SA31B-07 1205h

Analysis of the Energy Input and Loss in the Thermosphere During the Auroral Events Using SABER Infrared Limb Emission and GUVI Limb Emission

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The SABER instrument on TIMED is continuously measuring limb radiance profiles of CO_2 ν_3 (4.3-μm) and ν_2 (15-μm) and NO (5.3-μm) with unprecedented sensitivity. SABER provides limb radiances up to ∼130km for the 15-μm channel and ∼140-150km (approaching 200km during strong auroral events) for the 4.3-μm channel and over 200km (to 300km during storm conditions) for the 5.3-μm channel. From the SABER infrared channels and the GUVI FUV we have a measure of the auroral energy input at high latitudes into the lower thermosphere and its transport southward and its radiative loss through NO emission. We have previously reported that during the April 2002 geomagnetic storm the 4.3-μm band nighttime emission was enhanced dramatically in the high latitude regions. The NO 5.3-μm band emission also dramatically increased but it was not limited to the auroral zone. We extend this analysis to the October 2002 and May 2003 geomagnetic storms and to more isolated (short time) but strong auroral events. We will compare the morphology and time dependence of the enhancement in the 4.3-μm and 5.3-μm channels. Examining different situations in terms of length and strength of energy input allows us to better determine the lifetime of the enhanced NO emission (and hence a clue to the NO cooling) and the contribution of excited NO from auroral chemistry versus temperature and composition changes.

SA32A MCC: 2006 Wednesday 1340h

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

Presiding: **J Forbes,** University of Colorado

SA32A-01 1340h INVITED

Some Aspects of the Momentum Balance in Thermospheric Dynamics

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In the absence of drag, zonally averaged meridional pressure gradients drive purely zonal winds. However, the ions present in a weakly ionized thermosphere are constrained by electromagnetic forces and introduce a drag on the fluid. Zonal winds are slowed, and a global meridional circulation develops that introduces neutral composition changes and a feedback on the ionosphere. At high latitudes, where the magnetospheric convection electric fields force plasma to high velocities, collisions with the neutral atmosphere imparts a momentum source driving winds of many hundreds of meters per second. In addition, inertial forces introduce large asymmetries in the wind magnitudes expected in the dawn and dusk sector of the auroral oval. Sudden changes in high latitude forcing drive global-scale gravity wave surges. These surges propagate towards the equator, transmit new pressure fields, and impact the global wind field. At low latitudes, the Coriolis force tends to zero, leading to possibility of unforced zonal winds. Equatorial electrodynamics can move plasma and produce regions where ion drag is virtually zero, allowing large zonal winds to emerge.

SA32A-02 1400h

Studies on the Coupling Between the Neutral Winds and the Ionosphere at Low Latitudes

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The Appleton anomaly is caused by the upward E x B drift of the equatorial ionospheric plasma and subsequent diffusion along magnetic field lines to lower altitudes at higher latitudes. The strength and location of the Appleton anomaly has been thought to be controlled mainly by the interaction of the neutral winds with the electric and magnetic fields. Variability can arise from different geophysical processes affecting the neutral dynamics and the background electric/magnetic fields. In addition, ion drag from the differing densities between the two peaks of the anomaly can induce hemispheric differences in the zonal wind circulation. Recent global observations of the low latitude ionospheric structure revealed by TIMED/GUVI, TOPEX, and DMSP allow us to investigate the interplay between the neutral, plasma, and background fields. In this paper we will examine both satellite and groundbased measurements and interpret the findings using a global thermospheric/ionospheric model.

SA32A-03 1415h

Gravity Wave Forcing, Interactions, and Variability in the MLT

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Numerical studies of gravity wave breaking are revealing dramatic impacts on wave amplitudes, with amplitude reductions accompanying instability and turbulence far exceeding previous expectations. Theoretical studies likewise imply significant effects of strong local body forcing, while observational studies suggest occasionally strong forcing and considerable variability in both gravity wave activity and forcing of the large-scale flow. These effects are believed to be due to variable sources and to filtering by variable tidal and planetary wave motions. This talk will examine the likely impacts of these processes for wave forcing, wave interactions, and the parameterization of gravity wave effects throughout the MLT.

SA32A-04 1435h

Lidar Observations of Instabilities and Gravity Wave Dissipation in the Mesopause Region at Maui, Hawaii.

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Gravity wave dissipation in the mesopause region is closely related to stabilities of the atmosphere. The relations between the convective and dynamic instabilities and gravity wave dissipation are investigated using measurements made from a high-resolution Na wind/temperature lidar at Maui, HI (20.7 N, 156.3 W). It is found that the stabilities are modulated by the strong tidal perturbations in this low latitude site. Unstable layers appear as gravity waves pass through low stability regions that are formed by tides. Strong wind shear tends to occur in regions with high convective stability. There is also a clear correlation between the stabilities and gravity wave energy. The implications of these results on gravity wave dissipation and its impact on the mean atmosphere will be discussed.

SA32A-05 1450h INVITED

Elements of the energy budget of the mesosphere as revealed by the SABER experiment

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The energy budget of the terrestrial mesosphere remains a frontier of scientific inquiry. Many processes including direct deposition of solar energy, exothermic chemical reactions, and radiative emission by species such as carbon dioxide and ozone influence the energy balance and hence the thermal structure. The Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) experiment now operating in orbit on the Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics (TIMED) satellite has been designed to provide measurements of virtually the entire set of solar, chemical, and infrared radiative sources and sinks of energy in the mesosphere. In this paper we present the first assessment of these many sources and sinks of energy. We focus on the processes of solar energy deposition and conversion of energy to heat by exothermic chemical reactions, including an accounting of the loss of energy by airglow and chemiluminescence that reduces the amount of energy available for heat.

SA32A-06 1510h

Oxygen-Hydrogen Chemistry and Emissions in the Mesosphere: Modeling and SABER Observations

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Chemical reactions of the oxygen and hydrogen families control trace species such as mesospheric ozone and emissions by the dominant airglow features. In this study we focus particularly on the chemistry that affects the OH Meinel band emission of the upper mesosphere, which is measured by SABER. We compare model simulations with SABER emission data and address the following topics: the processes that maintain the vertical structure of the volume emission rate, the role of atomic oxygen transport in the structure and variability of emissions, and how tides and other dynamical processes affect the mean height and emission rate.

S A

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.