Report for “Integration of nitrogen dynamics into the Noah-MP land model v1.1 for climate and environmental predictions”

The main task of this paper is to improve the N cycling processes represented in large-scale land surface model Noah-MP by integrating necessary processes in FUN for plant N uptake and fixation and processes in SWAT for soil N cycling. Such effort can lead to new contribution to improvement of the land surface modeling, especially for N cycle application and is of great importance to model community of climate, environment as well as biosphere.

My main concern is as following:

1. There may be systematic error in soil moisture modelling in your updated Noah-MP. As I noticed that the model generally overestimated and underestimated the soil moisture at low- and high-soil moisture cases, respectively, despite the observed outliers. Another issue in soil moisture modelling is that the tillage did not change the water dynamics in soil. However, you stated that you considered the redistribution of N in the submodel (SWAT). The question is how is the redistribution of N represented in SWAT? Does not it couple to soil water dynamics in SWAT or to other processes? You should explain this point a little bit more!
2. The effectiveness of this mode for a large-scale application. Since this model is only evaluated on one site in LTER of USA, I worry about the large-scale performance of this model. Yes, I know that the observations for N cycle components are generally limited. But I still wonder if you can get a more realistic result of NPP or NEE at other sites spanning a great climate gradient, for example, comparing to the default Noah-MP. One valuable point for your model is that the new Noah-MP model seemingly produce a more realistic interannual variation of NPP comparing to observation, whereas the default Noah-MP failed. This could be due mainly to the effects of dynamic N cycling together with the soil dynamics. I suggest to perform your model to some other sites spanning a great climate gradient to see whether you can get an improved estimation of NPP/NEE (as well as the IAV) comparing to the default one. This can partly verify that your model can be applied on a larger scale.

In a word, I suggest a moderate revision before accept for publication on GMD.

Some specific comments:

1. Please check: “…land model…” or “…land surface model…”
2. Page 4116, line 10: please give the full presentation for LSMs (i.e. Land Surface Models), because not all of the reader are familiar land surface modelling.
3. Page 4119, line 20: what is the BNF?
4. Page 4119, line 3-4, I did not find the mentioned equation (Eq.) 1-4 in your paper! Do you mean the equations in Fisher et al. (2010)? If so, please state it clearly. If not, please provide them.
5. Page 4120, line 5, how did you determine K_N and $K_{C,}$ are they parameters? Where did you get the N_{leaf} (I mean which submodel is in charge for N_{leaf}, please clarify it)?
6. Page 4120, Eq. 7: there may be some error in the last component of this equation, please make sure you make sum from i = 1 to Nsoil, or to number of soil? I guess it should be the number

of soil, but Nsoil is the available N in specific soil layer as you explained.

7. Page 4121, line 8, soil temperature or air temperature?
8. Page 4121, Eq. 11, what are the $\gamma_{tmp,ly}$ and $\gamma_{sw,ly}$? Are they parameters, or how do you parameterize them?
9. Page 4124, where did you get the Eq. 19? How did you define the threshold for $\gamma_{sw,ly}$?
10. In section 3.5, you mentioned that all of the fertilization activities occurred after late June. Could you please show the fertilization records for this site? To my knowledge, the fertilization is quite different for different kinds of crops; for winter wheat the fertilization should not be so late, but for summer crops it can be. Another question is that how do you represent the crop rotation?
11. Page 4132, line 11: with the default? Or with the observation? I did not see the default model results on figure 8.
12. In figure 8, you state that the N leaching is more in default simulation that the others; did you perform the t-test? This comment is applicable to others similar comparision!
13. There are few grammar errors throughout the paper.