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Simulation of wetting front dynamics in water repellent soils using fluid flow theory at the pore scale

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Water repellency causes the wetting front to become unstable and as a result water flows in fingers down and only partially wetting the soil. Although the phenomenon has been widely observed, there is still no satisfactory explanation of the behavior at the wetting front itself.

In order to explain the wetting front behavior, the concept of dynamic contact angle has been introduced, which is greater than the contact angle under static conditions. Many contradicting theories have been proposed. In this presentation we will show that by solving the fluid flow equations at the pore scale, the dynamic contact angle is a function of the pressure applied and to lesser degree of the static contact angle as long as it exceeds the pressure needed for water to enter the pore. Our results compare well with the experimental observations of Hoffman in the seventies in which the change in contact angle was measured as a function of flow velocity.