



Supplement of

Evaluation of CMIP6 model performance in simulating historical biogeochemistry across the southern South China Sea

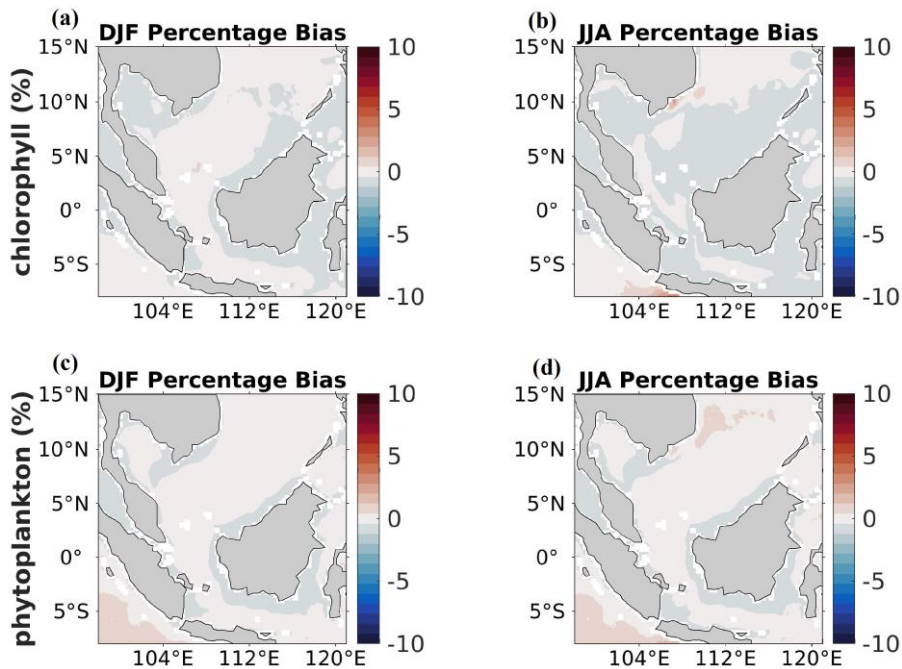
Winfred Marshal et al.

Correspondence to: Jing Xiang Chung (jingxiang@umt.edu.my)

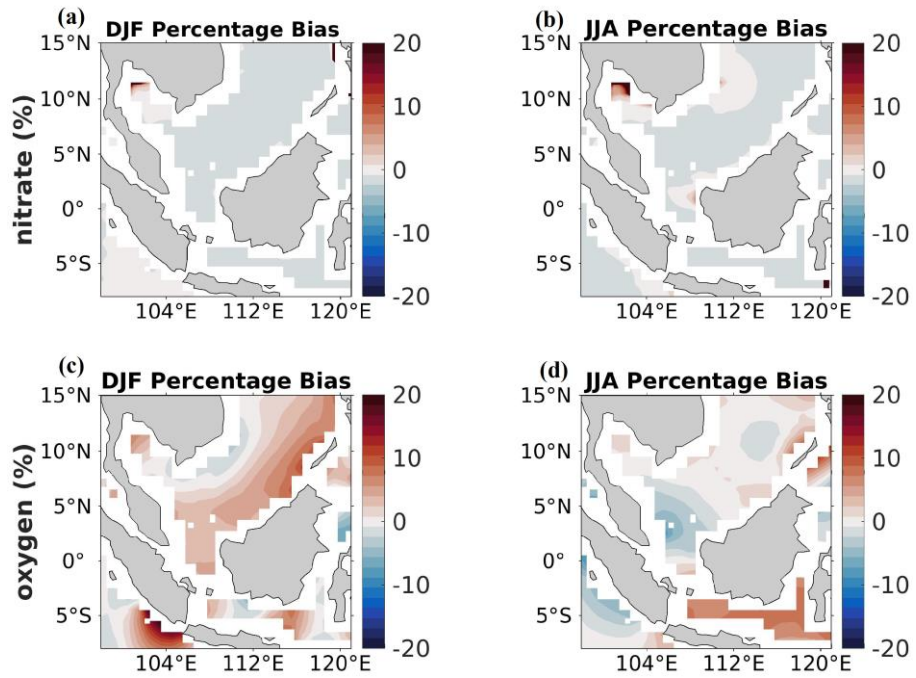
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5 **Table S1** Validation results of CMEMS (1993 - 2014) climatology against the Observation climatology of WOA18 data (1960 – 2017) and Satellite data (GlobColour: 1997 - 2014) across the study domain (southern South China Sea). Satellite provides chlorophyll and phytoplankton data and WOA18 provides nitrate and oxygen data. Correlation Coefficient (CC), Root Mean Square Difference (RMSD), Mean Bias Error (MBE) and Mean Percentage Bias (MPB).

