Atmospheric
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Discussions

Interactive comment on "The incorporation of an organic soil layer in the Noah-MP Land Surface Model and its evaluation over a Boreal Aspen Forest" *by* L. Chen et al.

Anonymous Referee #2

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Title: The incorporation of an organic soil layer in the Noah-MP Land Surface Model and its evaluation over a Boreal Aspen Forest

Authors: Liang Chen et al. General Comments: The paper has scientific relevance in evaluating the performance of the Noah-MP for boreal forest site. In addition, a parameterization was included in the Noah-MP LSM to represent the vertical heterogeneity in the soil structure, through the introduction of an organic soil layer. Such efforts contribute to the improvement of land surface models. However, the manuscript needs major revisions to be accepted.

The authors need to rewrite the results to correlate them with the proposed objective.

For example: 1) Describe the results of the figure X which are relevant to the purpose of the manuscript. 2) Discuss these results.

According to the figures presented in the manuscript, the OGN simulation is better than the CTL simulation, for the sensible heat flux in spring, the soil temperature at depths of 10-40cm and 40-100cm, and the soil moisture at 40-100cm. The latent heat flux and soil temperature at the topsoil layer from the OGN simulation are very close to the CTL simulation. The soil moisture at the topsoil layer from the OGN simulation presents a worse performance than the CTL simulation, compared with the observations. However, for wet years, there are an improvement (closer to the observations) in the latent and sensible heat fluxes and volumetric liquid water from the OGN simulation in relation to the CTL simulation during spring. So, the authors should review the affirmation below presented in the abstract, and mentioning carefully their principal results.

"By including an organic-soil parameterization within the Noah-MP model for the first time, the verification results (OGN) against site show significantly improved performance of the model in surface energy fluxes and hydrology simulation due to the lower thermal conductivity and greater porosity of the organic soil."

The authors need to improve their discussion about results. For example, the authors did not discuss the positive bias found in both simulations for the SH in summer. The authors presented the result of the soil temperature at the topsoil layer, but the discussion only appeared in the end of the section.

In addition, the authors need to improve the readability to clarify some phrases. Some of mistakes could be fixed by a final reading before submission, such as blanks in the text, two identical phrases in the section 3.1, mistakes in the figure captions.

Specific comments: - Lines 11-12: ". . ., the most widely used numerical weather prediction and regional climate model in the world." Are there any references about this affirmation?

- Line 13: As a suggestion, the authors could include the reference Pilotto et al. (2015).

- Lines 13-14: "...compared to the legacy Noah LSM...". I suggest replacing "legacy Noah LSM" by "earlier versions of the Noah LSM".

- Lines 21-22: "Despite continuous evaluation and improvements, Noah-MP has not been evaluated in boreal forest regions." And Yang et al. (2011)?

- Line 36: I think the word "old" should be removed in this phrase.

- Line 61: I would replace "thermal and hydrological components" by "surface components".

- Lines 73-76: I suggest that the soil types at the site should be described with more clarity.

- Line 100: "Data gaps were filled using a standard procedure." Reference?

- Lines 125-126: "Noah- MP is a new-generation of LSM, developed to improve major weaknesses of the Noah LSM.." I suggest to change this sentence to something like: "Noah-MP is a new-generation of LSM, which was developed to improve the performance of the Noah LSM.."

- Lines 205-206: "They are then treated as the most appropriate combinations for our study site (see Table 3)." This sentence is not clear if the authors used the parameterization options mentioned in the sentence above. I think it should be rewritten.

- Lines 206-208: "The order of the categories based on the IOA scores from the highest to the lowest is...". If the authors kept the comparison between the parameterization options, perhaps this result should be explored and discussed.

- The text does not mention how many soil layers were used in the simulations, and what the depths were used. I believe that the authors have used four layers. Three layers were mentioned in the results: 0-10cm, 10-40cm, and 40-100cm. In the caption of the figure 6, a fourth layer was mentioned as been referring to 100-200cm. Is it

correct? Please explain in the methodology.

- Line 210: I think the authors should create a specific title for the section 4.3, as it was presented in the sections 4.4 and 4.5. In fact, the "evaluation results" also include the sections 4.4 and 4.5.

- Perhaps the figures 4 and 5 can become a single figure, as done in the figures 6 and 7. This may help in the analysis of results.

