

## ***Interactive comment on “The contrasting response of outlet glaciers to interior and ocean forcing” by John Erich Christian et al.***

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Dear Colleagues

This is a very nice manuscript, well presented, with a good methodology and a thorough set of model experiments that comes to significant and interesting conclusions.

There are only a few minor things I would like to see changed, and which are indicated below.

Best regards,

Martin Lüthi

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C1

General comments:

- clearly written
- flotation-based calving criterion -> what would change with other parametrizations?
- call "interior forcing" something more like "mass balance forcing"
- The paper structure, even if it is not following the standard pattern, is useful and helps guiding the reader through the manuscript.
- The bibliography should be carefully revised. Capitalization of journal names is often wrong, and DOIs are missing. IPCC (in Stocker..) should be mentioned, etc..

Style (to be adapted to journal standard everywhere):

- do not put variables in parentheses (as is occasionally done)
- no colons before equations
- write out "Equation" in the text, only abbreviate in parantheses using "Eq." oder "Sect." is not commonly used in manuscripts.
- use real fractions in equation environments:

$\frac{1}{2}$  etc

Specific comments:

76 variable names should consistently \*not\* be enclosed in parentheses. Also indicated that this is just a statement of conversation of mass.

86 "Glen-type coefficient": better say you use power-law rheology with A and n.

89 In an equation you should use real fractions:  $\frac{1}{2}$  also in Eq. (7) etc  $\frac{\tau_b}{C} \frac{1}{m}$  and so on,

please change everywhere in the manuscript

C2

105 so, here you allude that your model is defined on a grid?

115 "Section" (not abbreviated in the text)

- Figure 1d: it would be interesting to also display the forcing (maybe as gray line with appropriate scaling).

- Table 1: why is the sliding coefficient given with 5 significant digits? I think in this study this can be any arbitrary number of about that order of magnitude. Same for A.

Scientific notation does not use a  $\times$ , but a  $\cdot$

Also consider two more columns, one for the symbol (should come first) and one for the units.

Table header should not be given in bold.

164 it is not clear what the "two stages" are. Some other designation might better describe the model.

165 "static geometry" (as opposed to "dynamic") is probably what is assumed by all models. Do you mean "linear/sloped"?

167 " $S \times L$ " should be " $S \cdot L$ " or just "SL". Do not put variable names in parentheses in some places.

167 "Q" : what is this, the flux into the grounding zone? Please make description clearer.

190 Repeat which variable is the "mass balance rate" (I think S)

192 What is this "small reservoir"? Until now there was just one, described by S and L. Maybe this is the purple box in Figure 2. If so, this setup should be made more explicit from the beginning, and Figure 2 should be improved.

200 It is not clear what the use of a linearized system is. It is certainly useful to find eigenvalues and eigenvectors at a certain state.

C3

But having a "full" model with all nonlinearities, and then using a linearized "deviation model" makes no sense for the large changes investigated. Also, the "full" model is extremely cheap to calculate, as it is just a 2-variable ODE.

Especially given the comments in line 210 that the nonlinear ("full") ODE give the same results makes one wonder, why the linearized version is used at all (except for investigation of eigenvalues).

250 Sn important additional argument in this discussion is also the spatial scale. Interior changes take a certain time, given by the ice flow speed, to affect the terminus, while processes at the terminus are immediately affecting glacier length. This is the same as on any glacier, but the effect of terminus dynamics in tidewater are much faster and bigger than those of terminus melt on a mountain glacier.

265 Here a link to kinematic wave speed would be very interesting. How fast is the terminus signal propagating upstream.

Figure 3: The two blueish-greenish colors are difficult to distinguish, use a better color table.

Figure 4: Use clearer colors, full red, blue etc. They might look less appealing, but are easier discernible.

308 "white noise forcing" (also 311)

346 where do these exact numbers come from?

350 should the "as of 2020" follow "transient response"?

Figure 5: caption: "Table" (upper case)

457 Here the question posed above gets more pressing: why is the linearized model used? Can it be used at all for such large changes? How wrong do the results get? Why is not the "full" simple model used here?

C4

458 And then also: are the time scales always the same, even if the glacier geometry changes by a very large amount?

467 "time series" (two words)

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-301>, 2020.