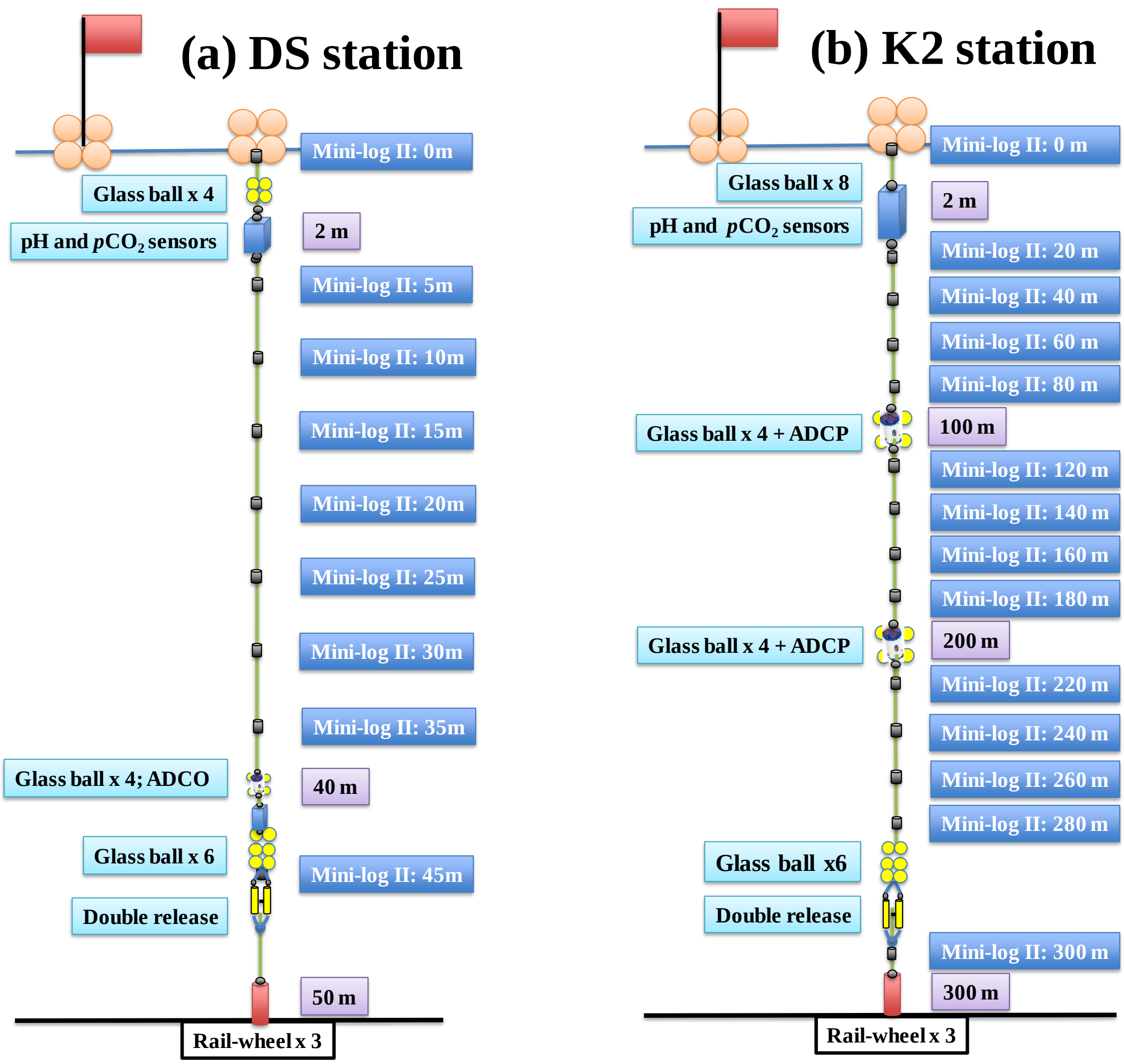
