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Stratospheric gravity wave observations of AIRS and HIRDLS

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The Atmospheric InfraRed Sounder (AIRS) aboard NASA's Aqua satellite provides stratospheric temperature observations for a variety of scientific analyses. However, the horizontal resolution of the operational temperature retrievals is generally not sufficient for studies of gravity waves. The AIRS high-resolution retrieval discussed here provides stratospheric temperature profiles for each individual satellite footprint and therefore has nine times better horizontal sampling than the operational data. The retrieval configuration is optimized so that the results provide a trade-off between spatial resolution and retrieval noise that is considered optimal for gravity wave analysis.

To validate the AIRS data we performed an intercomparison with stratospheric temperature measurements of the High Resolution Dynamics Limb Sounder (HIRDLS). Selected case studies of gravity wave events are analyzed. AIRS and HIRDLS utilize rather different measurement geometries (nadir and limb) and have different sensitivities to gravity wave horizontal and vertical wavelengths, as indicated by their observational filters. Nevertheless, the wave structures found in the stratosphere in AIRS and HIRDLS data are often in remarkably good agreement. The three-dimensional temperature fields from AIRS allow us to derive the horizontal orientation of the phase fronts, which is a limiting factor for gravity wave analyses based on limb measurements today.

In addition, a statistical comparison focuses on temperature variances due to stratospheric gravity wave activity at 20-60 km altitude. The analysis covers monthly zonal averages and time series for the HIRDLS measurement time period (January 2005-March 2008). We found good agreement in the seasonal and latitudinal patterns of gravity wave activity. Time series of gravity wave variances show a strong annual cycle at high latitudes with maxima during wintertime and minima during summertime. Largest variability is found at 60°S during austral wintertime. The large variability in gravity wave variances follows the variation in the zonal wind.

In summary, AIRS and HIRDLS gravity wave variances agree well and can be used complementary to each other to provide observations for large parts of the gravity wave spectrum. This offers an exciting perspective for future gravity wave research.