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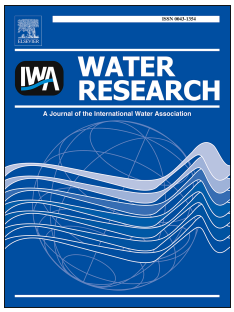

Nitrogen sources and cycling revealed by dual isotopes of nitrate in a complex urbanized environment

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Seawater Sample

Plot Salinity vs. NO_3^- concentration

Does it follow conservative mixing?

Yes

Plot Salinity vs. $\delta^{15}N$, $\delta^{18}O$

Does it follow conservative mixing?

Yes

Identify putative end members

This is rare for a real life scenario

Apply simple linear mixing model to determine relative contribution of sources

No

Plot $\delta^{15}N$ vs. $\delta^{18}O$

N:O isotope effect = 1:1?

Yes

Fits with algal NO_3^- assimilation/ denitrification

Is DO < 2mg/L?

Yes

Denitrification is a significant contributor

No

Determine isotope enrichment factor (ε)

If -0.7‰<ε<-23‰ Assimilation is a significant contributor

No

Refer to Ye et al 2015

No

$N^* = NO_3^- - 16xPO_4^{3-} + 2.9$

dual isotopes vs. $1/NO_3^-$

dual isotopes vs. $\ln(NO_3^-)$

Refer to Kendall et al 2007

If N* > 0; denitrification
If N* < 0; N2 fixation and/or nitrification

Straight line = denitrification
Curve = mixing of two sources

Straight line = mixing of two sources
Curve = denitrification

No

Sigman et al 2005

Δ(15,18)

Casciotti et al 2009

$\Delta\delta^{15}N = \delta^{15}N_{NO3^-} - \delta^{15}N_{NO2^-}$

Δ minimum = N2 fixation and/or nitrification

Quantify N2 fixation/ denitrification ratio

Δδ15N > 0; NO_2^- reoxidation
Δδ15N < 0; NO_2^- reduction (denitrification or anammox)

After consideration of all biogeochemical processes, proceed to identify putative end members that can influence the isotope value by mixing

Philips & Gregg 2001