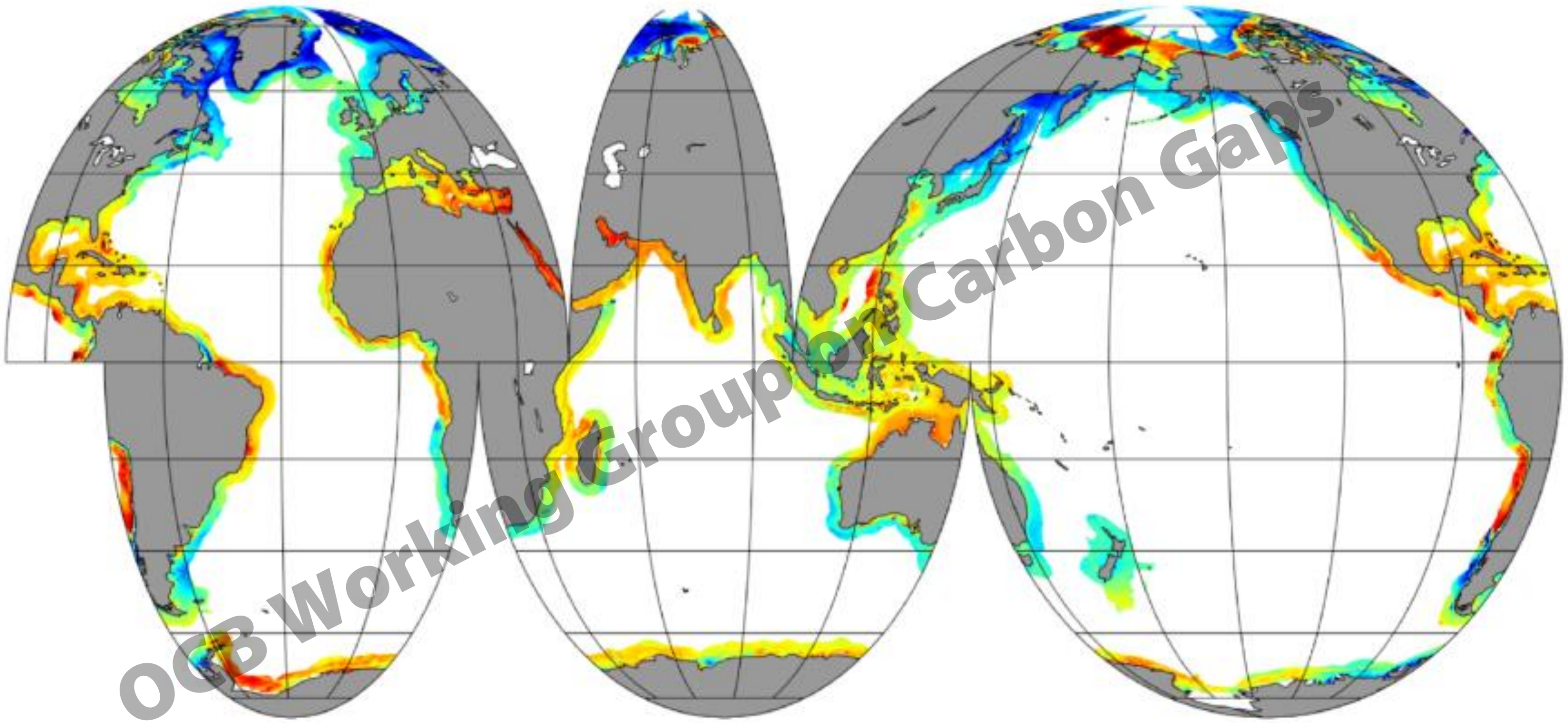
Coastal data and global data products



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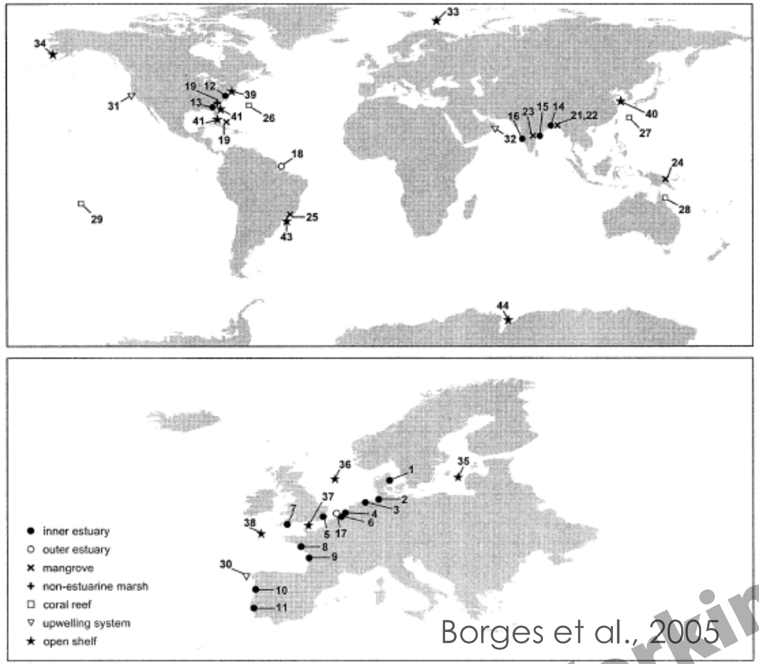
