Spacio-temporal distributions of atmospheric nitrous oxide and its isotopocules in the Arctic region

Sakae Toyoda[1], Toshinobu Machida[2], Yasunori Tohjima[2], Shinji Morimoto[3],
Doug Worthy[4], Kentaro Ishijima[5], and Naohiro Yoshida[1]
[1]*Tokyo Institute of Technology*, [2]*National Institute of Environmental Studies*, [3]*Tohoku University*,
[4]*Environment Canada*, [5]*Japan Agency for Marine-Earth Science and Technology*

Nitrous oxide (N_2O) is one of the increasing greenhouse gases in the troposphere and is the most important stratospheric ozone-depleting gas emitted in the 21st century [*IPCC*, 2013; *Ravishankara et al.*, 2009]. In Arctic region, origin of atmospheric N_2O includes human activity in Europe, Russia, and North America (e.g., agriculture), biomass burning (forest fires), oceans in high-latitude northern hemisphere, and future climate change might cause substantial change in such sources. Isotopocule ratios of N_2O, which include not only elemental $^{15}N/^{14}N$ and $^{18}O/^{16}O$ ratios but also site-specific $^{15}N/^{14}N$ ratio in asymmetric NNO molecule, are regarded as useful parameters to infer the origin and production–consumption mechanisms of N_2O, and to estimate its global budget. Previous studies on N_2O trapped in the firn in polar ice sheet revealed the secular trend of isotopocule ratios, but there has been no reports on long-term monitoring of N_2O isotopomer ratios in Arctic atmosphere.

We have been measuring mixing ratio and isotopocule ratios of N_2O at two sites in Arctic region (Figure 1). At Novosibirsk, western Siberia (55°N, 83°E), monthly samples are collected at altitude of 500 m and 7000 m by aircraft, and N_2O isotopocule data has been obtained since 2005. At Churchill, northern Canada (59°N, 94°W), surface air samples are collected biweekly, and N_2O isotopocule analysis has been conducted bimonthly since 2011.

Results show that the bulk nitrogen isotope ratio ($\delta^{15}N^{bulk}$) are decreasing at the similar rate (about -0.04‰ yr^{-1}) as reported by firn-air analysis while the N_2O mixing ratio are increasing (about 0.8 ppbv yr^{-1}). This suggests isotopically light N_2O sources such as agriculture are still contributing to the increase in atmospheric N_2O. However, they also suggests a slight change in isotopic trend recently. Short-term variations, vertical gradient over Novosibirsk, and difference between the two sites will also be discussed along with atmospheric model simulation.

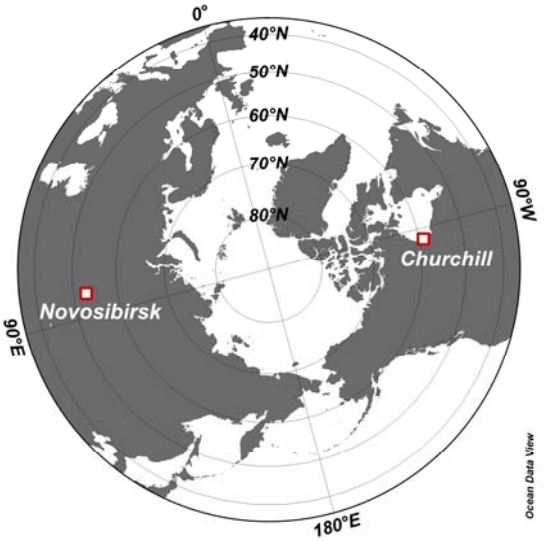

Figure 1. Map of air sampling stations

References

IPCC (2013), Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change 1535 pp., Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

Ravishankara, A. R., J. S. Daniel, and R. W. Portmann (2009), Nitrous oxide (N_2O): The dominant ozone-depleting substance emitted in the 21st century, Science, 326, 123, doi:10.1126/science.1176985.