COLLABORATIVE RESEARCH SURVEY ON MARINE FISHERIES RESOURCES AND ENVIRONMENT IN THE GULF OF THAILAND 2018

Carbon dioxide fluxes and chlorophyll-a distribution in the Gulf of Thailand during 2018 Southwest Monsoon

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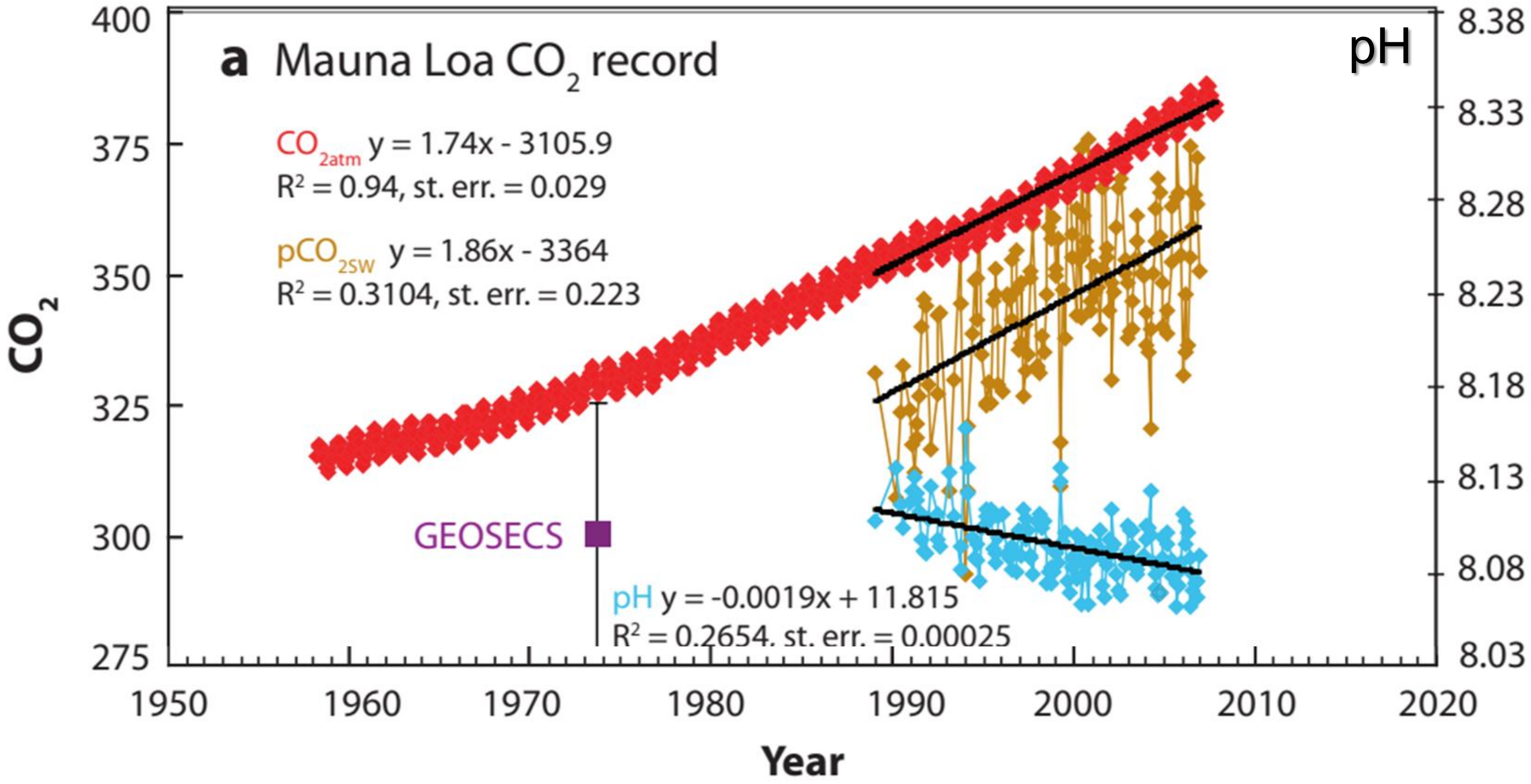
Significance – CO2

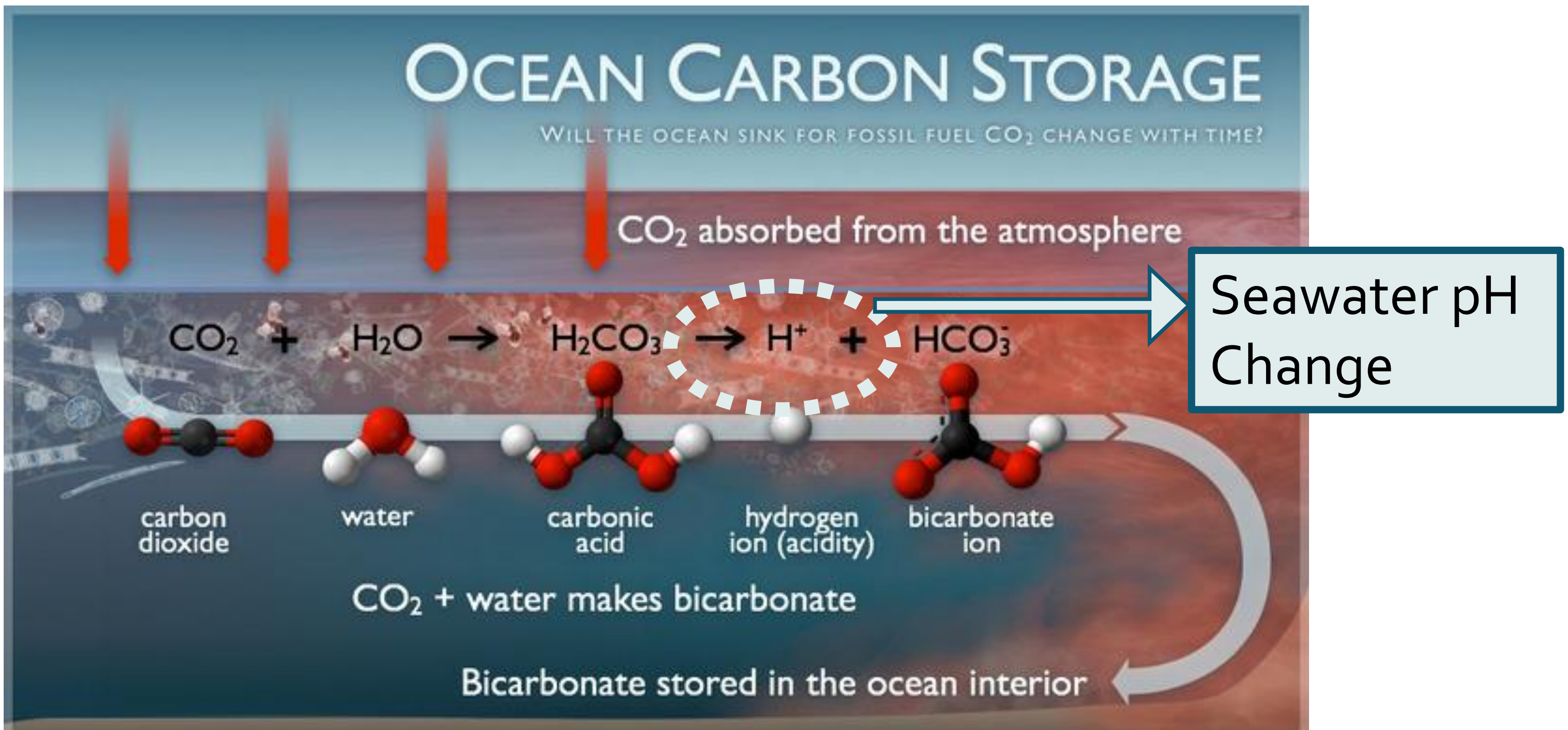
An increase in atmospheric CO2 with the decrease of seawater pH



Doney et al., Annual Review of Marine Science, 2009 1: 169-92

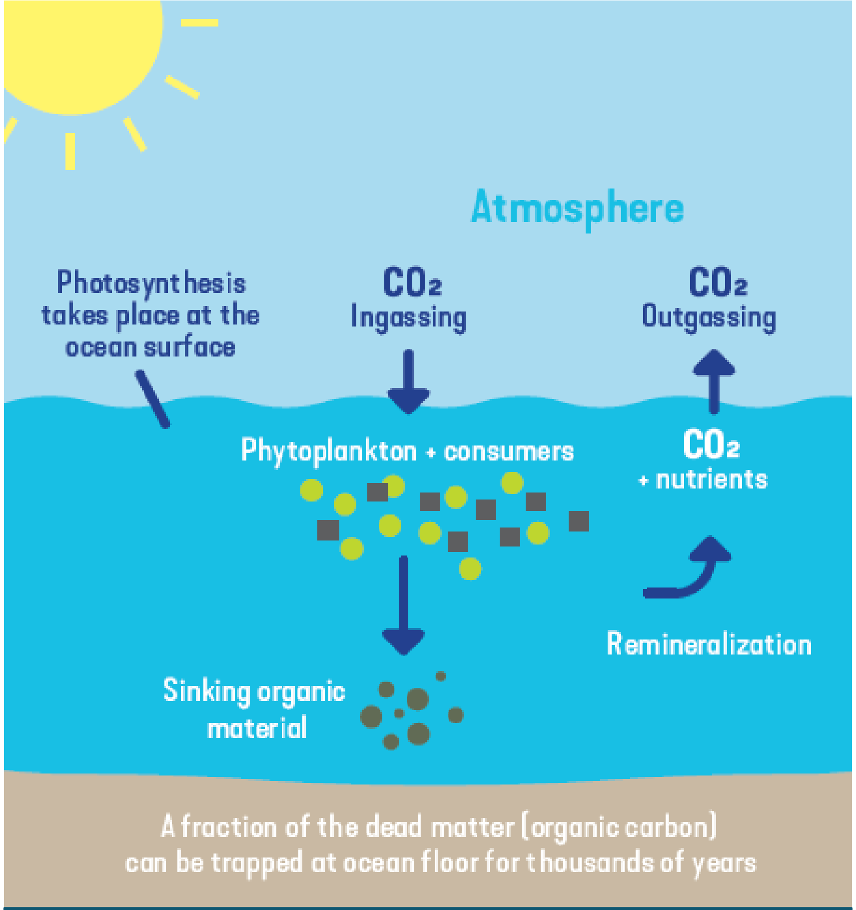
Significance – CO_2

- **Increase of atm CO_2** to 404.06 ppm in 2018
- Ocean ; **adsorb CO_2 and react with seawater**
- Dissolved CO_2 **Speciation**; H_2CO_3, HCO_3^- and CO_3^{2-}



