A Study on reduction of Chlorophyll-a after a typhoon passage off northeastern Taiwan

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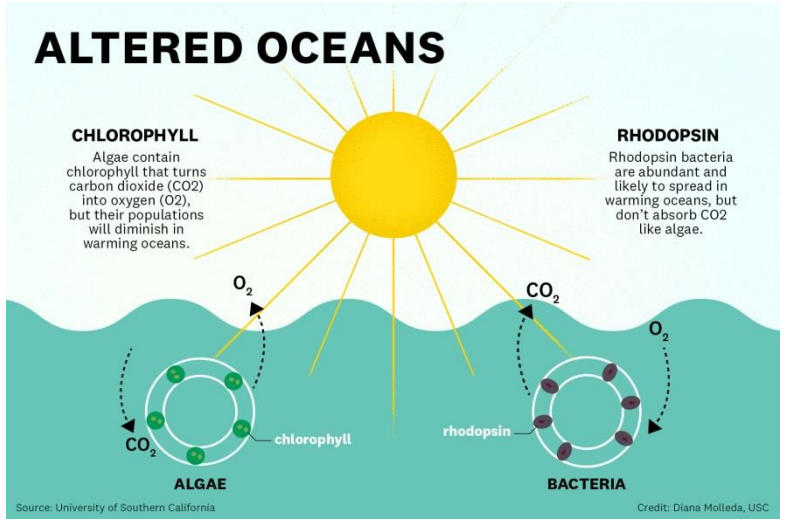
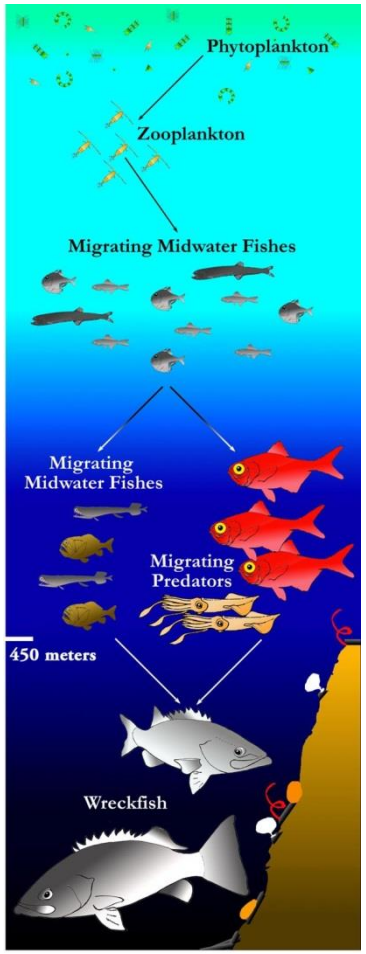
Motivation

Chlorophyll-a (Chl-a) influences
1. Food-chain
2. Carbon cycle → Regulate climate

