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Numerous ground and space-based measurements have shown that the aurora modifies thermospheric composition by increasing, relative to diffusive equilibrium, the mixing ratio of heavy molecular species at higher altitudes. The presumed mechanism for this mixing has been vertical wind circulation driven by the aurora. However, prior to the HEX rocket mission, no experiment had ever tested this hypothesis by mapping the actual vertical wind field in the E-region near an individual auroral arc. With HEX, we measured the vertical wind as a function of latitudinal distance from a pair of quiet pre-midnight arcs, using a visible chemical trail deployed along a novel near-horizontal trajectory. Instruments aboard the rocket also observed the in-situ electron density and the auroral luminosity. The measurements were of high quality, and their outcome was clear: The hypothesis was false. No upwelling and no significant mixing were occurring due to this particular system of quiet arcs. Assuming these results are typical, HEX demonstrated that quiet pre-midnight arcs play little role in mixing the thermosphere. With its successful characterization of quiet-time "baseline" conditions, HEX now gives us the tool to study active post-midnight aurora that likely does drive the mixing that has been observed.

SA21B MCC: Level 1 Tuesday 0830h

Ionosphere Measurements and Models I Posters *(joint with AE)*

Presiding: **R E Daniell,** Computational Physics, Inc.

SA21B-0065 0830h POSTER

Ion temperature climate in the polar ionosphere using incoherent-scatter radars

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We focus on seasonal and solar activity dependences of the ion temperature in the polar ionosphere using data from several incoherent scatter-radars (ISR): the Sondrestrom ISR (67°N, 309°E, 74° magnetic latitude), the European Incoherent Scatter (EISCAT) UHF Tromsø radar (69°N, 19°E, 66° magnetic latitude), and the EISCAT Svalbard radar (ESR: 78°N, 16°E, 75° magnetic latitude). Since these radars are located at different magnetic latitudes, we can estimate the meridional structure of ion temperature from the statistical results calculated using long-term data sets. Below about 300 km, the energy transfer from neutrals to ions plays a significant role than that from electrons because the ion-neutral collision frequency is much higher than the ion-electron collision frequency for this height region. While studies of neutral temperature using the ion temperature data from ISRs have been conducted for more than two decades, the relationship between the ion and neutral temperatures is not well known at high latitudes because of recurrent joule energy dissipation. On the other hand, above 300 km the energy transfer from electrons through collisions becomes important with increasing heights. The statistical results from the EISCAT Tromsø radar data for about one solar cycle show that for summer the ion temperature in the upper F-region has higher values at local night than at local noon, and for other seasons daytime values are higher than night values. Statistical results for the ESR data show not only summer, but also some other seasons, show higher temperatures at local night than at local noon in this height region. In the case of the Sondrestrom radar data, the ion temperatures at summer night are also higher than the daytime values. These characteristics are not in agreement with standard model profiles of the ion temperature. The different characteristics suggest that the ion temperature climate in the polar ionosphere should have the meridional structure, which might be associated with the auroral oval. We will show these differences as well as other climate of the ion temperature in more detail in the presentation.

SA21B-0066 0830h POSTER

The Ionospheric Cusp, A Region of Thermospheric Up-welling

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The satellite CHAMP with its sensitive accelerometer on board provides the opportunity to investigate the thermospheric dynamics in great detail. On its near-polar, low-Earth (about 400 km) orbit it is well suited to map the air density along the track. In this study we concentrate on density structures in the auroral region. Special attention is paid to features in the cusp. During 25 Sep. 2000, the day we take as an example, air density enhancements of almost a factor of two are observed whenever the satellite passes the cusp region. For the interpretation of these events we consider also the concurrent ionospheric Hall and field-aligned currents (FACs) which are estimated from the magnetic field measurements. As expected, sizable currents are found in the regions of dense air. The reverse is however not always true. On the nightside there are partly even stronger currents, but no thermospheric response is observed. Small-scale FAC filaments (1-km size) seem to play an important role in the heating. Whenever these very intense FACs with amplitudes of several hundreds of A/km**2 show up, density enhancements occur. So far these FAC filaments have not received a lot of attention in the context of Joule heating. Our new observations suggest that the cusp, where small-scale FACs occur rather frequently, seems to be a prominent region for refilling the upper atmosphere.

