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Linking fractional wettability and contact angle dynamics in water repellent soils

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Dynamic soil water repellency has become a highly documented soil phenomenon across a range of environmental conditions and investigated within a range of disciplines. With global climate change at the environmental science fore, there is growing concern and need for accurate quantification of fundamental soil hydraulic properties and model parameterization. In the presence of soil water repellency, however, substantial unknowns remain in terms of characterizing repellency and drawing linkages to fundamental hydraulic parameters. This is often related to the complexity of investigating soil water repellency, which is often a challenging environment because of its spatially and temporally variable nature. To help bridge this gap, this work reports on different approaches using various technologies to explore opportunities that yield greater quantification and parametrization of soil water repellency in natural hydrologic systems at different scales. These approaches include X-ray microtomography (μXCT), Axisymmetric Drop Shape Analysis (ADSA), Drop Penetration tests (MED/WDPT), and Tension Infiltrometry. This work has shown the strength of conceptually linking contact angle dynamics and fractional wettability as a means to understand the nature of infiltration in water repellent soils and provide a mechanistic foundation upon which repellency can be quantified and related to fundamental hydraulic properties. Contact angle dynamics and fractional wettability are complimentary terminology that appear in the multiphase flow and soil physics literature, but have largely/essentially only been applied in synthetic systems. Their utility in natural environments is potentially significant and conceptually useful since they can readily incorporate existing characterizations while providing greater opportunity for articulating and defining specific behaviours in systems with high spatial and temporal heterogeneity.