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The Global Ultraviolet Imager (GUVI) on the NASA TIMED spacecraft gives a unique and powerful window into the global ionosphere. Because TIMED is in a near polar 74.1 deg inclination orbit and precesses through all local solar times in just 60 days, we have the opporunity to study the bahavior of the ionosphere as a function of season and local solar time. We are also able to investigate the coupling with the neutral atmosphere as well. The technique that we employ uses the radiative recombination of ionospheric O+ with electrons to produce a signal that we can invert into an electron density profile. This technique is most readily employed on the nightside but can be use, at solar maximum, during the day as well. In this paper we show the results of our analysis of typical and atypical i.e. disturbed days and the response of the thermosphere to changing magnetospheric and solar inputs. We find that the International Reference Ionosphere climatology does not reproduce the behavior observed by GUVI on any typical day and that even the global circulation models like the TIMEGCM have difficulty replicating the observed behavior. We discuss the reasons why this is and what can be done to improve the modeling efforts.

SA41B-03 0900h INVITED

Measurements of Equatorial Thermospheric Dynamics - Quo Vadis?

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Observations of equatorial thermospheric winds and temperatures at Arequipa, Peru, have been carried out over two decades with a pressure scanning Fabry-Perot interferometer. The results from this long series of measurements will be summarized, and new plans for the future presented. The work for the future will be based upon the upgrade of the instrument sensitivity to be obtained through the replacement of the photomultiplier detector with a CCD camera producing an expected increase of sensitiivty by a factor of 15 and decreasing measurement errors to less than 5 ms^{-1} and 20 K in 2 to 5 minutes of signal collection. The new plans include the initiation of twilight studies of the 732 nm airglow emission, which is generated by radiative ionization of [O]. This will enable the study of atomic oxygen concentration variations combined with ion drift measurements during the evening and morning twilight periods. Results from the first series of measurements with this new capability will be presented.

SA41B-04 0915h

Electron Density Profiles and Total Electron Content at Low Latitudes During Magnetic Storms

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Magnetic storm effects on the electron density profiles and the total electron content (TEC) at low-latitude are presented. The data correspond to two storms: April 17-18, 2002 and October 29-31, 2003. The observations include data from ionosondes, GPS receivers, satellite altimeters, as well as in situ density from Challenging Minisatellite Payload (CHAMP) and Defense Meteorological Satellite Program (DMSP). These polar orbiting satellites are in circular orbits, at 400 and 830 Km altitude, respectively. The observations are compared with results from several models. These models include: climatological models, assimilative physics-based models, as well as the TIME-GCM model. Because CHAMP orbit is so low, its in situ density data are particularly useful in testing the ability of the models to capture important profile features such as the bottom-side density profile and F region height. In addition, CHAMP provides the density latitudinal variation. During the October 2003 storm, CHAMP was in a noon-midnight plane. Around midnight, the in situ density appears erratic. For example, it is very low south of the equator - lower than the satellite lowest detectable value. It becomes very large, 2. 10E6 el/cc, north of the equator. Around noon, the density meridional variations start off exhibiting symmetric twin peaks (e.g. at 07:15 UT, Oct 29). Meridional variations then become asymmetric, and the asymmetry tends at times to increase to extremes (e.g. 06:20 UT, Oct 30). We speculate that these asymmetries may be attributed to changes in the neutral wind.

SA41B-05 0930h

Inter-Hemispheric Comparisons of the Latitude Extent of Thermosphere-Ionosphere Disturbances

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All-sky imagers located at Arecibo, Puerto Rico (18.3° N, 66.7° W, 28° N dip) and El Leoncito, Argentina (31.8° S, 69.3° W, 18° S dip), are used to compare 6300 Å airglow emission features. Airglow depletions associated with Rayleigh-Taylor instability (ESF) and brightness waves associated with the midnight temperature maximum (MTM) are frequently observed at both sites. While not at conjugate points, these two sites allow the evaluation, for the first time, of statistical occurrence patterns and, occasionally, simultaneous case-study events from the same longitude sector in both hemispheres. While both types of disturbances are well studied at near-equatorial latitudes (L $\sim$ 1.15), we find the intrusion of those processes to lower-mid latitudes (L $\sim$ 1.35) on a relatively frequent basis. These studies suggest that the traditional role of latitude coupling (from high to low-latitude) needs to be expanded by the study of how equatorial aeronomy phenomena reach into mid-latitude domain.

