Production of mycosporine like amino acids (MAAs) by natural phytoplankton community in the Artic

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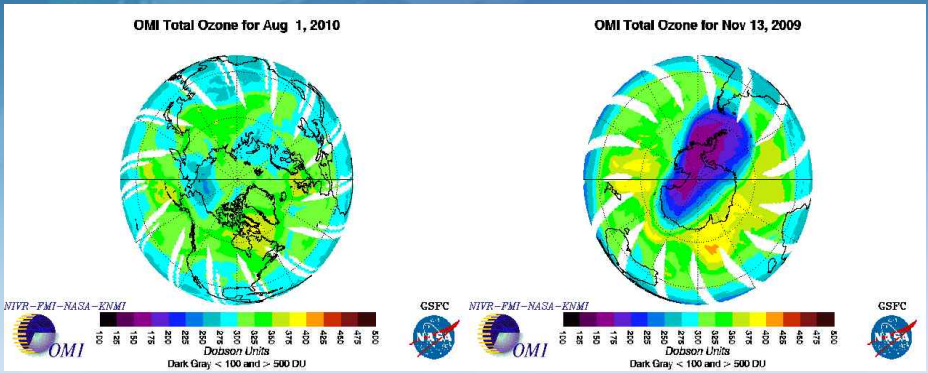
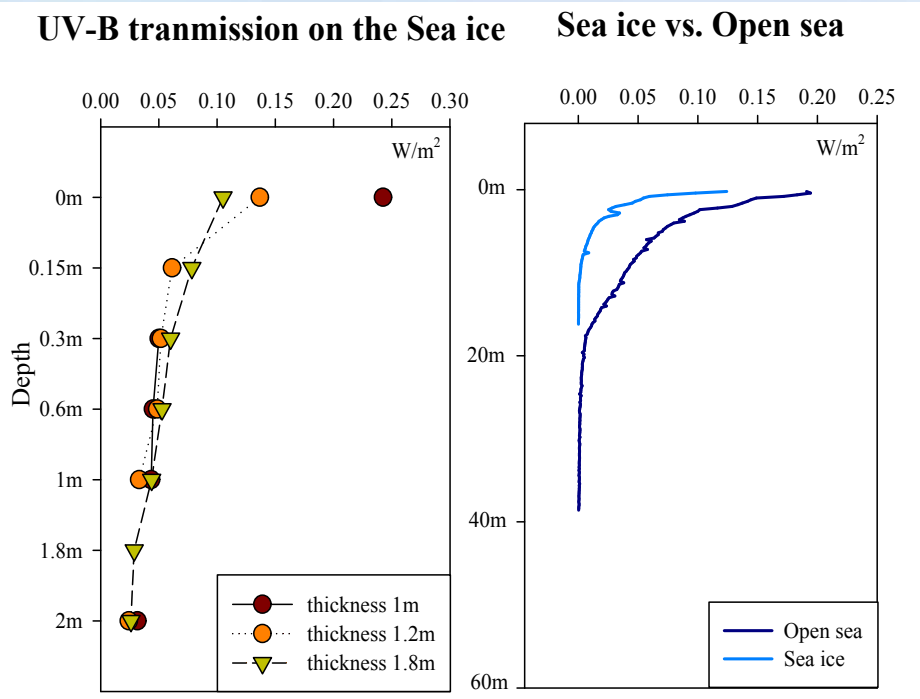
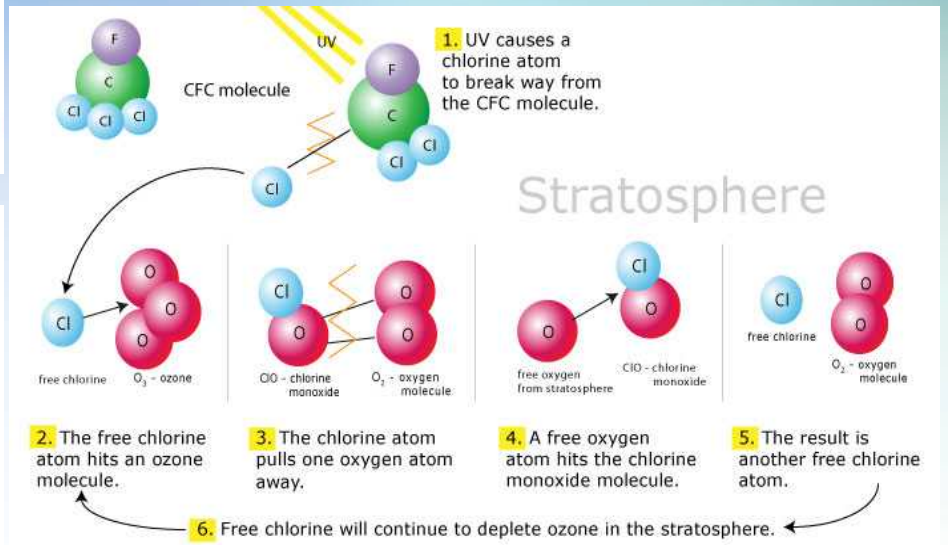
Background

