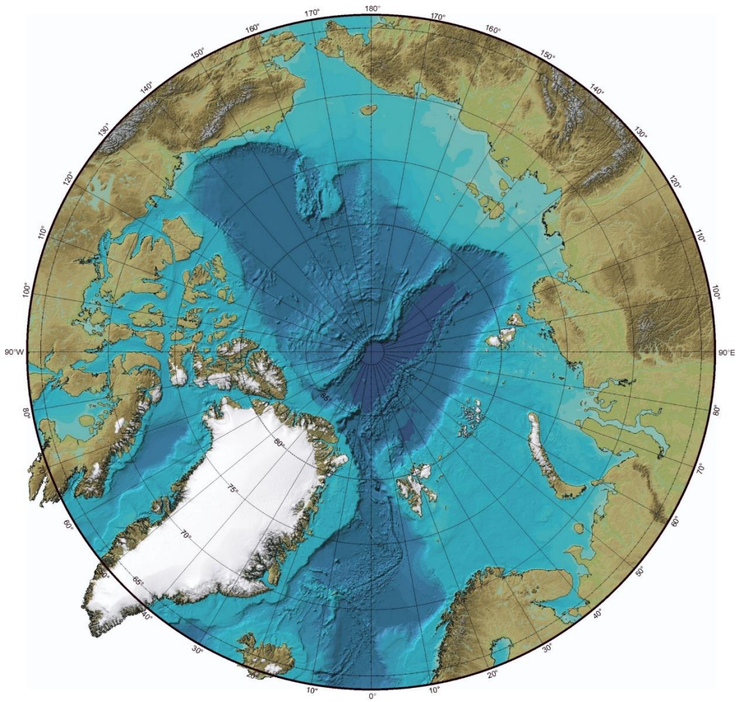
Eukaryotic biodiversity in sub-ice water column across the Marginal Ice Zone of the European Arctic:
A multi-marker eDNA metabarcoding survey

Murray *et al.*, In Press. *Science of the Total Environment*



Map credit: IBCAO (http://www.ibcao.org)

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

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A rapidly changing Arctic

- Arctic warming 4x faster than rest of world

  (Rantanen et al., 2022)

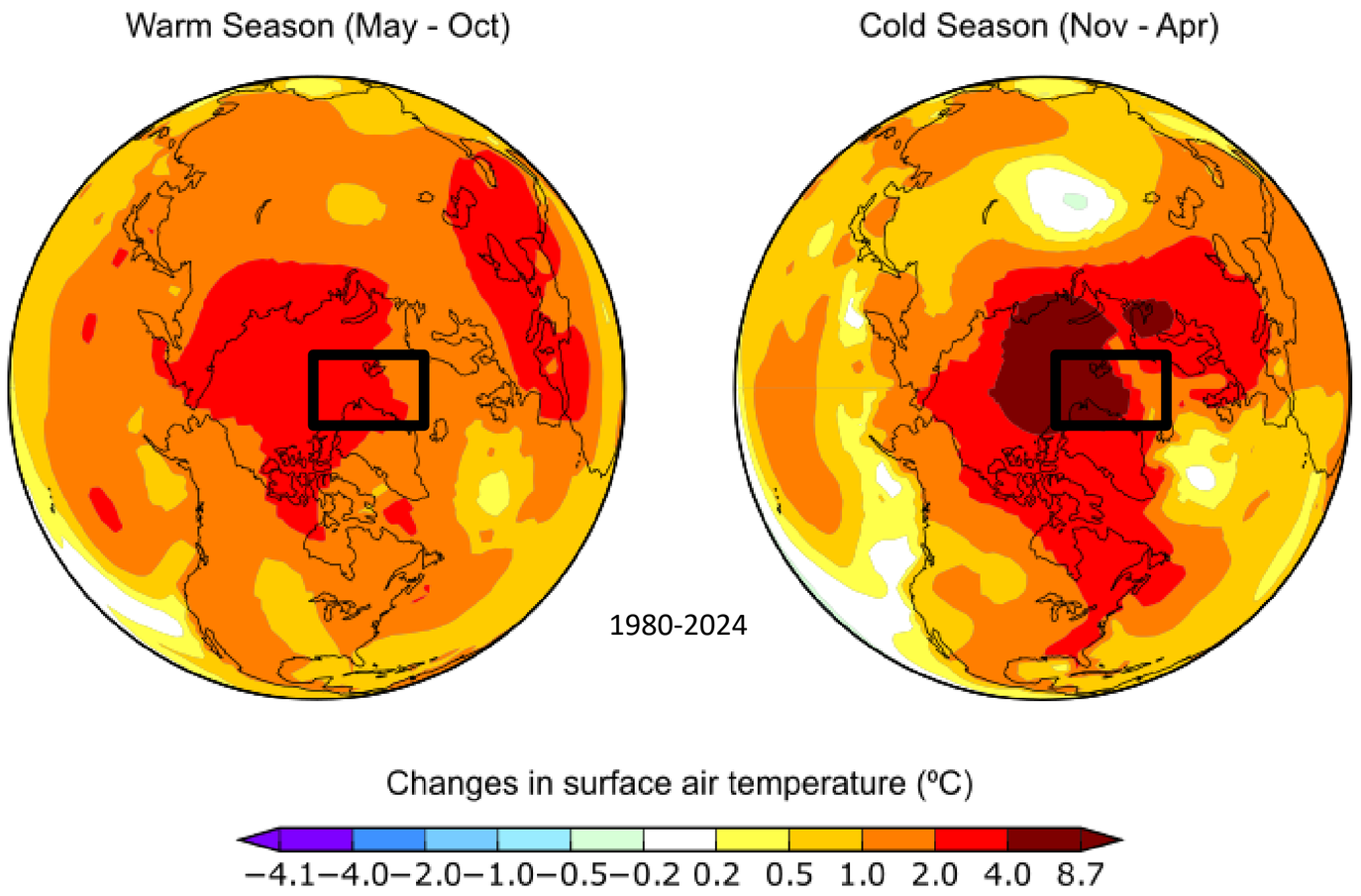
- Winter/cold season → strongest warming

