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The implementation of the CLaMS Lagrangian transport core into the chemistry climate model EMAC 2.40.1: application on age of air and transport of long-lived trace species

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Abstract. Lagrangian transport schemes have proven to be useful tools for modelling stratospheric trace gas transport since they are less diffusive than classical Eulerian schemes and therefore especially well suited for maintaining steep tracer gradients. Here, we present the implementation of the full-Lagrangian transport core of the Chemical Lagrangian Model of the Stratosphere (CLaMS) into the ECHAM/MESSy Atmospheric Chemistry model (EMAC). We performed a 10-year time-slice simulation to evaluate the coupled model system EMAC/CLaMS. Simulated zonal mean age of air distributions are compared to age of air derived from airborne measurements, showing a good overall representation of the stratospheric circulation. Results from the new Lagrangian transport scheme are compared to tracer distributions calculated with the standard flux-form semi-Lagrangian (FFSL) transport scheme in EMAC. The differences in the resulting tracer distributions are most pronounced in the regions of strong transport barriers. The polar vortices are presented as an example for isolated air masses which are surrounded by a strong transport barrier and simulated trace gas distributions are compared to satellite measurements. The analysis of CFC-11, N_2O, CH_4, and age of air in the polar vortex regions shows that the CLaMS Lagrangian transport scheme produces a stronger, more realistic transport barrier at the edge of the polar vortex than the FFSL transport scheme of EMAC. Differences in simulated age of air range up to 1 year in the Arctic polar vortex in late winter/