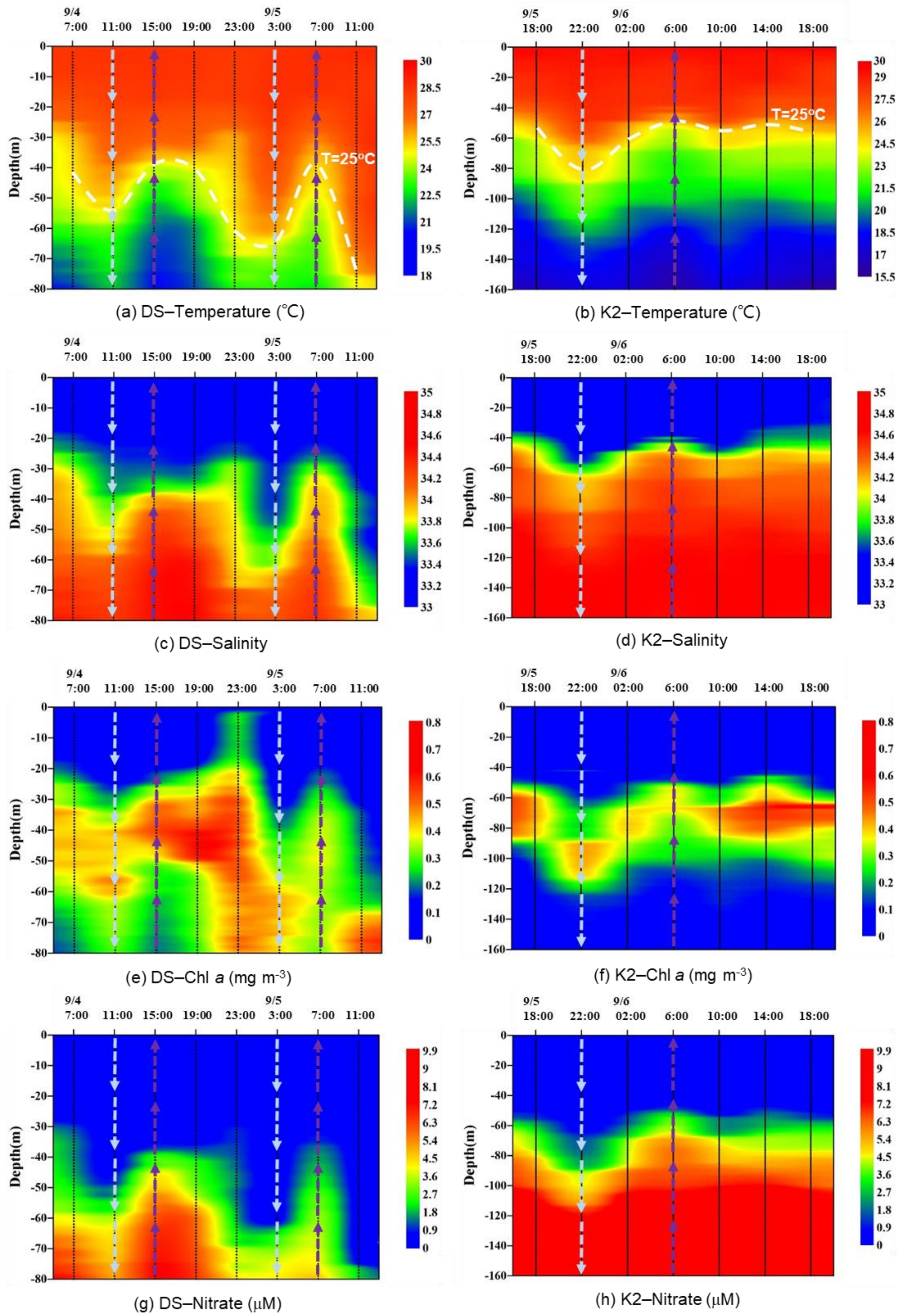
Supplementary Material

