

# Impact of changing Siberian land-shelf-basin on the Arctic Ocean biogeochemical dynamics

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**Russian vessel**



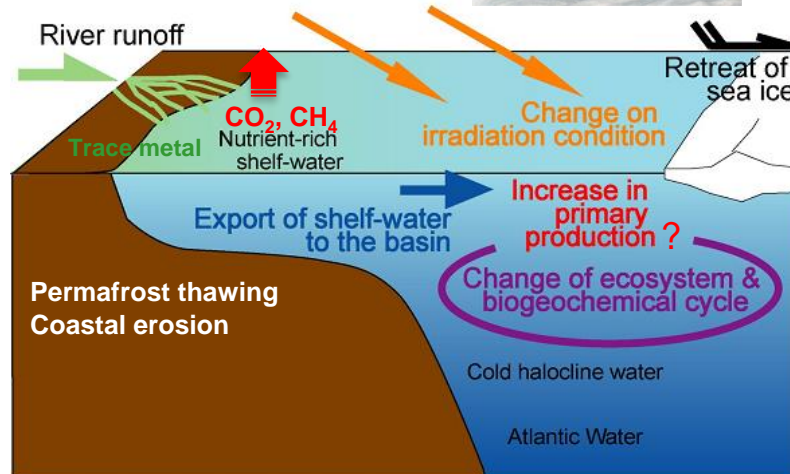
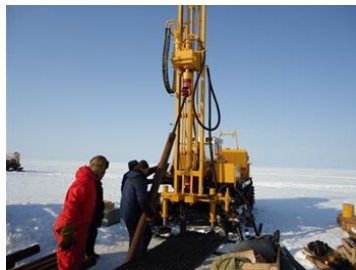
**IB Oden**



**R/V Mirai**



**Drilling**



# Why Siberian Arctic?

Data are lacking because of **Russian EEZ**, but it is an important area for the Arctic Ocean biogeochemical dynamics.

**Subsea permafrost thawing, coastal erosion and reduction of sea ice** induced by global warming are key processes.

Russian vessel



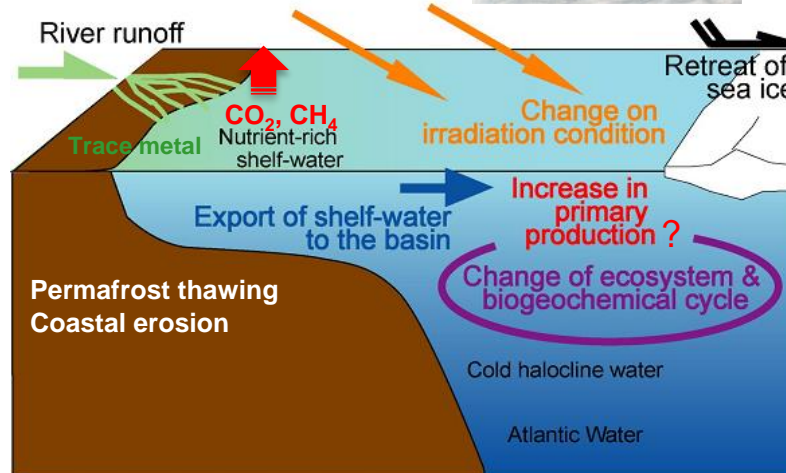
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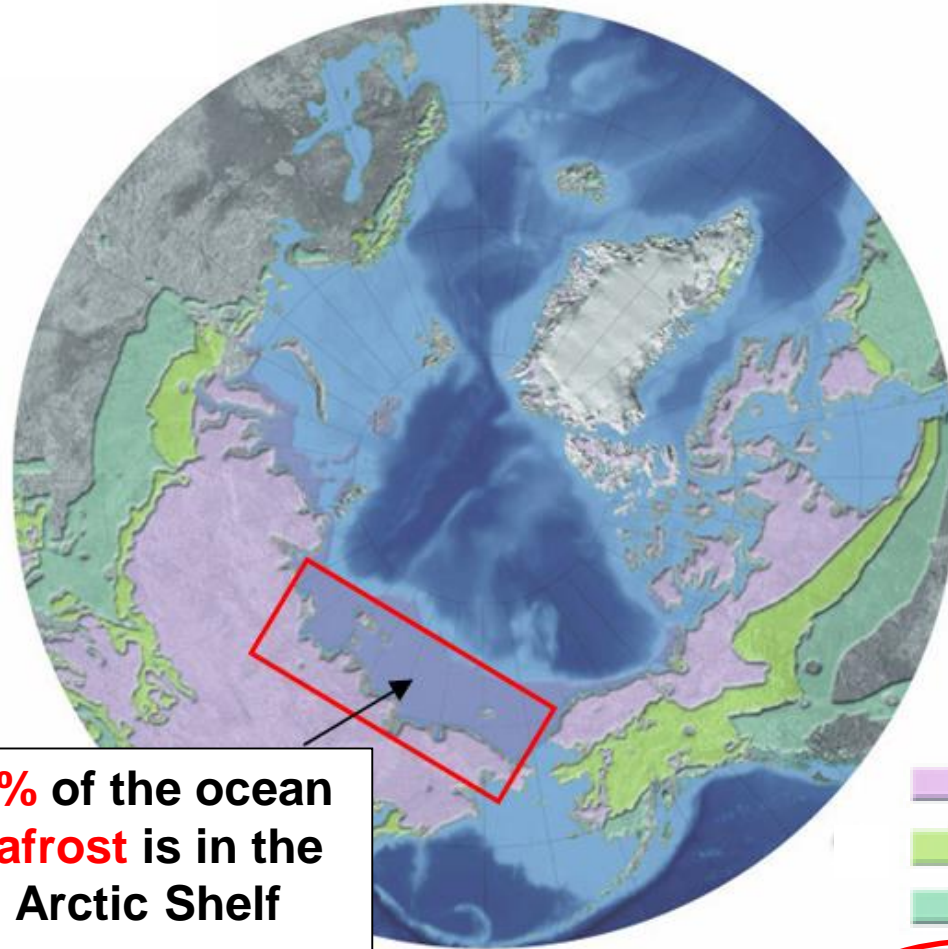
R/V Mirai



