Projections of future oceanic biogeochemical conditions in the Gulf of St. Lawrence and on the Scotian Shelf using a coupled regional climate model

Diane Lavoie, Nicolas Lambert, Joël Chassé, Michel Starr, Dave Brickman, William Perrie, Zhenxia Long, Kumiko Azetsu-Scott, Denis Gilbert, Jacqueline Dumas
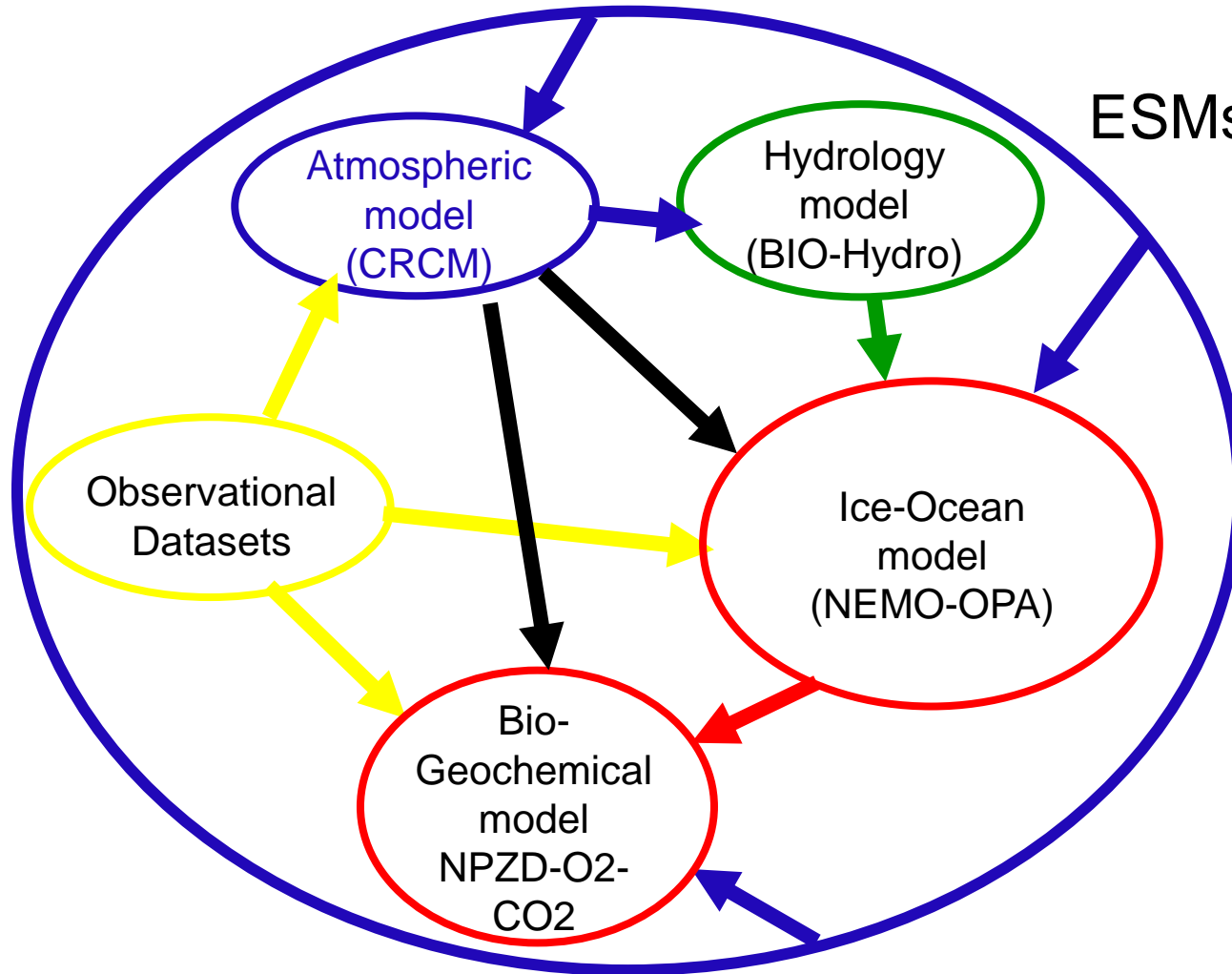
Maurice-Lamontagne Institute, Gulf Fisheries Center, Bedford Institute of Ocean Science
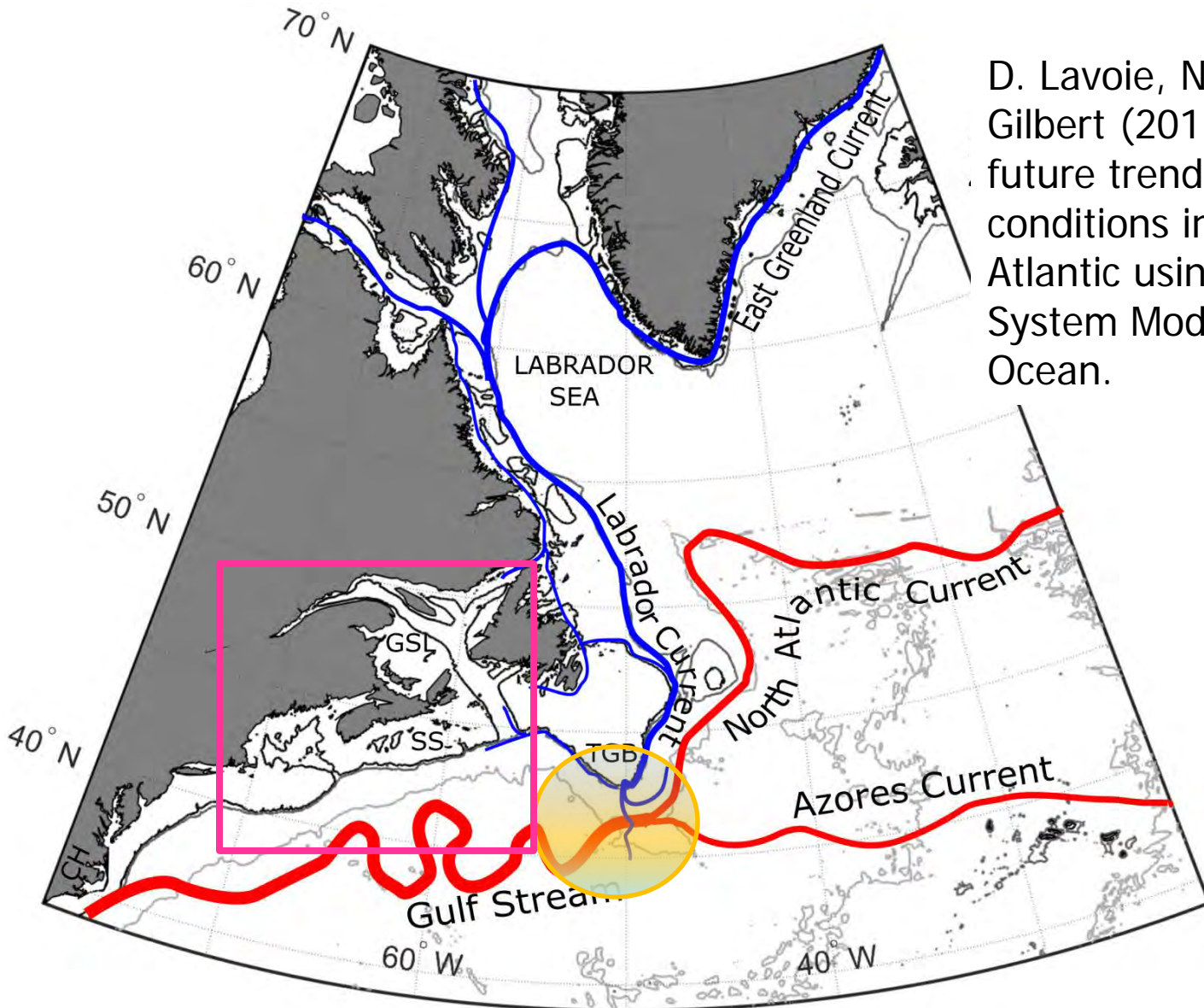
ECCWO Symposium 2018

Canada

ESMs:

