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Geoscientific Model Development Discussions

Interactive comment on "Simulating the thermal regime and thaw processes of ice-rich permafrost ground with the land-surface model CryoGrid 3" *by* S. Westermann et al.

Anonymous Referee #2

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This paper describes the complexity of simulating permafrost temperatures and degradation in a remote region with limited data. The model described in this paper is simple and focuses its complexity on the upper boundary conditions in order to calculate ground temperatures and permafrost degradation. The new aspects of the model are in the treatment of snow and a simplified way of incorporating subsidence as a result of loss of excess ice in permafrost. A lot of time is spend in the paper describing the overall problem and available data (too much maybe?), the complexities of measurements used and overall conditions of the field setting, minimum time is spend on the equations and justifying them. This is excused by the authors saying that the reader is free to use the code and can change to equations at will. However ideally a modeling

paper should describe why particular equations were chosen over others and a description of the pros and cons of that equation set, supported by field measurements. The turbulent boundary fluxes are describe in great detail in this model, but no reason is given why it is important to have in the model.

Snow is considered and important variable for the overall energy balance of the ground, but is the snowmelt period really that important?

Are there two different models described in this paper or is the Xice portion a module that can be turned on and off?

Natural porosity is an unusual term and should be cited: e.g. Hopkins and Sigafoos in Contributions to general Geology 1950.

The model seems to perform well, but the scales in the figures do not allow accurate assessment of the fit. For instance the 1 to 1 line in figure 2 shows a spread of over 10 degrees Celsius between measured and simulated even close to the freezing point. Is that really a good fit or maybe it is not really important to know the exact surface temperature for permafrost degradation if the micro thermal conductivity is not really known? Why not apply the Stefan solution and some n-factors? The argument that lateral fluxes do not mater at a small scale is not true. They are even more important on a small scale, because the portion of the lateral flux to vertical flux is greater. Therefore coarser scale models can ignore lateral fluxes more easily. The problem of scale and resolution will always be against accurate representation of the system. On the other hand more can be done in this model on a sub-grid level to improve representation of the lateral fluxes.

The paper is publishable, because it attempts to fill a gap in the capability of existing models where the model domain itself changes as a function of boundary thermal forces. This type of model should be useful to people how may not have experience using large main frame computers that attempt to solve the entire set of physics. Ultimately though will scientists use this model if the results it provides are based simplified

physics? The model description should be focused more on understanding the effects of the physical simplifications on the results, but maybe that is the intended goal for others to figure out?

Specific edits: Equation 14 T* not described. Equation 17 θ* not described 6941 L10 define the state of zero energy content 6941 L13-14 delete “corresponding amounts of” 6946 L1 “re” needs to be added to “mains” 6961 L20 delete one of the “a” 6962 L25 should be “stable” not “stably”

Interactive comment on Geosci. Model Dev. Discuss., 8, 6931, 2015.