DTU Library

Impact of External Forcing on Glacier Dynamics at Jakobshavn Isbræ during 1840-2012

Muresan, Ioana Stefania; Khan, Shfaqat Abbas; Aschwanden, Andy; Khroulev, Constantine; Bjørk, Anders A.; Box, Jason E.

Publication date:
2014

Document Version
Publisher's PDF, also known as Version of record

C51B-0257:

Impact of External Forcing on Glacier Dynamics at Jakobshavn Isbræ during 1840-2012

Friday, 19 December 2014

Ioana Stefania Muresan[1], *Shfaqat Abbas Khan*[1], *Andy Aschwanden*[2,3], *Constantine Khroulev*[3], *Anders A Bjork*[4] *and Jason E Box*[5], *(1)DTU Space, Technical University of Denmark, Geodesy, Kgs. Lyngby, Denmark, (2)University of Alaska Fairbanks, Arctic Region Supercomputing Center, Fairbanks, AK, United States, (3)University of Alaska Fairbanks, Geophysical Institute, Fairbanks, AK, United States, (4)Centre for GeoGenetics, Natural History Museum, University of Copenhagen, Copenhagen, Denmark, (5)Geological Survey of Denmark and Greenland, Copenhagen, Denmark*

Abstract:

Greenland's main outlet glaciers have more than doubled their contribution to global sea-level rise over the past decade through acceleration of ice discharge. One of the triggering mechanisms is a reduction in resistance (buttressing) at the marine based glacier front (i.e. through reduced thickness or retreat of the floating tongue of a glacier) caused by enhanced calving or a longer-term thinning due to a mass deficit of the ice sheet. Recent findings indicate the reduced buttressing at the marine terminus is responsible for the recent dynamic changes observed in Greenland, but the controlling processes and triggering mechanisms are still unclear. Furthermore, our current understanding is almost entirely based on observations from a short-term record spanning only from a year to a decade, and is characterized by short-term fluctuations and therefore not representative for longer-term trends of several decade time scales.

Here, we study the mechanisms controlling dynamic changes at the terminus of Jakobshavn Isbræ over a period of 172 years. The recent glacier acceleration began in late 1990s but there is evidence for glacier retreat of comparable magnitude in 1930s, when a similarly warm period occurred. To control the acceleration and retreat based on observed front positions during 1840-2012, we use an ocean model modifier that implements forcing at the ocean boundary using melange back pressure offsets. The mean temperature anomaly in west Greenland, the North Atlantic oscillation (NAO) winter index and the Atlantic multidecadal oscillation (AMO) index anomalies for the period 1900-2012 sustain our modelling results. The modelled surface elevation changes near the front are considered and compared with observed surface elevation changes for the period 1880-2012. Furthermore, the modelled mass loss signal between 1997-2012 is validated based on ice mass change observations which we estimate using altimeter surveys from NASA's ATM flights during 1997-2012 supplemented with high-resolution Ice, Cloud and land Elevation Satellite (ICESat) data during 2003-2009 and Land, Vegetation and Ice Sensor (LVIS) data during 2007-2012.

Our choice of ice sheet model comprises the Parallel Ice Sheet Model (PISM) and a continuous 172 years reconstruction of surface mass balance and its sub-components (Box, 2013).