Global Biogeochemical Cycles

Supporting Information for

# Dissolved Nitrogen Cycling in The Eastern Canadian Arctic Archipelago from Stable Isotopic Data

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## Contents of this file

Text S1 to S2
Figures S1 to S4

## Introduction

The following is a description of the parameters used in our simple steady-state isotopic model for $NO_3^-$ cycling in rivers in the study area. This model is used to qualitatively evaluate if the observed Δ(15-18) of $NO_3^-$ can be reproduced by considering different dissolved $NO_3^-$ sources (nitrification and atmospheric depositions) in glacial rivers. Subsequently, we provide figures of surface salinity and $\delta^{18}O$ of water in the study area, and nitrate depth profiles. Description of River Isotopic $NO_3^-$ model.

## Definition of terms

$a$ = nitrified $NO_3^-$ (from permafrost or atmospheric $NH_4^+$)
$b$ = atmospheric $NO_3^-$ (from glacial snow melt)
$d$ = assimilation of $NO_3^-$
$e$ = recycled production of $NO_3^-$
$\delta^{15}N_{nit}$ = $\delta^{15}N$ of $NO_3^-$ produced during complete nitrification of permafrost or atmospherically derived ammonium, average of 1.22‰ (range: -6 to 10‰; Arendt et al. 2016; Heikoop et al. 2016)
$\delta^{18}O_{nit}$= $\delta^{18}O$ of $NO_3^-$ produced though nitrification of ammonium, average of -14.21‰ (range: -19.51 to -8.9‰; assuming $\delta^{18}O$ DO of 23.5-24.2‰ (Kiddon et al., 1993; Wang & Veizer, 2000; Horibe et al., 1973 as in Wynn et al., 2007) and $\delta^{18}O$ $H_2O$ of -12 to -22‰ (Arendt et al. 2016, Wynn et al., 2007))
$\delta^{15}N_{atm}$ = $\delta^{15}N$ of $NO_3^-$ from atmospheric deposition, -3.54‰ (-8.72-1.40; Ansari et al., 2013; Hastings et al., 2003; Heikoop et al., 2015; Louiseize et al., 2014)
$\delta^{18}O_{atm}$ = $\delta^{18}O$ of $NO_3^-$ from atmospheric deposition, 72.07‰ (60.30-80.20; Ansari et al., 2013; Hastings et al., 2003; Heikoop et al., 2015; Louiseize et al., 2014)
$\varepsilon_{as}^{15}$ = isotope effect of $NO_3^-$ assimilation on N (5‰; Altabet, 2001)

$\varepsilon_{as}^{18}$ = isotope effect of $NO_3^-$ assimilation on O (5.9‰; Rafter & Sigman, 2015)
$\delta^{15}N_{re}$ = $\delta^{15}N$ of $NO_3^-$ from recycled production
$\delta^{18}O_{re}$ = $\delta^{18}O$ of $NO_3^-$ from recycled production average of -14.21‰ (range: -19.51 to -8.9‰; assuming $\delta^{18}O$ DO of 23.5 to 24.2‰ (Kiddon et al., 1993; Wang & Veizer, 2000; Horibe et al., 1973 as in Wynn et al., 2007) and $\delta^{18}O$ $H_2O$ of -12 to -22‰ (Arendt et al. 2016, Wynn et al., 2007))
$\delta^{15}N_{as}$ = $\delta^{15}N_{box}$ - $\varepsilon_{as}^{15}$ = $\delta^{15}N$ of $NO_3^-$ assimilated
$\delta^{15}N_{box}$ = model output of $\delta^{15}N$ of $NO_3^-$ in the river

**Model Conditions**

- Nitrified $NO_3^-$ is a source
- Atmospheric $NO_3^-$ is a source
- $NO_3^-$ assimilation is a sink
- Recycled production accounts for 50% or 25% of supplied $NO_3^-$
- No denitrification

For $\delta^{15}N$

$$\delta^{15}N_{box} = a \times \delta^{15}N_{nit} + b \times \delta^{15}N_{atm} - [(d - e) \times (\delta^{15}N_{box} - \varepsilon_{as}^{15})]$$

