



NEMO usage in Canada

Overview & update

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Steiner³, Keith Thompson⁵, et al.**

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³Fisheries and Oceans Canada

⁴University of Alberta

⁵Dalhousie University

NEMO users meeting
Toulouse, 12 October 2018



Canada

★ Universities

★ Federal Government



THE UNIVERSITY OF BRITISH COLUMBIA



DALHOUSIE UNIVERSITY



Environment and Climate Change Canada



Fisheries and Oceans Canada



National Defence



Climate applications

e.g. ESMs, RCMs,
ocean downscaling

CMIP6, ACASP etc



Forecasting applications

e.g. NWP, waves, oil spills,
plankton blooms

MEOPAR, CONCEPTS etc



Ocean forecasting efforts in Canada Universities - “Best effort”



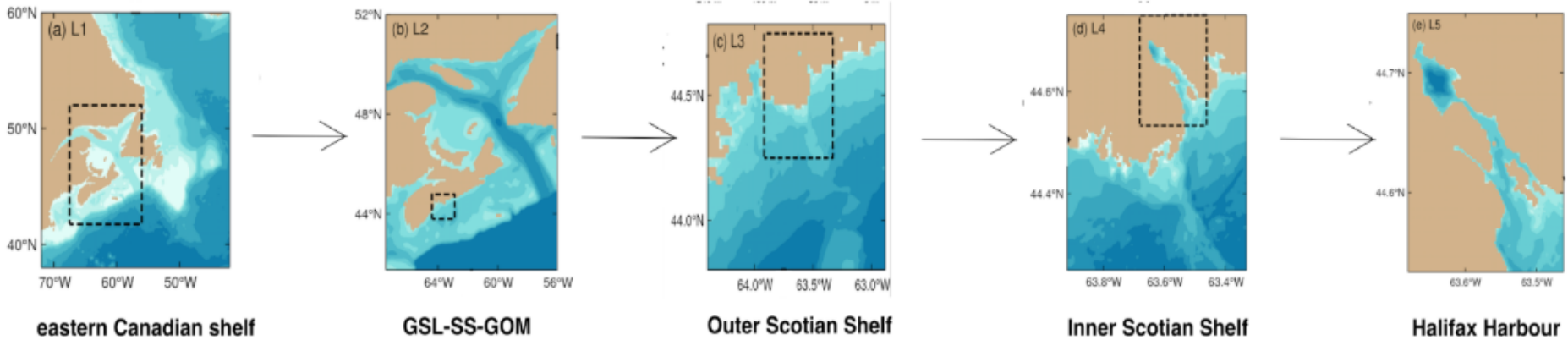
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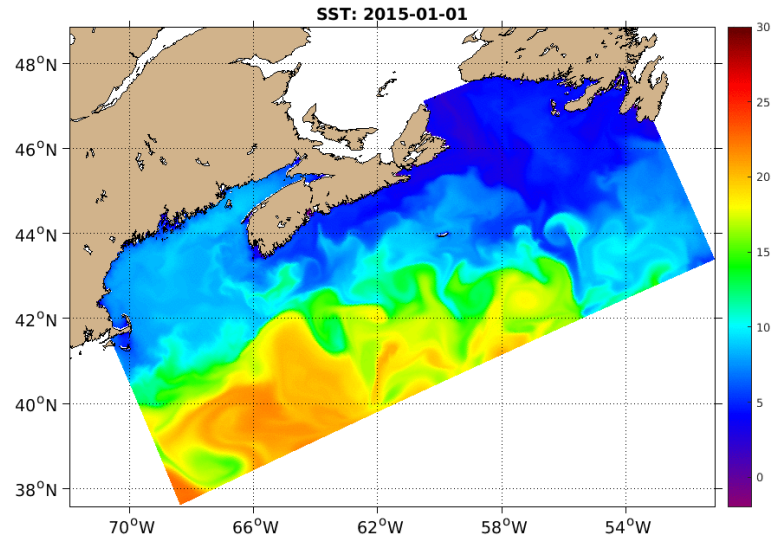
DALHOUSIE COASTAL OCEAN FORECAST SYSTEM

