

*Global Biogeochemical Cycles*

Supporting Information for

Carbon-based estimate of nitrogen fixation-supported net community production in N-depleted ocean gyres

Young Ho Ko1,Kitack Lee1\*, Taro Takahashi2, David M. Karl3,

Sung-Ho Kang4, Eunil Lee5

1Division of Environmental Science and Engineering, Pohang University of Science and Technology, Pohang, Republic of Korea

2Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY 10964, United States

3Daniel K. Inouye Center for Microbial Oceanography: Research and Education, University of Hawaii, Honolulu, Hawaii 96822, United States

4Division of Polar Ocean Sciences, Korea Polar Research Institute, KIOST, Incheon, Republic of Korea

5Ocean Research Division, Korea Hydrographic and Oceanographic Agency, Busan, Republic of Korea

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Captions for Dataset S1 & Dataset S2

**1. Supplemental Text**

S1.Net air-sea CO2 flux

Following the procedure described by Takahashi et al. (2009), the net air-sea CO2 flux (*F*) is estimated using *F* = *k* α ΔpCO2 = Tr ΔpCO2, where *k* is the CO2 gas transfer velocity; α is the solubility of CO2 in seawater; Tr is the air-sea gas transfer coefficient; and ΔpCO2 is the air-sea pCO2 difference (pCO2air – pCO2SW) in the reference year 2005. Tr is calculated using the equation:

Tr (g C m−2 month−1 μatm−1) = 0.585 ∙ α ∙ (Sc)−1/2 ∙ (*U*10)2

where α is the solubility of CO2 in seawater (mol liter−1 atm−1, (Weiss, 1974)), Sc is the Schmidt number, and *U*10 is the wind speed (meter s−1) at 10 m. The constant 0.585 is a unit conversion factor that takes into account the scaling factor for the gas transfer rate of 0.26; the conversion from (mol liter−1 atm−1) to (g–C m−3 μatm−1) in CO2 solubility in seawater; and the conversion form (cm hr−1) to (m month−1) in gas transfer piston velocity; and a reference Schmidt number of (6601/2).

**Table S1.** Net air-sea CO2 flux and diffusive CT and NO3− fluxes

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Basina | Areab  (1012 m2) | Net air-sea CO2 fluxc | |  | Diffusive CT and NO3− flux | | | |
| (mol C m−2  8–month−1) | Total  (Pg C 8–month−1) |  | CT gradient  (mmol C m−4) | NO3− gradient  (mmol N m−4) | C:N ratio of CT and NO3− flux | Net CT fluxd  (Pg C 8–month−1) |
| North Pacific | 26.3 | 0.09 | 0.04 |  | 0.26 | 0.037 | 7.2 | 0.00 |
| South Pacific | 15.0 | 0.08 | 0.03 |  | 0.24 | 0.024 | 10.3 | 0.01 |
| North Atlantic | 10.6 | 0.04 | 0.00 |  | 0.20 | 0.030 | 6.7 | 0.00 |
| South Atlantic | 8.3 | −0.12 | −0.05 |  | 0.17 | 0.049 | 3.1 | −0.01 |
| Indian | 10.9 | 0.05 | 0.01 |  | 0.39 | 0.037 | 10.5 | 0.01 |

aNet air-sea CO2 flux was estimated using the pCO2 climatology compiled by Takahashi et al. (2014) for each basin where CT removal occurred in the absence of NO3−. To calculate the diffusive CT and NO3− fluxes the vertical CT and NO3− profiles for each basin were separately estimated for the North Pacific (15°N–30°N, 140°E–140°W); the South Pacific (30°S–15°S, 160°E–120°W); the North Atlantic (15°N–30°N, 70W–30°W); the South Atlantic (30°S–15°S, 30°W–0°W); and Indian (30°S–15°S, 20°E–90°E and 10°S–20°N, 30°E–90°E) oceans.

bTotal area of each basin for which NCPN2fix values were available

cPositive values indicate fluxes of CO2 into the ocean, whereas negative values indicate fluxes of CO2 out of the ocean.

dCalculated using an eddy diffusivity coefficient *K*v of 0.2 cm2 s−1 and a C:N ratio of 7.

