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# Dynamics of lee waves on the boundary layer inversion

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Lee waves are horizontally propagating non-hydrostatic internal gravity waves that may be generated when stratified flow is lifted over a mountain. Depending on the upstream conditions, two types of lee waves can be distinguished. First, resonant lee waves, which are often explored in the context of Scorer's theory of wave trapping in a two-layer atmosphere, where a discontinuity in the Scorer parameter - with evanescent conditions in the upper layer - gives rise to trapped waves. Second, interfacial lee waves, which may form along a density discontinuity, e.g. a temperature inversion, similar to surface waves on a free water surface. While resonant lee waves have been studied extensively, interfacial lee waves were only rarely discussed in meteorological literature so far. For example, observational studies as well as systematic studies on the wavelength dependencies still seem to be lacking.

In this work, we modify Scorer's wave trapping theory by applying a boundary condition that accounts for a density jump between the two fluid layers. In this case, wave resonance is possible along the density discontinuity even if the lower layer is neutrally stratified. The resulting linear theory can be applied for instance to atmospheric boundary layer flows over complex terrain, where part of the mountain wave energy can be trapped along the inversion that caps the boundary layer. We validate this model with observations taken in the area of Vienna and highlight the lee wavelength dependence on the flow parameters by systematically varying the upstream conditions. Since interfacial waves have transcendental frequency dispersion relationships that cannot be solved analytically, we also discuss the implications of the shallow- and deep-water approximations on the wavelength of the resonant mode.