The International Synoptic Arctic Survey (SAS): Updates on 2021-2022 Field Program

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https://synopticarcticsurvey.w.uib.no/

IASC

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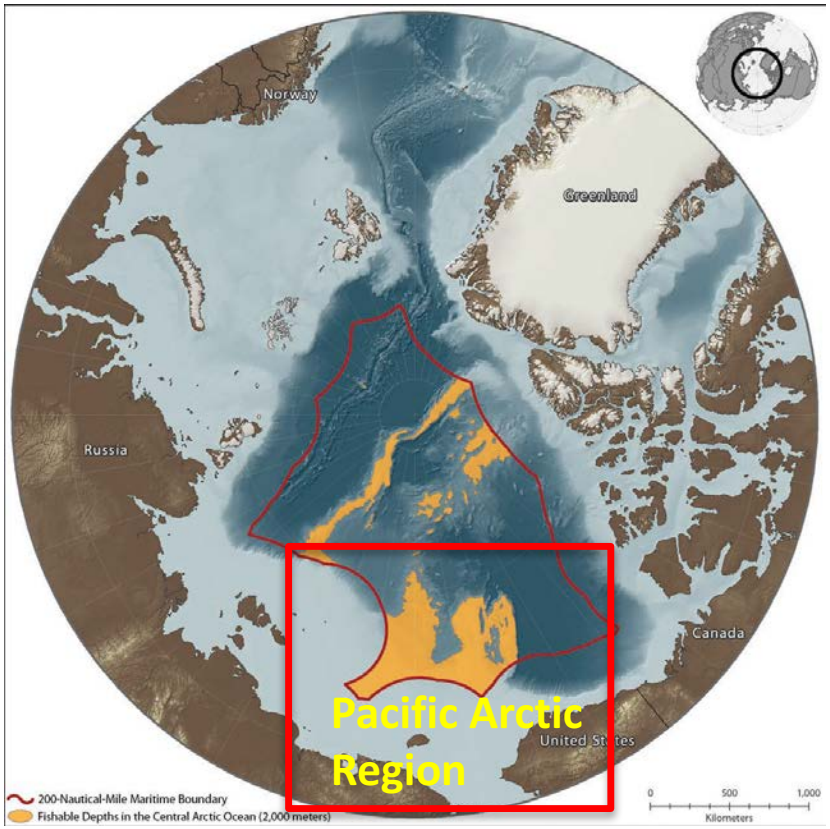
International Contributions to SAS: Pacific Arctic



Fishable depths were derived from IBCAO v3 bathymetry (www.ngdc.noaa.gov/mgg/bathymetry/arctic/).

- Twenty-two percent of the Central Arctic Ocean (CAO)is made up of ridges and continental shelves at fishable depths ≤2,000 meters
- International waters of CAO north of 200 nm Exclusive Economic Zones (EEZs)

- Earlier sea ice retreat, atmospheric changes, and northward advection of warming Pacific water into the region; opening light to region earlier
- SAS will have multiple transects into the basin in 2020-2022 as a pan-Arctic effort to better understanding status and trends in physical drivers, the carbon components, and ecosystem response
- Ecosystem pelagic & benthic components, including paired trawls and acoustics for fisheries (ship dependent)
- Multiple SAS cruises planned by Canada, China Korea, Japan and USA in the Pacific Arctic region

Addressing Arctic Challenges Requires a Synoptic Ocean Survey

A coordinated effort involving trailblazing science—and icebreaking ships—from many nations is needed to fill gaps in our understanding of the Arctic Ocean and how it's changing.

In this 2007 photo, the Swedish icebreaker *Oden* (left) runs a seismic cable in the wake of the Russian nuclear-powered icebreaker *50 Let Pobedy*, which is plowing through heavy ice north of Greenland. The Synoptic Arctic Survey team plans to launch a coordinated multinational campaign using icebreaker ships to gather data in the Arctic Ocean beginning in 2020. Credit: Leif Anderson

[Paasche et al. 2019 Eos, Nov]

