Atmos. Chem. Phys. Discuss., 10, C14579–C14584, 2011
www.atmos-chem-phys-discuss.net/10/C14579/2011/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Measurements of cloud condensation nuclei activity and droplet activation kinetics of fresh unprocessed regional dust samples and minerals" *by* P. Kumar et al.

P. Kumar et al.

nenes@eas.gatech.edu

Received and published: 17 March 2011

We thank Anonymous Referee #1 for the thoughtful comments. Please find our responses to the comments below.

Reviewer: The paper focuses on unprocessed mineral dust. Could the authors expand the discussion a little to postulate how the presence of hydrophillic material would affect the activation. Although dust can remain unprocessed in the atmosphere it is unlikely that pure dust particles will exist far from source. Would coagulation with e.g. soot block adsorption in some of the surface area? Can FHH and KT be combined in some way for mixed particles?

Author: We have expanded the discussion on the presence of hydrophilic material on activation. There are a fair number of published studies that document dust remain unprocessed after long-range (transatlantic) transport (Prospero, 1999; Ganor and Mamane, 1982; Ganor and Foner, 1996). It is possible that mixing with other atmospheric particles (like soot) may affect the surface area available for adsorption, but is not treated in this study. If the dust is mixed with soluble species, the threshold of nucleation will certainly be lower than that for a pure hydrophilic insoluble FHH particle because of solute effects on water activity. A theory that combines KT with FHH-AT is addressed in a sequel paper to be submitted shortly for publication in ACP (Kumar et al., 2011, in preparation).

Reviewer: The authors propose that one set of FHH parameters are suitable for all species considered, please place these values in context of other measurements of AFHH and BFHH, for example Kumar et al, GRL, 2009 Table 1, suggest that Arizona test dust has a AFHH = 0.27 and BFHH = 0.79, which is different to that proposed here. Is that all from the charge and shape corrections? Please clarify.

Author: The differences in FHH parameters for ATD between Kumar et al., GRL, 2009 and this study likely arise from the application of charge and shape corrections used in the latter. Furthermore, data presented in the in our GRL, 2009 paper were taken from [Koehler et al., 2009] that used a fluidized bed to generate aerosols, while in this study we performed measurements using a dry generation soft-saltation technique. We have clarified these points in the revised manuscript.

Reviewer: Section 3.1.2: As the value of shape factor is unknown for the samples the authors use a range of non-sphericities to test the sensitivity of the derived Sc-Ddry relationship to non-sphericity. It is unclear to me how this range was used in the calculation (page 31051 around line 20).

Author: We revised the text to clarify this point.. In our approach, we used χ = 1.3 to *convert from charge corrected electrical mobility diameter, D_m to the shape corrected surface-area equivalent diameter, D_{se}. The error bars on D_{se} represent the range using χ = 1.1 as the lower limit and χ = 1.5 as the upper limit.*

Reviewer: Section 3.1.1: Explain why the non-sphericity causes an increase in the activation diameter.

Author: In a DMA, the particle size is selected according to the electrical mobility equivalent diameter, which assumes a spherical shape of the particles. However, non-spherical particles experience more drag than their volume equivalent spheres because they present a larger surface area. As a result actual drag force measured inside the DMA is lower than what is should actually be. This causes an underestimation of drag force on the particle, which translates to an underestimation of the surface area of the particle. Consequently, a correction of drag force expressed in terms of D_{se} results in phenomenically larger activation diameters. A complete derivation has been provided by Leith (1987).

Reviewer: It would be interesting to also see the dependence of the calculated AFHH and BFHH on the assumed value of χ

Author: We included the dependence of the calculated A_{FHH} and B_{FHH} on the assumed value of χ in Table 2 of the revised manuscript.

Reviewer: Section 3.3: What is the significance of the retarded kinetics for cloud formation and properties?

Author: Retarded activation kinetics may have an impact on the activated droplet number in clouds that contain dust CCN. The extent of the impact depends on the vertical velocity, CCN concentration and the relative proportion of KT to FHH-AT particles. A thorough assessment will be the focus of a future study.

