Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2019-85-RC2, 2019

Geoscientific Model Development Discussions

Interactive comment on "Developing a sequential cropping capability in the JULESvn5.2 land–surface model" *by* Camilla Mathison et al.

Anonymous Referee #2

Received and published: 18 June 2019

General comments

The manuscript submitted by Mathison et al. presents the development of a new functionality within the JULES land-surface model enabling at accounting for several crops in one growing season (ie sequential cropping capability). This is certainly a functionality that will contribute at better representing the phenology and the water and energy fluxes and other related variables in areas of the World where multicropping is commonly applied. The motivations behind this development are rather well adressed in the Introduction section. However, the manuscript lacks of key significant objectives and the rest of the manuscript strongly suffers of this absence.

Currently, the manuscript presents the results of this new version at two locations: 1) a super-site in France (Avignon) where long-term measurements of canopy height, lai,

above ground biomass, carbon (GPP) and energy (latent and sensible heat) fluxes are available. Simulated variables are compared to in-situ data for this set of fluxes and biometric variables. In addition, GPP, LE and H fluxes simulated with the version including the sequential cropping functionality are compared to those obtained with a version in which lai and the canopy height are prescribed from in-situ observations; 2) a set of four Indian "points" where the model is ran with sequential cropping of wheat and rice. Modelled annual yields over these four points are compared to two observation-based yield estimates and the model evolution for an extended set of variables (lai, carbon pools, LE, H, NPP, GPP, soil moisture, dvi, canopy height, maintenance respiration, plant respiration) is shown for these four points.

As presented in the manuscript, the objective of the paper appears to be the development of the sequential cropping functionality and the results presented in the manuscript are mainly a set of model outputs for a suite of variables showing that the objective has been achieved (by producing two cycles for LAI, canopy height, gpp, ... within a year). The development of the sequential cropping is a functionality helping at addressing scientific questions. In this respect, although being a Technical and Development Paper, the manuscript really needs more challenging scientific objectives. Currently, due to the lack of appropriate scientific evaluation of the sequential cropping functionality (and of its added value), I would not support the publication of the manuscript in its present form.

A general question to address could be "what's the added value of representing the sequential cropping on a given variable or process?". The variables and/or the scale to focus on should be chosen adequately, as it is sure that looking at LAI at site-level can only lead to the conclusion that the version with the sequential cropping performs better than a version with only one crop per year, for a site where sequential cropping is applied. Addressing that type of question would need the provision of simulations with a model configuration without the sequential cropping (ie with only one crop growing within a year), to be used as a reference. The authors mention page 29 line 15

that they plan using this sequential cropping method for regional simulations ("these regional simulations will be the focus of work that follows this paper"). I would strongly encourage the authors to include these regional simulations in the present study. Performing such regional simulations for present-day conditions, with and without the sequential cropping (ie with only one of the two crops grown within a year) would enable to investigate the impact of the sequential cropping on the vegetation intensity and the soil moisture at regional scale and to directly compare these modelled variables with observation-based data provided by remote-sensed products (LAI (or fPAR) and soil moisture from satellite sensors such as MODIS or GRACE for instance). This could be performed on the studied region of North India.

Still aiming at assessing the added value of representing the sequential cropping, another key objective could be to quantify the effect of considering a crop on a given crop period (instead of bare soil) on the consecutive crop period in terms of yield or soil moisture content (typically what is the lag effect of a crop development ?). For instance, on the four Indian points, do you improve the model predictability in terms of yield during the periods where wheat is grown when considering rice/wheat rotations (sequential cropping) compared to simulations with only wheat periods (and bare soil during the periods where rice is grown). The same for rice yield assuming bare soil instead of wheat development. You may use the same simulation set-up for looking at the impact on the model predictability for soil moisture at regional scale (see above).

