Diffusive separation of the lower atmosphere suggested by Ar/N_2, delta^{15}N of N_2, delta^{18}O of O_2 observed at Ny-Ålesund, Svalbard.

*Shigeyuki Ishidoya[1], Daisuke Goto[2], Satoshi Sugawara[3], Shinji Morimoto[4], Shuji Aoki[4], Shohei Murayama[1], Takakiyo Nakazawa[4]

1.National Institute of Advanced Industrial Science and Technology (AIST), 2.National Institute of Polar Research, 3.Miyagi University of Education, 4.Tohoku University

Recent technical advances has made it possible to observe a molecular diffusive separation of the atmosphere based on high precision measurements of the composition of atmospheric major components. In the middle to lower stratosphere, Ishidoya et al. (2013) reported the existence of observable gravitational separation based on the measurements of stratospheric air samples collected using a balloon-borne cryogenic air sampler. In the lower atmosphere, Adachi et al. (2006) reported the diffusive separation of Ar and N_2, mainly due to thermal diffusion, in the center of a wide desert during the nighttime when vertical temperature inversions are generated. To examine whether the diffusive separation of the atmosphere is also detectable near the surface in polar region, air samples collected at Ny-Ålesund, Svalbard (79°N, 12°E) have been analyzed for delta(Ar/N_2), delta(O_2/N_2), delta^{15}N of N_2, delta^{18}O of O_2 and delta^{40}Ar by using a mass spectrometer (Ishidoya and Murayama, 2014) since January 2013. It was found that delta^{15}N and delta^{18}O show small but significant seasonal cycles, with the seasonal maxima and minima in winter and summer, respectively. The peak-to-peak amplitudes of the respective seasonal cycles of delta^{15}N and delta^{18}O were about 2 and 4 per meg. On the other hand, no significant seasonal cycle was seen in delta(Ar/N_2). If we assume the seasonal cycles of delta^{15}N and delta^{18}O are attributed mainly to gravitational separation in a temperature inversion layer during polar night in winter and corrected the delta(Ar/N_2) for the separation by subtracting 12 x (delta^{15}N + delta$^{18}O/2)/2$ (delta$(Ar/N_2)_{cor}$), then the delta$(Ar/N_2)_{cor}$ show clear seasonal cycle with a maximum in August. The peak-to-peak amplitude of the seasonal delta$(Ar/N_2)_{cor}$ cycle is about 25 per meg, and the appearance time of seasonal maximum agrees with that of the sea surface temperature around Ny-Ålesund. These results suggest that gravitational separation is observable near the surface at Ny-Ålesund. Our suggestion would be supported by Keeling et al. (2004) who reported the delta(Ar/N_2) observed in the polar region may be detectably enriched near the ground by gravitational separation or thermal diffusion under condition of strong surface inversions.

References

Adachi, Y. et al. (2006) Diffusive separation of the lower atmosphere, *Science*, 311, 1429.

Ishidoya, S. et al. (2013) Gravitational separation in the stratosphere –a new indicator of atmospheric circulation. *Atmos. Chem. Phys.*, 13, 8787–8796, www.atmos-chem-phys.net/13/8787/2013/, doi:10.5194/acp-13-8787-2013.

Ishidoya, S. & Murayama, S. (2014) Development of high precision continuous measuring system of the atmospheric O_2/N_2 and Ar/N_2 ratios and its application to the observation in Tsukuba, Japan. *Tellus B*, 66, 22574, http://dx.doi.org/ 10.3402/tellusb.v66.22574.

Keeling, R. F. et al. (2004) Measurement of changes in atmospheric Ar/N2 ratio using a rapid-switching, single-capillary mass spectrometer system, *Tellus B*, 56, 322–338.

Keywords: diffusive separation of the atmosphere, Ar/N2 ratio, delta15N of N2, delta18O of O2, vertical temperature inversions

