

Title: Linking recent variability in Atlantic Ocean circulation and glacier mass balance in Greenland and Norway.

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University of Registration: University of Aberdeen

Proposed research:

This studentship will examine the relationship between ocean heat transport and the mass balance of terrestrial ice masses around the periphery of the northern North Atlantic. The North Atlantic Oscillation is the dominant player in short term atmospheric variability in the region and has been shown to exert significant control on both glacier mass balance and oceanic variability but longer period trends may now begin to become more influential. Although there has been great interest in the potential effects of increased freshwater input from terrestrial ice masses on meridional overturning circulation in the North Atlantic, archival data has been insufficiently studied to examine the linkages between the two over decadal time periods. Time series covering ≤ 50 years of oceanic monitoring from the north-east Atlantic and Norwegian Sea between Scotland and Svalbard reveal cyclical variations in temperature and salinity which have typically decadal periodicities set against a trend of increasing temperature. Similar temporal cyclicity can be observed in Norwegian glacier mass balance records covering this time period. A detailed set of winter, summer and annual mass balance records are available for a number of Norwegian glaciers (one > 50yr, five > 40 yr, two > 30yr, two > 20 yr and three > 15 yr) and additional records are available from Svalbard and Sweden (20, 24 and 60 yr time series), thus giving significant latitudinal coverage. Greenland Ice Sheet ice core accumulation records provide further records of North Atlantic derived precipitation which is modulated by the North Atlantic Oscillation. Monthly to annual instrumental records of temperature and precipitation spanning 10-100 year timescales are also available for selected sites in Norway, Iceland and Greenland. These data may be used to: 1) determine linkages between oceanic fluxes and glacier mass balance (e.g. Figure 1); 2) calibrate and run a simple degree-day melt model across major ice masses to estimate changes in glacial runoff into the North Atlantic and 3) investigate potential feedbacks between the North Atlantic Ocean and adjacent terrestrial cryosphere under changing climate scenarios. This research represents an opportunity to elucidate the complex links and feedbacks between ocean heat transport and terrestrial climate manifest in glacier mass balance. The successful candidate will have an opportunity to contribute to existing datasets by participating on an oceanic research cruise and possibly to undertake field research in Greenland and/or Norway.

Additional Funding: The £7k/yr for fees and research expenses will be met by contributions from both the University of Aberdeen, and the Scottish Association for Marine Science (SAMS).

Techniques:

- i) Acquisition of archived and published glacier mass balance and ice core accumulation records for ice masses around the margins of the North Atlantic. Similar acquisition of oceanic parameters datasets for the North Atlantic. This will include data mining the

academic literature, accessing NSIDC and World Glacier Monitoring Service (WGMS) databases and other historical records.

- ii) analysis of glacier mass balance records and integration with meteorological records (e.g. downscaled ECMWF meteorological (re) analysis data) and ice core accumulation histories for regions surrounding the North Atlantic
- iii) measurement and interpretation of oceanic parameter datasets
- iv) analysis and integration of datasets using time series and multivariate statistical techniques
- v) modelling glacial melt and runoff using a simple degree-day model (e.g. Arendt and Sharp, 1999)

Training:

Beyond the general training elements generic to any PhD (e.g. time management, scientific writing, presentation skills), training will be provided in all aspects of the above techniques, by participation in short courses (where applicable) and through mentoring by the supervisor group members. Any additional training will be targeted as the project develops.

Available facilities, infrastructure and funding:

The project does not require any additional facilities, software, or funding which is not already in place. The datasets are publicly available (and searching for additional datasets may prove fruitful) though quality control and processing of the data into suitable formats may well be necessary. A high spec PC will provide sufficient computing power for the project and will be funded from the research expenses.

Project Advertising Summary:

This project will elucidate linkages between glacier mass balance, glacier meltwater runoff and oceanic temperature and salinity variability around the margins of the North Atlantic. Analysis and integration of existing archival meteorological, glaciological and oceanic data sets will be undertaken along with hindcasting of changes in glacier runoff through modelling experiments. The **ideal candidate** will have a good BSc or MSc in Physics / Maths / Engineering or a Physical Earth Science subject (such as meteorology or physical oceanography), and be numerically literate. S/he will be required to spend part of their time in each of the two institutions.

