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Late Holocene Ice stream dynamics in Greenland: new observations on the interaction between Jakobshavns Isbrae, climate and ocean circulation

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Recent years have seen a growing interest in the behaviour of ice streams and ice shelves and, in particular, the possibility of catastrophic collapse triggered by future climate change. Indeed, the recent collapse of the Larsen Ice Shelf and the thinning and retreat of the Pine Island ice stream in Antarctica and Jakobshavns Isbrae in West Greenland, suggest that rapid changes in ice stream and ice sheet dynamics may already be underway. The late Holocene provides an important time window from which to assess the significance of these recent events and, in particular, to establish whether they are exceptional or simply part of natural system variability.

Historical evidence documents a 25 km retreat of the Jakobshavns Isbrae terminus from the Neoglacial maximum position of 1850. The terminus stabilised between about 1950 and 1995, after which ice velocity increasing abruptly from 5 kma^{-1} in to 12.6 kma^{-1} by 2003. This was associated with a further 12 km retreat of the ice front. The reason for this accelerated retreat is unclear, but one possibility is that the ice stream is beginning to respond to recent changes in climate.

Several bedrock pinning points act to restrict rapid and potentially catastrophic drawdown of ice from Jakobshavns Isbrae. The present day ice front is close to one such pinning point which marks the mouth of a rock trough that extends 1200 – 1500 m below sea level and over 50 km inland. Retreat of the present grounding zone past this pinning point might lead to a catastrophic drawdown of the ice stream.

This study aims to investigate the possibility for such catastrophic drawdown over

the last 3000 years. To do this we use high resolution marine cores from close to the mouth of Jakobshavns Isfjord and further out in Disko Bugt to investigate the interaction between Jakobshavns Isbrae, climate and ocean circulation during the late Holocene.

Marine cores from close to the mouth of Jakobshavns Isfjord clearly show a link between sediment and meltwater discharge and broader climate trends. During relatively cold periods there is evidence of a substantial increase in meltwater and sediment production deflecting the warm West Greenland Current westwards away from the coastal areas. This may be linked to an advance of the ice front. During relatively warm periods there is evidence of a major decrease in sediment and meltwater discharge associated with ice front retreat. The activity of Jakobshavns Isbrae can also be correlated to changes in ocean circulation, climate and ice advance/retreat from other parts of the Greenland margin. The data from the marine cores suggests a significant retreat of Jakobshavns Isbrae corresponding to the 'Medieval Warm Period'. This was followed by a two phased advance and increase in discharge associated with the 'Little Ice Age'.

While our data shows evidence for changes in ice discharge and probable position of the ice front correlated to climate fluctuations we find no evidence of catastrophic collapse/drawdown of Jakobshavns Isbrae during the last 3000 years.