# Toward the Management of Eutrophication of NOWPAP Sea Area: Monitoring by New Satellites and Modeling

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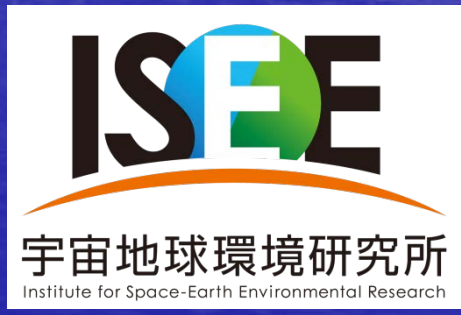



2nd CEARAC Expert Meeting on Eutrophication Assessment in the NOWPAP Region
2019 March 22

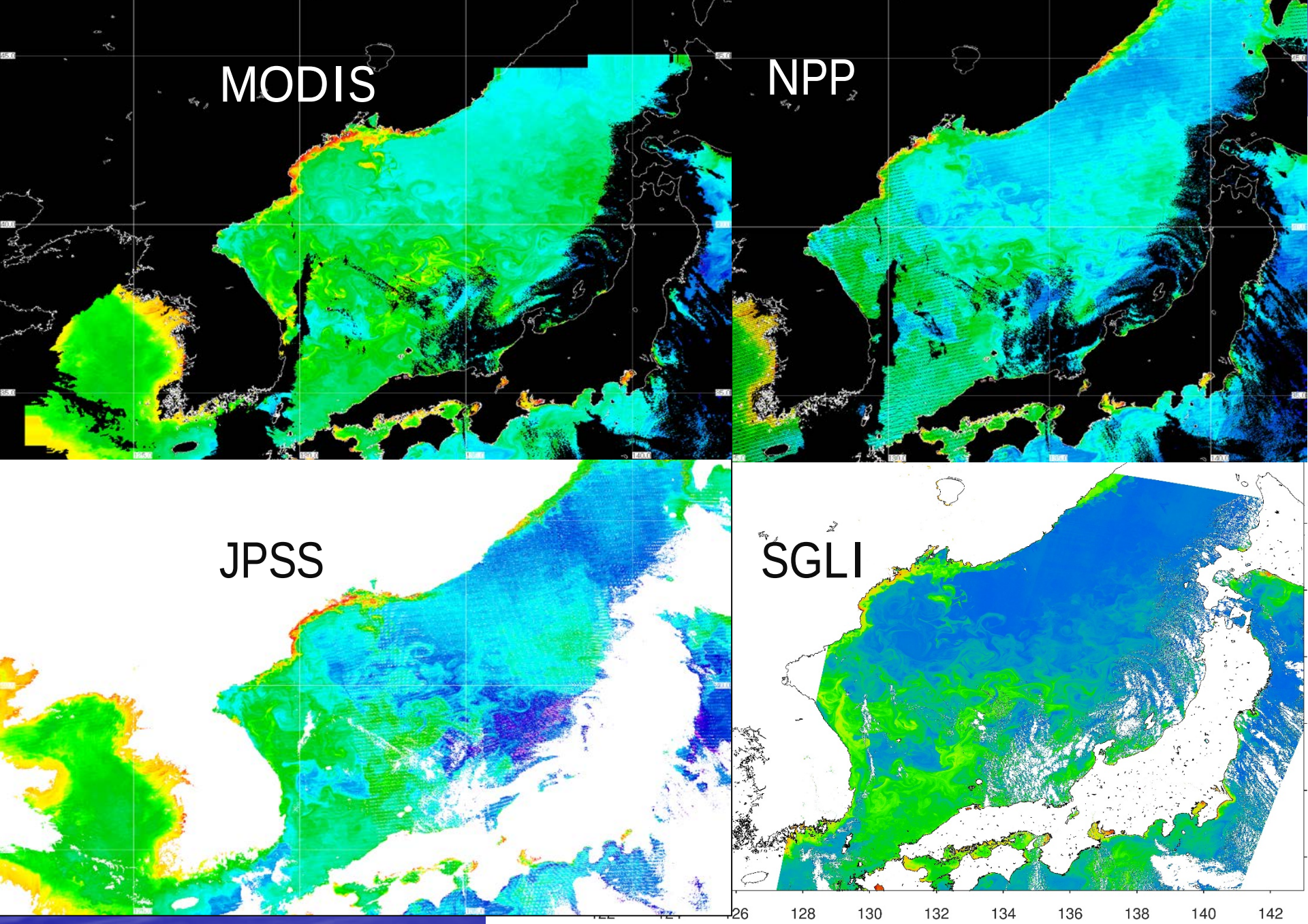
# Outline

- Time Series of Satellite Ocean Color
- Possibility of Phytoplankton Community Monitoring
- Possibility of Use of Modelling for Management of NOWPAP area

# Major Ocean Color Sensors Available for Eutrophication Monitoring

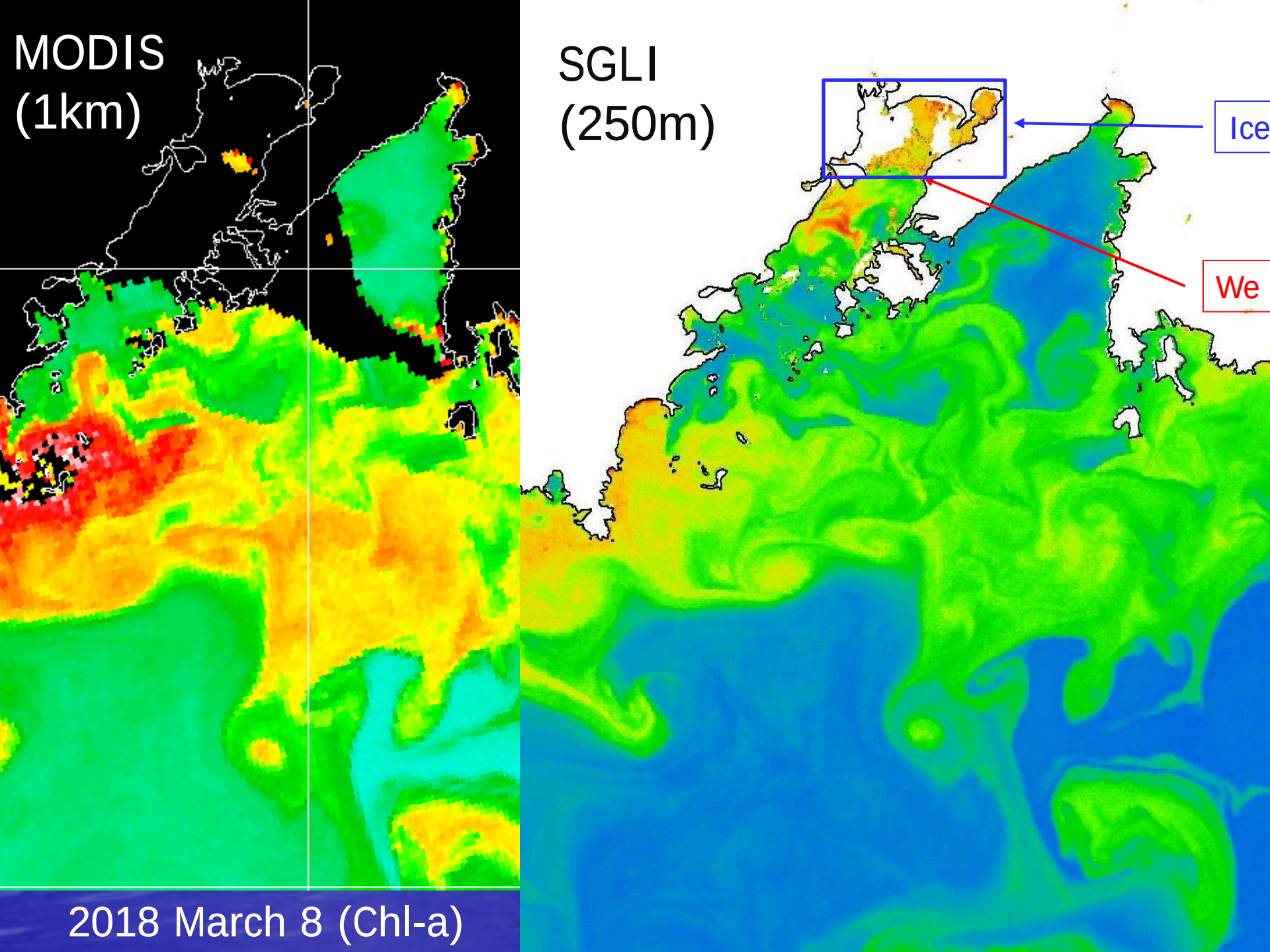
| Sensor | Satellite | Agency | Spatial | Year | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Resolution | 98 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| SeaWiFS | SeaSTAR | NASA | 1100 | | | | | | | | | | | | | | | | | | | | | | | |
| MODIS | AQUA | NASA | 1000 | | | | | | | | | | | | | | | | | | | | | | | |
| GOCI | COMS | KARI/KOSC | 500 | | | | | | | | | | | | | | | | | | | | | | | |
| VIIRS | SuomiNPP | NOAA | 750 | | | | | | | | | | | | | | | | | | | | | | | |
| VIIRS | JPSS-1/NOAA-20 | NOAA/NASA | 740 | | | | | | | | | | | | | | | | | | | | | | | |
| OLCS | Sentinel-3A | ESA/EUMETSAT | 300 | | | | | | | | | | | | | | | | | | | | | | | |
| OLCS | Sentinel-3B | ESA/EUMETSAT | 300 | | | | | | | | | | | | | | | | | | | | | | | |
| SGLI | GCOM-C | JAXA | 250 | | | | | | | | | | | | | | | | | | | | | | | |

