CAMAS 2025: Continuing to Advance Arctic Marine Science

The Consortium for the Advancement of Marine Arctic Science (CAMAS) continues its mission to advance Arctic marine science during its second annual workshop

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Summary

The Consortium for the Advancement of Marine Arctic Science (CAMAS) held its second annual Workshop and Early-Career School in Seattle, WA, on April 15-18, 2025. The workshop attracted 74 participants, including a dozen scientists from Europe (8) and Asia (4). The goal of CAMAS is to facilitate and enhance international collaboration on marine Arctic science, in order to advance the understanding and model representation of key marine Arctic processes that contribute to the rapid changes in the Arctic Earth system. These rapid changes have profound impacts on operations in the Arctic, including those associated with the national and energy security of the United States.

The Early-Career School started the event on Tuesday April 15. Thirty-three early-career scientists (postdocs and students) gathered for lectures and discussions on topics like high-resolution Arctic Ocean and sea ice modeling; biogeochemistry of the Arctic; Machine Learning for Arctic Earth system modeling; and an Arctic perspective on geo-engineering.

The workshop consisted of a series of presentations and discussion sessions on the three main themes of the workshop, namely:

- Drivers and impacts of ocean heat and freshwater transport into and out of the Arctic
- Ocean-ice-atmosphere interactions in a warming Arctic
- Biophysical impacts of Arctic marine biogeochemistry

Additional sessions focused on key relevant topics such as sea ice predictability; interactions between the Arctic marine environment and ice sheets, as well as the terrestrial domain; and advances in observing and modeling the Arctic marine environment.

A key program element was a series of breakout sessions that enabled project teams to discuss collaborative projects. An American Geophysical Union (AGU) Special Collection has been secured that will allow the teams to publish their findings on a dedicated platform.

Knowledge Gaps and CAMAS projects

The meeting participants identified several knowledge gaps that limit our understanding of the Arctic marine environment, and hence our ability to accurately model and predict variability and changes in the Arctic sea ice and ocean system in the coming decade. Project teams self-organized during a series of breakout sessions and discussed collaborative projects to address these gaps. Among these issues are:

- After a gradual decline followed by a dramatic drop in 2007, the overall extent of Arctic sea ice has remained more or less stable, despite the continued warming that has affected other elements of the Arctic Earth system. Understanding this behavior is key to improving our predictions of Arctic sea ice conditions on interannual timescales. A CAMAS team will carefully investigate the causes of this hiatus in Arctic sea ice decline in observations and a series of numerical models of the Arctic ocean/sea ice system.
- Arctic cyclones are rare synoptic atmospheric events that have been observed to impact sea ice. It is not clear whether these events have a long-term impact on sea ice, or whether their impact is only temporary. A project team will compare the impact of historical events on the ocean/sea ice system in a number of numerical models, and compare with available observations to understand the overall impact of severe Arctic storms on the ocean/sea ice system.
- The stratification, or the interlayering of waters with different salinity and temperature properties, is a critical factor in determining the acoustic properties of the Arctic Ocean, a key driver of sea ice variability and change, and, through its impact on water mass transformations, an important control on the global overturning circulation. However, this stratification is generally poorly represented in global and regional Earth system models. Several project teams will collaboratively address this bias by systematically investigating the processes that are responsible for maintaining the stratification in models of the Arctic Ocean.
    - One team will carefully investigate the mixing processes that maintain the stratification of the Arctic Ocean and consider ways to improve the representation of these processes, and hence the stratification, in numerical models.
    - A second team will focus specifically on the pathways of different sources of freshwater through the Arctic Ocean, by performing coordinated dye tracer experiments in numerical ocean models. The goal is to understand in particular the recent freshwater accumulation in the Beaufort Gyre, which, once released, can have profound impacts on the global ocean circulation.

