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Simulations of gravity waves over Antarctica and the Southern Ocean: comparison to balloon observations and investigation of non-orographic sources

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Gravity waves in the lower stratosphere above Antarctica and the Southern Ocean have been characterized from observations by superpressure balloons from the Vorcore campaign (Hertzog et al 2008). Mesoscale simulations with the WRF (Weather Research and Forecast Model) are carried out to analyze further the gravity-wave field, with an emphasis on non-orographic waves.

First, the realism of the simulated waves is assessed by comparison to the observations. A satisfactory overall agreement is found, but different behaviour is noted for orographic waves (overestimation in the simulations relative to the observations) and non-orographic waves (underestimation).

Second, the gravity-wave field is analyzed in more detail. It is necessary to quantify orographic and non-orographic waves separately. Orographic waves are larger and more intermittent, yet affect only a limited geographical region. Hence their overall contribution to momentum fluxes entering the stratosphere is comparable to that of non-orographic sources. A diagnostic for intermittency, the Gini coefficient, is proposed.

Third, in order to better identify non-orographic sources, case studies are carried out for episodes of intense momentum fluxes over the Southern Ocean, far from islands. The emitted gravity waves occur over intense and rapid cyclogenesis events (polar lows). It appears that, despite the high latitude, moist effects play a crucial rôle in the emission of the gravity waves.

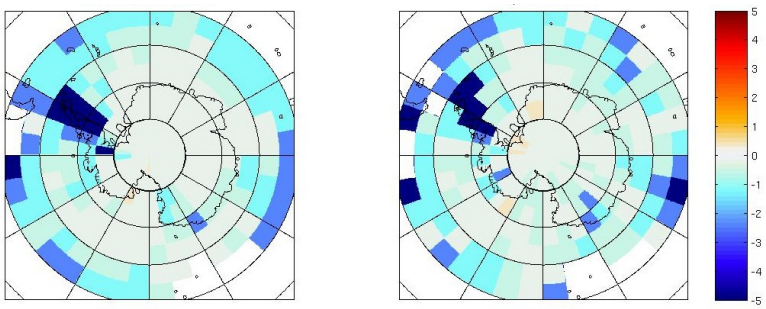


Figure 1: Zonal momentum fluxes at ~19 km from the simulations (left) and the balloon observations (right), averaged over the period 21/10 - 18/12/2005. The simulations are sampled at times and locations where balloons were present (see Plougonven et al 2013). Color range is voluntarily limited to [-5 ; 5] hPa, in order to reveal the spatial structure over the ocean.

Hertzog, A., et al (2008) : Estimation of gravity-wave momentum fluxes and phase speeds from long-duration stratospheric balloon flights. 2. Results from the Vorcore campaign in Antarctica, J. Atmos. Sci., 65, p3065-3070.

Plougonven, R., et al (2013) : Gravity waves over Antarctica and the Southern Ocean: consistent momentum fluxes in mesoscale simulations and stratospheric balloon observations, Q.J. Roy. Met. Soc., 139, p101-118.