

A Southern Ocean sea-surface temperature compilation for the Last Glacial Cycle

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The PAGES Data Stewardship Scholarship program allowed us to compile and transform Southern Ocean sea-surface temperature data into the LiPD format, increasing the interoperability and, thus, facilitating analyses and comparisons.

Motivation

The C-SIDE working group (pastglobal-changes.org/c-side) has been diligently working towards unraveling the complexity of past Southern Ocean dynamics, with a specific focus on the role of Antarctic sea ice. Previous efforts, spearheaded by Chadwick et al. (2022), aimed to investigate the different patterns in sea-ice dynamics over the Last Glacial Cycle (130–12 ka). One of the primary objectives was the compilation of a comprehensive dataset on Antarctic sea ice, laying the groundwork for a deeper understanding of its dynamics in different regions on a glacial-interglacial timescale.

However, Antarctic sea ice, while a crucial component of Southern Ocean dynamics, is just one of many processes governing the region's past oceanographic – and thus global climate – changes. Furthermore, the interplay of different processes remains unclear. Amongst these processes, sea-surface temperature (SST) dynamics seem to be the obvious first candidate to strongly influence sea ice, and vice versa.

Recognizing the need for a holistic approach, we sought to provide insights into circumpolar Southern Ocean SST changes. To achieve this, we meticulously compiled previously published SST data, positioning our project within a broader context of Southern Ocean dynamics. By undertaking this comprehensive analysis, we aimed to uncover not only the isolated impacts of SST, but also its potential co-dependencies with other factors, foremost sea-ice dynamics.

Southern Ocean SST data compilation and LiPD format standardization

The initial phase of our project involved the compilation of previously published SST data. Here, our focus lay on expanding on efforts by Kohfeld and Chase (2017), mostly adding later datasets. We considered datasets of all resolutions and proxies that cover the Last Glacial Cycle. In the future, the inclusion of certain proxies might be under debate if results point to a misuse of that proxy as an SST proxy.

A first main outcome from the compilation is the distribution of cores, and the scarcity of cores and data for certain regions and zones (Fig. 1). The low number of records from the Antarctic Zone limits the possibilities of investigating connections to sea ice, as well as calculating basin-spanning SST gradients. Furthermore, the Pacific basin is strongly

underrepresented, limiting the significance of general findings.

To enhance interoperability and facilitate the seamless reuse of our data compilation, we adopted the LiPD format (McKay and Emile-Geay 2016). This decision was underpinned by the LiPD format's provision of standardized metadata and vocabulary, streamlining the process of data interoperability and reusability for fellow researchers. The LiPD format not only aligns with best practices in data management, but also reflects our commitment to contributing to a collaborative and interconnected (paleo)research environment.

One of the most challenging aspects we encountered was reconciling variations in age models and proxy calibrations across and within different datasets. Addressing these discrepancies proved very challenging due to limited documentation on changes, reasoning and references to previous data. Similarly, retracing these steps and recalibrating both age-model constructions and proxy calibration was hindered by the sparse documentation and availability of raw data. With the compiled and standardized dataset at our disposal, we could start analyzing the patterns and dynamics of past SST in different basins and zones of the Southern Ocean for the Last Glacial Cycle.

Current and future plans

The C-SIDE Southern Ocean SST data compilation, together with our analyses scripts (in R), will be made available on PANGAEA and the LiPDverse website (lipdverse.org). A future project, granted by the Dutch Research Council (NWO), will aim to expand this

database and include other proxy data for the Southern Ocean. This will further enhance the interoperability of past Southern Ocean data, and facilitate disentangling different processes driving CO₂ storage and release, and comparison to models. Our team is preparing a manuscript describing the data compilation, analyses and new results emerging from this SST overview for the Southern Ocean.

DISCLAIMER

During the preparation of this work the author(s) used ChatGPT 3.5 in order to try out its usefulness. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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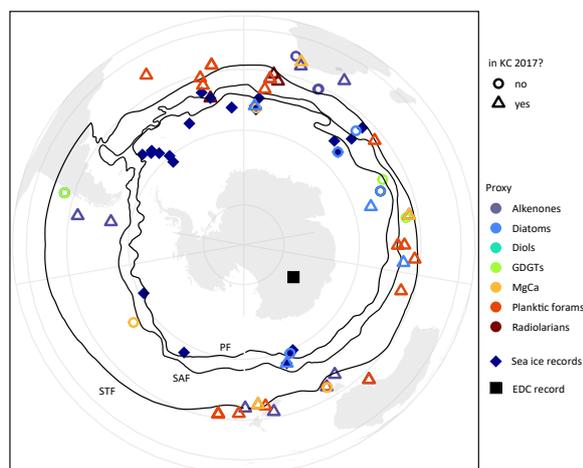


Figure 1: Overview map of compiled SST proxy data for the Last Glacial Cycle. KC 2017: Kohfeld and Chase (2017).