Crop model data assimilation with the Ensemble Kalman filter for improving regional crop yield forecasts

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Abstract

Uncertainty in spatial and temporal distribution of rainfall in regional crop yield simulations comprises a major fraction of the error on crop model simulation results. In this paper we used an Ensemble Kalman filter (EnKF) to assimilate coarse resolution satellite microwave sensor derived soil moisture estimates (SWI) for correcting errors in the water balance of the WOFOST crop model. Crop model simulations with the EnKF for winter-wheat and grain maize were carried out for Spain, France, Italy and Germany for the period 1992-2000. The results were evaluated on the basis of regression with known crop yield statistics at national and regional level. Moreover, the EnKF filter innovations were analysed to see if any systematic trends could be found that could indicate deficiencies in the WOFOST water balance.

Our results demonstrate that the assimilation of SWI has clearly improved the relationship with crop yield statistics for winter-wheat for the majority of regions (66%) where a relationship could be established. For grain maize the improvement is less evident because improved relationships could only be found for 56% of the regions. We suspect that partial crop irrigation could explain the relatively poor results for grain maize, because irrigation is not included in the model.

Analyses of the filter innovations revealed that normalised innovations are not Gaussian and show spatial and temporal patterns correlations, indicating that the EnKF performs suboptimal. Possible solutions to this problem could be that the initialisation period of the crop water balance should be increased, and that the crop parameter values in the current system should be changed in order to make the crop simulation less drought tolerant.

Conference theme: Data assimilation and integration of remote sensing in dynamic process models

Keywords: crop simulation models, crop yield, regional scale, data assimilation, soil moisture, Ensemble Kalman filter