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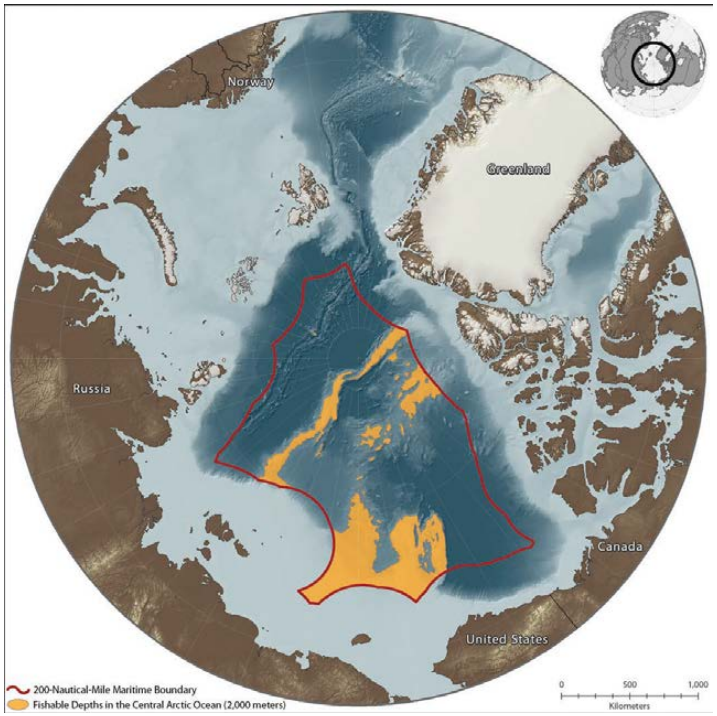
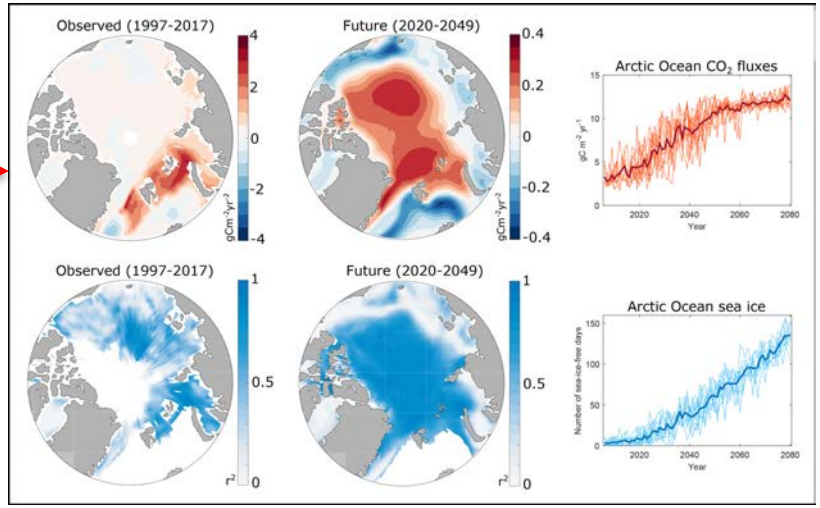




Synoptic Arctic Survey

What are the present state and major ongoing transformations of the Arctic marine system? (specifically the ecosystem and carbon system)

- Describe the present state of the Arctic Ocean to provide the foundation against which future states can by compared to quantify change.
- Three key foci:
    1) Physical drivers of importance to the ecosystem and carbon cycle,
    2) Ecosystem response, and
    3) Carbon cycle and ocean acidification
- Envisioned to repeat each decade