Drilling



# 1. Scientific background



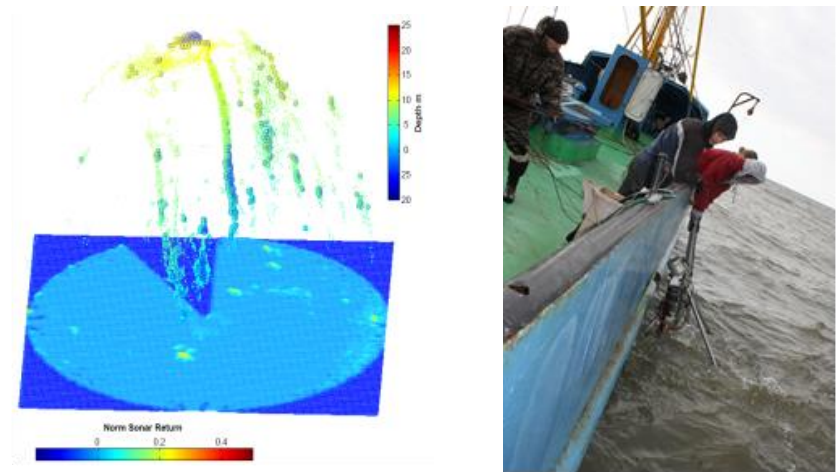
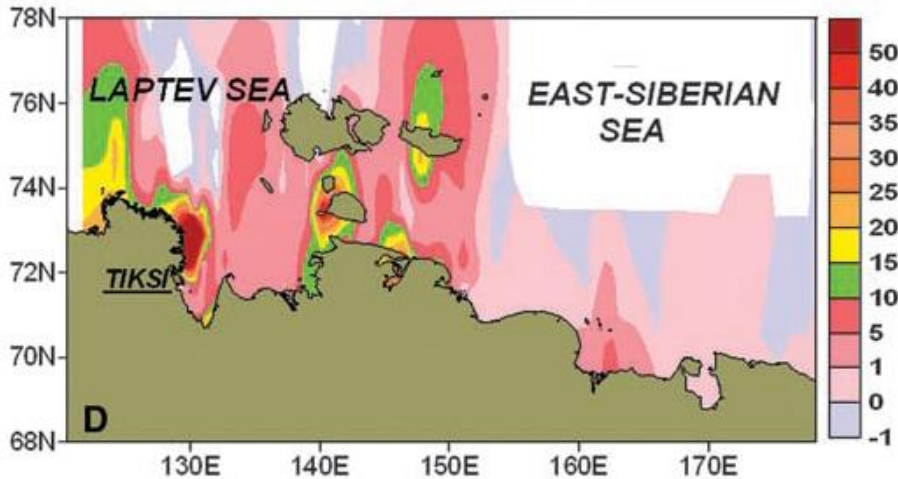
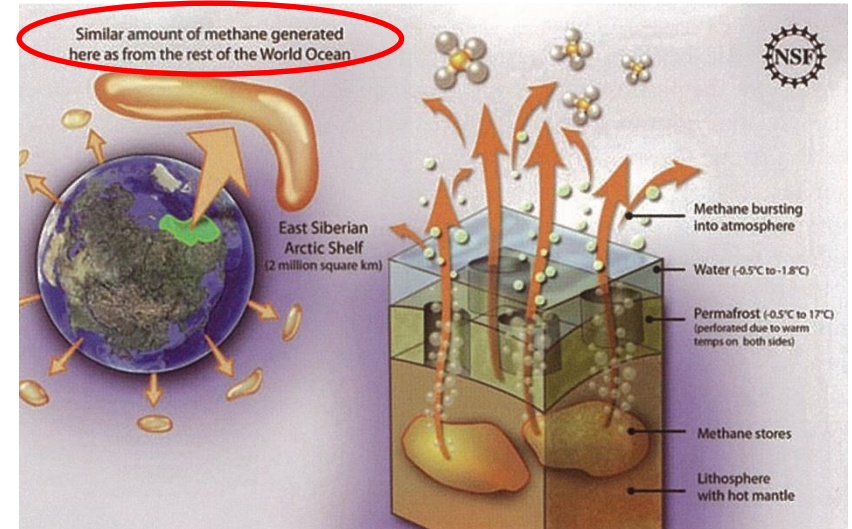
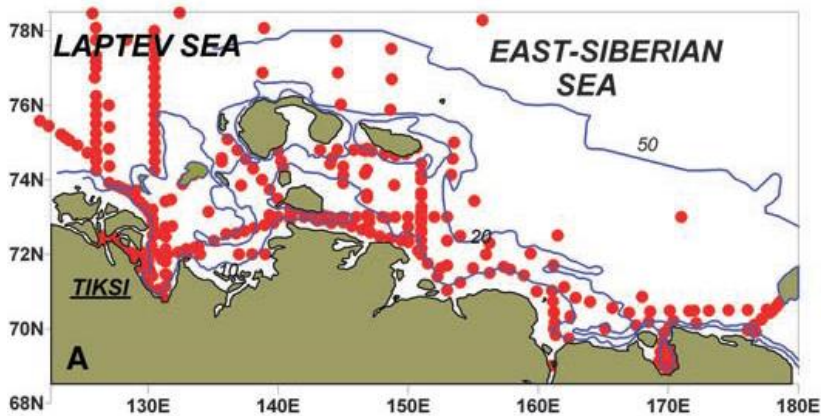
More than **80%** of the ocean **subsea permafrost** is in the East Siberian Arctic Shelf (ESAS).

- Continuous
- Discontinuous
- Sporadic
- Subsea



# Subsea permafrost thawing

- methane emission into the atmosphere
- possible positive feedback in global warming



Summertime observations of dissolved CH<sub>4</sub> and fluxes of CH<sub>4</sub> venting to the atmosphere.

Detection of methane ebullition (left) using the lander (right) equipped with the multi-beam sonar.

