

Supplementary material

Supplementary Figure 1. Temporal and longitudinal distribution of SST, $f\text{CO}_{2,\text{sw}}$, FCO_2 , pH_T and $\text{pH}_{\text{T},18}$ in the Strait of Gibraltar from February 2019 to March 2021.

Supplementary Figure 2. Temporal and longitudinal distribution of SSS, Chlorophyll *a*, C_T and NC_T in the Strait of Gibraltar from February 2019 to March 2021.

Supplementary Figure 3. Seasonal variability of average SST, $f\text{CO}_{2,\text{sw}}$, FCO_2 , pH_T , $\text{pH}_{\text{T},18}$, along the northern (blue) and southern (red) sections in the Strait of Gibraltar.

Supplementary Figure 4. Seasonal variability of average SSS, Chlorophyll *a*, C_T and NC_T along the northern (blue) and southern (red) sections in the Strait of Gibraltar.

Supplementary Figure 5. Temporal and latitudinal distribution of the $f\text{CO}_{2,\text{sw}}$ values obtained from SOCAT (a.1) and CanOA-VOS (a.2) data in the Strait of Gibraltar (6.2-5.1°W). b) The seasonality of $f\text{CO}_{2,\text{sw}}$ obtained from both datasets were evaluated in an entire annual cycle referenced to 2019 and using the harmonic equations Eq. 12 and 13.

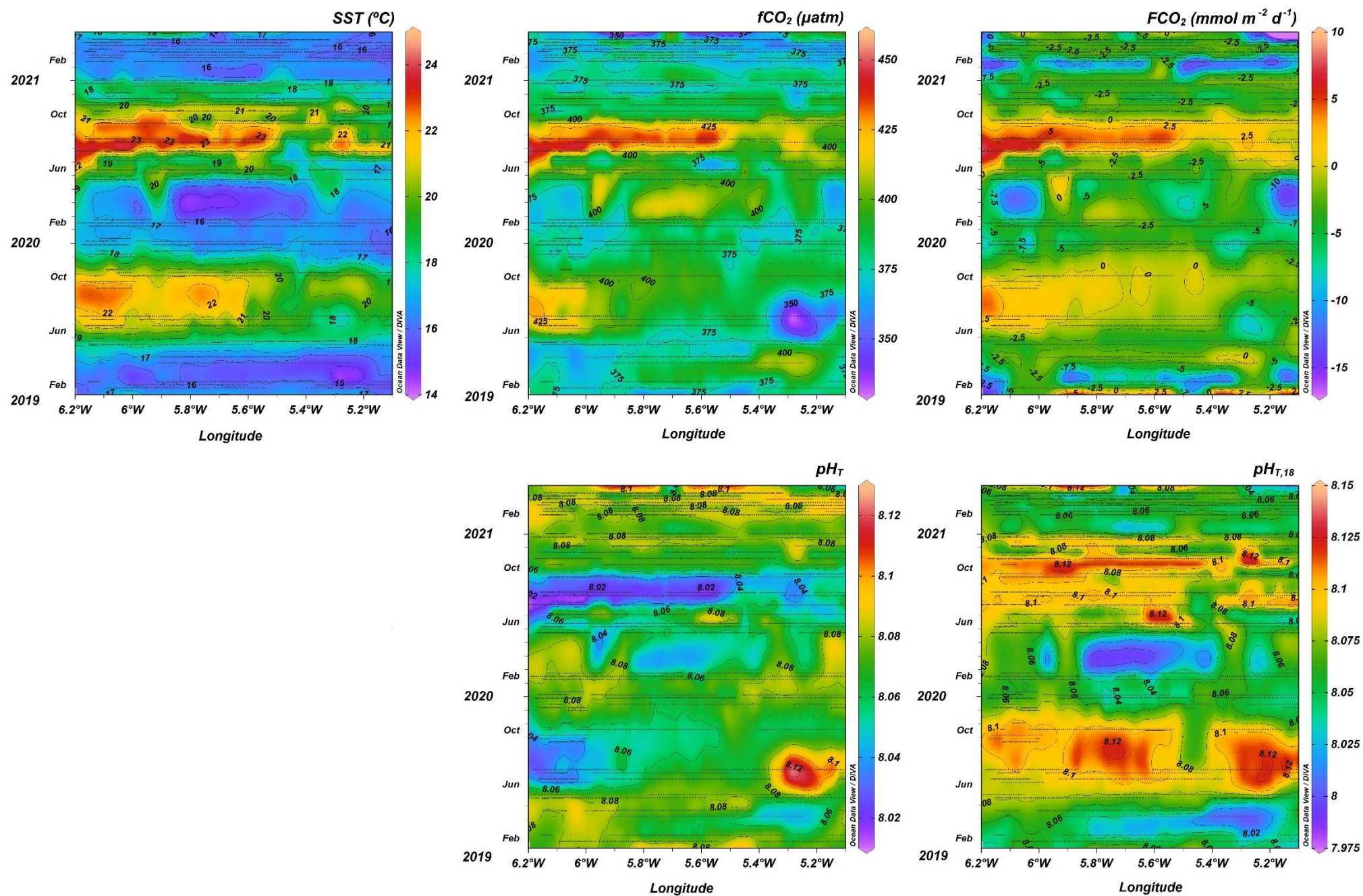
Supplementary Figure 6. Seasonal variability of average SST, $f\text{CO}_{2,\text{sw}}$, $f\text{CO}_{2,\text{thermal}}$, $f\text{CO}_{2,\text{non-thermal}}$, FCO_2 and pH_T at the northern (blue) and southern (red) part of the station S5 in the easternmost part of the Strait of Gibraltar.

Supplementary Figure 7. Seasonal variability of average SSS, C_T , NC_T and Chlorophyll *a* at the northern (blue) and southern (red) part of the selected stations (from S1 to S5) in the Strait of Gibraltar.