Long time series
Geostationary
High resolution

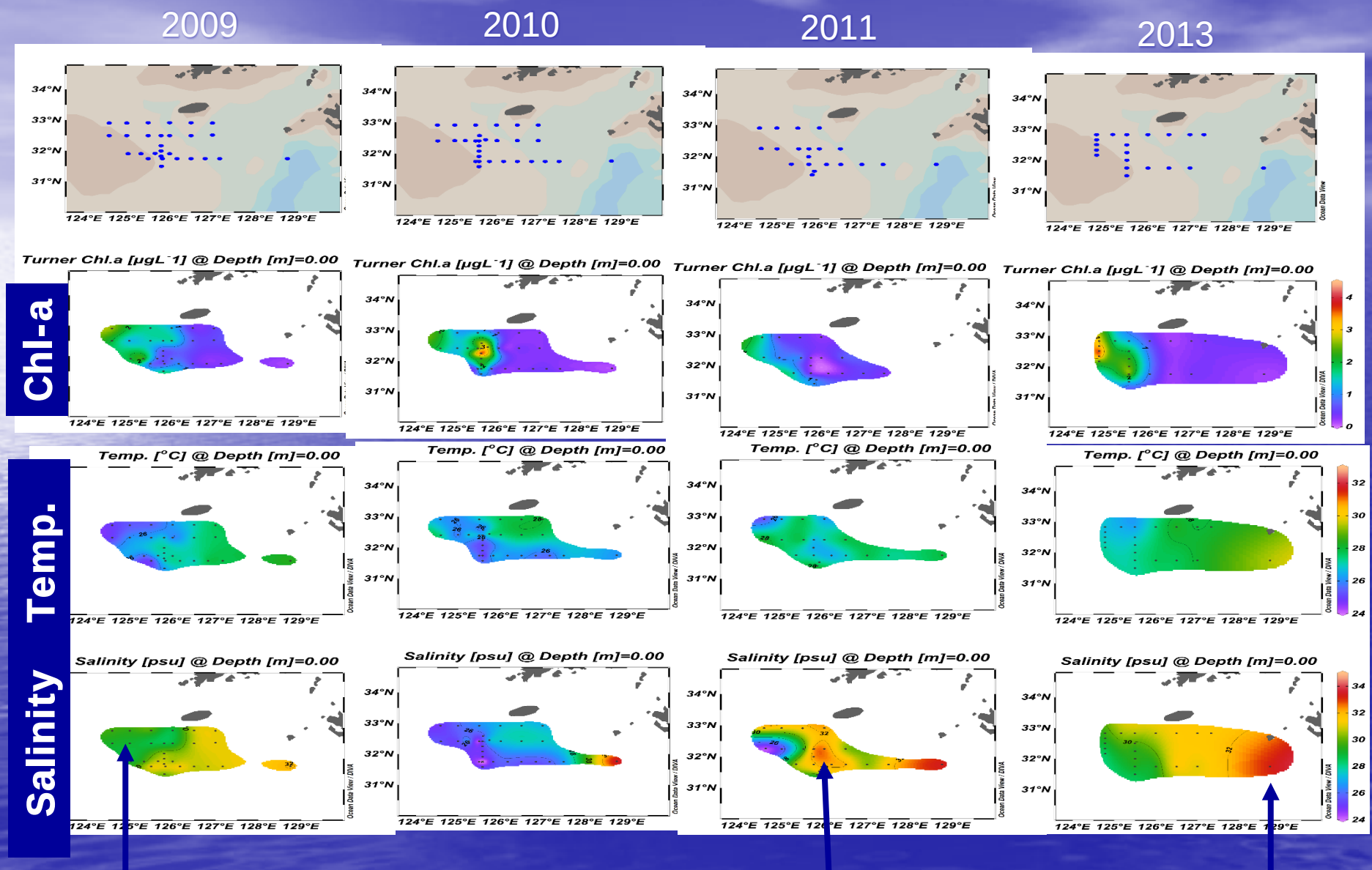


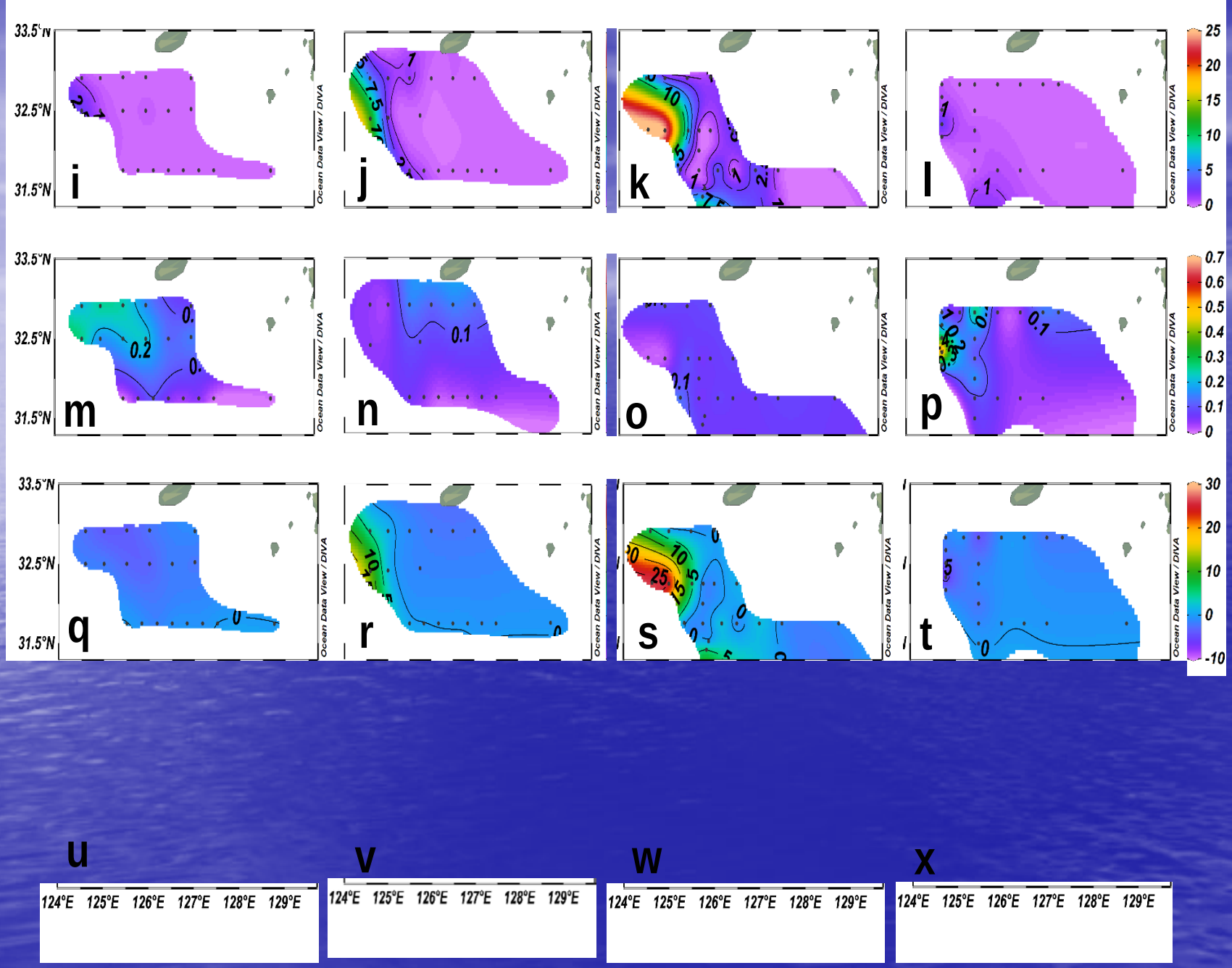

2018 March 8 (Chl-a)

Need Inter-calibration

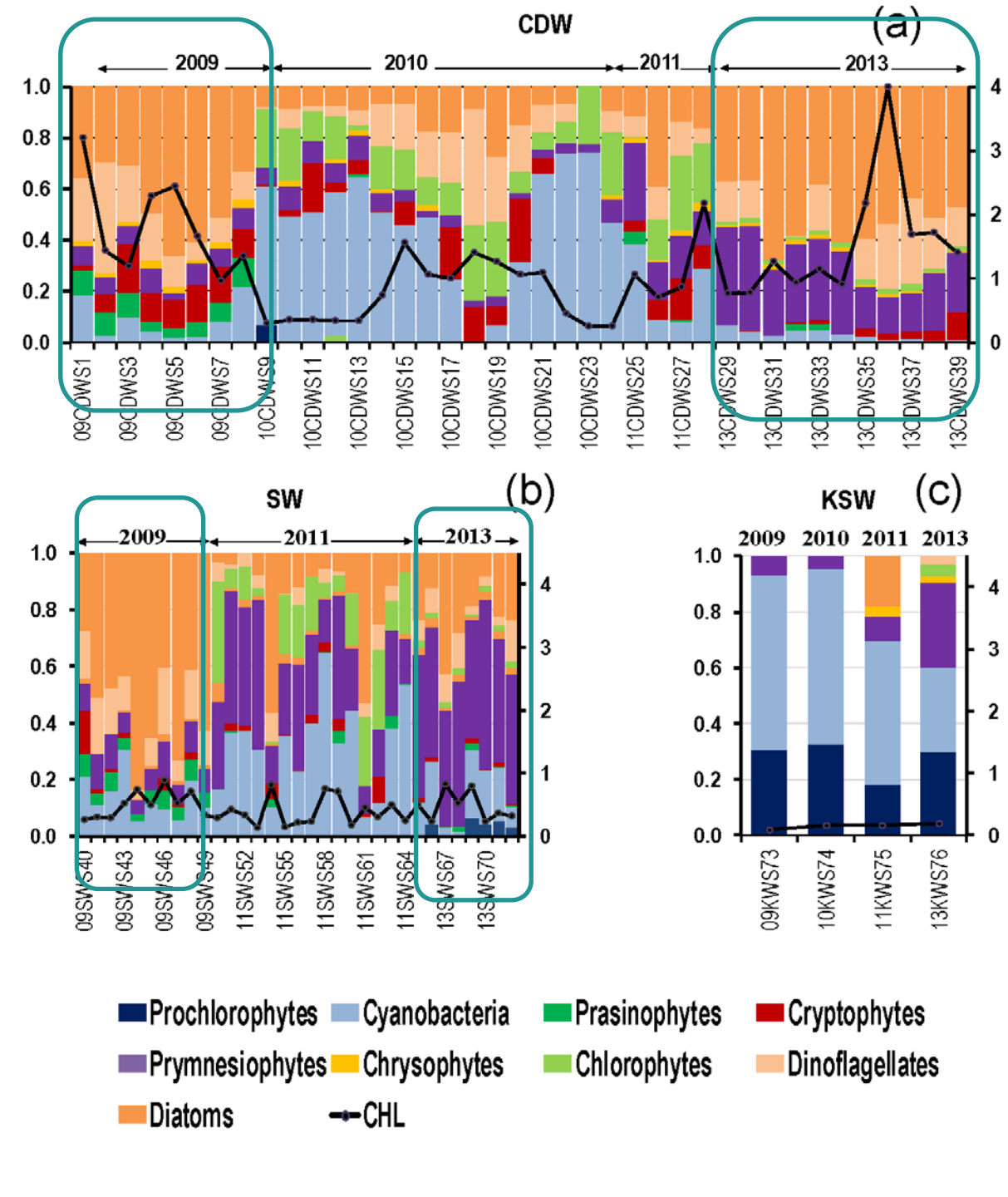

MODIS
(1km)
SGLI
(250m)
Ice
We
2018 March 8 (Chl-a)

# Influence of Changjiang to East China Sea





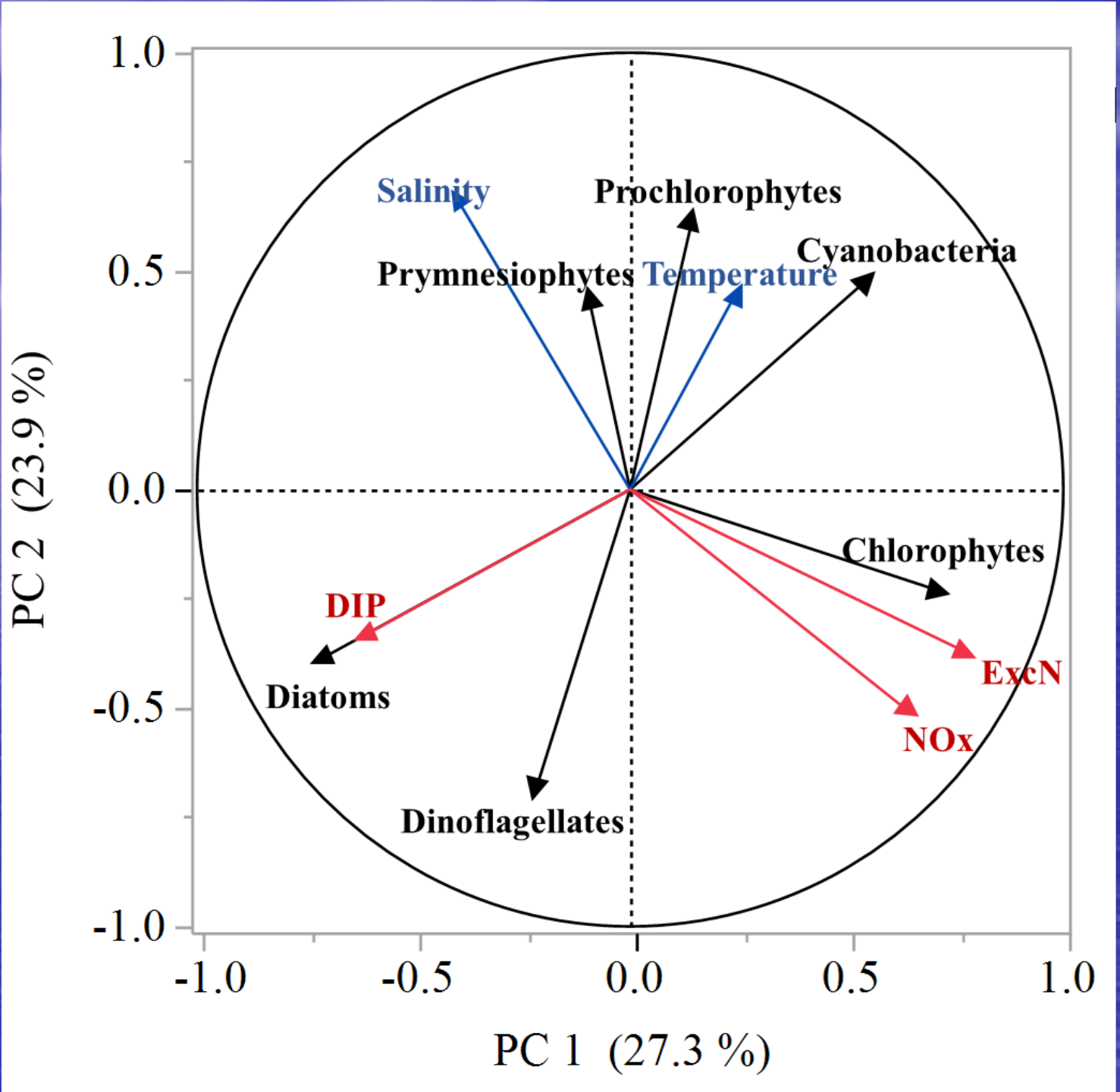

High P, Low Excess N – High Chl-a (Xu et al. JO-2019)

