# Synoptic Arctic Survey

# Synoptic Arctic Survey (SAS) International Synthesis Workshop Report

#### Dates: June 7-9, 2023

Venue: Clark Building, 5<sup>th</sup> Floor, Woods Hole Oceanographic Institution, Massachusetts, USA

### Summary of agenda

#### Day 1 (June 7)

- Welcome and logistics Carin Ashjian
- Overview of the SAS Program Øyvind Paasche
- Overview of cruises by country with focus on synthesis Country Representative/Chief Scientist
- Individual Presentations (10 minutes each + 5 min questions) of envisioned synthesis papers

#### Day 2 (June 8)

- Open discussion on ideas for synthesis plenary
- Open discussions to identify synthesis papers in 3 disciplinary break-out groups: physical oceanography, biogeochemistry, and ecosystems to plan synthesis papers regarding core questions, themes, data availability and potential working groups.
- Brief out summaries from each break-out group plenary
- Second set of break-out groups to discuss specific synthesis papers
- Brief out summaries from second break-out groups plenary
- Poster session

#### Day 3 morning (June 9)

- Summary of Day 2 and planning of how to proceed with the synthesis plenary
  - Go through the list of potential synthesis papers and assign working groups
  - SAS in a bigger context (IPY2032-33, UNDOS Action) Øyvind Paasche
  - Special issue Are Olsen
  - Data management issues Are Olsen
  - Recruiting new people to SAS, including early career researchers Are Olsen
  - Next meetings Carin Ashjian
    - Nansen Legacy science conference Nov. 2023 Dinner meeting
    - OSM Feb 2024- SAS Town Hall meeting and High Arctic session
    - ASSW23 Edinburgh, Scotland-Mar 2024, Session deadline Sept 30, 2023

# Summary of notes

#### Day 1

The country representatives gave an overview of each country's contribution to SAS with regards to where the cruises had been, which data was collected and what papers are envisioned and/or in writing/review. These presentations provided a collective overview of what has been done so far and were a good basis for the discussions planned for the next days. The overview presentations per country and the individual presentations can be found at the SAS international website: <u>https://synopticarcticsurvey.w.uib.no/</u>.

#### Day 2

Ideas for synthesis: SAS atlas like WOCE – suggested by Mary-Louise Timmermans The World Ocean Circulation Experiment (WOCE) resulted in an electronic collection of ocean atlases: <u>http://woceatlas.ucsd.edu/</u>. It displays the physical and chemical properties in four volumes, one for each ocean: the Southern, the Pacific, the Atlantic and the Indian. The data was measured in a comprehensive global hydrographic survey in the 1990s. There is no atlas for the Arctic Ocean, but SAS has collected the necessary hydrographic for such an atlas.

An SAS atlas is a great way to visualize the hydrographic data of SAS, which is useful both for scientists, students, and the public to get a general idea of the region/area. It would mainly be hydrographic section plots, and no freshwater maps, but biogeochemistry and ecosystem data can be added in the same way as WOCE section plots that are colored with a different color for each nutrient. It will not only be an outreach project and teaching tool, but could also have a DOI like a dataset, and be connected to the cruise datasets and synthesis papers.

Making an SAS atlas will force us to bring data together and be a good start for an overview paper. It will require quite some effort to make the section plots, so it would be great if someone would be paid to do so. We should restrict the efforts to the pan-Arctic snapshot of SAS, which is August-October 2020-2022. Additional temporal scale/seasonality and/or other cruise data can be considered at a later stage, for instance to provide context in an appendix of the atlas. No other atlas effort is known, and thus the suggestion of making an SAS atlas was broadly supported by the workshop participants.

#### Ideas for synthesis: Identify potential papers - convened by Are Olsen

We have the 9 research questions to answer and many of the papers suggested in the presentations on day 1 were individual papers from one cruise and not the pan-Arctic studies that had been envisioned as the synoptic synthesis of results. We decided in plenary to divide into disciplinary break-out groups and consider the following questions:

- What synthesis paper are you ready to write together?
- Which of the 9 SAS research questions are still relevant? Which can be answered?
- Are there other questions that need to be addressed?
- What info do you need from the other disciplines?





#### Summary of the first set of break-out groups

The physical oceanography (PO) break-out group focused on the SAS research question #1: The state of heat and freshwater in the Arctic Ocean 2020-2022 as getting it out soon is particularly valuable with the current geopolitical situation. They planned to use CTD, O18, nutrients and CDOM data and would need one person from each cruise for data sharing and harmonization. They would need help from the biogeochemists to attribute water mass fractions, layers, sources, and sinks. They also saw that the data analysis has a clear relation with the atlas and that the SAS research questions #2 and #3 can be answered, but that these would best be addressed after #1 is completed. A map of all cruise tracks and station locations would be very useful.

The ecosystem (ECO) break-out group discussed which aspects of the SAS research questions #4-6 could be answered with the data collected as not all cruises collected that many biological parameters. They came up with 6 synthesis papers. Primary production data is highly dominated by seasonality and therefore best estimated with integrative measures for comparison between regions. A synthesis paper on the state of the ecosystem in the Arctic would be closely related to a synthesis paper on signs of migrating species and predictions thereof. First step towards a synoptic study of the Arctic ecosystem is to make the cruise matrix more specific to see how many observations are in each location (like a heat map?).

The biogeochemistry (BGC) break-out group focused on the carbon cycle and ocean acidification. They identified 6 synthesis papers to cover various aspects of research questions #7-9 that can be answered and assigned participants to lead the corresponding working groups (see overview on Google Drive table). The data should follow a template that has Exchange format files (ascii files) with standardized units. Are Olsen will make this template and upload it to a common SAS folder at Google Drive that is protected. The data should go through a quality control as is performed at Glodap, so everyone is encouraged to send the individual cruise data to the next GlodapV3 year 2025.

