Supplement of Biogeosciences, 19, 5879–5891, 2022
https://doi.org/10.5194/bg-19-5879-2022-supplement

Biogeosciences Open Access EGU

Supplement of

Nitrogen isotopes reveal a particulate-matter-driven biogeochemical reactor in a temperate estuary

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Mass balance calculations. To investigate nitrogen cycling in detail, we used an isotope mass balance approach. Each point of measurements along the Elbe River is conceptualized as representing the homogenous composition of a parcel of water, with the sampling location as the center of the parcel. Considering four pools of N (PON, NO3-, NO2-, NH4+), we calculate the total N (TN) pool (omitting DON) as:

$$[TN] = [PON] + [NO3-] + [NO2-] + [NH4+] \quad \text{Eq. S1}$$

The mass weighted isotopic composition of total nitrogen (TN) is computed as:

$$\delta^{15}N_{TN} = [\delta^{15}N_{NO3} * [NO_3^-] + \delta^{15}N_{NH4} * [NH_4^+] + \delta^{15}N_{NO2} * [NO_2^-] + \delta^{15}N_{PN} * [PN]] / [[NO_3^-] + [NH_4^+] + [NO_2^-] + [PN]] \quad \text{Eq. S2}$$

We use this isotope mass balance calculation to examine downstream changes to total N and explore biogeochemical explanations for regions where observations are in violation of isotope mass balance.

Table S1. Suspended matter characteristics in the Elbe Estuary. n.a. – not analysed

Stream km	suspended matter [mg L^{-1}]	Chlorophyll [ng L^{-1}]	C/N ratio	PN [µM L^{-1}]	$\delta^{15}N_{SPM}$
610	43.1	24.2	6.7	94.2	6.3
614	53.8	22.5	6.7	93.6	6.0
618	34.8	15.3	6.6	69.3	4.3
620	27.6	10.3	6.6	55.5	5.4
623	29.3	8.5	7.1	45.5	4.9
626	18.0	6.2	6.8	33.2	4.9
628	19.3	6.1	7.0	31.8	5.0
630	23.4	5.4	7.8	35.1	5.4
632	20.3	4.6	7.7	27.3	5.6
635	25.3	4.7	7.8	29.2	6.4
639	60.7	6.7	7.7	63.6	7.6
641	50.3	7.9	7.5	59.2	8.1
645	32.3	8.7	7.0	42.4	9.3
648	36.3	11.4	6.7	42.1	10.4
652	21.9	8.5	6.9	26.8	10.5
656	20.7	5.0	7.9	21.0	10.4
661	29.4	4.7	8.4	25.1	10.2
665	28.7	4.3	9.4	19.0	n.a.
669	49.1	5.2	9.5	34.7	9.6
671	69.2	4.9	9.8	47.9	9.2
678	35.8	5.2	8.2	36.7	9.8
682	49.5	5.6	9.5	29.8	9.9
683	39.9	4.6	9.6	27.8	9.7
689	44.1	4.6	9.5	30.7	9.0