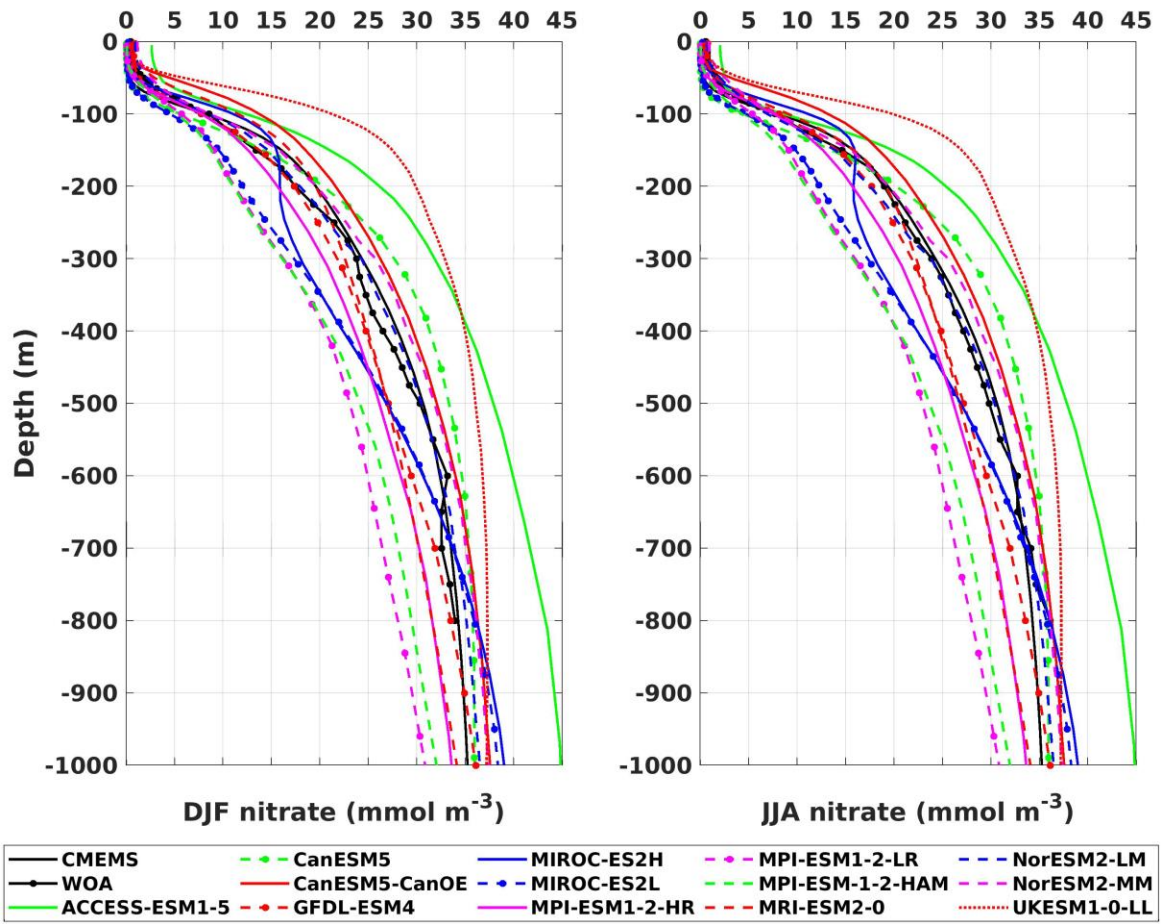
Variables	CC		RMSD		MBE		MPB (%)	
	DJF	JJA	DJF	JJA	DJF	JJA	DJF	JJA
chlorophyll (mg m^{-3})	0.69	0.68	0.19	0.2	-0.18	-0.21	-3.5	-4.8
phytoplankton (mmol m^{-3})	0.68	0.7	1.19	1.27	0.55	0.54	3.25	3.17
nitrate (mmol m^{-3})	0.33	0.31	0.33	0.36	-0.1	-0.1	-0.96	-0.97
oxygen (mmol m^{-3})	0.47	0.68	8.4	6.7	1.9	0.4	2.79	1.2



