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TITLE: Marine N₂O Emissions From Nitrification and Denitrification Constrained by Modern Observations and Projected in Multimillennial Global Warming Simulations

AUTHOR: ['Gianna Battaglia', 'Fortunat Joos']

ABSTRACT:

Nitrous oxide (N 2 O) is a potent greenhouse gas (GHG) and ozone destructing agent; yet global estimates of N 2 O emissions are uncertain. Marine N 2 O stems from nitrification and denitrification processes which depend on organic matter cycling and dissolved oxygen (O 2). We introduce N 2 O as an obligate intermediate product of denitrification and as an O 2 ?dependent by?product from nitrification in the Bern3D ocean model. A large model ensemble is used to probabilistically constrain modern and to project marine N 2 O production for a low (Representative Concentration Pathway (RCP)2.6) and high GHG (RCP8.5) scenario extended to A.D. 10,000. Water column N 2 O and surface ocean partial pressure N 2 O data serve as constraints in this Bayesian framework. The constrained median for modern N 2 O production is 4.5 (±1 ? range: 3.0 to 6.1) Tg N yr ?1 , where 4.5% stems from denitrification. Modeled denitrification is 65.1 (40.9 to 91.6) Tg N yr ?1 , well within current estimates. For high GHG forcing, N 2 O production decreases by 7.7% over this century due to decreasing organic matter export and remineralization. Thereafter, production increases slowly by 21% due to widespread deoxygenation and high remineralization. Deoxygenation peaks in two millennia, and the global O 2 inventory is reduced by a factor of 2 compared to today. Net denitrification is responsible for 7.8% of the long?term increase in N 2 O production. On millennial timescales, marine N 2 O emissions constitute a small, positive feedback to climate change. Our simulations reveal tight coupling between the marine carbon cycle, O 2 , N 2 O, and climate.

SOURCE: Global biogeochemical cycles

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