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Chironomids as indicators of climate change: a temperature inference model for Greenland

Eleanor J. Maddison (1), Antony J. Long (1), Sarah A. Woodroffe (1), P. Helen Ranner (2), and Brian Huntley (2)

(1) Department of Geography, Durham University, Durham, United Kingdom (e.j.maddison@durham.ac.uk), (2) School of Biological and Biomedical Sciences, Durham University, Durham, United Kingdom

Current climate warming is predicted to accelerate melting of the Greenland Ice Sheet and cause global sea level to rise, but there is uncertainty about whether changes will be abrupt or more gradual, and whether the key forcing will be air or ocean temperatures. Examining past ice sheet response to climate change is therefore important, yet only a few quantitative temperature reconstructions exist from the Greenland Ice Sheet margin.

Subfossil chironomids are a widely used biological proxy, with modern calibration data-sets used to construct past temperature. Many chironomid-inferred temperature models exist in the northern hemisphere high latitudes, however, no model currently exists for Greenland. Here we present a new model from south-west Greenland which utilises 22 lakes from the Nuup Kangerlua area (samples collected in summer 2011) and 19 lakes from the Kangerlussuaq fjord area (part of a dataset reported in Brodersen and Anderson (2002)).

Monthly mean air temperatures were modelled for each lake site from air temperature logger data, collected in 2011-2012 from the Nuup Kangerlua area, and meteorological station temperature data. In the field, lake physical parameters and environmental variables were measured. Collected lake water and sediment samples were analysed in the laboratory. Statistical analysis of air temperature, geographical information, lake water chemistry and contemporary chironomid assemblage data was subsequently undertaken on the 41 lake training set.

Mean June air temperature was found to be the main environmental control on the chironomid community, although other factors, including sample depth, conductivity and total nitrogen water content, were also found to be important. Weighted averaging partial least squares (WA-PLS) analysis was used to develop a new mean June air temperature inference model. Analysis indicated that the best model was a two component WA-PLS with r2=0.77, r2boot=0.56 and root mean square error of prediction = 1.7°C.

The development of this new chironomid-inferred temperature model provides an opportunity to increase the number of quantitative palaeotemperature records from the Greenland Ice Sheet margin. Using this model, quantitative Holocene temperature reconstructions of new and existing Greenland chironomid records will be presented. Comparison of these new chironomid-inferred palaeotemperature records with other Greenland proxy records will demonstrate the potential of this new model for improving understanding of Greenland climate dynamics.