Supplementary Material: A Growing Oceanic Carbon Uptake ...

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1 Timeseries

Verification of the individual cells in the MCMC inversion of LDEO2010 is a lengthy process. In this section, we show maps of the root mean squared error and some example posterior pCO_2 timeseries (green) and the LDEO2010 values (red) for major ocean regions. We focus our attention on the Southern Ocean south of 45S (c.f. fig. 1), the Southern Ocean between 45S and 30S (c.f. fig. 2), the Indian Ocean (c.f. fig. 3), the Equatorial Pacific (c.f. fig. 4), the North Pacific (c.f. fig. 5), the Subpolar North Atlantic (c.f. fig. 6) and the Subtropical North Atlantic (c.f. fig. 7).

2 Regional Trends and Fluxes

Here we list regionally compiled results from the MCMC inversion of LDEO2010. We use the regional maps from CARBONTRACKER (c.f. main text for reference) to divide the ocean surface. The regions are shown in figure 8. Table 1 shows the regionally-averaged slope estimates for the MCMC results and the prior distribution. The error estimate in the slope measurement is reported in two ways. The first is by calculating the root sum of squares of the error of the cells in the region as traditional uncertainty analysis requires. This is reported as the $\pm\sigma$ bands in the slope estimates. We also show the standard error of the slope estimates over the region, which is the root sum of squares of the difference between each grid cell's estimate for A and the regional mean. This is meant to show the level of coherence in the estimate across each region.

Table 2 shows the regional breakdown of the flux estimates. There we show the 10-yr averaged flux about the year 2000 into the different ocean regions, in Pg C yr^{-1}, for the MCMC-derived pCO_2 fields. We also show the change in the flux into each region over the 30 year time period, 1980-2009, in the column $MCMC\Delta$, to give an indication of the importance of the time-varying nature of the pCO_2 history. For comparison, we also include the climatological fluxes from Takahashi et al. (2009, see main text).

