Effect of strong turbulent mixing on phytoplankton around the Tokara Strait

I. *Introduction*
II. *Detail of Observation*
III. *Method of Incubation Experiment*
IV. *Results*
V. *Summary*

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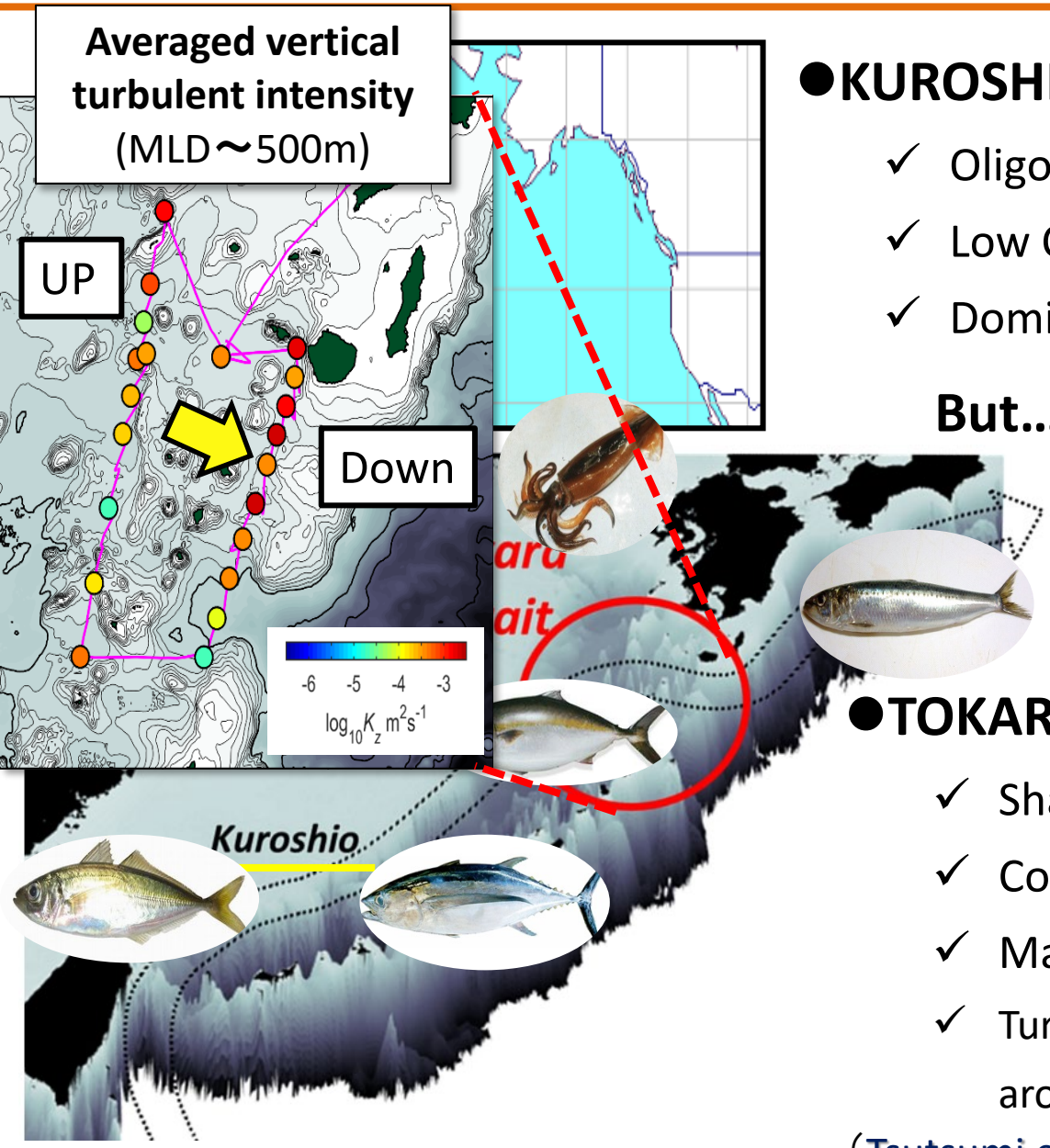
Introduction



●KUROSHIO

- ✓ Oligotrophic
- ✓ Low Chlorophyll
- ✓ Dominated by small sized phytoplankton

But… It is chosen as major spawning grounds by numerous fish species.

Why?

●TOKARA STRAIT

- ✓ Shallow
- ✓ Complex topography
- ✓ Many seamounts and islands
- ✓ Turbulent intensity is one of the strongest around the Kuroshio region

（Tsutsumi et al., 2017, Nagai et al., 2017）

Introduction

Hypothesis

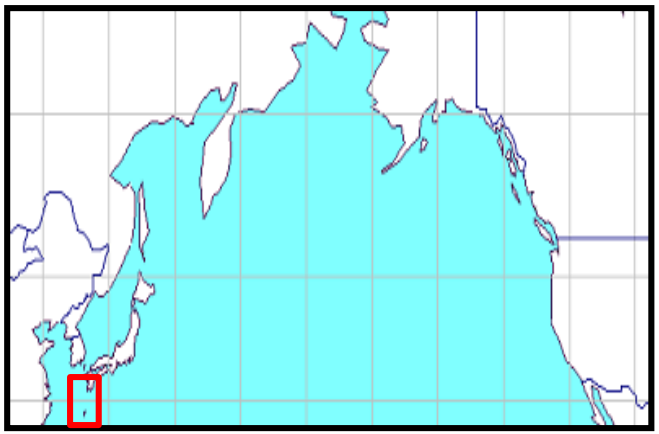
I. *Phytoplankton biomass increase by nutrient supply driven by turbulent mixing around the Tokara strait in downstream region.*

