Nitrous oxide (N\textsubscript{2}O) is a trace gas that contributes to both global warming and stratospheric ozone depletion. Its major sources are nitrification and denitrification by microorganisms in soils and waters. Emission of N\textsubscript{2}O from the ocean to the atmosphere is estimated to take account for 20\% of global N\textsubscript{2}O sources. Based on the distribution of N\textsubscript{2}O dissolved in the surface seawater, most of the emission is considered to occur near the eutrophic, suboxic water mass like eastern tropical Pacific, where N\textsubscript{2}O is produced by denitrification. However, N\textsubscript{2}O concentration shows its maximum in middle layer (600-1000 m) in many sea areas, and the origin of the concentration maximum is not clear. In addition, N\textsubscript{2}O is also supersaturated in deep water and its concentration has been found to be different among sea areas. In this study, we focus attention on isotope ratios of N\textsubscript{2}O (oxygen isotope ratio, delta-\textsuperscript{18}O, difference in abundance of isotopomers \textsuperscript{14}N\textsuperscript{15}N\textsuperscript{16}O and \textsuperscript{15}N\textsuperscript{14}N\textsuperscript{16}O, Site Preference (SP), and average nitrogen isotope ratio, delta-\textsuperscript{15}N) as informative parameters reflecting microbiological metabolisms, and make an analysis of origin of N\textsubscript{2}O in the middle and deep ocean by the use of distribution of isotope ratios as well as concentration.

In addition to published data obtained in the western North Pacific, subtropical North Pacific, eastern tropical North Pacific, eastern subtropical South Pacific, and eastern subtropical Pacific, we obtained depth profiles of N\textsubscript{2}O and its isotope ratios in the Southern Ocean, equatorial Pacific, and North Pacific by analyzing the samples collected in cruises KH01-3, MR02-K06, and MR07-04, respectively. Comparison of the profiles indicated that (1) the dissolved N\textsubscript{2}O concentration reaches its maximum in the layer of sigma-theta = 26.5-27.5, which corresponds to the depth of 100-300 m in the Southern Ocean and equatorial Pacific and 700-1500 m in other regions, and (2) the maximum concentration is about twice and 4-7 times as large as saturation concentration for atmosphere-ocean equilibrium in the southern (Southern Ocean and South Pacific) and other stations, respectively. Isotope ratios at the N\textsubscript{2}O concentration maxima also shows a variation among the ocean areas, but there is no significant relationship between the concentration and isotope ratios. This means that the origin of N\textsubscript{2}O maxima observed in the Pacific is not identical, and in situ production plays more important role than lateral advection or diffusion. Assuming that the N\textsubscript{2}O excess is caused by in situ production, we estimated isotope ratios of the produced N\textsubscript{2}O as 7-11 permil, 50-65 permil, and 18-35 permil for delta-\textsuperscript{15}N, delta-\textsuperscript{18}O, and SP, respectively. The SP value was higher in the northern stations than in the southern stations. On the other hand, average concentration and isotope ratios of N\textsubscript{2}O in the deep layer (below 2000 m) show a significant correlation with the age of the water mass estimated from \textsuperscript{14}C concentration, suggesting that N\textsubscript{2}O is produced during the deep water circulation. Estimated isotope ratios for the N\textsubscript{2}O produced were 10 permil, 62 permil, 29 permil for delta-\textsuperscript{15}N, delta-\textsuperscript{18}O, and SP, respectively.

The estimated delta-\textsuperscript{15}N and SP of N\textsubscript{2}O produced in the middle and the deep layer almost agree with the values of N\textsubscript{2}O produced during nitrification (NH\textsubscript{2}OH oxidation) by ammonia-oxidizing archaea (AOA), which were recently obtained by laboratory incubation experiments. However, the estimated delta-\textsuperscript{18}O value in the middle/deep water is about 20 permil higher than that of AOA-produced N\textsubscript{2}O, and SP of N\textsubscript{2}O in the middle layer shows lower value in some areas. We therefore cannot exclude the contribution from bacterial nitrification and denitrification (nitrite reduction by nitrifier or denitrifier). Further researches on isotopic fractionation during the N\textsubscript{2}O production by AOA is needed with respect to its variation among species and dependence of environmental factors.

Keywords: Nitrous oxide, ocean, stable isotope ratio, nitrification, denitrification, ammonia-oxidizing archaea