

# Responses of Phytoplankton Assemblage and Organic Carbon Dynamics to CO<sub>2</sub> Increase

Effects of Climate Change on the World's Oceans  
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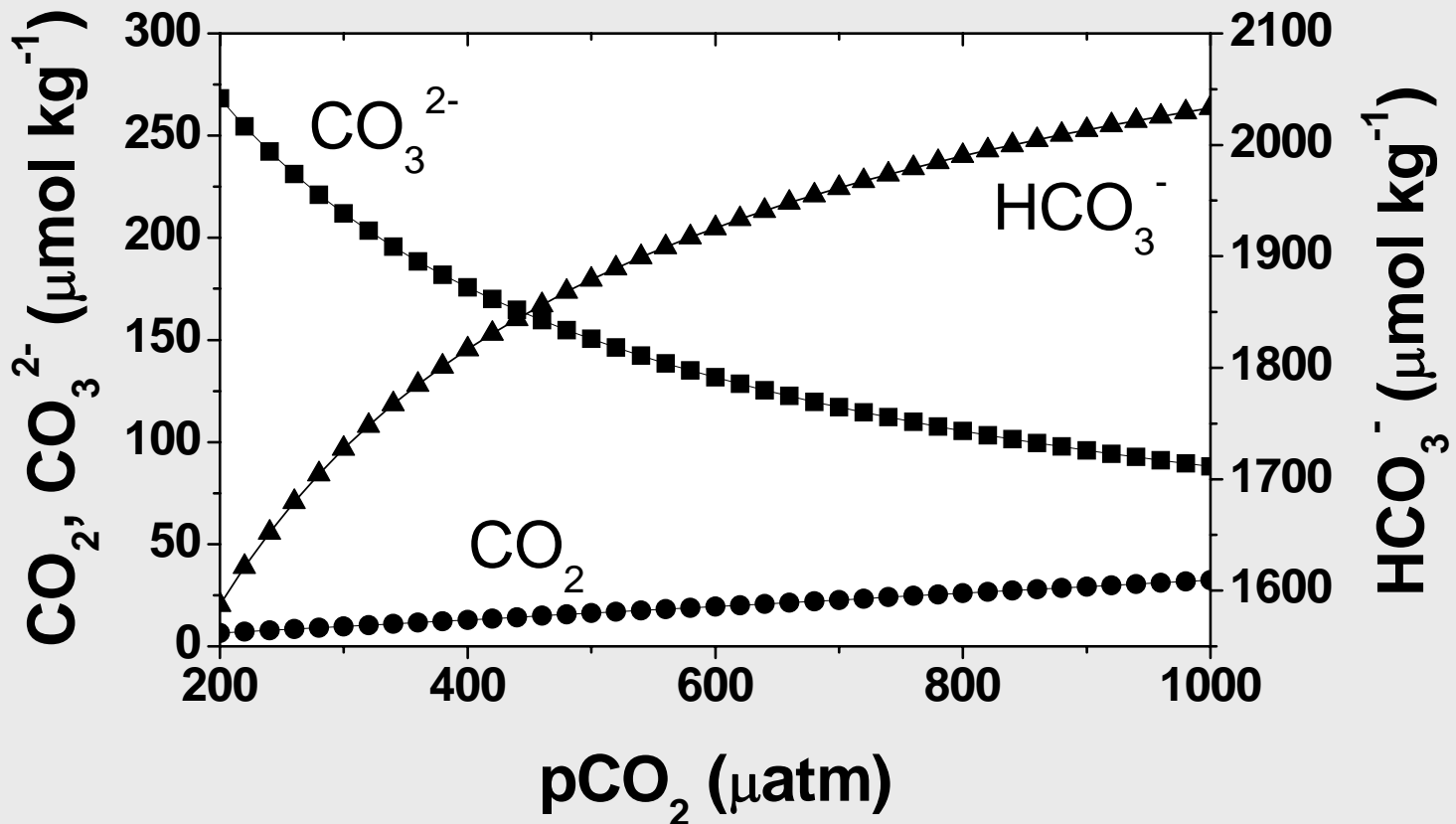
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# Background

- Atmospheric CO<sub>2</sub> increase alter the CO<sub>2</sub> system in seawater
- CO<sub>2</sub> system ↔ Photosynthesis



