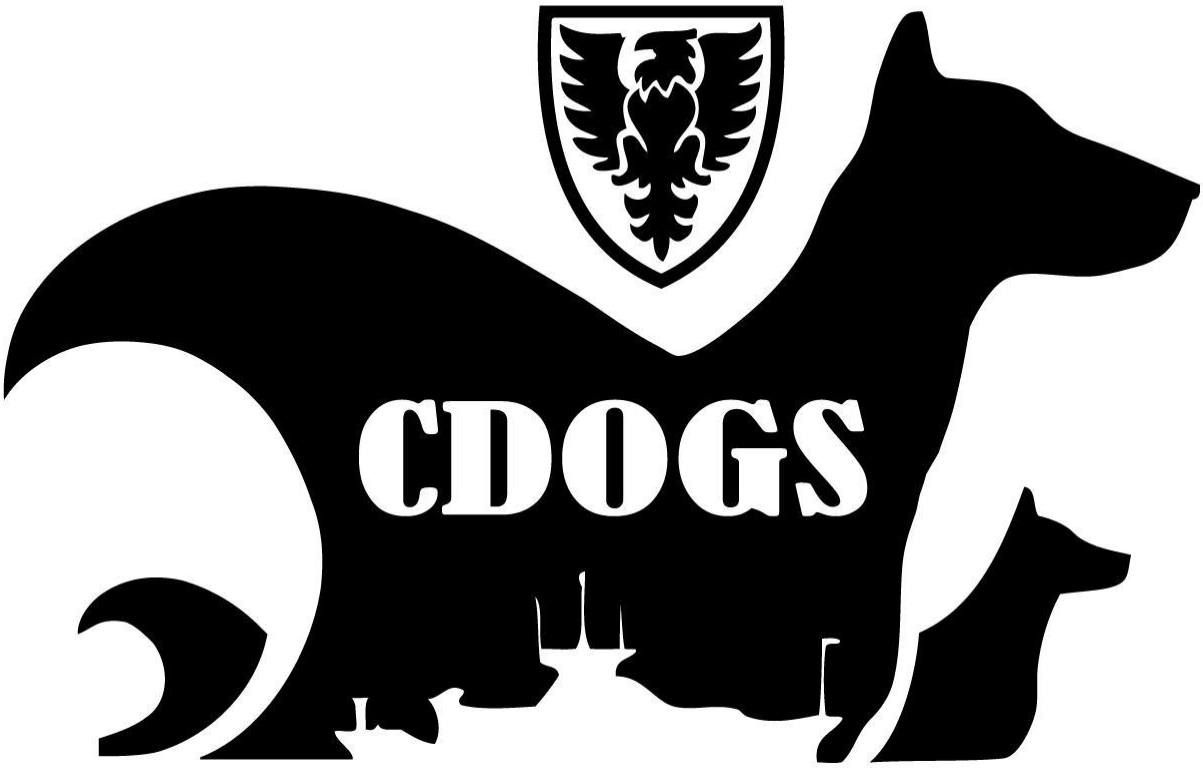

CDOGS 2024

Conference of Dalhousie Oceanography Graduate Students

Friday March 22, 2024

8:30 – 17:00, McInnes Room, DSU Building

Reception: 17:30 – 21:00, Bev Myers Room, DSU Building

Dalhousie University, Halifax, Nova Scotia

Schedule

9:10: ***Opening Remarks***

9:25: ***Dylan Seidler***

9:40: ***Claire Haar***

9:55: ***Kit Tymoshuk***

10:05: ***Adam White***

10:20: ***Coffee Break***

10:45: ***Kevan Merrow***

11:00: ***Rhyl Frith***

11:15: ***Caitlin Huard***

11:30: ***Lina Garcia-Suarez***

11:45: ***Adam Stoer***

12:00: ***Ocean Frontier Institute***

12:10: ***Lunch/Booths***

1. CMOS

2. OFI

3. RBR

4. Planetary

5. OTN

13:15: ***Dr. Carly Buchwald***

Plenary Talk - Stable Isotopes: The Key to Deciphering the Oceanic Nitrogen Cycle

13:45: ***Qiantong Pei***

Storm-Induced Hydrodynamic Changes and Wave-Current Interaction over the Southeastern Canadian Shelf during Hurricane Fiona *15*

14:00: ***Ajatshatru Balaji***

On Wave-generated Sea-spray Aerosols in the Bedford Basin *16*

14:10: ***Yucheng Zi***

Roles of Planetary Waves during Fast and Slow Sudden Stratospheric Warming Events *17*

14:25: ***Kamden Thebeau***

Localizing North Atlantic Right Whales Using a Deformable Sonobuoy Grid *18*

14:40: ***Coffee Break/Poster Session***

Jacob MacDonald

Mechanistic Breakdown of Bedford Basin Intrusion Events Using a High-Resolution Regional Model

Lara Mitchell

Optimizing nutrient delivery and sterilization techniques and improving the methods for monitoring nutrient consumption throughout the hatchery season for Saccharina latissima

Michael Solomon

Site Suitability for Kelp Aquaculture in Nova Scotia using Multi-Criteria Decision Analysis

Nicole Neriuoka

A Climatology of Polynyas Along the Labrador Coast and Shelf Region

Ainhoa Fournier

Testing the tests: analysing and developing methods of characterizing phenotypes of Saccharina latissima in Nova Scotia, Canada

Mackenzie Burke

Effects of acute simulated Ocean Alkalinity Enhancement on natural phytoplankton assemblages in the North Atlantic Ocean

Emile Weber

Nutrient Budget Assessment of the Bedford Basin: 2002 to 2022

Kate Metcalfe

Mapping Lobster Habitat in the Northumberland Strait

Daniel Ng

Mapping benthic habitats of the Bras d'Or Lake / Pitu'paq, Cape Breton Island, Nova Scotia

Maija McGraw

The Elemental Stoichiometry of Mesozooplankton Taxa in the Labrador Sea

Anna Victor

Sensor Response Corrections for RBR Argo CTDs

Gwenyth Logan

Improving Sound Mapping Methods Using Data Assimilation in the Strait of Georgia

15:25: *Emma Taniguchi*

iKaluk: An Overview of Arctic char Fishery in Nunatsiavut to Support Inuit Food Security

