CropM WP1– model intercomparison

coordinated by:

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ROTATIONEFFECT

A multi-model comparison focusing on the comparison of simulating crop rotations vs. single year modeling

STEP 1: datasets of Müncheberg & Braunschweig

GOAL & OBJECTIVES

1. to test the validity and sensitivity of crop models towards climate and management
2. to compare the accuracy and performance of models and model ensembles in simulating growth and yield formation (as well as soil water and N dynamics) for a sequence of crops (year-by-year modeling vs. the modeling of the whole rotation, carry-over effects)
3. to identify possible avenues for improving the models' behavior in representing sequences of crops and to extent their spectrum of crops

BACKGROUND

"Crop modeling needs an overhaul" (Rötter et al, 2011)

The main deficiencies in recent crop modeling studies identified by Rötter encompass:

- studies fail to incorporate latest knowledge on crop physiology
- studies fail to quantify model uncertainties
- studies fail to test model performance and sensibility
- studies rarely provide model inter-comparisons

Since then, several activities have been launched to overcome main deficits, such as AgMIP, the agricultural model intercomparison and improvement project. Still, there is few information on the effects/uncertainties when modeling consecutive years of crop growth, including crop rotation.

SITES/DATASETS

Within this model intercomparison study we will concentrate on the six agronomical datasets given in Table 1.

Table 1: Datasets used for model intercomparison

Country	Name of dataset	Treatment	Crops
STEP1			
Germany	Müncheberg	shifted rotation, irrigation	sugar beet, winter wheat, winter barley, winter rye (oil raddish)
Germany	Braunschweig	CO_2, nitrogen	winter barley, ryegrass (catchcrop), sugar beet, winter wheat
STEP2			
Denmark	Foulum	tillage, nitrogen	winter barley, winter oilseed rape, winter wheat, winter barley
Austria	Hirschstetten	soil	grain maize, winter wheat, spring barley, mustard , spring wheat, potatoe
France	Thibie	Nitrogen/ with and without catch crops	Pea, (orchardgrass),winter wheat, (radish), sugar beet, (w.barley), pea, …
Italy		tillage	durum wheat, maize
Czech Republik	Domaninek	sowing date, nitrogen, variety	spring barley, winter wheat, winter oilseed rape

MODELING ACTIVITIES

Within this STEP 1 two datasets will be simulated:

1. Müncheberg dataset

The Müncheberg dataset contains a 6-year crop rotation trial (1992-1998), where on 4 plots the crop sequence is shifted by one year (see description of dataset in separate file) and in each plot a rainfed and an irrigation treatment was conducted. Hence, the modeling exercise will encompass 6-year simulations of **8** sites with identical climate, but differing crops and treatment.

For the Müncheberg dataset we provide the following information within the attached Excel files:

- a dataset describing the soil on the plots
- dates and amounts of irrigation, fertilization and tillage
- phenology (date of emergence)
- crop yields for 1 out of the 8 data sets for calibration
- details on the cultivation (e.g. sowing/harvest dates)
- initial variables (water content, mineral soil N) at the beginning of the rotation
- daily climate data

2. Braunschweig dataset

The Braunschweig data set provides data of a FACE experiment with 2 x 3-year C_3 crop rotation under ambient (374 ppm) and elevated (550 ppm) CO_2 concentration with high and low N fertilization (see description of dataset in separate file). Hence, the modeling will encompass 6-year simulations for **4** sites with identical crops, but differing CO_2 concentration and N-fertilisation.

