

Author Responses to Reviewer 2 Comments on “Calibrating soybean parameters in JULES5.0 from the US-Ne2/3 FLUXNET sites and the SoyFACE-O3 experiment” by Leung et al., (Manuscript ID: gmd-2020-97-RC1)

Our point-by-point responses are provided below. The referees’ comments are *italicized*, the texts from the manuscript are in blue and our new/modified text is highlighted in **bold**. The revised manuscript with tracked changes is also included in the linked file below for the Editor’s easy reference:

Response to Reviewer #2

We thank the reviewer for the complement and helpful comments. The paper has been revised accordingly to address the reviewer’s concerns point by point, and all changes are cited and discussed in the responses below.

Could crop rotation and irrigation vs. rainfed issues affect the tuning parameters? Introduction and discussion on this are necessary for readers unfamiliar with the sites and the tuning process. In the tuning process, seems like 2002 and 2004 (and 2006 and 2008?) are picked for tuning, why are these years selected? Is it because of data availability or other reasons? Please clarify.

No, crop rotation and irrigation would not affect the tuning. We only simulated the years where soybean is grown. Maize grown in the odd years (2003, 2005 etc.) are not included in our tuning. JULES could simulate irrigation and refed and represent them well. Examples of JULES-crop representing irrigated and rainfed tunings can be found in Williams et al., (2017) Evaluation of JULES-crop performance against site observations of irrigated maize from Mead, Nebraska.

The years 2004, 2006 and 2008 are picked because these are the years which soybeans are grown. I have clarified it in L104

We first tuned the JULES-crop soybean parameterisation at the US-Ne2 and US-Ne3 Mead sites, where three years of soybean physiological and meteorological observations were available, at ambient ozone (Figure 1, steps 1-5). **The three years are 2004, 2006 and 2008 which soybeans were grown in Mead, maize were grown in other years.**

Section 2.1 description is too short. Could it be extended by two or more sentences with more details in the main manuscript?