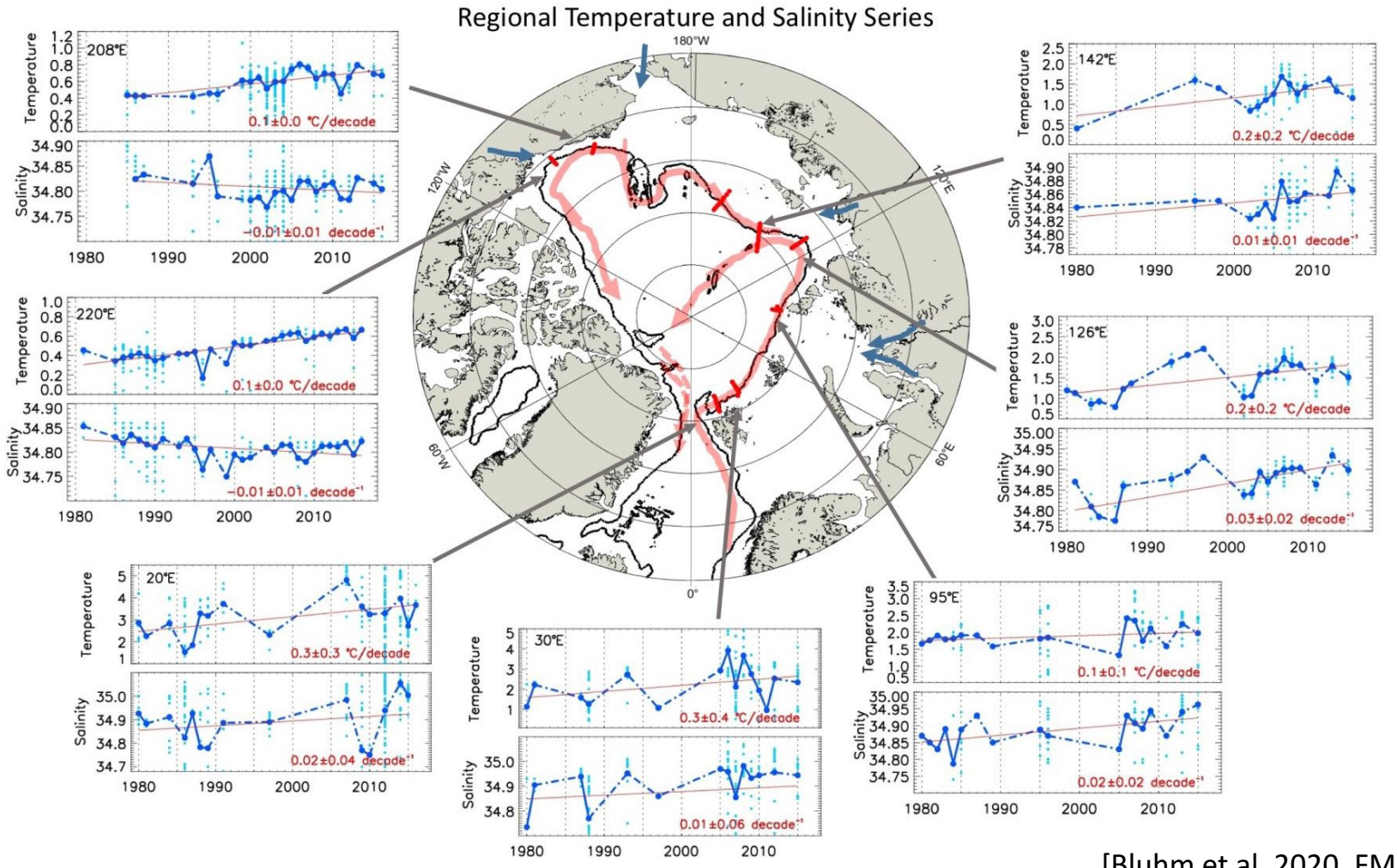
SAS and Central Arctic Ocean

- The short-term results of the SAS project will provide a unique baseline of the Arctic Ocean (slopes and basin) summer conditions to which both historic and future observations can be compared.
  - https://synopticarcticsurvey.w.uib.no/2020/11/16/sas-november-webinar/

- A synoptic picture with SAS data sets are a prerequisite for detecting changes of the many components