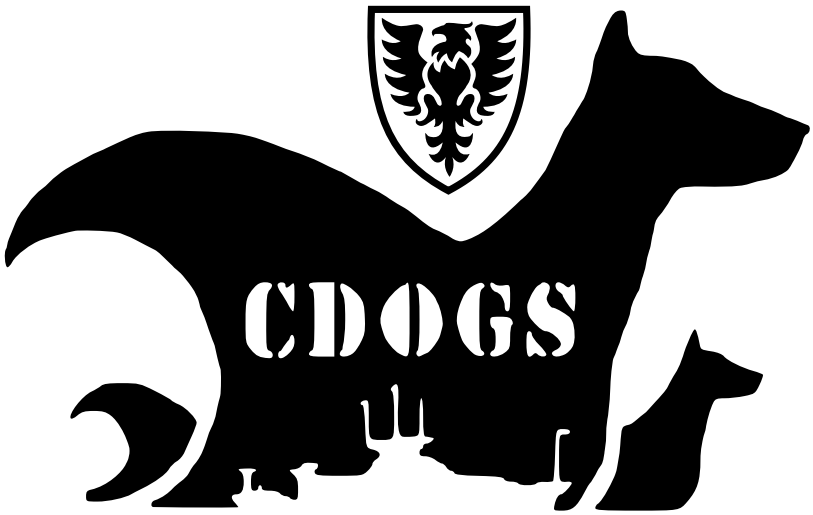

CDOGS 2022

Conference of Dalhousie Oceanography Graduate Students

Friday March 25, 2022
9:00 - 17:15, McInnes Room, DSU Building, and Zoom
Dalhousie University, Halifax, Nova Scotia

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Using drifters to understand the dynamics of the Labrador Current System over the shelf

Taylor Davies[1] Eric Oliver[1]

[1]Department of Oceanography, Dalhousie, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at ty993845@dal.ca

The Labrador Current is the western boundary current of the subpolar gyre, a key element of the circulation in the Labrador Sea, and a major outflow from the Arctic to the North Atlantic. This boundary current is a system of currents consisting of an inshore (or coastal) branch, a shelf-break branch, and a deep branch along the lower slope. Given the rapid climate change that the North Atlantic is experiencing, a better understanding of the dynamics along the Labrador coast and shelf is necessary as it may inform and improve future climate models. Historically, sparse in-situ data, particularly over the Labrador shelf and coast, have made it difficult to get a complete picture of the Labrador Current System. Ocean drifters are a relatively inexpensive and accessible technology that present a Lagrangian perspective of fluid flow in the ocean and can be used to understand boundary current dynamics. The community-based observing of Nunatsiavut coastal ocean circulation (CONOC) project has deployed numerous ocean drifters off northern Labrador since 2018. Here we use these drifters, along with those in the region from the Global Drifter Program, to examine the Labrador Current System along the Labrador coast and shelf. Specifically, we decompose the Lagrangian drifter velocity into a sum of the mean flow, tidal components, and the residual. Further work will decompose the residual into physically meaningful components, including the Ekman flow, the geostrophic flow, inertial oscillations, etc. Results show a clear separation between the coastal and shelf-break branches of the Labrador Current System, highlight the dominance of tidal flows near the northern tip of Labrador, and demonstrate regions of connectivity between the two branches. Ongoing work will examine the wind-driven and geostrophic components of the Labrador Current System off the Labrador coast and shelf.

Acoustic Source Mechanisms and Passive Acoustic Monitoring of Hydrothermal Vents at the Endeavour Hydrothermal Vent Field

Brendan Smith[1] David Barclay[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at brendan.smith@dal.ca

The interaction between hot, turbulent hydrothermal fluid flow, cold ambient seawater, and vent structures can lead to sound generation by hydrothermal vents. As a result, passive acoustics may provide a method for detection and long-term monitoring of hydrothermal activity. Direct measurement of hydrothermal flow can be challenging as the fluid is often high temperature (>300 °C) and acidic. The discovery of new vent sites can also be challenging as chemical detection of vent plumes or high-resolution seafloor mapping is required. For these reasons, remote detection and monitoring with passive acoustics can be advantageous. In this presentation, long-term passive acoustic data recorded in 2019 from an Ocean Networks Canada (ONC) bottom-mounted hydrophone in the Endeavour Hydrothermal Vent field are presented. A 6-month time window from April through October 2019 was selected for analysis, when fin whale calls were less prevalent. Statistical noise level metrics (e.g. the median) were used to reduce the influence of transient, infrequent events such as fin whale calls and ship noise, as the vent signal was expected to be relatively constant compared to these sources. Spectral analysis of the resulting time series across multiple frequency bins shows evidence of tidal-period variations in power spectral density which may be related to hydrothermal vent dynamics. Comparison is made to other nearby ONC sensors such as vent temperature, bottom pressure, and acoustic doppler current profiler measurements. A hydrophone array deployment at the same location, utilizing an instrument called the Deep Acoustic Lander (DAL) is also analyzed, and the measured acoustic signals are attributed to hydrothermal vent source mechanisms.

Accounting for Seasonally Biased Data When Estimating Anthropogenic Carbon

Claire Boteler[1] Michael Dowd[1] Eric C. J. Oliver[2] Elias T. Krainski[3] Douglas W. R. Wallace[2]

[1]Department of Statistics, Dalhousie University, Halifax, NS, Canada, B3H 4R2
[2]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2
[3]Department of Statistics, King Abdullah University of Science and Technology, Thuwal, Makkah Province, 23955-6900, Saudi Arabia

Speaker may be reached at claire.boteler@dal.ca

The NW Atlantic Ocean is an important global sink for atmospheric carbon produced by anthropogenic activities. However sparse and irregular sampling of ocean carbon make it difficult to capture a full picture of its temporal variations. We aim to improve our understanding of ocean carbon's temporal trends and sources of variability at three depth layers from the surface to the deep. We propose a time series generalization of the eMLR method that produces monthly times series estimates and errors for the increase of excess DIC due to anthropogenic sources. Using observations of dissolved inorganic carbon (DIC) from the GLOPAPv2 database, they first were monthly averaged and deseasonalized to account for the data's seasonal bias. The deseasonalized DIC anomalies were then modeled with a dynamic linear regression, where its relationship with temperature and salinity accounts for carbon's natural variability, and a time varying intercept accounts for the excess carbon due to anthropogenic sources. After estimating DIC's sources of variability, these components were reassembled to produce a monthly times series estimate of total ocean carbon that accounts for missing observations and the seasonal sampling bias of the inputted data.

