Phytoplankton and nutrient dynamics in the western Seto Inland Sea, Japan based on observation and a modified NEMURO model

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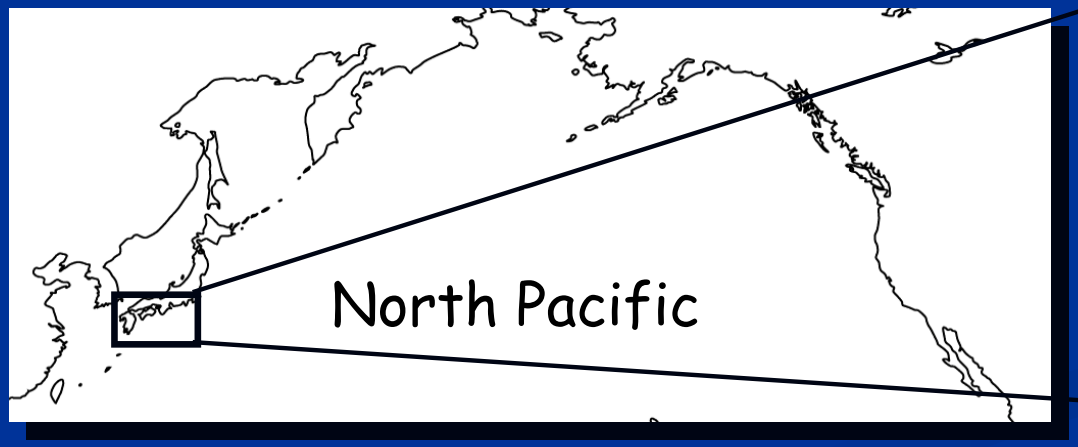
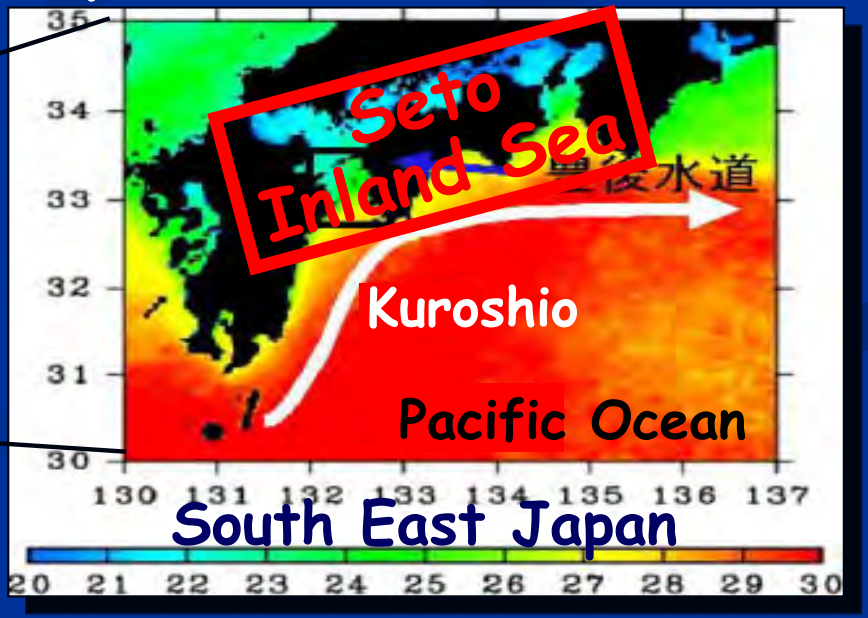
NEMURO MAFIA

Introduction of Seto Inland Sea

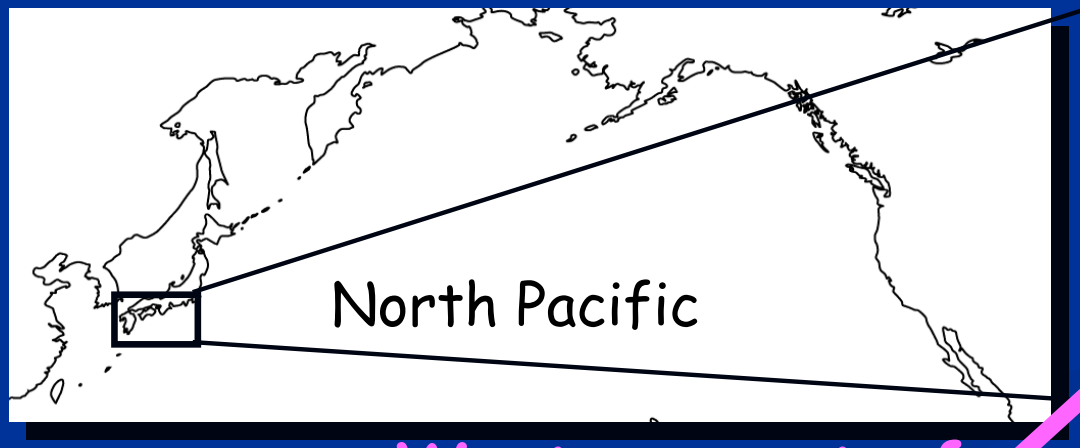
- Seto Inland Sea is a semi-enclosed coastal sea in the southern part of Japan.
- The efficiency of production is much higher, and fish catch is one of the world's most productive (21t km^{-2} yr^{-1}).
- This sea is surrounded by heavily industrialized areas, & affected by anthropogenic impacts for last 50 years.
- For sustainable fisheries and environmental recovery, it is important to carry out comprehensive research.



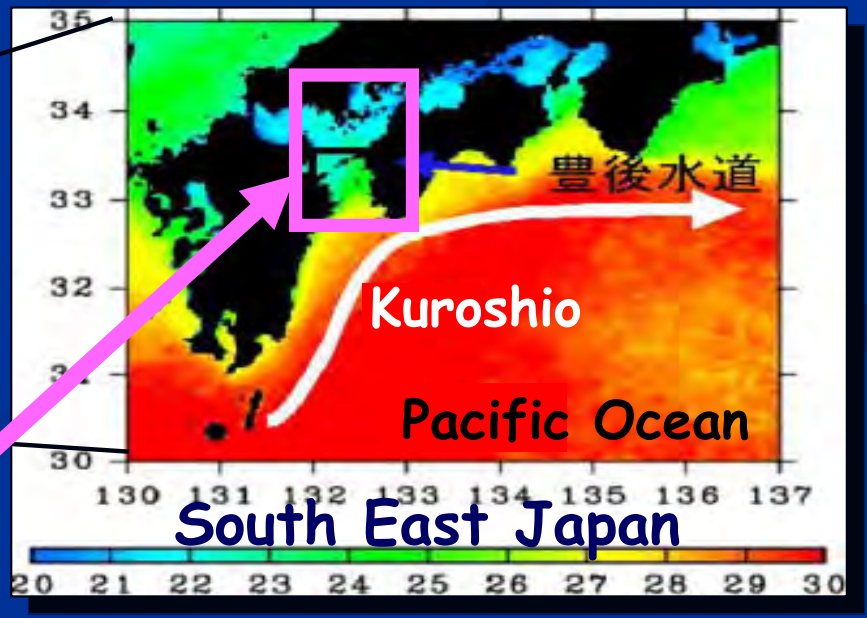


Introduction cont.

- We are developing an ecosystem model for the Seto Inland Sea for understanding ecosystem dynamics.
- There is little comprehensive data for the model validation in the western part of the Seto Inland Sea.
- We observed the spatiotemporal distribution of nutrient and plankton in these region in 2009.
- We show the nutrient and phytoplankton dynamics and the preliminary results of our ecosystem model.



