



*Supplement of*

## **Evaluating seasonal sea-ice cover over the Southern Ocean at the Last Glacial Maximum**

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**Table S1.** Compilation of 149 proxy records used in this study for the Last Glacial Maximum (LGM, Allen et al., 2011; Benz et al. 2016; Ferry et al. 2015; Xiao et al. 2016; Gersonde et al. 2005; Ghadi et al. 2020; Nair et al. 2019). SSST represents summer sea-surface temperature, WSIC represents winter sea-ice concentration, *Fcc* WSI represents *Fragilariopsis curta* and *cylindrus* winter sea ice, SSIC represents summer sea-ice concentration, and *Fobliq* SSI represents *Fragilariopsis obliquecostata* summer sea ice.

Core Name	Latitude	Longitude	LGM	LGM	LGM	LGM	LGM	Reference
			SSST	WSIC	<i>Fcc</i> WSI	SSIC	<i>Fobliq</i> SSI	
			(°C)	(%)	(%)	(%)	(%)	
ELT11-1	-54.91	-114.70	5.68	2.8	0.0	0.0	0.0	<b>Gersonde et al., 2005</b>
ELT11-2	-56.06	-115.06	5.53	2.6	0.0	0.0	0.0	
ELT11-3	-56.90	-115.24	3.36	12.0	0.0	0.0	0.3	
ELT11-4	-57.83	-115.21	4.20	20.0	0.0	0.0	0.0	
ELT14-6	-57.02	-160.09	3.42	22.4	0.0	0.0	0.0	
ELT15-12	-58.68	-108.80	3.98	2.6	0.0	0.0	0.0	
ELT15-4	-59.02	-99.76	4.74	2.6	0.0	0.0	0.0	
ELT15-6	-59.97	-101.32	4.79	9.2	0.0	0.0	0.0	
ELT17-9	-63.08	-135.12	0.88	49.2	0.0	0.0	0.0	
ELT19-7	-62.16	-109.09	1.57	34.0	0.0	0.0	0.0	
ELT20-10	-60.22	-127.03	2.68	7.0	0.0	0.0	0.9	
ELT35-15	-52.94	116.99	3.86	2.6	0.0	0.0	0.0	
ELT36-36	-60.39	157.53	1.51	40.0	2.8	0.0	1.9	
ELT39-13	-45.01	125.98	4.95	0.0	0.0	0.0	0.0	
ELT39-18	-48.03	126.13	4.28	0.0	0.0	0.0	0.0	
ELT39-21	-48.86	126.02	3.54	0.0	0.0	0.0	0.3	
ELT45-29	-44.88	106.52	5.57	0.0	0.0	0.0	0.0	
ELT45-35	-53.50	111.33	2.85	22.8	0.0	0.0	0.0	
ELT45-63	-53.44	114.26	1.51	37.2	0.0	0.0	0.3	
ELT45-64	-52.48	114.09	1.68	22.6	0.3	0.0	0.3	
ELT45-79	-45.06	114.37	5.23	0.0	0.0	0.0	0.0	
ELT48-27	-38.54	79.87	16.25	0.0	0.0	0.0	0.0	
ELT49-6	-51.01	109.99	1.64	33.4	0.0	0.0	0.3	
ELT49-7	-53.04	110.05	1.37	45.2	0.3	0.0	0.3	
ELT49-8	-55.07	110.02	1.06	45.2	0.0	0.0	0.0	
ELT50-11	-55.95	104.95	1.66	34.6	0.9	0.0	0.3	
IO1277-10	-52.02	20.47	1.36	37.6	1.4	0.0	2.1	
IO1578-4	-59.23	-19.73	0.53	62.3	0.4	0.0	0.8	
KR88-22	-64.67	119.51	0.39	81.4	1.3	1.0	8.2	