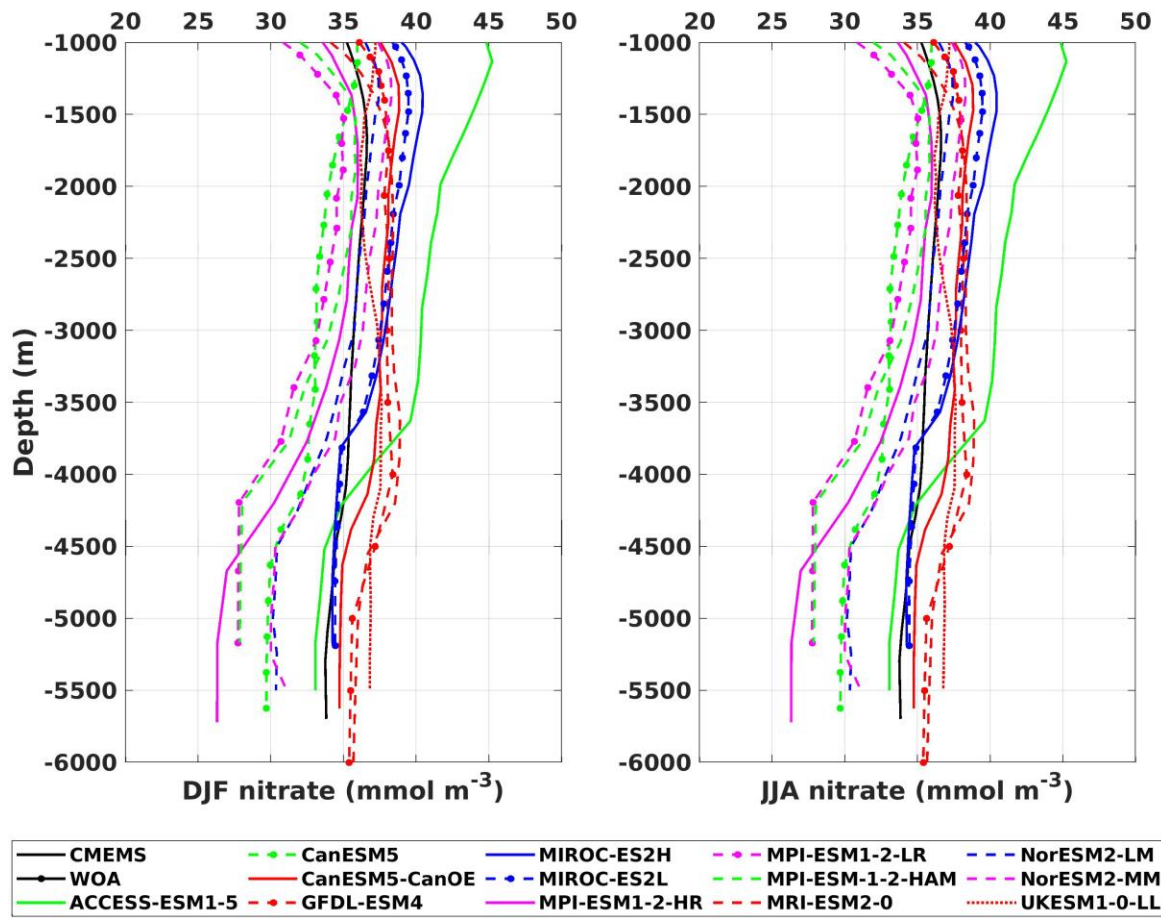
10 **Figure S1** Seasonal Percentage Bias of chlorophyll (a-b) and phytoplankton (c-d) climatology from CMEMS (1993 - 2014) against Satellite data (GlobColour: 1997 - 2014).



15 **Figure S2** Seasonal Percentage Bias of nitrate (a-b) and oxygen (c-d) climatology from CMEMS (1993 - 2014) against observation data (WOA18: 1960 - 2017).



20 **Figure S3** Climatology of nitrate depth profile up to 1000 meters for reference (CMEMS: 1993 – 2014) and observation (WOA18: 1960 – 2017) data with 13 selected CMIP6 ESMs for (1993 - 2014).



25 **Figure S4** same as Figure S3 but for depth from 1000 to 6000 meters.