Western part of the Seto Inland Sea

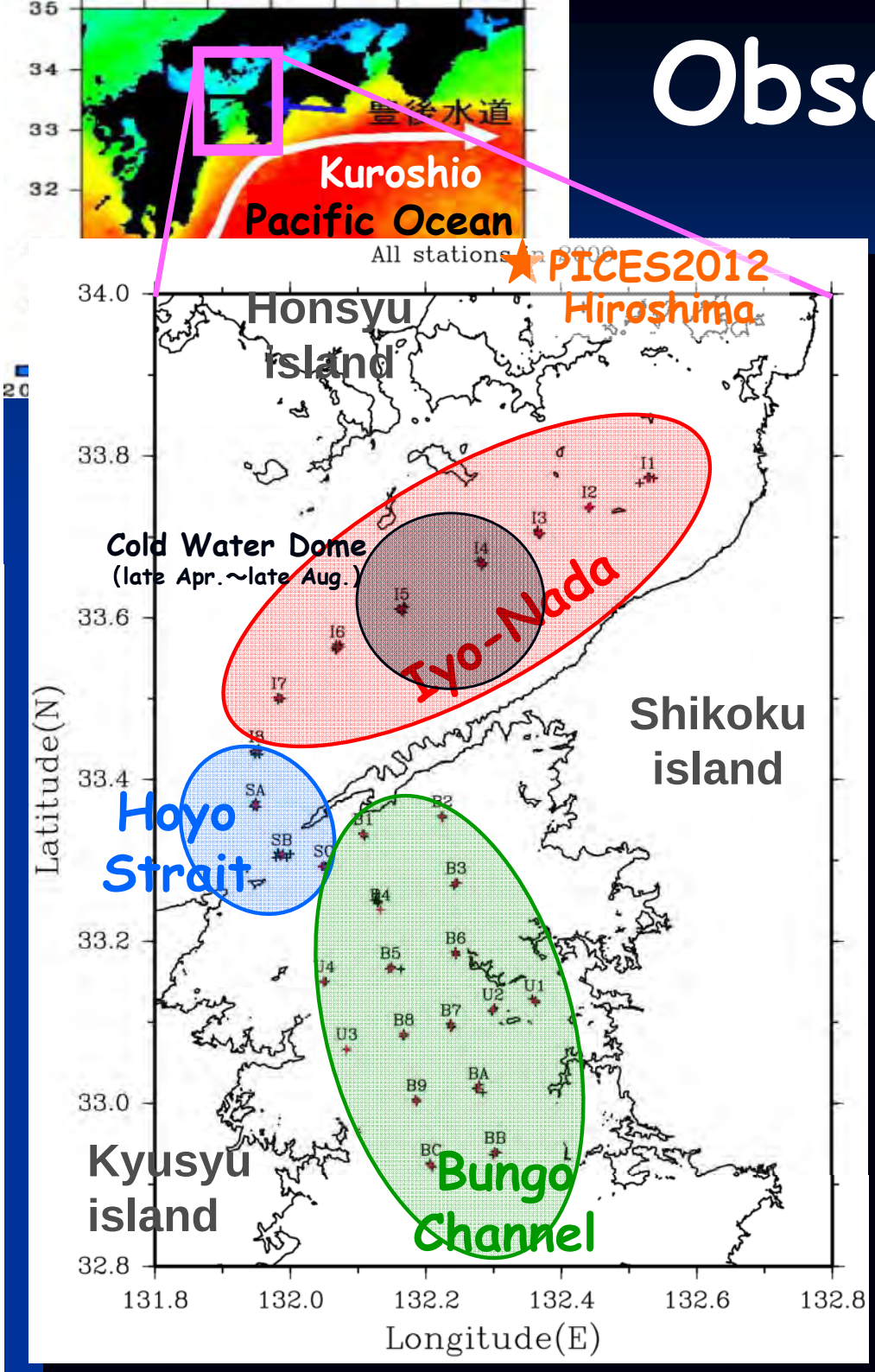


Observation

Region: Iyo-Nada, Hoyo Strait & Bungo Channel

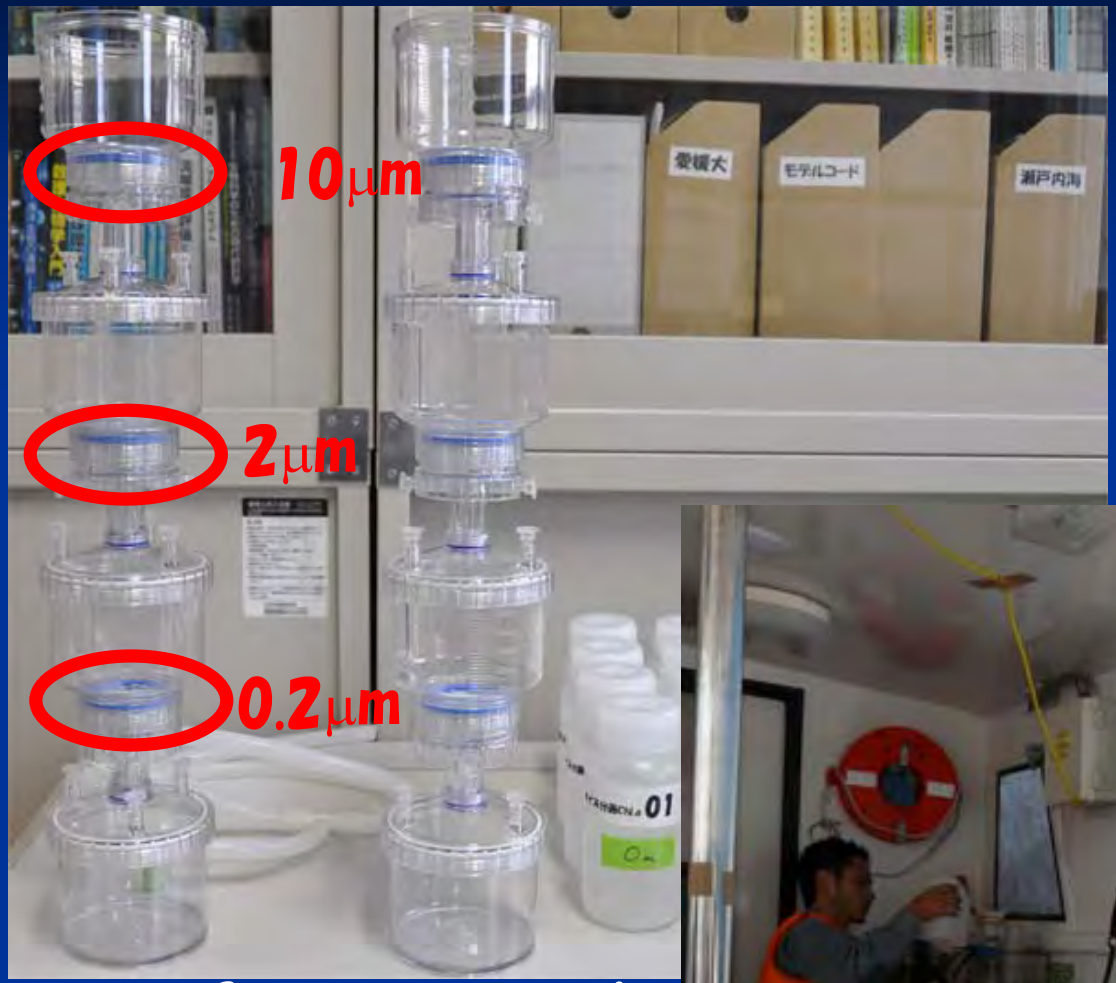
Period: '09 Apr.-Nov. (10 times)

Items: T, S, Tur., PAR, DO, NO_3, $Si(OH)_4$, PO_4, NH_4, SS, Chl.a, Phytoplankton group comp., Zooplankton group comp.