Shakhova *et al.* (2010a, b)

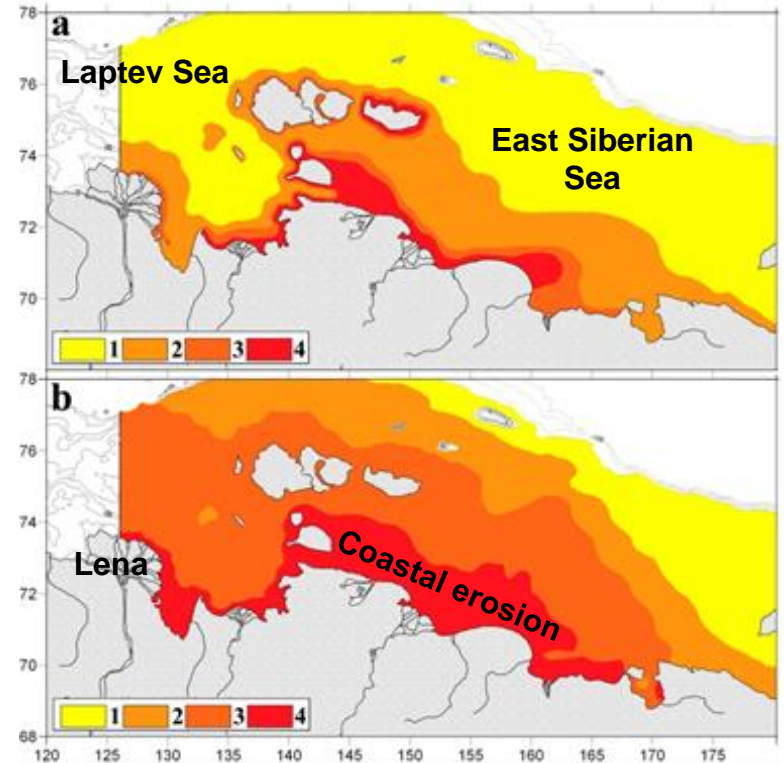
# Coastal erosion

- dominating role in Siberian shelf sedimentation
- Influencing carbon and nutrient cycles
- Influencing light condition for biological production



Photo: Igor Semiletov

- Rates of coastal erosion can be up to 25 m/yr and higher.
- The secondary role of the Lena River and the dominating role of coastal erosion in ESAS sedimentation.



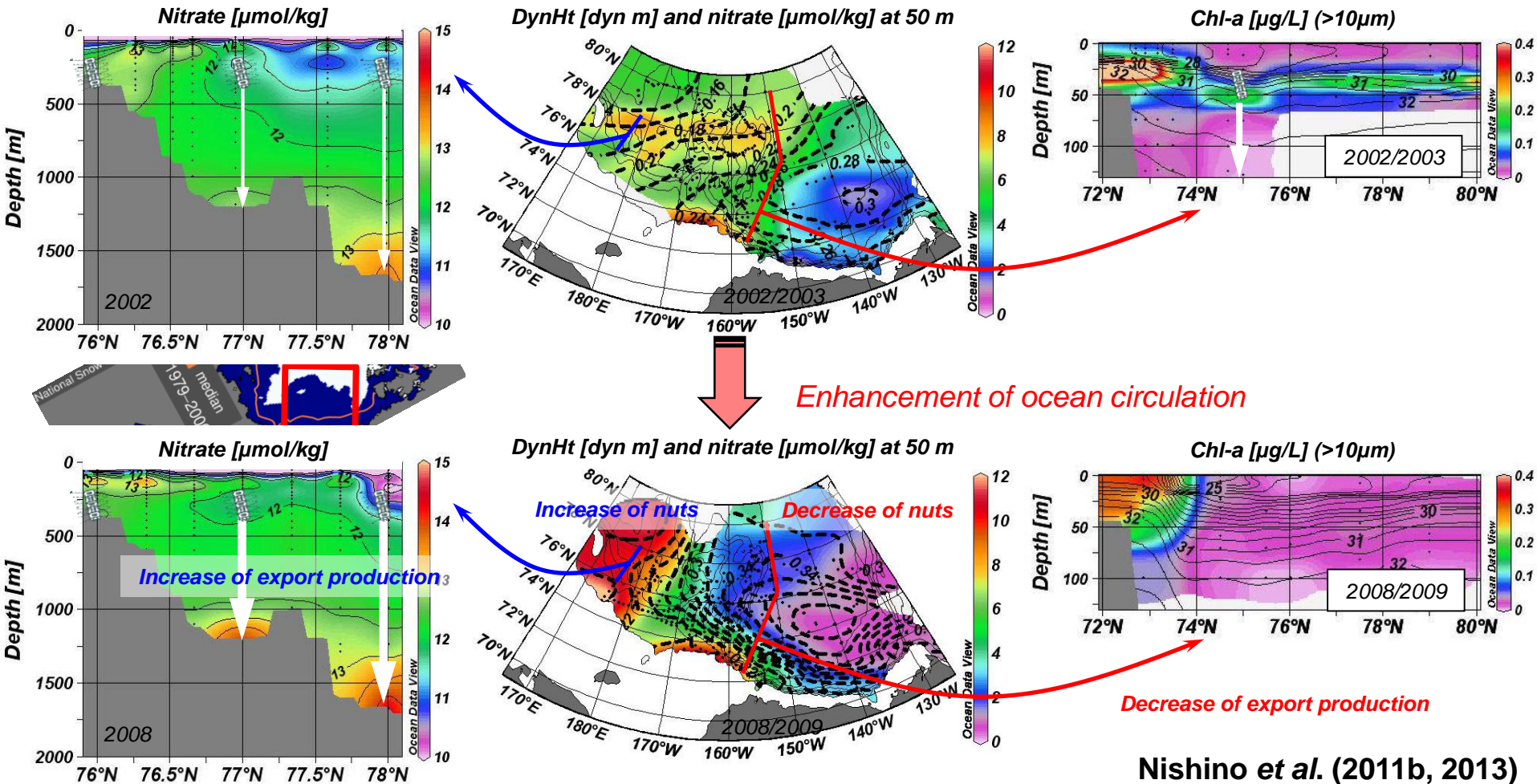
Surface distribution of a) suspended particulate materials ( $\text{mg l}^{-1}$ ): 1)  $<2$ , 2) 2-12, 3) 13-24, 4)  $>24$ ;  
b) contribution of terrestrial OM to POC (%): 1)  $<25$ , 2) 25-49, 3) 50-75, 4)  $>75$ .

**Semiletov *et al.* (2011, 2012, 2013)**



# Reduction of sea ice and changes in biological production

- In the Alaskan Arctic, nutrient decrease resulted in the decrease of export production.
- In the Siberian Arctic, nutrient increase is expected to increase the export production.



