### SA32A-07 1525h

#### Modeling of the Energy Balance in the Mesosphere and Lower Thermosphere

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The TIMEGCM is used to simulate solar maximum and solar minimum conditions, for both geomagnetically quiet and active intervals. The most important heating and cooling terms are identified, and the structure of the 3-D global energy balance is contrasted for these different conditions. One of the main science goals for the TIMED mission is to understand the energetics of the MLT region. It is difficult to measure all of the energetics terms simultaneously, but we review the TIMED measurements and their relevance to the MLT energetics. We show how the TIMED mission addresses the major heating and cooling terms.

## SA32B MCC: 2006 Wednesday 1600h

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

***Presiding:*** **G Crowley,** Southwest Research Institute

### SA32B-01 1600h

#### An Overview Of The SABER Experiment And Science Results

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The Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) experiment was launched on December 7, 2001 into a 74.1o inclined, 625 km orbit onboard the TIMED satellite. The primary science goal of SABER is to achieve major advances in understanding the structure, energetics, chemistry, and dynamics in the atmospheric region extending from 60 to 180 km altitude. SABER has been operating almost continuously since activation using the space flight proven experiment approach of spectral broadband limb emission radiometry. The instrument scans the earth limb in 10 selected spectral bands ranging from 1.27 mm to 17 mm wavelength. The observed limb emission profiles are being processed on the ground to provide vertical profiles with 2 km altitude resolution of the following: temperature, O3, H2O, and CO2 mixing ratios; volume emission rates due to O2 (1D), OH (u=3,4,5), OH (u=7,8,9), and NO; key atmospheric cooling rates, solar heating rates, chemical heating rates, and airglow losses; atomic oxygen, atomic hydrogen and geostrophic winds. Measurements are made both night and day over the latitude range from 54oS to 87oN with alternating hemisphere coverage every 60 days. SABER has provided new information on energetics of the TIMED core region, observed atmospheric effects of major solar storms and made measurements in both northern and southern polar summers. This paper provides an experiment overview, orbital performance, comparisons with correlative observations and an overview of science results.

### SA32B-02 1615h

#### Fast planetary waves in the mesosphere and lower thermosphere observed by SABER

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SABER version 1.02 (non-LTE) temperature data is used to document the presence of fast, planetary-scale waves in the mesosphere and lower thermosphere (MLT) for different seasons during 2002. The results show that, at periods $\tau < 5$ days, the planetary-scale wave field is dominated by migrating and non-migrating tides, equatorial Kelvin and inertia-gravity waves, and the 2-day wave. The latter actually appears as the strongest component of an ensemble of normal mode-like oscillations, with maximum amplitude at m=3 and 4 near 2 days. Temperature amplitudes associated with these waves range from a few K for the Kelvin waves and non-migrating tides to about 15 K for the diurnal tide; estimated horizontal velocity amplitudes are in the range 10-50 $ms^{-1}$. It is also shown by comparison with GCM results that these waves should produce large perturbations in the distribution of chemical species in the MLT.

### SA32B-03 1630h

#### On the use of Hough Mode Extensions (HMEs) to fit Tidal Structures From SABER and TIDI Measurements

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Hough Mode Extensions (HMEs) are analogs of solutions to Laplace's Tidal Equation (i.e., eigenfunctions corresponding to waves of a specified frequency and zonal wavenmber), except that latitudinal and vertical changes in structure due to dissipation are taken into account. In this study, HMEs are computed using the Global Scale Wave Model (GSWM) with arbitrary forcing. HMEs are global (i.e., pole to pole, surface to 250 km). For a give HME, the relative amplitudes and phases of eastward, northward, and vertical velocity components, as well as temperature, density and geopotential perturbations, are internally consistent and fixed. Herein, the concept of using HMEs to extend globally tidal structures determined from TIMED/TIDI and TIMED/SABER wind and temperature measurements, respectively, is explored by using output from the Kyushu University GCM as proxy data. This also provides a means of ascertaining the merit of the globally-extrapolated fields via comparison with the exact solution. Examples are shown for the westward propagating diurnal tides with zonal wavenumbers s = 1 and s = 2, the eastward diurnal tide with s = 3, and the zonally symmetric (s = 0) diurnal tide using data from 95 km only. Very good agreement is achieved in matching global structures, setting the stage for future applications with observational data. Advantages, caveats and shortcomings of the technique are also explored.

