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Editorial: Nitrous oxide production processes and associated mechanisms in estuarine and coastal ecosystems

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Editorial on the Research Topic
Nitrous oxide production processes and associated mechanisms in estuarine and coastal ecosystems

Anthropogenic activities have doubled the nitrogen loading, resulting in high nitrous oxide (N_2O) emissions (Murray et al., 2015). The atmospheric N_2O concentrations increased significantly at a rate of roughly 0.8 ppb yr^{-1} (IPCC, 2014). N_2O is a major substance depleting the stratospheric ozone layer. Increasing concerns have been raised regarding the N_2O production. Recently, critical N_2O emissions have been found in five subtropical estuaries located in southeast China (Li et al., 2022), the Pearl River Estuary (Tan et al., 2019; Xiang et al., 2023) and the Chesapeake Bay (Tang et al., 2022). Different pathways responsible for N_2O production (Li et al., 2023) and related microbial communities (Hu et al., 2023) have been also investigated. Still, microbial mechanisms of N_2O production and associated responses to environmental changes remain largely unknown.

Four articles in this Research Topic have reported interdisciplinary approaches (including isotopic tracing and molecular biology methods), seasonal investigations and historical data to investigated the mechanisms of N_2O production in oceans, river network, aquaculture systems and blue mussel. The summaries are listed below.

Heo et al. investigated the distribution, production and control mechanism of N_2O in the Subtropical Western North Pacific Ocean (STWNPO). Results showed that the STWNPO was the main source of atmospheric N_2O with average air-sea flux of 2.0 ± 0.3 mmol m^{-2} d^{-1}. The relationship between N_2O and apparent oxygen utilization and nitrate in different water layers indicated that N_2O was mainly produced from nitrification and denitrification. This study highlighted the overall N_2O dynamics in understanding STWNPO and provided an important basis for further exploration of the relationship between environmental factors and N_2O dynamics.

Wang et al. summarized the N_2O emission data of the Changjiang River network (CRN) from 1986 to 2014 throughout the main area of this basin, emphasizing the control of N_2O emissions by basin-scale. The N_2O emission rates and flow rates of the headwater stream were higher than that of the mainstem and the estuary, indicating that the headwater stream was the hotspot of N_2O emission in the whole aquatic continuum. The N_2O discharge rate is negatively correlated with the Strahler river order and positively correlated with the nitrogen loading, suggesting that increased nitrogen loading induced by human activities would affect nitrogen cycling in CRN. This study provided a systematic analysis for the N_2O budget source of large river networks in the world.

Niu et al. reported the microbial nitrogen cycling process in the zero-water exchange aquaculture system. The nitrification and denitrification rates varied from 149.77 to 1024.44 ng N g^{-1} h^{-1} and from 48.32 to 145.01 ng N g^{-1} h^{-1}, respectively, indicating that the zero-water exchange pond had great potential nitrification and denitrification performance. Furthermore, the gene abundance of denitrifiers was higher than nitrifiers, which suggested that denitrification process was the main driver of nitrogen removal. In addition, *Bacillus, Flavobacteria* and *Shewanella* were the key nitrogen removal bacteria in the zero-water exchange pond, and their microbial communities were positively correlated with ammonia and nitrate concentrations. This study contributes to a better understanding of the relationship of nitrogen removal and microbial communities in zero-water exchange ponds.

Voet et al. quantified the contribution of blue mussel and its shell biofilm to marine N_2O production by cultivating blue mussels and ^{15}N isotopic tracing. Net $^{45}N_2O$ and $^{46}N_2O$ were both detected in the blue mussel and its shell membrane after incubation with ^{15}N tracer. Nitrifier denitrification was the main pathway of N_2O production of blue mussel and its shell biofilm. Closed-core incubation experiments showed that warmer condition would increase the N_2O production of blue mussel and the shell biofilm. In contrast, the N_2O production rate decreased under acidification conditions. This study refined the role of animal-related nitrogen cycling and climate change in the region where blue mussels are increasing.

Overall, this Research Topic brings progress, datasets, as well as novel methodologies for understanding N_2O production processes and associated mechanisms in estuarine and coastal ecosystems.

Author contributions

JW: Writing – original draft, Writing – review & editing. XL: Conceptualization, Writing – original draft, Writing – review & editing. XZ: Conceptualization, Writing – review & editing. WW: Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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