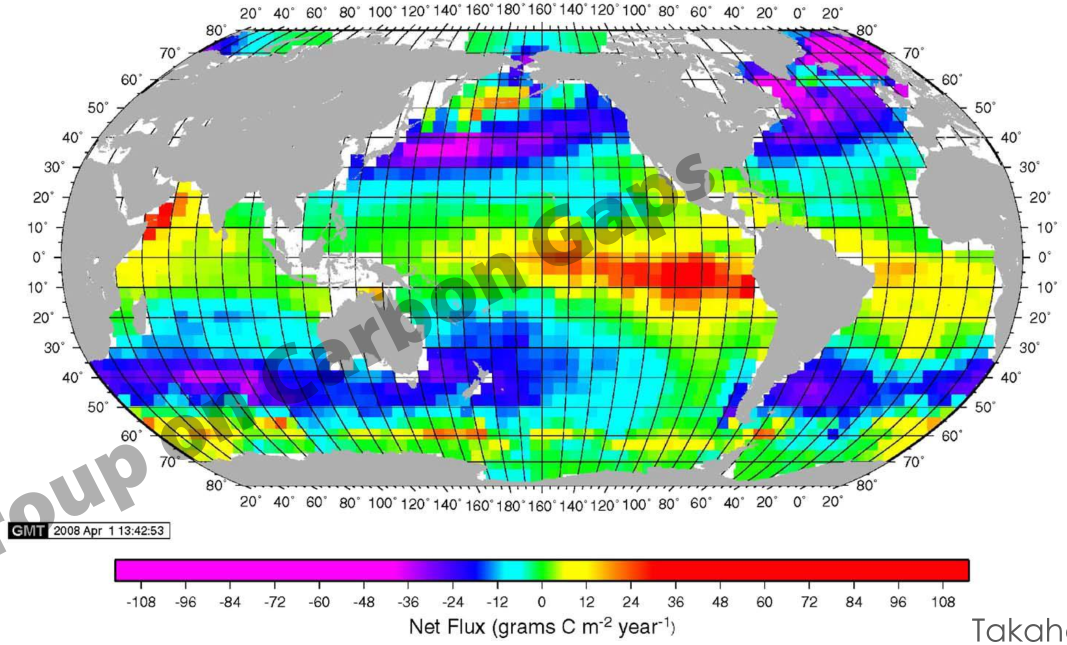
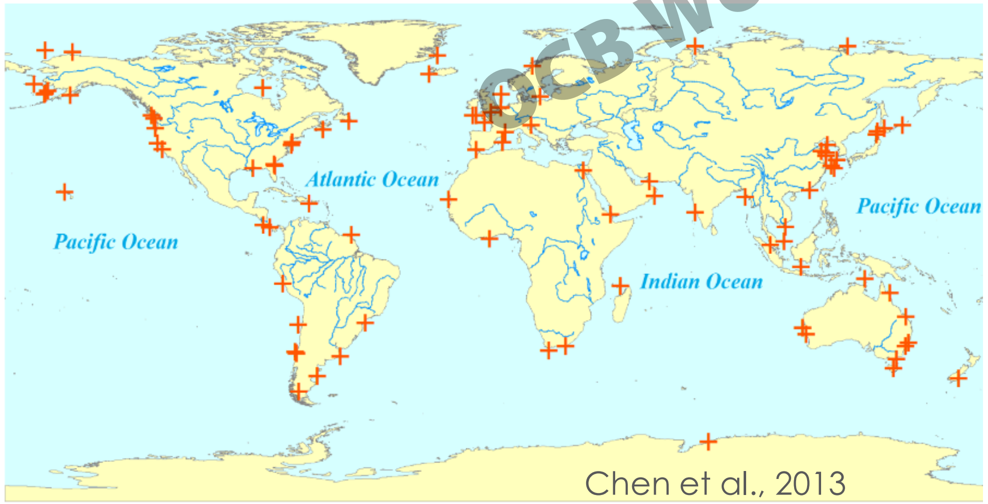
Earlier coastal and open ocean global CO_2 sink estimates



