Plasma simulations demonstrate that meteor trails are unstable to growth of gradient-drift Farley-Buneman (GDFB) waves that become turbulent and generate large B-field aligned irregularities (FAI). These simulations and our analysis indicate that the non-specular echos, that can extend between 5-10 km in altitude range, are reflections from plasma instability generated FAI. We present models showing that the specific altitude range of trail instability depends on meteor and atmospheric properties. This variability will allow researchers to infer neutral temperature, neutral wind velocity, and meteoric velocity and composition in completely new ways. We demonstrate some of these non-specular trail diagnostic techniques using radar observations from the ALTAIR and Piura radar facilities. Finally, we present examples of a low altitude variety of non-specular echos that may be related to PMSE.

SA41A-05 0910h

Micrometeroid Flight in the Upper Atmosphere: Electron Emission and Charging

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Solving the simultaneous equations for the continuity of charge, mass, momentum and energy of a micrometeoroid entering the earth's atmosphere, we study its charging, ablation, deceleration and heating along its path. This analysis, which considers different initial entry speeds and angles, builds on an earlier study (G. Sorasio, D. A. Mendis and M. Rosenberg, 2001, Planet. Space Sci., 49, 1257) where only normal entry at a single speed was considered, while emphasizing the important role of thermionic emission of electrons from the frictionally heated micrometeoroid. While the main conclusions are qualitatively similar, the quantitative differences are significant. As before the micrometeoroid can change its charge polarity during flight and the altitude range of meteoric ionization is larger than in the case when ionization is due only to collisions between sublimating molecules and background atmospheric molecules. However, the present study shows that this range becomes larger, with earlier onset of ionization, as the initial entry speed becomes larger and the initial entry angle becomes smaller. Interestingly we also find that the residual mass of the ablated micrometeoroid is a minimum at a certain critical angle of entry, for a given initial speed. The implications of this study for atmospheric ionization by different meteor streams, as well as for radar observations of meteors (e.g., the head and trail echoes) will be discussed. The implications of this study for atmospheric ionization by different meteor streams, as well as for radar observations of meteors (e.g., the head and trail echoes) will be discussed.

SA41A-06 0925h

Charging of meteoroids: effect of thermionic emission

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In the present work we focus on the role of thermionic emission in the charging of a meteoroid. It has been shown [1] that the higher mobility of the plasma electrons (that would lead to negatively charged meteoroids) can be overcome by electron emission, thus reversing the meteoroid polarity. Moreover, recent work [2] has shown how electron emission can fundamentally affect the shielding potential around the dust. In particular, depending on the physical parameters of the system the shielding potential can develop an attractive potential well. The aim of the present work is two-fold. First, we will present a parametric study in order to understand the conditions for the formation, as well as the stability of the well. Furthermore, simulations will be presented with physical parameters corresponding to the ionosphere, thus extending our study to the case of meteoroids. [1] G. Sorasio, D. A. Mendis, and M. Rosenberg, "The role of thermionic emission in meteor physics," Planet. Space Sci. 49, 1257, 2001. [2] G.L. Delzanno, G. Lapenta, M. Rosenberg, "Attractive Potential among Thermionically Emitting Microparticles", submitted.

SA41A-07 0940h

Meteor Observations Near the Arctic Circle

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Since October 2001, we operate a Skiymet meteor radar at the ALOMAR site (69°N latitude) close to the Arctic circle. The gain pattern of the antenna covers a broad range in elevation angles and is almost independent of the azimuth. Due to its location, the axis of the radar antenna sweeps through the ecliptic North pole once a day throughout the year. In this geometry, it thus records meteor entry trajectories from a very large portion of the ecliptic Northern hemisphere. We report on the annual variation and altitude dependence of the observed meteor rate while the radar field-of-view is centered on the North ecliptic pole. The maximum meteor rate is reached in June, while the minimum (in January) is almost a factor three less. Independent of this special look direction, we have also report on the observed diurnal variation of the meteor rate throughout all seasons.

SA41B MCC: Level 1 Thursday 0830h

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

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

SA41B-0426 0830h POSTER

Measurements of Solar FUV Spectral Irradiance: TIMED-SEE Results Compared with UARS and SORCE

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The solar radiative output in the far ultraviolet (FUV, from 120 to 200 nm in wavelength) deposits its energy in the Earth's mesosphere and lower thermosphere (MLT). Solar variability causes variability in atmospheric temperature, dynamics, and composition, making an understanding of the solar FUV vital to understanding the MLT region of the atmosphere. Currently there are three satellites with sets of instruments measuring the solar FUV spectral irradiance. The Solar EUV Experiment (SEE) on board the TIMED satellite has been measuring both the solar EUV and FUV daily since early 2002. The Upper Atmosphere Research Satellite (UARS), launched in 1991, continues to measure the FUV with two instruments: the Solar Stellar Irradiance Comparison Experiment (SOLSTICE) and the Solar Ultraviolet Spectral Irradiance Monitor (SUSIM). The Solar Radiation Climate Experiment (SORCE) mission was recently launched in early 2003 carrying two SOLSTICE instruments which measure the solar FUV. This paper will present the TIMED-SEE FUV measurements from early 2002 to the present and compare them with historical and simultaneous measurements from the UARS and SORCE FUV instruments, providing an overview of solar FUV variability on time scales from days to a full solar cycle.