CanESM2
HadGEM2-ES
MPI-ESM-LR
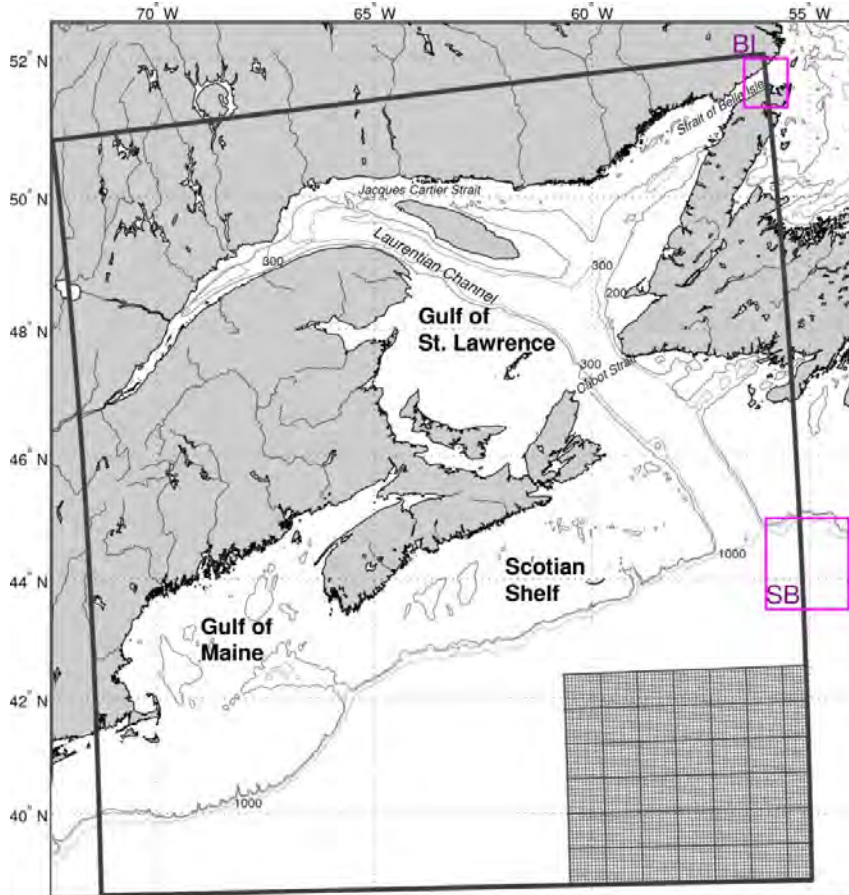
D. Lavoie, N. Lambert & D. Gilbert (2017): Projections of future trends in biogeochemical conditions in the Northwest Atlantic using CMIP5 Earth System Models, Atmosphere-Ocean.
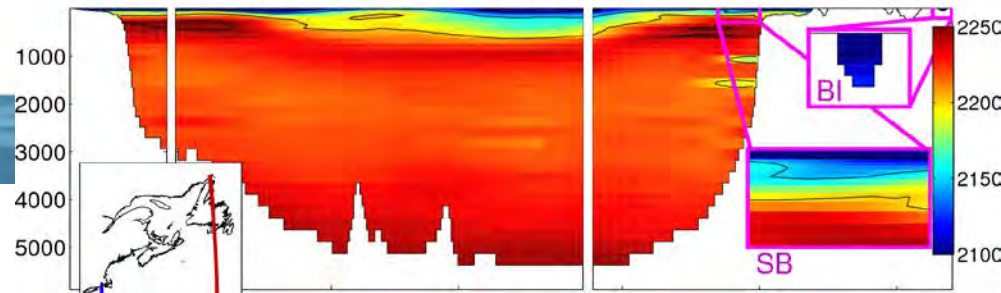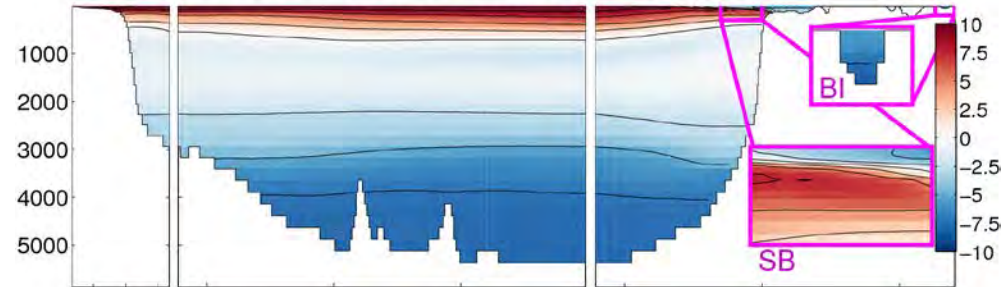
Model domain

DIC climatology (1990-2016) and trends (1970-2099) at the boundaries with MPI-ESM-LR , HadGEM-ES and CanESM3
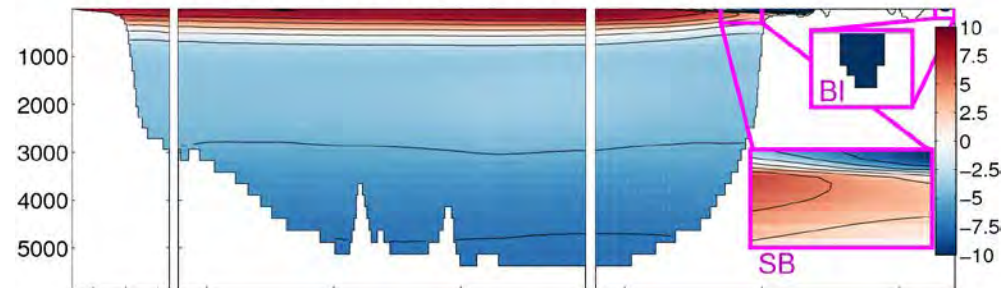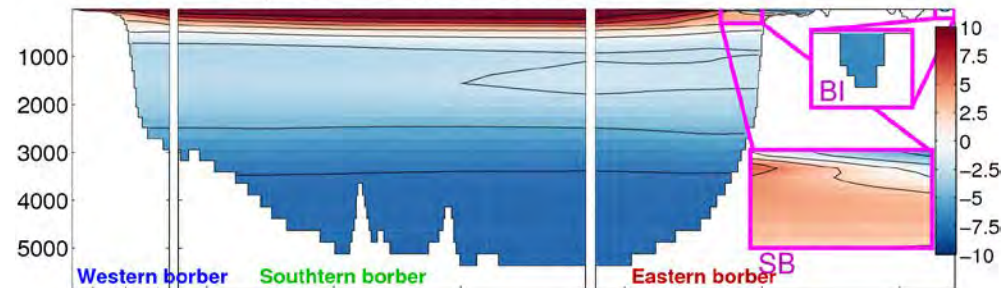

Mean DIC concentration (climatology)

