

Illustrative Abstract

The influence of bottom water intrusion events on the biogeochemistry of a coastal fjord

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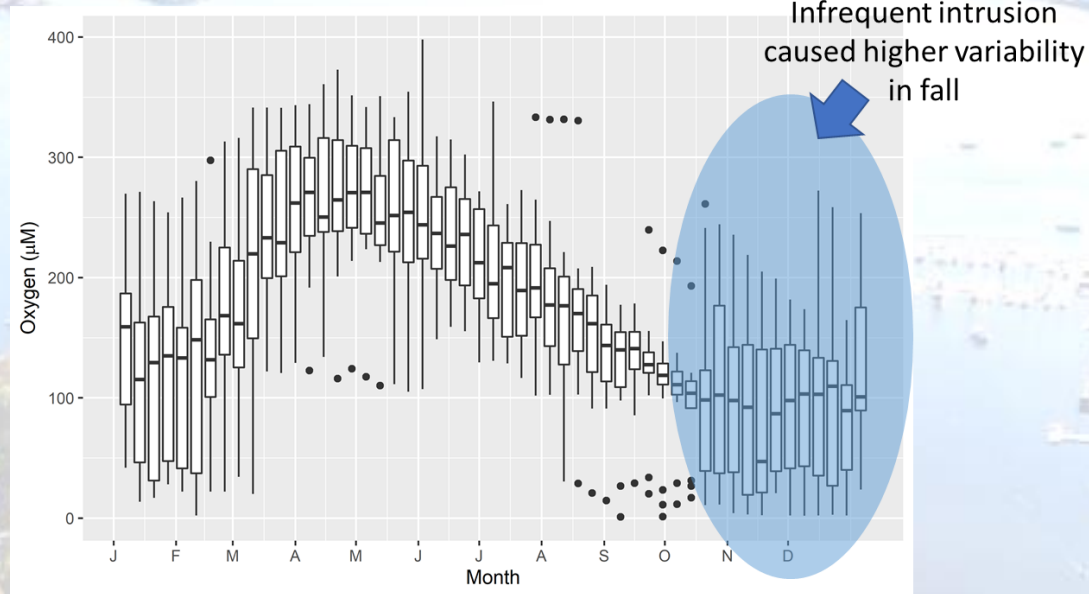
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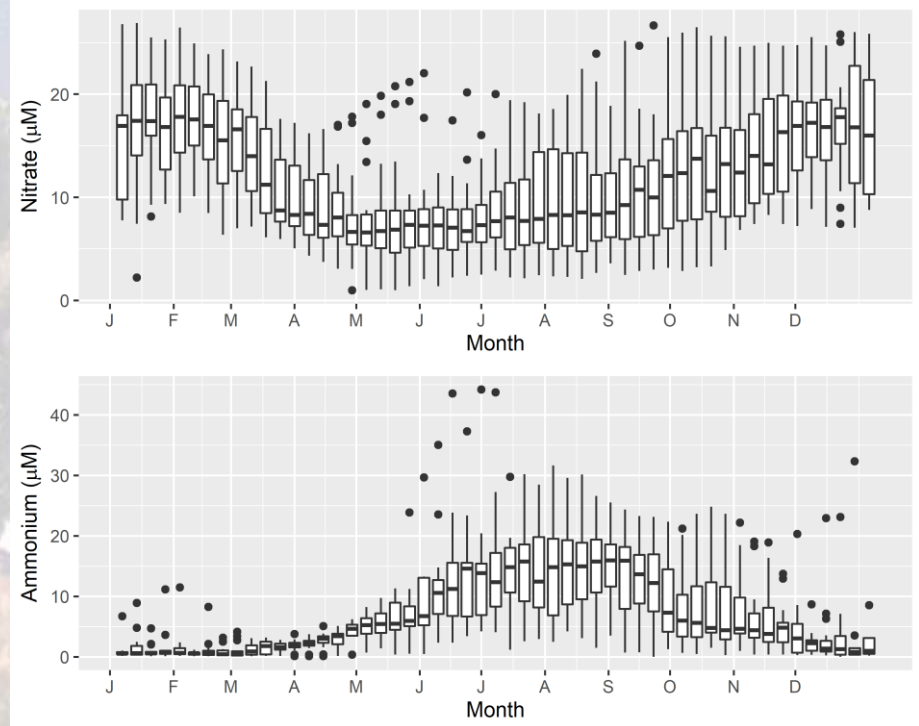
Lack of bottom water exchange in fjord-like estuaries can result in low oxygen conditions and creating sites of redox-sensitive biogeochemical processes, such as denitrification. In many of these systems, occasional intrusions of well-oxygenated bottom water may temporarily alter redox gradients and sediment-water biogeochemistry. Quantifying the magnitude and importance of these changes is a challenge due to the short timescales over which these events can occur. Here we present results from Bedford Basin, a 71 m deep coastal fjord in eastern Canada, where a 20-year, weekly timeseries of bottom water conditions indicates that autumn wind-driven intrusion events are a common, but infrequent, feature of its circulation.