SA41B-0427 0830h POSTER

Solar EUV Energy Deposition Rate Calculations for General Circulation Models

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With new measurements of solar irradiance, such as by the TIMED solar extreme-ultraviolet experiment, now available in the extreme ultraviolet (EUV) and soft X-ray (XUV) regions of the spectrum from 1 to 103 nm, it is important to re-examine our quantitative representations of their effect on the Earth's atmosphere. EUV and XUV radiation photoionizes the upper atmosphere and creates the ionosphere, and also causes a variety of ancillary processes, including dissociation, excitation, and generation of photoelectrons. The solar spectrum is highly structured in parts of this region, so precise calculations of these effects should be made using high spectral resolution. This may be appropriate for detailed models of thermosphere/ionosphere processes, but global models require greater computational efficiency. Representation of photoelectron ionization is a particular problem for global models, because the ratio of photoelectron to photon ionization is so variable with altitude. We have developed a new method for parameterizing solar energy deposition and partitioning in the thermosphere that can be employed at fairly low spectral resolution with accurate results. This method is described, and its application to modeled and measured solar spectra demonstrated.

SA41B-0428 0830h POSTER

Detection of Long-Term Variations in Neutral Thermospheric Density

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A new database of thermospheric densities has been derived for the period 1970 - 2000 from satellite orbital decay analysis. The data are generated from actual radar tracking observations, rather than from the less accurate historical element sets, to form precise orbit and drag/density data with improved accuracy and one-day resolution. Satellites with relatively high eccentricities were used to achieve long lifetimes and relatively localized latitude and local time resolution. We analyze data from six satellites with an average altitude of about 350 km. Data are compared to three empirical models (Jacchia, NRLMSIS and NASA MET). The data are normalized to remove systematic model errors vs solar activity detected in all three models. A linear regression fit through these normalized data is obtained for each satellite. The weighted average of these fits show a downward trend of 5.2 percent over 30 years with a 95 percent confidence interval of 1.1 percent. The results are analyzed as a function of solar flux and compared to theoretical predictions. Possible dependencies on local time, latitude and geomagnetic activity are also examined. These results tend to confirm global cooling at satellite altitudes, possibly associated with increased carbon dioxide in the thermosphere.

SA41B-0429 0830h POSTER

Long-term change in mesopause region temperatures over Fort Collins, CO (41N, 105W): Solar cycle effect and trends

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The Colorado State University Sodium Lidar has measured temperatures in the mesopause region (80-105km) for over 12 years. Based on 7 years' observation, an episodic change with a warming of 11.8K in 1993 at the mean mesopause altitude of 98km, attributable to Mt. Pinatubo eruptions, was reported. In this paper, we focus on the solar cycle effects. With 11 years of data to the end of 2001, we observed a maximum solar response of 0.06K/SFU at 99km, which decreases at lower and higher altitudes to nearly zero and appears to change sign at 82km and 104km. The phase changes are consistent with earlier midlatitude

observation with incoherent scatter radar above and Rayleigh lidar below the altitudes reported here, providing clear experimental evidence of dynamical influences thoughout different layers of Earth's atmosphere. We discussed the altitude dependence of response amplitudes and delay the volcanic and solar flux effects have on the mesopause region temperatures, as well as long-term temperature trends. In this paper, we reinvestigate the questions with the 2002 data added, and take up the question of seasonal dependence (summer vs winter) as well as difference in QBO phases (east vs. west).

SA41B-0430 0830h POSTER

FUV Spectroscopy of the Dayglow and Aurora from the TIMED/GUVI Sensor

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The Global Ultraviolet Imager (GUVI) on the TIMED spacecraft generates horizon-to-horizon images of the far ultraviolet (FUV) radiance in five bands (HI 121.6 nm, OI 130.4 nm, OI 135.6 m, N_2 LBH short 140 - 150 nm, N_2 LBH long 165 - 180nm). The GUVI instrument scans cross-track through 127.2° producing an orbit swath ∼2500 km across on the disk of the Earth. This produces 2-dimensional radiance maps for each orbit. A special spectrograph mode of operation is available on the instrument where the entire spectrum from 115 nm to 180 nm is sent down and the scan mirror is in a fixed (generally nadir pointing) location. In this paper we present an analysis of the nadir dayglow data and nadir aurora data and compare it to the normal imaging mode data from neighboring orbits. In this analysis we will discuss the impact of recent estimations of an enhanced N_2 LBH excitation cross section as well as the OI 135.6 nm to N_2 LBH ratio and how well the GUVI spectroscopy mode data supports these changes. These cross section changes have implications for the derivation of O / N_2 in the dayglow and aurora.

SA41B-0431 0830h POSTER

Retrieval of thermospheric temperature and N2, O, and O2 concentrations from GUVI limb scans

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The atomic oxygen 135.6 nm and the molecular nitrogen LBHS (140 - 150 nm) channels of the Global Ultraviolet Imager (GUVI) investigation can be used to remotely sense the state of the thermosphere. Observation of these emissions on the Earth limb are inverted using discrete inverse theory to retrieve altitude profiles of the N2, O, and O2 concentrations and temperature. The O/N2 column concentrations so obtained are found to be in excellent agreement with those derived independently from downward viewing of the Earth disk by GUVI. Low O/N2 regions during geomagnetic storms are found to have elevated temperatures. These composition and temperature correlations are consistent with the view that low O/N2 originates at high latitudes due to upwelling caused by Joule and particle heating. The molecular rich air then moves equatorward at night and migrates into the day where it can be observed by GUVI before cooling. Examples of this behavior from several geomagnetic storms will be presented.