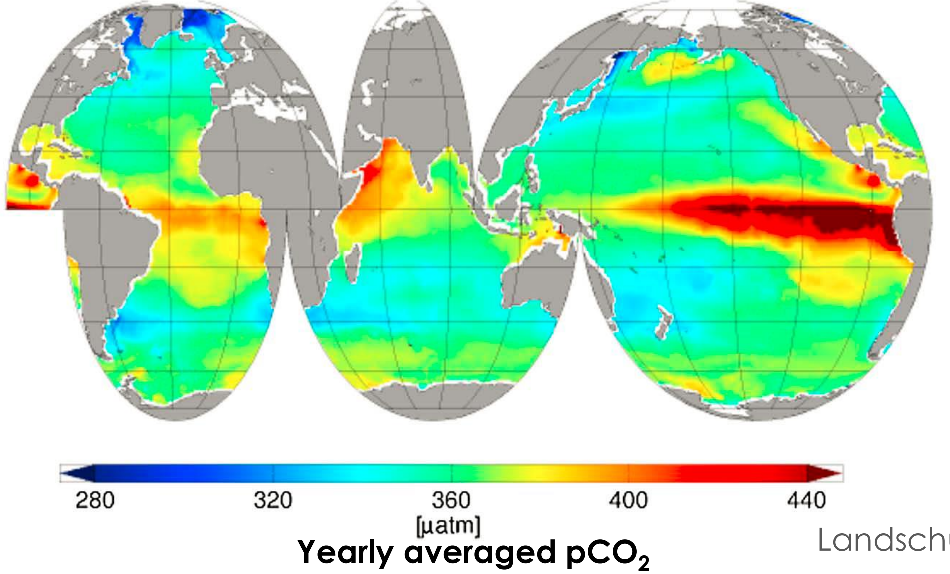
Borges et al., 2005



Takahashi et al., 2009



Chen et al., 2013



Landschützer et al., 2014

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First data-driven global coastal pCO_2 climatology

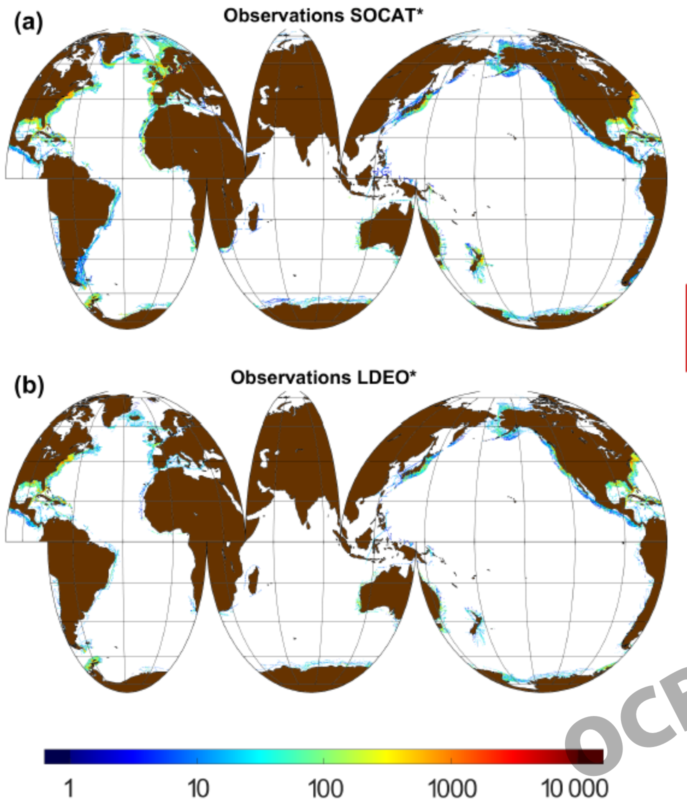


Figure 2. Number of observations contained in each 0.25° grid cell of the SOCAT* **(a)** and LDEO* **(b)** databases.

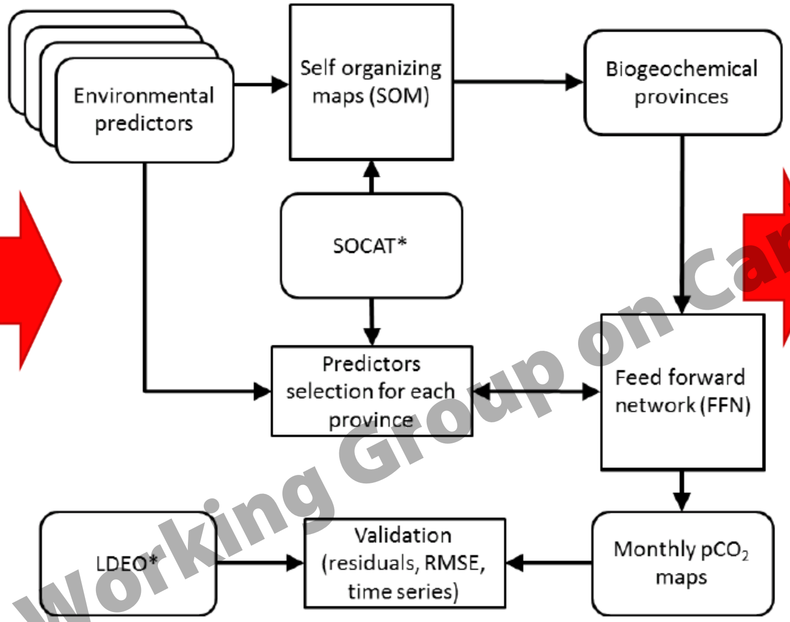
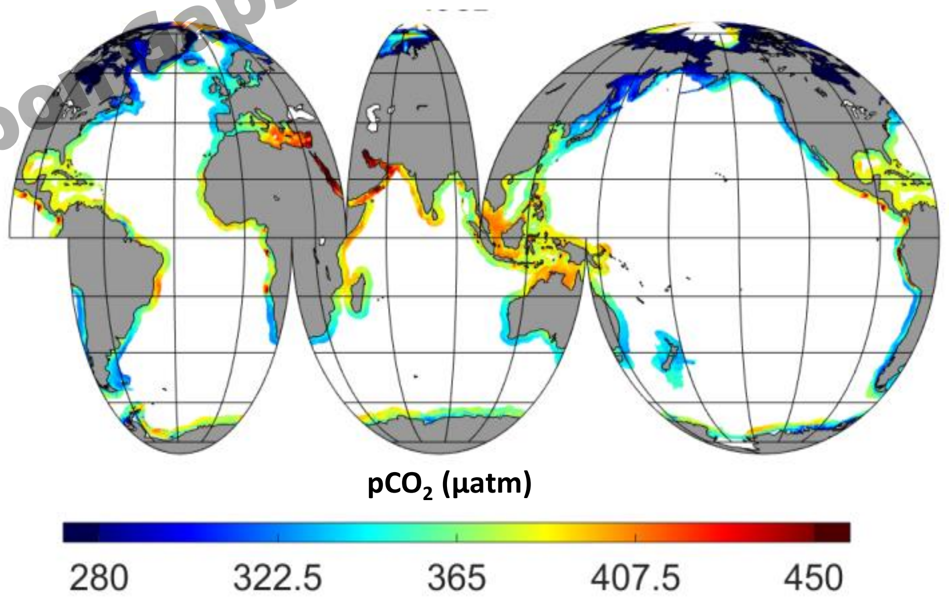