DIC trend (1970–2099) with **MPI-ESM-LR**

DIC trend (1970–2099) with **HadGEM2-ES**

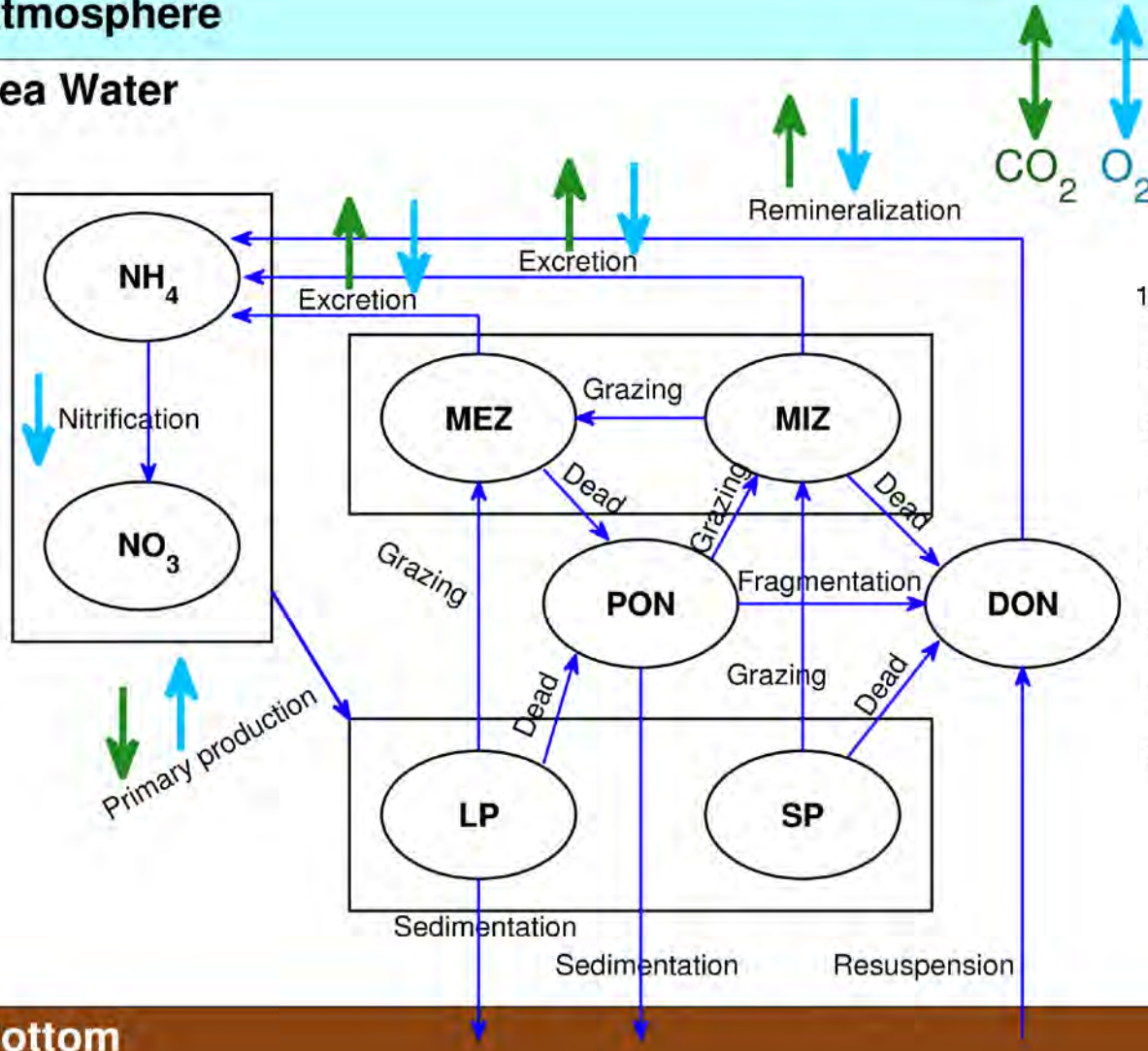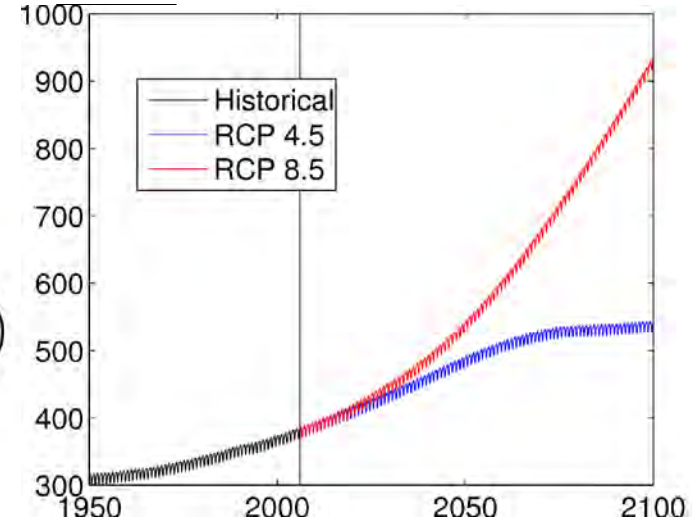DIC trend (1970–2099) with **CanESM2**

Western border   Southern border   Eastern border

Biogeochemical module

Atmospheric CO_2 concentration (ppm)
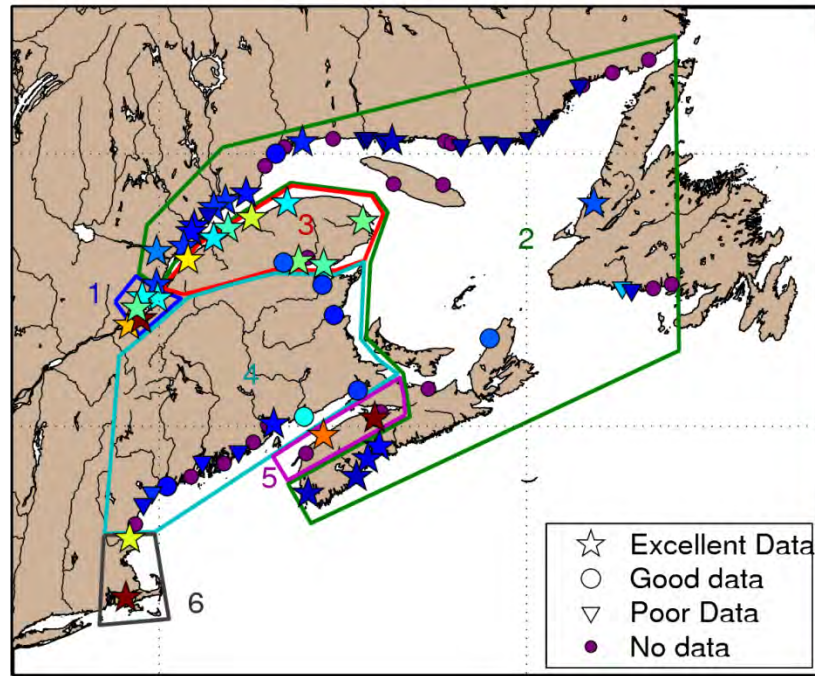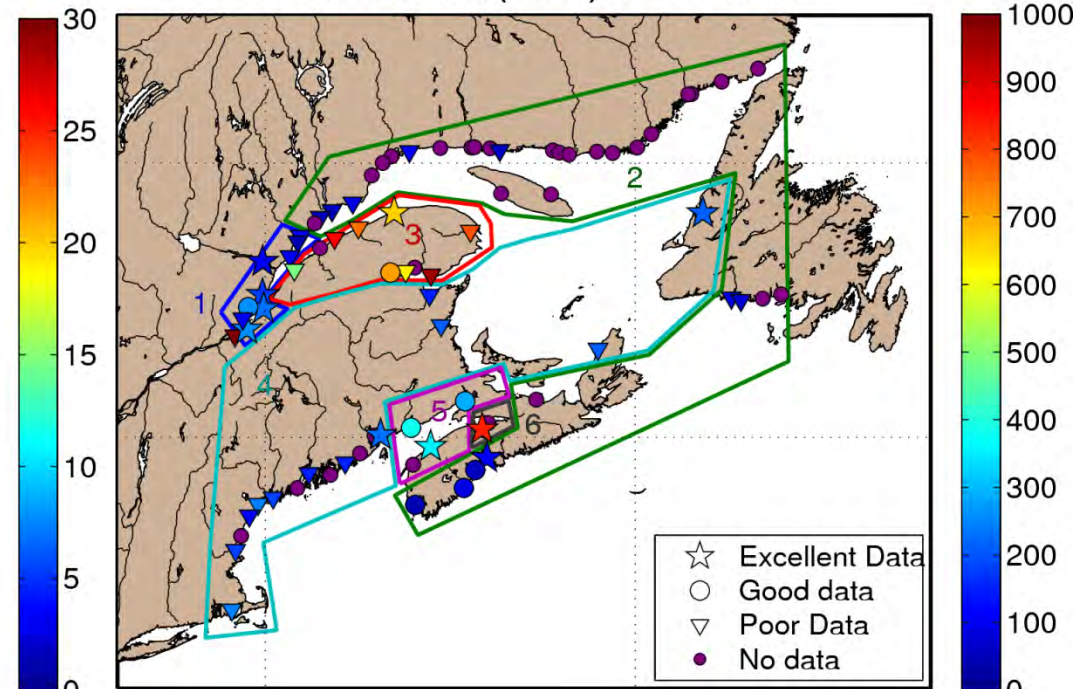
Riverine input of nitrate and DIC

