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Challenges ahead for atmospheric boundary layer research: open debate

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The canonical view of the atmospheric boundary layer, namely the convective and stable archetypes, has been very successful in understanding and representing its dynamics. However, in the last decade, new observational evidence and numerical studies have shown that there are still gaps of knowledge that influence not only boundary-layer dynamics, but also large-scale weather processes and biochemical processes at the surface. Relevant ones are: (a) transitional periods, (b) the role of surface heterogeneity and (c) the interactions with larger (meso-) and smaller atmospheric (micro-) scales. More specifically, the morning and afternoon transition still require deriving an appropriate scaling that adapts to the transitions between convective and stable conditions. In turn, these unsteady situations are influenced by the surface flux variability, the impact of non-local and non-stationary processes or the influence of larger circulations driven by topography or land heterogeneity. The latter, depending on the heterogeneity length scale, could induce secondary circulations that enhance cloud formation and its intensity.

These processes normally occur at the regional scales in which the modelled large scales are explicitly resolved whereas smaller scalers, sub-kilometre, require to be parameterized, i.e. the grey zone. Last but not least, it still an open discussion how to connect boundary-layer dynamics to other processes, which demand crossing disciplines and move beyond the physics. Just to put a couple of examples closely connected to the transitions in boundary layer dynamics and land heterogeneity: (a) the impact of clouds and aerosol (chemistry) by perturbing radiation modifies the surface and ABL dynamics and (b) the role of vegetation/soil (carbon diurnal cycle) in controlling the partitioning between evapotranspiration and sensible heat flux.

Our presentation takes a participative format in which the audience is an active part. First, we will shortly introduce the subjects and attempt to define the challenges. Subsequently, we discuss how new instrumental devices and fine-scale large eddy simulations can contribute to advance in the understanding. Finally we will discuss how to transfer this knowledge to weather and climate model to improve the representation of the atmospheric boundary layer.