Supplement of Earth Syst. Sci. Data, 10, 609–626, 2018
https://doi.org/10.5194/essd-10-609-2018-supplement

Open Access Earth System Science Data

Supplement of

The Ocean Carbon States Database: a proof-of-concept application of cluster analysis in the ocean carbon cycle

Rebecca Latto and Anastasia Romanou

Correspondence to: Rebecca Latto (rl2797@columbia.edu)

S3. Methodology

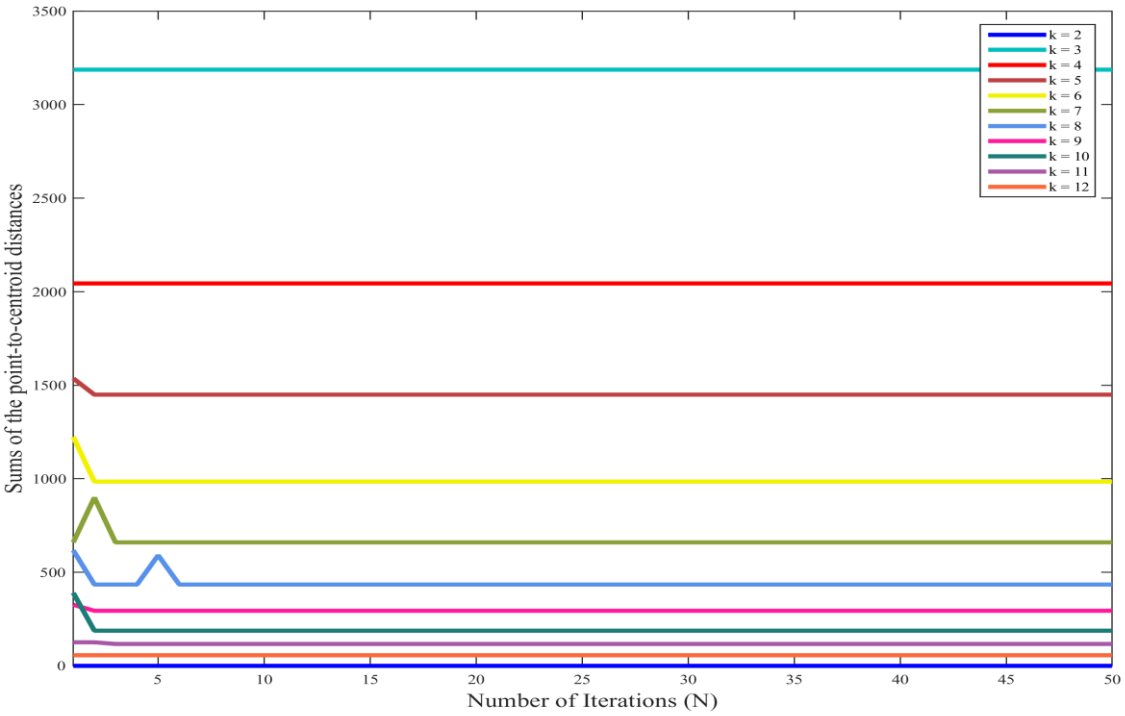


Fig. S1: Convergence test that shows the number of iterations needed so that clusters are unchanged. Each clustering analysis is performed for a different number of predetermined clusters (k) and is deemed as converging when the sum of the distances between each member 2D histogram from the cluster centroid is no longer changing. Convergence is tested for different number of predetermined clusters, k=1, k=2, …, k=12. We find that less than 10 iterations are needed to obtain convergence.

S4. Results

S4.1 The North Atlantic Ocean Carbon States

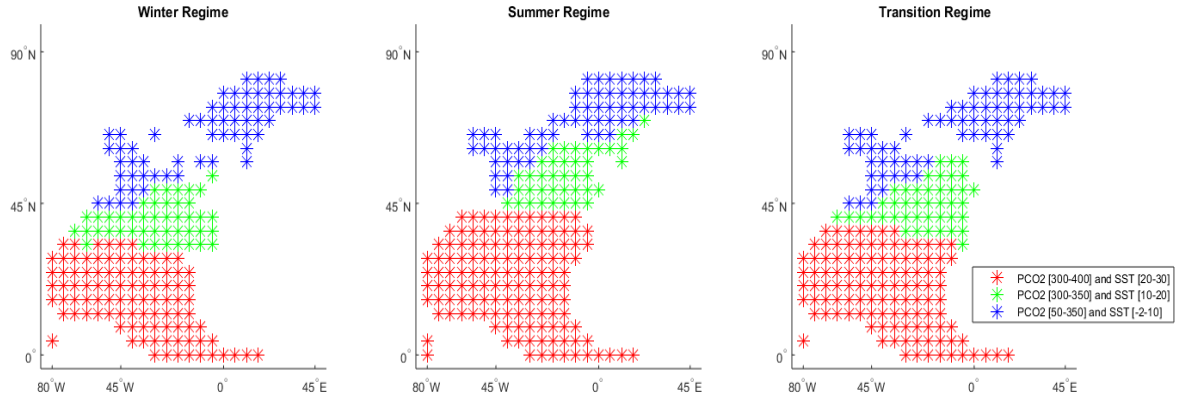
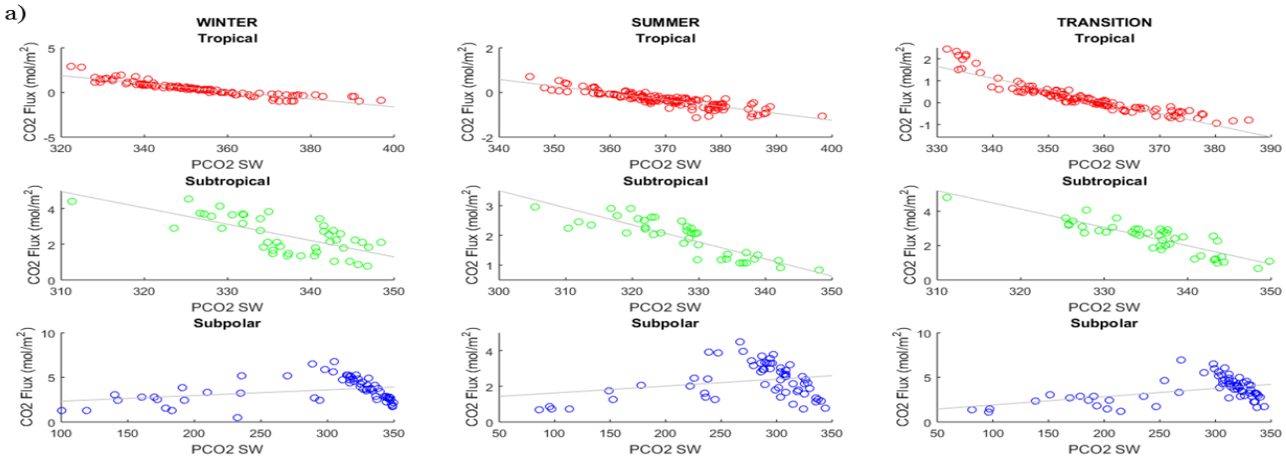


Fig. S2: Demarcated regions within the North Atlantic basin defined by ranges of pCO_{2SW} and SST values in the observed ocean carbon states.

