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Urban soil moisture affecting local air temperature

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The climate in cities differs from that in the surrounding area due to modified surfaces. Parameters like surface sealing ratio, vegetation and building material are known to be relevant for the intensity of the microclimatic modification. But what about the influence of soil moisture content and availability at the soil surface?
Soil acts as a storage and transmitter for water. In doing so, it may have a differently pronounced impact on local climate through distinct evapotranspiration. The actual evapotranspiration rates are determined by water availability at the surface - dependant from soil physical properties and water refill from above or below – and the presence of evapotranspirators, i.e. plants that transpire water from deeper soil areas. The issue of soil hydrological characteristics and water replenishment limiting the local cooling effect of soils is the topic of this contribution.

A long-term record (2010-2014) of ongoing measurements in the city of Hamburg, Germany, is evaluated. The data is provided by atmospheric and pedologic measurement sites of the HUSCO network (Hamburg Urban Soil Climate Observatory). They are located within six urban districts: the city core, four suburban districts, featuring different mean groundwater table depths (> 5 m below surface / < 2.5 m below surface), and one industrial area.
The temporal evolutions of water content and soil water tension of the suburban soil profiles are found to be very diverse, related to soil substrate, organic matter content and groundwater table depth. Most distinct variations are observed within the upper horizons of suburban soil. Soil hydrological processes show characteristic patterns at each measurement site, including topsoil water content (Θ) variability. Yet, differences between distinct urban land use types are visible only according to differences in the prevailing soil texture. Impacts of different vegetation types on the soil water dynamics can be identified, while the influence of urban land use is not found to be definite.
Air temperature (Ta) anomalies of the suburban sites from the inner city site are analysed for several periods and seasons. During daytime a significant annual mean deviation is observed above unsealed, vegetated surfaces from a sealed site during selected relevant days. Remarkably, about a fifth of the variance of the diurnal Ta span, i.e. increase of Ta during the day, is found to be explained by normalized Θ for selected meteorological situations. In this contribution this observed relation between topsoil moisture and air temperature increase during daytime at suburban sites will be presented after describing the local conditions and soil hydrological heterogeneities at the observed urban sites.