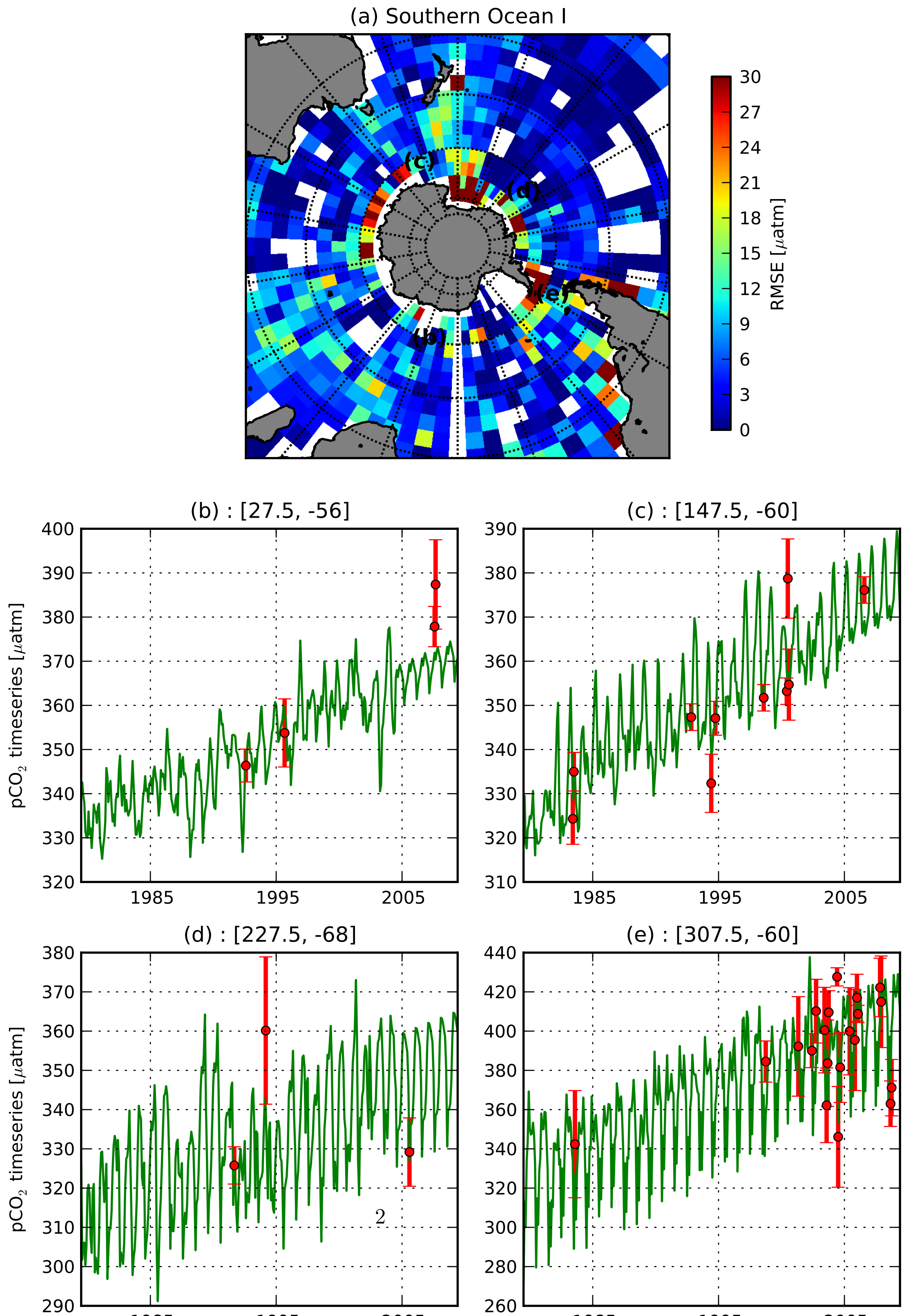

Figure 1: Southern Ocean Results, < 45S: RMSE in region and 4 example timeseries

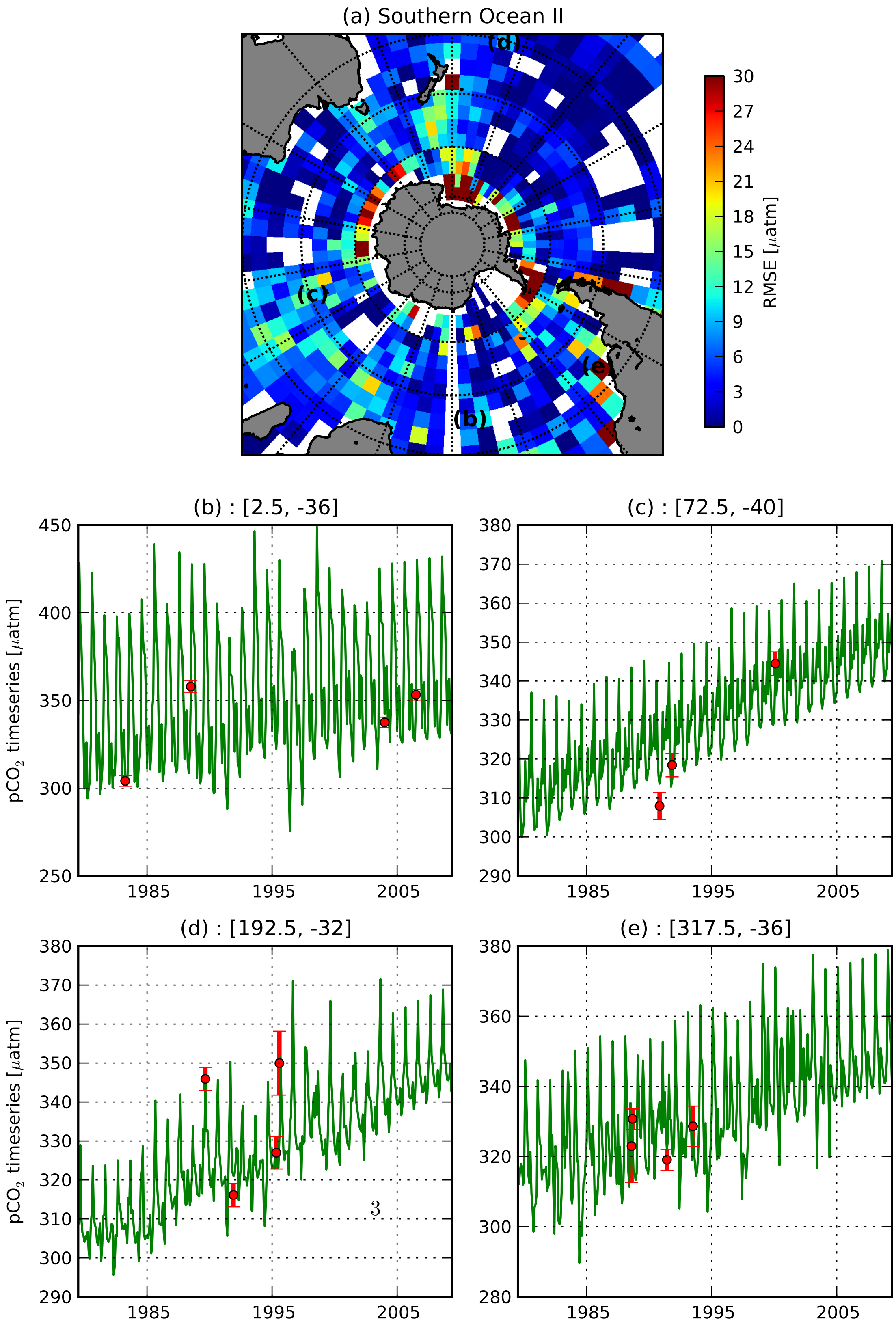

Figure 2: Southern Ocean Results, <30S, >45S: RMSE in region and 4 example timeseries

