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Mg/Ca ratios in coralline red algae as temperature proxies for reconstructing Labrador Current variability

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Climate and oceanographic changes in the Northwestern Atlantic have recently had a dramatic impact on ecosystems and fishery yields. Fluctuations of North Atlantic marine climate have been linked in part to a dominant pattern of atmospheric circulation known as the North Atlantic Oscillation, which has a strong influence on transport variability of the Labrador Current (LC) flowing along the Eastern Canadian coastline. Although interdecadal and interannual variability of SST and salinity in the LC system have been documented, a clear cyclic pattern has not been identified. In order to better understand the observed ecosystem changes and predict future changes in LC flow, a spatial and temporal reconstruction of the LC is needed. This, however, requires reliable long-term and high-resolution temperature records, which are not available from short instrumental observations.

Our research is therefore concerned with establishing century-scale sea-surface temperature (SST) reconstructions from the Northwest Atlantic using long-lived coralline red algae. Coralline red algae have a high-Mg calcite skeleton, live in shallow water worldwide and develop annual growth bands. It has previously been demonstrated that subannual resolution SST information can be obtained from coralline red algal Mg/Ca ratios, a commonly used paleotemperature proxy. Specimens of the long-lived coralline red algae Clathromorphum compactum were collected alive in August 2008 along a latitudinal transect spanning the southern extent of LC flow in Nova Scotia and Newfoundland. This collection is supplemented with specimens from the same region collected in the 1960's. In order to reconstruct spatial and temporal patterns of the LC, selected samples of C. compactum were analyzed for Mg/Ca using Laser Ablation Inductively-Coupled Plasma Mass Spectrometry (LA-ICP-MS). Age models were established for all specimens by counting annual growth increments, which average 350 microns/year. Mg/Ca ratios range from 0.055 to 0.138 (measured in weight %) and relate to water temperatures of -1 to 10°C. An integration of observed element cycles and age model data yields Mg/Ca-based SST reconstructions dating back to the industrial revolution. Multidecadal spatial correlations of our C. compactum records with satellite-derived sea-surface temperatures clearly indicate the influence of a LC signature on the Mg/Ca time series and highlight the value of the algae as a proxy to resolve large-scale and long-term LC variability.