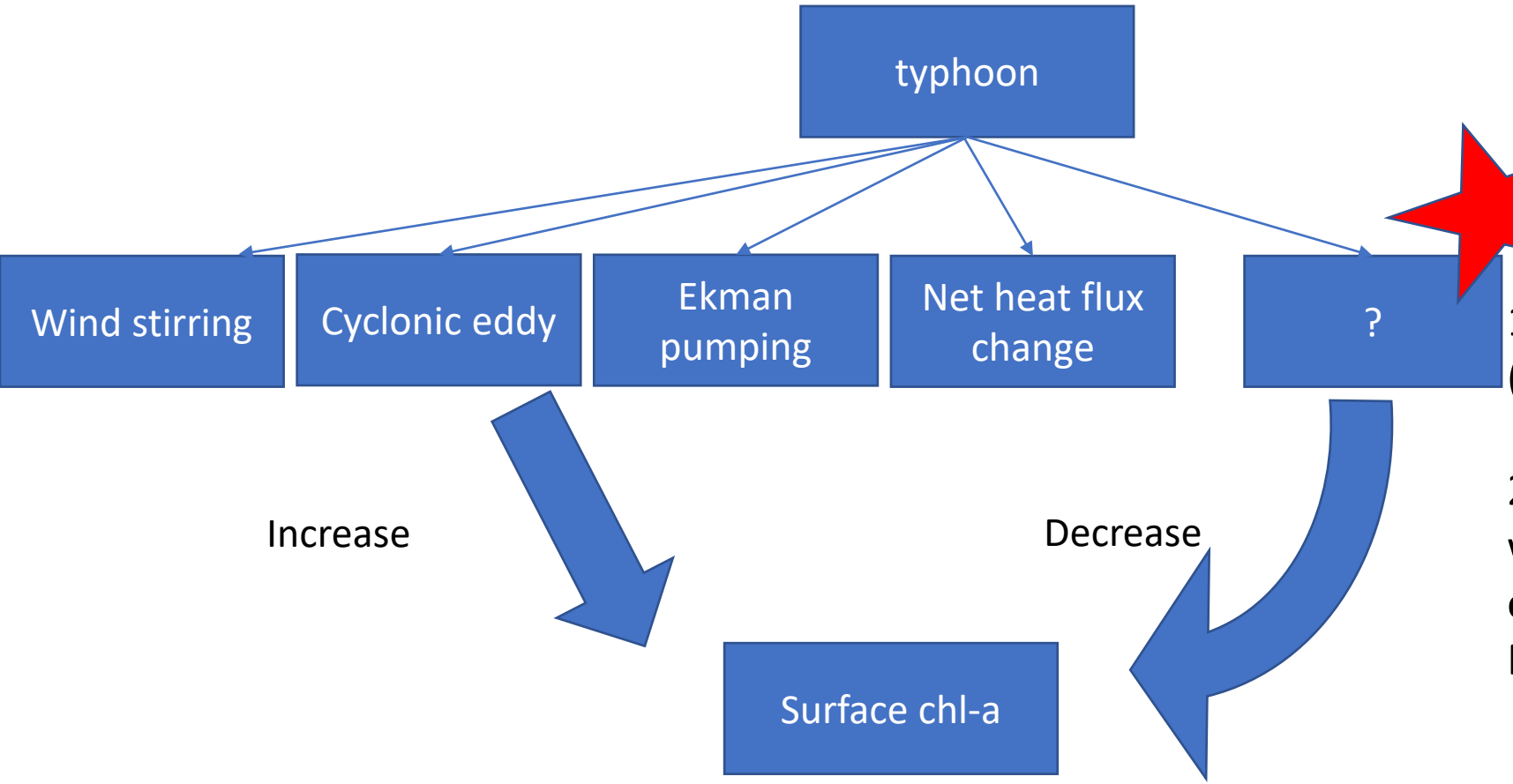


Creator: Illustration/Diana Molleda



https://noaateacheratsea.blog/tag/food-chain/page/2/

Motivation



Targets

1. Confirm whether such phenomena (reduction of Chl-a) really exist

2. Find out the actual physical process with reconstruct the background environment provided by Ocean Model (ROMS)

Data source

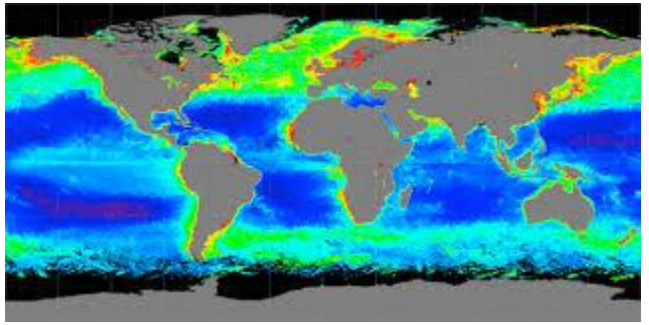
- Chl-a data : OC-CCI Satellite composite data version 4.2

  (https://esa-oceancolour-cci.org/)

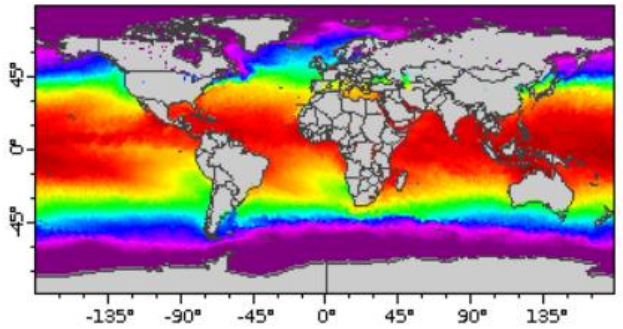
- SST data : NASA JPL MUR SST Analysis (https://coastwatch.pfeg.noaa.gov/erddap/griddap/index.html?page=1&itemsPerPage=1000)

- Typhoon data: IBTrACS

  (http://www.atms.unca.edu/ibtracs/ibtracs_current/)



https://oceancolor.gsfc.nasa.gov/atbd/chlor_a/

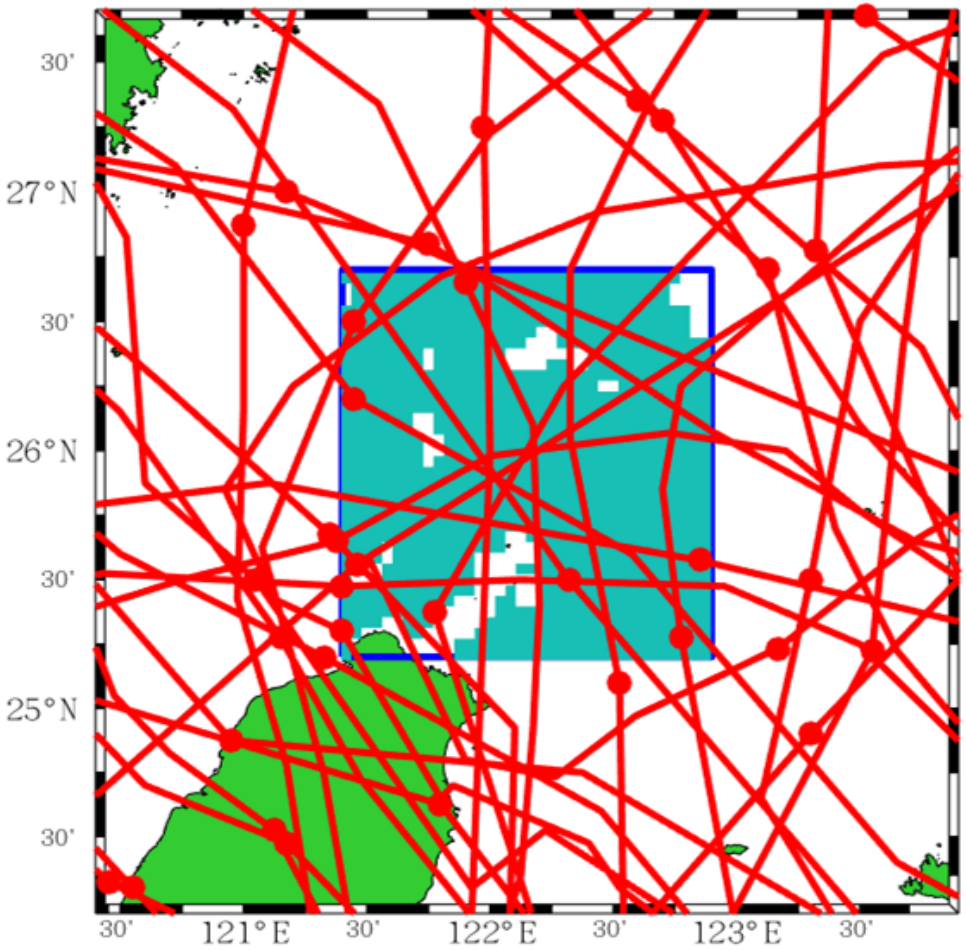


Ocean Model

Regional Ocean Modeling System (ROMS)