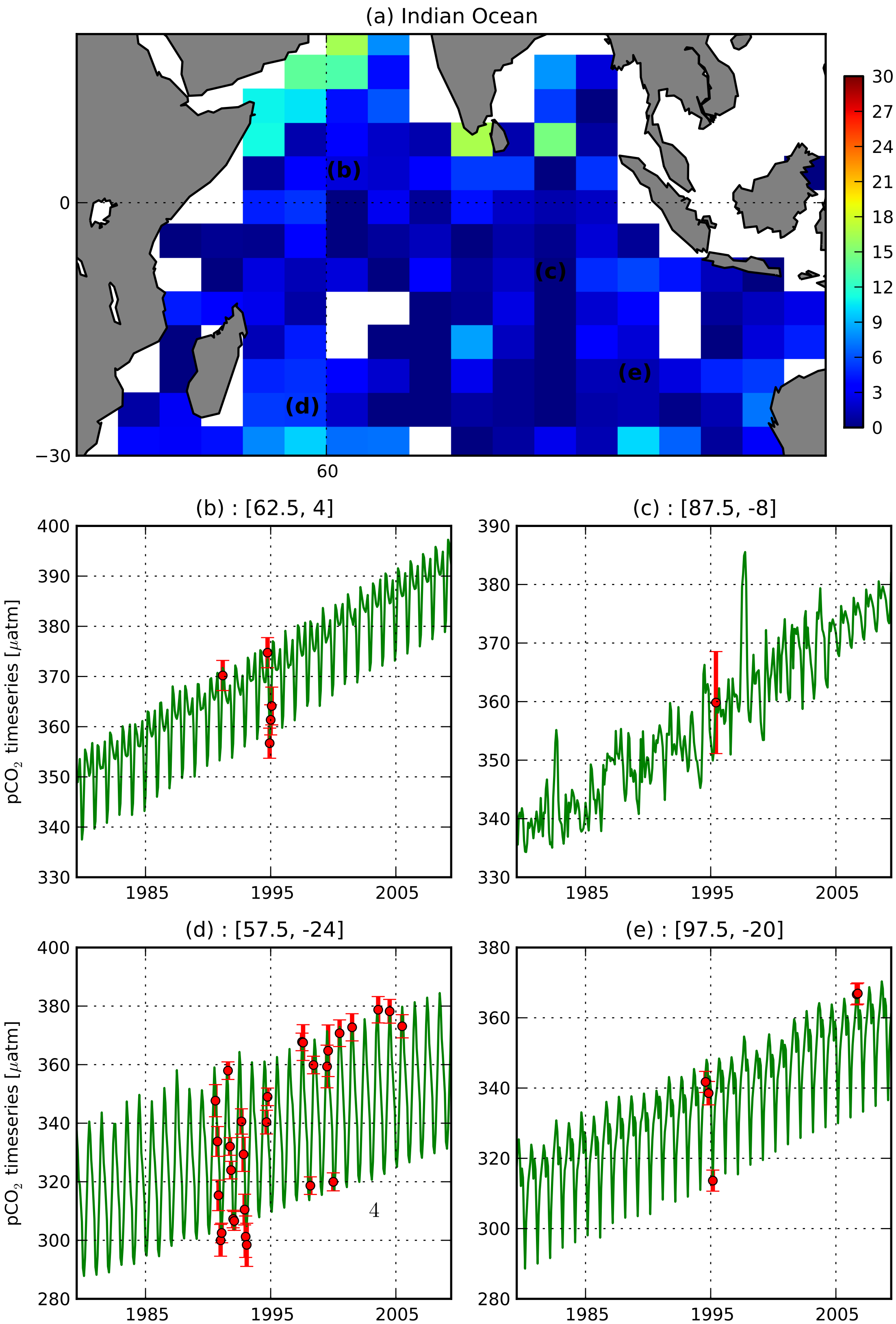

Figure 3: Indian Ocean Results: RMSE in region and 4 example timeseries

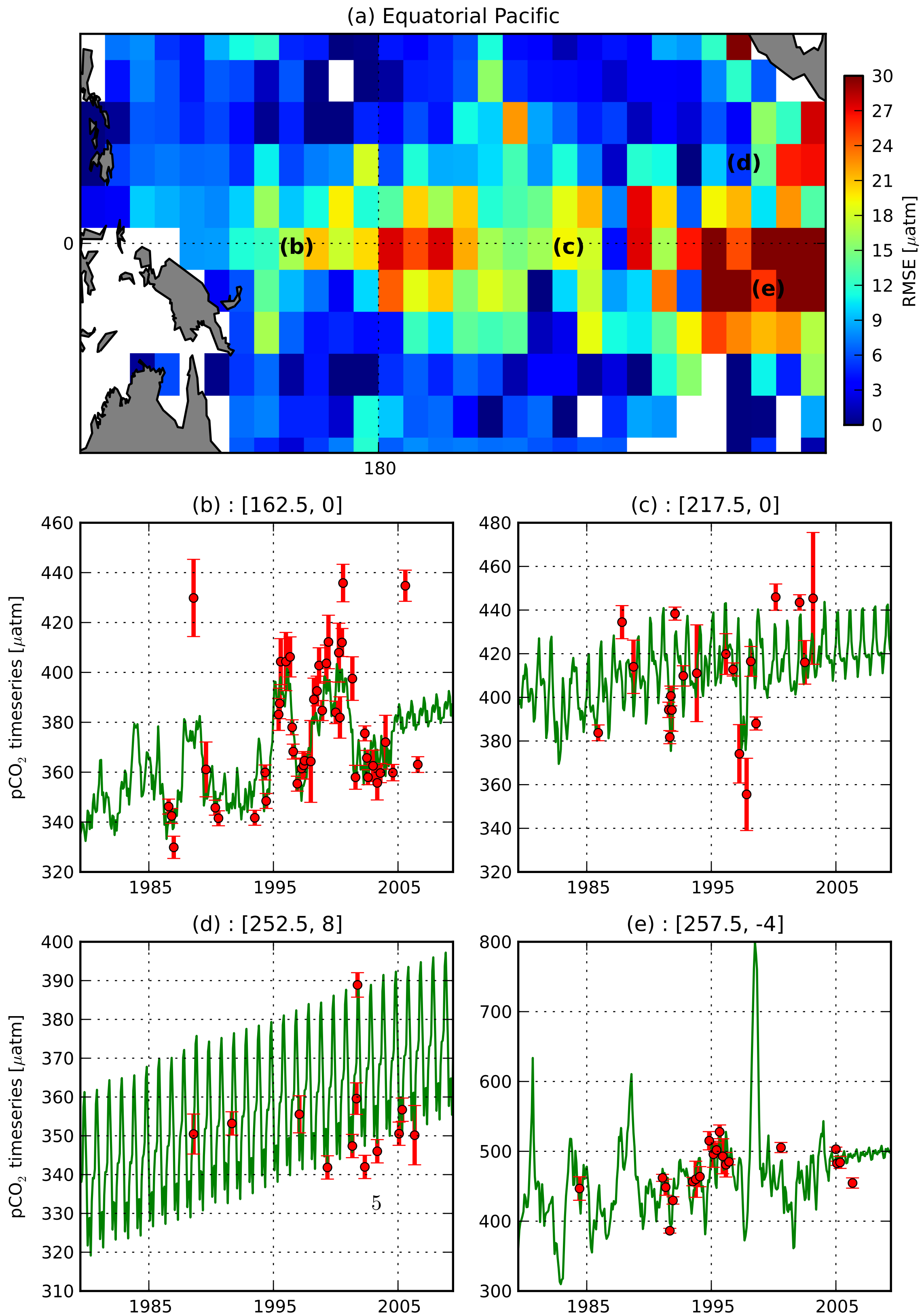