of the Arctic Ocean system, be it the physics, biology or chemistry components.

- ASSW21 SAS session (#17)-abstract submission open; see link for summary of session to includes updates on field results and future planned activities, including synthesis

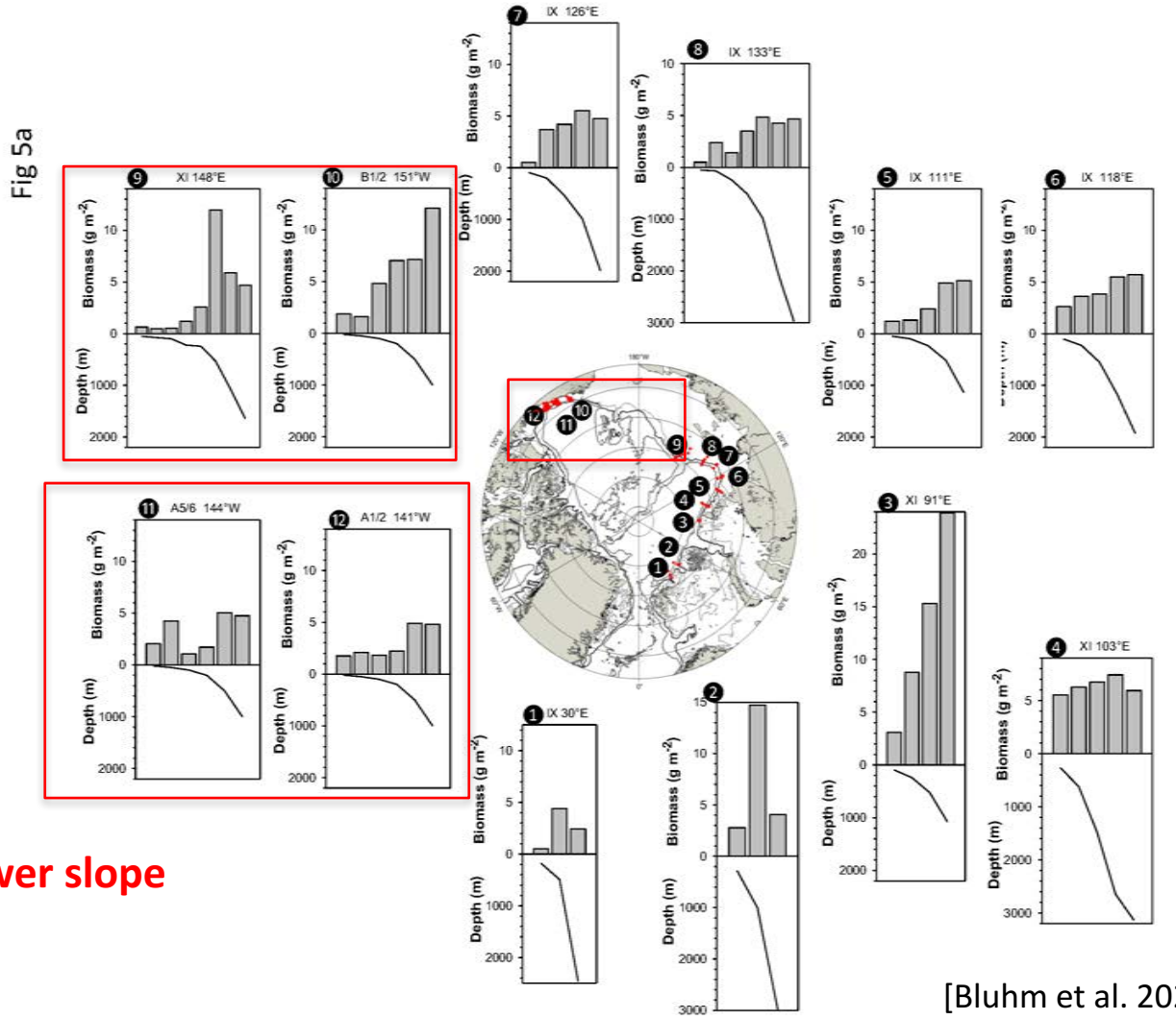
Atlantic Water core temperature (defined by potential temperature maximum) and associated salinity from 1980 to 2015 over the Arctic slope



