Diurnal variations of energy distributions of hotO(3P) and O(1D) atoms in the thermosphere and the upper mesosphere are investigated. The rate of atmospheric heating by hot oxygen atoms and non-equilibrium rates of atmospheric chemical reactions involving O(3P) and O(1D) atoms are calculated using non-thermal distributions of oxygen atoms. The non-Maxwellian energy distributions of the ground state and metastable oxygen atoms are determined by solutions of the coupled kinetic equations describing the energy relaxation of the fast O atoms in elastic and quenching collisions with the ambient gas. Quenching collisions of metastable oxygen atoms with N2, O2 and O are secondary sources of energetic O(3P) atoms. Relative fractions of metastable atoms in non-thermal distributions are calculated and compared with results of previous modeling.

SA72A-0516 1330h POSTER

The Response of the Martian Thermosphere/Ionosphere to Enhanced Fluxes of Soft X Rays

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We investigate the response of the thermosphere/ionosphere of Mars to enhanced fluxes of solar soft x rays, as have been measured by the SNOE satellite and the SEE instrument on TIMED. We model the Martian upper atmosphere for both high and low solar activities, with fluxes from both Hinteregger and Tobiska. We find that the lower peak in the electron density profile is increased, especially at high solar activity. The odd nitrogen densities in the lower thermosphere are enhanced, but the NO densities remain relatively constant. Only the N densities are significantly larger. Thus larger fluxes of solar soft x rays cannot account for the large NO densities measured by Viking 1 below 140 km, but can account for the often prominent peak seen below the main ionospheric peak by the MGS radio occultation measurements.

SA72A-0517 1330h POSTER

Sources of 5.3 μm emission from NO observed by SABER

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The SABER (Sounding of the Atmosphere by Broadband Emission Radiometery) instrument aboard the TIMED (Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics) satellite has made spectacular observations of emission from NO around 5.3 μm under diverse geophysical conditions. This fundamental vibration-rotation band emission from vibrationally excited NO in the terrestrial thermosphere may by produced by the inelastic collisions of the ground state NO with O, and also by the highly rotationally and vibrationally excited NO resulting from the reaction of $N(^4S)$ and $N(^2D)$ atoms with O_2. While the 5.3 μm emission resulting from the inelastic process is always there, that due to chemiluminescent processes may be very strong or may be entirely absent depending upon the geophysical conditions. In this talk we quantatively calculate the source of 5.3 μm emission transmitted by the SABER filter as function of altitude for a few geophysical parameters. We also give the contributions of these sources as a function of tangent height to compare our calculations with the SABER observations so that these impressive observations may of greater use to the scientific community.

SA72A-0518 1330h POSTER

Oxygen Molecular Spectroscopy: The Impact of Astronomical Sky Spectra

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Astronomical sky spectra obtained at the W. M. Keck Observatory on Mauna Kea have greatly increased our knowledge of the spectroscopy of the O_2 molecule. In the past, high-resolution studies on O_2 have been largely limited to absorption measurements from the ground state, and those electronic states and vibrational levels that can not be accessed in that way have essentially not been studied. We will review the new nightglow data in this presentation. Included are the following cases, where measurements are made with an instrumental resolution of about 40,000:

1) $O_2(X^3\Sigma_g^-)$, v = 0-15, J = 0-25 (much higher for v = 0,1)

2) $O_2(a^1\Delta_g)$, v = 1-10, J = 2-25

3) $O_2(b^1\Sigma_g^+)$, v = 0-15, J = 0-25 (much higher for v = 0,1)

4) $O_2(A'^3\Delta_u,[\Omega=3])$, v = 2-10, J = 2-25

We also find it possible to carry out spectroscopy on the b-X 0-0 band from the ground, the atmosphere being relatively transparent to high-J lines originating in the ionosphere. In addition, a new O_2 emission system has been discovered, the $c^1\Sigma_u^-$ - $b^1\Sigma_g^+$ bands. There has been a synergistic effect of the existence of such data on laboratory studies, where information is now available for both the $a^1\Delta_g$ and $b^1\Sigma_g^+$ states in the v = 10-25 range, not only in terms of spectroscopy, but also for removal rate coefficients and reaction pathways.[1]

We are grateful to the various astronomers who have shared their Keck sky spectra with us. This study has been supported by the NSF Aeronomy program.

[1]K S Kalogerakis, A Totth, P C Cosby, T G Slanger, and R A Copeland, Laboratory studies of the production of highly vibrationally excited $O_2(a^1\Delta_g$ and $b^1\Sigma_g^+)$ from $O_2(A^3\Sigma_u^+)$ relaxation, Eos Trans. AGU 81, F944 (2000).

SA72A-0519 1330h POSTER

The Far-Ultraviolet Emission From SO_2 by Electron Impact

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The auroral FUV observations of IO by the Space Telescope Imaging Spectrograph (STIS)on board the Hubble Space Telescope (HST) revealed strong emission features of atomic sulfur and atomic oxygen. For the purpose of interpreting these observations laboratory studies of electron-impact UV emission spectrum of S and O bearing species become necessary. Electron-impact UV emission spectrum of SO_2 has been studied from 1250 - 1490$\AA$ at high resolution (0.1$\AA$) using 100 and 30eV electrons. The laboratory spectrum emitted by dissociatively excited atomic sulfur from SO_2 has been compared with HST STIS observations for IO and also with the model spectrum of electron excitation of atomic Sulfur. FUV emission cross sections have been established for fine structure spectral lines of neutral and ionic O and S produced by collision of 100 and 30eV electrons with SO_2 molecules.

