ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Max Planck Institute for Marine Microbiology

# Towards an integrated microbial observatory in the Arctic Ocean


Eddie Fadeev (efadeev@awi.de)

*HGF MPG Joint Research Group for Deep-Sea Ecology and Technology, Alfred-Wegener-Institute Helmholtz-Centre for Polar and Marine Research and Max-Planck-Institute for Marine Microbiology*

# Why Arctic Ocean?

- Global climate change causes remarkable changes in the Arctic region
- These changes potentially affect the entire food web and the biogeochemical cycles in the Arctic Ocean

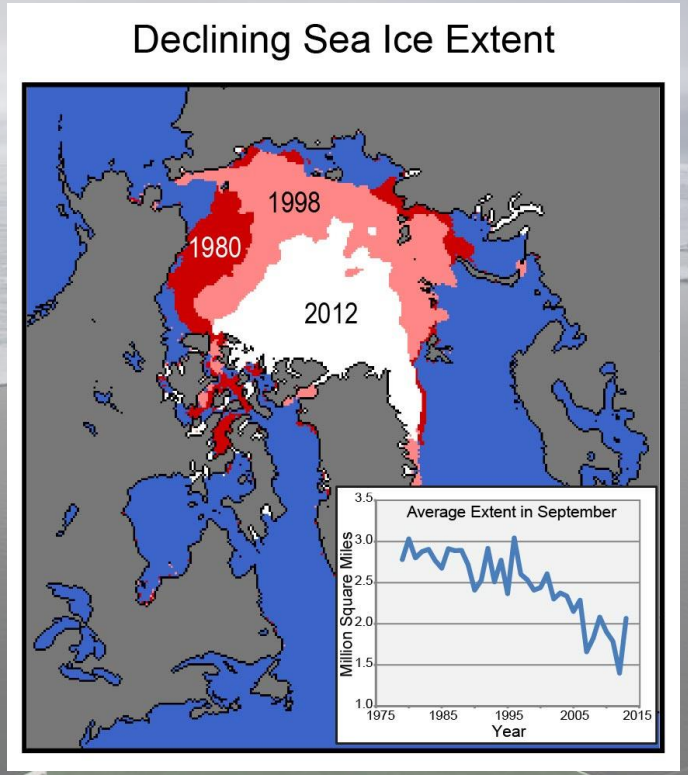



Fig. 1: Sea ice extent change. (Image: GlobalChange.gov)

# Why Arctic Ocean?

- Global climate change causes remarkable changes in the Arctic region

- These changes potentially affect the entire food web and the biogeochemical cycles in the Arctic Ocean

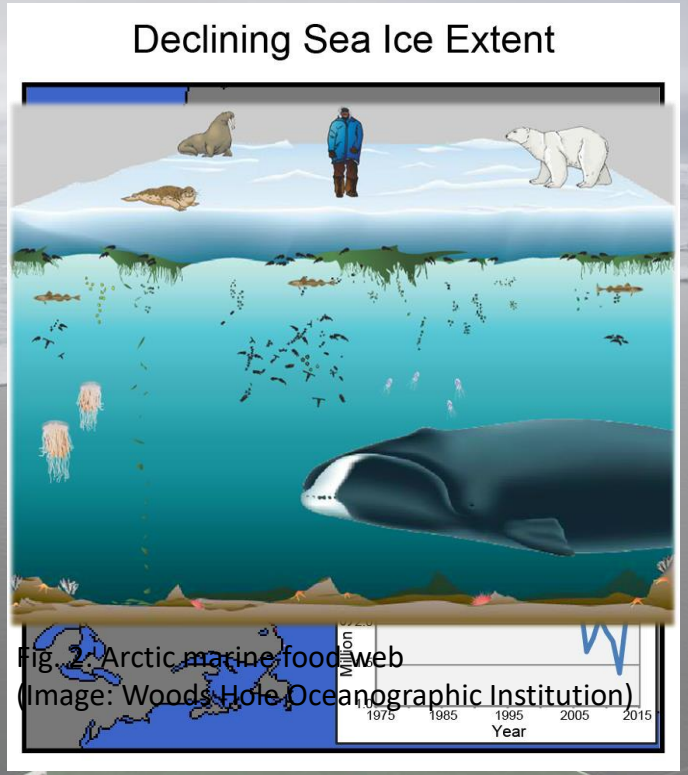



Fig. 2: Arctic marine food web
(Image: Woods Hole Oceanographic Institution)

# Why microbes?

- The majority of the primary production in the Arctic is conducted by marine microorganisms
- Form the basis of the marine food chain
- Have a major importance in the turnover of nutrients

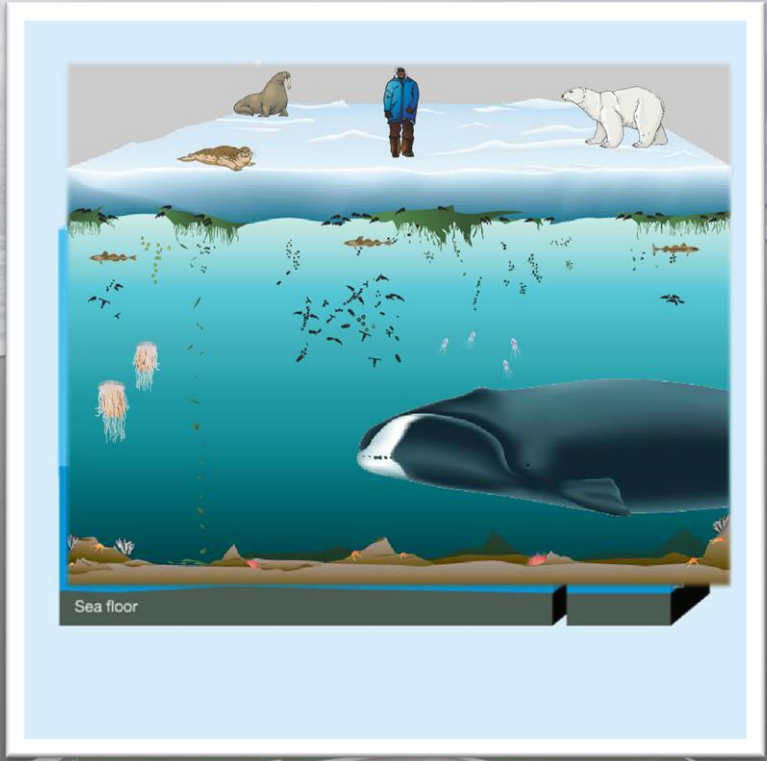



Fig. 3: Carbon cycle in the marine environment. (Image: Chisholm, S.W. *et al* 2000)

# Why microbes?

- The majority of the primary production in the Arctic is conducted by marine microorganisms
- Form the basis of the marine food chain
- Have a major importance in the turnover of nutrients

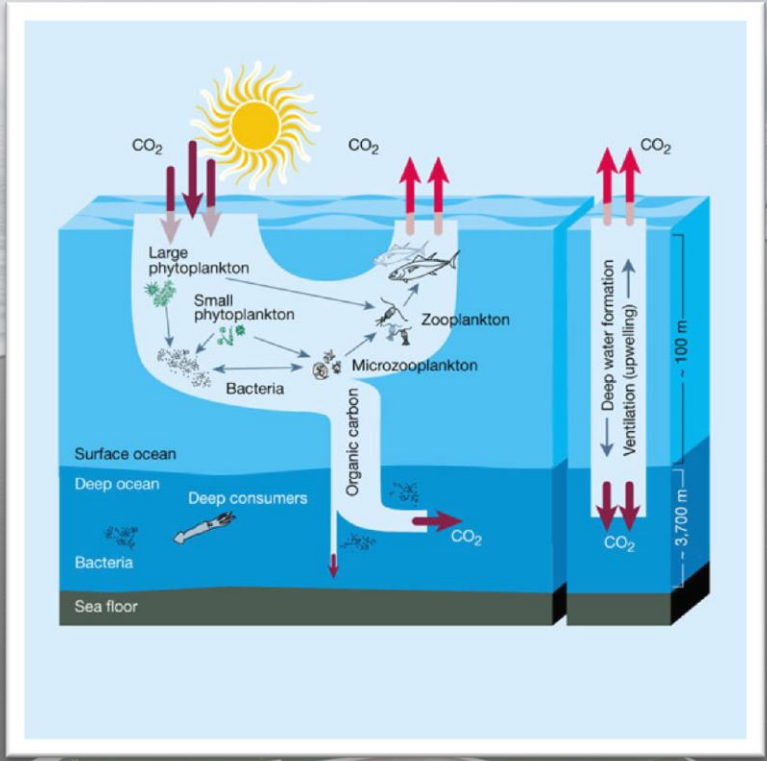



Fig. 3: Carbon cycle in the marine environment. (Image: Chisholm, S.W. *et al* 2000)