Rivers data (no3) in NEMO
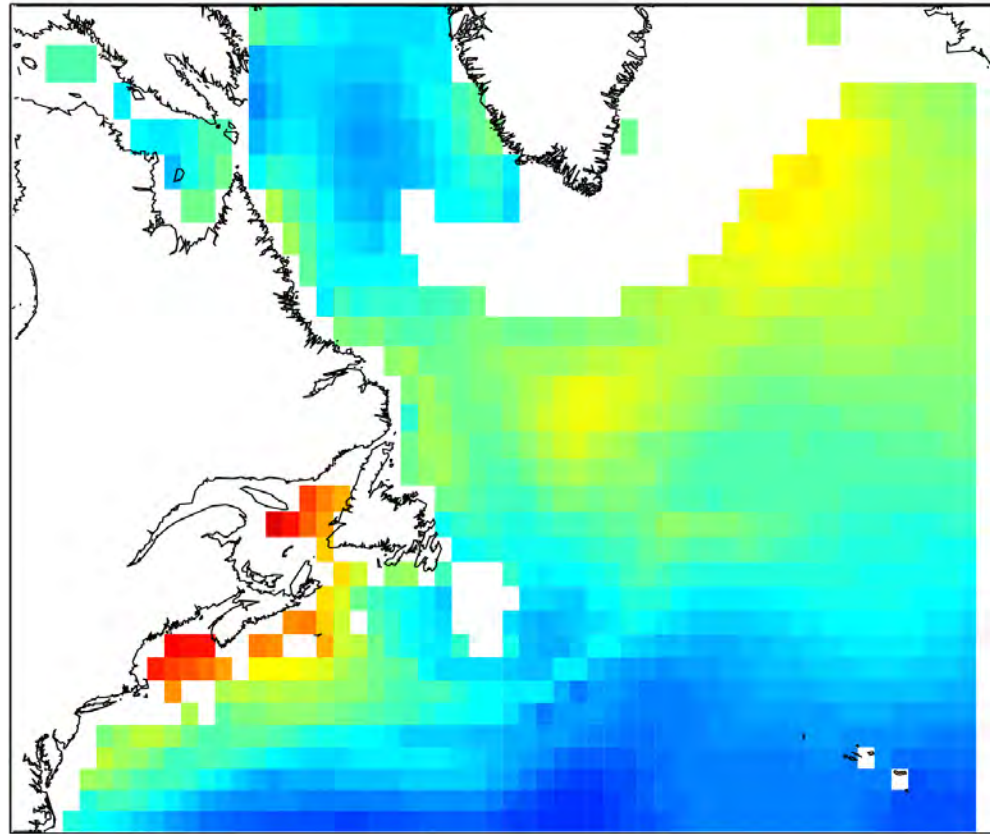
Rivers data (DIC) in NEMO

Input of ammonium, alkalinity, dissolved and particulate nitrogen also included

Sources: Provincial governments of Quebec, New-Brunswick, Newfoundland and Labrador, Nova-Scotia, Environment Canada, United-States Geological Survey and from the literature for some of the GSL's north shore rivers
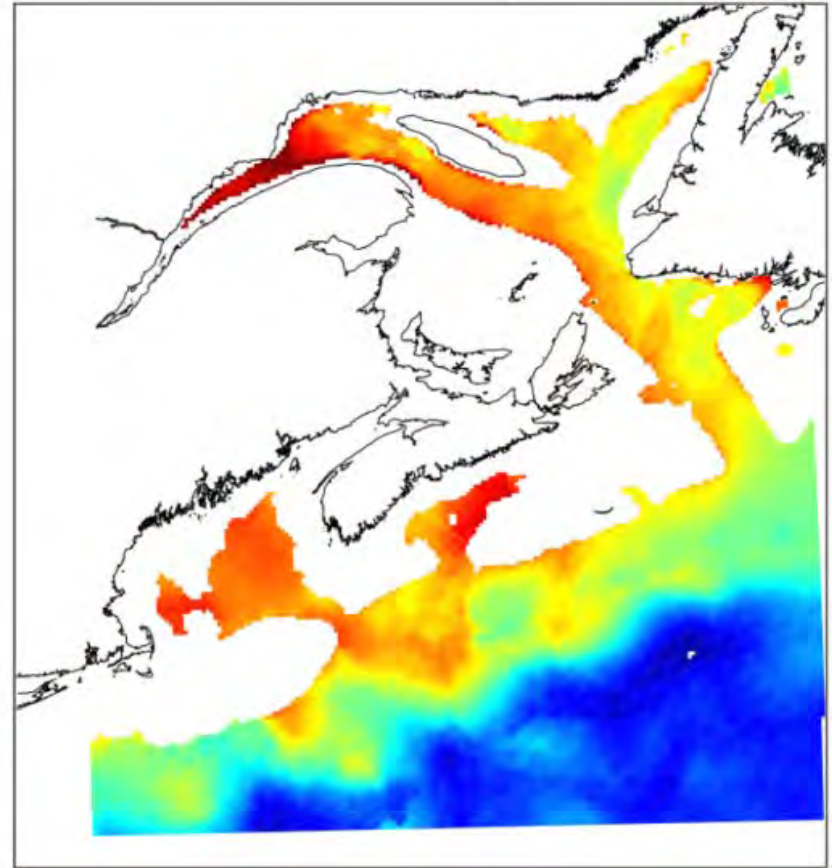
World Ocean Database