Sunday, September 16, 2018

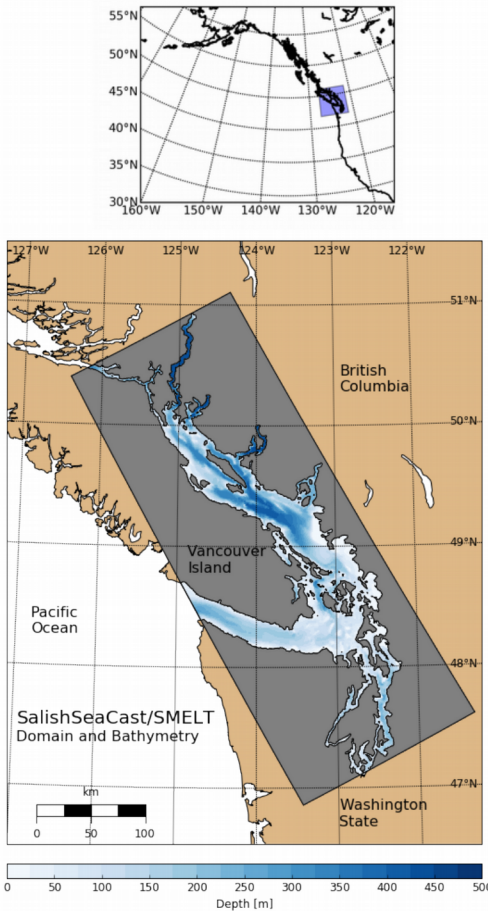


Jinuy Sheng and Keith Thompson

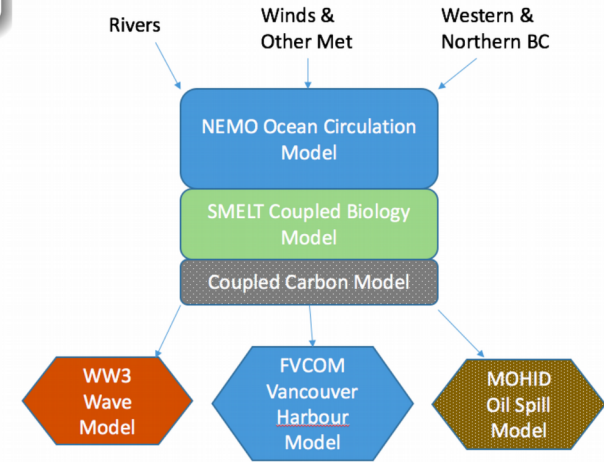
MEOPAR:
GoMSS



SalishSeaCast



- NEMO 3.6, VVL, z-levels with partial steps
- Horizontal grid 500 m x 440 m
- Vertical grid 1 m near surface, 27 m at bottom (430 m)
- Total grid cells 898 x 398 x 40
- Split time step (2 s barotropic, 2 s vertical advection, 40 s baroclinic)
- Energy and enstrophy conserving with Hollingworth correction
- k- ϵ GLS vertical turbulence
- No restoring, no data assimilation



Ocean forecasting efforts in Canada: 24/7 support – CONCEPTS efforts



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Climate Change Canada



Fisheries and Oceans
Canada



National
Defence

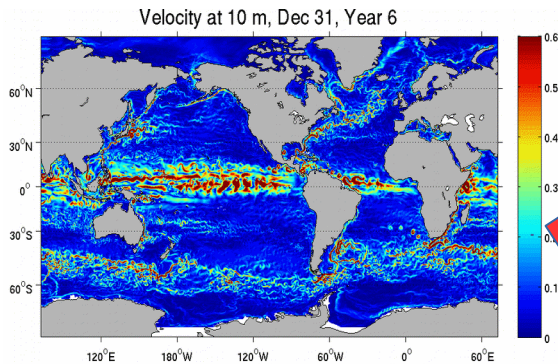


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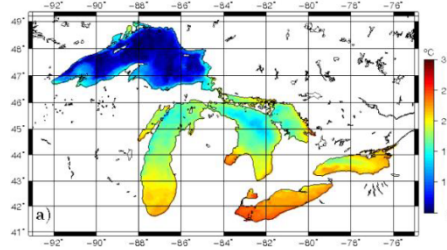
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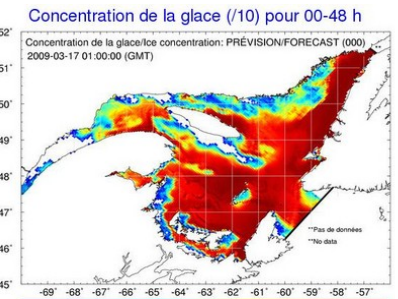
NEMO+CICE



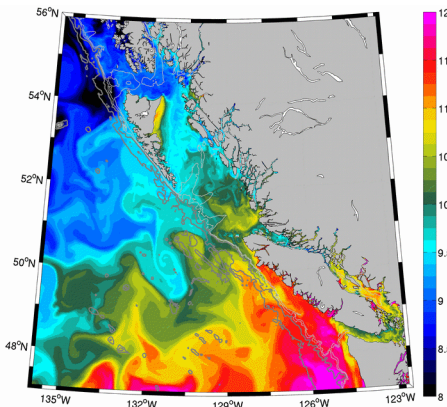
GIOPS: $1/4^\circ$, DA, operational since Aug 2015; two versions: 30-day ensemble, 10-day deterministic coupled to weather



