Goose Bay/Lake Melville Model for Methylmercury in Water

Presentation to Government of Newfoundland and Labrador

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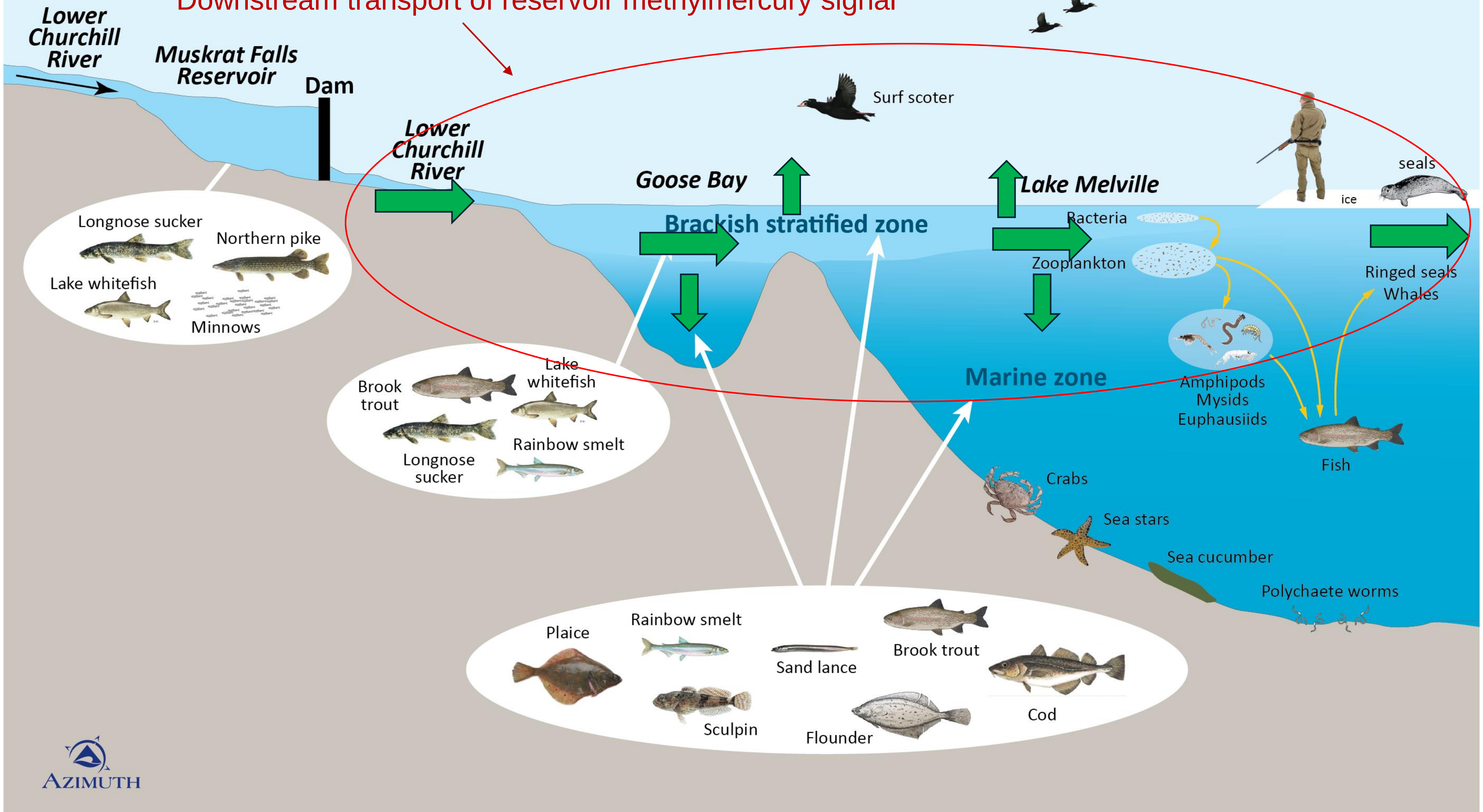
Focus of this presentation:
Downstream transport of reservoir methylmercury signal



Approach

- A high-resolution 3-D model was used to simulate hydrodynamics in Goose Bay and Lake Melville

- The model was calibrated to temperature, salinity, and velocity measurements made by Memorial University.

- The model was also used to simulate downstream transport of methylmercury from the reservoir flood zone, examining the effects of mixing and dilution (but not removal processes).