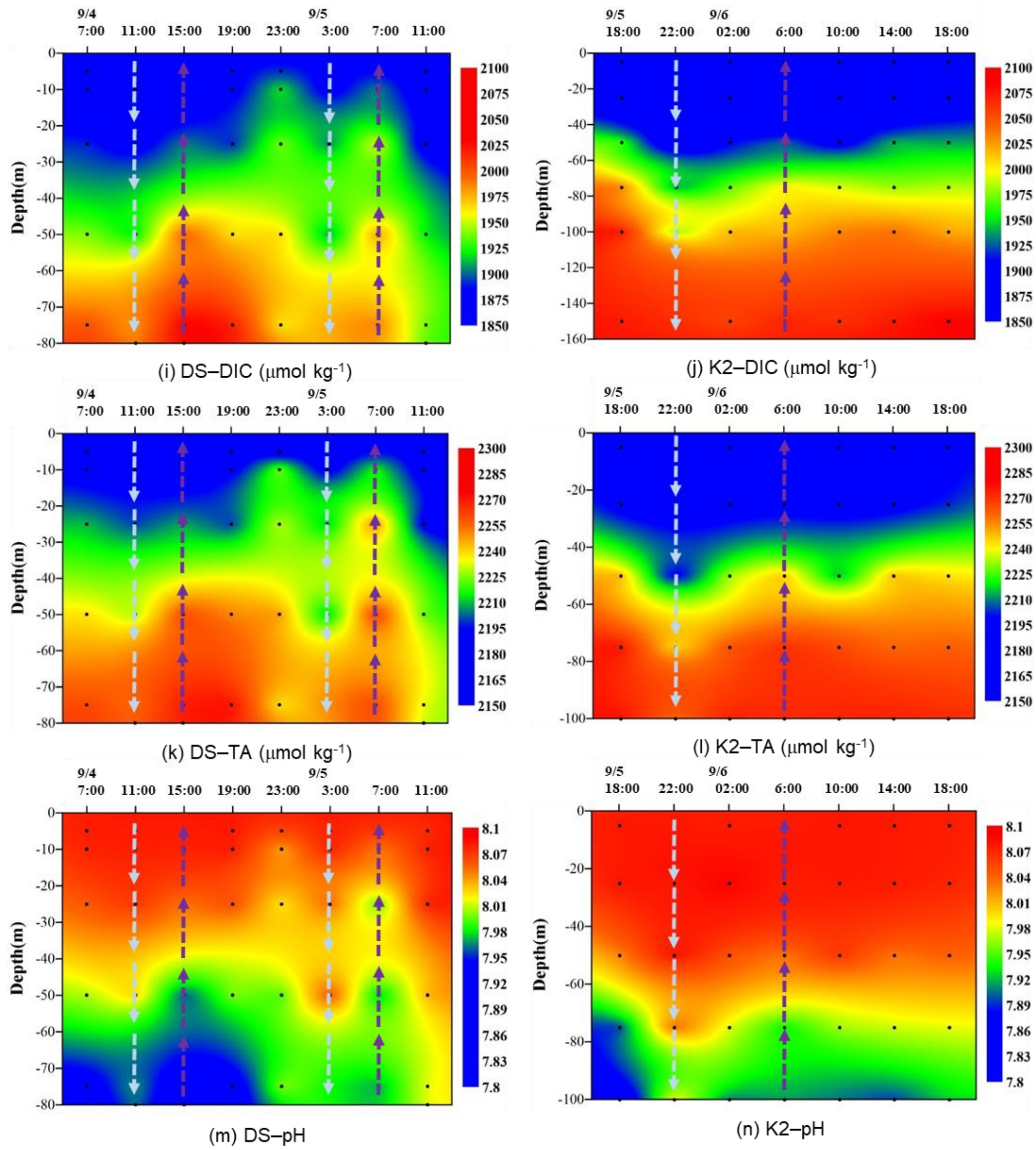
1. Supplementary Figures



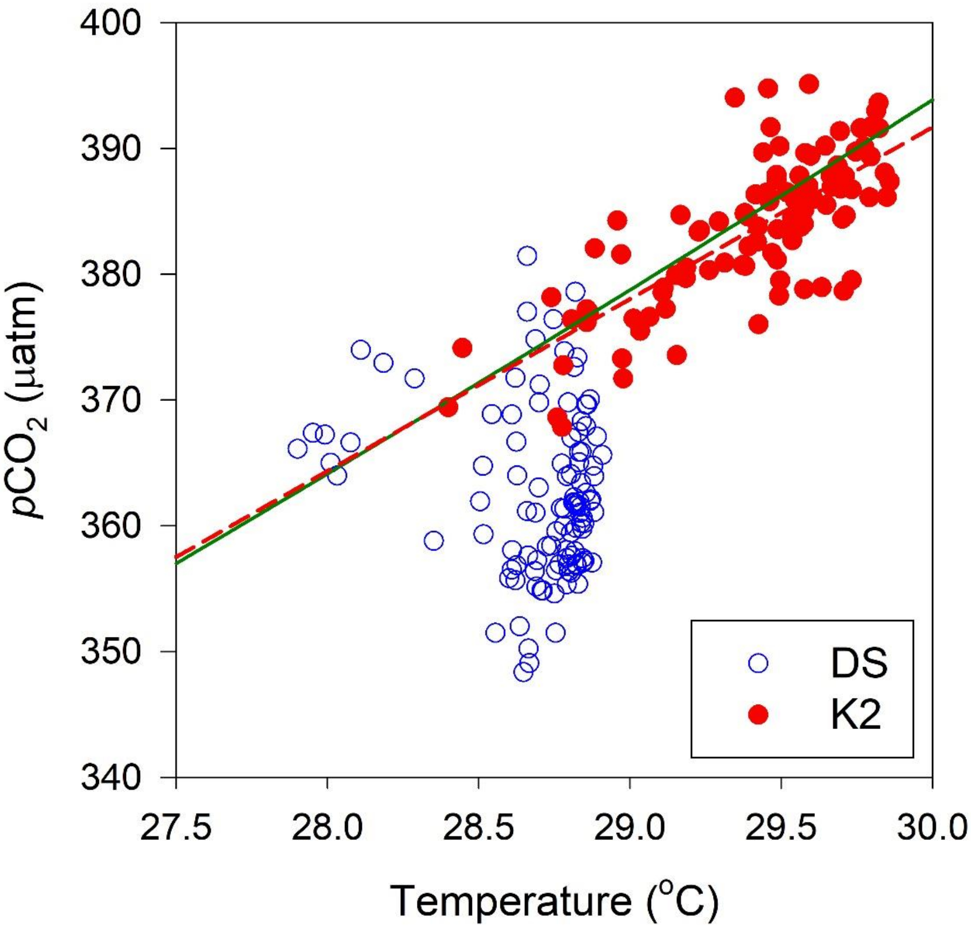
Supplementary Figure 1. The configurations of the moored buoys deployed at the (a) DS, and (b) K2 stations. The moored buoy at the DS station contains 9 temperature data loggers (Minilog-II-T, VEMCO) at depths of 0, 5, 10, 15, 20, 25, 30, 35 and 45 m; an acoustic Doppler current profiler (ADCP; WH Sentinel, Teledyne RD Instruments) at 40 m; and a pH sensor (SeaFETTM V2, Sea-Bird Scientific) and a pCO_2 sensor (Mini CO2TM, Pro-Oceanus Systems) at 2 m. The moored buoy at the K2 station contains 14 temperature data loggers at depths of 0, 20, 40, 60, 80, 120, 140, 160, 180, 220, 240, 260, 280 and 300 m; two ADCPs at depths of 100 m and 200 m; and a pH sensor and a pCO_2 sensor at 2 m.



