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Gravity Wave Emission by Spontaneous Imbalance of Baroclinic Waves in the Continuously Stratified Rotating Annulus

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We use a numerical model of the classic differentially heated rotating annulus experiment to study the spontaneous emission of gravity waves (GWs) from jet stream imbalances, which is a major source of these waves in the atmosphere for which no satisfactory parameterization exists. Atmospheric observations are the main tool for the testing and verification of theoretical concepts but have their limitations. Given their specific potential for yielding reproducible data and for studying process dependence on external system parameters, laboratory experiments are an invaluable complementary tool. Experiments with a rotating annulus exhibiting a jet modulated by large-scale waves due to baroclinic instability have already been used to study GWs: Williams et al (2008) observed spontaneously emitted interfacial GWs in a two-layer flow, and Jacoby et al (2011) detected GWs emitted from boundary-layer instabilities in a differentially heated rotating annulus.

Employing a finite-volume code for the numerical simulation of a continuously stratified liquid in a differentially heated rotating annulus, we here investigate the GWs in a wide and shallow annulus with relatively large temperature difference between inner and outer cylinder walls. In this atmosphere-like regime where the Brunt-Vaisala frequency is larger than the inertial frequency, various analyses suggest a distinct gravity wave activity.

To identify regions of GW emission we decompose the flow into the geostrophic and ageostrophic part through the inversion of the quasi-geostrophic potential vorticity (e.g. Verkley, 2009). The analysis of the geostrophic sources of the ageostrophic flow indicates that, in addition to boundary layer instabilities, spontaneous imbalance in the jet region acts as an important source mechanism.

Jacoby, T. N. L., Read, P. L., Williams, P. D. and Young, R. M. B., 2011: Generation of inertia-gravity waves in the rotating thermal annulus by a localised boundary layer instability. Geophys. Astrophys. Fluid Dyn., 105, 161-181. Doi:10.1080/03091929.2011.560151

Verkley, W.T.M., 2009: A balanced approximation of the one-layer shallow-water equations on a sphere. J. Atmos. Sci., 66, 1735-1748. Doi:10.1175/2008JAS2837.1

Williams, P. D., Haine, T. W. N. and Read, P. L., 2008: Inertia-gravity waves emitted from balanced flow: observations, properties, and consequences. J. Atmos. Sci., 65, 3543-3556. Doi:10.1175/2008JAS2480.1