- *u, v, w, T, S (in 3-D)*
- deatailed process

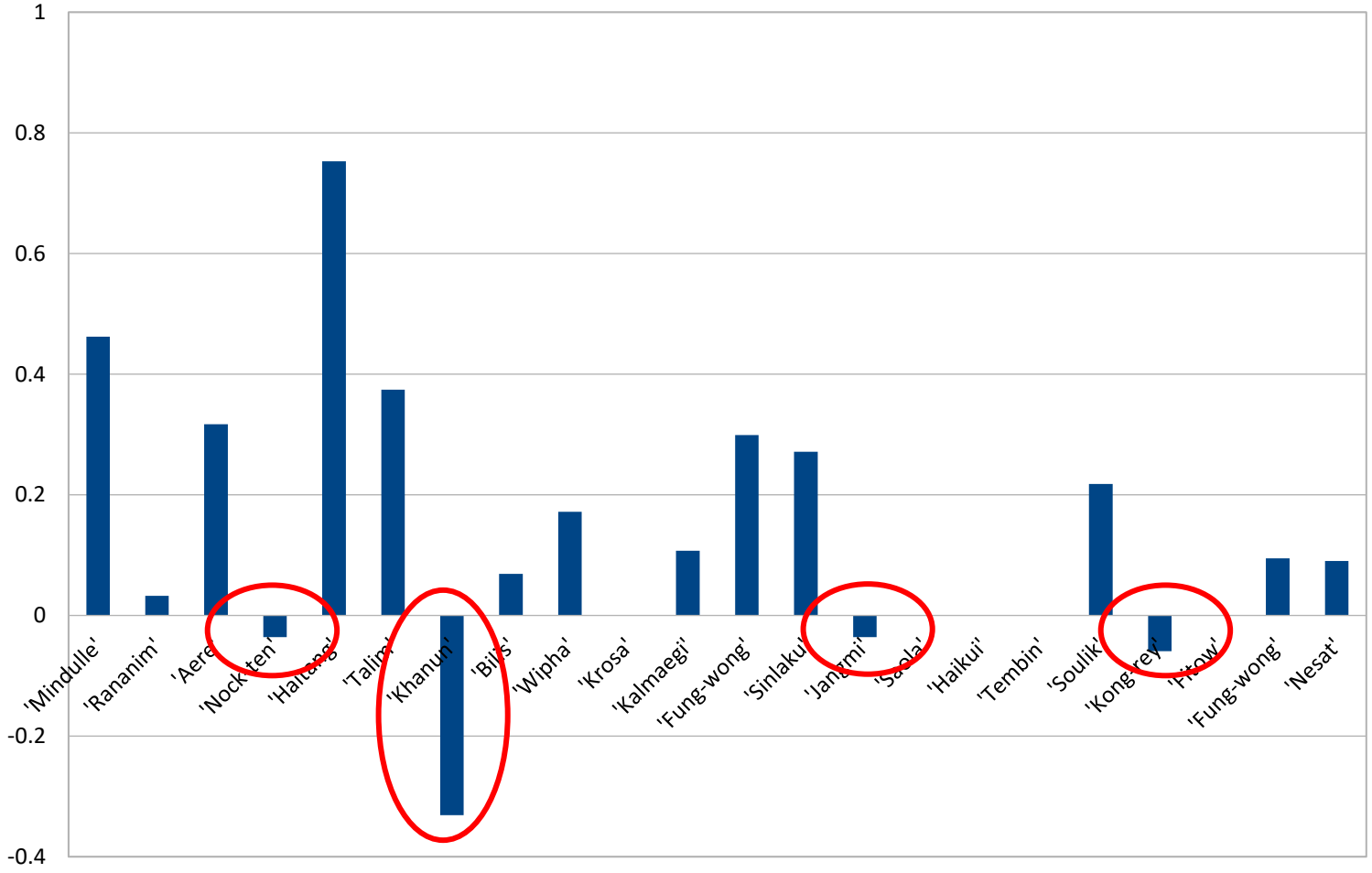
Data process and statistics



Study period : 2003-2017

Study-region : 25.2-26.7N, 121.4-122.9E
(Boundary-region : 24.2-27.7N, 120.4E-123.9E)

Case and Chlorophyll A change



Total : 22 typhoon

5 case Missing values too much(>50%)