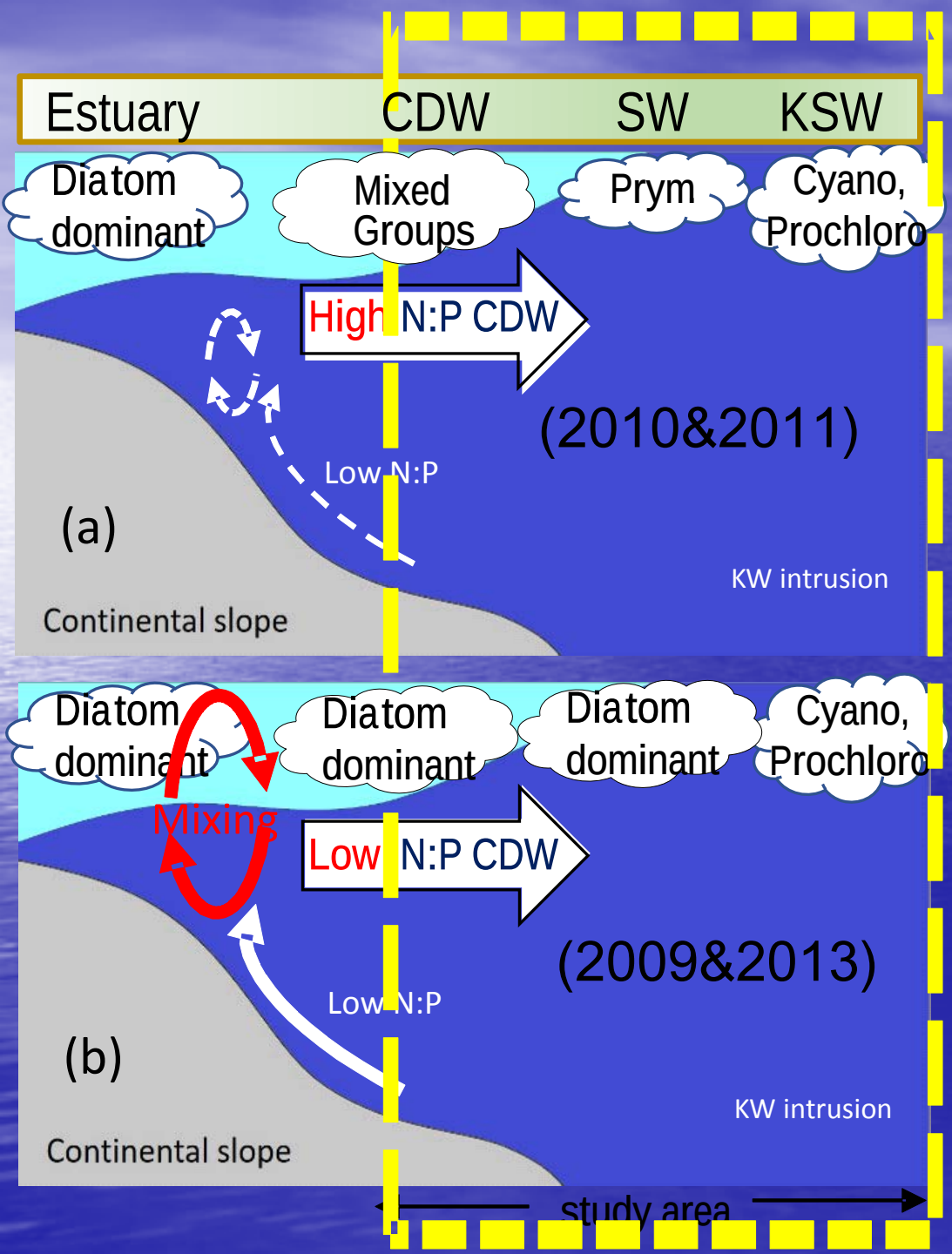



**2009/2013**
**High**
**Diatom**
**Phosphate**

**2010/2011**
**Low Diatom**
**Phosphate**

# PCA


1.0
0.5
0.0
-0.5
-1.0
PC 2 (23.9 %)
-1.0
-0.5
0.0
0.5
1.0
PC 1 (27.3 %)
Salinity
Prochlorophytes
Cyanobacteria
Prymnesiophytes
Temperature
Chlorophytes
DIP
ExcN
Diatoms
NOx
Dinoflagellates

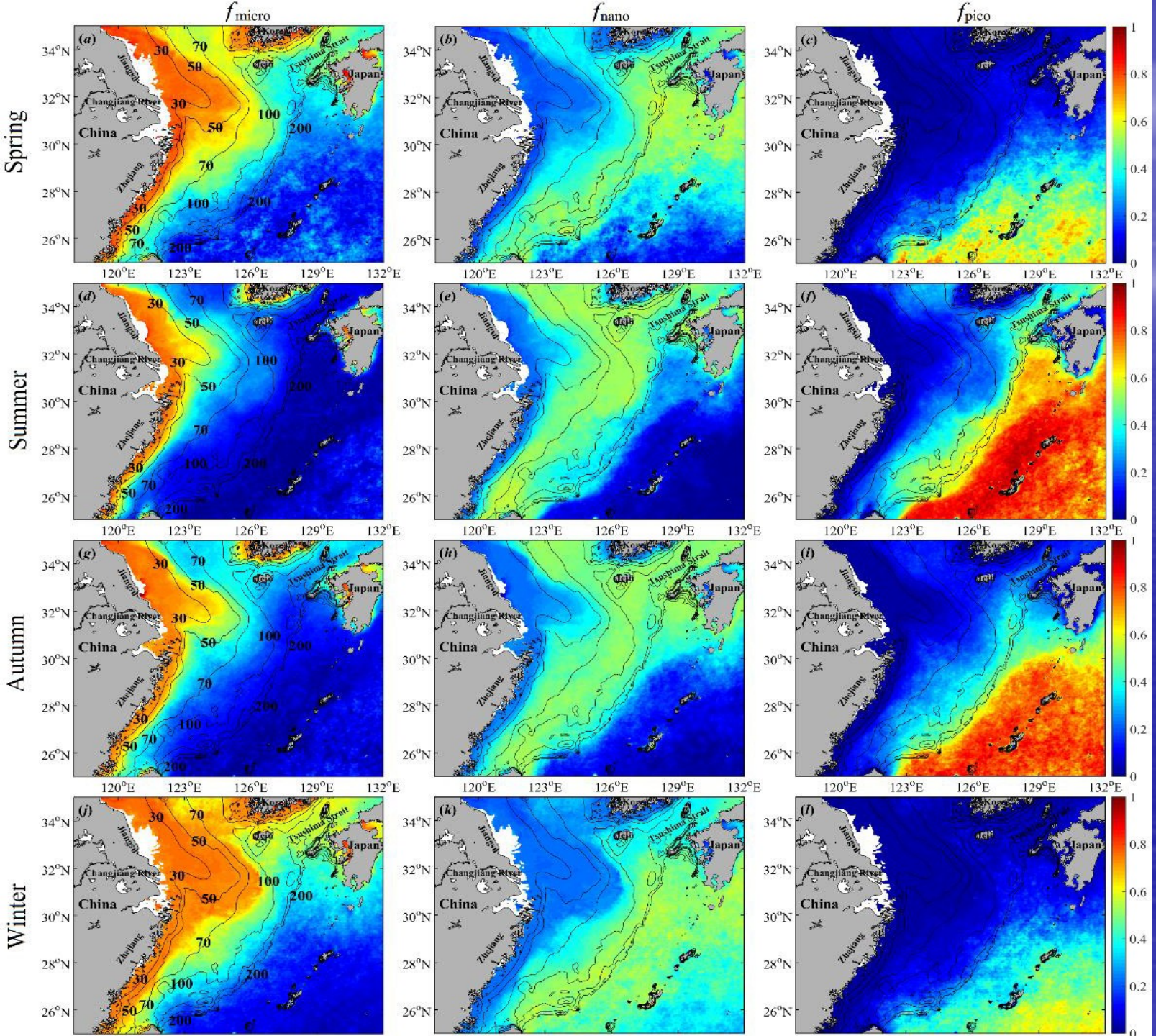



# Difference of N:P ratio

⇓

# difference of phytoplankton groups

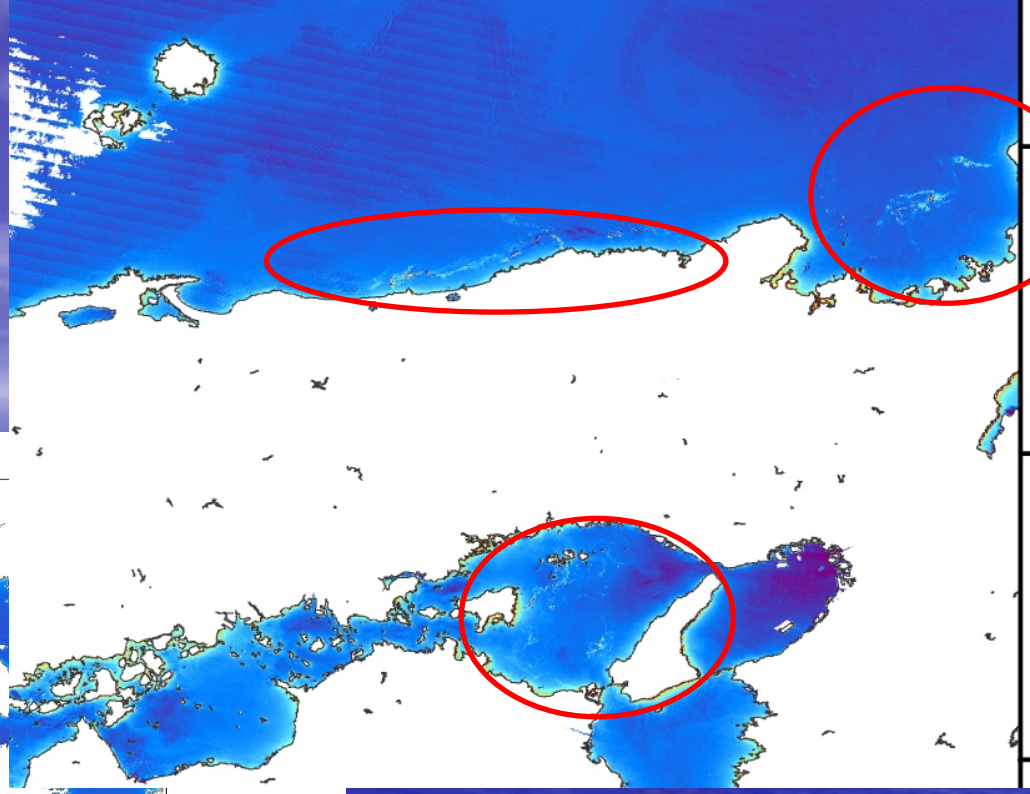
(Xu et al., JO-2019
Gomes et al., FMS-2019)



