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Reduced soil wettability can affect greenhouse gas fluxes

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Soil moisture is known to be an important factor affecting the carbon (C) dynamics in soils including decomposition of organic matter and exchange of gases like CO_2 and CH4 between the soil and the atmosphere. Most studies and process models looking at the soil C dynamics assume, however, that soils are easily wettable and water is relatively uniformly distributed within the soil pores. Most soils, however, do not wet spontaneously when dry or moderately moist, but instead exhibit some degree of soil water repellency (i.e. hydrophobicity), which can restrict infiltration and conductivity of water for weeks or months. This is world-wide occurring phenomenon which affects all soil textural types but is particularly common under permanent vegetation e.g. forest, grass and shrub vegetation. Soil water repellency is most profound during drier seasons, when the soil moisture content is relatively low. Although prolonged contact with water can gradually decrease water repellency, some soils do not recover to being completely wettable even after very wet winter months or substantial rainfall events. It has been recognized that with the predicted climatic changes the phenomenon of soil water repellency will become even more pronounced and severe, additionally it may occur in the areas and climatic zones where the effect have not been currently recognized.
One of the main implications of soil water repellency is restricted water infiltration and reduced conductivity, which results in reduced soil water availability for plants and soil biota, even after prolonged periods of rainfall. As the process of C mineralization and consequently CO_2 efflux from soil is driven by the accessibility of organic matter to decomposing organisms, which in turn is directly dependent on (i) soil moisture and (ii) soil temperature it is, therefore hypothesised that carbon decomposition and CO_2 efflux in water repellent soils will also be affected when soil in the water repellent state. The CO_2 fluxes will, however, increase once the soil switches to wettable conditions. In a similar way the water repellency affects soil CH4 fluxes favouring the process of oxidation by methanotrophs in water repellent soils.
The results of the interdisciplinary study of CH4 and CO_2 fluxes from water repellent soils in field and laboratory conditions will be presented. The study sites located in the Netherlands and United Kingdom and include the areas under climatic drought and temperature simulations in the heath-land areas, as well as the sites under natural climatic conditions under grassland and forest land use in the temperate climate.
The results available to date provide a strong indication that C mineralization is reduced in water repellent soil, and, given that the total plant biomass in naturally water repellent soil-vegetation systems appears unaffected, this could enhance soil C sequestration on the long term.