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The Cryosphere Discussions

Interactive comment on "Overview of areal changes of the ice shelves on the Antarctic Peninsula over the past 50 years" *by* A. J. Cook and D. G. Vaughan

Anonymous Referee #2

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General Comment

The paper gives an overview of retreat rates of ice shelves along the Antarctic Peninsula from mid 1900s to 2009.

Although this study analysed a large number of data, it remains unclear which results are new and which just confirm former numbers of retreat and area – this applies in particular to Larsen A, B and Wilkins and Wordie. The list of the former studies by other authors given in Tab.1 is incomplete – which is very surprising given the fact that you are studying areas and topics others have already analysed as well. Moreover, formerly published numbers were not compared and discussed at all, e.g. size of Larsen B in

Rott et al. (2002) in 1986 is 11500kmˆ2, while you give an area of 12190kmˆ2 – such differences need to be discussed!

The discussion of the reasons for ice front retreat in this study again reports and summarizes other work and there is no new idea about the causes of ice front retreat presented.

There are many details which are incorrect and all those are listed below. The benefit of this paper is that it lists the retreat numbers for all ice shelves in one paper – however, it is unclear where it provides new information. This is also reflected in the enthusiastic comment of Marie Pelto 'useful comprehensive REVIEW of the changes'. I agree, that a review is useful, but it does not fulfill the requirement of the general guidelines of 'concentrating on new results'. Thus I recommend performing major changes, in which the authors compare their numbers with formerly published numbers and discuss differences and agreements. Furthermore, the authors shall provide an analysis of the correlation between ice front retreat rates and possible causes for the specific ice shelves.

Specific Comment

Page 581

Line 13-18: Recent data shows that the acceleration as response to retreat or loss of ice shelves is a temporal limited feature and that the acceleration is stagnant. This implies some kind of stabilizing internal feedback algorithm which is yet not well understood. I think this should be mentioned here, as it has implications on sea level rise and suggests that, in contrary to the statement in line 18, the contribution to sea level rise is temporarily limited.

Line 25: Suyetova (1986, translated into English) presents a study where ice shelves all around Antarctica are monitored from 1961 to 1984. Although the absolute numbers are likely not accurate and the quality of data analysis of that paper and the here

presented study are not comparable, the reported changes are worth to note.

Page 584

Line 3: The term collapse has in the past been attributed to the dynamics of the retreat (e.g. MacAyeal et al. 2003, Braun et al. 2009). I suggest to use disintegration instead of collapse.

Line 8: 'original area' is surely not the area it had in 1976.

Line9-17: As on page 581 line 9-11 the discussion about the oceanic contribution to the viability of ice shelves is opened, I expect this to be discussed here, following line 17 as well.

Page 585

Line 19: Is fast really the right attribute here?

Line 20: 'at approximately 50%' taking the second half of the sentence into account.

Page 586

Line 1-2: Who observed the undermelt (basal melt?) in this(?) ice shelf system in the recent years?

Page 587

Line 6: The flow regime of Larsen B (modeling study of Doake et al. 1998) and Jones are not comparable, although areas of divergent flow are indeed more prone to retreat. I interpret Fig. 4b such that the convergent stress area has retreated faster than the divergent stress area. Doake et al. 1998 discuss the retreat behind an arch of compressive stress regime and calving behind isotropic points. I think this is not comparable to the scenario at Jones Ice Shelf. It would be interesting to discuss if the ice in the channel between Arrowsmith Peninsula and Blaicklock Island is meteoric ice or if it might consist of marine ice with different rheology and fracture toughness – this

connects to the statement in

line 10: it remains unclear to the reader of this paper how the ice thickness varies along/across the ice shelf. Please give the reader a chance to understand how the different factors are connected to the disintegration.

Line 9: The figure does not show any pinning points. Are there ice rises or which kind of pinning points are you referring to?

Line 19: 'most dramatic' is very valuing. There might have been many events of ice shelf disintegration that did never came into our mind as they took place before the era of polar research begun. They were probably similar 'most dramatic'. The disintegration of the Wordie Ice Shelf brought all the questions, that are partly still unsolved today, in our minds and demonstrated the urge to study ice shelf disintegration and its causes.

Line 20-21: This sentence contradicts the one on page 588 line 1-2!

Page 588

Line 5: The data of this work allows to quantify 'rapid' and the previously mentioned 'fast'.

Page 589

Line 22: Replace break-up by calving. That the sea ice prevents the northern ice front from calving is a hypothesis if not an assertion. An argumentation for the prevention of calving by sea ice could be that ocean swell is reduced and that the meteorological situation suppresses storms that support often thought to be the trigger of the final lateral rift propagation leading to calving. Modelling studies of Humbert (2008) showed that the stress regime along the northern ice front is very different from the one at the southern end.

