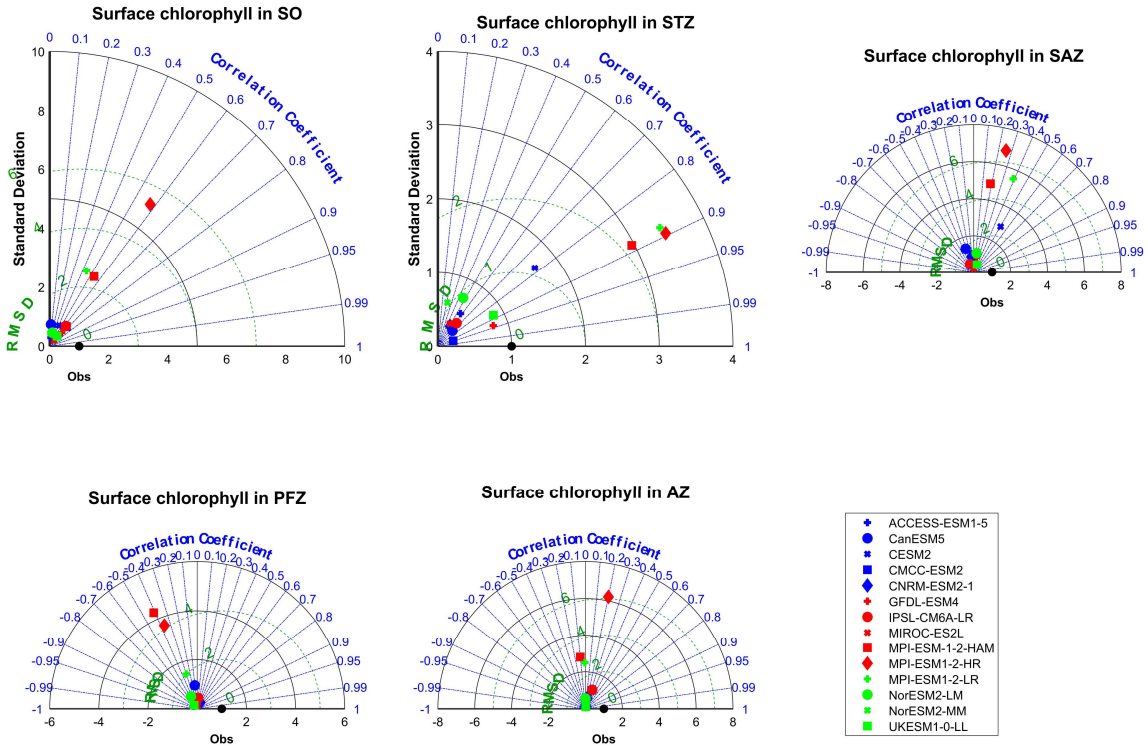
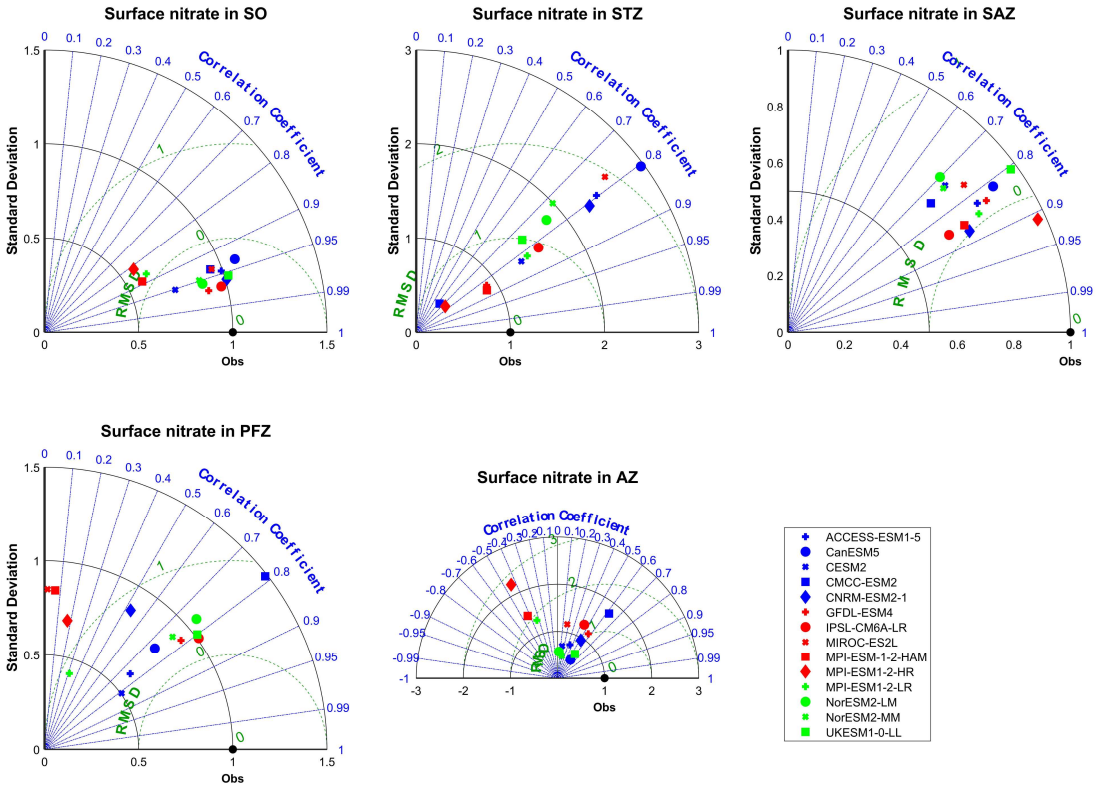


Figure S1: Taylor diagrams for surface chlorophyll in December-January-February (DJF) across the Southern Ocean (SO) and its subregions-the subtropical zone (STZ), the subantarctic zone (SAZ), the polar front zone (PFZ), and the Antarctic zone (AZ). The black circle denotes observational reference, while different colours and shapes represent individual CMIP6 models. The radius of each model's position on the diagram corresponds to its standardised standard deviation (SSD), indicating the model's variability relative to observations. The angle of the arc represents the correlation coefficient (CC), measuring the strength of agreement in spatial patterns between the model and observation. The Euclidean distance between a model's position and the observational reference reflects the root-mean-squared deviation (RMSD), where smaller distances indicate better agreement with observations.