- Two estimates of methylmercury loads from the reservoir were used in simulations (based on FLUDEX experiment and ResMerc model). Used the average of the results.

- A 'box model' extended the results from the 3-D model to include photodegradation and settling of MeHg.

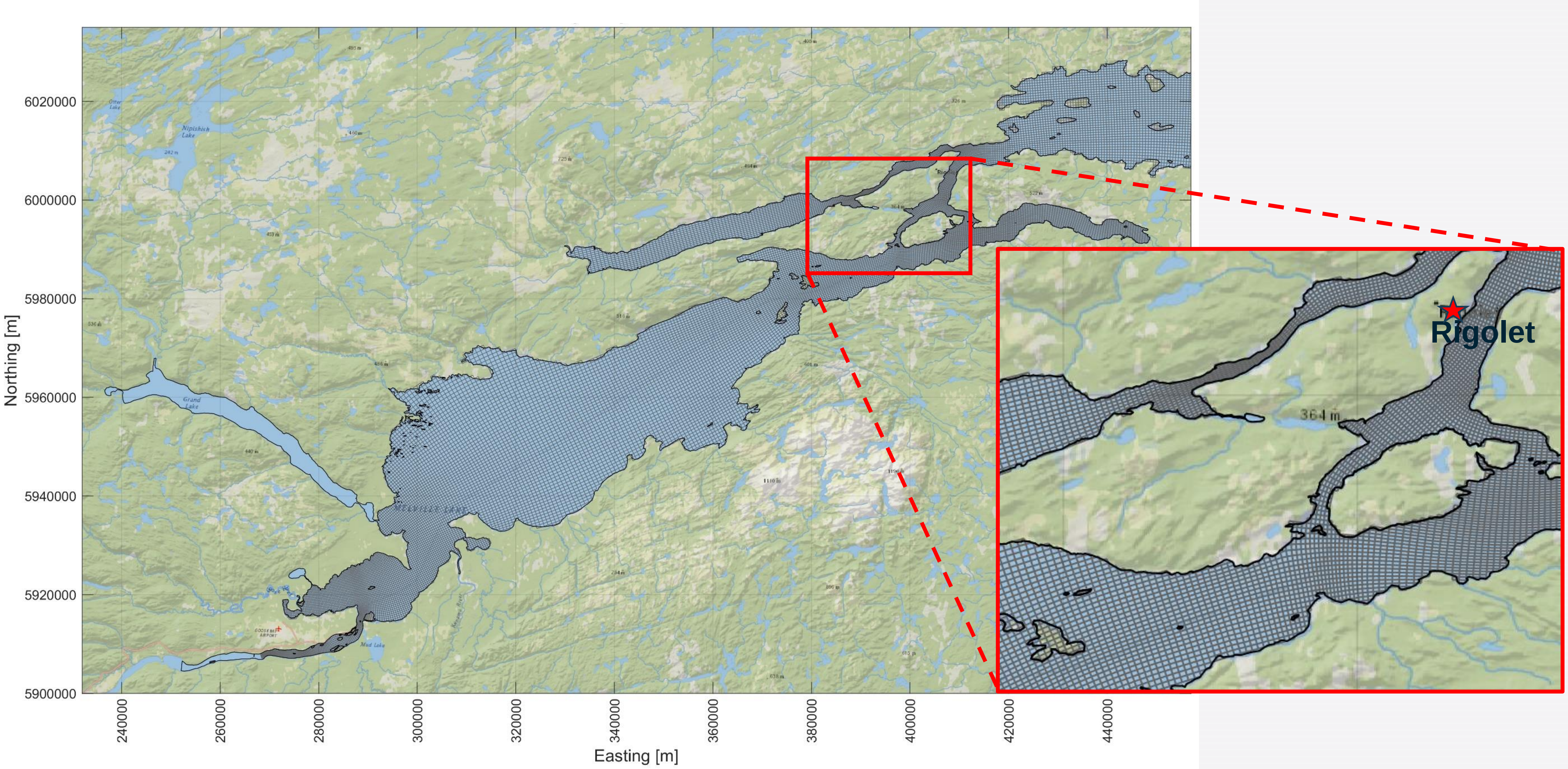
3-D Model

- Used Delft3D model:
  - Industry-standard for hydrodynamics in estuarine systems

