

Supplementary Materials for

Global decline in ocean memory over the 21st century

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Published 6 May 2022, *Sci. Adv.* **8**, eabm3468 (2022)
DOI: 10.1126/sciadv.abm3468

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Figure S1. Shoaling mixed layer depth (MLD) through the 21st century. a. Climatological MLD for the end of the 19th century (1870-1899). b. Change in MLD from 1870-1899 to 2071-2100 under SSP5-8.5 scenario. Values are averaged over individual realizations from 20 different climate models from the CMIP6 multi-model ensemble (MME). Changes outside the gray dotted area are robust (methods). c. Global-mean MLD in 30-yr rolling windows from CMIP6 simulations for the historical and future (SSP) scenarios. Gray shadings show the range of values across models in percentiles: 25%–75% (dark) and 5%–95% (light). The dashed line is the MLD averaged over the preindustrial control runs from the CMIP6 MME, with an error bar (cadet blue) showing the uncertainty in the MME (methods). Error bars are also shown to quantify the cross-model spread (purple) and internal variability (salmon) (methods). The model MLD is bias corrected by subtracting the climatological monthly MLD (1980-2014) from each model at each grid point to ensure the same historical climatology across the models. The reanalysis MLD data is the Global Ocean Physics Reanalysis C-GLORS v5 (72) obtained from <http://c-glors.cmcc.it/index/index.html>.

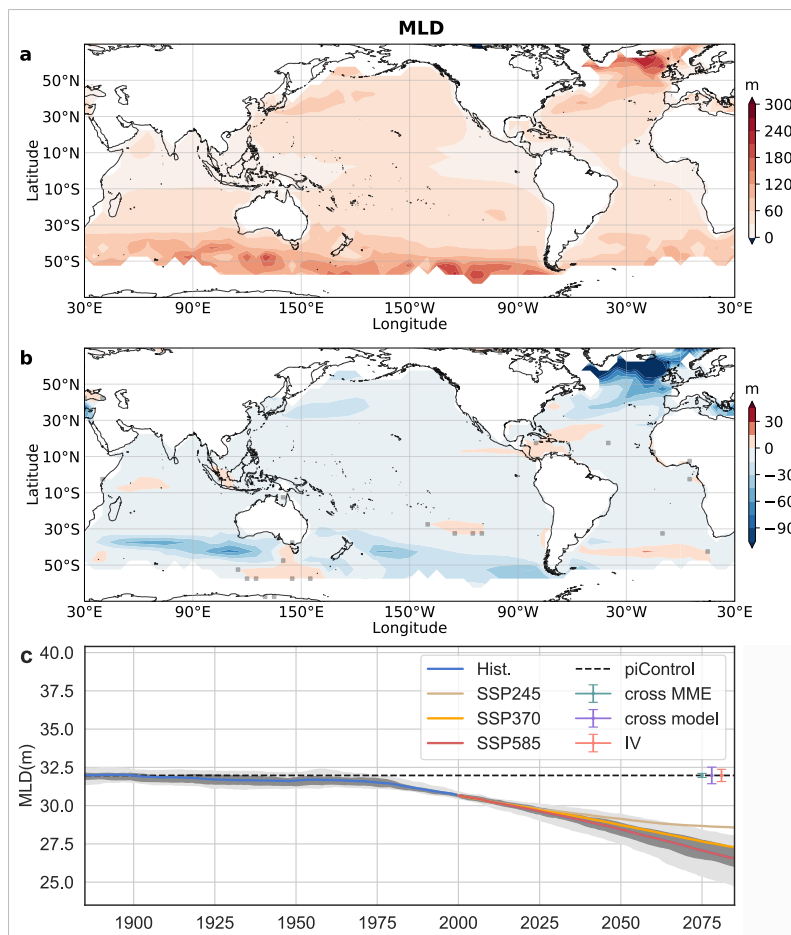


Figure S2. Observed (a) and CMIP6 model simulated (b) climatological one-year autocorrelation, $A(1)$, of annual SST anomalies during 1961-2014. The magenta lines bound regions of statistically significant $A(1)$ (correlation=0.23, DOF=48). White regions over ocean have seasonal or permanent sea-ice cover (methods). Observational data is the HadISST data obtained from the UK Met Office (<https://www.metoffice.gov.uk/hadobs/hadisst/>).

