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Orographic induced blocking, mountain wave, channelling and expansion fan observations in small-scale complex terrain

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Dynamics in complex terrain can prove difficult to understand and is further complicated if the size of the features is reduced. Previously regarded insignificant phenomena enticed by 'small-scale' topographic features, produced a fatal light aircraft crash on 16 December 2015. To better understand the meso- to microscale flow dynamics in the terrain a network of automatic weather stations were set up; in a nearby valley, along the upwind ridge and along the sides of the gap. These surface stations were supplemented by upper air soundings. The upwind ridge rises approximately 400m above the valley floor with the gap measuring 1500m wide. No smaller scale similar observational study could be found in literature. During four field events, three dominant features were observed; blocking, mountain waves and channelling. Surface winds reaching up to 45m.s̃(-1) were measured. Sounding data included up- and downdrafts up to 6.6m.s̃(-1). Upwind sounding data was analysed and the Scorer, Froude Number, Froude derived height scale, Burger Number, Rossby radius and thermal wind equations were determined for all events. In three events, Froude and Burger parameters predicted over-ridge-flow and only a partial blocking jet; yet still the blocking jet was observed more intense than the channelled flow. The one exception (subcritical Froude value) resulted in an inexplicable contradiction where no blocking was observed. When compared to scatterometer and radiosonde data, calculated parameters displayed an acceptable accuracy and were consistent with observations. Froude derived height scale suggested a jet up to 1000m deep. By applying the Rossby Radius equation, a jet horizontal scale exceeding 100km wide was suggested. Finally the thermal wind equation predicted blocking induced speed increases up to 12m.s̃(-1). The blocking jet was found to peak close to mountaintop, this is inconsistent with other studies in higher elevation areas (like the Sierra Nevada). During events similar to the crash date, the site acted as a convergence area for different airmasses (pre-frontal, pre-coastal low and post-frontal) clouding the dynamics supposed to form the basis of flow dictation. Over the four events little variation in Scorer and Froude values were observed. Mountain wave events in this study had a typical duration of less than four hours and displayed the classic feature of reduced amplitudes with successive downwind waves. A variety of wave observations were made; stationary, up- and downwind moving waves, waves breaking up from changes in airmass, waves taking a herringbone-shape and waves in a superadiabatic environment. The flow channelled through the gap exhibited, firstly, a positive correlation to the nocturnal inversion; simulating a Venturi-effect with stronger evening winds. Secondly, divergence at the gap exit, being stronger to the right diverging-flank than to the left. Lastly, a deviation of flow in the horizontal - suggesting a possible combination of rotating eddies and lee-down-valley flow. The most interesting observation includes a small wave feature portraying 100m wavelength and 40m amplitude at the channel outflow. This observation offers a remarkable resemblance to a gravity wave trapped in an expansion fan - as is observed in water bodies.