

Interactive comment on “Recent dynamic changes on Fleming Glacier after the disintegration of Wordie Ice Shelf, Antarctic Peninsula” by Peter Friedl et al.

Anonymous Referee #2

Received and published: 25 October 2017

Friedl et al. present a dense time series of surface velocities and elevation change rates of the Fleming Glacier system in the past two decades from multi-source remote sensing data. This study identified two significant acceleration phases occurred in 2008 and 2010–2011 after the Wordie Ice Shelf has nearly disappeared in front of the Fleming Glacier. The determination of floating area based on the hydrostatic height anomalies, bedrock data, elevation change rates, and acceleration phase is very helpful to explain the rapid dynamic changes after 2008. However, some points in this study are not well explained and need further rewording. Some minor wording and grammar errors also need to be fixed.

C1

Here are some general comments:

1) It is not clear about the epoch of the 2008 grounding line position. Please clarify it, particularly regarding locations in Fig. 6 and Fig. 6S.

2) The method used to determine the grounding line position in 2008, 2011 and 2015 from the velocity data, surface-thinning rate, and the bedrock data is not clear enough in the method (Sect. 4.3, P7, L19–27) and result section (Sect. 5.3), especially regarding the determination of the grounding line position in 2008. From Fig. 6, it is appeared that the 2015 grounding line is mainly based on the ridges of modelled bedrock combined with the hydrostatic height anomalies along OIB flight lines. However, profiles in Fig. S5 show that how much the Bedmap2 bedrock and Huss and Farinotti’s modelled bedrock can differ from the PIB and OIB measurements. Then how reliable are the hills used to decide the grounding line location? In the analysis of Fig. 6S, it is better to explain how the different evidence (velocity profiles, elevation change profiles, hydraulic height anomalies, and modelled bedrock) is being combined to determine the estimated 2008 and 2015 grounding line. If they are not consistent with each other, please explain the final selection.

3) This study (P11, L27–29) concludes that the basal melting driven by ocean-warming is the dominant trigger of the grounding line retreat and glacier acceleration. However this lacks direct evidence, namely the basal or frontal melting rates underneath the ice shelf. Given the little ice shelf left in 2008, it is not very convincing to say that the basal melting underneath the ice shelf dominates the ungrounding process.

Specific Comments:

P1, L8: change to “... regions most affected by climate change”

P1, L14: The finding about glacier ungrounded in 2008 between January and March has not been confirmed by observation or measurements. Please reedit this sentence.

P1, L24: “Currently, the tongue of Fleming Glacier is grounded in a zone of bedrock

C2

elevation of -400 m” This statement is not mentioned in the main text. Please state this in the main text and make the elevation color bar in Fig. 6 clearer for reading the elevation values. It will be helpful to add elevation contours.

P1, L26: You can't say “this endangers” “a huge potential”. Add a suitable verb before “a huge potential”. “huge” is not appropriate here.

P2, L4: Add “be” before the number “4.21”.

P3, L3: “former tributary glaciers” is confusing since the glaciers still exist, Suggest instead “. . . originally fed by several major tributary glaciers (Fig.1). Among these, Fleming Glacier is . . .”.

P3, L10: “Here the ice shelf was temporarily grounded and stabilized . . .” is confusing. Does “Here” mean at a time point or at the location of the pinning points? Is there evidence of grounding of the previously floating Wordie Ice Shelf? Do you mean it was stabilized temporarily? Do you mean “the next rapid break up event” occurred in 1989? If yes, please specify it.

P3, L18-19: Please add the ice front position in 1997 and 2000 in Fig. 1. It will help reader to understand your statement here.

P4, L21-25: The information about the modelled bedrock topography from Huss and Farinotti 2014 is not enough. Given its role, indication of origins and uncertainties should be included in the paper.

P7, L18: Modify “Sect. S2” to “Sect. S3”.

P7, L22: “mitigates” is hardly correct for 90

P7, L22-23: It is not clear how you decide the grounding line position from the surface velocities. Please clarify. If you define the grounding line based on where the maximum velocity increase occurred, please specify it with relevant references.

P7, L23: replace “determent” - do you mean “determinant”?

C3

P8, L18: Please comment on the higher velocity changes in the 2011 glacier front in Fig. 3 and why it is ignored.

P8, L23-24: Suggest updating Table2 by adding the velocity in 2015 from Walker and Gardner, 2017 at three sites.

P8, L27: As I could tell, the highest ice thinning rates for Fleming Glacier from Fig. 4 (orange color) is higher than 6 m a-1.

P9, L2: “For the location of the data see Fig. 4” → “The location of the data is shown in Fig. 4”.

P9, L13: Missing space after the full stop.

P9, L19-20: It would be useful to compare your thinning rate with that from Zhao et al., 2017 and Walker and Gardner, 2017.

P10, L1-3: The “We extracted” part of the statement should explicitly refer to Fig. 6S, and the location of the four profiles should refer to Fig. 6.

P10, L3-4: For “The plots”, you mean Fig. 6 or Fig. S6? It would be clearer to say “Those profile plots (Fig S6 1-4) suggest . . .”. Which glacier or profile are you talking about for the 2008 grounding line position?

P10, L5-6: “possible” and “likely” are same to me. It's not clear how the grounding line positions in 2008 are decided on Profile 2, 3, and 4.

P10, L7-15: Is detailed discussion of a supplementary figure in the main text proper? Consider including Fig. S6-3.

P10, L18-20: About “no significant acceleration since 1996 . . .”, if you compare the velocity at three sites with the 2015 velocity from Walker and Gardner, 2017, you will find some speed up from 1996 to 2015. Alternatively you need to qualify with “by 2013”.

P10, L27-28: Besides the surface melt, basal melting water generated from the basal

C4

frication heating could be another trigger of enhanced basal sliding. It's hard to rule out the possibility of enhanced basal sliding unless you have further evidence.

P10, L30-31: If this is your method to decide the grounding line position from the velocity data, please move this sentence to Sect. 4.3.

P11, L12: Please cite references for the Twaites Glacier and the Pine Island Bay.

P24, L4: Modify "Linens" to "Lines".

Supplement Material

It is better to use consistent zero distance mark for the various profiles in both the main text (Fig. 2, 3, 5, 6) and the supplementary material (Fig. S6). The use of different starting points (the 1996 grounding line position or the 2007 ice front position) for describing the distance is confusing. If it is too difficult to shift the origin in the supplementary figures, the GL96 grounding line needs to be clearly marked.

P12: Modify the legend of a) and b) from "Ice Surface/Bottom elevation (OIB)" to "Ice Surface/Bottom elevation (PIB)".

P15, L3: Modify "profiles 1-5" to "profiles 1-4". Also consider labeling figure parts as S6.a-d for consistency with other sections. Anyway add labels to the profile figures.

P15, L4: Can't find OIB ice surface/bottom in those figures.

P15, L5: Modify "grounding line" to "GL".

P15, L6-7: Can't find Green, Red and Blue lines in those figures.

P16, L7-8: It's hard to tell the 2008 grounding line position upstream the 2011 front without direct evidence. Please explain it.

P16, L10-11: Please add GL11 in Fig. S6.2.

P17, L3: Move "in 2008" after "the grounding line".

C5

P17, L5-6: Along Profile2, it's hard to tell this hill in Fig. 6. Considering the uncertainty of bedrock (yellow and brown line in Fig. S6.3), is it possible that this smaller hill is not physically real? On P18, L5-6 you suggest that "the topography may be distorted in the modelled bedrock data".

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2017-91>, 2017.

C6