Here we can see in the long-term climatology of Bedford Basin bottom water the intrusion events caused the higher variability in the Fall.

However, such variability is not evident in the climatology of the dissolved inorganic nitrogen (DIN → ammonium + nitrate). Rather it shows nitrification cascade in annual scale – collapse of spring bloom causes to ammonification of organic matter leading to



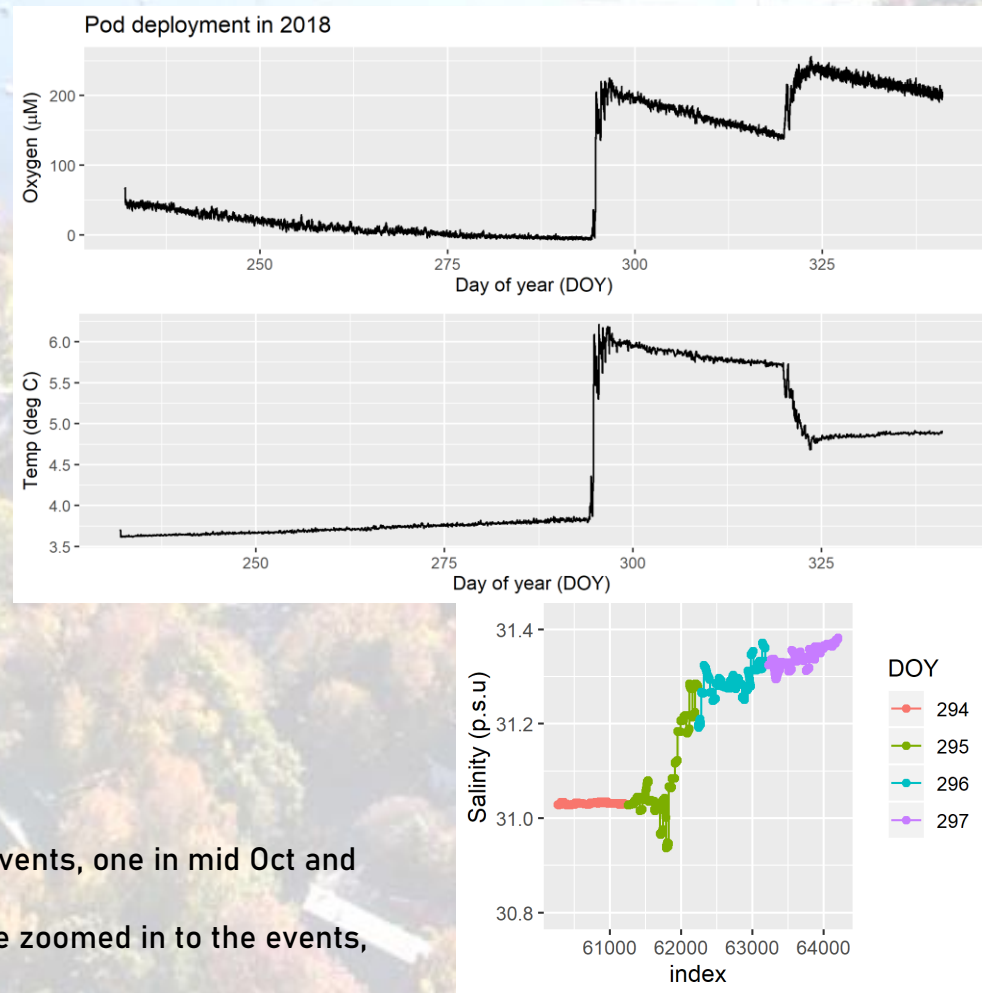
accumulation of ammonium followed by complete consumption through nitrification and accumulation of nitrate towards the end of the year.