Figure 1. Schematic scheme of the different steps involved in the SOM-FFN artificial neural network calculations leading to continuous monthly pCO_2 maps over the 1998–2015 period.

Data coverage: 1998 – 2015
Resolution: 0.25 degree – monthly
Spatial extent: 76 10^6 km^2



Laruelle et al., BG 2017

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Main differences with the open ocean product (i.e. Landschützer et al., 2014)
Higher spatial resolution: 0.25 degree instead of 1 degree
Additional predictors: chlorophyll a and sea-ice coverage
Model only trained with coastal data distributed between 10 biogeochemical provinces

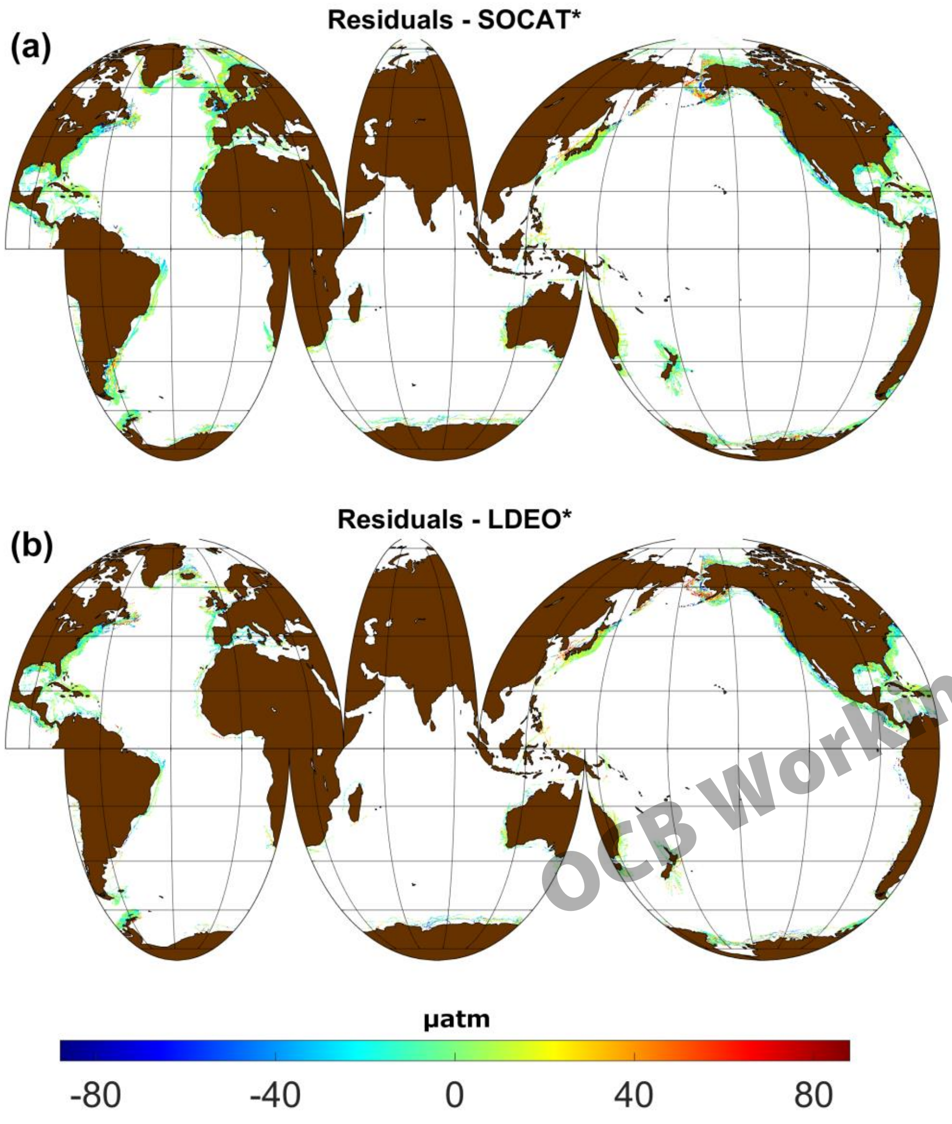

Figure 5. Mean residuals calculated as the difference between the SOM_FFM pCO_2 outputs and pCO_2 observations from SOCAT* **(a)** and LDEO* **(b)**.

