Seasonal and interannual variations of the Atmospheric Potential Oxygen over the Western North Pacific observed by using a cargo aircraft C-130H

*Shigeyuki Ishidoya[1], Kazuhiro Tsuboi[2], Yosuke Niwa[3], Shohei Murayama[1], Hidekazu Matsueda[2], Yousuke Sawa[2], Nobuyuki Aoki[1], Kentaro Ishijima[2], Kentaro Kozumi[4], Genta Umezawa[4], Kazuya Yukita[4], Shigeharu Nishida[4], Megumi Yamamoto[4]

1. National Institute of Advanced Industrial Science and Technology (AIST), 2. Meteorological Research Institute, 3. National Institute for Environmental Studies, 4. Japan Meteorological Agency

The cargo aircraft C-130H flies once per month from Atsugi Base (35.45˚N, 139.45˚E), Kanagawa, Japan, to Minamitorishima (MNM; 24.28˚N, 153.98˚E), and air samples are collected during the level flight (~6 km) and the descent portion at MNM. The air samples have been analyzed for $O_2/N_2$and Ar/N_2ratios and stable isotopic ratios of N_2, $O_2$and Ar since May 2012. The analysis indicated a significant artificial fractionation due to thermal diffusion during the air sample collection. Nevertheless we succeeded to correct the effects of the fractionation on the observed O_2/N_2ratio precisely by using the observed Ar/N_2 ratio (Ishidoya et al., 2014). The corrected O_2/N_2ratio showed a secular decrease accompanied by a prominent seasonal cycle. The average secular change rate of the mid-tropospheric corrected O_2/N_2ratio was found to be -25.2±0.5 per meg $yr^{-1}$for the period 2012 –2018, which agreed well with that observed at La Jolla, USA by Scripps O_2program (Keeling and Manning, 2014). As the uncertainty of the change rate, we considered the spatial difference of the rates and the stability of the O_2/N_2ratio of standard air.

The Atmospheric Potential Oxygen (APO=O_2+1.1xCO_2), calculated by using the corrected O_2/N_2ratio, also showed prominent seasonal cycles, and the amplitude of the mid-tropospheric seasonal APO cycle observed at 25.5˚N was found to be 55 and 31 % of those observed at 33.5˚N and the surface MNM (Ishidoya et al., 2017), respectively. On the other hand, the corresponding seasonal amplitude of CO_2at 25.5˚N was found to be 72 and 93 % of those at 33.5˚N and the surface MNM, respectively. An atmospheric transport model (Niwa et al., 2017) reproduced general features of the observed seasonal APO and CO_2cycles, and its tagged simulation suggested that the mid-tropospheric seasonal APO cycle in the northern low latitudes was reduced significantly by the anti-phase seasonal APO cycle from the southern hemisphere. The observed APO showed interannual variations superimposed on secular downward trends, and the temporal change rates take maxima from the end of 2014 to the beginning of the 2015 at the surface MNM and in the mid-troposphere at 29 –34 ˚N. A comparison between the observed and simulated interannual variations of APO suggested that an interannual variation of the atmospheric transport contributed about 30 % of the observed variation.

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