[Bluhm et al. 2020, FMAS]

- Increase of AW core temperature (defined by potential temperature maximum) and associated salinity from 1980 to 2015 over the Arctic slope from 1980 to 2015 (Igor Polyakov data in Bluhm et al. 2020)

Biomass distribution of mesozooplankton over slopes

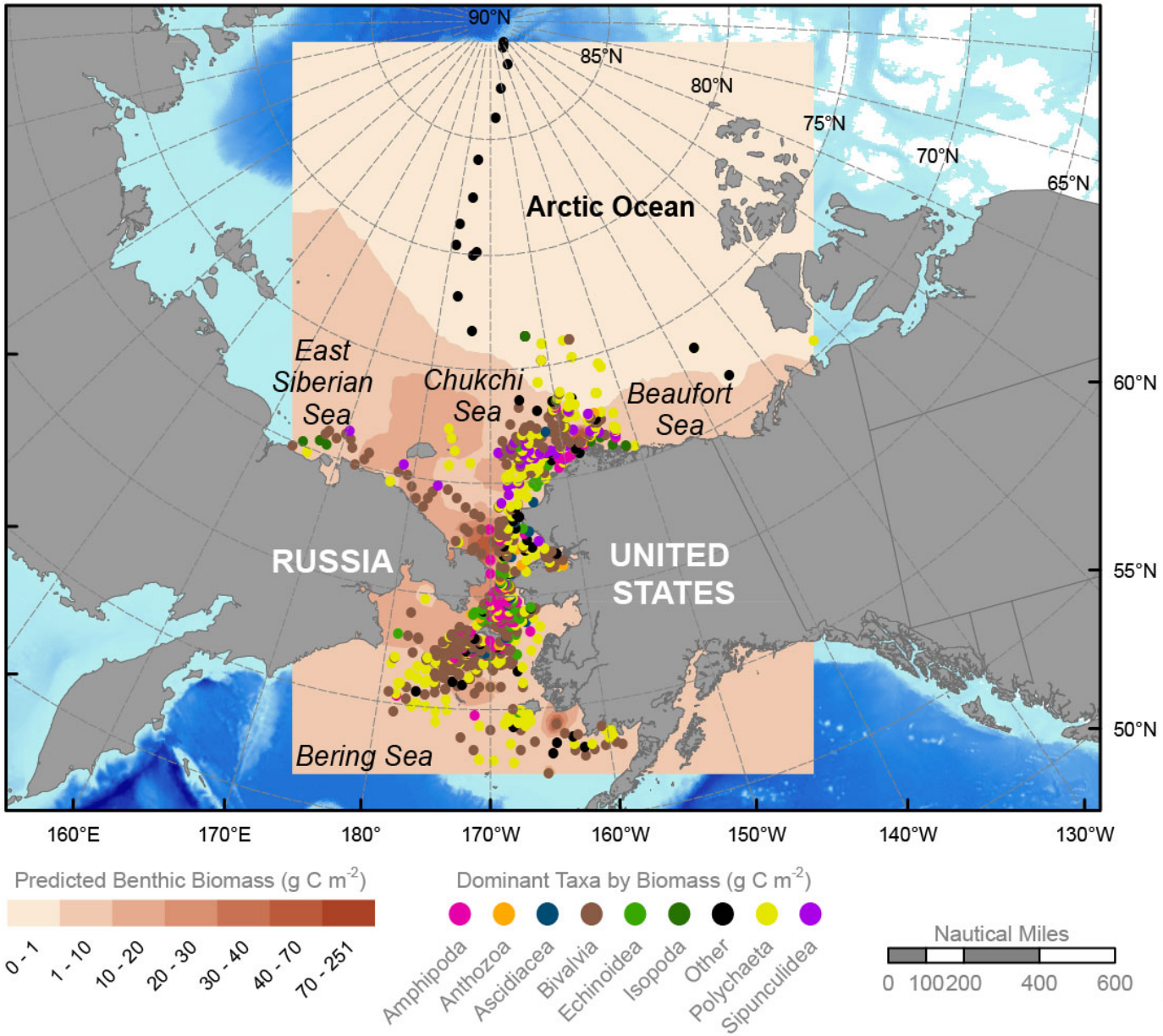


Increase at lower slope region 1000m

[Bluhm et al. 2020, FMAS}

- Vertically integrated dry weight biomass of mesozooplankton over slopes (20 to bottom depth of ≥1000 m) show enhanced biomass over slopes (modidfied from Kosobokova and Hirche, 2009, Smoot and Hopcroft, 2017)

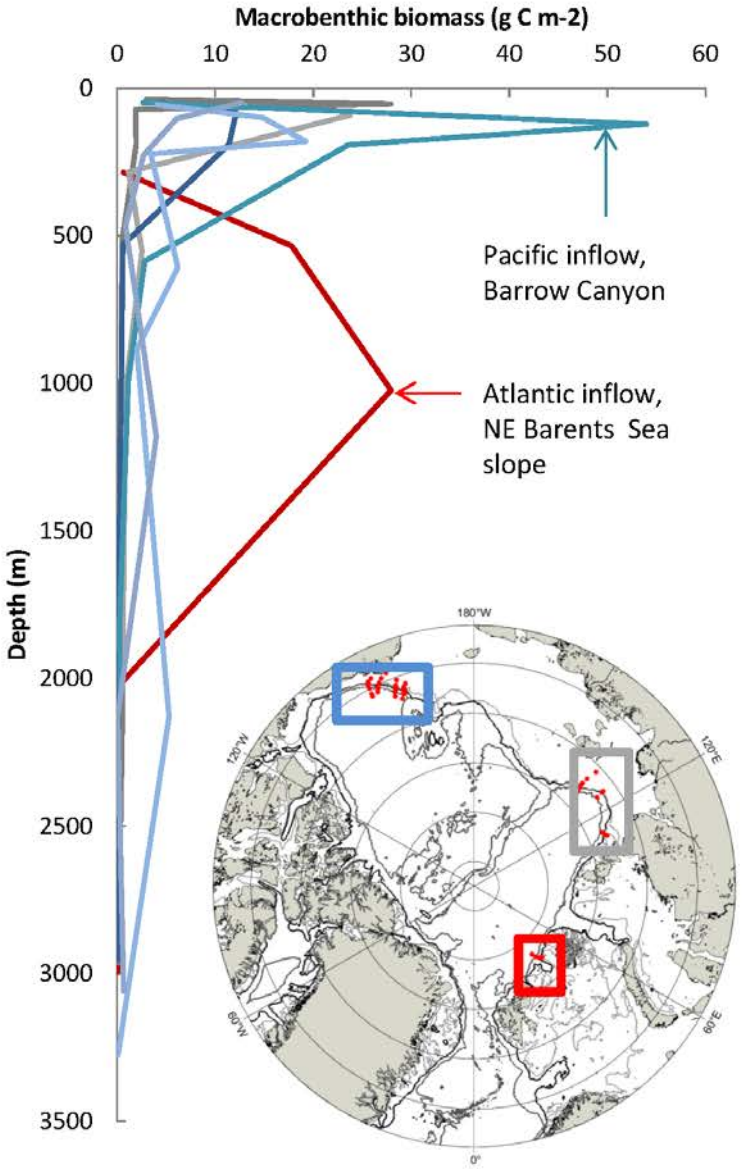
Distribution of macroinfaunal station biomass (g C m^{-2}) and dominant infaunal over four decades (1970-2012) in the Pacific Arctic



- Limited biogeochemical and biological studies on the outer continental shelf and slope regions of the East Siberian and Chukchi Seas as well as Chukchi Borderland and Arctic basin

[Bluhm and Grebmeier 2011]