# Why microbes?

- The majority of the primary production in the Arctic is conducted by marine microorganisms
- Form the basis of the marine food chain
- Have a major importance in the turnover of nutrients

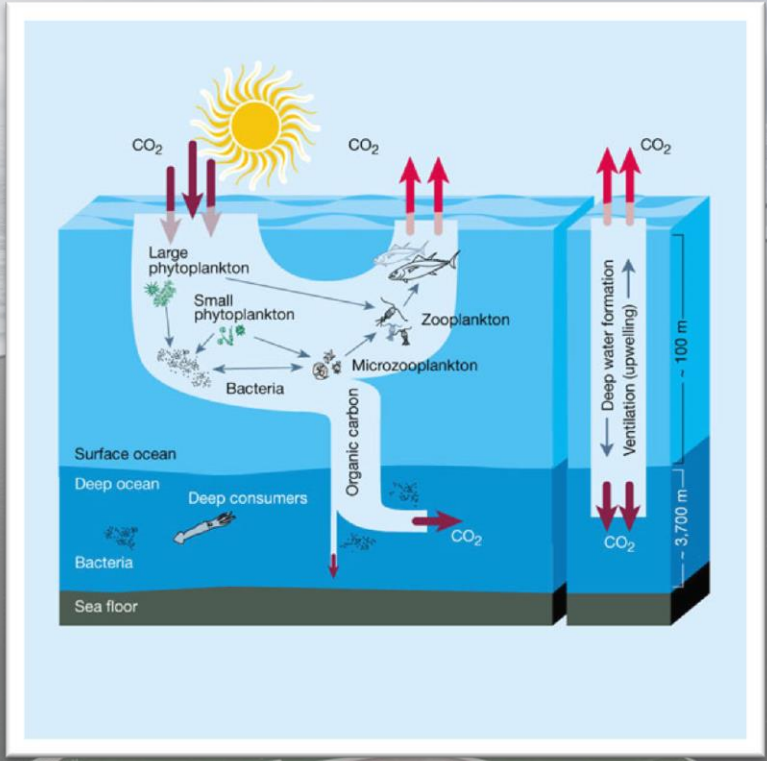



Fig. 3: Carbon cycle in the marine environment. (Image: Chisholm, S.W. *et al* 2000)

# “Atlantification”

- Polar water characteristics change towards North Atlantic ones

- To understand the impact on the marine ecosystem, the research focused in the “Fram Strait”

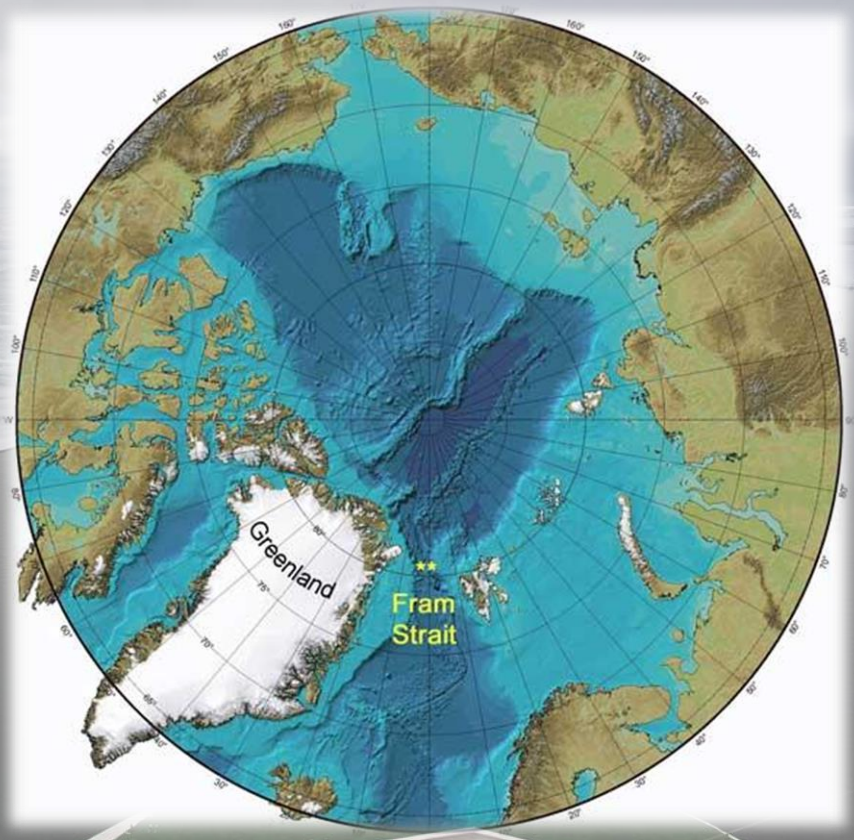



Fig. 4: Fram Strait is wedged between Greenland and the Norwegian archipelago of Svalbard(Image: NOAA)

# “Atlantification”

- Polar water characteristics change towards North Atlantic ones

- To understand the impact on the marine ecosystem, the research focused in the “Fram Strait”

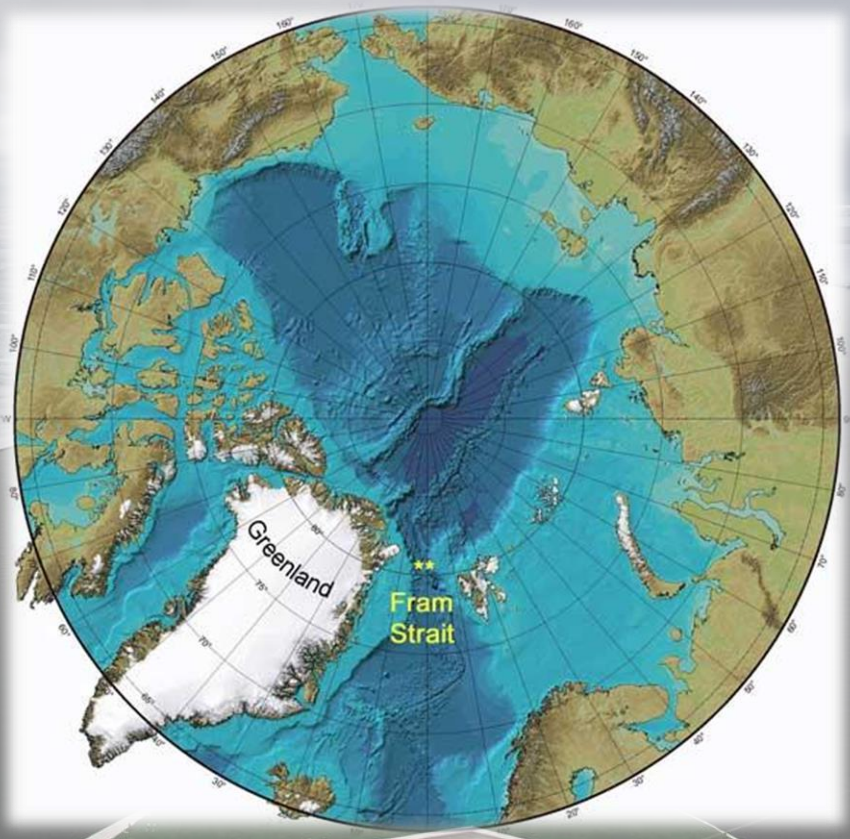



Fig. 4: Fram Strait is wedged between Greenland and the Norwegian archipelago of Svalbard(Image: NOAA)

# Fram Strait

- The main Atlantic-Arctic interaction zone

- Exchanges water masses between north Atlantic and the Arctic oceans
- The only gateway of deep waters in the Arctic ocean