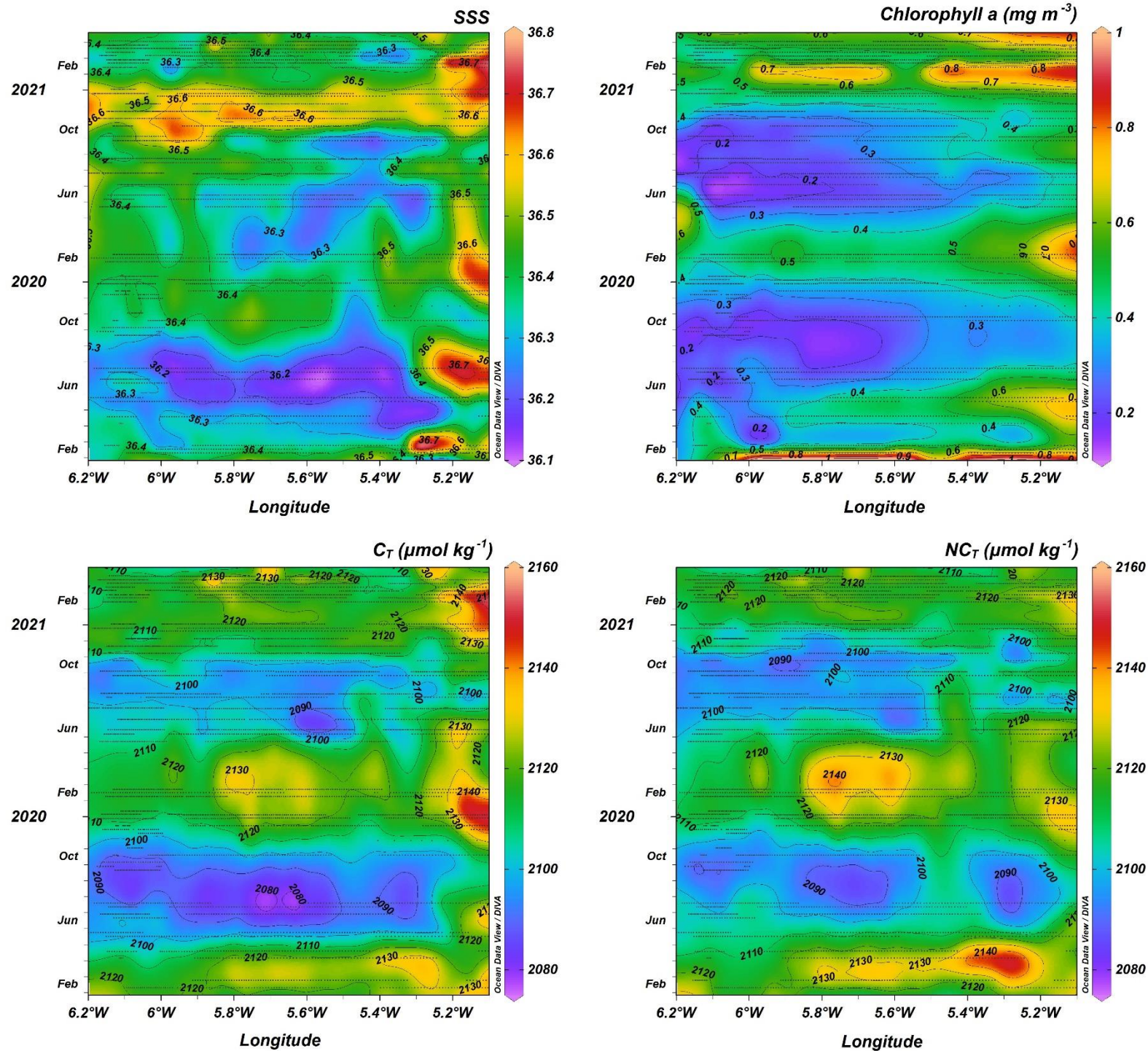
Supplementary Figure 8. Temporal distribution of the monthly average FCO_2 , $\Delta f\text{CO}_2$ and wind speed values along the northern (left) and southern (right) sections.

Supplementary Table 1. Coefficients and r^2 of the harmonic fitting equation $MLD = a_0 + a_1 \cdot \cos(w \cdot \text{days}) + b_1 \cdot \sin(w \cdot \text{days}) + a_2 \cdot \cos(2 \cdot w \cdot \text{days}) + b_2 \cdot \sin(2 \cdot w \cdot \text{days})$ used to compute the annual cycle of the MLD at stations S1-S5.

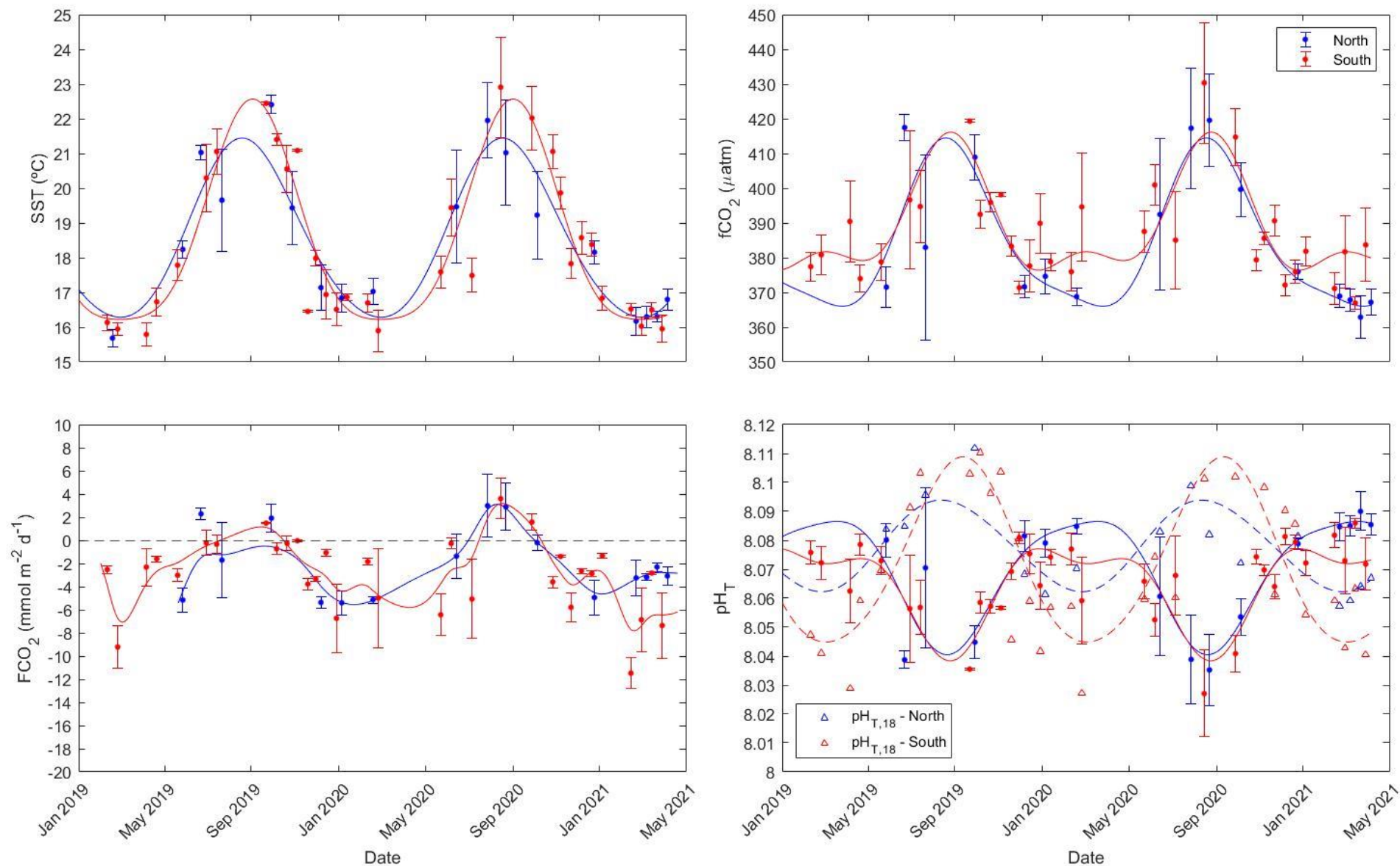
Supplementary Table 2. Coefficients (*a-e*) and r^2 of the harmonic fitted equation (Eq. 11) used to study the seasonal variation of SST, SSS, Chlorophyll *a* and CO_2 system variables along the northern and southern sections and at each of the selected stations (S1-S5) in the Strait of Gibraltar.