#### General discussion in plenary

Each break-out group shared a summary of their discussions (see summaries above). The proposed synthesis papers by each group were discussed in plenary and rearranged and adjusted. It became obvious that the PO-group and ECO-group had some synergies with regards to the relation between heat and primary production, especially algae bloom.

#### Summary of the second set of break-out groups

The water mass, heat budget, fresh water and algae bloom study was convened by Mary-Louise Timmermans. Knowledge between disciplines was exchanged. The group agreed to ensure that the paper would give a pan-Arctic overview and zoom on some regions with good data coverage and interesting details. The study will start with ocean circulation in SAS





profiles incl. atmospheric conditions, then compare the Atlantic water in the Pacific sector with the Pacific water in Fram Strait and its effects on the North Atlantic. Lee Cooper and Melissa Chierici will help with nutrient signature of water masses. The following points were noted:

- The state of heat and fresh water that will be reported for the Arctic Ocean should be consistent with data from lower latitudes that is used for IPCC reports.
- We must be careful with surface water up to a depth of 30 meters as this is influenced by seasonality. Claire Gaffrey, a PhD student of Karen Frey has measured Chlorophyl-A and phytoplankton and it seems that local heating of sea water depends on the amount of solar radiation and what can absorb this in the water column.
- 2021 was a record year with low sea ice in Fram Strait and high temp in Greenland Sea because of a long period of Southerly wind.
- The SAS atlas sections with data should have the same format and be linked to a common Ocean Data View dataset/folder to share.

#### Day 3

#### Plenary discussions

We assigned working groups and a lead person to each planned synthesis paper. Each working group must write a small paragraph to circulate to the broader SAS community by July 3. We discussed the plan for each synthesis paper in plenary. The overview paper can have the same author list approach as for MOSAIC with each cruise team being an independent author. The choice of journal depends on the content (historic, geopolitical, or natural scientific?), but a concise note in Science or Nature would of course be great. More details on each synthesis paper will come from the working groups.

SAS in a bigger context was raised and plans to bring SAS into the ICARPIV planning and get UNDOS endorsement were discussed.

2 special issues Data management Recruitment of new people

## Actions and outcomes

Carin Ashjian will ask NSF to pay a person to make the section plots for the SAS atlas
Establish a working group for the SAS atlas led by Carin Ashjian and Mary-Louise
Timmermans

3: Assemble working groups for each synthesis paper, make overview in Google Drive table (done on day 3, confirmations in progress per email).

4: Agree on a timeline for the working on synthesis papers, first step is a short description of paper (just a paragraph) to be written by July 1 and shared on common Google Drive folder.5: SAS secretariat makes map of cruise tracks and station locations





6: Make a protected Google Drive folder for sharing BGC data

7: Heidemarie Kassens will submit an idea about SAS to ICARPIV

8: SAS secretariat will apply for UNDOS endorement



Group photo of the participants in the SAS synthesis workshop. Photo credit: Jackie Grebmeier





Contact	informatio	n of par	ticipants
---------	------------	----------	-----------

First name	Last name	Email address	
Carin	Ashjian	cashjian@whoi.edu	
Maria Cristina	Alvarez	alvarmar@oregonstate.edu	
Ashley	Arroyo	ashley.arroyo@yale.edu	
Maurizio	Azzaro	maurizio.azzaro@cnr.it	
Manuel	Bensi	mbensi@ogs.it	
Maria Teresa	Bezem	Maria.Bezem@uib.no	
Marcia	Campbell	mcampbell6@umassd.edu	
Robert	Campbell	rgcampbell@uri.edu	
Jenny Melissa	Chierici	melissa.chierici@hi.no	
Tia	Chung-Swanson	tchungsw@uci.edu	
Lee	Cooper	cooper@umces.edu	
Seth	Danielson	sldanielson@alaska.edu	
Jessica	Drysdale	jdrysdale@whoi.edu	
Adam	Fagan	afagan@uci.edu	
Agneta	Fransson	agneta.fransson@npolar.no	
Karen	Frey	kfrey@clarku.edu	
Rafael	Goncalves Araujo	rafgo@aqua.dtu.dk	
Jacqueline	Grebmeier	jgrebmei@umces.edu	
Heidemarie	Kassens	hkassens@geomar.de	
Cedric	Magen	cmagen@umd.edu	
Annika	Margevich	annika.margevich@yale.edu	
Priscilla	Mooney	prmo@norceresearch.no	
Shigeto	Nishino	nishinos@jamstec.go.jp	
Are	Olsen	are.olsen@uib.no	
Øyvind	Paasche	oypa@norceresearch.no	
Robert S.	Pickart	rpickart@whoi.edu	
Cheryl	Rosa	crosa@arctic.gov	
Savannah	Sandy	ssandy3@alaska.edu	
Leonard	Sussman	Lsuss410@pipeline.com	
Mary-Louise	Timmermans	mary-louise.timmermans@yale.edu	
John	Wigglesworth	jcwiggs11@gmail.com	
Yun	Li	yunli@udel.edu	
Paul Arthur	Berkman	pberkman@law.harvard.edu	
Pauline	Snoeijs Leijonmalm	pauline.snoeijs-leijonmalm@su.se	
Kyoung Ho	Cho	kcho@kopri.re.kr	
Jee-Hoon	Kim	jeehoonkim@kopri.re.kr	
William	Williams	bill.williams@dfo-mpo.gc.ca	
Kumiko	Azetsu-Scott	Kumiko.Azetsu-Scott@Dfo-mpo.gc.ca	



