

Table S1. Comparison between the TCO₂ climatology of Lauvset et al. (2016) and the one of the present study at different depth levels.

Depth layer	RMSE (μmol kg ⁻¹)	Bias (μmol kg ⁻¹)	r ²
0	31.5	-8.3	0.85
100	15.9	0.9	0.95
250	10.5	1.3	0.97
500	7.6	1.0	0.99
1000	6.8	0.4	0.99
2000	4.8	-0.4	0.995
3000	5.3	-1.4	0.993
4000	5.4	-1.2	0.99

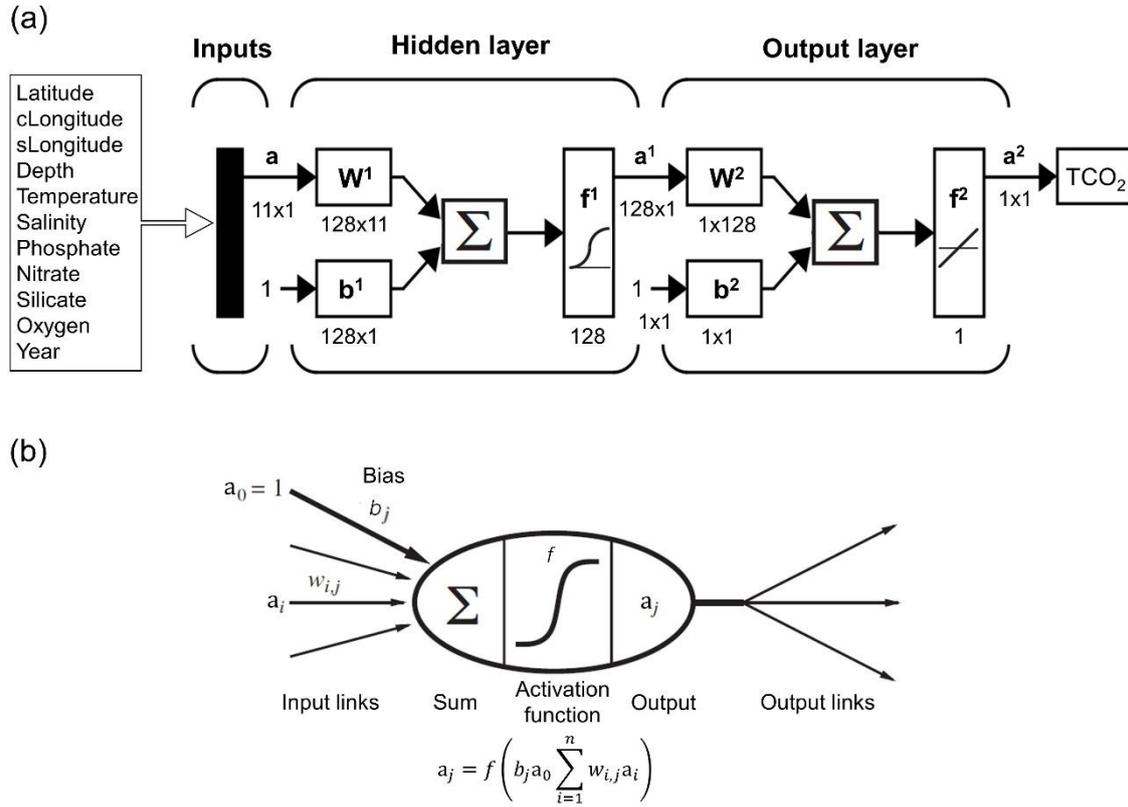


Figure S1. (a) Neural network configuration. The notation is in agreement with Hagan et al. (2014). \mathbf{a} : input vectors; \mathbf{W} : weight matrix; \mathbf{b} : bias matrix; Σ : sum; f : transfer function; \mathbf{a}^x : output matrix. The superscripts indicate the number of the layer. $cLongitude = \cos(\frac{\pi}{180^\circ} longitude)$; $sLongitude = \sin(\frac{\pi}{180^\circ} longitude)$. The dimensions of the matrices are for an individual sample. Modified from Hagan et al. (2014). (b) Neuron. a_i : inputs to each neuron; $w_{i,j}$: weights of each input to each neuron. Modified from Russell and Norvig et al. (2010).