This can be arranged to

$$\delta^{15}N_{box} = \frac{a \times \delta^{15}N_{nit} + b \times \delta^{15}N_{atm} + [(d - e) \times \varepsilon_{as}^{15}]}{(1 + d - e)}$$

For $\delta^{18}O$

$$\delta^{18}O_{box} = a \times \delta^{18}O_{nit} + b \times \delta^{18}O_{atm} - [d \times (\delta^{18}O_{box} - \varepsilon_{as}^{18})] + e \times \delta^{18}O_{re}$$

This can be arranged to

$$\delta^{18}O_{box} = \frac{a \times \delta^{18}O_{nit} + b \times \delta^{18}O_{atm} + d \times \varepsilon_{as}^{18} + e \times \delta^{18}O_{re}}{(1 + d)}$$

The Δ(15,18) is calculated according to Rafter and Sigman (2016):

$$\Delta(15,18) = \delta^{15}N - \delta^{18}O$$

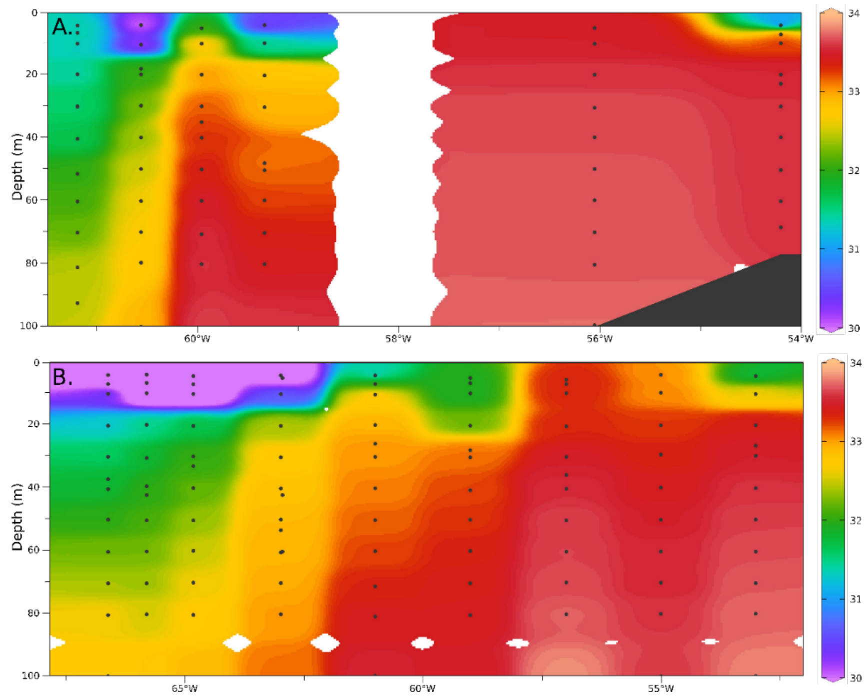


**Figure S1:** Salinity cross sections of A. Transect 1 and B. Transect 2

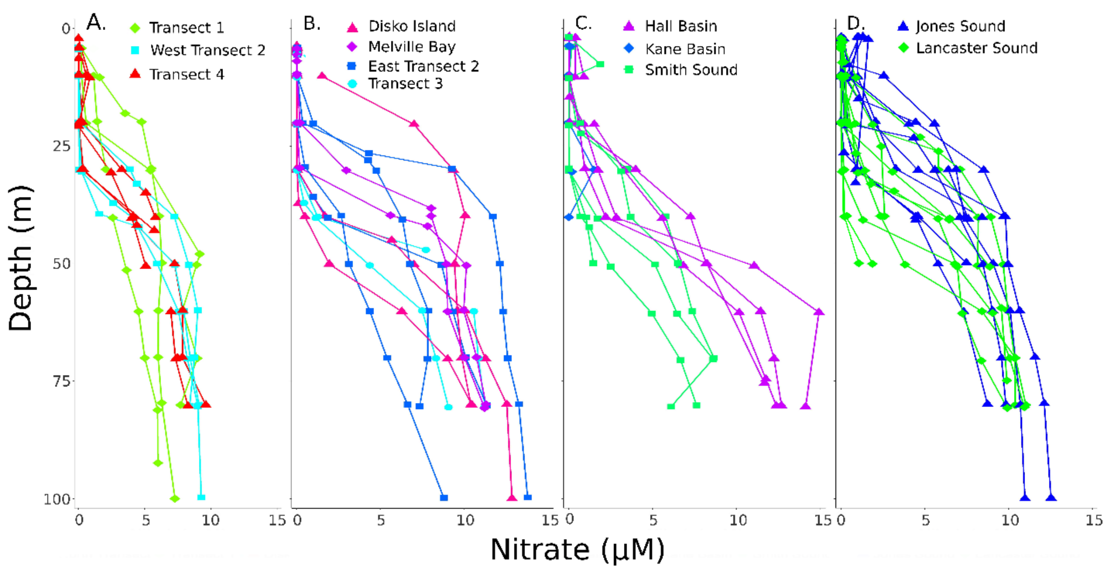


**Figure S2:** Nitrate depth profiles for A. Western Baffin Bay B. Eastern Baffin Bay C. Nares Strait and D. Jones and Lancaster Sounds

