Towards an integrated microbial observatory in the Arctic Ocean

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

Declining Sea Ice Extent

Fig. 2: Arctic marine food web (Image: Woods Hole Oceanographic Institution)
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)
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Fig. 3: Carbon cycle in the marine environment. (Image: Chisholm, S.W. et al 2000)
Why microbes?

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Fig. 3: Carbon cycle in the marine environment. (Image: Chisholm, S.W. et al 2000)
• 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)
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Fig. 4: Fram Strait is wedged between Greenland and the Norwegian archipelago of Svalbard(Image: NOAA)
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)
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Fig. 5: Transformation of warm subtropical waters into colder subpolar and polar waters in the northern North Atlantic. (Image: Cherkasheva, A. et al 2014)
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Fig. 5: Transformation of warm subtropical waters into colder subpolar and polar waters in the northern North Atlantic. (Image: Cherkasheva, A. et al 2014)
• 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)
To understand the ongoing changes in the ecosystem of Fram Strait, time-series studies are required.

Long-Term Ecological Research (LTER) observatory HAUSGARTEN was established in 1999.
- 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)
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Fig. 8: Technology equipment used for LTER sampling. (Images: Alfred-Wegener-Institute)
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Fig. 8: Technology equipment used for LTER sampling. (Images: Alfred-Wegener-Institute)
• 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)
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• During cruise of summer 2016, a first complete top-bottom survey on pelagic Bacteria and Archaea was conducted.

Fig. 10: RV “Polarstern” and PS99 expedition logo.
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)
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• The samples were sequentially filtered through 5 and 0.22 μm membranes
Water column physical characteristics were acquired using CTD (salinity, temperature, depth)
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• Nutrient analyses were conducted on board
• **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

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

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• Characterization of the microbial communities in the different water masses

• Special attention will be paid to nitrogen cycle related organisms

• Monitor annual changes in the microbial communities of all three domains of life
Further work plan

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Thank you!