SA22C MCC: 2006 Tuesday 1600h

Equatorial Ionosphere Irregularities

Presiding: **F J Rich,** Air Force Research Laboratory (VSBXP)**; O de La Beaujardiere,** Air Force Research Laboratory

SA22C-01 1600h

GPS Occultation Observations of the Global and Seasonal Distribution of Equatorial Scintillation

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We present a globally and seasonally distributed set of observations of radiowave scintillation by GPS occultation sensors on-board the PICOSat, CHAMP, and Sac-C satellites. GPS occultation measurements provide a means of measuring ionospheric scintillation on a global basis, which can not be done using traditional ground-based scintillation monitoring techniques. Strong fluctuations in the GPS C/A code signal-to-noise ratio (SNR) data at the L1 frequency (1.575 GHz) are shown to be indicative of scintillation. The source of the SNR fluctuations is evaluated through a statistical analysis of a full year of occultation data from January - December, 2002. The geographic and local time distributions of occultations having large values of the S4 scintillation index are consistent with known scintillation climatology, unambiguously identifying the fluctuations as ionospheric scintillation. We also show that, given the proper geometry, the occultation technique enable mapping of the vertical distribution of the ionospheric structures (bubbles) responsible for the scintillation.

SA22C-02 1615h

F-region Ionospheric Irregularities Observed by ROCSAT-1 in the South Atlantic Anomaly Longitude Sector

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Data from the Ionospheric Plasma and Electrodynamics Instrument (IPEI) onboard ROCSAT-1 during the solar maximum years of 2000 and 2001 are used to investigate the plasma depletion (bubble) structures observed in the South Atlantic magnetic Anomaly (SAA) longitude sector. In this longitude sector, the geomagnetic field exhibits great variations in its magnitude, declination, and geographic latitude of the magnetic equator. With the 35-degree inclination orbit, ROCSAT-1 had the opportunity to travel either nearly along the magnetic equator or approximately along the magnetic meridian. We examine how the occurrence probability of the observed bubbles depends on local time, season, magnetic field configuration, and geomagnetic activity. Furthermore, we perform spectral analyses on the high-resolution ion density and cross-track ion velocities data for some representative passes to investigate how the spectral relationships among the density and velocity components are changing as the bubble structures evolve. Significant results from our analyses of the SAA bubbles are: (1) to confirm the magnetic-field-aligned characteristics of plasma bubbles, (2) to evaluate how important role that the magnetic-field-aligned neutral wind plays in producing the growth and the season of bubble structures, and (3) to verify the existence (absence) of the transitional-scale drift waves in the growing/developed (decaying) bubbles near the magnetic equator.

SA22C-03 1630h

Simultaneous Observations of Equatorial Plasma Depletion by IMAGE and ROCSAT-1 Satellites

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Simultaneous observations of the equatorial ionosphere by ROCSAT-1 and IMAGE satellites have been used to study plasma characteristics of equatorial plasma bubbles. IMAGE Far-ultraviolet (FUV) nighttime images have indicated signatures of depression in the brightness of equatorial airglow arcs. Using the list of airglow brightness depression events observed by IMAGE, we surveyed ROCSAT-1 IPEI data for simultaneous plasma observations in the same local time. Our preliminary investigation has indicated that features of brightness depression seen in FUV images were correlated with equatorial plasma bubbles detected by ROCSAT-1 at 600 km altitude. Successive FUV images are averaged to produce a keogram with UT versus longitude, which is then used to deduce drift velocity for plasma density depletions. For the simultaneous observation events of plasma density depletion, we compare the ion drift velocities measured by ROCSAT-1 with the drift speed determined from the FUV keogram. We examine the relationship among the drifting speed of airglow brightness depression, the ion velocity inside equatorial plasma bubbles, and the ion velocity of the background plasma. The analysis results are used to answer questions about whether the bubbles are drifting faster than the ambient plasma, and how equatorial plasma bubbles evolve as they drift.