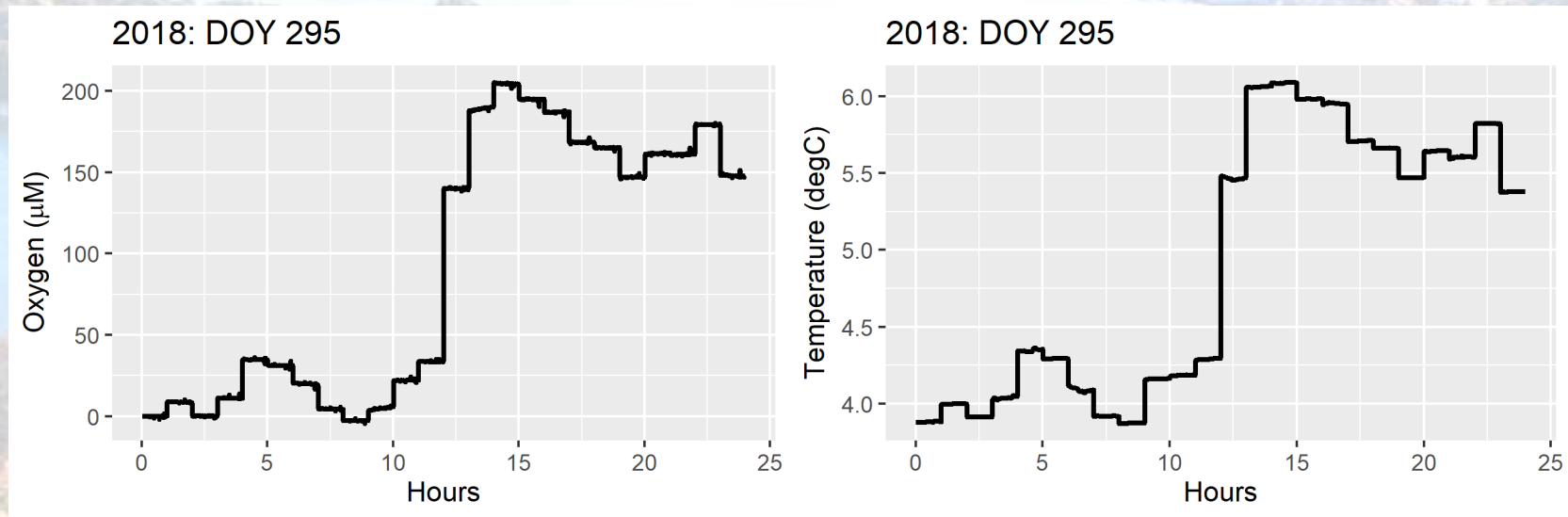
To examine the impact of these intrusions on biogeochemistry, we deployed a benthic instrument pod at 60 m depth to record high-resolution measurements of temperature, salinity, nitrate, oxygen, and fluorescence over a 4-month period during the fall of 2018.