SA21B-0067 0830h POSTER

Variability of High-Latitude Vertical Plasma Flux using DMSP Measurements

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We have examined characteristics of the vertical ion flux in the topside high-latitude ionosphere from measurements of the vertical ion drift and ion number density made by the DMSP F13 satellite. In the polar cap the vertical ion flux is uniformly downward at all locations. However, in the auroral zone the ion flux is highly structured and a net upward flux is produced only by spatially and temporally confined events containing upward fluxes in excess of 10^9 $cm^{-2}s^{-1}$ that have no downward counterparts. The distribution of the plasma's vertical flux varies by both season and solar cycle with wider variability occurring during winter and at lower levels of solar activity. We also look at variations of the upward flux events as a function of geomagnetic activity.

SA21B-0068 0830h POSTER

Ionospheric Data Assimilation 3D (IDA3D), SuperDARN, and Magnetometer Analysis of Currents Over Greenland

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A high latitude tomography array has been deployed and operated along the west coast of Greenland since September 2000. The array routinely produces two-dimensional images of electron density along the array axis. While two-dimensional images have tremendous value, in order to investigate the structure of conductances and currents a local three-dimensional analysis is necessary. We have recently developed a full three-dimensional space weather analysis algorithm called ionospheric data assimilation 3D (IDA3D). In addition to the tomographic data from the Greenland array, this algorithm ingests data from ground GPS, GPS occultations, ionosondes and DMSP measurements to compute the 3D electron density over the entire high latitude ionosphere. From the three-dimensional estimation of electron density, local estimations of conductances can be derived. By combining the IDA3D estimation of conductances with convection velocities measurements from SuperDARN and magnetometer measurements we are able to investigate the local three-dimensional structure of current density over Greenland. We present an analysis of the local Greenland current density structure. The analysis includes combining IDA3D derived conductances with SuperDARN convection velocity measurements to obtain currents, which can then be compared with equivalent currents obtained from magnetometer data. Conversely, magnetometer estimates of equivalent currents can be combined with IDA3D conductances and compared with SuperDARN convection velocities. Results are presented for several days analysis in winter of 2001.

SA21B-0069 0830h POSTER

Energy Distribution of Precipitating Electrons Estimated From Optical and Cosmic Noise Absorption Measurements

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This study is a statistical analysis on energy distribution of precipitating electrons, based on CNA (cosmic noise absorption) data obtained from the 256-element imaging riometer in Poker Flat, Alaska, and optical data measured with an meridian scanning photometer over 79 days during the winter periods from 1996 to 1998. On the assumption that energy distributions of precipitating electrons represent Maxwellian distributions, CNA is estimated based on the observation data of auroral 427.8-nm and 630.0-nm emissions as well as the average atmospheric model, and compared with the actual observation data. Although the obsevation data have a broad distribution, they show systematically larger CNA than the model estimate. CNA determination using kappa or double Maxwellian distributions, instead of Maxwellian distributions, better explains the distribution of observed CNA data. Kappa distributions represent a typical energy distribution of electrons in the plasma sheet of the magnetosphere, the source region of precipitating electrons. This result suggests that the energy distribution of precipitating electrons reflects the energy distribution of electrons in the plasma sheet.

SA21B-0070 0830h POSTER

A Sequential Sounding Rocket Flight Through Nighttime Midlatitude Plasma Layers

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A sequential rocket campaign launched out of NASA's Wallops Island Flight Facility (37.84N, 75.49W) sent four rockets though Sporadic-E and a suspected intermediate layer during one night in July of this year. The four payloads were launched between the hours of 3:19 and 7:07 GMT. Three of the rockets were mother-daughter payloads equipped with plasma impedance probes supplied by Utah State University and TMA chemical releases from Clemson University. The fourth rocket housed an electric field instrument, an ion mass spectrometer, and the new neutral wind instrument from the University of Texas Dallas along with a set of plasma impedance probes from Utah State University. An overview of the UTD instruments and the ionospheric conditions as derived from these data will be presented herein.

