



Lidar measurements of gravity waves in the middle atmosphere in southern hemisphere winter above New Zealand

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The international Deep Propagating Gravity Wave Experiment (DEEPWAVE) campaign was carried out in New Zealand during austral winter 2014. Its aim was to extensively study gravity waves from their sources in the troposphere, along their propagation through the atmosphere to the regions of dissipation at high altitudes. New Zealand was chosen due to its proximity to the edge of the polar vortex and its orography where strong flows excite gravity waves, making it one of the world's gravity wave hotspots. During DEEPWAVE, a comprehensive set of instruments was operated to observe gravity waves.

The DLR Rayleigh/Raman lidar was set up at NIWA station in Lauder on New Zealand's South Island in June 2014. The instrumented was operated whenever weather permitted. Temperature profiles are retrieved between 22 and 80 km with 10 min temporal and 1 km vertical resolution. In order to study variations in gravity wave propagation associated with the breakdown of the polar vortex, observations were continued beyond the DEEPWAVE campaign. In total 755 operation hours during 99 nights were accumulated between June and November 2014.

We present statistics of gravity wave activity and wave parameters which we derived from this extensive dataset using filtering techniques and spectral analysis. In a first step, we characterize gravity wave activity using the gravity wave potential energy density. Then we study spectral properties of the waves using two-dimensional FFT of wave-induced temperature variances. We find that in the stratosphere, low-frequency waves with periods close to the inertial period are very common. Large-amplitude waves with periods of less than two hours occur at times mainly in the mesosphere. The distribution of observed phase speeds suggests that observed waves fall into three groups: one group with mean phase speeds of ~ 3 km/h, one group with phase speeds close to zero, and a broad background. In addition to statistics, we show case studies of selected gravity wave events.