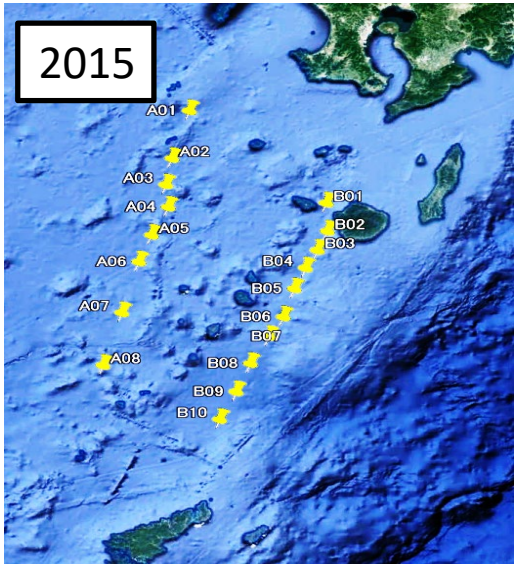
II. *Size of phytoplankton in upstream shift to larger size in downstream since the Tokara strait.*

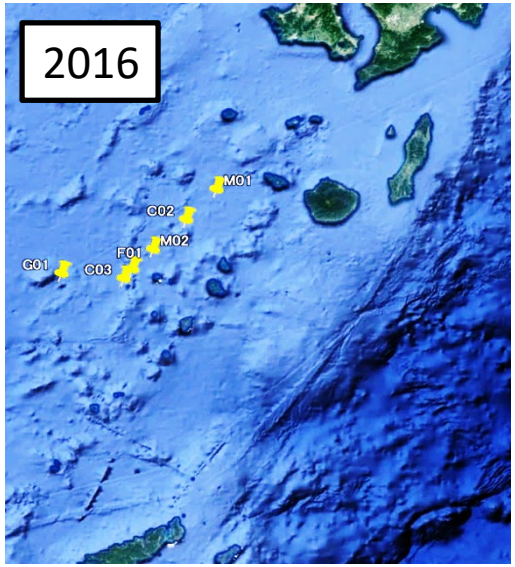
III. *Good feeding condition is created for zooplankton and fish larvae around the Tokara strait*

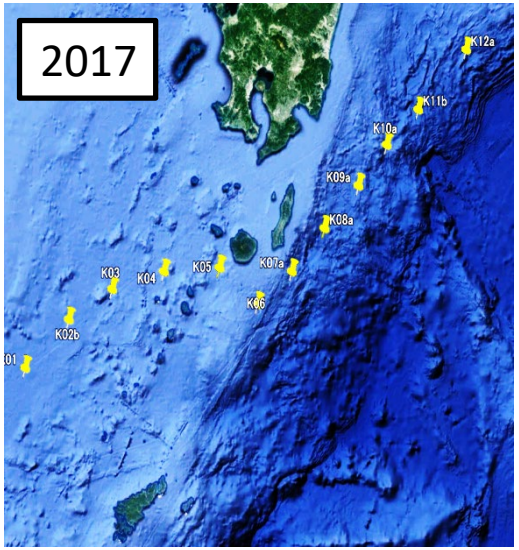
Observation

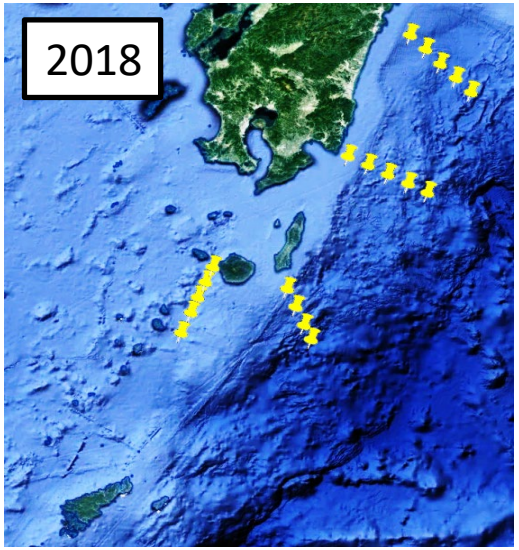
Observations around Tokara strait from 2015 to 2018（November）