Dylan Seidler

Seidler, D. (Department of Oceanography, Dalhousie University, Halifax, Nova Scotia, Canada)

Arctic char (*Salvelinus alpinus*) are one of three essential dietary staples for Inuit communities in Nunatsiavut. As the climate continues to change across the Inuit Nunangat or homeland, Caribou numbers have declined and local communities are increasing their reliance on char for sustenance. Nunatsiavut is an Inuit Governed territory established in 2005 through the Labrador Inuit Land Claims Agreement. This agreement allocated 100% of Arctic regional char quota licenses, issued by the Department of Fisheries and Oceans Canada (DFO), to the Nunatsiavut Government. Due to a combination of lifecycle complexity and a history of inconsistent broad-scale federal monitoring support, abundance estimates for Arctic char residing in Nunatsiavut waters have high uncertainty. Therefore, it is unclear how many char will be there for future generations. On a place-based level, the Arctic char fishery is knowledge rich, with a local history of documenting char migrations since time immemorial. Yet, this fishery has been historically categorized by DFO as "data deficient." Through a data synthesis report this presentation will provide a glimpse into the history of the char fishery in Nunatsiavut and illustrate how different types of knowledge and data must be included in order to get a holistic estimate of char populations. As the project is in its early stages, this talk will specifically focus on providing an overview of the char fishery by bringing qualitative and quantitative data sources together to identify gaps in population knowledge that will be filled in subsequent years.

Assessing processes of physical change and recovery of benthic ecosystems in active bottom-contact fishing zones: A case study of the Banquereau Bank Arctic surfclam fishery

Claire Haar

Haar, C. (Department of Oceanography, Dalhousie University, Halifax, Nova Scotia, Canada); Lawler, E. (Department of Mathematics and Statistics, Dalhousie University, Halifax, Nova Scotia, Canada); Mills-Flemming, J. (Department of Mathematics and Statistics, Dalhousie University, Halifax, Nova Scotia, Canada); Gazzola, V. (Department of Oceanography, Dalhousie University, Halifax, Nova Scotia, Canada); Brown, C.J. (Department of Oceanography, Dalhousie University, Halifax, Nova Scotia, Canada)

Bottom-contact fishing methods such as dredging for infaunal bivalves cause unnatural disturbance to benthic habitats, and the time required for ecosystems to recover to pre-fishing conditions is site-specific and often unknown. In partnership with Clearwater Seafoods and Fisheries and Oceans Canada, a field survey was designed to examine the short and long-term impacts of hydraulic dredging on the physical habitat and benthic populations on Banquereau Bank. Banquereau is a sandy, storm-dominated bank located at the outer eastern edge of the Scotia Shelf, which has supported an abundant Arctic Surfclam fishery since the mid-1980s. A series of thematic maps were generated for the bank using available multibeam echosounder (MBES) data along with ground-validation datasets and a comprehensive harvest database that documents the location of each dredge tow and associated catch information. These maps, combined with the privately held harvest database, were used to design a post-fishing study at sites in various stages of recovery. A total twelve study sites (500 m x 500m) were selected across 3 areas of the bank, each consisting of three treatments representing areas last fished in 2015, 2018, and 2021, paired with a control (unfished) site with similar seafloor habitat conditions. Field surveys focused on the collection of new acoustic mapping and ground validation datasets. Each study site was remapped using either a side-scan sonar (SSS) or multibeam echosounder (MBES) to evaluate changes in seabed condition. Additionally, extensive benthic sampling efforts were conducted via subsea video transects and sediment grabs to assess benthic community composition and changes to seafloor habitat characteristics. A final survey will take place in 2024 to mimic commercial dredging practices, to evaluate catch rates of Arctic surfclam at each location. These datasets will offer valuable insight into the processes and time required for habitats to return to their natural state following fishing and provide information from which sustainable rotational harvest strategies for clam fishing can be developed.

Using gametophyte cultures to maximize the Sugar kelp (*Saccharina latissima*) growing season in Nova Scotia

Kit Tymoshuk

Tymoshuk, K. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Buchwald, C. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada)

Kelp aquaculture is a growing field in Nova Scotia. The production of kelp starts with a nursery phase in the lab, where culture string is seeded for sporophyte production. When the sporophytes are large enough, they are out-planted at an ocean field site to grow from late fall to early spring. To maximize growth and harvest, early November deployment in the ocean is beneficial.

A common way of seeding juvenile kelp during the nursery phase is to collect reproductive sorus tissue from wild plants during their reproductive period in the fall. However, in Nova Scotia, it is difficult to find spawning seaweed earlier than October, resulting in a delayed nursery phase and ocean deployment, and a shortened growing season. Creating gametophyte cultures is an alternative way of producing young sporophytes in the lab. This method isolates individual kelp gametophytes until ready for use, allowing kelp to be seeded with more temporal flexibility and leading to a longer growing season.

At our field site, Indian Point Marine Farms in Mahone Bay, kelp was previously seeded using the wild sorus tissue collection method. To optimize future growing seasons, my project will focus on developing a kelp gametophyte culture collection to allow us to out-plant future kelp earlier in the season. I will then determine if this method will increase harvest yield.

Creating a working gametophyte culture collection and protocol could have implications for regenerative seaweed aquaculture in Nova Scotia. This research could help small-scale seaweed farmers achieve greater control over their crop and make it easier for potential farmers to establish their own nurseries.

Labrador Current on-shelf Variability over the Holocene

Adam White

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The Labrador Sea is a climatically important area where conditions allow the formation of deep waters, helping to drive the global overturning circulation. Changes in deep water formation influence the Atlantic Meridional Overturning Circulation (AMOC), of which the Labrador Current system is an important segment. Very few sediment grain size data exist to reconstruct the strength of major currents in this area over the Holocene (the last 10 ka). The earliest instrumental observations only date back to the mid-1900s. This study examines sediment cores with the goal to reconstruct bottom water flow speeds over the Labrador Shelf in the Holocene, focusing on two sediment cores off the coast of Labrador at 202 m and 564 m water depth, which lay underneath the inner arm of the Labrador Current. The sortable silt index in these sediments indicates a rapid current speed increase starting ~9 ka lasting until 7 ka, which is followed by a net decrease spanning 6-2 ka, followed by a final increase towards the present. Comparisons with other sediment core records throughout the North Atlantic region show that the temporal changes seen in the inner arm are not mirrored in the other currents (West Greenland Current, Iceland-Scotland Overflow, Labrador Current Outer Arm). This would suggest that the current makeup of Baffin Bay and Hudson Bay outflow driving the inner Labrador current has been in place since 7-9 ka before present.

