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ATLAS - A new Lagrangian transport and mixing model with detailed stratospheric chemistry

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We present a new global Chemical Transport Model (CTM) with full stratospheric chemistry and Lagrangian transport and mixing called ATLAS. Lagrangian models have some crucial advantages over Eulerian grid-box based models, like no numerical diffusion, no limitation of the time step of the model by the CFL criterion, conservation of mixing ratios by design and easy parallelization of code.

The transport module is based on a trajectory code developed at the Alfred Wegener Institute. The horizontal and vertical resolution, the vertical coordinate system (pressure, potential temperature, hybrid coordinate) and the time step of the model are flexible, so that the model can be used both for process studies and long-time runs over several decades. Mixing of the Lagrangian air parcels is parameterized based on the local shear and strain of the flow with a method similar to that used in the CLaMS model, but with some modifications like a triangulation that introduces no vertical layers. The stratospheric chemistry module was developed at the Institute and includes 49 species and 170 reactions and a detailed treatment of heterogenous chemistry on polar stratospheric clouds.

We present an overview over the model architecture, the transport and mixing concept and some validation results. Comparison of model results with tracer data from flights of the ER2 aircraft in the stratospheric polar vortex in 1999/2000 which are able to resolve fine tracer filaments show that excellent agreement with observed tracer structures can be achieved with a suitable mixing parameterization.