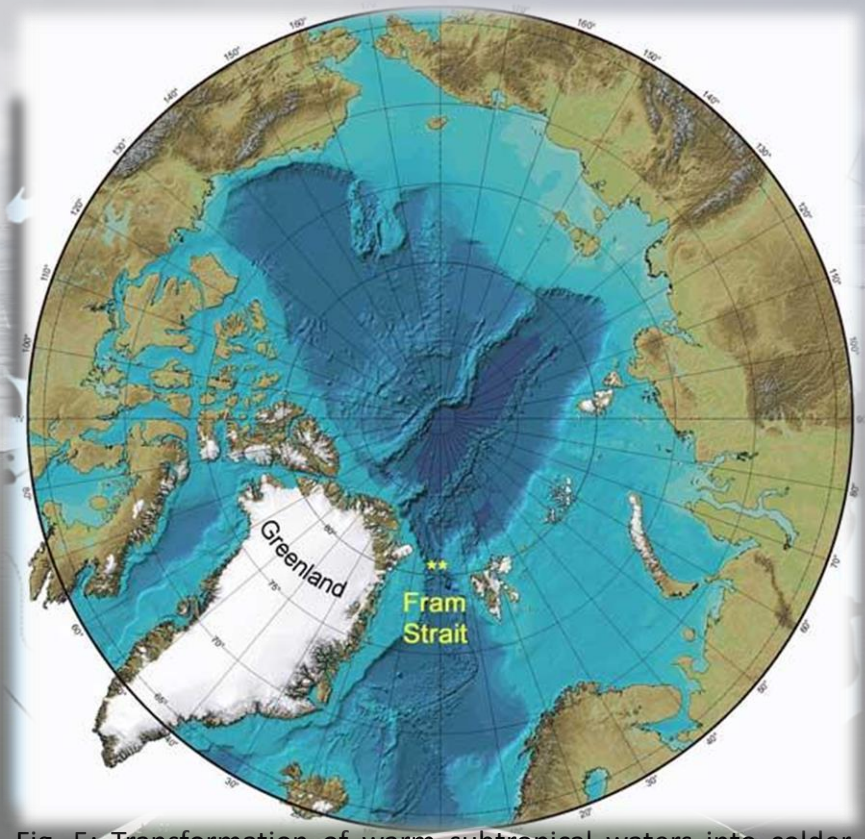



Fig. 5: Transformation of warm subtropical waters into colder subpolar and polar waters in the northern North Atlantic. (Image: Cherkasheva, A. *et al* 2014)

# Fram Strait

- The main Atlantic-Arctic interaction zone
- Exchanges water masses between north Atlantic and the Arctic oceans
- The only gateway of deep waters in the Arctic ocean


Fig. 5: Transformation of warm subtropical waters into colder subpolar and polar waters in the northern North Atlantic. (Image: Cherkasheva, A. *et al* 2014)

# Fram Strait

- The main Atlantic-Arctic interaction zone
- Exchanges water masses between north Atlantic and the Arctic oceans
- The only gateway of deep waters in the Arctic ocean


Fig. 5: Transformation of warm subtropical waters into colder subpolar and polar waters in the northern North Atlantic. (Image: Cherkasheva, A. *et al* 2014)

# Fram Strait hydrography

- East Greenland current (**EGC**) transports Polar water and sea-ice southwards

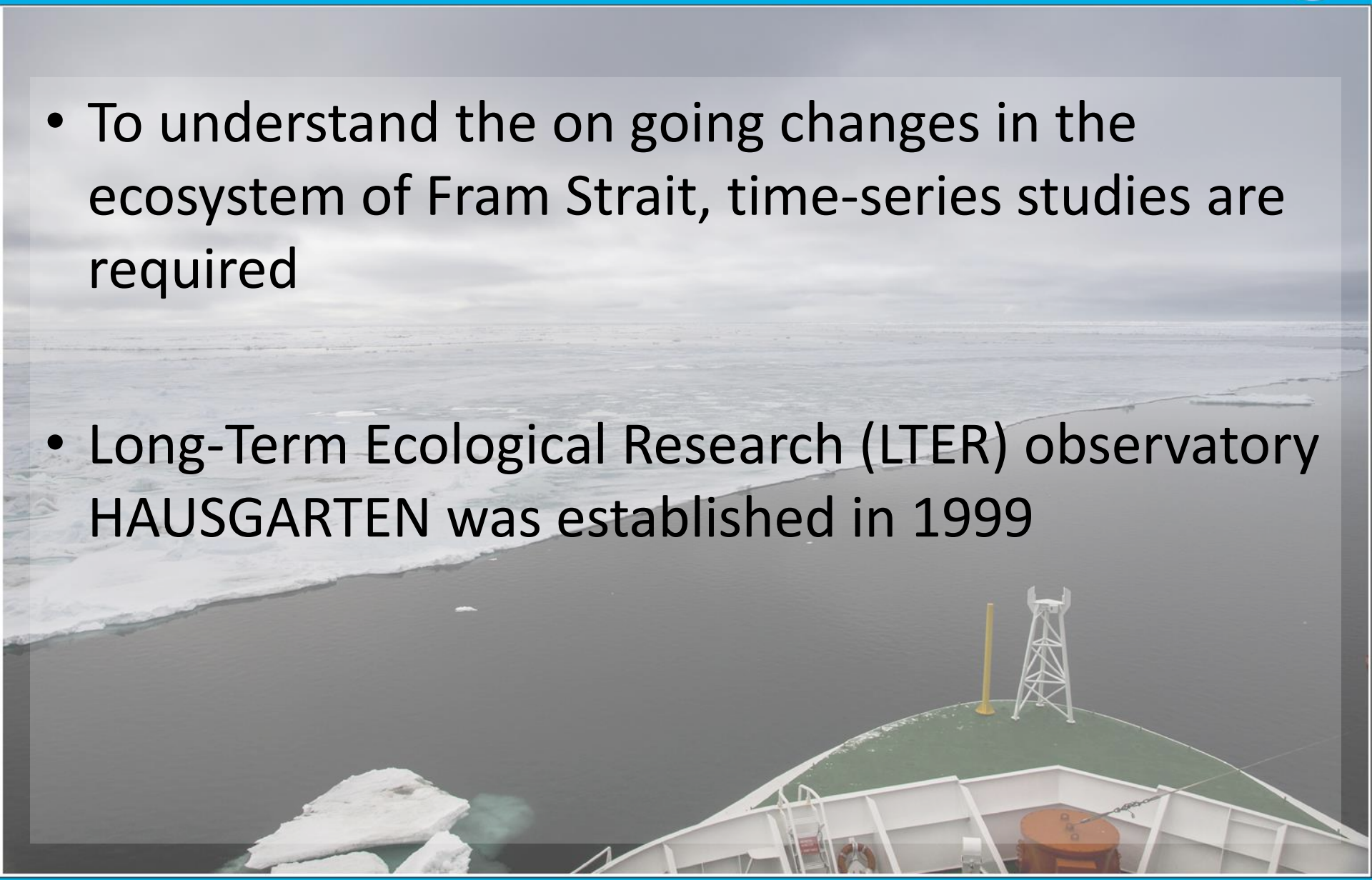
- West Spitzbergen current (**WSC**) transports Atlantic water northwards


Fig. 6: Major current systems in Fram Strait. (Map: Google Earth)

# LTER HASUGARTEN

- To understand the on going changes in the ecosystem of Fram Strait, time-series studies are required

- Long-Term Ecological Research (LTER) observatory HAUSGARTEN was established in 1999



# LTER HASUGARTEN

- Covering all parts of the open-ocean ecosystem
- The sampling is conducted in annual summer expeditions
- Provides infrastructure for interdisciplinary marine research

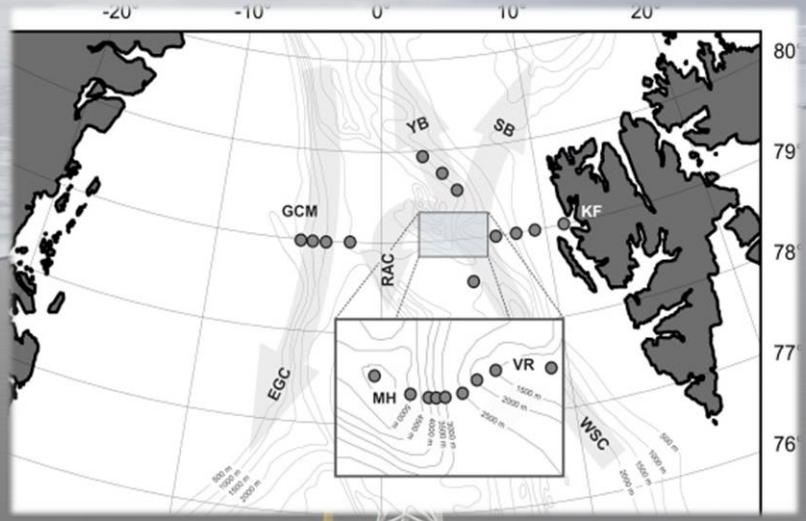



Fig. 7: LTER observatory HAUSGARTEN sampling sites. (Image: Soltwedel, T. *et al* 2015)

# LTER HASUGARTEN

- Covering all parts of the open-ocean ecosystem
- The sampling is conducted in annual summer expeditions
- Provides infrastructure for interdisciplinary marine research

