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Article

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Present-day North Atlantic salinity constrains future warming of the Northern Hemisphere

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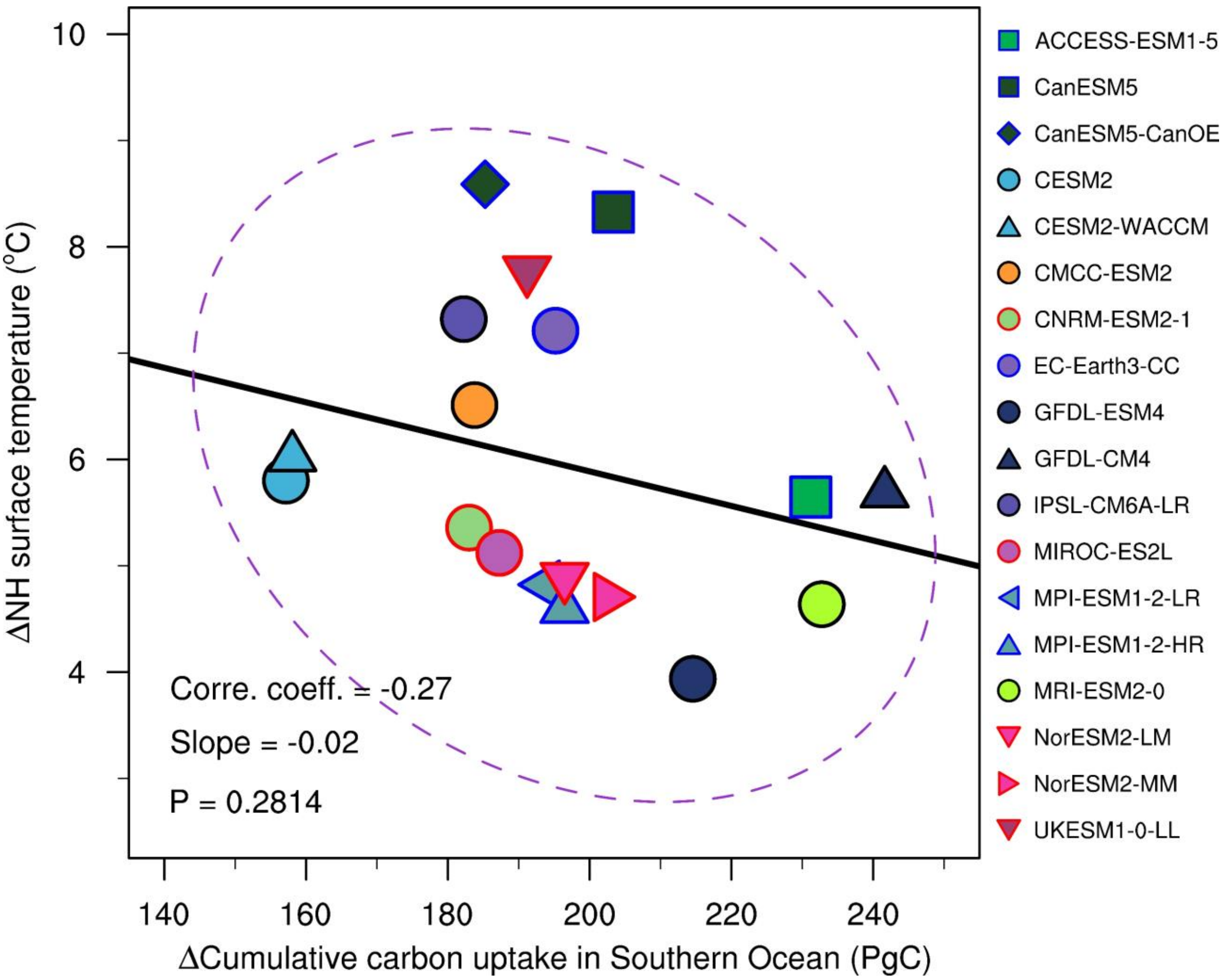
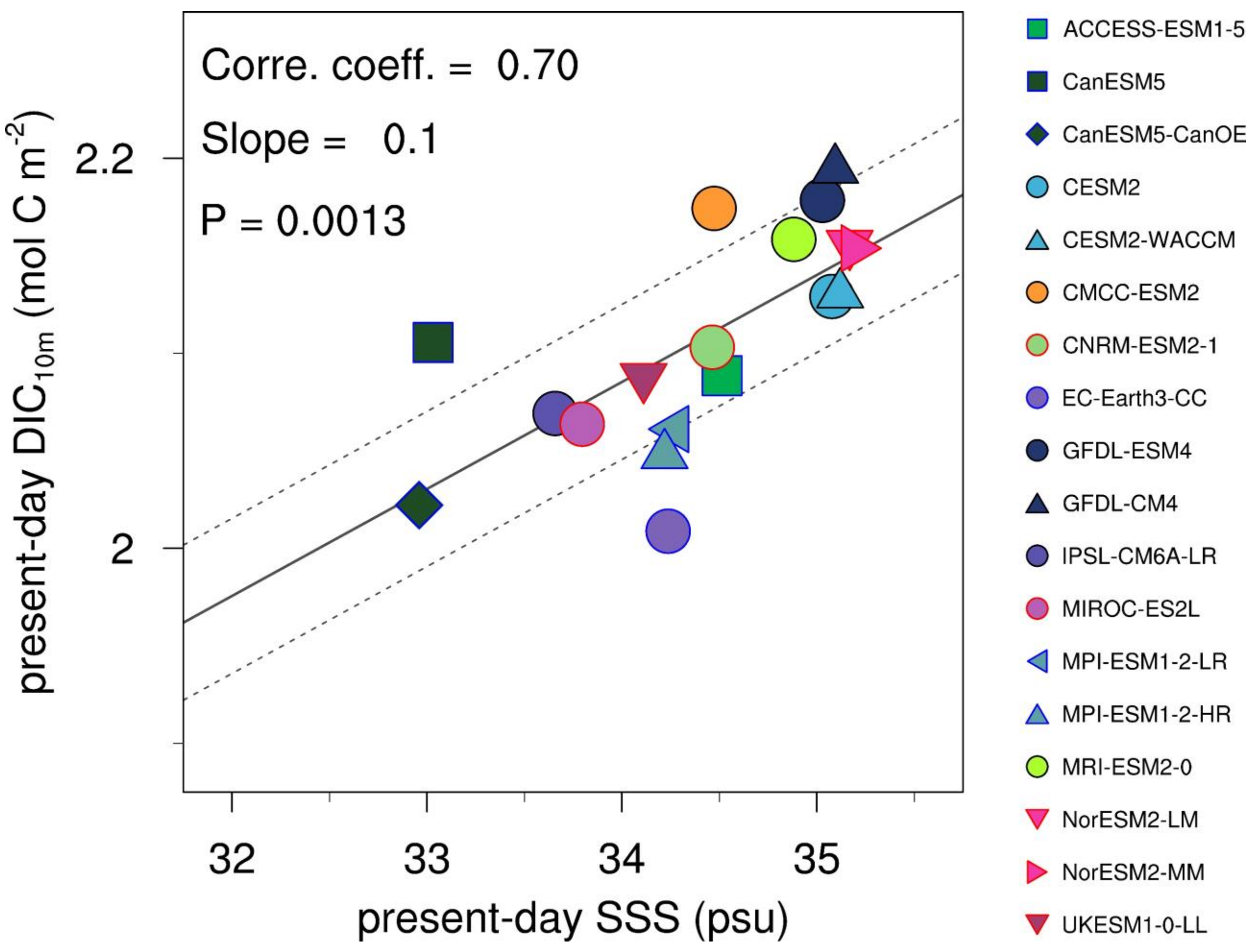
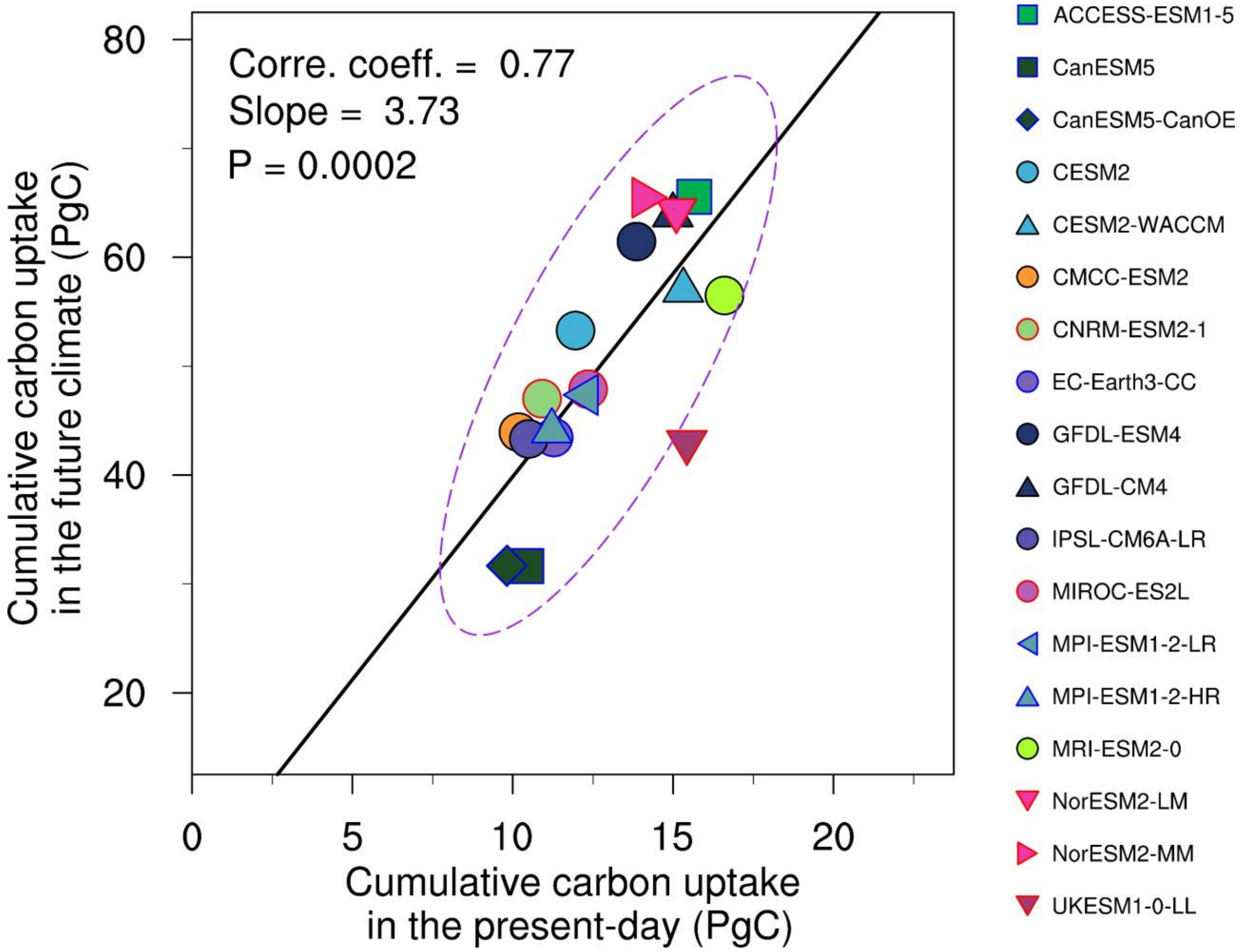


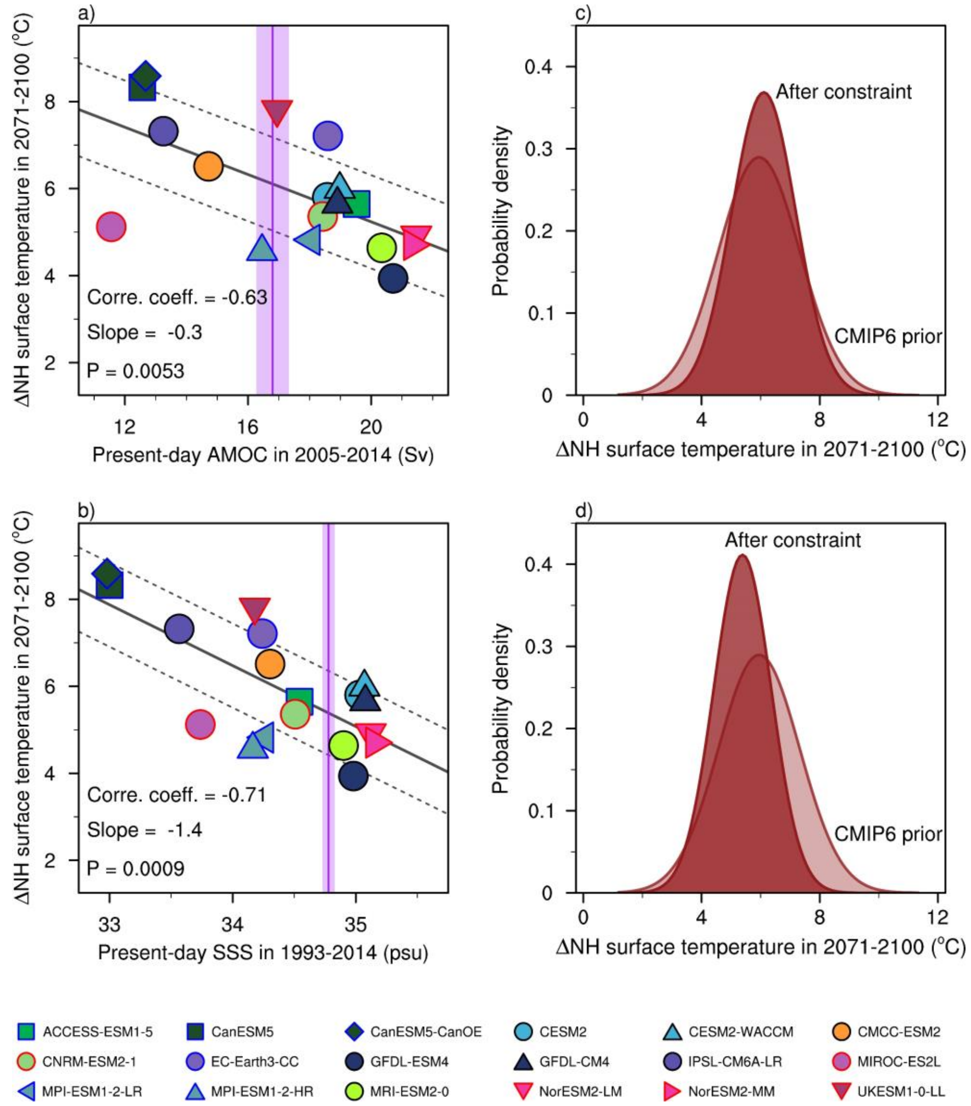
Supplementary Fig. 1 | Inter-model differences in future cumulative carbon uptake in the Southern Ocean (0–360°E and 34°S–90°S) versus future surface temperature changes in the Northern Hemisphere (NH). The purple dashed ellipse is calculated based on the multivariate