### SA32B-04 1645h

#### Observations of Seasonal Variations of Mesosphere and Lower Thermosphere Tides by the TIMED Doppler Interferometer

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Using neutral wind measurements by the TIMED Doppler Interferometer (TIDI), we examine seasonal variations in the migrating tide. TIDI samples four local times at latitudes between 60N and 60S on every orbit. The instrument measures winds from 70 to 105 km altitude during the day and 85 to 100 km during the night. Since the orbital precession rate of the TIMED satellite is 3 degree/day, it takes 60 days (one yaw period) for TIDI to sample the full range of solar times. We examine the possibility of extracting tidal wave features using data periods of less than 60 days. In spite of the limitation on local time coverage, TIDI can provide a global view of the tidal structure. The observational results will be compared with model runs from GSWM02 and the TIME-GCM. We also compare tidal amplitudes and phases obtained from TIDI with ground-based observations.

### SA32B-05 1700h

#### Possible Role of the Mesosphere in the 2002 Southern Hemisphere Major Stratospheric Warming

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The 2002 major stratospheric warming is an unprecedented event in the Southern Hemisphere and has been under intensive investigations since it was observed. These studies, however, have focused mainly on the dynamical and chemical processes in the troposphere and stratosphere. In this study, both the National Center for Environmental Predication (NCEP) data (below the 1 hPa level) and a NCAR thermosphere-ionosphere- mesosphere-electrodynamics general circulation model (TIME-GCM) simulation, with its lower boundary specified by the NCEP data at 10 hPa for 2002, are used to analyze this warming event and to explore the possible role of the mesosphere in the dynamical processes. Our analysis shows that significant changes in the wind and temperature fields first occur in the mesosphere due to a strong wave 1 event about a month before the major warming. Then a series of wave events (about 3 of them) in the following month erode the polar jet and alter the transmission conditions for planetary waves at progressively lower altitudes. This helps to set up the atmospheric conditions favorable for the upward and poleward propagation of the wave energy, not only for wave 1 but also for wave 2 and 3. At the same time, the jet reversal and the planetary wave surf zone also descend from the mesosphere down to the stratosphere. The preconditioning ultimately leads to an extensive breaking of the polar jet and wave 1 in the stratosphere and thus the major warming.

### SA32B-06 1715h

## Effects of Geomagnetic Storms and Sudden Stratospheric Warmings on Mesosphere and Lower Thermosphere Winds

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Neutral winds in the MLT region are affected by dynamical influences from above and below. This is particular true at high latitudes, where solar forcing of the migrating tide may be smaller but other forcings play a big role. During geomagnetic storms, MLT neutral winds can be driven by magnetospheric convection through ion-neutral interactions. This is imparted onto the ionosphere as a cross polar cap potential forming an anti-sunward two-cell ion convection pattern which in turn drives the neutral winds in the polar MLT region. The question has always been how deep into the atmosphere the ion drift can affect the neutral wind. Scarcity of high-latitude data has hampered further understanding of the problem. Also, in the winter polar regions, the stratosphere from time to time experiences sudden warming events. While it is generally understood that these warmings are caused by troposphere planetary wave activity, there are still many unknown aspects to their excitation and propagation. There are also changes in the MLT region associated with these warming events. Moreover, this phenomena, although usually confined to the northern hemisphere, occurred in the southern hemisphere in 2002. We will use TIDI data to examine MLT neutral winds during the recent geomagnetic storm events in 2002 and 2003, and present data during the recent 2002 southern hemisphere warming event.

### SA32B-07 1730h

## Search for Thermospheric Composition Changes in the Morning Sector near Local Midnight in Association with Intense Substorm Activity

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Repeated DE-1 and other spacecraft observations have established that transient decreases in the far-ultraviolet (FUV) terrestrial OI emissions at subauroral latitudes in the morning sector are associated with decreases in the O/N2 ratio at thermospheric altitudes. The largest decrease is at 130.4 nm. These decreases are observed following onset of intense auroral activity, and at northern latitudes the greater spatial extent and depth of decrease are associated with a positive IMF By component. The DE-1 viewing geometry generally precluded clear observations in the morning sector at local solar times earlier than about 0600 hours. However, it is believed that the altered composition is driven by aurorally related heating and the antisunward polar jet that transports heated air to subauroral latitudes in the very early hours of local time and then into the morning sector. FUV observations of altered composition closer to local midnight are lacking, but are necessary to support this general expectation. The GUVI observations at FUV wavelengths are providing an extensive new set of unambiguous thermospheric composition and temperature measurements over a wide range of local times and latitudes in both auroral hemispheres as the orbit of the near-polar-orbiting TIMED spacecraft processes rapidly in local time. These data are being scanned in a search for the requisite combination of sampling at the right local times in periods of auroral substorms to address the question of composition changes near local midnight. A report on this search and its findings are presented in this paper.

