

# MODUSS

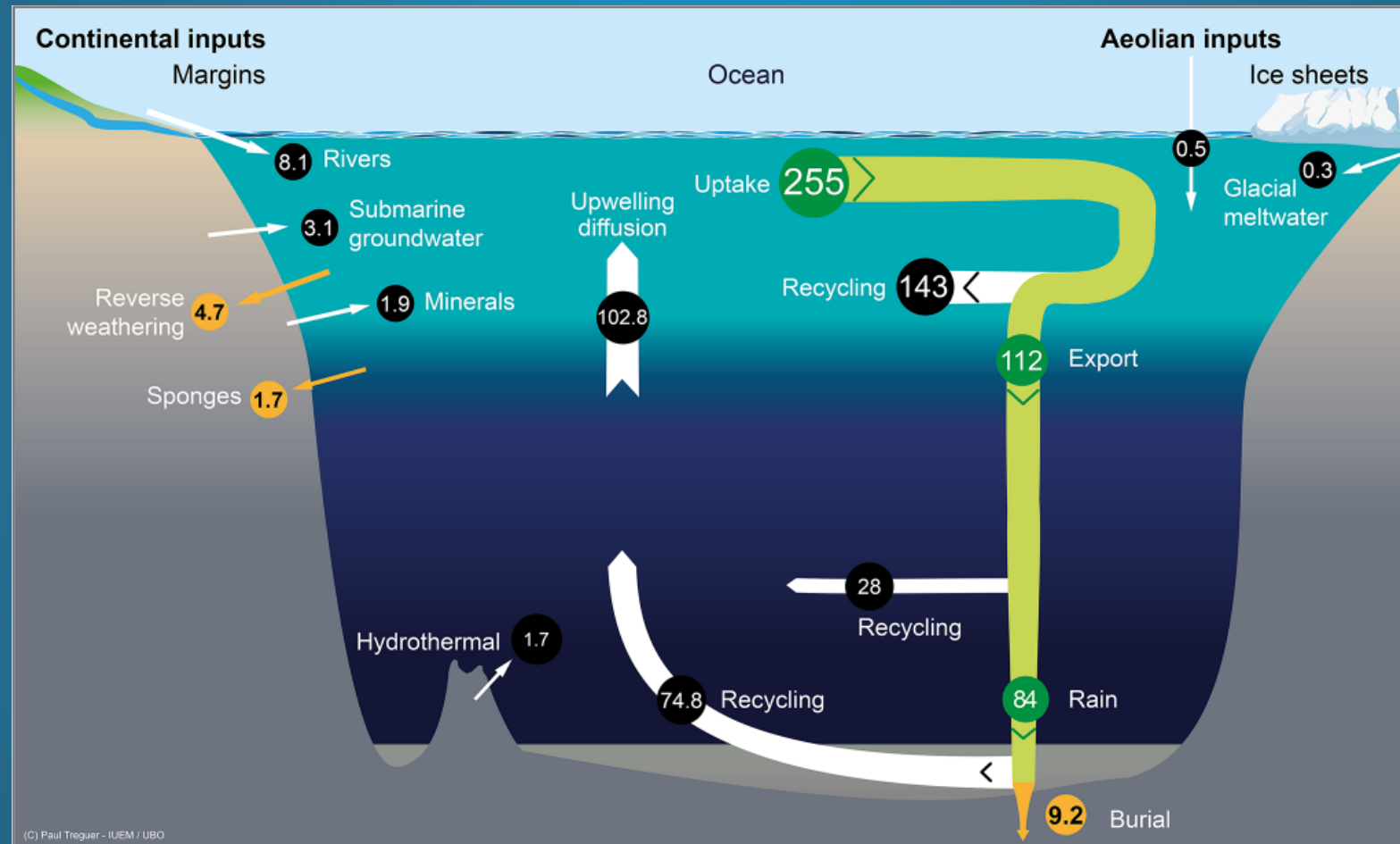
## Marine Observatory Development with an Autonomous Silicon Sensor

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*European Institute for Marine Studies, Technopôle Brest-Iroise, Rue Dumont D'Urville, 29280 Plouzané,  
France*



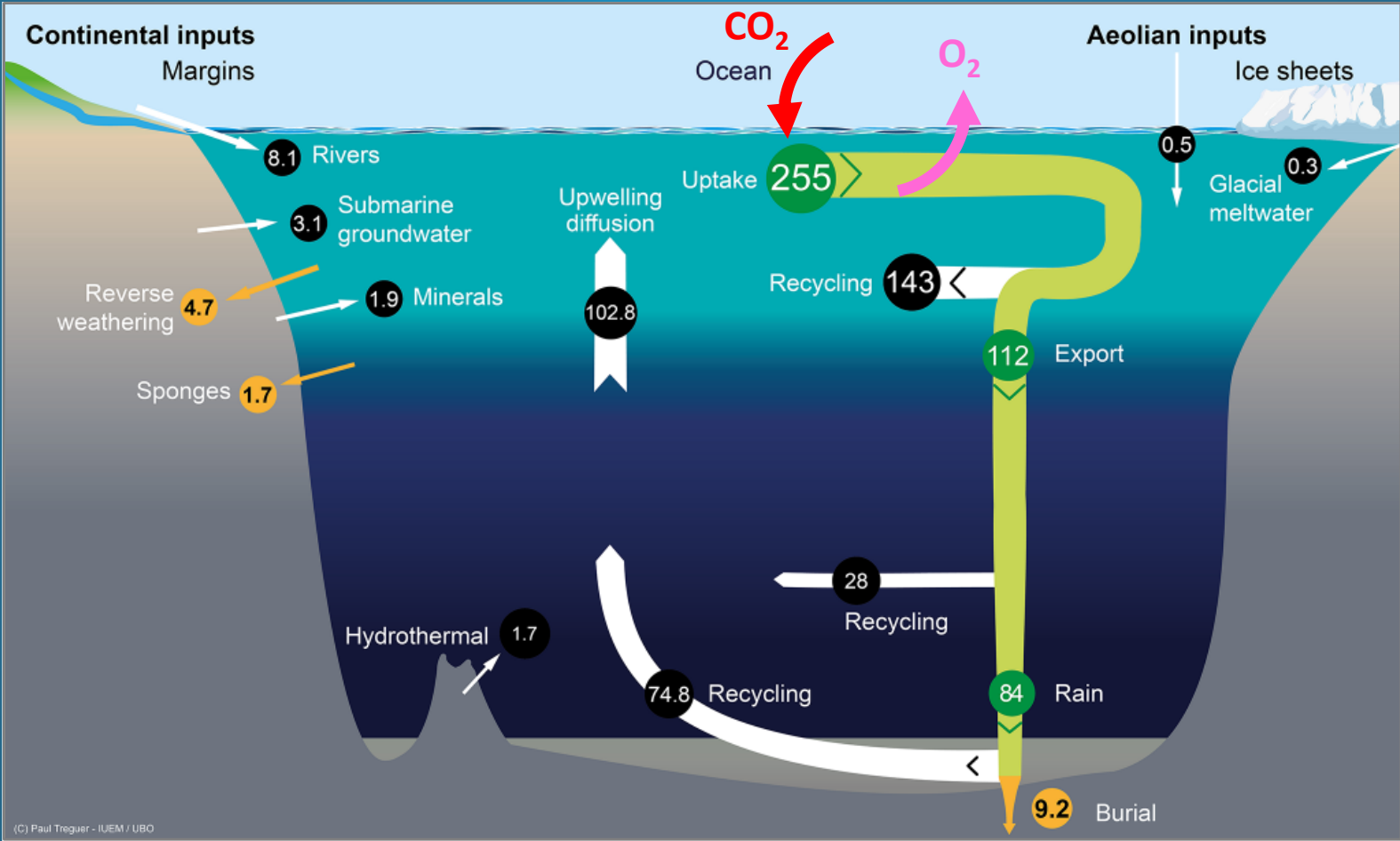
# Marine Silicon Cycle: why do we care?