R/V "ISANA" of CMES, Ehime Univ.
LOA: 17.5m, Cruise speed: 43km/h

Phytoplankton group composition



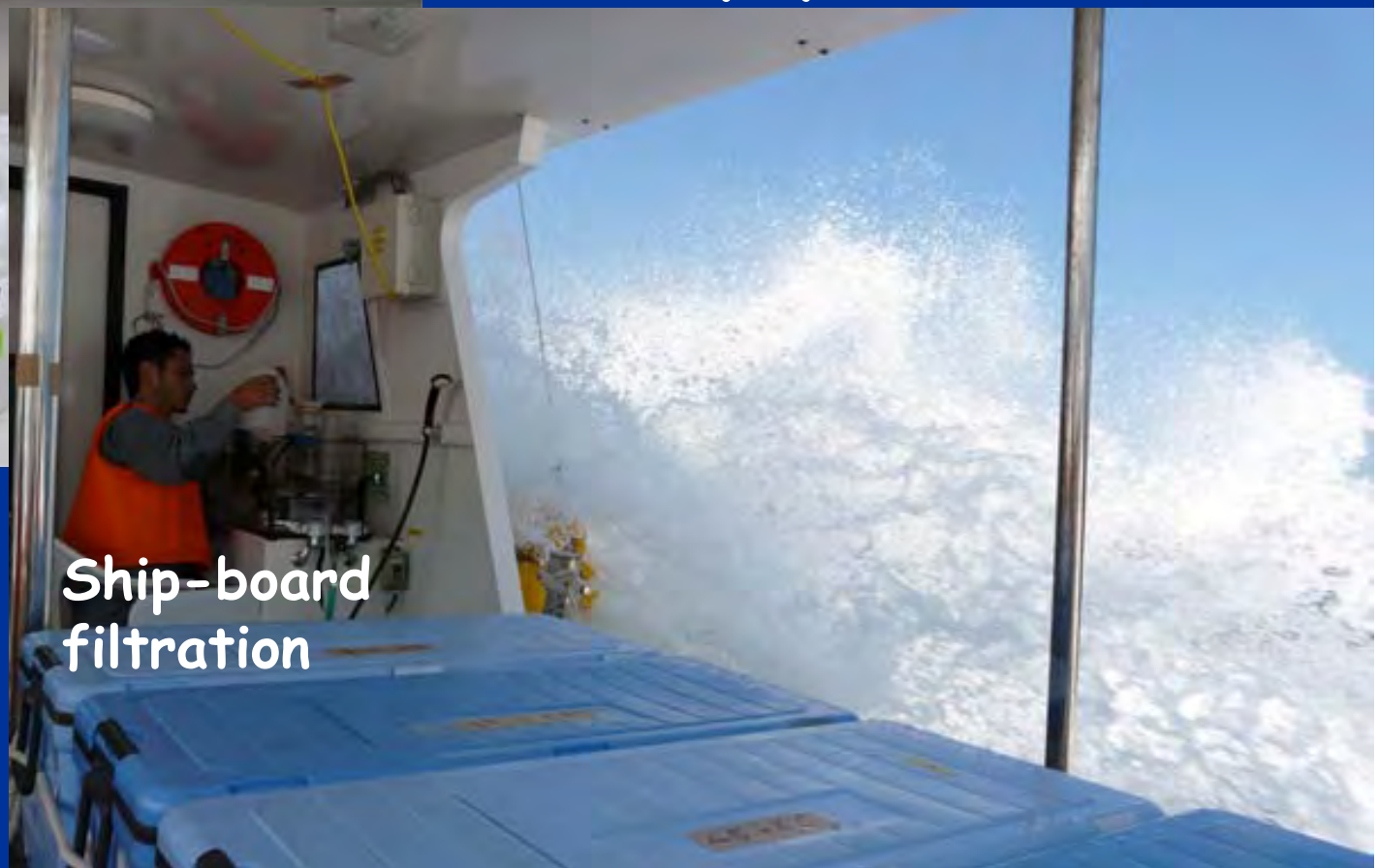
Size fractionated filtration system

Obs. Scene in Sept. 2009

Size fractionated Chl.a

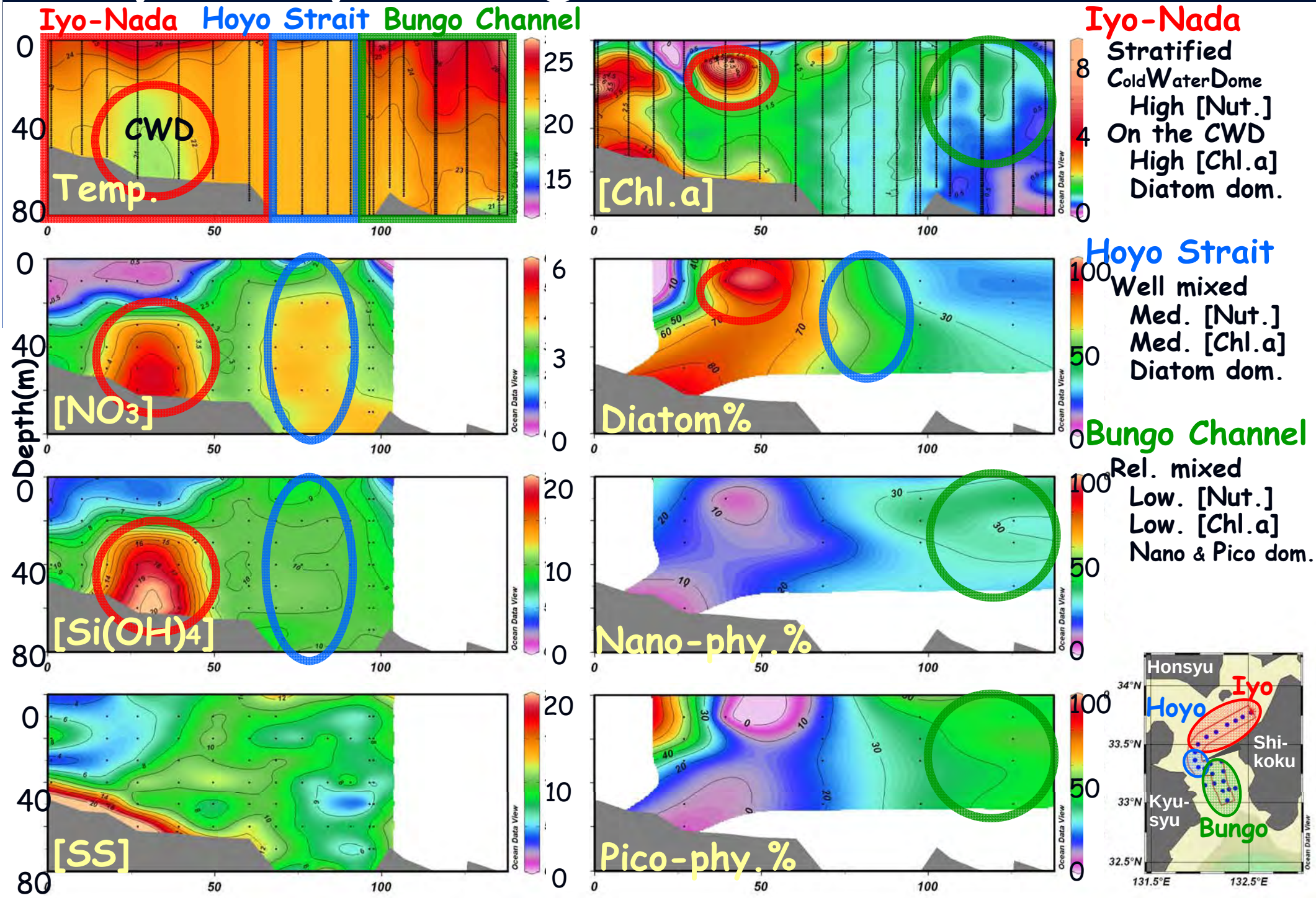
(Detph:0,10,20,30,50m)

1. Micro-phyt.: >10μm
2. Nano-phyt.: 2-10μm
3. Pico-phyt. : 0.2-2μm



Ship-board filtration

Iyo-Hoyo-Bungo transect (at 23 Aug.)



Iyo-Nada

Stratified
ColdWaterDome
High [Nut.]
On the CWD
High [Chl.a]
Diatom dom.

