the years 2000-2003, the apogee for the Polar spacecraft was located at ~9 RE near the equator with a local time in the pre-midnight magnetotail. From this vantage point, the far ultraviolet sensitive Earth Camera of the Polar/Visible Imaging System (Polar/VIS) acquired simultaneously (in a single image frame) observations of magnetically conjugate northern and southern auroral locations for most of the nighttime sector. The image frame cadence was 54 s. These conjugate observations have the advantage of being acquired from a similar perspective with a single camera, a single bandpass sensitivity, and exactly simultaneous timing. The altitude of Polar was sufficiently high to allow determination of the latitudinal distribution of auroral luminosities at a spatial resolution of ~150 to 200 km. The timings, motions, and auroral locations of several events will be presented.

SM23A-05 1440h

### Near-Simultaneous Observations of Low-Altitude ENA Emissions from Northern and Southern Hemispheres

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During 2003, the IMAGE orbit has evolved such that the orbit perigee has passed across the equator from south to north. This orbital configuration has provided opportunities to view low altitude ENA emissions sequentially in the northern, and then southern hemispheres from intermediate to low altitudes. At these times, structured ENA emission signatures are observed. These signatures are peaked in invariant latitude. Their distribution in magnetic local time seems to depend both on the instantaneous viewing geometry and on the current state of geophysical activity (i.e.: storm phase). Operating under the assumption that these low altitude emissions emanate from the Oxygen exobase at an altitude near 650 km, we look at their spatial distribution, with a focus on comparison of near simultaneous observations from the northern and southern hemispheres.

SM24A CC: 518 A Tuesday 1530h

### What Controls the Degree of Conjugacy in Auroral Phenomena? II (joint with SA)

**Presiding:** N Ostgaard, University of California, Berkeley; J F Spann, NASA Marshall Space Flight Center

SM24A-01 1530h INVITED

### Interhemispheric conjugacy of ionospheric convection and field-aligned currents

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The Assimilative Mapping of Ionospheric Electrodynamics (AMIE) procedure has proved to be a very useful tool to estimate the large-scale instantaneous patterns of ionospheric conductance, electric potential, and other related quantities by combining simultaneous measurements from satellites, radars, and ground magnetometers. In this paper we apply the AMIE procedure to investigate the conjugacy of the large-scale high-latitude ionospheric convection and field-aligned current patterns between the northern and southern hemispheres under various solar wind and IMF conditions. The different magnetospheric drivers for the convective flows and their quantitative contributions to the total cross-polar-cap potential drop will be examined. We also investigate the possible seasonal effects on such interhemispheric conjugacy.

SM24A-02 1550h

### Hemispheric asymmetries in the location and intensity of the auroral ovals and their association with ionospheric convection and IMF

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As the orbit of the Polar spacecraft has precessed over time, the VIS Earth camera has been able to capture simultaneous images of the aurora in both the

northern and southern hemispheres. The angular resolution of these images is sufficient to be able to determine the accurate location and intensity of the two ovals. Preliminary studies have revealed that while the auroras seem to be mirror images of one another on a broad scale, there are a number of fine scale features which are not conjugate in both hemispheres. The mapping of the auroras has revealed that there are longitudinal differences in the onset locations. In this paper, we use the radars of the northern and southern SuperDARN network to investigate whether the convection patterns match the longitudinal differences in the onset locations of the auroral features in the two hemispheres. Differences in the auroral intensity detected in the two hemispheres were found and we determined their association with the electric field strength and convection speeds. The IMF data were studied to determine if these hemispheric asymmetries were due to variations in the IMF direction