Nishino et al. (2011b, 2013)

## 2. Research plans

- Subtheme 1: **Carbon, nutrient and trace metal** cycling and transports in the **Siberian land-shelf-basin continuum** (joint cruises of **R/V Mirai and Russian vessels**).
- Subtheme 2: **Seasonal changes in biogeochemical cycles** (combination of **IARC winter ice camps, JAMSTEC moorings and sediment traps**).
- Subtheme 3: Contribution of Siberian Arctic to **pan-Arctic and global climate** (development and improvement of the integrated **biogeochemical models**).

# Subtheme 1: Carbon, nutrient and trace metal cycling and transports in the Siberian land-shelf-basin continuum (joint cruises of R/V Mirai and Russian vessels).

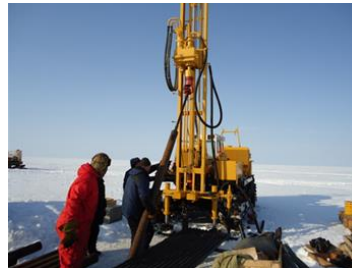
Data are lacking in the Russian EEZ area.

Collaboration with Russian scientists in IARC is needed.

Russian vessel



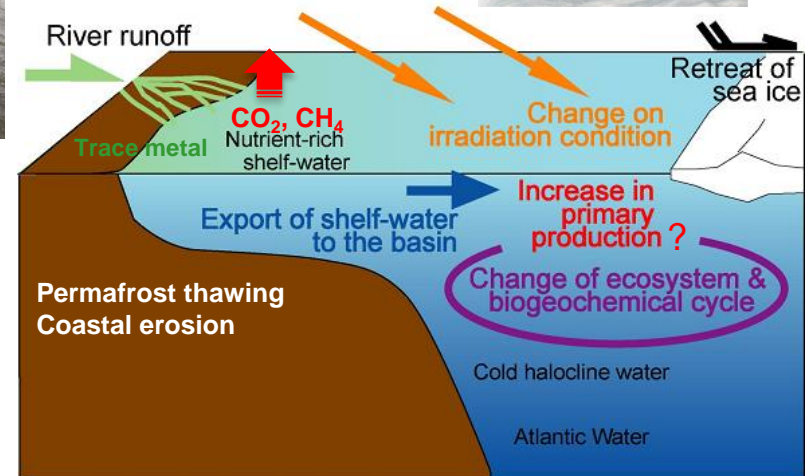
Drilling



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R/V Mirai

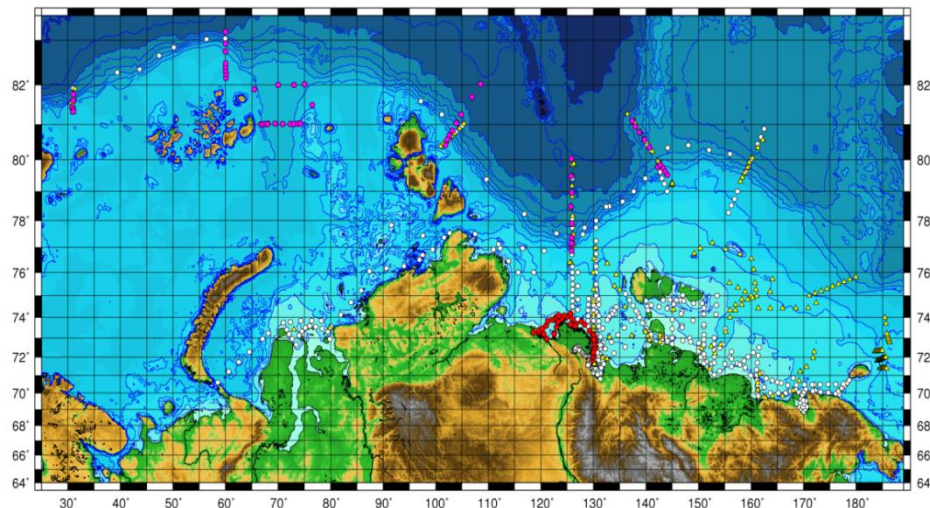




# Challenges and Concerns

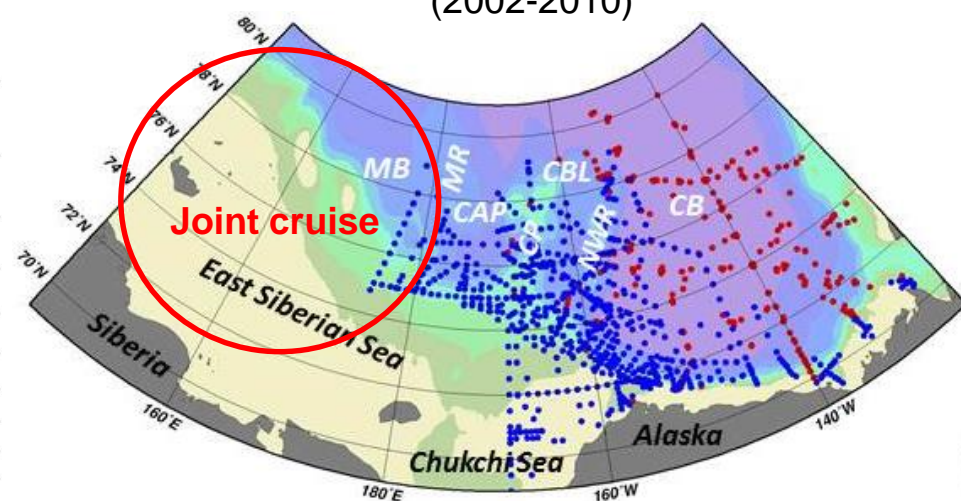
- Data integration and **joint cruises** of R/V Mirai and Russian vessels are needed to understand Siberian arctic land–shelf–basin implications on marine biogeochemical dynamics.
- The Siberian Arctic Ocean is a target area for future biogeochemical and ecological studies because the area is expected to dramatically change in biogeochemical cycles and biological production with the **subsea permafrost thawing**, **coastal erosion**, and **sea ice reduction**.

