On the derivation of mean age of air and spectra from ideal and realistic tracers

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Age of air (AoA) is a diagnostic of transport along the stratospheric Brewer Dobson circulation.

As there are differences in trends of AoA in models and observations, it is important to improve the understanding of uncertainties in the calculation of AoA.

First, we investigate mean AoA in a transient climate simulation of the chemistry climate model EMAC (ECHAM MESSy Atmospheric Chemistry). Mean AoA and its trend from a linearly increasing tracer and an SF6-like tracer are analysed assuming the width of the AoA spectrum according to a one dimensional diffusion analog for the SF6 like tracer. The age values calculated from the linear tracer and from the SF6 tracer agree well within 1990-2010 but the trends over the full simulation period differ.

To better understand the assumptions made in the mean age calculations, further methods are tested in time slice simulations. A set of inert pulsed tracers are implemented in an EMAC simulation which provide an actual age spectrum. The resulting mean age and width can be compared to the results from the linear tracer and the SF6 like tracer. Also, to gain insight into more realistic tracers, mesospheric sinks of SF6 are implemented. As expected, this leads to higher stratospheric AoA values, in particular in the high latitudes, most pronounced in the southern hemisphere upper winter stratosphere.

Furthermore, we compare spectra of inert tracers to spectra for realistic tracers with chemical loss, giving information on the actual transport times relevant for chemical tracers. The spectra of present day climate are compared to spectra for a future climate with a changed transport circulation.

Key words: Age of air, stratospheric transport, Brewer-Dobson circulation