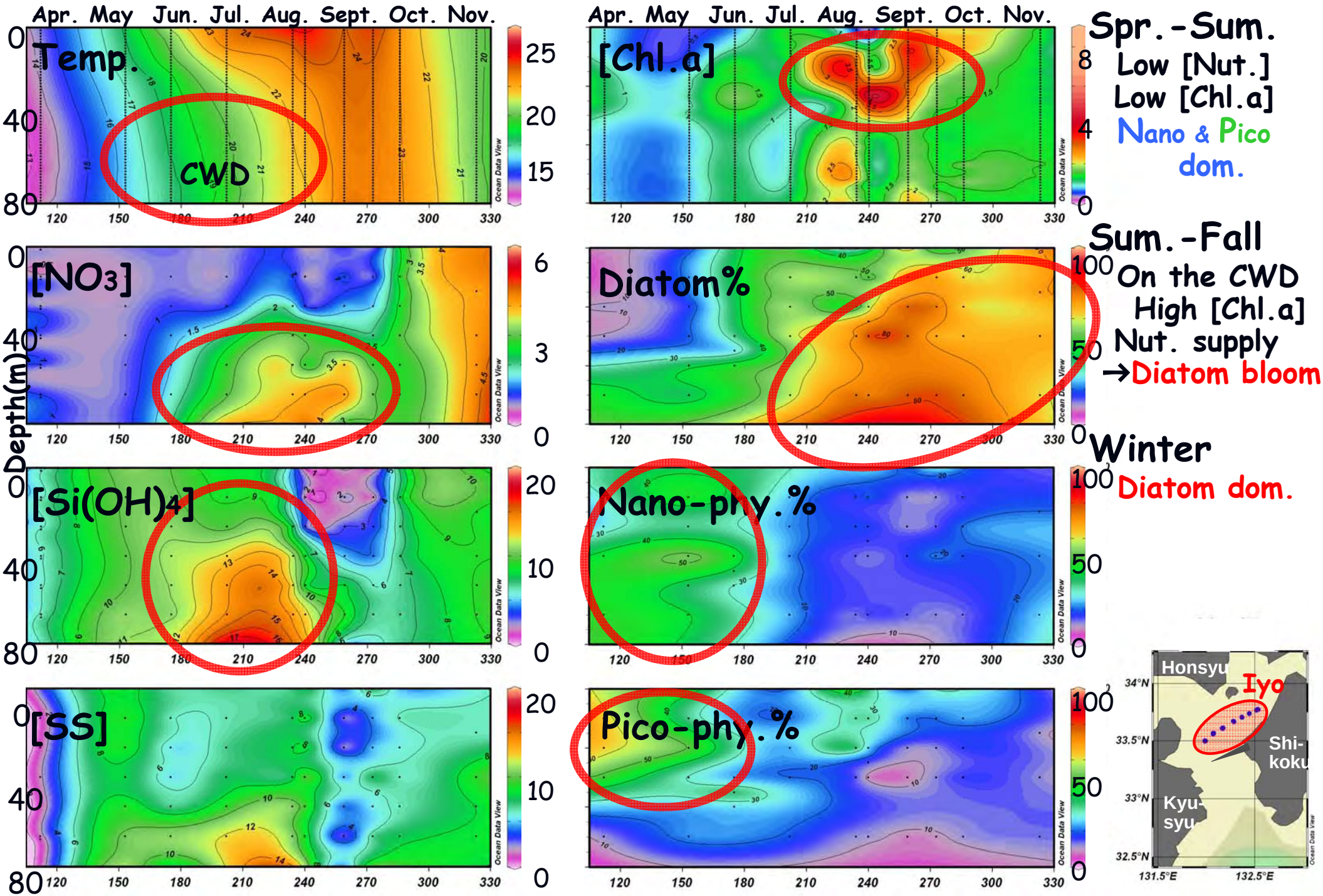
Hoyo Strait

Well mixed
Med. [Nut.]
Med. [Chl.a]
Diatom dom.

Bungo Channel

Rel. mixed
Low. [Nut.]
Low. [Chl.a]
Nano & Pico dom.

Seasonal changes in Iyo-Nada

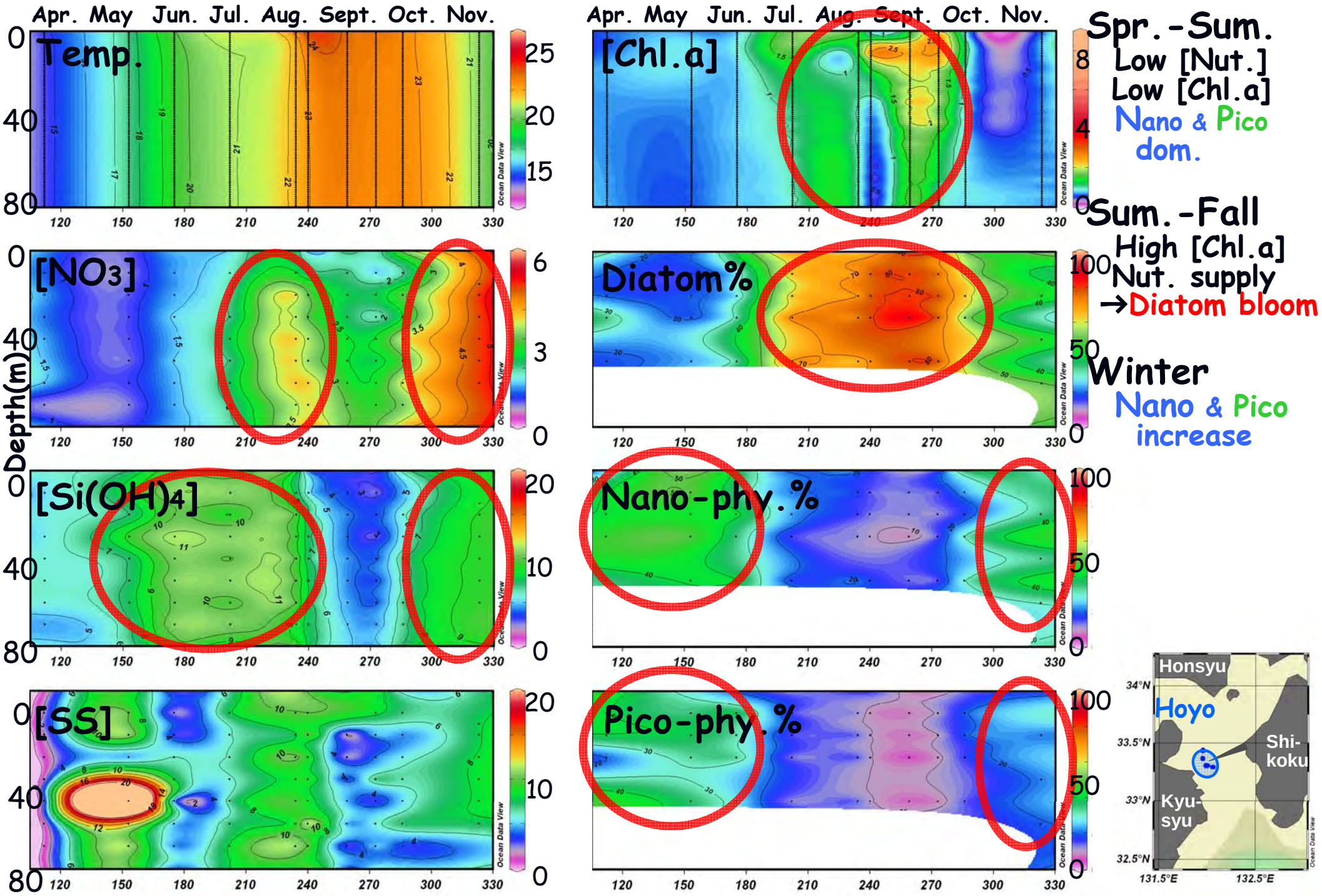


Spr.-Sum.
Low [Nut.]
Low [Chl.a]
Nano & Pico dom.

Sum.-Fall
On the CWD
High [Chl.a]
Nut. supply
→Diatom bloom

Winter
Diatom dom.

Seasonal changes in Hoyo Strait

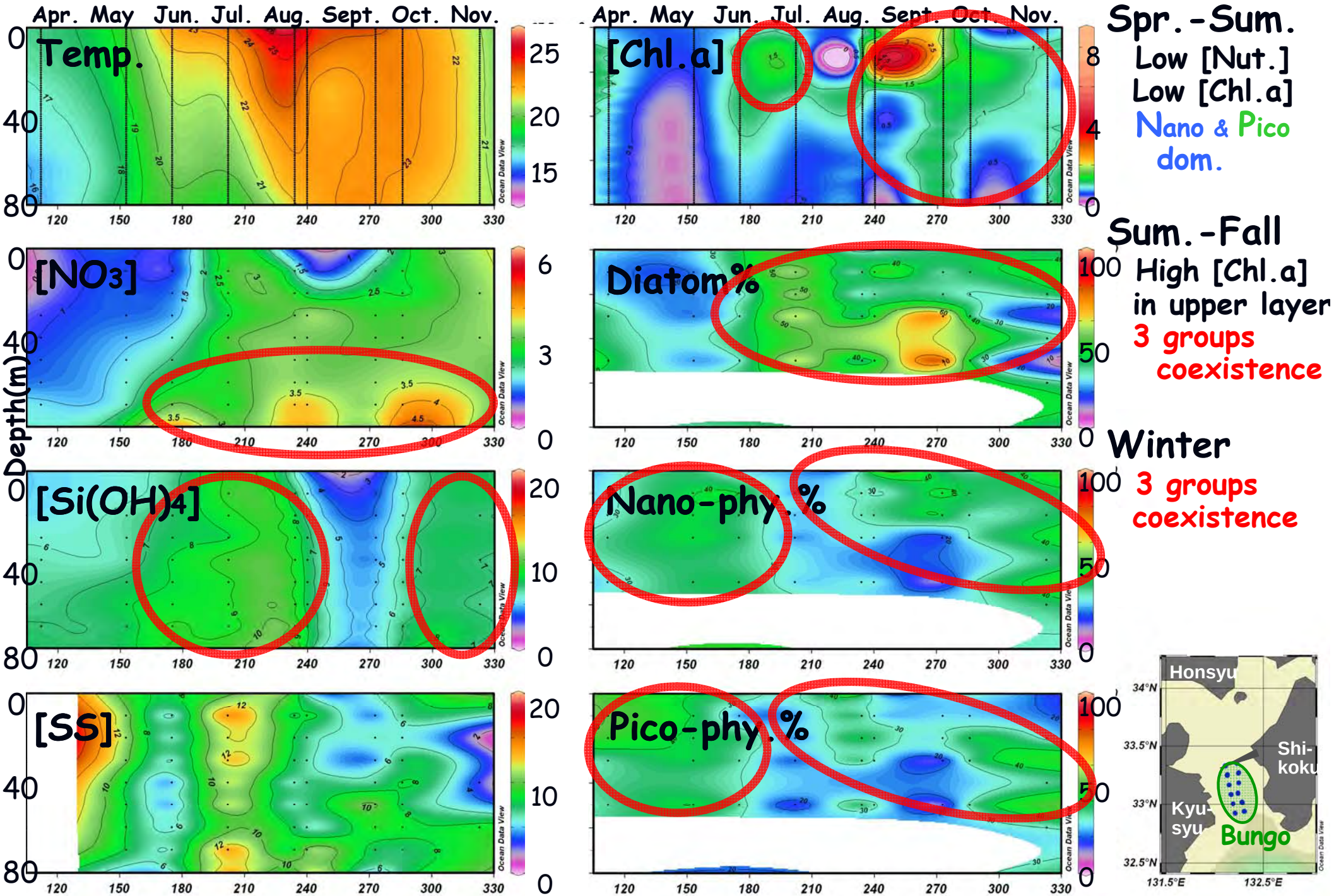


Spr.-Sum.
Low [Nut.]
Low [Chl.a]
Nano & Pico dom.