- Decrease in sea ice thickness + extent
  - Ice-free summers by 2050?
  - Ice-dominated → open water system

  (IPCC, 2022)

- Shifting species distributions

  (Basedow et al., 2018; Dalpadado et al., 2016)



Source: NASA GISTEMP http://data.giss.nasa.gov/gistemp/maps/

More baseline biodiversity data needed to track responses to climate change

The Marginal Ice Zone (MIZ)

- Forms at the end of winter
- 15% - 80% sea ice concentration
- 10s-100s of kms in width
- Biological hotspot

    → Primary production + grazing + predation

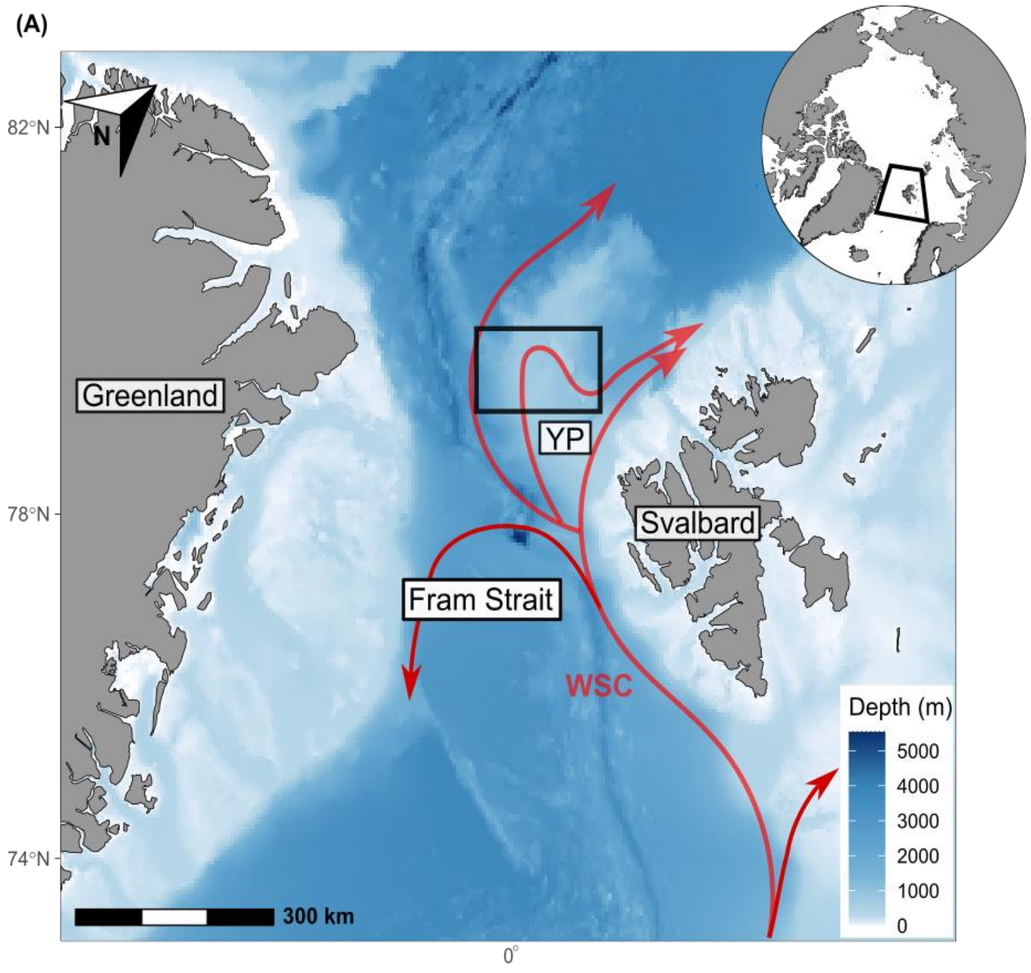
- Highly dynamic conditions
- Under-studied habitat

