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Spatial and temporal patterns of soil moisture in agricultural landscapes

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Soil moisture is a key variable for a vast variety of environmental processes, e.g. surface energy transfer, evapotranspiration, runoff, soil respiration, etc.. Nevertheless, its spatial and temporal patterns are often not well represented in environmental analysis and modelling. Within the SFB Transregional Collaborative Research Centre 32 entitled "Patterns in Soil-Vegetation-Atmosphere Systems: monitoring, modelling and data assimilation" our group seeks to improve the understanding of spatio-temporal patterns of soil moisture in agricultural landscapes on different scales and to analyse the effects of these patterns on water and carbon fluxes. The research is based on a combination of field measurements, radar remote sensing (ERS-2, ENVISAT, ALOS) and land surface modelling (PROMET-V). Here the first results from spatially distributed field measurements and spatial analysis are presented. Field measurements are carried out in two test sites within the Rur catchment, Western Germany. One test site (Rollesbroich, 32 ha) represents a typical grassland within the rolling topography of the Eifel, the other one (Selhausen, 41 ha) represents an intensively used agricultural area, where cash crops are grown on slight slopes. Starting in May 2007 surface soil moisture (0-5 cm) has been measured in a 50 x 50 m grid at each day of ERS-2 and ENVISAT passes over the test sites. Beside the measuring campaigns soil moisture has been continuously monitored in three depths (10, 30, 60 cm) at three locations and meteorological and water flux data have been measured with a Bowen-Ratio-Station and an Eddy-Flux-Tower.

Surface soil moisture within the grassland test site was generally at a relatively high level (42 to 61 Vol.-%) caused by regular rainfall in the area ($>$ 60 mm per month)

and by the large amount of living biomass within the topsoil. As driving parameters for soil moisture patterns in the topsoil ($<$ 5 cm) we identify the topography and topography induced variability of soil texture and organic matter. Effects of differences in grassland management could not be detected. In general, differences in surface soil moisture within the test site were rather small (ś 5 Vol.-%) for any given day of one of the nine measuring campaigns. Soil moisture was always lower in the deeper soil layers (10, 30, 60 cm) again indicating the effect of living grass roots in the topsoil.

Due to the high amount of coarse alluvial deposits reducing the water holding capacity, patterns in soil moisture within the intensively used Selhausen test site most likely occur in the eastern part of the area after prolonged dry periods. Most pronounced differences (max. 18 Vol.-%) were found after a longer period without precipitation in July. In comparison to the effects of stony soils in some parts of the test site, no significant differences in surface soil moisture could be found between the different fields of the test site.

In general, the data from the test sites provide insights into the driving parameters of spatio-temporal soil moisture patterns, namely topography, land use, soil texture and structure. Based on this data set the potential of integrating spaceborne radar remote sensing into environmental modelling will be tested. This integrating approach appears promising to overcome problems of single approaches (e.g. not modelled but remotely detected moisture effect of stony soils) and could improve future applications in soil moisture modelling.