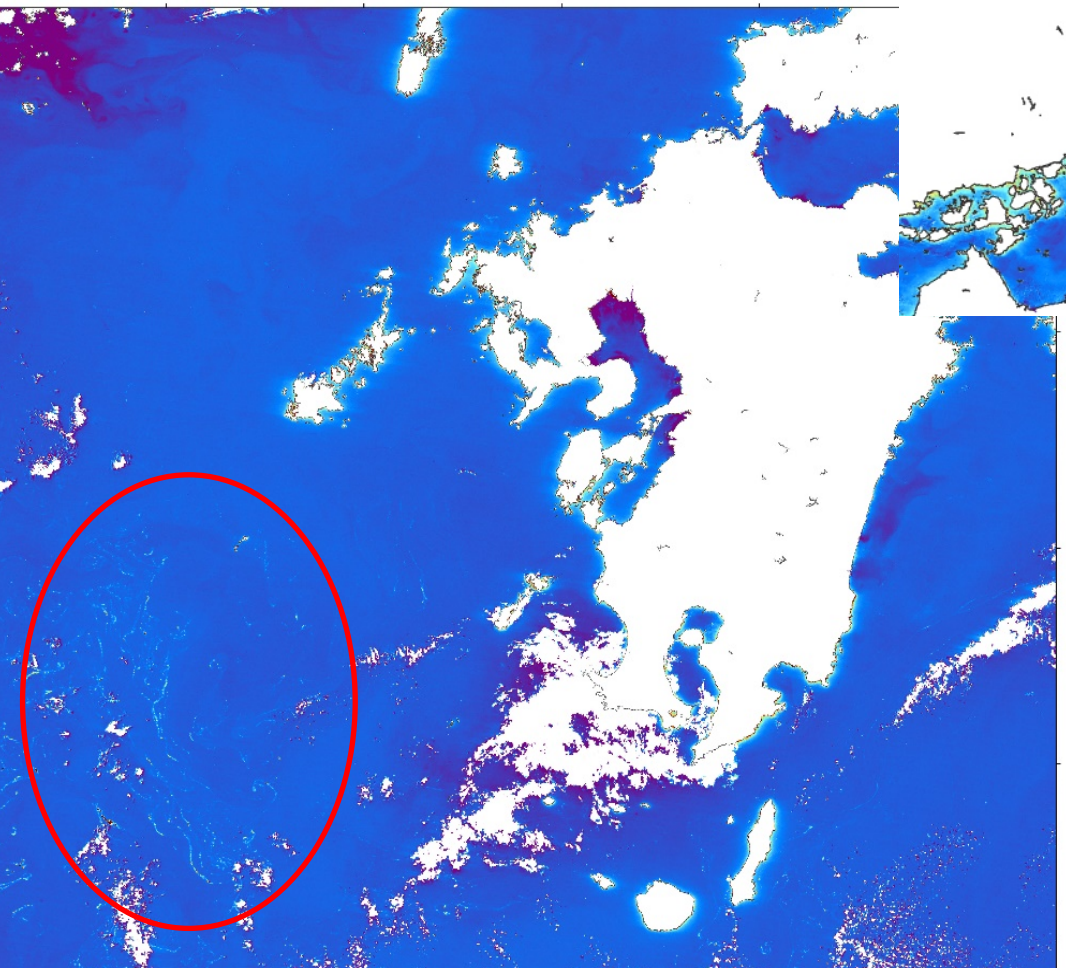

Phyto plankton Size in the East China Sea (Zhang et al., JGRO-18)

# GCOM-C/SGLI (JAXA)

Noctiluca bloom ⇒
in Japan Sea
April 20, 2018

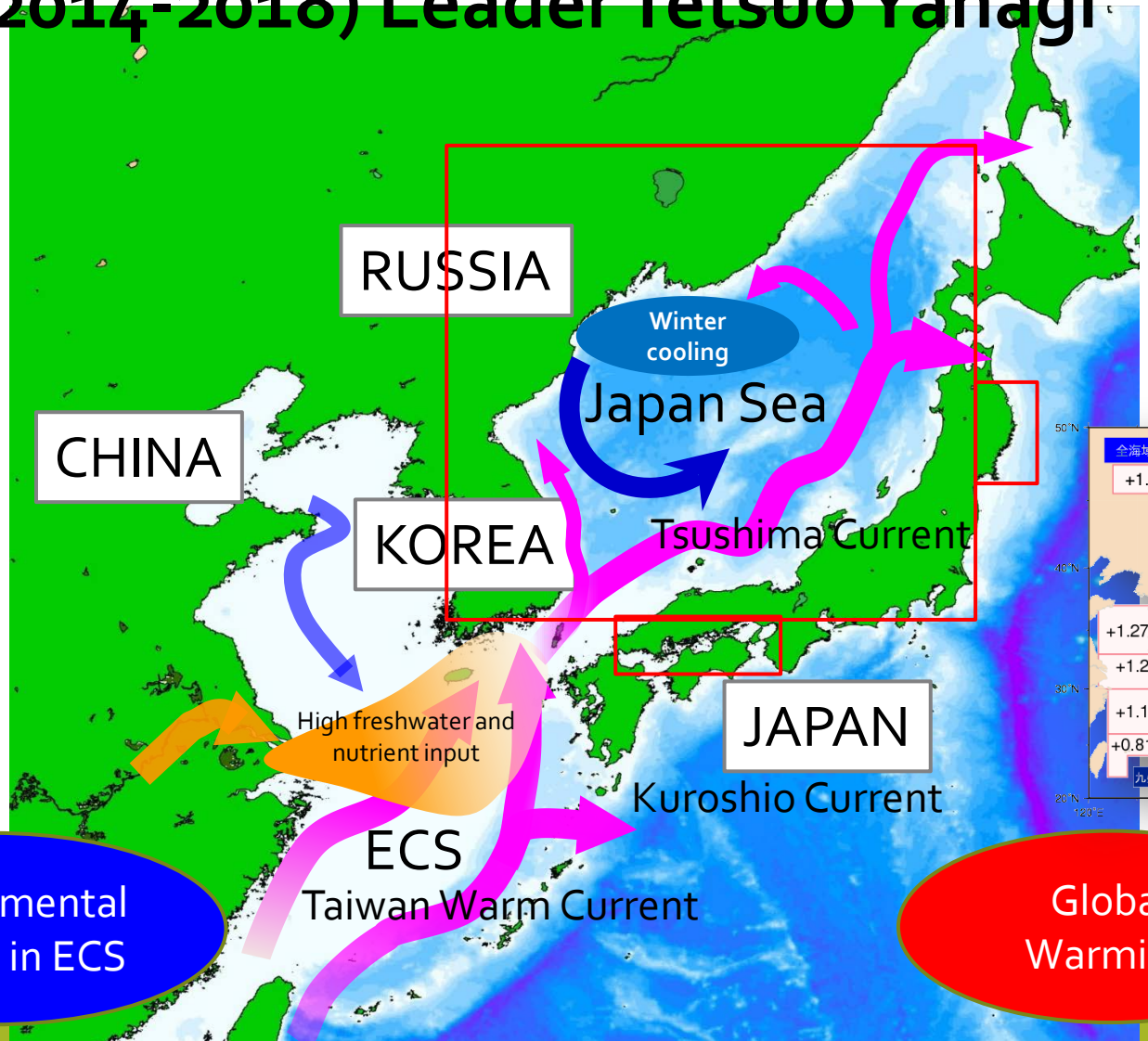


GC1SG1_201803140143U05710_1BSG_VNRDQ_E007.h5, Param Name= FAI

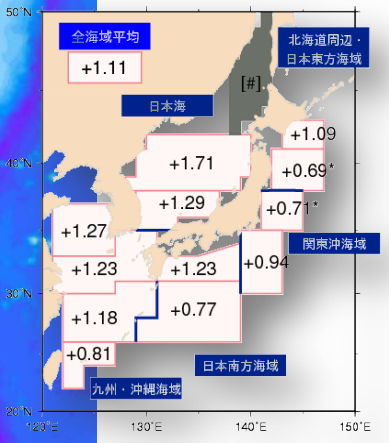



⇐ Macro-algae bloom
(Brown Algae)
in East China Sea
In March 14, 2018

# Environment Agency R&D Project S-13: Development of Coastal Management Method to Realize the Sustainable Coastal Area (2014-2018) Leader Tetsuo Yanagi




World average
+0.54℃/100 years



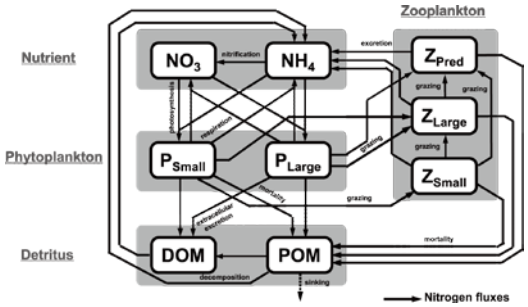

Environmental Change in ECS

Global Warming

# Research Method: Ecosystem Models

## Low trophic

### Prof. Morimoto
### Ehime University

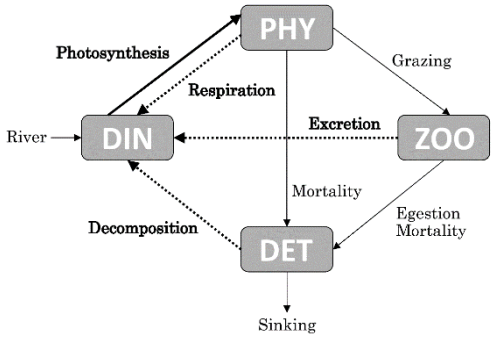



【Characteristic】
Detailed classification of phyto-zooplankton

【Objective】
Understanding response of low trophic species to change of nutrient condition

Impact from the ECS

### Prof. Hirose
### Kyushu University




【Characteristic】
Simplification of phyto-zooplankton
Data assimilation by DO

【Objective】
Forecasting long-term trend

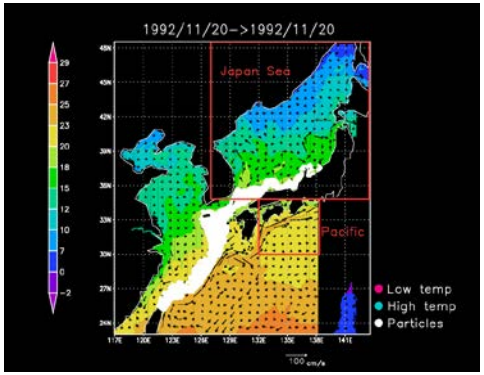
Impact of Global warming

## High trophic

### Prof. Guo
### Ehime University

Japanese common squid
(*Todarodes pacificus*)

Snow crab
(*Chionoecetes opilio*)