SA41B-06 0945h

A Comparison of LORAAS and GUVI Observations of the Low-Latitude Ionosphere

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The Low Resolution Airglow and Aurora Spectrograph (LORAAS) aboard the Advanced Research and Global Observation Satellite (ARGOS) collected numerous spectra of Earth's airglow in the extreme ultraviolet and far ultraviolet regimes (80 - 170 nm) from 1999-2002. From the limb scans made of the 135.6 nm ultraviolet emission, profiles of the nighttime (0230 LT) electron density in the ionosphere can be derived. The Global Ultraviolet Imager (GUVI) aboard NASA's Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics (TIMED) satellite scans a nadir-to-limb swath in five spectral channels, including 135.6 nm. In early March 2002, the paths of ARGOS and TIMED nearly coincided, providing an opportunity to compare the 135.6 nm observations of both LORAAS and GUVI in the low-latitude region at various longitudes. In this study, we compare the electron density profiles derived from the LORAAS and GUVI limb data. We vertically integrate the density profiles to obtain the total electron content (TEC) as a function of latitude and compare these results with TEC derived from GUVI images of the disk on the nightside as well as TEC obtained from the global network of GPS receivers. We further compare these observations to first principles ionospheric models.

SA42A CC: 519 A Thursday 1030h

New Frontiers in Equatorial Ionospheric Observations and Models II

Presiding: **O de La Beaujardiere,** Air Force Research Laboratory**; V Eccles,** Space Environment Corporation

SA42A-01 1030h INVITED

Data Assimilation Studies of the Equatorial Ionosphere Using the USU GAIM Model

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The ionosphere is a highly dynamic medium that can vary appreciably from day to day and from hour to hour at a given location, and these variations can have detrimental effects on military and civilian systems. In an effort to mitigate these detrimental effects, a physics-based data assimilation model of the ionosphere is under development. This Global Assimilation of Ionospheric Measurements (GAIM) model provides both specifications and forecasts on a spatial grid that can be global, regional, or local. GAIM uses a physics-based ionosphere-plasmasphere-polar wind model and a Kalman filter as a basis for assimilating a variety of data sources. The new ionosphere-plasmasphere-polar wind model includes six ion species (NO^+, $O_2{}^+$, $N_2{}^+$, O^+, H^+, He^+) and extends from 90 to 20,000 km at mid-latitudes and 90 to 10,000 km at high latitudes. Currently, the GAIM physics-based model assimilates in situ electron densities from the DMSP satellites, occultation TECs from three low altitude satellites (IOX, CHAMP, SAC-C), bottomside electron density profiles from several ionosondes, and GPS-TEC from a global network of 160 ground stations. The primary GAIM output is a 3-dimensional electron density distribution at specified times. However, GAIM also provides ancillary parameters ($N_m F_2$, $h_m F_2$, etc.) and global distributions of the self-consistent ionospheric drivers (neutral winds, electric fields, etc.). In addition to the full physics Kalman filter model, both regional and global Gauss-Markov Kalman filter models have been developed. The global Gauss-Markov model can assimilate four data types, including Ne profiles from digisondes, in situ satellite densities, occultation data, and GPS-TECs from 900 ground stations. The status of these models and the relevant equatorial applications will be presented.

SA42A-02 1045h INVITED

Assessing a Low-Latitude Ionosphere Model Driven with Data-Determined ExB Drifts

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The Low-Latitude Ionosphere Sector (LLIONS) model is a single sector ionosphere model capable of using data-determined drivers. The important drivers for the low latitude ionosphere are the vertical E×B plasma drift and the cross-equator neutral wind. The western coast of South America (Peruvian sector) is well instrumented with magnetometers, ionosondes, GPS-TEC monitors, ionosondes and radars. Magnetometer data, ionosonde data, and radar data from

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February 15 to March 15, 2003 are used to determine the EB vertical drift of plasma for a one-month period. The data-determined driver is used to drive the LLIONS model and obtain a specification of the ionosphere in the Peruvian sector. The GPS-TEC observation chain of South America and TOPEX TEC data are used to examine the veracity of the LLIONS results. A second model study will make adjustments to the LLIONS drivers, both EB and meridional neutral wind, to move LLIONS results into optimal agreement with TEC data. The comparisons of the two runs are used to give insights into the remaining problems of ionospheric models and unknowns in the drivers.

