Schulz et al., 2023 conducted underway surface measurements of N2O concentration in the Elbe estuary on 9 cruises across spring, summer and winter. They showed a large spatial variation of N2O concentration and flux, and identified two hotspots of N2O production including the Port of Hamburg and region near the estuarine turbidity maximum. They argued that there is not much seasonal variation in N2O flux because high riverine N2O concentration in winter may compensate for its low biological N2O production compared to summer. This manuscript presents a valuable dataset of N2O concentration and flux from a European estuary. Especially, the seasonal pattern of estuarine N2O flux has been poorly observed and understood. However, there are some points needed to be considered/corrected such as the interpretation of the relationship between excess N2O and AOU, evaluation of environmental controls on N2O concentration/flux, calculation of annual N2O flux and uncertainty estimate. See detailed comments below.

Line 17-18: what do you mean by "compensated the effect of decreasing dissolved inorganic nitrogen (DIN) loads"?

Line 25: How does 0.24±0.06 Gg N2O y-1 emission compare to global estuarine N2O emission?

Lines 40-42: Denitrification could also occur in anoxic water column contributing to N2O production (Ji et al., 2018; Tang et al., 2022).

Line 44: specify Port Hamburg as the third largest port in Europe.

Line 70: how deep is the Elbe estuary? This gives an idea if sedimentary processes (e.g., N2O production) may affect N2O concentration in the surface water column.

Figure 1: There are too many city names on the map, which is distractive. It may be clearer to label only the key cities like Cuxhaven or island Scharhorn where the Elbe River enters the North Sea or Oortkaten.

Lines 85-87: Why transect sampling was performed after high tides? What's the effect of tides on N2O concentration? Tidal cycles of N2O concentration have been observed in other estuaries (Goncalves et al., 2015; Barnes et al., 2006).

Line 116 in Equation 1: is N2Ocw the partial pressure of N2O in water? Otherwise, the saturation should be calculated as the $\frac{N2Ocw}{N2Oeq}$*100 where N2Oeq is the equilibrated N2O concentration with atmosphere. Similarly in Equation 3. N2Oair should be N2Oeq.

Line 143: Why nitrate concentration increased at 700 km? Are there tributaries or point sources?

Lines 148-149: Why ammonium and nitrite concentration increased near Hamburg Port? Is it due to internal organic matter remineralization or point sources or sedimentary flux?

Figure 2: It is hard to tell the difference among each cruise with so many colored lines. How about presenting data from the same season using the same color to illustrate the seasonality as a supplementary figure?

Lines 211-218 and lines 232-234: Figure 4 a and b are both from June, summer. The linear positive relationship between AOU and excess N2O suggests N2O production from nitrification (e.g., Nevison et al., 2003). The increase in the slope should be interpreted as an increase in the N2O production yield or external N2O input (e.g., point source).

Figure 4: It would be interesting to systematically/statistically assess the relations between excess N2O and environmental factors like salinity (non-conservative behavior of N2O) or dissolved inorganic nitrogen (infer N2O production pathways), PN, PC, and SPM. There seems to be a good relation between N2O and ammonium/nitrite concentration shown in Figure 2.

Lines 242-243 and Figure 5: What about the variations of the N2O%, oxygen and total nitrogen concentration? The riverine N concentration is decreasing, what about the changes in other point sources of N input along the estuary (e.g., from wastewater treatment plants) or concentration in the estuary?

Line 272: “this suggests”

Line 273: how is MTZ defined? What threshold of suspended particle material is used to define the MTZ?

Line 287 and 296-297: clarify the reference: Kappenberg and Fanger, 2007 (German?) and source of organic matter from the North Sea into the Elbe estuary.

Lines 311-313: How about showing the relations between ammonium, nitrite and N2O in figures?

Line 315: What are R values? R is positive for nitrite concentration.

Line 320-321: Is nitrification responsible for the remaining oxygen consumption?

Line 326 and Figure S1: why C/N ratio was so high in 2021 March?

Line 345-347: “Ammonium and N2O concentrations are high in the pore water of underlying sediments”. Reference or example of the concentration. What about the timing of deepening and dredging works in the Hamburg Port compared to the cruise periods?

Lines 360-361: Has there been any N2O measurement from this wastewater treatment plant (WWTP) Köhlbrandhöft? The ammonium concentration in 2021/03 is not exceptionally high compared to previous cruises (e.g., 2020/06). What about the direct N2O output from the wastewater treatment plant?

Figure 7. Use month or season as the x axis instead of cruise number? Add description of the boxplot. Why not adding error bars for emissions?

Table 3. How is annual N2O emission calculated? Since there is a seasonal variation in the N2O flux, monthly or seasonal N2O emission may be more representative. Because N2O flux was measured at a high spatial resolution, it may be useful to calculate the N2O flux across the whole estuary by integrating the flux and area section by section (e.g., River section, Hamburg port, Oligohaline section) instead of multiplying the average N2O flux by the whole area of Elbe estuary.

Line 406: Why do you think there is no seasonality in N2O emission? N2O flux is different comparing spring, summer and winter shown in Table 3.

References:

Barnes, J., Ramesh, R., Purvaja, R., Nirmal Rajkumar, A., Senthil Kumar, B., Krithika, K., ... & Upstill-Goddard, R. (2006). Tidal dynamics and rainfall control N2O and CH4 emissions from a pristine mangrove creek. *Geophysical Research Letters*, *33*(15).

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Ji, Q., Frey, C., Sun, X., Jackson, M., Lee, Y. S., Jayakumar, A., ... & Ward, B. B. (2018). Nitrogen and oxygen availabilities control water column nitrous oxide production during seasonal anoxia in the Chesapeake Bay. *Biogeosciences*, *15*(20), 6127-6138.

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