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Different response of nitrifiers and denitrifiers to re-wetting shape the NO release from soils in laboratory incubation experiments

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Laboratory incubation studies incubating soils at a wide range of soil moistures, soil temperatures and mixing ratios of NO in the headspace and inorganic nutrient contents (NH4+,NO_3-, NO_2-) showed that release rates of NO follow an exponential function with increasing soil temperature and an optimum function for soil moisture. This approach assumes that environmental factors play the dominant role in shaping an ecosystem and thereby microbial communities and control the NO release from soil. We determined the NO release rate for a dryland farming soil under flooding irrigation in Xinjiang, China, a mid-latitude agricultural soil (Mainz, Germany), and a rice paddy (Ambai, India) upon wetting and subsequent drying out of soils. Only the release rate for the mid-latitude agricultural soil followed an optimum function for soil moisture. Release rates for the dryland farming soil and rice paddy, however, followed a two maxima function with distinct maxima at higher and lower soil moisture. Acknowledgement of two distinct maxima is critical for more accurately assessing regional biogenic NO emissions of soils under field conditions. To analyse the response of nitrifiers and denitrifiers involved in NO turnover in more detail we linked molecular analysis of functional gene expression (nirK and nirS, bacterial and archaeal amoA) and microbial community composition to NO release rates. We could show that the maximal transcriptional activity of denitrifiers and ammonia oxidizers differs with soil moisture and that higher transcriptional activity of nirS-type denitrifiers at higher soil moisture and of archaeal ammonia oxidizers at lower soil moisture may explain the two maxima for NO release.