Yes, I agree that it is a bit too short. I have now extended it on L123

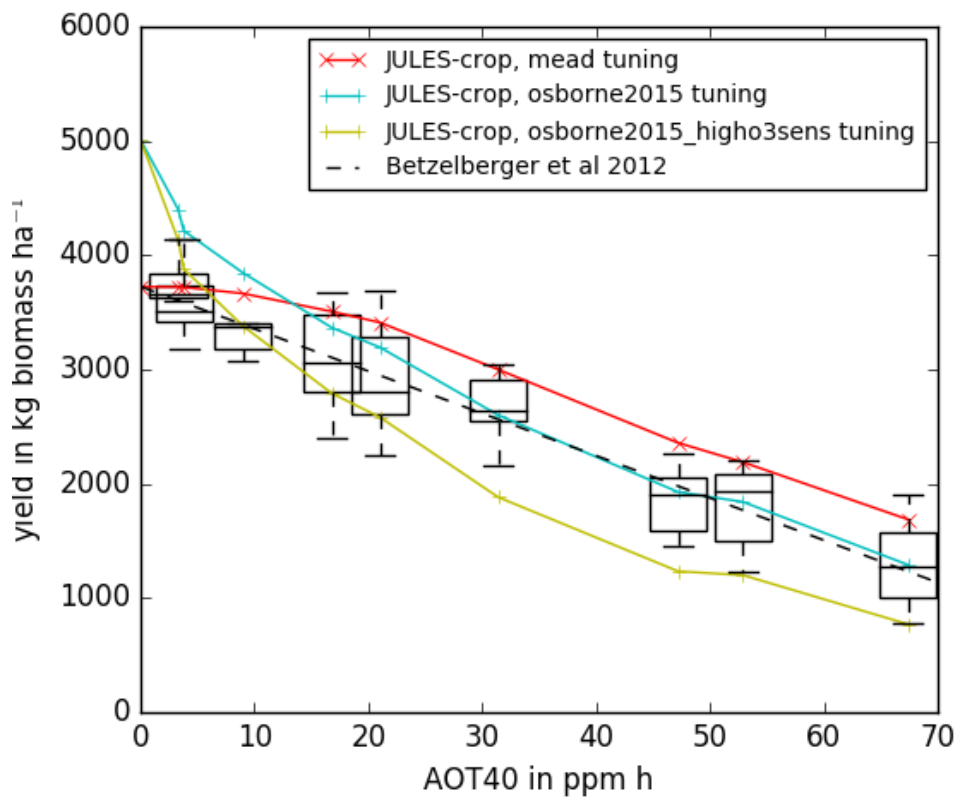
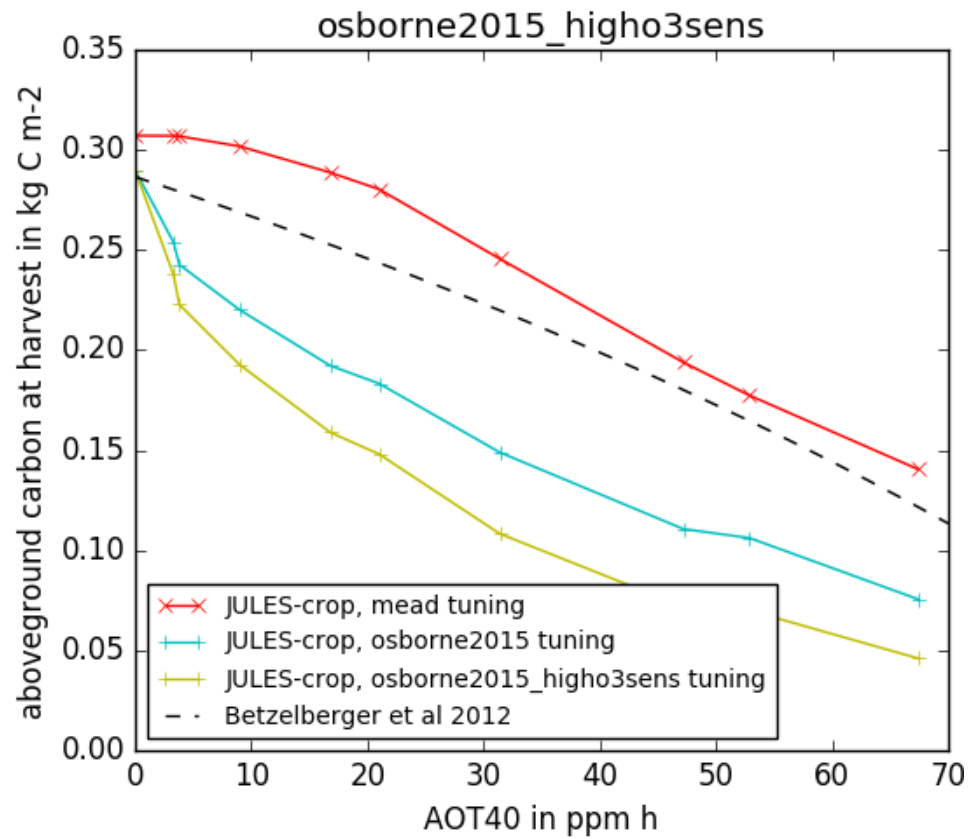
Step 1 involved using Mead observation to tune the parameters needed by all PFTs in JULES with the crop model switched off. Step 2 is to evaluate the model

performance of GPP using Mead meteorology and LAI. Step 3 tunes the parameters needed by crop only. Step 4 evaluated the JULES-crop run performance with observed carbon pools in leaf, stem, harvest etc. Step 5 demonstrated the full JULES-crop runs at Mead using Mead meteorology and compared the model with observed GPP, aboveground carbon etc. Step 6 tune ozone damage using SoyFACE LiCOR measurements. And finally step 7 evaluates JULES-crop performance using SoyFACE meteorology and compare with observed yield and LAI.

Figure 3, 4 and Section 3 include the major results of this manuscript, which is the evaluation of aboveground carbon and yield against SoyFACE observations and previous model results, and the new, calibrated run underestimates ozone impact significantly at most of the ozone levels. Authors argue that this is due to underestimation of water stress in the model and some testing has been done. Could authors make some assumptions about water stress (like $p_0=0$ mentioned) and include the results in Figure 3 and 4?