Evaluating the effects of biogeochemical data assimilation in a physical-biological model: A learning process

Edmundo David Garcia Larez[1] Katja Fennel[1] Bin Wang[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at eddg@dal.ca

Data assimilation of satellite ocean-colour radiometry has been shown to improve the performance of biogeochemical ocean models; however, this is limited to the surface ocean since little information can be derived or extrapolated of the ocean interior using these observations. BGC-Argo floats have the potential to provide us with abundant observations of the ocean interior that can be used to improve subsurface model performance. My goal is to ultimately perform data assimilation using BGC-Argo profile data from an area with a high number of profiles available and evaluate its benefits on model performance. To accomplish this, the Regional Ocean Modeling System (ROMS) was configured in an idealized ocean channel. And through the manipulation of surface wind stress and the diffuse attenuation coefficient I aimed to get familiarized with the model mechanics. By manipulating these parameters, deep water upwelling and changes in PAR were simulated, respectively, to observe the effects of changes in nitrate concentrations and light availability on chlorophyll concentrations in surface layers. The next steps of my learning process include acquiring the ability to perform data assimilation on the model and ultimately, translating the skills acquired to a more complex physical-biological model using real observation from BGC-Argo floats.

The underwater sound of a snowmobile traveling on sea-ice

Emmanuelle Cook[1] John Winters[1] Katrina Anthony[1] David Barclay[1] Eric Oliver[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at emmanuellecook@dal.ca

As part of the Sustainable Nunatsiavut Futures project, a field experiment to determine the acoustic properties and radiated sound level of a snowmobile was designed and executed. The fieldwork consists of lowering a hydrophone under the sea ice and driving a snowmobile with a known path and velocity to evaluate its speed-dependent source level. This experiment is the first step toward collaborative Dalhousie and community research on underwater sound as it relates to the marine habitat and human use of the ocean and sea-ice in Nunatsiavut. Along with the primary scientific objective, the research aims to share and learn knowledge systems, capacities and interests, and to further guide and develop relevant research questions on underwater noise. Due to COVID-19, the fieldwork in Nunatsiavut is scheduled to be conducted by local Inuit Research Coordinators (IRCs). The preparations for fieldwork began in 2021 and has consisted of discussions with IRCs to develop the experimental set-up, coordinate logistics and training, and testing the equipment. In 2022, a parallel Dalhousie-led experiment was conducted in Caraquet, New Brunswick using a vertical array of hydrophones to test the experimental procedure and obtain underwater sound data from a moving snowmobile. Sea-ice thickness, temperature, salinity, and sound-speed data were collected and spectrograms of the passing skidoo over a range of speeds were computed.

Benthic-pelagic nutrient cycling along the Labrador Shelf and their impact on marine nutrient availability on the Scotian Shelf

Haley Geizer[1] Chris Algar[1]

[1]Dalhousie University

Speaker may be reached at haley.geizer@dal.ca

It is suggested that climate change induced loss of sea ice may result in a more productive Arctic with greater deposition of organic matter to the seafloor. Remineralization of organic matter results in the return of dissolved nutrients (e.g. nitrate and phosphate) to the overlying water, however nitrate can also be removed through denitrification. There is evidence that increased sedimentary coupled nitrification/denitrification may remove bioavailable nitrogen by converting it into N_2 gas. This increased remineralization of nutrients may deplete the south-flowing Labrador Current of essential nutrients that fuel the metabolism of the Scotian Shelf. In this research project I will quantify benthic carbon mineralization processes such as: oxic remineralization, denitrification, metal oxide, sulfide reduction, and methanogenesis from the Canadian Arctic to the Scotian Shelf to assess the strength of benthic-pelagic nutrient cycles. Sediment cores were collected in the summer of 2021 aboard the Admunsen research vessel using an ROV and box coring methods. The ultimate goal of this project is to observe nutrient cycling along the track of the Labrador Current to compare with the processes occurring on Scotian shelf and to classify all sites as either nitrogen sources or sinks depending on their available nutrients and specific microbial communities. Preliminary results will be shared of a few sites to highlight the importance of biogeochemical cycling in our changing climate.

Tides, winds, and ice: uncovering ocean processes in the Canadian Arctic Archipelago

Lina Rotermund[1] Ruth C. Musgrave[1] Clark G. Richards[2]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2
[2]Bedford Institute of Oceanography, Dartmouth, NS, Canada, B2Y 4A2

Speaker may be reached at lina.rotermund@dal.ca

In the Canadian Arctic Archipelago (CAA), understanding water mass modification and mixing processes is crucial as the export of these water masses into the North Atlantic, in particular low-salinity waters, play an important role in the meridional overturning circulation. Water mass variability, driven by mixing, also impacts local nutrient fluxes, primary production, and sea ice conditions, which are important to northern communities. The physical processes that modify and mix the water masses passing through Barrow Strait within the CAA are investigated. Ocean currents, water temperature, salinity, and sea ice thickness and velocity were measured intermittently at five mooring locations across the strait from 1998 to 2018. A nearby meteorological station provided air temperature, wind speed, and direction. My focus is on processes that lead to water mass modification, including mixing through internal waves generated by tides interacting with the variable seafloor topography or by wind, and on surface processes such as the formation of cold, salty or low-salinity waters as sea ice grows or melts. In this presentation I will discuss the temporal and vertical structure of the tide in Barrow Strait and its modification by seasonal sea ice cover.