Regional model initial conditions

Nutrient trap and pump
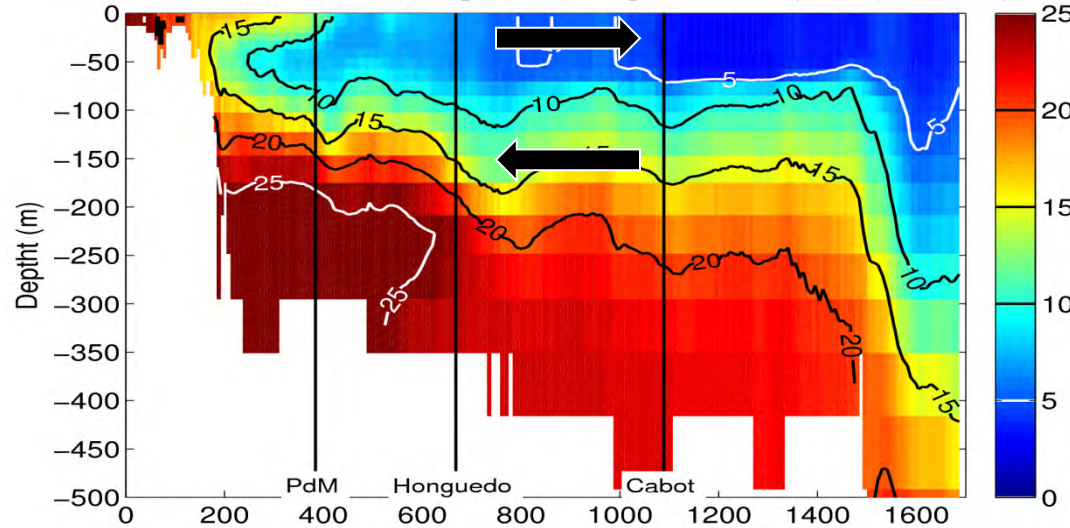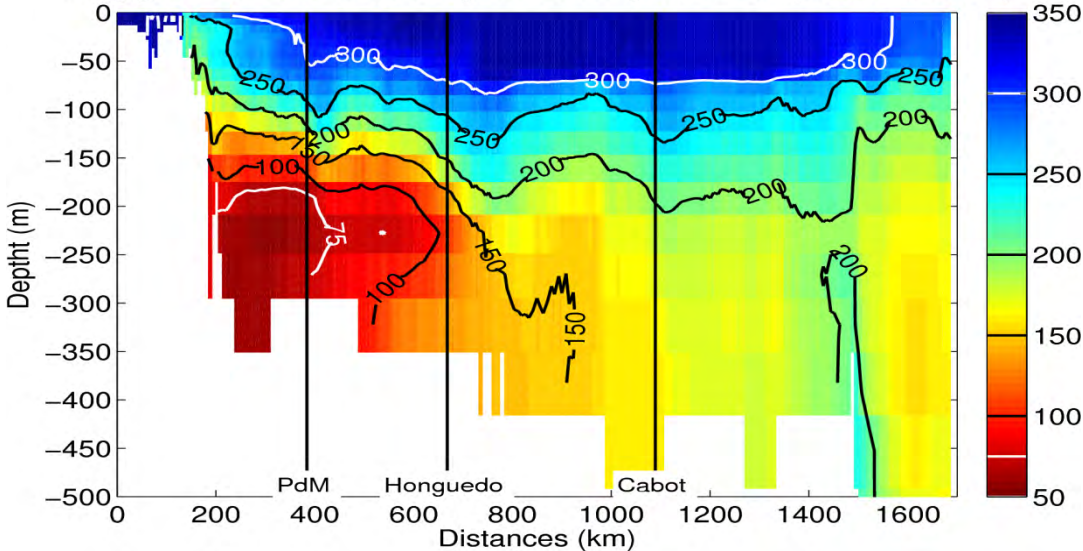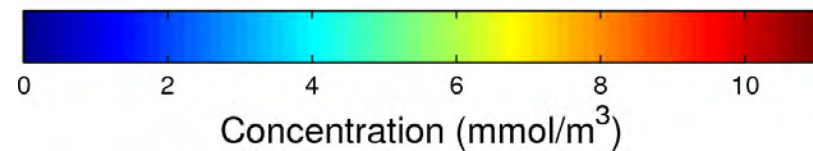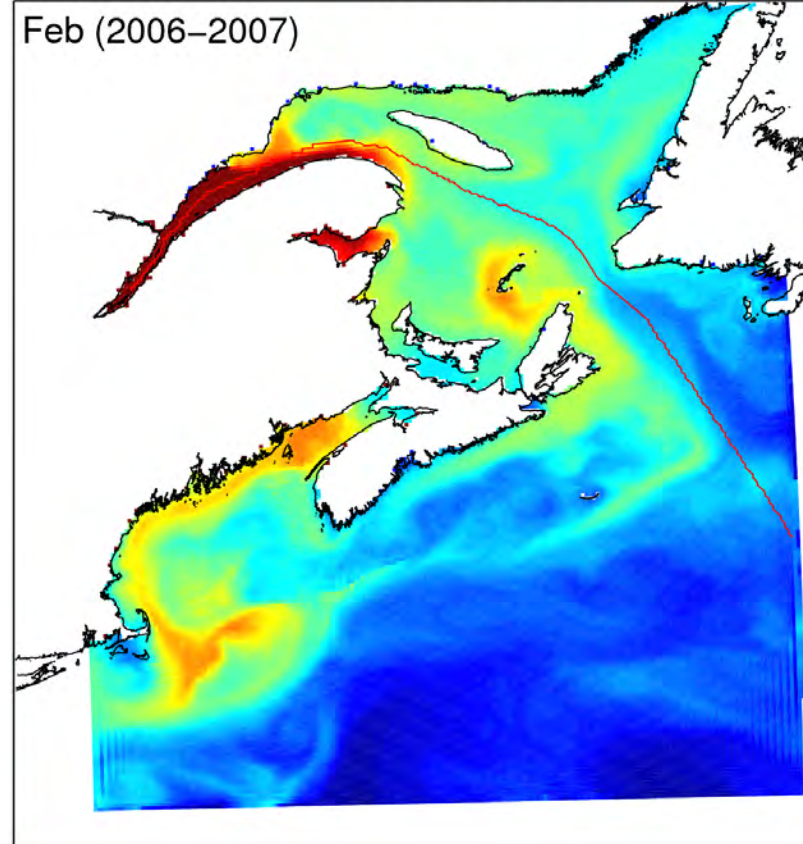
Observed oxygen saturation and aragonite Ω

Denis Gilbert, IML, 2004-2005

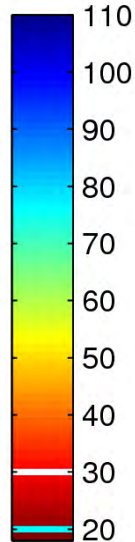Aragonite saturation
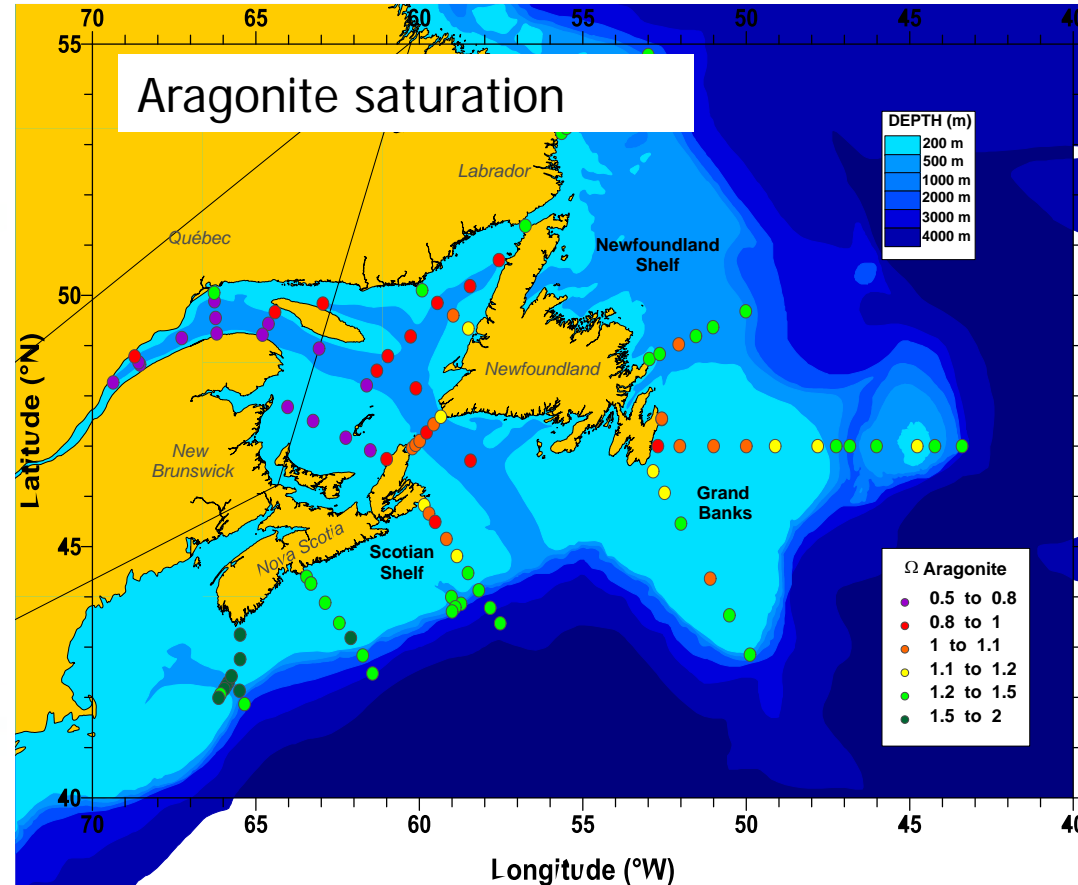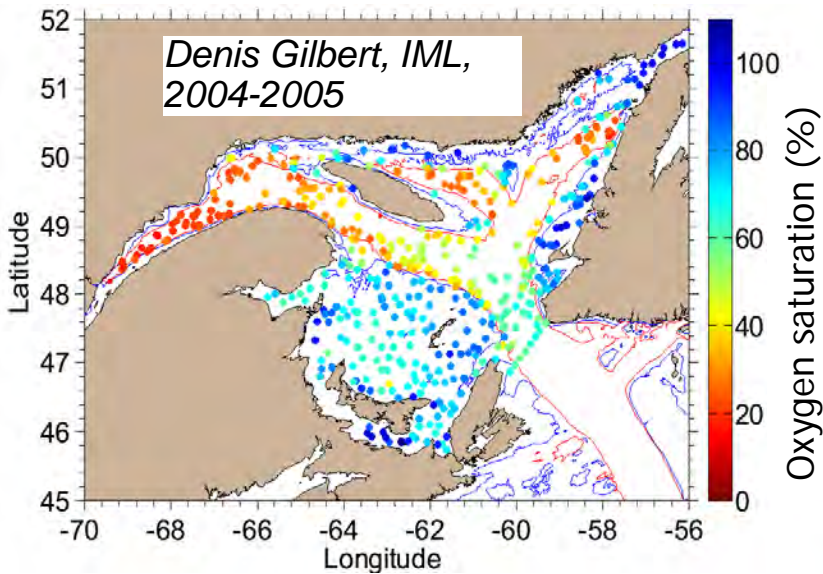
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Inside trend greater than trend at boundary

