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Interactive comment on "Exceptional retreat of Novaya Zemlya's marine-terminating outlet glaciers between 2000 and 2013" *by* J. Rachel Carr et al.

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We thank Robert McNabb for his constructive and very positive comments on the paper. We have addressed all of the comments and provide our responses below, along with a reiteration of the comments, for reference.

The authors have presented a record of glacier front positions for glaciers on Novaya Zemlya for the period covering 1975 - 2015. They have compared these changes with changes in air temperature, sea ice concentration, and climatological oscillations, analyzing the results with robust statistical methods. They conclude based on these results that the period 2000-2013 was significantly different for the marine-terminating glaciers,

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while other terminus types do not show significant changes throughout the time period. The methods are well-described, the results well-presented and discussed, and the conclusions appear to be robust. As such, I have only a few minor comments, and I recommend the paper for acceptance pending these few comments. RESPONSE: We thank you very much for your positive comments regarding the paper and for the minor improvements suggested below. Specific line 15: delete “the” before “1973/76” RESPONSE: Updated. lines 120-122: These sentences are a little confusing to me. Consider emphasizing that these three glaciers were previously unknown to surge, if that is the case. RESPONSE: Two of the glaciers were known to surge, but our data better constrains the timing, and the third was suggested to surge and we show it surging for the first time. We have revised the text to clarify (Lines 122-130). lines 131-132: What about orthorectification? It should not be much of a problem for tidewater glaciers, but land-based glacier termini significantly above sea level could be misplaced if the images are not orthorectified. RESPONSE: We do not believe that orthorectification is required here. The terrain is relatively gentle and not mountainous around these termini, unlike areas such as the Himalaya or the Alps, where glaciers are constrained in high-sided valleys. As such, orthorectification is unlikely to make any discernible difference. We also checked each of the manually georeferenced images against Landsat 8 imagery (which we took as the most likely to be accurately georeferenced), to ensure that they matched correctly, for both land- and marine-terminating glaciers. We did this by matching up features that should not move (e.g. large rock fractures) close the glacier termini and also checking for any unexpectedly large changes in the glacier margins. We rejected any images where we saw movement of features that should be static and/or where the glaciers were clearly incorrectly located. As such, we are confident that the geoferencing was sufficient for the marine- and land-terminating glaciers here and that the images are co-located as closely as the imagery resolution allows. We have added a brief explanation of this at Lines 143-150. Lines 179-181: How good an approximation is this to conditions near the glaciers? RESPONSE: This is the best approximation we have. We wanted to use the same dataset for the entire time series,

to ensure consistency, which means we had to compromise on the spatial resolution. NVZ glaciers are relatively exposed to the open ocean and do not have long winding fjords. As such, conditions immediately offshore are likely to be reasonably representative. In an ideal world, we would have data directly from the glacier front, but it is not possible over these time scales. We have added text to this effect (Line 198-203) Line 309, elsewhere: I think there should be commas between R2 and p values. RESPONSE: Yes, agreed. We have updates this throughout. Line 316: If RHO is an acronym, it should be defined. If it is the Greek letter rho,use instead. RESPONSE: Yes, agreed. It should be the Greek letter rho. line 432: 18 years is an incredibly long time for an active phase! RESPONSE: Yes, we agree. This was one of the justifications for including the surge-type glaciers in the paper, as it seemed incredibly long. It may be even longer, as we are only looking at terminus change here. We suspect it may be towards the end member of surging, possibly due to low mass turnover, comparatively cold conditions and the glaciers being polythermal. We do not know about the substrate, but this may also contribute. We wanted to note these characteristics and believe it would be an interesting focus for follow up work. line 503: linear relationship with latitude RESPONSE: Updated. line 643: Check the names here. It looks like MAS advances for 18 years (cf. also l. 432), SER advances for 15 years, and ANU begins surging in 2008. RESPONSE: Updated. line 651: Specify that the three glaciers you reference here are MAS, SER, and ANU, and not Tunabreen, Basin 3, and Variegated Glacier. RESPONSE: Updated. lines 659,663: I think you mean Fig. 10, and not Fig. 9. The large sediment plume is rather hard to see in Fig. 10c - you might consider enhancing this somehow. You could also make these into a separate figure, and include other images, say from 1985 and 1995, if they are available. RESPONSE: Figure numbers have been updated. As suggested, we have added in imagery from other time points, to show the surge progression in more detail. Specifically, we show pre-surge (1976), surge of the tributary (1985-1988) and surge of the main front (2000). We show the maximum terminus extent in 2007. The image dates are the best available. We have also added a subâĂŤfigure, showing the plumes from ANU, which are more

obvious than those from MAS. Figure 5: Fix the y-axis tick labels, as they should not go from 2 to -4 to 2 to -4 km. RESPONSE: Updated. Figure 10a: Relative frontal position in m, not km. RESPONSE: Updated.

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