https://www.pmel.noaa.gov/co2/files/pmel-research.004_med.jpg

Significance – Carbon cycle in ocean

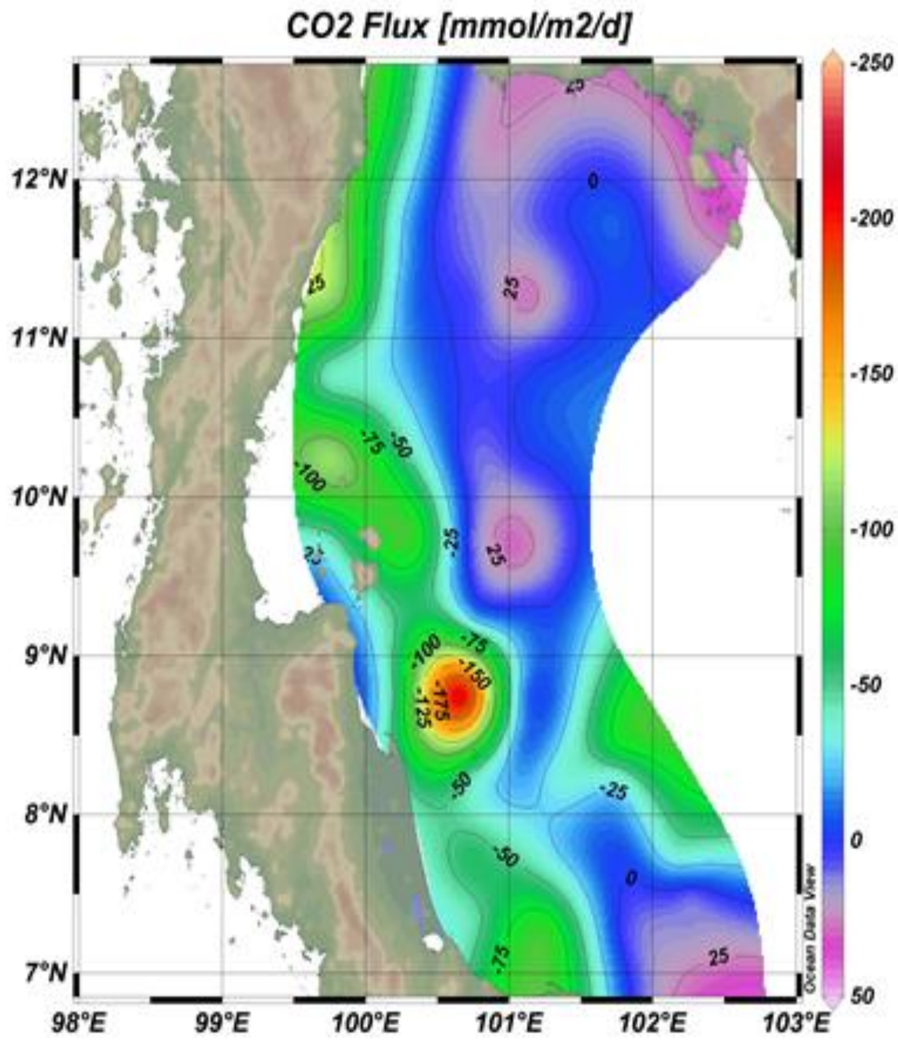


Carbon pump and solubility pump

- Modern Ocean = H^+ increase
- Change buffering capacity (pH) => ocean acidification
- Reduction of primary productivity (Chlorophyll-a)
- Dissolution of $CaCO_3$ shell formation

https://marine.copernicus.eu/wp-content/uploads/2019/07/Carbon-pump.png

Significance – GOT as CO_2 storage



Previous study- SEAFDEC 2013 (inter monsoon)

Flux CO_2 [mmol/m^{-2}day]

(-249) – (+36)
(sink) (source)

Consider as CO_2 sink except coastal area (blue-pink color)

Pisut Tassawad, 2014

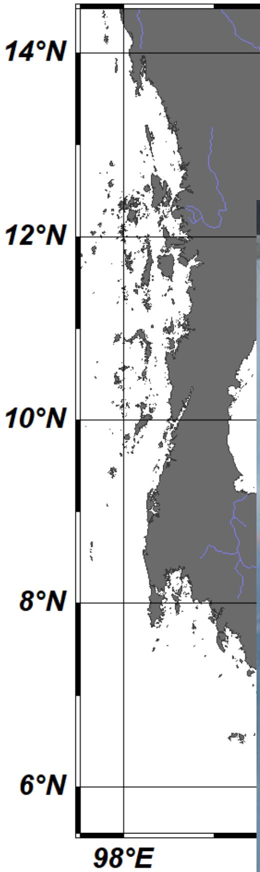
Objective - Air-Sea CO_2 Flux in GOT

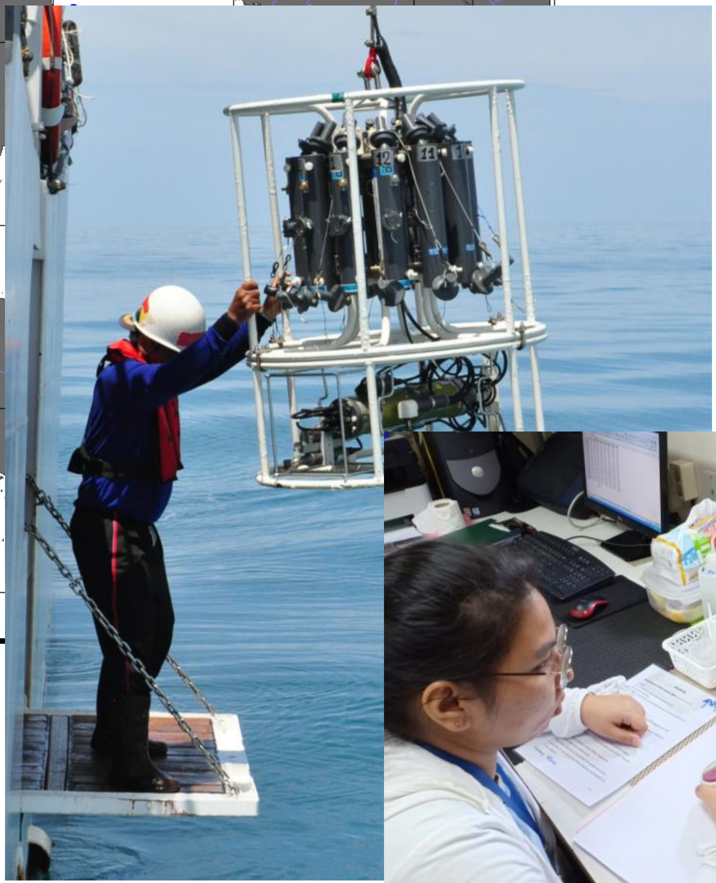
Role and capacity of the GOT as carbon (as CO_2) storage

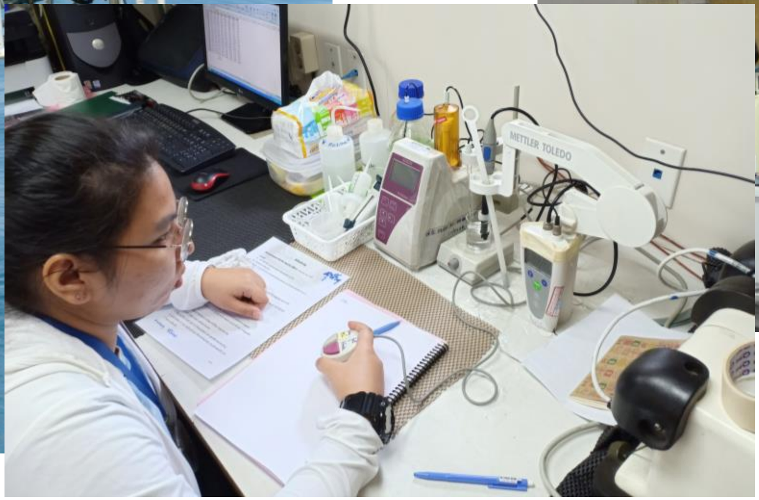
Scope of study – Sampling and Data

- **Calculation air-sea flux of CO_2** required data inputs from SEAFDEC-2018 research survey as follows
- 73 station (4-6 depths) – water sampling with Niskin bottles coupled with CTD rosette system data
  - CTD data => salinity [psu], pressure [dbar], pH and temp [°C]
  - Niskin Bottles (water sampling) => total alkalinity, nutrient; silicate and phosphate, chlorophyll-a, total suspended solid
  - Meteorological data; wind speed [m/s]

Sampling and preparation







Sample and data analysis for CO_2 Flux

- Silicate, phosphate and chlorophyll-a; colorimetric method (Strickland and Parsons, 1972)
- Total alkalinity – potentiometric titration with gran plot (Grasshoff et al., 1999)
- Calculation of CO_2 speciation in seawater (CO2SYS ver 25) (Pelletier et al.,2015 and Lewis and Wallace, 1998) ; pCO_2 [uatm] and TCO_2 [umol/kg sw]
- Air-Sea Flux Calculation [mmol/m²/d] (Balcorta, 2015; Matlab code)

Air – Sea flux of CO2 ($mmol.m^{-2} d^{-1}$)

$$FCO2 = K*a(dpCO_2)$$

Where dpCO2 is $pCO2_{agua} - pCO2_{atm}$

$pCO2_{atm}$: fix value(404.66 ppm; NOAA, 2018)

K is the transfer velocity (Wanninkhof, 1992)

a = CO2 solubility constant (Weiss ,1974)

