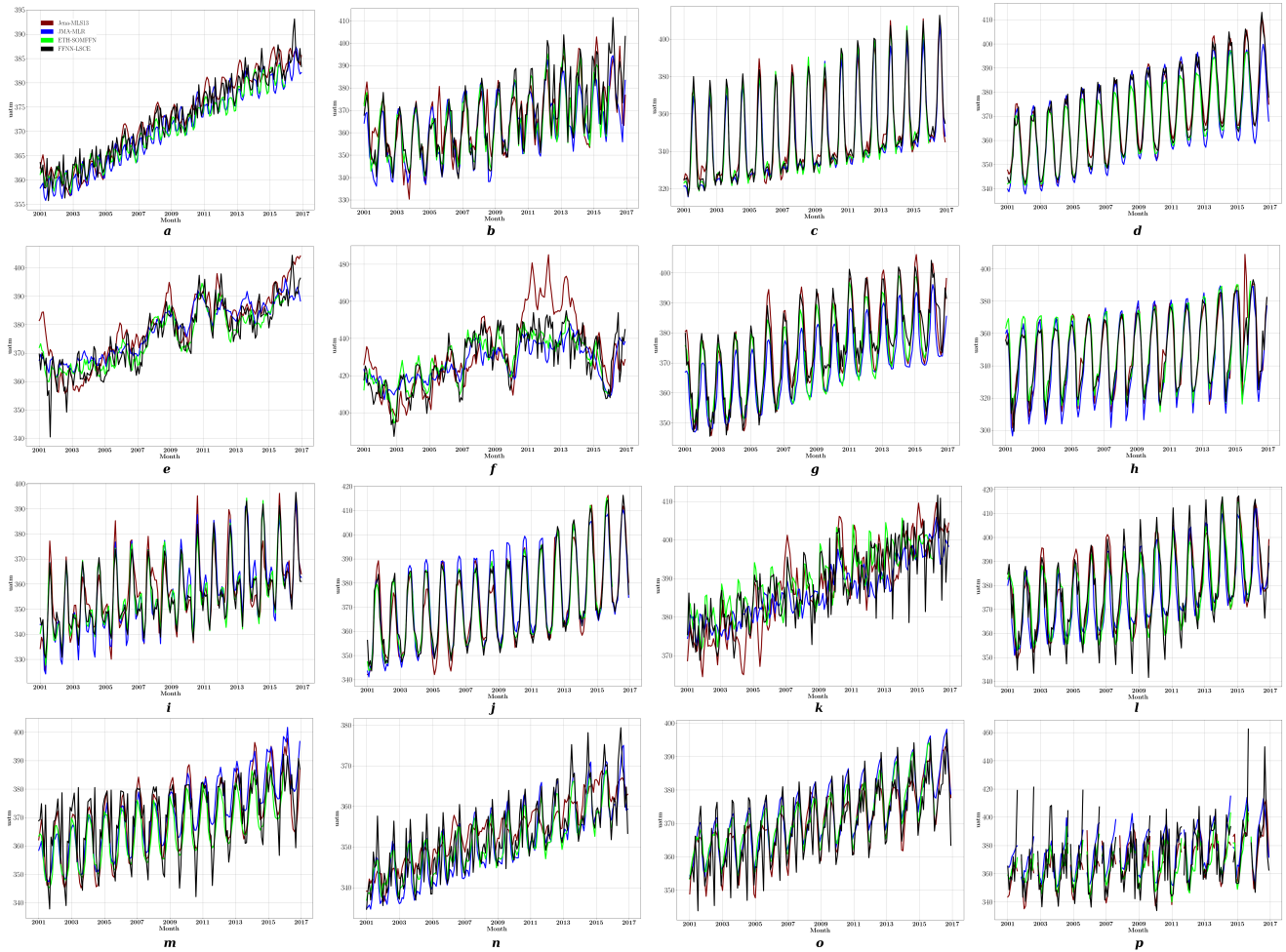**Figure S1: K-fold cross-validation data distribution with 50% of data for training (green), 25% of data for validation (red) and 25% of data for evaluation (blue) for each sampling. Validation and evaluation data are different each time**

Figure S2: Monthly time series of pCO₂ of FFNN-LSCE (black), JMA-MLR (blue), Jena-MLS13 (brown), ETH-SOMFFN (green) averaged over: (a) – globe; (b) – biome 2; (c) – biome 3; (d) – biome 4; (e) – biome 5; (f) – biome 