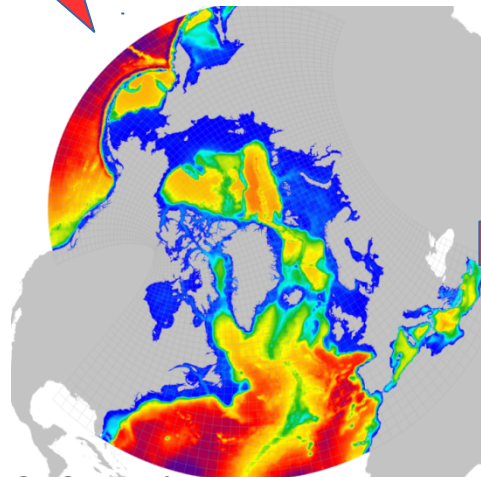
Great Lakes: 2 km, coupled to weather, since 2014



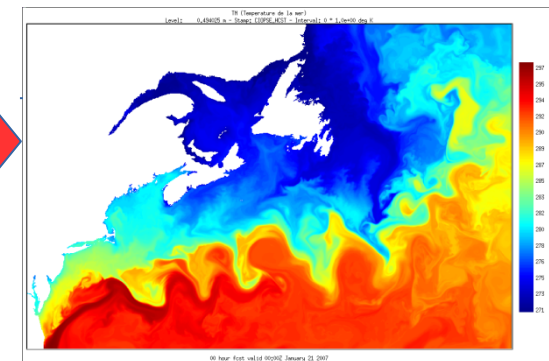
Gulf of St Lawrence: 5 km, coupled to weather, since June 2011; in process of being updating to 500m



CIOPS-west: $1/36^\circ$, spectral nudging, operational by end of 2018



RIOPS: $1/12^\circ$, DA, operational by end of 2018; will replace existing system based on spectral nudging towards GIOPS, mainly used for short-term sea-ice forecasting



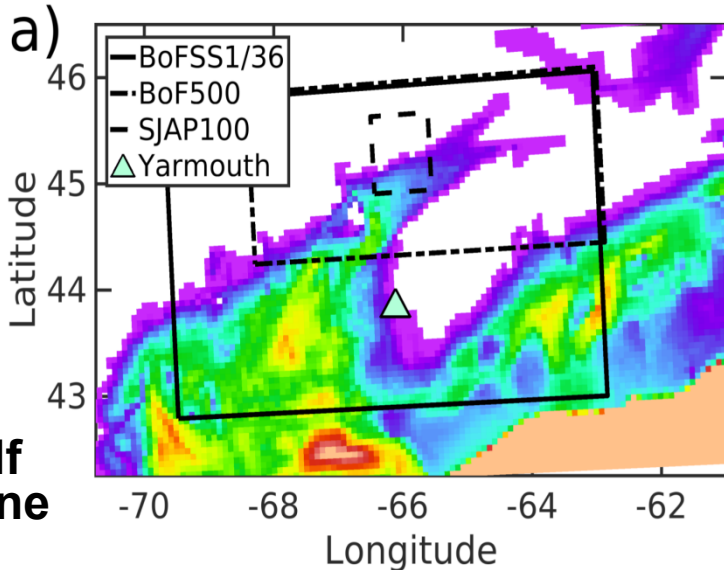
CIOPS-east: $1/36^\circ$, under development

Downscaling to Harbours: Saint John Harbour NEMO: multi-level 1- way nesting

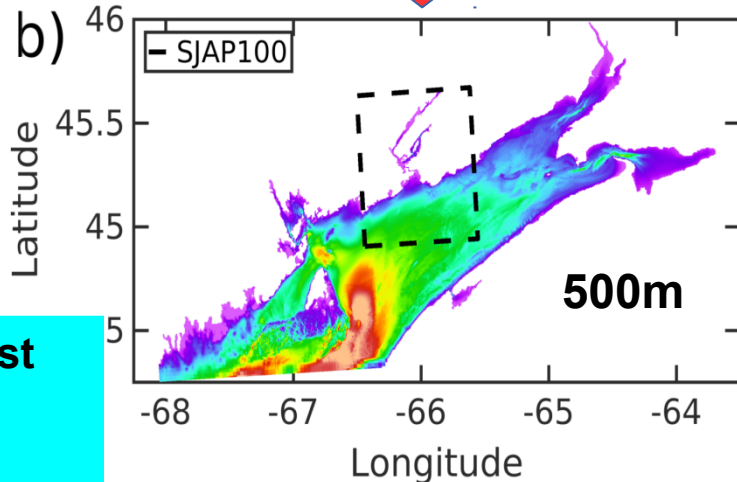
Youyu Lu, Jean-Philippe Paquin,
Gregory Smith, Fraser Davidson

