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Impact of gravity waves on long-range infrasound propagation

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In this work we study infrasound propagation in acoustic waveguides that support a finite number of propagating modes. We analyze the effects of gravity waves on these acoustic waveguides. Testing sound propagation in such perturbed fields can potentially be used to improve the gravity wave models. A linear solution modeling the interaction between an incoming acoustic wave and a randomly perturbed atmosphere is developed, using the forward-scattering approximation. The wave mode structure is determined by the effective sound speed profile which is strongly affected by gravity wave breaking.

The random perturbations are described by a stochastic field predicted by a multiwave stochastic parameterization of gravity waves, which is operational in the LMDz climate model. The justification for this approach is two fold. On the one hand, the use of a few monochromatic waves mimics the observations of rather narrow-banded gravity wave packets in the lower stratosphere. On the other hand, the stochastic sampling of the gravity wave field and the random choice of wave properties deals with the inherent unpredictability of mesoscale dynamics from large scale conditions provided by the meteorological reanalysis.

The transmitted acoustic signals contain a stable front and a small-amplitude incoherent coda. A general expression for the stable front is derived in terms of saddle-point contributions. The saddle-points are obtained from a WKB approximation of the vertical eigenvalue problem. This approach extract the dominant effects in the acoustic - gravity wave interaction. We present results that show how statistics of the transmitted signal are related to a few saddle-points and how the GW field can trigger large deviations in the acoustic signals. While some of the characteristics of the stable front can be directly related to that of a few individual gravity waves, it is shown that the amount of the launched gravity waves included in climate models can be estimated using recorded infrasound signals.