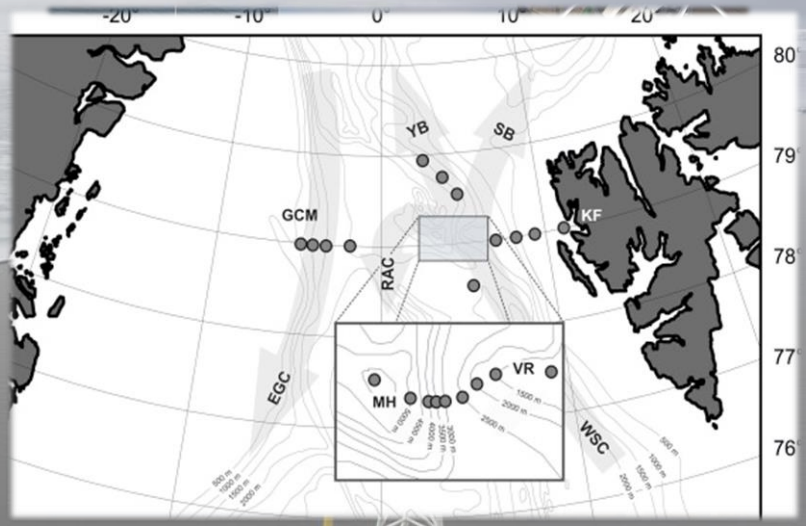



Fig. 8: Technology equipment used for LTER sampling. (Images: Alfred-Wegener-Institute)

# LTER HASUGARTEN

- Covering all parts of the open-ocean ecosystem
- The sampling is conducted in annual summer expeditions
- Provides infrastructure for interdisciplinary marine research

Fig. 8: Technology equipment used for LTER sampling. (Images: Alfred-Wegener-Institute)

# Who is out there?

- Microbial research in the water column has focused mainly on eukaryotes

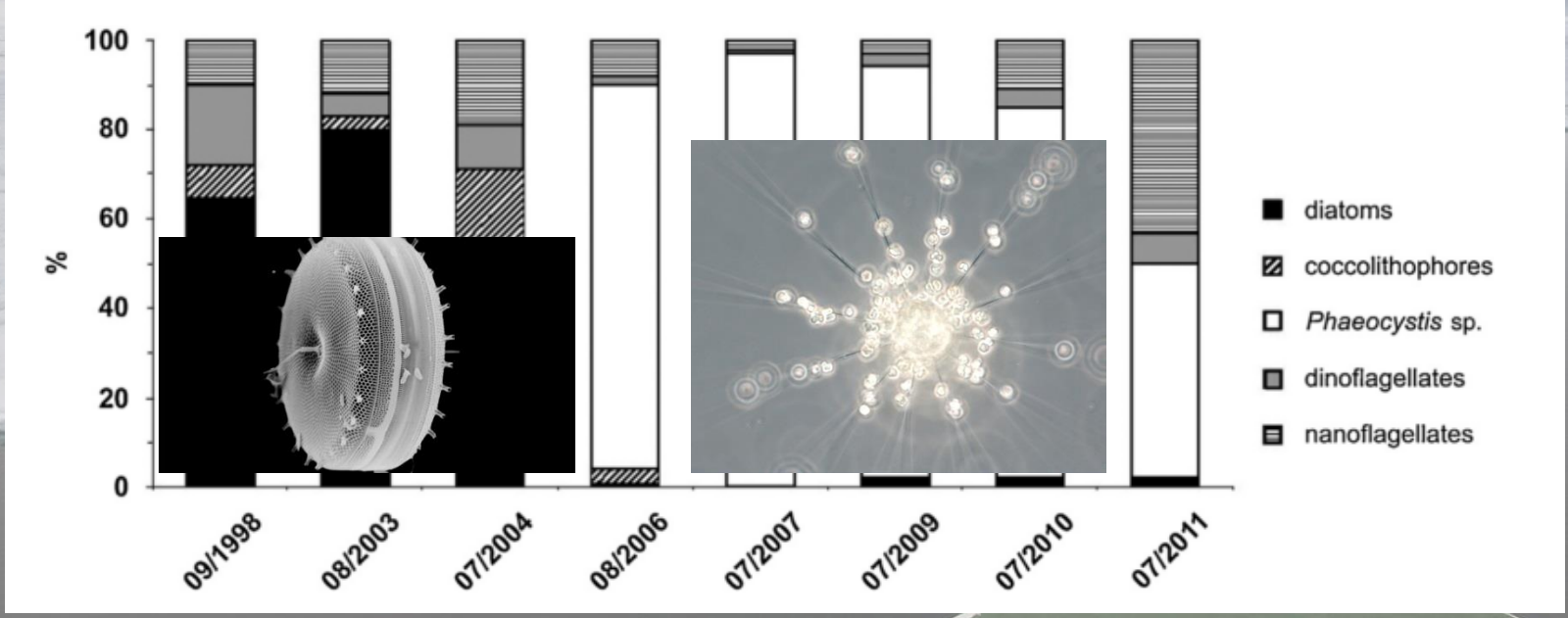



Fig. 9: Composition of unicellular planktonic protists (>3 µm) in the chlorophyll *a* maximum of the water column at the central HAUSGARTEN site for eight years from 1998 to 2011.
(Image: Soltwedel, T. *et al* 2015)

# Who is out there?

- Microbial research in the water column has focused mainly on eukaryotes

- During cruise of summer 2016, a first complete top-bottom survey on pelagic Bacteria and Archae[illegible] w[illegible] conducted

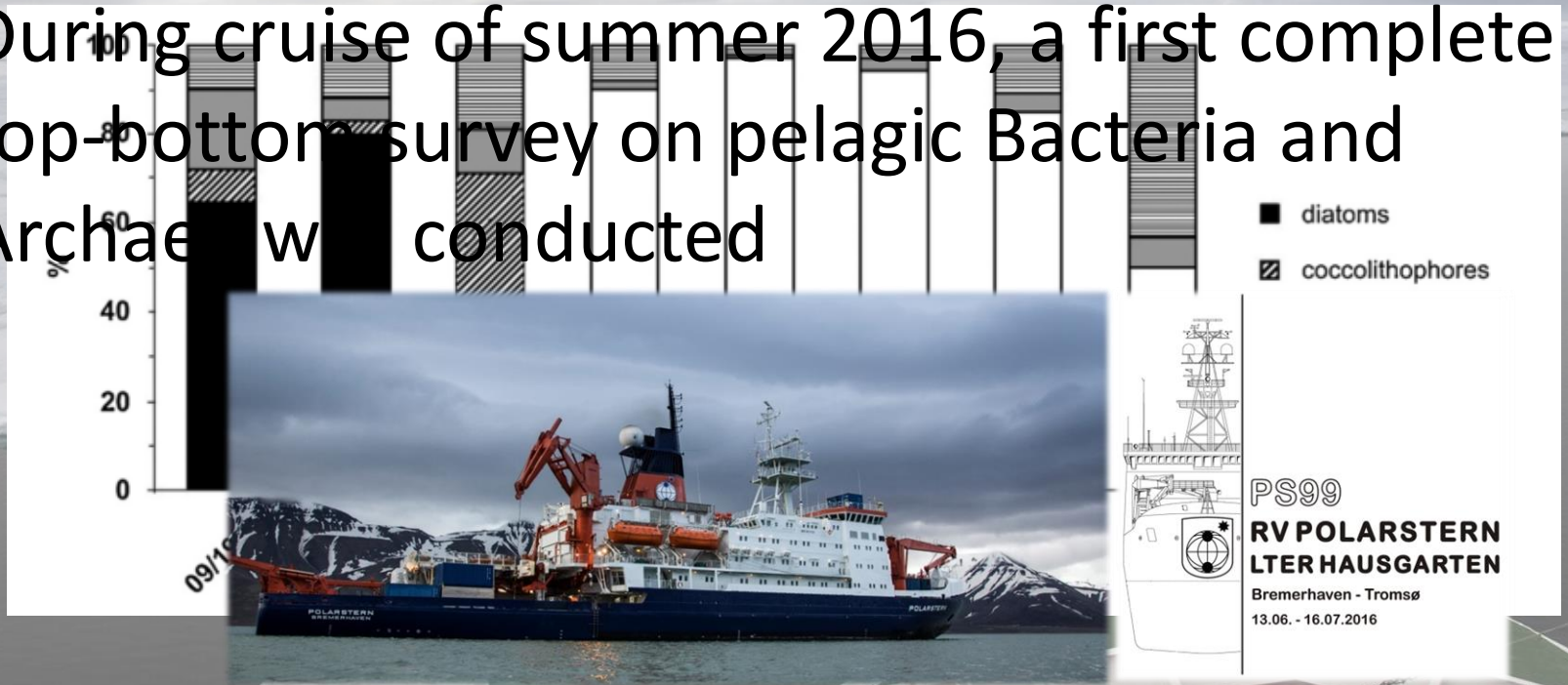



Fig. 10: RV "Polarstern" and PS99 expedition logo.

