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Increased ambient air temperature alters the severity of soil water repellency

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Soil repellency, the inability of soils to wet readily, has detrimental environmental impacts such as increased runoff, erosion and flooding, reduced biomass production, inefficient use of irrigation water and preferential leaching of pollutants. Its impacts may exacerbate (summer) flood risks associated with more extreme drought and precipitation events. In this study we have tested the hypothesis that transitions between hydrophobic and hydrophilic soil particle surface characteristics, in conjunction with soil structural properties, strongly influence the hydrological behaviour of UK soils under current and predicted UK climatic conditions. We have addressed the hypothesis by applying different ambient air temperatures under controlled conditions to simulate the effect of predicted UK climatic conditions on the wettability of soils prone to develop repellency at different severities.
Three UK silt-loam soils under permanent vegetation were selected for controlled soil perturbation studies. The soils were chosen based on the severity of hydrophobicity that can be achieved in the field: severe to extreme (Cefn Bryn, Gower, Wales), intermediate to severe (National Botanical Garden, Wales), and subcritical (Park Grass, Rothamsted Research near London). The latter is already highly characterised so was also used as a control. Soils were fully saturated with water and then allowed to dry out gradually upon exposure to controlled laboratory conditions. Soils were allowed to adapt for a few hours to a new temperature prior to initiation of the controlled experiments. Soil wettability was determined at highly regular intervals by measuring water droplet penetration times. Samples were collected at four time points: fully wettable, just prior to and after the critical soil moisture concentrations (CSC), and upon reaching air dryness (to constant weight), for further (ultra)metaproteomic and nanomechanical studies to allow integration of bulk soil characterisations with functional expression and nanoscale studies to generate deep mechanistic understanding of the roles of microbes in soil ecosystems.
Our controlled soil pertubation studies have shown that an increase in ambient temperature has consistently affected the severity of soil water repellency. Surprisingly, a higher ambient air temperature impacts soils that in the field develop subcritical and extreme repellency, differently under controlled laboratory conditions. We will discuss the impact of these results in relation to predicted UK climatic conditions. Soil metaproteomics will provide mechanistic insight at the molecular level whether differential microbial adaptation is correlated with the apparent different response to a higher ambient air temperature.