**Table S2.** Estimates of horizontal CT fluxes

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Basin | Regiona | Zonal  nCT gradientb  (μmol kg−1 km−1) | Meridional  nCT gradientb  (μmol kg−1 km−1) | Zonal Ekman and geostrophic flowc  (km day−1) | Meridional Ekman and geostrophic flowc  (km day−1) | Net CT fluxd  (Pg C 8–month−1) |
| North Pacific | W | 0.0010 | 0.0097 | −5.3 | 3.6 | 0.07 |
| C | 0.0043 | 0.0059 | −5.9 | 5.0 |
| E | 0.0083 | 0.027 | −6.2 | 3.3 |
| South Pacific | W | −0.0010 | −0.025 | −1.2 | −2.4 | 0.13 |
| E | 0.0069 | −0.044 | 0.2 | −2.1 |
| North Atlantic | N | 0.0078 | 0.027 | 0.2 | −0.7 | −0.04 |
| S | 0.012 | 0.0023 | −5.3 | 2.0 |
| South Atlantic | N | 0.012 | −0.011 | −4.9 | −1.8 | −0.04 |
| S | 0.0055 | −0.053 | 3.2 | 1.2 |
| Indian | Eq | 0.0051 | −0.0025 | 7.0 | −4.2 | 0.04 |
| W | 0.0053 | −0.020 | −2.3 | −4.7 |
| E | 0.0044 | −0.025 | −3.7 | −3.8 |

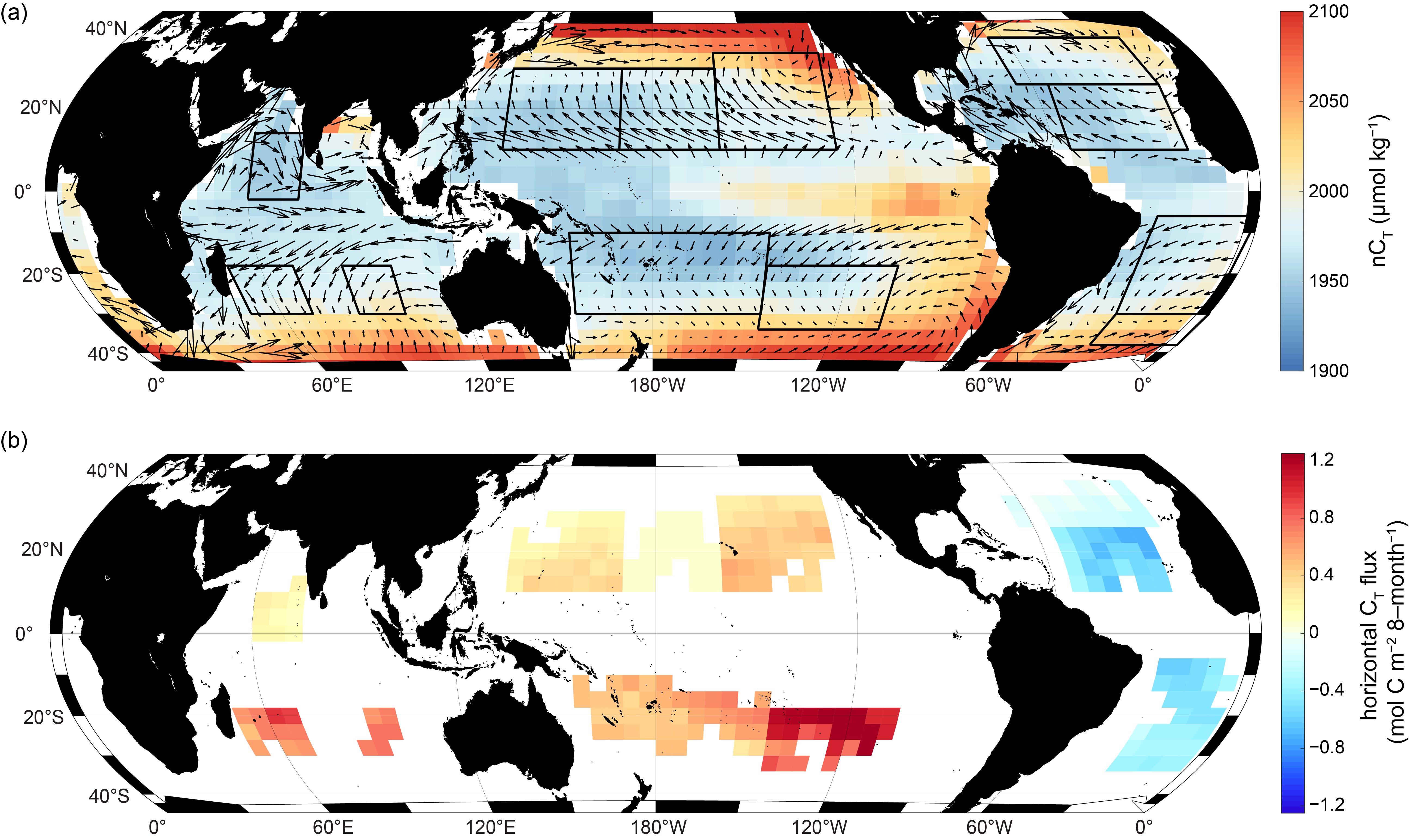
aEach region is shown in Figure S1 (W: Western basin; C: Central basin; E: Eastern basin; N: Northern basin; S: Southern basin;

Eq: Equatorial region).