Effects of an Aquaculture Fish Farm on the Sediment Geochemistry of a Naturally Anoxic Basin

Stormy Vanderplas[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at st694494@dal.ca

Whycocomagh Basin is a deep, naturally anoxic basin located in the Bras d'Or Lakes, Nova Scotia. Presently a Steelhead Trout (Oncorhynchus mykiss) aquaculture farm leased by the Waycobah First Nation operates as an economic resource. However, hazards associated with free sulfide accumulation following anaerobic processes pose challenges to sustainable management practices for the fish farm pens. Accumulation of total dissolved free sulfide (S^{2-}= H_2S + HS^- + S^{2-}) concentrations can reach toxic levels in the bottom water and sediment, and it could impact fish in floating pens at the surface and the surrounding biogeochemical environment. Porewater chemistry, microsensor profiling, and CHN analysis of the sediment-water interface, both below and away from fish pens, were collected to assess the fish farm impacts on the sediment geochemistry and to understand the influence of the farm on the natural biogeochemical cycles

Passive Acoustic Ship Detection Performance near the Port of Sept-Îles, Quebec, Canada

Marina Antipina[1] David Barclay[1] Bruce Martin[2]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2
[2]JASCO Applied Sciences, Dartmouth, NS, Canada, B3B 1Z1

Speaker may be reached at antipina.marina96@gmail.com

An acoustic recorder was deployed near the Port of Sept-Îles, Quebec, Canada in the fall of 2020 and collected one year of data on a four-channel orthogonal array. The system, a JASCO AMAR integrated on a C-Lander mooring, operated on a duty cycle consisting of 340 s of data recorded at 32 kHz sampling rate, 1 min of data recorded at 256 kHz sampling rate followed by 500 s of sleep. Data were stored on SD memory cards for post-retrieval analysis. Vessels were detected using narrowband tonals produced by their propulsion system and other rotating machinery and the sound pressure level (SPL) for each minute of data in the 40–315 Hz shipping frequency band was then computed. A 10 min shoulder period before and after the detection was then searched for the highest 1 min SPL which was identified as closest point of approach (CPA) time for each acoustic contact. Vessel track data from the automatic identification system (AIS) were used to compute CPAs for vessels carrying an AIS transponder during the deployment period. A comparison of the two results was used to identify missed and false detections, and to assess the algorithm's performance. Also, DEMON processing was used to compare number of DEMON tonals to the JASCO vessel detector algorithm results. Recommendations for implementing an improved detection approach will be discussed.

Variability in marine export productivity in the Gulf of Maine using amino acid δ^{15}N patterns from sediment traps and surface sediments

Nina Golombek[1] Cynthia Pilskaln[2] Markus Kienast[3] Owen Sherwood[1]

[1]Department of Earth and Environmental Sciences, Dalhousie University, Halifax, NS, Canada, B3H 4R2
[2]School for Marine Sciences and Technology, University of Massachusetts Dartmouth, Dartnouth, MA, USA, 02747-2300
[3]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at Nina.Golombek@dal.ca

The Gulf of Maine is a semi-enclosed continental shelf sea at the confluence of the Gulf Stream and Labrador Current. Variations in the strength and position of these currents have a strong influence on hydrography, nutrient distributions, and productivity within the Gulf. The region is undergoing some of the most rapid warming of any ocean region. But there are few paleoceanographic records to put these changes into the context of Holocene-scale climate variability and its impacts on biological productivity. The goal of this study was to develop a better understanding of N isotopic records preserved in paleoceanographic archives (e.g., sediments, deep-water corals) by investigating factors contributing to the variability in the molecular and isotopic composition of export productivity in the Gulf of Maine. To begin to address these knowledge gaps, we analyzed sediment trap samples from Jordan Basin collected in 2010-2011 to evaluate changes in the composition of export productivity in relation to depth and seasonality. The sediment trap materials were analyzed for molecular abundance and N isotopes of amino acids, from which a suite of indices to investigate primary producer functional groupings, degradation, trophic position, and nutrient sources were derived. Understanding potential short-term fluctuations and baseline variability in biological productivity will ultimately help to better constrain the biogeochemistry of underlying sediments and benthic communities. Our preliminary results show distinct differences between shallow and deep sediment trap amino acid parameters including greater degradation in deep traps. We further see chemical markers of higher trophic levels in shallow trap samples and differences in source δ^{15}N metrics, suggesting different organic matter sources for deep traps compared to shallow traps. Seasonal patterns coinciding with local pteropod blooms and implications for sediment core-based paleoceanographic reconstructions will be discussed.

Export productivity variability from compound-specific isotope analyses of amino acids in sediment trap time series in the Northern Labrador Sea

Shaomin Chen[1] Thibaud Dezutter[2] David Cote[3] Evan Edinger[4] Owen A. Sherwood[1]

[1]Department of Earth and Environmental Sciences, Dalhousie University, Halifax, NS, Canada, B3H 4R2
[2]Department of Biology, Laval University, Québec, QC, Canada, G1V 0A6
[3]Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre, St. John's, NL, Canada, A1A 5J7
[4]Department of Geography, Memorial University of Newfoundland, St. John's, NL, Canada, A1C 5S7