**1/12°
RIOPS**
↓
1/36°

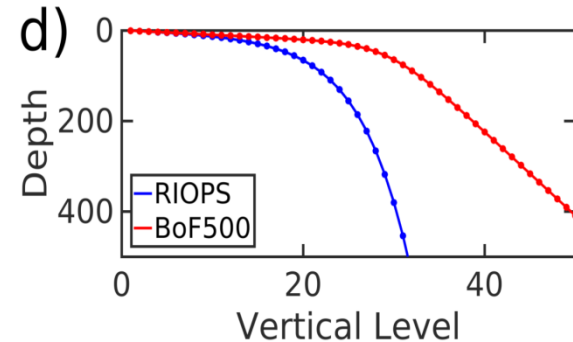
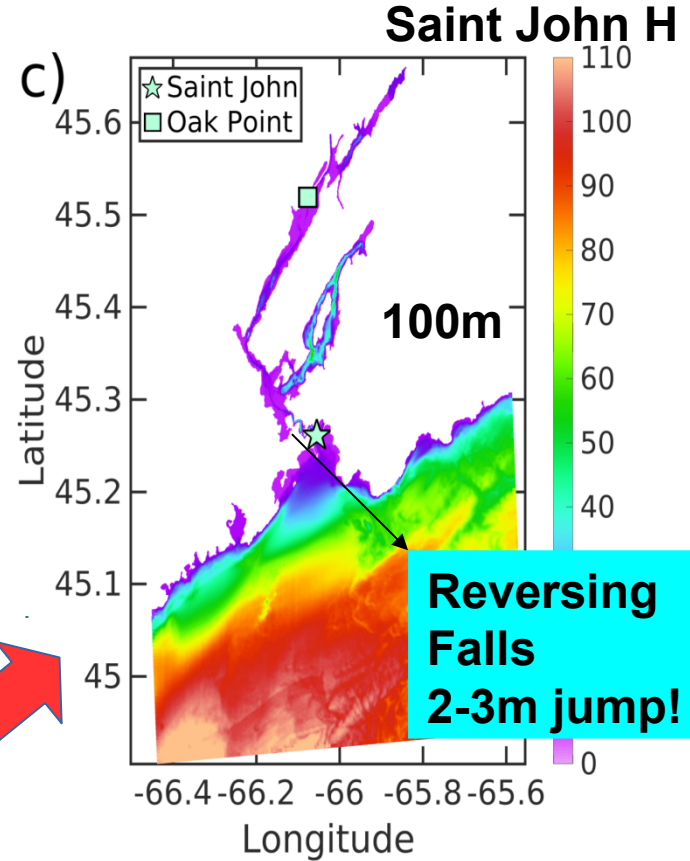
**Scotian Shelf
+Gulf of Maine**



