MLS Scientific Publication

Scientific Themes: Atmospheric Dynamics, Satellite Data Analysis, Gravity Wave Modeling

A Search for Mountain Waves in MLS Stratospheric Limb Radiances from the Winter Northern Hemisphere: Data Analysis and Global Mountain Wave Modeling

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Summary

This paper described a thorough study of along-track fluctuations in UARS MLS limb-track stratospheric radiance measurements in the northern hemisphere. The MLS measurement is modeled using a three-dimensional (3D) instrument function that models the sensitivity of the limb track randiances to stratospheric gravity waves (GWs) of different orientations and wavelengths with respect to the satellite orbit. This GW visibility function allows us to use global GW models, such as the Mountain Wave Forecast Model (MWFM), to generate anticipated wave fields, then to "orbit" an MLS-like instrument around the Earth to simulate an MLS "measurement" of these model-generated waves. This permitted improved comparison between model GW predictions and MLS radiance fluctuations, and has allowed us to separate out background wind effects, to identify GW sources, and to explicitly link specific features of these measurements to orographically generated mountain waves (MWs) in the extratropical northern hemisphere.

This work shows that MLS can provide critical global measurements on MW-induced temperature variability in the high-latitude stratosphere. Such data are critical for refining and constraining parameterizations of these processes for global weather, climate and chemical transport models. This study also provides an important guidance for the new EOS MLS instrument (due for launch in 2004), and provides a much-needed and carefully-validated long-term global stratospheric GW product for climate research. Ongoing research with data from UARS-MLS as well as from EOS-MLS, combined with various numerical simulations, will provide a clearer global picture of GW dynamics.

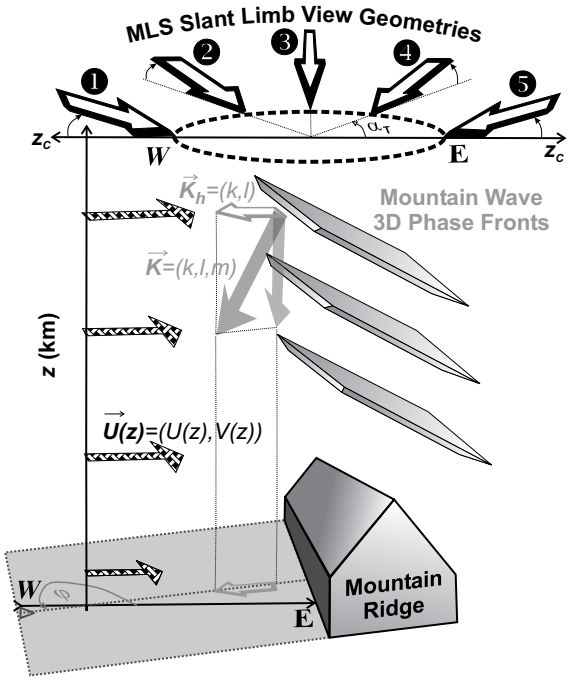

Figure 2: Schematic 3D depiction of mountain waves forced by eastward horizontal winds (U,V) over an idealized mountain ridge. Five potential MLS slant viewing geometries are envisaged as passing through its 3D structure while acquiring saturated radiances from this volume of atmosphere. Viewing geometries 1-3 are most favorable for resolving this wave pattern because it views quasi-parallel to the waves phase fronts. Viewing geometry 5 is least favorable for the purpose.

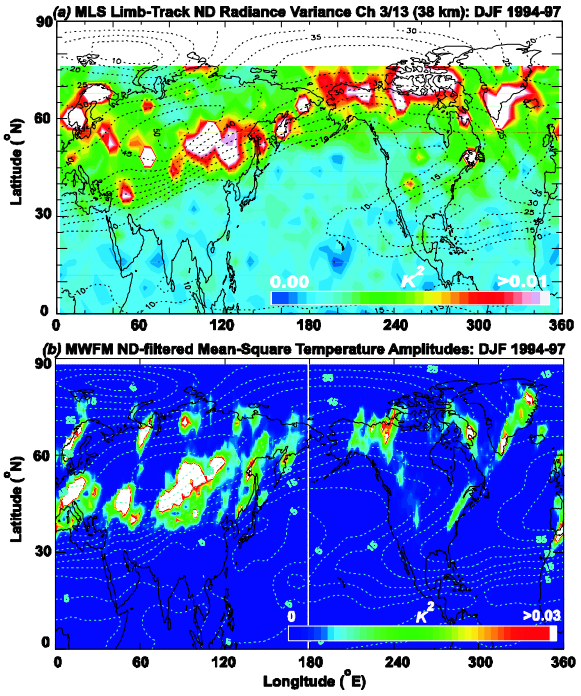

Figure 14: MLS north-looking descending limb-track radiance variances (a) compared with MWFM simulated mean-square peak mountain wave induced temperature amplitudes (b) after application of the MLS GW visibility filter. There is a substantial agreement between the MWFM and MLS maps, which is much improved over the MWFM control run without inclusion of MLS observing effects. This leads us to conclude that MLS indeed provides critical information on global mountain wave activities propagating into the stratosphere.