SA21B-0071 0830h POSTER

Mode-conversion effects in modeling ionospheric interaction experiments

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The propagation of radio waves in an inhomogeneous magnetized plasma with a complex permittivity tensor is investigated to study linear mode-conversion during ionospheric modification experiments. Time-dependent Schrodinger type equations are derived for the propagation of the O and X modes in inhomogeneous magnetized plasmas. The one-dimensional (1D) and two-dimensional (2D) full-wave electromagnetic codes to solve these equations with implemented perfectly matched layer boundaries have been developed. Recent results in ionospheric modification studies at high latitude facilities (Tromso, HAARP) and earlier experiments at the Sura facility, have indicated that the enhancement caused by HF radio waves is localized near the field-aligned position. Analysis of the numerical results for a normal vertically stratified ionosphere and a tilted ionosphere will be presented. We will also present results relevant to the E-region experiments at Tromso. The topside E-region enhancements observed are likely due to linear mode conversion and Z mode propagation to the topside E region. The characteristics of the mode-conversion process have been investigated for linear and parabolic density profiles as the angle of incidence of the heater wave is varied.

SA21B-0072 0830h POSTER

Effect of the Theta Aurora on the Polar Thermosphere

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The theta aurora is characterized by a transpolar auroral arc, connecting the dayside to the nightside auroral oval A high-resolution time-dependent model of the global thermosphere is used to estimate the effects of this transpolar arc on the polar thermosphere. A background ionospheric model is assumed, and a simple but physically plausible representation of the ionospheric conditions within the transpolar arc is "superimposed" on the background ionosphere. The thermospheric model is then solved both with and without the imposed transpolar arc to determine the arc's effects on the neutral gas. In particular, percentage changes in thermospheric mass density and temperature are computed. These percentage differences are significant and are seen to vary systematically with the level of the ionospheric density enhancement within the arc. A strong dependence on solar activity level is also noted.

SA21B-0073 0830h POSTER

High resolution three-dimensional simulations of structuring of polar cap patches

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Results from three-dimensional (3D) nonlinear simulations for investigating density and velocity structuring of high latitude plasma patches will be presented. The high-resolution data from these simulations obtained with our parallel 3D finite difference code, has a dynamic range that allows us to make detailed comparisons with observed spectra for the density and velocity fluctuations. These results are compared with data from our earlier simulations as well as with those from DE/DMSP satellites. TEC plots similar to ones for real data have been constructed to compare with observations. Also statistical comparisons to produce histograms of characteristics of leading and trailing edges of the patch to compare with the work of Cooley and Heelis have been performed. The present model shows very good agreement with observations thereby providing a first principle understanding of the cause of the observed structuring in high latitude patches.

SA21B-0074 0830h POSTER

The Neutral Polar Wind

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The classical polar wind is an ambipolar outflow of ions from high latitudes along open geomagnetic field lines. The polar wind consists of light thermal ions (H^+, He^+), and energetic light and heavy ions (H^+, He^+, O^+). The characteristics of these ions have been studied quite extensively since the 1960's. In just the last 20 years, however, energetic neutral atoms (ENA) that are produced in charge exchange reactions between the singly ionized polar wind ions and the surrounding neutral atoms have been used as a means to remotely probe plasma populations. Recent estimates for neutral outflow integrated fluxes from the LENA instrument on board the IMAGE spacecraft have shown values of 1-4x10^9 $cm^{-2}s^{-1}$, with a considerable diurnal variation. The theoretical model used in this study is similar to the high-altitude hydrodynamic polar wind model developed at Utah State University, and has been expanded to include the effects of neutral stream particles between the altitudes of 500 km and 9000 km. The model results show a high neutral outflow flux on the order of 10^9 $cm^{-2}s^{-1}$, which would seem to be in agreement with the LENA instrument data.

