

Response to comments from Reviewer 1

Review of "Development of a source oriented version of the WRF/Chem model and its application to the California Regional PM10/PM2.5 Air Quality Study by Zhang et al.

General remarks:

The paper describes the implementation a new aerosol module into WRF-Chem. The new model system avoids the implicit assumption of instantaneous internal mixing of aerosols and allows tracking separately particulate matter from different sources. Results of a model application for California are shown for a stagnation episode in winter.

The material presented by the authors is original and definitely very interesting. However, the quality of the presentation must be improved considerably. The paper as well as the Appendix (see comments below) needs major revisions.

Response: The authors thank the reviewer for comprehensive suggestions to improve the manuscript. Changes and response are made according to all the comments. Specific responses are listed with each comment.

Decision: Major revisions (not only the paper, but also the Appendix)

Specific remarks: Paper

After the comments of Jerome Fast and Referee #2, there are only a few remarks I have to add on top. First of all, I want to emphasize that I fully agree with all comments of Referee #2. In particular, I agree that the model description given in section 3 should be replaced by a description of the scientific implementation of the new aerosol module (Aquila et al., 2011, doi:10.5194/gmd-4-325-2011 is a good example, how such a description could also look like).

Response: The section 3 was modified to be a description of the scientific implementation.

The authors should follow all recommendations given in the review by Referee #2 and carefully address all questions raised in this review and by Jerome Fast.

Response: Their comments were addressed.

I just want to add that the model description should also include a brief description of the gas phase chemistry. So far the phase gas chemistry mechanism is only mentioned in the Abstract and in the Appendix. Please address also my comments referring to page 9 of the Appendix.

Response: Introduction of gas phase chemistry was added.

While most of the current model description should be moved from the paper to the Appendix and merged with the existing text of the Appendix, there are also a few issues that should be addressed not

only in the Appendix but also in the paper (e.g. gas phase chemistry or some aspects of the model setup for the particular episode, previous source oriented modeling studies like Mahmud et al., 2010).

Response: The description of these issues was modified in the manuscript and appendix.

Side note: I could find four different ways how the authors spell WRF-Chem in the paper and the Appendix (WRF-Chem, WRF/Chem, WRF Chem, and WRF CHEM). I agree that this is difficult. WRF/Chem is used in the User's Guide, but otherwise the spelling seems to converge towards WRF-Chem. No matter how the authors will decide, the spelling should be uniform within the paper and the Appendix.

Response: WRF/Chem was used as the User's Guide consistently in both the manuscript and appendix.

Specific remarks: Appendix

As in this case the Appendix is an important part of the paper, it should also be revised thoroughly. The current version of the Appendix is prepared in an extremely sloppy manner and needs to be cleaned-up and streamlined considerably.

Response: The manuscript was modified accordingly.

The Appendix is quite hard to read due to the large number of abbreviations and variable names. A different type face for the variables and a list of variables might be helpful for the reader. Abbreviations should be avoided as far as possible.

Response: The manuscript was modified accordingly.

Page 1 of the Appendix

First paragraph:

. Please mention the model version where you made your changes.

Response: Model version was added.

. I think Figure 1 and Figure 2 is currently identical with Figure A2 and Figure A3 and will be removed in the revised version.

Response: Figure 1 and Figure 2 in the manuscript were removed.

Page 2

Second paragraph:

. 'Air quality concentration' should be considered as a proper noun here, which should also be shown by a different type face.

Response: The manuscript was modified accordingly.

. Where is Appendix A?

Response: The typo was corrected.

Third paragraph:

Where is Appendix Section C?

Response: The typo was corrected.

Page 3

Middle of second paragraph:

. 'Writing history output [?]' And what about computing time?

. 'the original WRF CHEM model'. What do the authors mean with [?] 'original' (i.e. which chemistry options)?

Response: The information about the model was added.

. 'The value of KAQC can be changed at runtime by editing the [?] 'KAQC' value under the [?] '&Chem' section of the namelist.input file.' Common features of WRF-Chem should be addressed more briefly (this holds for the entire Appendix, not only here).

Response: The appendix was modified accordingly.

