

Canadian ocean modelling workshop 2026

Online



CANADIAN NEMO OCEAN
MODELLING FORUM
COMMUNITY OF PRACTICE



MEOPAR

House Rules:

- Please raise your hand if you want to speak
- If you suggest a paper or link please add it to the meeting notes
 - Note link will be added to the chat, but if you don't see it, let us know!
- Please be respectful to everyone that is participating
- If your internet connection is good and you feel comfortable with sharing your camera, please keep your camera on.



11 May 2026: Day 1

Ocean model development: Globally and in Canada

Paul Myers and Nicolas Lambert



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Outline of Session

- Reminder/Background on NEMO/Ocean Modelling Forum
- Some general points on ocean model development
- Drakkar NEMO 2026 Work Plan
- NEMO Analysis Tool Box (maybe move all related slides into discussion section)
- Initial Work with NEMOv5 and SI3
- Work on Forcing Products
- Running Very High Resolution Configurations
- Topics for Discussion
- White Paper on Ocean Modelling in Canada

Canadian NEMO/Ocean Modelling Forum



- There has been a long term desire to bring together ocean modellers in Canada, from government and academia, to increase collaboration, sharing and interaction
- Events have been occurring associated with the CMOS Congress for years
 - E.g. Those activities led by Youyu Lu and Susan Allen, for example
- Links have occurred for many years with CONCEPTS
 - Canadian Operational Network of Coupled Environmental Prediction Systems
- Many interactions through MEOPAR and Its Prediction Core
 - Marine Environmental Observation, Prediction and Response Network

Communities of Practice

- A key part of MEOPAR is their Communities of Practice (CoP)
 - Goal is to bring together practitioners working on a given topic
- In the Ocean Modelling Space
 - Bring together Canadian NEMO users – or more broadly all Canadian Ocean Modellers
- Goals
 - Easily see what we are all up to
 - Request/share: code/output/data
 - Increase interaction of HQP and ECR with potential employers and share/teach desired skills
- Which leads to the overarching goal of **Increased Communication and Collaboration**

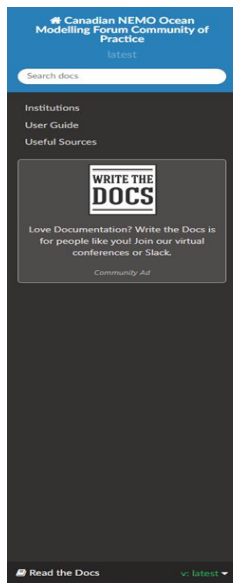
Canadian NEMO/Ocean Modelling Forum

- With MEOPAR refunded and morphing from an NCE to an SSF, there was a call to fund Communities of Practice
- We submitted one for a Canadian NEMO/Ocean Modelling Forum
- Was originally funded by the new MEOPAR SSF for Nov 2024 – Oct 2025
 - Now funded for Oct 2025 through March 2028
- Several key activities were proposed

I: Regular Seminar Series on Ocean Modelling

- Proposed a bi-monthly series, but in practice, have been running it monthly since January 2025
 - First Monday of the month
 - January – June, September - December
 - Plan a two month Summer gap then will restart in September
 - Normally 2 seminars each month
 - ~20 minutes each
 - Ideally, one more theoretical and one more applied (but lots of flexibility)
- <https://canadian-nemo-ocean-modelling-forum-community-of-practice.readthedocs.io/en/latest/index.html>
 - You can see past events, abstracts, through the calendar
- Speakers needed from September onwards
- Coordinator: Tahya Weiss-Gibbons (weissgib@ualberta.ca)

Website



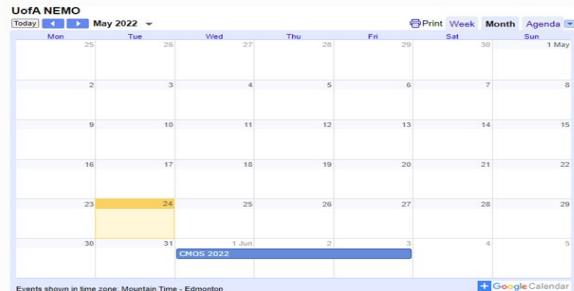
NEMO Ocean Modelling Forum Community of Practice

Welcome to the NEMO Ocean modelling forum community of practice. The goals of this site is to encourage collaboration across Canadian institutions to share our NEMO modelling progress, development, code, accomplishments, successes and failures, and many other aspects.

Contents

- [Institutions](#)
- [User Guide](#)
- [Useful Sources](#)

Upcoming Events:



Join our Slack channel.

This website is under active development.

- Request/share: code/output/data
- Help to share documentation
- Help to share output/forcing files/etc
- Goal: increase collaboration
- <https://canadian-nemo-ocean-modelling-forum-community-of-practice.readthedocs.io/en/latest/index.html#>

Canadian Ocean Modelling Forum workshop

Ocean model development: Globally and in Canada

A few general points:

- Numerical ocean models include **components** of circulation (with T/S), sea-ice, waves, sediment, BGC, etc.
- For each component, different models (systems, codes) exist. They have a lot in **common** (solving same or similar equations), but also many **differences** (in simplifying equations, parameterization of unresolved processes, numerical schemes, grid setups, code & software structure, regional scopes, input data, etc.)
- A particular model may **perform better over others for certain purposes** (climate simulation or short-term prediction; global/deep ocean, shelf, coastal, nearshore, lakes), due to the specific model design, experience of users, etc.

A few general points (cont'd):

- **Internationally, there are R&D groups** dedicated in developing ocean models, many are open sourced
- In the past (before 2000), Canadian researchers have worked on developing (or co-developing) **“own” ocean models**, hence possessing expertise in developing numerics
- In recent two decades, we are mainly **using open-source models** for global and regional applications, hence focusing on using, setting up, modifying/integrating & tuning models.
- This still requires **developing, cumulating and sharing expertise**, within specific groups and across different groups. These are facilitated by major national programs/projects, e.g., CONCEPTS & MEOPAR, and academic training (graduate students & postdocs) and subsequent staffing

List of major ocean **circulation** (+ **other modules**) models currently used in Canada

■ **Structured-grid** models

- **NEMO + ice (LIM, CICE, SI3) + waves + turbidity + BGC**
- **ROMS + ice (CICE) + waves + sediment + BGC**
- **MOM + ice (CICE)**
- **POM & ELCOM + ice; MITgcm**
- **MOHID + oil fate & behavior**
- **CROCO (ROMS-AGRIF) ? , ? (R Musgrave)**

■ **Unstructured-grid** models

- **FVCOM + ice + waves + sediment + BGC?**
- **SCHISM + ice + waves + sediment + BGC?**
- **French tidal model (D Greenberg)? FESOM? + ice + BGC**
- **MIKE ?**

Major usage of ocean models in Canada

- **Short-term operational forecasting**
 - NEMO + GEM @ CONCEPTS (ECCC, DFO port models), UBC
- **Coupled climate modelling**
 - NEMO + CanAM6-GEM + other components @ CCCma
 - NEMO + WRF @ DFO
 - NEMO + WW3 @ UQAR, UofA
 - ?? + other earth system components @ UQAM?
- **Long-term historical hindcasting & future ocean-only climate modelling**
 - NEMO + ice + BGC @DFO, UoA, DAL, UBC, etc.
 - ROMS + ice + waves + BGC @DAL, DFO

Major usage of ocean models in Canada (cont'd)

- **Processes studies & specific applications**
- FVCOM & SCHISM for **aquaculture** @DFO, DAL
- NEMO & ROMS + ice+ BGC for **ecosystems** @DFO, DAL, UBC, UoA, UoM
- ROMS & NEMO + waves for **wave-current interaction** @DAL, DFO
- FVCOM, SCHISM & MIKE + waves + sediment for **sediment transport, tidal & wind power** @DFO, RMC? UoQ?
- NEMO, FVCOM, POM & ELCPM + ice for **lakes** @ECCC, RMC?
- MITgcm & ?? for **process studies** @Dal, UoW?, UQAR? GEM @ CONCEPTS (ECCC, DFO port models), UBC
- French tidal model for **tides** @DFO (D Greenberg)

NEMO Community Ocean Model

- <https://nemo-ocean.eu/>

The NEMO ocean model has 3 major components:

- **NEMO-OCE** models the ocean {thermo}dynamics and solves the primitive equations
 - **NEMO-ICE** models sea-ice {thermo}dynamics, brine inclusions and subgrid-scale thickness variations
 - **NEMO-TOP-PISCES** models the {on,off}line oceanic tracers transport and biogeochemical processes
-
- Latest version 5.0.1 bug fix

NEMO Governance and Strategy

- The **Steering Committee** agrees on the tasks on the NEMO System Team's (NST) annual work-plan, seeks funding opportunities and is responsible for delivery of staff resources to the System Team.
- The **Scientific Advisory Committee** is tasked with providing objective review and comment to ensure NEMO remains a state-of-the-art ocean model. This group is consulted on a 3-5 year period to advise on strategy, work-plans and promote international collaborations. More info [here](#).
- The **Working Groups** (WGs), with assistance from NST members, propose and help to carry-out work in their areas of expertise. See the current list of WGs [here](#).
- There are 5 **Consortium Experts**, one representative from each of the NEMO partner institutes. These individuals represent the interests of their institutions and guide the “drivers and requirements” of the NEMO framework according the to needs of their respective user base.
- The **Developers Committee** are comprised of the Working Group Leaders, the NEMO Officers and the Consortium Experts. This group is responsible for leading the writing of the the NEMO Development Strategy and reviewing the NST annual work-plan. More info [here](#).
- The **NEMO System Team** undertakes the maintenance and development of the NEMO code along with updating the accompanying documentation and user guide.

