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Evaluating expert based irrigation recommendations by the simulation of irrigation water demand in a humid investigation area in Northern Germany with SWAP

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Climate change projections agree in the future rise of temperature, which will increase evapotranspiration and therefore most likely increase the water demand of plants. Saving irrigation water is a key contribution to sustainable water management in agricultural catchments, not only in arid and semi-arid regions but also in humid regions.
The agricultural chamber (Landwirtschaftskammer) of the Federal State of Lower Saxony operates experimental fields in Hamerstorf within the Ilmenau River catchment (Germany), where plant growth and crop yields are investigated for different local crops and for two irrigation control strategies: optimal irrigation and deficit irrigation. Based on these experiments along with the weather forecast and expert knowledge, state-wide recommendations for irrigation are published weekly.
This study compared the expert recommendations with irrigation demand simulated by the model SWAP (Soil, Water, Atmosphere and Plant). The model was calibrated against observed soil moisture (gravimetric) of one plot for the years 2009 and 2010. The local heterogeneity of the soil and the choice of the pedo-transfer function for deriving soil physical parameters were a challenge in calibration. SWAP performed well within the upper 30 cm of the soil profile, but less good in deeper layers. The observed crop yield from the experimental fields was underestimated for most crops by using standard parameters. For the years 2014 to 2016, initial crop parameters failed due to higher observed temperature. The plant growth parameters had to be adjusted beyond published values for Northern Germany.
The seasonal irrigation amount of the experimental fields differed from the model scenario of the expert recommendations by only 7 %. Hence, the validity of the recommendations could be confirmed. The experiments and simulations also showed that deficit irrigation strategies can significantly reduce the irrigation water amount with a small decrease in crop yield, hence improve the irrigation water use efficiency.

Keywords: irrigation control, SWAP, deficit irrigation, soil water model