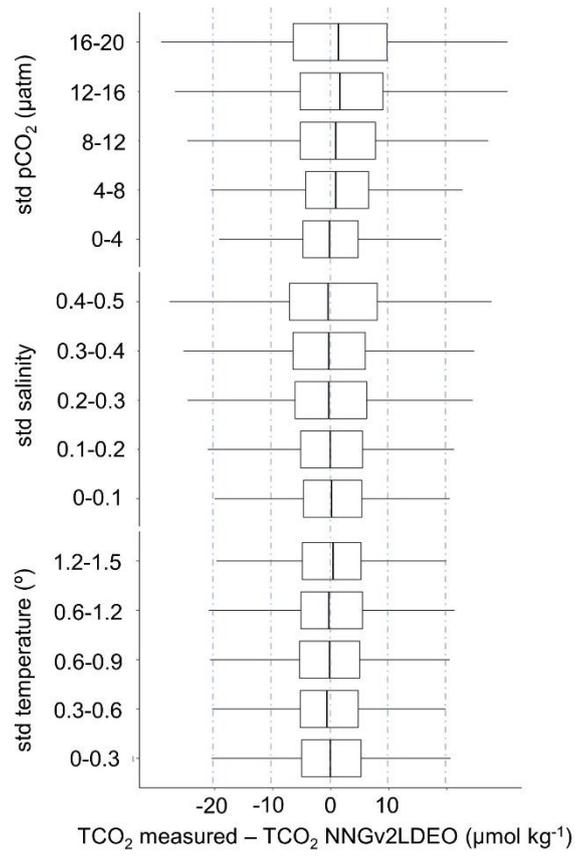


Figure S2. Box plots of differences between measured and computed TCO₂ in LDEO.

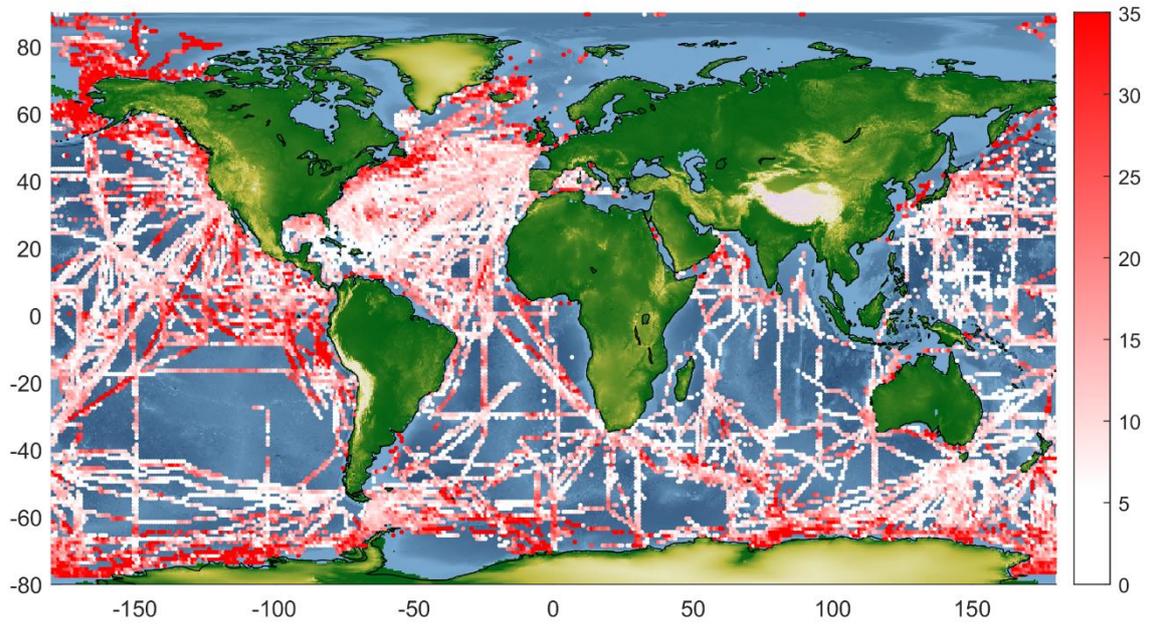


Figure S3. Differences between measured and computed pCO₂ with A_T from NNGv2 (Broullón et al., 2019) and TCO₂ from NNGv2LDEO in LDEO. Units are microatmospheres (μatm).

