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Ecosystem Functions
Marine- & Freshwater Solutions

Benthic nitrous oxide cycling in a changing coastal sea

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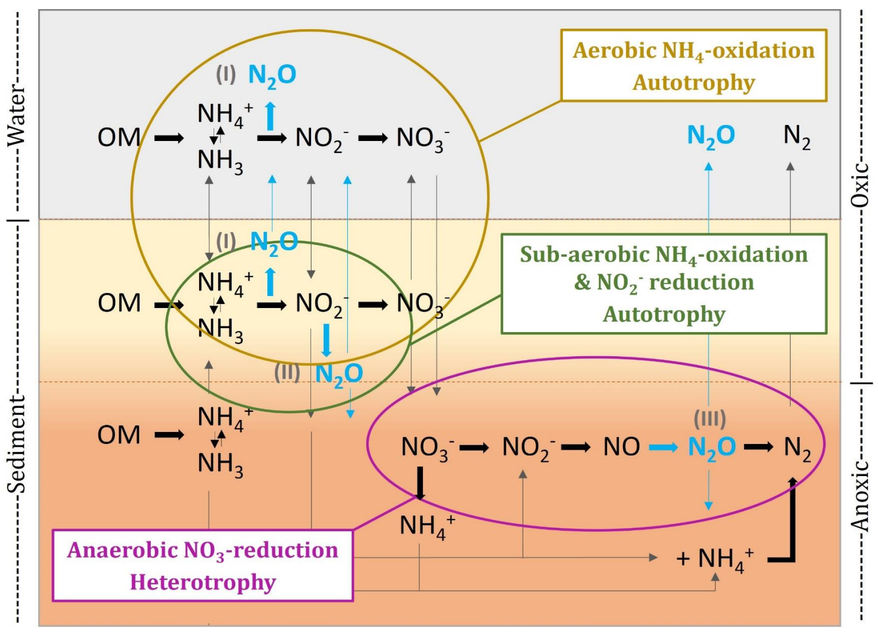
2022-2025; incld. Hermann Bange (GEOMAR), Robinson Fulweiler (BU), Kirsten S. Jørgensen (SYKE), Aleksandra Lewandowska (HU), Mikko Kiljunen (JYU), Bärbel Mueller-Karulis (SU), Kristian Spilling (SYKE), Xiaole Sun (CAS)

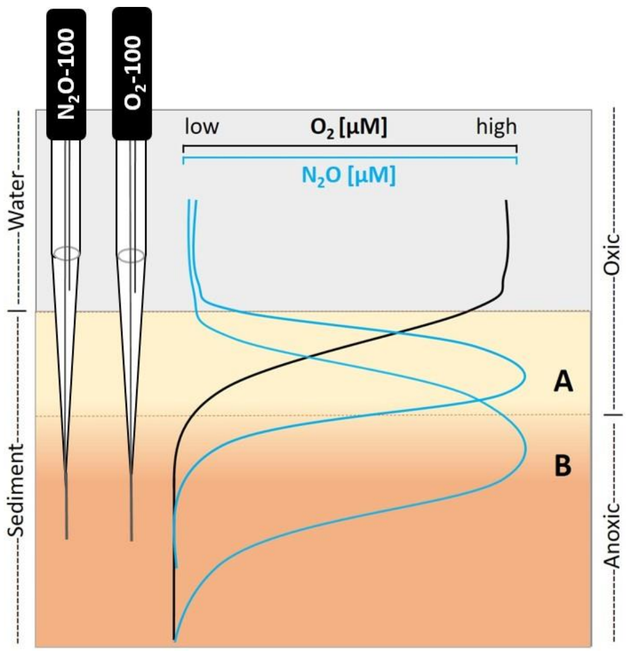
Motivation

Nitrous oxide (N_20) is a powerful greenhouse gas, that, beyond its anthropogenic sources, is naturally produced (and partly consumed) by the microbial processes nitrification (**I**; by-product), nitrifier denitrification (**II**; end-product), and denitrification (**III**; intermediate).

Coastal sediments, being rich in organic matter and nutrients, contribute considerably to marine N_2O cycling, but the significance of each microbial process is uncertain due to methodological constrains.

This prevents assessing present and future coastal N_2O dynamics, as the microbial processes involved are assumed to respond differently to changes in environmental conditions based on their specific metabolism.





Aim and Approach

Disentangling the different microbial processes adding to net benthic N_2O production
(i) under present and future eutrophication status and water temperature
(ii) over seasonal changes in environmental conditions
to gain better mechanistic knowledge and (iii) improve predictions for future net N_2O production in coastal sediments of the northern Baltic Sea.

Micro-sensors + microbial functional gene expressions (adapted from *Meyer et al. 2008*)

(A) N_2O peak in oxic sediment layer: aerobic NH_4-oxidation (Σ nitrifi. + nitrifier deni.)
Functional genes: *amoA* (nitrification), *nirK* (nitrifier denitrification)

(B) N_2O peak in anoxic sediment layer: anaerobic NO_3-reduction (denitrification)
Functional genes: *cnorB* (deni.: N_2O production), *nosZ I* (deni.: N_2O consumption)

Implementation

Benthic mesocosm experiment (aim i)
Sediment boxes from Tvärminne archipelago, northern Gulf of Finland, treated for 10d (n=6) and 20d (n=6) with temperature (*in situ*, +2°C, +4°C; *HELCOM & Baltic Earth 2021*) and organic matter (*in situ*, +algae).

Seasonal fieldwork (aim ii)
Sediment sampling in the Tvärminne archipelago (same site and parameters as experiment) every 5 weeks over 1 year. Additionally: N_2O sediment-water fluxes and N_2O water column concentrations.

Modelling (aim iii)
Microbial reactive transport model fed with all obtained project data.

Parameters taken to better understand benthic N_2O dynamics
Microprofiles (N_2O, O_2, pH, H_2S), sediment DNA+RNA, porewater constituents (NH_4^+, NO_3^-, DOC, DOM), sediment Chl a, POC/N, TOC, and porosity, bottom water nutrients and oxygen. Only experiment: N_2O production in denitrification measured with IPT (method comparison).

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