

Interactive comment on “Development of an inorganic and organic aerosol model (Chimere2017 β v1.0): seasonal and spatial evaluation over Europe” by Florian Couvidat et al.

Anonymous Referee #2

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The manuscript describes an updated aerosol module for the CHIMERE regional air quality model, along with evaluation of these changes against surface concentration measurements over Europe. The updates cover a number of different processes within the model: emissions, wet deposition, evaporation and condensation of both organic and inorganic semi-volatile components and hygroscopic growth. A set of performance criteria from the literature are adopted and the model is shown to perform well against these.

However, while the work itself is a worthy contribution to the field of aerosol modelling for air quality applications, there are a number of deficiencies in the presentation such

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that I would recommend major revisions before the manuscript is suitable for publication in GMD.

General comments

1. There are a very large number of figures (21), many of them with multiple panels and similar in nature and with dense high-frequency time series that are hard to interpret. This makes it difficult for the reader to discern what are the important results being presented. If this level of detail is necessary for completeness, it would be better placed in supplementary material, and a smaller number of clearer figures used to (i) exemplify the raw data, and (ii) summarise its meaning statistically in a visual form.
2. The manuscript presents an updated version of an existing model; however it is frequently unclear how the new schemes described here compare to those used in the reference/baseline version of CHIMERE (Menuet et al., 2013) in their formulation and complexity. Corresponding results for the reference version should also be included, in order to assess not only the absolute performance of the revised model, but to what extent the changes described in this manuscript produce improvements in these performance metrics.
3. In several places in the manuscript, positive and negative biases and larger or smaller errors and correlations are shown at individual stations and over various regions. These may very well be statistically significant variations, however the analysis presented does not adequately demonstrate this.

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Specific comments

4. Page 1, line 1. This describes a “new” aerosol module, although elsewhere it is clear that this is in fact an update to an existing module; the introductory text should be re-worded accordingly.
5. Page 1, lines 1–17. It would be good to see some quantitative results quoted in the abstract about the performance of the updated model and how that compares to the reference/baseline version.
6. Page 1, line 19–page 2, line 3. The introductory paragraph is quite vague on the subject of why such models are useful, despite the list of model references. A little more background on the motivation for such modelling would be welcome.
7. Page 2, line 10. What definition of “fine” is being used in this context?
8. Page 3, line 19–21. An overview of the reference/baseline model version here would be very useful – overall approach and assumptions, what are the tracers used, does it represent the particle size distribution or is it a bulk scheme etc.? This would also make it easier to clarify in the rest of the section how the updated schemes relate to this baseline.
9. Page 3, line 24–page 4, line 10. How does this compare to the chemical mechanism in the baseline version?
10. Page 4, lines 13–22. How does this compare to the treatment of biogenic emissions in the baseline version?
11. Page 4, line 25. A brief discussion of what these emissions are would be helpful, even if further detail is to be found in the reference.

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12. Page 4, line 25–page 5, line 17. This subsection cites various conflicting studies, but leaves the reader unclear as to what conclusion is drawn for the purposes of this work.
13. Page 5, line 20–page 6, line 14. How does this compare to the treatment of aerosol thermodynamics in the baseline version?
14. Page 6, line 10. A description and/or reference should be provided for the “H²O mechanism”.
15. Page 8, line 1–page 9, line 1. How does this compare to the treatment of wet deposition in the baseline version?
16. Page 9, lines 3–28. How does this compare to the treatment of condensation/evaporation in the baseline version?
17. Page 10, lines 1–8. How does this compare to the treatment of coagulation in the baseline version?
18. Page 10, lines 11–12. There are several IFS-based products from ECMWF. Please clarify whether this refers to operational analyses or forecasts, or to one of one of the reanalyses (e.g. ERA-Interim).
19. Page 11, lines 7–11. The description of the observations is very brief, and would benefit from being extended – e.g. what type of instruments to these measurements come from, and how extensive is its coverage in space and time? Also, a reference and acronym expansion should be provided for EBAS if possible.
20. Page 11, lines 23–24. Please explain why this is a likely explanation for the Na and Cl results.
21. Page 13, lines 23–25. It could also be that a third factor which is poorly captured in the model affects both sulfates and nitrates.

