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Interactive comment on "Development of an aerosol microphysical module: Aerosol Two-dimensional bin module for foRmation and Aging Simulation (ATRAS)" *by* H. Matsui et al.

Anonymous Referee #2

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The paper "Development of an aerosolk microphyiscal module: Aerosol Two-dimensional bin module for foRmation and Aging Simulation (ATRAS)" by Matsui at al. describes the structure of a detailed microphysical aerosol module and its application over East Asia. The model features a high number of aerosol size bins to distinguish the particle composition with respect to the amount of black carbon in the particles. The effect of the detailed mixing state desription and its effects on the BC budget as well as on optical properties and CCN numbers are analysed; furthermore the effect of the model description of nucleation and SOA formation and partitioning is investigated. The paper is well written, even though it is relatively technical. The gain of new scien-

tific knowledge from the paper is only average as typical for model development and evaluation papers, such that a publication in "Geoscientific Model Development" might have been more suitable and should be considered for future publications of this type. Apart from this, I nevertheless recommend publication after addressing a few minor points:

1) Even though the individual model components are described in previous publication are short description of the NPF (e.g. whether The H2SO4-Water system or a more complex scheme (neutral and ion induced nucleation, amines, etc.) is used) and the SOA scheme (number of volatility classes, hygroscopicity, ageing included or not) should be included in the manuscript.

2) The authors mention an increase in computational cost; however, it would be useful for readers to get a reference number (for e.g. the M10SN simulation) of the CPU hours per simulation day required including information on the processor machine type. This would provide information on the real computational cost compared to other "cheaper" aerosol modules.

3) The evalution is relatively simple; a more detailed evaluation of the full composite of the model components as given by ATRAS could be provided in an electronic supplement.

4) The authors state, that there is no consideration of coarse mode emissions. Why is PM2.5 and not PM1 used for the analysis, as this should be more representative for the simulated fine mode aerosol. Is there a significant amount of larger particles in the simulations and where do they come from? They are not visible in Fig. 6d.

5) Does cloud processing and release from evaporated hydrometeors contribute to NPF? If so, how important is this process?

6) Using the M08_SN, M06_SN and M04_SN simulations the authors state that they can explain a certain precentage of the total effect. How is this determined? Is this

simply the difference between the simluations compared to the total spread given by M10_SN compared to M01_SN or are more sophisticated statistical methods, e.g. EOF analysis or other forms of data compression used to explain the variability.

7) Can coated BC particles contribute to CCN? If so, how does the coating change the activation? I would guess that a coating by inorganics should allow the BC to act as CCN. Do you consider aerosol activation of BC coated particles as internally mixed particles with a total hygroscopicity based on the coating and the BC or as hydrophilic particles with a solid core? The latter one, would likely result in more CCN as the hygroscopicity of those particles is larger. Could you analyse from your data which material is in the activated particles and compare the chemical composition of activated particles with those of the original aerosol distribution, i.e. the fraction of activation for each of the bins?

8) When comparing the compensating effects of absorption and budget changes of BC, and the effects of SOA can you state whether these effects are linear? Is SOA only scattering or do you consider some "brown" carbon absorbing as well?

9) To which degree is the high number of bins neccessary, especially for the NPF? Of course, coagulation and further condensation of hydrophilic material and SOA are important for the particle size distribution, but as the model operates on a relatively coarse grid, also the time evolution of the aerosol size distribution from a NPF event to an aged aerosol population is unlikely to be resolved.

10) Comparing the results from MADE-IN (Aquila et al., GMD, 2011) with the findings from ATRAS it seems that the consideration of a mixed BC mode on its own, is already a reasonable improvement for coarse grid models. This manuscript is missing in the list of references.

11) Fig. 6d shows a very strong nucleation mode for the period and domain average. However, there are an substantial amount of aitken and some accumulation mode particles available as well. From a typical thermodynamic point of view condensation

should be preferred to nucleation which usually takes place in individual events. Is condensation considered as a secondary process in your model, overemphasising NPF? Are the individual nucleation events so strong that they prevail in the spatial and temporal average? How is the variability (spatial and temporal) of this distribution? Could you check how much inorganic material is in the aerosol phase from NPF compared to condensation?

12) Fig. 8a is in the text referenced as column AAOD, but in the figure caption at a specific altitude. What is correct? The values appear to be relatively large for a single altitude. If the latter is the case what is the thickness of the layer? 8b and 8c are likely given at the specific altitude.

13) Fig. 10 is interesting, but only very shortly described in the manuscript. In my opinion this figure summarises your findings well and its discussion should be extended - potentially also as part of the conclusions if accompanied with some quantitative numbers.

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