Simulations of greenhouse gas emissions and soil organic carbon with ECOSSE for a rice field in Northern Italy

Kuhnert, M.[1,*] ; Viktoria Oliver[1], Andrea Volante[2], Stefano Monaco[2], Yit Arn Teh[3]; Smith, P.[1]

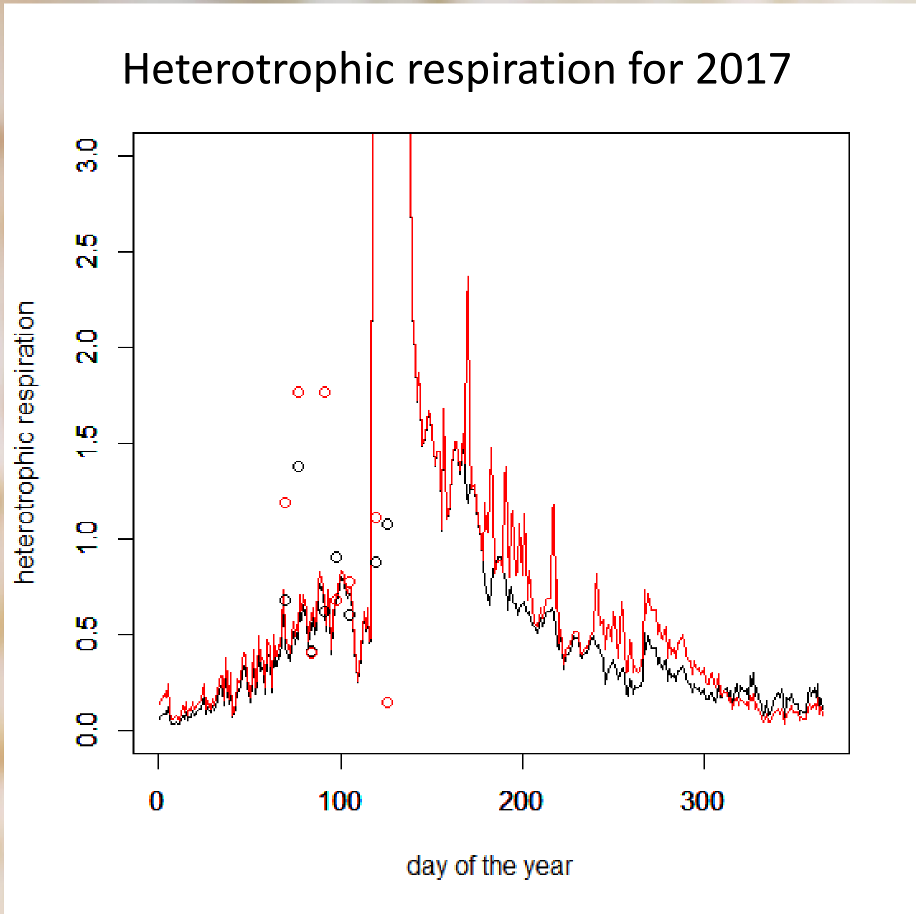
[1] Institute of Biological & Environmental Sciences, University of Aberdeen, UK; [2] Consiglio per la Ricerca in Agricoltura e l'analisi dell'Economia Agraria (CREA), Italy; [3] School of Natural and Environmental Sciences, Newcastle University, UK.