Calculated with Pierrot et al., 2006, co2sys\_xls\_program



# Impacts of pCO<sub>2</sub> increase

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Early results using a natural phytoplankton community under an **artificial blooming condition**

- Equatorial Pacific (Tortell et al., 2002, MEPS)  
Primnesiophytes → Diatoms
- Southern Korea (Kim et al., 2006, L&O)  
Increase in growth of *Skeletonema costatum*
- Bering Sea (Hare et al., 2007, MEPS)  
Diatoms → Nanophytoplankton
- Southern Norway, PeECE (e.g., Riebesell et al., 2007, Nature)  
Increase in TEP production



# Motivation

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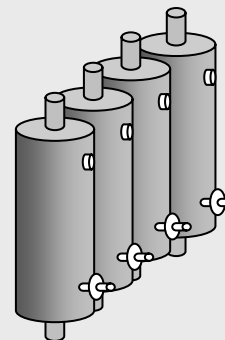
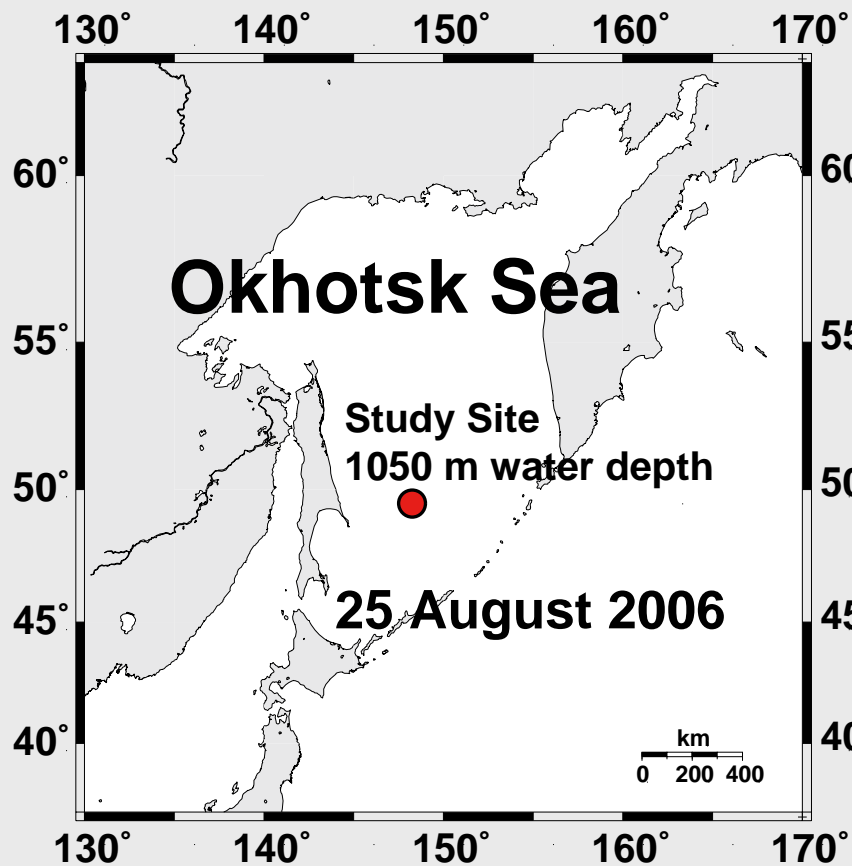
Impacts of changes in  $p\text{CO}_2$  on natural phytoplankton community under a **regenerated system?**

## **CO<sub>2</sub> manipulation experiment**

- Using a **natural phytoplankton community** in a **nutrient depleted water**
- **No** nutrient addition
- **Long** incubation period