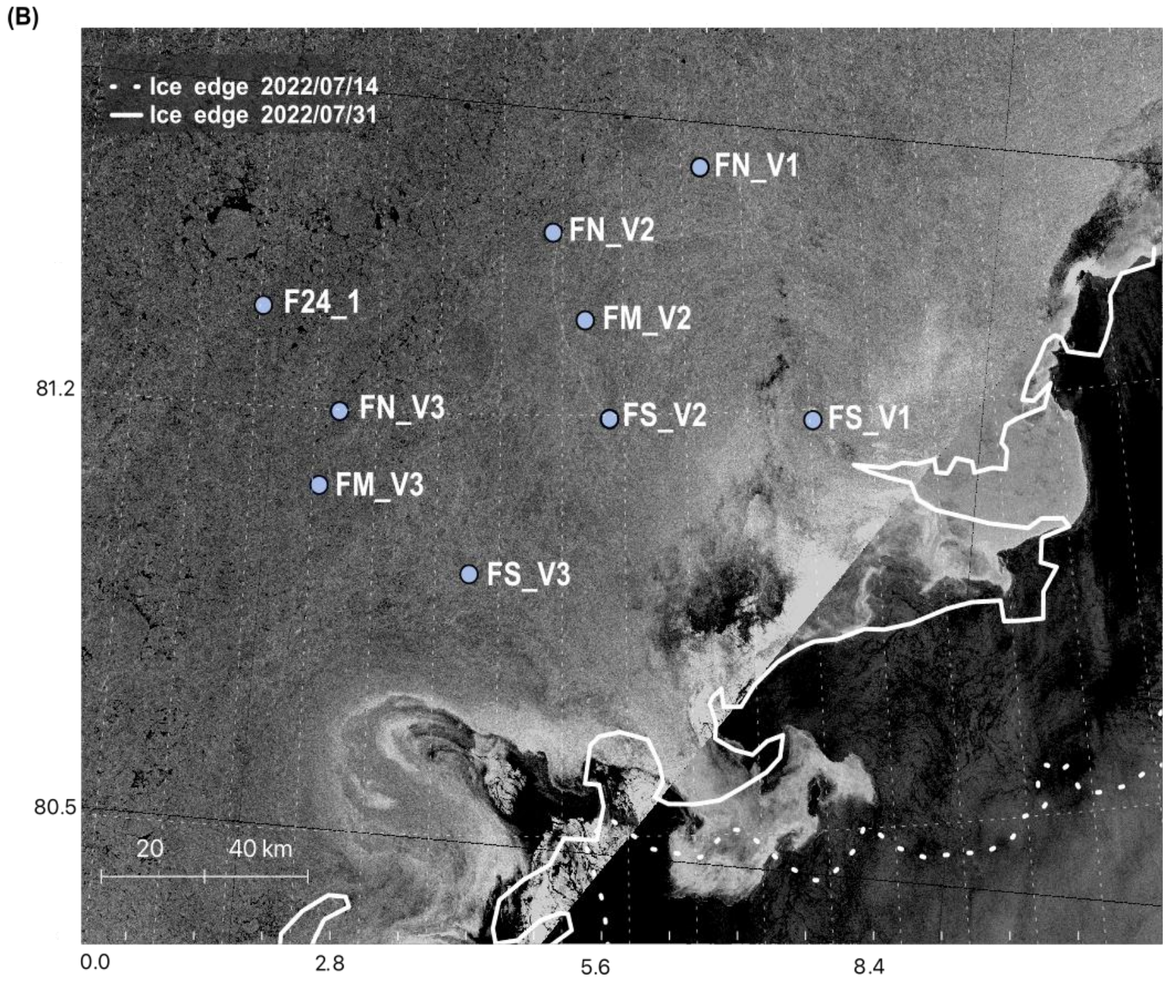
    → Especially directly below sea ice

- Will disappear with other ice habitats

    → Risk losing species before discovery

Sampling Area: Fram Strait





eDNA sampling → sub-ice seawater

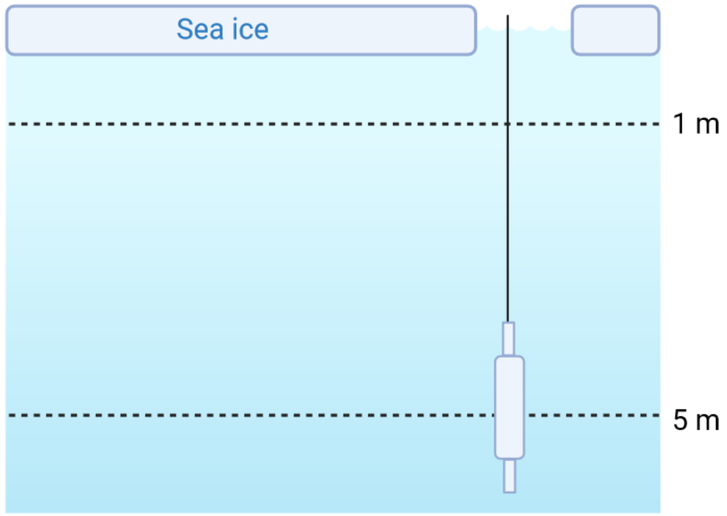


Figure made in Biorender

Depths: 0 m and 5 m

Volume: 6L per depth → 3x 2 L triplicates

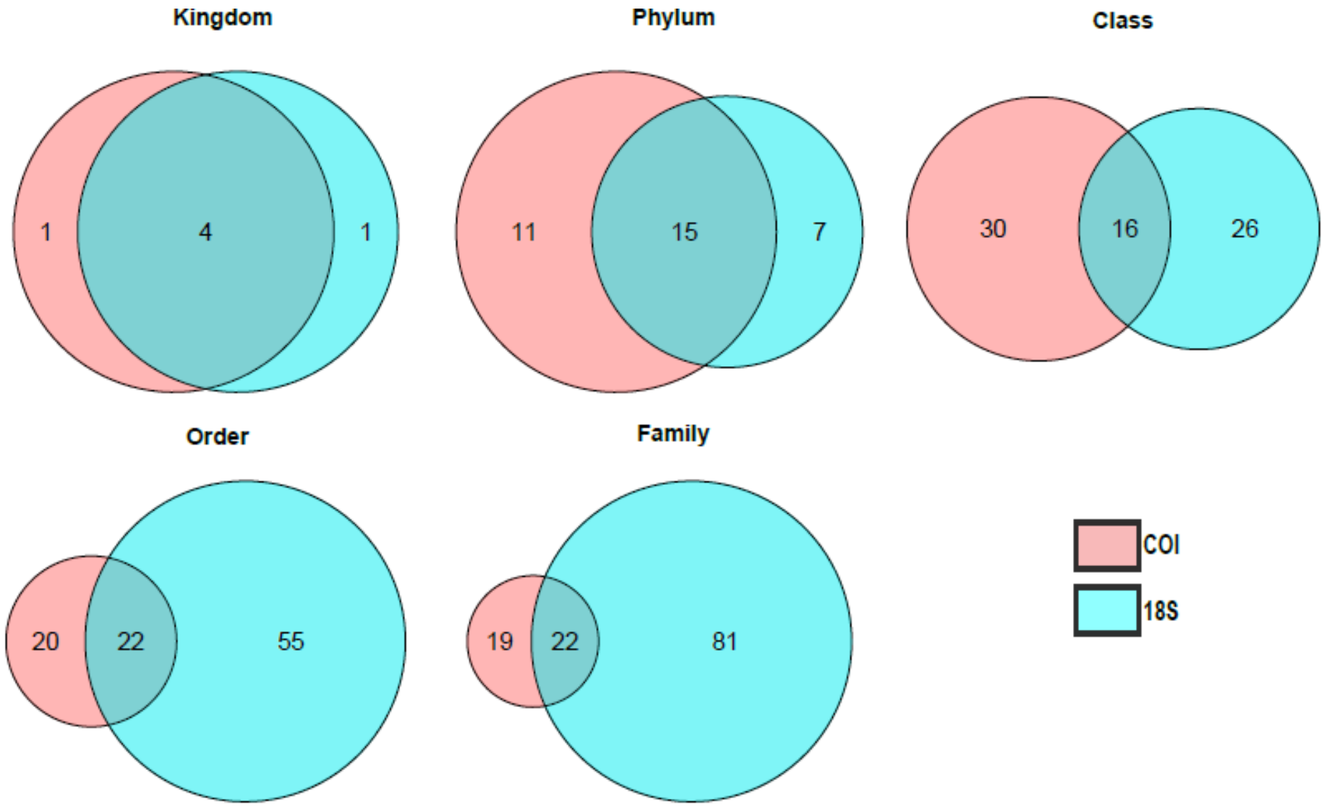
Filtration: Sterivex filters (0.22 uM)