NEMO System Team

NEMO System Team 2026

Co-Project Managers: Katherine Hutchinson and Sébastien Masson

Scientific Leader: Gurvan Madec



NEMO Officer
Clément Rousset

Members
Christian Ethé
Stephen Griffies
Katherine Hutchinson
Gurvan Madec
Eric Maisonnave
Sébastien Masson
Pierre Mathiot
Renaud Person
Clément Rousset
Sibylle Téchené
Martin Vancoppenolle



NEMO Officer
Aimie Moulin

Members
Francesco Cocetta
Italo Epicoco
Dorotea Iovino
Tomas Lovato
Diana Azevedo
Francesca Mele
Aimie Moulin



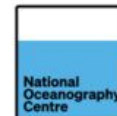
NEMO Officer
Guillaume Samson

Members
Jérôme Chanut
Stella Paronuzzi
Mathieu Peltier
Guillaume Samson
Julien Temple-Boyer



NEMO Officer
Daley Calvert

Members
Ana Aguiar
Isabella Ascione
Mike Bell
Diego Bruciaferri
Daley Calvert
Dave Storkey



NEMO Officer
Andrew Coward

Members
Andam Blaker
Andrew Coward
James Harle
Simon Müller
Jeff Polton
Chris Wilson

Developer's Committee Co-chairs: Pierre Mathiot & Dorotea Iovino

2026 NEMO Work Plan: highlights



- AGRIF
- Air-Sea Interactions
- Data Assimilation interface
- Eddy Closure
- HPC
- Kernel
- Land Ice-Ocean Interactions
- Machine Learning and model uncertainties
- Sea Ice
- Tides
- TOP
- Verification and Validation
- Diagnostics
- Community Engagement₈

What is it?

106 actions planned by all the thematic WGs on:

- Maintaining current functionalities
- Testing new functionalities
- Documenting new functionalities
- Developing new functionalities
- Improving HPC performances

Full list here

By:

- The system team **and** the community

2026 NEMO work plan (please do not copy and paste full rows directly from 2025WP, the format is different)							
Reorder (un)toggle the col with +/-							
WP 2026 - 10							
Action Name	Lead person	Institution	WG	Action type	Funding	results	
Isoberg in AGRF zoom	E. Massonave	CNRS	AGRF	Development	ENMAGS E	After implementation of the resulting interface, we will proceed with testing the AGRF and AGRFed routines	
Enable 3-way zooms with complex geometries	G. Imbrato, S. Masson	CNRS	AGRF	Development	ENMAGS E	EnMAGS task 3.5. May all Develop. We need to make documentation, prepare a shared	
Update of AGRF + timing of AGRF	S. Masson	CNRS	AGRF	Development	NST FTE	Update AGRF governance for the 2026 AGRF features, with a	
AGRF coarsened outputs	J. Charut	Mercator	AGRF	Development	NST FTE	Time-based coarsening of AGRF operators	
AGRF and under ice shelves cavities	D. Bruckert	Met Office	AGRF	Development	ENMAGS E	Design of a database task log for the 3D ice-shelf algorithm as required.	
Wetting and drying in AGRF needs	A. Coward	INOC	AGRF	Development	ENMAGS E	EnMAGS task 3.2. Update AGRF sed where melting occurs of the ice shelf.	
Improve MP's bulk formula	D. Azevedo	CMCC	At-Sea-Interaction	Development	NST FTE	Improve the 2025 model, starting from 2025, and	
Langmuir in GLS vertical mixing	A. MolinO Azevedo	CMCC	At-Sea-Interaction	Development	NST FTE	Improve from 2025, and starting from 2025, and	
Wave clearing	A. Mouli	CMCC	At-Sea-Interaction	Maintenance Documentation	NST FTE	code sharing and discussion	
Coupling interface refactoring	E. Massonave	CNRS	At-Sea-Interaction	Development	NST FTE	Improve from 2025 New interface of the AGRF, offsetting existing interface between existing interface between existing interface	
Updated stability-massflux scheme	G. Cammon / J. Bruckert / D. Azevedo	Mercator	At-Sea-Interaction	Maintenance	NST FTE	Improve from 2024-2025 update - new interface with existing with existing with existing	
neutral drag/Chemo coefficient from wave model with all bulk formula	D. Barson	Mercator	At-Sea-Interaction	Development	NST FTE	Allow to use neutral drag from wave model forcing	

New physics

Icebergs: Improving thickness, grounding and interaction with sea ice

Sea ice: Floe Size Distribution, Brittle rheology and new advection scheme

Eddy Closure: biharmonic GM and improvement of GEOMETRIC

Stochastic physics: complete revisit (pert. generation and ML)

Tides: tidal internal drag

Mixing: major update of Eddy Mass Flux Convection

Performance

Modularity

- Coupling interface refactoring (PISCES, SI3, ICB, SBC, ML, ...)

GPU

- Pursue work on PSyclone
- Testing on multiple architectures

Precision

- Single precision

Tiling

- Improving tiling capability (openMP)

Capabilities

AGRIF

- Improve AGRIF compatibility with all NEMO components (ICB, ISF, WAD)

Machine Learning

- Capability to steer NEMO from Python (teaching, dbg, hybrid modelling)

BGC

- FABM interface to couple NEMO to any BGC model

Coordinates

- GVC framework / Pressure coordinates

Topics for discussion

1. Spatial Scales - each with their own challenges
 1. Global
 2. Regional
 3. Coastal/limited domain
 4. Very high resolution
2. 'Time' Scales
 1. Hindcast
 2. Forecast
 3. Projections
3. What do groups think of these topics, and how can we best move forward and work together on simulations for all spatial and time scales

Spatial and Temporal

Global	Regional	Coastal/Limited Domain	Very High Resolution
Need global forcing products	Boundary Conditions	Boundary Conditions	High-resolution forcing products
Process may behave differently in distinct regions	Initial Conditions for different time frames	Standalone vs AGRIF	Mapping to detailed coastlines and fiords
Global means need expertise in many regions (and just looking at them)	Where to place boundaries	Tides	Observations for high-resolution evaluation

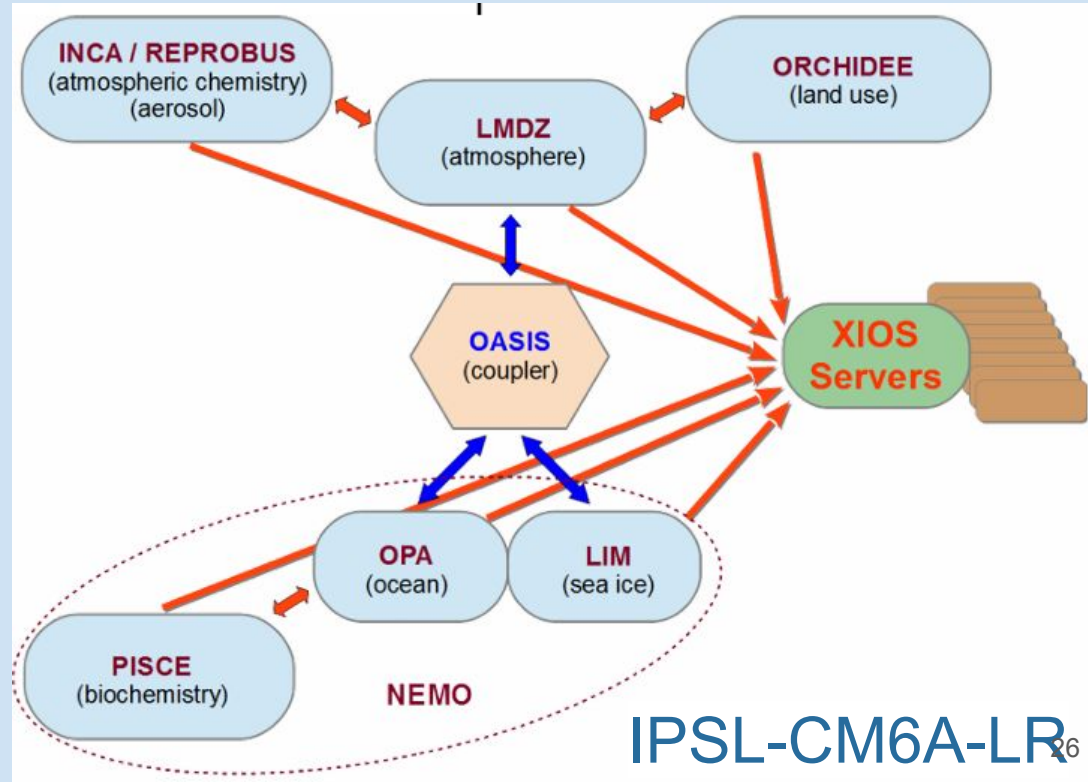
Hindcast	Forecast	Projects
Initial Conditions for different time frames	Data Systems	Which projections/scenarios to use
Forcing products for recent years	Evaluation	High-frequency forcing, runoff routing

Topics for discussion

- What activities should be consider going forward
 - Sharing Portals – Git/code and/or data
 - Online Forum - Slack/Discord channel
 - Website
 - Virtual meetings
 - Broad, or on a specific sub-topic
 - Resources (computational or storage) for common usage?
 - White Paper
 - Canada's role in the NEMO Consortium

Adjacent modules and libraries

- SI³ (sea ice models)
- PISCES (BGC models)
- XIOS (I/O servers)
- OASIS (couplers)
- Interactive Wave models
- River routing models
- Tides & Storm Surge Model
- Ice sheet dynamic model



Adjacent modules and libraries

1. Overview, Portability & Coordination

- What NEMO-adjacent components are **currently** used across Canadian institutions, and how **fragmented** is the ecosystem?
- How **portable** are these systems across HPC platforms, and how easy is it to **reproduce** another group's full setup?
- Are similar tools or systems being **developed in parallel** across institutions?
- Where could better **coordination** improve portability, reduce duplication, or enable shared infrastructure?

Adjacent modules and libraries

2. Integration & Use of Components

- How well are adjacent systems **integrated** with NEMO, and what are the main technical or workflow **pain points**?
- To what extent are default NEMO components (e.g., XIOS, OASIS, BGCs) **used** as intended, vs **adapted** locally?
- Where do groups **diverge** from standard components, and what drives the development of **in-house** solutions?

Adjacent modules and libraries

3. Governance, Coordination & Future Directions

- Who **maintains** and supports these systems in Canada, and how **coordinated** are efforts across institutions?
- How do Canadian developments connect to the international **NEMO ecosystem**, and is stronger **coordination** needed?
- Looking ahead, where should Canada focus: sustaining **existing** systems or investing in **new capabilities** (e.g., AI/ML, coupling tools, workflows)?