SA41B-0432 0830h POSTER

Auroral Energy and Energy Flux Measurements using GUVI

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We present estimates of the average characteristic energy and energy flux of energetic precipitating auroral particles. These estimates are derived from irradiance data measured on the Global Ultraviolet Imager (GUVI) flying on the TIMED satellite. We will present both the average and standard deviation of global maps of the energy and energy flux during the first year of GUVI data. We will compare results of the GUVI derived measurements to previous estimates of Hardy who used in-situ particle measurements from the Defense Meteorological Support Satellite (DMSP) program.

SA41B-0433 0830h POSTER

Products Derived From GUVI Auroral Data and Comparisons With Ground-Based Results From Poker Flat and Ft. Yukon, AK

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The TIMED/GUVI experiment has been making routine auroral/airglow far ultraviolet measurements since January 2002. Routine auroral measurements at visible/near IR wavelengths from the ground sites identified in the title have also been made that offer the opportunity to compare derived data products when GUVI is making coincident observations. The products of interest are characteristic energy E_o and energy flux Q of precipitating electrons along with a scaling factor f_O of the atomic oxygen number density (referenced to a specific MSIS atmosphere) that addresses composition changes arising from auroral heating. Comparisons of these products will be presented as derived from TIMED/GUVI Earth-disk data (using the 135.6, LBH_S and LBH_L spectral channels) and coincident ground-based data recorded at Poker Flat and Ft. Yukon, AK (photometer zenith observations of OI 844.6 nm, OI 630.0 nm, N_2^+ 427.8 nm, and N_2 1PG 871.0 nm). Primary attention will be directed to GUVI data from a single orbit on April 17 2002 that recorded significant aurora emission over Alaska and elsewhere. The above products from coincident measurements of the two observing systems are in reasonable agreement and show significant reductions in f_O compared to undisturbed values. Similar comparisons will also be presented from other times during 2002 and 2003.

SA41B-0434 0830h POSTER

Height-integrated Joule and particle heating rates determined by TIMED GUVI and SuperDARN

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Magnetosphere-ionosphere coupling at high latitudes provides two important sources of thermal energy for the Earth's upper atmosphere: (1) particle heating by collisions with energetic auroral precipitation; and (2) Joule heating by dissipation of electric currents in the resistive ionosphere. In this paper, we present height-integrated Joule heating rates calculated by combining F-region electric field measurements from the Super Dual Auroral Radar Network (SuperDARN) with ionospheric conductivity estimates from the Global Ultraviolet Imager (GUVI) aboard the TIMED spacecraft. Hemispheric maps of Joule heating rates are compared with similar maps of particle heating rates determined from the GUVI auroral images. It is shown that auroral activity and the strength of ionospheric convection are, to a certain extent, anti-correlated with each other. One result of this behavior is that particle heating is generally the dominant heat source post-midnight, whereas Joule heating dominates near dusk.

SA41B-0435 0830h POSTER

Low-Latitude Ionospheric Plasma Depletions: Imaging, Modeling, and Interpretation Using Space-Based Ultraviolet Measurements

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Modeling and characterization of ionospheric structures and dynamics are important issues in space weather research. Recently the Global Ultraviolet Imager (GUVI) on-board the Thermosphere Ionosphere Mesosphere Energetics and Dynamics (TIMED) satellite has detected far ultraviolet (FUV) images of plasma depletions in the low latitude and equatorial ionosphere. A model of GUVI observation geometry was developed to simulate radiance observations of a model ionosphere. The model has been refined to incorporate geomagnetic coordinates and to allow plasma depletions to be aligned with magnetic field lines. We report on new results in reconstructing multi-dimensional electron density profiles from GUVI brightness measurements through the use of statistical inversion techniques and modeling studies. These results include three-dimensional images of field-aligned depletion structures. Case studies and comparisons with overlapping data sets are presented as a means of validation of these results.

SA41B-0436 0830h POSTER

Automatic Detection of Equatorial Plasma Bubbles in GUVI Data

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The TIMED spacecraft is currently mapping the Earth disk and limb with the Global Ultraviolet Imager (GUVI). Images are made at six different wavelengths including the optically thin OI 135.6 nm line that is excited by the recombination of O+ ions at night. The intensity in these nighttime disk images is related to the total electron content of the ionosphere and density profiles can be recovered from the limb scans. Prominent in these images are UV signatures of the Equatorial Anomaly (EA) where Equatorial Plasma Bubbles (EPBs) can be seen. We present a method to detect EPBs in GUVI data based upon image subspace techniques. We then present EPB detection rates in the entire 2002 GUVI dataset. Observations are made about rate dependencies to season, zone, local time, and the general condition of the EA. Finally, these results are compared with similar in situ based observations.