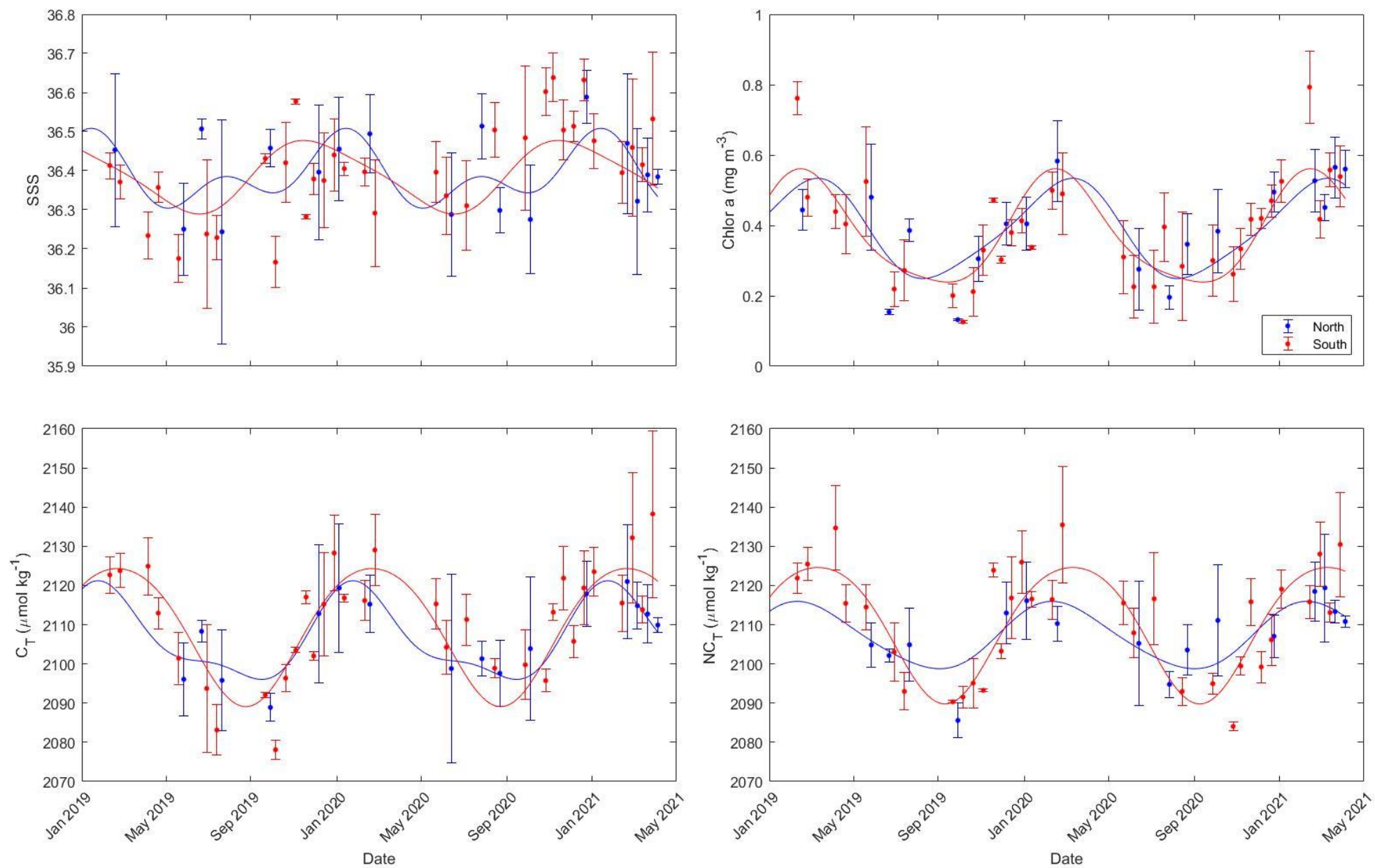
Supplementary Figure 1.



