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Assessing changes in stratospheric mean age of air and fractional release using historical trace gas observations

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Large-scale stratospheric transport is pre-dominantly governed by the Brewer-Dobson circulation. Due to climatic change a long-term acceleration of this residual stratospheric circulation has been proposed (e.g. Austin et al.,2006). Observational evidence has revealed indications for temporary changes (e.g. Bönisch et al., 2011) but a confirmation of a significant long-term trend is missing so far (e.g. Engel et al., 2009). A different aspect is a possible long-term change in the break-down of chemically important species such as chlorofluorocarbons as proposed by Butchart et al. 2001. Recent studies show significant differences adding up to more than 20 % in the chlorine released from such compounds (Newman et al., 2007; Laube et al., 2013). We here use a data set of three long-lived trace gases, namely SF6, CF2Cl2, and N2O, as measured in whole-air samples collected during balloon and aircraft flights between 1975 and 2011, to assess changes in stratospheric transport and chemistry. For this purpose we utilise the mean stratospheric transit times (or mean ages of air) in combination with a measure of the chemical decomposition (i.e. fractional release factors). We also evaluate the influence of different trend correction methods on these quantities and explore their variability with latitude, altitude, and season.

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