Figure 4: Equatorial Pacific Results: RMSE in region and 4 example timeseries

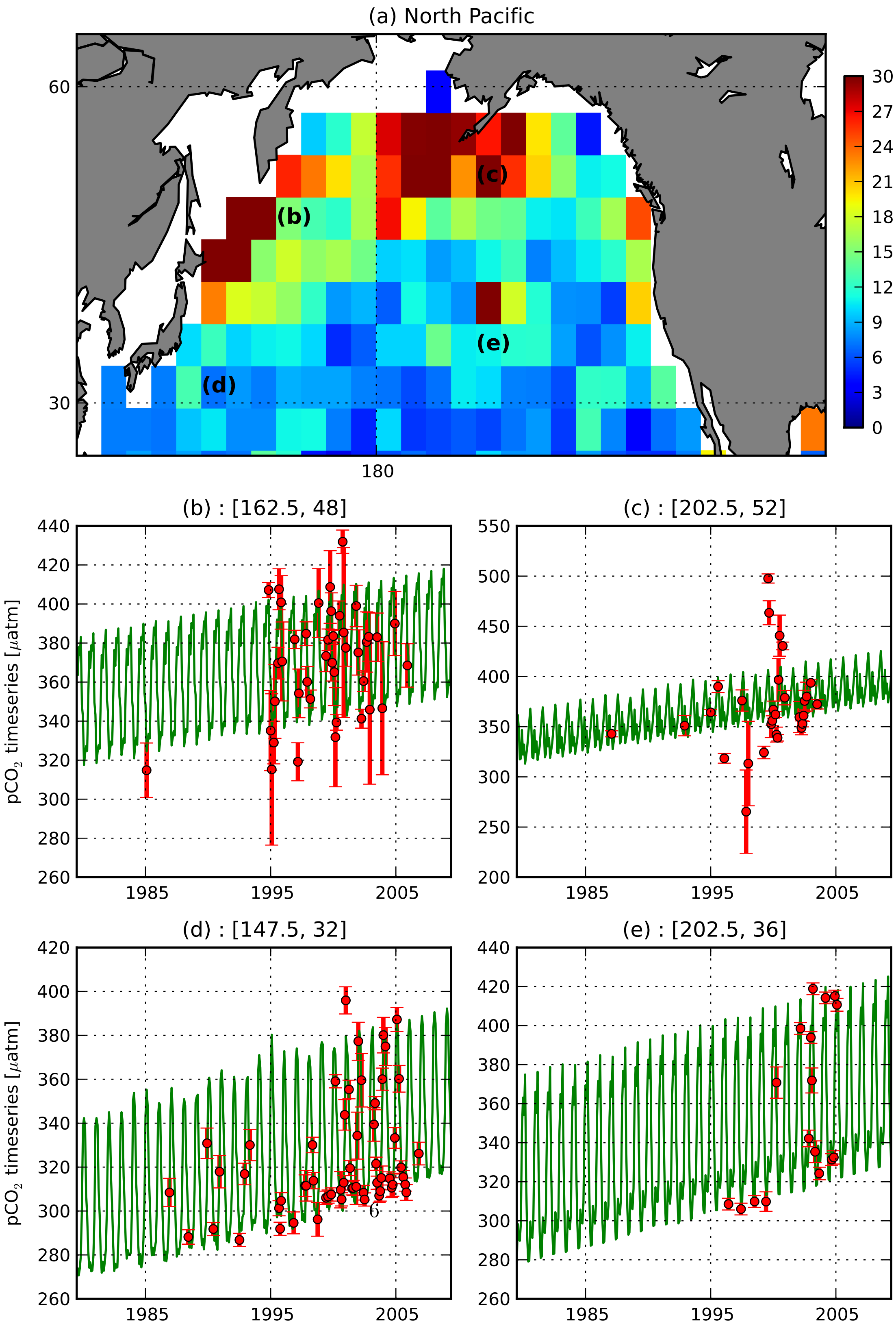

Figure 5: North Pacific Results: RMSE in