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Submeso structures in an alpine valley: an exception or the rule

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Boundary layers in complex terrain are characterized by motions on scales ranging from synoptic to turbulence. Turbulent transport of heat, mass and momentum is generally considered to be the main driver of the surface-atmosphere exchange, however, it is progressively more recognized that non-turbulent structures on scales larger than turbulence have a non-negligible contribution to the over-all transport. Since these motions are still smaller than (or comparable to) the resolution of most operational numerical models, they need to be parameterized (in coarse resolution models) and therefore their interaction with turbulence needs to be well understood.

Previous studies have suggested that properties of the submeso motions close to the surface are only weakly affected by upstream terrain complexity. The question remains what the characteristics of the submeso motions and their contribution to the total transport in truly complex terrain are?

In this contribution we present a long-term study of submeso motions in the surface layer of an alpine valley within the Innsbruck Box (short i-Box) project. I-Box is a test bed for studying boundary layer processes in complex terrain and consists of long-term turbulence measurements at 6 stations of different slope (0 - 30°), elevation (600m - 2000m) and exposition (N and S) - in combination with high-resolution numerical modeling. The stations are located in the Inn Valley, a complex, approximately E-W oriented valley in Austria. The 20 Hz turbulence measurements from 5 stations, ranging in length from several months to more than a year, are used in this study to explore the relative contributions of turbulence and non-turbulent submeso motions to total transport. Submeso structures are extracted from the time series by means of a novel detection and clustering method (Kang et al. 2014) that separates potential events from the background noise. The structures are found at different scales ranging from minutes to tens of minutes. Here we examine the frequency of occurrence of different structures, their structure and contribution to the total flux of momentum and heat and compare it to the turbulent transport. The impact of these submeso motions on Monin-Obukhov similarity theory is also investigated.