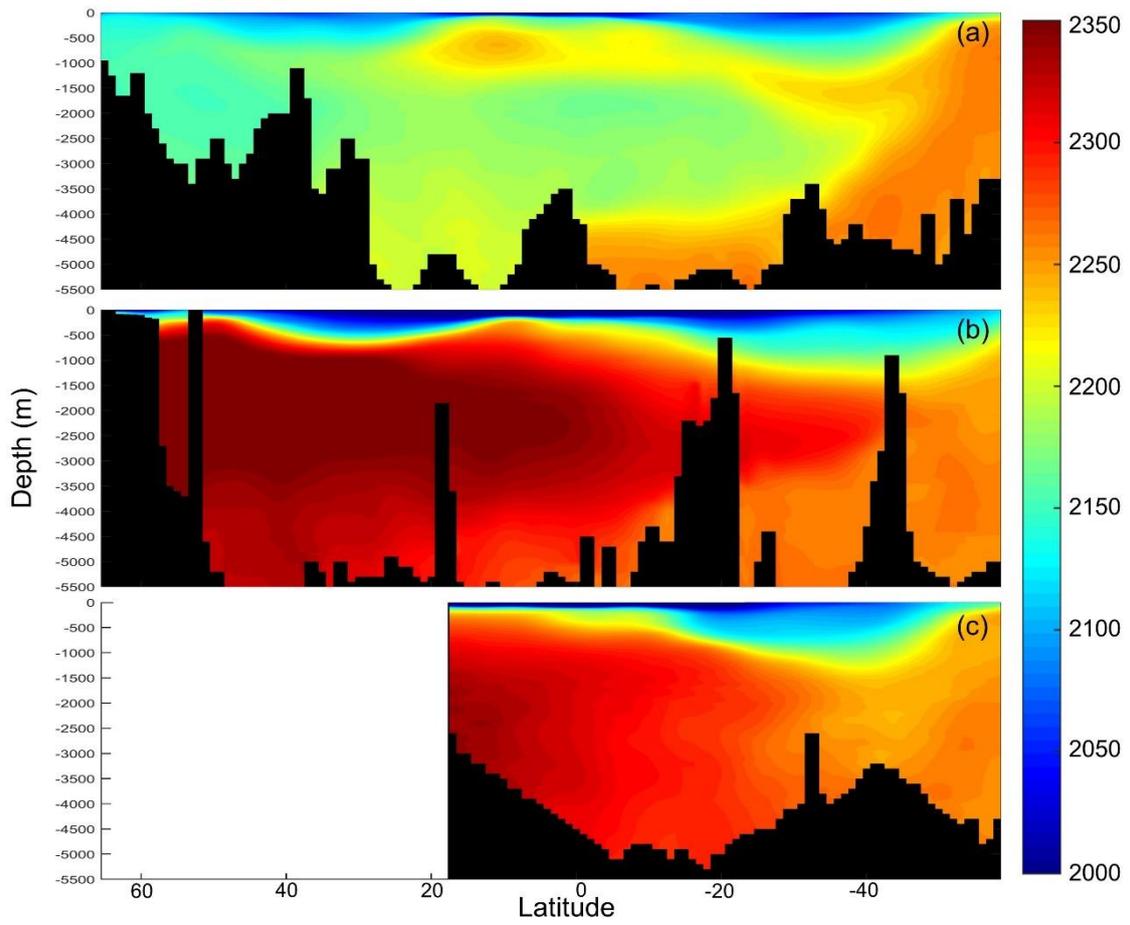


Figure S4. Sections of TCO₂ in (a) Atlantic (longitude: 28.5° W), (b) Pacific (longitude: 174.5° W) and (c) Indian (longitude: 84.5° E) oceans. Units are micromole per kilogram ($\mu\text{mol kg}^{-1}$).