Analysis tools - NEMO Diagnostics Working Group

DRAKKAR 2026 - 3rd day planetary session

Motivation for this discussion

- The majority of people in this room and in the NEMO community are analysts (or they wear the hat of an analyst at times):
 - Early career to senior researchers write code to examine/probe simulations.
 - Robust and documented analysis code builds science stories and science community.
 - Many journals require analysis code (e.g., Python notebooks) to be shared via Zenodo/Github.
- Each of these (dozens/hundreds?) of people can offer insights, codes, experiences to enhance the skills and capabilities of the community.
- One way to build a better NEMO is to support better analysis and analysts.
- Much is out there today.
 - This plenary aims to help coordinate/support those efforts and to facilitate further advances.

Analysis tools - NEMO Diagnostics Working Group

Inline diagnostics

- **diar5**: miscellaneous CMIP5 diagnostics
- **dia25h**: Harmonic analysis of tidal constituents
- **diadct**: transport through transect
- **diahsb**: Heat, salt and volume budgets
- **diaptr**: meridional transports and zonal means

Offline diagnostics tools

- **CDFTOOLS**
github.com/meom-group/CDFTOOLS
meom-group.github.io/doc/CDFTOOLS/
- **NEMO Cookbook**
github.com/NOC-MSM/nemo_cookbook
noc-msm.github.io/nemo_cookbook/
- **NEMOScope**
github.com/dfo-dpnm/nemoscope

NEMO Cookbook:

Recipes for reproducible analysis of NEMO outputs using xarray.

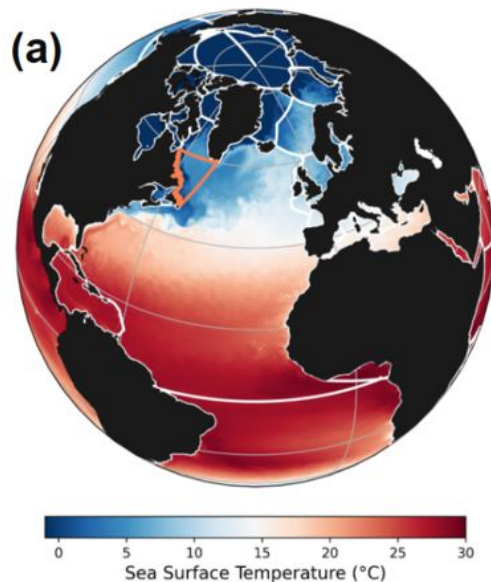
Ollie Tooth¹, Adam Blaker¹, Andrew Coward¹

¹. National Oceanography Centre, Southampton

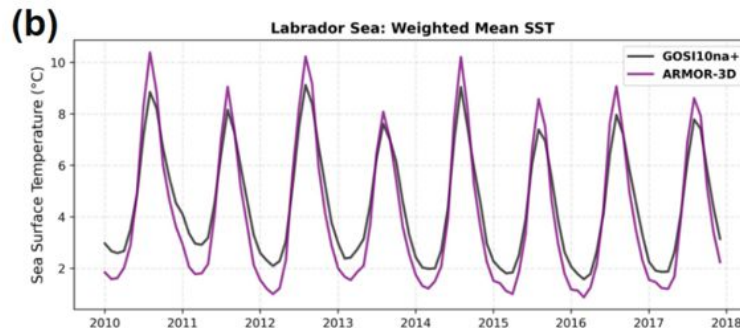
oj-tooth

oliver.tooth@noc.ac.uk

NEMO Cookbook



```
# eORCA025 Global Parent Domain:  
nemo.masked_statistic(grid='gridT',  
                       var='tos_con',  
                       lon_poly=lon_poly,  
                       lat_poly=lat_poly,  
                       statistic='weighted_mean',  
                       dims=['i', 'j'])
```



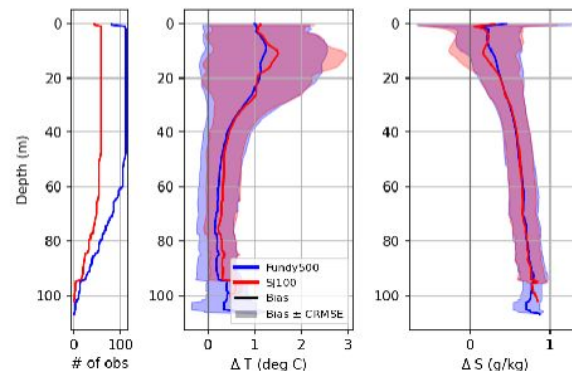
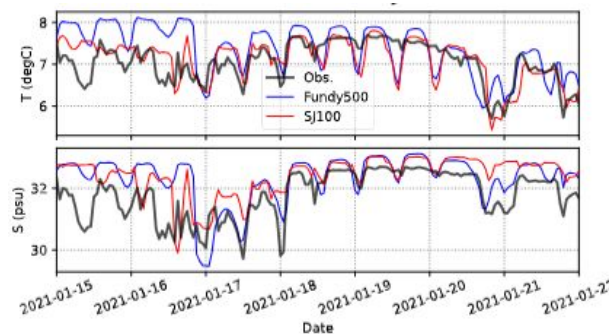
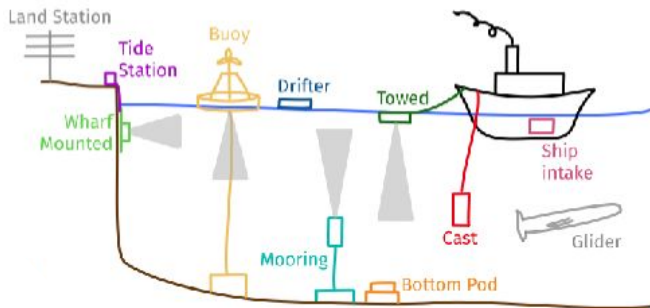
NEMOScope: A Toolbox for Evaluating and Analyzing Coastal NEMO Models Using In-Situ Observations

Stephanne Taylor¹, Justine McMillan¹, Michael Dunphy², Maxim Krassovski², Hauke Blanken², Simon St. Onge-Drouin³, Rachel Horwitz¹, and Andy Lin²

Fisheries and Oceans Canada 1: Bedford Institute of Oceanography, Dartmouth NS 2: Institute of Ocean Sciences, Sydney BC 3: Institut Maurice-Lamontagne, Mont-Joli QC



stephanne.taylor@dfo-mpo.gc.ca



Analysis tools

1. Current Practices & Fragmentation

- What diagnostics workflows and tools are **currently** used across Canadian groups?
- How **fragmented** is the ecosystem, and does this limit awareness and use of existing tools?
- Are **existing** NEMO online or offline diagnostics being used effectively? If not, what are the main **barriers** (awareness, documentation, robustness)?

Analysis tools

2. Reproducibility, Reuse, and Gaps

- How **reproducible** are current diagnostics workflows across institutions?
- Are existing analysis tools sufficiently shared and reused, or are we **duplicating effort**?
- Where would better coordination improve **reuse**, and where are **new developments** genuinely needed?

3. Toward a Community Toolbox (Future Directions)

- Do we need better visibility, organization, or centralization of **existing** diagnostics tools?
- Is there **interest** in contributing to shared tools, documentation, or coordinated efforts?

11 May 2026: Day 1

AI integration into NEMO modelling and analysis processes

Amber Holdsworth and Andrew Shao



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1-slide updates from groups

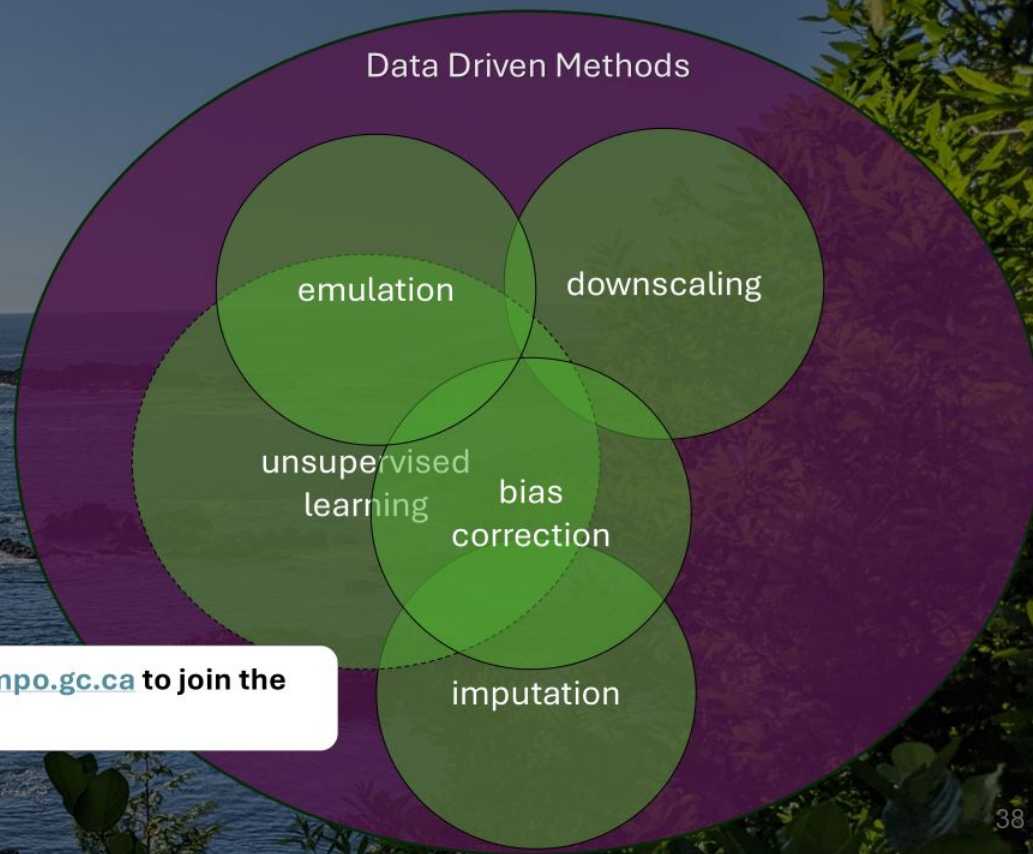
Machine Learning for Ocean Applications Working Group

Who: International expertise from oceanography, atmospheric science, statistics and ecology (government, academia, and ngos)

What: Community, Seminars and Discussion Sessions and Hackathons.