10 **Figure S2: Taylor diagrams for surface nitrate in DJF across the Southern Ocean (SO) and its subregions-the subtropical zone (STZ), the subantarctic zone (SAZ), the polar front zone (PFZ), and the Antarctic zone (AZ).**

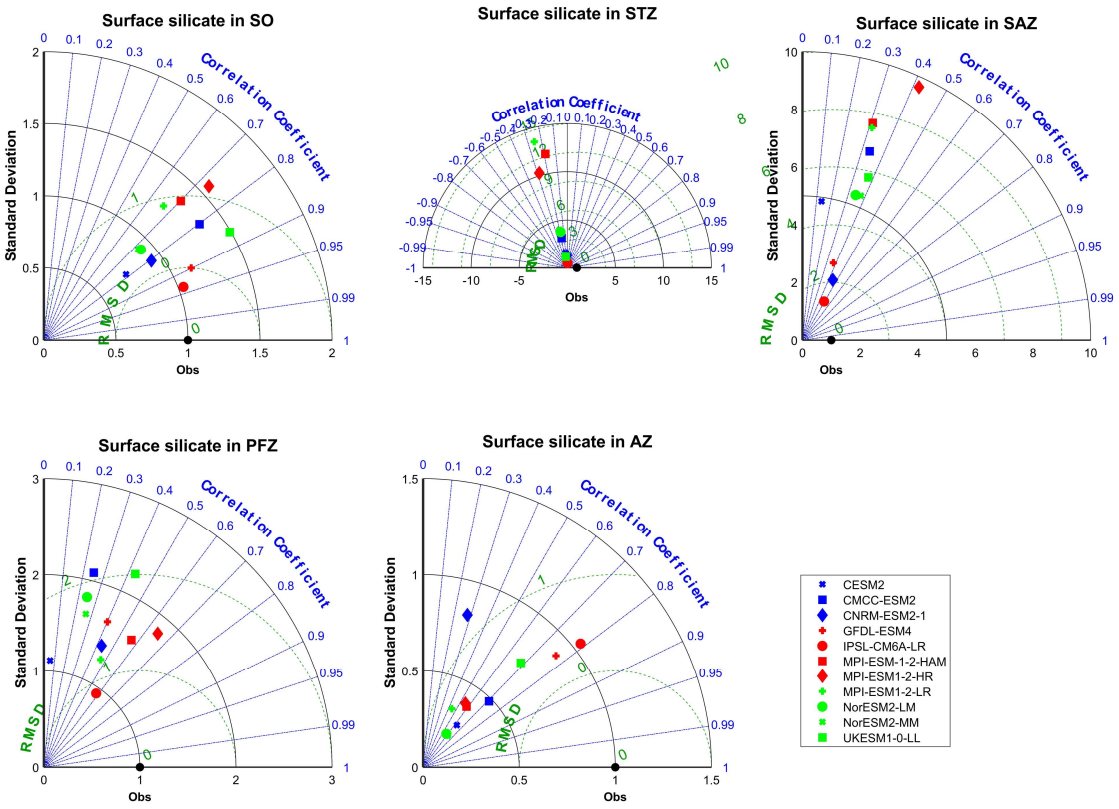


Figure S3: Taylor diagrams for surface silicate in DJF across the Southern Ocean (SO) and its subregions-the subtropical zone (STZ), the subantarctic zone (SAZ), the polar front zone (PFZ), and the Antarctic zone (AZ).

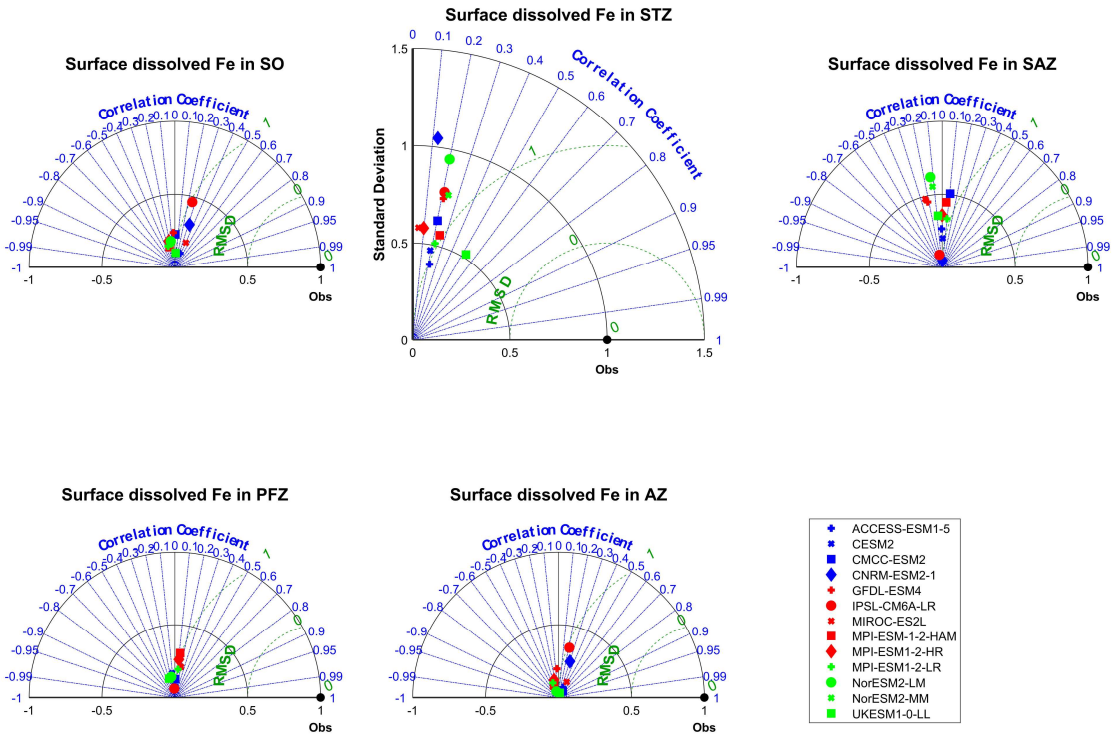


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Figure S4: Taylor diagrams for surface dissolved iron in DJF across the Southern Ocean (SO) and its subregions-the subtropical zone (STZ), the subantarctic zone (SAZ), the polar front zone (PFZ), and the Antarctic zone (AZ).

