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Abrupt changes in Greenland Ice Sheet runoff and sea water temperature since 1821 recorded by coralline algae

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The Greenland Ice Sheet (GrIS) contains the largest store of fresh water in the northern hemisphere, equivalent to $\sim$7.4m of eustatic sea level rise, but its impacts on current, past and future sea level, ocean circulation and European climate are poorly understood. Previous estimates of GrIS melt, from satellite observations, temperature driven melt-models and palaeo reconstructions over $<$100y, show a trend of increasing melt. There are however no runoff data of comparable duration with which to validate temperature-based runoff models, or relationships between the spatial extent of melt and runoff. Further, longer runoff records that extend GrIS melt records to centennial timescales would enable recently observed trends to be put into a better historical context. We measured Mg/Ca, δ^{18}O and structural cell size in annual growth bands of red coralline algae to reconstruct: (1) near surface sea water temperature; and, (2) melt/runoff from the GrIS. (1) Temperature: we reconstructed sub-annual resolution record of water temperature in Disko Bugt between 1821-2009 showing an abrupt change in temperature oscillation patterns during the 1920s. That change may be attributable to an alteration in the interaction between atmospheric temperature and mass loss from Jakobshavn Isbrae. (2) GrIS runoff: using algal samples from distal parts of Søndre Strømfjord we produced the first reconstruction of GrIS runoff between 1939-2002. We observed significant negative relationships between historic runoff, relative salinity and marine summer temperature. Our reconstruction shows a trend of increasing reconstructed runoff since the mid 1980s. *In situ* summer marine temperatures followed a similar trend. We suggest that since the late 1930s atmospheric temperatures have been important in forcing runoff into Søndre Strømfjord.