Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Home
Online Library ACP
Recent Final Revised Papers
Volumes and Issues
Special Issues
Library Search
Title and Author Search
Online Library ACPD
Alerts & RSS Feeds
General Information
Submission
Review
Production
Subscription
Comment on a Paper

Volumes and Issues Contents of Issue 20

Atmos. Chem. Phys., 8, 6189-6197, 2008
www.atmos-chem-phys.net/8/6189/2008/

Long-term observation of mass-independent oxygen isotope anomaly in stratospheric CO_2

S. Kawagucci[1,*], U. Tsunogai[1], S. Kudo[1], F. Nakagawa[1], H. Honda[2], S. Aoki[3], T. Nakazawa[3], M. Tsutsumi[4], and T. Gamo[4]

[1]Earth and Planetary System Sciences, Faculty of Science, Hokkaido University, Sapporo, Japan

[2]Japan Aerospace Exploration Agency, Sagamihara, Japan

[3]Center for Atmospheric and Oceanic Studies, Graduate School of Science, Tohoku University, Sendai, Japan

[4]Dept. of Chemical Oceanography, Ocean Res. Ins., Univ. of Tokyo, Nakano-ku, Tokyo, Japan

[*]present address: Dept. of Chemical Oceanography, Ocean Res. Ins., Univ. of Tokyo, Nakano-ku, Tokyo, Japan

Abstract. Stratospheric and upper tropospheric air samples were collected during 1994–2004 over Sanriku, Japan and in 1997 over Kiruna, Sweden. Using these archived air samples, we determined the triple oxygen-isotope composition of stratospheric CO_2 and the N_2O mixing ratio. The maximum $\Delta^{17}O_{CO_2}$ value of +12.2 ‰, resembling that observed previously in the mesosphere at 60 km height, was found in the middle stratosphere over Kiruna at 25.6 km height, suggesting that upper stratospheric and mesospheric air descended to the middle stratosphere through strong downward advection. A least-squares regression analysis of our observations on a $\delta^{18}O_{CO_2}$–$\delta^{17}O_{CO_2}$ plot (r^2>0.95) shows a slope of 1.63±pm0.10, which is similar to the reported value of 1.71±0.06, thereby confirming the linearity of three isotope correlation with the slope of 1.6–1.7 in the mid-latitude lower and middle stratosphere. The slope decrease with increasing altitude and a curvy trend in three-isotope correlation reported from previous studies were not statistically significant. Using negative linear correlations of $\Delta^{17}O_{CO_2}$ and $\delta^{18}O_{CO_2}$ with the N_2O mixing ratio, we quantified triple oxygen-isotope fluxes of CO_2 to the troposphere as +48 ‰ GtC/yr ($\Delta^{17}O_{CO_2}$) and +38 ‰ GtC/yr ($\delta^{18}O_{CO_2}$) with ~30% uncertainty. Comparing recent model results and observations, underestimation of the three isotope slope and the maximum $\Delta^{17}O_{CO_2}$ value in the model were clarified, suggesting a smaller O_2 photolysis