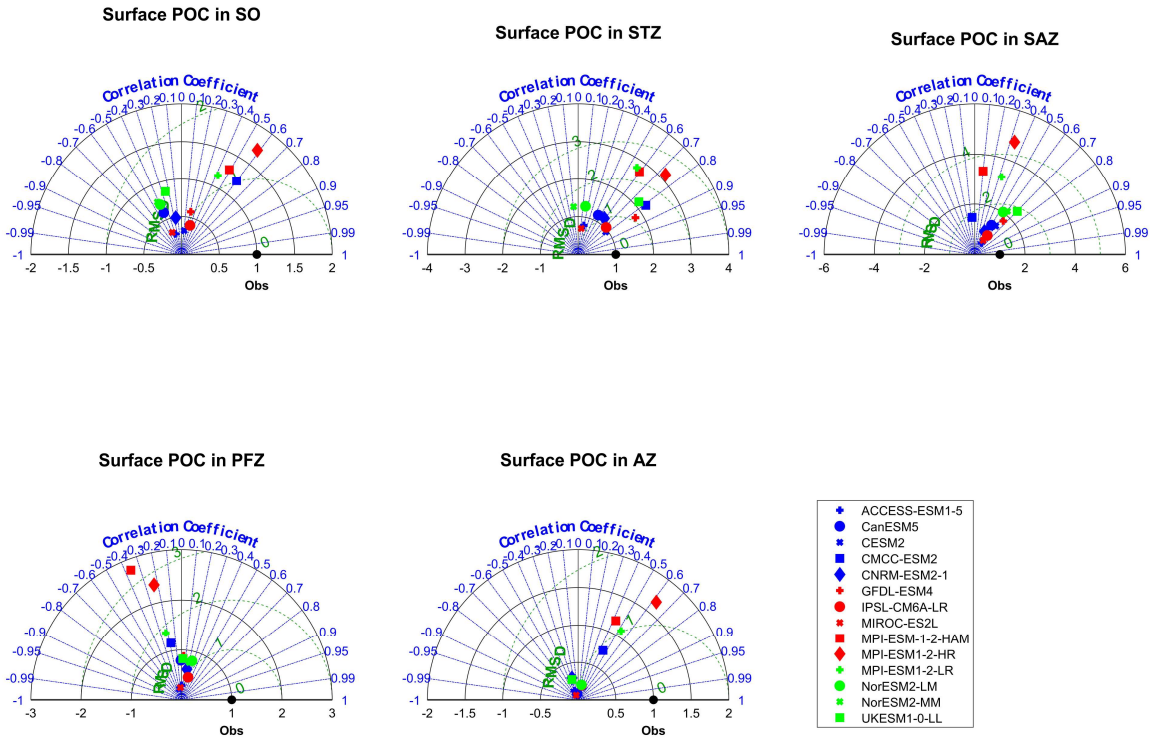

Figure S5: Taylor diagrams for yearly surface particulate organic carbon (POC) across the Southern Ocean (SO) and its subregions-the subtropical zone (STZ), the subantarctic zone (SAZ), the polar front zone (PFZ), and the Antarctic zone (AZ).

