



Influence of secondary orography on boundary-layer separation and rotors

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Boundary-layer separation in the lee of mesoscale orography is important for the formation of mountain-wave induced rotors. Rotors, turbulent horizontal eddies forming in the lee of orography, pose a significant threat to aviation but are also important for air-pollution due to fluid recirculation and mixing. Boundary-layer separation and rotors are therefore particularly important in valleys. Results of a limited number of previous studies suggest that, apart from surface roughness, terrain slope and the flow regime, boundary layer separation might be facilitated by the existence of downstream orography.

In this study we examine how secondary orography, such as islands or downstream ridges, influences boundary-layer separation and rotor formation under different flow regimes, including trapped waves and undular hydraulic jumps. Here we present the results of idealized and real-data high-resolution numerical simulations of flow over double orography performed with the NRL COAMPS model.

The results show that certain types of gravity wave response are particularly sensitive to secondary orography, even when the secondary orography is significantly lower than the primary one. In the trapped lee wave regime the onset of boundary layer separation within the valley, in between the two ridges, appears almost unaffected by the secondary ridge; however, for higher mountains downstream orography is responsible for the decrease in rotor intensity within the valley. Even downstream of the secondary ridge, where trapped lee wave interference determines the wave amplitude, boundary layer separation is not facilitated. On the other hand, for hydraulic-type flows the secondary ridge is able to induce boundary layer separation for conditions under which it would not occur in the lee of a single ridge. In this case, the point at which flow separates from the surface as well as the intensity of rotor circulations are both affected by the downstream mountain.