

*Global Biogeochemical Cycles*

Supporting Information for

**The spatiotemporal dynamics of the sources and sinks of CO2 in the global coastal ocean**

Alizée Roobaert1, Goulven G. Laruelle1, Peter Landschützer2, Nicolas Gruber3, Lei Chou1, and Pierre Regnier1

1Department of Geosciences, Environment & Society (DGES), Université Libre de Bruxelles, Brussels, CP160/02, Belgium.

2Max Planck Institute for Meteorology, Bundesstr 53, Hamburg, 20146, Germany.

3Environmental Physics, Institute of Biogeochemistry and Pollutant Dynamics, ETH Zürich, Universitätstrasse 16, 8092 Zürich, Switzerland.

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**Introduction**

The supporting information includes two figures and one table. The first figure (figure S1) represents, for each latitudinal band, the contribution of the different drivers to the seasonal *FCO2* variability. In Table S1, *FCO2* (in mol C m-2 yr-1) and integrated *FCO2* (in Tg C yr-1) are calculated in this study, by Laruelle et al. (2014) and by Bourgeois et al. (2016) and are compared for the different MARCATS regions. Figure S2 presents a comparison between the *FCO2* (in mol C m-2 yr-1) calculated in these studies at the MARCATS scale.



Figure S1. Contributions of the different drivers (*βx* with x = (a) *ΔpCO2*, (b) the wind speed, (c) the sea-ice cover and (d) the cross-correlation between the 3 terms) to the seasonal $FCO\_{2}^{'}$ for each MARCATS region, plotted by latitude. Colors correspond to the seven major MARCATS classes (see Figure 1, Liu et al., 2010). For each MARCATS and driver, *β*  is calculated using equation 8. A value close to one indicates that the term contributes strongly to $FCO\_{2}^{'}$ whereas a value of 0 shows that $FCO\_{2}^{'}$ is insensitive to that term. Negative values indicate that the term is anti-correlated with $FCO\_{2}^{'}$.

