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Horizontal rays and vertical modes method for the computation of the vertical propagation of acoustic-gravity waves

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We consider the vertical propagation of acoustic-gravity waves generated by a finite-size perturbation at the bottom, through a moving inhomogeneous atmosphere. Under the hypothesis of weak inhomogeneities in the horizontal direction, an approximate solution is obtained in terms of normal modes and horizontal rays. The problem is thus reduced to a depth-separated equation very similar to the standard Taylor-Goldstein equation, with weak dependence of the parameters on the horizontal coordinates, and to ray equations along the horizontal – thus decreasing the computational resources needed.

One advantage of this method is to retain the signal that is partially transmitted across reflecting regions that may exist due to the background wind jet, contrary to standard ray tracing that would predict pure reflexion. In addition, the limitation to an homogeneous medium along the horizontal coordinates that applies to other standard methods based on spectral integral transforms is released with the current approach.

An idealized configuration is investigated, where numerical results are shown. Finally, a more general formulation in terms of approximate adiabatic spectral integral transform is presented. Implications for the computation of the propagation of Tsunami-generated acoustic-gravity waves, and more generally waves generated at the bottom of an inhomogeneous moving fluid, are discussed.