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Interactive comment on "Velocity increases at Cook Glacier, East Antarctica linked to ice shelf loss and a subglacial flood event" *by* Bertie W. J. Miles et al.

Anonymous Referee #2

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Summary

This is an interesting paper, which relies on remote sensing to investigate velocity and ice front position of Cook ice shelves. The text is generally well written and structured and the images are relatively clear. However, I recommend that a few things are addressed/clarified before the manuscript can be recommended for publishing.

General comments

-I am surprised to find no mention of grounding line migration. Much emphasis is put on calving front location and velocities, which both play an essential role in ice-shelf stability. However, grounding line position is equally –if not more – important, when it

comes to ice-shelf stability and loss of buttressing. All the more so, given that Cook is a marine basin with a retrograde slope.

Is there a particular reason why only optical data are used to derive velocities and not SAR images? The latter could have helped you to overcome the lack of suitable data.

Have you considered the role of pinning points? You mention ice rises when it comes to co-registering the images but would it be possible that the observed acceleration is somehow linked to a loss of contact with a pinning point (ice rise or ice rumple)?

Have looked at strain rates and their evolution? I think it could provide valuable information about dynamic changes over the period you cover.

I am surprised to see that the paper from (Liu et al., 2015) is not cited and the type of caving occurring at Cook ice shelves (tabular vs disintegrating) not discussed.

How do your velocity fields compare to (Rignot, Mouginot, Scheuchl, 2011)? You only mention this field when you remove outliers but not when you assess your velocity fields.

You talk about an increase in velocity but does this acceleration appear everywhere? Does it vary spatially? You only show changes over one velocity profile in Fig 6.

I feel that that the overall number of figures in the main paper could be reduced, as not all of them are highlighting essential information. For instance, Fig 3 and Fig 7 could be 2 subplots of a same figure. Or Fig 2 and 12 are not really exploited in the main paper so could go in the supplementary.

Generally, I think it would be good to link a bit more the processes occurring in both ice shelves in the discussion. Given their proximity and the similarity in their configuration, it is surprising to find different behaviours. For instance, in section 4.2.3 you conclude that the significant retreat of Cook West's front is probably due to intrusion of mCDW but then how do you explain that Cook East didn't experience the same retreat? (you state yourselves that the ocean source is probably the same for both ice shelves).

Specific and technical comments

L27 : “Ice which is grounded well below sea level in the marine basins of Antarctica is potentially vulnerable to marine ice sheet instability.” To trigger a marine ice sheet instability, you need two conditions: 1) a bed grounded below sea-level and 2) and retrograde slope (i.e. an inland-sloping bed. It would be good to state this fact more clearly in the text. A bedrock below sea level is not sufficient alone to trigger a marine ice sheet instability. I find that your phrasing here is somehow ambiguous.

L39: “WAIS” is it really useful to introduce this acronym that is used only once?

L44: “substantial” can you give an order of magnitude?

L49: “SLE” acronym not defined

L76, L83 : position not “positon”

L78: “Errors using this method” how is it quantified?

L102: coregistration: aren’t the orbital data precise enough to co-register the images? (at least for landsat 8)

L105: “Because these features were relatively common” the features ‘are’ (it’s still the case).

L107: “a grid size of 20 x 20 pixels” what do you mean? Is the spacing 20 pixels or the final grid made of 400 pixels in total? Also, what is the final resolution of your velocity fields?

L108: “Error in surface displacement was estimated at 0.5 pixels” how is it estimated? With stable surfaces?

L117: why this value of 450 m/a?

L116: Fig 2.). Bracket is missing

L144-147. I am a bit lost here. What makes you say that? Why 2015? It’s not very

clear from Fig. 4.

L170-172: “This resulted in an estimated total loss of 1,200 km2 of ice shelf between 1947 and 1989. The large retreat of 5 km between November 1973 and January 1974 (Fig. 7 8)” It is visible in Fig 7 but I cannot see the 5km retreat between 1973-1974 on Fig 8. Why?