region and 4 example timeseries

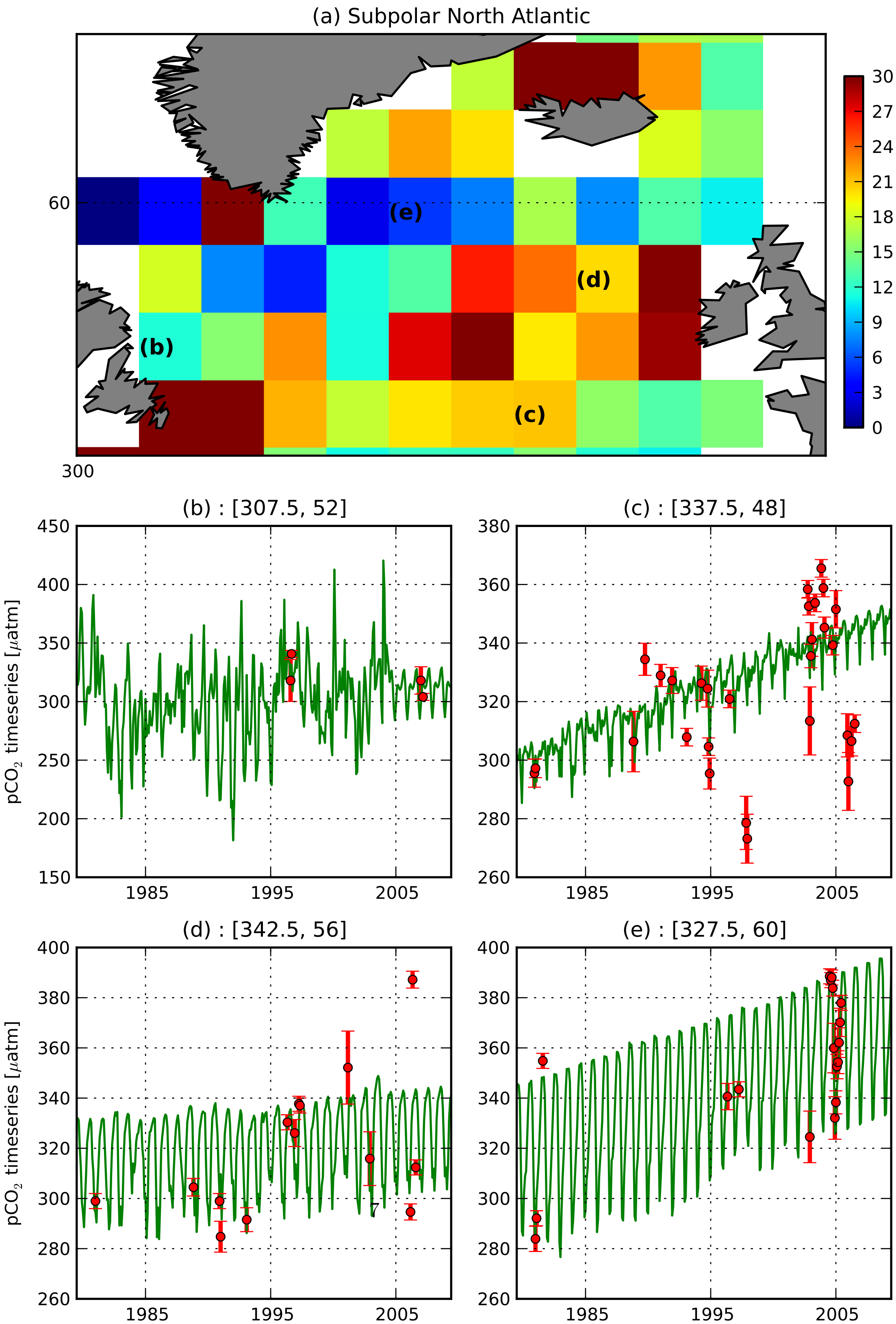

Figure 6: Subpolar North Atlantic Results: RMSE in region and 4 example timeseries