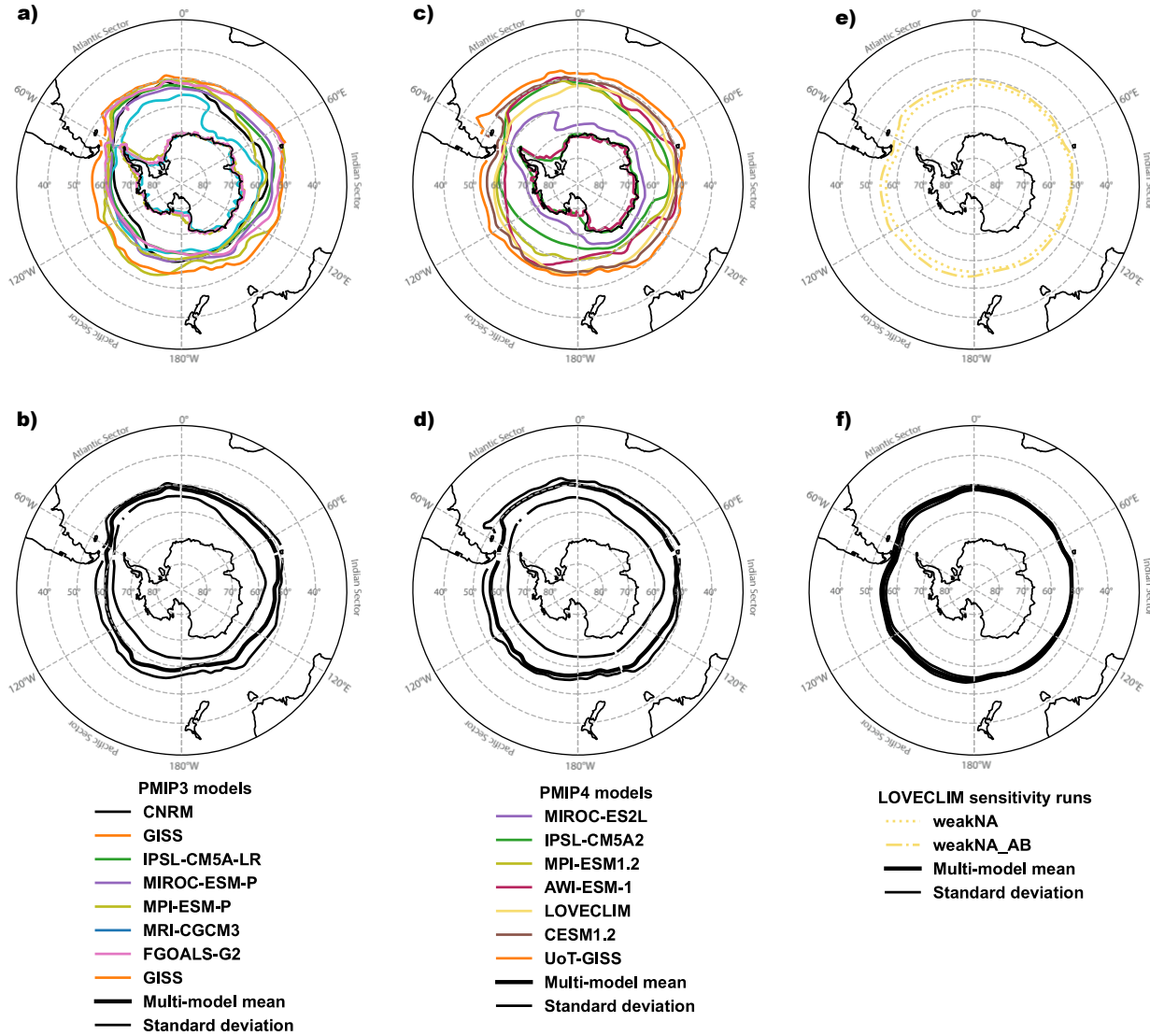
KR88-27	-63.65	101.15	0.39	81.4	2.2	1.0	9.3	
KR88-29	-62.49	95.89	0.40	76.8	1.9	0.4	3.4	
MD24-KK63	-51.91	42.88	0.86	55.2	3.7	0.8	1.6	
MD73-026	-44.98	53.28	7.72	0.0	0.0	0.0	0.0	
MD80-304	-51.06	67.72	2.13	32.0	1.3	0.4	1.6	
MD82-424	-54.09	-0.35	0.62	61.6	5.2	0.4	3.9	
MD82-434	-58.85	-16.65	0.67	62.2	0.0	0.8	1.3	
MD84-527	-43.49	51.32	8.20	0.0	0.0	0.0	0.0	
MD84-529	-48.89	61.66	2.98	2.6	0.0	0.0	0.0	
MD84-551	-55.00	73.26	0.93	49.6	2.2	0.4	1.0	
MD84-552	-54.91	73.84	1.12	34.8	0.9	0.0	0.0	
MD88-769	-46.06	90.09	7.19	0.0	0.0	0.0	0.0	
MD88-770	-46.02	96.43	5.68	0.0	0.0	0.0	0.0	
MD88-773	-52.90	109.85	2.29	23.7	0.0	0.0	0.6	
MD88-784	-54.19	144.79	3.50	13.4	2.2	0.1	0.0	
MD88-787	-56.38	145.30	2.33	19.0	2.5	0.2	0.6	
PS1433-1	-47.54	15.36	2.67		1.2		0.0	
PS1444-1	-55.37	9.98	0.10		4.1		0.7	
PS1649-2	-54.91	3.31	-0.10		7.7		1.3	
PS1651-1	-53.63	3.86	0.00		8.4		2.4	
PS1652-2	-53.66	5.10	-0.50		18.3		1.1	
PS1654-2	-50.16	5.72	1.40		2.1		0.3	
PS1756-5	-48.90	6.71	1.60		1.8		0.2	
PS1765-3	-51.83	4.81	0.80		4.7		0.4	
PS1768-8	-52.59	4.48	0.50		7.9		0.6	
PS1775-4	-50.95	-7.51	0.40		8.2		0.4	
PS1777-6	-48.23	-11.04	2.00		1.6		0.1	
PS1778-5	-49.01	-12.70	1.70		1.3		0.1	
PS1779-2	-50.40	-14.08	1.20		2.5		0.1	
PS1780-5	-51.70	-15.30	1.10		3.7		0.0	
PS1782-5	-55.19	-18.61	1.40		3.7		0.0	
PS1783-5	-54.91	-22.71	0.40		6.2		0.4	
PS2082-1	-43.22	11.74	4.80		0.3		0.1	
PS2089-1	-53.19	5.33	0.20		10.2		0.3	
PS2090-1	-53.18	5.13	0.40		5.8		0.8	
PS2102-2	-53.07	-4.99	0.00		12.0		0.4	
PS2250-5	-45.10	-57.95	3.00		0.2		0.0	
PS2276-4	-54.64	-23.95	0.50		3.4		0.0	
PS2278-3	-55.97	-22.22	0.60		2.8		0.1	
PS2280-4	-56.84	-22.32	0.80		2.7		0.1	
PS2305-6	-58.72	-33.04	0.20		7.9		0.3	
PS2307-1	-59.05	-35.61	0.00		7.0		0.0	