Ozone depletion in Arctic and Antarctica

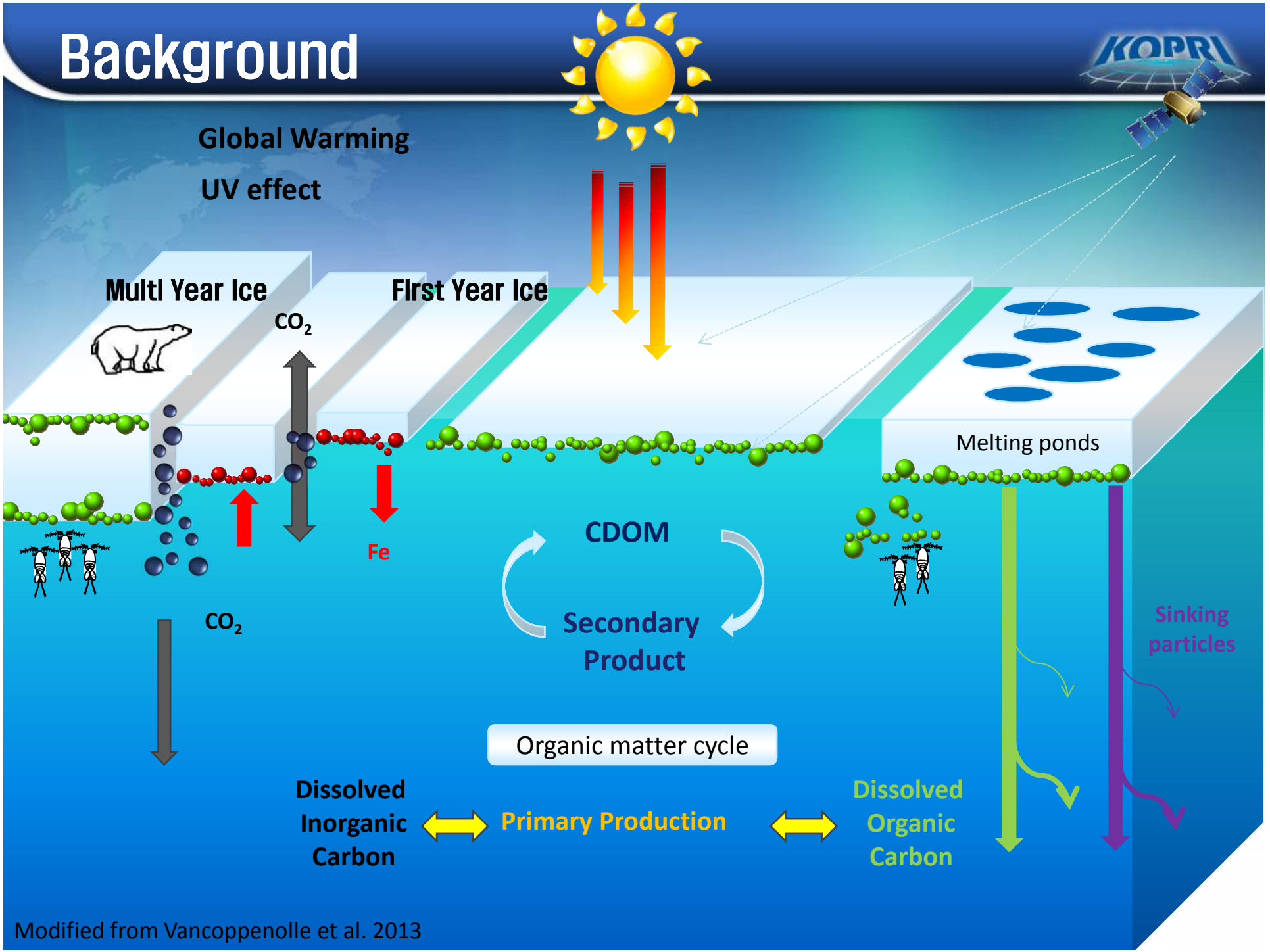




- ✓ In 1985, Reported the 'Ozone hole' over Antarctica.
- ✓ Ozone depletion still occurs and continue



- ✓ In 2013, the average size of the ozone hole was 8.1 million square miles.
- ✓ UV-B transmission on the different sea ice thickness and UVBR have transmitted deeper in open sea water.

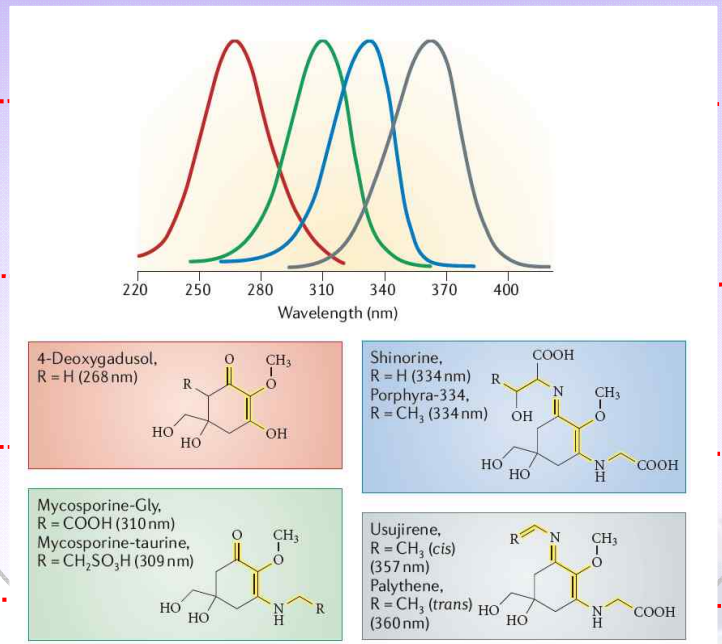

Background
Global Warming
UV effect
Multi Year Ice
First Year Ice
CO_2
CO_2
Fe
Melting ponds
CDOM
Secondary Product
Sinking particles
Organic matter cycle
Dissolved Inorganic Carbon
Primary Production
Dissolved Organic Carbon
Modified from Vancoppenolle et al. 2013

Background

Mycosporine-like amino acids (MAAs) as versatile elements

Function Values

- Anti-Oxidant
- Sunscreen protection
- Proto-protection
- Osmotic pressure



Ecological Significance

- Nitrogen storage
- Photosynthetic efficacy
- Thermal stress
- Desiccation stress