SA72A-0520 1330h POSTER

VUV Photoabsorption Cross Section Measurements of Carbon Dioxide in Support of Analyses of Planetary Atmospheres

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We report preliminary measurements of carbon dioxide photoabsorption cross sections in the 106 to 120 nm region. CO2 is the principal constituent of the atmospheres of Mars and Venus. Its dissociation by ultraviolet solar radiation initiates the production of non-thermal atoms that may escape these atmospheres, and leads, through further photochemistry, to ultraviolet and visible airglow features. The analyses of recent high-quality VUV observations of emission features in the Martian atmosphere and the modeling of non-thermal escape mechanisms from the Martian and Venusian atmospheres are limited by poorly and incompletely characterized CO2 VUV photoabsorption cross sections.

We recently tested the feasibility of a new measurement program for CO2 absorption cross sections in the 91 to 120 nm region at 295 K and 195 K. Our preliminary results for the 106 to 120 nm region derive from that feasibility study. Our measurements, at a resolution of 0.05 , were carried out on the 3-meter normal-incidence vacuum monochromator on the BL-20A beam line at the Photon Factory synchrotron facility in Tsukuba, Japan. Two points are evident from the preliminary spectra: (a) there is significant spectral structure in the CO2 absorption cross section that is not resolved in earlier lower-resolution work, and (b) there is clear evidence of systematic underestimation of peak absorption cross sections for the strongest CO2 features in the existing literature - a consequence of inadequate instrumental resolution.

SA72B MCC: Hall D Sunday 1330h

Ionosphere-Thermosphere Modeling Posters *(joint with SM)*

Presiding: **H F Parish,** University of California, Los Angeles**; A G Burns,** National Center for Atmospheric Research

SA72B-0521 1330h POSTER

Nonlinear Energy Transfer from Linear Right-hand polarized Instabilities to Left-handed waves

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Is shown that an ion-beam plasma electromagnetic right-hand polarized instability can be stabilized at the expense of nonlinear growth of left-hand polarized waves. In other words, due to nonlinear effects, left-hand polarized Alfvén or ion-cyclotron waves can grow even when the system is left-hand polarized linearly stable. This phenomenon constitutes a nonlinear dissipation mechanism for right-hand polarized instabilities.

SA72B-0522 1330h POSTER

Structuring of full plasma patches in the high latitude with realistic drives-continued.

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The robustness of plasma patches, in spite of structuring by a combination of gradient drift and secondary Kelvin-Helmholtz (KH) instabilities, has been attributed to the strong stabilizing influence of dynamics of electrons along the field line and the break-up of the gradient drift instability driven fingers by secondary KH instabilities. Another physical effect that contributes significantly to the robustness of the patch is the variability of the convection of the patch over the polar cap region. Recently we have developed a parallel version of our 3D code, which can run on the IBM SP. We will present results of a set of runs with realistic convective drives obtained from MHD simulations of real event studies of substorms. The goal is to develop a database to provide statistical information on the nature of structuring in high latitude plasma patches. We are also developing diagnostic capabilities to compare with reconstructed images of the 3D transverse as well as parallel structure of the irregularities.

SA72B-0523 1330h POSTER

The Spin-Up Circulation of High-Latitude Ion Drag-Driven Gyres

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We have used a model of thermospheric gyres with simplified geometry (azimuthally symmetric cylindrical coordinate) to study dynamical adjustment for high-latitude gyres spun up into rapid motion by ion drag. We examine the radial circulation forced by dynamical imbalances when winds are spun up subject only to circum-gyre ion-drag forcing resulting from strong radial electric fields. Our major finding is that the divergent radial wind driven by the imbalance between the inertial forces (centrifugal and Coriolis) and the pressure gradient force during spin-up is a significant contributor to the radial circulation forced by all sources. While diabatic heating over the polar cap acts to elevate the temperature over the polar cap as a whole, the changes induced by the dynamically induced circulation account for the fact that cyclonic gyres in the lower thermosphere are relatively colder and denser and the anticyclonic gyres are relatively warm and less dense. We suggest that this is a result of a dynamical adjustment in which the divergent radial circulation attempts to bring the ion drag-driven circum-gyre winds into a balanced state resembling gradient wind balance.

SA72B-0524 1330h POSTER

The Closure of the Hall Currents During Substorms and Its Ground Magnetic Effects

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In the study of high-latitude electrodynamics of the M-I system, two assumptions have been widely used. One is that the field-aligned currents are solely closed by the Pedersen currents in the ionosphere and the Hall currents are divergence-free. The other is that the ground magnetic disturbances associated with the currents in the ionosphere are caused by the Hall currents only. By using an M-I coupling model, in which the electrodynamics is fully self-consistent via an Alfven wave approach, and a magnetic inversion model, we will clearly demonstrate that these two assumptions can become totally invalid when the M-I system is in disturbance conditions, especially during substorm periods. We will quantitatively show how a significant amount of the Hall currents in the substorm onset regions is closed by the field-aligned currents and how the Pedersen and field-aligned currents make significant magnetic disturbances on the ground. We conclude that the electrodynamic M-I coupling approach characterized by Alfven waves is essential for a more accurate and realistic description of the high-latitude ionospheric electrodynamics as well as the associated ground magnetic disturbances.