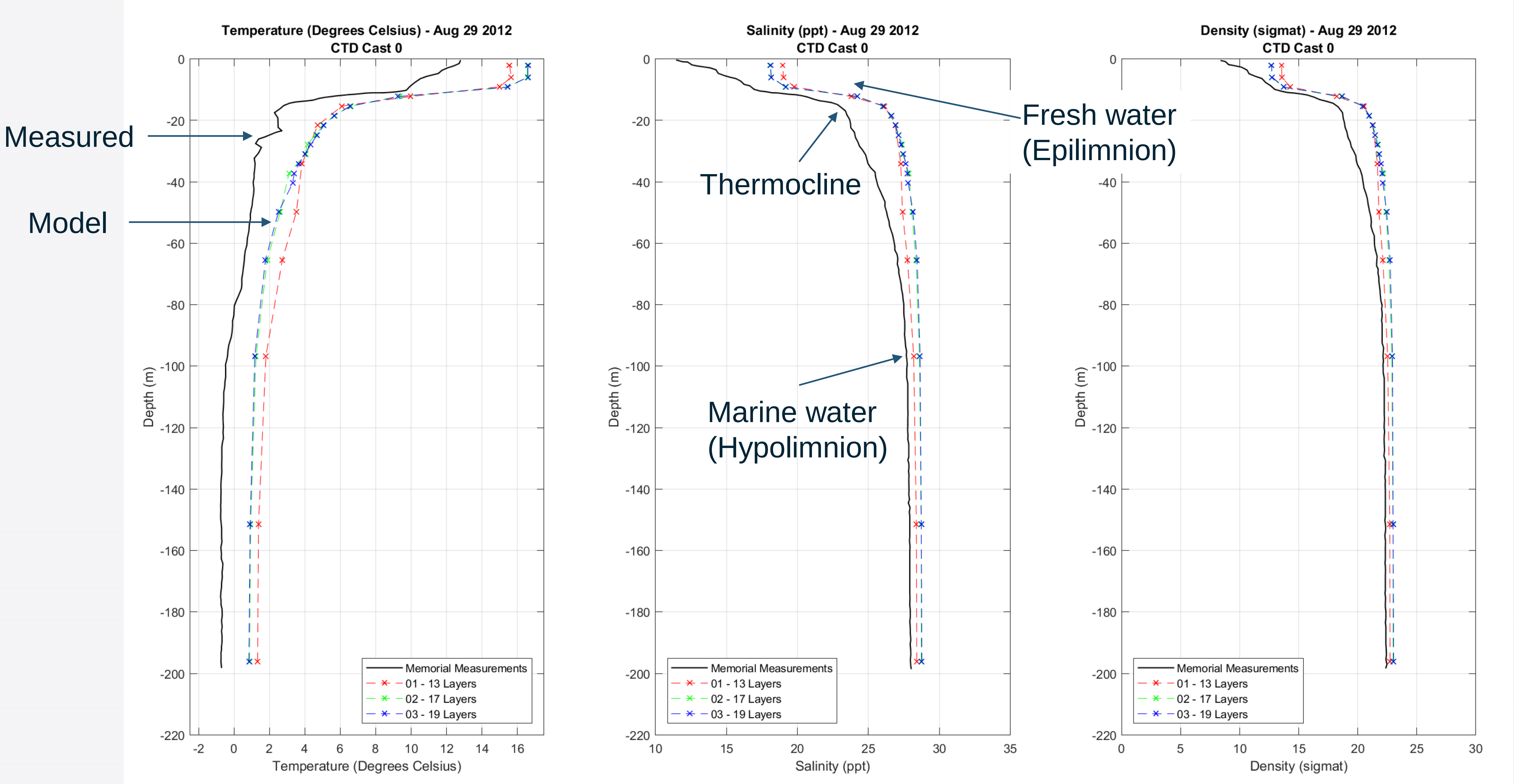
- Includes effects of:
  - Tides
  - Salinity (sea water and fresh water)
  - Freshwater inflows
  - Local weather conditions (temperature and wind)

- 300,000 individual grid cells (20,000 horizontally x15 layers vertically)

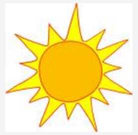
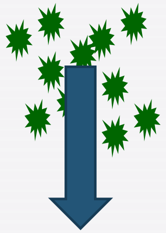
Model Grid