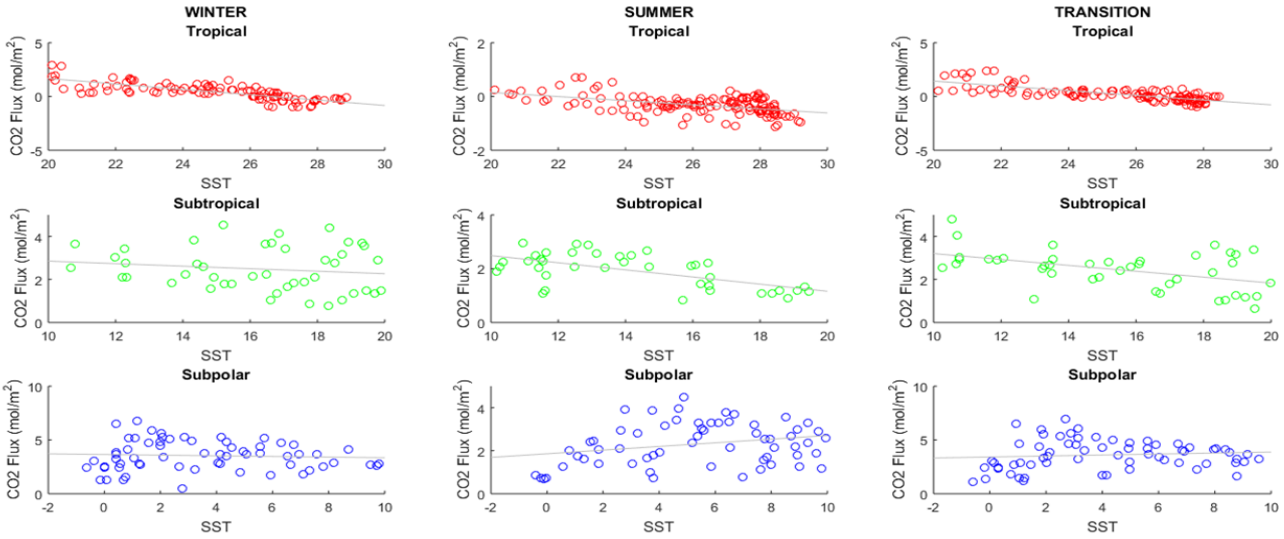


	RMSE	WEIGHT	Contribution
Tropical	37.123	-0.043694	-1.6221
Subtropical	18.353	-0.091541	-1.6801
Subpolar	117.85	0.0063676	0.75041

	RMSE	WEIGHT	Contribution
	35.568	-0.030469	-1.0837
	18.843	-0.057559	-1.0846
	74.048	0.0038785	0.2872

	RMSE	WEIGHT	Contribution
	37.407	-0.053648	-2.0068
	18.45	-0.1068	-1.9705
	96.923	0.0092523	0.89676

b)

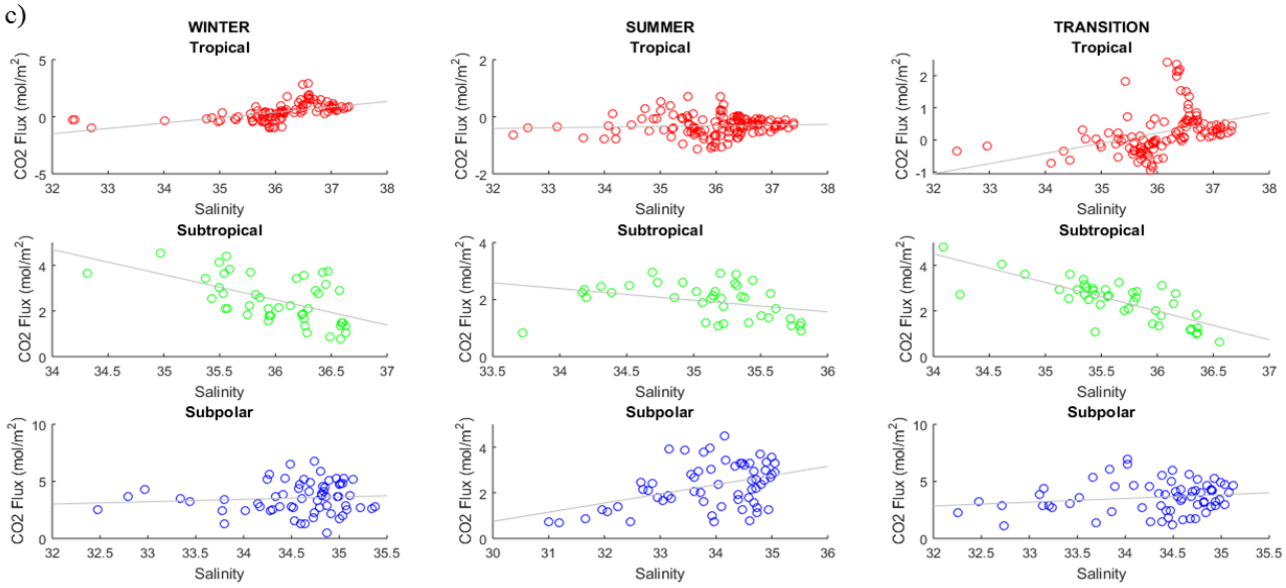


	RMSE	WEIGHT	Contribution
Tropical	1.0468	-0.25058	-0.26232
Subtropical	1.1045	-0.058524	-0.064639
Subpolar	2.8934	-0.030098	-0.087086

	RMSE	WEIGHT	Contribution
Tropical	1.4495	-0.076231	-0.1105
Subtropical	1.4735	-0.13263	-0.19542
Subpolar	3.4485	0.084806	0.29245

	RMSE	WEIGHT	Contribution
Tropical	1.0793	-0.22019	-0.23765
Subtropical	1.1242	-0.13694	-0.15395
Subpolar	2.9089	0.046045	0.13394

c)