Speaker may be reached at shaomin.chen@dal.ca

Rapid changes in sea ice coverage, temperature, and stratification in Arctic and subarctic regions due to global warming are expected to lead to changes in surface ocean primary productivity. These changes may impact the timing, composition, and quality of export production that supports deep-water benthic food webs. Since summer, 2017, a mooring program has been in operation at Saglek Bank on the outer northeast Labrador shelf. The study site lies at the confluence of Arctic outflow and Atlantic waters and is hence sensitive to basin-scale climate forcing. It is also known to support abundant cold-water corals and associated benthic organisms. Sediment traps have been deployed on the moorings. We investigated both bulk and amino acid carbon and nitrogen stable isotope (δ^{13}C and δ^{15}N) data from the first two years of sediment trap deployments complemented by oceanographic and biological data at the mooring sites. The HiBioA-17 trap was deployed at a depth of 469m from November 2017 to August 2018 at, 40m off bottom. The HiBioC-18 trap was deployed at 915m from August 2018 to July 2019, 100m off bottom. Both deployments had similar organic carbon fluxes, ranging 4.3-36.1 and 5.2-49.3 mg C $m^{-}2$ $d^{-}1$ and peaking in August and July for 469m and 915m traps, respectively. Significant differences were found in both bulk δ^{13}C and δ^{15}N in the 469m trap (-24.3 $\pm$ 0.4 ‰ and 7.1 $\pm$ 0.7 ‰, respectively) from the 915m trap (-25.0 $\pm$ 0.6 ‰ and 9.1 $\pm$ 0.6 ‰, respectively). A decline in δ^{15}N by 2‰ in both traps in mid-April may be caused by incomplete nitrogen utilization during the spring bloom. Compound-specific isotope analysis of amino acids were carried out to estimate variability in baseline nitrogen sources, trophic fractionation, microbial degradation, and plankton community composition. The δ^{13}C-EAA patterns indicate well preserved primary production and minimal contribution of microbial biomass in the export production. The δ^{15}N-AA proxies suggest a relative dominance by fecal pellet in export production. Overall, this study provides new insights into export productivity variability in a remote subarctic marine environment and suggests that exported fecal pellet may be a critical source of C and N for benthic fauna in this subarctic region.

Nitrous Oxide Time Series in the Bedford Basin

Adriana Reitano[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at ad207770@dal.ca

Nitrous oxide (N_2O) is a potent greenhouse gas, (296-340 times more powerful than carbon dioxide) with an atmospheric lifetime of 114-120 years. In the stratosphere N_2O is oxidized by the reactive oxygen species O(1D), this reaction produces species of nitrogen oxides (NOx) which are then able to further react and deplete stratospheric ozone (O_3). The ocean is a variable and, potentially, significant source of N_2O to the atmosphere (10-53% of natural and anthropogenic sources). N_2O samples were obtained from the Bedford Basin for the years of 2015-2020 as apart of the weekly time series conducted by Dalhousie University and Fisheries and Oceans Canada. Concentrations were determined by headspace analysis and gas chromatography (GC). The concentration of N_2O at 60m had strong seasonality and became supersaturated in late summer/early winter in all years. In December 2019 N_2O at 60m was found to have a peak concentration of 90.96 nanomoles/L (nM) which deviated significantly from the previously recorded maxima of approximately 40nM (December, 2017). Ratios of N_2O/NO_3^- and N_2O/NH_4^+ were calculated for the timeseries whereby both ratios were found to have the greatest increase associated with the anomalous event. Nitrate (NO_3^-) seasonality was relatively constant throughout the timeseries duration, however; ammonium (NH_4^+) seasonality was found to have increased along with the N_2O deviation, reflecting delayed nitrification. Very low (but non-zero) oxygen concentrations were observed (6 - 8 μM) in the same time-period as the anomalous rise in N_2O. This is consistent with the highly non-linear dependence of N_2O production on oxygen during nitrification and a possible link to changes in microbial community composition associated with water column mixing.

Trends and variability in sea ice along the Labrador coast and shelf

Kaitlyn Quinn[1] Alexa MacIsaac[1] Peter MacGregor[1] Lily Musselman[1]

[1]Dalhousie Integrated Science Program (DISP), Dalhousie University, Halifax, Canada, B3H 4R2

Speaker may be reached at quinn.kait@gmail.com

Sea ice along the Labrador coast and shelf is an integral part of Inuit life and culture, and is important for regional ecosystems. However, the long-term changes to sea ice in this region under a warming climate are poorly understood. Here, we aim to quantify the climatology, trends, and correlation between sea ice area (SIA), sea ice thickness (SIT), and air temperature (AT) in four domains in this region over the past four decades. To calculate these trends and variability, we used python to perform simple statistical analysis using SIA and SIT data from the Canadian Ice services, and AT data from ERA5 reanalysis between 1980-2021. AT reaches a minimum in February and a maximum in August and has a positive trend with an increase of 0.7℃ per decade. SIA and SIT in all regions exhibit negative trends, averaging -1,222.87 km^2/decade and -0.06 m/decade respectively, indicating a loss in sea ice. SIA and AT demonstrate a strong negative correlation while SIT and AT share a moderate negative correlation, suggesting that AT may be one of many influences on SIA.

Antacids for the sea: the effect of extreme alkalinity enhancement on sinking rate and photosynthetic response in two diatoms.

Mikaela Ermanovics[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at mk667000@dal.ca

Climate change is the most pressing issue of our time. All IPCC emissions pathways that are compatible with the 1.5 degree C-warming target set out by the 2015 Paris Agreement rely on carbon dioxide removal (CDR). One promising CDR is ocean alkalization enhancement (OAE) coupled with the production of H_2 as a clean fuel, a technology developed by Planetary Technologies (Dartmouth, NS). Hydroxide, produced as a by-product, would be discharged to capture atmospheric CO_2 as bicarbonate. In partnership with Planetary Technologies, a joint Dalhousie research effort seeks to assess the effects of OAE on the ocean environment. Social acceptance of OAE will require monitoring its impact on ocean biota, including phytoplankton, the primary producers at the base of marine food webs. This study examines the effect of extreme alkalization enhancement (1 mM NaOH; pH = 9.1) on photosynthetic performance and relative sinking rate. (See presentation by J. Oberlander for effects on viability.) Changes in apparent biomass and photosynthetic parameters were measured simultaneously with a Satlantic Fluorescence Induction and Relaxation (FIRe) fluorometer. Tests focused on two species of diatoms: *Entomoneis cf. alata* (c. 40 μm) and *Minutocellus polymorphus* (c. 3 μm). The hydroxide treatment enhanced sinking in both species. Hydroxide had no effect on photosynthetic parameters in *Entomoneis*. In *Minutocellus*, there was a significant decrease in the quantum yield of Photosystem II and an increase in the photosynthetic turnover time. There was no change in the photosynthetic cross-section.