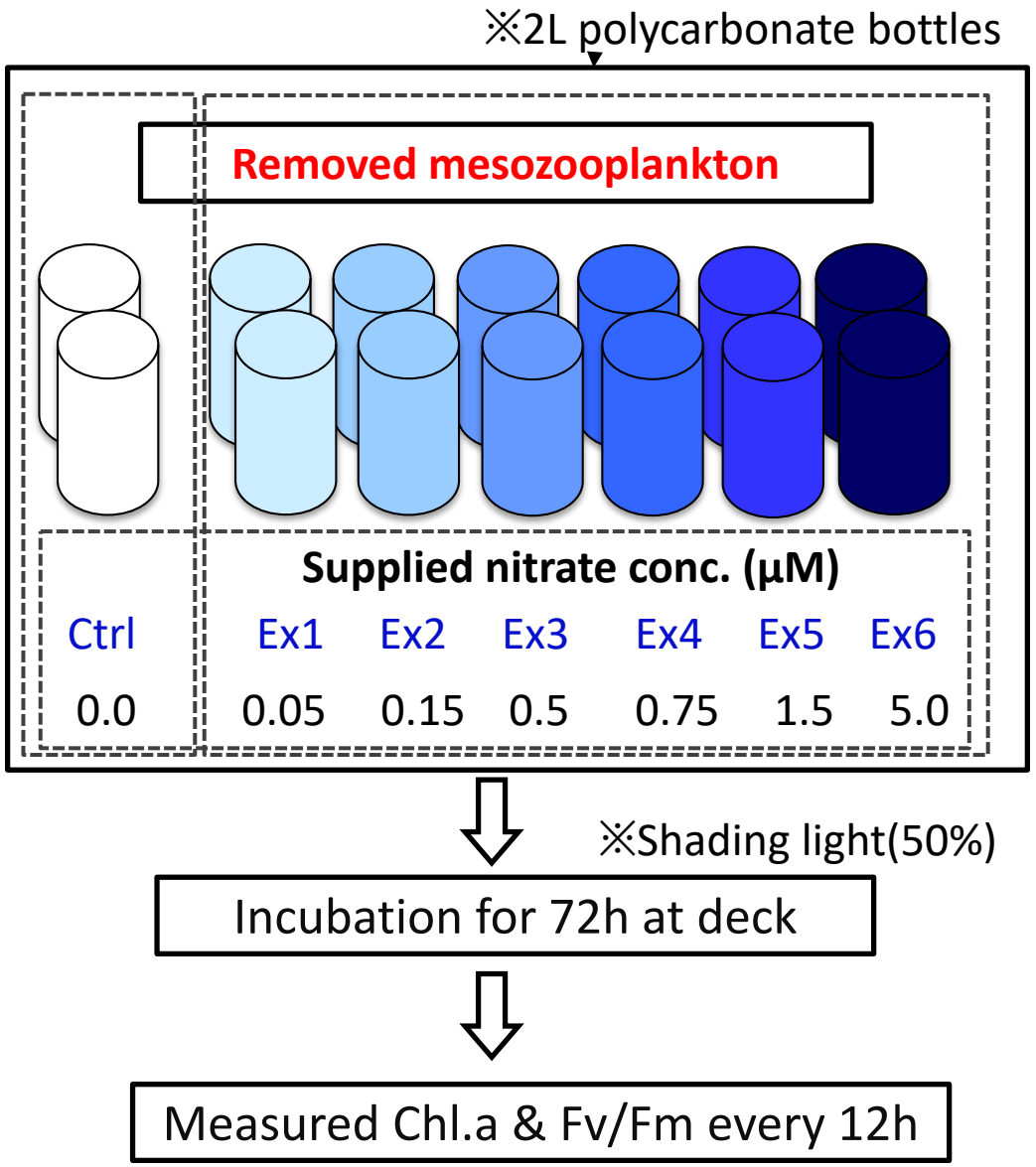






- **Obs. Summary**
- **Nutrient**
- **Phytoplankton**
  - **Incubation experiment**
- **Zooplankton**
- **Turbulence**
- **Temp, sal, depth …ect.**

Method: Incubation Experiment



- Purpose
  - Investigate responsivities of phytoplankton to nutrient supply around Tokara strait
- Hypothesis
  - Turbulent mixing