4 case decrease

13 case increase

23% typhoon case decrease

Before

After

Khanun

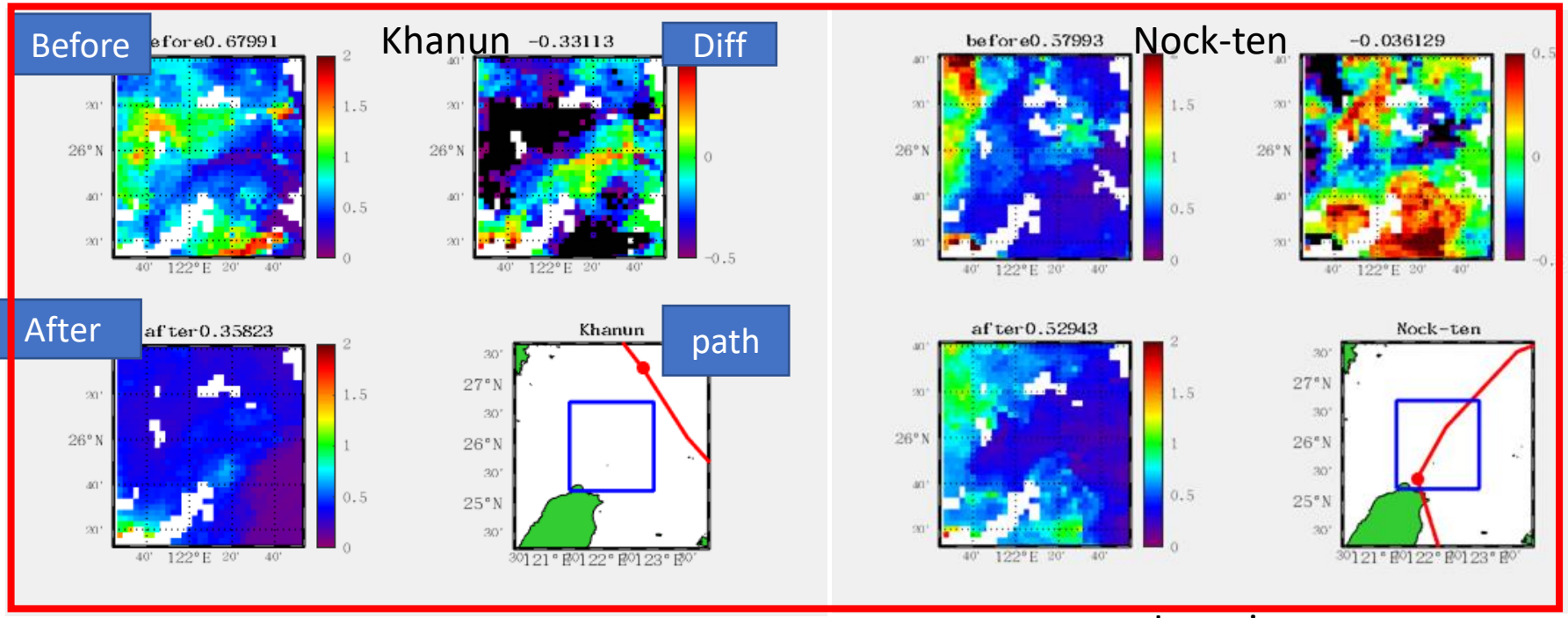
Diff

path

Nock-ten

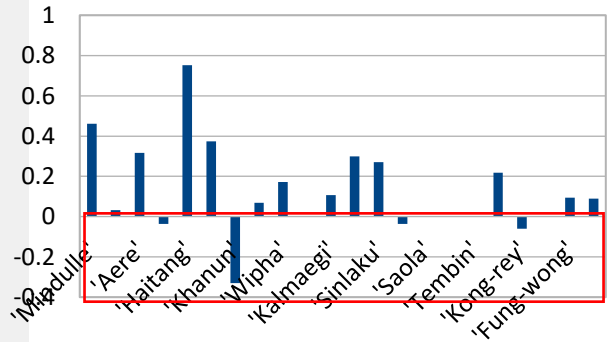
Kong-rey

Jangni



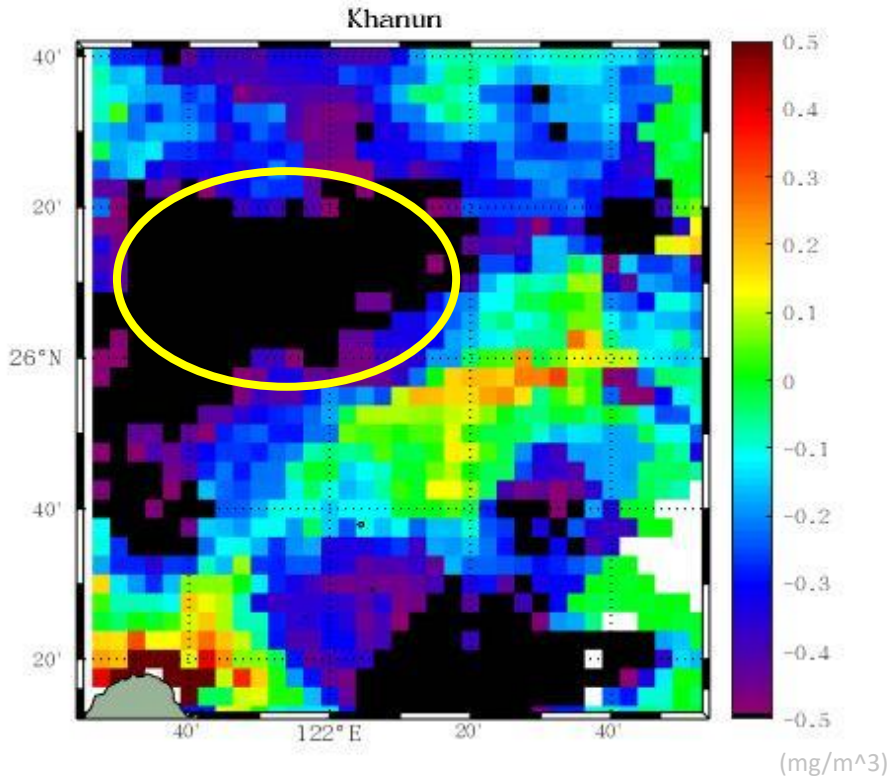
Criteria of data selection

Missing value + Chl-a variation

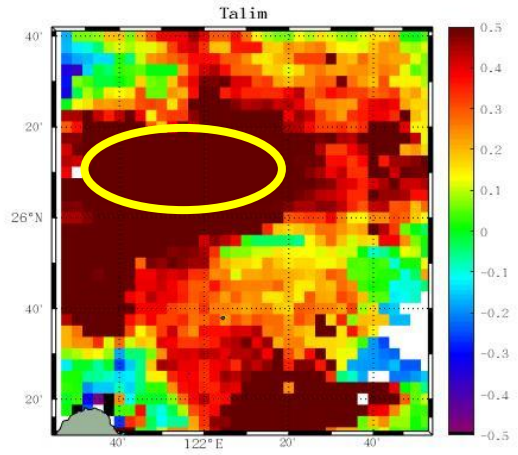