Stations of Russian vessels (2003-2010)



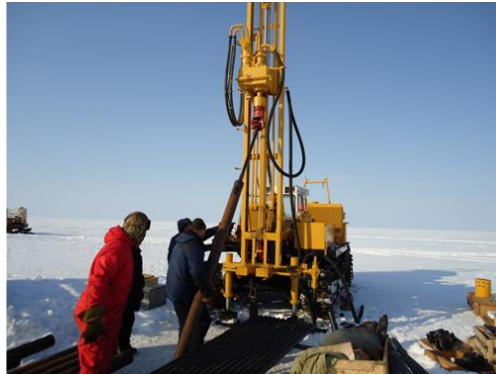
From Semiletov, I., and N. Shakhova

Stations of R/V Mirai and  
US&Canadian icebreakers  
(2002-2010)



From Nishino *et al.* (2013)

**Subtheme 2: Seasonal changes in biogeochemical cycles** (combination of **IARC winter ice camps**, **JAMSTEC moorings** and **sediment traps**).

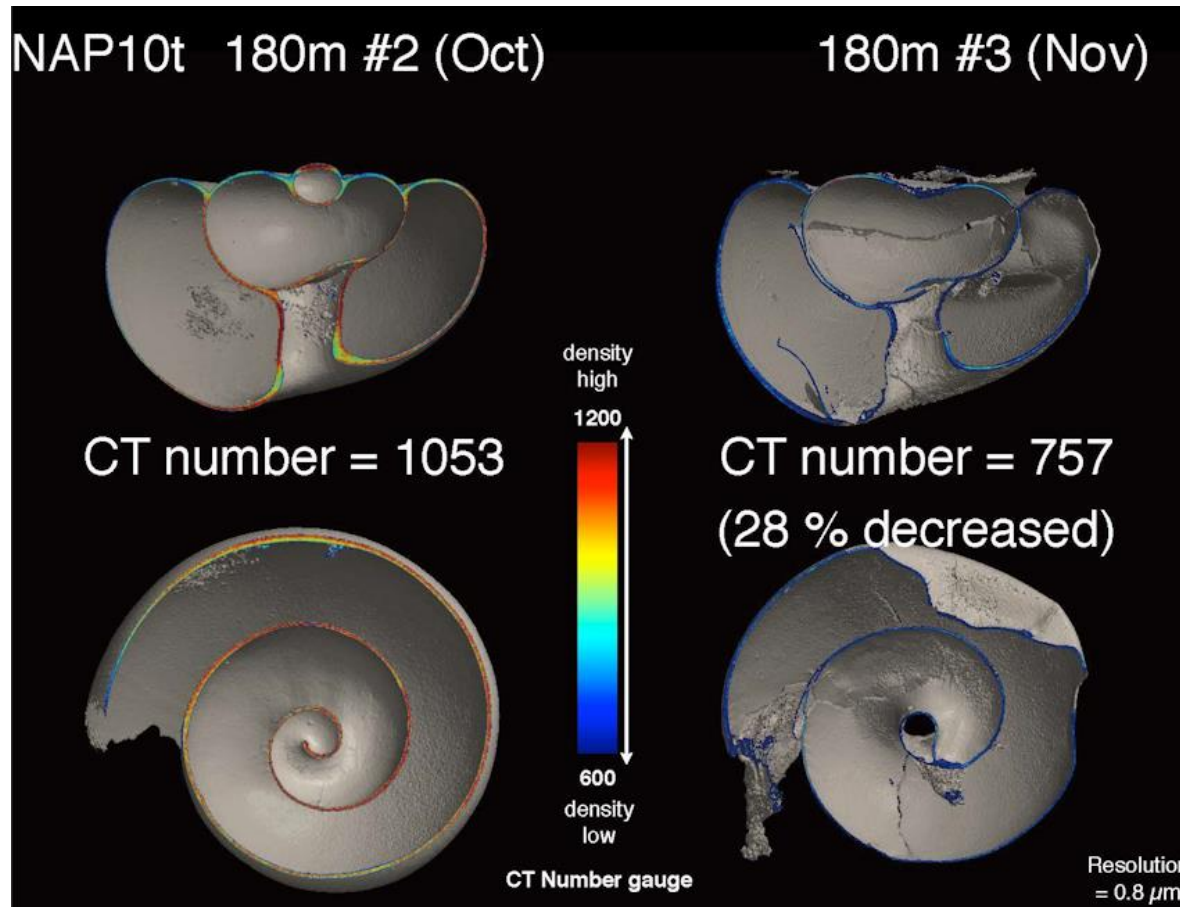


**IARC winter ice camp**

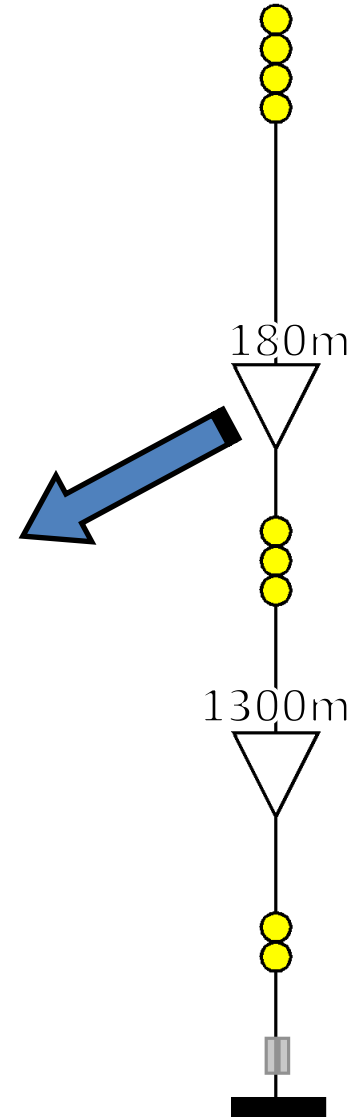