SA22C-04 1645h

Global Characteristics of the Equatorial Anomaly of the low Latitude Ionosphere Observed by IMAGE/FUV

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The Equatorial Anomaly (EA) of the low latitude ionosphere has been studied extensively since its discovery by Nanba and Maeda (1939) and Appleton (1946). The EA is produced basically by the uplift of the F-layer plasma at the magnetic equator by zonal electric fields, which subsequently enhances the density of the plasma at the base of field lines on both sides of the magnetic equator. Also important for the EA development is the field-aligned plasma flow which is driven by the neutral wind. Because the electric field is mainly generated through interaction between the neutral atmosphere and the plasma, the EA is thought to represent the coupling of the neutral atmosphere and the ionosphere at low latitude. However, it has been difficult to characterize global EA features observationally because of the lack of global observation of the ionosphere at low latitudes. IMAGE/FUV takes the images of 135.6 nm nightglow emission globally. This enables us to analyze characteristics of the nighttime EA distribution as it changes with the longitude. The IMAGE/FUV instrument images the whole earth visible from the maximum distance of 40,000 km, and observed the low latitude ionosphere for more than 6 hours continuously in early 2002, while repeating observations every two minutes. For analysis we use constant local time maps (LT maps). LT maps are constructed by binning the IMAGE/FUV data of several consecutive days into the local-time, latitude and longitude bins. Then, by choosing bins with a constant local time, we can obtain the LT map of 135.6 nm emission. By taking this method, longitudinal variations of EA can be easily seen. LT maps of 135.6 nm nightglow indicate that there is a considerable variation of the EA development depending on longitude.

SA22C-05 1700h

Dynamics of the Local E-Region Neutral Winds at Midlatitudes Observed With a Sequence of Chemical Tracer Releases During Sporadic E Conditions

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On the night of June 30, 2003, four rockets were launched from Wallops Island, VA. The first three rockets each carried a chemical tracer experiment, and were launched with a separation of approximately two and a half and one hours, respectively. Each chemical tracer release provided upleg and downleg horizontal neutral wind profiles. This paper focuses on the shears in the wind profiles and the changes in the neutral winds over time. We also discuss the correspondence of the variations in the wind profiles to the ionosphere conditions obtained from the on-site ionosonde which showed persistent sporadic E layers throughout the observation period. Further, we compare the horizontal neutral wind measurements to previous wind observations above Wallops Island under similar conditions.

SA22C-06 1715h

Instability of the *E*-*F* Coupled Nighttime Midlatitude Ionosphere

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The *F* layer is unstable at night as described by *Perkins* [1973]. Sporadic *E* (E_S) layers are unstable at night as described by *Cosgrove and Tsunoda* [2002a, 2003]. Both instabilities involve the growth of plane-wave altitude modulations of their respective layers, and have growth rates that maximize for a tilted orientation of the plane wave phase fronts. Using the assumption that electric fields map between the *E* and *F* regions along magnetic field lines, we find that under certain conditions the two instabilities reinforce one another, thus giving rise to a coupled instability of the nighttime midlatitude ionosphere. The result is a verification of the coupled process postulated in *Tsunoda and Cosgrove* [2001]. The involvement of the wind-shear-driven E_S layer polarization mechanism [*Cosgrove and Tsunoda*, 2002a] significantly enhances the growth rate for *F* region structure, as compared with the Perkins instability.

