

Interactive comment on “Hypsometric amplification and routing moderation of Greenland ice sheet meltwater release” by Dirk van As et al.

Dirk van As et al.

dva@geus.dk

Received and published: 9 April 2017

X. Fettweis (Referee)

- The paper should more highlight that the considered catchment (in a very dry area) is likely not representative of other GrIS areas (for meltwater retention, lake drainage, ...).

Indeed, the lower elevations of the Kangerlussuaq catchment are relatively dry in terms of precipitation compared to other ice sheet marginal areas. We do not consider it unrepresentative, but it is important to inform the reader on climatological particularities. Therefore we suggest the following: To add/change to the introduction: “Our study area is the relatively arid sector of the Greenland ice sheet east of the Kangerlussuaq settlement, located in southwest Greenland”. We change a sentence in section 2.3 to

C1

read: “. . . because of the arid climate that governs the lower elevations of the Kangerlussuaq catchment”. In 4.3 we add: “Since supraglacial lakes are relatively abundant in the wide melt area of the Kangerlussuaq catchment, the impact of lake drainages on studies using our methodology would logically be smaller elsewhere in Greenland”. Section 4.4 can read: “Climatologically though, Kangerlussuaq is arid in terms of precipitation due to blocking topography to the southwest (Van den Broeke et al., 2008; Johansson et al., 2015), providing this study with the possibility to study routing delays in an environment where complications by rain are minimal”. We rewrite in section 4.6: “Also, (increases in) meltwater storage in supraglacial lakes (Fitzpatrick et al., 2014) are not calculated by the model”. To the conclusions we add: “. . . takes 5-6 days to be released from this relatively arid sector of the ice sheet”. We hope that these changes suffice in characterizing the Kangerlussuaq sector of the ice sheet to the reader.

- An interesting sensitivity experiment to evaluate the retention in firn (Section 4.6) should be to increase the winter snowfall by a factor 2. While the agreement is very good with obs, higher winter accumulation and higher melt could give similar results. Therefore, it is for me a bit too early to claim that there is not meltwater retention in this catchment. This should be confirmed by sensitivity experiments (e.g. Snowfall x 2 + Melt x 1.5).

Note that we do not make statements about the retention of meltwater in firn in the manuscript. Such retention is small compared to the catchment-total runoff even during peak melt events (Machguth et al., 2016). We would not be able to make solid claims on the topic even if meltwater retention in firn was twice as high, because this signal would drown in the uncertainties of observed river discharge and modelled ice sheet runoff. Instead, in section 4.6 we first mention that the model underestimates meltwater retention in winter-accumulated snow. Also we mention that we find no evidence for meltwater storage in the en- and subglacial environments. So in neither occasions do we mention retention in firn, in the supraglacial environment. Although your suggestion for a sensitivity experiment is an interesting one, it would not affect the

C2

outcome of the study, and it will divert the attention of the reader away from the main conclusions. Therefore we suggest not to include this sensitivity experiment.

- Daily MAR outputs could be used in addition to check that melting routing delay used here are not too model dependent because it is very likely that the melting routing delays used here (Fig9) could compensate biases in the model. MAR has also its own but different biases. Evaluating how the routing delay is model dependent will add robustness in the paper. I can provide 7.5km daily outputs to the authors if they find that it is an interesting addition to their paper.

This is indeed an interesting suggestion and something to discuss for a follow-up study. As it stands, the current study is entirely based on observations for reasons of accuracy in terms of absolute values and temporal variability. We invested much effort into obtaining the most accurate as possible time series of ice sheet runoff to perform the routing delay calculation, because lower accuracy undoubtedly reduces the correlation with river discharge. Arguably, the ice sheet runoff values that we obtained at hourly resolution cannot be improved upon by a model that contains as accurate surface energy balance calculations, but is forced by observations at the lateral boundaries hundreds of kilometres away. Our forcing parameters, e.g. temperature, humidity, wind speed, solar/terrestrial radiation, and albedo, are all derived at the actual interface between the atmosphere and ice sheet, and should logically lead to an optimal result in terms of SMB calculations. Still, your idea is intriguing and deserves further consideration. Besides, recently I've learned that a study dealing with ice sheet routing delays is already underway, making use of MAR data as you suggest, providing an excellent opportunity to compare results.

- What does "ca." mean? It is used several times in the paper.

We use it as the abbreviation of "circa", which could also be "c.". If the editor wishes, we can use something else.

Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2016-285, 2017.