

## ***Interactive comment on “Basal drag of Fleming Glacier, Antarctica, Part A: sensitivity of inversion to temperature and bedrock uncertainty” by Chen Zhao et al.***

### **Anonymous Referee #1**

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#### General comments

This paper presents results from a series of Elmer/Ice simulations of the Wordie Ice Shelf-Fleming Glacier system in West Antarctica. It aims to demonstrate the sensitivity of model inversion to englacial temperature, bedrock topography and ice front boundary, as well as provide a realistic basal shear stress field. It uses a similar multi-step inversion process to Gladstone et al. (2014), where surface relaxation is followed by an inversion for basal friction coefficient (C); then a steady-state temperature simulation using this C and velocity; and another inversion using the steady-state temperature. This process is applied iteratively in three cycles, which they show helps remove the

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dependence on the initial temperature distribution. They argue this is particularly important to Fleming Glacier given the sensitivity of the system to englacial temperatures, due to the dominance of internal deformation over basal sliding. Using one of the initial temperature distributions, they run the inversion process several more times, testing the sensitivity of the inverted basal traction coefficient to bed geometry (e.g. bedmap2 versus mass-conserved), and the ice front boundary condition.

Overall this manuscript is well structured and clearly written, although some of the description of figures and discussion of results are fairly laborious and may benefit from being reduced in length. The conclusions are clearly supported by the results presented. I recommend this manuscript is published in The Cryosphere, provided the authors address the following comments.

#### Specific comments

Line 47: “especially for small-scale glaciers.” Not sure this is relevant, or are there papers that show greater sensitivity of small- over large-scales systems?

Line 45 – 50: These two sentences appear to be contradicting each other – firstly you say that these uncertain quantities pose a challenge for modelling basal shear stress, and then you say they are not important (to that particular ice cap). I wonder if it’s worth holding off on discussing the results of the Vestfonna studies until the discussion.

Line 132: Why do you make this assumption? I know it is discussed further on that the ice shelf is effectively only 1.5 km long by 2008, but before knowing this, this statement seems strange, especially given that an ice shelf is mentioned previously.

Line 163: What is your justification for using a linear sliding law?

Line 263: What do you mean by “imposed by a neighboring glacier”?

Line 274 – 277: This seems out of place here, and the related discussion in Section 4.3 is not obvious.

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Line 334: add “, than CONTROL” to end of sentence? The similarity between BEDZC and BEDMC compared to CONTROL seems unsurprisingly, i.e. the two surfaces are more similar than the two thicknesses.

Line 352: Possibly worth mentioning Sun et al. (2014) here as another study that demonstrates the sensitivity of grounding line dynamics to bedrock topography.

Line 256 – 257: This seems unsurprising seeing as BEDZC makes use of surface (and mass conserved thickness?) from 2008, the same year as the velocity observations.

Line 387 – 88: Why doesn't altering the sea level affect the grounding line position?

Line 420 – 422: Not sure “spreading” is the right word: spreading in which direction?

Technical corrections

Line 21 – 23: unnecessary repetition of “temperature-dependent” deformation, combine to one sentence

Line 67: add comma at end of line

Line 108: Here FG is used for Fleming Glacier, whereas previously FGL is used. I suggest you use FG consistently (to me GL is grounding line).

Line 184: Inconsistent use of basal sliding/drag/friction coefficient, as well as inconsistent use of boldface C.

Discuss results in the present tense

Line 295: remove quotations from CONTROL”

Line 353: “most accurate”, rather than “best”?

Line 403 – 410: remove quotations from simulation names, e.g. “IFBC3”.

Figure 8: Could the 1500 m/yr contour be included in the other plots too, to help with comparisons?

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Figure 8: Mention these are from after cycle 3

References

Sun, S., Cornford, S.L., Liu, Y., Moore, J.C., 2014. Dynamic response of Antarctic ice shelves to bedrock uncertainty. *The Cryosphere* 8, 1561–1576.

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