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**Geoscientific
Model Development
Discussions**

Interactive comment on "*ESCIMO.spread* – a spreadsheet-based point snow surface energy balance model to calculate hourly snow water equivalent and melt rates for historical and changing climate conditions" *by* U. Strasser and T. Marke

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********** Review: The figures are clear with the exception of figure 2. Fig. 2 hardly readable -> please revise; column explanations are detailed but not relevant for the paper since the mentioned columns are not shown in the figures; maybe this would be better as additional material together with the spreadsheet model.

Comment: We actually do consider Fig. 2 worth being in the paper, since the spread-

sheet itself is a significant part of the paper (it is available for free from the authors) - and we have improved the figure quality. The column explanations are not meant to be identified in the figure, but to help to navigate in the spreadsheet file. We have attached the latter to be loaded up on the GMD server.

********** Review: The possibility to see changes in parameters in a kind of white-box model is especially relevant for student courses. On contrary, the advantages for field work are not described clearly.

Comment: Please see changes in publication text, we have modified the manuscript accordingly.

********** Review: Consequently, these data provide sufficient information, particularly when considering the mentioned model accuracy of one week.

Comment: Here seems to be a misunderstanding. The validation on a (nearly) weekly time basis results from the frequency of snow water equivalent (swe) pit samples taken in the field and does not correspond to model accuracy.

********** Review: Additionally, parameter optimizations in the model, where needed, or more detailed simulations should be carried out with a model version containing more details as for example the iterative routine for calculating surface temperature for air temperatures below 273.15 K, as described in Strasser (2008).

Comment: The presented model is designed as a performant, easy to use tool that substitutes computational expensive iterations and detailed descriptions of physical processes e.g. by common bulk formulations. A comparison of results achieved using these simplified approaches to more complex process descriptions has been carried out by Strasser (2008, p. 61). The results of this comparison indicate a comparably good model performance even under the given restrictions of limited detail in the process description. Including iterative approaches in the spreadsheet version would strongly limit the usability with different spreadsheet programs as the functional imple-

mentation of iterative algorithms is different and incompatible.

********** Review: The option of simulating climate change impacts on the snow cover in changing air temperature and precipitation is an interesting tool. Nevertheless, the description of the modifications requires more details (p. 634). Is the temperature increase simulated uniformly over the year? Is there a way to differentiate between the seasons? What exactly happens in shifting precipitation from summer to winter? Furthermore, the question raises, if such a simple climate change simulation tool should be applied in education. Is there a risk to give a wrong impression of climate change impacts in uniformly (if this is the case) modifying the temperature? Despite a temperature increase, winters with a large amount of snowfall still can happen in the future, although they might be rare. The tool offers a lot of options, but it should be applied carefully in education.

Comment: Details on the description of climate change parameter modifications have been added to the publication. The effect of potential changes in temperature and precipitation on the snow conditions are shown by the example of two scenario simulations for the Kuehroint site in the Nationalpark Berchtesgaden in the paper. As the effect of climate change depends on the defined parameter values as well as on the meteorological recordings setting the data basis for climate change modifications, future users of the model are highly encouraged to conduct own studies in order to analyze climate change effects on the snow conditions under different scenario conditions and at other sites. Of course we agree that the climate change modifications in ESCIMO.spread strongly simplify the complex meteorological processes and interactions involved. Still, this pragmatic approach allows to deal with climate change related questions e.g. in how far the effect of rising air temperatures on the snow conditions might be compensated by an increase in winter precipitation - if it falls as snow. Alternatives to our approach can be found in the utilization of climate model simulations including a subsequent downscaling of the data, both are connected to immense computational effort and suffer limited regional transferability. From our point of view, there is no question

that the model can and should be used in education as it is the responsibility of the teacher to guarantee a reasonable interpretation of the methods and results.

********** Review: Although it is referred to a variety of studies, a validation of the spreadsheet model at another place with different climatic conditions would improve the validation chapter.

Comment: This is a very valuable suggestion. In fact, the model has been applied and validated in it's FORTRAN version at middle elevation temperate, high elevation temperate, eastern US and arctic sites in the framework of the Snow Models Intercomparison Project (SnowMIP) (http://gaim.unh.edu/Structure/Future/MIPs/SnowMIP.html). The results of the project indicate that the model is capable of simulating local snow conditions under a variety of of climatological and environmental boundary conditions. This information has been added to the publication text (please see changes in the manuscript).

********** Review: Melting point of water at 273.15 K -> please check manuscript.

Comment: The melting point of water has been formulated as 273.16 K to assure consistency with the FORTRAN version of the ESCIMO model. Note that this parameter can easily be adjusted in the spreadsheet.

********** Review: Missing citations for parameterization of sensible and latent heat fluxes (eq. 4 and 5)

Comment: Thank you very much, we have forgotten to add citations here. This has been corrected in the text (please see changes in the manuscript).

********** Review: Mauser and Bach 2008 can not be found in the references -> 2009?

Comment: You are right, this has to be 2009. We have corrected this issue in the text (please see changes in the manuscript).

********** Review: For Prasch et al. (2008) two references -> which is referred to?

Comment: You are right here again, there are two publications that are now clearly distinguished (please see changes in the manuscript).

********** Review: DANUBIA is explained in cited publications, but not DANUBIA-Light -> please give an explanation

Comment: DANUBIA-Light is the FORTRAN version of DANUBIA. As ESCIMO is implemented in DANUBIA and DANUBIA-Light, we avoid the confusion by only using one term "DANUBIA" (please see changes in the manuscript).

********** Review: Please give more details for the description of the modifications to simulate climate change impacts on the snow cover

Comment: Details on the description of climate change parameter modifications have been added to the publication (please see changes in the manuscript).

********** Thank you very much for all your valuable comments and suggestions for further improving our manuscript! Your endeavours are highly appreciated!

Interactive comment on Geosci. Model Dev. Discuss., 3, 627, 2010.