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Interactive comment on "NHM-Chem, the Japan MeteorologicalAgency's regional meteorology – chemistry model (v1.0): model description and aerosol representations" *by* Mizuo Kajino et al.

Anonymous Referee #1

Received and published: 14 August 2018

The manuscript 'NHM-Chem, the Japan MeteorologicalAgency's regional meteorology - chemistry model (v1.0): model description and aerosol representations' by Mizuo Kajino et al. describes the current state of implementation of the aerosol model in NHM-Chem and compares the three available aerosol representations (bulk, 3 category and 5 category) with each other. Focus of this comparison is differences of simulated ground surface concentrations and other properties as AOD and CCN. A comparison with observations is not performed, this is presented in a different manuscript submitted to a different journal. In general the paper fits well in the scope of GMD. However, at the current state I cannot recommend it for publication in GMD. My biggest concern is the current split between the two different manuscripts,

especially as parts of the two manuscripts share large fragments of the text. Please see below for more detailed specific comments. Please note, that at the current state I did not perform a full in detail review and focus on some general comments. Before performing a detailed review I think that these general comments have to be clarified. However, if these general aspects are clarified I am happy to perform a more detailed review.

General comments:

1) Large parts of the paper are identical to Kajino et al. 2018a (which is in review at a different journal). The parts I noticed during reading are the following lines (page and line numbers refer to the manuscript reviewed here) :
p2l11 – p3l5
p3l21 – p3l26
p3l28 – p4l14
p4l16 – p4l26
p6l23 – p7l7
p17l6 – p17l17
p18l9 – p18l15
Fig 1

If I didn't count wrong, this ends up in 15–20 % duplicated text.

Clearly, common parts of the model description in different manuscripts are a consequence of describing the same model. However, even in this case the identical parts should be clearly marked as a citation. Moreover, for the current manuscript I feel that the parts of the manuscripts which are identical to Kajino et al. 2018a are too large,

especially as not only parts of the model description but also in the Introduction and the Conclusion are identical.

I think there would have been two options:
1) Combination of the current manuscript and Kajino et al. 2018a in one manuscript.
2) Two separate papers in the **same** journal; eg:

- 'NHM-Chem, [...] Part 1: model description and aerosol representation' and

- 'NHM-Chem, Part 2: model evaluation'.

In this case the large reduplication of the model description would not have been necessary.

At the current state these two options might not be possible anymore. The authors should come up with an idea on how to handle the current manuscript.

2) I think the title of the manuscript is misleading. In the current state I would recommend a title such as: 'Comparing the three aerosol representations in NHM-Chem v 1.0'

From the present title the reader has the impression that the NHM-Chem model will be described in detail, but almost all important details of the model, are not presented in detail in the current paper (e.g. coupling procedure between CTM and NHM, update frequency of the meteorological data, flowchart of the model, description of dry and wet deposition processes, lightning NOx emissions). Of course, a detailed description of some processes might be beyond the scope of such a manuscript, but for me a paper which should serve as reference for the model description should contain the most important information of all considered chemical/physical processes. Especially

the differences to WRF/RAQM2 are not clear to me. While reading I got the impression that mainly the aerosol scheme and some slight other details were changed (p4l6ff). However, if '-Chem' is actually only a slightly changed RAQM2, why a new interface to WRF is developed (p3l21)? I think for users which are not familiar with RAQM2, an additional section like 'model improvements/changes since RAQM2' would be very helpful.

In the context of a model description of NHM-Chem the differences and similarities to other comparable models should be at least partly discussed (e.g. WRF-CHEM, CMAQ, ...). Further, the advantages to the predecessor WRF/RAQM2 should be discussed. Why has WRF been replaced with NHM? Has the model performance been improved by this update?

If the document should serve as model description it should contain some more information about the model itself (e.g. offline coupling of NHM and the CTM part)

3) I have the impression that the authors overstate the possibility of their aerosol model. The bulk and 5 category model are called unique. What exactly is unique in this sense? For this, a discussion of their model in the context of other aerosol models is completely missing. Models like GMXE (Pringle et al., 2010), M7 (Vignati et al.,2004), ECHAM-HAM (Zhang et al.,2012), MAM3/7 (Liu et al., 2012), MAM4 (Liu et al., 2016) or MADE-in (Aquila et al., 2011) feature a similar or even larger complexity. I think a model description should (at least partly) review other available schemes to discuss the new features of the described model in the context of already available schemes.

4) I think the comparison of the three aerosol representations is in general interesting

and it is in general worth to publish such a comparison. With the current status, however, I have five major remarks:

- From the manuscript I cannot judge if the performance with respect to observations increase with increasing complexity of the model. Very often you refer to Kajino et al. 2018a which makes reading very hard - actually the reader has to read both manuscripts at the same time to follow your argumentation.

- Currently, the '-Chem' part is only coupled off-line, e.g. no feedback with the meteorology is simulated. These simplifications should be discussed (see also below).

- Your model description is lacking many details like time steps of the models, more information about the meteorological data (settings of NHM). Further, many assumptions are described in Sect. 4.2 like the NOx split (and many more). Are all these assumptions 'expert guesses'? Are they based on other recommendations? Further points which could be discussed are a more proper definition of the applied NMHC-speciation to the emissions (in the supplement), total amounts of emissions, or the error which is introduced by taking boundary conditions from two different models as well as missing boundary information for species like PAN or longer lived NMVOCs.

- In general the analyses should be more quantitatively and would benefit strongly from taking observations into account (see above). Thinks which could further be discussed are: What are differences in regional budgets caused by the three different representations? Does the tropospheric oxidation capacity change? How do vertical profiles of the simulated properties change? Further you show only relative differences which can be misleading in regions where absolute values

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are low. Therefore you might should consider taking into account absolute differences. Further it would be very interesting to see the differences between the three representations with respect to the on-line interactions with the meteorology e.g. do the simulated regional climate change with different aerosol representations? At the current state, however, such questions cannot be answered with the model.

- Could you come up with a more general conclusion taking into account the computational time? Is it worth using the 3 category method compared to the 5 category method with respect to the needed computational time? Which schemes are you planning to use for which purpose?

Specific comments:

p8l28ff: Please clarify your procedure for combining the two simulation periods. If both simulations simulate a half year and start in July, how can you end up with the full year 2006? Please clarify why you use such a splitting of the simulated year.

p5l20: Also WRF-Chem and CMAQ feature aerosol model with more complex scheme as the standard 3 modal scheme.

p12L24ff: How large is the difference between simulation and observation?

Figure 2: Why are you not showing ozone for the 3 category method? This figure should be added or it should be discussed.

p313l30: Please rephrase (difference is different)

p14l10: significant in which context?

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