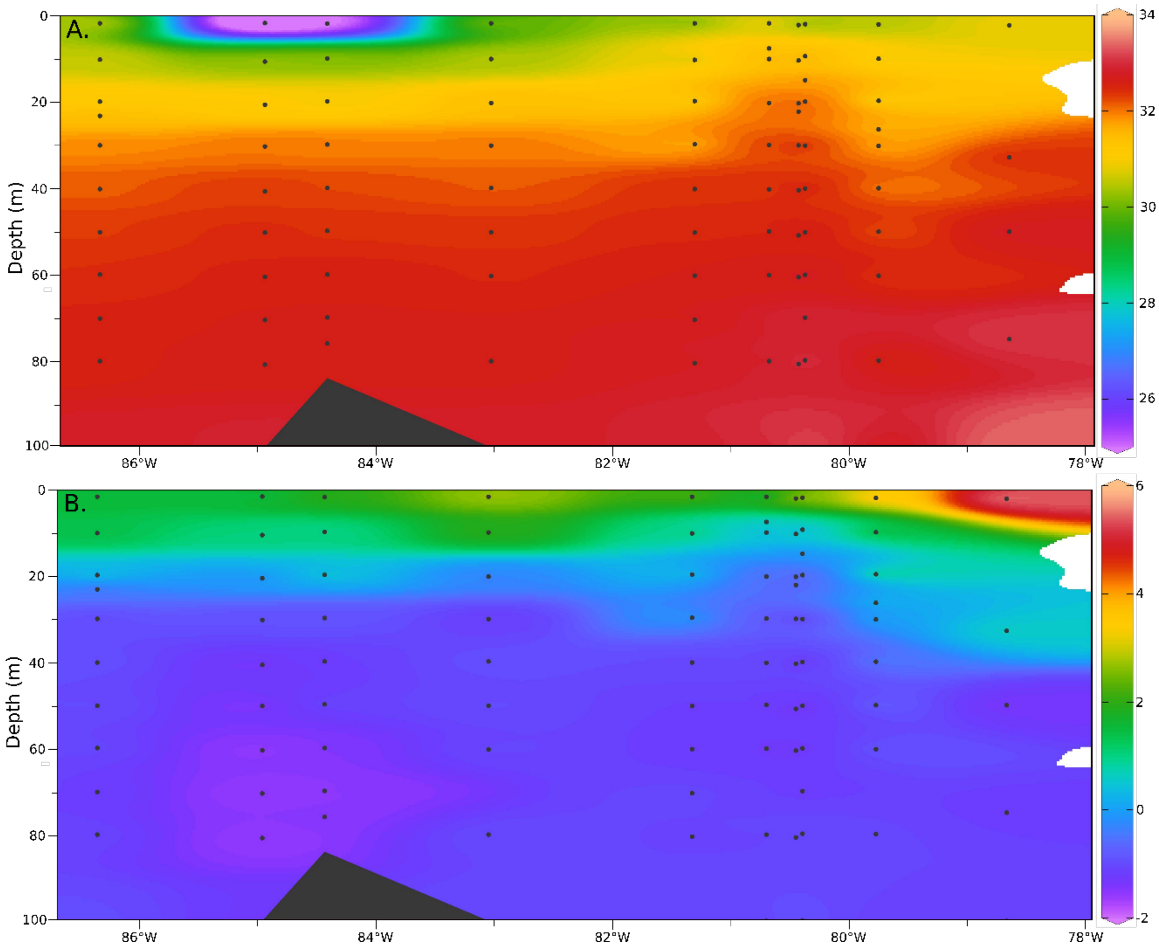

**Figure S3:** Jones Sound Salinity (A) and Temperature (B) Cross Section.