(+) sea > air => **source**

(–) sea < air => **sink**

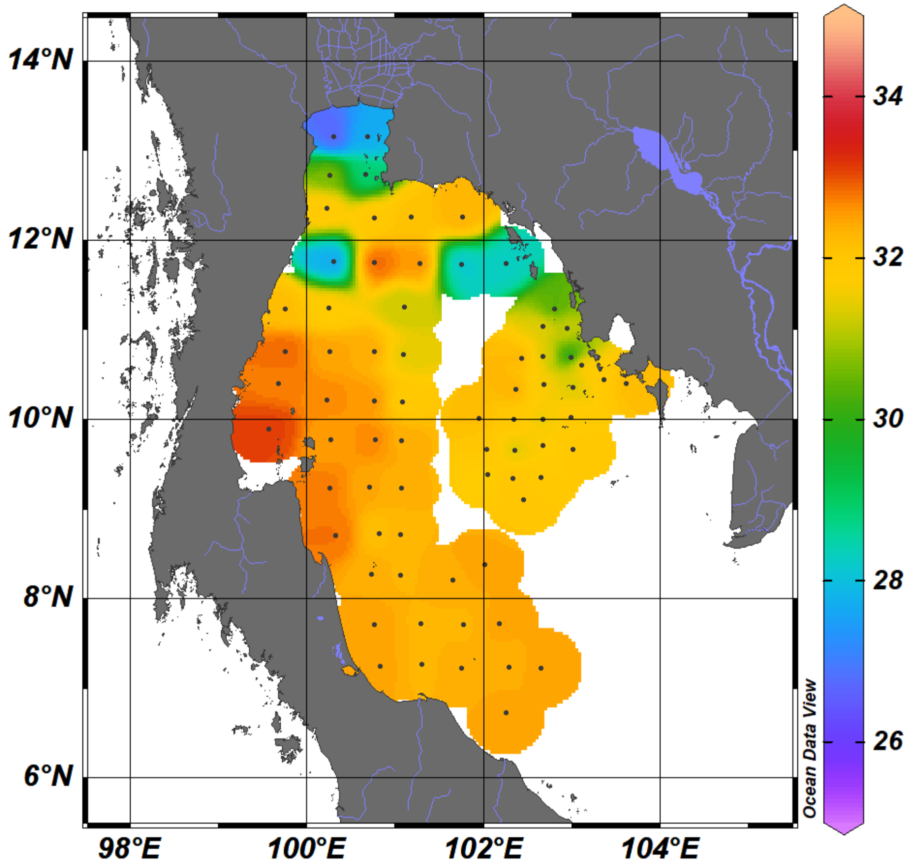
Function for air-sea CO2 flux calculation in matlab
(Cecilia Chapa Balcorta, 2015)

Summary – Parameters in SEAFDEC-2018

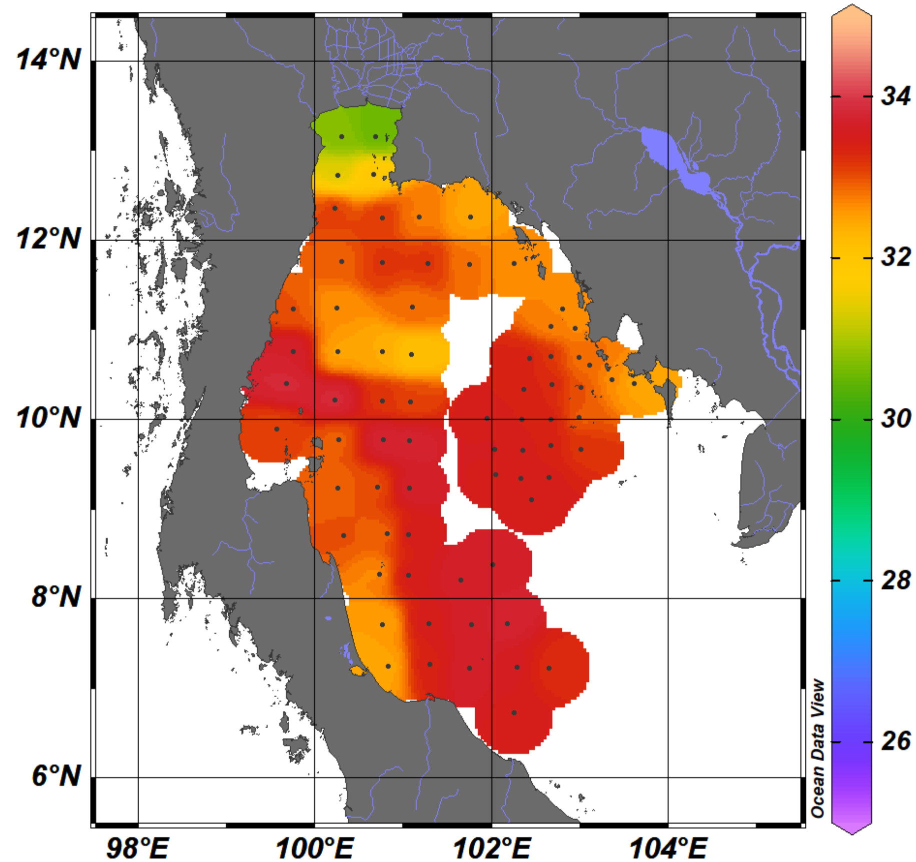
Parameter	Min	Max	Avg	± SD
Salinity[PSU]	26.7	33.8	32.5	0.90
pH	7.690	8.302	8.118	0.101
Temperature[°C]	25.7	30.1	28.7	0.82
Oxygen[mg/l]	3.80	8.28	6.58	0.95
Alkalinity [µmol/KgSW]	1833	2506	2099	88.59
Phosphate [µmol/KgSW]	0.01	0.50	0.11	0.08
DSi [µmol/KgSW]	2.37	57.4	13.6	13.2
Chlorophyll-A [µg/L]	0.03	4.26	0.51	0.55
TSS [µg/L]	1.27	25.07	6.55	2.62
TCO2 [µmol/KgSW]	**1608**	**2231**	**1850**	**92.81**
pCO2 [µatm]	**282.2**	**1443.7**	**503.0**	**172.2**

