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Spectral Microphysics in the regional Forecast Model Lokalmodell

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Quantitative precipitation prediction is one of the most uncertain parts of weather forecast models. The formation of precipitation is strongly connected to the drop number distribution inside a cloud. However, for a given dynamic situation, amount and size of the nucleated droplets depend on the amount, size and chemical composition of the aerosol particles which are available in the atmosphere. Thus, in the numerical prediction of precipitation it is desirable to take into account aerosol particles and the droplet nucleation process as detailed as possible.

In this work, a detailed spectral bin microphysics model is coupled to the Lokalmodell, which is the regional part of the operational model system of the German Weather Service. The microphysics model describes cloud condensation nuclei and drops in a joint field of 66 size bins and includes soluble and insoluble aerosol mass explicitly. Besides condensation and evaporation, collision and break-up are taken into account. The model system involves strongly differing time scales. Therefore, the slow dynamical and diffusional tendencies of the wind fields, temperature, and pressure are calculated with a large time step of 10 s to 100 s whereas the microphysical processes are calculated with a time step of 1 s or smaller. Since the hydrometeor quantities are strongly altered during the microphysics, their advection as well as the advection of the water vapor is carried out within the small time step as well.

Two artificial test cases were established: a three-dimensional heat bubble and a two-dimensional mountain ridge overflow. Both cases show reasonable results. Sensitivity studies with respect to microphysical parameters show the strong influence of the initial aerosol properties. An increase of the initial number of aerosol particles leads to an increase of drop number but a decrease of drop size and is connected with a lower maximum supersaturation inside the cloud. Finally, precipitation is considerably

reduced due to a later onset of coalescence. Overall, the coupled model system of the spectral bin microphysics and the three-dimensional mesoscale Lokalmodell performs well and builds the basis for a more detailed investigation of the relation between precipitation and aerosols.