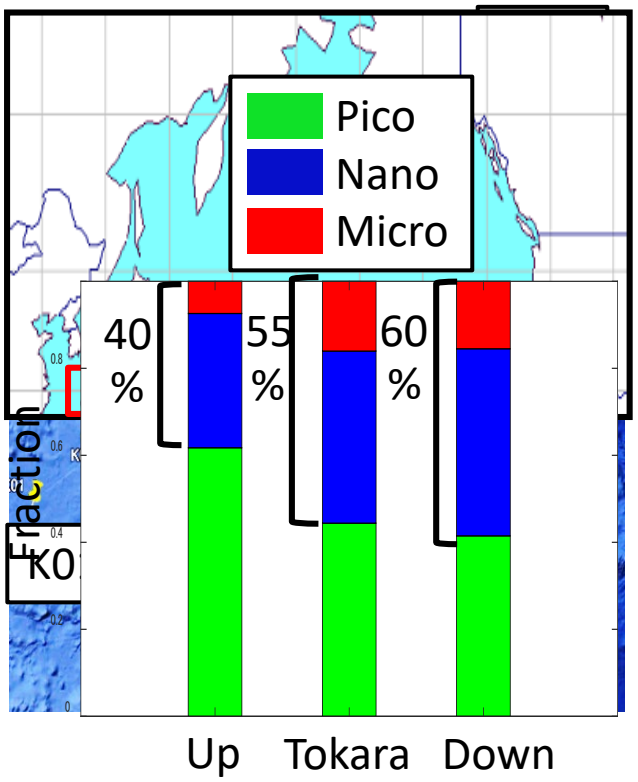
→ Nutrients supply to euphotic layer

→ Increase of phytoplankton

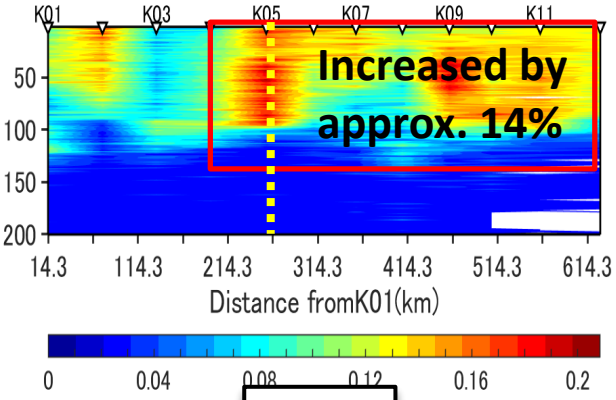
→ Rapid grazing by zooplankton

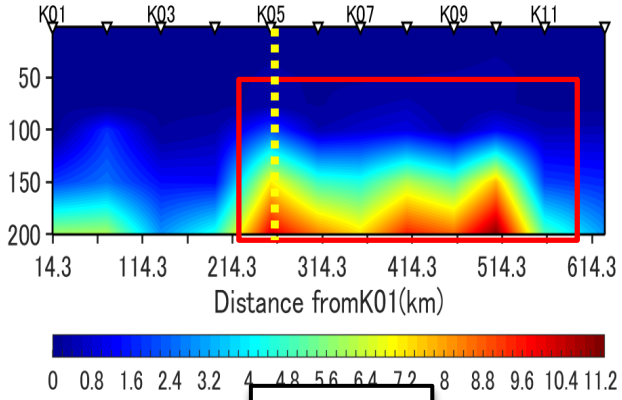
Results: Lagrange Observation in 2017

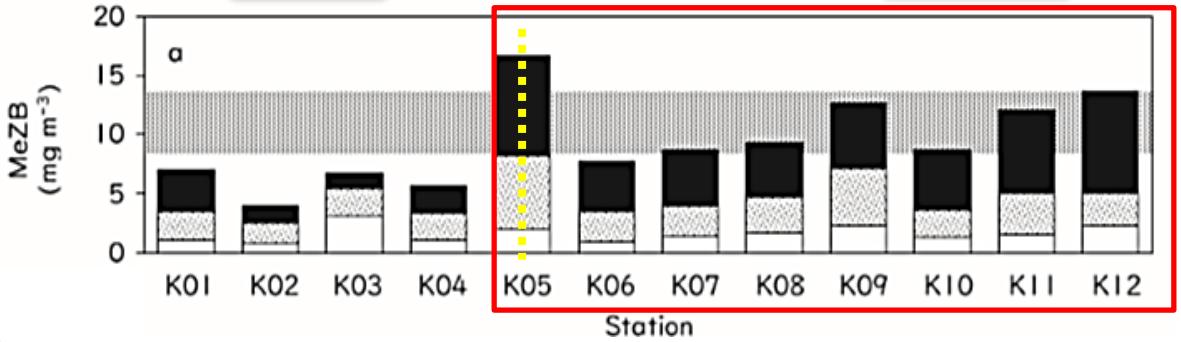
- Nitrate in the subsurface layer, Chl.a and zooplankton biomass clearly increased in downstream region since the Tokara strait.
- Fraction of nano & micro sized phytoplankton also increased in downstream region.



Fraction of each size of phyto.

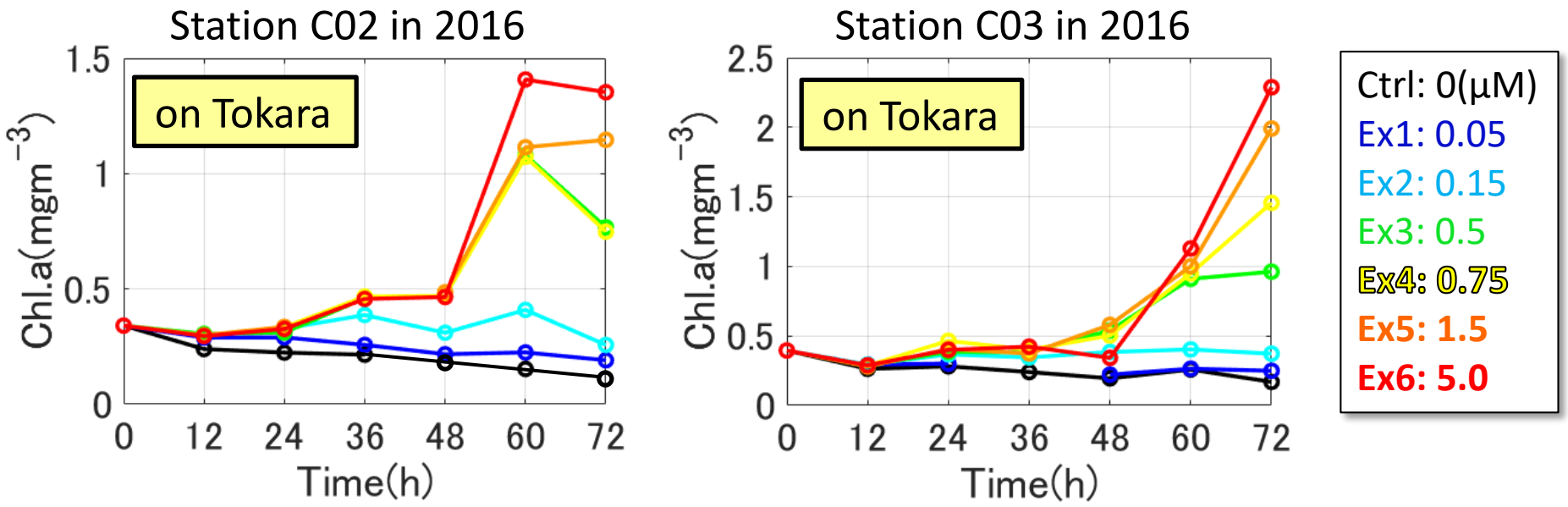






Zooplankton biomass at 0-200m (Kobari et al, 2018)