Yes, for the p_0 value, we used the FAO document 56 (Allen and Pereira, 2006) which used the value $p_0=0.5$ and I showed it in Table 3. I have now showed the results of $p_0=0$ in Supplementary instead to avoid confusion. L262 is now updated

We tested the sensitivity to this choice by re-running this configuration with $fsmc_p_0=0$ which represents water stressed conditions, and this caused a 12% reduction in aboveground carbon (plots show in Supplementary).



Supplementary Figure that shows p0=0 reduce the approximately 12% of the aboveground carbon and yield compared to Figure 3 and 4.

Figure 5, could these figures be condensed into 9 panels or fewer instead of 27? So that three sets of model runs could be compared against each other. Results and discussion around Figure 5 could be easier to comprehend if they are compared side to side.

Yes, you are right. I have condensed them into 9 panels, with each model set in different colours for easier comparison.

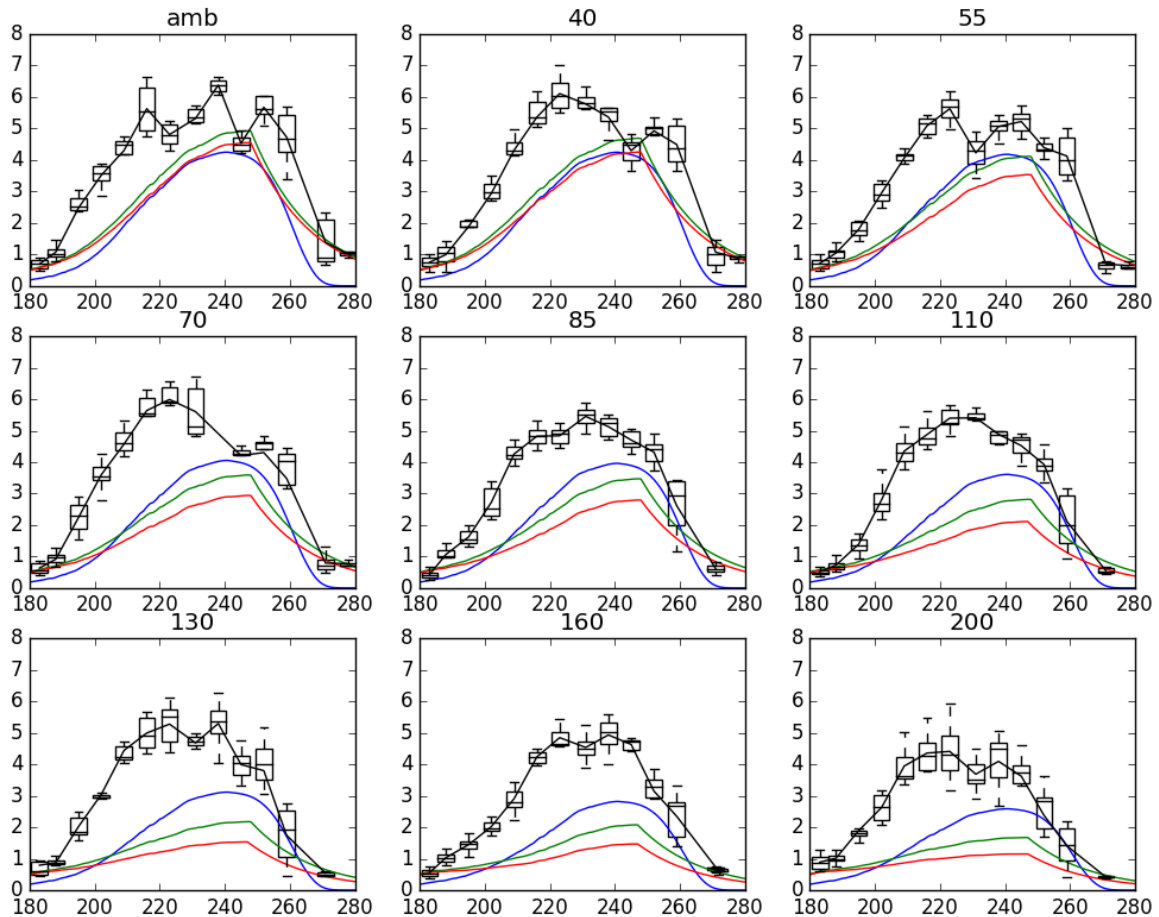


Figure 5 Time series of Leaf Area Index (LAI) responses on different target ozone concentration at SoyFACE. Black line is observed LAI from Betzelberger et al., (2012) and the other lines are JULES-crop LAI with different tunings. Blue: calibrated JULES-crop using Mead observations. Green: Osborne 2015 tuning with low sensitivity. Red: Osborne 2015 tuning with high sensitivity to ozone.

Line 138, please include definition of daytime hours.

It is 12 hours between 0700 to 1900. It is now changed in L146

The integral is taken over daytime hours between 0700 to 1900

Line 183, linear -> linearly

Line 183, photosynthetic rate A , if A will not be used in the manuscript, don't include it.

Thanks, it is now changed in L191

...Given that g_l and photosynthetic rate are **linearly** related [Cox et al., 1999], g_l is given by...

Line 189, '(dfp_dcuo_io)' is this used later? If not, don't include it.

It is now changed in L196

Fractional reduction of photosynthesis with the instantaneous uptake of O_3 by leaves (mmol m^{-2}) determines the sensitivity of soybean to O_3

Line 173 and line 194, what is this F ? is it the same as f in equation 2, 3 and 6. I am confused. Line 193-195 doesn't make sense to me.

Sorry for the confusions. I have change the letter F to be capital letter to make it consistent. Please check L194

$$g_l = g_p F \quad (6)$$