normal distribution with 5–95% ranges. Correlation coefficient (Corre. Coeff.), slope and P value determined by a two-sided Student's t-test are also provided with a regression line (black solid line).



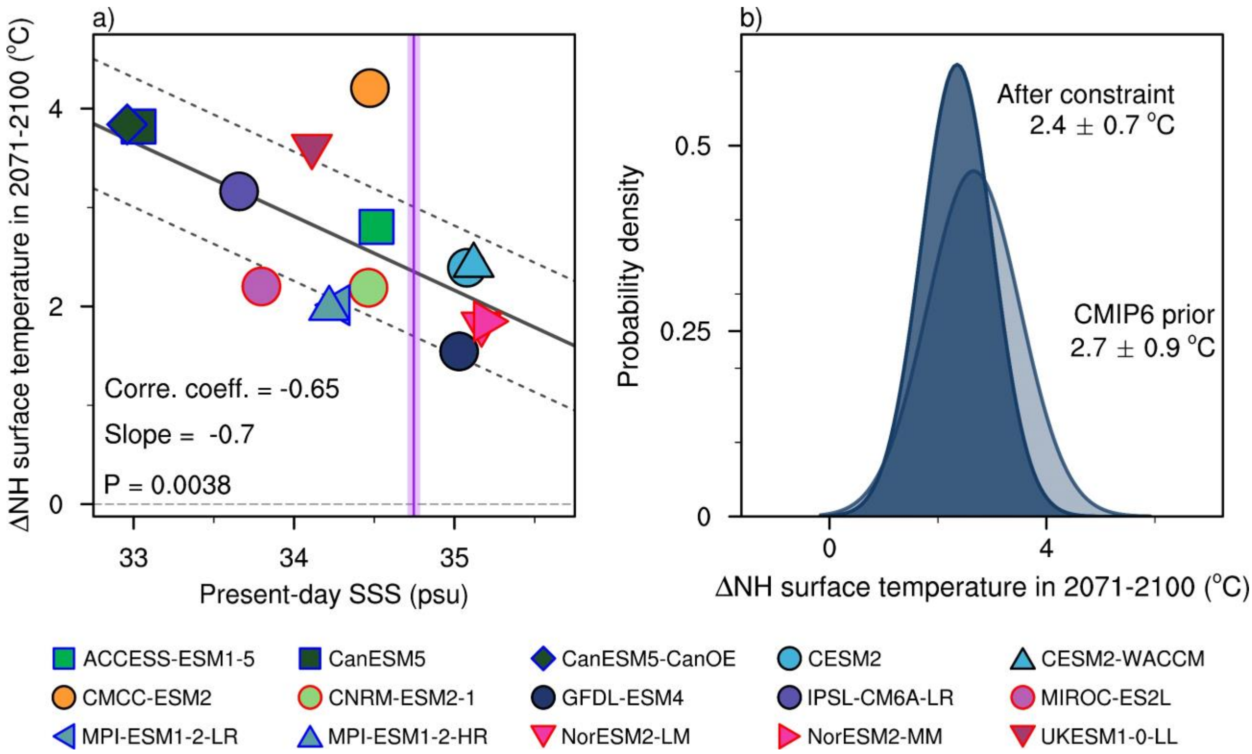
Supplementary Fig. 2 | Inter-model relationship between SSS and dissolved inorganic carbon (DIC) in the present-day climate. Simulated SSS versus near surface (10m) DIC in the NA subpolar region during the present-day climate. The solid black line follows the linear regression of 18 CMIP6 ESMs, while the dashed black lines indicate prediction errors with one standard deviation (and 68% confidence intervals).



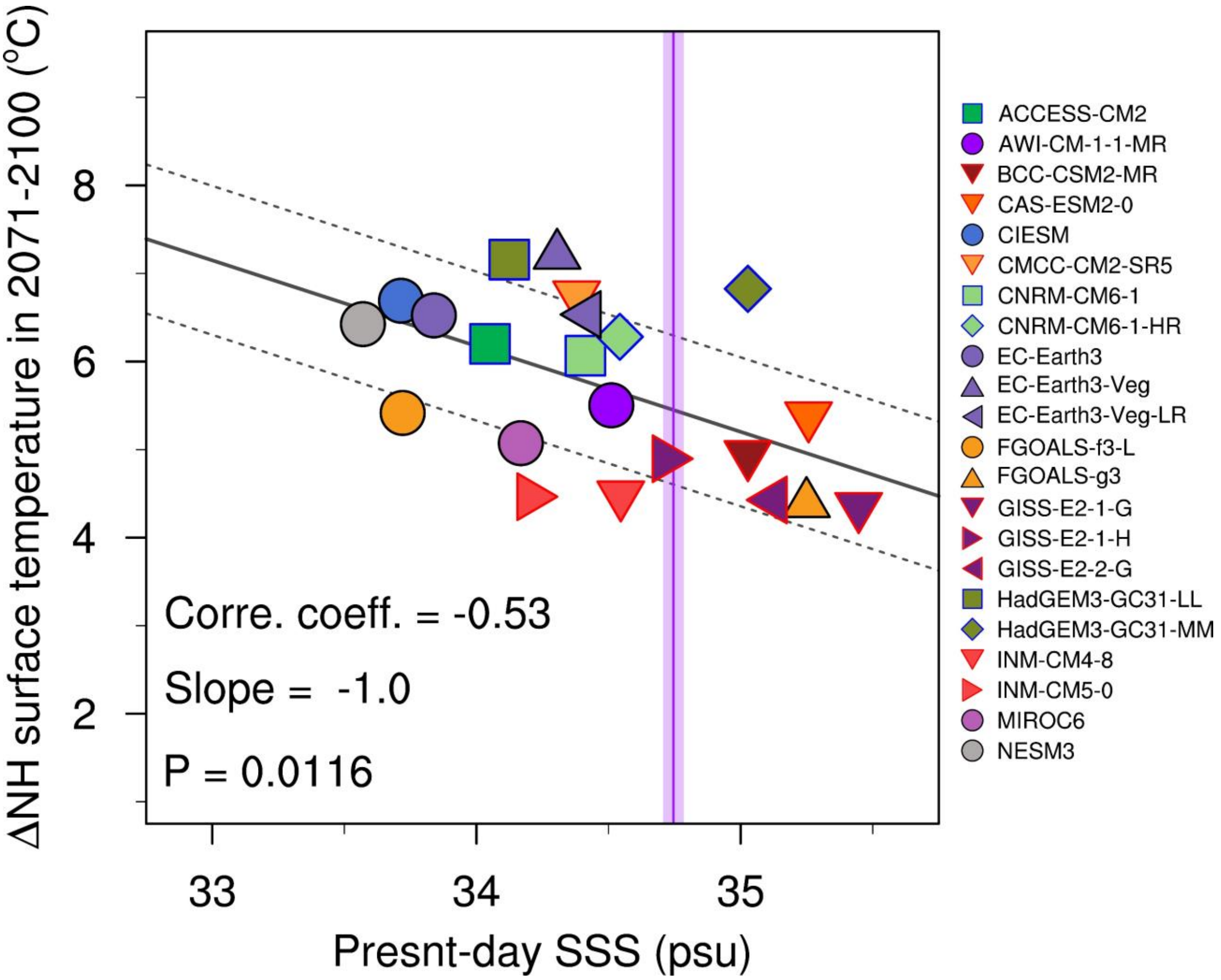
