Supplement of Clim. Past, 18, 1815–1829, 2022
https://doi.org/10.5194/cp-18-1815-2022-supplement

Climate of the Past
Open Access
EGU

Supplement of

Compilation of Southern Ocean sea-ice records covering the last glacial-interglacial cycle (12–130 ka)

Matthew Chadwick et al.

Correspondence to: Matthew Chadwick (m.chadwick@cornwall-insight.com)

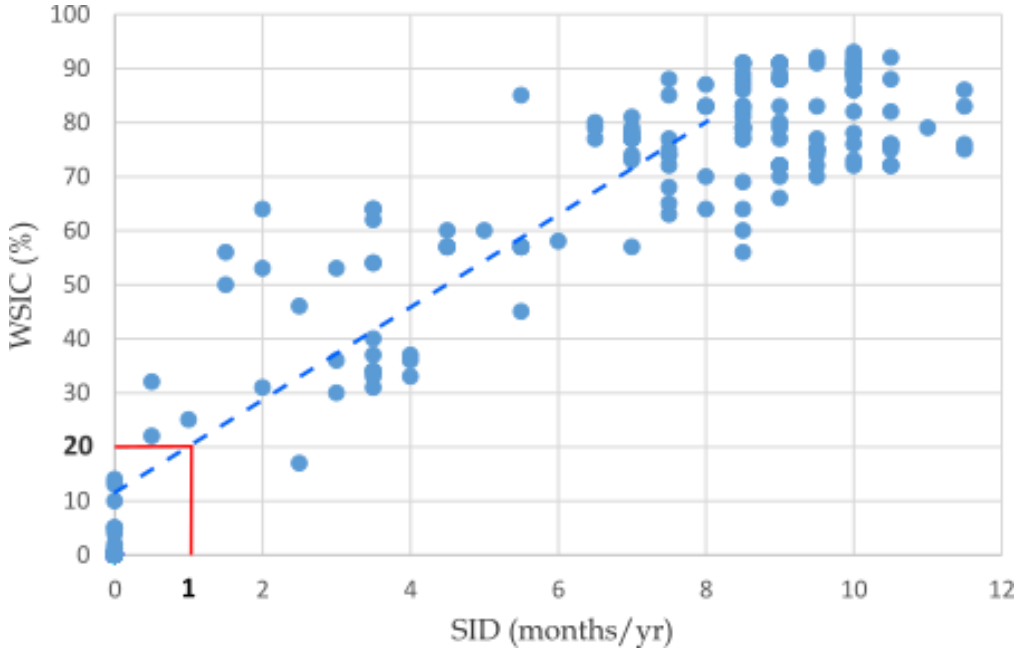

Figure S1: Plot of winter sea-ice concentration (WSIC) and sea-ice duration (SID) for 276 seafloor surface sediment samples indicating that for SIDs <8 months/yr there is a good (R2 = 0.92) linear correlation (dashed blue line) between WSIC and SID. The red lines indicate the 20 % and 1 month/yr values that mark the mean WSIE in the two parameters.

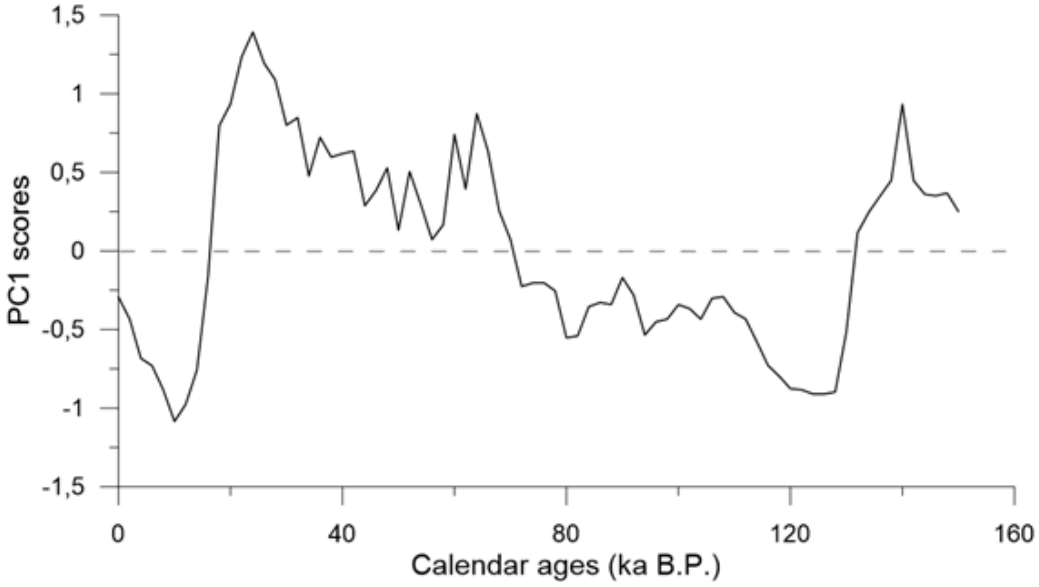

Figure S2: Scores of the first principal component (PC) versus age, as identified by the PCA applied to the resampled and normalised sea-ice records listed in Table 1.