Macrofaunal Benthic Biomass over shelf-slope in the Pacific and Atlantic Arctic

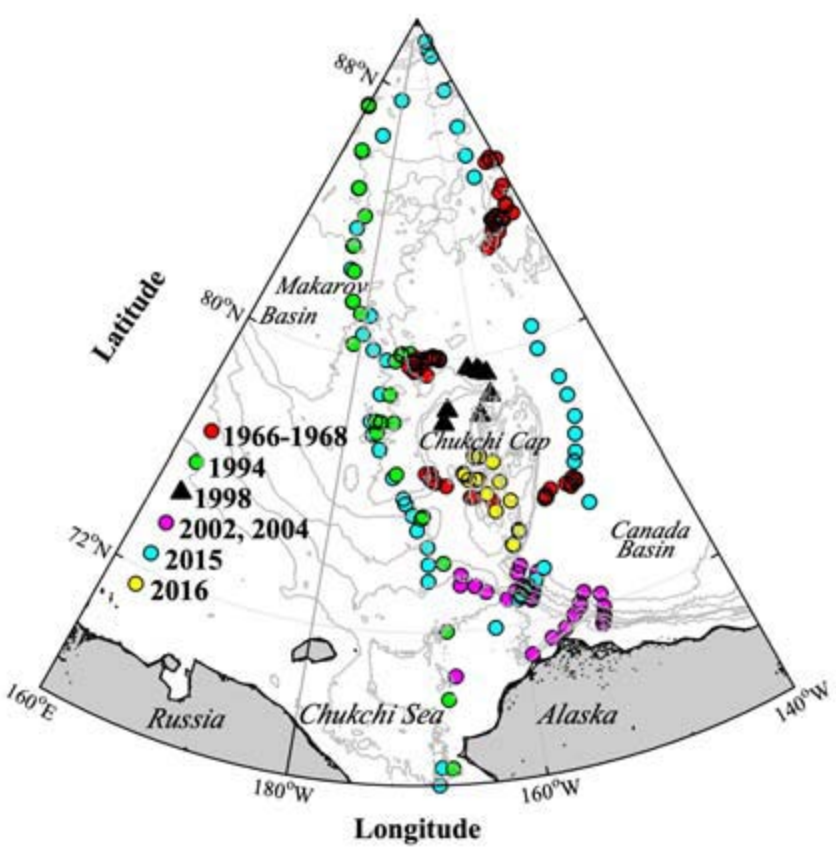


- Macrofaunal biomass highest on upper slope downstream of Barrow Canyon within Pacific Arctic inflow to Arctic Basin
- By comparison, macrofaunal biomass highest on the lower NE Barents Sea slope of Atlantic inflow to Arctic Basin

[Bluhm et al. 2020, FMAS]

Proposed USA SAS Cruise, Aug-Sept 2021

[USCGC Healy or other international icebreaker; coordination with other ongoing cruises]