    - Another team will evaluate the transports through the gateways that connect the Arctic Ocean to the North Atlantic and North Pacific Oceans, by carefully comparing model-predicted gateway transports with those inferred from monitoring arrays and other observations. Numerical models show that there is a strong relationship between Arctic sea ice and heat transports into the Arctic Ocean, demonstrating the need to better constrain the gateway transports in Earth system models.
    - Finally, a team will investigate the water masses properties of the Pacific sector of the Arctic Ocean by applying a Machine Learning technique to a new data set of high-quality hydrographic observations. The water mass classifications will be compared with those from numerical models of the Arctic Ocean to investigate these models' ability to accurately represent these water masses.
- Phytoplankton blooms are a foundational component of the Arctic marine ecosystem, play a major role in the carbon cycle of the Arctic, and influence thermal stratification via their ability to absorb downwelling shortwave energy. Continued warming of the Arctic will increase their importance as a component of the Arctic Earth system. However, observational challenges limit our understanding of these blooms in the harsh Arctic environment. Several collaborative efforts will address this knowledge gap.
    - One effort will focus on under-ice pelagic plankton blooms, which are suspected to have a significant but highly uncertain impact on the carbon budget of the Arctic Ocean. The team will compare the representations of these plankton blooms in models with recent observations.
    - Arctic rivers drain a significant fraction of the Arctic and sub-Arctic land regions, and are a source of nutrients and carbon for the Arctic Ocean. A team will compare the representation of Arctic river transports in regional and global Earth system models, in order to understand how river inputs can drive changes to coastal Arctic heat, nutrients and carbon budgets.
    - Another effort will focus on the representation of fall phytoplankton blooms in the Pacific Arctic in Earth system models and a comparison with a set of recent high-quality observations. Observations show that fall phytoplankton blooms are increasing in prevalence. Mechanisms for mixing and resupply of nutrients to the euphotic zone, such as cyclones, will be investigated among a suite of models to determine their impact on the initiation of late season phytoplankton blooms.

Acknowledgements

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Appendix A: Pictures

Figure 1: Early-career scientists enjoyed presentations by several Arctic marine experts, including Professor Georgy Manucharyan (U. Washington).

Figure 2: Participants of breakout sessions engaged in productive discussions about collaborative projects.

Figure 3: Group photo of CAMAS 2025 workshop participants.

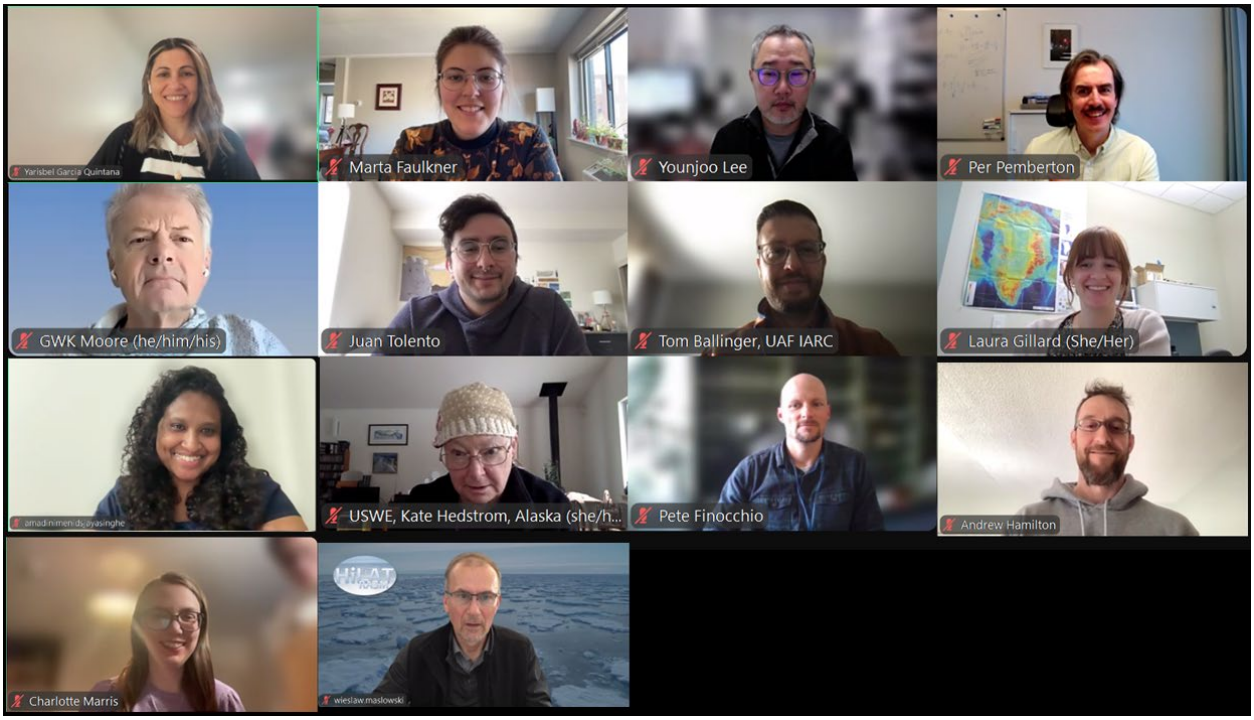

Figure 4: Screenshot of CAMAS 2025 remote workshop participants.

