

***Interactive comment on* “Formation of secondary aerosols: impact of the gas-phase chemical mechanism” by Y. Kim et al.**

Anonymous Referee #2

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This manuscript addresses the impact of two specific gas-phase chemical mechanisms (CB05 and RACM2) on resulting predictions of secondary particulate matter in Europe; the title should state this more explicitly (as opposed to generally, which gives the impression that several mechanisms were tested). Simulation of secondary particulate matter is certainly of relevance to the readership of ACP, but I will admit that I felt as if I were reading a consulting report, not a scientific manuscript. I do not feel that conclusions or interpretations beyond “these simulation results differ between the two mechanisms because of reason x, y, or z” were made (and many of these results were intuitive). Tools and analysis techniques were unoriginal, but the scientific method used was sound. That being said, the manuscript was well written and used appropriate citations. The abstract captures the contents of the manuscript adequately. Tables provide necessary information, and the figures, while numerous and somewhat repet-

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itive, do as well. There are no major weaknesses with this paper beyond a lack of interpretation/conclusions; however, in my opinion, this is sufficient to prevent publication. Several questions, suggestions, and corrections follow in case the editors/other reviewers disagree and wish to encourage publication.

It should be noted that one of the major references cited (that describes the SOA model being used) [Debry et al., 2007] is not from a published, peer-reviewed manuscript. Perhaps the authors should consider providing more details on that model in this manuscript? That would certainly make an impact on the importance of this paper.

At the start of section 2.2, the authors state that oxidation of organics lowers volatility. This is not strictly always true – in some gases, fragmentation occurs that breaks carbon chains, increasing the volatility.

Does copying reactions from RACM2 into CB05 as described on page 20631, line 14, homogenize the mechanisms, thereby defeating the whole purpose of this exercise?

On page 20632, line 19, should it say that the EMEP inventory provides yearly emissions of PM, not yearly concentrations? On line 24, the definitions of API and LIM should be given earlier (upon first use; those abbreviations are used previously in the text).

At the top of page 20633, are sea-salt emissions included in fine or coarse aerosol? Earlier the manuscript states that PM coarse is totally attributed to dust and also gives a distribution for PM fine. Is this first set of information only for emissions on land? If so, this needs to be specified. If the sea salt emissions composition is for over coastal domains, how is the sea salt distributed between fine and coarse material?

I applaud the authors' effort to evaluate the model versus observed data. However, not enough information is given regarding the temporal resolution of the data, the sites that are used, the methodology for data generation, etc. (section 3.2).

With respect to sulfate formation, the model results indicate that the predominant path-

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way is via $\text{SO}_2 + \text{OH}$. Does this occur in upper levels of the model? In general, near the surface, SO_2 deposition is thought to occur more rapidly than its homogeneous oxidation by OH.

The statement on page 20639, line 10 concerns me in that it implies that emissions rates are different between the two mechanistic applications. This confounds their comparison of output results because, for example, you will get more SOA from compound A in a model if more of compound A is emitted. If the impact of the mechanism is to be isolated, emissions need to be identical.

The version of Figure 6 provided needs to be updated. It appears that the value being presented only has three values across the entire continent (zero, 1, and somewhere in between). I assume this is incorrect.

Corrections: 20626, lines 20 and 22, should aromatics be aromatic?

20627, lines 1-5, these need to be broken into two complete sentences

20627, line 19, references for these mechanisms should be provided

20627, line 20, formations should be formation

20629, line 17, specifies that organic reactions added/modified are described in the following paragraph. However, the following paragraph discusses N_2O_5

20632, line 14, non does not need to be capitalized

20637, lines 11 to 15, these need to be broken into two complete sentences

20638, line 11, need with between reaction and LIM; line 17, the first SOA can be removed

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