Geophysical Research Abstracts
Vol. 16, EGU2014-7436, 2014
EGU General Assembly 2014

The effects of mixing on stratospheric Age of Air in global models

Hella Garny (1), Thomas Birner (2), and Harald Bönisch (3)

(1) DLR, Institute for Atmospheric Physics, Oberpfaffenhofen-Wessling, Germany (hella.garny@dlr.de), (2) Colorado State University, Fort Collins, Colorado, USA, (3) Institute for Atmospheric and Enviromental Sciences, Goethe University Frankfurt, Frankfurt am Main, Germany

The stratospheric Brewer-Dobson circulation is often quantified by the integrated transport measure stratospheric age of air (AoA). AoA is influenced both by mean transport along the residual circulation and by two-way mixing. Therefore, AoA is a good measure of the overall capabilities of a global model to simulate stratospheric transport. Currently, a large spread in the simulation of AoA by global models is found.

In this study we use a method that allows us to quantify the effect of mixing on AoA from global model data. AoA is contrasted with a hypothetical age – the age air would have if it was only transported by the residual circulation, the residual circulation transit time (RCTT). The difference of AoA and RCTT is interpreted as the additional aging by mixing. Mixing causes air to be older almost in the entire lower stratosphere (AoA > RCTT). This increase in AoA by mixing is largely due to mixing between the tropics and extratropics, that leads to recirculation of air through the stratosphere. A "mixing efficiency" is defined as the ratio of the two-way mixing mass flux across the subtropical barrier to the net (residual) mass flux. This mixing efficiency controls the ratio of tropical mean AoA to RCTT, and thus the relative increase in AoA by mixing.

These diagnostics are applied to a set of global model simulations to examine the causes for the spread in the simulation of AoA in different models. It is found that both differences in the residual circulation strength and in mixing contribute to the spread in simulated AoA. The mixing efficiency varies strongly between models – leading to differences in AoA between models even if the residual circulation strength did not differ. Possible causes for the differences in the mixing efficiency might be found in the model dynamics (e.g. the wave spectrum) and/or numerics (e.g. the advection scheme used). The different mixing efficiencies in models also modulate the response of AoA to long-term changes in the residual circulation, as projected by most global models. A better understanding of the processes that control AoA might help to reconcile current discrepancies between modelled and observed long-term changes in AoA.