For the Braunschweig dataset we provide the following information within the attached Excel files:

- a soil profile for the plots
- dates and amounts of irrigation, fertilization and tillage
- phenology (date of emergence)
- crop yields for 3 out of 6 years (1 year per crop) for calibration
- details on cultivations
- initial variables (water content, mineral soil N) at the beginning of the rotation
- daily climate data

3. Steps to come

- STEP 1b: modelers will be asked to re-calculate the single-year-simulation with additional information given: For both, the Müncheberg dataset and the Braunschweig dataset we will provide the initial values (water content and mineral soil N) for each year.
- STEP 2a: the next datasets with 4 new sites will be provided to the modelers
- STEP 2b. similar to 1b (recalculation of STEP 2a data with yearly initial values)

- STEP 3: data of climate scenarios will be provided to the modelers (second paper)
- we will compare simulated with observed state variables for each crop based on results from STEPs 1 and 2
- modeling approaches that best represent and poorly represent a) single crops b) the whole crop rotation will be identified
- avenues for improving the models´ behavior in representing sequences of crops and to extent their spectrum of crops will be explored

Table 2. Schedule of the study ROTATIONEFFECT.

Date	Person	Action
28 May	Kollas	Workplan finalized and circulated
30 July	Kollas	STEP1a: dataset Müncheberg and Braunschweig distributed
30 Aug	Kollas	STEP2a: datasets Foulum, Italy, Hirschstetten, Domaninek, Thibie distributed
a.s.a.p., not later than Oct. 15.	**All**	**Results of STEP1a and STEP2a sent to Kollas**
when results of STEP 1a and 2a arrived	Kollas	Yearly Initial values distributed for re-calculation (STEP 1b/2b)
1 Nov	**All**	**Simulation results of STEP1b/2b sent to Kollas**
1 Nov	Kollas	Climate scenarios for all sites are distributed (STEP 3)
15 Dec	All	Results of STEP 3 sent to Kollas
31 Dec	All	Supply a brief description for each model. These information will be incorporated into the publication (e.g. supplementary). We will provide a table for organizing these information.
31 Jan	Kollas	Presentation of results and draft publication, just before the Oslo meeting

We recommend to send the results of STEP 1a and 2a as early as possible. Receiving these results, we will instantly send the data (initial values) for STEPS 1b and 2b to you, early enough to complete all simulations until the deadline.

INSTRUCTIONS for the 1st activity, Müncheberg dataset

1) According to the models capability, we want it to simulate both:
   a) the **whole** crop rotation (with given initial conditions at the beginning of the rotation. Note, simulations of a part of the rotation are not regarded here)

   AND

   b) crop growth for single years (with the modelers individual assumptions on initial moisture and N concentration based on e.g. previous crop management)

   (if the model is capable of part b) only, please sent the results of b)

2) Use 370 ppm CO2 concentration for this experiment
3) Please calibrate your model on the first treatment of the dataset (see Table 5)
4) Next, set up and run the simulations for all of the 8 treatments.
5) The following data on the experiment is supplied in the files *CropM_model_input_muencheberg_1* to C*ropM_model_input_muencheberg_8*: soil profile, management (tillage, irrigation and fertilization), phenology, cultivation, initial conditions (first year: water content, mineral soil N) and crop and fertilizer codes. Additionally, for the first treatment total biomass at harvest is provided for calibration.
6) The supplied weather information (*CropM_muencheberg_weather.txt*) is identical for all 8 treatments.
7) Once the simulation runs have been completed, please save the results into the two template sheets:
   The first sheet *"Summary-template_CropM_Rotationeffect_STEP1.txt"* contains summary information at the time of harvest (e.g. final grain yield).
   The second sheet *"Daily_Template_CropMRotationeffect_STEP1.txt" contains* the daily outputs (daily results either for the whole rotation (sowing 1st crop to maturity last crop), or for single crops from sowing to maturity).
   For each sheet, please insert in the first column your model name using the 2-LETTER Model Code from Table 3. Then, for each variable add the results you have simulated. If your model does not simulate one of the outputs leave "na" in there. Please make sure that your outputs match the UNITS given in the third row of the output file.
   These two output files must be generated for each of the 8 treatments.
   (for descriptions of output variables see ROTATIONEFFECT_model_output_description.xlsx)
8) Please save the resulting files into "TAB" limited text files.
9) Rename the resulting text files in the following way:
   - For daily output files
     a) whole rotation: one file for each treatment (**total of 8 files**)
        AND
     b) crops in single year simulations (**total of 8 treatments x number of selected crops**)):

ModelCodeSitetreatment numberrotationDAY.txt.