Determining rates of benthic-pelagic carbon cycling in the Northwest Arm

Katie MacDonald[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at kt376838@dal.ca

Coastal sediments are some of the most productive in the ocean, supporting high rates of nutrient cycling, especially carbon and nitrogen. Coastal areas can also act as carbon sinks due to high productivity in the overlying waters, as well as sites of denitrification. Nitrogen is an important nutrient for biological productivity and often limits biological carbon production within surface waters. Quantifying rates of biogeochemical processes in such a dynamic environment is difficult, but we sought to better understand sedimentary nutrient cycling in an urban estuarine environment. A 24-hour flux incubation experiment was used to measure respiration rates in sediment cores taken from the Northwest Arm, an offshoot of Halifax Harbour. Measuring changes in nutrients including $[NO_3^-]$, $[NH_4^+]$, and $[PO_4^3-]$ within these cores allows determination of respiration rates due to microbial processes. Nutrient profiles were constructed from the porewater and overlying water column samples, and analysis was performed to calculate oxygen consumption rates. The dissolved oxygen in the treatment cores decreased 4.5 times faster than the control core, consistent with sediment respiration consuming oxygen in the overlying water. $[NO_2^-]$ and $[NH_4^+]$ concentrations increased in the water column of the treatment cores, whereas $[NO_3^-]$ decreased. Porewater $[NH_4^+]$ and $[H_2S]$ concentrations increased linearly with depth, consistent with increased anaerobic microbial activity in anoxic sediments below the sediment-water interface.

Big BRUVer Watches the Bedford Basin

Jessica Sajtovich[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at `js413359@dal.ca`

Benthic ecosystems contribute to the overall health of global oceans through the provision of biogeochemical functions and ecosystem services, such as organic matter breakdown, and nutrient cycling. However, marine ecosystems are becoming increasingly threatened due to the impact of anthropogenic pressures such as climate change. Additionally, many benthic fauna are largely sedentary and therefore obtain reduced capabilities to respond to deteriorating marine conditions, making them valuable bio-indicators of overall ecological health. Therefore, it is becoming increasingly important to monitor the health of benthic marine ecosystems and to evaluate management strategies. Many traditional marine monitoring methods can be costly, labor intensive, or extractive, resulting in adverse impacts to marine habitats and significantly limiting the scope and timescales of many marine monitoring surveys. Baited remote underwater video systems (BRUVS) represent an innovative, cost-effective, non-destructive monitoring technology. Additionally, calibrated stereo-BRUVS (utilizing two integrated camera systems are capable of making accurate length measurements of marine organisms, providing advantages for marine monitoring surveys. The use of BRUVS began in the mid 90's and grew in popularity for marine surveys largely due to technological advancements in high quality, low-cost digital cameras. However, an overwhelming majority of BRUVS surveys have been conducted in the photic zone within the southern hemisphere, and significant knowledge gaps surround the use of BRUVS, with integrated lighting for us in poorer-visibility, low light, or aphotic environments in more northern latitudes such as the North Atlantic. The goals of this study were firstly to construct and calibrate a cost-effective stereo-BRUVS with integrated lights, capable of marine monitoring. Secondly, this study aimed to test and evaluate the technological and operational methodologies of the stereo-BRUVS for effective characterization of mobile benthic macro- and mega-faunal assemblages. Within this study, two stereo-BRUVS, designed by the Seascape Ecology and Mapping lab (SEAM) at Dalhousie University, were constructed and utilized to monitor diurnal and nocturnal benthic marine assemblages within Halifax Harbor. The stereo-BRUVS systems were calibrated prior to field sampling, enabling length measurements to be performed on observed marine fauna. Sequential field deployments took place over four weeks, testing two different light treatments, white and red light, and collecting video at 3 different durations, 10, 20 and 30 seconds, and four different intervals, every 5, 10, 15 and 30 minutes. Community assemblages varied between nocturnal and diurnal sampling, and between light treatments. Nocturnal sampling using white light observed the greatest number of species, however, red light overwhelming observed the greatest number of individuals, suggesting a behavior response of some marine organisms to red light. Recording duration was found to have a negligible impact on species observations, however, increasing recording intervals were found to decrease the number of species and individuals observed. Additionally, this study makes recommendations for refinement and improvement of the stereo-BRUVS system associated with camera orientation, light choice, and camera settings, while identifying potential for future research utilizing stereo-BRUVS.

Less Is More: Building A Novel ALGArithm For Real-Time Classification Of Phytoplankton Community Composition

Sofya Pesternikova[1] Dr. Hugh MacIntyre[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at sf773280@dal.ca

Monitoring phytoplankton communities is essential for understanding their responses to global climate change and for detecting the increasing occurrence of harmful algal blooms (HABs). Optical remote sensing of reflectance via satellites offers unparalleled spatial coverage but has limited resolution of depth distributions, temporal variability, and community composition. In-water monitoring of chlorophyll fluorescence is a technology that can complement remote by addressing these limits. Spectral fluorescence excitation and/or emission signatures have the potential to provide real-time classification of community composition. Instruments are available commercially (e.g. from bbe Moldaenke or JFE) but, to my knowledge, no objective means of optimizing the classificatory wavelengths has been published. I have used machine learning methods with a library of full spectra from over 40 phytoplankton species to identify and optimize the wavelengths used to classify 4 pigment-based groups (chlorophytes, chromophytes, phycoerythrin-rich cryptophytes, and phycocyanin-rich cyanobacteria). Full fluorescence excitation spectra contain important differences in only a few parts of the spectrum. I used machine learning to optimize the discriminatory ability of a signature-based classification by using LASSO to identify a greatly reduced number of wavelengths (7 vs 460). I used the same approach to optimize the accuracy of an existing instrument with multiple optical channels, the Multi-Exciter (JFE Advantech, Nishomiya, Japan). Optimal classification of the 4 main pigment groups is achieved using only 4-5 of the 9 Multi-Exciter's channels. This reduced the error estimate by 10-fold compared to use of all 9 channels. This machine learning approach can be used in a forward model, such as designing a next-generation battery-powered spectrofluorometer to be used in autonomous monitoring (e.g., moorings, Argo floats, or wave gliders). Equally, it can be used in reverse to optimize the classificatory power of an existing instrument with multiple optical channels. In this case, less is more.