Salinity

Salinity [PSU] 5 m below surface

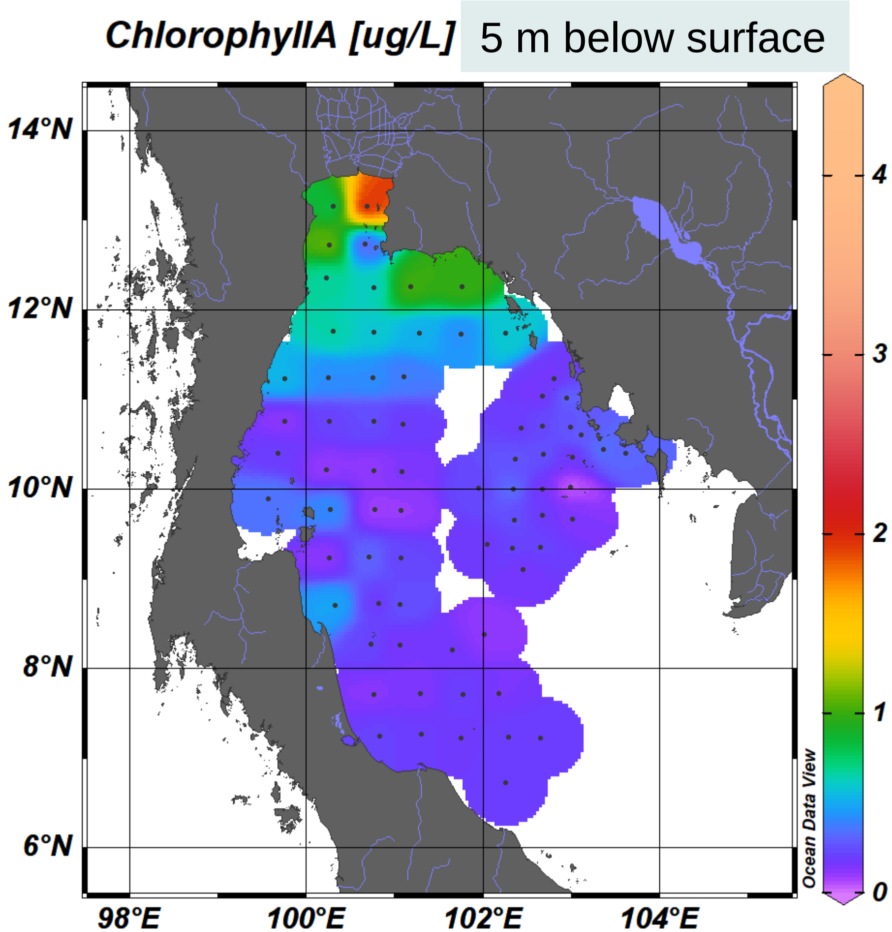


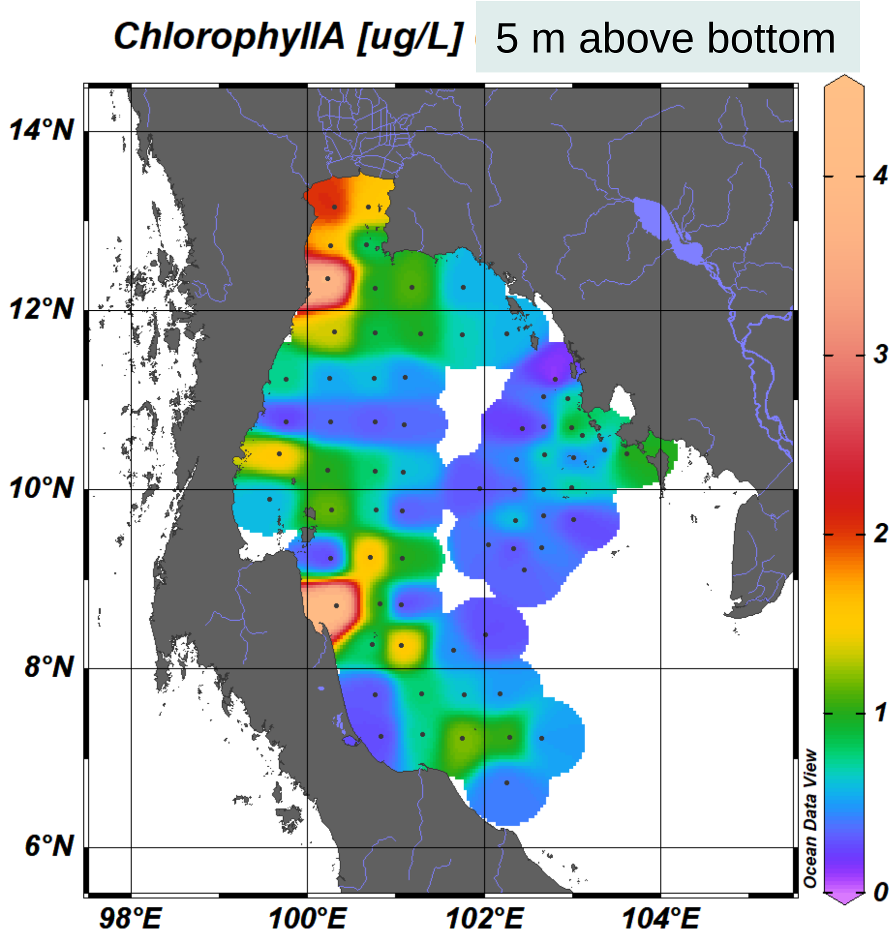
Salinity [PSU] 5 m above bottom



Greater salinity in bottom water

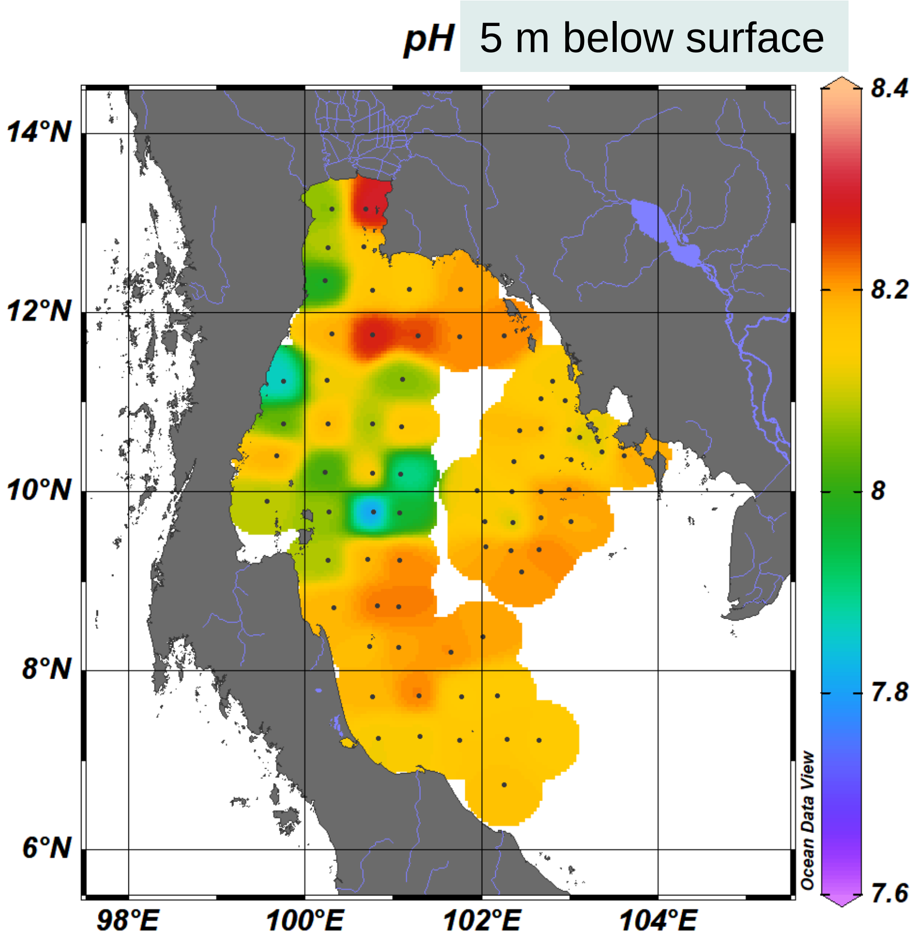
Chlorophyll-A [ug/L]

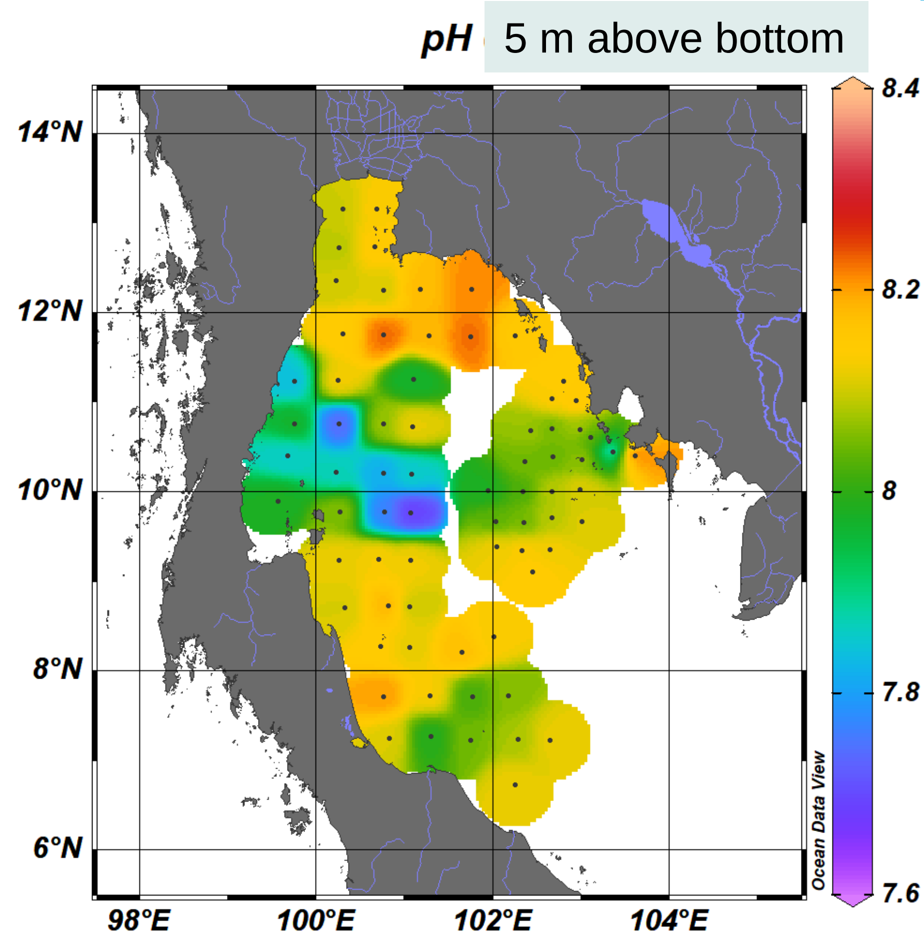




Greater bottom Chl-a => higher productivity
(higer conc. of bottom nutrient)