Stoichiometric analysis of zooplankton-phytoplankton interactions in the Pacific Ocean

Kevan Merrow

Merrow, K. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); McGinty, N. (Department of Biology, Dalhousie University, Halifax, NS, Canada); Tuo, SH. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Hu, YY. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Bretherton, L. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Finkel, Z (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Irwin, A. (Department of Mathematics and Statistics, Dalhousie University, Halifax, NS, Canada)

Plankton in the surface ocean typically have a molar CNP ratio of 106:16:1 (Redfield ratio), however values can vary considerably with environmental conditions and taxonomy. Zooplankton CNP is more stable than that of phytoplankton due to a higher degree of homeostasis, and elemental imbalance between these two groups can impact how nutrients and carbon are recycled in the water column. Using direct CNP measurements of phytoplankton and 4 size ranges of zooplankton collected between the North Pacific subtropical gyre and the equator, we examined the link between environmental conditions and resource stoichiometry, and in turn how this affects the elemental imbalances between resource and consumer. We find that nitrogen limited areas and phytoplankton (N:P<16) result in a bigger N:P imbalance between phytoplankton and larger sized zooplankton. Larger imbalances means that zooplankton are consuming poor-quality food which could lead to less recycling of nitrogen back into the environment and affect biogeochemical cycles and food web dynamics.

Does the Gulf of St. Lawrence have enough food to support North Atlantic right whales (*Eubalaena glacialis*)?

Rhyl Frith

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Critically endangered North Atlantic right whales (*Eubalaena glacialis*) (NARW) foraged in the Bay of Fundy (BoF) during the summer months until the mid-2010s, when the population dispersed to higher latitudes to feed in the Gulf of St. Lawrence (GSL). This change in foraging habitat followed a climate-induced oceanic regime shift in the BoF that caused a decline in their copepod prey. It is not clear whether there is sufficient prey available in the GSL to support NARW, nor whether the mechanism of dispersal was enough to buffer against climatic shifts in prey, or if behavioural adjustments such as increased foraging effort were also needed. Evaluating whether the GSL can support the energetic needs of NARW will involve comparing the ratio of caloric consumption to energetic requirements. Caloric consumption will be estimated based on time spent foraging (inferred from 3D inertial sensing CATS tags), energetic density and abundance of encountered prey, baleen filterability, and mouth gape. Measuring energetic expenditure will involve estimating metabolic rates based on respiration frequency and tidal lung volume. In 2023, we obtained prey field samples (n = 26 stations) in the presence and absence of tagged, foraging NARW using zooplankton nets, an optical plankton counter, and an underwater vision profiler. Concentrations of up to 31,935 ind m-3 of NARW prey (late-stage *C. finmarchicus)* were identified near the seafloor where tagged whales were confirmed to be feeding. These concentrations are the highest ever recorded in the presence of foraging NARW. The ratio of caloric consumption to energetic requirements for NARW foraging in the GSL will be compared to existing data from the BoF to test for differences in caloric intake and foraging effort between the two habitats. This knowledge is essential for evaluating the health and resiliency of NARW as oceanic conditions continue to change.

Investigating borealization in known foraging grounds of the Eastern Canada-West Greenland Bowhead whale (*Balaena mysticetus*; ᐊᖏᕐᕋᒃ)

Caitlin Huard

Huard, C.B. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Fortune, S.M.E. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada)

Polar environments are particularly vulnerable in the face of ongoing climate change. In addition to ecosystem shifts associated with decreased ice cover, increased anthropogenic activity in the Arctic introduces further risk to wildlife health. The Canadian Arctic is an important habitat for the Eastern Canada-West Greenland (ECWG) bowhead whale population, particularly for foraging in the summer months. As a species that follows seasonal ice patterns, future warming of the Arctic environment has the potential to cause shifts in distribution in accordance with prey availability. Calanoid copepods are their preferred prey, but temperate species are becoming more abundant in parts of their range (Disko Bay, Greenland), replacing high energy Arctic species. This is referred to as borealization and it is hypothesized to impact the energetic balance of bowheads as temperate species are lower in lipid content. To determine the extent to which alterations in prey quality and quantity are underway, biological and physical oceanographic data collected near bowhead whales in Cumberland Sound, NU between 2016 and 2023 will be used to gain a more comprehensive understanding of the prey field composition. Changes to species composition were evaluated by applying the Shannon Weaver Index to microscopy and enumeration data collected with a zooplankton net (2016 and 2023). Vertical profiles of particle distribution and size spectra (Optical Plankton Counter in 2016, Underwater Vision Profiler in 2023) were coupled with oceanographic characteristics (CTD in 2016 and 2023) to investigate the conditions that aggregations of Calanoid copepods occur in. In future work, this analysis will inform a bioenergetics model that will provide a look at the daily energetic budgets of different age-sex groups of bowheads to predict the effects of borealization on population health.

Circulation changes are projected to lead to a decline in productivity on the northwest North Atlantic shelf

Lina Garcia-Suarez

Garcia-Suarez, L. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Fennel, K. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada)

We hypothesize that future changes in the strength of the equatorward-flowing Labrador Current and variations in the Gulf Stream path will profoundly affect biogeochemical processes on the northwest North Atlantic shelves. Using a regionally nested future projection of the high-resolution GFDL CM2.6, we evaluate the impact of climate-induced changes of circulation on nutrient fluxes and primary productivity on the Scotian Shelf. In response to increasing atmospheric CO_2, the model shows a substantial drop in nutrient supply that results in a significant decline in new production on the shelf. The decline in nutrient supply coincides with a weakening of the shelfbreak jet, a branch of the Labrador Current system that hugs the edge of the Scotian Shelf, downstream of the Tail of the Grand Banks. The reduced transport of the jet is a response to buoyancy gain of the upper water column along the shelf edge due to warming of the upper slope water. Interestingly, this warming does not result from a pronounced northward shift of the Gulf Steam. Although, the model shows that warm, salty subtropical water moves northward in the slope region pushing onto the edge of the continental shelf, the surface maximum velocity associated with the Gulf Stream core does not significantly shift its mean position northward of Cape Hatteras. This finding is in contrast to previous studies which postulated a pronounced shift of the Gulf Stream trajectory using the temperature-based Gulf Stream North Wall criterion. We show here that this temperature-based index is not a good indicator for the mean position of the Gulf Stream east of 70°W and should not be used to infer its path in climate future projections.

