TEAMx: A research programme on observing and modelling the mountain boundary layer

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The mountain boundary layer (MoBL) may be defined as the part of the troposphere that is directly influenced by the mountainous terrain. It is subject to mountain-induced thermal circulations and venting processes, as well as to mechanical lifting of air masses and the associated buoyancy perturbations in the flow. The MoBL exchanges heat, momentum, tracers and moisture with the Earth's surface and with the free atmosphere on time scales between about one hour and one diurnal cycle. It is heavily influenced by atmospheric turbulence, but also by meso-scale and synoptic-scale weather processes.

Numerical weather prediction and climate simulation models account for exchange processes at the land surface and within the boundary layer using empirically tuned and inherently uncertain parameterization schemes. These represent the effects of sub-grid-scale turbulent processes with concepts drawn from boundary-layer meteorology (e.g., scaling based on dimensional analysis), which work reasonably well over flat and homogeneous terrain but often prove too simplistic in the MoBL. Because about 30% of the land surface is occupied by complex orography, the implications of suboptimal boundary-layer modelling are likely to be significant.

The talk begins by outlining a few key aspects of recent MoBL research that are relevant to parameterization development: limitations of Monin-Obukhov surface-layer scaling, horizontal exchange in the boundary layer, challenges in determining the mixing height. It then illustrates how a newly launched research programme, TEAMx, plans to increase the body of experimental evidence about MoBL processes and exploit it for model development.

The two pillars of TEAMx are: (i) A field campaign, planned for 2023-2024 in the European Alps, with large-scale deployment of micrometeorological instrumentation, ground-based profiling instruments and airborne sensors; (ii) Coordinated model evaluation studies, combining a hierarchy of tools from large-eddy simulation to regional models to improve exchange parameterizations (land-atmosphere exchange, turbulence, convection, gravity wave drag) across modelling grey zones.