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Physical modeling of Earth's near-surface environment in the laboratory: Concepts, considerations, and demonstration of intermediate-scale coupled wind tunnel-porous media experimentation

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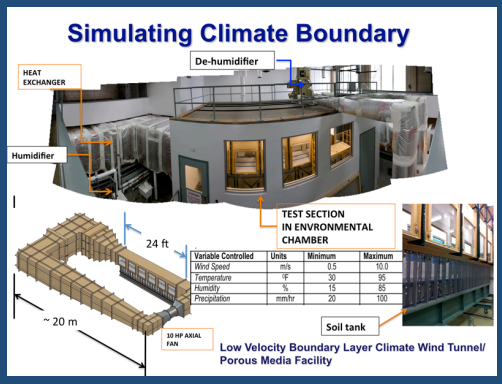
Aula RH01 "A. Bezze" (Ex Fisica tecnica)



Soils, plants, and the atmosphere are inexorably interlinked by a myriad of feedback processes involving the simultaneous transport and transfer of heat, mass, and momentum within Earth's near-surface environment. These feedback processes can have significant impacts on the availability and distribution of soil moisture which, while accounting for less than 0.001% of all water on Earth, is critical to climate, plant community performance (i.e., fecundity, growth, survival), and surface energy budgets. In these contexts, experimentation for fundamental process understanding and dataset generation for model testing/validation is not a straight forward task as there are a number of limiting factors associated with traditional laboratory and field approaches. Most laboratory experiments for example, are not physically large enough to reproduce scale-dependent processes or incorporate sufficient complexity and realism. Field data collection in turn, is site specific and subject to the spatiotemporal uncertainty of subsurface/surface heterogeneity and climate variability; field sites and processes furthermore cannot be characterized and measured at the scales required.

Physical modeling at test-scales that are intermediary between conventional laboratory test systems (<1 m) and the field (>50 m) continue to gain popularity in traditional subsurface investigations and offers an alternative approach for studying near-surface heat, mass, and momentum transfer processes. The experiments conducted at this intermediate test-scale have a number of advantages for investigating problems requiring the accurate characterization of the porous medium, control of initial and boundary conditions, and the generation of accurate data at high spatial and temporal resolutions. This talk introduces the concepts, considerations of coupled intermediate-scale wind tunnel-porous media research for various applications. The feasibility of such an experimental approach is demonstrated through several past and ongoing case studies conducted in a closed-circuit, climate-controlled, low-windspeed, micrometeorological wind tunnel interfaced with large 7.3 m long soil tanks in which synthetic soil-plant-atmosphere continuum environments can be created.