

## ***Interactive comment on “MATRIX-VBS: implementing an evolving organic aerosol volatility in an aerosol microphysics model” by Chloe Y. Gao et al.***

**Anonymous Referee #1**

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This paper documents the addition of the VBS to a box model of MATRIX and shows results from some basic test simulations. It generally fits with GMD and overall seems scientifically sound. However, the paper is missing much information that would be necessary for someone to repeat the analysis, and I believe there is an issue with Figures 6 and 7. I support publication of this paper once my concerns are addressed.

Figures 6 and 7: In Figures 6 and 7, for each population, the median diameters of the number, surface-area, and volume distributions are all the same. For example, in Figure 6 for “T=120hr new”, the median diameter for BOC is 80 nm in each of the three distributions. The median diameter of a mode is only the same for number, surface area, and volume distributions if the particles are in that mode are all exactly

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the same size. Yet, the modes representing the populations in Figures 6 and 7 are shown having a finite width, which means that the median diameter of the surface-area median diameter should be larger than the number-median diameter, and the volume-median diameter larger than that for surface area. I'm guessing that MATRIX is only simulating 2 moments per population (though this is never explicitly stated) and an assumption is made about a 3rd moment is made in order to get the modal width in Figures 6 and 7. This 3rd-moment assumption is fine, but this 3rd-moment assumption needs to be consistently used such that the median diameters shift between the three distributions.

The following information is either missing from the paper or shows up later than ideal: Enthalpy of vaporization that drives the temperature dependence of C\*s. How many moments tracked per population? I'm guessing 2 since that what I remember from previous MATRIX papers, but it needs to be explicitly stated here. Which moments? Number and mass (volume)? In Figures 6 and 7, it looks like the moments are converted to modes. If there are just 2 moments, I'm guessing you assumed a fixed width (this looks to be the case). What width did you use or what did you assume about a 3rd moment? Also see comment about the number, surface area, and volume median diameters of the modes incorrectly being the same. Several things should be explicitly stated in the methods but aren't discussed until later in the paper: (a) the duration of the simulations (10 days), (b) are emission continuous?, (c) oxidant concentrations. What is the diurnal cycle of temperature and oxidant concentrations? What are the gas-phase chemical rate constants? Is condensation/evaporation to each population calculated through kinetic mass transfer, or are the populations and gas-phase assumed to be in instantaneous equilibrium? Instantaneous equilibrium might work ok here where all of the populations interacting with the gas-phase organics are essentially all accumulation mode (and thus the populations have similar equilibrium timescales); however, this assumption will likely fail when the authors begin to consider organic uptake to the nucleation and Aitken modes, and the equilibration time will vary between modes.

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Other comments

Title: “an evolving organic aerosol volatility” sounds awkward to me. What about “an organic aerosol volatility scheme” or removing the word “an” from the current title?

P1 L21: Can you define the low- and high-volatility ranges?

P1 L22: “The \*final\* volatility distribution. . .”?

P4 L27: This sentence is confusing. I thought that in the old scheme, non-volatile SOA condensed onto modes too (see P3 L21), but this sentence says coagulation is the only process involving organics.

Figures 2 and 3: I think it would make more sense to have the black line showing the mass in the old scheme in the “aerosol phase” panels rather than the “total” panels since the old scheme was only tracking the aerosol mass. I view the aerosol mass in the new scheme and the old scheme’s aerosol mass as the apples-to-apples comparison.

P7 L30: “...total gas-phase \*concentration\* reaches. . .”

P8 L6: “...would expect \*higher\* gas-phase \*concentrations\* due to. . .”

Copy editing: The paper would benefit from having compound adjectives being properly hyphenated. Also commas appear in some places they shouldn’t and don’t appear in some places they should.

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