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Spontaneous Gravity Wave emission in the differentially-heated rotating-annulus

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The source mechanism of inertia-gravity waves (IGWs) observed in numerical simulations of the differentially heated rotating annulus experiment is investigated. The focus is on the wave generation from the balanced flow, a process presumably contributing significantly to the atmospheric IGW spectrum. Direct numerical simulations are performed for an atmosphere-like configuration of the experiment and possible regions of IGW activity are characterized by a Hilbert-transform algorithm. Subsequently, the flow is separated into a balanced and unbalanced part, assuming the limit of small Rossby number, and the forcing of IGWs by the internal balanced flow is derived rigorously. Tangent-linear simulations are then used to identify the part of the IGW signal that is rather due to radiation by the internal balanced flow than to boundary-layer instabilities at the side walls. An idealized fluid setup without rigid horizontal boundaries is considered as well, to see the effect of the identified balanced forcing unmaske by boundary-layer effects. The direct simulations show a clear baroclinic wave structure exhibiting a realistic jet-front system superimposed by three distinct wave packets. The subsequent linear analysis indicates that one wave packet is radiated from the internal flow, one affected both by the internal flow and by the inner boundary layer, and a third one is probably caused by boundary layer instabilities. The balanced forcing is found to play a significant role in the generation of unbalanced flow so that it supplements boundary-layer instabilities as key factor in the IGW emission in the differentially heated rotating annulus.