Sum.-Fall
High [Chl.a]
Nut. supply
→Diatom bloom

Winter
Nano & Pico increase

Seasonal changes in Bungo Channel

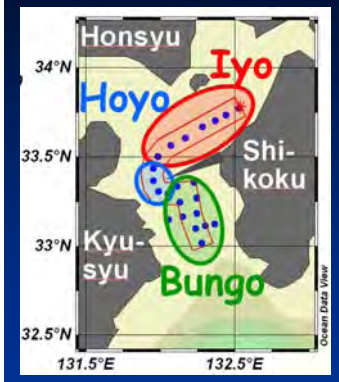


Spr.-Sum.
Low [Nut.]
Low [Chl.a]
Nano & Pico dom.

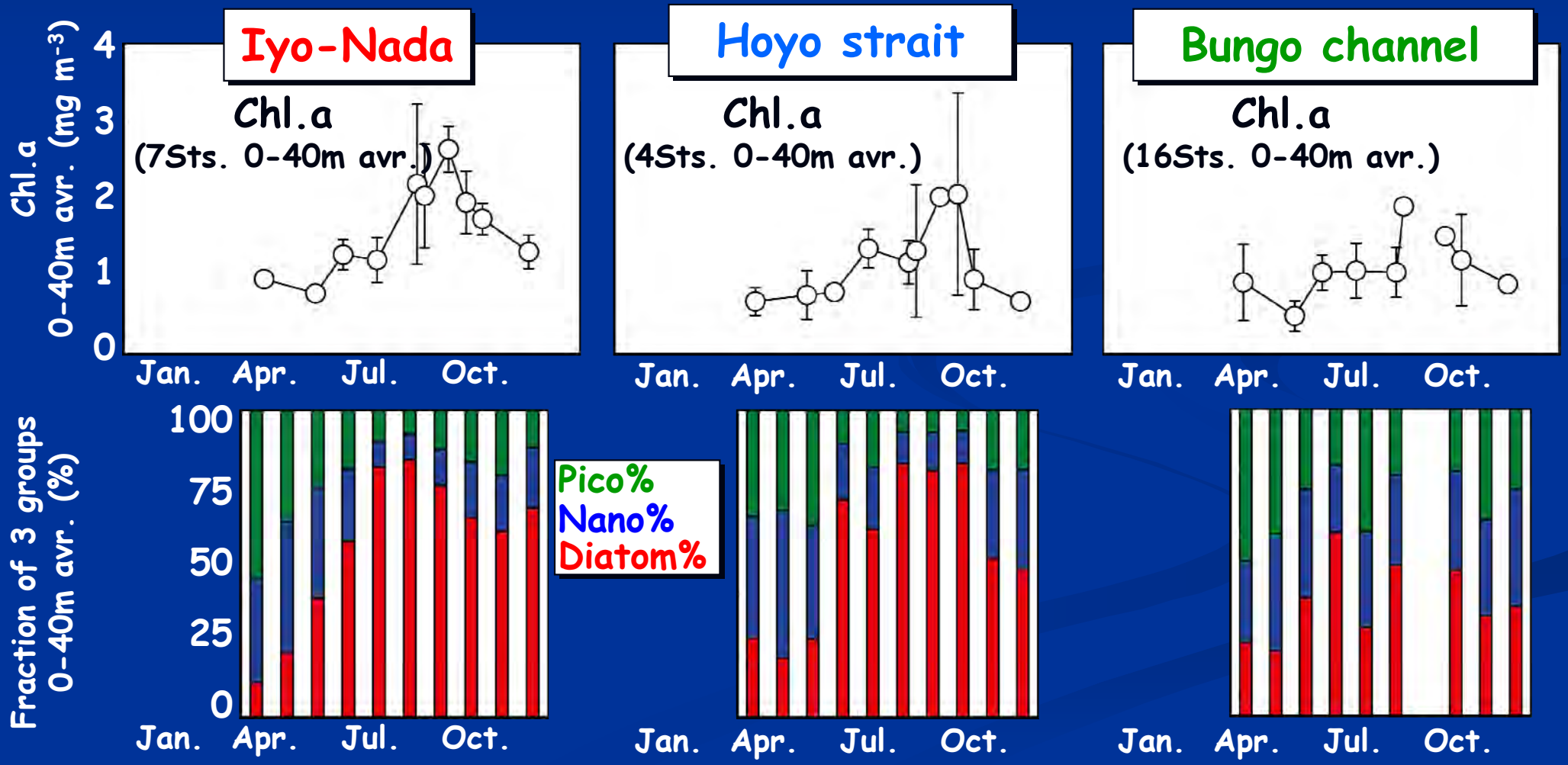
Sum.-Fall
High [Chl.a] in upper layer
3 groups coexistence

Winter
3 groups coexistence

Seasonal changes in phytoplankton



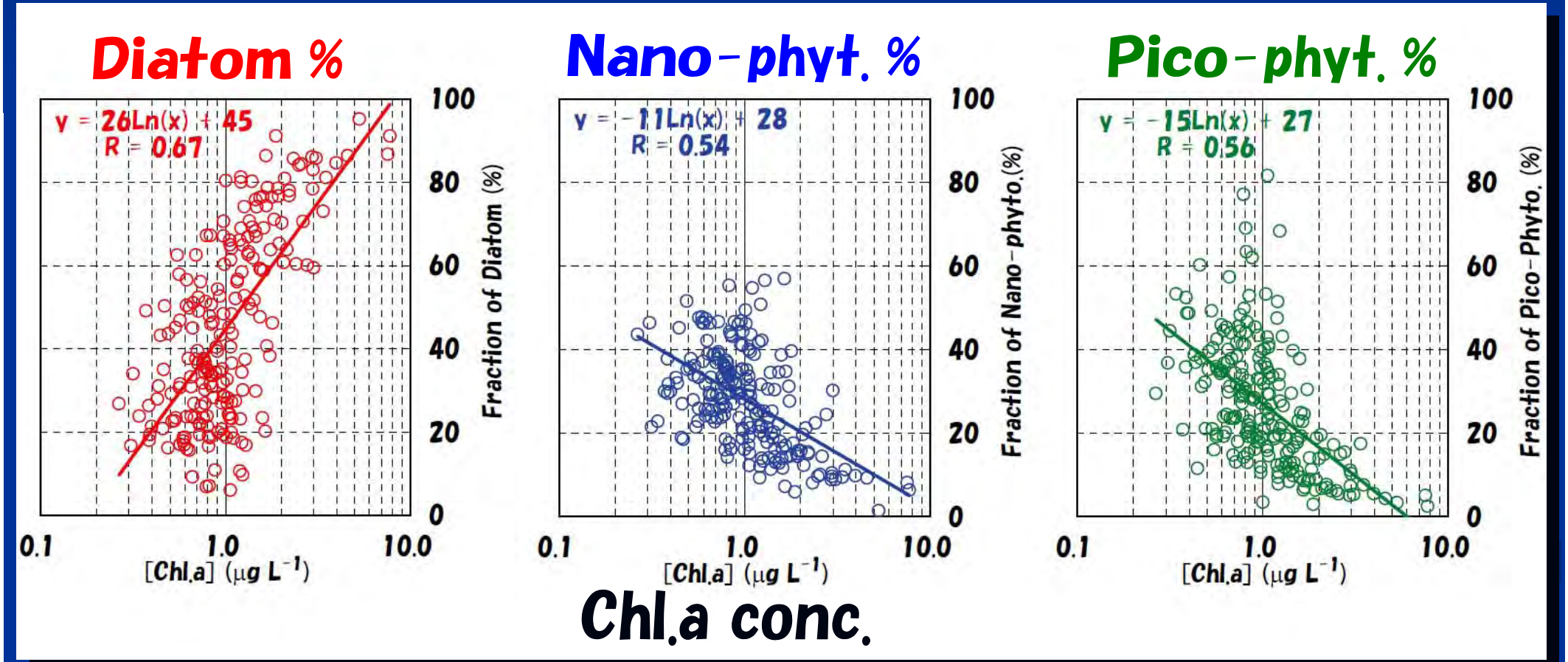
Season	Iyo-Nada	Hoyo strait	Bungo channel
Spring	Pico & Nano dom.	Pico & Nano dom.	Pico & Nano dom.
Sum.-Fall	Diatom bloom	Diatom bloom	3 groups coexist.
Winter	Diatom dom.	3 groups coexist.	3 groups coexist.