Supplementary Figure 2. The temporal variations in the depth distributions of temperature (a and b), salinity (c and d), nitrate (e and f), and Chl *a* (g and h) at the DS (left) and K2 (right) stations. The light blue and purple arrows denote the downward and upward phases of isotherm displacements.



Supplementary Figure 2 (continued) The temporal variations in the depth distributions of DIC (i and j), TA (k and l), and pH (m and n) at the DS (left) and K2 (right) stations. The light blue and purple arrows denote the downward and upward phases of isotherm displacements.



Supplementary Figure 3 Plot of pCO_2 vs. temperature for the data collected from the DS (open circles) and K2 (solid circles) stations. The dashed line represents the linear regression on the data collected from the K2 station, and the solid line corresponds to the theoretical thermodynamic dependency between pCO_2 and temperature.

2. Supplementary Table

Supplementary Table 1. A comparison of the variation range and mean ± standard deviation of temperature, pCO_2 and pH in surface water (2 m) between the DS and K2 stations. Differences in all parameters' means between the DS and K2 stations were assessed using an analysis of variance (f-test) followed by a comparison of mean values (t-test), and a significance level (p-value) of 0.001 was used to determine significant statistical differences.

	DS station	K2 station	p-value
Temperature (°C)	27.9–28.9 (28.7±0.2; n=109)	28.4–29.9 (29.4±0.3; n=97)	$p<0.001$
pCO_2 (μatm)	348–381 (362±7; n=109)	368–395 (383±6; n=97)	$p<0.001$
pH	8.01–8.05 (8.03±0.01; n=163)	8.00–8.03 (8.01±0.00; n=146)	$p<0.001$

Supplementary Method

Calculation of temperature driven *p*CO_2 and non-temperature driven *p*CO_2

In order to better understand the processes controlling the observed variation in surface *p*CO_2, we have calculated the temperature driven *p*CO_2 and non-temperature driven *p*CO_2 using the method proposed by Takahashi et al. (2002):

Temperature driven pCO_2 = (Mean pCO_2) × exp [$0.0423(T_{obs} - T_{mean})$]…(1)

where T is temperature in °C, and the subscripts "mean" and "obs" stand for the average and observed values, respectively. In the calculations, we used the averaged values of *p*CO_2 (362 and 383 μatm for the DS and K2 stations, respectively) and temperature (28.7 and 29.4℃ for the DS and K2 stations, respectively) measured throughout the mooring period as the mean. The resultant *p*CO_2, designated as "temperature driven *p*CO_2", are the expected *p*CO_2 values that are only affected by temperature if a parcel of water with the mean *p*CO_2 value are subjected to temperature changes (the difference between observed and mean temperature) under constant TA and DIC.

Moreover, in order to further discern other factors besides temperature that may affect *p*CO_2 changes, we normalized the observed *p*CO_2 to a constant temperature using the following equation (Takahashi et al. 2002):

Non-temperature driven pCO_2 = $(pCO_2)_{obs}$ × exp [$0.0423(T_{mean} - T_{obs})$] …(2)

where T and the subscripts "mean" and "obs" are defined as the same as those in Eq. (1).

Reference:

Takahashi, T., Sutherland, S.C., Sweeney, C., Poisson, A., Metzl, N., and Tillbrook, B. (2002). Global sea-air CO_2 flux based on climatological surface ocean *p*CO_2, and seasonal biological and temperature effects. Deep-Sea Res. II 49, 1601–1622.