

Arctic Ocean observation activities and international collaboration

Michael Karcher

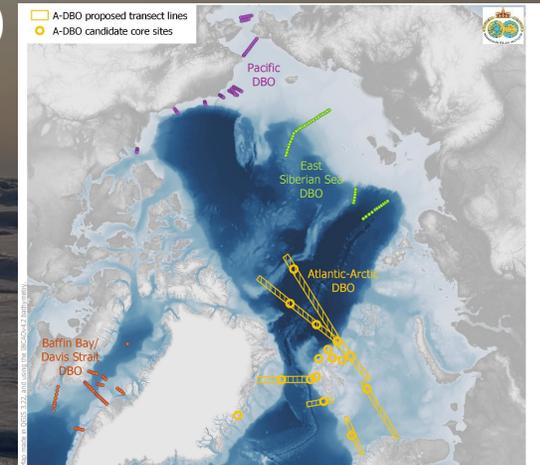
With contributions from Torsten Kanzow, Marcel Nicolaus, Benjamin Rabe, Walter Geibert

International Workshop on Arctic Observation:
Future collaboration by Research Vessels and Icebreakers
17-18 Nov. 2023, Tokyo

Knowledge gaps and future research collaboration

...in the context of the new research icebreaker of Japan

- Caters to the need for coordinated multi-disciplinary research and monitoring of the Arctic Ocean as part of the larger coupled system
- Provides additional support for the newly developing set of Distributed Biological Observatories (DBOs) in the Pacific Arctic, Siberian central Arctic, the Atlantic Arctic and the Baffin Bay/Davis Strait region (plus potential additional future Arctic DBO in central Arctic?)

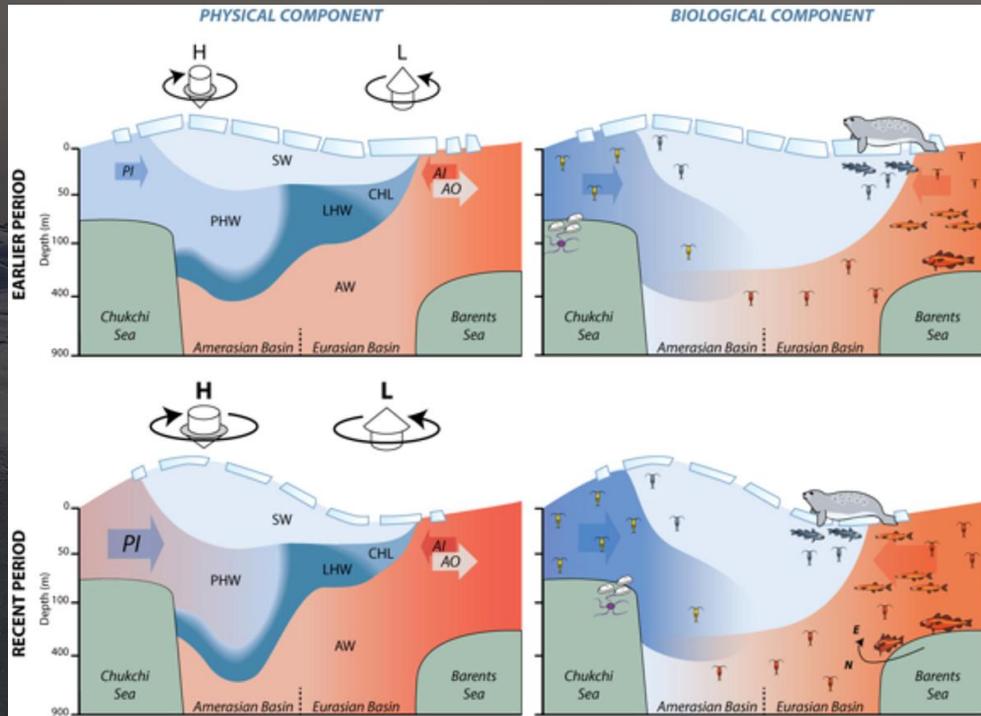


- Will allow multi-ship experiments in the ice-covered part of the central Arctic, such as the Canadian Basin or the last ice area enhancing the international icebreaking research vessel fleet.
- Will also have a strong positive impact on the SAS II and the IPY capabilities.

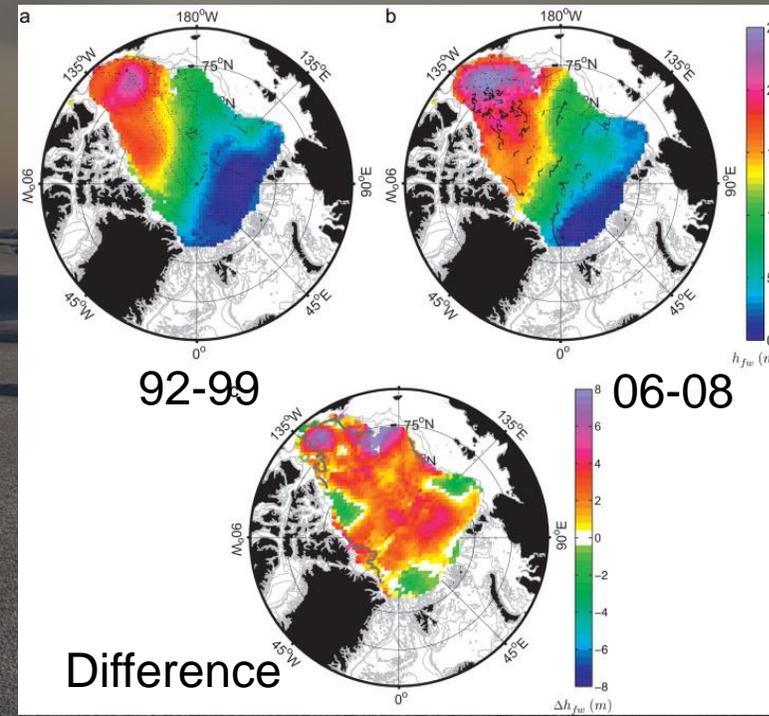
Knowledge gaps and future research collaboration

...in the context of the new research icebreaker of Japan

- The new ice-breaking platform allows much enhanced options for documenting the development of the freshwater lens of the Beaufort Gyre and the Atlantic Water under the ice covered part of the Canadian Basin in international coordination.



Polyakov et al., 2020



Rabe et al., 2011

Freshwater inventory surface to 34 Salinity in JAS

Knowledge gaps and future research collaboration

...in the context of the new research icebreaker of Japan

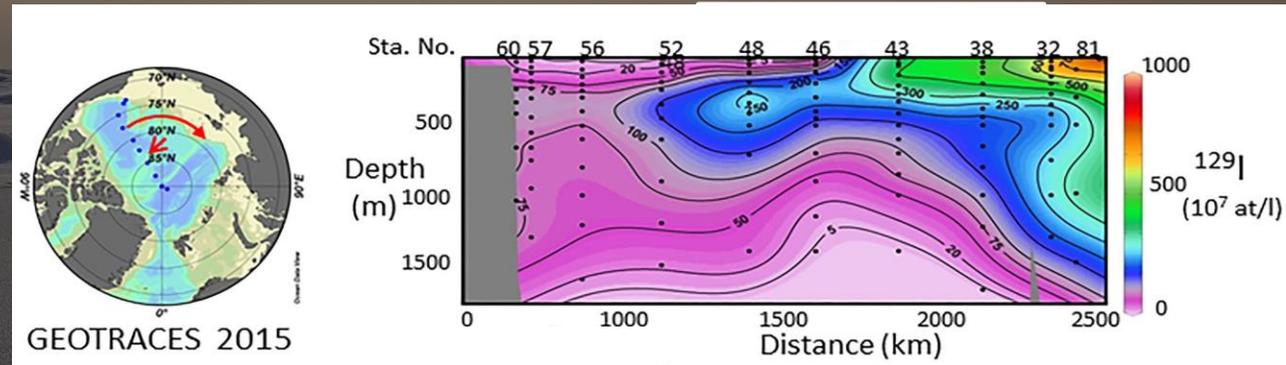
- Also offers additional capacity for studying the impact of retreating sea ice cover in summer and in shoulder seasons in the central basins
- monitoring of fisheries resources and ecosystem parameters in ice-covered waters is essential to provide management advice: e.g. Central Arctic Ocean Fisheries Agreement (CAOFA), (Japan signatory party), ship equipped to conduct fisheries surveys?



