Significant decrease in nitrification rates by Arctic environment changes

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Nitrification is the process by which ammonia is converted to nitrite and then to nitrate by specialized prokaryotic microorganisms, and plays a central role on nitrogen cycling. Some studies using isolated cultures or in the other ocean show that nitrification is susceptible to the change of light and pH. The Arctic Ocean is experiencing rapid environment changes, typically sea ice reduction, which alters light and pH environments in the water column. Hence, recent Arctic environment change could impact on nitrification, but the sensitivity of nitrification against light and pH has not been clarified in the Arctic Ocean. We performed light and pH control experiments and field observation in the Chukchi and Beaufort Sea, western Arctic Ocean in late summer. The light control experiments showed that nitrification was inhibited by light intensity above 0.11 mol photons m^{-2} d^{-1}. In the pH control experiments, nitrification rates significantly declined when pH became 0.23 lower than the controls. Field observation showed that maximum nitrification rate in the Chukchi shelf region occurring near bottom (<60 m) was significantly lower than the maximum at 200 m in the Beaufort Sea, suggesting that nitrification was suppressed in the shelf region. Ammonium concentration in the near bottom water was very high (up to 11.6 μM), and thus, substrate unlikely limit nitrification. The bottom light intensity was higher than 0.11 mol photons m^{-2} d^{-1} at the most of shelf stations. Therefore, light could limit nitrification throughout the water column in the shelf region. The pH value near the seafloor was 0.21–0.44 lower than the surface water, indicating that nitrification would also be limited by the low pH. Our experiments clearly demonstrated that Arctic nitrification is affected by light and pH. These results suggested that recent Arctic changes could decrease in nitrification rates and thus impact on the nitrogen cycling.

Keywords: nitrification, Arctic Ocean, nitrogen cycling, global warming, ocean acidification