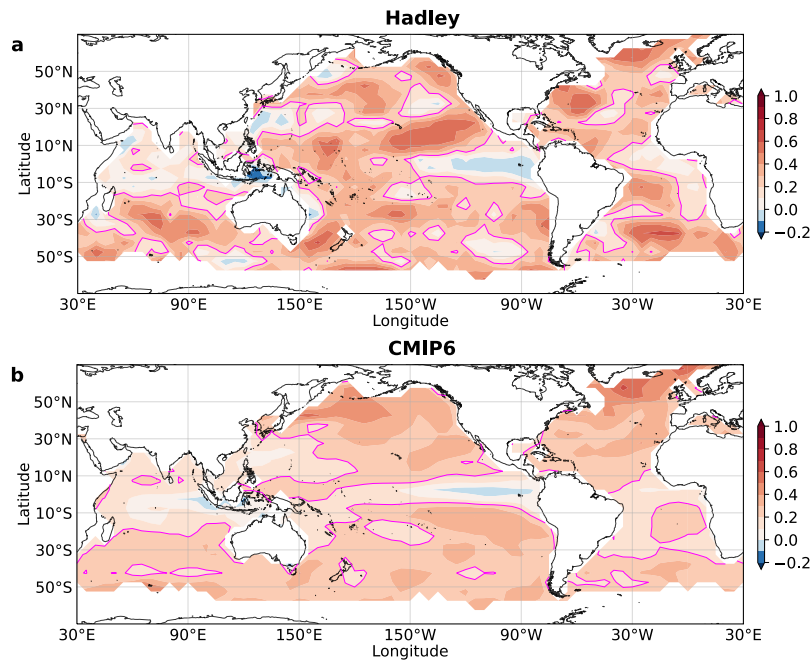


Figure S3. Changes in ocean memory for boreal winter (Dec-Jan-Feb, DJF, left column) and summer (Jun-Jul-Aug, JJA, right column). a.d. Climatological one-year autocorrelation, A(1), of SST anomalies at the end of the 19th century (1870-1899). b.e. Same as a.b but for future projection (2071-2100) under SSP5-8.5 scenario. The magenta lines mark statistically significant A(1) (correlation=0.3, DOF=28). c.f. Change in A(1) from 1870-1899 to 2071-2100 under SSP5-8.5 scenario. The magenta lines mark statistically significant A(1) in 2071-2100. Changes outside the gray dotted area are robust (methods). All values are from CMIP6 MME.

