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Cold-air pooling in a wide Pyrenean valley

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The official records taken within La Cerdanya valley (western Pyrenees, Catalonia) traditionally provide temperature values noticeably lower than the surrounding areas under anti-cyclonic weather conditions. The valley is a graben 35 km long and 9 km wide located at 1000 m above sea level (asl), bounded to the north by the main axis of the Pyrenees (peaks above 2900 m asl) and by the Cadí mountain range to the south (maximum high 2649 m asl). This topographical configuration seems indicated for the development of strong cold-air pooling and therefore responsible for such low temperatures at night. A study on the thermal structure and wind circulation of the air within La Cerdanya valley under fair-weather conditions is required to understand the behaviour of such extreme values observed in the area.

In the current work, two complementary approaches are used: first, a four-year long period (September 2010 – August 2014) of data from several meteorological stations operating around the area lead to a statistical study of the phenomena, allowing to select representative cases. Second, a three-day long case (October 2011) is taken for a more detailed analysis, combining meteorological data, satellite information and a high-resolution mesoscale simulation.

This communication describes the statistical occurrence and main characteristics of cold-air pooling within La Cerdanya valley and identifies the physical processes that dominate its evolution, including the role of the drainage flows that form at low levels. During the analysed period, cold-air pools occur during almost 60% of the nights, even under significant synoptic pressure gradient. Cold-air pooling begins approximately one hour after sunset, extending across most of the valley bottom. Wind veers down-valley along the main axis two to three hours after sunset and the wind direction is approximately maintained until after sunrise. A very strong thermal inversion develops close to the surface, with a depth of up to one hundred meters in the lowest parts of the valley according to the mesoscale simulation. The numerical results also show that radiative processes, together with turbulence in the lowest layers, dominate the evolution of the cold pool, while drainage flows developed over valley sidewalls and from the main tributary valleys carry cold air to the already settled pool.

The statistical study has allowed to design a series of field campaigns that took place during autumn 2015 and winter 2017 seasons to corroborate some of the findings provided by the mesoscale simulation.