SYMPOSIUM OP'24 ADVANCING OCEAN PREDICTION SCIENCE FOR SOCIETAL BENEFITS

Semi-operational forecasts from a two-way nested circulation-biogeochemical model supporting research in Halifax Harbour, Canada

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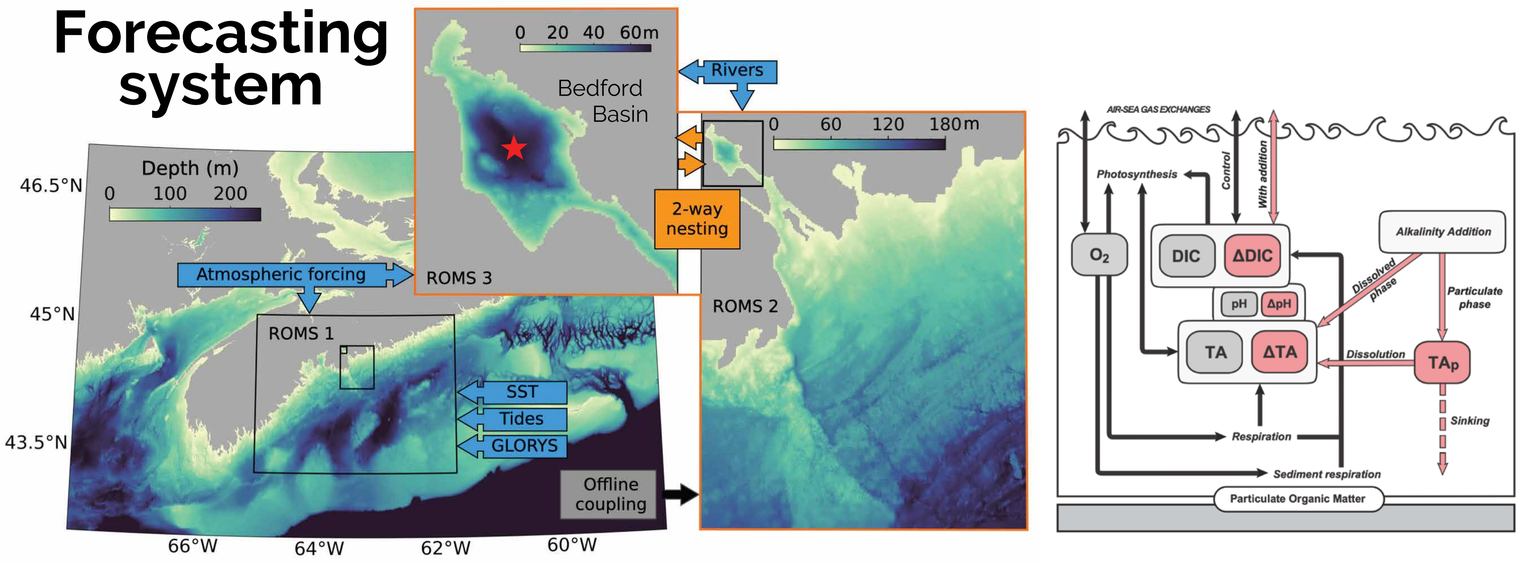
Summary

Bedford Basin has long been the focus of research, with a long-term monitoring station located in its center (BBMP). Halifax Harbour is currently a site of ocean alkalinity enhancement research with on-going alkalinity addition trials. In this context, a semi-operational, 10-day forecasting system was developed to support research. Routine forecasts have been carried out in Summer/Fall 2023 and 2024. The model is able to forecast dynamical events such as flooding (Aug. 2023) or intrusion (Oct. 2024) well ahead of time but their magnitude may be overestimated (Sep. 2023) resulting in a degradation of the model efficiency. Despite this mismatch, the model has forecasting skill. To improve the forecasts, the next step will be to assimilate routine observations into the model.

