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The Cryosphere Discussions

Interactive comment on "The evolution of the western rift area of the Fimbul Ice Shelf, Antarctica" *by* A. Humbert and D. Steinhage

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Summary:

This paper presents a detailed study of the ice structures of the boundary region between the Jutulstraumen and the western part of the Fimbul Ice Shelf, where large rift systems originate which later lead to calving from the Trolltunga. The study is based on an extensive dataset consisting of TerraSAR X imagery and airborne ice penetrating radar. The main findings are that the western part is well coupled to the fast moving glacier tongue so that shear stress can be transferred well across the boundary. A relation between the features visible in radar remote sensing imagery and internal structure derived from ground penetrating radar has been found. A phenomenon called "down-welling" of internal layers has been described.

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Interactive Discussion

Discussion Paper

This study contains plenty of valuable information about the structure of the Fimbul Ice Shelf. The classification of the zones based on TerraSAR X and GPR can be useful as basis for numerical modeling and can potentially be applied to other ice shelves as well. It is a significant finding that the surface features correlate with certain internal structures. However, I have some major concerns:

Structure

I think by giving the manuscript a clearer structure the authors would make it easier for the reader to access all the information. The parameters on which the classification is based are described in detail in the text. A table or a structural diagram of the single classes/areas and their properties would help to visualize this information and keep the text concise.

The manuscript would also benefit from focusing on the zones which are discussed later as the key areas for the western rift system. I appreciate the completeness of the presented approach, but it is at times difficult to link the discussion to the figures.

Radargrams

It would be helpful to highlight one or two of the layers in colour to visualize the amount of distortion. It is difficult to follow the single layers in the figures with the resolution provided.

Arrows could highlight the features discussed in the text in all radargrams and be linked to distinct marks on the satellite imagery, for example one particular dark stripe. Page 1106, second paragraph. To me it is not obvious from the figures that strain thinning is different above crevasses from figure 4a. It would be helpful to highlight this or zoom in on one region.

The radar profile A to A' cannot be 120 km long. Is there a factor two in here? The same is true for the profile from B to B'. This is essential because it appears to have lead to a misinterpretation of the data: Page 1105, last paragraph: To me it seems as

TCD
5, C551–C553, 2011

if the hyperbolas start right at the position where the stripy features are visible on the imagery. Again, it would be very helpful to indicate examples for the discussed features in the figures. Profile C seems to be ok.

Down-welling of radar layers

Most importantly: How is the radar data corrected for topography? If the hyperbolae are caused by basal crevasses, the dark stripes which are also visible in optical remote sensing data could indicate surface troughs, which can amount up to several meters in depth. Ignoring this might lead to an apparent distortion of layers which becomes stronger with depth.

The B profile cuts across the smooth ice zone downstream of the ice rumple (zone nine). To me it looks like if the extreme disturbance of the layering in the first half of the profile coincides with the boundaries of this region. On optical remote sensing data (e.g. Moa) this area appears to be under compression and is narrowing (distance between stripes on either side gets smaller). Could lateral compression perpendicular to the flow direction be a reason for the strong distortion?

I also do not understand the argument that basal melting could occur in the crevasses, deepen them, and lead to further distortion of the radar layers. The pressure dependence of the melting point would rather suggest freezing under thinner ice.

Additionally:

A rough ice shelf base is not the only explanation for the lack of a basal reflector in the radar data. Especially downstream of the Ahlmannryggen the reason could be accumulated marine ice (Holland et al, 2008).

Page 1107, second paragraph: See Glasser et al. (2008) and Holland et al. (2008), also Hulbe et al. (2010), might be worth citing one of these.

Interactive comment on The Cryosphere Discuss., 5, 1089, 2011.