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Modelling spatial variation of winter wheat growth and yield in response to soil - climate - management interactions across southern Sweden

Elsa Coucheney (1), Karin Blombäck (1), Henrik Eckersten (2), Lena Engström (1), Anders Larsolle (3), Elisabet Lewan (1), Åsa Myrbeck (1), and Bo Stenberg (1)

(1) Swedish University of Agricultural Sciences (SLU), Soil and Environment, Uppsala, Sweden (elsa.coucheney@slu.se), (2) Swedish University of Agricultural Sciences (SLU), Crop Production and Ecology, Uppsala, Sweden, (3) Swedish University of Agricultural Sciences (SLU), Energy and Technology, Uppsala, Sweden

An improved understanding of how soil - climate - management interactions influence the soil functions important for sustainable agriculture is needed to better adapt management practices to contrasting climatic and agronomic conditions. In particular, spatial variation in soil properties has to be taken into account when designing management practices in an optimal way to limit environmental impacts (e.g. leaching of nutrient or pesticides, losses of soil organic carbon) while maintaining high yields.
In this study, we combined both field experiments and process-based soil-plant-atmosphere models to study how and why the response of winter wheat yields to different management practices varied between and within field sites with respect to contrasting soil properties (i.e. soil x climate x management interactions). The aims were to (i) provide data for model calibration under a wide range of soil and agronomic conditions, (ii) use models to explain observed differences in yield by estimating soil functions that were not continuously measured (e.g. water and nutrient dynamics) and (iii) highlight knowledge gaps and data needs to improve model predictions.
Field experiments with winter wheat were conducted (2015-2017) in four major agricultural regions of South Sweden following a fractional factorial design in terms of different management practices, i.e. water, nutrient and pesticide supply, was applied. One treatment using irrigation and high inputs of nutrients and pesticides was applied to estimate the potential attainable wheat yield at each site, i.e. under non-limiting conditions. We found a wide variation in the effects of management practices on crop yield both within and between sites. This emphasizes the importance of adjusting inputs and management to local (within field) conditions. The testing of soil-plant models against such datasets will help improving model concepts and model sensitivity related to different management strategies and thus also supports the development and implementation of appropriate management strategies.
The parameters driving the phenology and crop growth of the models under potential yield conditions (i.e. non-limiting water and nutrient conditions) were first calibrated against observed crop phenology, biomass accumulation and yield under the high input treatment (i.e. potential yield) at each site. Thereafter, the ability of the models to reproduce the observed yields under different managements (limited water and nutrient supply) at the different locations was evaluated. We will present results of calibration and evaluation of two models (CoupModel, STICS) against this dataset.