6020000
6000000
5980000
5960000
5940000
5920000
5900000
Northing [m]
240000
260000
280000
300000
320000
340000
360000
380000
400000
420000
440000
Easting [m]
Rigolet
364 m

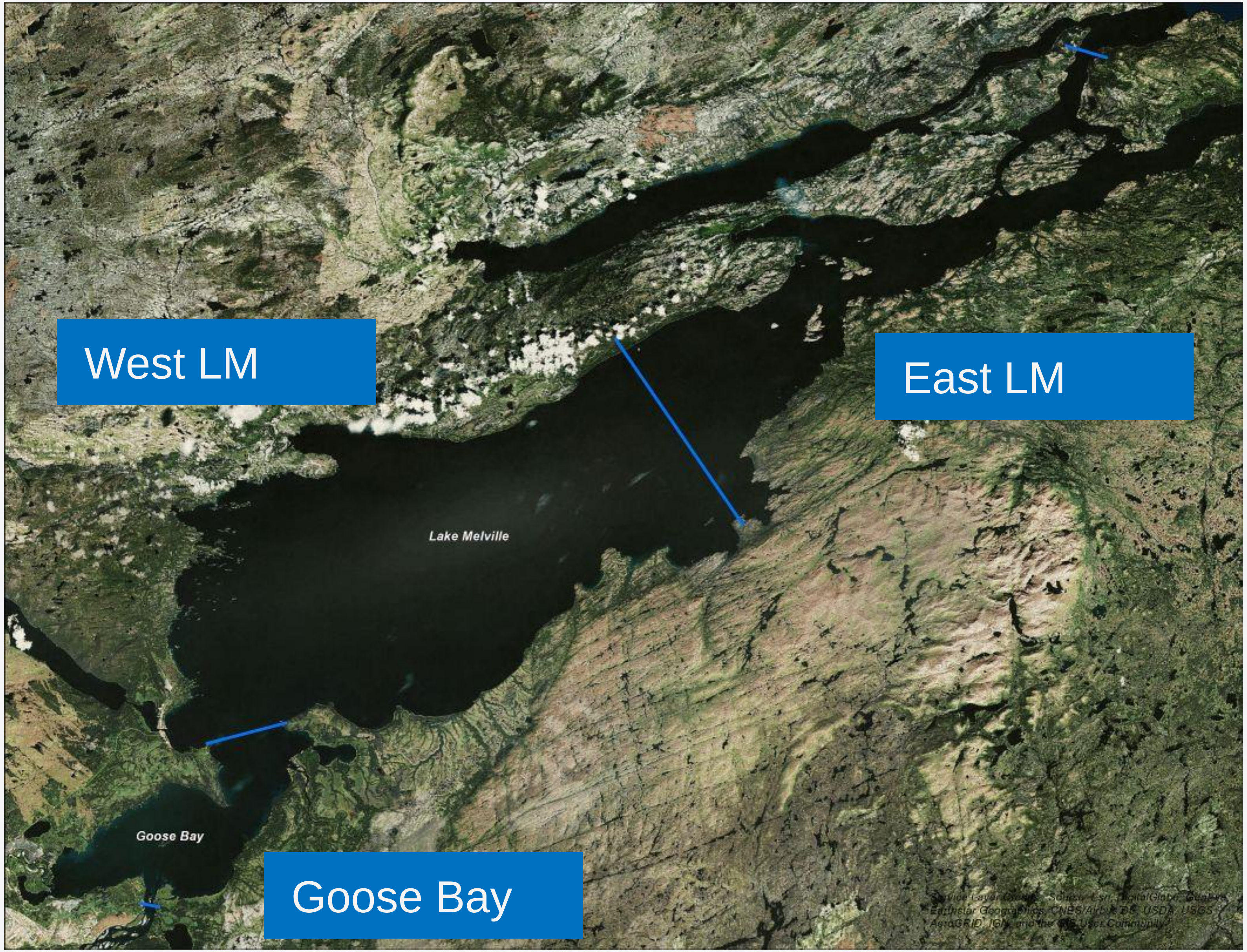
