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Step-change in retreat rates on Novaya Zemlya outlet glaciers

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Arctic ice masses have rapidly lost ice from the mid-1990s, through a combination of negative surface mass balance and accelerated ice discharge from marine-terminating outlet glaciers. In the past decade, substantial mass deficits have been identified on Novaya Zemlya (NVZ), Russian High Arctic, and its outlet glaciers began to retreat rapidly, from ∼2000 onwards. However, little is known about longer-term glacier behaviour on NVZ, meaning we have limited context for their recent acceleration in retreat. Here, we greatly extend the available record of glacier retreat, and assess multi-decadal glacier response to forcing between 1976 and 2015, using remotely sensed data. Using statistical changepoint analysis, we demonstrate a significant change in retreat rates for many glaciers, during the early 2000s. We also show that retreat slowed on numerous outlets from ∼ 2013 onwards, and that some glaciers even began to advance. NVZ glaciers have previously shown step-like changes in retreat rates, so we cannot determine whether this represents a longer-term trend or short-term slow-down, but it warrants future monitoring. We also assessed spatial patterns of retreat and found no significant differences in retreat rates according to coast or ice mass. Instead, the rate and temporal pattern of retreat were strongly dependant on terminus type: outlets terminating in lakes or the ocean retreated significantly faster than those ending on land. Interestingly, retreat rates on marine- and lake-terminating glaciers were not significantly different. However, the lake-terminating glaciers showed very little variation in retreat rates between glacier or over time, whereas the variability was very large on ocean-terminating glaciers. In terms of climatic controls, significant changes in Jul-Sep sea ice on both coasts of NVZ coincide with the onset of more rapid retreat, but there is large internnual variability in the data.