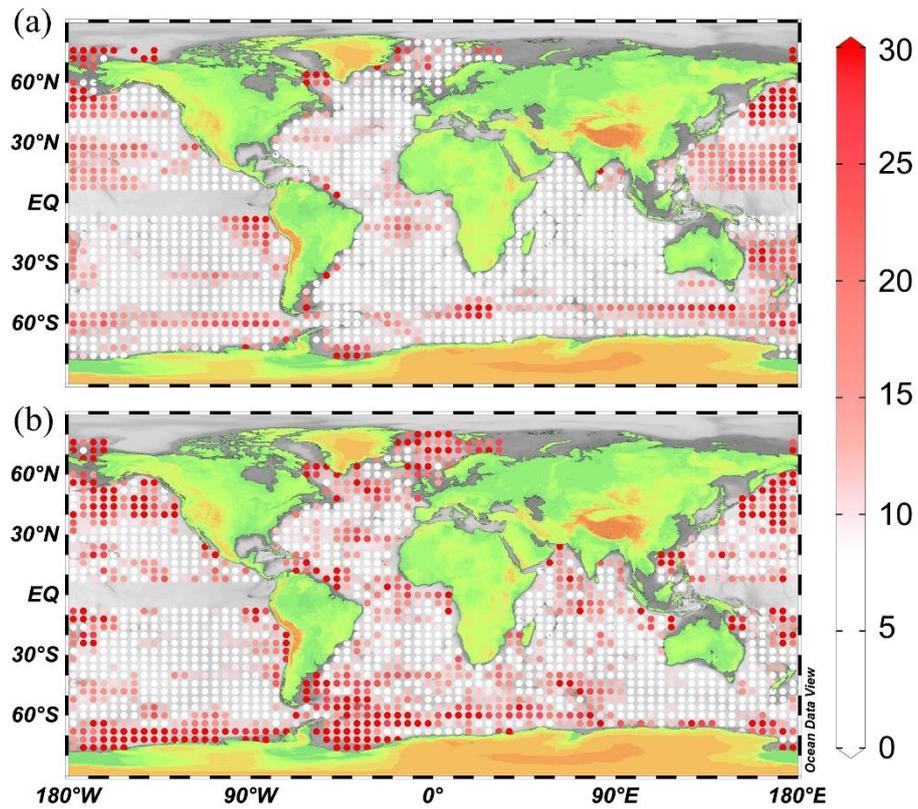


Figure S5. Absolute differences between the annual mean of the surface TCO₂ neural network climatology and (a) Takahashi et al. (2014) and (b) Lauvset et al. (2016) surface annual mean climatology. Units are micromole per kilogram ($\mu\text{mol kg}^{-1}$). The color bar was developed in order to show the highest differences beyond the errors of each method. This figure was made with Ocean Data View (Schlitzer, 2016).