SA72B-0525 1330h POSTER

Ionospheric Dynamo Currents and Magnetic Perturbations at the Ground and Above the Ionosphere Modeled by the TIEGCM

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The National Center for Atmospheric Research Thermosphere-Ionosphere-Electrodynamics General-Circulation Model (TIEGCM) is used to study the spatial and universal-time variations of electric currents generated by the ionospheric wind dynamo, and their associated geomagnetic perturbations at the ground and at low-Earth-orbit (LEO) altitudes. By comparing the geomagnetic perturbation at the ground with geomagnetic data the influence of the distorted geomagnetic-field can be studied and the importance of tidal winds, contributing to the ionospheric wind dynamo, can be examined. The magnetic perturbations at LEO altitudes can be approximated by considering the field-aligned currents flowing between the northern and southern hemisphere at low and middle latitudes.

We will study the patterns of the field-aligned currents and the associated magnetic perturbation for quiet conditions and examine and discuss the influence of the tidal winds.

SA72B-0526 1330h POSTER

Study of Joule Heating for Small Scale Magnetosphere-Ionosphere Coupling Processes

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Large scale models and observations determine Joule Heating in the ionosphere using a large scale average electric field which is limited in resolution either due to grid resolution of the model or due to the field of view and the temporal resolution of the observation. Typically these averages are obtained over length scales of several ten to about a hundred kilometers. However, it is well known that the electric field in the vicinity of active discrete Aurora is much larger than a large scale average because it is confined to narrow layers with a length scale of the order of a few kilometers or less. Joule heating is proportional to the square of the electric field such that the total Joule Heating of the average field is always smaller than the heating due to the actual fields. We will present a simulation study of small scale magnetopshere-ionosphere coupling processes where a field-aligned current becomes distorted in the presence of a localized parallel electric field in the acceleration region. The resulting dynamics leads to the formations of thin precipitation layers and to a highly variable and localized plasma flow in the ionosphere. These flows are confined to a few hundred meter to kilometer scale. We will present the model and discuss the implications for Joule dissipation for the actual electric field and for different scale averaged electric fields.

SA72B-0527 1330h POSTER

Modeling of Ionospheric Responses to the Solar Flux Change Based on Millstone Hill Incoherent Scatter Radar

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In order to develop ionospheric empirical models of electron density Ne, plasma temperatures (Te and Ti) and ion drifts based on Millstone Hill incoherent scatter radar observations, we investigate an important issue of ionospheric responses to the solar flux changes that have to be quantitatively represented. The representation is associated with selecting a mathematical function where a suitable solar flux index at a proper time ahead the observing time has to be determined. Traditionally, the solar 10.7 cm flux F107 for the previous day is applied, and a linear function is used. However, the non-linear feature of Ne responses to the solar flux was discovered previously. This paper shows the development of the non-linear feature with altitude, season and local time, and also indicates the non-linear feature for the Te and Ti responses. A mathematical function is proposed. We also discuss the use of other solar flux indices, in addition to F107.

SA72B-0528 1330h POSTER

F2-Layer Behavior Modelled With Coupling From the Lower Atmosphere

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We present results from the TIME-GCM-CCM3 thermosphere-ionosphere-lower atmosphere flux-coupled model, and investigate how well the model simulates known F2-layer day/night and seasonal behavior and patterns of day-to-day variability at seven ionosonde stations. Of the many possible contributors to F2-layer variability, the present work includes only the influence of meteorological disturbances transmitted from lower levels in the atmosphere, solar and geomagnetic conditions being held at constant levels throughout a model year.

In comparison to ionosonde data, TIME-GCM-CCM3 models the peak electron density (NmF2) quite well, except for overemphasizing the daytime summer/winter anomaly in both hemispheres and seriously underestimating night NmF2 in summer. The peak height hmF2 is satisfactorily modelled by day, except that the model does not reproduce its observed semi-annual variation. Nighttime values of hmF2 are much too low, thus causing low model values of night NmF2. Comparison of the variations of NmF2 and the neutral [O/N2] ratio supports the idea that both annual and semiannual variations of F2-layer electron density are largely caused by changes of neutral composition, which in turn are driven by the global thermospheric circulation.

Finally, we describe and discuss the characteristics of the F2-layer response to the imposed meteorological disturbances. The ionospheric response is evaluated as the standard deviations of five ionospheric parameters for each station within 11-day blocks of data. At any one station, the patterns of variability show some coherence between different parameters, such as peak electron density and the neutral atomic/molecular ratio. Coherence between stations is found only between the closest pair, some 2500 km apart, which is presumably being related to the scale size of the meteorological disturbances. The F2-layer day-to-day variability appears to be related more to variations in winds than to variations of thermospheric composition.