Knowledge gaps and future research collaboration

...in the context of the new research icebreaker of Japan

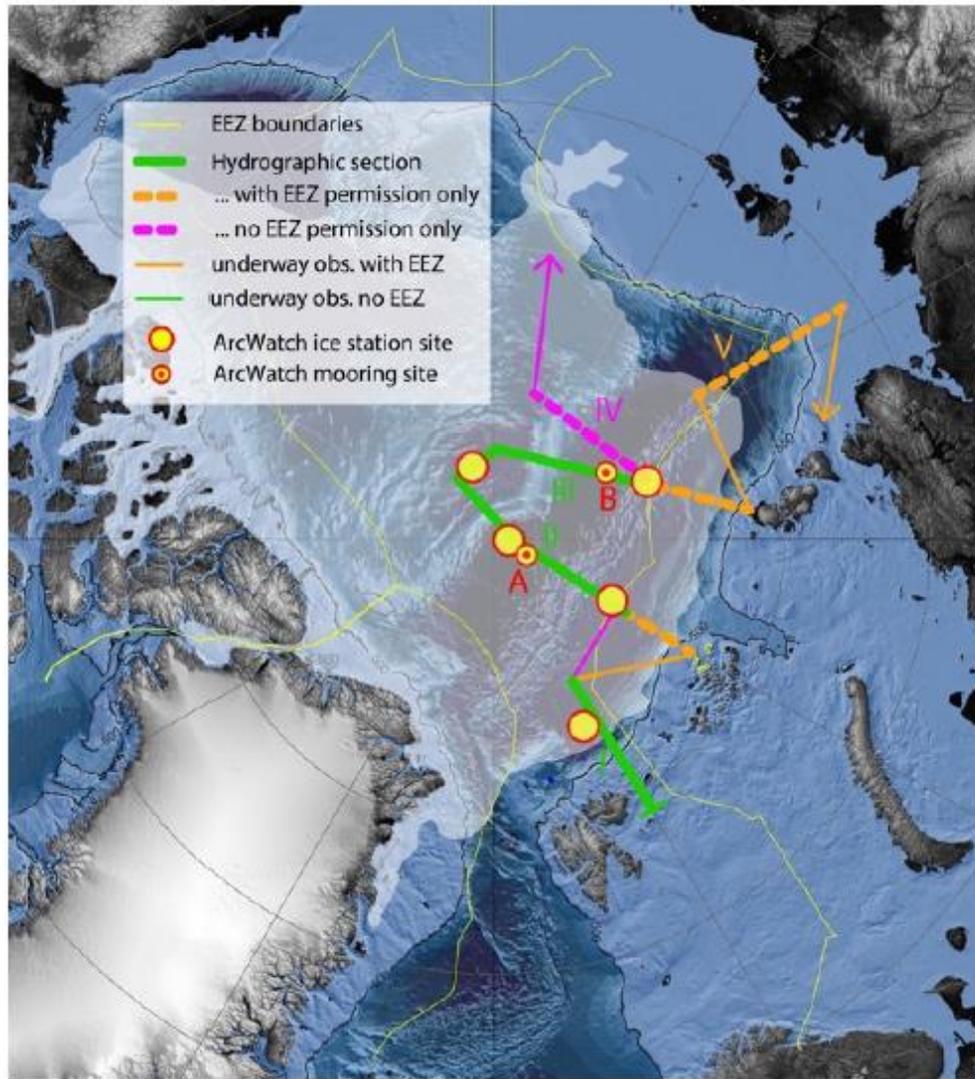
- Assessing the current and future trace element composition of the ocean is crucial for understanding oceanic transport, marine ecosystems and those depending on it. In this area, Japan has delivered an outstanding contribution to the international GEOTRACES programme, which requires special sampling capabilities and cross-calibration of analyses between groups and countries. We hope that this contribution can now be expanded further to the polar regions



Smith et al., 2021

Examples for planned AWI research and monitoring activities in the Arctic Ocean





ArcWatch - Interdisciplinary long-term observation of change in the central Arctic Ocean

- Common objective to understand and observe the on-going transformation of the Arctic marine system
- Based on commonly created datasets
- 4 Expeditions embedded into POF4
 - ArcWatch 1: 2023 (concept: IceArc)
 - ArcWatch 2: 2024 (concept: TransArc)
 - **CONTRASTS 2025 (ArcWatch3, new concept)**
 - ArcWatch 4: 202? (synthesis study)

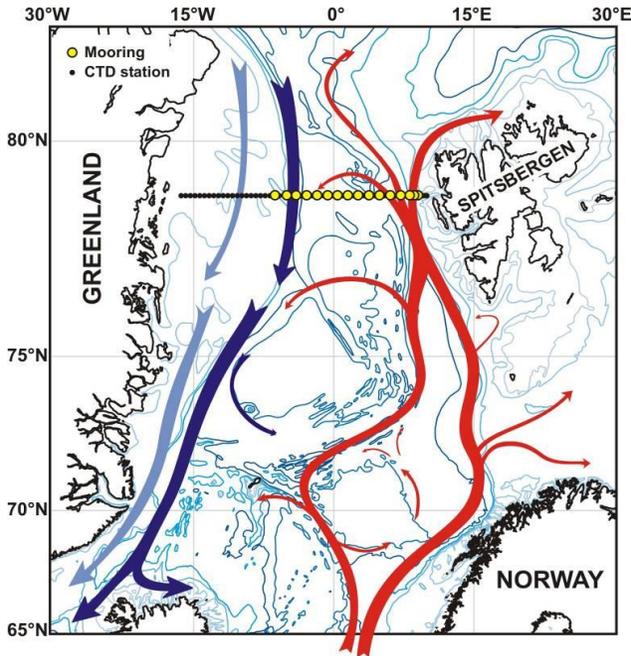


- Add the “ice regime” dimension
 - The multi-year and old ice
 - Region I: older ice, high dynamics
 - Different oceanographic conditions
 - Similar time, different regions
- MOSAiC legacy
 - Teams and partners
 - Interdisciplinary collaboration
 - Sampling
 - Data management
 - Observational concepts
 - Links to models
- The next chance to fill gaps

French Tara Icedrift planned for ~ a decade. AWI (Marcel Nicolaus) involved.

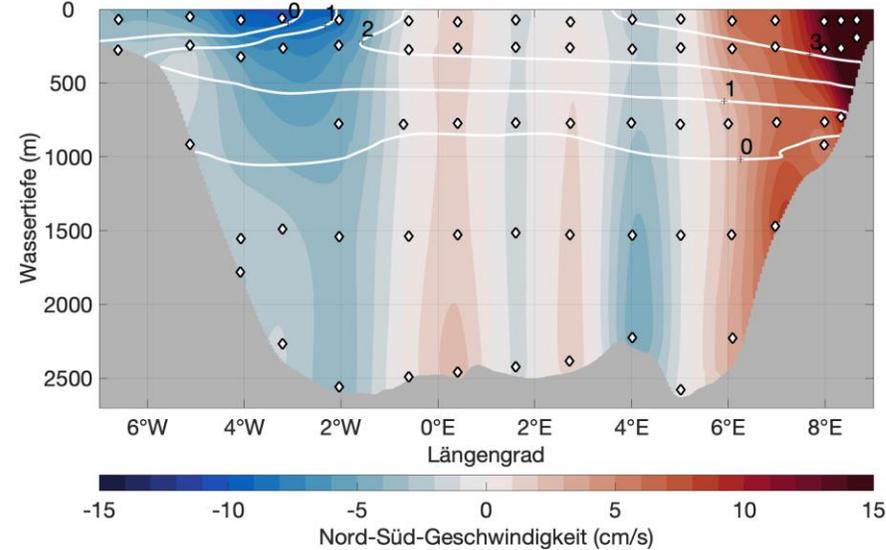


© Fondation Tara Ocean- Olivier Petit



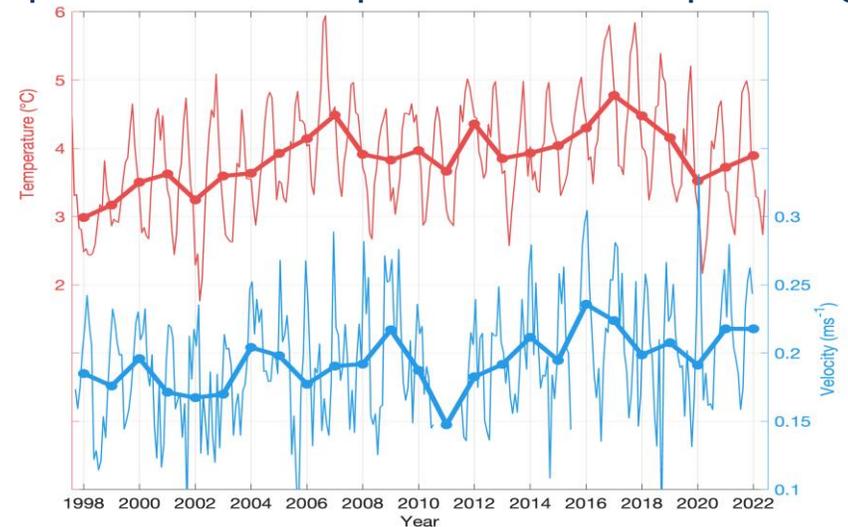
- Arctic ice and freshwater outflow
- Arctic deep outflow and overflow
- Atlantic inflow

