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Non-orographic and orographic sources of gravity waves above Antarctica and the Southern Ocean

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A major weakness of Gravity Wave (GW) parameterizations is the representation of sources, in particular non-orographic ones. These are most often arbitratily set, and tuned to yield a satisfactory circulation in the middle atmosphere. This stems both from our lack of physical understanding of the mechanisms involved, in particular GW radiation from jets and fronts, and from insufficient constraints from observations and modelling.

We will present results from meso-scale simulations covering two months (October 21 to December 18, 2005) for a domain covering Antarctica and the Southern Ocean (10,000 x 10,000 km, with a resolution dx = 20 km). These simulations contribute to both endeavours:
- they constitute a realistic counterpart to the idealized baroclinic life cycles which have strongly contributed over the past fifteen years to our understanding of GW radiation from jets.
- the simulations complement the Vorcore observational campaign, during which 27 superpressure balloons were launched into the stratospheric polar vortex (September 2005-Januray 2006).

The first issues investigated in these simulations are:
1- how comparable are the simulated GW relative to the balloon observations from the Vorcore campaign?
2- how similar are non-orographic waves in these real-case simulations to those found in idealized baroclinic life cycles?

In answer to 1, it appears that the simulations succeed in capturing the overall distribution of momentum fluxes due to GW in the lower stratosphere, with a distinct maximum over the Antarctic Peninsula, yet these fluxes are somewhat underestimated relative to the estimations from the balloons. The resolution used (dx=20km) is generally insufficient for a detailled comparison to be made for individual wave packets. To test the sensitivity to resolution, nine days were simulated with doubled horizontal resolution. Momentum fluxes are nearly doubled, most of the changes affecting the vertical velocity (finer structure, enhanced amplitudes). In agreement with Vorcore observations, the overall contribution from oceanic regions is comparable to that from regions with orography, but intermittency is far greater over the latter. The comparison also sheds new light on the uncertainties and limitations of the estimations made from Vorcore measurements.

In answer to 2, the real case simulations do show cases of gravity waves present in jet exit regions, with wave capture playing a role, similar to the configuration emphasized in several studies of idealized simulations (baroclinic waves and dipoles). However, the wave field has significantly greater complexity than that analyzed in the idealized simulations, indicating that contributions from other generation mechanisms need to be taken into account.

The third set of questions we can investigate in these simulations concern the sources: what diagnostic from the large-scale flow is relevant to quantify emission from jets and fronts? How wide an area is affected by waves originating from mountains, including through secondary generation? Preliminary results on these issues will be discussed.