SA41B-0437 0830h POSTER

Equatorial, Daytime ExB Drift Velocities Inferred From GUVI 1356 A Radiance Observations

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Currently, there does not exist a way of estimating low latitude, ionospheric daytime vertical ExB drifts, day-to-day, around the globe. In this talk we present a promising, new technique that would enable us to estimate the day-to-day variability in daytime ExB drift velocities using the nighttime 1356 Å radiance observations from the GUVI instrument -Global UltraViolet Imager- on the TIMED satellite. It is well known that the greater the upward, daytime ExB drift velocity in the low latitude ionospheric F region, the greater the latitude separation of the crests in maximum electron density, Nmax, known as the equatorial anomaly. At night, the observed 1356 Å GUVI radiance observations can be primarily attributed to the radiative recombination reaction, O+ + e = O* + hv. This means that the 1356 Å intensity is proportional to the height integral of Ne2, with most of the radiation originating near Hmax. In this talk we describe the procedures that have been carried out to estimate the post-sunset latitude crest separation in Nmax inferred from GUVI observations for a significant number of nights in the low latitude Peruvian longitude sector and how these crest separations are directly related to the observed strength of the daytime ExB drift velocities on these days in this longitude sector. In addition to presenting the derived Crest Separation vs Average Daytime ExB Drift Velocity relationship, we discuss the importance of these findings as they relate to the recently developed Global Assimilation of Ionospheric Measurements -GAIM- model.

SA41B-0438 0830h POSTER

Upper Atmosphere Temperature Effects of Energetic Electron Precipitation During Substorms

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From X-ray measurements with PIXIE on the Polar satellite we infer the global distribution of precipitating energetic electrons. These electrons ionize, dissociate, and excite atmospheric species, and initiate chemical and physical processes that lead to neutral gas heating in the thermosphere. The particle precipitation may also cause temperature changes in the upper mesosphere. Neutral gas temperatures are measured by the SABER instrument on the TIMED satellite. We study the effects of energetic electron precipitation on the temperature in the lower thermosphere and upper mesosphere during a substorm event on 30 October 2002.

SA41B-0439 0830h POSTER

SABER Observations of Polar Summer/Winter Mesospheric and Lower Thermospheric Temperatures and Comparisons With Correlative Measurements Taken During the MaCWAVE Campaign

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The Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) experiment was launched onboard the TIMED satellite in December 2001. SABER derives kinetic temperature (Tk) in the mesosphere and lower thermosphere (MLT) from broadband measurements of CO_2 15 um limb emission, in combination with measurements of CO_2 4.3 um limb emission used to derive CO_2 volume mixing ratio. Infrared emissions from the CO_2 ro-vibrational bands are in non-local thermodynamic equilibrium (non-LTE) in the MLT, requiring non-LTE processes to be accurately modeled in the retrieval algorithm. In this paper we focus on Tk and show results derived from the non-LTE retrieval algorithm. We demonstrate the ability to retrieve Tk in an extreme non-LTE environment by comparing SABER MLT Tk with rocket falling sphere (FS) and sodium lidar measurements taken during the 2002 summer MaCWAVE campaign. The summer Tk profiles show that the SABER non-LTE retrieval algorithm improves upper mesospheric Tk retrievals by 35 K to 45 K, as compared to SABER LTE Tk retrievals. Combined measurements from SABER and MaCWAVE show a mesopause region that is highly variable in space and time. SABER data also show a mesopause altitude that changes with latitude and season, consistent with the bimodal character of the mesopause height. We also show preliminary comparisons with the recently available FS and sodium lidar measurements taken during the 2003 winter MaCWAVE campaign.

SA41B-0440 0830h POSTER

Derivation of Mesospheric Ozone from TIMED/SABER Measurements of the O_2 Infrared Atmospheric Band Emission in the Dayglow

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The Sounding of the Atmosphere using Broadband Emission Radiometery (SABER) is one of four instruments on NASA's TIMED Mission. SABER is a broadband limb scanning radiometer that measures infrared emission from atmospheric species between 10 and 280 km tangent point altitude. One of the SABER channels is centered at 1.27 μm where the O2($a^1\Delta_g$–$X^3\sigma_g^-$) Infrared Atmospheric band emission dominates the atmospheric airglow. In the sunlit mesosphere, direct production of $O_2(a^1\Delta_g)$ during solar photolysis of O_3 in the Hartley band is the major source of this O_2 emission and atmospheric ozone abundances between 60 and 90 km can be deduced from the measured $O_2(^1\Delta_g)$ volume emission rates using a simple photochemical model. We have inferred the daytime O_3 abundances between 60 and 90 km using SABER measurements taken during the period January 25 2002–January 24 2003. In this paper the derived O_3 concentrations are presented and compared with those obtained from other observations and predictions by photochemical models.

SA41B-0441 0830h POSTER

Local Time Dependence of CO_2 LWIR Emission in the Lower Thermosphere from SABER: Implications for Atmospheric Cooling

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Emissions in the 15 μm bands of CO_2 are extremely important for the energy balance in the lower thermosphere, but uncertainty remains concerning the rate at which the principal excitation process, collision with atomic oxygen, proceeds. The SABER data set confirms that there is great variability in limb radiance profiles in this region, seen most prominently as local maxima ("knees") that appear frequently but unpredictably near 100-110 km. We examine these data in search of explanatory patterns, such as correlation of radiance levels with latitude, local time, and season. We combine this with a modeling effort to see how successfully the currently accepted modeling parameters can reproduce profiles found in the data, and discuss the implications of these patterns for atmospheric cooling rates.

