Understanding the influence of soil moisture and surface water fluxes on extreme convective precipitation events during summer in South Norway

L. Ehrnsperger, M. Wolff[2]. B. Bhattarai, V. Kristiansen[4]
[1,2,3,4]Norwegian Meteorological Institute
Henrik-Mohns plass 1, 0313, Oslo – Norway
Email: laurae@met.no (optional)

ABSTRACT

Climate change is predicted to be especially pronounced in the higher latitude regions. Precipitation will likely increase in subpolar and polar areas with higher occurrence of extreme precipitation both in winter and summer. Norway is especially vulnerable to flash floods caused by heavy precipitation due to its topographic conditions with steep slopes and a shallow soil layer. In this context it is essential to have accurate forecasts of extreme precipitation events that might lead to flooding. These heavy precipitation events occur mostly during convective conditions in summer and are notoriously difficult to predict due to their short evolution time and our lack in understanding underlying processes at the land-atmosphere-boundary. The H2O projects of the Norwegian Meteorological Institute aims to improve the understanding of processes between soil, vegetation and the atmosphere in Norway and identify the role of soil moisture in the development of convective summer precipitation. Soil moisture is usually neglected in models as soil water content measurements are sparse and the relationship between land and atmosphere is not fully understood. In this project, observations of soil moisture and turbulent fluxes during the summer seasons in 2021 and 2022 in South Norway will be used to improve the ability of land surface models (LSM) to represent real-world surface conditions. Ultimately, the observations should help improve forecasts of extreme convective precipitation by numerical weather prediction (NWP) models with the goal to implement these findings into operational weather forecasts of Norway. Model results will be compared with the spatial and temporal patterns observed by real-world measurements before and during extreme convective precipitation. Our results show that the latent heat flux (LE) was dominating the surface energy balance and LE, sensible heat flux (H) and evapotranspiration (ET) were highest under convective conditions showing the high amounts of energy that are transported from the surface to the atmosphere under these conditions. The dominance of water-related fluxes showed that soil moisture as an essential part of the water cycle can no longer be neglected in weather forecasting. The NWP model results tend to overestimate evapotranspiration compared to observations. This is likely linked to the complex heterogenous pattern of soil moisture we measured, which is directly linked to ET and LE rates of soil and vegetation and indicates that the forcing data that is currently used for NWP models has to be expanded by observations of soil moisture and evapotranspiration.

Keywords: Extreme precipitation; land-atmosphere-interactions; soil moisture; convective events; weather forecast; observations; numerical weather prediction