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Stratospheric age of air computed with trajectories based on various 3D-Var and 4D-Var data sets

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Abstract. The age of stratospheric air is computed with a trajectory model, using ECMWF ERA-40 3D-Var and operational 4D-Var winds. Analysis as well as forecast data are used. In the latter case successive forecast segments are put together to get a time series of the wind fields. This is done for different forecast segment lengths. The sensitivity of the computed age to the forecast segment length and assimilation method are studied, and the results are compared with observations and with results from a chemistry transport model that uses the same data sets. A large number of backward trajectories are started in the stratosphere, and from the fraction of these trajectories that has passed the tropopause the age of air is computed. First, for ten different data sets 50-day backward trajectories starting in the tropical lower stratosphere are computed. The results show that in this region the computed cross-tropopause transport decreases with increasing forecast segment length. Next, for three selected data sets (3D-Var 24-h and 4D-Var 72-h forecast segments, and 4D-Var analyses) 5-year backward trajectories are computed that start all over the globe at an altitude of 20km. For all data sets the computed ages of air in the extratropics are smaller than the observation-based age. For 4D-Var forecast series they are closest to the observation-based values, but still 0.5-1.5 year too small. Compared to the difference in age between the results for the different data sets, the difference in age between the trajectory and the chemistry transport model results is small.

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