Target markers: COI Leray + 18S V1-V2

Sequencing platform: Illumina Novaseq 6000

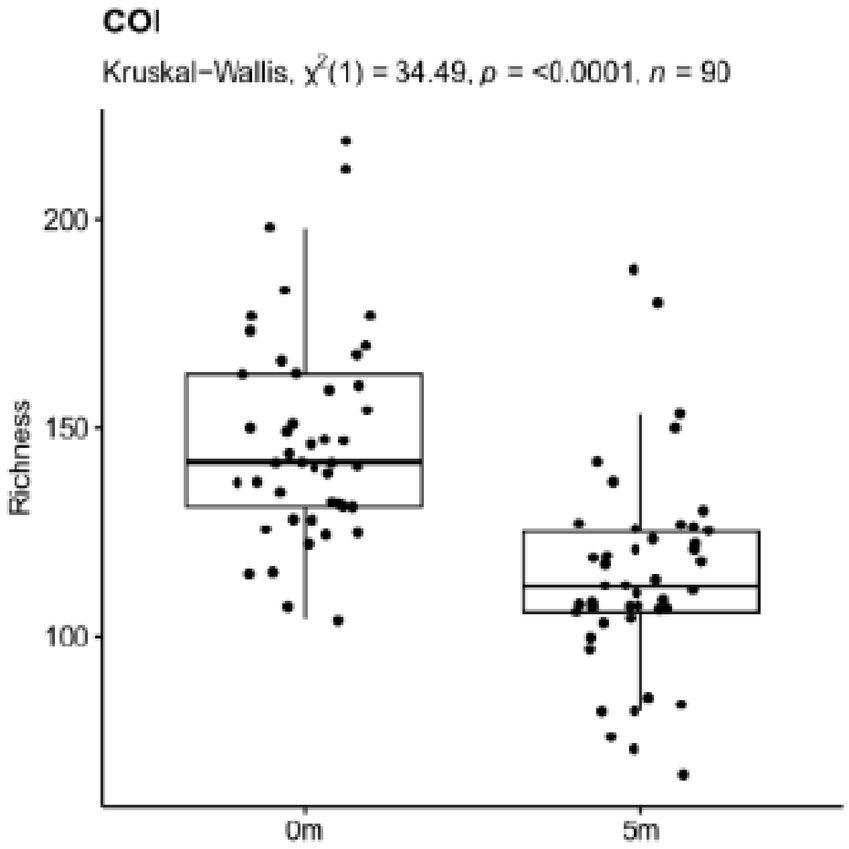
Output: MOTUs (COI) + ASVs (18S)

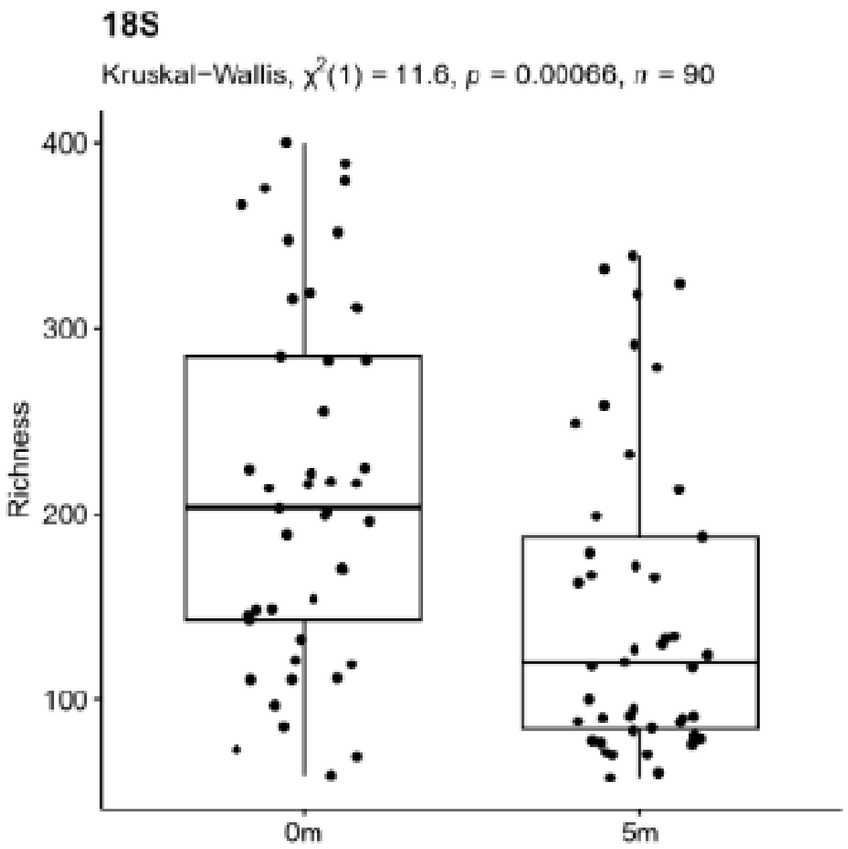
Under-ice eukaryotic biodiversity



- Range of primer producers and metazoans
  → ice-associated and pelagic
- Many unassigned taxa → high levels of ‘hidden’ diversity
- 2 markers = 2 different communities captured!