Khanun

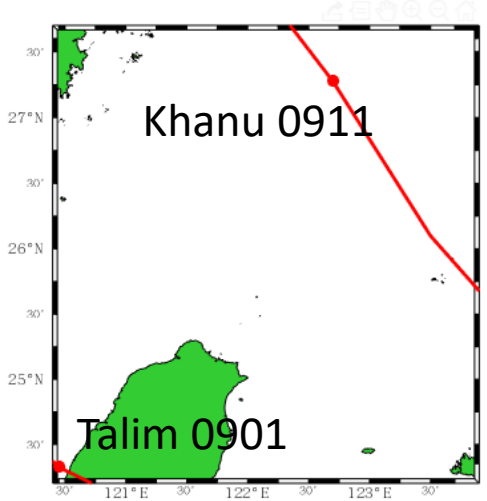
Chl-a change by Khanun



Strong Chl-a increasing by previous typhoon Talim

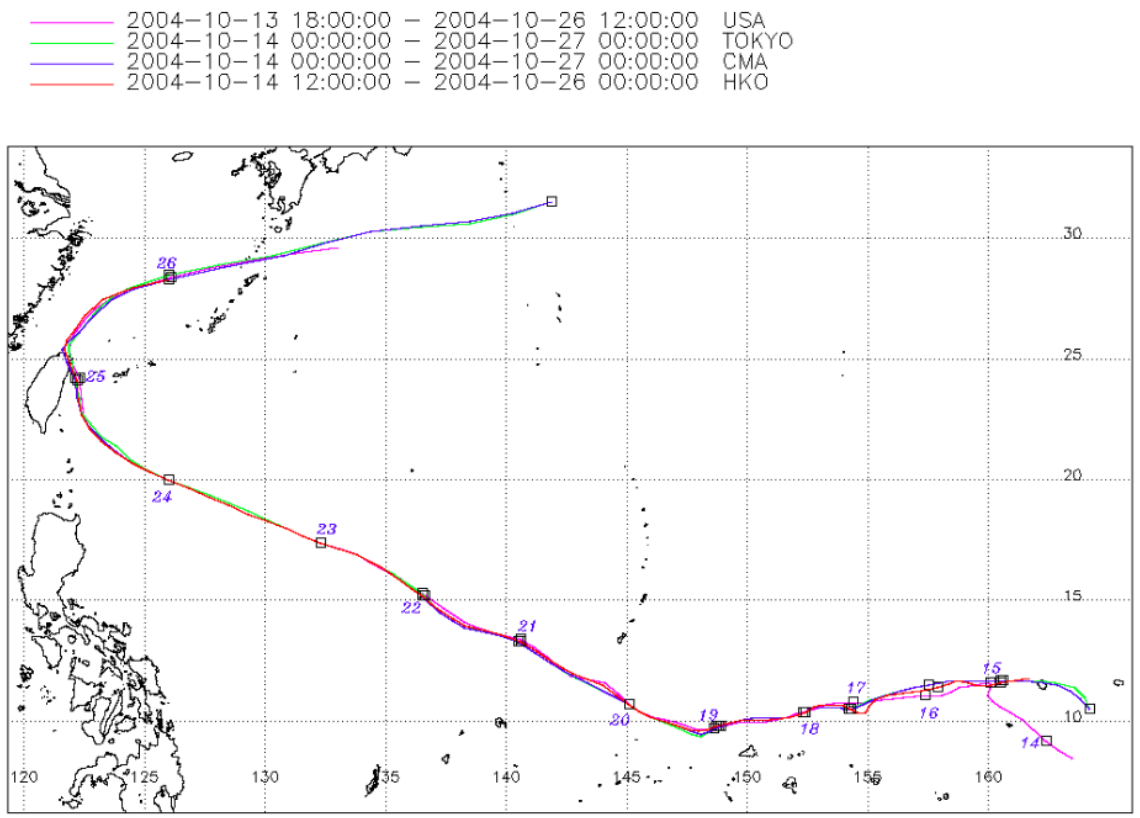


Two close typhoons

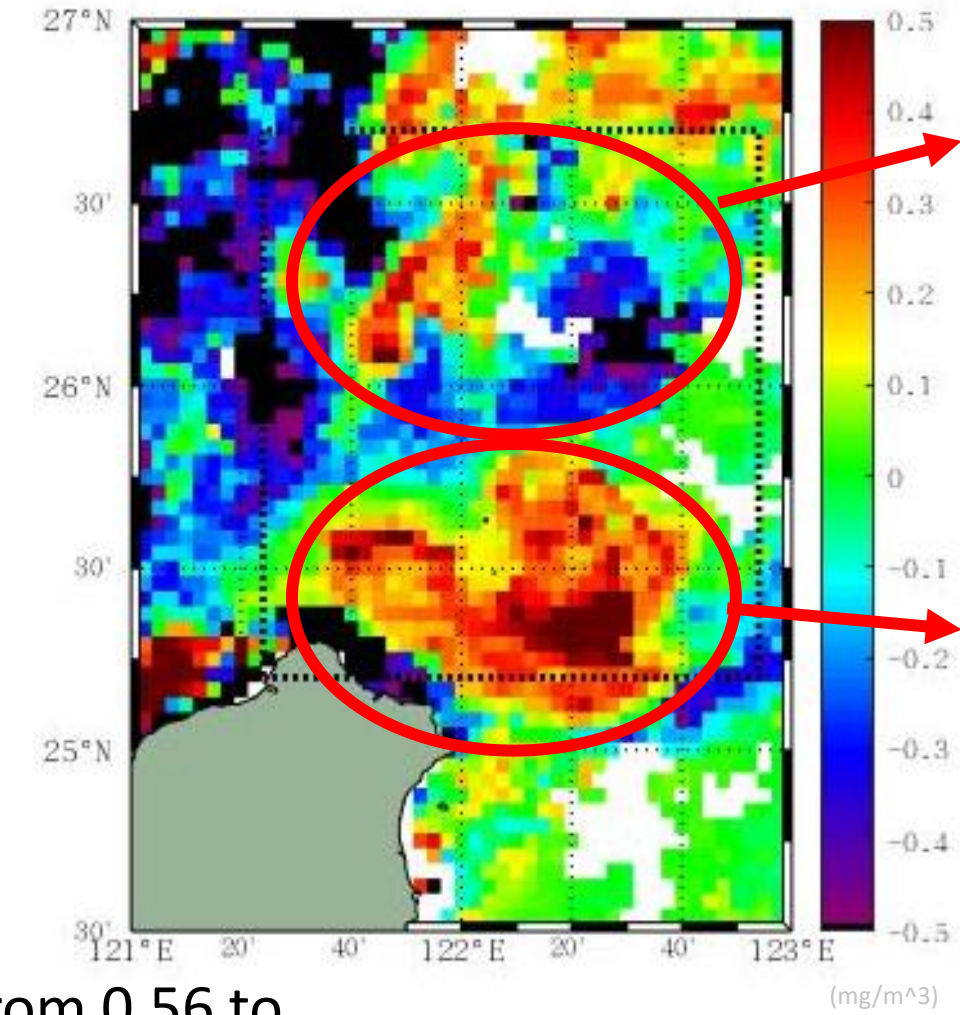


The Chl-a concentration reduction shown in this case was obviously not caused by typhoon Khaun .

