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Impact of maize management variability modeled as decision rules on yield and drainage at the regional scale

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MACSUR and AgMIP jointly present the International Crop Modelling Symposium

Crop Modelling for Agriculture and Food Security under Global Change

MACSUR

AgMIP

ABSTRACTS

Editors

Frank Ewert
Kenneth J. Boote
Reimund P. Rötter
Peter Thorburn
Claas Nendel

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Welcome

It is with pleasure that we welcome the international crop and agro-ecosystem modelling community and scientists from related disciplines to the International Crop Modelling Symposium 2016, in Berlin.

The past decade has seen a number of research initiatives launched to advance crop modelling and related research. Among these initiatives, The European Knowledge Hub MACSUR (Modelling European Agriculture with Climate Change for Food Security, http://macsur.eu/) and the international AgMIP project (Agricultural Model Intercomparison and Improvement Project, http://www.agmip.org/) stand out in terms of the breadth of their research scope. A large and important part of the activities in both projects is comprised of the improvement, comparison and application of crop models for climate change impact and risk assessment for food security in Europe (MACSUR) and further (AgMIP). These projects have brought together a large number of scientists from around the world and produced a substantial body of novel results. The international MACSUR symposium on crop modelling in Oslo in 2014 and the annual Global Workshops of AgMIP have provided forums to exchange some of these results and have been initial and important events towards this symposium. The increasing interest from within and beyond the crop modelling community for a more comprehensive forum for the exchange of results ultimately motivated representatives of MACSUR and AgMIP to organise this symposium, reflecting the successful and joint work of both projects including successful interaction with other international networks.

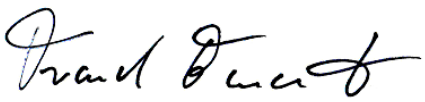
The overwhelming interest in participation in this symposium has exceeded original expectations. From the large number of submitted papers, it was possible to develop what we, the Symposium Chairs, hope is an exciting programme of oral and poster presentations combined with a range of internationally recognised keynote speakers. The workshop structure follows the main activities related to model improvement and model application, as well as anticipating improvements in genetics, and links between crop and related modelling fields such as grassland and vegetation modelling, and

functional structural plant modelling. Accordingly, four sessions have been organised:

- Session 1: Improvement of crop models and modelling approaches
- Session 2: Linking crop models and genetics
- Session 3: Crop modelling for risk/impact assessment
- Session 4: Expanding and supporting modelling activities

The organisation of this symposium was only possible due to the help of several people. Special thanks go to the Session Chairs and the Scientific Committee Members for supporting the development of the symposium programme. We are particularly grateful for the effort of the local host ZALF (Centre for Agricultural Landscape Research) for organising the venue, registration, website and logistics of the programme. The financial and in-kind support from the Research Council of Norway through MACSUR, CSIRO, AgMIP, University of Bonn, Luke and the University of Florida are likewise gratefully acknowledged.

We wish all participants a very fruitful and inspiring symposium and we look forward to the many interesting keynotes, oral and poster presentations. We also hope to have the chance to interact with many of you during the course of the symposium and that the symposium may help to support ongoing and initiate new collaborations to further advance research on crop modelling.



Frank Ewert

On behalf of the Symposium Chairs, Kenneth J Boote, Peter Thorburn and Reimund Rötter, and the local host at ZALF, Claas Nendel.

Abstracts of Keynote Presentations

Impact of maize management variability modeled as decision rules on yield and drainage at the regional scale

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Introduction

Crop model are often applied at large scale to assess the impact of climate change on production for instance. Generally input data for models are not available all over the target area, and average values are often used. For management practices, fixed dates and quantities of inputs are used, whose values correspond to the mean of observed values over the region. However, management is highly variable within a region. The impact of this variability at such scale on model outputs is not well known. We assess the impact of management variability on crop model output at the regional scale for crop yield, water losses and as compared to a fixed management.