6; (g) – biome 7; (h) – biome 9; (i) – biome 10; (j) – biome 11; (k) – biome 12; (l) – biome 13; (m) – biome 14; (n) – biome 15; (o) -biome 16; (p) - biome - 17
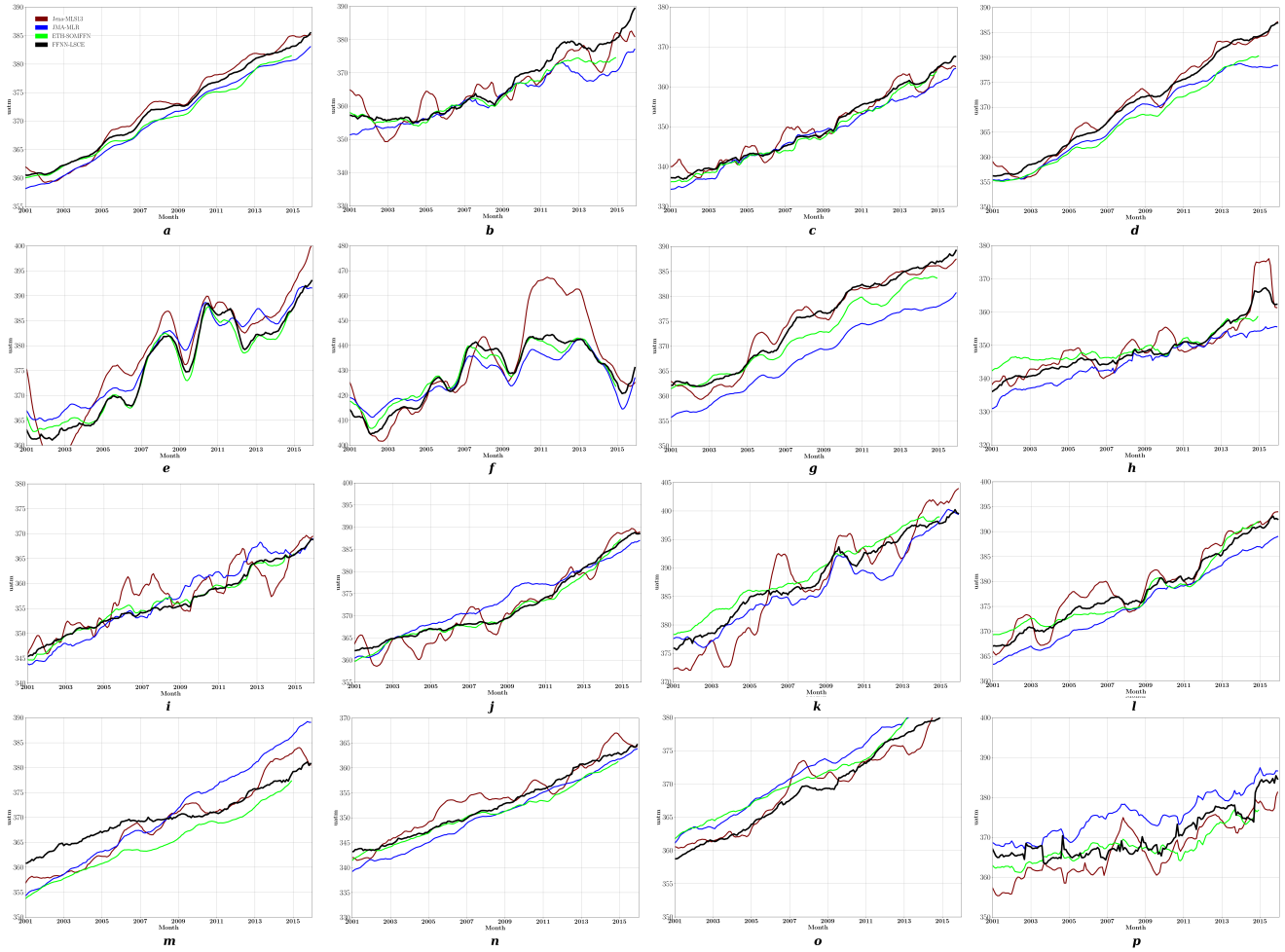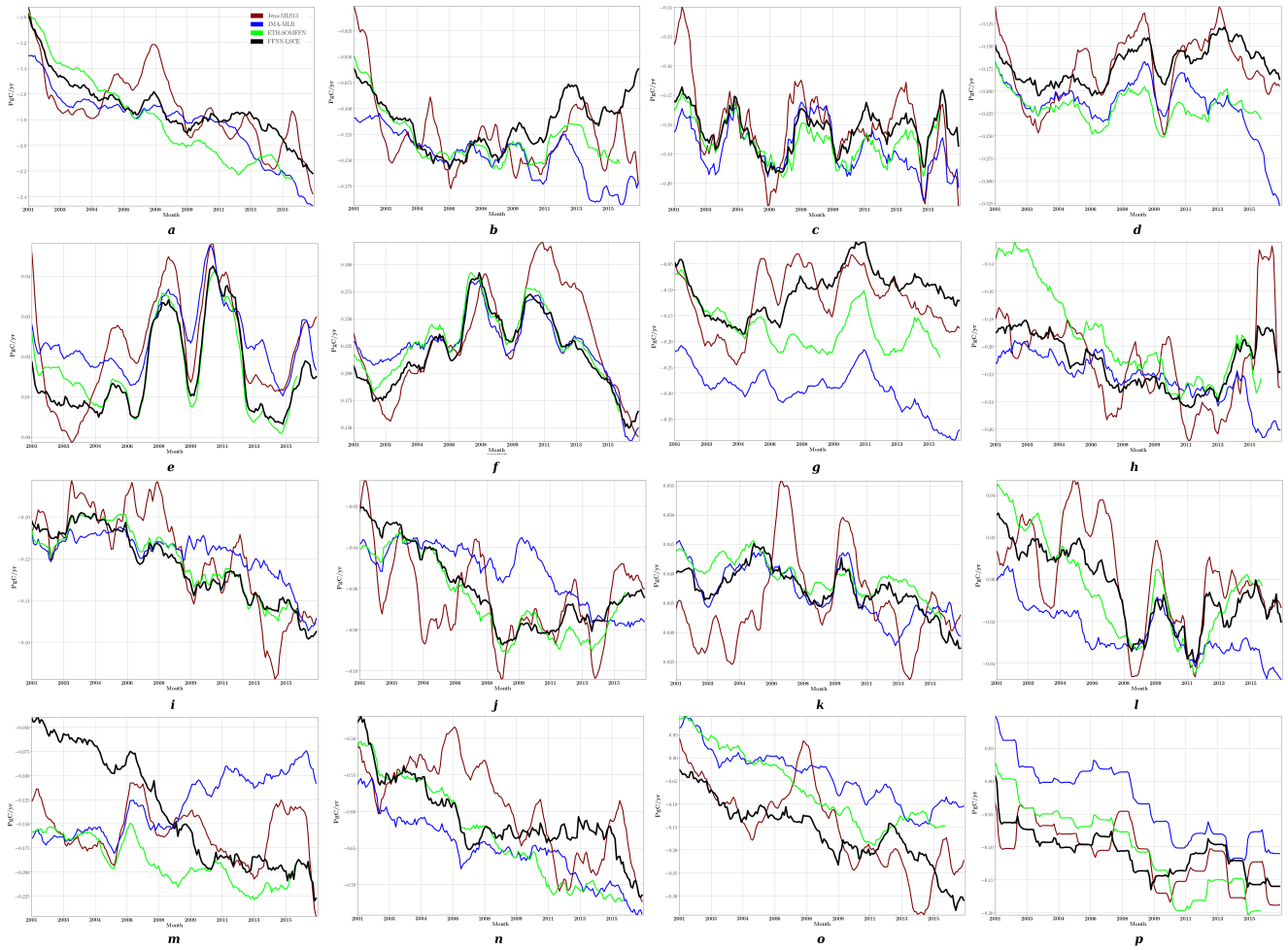
Figure S3: 12-month running mean of pCO₂ of FFNN-LSCE (black), JMA-MLR (blue), Jena-MLS13 (brown), ETH-SOMFFN (green) averaged over: (a) – globe; (b) – biome 2; (c) – biome 3; (d) – biome 4; (e) – biome 5; (f) – biome 6; (g) – biome 7; (h) – biome 