Annual mean north-south Velocity in Fram Strait (cm/s)



Courtesy of Wekerle

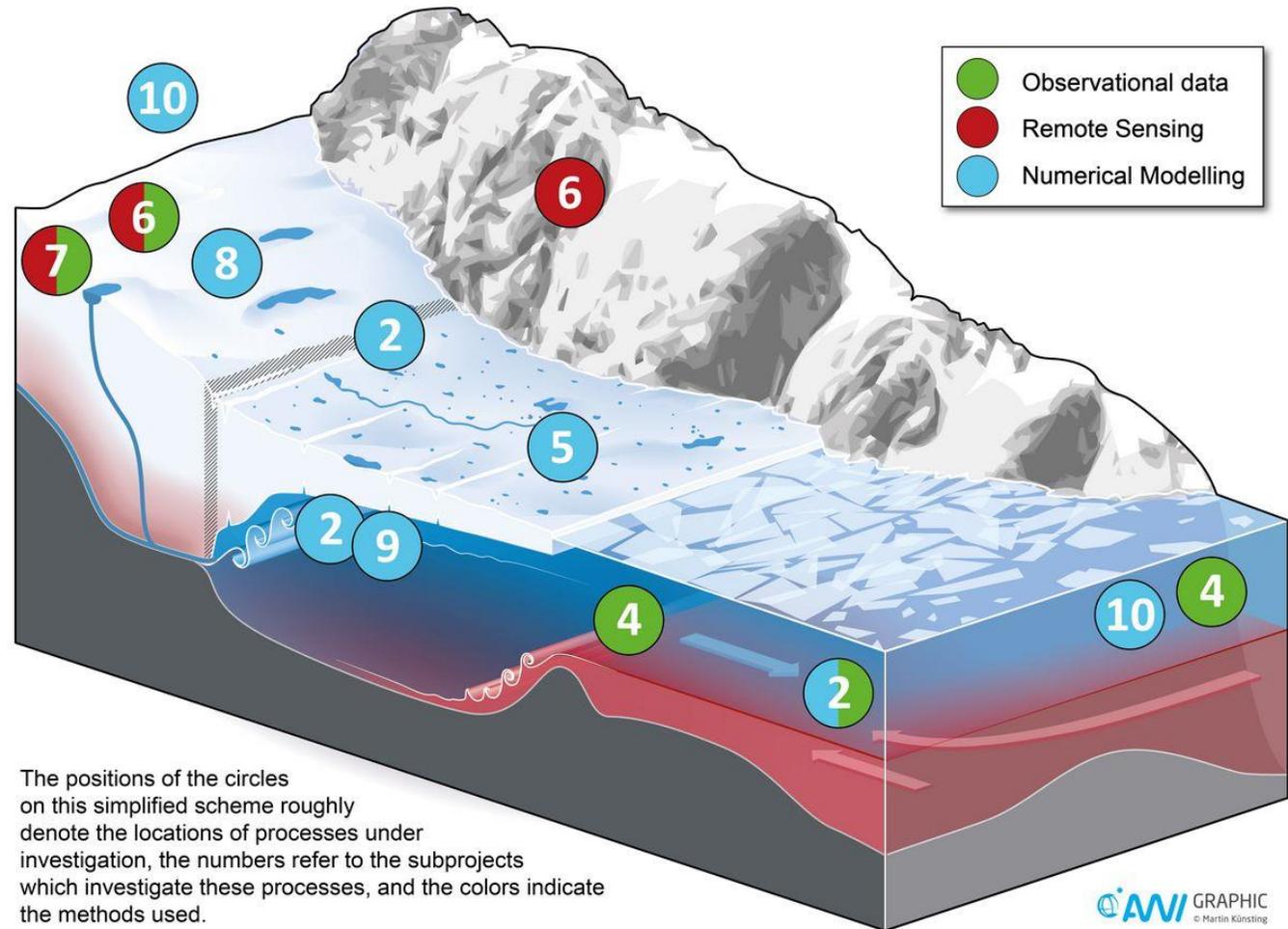
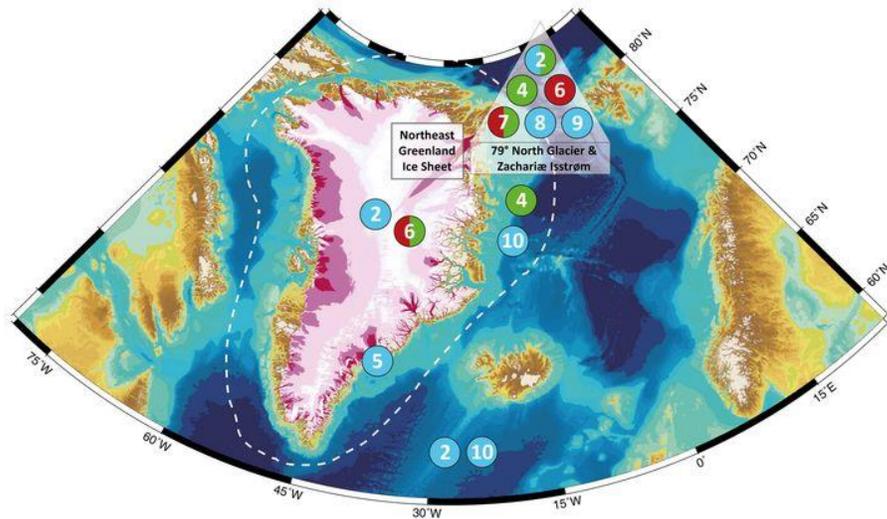
Temperature and Speed of West Spitzbergen Current



McPherson et al. (in prep.)

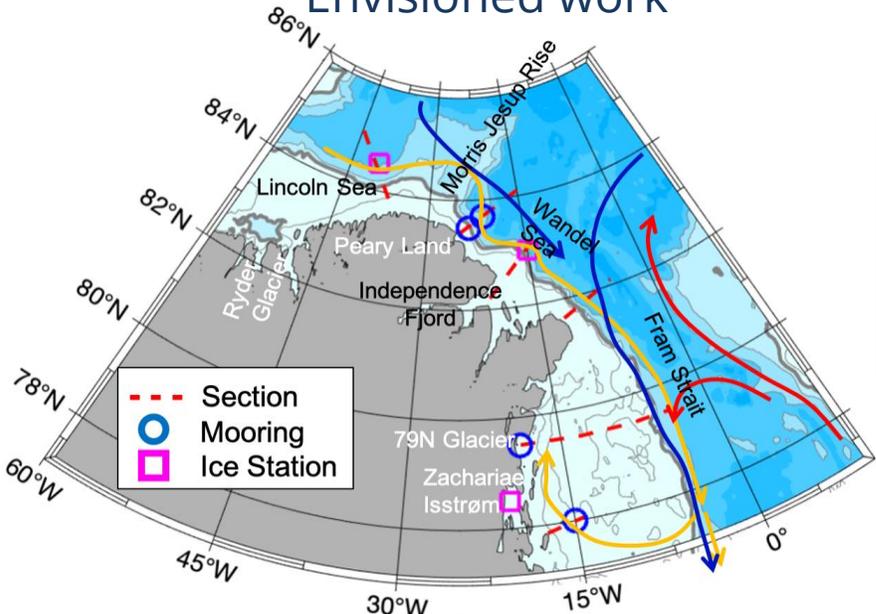
- Exchange gateway to the Arctic Ocean
- West Spitzbergen Current carries 3 Sv of Atlantic Waters (>2°C)
- AWI maintains moorings in WSC since 1997
- **Cooperation between AWI (WSC) and Norwegian Polar Institute (East Greenland Current)**

GROCE – Greenland Ice Sheet Ocean Interaction (BMBF)



The positions of the circles on this simplified scheme roughly denote the locations of processes under investigation, the numbers refer to the subprojects which investigate these processes, and the colors indicate the methods used.