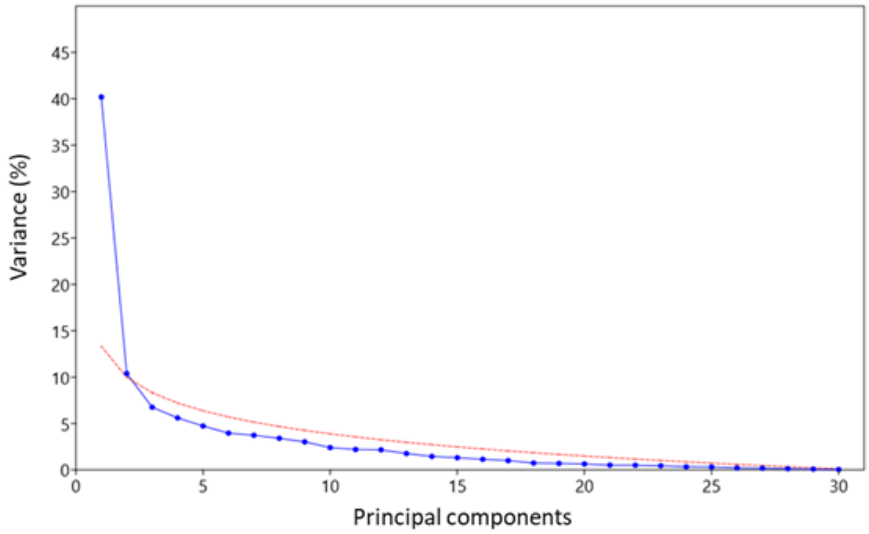

Figure S3: The variance explained by each principal component (dark blue curve), along with the broken stick curve (red), identified by the PCA applied to the resampled and normalised sea-ice records listed in Table 1.

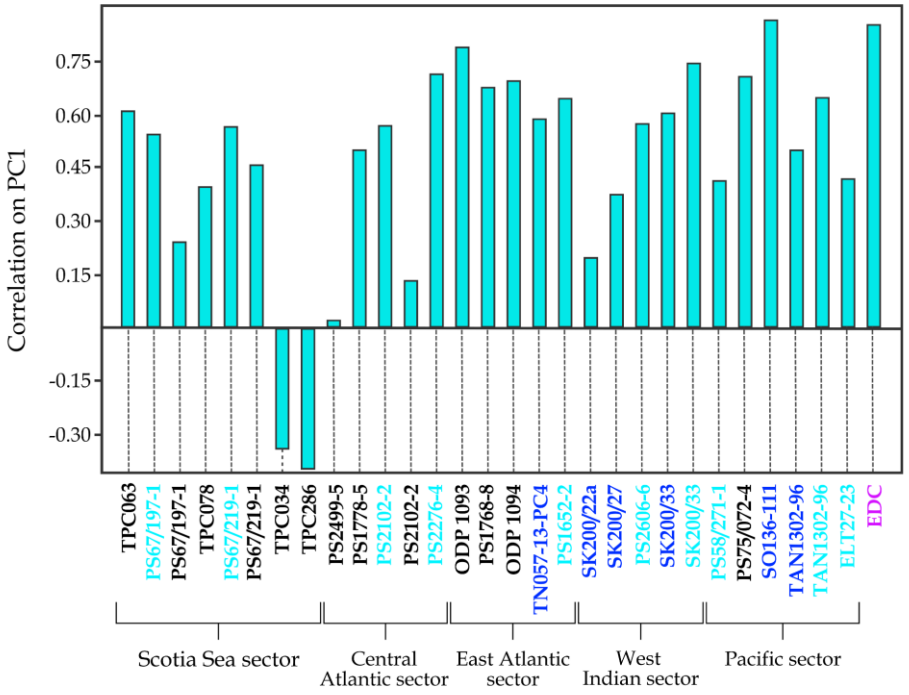

Figure S4: Correlation coefficients of the different cores on PC1 as identified by the PCA applied to the resampled and normalised sea-ice records presented in Table 1. Cores are grouped by Southern Ocean sector and ordered from north to south within each sector. In black: FCC proxy; in dark blue: SID; in light blue: WSIC; in purple: Na_{ss} flux, as in Figure 1.

