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

Simon Vosper[1], Peter Sheridan[1], Stephen Mobbs[2] and Ralph Burton[2]

[1]Met Office, Exeter, UK [2]School of Earth and Environment, University of Leeds, Leeds, UK

## 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 ($\Delta x$=333 m) resolution.

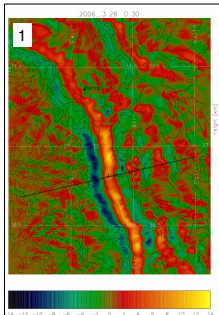



**Fig 1**: Forecast vertical velocity (ms$^{-1}$) at 5 km valid at 0030Z 26 March.

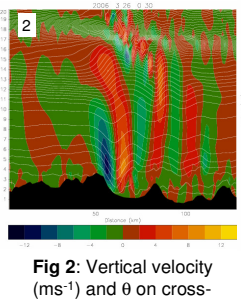



**Fig 2**: Vertical velocity (ms$^{-1}$) and θ on cross-section through Independence.

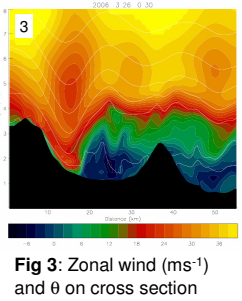
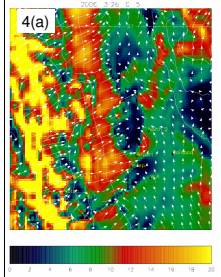



**Fig 3**: Zonal wind (ms$^{-1}$) and θ on cross section through Independence.



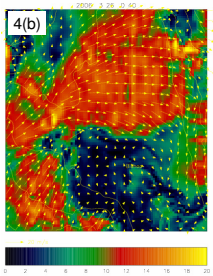




**Fig 4**: 10 m wind vectors and speed (ms$^{-1}$) across the Owens Valley near:
(a) Independence (0005Z)
(b) Bishop (0040Z)
on 26 March.

## Results for IOP-6 24-26 March 2006

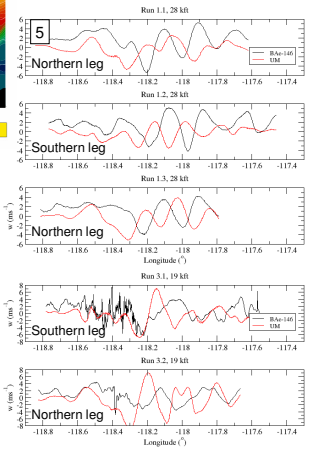



**Fig 5**: The model vertical velocity and that measured by the BAE-146 during flight B181, 26 March 2006.

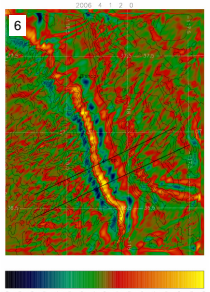



**Fig 6**: Forecast vertical velocity (ms$^{-1}$) at 5 km valid at 0200Z 1 April.

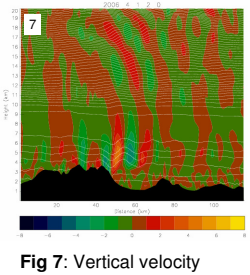



**Fig 7**: Vertical velocity (ms$^{-1}$) and θ on cross section through Independence.

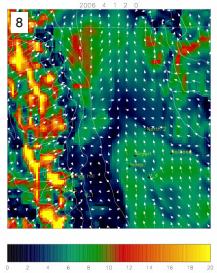



**Fig 8**: 10 m wind vectors and speed (ms$^{-1}$) across the Owens Valley near Independence at 0200Z on 1 April.

## Results for IOP-8 31 March – 1 April 2006

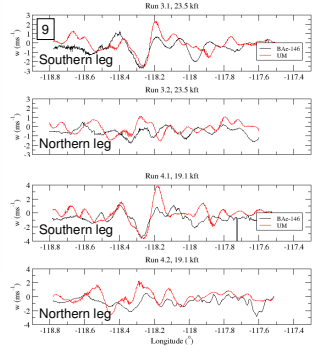



**Fig 9**: The model vertical velocity and that measured by the BAE-146 during flight B184, 31 March 2006.

## IOP-6 summary

- 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.

## IOP-8 summary

- 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.

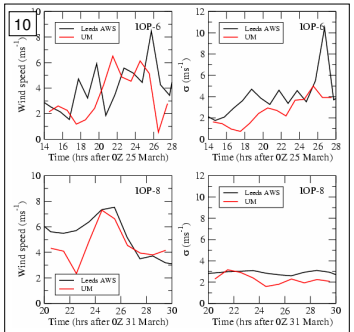



**Fig 10**: Hourly mean wind speed and standard deviation across the Owens Valley floor computed from Leeds AWS sites and model predictions at the same sites. Results are shown for IOP-6 and IOP-8.

Met Office FitzRoy Road Exeter Devon EX1 3PB United Kingdom
Tel: 01392 884584 Fax: 01392 885681
Email: simon.vosper@metoffice.gov.uk