Geophysical Research Abstracts
Vol. 20, EGU2018-6655, 2018
EGU General Assembly 2018

Dynamic changes in outlet glaciers in northern Greenland from 1948 to 2015

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Mass loss from the Greenland Ice Sheet has accelerated since the early 2000s, due to negative surface mass balance and increased ice discharge from marine-terminating outlet glaciers. Recent outlet glacier retreat in south-east and central-west Greenland has been identified as a key control on inland ice flow acceleration and dynamic surface thinning. Northern Greenland is a comparatively understudied region of the ice sheet, with few comprehensive datasets of long-term glacier change at glacier fronts, and their potential impact on ice flow further inland. In particular the region wide response to floating-ice tongue loss remains unknown. Here, we combine multi-platform satellite imagery and historical map charts to provide an unprecedented, 68-year record of frontal position change at 18 major outlet glaciers in northern Greenland. Overall mean retreat rates were higher between 1995 and 2015 compared to the previous 47 years (1948 to 1995). We also provide a systematic analysis of the dynamic behaviour (i.e. acceleration and surface thinning) of three major groups of outlet glaciers in the region (grounded-terminus, floating-terminus, and surge-type). A key conclusion of this work is that the dynamic response of outlet glaciers in the region appears highly dependent on their terminus type, with grounded and floating termini showing significantly different behaviour. Grounded-terminus glaciers showed prolonged acceleration and surface thinning in response to steady retreat, whilst in most cases glaciers terminating in floating ice tongues appeared dynamically insensitive to large calving events. Glacier geometry (e.g. fjord width and basal topography) are also highlighted as important controls on the dynamic re-adjustment of these groups of glaciers to changes at their terminus. The recent loss of several ice tongues and the continued retreat of several grounded-terminus outlet glaciers, suggests northern Greenland is undergoing rapid change, and that this may soon impact large areas of grounded ice, and hence contribute to sea level rise in the future.