### SA32B-08 1745h

## F-Region Plasma Distribution seen from TIMED/GUVI and its Effect on the Equatorial Spread F Activity

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The nighttime plasma distribution in the low-latitude F region was investigated using the measurements of O I 135.6-nm intensity from the Global Ultraviolet Imager (GUVI) on board TIMED satellite. The 135.6-nm disk scan images of the Earth showed the equatorial ionization anomaly (EIA) features around $\pm 12^{\circ}$-$15^{\circ}$ magnetic latitudes. The EIA strength was maximum during equinox periods and minimum during northern summer at most of longitude regions. The most distinguishing feature was a suppression in 135.6-nm intensity in the southern American-Atlantic sector during northern summer. Those observations indicate an existence of season-longitudinal variations in the F-region plasma density that may affect the equatorial spread F (ESF) activity. That is, it is suggested that an occurrence of low plasma density is responsible for the suppressed ESF activity during northern summer in the American-Atlantic sector, whereas an occurrence of high plasma density is responsible for the strong ESF activity during equinox periods in most of longitude regions. We will further investigate the growth condition of ESF by calculating the growth rate of Rayleigh-Taylor instability using the GUVI limb data.

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# SA41A MCC: 2006 Thursday 0800h

## Meteors and the Mesopause I

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

### SA41A-01 0800h INVITED

## The Mesopause as a Physical Boundary

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Large quantities of meteoric material impact the Mesopause region on a global scale. In this highly elevated region of the atmosphere where, large man-made vehicles first encounter the near-continuum flow regime (the so-called entry interface), there is a complex interplay of air chemistry, charged meteoric aerosol debris in the presence of water vapor, the presence of the Sodium and other metallic layers, solar electromagnetic radiation absorption, terrestrial infrared radiation cooling in the presence of a rapidly changing dynamic circulation pattern, height variable mean molecular weight, etc. In addition, there are also individual wake ionization effects and coupling with the lower ionosphere aloft as well as the presence of strong vertical shear of the horizontal wind and subsequent atmospheric turbulence and propagating neutral gravity and tidal waves, etc. This region of relatively small pressure (density) scale height acts as a physical boundary (for a range of sizes, entry velocities, entry angles, bulk densities or volume porosities, etc.) to the penetration of meteoric material through the atmosphere. We will illustrate this process using recently developed and interconnected highly detailed hydrodynamic and non-hydrodynamic models (including detailed fragmentation processes and panchromatic luminosity generation as well as infrasound generation, etc.) that are applicable to all sizes and type of meteors and meteor-fireballs. Expected effects of this meteoric population on the Mesopause region will be examined.

### SA41A-02 0820h INVITED

## Meteors and their impact on the atmosphere

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This paper will begin with an overview of the mesosphere/lower thermosphere (MLT), and the historical role that meteors and the metal layers produced by meteoric ablation have played in understanding the region. The MLT is characterised by enormous seasonal variations in temperature, very low pressures, and is subject to solar radiation extending into the extreme ultra-violet. In addition, more than 50 tonnes of interplanetary dust enters the atmosphere each day, mostly ablating in the MLT region. All of these features contribute to a very unusual chemistry that is quite distinct from the lower atmosphere. Phenomena that will be discussed include: aspects of meteoric ablation; the global layers of metal atoms such as Na and Fe; the Na airglow; sporadic layers of metal ions and neutral atoms; and the role of meteor smoke. I will emphasise the contribution that laboratory studies can make to advancing MLT science, because the region is so difficult to explore directly.

### SA41A-03 0840h

## The EEA method of chemical lifetime calculation and its application to the sodium layer

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The method of the eigenvalue and eigenvector analysis (EEA) to determine the response of a chemical system to perturbations is introduced. We apply the EEA method to analysis of the mesospheric sodium layer. The results show that the lifetime determined using EEA is more than a day in the vicinity of the peak of sodium layer while the traditionally defined chemical lifetime for sodium is only a few minutes. In the region near the peak of the sodium layer, the timescale for gravity wave transport is substantially shorter than the chemical lifetime, indicating that the Na layer acts as a tracer of dynamical perturbations on short time scales (a day or less). At the bottom side of the sodium layer, photochemistry is rapid compared to transport or diffusion. Tests of the sensitivity of the EEA chemical lifetime of Na show that it is sensitivity to changes in the densities of background chemical species such as O3, H, and O, but that the transport timescale is shorter than the chemical timescale for realistic values. These results provide a theoretical basis for using Lidar observations of sodium to infer gravity wave vertical velocities.

### SA41A-04 0855h

## Non-specular meteor trail diagnostics

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