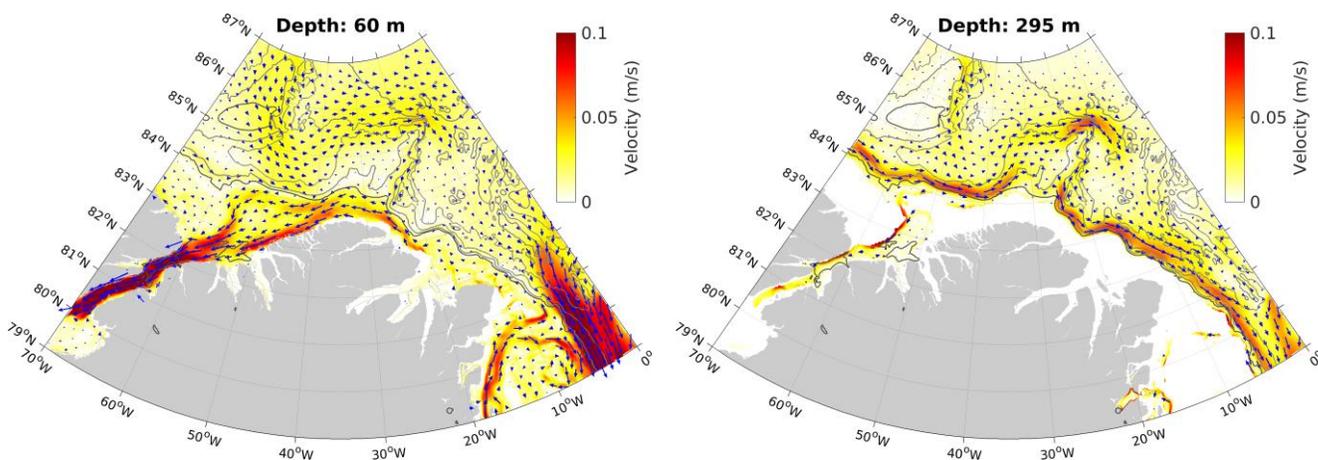
Envisioned work



Mission: Explore the source water branches of the East Greenland Current in different sea ice regimes and their impact on both marine terminating glaciers in Northeast Greenland and biogeochemical cycling in Fram Strait

- Expedition proposed for 2025 (decision expected early 2024)

Simulated circulation north of Greenland



Two large EU Projects of relevance for the international collaboration of Arctic Ocean research and monitoring



POLARIN: POLAR Research Infrastructure Network

Access integration to **64** research infrastructures and their services in **both poles**.



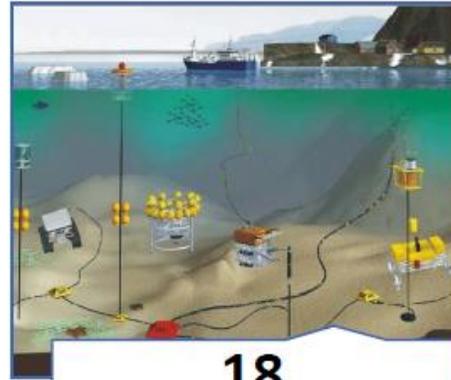
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Research stations



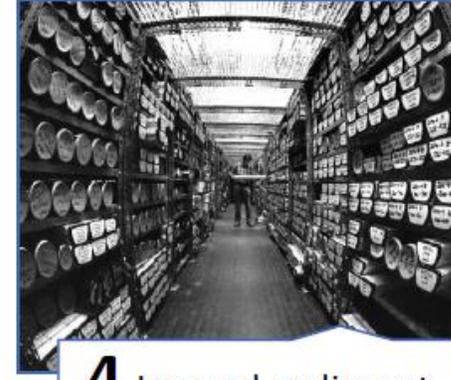
12

Polar vessels



18

Observatories



4

Ice and sediment
core repositories



7

Data
infrastructures

March 2024 – February 2029; 15M€

Further information:



Project coordinator:

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Project manager:

Verónica Willmott, AWI

E-mail: Veronica.Willmott@awi.de

HELMHOLTZ

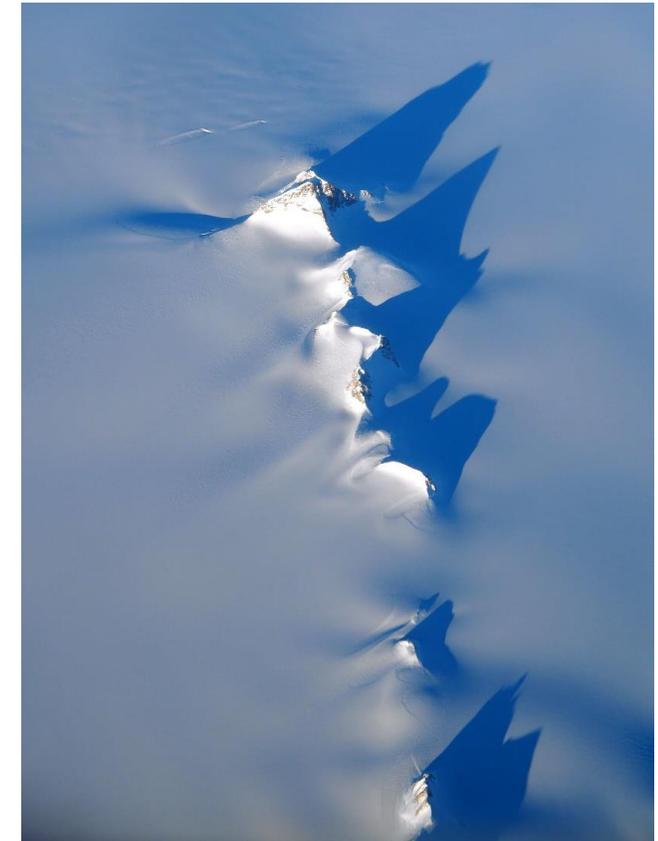


ARCTIC PASSION

Pan-Arctic Observing
System of Systems:
Implementing Observations
for Societal Needs

**Collaborating towards a better coordinated
and integrated, more useful and more
equitable Arctic Observing System**

- European Commission H2020 Program, 15 Mio Euro
- > 40 partner institutions and Indigenous Communities from 18 nations
- July 2021 – June 2025
- Website: www.arcticpassion.eu

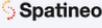


© M. Karcher

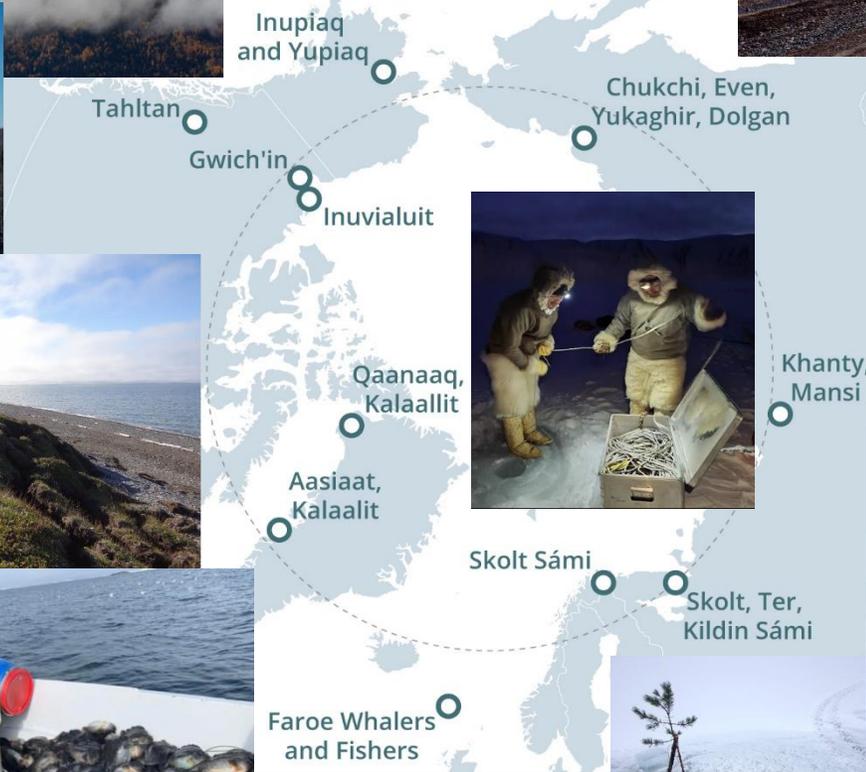
Coordination: Alfred Wegener Institute for Polar and Marine Research



