

## ***Interactive comment on “A new chemistry option in WRF/Chem v. 3.4 for the simulation of direct and indirect aerosol effects using VBS: evaluation against IMPACT-EUCAARI data” by P. Tuccella et al.***

### **Anonymous Referee #2**

Received and published: 2 April 2015

This paper describes a new option for WRF/Chem to allow the simulation of aerosol direct and indirect effects (based on the existing aerosol microphysics scheme (including a VBS treatment of SOA)) and their feedbacks on clouds and meteorology. The paper is interesting and certainly within the scope of GMD, I would recommend publication after clarification on the below issues.

Most of my comments relate to adding extra details/clarification that I think are probably necessary given that this is GMD.

My general thoughts are that it is not entirely clear whether including the new VBS treat-  
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ment of SOA represents an improvement here or not, since the comparison is made to an equivalent simulation without SOA (not the previous version of WRF/Chem). This is something that could be addressed in the Conclusions and Abstract.

Specific Comments:

p794, line 18: Specify here that you are talking about the change in aerosol due to anthropogenic emissions, since pre-industrial times

p795, line 22: the range given by Scott et al. (2014) was +0.01 W/m<sup>2</sup> to -0.77 W/m<sup>2</sup>, when accounting for the potential contribution of biogenics to new particle formation.

p796, line 22-23: given that this is a new aspect that you are examining I think this requires slightly more detail than one sentence. The reader can look up Ahmadov et al 2012 but it would be good to summarise briefly here what this approach involves.

p799, line 15-17: at the moment this reads slightly like you have the PM<sub>2.5</sub> and PM<sub>10</sub> emissions and then add extra EC and OC? Might be worth rephrasing to clarify here, is the PM<sub>2.5</sub> / PM<sub>10</sub> disaggregated into different components?

p799, line 25: which biogenic emissions do you include? Monoterpenes? Isoprene? Do the NMVOCs contribute anthropogenic SOA?

p799, line 26: where do the dust and sea-salt fluxes come from?

p809, line 24-26: could you expand on this? Or at least clarify the implication, which I think is that if POM is underestimated, the amount of SOA being formed would also be underestimated (according to the VBS approach)

p810, lines 11-15: in this section you refer to some of the specific flights, but other than the date/time of the flights given in Table S1, we don't have any other information about where these flights went; an additional figure to show the flight tracks would be useful, if possible.

p811, lines 18-19: how do you actually calculate CCN from the model? Sorry if I've

missed this somewhere, Figure 8 just says calculated at 0.2%. Later on you refer to calculating CCN using the particles in the accumulation mode, and mention the hygroscopicity of aerosol, so some clarification on how this calculation is done in WRF/Chem would be beneficial.

p811, lines 22-24: this seems like a point that is relevant to your observed v. simulated CN comparisons? if you are missing everything below 15 nm in the observations surely this would account for some of your over prediction, unless you are calculating your modelled CN above 15 nm? Then you say “Therefore the so calculated CCN efficiency is underestimated.” But if you are talking about the observations, I would have thought the CCN efficiency is overestimated if your CN value is lower than it should be? Or do you mean relative to the modelled CCN efficiency? Either way this paragraph requires some clarification.

p812, line 13-14: this is tricky to attribute to anything because we don't have any spatial information on where the number (and mass which is probably more important for AOT at 550 nm?) is over predicted, whereas the AOT is over predicted predominantly in the east of the domain

p812, line 14-17: so what is the implication of this? It's probably worth reiterating what your assumptions are regarding mixing state

p813, line 1-2: I think this sentence requires some rephrasing, shift in what sense?

p813, line 8+: it would be useful here to clarify what you are actually turning off, the biogenic emissions? just in this domain? (+ what are the implications of that) It would also be useful to have some domain wide summary statistics (like Table 3) for the NOSOA simulation. Also it would be good to be consistent with how you refer to these simulations i.e., CTRL (sometimes called “reference run”) and NOSOA (sometimes called “sensitivity run”)

p814, line 17: I wouldn't use the word larger (this suggests something about the size of

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the CCN), do you mean higher concentrations? The increase in droplet concentration does not spatially overlap with the increase in CCN concentration, it would be worth some explanation of this, particularly since in the previous section you are suggesting that overestimating CCN would lead to overestimating CDN which would lead to overestimating CWP.

p814, line 24-26: Unless I've misunderstood, something is the wrong way around here, which simulation has 10% more optically thin clouds? Or is it just a coincidence that the difference between the amount of the total clouds accounted for by thin clouds in each sim is also 10%?

p815, lines 3-4: where does the smaller effective radius come from? The previous sentence made sense, perhaps remove (or clarify) this one

p819, line 5: it would be good to keep the description consistent, if you're using VBS to simulate the partitioning of secondary organics into the particle phase, you're not excluding “SOA particles” as such, would be better to say “SOA is excluded”

p819, lines 20-21: these are not the same values as you give on p814, so one set needs updating.

Technical Comments:

P793, line 4: insert “the” before WRF/Chem?

p797, line 7: insert “the” before “new chemistry package”?

p798, line 17: remove “the” before Table 1

p801, line 9: replace “counters” with counter?

p802, line 4-6: refer the reader to Table 2 here.

p807, line 10-11: refer the reader to Figure 6 here

p811, line 4: the end of this sentence doesn't make sense, please rephrase

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p811, line 6-7: again doesn't quite make sense, please rephrase (perhaps replace "of predicted CN larger" with "between simulated and observed CN being larger")

p811, line 12: "Andrea" should be "Andreae" (it's correct in the Reference list)

P813, line 20: replace "ticker" with "thicker"

p835, Table 2: I think it would be useful to specify in the caption what the abbreviations (WS, WD etc) mean so that the reader doesn't need to look elsewhere. Also should the 6th entry in the WD section be WD200 (currently reads WS200)?

p844 and p845, Figures 7 and 8: although these are the same as Figure 6 it would be useful to include in the caption what the different colours represent so the reader does not have to keep referring back to Figure 6.

Supp Info: I think the second "Figure S1" should be called Figure S2.

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Interactive comment on Geosci. Model Dev. Discuss., 8, 791, 2015.