Bay of Fundy



**The strongest
tides in the
world!**



Ocean climate efforts in Canada



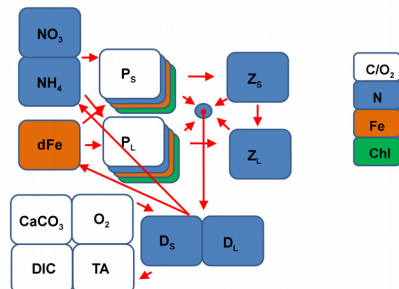
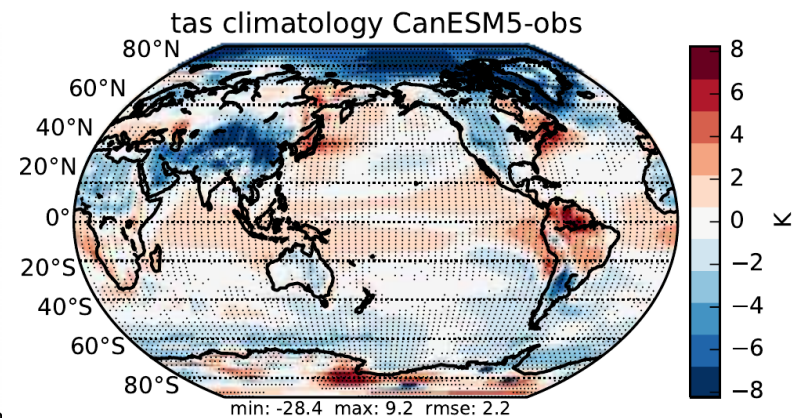
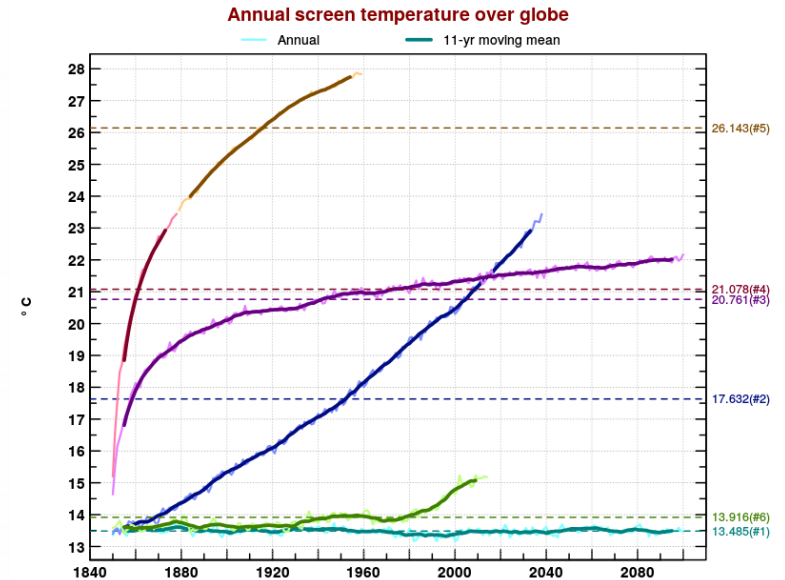
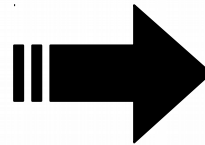