Why? ML advances rapidly and advancement requires an understanding of the oceanographic data.

Email Amber.Holdsworth@dfo-mpo.gc.ca to join the mailing list!



University
of Victoria



Fisheries and Oceans
Canada

Pêches et Océans
Canada

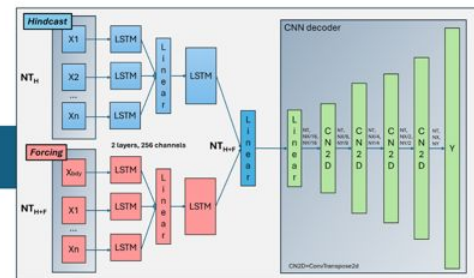
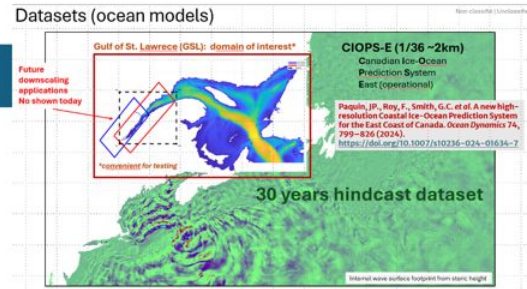
Ongoing efforts in ocean AI/ML at CCMEP

Areas of interest

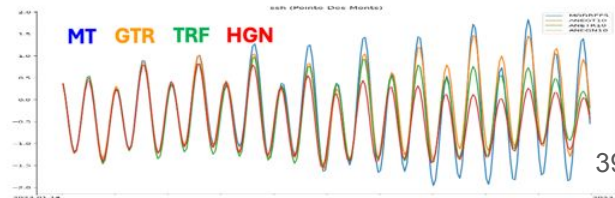
- **Global Emulators:**
 - Use of GloNet or Anemoi, spectral nudging in GIOPS, participation in OceanBench
 - Working on GIOPS reanalysis as part of CMEMS GREP (CMOS presentation)
 - Use of emulator as part of assimilation system and for ensembles
- **Regional Emulators:**
 - Working on emulator for RIOPS/CAPS using Anemoi (GNN)
 - Key challenge: capturing detailed ice edge and including tidal variability
- **Coastal Emulators and downscaling:**
 - Emulator for CIOPS using LSTM and Anemoi
 - Downscaling to GSL500 and SS500

Overarching issues

- Need for high-quality training datasets
- How to exploit ML for new applications (data assimilation, compression, ...)
- New physically-based evaluation approaches to ensure quality of forecasts and products
- How to accommodate need for integrated platforms (digital twins) and diversity of ML applications that are expected to develop over next few years



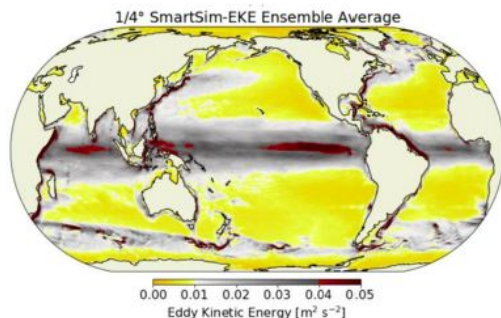
F. Roy, G. Smith, F. Dupont, C. Hebert-Pinard, R. Islam, Y. Martinez, Y. Liu



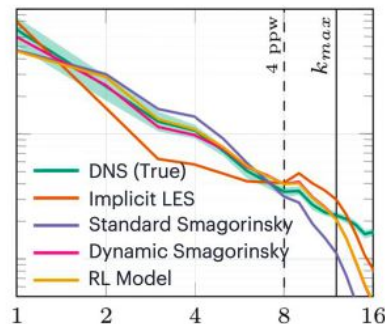
AI/HPC research HPE Labs

Andrew.Shao@hpe.com

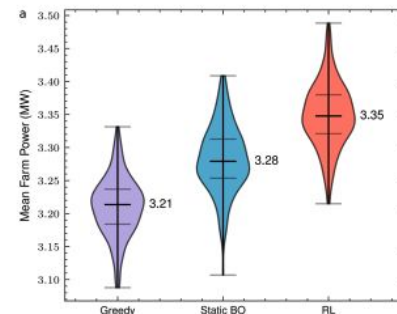
- HPE Labs performs fundamental research with external partners across the computer and domain sciences
 - PhD internships, postdoc, co-PIs
- Three research areas under my portfolio
 - What numerical techniques can be applied to AI surrogates of dynamic systems?
 - Where are the benefits of blending AI methods and simulation to open new areas of research?
 - How do these hybrid simulation/AI applications challenge our view of computing and what software needs to be developed?
- Numerical techniques and AI (UVic, RWE)
 - Multi-timescale aware loss functions for training surrogate models of coupled earth system
- Blending AI/Simulation (DOE, LRZ)
 - Active learning and Bayesian methods for experimental design
- Open-source software for AI/Simulation
 - Scalable Hybrid HPC/AI workflow tools for AI-in-the-loop/AI-around-the-loop motifs (Rutgers/DOE)
 - Strategies for AI workloads in Fortran (Berkeley, Nvidia, Cambridge)



Partee et al.[JCS, 2023]



Kurz et al. [Physics of Fluids, 2024]



Mole et al. [Arxiv, 2025]

12 May 2026: Day 3

Biogeochemical models development and directions

Inge Deschepper and Elise Olson

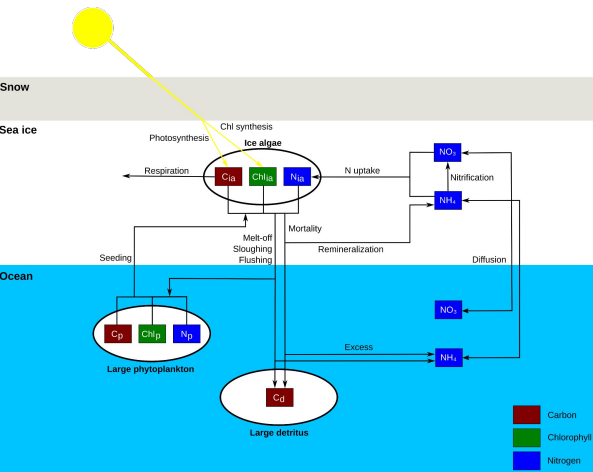


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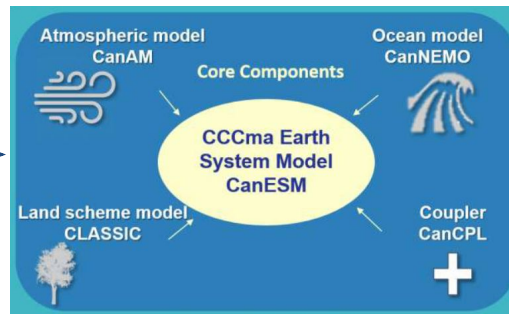
1-slide updates from groups

Canadian Sea Ice Biogeochemistry v2 (CSIB2)

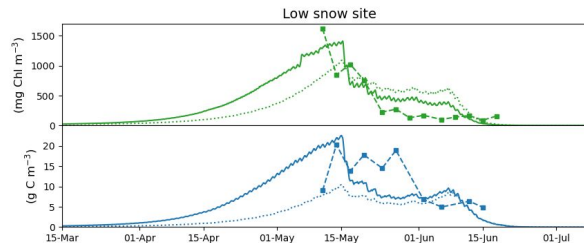
Antoine Haddon, Tessa Sou, Nadja Steiner



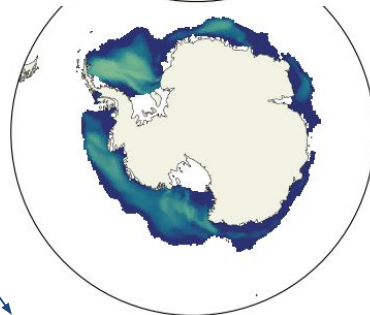
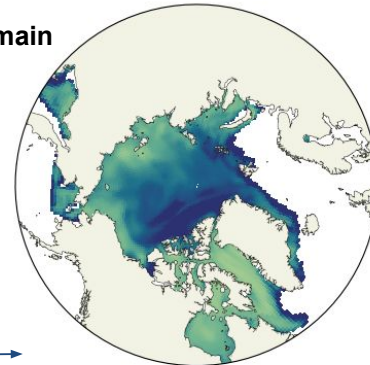
Canadian Earth System Model



1D sea ice + ocean model (GOTM+FABM)



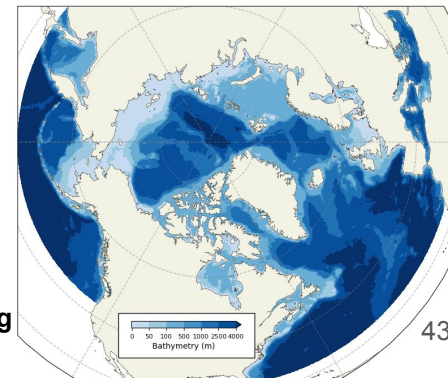
Global domain (eORCA1)



New developments

- Variable ice algal stoichiometry (C, Chl, N)
 - Photoacclimation
 - C enrichment
- Biomass export to ocean due to sea ice warming
- Implementation in NEMO4.2-SI3

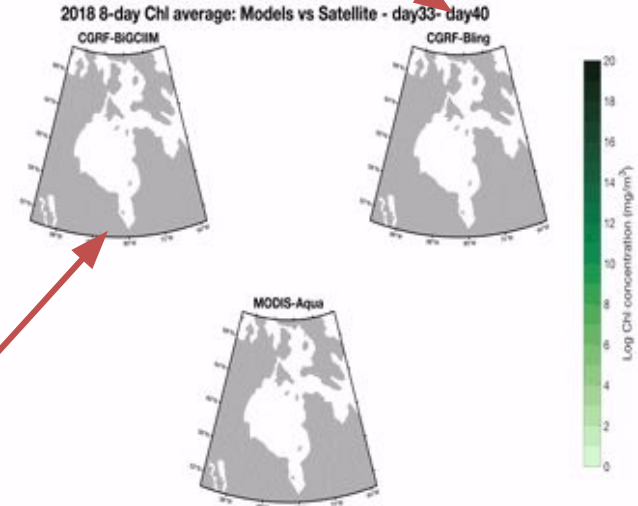
Canadian Three Oceans Downscaling System (CanTODS)