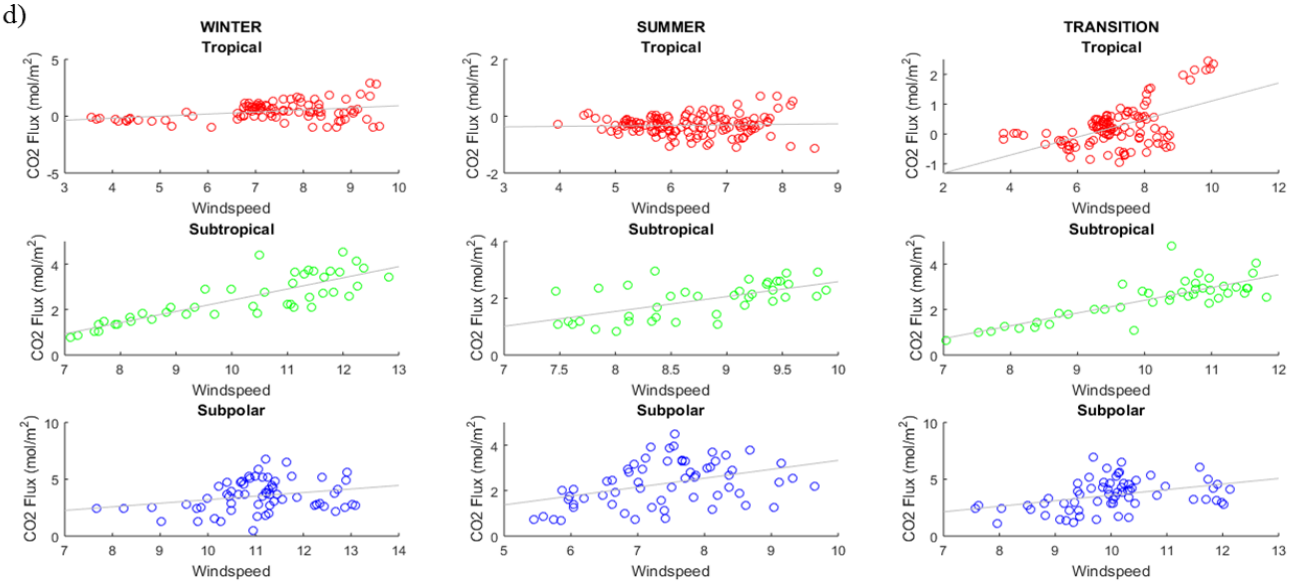


	RMSE	WEIGHT	Contribution
Tropical	0.5883	0.47181	0.27757
Subtropical	0.40244	-1.1026	-0.44372
Subpolar	1.3832	0.20802	0.28773

	RMSE	WEIGHT	Contribution
Tropical	0.59543	0.024209	0.014415
Subtropical	0.44111	-0.40821	-0.18007
Subpolar	1.9603	0.40142	0.78691

	RMSE	WEIGHT	Contribution
Tropical	0.49914	0.31722	0.15834
Subtropical	0.49651	-1.2557	-0.62347
Subpolar	1.5649	0.32974	0.51601

d)



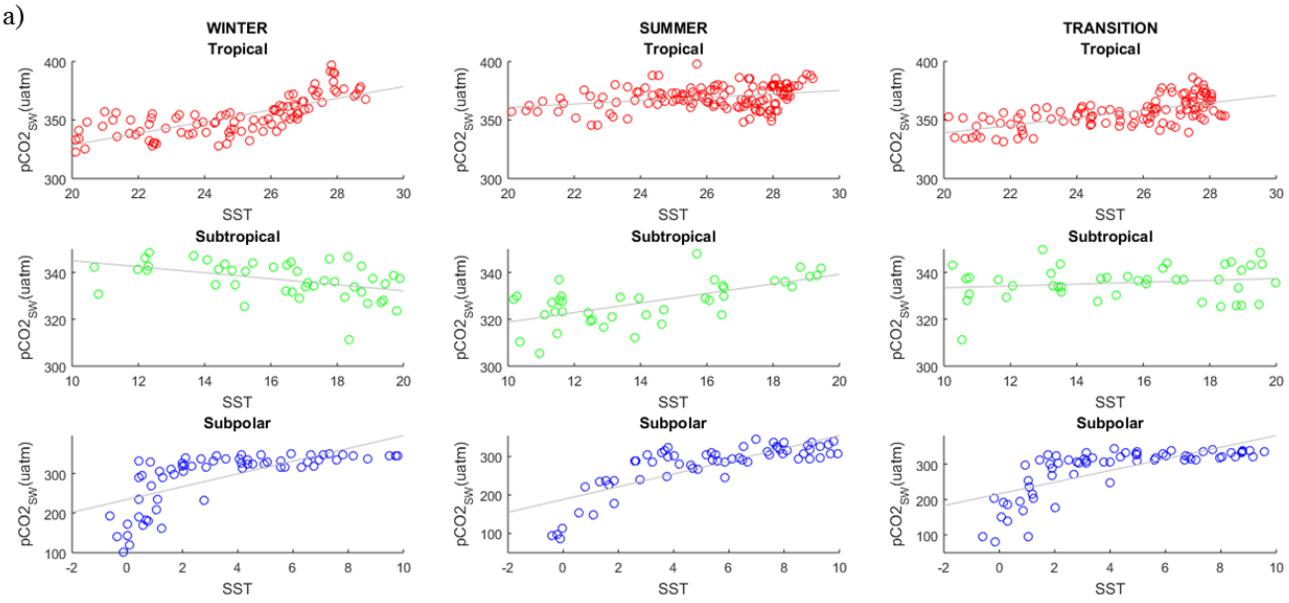
	RMSE	WEIGHT	Contribution
Tropical	1.1223	0.1827	0.20505
Subtropical	1.2357	0.49259	0.60867
Subpolar	2.4854	0.3137	0.77966

	RMSE	WEIGHT	Contribution
	1.1988	0.017796	0.021335
	1.3952	0.52245	0.72895
	1.077	0.39131	0.42143

	RMSE	WEIGHT	Contribution
	1.2952	0.30141	0.39039
	1.1105	0.56098	0.62298
	1.8207	0.48872	0.8898

Fig. S3: Scatter diagrams and linear fits of the air-sea flux of CO2 with a) $pCO2_{SW}$, b) SST, c) salinity, and d) wind speed in each of the North Atlantic regions that is represented in each regime. The regions are also shown in Fig. S2. The RMSE terms are the bias terms denoted as Δq and the weight terms are the $\frac{\partial F}{\partial q}$ terms in Eq. (5). The contribution terms are the products of each bias*weight terms in Eq. (5).

a)