SA72B-0529 1330h POSTER

Wavelet-based Analysis of Wave-like Structures in the Ionospheric F-Region Electron Concentration

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The present work provides a contribution to the study of short-term variabilities (from 15 minutes to 4 hours) observed in F region of ionosphere and due to acoustic-gravity waves (AGW). To this end, electron densities are measured in Pruhonice observatory (49.9N, 14.5E - vertical ionospheric sounding with repetition time 5 minutes and 1 minute). From data, collected during several campaigns of rapid sequence sounding, one-dimensional time series are constructed and analysed, consisting of diurnal variation of electron concentration. The aim of the analysis proposed here is to detect wave-like structures related to AGW and to characterize them with respect to solar and geomagnetic conditions and solar eclipse event. Data from high as well as low solar activity periods are used. Information contained in one dimensional time series is represented into a Time and Period two-dimensional plan thanks to Continuous Wavelet Transforms. The analysis of wavelet power spectra (squared-modulus of the wavelet coefficients) computed at various heights allows to detect and to locate dominant modes of variability. Then, it enables to characterize those wave-like structures and to determine their key parameters (onset time, period, period-height shift, vertical component of phase velocity, group velocity etc.). Simulations are also conducted, consisting of numerical propagation of acoustic-gravity type waves. The analysis of the corresponding wavelet power spectra offers a useful help in interpretation those obtained form actual data. Such studies show the existence of various families of propagating waves that can be characterized and classified through the values to which their different parameters adjust.

SA72B-0530 1330h POSTER

A Modeling Study of the Ionospheric F Region Electron Densities

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The high-resolution Thermosphere/Ionosphere Nested Grid (TING) model has been used to study the variability of ionospheric F region electron densities under various geophysical conditions. Important space weather phenomena such as the tongue of ionization and mid-latitude electron density trough, which are not well simulated in global models, can be readily studied using high spatial resolution nested grids. In this presentation we will discuss the effects of geomagnetic activity, solar cycle, seasonal and UT variations on the ionospheric F-region electron densities. It is found that geomagnetic activity can greatly enhance the polar cap tongue of ionization and nighttime auroral F region electron densities (blobs). Such enhancements in auroral electron densities have a strong effect not only locally, but also in the mid latitudes as a result of changes in the neutral circulation.

SA72B-0531 1330h POSTER

3-D High Resolution Simulations of the Thermospheric Response to the Postmidnight Diffuse Aurora

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Measurements within the substorm recovery phase dawn sector diffuse aurora reveal features which are not well understood. Strong neutral winds are seen within the postmidnight diffuse aurora in measurements from the series of ARIA (Atmospheric Response in Aurora) campaigns, which show a great deal of vertical structure and large vertical shears. The ARIA observations consistently show a peak in the wind magnitude between around 110 km and 120 km, which has not been well explained, and strong shears below the peak. Some of these shears are unstable, with a Richardson number < 0.25. A 3-D high resolution model which has been developed recently at UCLA, has been used to perform simulations to try to understand the poorly explained phenomena observed in the ARIA measurements. Model simulations show that large zonal and meridional winds can be produced in the region of the postmidnight diffuse aurora, and a wind maximum is produced in the 110 to 120 km altitude range, within the same height range as the maxima found in the ARIA observations, using auroral forcing alone. When sufficiently high vertical resolution is used, using auroral forcing parameters within the range of observations, the region below the peak is found to be unstable, with a Richardson number < 0.25. When simulations are performed with auroral forcing parameters based on measurements from the ARIA I campaign, and background winds and tides are introduced from the CTIP (Coupled Thermosphere Ionosphere Plasmasphere) model, the basic features of the vertical structure of the ARIA I wind measurements are reproduced. The results of simulations suggest that tidal forcing, especially of higher order tidal modes, is important in producing the observed vertical structure. The 115 km peak is likely produced by a combination of auroral and tidal forcing processes. The vertical structure of the winds is sensitive to the phases of the tidal modes. Improvements in the ability of the model to simulate the observations from the ARIA campaign may be due to the use of the 3-dimensional rather than a 2-dimensional high resolution model.

SA72B-0532 1330h POSTER

Storm-time Interactions between the Ionosphere and Thermosphere

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A new 3-dimensional coupled model of the global Ionosphere and Thermosphere has been developed with the main focus of addressing the challenge of understanding and predicting the response of the coupled Ionosphere-Thermosphere system to geomagnetic storms. The model can be applied to such global scale phenomena as traveling atmospheric disturbances (TADs), traveling ionospheric disturbances (TIDs), which are associated with geomagnetic storms and substorms. TADs play a significant role in changing the global circulation, redistributing the energy and momentum of magnetospheric origin, from high to lower latitudes, and modifying the electrodynamics.

The storm-time simulations demonstrate that the neutral atmospheric disturbances propagate to lower latitudes with strong LT dependences. The propagation properties are controlled by ion-drag, represents one of the key interaction processes between the neutral and ionized species, and is determined by both the plasma density and drift. At the same time, the plasma density and drift respond to the altered electrodynamics, as well as the neutral atmospheric disturbances. Changes in ion-drag affect the global propagation of the neutral atmospheric disturbances and establishment and temporal evolution of the global circulation.

The global coupled model is a valuable resource to help elucidate the interacting processes in the time-dependent coupled system of the global thermosphere and ionosphere.