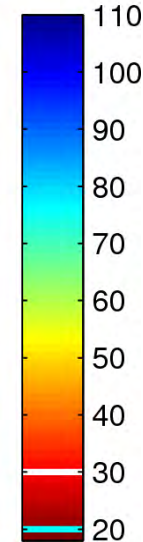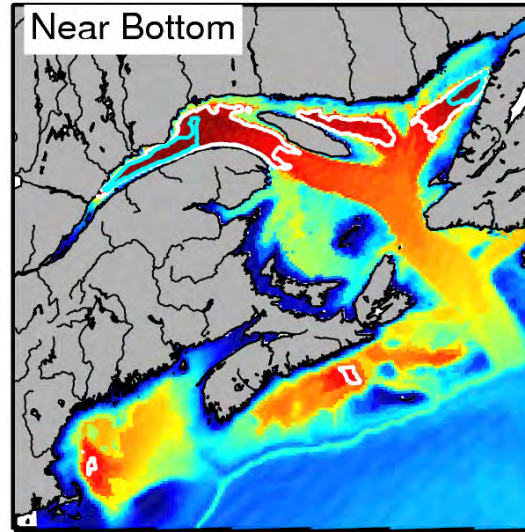Historical Oxygen (1991–2010)

Future Change with MPI–ESM–MR (2061–2069)

150-300 m
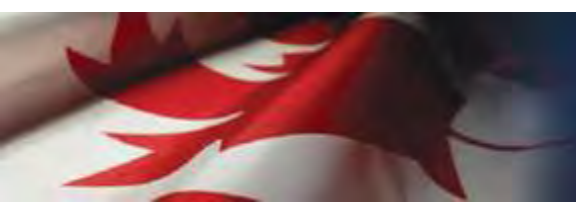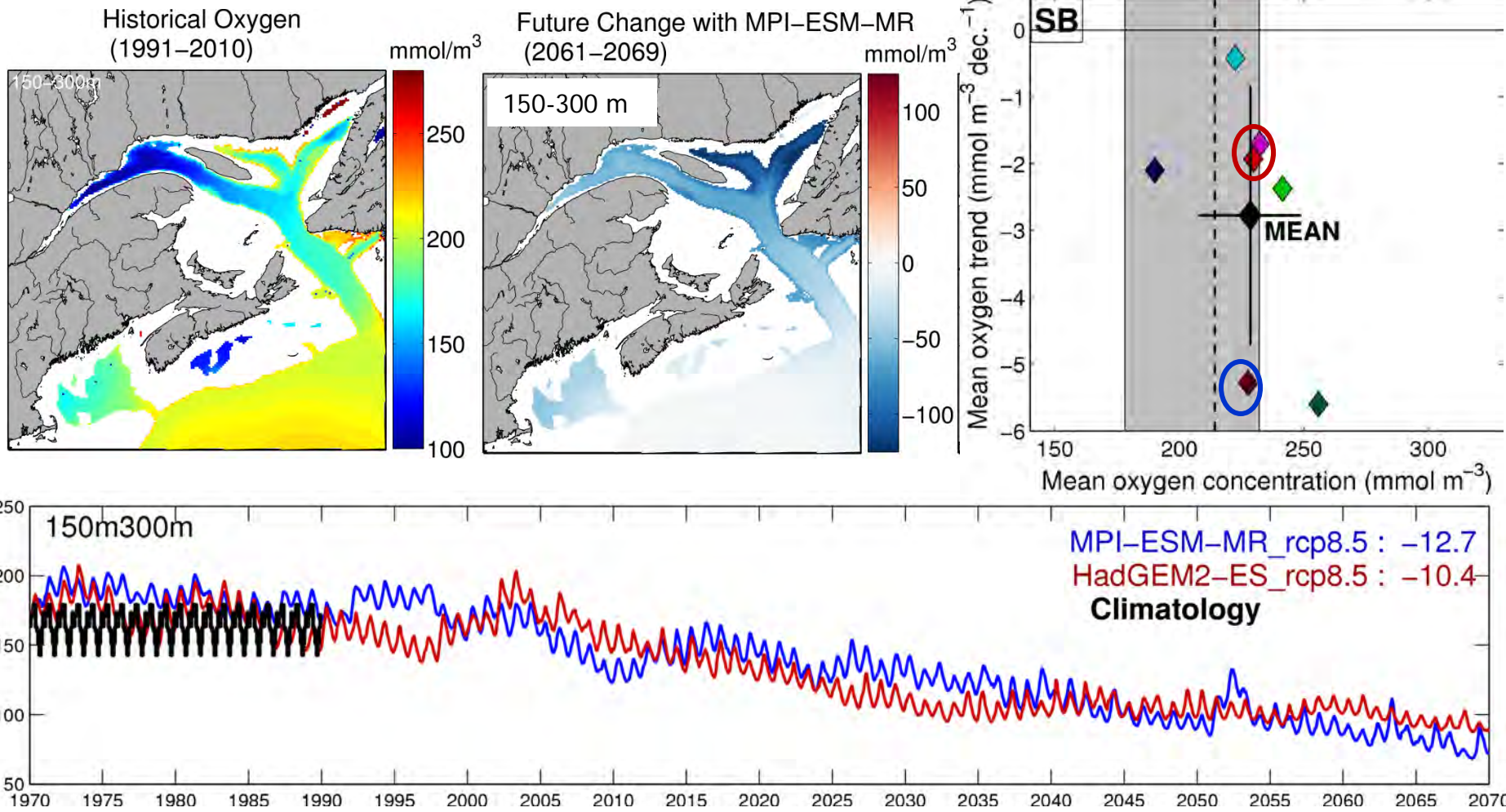
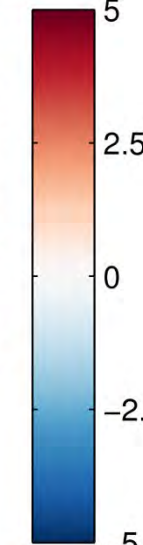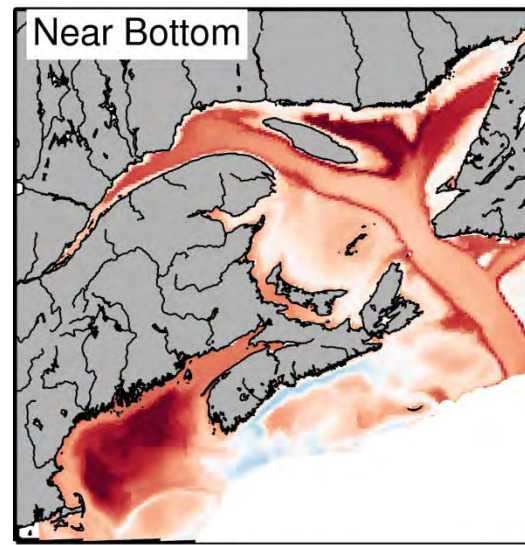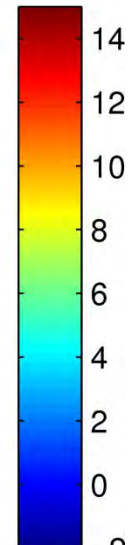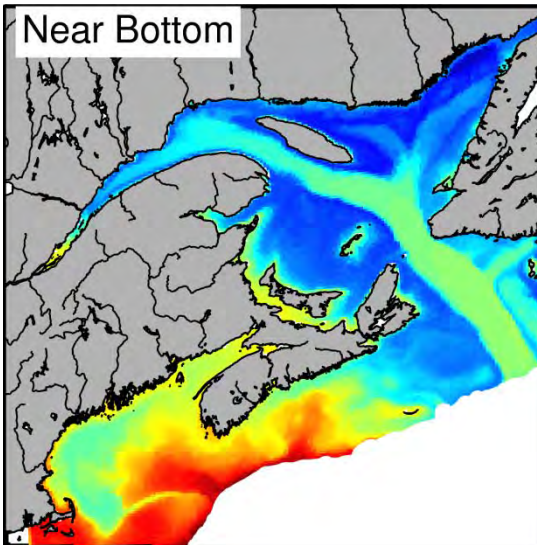# Bottom oxygen saturation and T with MPI-ESM-LR