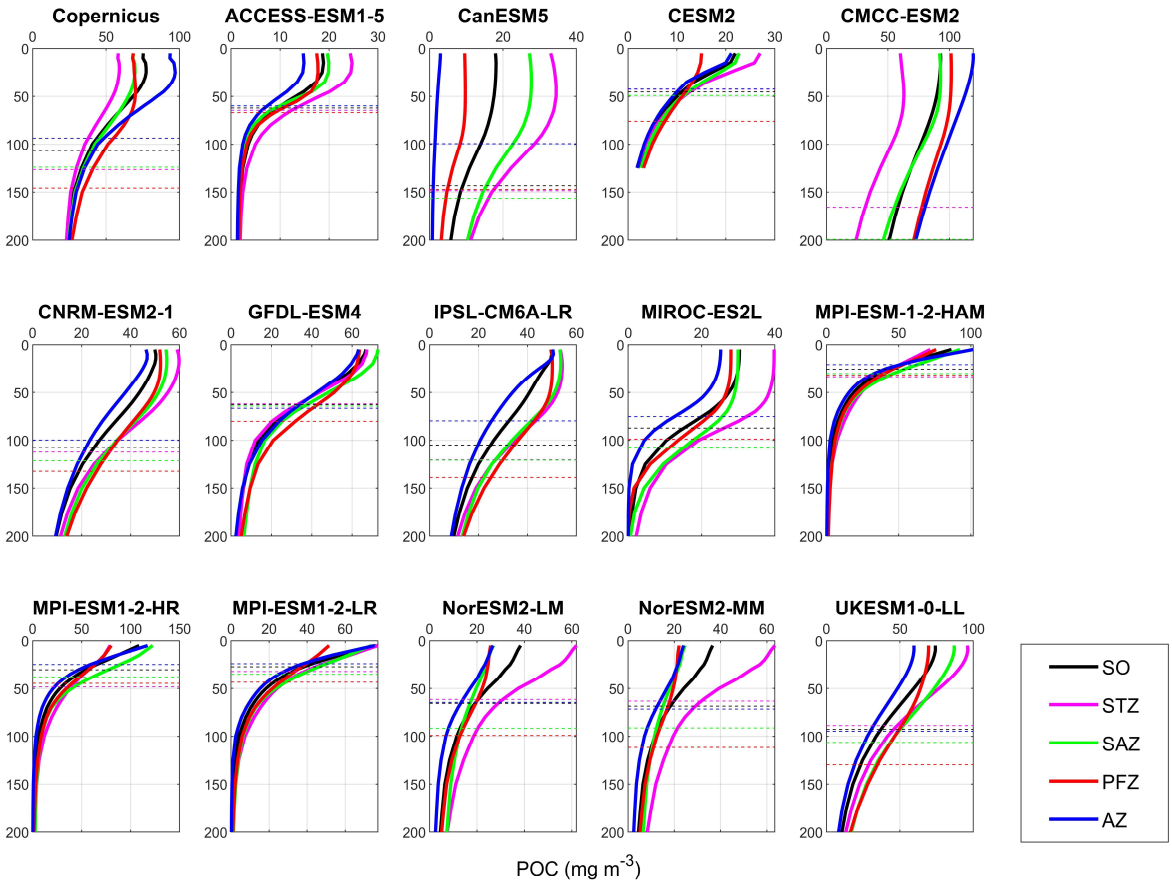

Figure S6: Mean vertical profiles of yearly particulate organic carbon (POC) across the Southern Ocean (SO) and its subregions: the Subtropical Zone (STZ), Subantarctic Zone (SAZ), Polar Frontal Zone (PFZ), and Antarctic Zone (AZ), based on observations (Copernicus) and 14 CMIP6 models. Solid lines represent POC profiles in different regions, while dashed lines indicate the threshold depth of POC, defined as the depth at which POC concentration reaches 50% of the maximum value.

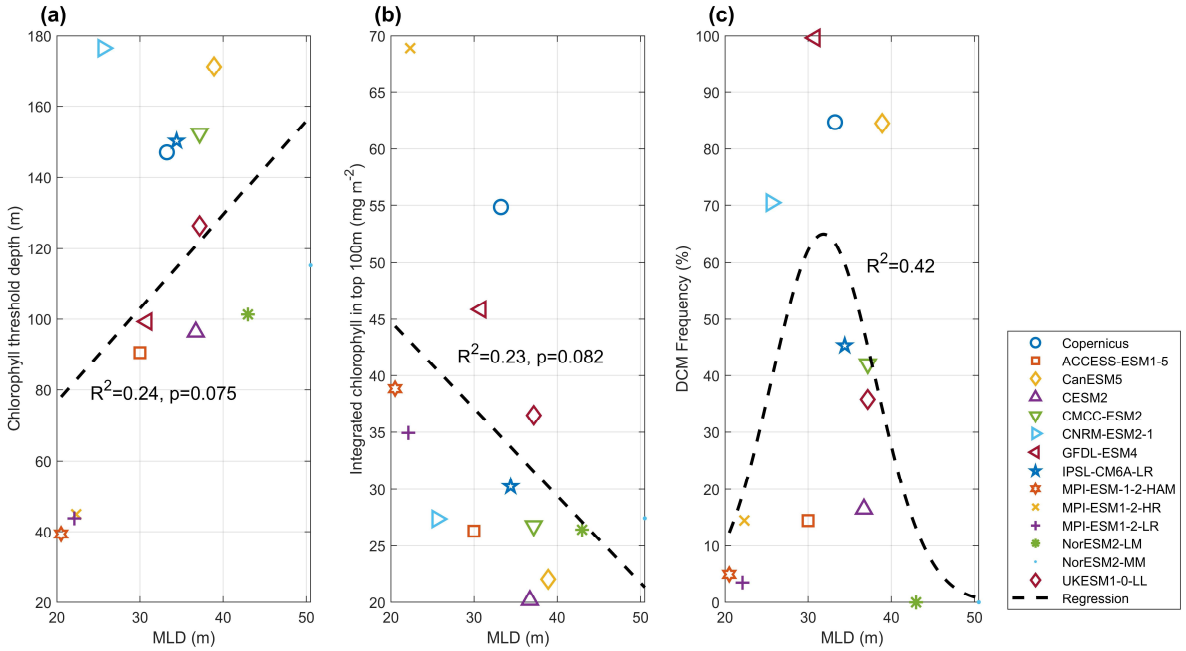

Figure S7: Relationships between (a) chlorophyll threshold depth, (b) integrated chlorophyll in the top 100m, (c) deep chlorophyll maximum (DCM) frequency and mixed layer depth (MLD) for observation and 14 CMIP6 models in the Southern Ocean during the period 2000-2014. Each point (colour/shape) represents a CMIP6 model (or the Copernicus reference), and dashed lines indicate regression fits where relevant. Corresponding P-values and R² statistics (for linear regressions) are displayed on each panel.

Table S1: Statistics of standardised standard deviation (SSD), root-mean-squared deviation (RMSD), and correlation coefficient (CC) for surface chlorophyll of 14 CMIP6 models in December-January-February (DJF) across the Southern Ocean (SO) and its subregions- the subtropical zone (STZ), subantarctic zone (SAZ), polar front zone (PFZ), and Antarctic zone (AZ).

