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Interactive comment on "Modelling of primary aerosols in the chemical transport model MOCAGE: development and evaluation of aerosol physical parameterizations" *by* B. Sič et al.

Anonymous Referee #1

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General Comments:

This paper documents several developments recently made in the chemical transport model of Meteo-France (MOCAGE). This includes updates to aerosol emission parameterizations for dust and sea salt, and also updates to parameterizations for aerosol wet deposition and sedimentation. The paper evaluates the current and updated model using aerosol optical depth (AOD) from MODIS and AERONET. Comparisons are also made to AeroCom multi-model averages and with regional AOD over Europe from SEVIRI geostationary observations. Results of sensitivity studies are also presented to isolate the impact of the various changes. The paper is generally well organized. However, there are several points where the discussion appears to lack completeness or

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clarity, as outlined below. The paper should be suitable for publication if the following points can be satisfactorily addressed.

Specific Comments:

1) P2751L19-22: Could you include a note here about how the water uptake on the aerosol is considered?

2) P2752L7: Please specify if dry or wet diameter is used in the equation. Similarly, in the discussion of the below-cloud scavenging parameterization, please specify if wet or dry diameter is used. Also, perhaps I missed this, but was there a description of the dry deposition scheme used in the model?

3) P2753L10: I assumed here that there are separate calculations for both in-cloud and below-cloud scavenging as opposed to only one coefficient, but this could be more clearly indicated.

4) P2753L23: Is Q a grid-mean value and is L_st an in-cloud value? Please specify? Also does Q include both liquid and ice or only liquid? Is there any temperature dependence to the in-cloud scavenging?

5) Section 3.2: I was not clear about the model's previous parameterization for the fraction of precipitating cloud cover that was used in the SIM1. I assume this section described the parameterization for SIM2.

6) P2754L15: By 'scavenging coefficient', do you mean the below-cloud or in-cloud scavenging coefficient or both?

7) P2754L24: Is Q in this equation the same as Q in Eq. 5? I think that Q in Eq. 5 is the grid mean Q based on Giorgi and Chameides (1986). However, based on the definition of L following Eq. 7, would this Q in Eq. 7 be an in-cloud value? In this equation, I would expect that both Q and L are grid-mean or both are in-cloud values, please specify this more clearly?

8) P2755L1: Could you mention the assumed values for the scavenging efficiency for uptake into the cloud droplets for the species considered in the model that would be used in Eq. 7?

9) P2755L4: Please check this line, do you mean that sulfate is considered as insoluble? This seems strange. Also, are all carbonaceous aerosols treated as soluble species for the purposes of wet deposition in the model? Is all dust also treated as soluble?

10) P2755L15: The text is not clear here about the precipitation fraction used for the purposes of below-cloud scavenging. Is this based on the maximum fraction from overlying layers? This paragraph should also be clearer about the parameterization for the current and the revised model. Would introducing the names of the two primary simulations (SIM1 and SIM2) earlier in the text be helpful in making this description more readable?

11) P2757L5: Is this raindrop diameter or radius?

12) P2757L7: I was not clear here about when the exponential raindrop distribution is used. Is this for SIM2 and the standard model (SIM1) assumes the fixed size? I think this is the case from Table 2, but this is not clear in the text.

13) P2757L13: Is it possible to directly compare a field measurement and a theoretical value for the scavenging coefficient due to confounding dynamical factors?

14) Section 3.2.4: Were you able to isolate the impact of the addition of evaporation between SIM1 and SIM2? Can you comment on this?

15) Section 3.3: Are the emissions of carbonaceous aerosols changed between SIM1 and SIM2? This looks to be the case from Table 4 but I was not clear about the changes when reading this section.

16) P2762L5: The text mentions that hygroscopic growth affects optical properties, sedimentation and dry deposition. Please state clearly if this Eq. 20 is the equation

used in the model to obtain the wet radius for all aerosols for optical properties and deposition and including also for below-cloud scavenging.

17) P2763L5: Are you able to comment on how this change in interpolation influenced the wind fields? Why did you choose to make this change? A comparison of the precipitation fields with GPCP is shown, but are you able to comment on the comparison with observations for the wind fields used? Also the text could be clearer here about which interpolation method used for SIM1 and SIM2, respectively.

18) Section 4: Do you filter the model data using the same criteria as applied to the MODIS data? Also do you sample the model exactly at the satellite overpass times?

19) P2764L8: Is there any filtering process applied to SEVIRI data?

20) P2765L14: Can you quantify what you mean by 'significant improvement'?

21) Figure 1: I found the colors on the right side panels to be counter-intuitive. Would it be better to show (Model – MODIS), then a negative bias as mentioned in P2765L27 would appear as a negative number on the figure.

22) Can you explain why you chose to present 'bias' as your metric opposed to something else such as fractional mean bias, which also allows for error in the observations, as outlined in Boylan and Russell (2006), Atmos.Environ.? Please explicitly provide the definition for your bias metric and perhaps consider presenting an alternative metric. Could a global metric be included perhaps on Fig. 1?

23) P2768L12: Table 4 seems to indicate that the SIM2 burden does not correspond as well to the AeroCom mean as for SIM1, please check this sentence.

24) P2768L15: Do you mean that the sea salt lifetime shows improved agreement with the AeroCom mean, despite the poorer agreement with the burden? Could the text provide information at some point about how the sea salt mass is distributed differently among the 6 size bins between SIM1 and SIM2 and how this impacts the various scavenging processes?

25) P2769L2: Is this 22% decrease for certain species?

26) P2769L27: The text is rather vague about increases and decreases depending on location, could you summarize the most relevant changes more explicitly?

27) P2769L29: There is mention of 'high precipitating cloud fraction' in SIM2_WDEP, but this is not explicitly presented. How much difference was there in this fraction between the simulations? Also were you able to isolate whether this cloud fraction or the addition of re-evaporation had a greater impact on your results?

28) Figure 6b, thinking of the above point and the related discussion of this figure here, would you be able to color-code the points in the scatter plot somehow to indicate the tropical regions where evaporation is expected to be more important?

29) P2770L23: Dust overestimation found by Zhang et al. (2012) does not seem consistent with your findings of underestimation. Please check this. Also here in regard to the Jeagle et al. (2012) paper is the sea salt underestimation value quoted for the tropics or global?

30) P2771L15: Could the apportioning between the bins also contribute to this discrepancy? Could the text more explicitly discuss how this is different between the different simulations and how this influenced the results for dust and sea salt in particular.

31) P2772L3: "longer mean atmospheric residence time" relative to what? Please specify.

32) P2772L13: "complex and balanced"... are there any relevant patterns that you could mention here?

33) P2773L19-22: Please quantify what you mean by 'significantly improve' and 'correspond better'.

34) Table 4: Why is OC missing from the table?

35) Figure 2 and 6: Could any color-coding be added to the scatter plots to provide

more information, perhaps by geographic region?

36) Figure 5: Why was only one day chosen? Were than any other days when the primary aerosols were dominant that could make the comparison more robust?

Technical Corrections:

P2748L15: Consider replacing 'condensate' with 'condense', the more common verb tense.

P2750L2: Consider replacing 'validate' with 'evaluate' as a closer description of your process, here and throughout the text.

P2754L19: Perhaps change 'Besides' to 'Additionally'.

P2759L10: Add 'snow crystal' before 'type'.

P2762L25: Change 'soviet' to 'Soviet'.

P2765L8: Remove the '….' notation in text.

P2770L26: Remove 'than' before 'as'.

P2771L4: Replace 'present time's' with 'present-day'.

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