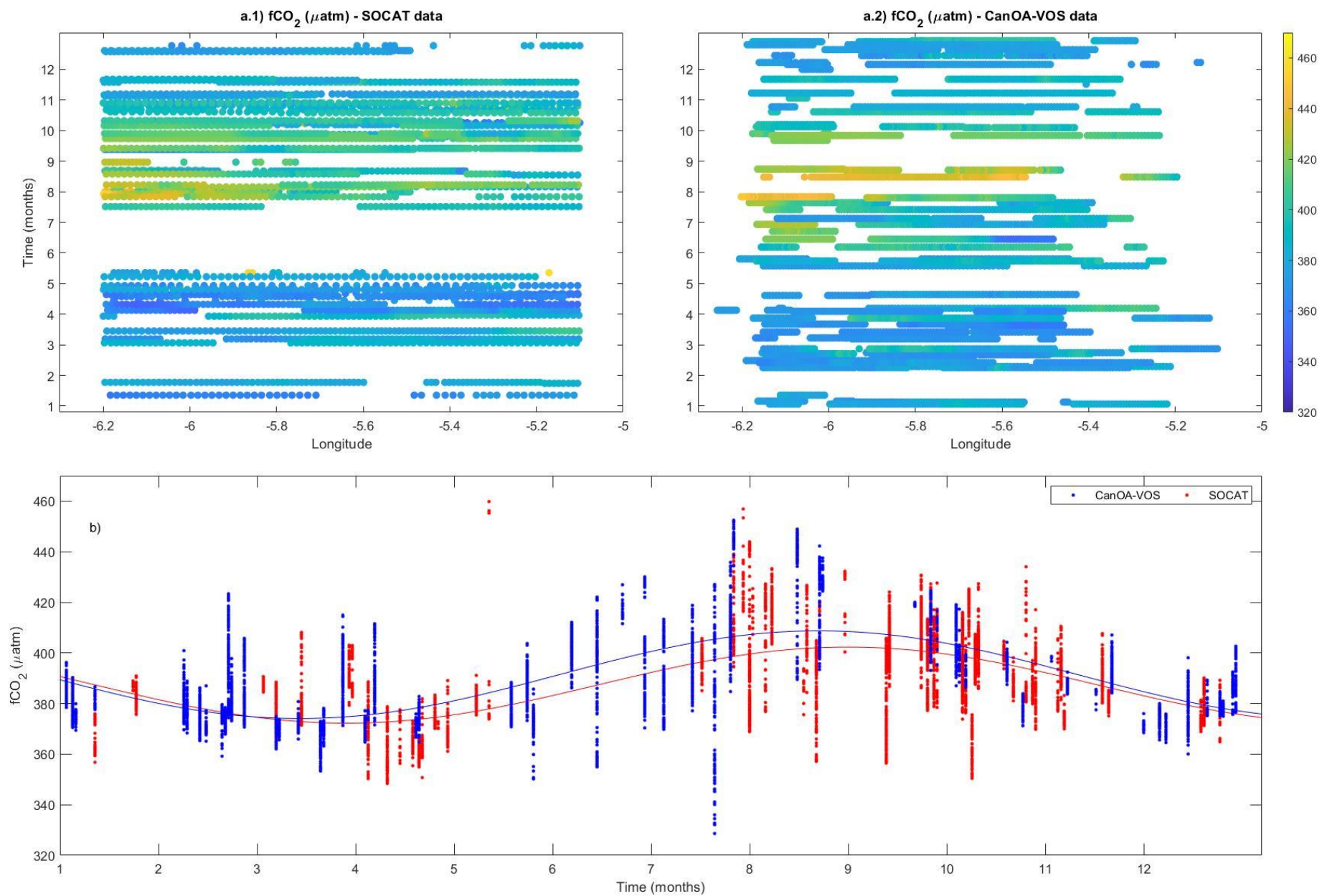
Supplementary Figure 2.



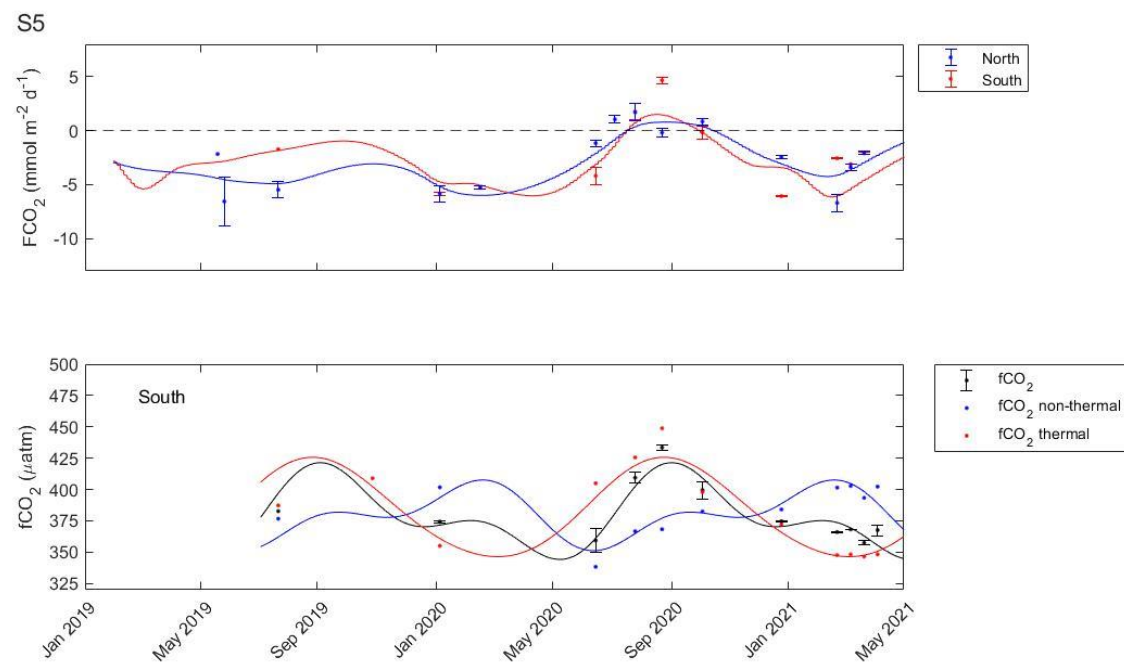
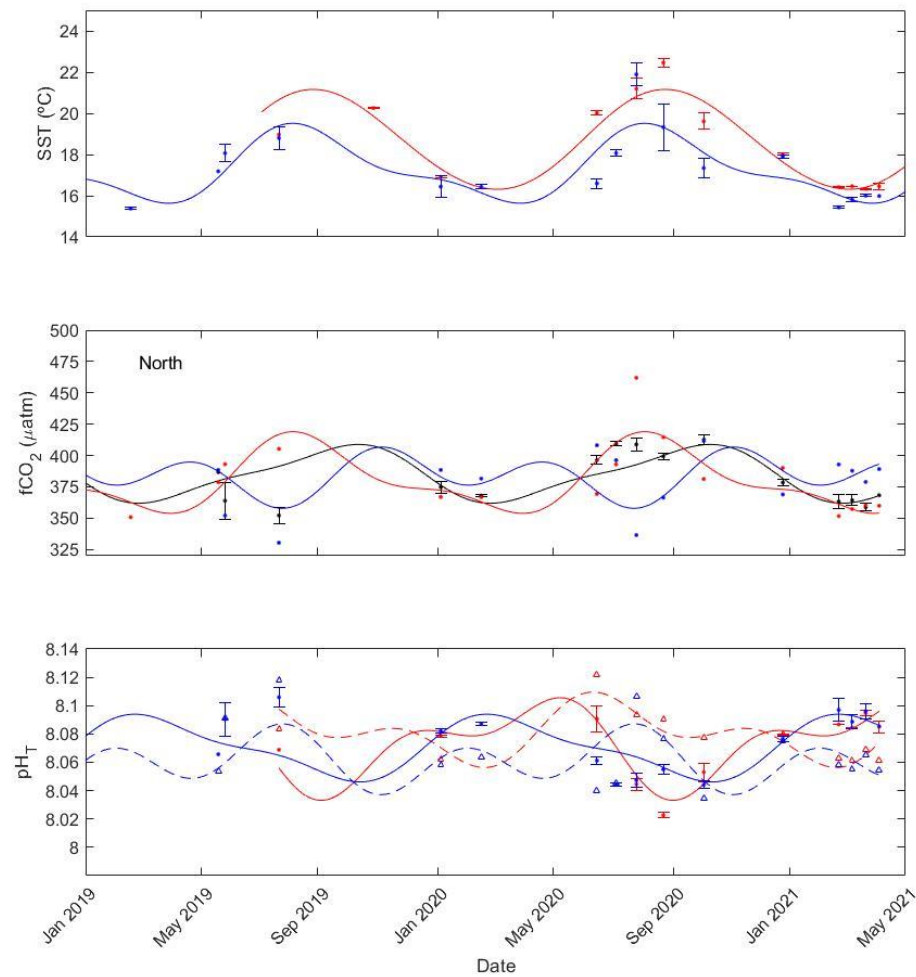
Supplementary Figure 3.



