The Cryosphere Discuss., 6, C958–C962, 2012
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The Cryosphere Discussions

Interactive comment on "Twelve years of ice velocity change in Antarctica observed by RADARSAT-1 and -2 satellite radar interferometry" *by* B. Scheuchl et al.

Anonymous Referee #3

Received and published: 7 July 2012

The paper reports on ice velocity (speed, really) changes for two major ice shelves, and some of the adjacent grounded ice, based on a pair of InSAR mappings in 1997 (associated with the RAMP AMM-1 mapping) and 2009 (a part of the GYPSY multi-sensor mapping for IPY, in this case using Radarsat-2). The paper focuses on the description of the observations, without a significant analysis of causes, or an in-depth review of the previous discussions of some of these changes.

Overall, the paper presents a useful mapping of ice sheet and ice shelf changes, and should be published. I recommend, however, a serious and thoughtful re-writing, taking more time with existing literature on the regions and some attempt to describe the

causes of the observed 2 or 3 major changes in more detail.

Abstract is a bit unfocussed, just a listing of measurements, without a connecting theme. Leading with the rift-associated ice front speed-ups is a case of 'burying the lead' of more interesting changes. Also, for the Ross especially, there is little attempt to unify the changes in the context of the Kamb cessation, Whillans slowdown, and subsequent adjustments by the other ice streams. Noting a cause of the Whillans/Mercer decline would be good – at least mentioning those that have been proposed. Perhaps the extended area of slowing upstream and downstream that is observed here leads to an insight as to causality.

Section 3.3 - the section is a bit strident, the case was made in the earlier paper GRL paper – moreover, this paper and the GRL paper still have the same flaw; the grounding line is incomplete.

[What I think would be an interesting addition here – since the data set for the 2009 DInSAR is so consistent – would be an initial examination of the grounding zone width, and a comparison of that with the ice thickness in areas where thickness is known (the tidal range would also be a component of the analysis). To first order, the width of the flexure zone should be a function of ice thickness, with ice flow speed and ice temperature involved as well. I suppose this would be best placed in a separate paper.]

Section 4 Results – I agree with the earlier review that more space than is needed is devoted to the tidal correction. It does not provide further science insight. (But, yes, it is worth noting in the Methods section that it works well and enables the change detection. Two or three sentences, and reference, is all that is required in my opinion).

Section 5 Discussion – this section rambles from one brief summary observation and hypotheses to another, and is of little value to a reader. Each of these changes has had relevant material published about it before. I recommend that the authors completely re-write the discussion, and focus on one or two areas of change (Mercer-Whillans and Ross; and the general slowdown of the RonneFilcher) and provide some useful

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analysis integrated with a review of the existing literature. Either make it a paper useful for understanding ice dynamics, or strip it of speculation and present it as a ice speed change data set with a cursory and short discussion of the method and observational highlights.

Looking at the data sets in Figures 3 and 4, there are many more artifacts than the Methods section implies – a general splotchy-ness especially near the edges of the data. I note that on the van der Veen arm of Whillans Ice Stream, there is a thin line of speed-up on the southern grounded ice, and slowdown on the northern ice stream margin – is this related to a geo-location error? What is to be trusted? Re other spots of small extent on the grounded ice – what would sub-glacial lake infill and drainage look like in the Figure 3 and 4 representation?

Substantial work has been done on structure, speed, and history of ice changes on the Ross Shelf, the ice plain, and its glaciers, by Catania, Hulbe, Fahnestock, Stearns, Bindschadler.. It would seem that a longer summary of this well-known slowdown in the context of this past work is in order. Note, there is a new paper using ICESat data to map the slowdown and compare it to RIGGS measurements in Remote Sensing of Environment (Lee et al., 2012). Does this new mapping match this one?

Did the authors consider mapping any flow directional changes? If not, and if they are not discussed somewhere (in terms of sensitivity, error, effect on speed changes), then nearly all of the places where the word 'velocity' is used should properly be replaced with 'speed'.

Also - noticing some odd features on the Ronne Shelf and Berkner Island - would firn collapse events (sometimes called firnquakes) affect the differencing in InSAR? These collapses can extend across the surface for a few km, with a vertical movement of a few cm (They result from a collapse of a weak snow hoar crystal layer at depth).

The yellow arrow on Figure 4 is not easily seen at first, could be clearer – or perhaps a yellow circle around the area in question. Also, on Figure 4 I note some long sin-

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uous features, a trail of ice slowing, on Recovery Glacier. The feature is mapped as a deceleration, but is narrow and follows the flowlines of the glacier. This should be mentioned. A similar feature may be present on Foundation Ice Stream.

p2 line 11 and elsewhere: 'slow down' and 'speed up' - these are too colloquial, use 'reduction in speed' or 'deceleration'; 'increase in speed', or 'acceleration'.

p2 line 18-19 awkward sentence, no significance to 'the 8% level', is there?

p2 line 22-23 - for these glaciers, a small change _is_ discussed in the text. Please re-word this line.

p2 line 23 'On the Filchner Ice Shelf itself..' would be better.

p2 line 25 -end. Really? it would seem that slowing is fairly common on these glaciers. I think a quantitative assessment is warranted here – or, instead, focus the paper more generally on the historical changes and their causes for the two shelves.

p4 line 13 - '. . .limited data collection..'

p6 line 14 - no need for the dashes separating out 'or the interferometric phase'.

p7 line 20 - '. . .was not effected in the best manner.' this is a bit awkward.

p8 line 6 - ' central Antarctica north of Titan Dome..' this needs a lat-long location to define it, and the phrase should not be capitalized.

p8 line 11 - 'and the precision of our detected changes is about. . .'

p8 line 12 - Looking over the velocity change maps, it is clear that the last sentence is an understatement, and more has to be said about the level of accuracy in the presented data. In the Ross (Figure 3) there are abrupt changes near Crary Ice Rise with no clear explanation; striping effects are (to my eye) at least 10 to 20 m/yr scale, and there are mottled areas along the southwestern edge of the DInSAR coverage that are not related to real velocity changes, but some error effect. On the Ronne, similar

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things are observed, well away from the grounding line and at a scale far smaller than tidal fluctuations.. this needs to be addressed. There's no doubt that the overall signal is real, but a more realistic estimate of the error would be +/- 15 m/yr change, and some of the blotchy-ness should be addressed.

p9 line 18 - in fact, the MOA grounding line shows a large island iceplain in front of Slessor glacier that is correctly aligned with the InSAR determined grounding line one – this would minimize the effects on the tidal correction. Further, there are similar-scale issues elsewhere in the Ronne that are unlikely to be a part of grounding line location errors, including some sharp variations on grounded ice (Berkner island) and sharp small-scale problems within the Filchner. Showing the MOA grounding line over the rest of the image in Figure 4 would reveal the level of consistency between the two determinations, and the completeness of the MOA line.

p9 line 18 - 'flaps up and down' - that is a bit much, perhaps just 'moves up and down'.

p10 line 1-3 - end the sentence at the words '. . . ice streams' The rest is not needed, can be misinterpreted (the source of the slowdown or the source of the tributary? and the noise floor is not the source of the tributary)

p10 line 11 '. . .that happened after 1997.'

p12 line 17 ' 24 days ' (not 'day', and no hyphen)

p14 line 20-25 - the magnitude is real. . . not well-put, you mean the magnitude and extent and the uniformity of the speed change is unlikely to be an artifact of tide, noise, or errors in processing, and so is most likely explained by a real change in flow speed. The most reasonable explanation is (the one you cite). . . other explanations include. . .(cite some more).

Interactive comment on The Cryosphere Discuss., 6, 1715, 2012.