Who we are: Institutional partners

 AINA Calgary, Canada	 AMAP Trondheim, Norway	 APECS Potsdam, Germany	 AWI Bremerhaven, Germany	 Carleton University Ottawa, Canada	 GINR Narsarsuaq, Greenland	 GRID-Arendal Arendal, Norway	 iLAB Hamburg, Germany	 SIOS Longyearbyen, Svalbard, Norway	 Snowchange Lehtoo, Finland	 Spatineo Helsinki, Finland	 Syke Helsinki, Finland
 CAE San Lazzaro di Savena, Italy	 CNR Italy	 CNRS Paris, France	 DMI Copenhagen, Denmark	 INPO Lindholm, Sweden	 IOBAS (Former partner) Moscow, Russia	 KOPRI Incheon, Korea	 MET Norway Oslo, Norway	 TSU (Former partner) Tomsk, Russia	 UiB Bergen, Norway	 UIT Tromsø, Norway	 UKRI-BAS Cambridge, United Kingdom
 DTU Lyngby, Denmark	 EC Europe	 EPB The Hague, The Netherlands	 FMI Helsinki, Finland	 NCPOR Vasco da Gama, Goa, India	 NIPR Tokyo, Japan	 NPI Tromsø, Norway	 OASYS Hamburg, Germany	 ULAP Rovaniemi, Finland	 ULLUND Lund, Sweden	 UMCES Solomons, United States of America	 UNIVBRIS Bristol, United Kingdom
 UW Seattle, United States of America	 WoA Rovaniemi, Finland	 WSL-SLF Davos, Switzerland	 Japan Agency for Marine- Earth Science and Technology								

+ many collaborating institutions and programmes



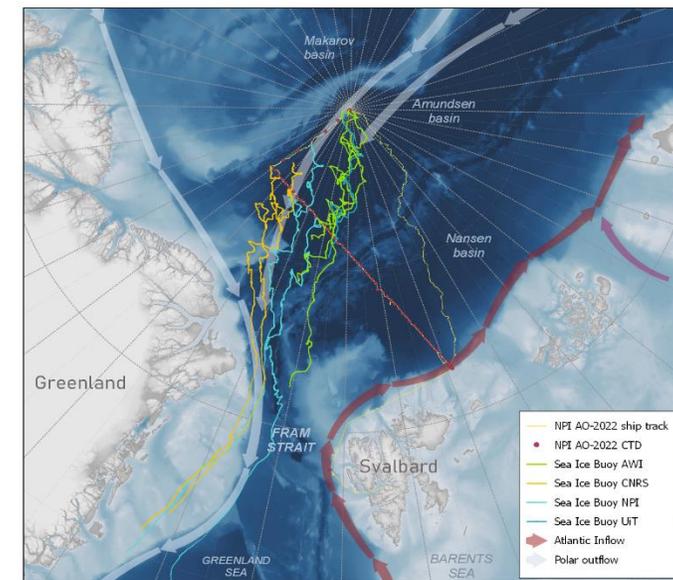
- Enhancing instrumentation and coordination
- Inclusion of different knowledge systems
- Enhancing the functionality of the Arctic Data System
- Developing new services
- Piloting the ‚Shared Arctic Variables‘ concept of SAON
- Developing societal benefit assessments
- Enhancing international collaboration
- Providing policy and decision-making support
- Contributing to developing a clearer and more equitable international Structure for Arctic observing



➔ founding on and collaborating with previous and ongoing international efforts

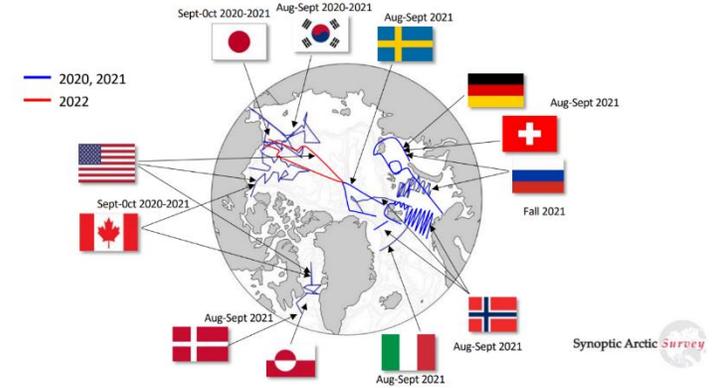
Examples:

- New multi-disciplinary moorings
- New sensor and instrumentation developments for marine sphere and atmosphere
- Deployment of drifting buoys
- Building unified snow/ice interface detection for IMBs
- Building of a microwave observation operator for sea ice
- Improving monitoring of glacier runoff and calving front positions

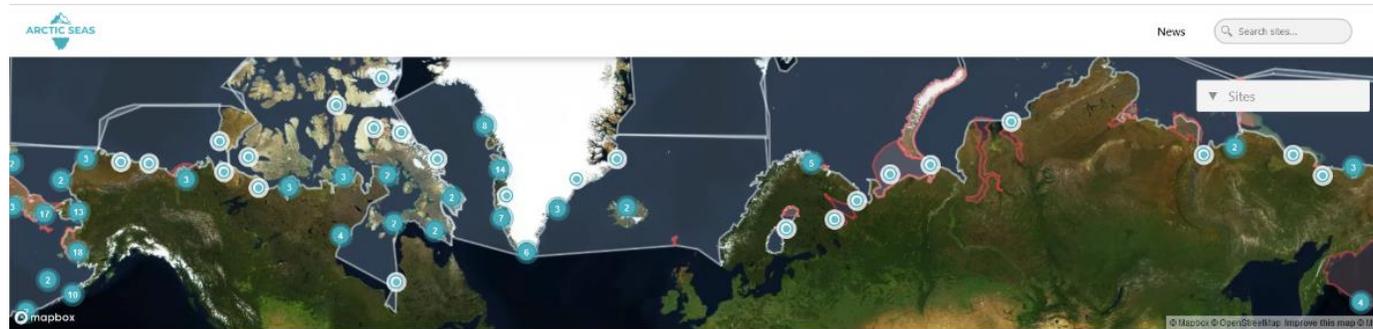


Sundfjord, NPI

- Advancing the Synoptic Arctic Survey SAS, including preparation for SAS II
- Advancing the visibility of Indigenous marine occupancy, situated locations and knowledge by developing and maintaining the portal arcticseas.org



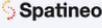
International SAS Cruises (12 Nations)



Snowchange Arctic Seas Portal - Information about Indigenous Communities and Ecology of Northern Waters. [More information](#)



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 UW Seattle, United States of America	 WoA Rovaniemi, Finland	 WSL-SLF Davos, Switzerland	 JAMSTEC								

- Contribute to the formation of the Arctic GOOS Regional Alliance
- More than a dozen partners in Arctic PASSION active in Arctic Ocean observations

➔ Offer to make use of the Arctic PASSION network to continue discussion on future collaboration on research and monitoring, including the joint use and coordination of icebreaking research vessels in the Arctic Ocean

Infrastructure (Germany)

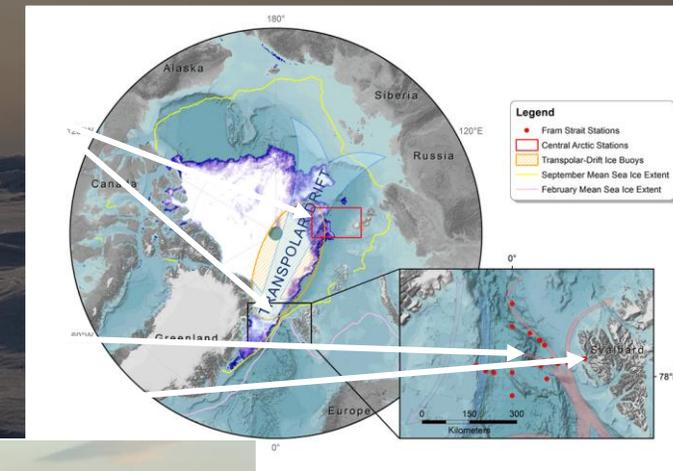
- **Polarstern** – Germany’s multidisciplinary research icebreaker
- **Polarstern II** – New Icebreaker in Development
- **FS Maria S. Merian** (Ice margin vessel, PC7/E3)
- **Multidisciplinary Ice-based distributed observatory (MIDO)** observatory in Central Arctic Ocean – sustained sea ice-ocean monitoring based on ice buoys
- **Frontiers in Arctic Marine Monitoring (FRAM)** observatory in FRAM Strait – longterm physical-biogeochemical-biological monitoring based on mooring time series and annually repeated ship-based observations
- Observatory **HAUSGARTEN - Long-Term Ecological Research** in the deep Fram Strait region and **AWIPEV Station in Ny Alesund (Svalbard)** – atmospheric and coastal marine biology monitoring
- for atmospheric, sea ice and glaciological research **Research planes Polar 5 and 6**