The Model Code is provided in Table 3
The Site code is provided in Table 4
The Treatment number is provided in Table 5
The Rotation code is provided in Table 7

For instance, the resulted text file of daily outputs of the DSSAT model simulating "treatment 1" of the Müncheberg dataset as a single year simulation in 1995 (harvest year) should be named DSMU01S1995DAY.txt. Results of the simulation of the whole rotation of "treatment 1" should be named DSMU01RDAY.txt

- For the summary output file:
  a) whole rotation (total of **8 files** including all treatments)
  AND
  b) crops in single year rotations (**total of 8 treatments x number of selected crops**)

  ModelCodeSitetreatment numberrotationYEAR.txt

  (e.g. the text file of summary results of the DSSAT model simulating the full rotation of Müncheberg dataset," treatment 1" should be named DSMU01RYEAR.txt)

10) Please return your result files (for Müncheberg dataset):
    8 files with daily outputs plus 8 files with annual outputs), together with the signed "Participant Agreement" (last page of this document)
    as soon as possible to Chris Kollas by email [chris.kollas@zalf.de], with cc to Christian Kersebaum [ckersebaum@zalf.de].
11) Once we got your results we will provide initial values (soil moisture and Nmin) for each year and ask you to re-calculate the single year simulations. **Deadline Nov. 1st .**

INSTRUCTIONS for the 1st activity, Braunschweig dataset

1) According to the models capability, we want it to simulate both (if possible):
   a) the **whole** crop rotations (with given initial conditions at the beginning of the rotation. Note, simulations of a part of the roation are not regarded here)

   AND

   b) crop growth for single years (with the modelers individual assumptions on initial moisture and N concentration based on e.g. previous crop management)

   (if the model is capable of part b) only, please sent the results of b)

2) Please calibrate your model on the first 4 crops (years 1999-2002).
3) Next, set up and run simulations for the 4 treatments for all years.

4) The following data on the experiment is supplied in the file *CropM_model_input_braunschweig_1* to C*ropM_model_input_braunschweig_4:* soil property, soil profile, management (tillage, irrigation and fertilization), phenology , cultivation, initial soil conditions (first year: water content, mineral soil N) and crop and fertilizer codes.
5) The supplied weather information (*CropM_braunschweig_weather.csv*) is identical in all 4 treatments.
6) Once the simulation runs have been completed, please save the results into the two template sheets:
   The first sheet *"Summary-template_CropM_Rotationeffect_STEP1.txt"* contains summary information at the time of harvest (e.g. final grain yield).
   The second sheet *"Daily_Template_CropMRotationeffect_STEP1.txt" contains* the daily outputs (daily results either for the whole rotation (sowing 1st crop to maturity last crop), or for single crops from sowing to maturity).
   For each sheet, please insert in the first column your model name using the 2-LETTER Model Code from Table 3. Then, for each variable add the results you have simulated. If your model does not simulate one of the outputs leave "na" in there. Please make sure that your outputs match the UNITS given in the third row of the output file.These two output files must be generated for each of the 4 treatments.
   (for descriptions of output variables see ROTATIONEFFECT_model_output_description.xlsx)
7) Please save the resulting files into "TAB" limited text files.
8) Rename the resulting text files in the following way:
   - For daily output files:
     a) whole rotation: one file for each treatment (**total of 4 files**)
        AND
     b) crops in single year simulations (**total of 4 treatments x selected crops**):)):

ModelCodeSitetreatment numberrotationDAY.txt.