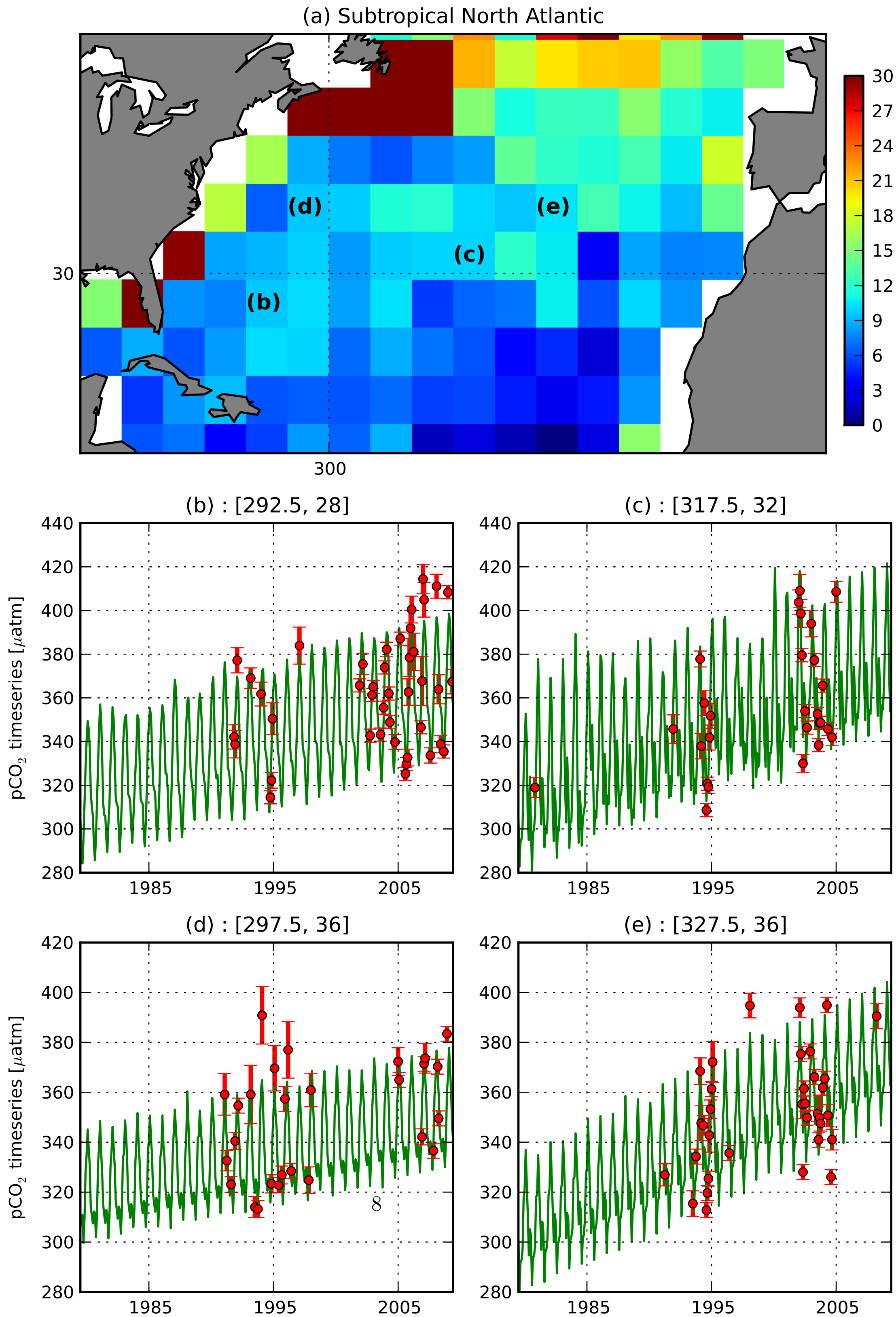

Figure 7: Subtropical North Atlantic Results: RMSE in region and 4 example timeseries

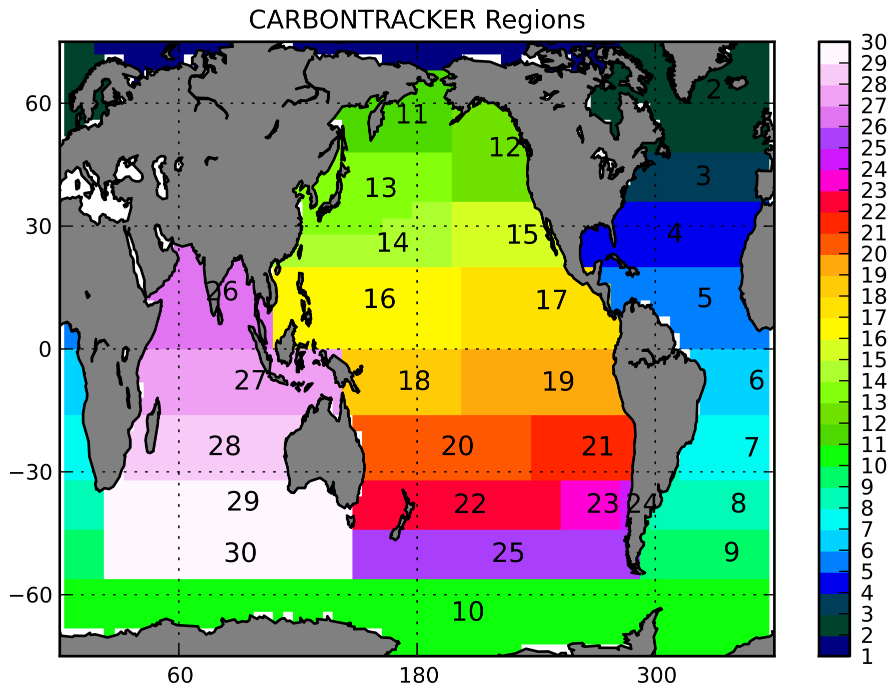

Figure 8: The CARBONTRACKER regions used for dividing the ocean are mapped and labeled in this figure.

Tables 3 and 4 show the differences in the regional results of the MCMC sensitivity inversion cases.

