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Title: Development of a winter wheat model in the Community Land Model  
(version 4.5)

### General remarks:

The paper contributes to on an interesting and important question: How to improve wheat growth models for a better prediction of future global grain production? For this purpose the paper addresses in particular the question how to better simulate leaf area growth of winter wheat. It reports on the update of an existing crop growth model to the actual state of the art of describing vernalization, frost tolerance and damage, and on an improved parametrisation of carbon allocation to leaf and stem. The improved model is tested considering data sets from four different sites and up to six different winter seasons for each site across the USA representing different climatic conditions.

Generally I have difficulties to understand the focus of the paper: Is it the test of the proposed model update by comparison with data on frost impact on winter wheat growth and carbon allocation at the plot scale (fig.2-4) , or is it a general comparison with simulation results between the old (CLM4.5) and the new (CLM5.0) model at the US wide scale(fig.6-7) to show improvements?:

In the abstract the authors promise a validation of the updated model, but in my view the data sets for testing the simulation of leaf development (as dependent on vernalization and frost) are not sufficient to evaluate the presented algorithms of process descriptions (eq. 1-12): Although figures (fig.2) show for the sites US-ARM and US-PON improved LAI simulations, it is difficult to understand why this is the case: It should be carefully analysed if the improvement is based on a now more adequate description of frost damage/tolerance and/or on a more accurate description/parametrisation of carbon allocation to the leaves. Also, it is not clear to me if the test is performed using independent data sets which are not used for model parametrisation (in respect to both LAI and yield data): It would be helpful for the reader if the authors clearly indicate which data are used for model parametrisation and which data for model testing.

In summary, the paper could be considerably improved, if the proposed model update (eq. 1-12) is tested by data that are directly related to the underlying model mechanisms, i.e. by data on vernalization, frost damage and frost tolerance and by data on carbon allocation to leaves, stems and roots. Since both the model update and the allocation scheme are not new and the coupling of crop growth models to land surface models such as CLM has been successfully achieved already by different research groups, the paper would gain scientific value by a more thorough test.

In conclusion, the paper needs a total revision to ensure that the objective is met, i.e. of assessing the value of a more detailed description to improve model application at field and regional scale studies. In its present form the paper should not be published (see also special remarks).

## Special remarks:

p=page, l=line

- p=3 l=93 : Is the model you use for update the same as the AgroIBIS model?  
If not, which are the differences?  
l=106 : Please insert the year: ... Levis et al. (2012) ...  
l=107 : "has never been validated": at which scale?  
was the the AgroIBIS never tested?  
l=136 : Williams and Torn (2015) is not in the list of references.
- p=4 l=142 : Are there data on possible frost damage included?
- p=5 l=165-166 : Are these algorithms used in parallel?  
l=172 : Why are exactly these depths considered?
- p=7 l=242 : ...  $LT_{50}$  ...  
l=274 : ...  $LT_{50}$  ...
- p=8 l=310 : ... be likely to suffer as much from ...
- p=9 l=336 : ... the approach resulted in a rapid decline of ...
- p=10 l=361 : Was this performed for both models in the same way?  
l=278 : How long is a longer time?
- p=11 l=404 : Was this really achieved by better simulation of vernalization  
and frost damage?
- p=12 fig.2 : Why are there no error bars for CLMBASE?  
Was the lower observed LAI due to frost damage?  
Did you simulate some damage?
- p=13 l=458-461 : Legend of fig.3: "CLMCWHE" is this another model  
or is this a typo?
- p=14 l=498-500 : But now you may underestimate spring evaporation  
as strongly as you overestimated in later months.  
Please discuss in the discussion section.  
Moreover, observed times of LAI peaks are the same as LE peaks,  
at both sites, where you have observations!  
Therefore, I don't understand l=498-500.
- p=15 l=515 : bu/ac? Please use SI units throughout the paper.
- p=17 fig.6 : Could you compare with CLMBASE simulation?  
Is there an improvement compared to CLMBASE  
simulations and compared to US yield statistics?
- p=18 l=581-582 : Is this really an improvement, if you don't know that you simulate  
the processes correctly? In my view you should have compared  
with observed data to justify such a statement.
- p=19 l=617 : (Williams and Torn ... Please insert bracket and year of publication.  
l=636 : There is overestimation for US-ARM and US-PON, see fig.5  
Please correct your sentence: tends to underestimate  
US national average.