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CO_2 response to rewetting of hydrophobic soils - Can soil water repellency inhibit the 'Birch effect'?

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Rewetting of dry soils is known to cause a short-term CO_2 pulse commonly known as the 'Birch effect'. The displacement of CO_2 with water during the process of wetting has been recognised as one of the sources of this pulse. The 'Birch effect' has been extensively observed in many soils, but some studies report a lack of such phenomenon, suggesting soil water repellency (SWR) as a potential cause. Water infiltration in water repellent soils can be severely restricted, causing overland flow or increased preferential flow, resulting in only a small proportion of soil pores being filled with water and therefore small gas-water replacement during wetting. Despite the suggestions of a different response of CO_2 fluxes to wetting under hydrophobic conditions, this theory has never been tested.

The aim of this study is to test the hypothesis that CO_2 pulse does not occur during rewetting of water repellent soils. Dry homogeneous soils at water-repellent and wettable status have been rewetted with different amounts of water. CO_2 flux as a response to wetting has been continuously measured with the CO_2 flux analyser. Delays in infiltration and non-uniform heterogeneous water flow were observed in water repellent soils, causing an altered response in the CO_2 pulse in comparison to typically observed 'Birch effect' in wettable systems.

The main conclusion from the study is that water repellency not only affects water relations in soil, but has also an impact on greenhouse gas production and transport and therefore should be included as an important parameter during the sites monitoring and modelling of gas fluxes.