

## ***Interactive comment on “The effect of dry and wet deposition of condensable vapors on secondary organic aerosols concentrations over the continental US” by C. Knote et al.***

**Anonymous Referee #3**

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General Comments: This is an interesting paper that has important implications for air quality modeling, particularly for prediction of secondary organic aerosol (SOA). The paper is well written and logically presented. The paper presents a modeling study where a new method for estimating Henry's law solubility constants (H) for gas-phase SVOCs is used in WRF-Chem to compute wet and dry deposition. They contend that this new method of estimating H for SVOCs according to volatility in the VBS SOA model in WRF-Chem reduces SOA concentrations by roughly half compared to modeling with no consideration of SVOC deposition. One problem is that the paper which describes the Henry's law estimates according to volatility is not yet published.

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Thus there should be more description of the parameterizations from the Hodzic et al. (2014) paper here.

While the study does a reasonable job of exploring various sources of uncertainty, a glaring exception is in the dry deposition calculations which is clearly a key process. The WRF-Chem uses the Wesely (1989) dry deposition model which parameterizes deposition with serial and parallel resistances. Many of the surface resistances are functions of Henry's law values for both wet and dry surfaces. The manuscript includes very little description of the dry deposition model and seems to assume that there is no significant uncertainty in its formulation. Wesely (1989) discusses many limitations and simplifications involved in his model and therefore makes it clear that the dry deposition estimates are very uncertain especially for chemical species other than ozone or SO<sub>2</sub>. While the Wesely model was an important advance in dry deposition modeling when it was published it is now quite out of date. A particularly important aspect of the Wesely model is the pervasive influence of H in all conditions. More recent models parameterize resistance to wet surfaces as functions of solubility but not dry surfaces. Thus the Wesely model is likely to be much more sensitive to H than other dry deposition models especially in dry climates. The resulting effects of including dry deposition on SOA as shown in Figure 4 seem unreasonable in that the effects are similar in the dry western part of the US as in the much wetter climate in the East. Even if it is hypothesized that dry cuticle resistance should scale on H there is so much less vegetation in most of the western areas that there should be little influence of solubility. There is certainly no reason that deposition to dry ground should scale on H. Thus I suggest that this study be re-modeled using a more up-to-date dry deposition model that has more realistic treatment of the effects of vegetation coverage and where the influence of solubility is primarily for wet surfaces (dew or rain).

Specific comments:

Page13734 line1: It should be noted that the CMAQ model uses acetic acid as a surrogate in the dry deposition calculation and adipic acid in the wet deposition calculation.

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P13737 ln11-12: How the Wesely model uses H in the parameterization of various surface resistances should be much more thoroughly described. Simply saying that H is used for “partitioning into plants and other wet surfaces” is incomplete and incorrect. If H were not also used in scaling of resistances to dry surfaces the effects shown in this paper would probably not be nearly so large. These issues need to be addressed.

P13738ln15: what is “the forcing data”?

P13739lns12-16: The surface resistance should become negligible at very high H\* only when the ground and leaves are wet. I think this is a critical flaw in this study.

P13742ln2: I think the words “in summer” were left off the end of this sentence.

P13745ln8: Please give reference for the H\* value for HNO<sub>3</sub>. Note that Wesely (1989) used 10e14.

P13746lns10-11: please re-write this sentence.

P13746ln22: should give units.

P13747lns27-29: This sentence should be qualified to state “for wet deposition only”. There is no such evaluation and confidence for dry deposition.

Figure 5: these plots are way too small.

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