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Climate impacts on multidecadal $p\mathrm{CO_2}$ variability in the North Atlantic: 1948–2009

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To assess the model's ability to capture the vertical distribution of DIC, we compare here the 0-4000m average 1948-2009 model DIC profile to the GLODAP (Key et al. 2004) estimate of pre-industrial DIC across the subpolar gyre (35-55N, 5-60E, Figure S1). The model falls within the uncertainty of the observed estimate from 0-2000m, and is a few percent below the observed estimate from 2000-4000m . The average annual maximum MLD of this region is 284m and the annual maximum MLD across all points in the region is 3215m. Thus, annual vertical mixing occurs predominantly in the depth range where the model captures the observed estimate. In sum, this comparison suggests that model is a reasonable tool for studying how climate variability impacts variability in the vertical supply of carbon from the deep to surface ocean in the subpolar North Atlantic.

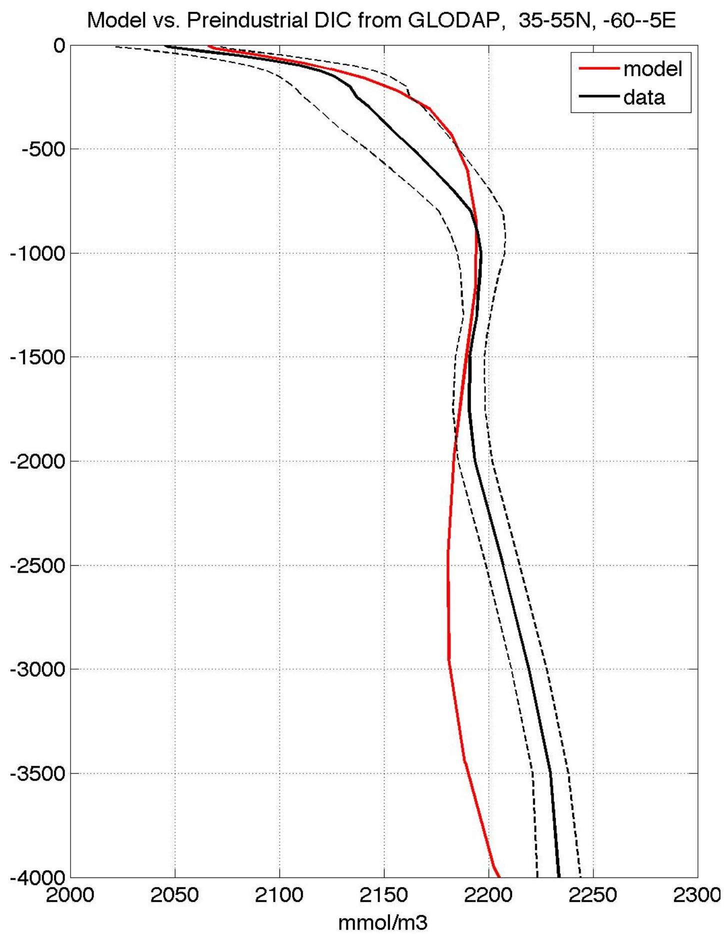

Figure S1: 35-55N, 5-60E average profile of 1948-2009 Model (red) and GLODAP preindustrial DIC (black) in mmol/m^3.

