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Data from the Arecibo incoherent scatter radar (ISR) and the DMSP-F13 (Defense Meteorological Satellite Program) satellite are presented and compared. Observations from periods exhibiting the He+ layering phenomenon are analyzed. Historically, there has been little attempt to compare data from the two sources due to difficulties in combining ground-based and space-based studies; also, only recently have light ion concentration measurements from Arecibo been possible in the topside ionosphere up to 2000 km altitude. The results presented show favorable comparison between the two data sources, giving users increased levels of confidence in the observations. Regions where the helium ions are of comparable concentration to the major ions (O+ and H+) are apparent in the data, serving to reinforce the view that the helium ion should not be regarded as a minor ion under all conditions.

SA21B-0092 0830h POSTER

Seasonal and Latitudinal Distributions of the Dominant Light Ions at 600 km Topside Ionosphere During Years of Solar Maximum

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Data taken by ROCSAT-1 from 1999 to 2002 during years of solar maximum has been analyzed for the observations of the dominant light hydrogen or helium ions at 600 km topside ionosphere. The results reveal some interesting seasonal and latitudinal distributions of the dominant light ion species in the topside ionosphere even during years of high solar activity. The hydrogen ions are observed as the dominant ion species only during the nighttime. Except for the March spring, the distribution for such transition shows a strong hemispheric asymmetry. Furthermore, the transition that occurs in the winter hemisphere during the solstice seasons seems to be bounded along a low dip-latitude that circumscribes most of the transition occurrences in one hemisphere. No significant seasonal dependence of this latitude bound is noticed during high solar activity years. On the other hand, the occurrence of dominant helium ions is very rare but it shows the seasonal and latitudinal distributions similar to that of dominant hydrogen ions. Finally, a good correlation between the observed field-aligned ion flow and the hemispheric asymmetry for the transition of dominant hydrogen ions has been found as the cause for the asymmetry inferred from the existence of interhemispheric plasma flow in relation to the hemispheric asymmetry of the F peaks and to the enhancement or retardation of the nocturnal re-distribution of the light ions along the field line.

SA21B-0093 0830h POSTER

Manifestation of the 27 day solar activity period in the topside ionosphere electron temperature

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Response of electron temperature (Te) and density (Ne) to solar activity variation in solar maximum is studied. The 27 day period in solar activity is characterized by the F10.7 index. The Te and log Ne response was approximated by a linear dependence. The manifestation of solar flux variation in Ne is rather small. The Te dependence on the solar flux was included in an empirical model based on the Intercosmos satellites data. The model values were compared with Hinotori (altitude 600 km) and ISIS-1 (altitude 2500 km) Te data. The best agreement was found at equatorial and low latitudes. The possible mechanisms are discussed.

SA21C MCC: 2006 Tuesday 1020h

Small-Scale Processes in the High-Latitude E Region II *(joint with SM, AE)*

Presiding: **M Conde,** University of Alaska**; M Larsen,** Clemson University

SA21C-01 1020h INVITED

Joule Heating at High Latitudes

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The first attempts in the early 1960s, to compute thermospheric neutral winds were based on the existence of a global pressure pattern inferred by satellite drag observations. These early simulations did not include a high-latitude energy source. Later attempts in the 1970s and 1980s to compute the winds based on the energy budget of the thermosphere required the introduction of a heat and momentum source due to auroral processes. Models of auroral particle precipitation and plasma convection needed to calculate the energy inputs were developed in the 1980s. These models were based on averaging large data sets and the resulting patterns were forced to be smooth. The variability associated with the derived patterns of plasma convection was neglected. A “missing energy” puzzle developed as factors of 2 and 3 were needed for the Joule Heating calculations in global circulation models, in order to generate the observed wind and temperature structure. Small scale variability in the high-latitude ion convection pattern has been proposed in the 1990s as an additional source of Joule heating and has been shown capable to supply the missing energy. This paper will review the history and the status of high-latitude small-scale variability associated with the plasma convection pattern and its importance for the energy balance of the thermosphere-ionosphere system.

SA21C-02 1035h INVITED

How Small Scale E Region Irregularities Evolve and Local Implications for the Atmosphere

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On scales ranging from cm to 100 m in size, the presence of positive feedback mechanisms is able to greatly enhance the magnitude of initially small amplitude structures. The growth associated with these plasma instabilities is such as to accelerate the return to equilibrium conditions. If currents are the main driver, the main role of the short scale irregularities is to somehow reduce the currents. If density gradients are the main driver, the irregularities accelerate ordinary diffusive processes by introducing mixing. The structures also change the conductivity of the medium both directly through the introduction of anomalous diffusion and indirectly through enhancements in electron collision frequencies triggered via electron heating by plasma waves. The electron heating itself is a manifestation of an increase in the Joule heating rate. In this talk I will review the current state of the linear, quasilinear and intermittency theories, relate these theories to some of the numerical simulations, and connect the processes to the conductivity and Joule heating rate problems.

