

First of all, I would like to thank the reviewer for the comments. Detailed answers are given below. In bold I quote the reviewer's comments.

General comments:

**1. I read the manuscript with great interest. The paper addresses an important subject, the treatment of multiphase processes in atmospheric 3d models. The authors describe and discuss a new cloud chemistry module recently implemented in the regional scale MesoNH model. The module has been tested on three idealized applications, which emphasize different features of the approach. Unfortunately the coupling between chemistry, microphysics and the transport processes are not described in detail. In my feeling, this can contribute to a better understanding of the whole algorithm as well as to a fair evaluation of the test results. Is the usual "operator splitting" approach applied for integrating the different terms in system (1)--(2)? In this case, the authors should give more information about the choice of the step sizes, the influence of the used splitting sequence and the expected splitting error.**

In the aqueous model, each soluble species (1 gas phase, 2 liquid phases and 1 ice phase) is described by a prognostic variable. Each prognostic variable is transported by the flow and by the turbulent motion while the microphysical transfer rates are computed according to the microphysical scheme. All these processes are integrated process by process with the single time step. In addition, the set of differential equation for chemistry (including the chemical reactivity in gas phase and in aqueous phase and the mass transfer rates between gas phase and droplets) is integrated by family of an implicit Runge-Kutta scheme called the Rosenbrock method. This method, suitable for the integration of stiff systems of ordinary differential equations, is based on variable sub time steps, which are automatically computed in the scheme. The code implemented in model MesoNH makes use of some routines of the KPP package of Sandu and Sander (2006), which have been interfaced and "tolerance" coefficients have been adjusted. The kinetic terms are integrated at the end of the model time step.

Specific comments:

**1. p. 966, typo in formula (6): Replace "rc" by "r<sub>c</sub>"**

Done.

**2. p. 969, first paragraph: The authors point out that a polynomial equation of degree 8 has to be solved for determining the pH. Does a positive solution of the equation exist in all cases? Usually, the solution is not unique. How is the corresponding pH value selected?**

The root searching method is very robust since practically we encounter no difficulty to select the true physical root ( $0 < \text{pH} < 12$  because cases with  $12 < \text{pH} < 14$  are extremely rare) at each grid point and at each model iteration step. In very few non-standard cases, i.e. cloud edges where the cloud water content and the dissolved gases evolve rapidly, a secured pathway favours the most recent pH value when the physical root is out of range.

**3. p. 970 and p. 972, first paragraph: The authors should check the equations (13) and (14). Why the second terms on the right hand side (“grau”) are not multiplied by  $X_{ice}$  ?**

Eqs 11-13 are consistent with the conservation of species  $X=X_g+X_w+X_{ice}$ .

Eq. 14 referring to the specific sedimentation term, gives an example of how a change in mixing ratio of species “z” affects a change of dissolved gas quantity  $X_z$  in proportion.  $X_{ice}$  represents the mixing ratio of species X dissolved in “snow” and “graupel” particles. The assumption here is that both mixing ratios – microphysical particles and dissolved gases - are falling at the same speed.