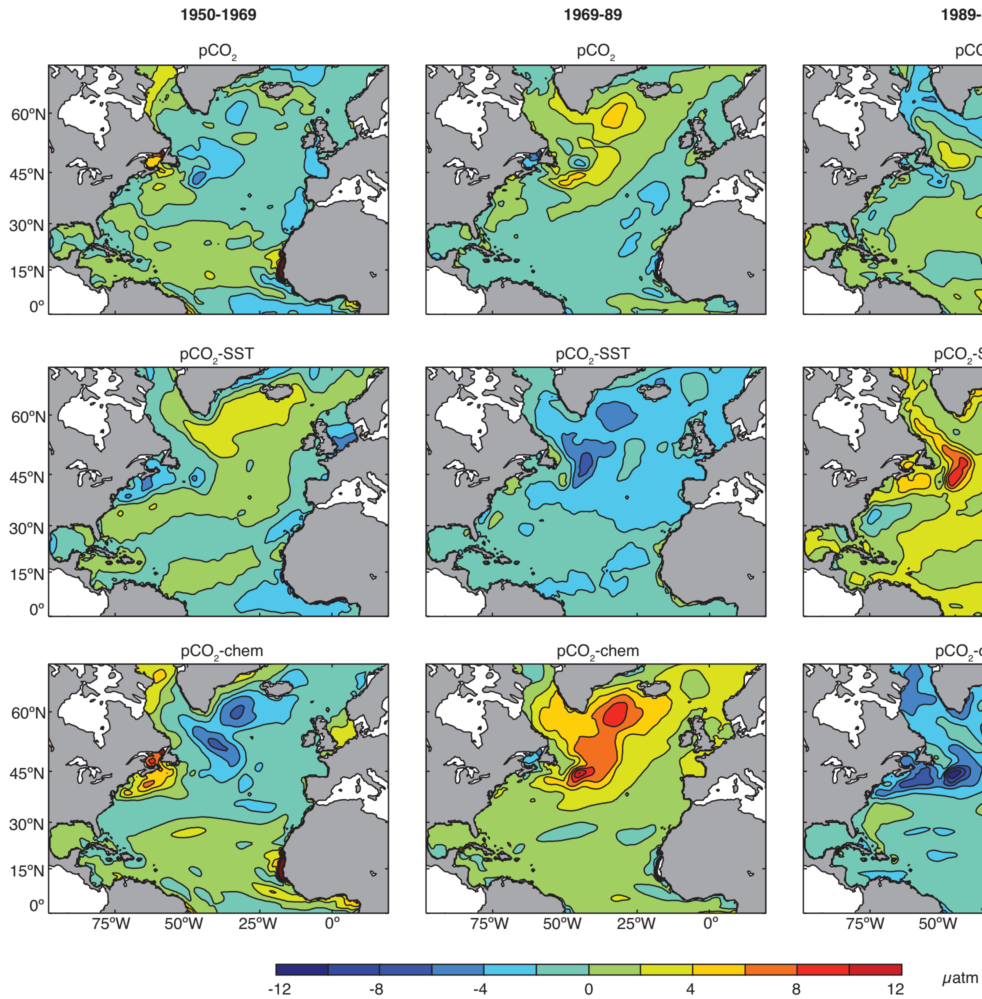

Figure S2: 20-year mean anomalies with respect to the 1948-2009 average for: a-c) pCO_2, d-f) pCO_2-SST, g-i) pCO_2-chem.

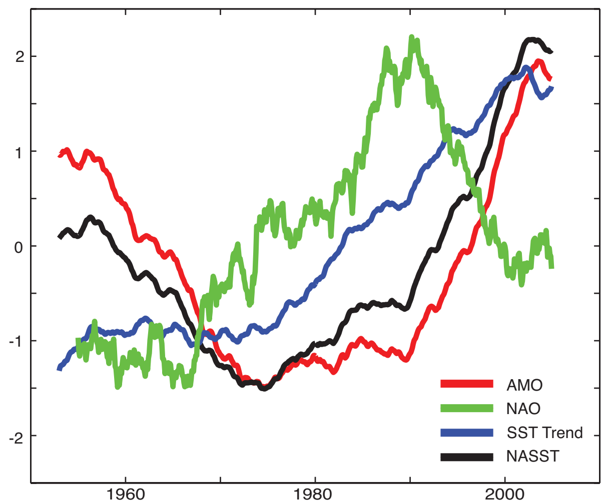

Figure S3: Same indices as in Figure 1d, as well as 121-month smoothed, standardized NAO index from NOAA ESRL (http://www.esrl.noaa.gov/psd/data/climateindices/list/).