Model captured vertical mixing



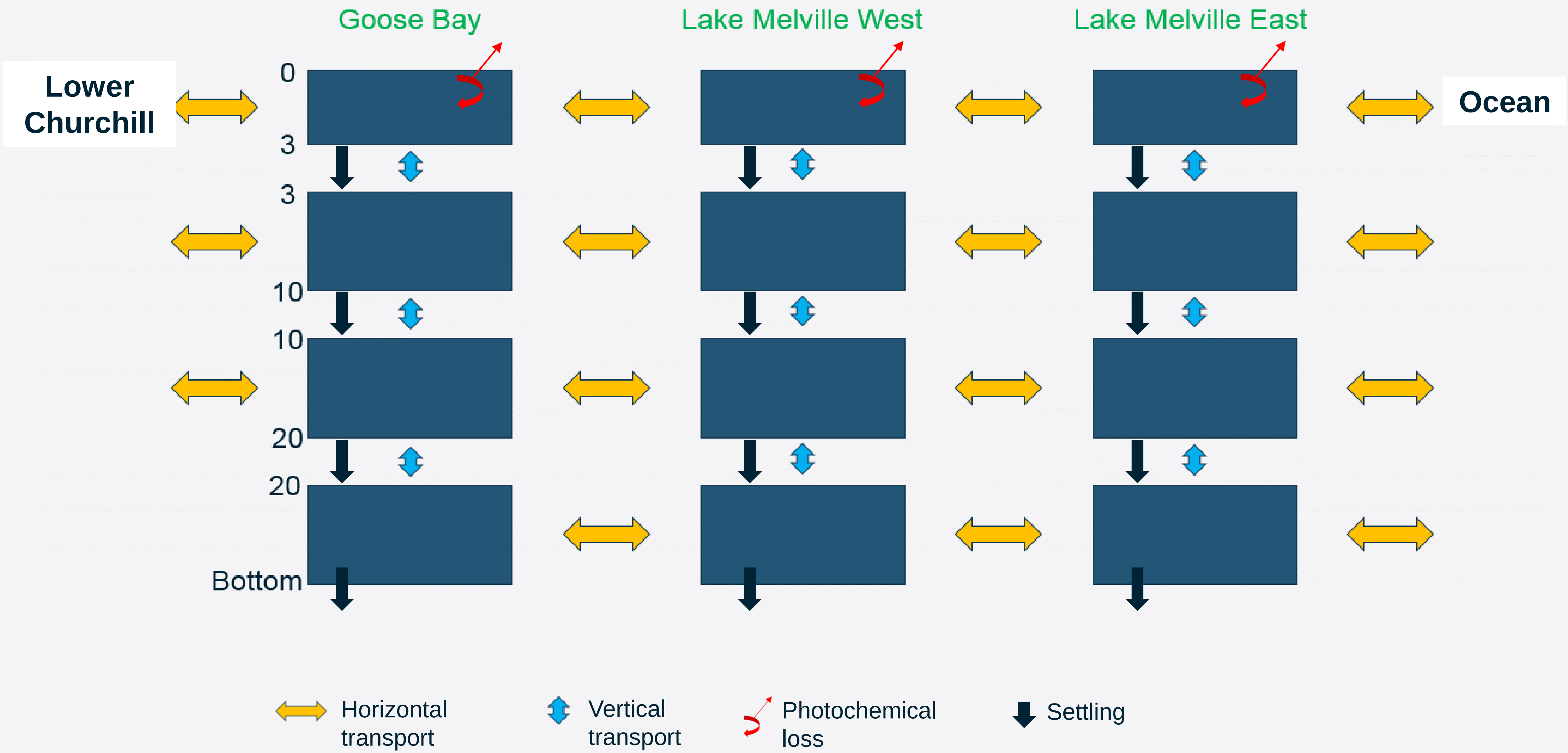
Box Model

- Set up to account for losses of MeHg from:
  - Photodegradation 
  - Settling of solid-bound MeHg 

