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Atmosphere-ground interaction in the context of convective precipitation using a soil moisture and energy balance network during COPS

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Within the soil-atmosphere system the temporal and spatial variability of soil moisture are important parameters that influence the hydrology on small to medium scales as well as the availability of moisture within the atmosphere. The latter may have significant influence on the local and the mesoscale, e.g. concerning the initiation of thermally induced wind regimes, and in connection with the initiation of convective systems. In spite of the importance, there is still an almost complete lack of operational soil moisture observations within the meteorological community. Basically depending on soil type, surface characteristics, land use and vegetation soil moisture can vary significantly over spatial scales of even a few centimetres, making an operational measurement network for meteorological purposes difficult.

Besides soil moisture monitoring on larger scales using spatially integrating remote sensing methods, near-field in-situ measurements on smaller scales (point measurements) is one of the most common approach for monitoring soil moisture. Additionally hydrogeophysical methods are used on an intermediate scale, because of their applicability for 2D and 3D problems (penetration depths of several meters) and their flexible spatial scales (between the centimetre scale and a few kilometres).

Within a large experimental and modelling investigation of the influence of soil moisture variability on convection initiation in orographic terrain, a soil moisture network was installed within the international Convective and Orographically-induced Precipitation Study (COPS) campaign, which was conducted in summer 2007 in south-western Germany and eastern France. The COPS experiment on warm season precipitation formation provides a unique data set documenting the lifecycle of convective systems in the atmosphere. With particular emphasis on its initiation, precipitating convection is investigated in response to forcing by mountain effects, the state of soil and vegetation. As convective precipitation formation can be initiated by (amongst others) (1) surface heating and moisture supply overcoming convective inhibition during potentially instable stratification as well as (2) hot spots at the surface and low-level flow convergence over mountains crests, energy balance and moisture availability at the surface may play a critical role in cases of strong local atmosphere-ground coupling (= weak mesoscale forcing).

Selected COPS cases will be analysed to decide on the controlling factors, which have to be adequately represented in models for quantitative precipitation forecast (QPF). In this contribution we will introduce the soil moisture monitoring network, including a simplified soil moisture probe (SISOMOP) and several innovative techniques for spatial soil moisture measurements, and will present first results on atmosphere-ground interaction in orographic terrain.