Geophysical Research Abstracts
Vol. 16, EGU2014-6563, 2014
EGU General Assembly 2014

Air temperature drives 140 years of fluctuations at a major Greenlandic tidewater glacier.

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The primary controls on the fluctuations of tidewater glaciers are currently poorly understood. Both oceanic and atmospheric forcing mechanisms have been invoked to explain observed changes. Numerical modelling simulations have previously utilised only relatively short observational records for calibration and validation. Hence the longer term climatic controls on tidewater glacier stability are not well known. Herein we apply a 1-D numerical flow-band model with a crevasse water depth calving criterion (Nick et al., 2010) to Kangiata Nunaata Sermia (KNS), SW Greenland. We force the model using air and sea surface temperature records for the period 1871-2012. Model sensitivity to climate forcing was determined by varying climatic tuning coefficients using a Monte Carlo approach. The output from 1500 model runs was compared against observations of terminus position and glacier geometry from the last 140 years. The results of best-fit model runs were then used to evaluate the relative sensitivity of KNS to changes in atmospheric or oceanic forcing.

Our results show that all best-fit model runs have tuning coefficients associated with strong atmospheric forcing, but do not all require strong oceanic forcing. This suggests that changes in air temperature are the primary driver of the terminus fluctuations of KNS from 1866-2012, and may be the principal climatic control on glacier stability for similar tidewater glaciers in Greenland.