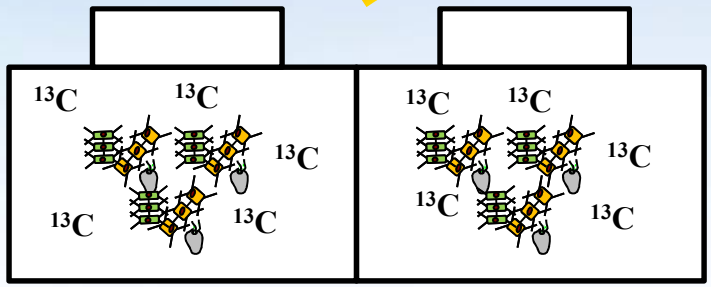
From: Gao and Garcia-Pichel 2011

Modified from Bhatia et al. 2011

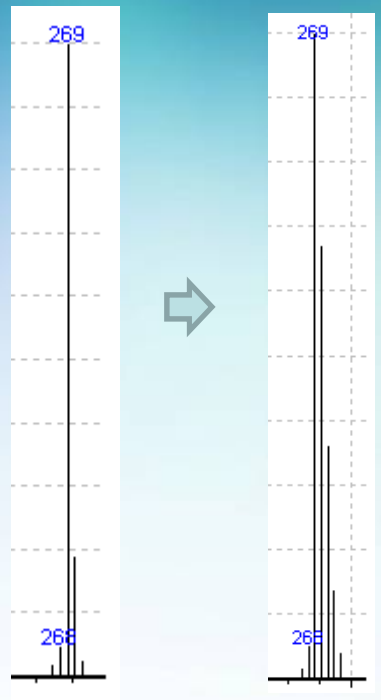
Experiment of Specific compounds isotope

UVR

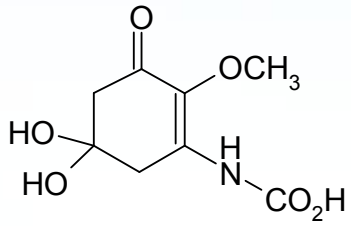
In situ incubation



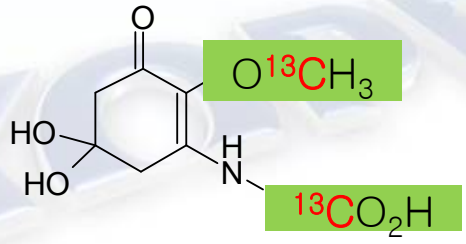
Fatty acids
C16:1



Mycosporine-like amino acids

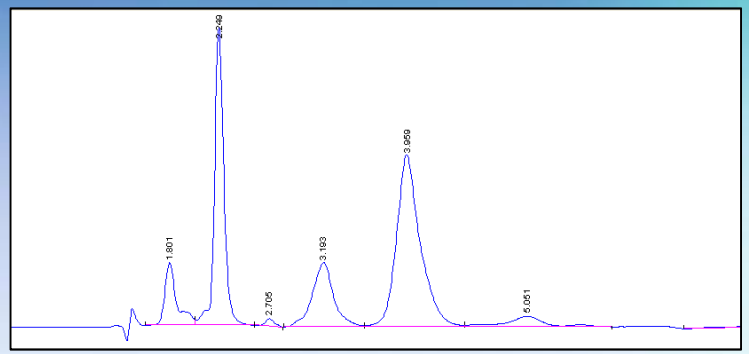


Mycosporine-glycine



Production rate of MAAs using HPLC

Separated MAA by HPLC



Collected each compounds

Measured the ^{13}C value of each compounds

To calculated production rate of individual MAA

$$\Delta MAC(t) = MAC \times \frac{a_{is} - a_{ns}}{a_{ic} - a_{ns}}$$

ΔMAC : The amount of each MAA carbon photosynthetically produced during the incubation

a_{is} : ^{13}C atom % in each MAA of incubated sample

a_{ns} : ^{13}C atom % in each MAA of natural sample

a_{ic} : ^{13}C atom % in ^{13}C enriched inorganic carbon

MAC : Concentration of each MAA carbon at the end of incubation

Ha et al. 2012

Photochemistry and Photobiology B: Biology 114: 1-14

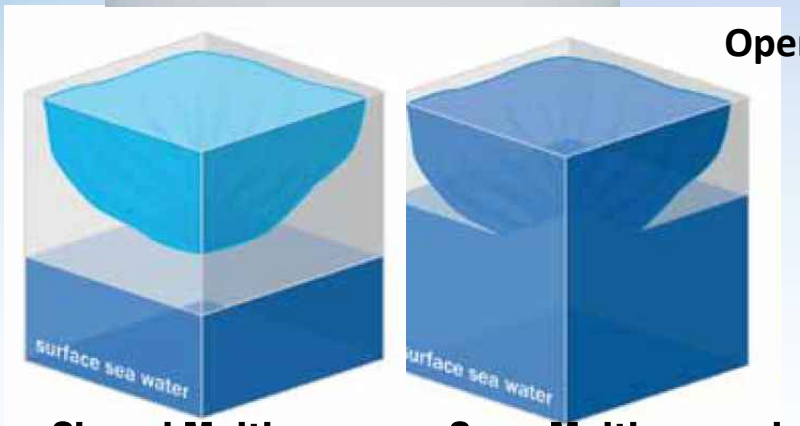
Results and Discussion

- **Production of MAAs of phytoplankton on the melting ponds, Arctic**
- **Distribution of MAAs along size-fractionated phytoplankton in the Beaufort Sea, Arctic**
- **Production rate of Phto-protective compounds on Lab-culture (*Porosira glacialis*)**