SA21B-0075 0830h POSTER

Active Role of the Ionosphere in M-I Coupling

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Magnetosphere-ionosphere (M-I) coupling is a key element in solar-terrestrial physics and is of fundamental importance to space weather forecast. In the traditional research approach of M-I coupling processes, the ionosphere is treated as a passive medium. Even in the most recent coupled global magnetosphere-ionosphere models, the active role of the ionosphere has not been fully appreciated. Using a self-consistent M-I coupling model, it will be shown that the ionosphere can generate its own field-aligned currents and develop its own structured electric field and their impacts on the M-I coupling will be discussed. Also the approach of how to improve the M-I coupling component in the coupled global magnetosphere-ionosphere models will be suggested.

SA21B-0076 0830h POSTER

Plasma Viscous Heating in Sheared Regions of the High Latitude Ionosphere

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A sheet of plasma with elevated ion and electron temperatures has been observed in the high latitude ionosphere with the EISCAT tri-static UHF radar in Northern Scandinavia. The sheet has a thickness of about 100-200 km along geomagnetic latitude or 1-2 degrees and is extended in altitude from about 200 km to beyond the highest measured altitude of 500 km. Both temperatures are several times hotter in the sheet than in the surrounding plasma, reaching up to 7000 K in some occasions. The transition from background values of 1000-2000 K is very sharp. The hot sheet or hot spot is aligned precisely with a region of large velocities and very large shears in the ionospheric plasma convection pattern. The shear is manifested mostly by abrupt changes in direction – which some times may result in reversals – and sometimes by transitions to very low velocities. Numerical solutions of the energy balance equation including viscous heating as the source and convection and conduction as the sinks reproduce the measurements well indicating that energy of magnetospheric origin is primarily transfered to the ionosphere by viscous heating in regions of high convection velocity shears.

SA21B-0077 0830h POSTER

Modeling the Neutral E Region Response to the Recovery Phase Diffuse Aurora

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Measurements from chemical release experiments within the dusk sector recovery phase diffuse aurora, and observations made during ARIA (Atmospheric Response in Aurora) and pre ARIA rocket campaigns within the dawn side diffuse aurora, reveal very large neutral winds in the E region, with strong vertical shears. Winds of 150 to 200 m/s were found around 110 to 120 km altitude within the dawn sector diffuse aurora, and even larger winds of 350 to 400 m/s were found in the dusk sector around 130 km. Winds of this magnitude are hard to explain in terms of geomagnetic forcing at E region altitudes and the reasons for such large winds are still not fully understood. Both dawn and dusk sector observations show very strong vertical structure, and regions below the vertical shears sometimes appear to be unstable, with Richardson number less than 0.25. Instabilities associated with these shears could produce turbulence, enhanced eddy diffusion and strong localized composition changes, and may feedback into auroral generation processes or produce various types of waves. Recent work suggests that tidal forcing plays an important role in producing the wind structures observed within the dawn sector diffuse aurora during the ARIA I campaign. However, the relative importance of tidal and geomagnetic forcing in producing the strong vertical variations in the winds is not well known. Also it is not known whether the different conditions for accelerating winds in the pre and post midnight sectors of the auroral oval produce significantly different neutral responses on the dawn and dusk sides of the diffuse aurora. Simulations have been performed using a 3-dimensional, high resolution, limited area model developed at UCLA, to try to determine the processes that are responsible for producing the strong vertical variations seen in the neutral atmosphere within both the dawn and dusk side diffuse aurora. Global background winds and tides have been provided by the CTIP (coupled thermosphere ionosphere plasmasphere) model. The sensitivity of the response to varying auroral forcing parameters and to changing background conditions of winds, tides and interplanetary magnetic field have been investigated.

SA21B-0078 0830h POSTER

Examing the Effects of Different IMF, F10.7, and Auroral Inputs on the Thermospheric Neutral Winds

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To obtain a better understanding of how the magnetosphere effects the global thermospheric and ionospheric structure, we conduct some numerical experiments using the University of Michigan's Global Ionosphere-Thermosphere Model (GITM). We have run GITM to roughly steady-state using different strengths of the high-latitude electric potential pattern, F10.7, and auroral inputs to determine how these effect the temporal history and stead-state of the thermospheric neutral winds. Our model reproduces the well known fact that the neutral winds are strongly driven by the ion convection above approximately 300 km, and that the ramp-up time is very dependent upon the altitude. We show quantitative results of the ramp-up times and maximum neutral wind speeds for the different driving conditions.