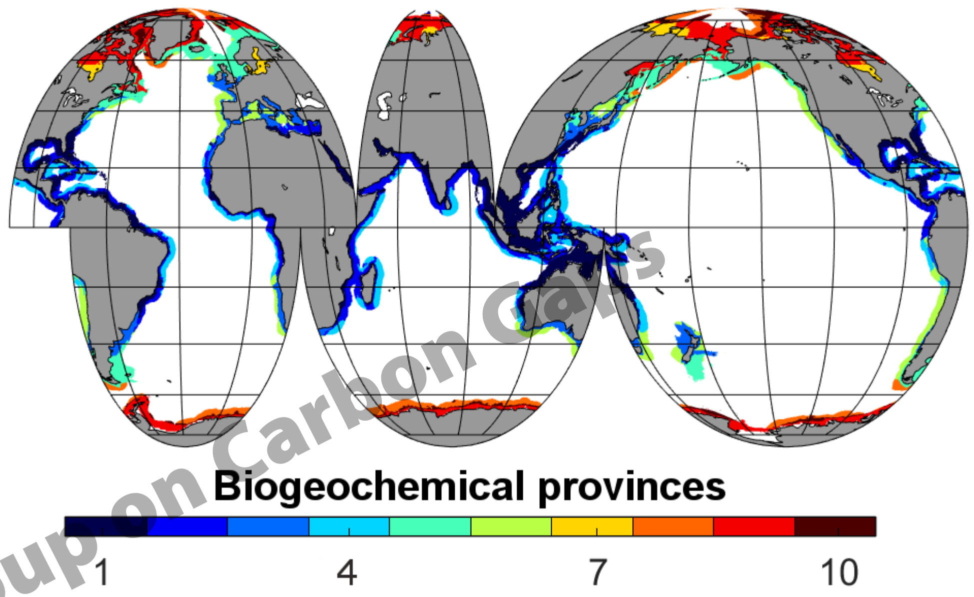

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Table 3. Root mean square error between observed and calculated pCO_2 in the different biogeochemical provinces. The SOM-FFN results are compared to data extracted from the LDEO database (Takahashi et al., 2014) and the overlapping cells from the Landschützer et al. (2016) pCO_2 climatology.

Province	Surface area (km^2)	Ice cover (%)	SOCAT* bias (µatm)	RMSE (µatm)	Landschützer bias (µatm)	2016 RMSE (µatm)	LDEO bias (µatm)	RMSE (µatm)
P1	8.2×10^6	0	0.0	19.1	2.0	27.2	2.0	20.5
P2	10.9×10^6	0	0.2	24.7	9.3	24.2	1.3	27.2
P3	4.4×10^6	0	−0.3	16.1	2.2	37.9	2.3	22.7
P4	16.6×10^6	0	−0.2	31.2	8.0	21.1	−1.6	33.0
P5	7.5×10^6	57.1	0.0	34.2	11.5	30.9	−1.4	38.0
P6	4.8×10^6	0	0.0	24.3	6.8	18.1	1.3	27.9
P7	9.3×10^6	0.0	0.1	37.2	0.7	23.5	−0.2	52.5
P8	3.3×10^6	38.5	0.2	46.8	13.9	70.1	3.9	51.4
P9	2.9×10^6	54.3	−0.1	23.0	−5.2	42.5	−2.5	33.4
P10	9.0×10^6	45.8	0.0	35.7	−9.7	50.9	1.6	53.1
	76.9×10^6		0.0	32.9	3.9	34.7	0.0	39.2

