

Change of the mean age of stratospheric air estimated from CO₂ concentration

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Systematic collections of stratospheric air samples have been carried out over Japan since 1985, using a balloon-borne cryogenic sampler. The air samples collected were analyzed for the CO₂ concentrations and various gases. The CO₂ concentration increased almost linearly at heights above 20-25 km. The rate of the secular CO₂ increase in the stratosphere, 1.48 (+0.04) ppmv/year, were slightly smaller than that observed in the troposphere for the same period. 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. The mean age of stratospheric air varies between 4.2 and 5.8 years, especially being larger in the last decade. The average change rate of the mean age in the mid-stratosphere, calculated by using a least-squares method, was 0.06(+0.02) years/year. Recent model studies suggest that the global warming should have strengthened the Brewer-Dobson circulation by an enhanced mass flux from the tropical troposphere into the stratosphere, which should result decreasing of the mean age. However, our result shows no decreasing trend of the mean age for the last 2 decades.