SA21B-0079 0830h POSTER

Winds in the High-Latitude Lower Thermosphere Estimated From the TIEGCM

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To better understand how high-latitude electric fields influence thermospheric dynamics, we study winds in the high-latitude lower thermosphere using the Thermosphere-Ionosphere-Electrodynamics General Circulation Model of the National Center for Atmospheric Research (NCAR/TIEGCM). In order to compare with Wind Imaging Interferometer (WINDII) observations the model is run for the conditions of 1992-1993 southern summer. The association of the model results with the interplanetary magnetic field (IMF) is also examined to determine the influences of the IMF-dependent ionospheric convection on the winds. The wind patterns show good agreement with the WINDII observations, although the model wind speeds are generally weaker than the observations. It is confirmed that the influences of high-latitude ionospheric convection on summertime thermospheric winds are seen down to 105 km. For negative and positive IMF By the difference winds, with respect to the wind during null IMF conditions, show significantly strong anticyclonic and cyclonic vortices, respectively, down to 105 km. For positive IMF Bz the difference winds are largely confined to the polar cap, while for negative IMF Bz they extend to subauroral latitudes. The IMF Bz-dependent diurnal wind component is strongly correlated with the corresponding component of ionospheric convection velocity down to 108 km and is largely rotational. The influence of IMF By on the lower thermospheric summertime zonal-mean zonal wind is substantial at high latitudes, with maximum wind speeds being 60 m/s at 130 km around 77 magnetic latitude.

SA21B-0080 0830h POSTER

Large-scale Structure of Equatorial Plasma Depletions, With Implications for Seed Populations

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There is mounting evidence that the seed perturbations, which initiate bubble formation, may directly influence large-scale depletion features, and may also account for some of the observed variations in seasonal and longitudinal (s/l) bubble occurrence. While previous scintillation and in-situ studies have examined occurrence frequency patterns, they do not readily isolate the effect of seeds. We characterize pre-midnight depletion regions here in terms of their large-scale properties of width, depth, and spacing. Our results demonstrate that large-scale bubble features vary significantly with longitude and season, and point to a similar variation in seed properties.

SA21B-0081 0830h POSTER

On the Effect of Modified High-Latitude Drivers (Convection and Precipitation) on the Ionospheric Plasma Density Distribution

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We present our work in developing and testing the high-latitude drivers for Utah State University (USU) GAIM (Global Assimilation Of Ionospheric Measurements). GAIM uses a physics-based model and a Kalman filter as a basis for assimilating a diverse set of real-time (or near real-time) measurements. Particle precipitation and convection patterns are the high-latitude drivers for GAIM. The Weimer convection model [*Weimer, JGR, 2001*] and Hardy precipitation model [*Hardyetal, JGR, 1985*] represent climatological patterns for these drivers. On any given day, the climatological drivers differ significantly from the real-time drivers. For ionospheric specifications and forecast, real-time high-latitude drivers are needed to get a more realistic prediction for the ionosphere. New modified high-latitude divers are developed by using real-time in situ DMSP satellite measurements. To investigate the effect of the modified drivers on the ionosphere, the climatological and modified high-latitude drivers are used to drive the Ionosphere Forecast Model (IFM) and the calculated plasma densities are then compared to the in situ densities measured along the DMSP orbits.