9; (i) – biome 10; (j) – biome 11; (k) – biome 12; (l) – biome 13; (m) – biome 14; (n) – biome 15; (o) – biome 16; (p) – biome - 17
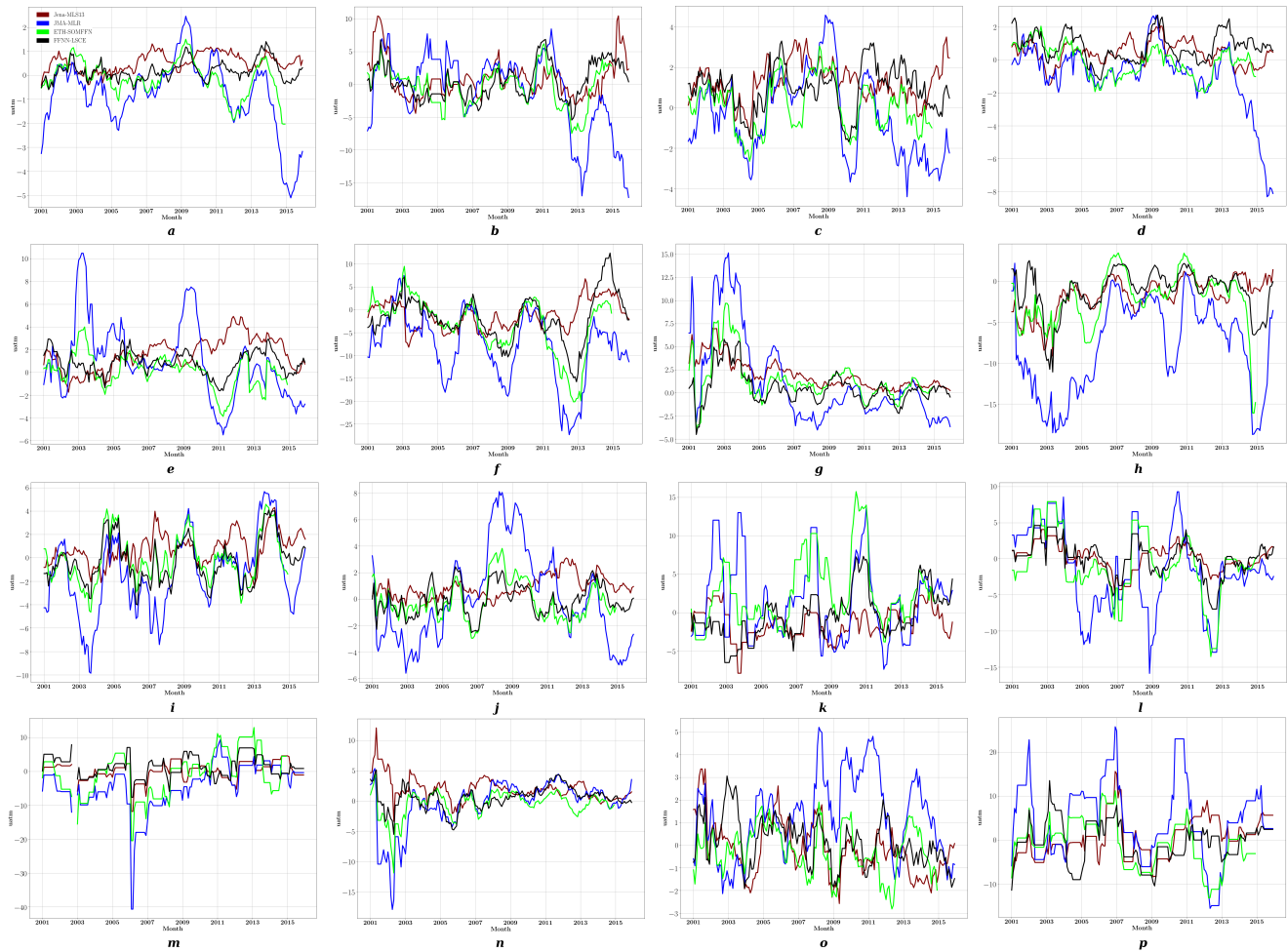
Figure S4: Yearly pCO₂ mismatch (difference of mapping methods and SOCAT data) of FFNN-LSCE (black), JMA-MLR (blue), Jena-MLS13 (brown), ETH-SOMFFN (green) averaged over: (a) – globe; (b) – biome 2; (c) – biome 3; (d) – biome 4; (e) – biome 5; (f) – biome 6; (g) – biome 7; (h) – biome 9; (i) – biome 10; (j) – biome 