Line 23-25: If the ice front is not visible in the imagery, additional sourced like altimetry

data could be used in order to constrain the location of ice front.

Page 590

Line 6-10: It is worth to mention that the presence of the melt ponds is restricted to some tenths of kilometers in the middle between the two ice fronts and that it is triggered by sedimentary rock particles which are blown onto the surface of the ice shelf from the mountains on Alexander Island. I suggest that this is the persistence factor you are after in line 12-19.

Page 591

Line 12: I suggest to insert 'For a description of the full coastal-change time series for Wilkins Ice Shelf see Braun et al. (2009).' As the changes of the ice front position were investigated in that paper already.

Line 14: I doubt that the data from 1947 gives evidence for an advance between '47 and mid80s. The series of retreat events have been investigated by Braun et al. (2009) and their conclusion is that the earliest retreat of the ice front happened in 1991.

Line 16: The events at Wilkins Ice Shelf were break-up events, thus area loss on short time scales with numerous icebergs of variable size. This is in contrast to ordinary calving. I suggest to introduce here the terminology break-up event and in particular to delete the term 'disintegration' event, which implies the loss of about 90% of the size.

Line 19: The 800kmˆ2 do not coincidence with the numbers given by Braun and Humbert (2009) and Scambos et al. (2009). You should discuss the difference. Furthermore, you should add a note that the 1450kmˆ2 are not in agreement with the 1220+-75kmˆ2 found by Humbert and Braun (2008), which is based on a large time series of satellite images.

Line 22: As you are investigating the area loss in 2009, it is unclear why you take into account only part of the area that was lost. In total 730kmˆ2 were lost and the newly formed ice front shown in Fig4e is quite misleading as it represents only a snapshot

within a process.

Line 23: No – the 5434kmˆ2 is your sum of the lost area!

Line 26: This range of the flow speeds represents an interior fraction of the ice shelf. Braun et al. (2009) shows inflow from Lewis Snowfield with up to 180m/a (interferometric velocities).

Line 27: The flow speeds of the GeorgeVI Ice Shelf reported by Rignot (2006) are larger than 200m/a.

Page 592

Line 6: below sea-level?

Line 17-20: No, Humbert and Braun (2008) did not show that.

Page 595

Line 13+18: Sjögren (also in Fig4h)

Page 596

Line 1: I'm missing in this list as separate item the Larsen Inlet discussed by Rott et al., 1996 & 1998 and Skvarca 1993. In Tab.1 it is on the other hand listed separately.

Line 7: delete 'now'

Line 14-18: You should cite Rott et al., 1996 & 1998 as they discuss this retreat in detail.

Line 19+14: Larsen A was the most spectacular event in 50 years and Larsen B was on an even larger scale? I understand the wish to express the particularity of these events, but I suggest that you re-evaluate which events were similarly spectacular, which is their joint nature of particularity and if this is their explosive nature and/or the short time period on which it happened, name it properly.

Page 597

Line 16: MacAyeal et al. (2003) discusses the rapid area increase of what you called plume. It's MacAyeal et al. (2009) which discusses the energy release by capsizing icebergs – what you called domino effect.

Page 598

Line 28: IS already defined?

Page 602

Line 6: century is not a SI unit.

Page 604

Line 18-19: This is not correct. Humbert (2008) discusses the southern ice front.

Line 17 onwards: On the previous page and in the upper half of this page you describe causes for retreat and/or instability which are not linked to the atmospheric warming. It is odd that you still expect that all retreat events should be connected to the proposed (we should take it literally – it is a proposed limit of viability) -9°C isotherm. If there are other causes, like the influence of the ocean, why do you expect all retreating ice fronts to lie within this isotherm? In this discussion you also miss the argumentation following the number of positive degree days – which is a quantity which is more directly linked to surface melt water related instability.

Table1

This table should be arranged like Tab.3, with numbers not only for the first and last year of observation, but all numbers given in the studies. In order to avoid inconsistencies due to different grounding line position give the retreat areas reported in these studies and your retreat numbers for the same time period in order to allow the reader to compare the numbers. Please discuss these numbers in the text!

Line Müller Ice Shelf: Wards first number is from 1947 'advance of the ice front between 1947 and 1956, increasing the ice shelf from approximately 51kmˆ2 to c. 78kmˆ2'

Line Prince Gustav Channel + Larsen Inlet + Larsen A: Rott et al. (1998) is missing. Data given for 1986 and 1997!

Line Wilkins Ice Shelf: The study of Braun et al., 2009 is not mentioned here at all. It covers the time period from 1986-2008 and gives retreat for particular years.

Line Wordie Ice Shelf: Reynolds (1988) missing (British Antarctic Survey Bulletin!). Size of the Wordie in 1979: 1060+-20kmˆ2.

Interactive comment on The Cryosphere Discuss., 3, 579, 2009.