SA42A-03 1100h

Theoretically Modeling the Ionospheric Response at Low Latitudes to the Great Storms in October, 2003

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In the low latitude, ionospheric F region, the primary transport mechanism that determines the electron and ion density distributions is the magnitude of the daytime, upward ExB drift velocity. During the geomagnetic storms on Oct. 29 and 30, 2003, we have inferred these upward ExB drift velocities from ground-based magnetometer observations at Jicamarca and Piura, Peru as a function of local time (0700 - 1700LT). On both days these ExB drifts exceeded 80 m/sec which is about four times greater than the normal, quiet time value of 20 m/sec. We study the ionospheric response in the Peruvian longitude sector to these large upward drifts by theoretically-calculating electron and ion densities as a function of altitude, latitude and local time using the time-dependent Low-Latitude Ionospheric Sector model (LLIONS). This is a single sector ionosphere model capable of incorporating data-determined drivers. Initial results indicate that the large, upward ExB drift velocities on Oct. 29 produce equatorial anomaly crests in ionization at +/- 22° dip latitude rather than the usual +/- 16° dip latitude. We compare the theoretically-calculated results with a variety of ground-based and satellite observations for Oct. 28, 29, 30 and 31 and discuss the implications of these comparisons as they relate to the capabilities of current theoretical models and our ability to infer ionospheric drivers such as ExB drifts.

SA42A-04 1115h INVITED

Assimilative Modeling of Low-Latitude Ionosphere

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Ionospheric zonal electric field and thermospheric winds drive and affect the sharp latitudinal structures and occurrence of irregularities in the low latitude ionosphere. The prediction of the daily variability of these ionospheric features against their climatological patterns requires the prediction of the dynamical driving forces. We will present a fully 3-dimensional (3-D) global assimilative ionospheric model (GAIM) and its application to low-latitude modeling, particularly to the estimation of the dynamical driving forces. GAIM numerically solves the ionospheric plasma fluid-dynamic equations to obtain ion and electron densities on a 3-D grid, and optimizes the solutions by assimilating various kinds of ionospheric measurements such as line-of-sight total electron content (TEC) derived from dual-frequency Global Positioning System (GPS) measurements. The GAIM optimization techniques include the Kalman filter and 4-dimensional variational approach (4DVAR). The Kalman filter corrects the modeled ionospheric state by estimating its error covariance. The 4DVAR technique estimates the model driving forces that satisfy a requirement of minimization of the difference between the modeled state and observations in an entire region. The assimilative modeling of low-latitude ionosphere can be conducted by combining both optimization techniques and particularly through the estimation of plasma drift (driven by zonal electric field) and thermospheric winds. Examples of such modeling with assimilation of GPS data available from global and regional GPS networks will be presented. A short-term forecast scheme for prediction of ionospheric weather conditions will also be presented that utilizes the GAIM with the optimized solutions of both dynamical forces and state.

