

Distributions of methane, nitrous oxide, and their isotopomers in the Arctic Ocean

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Methane (CH₄) and nitrous oxide (N₂O) are increasing greenhouse gases, and N₂O is also the most important ozone-depleting gas in the stratosphere [IPCC, 2013; Ravishankara *et al.*, 2009]. Although the increase of CH₄ and N₂O is mainly caused by anthropogenic emissions such as agriculture and fossil fuel combustion, they are biogenically produced or consumed, and emitted from various sources including oceans. Several studies have reported over-saturation of CH₄ and N₂O with respect to atmospheric equilibrium in the surface water of several regions in the Arctic Ocean [Kitidis *et al.*, 2010 and references therein]. In this study, we aimed to reveal the horizontal and vertical distributions of CH₄ and N₂O in the Bering Strait and the Chukchi Sea and to analyze their production or consumption processes based on relative abundance of isotopomers, isotope-substituted molecules such as ¹³CH₄, CH₃D, ¹⁵NNO, N¹⁵NO, and NN¹⁸O.

Seawater samples were collected at 22 and 14 stations in August-September 2012 and 2013, respectively, during the cruises of R/V Mirai (MR12-E03 and MR13-06) (Figure 1). Surface or 5-m depth water was sampled for CH₄ concentration analysis at all the stations, and samples at several depths and those for N₂O and isotopomer analyses were collected at selected stations. Dissolved CH₄ was determined with GC-FID and dissolved N₂O and its isotopomers were determined with GC-IRMS [Yamagishi *et al.*, 2007].

Concentrations of dissolved CH₄ and N₂O ranged from 0.5 to 48.5 nmol/kg and from 9.3 to 49.0 nmol/kg, respectively, and most of the samples showed oversaturation of these gases with respect to the atmosphere. The highest values were observed near the seafloor at a shallow station in continental shelf (72.7°N, 168.2°W) in 2013. They correspond to 1281% and 306% saturation, respectively, and are as high as ever reported in the Arctic Ocean. Maxima of CH₄ and N₂O were also observed in the surface or subsurface water at deeper stations and they did not always coincide. These results suggest that production of CH₄ and N₂O occurs not only in the sediments but also in the water column. Isotopomer analysis of N₂O indicated that origin of N₂O is different between shallow and deep stations.

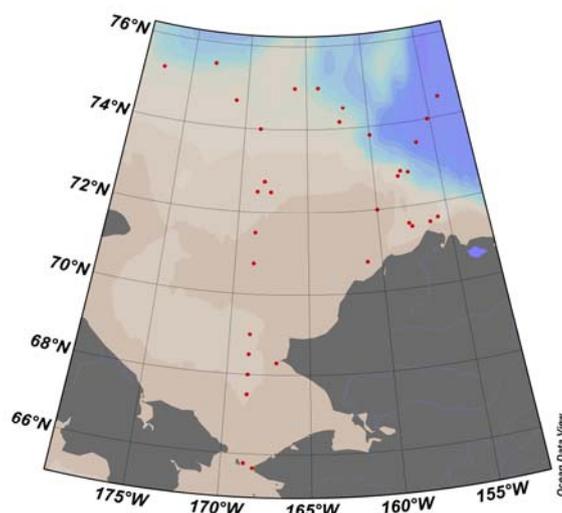


Figure 1. Map of seawater sampling stations in 2012 and 2013.

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