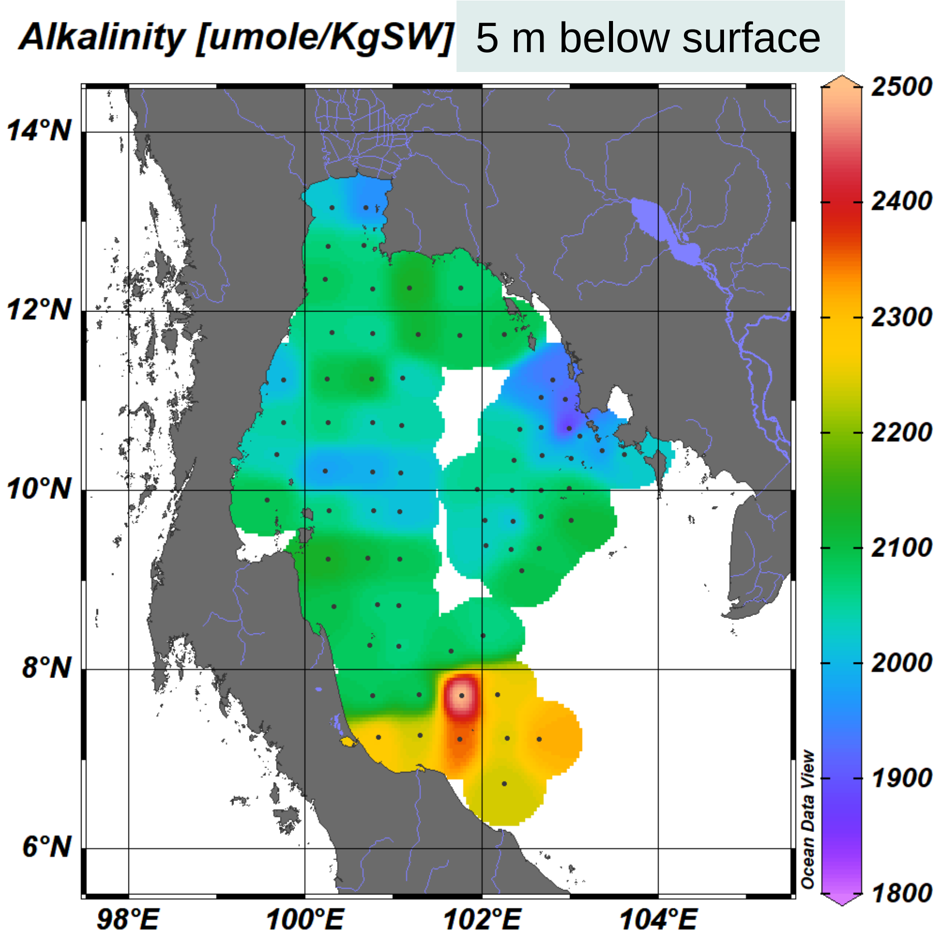
pH

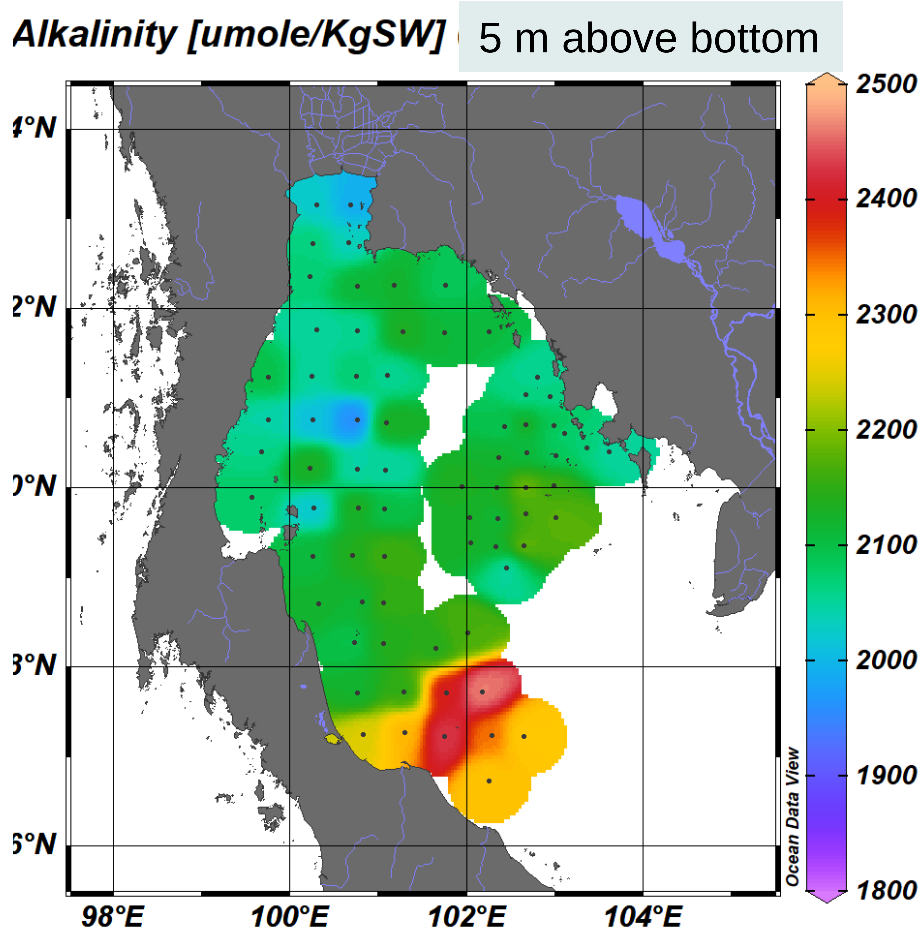




Lower pH in bottom water

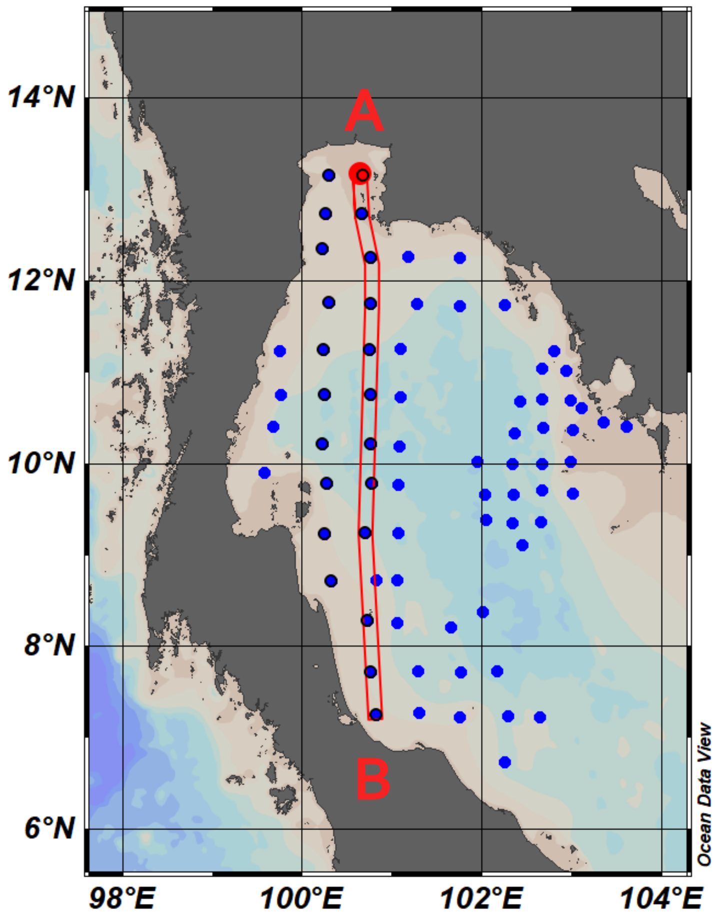
Total Alkalinity [umol/kg-sw]

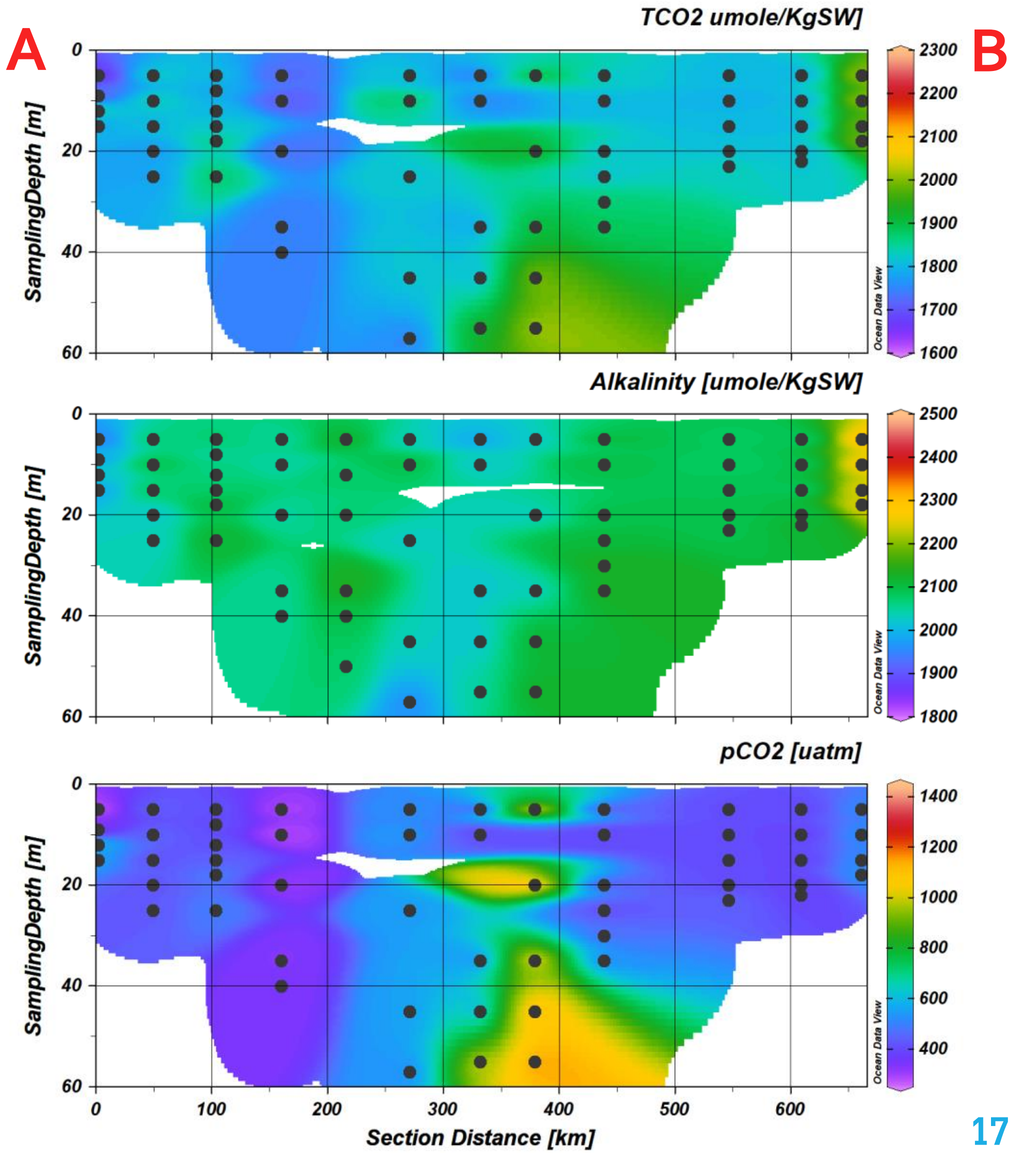




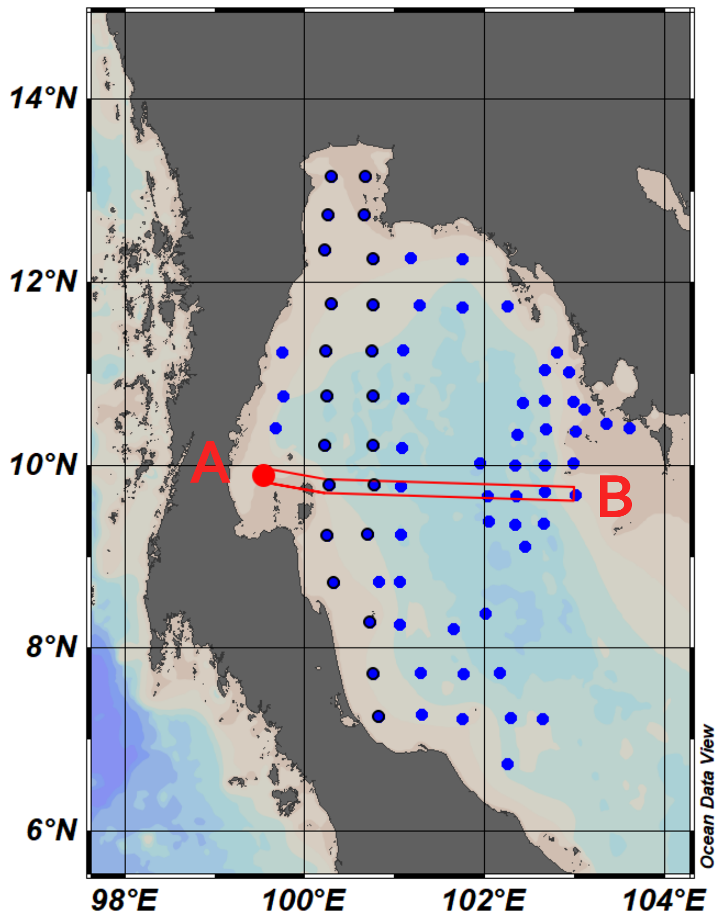
Highest conc. in lower GOT [greater buffering capacity]