SA41B-0442 0830h POSTER

Synoptic Distributions of SABER Temperature Data and Implications for Derived Dynamical Quantities

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The Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) instrument aboard the TIMED (Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics) satellite has been obtaining measurements since January 2002. The Version 1.02 Level 2A LTE temperature data have been compared with temperature data obtained by other satellites, lidars, and falling spheres. The agreement between the SABER temperature profiles and those for other data sets indicates that the Version 1.02 SABER LTE temperature versus pressure distributions should be suitable for use in dynamical studies of the middle atmosphere through the calculation of winds and potential vorticity. A first step in the calculation of dynamical parameters is to use a sequential estimation technique to obtain synoptic temperature distributions from the asynoptic SABER satellite data. The algorithm that was used generates Fourier coefficients of temperature (through zonal wavenumber 6) which are output at noon UT for each day as a function of latitude. From these spectral coefficients, synoptic temperature fields are estimated. Geopotential height fields are calculated from the mapped temperature data, and winds are obtained using the geopotential height fields. The estimated data are compared with products from the Met. Office analyses to further assess the quality of the SABER data.

SA41B-0443 0830h POSTER

Laboratory Studies of $CO_2(\nu_2)$-O Vibrational Energy Transfer

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For altitudes above about 80 km, oxygen molecules are increasingly dissociated by solar VUV absorption, and O atoms, together with N_2, become a principal constituent of the atmosphere. Through collisions with the ambient O atoms, the ground vibrational state of CO_2 is efficiently excited to its lowest excited vibrational state, with one quantum of energy in the ν_2 bending mode. In the near-space environment, a sizable fraction of this population relaxes via 15-μ spontaneous IR emission, which effectively converts ambient kinetic energy into radiative energy that passes into space. This process is the principal upper atmospheric cooling mechanism in the 75-120 km altitude range. Despite the importance of this mechanism, current estimates of the $CO_2(\nu_2)$-O vibrational relaxation rate constant vary over a factor of six, with the laboratory measurements clustering in the 1-1.5 $\times$ 10^{-12} cm^3s^{-1} range, and the aeronomical estimates in the 3-6 $\times$ 10^{-12} cm^3s^{-1} range. We are currently pursuing vibrational relaxation measurements on the $CO_2(\nu_2)$-O system in the laboratory, using the temperature jump method together with transient diode laser absorption spectroscopy detection of the CO_2 vibrational level populations. We will present the current state of progress of the experimental effort, as well as possible future directions.

SA41B-0444 0830h POSTER

Comparison of TIMED/SABER non-LTE temperature retrivals with ground based mesospheric temperature mapper measurements

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An important goal of the NASA TIMED satellite mission is to map the temperature field of earth's upper atmosphere (core region 60-180 km) on a global scale. The SABER instrument onboard TIMED uses measurements of the CO2 limb emissions at 15 microns to derive height profiles of atmospheric temperatures (altitude 40-135 km) with a vertical resolution of 2 km. As part of a novel program to investigate the dynamics of mesospheric temperature variability at low latitudes, ground-based measurements using the USU-CEDAR Mesospheric Temperature Mapper (MTM) located at Maui, Hawaii (20.8N, 156W) have recently been compared with TIMED/SABER overpasses within 500 km of the Hawaiian islands. The combination of these two separate measurement techniques provides a powerful and complimentary method for investigating temporal and spatial induced variability. This poster focuses on data from February and July/August 2002 to investigate winter-summer differences and nocturnal variability.

SA41B-0445 0830h POSTER

Impact of SABER-Observed CO_2 Concentrations on SABER-CSU Lidar Mesospheric Temperature Comparisons at Fort Collins, Colorado.

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The Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) experiment was launched onboard the TIMED satellite in December 2001. Mesospheric and lower thermospheric kinetic temperature (Tk) and CO_2 volume mixing ratio (vmr) are simultaneously retrieved during daytime from measurements of broadband Earth limb emission in the SABER CO_2 15 um and CO_2 4.3 um channels, respectively. At night only Tk is retrieved from SABER measurements in the CO_2 15 um channel. The Tk/CO_2 retrieval algorithm includes non-local thermodynamic equilibrium processes in the inversion scheme. The CO_2 concentrations needed in the nighttime Tk retrievals are taken from the TIME-GCM climatology. The quality of the daytime-retrieved CO_2 profiles is assessed by comparing nighttime SABER Tk profiles with nighttime Tk observations taken from sodium lidar measurements at Fort Collins, Colorado. There are a number of days in 2002 where SABER measurements were taken over Fort Collins during daytime and nighttime hours on the same day. For the nighttime overpasses, two SABER Tk retrievals are performed for each coincidence scan: one retrieval using the TIME-GCM CO_2 concentration and the other retrieval using the SABER-retrieved CO_2 concentration from the corresponding daytime scan. If the SABER-lidar nighttime Tk comparisons are improved by using the SABER-retrieved CO_2 profiles in the Tk retrieval, we conclude that SABER has improved our knowledge of mid-latitude CO_2 abundance.

SA41B-0446 0830h POSTER

Remote Sensing of Thermospheric Atomic Oxygen or Temperature Using NO Radiances from TIMED/SABER and SNOE

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A major mechanism for vibrational excitation of NO in the thermosphere is collisional energy transfer from atomic oxygen, NO(v=0) + O $\rightarrow$ NO(v=1) + O. Emission from NO(v=1) produces the bright 5.3 micron band. At altitudes where this process dominates vibrational excitation during daylight or aurora, a relationship exists between atomic oxygen and ground state NO densities and temperature (due to the strong temperature dependence of the rate coefficient for vibrational excitation). Simultaneous measurements of ground state NO density, NO 5.3 micron volume emission rate, and either temperature or atomic oxygen density, would enable determination of the remaining quantity. This could provide a powerful remote sensing technique for temperature or atomic oxygen for altitudes where their determination is presently difficult. We present retrievals using combined SABER 5.3 micron radiation and SNOE fluorescent scattering measurements, and examine the effect of various NO + O reaction rates.

