Review comments for ACP MS No. acp-2011-607
Title: A hybrid bin scheme to solve the condensation/evaporation equation using a cubic distribution
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This study developed a numerical method which modifies the method of Chen and Lamb (1994) by replacing their linear sub-bin distribution with a cubic distribution. Furthermore, the mean number densities (at the mean mass) of the two neighboring bins are used as the two extra parameters, in addition to the number and mass, that needed to solve the cubic equation. This method is able to reduce the bin number by about 20% for the same accuracy. Such a technique is innovative and can be useful to many cloud and aerosol microphysics modelers. But its true usefulness remains to be proven as indicated in my major comments #3 and #4. I will recommend acceptance for publication if these concerns can be responded satisfactorily. Also, because of its technical nature and relatively short length, this manuscript is more suitable to be published as a notes or correspondence in conventional journals. Since ACP does not seem to separate out such publication types, I will leave this to the editor's discretion.

Major comments:

1. P. 21639, line 5:
   Values from this equation will not be within the range -1 and +1, thus violates the definition of χ on p. 21636, line 16. Will this cause a problem? If not, then the definition of χ should be modified.
2. P. 21643, Section 3.2:
   Mathematically, this case is the same as that presented in the previous section. The only difference is to allow supersaturation to vary with time (i.e. open system versus closed system), but this variation is of no numerical importance. Besides, ice crystal growth has its own complexity that comes from the shape effects. I suggest the authors focusing on the numerical methods and conduct more thorough analysis, such as comparing the results for case 1 with increasing resolutions (such as those given in Table 1). One should see the results to converge at high resolutions.
3. P. 21645, lines 5-6: "For the same accuracy, the number of bins required for the cubic scheme is 20±5% less than that of the linear scheme."
   The authors addressed only the computation accuracy but not the computation efficiency. A reduction of bin number by 20% might not be much, considering that the cubic method necessarily use more computation time than the linear method on the individual bin bases. Does the reduced bin number (by 20±5%) enough to compensate the extra computation? The authors need to provide a CPU-time analysis.
4. P. 21645, Summary:

Bin models also need to deal with collision processes. One of the key benefits of the cubic method is to reduce the number of bins for condensation/deposition calculation. But reducing the bin number necessarily causes large error in the collision growth processes, unless the cubic method can also be easily applied to such calculations. The authors discussed a little bit about this in the Summary section and provided a seemly good solution, i.e. use less bins with the cubic method for the condensation-dominant sizes, whereas apply more bins with the linear method for the collision-dominant sizes. However, the most critical collisions are "raindrop initiation collisions" between large cloud drops, which is still in the condensation-dominant size regime. Also, the condensation process tends to narrow the cloud drop spectrum, and often only very few bins (may be a little as 1 if the bin sizing factor is above 2) contain cloud drops. Yet, most bin models do not consider collisions within a bin. If only 1 bin contains cloud drops, there will be no collision in such models. So, decreasing the bin number in the condensation-dominant size regime inevitably causes artificial reduction in rain initiation by collision. Therefore, reducing the bin number is not necessary the best numerical strategy.

Minor comments:

1. p. 21633, line 17: "aggregation"
   the traditional term for drop-drop interaction is "coalescence"
2. p. 21635, line 6: "μ_1, μ_2, …, μ_{N+1}"
   Why not just use m_1, m_2, ..., m_{N+1} as done in the previous page? If m_i are intended to be variable (i.e. Lagrangian boundaries), then modify the previous notation of m with m.
3. p. 21636: "the assumption that the growth rate of particles in the bin is equal to the growth rate of the mean mass is least accurate at the bin boundaries."
   It is better to explain this on the previous page
4. p. 21637, line 20: How is this equation calculated for partially empty bins?
5. P. 21638, Eq. 16: Should the exponent in the denominator be 3 instead of 2?
6. P. 21642, line 20: RMS errors
   Can you also show the RMS error for <u>mass</u>?
7. With Figs. 2 and 4, Tables 1 and 2 are redundant.