S1 Sea-surface temperature (SST) records

We have identified published Southern Ocean SST records that cover the last G-IG cycle and are from marine sediment cores located within fifteen degrees of the modern mean WSI edge (Figure S5 and Table S1). Only records which have a mean sample resolution of <3 ka were considered. We selected twenty four SST records from twenty three core sites (Table S1) and normalised them following the same methodology as for the sea-ice records (detailed in section 2.2). The normalised records were resampled at 2 ka resolution, grouped and stacked into three Southern Ocean sector stacks: the Atlantic sector stack (30 ºW - 30 ºE), the Indian sector stack (30 - 120 ºE) and the Pacific sector stack (150 ºE - 105 ºW). Unlike the normalised sea-ice stacks in Figures 2 and 4, the patterns and timings of changes in the SST stacks is largely consistent between Southern Ocean sectors (Figure S6) and therefore, for our comparison with G-IG sea-ice changes, all twenty four SST records are stacked together in a single Southern Ocean stack (Figure 4).

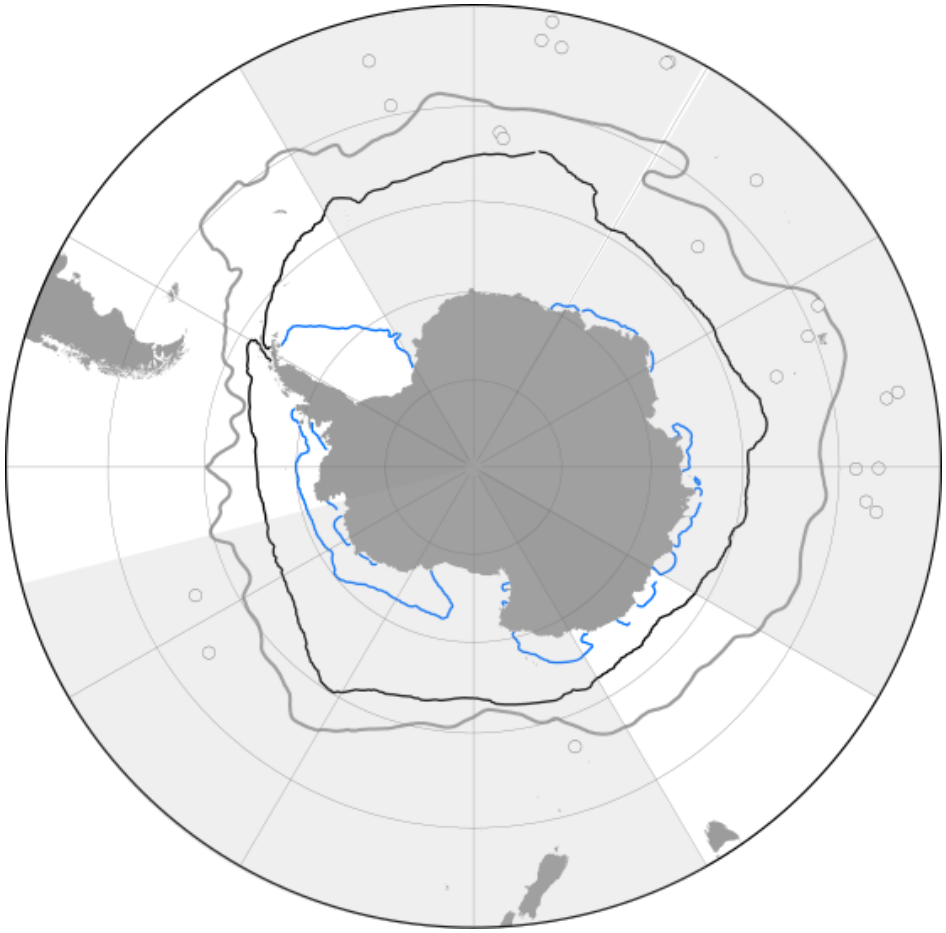

Figure S5: Map of the twenty three marine sediment core sites (Table S1) from which SST records are used in this study (white circles). Grey background shading marks the three Southern Ocean sectors for which normalised SST stacks are presented in Figure S6 (the Atlantic sector (30 ºW - 30 ºE), the Indian sector (30 - 120 ºE) and the Pacific sector (150 ºE - 105 ºW)). The modern February (blue line) and September (black line) sea-ice extents (data from Fetterer et al. (2017)) and the modern APF position (grey line; Trathan et al. (2000)) are also marked.