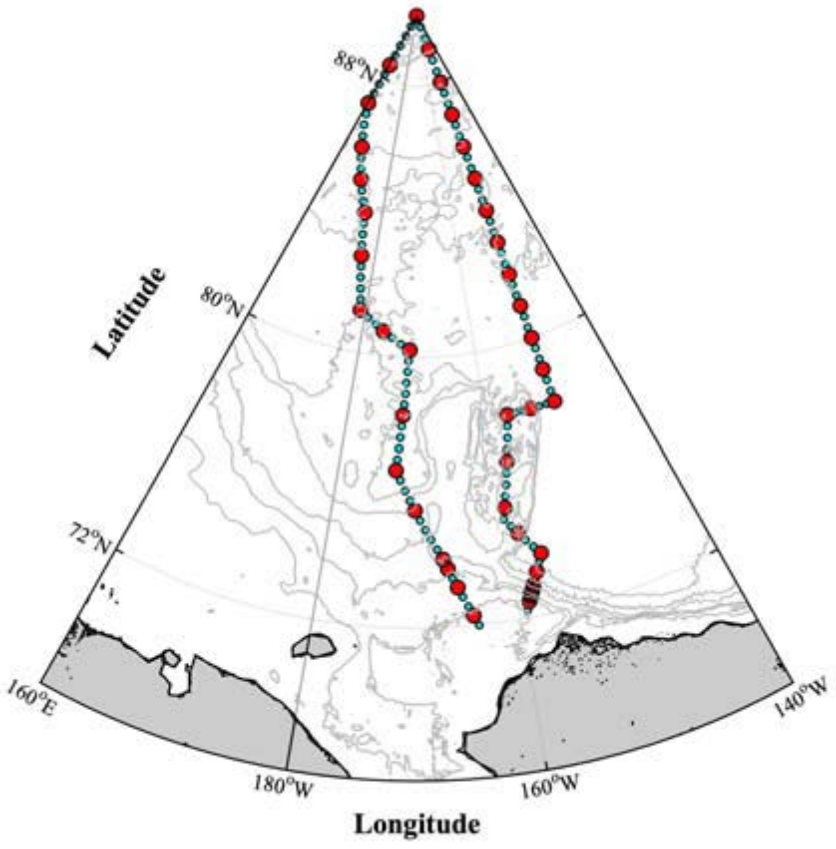


Figure. (Left) Historic summer stations in the Canadian Basin, including T-3 (1966-1968), AOS (1994), SHEBA (1998), SBI (2002-2004), Arctic GEOTRACES (2015), and Hidden Ocean (2016). (Right) DRAFT cruise track for 2021. Locations subject to change based on ice conditions, cruise scheduling, and water mass distributions. Red=Long Stations; Cyan=Short Stations.

[courtesy Carin Ashjian and US SAS SSC]

International SAS Essential Ocean Variables

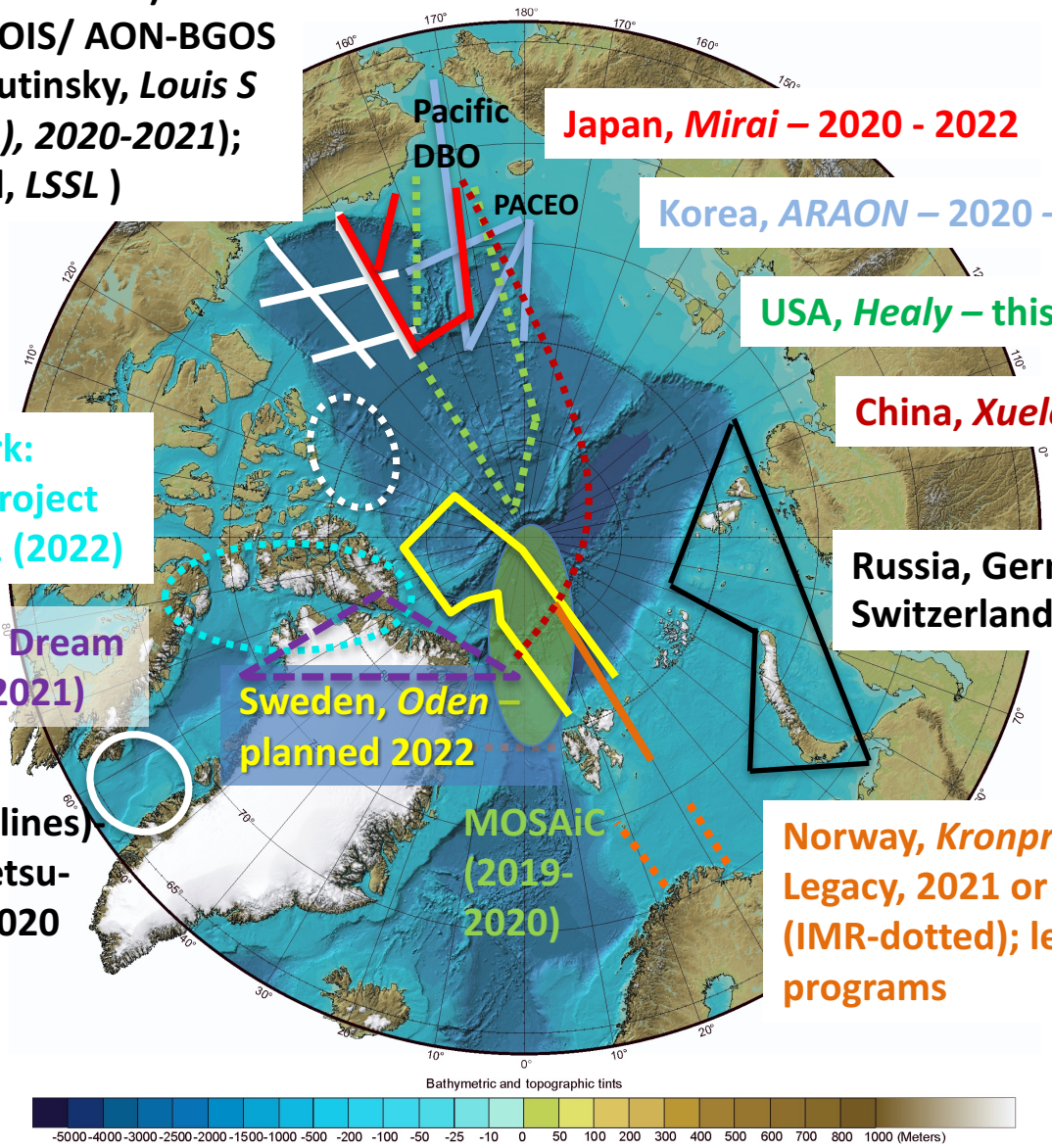
Box 2. Essential Ocean Variables (EOVs) of the SAS
('*' indicates variable here proposed to be measured)