Biogeochemical modelling in the ocean and sea ice of subarctic regions

Inge Deschepper (ideschep@ualberta.ca)

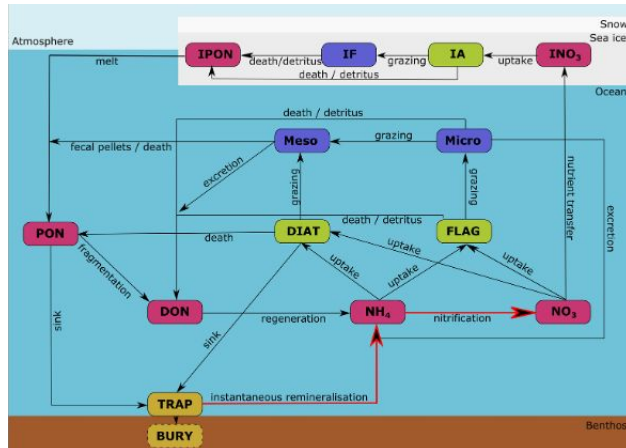
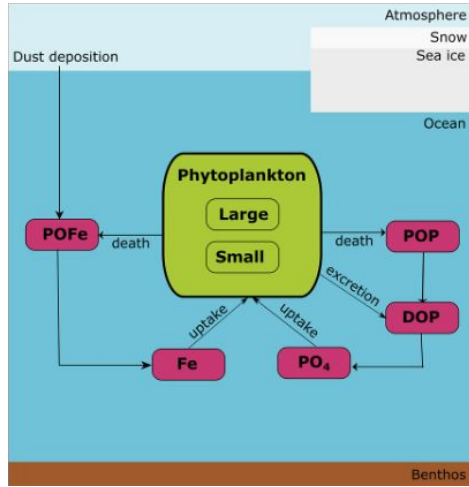
- The **Biogeochemical, Light, Iron, Nutrients and Gases Model (BLING)** is a simplified pelagic only model.



- The **BioGeoChemical Ice Incorporated Model (BiGCIIM)** includes both pelagic and sympagic components.

Current work:

- Upgrade into NEMO5 and SI3
- Tidal and river runoff investigation



North Atlantic Ocean-BioGeoChemical Downscaling Model System (NAODS-CanOE)

Yujuan Sun, Diane Lavoie, Joël Chassé, Guoqi Han, DFO

Objectives: Assess the impact of seasonal and inter-annual variability and climate change on the ecosystem of the Northwest Atlantic.

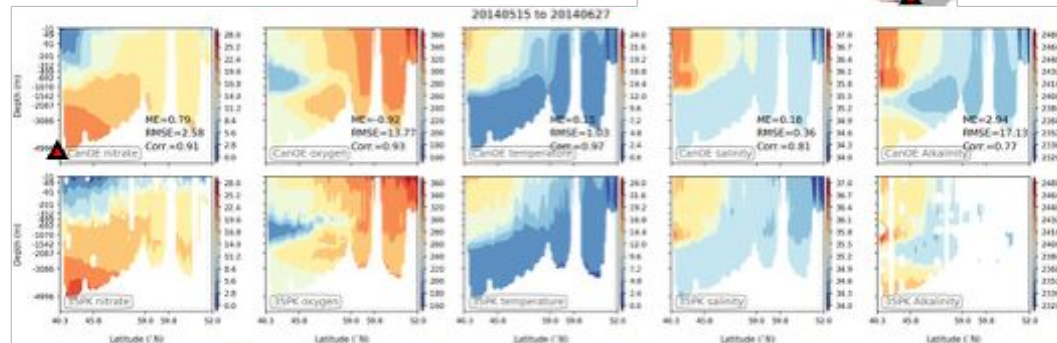
Ocean model: NEMO 3.6 (Han et al., 2021)

Biogeochemical model: CanOE (Christian et al., 2022)

Hindcast simulations under the driven of MOI_BIO4 analysis;

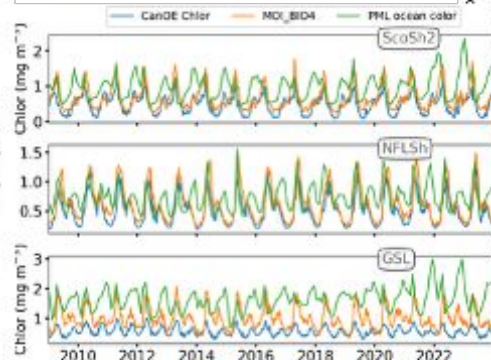
Climate simulations under MPI-ESM1-2-HR global model.

Model validation to sectional measurements



1/4° to 1/12°

Phytoplankton Blooms



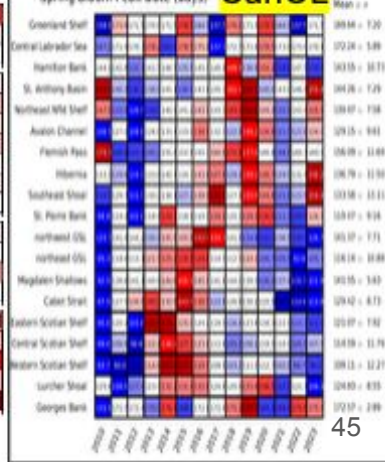
Greenland Shelf
Lar Labrador Sea
Hamilton Bank
St. Anthony Basin
theast Mid Shelf
Avon Channel
Flemish Pass
Hibernia
Southeast Shoal
SL Pierre Bank
Northwest GSL
Northeast GSL
ugden Shallows
Cabot Strait
arn Scotian Shelf
tral Scotian Shelf
arn Scotian Shelf
Lurche Shoal
Georges Bank

Spring bloom peak timing

MODIS data



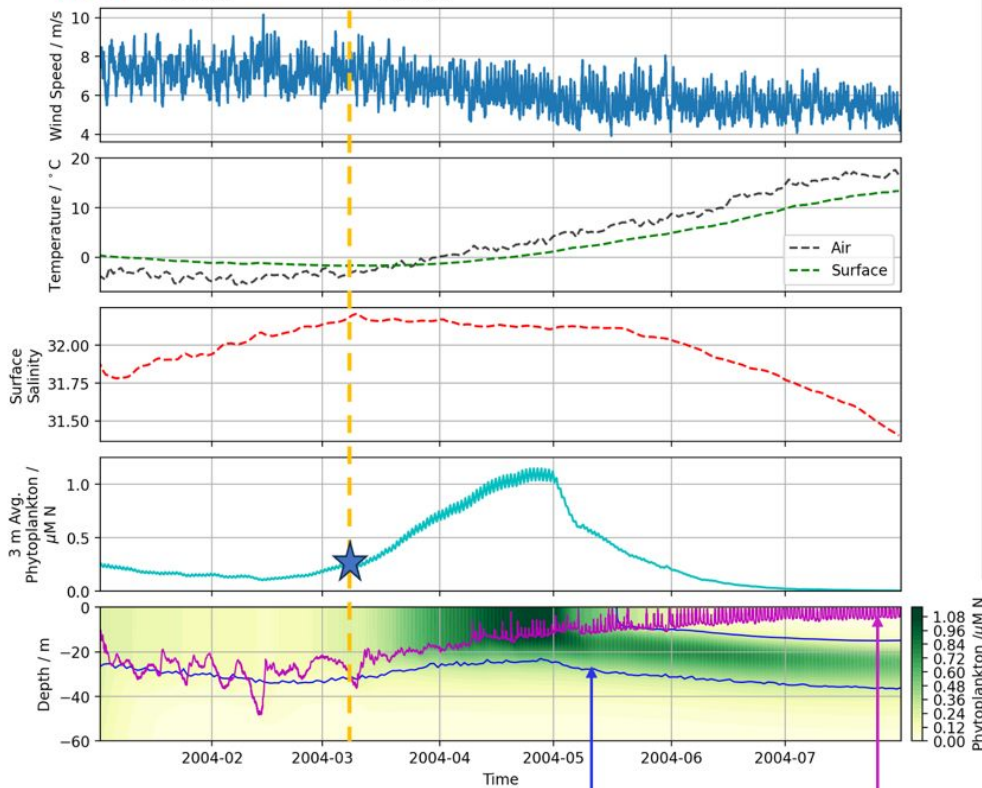
Spring Bloom Peak Date (days) CanOE





Fisheries and Oceans
Canada

Pêches et Océans
Canada



Collins, A. K., Allen, S. E., & Pawlowicz, R. (2009). The role of wind in determining the timing of the spring bloom in the Strait of Georgia. *Canadian Journal of Fisheries and Aquatic Sciences*, 66(9), 1597–1616. <https://doi.org/10.1139/F09-071>

Allen, S. E., & Wolfe, M. A. (2013). Hindcast of the timing of the spring phytoplankton bloom in the Strait of Georgia, 1968–2010. *Progress in Oceanography*, 115, 6–13. <https://doi.org/10.1016/j.pocean.2013.05.026>

Mixing Layer Depth

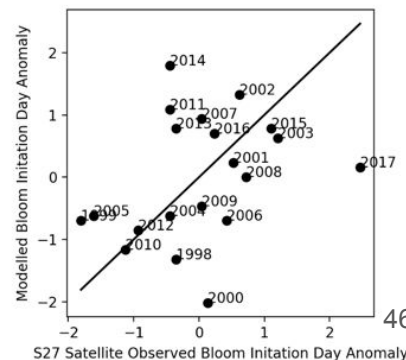
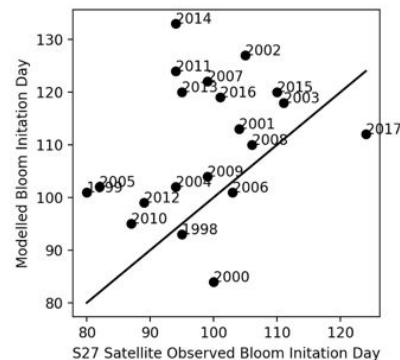
Compensation Depth