SA72B-0533 1330h POSTER

Changes in Neutral Composition During the Bastille Day 2000 Geomagnetic Storm

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Geomagnetic storms as large as the Bastille Day, 2000 event occur very infrequently. Such a great event presents a rare opportunity to study the thermosphere and ionosphere under conditions of very strong forcing. This presentation describes a study of the neutral composition changes that took place in the Bastille Day storm that has been undertaken using a Thermosphere-Ionosphere Nested Grid (TING) model simulation. The main results of this study are: 1) there is a large depletion in the O/N2 ratio that corresponds to the region of decreased electron densities in the middle and low latitudes over the Atlantic Ocean; 2) this region of depletions is partially isolated from the region of depletions at higher latitudes; 3) The region of depletions occurs as a result of advective processes.

SA72B-0534 1330h POSTER

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 C/NOFS mission, our laboratory has been developing a system of first-principles ionospheric/thermospheric models to predict the regions affected by spread-F and the severity of the scintillation within those regions. The system begins with a calculation of the ambient plasma density on near-equatorial field lines to forecast the state of the global ionosphere and 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. The initial state of the ionosphere and the variation of driver parameters can be specified by data assimilation. After describing the model, I will present case-study runs of the model for the first few months of 2002, driving it with plasma velocities determined from the ionosonde at Jicamarca by David Anderson, and comparing the output of the model with measurements of scintillation on nearby radio links by Cesar Valladares. These calculations illustrate the variability of space weather in this dynamic region of the ionosphere.

SA72B-0535 1330h POSTER

Effect of Equatorial Plasma Bubbles on the Thermosphere

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Equatorial plasma bubbles are common in the low-latitude ionosphere at night, particularly at solar maximum. The bubbles form on the bottomside of the F-layer as a result of the Rayleigh-Taylor instability and then drift upwards and to the east. As the bubbles evolve, the entire north-south extent of the plasma flux tubes in the bubbles becomes depleted, and the bubbles take the form of vertically elongated wedges of depleted plasma. The east-west width of a bubble domain can be several thousand km and the plasma density depletion in the bubbles varies from a factor of 10 to 1000. Because equatorial plasma bubbles could have an appreciable effect on the upper atmosphere, a time-dependent, 3-dimensional, high-resolution model of the global thermosphere was used to calculate the response of the neutral gas to "representative" plasma bubbles. The model predicts that there are both neutral density and temperature depressions and enhancements in association with the plasma bubbles. The bubble regions can contain either neutral gas enhancements or depressions depending on the background conditions, which change throughout the night. However, the neutral gas perturbations are small, with maximum neutral density perturbations of 6% and maximum temperature perturbations of about 35° K.

SA72B-0536 1330h POSTER

Space-Based Ultraviolet Images of Low Latitude Ionospheric Structures: A Preliminary Model-Data Comparison

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Satellite ultraviolet imaging has been shown to be a technique for producing global maps of ionospheric electron density and thermospheric neutral density. The ionosphere can be structured over a large range of scales from the global macroscale (hundreds to thousands of kilometers) to the mesoscale (tens to hundreds of kilometers) down to the microscale (centimeters to tens of kilometers). The characterization and description of ionospheric dynamics and structure are important issues in space weather research. Recently the Global Ultraviolet Imager (GUVI) on board the Thermospheric Ionospheric Mesospheric Energetics and Dynamics (TIMED) satellite has detected far ultraviolet (FUV) images of structures in the low latitude and equatorial ionosphere. In addition we have developed a nonlinear three-dimensional time-dependent dynamical-radiative numerical simulation model applicable to the low latitude and equatorial ionosphere. We have used this code to generate UV signatures of simulated Rayleigh-Taylor bubbles. Preliminary comparison of the simulation model with the TIMED data indicate that the FUV images are consistent with the nonlinear evolution of Rayleigh-Taylor bubbles. In this talk we will present further comparisons between TIMED observations and the nonlinear dynamical model. In addition we will attempt to relate characteristics of the UV images with ionospheric physical dynamical processes.

SA72B-0537 1330h POSTER

The Equatorial Anomaly and Equatorial Spread F: Their Joint Dependence on Maximum Pre-reversal Drift Velocity Measured During Solar Maximum

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The anomaly F layer electron density at 2100 LT (Ne) together with equatorial spread F (ESF) at 2 levels of bottomside spread F (BSSF) and macroscopic bubbles have been measured on each day of a solar maximum year by an array of ionosphere sounders located in the Western American sector. These measurements have been combined with the maximum pre-reversal vertical plasma drift velocity (ExB drift) measured by the Jicamarca incoherent scatter radar at the same longitude and also during solar maximum conditions. The result is that Ne increases as a linear function of ExB drift.

During equinox months (Mar Apr Sep Oct) the relative occurrence of each level of ESF increases nearly linearly with anomaly Ne. Therefore ESF increases nearly linearly with ExB drift as a consequence of the dependence of Ne on ExB drift. Similarly during winter (May-Aug) the same nearly linear relations exist as in the equinox months, but at much reduced levels of Ne, ExB drift and ESF. In contrast, during summer (Nov-Feb), although Ne is a linear function of ExB drift, ESF is not, an indication of the effect of the reduced post-reversal drift velocity that prolongs ESF production.