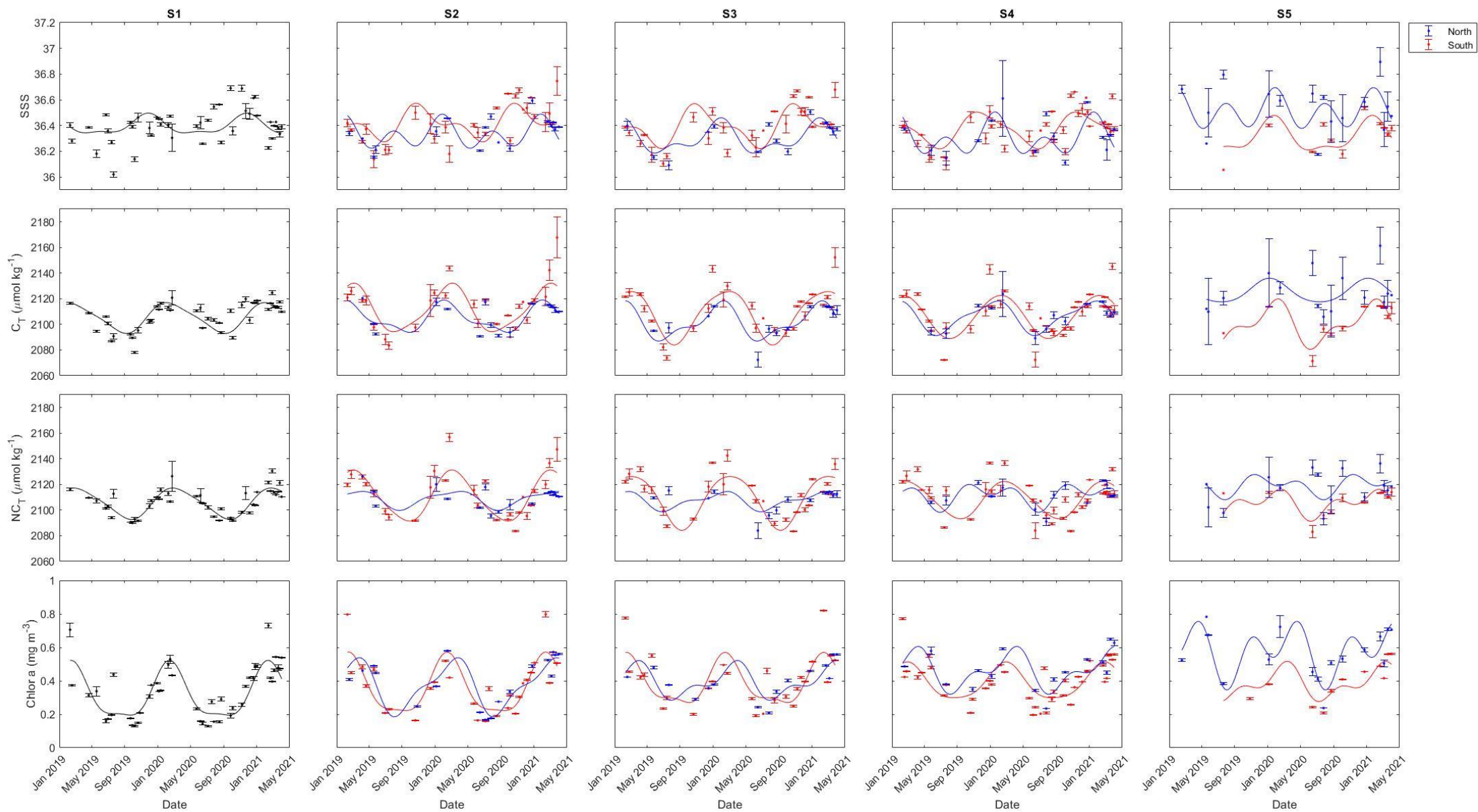
Supplementary Figure 4.