Nock-ten

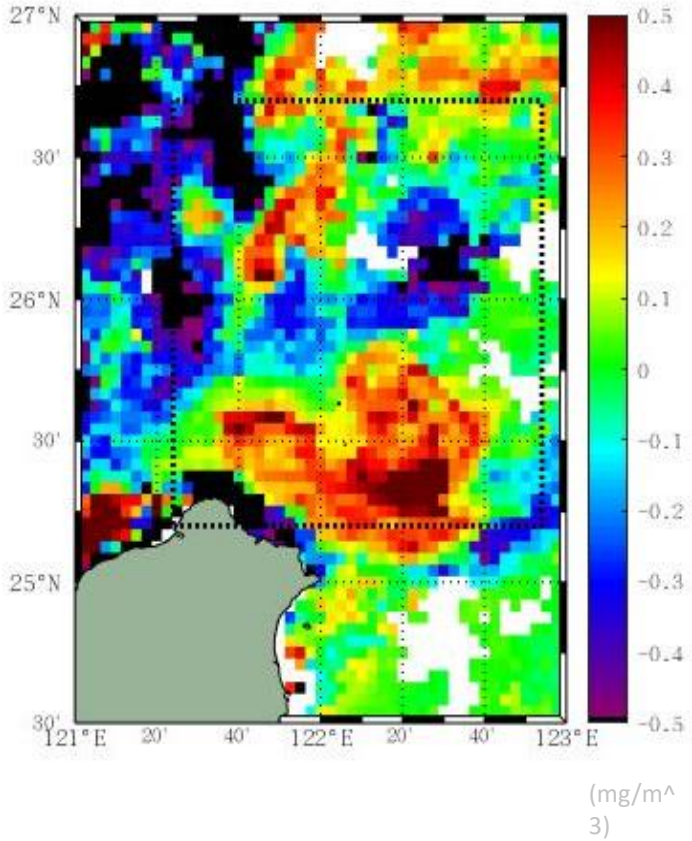


Chlorophyll-A change

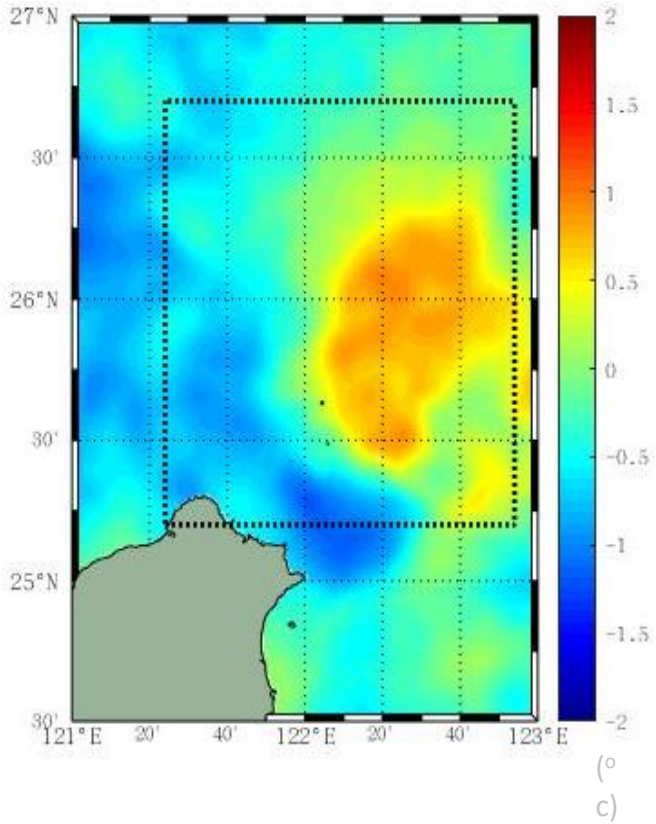


Average of the entire study area has dropped from 0.56 to 0.51 (mg/m^3).

Sea Surface Temperature (SST) Comparison

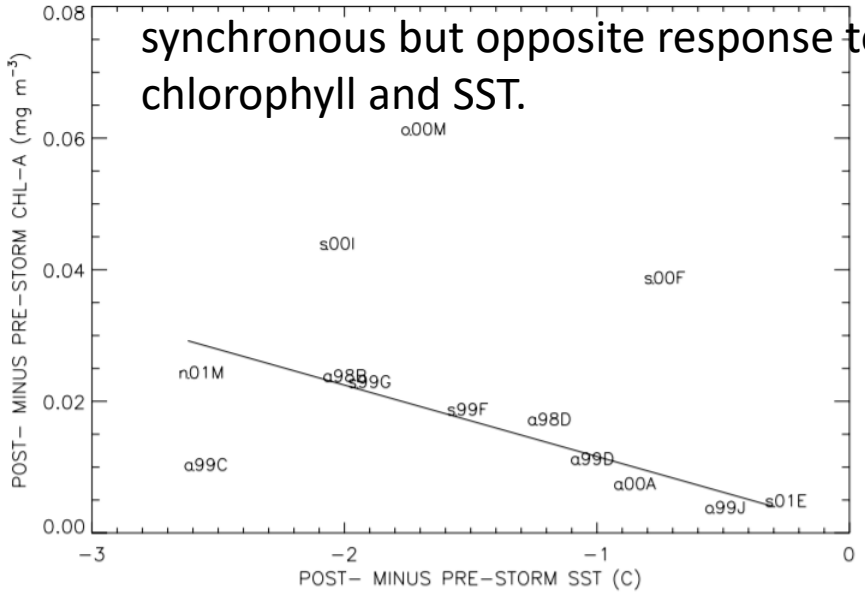


CHL-a change



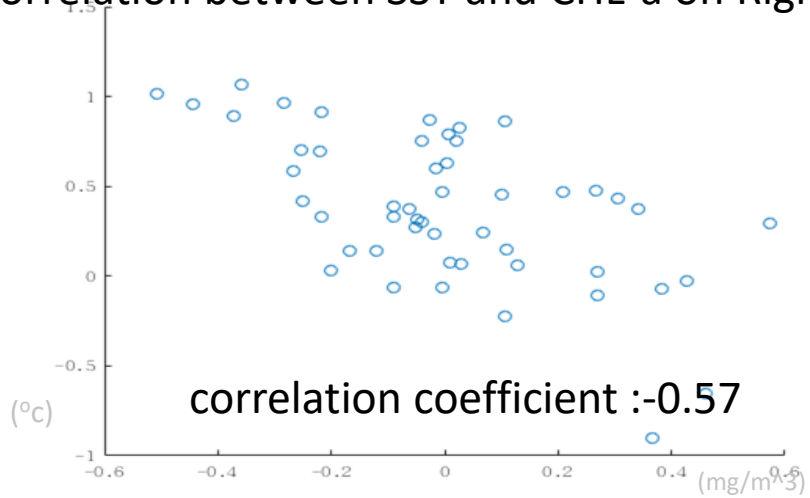
SST change

Satellite evidence of hurricane-induced phytoplankton blooms in an oceanic desert (Babin et al.,2003)