Production of MAAs of phytoplankton on the melting ponds

- Ha et al. 2014 in Journal of Phycology

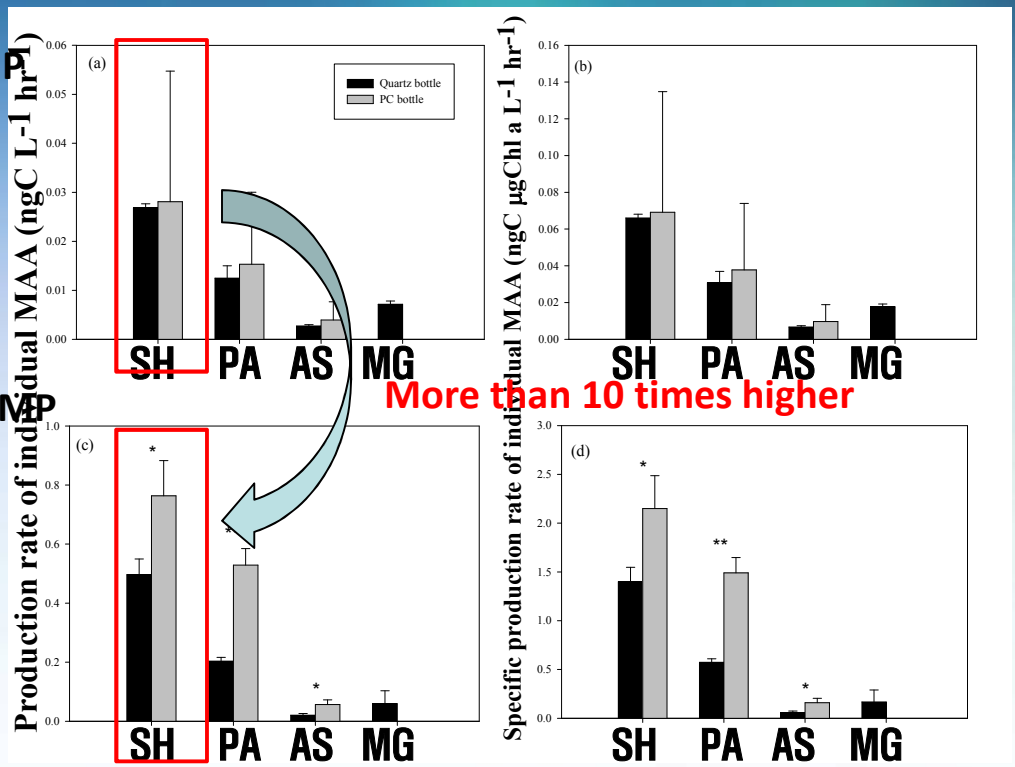
Closed MP



Open MP

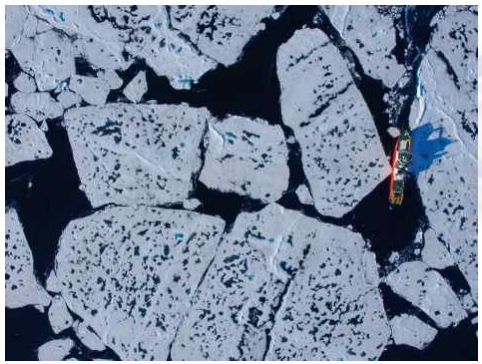
