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Influence of fjord topography and climatic/oceanic forcing on outlet glacier dynamics in Novaya Zemlya

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Arctic ice masses have rapidly lost mass from the mid-1990s through a combination of negative surface mass balance and accelerated ice discharge from tidewater outlet glaciers. In the past decade, substantial mass deficits have been identified in the Russian High Arctic, predominantly on Novaya Zemlya. However, the factors driving recent changes and the relative contribution of increased glacier discharge to observed mass losses are very poorly understood in this region. Here, we assess the climatic/oceanic and glacier-specific controls on the behaviour of 28 marine-terminating and 10 land-terminating outlet glaciers of the northern ice cap, Novaya Zemlya. We use a combination of ESA SAR Image Mode data and visible imagery to show that >90 % of the study glaciers retreated between 1992 and 2010, at rates of up to 190 m a-1. Mean retreat rates were an order of magnitude greater on marine-terminating outlets (51.2 m a-1) than on their land-terminating counterparts (4.8 m a-1). Moreover, results suggest that the mean retreat rate on marine-terminating glaciers accelerated during the study period, increasing from 22.9 m a-1 (1992-2000) to 88.4 m a-1 (2005-2010), whereas retreat rates on land-terminating glaciers showed little change. We compare marine-terminating outlet glacier frontal position to sea ice concentrations, air temperatures and ocean temperatures, derived from remotely sensed data, and results suggest that sea ice and ocean temperatures are primary controls on frontal position. Mean retreat rates were consistently higher on glaciers terminating in the Barents Sea than in the Kara Sea, potentially due to the longer duration of ice-free conditions and lower sea ice concentrations on the Barents Sea coast. However, the magnitude of marine-terminating outlet glacier retreat varied dramatically between individual glaciers, indicating that glacier-specific factors are a key determinate of glacier response to climatic/oceanic forcing. Specifically, we identify variations in fjord width as a primary control on the pattern and rate of retreat and provide empirical examples of the influence of fjord width on marine-terminating outlet glacier behaviour.