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Assimilation of LAI time-series in crop production models

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Agriculture is worldwide a large consumer of freshwater, nutrients and land. Spatial explicit agricultural management activities (e.g., fertilization, irrigation) could significantly improve efficiency in resource use. In previous studies and operational applications, remote sensing has shown to be a powerful method for spatio-temporal monitoring of actual crop status. As a next step, yield forecasting by assimilating remote sensing based plant variables in crop production models would improve agricultural decision support both at the farm and field level.
In this study we investigated the potential of remote sensing based Leaf Area Index (LAI) time-series assimilated in the crop production model LINTUL to improve yield forecasting at field level. The effect of assimilation method and amount of assimilated observations was evaluated. The LINTUL-3 crop production model was calibrated and validated for a potato crop on two experimental fields in the south of the Netherlands. A range of data sources (e.g., in-situ soil moisture and weather sensors, destructive crop measurements) was used for calibration of the model for the experimental field in 2010. LAI from cropscan field radiometer measurements and actual LAI measured with the LAI-2000 instrument were used as input for the LAI time-series. The LAI time-series were assimilated in the LINTUL model and validated for a second experimental field on which potatoes were grown in 2011. Yield in 2011 was simulated with an R2 of 0.82 when compared with field measured yield. Furthermore, we analysed the potential of assimilation of LAI into the LINTUL-3 model through the 'updating' assimilation technique. The deviation between measured and simulated yield decreased from 9371 kg/ha to 8729 kg/ha when assimilating weekly LAI measurements in the LINTUL model over the season of 2011. LINTUL-3 furthermore shows the main growth reducing factors, which are useful for farm decision support. The combination of crop models and sensor techniques shows promising results for precision agriculture application and thereby for reduction of the footprint agriculture has on the world's resources.