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Potentials and constraints of different types of soil moisture observations for flood simulations in headwater catchments

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Flood generation in mountainous headwater catchments is governed by rainfall intensities, by the spatial distribution of rainfall and by the state of the catchment prior to the rainfall, e.g. by the spatial pattern of the soil moisture, groundwater conditions, and possibly snow. The work presented here explores the limits and potentials of measuring soil moisture with different methods and in different scales and their potential use for flood simulation. These measurements were obtained in 2007 and 2008 within a comprehensive multi-scale experiment in the Weisseritz headwater catchment in the Ore-Mountains, Germany. The following technologies have been applied jointly thermogravimetric method, Frequency Domain Reflectometry (FDR) sensors, Spatial-Time Domain Reflectometry (STDR) cluster, Ground Penetrating Radar (GPR), airborne polarimetric synthetic aperture radar (polarimetric-SAR) and Advanced Synthetic Aperture Radar (ASAR) based on the satellite Envisat. We present exemplary soil measurement results, with spatial scales ranging from point scale, via hillslope and field scale to the catchment scale. Only the Spatial-TDR cluster was able to record continuous data. The other methods are limited to the date of over flights (airplane and satellite) or measurement campaigns on the ground.
At a first glance, using soil moisture data to initiate better flood modelling (including flood forecasts) seems to be a rather straight forward approach. However, this approach bears several problems regarding the operational use of such data and the model parameterisation: 1) A main constraint is that the observation of spatially distributed soil moisture and the subsequent data processing are still far from an operational stage because continuous or quasi-continuous air-borne observation and processing of soil moisture is not available; 2) remote soil moisture sensors observe only a quite shallow soil depths, which are of restricted relevance for flood generation and water budgets, 3) satellite data are not yet readily available continuously and in a way that they can be used directly for flood forecasting, and 4) hydrological models which can directly process such information are not readily available.