(C) Paul Tréguer - IUEM / UBO

(Tréguer et al., 2021)

# Marine Silicon Cycle: why do we care?



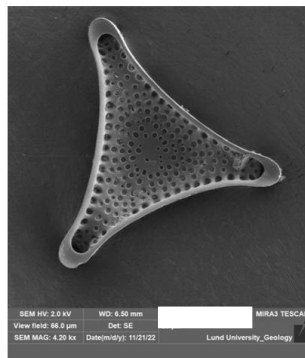
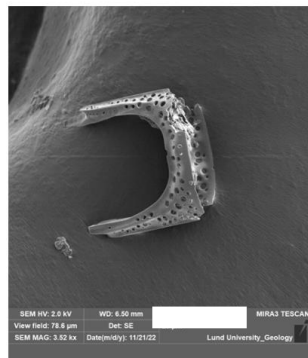
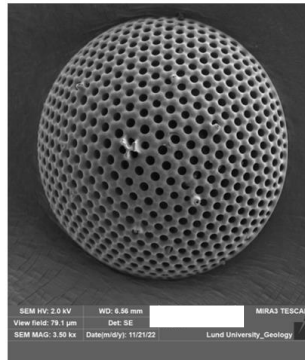
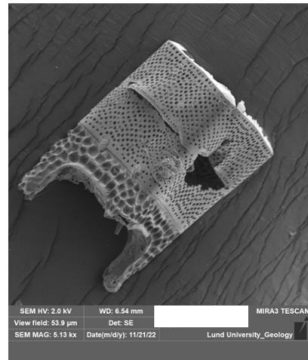
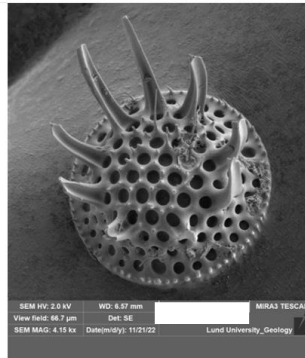
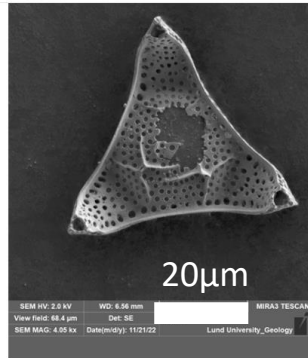
(C) Paul Tréguer - IUEM / UBO

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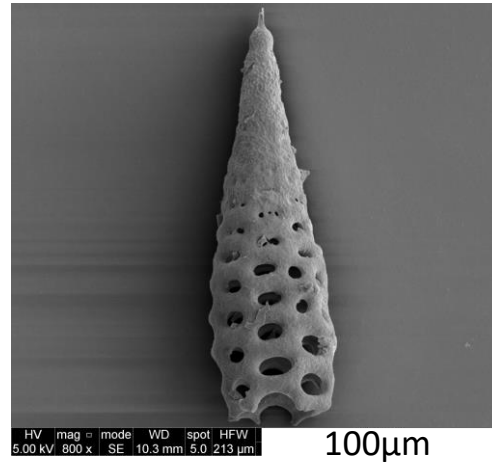


