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Observations and simulations of a large-amplitude mountain wave breaking over the Antarctic Peninsula

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A case study of a large-amplitude orographic gravity wave occuring over the Antarctic Peninsula is presented, based on observations from the Vorcore balloon campaign and on mesoscale numerical simulations. The Vorcore campaign (September 2005–February 2006) consisted in the flight of 27 superpressure balloons in the core of the Southern Hemisphere stratospheric polar vortex at altitudes of 16-19˜km, from September 2005 to February 2006. On October 7, 2005, one of the balloons exploded as it was flying above the Antarctic Peninsula. The observations collected by another balloon that was flying during the same time period above the Peninsula suggest the presence of a very intense gravity wave (peak-to-peak amplitude of the order of 30˜\ms˜in zonal- and meridional-velocity disturbances). The wave packet is likely under-sampled in the balloon observations due to its high intrinsic frequency, but the balloon dataset is complemented with high-resolution numerical simulations carried out with the Weather Research and Forecast Model. The simulations are validated by comparison with the balloon measurements, and show that the wave was breaking in the lower stratosphere at the time and height where the balloon exploded. The simulations highlight several consequences of the mountain wave on the stratosphere: forcing of the mean flow, generation of secondary inertia-gravity waves, and turbulence and mixing. In particular, the momentum fluxes are calculated and are found to compare well with the estimates from balloon measurements. The large values found are likely extreme values, which raises the issue of their representativity. To discuss this, the balloon measurements are used in conjunction with operational analyses to estimate the frequency of such large-amplitude gravity waves, i.e. to provide an estimate of their

intermittency.