Pages 4 and 5

[?] Where is Appendix B? Where is Appendix A?

Response: The typo was corrected.

Page 6

'The process of adding fresh source-oriented emissions into the SOWC variable arrays starts within [?] echem/emissions_driver [?]...' This is commonly the case for WRF and WRF-Chem. Therefore, this could be streamlined a bit (This holds for all occurrences of xxxx_driver on the following pages).

Response: The appendix was modified accordingly.

Middle paragraph (emission conversion):

This is a bit too much detail

Response: The appendix was modified accordingly.

Page 7

First paragraph of §5. INITIAL CONDITIONS’:

‘... a subroutine ...’ Everywhere else, the name of the subroutine is mentioned.

Response: The appendix was modified accordingly.

Second paragraph of §5. INITIAL CONDITIONS’:

This is mostly a description of a particular setup for the case study discussed in the paper.

Response: The paragraph was removed.

Page 9

Last paragraph of §7 DRY DEPOSITION’.

If there exist §... other source-oriented chemical transport models ...’ this has also to be mentioned in the paper and a reference to Mahmud et al., 2010 should also be given there.

Response: The manuscript was modified accordingly.

Page 9, §8. THE SAPRC90 GAS-PHASE MECHANISM’

‘The standard WRF-Chem model has several options for gas-phase reaction mechanisms, but the SOWC model represents the first application of the SAPRC mechanism in WRF’ Is this true? Already WRF-Chem version 3.1 included the KPP preprocessor, which permitted the WRF-Chem users to add any gas phase chemistry mechanism they want in an easy way. Since version 3.3 SAPRC99 is also distributed with the public version of WRF-Chem. Why is KPP not used? Does the authors’ implementation interfere with KPP or can the KPP mechanisms still be applied?

Response: The current project was the first to attempt adding the SAPRC mechanism to WRF but the long completion time resulted in several later WRF versions that already included the SAPRC mechanism. Hence, the statement in the paper is no longer accurate and has been removed.

The SAPRC mechanism was added to WRF following the standard treatment used by the UCD family of air quality models. This will allow for future enhancements to track sources of secondary aerosol and new SOA mechanisms. This point has been clarified in the revised text.

Page 10

Second paragraph:

See remarks referring to page 6.

Response: The manuscript was modified accordingly.

Paragraph on photolysis:

Is this an own development or on the modules that come with the public version of WRF-Chem? Some remarks seem also appropriate in the scientific description in the main paper.

Response: This is an own development. Remarks were added to the main paper.

Last line of page 10:

What is the MOD file?

Response: It is a file containing basic species information for the chemical mechanism in the UCD family of SAPRC mechanism compilers. The manuscript was modified to avoid confusion.

Page 11

☐'9. GAS-PARTICLE PARTITIONING IN ISORROPIA AND COAGULATION':

. Can the original SORGAM module that comes with WRF-Chem still be used or not? Are other chemistry options still working at all?

Response: For convenience, the first version of the SOWC model was created by over-writing some portions of the original SORGAM module, meaning that it can't be used in the current implementation. Later revisions will leave the SORGAM modules intact.

SORGAM is used in WRF-Chem in combination with modal aerosol modules. You used a sectional module. Please add some more explanations here.

Response: Explanation was added.

Page 12

Second line:

☐'units are converted from $\mu\text{g m}^{-3}$ to $\mu\text{moles m}^{-3}$,': A bit too much detail

Response: The manuscript was modified accordingly.

3 lines before the end of section 9:

What do the authors mean with 'this test'

Response: It means the application of the SOWC model in CRPAQS. The phrase was removed to avoid confusion.

Page 15

'The SOWC model currently uses the radiation modules developed by the Goddard Space Flight Center (GSFC).' Please add a reference.

Response: Reference was added.

The first paragraph contains very much standard WRF-Chem handling, please shorten this.

Response: The paragraph was shortened.

References

Please do some formatting for better readability

Response: The format was adjusted.

Please give a more detailed reference for (Michalakes and Schaffer, 2004).

Response: The reference was updated.

Figures

Do the green and blue colors really add more information to Figures A2 and A3?

Response: The authors feel that the green and blue colors helped readers organize the various modules.