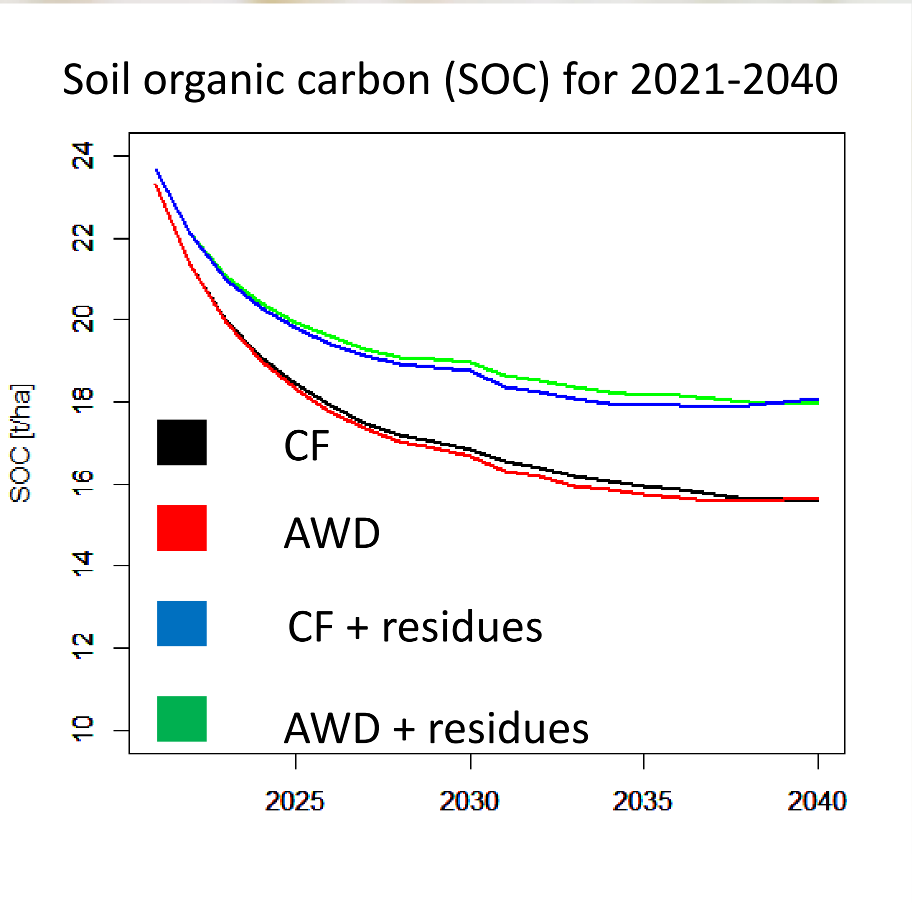
** matthias.kuhnert@abdn.ac.uk*

The Green Rice Project

SUMMARY

Model simulations of a European rice site with the biogeochemical model ECOSSE. The model is calibrated and evaluated by measurements and used for future estimates of SOC.





Objective

- Calibrate and evaluate the biogeochemical model ECOSSE for the experimental sites
- Analyse the differences between continuous flooding (CF) and alternated wetting and drying (AWD)
- Analyse long term impacts on SOC (2021-2040)

Study Site

The study site is situated in the Po River Valley in Northern Italy. The fields are under rice cultivation for more than 30 years. The average annual temperature is about 23°C with an average precipitation of about 1300 mm.

Table 1: List of baseline and scenarios. The management options that are measured are indicated with a star. Fertilizer and manure values are given in kg N ha^{-1}.

management	Baseline*	Scenario 1*	Scenario 2	Scenario 3
tillage	yes	yes	yes	yes
fertilizer	19 + 57	19 + 57	19 + 57	19 + 57
manure	no	no	no	no
Water management	Continuous flooding	Alternated wetting & drying	Continuous flooding	Alternated wetting & drying
residues	no	no	yes	yes

Experimental Design

AWD block 1		
Baldo	Gageron	Gines
Vialone	Arelate	JSendra
Selenio	Puntal	Gleva
Centauro	Loto	Prometeo

CF block 1		
Arelate	J. Sendra	Gleva
Vialone	Puntal	Gageron
Baldo	Centauro	Selenio
Loto	Gines	Prometeo

CF Block 2		
Puntal	Gageron	J. Sendra
Centauro	Gines	Vialone
Selenio	Prometeo	Baldo
Gleva	Arelate	Loto

AWD block 2		
Gleva	Arelate	Centauro
Selenio	Vialone	Gageron
J. Sendra	Puntal	Loto
Prometeo	Gines	Baldo

