Geophysical Research Abstracts
Vol. 21, EGU2019-6869, 2019
EGU General Assembly 2019

Monolayer water is not responsible for the increase of soil water repellency at low soil water content

Enoch V. SW. Wong (1), Phil R. Ward (2), Matthias Leopold (1), Daniel V. Murphy (1), and Louise Barton (1)

(1) UWA School of Agriculture and Environment (M087), The University of Western Australia, 35 Stirling Hwy, Crawley, WA 6009, Australia, (2) CSIRO Agriculture, Private Bag No 5, Wembley, WA 6913, Australia

Soil water repellency causes preferential flow of water into soil channels while the majority of the soil remains dry. This poses problems to agricultural production, causing poor crop germination, emergence and growth due to poor water infiltration and low soil water contents. Soil water repellency has been shown to increase with soil water content to a maximum value, beyond which soil water repellency declines with further increases in soil water content. Furthermore, the water molecules have been shown to become 'ice-like', causing the surface to become less hydrophilic, when the amount of water decreases to a monolayer of water molecules on mineral surfaces free of water and organic compounds. Beyond a few layers of water molecules, the water molecules recover their 'bulk-like' behaviour and wettability. Others have hypothesised that the initial increase in soil water repellency with water content could be due to the formation of a thin layer of water molecules on the particle surfaces. Consequently, we evaluated whether the presence of a thin layer or more specifically, a monolayer of water on a water repellent soil surface [molarity of ethanol droplet test (MED), 2.0 M $\pm$ 0.2] is responsible for the observed initial increase in soil water repellency. This was achieved by constructing a water desorption isotherm using a dynamic vapour sorption instrument and an octane sorption isotherm using an inverse gas chromatography instrument. Octane was used because it is the international standard for determining surface area of soils with specific surface areas less than 1 m^2/g. The soil was dried at 20˚C for 180 minutes (for water desorption isotherm), or 30˚C (for octane sorption isotherm) for 120 minutes, under a continuous flow of dry nitrogen gas before being exposed to a range of relative pressures (0.00–0.95 kPa/kPa). The Brunauer-Emmett-Teller model was fitted to the isotherms over a range of relative pressure (0.05–0.30 kPa/kPa) to determine the monolayer water content. The monolayer water content determined to be 0.26% using the water vapour desorption isotherm, whereas the monolayer water content was 0.004% using the octane sorption isotherm. In the same soil, water repellency only increased when the soil water content reached 0.66 $\pm$ 0.02 % at 20˚C, indicating a monolayer of water was not responsible for the observed increase in soil water repellency. The water vapour sorption isotherm instead indicates the increase in soil water repellency with soil water content coincided with capillary condensation of water in the soils. Understanding the mechanism contributing to soil water repellency will aid modelling and prediction of water repellency and preferential flow in soils.