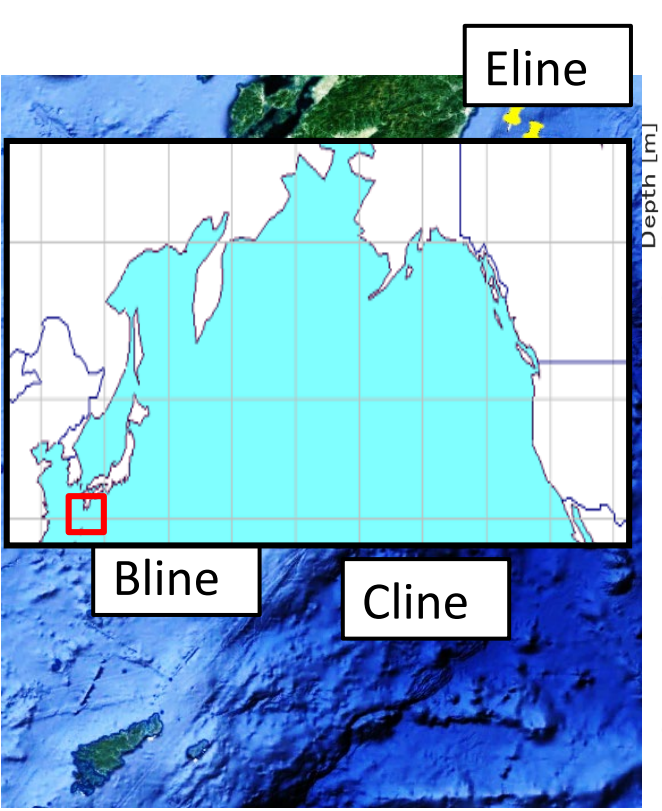
Results: Incubation Experiment

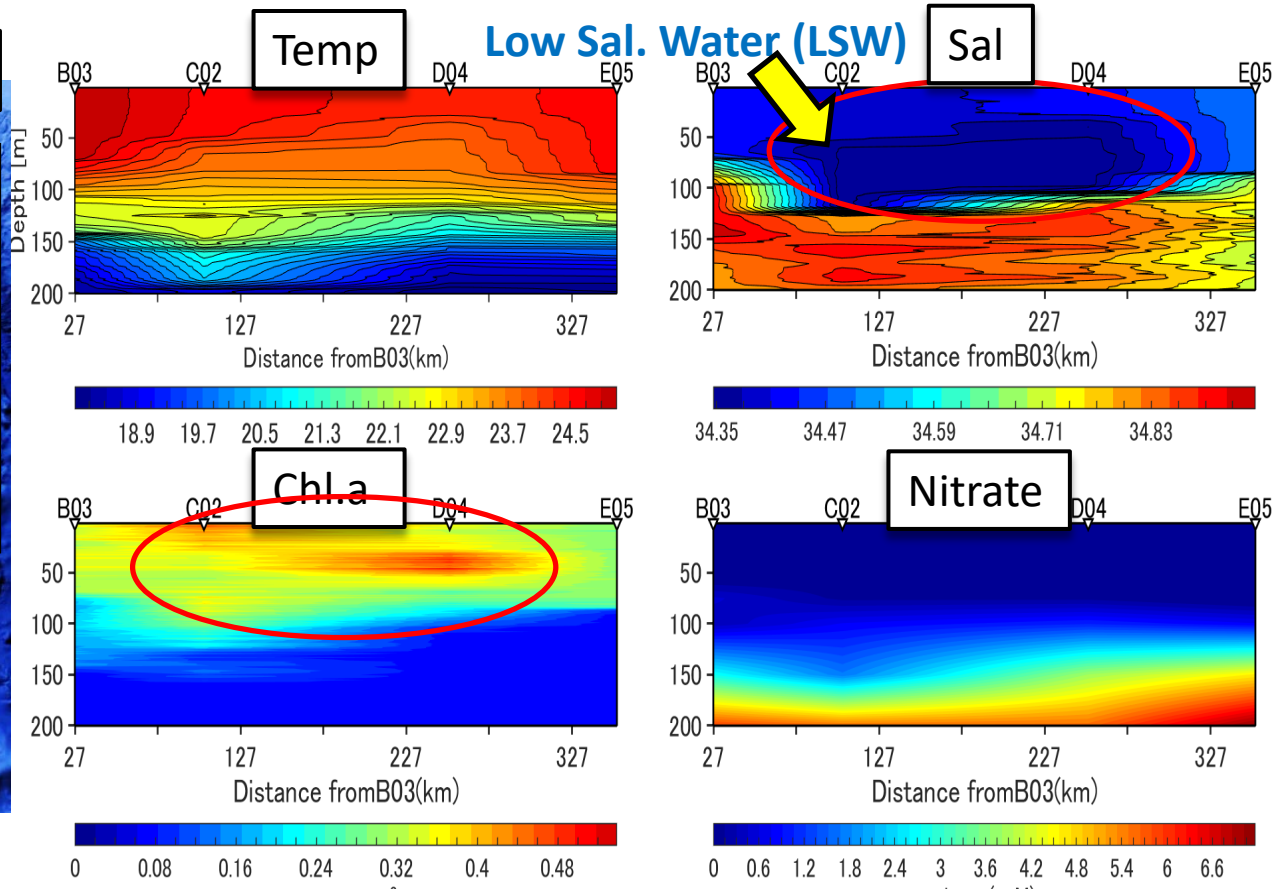


Time series of Chl.a in the various nutrient supply from the incubation Exps.

- Phytoplankton Increased over 0.15μM after 24 - 36h
- Phytoplankton sufficiently increase by nutrient supply around the Tokara strait.
  - Nitrate supplied around Tokara was estimated to be 0.41μM (Kobari *et al., submitted*).