SA21B-0082 0830h POSTER

Enhanced Auroras and Current Driven Instabilities in Thin Ionization Layers

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Natural auroras frequently exhibit enhanced intensity within relatively thin (1 km) horizontal layers [Hallinan, J. Geophys. Res., 8461, 1985]. These layers appear to be relatively stable atmospheric structures. Radar observations also show enhancements in the background electron density around the same altitude. The electron enhancement is related to an accumulation of heavy Fe and Mg into thin layers, which occurs for specific orientations of the ionospheric electric field. The similarity in altitude and duration of the enhanced aurora and heavy ion layers suggests a connection. We investigate instabilities that occur in dense, heavy ion layers in the presence of strong cross-field currents that accompany electron precipitation. The growth rate of the lower hybrid drift instability is increased in the dense, heavy ion layer, and ambient electrons may be heated into a suprathermal tail. Such electrons could produce enhanced emissions in the aurora. We present analytical full-wave solutions and full-particle electrostatic simulations of the nonlinear development of the instability.

SA21B-0083 0830h POSTER

The Linear Dependence of the Post-sunset Equatorial Anomaly Electron Density on Solar Flux, and its Relation to the Linear Dependence of the Maximum Pre-reversal ExB Drift Velocity on Solar Flux.

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The maximum F layer electron density which occurs in the post sunset equatorial anomaly near 2100 LT, Nemax, has been found to be a linear function of the maximum pre-reversal ExB drift velocity. The results, based on measurements on each day of a solar maximum year, are extended here to study the dependence of this relation on solar flux. The source of the data is an array of 10 ionospheric sounders located from eastern Asia through the Pacific to the Americas, and situated at both north and south dip latitudes. Nemax recorded at each location is examined as a function of solar flux over the range from 70 to 285 solar flux units on a monthly basis during the 13 years of an entire solar cycle. The principal result is that the monthly median Nemax increases linearly with the monthly average solar flux, Sa, at each location for each month for the entire range of time and Sa. The linear function varies continuously by month at each location, and although magnitudes differ between locations, at each location maxima are in the equinoxes and minima are in the solstices. Because of this linearity, the entire dependence of Nemax on Sa over the solar cycle can be represented the 2 parameters, slope and intercept of the line for each month for each location. The further understanding of this linearity lies in the fact that ExB drift also increases linearly with Sa. As measured at Jicamarca, the linear function is greatest in the equinoxes, least near June and intermediate near December, a seasonal dependence which is very similar to that of Nemax measured at the same longitude as Jicamarca. As derived from these two relations to Sa, Nemax is nearly the same linear function of ExB as that found in the earlier study, implying that the function is independent of solar flux.

SA21B-0084 0830h POSTER

Ionospheric signatures of Lightning

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The geostationary metrology satellite (GMS) monitors motions of thunderstorm cloud, while the lightning detection network (LDN) in Taiwan and the very high Frequency (VHF) radar in Chung-Li (25.0°N, 121.2°XE) observed occurrences of lightning during May and July, 1997. Measurements from the digisonde portable sounder (DPS) at National Central University shows that lightning results in occurrence of the sporadic E-layer (Es), as well as increase and decrease of plasma density at the F2-peak and E-peak in the ionosphere, respectively. A network of ground-based GPS receivers is further used to monitor the spatial distribution of the ionospheric TEC. To explain the plasma density variations, a model is proposed.

SA21B-0085 0830h POSTER

Comparison of DMSP SSIES Density and Temperature Measurements With Ground-Based Incoherent Scatter Radar Data

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We have compared electron density and temperature data, measured aboard the Defense Meteorological Satellite Program (DMSP) spacecraft, against POLITE campaign data collected by the Millstone Hill incoherent scatter radar. The POLITE data span the period between February 1996 (near solar minimum) and July 2000 (near solar maximum). Following the work of Sultan and Rich [2000], we averaged the DMSP data within a five-degree circle of Millstone Hill, and averaged the corresponding radar data within $\pm$30 minutes of the satellite overflight time. Our study revealed that the average electron density difference between DMSP and Millstone data exceeds 20 percent, which is statistically significant compared to the published DMSP topside ionospheric plasma monitor (SSIES) instrument accuracy. Further, DMSP density values are typically lower than the corresponding radar measurements; this negative bias is largest near solar minimum. Conversely, DMSP electron temperature values are an average 23 percent higher than the radar-derived temperature. This difference is statistically significant compared to both the DMSP and radar errors. As with the electron density, the bias lessens toward solar maximum. This temperature bias appears to decrease as the DMSP zenith angle increases, and this suggests the possibility of increased photoelectron contamination of the Langmuir probe for smaller zenith angles. Apart from this, however, the root cause(s) for these density and temperature differences remain under study.