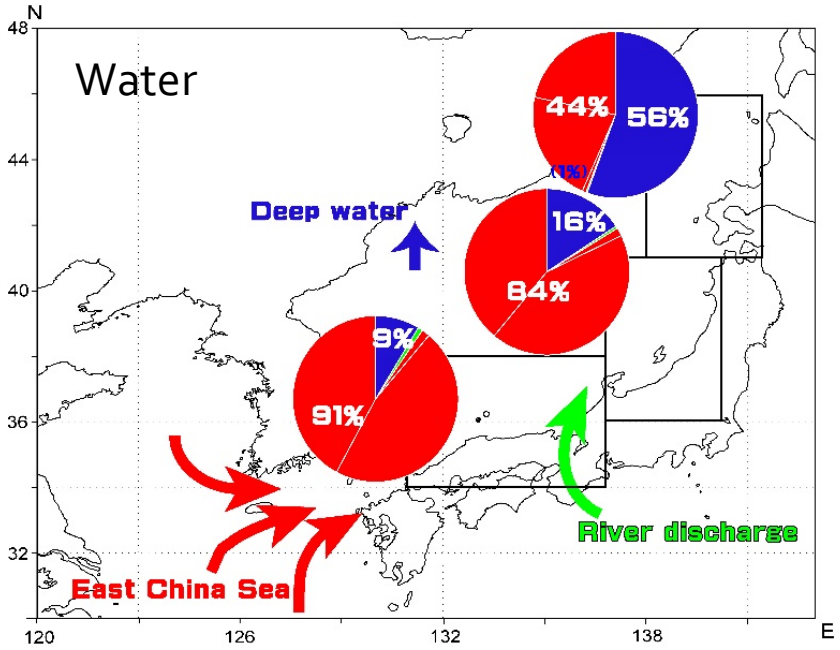



【Characteristic】
Transportation of egg and larvae and its survival under environmental and feed condition

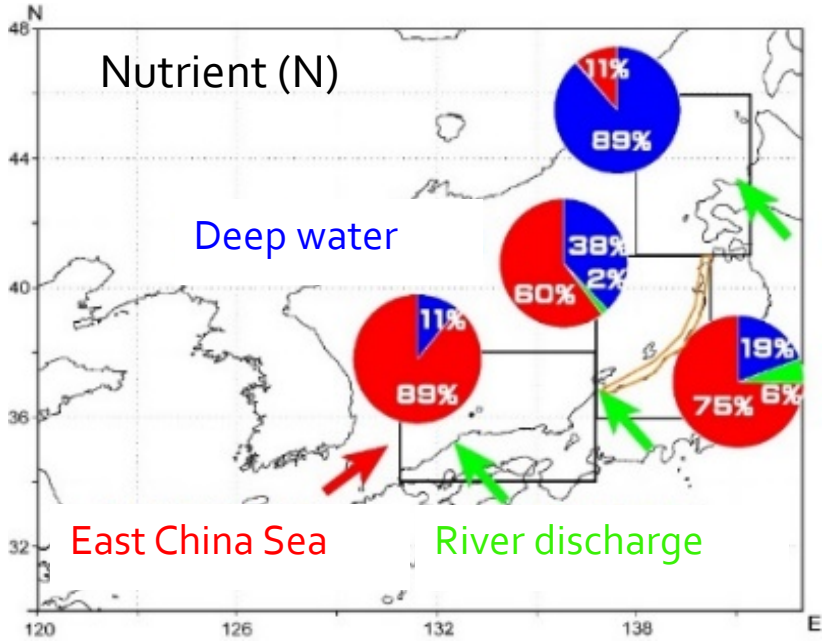
【Objective】
Effective/efficient setting of MPAs

# Impact from the East China Sea?

**Where is the main source of water and nutrient in coastal area of Japan?**



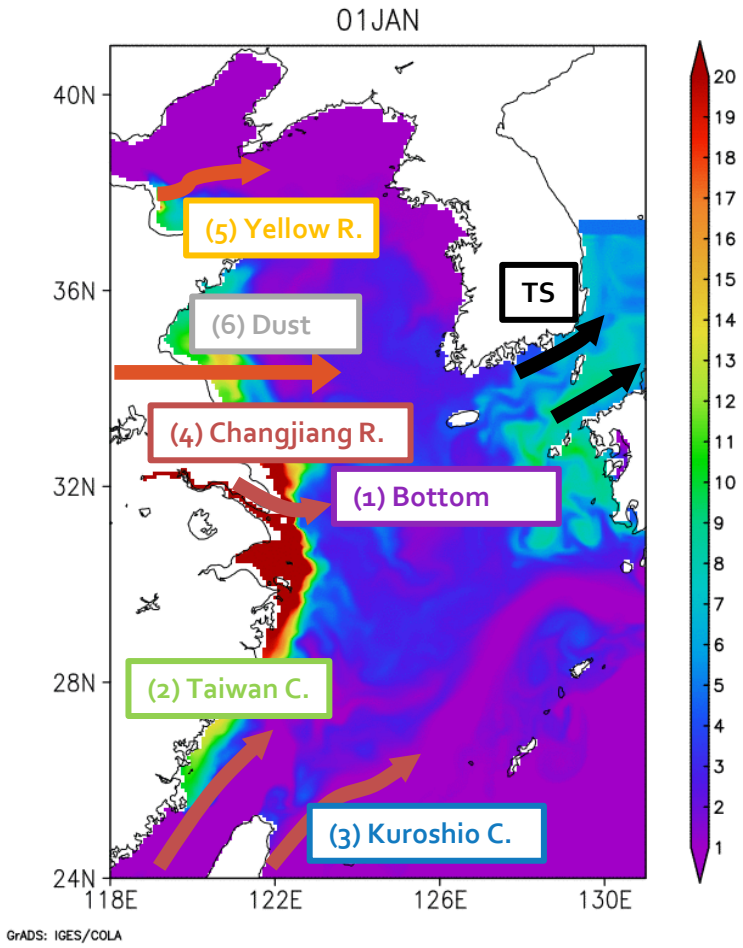

Ratio of three different sources of waters in the surface of Japan Sea

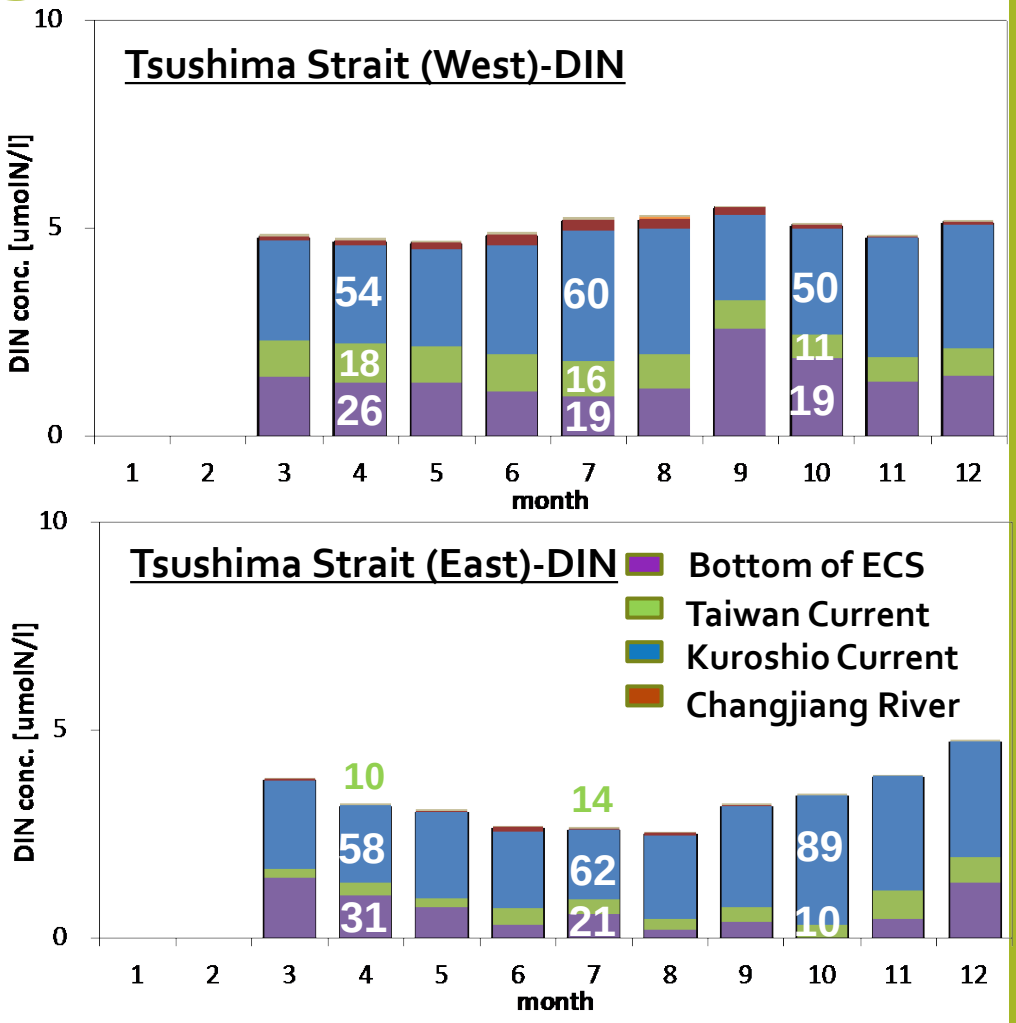



Ratio for utilization of three different sources of nutrient (N)

**Environment of Japanese coastal area is controlled by the ECS**

# Where is origin of nutrient ?



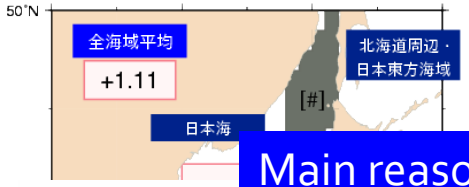




**Direct impact of river discharge on environment of Japan Sea: small?**

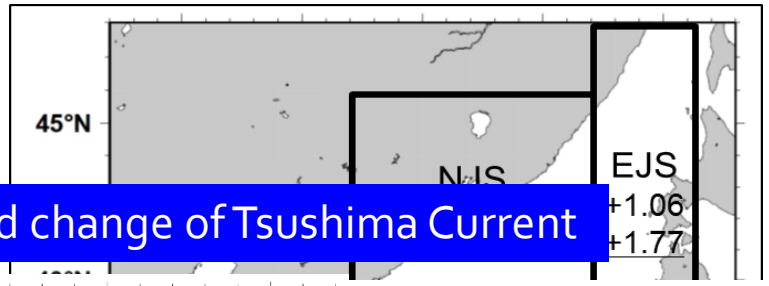
# Impact of global warming on SST?

