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The Cryosphere Discussions

Interactive comment on "Increased West Antarctic ice discharge and East Antarctic stability over the last seven years" *by* Alex S. Gardner et al.

Anonymous Referee #3

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Summary The key results presented in this paper are measurements of Antarctic ice flow from Landsat 8, velocity change computed for a ∼6-year period between ∼2014 and ∼2008, and Antarctic mass balance calculated for ∼2014 using the input output method.

This paper is poorly written and uninteresting to read, largely due to the tedious methods section where two very similar feature tracking techniques are documented at great length. This could be of value if a robust inter-comparison between the two approaches was performed, or if the differences between the two results was analysed in detail, however, given that this work isn't done, there is really no scientific justification for presenting the two Landsat methods in this paper. Overall the paper would greatly benefit from a thorough re-write, which should mainly consist of condensing the methods

text, which is unnecessarily long and often repetitive. In addition to writing style, this manuscript must be edited to properly cite previous publications. I have noted throughout the methods and results sections that the authors have done a very cursory job of this, with many directly relevant papers not acknowledged in the text. Aside from reporting the new dataset, this paper doesn't deliver any novel science about the spatial pattern or magnitude of ice velocity changes in Antarctica, because regional case studies covering the present day time period have already been published in areas experiencing the largest change. This is however, is the first time Antarctic ice speed for the 2013-2015 period has been presented, along with ice sheet wide velocity change since 2008, so these results are novel. Again the discussion of these new results would be considerably improved if the continent wide signal was assessed in the context of previously published regional case studies.

Despite these major criticisms, which can only be addressed by significantly editing the existing manuscript, this paper does describe a new dataset that will likely be used by the scientific community.

Specific Edits L1 – Ice sheet instability and imbalance are not the same thing. The authors have shown that East Antarctica is not negatively out of balance during their study period, but their results don't prove stability. Replace this word in the title, and check use of the word 'stability' throughout the rest of the paper. L17 – New velocity map does not provide complete inland coverage of ice velocity as there is a data gap south of 82.4°. Edit wording in abstract to be factually correct. L20 – In the abstract, Marguerite Bay, West Antarctic Peninsula is flagged up as a key region with one of the most rapid velocity change, however the velocity change for this full region isn't visible in Figure 8. Edit fig 8 to show velocity change map in zoom for this region. L22 – Incorrect use of term stable. Edit throughout paper. L32 – Check sentence wording. Doesn't read smoothly. L36 – Mass change can be measured by multiple techniques with high precision and accuracy, e.g. gravimetry and altimetry in addition to velocity. Edit sentence to reflect that one technique, not all, require ice velocity to measure

mass change. L45 – Edit sentence to reflect that Landsat-8 measurements are only acquired during the summer. Use of the word annual implies that it is a true yearly average, when it is in fact just a summer mean so the speeds could be biased high. If the authors believe their measurements are representative of the annual mean, then evidence should be presented to support this. L67 – Attribution of author contribution to the paper should be listed in the acknowledgements, not the main body of a paper. L80 – The authors have clearly stated their adaptive window size used for velocity tracking. Add sentence to also state the step size. L84 – State the method used to correct the scale distortion, and provide some statistics evidencing that the error has been reduced. L86 – Is the variability of the ice speeds measured with all window sizes, less than the stated accuracy of the velocity measurements, (i.e. $\sim$10 m/yr)? L92 – State the threshold ice speed that was used to identify 'stable' (or rather stationary/slow flowing) ice surfaces. Were all areas classed as stationary used to improve the image co-registration, or was it a subset? If the later please edit the text to clarify rational for selecting ground control sites. Again the authors should also re-evaluate their use of the term 'stable'. L135 – The authors have used a shorter epoch for the raw data used as input to the NSIDC LISA processing technique. Why do this? If the purpose of the paper is to provide a present day assessment of Antarctic ice speeds and compare this with historical data, then only one processing technique is required. If alternatively, the authors aim to inter-compare multiple techniques to asses their respective merits, then the study period has to be the same for any meaningful inter-comparison to be performed. Either process data over the same time period or remove the poorer Landsat-8 method info and results. L145 – Again state the step size used. L145 – The authors used chip sizes ranging from 16 to 128 pixels in the JPL method, and 20 pixels in the NSIDC method. This will have a measurable impact on the output velocity measurements, as ice speed derived from larger window sizes will be biased lower than if a smaller window size was used on the same image pair. The authors should demonstrate how they have accounted for this. L150 – Quantify 'fairly strong', or amend writing style. L152 – Edit double full stop. L166 – State the maximum temporal base-

