

SA13A CC: 519 A Monday 1330h**Mesosphere Dynamics and Energetics**
(joint with A, P)**Presiding: T G Slanger**, Molecular
Physics Laboratory, SRI International
SRI International; **J M Russell**,
Hampton University**SA13A-01 1330h****Nonmigrating Tides as Measured by the
SABER Instrument on TIMED****Jeffrey M Forbes**¹ (303-492-4359;
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Temperature measurements from 30 to 100 km from the SABER instrument on TIMED are used to investigate nonmigrating solar tides during March-August, 2002. The measurements include corrections for non-LTE effects. The most prominent nonmigrating tide oscillations include eastward-propagating diurnal tides near the equator and tropics, and semidiurnal tides with zonal wavenumbers $s = 1$ and $s = 3$ and diurnal tides with zonal wavenumbers $s = 0, 2$ and 3 at higher latitudes. Nonlinear tide-tide and tide-planetary wave interactions are explored as possible mechanisms to account for the existence of the high-latitude tides, while the low-latitude oscillations appear more likely to originate in latent heating associated with deep tropical convective systems.

SA13A-02 1345h**The TIMED Doppler Interferometer
(TIDI) Neutral Wind Data From The
O2 P Branch Broadband Filter****T. L. Killeen**¹ (killeen@ucar.edu); **Q. Wu**¹
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A new operational mode for the instrument has been designed to incorporate a broadband filter, which allows most of the O₂ (0-0) P branch to pass through. The broadband filter data increases the signal level by an order of magnitude, which greatly increases the accuracy of the neutral wind allowing more detailed analysis of the migrating and non-migrating tide in the MLT region. Already the new wind data have shown strong non-migrating tide component. Comparisons with ground-based radar measurements show a much better consistency. We will report these new data and tidal analysis results.

SA13A-03 1400h**Significant Intraseasonal Oscillations in
the Mesosphere****Jason Philip Russell** (506 447 3093; jruss@unb.ca)University of New Brunswick, Physics Dept. Box
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With the vast set of airglow nighttime data collected by the WINDII instrument on board the Upper Atmospheric Research Satellite, large time series of the order of half a solar cycle can be generated. Time series of atomic oxygen mixing ratios derived from two measured nightglow emissions have been used to obtain significant intraseasonal (50-122 day period) oscillations that are comparable in strength to annual and semi-annual oscillations. The most significant of these being a 61-day oscillation found at mid-latitudes. The amplitudes and phases of these oscillations will be shown to vary with latitude.

SA13A-04 1415h**Zonal-Mean Quasi Bi-Monthly
Oscillations (BMO) in the Mesosphere****Frank T Huang**¹ ((301) 474-8675;
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In the zonal mean ($m = 0$), oscillations are observed with the UARS spacecraft that have periods of months. Based on measurements from the High Resolution Doppler Imager (HRDI) instrument, Quasi Bi-Monthly Oscillations (BMO) appear in the meridional winds at equatorial latitudes and at 95 km altitude, as reported by Huang and Reber (JGR, 2003). Such oscillations are also observed in temperatures at altitudes of about 55 km, which are measured with the Microwave Limb Sounder (MLS) and the Cryogenic Limb Array Etalon Spectrometer (CLAES) on UARS. Considering that it takes 36 days to cover all solar local times, a two-dimensional Fourier least squares analysis is carried out to delineate in the temperature variations (a) the tides (diurnal and semidiurnal) and (b) the zonal-mean component. The inferred zonal-mean temperature variations have periods between 2 and 3 months, and they are larger away from the equator. The amplitudes of this BMO are about 4 K, and the oscillations are in opposite phase in the two hemispheres. We shall investigate the BMO with the temperature and wind measurements from the TIMED spacecraft, which are available at common altitudes throughout the mesosphere and thus can provide a more definitive picture of this phenomenon. Oscillations of the kind discussed have been identified in a modeling study (Mayr et al., JATP, 2003). It is shown there that the meridional momentum source from parameterized small-scale gravity waves generates variations in the meridional winds with periods between one and three months that have the character of a non-linear auto-oscillator – the apparent counterpart of the Quasi-Biennial Oscillation (QBO) in the zonal circulation. The meridional wind oscillations are largely confined to equatorial latitudes, and they generate through dynamical heating and cooling temperature oscillations in the two hemispheres on either side of the equator.

SA13A-05 1430h**Variations in the Mesospheric OH
Vibrational Distributions****Tom G. Slanger**¹ (650-859-2764;tom.slanger@sri.com); **Philip C. Cosby**¹
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Intensity-calibrated sky spectra from the Keck II telescope on Mauna Kea, measured throughout the visible and the infrared to 1.09 microns, show that there

