Review for "*Antarctic Peninsula ice shelf collapse triggered by föhn wind-induced melt*" by Laffin et al.

General comments

This paper has the potential to be a very interesting study about the possible influence of föhn winds on the large-scale collapse past events of the Larsen A and B ice shelves, and on potential future break-up events of Antarctic Peninsula ice shelves. However, in its current state, it is poorly written and badly structured in many places, e.g. why are föhn winds only defined and described in the Results and not in the Introduction? I give more examples in my line-by-line comments below.

Additionally, the current paper includes extremely limited references to relevant work that has already been done (particularly regarding föhn winds, but also regarding surface melt processes in general). A good example of this is the sentence in the abstract (line 13/14) which reads: "However, no studies examine the timing, magnitude, and location of surface melt processes immediately preceding these disintegrations." This statement about the Larsen A and B ice shelves is entirely incorrect as there have been many studies that have examined surface melt processes on these ice shelves, e.g. Scambos et al (2000, 2003, 2004) Glasser and Scambos (2008), Leeson et al (2017, 2020), Banwell et al (2013; 2014), Kuipers Munneke et al (2014), Lenaerts et al (2017) and Robel and Banwell (2019), to name just a few. I suggest that this sentence (and similar sentences in the Introduction) are reworded to specifically focus on the research to-date regarding effects of foehn winds on surface melt on ice shelves. Currently this paper references only a few such föhn wind studies; the following key studies about föhn wind induced ice-shelf melt are missing: Datta et al (2019), Wiesenekker et al (2018), Bozkurt et al (2018), Kirchgaessner et al (2021), and I suspect a good few others. Kirchgaessner et al (2021) is particularly relevant to the current study as it also focusses on AP ice shelves. As I am not 100% up to date with the ice-shelf melt-related föhn wind literature myself, it has been hard for me to give this paper thorough review given that the authors have not placed their study in the context of existing knowledge from other literature.

Finally, unlike the LAIS, I think I agree with the statement that the 'LBIS collapse was not directly related to the impact of föhn-induced melt', e.g. as the authors state on line 190 and in the Conclusion. However as the initial LBIS collapse on Feb 9 2002 coincided with a föhn wind event, I wonder if the authors have considered the idea that that föhn wind event may have helped produce sufficient surface meltwater such that the drainage of multiple surface lakes via hydrofracture cascades may have been triggered (i.e. 'chain reaction' lake drainage), thereby resulting in LBIS's near complete collapse a couple of weeks later (see Banwell et al 2013, Robel and Banwell, 2019). So in that sense, I am wondering what the authors think about the idea of föhn winds having been an indirect cause of LBIS's break-up?

Specific comments

Line 11: 'Add 'grounded' before 'glaciers'.

12/13: In addition to surface melting, a mention of lake drainage via hydrofracture, and/or cascades (or a chain reaction) of lake drainage events could be mentioned here.

13/14: See 'general comment' above.

16: Mention the paper's specific focus on Antarctic Peninsula shelves.

18: 'less' vulnerable compared to what?

22: 'Forensic' is the wrong word as there is no link with crime.

26 – 28: Similar to the comment I made about line 13/14 in the abstract, this sentence is entirely incorrect and does not reference prior key studies regarding both surface melt processes on ice shelves and föhn winds specifically. I suggest you add at least the references I mention above, but I will have missed some.

29 – 30: Be clear that you are using a ML method you developed in a previous study (at least that is what I am guessing), i.e. Laffin et al (2021), and reference that. Currently this sentence is vague.

30- 32: You state that your method is the 'most accurate', but you do not state what other methods/studies you are comparing it too, and nor do you state how you came to such a conclusion? Did you do some sort of intercomparison study? If so, that should be briefly explained.

33 – 41: This is interesting, as it totally contradicts the statements made in the Abstract and Introduction about there being no studies that have looked at such ice shelf melt/collapse processes! Additionally, by 'warm water intrusion', I assume you are referring to enhanced basal melting? And another good example of a study that demonstrated how sea swell caused ice shelf frontal break up is Banwell et al (2017).