# Biological sampling

- Water samples were collected from 4 depths :

I. Deep chlorophyll maximum (~25 m)
II. Pycnocline depth (100 m)
III. Mesopelagic zone (1000 m)
IV. Bottom depth (<5500 m)

Fig. 11: Water sampling using Niskin bottles rosette.

# Biological sampling

- Water samples were collected from 4 depths :

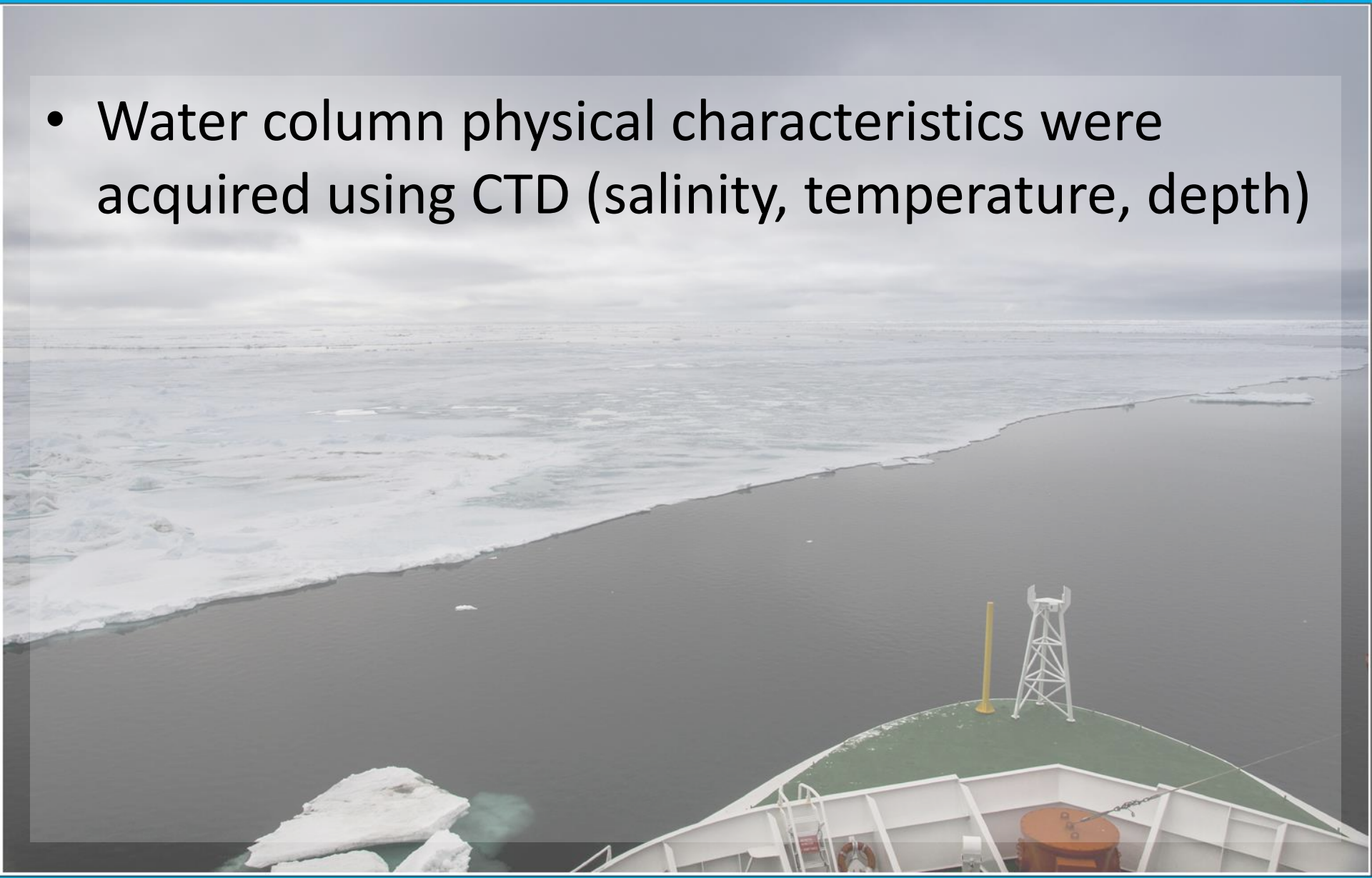
  I. Deep chlorophyll maximum (~25 m)
  II. Pycnocline depth (100 m)
  III. Mesopelagic zone (1000 m)
  IV. Bottom depth (<5500 m)

Fig. 12: On board filtration using peristaltic pumps.

- The samples were sequentially filtered through 5 and 0.22 µm membranes

# Water column conditions

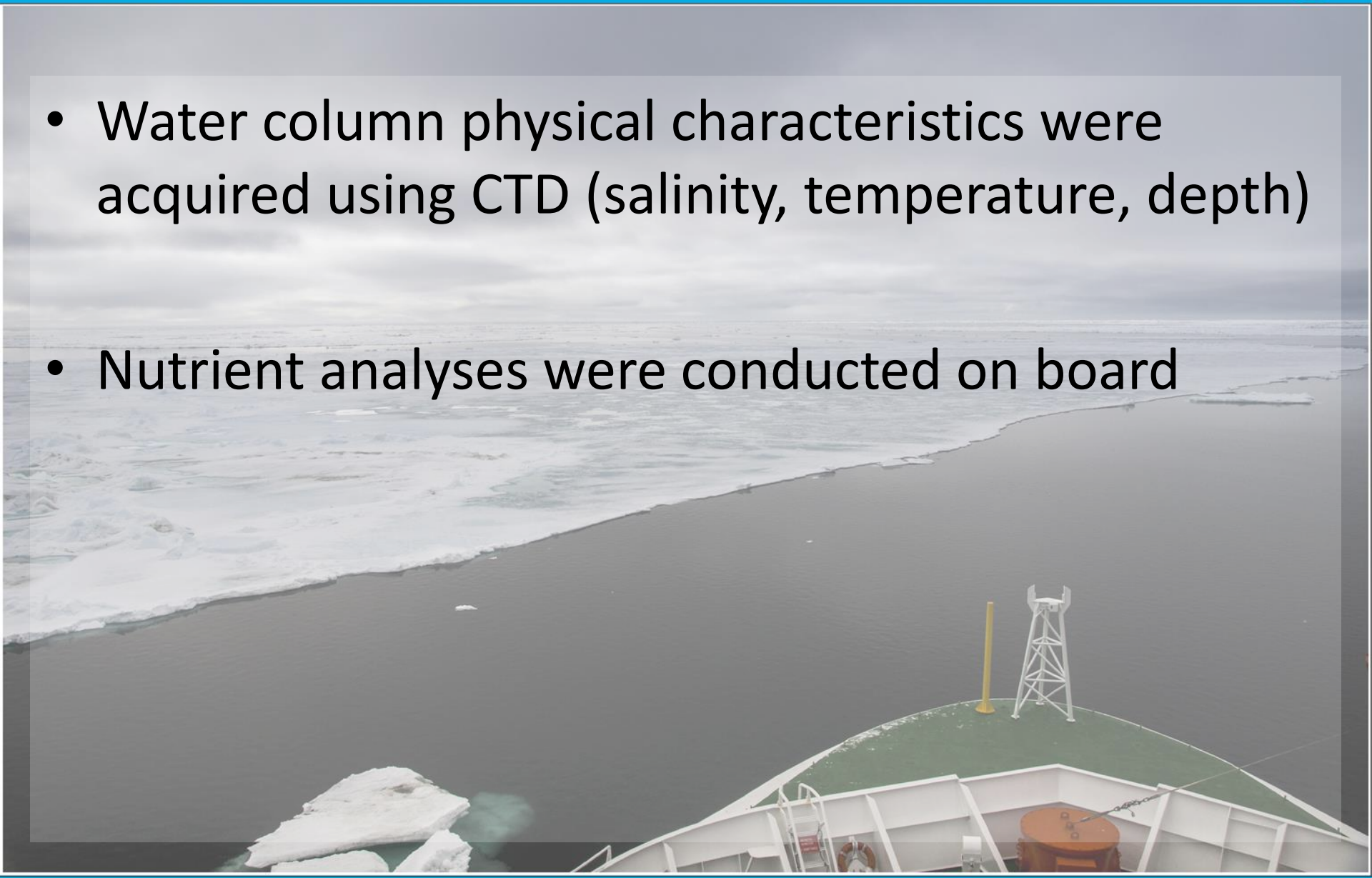
- Water column physical characteristics were acquired using CTD (salinity, temperature, depth)