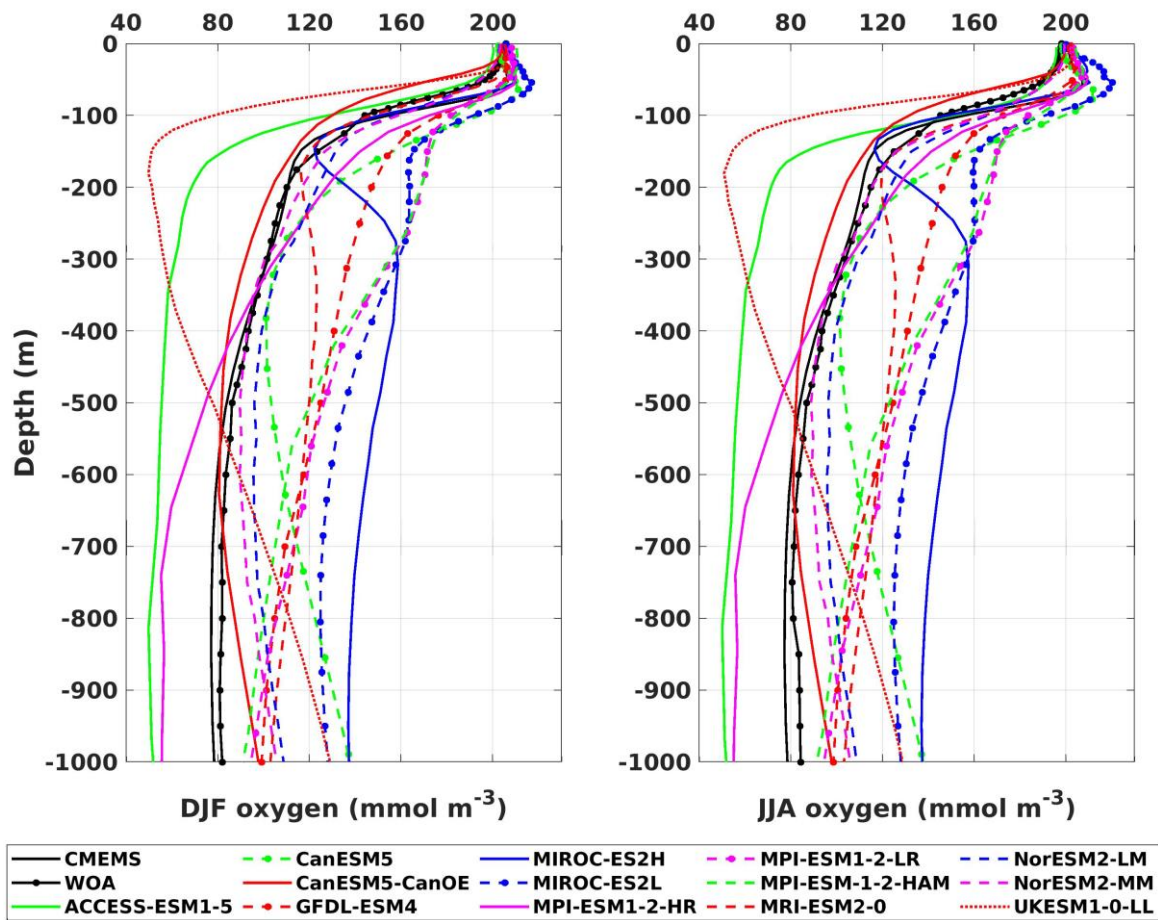


Figure S5 Climatology of oxygen depth profile up to 1000 meters for reference (CMEMS: 1993 – 2014) and observation (WOA18: 1960 – 2017) data with 13 selected CMIP6 ESMs for (1993 - 2014).

