



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

The Halifax Harbour is a fjord-type estuarine system located on the eastern coast of Canada. The Harbour is characterized by estuarine circulation with tidal forcing and wind-driven surface flow. Bedford Basin, the 70-m deep basin at the head of the harbour, experiences bottom water deoxygenation punctuated by occasional deep-water intrusions and convective mixing in winter that reset its physical and biogeochemical conditions. Bedford Basin has long been the focus of research, with a long-term monitoring station located in its center. Halifax Harbour is currently a site of ocean alkalinity enhancement research with on-going alkalinity addition trials. In this context, a high-resolution coupled physical-biogeochemical model of the Harbour has been developed. Here we describe the semi-operational, 10-day forecasting version of the model which supports the ongoing research. The model is a local implementation of ROMS with a nested grid configuration that covers the inner Scotian Shelf and reaches a high spatial resolution of 60 m in Bedford Basin. The biogeochemical model simulates oxygen dynamics and carbonate system parameters, including air-sea gas exchange of CO₂. The forecasting system is driven by ECMWF medium-range operational weather forecasts, Copernicus Operational Mercator global ocean analysis and forecast system, and real-time river flow observations extrapolated forward in time. Forecasts provide hourly spatially-resolved currents, temperature, salinity and biogeochemistry (oxygen, inorganic carbon), and may include the dispersion of added passive (e.g., rhodamine) or active (e.g., Mg(OH)₂) tracers to support field experiments. The forecast skill is examined using routine weekly and bi-weekly monitoring.

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