The Cryosphere Discuss., 2, S546–S550, 2009
www.the-cryosphere-discuss.net/2/S546/2009/

The Cryosphere Discussions

Interactive comment on "Changes of Wilkins Ice Shelf over the past 15 years and inferences on its stability" *by* M. Braun et al.

M. Braun et al.

Received and published: 8 March 2009

Braun and others, (2008) provide a thorough review of Wilkins Ice Shelf (WIS) behavior illustrating its dynamic nature. Given that the process of ice shelf collapse is not understood detailed reviews of the evident changes in ice shelf physical characteristics offered here and by Glasser and Scambos (2008), are of great importance. Three key observations of this paper are: 1. That no continuous ordinary calving events occur on WIS. 2. That the central part of WIS did not have rifts prior to 1990, that by 1994 rifts had begun to expand in the northern front of the WIS and that today the central area is intersected by long rifts. 3. That surface meltwater ponds and channels are not related to the WIS breakup of 2008. It is worth noting that on Larsen B the large shear rifts that were key in the collapse were not evident more than 20 years prior to the collapse either (Glasser and Scambos, 2008). Is this a sign of changing buoyancy

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

forces allowing the bending stresses to develop the extensive rifts?

Answer: We very much acknowledge the positive and constructive feedback from M. Pelto. In fact he points out some of the main findings of our paper. We refer to bending stress and buoyancy forces in regard to the rift formation in July 2007 on the bridge between Charcot and Latady Island. We cannot give evidence from our data that buoyancy forces and hence bending stresses have changed over time, but it seems very plausible to us that basal melting has thinned the part where the Feb and May break-up occurred (See section 4.1, last sentence). We explain in section 4.3 that either changes in material parameters or changes in ice thickness (and in this case buoyancy forces) cannot be ruled out as explanation. We do not explain all the rifting starting in the early 1990’s seen along the northern ice front by buoyancy forces. We have now included a new paragraph in the conclusion section referring to Glasser & Scambos (2008) findings and also include a structural glaciological map similar to the maps presented by latter authors.

Most of the following comments are offered to encourage the authors to more clearly and convincingly answer this question. A figure illustrating terminus position of ice front at least in vicinity of Charcot and Latady Island would be useful. This map could further illustrate via shading the two discussed areas prone to further collapse. A map based figure more fully illustrating the structural characteristics of the ice shelf similar to those used by Glasser and Scambos (2008) would be quite useful at least in the Charcot and Latady Island area.

Answer: Figure 4 and also Figure 8 illustrate terminus positions in the requested area. We have followed the other comment and include now a figure (Fig. 5) on these structural parameters similar to Glasser & Scambos (2008). In order to keep the paper concise we have deleted the Figure 5 of the previous manuscript version.

The comments to follow are offered as they appeared in the paper with an aim of enhancing the clarity of the paper. 352-3 It is noted that beyond the fast edge there is

TCD

2, S546–S550, 2009

an area of open water in some years. How wide is the fast ice? What is the size of the open water fetch? How long does the open water tend to last? What was the sea ice state in 2008?

Answer: None of the authors is a specialist in sea ice and thus this question is beyond our scope. We have therefore decided to change our statement about sea ice to: 'Visual inspection of MODIS images from 2002 to 2007 showed that the sound free of sea ice in some of these years, while the northern ice front has not retreated during that time.'

353-22 After defining crack types, it is important to consistently identify rifts as either tensile or shear stress induced based on orientation. This will aid the reader in developing a sense of the relative importance of each crack type. For example when fractures are discussed on 354-14-25.

Answer: Yes, we agree and worked through the manuscript to follow this advice.

355-5 ...Crack propagation toward the ice front... is this in general or in reference to a specific crack? Are the associated cracks in this paragraph tensile or shear in origin?

Answer: This relates to the former sentences. The fractures are tensile ones. The entire discussion about this open water area has been revised taking into account the comments of reviewer #2.

358-17 It is noted that ice rises have been viewed as key pinning points in the past, and not key zones of weakness development. There is a fine line separating these two differing roles. I would guess that the authors are suggesting that there is a limit beyond which the thickness of the ice shelf is insufficient for the pinning point to be a stabilizing force. That thinning is the preconditioning of the ice shelf to reach this point.

Answer: In the entire paragraphs from 358-16 until 359-18 we do not refer to thinning as pre-conditioning.

The change in buoyancy forces as a result and bending stresses would then tend to

TCD

2, S546–S550, 2009

help develop rifts. Whether this is correct or an incorrect, the reasoning sequence for ice rises being a locus of failure needs to be completed. The authors may in fact be saying this in this sentence...Hence, ice rises are, in the absence of a compressive stress zone that hinders rift propagation, a destabilising factor... Simply more attention is needed to at least qualitatively clarify the process.

Answer: It seems to us, that here a misunderstanding occurred. The break-up - independent of its own causes and mechanisms - happening far away from the central part of the ice shelf, caused the failure zones in the vicinity ice rises in the central part of the ice shelf. Whatever the cause for the break-up is, the 'event' break-up itself causes a fast (dynamic time scales) extension of the failure zones at ice rises.

359-9 ...drastic rift extension in coherence with break-up events... Can this observation be quantified in some fashion?

Answer: We now give various examples. Please see also our statement to a similar request of the reviewers below.

361-9 I agree with the conclusion that bending stresses and changing buoyancy forces are a cause for break-up. However, a better explanation of the nature and cause of the changes in bending stresses and buoyancy forces is required to sell this point.

Answer: In these lines we discuss the 1998 break-up event not the Feb & May break-ups. Selling this point for the 1998 break-up event better would require a 3D stress computation of this entire area, which is beyond the scope of this manuscript. We take this comment however as a general one and have improved our discussion concerning bending stresses in the according paragraphs.

Figure 6. Identify type of crack formation. The text says (354/3-8) 'Shear rifts mapped in the Landsat image from 1990 are displayed in blue colour. Those rifts moved with the ice flow downstream and experienced tensile stress, which is verified by their new shape in form of a wing crack. '

TCD

2, S546–S550, 2009

Interactive Comment

Answer: The captions says 'The blue lines are shear rifts locations and the green ones rifts caused by tensile stress, both in the 1990 Landsat image.'

Figure 9. Identify type of crack formation of rifts. Any other information quantifying rift changes, such as length or width?

Answer: This is now Figure 8. Crack type is now specified. Lengths are given as example.

Interactive comment on The Cryosphere Discuss., 2, 341, 2008.