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Trapped lee wave interference in presence of surface friction

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Trapped lee waves form downwind of a mountain ridge under conditions conducive to wave energy confinement within the lower troposphere. Placing a secondary ridge downwind of the first significantly affects the lee wave field. As shown in our earlier study of lee wave resonances under free slip conditions, constructive and destructive interference can occur, and their appearance is governed by the ratio of the intrinsic trapped lee wave wavelength and the ridge separation distance. In this study we investigate trapped lee wave interference over twin peaks in the presence of a frictional boundary layer, under conditions that can lead to boundary-layer separation and formation of rotors, with the attendant recirculating regions forming underneath the wave crests. Idealized high-resolution two-dimensional simulations with the NRL COAMPS model are used to investigate both the linear and nonlinear flow regime, and the effect of trapped lee wave interference on formation and characteristics of lee-wave rotors.

The results show that the interference pattern for all mountain heights examined is consistent with the predictions of linear interference theory. The wave response is found to be strongest in the lee of the downstream ridge, where changes in the wave amplitude due to interference affect the rotor strength most significantly. However, only for the strongest nonlinear regime examined (h=1000m) is the rotor strength amplified by constructive interference beyond that obtained in the lee of a single mountain. The rotors within the valley are always weaker than those downstream of a single obstacle. The flow within the valley displays sensitivity to the ridge separation distance and the interference pattern below the wave-amplitude threshold for rotor formation. Beyond that threshold, the variations of maximum surface wind speed as well as the strength of the reversed flow in the rotors within the valley appear to be significantly diminished and insensitive to the ridge separation distance.