Interactive comment on "The MESSy aerosol submodel MADE3 (v2.0b): description and a box model test" *by* J. C. Kaiser et al.

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General Comments: The authors describe a revision of the Modal Aerosol Dynamics model for Europe (MADE) to allow for more aerosol species to be considered. It is very well presented contribution, especially the background of the modeling development. The main thrust of this paper is the inclusion of an active coarse mode allowing gas-phase species to partition (condense) upon the sea-salt and dust particles as well as allowing BC to be possible present in the coarse mode. This is an excellent improvement.

Specific Comments

Discussion of coagulation is not quite transparent. For example Equations 1 and 2 de-

scribes the number coagulation process from Riemer (2009), but equations 13 and 14 are for number and mass and seem to have little to do with equations 1 and 2. Further the discussion of equation 15 is not completely clear because it depends upon the first Kroecker delta in which the subscripts are not quite consistent; e.g. one subscript is an integer, the second subscript is an array. The coagulation in this system is complicated and important. Thus, an appendix describing this in a bit more detail would help the reader grasp the way coagulation is actually calculated. Further, a diagram or table similar to Table 3. of Aquila et al. (2011) for the 9 by 9 system described here would be greatly appreciated.

Page 709. The authors chose to compare MADE3 with MADE from the Lauer et al. (2005) paper rather than comparing with MADE-in (Aquila et al., 2011) even when they say the path to MADE3 was through MADE-in. This confuses the situation. MADE3 is closer to MADE-in than it is to MADE. Why not just compare with MADE-in?

Page 710 –lines 1 and 2 How do dust particles get into the Aitken mode?

Pages 710 and 711 describe PartMC-MOSAIC and alternative aerosol dynamics method that tracks individual particles rather than particle distributions. (Here is where Equation 1 is more appropriately displayed). The authors have chosen to use PartMC-MOSAIC as a reference method. It is important to note here that the difference between MOSAIC and EQSAM (EQuilibrium Simplified Aerosol Model) form a second confounder between MADE3 and PartMC-MOSAIC. Thus, comparisons between MADE3-EQSAM PartMC-MOSAIC should be made with great caution, as the authors have done.

The difference in Aitken mode behavior between MADE3-EQSAM and PartMC-MOSAIC is most likely due to the fact that these comparisons are done in a box-model. Transport processes tend to broaden the size distributions in an Eulerian framework. This broadening is often excessive as our experience with CMAQ shows. The limitations that we put in were to keep the geometric standard deviations from growing too

large.

Ambient data do not seem to show this very narrow Aitken mode. Therefore, fixed geometric standard deviations is a much better idea 3D codes.