Supplementary Fig. 3 | Inter-model difference of the cumulative carbon uptake in the North Atlantic (NA) between the present-day and the future climate among CMIP6 ESMs. The present-day cumulative carbon uptake in the NA against that of the future climate among ESMs. The purple dashed ellipse is calculated based on the multivariate normal distribution with 5–95% ranges. Correlation coefficient (Corre. Coeff.), slope and P value determined by a two-sided Student's t-test are also provided with a regression line (black solid line).



Supplementary Fig. 4 | Emergent constraints on the Northern Hemisphere (NH) surface warming with a short-term period of datasets. a-b, Projected changes in NH surface temperature under SSP5-8.5 scenario versus a, the present-day (2005–2014) AMOC, while sea surface salinity (SSS) of the North Atlantic (NA) subpolar region in the present-day climate (1993–2014). The solid black line follows the linear regression of 18 CMIP6 ESMs, while the dashed black lines indicate prediction errors with one standard deviation (and 68% confidence intervals). A solid purple line (shading) indicates the climatology (one standard error) of AMOC in Rapid Climate Change-Meridional Overturning Circulation and Heat flux Array (RAPID/MOCHA) and SSS in Multi Observation Global Ocean Sea Surface Salinity and Sea Surface Density with slope and p-value determined by a two-sided Student's t-test. **c-d,** Probability density functions for the projected NH surface warming and before ("CMIP6 prior", transparent) and after ("after constraint", opaque) when the emergent constraint is applied.



Supplementary Fig. 5 | Emergent constraints on the Northern Hemisphere (NH) surface warming under the low-emission future scenario. **a,** Projected changes in NH surface temperature under SSP1-2.6 scenario versus sea surface salinity (SSS) of the North Atlantic (NA) subpolar region in the present-day climate (1981–2010). The solid black line follows the linear regression of 15 CMIP6 ESMs, while the dashed black lines indicate prediction errors with one standard deviation (and 68% confidence intervals). A solid purple line (shading) indicates the climatology (one standard error) of the World Ocean Atlas 2018 with slope and p-value determined by a two-sided Student's t-test. **b,** Probability density functions for the projected NH surface warming and before ("CMIP6 prior", transparent) and after ("after constraint", opaque) when the emergent constraint is applied.



Supplementary Fig. 6 | Inter-model difference in present-day sea surface salinity (SSS) in the North Atlantic subpolar region and future Northern Hemisphere (NH) surface air temperature changes among 22 CMIP6 ESMs without ocean biogeochemistry scheme.