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Atmospheric boundary layer separation scaling in the wake of heterogeneous canopies

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Wakes behind canopies have been shown to cause significant wind sheltering of small lakes, wetlands and clearings, leading to much reduced momentum transfer, as well as altered heat and mass fluxes across the air-water and land-atmosphere interfaces compared to the fully developed boundary layer. Canopy length and porosity strongly affect the extent of the wake-affected region downwind from the canopy and therefore the rate of recovery of the boundary layer. Unlike in classical roughness transitions, the scale of the boundary layer separation determines the new origin and the rate of the boundary layer re-development downwind from the canopy. Prediction of the separation scale is crucial for developing models for boundary layer transitions over wake-affected landscapes. We investigate the dynamics associated with geometric properties of canopies to determine the existence and estimate the extent of flow separation and boundary layer recovery. New scaling arguments and criteria will be presented, supported by wind tunnel and field experiments of turbulent flow and surface flux measurements in the wake of canopies with variable length and porosity.