

# The second phase of the Cycle of Sea-Ice Dynamics in the Earth System (C-SIDE) working group

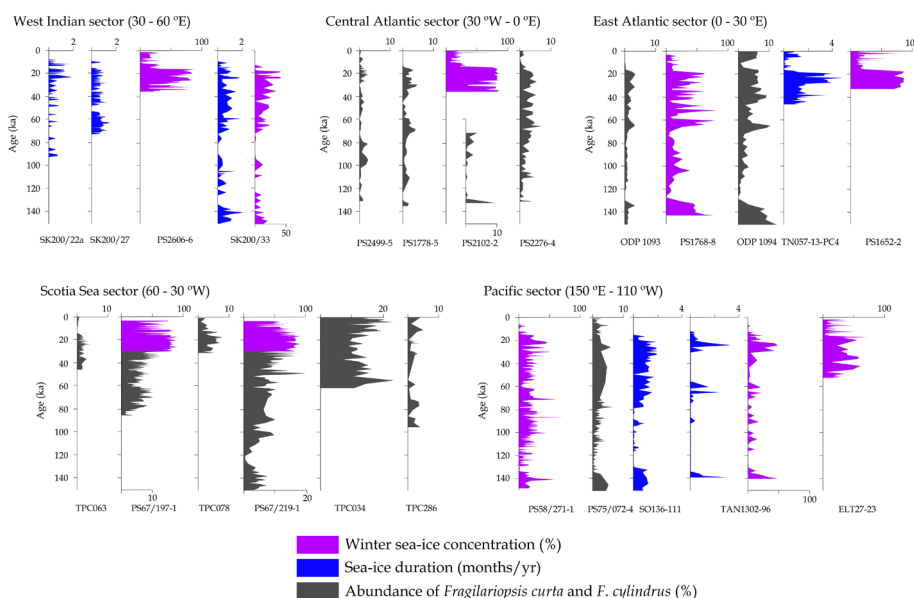


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Antarctic sea ice plays several crucial roles within the Earth system. The sea-ice seasonal cycle influences atmospheric dynamics (heat and air-sea gas exchanges; Rysgaard et al. 2011) and affects the circulation of heat, salt, and nutrients within the ocean (Maksym 2019). On glacial-interglacial timescales, sea ice has been proposed as an important player in modulating changes in atmospheric carbon dioxide concentration (Kohfeld and Chase 2017). Our understanding of the role of sea ice within this system is dependent on our ability to reconstruct and model past sea-ice changes, as well as to reconstruct and model complementary changes within the Earth and climate system.

The Cycles of Sea-Ice Dynamics in the Earth System (C-SIDE; [pastglobalchanges.org/c-side](https://pastglobalchanges.org/c-side)) working group was established in 2018 to synthesize existing sea-ice records from the Southern Ocean over the past 130,000 years. The main objective of C-SIDE is to better understand how changes in sea ice were related to other important oceanic processes, and to examine more closely how sea ice is simulated in Earth system model simulations of the last glacial period. Our choice of this timescale was selected so that we could evaluate sea-ice dynamics during previous warm periods (e.g. the Last Interglacial Period when Antarctica was 2°C warmer than today), warming glacial-to-interglacial transitions, and the major cooling periods of glacial inception, during which ocean carbon uptake was substantial.

During our first three years, the C-SIDE group held two workshops with the sea-ice community, which helped us to establish research priorities and outline the scope of our efforts. We assembled a comprehensive inventory of Southern Ocean sea-ice records covering at least a part of the time interval between 130,000 years ago and the Holocene. From this inventory, we identified 24 sites with high-resolution and long-duration sea-ice records for the last glacial-interglacial cycle (Fig. 1; Chadwick et al. 2022b). These data have been submitted to the PANGAEA database, and the paper has been submitted as part of a special issue that we organized for *Climate of the Past* entitled "Reconstructing Southern Ocean sea-ice dynamics on glacial-to-historical timescales". This special issue will be accepting topical submissions until December 2022. In addition to the sea-ice compilation, this special issue includes articles presenting new Southern Ocean sea-ice reconstructions (Chadwick et al. 2022a; Jones et al. 2022), as well as articles discussing developments in novel Antarctic sea-ice proxies (Lamping et al. 2021; McClymont et al. 2022; Vorrath et al.



**Figure 1:** Compilation of Southern Ocean sea-ice records for the last 150,000 years from 24 core sites. Sea-ice records are grouped by region of the Southern Ocean and colored according to sea-ice reconstruction type. This figure is adapted from Chadwick et al. (2022b).

2020). It also contains articles evaluating the processes controlling sea-ice distribution and deep-ocean circulation in simulations of the last glacial maximum, using climate models from the Paleoclimate Modelling Intercomparison Project PMIP3 and PMIP4, and iLOVECLIM (Lhardy et al. 2021; Green et al. 2020).

The second phase of the working group is already brimming with activities. Two review papers are nearing completion and will address, firstly, the use of a range of proxies for reconstructing sea ice during the last 130,000 years and, secondly, the current state of our understanding of how sea ice is linked with atmospheric, oceanic, land ice, and biogeochemical processes on glacial-interglacial timescales. With the help of funds from Simon Fraser University (SFU) and the Canadian Mitacs program, C-SIDE members will be hosting three early-career researchers at SFU to bring together complementary datasets (sea-surface and subsurface temperature records reconstructed using radiolarian proxies) to examine temporal relationships between sea-ice changes and ocean temperature and water mass behavior in the Southern Ocean. C-SIDE is also collaborating with the leaders of the Arctic Cryosphere Change and Coastal Marine Ecosystems (ACME; [pastglobalchanges.org/acme](https://pastglobalchanges.org/acme)) working group to produce a PAGES Magazine issue on sea-ice changes at both poles to be published in the second half of 2022. Finally, as international travel possibilities re-emerge, the C-SIDE steering committee

is looking into opportunities to reschedule our third, postponed, workshop, to focus our ongoing efforts within the global sea-ice and PAGES communities.

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