# Marine Silicon Cycle – main actors

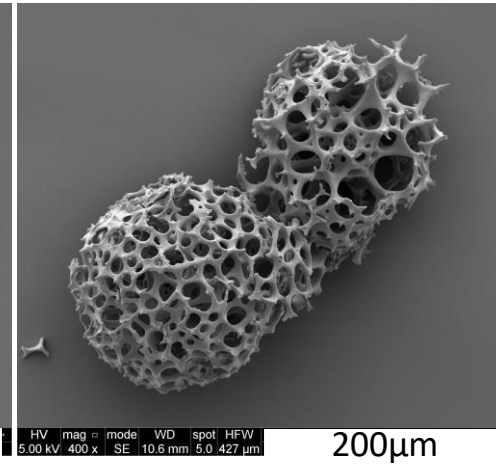
## Diatoms



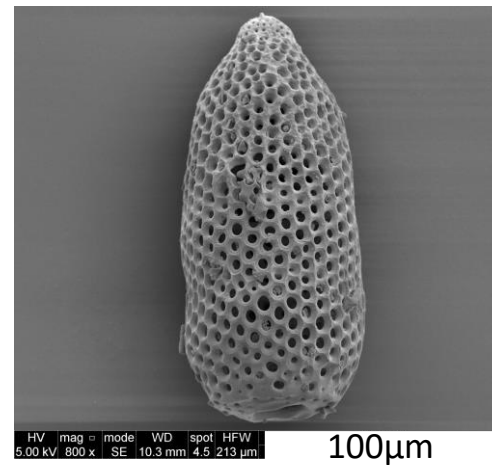
## Radiolarians



100µm

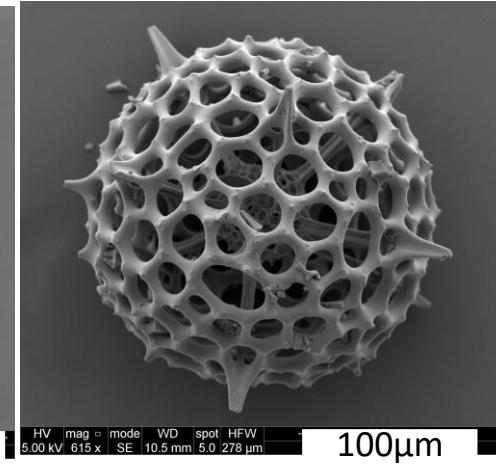


200µm



100µm

Nassellaria



100µm

Spumelaria

## Sponges

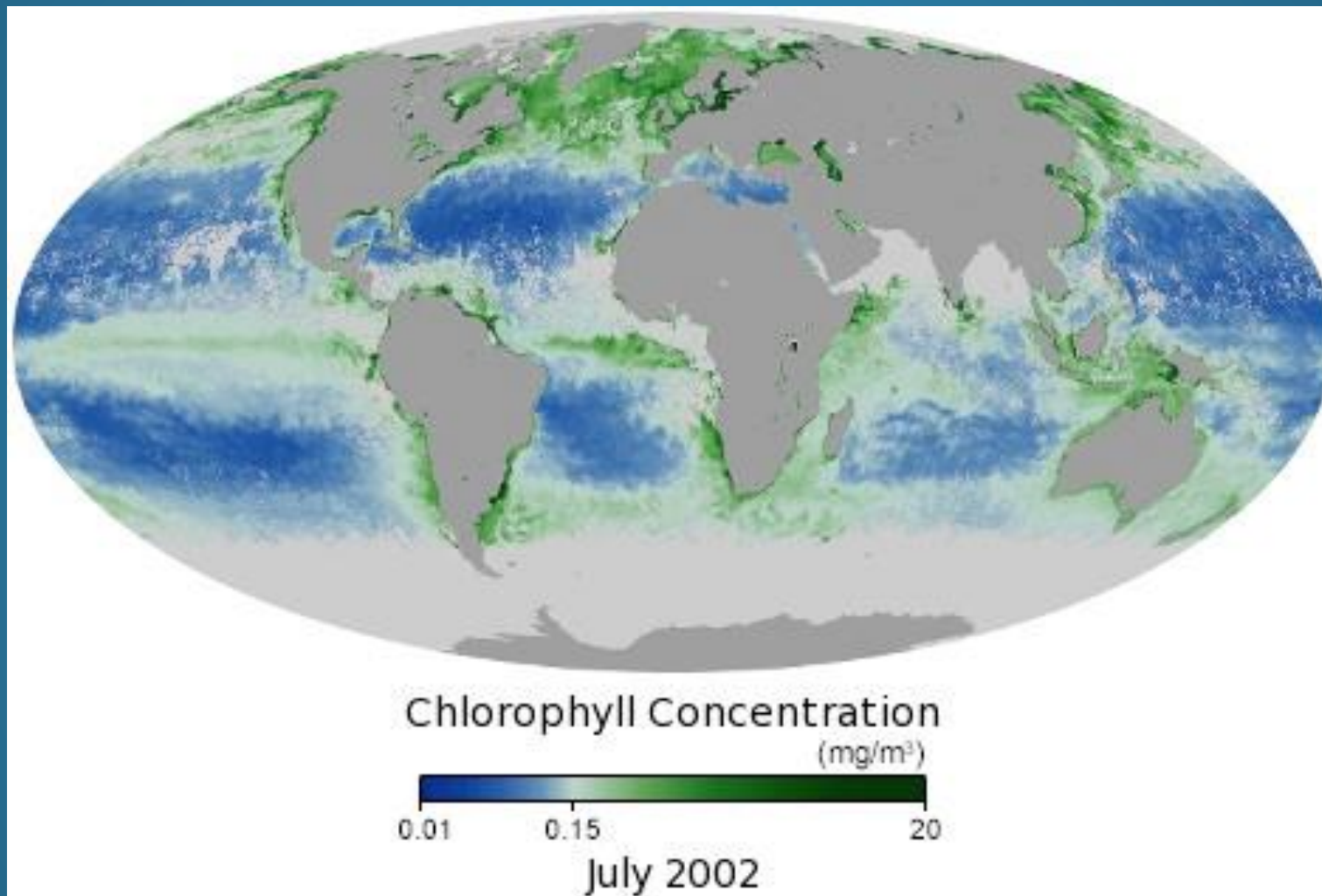


Hexactinellida, *Euplectella aspergillum*



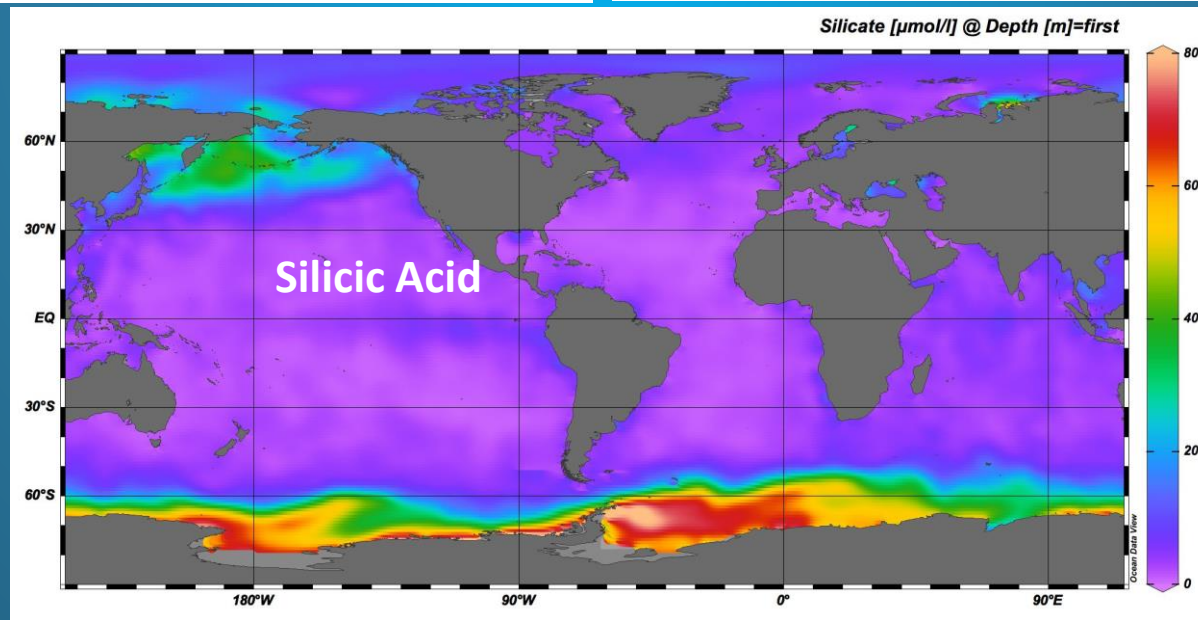
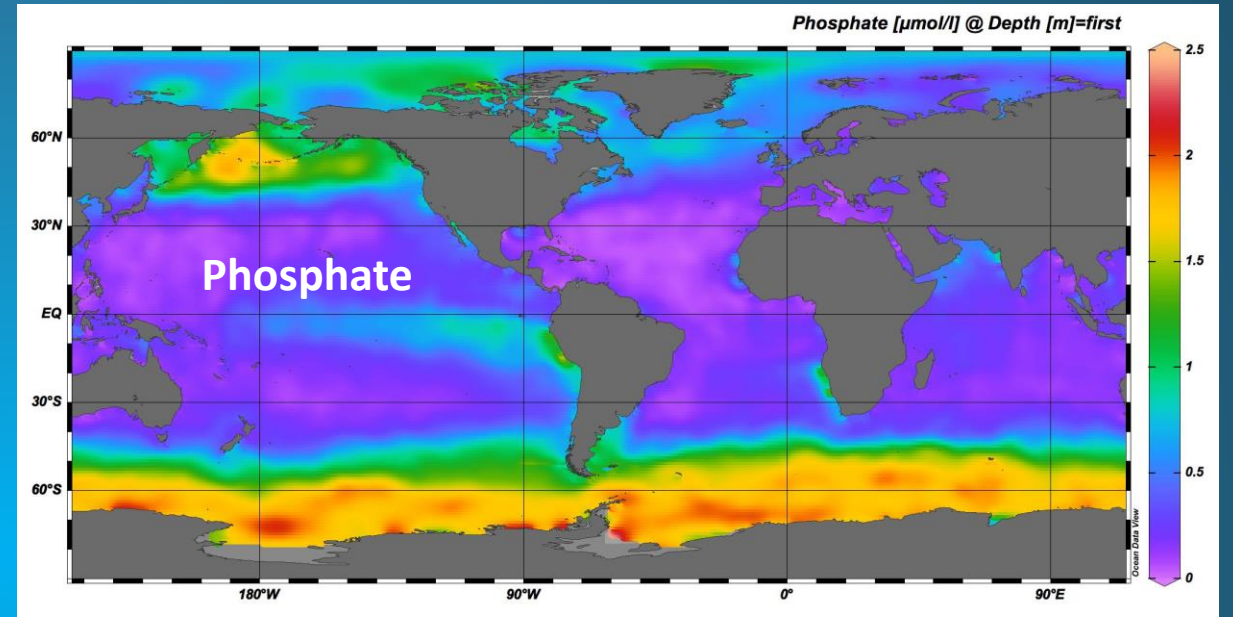
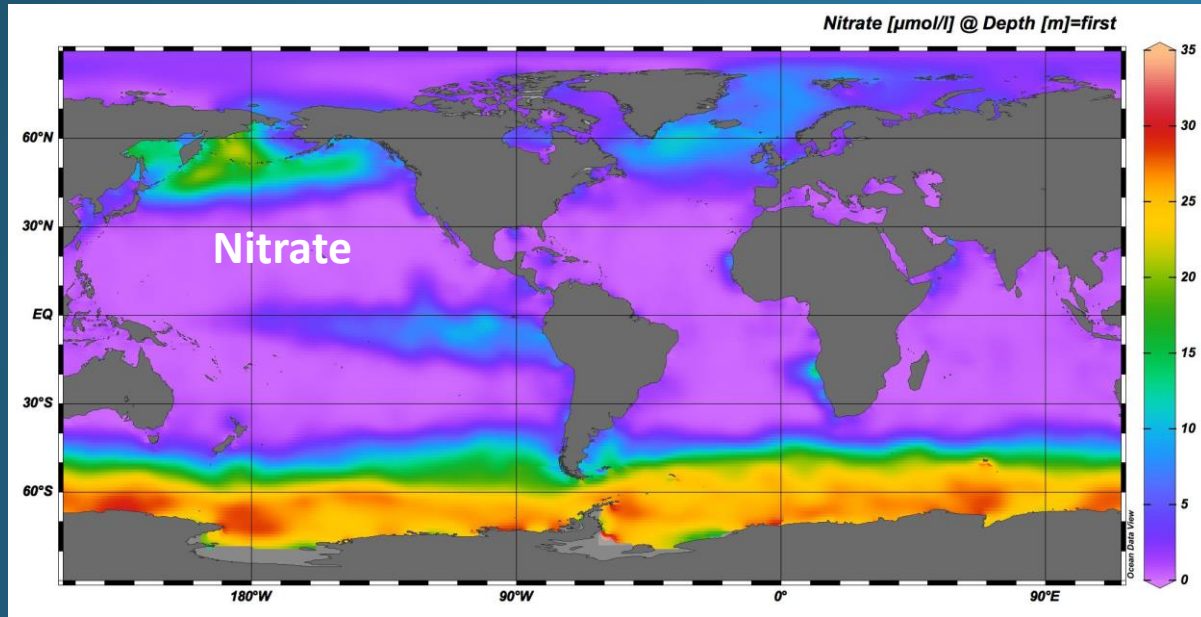
Demospongiae, *Suberites carnosus*