AWD Block 3		
Baldo	J. Sendra	Puntal
Gageron	Gleva	Gines
Vialone	Selenio	Loto
Prometeo	Arelate	Centauro

CF block 3		
Gageron	Loto	Vialone
Puntal	Gines	Selenio
Prometeo	Gleva	J. Sendra
Arelate	Centauro	Baldo

CF block 4		
Centauro	Baldo	J. Sendra
Loto	Vialone	Selenio
Gageron	Arelate	Gines
Gleva	Puntal	Prometeo

AWD block 4		
J. Sendra	Selenio	Centauro
Gines	Puntal	Prometeo
Gleva	Gageron	Baldo
Vialone	Arelate	Loto

Figure 1: Experimental design:

- 12 varieties
- 4 replicates
- Two water treatments (continuous flooding (CT) and alternated wetting and drying (AWD))
- One season (2017)
- Two fertilizer applications

Results – test for relevance

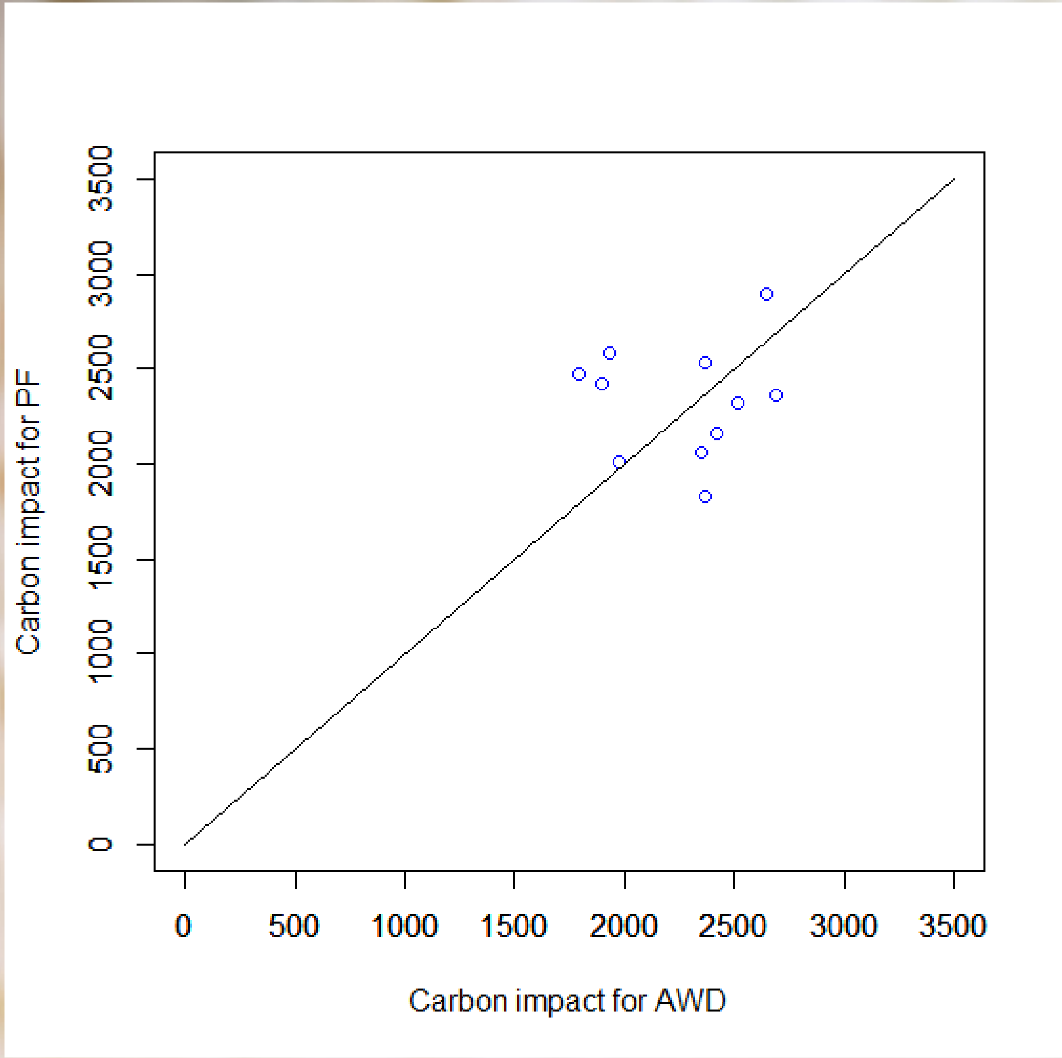
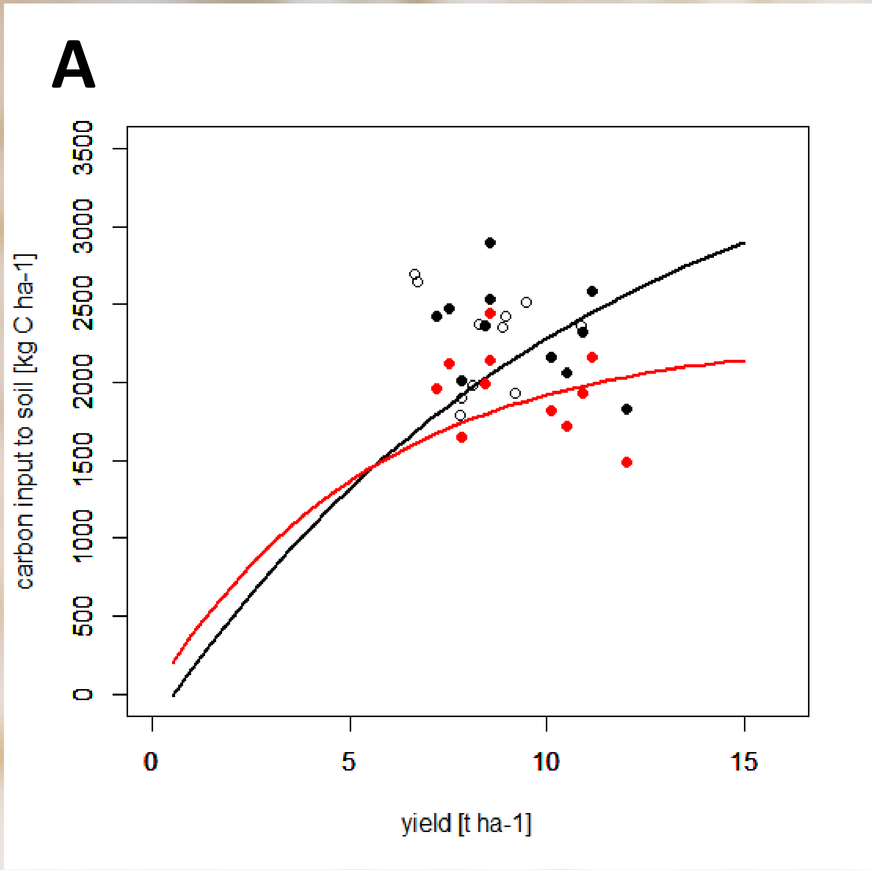
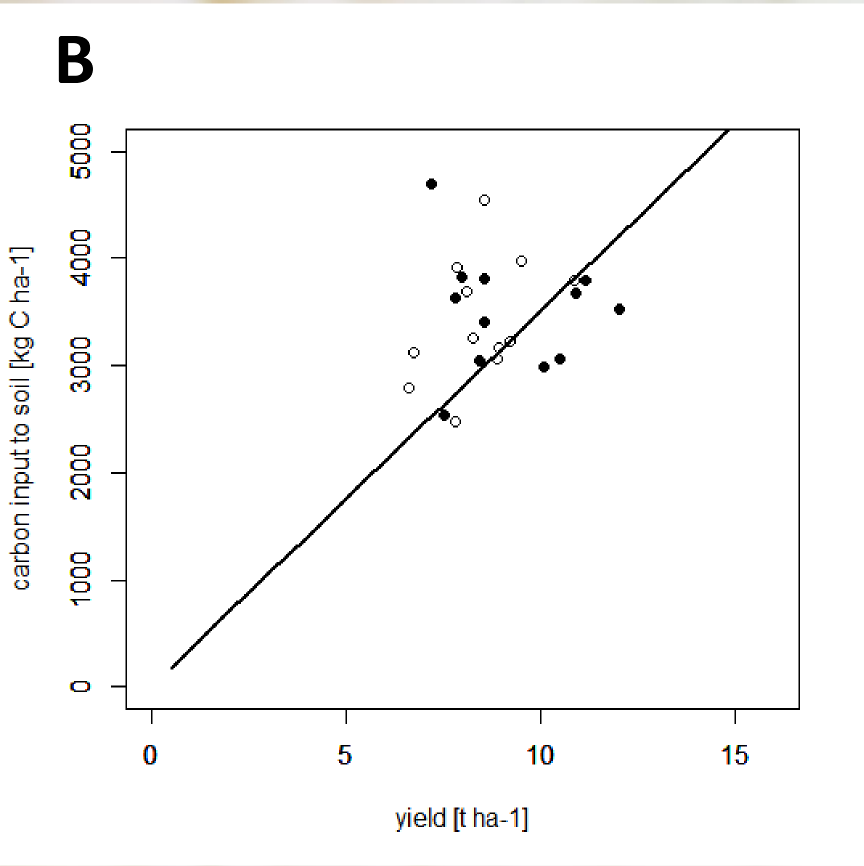