11; (k) – biome 12; (l) – biome 13; (m) – biome 14; (n) – biome 15; (o) – biome 16; (p) – biome - 17
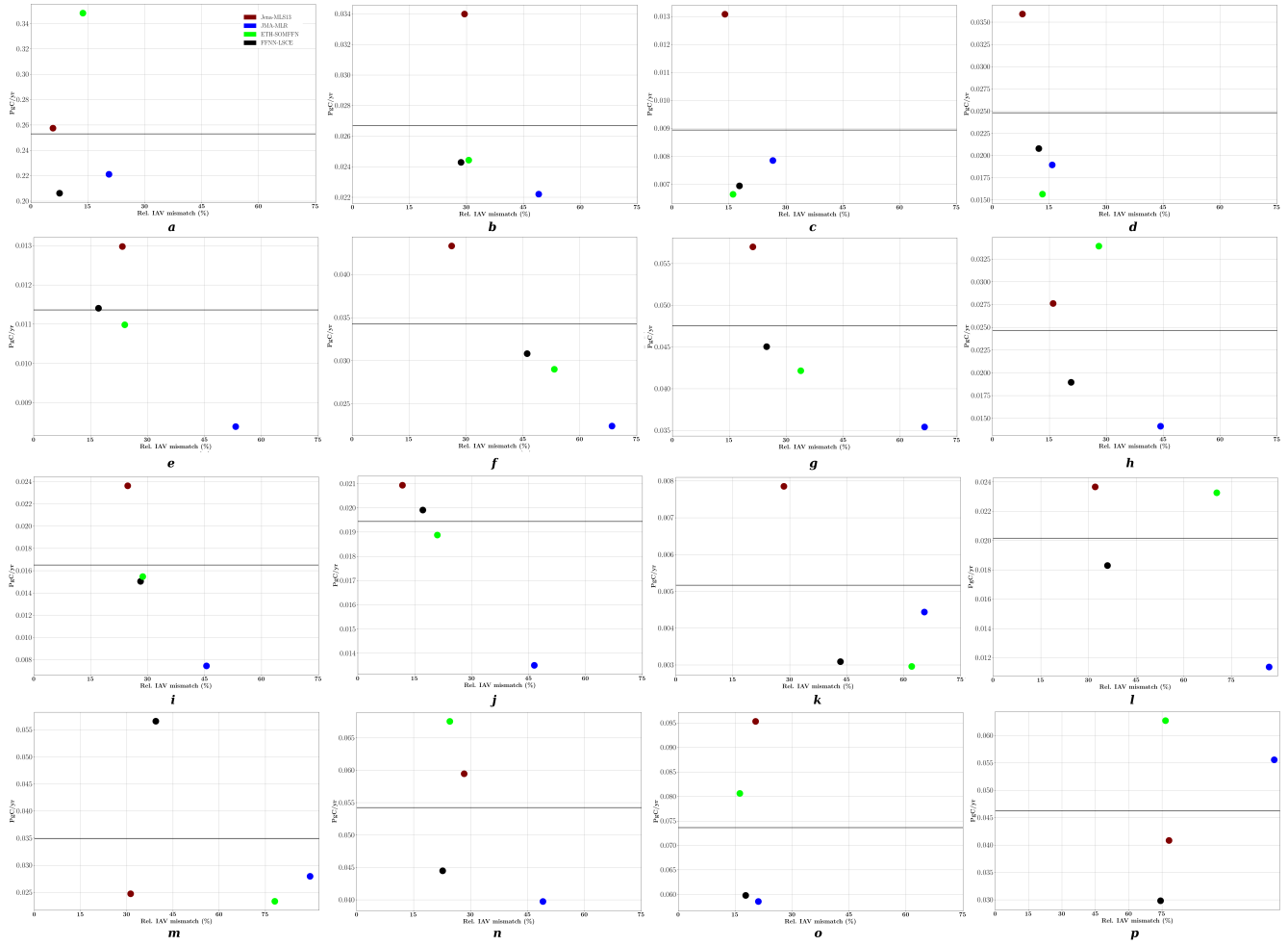
Figure S5: Interannual sea-air CO2 flux (12-month running mean) from FFNN-LSCE (black), JMA-MLR (blue), Jena-MLS13 (brown), ETH-SOMFFN (green) averaged over: (a) – globe; (b) – biome 2; (c) – biome 3; (d) – biome 4; (e) – biome 5; (f) – biome 6; (g) – biome 7; (h) – biome 9; (i) – biome 10; (j) – biome 11; (k) – biome 12; (l) – biome 13; (m) – biome 14; (n) – biome 15; (o) – biome 16; (p) – biome - 17