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22. Page 14, line 20. Please describe and/or give a reference for MELCHIOR 2.
23. Page 15, line 9. It is not clear whether “OC concentrations were calculated directly” from the model or from observations. Please clarify.
24. Page 16, line 6. MFB for PM₁₀ is still positive, suggesting coarse particles are still *overestimated*, just less so than smaller particles.
25. Page 17, line 26. This sounds like the *measurements* are overestimated, but presumably is intended to say that the *model* overestimates NO₃ *compared to* the measurements?
26. Page 17, line 34–page 18, line 1. Please explain why a lack of HNO₃ condensation is likely to explain this.
27. Page 20, line 23. A reference to the data referred to here would be good.

Technical corrections

28. Page 1, line 8 (and elsewhere): Performances were → Performance was.
 29. Page 1, lines 8 and 10 (and elsewhere): sea salts → sea salt.
 30. Page 1, line 15: most of stations → most of the stations.
 31. Page 2, line 18: dusts → dust.
 32. Page 2, line 24: aerosols thermodynamics → aerosol thermodynamics.
 33. Page 3, line 15: described in *which* part of the paper?
 34. Page 3, lines 25–26: “a” should be before “function”, not “partitioning”.
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35. Page 3, line 28: insert “and” before “equilibrium constants”.
 36. Page 4, line 14: “temperature” and “solar” should not be capitalised.
 37. Page 4, lines 16–17: “wilting point” should not be capitalised.
 38. Page 4, line 20: landuse → land-use.
 39. Page 5, line 14: vehicle → vehicles.
 40. Page 5, line 15: aromatics compounds → aromatic compounds.
 41. Page 9, line 13: *Delta* → Δ.
 42. Page 9, lines 15 and 17: what is *Kn*?
 43. Page 9, line 21: insert “in” before “computed with”.
 44. Page 9, line 25: CaCO₃ of dusts → CaCO₃ in dust.
 45. Page 10, lines 12 and 15: “temperature” should not be capitalised.
 46. Page 10, line 15: “wind speed” should not be capitalised.
 47. Page 10, line 16: underestimation of the PBL around... → underestimation of the PBL height of around... .
 48. Page 10, lines 17–18: “boundary conditions” should not be capitalised.
 49. Page 10, lines 21–22 (and elsewhere): performances → performance.
 50. Page 11, line 25: than → as.
 51. Page 11, lines 29–30: observed of Na → observed Na.

52. Page 14, line 3: “summer” should not be capitalised.
53. Page 15, line 19: criteria is → criteria are.
54. Page 15, lines 19–20: overestimation...do not correspond → overestimation... does not correspond.
55. Page 16, line 18: delete “the” before “Southern Europe”.
56. Page 16, line 24: PM_{2.5} are → PM_{2.5} is.
57. Page 16, lines 25, 31–32: “winter”, “spring”, “summer” and “fall” should not be capitalised. Also, please use either “fall” or “autumn” consistently throughout – both appear in the manuscript.
58. Page 16, line 32: due to mostly to → due mostly to.
59. Page 17, lines 20–23. This sentence is confusing, with two consecutive “but” clauses and multiple parentheses. Consider breaking it up to clarify the meaning.
60. Page 17, line 27: faction → fraction.
61. Page 18, line 14: “April” and “August” should be capitalised.
62. Page 18, line 31: could be explain → could be explained.
63. Page 19, line 4: emissions is → emissions are.
64. Page 20, line 13: inorganics aerosol → inorganic aerosol.
65. Page 20, line 24: the “S. et al” citation should have a full surname, not just an initial. (The same applies to all authors in the corresponding bibliography entry.)
66. Page 21, line 9: dynamic → dynamics.

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67. Page 21, line 14: “CHIMERE” should be capitalised as elsewhere in the manuscript.

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