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Interactive comment on "The effect of physical and chemical aerosol properties on warm cloud droplet activation" *by* G. McFiggans et al.

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The authors have written an extensive and very interesting manuscript and address in many ways the need to have a review of aerosol effects on warm cloud formation. I would like to comment the authors on their work and effort that has gone into this manuscript!

After going through the document, I have noticed some important reference omissions and a few incorrect statements. These need to be corrected and addressed before the manuscript is publishable.

General comment: The paper does not consider numerous studies (e.g., Conant et al., 2003; Meskhidze et al., 2005) that focus on cloud-droplet closure, and the ability of cloud droplet formation parameterizations to predict cloud droplet concentrations in insitu clouds. A relevant issue is quantifying the CCN prediction error with cloud droplet number error, and its relevance for the aerosol indirect effect (e.g., Sotiropoulou et al., 2006). Please include them.

Page 11: In mentioning activation parameterizations for lognormal aerosol, the authors did not mention the Fountoukis and Nenes (2005) parameterization, which can consider an external mixture of lognormal aerosol concurrently competing for water vapor, as well as aerosol containing organic surfactants that depress surface tension and the water vapor accommodation coefficient. The authors also do not reference the Nenes and Seinfeld (2003) which can consider all the compositional complexities of the Fountoukis and Nenes (2005) formulation, but within a sectional aerosol framework. It should also be noted that Cohard and Pinty parameterization are developed for a generalized sigmoidal CCN spectrum, and not necessarily for lognormal aerosol alone.

Section 3.1.3 : The work of Rissman et al., (2004) should also be referenced here, as it provides sensitivity ratios (calculated analytically) using a modified aerosol activation parameterization. The title of the paper itself indicates that the Twomey effect may actually decrease droplet formation, and this is shown clearly. Furthermore, Rissman et al. explore the effect of the organic fraction (solubility, surface tension depression), which is not done in Feingold (2003), and provide conditions where sensitivity of droplet number to fluctuations in organic variability can compete with dynamic variability in clouds.

Page 31: It should be noted that a major difference between some CCN instruments is that some * count * droplets that form, while others * infer * CCN spectra.

Page 32: "A representative value is ˜ 10 s and is consistent with growth times in many CCN instruments. AlthoughĚ experimentally." This statement is not exactly true. The groups that use continuous flow chambers typically examine the effect of exposure time on CCN activation, and examine whether or not the exposure time biases the CCN concentrations.

Page 75: “Abdul-Razzak and Ghan (2000) developed a parameterisation based on Kohler theory that can describe cloud droplet formation for a multi-modal aerosol. This approach has been extended by Nenes et al. (2001b) to include kinetic effects, such that the largest aerosols do not have time to grow to their equilibrium size.” This statement is incorrect. First of all, the appropriate reference is Nenes and Seinfeld (2003) (and not Nenes et al., 2001!). Second, Nenes and Seinfeld (2003) did NOT extend the Abdul-Razzak approach, which is based on determining maximum supersaturation by fitting parcel model simulations to non-dimensional groups through non-linear regression. Nenes and Seinfeld completely revisited the droplet growth problem and came up with a largely analytical treatment of the problem “from scratch”. Anyone reading the relevant papers would see the difference. Also, the Nenes and Seinfeld (2003) paper is for sectional, externally mixed aerosol with any kind of chemical composition. Surfactants are treated (figure 10 of Nenes and Seinfeld, 2003), and with the modifications of Fountoukis and Nenes (2005), film-forming compounds and slowly-growing CCN can be explicitly treated in both sectional (Nenes and Seinfeld, 2003) and lognormal (Fountoukis and Nenes, 2005) formulations of the parameterization.

Page 75: “While the effect of surface-active organics and slightly soluble organics has recently been included in the parameterisation of cloud droplet formation by Abdul-Razzak and Ghan (2004, 2005), other effects of organics, such as their filmforming ability are not considered yet.” Nenes and Seinfeld (2003), Rissman et al (2004) and Fountoukis and Nenes (2005) consider surface tension depression. Also, Fountoukis and Nenes (2005), hence, Nenes and Seinfeld (2003), can consider film-forming compounds (i.e., changes in accommodation coefficient). Please correct accordingly.

General comment: Compositional effects on the size of Giant CCN (GCCN) can have some interesting impacts on cloud microphysics. The authors point out the work of

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Medina and Nenes, where film-forming compounds can potentially reduce the size of GCCN. To this effect, black carbon inclusions can also act in a similar manner (Nenes et al., 2002b), if important, a warming mechanism can decrease cloud drizzle and potentially enhance SW cooling.

References

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