SA21C-03 1050h INVITED

Height-Resolved Observations of Electrodynamic Properties in the High Latitude E-Region

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The high latitude region between 90 and 150 km is significantly structured in many of the state parameters that describe the thermosphere and ionosphere, such as neutral winds, ion motion, ion temperature, electron temperature, electron density, neutral density and neutral temperature. Each state parameter responds differently to the various processes at play in the polar regions. These state parameters combine to establish the electrodynamic properties of the E-region, such as currents, conductivities and the electric field in the rest frame of the neutral gas. These structured electrodynamic parameters have an important impact on the amount of energy exchange that takes place between the magnetosphere and ionosphere, and on how the ionosphere and thermosphere responds. In this talk, comprehensive measurements provided by the incoherent scatter radar technique will be used to investigate the observed vertical structure in the high-latitude E-region state properties and the electrodynamics. The height structure in the Joule heating rate and related energy dissipation properties will also be presented and the influence of neutral winds will be elucidated. In addition, deployment plans for the new Advanced Modular Incoherent Scatter Radar (AMISR) in Poker Flat, Alaska and Resolute Bay, Canada will be discussed.

SA21C-04 1105h

The JOULE Experiment: Observations of Small-Scale Structure in the Auroral Oval During a Substorm Event

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The JOULE experiment was carried out at the Poker Flat Research Range in Alaska on March 27, 2003, during a substorm event in the postmidnight sector. The objective of the experiment was to measure the electric fields and the Joule heating over a range of scale sizes from approximately 1000 km to a few tens of meters with the specific goal of obtaining estimates of the contributions of the small-scale fluctuations in the forcing to the overall Joule heating rates. The instrumentation included the SuperDARN radars covering the Alaska sector which represented the largest scales, an imaging coherent scatter radar covering the intermediate scales, and two instrumented rockets covering the smallest scales. In addition, chemical tracer releases provided information about the E-region wind profiles and the horizontal gradients in the winds across the auroral oval. An overview of the experiment, the substorm event, and the measurements will be presented.

SA21C-05 1120h

Dual Rocket Observations of Large, Intermediate, and Short Scale Electric Fields in the Lower Auroral Ionosphere and Their Contribution to Joule Heating

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0n March 27, 2003, a multiple rocket and radar investigation was carried out from Poker Flat, Alaska to investigate the complex electrodynamics and neutral-plasma coupling inherent to the high latitude, lower ionosphere (100-200 km) and in particular to quantify the Joule heating in this region. Measurements within these altitudes gathered along vertical trajectories permit the Joule heating to be calculated where the Pedersen conductivity maximizes and where the ratio of the ion-neutral collision frequency to the ion gyro frequency varies considerably. Two instrumented rockets were launched into a post-midnight aurora within 3 minutes of each other, achieving apogees near 200 km while a third rocket was launched a minute later that released TMA trails to measure the neutral wind velocity. In this presentation, we focus on the in situ measurements of DC, quasi-DC, and AC electric fields gathered using the double probe technique, although we also use the measurements of plasma density, energetic electrons, and suprathermal ions to calculate conductivities and other important parameters related to Joule heating. In addition, data from the imaging coherent scatter radar provide information concerning the ambient plasma drifts and enable the in situ data to be placed in context. During the upleg of each rocket, the in situ measurements revealed 50mV/m DC electric fields directed towards the equator that, for each rocket, became considerably structured near apogee and during the downleg portions of their trajectories. Each payload encountered intermediate (10 km - 100 km) and small scale (10m - 10 km) electric fields with the largest amplitudes along their paths typically within the range of 5-25 mV/m. Such waves can contribute significantly to Joule heating, although they are frequently not included in models due to their small spatial scales. The rocket payloads also encountered intense (20-30 mV/m) Farley-Buneman two-stream waves with very short wavelengths (1-10m) in the auroral electrojet region (90-118 km). We use the neutral wind measurements to establish the relative frame of the ion and neutral gases and calculate the Joule heating associated with the electric fields at all scales as a function of altitude.

SA21C-06 1135h

Imaging Radar Observations of the Auroral Electrojet During the JOULE Campaign.

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We have used aperture synthesis imaging techniques to observe the radar aurora with a 30 MHz radar from Anchorage, Alaska during the JOULE campaign. Radar imaging allows us to sort the echoes into bearing as well as in range and Doppler bins. Because of the high radar PRF and low radar frequency, the echoes we observed, both type 1 and type 2, were underspread, and the data therefore suffer no range, Doppler, or bearing ambiguities. The radar range and azimuth resolution was 2.5 km and about 0.4°, respectively, during our observations. We observed type 1 and type 2 echoes with Doppler shifts that varied rapidly and sometimes discontinuously with range and azimuth (and time), suggesting fine structure in the electric field on the scale of the radar resolution. Using regularization methods, it should be possible to infer the convection pattern in the volume illuminated by the radar and to calculate the contribution to the overall Joule heating rate from the fine structure. It will also be possible to make direct comparisons between the electric fields and winds measured in situ and the Doppler spectra measured by the radar for the first time.

