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Stratospheric gravity waves at southern hemisphere orographic hotspots: 2003-2014 AIRS/Aqua observations

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Stratospheric gravity waves from small-scale orographic sources are currently not well-represented in general circulation models. This may be a reason why many simulations have difficulty reproducing the dynamical behaviour of the southern hemisphere polar vortex in a realistic manner. Here we discuss a 12-year record (2003 – 2014) of stratospheric gravity wave activity at southern hemisphere orographic hotspots as observed by the Atmospheric InfraRed Sounder (AIRS) aboard the National Aeronautics and Space Administration's (NASA's) Aqua satellite. We introduce a simple and effective approach, referred to as the 'two-box method', to detect gravity wave activity from infrared nadir sounder measurements and to discriminate between gravity waves from orographic and other sources. From austral mid fall to mid spring (April – October) the contributions of orographic sources to the observed gravity wave occurrence frequencies were found to be largest for the Andes (90%), followed by the Antarctic Peninsula (76%), Kerguelen Islands (73%), Tasmania (70%), New Zealand (67%), Heard Island (60%), and other hotspots (24 – 54%). Mountain wave activity was found to be closely correlated with peak terrain altitudes, and with zonal winds in the lower troposphere and mid stratosphere. We propose a simple model to predict the occurrence of mountain wave events in the AIRS observations using zonal wind thresholds at 3 hPa and 750 hPa. The model has significant predictive skill for hotspots where gravity wave activity is primarily due to orographic sources. It typically reproduces seasonal variations of the mountain wave occurrence frequencies at the Antarctic Peninsula and Kerguelen Islands from near zero to over 60% with mean absolute errors of 4 – 5 percentage points. The prediction model can be used to disentangle upper level wind effects on observed occurrence frequencies from low level source and other influences. The data and methods presented here can help to identify interesting case studies in the vast amount of AIRS data, which could then be further explored to study the specific characteristics of stratospheric gravity waves from orographic sources and to support model validation.

Reference: Hoffmann, L., Grimsdell, A. W., and Alexander, M. J.: Stratospheric gravity waves at Southern Hemisphere orographic hotspots: 2003–2014 AIRS/Aqua observations, Atmos. Chem. Phys., 16, 9381-9397, doi:10.5194/acp-16-9381-2016, 2016.