A one-dimensional coupled physical-biogeochemical model of the spring phytoplankton bloom on the Newfoundland shelf

Jared Penney¹, Changheng Chen¹, Nancy Soontiens¹, Frédéric Cyr², David Bélanger¹, Aaron Adamack¹

¹Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre

²Center for Fisheries and Ecosystem Research (CFER) Fisheries and Marine Institute, Memorial University of Newfoundland and Labrador



Understanding Extremes in the Northeastern Pacific

Geophysical Research Letters*

RESEARCH LETTER
10.1029/2024GL112591

Clustering to Characterize Extreme Marine Conditions for the Benthic Region of the Northeastern Pacific Continental Margin

Amber M. Holdsworth¹, Andrew Shao², and James R. Christian^{1,3}

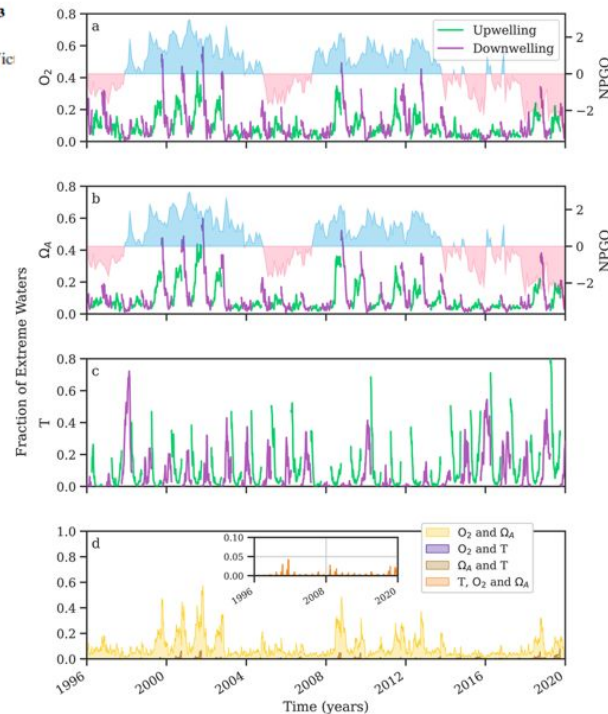
¹Fisheries and Oceans Canada, Victoria, BC, Canada, ²Hewlett Packard Enterprise, Victoria, BC, Canada, ³Centre for Climate Modelling and Analysis, Victoria, BC, Canada

A generalizable method for characterizing ocean extremes using unsupervised clustering

Climate indices are predictive of extreme conditions for the Northeastern Pacific continental margin.

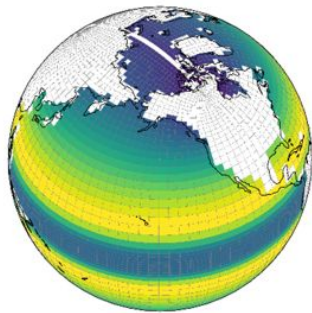
Compound extremes are rare, but are increasing in some regions, with **most involving compound extremes of oxygen and acidity.**

Canyons Cluster



I recently added oxygen diagnostics to disentangle physical and biological controls on hypoxia across the shelf

CCCma CanTODS + BGC: work ongoing

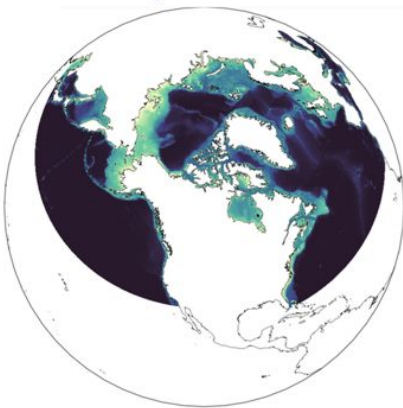


Global (Can)ESM

- fully coupled
- atmosphere, land, ocean

Provide:

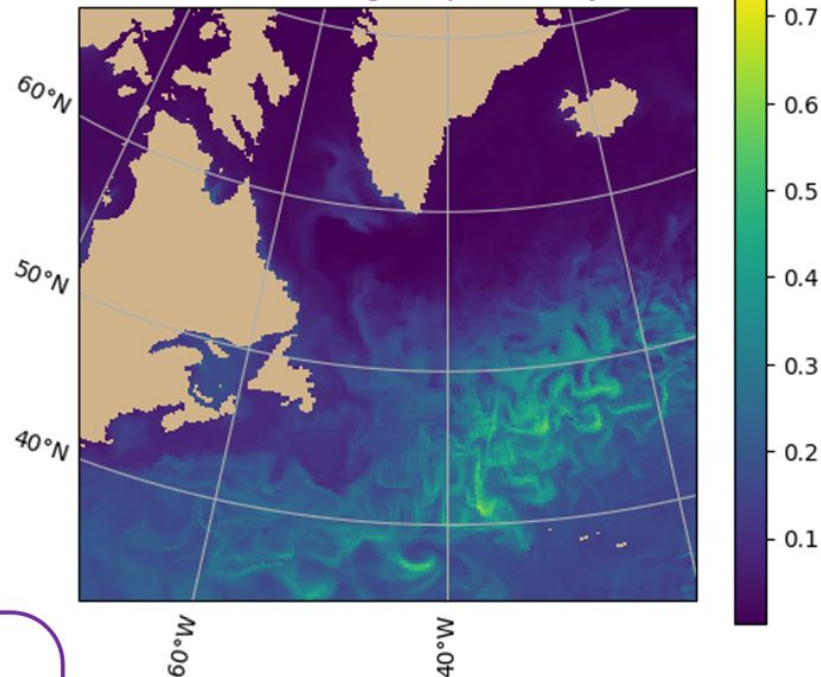
Atmospheric Forcing
Ocean Boundary Conditions
Initial Conditions (optionally)
Rivers



Canadian Three Oceans Downscaling System

- downscaled projections
- downscaled predictions
- testing/configuring BGC options
 - CMOC, CanOE

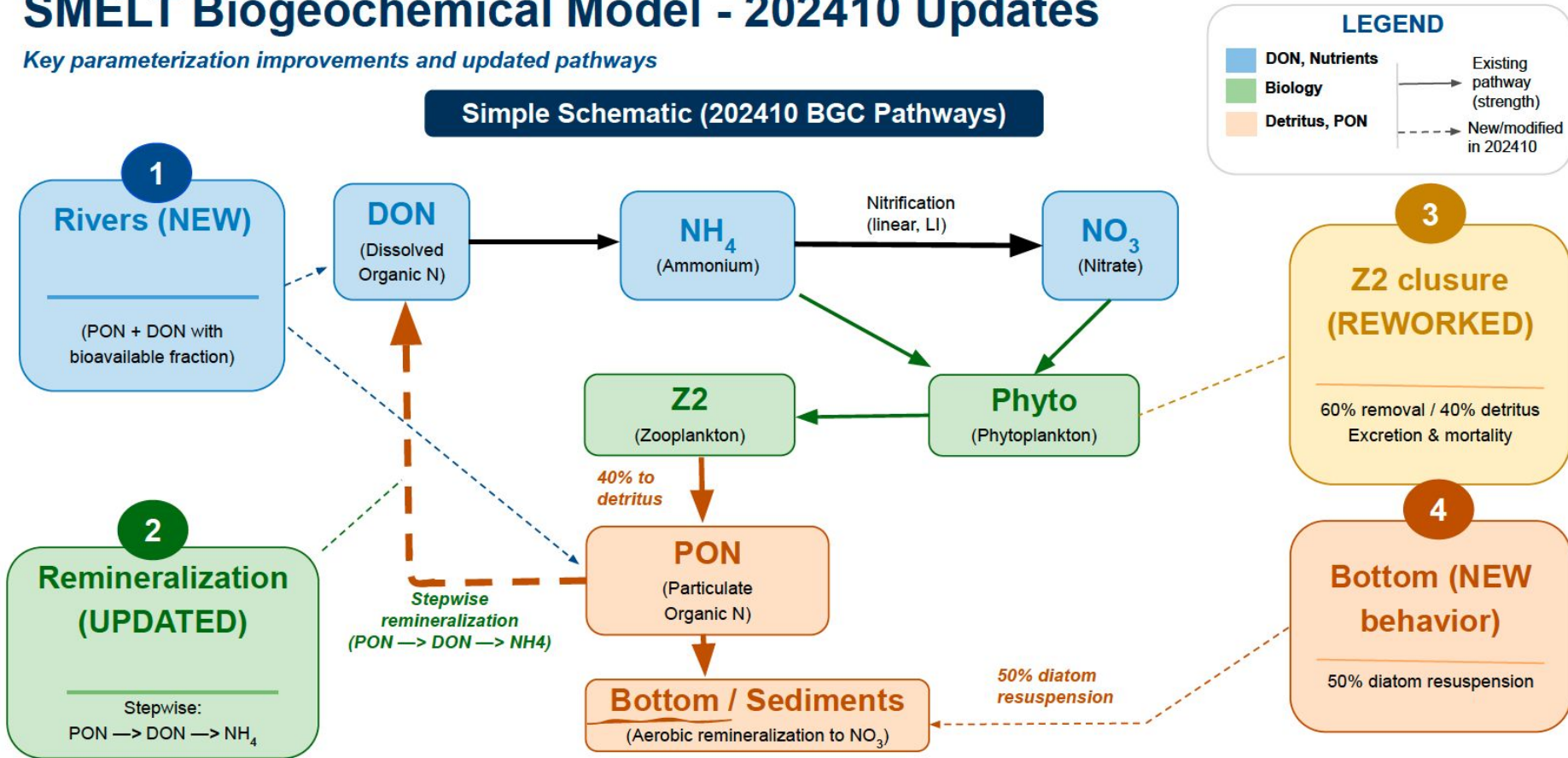
Surface Chl (mg/m^3), February 1993
CMOC, 0.25 degree (preliminary)



Contributors and Collaborators: ECCC
Climate Modelling Division (CCCma,
S2DP), DFO, U Alberta, +

SMELT Biogeochemical Model - 202410 Updates

Key parameterization improvements and updated pathways



Takeaway: The 202410 parameterization enhances representation of terrigenous input, organic matter cycling, and Z2-detrital coupling, with implications of remineralization and dissolved oxygen consumption.

