SA61A MCC: 124 Saturday 0830h

Scientific Results From the TIMED Mission I *(joint with A)*

Presiding: **J Yee,** Applied Physics Laboratory**; G Crowley,** Southwest Research Institute

SA61A-01 0830h INVITED

An Overview and Science Results from the SABER Experiment on the TIMED Satellite

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TThe Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) experiment was launched onboard the TIMED satellite by a Delta II rocket at 7:07:35 am PST on December 7, 2001 from the Western Test Range. The satellite was placed in a 74.1° inclined, 625 km orbit. 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. The SABER instrument is a 10-channel limb scanning infrared emission radiometer that provides radiance profiles in selected spectral bands ranging from 1.27 μm to 17 μm wavelength. The observed radiance profiles are processed on the ground to provide vertical profiles with 2 km altitude resolution of the following: temperature, O_3, H_2O, and CO_2 mixing ratios; volume emission rates due to O2 ($^1\Delta$), OH (v = 3,4,5), OH (v = 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 54° S to 87° N with alternating hemispheric coverage every 60 days. This paper provides an experiment overview, orbital performance, example data products, and comparisons with correlative observations. Key science highlights will be described.

SA61A-02 0850h

Derivation of Mesospheric Ozone From SABER/TIMED 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 11 2002–July 31 2002.

In this paper the derived O_3 concentrations are presented and compared with those obtained from other observations and predictions by photochemical models.

SA61A-03 0905h

Evidence for an OH(v) Excitation Mechanism from CO_2 4.3-μm Nighttime Measurements Taken by the SABER Experiment on the TIMED Mission

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The SABER instrument on the TIMED satellite is currently measuring the $CO_2(\nu_3)$ daytime and nighttime limb radiance at 4.3 μm from the lower stratosphere to the lower thermosphere, near-globally and with a very high signal-to-noise ratio. We present a preliminary analysis of some representative nighttime scans by comparing them with model simulations. Existing models generally underpredict the measured nighttime radiance in the upper mesosphere and lower thermosphere, especially if the role of excited OH is neglected. Direct OH(v) emissions in the 9-8 and 8-7 bands also fall within the 4.3-μm bandpass, but account for only a small part of typical discrepancies. However, OH(v) is thought to transfer energy to N_2(v=1), and hence to $CO_2(\nu_3)$, a mechanism proposed by Kumer et al. (1978), but the rate at which this occurs is not well known. The ability to unravel the roles of processes impacting the nighttime radiance is facilitated by the quality and uniqueness of the SABER data set, providing low-noise 4.3-μm radiance data, temperature, and pressure, as well as OH(v) populations from its two OH channels. Using the LTE retrievals of pressure and temperature from SABER and TIME-GCM predictions above 85 km, we investigate the extent to which the OH(v)→N_2(1)→$CO_2(\nu_3)$ mechanism is capable of accounting for the model underprediction. The results suggest that a mixture of 'sudden death' for high vibrational levels and 'cascade' for lower levels for the quenching of OH(v) by N_2, similar to that derived by Adler-Golden (1997) for the quenching by O_2, explain SABER radiances very well, both in absolute magnitude and shape. Other alternative excitation mechanisms that may enhance the nighttime limb radiance in the mesosphere were considered and disregarded. The result is still preliminary and its confirmation awaits for the fully consistent data set derived from SABER.

SA61A-04 0920h INVITED

Measurements of Mesosphere and Lower Thermosphere Winds by the TIMED Doppler Interferometer

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Since the launch of the NASA Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics (TIMED) satellite in December 2001, the TIMED Doppler Interferometer (TIDI) has been measuring the global wind field in the mesosphere and lower thermosphere. Validation of these data using ground-based and other space-based observations is in progress. Early analyses have focused on wind measurements in the 60 to 110 km altitude region using emissions from the O_2 Atmospheric (0-0) band. We will present results showing the variability of tidal oscillations in the middle atmosphere, and new measurements of polar mesopause dynamics.