# Why the Southern Ocean?



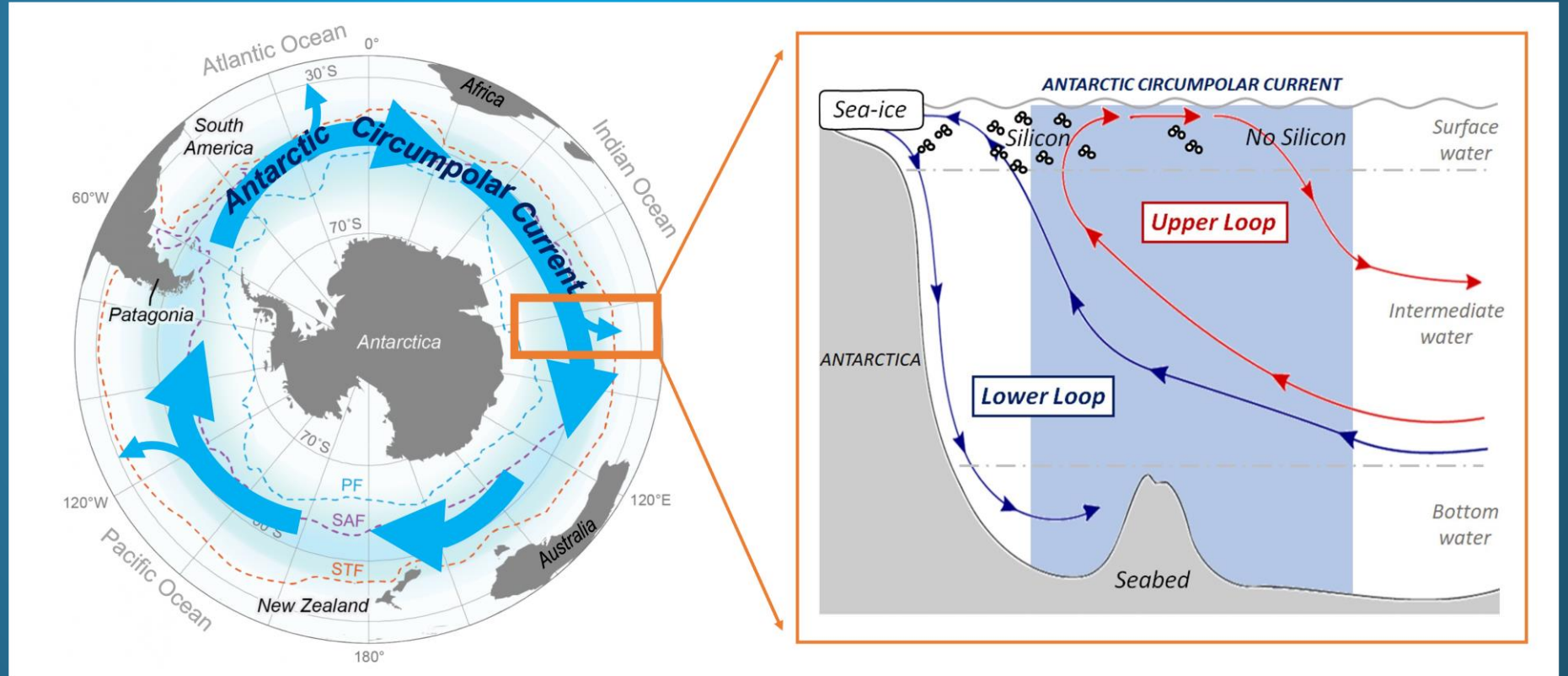
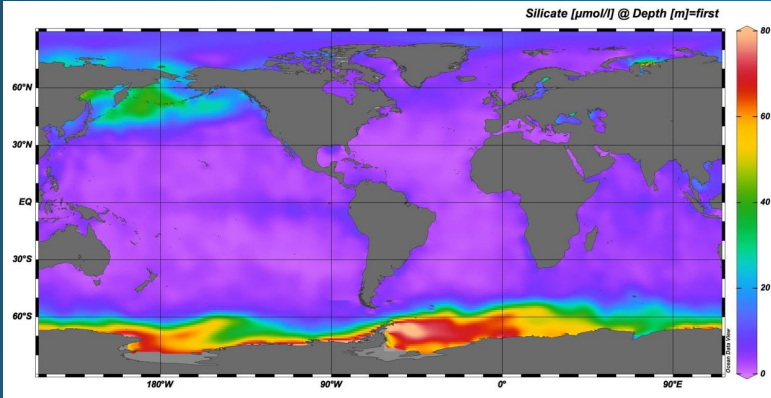


