SPA-Aeronomy

SA11A CC: 519 A Monday 0830h

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

Presiding: **R P Lowe,** University of Western Ontario**; p M Franke,** University of Illinois

SA11A-01 0830h INVITED

Can Satellite Remote Sensors Measure Gravity Wave Momentum Flux?

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The huge impact that satellite data have had on our understanding of synoptic scale dynamics, chemistry and transport processes in the atmosphere raised expectations that new high-resolution instruments could provide similar generational advances in our understanding of global gravity wave (GW) activity and its role in driving the atmospheric circulation. Thirty or more publications, have appeared recently, based on analyzing fluctuations in data acquired by different limb-sounding techniques (infrared and microwave emissions as well as GPS occultation). Enhanced GW variances have been attributed to waves radiating from various tropospheric sources, such as orography and convection. However, since all these studies are based on temperature variances or potential energies they cannot quantify wave momentum fluxes and flux divergences, parameters most relevant to the GW driving of global circulation patterns. In this talk we discuss infared limb-scan temperature data taken by the CRISTA instrument. We consider a case study of mountain waves above South America and discuss the sensitivity of the instrument, vertical-profile analysis and horizontal variation of GW phase. On this basis we introduce a technique to infer temperature amplitudes, vertical and horizontal wavelengths of GWs simultaneously allowing us to infer GW momentum flux (MF) in an operational way. This technique is tentatively applied to the CRISTA data. Despite large uncertainties and the fact that we cannot resolve the direction of the MF owing to insufficient horizontal sampling of the instrument, important results can nonetheless be obtained. Specifically, we find: 1.) Due to large amplitudes and short horizontal wavelengths, GWs excited by distinct sources as deep convection and orography carry large MF. 2.) GW potential energies must not be used as a proxy for GW momentum flux. In particular, even a transfer based on a simple horizontal wavelength distribution (i.e. dependence on Coriolis paprameter) does not result in correct MF values. Encouraged by these results we will finally formulate the requirements for an instrument resolving MF direction at reasonable errors and discuss the prospects of such an instrument.

SA11A-02 0850h INVITED

Linear theory estimates of global distribution of convectively generated gravity waves

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Linear theory can be used to derive relationships between the properties of convectively generated gravity wave spectrum and convection characteristics. Such relationships enable the derivation of global distribution of convectively generated gravity waves using either data or convective scheme output from a General Circulation Model (GCM). These estimates are particularly useful for the high-frequency, short horizontal wavelength gravity waves (waves with periods between 10 and 100 minutes and horizontal wavelengths about 100 km), as these waves can not be measured globally and are not resolved in any global model. In this talk, linear theory of gravity wave excitation mechanisms in convection will be discussed and a method of specifying gravity wave momentum flux above convection will be presented. Subsequently estimated gravity wave momentum flux and spectral characteristics will be shown using global fields from the Whole Atmosphere Community Climate Model (WACCM). Gravity wave properties will be discussed close to their source levels in the troposphere as well as in the stratosphere and mesosphere. Lastly we will discuss how the linear estimates can be combined with observations to reduce the uncertainty in global gravity wave characteristics and magnitude of gravity wave drag in the middle atmosphere.

SA11A-03 0910h

Concurrent Wave Activity in the Polar Mesosphere-Ionosphere Region

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Airglow observations from the winter polar mesosphere and ionosphere over Eureka, Nanavut (80 degrees N, 86 degrees W) through the past solar cycle have shown occasional coupling of mesospheric gravity and tidal waves with the F-region (as seen from [O] 630 nm airglow emissions). In addition to what appear to be tidal harmonics, there are observations of shorter duration gravity waves of 15-30 minute periods. The characteristics of these waves will be illustrated and coupling processes will be discussed.

SA11A-04 0925h INVITED

Application of GPS Radio Occultation Data for the Studies of Atmospheric Waves

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It is well known that gravity waves play a crucial role in driving the general circulation of the middle atmosphere. In any general circulation modeling efforts, GW effects must be considered properly, because effects of the wave-driven pumping can be significant at much lower altitudes, both on tropical upwelling and on polar down-welling. The upward transport and the subsequent deposition of momentum and energy from lower heights form a major part of the dynamical coupling between different parts of the atmosphere. This determines the general circulation and structure of the middle atmosphere. During the past two decades with the advent of VHF radars and lidars, considerable effort has been devoted in characterizing GW. Although these techniques can provide observations with excellent temporal and spatial resolution, the network of these ground-based instruments is coarse and hence the global morphology of GW activity, as acquired with these techniques is poorly known. On other side atmospheric sounding by GPS radio occultation is emerging as a promising tool for numerical weather forecasting and climate change studies due to its high resolution, long-term stability, all weather capability, and global coverage. GPS occultation technique provides profiles of water vapor, temperature and electron density with high accuracy and a very good height resolution superior to other satellite techniques. Using GPS/MET, CHAMP/GPS, and SAC-C data sets, studies related atmospheric waves are carried out. The presentation includes basic concept of GPS occultation measurements, its validation (temperature), Kevin waves observed at equatorial latitudes, global distribution of the stratospheric gravity wave activity, which includes their generation due to convection, topographic forcing, and enhancement over some regions without convection and topography, wave generation associated with stratospheric sudden warming over Antarctica in 2002.

SA11A-05 0945h

Observations of a large-scale thermospheric gravity wave using ISR, TEC, and airglow data and its effect on the mesosphere

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On October 1-2, 2002, a moderate geomagnetic storm took place with the 3-hour K_p index reaching 5- for 24 hours and 7+ twice. Evidence from ISR, TEC, airglow, and ionosonde data indicate that a series of large-scale thermospheric atmospheric gravity waves were launched from the auroral zone, modulating the mid-latitude ionosphere over Arecibo by over 150 km and driving mid-latitude and indirectly equatorial spread-F. A unique method is presented to "image" the TIDs using TEC perturbations, which can be interpreted as the effect of the F-layer modulation due to neutral wind perturbations on the plasma pressure (plasmaspheric flux). These TIDs, while inherently thermospheric, also effected the mesosphere. We show 630.0-nm and 557.7-nm airglow measurements from Hawaii and Arecibo that show a change in the emission levels of several hundred Rayleighs, most of which was due to the F-layer fluctuations. However, the TID also caused an enhancment in the mesospheric portion of the 557.7-nm emission. Via a modeling study of the two emissions using standard techniques, we find that an atomic oxygen fluctuation of about 15% is required to explain the observed intensities. These variations may be associated with changes in the eddy diffusion parameters associated with the gravity wave passage.

SA12A CC: 519 A Monday 1030h

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

Presiding: **R P Lowe,** University of Western Ontario**; p M Franke,** University of Illinois

SA12A-01 1030h

Gravity Wave Observations From Space - What can we Expect to see and Learn?

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A number of missions have been proposed to image gravity wave signatures from a space-born platform. Most are based on well-proven ground-based techniques which utilize the naturally occurring airglow emissions to investigate gravity wave signatures as they propagate (and break) in the upper reaches of the mesosphere and lower thermosphere (MLT) region (altitude 80-100 km). There are several important advantages of satellite-borne observations: (1) they will provide the first global measure of wave occurrence, spatial characteristics, directionality, seasonal and geographic variability, (2) they can make measurements over regions that are not readily accessible by ground-based instrumentation (e.g. deserts, oceans, ice shelfs etc), and (c) they will be able to measure the near and far field signatures of the propagating wave patterns generated