SA22C-07 1730h

Predicting Equatorial Spread-F with First-Principles Ionospheric Models

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The generation of radio scintillation in the equatorial ionosphere involves physical processes acting on scales from the global down to the sub-kilometer. In preparation for the launch of the Communication and Navigation Outage Forecast System (C/NOFS) satellite, our laboratory has been developing a system of first-principles ionospheric/thermospheric models to predict the strength of scintillation in regions affected by equatorial plasma bubbles. The forecast system begins with a specification of the current state of the ambient ionosphere by assimilation of in-situ data. From this initial state, the ambient plasma density on near-equatorial field lines is calculated in the near future, to provide the background conditions for a nonlinear model of the development of plasma structures on mesoscales (1-1000 km), in a nested-grid description. To estimate the strength of scintillation, the statistical properties of the mesoscale turbulence are then extrapolated down to the scales where plasma density irregularities affect radio propagation. After describing this forecast system, I will present case-study runs of the models driven by assimilating plasma velocity data from the ROCSAT satellite. Comparisons of the computed plasma density along the satellite track will then

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be made with in-situ measurements. Similarly, comparisons of in-situ plasma density irregularities will be made with the locations of scintillation predicted by the model. These studies are part of a validation campaign for the forecast models prior to launch of the C/NOFS satellite.

SA31A MCC: 2002-2004 Wednesday 0900h

Van Allen Lecture *(joint with SH, SM)*

Presiding: **D Baker,** Laboratory for Atmospheric and Space Physics, University of Colorado**; R Strangeway,** Institute of Geophysics and Planetary Physics, University of California, Los Angeles

SA31A-01 0910h INVITED

New Insights Into Magnetospheric Physics From Recent Multi-Spacecraft Observations

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Please see abstract paper number SM31D-01 for the complete abstract.

SA31B MCC: 2006 Wednesday 1020h

Energy and Momentum Balance in the Mesosphere and Lower Thermosphere: Results From the TIMED Mission I *(joint with A)*

Presiding: **J Yee,** Applied Physics Laboratory, Johns Hopkins University

SA31B-01 1025h INVITED

Solar Ultraviolet and X-ray Energy Deposition and Partitioning in the MLT

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Solar irradiance in the far-ultraviolet, extreme-ultraviolet, and soft X-ray regions of the spectrum is the primary energy source for the mesosphere and lower thermosphere (MLT). Recent measurements from the solar EUV experiment on the TIMED satellite, from the UARS, SOHO, SNOE, and SORCE satellites, and from various rocket flights, have greatly increased our knowledge of the intensity and variability of the solar spectrum. In this paper, model calculations are combined with measured solar irradiances to produce a description of ionization, dissociation, excitation, and heating rates in the MLT. Key issues and uncertainties are discussed, and a method for efficient computation of these rates in general circulation models is described.

SA31B-02 1045h

Solar Ultraviolet Variability During the TIMED Mission

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The TIMED satellite was launched in December 2001 near solar cycle maximum. The solar activity remained at solar maximum conditions during 2002 and has declined to moderate activity during 2003. As part of the TIMED mission objective to study the energetics of the upper atmosphere, the Solar EUV Experiment (SEE) aboard TIMED measures the solar extreme ultraviolet (EUV) energy input. The SEE instrument is measuring the solar UV irradiance with a spectral resolution of 0.4 nm between 27 and 194 nm and with 7-10 nm resolution shortward of 27 nm. The solar UV irradiance varies on all time scales, seconds to years, and this variation is very dependent on wavelength. During the TIMED mission, the SEE instrument has observed over 90 flares which last from minutes to hours, over 24 solar rotations which have a period of about 27 days, and maximum to moderate conditions during the current 11-year solar cycle. The coronal emissions, such as the Fe XVI 33.5 nm emission and X-rays, vary the most, with variations of a factor of 10 for the larger flares, a factor of 2 for solar rotation, and a factor of 4 during the TIMED mission (2 years). The transition region emissions, such as the H I 121.6 nm and He II 30.4 nm emissions, vary less, with variations of a factor of 1.2 for solar rotation and a factor of 1.4 during the TIMED mission. The chromospheric and photospheric emissions vary even less. The variations of the solar UV irradiance shortward of 194 nm and its effects on the upper atmosphere above 60 km will be discussed in the context of the TIMED mission.