Spatial patterns of diversity in Marginal Ice Zone (MIZ)

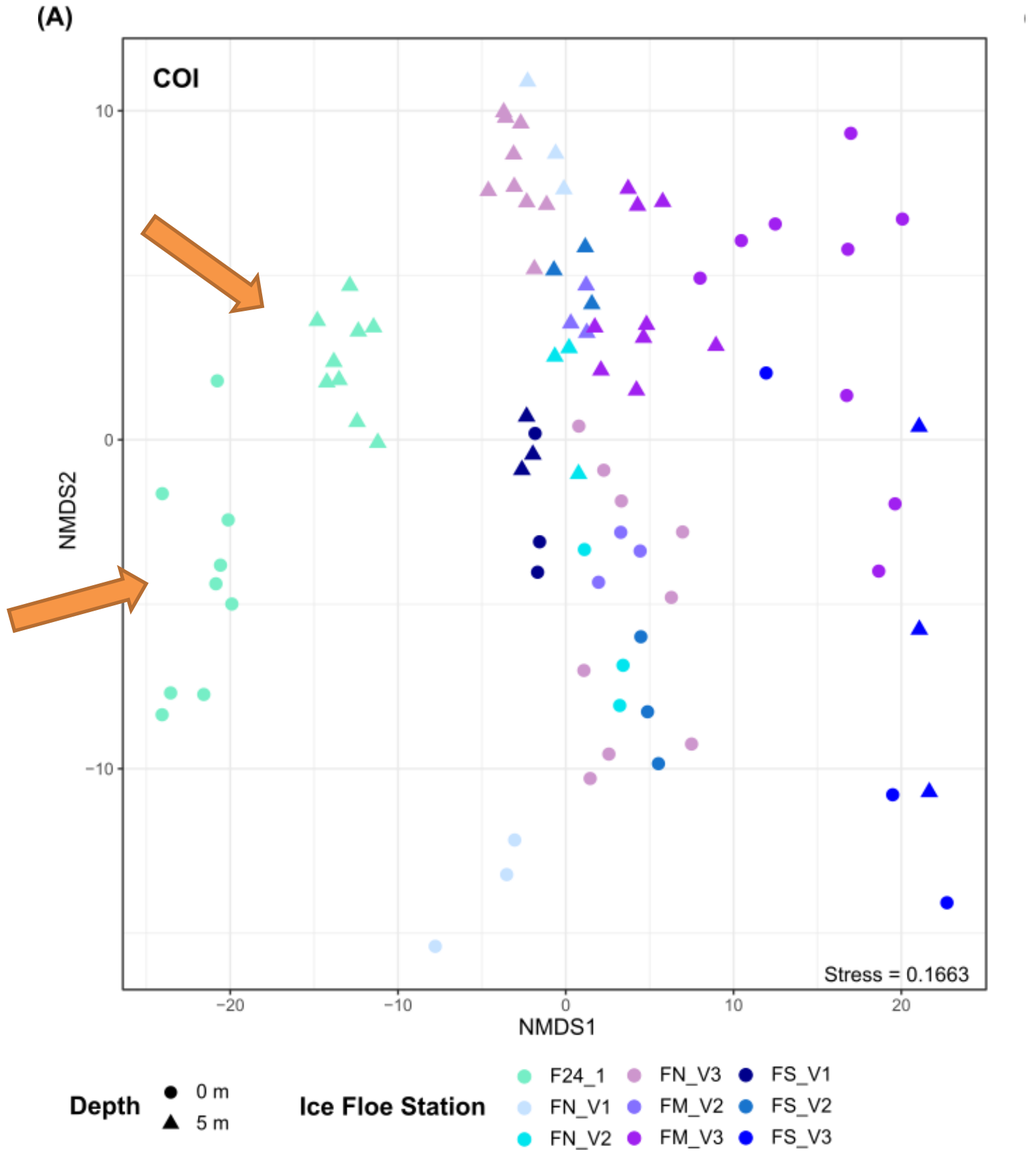




Alpha diversity

- Vertical structuring
  - Higher richness at 0 - 1 m
- Similar patterns in COI and 18S

Spatial patterns of community composition (COI)



