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Comparison of site sensitivity of crop models using spatially variable field data from Precision Agriculture

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Abstract/Executive summary

Site conditions and soil properties have a strong influence on impacts of climate change on crop production. Vulnerability of crop production to changing climate conditions is highly determined by the ability of the site to buffer periods of adverse climatic situations like water scarcity or excessive rainfall. Therefore, the capability of models to reflect crop responses and water and nutrient dynamics under different site conditions is essential to assess climate impact even on a regional scale. To test and improve sensitivity of models to various site properties such as soil variability and hydrological boundary conditions, spatial variable data sets from precision farming of two fields in Germany and Italy were provided to modellers. For the German 20 ha field soil and management data for 60 grid points for 3 years (2 years wheat, 1 year triticale) were provided. For the Italian field (12 ha) information for 100 grid points were available for three growing seasons of durum wheat. Modellers were asked to run their models using a) the model specific procedure to estimate soil hydraulic properties from texture using their standard procedure and use in step b) fixed values for field capacity and wilting point derived from soil taxonomy. Only the phenology and crop yield of one grid point provided for a basic calibration. In step c) information for all grid points of the first year (yield, soil water and mineral N content for Germany, yield, biomass and LAI for Italy) were provided. First results of five out of twelve participating models are compared against measured state variables analysing their site specific response and consistency across crop and soil variables.

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Introduction

Soils play a relevant role for crop production and determine significantly the impact of climate change on crop growth (Kersebaum and Nendel 2014). Spatial aggregation of soils can have a dominant influence of the outcome of regional yield simulations (Hoffmann et al. 2016). The variability of soil properties within a field often represents most of the variability of a whole landscape (De Wit and van Keulen, 1987) since processes of soil development vary according to almost every spatial and temporal scale. Hence, chemical, physical, and biological soil properties differ greatly even in their small-sale distribution (Pätzold et al., 2008; Selige et al., 2006; Kersebaum et al. 2002; Moore et al., 1993). A proper response of crop models to different site conditions is a pre-requisite for a realistic assessment of climate change impact on a regional scale. However, the possibility to test model outputs on a regional scale is usually limited since especially management data on such a scale are usually not available. Within the framework of precision agriculture spatial variability of soils and their relation to crop growth have been increasingly investigated during the last decade (e.g. Kersebaum et al. 2005). Since such data provide a good opportunity to test the model response on variable site conditions within one field with known management and weather conditions, a model inter-comparison was performed, where 12 modeller groups applied their models on two data sets from precision agriculture.

Methods

Data from two fields from Germany and Italy was provided to twelve modelling groups using in total 8 different crop models. The data sets comprise of measurements at 60 and 100 sampling points during three subsequent growing seasons. They were described in detail already in deliverable report D-C1.1.1. The data set of the German field has been prepared for a data publication and is ready to be supplied to the Open Data Journal (Wallor et al. 2017).

The protocol for the model exercise was also described in deliverable report D-C1.1.1 and will therefore be presented only briefly here. Fig 1a shows the main aggregated texture classes according to the German Soil taxonomy and the grid points for Beckum, Germany. The spatial distribution of soil clay and organic matter and the observation grid points of the site Foggia are shown in Fig. 1b.

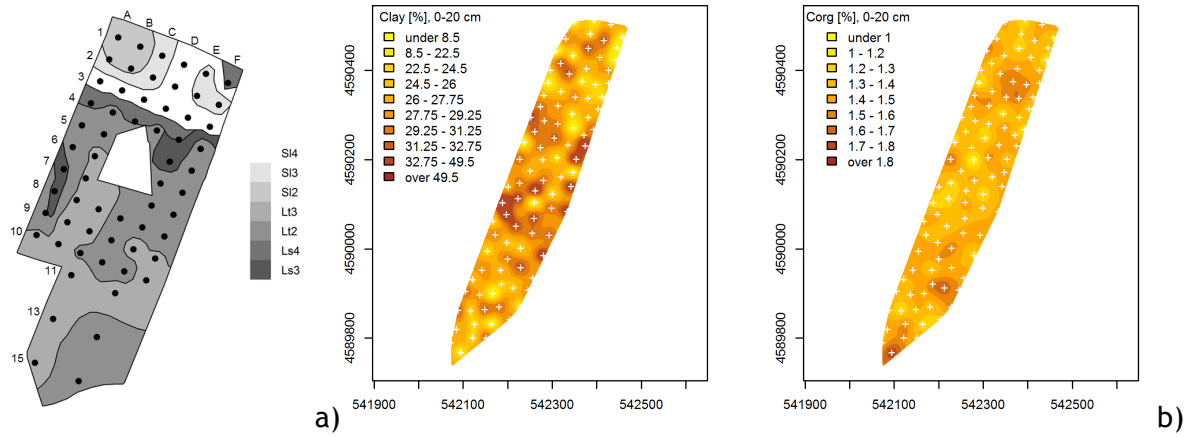

Fig. 1: Spatial distribution of a) texture classes according to German soil taxonomy at Beckum, Germany and b) clay and Corg content of the upper 20 cm at Foggia, Italy.

All simulations should be performed as continuous simulations along the three years of the crop rotation with different levels of calibration. For step (a) we provide only the texture (and estimated stone content) data for the grid points, soil organic matter of the ploughing