**JAMSTEC sediment trap**



# Micro-focus X-ray CT (MXCT) technology



Bottom-tethered mooring

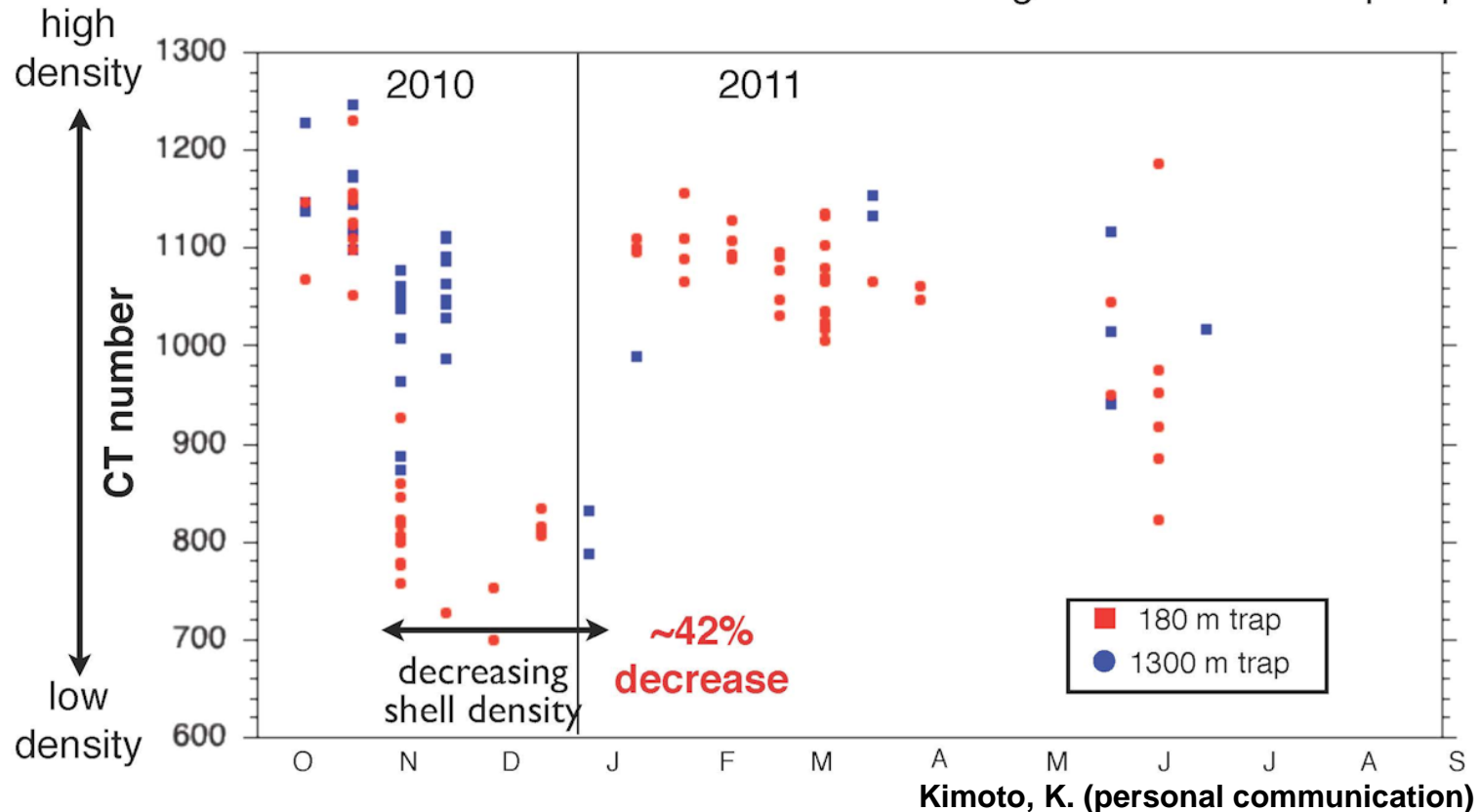


(photos by Dr. Kimoto, K.)



# CT number of Pteropods in NAP-10t sediment trap

1~10 individuals were used for measuring each sediment trap cups.



Decreasing of shell density on Pteropod shells enhanced during winter (Nov-Jan).

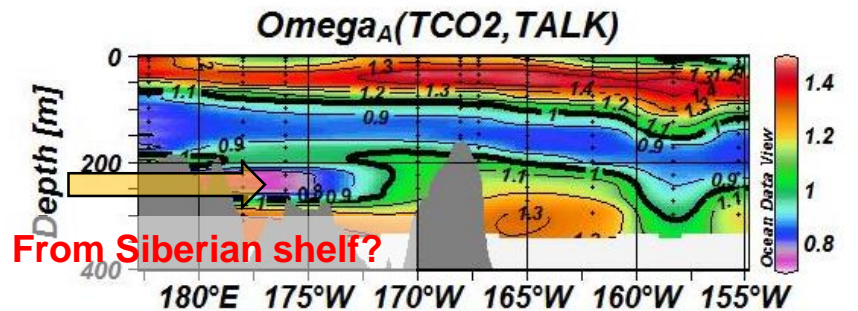
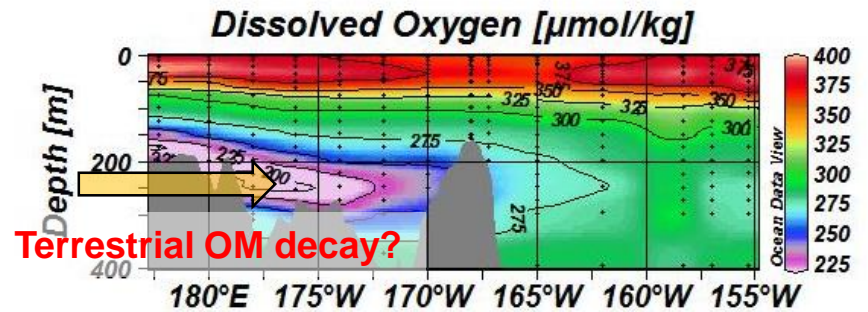
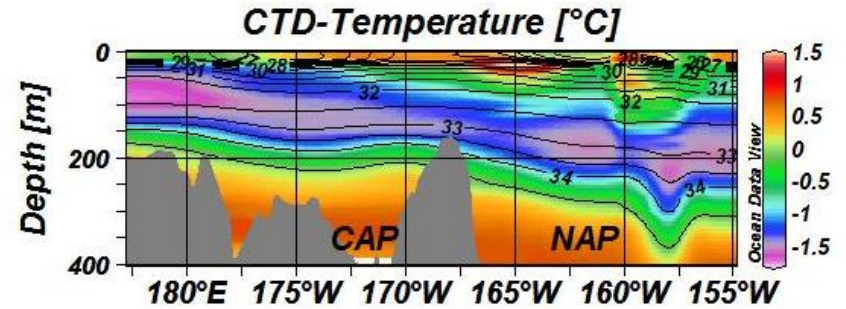
It enhanced at **shallower sediment traps rather than deeper one.**

