APPLICATION AND INTERCOMPARISON OF ADVECTION SCHEMES FOR TRACE SPECIES TRANSPORT WITHIN THE ONLINE-COUPLED REGIONAL METEOROLOGY CHEMISTRY MODEL MCCM AND ITS IMPACT ON ATMOSPHERIC PHOTO-SMOG SIMULATIONS

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Air quality modeling involves the integration of a large number of continuity equations for atmospheric dynamics as well as for the chemical trace species involved. The effort for the numerical treatment of the trace species advection demands about a fifth of the overall computational time and is therefore a limiting factor. Due to a steady increase in computational resources and availability of high resolution emission inventories, there arises a demand for high resolution regional air quality simulations. The existing mesoscale models have to be adapted to this trend. Special interest will be the capability to handle steep gradients close to strong emission sources.

The MCCM standard advection scheme is the MPDATA of Smolarkiewicz. For the inter-comparison, a new version of the positive definite and the monotone version of the advection scheme of Bott for non-uniform grids were developed, adapted to the MM5/MCCM coordinate system and implemented in MCCM.

The performance was first evaluated by a numerical experiment based on the model equations in the terrain following coordinate system. The inter-comparison of the transported profiles with its analytical solution of the simulated transport problem has shown clear advantages for the positive definite advection scheme of Bott. Its properties to preserve steep gradients is superior, while the monotone version of the Bott scheme is still less diffusive compared to the MPDATA.

A photosmog episode in summer 2003 was simulated for the real case performance evaluation for southern Bavaria. The high resolution simulations of 4 nested domains down to 6 and 2 kilometers have shown higher concentrations and steeper gradients of primary pollutants in the plumes close to the emission sources urban and suburban regions for the positive definite advection scheme of Bott, while the MPDATA smoothly smears out the gradients.

The urban and suburban NO-concentrations affect the photo stationary equilibrium and result in major differences in O3-concentrations. An inter-comparison with urban and suburban O3-measurements show a better agreement for the MPDATA-simulation compared to the simulations with the gradient preserving schemes of Bott.

EXTENDED ABSTRACT NOT SUPPLIED