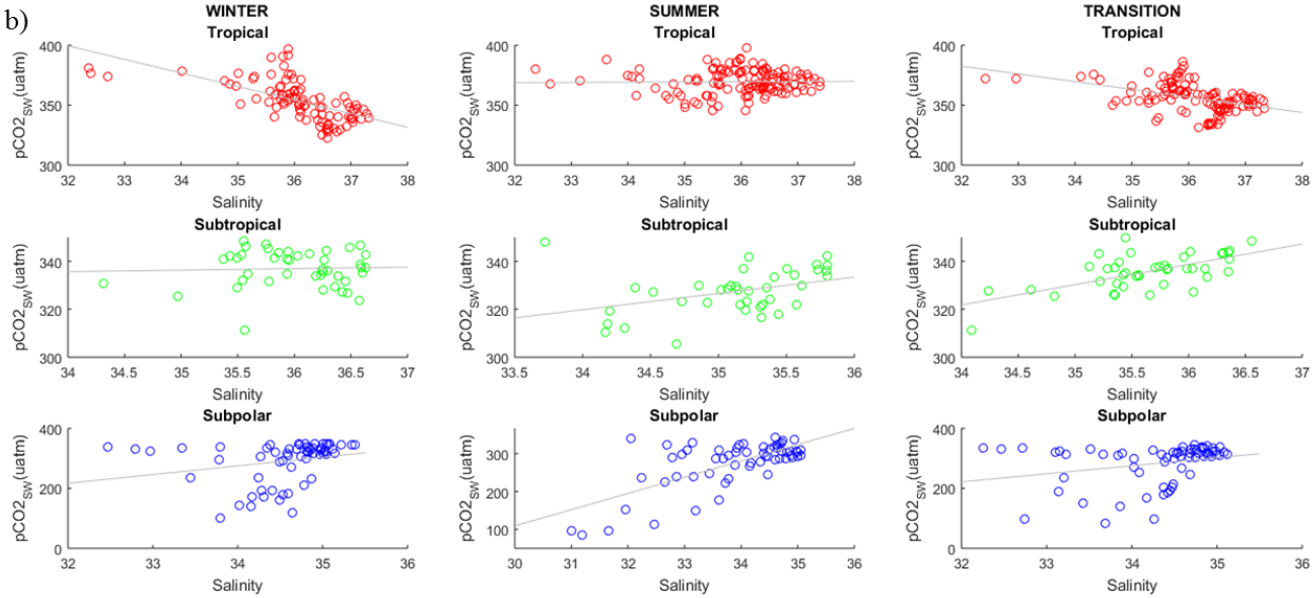


	RMSE	WEIGHT	Contribution
Tropical	1.0468	4.9894	5.223
Subtropical	1.1045	-1.2823	-1.4162
Subpolar	2.8934	16.13	46.67

	RMSE	WEIGHT	Contribution
	1.4495	1.4411	2.0889
	1.4735	2.0355	2.9992
	3.4485	16.581	57.18

	RMSE	WEIGHT	Contribution
	1.0793	3.2127	3.4675
	1.1242	0.39731	0.44666
	2.9089	16.442	47.828

b)



	RMSE	WEIGHT	Contribution
Tropical	0.5883	-11.311	-6.6541
Subtropical	0.40244	0.62911	0.25318
Subpolar	1.3832	28.93	40.015

	RMSE	WEIGHT	Contribution
	0.59543	0.17952	0.10689
	0.44111	6.7983	2.9988
	1.9603	43.005	84.304

	RMSE	WEIGHT	Contribution
	0.49914	-6.4285	-3.2088
	0.49651	8.4545	4.1977
	1.5649	26.782	41.911

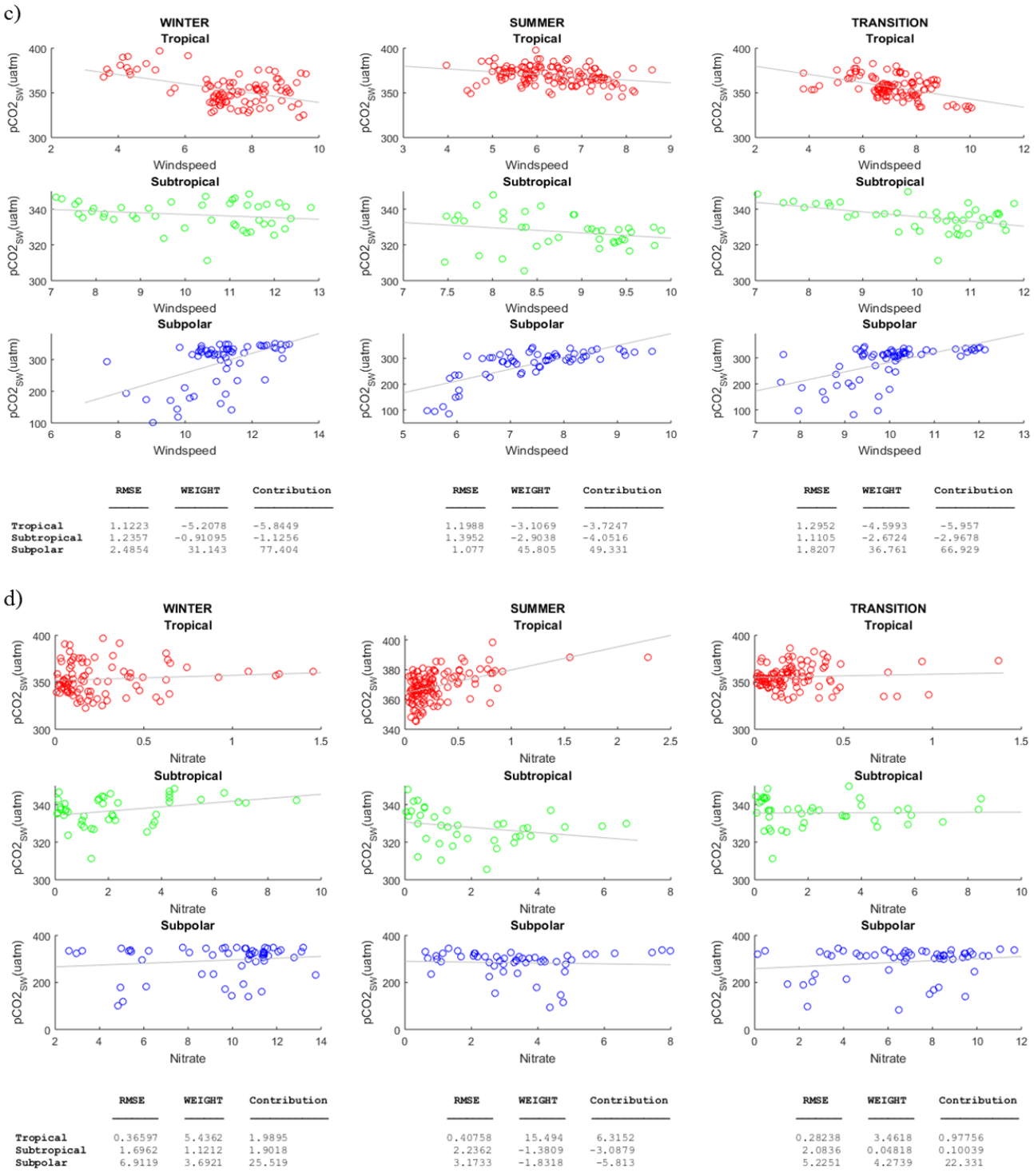


Fig. S4: Scatter diagrams and linear fits of $pCO2_{SW}$ with a) SST, b) salinity, c) wind speed and d) nitrate in each of the North Atlantic regions of each regime.