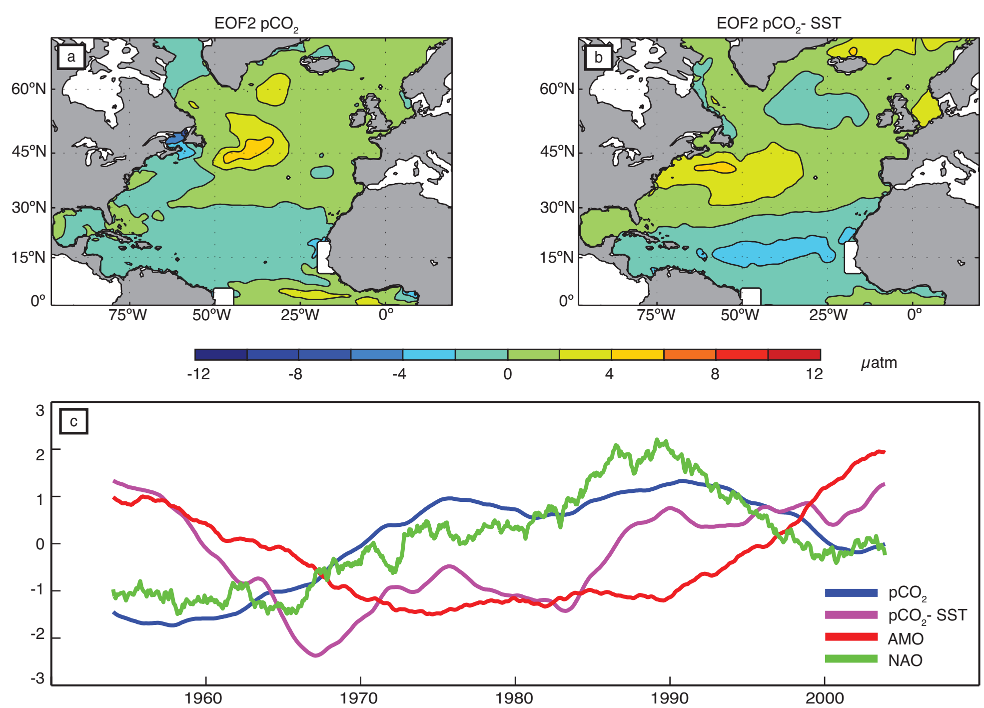

Figure S4: a) EOF2 of total pCO_2 (μatm), b) EOF2 of pCO_2-SST (μatm), explaining 13% and 12% of total variance, respectively. c) PC2- pCO_2 (blue), PC2-pCO_2-SST (pink), AMO index (red), and NAO index (green). Timeseries are smoothed with a 121-month box smoother.