1991–2010 Summer Oxygen Saturation
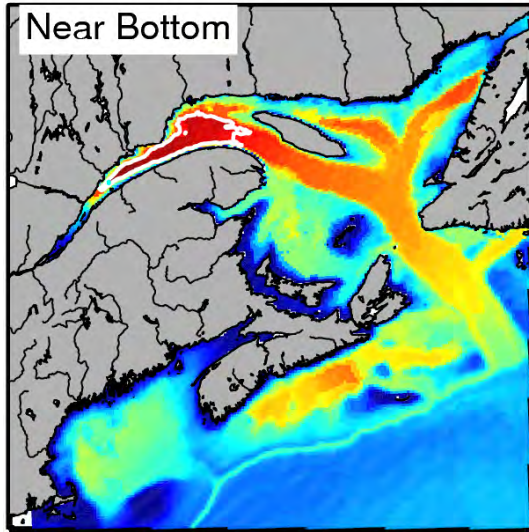
2060–2069 Summer Oxygen Saturation

Bottom pH / pH au fond
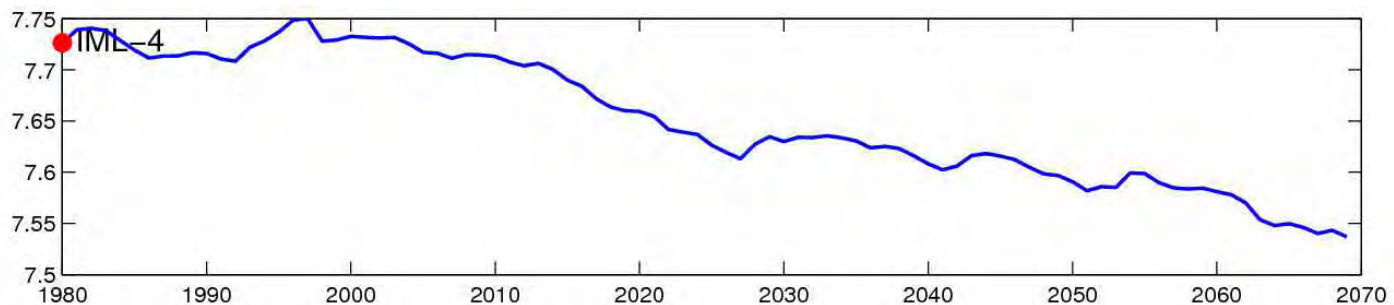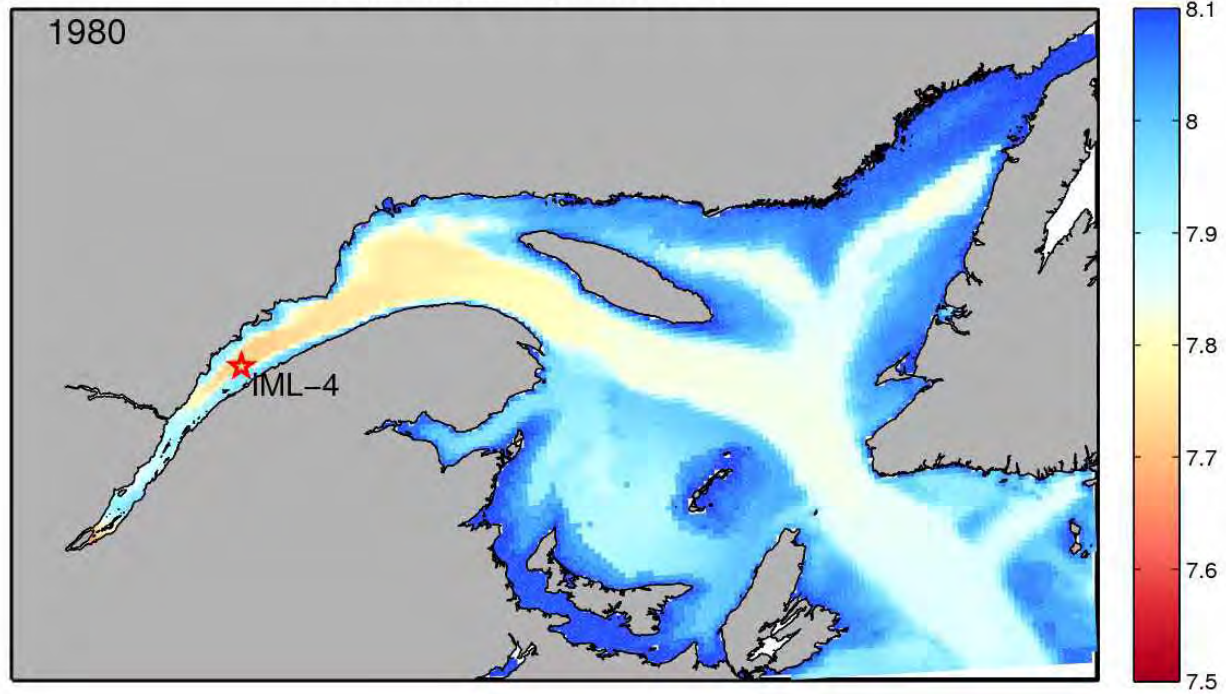
Preliminary results – Aragonite saturation
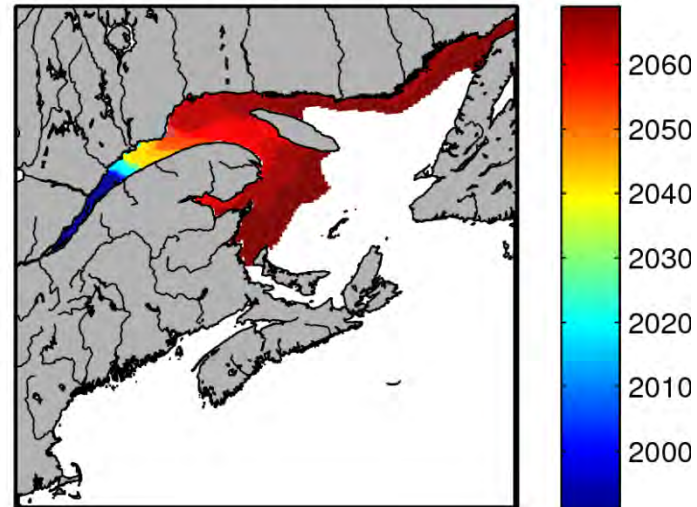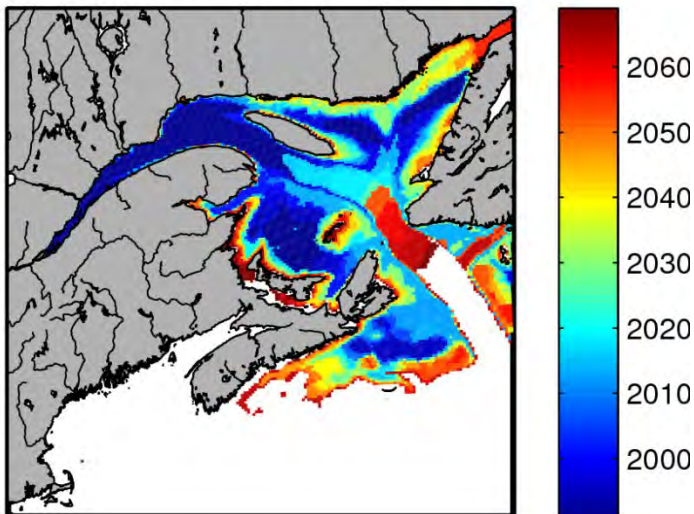
Preliminary results – Calcite saturation
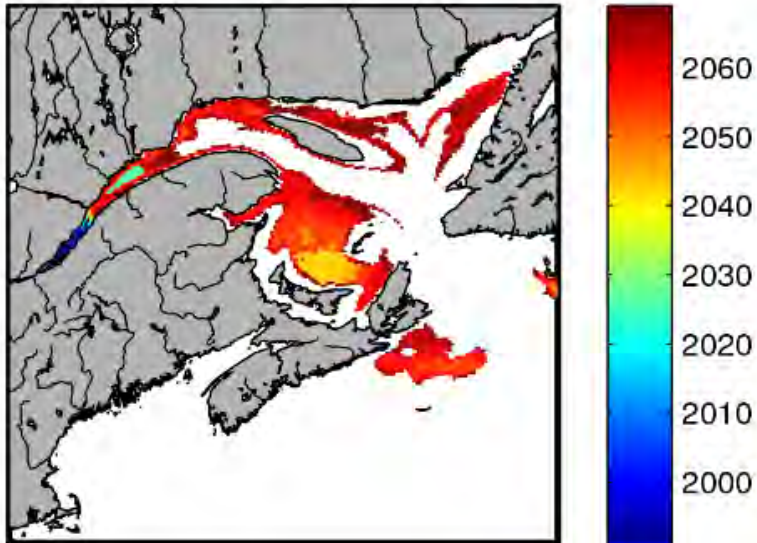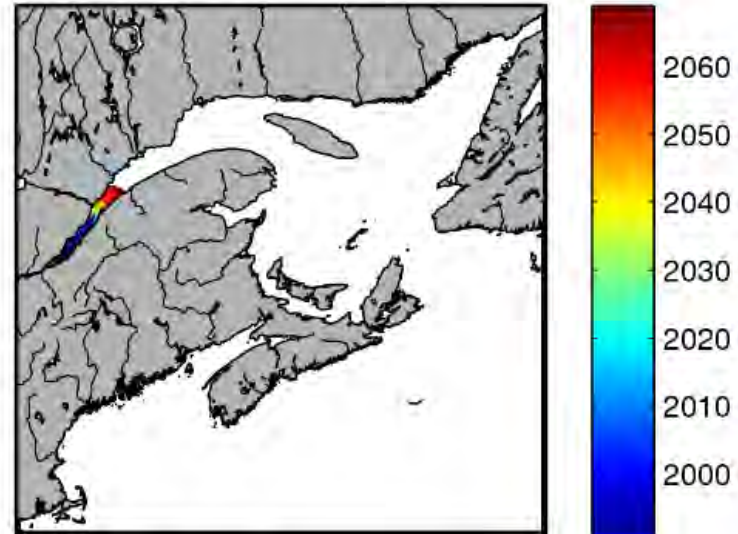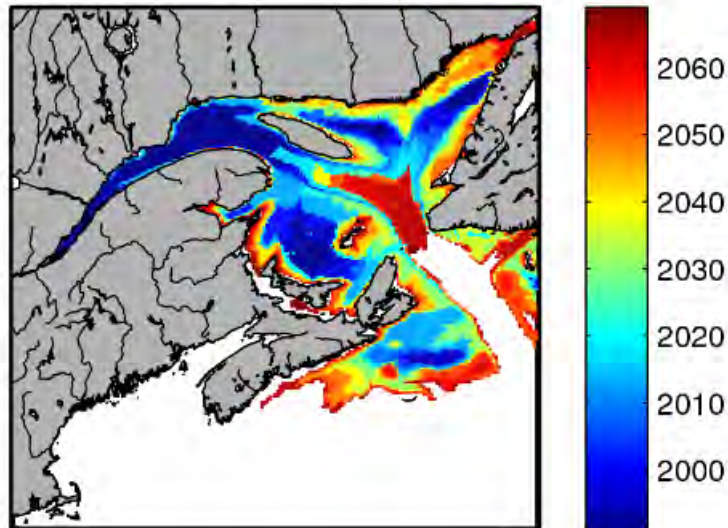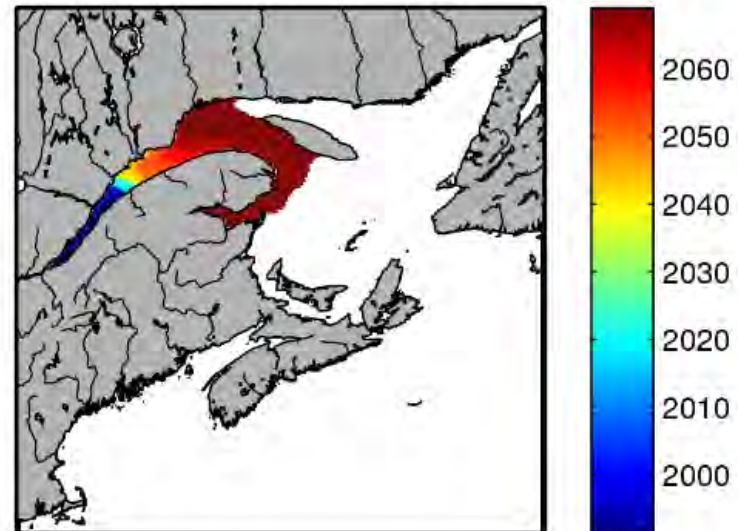
$$NO_3 + NH_4 + Diat + Flag + microzoo + mesozoo + DON + PON + O_2 + pH + ArSat + T + S$$

