Operational Irrigation Scheduling for Citrus Trees with Soil Moisture Data Assimilation and Weather Forecast

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Agricultural areas in the Mediterranean are expected to face more drought stress in the future due to climate change and human activities. Irrigation scheduling is necessary to allocate the optimal water amount at the right time period to avoid unnecessary water losses. An operational data assimilation framework was set-up to combine model predictions and soil moisture measurements in an optimal way for characterizing the soil water status of the root zone. Irrigation amounts for the next days are optimized on the basis of the soil water status of the root zone and meteorological ensemble predictions. In these experiments, the uncertainties of atmospheric forcings and soil properties were considered. The uncertain model forcings were taken from an ensemble of weather forecasts by ECMWF, and delivered by MeteoFrance in this project. The improved soil moisture profile was used to calculate the irrigation requirement taking into account the root distribution of citrus trees in the subsurface.

The approach was tested operationally for the experimental site near Picassent, Valencia, Spain. Three fields were irrigated according to our approach in the years 2013 and 2014. Three others were irrigated traditionally, based on FAO-criteria. Soil moisture was measured by FDR probes at 10 cm and 30 cm depth at various fields and these real time data were assimilated by the Local Ensemble Transform Kalman Filter (LETKF) into the Community Land Model (CLM) to improve the estimation of the soil moisture profile. The measured soil moisture was assimilated five times per day before the start of the next drip irrigation. The final results (total amount of irrigated water, stem water potential and citrus production) show that our strategy resulted in significantly less irrigated water compared to the FAO-irrigated fields, but without indications of increased water stress. Soil moisture contents did not decline over time in our approach, stem water potential measurements did not indicate water stress and citrus production was not affected by less irrigation.