CMIP6 ESMs	SSD					RMSD					CC				
	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ
ACCESS-ESM1-5	0.29	0.54	0.37	0.18	0.26	1.00	0.82	1.01	1.15	1.07	0.15	0.57	0.15	-0.81	-0.17
CanESM5	0.74	0.29	1.38	0.96	0.15	1.21	0.83	1.94	1.45	1.00	0.06	0.69	-0.32	-0.11	0.09
CESM2	0.77	1.69	2.90	0.26	0.65	0.98	1.11	2.54	1.06	1.05	0.41	0.78	0.51	-0.09	0.24
CMCC-ESM2	0.87	0.22	0.41	0.29	1.06	0.79	0.80	1.18	1.09	1.20	0.65	0.94	-0.28	-0.16	0.32
CNRM-ESM2-1	0.39	0.32	0.88	0.28	0.58	0.91	0.87	1.42	0.92	1.07	0.43	0.53	-0.13	0.43	0.16
GFDL-ESM4	0.61	0.80	0.87	0.36	0.37	0.75	0.37	1.20	0.99	1.03	0.66	0.94	0.18	0.22	0.11
IPSL-CM6A-LR	0.87	0.40	0.50	0.44	1.09	0.82	0.81	1.28	1.05	1.20	0.63	0.63	-0.40	0.10	0.34
MIROC-ES2L	0.25	0.34	0.18	0.12	0.23	0.87	0.89	1.01	0.99	0.96	0.62	0.46	0.01	0.18	0.27
MPI-ESM-1-2-HAM	2.80	2.96	4.89	4.31	2.81	2.41	2.13	4.81	4.81	3.08	0.54	0.89	0.19	-0.41	-0.10
MPI-ESM1-2-HR	5.90	3.45	6.83	3.66	6.21	5.38	2.59	6.64	4.13	6.09	0.58	0.90	0.26	-0.36	0.20
MPI-ESM1-2-LR	2.84	3.41	5.52	1.47	2.49	2.56	2.58	5.21	2.02	2.70	0.44	0.88	0.39	-0.30	-0.01
NorESM2-LM	0.46	0.74	1.08	0.56	0.56	1.02	0.93	1.36	1.35	1.14	0.19	0.46	0.14	-0.45	0.01
NorESM2-MM	0.43	0.60	1.04	0.52	0.48	1.06	1.05	1.32	1.35	1.09	0.07	0.22	0.16	-0.54	0.05
UKESM1-0-LL	0.42	0.86	0.47	0.19	0.11	0.82	0.49	0.93	1.13	0.99	0.60	0.87	0.38	-0.66	0.16

Table S2: Statistics of standardised standard deviation (SSD), root-mean-squared deviation (RMSD), and correlation coefficient (CC) for surface nitrate of 14 CMIP6 models in December-January-February (DJF) across the Southern Ocean (SO) and its subregions- the subtropical zone (STZ), subantarctic zone (SAZ), polar front zone (PFZ), and Antarctic zone (AZ).

CMIP6 ESMs	SSD					RMSD					CC				
	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ
ACCESS-ESM1-5	0.99	2.40	0.81	0.60	0.77	0.33	1.72	0.56	0.68	1.03	0.95	0.80	0.83	0.75	0.35
CanESM5	1.08	2.97	0.89	0.79	0.48	0.39	2.24	0.58	0.68	0.83	0.93	0.80	0.81	0.74	0.57
CESM2	0.73	1.35	0.76	0.50	0.70	0.38	0.76	0.68	0.66	1.14	0.95	0.83	0.73	0.81	0.14
CMCC-ESM2	0.94	0.39	0.68	1.49	1.76	0.35	0.81	0.67	0.93	1.38	0.94	0.63	0.74	0.79	0.62
CNRM-ESM2-1	1.01	2.28	0.74	0.87	0.95	0.28	1.58	0.51	0.92	0.96	0.96	0.81	0.87	0.53	0.52
GFDL-ESM4	0.90	0.90	0.84	0.93	1.16	0.25	0.56	0.55	0.64	1.02	0.97	0.83	0.83	0.78	0.56
IPSL-CM6A-LR	0.97	1.58	0.67	1.01	1.28	0.25	0.95	0.55	0.62	1.22	0.97	0.82	0.86	0.81	0.44
MIROC-ES2L	0.95	2.60	0.81	0.85	1.17	0.35	1.93	0.64	1.30	1.40	0.94	0.77	0.77	0.02	0.18
MPI-ESM-1-2-HAM	0.58	0.87	0.73	0.84	1.47	0.55	0.51	0.53	1.26	2.11	0.89	0.86	0.85	0.07	-0.43
MPI-ESM1-2-HR	0.58	0.41	0.97	0.69	2.22	0.62	0.74	0.42	1.11	2.81	0.82	0.75	0.91	0.17	-0.44
MPI-ESM1-2-LR	0.62	1.43	0.80	0.42	1.31	0.55	0.83	0.53	0.96	1.90	0.87	0.83	0.85	0.31	-0.33
NorESM2-LM	0.88	1.83	0.77	1.06	0.57	0.30	1.25	0.72	0.72	1.13	0.96	0.76	0.70	0.76	0.05
NorESM2-MM	0.87	2.00	0.75	0.91	0.48	0.33	1.44	0.68	0.68	1.02	0.95	0.73	0.73	0.75	0.19
UKESM1-0-LL	1.02	1.49	0.98	1.01	0.64	0.30	0.99	0.61	0.64	0.82	0.96	0.75	0.81	0.80	0.58

Table S3: Statistics of standardised standard deviation (SSD), root-mean-squared deviation (RMSD), and correlation coefficient (CC) for surface silicate of 14 CMIP6 models in December-January-February (DJF) across the Southern Ocean (SO) and its subregions- the subtropical zone (STZ), subantarctic zone (SAZ), polar front zone (PFZ), and Antarctic zone (AZ).

CMIP6 ESMs	SSD					RMSD					CC				
	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ
ACCESS-ESM1-5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CanESM5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CESM2	0.73	1.65	4.86	1.11	0.28	0.62	2.02	4.82	1.45	0.85	0.78	-0.11	0.14	0.06	0.63
CMCC-ESM2	1.35	3.19	6.94	2.09	0.48	0.81	3.51	6.67	2.08	0.74	0.80	-0.18	0.34	0.25	0.71
CNRM-ESM2-1	0.93	1.28	2.33	1.40	0.82	0.61	1.65	2.08	1.32	1.10	0.81	-0.04	0.45	0.43	0.28
GFDL-ESM4	1.14	0.69	2.88	1.65	0.90	0.50	1.15	2.67	1.55	0.66	0.90	0.10	0.37	0.40	0.77
IPSL-CM6A-LR	1.04	0.47	1.53	0.94	1.04	0.37	1.08	1.36	0.89	0.67	0.94	0.06	0.49	0.58	0.79
MIROC-ES2L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MPI-ESM-1-2-HAM	1.35	12.06	7.90	1.61	0.39	0.97	12.29	7.65	1.33	0.83	0.70	-0.19	0.31	0.57	0.59
MPI-ESM1-2-HR	1.56	10.29	9.66	1.83	0.40	1.08	10.61	9.28	1.40	0.85	0.73	-0.28	0.42	0.65	0.55
MPI-ESM1-2-LR	1.25	13.54	7.74	1.27	0.34	0.95	13.83	7.49	1.19	0.90	0.67	-0.25	0.31	0.47	0.44
NorESM2-LM	0.92	3.83	5.36	1.82	0.21	0.71	4.13	5.10	1.85	0.90	0.73	-0.18	0.34	0.25	0.57
NorESM2-MM	0.91	4.08	5.40	1.65	0.21	0.72	4.39	5.11	1.69	0.89	0.72	-0.20	0.37	0.26	0.62
UKESM1-0-LL	1.49	1.15	6.09	2.22	0.74	0.80	1.62	5.79	2.01	0.73	0.86	-0.14	0.38	0.43	0.68