Beta diversity

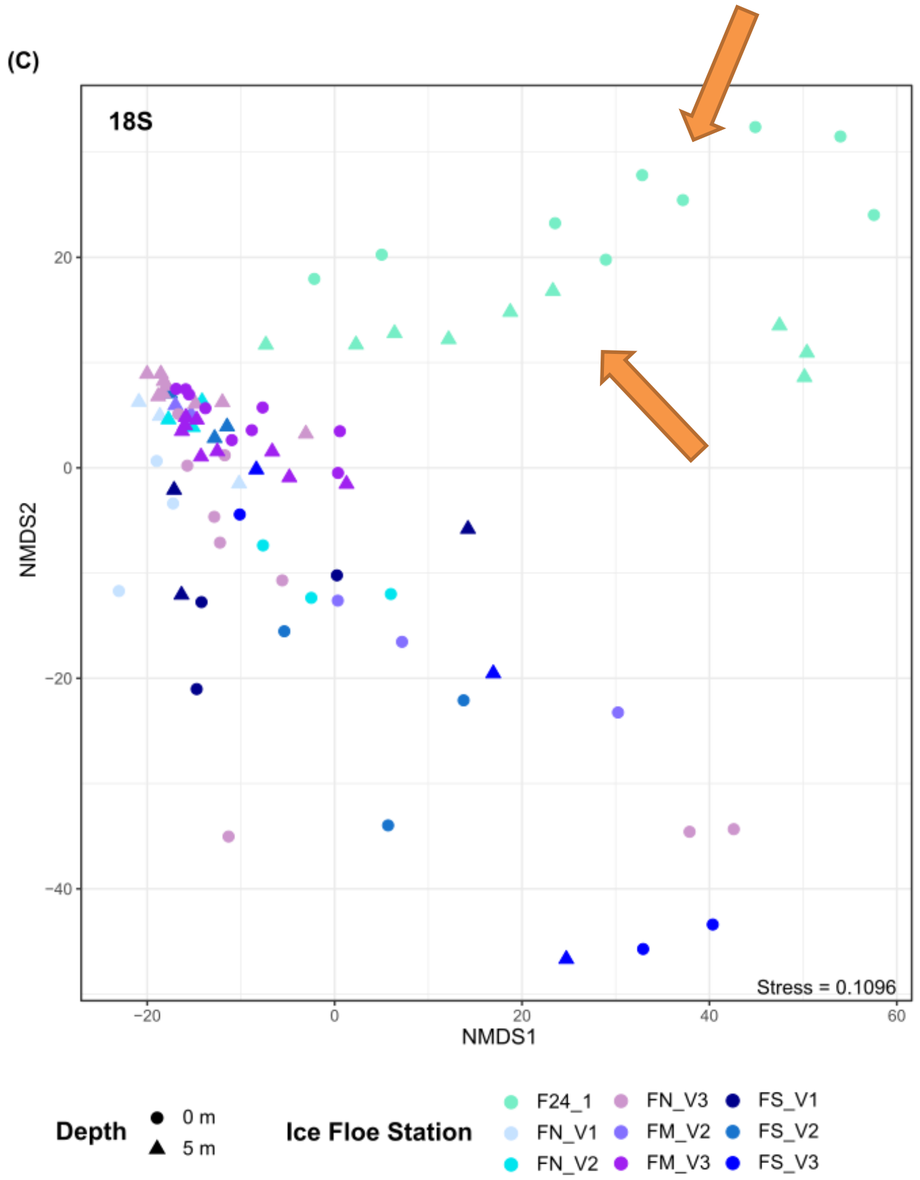
- Vertical structuring

  →Different communities at 1 m vs 5 m

- Horizontal structuring

  → Different communities among ice floes

Spatial patterns community composition (18S)