Figure S2. Comparison of the air-sea CO2 exchange rate (*FCO2*, mol C m-2 yr-1) calculated for the different MARCATS regions in this study with that of (a) Laruelle et al. (2014, LA2014) and that of (b) Bourgeois et al. (2016, BG2016). Colors correspond to the seven major MARCATS classes (see Figure 1, Liu et al., 2010). Error bars in the LA2014 study correspond to the uncertainties associated to the data coverage in time and space when deriving *FCO2*. For BG2016, it corresponds to the *FCO2* interannual variability for the 1993-2012 period. In this study, *FCO2* uncertainties are calculated according to section 2.5.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| N° | System name | Class | Surface area(103 km2) | FCO2 (mol C m-2 yr-1) | Integrated FCO2 (Tg C yr-1) |
|  |  |  | BG2016 | LA2014 | This study | BG2016 | LA2014 | This study | BG2016 | LA2014 | This study |
|  |  |  |  |  |  | mean | σ | mean | σ | mean | σ | mean | σ |  | mean | σ |
| 1 | North East Pacific | Subpolar | 397 | 350 | 394 | -2.29 | 0.17 | -1.61 | 0.25 | -1.59 | 0.6 | -10.94 | 0.82 | -6.78 | -7.53 | 2.67 |
| 2 | Californian current | EBC | 118 | 208 | 186 | -0.34 | 0.10 | -0.05 | 0.50 | -0.60 | 0.2 | -0.48 | 0.15 | -0.14 | -1.33 | 0.48 |
| 3 | Tropical East Pacific | Tropical | 152 | 183 | 162 | -0.12 | 0.05 | 0.09 | 0.60 | 0.00 | 0.1 | -0.22 | 0.10 | 0.19 | 0.00 | 0.18 |
| 4 | Peruvian upwelling current | EBC | 138 | 143 | 121 | 1.44 | 0.80 | 0.65 | 0.60 | -0.83\* | 0.6 | 2.39 | 1.33 | 1.07 | -1.20 | 0.88 |
| 5 | Southern America | Subpolar | 1126 | 1190 | 1163 | -1.51 | 0.13 | -1.31 | 0.50 | -1.24 | 0.5 | -20.46 | 1.71 | -18.72 | -17.38 | 6.53 |
| 6 | Brazilian current | WBC | 475 | 484 | 497 | -0.33 | 0.08 | 0.10 | 0.25 | -0.12 | 0.3 | -1.87 | 0.48 | 0.57 | -0.72 | 1.55 |
| 7 | Tropical West Atlantic | Tropical | 479 | 488 | 490 | 0.86 | 0.10 | 0.07 | 0.60 | 0.25 | 0.3 | 4.93 | 0.55 | 0.39 | 1.49 | 1.86 |
| 8 | Caribbean Sea | Tropical | 303 | 358 | 289 | 0.10 | 0.10 | 0.81 | 0.60 | 0.80 | 0.2 | 0.37 | 0.35 | 3.46 | 2.77 | 0.53 |
| 9 | Gulf of Mexico | Marginal sea | 469 | 532 | 501 | -0.79 | 0.11 | -0.33 | 0.50 | 0.24 | 0.3 | -4.48 | 0.63 | -2.10 | 1.42 | 1.90 |
| 10 | Florida upwelling | WBC | 545 | 591 | 804 | -2.25 | 0.21 | -0.38 | 0.25 | -0.83 | 0.2 | -14.69 | 1.35 | -2.72 | -8.00 | 2.04 |
| 11 | Sea of Labrador | Subpolar | 576 | 638 | 342 | -1.27 | 0.18 | -1.72 | 0.60 | -1.88 | 0.6 | -8.81 | 1.24 | -13.17 | -7.70 | 2.38 |
| 12 | Hudson Bay | Marginal sea | 998 | 1064 | 1013 | 0.31 | 0.29 | - | - | -1.38 | 0.1\*\*\* | 3.76 | 3.42 | - | -16.81 | 1.04 |
| 13 | Canadian Archipelago | Polar | 1001 | 1145 | 1020 | -0.52 | 0.06 | -1.02 | 0.60 | -0.40 | 0.1 | -6.23 | 0.75 | -13.99 | -4.91 | 1.65 |
| 14 | North Greenland | Polar | 544 | 602 | 572 | -0.97 | 0.15 | -0.61 | 0.50 | -0.93 | 0.2 | -6.33 | 1.00 | -4.40 | -6.38 | 0.63 |
| 15 | South Greenland | Polar | 238 | 262 | 248 | -3.35 | 0.44 | -3.81 | 0.50 | -2.90 | 0.3 | -9.56 | 1.26 | -11.97 | -8.61 | 0.99 |
| 16 | Norwegian Basin | Polar | 141 | 162 | 142 | -2.87 | 0.23 | -1.72 | 0.25 | -2.55 | 0.5 | -4.86 | 0.40 | -3.34 | -4.34 | 0.83 |
| 17 | North East Atlantic | Subpolar | 1020 | 1073 | 1040 | -2.16 | 0.12 | -1.33 | 0.25 | -1.10 | 0.2 | -26.50 | 1.42 | -17.17 | -13.68 | 2.77 |
| 18 | Baltic Sea | Marginal sea | 324 | 364 | 336 | 0.30 | 0.07 | 0.51 | 0.50 | -0.39 | 0.4 | 1.18 | 0.29 | 2.25 | -1.58 | 1.66 |
| 19 | Iberian upwelling | EBC | 251 | 267 | 251 | -1.13 | 0.12 | 0.04 | 0.25 | -0.87 | 0.3 | -3.39 | 0.35 | 0.12 | -2.64 | 0.91 |