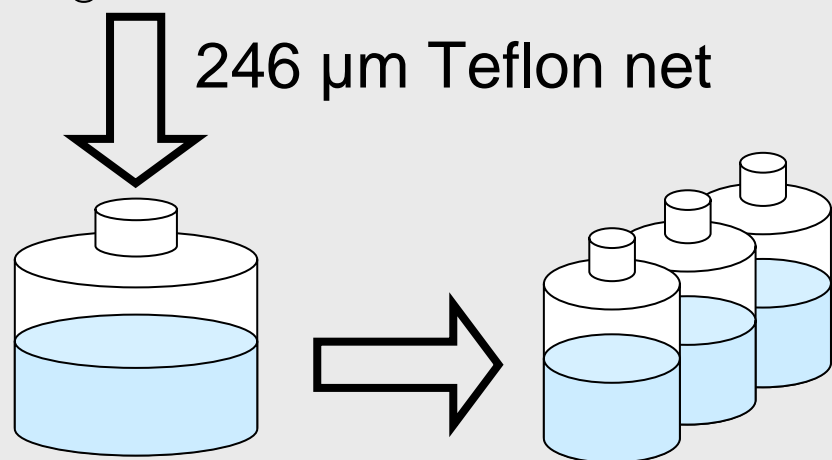
# Experimental Method

## ■ Sampling for a CO<sub>2</sub> manipulation experiment



- 160-L of 10-m depth water
- Trace metal clean technique

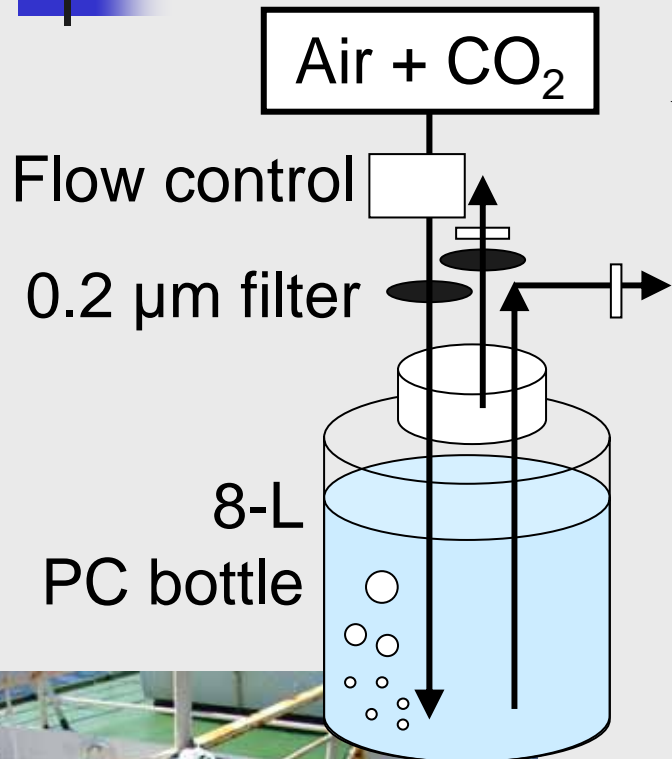
246  $\mu$ m Teflon net



50-L PP carboys  
x 4

8-L PC bottles  
x 12

# Experimental Method



## ★ Treatments (triplicate)

Air + CO<sub>2</sub>

- 180 ppm

- 380 ppm

- 750 ppm

- 1000 ppm

- In-situ temp (13.5°C)

- 50% surface irradiance

- 14-day incubation



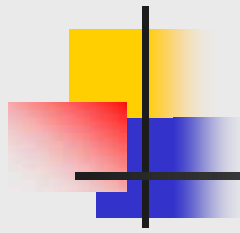


# Measurements

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- Nutrients
- Dissolved Inorganic Carbon, alkalinity
- Chlorophyll *a* (10  $\mu\text{m}$ , GF/F)
- Phytoplankton Pigments – HPLC
  - pooled samples from the triplicate bottles
- Particulate Organic Carbon (POC)
- Dissolved Organic Carbon (DOC)
- Coccolithophores – Scanning Electron Microscope
  - no cells were detected





# pCO<sub>2</sub>, pH in Each Treatment

	pCO <sub>2</sub> ( $\mu$ atm)	pH
180 ppm	148	8.40
380 ppm	278	8.17
750 ppm	489	7.96
1000 ppm	596	7.89