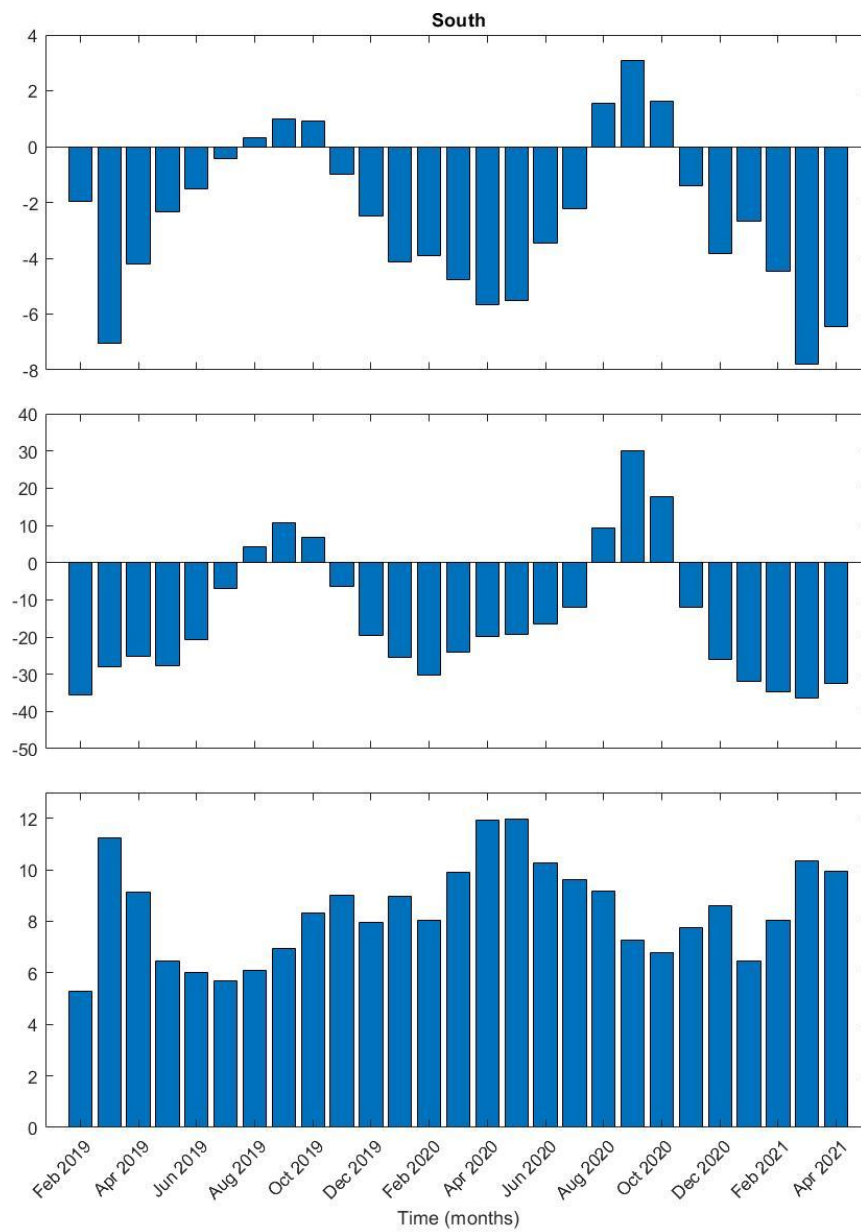
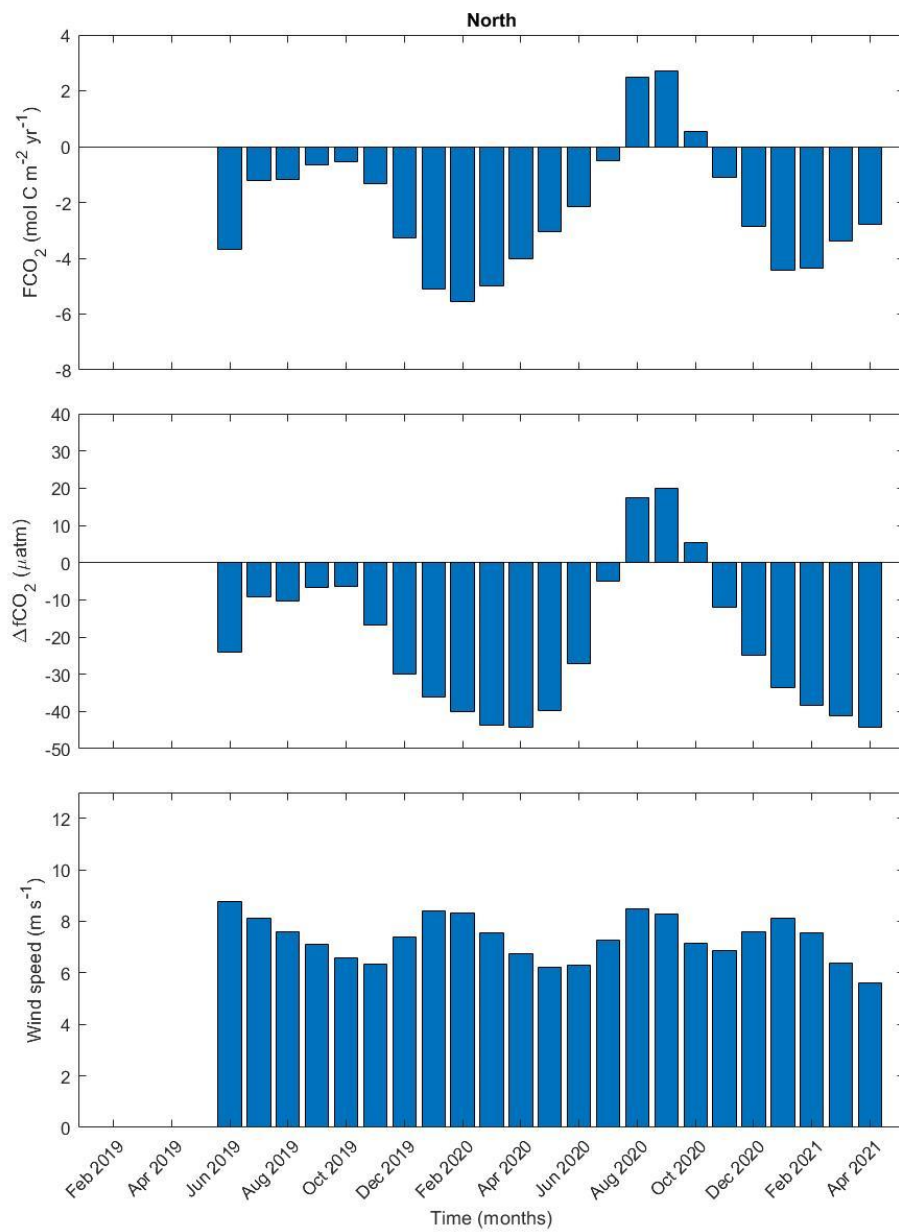
Supplementary Figure 5.



