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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Comment on Kokkola et al. (2008) – Comparisons with analytical solutions from Khvorostyanov and Curry (2007) on the critical droplet radii and supersaturations of CCN with insoluble fractions" *by* V. I. Khvorostyanov and J. A. Curry

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To clarify the previous comment SC C257 on the manuscript (Khvorostyanov and Curry, 2009): In my comment, my intention was not to discard the major conclusions in the manuscript, only the erroneous use of plus instead of minus, since changing plus to minus does not reproduce the curves in Fig 1 of Kokkola et al., 2008. We agree that, as

said in the manuscript, the conclusion of the validity of KC07 only for a certain insoluble fraction is false and also a result by an error in calculation. Also, major conclusions are correct in the manuscript.

Also in my comment, I am trying to emphasise that the comparison should have been done so that r_{cr} from equation (27) which is the analytical solution to the Kohler equation was used and thus corresponds to the analytical solution given by Kokkola et al., 2008. In Kok08, critical radius was erroneously calculated from equation (30) and substituted in equation (31). As was stated in KC07, this equation (30) can be used when soluble fractions are very small or when radii are small. So, using this equation (30) to validate the equations in Kok08 lead to false conclusions about the validity of KC07. This was a human error and in no way an attempt to deliberately detract from the importance of KC07. Maybe it would have been easier to find this out by contacting us first.

In the reply by AC C492, Dr. Khvorostyanov raised an issue of assuming ideal solution in the cloud droplets. On the other hand, equations given in Kok08 were derived with an assumption that they are used in large scale atmospheric models which need fast calculation of critical supersaturation of the droplets. In atmospheric conditions, particles with insoluble core and low soluble fraction are most likely found in large particles. For large particles, the water mole fraction can be safely assumed to be close to unity at cloud activation. Yet, if particles with diameter of 50 nm and soluble fraction of 10^{-2} are found in the atmosphere, the water mole fraction will go down to slightly over 0.99. On the other hand, the critical supersaturation needed for these particles to activate will be more than 2 %. In practice, the dilute assumption should be valid in all atmospheric conditions. It is unlikely that in atmospheric conditions the assumption of ideality will result in 10 % error as suggested.

Khvorostyanov, V. I. and Curry, J. A.: Comment on Kokkola et al. (2008) – Comparisons with analytical solutions from Khvorostyanov and Curry (2007) on the critical droplet radii and supersaturations of CCN with insoluble fractions, Atmos. Chem. Phys.

Discuss., 9, 9537-9550, 2009.

Kokkola, H., Vesterinen, M., Anttila, T., Laaksonen, A., and Lehtinen, K. E. J.: Technical note: Analytical formulae for the critical supersaturations and droplet diameters of CCN containing insoluble material, Atmos. Chem. Phys., 8, 1985-1988, 2008

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 9537, 2009.