Carbon-centric dynamics of Earth's marine phytoplankton

Adam Stoer

Stoer, A. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Fennel, K. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada)

Knowledge on the distribution and dynamics of marine phytoplankton biomass is fundamental to our understanding of Earth's ecology and biogeochemistry. Our understanding of large-scale phytoplankton dynamics has greatly benefited from, and is largely based on, satellite ocean color observations from which chlorophyll-a, a commonly-used proxy for carbon biomass, can be estimated. However, ocean color satellites only measure a small portion of the surface ocean, meaning that subsurface phytoplankton biomass is not directly monitored. And chlorophyll-a is an imperfect proxy for carbon biomass because cellular physiology drives large variations in their ratio. The global network of Biogeochemical (BGC)-Argo floats now makes it possible to complement satellite observations by addressing both these issues at once. In our study, we use ~100,000 water-column profiles from BGC-Argo to describe Earth's phytoplankton carbon biomass and its spatiotemporal variability. We estimate the global stock of Earth's phytoplankton biomass at ~341 Tg C, half of which is present at depths out-of-view from satellites. Nearly half of phytoplankton are present in the Southern Ocean. We also compare the seasonal cycles of carbon biomass stocks with those of surface chlorophyll-a visible from space, and find that surface chlorophyll-a does not accurately identify the timing of the peak annual bloom in two-thirds of the ocean. Our study is a novel demonstration of global-scale, depth-resolved monitoring of Earth's phytoplankton, which will be crucial for understanding future climate-related changes and the effects of geo-engineering interventions if implemented.

Storm-Induced Hydrodynamic Changes and Wave-Current Interaction over the Southeastern Canadian Shelf during Hurricane Fiona

Qiantong Pei

Pei, Q. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Sheng, J. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada)

Hurricane Fiona in late September 2022 was a large and destructive Category-4 Atlantic hurricane, with the wind gusts of about 180 km/h recorded at Arisaig of Nova Scotia. This storm was the most intense tropical/post-tropical cyclone to hit Atlantic Canada on record. A coupled wave-circulation model is used in this study to examine the storm-induced hydrodynamic changes and effects of wave-current interaction (WCI) during Hurricane Fiona. The coupled modelling system is based on the Regional Ocean Modeling System (ROMS) and the Simulating Waves Nearshore model (SWAN). Analysis of model results demonstrates very intense vertical mixing and currents generated by Hurricane Fiona in the surface mixed layer, both of which are biased to the right of the storm track. In addition to the strong wind forcing and large atmospheric pressure perturbations, the WCI plays a very important role in the hydrodynamic changes in the top ~80 m over the eastern Scotian Shelf and adjacent waters. Over the offshore deep waters (coastal waters) of the study region, the maximum significant wave heights (SWHs) reach up to 21 m (16 m), biased to the right of the storm track.

On Wave-generated Sea-spray Aerosols in the Bedford Basin

Ajatshatru Balaji

Balaji, A. (Department of Physics & Atmospheric Science, Dalhousie University, Halifax, NS, Canada); Chang, R. (Department of Physics & Atmospheric Science, Dalhousie University, Halifax, NS, Canada)

Aerosols emitted into the atmosphere from the sea surface contain compounds that affect the process of cloud formation and in turn Earth's climate. Despite their crucial role, the characteristics, composition, and dynamics of these important components of the global climate regulation are largely unknown to us. This study explores the possibility that the biogeochemistry of a parcel of seawater uniquely affects the flux and physical characteristics of aerosols and ultimately their ability to facilitate condensation and freezing in the atmosphere. During this study, using a wave tank, we artificially create sea-spray aerosols from surface samples. The samples are collected at regular intervals throughout the year from coastal Nova Scotia, predominantly the Bedford Basin. Through analysis of the physical and chemical properties and the cloud forming potential of these aerosols we study the relationship between surface oceanic processes and cloud formation.

Roles of Planetary Waves during Fast and Slow Sudden Stratospheric Warming Events

Yucheng Zi

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Major Sudden Stratospheric Warming (MSSW) is defined as an event in which the stratospheric polar vortex (SPV) at 10hPa reverses from the westerly to the easterly during a short period. The warming rates of 48 MSSW events during 1940-2021 are examined using the ERA5 reanalysis in this study. Those MSSW events are separated into 27 fast-warming events (FWEs) and 21 slow-warming events (SWEs) based on the decay rates of the SPV's intensity. Our composite analysis shows that the average time scale of FWEs (SWEs) is about 20 (32) days. The early stage of the FWE (SWE) is accompanied by a strong (normal) SPV, which suppresses (inspires) the upward motion of planetary waves, leading to the accumulation (release) of planetary waves, and ultimately leading to the fast (slow) decay of SPV. Within ~40 days before the FWE, blocking high events (BHs) occur over Greenland, the North Atlantic east coast, the Nordic and Ural Mountains, and Alaska regions. This spatial distribution of BHs can significantly enhance climatological planetary wave-1 and wave-2 (linear effects). However, in the SWE, BHs just occur over Greenland, the North Atlantic east coast, and near Bering Strait. This can only enhance planetary wave-1 (linear effects), but not wave-2. In comparison with the SWE, more frequent and stronger BHs in the FWE lead to stronger baroclinicity and transient eddy effects (nonlinear effect), causing the SPV to weaken rapidly and faster tropospheric response.