Leitstelle Dt. FS



AWI



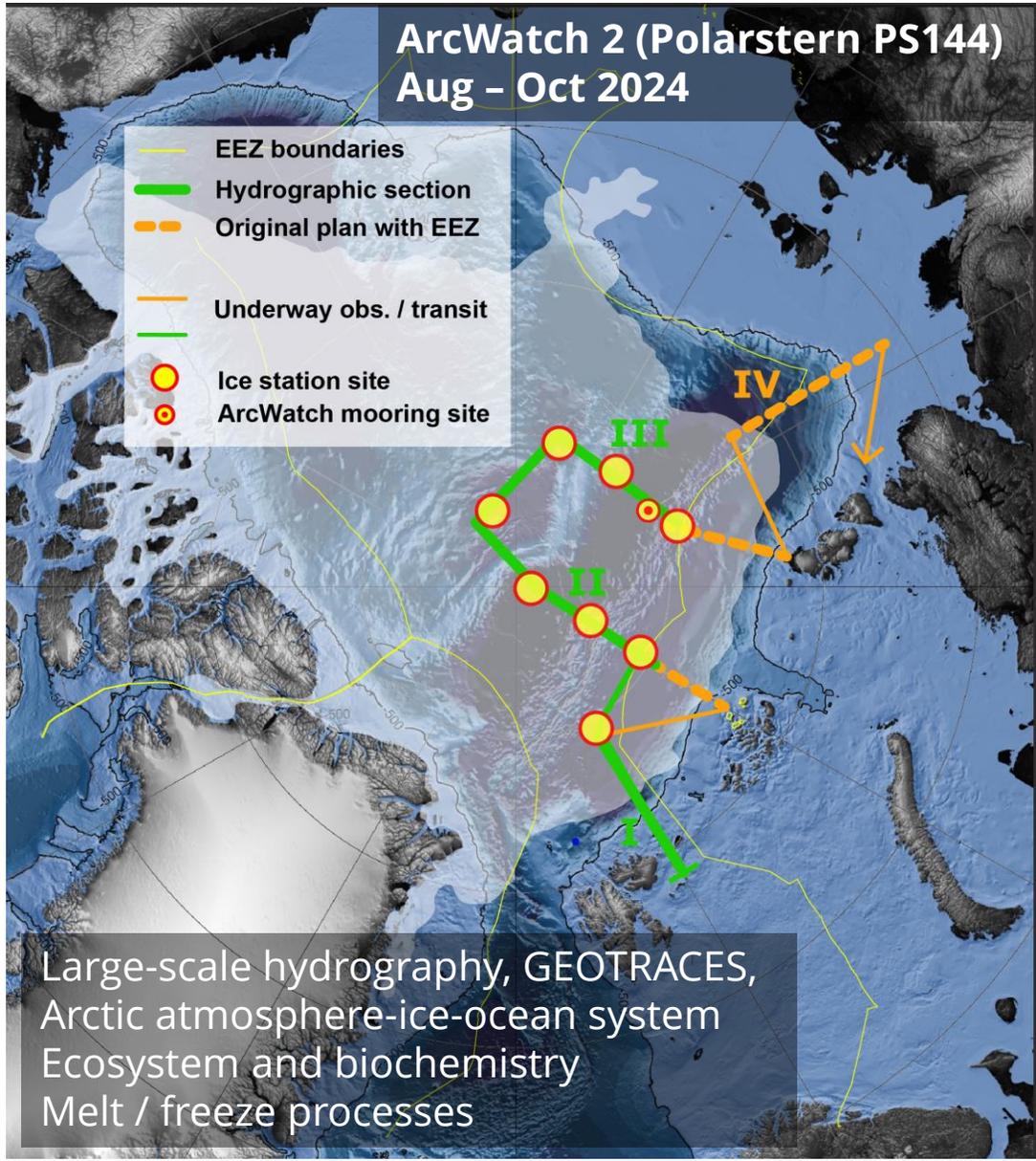
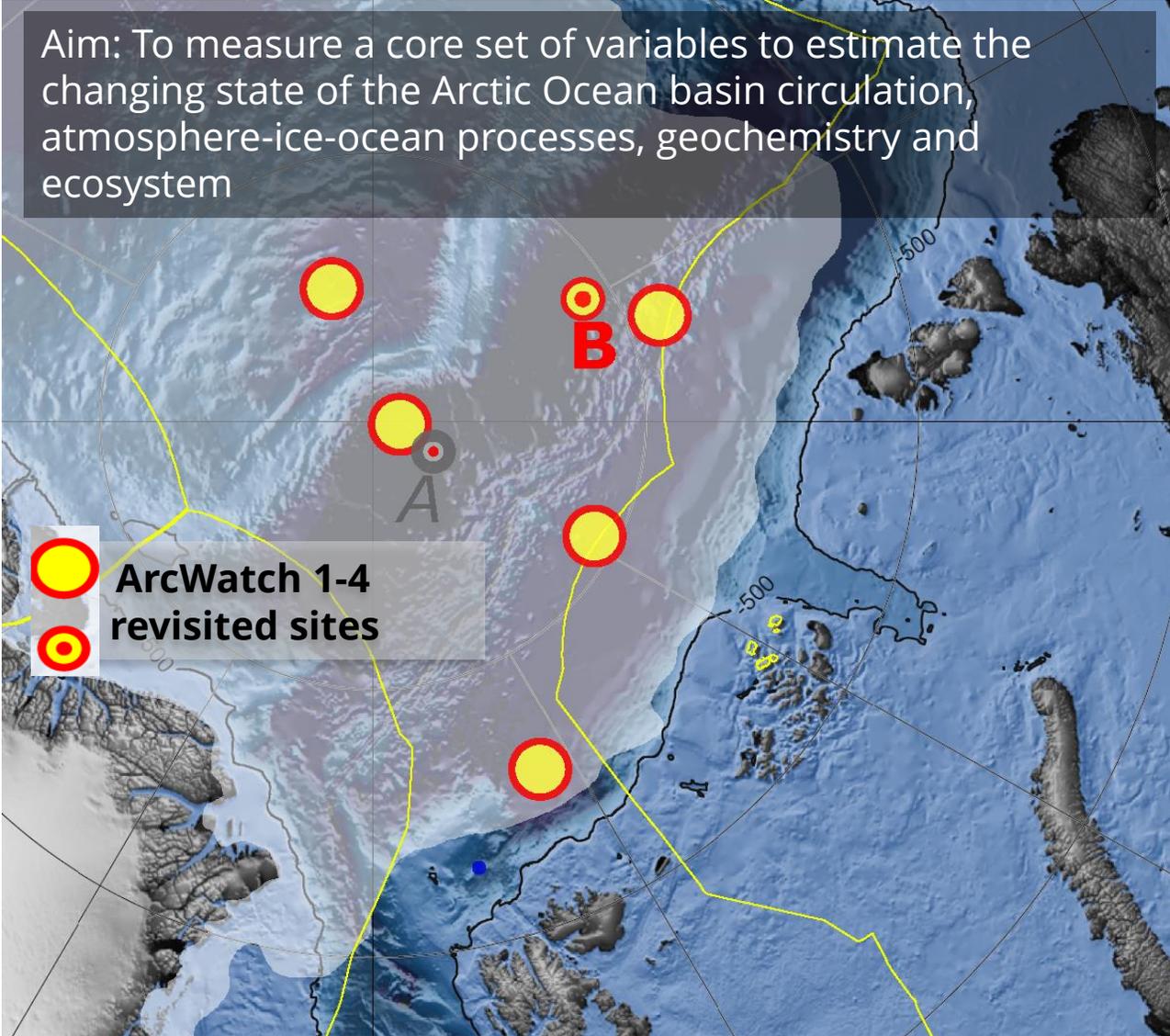
S. Hendricks, AWI

