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Little Ice Age wintertime climate cooling linked to N-Atlantic subpolar gyre warming

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Traditionally, the Little Ice Age (LIA) in the North Atlantic is believed to have been marked by negative Sea Surface Temperature (SST) anomalies. In apparent contrast, we present evidence from sediment core records from the N-Atlantic Subpolar Gyre showing prevalence of warm SST conditions. Our proxy data include both alkenone-based SST reconstructions and results from faunal and geochemical foraminiferal studies. Subpolar Gyre SST warming after the Medieval Climate Anomaly is observed in the Labrador Current close to the Gulf Stream boundary off Newfoundland, which agrees with previously reported increased influence of warmer, Gulf Stream-derived Slope Water off southern Newfoundland(1). Our core records from the West- and East Greenland Current realm off southern Greenland, as well as sites in Faroese waters, correspondingly indicate increased influence of warm, saline North Atlantic / Irminger Current waters. Other recently published studies also report LIA SST warming in the northern subpolar North Atlantic(2) as well as increased heat transport into the Arctic via the West Spitsbergen Current(3). Growing evidence indicates that positive SST anomalies in the North Atlantic Ocean can promote negative NAO conditions, thus be linked with cold wintertime conditions in Northwestern Europe. A published modeling study using ensemble simulations with an atmospheric GCM forced with reconstructed SST data for the period 1871-1999 shows weakening of the westerly winds around 60o N with SST anomalies that have the same sign across the North Atlantic(4). Six other climate models show that with some years of delay, an intensified Atlantic Meridional Overturning Circulation leads to a weak negative North Atlantic Oscillation (NAO) phase during winter(5). Furthermore, it was recently found that the stratosphere is a key element of extra-tropical response to ocean variability. Observational analysis and atmospheric model experiments indicate that large-scale Atlantic Ocean warming drives high-latitude precursory stratospheric warming in the first part of the winter, which propagates downward and leads to a negative tropospheric NAO(6). In summary, our results in combination with other proxy records and modelling experiments are consistent with a prevailing NAO negative atmospheric circulation mode and thus relate LIA continental wintertime cooling to a relatively warm N-Atlantic Subpolar Gyre, a scenario which may have implications for ongoing and future ocean warming conditions.

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