S4.2 The Southern Ocean Carbon States

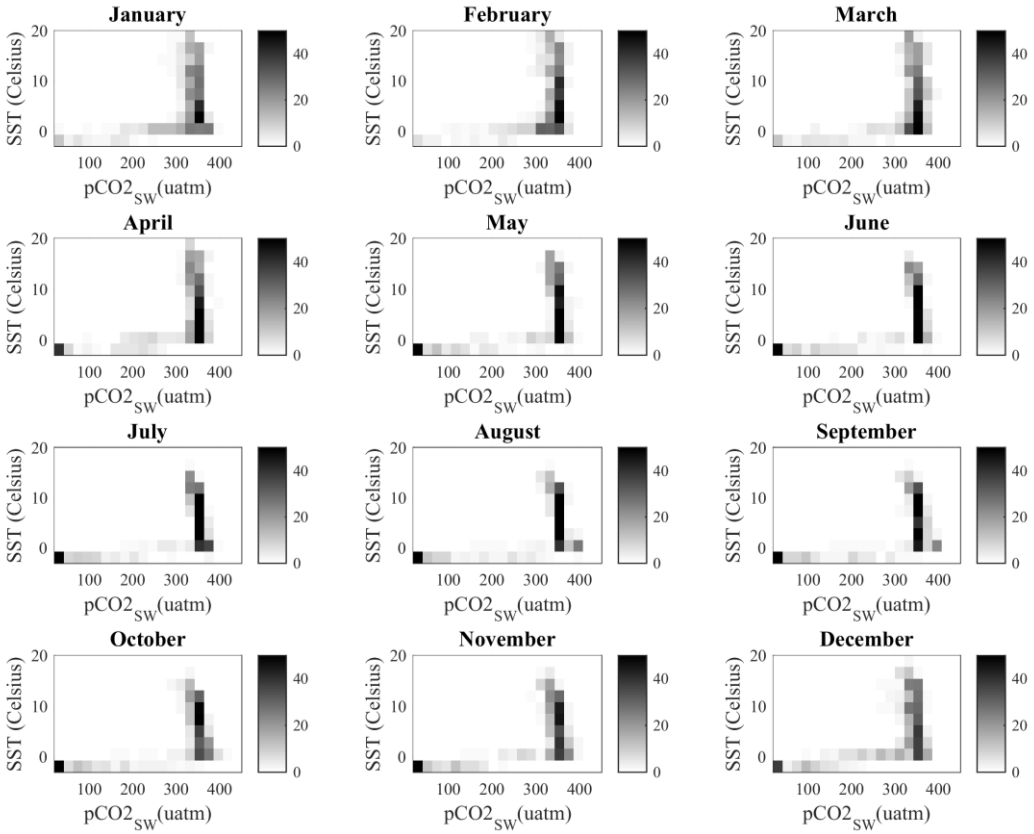


Fig. S5: Monthly 2D histograms of pCO2 of surface water (pCO2sw) and SST in the Southern Ocean (defined as 180°W to 180°E, 90°S to 40°S) from the Takahashi observational dataset.

5

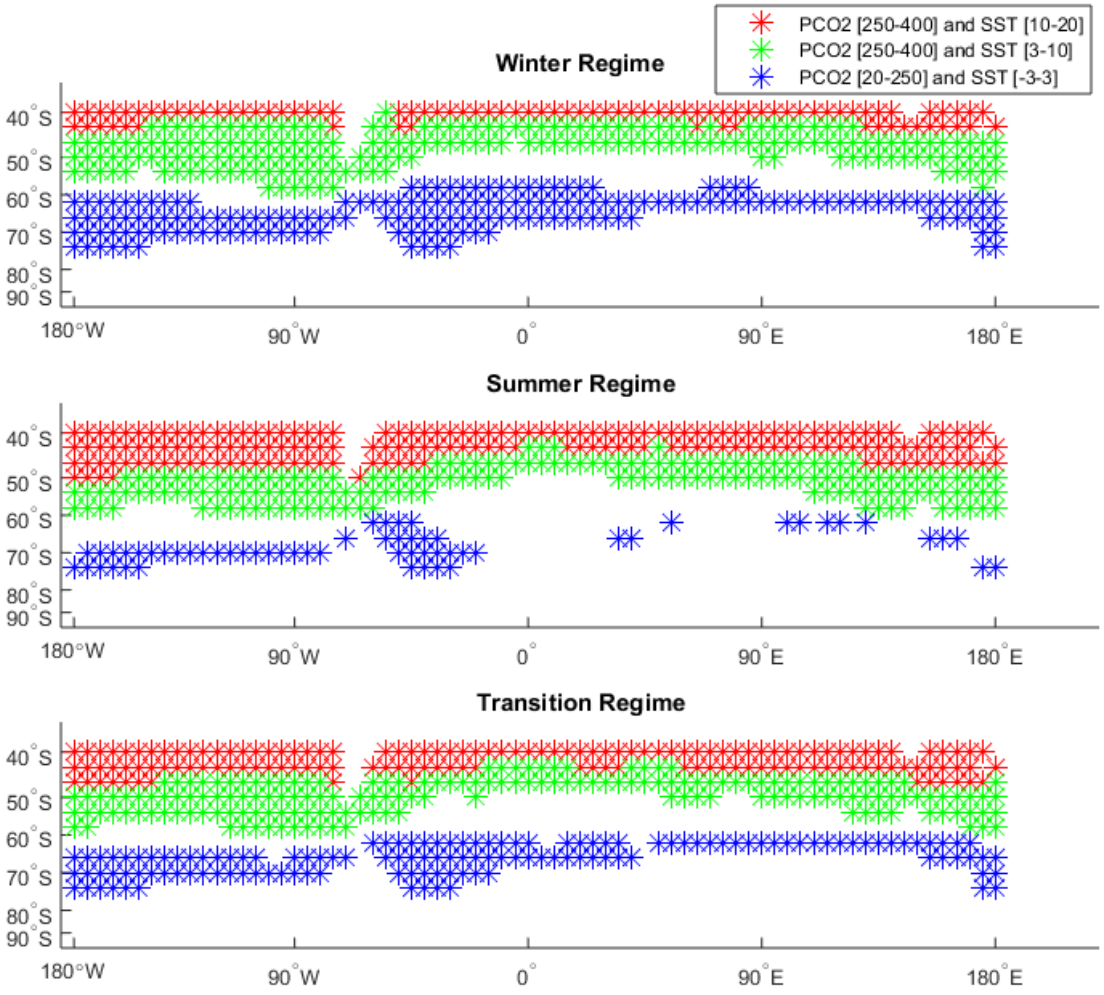


Fig. S6: Demarcated regions within the Southern Ocean basin defined by ranges of pCO_{2SW} and SST values. The choice of the regions is based on the dominant bins in each ocean carbon state.