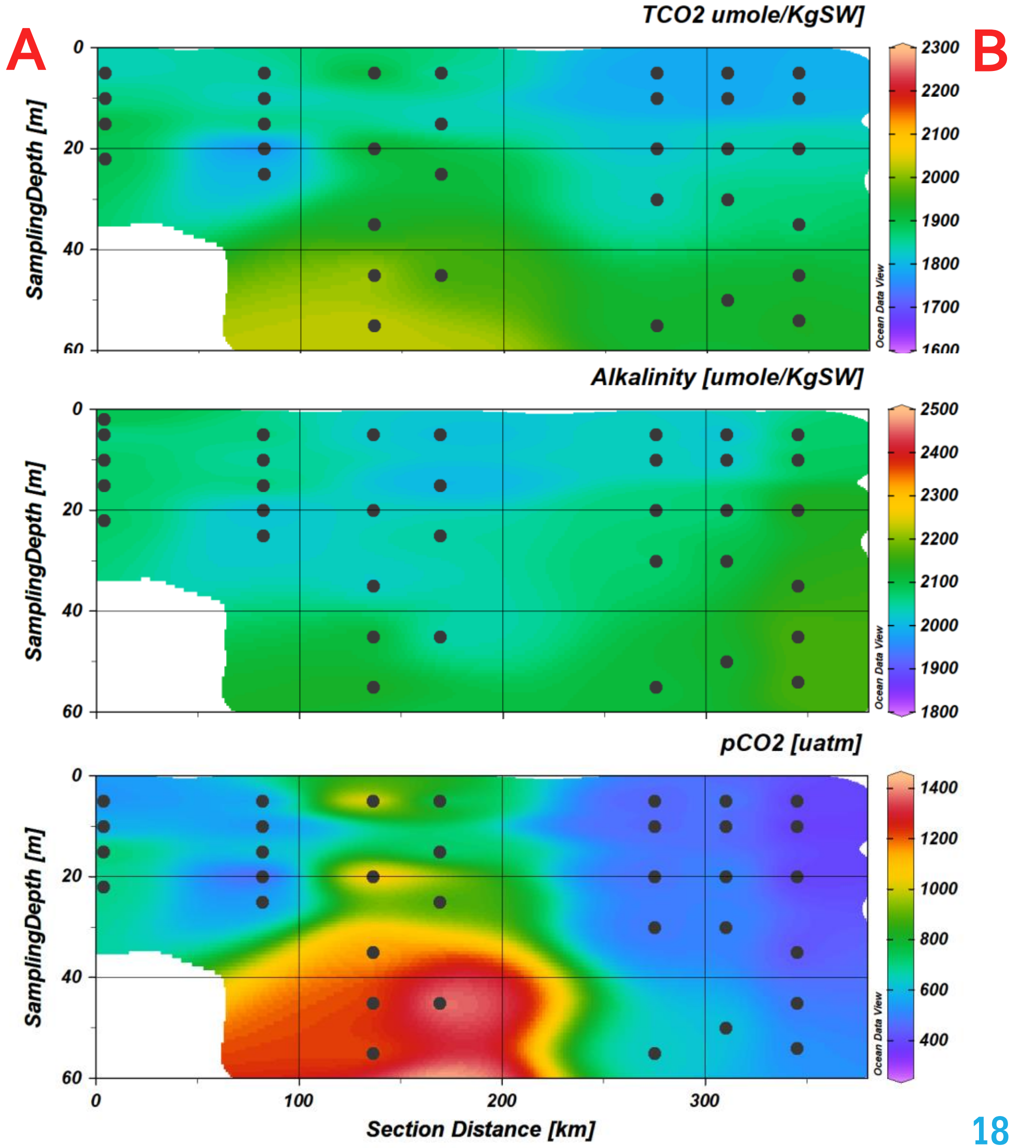
Cross section – North to South



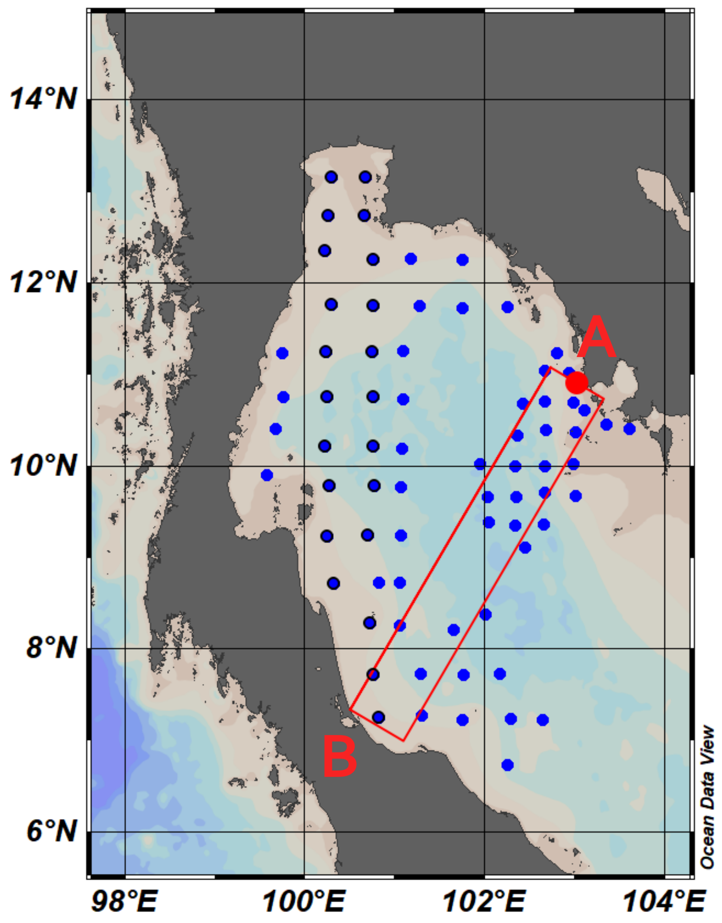


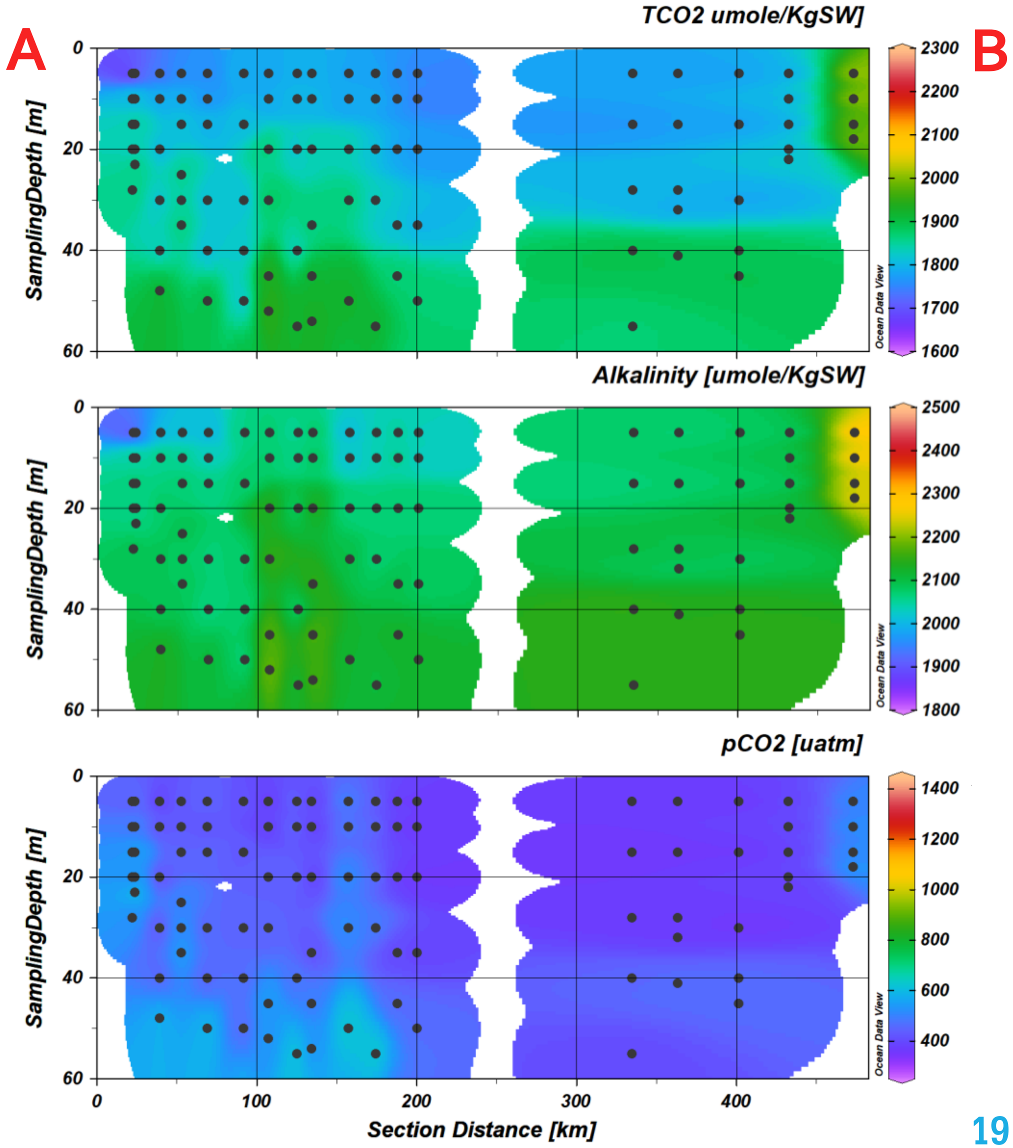
Cross section – West to East



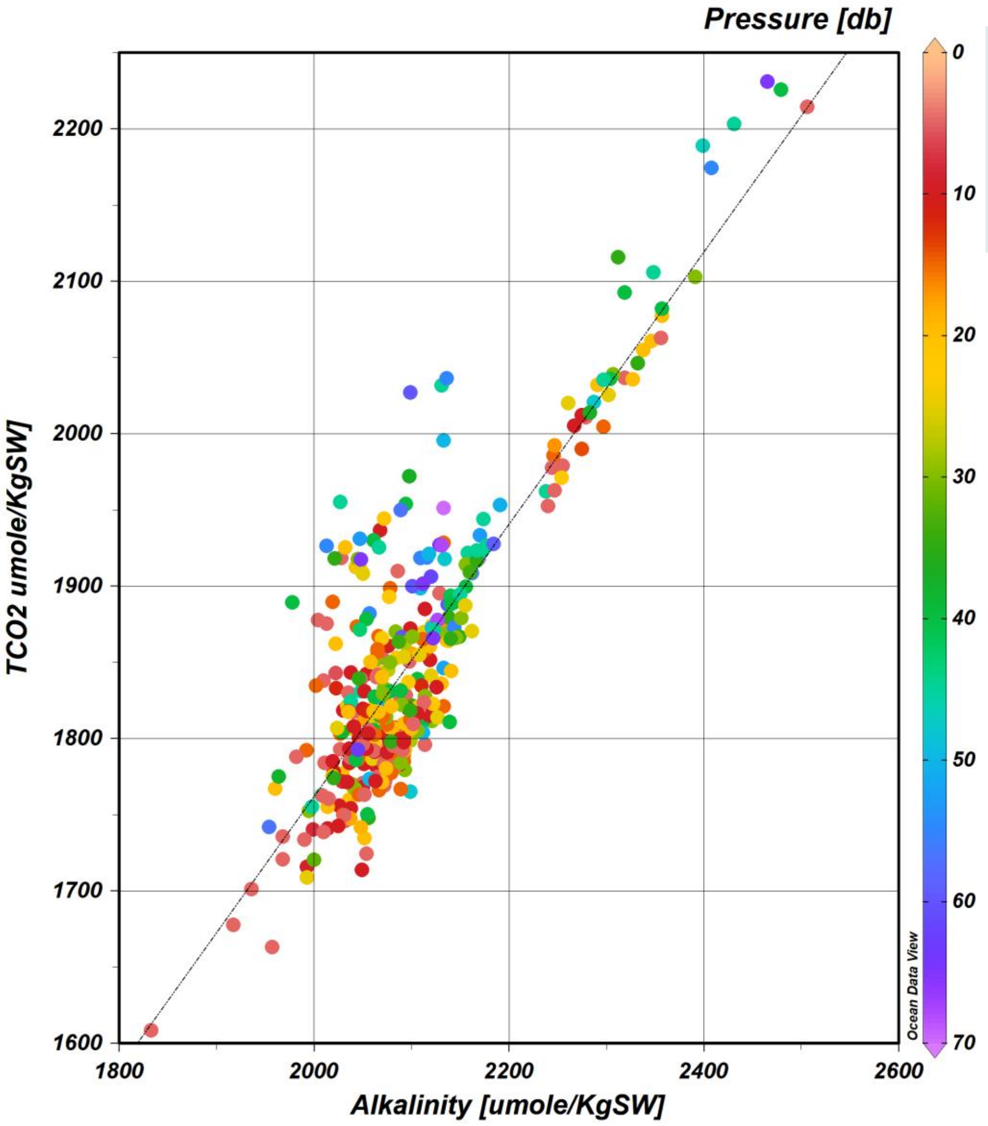


Cross section – Across Sill





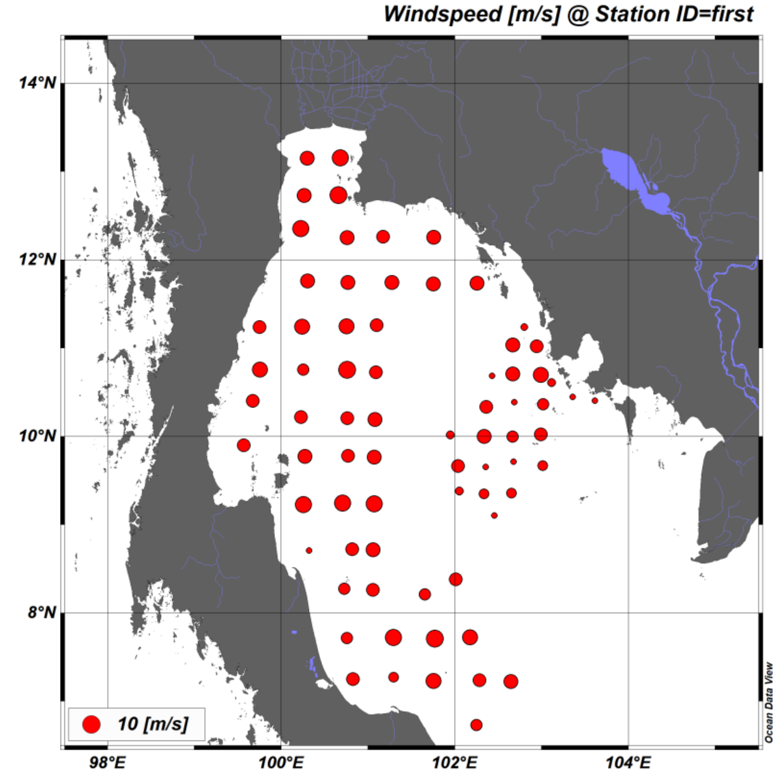
Scatter plot



Relationship [Alk] vs [TCO2]