# Why the Southern Ocean?

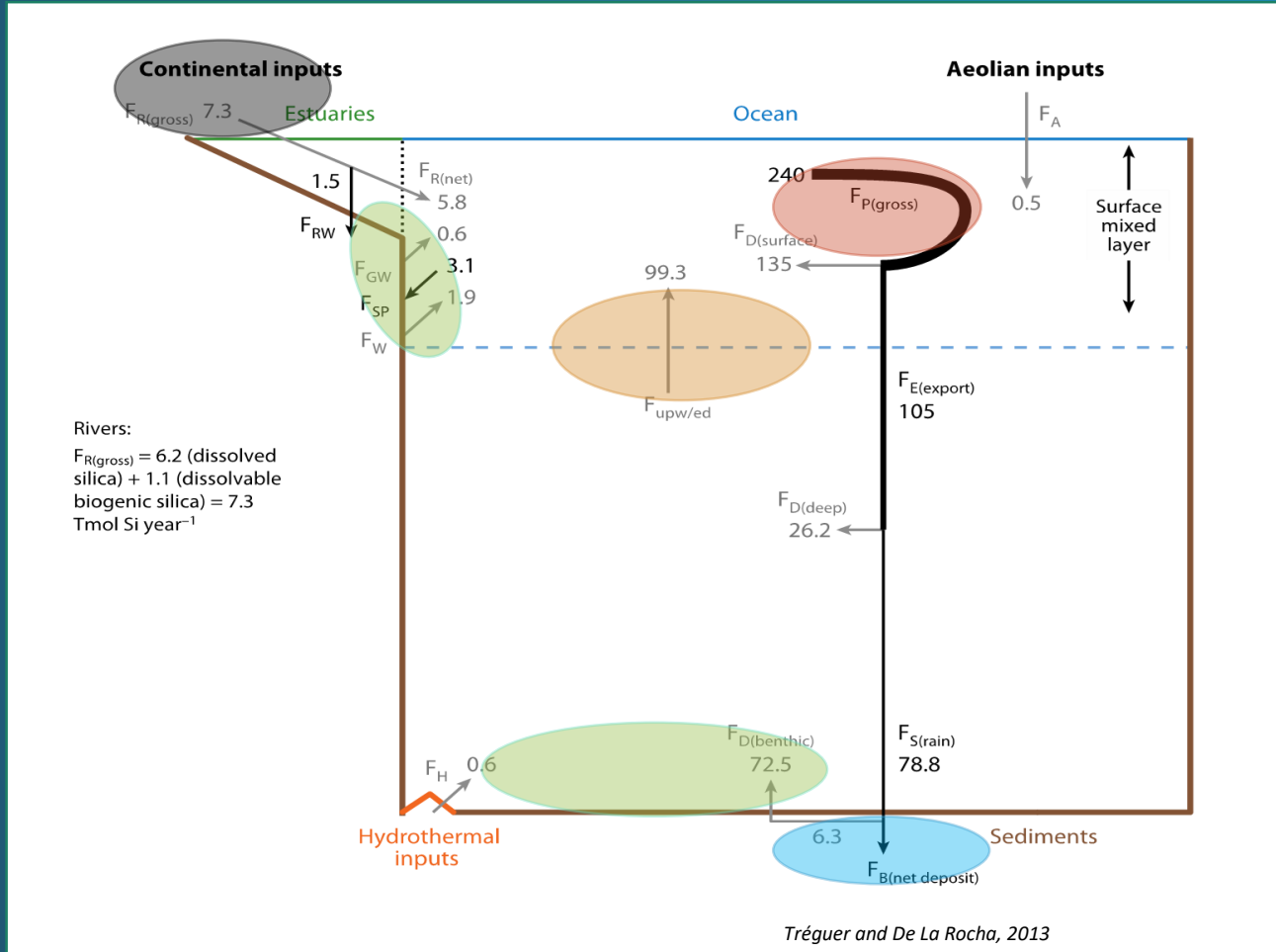


# The Southern Ocean = The Si trap

## Silicic Acid



# $\delta^{30}\text{Si}$ and $\Delta^{30}\text{Si}$ : why do we care?



Weathering

Marine organisms:  
Diatoms  
Radiolarians  
Sponges

Water masses mixing

Burial and diagenesis

Benthic / groundwater / hydrothermal fluxes

3 stable isotopes:

$^{28}\text{Si}$  (92.2%)

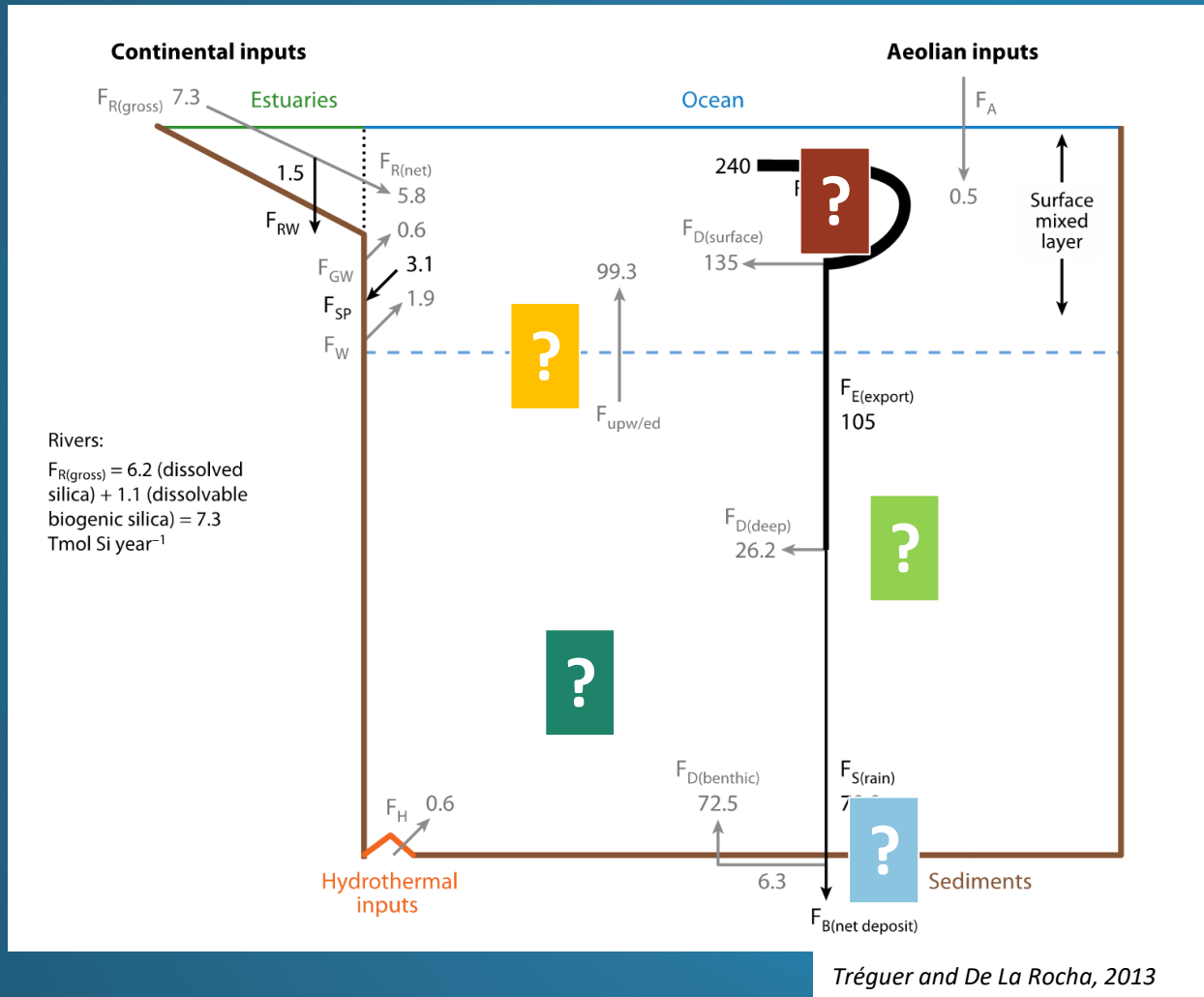
$^{29}\text{Si}$  (4.68%)

$^{30}\text{Si}$  (3.08%)

$$\delta^{30}\text{Si} = \left[ \frac{\left[ \frac{^{30}\text{Si}}{^{28}\text{Si}} \right]_{\text{sample}}}{\left[ \frac{^{30}\text{Si}}{^{28}\text{Si}} \right]_{\text{standard}}} - 1 \right] \times 1000$$