Comparison between coastal and open ocean products

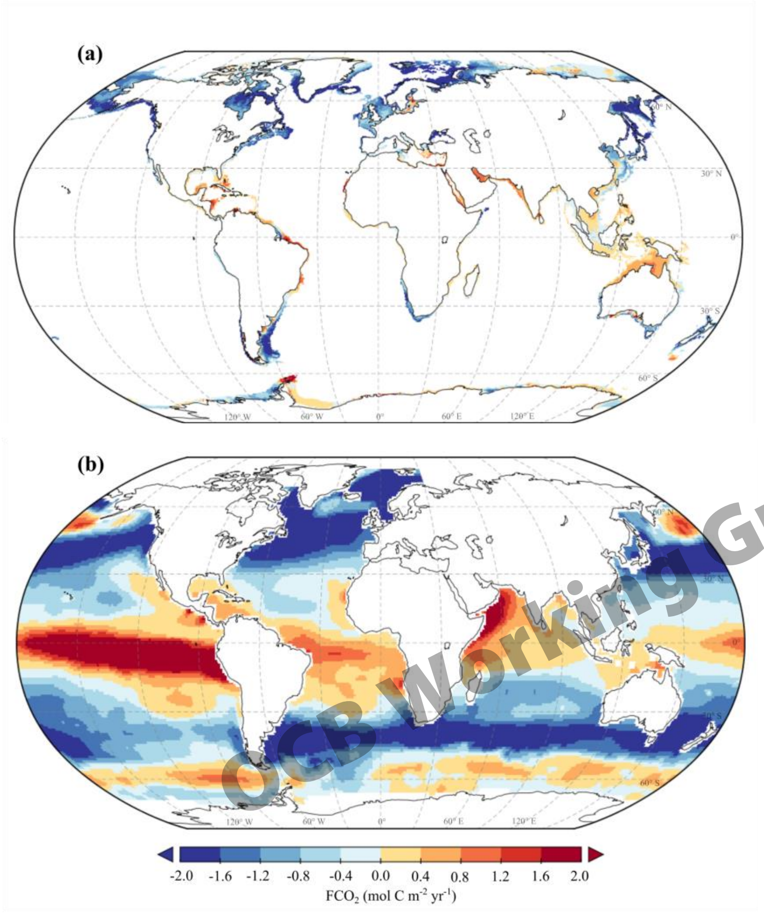

Figure. Global distributions of the annually averaged mean air-sea CO_2 exchange rate (FCO_2, mol C m^{-2} yr^{-1}) generated from a 18-year climatology (1998-2015) (a) for the coastal seas and (b) for the open ocean. A positive FCO_2 value represents a source of CO_2 for the atmosphere, and vice versa for negative FCO_2. seas, respectively.

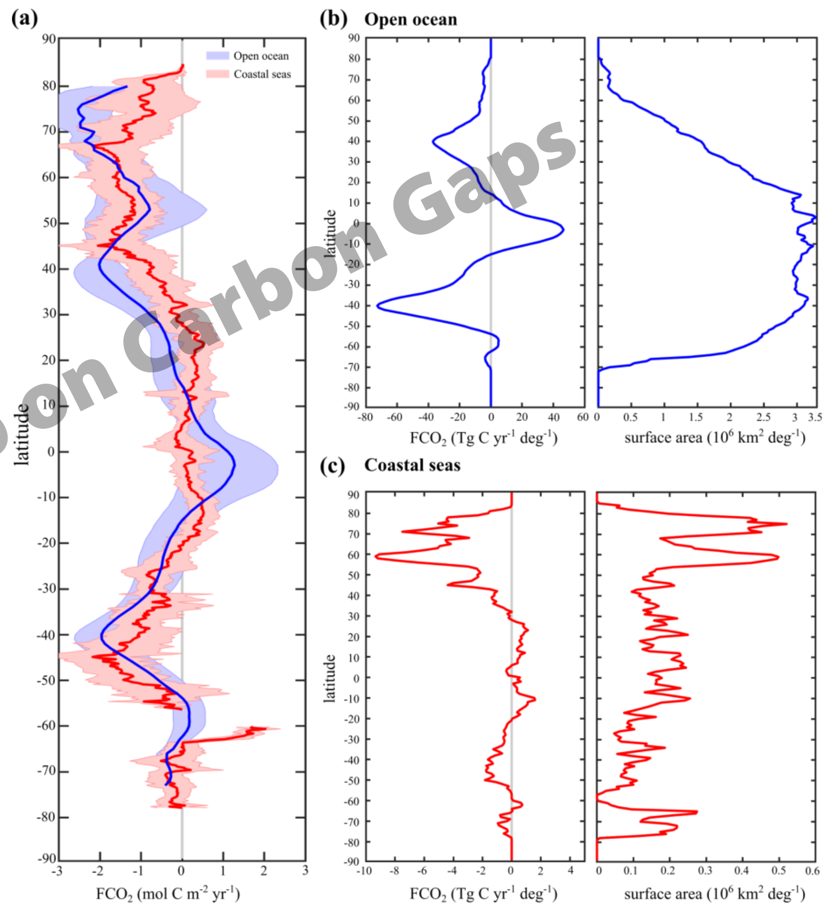

Figure. (a) Amplitude of the spatial variability within latitudinal bands of the mean air-sea gas exchange rate of CO_2 (FCO_2, mol C m^{-2} yr^{-1}) for the coastal seas (in red) and the open ocean (in blue). Shaded areas correspond to the FCO_2 longitudinal variability. (b-c) Spatial variation by 1 degree latitudinal bands of the integrated FCO_2 (Tg C yr^{-1}) and the surface area (10^6 km^2) for the open ocean and for the coastal seas, respectively.