Localizing North Atlantic Right Whales Using a Deformable Sonobuoy Grid

Kamden Thebeau

Thebeau, K. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Barclay, D. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Binder, C. (Defence Research and Development Canada, Atlantic Research Center, Dartmouth, NS, Canada)

The North Atlantic right whale (NARW) is an endangered species whose premature death is usually from anthropogenic causes. This stems from vessel strikes and entanglements, though non-life-threatening activities (e.g., anthropogenic noise) have also been shown to impact the marine mammal's health. One way the harm from these human activities can be mitigated is through passive acoustic monitoring (PAM). PAM can be used to listen to marine mammal vocalizations to determine their location. This information can then be used to ensure harmful activities are minimized in those areas of detection. In 2018, a large-scale data collection effort was conducted in the Gulf of Saint Lawrence, a known feeding ground for NARW, over two days. On each day, visual surveys were conducted, 32 sonobuoys were deployed to gather directional acoustic time series, and a Slocum glider operated in the area to collect oceanographic data. Following the collection phase, the acoustic data were manually annotated with a focus on NARW vocalizations. This project uses the multi-modal dataset to localize NARW using three algorithms. The first method of localization uses the directionality of the calls, where probability density maps are created by overlapping the bearing statistics across each relevant sonobuoy, commonly called cross-fixing. Range dependence is also incorporated with the bearing maps by using probabilistic transmission loss, where the transmission loss is calculated using in-situ data for sound speed profiles and a range of bottom parameters. This transmission loss is then used to calculate a source level range to compare with values from literature. The second localization approach uses a spherical interpolation method to initialize a maximum likelihood time difference of arrival algorithm. Finally, matched-field processing is used to model replica fields at potential source locations and correlate the replicas with the received pressure on the hydrophones.

Quantifying blue carbon storage in eelgrass beds: Combining sediment analyses with geospatial mapping on the Nova Scotian coast

Emma Taniguchi

Taniguchi, E. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Kienast, M. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Brown, C.J. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada)

In a world where carbon is being produced at a rate much higher than the sequestration capabilities of the natural environment, researchers have been investigating ways to increase the proficiencies of existing carbon stocks. In recent years, seagrass ecosystems have been recognized as a potential avenue for elevated carbon sequestration. Despite comprising only 0.2% of the seafloor, seagrass meadows are responsible for burying 10% of total carbon in the ocean and have twice the carbon storage capacity as compared to terrestrial forests. To date, there have been many studies testing eelgrass storage capacity across the world, but a significant knowledge gap exists in investigating how far away from the eelgrass beds that carbon storage is elevated. This study seeks to measure blue carbon storage in several known eelgrass meadows along the Nova Scotia coastline, and test how far away from the meadows blue carbon is elevated in the sediments.

To measure this, a high-resolution multi-beam echosounder (MBES) will collect spatial data in and around various eelgrass meadows to approximate organic carbon percentage in surface sediments, which will be used to create a benthic habitat map. This data will be collected in combination with push core samples taken both within and at various distances from the edges of the eelgrass beds to determine a depth profile and quantify how much of the carbon is stored in aboveground versus belowground biomass. A combination of spatial mapping and sediment analysis will be conducted to both determine the spatial distribution of blue carbon and test the depth and distance at which it is elevated within the eelgrass meadows and their surrounding areas. The results of this study will contribute to the body of existing knowledge of the carbon sequestration capabilities of eelgrass in the North Atlantic and hopefully aid in the decision-making regarding the protection and restoration zones of eelgrass.

Investigating benthic-pelagic carbon remineralization overlaying the southernmost documented permafrost unit and possible impacts of rising temperatures

Haley Geizer

Geizer, H. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada); Algar, C. (Department of Oceanography, Dalhousie University, Halifax, NS, Canada)

A concern as temperatures rise is the thaw of permafrost which can occur both terrestrially and within the marine environment. According to Sayedeh et al. (2020) marine permafrost can be defined as “unglaciated continental shelf areas exposed during the last glacial maximum”. These regions are known to contain large stocks of OM and methane (~1400 Pg C) that could be released under a thawing regime. Literature has also demonstrated that subsea permafrost can be formed due to groundwater seepage and in 2021, such a feature was discovered in Webb’s Bay Labrador- making it the most southern unit of permafrost known to date. In July 2023, sediment cores were collected aboard the William Kennedy to help determine the origin of this permafrost (ie. marine or freshwater). Porewater samples were extracted onboard and incubation experiments will be conducted this spring to quantify remineralization. All this information will be used in a 1-dimensional diagenetic model to reveal what will happen to the carbon locked within this frozen sediment as our climate continues to warm.

Uniform $\delta^{15}N_{AA}$ signatures of sedimentary organic nitrogen imply common mode of preservation

Nina Golombek

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The degree to which organic matter (OM) exported from the surface ocean is preserved in seafloor sediments has important implications for estimates of carbon cycling and source-to-sink transport. This is particularly true for continental shelves, which are generally characterized by high surface ocean production and relatively short export pathways. This study investigates the composition and alteration of exported OM into marine sediments using amino acid-specific degradation indices and nitrogen isotope signatures ($\delta^{15}N_{AA}$). We analyzed surface sediments from eight globally distributed continental margin settings that span the largest possible range in depositional environments and preservation characteristics. The degradation indices show variable levels of OM degradation between locations, whereas the isotopic signatures imply strong overprinting of original primary producer signatures, with very little resemblance to the OM exported from the surface ocean in the form of phytoplankton, zooplankton or fecal pellets. Together, the amino acid data presented here suggest that only highly degraded OM is deposited in continental margin sediments, irrespective of local conditions.

Constraining recycled production and $\delta^{15}N_{NH4}$ using $\delta^{15}N_{PN}$ during the dissipation of a *Phaeocystis* bloom in the Labrador Sea

Britton Depmsey

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Fixed nitrogen in the form of ammonium (NH_4^+) and nitrate (NO_3^-), are the primary substrates that limit the growth of marine primary production, effectively defining the magnitude of exportable particulate organic carbon (POC) supplied to the biological carbon pump (BCP). In the Northwest Atlantic, oceanographic conditions support a significant supply of new NO_3^- to surface waters, theoretically enabling considerable amounts of POC export based on classical assumptions related to the *f*-ratio. However, a full understanding of export dynamics in this region is hampered by the lack of field studies characterizing intraseasonal variability of new vs. recycled production during the spring and summer months. In addition, it is unclear how sensitive export production will be to increased stratification in a warming climate, which may cause the relative contribution of recycled production to total primary production to increase. Before formulating hypotheses on how the system will respond to climatic perturbation, more frequent surveys are required to characterize present N cycling controls on the region's BCP. Here, we assess the biochemical controls on fixed N speciation during the dissipation of a *Phaeocystis* bloom in the Labrador Sea by measuring rates of N uptake, nitrification, and NH_4^+ regeneration. The relative contribution of each rate to fixed N pools was then determined by interpreting stable isotopic measurements of NO_3^- and particulate N ($\delta^{15}N_{PN}$). The entire survey exhibited a significant accumulation of surface NH_4^+, likely promoting the higher NH_4^+ uptake that was observed compared to NO_3^- uptake, suggesting an increased reliance on recycled production for this period. In addition, associated isotope effects for each N transformation process were inversely determined using a 1-D reaction-diffusion model fit to field measurements of natural abundance stable isotopes. Fitting the model to $\delta^{15}N_{PN}$ observations yielded isotope effects of nitrification, NH_4^+ regeneration, and NH_4^+ uptake ranging from 30 – 40‰, 2 – 3‰, and 7 – 9‰, respectively. The model's apparent sensitivity to NH_4^+ cycling is an exhibition of its potential to quantify integrated rates of recycled production and nitrification using field measurements of natural abundance stable isotopes as a constraint.