Pod

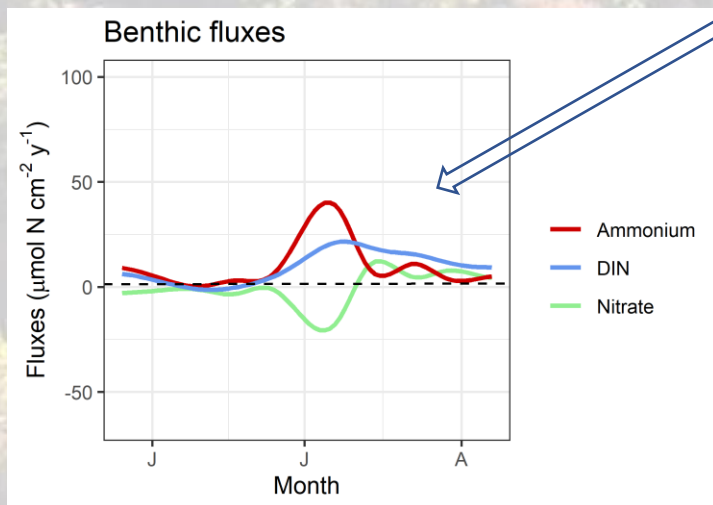
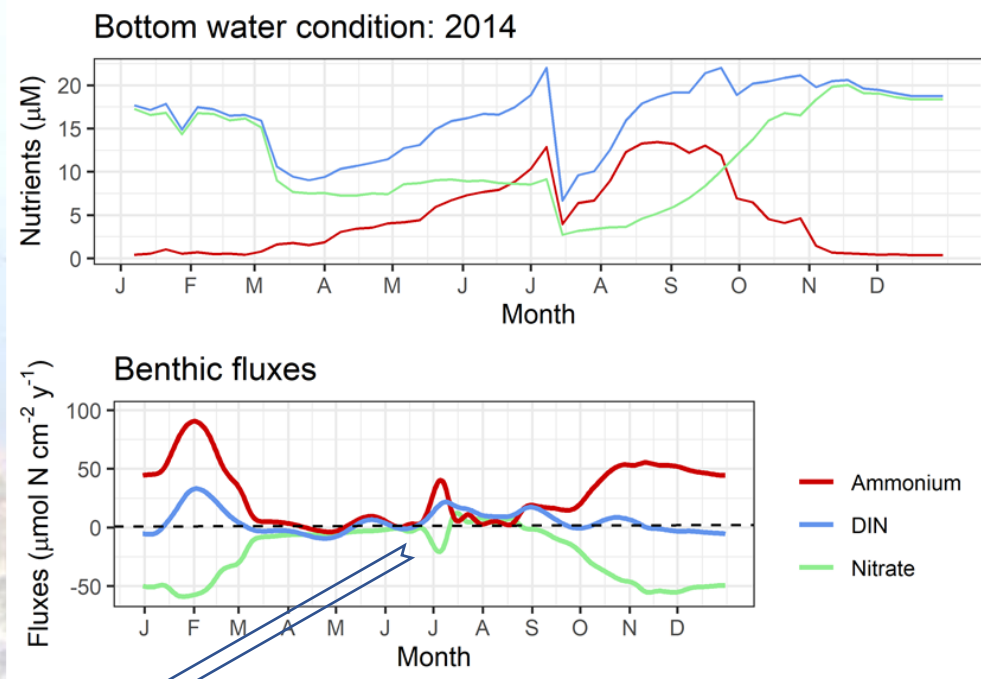
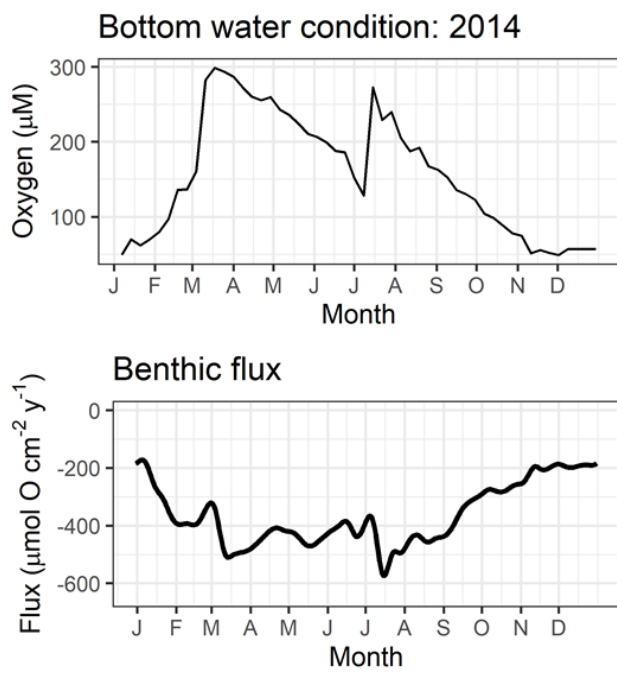
During this time, we captured two intrusion events, one in mid Oct and another in mid Nov as shown above. When we zoomed in to the events,



