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Propagation of gravity waves through non-uniform stratification

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We present a method to compute the transmission of gravity waves through a finite region of a non-uniformly stratified atmosphere. It is based on an approximate solution of the Taylor-Goldstein equation.

With the method, we are able to compute a transmission coefficient for gravity waves, which is defined as the ratio of the vertical wave energy fluxes below and above the region of non-uniform stratification. It makes use of the fact that plane wave solutions exist in uniform stratification and models the atmosphere as a multi-layer fluid where each layer is uniformly stratified. The solutions are matched at the interfaces in a way that the continuity of pressure and vertical wind is ensured, so that we are finally able to relate incident and transmitted wave amplitudes. Further, the limit of increasing number of layers is investigated and we obtain a reformulation of the Taylor-Goldstein equation. This equation can not be solved analytically, but numerically, giving a solution in which it is possible to distinguish between the two branches of the gravity wave dispersion relation, namely upward and downward travelling waves. Hence, we are also able to compute a transmission coefficient from this procedure. Moreover, it can be shown that the multi-layer solution converges to the limit solution quadratically with increasing number of layers. The results we obtain for some test cases are in accordance with several existing results, but provide more general insights into the interaction of gravity waves propagating through non-uniform stratification. Also, the multi-layer method can be extended to give an approximate solution to the Taylor-Goldstein equation without using any numerical integration.