43: For the 1 metre lake depth reference for LBIS, the two references given are incorrect. They should be Glasser and Scambos (2008) and Banwell et al (2014).

47: Regarding 'ice shelves into sections with aspect ratios that support unstable rollover', Burton et al (2013) would be a very appropriate reference to add.

48: Robel et al (2019) is incorrect. It should be Robel and Banwell (2019).

49 - 51: The first part of the following sentence requires references, and the second part is incorrect (for the reasons I give above in General Comments): '*Previous research acknowledges enhanced surface melt during years of collapse and the presence of föhn wind events in the region, however, no attempt to produce a timeline of total melt quantity or melt caused by föhn before and during ice shelf breakup has been undertaken*'

52/53: Poor English. Reword.

55 – 58: These questions are good; clear and precise.

59/60: 'spatial distribution' of what? Poor English.

85: It needs to be much clearer that the current study uses a föhn detection algorithm developed in a prior study (Laffin et al. 2021), and NOT in this study (at least that is my understanding from the current paper).

86 – 97: It would be interesting for the authors to compare how their algorithm compares to that used by Datta et al 2019 ('Foehn Index'; also used in Banwell et al. 2021) and perhaps other existing algorithms too. E.g., on what basis/using what evidence can the authors state that there '*method is the most accurate compared to previous work*' (without even giving reference to that previous work).

105: I think these should more accurately be described as ice shelf "areas" given that Larsen C is split into two areas. Also, I suggest listing those ice shelves/areas in this sentence.

113: you have already defined AWS elsewhere.

116 – 120: This useful definition/description about föhn winds needs to be moved into the Introduction; it does not belong here.

121: '*AP winds from the west and northwest (*föhn *influence)'* is not clear. Are you suggesting that all winds from the W and NW on the AP are föhn? (If so, that isn't clear, and I assume not all winds from that direction are föhn?

121/122: I assume this is a result from the current study, but that needs to be made clear if so.

129: '*The degree to which föhn winds impact surface melt on each ice shelf varies…*' state what timescale(s) are being considered here.

131: Figure 5 is mentioned before figures 3 and 4 have been mentioned.

140/141: I simply do not know what the authors are trying to state by the following sentence: '*However no single factor, including föhn-induced melt rate, lessens the influence of all the other factors that contributed to these collapses.*'

153/54: For the first part of this sentence, please acknowledge (and reference) other studies that have also established this fact.

168: Banwell et al (2013) did not study Larsen A.

190: Please see the final paragraph in my 'general comments' above.

211-225: It seems like some of this material (inc. equation1) should be in the Methods, not Results?

229/230: Again, discuss this statement in the context of the findings of other studies.

251: Glasser et al 2018 should be 'Glasser and Scambos (2008)', and Glasser et al (2021) is not in the reference list.

274: Satellite-derived depths of lakes are in Banwell et al (2014).

278 – 281: The authors state the following two sentences, which I disagree with: '*The large melt volume in a relatively short amount of time spatially expanded and increased melt lake formation and depth, filled crevasses, increased water pressure on the crevasse tip and walls and triggered large-scale hydrofracture cascades that led to catastrophic disintegration of the LAIS (Scambos et al., 2000; Banwell et al., 2013). The same cannot be said about the LBIS*'. The processes described in the first part of the sentence are what various studies have proposed caused the ultimate collapse of the LBIS, but I am not aware of any study have proposed the same mechanism for LAIS (Scambos et al 2000 or Banwell et al 2013 certainly did not).

290: George VI is not a good example to use here as it has very constrained, compressed ice flow.

293: '*more stable'* than what? This is vague.

294: 'than previously thought' – by who? Give references.

Figures

Figure 2: I assume the data shown in panels b) and c) are from RACMO2, but that should be clarified.

Figure 3: Again, where is the data shown in this figure derived from?

Figure 4: Again, please state the source of the data.

Figure 5: Again, state the source of the data in the caption, and specify what kind of data it is. 'data' is vague.

Figure 6: Again, state data source. And for a), should this be 'total melt'?

References (those in **bold** are not referenced in the current paper)

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