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Interactive Comment

Interactive comment on "Evaluation of the Community Multiscale Air Quality (CMAQ) model v5.0 against size-resolved measurements of inorganic particle composition across sites in North America" *by* C. G. Nolte et al.

Anonymous Referee #1

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This manuscript presents an evaluation of the Community Multiscale Air Quality Model (CMAQ) v5.0 against a unique set of size resolved measurements of inorganic aerosol mass.

Similar CMAQ evaluation studies have been published before (as referenced properly), but the present study is the most comprehensive analysis using, as the authors claim, the most extensive data set of size resolved inorganic particle mass available in North America. This data set consists of Micro-orifice Uniform Deposit Impactor (MOUDI) measurements from a rather large number of campaigns conducted across the United

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States and Canada between the years 2001-2005. This paper is an excellent example that the best observation data available for model evaluation are not necessarily the most recent ones and that it may be very useful to revisit some of the more ancient data sets.

The publication is very well written, clearly structured, and to the point. The analysis is highly relevant as the inorganic fraction makes up a significant fraction of the aerosol, and is fairly unique as model evaluation studies of size-resolved inorganic particle composition are still very scarce. I thus strongly recommend this manuscript for publication in GMD once the following points (mostly minor) have been addressed.

Main point:

Model-observation differences are only discussed in terms of possible model deficiencies implicitly assuming that the measurements are correct. Since I don't know the MOUDI instrument, I cannot really judge the quality of the measurements, but offline aerosol composition measurements may easily be susceptible to sampling biases for some compounds, most notably nitrate. Possible biases of the measurements should be discussed and, if relevant, better emphasized in the manuscript. As explained by the authors, the gas-particle partitioning of nitrate is thermodynamically driven and is a function of temperature and humidity. At what temperatures and humidity are the MOUDI instruments operated? How are the samples treated after collection? PM10 filter samples taken in winter, for example, are known to lose some of the nitrate mass once taken to the lab where they are analyzed at higher temperatures (references xxx). Potential biases in nitrate would also affect the chloride measurements.

In any case, some discussion of measurement uncertainty is needed.

Minor points:

- Page 3864, line 5: These are "numerical" rather than "mathematical" models

- P3866, L13: Since this manuscript evaluates aerosol size distributions and compo-

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sition, it would be useful to add 2 or 3 sentences here briefly explaining the aerosol module AERO6 (Modal or sectional, number of modes, etc.). This is described later under “Data pairing and analysis” but I feel that section 2.1 would be the better location.

- P3866, L18: Is this exactly the same 35 layers as in CMAQ? Does CMAQ have a model top at 50 hPa, too?

- P3872, L20: How is the model evaluated at mountain sites? At the lowest model level or at the true elevation of the site (which may be well above model ground)? It would be good to add the altitude of the stations in table 1.

- P3874, L7: I assume you are suspecting that the missing Ca2+ source is sea spray. Why not mention this explicitly?

- P3874, L17ff: Do you know which source of K+ is more important: Natural biomass burning or anthropogenic biofuel burning?

- P3875, L4: As mentioned earlier, NO3 might not only be a challenge for the model but also for the measurements.

- P3877, L5: Could the summer low bias be due to SOA?

- P3878: Use past tense as done in section 2.1. Thus, change “are” to “were” on line 2, “is” to “was” on line 9, and “are” to “were” on lines 10 and 12.

- P3878, L16: “non-carbonaceous organic matter” sounds like a contradiction in itself. Is this supposed to be all molecules other than C?

- P3880, L6: PMEMIS should probably be replaced by BASE here.

- P3881,L27: Again, the obvious reason for the underestimation of Ca2+ at coastal sites is not mentioned explicitly.

- P3882, L9: Maybe a good place to mention that some of the nitrate biases are related to biases in other ions.

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