Supplementary Figure 6.



Supplementary Figure 7.



Supplementary Figure 8.

Supplementary Table 1.

Station	Section	Coefficients (95% confidence)						r^2
		a_0	a_1	b_1	a_2	b_2	w	
S1		28.69	6.53	3.09	19.60	8.65	8.33×10^{-3}	0.79
S2	North	26.56	5.93	1.97	17.14	5.34	8.16×10^{-3}	0.88
	South	30.82	4.05	2.82	15.67	9.03	8.32×10^{-3}	0.91
S3	North	21.34	3.18	1.10	10.45	4.78	8.25×10^{-3}	0.91
	South	22.91	5.67	1.37	13.16	5.23	8.12×10^{-3}	0.87
S4	North	12.99	0.51	0.17	1.99	1.85	8.52×10^{-3}	0.86
	South	19.40	2.37	1.29	8.18	5.89	8.47×10^{-3}	0.89
S5	North	13.59	0.23	0.31	1.13	2.33	9.18×10^{-3}	0.61
	South	17.91	1.10	1.11	4.80	5.47	8.80×10^{-3}	0.81

Supplementary Table 2.

		Coefficients (95% confidence)					r ²
		a	b	c	d	e	
S1	SST (°C)	19.14	-1.73	-2.60	-0.04	0.47	0.89
	SSS	34.40	0.06	-0.04	0.01	-0.03	0.08
	C _T (μmol kg ⁻¹)	2105.00	7.33	8.67	2.14	-0.14	0.55
	NC _T (μmol kg ⁻¹)	2105.00	3.92	11.07	1.53	1.09	0.70
	fCO _{2,sw} (μatm)	391.50	-19.02	-18.44	2.02	9.99	0.72
	fCO _{2, thermal} (μatm)	396.30	-29.48	-44.05	-1.09	9.66	0.88
	fCO _{2, non-thermal} (μatm)	386.10	9.65	24.27	2.20	1.62	0.76
	pH _T	8.062	0.018	0.017	-0.002	-0.009	0.74
	pH _{T,18}	8.080	-0.008	-0.022	-0.002	-0.002	0.75
	Chlor a (mg m ⁻³)	0.31	0.12	0.11	0.01	0.05	0.67
S2	SST (°C)	18.64	-1.17	-2.05	-0.06	0.18	0.70
	SSS	36.33	0.06	0.02	0.05	0.08	0.07
	C _T (μmol kg ⁻¹)	2105.00	7.37	7.58	3.18	3.15	0.43
	NC _T (μmol kg ⁻¹)	2108.00	3.43	5.79	-0.35	-2.10	0.16
	fCO _{2,sw} (μatm)	387.30	-12.21	-18.29	-0.05	5.95	0.68
	fCO _{2, thermal} (μatm)	393.70	-20.01	-34.39	-1.17	4.21	0.70
	fCO _{2, non-thermal} (μatm)	377.90	7.00	13.35	-0.10	0.47	0.19
	pH _T	8.066	0.012	0.018	0.000	-0.005	0.68
	pH _{T,18}	8.075	-0.006	-0.012	0.001	0.000	0.15
	Chlor a (mg m ⁻³)	0.37	0.09	0.12	-0.05	-0.02	0.69
	SST (°C)	18.72	-1.43	-2.88	-0.35	0.28	0.81
	SSS	36.42	0.08	-0.07	-0.06	-0.02	0.22
	C _T (μmol kg ⁻¹)	2111.00	11.14	14.11	-3.36	1.73	0.47
	NC _T (μmol kg ⁻¹)	2110.00	6.54	18.27	0.31	2.69	0.60
	fCO _{2,sw} (μatm)	392.20	-9.46	-11.51	-3.53	11.25	0.36
	fCO _{2, thermal} (μatm)	400.70	-24.71	-49.42	-6.86	6.57	0.81
	fCO _{2, non-thermal} (μatm)	384.20	14.34	35.66	1.60	7.06	0.62
	pH _T	8.062	0.010	0.011	0.003	-0.011	0.39
	pH _{T,18}	8.073	-0.012	-0.033	-0.003	-0.006	0.63
	Chlor a (mg m ⁻³)	0.35	0.12	0.12	0.00	0.05	0.60
S3	SST (°C)	18.53	-1.31	-2.03	-0.13	0.08	0.78
	SSS	36.30	0.10	0.03	0.02	0.06	0.43
	C _T (μmol kg ⁻¹)	2101.00	12.01	4.06	-0.76	5.68	0.67
	NC _T (μmol kg ⁻¹)	2107.00	5.92	1.87	-2.26	1.87	0.09
	fCO _{2,sw} (μatm)	382.20	-5.40	-24.82	-5.04	10.44	0.72
	fCO _{2, thermal} (μatm)	386.10	-21.60	-33.50	-2.48	2.47	0.76
	fCO _{2, non-thermal} (μatm)	378.20	15.60	6.15	-4.17	5.59	0.53
	pH _T	8.070	0.006	0.024	0.005	-0.009	0.75
	pH _{T,18}	8.078	-0.014	-0.005	0.005	-0.005	0.47
	Chlor a (mg m ⁻³)	0.39	0.04	0.08	-0.05	-0.01	0.45
	SST (°C)	18.88	-1.68	-3.03	-0.42	0.60	0.85
	SSS	36.39	0.10	-0.09	-0.07	-0.02	0.38