SA21B-0086 0830h POSTER

Observations of Langmuir Waves in the High-Latitude Winter Auroral Ionosphere

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In late January and early February of 2003 the EISCAT Svalbard Radar (ESR), located on Spitsbergen in the Arctic Ocean at 78 degrees north latitude, was used to observe incoherent scatter plasma lines due to backscatter from ionospheric Langmuir waves over a frequency band covering approximately 3.3 to 4.7 MHz. The observations were performed during the early morning hours of 6 to 10 AM local time (5-9 UT). These are the first plasma line observations with the ESR, as plasma line receivers had been installed in the 32-m, fully-steerable antenna system just two weeks before. In addition, during 2002 the ESR data-taking system was upgraded to make it much easier to record unprocessed raw data, which in the case of this plasma line data provided a maximum time resolution of between 50 and 200 ms. A 550-microsecond pulse was used with four radar frequencies, transmitted in alternating pairs of pulses. During the observations the antenna was pointed along the geomagnetic field line (82-degree elevation angle). Both up- and downshifted and both bottomside and corresponding topside F-region plasma lines were observed, and simultaneous ion line data was also recorded. There were no local photoelectrons present during the observations, as it was dark (early morning, late January, 12 degrees latitude from the north pole) and thermal-level Langmuir waves are normally too weak to produce observable plasma lines. Most of the observed lines are likely due to backscatter from Langmuir waves enhanced by a background "drizzle" of energetic particles. The altitudes of some of the plasma line enhancements were quite irregular with time, changing by roughly 100 km in a period of a few seconds, which may reflect the irregular characteristics of the precipitating drizzle. There may also be some contributions from conjugate photoelectrons. Some of the enhancements may be associated with backscatter from nonthermally-enhanced ion-acoustic waves via the natural excitation by energetic particles of parametric and/or cavitating Langmuir turbulence. Several examples are presented which illustrate the characteristics of natural plasma lines in the high-latitude winter auroral ionosphere.

SA21B-0087 0830h POSTER

Total Electron Content in Nighttime Equatorial Ionosphere: Theoretical Calculations and Comparisons With Data

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Theoretical calculations of the electron density distribution in the nighttime equatorial ionosphere are presented. Particular attention is given to the total electron content (TEC) in the Appleton anomaly region and its dependence on the vertical plasma drift velocity, which is enhanced after sunset. The calculations are done by assimilating plasma drift velocity measured by Jicamarca incoherent scatter radar into the low-latitude ambient plasma density model, which has been developed at the Air Force Research Laboratory (AFRL) in support of the C/NOFS mission. Specifically, drift velocity data for fourteen days in 2002 covering a wide range of values for the maximum value of the post-sunset drift velocity are used in the calculations. The latitudinal profiles of the calculated TEC are compared with those obtained from GPS and TOPEX measurements, and are found to be in reasonably good agreement. Relationships between the maximum value of the post-sunset plasma drift velocity and the various parameters that characterize the nighttime anomaly are also examined. It is found that definite linear relationships with statistically significant correlation coefficients exist between the maximum value of the post-sunset drift velocity and the peak-to-valley ratio of anomaly TEC. The significance of this finding lies in the fact that the maximum value of the post-sunset vertical drift velocity is an important, perhaps the most important, plasma parameter for determining both the intensity and the latitudinal distribution of equatorial scintillation. When this plasma parameter is not available from any direct measurement, the linear relationships may be used to estimate it from the peak-to-valley ratio of anomaly TEC, which, in turn, can be derived from the ultraviolet (UV) imagery data of the anomaly region acquired by GUVI on TIMED and hopefully by SSUSI on DMSP and by similar sensor on NPOESS. The theoretically derived linear relationships are compared with similar relationships suggested by the TEC data obtained from GPS measurements.

