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The Cryosphere Discussions
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Interactive comment on "Brief Communication: Heterogenous thinning and subglacial lake activity on Thwaites Glacier, West Antarctica" *by* Andrew O. Hoffman et al.

Anonymous Referee #2

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While the presence of active subglacial lake systems in Greenland and Antarctica has been known for decades, the impact of the filling and draining of the lakes on the ice flow is still not well understood. This paper provides a comprehensive investigation using remote sensing observations and continuous GNSS monitoring on the Thwaites and Haynes glaciers in Antarctica, in a region that is undergoing rapid changes in ice dynamics. The paper is well written and presents excellent observational data sets combined with modeling subglacial water routing and basal friction estimation. The study demonstrates an innovative use of remote sensing, including the generation of high temporal resolution records of vertical displacement from Sentinel observations and ice sheet elevation from radar altimetry. The combined interpretation of the obser-

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vations and the modeling results suggests that ice acceleration is not or only weakly sensitive to subglacial drainage, and, thus, the authors conclude that while the 2012 speed-up of the Thwaites Glacier trunk occurred shortly after the 2013 drainage event, it was due to enhanced sub-ice-shelf melt.

The study is worthy of publication and includes important results, but it still leaves some questions open. The authors lay out a convincing argument about the evolution of the subglacial conditions using reasonable assumptions, supported by previous work. However, the two GNSS stations provide only limited information for a basin-scale interpretation. For example, it is not clear how sensitive the locations of UTHW and LTHW are for changes in subglacial hydrology or diffusion thinning originating from the grounding line. Showing UTHW on S Fig.3 would help in the interpretation. Also, due to its position on the boundary of Lake Thw124, LTHW might be sensitive to complicated local processes that could even reduce the response to the drainage events.

Also, there are two questions that the manuscript could have answered:

1. Smith et al., 2017 hypothesized that lake drainage events would occur in 20-80 years periods. Do the authors have an explanation of the observed much shorter timescale ($\sim$6 years). Also, the range of elevation change is increasing in time (Fig. 3). Could the shorter and more substantial variation indicate a rearrangement of the drainage system and a potential increase of its sensitivity to changing forcing?

2. The authors conclude that the speed-up of Thwaites glacier following the 2013 drainage event was due to increasing sub-ice melt rather than the subglacial lake drainage events. Does it mean that the two types of events (acceleration and drainage) not connected? Or could the drainage events be caused by slight changes in velocity/subglacial routing as the glacier started to speed up and thin?

Detailed comments:

Lines 36-37: I suggest to show Backer Island and Howard Nunatak on Fig. 1. I assume

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that the distances are relative to one of the GNSS receivers – which one?

Line 39: Include reference for Savitzky-Golay filtered averages

Line 39-40: What is the time period for the Eulerian speed? Is it a mean velocity for a longer period or derived from a single SAR image pair?

Line 45: I assume that the component of motion in LOS direction was estimated by InSAR processing. Please include a reference.

Line 54: Add the word “solid” before vertical bars to distinguish from the dashed vertical bars.

Lines 65-66: Include explanation for E (expected value)

Line 65-67: This sentence is confusing. What is the “respectively” refer to?

Lines 83-84: The western Thwaites tributary and Haynes Glacier Lakes appears to be switched, according to the text, the Thwaites tributary (WT) has a large drainage event, while Fig. S2 shows the larger drainage for the Haynes Glacier lakes.

Lines 99-100: It is not clear what different average fill rates refer to. For example, $\sim$0.16 km3/yr appear to refer to the subglacial routing (Fig. S3), but the next sentence mentions the same estimate with a different value.

Line 135: LTHW is not shown in Fig. S3.

Figures:

The names of the lakes should be shown in the same way everywhere. Currently, both THW124 and Thw124, etc. are used.

Figure 1 caption: include the date (period) of the MODIS mosaic and the SAR velocity

Figure 2 caption: include projection – I assume it is EPSG 3031. Including a verbal description of the different symbols would make it easier to understand the figure, e.g., “from SAR LOS (colored dots, left abscissa or axis, locations marked in panels A and

B).

Figure 3 caption: again, description of the symbols in the caption would be helpful, especially for the symbol showing the angle, e.g., “Also plotted the LTHW GNSS station direction change (purple dots).” Should include a reference to Fig. 1 for finding the locations and abbreviations. Finally, which direction is the direction given? Clockwise or counterclockwise?

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