First findings from the CROSSINN campaign on the structure and variability of cross-valley circulations in the Inn Valley, Austria

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Over flat and horizontally homogeneous terrain, vertical exchange mechanisms govern the coupling between the surface and the free troposphere. However, over sloping terrain and heterogeneous land-use, this coupling takes a three-dimensional character across a range of spatial scales, introducing uncertainties when attempting to parameterize resulting flow structures in operational numerical weather prediction. Superposition of these spatial scales is particularly pronounced in mountain valleys, for which a theoretical framework capable of explaining such alteration of exchange mechanisms does not currently exist. The resulting flow structures may assume several different properties and formations, ranging from asymmetrical cross-valley circulation cells to curvature-induced circulations accompanied with marked turbulence. To date, such flow structures have been sampled only during a few selected ambient conditions and with limited spatio-temporal resolution, leaving many open-ended questions as to their persistence and their effect on the coupling between the surface and the free troposphere. To address these questions and improve our understanding of the evolution of such cross-valley flow, we conducted the CROSSINN (Cross-valley flow in the Inn Valley investigated by dual-Doppler lidar measurements) field campaign in the Inn Valley, Austria, from 1 August to 13 October 2019.

In this talk, we present preliminary findings from one Intensive Observation Period (IOP). The thermodynamic state of the mountain boundary layer during this IOP was sampled with a rich suite of measurements, including five Doppler LiDARs, a Raman LiDAR, a ceilometer, a microwave radiometer, surface energy balance measurements, as well as frequent radiosoundings. To sample the cross-valley flow structure with adequate spatio-temporal resolution, three Leosphere Doppler LiDARs Windcube 200s, which are part of the mobile integrated atmospheric observation platform KITcube, were set up in two dual-Doppler configurations covering each one half of the valley atmosphere in a single vertical plane. Such a configuration enabled the retrieval of two components of the wind field along this single vertical plane, giving us desired insight into the structure of the cross-valley flow. The spatial coverage, with the extent of 5x3 square kilometers on average, was resolved with a 50-m grid spacing throughout the entire duration of CROSSINN, sufficiently fine to assess the spatial extent of the cross-valley flow observed during this IOP. During this IOP, we observed several features of interest, including a twice daily transition from nighttime downvalley to more intense daytime upvalley flow and vice versa, as well as a shallow daytime convective boundary layer. Owing to the intense upvalley flow, the cross-valley flow structure, as obtained from the dual-Doppler algorithm, resembled an asymmetrical, single closed cell restricted to altitudes below the surrounding Alpine ridgetops.

Key words: complex terrain, cross-valley flow, Doppler LiDAR, turbulence, atmospheric boundary layer