URL: http://landau.geo.cornell.edu

SA21C-07 1150h

Relationship between magnetospheric energy sources and ionospheric variability during the substorm cycle

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Magnetospheric substorms produce intense localized perturbations in the ionosphere as a result of the dissipation of electromagnetic and kinetic energy. The true spatial-temporal variability of the ionospheric response is not captured by space-borne auroral imagers, nor by ground-based magnetometers, nor by coherent backscatter radars. Efforts to assimilate these diagnostics into a coherent picture of electrodynamic coupling are inherently unreliable during active periods. The undersampled variability cannot be treated as an averaging effect since the underlying physics is itself scale-dependent (e.g., Alfvenic versus inverted-V versus diffuse aurora). This paper considers the relationship between the magnetospheric energy source and small-scale ionospheric variability during the substorm cycle. A combination of space-borne measurements from FAST and IMAGE, and IS radar and optical measurements from the Sondrestrom facility is used to identify changes in the ionospheric plasma state (Te, Ti, Ne, Vi, and ion production rate) with respect to specific features in the magnetospheric source, thereby resolving the scale dependent physics. Implications for various approaches to modelling high-latitude MI coupling are discussed.

URL: http://isr.sri.com

SA21C-08 1205h

High-Resolution Limb Observations of Proton Aurora

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The interaction of precipitating protons in the upper atmosphere involves charge exchange, ionization, elastic and inelastic collisions, and the deposition of energy from the bottom of the F-region to the D-region of the ionosphere. These processes and the transport of incident protons through this range of altitudes has been described through a variety of modeling techniques but there has been a dearth of altitude-resolved observations of proton precipitation with which to validate such models. We present new limb observations of Doppler-shifted Lyman-α proton aurora emissions obtained by the High-resolution Ionospheric and Thermospheric Spectrograph (HITS) aboard the Advanced Research and Global Observation Satellite (ARGOS) that fill this niche. HITS performs limb scans that include tangent altitudes between 90 km and 400 km with approximately 5 km vertical resolution. The Doppler shifts of the proton aurora Lyman-α emissions are measured with 1.5 Angstrom resolution and are used to infer mean energies of the incident protons as a function of altitude. Observed energy-range (dE/dz) relations are compared to those predicted by a Monte Carlo simulation of proton transport in the upper atmosphere.

SA22A MCC: Level 1 Tuesday 1330h

Small-Scale Processes in the High-Latitude E Region III Posters

(joint with SM, AE)

Presiding: **M Conde,** University of Alaska**; M Larsen,** Clemson University

SA22A-0094 1330h POSTER

SMALL SCALE STRUCTURE IN THE HORIZONTAL NEUTRAL WIND FIELD AT SONDRESTROM (KANGERLUSSUAQ), GREENLAND

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The thermospheric neutral wind field at Sondrestrom (Kangerlussuaq), Greenland is monitored with two independent instruments: direct measurements of the neutral wind are obtained optically by a Fabry-Perot interferometer, while an incoherent scatter radar indirectly determines the wind from plasma drift measurements. The location of the aeronomical observatory places it under the auroral oval during dusk and dawn and within the polar cap during the midnight sector. During all of these periods, electron and ion precipitation enhance the ionization of the E and F regions of the ionosphere in localized regions. This paper will describe the neutral wind field during these auroral events. The morphology of the auroral emissions is characterized by all sky imagery, which provides a context to the more narrow fields observed by the wind monitors.

SA22A-0095 1330h POSTER

Determination of the Altitude of Cosmic Noise Absorption at Cusp Latitudes Using the Vertical Parallax Technique

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The overlapping beam patterns of two closely spaced imaging riometers have been used to make direct observations of the altitude of maximum ionospheric absorption of cosmic radio noise. The method employs the simple vertical parallax technique. One drawback of the riometry technique of observing density enhancements in the ionosphere has been its inability to retrieve direct height information regarding precipitation regions from absorption measurements. To obtain absorption height information requires either the application of a multifrequency technique, or coordination of riometer data and data from independent instruments such as iono-digisondes or incoherent scatter radar. The unique proximal location of the Southern Hemisphere Imaging Riometer Experiment *SHIRE*, located at Davis, Antarctica and the NIPR/STELab imaging riometer at Zhongshan, Antarctica, just 109km away, presents an opportunity to use parallax methods as a means of determining the altitude of Cosmic Noise Absorption in the cusp region, on an event basis. The relative fields of view of the two instruments have near optimal overlap for the application of parallax methods of this kind, with overlapping beams at any altitude above 40km. Using this new technique, we confirm the altitude of maximum radiowave absorption at between 90 and 100km *ionosphericDregion* for auroral zone precipitation on the nightside, indicating precipitation

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