Introduction

Aerosol particles affect cloud microphysics (e.g. number and size of drops, precipitation formations, state of aggregation of the hydrometeors) with their size distribution, their number and chemical composition.

In addition, clouds act as chemical reaction chambers, where gases and particles are scavenged and modified.

The description of cloud processes in the currently available box models and Eulerian grid models (cloud or mesoscale models) focuses either on detailed microphysics or complex multiphase chemistry.

Modelling of tropospheric multiphase processes: tools and chemical mechanisms

The research project MODMEP

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The objective of the joint project is the development of a cloud module which combines a complex multiphase chemistry with detailed microphysics. The description of both components is given for a fine-resolved droplet spectrum.

An efficient numerical solution of the entire complex model strongly requires the development of new numerical methods. The influence of simplifications within single components and the kind of their coupling on the simulation results will be investigated for different tropospheric situations.

In the framework of the joint project, techniques will be provided and tested which allow the description of complex multiphase chemistry and of detailed microphysics in multidimensional chemistry-transport models. The development is performed in close cooperation with the joint cloud experiment project FEBUKO.

The following methods will be used for the development of the cloud module:

- Coupling of detailed microphysics with multiphase chemistry in several droplet classes
- Adapted multiphase mechanisms and tools for their implementation into complex models
- Methods for coupled time integration
- Spatial description of clouds in 3D models

The joint research project MODMEP started in January 2001 and is funded from the BMBF (German Science Ministry) within the AFO2000 research program. Within 6 subprojects from 3 different institutions new techniques for multiphase modelling will be developed.

Subprojects of the joint project MODMEP:
- Development of a multiphase mechanism for the interpretation of chemical processes in tropospheric clouds and aerosol (Hartmut Herrmann, Zoltan Majdik, IfT-Chem Leipzig)
- Reduction of multiphase reaction mechanism (Günther Mauersberger, BTU Cottbus)
- Investigation of the coupling between microphysical and multiphase chemical processes for polydisperse cloud particles populations (Frank Müller, MPI Hamburg)
- Coupled time integration of multiphase processes (Ralf Wolke, Oswald Knoth and Aissa-Mounir Sehili, IfT-Num Leipzig)
- Spatial description of clouds and their boundaries in multidimensional Eulerian grid models (Oswald Knoth, Detlef Hinneburg and Ralf Wolke, IfT-Num Leipzig)
- Numerical Simulations of the cloud – aerosol – gas interactions in the air flow over a mountain (Sabine Wurzler and Karoline Diehl, IfT-Mod Leipzig)

Size-resolved simulations (test example)

* different numbers of size classes for a lognormal distributed droplet spectrum, time-constant microphysics

* multiphase chemical mechanism CAPRAM2.4

Numerical efficiency for simulations with a different number of droplet classes and three chemical mechanisms