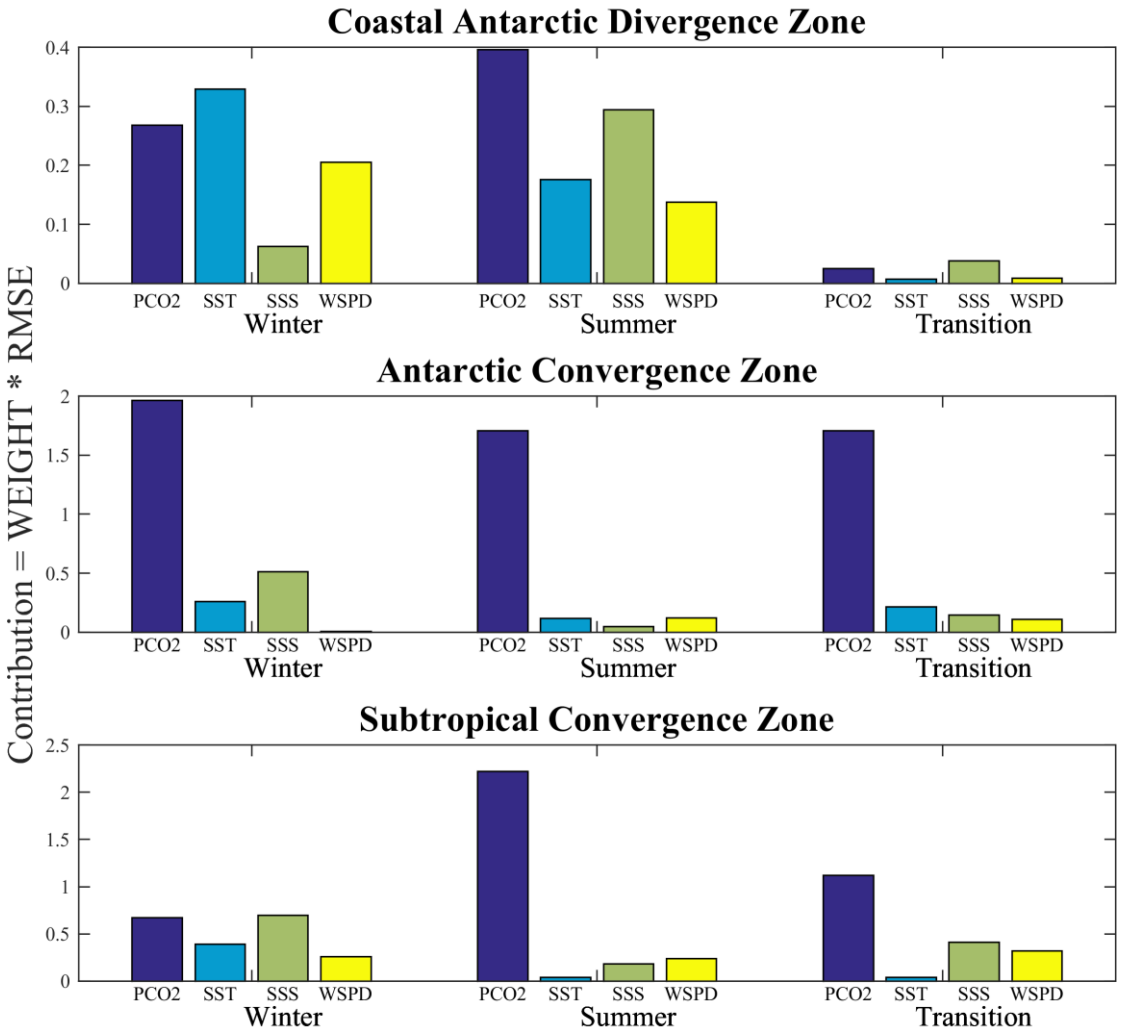
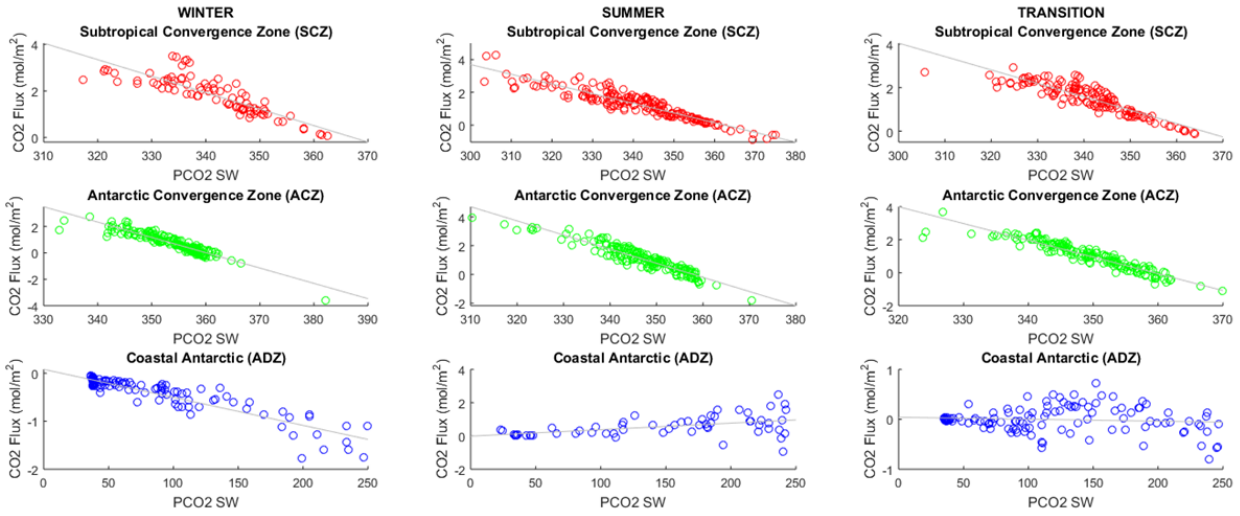


Fig. S7: Bias terms as computed in the Taylor expansion of the model bias for the air-sea flux of CO2.

a)

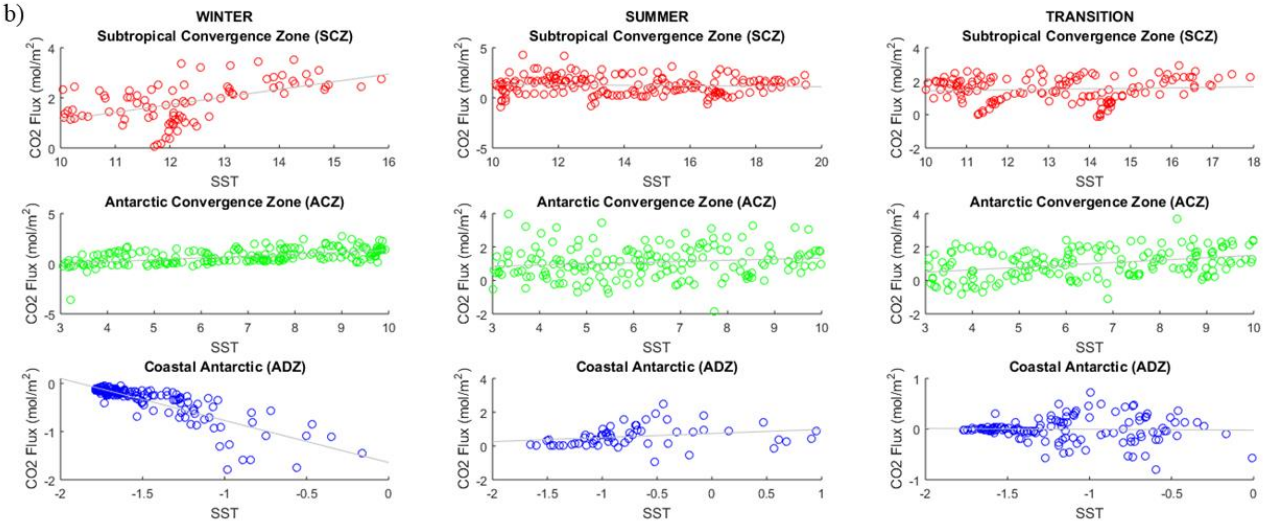


	RMSE	WEIGHT	Contribution
SCZ	9.4868	-0.070866	-0.67229
ACZ	16.926	-0.11606	-1.9645
ADZ	45.926	-0.0058327	-0.26787

	RMSE	WEIGHT	Contribution
SCZ	37.593	-0.059088	-2.2213
ACZ	17.335	-0.098416	-1.7061
ADZ	101.05	0.0039145	0.39556