SA41B-0447 0830h POSTER

Seasonal wind fields as determined by the TIMED Doppler Interferometer (TIDI)

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The TIMED Doppler Interferometer (TIDI) has been measuring the wind field in the mesosphere and lower thermosphere since early 2002. The instrument is a Fabry-Perot interferometer that simultaneously samples the limb of the Earth with four separate telescopes providing two forward views and two rearward views, one of each on either side of the orbital path. At equator crossings, these two side views are separated by about 30 degrees of longitude at the tangent point altitude, or 2 hours of local time. On any orbit TIDI obtains two horizontal vector winds at the dayside equator crossing and two on the nightside equator crossing for all low latitudes. The precession rate of TIMED requires a two month average of data to sample all local solar times This paper will describe the wind field that has been determined by the TIDI since operations commenced. The mean wind and tidal amplitudes are examined and seasonal variability examined. Results are also compared to fields measured earlier by HRDI and WINDII on the UARS spacecraft.

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SA41B-0448 0830h POSTER

TIDI OBSERVATIONS RELATING TO HIGH LATITUDE AERONOMY

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Unique observations of the horizontal neutral winds at high latitudes in the altitude range 60 to 180 km have been performed by TIDI (Thermosphere Ionosphere Doppler Interferometer) since January 2002. The satellite orbit is such that the TIDI field of view includes latitudes to both the north pole and the south pole. Though high latitude neutral wind measurements have been obtained from space with the DE-2 satellite and the UARS satellite, TIDI is the first instrument to sample the mesosphere and the lower thermosphere up to and including both polar regions on a long-term basis. Ground based studies have previously reported a strong semi-diurnal tide in the mesosphere over Resolute, Canada. This paper will describe the climatology that has been obtained by the TIDI instrument since early 2002 for high latitudes. The precession rate of TIMED supports two month averaging of data sets in order to sample all local solar time.

SA41B-0449 0830h POSTER

DEVELOPMENT OF A SEQUENTIAL ESTIMATOR FOR ASSIMILATION OF GROUND-AND SPACE-BASED MESOSPHERIC AND LOWER THERMOSPHERIC WINDS

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A sequential estimator for assimilation of ground- and satellite-based MLT wind measurements has been developed in support of the TIMED mission science goals. Preliminary experiments focused on the retrieval of monochromatic waves sampled by the TIMED satellite and the MF observing network. Ground-based measurements are found to be a critical compliment to the satellite database for defining the migrating semidiurnal tide. The assimilation algorithm is currently being tested on output from the NCAR Whole Atmosphere Community Climate Model (WACCM). The sequential estimator is able to resolve nonmigrating diurnal variability on times scales of 7 days and longer.

SA41B-0450 0830h POSTER

Dynamics of the 2-day wave in a nonlinear model of the middle and upper atmosphere

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The 2-day wave is investigated in a 3D model of the nonlinear primitive equations. Extending upward from the tropopause into the thermosphere, the model is forced stochastically by fluctuations of tropospheric wave structure. The behavior recovered is broadly consistent with linear calculations of the Rossby-gravity normal mode in the presence of instability. The mode's amplification depends sensitively upon details of the zonal-mean flow, which determine instability through a reversal of PV gradient. On the other hand, the mode's period and structure are robust. They retain much the same form under a variety of conditions. The response is sharply discriminated to wavenumber 3 and westward periods of 2.0 – 2.3 days, even though forcing is broad band. Under January conditions, strong easterlies and the accompanying reversal of PV gradient enable the mode to amplify through sympathetic interaction with the mean flow. The amplifying signal eventually emerges from random variability, which is excited by broad-band forcing. Amplification continues until eddy velocities approach 70 m/s, whereupon the signal saturates. Horizontal mixing then ensues, destroying the meridional gradient of PV, which in turn limits instability and further amplification. Under June conditions, the response fluctuates randomly during the entire integration, with no evidence of sustained amplification. Nevertheless, it too is sharply discriminated to westward periods of 2.0 – 2.3 days, achieving eddy velocities of 10 – 20 m/s. The sharply-discriminated response appears even when a reversal of PV gradient is absent, leaving the mean flow stable. Under all of these conditions, the structure of eddy streamfunction Psi' is nearly barotropic, with antisymmetric character between the hemispheres. Eddy motion assumes the form of a wavenumber-3 pattern of equatorial gyres, reducing in the tropics to v' and strong cross-equatorial motion. The pattern is very similar to the limiting structure of the 2-day wave observed by UARS. Although magnified in the summer stratosphere and mesosphere, the structure of Psi' is global, with a phase reversal between the hemispheres. The modal structure extends upward into the thermosphere and, albeit weaker, as low as the tropopause.