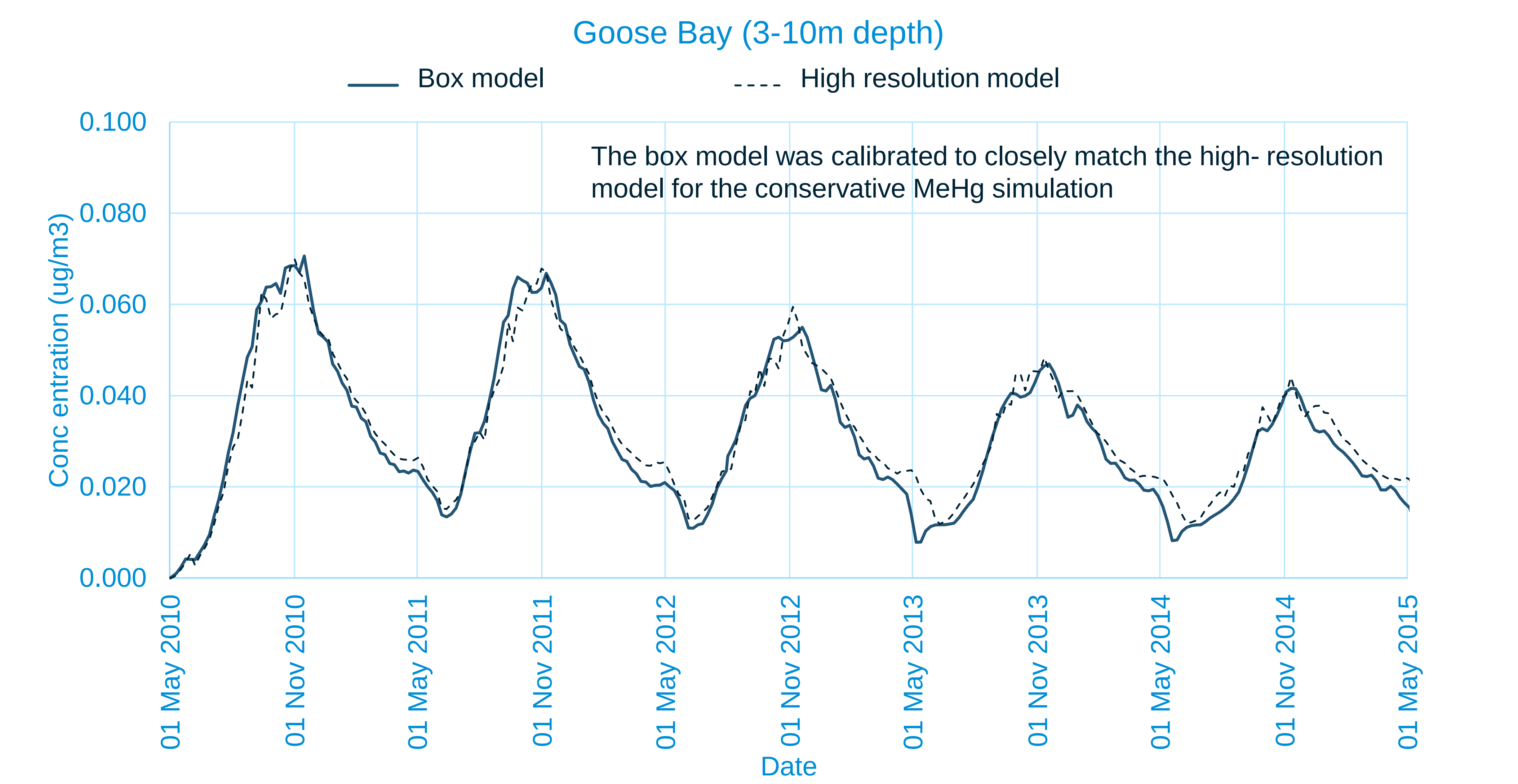
Three zones in box model



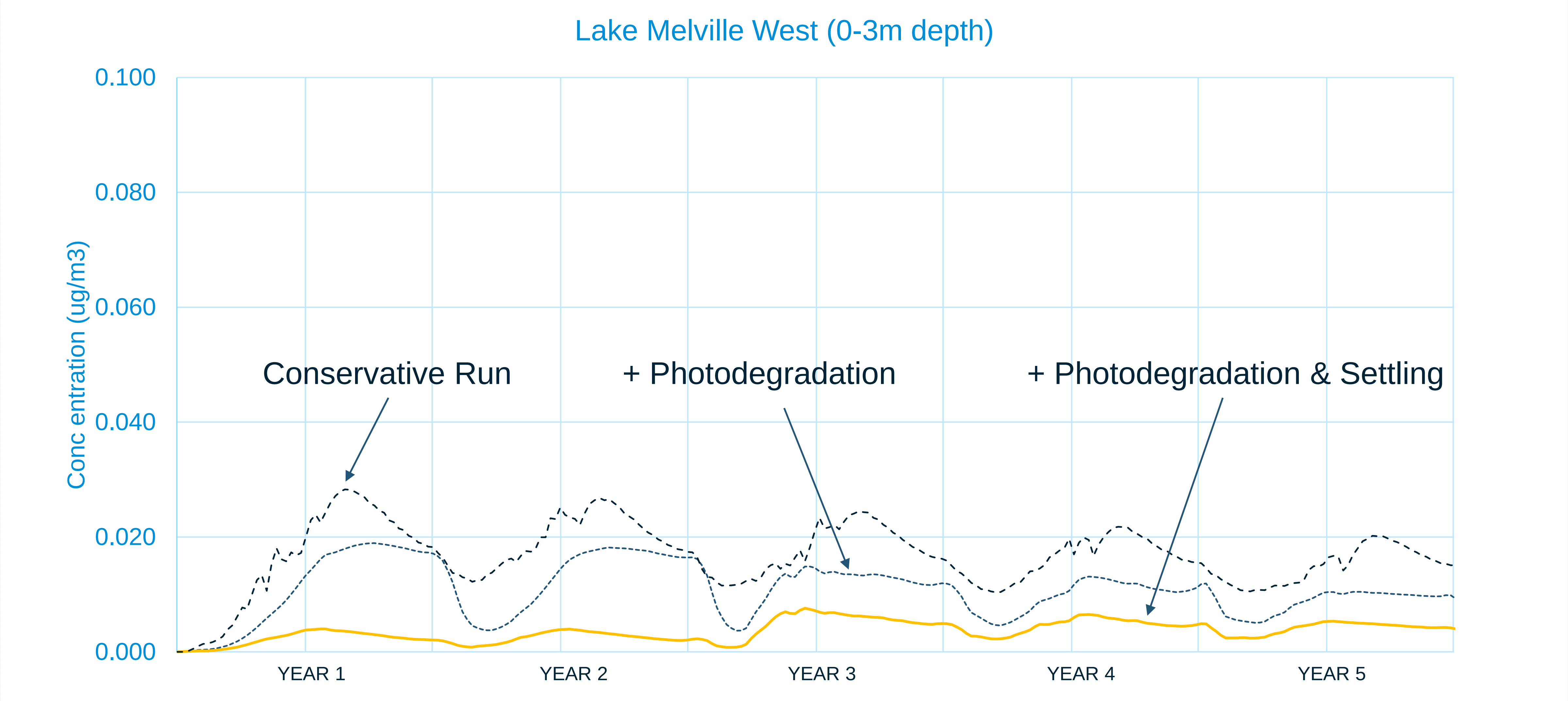
Box Model


Goose Bay
Lake Melville West
Lake Melville East
Lower Churchill
Ocean
0
3
3
10
10
20
20
Bottom
Horizontal transport
Vertical transport
Photochemical loss
Settling

Comparison of Box Model and High Resolution Model



Box model example results including photodegradation + settling



ResMerc Loads; Average Photodegradation Rates; 0.5 m/d

Predicted increases in MeHg concentrations in water

Surface waters (0-20 m)

Location	MeHg Concentration Increase: 3 Year average (ng/L, max)
Goose Bay	0.019
Melville West	0.006
Melville East	0.005

Deeper waters (>20 m)

Location	MeHg Concentration Increase 3 Year average (ng/L, max)
Goose Bay	0.013
Melville West	0.002
Melville East	0.003

Results for average of resmerc/fludex

Predicted relative increases in MeHg concentrations in water

Surface waters (0-20 m)

Location	Peak/Baseline
Goose Bay	2.1
Melville West	1.4
Melville East	1.3

Deeper waters (>20 m)

Location	Peak/Baseline
Goose Bay	1.9
Melville West	1.3
Melville East	1.4

Baseline concentrations: 0-20m: 0.017 ng/L. >20m: 0.015 ng/L (Goose Bay), 0.007 ng/L (Lake Melville)
Results for average of resmerc/fludex

Summary

- Applied a combination of high resolution and aggregated box models to predict the downstream fate of methylmercury supplied from the reservoir flood zone.
- Methylmercury in Lake Melville waters predicted to increase by ~30-40% (max) in upper 20m (based on 3 yr average).
- Predicted increases in water are lower than predicted by Calder *et al*. (2016).
- Difference is mainly due to lower predicted loads from the reservoir.
- This analysis does not include effects of Lake Melville biomass.