SA42A-05 1130h

GPS Occultation Sensor Contributions to Studies of the Equatorial Ionosphere

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The GPS occultation remote sensing technique provides highly precise profiles of limb-viewing total electron content (TEC). These TEC profiles can be converted into electron density profiles given assumption of spherical symmetry. In cases where ancillary data characterizing horizontal gradients is available, the spherical symmetry assumption can be relaxed and more accurate vertical density profiles can be inferred. While such profiles are more similar to traditional (e.g., ISR, ionosonde) ionospheric measurements, the occultation TEC observations can also be directly compared with a modeled ionosphere. We present such comparisons using the NCAR-TIMEGCM model together with both simulated occultation data and observations made by the Ionospheric Occultation Experiment (IOX). Our focus is to evaluate the extent to which occultation data can be used to identify the state of the equatorial anomaly (e.g, crest separation, altitude, and asymmetry). The anomaly region state is related to the strength of the pre-reversal enhancement (PRE) of the vertical ion drift and the meridional neutral wind. The TIMEGCM model provides a self-consistent picture of the equatorial ionosphere, including variability in the PRE driven by nighttime conductivity gradients in the E-region. The ability of occultation sensors to measure this low altitude portion of the ionosphere will also be discussed. Finally, GPS occultation measurements of ionospheric scintillation are also possible, but the sensitivity to ionospheric irregularities varies dependent on the occultation geometry relative to the Earth's magnetic field.

SA42A-06 1145h

Relative Importance of Direct Penetration and Disturbance Dynamo Electric Fields on the Storm-Time Equatorial Ionosphere and Thermosphere

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During geomagnetically active conditions, there are two major mechanisms responsible for ionospheric electric-field disturbances at low latitudes. The first is the direct penetration to lower latitudes of the electric field due to magnetosphere-ionosphere interactions at high latitudes. The penetration electric field reaches the magnetic equator almost instantaneously, but tends to decay with a time scale less than one hour. The time scale depends on under/overshielding conditions determined by magnetospheric properties and ionospheric conductivity. The second mechanism is the effect of the disturbed wind on ionospheric dynamo processes. The disturbance winds develop over a period of hours and can persist for several hours due to the neutral-air inertia. It has been difficult to actually identify the relative importance of these two mechanisms for the disturbance in the equatorial electric field and for the associated changes in the ionosphere and thermosphere in individual cases. This study utilizes the Coupled Thermosphere-Ionosphere-Plasmasphere-Electrodynamics (CTIPe) model where the mid-/low-latitude electrodynamics is solved self-consistently with the global ionosphere and thermosphere system. In order to investigate the effect of the direct penetration electric field together with the disturbance dynamo process on the equatorial ionosphere and thermosphere, Rice Convection Model (RCM) electric fields are imposed on CTIPe. Our preliminary results indicate that the direct penetration electric field can modify the ionospheric dynamo by changing the conductivity and neutral wind. We discuss our results in relation to observations of low-latitude ionospheric disturbances.

SA43A CC: 220 C-E Thursday 1330h

The Extended Ionosphere: A Unifying Approach to Magnetosphere-Ionosphere Coupling III Posters *(joint with SM)*

Presiding: **J Semeter,** SRI International**; J Horwitz,** University of Alabama in Huntsville

SA43A-01 1330h POSTER

Auroral energy deposition in the ionospheric F-region studied through ground-based optical tomography

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Studies of ionospheric perturbations produced by the aurora generally focus on the E-region where the majority of the kinetic energy flux is deposited. However, it is the state of the topside ionosphere that is most critical for mass coupling with the magnetosphere. In this paper, ground-based optical tomography is used to characterize auroral energy deposition in the E- and F-regions simultaneously. The tomographic data are derived using two imaging spectrometers in a 290km baseline near Sondrestrom, Greenland. Vertical profiles of volume emission rate were reconstructed for four prominent auroral emissions: 470.9 nm (N2+ 1NG), 557.7 nm (OI 1S), 630.0 nm (OI 1D), and 844.6 nm (O 3P). The ionospheric response was monitored using the Sondrestrom Incoherent Scatter Radar (ISR). An analysis of a stable auroral arc near the polarward edge of the auroral oval revealed a latitudinally broad region of 844.6 emission at 250km above a narrower region of 470.9 and 557.7 emission. The 844.6 emission is produced by impact of 11 eV electrons on atomic oxygen, suggesting that the primary electron spectrum had both a high and low energy component. The ISR measurements showed intense F-region ion heating on this flux tube, and a factor-2 increase over the ambient plasma density at 300km, demonstrating that the low energy end of the precipitating particle spectrum can have a significant affect on the topside ionosphere, even in relatively hard auroral arcs.

SA43A-02 1330h POSTER

Coupling between horizontal and vertical ion transport along the nightside polar cap boundary

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