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Interactive Comment

Interactive comment on "Analytical treatment of ice sublimation and test of sublimation parameterisations in two-moment ice microphysics models" *by* K. Gierens and S. Bretl

Anonymous Referee #1

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In the first place the paper deals with the physical incorrectness in modeling the number concentration of ice crystals during the sublimation process when a 2 moment scheme is used in order to follow their mass and number distribution. Furthermore the paper presents an analytical solution for depositional growth and sublimation of an ice crystal spectrum which is used in the paper to better understand the relation between number and mass evolution under ice sub-saturated conditions. The analytical techniques for the mathematical solution of the equations and their non-dimensional presentation and interpretation range the paper on a high scientific level. As a principal result the paper shows that significant errors occur when hydrometeor spectra are described in cloud models by 2 moment schemes. No real solution can be proposed to remedy the false prediction of the crystal number during the sublimation process. The paper thus demonstrates that 2 moment schemes are unable to correctly describe the life cycle of cirrus clouds and their results (which are widely disseminated in atmospheric sciences) should be considered with utmost caution.

Thus, I propose that the paper can be published after minor correction, listed below:

General comments:

In the introduction as well as in the conclusion the authors never touch the idea that other more sophisticated and more detailed solutions for the ice microphysics apart from 2 moment schemes exist. The authors should first mention that other methods are established (see references below) and furthermore explain why they refrain from using a detailed concept. In chapter 5 (page 6 left column) they even apply this detailed method (1000 mass bins) to test the critical relation fn=fmïĄą.

Potential references are: Jensen E. J., O. B. Toon, D. L. Westphal, S. Kinne and A. J. Heymsfield, 1994 : Microphysical modeling of cirrus. 1. Comparison with 1986 FIRE IFO measurements. J. Geophys. Res., 99, 10,421-10,442. Lin R.F., O'Starr, DeMott, Cotton, Sassen, Jensen, Kärcher, and Liu, 2002 : Cirrus Parcel Model Comparison Project. Phase 1: The Critical Components to Simulate Cirrus Initiation Explicitly. J. Atmos. Sci., Vol. 59, Issue 15, pp. 2305–2329. Monier M., W. Wobrock, J.-F. Gayet and A. I. Flossmann, 2006 : Development of a detailed microphysics cirrus model tracking aerosol particles histories for interpretation of the recent INCA campaign. J. Atmos. Sci., 63, 504-525. Leroy D., W. Wobrock and A. I. Flossmann, 2007: On the influence of the treatment of aerosol particles in different bin microphysical models : a comparison between two different schemes. Atmos. Res. Vol. 85, Issues 3-4, Pages 269-287 Leroy, D., W. Wobrock and A. I. Flossmann, 2009: The role of boundary layer aerosol particles for the development of deep convective clouds: a high-resolution 3D model with detailed (bin) microphysics applied to CRYSTAL-FACE , Atmos. Res.; DOI: 10.1016/j.atmosres.2008.06.001

Specific comments:

Page 2: Fig.1: Can one better ‘illustrate’ the meaning of the value a= -0.004 ng/s Which RHi decrease effects such an amount of a? Page 2: end of chapter 2, erase the second last sentence. (the case a>0 has no meaning at this place).

Page 3, Fig.2: in my black/grey printed version I can see two curves in Fig. 2. Is this true or a printer mistake? (If true what means the 2nd curve) The figure caption as well as the text does not explain the meaning of indices n and m for ïĄęk and later the (fractional functions) fk. I guess it stands for number and mass. “For various initial mean mass”: can you give at least the range (i.e., min and max) Fig.3: indicate with an arrow in Fig.3 the sense of the time evolution Also for Figs. 3 and 4 it would be helpful to get an information on ‘a’, the amount of the value a in terms of RHi decrease at what temperature and pressure as an example.

Page 4, (refers to Fig.5): right column ‘all these functions are quite similar’. It appears that the S shaped curve (called h(ïĄť)) also depends on a, b, and m0. Or does any pair (m0 ,a) lays on the same S shaped curve given in Fig. 5? It should also be better explained why values of h exist when ïĄť > 1 (as m0(t=T) = 0).

Page 4, right column 9 lines before the end: Lower branch of what? upper branch of what?

Page 5, left column, 6 lines before the end Should be . . . crystal mean mass “loss” decreases first . . . as well as in right column 2nd line: ...when the mean mass “loss” starts to decrease. . ..

Last equation on page 5 means probably the ‘numerator’ integral and not the ‘denominator’ integral.

Page 6 line 9-11, left column N and qc have no names!

In the equation for RHi the 5 x sinus oscillation appears ok, but why 5 times the mass fraction ïĄęm ? Concerning the units of ïĄęm one can hardly understand the equiva-

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lence with (RHi = (qvap+ qvap,subli) / qvsat (T,p))- and especially the factor 5!

Right column page 6: End of paragraph 5: These results request a comparison with detailed bin microphysics!

The remarks on Marshall Palmer distribution are misleading as this distribution is applied to rain and precipitation droplets and not to cloud droplets.

As mentioned in 'General Comments' above the authors should give some perspectives how this problem of sublimations could be investigated in future modeling activities.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 10549, 2009.