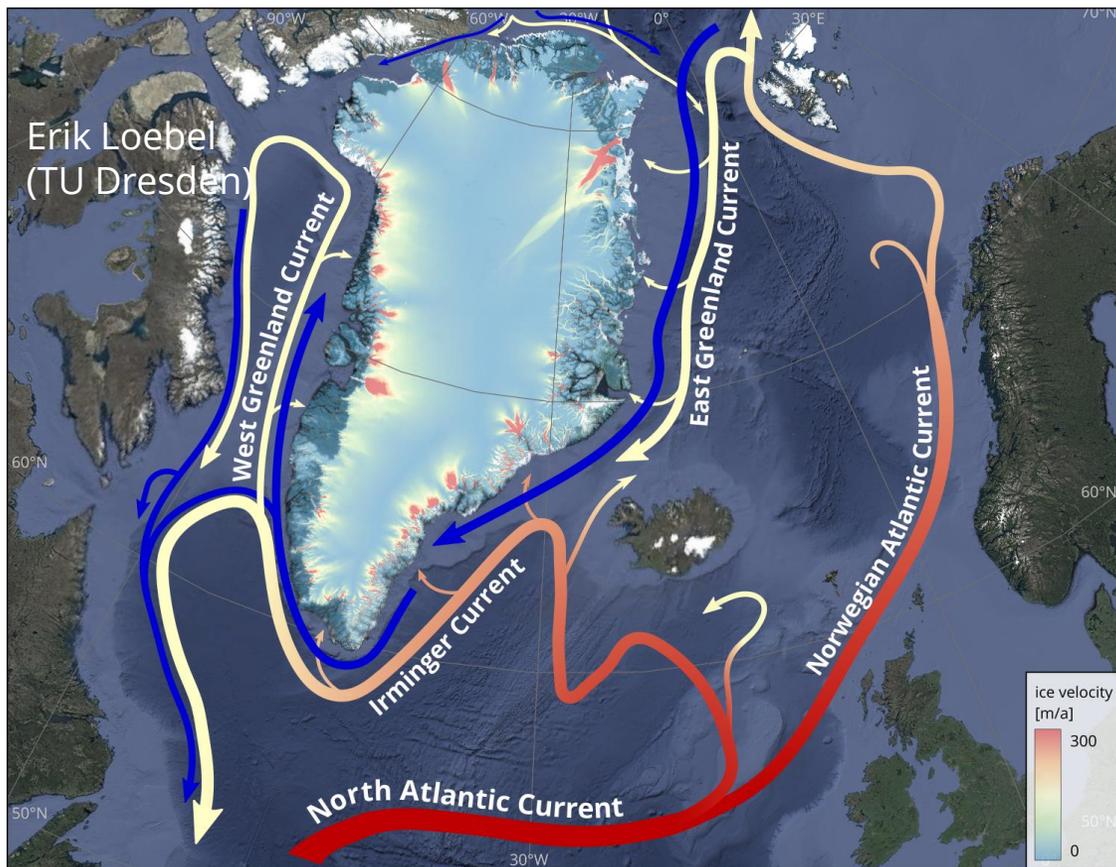
International and regional partnerships (Germany)

- **International expeditions with Polarstern** (e.g. Arcwatch series, Coordinated Drift Experiment MOSAiC and follow up analysis projects, Aircraft Campaigns such as ICEBIRD)
- **Large EU-funded projects** such as Arctic PASSION, EU-PolarNet 2, OCEAN:ICE, ARICE, EUROFLEETSplus
- **BMBF-funded projects** such as GROCE on ocean-glacier coupling in Greenland, MOMENT on permafrost research on the Methane budget of ecosystems
- **Bilateral research projects**, e.g. with BAS and UCL (as part of the NERC CAO program), with NPI, UiT, JAMSTEC, UAF, and others
- Participation in the **Joint Programme for Scientific Research and Monitoring** (JPSRM) of the Central Arctic Ocean Fisheries Agreement (**CAOFA**) (a follow-up project to EFICA is in preparation)
- **Networks and Observing Systems** like **SIOS, A-DBO, ARGO, Arctic Science Partnership (ASP)** (<https://asp-net.org/>), International Arctic Buoy Programme (**IABP**), **Fram Strait Arctic Outflow Observatory** (NPI initiative)
- **Organisations** such as **IASC, SAON, Arctic GRA**

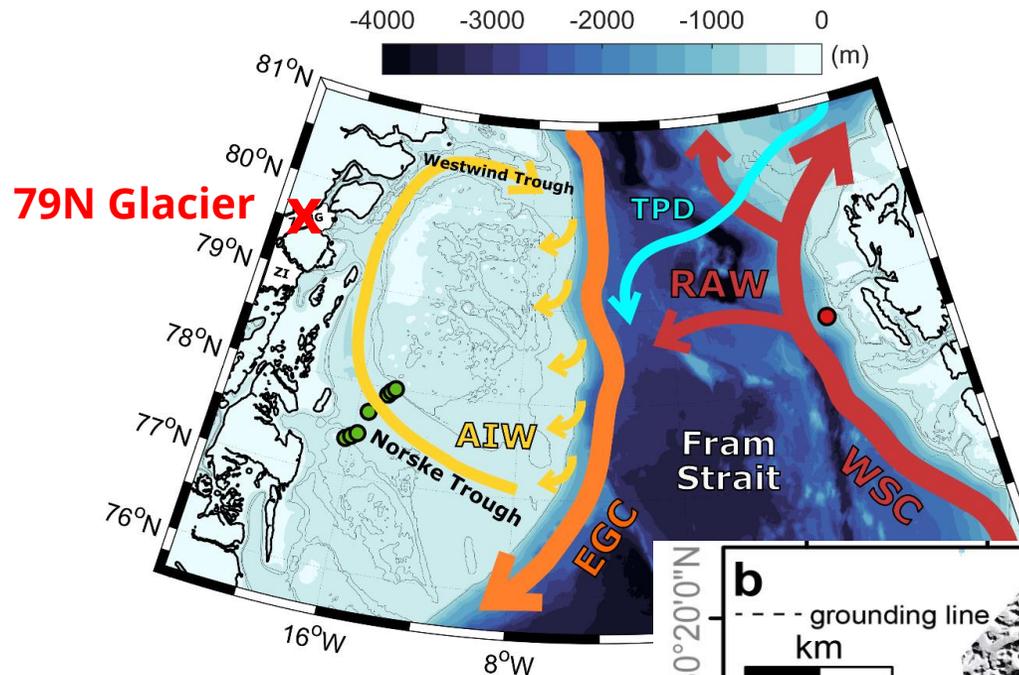
ArcWatch expeditions to the central Arctic basin with focus on the Eurasian Arctic

Aim: To measure a core set of variables to estimate the changing state of the Arctic Ocean basin circulation, atmosphere-ice-ocean processes, geochemistry and ecosystem

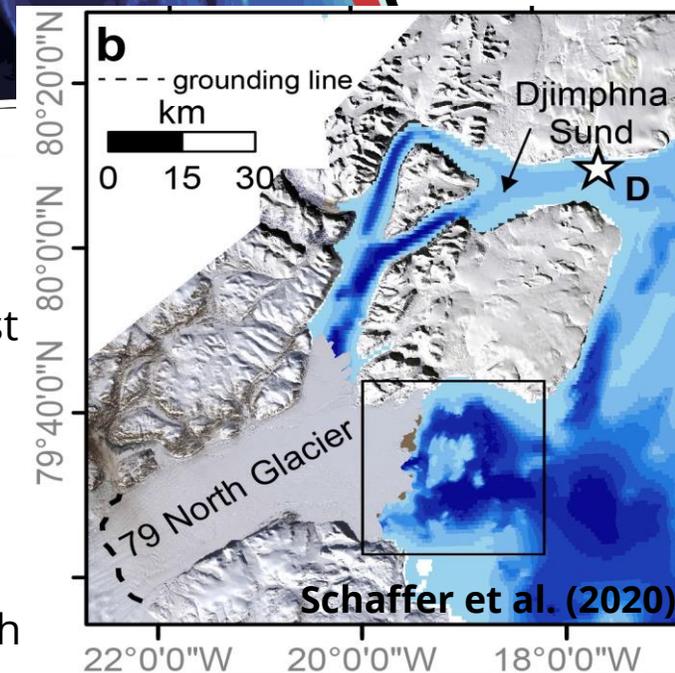




- Warm Atlantic Water found across the **continental shelf of Northeast Greenland**.
- Warm water travels from Atlantic to Arctic, **recirculates** in Fram Strait, moves south as EGC