Appendix B: List of Participants

First Name	Last Name	Affiliation
Vladimir	Alexeev	University of Alaska Fairbanks
Rainer	Amon	Texas A&M University
Tom	Ballinger	University of Alaska Fairbanks
Benjamin	Barton	National Oceanography Centre
Katerina Isabel	Benevides	Student Presenter Early Career Scientist
Clement	Bertin	Jet Propulsion Laboratory
Emma	Boland	British Antarctic Survey
Sawyer	Brand	Los Alamos National Laboratory
Samuel	Brenner	California Institute of Technology
Wei	Cheng	University of Washington
Nan-Hsun	Chi	University of Washington
Jackie	Clement Kinney	Naval Postgraduate School
Jacob	Cohen	University of Washington
Sylvia	Cole	Woods Hole Oceanographic Institution
Fiona	Davidson	University of Alberta
Tyler	De Jong	University of Britich Columbia
Inge	Deschepper	University of Alberta
Jakob	Dörr	University of Bergen
James	Doyle	U.S. Naval Research Laboratory
Patrick	Farnole	University of Victoria
Marta	Faulkner	Woods Hole Oceanographic Institution
Michaela	Fendrock	Alfred University
Peter	Finocchio	Naval Research Laboratory
Reed	Fitzpatrick	University of California, Riverside
Clare	Gaffey	Oregon State University
Yarisbel	Garcia Quintana	University of Toronto Mississauga
Georgina	Gibson	Los Alamos National Laboratory
Laura	Gillard	University of Alberta
Ruijian	Gou	Ocean University of China
Antoine	Haddon	University of Victoria
Andrew	Hamilton	University of Alberta
Camille	Hankel	University of Washington
Kate	Hedstrom	University of Alaska Fairbanks
Trevor	Hillebrand	Los Alamos National Laboratory
Lilli	Hirth	MIT/WHOI
Yiling	Huo	Pacific Northwest National Laboratory
Laurie	Juranek	Oregon State University
Who	Kim	NSF National Center for Atmospheric Research
Dong-Geon	Lee	Pohang University of Science and Technology
Yu-Chi	Lee	University of California, Riverside
Younjoo	Lee	Naval Postgraduate School
Lingwei	Li	University of Colorado Boulder
Caili	Liu	Ocean University of China
Georgy	Manucharyan	University of Washington
Charlotte	Marris	University of Oxford

Wieslaw	Maslowski	Naval Postgraduate School
Amadini	Mendis Jayasinghe	Los Alamos National Laboratory
Sergey	Molodtsov	Los Alamos National Laboratory
Kent	Moore	University of Toronto
Paul	Myers	University of Alberta
An	Nguyen	The University of Texas at Austin
John	Oklu	University of North Carolina Wilmington
Mukulika	Pahari	University of Alberta
Aidan	Parfett	University of British Columbia
Per	Pemberton	Swedish Meteorological and Hydrological Institute
Jaynise M	Perez Valentin	University of Washington
Romina	Piunno	University of Toronto
Spenser	Ross	University of Toronto
Carlyn	Schmidgall	University of Washington
Xuan	Shan	Woods Hole Oceanographic Institution
Lars	Smedsrud	University of Bergen
Katherine	Smith	Los Alamos National Laboratory
Michael	Steele	University of Washington
Harry	Stern	University of Washington
Daniel	Stern	Naval Research Laboratory
Anna-Marie	Strehl	University of Bergen
Juan	Tolento	University of California, Irvine
Milena	Veneziani	Los Alamos National Laboratory
Qiang	Wang	Alfred Wegener Institute
Stephanie	Waterman	University of British Columbia
Wilbert	Weijer	Los Alamos National Laboratory
Tahya	Weiss-Gibbons	University of Alberta
Jiaxu	Zhang	University of Washington
Yuanxin	Zhang	Japan Agency for Marine-Earth Science and Technology