Relevance to SAGES Theme 3:

This project directly investigates the recent instrumental record of oceanic variability (heat transport) and the terrestrial climate from direct measurements and proxy records available from glacier mass balance and meteorological data. The focus is on the North Atlantic and terrestrial margins. Thus, it clearly focuses on overarching area 3 within the theme.

Additional supporting information

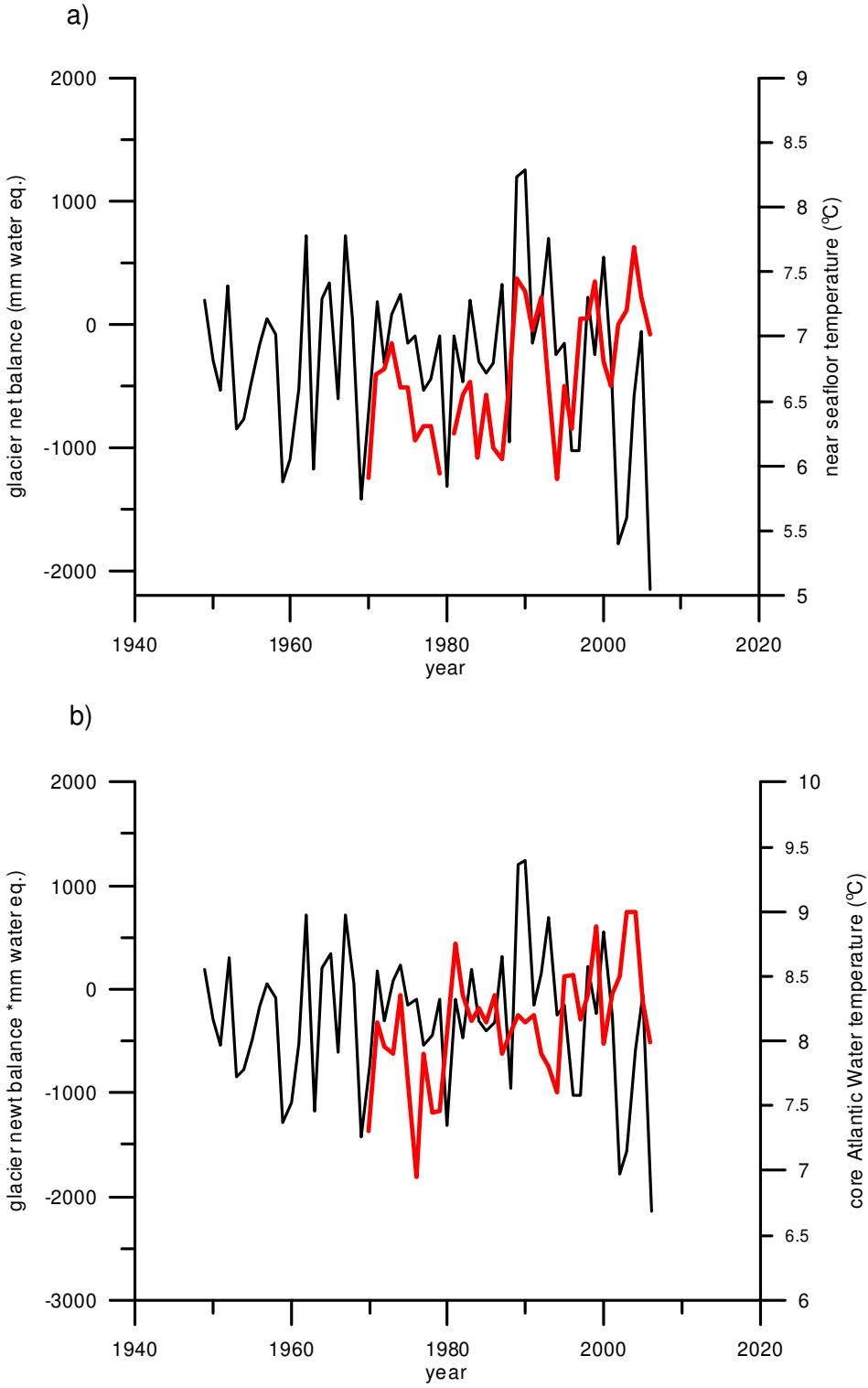


Figure 1. a) Time series showing Storbreen net balance (black) and near sea floor summer temperature in the NW North Sea (red). b) Time series showing Storbreen net balance (black) and core Atlantic Water summer temperatures (red) at the western edge of the Norwegian Trench (Norwegian Polar Institute, WGMS; ICES, 2007).