Surface Temperature Increase

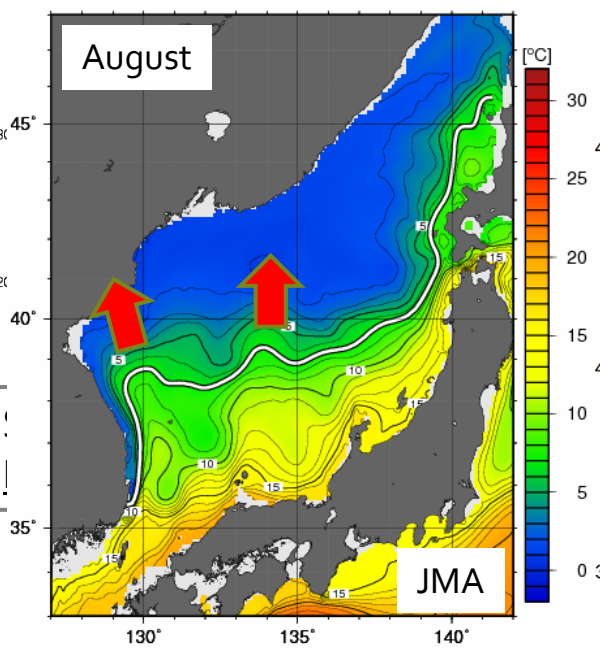
1917-2017

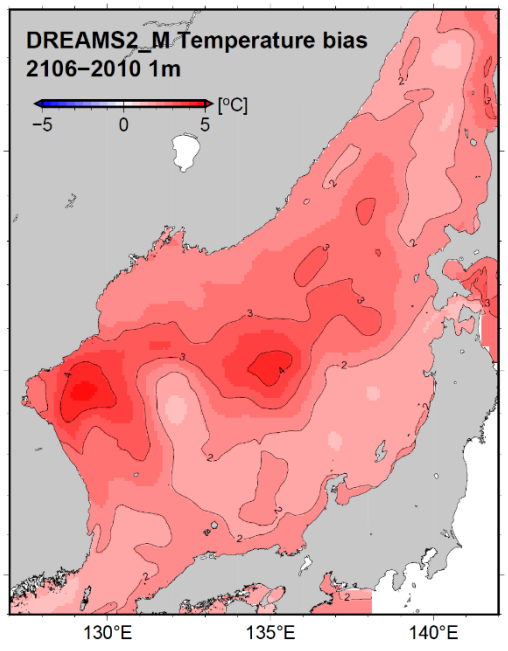


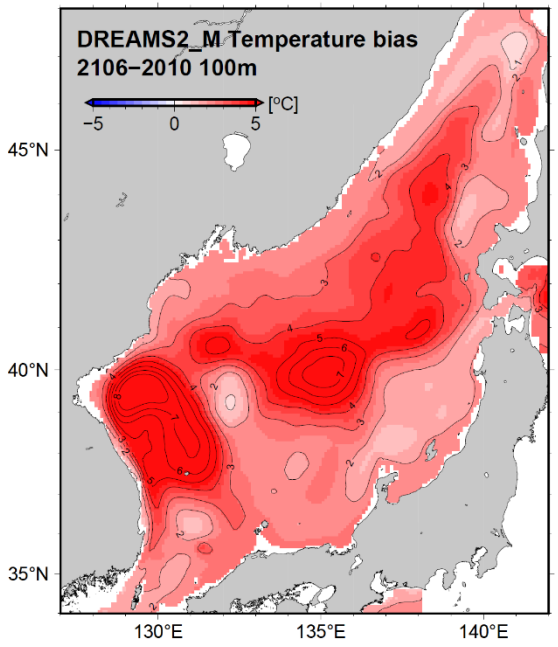

2000-2100




Main reason: Strengthen and change of Tsushima Current

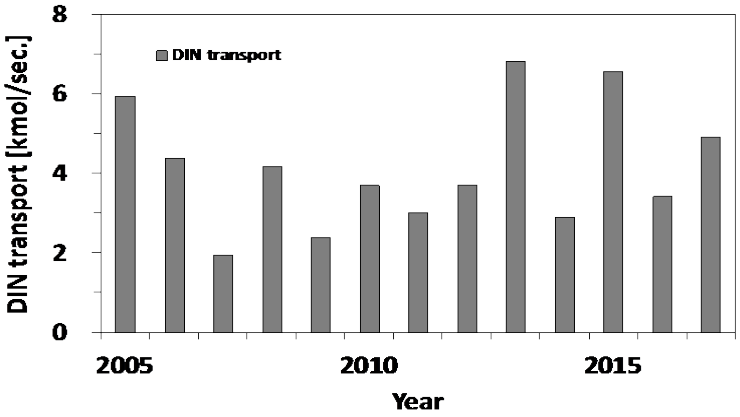


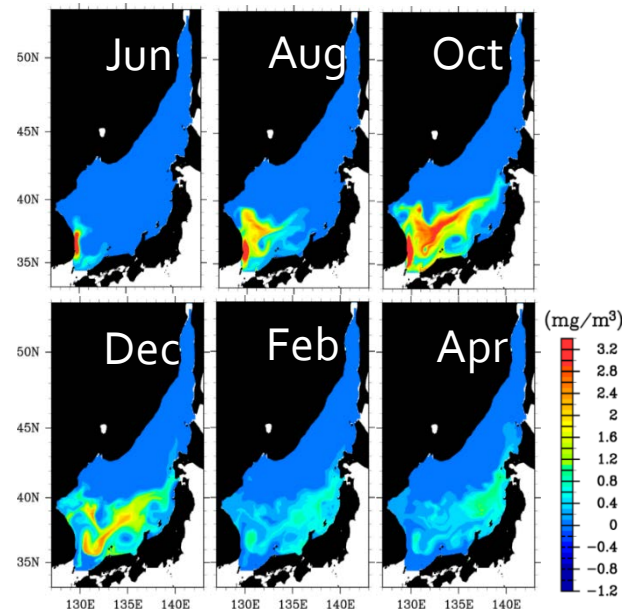



# Impacts on ecosystems in the JS

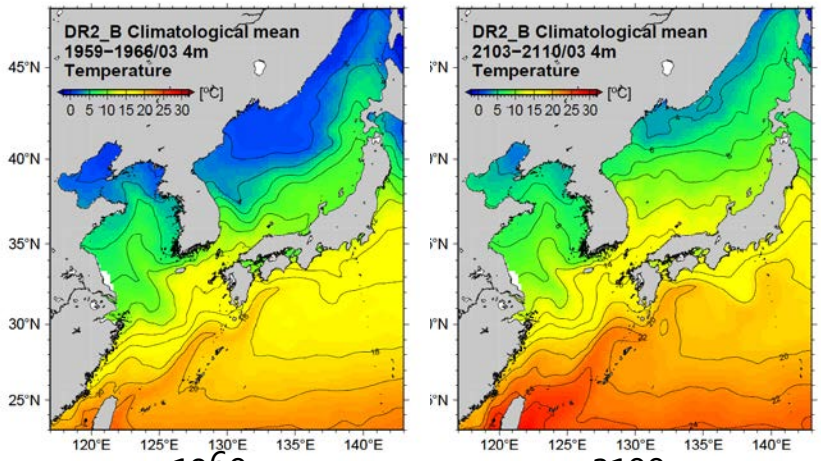
Nutrient input from the ECS



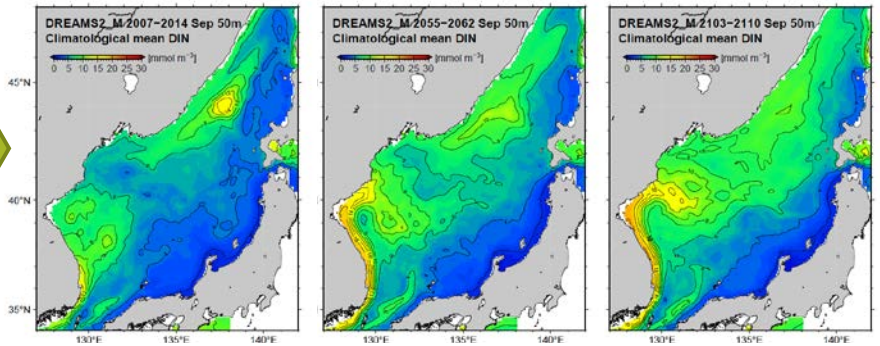

Change of primary production in JS




Impacts from GW



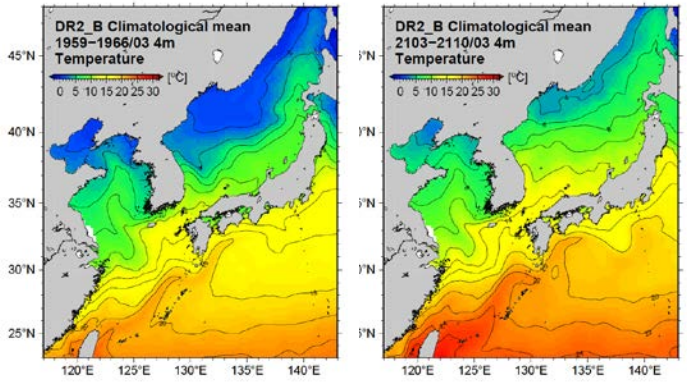

1960 2100



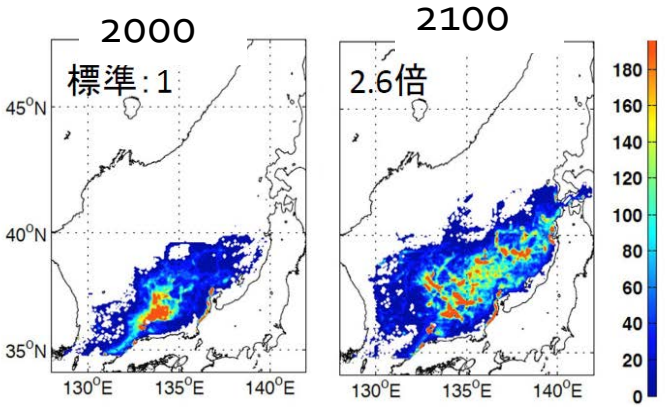

Nutrient condition in 2000, 2050 and 2100

# Impacts on ecosystems in the JS

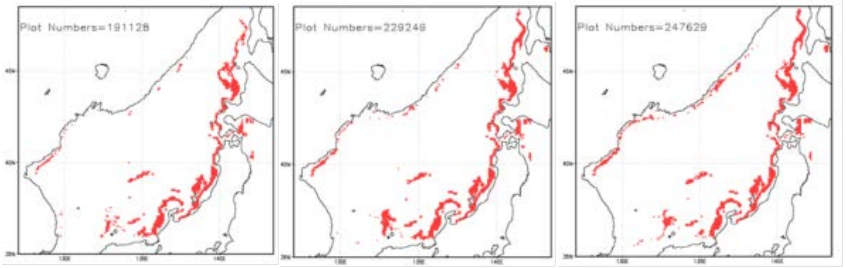
## Global warming




## Survival of Japanese Common Squid Larva

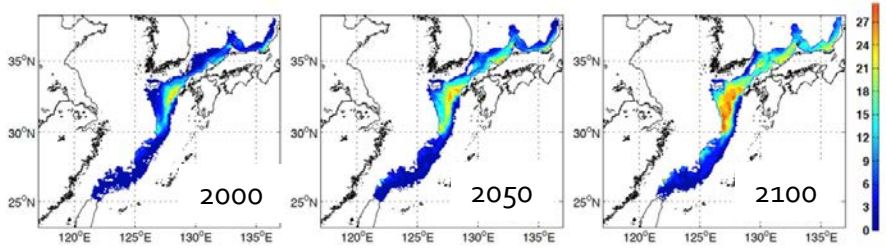



## Survival of Larva of Snow Crab

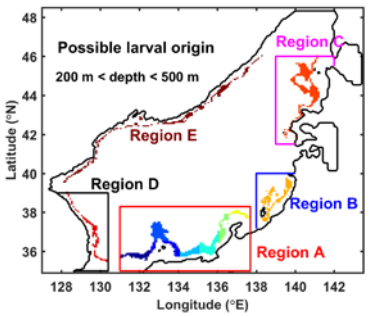


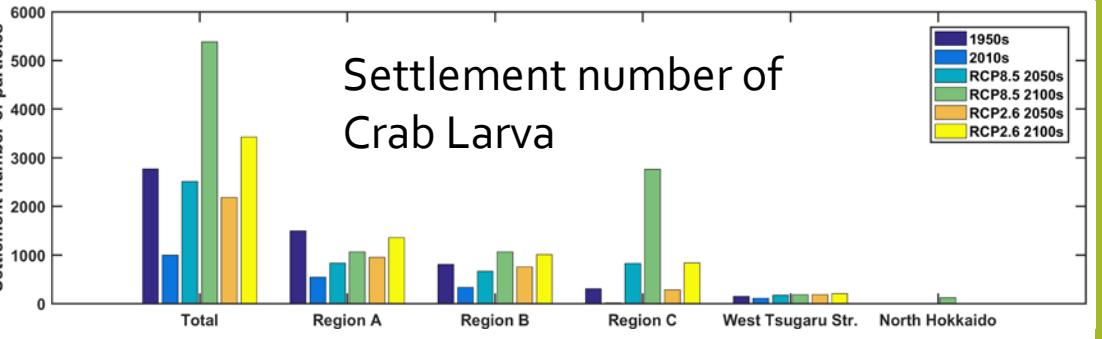

2000

## Spawning ground




2050 2100



# Management in the NOWPAP area

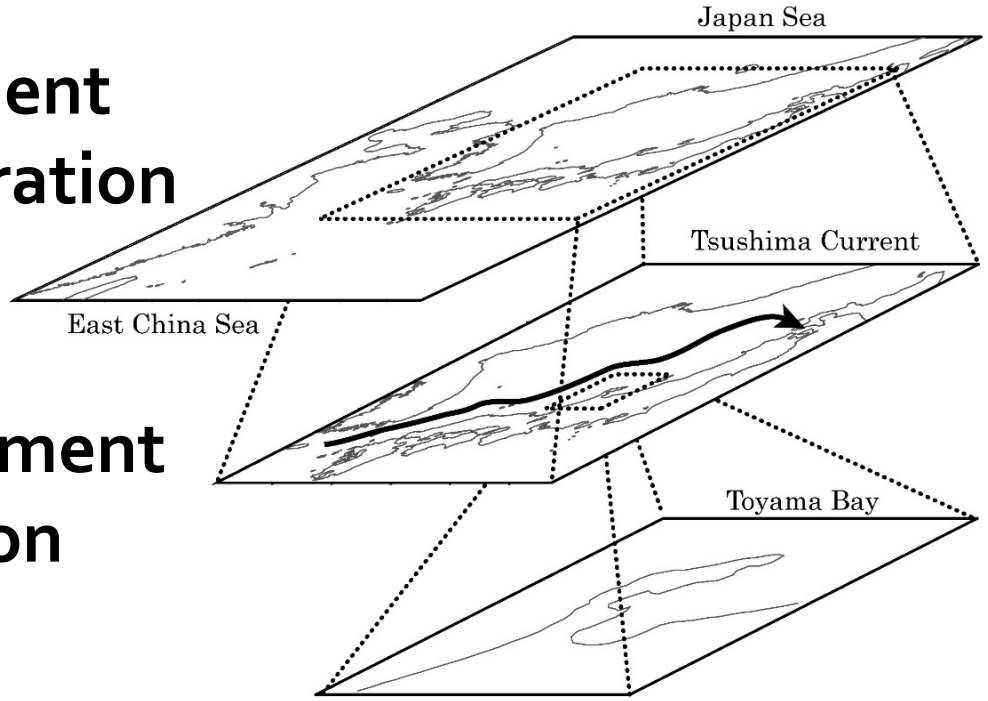
Dr. Yoshida, NPEC

## "Three Layer Management"

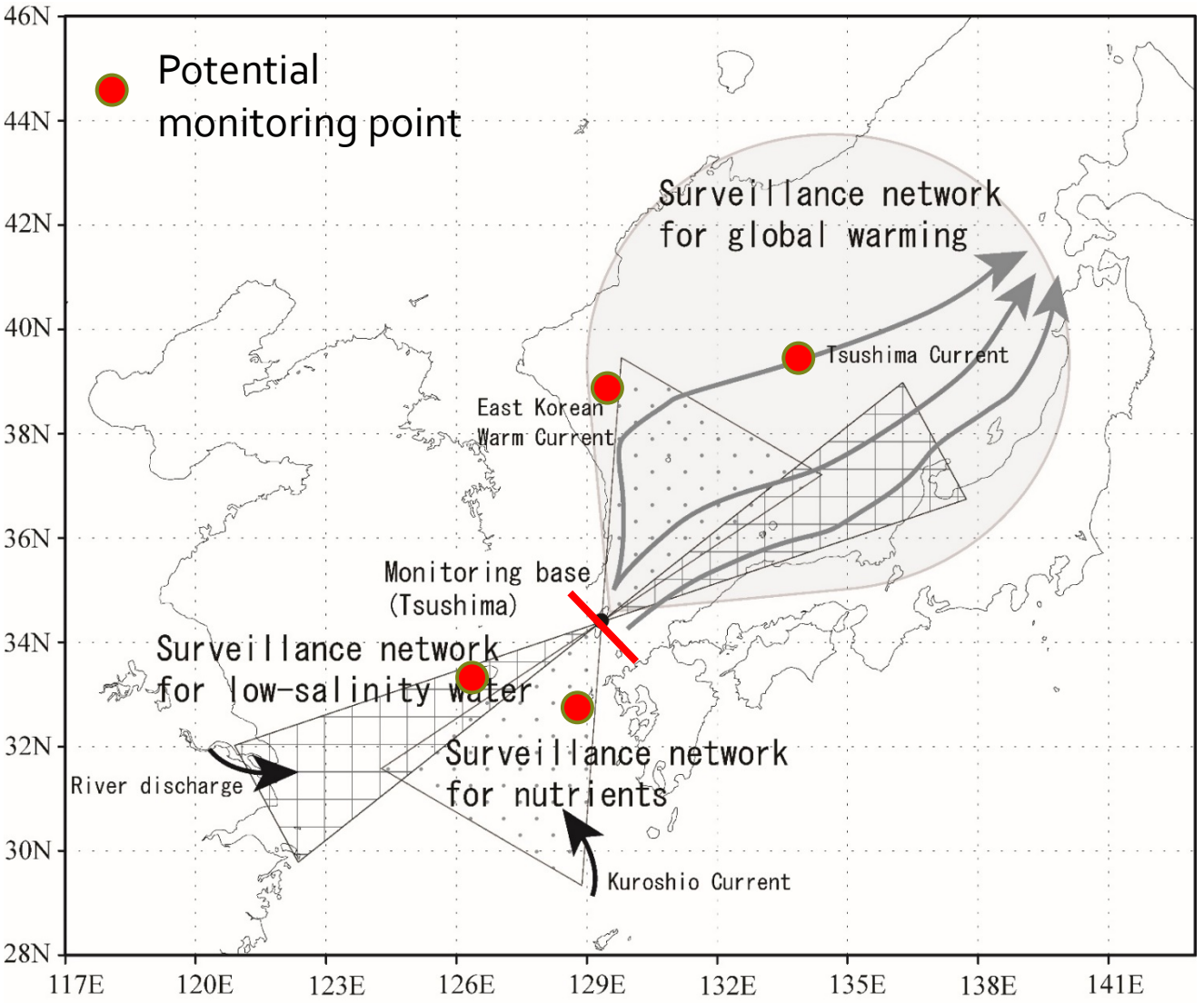
- **Wide scale management**
  **International cooperation**

- **Middle scale management**
  **Domestic cooperation**

- **Local scale management**