Evaluating the environmental impact of Finfish Aquaculture on a naturally anoxic environment.

Therese Wilson[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at th327195@dal.ca

Aquaculture is the fastest-growing sector of animal-protein production in the world and offers the promise of helping to meet the ever-increasing demand for protein-rich food sources which currently exceeds the capabilities of traditional fisheries However, the practice is linked to environmental impacts, such as the alteration of respiration rates via organic matter. While the impacts in oxic waters is well researched, little has been done in the way of evaluating these impacts in naturally anoxic waters. Here a series of anoxic sediment incubations experiments were performed to assess how organic matter loading beneath marine aquaculture cage systems alters carbon remineralization rates within an environment with a natural anoxic zone. The respiration rates were assessed at three sites in Whycocomagh Bay, NS, using sediment cores. The sites consisted of an unimpacted reference site, an old cage site, which has been fallowed for two years and a new cage site that was currently stocked with fish at the time of sampling. The subsamples were incubated in darkness and under anoxic conditions at in situ temperatures, for a total of three weeks. On weekly time intervals samples were sacrificed and porewater was analyzed for changes in the biproducts of respiration (i.e. DIC, total S^{2-}, NH_4^+, and Fe^{2+}). NH_4^+ was highest at the old cage site followed by the reference site, then finally the new cage. DIC was highest on average at the old cage site, followed by the new cage, then finally the reference. Fe^{2+} was highest on average at the new cage site, followed by the reference and finally the old cage site. Total $S^{2-}$was highest at the reference site followed by the new cage and finally the old cage. The differences between the means of the sites were determined to be statistically significant. Respiration rates were then calculated from the slope of a linear regression of the timeseries of respiration byproducts. The new cage site displayed the highest remineralization rate for S $^{2-}$, Fe^{2+}, and DIC, though the old cage site showed a 5% higher remineralization rate for NH_4^+ than the new cage. However, none of the linear regressions were deemed to be statistically significant. In conclusion the lack of trends between the respiration byproducts and site locations, as well as the fact that the respiration rates could not be accurately quantified, suggests incubations were too short to measure concentration of sufficient magnitude among the high background concentration of respiration byproducts. It is recommended that longer incubation times should be used to assess sediment respiration rates.

Improving estimates of the biological carbon pump in coastal regions: Quantifying particulate organic carbon fluxes using ^{234}Th

Madeline Healey[1] Stephanie Kienast[1] Christopher Algar[1] Erin Black[2]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2
[2]Department of Earth and Environmental Sciences, University of Rochester, Rochester, NY, USA, 14627

Speaker may be reached at mhealey@dal.ca

The ocean's biological carbon pump (BCP) plays a large role in the global carbon cycle. A fraction of the photosynthetically fixed organic carbon produced in the sunlit euphotic zone of the ocean is exported to depth in the form of particulate organic carbon (POC). This study quantifies seasonal changes in POC export within a semi-restricted coastal basin by utilizing the ^{238}U-^{234}Th radioisotope system. This system is widely used in the open ocean, however, its application in complex coastal regimes has been limited so far. The short-lived radionuclide thorium-234 (^{234}Th, $t^{1/2}$ = 24.1d) is a tracer used to quantify the magnitude of POC that is transferred from the surface ocean to depth. ^{234}Th decays from the conservative parent isotope, uranium-238 (^{238}U, $t^{1/2}$ = 4.47 x 109 yr). Unlike the conservative nature of ^{238}U, ^{234}Th is highly particle reactive and is scavenged by particles as they form and sink to depth. Consequently, the disequilibrium between ^{238}U and ^{234}Th can be identified and used to approximate the export of particles throughout the water column. Under steady-state conditions, the flux in the water column deficit should match those derived from ^{234}Th excess in the uppermost deposits of the sediment layer. Once flux is determined, the ratio of POC to ^{234}Th activity can be determined to identify downward carbon fluxes. Preliminary results from spring 2021 indicate general agreement between water column fluxes of ^{234}Th and ^{234}Th fluxes in the upper sediment layers of the coastal basin. The 2021 observations of ^{234}Th fluxes show an apparent increase in ^{234}Th activity in the water column, and thus a smaller deficit to ^{238}U, compared to all previous sampling efforts in 2019. If confirmed this would suggest less particulate matter and export to depth, possibly related to current changes in the seasonal cycle of stratification and mixing in the basin. If considered feasible, the ^{234}Th-^{238}U method opens the possibility of an alternative method for quantifying carbon fluxes in coastal settings and thus opens the door for addressing other complex questions and environmental concerns that face many coastal areas in the Anthropocene.