SA72B-0538 1330h POSTER

TEC and Density Profiles Associated With the Occurrence of Equatorial Spread-F in the American Sector

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We have used TEC values observed by a network of 10 GPS receivers located near Jicamarca to form latitudinal profiles of TEC. We have also employed data from the Jicamarca digisonde to construct profiles of the equatorial F-region bottomside. These profiles have been obtained concurrently with multi-sensor detections of the equatorial spread-F (ESF) phenomena. The characteristics of ESF have been measured with the digisonde, UHF scintillation receivers located at Ancon and Antofagasta, several GPS receivers, and sometimes with the JULIA radar. GPS scintillations are measured between 3° south of the equator and 23° north magnetic latitude. This large latitudinal coverage of the scintillation receivers allows us to know the maximum latitudinal extension of the irregularities and consequently set a lower limit of the maximum altitude of the plasma bubbles. The network of GPS receivers was completed on August 2001. Since then, we have been able to infer the maximum altitude of the plasma depletions on a day-to-day basis. The one-year span of these combined datasets provides an opportunity to study in detail the seasonal variability of the background ionospheric and investigate the relation of the day-to-day variability of the ionosphere with the occurrence of ESF. The maximum altitude of the plasma bubbles presents a large degree of variability even during magnetically quiet days. We have compared the maximum latitude of scintillations with distributions of TEC and the location of the crests of the anomaly. We have determined that during the majority of the cases scintillations reach the location of the crests of the Appleton anomaly. Only in very few cases, scintillations were seen poleward of the northern crest.

SA72B-0539 1330h POSTER

Gravity-Driven Dynamo in the Electrodynamics of the Low-Latitude Ionosphere

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Plasma drifts in the low latitude ionosphere are climatologically well defined and generally understood given the success of physics-based dynamo models. The neutral wind current dynamo during magnetically quiet periods dominates the determination of the low-latitude electric fields. However, a second dynamo is also involved in low latitude electric fields. A gravity driven current generated by GxB drift of O+ is essential to the Rayleigh-Taylor instability and equatorial spread F (ESF) phenomena. The gravity term is generally ignored in global dynamo electric field models, but is included in the low-latitude electrodynamics of *Haerendel et al.* [JGR, 1992].

This paper examines the effect of the gravity dynamo on the low-latitude background plasma drifts. The gravity dynamo only slightly effects the vertical plasma drifts at most local times. The largest effect occurs right before sunrise. The predawn vertical plasma drift becomes more positive under the influence of the gravity dynamo by about 8 m/s during solar maximum and about 2 m/s for solar minimum. Examination of h'F vertical lifts in the NGDC Ionospheric Digital Database shows a consistent vertical lift predawn in ionosondes within a couple of degrees of the magnetic dip equator.

The Coupled Ionosphere thermosphere Electrodynamics Forecast Model (CItEFM) [*Eccles*, JGR, 1998] also shows a similar predawn upward lift when the gravity dynamo term is included. The magnitude of the predawn lift depends on the nighttime decay of the O+ density. If the nighttime decay of O+ is not correctly modeled then the vertical lift before sunset will be not correct. The model also shows that the gravity dynamo strongly dependent on Apex altitude.

SA72B-0540 1330h POSTER

Simulation of the Non-Linear Evolution of the Sporadic-E Layer Instability in the Nighttime Midlatitude Iononsphere

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Recently, it has been shown that the configuration of a midlatitude sporadic-E (E_S) layer at a zonal windshear node becomes unstable at night [*Cosgrove and Tsunoda*, 2002]. The instability is the result of electrodynamical forces that arise when plane wave perturbations in altitude or density are imposed on the E_S layer. The growth rate of the instability depends on the azimuthal alignment of the plane wave distortion, a feature that is reminiscent of the Perkins instability [*Perkins*, 1973]. In this paper, the non-linear evolution of the instability is simulated using the flux corrected transport finite difference method, for the orientation of maximum growth rate. It is found that the instability growth generates significant polarization electric fields and structuring of the layer, yet can saturate without destroying the layer completely. The necessary ionospheric conditions, and relevance to observed E_S layer phenomena (such as QP echoes and frontal structures) are investigated.

SA72B-0541 1330h POSTER

Field-aligned Ion Motions in the Transient Region between Polar Ionospheric E- and F-regions

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We focus on field-aligned ion motions around the boundary between polar ionospheric E- and F-regions (from 140 to 250 km heights). Here we define a "transient region" as the boundary. Ionospheric parameters were obtained with the European Incoherent Scatter (EISCAT) Kiruna-Sodankylä-Tromsø(KST) UHF radar (931 MHz, 69.35°N, 19.14°E, 66.12° invariant latitude) in northern Scandinavia. The observation mode of the KST radar was so-called Common Program One (CP-1) mode where the antenna at Tromsøis pointed along the local magnetic field line there. This mode provides us with ion velocity, electron density, and electron and ion temperatures with high time- (order of minutes) and altitude- (about 3 km) resolutions along the radar beam. In addition, this mode conducts a tristatic measurement of ion velocity at 278 km thus the electric field vector assuming ExB drift. We used EISCAT data sets obtained for about one solar cycle ($\sim$ 11 years). In order to get an overview of the spectral behavior of the variations in field-aligned ion motions, a Lomb periodgram and a Fast Fourier Transform (FFT) were applied to EISCAT radar data sets that were selected every 24 hour intervals. The reason why we used two spectral analysis methods was to estimate effects of gaps in EISCAT radar data. Results from both spectral analysis showed that dominant oscillation periods at the lower (upper) region of transient region was 12 (24) hours. The phase and amplitude of 24/12 hours variations in the field-aligned ion velocity in the transient region had similar height profiles to those of thermospheric tide predicted by model calculation (Forbes, 1982) when electric field magnitude observed with the EISCAT radar was relatively small. Directions and magnitude of height gradient of field-aligned ion velocity in the transient region had also 24- and 12-hours periodic oscillations. These tendencies were dominant regardless of electric field magnitude. Because the pressure gradient force along the magnetic field line was considerably small to accelerate ions up to observed level even during high auroral activity (Fujii et al., 2002), thermospheric tidal motions could be a major cause that maintained the 24- and 12-hours oscillations of field-aligned ion velocity. Amplitude and phase of 24- and 12-hours oscillations strongly depended on the electric field magnitude. This suggests that electromagnetic force such as ion drag and pressure gradient caused by Joule and particle heating can generate and/or modulate thermospheric tides in the transient region.