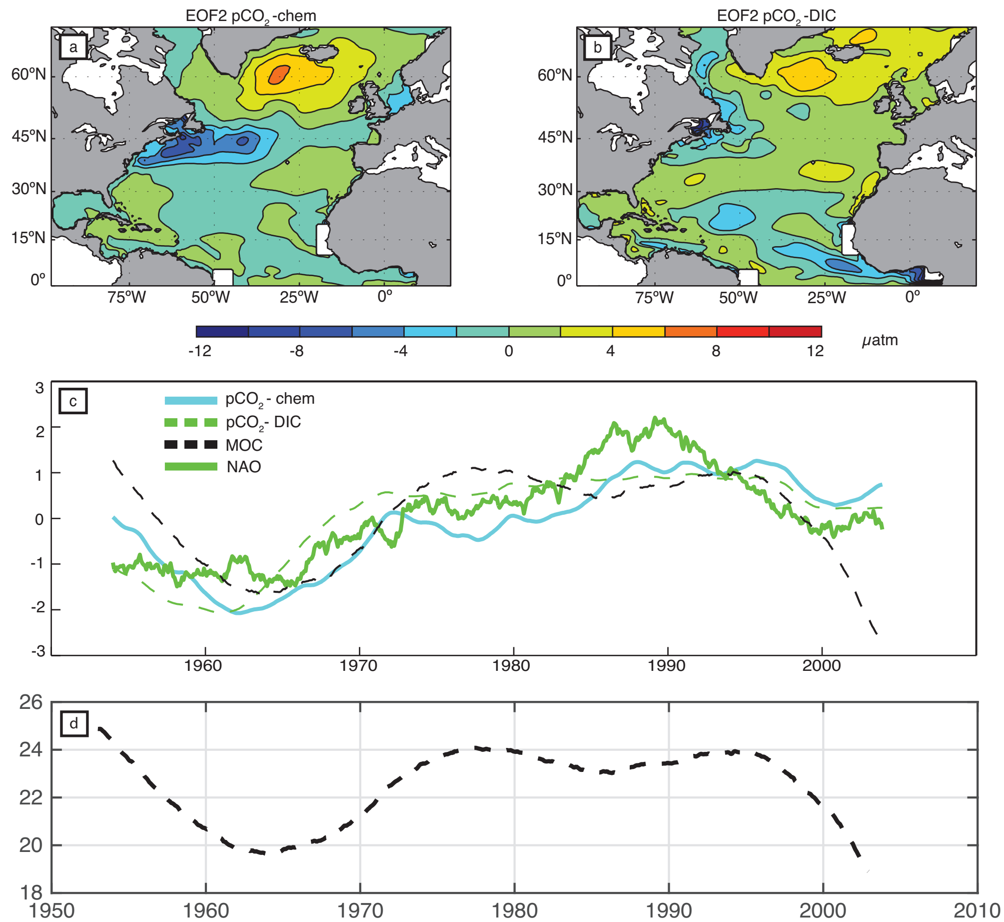

Figure S5: a) EOF2 pCO_2-chem (μatm), b) EOF2 pCO_2-DIC (μatm), each explaining 14% of total variance of each respective field. c) PC2- pCO_2-chem (cyan), PC2- pCO_2-DIC (green dash), NAO index (green), the modeled maximum Meridional Overturning Circulation at 45^{o}N (MOC, black dash), all standardized. d) unstandardized MOC, units Sverdrups (1SV = 10^6 m^3s^{-1}). Timeseries are smoothed with a 121-month box smoother.

	PC1-pCO_2	PC1-pCO_2-SST	PC1-pCO_2-chem	PC1-pCO_2-DIC	PC1-pCO2-ALK	SST	AMO	SST Trend	NAO	MOC
PC1-pCO_2	**1.0**	**0.91**	**0.66**	**0.67**	**-0.25**	**0.88**	**0.61**	**0.94**	**0.23**	0.0026
PC1-pCO_2-SST		**1.0**	**0.90**	**0.91**	.05	**1.0**	**0.86**	**0.78**	- 0.069	**-0.12**
PC1-pCO_2-chem			**1.0**	**0.98**	**.44**	**0.92**	**0.99**	**0.45**	**-0.42**	**-0.25**
PC1-pCO_2-DIC				**1.0**	**.35**	**0.93**	**0.96**	**0.49**	**-0.38**	**-0.18**
PC1-pCO2-ALK					**1.0**	**.12**	**.48**	**-.48**	**-.70**	**-.08**
SST						**1.0**	**0.90**	**0.74**	**-0.11**	**-0.13**
AMO							**1.0**	**0.37**	**-0.49**	**-0.32**
SST Trend								**1.0**	**0.51**	**0.21**
NAO									**1.0**	**0.57**
MOC										**1.0**

Table S1: Correlation between first principle components of the EOFs for pCO_2 and its components, climate indices, and the modeled maximum Meridional Overturning Circulation (MOC) at 45^{o}N. Index and MOC correlations are also shown. Bold indicates significance at the 95% level.

	PC2-pCO_2-	PC2-pCO_2-SST	PC2-pCO_2-chem	PC2-pCO_2-DIC	SST	AMO	SST Trend	NAO	MOC
PC2-pCO_2-	**1.0**	0.080	**0.80**	**0.96**	**-0.18**	**-0.59**	**0.50**	**0.89**	**0.56**
PC2-pCO_2-SST		**1.0**	**0.52**	-0.039	**0.70**	**0.60**	**0.57**	**0.18**	**0.37**
PC2-pCO_2-chem			**1.0**	**0.82**	**0.28**	**-0.11**	**0.75**	**0.82**	**0.65**
PC2-pCO_2-DIC				**1.0**	**-0.12**	**-0.51**	**0.52**	**0.83**	**0.51**

Table S2: Correlation between second principle components of the EOFs for pCO_2 and its components, climate indices, and MOC. Bold indicates significance at the 95% level.