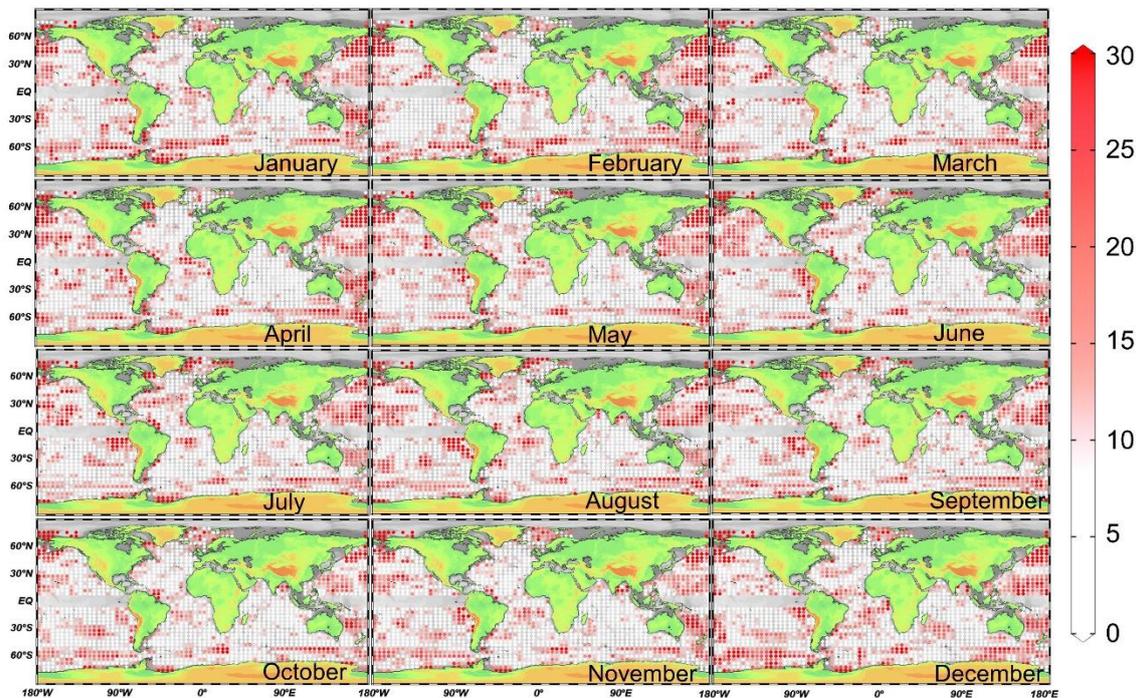


Figure S6. Absolute differences between the monthly climatology of TCO₂ of Takahashi et al. (2014) and the one of the present study. The color bar was developed in order to show the highest differences beyond the errors of each method. Units are micromole per kilogram ($\mu\text{mol kg}^{-1}$). This figure was made with Ocean Data View (Schlitzer, 2016).

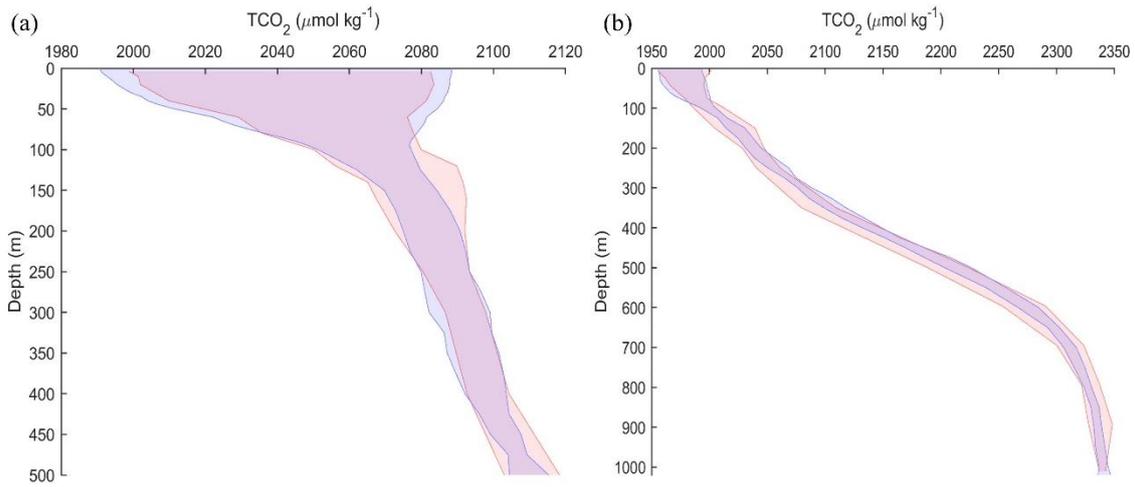


Figure S7. Profiles of the seasonal variability of the measured data (red lines and red shadow) and the TCO₂ climatology (blue lines and blue shadow) at (a) BATS and (b) HOT ALOHA locations. The variability of the measured data was computed subtracting the maximum and the minimum TCO₂ values of the measured climatological profiles depicted in Fig. 9. Note the different color of the overlapped area.