Closed Melting

Open Melting pond



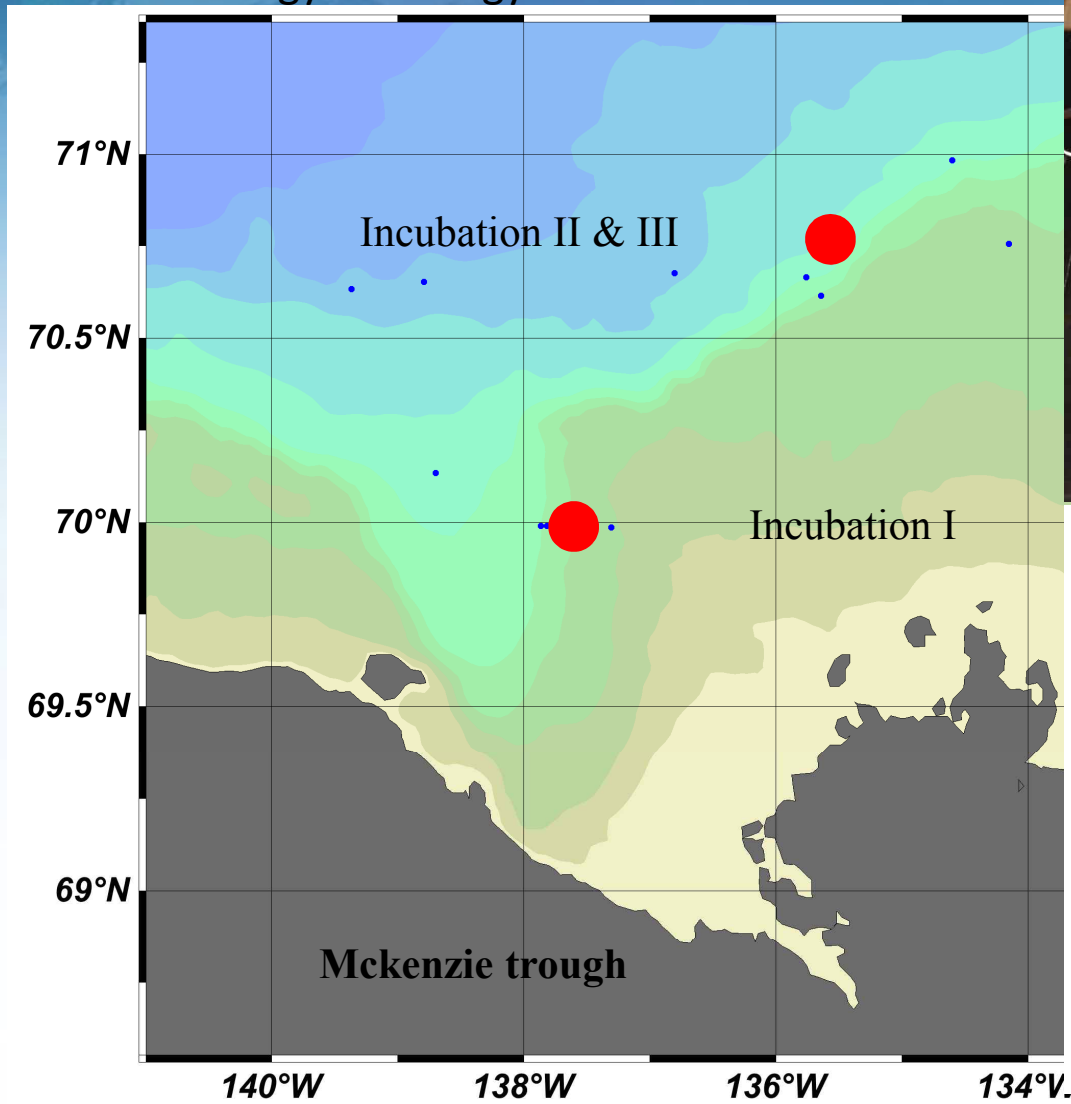
More than 10 times higher

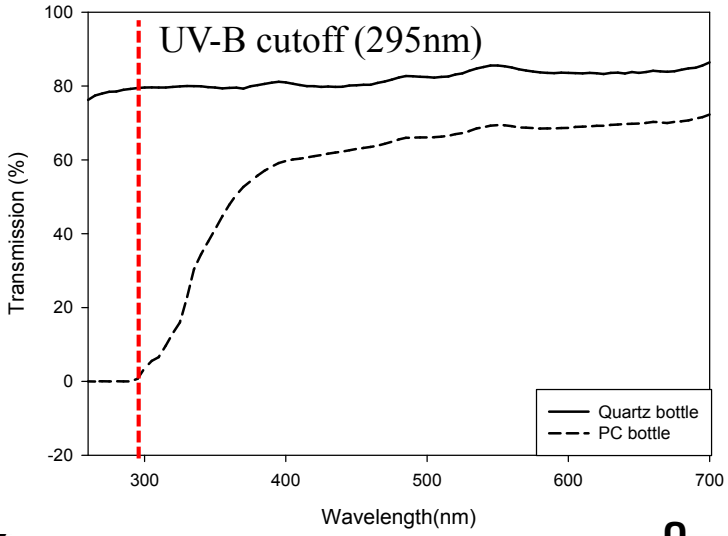
✓Production rate of MAAs on the melting ponds

