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Reconstruction of sea surface temperatures during past 40 ka in the Japan Sea using foraminifera clumped isotope thermometry

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Accurate reconstruction of past sea surface temperature (SST) changes is important and critical to help understand the evolution of the Earth. However, ancient SST variations in the Japan Sea so far have been inconclusive. Japan Sea is a semi-enclosed marginal sea separated from the Pacific Ocean by four shallow sills and it was almost isolated during the Last Glacial Maximum (LGM) when the sea-level was around 130 to 140 m lower than today (Oba et al., 1991). Both $\delta^{18}O$ thermometry of planktonic foraminifera and alkenone thermometry at face value would suggest high temperatures in the LGM compared to the Holocene, but these results have generally been dismissed and instead attributed to low salinity (Fujine et al., 2006; Yokoyama et al., 2007). Although low temperatures are supported by the occurrence of cold diatom species during LGM (Akiba et al., 2014), quantitative evidence has yet been lacking.

Carbonate clumped isotope thermometry provides an independent way to answer this question, as it is independent of seawater composition (e.g., Ghosh et al., 2006) and thus allows for the deconvolution of temperature and salinity effects. In this study, we have selected 14 planktonic foraminifera samples from marine sediment cores from the Japan Sea, with ages ranging from ~40 ka to present. All the samples were analyzed on a Thermo Scientific MAT253Plus mass spectrometer coupled to a Kiel IV device in the University of Bergen (Meinicke et al., 2020).

Our results do not support higher LGM SSTs compared to other periods. Instead, the SST of the Japan Sea in the LGM was indistinguishable from the preceding glacial period (40-30 ka) and the subsequent early Holocene (11.6-8 ka), while temperatures increased by ~6 °C in the late Holocene (after 8 ka). By combining clumped and oxygen isotope results, surface water $\delta^{18}O$ values can be estimated. Depleted seawater $\delta^{18}O$ values in the LGM indeed indicate the influence of freshwater, likely due to significant river inputs to the mostly enclosed Japan Sea. We will further discuss the implications of our findings for past environmental changes in the Japan Sea.