# My work so far



Biosilicification  
experimentation

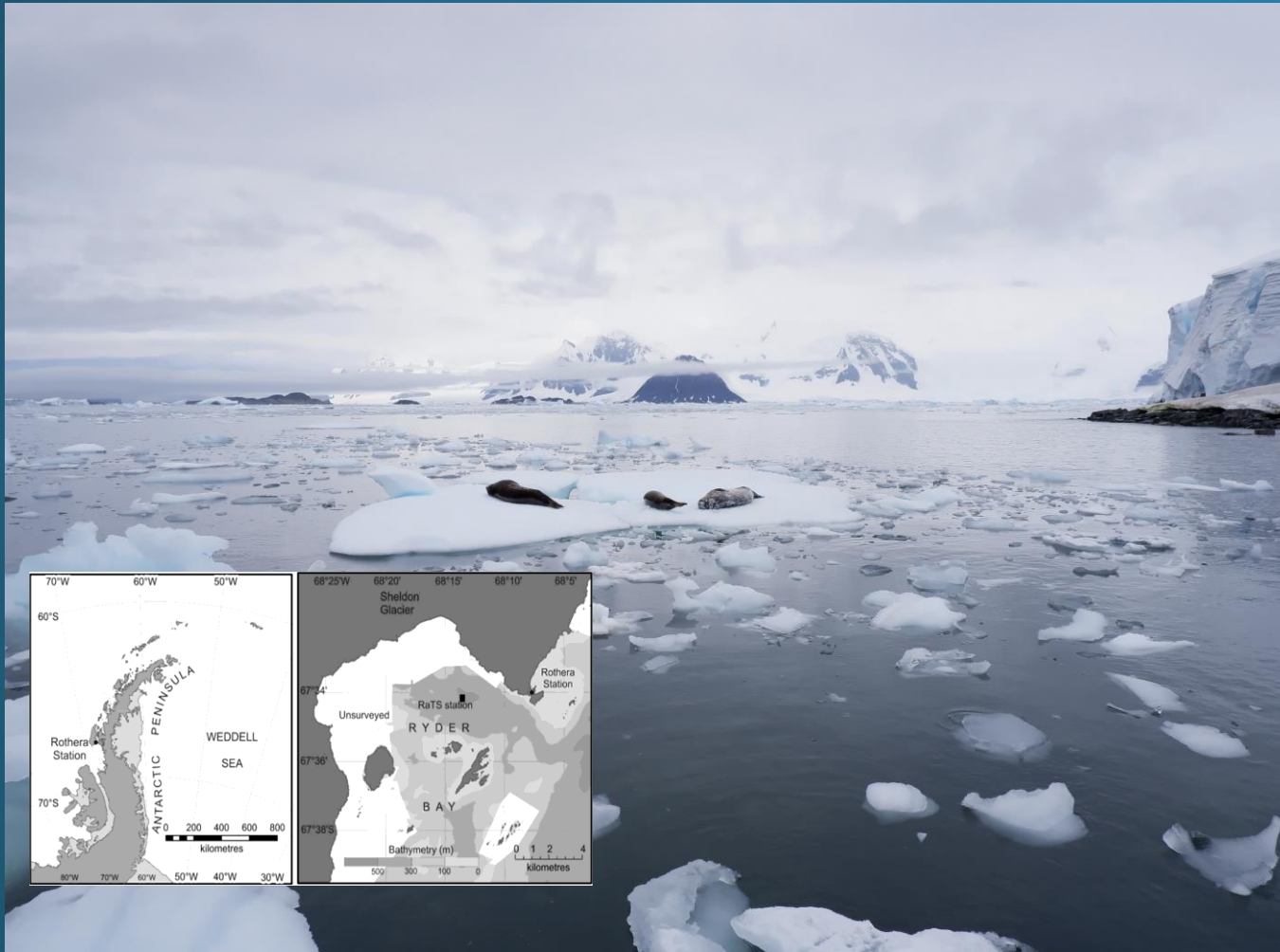
Sponge records

Pore fluid/sed

RaTS –  
time series

Modern  
Radiolarians

# Rothera Time series- RaTS





# Rothera Time series- RaTS

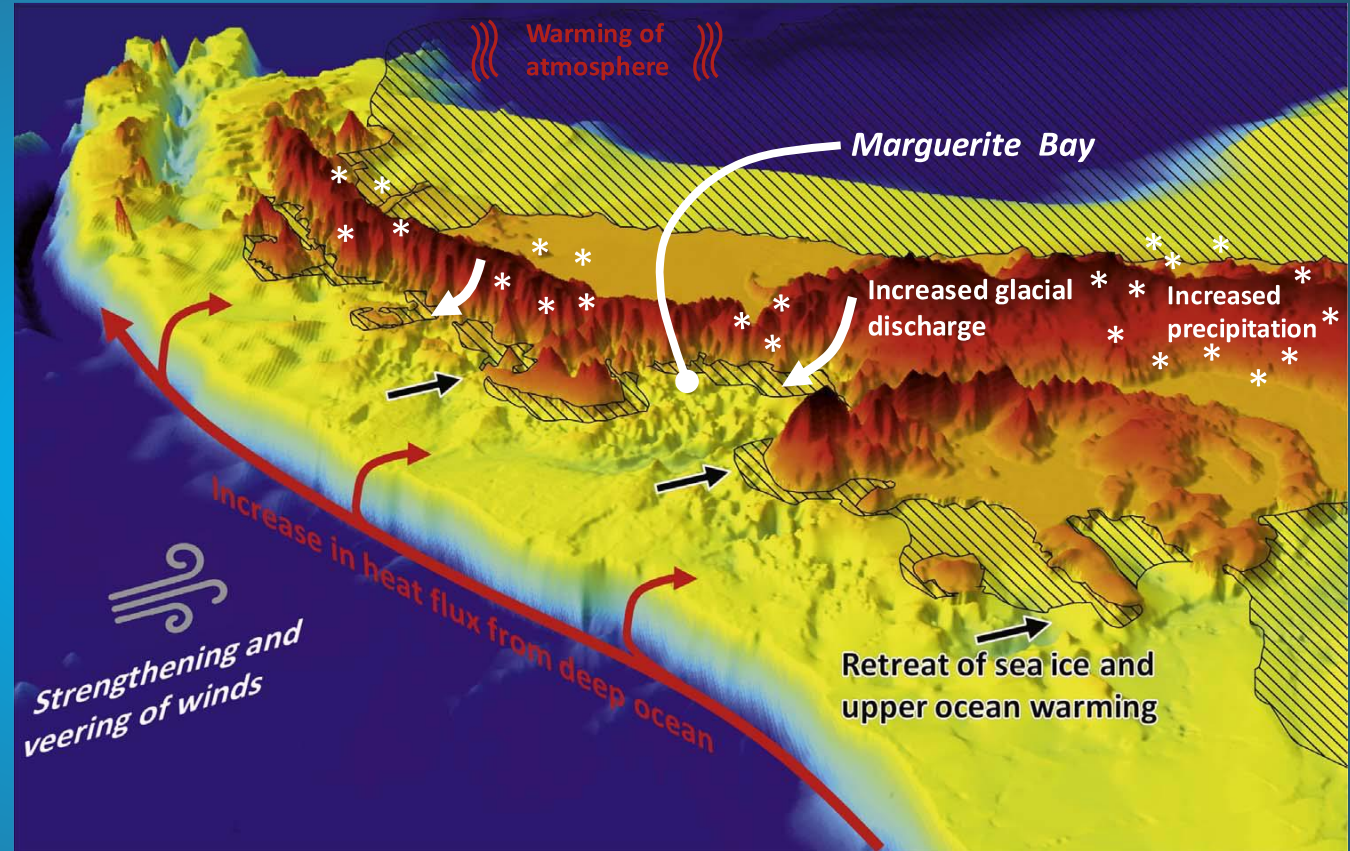
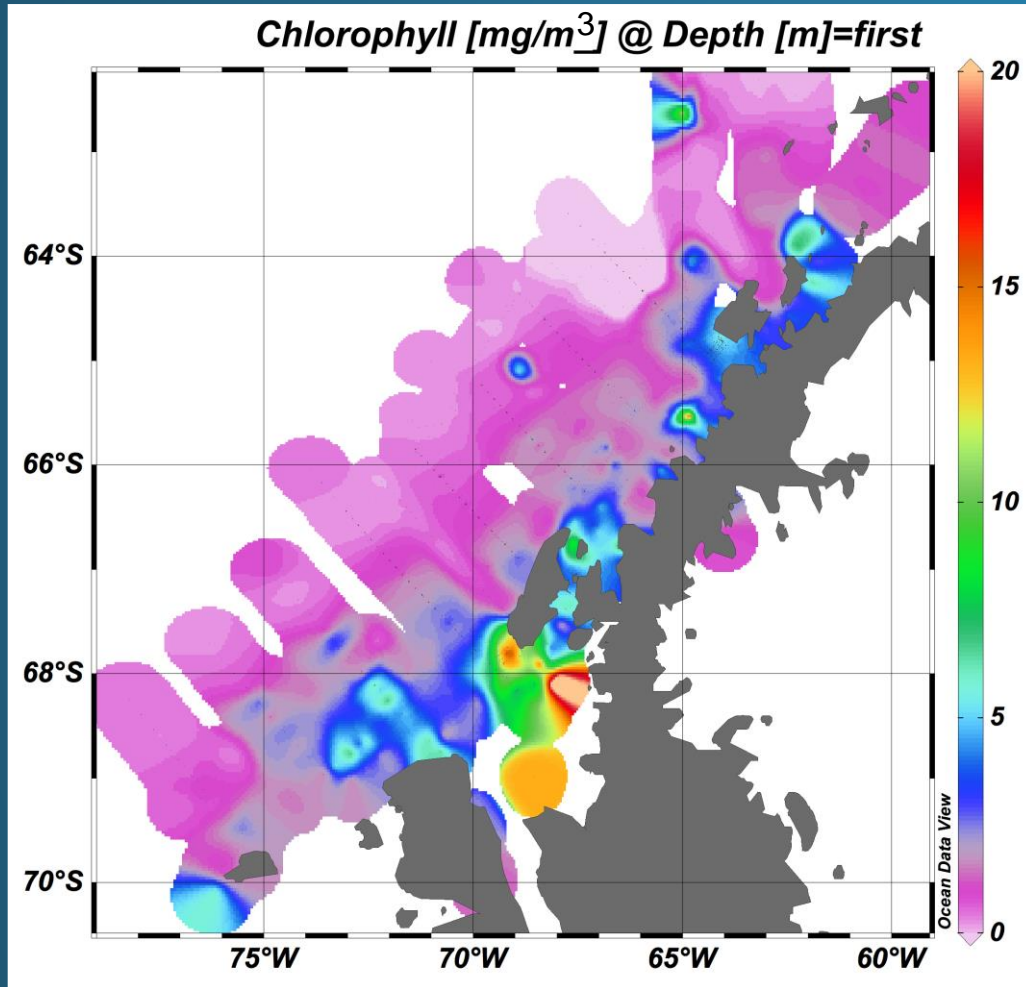
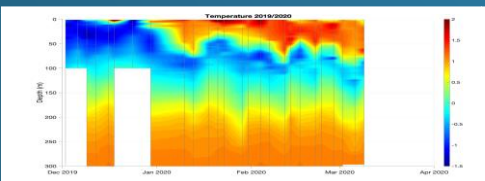
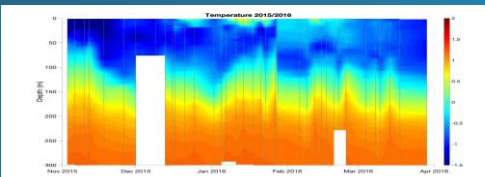
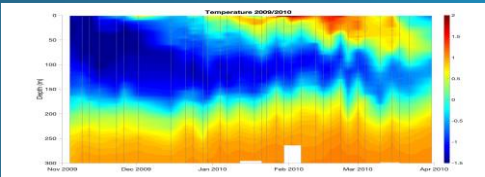
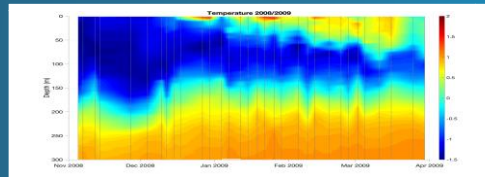
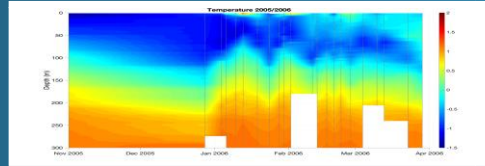
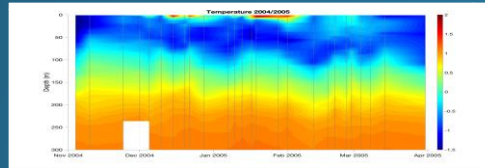