Response of the upper Arctic Ocean to marine heatwaves for regionally differing ice-ocean regimes: preliminary results

Benjamin Richaud[1] Eric Oliver[1] Katja Fennel[1] Xianmin Hu[1]

[1]Department of Oceanography, Dalhousie University

Speaker may be reached at bn512787@dal.ca

Arctic regions are warming at two to three times the global average rate. Superimposed on this trend, extreme events such as heatwaves are expected to become more frequent and intense. Simultaneously the sea ice phenology with which these events interact is also changing significantly in some regions. The Siberian atmospheric heatwave of 2020 saw temperature anomalies of +5°C from January to June of that year, with a record-high temperature of 38°C north of the Arctic circle reached at the end of June. The effects of such a heatwave on the Arctic Ocean depends in part on the specific sea ice regime present at that time, due to the high coupling between the atmosphere, the ocean and the cryosphere in those regions. In this study, we use a three-dimensional ice-ocean regional numerical model and apply a two-layer heat budget to investigate the ice-ocean response to the 2020 Siberian Heatwave and then further generalize across other extreme events in different Arctic regions. We consider different ice-ocean regimes, such as perennial versus seasonal ice-covered regimes and characterize the preconditioning of the system to an extreme warming event, the feedback between the climate components, and the recovery of the sea ice and ocean after anomalous warming events.

A win-win approach for transforming dairy waste into high-value products through algal culture

Tatyana Bouffard-Martel[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at tt718656@dal.ca

Managing nutrient-dense waste is a major environmental challenge. Discharge can cause significant damage to aquatic ecosystems, including hypoxia, Harmful Algal Blooms, and loss of critical habitat such as seagrass meadows. These can in turn lead to a loss of revenue from economic activities, such as fisheries and tourism. One solution to this problem is to minimize the anthropogenic release of nutrients through bioremediation. Microalgae have a very high photosynthetic efficiency and can assimilate some nutrient-rich industrial wastes used as constituents of their culture medium. This remediation can be utilized for a variety of waste streams and food-grade wastes. In Canada, the dairy industry produces large amounts of whey permeate, a phosphorous- and lactose-rich waste that has few commercially profitable uses. Using such wastes to subsidize the production of algal biomass for aquaculture feeds may be a feasible way to valorize them. This study tested the use of whey permeate as a means of producing algal biomass. It identified the trade-offs in maximizing biomass production rate vs the efficiency of nutrient reduction in the waste by comparing growth in batch and semi-continuous cultures. Tests on the marine alga Pinguiococcus pyrenoidosus (Heterokontophyta) showed that it achieved higher final biomass in whey-amended than control cultures. Whey-amended cultures down-regulated photosynthetic pigments, a common response in mixotrophic growth. Further steps to optimize algal remediation of whey permeate involve identifying more species of algae that can assimilate the organic nutrients and analyzing the cell quotas of high-valuable compounds when the cultures are grown on the waste. Algal culture has the potential to remediate dairy waste as well as to reduce the production costs of high-value algal metabolites that can be used in diverse markets such as aquaculture feeds, plant proteins, omega-3 fatty acids, or pharmaceuticals.

Numerical Study of Circulation, Hydrography and Dissolved Oxygen Concentration over the Scotian Shelf Using a Nested-grid Coupled Circulation-oxygen Model

Qiantong (Albert) Pei[1] Jinyu Sheng[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at qn317878@dal.ca

The main objective of this study is to examine the temporal and spatial variability of circulation, hydrography, and dissolved oxygen concentration (DO) over coastal waters of the Scotian Shelf. A simple oxygen model is coupled to level 3 sub-model of a nested-grid circulation-ice modelling system for the southeastern Canadian shelf (seCS). Model results produced by the nested-grid modelling system during the summer in 2018 are used to examine the effects of atmospheric and tidal forcing on general circulations, temperatures, and salinities over the seCS. A process study is conducted using the coupled circulation-oxygen model for investigating main physical processes affecting temporal and spatial variability of DO over coastal waters off southwest Nova Scotia during the summer in 2018. Model results demonstrate that both winds and tides affect coastal circulations and enhance the vertical mixing over the coastal waters. Winds significantly affect the hydrography and DOC in the upper water columns through wind effects on the air-sea fluxes and vertical mixing. Tides affect the local DOC maxima at the subsurface of about 20 m through mainly tide-induced mixing.

Sightings Per Unit Effort : a tool for protecting species at risk

M. K. Carr[1] A. S. M. Vanderlaan[2] C. T. Taggart[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2
[2]Fisheries and Oceans Canada (Maritimes Region), Bedford Institute of Oceanography, Dartmouth, Nova Scotia, B2Y 4A2

Speaker may be reached at m.k.carr28@gmail.com

Whales face risk from a variety of anthropogenic sources such as ocean noise, vessel strikes, entanglement, pollution, and beyond. For endangered whales these risks are even more dire and can represent a threat to their survival as a species. Sightings Per Unit Effort (SPUE) is a tool used to quantify the distribution of cetacean species. Unlike traditional distribution metrics, SPUE includes a measure of effort, which reduces bias and allows researchers to create more accurate distribution maps. This presentation explains how SPUE is calculated, introduces the advantages of SPUE over traditional distribution metrics and discusses how this tool can be used in risk assessments to better protect species at risk.

Recent observations of circulation in Bedford Basin and Halifax Harbour

Ruby Yee[1] Ruth Musgrave[1] Mathieu Dever[2,3] Richard Davis[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2D
[2]RBR Ltd, Halifax, NS, Canada
[3]Department of Physical Oceanography, Woods Hole Oceanographic Institution, 266 Woods Hole Road, MS 21, Woods Hole, MA, USA, 02543

Speaker may be reached at r.yee@dal.ca

Halifax Harbour and Bedford Basin form a fjord-like system, with the Sackville River at the northwest end and the open ocean to the southeast. The harbour and basin have been well-studied by researchers at both Dalhousie University and the Bedford Institute of Oceanography; data is available from long-term monitoring programs dating back more than two decades. However, three-dimensional circulation and the associated physical processes have yet to be characterized at high resolution. Here we present observations from two surveys of the harbour and basin, which took place in December 2021 and February 2022. Along- and cross-basin transects of temperature and salinity allow for novel insights on physical structure. Comparisons between the two study dates are used to further understand how the harbour and basin waters evolve in time. Historical data is also reviewed, with an emphasis on identifying episodic deep water renewals. These dramatic events can occur on timescales of hours and are distinct from the typical near-surface circulation in the basin, as they flush out and re-oxygenate the deep waters. They have important implications for hypoxia in the basin, but their physical drivers are not well understood.