Table 1: pCO_2 Slope Estimates

Region	Area (%)	MCMC A	MCMC SE	Prior A	Prior SE
1.0	1.4	1.52 ± 1.06	0.0	1.54 ± 1.08	0.0
2.0	2.7	1.24 ± 0.54	0.1	1.32 ± 0.68	0.0
3.0	2.1	1.31 ± 0.45	0.2	1.37 ± 0.85	0.1
4.0	3.9	1.58 ± 0.38	0.1	1.52 ± 0.66	0.1
5.0	3.8	1.40 ± 0.42	0.1	1.46 ± 0.46	0.0
6.0	2.8	1.44 ± 0.67	0.1	1.38 ± 0.71	0.0
7.0	3.2	1.53 ± 0.59	0.1	1.41 ± 0.63	0.1
8.0	2.8	1.33 ± 0.45	0.1	1.36 ± 0.53	0.0
9.0	2.5	1.45 ± 0.43	0.0	1.44 ± 0.46	0.0
10.0	7.4	1.29 ± 0.63	0.0	1.22 ± 0.67	0.0
11.0	1.3	1.33 ± 0.52	0.1	1.43 ± 0.56	0.0
12.0	2.4	1.58 ± 0.39	0.1	1.63 ± 0.50	0.0
13.0	2.8	1.42 ± 0.39	0.1	1.48 ± 0.53	0.0
14.0	2.9	1.48 ± 0.39	0.1	1.60 ± 0.50	0.0
15.0	2.9	1.40 ± 0.43	0.1	1.52 ± 0.85	0.1
16.0	6.2	1.35 ± 0.45	0.1	1.53 ± 0.63	0.0
17.0	5.5	1.59 ± 0.58	0.1	1.29 ± 0.84	0.0
18.0	3.2	1.37 ± 0.46	0.1	1.40 ± 0.61	0.0
19.0	4.8	1.58 ± 0.72	0.1	1.47 ± 0.86	0.1
20.0	4.4	1.38 ± 0.44	0.1	1.44 ± 0.46	0.0
21.0	3.0	1.43 ± 0.60	0.1	1.57 ± 0.66	0.1
22.0	3.4	1.44 ± 0.45	0.0	1.42 ± 0.47	0.0
23.0	1.0	1.55 ± 0.42	0.1	1.56 ± 0.42	0.1
24.0	0.2	1.47 ± 0.45	0.1	1.57 ± 0.46	0.1
25.0	4.0	1.51 ± 0.39	0.0	1.51 ± 0.42	0.0
26.0	3.5	1.39 ± 0.63	0.1	1.35 ± 0.64	0.0
27.0	4.5	1.45 ± 0.54	0.0	1.39 ± 0.56	0.0
28.0	4.3	1.49 ± 0.45	0.1	1.44 ± 0.49	0.0
29.0	4.0	1.45 ± 0.47	0.0	1.43 ± 0.50	0.0
30.0	3.5	1.52 ± 0.40	0.0	1.45 ± 0.41	0.0
World	100.0	1.44 ± 0.56	0.0	1.43 ± 0.66	0.0

Table 2: Regional Flux Estimates

Region	Area (%)	MCMC Flux [PgC]	MCMC Δ [PgCyr^{-1}]	Clim. Flux [PgC]
1.0	1.4	0.15 $\pm$ 0.03	0.0	0.06 $\pm$ 0.01
2.0	2.7	0.32 $\pm$ 0.06	0.1	0.27 $\pm$ 0.05
3.0	2.1	0.16 $\pm$ 0.03	0.1	0.13 $\pm$ 0.03
4.0	3.9	0.03 $\pm$ 0.01	-0.0	0.04 $\pm$ 0.01
5.0	3.8	-0.04 $\pm$ 0.01	0.0	-0.04 $\pm$ -0.01
6.0	2.8	-0.10 $\pm$ 0.02	0.0	-0.08 $\pm$ -0.02
7.0	3.2	-0.02 $\pm$ 0.00	0.0	-0.01 $\pm$ -0.00
8.0	2.8	0.21 $\pm$ 0.04	0.1	0.17 $\pm$ 0.03
9.0	2.5	0.11 $\pm$ 0.02	0.1	0.08 $\pm$ 0.02
10.0	7.4	0.06 $\pm$ 0.01	0.2	-0.05 $\pm$ -0.01
11.0	1.3	-0.03 $\pm$ 0.01	0.0	-0.00 $\pm$ -0.00
12.0	2.4	0.13 $\pm$ 0.03	0.0	0.14 $\pm$ 0.03
13.0	2.8	0.23 $\pm$ 0.05	0.1	0.24 $\pm$ 0.05
14.0	2.9	0.08 $\pm$ 0.02	0.0	0.09 $\pm$ 0.02
15.0	2.9	0.05 $\pm$ 0.01	0.0	0.04 $\pm$ 0.01
16.0	6.2	-0.05 $\pm$ 0.01	0.0	-0.03 $\pm$ -0.01
17.0	5.5	-0.11 $\pm$ 0.02	0.0	-0.14 $\pm$ -0.03
18.0	3.2	0.00 $\pm$ 0.00	0.0	-0.00 $\pm$ -0.00
19.0	4.8	-0.27 $\pm$ 0.05	-0.0	-0.29 $\pm$ -0.06
20.0	4.4	0.18 $\pm$ 0.04	0.1	0.16 $\pm$ 0.03
21.0	3.0	-0.04 $\pm$ 0.01	0.0	-0.03 $\pm$ -0.01
22.0	3.4	0.19 $\pm$ 0.04	0.1	0.18 $\pm$ 0.04
23.0	1.0	0.01 $\pm$ 0.00	0.0	0.00 $\pm$ 0.00
24.0	0.2	0.00 $\pm$ 0.00	0.0	0.01 $\pm$ 0.00
25.0	4.0	0.15 $\pm$ 0.03	0.0	0.10 $\pm$ 0.02
26.0	3.5	-0.08 $\pm$ 0.02	0.0	-0.09 $\pm$ -0.02
27.0	4.5	-0.03 $\pm$ 0.01	0.0	-0.03 $\pm$ -0.01
28.0	4.3	0.13 $\pm$ 0.03	0.0	0.13 $\pm$ 0.03
29.0	4.0	0.29 $\pm$ 0.06	0.1	0.29 $\pm$ 0.06
30.0	3.5	0.13 $\pm$ 0.03	0.1	0.10 $\pm$ 0.02
World	100.0	1.87 $\pm$ 0.37	1.2	1.42 $\pm$ 0.28