S4	North	C_T ($\mu\text{mol kg}^{-1}$)	2107.00	15.02	13.93	-1.88	-2.73	0.57
		NC_T ($\mu\text{mol kg}^{-1}$)	2108.00	9.08	18.90	1.91	-1.82	0.66
		$f\text{CO}_{2,\text{sw}}$ (μatm)	390.50	-7.55	-13.49	-3.85	8.22	0.26
		$f\text{CO}_{2,\text{thermal}}$ (μatm)	402.10	-29.11	-52.31	-7.97	12.11	0.85
		$f\text{CO}_{2,\text{non-thermal}}$ (μatm)	378.90	20.14	35.82	2.95	-1.55	0.66
		pH_T	8.063	0.008	0.012	0.003	-0.008	0.28
		$\text{pH}_{T,18}$	8.076	-0.018	-0.034	-0.003	0.001	0.66
		Chlor a (mg m^{-3})	0.38	0.09	0.10	0.01	0.05	0.45
		SST ($^{\circ}\text{C}$)	17.75	-1.11	-0.93	0.54	0.09	0.72
		SSS	36.30	0.09	0.03	0.09	0.06	0.22
		C_T ($\mu\text{mol kg}^{-1}$)	2106.00	11.92	-0.25	-1.22	3.42	0.79
		NC_T ($\mu\text{mol kg}^{-1}$)	2111.00	6.68	-1.64	-6.34	0.39	0.48
		$f\text{CO}_{2,\text{sw}}$ (μatm)	377.50	-2.84	-14.50	-1.35	5.10	0.70
		$f\text{CO}_{2,\text{thermal}}$ (μatm)	380.00	-18.03	-14.99	8.69	1.98	0.71
		$f\text{CO}_{2,\text{non-thermal}}$ (μatm)	374.70	14.28	-0.86	-10.36	2.01	0.58
		pH_T	8.075	0.004	0.014	0.002	-0.004	0.73
		$\text{pH}_{T,18}$	8.071	-0.013	0.001	0.011	-0.001	0.54
		Chlor a (mg m^{-3})	0.46	0.04	0.10	-0.05	-0.04	0.49
S5	South	SST ($^{\circ}\text{C}$)	18.70	-1.45	-2.58	-0.28	0.33	0.80
		SSS	36.37	0.12	-0.05	-0.03	-0.01	0.35
		C_T ($\mu\text{mol kg}^{-1}$)	2106.00	13.84	9.51	-0.63	-0.11	0.55
		NC_T ($\mu\text{mol kg}^{-1}$)	2108.00	7.00	12.50	1.17	0.66	0.47
		$f\text{CO}_{2,\text{sw}}$ (μatm)	388.10	-7.17	-17.29	-3.14	8.81	0.44
		$f\text{CO}_{2,\text{thermal}}$ (μatm)	395.50	-24.75	-43.72	-5.31	7.08	0.79
		$f\text{CO}_{2,\text{non-thermal}}$ (μatm)	380.10	16.57	24.86	1.73	2.91	0.54
		pH_T	8.065	0.008	0.016	0.003	-0.008	0.46
		$\text{pH}_{T,18}$	8.076	-0.014	-0.023	-0.002	-0.003	0.52
		Chlor a (mg m^{-3})	0.39	0.06	0.09	-0.01	0.02	0.40
	North	SST ($^{\circ}\text{C}$)	17.39	-1.06	-1.26	0.48	0.39	0.58
		SSS	36.51	0.06	0.02	0.07	0.10	0.01
		C_T ($\mu\text{mol kg}^{-1}$)	2126.00	9.14	1.15	1.23	0.20	0.11
		NC_T ($\mu\text{mol kg}^{-1}$)	2119.00	6.08	0.30	-2.93	-4.56	0.15
		$f\text{CO}_{2,\text{sw}}$ (μatm)	385.50	-4.93	-20.43	-2.47	-5.16	0.31
		$f\text{CO}_{2,\text{thermal}}$ (μatm)	382.40	-17.99	-20.47	8.04	7.70	0.55
		$f\text{CO}_{2,\text{non-thermal}}$ (μatm)	383.70	10.99	-1.42	-10.20	-12.75	0.01
		pH_T	8.070	0.005	0.020	0.003	0.006	0.28
		$\text{pH}_{T,18}$	8.061	-0.010	0.001	0.011	0.014	0.01
		Chlor a (mg m^{-3})	0.57	0.07	0.09	-0.08	-0.10	0.58
	South	SST ($^{\circ}\text{C}$)	18.68	-1.33	-2.02	0.06	0.09	0.79
		SSS	36.31	0.12	0.04	0.03	0.04	0.20
		C_T ($\mu\text{mol kg}^{-1}$)	2099.00	14.53	2.43	-1.24	7.94	0.70
		NC_T ($\mu\text{mol kg}^{-1}$)	2105.00	7.88	0.25	-3.19	5.78	0.27
		$f\text{CO}_{2,\text{sw}}$ (μatm)	379.10	-3.40	-27.17	-4.54	17.09	0.77
		$f\text{CO}_{2,\text{thermal}}$ (μatm)	383.70	-21.73	-33.00	0.49	2.82	0.77
		$f\text{CO}_{2,\text{non-thermal}}$ (μatm)	379.50	18.66	4.42	-6.36	11.66	0.68
		pH_T	8.073	0.004	0.026	0.004	-0.016	0.79

	pH _{T,18}	8.082	-0.017	-0.003	0.007	-0.012	0.65
	Chlor a (mg m ⁻³)	0.38	0.06	0.07	-0.05	0.02	0.46
Northern section	SST (°C)	18.66	-1.65	-1.96	0.08	0.23	0.82
	SSS	36.39	0.07	0.00	0.05	0.03	0.10
	C _T (μmol kg ⁻¹)	2106.00	9.33	6.10	3.46	2.15	0.77
	NC _T (μmol kg ⁻¹)	2107.00	5.62	6.28	0.78	0.49	0.41
	fCO _{2,sw} (μatm)	385.80	-14.02	-18.46	1.16	5.73	0.69
	pH _T	8.068	0.014	0.018	0.000	-0.005	0.72
	pH _{T,18}	8.078	-0.011	-0.012	0.001	0.000	0.52
	Chlor a (mg m ⁻³)	0.38	0.08	0.11	-0.02	0.00	0.50
Southern section	SST (°C)	18.72	-1.58	-2.75	-0.35	0.58	0.84
	SSS	36.39	0.08	-0.04	-0.01	0.00	0.18
	C _T (μmol kg ⁻¹)	2108.00	11.05	13.71	0.46	-1.56	0.61
	NC _T (μmol kg ⁻¹)	2109.00	6.48	16.14	1.34	-1.33	0.65
	fCO _{2,sw} (μatm)	390.60	-11.30	-13.14	-2.74	7.82	0.58
	pH _T	8.063	0.011	0.013	0.003	-0.007	0.61
	pH _{T,18}	8.074	-0.013	-0.029	-0.003	0.001	0.66
	Chlor a (mg m ⁻³)	0.37	0.10	0.12	0.01	0.03	0.55