Figure 2: ECOSSE does not simulate plant growth, but derives the carbon input based on the yield. This figure here shows the data for the plant carbon input into the soil for the PF and the AWD plots (these are measurements, no model results). The data are aggregated as the data for calibration. The results show an error or uncertainty, but no bias.

Results - Calibration

Figure 3: Calibration of the model for total plant carbon input to soil (A: black dots (measurement) and line (model), carbon input by stubbles and roots (A: red) and carbon input by straw (B).





Results – evaluation RH

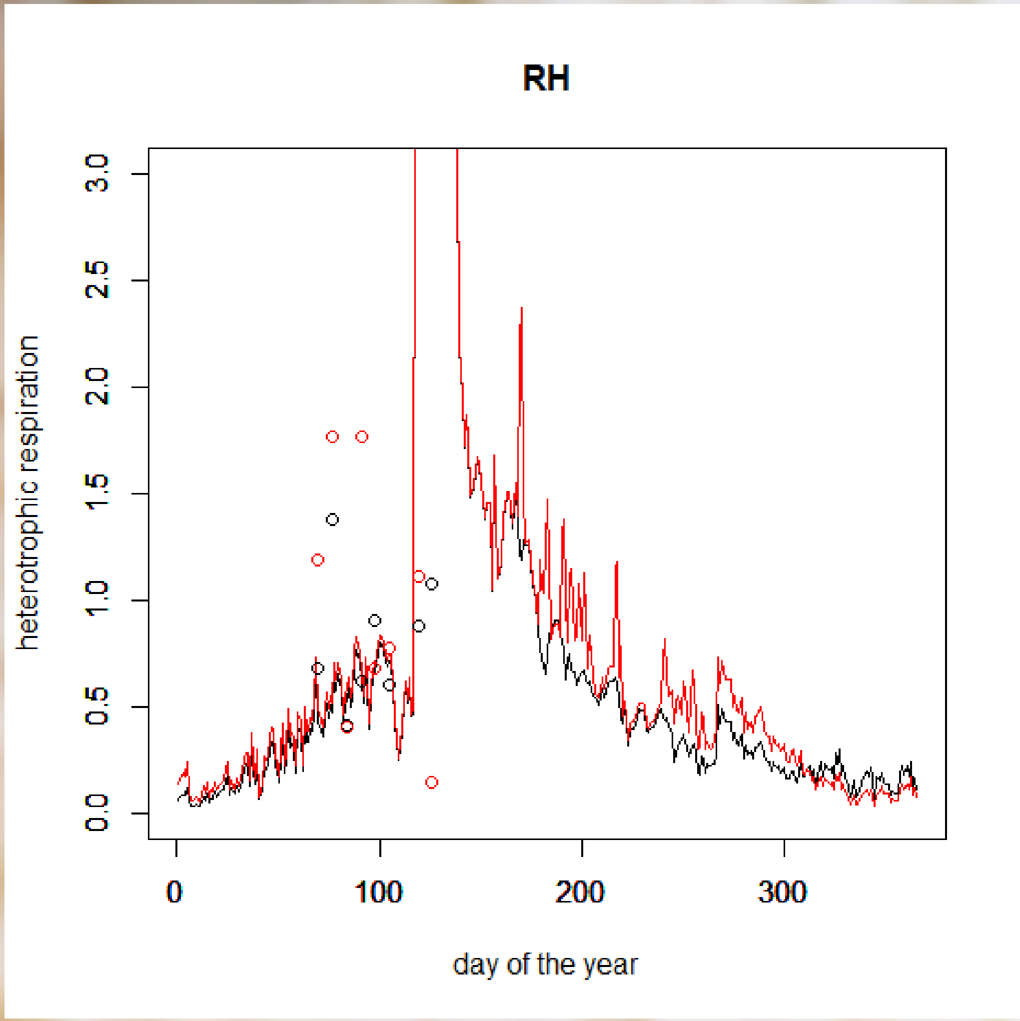


Figure 4: Measured (dots) and modelled (line) heterotrophic respiration (RH) for 2017.

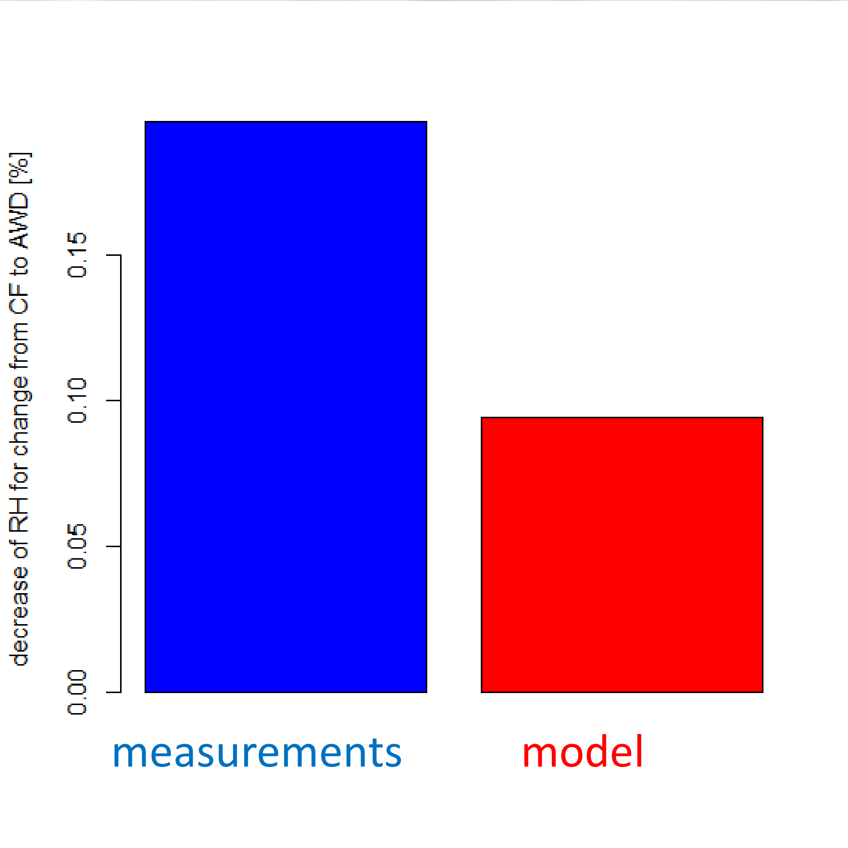


Figure 5: Relative decrease of heterotrophic respiration for change from CF to AWD. The measurements contain 8 values, while the model one year (365 values).

