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Quantifying uncertainties in global monthly mean sea surface temperature and sea ice at the Last Glacial Maximum

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Studying the Last Glacial Maximum (LGM), 21000 years ago, provides insights into climate sensitivity to greenhouse gases and critical interactions within the earth system (e.g. atmosphere, ocean, cryosphere) operating in a climate different from today. Much effort has been put into reconstructing the Sea Surface Temperatures (SST) at the LGM using a range of palaeoclimate records, statistical techniques and models. Large disagreements exist amongst reconstructions and between models and data. Disentangling the causes of these differences is challenging. How much of these differences are due to the choice of data used, their interpretation, the statistical method or climate models used? The polar regions are particularly difficult to reconstruct, yet are key for assessing polar amplification and key processes driving cryospheric changes. Combining the information gained from sea ice and SST proxies has the potential to improve reconstructions in those regions.

Here, we provide a new probabilistic joint reconstruction of global SST and sea ice concentration (SIC) that incorporates information from the ensemble of PMIP3 and PMIP4 models (Kageyama et al., 2021) and existing compilations of SST and sea ice. Our reconstruction was specifically designed to provide ensembles of plausible monthly mean fields that can be used to drive atmosphere models to investigate uncertainty in LGM climate and their potential effects/interactions on e.g. vegetation, ice and atmospheric circulation.

We present our statistical approach (Astfalk et al., 2021) in simplified terms for non-specialists, and discuss how different interpretations of the palaeo-records can be included in our statistical framework. Our results are compared to other recent reconstructions such as Tierney et al. (2020) and Paul et al. (2021). To interpret these differences, we test the effect of the choices of input proxy data and models on the reconstructed monthly mean SSTs and SIC.

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