Forbes, Atmospheric tides 2. The solar and lunar semidiurnal components, JGR, 87, 5241-5252, 1982.

Fujii, R., S. Oyama, S. C. Buchert, S. Nozawa, and N. Matuura, Field-aligned ion motions in the E and F regions, JGR, 107, A5, 2002.

SA72B-0542 1330h POSTER

Study of the Polar Cap Potential Under Conditions of Large Solar Wind Ram Pressures

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It is generally accepted that the magnitude of the potential drop in the ionospheric polar cap is predominately determined by the interplanetary magnetic field's (IMF) magnitude and orientation. However recent work by Ridley et al. (2002) shows that under extreme conditions of large ram pressures from the solar wind the ram pressure can play a significant role, resulting in potentials larger than predicted by the IMF alone. We have examined the 1998-2001 period of ACE data and identified about 70 events of unusually high ram pressure caused by the solar wind ion density being greater than 30 ions/cc (nominally it is around 5 ions/cc). We have examined the resulting ionospheric potentials observed by the DMSP spacecraft during these events. We compare the observed potentials to the predictions from the models. Excess potentials are examined as a function of both the ram pressure and the IMF orientation.

SA72B-0543 1330h POSTER

Ionospheric Geo-effectiveness of Magnetic Clouds

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We present an analysis of the geo-effectiveness of magnetic clouds and the disturbed solar wind surrounding them. Estimates of the ionospheric Joule heating rates based on two ground magnetic indices and estimates of auroral zone particle heating from polar satellites will be combined to provide a summary of the total geomagnetic heating during magnetic cloud passage. Preliminary estimates suggest that intervals of magnetic cloud passage experience about 50 percent greater heating rates than intervals associated with the more general class of interplanetary coronal mass ejection. Heating rates for magnetic clouds are about four times greater than heating rates estimated for intervals of background slow solar wind flow. Preliminary work also indicates that magnetic clouds lying in the ecliptic plane (leading or trailing fields oriented N-S or S-N) have heating rates about 50 percent greater than clouds with leading or trailing fields perpendicular to the ecliptic plane. We will provide hourly heating profiles for more than 50 magnetic clouds passing the earth during the rise and peak of solar cycle 23.

SA72B-0544 1330h POSTER

PML boundary conditions implementation in 1D and 2D wave propagation code for an inhomogeneous, magnetized ionospheric plasma.

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We have developed 1D and 2D full-wave propagation codes with arbitrary direction of propagation to the magnetic field and the plasma density relevant to ionospheric interaction studies. A wave launched from the bottom of computational box should be allowed to propagate out of the simulation box (top boundary for the 1D case and top and side boundaries for the 2D case) without providing spurious reflection from these computational boundaries. We have implemented the use of a Perfectly-Matched-Layer (PML) technique using matrix-marching algorithms to accomplish these goals. Results for various 1D and 2D cases with the existence of mode conversion layers for specified density profiles will be presented. These codes can be used to accurately compute the detailed mode structure of radio wave in complex magnetized plasma environments.

SA11A MCC: 134 Monday 0830h

Nicolet Lecture *(joint with SH, SM)*

Presiding: **D N Baker,** University of Colorado, Boulder

SA11A-01 0830h INVITED

Aeronomy: From Exploration to Data Assimilation

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During the last century, there has been continual progress with regard to elucidating the important aeronomic processes that operate in the Earths upper atmosphere. However, the progress was not uniform and there were certain periods of time when significant advances in knowledge were achieved due to an important discovery, a novel instrumental technique, or a new international program. Shortly after Marconi successfully transmitted radio signals across the Atlantic Ocean, the existence of the ionosphere was clearly established and its source, peak height, and layer characteristics were determined. In the mid-1940s, the rocket technology that became available was used by scientists to study the ionosphere and upper atmosphere. The great potential of this new technology, coupled with a major advance in ground-based instrumentation, led scientists to realize that a significant increase in knowledge of the terrestrial environment was possible. This resulted in the International Geophysical Year (1957-58) and the launch of the first satellite (Sputnik I). Another significant advance in aeronomy began in the mid-1980s, with the advent of supercomputers, the development of global numerical models, the existence of numerous ground-based instrument networks, and the proliferation of satellites. At the beginning of the new millennium, aeronomy is at the threshold of another rapid advance in knowledge due to the use of data assimilation techniques. Although data assimilation has been widely used by both meteorologists and oceanographers for several decades, only recently has there been a sufficient quantity of data for this approach to be useful in aeronomy. During the coming decade, tens of millions of measurements of the ionosphere-thermosphere system could become available on a daily basis from a myriad of in situ and remote sensing instruments. These data sets can be assimilated into a time-dependent, physics-based, numerical model of the ionosphere-thermosphere system via Kalman filters or other assimilation techniques. As a result, it will be possible to provide time-dependent 3-dimensional reconstructions of the ionospheric and thermospheric densities on an hourly basis day after day. These reconstructions will not only greatly advance aeronomy, but will also provide important societal benefits.