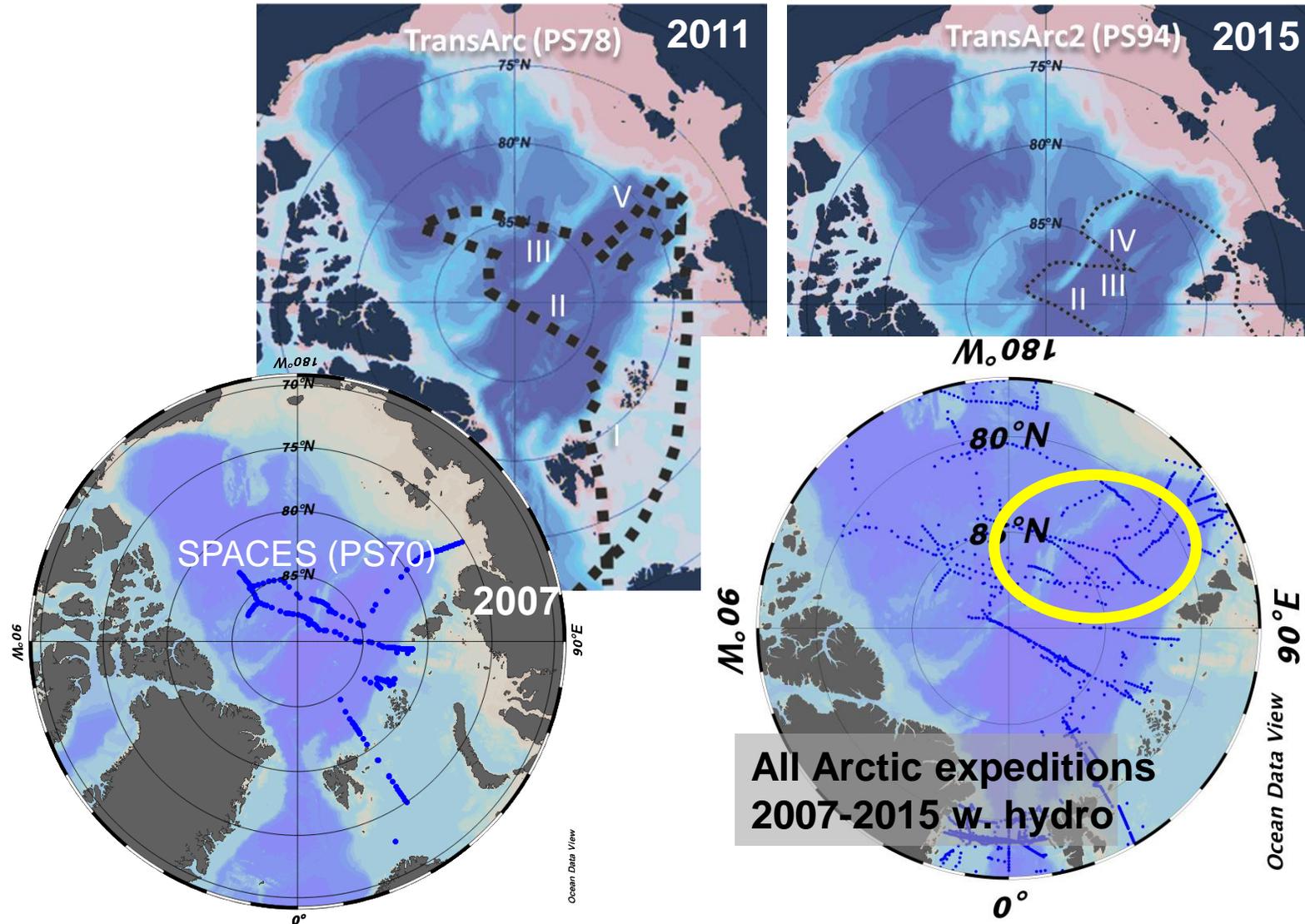


- 79N Glacier loses mass (Wilson et al. 2017)
- 79N Glacier thinning over past 20 yrs due to ocean warming (Mayer et al., 2018)
- year-round inflow of warm Atlantic Water into cavity (Schaffer et al., 2018; 2020) advected along Norske Trough



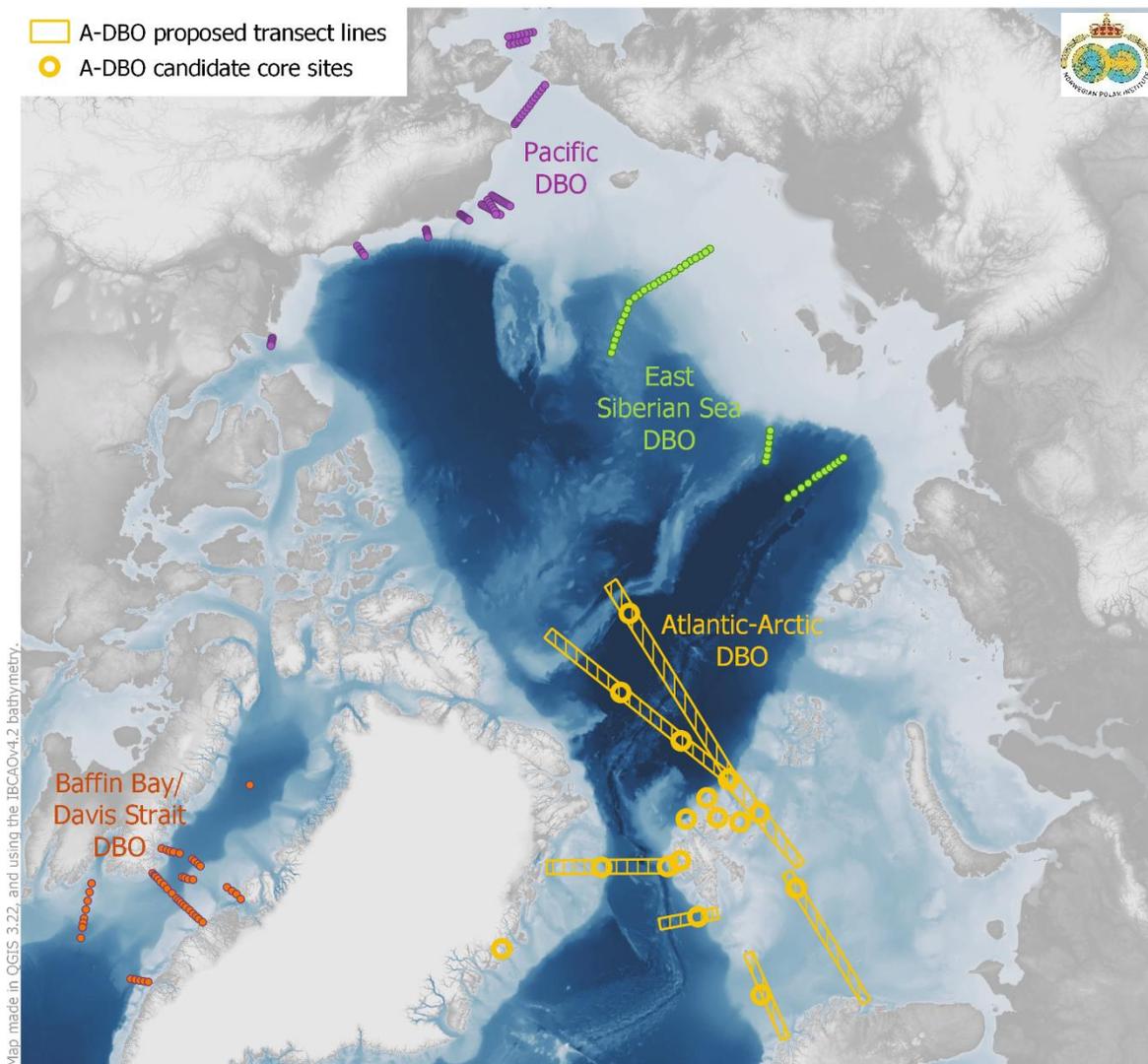
ArcWatch-2: Trans-Arctic survey of the Arctic Ocean in Transition III

Geibert, Rabe (AWI), Achterberg (GEOMAR), Heuzé (Gothenburg), Peeken, Haas (AWI), Heimbürger (CNRS), Casacuberta (ETH), Torres Valdes, Flores (AWI)



-> a comprehensive marine observing system for climate and environment

- Identify key locations for collaborative monitoring and research
- Joint and open planning - better use and sharing of infrastructure
- Better and more open sharing of data, common protocols for data processing and handling
- Create win-win situations between long-term funding and project-based research funding work



Preliminary A-DBO map, to be further refined