SA41B-0451 0830h POSTER

Collaborative analysis of Planetary Waves in the Mesospheric Neutral Winds with SuperDARN and TIMED Observations

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The SuperDARN HF radars are best known for observing the ExB drift of ionospheric plasma in the high-latitude F region. At mesospheric altitudes the trails of ionization produced by meteors provide another kind of target for radar backscatter, and the motions imparted to these trails by winds in the neutral atmosphere can be measured. In the northern hemisphere the coverage of mesospheric winds currently extends over a 180 deg longitude sector but is confined by propagation conditions to latitudes near 55 deg geographic. We have analyzed several extended periods of simultaneous observations of the neutral wind involving SuperDARN and the TIMED suite of instruments. Often, the winds show clear evidence of large-scale wave events, including activity with periods of about 2 days. These planetary waves have large amplitudes, their occurrence depends on season, and they seem to recur. By comparing the wave characteristics between the satellite and ground observations we obtain a complete breakdown of the wave activity in terms of periods and zonal wavenumbers. In this presentation we demonstrate the coherence of the wave activity between the radar and satellite observations, describe the properties of the planetary waves, and discuss our findings on the spectra of the wave modes.

SA41B-0452 0830h POSTER

Modeling the MLT Region in Light of Measurements From the TIMED Mission

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Our Numerical Spectral Model (NSM) extends from the ground up to the thermosphere and incorporates Hines' Doppler Spread Parameterization for small-scale gravity waves. This model describes in the mesosphere the major features of: (a) the equatorial oscillations (QBO and SAO), (b) the migrating as well as nonmigrating tides, and (c) the planetary waves. The model also generates distinct intra-seasonal oscillations with periods around 3 months and planetary-scale inertio gravity waves with periods around 10 hours. After a review of the model and major findings, we discuss the scientific investigations to be carried out with the measurements from the TIMED mission. As part of this investigation, we shall attempt to describe the observations empirically (statistically) with vector spherical harmonics that delineate the temperature and wind fields in terms of zonal wave numbers, m = 0 to 4. The spectral formulation of the model allows us then to study the observed dynamical components and their interactions. With emphasis on the dynamics and energetics of the mesosphere, we shall compare some of our model simulations with temperature data from SABER and winds derived from TIDI measurements. We shall also present model predictions for comparison with coordinated ground-based observations.

SA41B-0453 0830h POSTER

Effects of High Frequency Gravity Waves on the Mean Flow in the Mesopause Region at Maui, Hawaii

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Simultaneous observations of the OH Meinel and O2 Atmospheric (0,1) airglow intensity have been made by an OH/O2 zenith photometer at Maui, Hawaii (20.7 N, 156.3 W) since Jan. 2002. By combining these data with coordinated measurements using an all-sky OH imager and a meteor radar, the amplitude and phase of the airglow perturbations in the OH and O2 layers, as well as the characteristics of the high frequency gravity waves that induce these fluctuations, are determined. The observed intensity perturbation amplitude ratio and phase difference between the O2 and OH layer are compared with a 1-D model prediction to infer the gravity wave damping rate. The results show that heavily damped gravity waves are commonly observed in the mesopause region. The resulted mean flow accelerations are significant, suggesting that high frequency gravity wave dissipation play an important role in the momentum budget in this region. Possible mechanisms for gravity wave dissipation will also be discussed.

SA41B-0454 0830h POSTER

Estimating Gravity Wave Momentum Flux from Airglow Images

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Estimating gravity wave momentum flux from all-sky airglow images independent of high-resolution lidar/radar wind measurement is highly demanded for seasonal and geographical study of gravity waves in the mesopause region. A novel technique has been developed for extracting the vertical fluxes of horizontal momentum of high frequency gravity waves with airglow images and background lidar/radar winds. This approach identifies monochromatic wave components and extracts intrinsic wave parameters from Doppler corrected time differenced (TD) images. With momentum fluxes calculated for all the wave components from each TD image in one night, the statistical momentum flux value is estimated. This technique has been applied to OH data collected in 2002 at Maui, Hawaii and validated by comparing the daily results with the momentum fluxes extracted from temperature data collected by Na lidar that was operating simultaneously. Seasonal variations of high frequency wave propagation derived from all-sky images will be compared with low frequency wave directions acquired from lidar wind measurement using hodograph method.

SA41B-0455 0830h POSTER

Yearlong Na-Lidar observation of temperature and winds over full diurnal cycles above Ft. Collins, CO (40°N, 105°): Diurnal and semidiurnal tidal perturbations

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With a pair of robust Faraday Filters, Na-Lidar in Colorado State University has observed mesopause region temperature and winds (80-110km) over full diurnal cycle for more than one year. Here, we select only continuous 24-hour data sets with a total of 29 sets between May 02 and April 03 and form bi-monthly means for tidal analysis. We observed considerable daytime and nighttime differences for both temperature and winds (Zonal and Meridional). We investigated the tidal wave (Diurnal and Semi-Diurnal) activities and compared with GSWM (Global Scale Wave Model) and TIME-GCM output. Observed diurnal tides are in good agreement with GSWM prediction, though some discrepancies exist in semidiurnal tides comparison. Larger amplitude and shorter wavelength than what model predict are typically observed for semidiurnal tides. Data acquired after April 03 are used to assess tidal variability.

