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Convectively Forced Gravity Waves and their Sensitivity to Heating Profile and Atmospheric Structure

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It has been known for some time that convective heating is communicated to its environment by gravity waves. Despite this, the radiation of gravity waves in macro-scale models, which are typically forced at the grid-scale by meso-scale parameterization schemes, is not well understood. We present here theoretical work directed toward improving our fundamental understanding of convectively forced gravity wave effects at the meso-scale, in order to begin to address this problem. Starting with the hydrostatic, non-rotating, 2D, Boussinesq equations in a slab geometry, we find a radiating, analytical solution to prescribed sensible heat forcing for both the vertical velocity and potential temperature response. Both Steady and pulsed heating with adjustable horizontal structure is considered. From these solutions we construct a simple model capable of interrogating the spatial and temporal sensitivity to chosen heating functions of the remote forced response in particular. By varying the assumed buoyancy frequency, the influence of the model stratosphere on the upward radiation of gravity waves, and in turn, on the tropospheric response can be understood. Further, we find that the macro-scale response to convection is highly dependent on the radiation characteristics of gravity waves, which are in turn dependent upon the temporal and spatial structure of the source, and upper boundary condition of the domain.