Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC1
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Comment on gmd-2022-127

Anonymous Referee #1

Referee comment on "The CryoGrid community model (version 1.0) – a multi-physics toolbox for climate-driven simulations in the terrestrial cryosphere" by Sebastian Westermann et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-127-RC1, 2022

The CryoGrid community model (version 1.0) - a multi-physics toolbox for climate-driven simulations in the terrestrial cryosphere

The paper describes the CryoGrid model, which was initially developed to study the permafrost thermal process. The current model has multiple versions, and the capabilities of the model were substantially expanded, covering a broad spectrum of physical processes. The authors used Matlab's object-oriented programming to achieve modeling modularity, allowing swapping different methods and physics into the GryoGrid model. Increasing physical complexity of the model comes at the expense of computing time. It would be nice to have a graph showing how increasing model complexity affects model performance. The model is written in Matlab, which likely reduces the adoption of the model since not every organization or individual has access to a Matlab license. In addition, Matlab is an interpretive language and requires a certain style of code development which could lead to potential slowdowns in the execution time. I suggest including in the discussion why Matlab language was chosen and its downsides compared to the compiler languages like C++ and Fortran. Otherwise, this work is an important step that contributes to the development of the community types model. It would be nice to have a discussion about similar community-type models like CLM and others (similarities and differences). What are the benefits of loose versus tight coupling between different physical processes? Any thoughts on how the modular approach can be standardized and implemented across multiple platforms? How can mathematical programming like OpenFoam be helpful in moving toward usability and modularity?

Minor
Reading this technical paper without seeing examples of the code makes the overall understanding hard. I suggest adding the snippets of the code or pseudo code to illustrate the model design and structure (e.g. Line 201, explanation of the CHILD using code).
L 345. For more clarity, it would be nice to represent the grid schematically with the boundary condition included for one or multiple stratigraphy classes.
Are stratigraphies and physical processes the same things?
L394. Soil types. Are they mixed within the bulk soil layer or discrete and vary per depth?

2.2.9 I guess enabling different physical classes e.g. permafrost and glaciers, would significantly slow down the simulation. Can you provide any charts showing the execution time when adding more coupled different physical processes? Moving to 3D would substantially reduce the compute time. It would be nice to provide some estimates on that as well.
L699. Which version of the CryoGrid is used there? Similarly, include a version of the model was used to produce figures 5 and 6.
Figure 7. It talks about the ice impedance factor but there is no formula showing it.
Section 3.2. I suggest adding a few figures.
Figures 11 and 12 replace captions.
Figure 19 It looks like red and dashes red increase snow density too slowly, making soils much warmer, suggesting that these two formulations are not even appropriate.
L1108. Data assimilation or calibration?