Specific comments

- The manuscript presents the development of a sequential cropping capability in the JULES model. The authors define the sequential cropping as the cultivation of two or more crops on the same field in a given year (page 2 line 20). Later, the results of this new version are shown on a site in France (Avignon) where sorghum and wheat are grown. Page 7 line 1, it is written that sorghum is grown in summer and winter wheat in winter. I don't think this is correct. Winter wheat is sown in winter but grows over the spring up to early summer, while sorghum is sown in spring and grows up to late

summer (see figure 3). In this respect, Avignon is not a site where sequential cropping is applied but rather a site with the rotation of two crops (sorghum and wheat) over two consecutive years. This should be clarified in the manuscript. Although I have no doubt that Avignon is a super site where a huge set of measurements are performed, I don't clearly see the gain of applying JULES on this site when evaluating the sequential cropping functionality as it is not strictly speaking a site where sequential cropping is practiced. The motivations for using that site mentioned by the authors are "to illustrate that the new sequential cropping functionality in JULES can simulate more than one crop within a year and reproduce the correct growing seasons for each crop" (Page 8 line 9). In the results section it is also mentioned that "the aim of presenting this simulation is to demonstrate the method rather than provide a perfect representation of either of these crops" (Page 16 line 9). These objectives could be achieved by performing model simulations elsewhere than in Avignon, in regions where sequential cropping is commonly applied (like the region of India you focus on in the manuscript for instance). Also, about the model simulations performed for the Avignon site, I don't clearly understand the need/interest of the AviJUL-grass simulation which is driven by observations for LAI and the canopy height.

- Some figures would need some improvements. Especially, avoid the repetition of a same information in any sub-panel of a same figure. This is the case on Figure 3, Figure 4, Figure 5 about the location (Avignon). You can simply mention once at the top of the figure that it is for Avignon (or only in the Figure legend). The same with "India Points" for Figures 6, 10, 11, B2, B3, ... There are also redundancies between the information on the top of some subpanels and the information on the y-axis legend : on Figure 3 (total above ground biomass, LAI, canopy height), on Figure 4, Figure 5, Figure 6, ... Please specify one information at only a single location in one panel. On the other hand, there is information missing about variable units on Figure 4. Units of GPP, Latent heat flux and sensible heat flux are not specified at any place in the figure and not in the figure legend. The same on Figure 5 for "available moisture".

Technical comments

Page 3 line 11: Maybe explain what are the kharif and rabi seasons as they are quite specific terms.

Page 5 line 20: Define DVI before to use it.

Page 7 line 7: “between models”. Which models do you refer to ?

Page 7 line 19: “The simulations are divided ...”. Please, rephrase: The description of the simulations is divided ....

Page 7 line 19: “Section 4.1 applies the method...”. Please, rephrase: Section 4.1 presents how the method is applied...”

Page 7 line 23: Please define PFT before to use it.

Page 7 lines 26 to 30: Provide units to the variables and parameters used (vcmax, neff, nl, mu_rl, mu_sl) and a more physiological meaning to them.

Table 2: Could you clarify the value of 1 for Q10. Does it mean that Vcmax is insensitive to temperature ?

Page 8 line 16: Could you clarify the use of a spring wheat parametrization to represent the C3 winter wheat crop at Avignon. Especially regarding what is mentioned later for India Simulations Page 8 line 33 (the wheat varieties grown in this region are spring wheat, this is an important distinction as spring wheat does not require a vernalization period which is important for winter wheat varieties. Does the wheat variety sown in Avignon in winter need a vernalization period or not ?

Page 9 line 7: Map (b) in Figure 2

Page 10 line 23: include measurements of soil moisture

Page 10 line 31: Citations need parenthesis.

Page 11 line 24: The sentence “For 2008 and 2012...” has the same meaning than the

previous sentence.

From Page 11 line 28 to Page 12 line 1: Should be put in the Methods section

Page 13 line 4 (and table 6): Provide units to the values of RMSE and Bias

From Page 16 line 1 to Page 17 line 6: This paragraph should be moved to the Discussion or Conclusion sections.

Figure 7: When comparing harvested biomass from JULES to the two observation-based estimates, I think that it would be more suitable to present the model/data comparisons with scatter plots. It will better highlight the model capacity at simulating observed interannual variability than using time-series.

Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2019-85, 2019.