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Roobaert et al., GBC 2020

Merging coastal and open ocean products

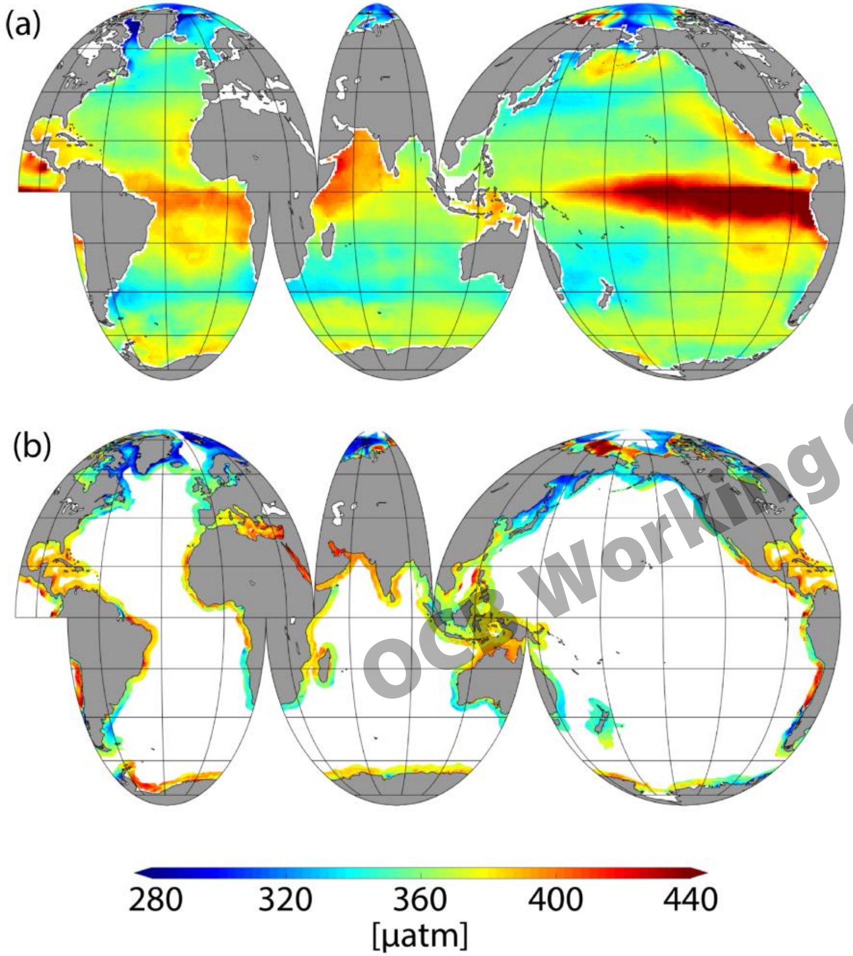

Figure. Global distributions of the annually mean pCO_2 (µatm) at the air-water interface for the open ocean and coastal seas generated from a 18-year climatology (1998-2015)

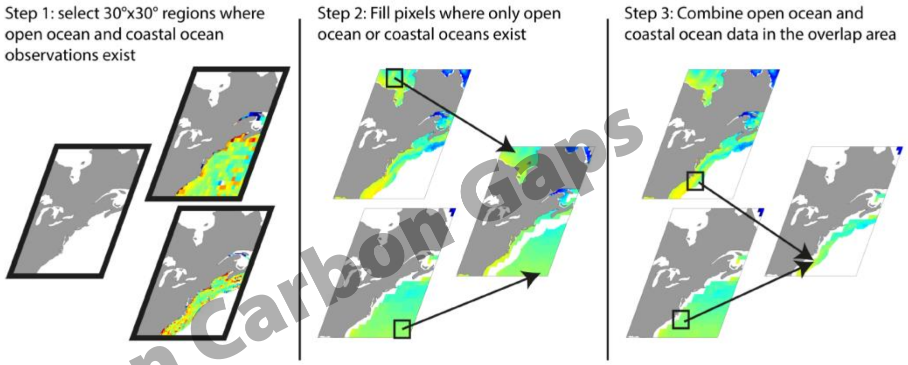

Figure. Schematic illustration of the merging steps. Step 1 shows an illustrative example of one selected 30° x 30° box where in Step 2 empty grid cells within the 30° x 30° box are filled with coastal ocean as well as open ocean datapoints and in Step 3 open ocean and coastal ocean datapoints are combined where both exist

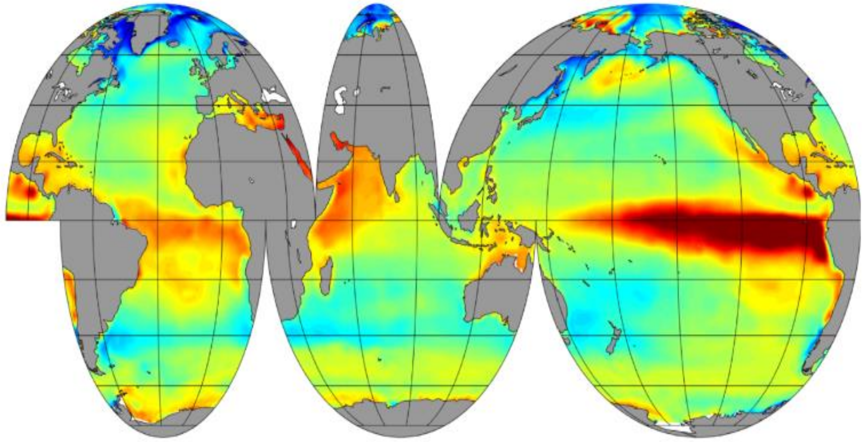

Figure. Global distributions of the annually mean pCO_2 (µatm) at the air-water interface for the merged product generated from a 18-year climatology (1998-2015)

Landschützer et al., submitted to ESSD

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Comparing products performances