URL: http://lasp.colorado.edu/see/

SA31B-03 1100h

Comparisons of Solar EUV Irradiance Variations from Measurements, Models and GUVI Terrestrial Far Ultraviolet Dayglow Observations

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During mid 2002, solar EUV irradiance changed slowly as the Sun rotated on its axis, and increased episodically in association with multiple solar flares. As the TIMED/SEE and SOHO/SEM instruments monitored the solar EUV irradiance changes directly, TIMED/GUVI observed concurrent fluctuations in the Earth's far UV dayglow. An integrated measure of solar EUV electromagnetic energy shortward of 45 nm, called QEUV, is derived from the GUVI dayglow measurements and compared with the directly measured EUV energy and estimates from four different variability models, each summed shortward of 45 nm. The values derived from the GUVI dayglow observations agree well with both the absolute values and solar rotation modulation of the NRLEUV model, and do not support recent suggestions that the solar EUV irradiances estimated by the model of Hinteregger et al. be increased by a factor of four, nor even a factor of two. High resolution (hourly) temporal structure present in QEUV tracks closely the increase in EUV energy during solar flares, monitored by SOHO/SEM, and documents a highly radiatively coupled solar-terrestrial system.

SA31B-04 1115h INVITED

High-latitude Energy and Momentum Balance in the Lower Thermosphere

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The high-latitude lower thermosphere is significantly influenced by energy and momentum forcing associated with magnetosphere-ionosphere coupling. Electric currents produce a force on the air and dissipate energy through Joule heating. The precipitation of energetic electrons and ions into the auroral regions produces additional direct heating, and also influences the energy balance through production of stored chemical energy, through modification of the concentrations of radiatively active species, and through modification of the electrical conductivity. We examine the resulting energy and momentum balance of the lower thermosphere with the aid of a thermosphere-ionosphere-electrodynamics general circulation model.

SA31B-05 1135h

Observations of High Latitude Magnetospheric Energy Deposition

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At polar latitudes, the highly variable magnetospheric energy sources, which manifest themselves as Joule and particle energy, complicate the energy balance of the lower thermosphere. The deposition rate of magnetospheric energy can, at active times and in specific altitude regimes, rival the deposition rate of solar VUV energy. The local heating produced by magnetospheric sources leads to a divergent wind circulation and the redistribution of composition over extended regions of the globe. The response of the mesosphere and lower thermosphere/ionosphere (MLTI) region depends not only on the magnitude of the magnetospheric energy source, but also on the altitude and type of energy deposited. Here, we investigate the vertical distribution of Joule and particle energy deposition rates as observed simultaneously with the Sondrestrom incoherent scatter radar. These observed rates will be compared with solar deposition rates determined from SEE observations of the solar VUV flux. The concurrent measurements in time and space of the two magnetospheric energy sources will also be used to investigate whether Joule energy and particle energy occur concurrently or illustrate any mutual dependence.

SA31B-06 1150h

Space Weather in the ITM: The May-June 2003 Storm and NASA TIMED/GUVI Observations and TIMEGCM Model Results

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The NASA TIMED mission samples all local solar times every 60 days. As such the coverage of any particular geophysical event could be at any local solar time. The May-June 2003 storm occurred when TIMED was in a near a 10AM LST at the ascending node when the storm began and precessed towards 8AM LST by the end of the storm. The Global Ultraviolet Imager (GUVI) on TIMED obtains images at 5 individual wavelength intervals simultaneously. From the TIMED vantage point at 625 km the instrument must scan from horizon to horizon (about 120 deg) to form an image. The integration period for any pixel is about 68 msec - this gives us an instantaneous picture of the auroral features. The May-June 2003 event was notable for the magnitude of the high latitude energy inputs - we see more than 100 ergs/cm2 at times in the GUVI images. We also report the observations of the southern hemisphere inputs. GUVI is able to track the response of the thermosphere to this energy input. We see large changes in the O/N2 ratio in the dayside images. We also note significant changes in the nightside electron density profiles.

URL: http://guvi.jhuapl.edu