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Untangling mountain boundary layer processes in the eastern Pyrenees: the case of the Cerdanya Basin and Andorra central valley

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The Pyrenees is a west to east oriented mountain range in southwest Europe along the border between France, Spain and Andorra. In the eastern part there are two relatively high populated valleys oriented ENE to WSW: (i) the Cerdanya basin, a wide valley (35 km long, 9 km wide) with the bottom around 1000 m asl at the centre and (ii) the Andorra Central valley, a more closed close valley (5 km long, 0.5 km wide) with the bottom about 1013 m asl on average.

In Cerdanya, northern synoptic flows favour mountain waves formation and associated rotors over the valley, with strong turbulence zones at the upper edge of the mountain wave crest (Udina et al. 2020). For specific precipitation events during the Cerdanya-2017 campaign there was no evidence of modification of precipitation profiles due to mountain-induced circulations (Gonzalez et al. 2019, 2021).

A decoupling is frequently observed between the stalled air of the valley and the air of the free atmosphere above the mountain crest level, at around 1000-1500 m agl. Circulations in the first hundreds of meters above the surface are dependent on multi-scale interactions and can be described as a function of thermal and dynamical stability. A remarkable feature in the valley is that nocturnal strong temperature inversions with cold-air pools formation occur more than 50% of the nights mainly during winter (Conangla et al. 2018, Miró et al. 2018), which lead to very low minimum temperatures (-22.8 °C, 12th February 2018).

In Andorra central valley, terrain-induced circulations dominate the mountain boundary layer structure. Winter temperature inversions and cold pools formation are one of the key factors that determine the thermal stability conditions and limit the pollutant dispersion. Persistent temperature inversions are identified, and selected case studies are explored using pseudo-profiles of observations and mesoscale models.

The study and comprehension of the aforementioned phenomena in mountainous terrain are fundamental for improving their representation in models and to assess the model limitations in resolving them.

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