Calculated using DIC and TAlk



# Initial Conditions

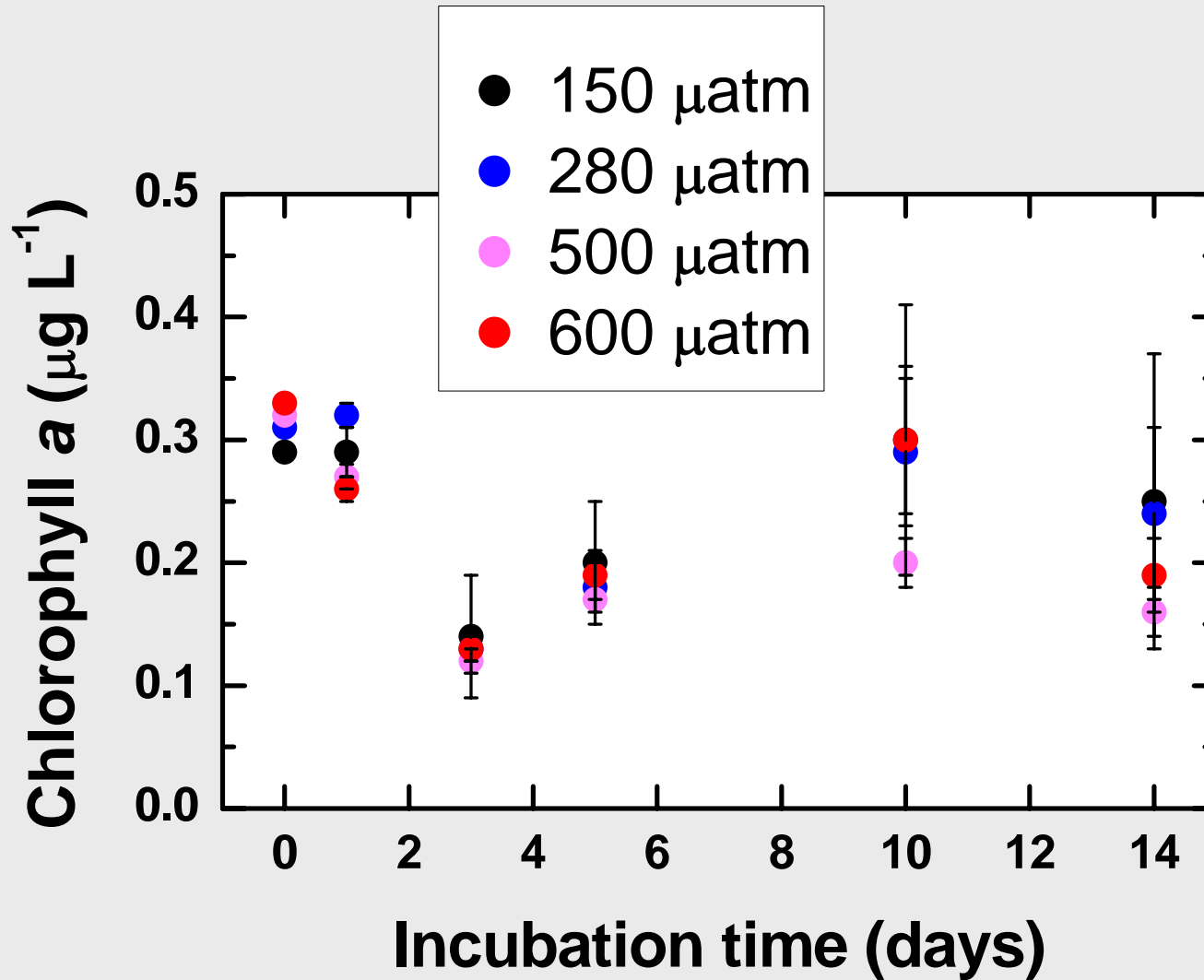
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	NO <sub>2</sub> <sup>+</sup> NO <sub>3</sub> μmol/L	PO <sub>4</sub> μmol/L	SiO <sub>2</sub> μmol/L	Large Chl <i>a</i> μg/L	Small Chl <i>a</i> μg/L
Initial	0.05	0.25	1.0	0.01	0.30