SM24A-03 1605h INVITED

### Simultaneous Global-scale Observations of Field Aligned Currents in the Northern and Southern Hemispheres

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We present observations of magnetic perturbations due to Birkeland currents from the Iridium constellation of satellites. The Iridium constellation consists of 70 satellites in 780 km circular polar orbits configured in six orbit planes spaced equally in longitude. The constellation therefore provides global coverage in both the northern and southern hemispheres. Engineering magnetometer data are used to study two aspects of hemispheric differences in Birkeland currents. Using key parameters statistics of the perturbations for 2000, 2001 and 2002 we first study the seasonal and diurnal variation of currents by comparing the ratio of perturbations between the north and south. These results show clear seasonal and diurnal variations in the relative current with approximately equal magnitude, amounting to a variation in relative current of a factor of two for each of seasonal and diurnal effects. The seasonal and diurnal amplitude as well as the seasonal variation of the diurnal currents are explained by variations in Pedersen conductivity due to solar EUV, auroral precipitation, and structure in Earth's main field at auroral latitudes. These results show that comparisons of Birkeland current intensities must properly account for differences in conductivity. We then examine the distribution of Birkeland currents for specific events for a range of IMF orientations. The dayside distribution is determined principally by the IMF. The northern and southern hemisphere distributions display mirror symmetry about the noon-midnight meridian, consistent with a reconnection driven dynamo. This symmetry is broken somewhat by the day-night gradient in Pedersen conductivity which favors (inhibits) current for dusk-to-dawn (dawn-to-dusk) convection at noon. In contrast to the dayside, currents at night have the same distribution in magnetic coordinates in the northern and southern hemispheres.

SM24A-04 1625h

### Seasonal Variations of Large-scale Field-aligned Currents

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Auroral electron acceleration is closely related to upward-flowing field-aligned currents (FACs), and therefore interhemispheric comparison of FACs should provide important clues for understanding (the lack of) auroral conjugacy. In the present study we statistically examine the seasonal dependence of large-scale FACs. We previously developed an automatic procedure to identify the structures of large-scale FACs [Higuchi and Ohtani, JGR, 105, 25,305, 2000], and the present study is based on 185,000 FAC crossings we identified by applying this procedure to magnetometer data from the DMSP-F7 and F12-15 spacecraft. The result confirms that the dayside FAC tends to be more intense in the summer hemisphere and weaker in the

winter hemisphere showing annual variations of its intensity. It is also found that the average latitude of midday FAC systems is higher in summer than in winter; the difference can reach as much as 5 degrees at solstices. This displacement can be explained in terms of asymmetric magnetospheric configurations. The degree of the winter-summer asymmetry diminishes away from the midday sector. On the nightside, the average FAC intensity tends to be larger around equinoxes and smaller around solstices, which is consistent with the well-known semiannual variations of geomagnetic activity. It is therefore concluded that the primary cause of the seasonal variation of large-scale FACs depends on local time. It is the ionospheric conductance owing to the solar illumination for dayside FAC systems, whereas for nightside FAC systems, it is the efficiency of energy coupling between the solar wind and the magnetosphere.

SM24A-05 1640h

### Seasonal Variation of Substorm Characteristics and the Implications for Auroral Conjugacy

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The hypothesis that ionospheric conductivity plays a major role in the global-scale dynamics of the aurora is further evaluated in this study. The rate of energy deposition by electron precipitation (hemispheric power), substorm expansion and recovery time scales, and the total electron energy input to the ionosphere/thermosphere during auroral intensifications are computed for over three hundred substorms observed by the Polar Ultraviolet Imager (UVI) in the northern hemisphere. Each substorm parameter is then sorted according to season. Substorm intensity, measured by the peak hemispheric power for each substorm, is greatest during the equinoxes but otherwise showed only minor seasonal variation. Substorm expansion time scales are shortest during the summer but also do not exhibit significant seasonal variations. On the other hand, the substorm recovery times are well ordered by whether or not the nightside auroral region is sunlit: substorms occurring in the winter and equinox periods have similar recovery time scales which are both roughly a factor of two longer than that for summer when the auroral oval is sunlit. These results strongly suggest that simultaneous auroral intensifications in the northern and southern hemispheres develop differently during solstitial conditions. We expect the auroral breakup in the dark (winter) hemisphere to be more intense and longer lived than that observed in the sunlit (summer) hemisphere. This also implies that more energy is deposited by electron precipitation in the winter hemisphere than in the summer one during a substorm. Conjugate auroral substorm observations by Polar UVI and the IMAGE FUV instrument are used to confirm this behavior. The observed hemispheric asymmetry and non-conjugacy of auroral substorms is consistent with the suppression of discrete aurora in sunlight and highlights the importance of this effect in magnetosphere-ionosphere coupling.

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