MLS-Related Scientific Publication

Scientific Themes: Atmospheric Dynamics, Earth System Modeling.

Horizontal Wavenumber Spectra of MLS Radiance Fluctuations. Dong. L. Wu, *J. Atmos. Terr. Phys*., **63**, 1465-1477, (Sep., 2001).

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Summary

Gravity waves play an important role in atmospheric circulation and mixing, but remain as a key component that limits model capability to accurately predict atmospheric dynamics. Their contribution is difficult to quantify due to lack of global observations and complicated wave behaviors. One of the useful observations is to measure gravity wave spectra where we can obtain valuable information about wave generation, propagation, breaking and interaction with the background atmosphere. This paper studies fluctuations of the 63-GHz radiances from Upper Atmosphere Research Satellite Microwave Limb Sounder (MLS) and interpret them simply as atmospheric temperature oscillations of short (≥30 km) horizontal and long (>10km) vertical scales of gravity waves. We average all the horizontal wavenumber spectra of MLS limb-tracking radiances to produce a seasonal climatology at wavelengths of 50-800km for 6 altitudes (38, 43, 48, 53, 61 and 80 km) and 8 latitudes (from 70°S to 70°N).

These observations will provide scientists with a more quantitative understanding of the wave distribution and evolution on a global basis, and thus will benefit society by helping improve the predictability of numerical climate and weather models.

Gravity waves with vertical wavelengths of 1-10km are thought mostly effective on the atmospheric circulation, and therefore in the future we hope to improve our results with observations of better vertical resolutions from Earth Observing System MLS.

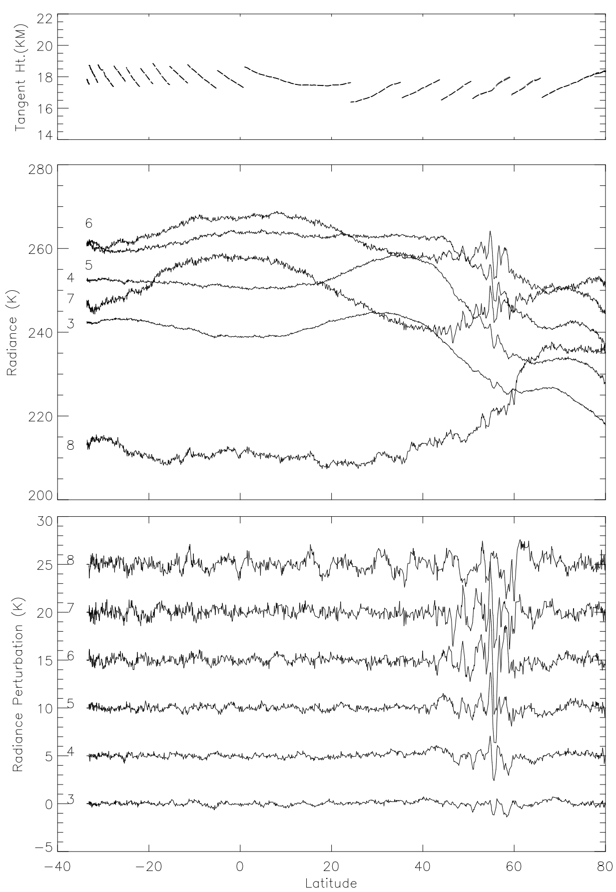

Figure 2. Time series of MLS limb-tracking altitude (top), saturated radiances (middle) and radiance perturbations with large (>1000km) scale waves removed (bottom). The spectral channels of MLS radiances are labeled on the left of the time series. Radiance perturbations of different channels are offset by a 5K increment from channel 3. The data were collected from the #12 orbit on 4 March 1995. Wave-like oscillations at several altitudes are evident and clearly show coherent phases among the perturbations at different altitudes.

The radiance fluctuations are analyzed with the Fast Fourier Transform to yield horizontal wavenumber power spectra in each 20°-latitudinal bin. Most of the power spectra exhibit a slope near –2 with some as steep as –3 in wave active regions. The spectral power density is strongly season-and-latitude dependent in the stratosphere, which is thought largely due to the modulation of the background winds on the vertical wavenumber spectrum. The amplitudes of the power density spectrum grow exponentially with height between 38 and 50 km but the growth rate becomes small or close to zero near and above 50 km. The growth rates at 38-53km altitudes are scale-dependent showing less efficient vertical propagation for larger-scale waves. The near-zero growth in the lower mesosphere is thought an effect of wave saturation or breaking at these altitudes.