# Seawater chemistry along the Arctic 75°N line from the R/V Mirai cruise in 2010

Low shell density sites



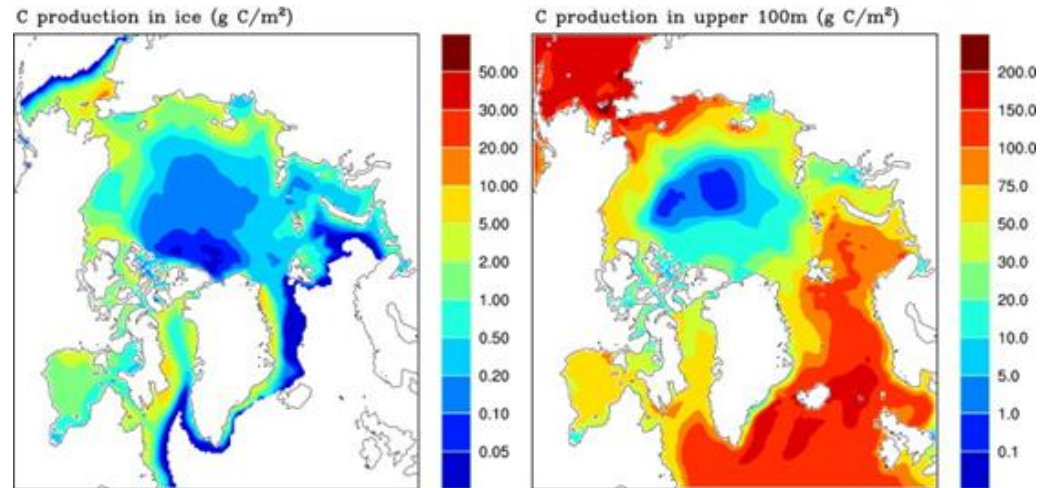
Kimoto, K. (personal communication)



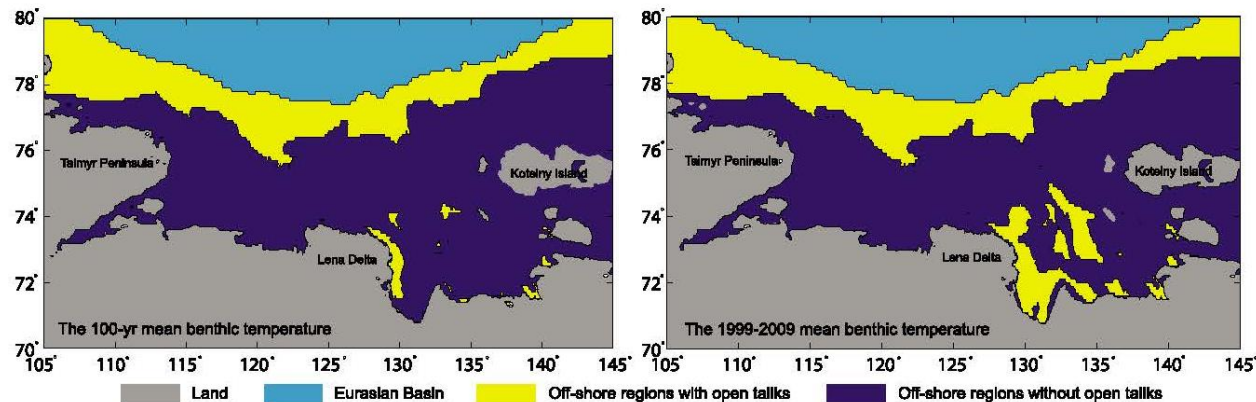
Need data from Siberian shelf influenced by coastal erosion and acidification!

# Subtheme 3: Contribution of Siberian Arctic to **pan-Arctic and global climate** (development and improvement of the integrated **biogeochemical models**).

Model sensitivity studies will be conducted to synthesize the effects on marine biogeochemical dynamics caused by permafrost thawing, coastal erosion and sea ice decrease in the Siberian Arctic Ocean using **coupled global ice-ocean-ecosystem model** (e.g., Jin *et al.*, 2012).