FVCOM-ICM modelling (Thomas Guyondet, DFO Gulf Region)

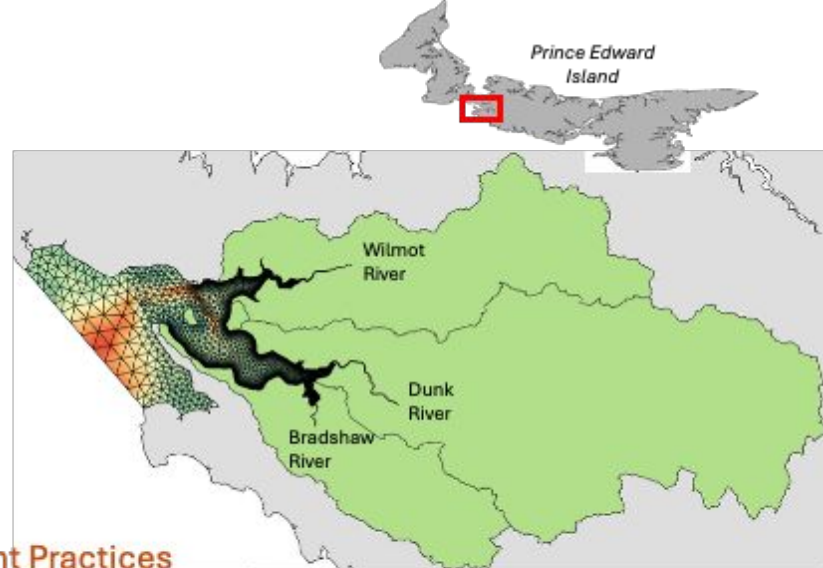
in support to eutrophication and bivalve resource management
in southern Gulf of Saint-Lawrence nearshore regions

NPZD + O₂ coupled with:

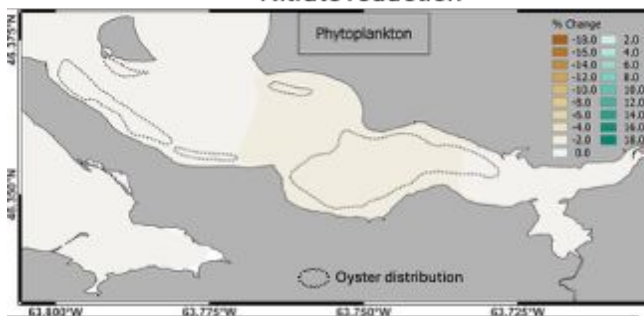
- **TSS** to improve light attenuation simulation
- benthic primary producers (**sea lettuce** and **eelgrass**)
- wild and cultivated **bivalves** (oysters, quahogs)

Scenarios:

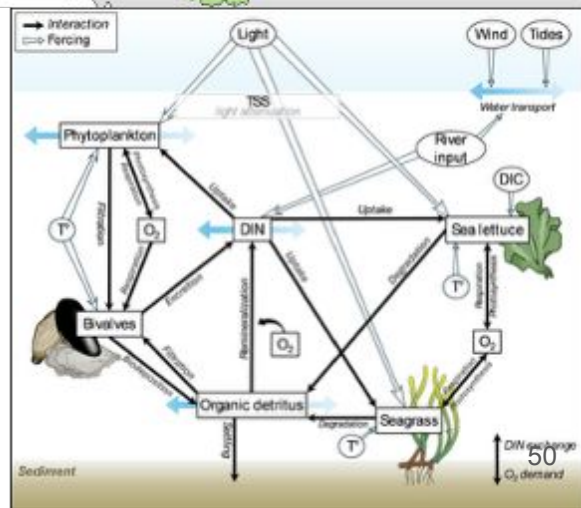
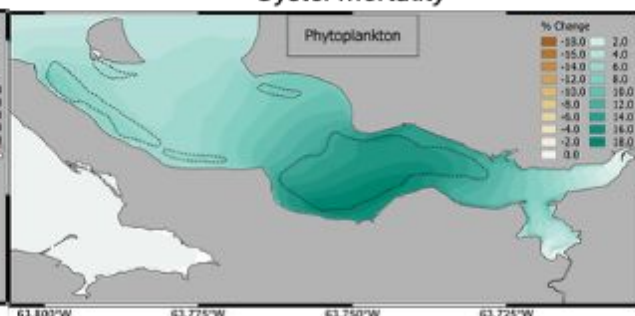
- **Nitrate loading reduction** from agricultural Best Management Practices
- **Bivalve mass-mortality** from emergent disease



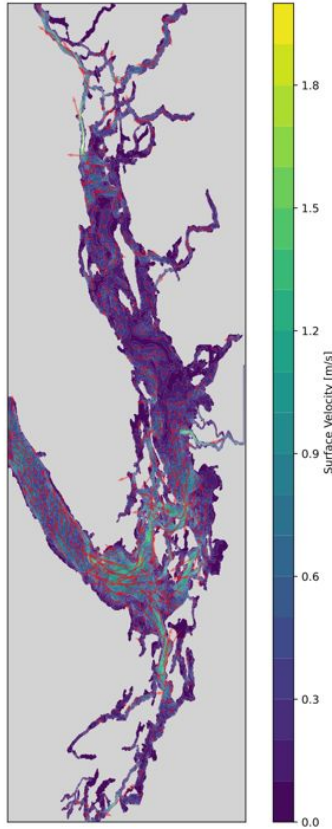
Nitrate reduction
Phytoplankton response in Dunk



Oyster mortality



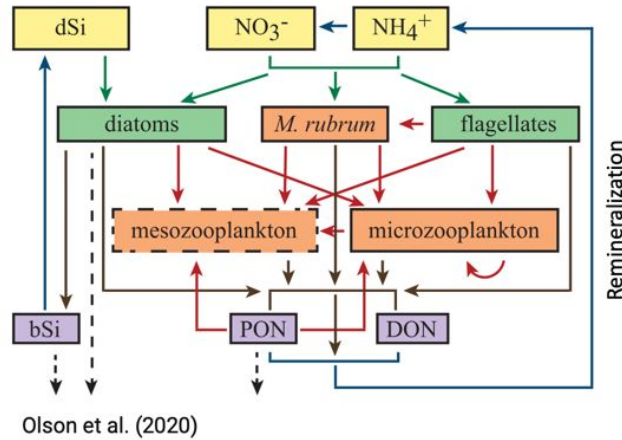
Domain



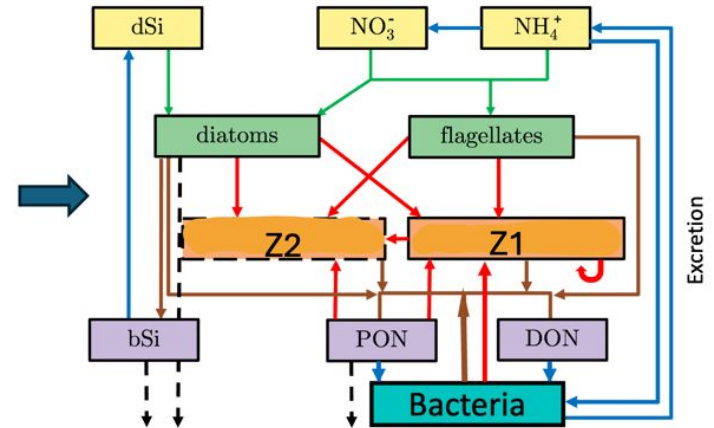
Update #2 on SalishSeaCast

Model biogeochemistry

SMELT (base biology)



New Scheme with Het. Bacteria



Would others like to introduce themselves and their research interests?

Intro for BGCM discussion

Some stated priorities for Canadian government and funding organizations:

- “Better understand **climate change impacts on ecosystems** and biodiversity resilience and change.” (CS2050)
- “Conduct collaborative research in **Earth system modelling** and in understanding the **carbon cycle**.” (CS2050)
- “Advance and evaluate **Earth system modelling** to better represent the...**oceanographic, ecological, and carbon cycle processes in northern regions**.” (CS2050)
- “Carbon cycle research is...needed to understand the potential of **nature-based solutions** and **carbon dioxide removal** methods and inform their inclusion in net-zero pathway analyses and emissions reporting.” (CS2050)
- “Decision-making should be informed by an understanding of **climate risks and vulnerabilities to minimize impacts and costs** before they occur and support emergency preparedness. Action to protect the **most vulnerable** communities and **ecosystems** should be prioritized.” (NAS)
- “identify **climate change impacts and vulnerabilities**, improve **ocean forecasting** and develop adaptation information and tools for **vulnerable coastal regions**” (NAS)
- “efforts to adapt fisheries, aquaculture, and aquatic ecosystems management to the changing climate, guided by foundational climate science data...” (NAS)
- “In particular, the **carbon sequestration potential of oceans and coastal ecosystems (blue carbon)** requires further research.” (2030NBS)

Intro for BGCM discussion

Some stated priorities for Canadian government and funding organizations:

- “**advanced ocean change projections and predictions** are needed to guide robust adaptation strategies that enhance socio-ecological system, community, and ecosystem readiness and resilience.” (MEOPAR)
- “Scientific advances should identify and address both the known long-term impacts of climate change, such as **ocean warming, acidification, and deoxygenation**, sea level rise and the **increasing occurrence of extreme weather and pollution events**, which place additional stress on marine socio ecosystems” (MEOPAR)
- “Marine Net Gain: developing the **Blue Economy** while minimizing environmental impacts and maintaining or improving the health of marine ecosystems” (MEOPAR)
- “Enable the **prediction and projection** of weather, **extreme events**, and **environmental conditions** in a changing climate.” (ECCC)
- “Inform the current and potential use of innovative and **fast-emerging technologies (such as artificial intelligence, machine-learning science**, and cutting-edge Earth observation missions) to support continual improvement of numerical weather and environmental prediction and the evolution of **integrated environmental monitoring**.” (ECCC)
- “improve **ocean forecasting in vulnerable coastal regions**.” (DFO)
- “inform our **management decisions related to adapting fisheries**, oceans, and coastal infrastructure.” (DFO)

Other priorities? What do you think will be coming next?