Fig. 2. Schematic of some of the major changes to the WAP environment that occurred during the second half of the 20th century.

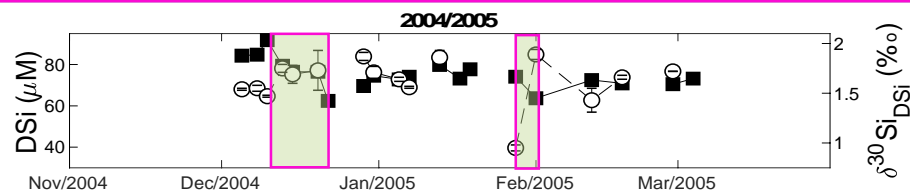


# Rothera Time series- RaTS

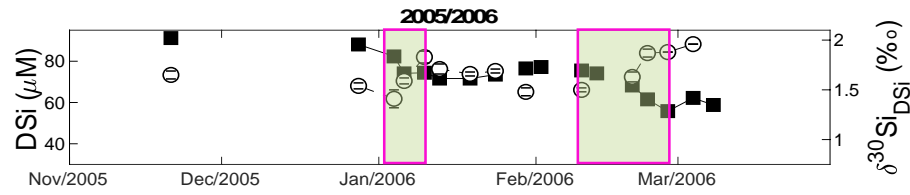
## Temperature (0-300m)