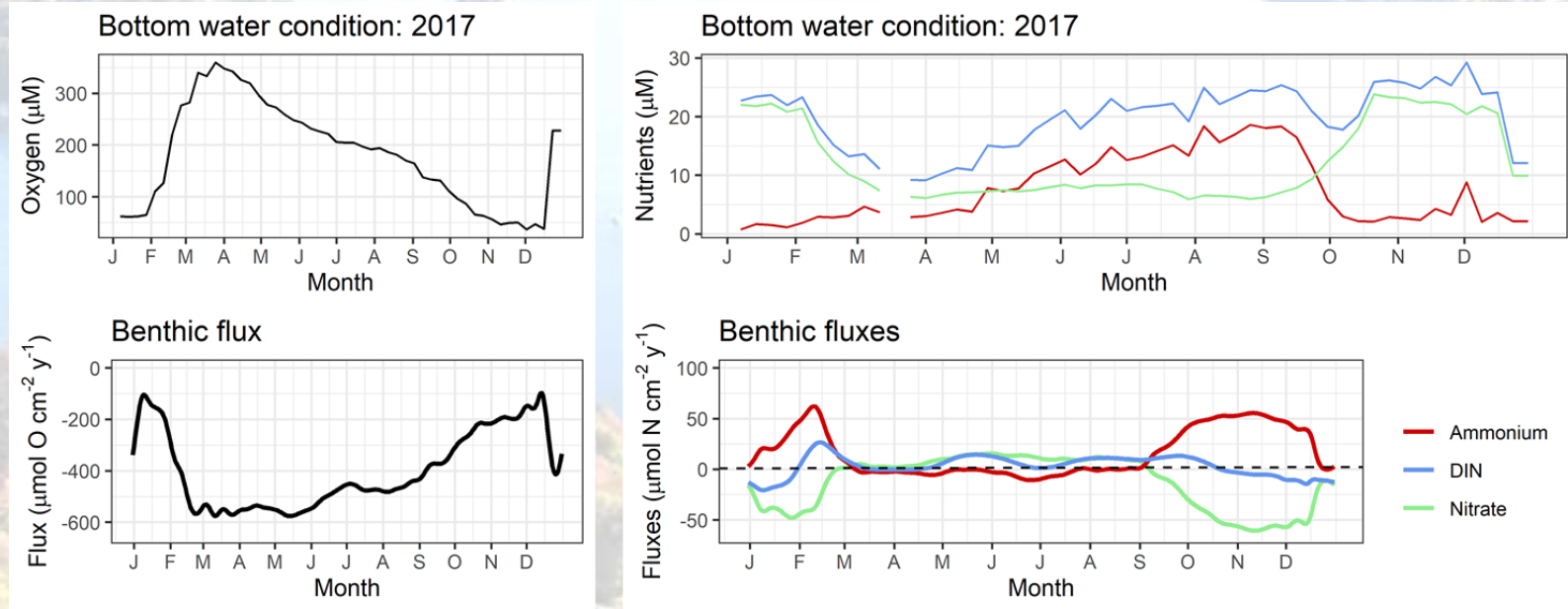


we find that the intrusion events occurred of a timescale of hours and resulted in sharp changes in temperature, salinity, and oxygen. The intruded water contains low DIN thus lowers ammonium and nitrate too.

Let's now consider a year with intrusion and see how benthic fluxes response with sudden change in water condition. Here we first consider 2014, where there was a prominent intrusion in the middle of the year. We applied an optimized reactive transport model to observe the sediment response in 1-day resolution.



Results show oxygen influx ~doubles in immediate response to intrusion. Nutrient flux also shows influence of intrusion however they return to pre-intrusion level in ~2 weeks' time, indicating resilience in sediment whereas oxygen takes longer. Relative comparison with a non-intrusion year (2017) shows no such mid-year change in flux.



To better understand what happens right during intrusion, we need higher temporal resolution data and accompanying model as we have previously seen the events happen in time scale of hours. As next step, we will run the model using the boundary condition provided by the pod typically in per minute resolution. This will give us a window to capture how the benthic processes respond in dynamically changing environment and give insights into mechanistic understanding of diagenetic processes.