Sources: [Climate Science 2050](#), [National Adaptation Strategy for Canada](#), [Canada's 2030 National Biodiversity Strategy](#), [Canada's blue economy](#), [Oceans Protection Plan](#), [MEOPAR Science Strategy](#), [ECCC Science Strategy](#), [DFO](#)

5 Minute Break?

Points to think about during the discussion session:

1. What knowledge gaps or technical limitations exist between current systems and societal needs?
 - a. What resources (funding, expertise, person-hours?) are available to address these gaps?
2. How can we collaborate to achieve this?
 - a. Government-academia-industry
3. Who can we identify as potential collaborators?
4. What do we need to achieve this?

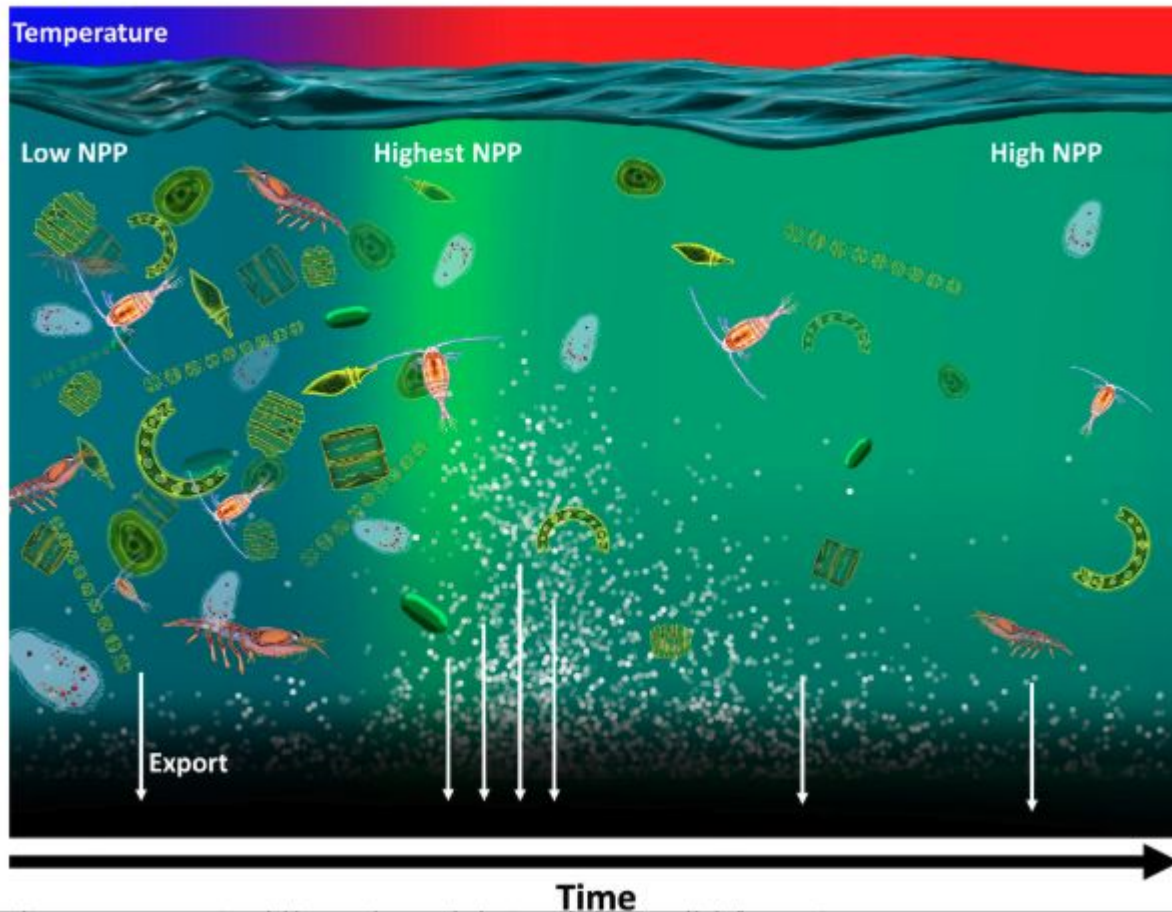
Development needs to advance topics

Example 1- BGC model advances to accurately simulate response to extreme events and climate change

- constraint of rate responses e.g. remineralization, primary production, grazing, mortality– to temperature and OA
-
- Are responses sufficiently constrained through observations and experimental evidence?
 - Communication with observationalists on rates that need to be identified (and relevant experimental design)
- Who has the capacity or allowed scope to do these tests or meta-analyses?

Schematic from Archibald et al. (2022)

(b)



[Thermal Responses in Global Marine Planktonic Food Webs Are Mediated by Temperature Effects on Metabolism - Archibald - 2022 - Journal of Geophysical Research: Oceans - Wiley Online Library](#)

Development needs to advance topics

Example 2- BGCM with tides:

- Incorporating tidal effects in global/basin-scale models?
- Or in terms of porting knowledge from the coastal modeling community?
- Constraining numerical instabilities shallow high tidal variation regions
 - Eg. Foxe Basin, English Channel, Chukchi Sea

Open Discussion – What else?

Development needs to advance topics

More Examples:

- Benthic interactions (Improved representation of benthic processes)
- River contributions to BGC (nutrients, carbon, CDOM, particulates) and how to constrain it
- ...

13 May 2026: Day 3

Cross-institute coordination of NEMO development

Natasha Ridenour and Heather Andres



CANADIAN NEMO OCEAN
MODELLING FORUM
COMMUNITY OF PRACTICE

Challenges and motivation

Challenges:

- Each group has their own model that they have spent a lot of time developing
- Each group has their own goals and deliverables
- Different resolutions and/or different model components

Motivation:

- Funding is difficult to get
- Not enough: people/compute resources/time for testing (or all of the above)
- We're all working on NEMO, therefore we all have the same NEMO problems

We do not need to rebuild the wheel, and we all have the same goal: better model simulations and newer versions of NEMO

Some examples of coordination happening now

- CCCma's CanTODS started from previous work from DFO and ECCCC
- CCCma has shared their NEMO4.2 code online, Tessa Sou at DFO was able to get the code and has been working on sea ice biogeochemistry
- U of M has developed a model analysis package
- UBC and DFO (IOS) have regular monthly meetings on various modelling topics
- CONCEPTS: the Prediction Systems WG meeting in Fall 2025 on NEMO upgrades
- DFO and ECCCC have memoranda of understanding with Mercator Ocean International to accelerate model development by partnering with them

NEMO CoP website

[Institutions — Canadian NEMO Ocean Modelling Forum Community of Practice 0.1 documentation](#)

 Canadian NEMO Ocean Modelling Forum Community of Practice
0.1.0

Search docs

Institutions

University of Alberta
Univeristy of Manitoba
Fisheries and Oceans Canada
ECCC-CCCMa

User Guide
Useful Sources
Monthly Seminar Series
NEMO Workshop 29 May 2025
Documents

 » Institutions

[View page source](#)

Institutions

NEMO is used across many institutions across Canada. The following list is those institutions which have joined this forum to share their NEMO modelling work.

- [University of Alberta](#)
- [Univeristy of Manitoba](#)
- [Fisheries and Oceans Canada](#)
- [ECCC-CCCMa](#)

 Previous

Next 

Questions for Discussion (~30 mins each)

- 1) What are the limiting factors that are currently hindering groups' abilities to conduct the modelling they would like?
 - Forcing => esp. High-res, river runoff, ice sheet melt,
 - Evaluation => e.g. NEMO5 migration/tuning
 - adaptations/parametrizations => not always publishable depending on extent of work
 - People => training, availability
 - Staying around long enough to build skills and small pool of skilled workers to start
 - Model complexity increases learning curve
 - Skill gaps (technical + leadership + enthusiasm)
 - Hiring challenging w/in gov't right now => often can only hire for ~3mo, so little motivation to accept position if can go elsewhere (e.g. outside CA)
 - In academia, want people to be able to get positions when done (paid poorly while studying)
 - Lack of stability
 - Lack of visibility of opportunities (CMOS initiatives)
 - Partnerships btw gov't and academia for current students?
 - E.g. Paul Myers' agreement w/ CCCma on river discharge
 - Easy to do informally; formal arrangements are more difficult (e.g. can't use gov't staff as external examiners)
 - Adjunct professorships
 - E.g. CP4C collaborative platform for CanESM
 - Extremely beneficial from student perspective

2. Possible areas for sharing/coordinating

Topic	Usefulness	Degree of difficulty	Comments
Forcing datasets/products/tools	1		storage?
Diagnostics/analysis tools		Easy	via python/matlab pkgs Can be linked via git repo
Observational datasets	1	More challenging	Ownership, formatting/prepping for use, QA/QC
Model code base	2	Easy if start w/ common git repo for CoP	- Compiling info to NEMO Consortium - issue tracking via git
Model configurations			
Model domains			Coastal refinement very useful storage?
Namelist		easy	
Model parametrizations/ adaptations	2		
Machine Learning	1		

Steps forward

3. How would we like to collaborate/share resources?

- a) Some ideas: Forum, email discussion list, quarterly meeting of NEMO rep from each group?
 - b) Shared table on forum/CoP website for parameters, namelists, data needs etc (including contact info), github organization,...
- Shared git repo => issue-based projects (free github organization for universities => multiple repos under org)
 - Reproducing NEMO forum for model-based developments?
 - Other non-NEMO specific work on Cdn git
- Format of CoP meetings modified => one presentation and rest round table discussion? Could focus discussion on theme
- forum /email list => requires work to maintain, focus around NEMO forum instead?
- Combined efforts for parameter testing? Simple test cases/geometries worked out beforehand
- Info on git becoming topics for seminars and vice versa

4. 1-2 action items for coordination for this coming year (who, what, how, when)

- To create/adapt github organization (could be gitlab, but depends on ability to add members for free) to set up for sharing among group [Who? Paul's group] => email out the link => Nicolas help with how to set up
- Complete Institution descriptions on CoP pg (for all) => include list of model setups, configurations, expts have run
- Start w/ volunteers who already have existing work to share via git (e.g. Natasha's checkerboard)? Others can comment
 - Volunteers: Natasha & Nicolas, Geoff
- People using git resource for collaboration

Conclusions:



CANADIAN NEMO OCEAN
MODELLING FORUM 68
COMMUNITY OF PRACTICE