is substantial variation in the vibrational distribution of OH($v=3-9$) during the night. From five nights of observation in March 2000, utilizing low-J lines of the 3-0 and 9-5 bands near 1 micron, the $v=3$ population typically fell by a factor of 2-4 over a 9-hour period, while the $N(v=3)/N(v=9)$ population ratio simultaneously decreased, by a factor of about two. Although the intensity changed in a different manner during four observing nights in October 2000, two in July 2000, and one in July 2001, the $v=3$ population and the $N(v=3)/N(v=9)$ ratio still co-vary. The total range of the ratio in our observations is 4-15. The vibrational distribution presented by McDade and Llewellyn [JGR, 92, 7643, 1987], based on various measurements, results in a value of 6.6 ± 0.7 for the ratio. Observations from the infrared SABER instrument on the TIMED satellite in March 2002 indicate that the highest OH intensities are seen at the lowest altitudes, and that the highest [low- v]/[high- v] intensity ratios are associated with the highest OH intensities. The presumption is that decreasing [low- v]/[high- v] ratios are indicative of increasing altitude and decreasing density in the glowing layer. We believe that the $N(v=3)/N(v=9)$ ratio as viewed from the ground defines the emission altitude and/or species density in the OH nightglow region. This study was supported by a grant from the NSF Aeronomy program.

SA13A-06 1445h**Determination of Atmospheric
Parameters in the Upper Mesosphere
and Lower Thermosphere Using
Rocket-Borne Ionization Gauge
Measurements****J H Clemmons**¹ (310 336 2428;
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The goal of rocket-borne ionization gauge measurements in the upper mesosphere and lower thermosphere (UM/LT) is to determine the flow parameters (density, temperature, and wind vector) of the ambient gas. These basic measurements can then be used to understand the dynamics of the region. However, interpretation of the raw measurements is complicated by a variety of factors that are difficult to assess from first principles. Included in these effects are the non-ideal aspects of transitional gasdynamic flow, vehicle outgassing and sensor temporal response. Two complementary techniques have been used to understand these factors so that their influence in the measurements can be appropriately treated. First, the instrumentation includes multiple, directional sensors so that several angles of attack can be monitored concurrently. Second, the direct simulation Monte Carlo (DSMC) method is used to simulate the gas flow in the transitional regime. These techniques are applied to the TOMEX sounding rocket flight to make accurate determinations of the atmospheric flow parameters in the UM/LT. The results are compared to concurrent measurements made by lidar. Time permitting, the technique as applied to other rocket flights is discussed. The understanding gained is also applied to the instrumentation designed for the upcoming TRIO sounding rocket experiment.

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A**SA14A CC: 519 A Monday 1530h****Mesosphere-Thermosphere-
Ionosphere Coupling Processes and
Issues for the Earth and Planets** (joint
with P, SM)**Presiding: M P Hickey**, Embry-Riddle
Aeronautical University; **P J Espy**,
British Antarctic Survey**SA14A-01 1530h INVITED****Physical Processes in Acoustic Wave
Heating of the Thermosphere****Gerald Schubert**^{1,3} (1-310-825-4577;
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We have previously studied how acoustic waves generated by strong thunderstorms and ocean waves propagate into the thermosphere and heat it. We revisit this investigation to clarify the physical processes contributing to the overall net heating. Our conclusions are based on numerical simulations of wave propagation using a full-wave model that solves the complete linearized equations of continuity, momentum, and energy for a compressible, viscous, and thermally conducting atmosphere with arbitrary altitude variations in thermal structure. It is found that acoustic waves heat the thermosphere through effects of molecular dissipation, sensible heat flux divergence, and Eulerian drift work. Only wave-induced pressure gradient work acts to cool the thermosphere. The net effect of all these processes is acoustic wave heating of the thermosphere at all heights. These physical processes act differently for gravity waves; in particular, gravity wave sensible heat flux divergence can cool the thermosphere. Acoustic waves generated by vigorous convection and storms in outer planet atmospheres could also contribute to the heating of these atmospheres.

SA14A-02 1550h INVITED

Gravity Wave Generation by Equatorial Inertial Instability

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Gravity waves (GWs) and inertio-gravity waves (IGWs) are an important means of transferring momentum from the lower to the middle and upper atmosphere. Gravity wave breaking is responsible for closing off the mesospheric jets and for producing the summer-to-winter-pole mesospheric circulation. They also interact with atmospheric tides and affect other large-scale phenomena in the upper atmosphere. GWs are generally thought to be produced in the troposphere by a number of different processes such as topographic generation, geostrophic adjustment, shear instability and convection. They propagate vertically to higher altitudes where, due to the reduction in density, the momentum they deposit can affect a large change in the background winds. This paper will focus on a different generation mechanism of GWs; specifically IGW generation by equatorial inertial instability. Due to their slow vertical propagation, IGWs may deposit their momentum horizontally far from the region where they were generated. Therefore, IGWs generated in the tropics by inertial instability may affect the background winds at midlatitudes. A 3d primitive equations model will be used to study this generation mechanism. In this presentation we will focus on the spectra and launch altitudes of the IGWs and their effect on the mean flow. Also, because inertial instability occurs typically at the smallest resolvable scales, we will examine the robustness of the results to changes in resolution and small-scale diffusion, both of which can affect the scales and the strength of inertial instability.