PS2319-1	-59.79	-42.68	0.50		10.2		1.4	
PS2491-3	-44.96	5.97	3.20		0.8		0.0	
PS2492-2	-43.17	-4.06	4.10		0.3		0.0	
PS2493-1	-42.88	-6.02	4.00		0.4		0.0	
PS2498-1	-44.15	-14.23	4.50		0.3		0.0	
PS2499-5	-46.51	-15.33	2.70		0.7		0.0	
PS2502-2	-50.25	-23.24	1.20		3.2		0.0	
PS2515-3	-53.55	-45.29	0.80		7.2		0.2	
PS2561-2	-41.86	28.54	10.90		0.8		0.0	
PS2563-2	-44.56	34.79	4.10		0.3		0.0	
PS2564-3	-46.14	35.90	4.30		0.3		0.0	
PS2567-2	-46.94	6.26	3.90		0.5		0.0	
PS2603-3	-58.99	37.63	0.90		3.7		0.7	
PS2606-6	-53.23	40.80	0.30		3.6		0.5	
PS2608-1	-51.88	41.65	0.10		5.0		0.8	
PS2610-3	-50.69	40.13	0.60		5.1		0.2	
PS58/271-1	-61.24	-116.05	1.70		1.2		0.0	
RC11-118	-37.80	71.53	16.25	0.0	0.0	0.0	0.0	
RC11-77	-53.05	-16.45	0.86	52.0	0.3	0.0	1.3	
RC11-78	-50.87	-9.87	0.73	61.0	0.6	0.8	3.7	
RC11-91	-56.57	34.18	1.82	45.0	0.9	0.0	0.0	
RC11-94	-54.48	53.05	0.75	58.0	1.3	0.0	0.0	
RC11-96	-50.47	59.58	1.45	45.2	0.9	0.0	0.0	
RC11-97	-50.32	61.20	2.21	27.7	0.3	0.0	0.0	
RC12-289	-47.90	-23.70	2.14	21.2	0.3	0.2	0.3	
RC12-294	-37.27	-10.10	17.32	0.0	0.0	0.0	0.0	
RC13-251	-42.52	11.67	10.02	0.0	0.0	0.0	0.0	
RC13-253	-46.60	7.63	4.08	2.8	0.0	0.0	0.0	
RC13-256	-53.18	-0.35	0.93	44.0	1.3	0.2	1.9	
RC13-259	-53.88	-4.93	0.78	48.4	1.3	0.0	2.7	
RC13-263	-53.80	-8.22	0.83	55.8	1.9	0.2	6.8	
RC13-269	-52.63	-0.13	1.91	36.5	2.1	0.0	0.5	
RC13-271	-51.98	4.52	2.32	15.8	0.0	0.0	0.9	
RC14-11	-38.00	51.18	14.00	0.0	0.0	0.0	0.0	
RC14-12	-38.75	59.30	13.59	0.0	0.0	0.0	0.0	
RC17-61	-52.20	54.47	1.90	16.8	0.3	0.0	0.3	
RC8-39	-42.88	42.35	9.65	0.0	0.0	0.0	0.0	
RC8-46	-55.33	65.47	0.91	47.0	0.6	0.0	0.0	
RC9-139	-47.77	123.10	4.75	0.0	0.0	0.0	0.0	
SO136-111	-56.67	160.23	2.21	22.3	0.4	0.0	0.6	
TN057-13-PC4	-53.17	5.11	1.17	48.2	2.1	0.4	2.3	

