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Interactive comment on "SEMIC: an efficient surface energy and mass balance model applied to the Greenland ice sheet" *by* Mario Krapp et al.

Anonymous Referee #1

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This is an excellent paper on a new type of energy and mass balance (SEMIC) model that has been developed for use over the Greenland Ice Sheet. The model uses a single-layer snowpack, which is much simpler than a multi-layer scheme, but includes a realistic treatment of albedo and a parameterisation of diurnal temperature variation to account for it being run at a daily (rather than higher) time resolution. It is therefore computationally efficient compared with a fully-fledged surface energy balance and snow model, yet produces results for historical and future GrIS evolution (years 1970-2100) that are very similar to - and essentially comparable with - MAR. SEMIC is based on a model scheme that has already been used to study glacial cycles and is argued to be inherently consistent with a variety of different climatic states - although one of its key parameterisations (daily temperature cycle) will likely change under different climate states - but this can be re-tuned more readily than the positive degree-day

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(PDD) factors in a PDD model, for example. Also the model code has been made open source and so is readily available to other researchers. Aspects of the model, such as the diurnal temperature variation scheme, can be significantly refined but this is for further work - the SEMIC model is already producing some excellent results. Importantly, while including realistic depiction of surface energy and mass fluxes on sub-diurnal to interannual timescales, SEMIC can be run for periods of thousands of years, for example being used as part of glacial-climate-Earth system simulations of glacial-interglacial cycles. SEMIC is methodologically superior to the PDD model which is currently widely still used for this purpose; yet SEMIC still requires downwelling shortwave and longwave radiation fields and surface wind speed, which the PDD model does not need as input. Therefore output from SEMIC is only as good as the reliability of these additional input data. Nevertheless, SEMIC presents an exciting new tool for modelling surface mass balance changes of the GrIS in a relatively computationally efficient way, so this paper should therefore be of broad interest to the glaciological, climate and modelling communities.

The manuscript is generally well argued, structured and presented and I have only a relatively few, mainly minor, specific queries and points of clarification:

page 3, line 19: rho of w (density of water) should be defined here. p.3, l.26 "For faster computation..." - faster than what? Please clarify. p.5, l.15: please add comma after "A set to zero". p.6, l.3 water density is defined here but should be defined earlier on p.3 (see above). p.6, l.18 "We neglect refreezing of melted ice and trreat ice melt as runoff." - what is the basis of this assumption? Is it reasonable and realistic for the GrIS? Adding a sentence or two of justification here would be helpful. p.7, l.8: "Tmin is set to 263.15K as originally proposed" - How reasonable is this assumption and is it supported by in situ and/or satellite data? What is the sensitivity of model results to varying it by several degC plus and minus? p.8, l.1 reword to "we refrain FROM USING..." p.8, l.15 -> "are close TO their expected trajectories." p.8, l.24: -> "while also allowing THE ASSESSMENT OF variables with different units." p.10, ll.4/5:

"While melting over the northern part of the ice sheet is overestimated by SEMIC, it is underestimated over the southern part of the ice sheet" - this seems opposite to what I interpret from studying Figure 3 - please check. p.11, l.8: -> "However, the surface mass balance itself is less sensitive TO A than melting." p.19, Figure 3 caption -> "The outlined contourS SHOW the boundaries..."

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