Results – SOC (2021-2040)

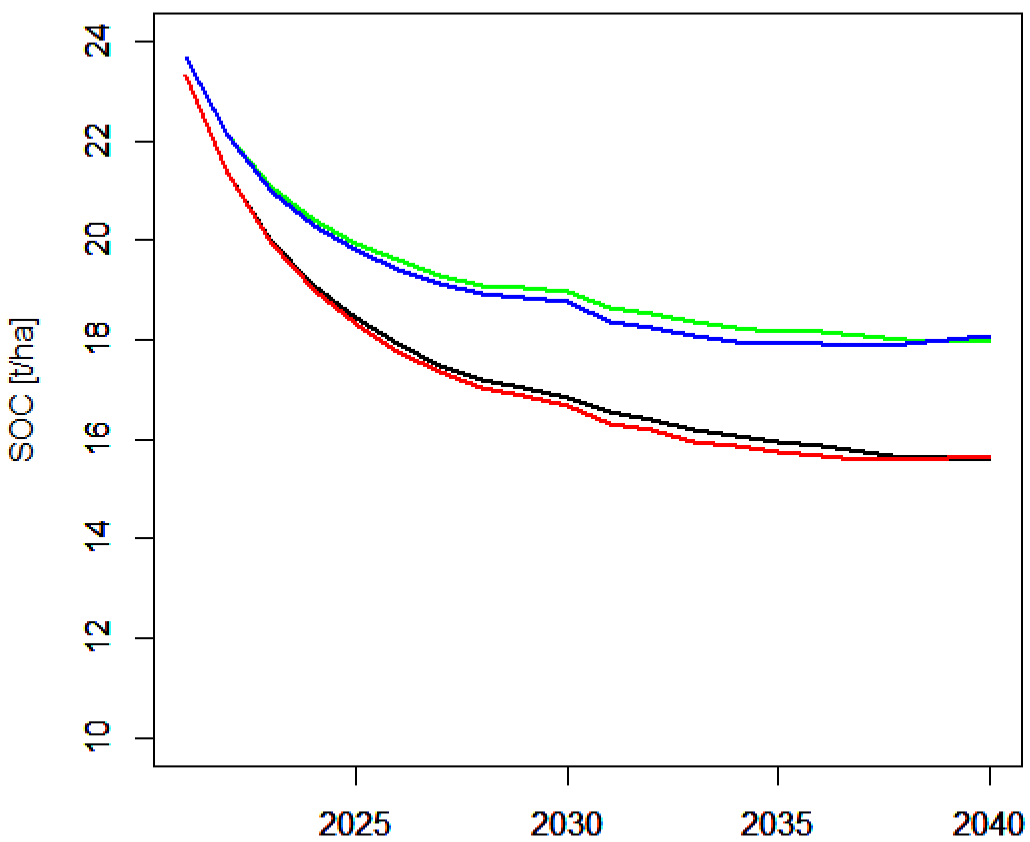


Figure : SOC for the period 2021-2040. There are only minor differences of the impacts for the different water treatments. By leaving the residues on the field the SOC will be 2 tons higher than without this treatment after 20 years.

- Baseline
- Scenario 1
- Scenario 2
- Scenario 3

Discussion

- Very good model calibration and evaluation for heterotrophic respiration.
- Despite differences in the respiration only small impacts on long term SOC for CF and AWD treatment
- Leaving residues on the field increases SOC over 20 year period, but with two tons the impact is relative small.

Questions to: matthias.kuhnert@abdn.ac.uk

Measurements in:

Oliver, V., Cochrane, N., Magnusson, J., Brachi, E., Monaco, S., Volante, A., Courtois, B., Vale, G., Price, A., The, Y.A. (2019). Effects of water management and cultivar on carbon dynamics, plant productivity and biomass allocation in European rice systems. Science of the Total Environment 685 (2019) 1139–1151