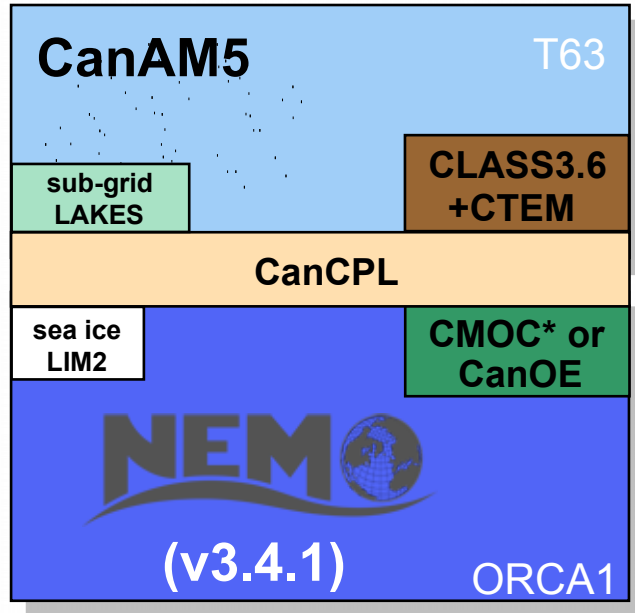
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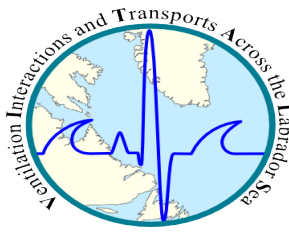
Canada 

The Canadian Earth System Model

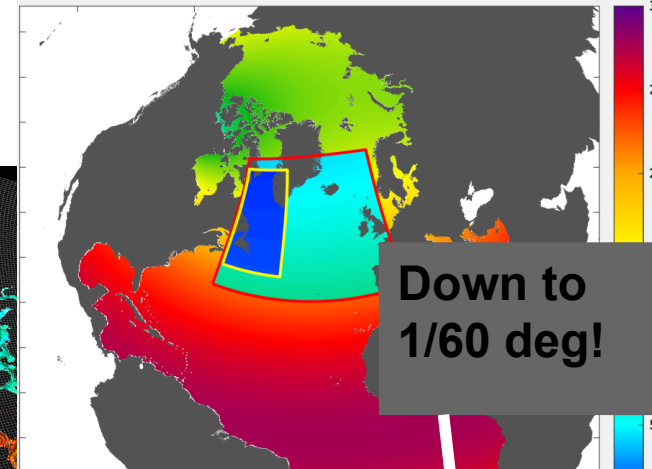
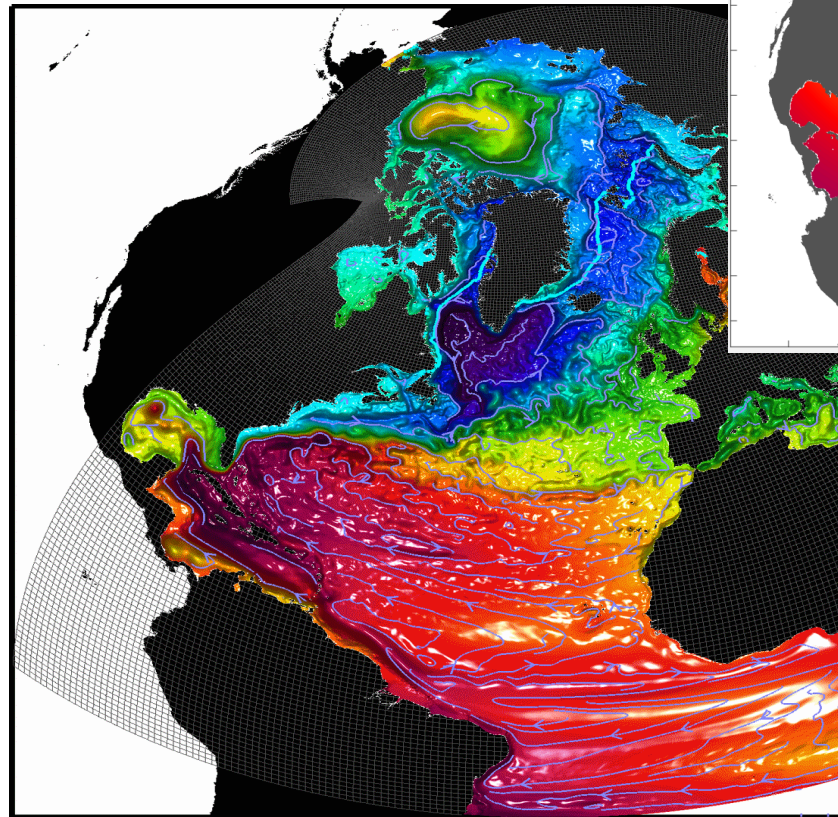
CanESM5 (CMIP6)