# Water column conditions

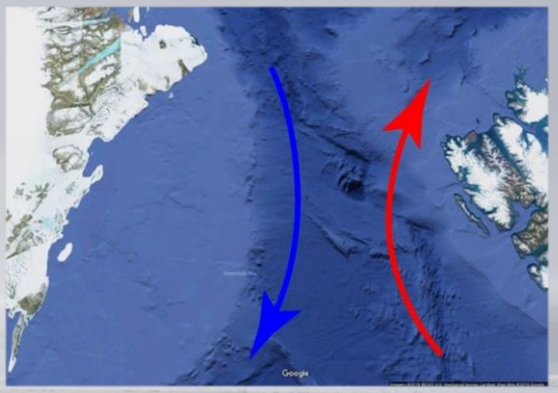
- Water column physical characteristics were acquired using CTD (salinity, temperature, depth)

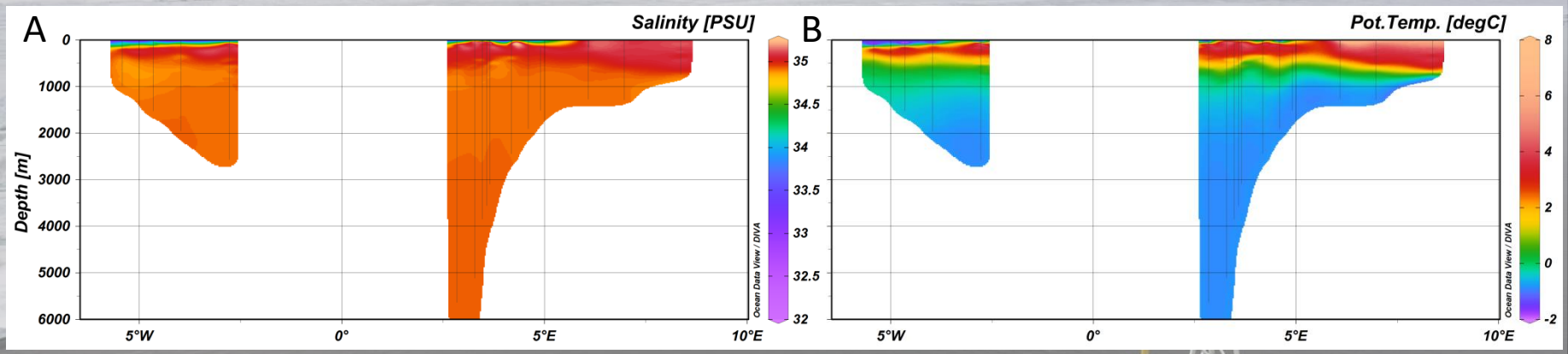
- Nutrient analyses were conducted on board



# Physical characteristics

- **EGC** consists of low temperature, low salinity, Arctic water in upper layers
- **WSC** consists of relatively high temperature Atlantic water





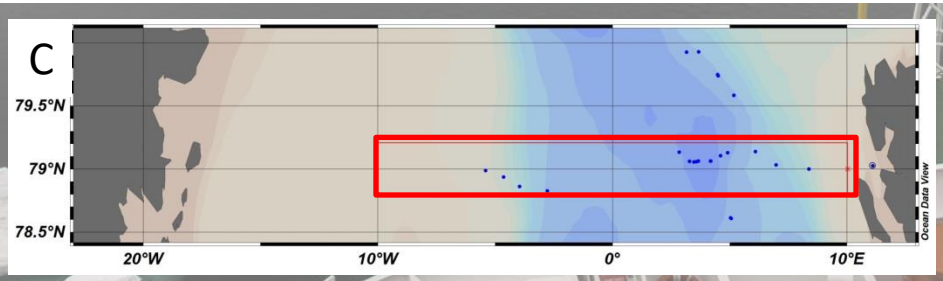
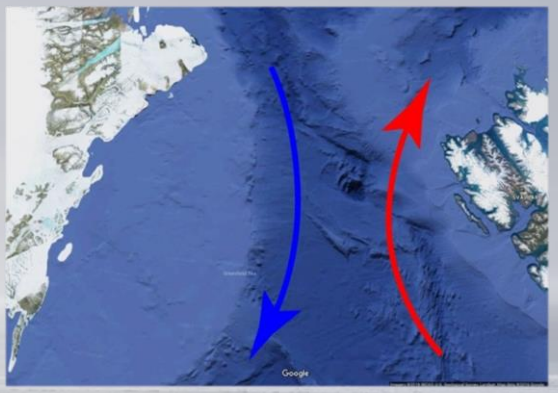
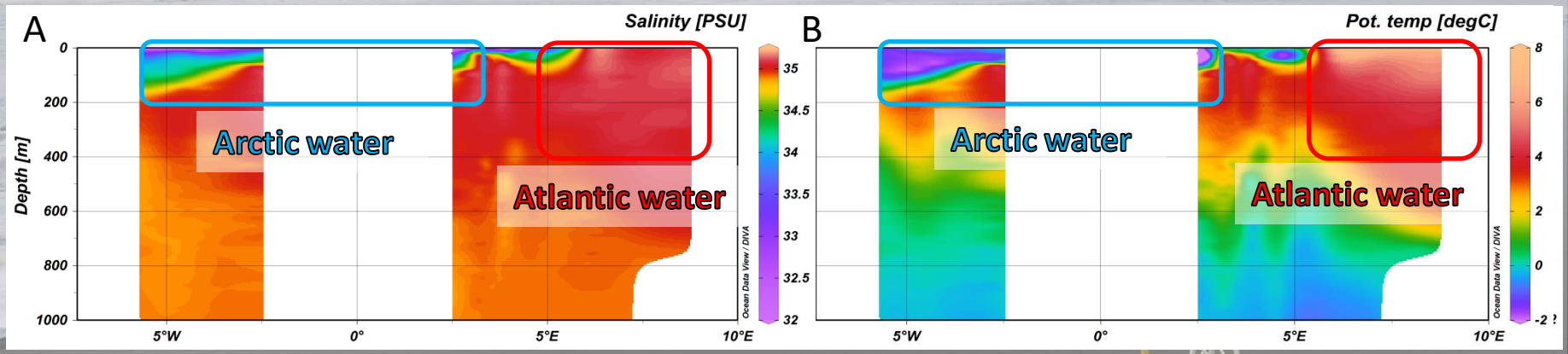




Fig. 13: Water column physical characteristics (A,B) along the East-West transect stations (C).

# Physical characteristics

- **EGC** consists of low temperature, low salinity, Arctic water in upper layers
- **WSC** consists of relatively high temperature Atlantic water