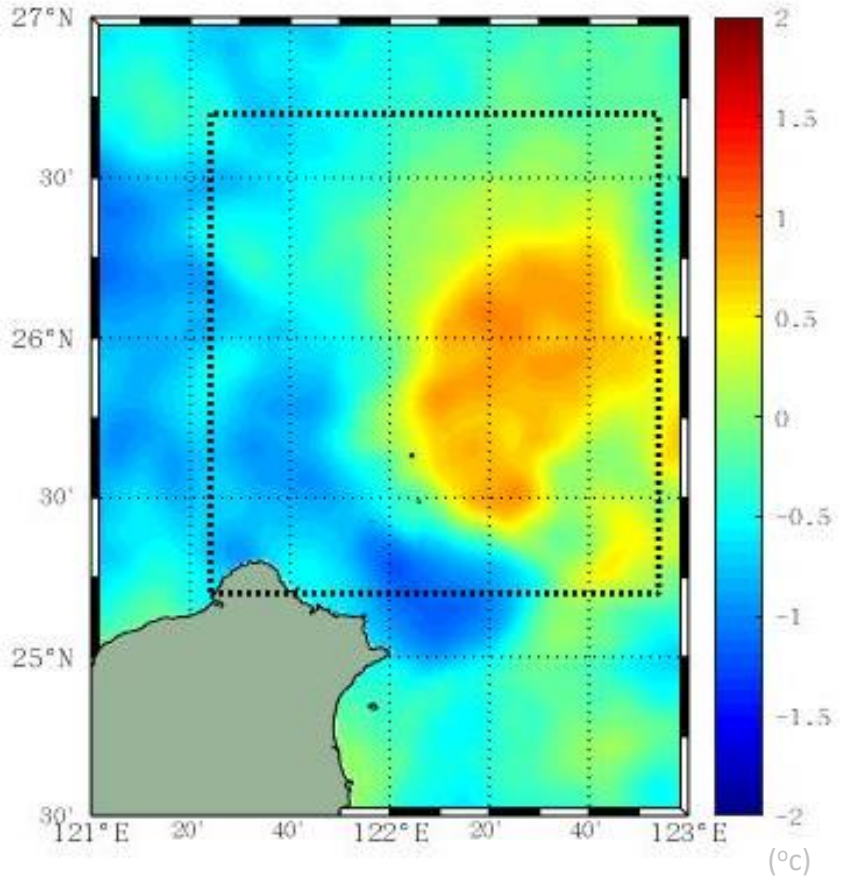


TC↑ => SST↓ Chl-a ↑ enhancement ↑

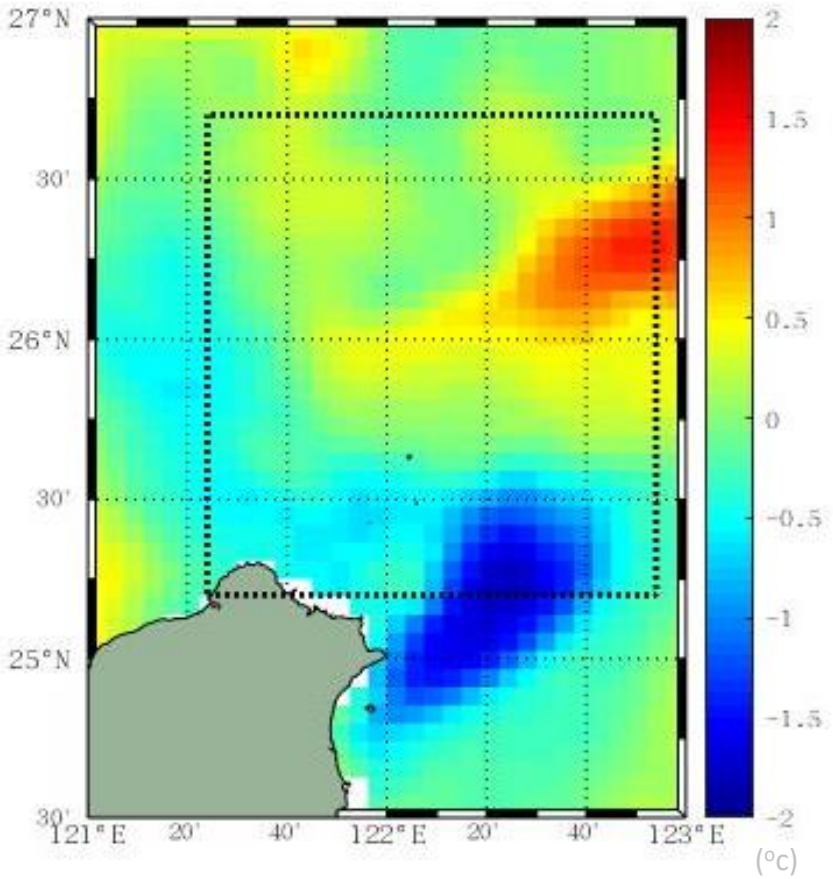
Correlation between SST and CHL-a on Right half area



