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Characterization of a valley exit jet at the foothills of the Pyrenees

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To study the evolution of the nocturnal atmospheric boundary layer in a nearly flat region at the foothills of a major mountain range, observations at the foothills of the Pyrenees during the Boundary-Layer Late Afternoon and Sunset Turbulence (BLLAST) experimental field campaign are taken together with high-resolution mesoscale simulations. The main site of the BLLAST campaign is Lannemezan, located on a nearly flat plateau at about 10 km from the exit of the Aura valley. This 40-km long valley is oriented to the north, with a width between mountain peaks of about 5 km in the middle of the valley, diminishing to 2 km at the end. Results show that under clear-sky conditions the evolution of the nocturnal boundary-layer in Lannemezan differs from what can be expected over an isolated flat terrain region due to the presence of thermally-driven winds. Locally-generated downslope winds are observed close to sunset over the plateau and as night progresses the thermal gradient between the plain and the mountains induce mountain-plain circulations. The organization of the flow in the Aura valley generates a valley exit jet close to midnight that travels through the foothills enhanced by the thermal gradient between mountain and plain already established. Once the valley exit jet propagates through the foothills, it interacts with the locally-generated circulations and decreases its speed and height. As a result, in Lannemezan a maximum of wind speed of about 5-10 m/s from the southern sector is found between 50 m and 200 m above the ground during nighttime. Results show that mesoscale winds can enhance or diminish the intensity of the valley exit jet and even advance or delay the arrival of the valley exit jet in Lannemezan.

The temporal and spatial evolutions of the valley exit jet are further analyzed with observations taken during summer 2018 in the Aura valley. Three meteorological stations along the valley axes and a Doppler scanning lidar at the valley exit are used to characterize the organization of the flow at lower levels in the valley and the formation of the valley exit jet. Data from the Atmospheric Research Center (CRA) at Lannemezan are also used together with several radio-soundings launched close to sunrise (the exit valley jet is completely developed in the simulations) to better characterize the vertical evolution of the jet when it propagates through the foothills.