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Estimation of the age of air in the Antarctic stratosphere

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Stratospheric air sampling experiments using the compact cryogenic sampler system (J-T sampler) were conducted at Syowa Station (69.08S, 39.58E), Antarctica, in January 2008 as a part of the scientific program of the 49th Japanese Antarctic Research Expedition (Morimoto et al., JOAT, 2009). On 4 January 2008, two J-T samplers were launched from Syowa Station. As a result, they had collected air samples of 2.4 and 5.0 L(STP) at 25-km and 18-km altitudes, where the atmospheric pressures were around 26 and 65 hPa, respectively. The air samples collected in the stratosphere over Syowa Station were analyzed for concentrations of CO₂, CH₄, N₂O, and SF₆, stable isotope ratios of CO₂ and CH₄ at Tohoku University. In this study, we estimated the mean age of air in the Antarctic stratosphere over Syowa station, and compare them with the results obtained from the previous Antarctic experiments. The CO₂ concentration was corrected for the effect of concentration change caused by the storing in samplers. The concentrations of CO₂ and SF₆ at 25 km altitude were 376.4 ppm and 5.0 ppt, respectively. After the CO₂ data was corrected for the CO₂ production by methane oxidation, the mean age of stratospheric air was estimated by comparing the observed concentrations with the CO₂ variation in the tropical troposphere. Because the tropospheric CO₂ variation contains seasonal and inter-annual variations, it was smoothed numerically by assuming that the age spectrum of stratospheric air is simply given as the inverse-Gaussian distribution. As a result, the mean age of stratospheric air was estimated to be 4.5 years. This value was slightly lower than those obtained from the previous Antarctic experiments. However, this result indicates no significant long-term change of the mean age.

Keywords: age of air, stratosphere, CO₂, SF₆, Antarctica