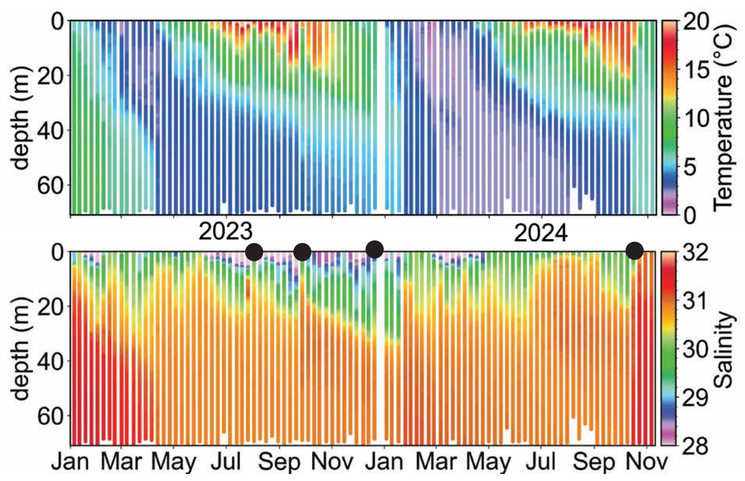
Forecasting system



The forecasting system is driven by ECMWF weather forecasts, Copernicus global ocean analysis and forecasts, and observed river flow extrapolated forward in time. Forecasts provide hourly physical parameters and may also incorporate biogeochemistry and passive tracers. ROMS 1 is run first to provide open boundary conditions to the 2-way nested ROMS2-3 models. Forecasts are compared with observations at BBMP (red star).

Results

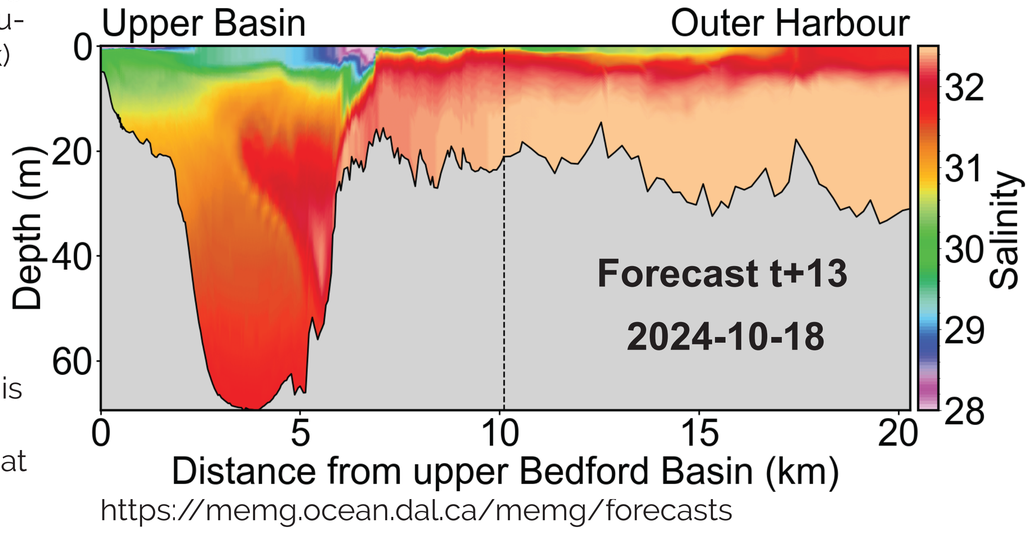
1. Observations



Bullets indicate events shown in other figures

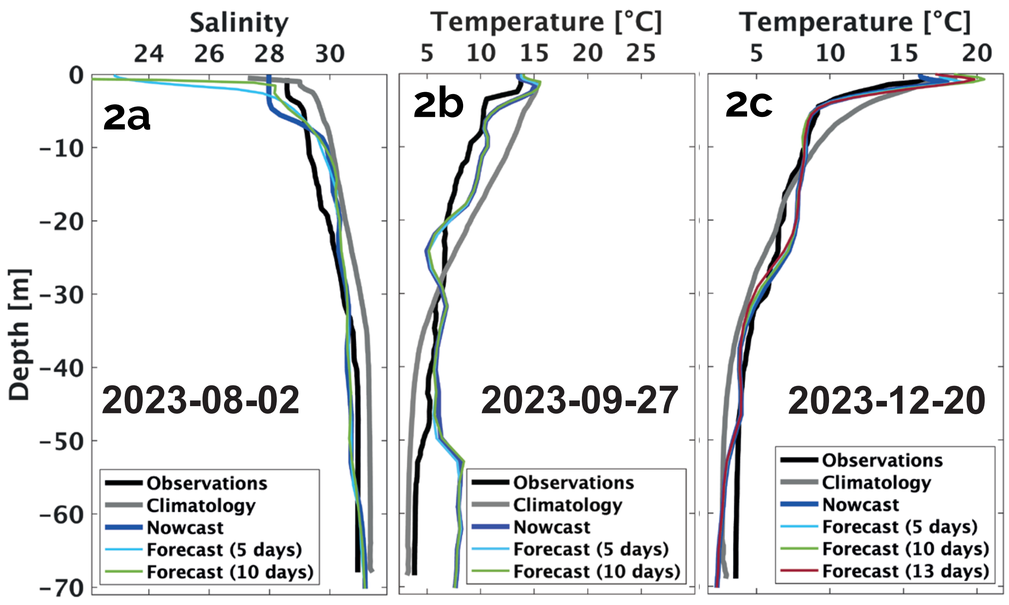
- Observations at BBMP (1) show convective mixing in late winter, a flooding event in summer 2023, as well as intrusion events in September 2023 (weak) and October 2024.
- The nowcast/forecasts simulate the surface freshening in 2023 (2a) with lower efficiency forward in time.
- Forecast profiles are also improved from climatology in September (2b) and December (2c) 2023. The mismatch at 50-70m in September 2023 is due to an overestimated intrusion event that results in a persistent bias at depth.
- The forecasted onset of the October 2024 intrusion is shown in the transect (3)