Materials and Methods

We selected a region in Germany, North Rhine-Westphalia (NRW), of ~34 000 km², for which we used climate and soil data at 1, 10, 25, 50 and 100 km resolution (Hoffmann et al., 2015) as input to the STICS crop model (Brisson et al., 2003). We simulated silage maize growth in NRW over 30 years (1982-2011), fertilized with nitrogen (N) in 2 dressings of 30 and 208 kg ha^{-1} yr^{-1} using fixed and adapted management dates.
For fixed management, sowing and first N dressing were on April 20th, the second N dressing on June 1st and harvest on September 20th. For adapted management, the sowing and fertilization dates were generated through decision rules independent of the crop model and harvest was simulated by the model. To choose the first possible date for sowing, we calculate the day for which the probability over 30 years to have frost (Temperature <-5°C) is null and the mean temperature in the 5 previous days of the year is above 8 °C. Then based on rainfall (r), we check each day if it rains more than 10 mm and if the soil is not too wet (r < 15 mm in the last 5 days) or too dry (r > 0 mm in the 10 previous days). If conditions are not met before May 10th, we force sowing at this date. For the 2nd N dressing, we calculate crop development stage as a sum of temperature (in base 6) since sowing. Fertilization on maize is often applied between the 6th and the 9th leaf. Considering that 80 °C·d are required for emergence and 45 °C·d for each leaf, we calculate the earliest date for fertilization since sowing. Then, each day, we check if the soil was not too wet and if it rained as for sowing. If these conditions are not reached at the 9th leaf, we forced fertilization.

Results and Discussion

The variability of sowing and fertilization dates was higher for finer than coarser resolutions due to a higher variability of climatic data. It resulted in slightly lower crop yields and higher water whatever the resolution of soil and climate, as compared to fixed dates. The standard deviation was almost the same for fixed and adapted management dates but extreme values were different particularly for drainage with lower minimum and higher maximum for adapted than fixed dates.

Table 1. Mean sowing and fertilization dates (with standard deviation), aboveground biomass and yearly drainage according to soil, climate and management resolution.

Soil x climate x management resolution (km)	Sowing date	2nd N input date	Aboveground biomass (t ha^{-1})	Drainage (mm yr^{-1})
100 x 100 x fixed	20 April	1 June	13.7 ± 5.6	390 ± 152
100 x 100 x 100	19 April ± 6	12 June ± 9	13.1 ± 5.6	398 ± 155
10 x 10 x fixed	20 April	1 June	15.1 ± 5.0	434 ± 216
10 x 10 x 10	17 April ± 11	10 June ± 11	14.2 ± 4.8	447 ± 219

Adapting sowing dates results in earlier sowing in the south-west and extreme north-east of the region and slightly later dates in the south-east. The impact on aboveground biomass of maize was less than 1 t ha^{-1} in average, except in the west where difference reached almost 4 t ha^{-1}. The pattern for drainage is less clear but a general trend of drainage increase with adapted dates appears.

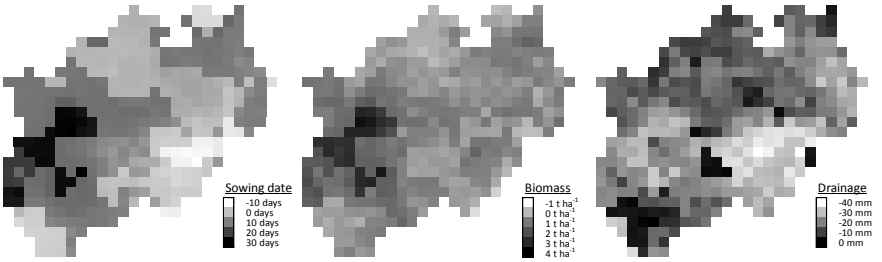

Figure 1. Mean differences over 1982-2011 of fixed and adapted management at 10 km resolution.

Conclusions

These preliminary results underline the interest to better understand the potential impact of using adapted management practices for crop model applications at regional scale. They should be extended to more models to confirm these results and other practices such as choice of crop maturity and nitrogen fertilization amounts.

Acknowledgements

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