ACINN Graduate Seminar, Innsbruck University
Location: Seminar Room on the 8th Floor of Bruno-Sander-Haus (60819SR)
Wednesday, 25 Apr 2018, 11:45

Observations and modelling of atmospheric rotors

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Atmospheric rotors are near-surface circulations of flow about a horizontal axis. They are often connected with severe turbulence and intense up- and downdrafts near the ground in mountainous regions. Pioneering investigations of rotors date back to the 1930s, and further progress was made with dedicated field campaigns in the 1950s (Mountain Wave Project), 1970s (near the Colorado Rockies) and 2000s (Sierra Wave Project and Terrain-induced Rotor Experiment, T-Rex). It is now well established that atmospheric rotors are embedded in non-hydrostatic flow, and that they are linked on one side to large-amplitude gravity waves in the overlying atmosphere and on the other to wave-induced boundary layer separation.

A few recent findings concerning atmospheric rotors are presented:

1. The intensity of turbulence within rotors is comparable to that in hydraulic jumps and in mid-tropospheric wave-breaking regions. Rotors react quickly to mesoscale forcing and may move steadily against the background wind on the lee side of a mountain as they dissipate. Supporting evidence includes Doppler cloud radar measurements made in 2006 in the lee of the Medicine Bow Mountains (Wyoming, USA). These observations are interpreted with the aid of mesoscale numerical simulations.

2. The development and evolution of rotors are considerably more complex in valleys than in the lee of isolated mountains, as demonstrated by the T-Rex campaign, held in 2006 in Owens Valley in the lee of the Sierra Nevada (California, USA). Findings from a few T-REX case studies and from a short-therm local climatology of leeside windstorms are presented.

3. Even when the primary mountain wave field is essentially hydrostatic, rotors may occur underneath a secondary wave disturbance resembling an undular bore. This finding is supported by idealized simulations of linearly stratified and vertically uniform flow over a mountain.