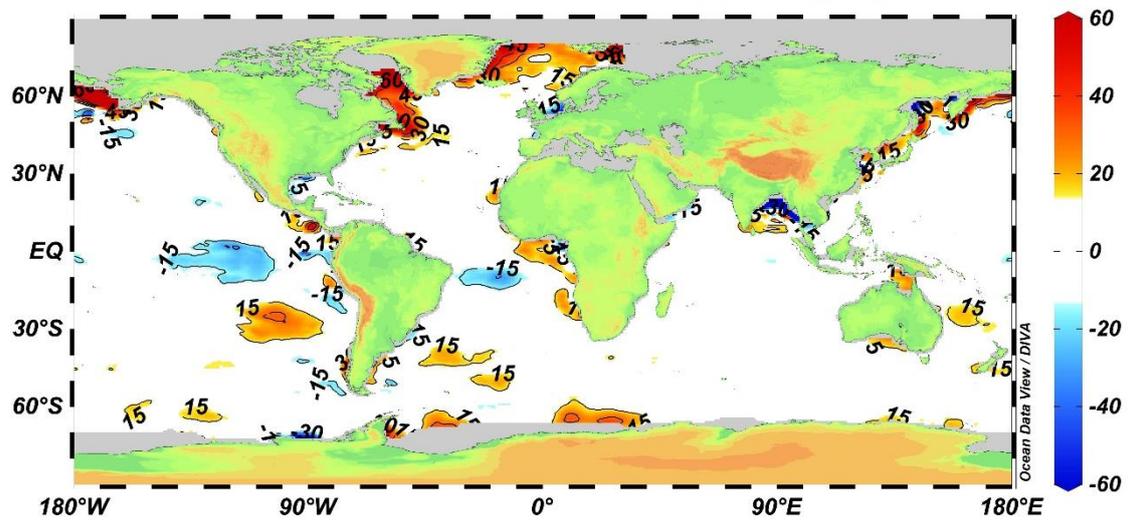


Figure S8. Differences between the annual mean climatology of pCO₂ from Landschützer et al. (2017) centered in 1995 and the one computed in the present study. Units are microatmospheres (μatm). The contour lines of 15, 30, 45 and 60 μatm are shown. This figure was made with Ocean Data View (Schlitzer, 2016).