Physical drivers of the projected disappearance of the shelfbreak jet in the Northwest North Atlantic

Lina Garcia[1] Katja Fennel[1] Jasmin John[2]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2
[2]NOAA/Geophysical Fluid Dynamics Laboratory, Princeton, NJ, USA

Speaker may be reached at lina.garcia@dal.ca

Despite a long history of observations and numerical model simulations, a solid understanding of the mechanisms behind the presently observed rapid warming of the Northwest North Atlantic Continental Shelf and its projected future trajectory is lacking. We hypothesize that the warming trend can be attributed to dynamical changes at the tail of the Grand Banks which could be a consequence of shifts in wind stress and air-sea heat flux, or advective signals that affect the momentum balance and reduce the westward connectivity of the Labrador Current. A 100-year projection from a global climate simulation (GFDL CM2.6 CO_2 doubling experiment) that resembles the rise in atmospheric CO_2 concentrations from the RCP6 scenario is used to examine the along-stream evolution of the Northwest Atlantic shelf break jet. A multidimensional empirical orthogonal function (EOF) analysis shows that an intensified subsurface warming and a shift of salinity accounts for more than 50% of the overall projected variability over the century, localized especially at the tail of the Grand Banks. Our results indicate a regime shift in the equatorward transport of cold, fresh Labrador Sea water on the Northwest North Atlantic shelf driven by changes in a long-shelf pressure gradients.

Environmental variability shapes copepod life history: What we learn from optimizing a C. finmarchicus population model in the northwest Atlantic

Emma Leitao[1] Dr. Catherine Brennan[2] Wendy Gentleman[1] Dr. Frédéric Maps[3,4] Dr. Catherine Johnson[2]

[1]Department of Engineering Mathematics, Dalhousie University, 5217 Morris Street, Halifax, NS B3J 1B6, Canada
[2]Fisheries and Oceans Canada, Bedford Institute of Oceanography, PO Box 1006, Dartmouth, NS, B2Y 4A2, Canada
[3]Takuvik Joint International Laboratory, Université Laval (Canada) – CNRS (France) / Québec-Océan
[4]Département de Biologie at Université Laval, 1045 Avenue de la Médecine, Québec, QC, G1V 0A6, Canada

Speaker may be reached at emma.leitao@dal.ca

Calanus finmarchicus dominates the biomass of mesozooplankton in the northwest Atlantic and has significant importance as the main prey of the endangered North Atlantic right whale. In recent decades, abundance declines and distribution changes in these copepods have been observed, possibly having negative impacts on North Atlantic right whales. This modeling study examines regional differences of *C. finmarchicus* characteristics and investigates the role of environmental variability in regulating their populations. Population models require specification of a suite of parameters related to mortality, egg production, and development rates, some of which are well defined, whereas others are not and need to be tuned. Here, we used a genetic algorithm to find parameter values that best fit model outputs to observations from the Anticosti Gyre station in the Gulf of St. Lawrence and the Halifax-2 station on the Scotian Shelf. Using historically warm and cool years, we then investigated the robustness of these populations to environmental variability. Model optimization highlighted trade-offs of different, but equally viable, parameter sets at each station, as well as diversity of strategies available between regions. When forced with historical environmental variability, the model reproduced observations and highlighted that warming and a delayed spring bloom are associated with population declines. This investigation emphasizes how regional environmental differences shape *C. finmarchicus* subpopulation characteristics and underscores the need for temporal resolution of parameterization. Interannual environmental variability directly impacts *C. finmarchicus* phenology and abundance and predicting these sub-decadal shifts is critical for North Atlantic right whale management and conservation.

Assessing Phytoplankton Viability in the Context of Ocean Alkalinity Enhancement – Testing the Test

Jessica Oberlander[1] Hugh MacIntyre[1]

[1]Department of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4R2

Speaker may be reached at Jessica.Oberlander@dal.ca

Over the past 250 years, atmospheric CO_2 concentrations have risen steadily from 277 ppm (Joos and Spahni, 2008) to 405 ppm (Dlugokencky and Tans, 2018), causing climate change to become one of the most pressing issues facing society today. As a result, new technologies are being developed to reduce or remove carbon from the atmosphere, with the primary focus on negative emission technologies (NETs). One proposed NET is Ocean Alkalinity Enhancement (OAE), which mimics the ocean's natural weathering processes and aids in the sequestration of CO_2 from the atmosphere. Measurement, reporting, and validation (MRV) are essential to this technology's acceptance when considering CO_2 trapping, especially because the values define the carbon offsets in a carbon credit marketplace. Social acceptance is equally important when confirming that there will be little to no impact on ocean biota. Ensuring that there are no adverse effects on phytoplankton is essential as they are the base of most marine food webs. A current detection method, the Serial Dilution Culture – Most Probable Number Assay (SDC – MPN), will be used in a modified format to assess the impact of alkalinity on phytoplankton viability. Previous data using *Tetraselmis suecica* suggests that the modified SDC – MPN is a valid method, but species of other lineages must be validated before approval can be made. *Thalassiosira pseudonana* has also been used to validate the modified SDC – MPN, but with less success. When grown in 48-well polystyrene cell culture plates the overall viability of untreated culture was much lower than anticipated; however, when grown in borosilicate glass tubes the viability was equivalent to anticipated control values. These results prompted further investigation. Hypotheses included the plates leaching plastic chemicals, a missing element in the growth medium, or the volume of the 48-well polystyrene cell cultures plates being too small. A combination of these hypotheses was determined to be the underlying issue in the reduced viability. This validation testing is vital to confirm that the final dose response curves are accurate representations of each individual species' response to OAE. Understanding how the use of OAE could impact phytoplankton will be critical in the coming years to prevent declining ocean health due to increasing atmospheric CO_2.