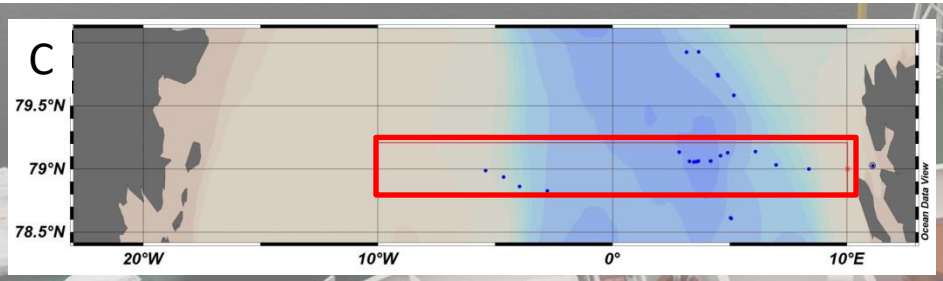
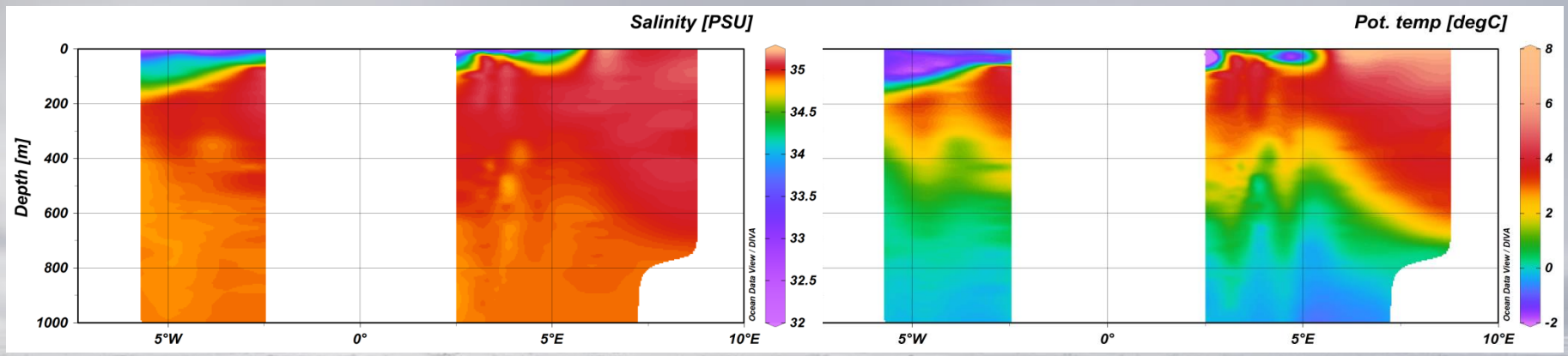
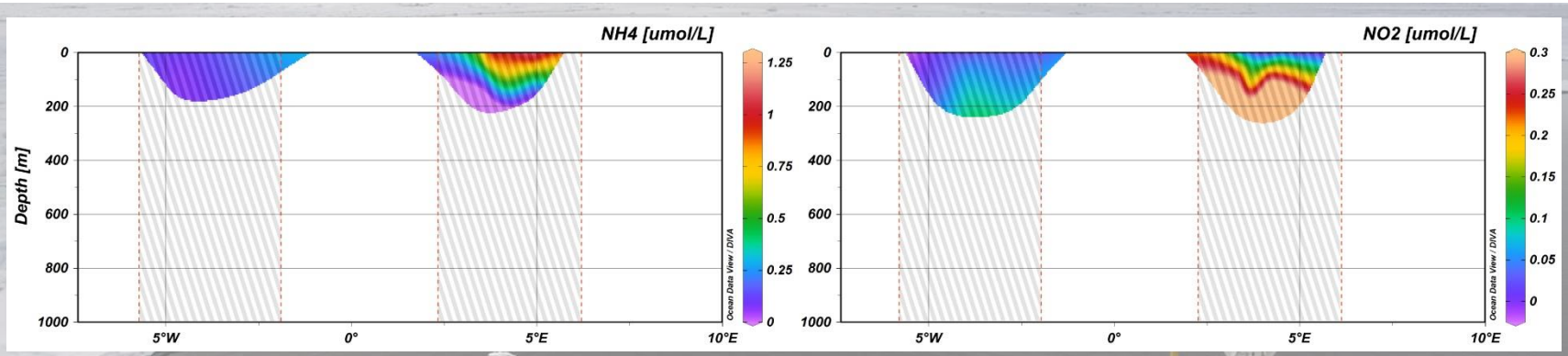




Fig. 14: Top 1000m water column physical characteristics (A,B) along the East-West transect stations (C).

# Chemical characteristics



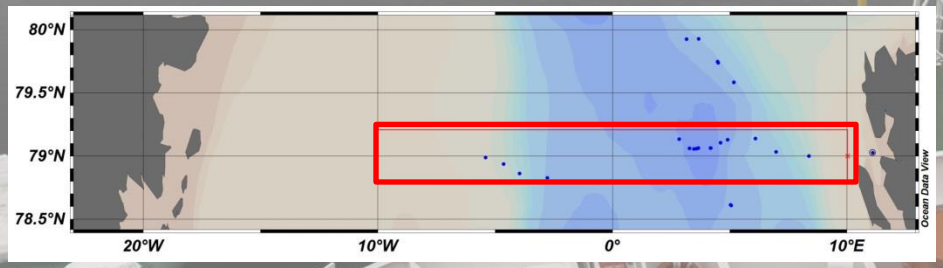
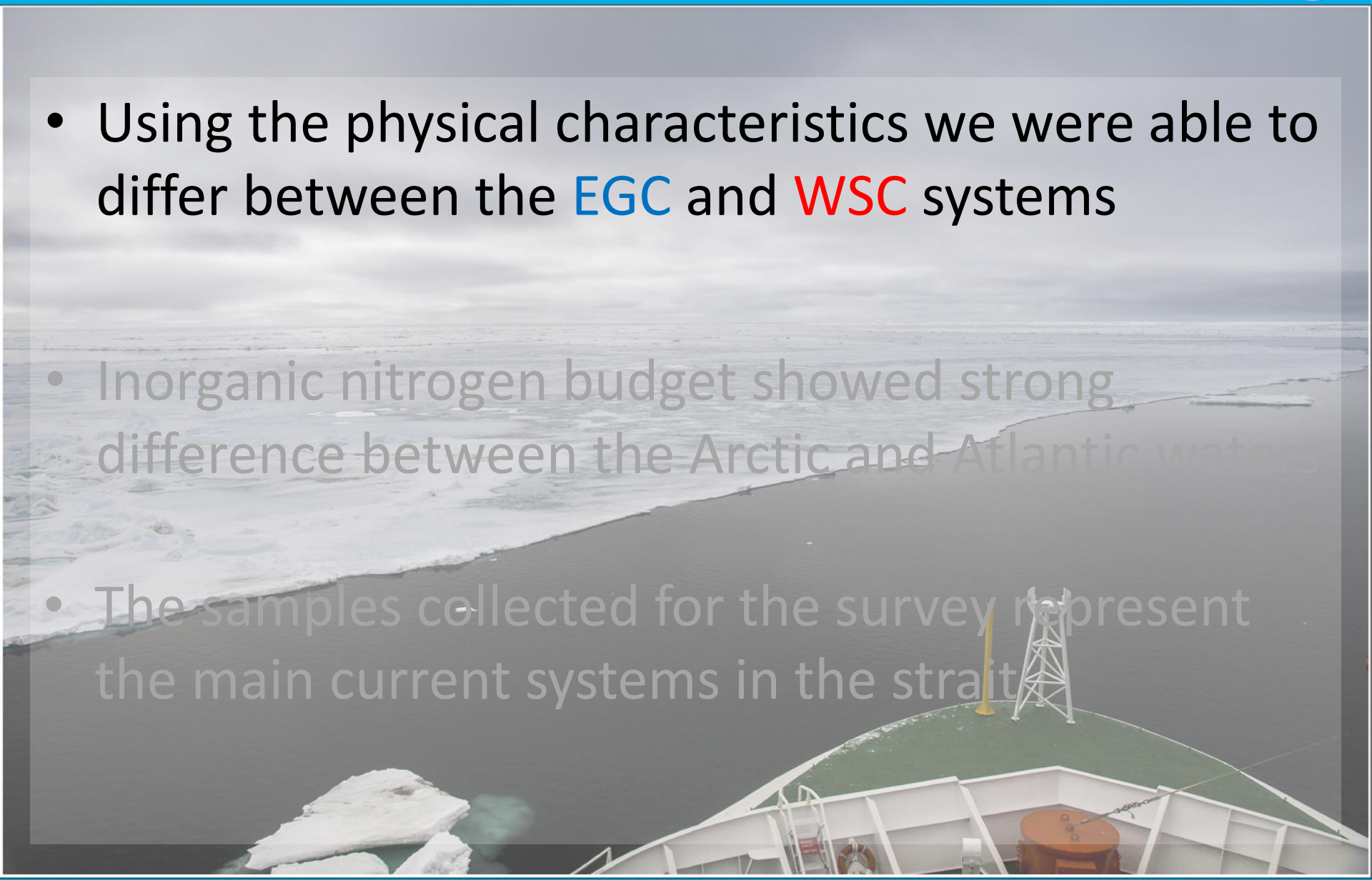




Fig. 15: Inorganic nitrogen measurements along the East-West transect stations .

