# MLS Scientific Publication

*Scientific Themes: Convective Processes, Gravity Waves, Tropical Meteorology*

# Geographical Distribution and Inter-Seasonal Variability of Tropical Deep-Convection: UARS MLS Observations and Analyses

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## Summary

In this paper, geographical distributions of humidity and cloudiness in the tropical tropopause-layer (TTL), and stratospheric gravity waves (GWs) are analyzed using a unique suite of data from the Upper Atmospheric Research Satellite (UARS) Microwave Limb Sounder (MLS). These MLS fields are compared to the corresponding maps of ECMWF simulated wind divergence, as well as NOAA outgoing longwave radiation (OLR) and CMAP rainfall data for different seasons. We found that high-altitude clouds in the TTL are usually surrounded by high humidity air, and their spatial pattern and seasonal variability are closely associated with regions of vigorous summertime deep-convection. Upward propagating gravity waves generated from these convective regions are shifted poleward by prevailing stratospheric winds. Low temperature regions in the TTL are associated with, but often drift away from the centers of deep-convection. Regions of water vapor maxima near the bottom of TTL are located directly above the deep-convection centers, but this moisture behavior is somewhat reversed at the top of TTL. The correlative pattern of these parameter fields lead to an improved recognition of the effects of tropical/sub-tropical convection in the tropopause and stratosphere worldwide, which could be important in affecting the short-term dehydration processes in the air ascending through the TTL. This work also suggest that the spatial organization and temporal development of tropical convective systems will be better monitored with the follow-on Earth Observation System (EOS) MLS instrument, improving our understanding of the complex interaction of tropical convection with large scale dynamic and thermodynamic conditions.

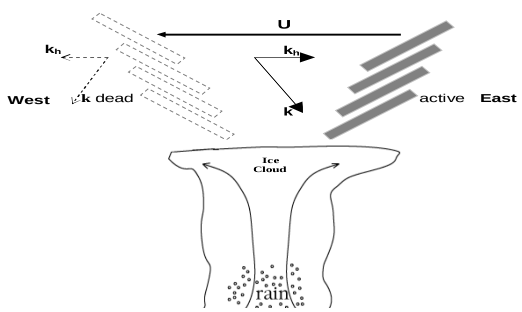


**Figure 1**: Schematic illustration of GWs radiated on top of tropical deep-convection generated ice cloud and rainfalls. MLS observations confirmed that only the wave-fronts at "eastern-half" of the convection have horizontal components of the wave vector $\mathbf{k_h}$ opposing to the background wind **U**, and thus can propagate upward into the stratosphere.

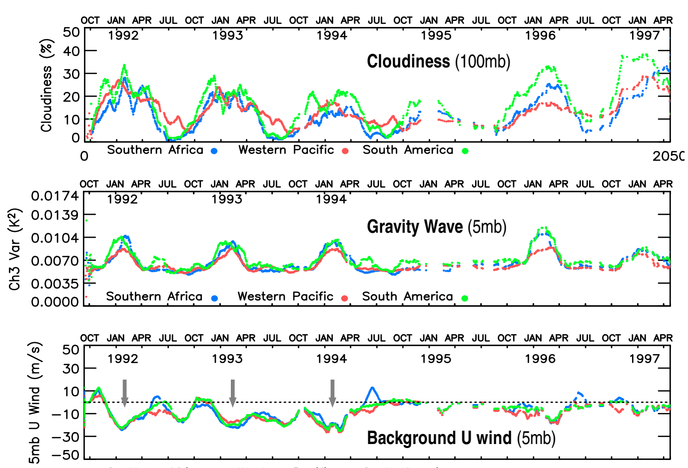


**Figure 2:** These sample plots show the time series of MLS measured cloudiness frequency at 100 hPa, MLS observed GW variance at ~5 hPa and the UKMO stratospheric background U wind at 5 hPa over the three major austral summer deep-convection centers.

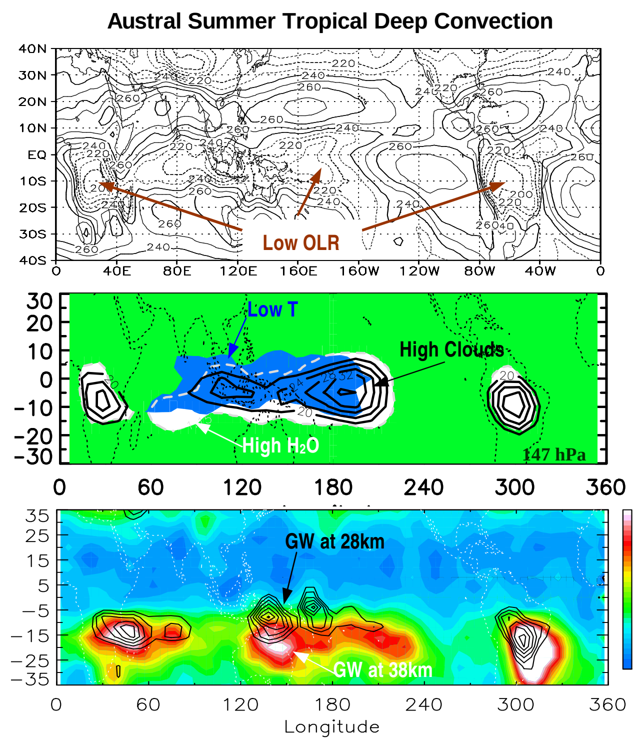


**Figure 3:** Examples of geographical distributions of OLR (top-panel, Jan/91-94), regions of high cloudiness, high water vapor and low temperature (from UKMO) in the TTL (mid-panel, Dec-Mar/91-92) and the stratospheric GWs (bottom-panel; Dec-Mar/91-94). The deep-convective activities are indicated by the regions of lowest OLR, above which the MLS measured high cloudiness and high moisture are seen in the TTL. The region of lowest tempera-ture is seen here at slightly down-wind-side of the western pacific convection. Because of the background wind filtering effect, the convection generated stratospheric GWs at 38 km are seen to shift poleward when compared to the GWs at 28 km.