SA11B MCC: 134 Monday 1000h

Tracing the Sun-Earth Connection Into the Upper Atmosphere: Study of the April 2002 Events I *(joint with SH, SM)*

Presiding: **L J Paxton,** Applied Physics Laboratory**; J U Kozyra,** University of Michigan

SA11B-01 1000h INVITED

Tracing the Sun-Earth Connection: The April 14-24, 2002 Events

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The interaction of the Earth with the Sun and the local space environment is complex and presents many challenges if that interaction if to be fully understood. The April 14-24, 2002 events may well serve as the catalyst for a new way of approaching the science that we do. A flotilla of spacecraft that can study the Sun, the interplanetary medium, the magnetosphere, and the Earth's atmosphere are now providing data. For the first time we can trace, in some detail, the chain of causality from the Sun to the Earth. We also have available to us a range of first principle models that allow us to validate our understanding of the physics of these processes by completely specifying their inputs and comparing their outputs to actual observations. Data provide the ultimate reality check on the models. This reality check will allow us to evaluate how faithfully models handle the transition from one region of applicability to another as we trace this storm from the sun to the Earth. For convenience we can consider this system of systems to consist of four chains that span physics disciplines: solar particles, magnetospheric drivers, solar radiance, and energy balance. In the invited talks that follow each element in this chain will be summarized. In this event we are able to trace the production of a disturbance on the Sun as active regions, flares and coronal mass ejections, through the interplanetary medium until it impinges upon the magnetosphere and interacts with the Earth's upper atmosphere. The April storm is unique, not only for the behavior of the storm, but for the addition of the information provided by TIMED as the newest element in the constellation of satellites providing data. We hope that this interactive and cooperative study will be a paradigm for future activities

URL: http://storms.jhuapl.edu

SA11B-02 1020h INVITED

Solar Radiance Chain in the April 2002 Series of Flares

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The April 2002 series of solar storms included a number of GOES M- and X-class flares, in particular, a X1.5 flare on April 21 that was observed by many spacecraft - SoHO, TRACE, Wind, and the recently launched RHESSI (Ramaty High Energy Solar Spectroscopic Imager), which is designed to study flare hard X-ray/gamma-ray emissions. At the same time the effects of these emissions on the Earth were observed by an fleet of spacecraft, including TIMED, and by ground-based instrumentation. The effects of the increased energetic photon flux on the Earth's atmosphere during solar flares is usually small in comparison to geomagnetic disturbances, but large X-class flares (such as the one on April 21, 2002) that are several hours in duration can have significant consequences. When the 1 to 10 nm region of the of the solar spectrum is enhanced during a flare, the energy is deposited largely in the E-region of the ionosphere, 100 to 120 km altitude, where increases in ion density, photoelectron production, airglow emission, and odd-nitrogen production can result. Higher energy photons (such as observed by RHESSI) penetrate to lower altitudes, where they have less effect on the atmosphere but can still create additional ionization in the D-region of the ionosphere, 80 to 100 km altitude, that is disruptive of certain types of radio communication. Here we present the observations of solar photon emissions and their effects on the Earth's ionosphere and atmosphere.

URL: http://storms.jhuapl.edu

SA11B-03 1040h INVITED

Tracing the Sun-Earth Connection: The Solar Particle Chain in April 2002

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Soon after the RHESSI spacecraft observed an X-class solar flare early on 21 April 2002 a coronal mass ejection (CME) moving at ~2500 km/sec was observed by SOHO to emerge from near the west limb of the Sun. Almost simultaneously, Type-II and Type-III radio emission was observed by the Wind spacecraft, indicating the onset of particle acceleration near the Sun. The active region on the Sun responsible for this event was magnetically well-connected to the Earth, leading to a prompt enhancement at 1 A.U. of solar particles (E>10 MeV) as seen by the ACE and SAMPEX spacecraft. Strong shock-related particle acceleration continued to occur as the CME propagated outward from the sun. The solar particle enhancement lasted from 21 April to 26 April (as seen by the NOAA/POES spacecraft) and included enhancement not only of solar protons and heavier nuclei extending to hundreds of MeV/nucleon but also solar electrons. The energetic particles produced near the sun, at this and preceding interplanetary shock waves, and deep within the Earth's radiation belts were all observed using TIMED and SNOE to produce substantial effects on the chemistry of the Earth's middle and upper atmosphere. We examine the impacts of this set of events on atmospheric heating and cooling rates and on ozone densities in the mesosphere. Using the remarkable constellation of available spacecraft, we are able to follow the particle chain from the Sun's surface all the way to the deep layers of Earth's atmosphere with unprecedented completeness.

SA11B-04 1100h INVITED

Overview of One Aspect of the Sun-Earth Connection during the April 2002 Events: the "Magnetospheric Driver" Chain

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