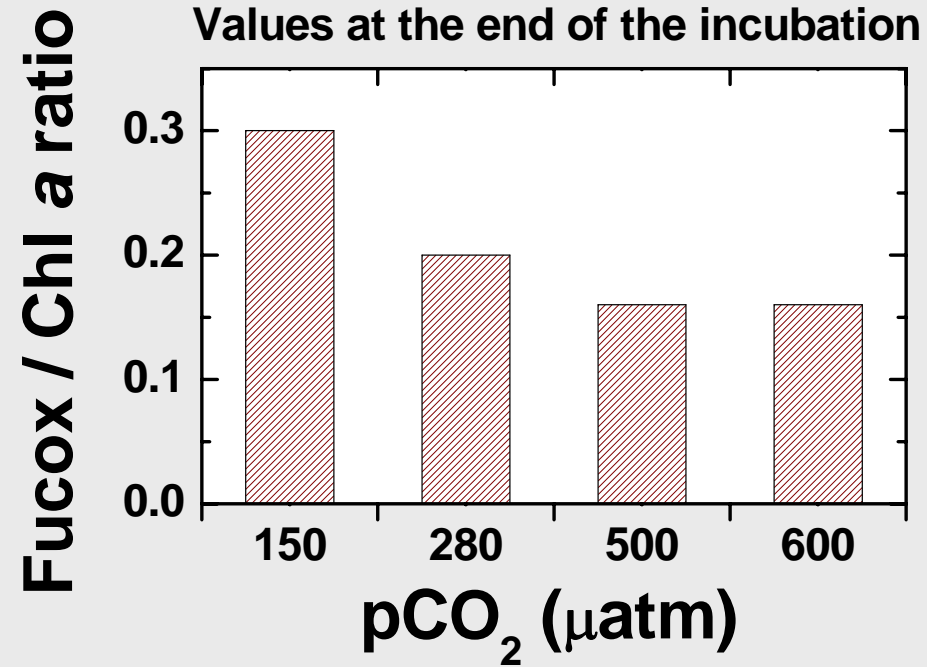
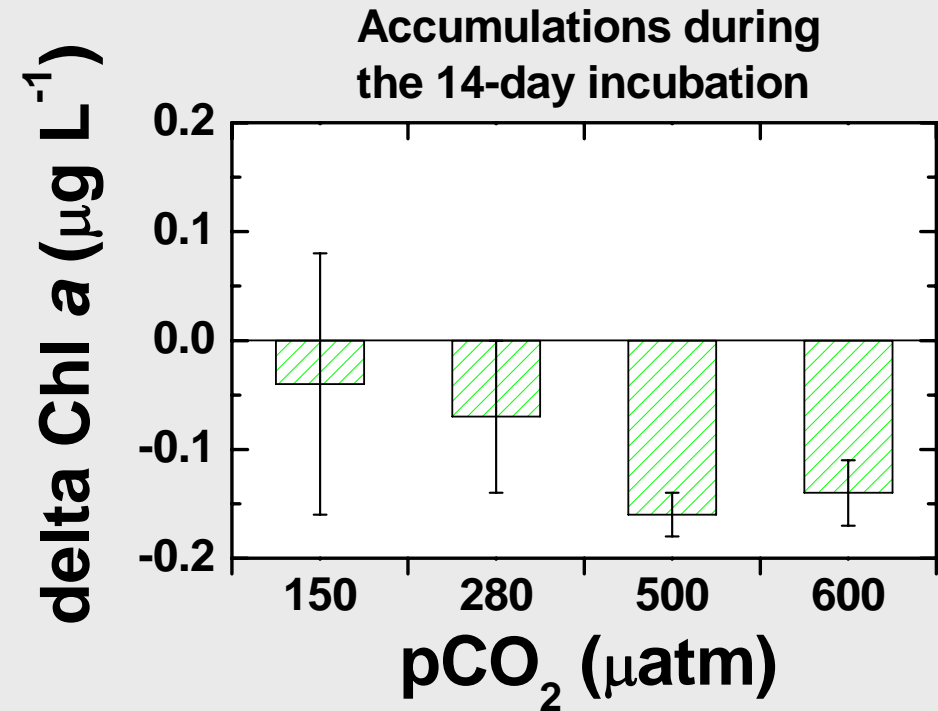
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- Depleted in nutrients
- Dominated by small phytoplankton