SA61A-05 0940h

Two Views of MLT Winds: TIMED/TIDI and UARS/HRDI

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The simultaneous operation of two MLT wind sensors, the TIMED Doppler Interferometer (TIDI) and the High Resolution Doppler Imager (HRDI) on the Upper Atmosphere Research Satellite (UARS) provides a

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unique opportunity to inter-calibrate these instruments and to perform scientific investigations that are difficult or impossible with a single instrument. Both instruments are Fabry-Perot interferometers used to measured emission lines in the MLT region. The TIMED and UARS satellites orbit at similar altitudes, but the orbital inclination of TIMED is 74 degrees while that of UARS is 57 degrees. This difference in inclination means that the latitude coverage is different for the two instruments (pole-to-pole for TIDI, +/- 75 degrees for HRDI) and the orbital, and hence local time, precession is significantly faster for UARS (5 degrees/day) than for TIMED (3 degrees/day). There are relatively few opportunities for direct comparisons of observations co-located in space and time. Statistical methods are required to perform the most meaningful comparisons. This paper will discuss the two data sets and illustrate early comparisons between them.

SA61A-06 1025h INVITED

Solar EUV Irradiance Variability Results from the TIMED Solar EUV Experiment

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The Solar EUV Experiment (SEE) is one of the four scientific instruments on the NASA Thermosphere-Ionosphere-Mesosphere-Energetics-Dynamics (TIMED) spacecraft. The SEE instrument measures the irradiance of the highly variable, solar extreme ultraviolet (EUV) radiation, one of the major energy sources for the upper atmosphere. The SEE spectral measurements span from 0.1 nm to 195 nm and are fundamental for the TIMED mission's investigation of the energetics in the tenuous, but highly variable, layers of the atmosphere above 60 km. The TIMED mission began normal operations on January 22, 2002, a time while the sun continues to display maximum levels for solar cycle 23. The solar variability observed by SEE include several moderate and large flares over periods of seconds to hours and several solar rotational cycles over a typical period of 27 days.

URL: http://lasp.colorado.edu/see/

SA61A-07 1045h INVITED

Global Ultaviolet Imager (GUVI): on-Orbit Performance and Initial Results

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The Global Ultraviolet Imager (GUVI) is one of four scientific instruments aboard the NASA TIMED (Thermosphere Ionosphere Mesosphere Energy and Dynamics) satellite launched Dec.6, 2001 into a 630 km circular polar orbit inclined at 74 degrees. The GUVI investigation is to provide geophysical variables derived from the far ultraviolet (FUV) dayglow and auroral emissions emanating from the Earth's thermosphere. The brightness of the FUV dayglow spectral features arising from H, O and N2 are analyzed to provide the spatial and temporal distributions and concentrations of the major species in the altitude range from approximately 130 to 400 km in the thermosphere. Observations include cross track imaging and limb scans. In auroral regions, the FUV emissions provide a measure of effective energy flux and ionization rate. The auroral data can also be analyzed to provide the neutral composition. The GUVI instrument is a hyperspectral imager using a cross track scanning mechanism to measure the principle nitrogen, hydrogen and oxygen emission features in the 115 to 180 nm wavelength range. It is based on a f/3, 0.215 m focal length concave, spherical toroidal holographic grating with 1200 grooves/mm. The slit is three way adjustable, however, the principal operating mode uses a slit that provides a line shape 2 nm FWHM. The instrument scans across the disk and the limb every 15 s and collects light in 14 spatial and 160 wavelength bins. Five spectral regions are selected and telemetered to the ground for analysis. The instrument response was fully calibrated prior to flight and its in-flight performance has been validated using a stellar calibration technique. Stellar observations have also been used to verify the pointing accuracy of the instrument. A summary of the data collected by the GUVI project will be provided. Examples of imaging mode data of the dayglow, nightglow and aurora demonstrate the potential of the GUVI data to address the goals of the TIMED mission.

SA61A-08 1105h

Thermospheric composition derived from TIMED/GUVI limb scans

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The Global Ultraviolet Imager (GUVI) investigation provides multiple wavelength simultaneous "monochromatic" images of the Earth's ultraviolet airglow and auroral emission in the far ultraviolet (FUV) at wavelengths from 115 nm to 180 nm. Among the five color bands that are monitored routinely are 135.6 nm (atomic oxygen) the LBHS (140 150 nm; molecular nitrogen). Limb images of these two emissions are combined and inverted using discrete inverse theory to retrieve the O and N2 concentration profiles. Information on O2 is available from extinction of the bottomside profiles. The data in the two channels is of high quality, with peak emission rates of order 10 kR on the limb near the sub-solar location. Examples of retrievals and comparisons with atmospheric models will be presented.

