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# Biogeochemical and Microbial Impacts of Simulated Atmospheric Nitrogen Wet Deposition in Chinese Coastal Waters

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Atmospheric deposition is an important source of nutrients to surface ocean and can alter marine phytoplankton production and nitrogen (N) cycle. The oligotrophic South China Sea (SCS) is particularly vulnerable to high anthropogenic N deposition, yet its impact on nutrient cycling and plankton community structure in the SCS remain poorly constrained. Here, 27 groups of microcosm experiment in the SCS were conducted to quantify the effects of N deposition on nutrient cycling and phytoplankton community changes in August 2024 and February 2025. We simulated the evolution of deposition flux from 1980 to 2030 (predicted) in China by using two $NH_x/NO_y$ ratios (4.8 and 0.5) . Results showed an immediate and transient response of dissolved ammonium and nitrate concentrations within one hour of N addition, suggesting a rapid saturation of initial uptake pathways. Following this initial pulse, different N species drove distinct ecological outcomes over the 6-day incubation. We observed rapid silicate consumption and *Synechococcus* growth in microcosms exposed to the historical high-ammonium ratio (4.8), suggesting a strong affinity for ammonium. In contrast, simulating future deposition dominated by nitrate (ratio 0.5) showed a 15.3-fold increase in maximum Chl-a relative to controls. This biomass surge was driven by a fundamental community restructuring where photosynthetic picoeukaryotes dominated, indicating their competitive advantage in the SCS pelagic system. Across treatments, N-addition increased N:P and was accompanied by rapid phosphate turnover, consistent with emerging P stress under N repletion. These multi-timescale results, from the hourly nutrient spike to the week-long community shift, highlighted the complex and rapid way the SCS ecosystem responds to changes in atmospheric N inputs. Hence, our results suggest that the ongoing shift in N deposition pattern in China is predicted to alter the mechanisms of biologically available N in SCS, with major implications for coastal nutrient stoichiometry and phytoplankton community composition.