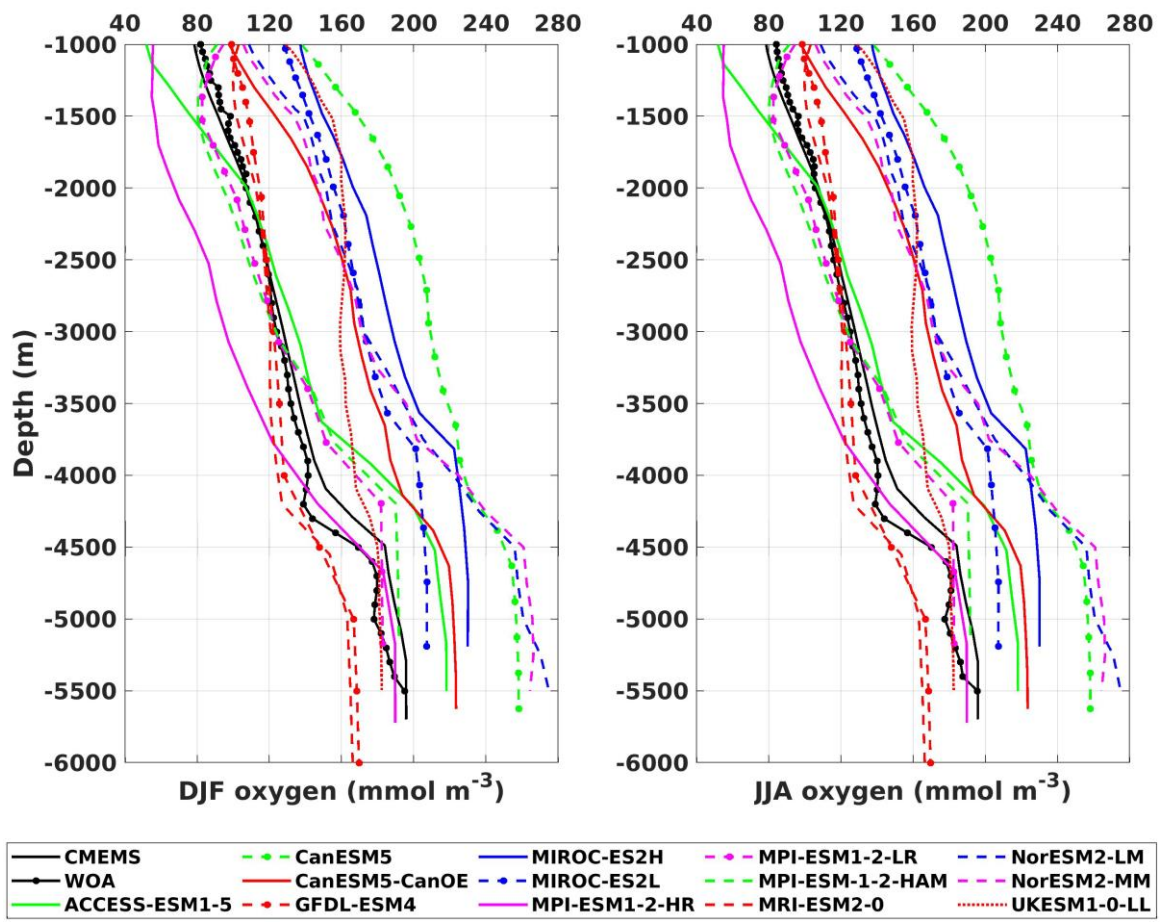


Figure S6 same as Figure S5 but for depth from 1000 to 6000 meters.

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Table S2 Spatial statistics of nitrate and oxygen at depth of 1000m for the selected 13 CMIP6 ESMs.

CMIP6 ESMs	nitrate 1000m			oxygen 1000m		
	CC	NSD	NRMSD	CC	NSD	NRMSD
ACCESS-ESM1-5	-0.20	7.01	7.27	-0.21	5.70	5.99
CanESM5	-0.08	1.77	2.10	0.44	1.27	1.22
CanESM5-CanOE	-0.20	2.45	2.82	0.22	2.12	2.14
GFDL-ESM4	0.02	3.86	3.96	-0.26	3.04	3.43
MIROC-ES2H	-0.77	0.18	1.14	0.30	0.69	1.03
MIROC-ES2L	-0.27	0.12	1.04	0.34	0.31	0.94
MPI-ESM1-2-HR	-0.79	1.62	2.49	0.61	2.91	2.43
MPI-ESM1-2-LR	-0.77	0.89	1.78	0.05	1.89	2.10
MPI-ESM-1-2-HAM	-0.74	0.60	1.49	0.19	1.73	1.82
MRI-ESM2-0	0.46	2.10	1.86	0.25	1.66	1.71
NorESM2-LM	-0.14	0.34	1.10	0.49	1.11	1.07
NorESM2-MM	-0.21	0.43	1.17	0.53	1.38	1.20
UKESM1-0-LL	-0.43	1.93	2.53	-0.06	2.65	2.89