

Change of the vertical gradient of stratospheric 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. Because CO₂ and SF₆ concentrations have been increased monotonously by human activities and conserved within the troposphere and stratosphere, the mean age of air can be inferred from stratospheric concentrations. It is expected that a possible long-term change of the Brewer-Dobson (BD) circulation is detectable from the change of mean age. We have previously reported that the average change rate of the mean age in the mid-stratosphere was 0.06±0.02 years/year. Recently, Engel et al. (2009, Nature Geosci.) evaluated the mean age from CO₂ and SF₆ concentrations observed by balloon experiments over the past 30 years. They concluded that the increase rate of the mean age is statistically indistinguishable from zero at the 90 % confidence limit. This does not agree with recent model predictions of an accelerating BD circulation with an enhanced mass flux from the tropical troposphere into the stratosphere. This discrepancy between observations and models can be resolved if the poleward transport in the lower stratosphere is enhanced and compensate for increased tropical upwelling. To examine an altitude-dependent change of the poleward transport in the stratosphere, we evaluate the vertical gradient of the CO₂ concentration. As a result, we found that the vertical gradient above 20-25 km changed from positive to negative in the past 20 years. This suggests that the poleward transport in the upper layer has been weakened more than in the lower layer.