SA41B-0456 0830h POSTER

Na lidar observed atmospheric instability and OH imager observed ripples as wave breaking signatures

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The Platteville OH imager has observed the nighttime all sky images of OH (87±5km) airglow layers since September 2001. On the night of September 5, 2002, we observed small-scale (also called ripple-type) wave structures with horizontal wavelength of 7km and lifetimes of 14.5min. At the same night, the CSU lidar at Fort Collins was in operation, measuring mesopause region temperature, zonal and meridional winds simultaneously. Since the lidar beams in the mesopause region are within the field view of the imager, atmospheric convective and dynamic instability before, during and after the ripples traverse the lidar beam may be assessed. We found that the small-scale wave structures appear at almost the same time with the local instability and they both have similar lifetime scale. This verified that the small-scale wave structures are associated with the localized instability and as suggested in earlier work [Hecht et al., 1997, Fritts et al., 1997], the ripple structure may be taken as signatures of wave breaking. We noted that these small-scale wave fronts are perpendicular to the fronts of much longer-lived gravity waves (30 to 50km horizontal wavelength), and that lidar observed convective instability where ripples occur, as well as dynamic stability in nearby convectively stable regions.

SA41C MCC: 2006 Thursday 1020h

Meteors and the Mesopause II

Presiding: **J Friedman,** National Astronomy and Ionosphere Center, Arecibo Observatory**; D Janches,** National Astronomy and Ionosphere Center, Arecibo Observatory

SA41C-01 1020h INVITED

Metal Layers at High Altitudes and Near the Polar Summer Mesopause

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Since 1996 the mobile potassium lidar of the IAP Kühlungsborn has measured metal densities and temperatures at various locations from the Antarctic to the Arctic. Between 1996 and 1998 simultaneous observations with our stationary double metal lidar at 54°N have been carried out. This instrument is able to observe two additional metals which can be sodium, calcium, iron or calcium ions. Both instruments have been aligned to the same field of view. Beside the unique possibility to observe meteor trails with high altitude (7.5 m) and time resolution (1 laser pulse) the obtained data also show close correlations between different metals at altitudes above 100 km. Similar correlations with other latitudes are visible when comparing the data with potassium observations at Tenerife (28°N) and Arecibo (18°N). Recent observations of the mobile potassium lidar at Spitsbergen 78°N show that the metal layer is strongly influenced by the presents of icy particles (NLC/PMSE) under the condition of the very cold polar summer mesosphere. During hundreds of hours of observations of NLC and potassium not one event was found where potassium and NLC coexist in the same altitude. On the other side potassium and NLC are frequently observed in two adjacent altitude channels the lidar (200 m).

SA41C-02 1040h

Dynamics of Charged Dust in the Polar Winter Mesosphere

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Four rockets carrying charged dust detectors were launched from Poker Flat in March 2002. The goal of the experiment was to examine the relationship between dust and neutral metals in the Earth's mesosphere. Each of the four identical payloads carried instruments to measure electric fields, charged dust density and plasma density. Ground-based iron and sodium lidars were used to determine conditions near the time of launch. One rocket was launched near midnight on the night of March 6; the remaining three rockets were launched over the course of the night on March 16. The multiple launches have allowed analysis of large-scale motions of charged dust and plasma relative to the lidar-measured neutral metals. In this paper we discuss correlations between measured charged dust densities, plasma densities and neutral metals on the two nights.

SA41C-03 1055h

Global Satellite Observations of the Sodium Layer

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Improved understanding of the fate of meteoric material in the Earth's atmosphere requires collaboration between a wide range of scientific disciplines. Much progress has been made in recent years concerning meteoroid influx, ablation processes and subsequent chemistry. The present study contributes to these research efforts by providing a global climatology of the mesospheric sodium layer. We present data from the OSIRIS optical spectrometer onboard the Swedish Odin satellite. Limb scattering profiles from the sodium layer are observed at the atomic Na D resonance lines near 590 nm. A detailed forward model for the resonance radiative transfer has been developed; profiles of sodium number density are retrieved using an Optimal Estimation Method (OEM). Retrieved profiles reveal the seasonal and latitudinal dependence of the sodium layer. These are compared to local climatologies of lidar measurements. Complementary model simulations are based on comprehensive new laboratory results on mesospheric sodium chemistry.

SA41C-04 1110h

Observations of Sporadic Sodium-, Iron- and E-Layers at a High-Latitude Site.

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Sodium resonance lidar observations have been ongoing at Poker Flat Research Range (PFRR), Chatanika, Alaska (65oN, 147oW) since 1995. Iron resonance lidar measurements have been ongoing at PFRR since 2000. We present an overview of the iron and sodium layer structure at this high-latitude site. In particular we focus on sporadic metal layer events highlighting differences in the appearance and altitude distribution of the sporadic layers in the two species. We compare these neutral metal events detected by the lidar with sporadic-E layer events detected by digisonde about 50 km from PFRR at College Alaska. We also compare the events to structures observed in 2-D images of the resonantly scattered sunlight from the sodium layer. We discuss the observations in terms of modeling studies of the mesospheric metal layers and the distribution of meteoric material in the atmosphere.

SA41C-05 1125h

Mesospheric Fe Layers Observed at the South Pole and Rothera by a Lidar

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Recently, the University of Illinois Fe Boltzmann temperature lidar was moved from the South Pole to Rothera (67.5°N, 68°W), Antarctica. The normal and sporadic Fe layers were observed at both locations. A few meteor trails were also recorded at Rothera in January 2003. We characterize the Fe layers at both locations and make a detail comparison. The summertime Fe layer at Rothera has higher number density and a lower peak altitude compared to the Fe layer at the South Pole. These features are most likely due to the temperature difference between the two locations, as observed by the lidar. We present the observations and compare them with numerical models of the Fe layer.