

General comments:

I reviewed the manuscript “Representing winter wheat in the Community Land Model (version 4.5)” drafted by Lu et al. The main contribution of this paper is improving the winter wheat representation in CLM, by modifying the vernalization, frost damage, and carbon allocation scheme etc. In general, the model structure and function is explained clearly, but some concerns should be clarified further, including:

1. what is the nitrogen limitation effect on the winter wheat growth and grain yield? Do you consider it? If not, please expand this part a little bit more.

We clarified this at line 434-444:

“We applied the nitrogen fertilization in all the simulations. CLM4.5 considered the nitrogen limitation through the down regulation of the potential photosynthesis based on the nitrogen demand and supply deficit, which was calculated by considering the complex below ground biogeochemical processes (e.g., nitrification, denitrification, leaching, soil organic matter decomposition). When nitrogen supply is less than the nitrogen demand, the potential photosynthesis will be reduced by the deficit factor. For the TXLU, KSMA, NESAs, NDMA, and ABLE site simulations, we applied the observed nitrogen fertilization amount (10-20 gN/m²) at the same days as the observation. While for the other sites and the US simulations, we applied the default nitrogen fertilization during leaf emergence every year for an amount of 8gN/m². With these nitrogen fertilization, there are no nitrogen limitation at all our simulations.”

2. I notice that your model generally overestimate the LAI for all simulations on TXLU, KSMA, NESAs, NDMA, ABLE, especially at the latter of growing season, but it simulate well at US-ARM. Can you explain a little bit more about it? Nitrogen? Or you do not have leaf senescence process in your model?

Such overestimation is due to the leaf senescence rate is too low. CLM considered the leaf senescence in the later growing season when crop enters the grain fill period. The US-ARM site actually showed a similar overestimation for the later growing season LAI. Such overestimation was averaged out for the monthly average plot (Figure 3a). An improvement plan is actually taken place to fix such problem. We pointed out such deficiency at line 475-477:

“Besides these improvements, we also observed an overestimation of LAI during the later growing season, which is due to the low leaf senescence rate during the grain fill period.”

3. where do you get the key equations for improving the winter wheat representation? I did not see the exact literatures for most of those equations?

The equation 1 to 10 were directly adopted from literature without any modifications. Specifically, equation 1 to 3 are from equation 2-5 in Streck et al., 2003. Equation 4-8 are from equation 1-5 in Bergjor et al., 2008. Equation 9-10 are from equation 1-2 in Vico et al., 2014. While equation 11 to 12 are our own empirical frost damage functions.

Vico, G., Hurry, V., and Weih, M.: Snowed in for survival: Quantifying the risk of winter damage to overwintering field crops in northern temperate latitudes, *Agr Forest Meteorol*, 197, 65-75, 2014.

Streck, N. A., Weiss, A., and Baenziger, P. S.: A generalized vernalization response function for winter wheat, *Agron J*, 95, 155-159, 2003.

Bergjord, A. K., Bonesmo, H., and Skjelvag, A. O.: Modelling the course of frost tolerance in winter wheat I. Model development, *Eur J Agron*, 28, 321-330, 2008.

Please also see my specific comments below. Specific comments

Line 19, is this module a new one? Or you just modify some specific processes on this module? If so, I suggested to change this sentence to one like “ We modified xxx or adapted xxx ”

We changed the sentence to “We modified the winter wheat model..”

Line 21, use the subscript

Modified.

Line 28, add some numeric evidence, such as how much reduction in RMSE? Line 30, to what extent does it underestimate winter wheat yield?

We added the numeric evidence for the two statements.

“reduced latent heat flux and net ecosystem exchange RMSE by 41% and 35% during the spring growing season.”

“historically greater yields by 35%.”

Line 54, literature? Line 59, literature?

We added Chouard (1960) for vernalization process at line 54, and updated the literature at line 59.

Line 173, there is no irrigation, right? I am not sure which sites do you finally use to validate your model, all or just some of them? You mentioned that there is nitrogen and irrigation experiment on these sites, but finally you select seven site-years rainfed plots. It is not clear.

We validated to all the five sites at rainfed years only. We pointed the site-year at line 173-174:

“For our validations, we only validated to seven site-year rainfed plots, which are TXLU-1985&1986, KSMA-1985, NESAs-1985&1986, NDMA-1986, and ABLE-1986.”

Line 204, what is the threshold of the maximum daily increment? Line 206, literature is needed.

The maximum daily increment is 26°day . We added Levis et al., 2012 to line 206.

Line 211, what is the planting depth for seeds? Line 235-248, literature?

CLM don't simulate the exact planting depth for seeds. We use the top two-layer soil temperature as a general estimation for the soil temperature that might affect seed germination. The equations at line 235-248 are from Streck et al., 2003, which has been added at line 220.

Line 252, you mentioned that the VF affects the grain filling with same extent to growth. But the VF is effective during leaf emergence to flowering. As far as I know the grain filling starts after flowering. How does it affect grain filling, by heading? Please clarify it.

VF was calculated from leaf emergence to flowering, but will affect the whole growing season through its impact on growing degree days. If VF is less than 1 (not fully vernalized), then $\text{GDD}_{\text{plant}}$ and grain carbon allocation coefficient will be both low, which will extend the leaf emerge period and reduce dry matter allocation to grain yield.

Line 465, to what extent?

We added: “RMSE was reduced by 19% and index of agreement was increased by 45%.”

L505, generally, there is energy closure problem at EC observations, and do you figure out the problem in LE?

The energy imbalance in EC system may resulted a lower observed LE. The ARM site has about 25% energy imbalance, but it will not affect our major conclusion: the simulated LAI peak not resulted a LE peak.

Line 586, do you compare your model simulation with observations from only rainfed regions or all winter wheat regions? I suggest to compare your model results with that from rainfed regions.

Yes, we only compared to USDA non-irrigated winter wheat yield.