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Precise observations of the atmospheric O2/N2, Ar/N2 and their stable isotopes for understandings of the climate system

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Precise observations of the atmospheric O2/N2 ratio (delta(O2/N2)) have been developed since early 1990s to elucidate the global CO2 budget (e.g. Manning and Keeling, 2006), which have been noted by the IPCC. The atmospheric Ar/N2 ratio (delta(Ar/N2)) is expected to be one of the promising indicators for the exchange of heat fluxes between atmosphere and ocean (e.g. Blaine, 2005), which may improve the delta(O2/N2)-based estimation of the global CO2 budgets (e.g. Ishidoya et al., 2012a). It has been also reported that the gravitational separation of gas materials in the stratosphere can be detected with the observations of the delta(Ar/N2), the stable isotopic ratios of N2, O2, and Ar, and that the secular trends in the Brewer-Dobson circulation would be detectable by using the observed gravitational separation (Ishidoya et al., 2013). Recently, we have developed an ultra-precision continuous measurement system of the atmospheric delta(O2/N2), delta(Ar/N2), stable isotopic ratios of N2, O2 and Ar, using a mass spectrometer at the AIST and are applying it to the following studies;

1. Continuous observations of the atmospheric delta(O2/N2), delta(Ar/N2), CO2 concentration, stable isotopic ratios of N2, O2 and Ar at Tsukuba, Japan.
2. Analyses of the delta(O2/N2), delta(Ar/N2), stable isotopic ratios of N2, O2 and Ar of the balloon-borne stratospheric air samples, in cooperation with Tohoku Univ., Miyagi Univ. of Education, National Institute of Polar Research and JAXA.
3. Observations of the mid-tropospheric delta(O2/N2) over the western North Pacific by analyzing the air samples collected using a cargo aircraft C-130H, in cooperation with Japan Meteorological Agency and Meteorological Research Institute.
4. Observations of the atmospheric delta(Ar/N2) at Hateruma, Japan, in cooperation with National Institute for Environmental Studies.
5. Development of the high precision gravimetric standard air for the measurements of the atmospheric O2/N2 ratio and the O2 concentration, in cooperation with National Metrology Institute of Japan, AIST.

We have also developed a continuous measurement system of the atmospheric delta(O2/N2) using a fuel cell analyzer in cooperation with the National Institute of Polar Research and Tohoku Univ. (Goto et al., 2013), and tested in the temperate deciduous forest site at Takayama, Japan. Further, we are analyzing the causes of the temporal-spatial variation of atmospheric delta(O2/N2) with the atmospheric transport models developed by the AIST and JAMSTEC (Ishidoya et al., 2012a, b). Integration of these studies will lead to a better understanding of the mechanisms for climate changes.