  **Local land-sea integrated management**



# EXAMPLE of wide-scale management: International surveillance network



# EXAMPLE of wide-scale management: International surveillance network

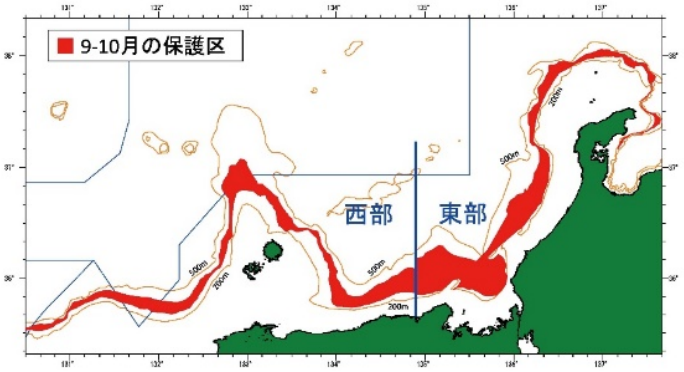
| Surveillance network | Monitoring items | Monitoring methods |
|---|---|---|
| **Global warming** | Water temp. (surface, bottom), Ocean Current (direction, velocity), DO, Nutrients (N, P) | Ship survey, Remote sensing, Argo float |
| **Nutrients** | Nutrients (N, P), Phytoplankton, Chlorophyll a | Ship survey, Remote sensing |
| **Low salinity water** | Salinity, PAHs, POPs | Ship survey |

Collaboration with International Organizations

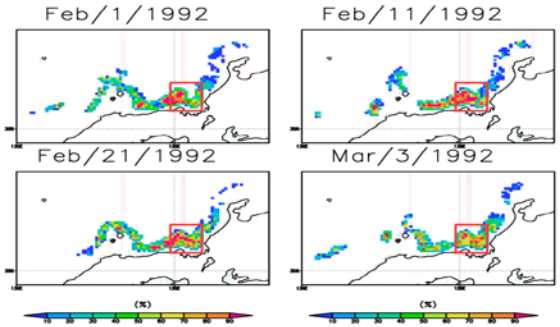
- IOC/WESTPAC
- NEAR-GOOS
- North Pacific Marine Science Organization（PICES） AP-CREAMS
- NOWPAP

# Middle scale management・Domestic cooperation
# Conservation of marine biodiversity/ecosystem

## Dynamic Marine Protected Area




Existing MPA for snow crab
（No fishing area, period）

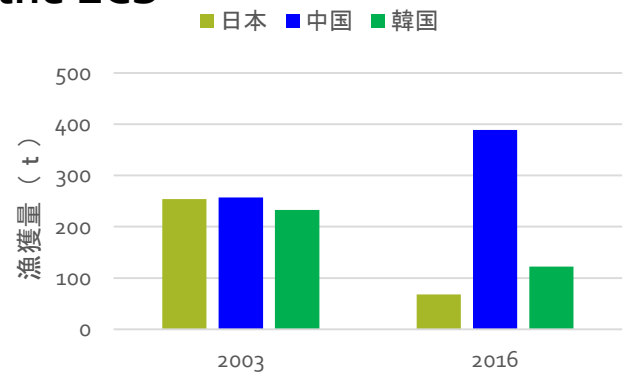



To protect main spawning ground where is changed by ocean environment

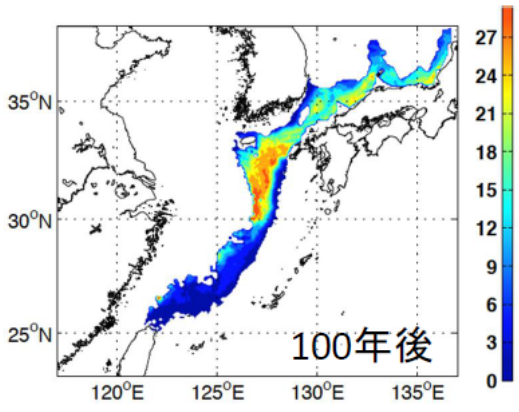
## Joint management of the ECS

High trophic

Phyto/zooplankton

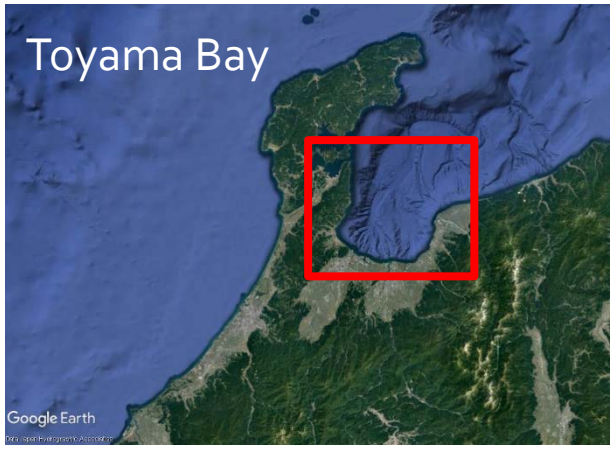


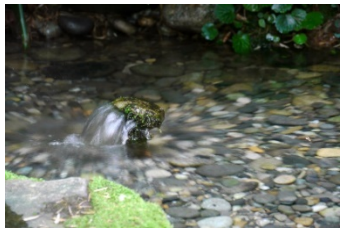

Catch of Japanese common squid



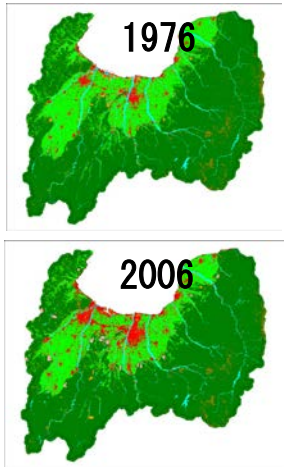

Ecological and biological significant sea area

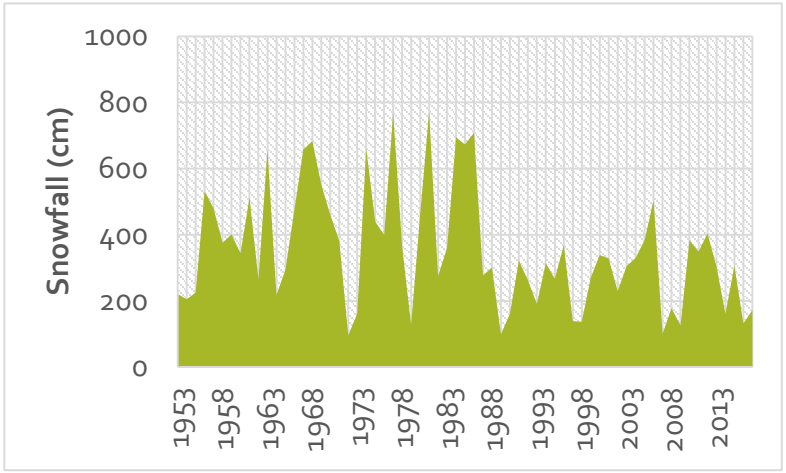
# EXAMPLE of local-scale management: Land-sea Integrated management