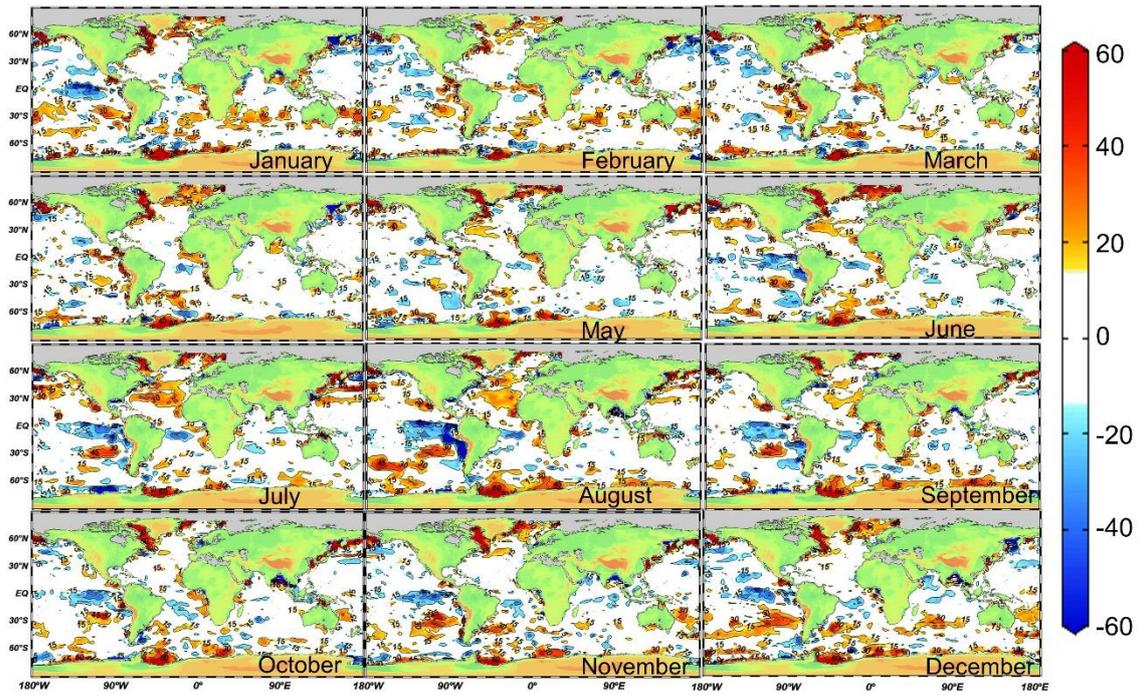


Figure S9. Differences between the monthly climatology of pCO₂ from Landschützer et al. (2017) centered in 1995 and the one computed in the present study. Units are microatmospheres (µatm). The contour lines of 15, 30, 45 and 60 µatm are shown. This figure was made with Ocean Data View (Schlitzer, 2016).

pCO₂ variability (µatm)

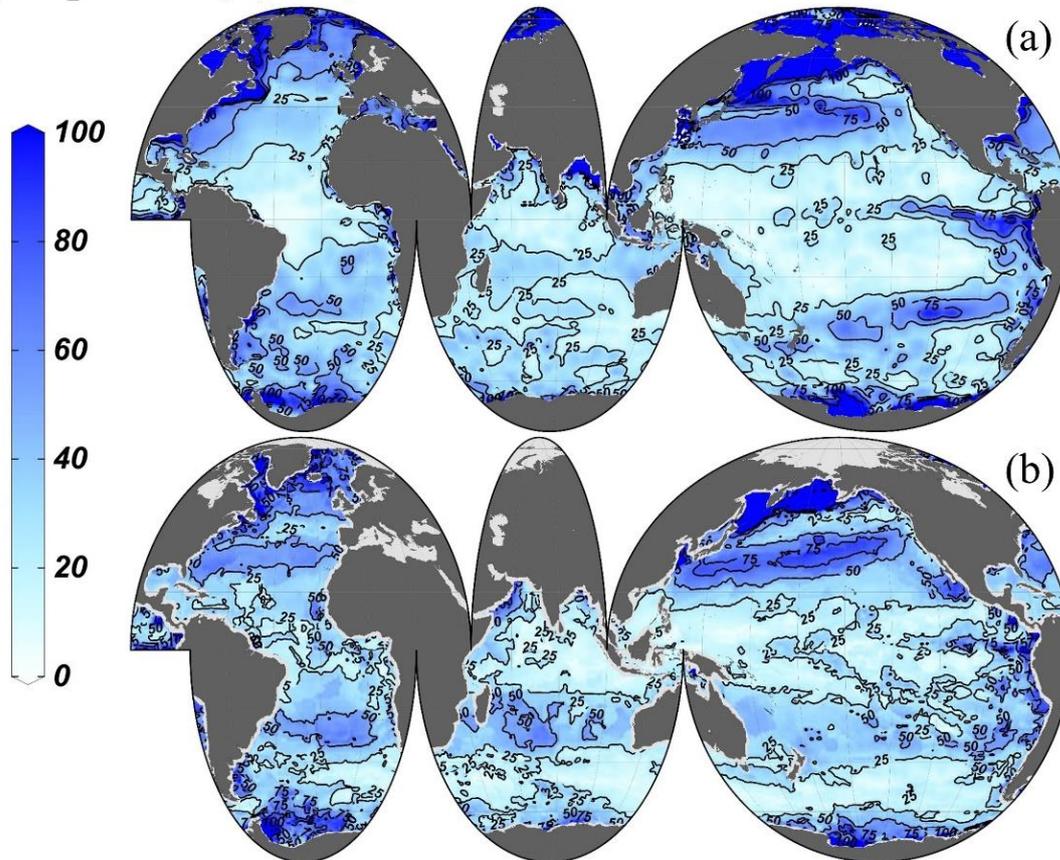


Figure S10. Seasonal amplitude of surface pCO₂ of (a) this study and (b) Landschützer et al. (2017) centered in the year 1995. The contour lines of 25, 50, 75 and 100 µatm are shown. This figure was made with Ocean Data View (Schlitzer, 2016).

References

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