# Time Course of Total Chl *a*

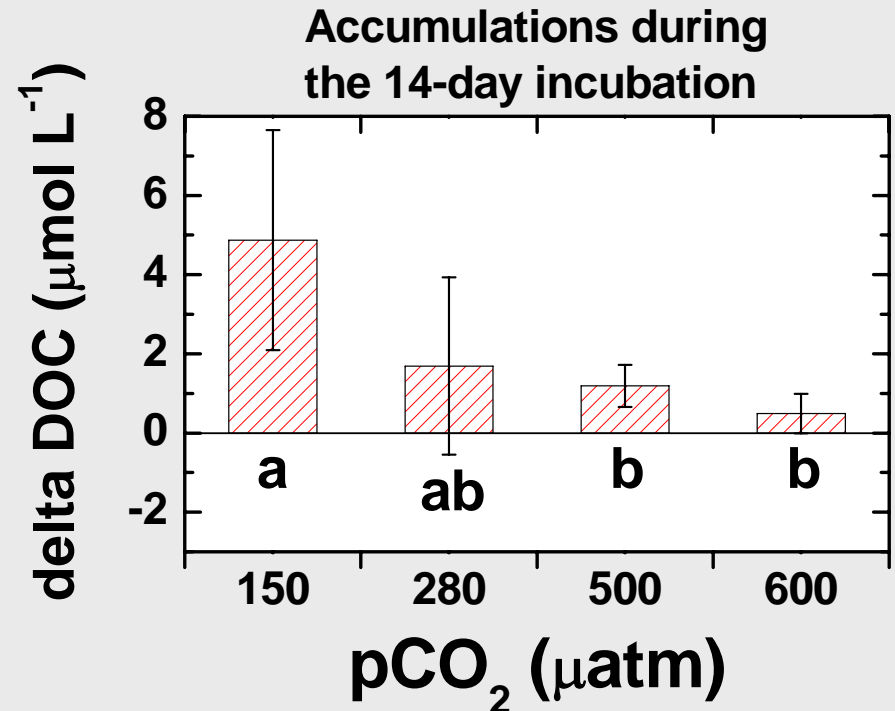
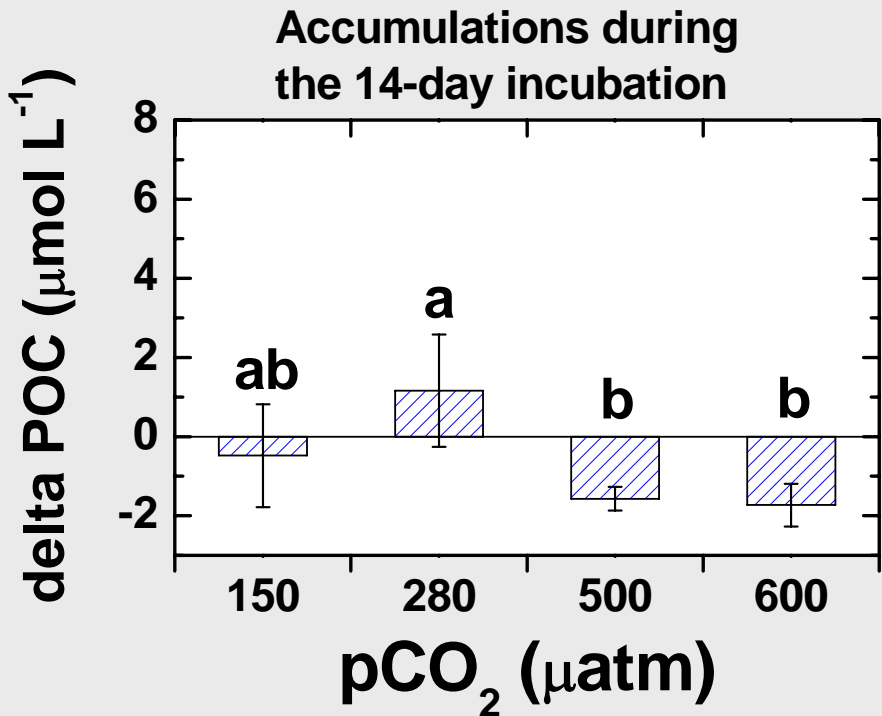


# Responses of Phytoplankton



- Relative contribution of diatoms may decrease with increasing CO<sub>2</sub>

# Responses of Organic C



Tukey's test ( $p < 0.05$ )

■ DOC accumulations decreased with increasing CO<sub>2</sub>



# Conclusion

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Change in seawater  $p\text{CO}_2$  potentially affect

- phytoplankton community structure
- organic carbon flow

in the nutrient-depleted surface water in the subpolar regions

# Future Plans

