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Lagrangian Transport in a coupled Chemistry Climate Model

C. Hoppe (1,2), R. Müller (1), G. Günther (1), and L. Hoffmann (2)

(1) Institute for Energy and Climate Research (IEK-7 Stratosphere), Forschungzentrum Jülich, Germany (c.hoppe@fz-juelich.de), (2) Jülich Supercomputing Centre JSC, Forschungszentrum Jülich, Germany

We describe the implementation of a Lagrangian transport core in a chemistry climate model (CCM). This is motivated by the problem that in many cases trace gas distributions in the stratosphere can not be represented properly in a classical Eulerian framework with a fixed model grid, especially in regions where strong trace gas gradients occur. Here, we focus on stratospheric water vapor, which is an important driver of surface climate change on decadal scales. In this case, the transport representation is particularly important in the tropical tropopause layer (TTL), where tropospheric air enters into the stratosphere, i.e. , where the entry level of stratospheric water vapor is determined.

For this purpose, the Chemical Lagrangian Model of the Stratosphere (CLaMS) is coupled with the ECHAM/MESSy Atmospheric Chemistry Model (EMAC). The latter includes the ECHAM5 climate model, and a coupling interface, which allows for flexible coupling and switching between different submodels. The chemistry transport model CLaMS provides a full Lagrangian transport representation to calculate constituent transport on a set of air parcels that move along trajectories.

In the Lagrangian frame of reference, different vertical velocity representations can be used to drive the trajectories:
- kinematic transport in isobaric coordinates with omega as vertical velocity,
- diabatic transport in isentropic coordinates, where thetadot calculated from diabatic heatingrates is used as vertical velocity.
Since vertical winds in the statosphere derived with the kinematic method from the continuity equation often suffer from excessive numerical noise and errors, we expect that constituent transport using the diabatic method will improve the simulations of stratospheric water vapor. We will present preliminary results illustrating how the different transport representations influence simulated tracer distributions.