Relationship Chl.a & phyt. group comp.

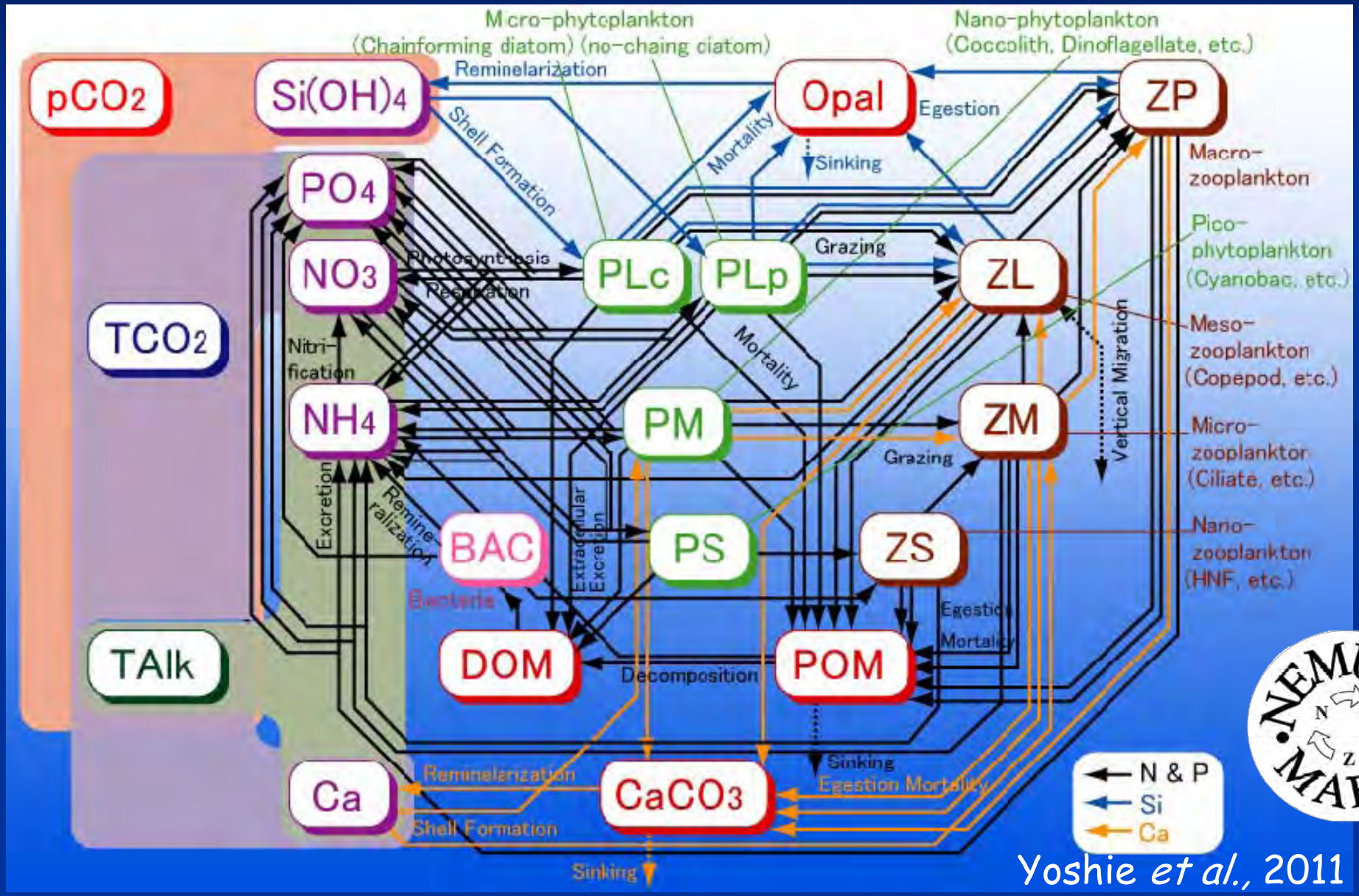
Diatom fraction has positive correlation with Chl.a
Nano & Pico fraction have negative correlation with Chl.a

Chl.a conc. ➡ Phytoplankton group composition



Ecosystem model (eNEMURO ver.4)

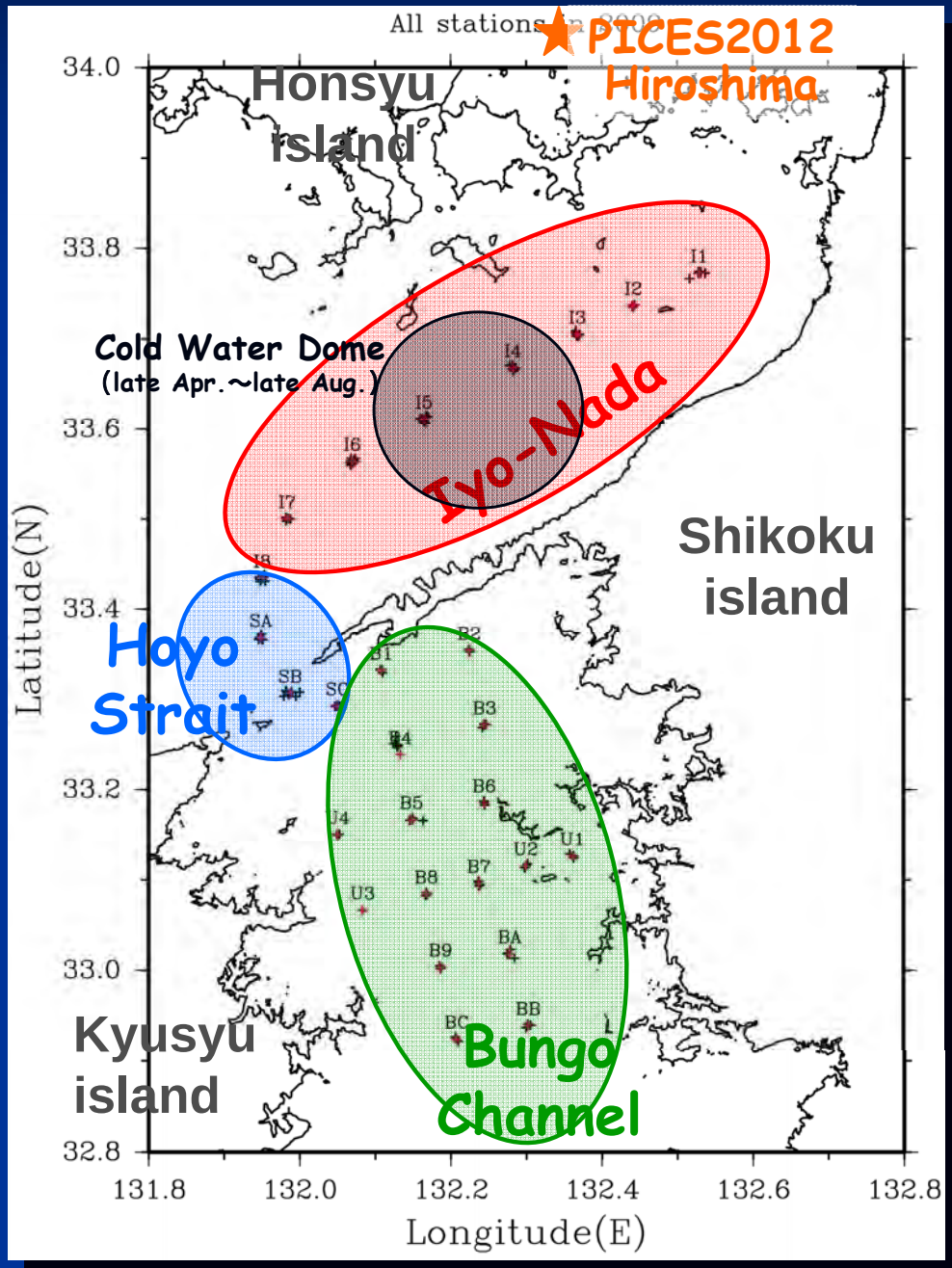
Plankton functional types model (4N-4P-4Z-4D) extended from NEMURO
(+Microbial food web +Two types diatoms +New temp. dep. +Phosphorus cycle)

