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A European vision for hydrological observations and experimentation

From observations towards operational site-specific soil moisture ensemble forecasting

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The use of numerical models for real-time management of water resources is becoming increasingly popular as the increasing frequency and intensity of extreme weather events negatively affect society, agriculture and crop yields. Prolonged droughts are becoming the new normal, which, among other things, increase the need for operational, site-specific soil moisture forecasting. A model that provides accurate site-specific soil moisture forecasts can support agriculture by contributing to precision irrigation and the provision of important information for crop planning, yield maximization and the coordination of field operations. Soil moisture assimilation has proven potential to provide appropriate initial conditions for such a forecast model. However, the operational estimation of an initial condition requires model-specific protocols for continuously incorporating new observational data into models for hydrological, crop, land surface, vadose zone, or subsurface processes that are not yet widely available. In this study, we present an automated data pipeline for operational, site-specific soil moisture ensemble forecasting based on the Community Land Model Version 5.0 (CLM5) taking the TERENO agricultural research station "Selhausen" in western Germany as an example. CLM5 simulates vegetation states, carbon and nitrogen pools prognostically. We compare land surface model prediction quality (e.g., soil moisture, crop yield) with and without weather forecasts and with and without near real-time soil moisture data assimilation. Climatological mean time series and 10-day ensemble weather forecasts from the German Weather Service, aggregated to the grid cell, are the atmospheric forcings in simulating future states. Forecasts start from the states of the last simulation time step with on-site measurements of precipitation, wind speed, air temperature, air pressure, relative humidity, and global radiation as the atmospheric forcings. In parallel with forward simulations from 2011-2021 (open loop experiment), soil moisture assimilation is being performed for 2018-2021 to generate site-specific initial conditions for the land surface model with reduced uncertainty. Forecasts starting from initial conditions based on soil moisture assimilation are more reliable as model bias is reduced. Preliminary results show that the inclusion of site-specific weather forecast uncertainties in the model improves the simulation of soil moisture dynamics at the plot scale and is thus important for optimizing irrigation schedules while keeping crop productivity stable.