	RMSE	WEIGHT	Contribution
SCZ	18.261	-0.061479	-1.1227
ACZ	16.81	-0.10166	-1.709
ADZ	64.404	-0.00038964	-0.025095

b)



	RMSE	WEIGHT	Contribution
SCZ	1.2786	0.30523	0.39028
ACZ	1.3621	0.19047	0.25943
ADZ	0.3775	-0.87228	-0.32929

	RMSE	WEIGHT	Contribution
SCZ	1.6707	-0.022858	-0.038189
ACZ	1.6092	0.071622	0.11526
ADZ	0.72537	0.24193	0.17549

	RMSE	WEIGHT	Contribution
SCZ	1.3296	0.030282	0.040262
ACZ	1.4999	0.14442	0.21661
ADZ	0.42541	-0.016302	-0.0069349

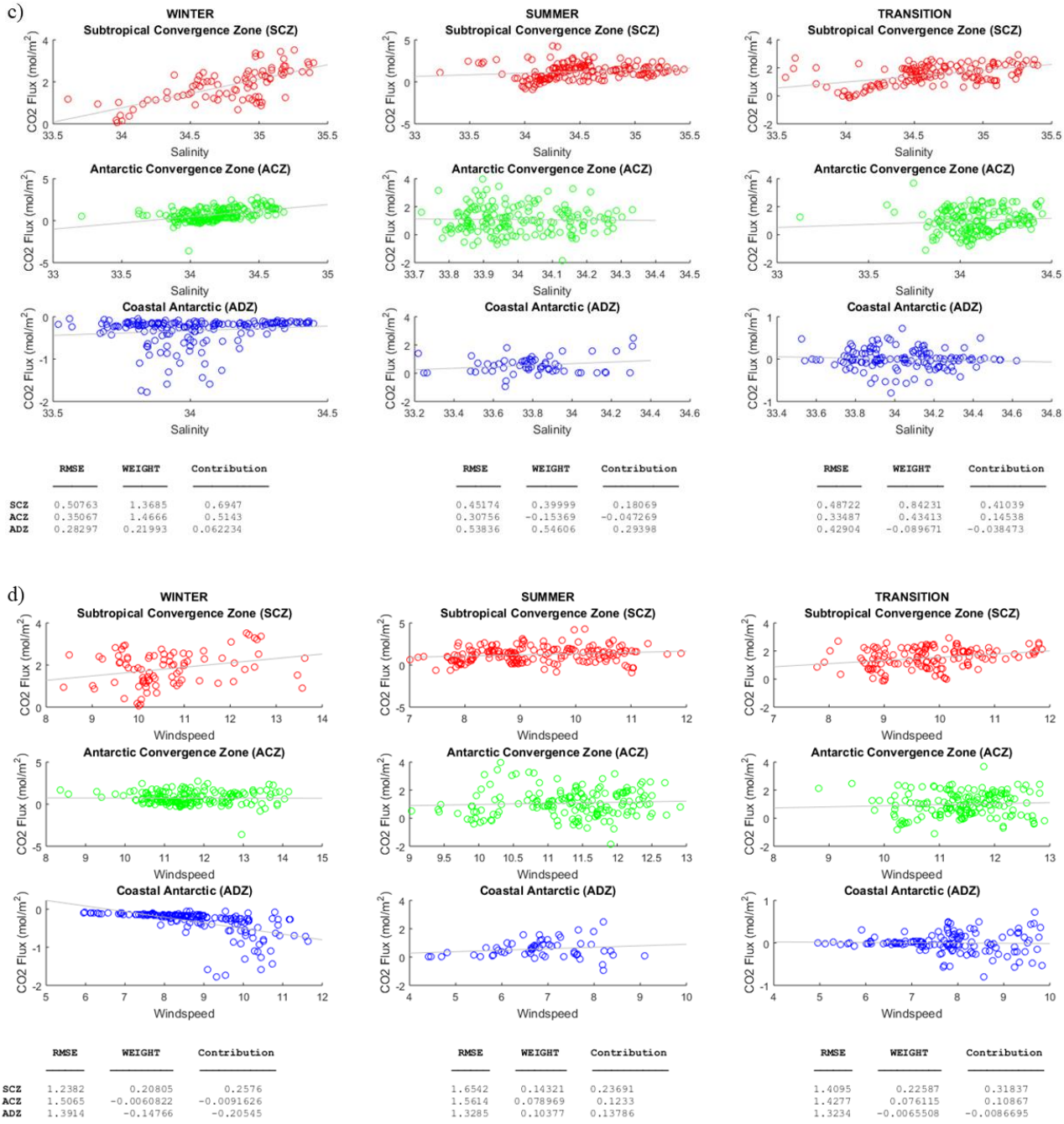
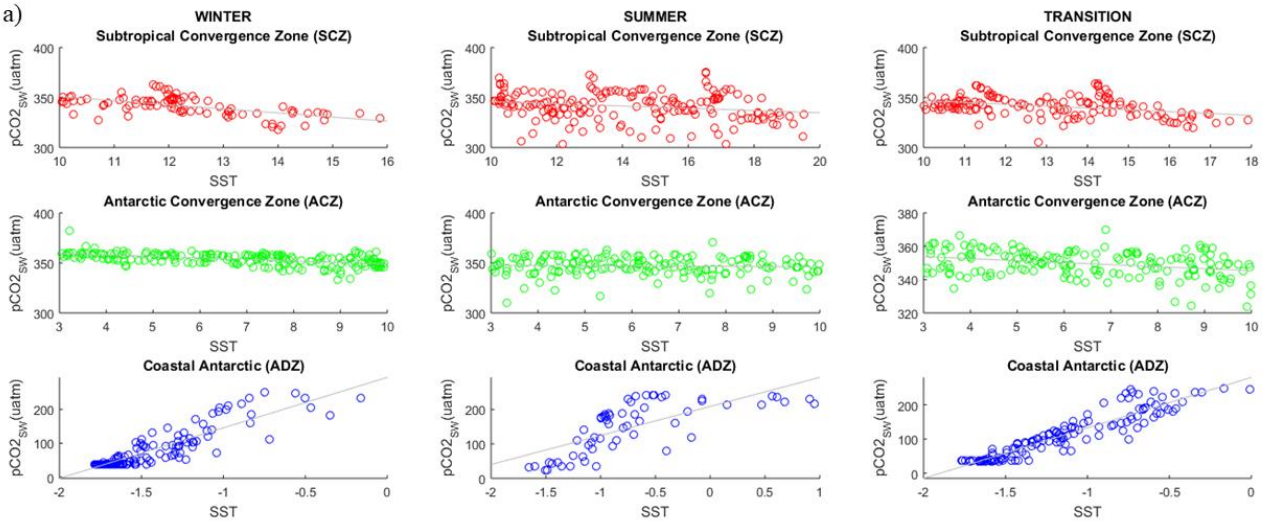


Fig. S8: Scatter diagrams and linear fits of the air-sea flux of CO_2 with a) $pCO2_{SW}$, b) SST, c) salinity, and d) wind speed in each of the Southern Ocean regions and for each regime.

a)