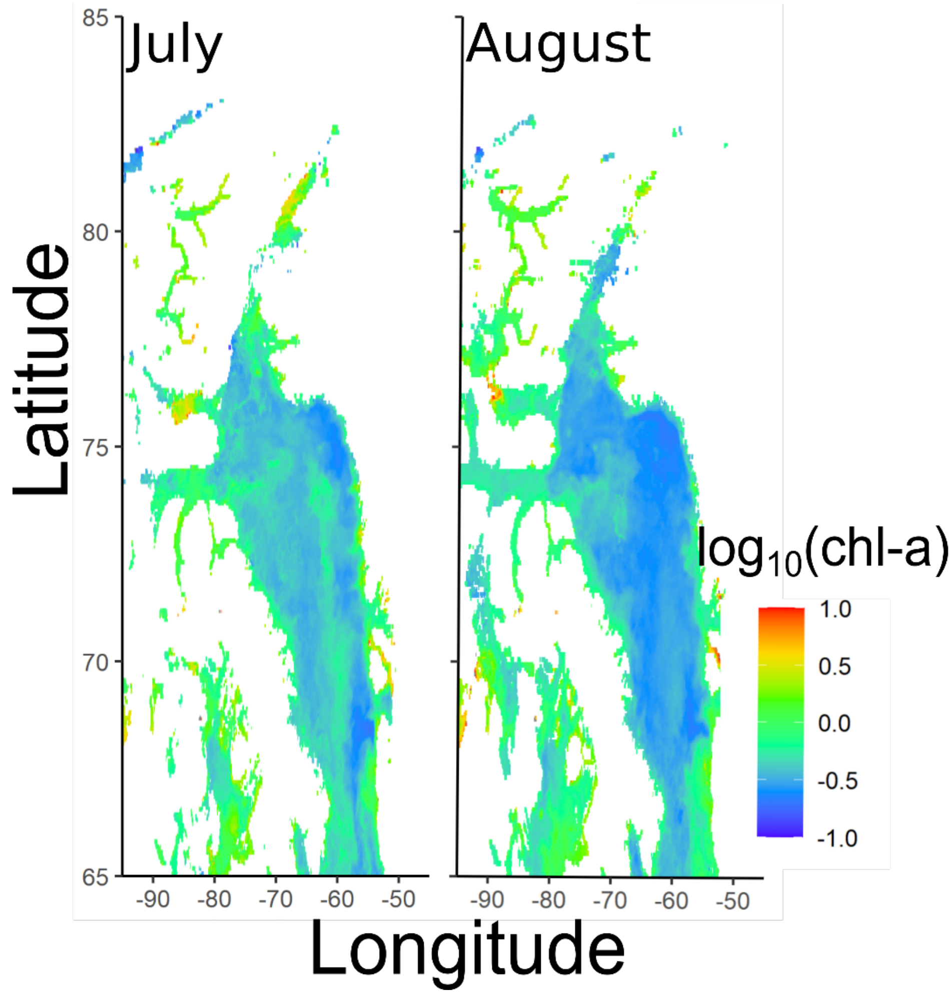


**Figure S4:** Chlorophyll-a in the study region via satellite observations