Results: Lagrange Observation in 2018

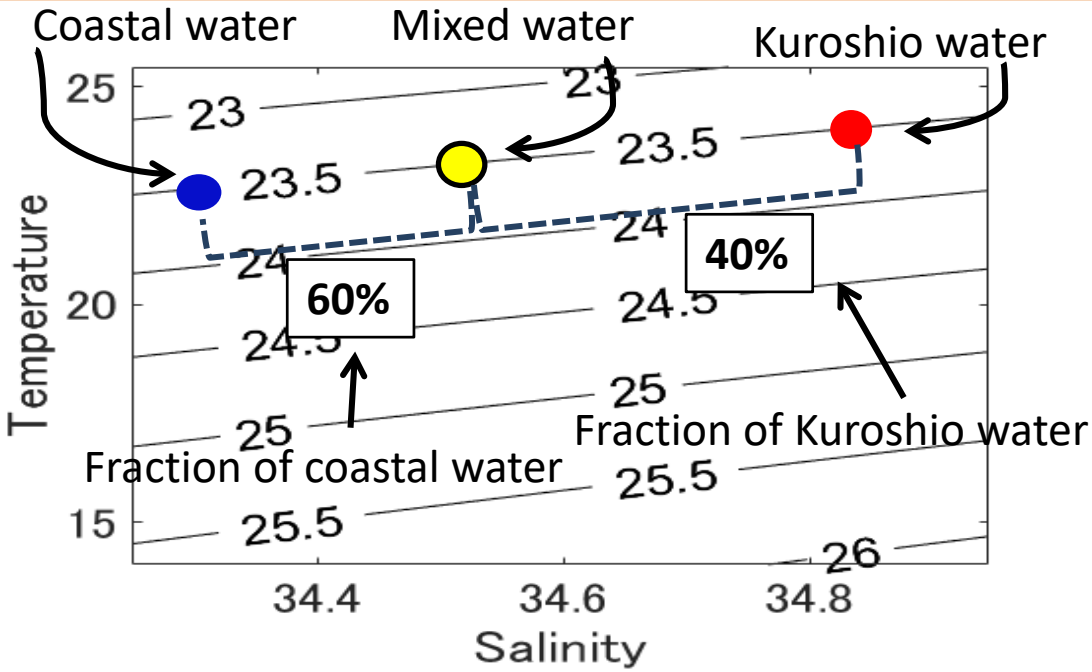




- Phyto. increased since Tokara strait. But Less saline water (High-Chl.a, Low-salinity coastal water) affected the phytoplankton.

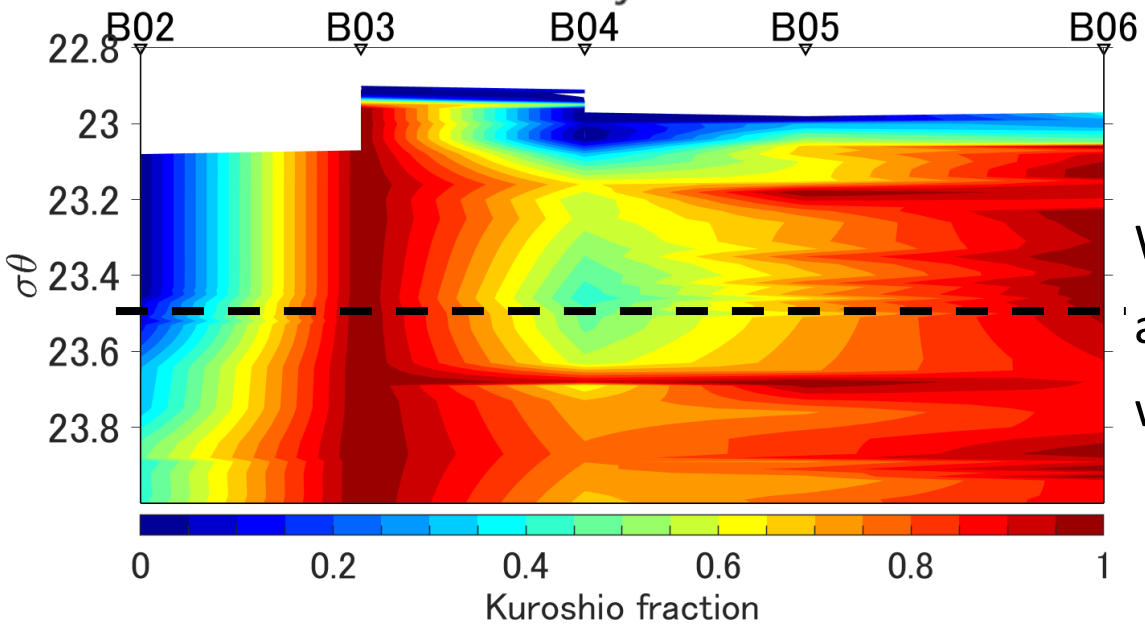
➢ **We try to remove the effect of less saline water in down region** to clarify the effect of the turbulent mixing around Tokara strait.

Fraction of “Kuroshio” in downstream region



➢Assuming isopycnal two water mixing, we calculated the fraction of Kuroshio water in the downstream region by salinity.

➢We’d like to try to estimate Chl.a conc. without the effect of coastal water by using the fraction.



Before this estimation…

We checked possibility of application of the isopycnal two water mixing to the Chl.a conc.

Possibility of application of two water mixing

➢We estimated Chl. a conc. by the isopycnal mixing between coastal and Kuroshio water with their fractions calculated before.