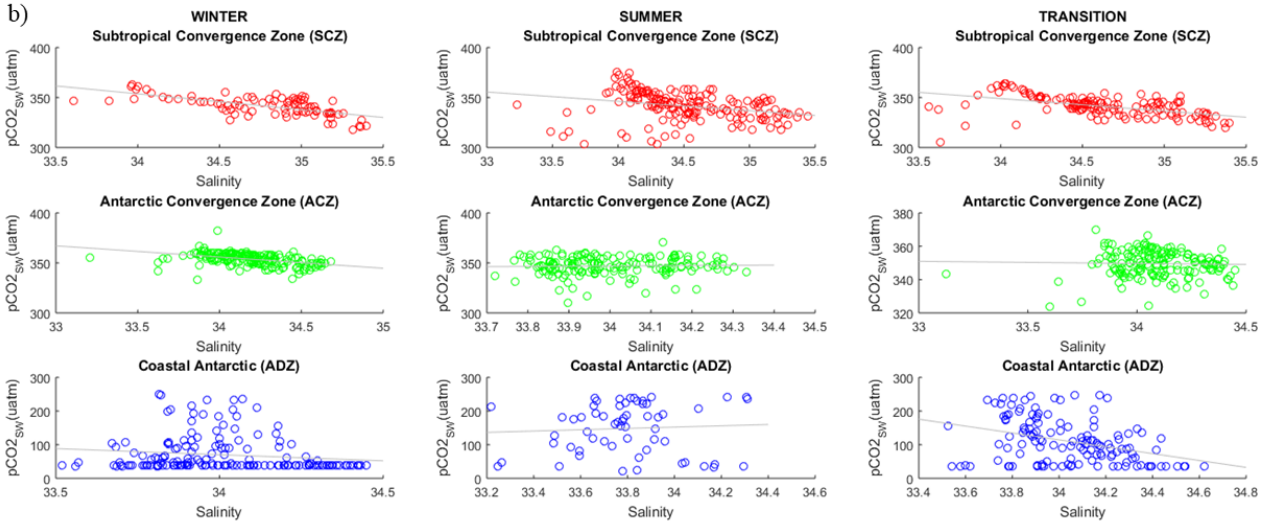


	RMSE	WEIGHT	Contribution
SCZ	1.2786	-4.1196	-5.2675
ACZ	1.3621	-1.5109	-2.058
ADZ	0.3775	148.92	56.217

	RMSE	WEIGHT	Contribution
	1.6707	-1.1189	-1.8693
	1.6092	-0.21114	-0.33977
	0.72537	84.277	61.132

	RMSE	WEIGHT	Contribution
	1.3296	-1.8385	-2.4444
	1.4999	-1.2111	-1.8165
	0.42541	147.62	62.799

b)



	RMSE	WEIGHT	Contribution
SCZ	0.50763	-15.768	-8.0045
ACZ	0.35067	-11.221	-3.935
ADZ	0.28297	-36.306	-10.273

	RMSE	WEIGHT	Contribution
	0.45174	-9.3632	-4.2298
	0.30756	2.3781	0.73142
	0.53836	19.523	10.51

	RMSE	WEIGHT	Contribution
	0.48722	-12.445	-6.0635
	0.33487	-1.2514	-0.41907
	0.42904	-102.26	-43.873

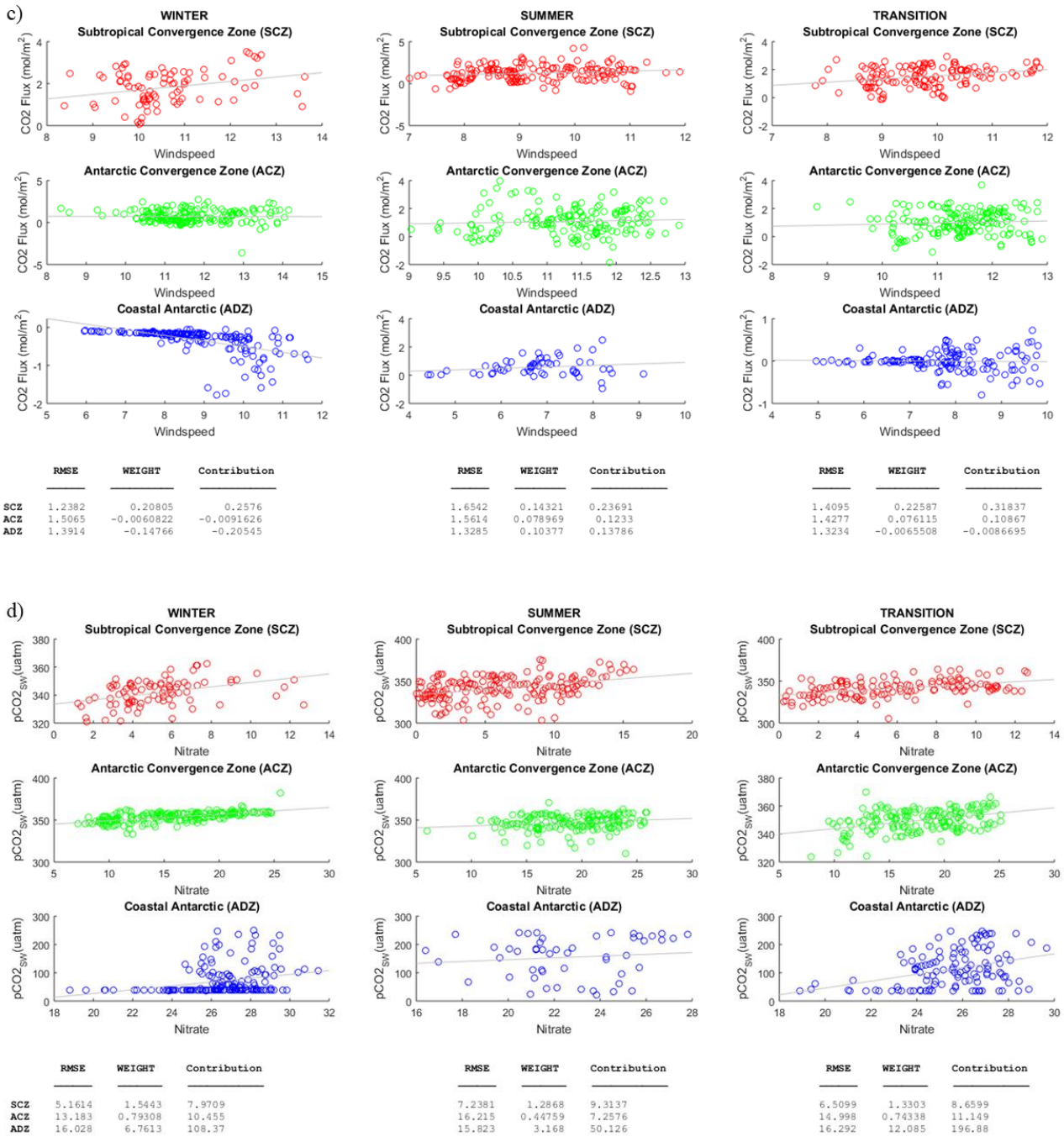


Fig. S9: Scatter diagrams and linear fits of $pCO2_{SW}$ with a) SST, b) salinity, c) wind speed and d) nitrate in each of the Southern Ocean regions and for each regime.