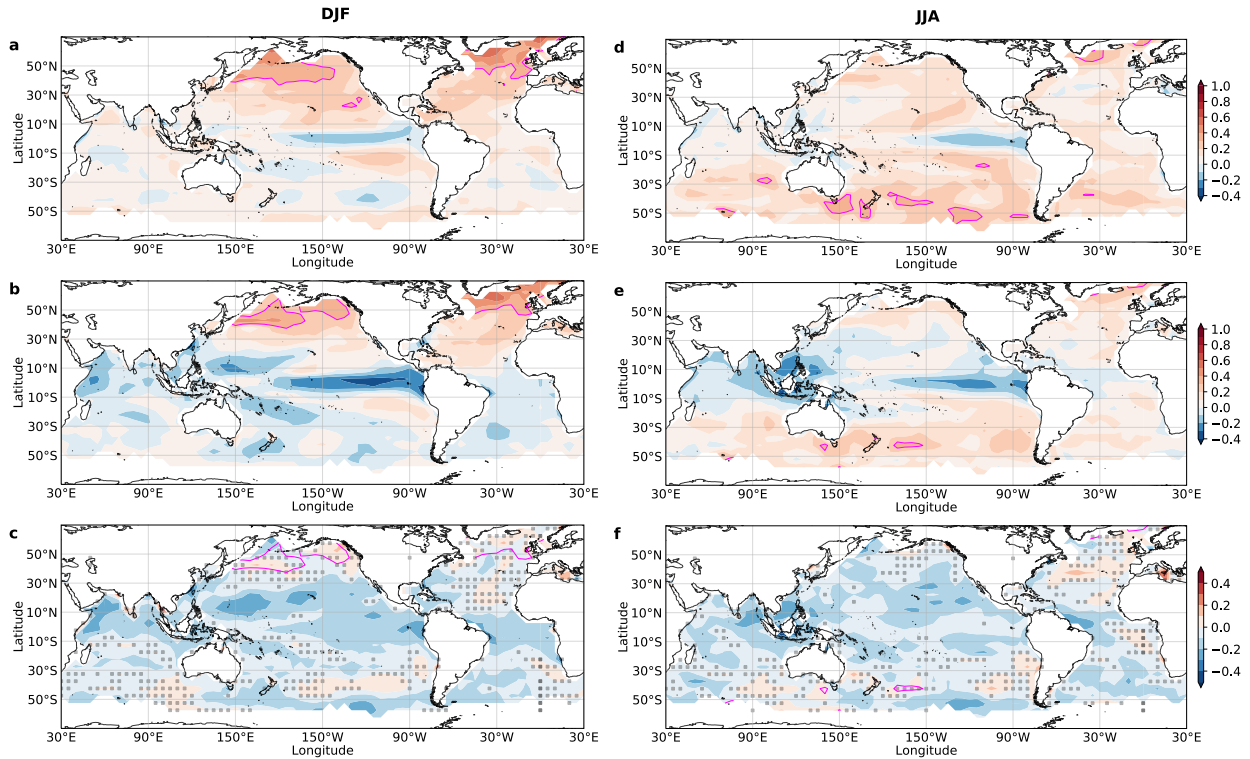


Figure S4. Same as Fig. S1a, b but for MLD changes in boreal winter (Dec-Jan-Feb, DJF, left column) and summer (Jun-Jul-Aug, JJA, right column) from 1870-1899 to 2071-2100 under SSP5-8.5 scenario in the CMIP6 multi-model ensemble.

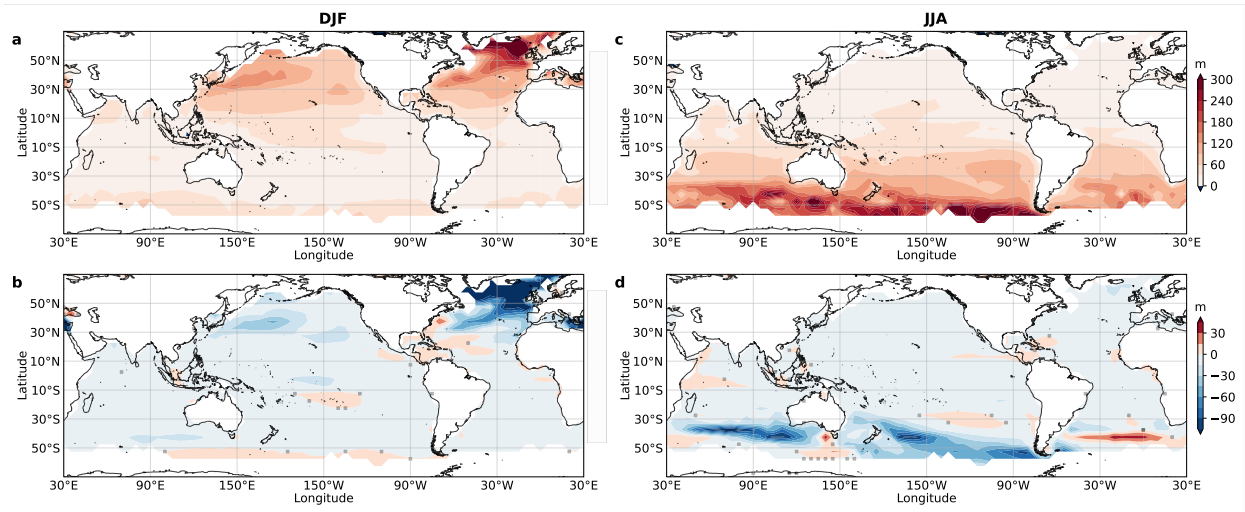


Table S1. CMIP6 models used for ensemble analysis

No.	Model name	No.	Model name
1	ACCESS-CM2	11	EC-Earth3
2	ACCESS-ESM1-5	12	EC-Earth3-Veg
3	AWI-CM-1-1-MR	13	GFDL-ESM4
4	BCC-CSM2-MR	14	IPSL-CM6A-LR
5	CAMS-CSM1-0	15	MPI-ESM1-2-HR
6	CanESM5	16	MPI-ESM1-2-LR
7	CESM2	17	MRI-ESM2-0
8	CESM2-WACCM	18	NorESM2-LM
9	CNRM-CM6-1	19	NorESM2-MM
10	CNRM-ESM2-1	20	UKESM1-0-LL

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