Where g_p is the leaf conductance in the absence of O_3 effects. The set of equations (3,5,6) produces a quadratic relationship as a function of F , that can be solved analytically (Sitch et al., 2007).

Line 191, should be "... the threshold ozone flux above which ozone would cause damage to ..."

Thanks for spotting the mistake. It is now changed in L196

Fractional reduction of photosynthesis with the instantaneous uptake of O_3 by leaves (mmol m^{-2}) determines the sensitivity of soybean to O_3 and the PFT-specific O_3 critical level ($FO_3 \text{ crit}$) determines the threshold O_3 flux **above** which would cause damage to photosynthesis (Oliver et al., 2018; Sitch et al., 2007).

Line 246, Section 3.1 is not necessary if there is not Sect. 3.2, 3.3, ... and next section should be Section 4, instead of 5. Numbering in Sect. 2 has some issues too, please correct them.

Thanks. I have corrected the numbering in section 2. And I have deleted the title of section 3.1. Please see L254

Results from JULES runs with crop model and ozone damage turned on are showed in Figure 3 and 4.

Simulation names: "Mead tuning", "Osborne 2015 tuning" and "Oseborne 2015 higho3sens tuning" in the figures and in the main text. Could these names be shortened and renamed?

Yes, it is now shortened to "mead", "Osborne 2015", "high O_3 sen"

Supplementary Figure S1-1, S1-2, S3-2, S3-3 and S3-5, image quality is low (S1-1, low resolution), and presentation is not quite clear. Vertical and diagonal crosses are difficult to differentiate. Caption for Figure S1-2, should be 'Figure S1-1' instead of 'Figure 10'.

Thanks for the comments. We have plotted a higher resolution images in PDF format, I will attached it separately. And the caption for Figure S1-2 is changed in L44

Colours show the cosine for the zenith angle (for legend, see **Figure S1-1**). Solid black line indicates $a = 1$.

Figure 4 caption: "... according to Table 4 and Figure 8." There is no Figure 8.

Thanks. Figure 4 caption is now changed in L524

The red line and crosses are the tuned parameters with Mead FLUXNET observation and SoyFACE ozone damage according to **Table 4**.

Figure 3 title unnecessary. Titles and axis labels in other figures are also messy, these need to be fixed for readers to follow.

Sorry about that, I have fixed Figure 3.

Should Figure A2 be included in the supplements instead of the main manuscript? I don't see the necessity of having appendix and supplements at the same time.

Yes, I agree. I have put the appendix in the supplementary materials.