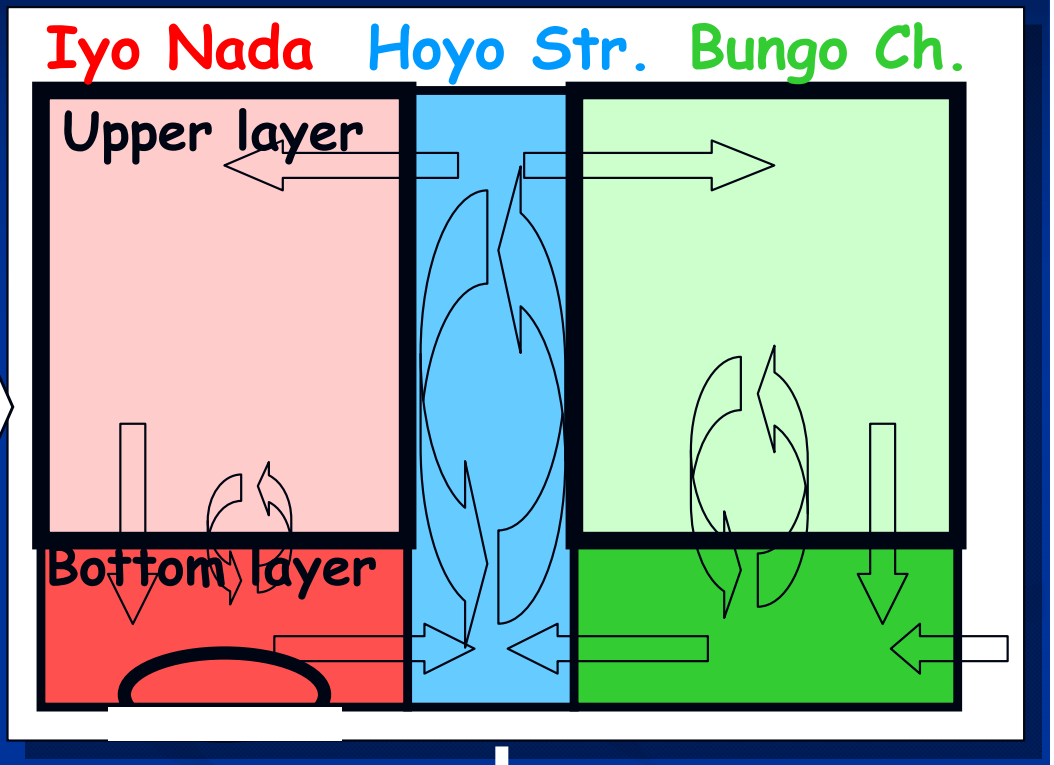


Yoshie *et al.*, 2011

Iyo-Hoyo-Bungo box ecosystem model

eNEMURO was coupled with 5box models (2boxes in the Iyo-Nada, 1box in the Hoyo strait & 2boxes in the Bungo channel).





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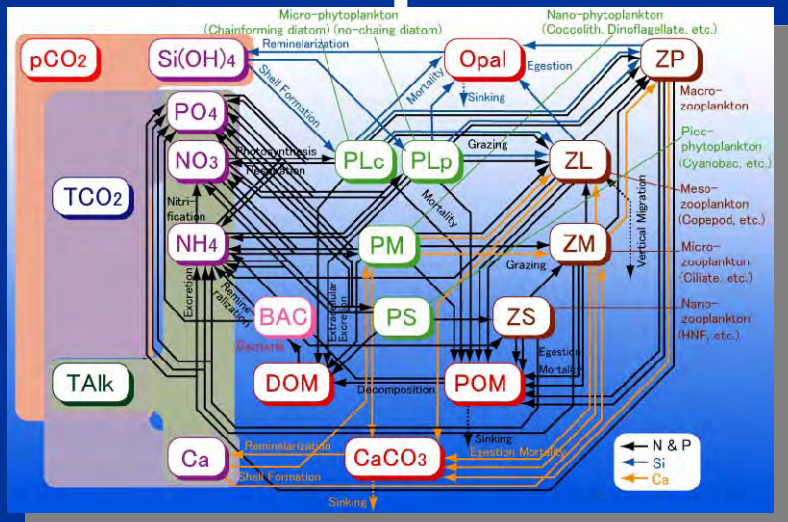
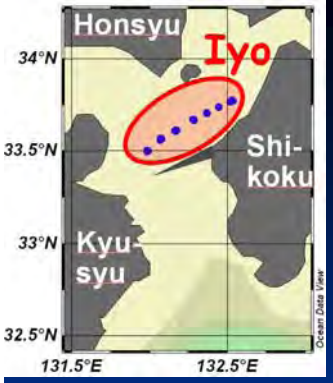
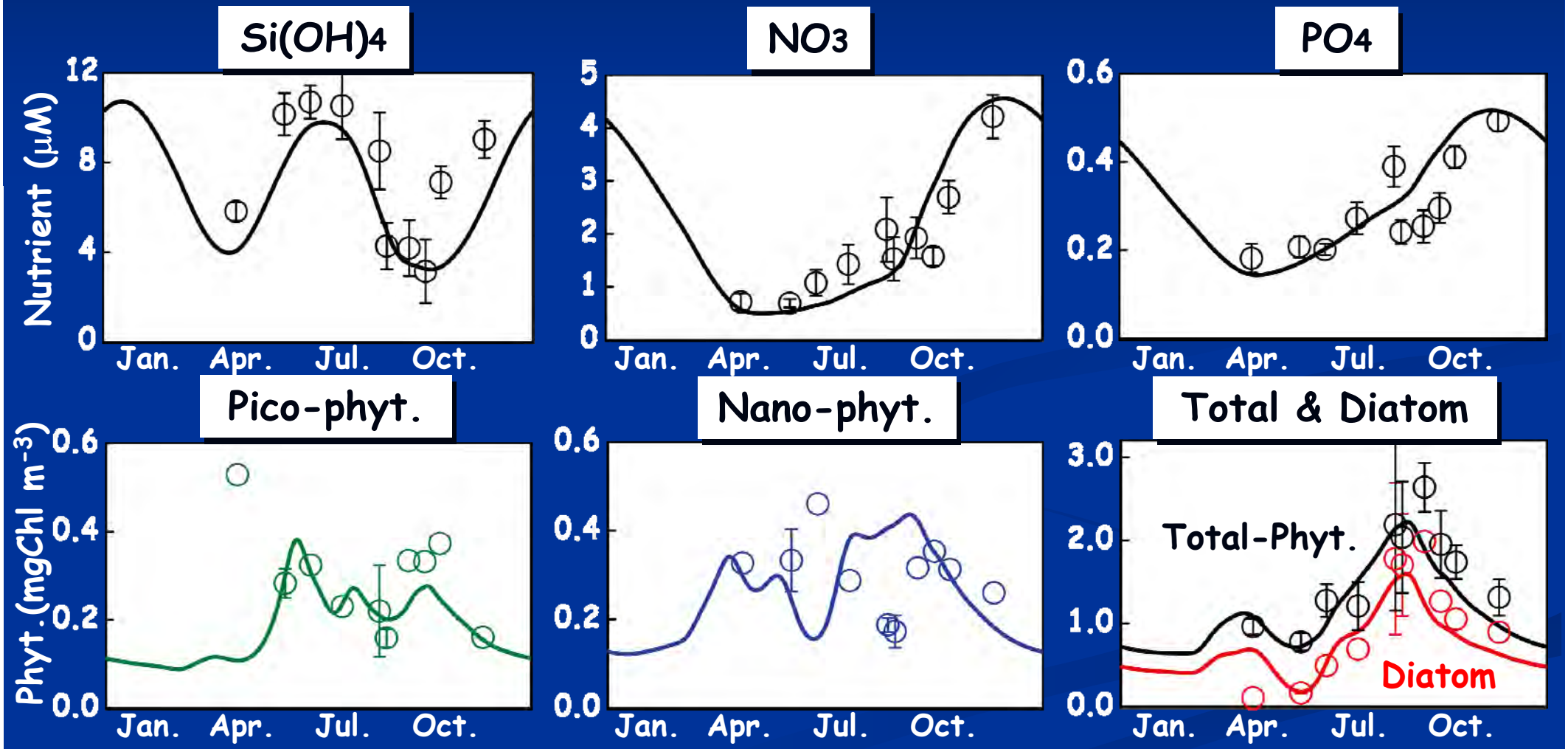
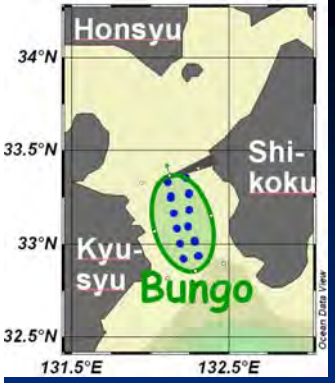