Table S4: Statistics of standardised standard deviation (SSD), root-mean-squared deviation (RMSD), and correlation coefficient (CC) for surface dissolved iron of 14 CMIP6 models in December-January-February (DJF) across the Southern Ocean (SO) and its subregions- the subtropical zone (STZ), subantarctic zone (SAZ), polar front zone (PFZ), and Antarctic zone (AZ).

CMIP6 ESMs	SSD					RMSD					CC				
	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ
ACCESS-ESM1-5	0.10	0.40	0.26	0.08	0.07	0.94	0.99	1.04	1.00	0.94	0.34	0.22	-0.02	0.00	0.39
CanESM5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CESM2	0.09	0.47	0.20	0.17	0.05	1.01	1.02	1.02	1.03	1.00	-0.06	0.19	0.02	-0.12	-0.02
CMCC-ESM2	0.23	0.63	0.51	0.13	0.05	1.02	1.07	1.07	1.00	0.97	0.01	0.20	0.11	0.02	0.57
CNRM-ESM2-1	0.31	1.05	0.05	0.06	0.26	0.95	1.36	1.00	1.01	0.95	0.33	0.12	0.03	-0.06	0.30
GFDL-ESM4	0.24	0.75	0.46	0.21	0.20	1.04	1.11	1.19	0.99	1.03	-0.05	0.21	-0.22	0.17	-0.05
IPSL-CM6A-LR	0.46	0.78	0.09	0.06	0.35	0.99	1.13	1.02	1.01	0.99	0.26	0.21	-0.22	-0.07	0.21
MIROC-ES2L	0.19	0.58	0.48	0.21	0.12	0.91	1.10	1.21	0.98	0.92	0.40	0.05	-0.24	0.19	0.47
MPI-ESM-1-2-HAM	0.14	0.56	0.45	0.31	0.09	1.05	1.02	1.07	1.01	1.03	-0.25	0.25	0.06	0.12	-0.36
MPI-ESM1-2-HR	0.19	0.58	0.36	0.26	0.12	1.06	1.11	1.06	1.01	1.04	-0.23	0.10	0.00	0.10	-0.25
MPI-ESM1-2-LR	0.15	0.51	0.34	0.19	0.11	1.06	1.02	1.02	1.00	1.04	-0.31	0.22	0.10	0.11	-0.36
NorESM2-LM	0.18	0.95	0.62	0.14	0.04	1.04	1.23	1.25	1.03	1.02	-0.15	0.20	-0.13	-0.17	-0.33
NorESM2-MM	0.16	0.77	0.56	0.14	0.05	1.04	1.11	1.20	1.03	1.01	-0.17	0.24	-0.12	-0.17	-0.31
UKESM1-0-LL	0.10	0.52	0.35	0.13	0.03	1.00	0.85	1.09	1.05	0.99	0.05	0.53	-0.08	-0.29	0.26

Table S5: Statistics of standardised standard deviation (SSD), root-mean-squared deviation (RMSD), and correlation coefficient (CC) for yearly surface particulate organic carbon (POC) of 14 CMIP6 models across the Southern Ocean (SO) and its subregions- the subtropical zone (STZ), subantarctic zone (SAZ), polar front zone (PFZ), and Antarctic zone (AZ).

CMIP6 ESMs	SSD					RMSD					CC				
	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ
ACCESS-ESM1-5	0.28	0.78	0.52	0.29	0.13	1.11	1.14	0.86	1.04	1.06	-0.29	0.20	0.51	0.01	-0.38
CanESM5	0.60	1.17	1.34	0.79	0.08	1.35	1.14	1.21	1.28	1.02	-0.39	0.46	0.50	-0.02	-0.16
CESM2	0.32	0.94	1.40	0.22	0.18	1.01	0.65	1.13	1.07	0.95	0.11	0.78	0.60	-0.22	0.37
CMCC-ESM2	1.22	2.21	1.47	1.16	0.74	1.01	1.52	1.84	1.66	0.94	0.60	0.81	-0.07	-0.18	0.45
CNRM-ESM2-1	0.49	1.18	0.99	0.62	0.30	1.18	1.00	1.10	1.08	1.12	-0.16	0.59	0.39	0.17	-0.27
GFDL-ESM4	0.58	1.80	1.74	0.88	0.19	1.04	1.10	1.33	1.30	0.97	0.21	0.84	0.65	0.05	0.27
IPSL-CM6A-LR	0.40	1.03	0.90	0.47	0.20	0.97	0.76	0.90	0.98	0.97	0.28	0.72	0.56	0.28	0.23
MIROC-ES2L	0.32	0.69	0.65	0.25	0.07	1.16	1.14	0.87	1.05	1.03	-0.39	0.12	0.52	-0.09	-0.39
MPI-ESM-1-2-HAM	1.29	2.74	3.34	2.78	1.17	1.18	2.29	3.39	3.28	1.17	0.49	0.59	0.10	-0.36	0.43
MPI-ESM1-2-HR	1.71	3.14	4.76	2.37	1.67	1.39	2.49	4.52	2.77	1.31	0.59	0.74	0.33	-0.23	0.62
MPI-ESM1-2-LR	1.16	2.79	3.26	1.38	1.09	1.17	2.38	3.09	1.88	1.02	0.42	0.56	0.33	-0.23	0.53
NorESM2-LM	0.72	1.29	2.03	0.81	0.20	1.44	1.51	1.69	1.11	0.98	-0.39	0.15	0.56	0.26	0.21
NorESM2-MM	0.76	1.27	2.15	0.76	0.19	1.49	1.69	1.74	1.13	0.98	-0.42	-0.10	0.61	0.20	0.19
UKESM1-0-LL	0.86	2.13	2.41	0.82	0.28	1.47	1.52	1.85	1.28	1.12	-0.25	0.76	0.70	0.03	-0.29