Contributions of Sewage Outflow on Nitrous Oxide Production in Bedford Basin

Zack Whitworth

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The Bedford Basin (BB) is a coastal fiord located in the Halifax Regional Municipality, for many years it has been a popular site for oceanographic research. Its convenient location makes it easy to obtain high resolution timeseries datasets of the BB's unique environment. The Bedford Basin Monitoring Program (BBMP) is a coalition effort done by Dalhousie University and the Bedford Institute of Oceanography. It aims to study the physical, chemical, and biological processes of the BB utilizing weekly and monthly sampling.

Timeseries datasets, such as the one collected by the BBMP, are useful for modeling fixed nitrogen (N) cycling within the BB. Fixed N is a subcategory of the major ocean nutrients which consists of ammonium, ammonia, nitrate, and nitrite; these are especially important as they are the forms of nitrogen which are bioavailable to primary producers. Since N is a limiting nutrient for primary production, understanding the nitrogen cycle within the BB gives insight to the amount of carbon export driven by primary production in the basin.

The BBMP, however, collects data at one point within the center of the basin, and does not include data from two possible anthropogenic sources of N: the Sackville River Estuary and the Halifax/Dartmouth wastewater treatment facility outflows. We have added sample collection stations at these locations to improve the dataset and build a more accurate model of N cycling within the BB.

These two sources are likely to increase the ammonium content of the BB with growing populations. More agricultural land around the Sackville River can add ammonium via fertilizer seepage and denser populations in the city can lead to increased ammonium through higher volumes of sewage output. As the health of the BB ecosystem is highly dependant on the level of fixed N, monitoring the fixed N cycling is crucial for conservation.

POSTER SESSION

Mechanistic Breakdown of Bedford Basin Intrusion Events Using a High-Resolution Regional Model

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Research on Ocean Alkalinity Enhancement (OAE) is ongoing in Halifax Harbour, a small, mid- latitude fjord. The Harbour consists of the 70-m deep Bedford Basin and a 20-m deep, narrow channel connecting the Basin to the adjacent Scotian Shelf. Physical and biogeochemical properties of Bedford Basin are strongly influenced by sporadic intrusion events, during which waters from the adjacent shelf replace bottom waters in the Basin. This project aims to provide a better understanding of the dynamical drivers of these events so we can gain predictive understanding and improve sampling strategies. We use a 20-year hindcast simulation, generated with a 3-level nested Regional Ocean Modelling System (ROMS) of Halifax Harbour, to define and explain the driving mechanisms behind the intrusion events. This mechanistic explanation improves our understanding of the dynamics of alkalinity and inorganic carbon properties in this system, allows for an optimal placement of observing assets, and guides model refinements as we work to improve its ability to predict intrusions and their biogeochemical effects.

Optimizing nutrient delivery and sterilization techniques and improving the methods for monitoring nutrient consumption throughout the hatchery season for *Saccharina latissima*

Lara Mitchell

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Understanding the specific growth conditions required to successfully produce seeded kelp lines in a lab environment is necessary to further the growth of the aquaculture industry and our scientific understanding of these organisms. By expanding our knowledge on *Saccharina latissima's* growth response to various nutrient delivery techniques and improving the ways in which we monitor nutrient consumption throughout the hatchery season, we can obtain a better understanding of how nutrient availability influences kelp biomass, and therefore determine the best ways to produce kelp seed. In this research, eighteen separate tanks were set up in the Dalhousie Aquatron facility and the growth of kelp seed was tracked using two different nutrient delivery techniques, high nutrient treatments and low nutrient treatments, and three different levels of sterilization, no extra sterilization, 0.35 µm filtration, and the addition of germanium oxide. We also examined how other factors such as light availability and intensity effect biomass growth. Nitrate concentrations were measured at distinct timepoints using the SUNA real-time nitrate sensor and using the NOx box nitrogen detector for selected comparison timepoints. The goal of this project was to determine the most effective growth conditions for kelp seed in terms of nutrient delivery techniques and sterilization levels, in addition to improving the methods for observing nutrient consumption. As data analysis and statistics on the collected data are still ongoing, results are not complete. Based on the raw data, it was observed that low nutrient treatments produced a higher kelp density than high nutrient treatments, the majority of nitrate consumption was in the final week of growth, and SUNA real-time nitrate sensor and NOx box nitrogen detector calibrations were comparable.

Site Suitability for Kelp Aquaculture in Nova Scotia using Multi-Criteria Decision Analysis

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Nova Scotia has a nascent kelp aquaculture industry. An industry study showed that kelp farming could become a multi-million-dollar industry in the future. However, there are only a handful of farmers that are operating today. There are many challenges barring development of a robust growing kelp industry. These have been outlined as lack of processing plants, market access, educational and awareness aids for farmers and stringent regulations. Kelp is environmentally benign compared to other mariculture industries. Yet, it is important that policy makers and farmers consider the potential for environmental degradation and socio-economic conflicts when choosing sites for kelp farming. Site suitability analysis has been used previously to help create effective policy surrounding mariculture to mitigate both environmental and socio-economic adversities. Using a Multi-Criteria Decision Analysis method, this research aims to construct a site analysis framework that will aid farmers and policy makers in choosing location and updating regulations for kelp farms. Furthermore, this research will apply this framework to a current farm in Mahone Bay as a case study to check the efficacy of the research.

