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Discussions

Interactive comment on "On the Appropriate Definition of Soil Profile Configuration and Initial Conditions for Land Surface-Hydrology Models in Cold Regions" *by* Gonzalo Sapriza-Azuri et al.

Anonymous Referee #1

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GENERAL COMMENTS

The manuscript presents a sensitivity analysis of a Canadian one-dimensional land surface model, MESH to the thickness of modeled soil profile and the length of model initialization period. The main conclusions are that a soil profile of 20m or greater is necessary for this particular model to represent the energy dynamics of permafrost, and that an initialization period much longer than 100 years is necessary to condition the model properly. The same results have been reported by a number of previous researchers using different permafrost models, and the present study confirms well known facts. A new contribution of this study would have been to present a rigorous and

systematic evaluation of the model sensitivity to soil profile thickness and initialization period. Unfortunately, the study falls short of delivering a new contribution due to a few important deficiencies in model boundary conditions as I explain below. I would suggest that the authors use appropriate boundary conditions and conduct new model sensitivity analyses that are scientifically defendable.

SPECIFIC COMMENTS

P3, L13-15. This paragraph seems to be out of place. I suggest deletion.

P4, L8. It is very unusual to have a 'grassland' ecosystem in a place like Normal Wells. I would suggest that the model be run with appropriate parameters to represent the vegetation typical of this environment.

P5, L4. The data from this borehole (84-1) is critically important for the evaluation of model performance. The model should be set up with the top boundary condition representing the vegetation characteristic of the local site, because the model simulation is compared against local data. The borehole data and site characteristics (including photographs) are publicly available from a report published by Natural Resources Canada. It appears that this site is located in a wetland surrounded by black spruce forests, typical of the Normal Wells region. To present a rigorous analysis (P19, L8), the model should use a set of parameters for wetlands, not grasslands for the top boundary.

P6, L22. Again, grass land cover is inappropriate for this particular model simulation.

P7, L1. The critical importance of geothermal heat flux applied to the bottom boundary is widely recognized by researchers in the permafrost modelling community, and is considered the standard practice. Geothermal heat flux data for the study region is readily available and used in previous studies (e.g. Zhang et al. 2008, cited by the authors). The absence of heat flux at the bottom boundary calls the scientific rigor of simulations in this study into question. I would strongly recommend that the authors re-run the simulations using a proper bottom boundary condition. If the model cannot handle geothermal flux, then it is not an appropriate modelling platform for permafrost environments.

P8, L6. Please report mean annual air temperature and total precipitation for these years, preferably in a table format.

P9, L15. This statement is true with respect to annual temperature oscillation. However, the effects of lower-frequency temperature fluctuations (see Figure 6) can penetrate much deeper into the soil (see Figure 2). For a proper evaluation of model sensitivity, the non-oscillation depth should be defined using simulated temperature over multiple years.

P10, L9. It is not clear what is shown in Figure 5. The figure caption says it is annual average temperature, but it clearly is not. Please explain.

P14, L7. As I mentioned above (P9, L15), the temperature invariance in annual time scale does not necessarily indicate the insensitivity of the model to soil profile depth when lower-frequency fluctuations in atmospheric forcing are considered.

P16, L12-14. In addition to temperature, important variables in permafrost environments are the depth to the permafrost table (i.e. top of the permafrost) and the thickness of permafrost, as they exert strong influences on energy and water transfer processes. It is highly desirable to evaluate the model performance with respect to these key variables.

P19, L8. I cannot agree that this study presents a 'rigorous' analysis, as it suffers from fundamental problems concerning model boundary conditions. Please revise the boundary conditions and re-run the model simulations.

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