SA61A-09 1120h

Search for Thermospheric Composition Changes in the Morning Sector near Local Midnight in Association with 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 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.

SA61A-10 1135h

Thermospheric wind, temperature, and compositional response to auroral events above Alaska and Western Canada

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We use data from three Fabry-Perot spectrometers located in Alaska and Western Canada to observe the thermosphere's vertical wind and temperature response to auroral forcing events. Large vertical wind events observed by these instruments are also expected to

modify the compositional structure of thermosphere at both E- and F-region altitudes. We have developed techniques for mapping the spatial distribution of wind-driven vertical displacement of the atmospheric column above 100-km altitude, based on compositional perturbations inferred from satellite ultraviolet auroral images. Displacements inferred from POLAR UVI images are shown to be consistent with vertical winds measured by the ground-based Fabry-Perot instruments. This same technique can be applied to TIMED-GUVI images using the "color" channels corresponding to ultraviolet emissions from oxygen at 135.6-nm and from nitrogen in the LBH-S and LBL-L bands. Although GUVI does not produce the long time-series of vertical displacement data that are available from POLAR-UVI, GUVI can instead yield maps of estimated thermospheric column displacement at much higher spatial resolution.

SA61A-11 1150h

Mesosphere and Lower-Thermosphere Wind Observations from a New South Pole Meteor Radar

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A new meteor radar with altitude resolution was installed at the Amundsen-Scott South Pole station as part of the TIMED/CEDAR program. The radar has been operating almost continuously for 8 months. Preliminary results from late January through February 2002 have been obtained using various analysis techniques. During this period of time, the averaged hourly winds were projected onto 8 different longitude meridians in the height range spanning 80-105 km with a 5 km height resolution. Our results show the presence of waves with periods of 12, 24, and 72 hours that propagate westward and are consistent with a zonal wavenumber one longitudinal structure. A zonal wavenumber of 2 is also present at times for the semidiurnal wave period. During this period, a consistent divergent wind pattern where the wind vectors are northward (away from the pole) at all longitudes occurs from 1700-0200 UT while cross polar winds are present at all other times. This paper will present these preliminary features of the wind field and discuss future comparison with TIMED measurements and other Antarctica radar measurements.

SA62A MCC: Hall D Saturday 1330h

Mesosphere/Lower Thermosphere Posters

Presiding: **H G Mayr,** NASA Goddard Space Flight Center

SA62A-0375 1330h POSTER

Stable Reflecting Layers at Medium Frequencies in the Equatorial Mesosphere During Sunrise and Sunset Hours

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The MF (1.98 MHz) partial reflection radar, operating at the Indian dip equatorial station Tirunelveli (8.7 deg. N, 77.8 deg. E, geographic; 0.4 deg. N dip), has been monitoring continuously the middle atmospheric dynamics (60-98 km) since 1992. At above about 90 km the ionospheric plasma irregularity is created mainly due to the gradient drift or cross-field instability and is called as type-II irregularity. Since this irregularity is associated with the fluctuations in the ambient electron density by a few percent, the received echoes from them are expected to be dynamic in nature. During the sunrise and sunset hours the EEJ electric field weakens and the plasma irregularity is created predominantly by the neutral turbulence. Since it is believed that the breaking of the gravity waves and certain modes of tides occurs at the mesopause region (∼85 km), a smooth stable reflecting irregularity layers are expected to be created at this height due to the anisotropic neutral turbulence. The MF echoes from them may be strong and static so that they can even saturate the receivers.

The two-minute scans, each comprising 256 data points, of the received radar echoes have revealed the same as expected. During the local sunrise and sunset hours the MF radar received echoes have shown the receiver saturation effects and the signals appear to be static in nature in the height range of about 84-94 km. The height profile of the signal power shows a sharp enchancement at about 88 km and then it remains as a constant up to 98 km. At these hours it is expected that the plasma instability induced irregularities loose their importance because of the weakening of the EEJ electric field. The neutral turbulence induced irregularities (Kolmogorov law) may play a dominant role even up to above 94 km at these times. However the exact mechanism of creating stable smooth layers at the mesopause heights during the sunrise and sunset hours is currently not known. Further analyses on other radar parameter changes during these hours are being carried out.

