

## ***Interactive comment on “Influence of temperature fluctuations on equilibrium ice sheet volume” by Troels Bøgeholm Mikkelsen et al.***

**Anonymous Referee #3**

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Review of manuscript “Influence of temperature fluctuations on equilibrium ice sheet volume” by Troels Bøgeholm Mikkelsen, Aslak Grinsted and Peter Ditlevsen [The Cryosphere Discuss. doi:10.5194/tc-2017-47

General comments This paper describes a study of a minimal ice sheet model of axially symmetric ice sheet resting on a bed that slopes linearly downwards from the center. Authors show that there is significant difference in the steady state volume if the model is forced with interannually variable  $T$  as compared with constant  $T$ . They further show that the effective temperature change resulting from considering fluctuating temperatures is dependent on the warming scenario. This is an interesting modelling study, but it is difficult to see the relevance of this simple model for more complex system, such as the Greenland Ice Sheet, as authors claim in lines 28-30 on page 11. The leap from

C1

this simple model study to conclusion about equilibrium ice volume of the Greenland Ice sheet is not justified in my opinion. The text needs much editing, and I suggest that authors rewrite most of the sections to improve the coherence of the paper. Some terms are called different names throughout the paper, which makes it very confusing to read,  $V_{IG}$  defined with Equation 2 is called mass balance,  $dV/dt$  and SMB, I suggest that authors stick to one name. The introduction section lacks coherence, it is not clear where authors are leading to, with their sentences and are jumping back and forth, for example WAIS instability is mentioned in line 20 page 1 and in again in different context in lines 13-15 page 2 and then jumping to threshold for GrIS. The result of the paper is announced in lines 14-16 on page 1, but not in any connection with the surrounding text. I suggest that complete rewriting of the introduction section be made where the current study is put in context, if that is possible (as said above it is not clear to me what the relevance of this modeling exercise is for any of the ice sheets on Earth). The first figure that shows the dependence of the equation of the ELA height with specific balance is introduced but never revisited or used in the study, as the authors (line 10 page 4) “investigate the effect of interannual temperature fluctuations” before proceeding with the simple model. The relationship between (if any) Eq. 1 and Eq. 2 is not explained and the two seem unrelated. Both  $K$  and  $^{\circ}C$  are used, select either one.

Specific comments: Page 1 Line 3, the time scale for weather is usually days or weeks, not interannual, it is therefore strange to call the interannual fluctuations “weather generated” Line 4 How is the “risk of collapse” possibly underestimated when the steady state ice sheet is slightly smaller with interannual  $T$  fluctuations than constant  $T$ ? Lines 5-7 This sentence is very confusing and needs clarifications. Line 5, what temperature variability (spatial, temporal, interannual?) What is the relation between “recent ensemble forecasting” and “present day observed value”? How is the effect “adjusted downward”, do you mean that the effect is smaller? This sentence needs rewriting. Line 7 use either “predicted” or “scenario” not both Line 9 it is not clear what “further influence” means here, needs clarification Line 11 clarify what “long term forecasting” means (100.000 years, 100 years?) Line 14 as explained above the context of this pre-

C2

sentation of the results is none and this sentence is strangely placed in the introduction. Line 20, something missing after “preindustrial” (time or value?) Lines 20-24 and 1-2 on page 2 strange sentences that need editing and clarification and some coherence

Page 2 Line 4, something is missing or badly placed () for reference, needs editing Line 5 suggest editing, the sentence is not clear (“is associated with” “likely long-term sea level rise” are strange choices - are those modeling results? Line 6 something missing after “interglacial” (period?) suggest to replace “points toward” with “suggest” Line 9-11 suggest editing, “corresponds to an ice free planed” seems strange here Lines 13-14 need editing (what is realistic future scenario?) missing reference for the statement of WAIS committed to collapse. Line 15 suggest to edit “within reach” do you mean “range”? Line 18-19 suggest editing, the context is not clear, as stated above there is lack of coherence in this whole section. Are you suggesting that your modelling study presented in the paper contributes to estimating whether ice sheet is close to a tipping point? Line 23 something missing, interannual variability of what? Line 24 what is “classic” about the study by Pollard et al (1990)? Line 25 suggest to replace “in” with “of” delete one “constant” - what variability? (interannual? Of T?) Line 26 and 27 suggest to replace “expected” with “computed” Line 27-29 the relationship between the simple minimal model of axially symmetric ice sheet resting on a bed that slopes linearly downwards from the centre and the Greenland surface mass balance, so this sentence is strange, needs clarification and editing Line 30 do you mean spatial or temporal variability?

Page 3 Lines 1-3 need editing, how is this related to the other text? Line 4, nonlinear with respect to what? What does “specifically avoid using monthly climatologies in order to include the effect of interannual variability” mean? Some editing is necessary. Line 5 and line 14 what does “climatology” mean here? Temperature and precipitation? Line 6 What kind of errors? Line 9 Bias correction of what? Lines 14-19 needs clarification and editing Lines 23-24, needs editing and missing reference for the “long term ice sheet study”

### C3

Page 4 As discussed above the relationship between Eq. 1 and 2 is not explained and there seems to be none here, how is Eq. 1 applied? Line 13, how do you know that the model is sufficient to illuminate the dynamic effect? It is not clear from the text of the paper.

Page 5 There is sometimes (line 1 and line3) swap of the variables in the equation  $f(T,V)$  Line 5 what meaning does the expectation value have? Line 20 replace “has” with “have” (variationS) Line 25 “tend to zero” for what condition?

Page 6 Line 10 what is  $Wt$ ? Lines 12 some editing is necessary, what process? Line 14 missing reference for the value Line 16 how do you determine that 1 year is sufficient? Line 21 suggest to replace “lower” with “smaller”

Page 7 Figure caption missing “simulation” after “constant temperature” and “fluctuating temperature” Line 7 missing “,” after specifically Line 8 suggest to replace “this” with “that”

Page 8 Line 1 sentence is not clear, needs editing Line 3 not clear what “this” means here Line 6 “here we take same approach” does not make sense here, are you “comparing the output of RCM. . .” (line 4)

Page 9 Line 11 red curveS .. show (delete s) Line 12 blue shaded Line 16 something missing after “preindustrial” Line 19-21 this is confusing, if the SMB of Greenland is -234 GT/a and 3°C warming will cause  $\Delta$ SMB to be 30 Gt/y, what does it mean for current mass loss? Line 22 suggest to replace “saturate” with “reach a constant value”

Page 10 Figure caption, explain what  $\Delta T$  and  $\Delta$ SMB mean in this context Line 5-6 text needs editing, it is not clear what are meant here.

Page 11 line 2 Suggest to add “simulations” after ice sheet model line 11 as explained above replace “mass balance” with ,  $V \dot{G}$  or  $dV/dt$  lines 11-14 need editing, confusing sentence lines 20-30 needs editing, the relationship of the model result to reality is not clear or justified. Technical corrections:

### C4

Please also note the supplement to this comment:

<http://www.the-cryosphere-discuss.net/tc-2017-47/tc-2017-47-RC3-supplement.pdf>

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