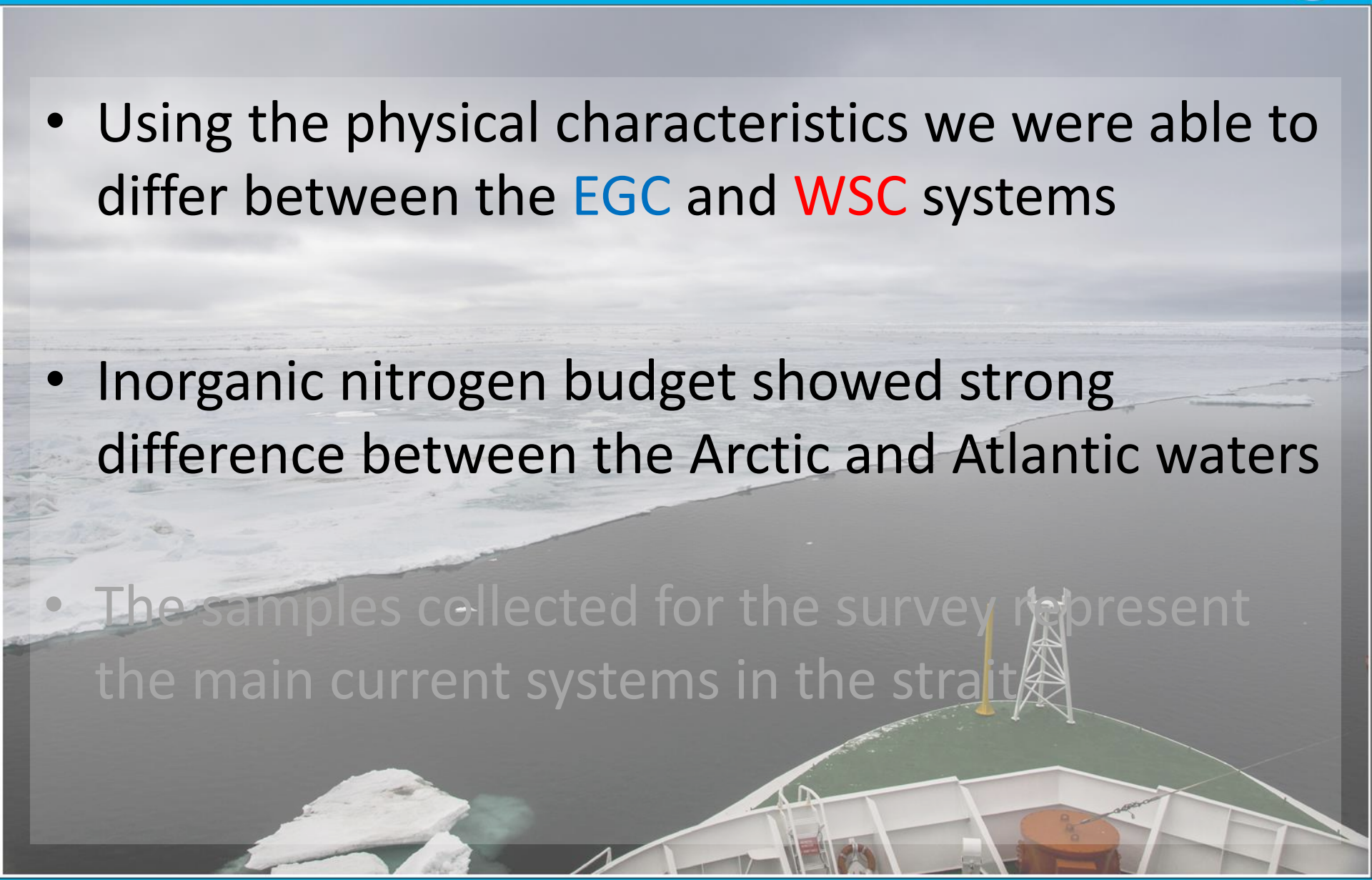
# Conclusions

- Using the physical characteristics we were able to differ between the EGC and WSC systems
- Inorganic nitrogen budget showed strong difference between the Arctic and Atlantic waters
- The samples collected for the survey represent the main current systems in the strait



# Conclusions

- Using the physical characteristics we were able to differ between the EGC and WSC systems
- Inorganic nitrogen budget showed strong difference between the Arctic and Atlantic waters
- The samples collected for the survey represent the main current systems in the strait

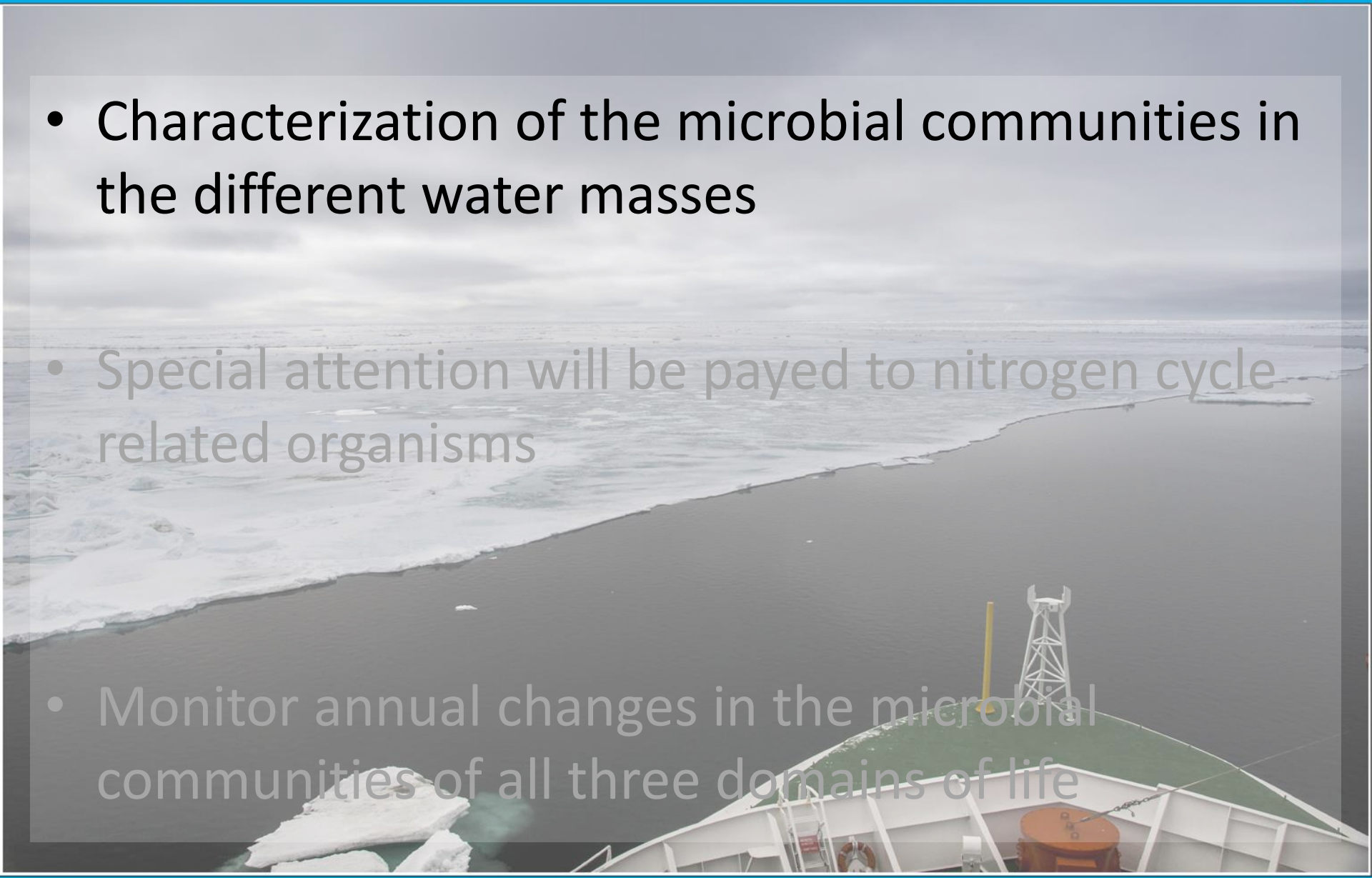


# Conclusions

- Using the physical characteristics we were able to differ between the EGC and WSC systems
- Inorganic nitrogen budget showed strong difference between the Arctic and Atlantic waters
- The samples collected for the survey represent the main current systems in the strait

# Further work plan

- Characterization of the microbial communities in the different water masses
- Special attention will be payed to nitrogen cycle related organisms
- Monitor annual changes in the microbial communities of all three domains of life



# Further work plan

- Characterization of the microbial communities in the different water masses
- Special attention will be payed to nitrogen cycle related organisms
- Monitor annual changes in the microbial communities of all three domains of life

# Further work plan

- Characterization of the microbial communities in the different water masses
- Special attention will be payed to nitrogen cycle related organisms
- Monitor annual changes in the microbial communities of all three domains of life

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Max Planck Institute for Marine Microbiology

## DSET bridge group:

Prof. Dr. Antje Boetius

Dr. Ian Salter

Dr. Christina Bienhold

Dr. Marianne Jacob

Dr. Pierre Offre

Josephine Rapp

## Phytochange group:

Laura Wischnewski

FRAM

erc

European Research Council

Established by the European Commission

# Thank you!