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# Interfacial and trapped waves in flows over mountains

Johannes Sachsperger (1), Stefano Serafin (1), Vanda Grubišić (1,2)

(1) University of Vienna, Department of Meteorology and Geophysics, Vienna, Austria (johannes.sachsperger@univie.ac.at), (2) Earth Observing Laboratory, National Center for Atmospheric Research, Boulder, CO, USA

The horizontal propagation of internal waves in stratified fluids is 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 lee waves. The frequency dispersion relationship (FDR) of these waves suggests that their horizontal wavelength depends on the Scorer parameters in both layers and on the depth of the lower layer.

Horizontal wave motion can also occur in form of interfacial waves along a density discontinuity in the interior of a fluid, similar to surface waves on a free water surface. The wavelength of interfacial waves is defined by the height and strength of the discontinuity and by the horizontal wind speed.

We modify Scorer's wave trapping theory by applying a boundary condition that accounts for a density jump between the two stratified layers. In this case, wave resonance is possible along the density jump even if the lower layer is neutrally stratified. Therefore, both interfacial waves and trapped lee waves are supported. The resulting linear theory can be applied for instance to 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 show that, under certain combinations of parameters, trapped lee waves behave exactly as pure interfacial waves, i.e. they obey to identical FDRs. Since trapped lee waves and interfacial waves have transcendental FDRs that cannot be solved analytically, we also discuss the implications of the shallow- and deep-water approximations on the wavelength of the resonant mode.