Numerical simulations of mountain waves and rotors observed during T-REX

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Introduction

The Terrain Induced Rotor Experiment (T-REX) took place during spring 2006, over the Sierra Nevada mountains and Owens Valley. Results are presented from high-resolution numerical simulations of mountain waves and associated rotor motions observed during T-REX. The results are compared with airborne and ground based observations.

The simulations

• The model used for this study is the Met Office Unified Model.
• Nested forecast simulations were performed with horizontal resolutions of 40 km, 12 km, 4 km, 1 km and 333 m.
• The vertical grid spacing used was 5 m at the surface, increasing to 200 m at 2 km.
• Simulations of flows observed during IOP-6 and 8 are presented. Results are shown for the finest (∆x=333 m) resolution.

Results for IOP-6

24-26 March 2006

• Large amplitude lee wave present in simulations (vertical velocities >12 ms⁻¹)
• Unsteady rotor motion present within Owens Valley. Wave breaking occurs above 14 km. Downslope winds penetrate into west side of valley. Return flow constrained to east side of valley.
• Near-surface winds exhibit jet structure near western foot of Sierras. Flow is highly unsteady and contains small-scale eddy motions. A fan-like jet is present to north of Bishop.
• Comparisons with data from BAE-146 flight B181 show the model captures the amplitude, but not the phase of the mountain-wave motion.
• Comparison with University of Leeds AWS data shows model slightly underestimates unsteadiness in near-surface flow across the valley floor.

Results for IOP-8

31 March – 1 April 2006

• Weak amplitude lee wave present in simulations (maximum w~7 ms⁻¹)
• No downslope wind or rotor motion present. The near-surface winds are relatively steady and generally southerly near Independence.
• Reasonable agreement between forecast wave motion and that observed during the BAE-146 flight B184.
• Comparison with Leeds AWS data shows model gives a good representation of the hourly mean wind speed and variability across the valley floor.

IOP-6 summary

IOP-8 summary

Fig 1: Forecast vertical velocity (ms⁻¹) at 5 km valid at 0030Z 26 March.

Fig 2: Vertical velocity (ms⁻¹) and θ on cross-section through Independence.

Fig 3: Zonal wind (ms⁻¹) and θ on cross section through Independence.

Fig 4: 10 m wind vectors and speed (ms⁻¹) across the Owens Valley near: (a) Independence (0005Z) (b) Bishop (0040Z) on 26 March.

Fig 5: The model vertical velocity and that measured by the BAE-146 during flight B181, 26 March 2006.

Fig 6: Forecast vertical velocity (ms⁻¹) at 5 km valid at 0200Z 1 April.

Fig 7: Vertical velocity (ms⁻¹) and θ on cross section through Independence.

Fig 8: 10 m wind vectors and speed (ms⁻¹) across the Owens Valley near Independence at 0200Z on 1 April.

Fig 9: The model vertical velocity and that measured by the BAE-146 during flight B184, 31 March 2006.

Fig 10: Hourly mean wind speed and standard deviation across the Owens Valley floor computed from Leeds AWS sites and model predictions at the same sites. Results are shown for IOP-6 and IOP-8.