The Cryosphere Discuss.,
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The Cryosphere Discussions
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Interactive comment on "Satellite altimetry detection of ice shelf-influenced fast ice" *by* Gemma M. Brett et al.

Anonymous Referee #1

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General Comments

The article and language are clear and easy to follow and it is an interesting demonstration of the use of CryoSat-2 to retrieve information about ice shelf-influenced fast ice using satellite remote sensing. It would be helpful to briefly set out the significance of the detection of ISW in terms of the remote sensing and climate impacts this study and similar studies could have, by outlining which parts of the method are novel and the potential insights to be gained. (Insights are discussed in Section 5.4 but would be useful summarised briefly in the introductory remarks/study motivations.)

It is positive that the study considers the potential impact of the dominant backscattering surface being somewhere other than the upper ice surface, this could be expanded to include further quantification relating to snow conditions. There is a heavy reliance

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on the assumption of hydrostatic equilibrium holding which is true for entire floes. Using this assumption requires careful sampling and the way this has been conducted in this study needs to be explained (point-to-point measurements an infrequent sampling over long length scales may not characterise the floe sufficiently well enough for an assumption of hydrostatic equilibrium to hold using measured thicknesses and densities.) Other studies looking at this area have found that sediments are present in large amounts which could also affect the ice and should be commented on (Rack et al., 2013 and Glasser et al, 2017) – it is important to outline whether this could this affect the assumptions used in the study. A constant ice density from the literature is assumed in this study – it would be good to determine the sensitivity of the conclusions to this considering its uncertainty, variability and validity for this study.

The methodology is sometimes not sufficiently detailed to assess what has been done, for instance there are many mentions of spline fitting without discussing the order or justification for the choice, noted in the Specific Comments. It is not clear in the text which aspects of the methodology are novel. These make it difficult to assess in terms of contribution to the field and quality of methodology.

Specific Comments

Line 57-58: It would be helpful to briefly outline the physical characteristics behind the buoyant forcing and how these influence ice freeboard.

Line 85: Please state which aspects of this methodology are novel.

Line 124: Are there other potential influences on the freeboard estimates, either from CS2 or in situ, ie not the SPL buoyancy effect. It would be good to confirm and justify as this is so crucial for the study. It would be good (either here, or further down) to justify the sampling strategy which ensured that hydrostatic equilibrium could be assumed, given that the whole floe will be in equilibrium whilst point measurements at limited locations may not indicate this. The spline fits cover huge areas but appear to be based on limited measurements.

Line 144: Please explain the spline interpolation including the order and a justification for this choice. Similar to the previous comment, are the drill holes single point measurements at each location and what is their uncertainty – and how does this compare to the lateral variation across a floe, and the justification for using hydrostatic balance to relate these quantities?

Line 160: Please explain the choice of a 'lower to mid-range SPL solid fraction'

Line 172: I have seen the SAR Interferometric mode sometimes referred to as SARIn, and sometimes (including here) as SIN. I don't know if the editor would have a preference for use in this journal?

Line 187: Please briefly justify whether you think the snow and ice characteristics are similar to November 2011, to explain the likely relevance or differences in comparison with your data.

Line 198-199: Please state why this is only in general (do you mean for your study or for others?) and how close the open water is relative to the study location – the distance is likely to be important in being able to compare local sea level.

Line 215: Please explain how well you think these corrections will have improved the freeboard estimates, can you give the level of remaining uncertainty and its causes? (Especially given the information in lines 523-532 and uncertainty about geiod detrending.)

Figure 2: It appears there may be a periodicity in the CS2 freeboards, is there a reason this might be the case and could it relate to corrections not entirely removing other effects in these data?

Line 255-257: It is a useful and interesting insight to see that the 'freeboard interfaces' were variable. Can you relate this to snow properties such as density if any data are available (you mention snow depth – can you quantify the effect of snow depth – is there a threshold value above which the ice surface is no longer the dominant scattering

surface or do you think other variables are influencing this also?) You mention this in Section 5.2 but do not quantify, but as you mention in Section 5 knowledge of the snow characteristics will be crucial.

Line 380: Sea surface height can vary over 25 km scales – it will be important to justify why this is not a problem for this study (the following sentences discuss this but it is not clear how this can be discounted as a source of bias.)

Line 427-431: Please quantify these so that a comparison can be made by specifying the increase you observed, using the SPL thickness measurements, to demonstrate how close the agreement is. Please include the magnitude of the higher freeboard in Price et al. (2013) and give an indication of the magnitude of the additional buoyant forcing of the sub-ice platelet layer.

Technical Corrections

Line 167: It would help to show individual tracks if they were plotted with slightly slimmer lines, especially for the East.

Figure 3: Missing label for x-axis

Line 355: Should 'd' be followed by a bracket ')'?

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