SA21B-0088 0830h POSTER

Variations of total electron content as influenced by geomagnetic activity

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A recent statistical study based on one year's worth of data has shown that the geomagnetic activity as inferred by the geomagnetic storm index, Dst, is one of the driving forces on the occurrence of seasonal peaks of ionospheric total electron content (TEC) in the northern hemispheric equatorial anomaly region [Wu et al., 2003]. In this study we use three years' worth of published TEC data (October 1985 - September 1988) by Huang et al [1989] to further study the geomagnetic effect. It is found that the monthly peaks of seasonal equatorial anomaly (four maxima and six minima) of the TEC during this period are well correlated with the monthly peaks of the Dst index, with three exceptions. These exceptions are also investigated. Detail data will be presented. Possible mechanisms associated with geomagnetic activity that affect the TEC anomaly will be discussed. Wu, C.-C. et al., variation in the Equatorial Anomaly Region during the solar minimum: September 1996 - August 1997, J. Atmos. Terr. Physics, in revision, 2003. Huand, Y.-N. et al., JGR, 94, 13515, 1989.

SA21B-0089 0830h POSTER

Comparison of IRI-2001 With TOPEX TEC Measurements

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The International Reference Ionosphere (IRI) is an international joint project of the Committee on Space Research (COSPAR) and the International Union of Radio Science (URSI). As one of the most comprehensive empirical models of the ionosphere, the IRI provides the electron density, electron temperature, ion temperature, and ion composition in the altitude range from about 50 km to 2000 km, and also the TEC for a given location, time and date, based on the various measurements from the ground and space. During the last decade, the TOPEX/POSEIDON satellite mission has provided a wealth of data pertaining to TEC measurements over the oceans, and these data can be used to further improve the IRI. With this in mind, we compared a 10-year TOPEX TEC dataset with IRI predictions. The study covered solar cycle, seasonal, geomagnetic activity, and longitudinal variations. The resulting comparisons provide information on how to improve the IRI over the ocean areas. For low solar activity, IRI slightly overestimates TEC at low latitudes and underestimates it at middle and high latitudes at all local times. For the high solar activity, however, a large underestimate appears at low latitudes and extends to mid-latitudes, but with a smaller magnitude. At high latitudes, the IRI TEC shows an overestimate in both hemispheres for equinox and in the winter hemisphere for solstice, but it underestimates in the summer hemisphere. For the geomagnetic activity, we observed little effects on both TEC maps. Another important result is that right after sunrise, the IRI TEC at low latitudes starts to increase always earlier than the TOPEX TEC. At low latitudes, the TOPEX TEC shows stronger annual and semiannual variations than the IRI TEC, and at higher mid-latitudes, both TECs show the seasonal anomaly for high solar activity. Finally, both IRI and TOPEX TEC maps show significant longitudinal variations.

SA21B-0090 0830h POSTER

Solar Activity Variations in the Topside Ionosphere

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The fundamental properties of the topside ionosphere are dependent on the low altitude F region plasma and neutral dynamics. Variations in solar activity can cause pressure gradients to drive neutral winds in the F region. These winds blowing from one hemisphere to another can raise the F peak in one hemisphere and lower it in the other hemisphere. This leads to field aligned motion of plasma in turn affecting composition and temperature in the topside. In this study, data are obtained from the Defense Meteorological Satellite Program (DMSP) satellites for varying levels of solar activity. Variations driven by solar activity within a month (for e.g. during equinox) and for the same months, the average F10.7 level is representative of the sunspot cycle. The aim here is to understand solar activity influences on the topside over periods ranging from many years (for e.g. fraction of a solar cycle) to a few months. During solstices, solar activity will additionally drive variations in E x B drifts and neutral winds responsible for changing the behavior in the topside. The extent to which these variations are seen over a period of a few months versus period of a few years (for e.g. fraction of a solar cycle) will be also investigated by examining daytime and nighttime passes.

SA21B-0091 0830h POSTER

Helium ion Measurements From the Arecibo Incoherent Scatter Radar and the DMSP Satelites

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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 revealed 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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