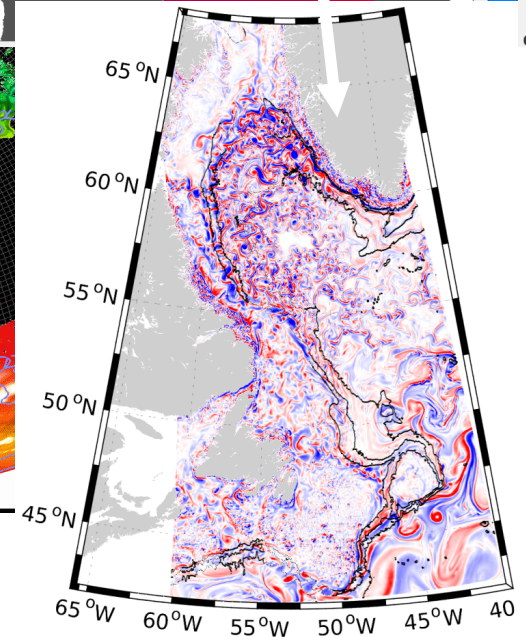
NEMO modelling with the Arctic Northern Hemisphere Atlantic Configuration



Ventilation, freshwater, bio-geochemistry... etc



Down to
1/60 deg!

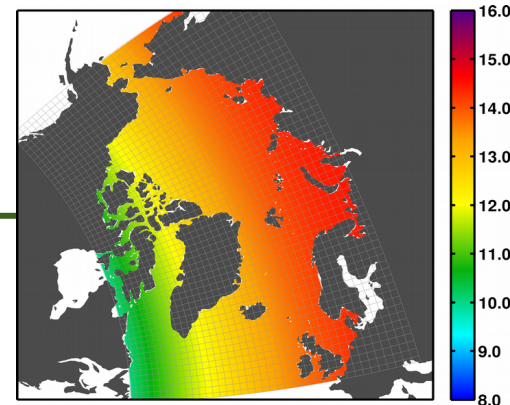
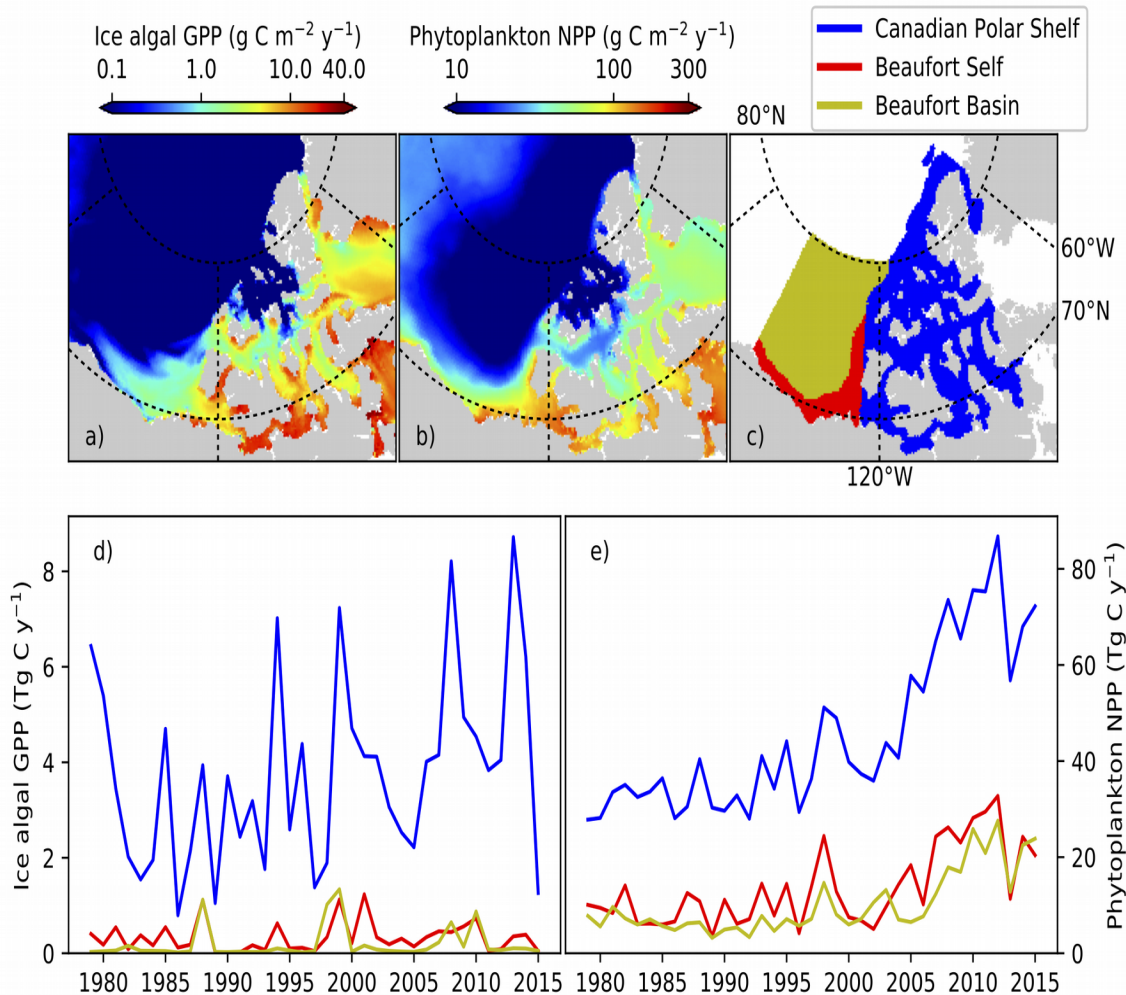


Paul G. Myers, Laura Castro de la Guardia, Charlene Feucher, Yarisbel Garcia Quintana, Laura Gillard, Nathan Grivault, Andrew Hamilton, Xianmin Hu, Amanda Kahn, Juliana Marson, Clark Pennelly, Natasha Ridenour



NEMO-Arctic: NAA-CanOE-CSIB

Nadja Steiner, Hakase Hayashida, et al.



**Config.: North Atlantic-Arctic (NAA) - NEMO-LIM2 (Hu & Myers 2014)
 Ecosystem: CanOE-CSIB**

Includes sea-ice BGC and DMS (Hayashida et al. 2018, GMD)