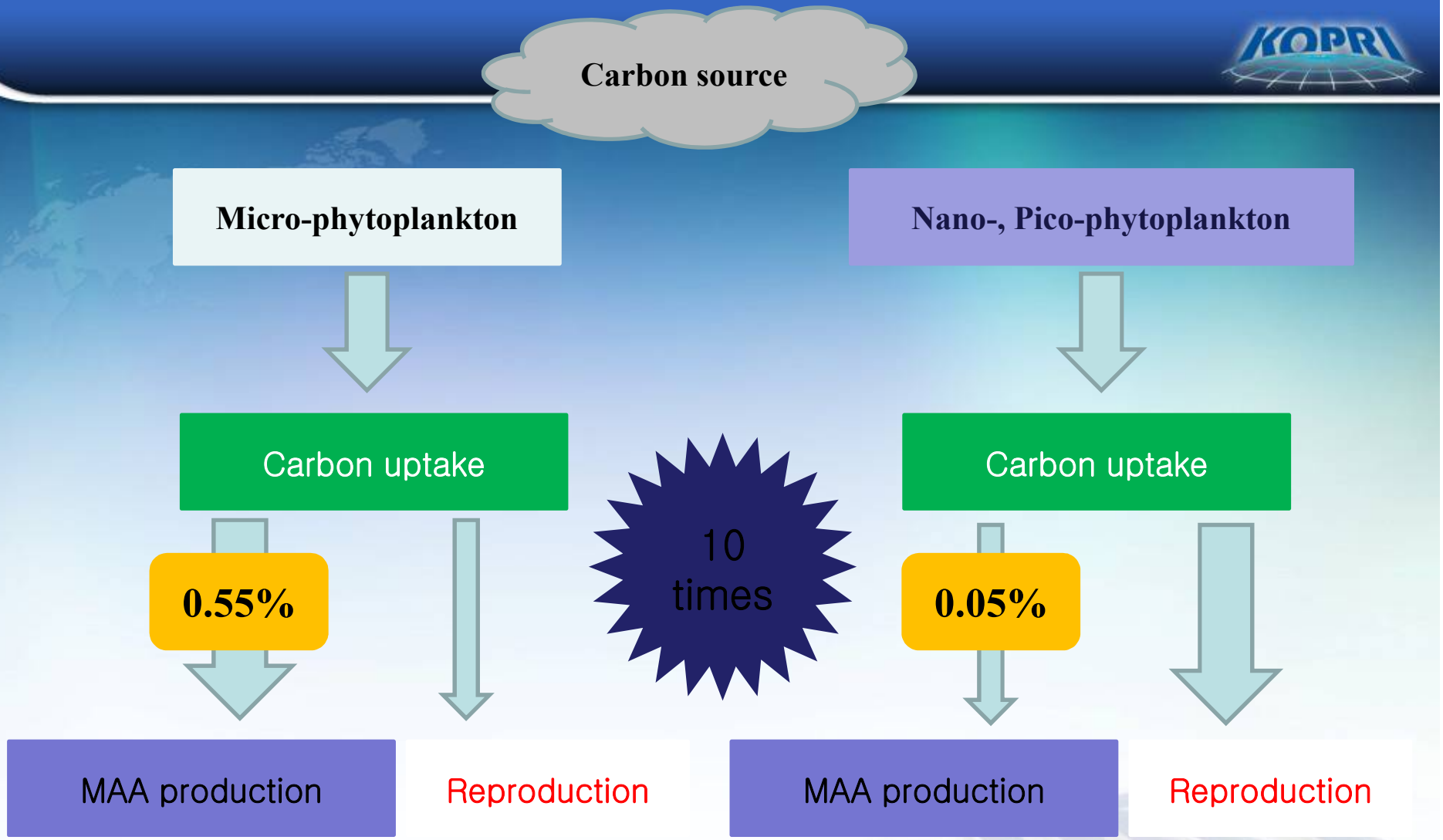


Distribution of MAAs along size-fractionated phytoplankton in the Beaufort Sea, Arctic