*Coupled global ice-ocean-ecosystem model (Jin et al., 2012)*

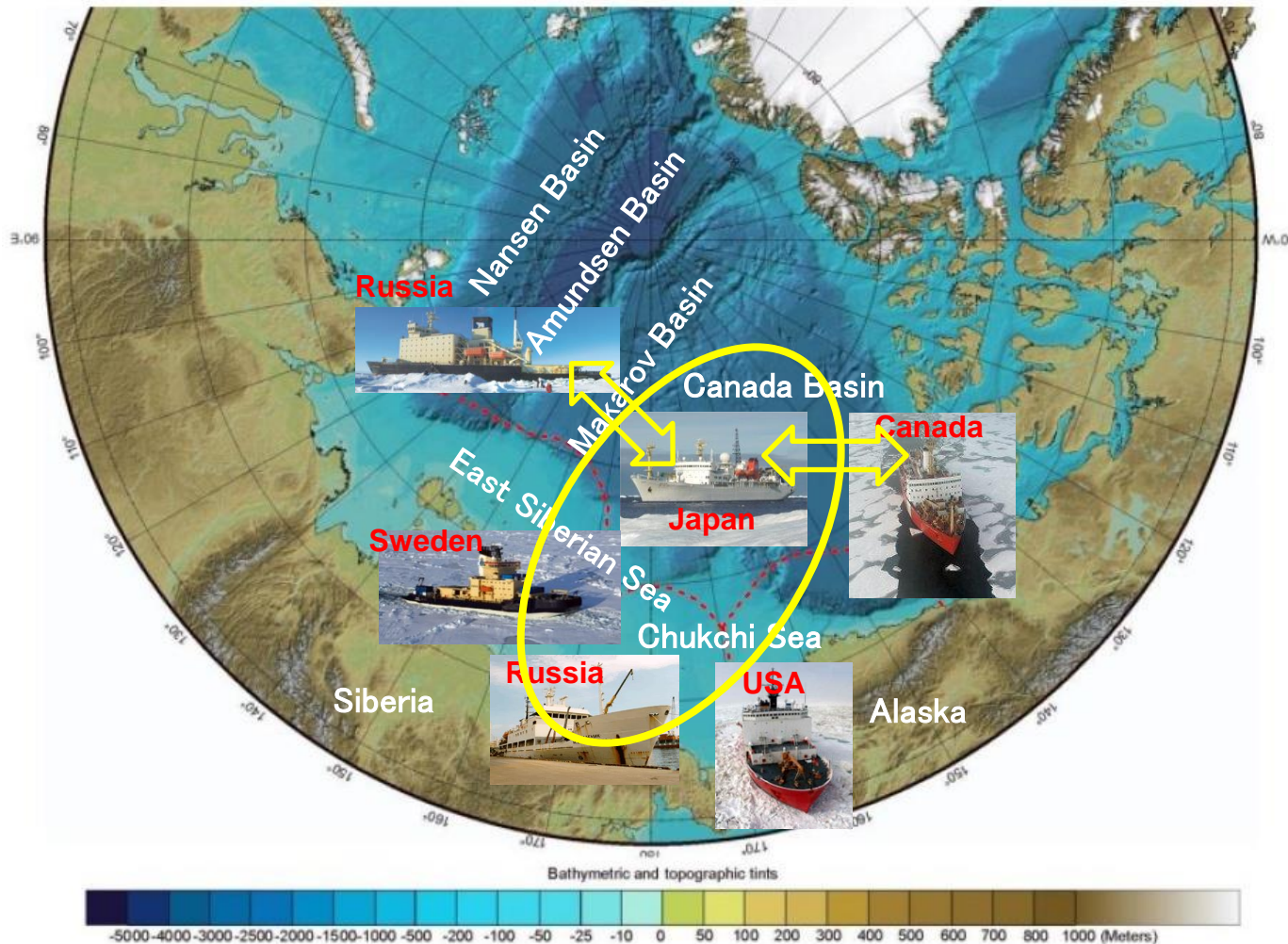


*Subsea permafrost model (Nicolosky et al., 2012)*



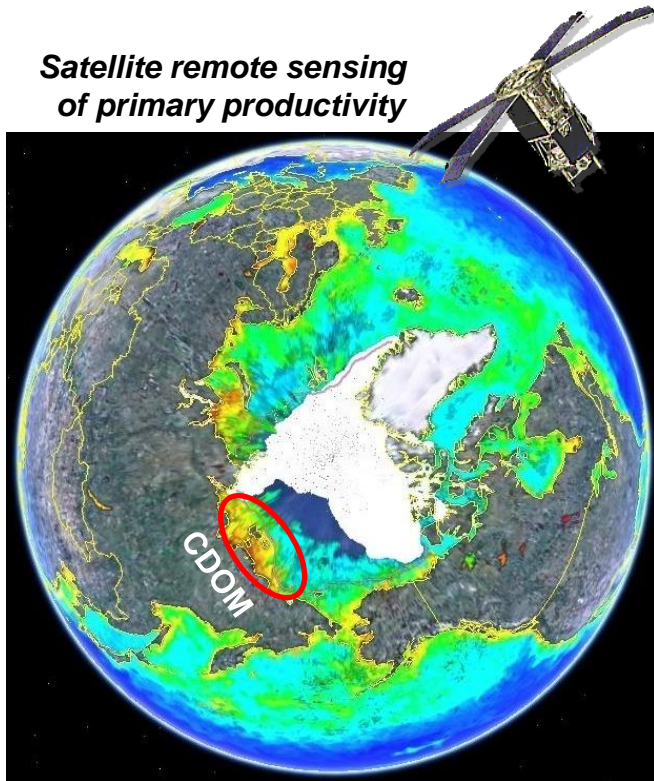
# **3. Contributions to research communities**

- R/V Mirai and Russian vessels will be operated in collaboration with U.S., Canada, and other countries activities in the Arctic Ocean. **Pacific Arctic Group (PAG)**, which is organized under the **International Arctic Science Committee (IASC)**, serves as a Pacific Arctic regional partnership to plan, coordinate, and collaborate on science activities.

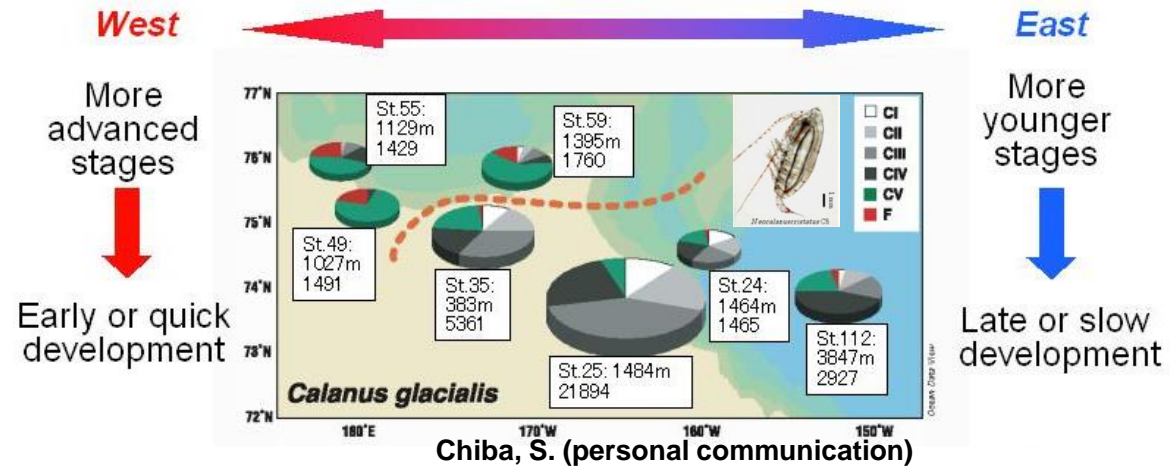


- This study will provide the **Japanese community with Arctic research** advantage through the participation in **R/V Mirai and Russian vessel cruises** that will foment opportunities for field experiments in the Siberian Arctic Ocean as well as the sharing of information from this undersampled region.

Satellite remote sensing of primary productivity



Differences in zooplankton between the east and west of Chukchi Plateau



Microbes and carbon cycle in the Arctic Ocean

Units: GtC or GtC/year