Table 3: Regional Slope Sensitivity

Region	Area (%)	IAV ΔA	SEAS ΔA
1.00	1.35	-0.01 $\pm$ 0.21	0.08 $\pm$ 0.49
2.00	2.67	0.03 $\pm$ 0.15	-0.10 $\pm$ 0.17
3.00	2.09	-0.02 $\pm$ 0.24	-0.05 $\pm$ 0.16
4.00	3.93	-0.00 $\pm$ 0.10	-0.01 $\pm$ 0.57
5.00	3.80	0.01 $\pm$ 0.08	-0.03 $\pm$ 0.09
6.00	2.75	0.04 $\pm$ 0.18	-0.02 $\pm$ 0.16
7.00	3.18	-0.06 $\pm$ 0.16	-0.01 $\pm$ 0.12
8.00	2.77	0.02 $\pm$ 0.12	-0.01 $\pm$ 0.11
9.00	2.46	-0.01 $\pm$ 0.10	-0.09 $\pm$ 0.14
10.00	7.40	0.00 $\pm$ 0.13	-0.00 $\pm$ 0.15
11.00	1.26	-0.02 $\pm$ 0.10	-0.12 $\pm$ 0.10
12.00	2.38	-0.01 $\pm$ 0.08	0.09 $\pm$ 0.09
13.00	2.85	-0.09 $\pm$ 0.08	0.06 $\pm$ 0.07
14.00	2.91	0.04 $\pm$ 0.08	0.00 $\pm$ 0.09
15.00	2.86	-0.06 $\pm$ 0.11	0.03 $\pm$ 0.10
16.00	6.19	-0.02 $\pm$ 0.11	0.03 $\pm$ 0.12
17.00	5.46	0.08 $\pm$ 0.19	-0.05 $\pm$ 0.20
18.00	3.20	-0.06 $\pm$ 0.13	0.00 $\pm$ 0.13
19.00	4.83	0.04 $\pm$ 0.19	-0.09 $\pm$ 0.21
20.00	4.42	0.00 $\pm$ 0.09	-0.01 $\pm$ 0.09
21.00	2.99	0.01 $\pm$ 0.11	0.02 $\pm$ 0.17
22.00	3.36	0.00 $\pm$ 0.10	-0.00 $\pm$ 0.09
23.00	1.04	0.01 $\pm$ 0.07	-0.01 $\pm$ 0.07
24.00	0.17	-0.00 $\pm$ 0.08	0.02 $\pm$ 0.07
25.00	3.95	-0.01 $\pm$ 0.08	-0.04 $\pm$ 0.09
26.00	3.51	-0.00 $\pm$ 0.11	0.04 $\pm$ 0.12
27.00	4.46	0.01 $\pm$ 0.13	0.02 $\pm$ 0.11
28.00	4.27	0.00 $\pm$ 0.08	-0.06 $\pm$ 0.09
29.00	3.98	-0.02 $\pm$ 0.09	-0.00 $\pm$ 0.09
30.00	3.49	-0.00 $\pm$ 0.08	0.02 $\pm$ 0.08
World	100.00	-0.00 $\pm$ 0.14	-0.01 $\pm$ 0.27

Table 4: Regional Flux Sensitivity

1.00	1.35	-1.92 ± 0.38	-6.90 ± 0.38
2.00	2.67	10.38 ± 2.08	10.65 ± 2.08
3.00	2.09	-1.13 ± 0.23	-6.31 ± 0.23
4.00	3.93	-0.73 ± 0.15	-1.12 ± 0.15
5.00	3.80	-3.50 ± 0.70	3.71 ± 0.70
6.00	2.75	0.64 ± 0.13	-0.58 ± 0.13
7.00	3.18	2.12 ± 0.42	-3.35 ± 0.42
8.00	2.77	3.17 ± 0.63	-16.88 ± 0.63
9.00	2.46	2.87 ± 0.57	-12.40 ± 0.57
10.00	7.40	-5.55 ± 1.11	-54.96 ± 1.11
11.00	1.26	0.68 ± 0.14	-17.37 ± 0.14
12.00	2.38	-1.61 ± 0.32	2.52 ± 0.32
13.00	2.85	-0.52 ± 0.10	-13.91 ± 0.10
14.00	2.91	2.69 ± 0.54	-6.92 ± 0.54
15.00	2.86	-0.57 ± 0.11	-2.27 ± 0.11
16.00	6.19	-5.22 ± 1.04	-8.88 ± 1.04
17.00	5.46	-5.76 ± 1.15	-14.05 ± 1.15
18.00	3.20	-2.81 ± 0.56	-6.87 ± 0.56
19.00	4.83	-7.54 ± 1.51	4.21 ± 1.51
20.00	4.42	-1.35 ± 0.27	1.95 ± 0.27
21.00	2.99	3.55 ± 0.71	-14.00 ± 0.71
22.00	3.36	0.32 ± 0.06	-7.82 ± 0.06
23.00	1.04	1.95 ± 0.39	-13.86 ± 0.39
24.00	0.17	0.10 ± 0.02	-0.92 ± 0.02
25.00	3.95	-3.16 ± 0.63	6.72 ± 0.63
26.00	3.51	1.36 ± 0.27	-6.37 ± 0.27
27.00	4.46	-0.79 ± 0.16	-9.00 ± 0.16
28.00	4.27	0.65 ± 0.13	-7.93 ± 0.13
29.00	3.98	-3.35 ± 0.67	-14.29 ± 0.67
30.00	3.49	-2.73 ± 0.55	-18.35 ± 0.55
World	100.00	-17.74 ± 3.55	-235.55 ± 47.11