L188: How can you be sure that the ice shelf has retreated in the constrained section of the embayment? Have you checked on passive shelf map from Fürst et al (2016)? Have you looked at the strain rates? I think that this claim needs to be substantiated.

L202-203: I don’t agree with you when you say that “The rate of ice-front advance is not a direct estimate of velocity because there are processes such as longitudinal stretching which can result in changes in the ice-front advance rate, without altering velocity over the grounding line” While it is true that it is not a direct estimate of velocity because icebergs calve off (as you explain in the methodology). It is not correct to suggest that longitudinal stretching shouldn’t be included in velocities. This stretching is the main deformation process that occur on an ice shelf and is also what causes such fast ice flow on ice shelves (and some ice streams). It is however true that, because of longitudinal stretching, velocity of the ice shelf front is different from that of the grounding line. Moreover, how does your feature algorithm work? Does it exclude the ice-shelf front? If not, I would assume that contrasts between the ocean and the ice is a good feature to track and therefore that you would get a very reliable velocity data point at the front (in the absence of calving).

L208: “change in ice shelf thickness”. Have you checked if they present Cook ice shelf in the supplementary of (Paolo, Fricker, Padman, 2015)?

L213: “ice shelf was flowing 12In find this phrasing confusing as I understand the sentence as “ the velocity at the grounding line was faster than the average of the whole ice shelf”, which is not what you mean (I think). It could be a good idea to rephrase this sentence.

L221: 5.2 . . . units are missing here

L223: “the calculated flow path” I get what you mean as flow paths are related to drainage basins but this is not what Fig 9 shows.

L250: “thinning signal is modest” which order of magnitude?

L280-285: Nice to see that!

L314: do you mean “discharge SINCE 1980”?

Figure 1:

-I find it confusing to have Cook East and West on the left and right, respectively, as maps are generally oriented towards the north. Have you considered rotating the map to make the North appear at the top? Or adding an arrow pointing towards the north or something?

-It would be nice to have the grounding line also on the left part of the image. Have you considered another grounding line dataset like (Depoorter et al., 2013) or the updated version of the MEASURE dataset (Rignot, Jacobs, Mouginot, Scheuchl, 2013)?

-I don’t find the color scale of the overview very helpful: I am not sure it is colorblind-friendly and, given the boundary of the color scale, it is hard to distinguish which part of the basin is below sea level.

-Have you considered delineating Wilkes Basin? (The overview map might be too small to discern anything though).

Figure 2:

-As the limit of the color scale varies for every map, it is hard to compare them.

-What is shown in background? Landsat images?

Figure 4

-It might be good to specify here as well that the ice-front position is taken in the box delineated in Fig 3

-I am confused here: you claim that ice-front advance accelerates (cf Fig 3) but in Fig 4 all what we see is a straight line, which suggests a constant advance.

Figure 5:

-Using the same color as the lines in Fig 3 (or Fig 6), could help identifying the data points you are referring to.

-Have you thought about marking the different periods you’re referring to in the text?

Figure 7

-To improve the readability of the figure I would suggest to delineate the grounding line with a dashed line.

Figure 8

-I find this figure a bit hard to read

-I am not sure than the right part (relative ice-front change) of the bottom panel is adding much information. However, if you decide to keep it, you could consider changing the color of labelling, to match the color of the markers.

-It is confusing to have different x-axis boundaries for the top and bottom panels

Figure 9

-Same comment as for the overview in Fig 1

-The star that locates Lake cook is relatively hard to spot, could you make it appear more clearly?

-I also think it would be interesting to delineate the ice shelves

Figure 10

The lightest lines (2009 on the left and 2014 on the right) are not very visible.

Figure 11

It could be a nice addition to delineate the grounding line here

Figure 12

I think units are missing on the y-axis

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