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Thermal adjustments of drying porous surfaces – pore scale spatial and temporal considerations

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The emptying of pores during drying of porous surfaces is accompanied by changes in surface thermal fields and subsequent changes to energy partitioning. A novel experimental system was designed to systematically evaluate the building blocks and key assumptions in the Pore-scale Coupled Energy Balance (PCEB) model [Aminzadeh and Or, 2014] that analytically links surface temperature evolution and evaporative fluxes during drying of porous surfaces. Details of thermal fields around evaporating pores drilled into rough glass surfaces were measured for various pore spacings along with evaporative fluxes. Observations were compared with model predictions for individual pores and mean surface values under different wind speeds and radiative regimes. The temporal evolution of thermal fields induced by pore emptying was captured by microscopic IR thermography demonstrating an instantaneous adjustment of surface thermal fields during drying (a few seconds). Pore emptying sequences of sintered glass bead surfaces obtained by optical and thermal imaging agree with predictions based on pore geometry. Local and average thermal and flux measurements were in good agreement with PCEB model predictions hence support the basic building block used to dynamically link evaporation rates and energy partitioning over drying porous surfaces.