3. Along harbour transect (intrusion)



https://memg.ocean.dal.ca/memg/forecasts

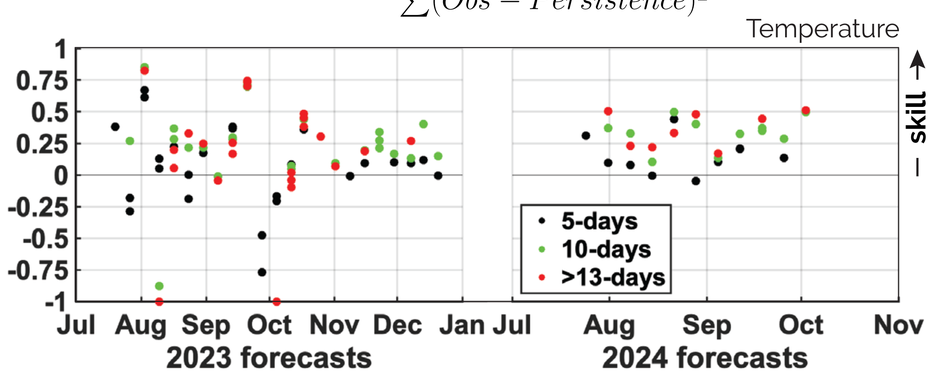
2. Comparison profiles



- For most dates FS > 0 indicating that dynamic forecasts consistently beat persistence forecasts (4). Longer forecasts tend to have higher skill since they can simulate future dynamical events.
- Despite the relative good agreement with observations in Figures 2a-c, model efficiency (same as Eq. (1) with climatology) is mostly negative. Over freshening at the surface (2a) and persistent bias at depth resulting from an intrusion event (2b) can explain these mismatchs.

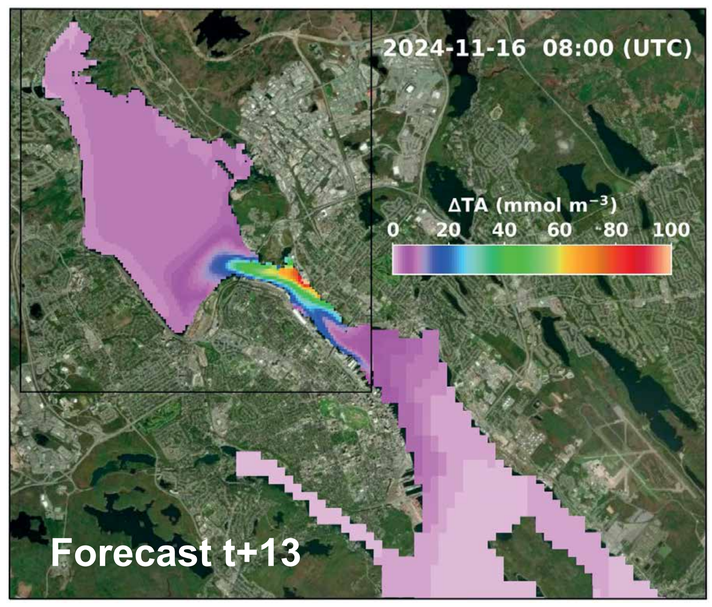
4. Forecast skills

$$FS = 1 - \frac{\sum(Obs - Forecast)^2}{\sum(Obs - Persistence)^2}$$ Eq. (1)



5. Forecast BGC

- Forecasts with biogeochemistry are produced weekly to support alkalinity addition trials in the Halifax Harbour. The surface map shows the forecast dispersion of added alkalinity in the Halifax Harbour. Scheduled alkalinity addition is used to force the model.
- The forecast is useful to adapt the sampling strategy and to provide an indication of the immediate addition effect on carbonate chemistry.



Conclusions

- Semi-operational forecasts are produced routinely to support research in the Halifax harbour, including biogeochemistry.
- The forecasts are able to simulate dynamical events well ahead of time, as well as on-going field trials.
- Mismatch in the magnitude of an event can lead to a persistent bias, particularly in the deep, semi-isolated waters of the Bedford Basin, deteriorating the model efficency.
- Assimilating routine observations is needed to correct for persistent errors and therefore improve model efficiency and forecast skill.

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