**Forcing:
 GFS 1969-2015, OB: ORAS4, CanRCM4 + CanESM2 anomalies, Initialisation
 PHC, GLODAPP**

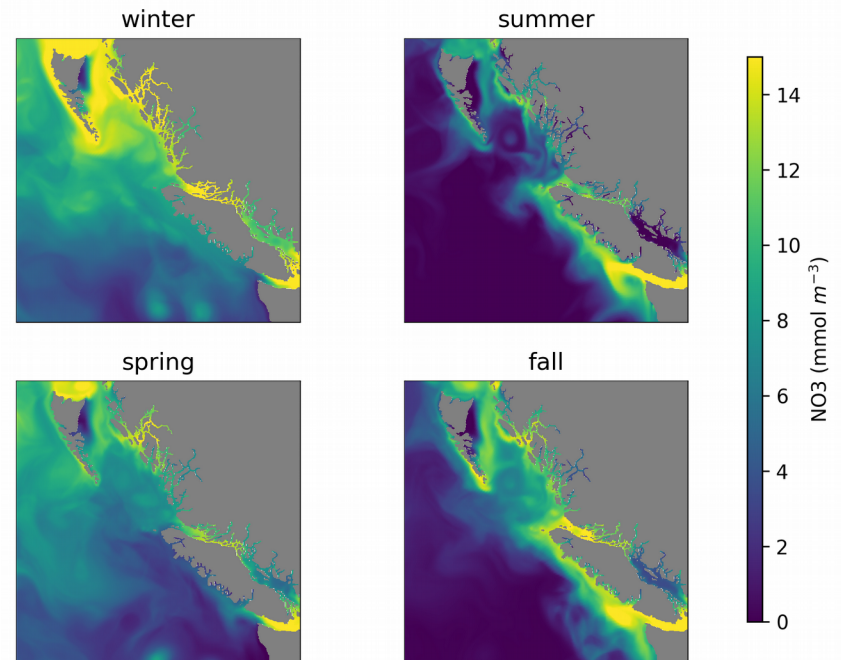
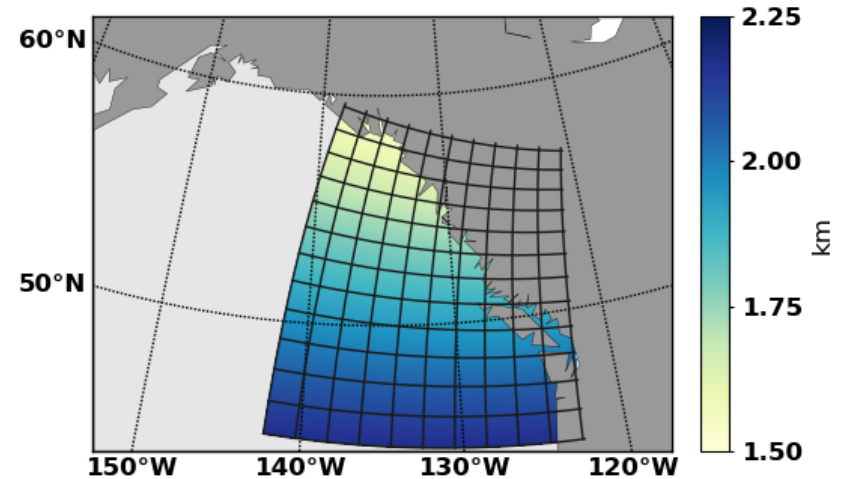
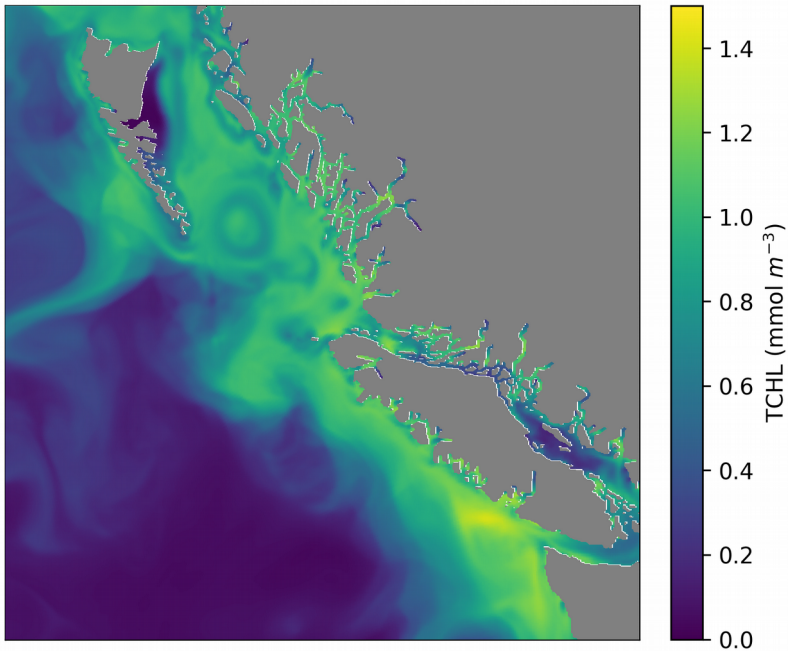
Example: Western Canadian Arctic (Steiner et al 2018, Frontiers, submitted)



Fisheries and Oceans
 Canada

NEMO NEP36 with CanOE BGC

Downscaling ocean climate



Amber Holdsworth, Jim Christian, et al.



Fisheries and Oceans
Canada

Summary

- NEMO widely used in Canada for forecasting and climate applications, in Government & Universities.
- Canada and the NEMO consortium – how best to organize internally?
- Interest in resolution of various v3.6 bugs, and contributions to future features.



NEMO3.6 notes:

- Default stable 3.6 version has a bug in U-V vertical metrics in presence of tides (z^*) which allows for negative values

⇒ we use a fix from Jerome Chanut (Mercator)

- BDY modified to accommodate a SSH only forcing, upstream of the Reversing Falls (i.e. river gauge equivalent).

- At very high resolution ($\leq 1/12$ deg), the temperature close to river mouths can go outside reasonable bounds

⇒ due to backwind (\neq upwind) approach in advection of river temperature (i.e. SST from ocean used as river T)

⇒ everybody should read T(&S) from files in absence of coupling with a true river model

⇒ depth-spreading is also an interesting feature, may help river plume being more realistic