A Climatology of Polynyas Along the Labrador Coast and Shelf Region

Nicole Neriuoka

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Polynyas are defined as regions of relatively lower ice concentrations surrounded by relatively higher ice concentrations that persist for several days to months where a thicker and more unified ice cover is expected. This study seeks to identify polynyas in the Labrador coast and shelf region using Canadian Ice Service (CIS) charts for the Hudson Bay region. CIS chart data is provided as arbitrary polygons with egg codes, where the egg codes include information about ice concentration and stage of development. This data was gridded into 1 km by 1 km cells by Dr. Eric Oliver and Dr. Clark Richards. We developed an algorithm to identify polynyas in the gridded CIS ice concentration data over a data period from September 1, 1997 to August 31, 2021. The algorithm loops over concentration levels from 0% to 100% and labels areas as polynyas where the ice concentration difference is equal to or greater than 20%. Two main recurring polynyas were noted along the Labrador coast in Groswater Bay and on the northern tip of Labrador. There are also less seasonally predictable polynyas, or flaw leads, that occur along the edge of landfast ice.

Testing the tests: analysing and developing methods of characterizing phenotypes of *Saccharina latissima* in Nova Scotia, Canada

Ainhoa Fournier

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A promising sustainable solution to the increasing global demand for aquatic products is aquaculture. The diversification of refined bioproducts derived from aquatic plants and algae has further increased this global demand. The main cultivated algae in Atlantic Canada is sugar kelp (Saccharina latissima), also known as sea lasagna. The current practices of cultivating S. latissima are not self-sustaining and rely heavily on the collection of natural broodstock. Due to S. latissima's reproductive temperature dependence, its cultivation practices are susceptible to increasing seawater temperatures caused by climate change. In attempts to improve the artificial cultivation of S. latissima, collaborative research between the National Research Council of Canada and Merinov aims to identify and biobank the optimal phenotype of S. latissima for cultivation in Nova Scotia. The optimal phenotype will be suitable for farming, yield the most blade biomass, and potentially possess resistance to climate change. This project, specifically, will test the efficiency, accuracy, and precision of the 1-dimensional (1D metric measurements), 2-dimensional (2D pictures analyzed in ImageJ), and novel 3-dimensional (3D scans analyzed in (CloudCompare) methods used to identify and physically characterize these phenotypes. It is hypothesized that using a 3D scanner and software to physically characterize phenotypes of S. latissima may be the most efficient and accurate method when measuring blade volume, comparatively.

Effects of acute simulated Ocean Alkalinity Enhancement on natural phytoplankton assemblages in the North Atlantic Ocean

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Climate change poses a significant threat to environmental and economic systems. To reach the 1.5 °C target set by the Paris Agreement, we must restrict CO_2 emissions and invest in CO_2 removal (CDR) techniques (IPCC, 2018). One CDR strategy is Ocean Alkalinity Enhancement (OAE) where an alkaline substance is added to the surface ocean to draw down CO_2 for long-term storage as bicarbonate. As part of a collaboration with industrial partner Planetary Technologies and the National Research Council of Canada (NRC), I tested the potential impacts of acute simulated OAE on natural phytoplankton assemblages through three separate mesocosm experiments. Each was run in duplicate with controls and NaOH-dosed treatments as follows: 1) To test the effect of exposure time, treatments were dosed to reach a pH of 8.8 and neutralized at different times (10, 60, 120 and 180 mins post addition); 2) To test the effect of exposure intensity, treatments were dosed to achieve a range of pHs (8.05, 8.3, 8.55 and 8.8) for 10 mins before neutralization; 3) To assess change in growth and grazing rates, plankton cages were suspended in treatment tanks dosed to pH 8.8, with no neutralization. Sampling occurred before and after dosing and at experiment end, 24 hours later. For all, physiochemical parameters pH, dissolved inorganic carbon and total alkalinity were measured alongside abundance (chlorophyll-a, particle counts and biovolume) and community (flow cytometry) metrics. Additional measurements for particulate carbon, nitrogen and phosphorous were taken for benchtop experiments. Statistical tests for treatment effects on abundance metrics were done using analysis of similarity (ANOSIM) and analysis of variance (ANOVA). Metric multidimensional scaling (mMDS) was performed to visualize trends of similarity or dissimilarity in all measured parameters between treatments. No significant treatment effect was detected for abundance metrics across experiments. Significant differences 01in dissolved inorganic carbon and total alkalinity were observed between OH^- dosed and control tank at harvest for the serial dilution experiment ($p<0.05$). This study is an important step in assessing OAE's impacts and shows it can have a negligible effect on ocean biota but a possible effect on marine carbon chemistry biomass.

Nutrient Budget Assessment of the Bedford Basin: 2002 to 2022

Emile Weber

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As we fail to mitigate climate change and as coastal populations continue to grow, the problems of diminishing water quality and low oxygen concentrations (hypoxia) worsen for coastal ecosystems globally. Climate change reduces the availability of dissolved oxygen (DO) in the water column by lowering oxygen solubility and intensifying density stratification which hinders the ventilation of subsurface waters. Furthermore, increasing sewage inputs provide an overabundance of nutrients that fuel excessive production of algal biomass which then sinks, decomposes, and consumes oxygen. The Bedford Basin is an estuary that is naturally prone to seasonal hypoxia and is at risk of anoxia (no DO) due to limited ventilation of its subsurface waters. Using the data collected by the Bedford Basin Monitoring Program, we were able to further our understanding of anthropogenic stressors (warming and eutrophication) on water quality (oxygen concentration) in the Bedford Basin over the past 20 years.

Mapping Lobster Habitat in the Northumberland Strait

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The Northumberland Strait, located in the southern Gulf of Saint Lawrence, is an important area for scallop and lobster fishing. Marine management strategies in the Northumberland Strait include the use of scallop fishing buffer zones to protect juvenile lobster habitat, with these protected areas informed through diving surveys. Our understanding of the benthic ecosystem composition of the area, however, could be greatly improved through creating benthic habitat maps of the area using multibeam echosounder (MBES) technology. Using bathymetry and backscatter collected by MBES, and drop camera imaging, substrate maps and habitat suitability maps for juvenile lobster were created using random forest and maximum entropy modelling respectively. The sediment was classified into four substrate categories using the Folk 7 classification scale; muddy sand, sand, mixed sediment, and course sediment. The location of the current fishing buffer zones (shoreline to 1km offshore) align with where hard bottom is expected to be. The drop camera footage showed lobsters were found on mainly mixed sediment. The substrate characteristics from the areas where the lobsters were found will be compared to the characteristics of the areas where they were absent to determine habitat preferences of the species. The placement of the fishing zones from a species conservation standpoint will be discussed based on the observed habitat preference. From these early results, it is predicted that there will be ideal lobster habitat located outside of the protected fishing zones, and that there are areas within the zones that lack hard/mixed sediment. Our increased understanding of the benthic habitat will allow decision makers to make more informed decisions about the area.

