Atmospheric rotors induced by stably stratified flows over mountains

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Abstract

When a stably stratified air mass is flowing over obstacles (hills, mountains), the formation of internal gravity waves on the lee side (lee-waves) is often observed. As these waves are bounded by the ground they are interacting with the atmospheric boundary layer, which is dominated by turbulent friction. The main phenomenon induced by theses interactions are so-called rotors, horizontal vortex rolls located beneath the wave crests . In contrast to the very smooth flow within lee waves, the rotor flow is very turbulent and can be also a hazard for aviation in mountainous terrain. For the latter reason, there have been intensive research activities on rotors by means of large field experiments like the terrain-induced rotor experiment (T-REX) in the Sierra Nevada and high resolution numerical simulations in the last decade.

Here we present some results on the rotor problem as obtained by laboratory experiments performed in the large stratified towing tank at Meteo-France in Toulouse. The experiments were performed for some idealized situations with respect to the environmental flow, where the main focus was on the influence of a temperature-inversion in the boundary layer close to the mountain top, which is supposed to be favourable for rotor formation. In combination with the LES simulations, some typical characteristics of the rotor flow (e.g. dimensions, velocity fields, turbulence) have been obtained. As experienced by glider pilots since a long time, rotors can be almost found every time under the wave crests between the surface and the mountain top. Hence they constitute a hazard to low level aviation close to mountains. Therefore the research on atmospheric rotors is not only of scientific interest but has also some practical applications.

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