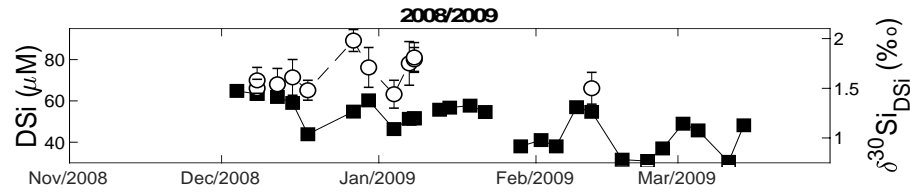
## Silicic acid and Si isotopes at 15m



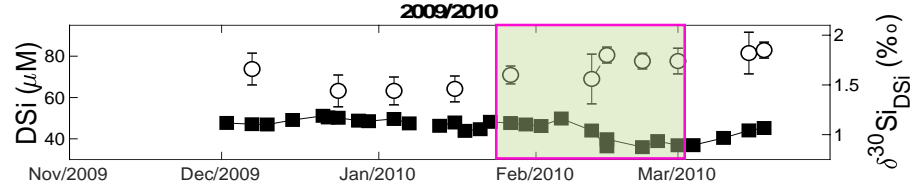
2004/2005  
*Cassarino et al., 2017*



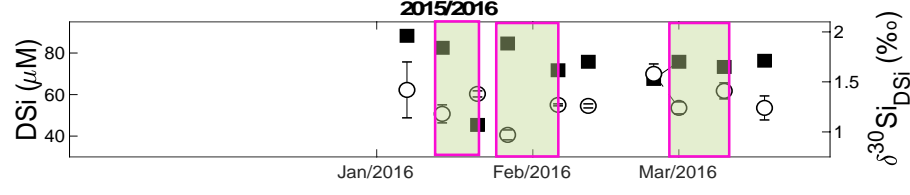
2005/2006  
*Cassarino et al., 2017*



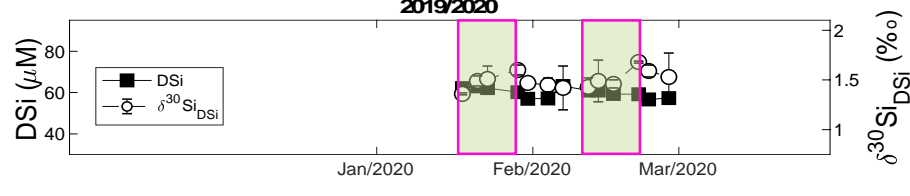
2008/2009  
*Annett et al., 2017*



2009/2010  
*Cassarino et al., in prep*



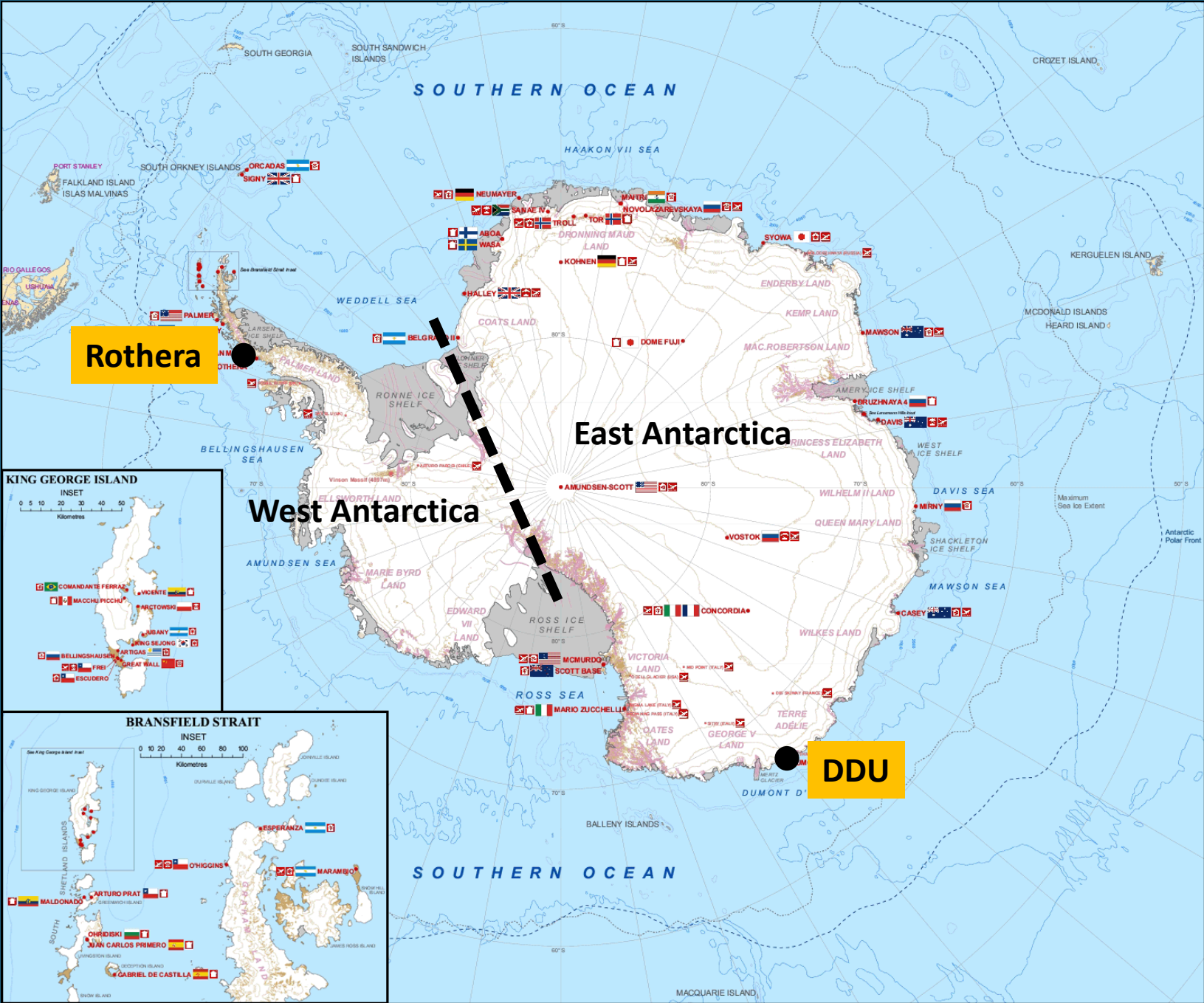
2015/2016  
*Cassarino et al., in prep*



2019/2020  
*Cassarino et al., in prep*







Rothera

East Antarctica

West Antarctica

DDU





# MODUSS aims and Objectives

- **First marine biogeochemical dataset in the coastal environment of Adelie Land (East Antarctica)**
- **High frequency data**
- **Investigate the dynamic of dSi and diatoms at DDU during austral summer**
- **Examine the winter water column**
- **Avoiding discontinuity in time series studies**

# MODUSS



## Why *in-situ* sensor deployment?

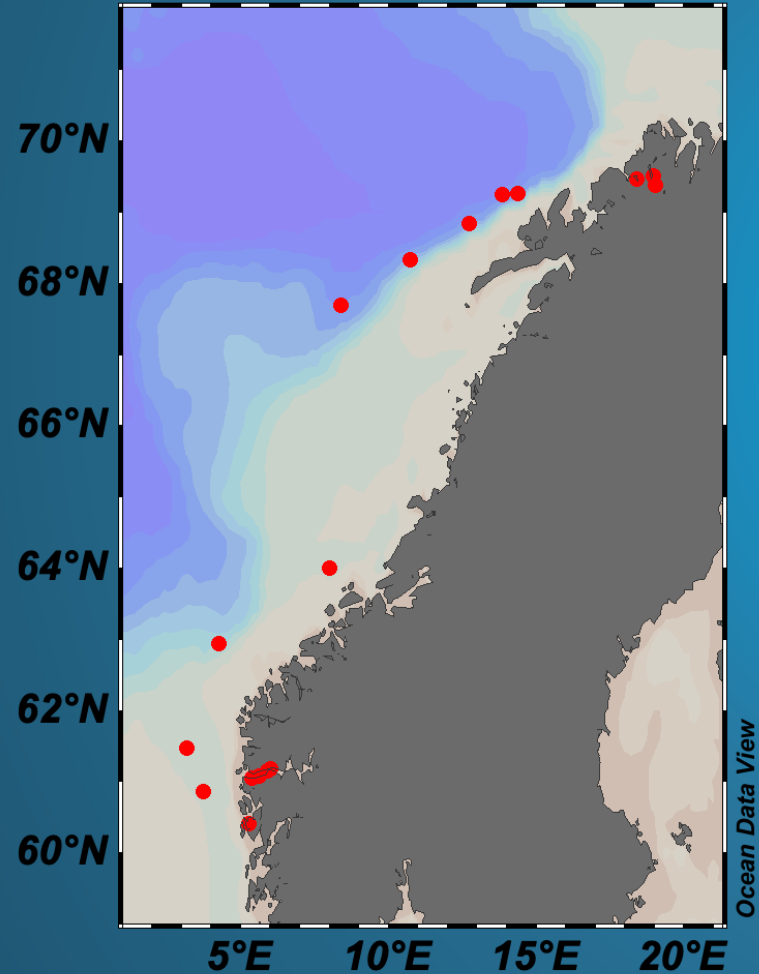
- Accessibility to difficult zone (e.g. under-ice)
- Reduce volume requirement.
- Time and human constrain for high frequency measurements.
- Reduce environmental perturbation.

**Silicon sensor**

ClearWater company

# MODUSS in Norway and Baffin Bay

DRASTIC June 2023



Baffin Bay Observatory System (BBOS) Jan – April 2024







# THANK YOU FOR YOUR ATTENTION

**B**ienvenue

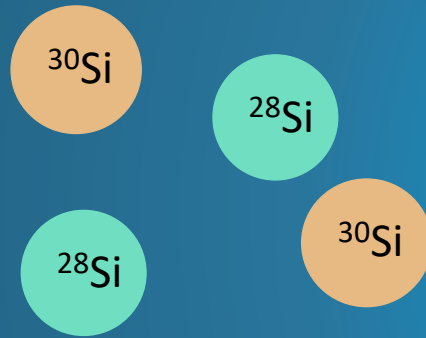


European Research Council  
Established by the European Commission



# $\delta^{30}\text{Si}$ and $\Delta^{30}\text{Si}$ : why do we care?

dSi Pool (i.e Seawater)



[dSi] ↓

$$\delta^{30}\text{Si}_{\text{dSi}} = 1 \quad \nearrow$$

bSi Pool (i.e Diatom, Radiolarian, sponges)



[bSi] ↑

$$\delta^{30}\text{Si}_{\text{bSi}} = 0.33 \quad \searrow$$



Apparent isotopic fractionation

$$\epsilon \sim \Delta^{30}\text{Si} = \delta^{30}\text{Si}_{\text{bSi}} - \delta^{30}\text{Si}_{\text{dSi}}$$