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Upscaling soil water storage change in clay areas using satellite based radar interferometry

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The soil moisture status of the unsaturated zone is a key factor affecting hydrological fluxes. Several methods to measure soil water content on different scales have been proposed, but all have limitations concerning their measurement volume. In-situ measurements are confined to very small spatial scales, while measurements on larger spatial scales are often limited to near surface soil moisture, and do not represent the soil moisture status of the unsaturated zone well.

It is desirable to develop an alternative methodology to measure larger-scale soil water contents and fluxes. For water balance studies the change in total water present in the soil is needed, rather than the exact vertical distribution of soil water. In soils with a large clay content, water content variations result in volume changes. The cumulative effect of this pore-scale process over the depth of the unsaturated zone is observable at the point-scale as soil surface elevation change. We may capitalize on the special properties of clay soils to derive soil moisture contents at larger scales.

We investigate the suitability of satellite based radar interferometry (InSAR) to observe very subtle surface elevation changes on larger spatial scales (e.g. field scale or small catchment scales). Interferometrically processed TerraSAR-X data offer high resolution (3 meter) and high frequency (11 days) phase information, which might be related to clay swell and shrinkage. Upscaling these observation over fields or catchment sections yields soil moisture storage changes over scales that are relevant for hydrological modelling, land management and policy making.

In-situ observations of soil moisture, surface elevation changes, and micro-meteorological variables together with laboratory measurements on clay swell and shrinkage are linked to InSAR observations. The results suggest that swell and shrinkage of clays is observable by InSAR. These observations could in the future be used to estimate soil water storage changes.