EGU2020-3375, updated on 24 Oct 2020
https://doi.org/10.5194/egusphere-egu2020-3375
EGU General Assembly 2020

Reconciling modelled and observed age of air through SF6 sinks

Sheena Loeffel[2], **Roland Eichinger**[2,1], Hella Garny[2,1], Thomas Reddmann[3], Stefan Versick[3], Frauke Fritsch[2,1], Gabriele Stiller[3], and Florian Haenel[3]

[1]Meteorological Institute, Ludwig Maximilians University, Munich, Germany (roland.eichinger@dlr.de)
[2]Institute for Atmospheric Physics, Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Weßling, Germany
[3]Institute for Meteorology and Climate Research, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Mean age of air (AoA) is a common diagnostic for the stratospheric overturning circulation in both climate models and observations. Observations of AoA mostly base on measurements of SF6, which is an almost ideal AoA tracer because its emssions across the recent decades increased nearly linearly and it is fairly stable in the troposphere and stratosphere. Over the last ten years, however, researchers were puzzled as to why AoA climatologies and trends of model simulations and observational data do not coincide. AoA in climate models is generally much lower than in observations and models show a clear decrease of AoA over time while measurements show a non-significant increase.

What is commonly not considered in the models is that SF6 has chemical sinks in the mesosphere, and these lead to apparently older air in the stratosphere. In our experiment, we explicitely calculate SF6 sinks based on physical processes in simulations with the global chemistry-climate model EMAC (ECHAM MESSy Atmospheric Chemistry). We show that considering the SF6 removal reactions strongly increases stratospheric AoA and leads to much better agreement between the climatologies of EMAC and MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) satellite observations. Moreover, the stratospheric AoA trend over the recent decades reverses sign when we derive it from SF6 with sinks. This means that the trend can such be reconciled with the trend that has been derived from long-term balloon-borne measurements. Our specifically designed sensitivity studies moreover reveal that this positive trend results neither from circulation changes, nor from variations of the reactive species involved in mesospheric SF6 depletion. Instead, it is generated through the temporally growing influence of the SF6 sinks themselves, an effect that overcompensates the negative trend resulting from the accelerating stratospheric overturning circulation.