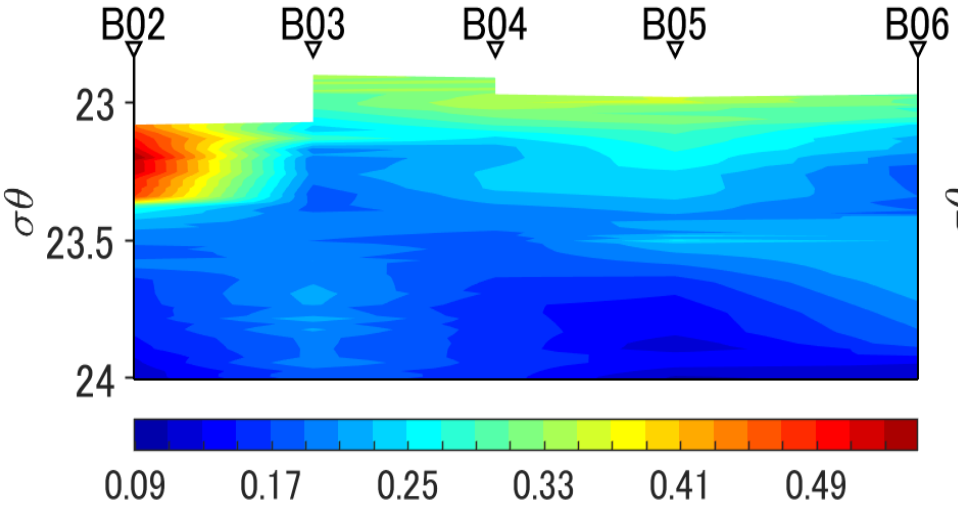


Fig1. Chl.a observed in the real ocean

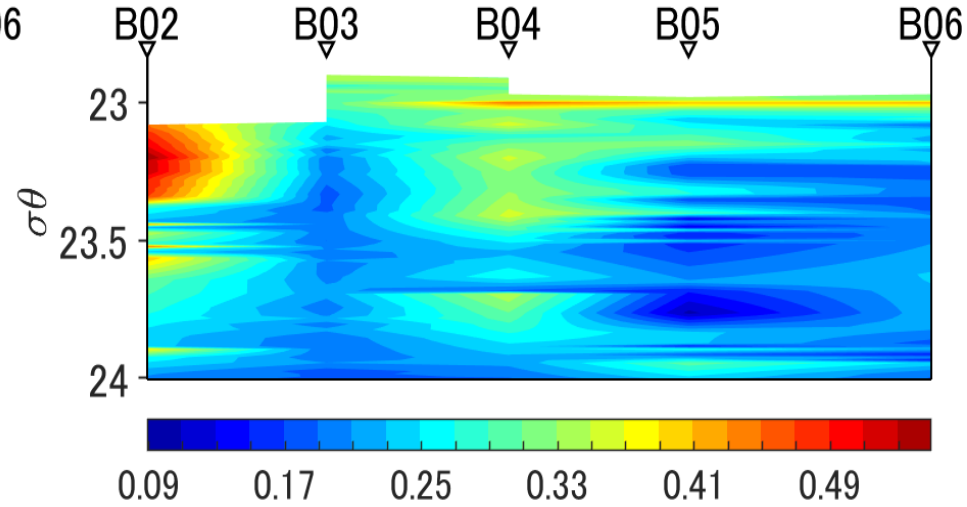


Fig2. Chl.a estimated by isopycnal mixing without biogeochemical processes

➢As the differences between estimated and observed Chl.a were not so large, We estimated Chl.a without the effect of coastal water by using Kuroshio water fraction.