- In the second paragraph of the section 4.3, the authors mentioned about the positive sensible heat flux bias simulated by the both simulations in summer. Why does this bias occur? Did you see the field of the net radiation? More interpretation would help.

- Why the RMSE and IOA were not calculated for the soil temperature and moisture?

- Why the simulations with the Noah-MP (independent of the soil type) produce a bias on soil temperature at the topsoil layer in winter? Parameterization?

- The authors did not describe the results of the soil temperature at the deeper layers, which show an improvement in the OGN simulation, compared with the CTL simulation. Why?

- Lines 247-248: "The inclusion of an organic soil horizon also affects the hydrologic cycle components such as soil water content, runoff, and evaporation (Figure 7)." I think that this phrase should be removed, because it does not represent which was presented in the figures until this moment.

- Lines 250-251: "...due to the contrasting water retention characteristics of organic and mineral soil." Do you have reference for boreal forest?

- Figure 12 is called before figure 8. Please verify the number of the figures.

- Lines 275-276: "The OGN-CTL difference is strongest for the drought years 2001, 2002 and 2003." I did not find this result based on figures 4-7.

- Did you calibrate the parameters used in the model? What were the parameters values used?

- I think the results need to be explored further in the section 4.4. This way is confusing to understand. I suggest that the authors should focus in the comparison of the OGN and CTL errors for each season in the drought and wet years. And, include a discussion these results.

- Lines 282-284: "In general, the OGN parameterization improved the simulation of daily daytime SH and LH in terms of both RMSE and IOA (Table 4),..." Rewrite this sentence, because the RMSE of the SH from OGN simulation is higher than the CTL simulation in all years (exception for 2005).

- Lines 292-293: "OGN overestimates daytime SH compared with observations, while CTL underestimates daytime SH for spring and summer (Figure 8a, b),..." The both simulations overestimate the SH in summer.

- Lines 294-295: Why did not you show the figure with the cycle of the soil temperature? The authors include a description of this result, but they did not show the figure associated. I think this figure should be included in the text.

- Lines 305-307: "Note that the OGN simulation also improves surface heat fluxes significantly in drought years, because the snowmelt process dominates during spring months." In drought years, the OGN simulation did not improve the SH, compared with the CTL simulation in spring. Note that the bias of the SH from OGN simulation is higher than the CTL simulation in spring.

- Do the curves of the diurnal cycle of the figures 8 and 9 represent the daytime, nighttime or mean?

- Section 4.5: Why did not the authors show the figure with the annual cycle of the soil temperature?

- Section 4.5: It is interesting that the authors mention that the annual cycle shows that

there has been an improvement (closer to the observations) in the latent and sensible heat fluxes and volumetric liquid water from the OGN simulation in spring for wet years, in relation to the CTL.

- Conclusions: The authors repeated the results. The conclusions should contain the principal results found and the suggested hypothesis or explanations associated to these results. As I mentioned before, I think the authors should focus the improvement of the OGN simulation based on the observations and the CTL simulation.

- Lines 369-370: "The incorporation of an organic layer at the top of the soil helps improve the nighttime sensible heat flux for all seasons." The authors did not mention about the nighttime sensible heat flux in their results. I think the authors should mention it in their results or they should remove this sentence of the conclusions.

Technical corrections: - Line 7 : "...multi-parameterization..." Niu et al. (2011) and Yang et al. (2011) use multiparameterization. - Lines 49-50: "...(Letts et al. 2000, Beringer et al. 2001, Molders and Romanovsky 2006, Nicolsky et al. 2007, Lawrence and Slater 2008, etc.)." I think it is would be better "...(e.g., Letts et al. 2000, Beringer et al. 2001, Molders and Romanovsky 2006, Nicolsky et al. 2007, Lawrence and Slater 2008)." - Lines 72-73: "The forest regenerated after a natural fire in 1919 and had a 1998 stand density of ∼830 stems ha-1." I think this sentence is confused, it could be replaces by "The forest was regenerated after a natural fire in 1919, and in 1998 it had a stand density of ∼830 stems ha-1." - Line 94: I think the authors should include in the manuscript the meaning of the variable theta. - Line 101: "The net radiation flux density Rn was calculated..." The authors should correct this phrase for "The net radiation flux density (Rn) was calculated..." or "The net radiation flux density, Rn, was calculated..." - Lines 128-130 and 135-137 are the same sentence. - Review the figure captions, especially the figures 6 and 7.