

## ***Interactive comment on “Summer snowfall on the Greenland Ice Sheet: a study with the updated regional climate model RACMO2.3” by B. Noël et al.***

**Anonymous Referee #2**

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### **Summary:**

The paper evaluates a new version of the RCM RACMO2 and compares new simulations over Greenland with an older version to examine the differences that the model upgrade gives in SMB over the ice sheet. Observations from stake measurements and AWS on the K-transect in Western Greenland provide independent data against which the models are assessed. The authors find an improvement in modelled SMB compared with stake measurements at the K-transect site attributable to the different partitioning of snowfall and rainfall in summer over the ablation zone of the ice sheet.

Comments: This is a nicely written and clearly put together paper, which summarises

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well the recent upgrades to the RCM as well as the effect these have on the modelled SMB of Greenland glaciers. The examination of the effect of the partitioning of summer precipitation into rain and snow is an interesting angle of the paper, though given that the effect is well known already, the novelty is mainly in trying to quantify the effect of this on the ice sheet. I suggest a few improvements below which would help to clarify the arguments made by the authors and which should make it a more robust study and some minor comments

### **Improvements:**

1. The paper reads more like a model evaluation paper than a study into the effects of summer snowfall on the ice sheet. I suggest updating the title to reflect this.
2. Given that the focus of the paper is very much on evaluating the different RACMO simulations, it is a little disappointing that only the K-transect AWS data is used, although no doubt for good reasons. Nonetheless, the GC-Net and PROMICE networks of AWS have freely available measurements of the usual meteorological variables, even if only for a short period compared to the simulations here. It would be nice to see at least a few of these used as well since we would expect the biases within and between the models to be spatially varying and using one or two other observation locations would help to tease this out.
3. The authors also assert that precipitation (and cloud cover) is improved without showing any evidence for this. While recognizing this is not easy to measure in Greenland, I note there are observations from shallow cores and the DMI coastal stations which could be useful for this purpose and again just a few key locations compared with the two simulations would help to show this. Cloud cover is also observed at Summit and some coastal stations and this could be interesting to compare too since the LW/SW fluxes are a crucial part of the story and the conclusion asserts, again without offering evidence, that the new RACMO has improved clouds. I emphasise this point as getting accumulation right is crucial for e.g. ice sheet modelling.

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4. Similarly for the SMB estimates from stake measurements around the ice sheet, although the K-transect measurements are pretty much the gold standard in Greenland, it would be nice to include a few other data sets from different locations (eg NEEM, Summit, NGRIP, Promice stations etc). The authors mention an ongoing study along these lines, but I see no reason why at least some of these other datasets could not also be combined here as it would strengthen the argument for the improved RACMO setup. Alternatively, perhaps a comparison of the new model with the old using the runoff data into the Nuuk fjords presented in Van As et al. 2014 would be instructive as this includes a region that certainly would see the effect of the different partitioning of snow and rainfall.

5. Section 3.2 on large scale changes in circulation, is not very clear. What causes the change in 500 hPa height? The paragraph implies that this is a response to the cooling in the upper troposphere? How do you know? Some fairly large changes appear to have been included in boundary layer, turbulence and radiation schemes which may also partly account for this.

Minor comments: a) P1180 L7,11 write "section" in full b) P1183, L25-26 also p1185, L18 – 19 I share Graham Cogley's dislike of this kind of sentence structure. Please make it into two sentences as it is much easier to read. c) P1184 L13-15 This sentence needs revising to make it simpler to read d) P1186 Section 4 please state which grid cell you used to make the comparison with. Was it the same procedure as when comparing SMB? This is a non-trivial problem when comparing point observations with 11x11 model grids as the authors acknowledge elsewhere. e) Figure text (at least on my print out) was mostly unreadably tiny, especially in Figure 5. f) On figure 1 the change in background albedo was also difficult to see, perhaps this could be enlarged or an alternative colour scheme used? g) Apparently, cumulated is an English word as I looked it up in the OED. Stylistically I prefer accumulated or cumulative but this is a matter for the editor as it is personal preference! I should say that given all authors are non-native speakers the grammar, spelling and English usage is exceptionally good

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(though not surprising!).

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Interactive comment on The Cryosphere Discuss., 9, 1177, 2015.

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