- Submitted in Journal of Photochemistry and Photobiology B: Biology







- ✓ Micro-phytoplankton use the carbon to photoprotective mechanisms rather than cell reproduction.
- ✓ However, nano-, and pico-phytoplankton focus on to cell reproduction due to poor photoprotective mechanisms.

Production rate of Photo-protective pigment

- Ha *et al*. 2014 in Diatom Research

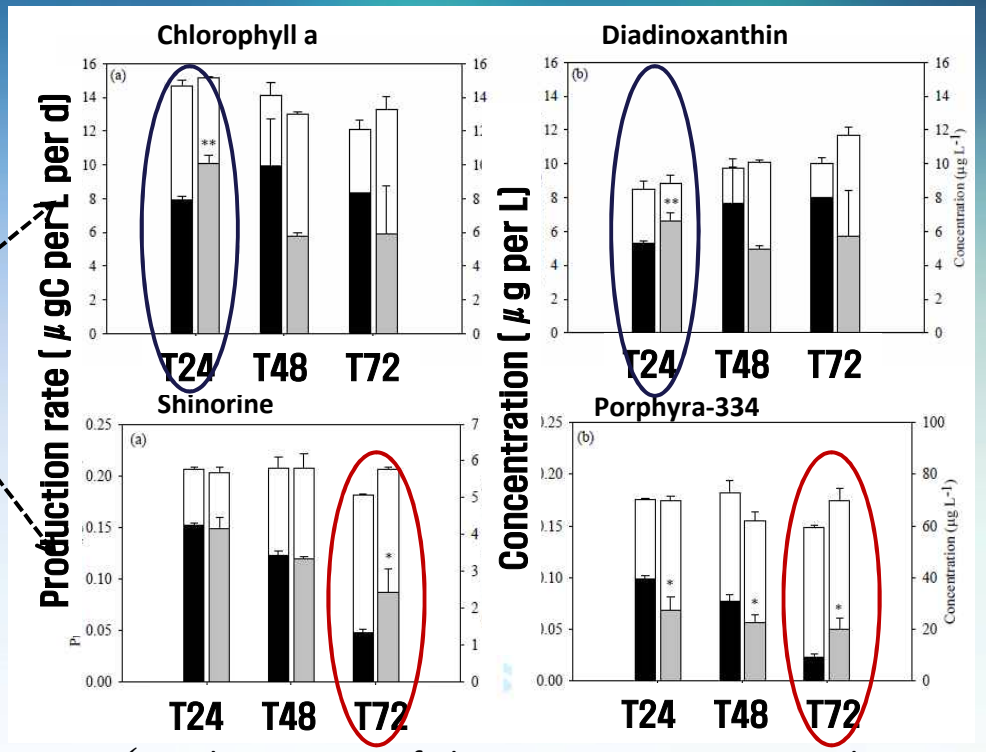
Porosira glacialis

Xanthophyll compounds

UV-absorbing compounds

Labelled ^{13}C tracer on compounds

➢ **Stable isotope probing method**



✓ Production rate of photo-protective compounds

➢ The time difference between the production of MAAs and the production of pigments is the direct result of **the allocation of carbon to different photo-protective compounds**

➢ We could find out the **stable isotope probing method** better than bulk concentration for interpreting the complex environment

Porosira glacialis

Xanthophyll compounds

UV-absorbing compounds

- To reflect the synthetic pathways of photoprotective compounds and the carbon cycle within the cell in contrasting patterns over time that are defined by the production of photoprotective pigments and MAAs.
- The time difference between the production of MAAs and the production of pigments is the direct result of the allocation of carbon to different photoprotective compounds.
- Organic carbon is initially fixed to produce photoprotective pigments and that organic carbon (^{13}C) is fixed to produce MAAs within the cell.

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From Joo