Physical	Pressure*
	Temperature*
	Salinity*
	Velocity*
	Transmissivity*
	Meteorological Measurements*
	Ice Characteristics
	Microstructure
	Seafloor Depth*
	Sediment Characteristics*
	Gravimetry*, Magnetometry
Biogeochemistry	Dissolved Oxygen*
	Nutrients (NO_3/NO_2, PO_4, SiO_3)*
	CDOM Fluorescence
	Chlorophyll* (pelagic, benthic)
	CFCs and SF_6
	DIC*, DOC*, POC*
	Total Alkalinity*
	pH*
	Methane
Ecosystem	Abundance/Biomass of Viruses, Bacteria, Phytoplankton, Micro- Meso-* and Macro-zooplankton, Benthic Meio-, Macro-*, and Epi-fauna, Epontic Organisms, Ichthyoplankton, Fish, Seabirds, Marine Mammals
	Net Community Production from O_2-Ar* & Nutrients
	Primary Production (^{13}C incubations, O_2 Isotopes*)
	Respiration of Different Trophic Levels*
	Elemental Composition* (C, N, stable isotopes)
	eDNA
	Molecular Voucher Specimens*

- Essential Ocean Variables (EOVs) as part of SAS activities (*EOVs in US NSF proposal)
- Goal: Standardize select variable for all SAS cruises
- Added additional variables for atmospheric and satellite observations
- NSF proposal by US SAS Science Advisory Committee-submitted Sept 2020
- If successful, 50% ship open for other participants to submit proposals (national and international participants; also will connect with ongoing shelf science programs
- Have suggested that SAS could be a "flagship" activity of IARPC (US Interagency Arctic Research Policy Committee)

International SAS Cruises: Confirmed and Planned

Canada, USA (white lines) - collaborations: JOIS/ AON-BGOS (Williams/Proshutinsky, *Louis S St. Laurent (LSSL), 2020-2021*); LIA-MPA (Michel, *LSSL*)



Japan, *Mirai* – 2020 - 2022

Korea, *ARAON* – 2020 – 2022

USA, *Healy* – this proposal 2022

China, *Xuelong – 2020, 2021?*

Canada/Denmark: Pikialasorsuaq Project and BBOS - 2021 (2022)

Russia, Germany, Switzerland – 2021

Denmark: Polar Dream Project (*Dana*, 2021)

Sweden, *Oden* – planned 2022

MOSAiC (2019-2020)

Canada, USA (white lines)- Davis Strait (Lee/Azetsu-Scott, *Armstrong),* 2020 (2021)

Norway, *Kronprins Haakon* (Nansen Legacy, 2021 or 2022-solid), *G.O. Sars* (IMR-dotted); leveraging existing programs

[updated B. Williams and J. Grebmeier, Sept 2020]

ASSW March 20-26, 2021 Theme: Observing the Arctic
Session ID: 17 - The Synoptic Arctic Survey (SAS) Activities
Convenors: Grebmeier, Paasche, Goethel, abstract deadline November 30, 2020

Abstract

The Central Arctic Ocean remains profoundly understudied, particularly carbon cycling, ecosystem alteration, and associated changes in atmosphere, ice and ocean physics that influence those biological and biogeochemical systems. The region is expected to continue to make marked changes over the next decades, driven by ongoing climate warming, yet our understanding of key process is limited for this area. The international Synoptic Arctic Survey (SAS) seeks to quantify the present states of the physical, biological, and biogeochemical systems of the Arctic Ocean. Multiple countries have both confirmed and pending cruises as part of the 2020/2021 SAS networked activities. Key goals of the SAS are to establish the present state of the Arctic system, to document temporal changes where possible through comparison with historical data, and to quantify linkages between the adjacent shelves, slopes, and deep basins, objectives that are shared with the broader Pan-Arctic effort of the composite SAS. The SAS consists of regional shelf-to-basin ship-based surveys in 2020 and 2021 to obtain a Pan-Arctic understanding of essential ocean variables (EOVs) on a quasi-synoptic, spatially distributed basis in which no single nation bears the full burden of collecting the requisite data. The multi-country field effort will provide a strong basis for educational opportunities for early career scientists. This SAS session will outline the benchmark and important legacy for SAS activities to future, quasi-decadal assessments of rapid and evolving Arctic Ocean system change. Updates on the 2020 SAS field program results and upcoming national plans for 2021 activities will be provided during the session.

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Thank you for your attention. Any questions?

http://www.synopticarcticsurvey.info/splan.html
https://web.whoi.edu/sas2019/

SAS Virtual workshop #17; abstracts due for ASSW2020 November 30 2020