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Heterogeneous evaporation across a turbulent internal boundary layer

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In local evaporation from sufficiently uniform and large surfaces, horizontal advection close to the changes in surface condition is not significant. Under natural condition, this assumption is often invalid and horizontal inhomogeneity is important. When partially saturated air flows from a uniform dry land surface over a wet surface, all lower boundary conditions of transport equations change abruptly. Also surface humidity and roughness are likely to be different from their upwind values. Due to these changes, the velocity profile and turbulence structure of the airflow must readjust. The vertical profiles are no longer in equilibrium and the horizontal gradients do not equal to zero. When there is more than one of these changes in the domain of interest, the interaction between different patches with a contrast in roughness, temperature or surface water content is also important.
Rigorous experimental and numerical analysis of turbulent transfer of mass and momentum in the so-called internal boundary layer (the region affected by such step changes in surface condition) is the aim of this work. A combination of numerical simulations using in-house codes and commercial softwares and experimental measurements in the environmental wind tunnel is performed. We are specifically interested in correct depiction of roughness, in a more accurate representation of the turbulent velocity profile and in a better description of turbulent diffusion close to the interface. A series of simplifying assumptions in the classical representation of this problem are investigated and a sensitivity analysis is performed to identify the contribution of neglected terms. We are also interested in the parameterization of the heat and mass exchange processes for the case with different wet patches in a background of dry soil, which is of interest in several field scale applications.