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Linear response of east Greenland's tidewater glaciers to climate warming

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Predicting the retreat of tidewater outlet glaciers forms a major obstacle to forecasting the rate of mass loss from the Greenland Ice Sheet. This reflects the challenges of modelling the highly dynamic, topographically complex and data poor environment of the glacier–fjord systems that link the ice sheet to the ocean. To avoid these limitations, we investigate the extent to which tidewater glacier retreat can be explained by three basic variables: meltwater runoff, ocean temperature, and a parameterisation for oceanic forcing based on the combined influence of these two variables. Over a 20-year period at 10 tidewater outlet glaciers along the east coast of Greenland, we find that the parameterised oceanic forcing can explain up to ∼75 % of the variability in terminus position at individual glaciers, 55 % of variation in terminus position across all 10 glaciers, and 67 % of the variation in mean retreat rate between the glaciers. Our findings thus indicate that despite the complexity of tidewater glacier behaviour, over multi-year time scales a significant proportion of terminus position change can be explained as a linear function of atmospheric and oceanic warming, indicating that simple parameterisations may play an important role in predicting the response of the ice sheet to future climate warming.