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Early forecasting of crop condition using an integrative remote sensing method for corn and soybeans in Iowa and Illinois, USA

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The weather-related risks in crop production is not only crucial for farmers but also for market participants and policy makers since securing food supply is an important issue for society. While crop growth condition and phenology are essential information about such risks, the extensive observations on those are often non-existent in many parts of the world. In this study, we have developed a novel integrative approach to remotely sense crop growth condition and phenology at a large scale. For corn and soybeans in Iowa and Illinois of USA (2003-2014), we assessed crop growth condition and crop phenology by EO data and validated it against the United States Department of Agriculture (USDA) National Agriculture Statistics System (NASS) crop statistics. For growth condition, we used two distinguished approaches to acquire crop condition indicators: a process-based crop growth modelling and a satellite NDVI based method. Based on their pixel-wise historic distributions, we determined relative growth conditions and scaled-down to the state-level. For crop phenology, we calculated three crop phenology metrics [i.e. start of season (SOS), end of season (EOS), and peak of season (POS)] at the pixel level from MODIS 8-day Normalized Difference Vegetation Index (NDVI). The estimates were compared with the Crop Progress and Condition (CPC) data of NASS. For the condition, the state-level 10-day estimates showed a moderate agreement (RMSE < 15.0%) and the average accuracy of the normal/bad year classification was well (> 70%). Notably, the condition estimates corresponded to the severe soybeans disease in 2003 and the drought in 2012 for both crops. For the phenology, the average RMSE of the estimates was 8.6 day for the all three metrics. The average |ME| was smaller than 1.0 day after bias correction. The proposed method enables us to evaluate crop growth at any given period and place. Global climate changes are increasing the risk in agricultural production such as long-term drought. We hope that the presented remote sensing method for crop condition and crop phenology contributes to reducing the growing risk of crop production in the Earth.