Model results in Iyo-Nada

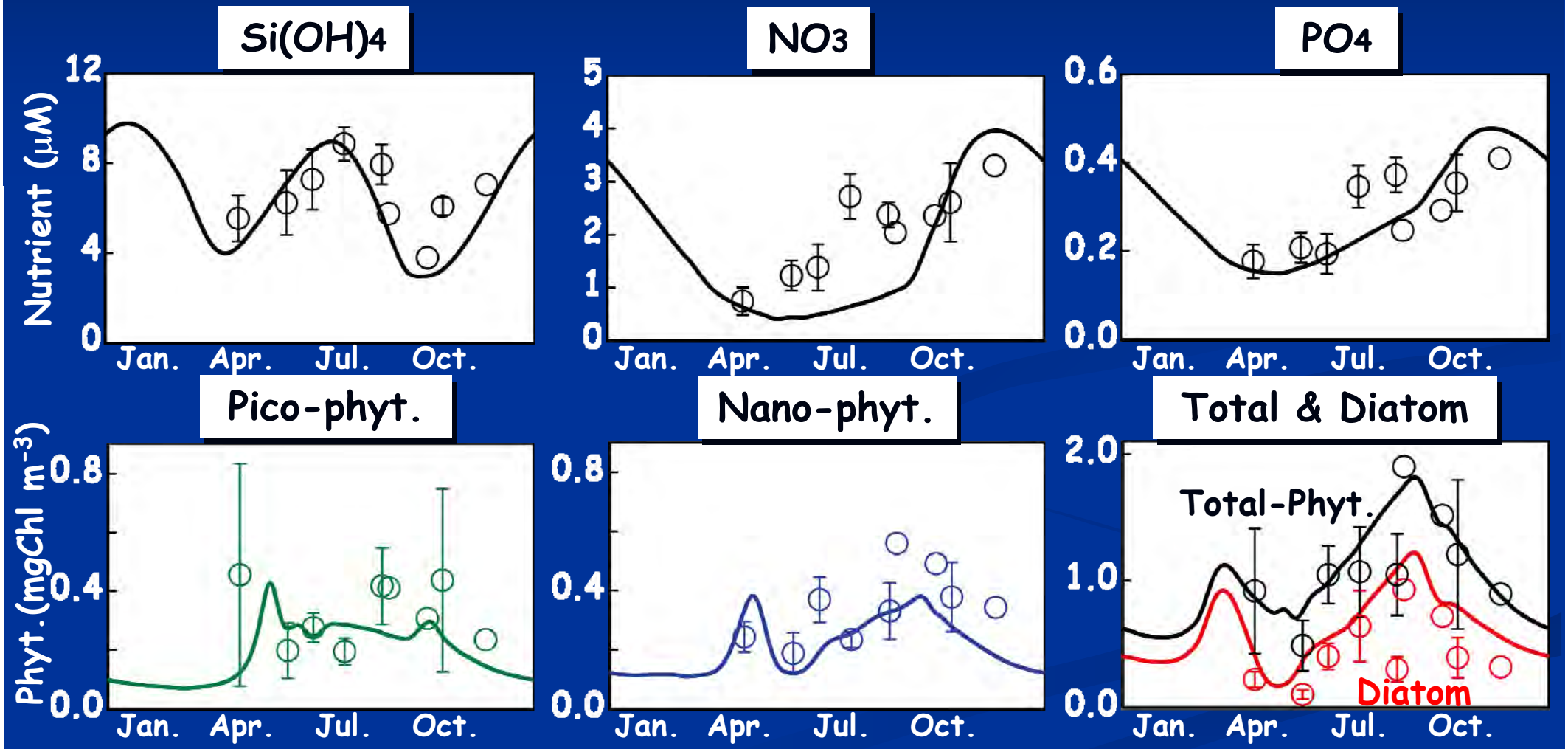
Our model successfully reproduced nutrients & phytoplankton dynamics in the Iyo-Nada.





Model results in Bungo Channel

Our model also successfully reproduced nut. & phyt. dynamics in the Bungo Channel.



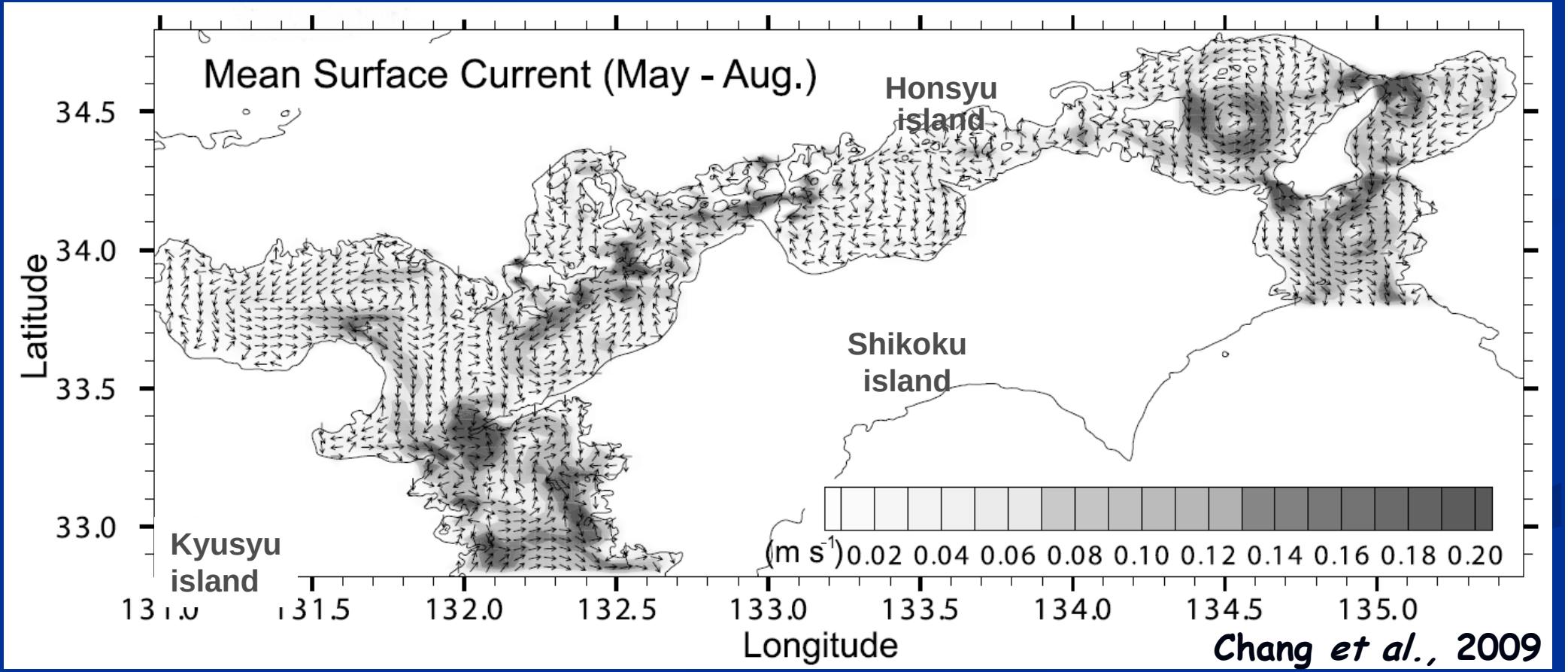
3D model under construction

eNEMURO with high resolution 3D physical ocean model

Princeton Ocean Model (POM, Chang *et al*, 2009)

Horizontal res.:1 x 1 km, Vertical res. : 21 **σ** layers

Including Nutrient supply from river and Tidal mixing *etc.*



Summary

- Nutrient and phytoplankton dynamics in the western part of the Seto Inland Sea were clarified.
- From Spr. to Sum., pico & nano-phyt. were dominant. From Sum. to Fall, diatom was blooming in Iyo-Nada and Hoyo strait.
- Model successfully captured nutrient & phytoplankton dynamics observed in Iyo-Nada & Bungo channel.
- Next step
  - Comparison with the zooplankton data
  - Coupling with the 3D physical ocean model
  - Investigation of the oceanic water intrusion

Thank you !