| 20 | Mediterranean Sea | Marginal sea | 423 | 529 | 474 | -0.24 | 0.06 | 0.62 | 0.60 | -0.01 | 0.1 | -1.20 | 0.33 | 3.93 | -0.07 | 0.51 |
| 21 | Black Sea | Marginal sea | 131 | 172 | 104 | -0.24 | 0.11 | - | - | -2.85 | 0.6 | -0.38 | 0.17 | - | -3.55 | 0.75 |
| 22 | Moroccan upwelling | EBC | 177 | 206 | 179 | 0.18 | 0.12 | 2.92 | 0.50 | 0.24\*\* | 0.6 | 0.39 | 0.26 | 7.22 | 0.52 | 1.20 |
| 23 | Tropical East Atlantic | Tropical | 225 | 259 | 259 | 0.09 | 0.08 | -0.06 | 0.60 | 0.03 | 0.1 | 0.24 | 0.21 | -0.17 | 0.09 | 0.29 |
| 24 | South West Africa | EBC | 300 | 298 | 295 | 0.43 | 0.40 | -1.43 | 0.50 | -1.06 | 0.8 | 1.54 | 1.45 | -5.10 | -3.76 | 2.66 |
| 25 | Agulhas current | WBC | 189 | 239 | 228 | -1.20 | 0.09 | -0.58 | 0.60 | -0.39 | 0.4 | -2.73 | 0.21 | -1.66 | -1.07 | 1.07 |
| 26 | Tropical West Indian | Tropical | 46 | 68 | 60 | -0.06 | 0.08 | 1.00 | 0.60 | 0.30 | 0.2 | -0.03 | 0.04 | 0.82 | 0.22 | 0.12 |
| 27 | West Arabian Sea | Indian margins | 82 | 92 | 81 | 0.35 | 0.04 | 1.14 | 0.60 | -0.11\*\* | 0.4 | 0.34 | 0.04 | 1.26 | -0.11 | 0.42 |
| 28 | Red Sea | Marginal sea | 158 | 174 | 165 | 0.24 | 0.03 | 0.16 | 0.60 | 0.67 | 0.1 | 0.46 | 0.07 | 0.33 | 1.33 | 0.20 |
| 29 | Persian Gulf | Marginal sea | 208 | 233 | 217 | 0.04 | 0.08 | - | - | 0.85 | 0.1\*\*\* | 0.09 | 0.20 | - | 2.20 | 0.26 |
| 30 | East Arabian Sea | Indian margins | 298 | 317 | 317 | 0.21 | 0.12 | 0.67 | 0.60 | 0.61 | 0.1\*\*\* | 0.75 | 0.43 | 2.56 | 2.31 | 0.34 |
| 31 | Bay of Bengal | Indian margins | 197 | 203 | 204 | -0.69 | 0.12 | -0.22 | 0.60 | 0.15 | 0.03\*\*\* | -1.64 | 0.28 | -0.53 | 0.36 | 0.08 |
| 32 | Tropical East Indian | Indian margins | 727 | 763 | 755 | -0.06 | 0.07 | -0.02 | 0.60 | 0.16 | 0.1 | -0.48 | 0.57 | -0.17 | 1.46 | 0.74 |
| 33 | Leeuwin current | EBC | 81 | 117 | 112 | -2.05 | 0.15 | -0.98 | 0.25 | -0.49 | 0.2 | -2.01 | 0.15 | -1.38 | -0.66 | 0.25 |
| 34 | South Australia | Subpolar | 392 | 436 | 429 | -1.37 | 0.18 | -1.14 | 0.50 | -0.28 | 0.3 | -6.44 | 0.86 | -5.98 | -1.44 | 1.60 |
| 35 | East Australian current | WBC | 98 | 130 | 133 | -1.74 | 0.18 | -1.09 | 0.25 | -0.74 | 0.2 | -2.04 | 0.21 | -1.70 | -1.18 | 0.35 |
| 36 | New Zealand | Subpolar | 263 | 286 | 266 | -1.23 | 0.16 | -1.25 | 0.50 | -0.90 | 0.2 | -3.88 | 0.50 | -4.27 | -2.88 | 0.49 |
| 37 | North Australia | Tropical | 2278 | 2292 | 2369 | -0.29 | 0.11 | 0.44 | 0.60 | 0.31 | 0.1 | -7.87 | 3.11 | 12.12 | 8.72 | 2.68 |
| 38 | South East Asia | Tropical | 2130 | 2160 | 2196 | -0.29 | 0.07 | -0.91 | 0.60 | 0.07 | 0.2 | -7.34 | 1.91 | -23.61 | 1.77 | 4.22 |
| 39 | China Sea and Kuroshio | WBC | 1132 | 1129 | 1172 | -1.99 | 0.15 | -1.41 | 0.60 | -0.59 | 0.1 | -27.05 | 1.99 | -19.10 | -8.30 | 2.03 |
| 40 | Sea of Japan | Marginal sea | 233 | 147 | 249 | -3.07 | 0.17 | -3.47 | 0.50 | -1.44 | 0.6 | -8.61 | 0.48 | -6.11 | -4.32 | 1.84 |
| 41 | Sea of Okhotsk | Marginal sea | 933 | 952 | 953 | -1.66 | 0.07 | 1.31 | 0.60 | -1.85 | 0.6 | -18.62 | 0.76 | 1.50 | -21.18 | 7.10 |
| 42 | North West Pacific | Subpolar | 1025 | 1000 | 1058 | -1.85 | 0.14 | -0.70 | 0.60 | -1.46 | 0.5 | -22.76 | 1.73 | -8.42 | -18.58 | 6.17 |
| 43 | Siberian Shelves | Polar | 1848 | 1889 | 1864 | -0.47 | 0.10 | -0.90 | 0.60 | -0.50 | 0.1 | -10.50 | 2.12 | -20.32 | -11.12 | 1.82 |
| 44 | Barents and Kara seas | Polar | 1559 | 1680 | 1609 | -0.75 | 0.14 | -1.60 | 0.60 | -1.78 | 0.4 | -14.18 | 2.59 | -32.23 | -34.41 | 7.75 |
| 45 | Antarctic Shelves | Polar | 2452 | 2936 | 2693 | -0.90 | 0.14 | -0.15 | 0.50 | -0.12 | 0.1 | -26.63 | 3.99 | -5.38 | -3.80 | 2.55 |