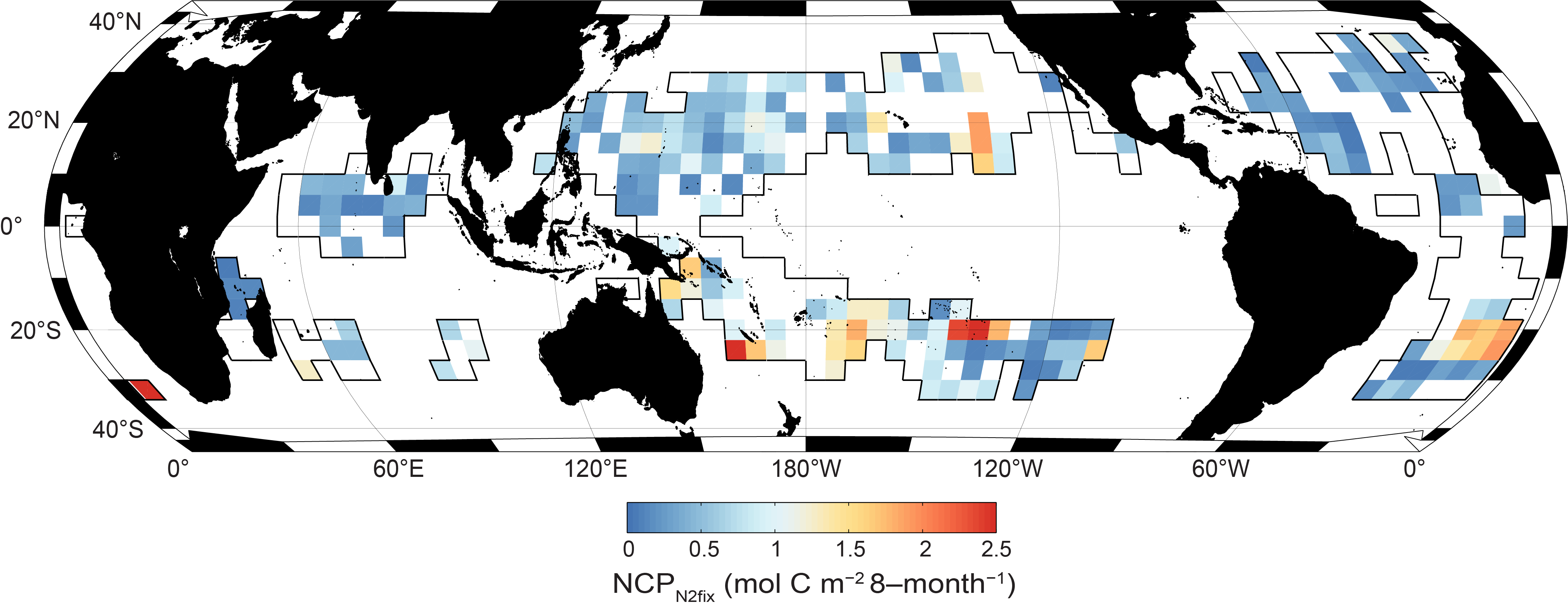
bPositive values for Zonal (Meridonal) nCT gradients indicate an eastward (northward) increase in nCT.

cPositive values for Zonal (Meridonal) flow indicate eastward (northward) flow.

dPositive values indicate that the horizontal CT flux increased seasonal nCT drawdown.



**Figure S1.** (a) Surface current velocities (black arrows) and horizontal nCT gradients, and (b) horizontal CT fluxes. Horizontal nCT flues were estimated from mean horizontal velocities and horizontal nCT gradients in the sub-regions indicated by the solid black boxes. Positive values of the net CT flux indicate increased seasonal nCT drawdown.



**Figure S2.** NCPN2fix calculated based on PO43− reduction in the N-depleted ocean (NO3− concentrations < 0.2 μmol kg−1 are indicated as black solid boxes). White pixels within the solid boxes indicate no PO43− drawdown during the warming period.

**Dataset S1.** NCPN2fix estimates for each pixel based on the mixed layer nCT reduction in the N-depleted ocean.

**Dataset S2.** NCPN2fix estimates for each pixel based on the mixed layer PO43− reduction in the N-depleted ocean.