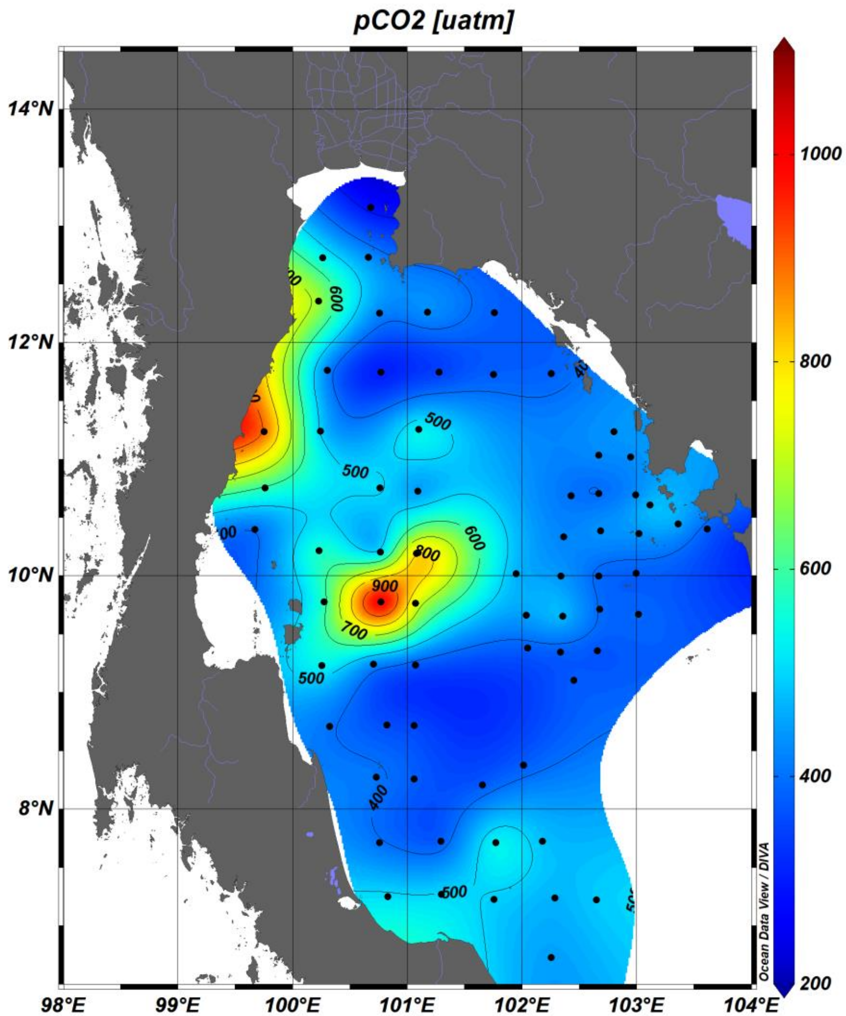
[TCO2] = 0.8479 [Alk] + 58.0487

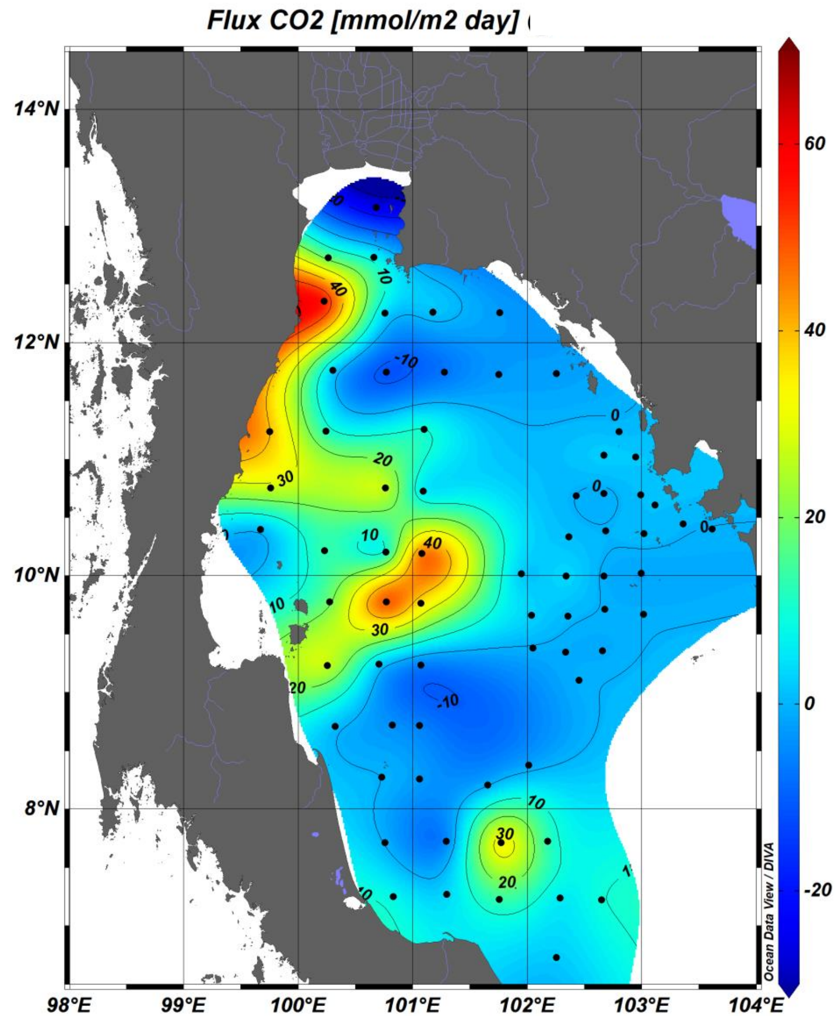
$r^2 = 0.904759$



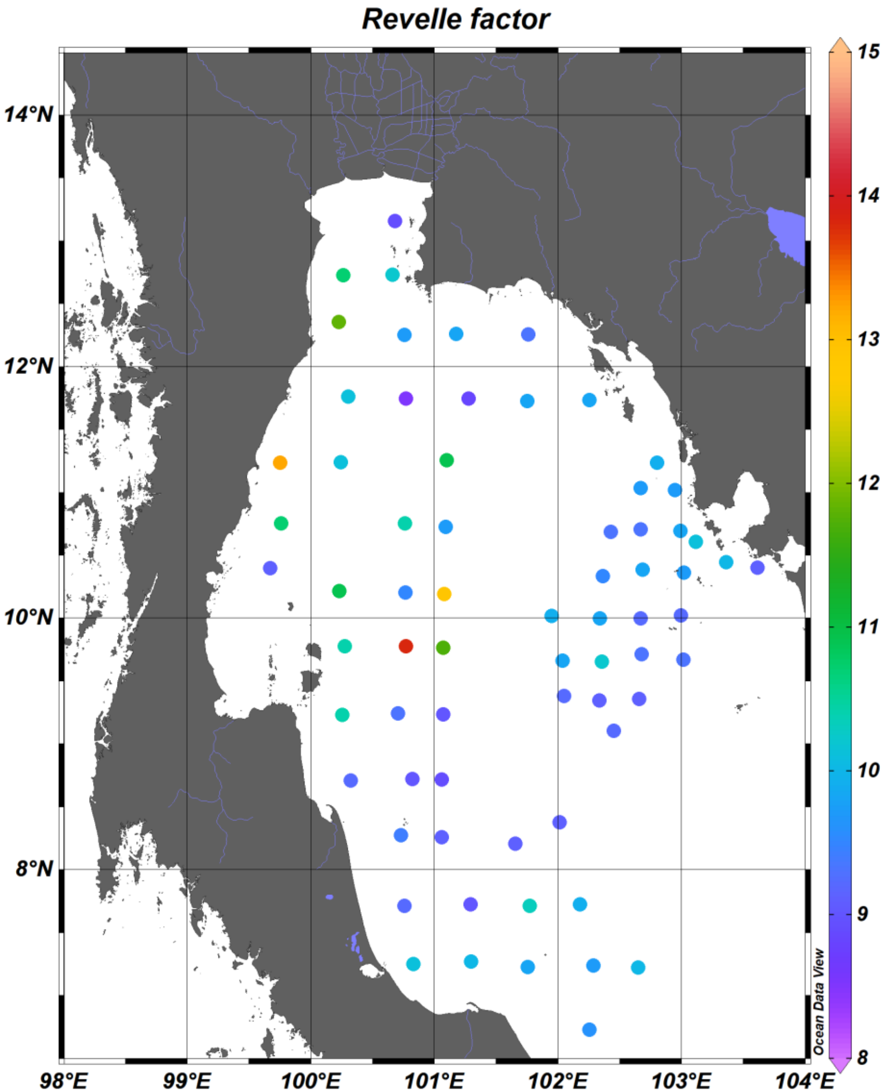
pCO2 [uatm] and CO2 Flux [mmol/m²/day]

Air – Sea Flux of CO_2 in GOT (- 25.6) to (+61.4) mmol/m²/day

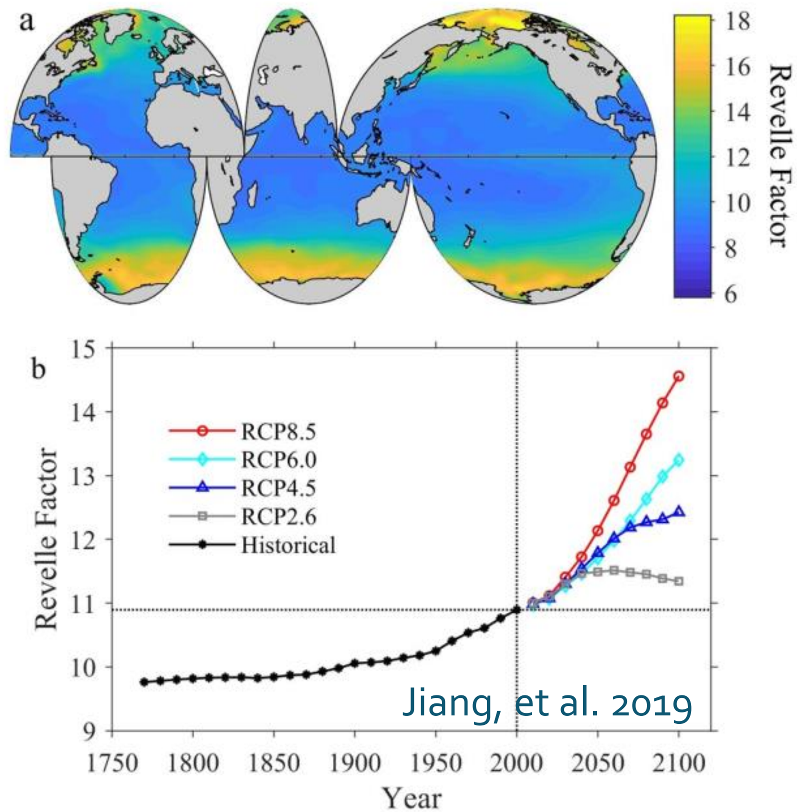




GOT as CO_2 sink (SW monsoon)

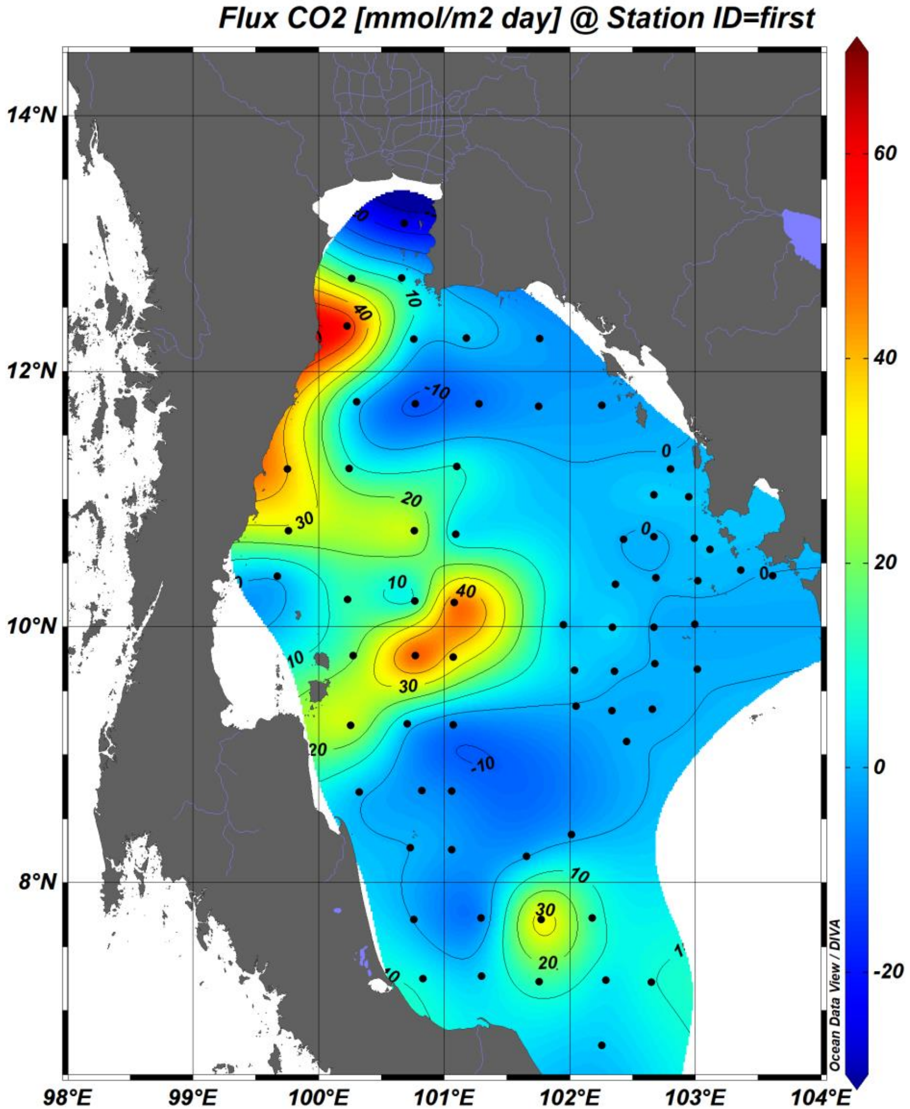


Revelle factor
buffering capacity (8 – 12)



Jiang, et al. 2019

Summary



- Bottom water show higher concentration of nutrients and Chlorophyll-a (mean conc. 0.51 + 0.55 ug/L) while pH is lowering
- However, total alkalinity still greater at bottom (greater buffering capacity)
- Cross section showed high pCO_2 at depth (near 10N)
- Flux of CO_2 range from **(- 25.6) to (+61.4) mmol/m²/day**
- GOT losing it CO_2 storage capacity in comparing with 2013 data

References

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to best practices for ocean CO2 measurements. PICES Special Publication 3, 191 pp)

Jiang L. Q., et al. 2019. Surface ocean pH and buffer capacity: past, present and future. Scientific Reports volume 9, 18624 https://doi.org/10.1038/s41598-019-55039-4

Ocean Data View (R. Schlitzer; Ocean Data View; http:/odv.awi.de, 2016)

Tassawad P. 2014. Sink and source of carbon dioxide in the Gulf of Thailand. Thesis dissertation. Chulalongkorn university

Thank you