SA62A-0376 1330h POSTER

Characteristics of Meteor Echoes and Preliminary Winds Collected With a Narrow-Beam Radar at Piura, Peru

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During the mid 1990's a MEDAC system was attached to the VHF wind profiler located in Piura, Peru to detect and collect meteor echoes and provide measurements of winds in the mesosphere-lower thermosphere. The collected data were different from those of similar systems operating at mid-latitudes and other equatorial sites. In particular, the echo rate was relatively low, the echoes were highly aspect sensitive, many of the meteor echoes were relatively weak suggesting the possibility that they were seen through a sidelobe instead of the main lobe of the antenna, and a great deal of activity was observed at nighttime when E-region echoes were also observed. A series of experiments have been designed to better understand the system and the resulting wind measurements. The first experiment was designed to increase the sensitivity of the radar and was conducted during one week in July 2002. Two transmitters were used instead of the single transmitter that normally feeds the transmit antenna on the wind profiler. Data was collected using three different systems: the wind profiler's own acquisition system, the MEDAC system, and a mode in which all data was collected and saved to the hard drive. This poster presents the results of the aforementioned experiment, compares the results provided by each data collection system, outlines the main features of the meteor echoes seen at Piura, and discusses the preliminary wind measurements.

SA62A-0377 1330h POSTER

Lidar Observation of Summer Mesopause Region Diurnal and Semi-diurnal Tides in Temerature, Zonal and Meridional Winds

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The Colorado State Two-beam Na Lidar has been configured for simultaneous measurement of the profiles of temperature, zonal and meridional winds in the mesopause region over Fort Collins (41N, 105W). Observations on these dynamical variables covering full diurnal cycles have begun since April 2002. Two campaigns, one between the end of May and the beginning of June and the other between the end of July and the beginning of August were completed, yielding a total of 448 hours of summer data with 12 sets of full 24-hour continuous observation. Harmonic decomposition of these data into 24-, 12-, 8- and 6- hour periods are under way. The results of the diurnal and semi-diurnal tidal amplitudes and phases derived from this thus-far unique data set will be compared to the model output of GSWM00 migrating tidal model in summer months. They will be also compared to the new GSWM model under development, which includes nonmigrating tidal forcing due to latent heat release associated with raindrop formation in deep convective clouds in the tropical troposphere. Science implication on the middle atmosphere dynamics will be discussed in relation to the model-observation comparison.

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Observations of Atmospheric Gravity Wave damping in the Mesosphere with lidar and airglow

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Correlative measurements of temperature and winds by Na lidar and brightness in OH and O2 Atmospheric band airglow have been made at Albuquerque, NM and Maui, HI for a study of high frequency (Period less than 30 minutes) Atmospheric Gravity Waves (AGWs). Waves studies from four nights have been made and the correlative information describes the intrinsic wave properties with altitude, their damping characteristics, and resulting accelerations to the large scale dynamics in the 85-100 km altidude region. Generally, saturated to super-saturated conditions were observed below 95 km. Above this altitude, they became freely propagating.

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Atmospheric Gravity Wave Properties for TOMEX as Observed With Na wind/temperature Lidar and Airglow Instrumentation From Albuquerque, NM

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On the night of October 26, 2000, the TOMEX sounding rocket was launched from White Sands rocket range 5 hours after sunset. Na lidar, airglow imagers, and a Michelson interferometer observed the perturbations in the mesosphere. In addition, the Na lidar measured the winds which were applied to the observed motion field from which intrinsic wave speeds were resolved. The extracted wave field from combined lidar and airglow observations included waves with periods of 5 hours, 1.5 hours, and 13 minutes present for the period leading to, and during the rocket launch. The vertical structures of the 13-minute and 1.5-hour period waves were determined primarily by the thermal structure, which was characterized by a small Brunt-Vaisala frequency between 90 km and 92 km with a strong gradient above and below. The 5-hour period waves exhibited a standing wave pattern, indicative of strong wave reflection in the mesopause region. In addition