Mapping benthic habitats of the Bras d'Or Lake / Pitu'paq, Cape Breton Island, Nova Scotia

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The Bras d'Or Lake (BdOL) / Pitu'paq is one of the largest estuaries in Atlantic Canada which provides a range of habitat and species and has cultural significance to the Mi'kmaq community. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has designated a UNESCO Biosphere Reserve since 2011. While knowledge in the habitat distribution is limited in BdOL, the need for comprehensive coverage mapping arises to better understand the unique ecosystems. An unsupervised IsoCluster analysis approach was used to classify the multibeam echosounder (MBES) data collected by the Canadian Hydrographic Service between 1999-2009 and level 2A satellite imagery collected by Copernicus Sentinel-2 from 2015. A 4k drop camera system and other underwater imaging methods were used to ground truth the seafloor. The collected images were used to classify georeferenced points into benthoscape classes (broad biophysical classes) derived from a modified Folk substrate classification scheme and conspicuous biota. An integrated benthoscape map with MBES and satellite imagery was created. Understanding the distribution of habitats at BdOL can provide information on species distribution and habitat use.

The Elemental Stoichiometry of Mesozooplankton Taxa in the Labrador Sea

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The Labrador Sea, situated between Canada and Greenland, plays a crucial role in ocean ventilation and global carbon cycling through deep-water convection and North Atlantic Deep Water (NADW) formation. This region is highly biologically productive, hosting diverse species, including zooplankton, which are pivotal in trophic energy transfer and biogeochemical processes such as the biological carbon pump (BCP). Understanding zooplankton elemental composition is essential, as it varies significantly both taxonomically and regionally due to factors like energy storage, growth rate, and nutrient availability. Despite global studies on zooplankton stoichiometry, there's a lack of comparisons between taxa in the Labrador Sea. Hence, our study investigates the particulate organic carbon (POC), particulate organic nitrogen (PON), and total particulate phosphorous (TPP) composition and stoichiometry of zooplankton exceeding 2000μm in length. Samples were collected during the May-June 2022 Celtic Explorer Cruise, where chaetognath, krill, gelatinous zooplankton (GZ), pteropods, and copepod (Paraeuchaeta sp. and Calanus sp.) taxa were obtained. Analytical methods included elemental analysis for POC and PON determination, and the Extra High Temperature Dry Combustion (X-HTDC) colorimetric method for TPP quantification. Our analysis revealed significant compositional differences between soft- and hard-bodied zooplankton, with POC, PON, and TPP values lowest in GZ and pteropods, and highest in copepods and krill. These preliminary findings offer valuable insights into the feeding habits and macromolecular allocation of these large zooplankton species, though further biochemical analysis is needed to bolster these results. Our study contributes to a better understanding of macro- and mesozooplankton ecology and physiology in the Labrador Sea and its implications for biochemical cycling in the region.

Sensor Response Corrections for RBR Argo CTDs

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The global Argo program consists of approximately 4000 freely drifting autonomous profiling floats, each sampling the ocean from 2000m to the surface every 10 days. The core sensor of the Argo program is the conductivity-temperature-depth profiler (CTD) which measures profiles of temperature and salinity during the ascent of the float. Current challenges facing Argo include a lack of sensor variety as the fleet is largely comprised of SeaBird Electronics CTDs. To address this issue, RBR Ltd. has developed new sensor technology and methods to correct the dynamic errors associated with RBRargo3 CTDs. Initial testing of RBRargo3 CTDs found that when corrections were applied to laboratory data, errors were within an acceptable range of uncertainty. Further research is required to assess the efficacy of these corrections on in situ data. This study aims to address this knowledge gap by applying dynamic error corrections to high-resolution data collected from two RBRargo^3 floats deployed in the Labrador Sea. At constant ascent rates, the accuracy of the corrected in situ data was found to be within Argo requirements, but application of the corrections when ascent rates are changing highlight some uncertainties. This is especially true for negative and near-zero ascent rates, which are outside of the typical range of float profile speeds. Corrections were adjusted to account for the behaviour of floats in situ, but emphasis remains on the importance of evaluating the corrected data in post-processing.

Improving Sound Mapping Methods Using Data Assimilation in the Strait of Georgia

Gwenyth Logan

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A longstanding challenge in physical oceanography is the accurate quantification of ambient sound fields in marine ecosystems. Human activities in the ocean have significantly altered marine ecosystems, raising concerns about the impact on the natural environment. As global expansion continues unabated, understanding and quantifying marine soundscapes and anthropogenic contributions to them becomes imperative. This study addresses this challenge by proposing advanced methods for quantifying and visualizing the ambient sound field. We present a novel model that integrates assimilated data to map sound levels. Utilizing the Climate Data Store's ERA5 reanalysis of wind speed, converted into wind-wave generated noise using a physical sound propagation model, we generated hourly 1000 Hz sound maps for the Strait of Georgia throughout March 2021. To validate the model output, we combined these maps with real-time hydroacoustic data from Ocean Network Canada. Data-model comparisons provide the opportunity to assimilate the data and correct potential inaccuracies and biases in the model's mapped noise level predictions. Our preliminary findings suggest a significant influence of shipping activities on the accuracy of the generated sound maps, particularly at frequencies around 1000Hz. This underscores the necessity of incorporating detailed shipping data and real time hydroacoustic measurements into sound mapping methodologies for more precise assessments. Enhancing sound mapping techniques represents a crucial step towards providing accurate assessments of marine soundscapes and anthropogenic noise contributions in marine environments. Furthermore, these advancements aim to increase accessibility of such assessments to diverse stakeholders, including non-scientists, policy makers, and the public. By fostering better understanding and awareness, we can facilitate informed decision-making and effective management of marine noise pollution.