ROMS Comparison



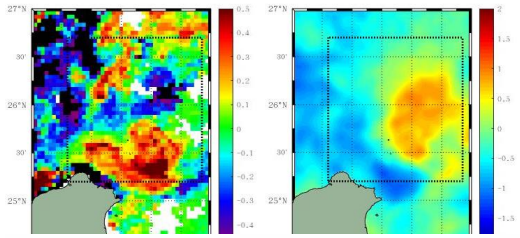
Satellite SST change



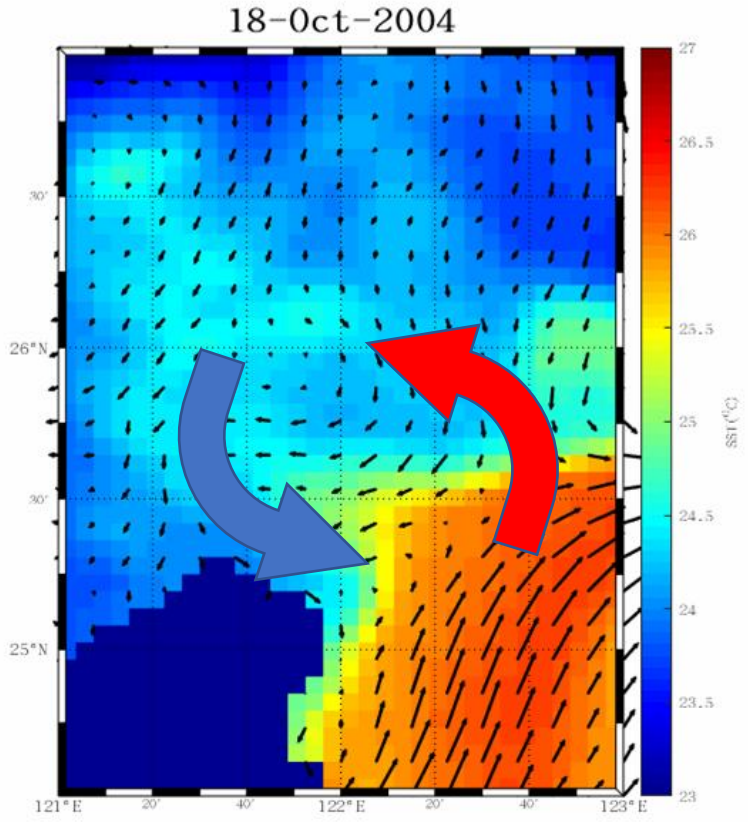
ROMS SST change

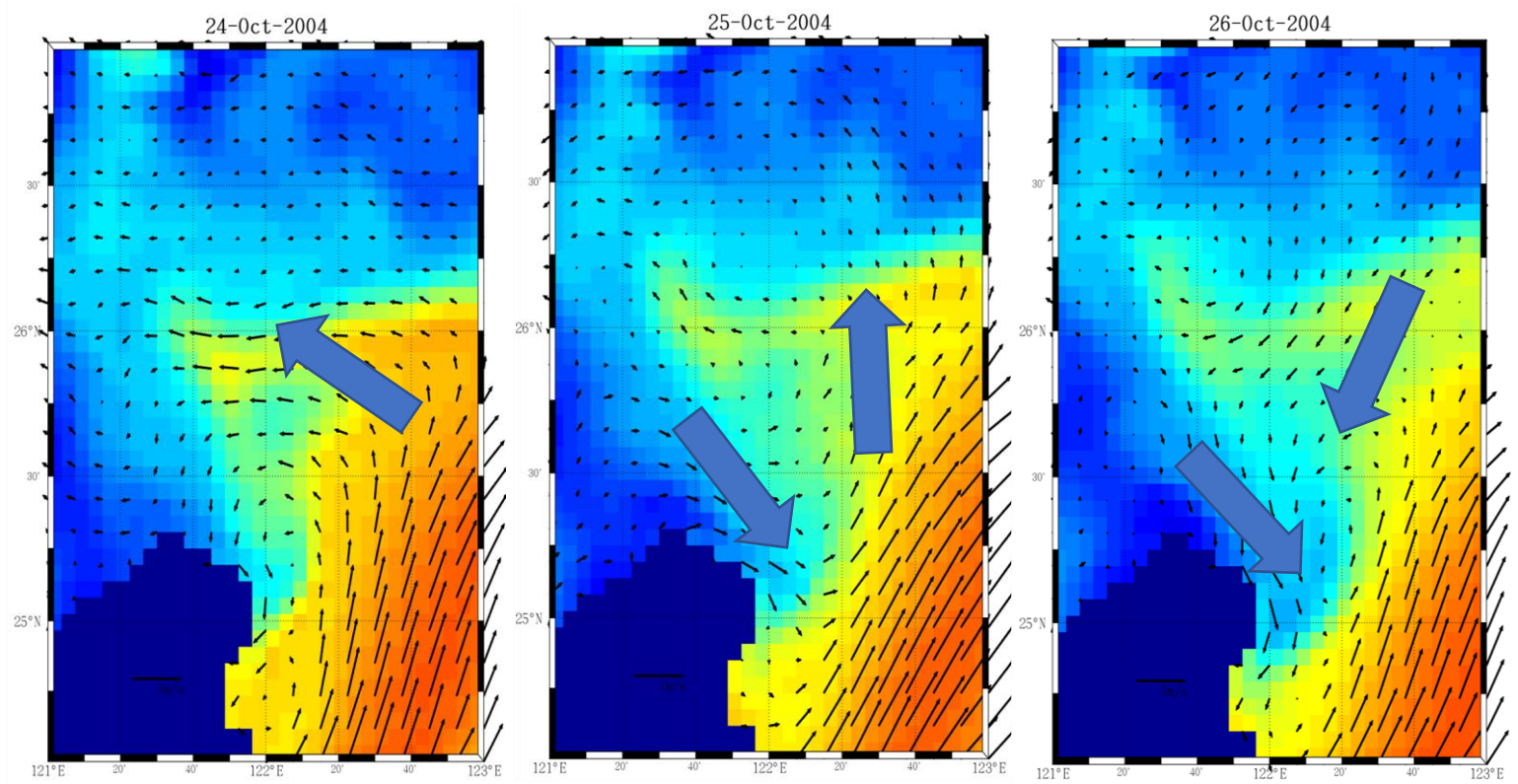
Abnormal dipole of SST with alternating cold and warm waters

Sea surface currents and Sea surface temperature



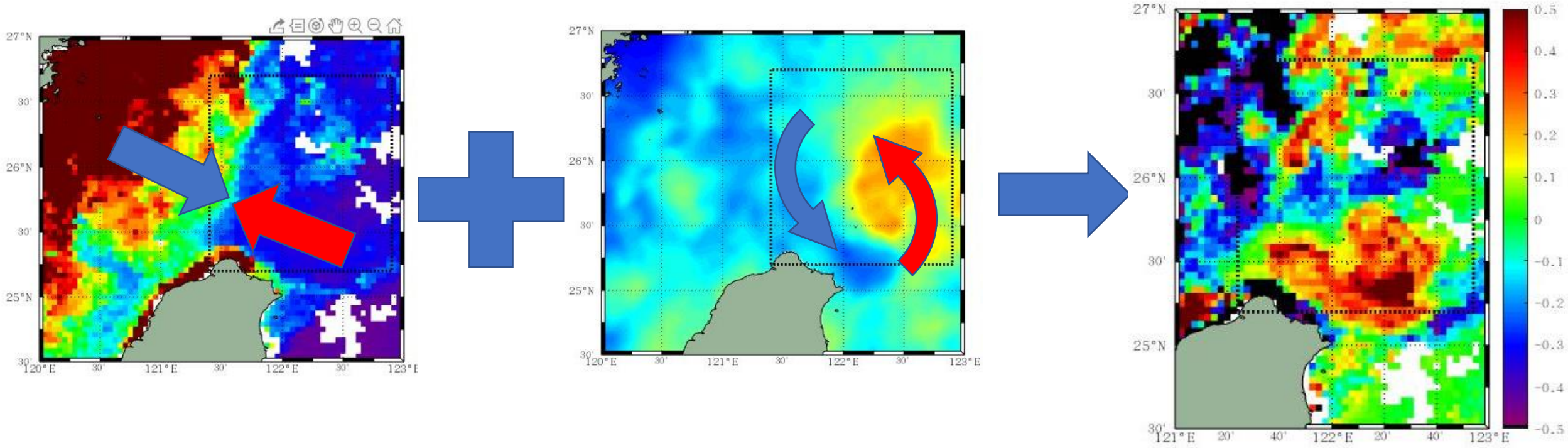
Sea surface situation underlying typhoon influence

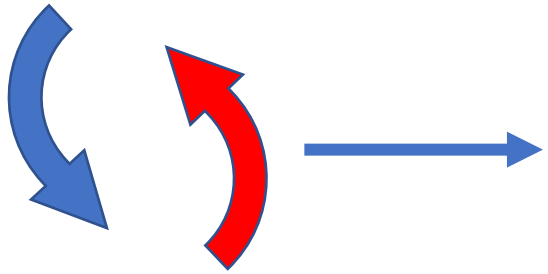




(°C)

Horizontal exchange of inshore/offshore water





Typhoon + Tide

Summary

1. 2003 to 2017, 23% typhoons cause decrease of Chl-a in this area

2. In case Nock-ten, we discovered a horizontal exchange of warm and cold water on the surface layer. This phenomenon affects the response of the typhoon to surface Chl-a and leads to a decrease in regional Chl-a.

3. This horizontal exchange of warm water and cold water in the northeastern Taiwan is caused by the influences of a typhoon and tide.

Future works

1. Analyze the movement of sea water in the vertical and to see whether the vertical stratification was affected by such horizontal exchange
2. Base on the model simulations in different scenarios to quantify the importance of the typhoon wind forcing and tides on the process
3. Analyze the remaining decrease cases to get more comprehensive understanding

References

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Thanks for listening