SA14A-03 1610h

Seasonal Variation in the Mesospheric Gravity-Wave Potential Energy Over the Antarctic Peninsula

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As part of a joint programme between the University of Illinois and the British Antarctic Survey, Rayleigh and Fe resonance lidar observations have been made from Rothera Station (68S, 68W) on the Antarctic peninsula. Gravity wave perturbations in both the vertical density and temperature structure have been measured, and the seasonal variation of the gravity-wave potential energy has been compiled. In addition, the phase change of the waves with altitude has been used to assess the relative contributions of stationary mountain waves and horizontally propagating gravity waves to the overall potential-energy budget. It has been found that the seasonal changes in the overall wave energy near the mesopause are consistent with the filtering of the gravity wave flux by the stratospheric winds. The seasonal variations in the ratio of mountain waves to horizontally propagating waves has been correlated to changes in the tropospheric wind field over the Trans-Antarctic Mountains. The impact of this partitioning and its seasonal variation on the forcing of the mesospheric wind field will be discussed.

SA14A-04 1625h

Theoretical Simulations of the Martian Ionosphere and Comparisons to Observations

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Approximately 2000 profiles of ionospheric electron density between 100 and 200 km altitude have been generated by the Radio Science Experiment on Mars Global Surveyor and publicly released on the PDS. We have developed a theoretical ionospheric model to help us analyse these observations. Our model includes photochemistry and diffusion of ions, solar fluxes from the SOLAR2000 model, and a simple fixed neutral atmosphere. We will compare each electron density profile to a predicted profile and investigate how well such basic parameters as the altitude, electron density, and layer width at several ionospheric peaks, total electron content, slab thickness, and topside scale height are predicted. We will compare variations in observed electron density to variations in predicted electron density due to day-to-day changes in the solar flux to test the hypothesis that solar flux variations are responsible for most ionospheric variations on that timescale. Martian ionospheric variabilities attributed to solar flux variations will be compared to terrestrial E-region variabilities. By adjusting the variation of neutral atmospheric density and temperature with altitude in our model, we are able to investigate how the properties of the thermosphere influence and control those of the ionosphere. As noted by Bougher and colleagues, tides in the thermosphere can cause the altitude of ionospheric electron density peaks to vary with longitude. We shall investigate whether other basic parameters extracted from the electron density profiles are also coupled to the thermosphere and show these tidally-induced variations. We shall vary the neutral atmospheric properties in our model to further investigate the effects of thermospheric tides on the martian ionosphere.

SA14A-05 1640h

Investigating tidal effects on mesospheric temperature and airglow emission altitudes

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An important aspect of wave coupling into the mesosphere and lower thermosphere (MLT) region is the propagation of atmospheric tides. Tides are known to have the large effects on wind and temperature variability. Tides also affect the airglow emission intensities and peak altitudes of the emission layers. This paper focuses on two aspects of tidal effects on OH/O₂ airglow emission rotational temperature and peak emission altitudes. First we summarize the results of a correlative study of OH rotational temperature measured using Mesospheric Temperature Mapper (MTM) with simultaneous SABER measurements from the NASA TIMED satellite showing best agreement when care is taken to use the appropriate emission altitude as measured by the satellite. Secondly, we utilize coincident temperature measurements by Na temperature lidar and MTM to investigate temporal variability in the altitudes of the emission layers due to long period gravity wave/tidal perturbations. In both studies, the measurements were made over Hawaii (20.8oN, 156oW) as part of the Maui-MALT and NASA TIMED coordinated ground-based study.

SA21A CC: 220 C-E Tuesday 0830h

Interpretation and Observation of Mesospheric Gravity Waves From Earth and Space III Posters (joint with A, P)

Presiding: M J Taylor, Utah State University; S M Melo, University of Toronto

SA21A-01 0830h POSTER

Simultaneous Imaging and Lidar Measurements of a Breaking Internal Gravity Wave in the Mesosphere

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A large wave event was observed in the three upper-mesospheric (80 to 105 km) airglow emissions of O(S), Na and OH by the Boston University all-sky imager at the Arecibo Observatory during the night of 2/3 May 2003. Simultaneous measurements of the 80 to 105 km height region were made by two co-located potassium and sodium resonance lidars. The K lidar measurements indicated the presence of a large temperature inversion (possibly the largest recorded in the mesopause region to date) of 90 K peak-to-peak between 88 and 96 km during the zenith transit time of the disturbance. Strong vertical motions were observed to occur in the K and Na layers during the passage of the disturbance - the top and bottom sides of both layers increased in height by 3 to 5 km. The instability exhibited several characteristics of a bore - a non-linear disturbance commonly observed in rivers, oceans, and the lower atmosphere, and recently identified in the mesosphere. However, the vertical phase variation suggested that it was a large downward-propagating internal gravity wave that was in the process of breaking, causing overturning and turbulence, probably as a result of interaction with a large coincident temperature maximum. The behavior of the disturbance was very similar to that of a so-called "wall"-type event (Swenson and Espy, 1995) and the event suggests that "wall"-type events and bores are different manifestations of a single type of disturbance.

SA21A-02 0830h POSTER

A Survey of All-sky Imaging Measurements of Bore- and "Wall"-like Disturbances in Mesospheric Nightglow.

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All-sky imagers regularly record quasi-monochromatic (QM) gravity wave activity in the various night-time mesospheric emissions (Taylor et