



## **Seasonality and extent of East Greenland glacier fluctuations from automatic satellite monitoring of calving glacier fronts**

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The recent acceleration of Greenland outlet glaciers shows that flow speeds can respond sensitively to changes of calving front positions, but little is known about the seasonality and range of margin position changes. To investigate the geographical extent of margin changes on subseasonal timescale, we developed an automated procedure for identifying calving margins from MODIS data (2000-2008), allowing for the analysis of 105,536 images of 32 glaciers in East Greenland. Validation exercises found results to compare well to those of other studies, which have been limited in either temporal resolution or spatial extent by more labor-intensive methods. All most all glacier exhibited seasonal cycles, demonstrating a strong sensitivity to environmental conditions. However, there was a distinct difference in response of glaciers north and south of 65.9°N. Those above showed close to no interannual change, whilst those below retreated rapidly by an average of 2.9 km over 2001 to 2005. We found that only a few glaciers have returned to their original calving position and that only 26% of the average calving retreat was recovered when the glaciers returned to a steady margin position during 2005 to 2008. The extent of rapid change of calving positions is consistent with the recent attribution of sustained mass losses in southeast Greenland to increased discharge. Meteorological records and climate reanalysis data show clear evidence of recent atmospheric warming in southeast Greenland, but this warming trend do not statistically explain the observed extent of margin recessions. A statistically convincing explanation was found in the output from the 1/4 degree NEMO ocean model where variable extent of Atlantic water intrusions onto the East Greenland continental shelf coincide with the observed glacier change.