	Latitude (ºS)	Longitude (ºE)	Southern Ocean sector	Data references
ODP 1089	40.93	9.90	Atlantic	Kohfeld and Chase (2017)
MD02-2588	41.20	25.50	Atlantic	Romero et al. (2015)
U1475	41.43	25.26	Atlantic	Tangunan et al. (2021)
PS2489-2	42.87	8.97	Atlantic	Kohfeld and Chase (2017)
PS2082-1	43.22	11.74	Atlantic	Kohfeld and Chase (2017)
RC11-120 (two records)	43.52	79.87	Indian	Kohfeld and Chase (2017)
PS2498-1	44.15	-14.23	Atlantic	Kohfeld and Chase (2017)
MD11-3357	44.68	80.43	Indian	Thöle et al. (2019)
MD88-770	46.02	96.46	Indian	Kohfeld and Chase (2017)
DCR-1PC	46.02	44.25	Indian	Crosta et al. (2020)
ELT49-18	46.02	90.16	Indian	Kohfeld and Chase (2017)
ELT49-23	47.13	95.08	Indian	Kohfeld and Chase (2017)
ELT49-17	48.28	90.24	Indian	Kohfeld and Chase (2017)
MD12-3394	48.38	64.59	Indian	Ai et al. (2020)
PS1778-5	49.01	-12.70	Atlantic	Kohfeld and Chase (2017)
MD11-3353	50.57	68.39	Indian	Ai et al. (2020)
PS1768-8	52.59	4.48	Atlantic	Kohfeld and Chase (2017)
ODP 1094	53.18	5.13	Atlantic	Hasenfratz et al. (2019)
PS75/059-2	54.22	-125.43	Pacific	Tapia et al. (2019)
MD84-551	55.01	73.17	Indian	Kohfeld and Chase (2017)
SK200/33	55.02	45.15	Indian	Ghadi et al. (2020)
E11-2	56.07	-115.08	Pacific	Kohfeld and Chase (2017)
SO136-111	56.67	160.23	Pacific	Kohfeld and Chase (2017)

Table S1: Details of the locations of the twenty three marine sediment cores (Figure S5) which have SST records used in this study. Cores are ordered by latitude from north to south.

