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Lee waves over double bell-shaped orography

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Most of theoretical and idealized numerical studies of terrain-generated lee waves have focused on the problem of atmospheric flow past isolated obstacles; only limited attention has been given to the problem of airflow past a double barrier. An almost perfect two-dimensional double barrier that has lately received considerable observational attention is the Sierra NevadaâEUR“White-Inyo system, well known for generation of large-amplitude mountain waves and rotors that were the focus of the recent Terrain-induced Rotor Experiment (T-REX in 2006) as well as its pilot Sierra Rotors Project (SRP in 2004). Observational evidence from these projects indicates that trapped lee waves play an important role in the formation of rotors. They also suggest that the largest amplitude lee waves have a wavelength close to the ridge separation distance, suggesting a resonant wave response of the atmosphere to the valley terrain profile. Here we report on results of idealized high-resolution numerical simulations of the double-barrier problem, carried out using the NRL Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS). The flow is taken to be two-dimensional, irrotational and dry. The baseline sounding is an idealized sounding representative of several SRP and T-REX large-amplitude mountain wave events. It is found that the presence of the second mountain exercises a profound influence on lee waves. The primary wavelength of the forced lee-wave corresponds to one of the spectral peaks of the double-barrier obstacle but the non-linear system shows preference toward shorter wavelengths. That is, resonant lee-wave wavelengths correspond to secondary and tertiary spectral peaks of the underlying terrain with the ratio of ridge-separation distance to the resonant wavelengths being an integer. We report also on the sensitivity of the double barrier flow to upstream conditions. Special attention is given to the mountain top inversion as well as the vertical wind shear profile.