Model Code provided in Table 3
Site code provided in Table 4
Treatment number provided in Table 6
Rotation code provided in Table 7

For instance, the resulted text file of daily outputs of the DSSAT model simulating "treatment 1" of the Braunschweig dataset as a single year simulation in 1995 (harvest year) should be named DSBR01S1995DAY.txt. Results of the simulation of the whole rotation of "treatment 1" should be named DSBR01RDAY

- For the summary output file:
  a) whole rotation (total of **4 files** including all treatments)
  AND
  b) crops in single year rotations (**total of 4 treatments x selected crops**)

  ModelCodeSitetreatment numberrotationYEAR.txt.
  (e.g. the text file of summary result of the DSSAT model simulating the full rotation of Braunschweig dataset, "treatment 1" should be named DSBR01RYEAR.txt)

9) Please return your result files (for Braunschweig dataset):
   4 files with daily outputs plus 4 files with annual outputs **as soon as possible** to Chris Kollas by email [chris.kollas@zalf.de], with cc to Christian Kersebaum [ckersebaum@zalf.de].
10) Once we get your results we will provide initial values (soil moisture and Nmin) for each year and ask you to re-calculate the single year simulations. **Deadline: Nov. 1st.**

Table 3: List of participating models

Contact name	Crop Model	2-letter model code
M. Trnka	DSSAT 4.6	**DS**
C. Kersebaum	HERMES	**HE**
C. Nendel	MONICA	**MO**
P. Martre	SiriusQuality	**SQ**
C. Müller	LPJml	**LP**
R. Ferrise	Cropsyst	**CR**
R.Rötter, T. Palosuo	WOFOST	**WO**
I. Lorite	AQUACROP	**AQ**
C. Hernandez	CROPSYST	**CS**
J. Olesen	Daisy	**DA**
J. Olesen	FASSET	**FA**
D. Ventrella	DSSAT	**DT**
L. Wu	SPACSYS	**SP**
H. Eckersten	MAISPROQ	**MA**
H. Eckersten	COUP	**CO**
M. Wegehenkel	Theseus/Opus/Hydrus	**TH**
J. Minet	CARAIB	**CA**

Table 4: Sites

Site	Site code
Foulum	FO
Müncheberg	MU
Braunschweig	BR
Hirschstetten	HI
Italy	IT
Domaninek	DO

Table 5: List of treatments **Müncheberg** dataset

Treatment	Treatment number	Comment
1st rotation, rainfed	01	
1st rotation, irrigated	02	
2nd rotation, rainfed	03	
2nd rotation, irrigated	04	
3rd rotation, rainfed	05	
3rd rotation, irrigated	06	
4th rotation, rainfed	07	
4th rotation, irrigated	08	

Table 6: List of treatments **Braunschweig** dataset

Treatment	Treatment	Comment

	number
low CO_2, low N	01
low CO_2, high N	02
high CO_2, low N	03
high CO_2, high N	04

Table 7: Rotations and single years ("R" for whole rotation simulation and "S"+ year (YYYY) for single year simulation)

Rotation/single year	**Rotation code**
Full rotation	R
Simulation of 1st year Müncheberg dataset	S1995
Simulation of 2nd year Müncheberg dataset	S1996

Appendix1. Participant's Agreement on data handling:

Modeller agreement

User of the data provided for the MACSUR model inter-comparison and improvement (WP1 CropM) agree to follow the below mentioned rules to respect the intellectual properties of data providers and the limitations set by the MACSUR WP 1 coordinators by their signature below this agreement.

Herewith, I agree

- to abide by the request of the specific data providers regarding their selected limitations and requirements for citation and publication
- not to distribute data or parts of it without permission of the data provider and WP1 coordinators
- to accept the temporal limitations given by the MACSUR Consortium Agreement or the data provider to present or publish data and model results based on data provided for the model inter-comparison and improvement exercises
- that all future simulation results of model exercises/inter-comparisons within the MACSUR model inter-comparison will belong to the group of participants as a whole and must not be used, distributed, presented or published in any individual or selected study within the time limit defined by the MACSUR Consortium Agreement or the data provider.
- that presentations and publications of outcome from the MACSUR model inter-comparison exercises will be led by the coordinators of the MACSUR model inter-comparison study and coordinated through the MACSUR task coordinators and must acknowledge each individual contribution via co-authorship.
- that data providers will be given the opportunity to participate as partners in scientific project proposals if their data contribute essentially to the research planed.

Place, Date, Signature:

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