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Observed temporal evolution of global mean age of stratospheric air for the 2002 to 2010 period

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An extensive observational data set from MIPAS measurements, consisting of more than one million SF_6 vertical profiles distributed globally has been condensed into monthly zonal means of mean age of air for the period September 2002 to January 2010, binned at 10° latitude and 1-2 km altitude. The data were analysed with respect to their temporal variation by fitting a regression model consisting of: a constant and a linear increase term, 2 proxies for the QBO variation, sinusoidal terms for the seasonal and semi-annual variation and overtones for the correction of the shapes to the observed data set. The impact of subsidence of mesospheric SF_6-depleted air and in-mixing into non-polar latitudes on mid-latitudinal age of air and its linear increase was assessed and found to be small.

The linear increase of mean age of stratospheric air was found to be positive and partly larger than the trend derived by Engel et al. (2009) for most of the Northern mid-latitudes, the middle stratosphere in the tropics, and parts of the Southern mid-latitudes, as well as for the Southern polar upper stratosphere. Multi-year decrease of age of air was found for the lowermost and the upper stratospheric tropics, for parts of Southern mid-latitudes, and for the Northern polar regions. Analyses of the amplitudes and phases of the seasonal variation shed light on the coupling between different stratospheric regions. In particular, the Northern mid-latitude stratosphere is well coupled to the tropics, while the Northern lowermost mid-latitudinal stratosphere is decoupled, confirming the separation of the shallow branch of the Brewer-Dobson circulation from the deep branch. We suggest an overall increased tropical upwelling, together with a weakening of mixing barriers, especially in the Northern hemisphere, as possible explanations for the observed patterns.

Reference: Engel, A., Möbius, T., Bönisch, H., Schmidt, U., Heinz, R., Levin, I., Atlas, E., Aoki, S., Nakazawa, T., Sugawara, S., Moore, F., Hurst, D., Elkins, J., Schauffler, S., Andrews, A., and Boering, K.: Age of stratospheric air unchanged within uncertainties over the past 30 years, Nature Geosci., 2, 28–31, doi:10.1038/ngeo388, 2009.