Beta diversity

- Vertical structuring

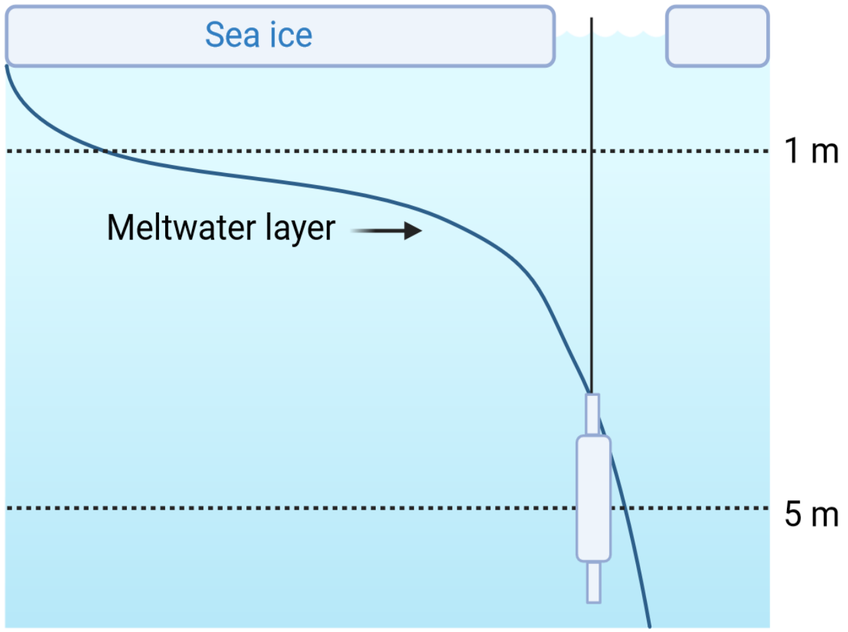
  →Different communities at 1 m vs 5 m

- Horizontal structuring

  → Different communities among ice floes

- Similar patterns in COI and 18S

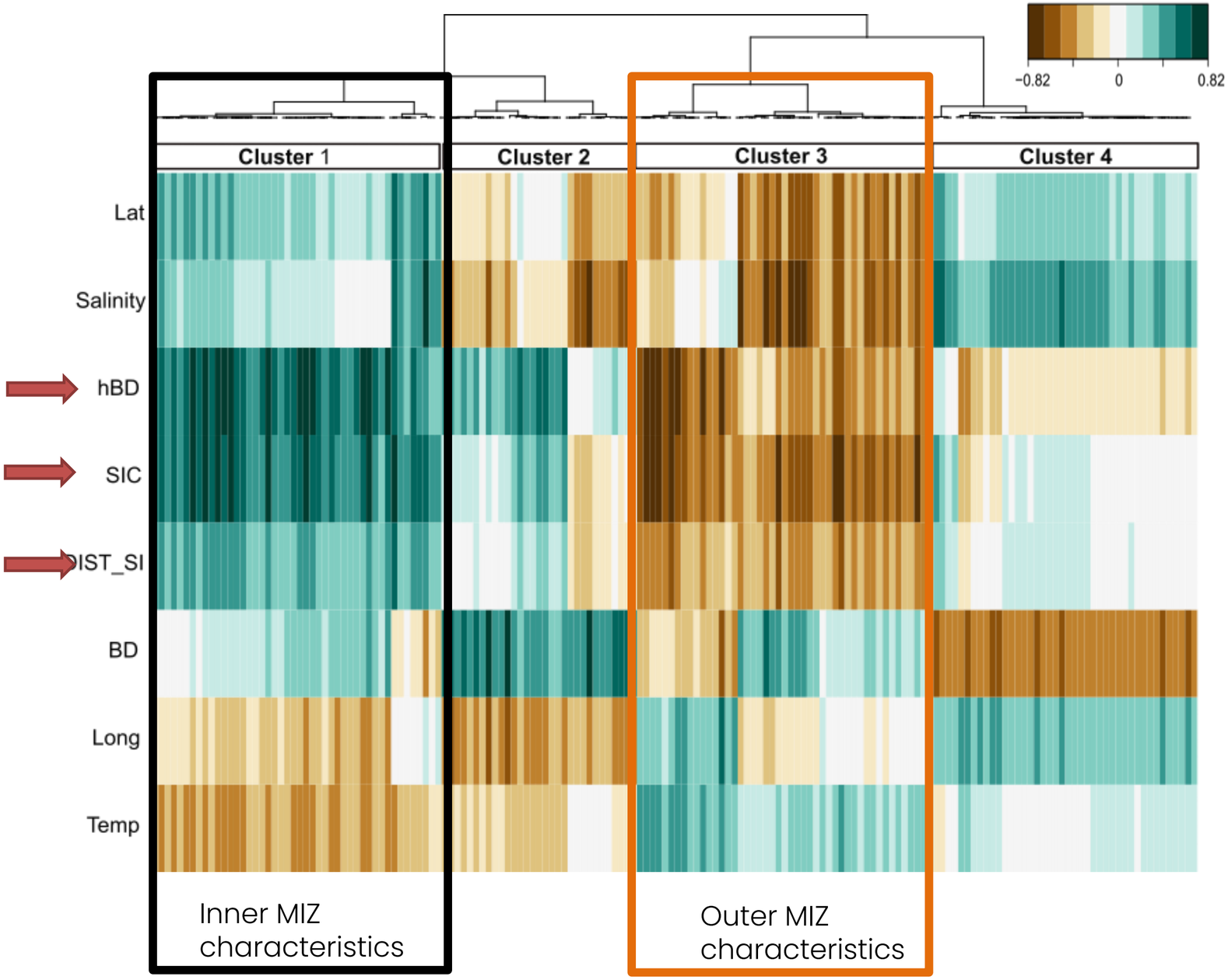
Further abiotic drivers of community composition – sea ice and meltwater



- Sea ice concentration (SIC)
- Distance from ice edge (Dist_SIC)
- Concentration of meltwater (BD)
- Depth of meltwater layer (hBD)

- Water temperature (^{0}C)
- Salinity
- Longitude (Lon)
- Latitude (Lat)

Meltwater and sea ice dynamics drive community composition



- **Inner MIZ community**→ more sea ice, far from ice edge + deep meltwater
- **Outer MIZ community**→ less sea-ice, close to ice edge + shallow meltwater
- Similar patterns in two markers
  → COI and 18S
- eDNA signals detected well-known associations
  → potentially new indicator species/communities

A first look at biodiversity in the ice-ocean interface of the MIZ

- Lot's of hidden diversity in MIZ

  →*Need to fill gaps in reference databases!*

- Using 2 markers extended coverage
- Diversity structured vertically and horizontally
- Meltwater + sea ice dynamics important drivers of community composition
- Jellyfish remain both mysterious and hard to get…

Thank you for listening ☺

PS131 - Grönlandsee (78°28'33.35'' N 12°33'20.95'' W) © Christian R. Rohleder 04.08.22 16:56:38 UTC (CC BY-SA)

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Impacts of rapid warming Arctic Marine Biodiversity

- Changes in habitat availability
  - E.g. less sea ice + more open water

(IPCC, 2022; Ingvaldsen et al., 2021)

- Shifting species distributions
  - arctic species → poleward range contractions
  - arctic-boreal + boreal species → expanding north

(Andrews et al., 2019; Basedow et al., 2018; Dalpadado et al., 2016)

- Altered community compositions + food web structure

(Csapo et al., 2021; Lanuzel et al., 2020; Wassmann et al., 2011)