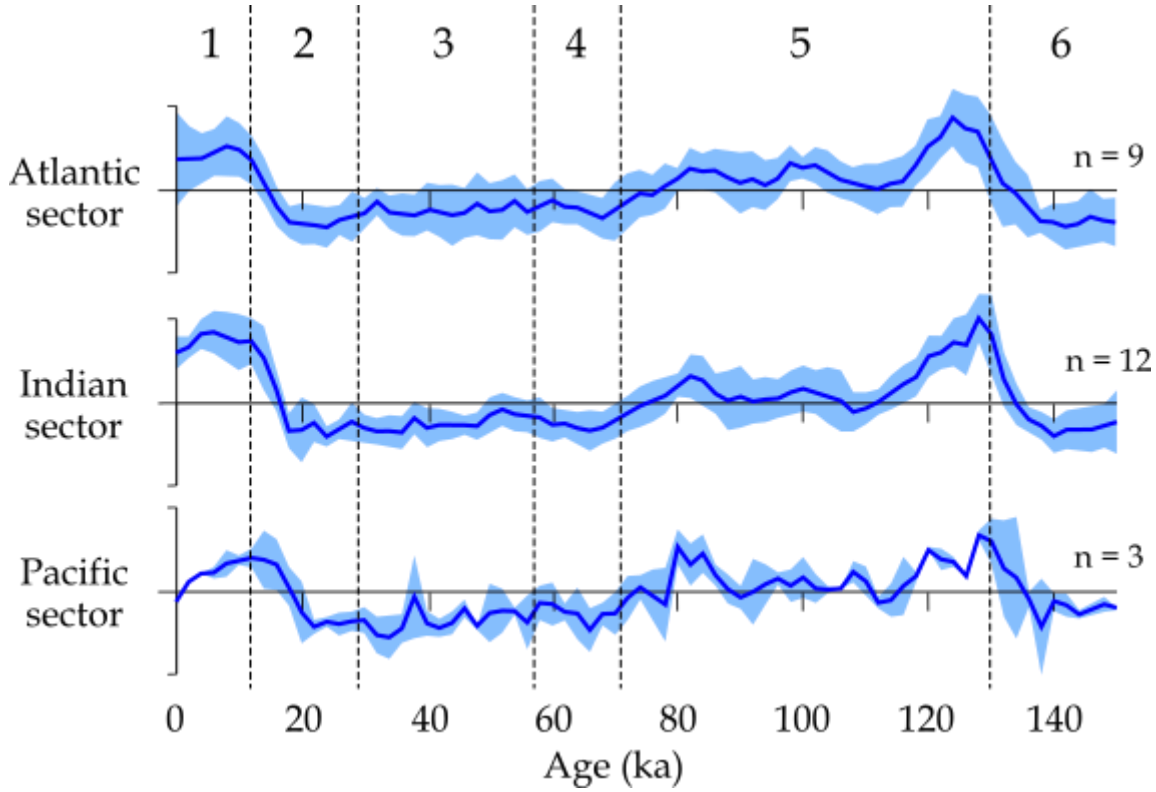

Figure S6: Stacks of the normalised and resampled SST records for three Southern Ocean sectors (the Atlantic sector (30 ºW - 30 ºE), the Indian sector (30 - 120 ºE) and the Pacific sector (150 ºE - 105 ºW)), with n values to indicate the number of SST records in each stack. The blue curves mark the mean values for each stack and the blue shading marks the interquartile ranges. Vertical dashed lines mark MIS boundaries with each MIS numbered at the top of the figure.

References

Ai, X. E., Studer, A. S., Sigman, D. M., Martinez-Garcia, A., Fripiat, F., Thöle, L. M., Michel, E., Gottschalk, J., Arnold, L., Moretti, S., Schmitt, M., Oleynik, S., Jaccard, S. L., and Haug, G. H.: Southern Ocean upwelling, Earth's obliquity, and glacial-interglacial atmospheric CO_2 change, Science, 370, 1348-1352, 2020.

Crosta, X., Shukla, S. K., Ther, O., Ikehara, M., Yamane, M., and Yokoyama, Y.: Last Abundant Appearance Datum of Hemidiscus karstenii driven by climate change, Marine Micropaleontology, 157, 101861, 2020.

Fetterer, F., Knowles, K., Meier, W. N., Savoie, M., and Windnagel, A. K.: Sea Ice Index, Version 3. NSIDC: National Snow and Ice Data Center, Boulder, Colorado USA, 2017.

Ghadi, P., Nair, A., Crosta, X., Mohan, R., Manoj, M. C., and Meloth, T.: Antarctic sea-ice and palaeoproductivity variation over the last 156,000 years in the Indian sector of Southern Ocean, Marine Micropaleontology, 160, 101894, 2020.

Hasenfratz, A. P., Jaccard, S. L., Martinez-Garcia, A., Sigman, D. M., Hodell, D. A., Vance, D., Bernasconi, S. M., Kleiven, H. F., Haumann, F. A., and Haug, G. H.: The residence time of Southern Ocean surface waters and the 100,000-year ice age cycle, Science, 363, 1080-1084, 2019.

Kohfeld, K. E. and Chase, Z.: Temporal evolution of mechanisms controlling ocean carbon uptake during the last glacial cycle, Earth and Planetary Science Letters, 472, 206-215, 2017.

Romero, O. E., Kim, J. H., Bárcena, M. A., Hall, I. R., Zahn, R., and Schneider, R.: High-latitude forcing of diatom productivity in the southern Agulhas Plateau during the past 350 kyr, Paleoceanography, 30, 118-132, 2015.

Tangunan, D., Berke, M. A., Cartagena-Sierra, A., Flores, J. A., Gruetzner, J., Jiménez-Espejo, F., LeVay, L. J., Baumann, K.-H., Romero, O., Saavedra-Pellitero, M., Coenen, J. J., Starr, A., Hemming, S. R., and Hall, I. R.: Strong glacial-interglacial variability in upper ocean hydrodynamics, biogeochemistry, and productivity in the southern Indian Ocean, Communications Earth & Environment, 2, 2021.

Tapia, R., Nürnberg, D., Ho, S. L., Lamy, F., Ullermann, J., Gersonde, R., and Tiedemann, R.: Glacial differences of Southern Ocean Intermediate Waters in the Central South Pacific, Quaternary Science Reviews, 208, 105-117, 2019.

Thöle, L. M., Amsler, H. E., Moretti, S., Auderset, A., Gilgannon, J., Lippold, J., Vogel, H., Crosta, X., Mazaud, A., Michel, E., Martínez-García, A., and Jaccard, S. L.: Glacial-interglacial dust and export production records from the Southern Indian Ocean, Earth and Planetary Science Letters, 525, 115716, 2019.

Trathan, P. N., Brandon, M. A., Murphy, E. J., and Thorpe, S. E.: Transport and structure within the Antarctic Circumpolar Current to the north of South Georgia, Geophysical Research Letters, 27, 1727-1730, 2000.