Table S6: The mean value of integrated chlorophyll concentration in the top 100m in DJF and yearly integrated particulate organic carbon (POC) concentration in top 100m of 14 CMIP6 models across the Southern Ocean (SO) and its subregions- the subtropical zone (STZ), subantarctic zone (SAZ), polar front zone (PFZ), and Antarctic zone (AZ). The values in brackets denote the percentage variation compared to observations. "-" means no data.

CMIP6 ESMs	Integrated chlorophyll in top 100m (mg/m^2)					Integrated POC in top 100m (mg/m^2)				
	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ
Copernicus (obs)	54.85(00%)	31.24(00%)	62.65(00%)	70.80(00%)	81.99(00%)	6154(00%)	5129(00%)	6153(00%)	6605(00%)	7805(00%)
ACCESS-ESM1-5	26.30(-52%)	29.19(- 7%)	27.70(-56%)	29.08(-59%)	24.06(-71%)	1333(-78%)	1665(-68%)	1282(-79%)	1246(-81%)	988(-87%)
CanESM5	22.06(-60%)	24.46(-22%)	34.63(-45%)	24.11(-66%)	5.52(-93%)	1960(-68%)	3237(-37%)	2705(-56%)	992(-85%)	184(-98%)
CESM2	20.19(-63%)	20.23(-35%)	24.73(-61%)	16.07(-77%)	22.58(-72%)	1196(-81%)	1348(-74%)	1267(-79%)	1076(-84%)	1085(-86%)
CMCC-ESM2	26.78(-51%)	12.46(-60%)	22.38(-64%)	28.36(-60%)	45.84(-44%)	8281(+35%)	5860(+14%)	8942(+45%)	9933(+50%)	11011(+41%)
CNRM-ESM2-1	27.39(-50%)	26.90(-14%)	26.86(-57%)	26.17(-63%)	31.51(-62%)	4386(-29%)	5128(00%)	4889(-21%)	4742(-28%)	3841(-51%)
GFDL-ESM4	45.85(-16%)	34.00(+ 9%)	55.26(-12%)	60.16(-15%)	54.11(-34%)	4288(-30%)	4195(-18%)	4760(-23%)	4782(-28%)	4248(-46%)
IPSL-CM6A-LR	30.25(-45%)	25.62(-18%)	29.50(-53%)	32.72(-54%)	40.02(-51%)	4182(-32%)	4824(- 6%)	4826(-22%)	4710(-29%)	3684(-53%)
MIROC-ES2L	42.07(-23%)	41.64(+33%)	44.38(-29%)	42.23(-40%)	43.18(-47%)	2675(-57%)	3532(-31%)	2750(-55%)	2474(-63%)	1908(-76%)
MPI-ESM-1-2-HAM	38.84(-29%)	28.12(-10%)	45.72(-27%)	41.96(-41%)	51.61(-37%)	2968(-52%)	3049(-41%)	3476(-43%)	3005(-55%)	2914(-63%)
MPI-ESM1-2-HR	68.92(+26%)	42.22(+35%)	82.04(+31%)	57.99(-18%)	76.42(- 7%)	4130(-33%)	4160(-19%)	5309(-14%)	3965(-40%)	3718(-52%)
MPI-ESM1-2-LR	34.93(-36%)	30.98(- 1%)	37.71(-40%)	26.12(-63%)	35.37(-57%)	2795(-55%)	3173(-38%)	3109(-49%)	2510(-62%)	2442(-69%)
NorESM2-LM	26.44(-52%)	23.80(-24%)	29.62(-53%)	30.06(-58%)	29.88(-64%)	2759(-55%)	3931(-23%)	1993(-68%)	2103(-68%)	1745(-78%)
NorESM2-MM	27.45(-50%)	25.59(-18%)	28.33(-55%)	31.14(-56%)	31.10(-62%)	2716(-56%)	4100(-20%)	1839(-70%)	1869(-72%)	1662(-79%)
UKESM1-0-LL	36.49(-33%)	33.92(+ 9%)	45.72(-27%)	44.52(-37%)	38.34(-53%)	6104(- 1%)	7276(+42%)	7163(+16%)	6226(- 6%)	4881(-37%)

Table S7: The mean value of yearly integrated phytoplankton carbon and zooplankton carbon concentration in the top 100m of 14 CMIP6 models across the Southern Ocean (SO) and its subregions- the subtropical zone (STZ), subantarctic zone (SAZ), polar front zone (PFZ), and Antarctic zone (AZ). The values in brackets denote the proportion in POC. "-" means no data. The values in Copernicus are estimated by the ratio of different POC pools mentioned in Section 4.2 of the main text.