More baseline biodiversity data needed to track responses to climate changec

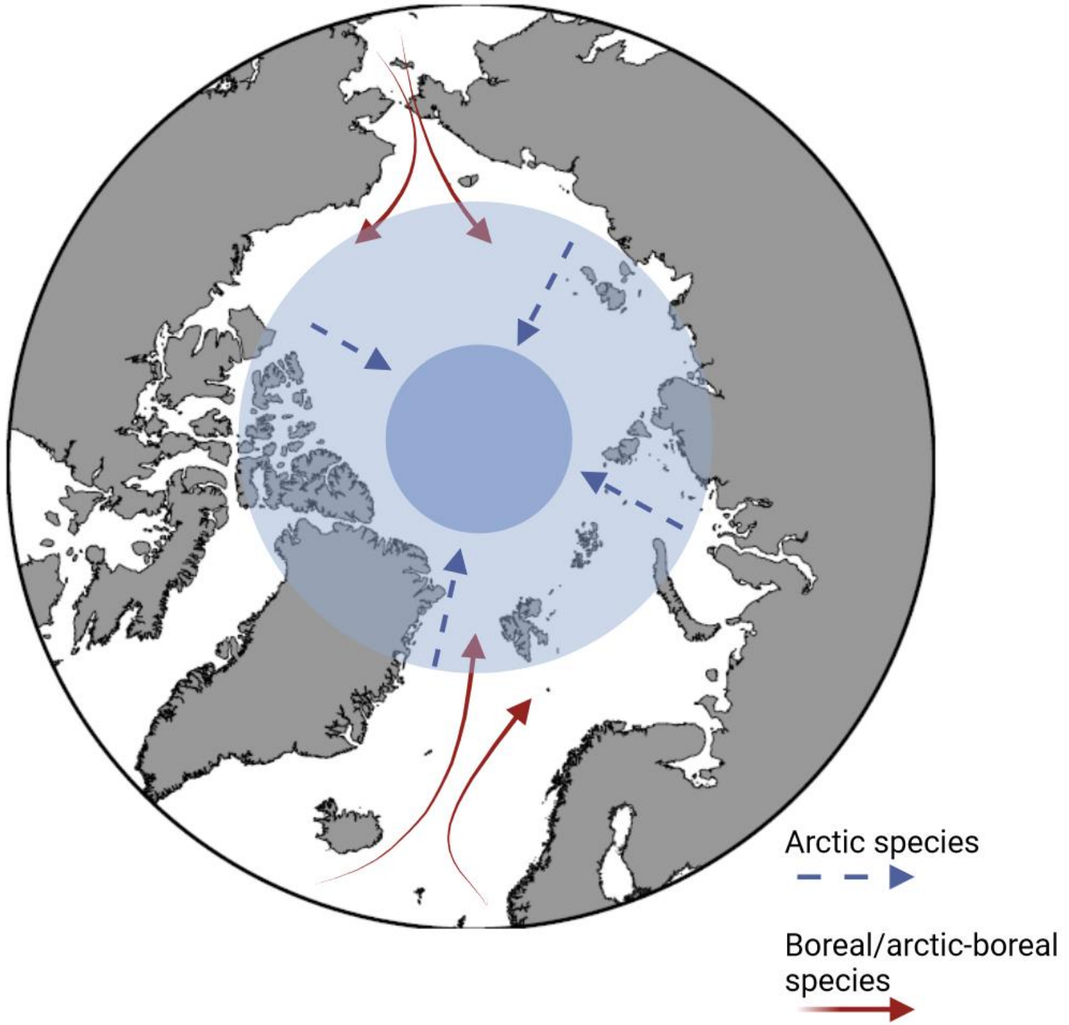


Figure made in Rstudio/Biorender

Marine Biodiversity in the Arctic Ocean

- World's smallest ocean
- Wide range of habitats and environmental extremes
- Intermediate levels of biodiversity

(Bluhm et al., 2011; CAFF, 2017)

- Lower levels of endemism

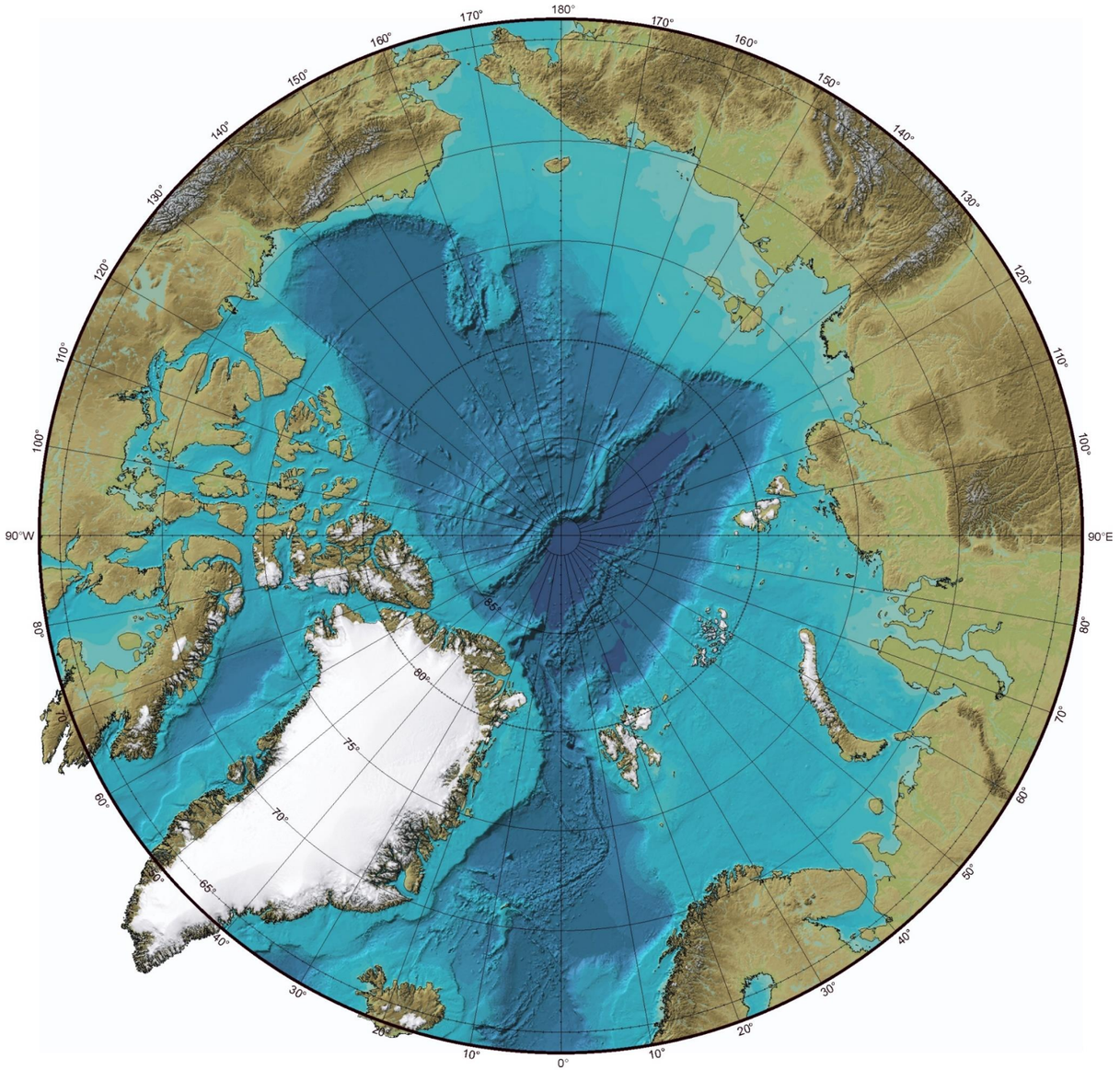
→ connectivity through Pacific/Atlantic gateways

(Piepenburg, 2005)

- Mix of biogeographic origins:

→ arctic, arctic-boreal and boreal taxa

(Bluhm et al., 2011)



Map credit: IBCAO (http://www.ibcao.org)