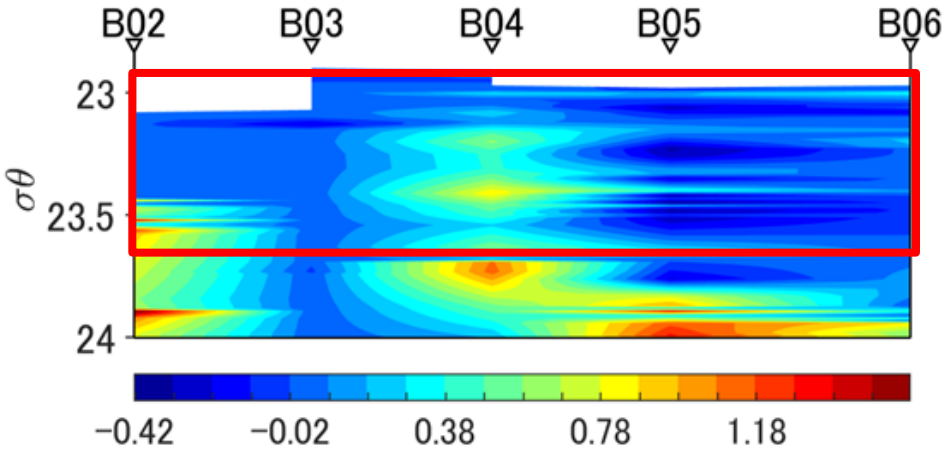
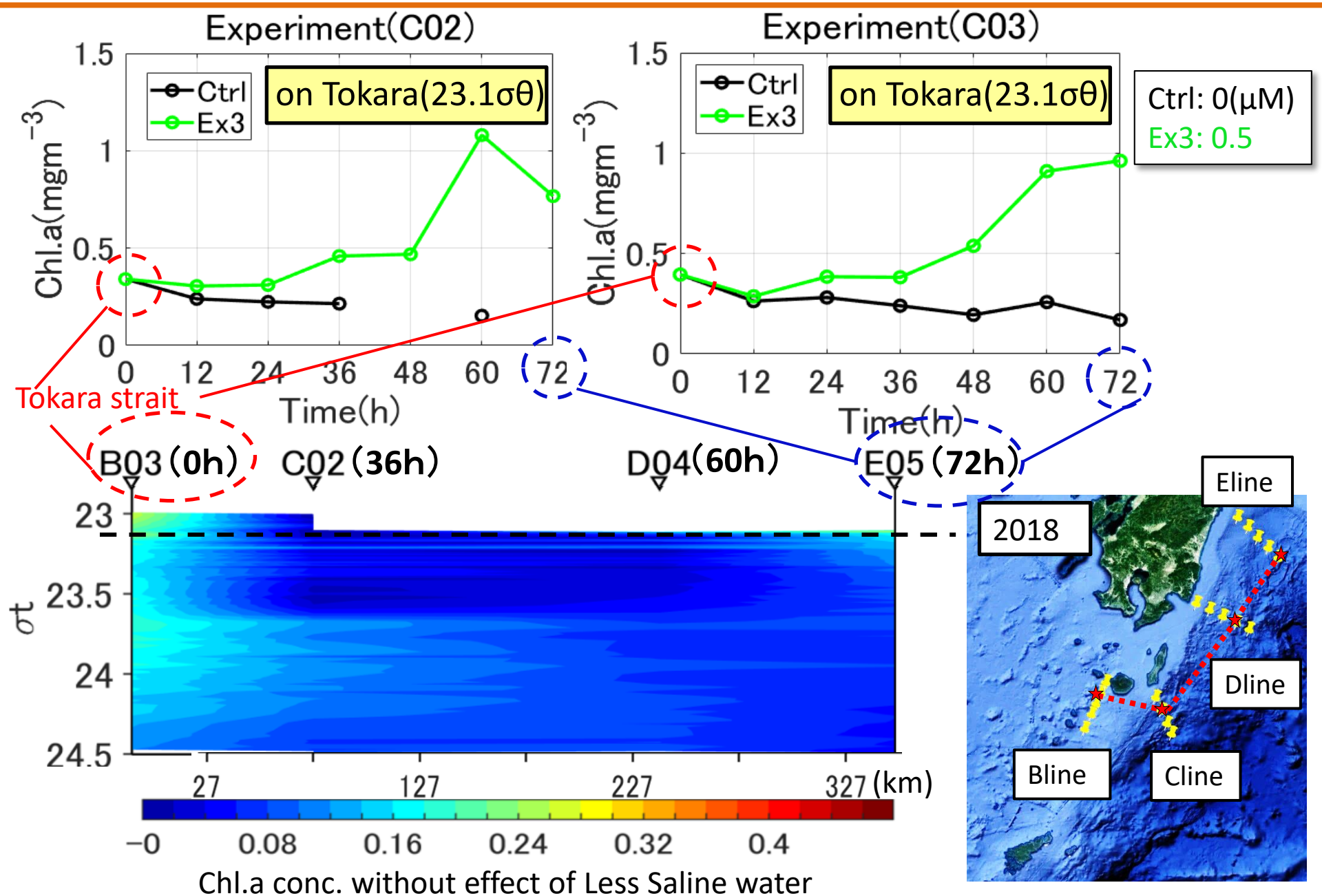
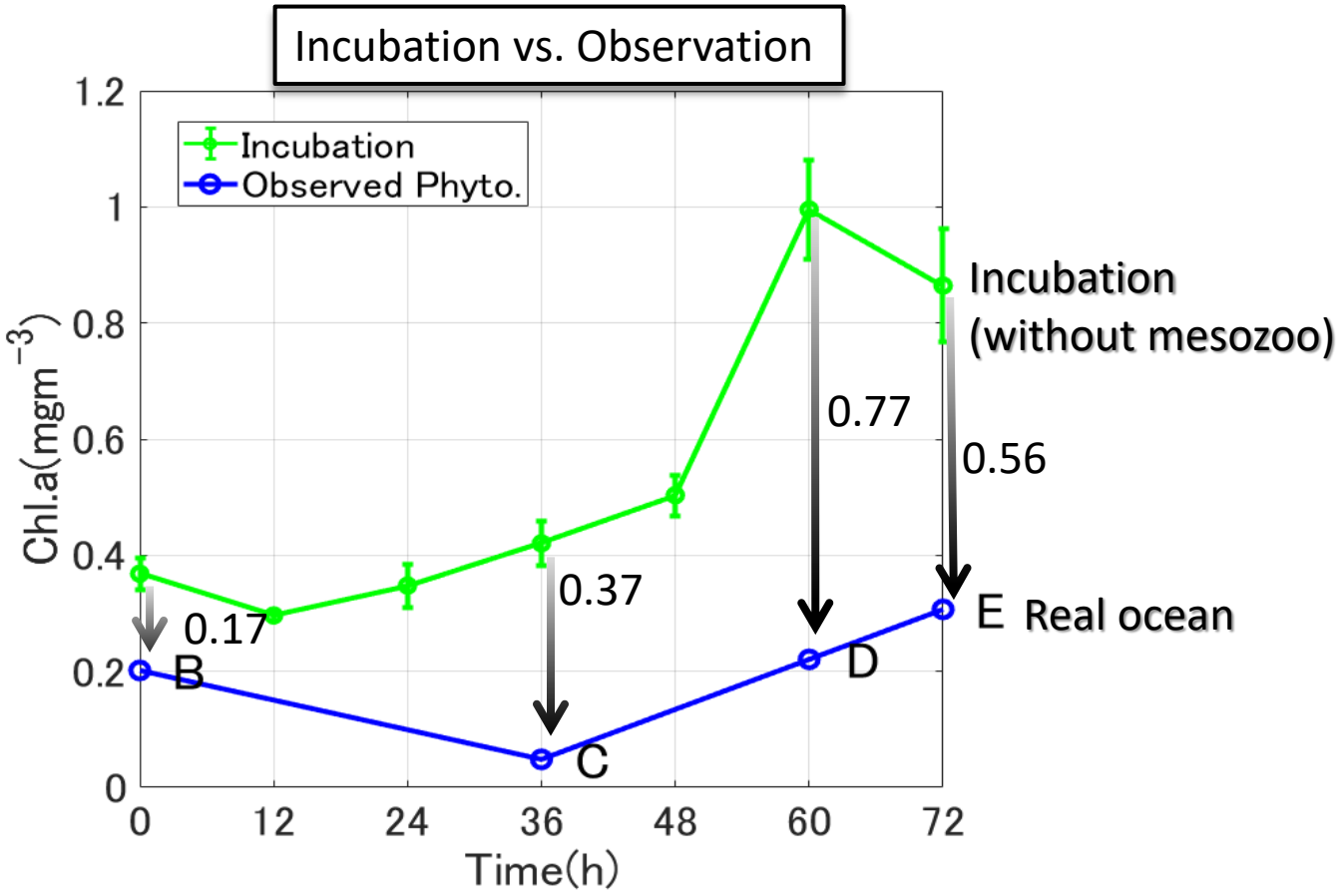


Fig3. Relative difference between above two Chl.a

Comparison : Incubation and Observation



Comparison: Incubation and Observation



Phyto. in real ocean decreased from B(0h) to C(36h) and didn't increase very much, while incubated phyto. enough increased at 36h and keep increasing to 72h.

These results indicate that **effect of mesozoo grazing is significantly large.**

Summary

- ☑ Does phytoplankton biomass increase by nutrient supply around Tokara strait?
- ☑ Is size of phytoplankton in downstream region larger than upstream region?
- ☑ Is environment since Tokara strait good for higher trophic ecosystems?

I. Phyto. increased by approximately 14% in downstream region.

II. Nano and micro sized phytoplankton were dominant over pico sized phytoplankton since Tokara strait.

III. Although phytoplankton increased by nutrient supply around Tokara, increased phytoplankton was rapidly grazed by mesozooplankton.

↓Take home message!!↓

Tokara strait offer higher trophic ecosystems good environment

Thank you for your attention!!