Sum of variables (13) with future change (mean of future period minus mean of historical period) greater than 3 standard deviation calculated over the historical period

Near Bottom
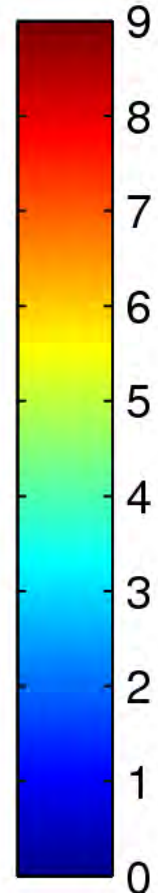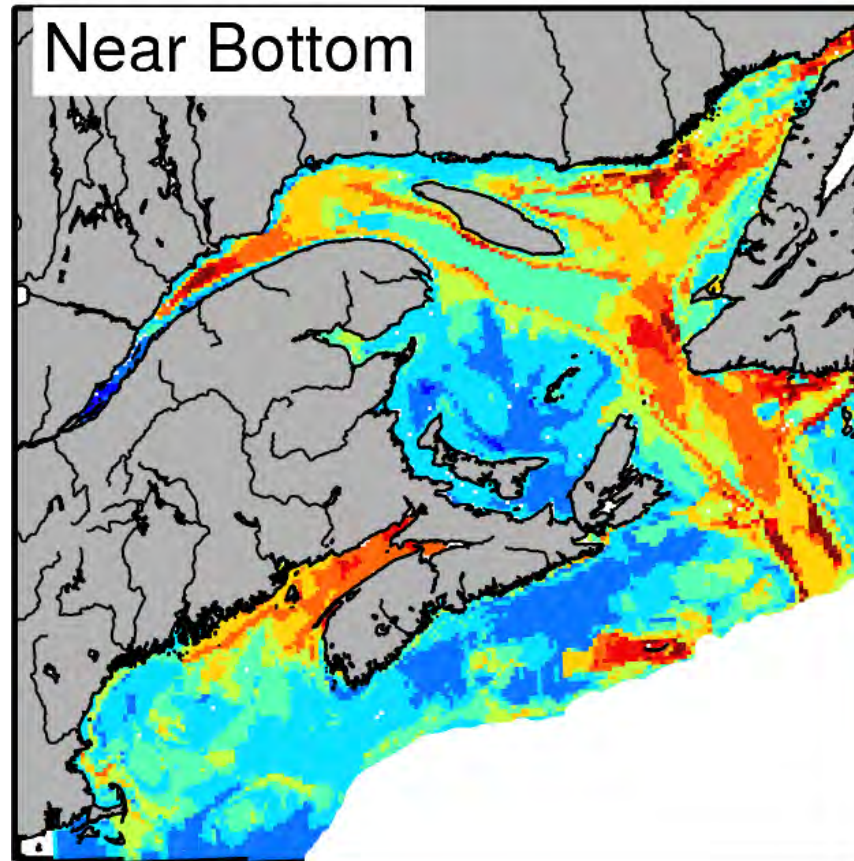
Conclusion

- Changes inside the Gulf of St. Lawrence are greater than those imposed at the eastern open boundary of the model

- Regional model predict important decrease in dissolved oxygen concentrations and saturations, pH, and calcium carbonate saturation states.

- Bottom calcium carbonate saturation states will reach values of 1 (aragonite) and 1.5 (calcite) over the whole Gulf of St. Lawrence and eastern Scotian Shelf by 2070.

- However, although not reaching critical values, the decrease is greater on the western Scotian Shelf and in the Gulf of Maine -> but uncertainty is greater for these regions.