Minor Comments and Typos

Reviewer: Page 31040, line 24. Really? I would suggest that there are organic

species less understood than dust.

Author: We changed the text to read as "Amongst atmospheric aerosol species, mineral aerosol (or dust) is one of the lesser understood components in the study of aerosol-cloud-climate interactions."

Reviewer: Page 31043, Line 25. Should read "even when it is well known" (or "even though").

Author: Done

Reviewer: Page 31047, Line 19. condensational growth

Author: Done

Reviewer: Equation 1: Define k prime straight after equation 1 and define Hv and Seq (or atleast point reader to the Appendix).

Author: Done.

Reviewer: Page 31050, Line 26. "somewhat higher compared to AR equal to", please rephrase.

Author: Done

Reviewer: Page 31051, Line 2. What are the techniques that give rise to different morphologies?

Author: The techniques involve soft-saltation method (this study), a fluidized bed (Koehler et al., 2009; Herich et al., 2009), and atomization of a dust aqueous suspension (Koehler et al., 2009; Herich et al., 2009; Kumar et al., in preparation).

Reviewer: Page 31054, Line 17. "KT aerosol" is an confusing expression here. Rephrase

Author: Changed to "for soluble aerosol like $(NH_4)_2SO_4$"

Reviewer: Page 31058, Line 23. aerosol at the same... determined for the...

Author: Done.

Reviewer: Page 31058, Line 23. the difference in outlet.. outlet? size?

textitAuthor: Changed to “outlet size..”

Reviewer:Page 31059, Line 14. consistent with the slower..

Author: changed to “consistent with the slower..”

Reviewer:Page 31060, Line 11. multiple charge corrections (not charging)

Author: Done

References:

Ganor, E., and Foner, H: The mineralogical and chemical properties and behavior of Aeolian Saharan dust over Israel, in The Impact of Desert Dust Across the Mediterranean, edited by S. Guerzoni and R. Chester, pp. 163– 172, Springer, New York, 1996.

Ganor, E., and Mamane, Y.: Transport of Saharan dust across the eastern Mediterranean, Atmos. Environ., 16, 581– 587, 1982.

Herich, H., Tritscher, T., Wiacek, A., Gysel, M., Weingartner, E., Lohmann, U., Baltensperger, U., and Cziczo, D. J.: Water uptake of clay and desert dust aerosol particles at sub- and supersaturated water vapor conditions, Phys. Chem. Chem. Phys., 11, 7804-7809, doi:10.1039/b901585j, 2009.

Koehler, K. A., Kreidenweis, S. M., DeMott, P. J., Petters, M. D., Prenni, A. J., and Carrico, C. M.: Hygroscopicity and cloud droplet activation of mineral dust aerosol, Geophys. Res. Lett., 36, L08805, doi:10.1029/2009GL037348, 2009.

Kumar, P., Sokolik, I. N., and Nenes, A.: Parameterization of cloud droplet formation for global and regional models: including adsorption activation from insoluble CCN, Atmos.

Chem. Phys., 9, 2517-2532, 2009a, http://www.atmos-chem-phys.net/9/2517/2009/.

Kumar, P., Nenes, A., and Sokolik, I. N.: Importance of adsorption for CCN activity and hygroscopic properties of mineral dust aerosol, Geophys. Res. Lett., 36, L24804, doi:10.1029/2009GL040827, 2009b.

Kumar, P., Sokolik, I. N., and Nenes, A.: Measurements of cloud condensation nuclei activity and droplet activation kinetics of wet processed regional dust samples and minerals, Atmos. Chem. Phys. Discuss., 2011, (manuscript in preparation).

Leith, D.: Drag on nonspherical objects, Aerosol Sci. Tech., 6, 153–161, 1987.

Prospero, J. M.: Long-range transport of mineral dust in the global atmosphere: Impact of African dust on the environment of the southeastern United States, Proc. Natl. Acad. Sci. USA, 96, 3396 - 3403, 1999.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 31039, 2010.