line used for the image pairs. L170 – Justify why different post-processing methods have been applied to the output from the JPL and NSIDC velocity processing chains once the velocity measurements have been obtained. L177 – Provide the statistics for this interomparison with Rignot et al 2011 for all three surface types, (rock, zero flow, slow flow). L180 – The paragraph structure in this paper must be reorganised, it's completely arbitrary in its current form. For example, why have the authors introduced vr, vz and vl in the previous paragraph (which started off describing the NSIDC post processing method), and then discussed use of these variables in the following two short paragraphs? It's not great throughout the rest of the paper, but its particularly infuriating in the methods section as the paper would read much more clearly if each paragraph did a specific job, i.e. explained a distinct aspect of the work. L185 – The 750m output grid size for the NSIDC dataset is substantially larger than the 240 m resolution of the JPL dataset, and this will impact any intercomparison between the two. The authors must state how they have accounted for this. L192 – The authors have chosen flux gates based on some fairly straightforward rationale. A bit of time should be spent making the description more concise, as two sides of A4 is unnecessarily long. L262 – There are known issues with assuming that firn corrected elevation change rates are 100% dynamic (Zwally et al 2015, Wouters et al 2013), so this assumption is not valid. Moreover, not all ice flowing at >200m/yr is dynamic either, so the authors should edit the paper to state their rationale, and cite published literature that have demonstrated the complexity of this issue if there is no alternative to this assumption. L265 – What's the logic for choosing 0.1m/yr or 30%? These numbers seem arbitrary, so assuming there is some justification, edit the paper to state rationale. L275 – Relevant mass flux literature should be cited through the methods section. For example, Rignot et al, Mouginot et al 2014, Chuter et al 2017. The authors have not invented a new technique, so previous publications should be acknowledged in the text. L349 – Nilsson et al 2016 was not the first publication to apply the surface fit solver to Cryosat data, therefore the authors should edit text to cite previous publications where this technique was developed. Moreover, the Nilsson et al 2016 paper documents a method for esti-

mating altimetry mass change of Greenland, not Antarctica, where the firn processes and therefore processing challenges associated with it, are not the same, as shown by Nilsson et al 2015. The Antarctica method should be explained in full, or an appropriate citation should be provided. L353 – Edit the manuscript to explain how the authors have extrapolated elevation change at the ice sheet margins, where interpolation between two data points isn't possible. It's in this area that the highest rates of elevation change are located, therefore although the area is small, the numbers are significant, particularly given the way the authors are using this result in this paper. L374 – The authors have presented two separate Landsat datasets, JPL and NSIDC. Please choose a nomenclature and stick to it throughout the paper as readers do not know which dataset is referred to by 'Landsat' alone. This should be edited throughout the paper. L377 – Figure 8 in this paper shows that there is large spatial variability in the velocity change parameter, therefore its not correct to assume that velocity change at FG1 is the same as at FG2. The error associated with this assumption must be sensibly quantified, or better, don't use this unsatisfactory approach at all. L384 – This one sentence does not constitute a rigorous inter-comparison between the JPL and NSIDC datasets. Aside form the fact that the epoch covered by each datasets is not temporally contiguous, the authors provide no discussion about the respective merits of each method, the statistical differences between the two datasets, or geographical regions over which one method might out perform the other. It is immensely frustrating to have had to read through lengthy methods description of two marginally different techniques, only to have one dataset discarded with no apparent logical basis other than the personal preference of the authors. This paper should be edited to remove the description of one of the Landsat datasets, or, the authors should to a formal inter-comparison. L390 – The time period covered by the JPL dataset is only $\sim$ 1 year longer than the epoch covered by more recent data in Mouginot et al 2014. Edit paper to state how these results differ from Mouginot et al paper during the time period they overlap, not just the period where they don't. L398 – Edit paper to comment how these Getz results compare to the Chuter et al 2017 result, and cite the relevant paper. L405 – Edit paper

to comment how these Bellingshausen results compare to the Hogg et al 2017 result, and cite the relevant paper. L418 – The authors state that Scar Inlet Ice Shelf has sped up, however in the lengthy methods section of this paper, there has been no mention of how tidally induced velocity changes have been removed from the new dataset. The authors should remove this statement about the cause of Leppard and Flask Glacier velocity changes, or demonstrate quantitatively in this manuscript that tidally induced velocity change has been removed from both the Landsat 8 and historical SAR dataset. L437 – The spatial pattern of speedup on Law dome looks like its associated with the spatial distribution of image tracks. Can the authors demonstrate that this speedup is not just an artefact caused by a processing error? L440 – Edit increase'd' L715 – Fig 1. Change figure to show inland ice speed (in the 'Pole hole') in the Rignot et al 2011 full Antarctic velocity map, or explicitly state in the figure caption that this area has been masked out to fit the spatial extent of the new JPL ice velocity datasets. It is missrepresation of the Rignot et al 2011 dataset to imply that there is large a data gap in areas where one does not exist, particularly when the authors have actually used their velocity measurements from this region in their assessment. L715 – Add spatially variable error map for each velocity dataset shown in Figure 1. Input data density is interesting, but the error estimate has practical value. L740 – Edit figure caption to state more clearly which Landsat dataset corresponds to each color in the bar charts. L760 – The spatial pattern of change in ice speed on Pine Island Glacier, shown in Figure 8, isn't in agreement with change in speed presented elsewhere, and published in Mouginot et al (2014). The authors should discuss if the pattern, (specifically the two separate patches of high speedup), is a real signal, or if it is due to an error in one of the datasets?

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