**\*** Due to the scarcity of the data in SOCATv4 dataset for this region, the *pCO2* product of Laruelle et al. (2017) underestimates the observed *pCO2* and does not reproduce the high *FCO2* source (5.7 mol C m-2 yr-1) of the region observed by Friederich et al. (2008).

**\*\*** A *pCO2* underestimation is also observed for these two regions because of the scarcity in data to train the algorithm for MARCATS 22 (Laruelle et al., 2017) and given that the monsoon-driven summer upwelling in coastal seas is not captured by the SOM-FFN in MARCATS 27.

\*\*\* The scarcity in data in MARCATS 12, 29, 30 and 31 does not allow one to calculate $σ\_{pCO2}$ for these regions in the total *FCO2* uncertainty calculation.

**Table S1**. Surface area (103 km2), air-sea CO2 exchange rate (*FCO2*, mol C m-2 yr-1) and integrated *FCO2* (Tg C yr-1) calculated for each MARCATS regions. BG2016 and LA2014 refer to the study of Bourgeois et al. (2016) and of Laruelle et al. (2014), respectively. *σ* in the LA2014 study corresponds to the uncertainties associated to the data coverage in time and space when they derived *FCO2*. For BG2016, uncertainty corresponds to the *FCO2* interannual variability for the 1993-2012 period. In this study, *FCO2* uncertainties are calculated according to section 2.5.