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## Multicriteria evaluation of the stics soil-crop model and implementation of an automated evaluation system

Samuel Buis, Elsa Coucheney, Marie Launay, Patrice Lecharpentier, Bruno Mary, Dominique Ripoche, Nicolas Beaudoin, Francoise Ruget, Inaki Garcia de Cortazar Atauri, Eric Justes, et al.

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15-17 March 2016, Berlin, Germany

iCROPM<sub>2016</sub>



MACSUR and AgMIP jointly present the International Crop Modelling Symposium  
**Crop Modelling for Agriculture and Food Security  
under Global Change**



**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.

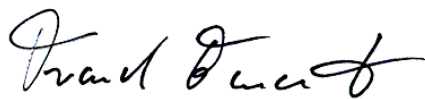
The overwhelming interest in participation in this symposium has exceeded original expectations. From the large number of submitted papers, it was possible to develop what we, the Symposium Chairs, hope is an exciting programme of oral and poster presentations combined with a range of internationally 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.

International Crop Modelling Symposium **iCROPM<sub>2016</sub>** 15-17 March 2016, Berlin

# **Abstracts of Keynote Presentations**

## **Multicriteria evaluation of the stics soil-crop model and implementation of an automated evaluation system**

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### **Introduction**

The STICS soil-crop model version 8.2.2 with its standard set of parameters has been evaluated with multiple complementary methods over a large dataset covering 15 crops and a wide range of agropedoclimatic conditions in France (Coucheney et al., 2015). An automatic evaluation system has been built following this work for a continuous monitoring of the model performances in parallel with its development.

### **Materials and Methods**

STICS is a soil-crop model which has been developed at INRA since 1996 (Brisson et al., 2009) and which software and documentation are freely available on the web at [http://www6.paca.inra.fr/stics\\_eng](http://www6.paca.inra.fr/stics_eng). It was conceived as a generic model able to adapt to various kind of crops and environmental conditions.

The dataset contains a total of 1809 simulation units covering 76 sites during the 1978-2009 period (440 site.years) and the main French crops (cereals, oilseeds and legume species, catch crops, forages, perennial crops), climatic areas, soils and agronomic practices. Situations which had been used in past studies to calibrate the value of one or several plant parameters provided with the standard version of the model were identified (one third of the total number).

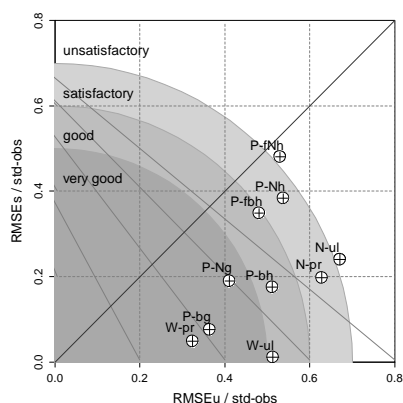
Evaluation method combined accuracy, robustness and behavioral analyses. Model accuracy was evaluated by computing multiple complementary statistical criteria (RMSEs, RMSEu, EF, R<sup>2</sup>, ...). To evaluate the model robustness we proposed to analyze the sensitivity of residuals to the crop type and to selected agro-pedoclimatic indicators with variance analysis technics.

### **Results and Discussion**

Model results showed a good overall accuracy, with little bias. Relative RMSE was larger for soil nitrate (49%) than for plant biomass (35%) and plant nitrogen content (33%) and smallest for soil water (10%). Performances for most variables lay in the very good to satisfactory range according to the boundaries defined by Moriasi et al.,



(2007) (Fig. 1). Observed trends induced by contrasted environmental conditions and management practices (N fertilization and irrigation mainly) were shown to be well reproduced by the model and robustness analysis showed limited dependency of model errors to crop type and environment.



*Figure 1.* Graphical decomposition of model RMSE between unsystematic (u) and systematic (s) contributions, for several outputs: plant variables at harvest (P-bh: aerial biomass in t ha<sup>-1</sup>, P-Nh: N in the plant in kg ha<sup>-1</sup>, P-fbh: fruit biomass in t ha<sup>-1</sup> and P-fNh: N content in fruits in % odb), plant variables along the growing season (P-bg: aerial biomass in t ha<sup>-1</sup>, P-Ng: N in the plant in kg ha<sup>-1</sup>), soil water and nitrate variables in the upper layer and in the soil profile respectively (W-l1: water content in g g<sup>-1</sup>, W-pr: water amount in mm, N-l1 and N-pr: nitrate amount in kg ha<sup>-1</sup>).

Following this work, a continuous integration system was built using Jenkins (<http://jenkins-ci.org/>) to link SVN-based version control system of the model sources and parameters, the evaluation dataset and R functions of test and performance evaluation. Each time the STICS source code or parameter values are modified in the SVN repository, test and evaluation procedures are now automatically performed.

### Conclusions

Measured accuracies were similar to what was found in literature for other crop models evaluated on smaller datasets and generally with calibration steps. The combination of good level of accuracy and robustness makes STICS a valuable tool for studying the effects of changes in agro-ecosystems over the domain explored. The automatic evaluation system will allow preserving and enhancing performances and robustness of future versions of the model and associated parameters.

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