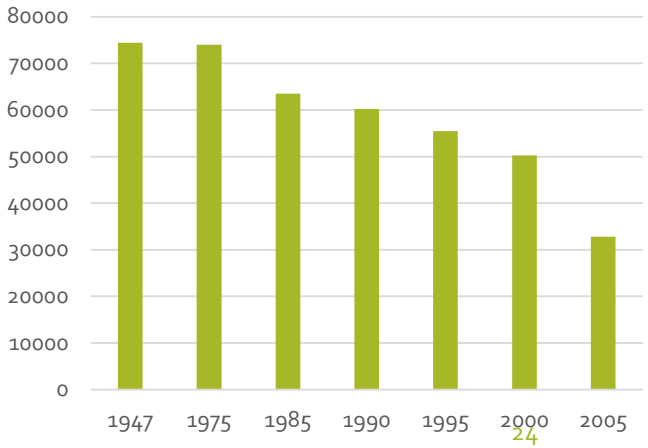


Change of natural and social environment



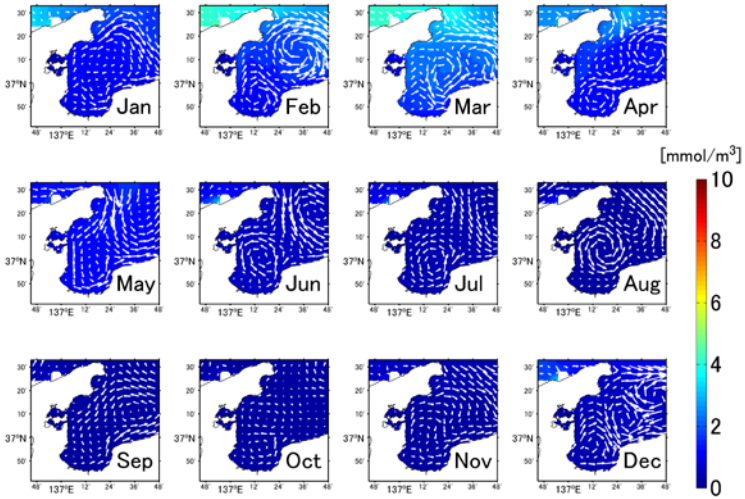

Land use

Snowfall

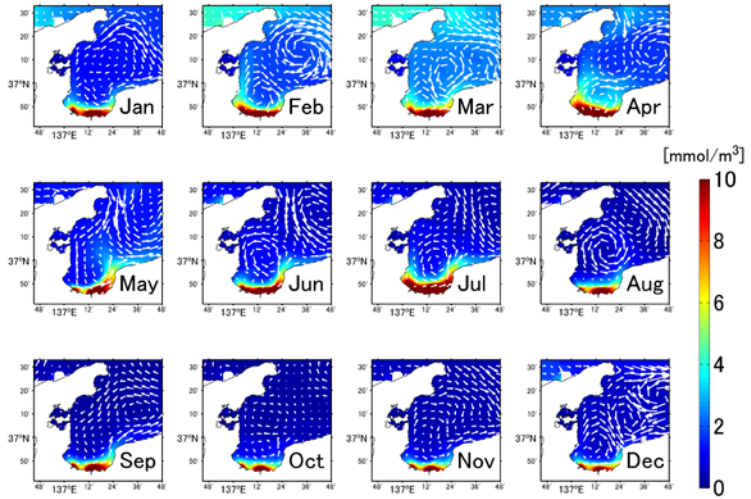
Rice paddy

# EXAMPLE of local-scale management: Land-sea Integrated management

Effect of river input

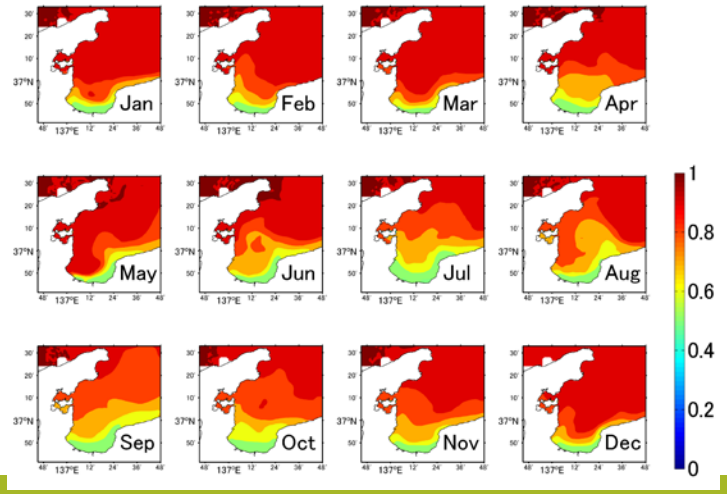


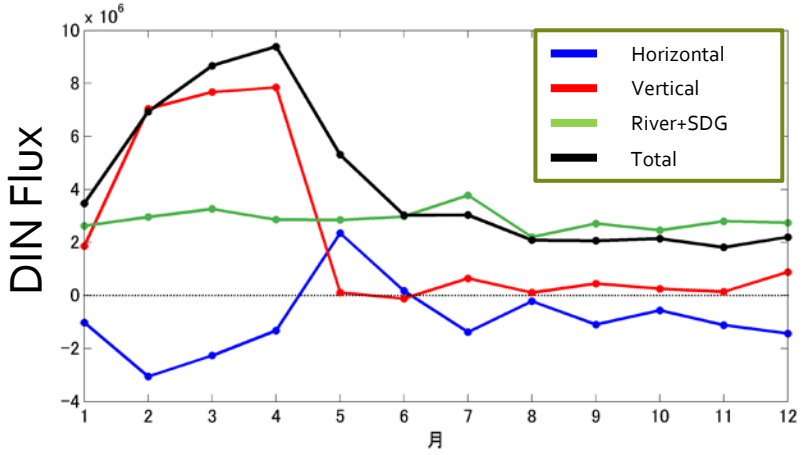

Without river discharge




With river discharge

Effect of SGD

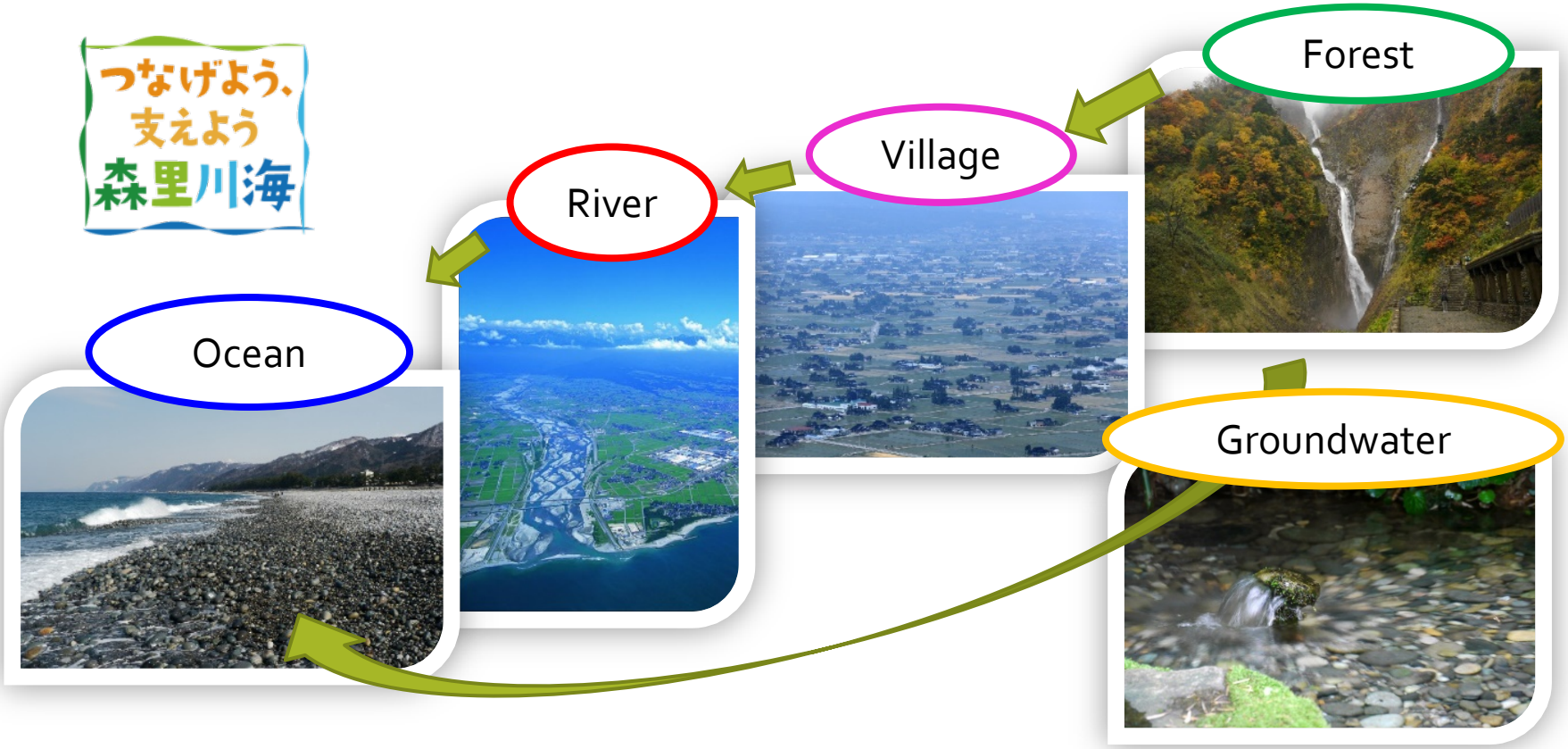


# EXAMPLE of local-scale management: Land-sea Integrated management

Ministry of the Environment, Japan

Forest-Village (Sato)-River-Ocean



# Conclusions

- More than 20 years of time series of satellite ocean color is available to use eutrophication monitoring (Need inter-calibration)
- High resolution satellite available recently
- Change of N/P ratio in East China Sea changes phytoplankton community
- Ocean color satellite is becoming possible to monitor phytoplankton community
- Prediction by numerical modelling is useful for management in near future