CMIP6 ESMs	Integrated phytoplankton carbon in top 100m (mg/m^2)					Integrated zooplankton carbon in top 100m (mg/m^2)				
	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ
Copernicus (obs)	1231(20.0%)	1026(20.0%)	1231(20.0%)	1321(20.0%)	1561(20.0%)	2277(37.0%)	1898(37.0%)	2276(37.0%)	2444(37.0%)	2888(37.0%)
ACCESS-ESM1-5	727(54.6%)	896(53.8%)	672(52.4%)	702(56.3%)	561(56.8%)	402(30.2%)	509(30.6%)	396(30.9%)	361(29.0%)	287(29.1%)
CanESM5	852(43.5%)	1199(37.0%)	1335(49.4%)	628(63.3%)	127(69.3%)	375(19.1%)	794(24.5%)	363(13.4%)	40(4.1%)	1(0.7%)
CESM2	737(61.7%)	838(62.1%)	808(63.8%)	637(59.1%)	665(61.3%)	458(38.3%)	510(37.9%)	459(36.2%)	440(40.9%)	420(38.7%)
CMCC-ESM2	1199(14.5%)	846(14.4%)	1341(15.0%)	1472(14.8%)	1612(14.6%)	677(8.2%)	731(12.5%)	783(8.8%)	689(6.9%)	617(5.6%)
CNRM-ESM2-1	1376(31.4%)	1440(28.1%)	1480(30.3%)	1536(32.4%)	1356(35.3%)	1178(26.9%)	1394(27.2%)	1353(27.7%)	1314(27.7%)	1024(26.7%)
GFDL-ESM4	1593(37.1%)	1497(35.7%)	1821(38.3%)	1856(38.8%)	1642(38.6%)	1763(41.1%)	1768(42.1%)	1940(40.8%)	1934(40.4%)	1685(39.7%)
IPSL-CM6A-LR	1347(32.2%)	1356(28.1%)	1501(31.1%)	1568(33.3%)	1326(36.0%)	1107(26.5%)	1316(27.3%)	1330(27.6%)	1300(27.6%)	938(25.5%)
MIROC-ES2L	1753(65.5%)	2228(63.1%)	1881(68.4%)	1720(69.5%)	1296(67.9%)	923(34.5%)	1304(36.9%)	869(31.6%)	754(30.5%)	611(32.1%)
MPI-ESM-1-2-HAM	1779(59.9%)	1579(51.8%)	2018(58.1%)	1856(61.8%)	1943(66.7%)	1175(39.6%)	1455(47.7%)	1440(41.4%)	1136(37.8%)	957(32.8%)
MPI-ESM1-2-HR	2835(68.6%)	2605(62.6%)	3589(67.6%)	2680(67.6%)	2773(74.6%)	1281(31.0%)	1540(37.0%)	1699(32.0%)	1271(32.1%)	933(25.1%)
MPI-ESM1-2-LR	1648(59.0%)	1650(52.0%)	1762(56.7%)	1489(59.3%)	1611(66.0%)	1135(40.6%)	1507(47.5%)	1333(42.9%)	1012(40.3%)	822(33.6%)
NorESM2-LM	989(35.9%)	1282(32.6%)	867(43.5%)	914(43.4%)	719(41.2%)	760(27.5%)	1124(28.6%)	517(25.9%)	555(26.4%)	447(25.6%)
NorESM2-MM	977(36.0%)	1312(32.0%)	803(43.7%)	855(45.8%)	714(42.9%)	745(27.4%)	1164(28.4%)	475(25.9%)	478(25.6%)	421(25.3%)
UKESM1-0-LL	2416(39.6%)	2741(37.7%)	2877(40.2%)	2652(42.6%)	2037(41.7%)	1873(30.7%)	2429(33.4%)	2190(30.6%)	1713(27.5%)	1324(27.1%)

Table S8: The mean value of yearly integrated detrital organic carbon and bacterial carbon concentration in the top 100m of 14 CMIP6 models across the Southern Ocean (SO) and its subregions- the subtropical zone (STZ), subantarctic zone (SAZ), polar front zone (PFZ), and Antarctic zone (AZ). The values in brackets denote the proportion in POC. "-" means no data. The values in Copernicus are estimated by the ratio of different POC pools mentioned in Section 4.2 of the main text.

CMIP6 ESMs	Integrated detrital organic carbon in top 100m (mg/m^2)					Integrated bacterial carbon in top 100m (mg/m^2)				
	SO	STZ	SAZ	PFZ	AZ	SO	STZ	SAZ	PFZ	AZ
Copernicus (obs)	2031(33.0%)	1693(33.0%)	2030(33.0%)	2180(33.0%)	2576(33.0%)	615(10.0%)	513(10.0%)	615(10.0%)	660(10.0%)	781(10.0%)
ACCESS-ESM1-5	203(15.2%)	259(15.6%)	214(16.7%)	184(14.8%)	140(14.1%)	-	-	-	-	-
CanESM5	736(37.5%)	1244(38.4%)	1007(37.2%)	324(32.6%)	55(30.1%)	-	-	-	-	-
CESM2	-	-	-	-	-	-	-	-	-	-
CMCC-ESM2	5738(69.3%)	3699(63.1%)	6056(67.7%)	7078(71.3%)	8047(73.1%)	668(8.1%)	584(10.0%)	762(8.5%)	693(7.0%)	735(6.7%)
CNRM-ESM2-1	1832(41.8%)	2294(44.7%)	2057(42.1%)	1893(39.9%)	1461(38.0%)	-	-	-	-	-
GFDL-ESM4	59(1.4%)	62(1.5%)	74(1.5%)	60(1.2%)	49(1.2%)	873(20.4%)	868(20.7%)	925(19.4%)	933(19.5%)	872(20.5%)
IPSL-CM6A-LR	1728(41.3%)	2151(44.6%)	1995(41.3%)	1842(39.1%)	1420(38.5%)	-	-	-	-	-
MIROC-ES2L	-	-	-	-	-	-	-	-	-	-
MPI-ESM-1-2-HAM	14(0.5%)	15(0.5%)	18(0.5%)	13(0.4%)	13(0.5%)	-	-	-	-	-
MPI-ESM1-2-HR	14(0.3%)	14(0.3%)	21(0.4%)	13(0.3%)	12(0.3%)	-	-	-	-	-
MPI-ESM1-2-LR	13(0.4%)	16(0.5%)	15(0.5%)	10(0.4%)	10(0.4%)	-	-	-	-	-
NorESM2-LM	1010(36.6%)	1525(38.8%)	609(30.5%)	635(30.2%)	580(33.2%)	-	-	-	-	-
NorESM2-MM	993(36.6%)	1624(39.6%)	560(30.5%)	535(28.6%)	527(31.7%)	-	-	-	-	-
UKESM1-0-LL	1815(29.7%)	2106(28.9%)	2095(29.3%)	1861(29.9%)	1520(31.1%)	-	-	-	-	-