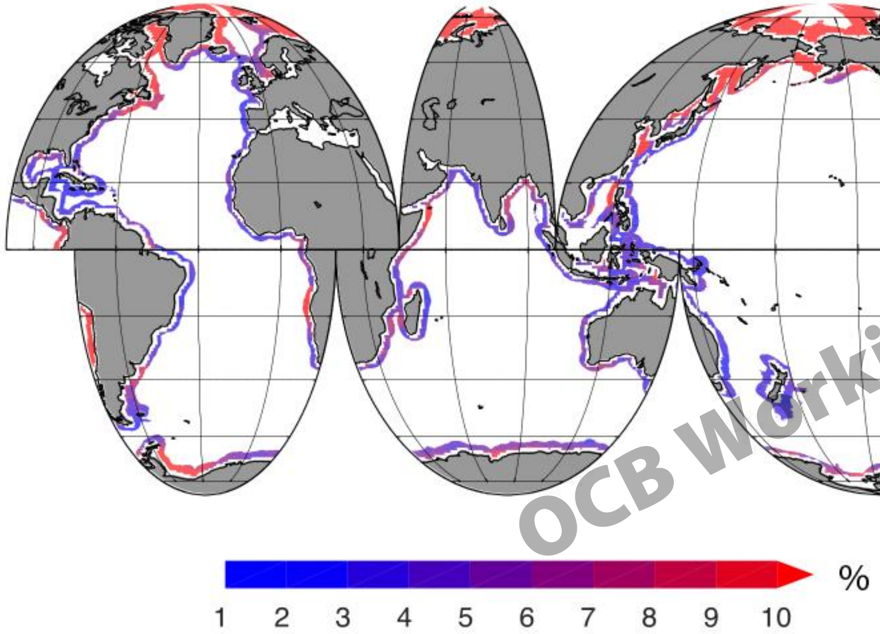

Figure 5. pCO_2 mismatch between NN_{coast} and NN_{open} in the overlap area relative to the mean CO_2 partial pressure of the merged product. Blue colors indicate a mismatch below 5%, whereas red colors indicate a mismatch of more than 5%.

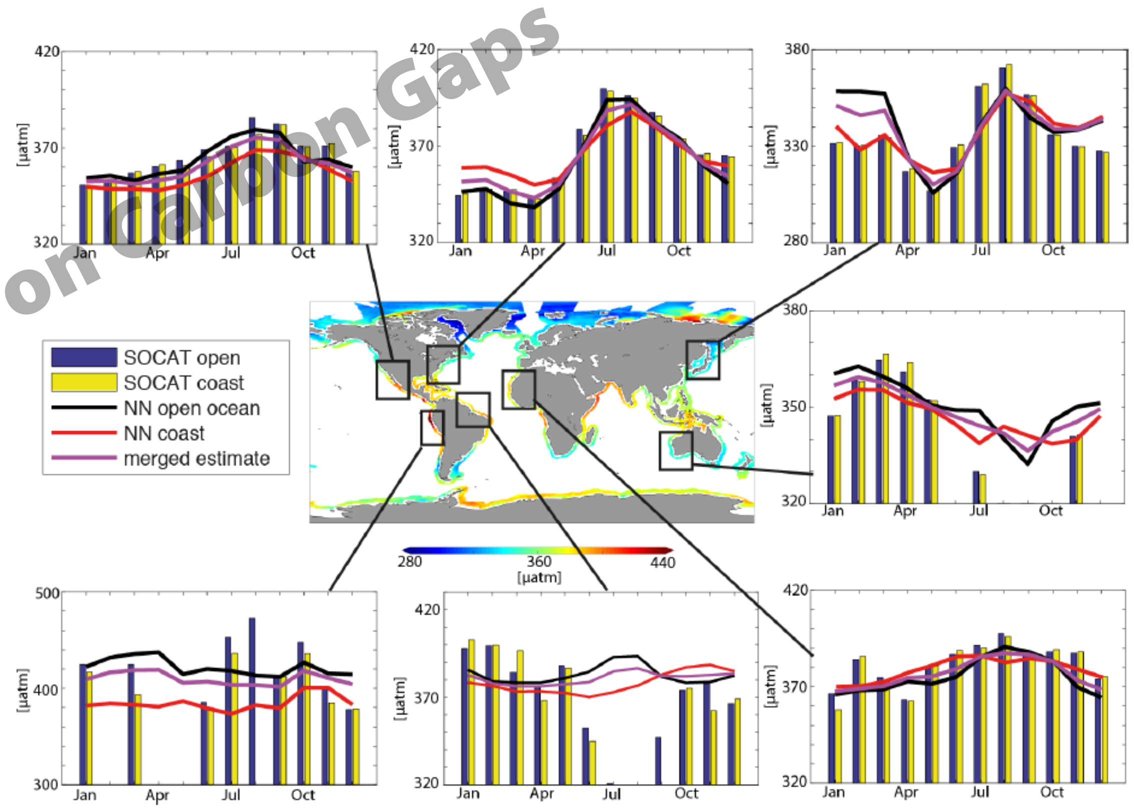

Figure 13. Seasonal pCO_2 cycle for the seven regions discussed in the text and highlighted in the center map. The seasonal cycles include a comparison of the monthly mean SOCAT observations without any interpolation (blue and yellow bars) as well as the open ocean (blue line), coastal ocean (red line) and merged (magenta line) reconstructions based on the respective SOCAT observations.

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Take home message

- The continuous increase in coastal observations in global pCO_2 databases allowed creating a coastal monthly pCO_2 climatology at 0.25 degree resolution over the 1998-2015 period (Laruelle et al., 2017)
- This climatology has been merged with an open ocean product (Landschützer et al., submitted to ESSD)
- Improvements still needed in some regions (high latitudes, data poor regions…)
- What about regions covered by sea-ice?

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