

Interactive comment on “GEOtop 2.0: simulating the combined energy and water balance at and below the land surface accounting for soil freezing, snow cover and terrain effects” by S. Endrizzi et al.

Anonymous Referee #1

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In their manuscript “GEOtop 2.0: simulating the combined energy and water balance at and below the land surface accounting for soil freezing, snow cover and terrain effects”, the authors present the latest version of the model suite GEOtop. The main components of the model are described in a very detailed manner. These are the soil volume heat flux equation, the water flow components, procedures to calculate radiative and turbulent fluxes, as well as the impact of complex terrain and the treatment of a seasonal snow cover. After referring to some validation efforts in the supplement of the paper, a synthetic model experiment and according results are presented.

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General Comments

The manuscript is in general of high technical quality. It is very well written, organized, and presented. The content has a value for the scientific community, as a very interesting model with innovative approaches is described. Specifically, the calculation of the energy-balance coupled to the water fluxes is very promising. However, this directly leads to my main concern regarding this work. Large parts of the paper consist of model descriptions, whereas the validation section is practically non-existent (or only refers to supplementary material), and the result section showing the model experiment is kept very short and results are rather limited.

The relation between pure model description (~85 %) and results (~15%) leads to a large imbalance of the manuscript. The text reads like a technical report, and not like a scientific paper. Generally, this might be more appropriate to be published in GMD than in other journals, but I still think this huge imbalance is unnecessary and not effective regarding the target of the work, which is - as stated in the abstract – to show the performance of the approaches and to demonstrate their functioning and possible relevance. The reader gets the impression, that a well-engineered technical model description was taken and decorated with an introduction and a small results section.

To overcome this imbalance and enhance the manuscript, I think it is necessary to intensely rework the results sections and possibly move some of the model descriptions to the appendix. More validation results including the respective figures should be presented in the manuscript. Actually, the most interesting validation results (which are quite impressive and good) are only shown in the supplement. Why not just extend section 6 (“Testing GEOTop”) and show these results in the manuscript? It would also be very interesting to see some more (point?) validation of the very interesting model approaches, if the respective measurements are available. E.g. the dynamic discretization scheme for the snow pack is a promising concept and approach, but unfortunately, the reader gets no idea how well this performs regarding e.g. snow temperature profiles and respective heat and mass fluxes. The aggregated results shown in

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the supplement (SWE and snow height) are quite good, but how well is the stratification actually represented? There is no result shown in the paper that focuses on this part of the model, so the description should be moved to the appendix. The reworked results section could also focus on a topic (e.g. stratification of the snow pack, or permafrost depth, or water fluxes) and show some more specific results (either of the experiment, or – even better - using validation data). I really like such idealized model experiments, as they can give highly valuable insights in complex systems. However, I am not sure if the presented model has undergone enough real validation efforts to give representable results (specifically regarding the modules that are in the focus here: thawing and freezing, active layer depth, snow layering scheme, 3D Richards-equation). The results in the supplement do only show the reproduction of soil temperatures and total snow amounts, but what about water fluxes in the saturated and unsaturated zones, groundwater table, routed runoff, etc.). In any case, as is, the validation and experiment sections definitely need some additional structuring in subsections (e.g. setup, input data, results, ...).

Specific Comments

The following specific suggestions and comments are referenced in page and line numbers.

P. 6280, L. 1/2 Rephrase to avoid repetition of “represents”.

P. 6281, L. 27-29 & P.6282, L. 3 The sub-clause “. . . , where snow and freezing . . .” is missing a verb.

P. 6282, L. 8 Place the above mentioned “(hereafter GEOtop)” somewhere here and stick to it in the rest of the manuscript!

P. 6282, L. 19 Consider using “is driven by meteorological forcings” instead of “is based on meteorological forcings”

P. 6283, L. 12 Please rephrase “. . . are here described.”

P. 6302, L. 19 Remove the brackets.

P. 6309, L. 6-9 The sentence “We also discuss. . . “ is partially incomplete/corrupted.

P. 6312, L. 1/2 Which data were used for the spin-up? Please explain! P. 6312, L. 12 and Fig. 3, caption Either write “at a depth of 4 m” or “at 4 m depth” instead of “at a 4 m depth”

P. 6312, L. 25 Rephrase “. . . and results significantly colder . . .”

P. 6315, L. 3 Use “. . . conserving mass. . .” or “. . . conservation of mass. . .”

Fig. 4 Why are the slopes presented opposed to Fig. 2? Please turn around one of the figures and consider adding a north arrow!

Fig. 4 and Sect. 7 What is the horizontal resolution within the synthetic experiment? Please add explanation in the manuscript. I understand that this is not that vital here, because of the artificial setup, nevertheless it is interesting, as “real” elevations and station data are used.

Interactive comment on Geosci. Model Dev. Discuss., 6, 6279, 2013.

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