V14-57	-57.57	-17.10	0.89	45.4	1.2	0.0	0.0	
V29-84	-43.85	27.60	7.71	0.0	0.0	0.0	0.0	
V29-86	-49.57	30.02	4.20	20.0	0.9	0.0	0.0	
V29-87	-49.10	27.38	3.00	20.0	0.0	0.0	0.3	
V29-89	-45.73	25.65	6.91	0.0	0.0	0.0	0.0	
V29-90	-43.70	25.73	10.07	0.0	0.0	0.0	0.0	
PS58/270-5	-62.03	-116.12	1.50	15.9				<b>Benz et al., 2016</b>
PS58/271-1	-61.24	-116.05	1.90	23.9				
PS58/274-1	-59.21	-114.89	1.90	19.0				
PS75/051-1	-52.81	-107.81	4.30	1.2				
PS75/054-1	-56.15	-115.13	2.60	12.1				
PS75/056-1	-55.16	-114.79	2.80	5.6				
PS75/059-2	-54.22	-125.43	5.10	1.4				
PS75/064-1	-61.01	-139.46	0.50	33.9				
PS75/072-4	-57.56	-151.22	1.00	51.9				
PS75/073-2	-57.20	-151.61	1.00	15.5				
PS75/076-2	-55.53	-156.14	3.00	9.9				
PS75/082-1	-59.04	-158.36	1.70	12.8				
PS75/085-1	-61.94	-160.12	0.70	26.2				
PS75/091-3	-63.69	-169.07	1.00	47.4				
PS75/093-1	-60.87	-169.55	1.30	6.1				
PS75/096-4	-58.55	-172.70	2.20	2.6				
PS75/097-4	-59.70	-171.36	1.60	6.8				
TCP036	-52.60	-46.88			5.6		0.1	<b>Allen et al., 2011</b>
TCP063	-53.93	-48.04			6.4		0.1	
TCP078	-55.55	-45.02			6.6		0.1	
KC081	-56.74	-42.97			8.3		0.0	
TCP034	-59.79	-39.60			11.1		0.9	
TCP287	-60.30	-36.65			6.6		1.0	
E27-23	-59.62	155.24		30.0				<b>Ferry et al., 2015</b>
SK200/22a	-43.70	45.06	2.05	10.5	2.2	0.0	0.0	<b>Nair et al., 2019</b>
SK200/27	-49.00	45.21	2.65	13.6	1.5	0.0	0.0	
SK200/33	-55.01	45.01	1.81	27.5	3.0	0.0	0.0	<b>Ghadi et al., 2020</b>
PS1768-8	-52.59	4.48	0.50	40.0	7.9		0.6	<b>Xiao et al., 2016</b>
PS1652-2	-53.66	5.10	-0.50	85.0	18.3		1.1	
PS1649-2	-54.91	3.31	-0.10	80.0	7.7		1.3	
PS2606-6	-53.23	40.80	0.30	60.0	3.6		0.5	
PS2102-2	-53.07	-4.99	0.00	85.0	12.0		0.4	

PS1652-2	-53.66	5.10	-0.50	80.0	18.3		1.1	
PS2102-2	-53.07	-4.99	0.00	80.0	12.0		0.4	
PS67/197-1	-55.14	-44.11		80.0	8.0		1.0	
ODP1093	-49.98	5.87		50.0	2.0		0.1	
ODP1094	-53.18	5.13		75.0	5.0		0.5	
ODP1090	-42.87	8.92		0.0	0.0		0.0	
MD11-3353	-50.37	68.39	2.60	26.0	0.6	0.0	0.4	<b>Crosta, Unpub.</b>

**Figure S1.** PMIP3 (a, b), PMIP4 (c, d) and LOVECLIM (e, f) annual mean simulated sea ice concentration at 15%. All individual model simulations are shown in the top row (a, c, e) and the multi model mean  $\pm$  one standard deviation is shown in the bottom row (b, d, f).



**Figure S2.** Scatter plot showing the relationship between austral summer sea-ice extent and Atlantic meridional overturning circulation (AMOC) depth and strength. Each  $R^2$  value is calculated and placed in the title of each panel.