Figure S6: Amplitude of interannual CO$_2$ flux plotted against the relative IAV mismatch amplitude for FFNN-LSCE (black), JMA-MLR (blue), Jena-MLS13 (brown), ETH-SOMFFN (green) averaged over: (a) – globe; (b) – biome 2; (c) – biome 3; (d) – biome 4; (e) – biome 5; (f) – biome 6; (g) – biome 7; (h) – biome 9; (i) – biome 10; (j) – biome 11; (k) – biome 12; (l) – biome 13; (m) – biome 14; (n) – biome 15; (o) – biome 16; (p) – biome – 17. The weighted mean is given as a horizontal lin*e*
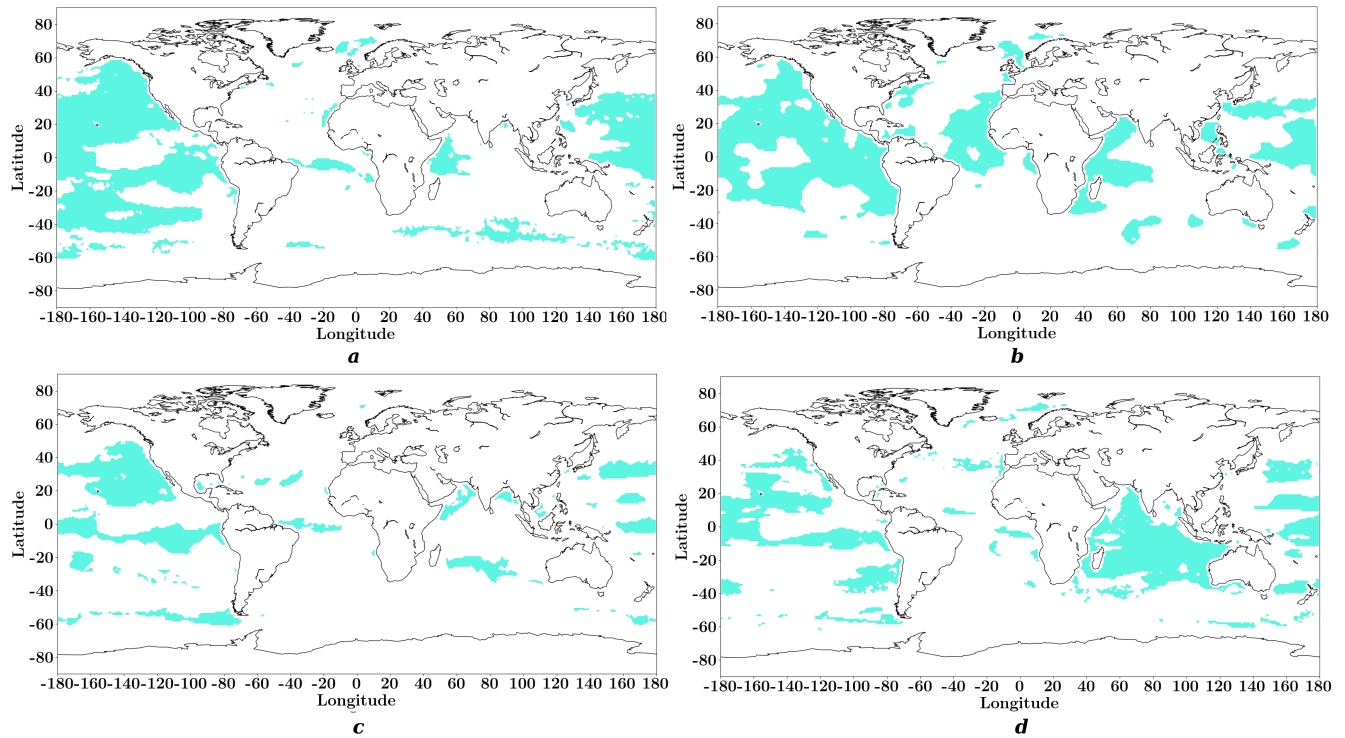
Figure S7: According between sea-air CO$_2$ flux and atmospheric pCO$_2$ trends. Blue color indicates the regions where two characteristics have the same sign of linear trend. Atmospheric pCO$_2$ from Jena inversion and: (a) - FFNN-LSCE; (b) - Jena-NLS13; (c) - ETH-SOMFFN; (d) - JMA-MLR

Table S1: Mean of sea-air CO$_2$ flux (PgC/yr) over the Global Ocean and per biomes (Rödenbeck et al., 2015) for common period 2001-2015.

Biome	FFNN-LSCE	ETH-SOMFFN	Jena-MLS13	JMA-MLR
Globe	-1.55	-1.67	-1.55	-1.74
2	-0.11	-0.12	-0.12	-0.14
3	-0.18	-0.18	-0.18	-0.18
4	-0.17	-0.21	-0.17	-0.21
5	0.016	0.017	0.023	0.024
6	0.22	0.22	0.23	0.23
7	-0.1	-0.17	-0.11	-0.28
9	-0.18	-0.16	-0.17	-0.18
10	-0.12	-0.12	-0.11	-0.11
11	-0.06	-0.06	-0.06	-0.05
12	0.03	0.04	0.03	0.03
13	-0.004	-0.004	0.0016	-0.024
14	-0.13	-0.18	-0.15	-0.13
15	-0.6	-0.63	-0.58	-0.65
16	-0.14	-0.05	-0.13	-0.04
17	-0.025	-0.024	-0.029	-0.0006