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.

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).

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.

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.

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).

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.

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 cleaned-up and streamlined considerably.

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.

Page 1 of the Appendix
First paragraph:
- Please mention the model version where you made your changes.
- I think 'Figure 1' and 'Figure 2' is currently identical ´with Figure A2 and Figure A3 and will be removed in the revised version.

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.
- Where is Appendix A?

Third paragraph:
Where is Appendix Section C?

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)?
- '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).

Pages 4 and 5
Where is Appendix B? Where is Appendix A?

Page 6
'The process of adding fresh source-oriented emissions into the SOWC variable arrays starts within 'chem/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).

Middle paragraph (emission conversion):
This is a bit too much detail

Page 7
First paragraph of '5. INITIAL CONDITIONS':
'… a subroutine …' Everywhere else, the name of the subroutine is mentioned.
Second paragraph of '5. INITIAL CONDITIONS':
This is mostly a description of a particular setup for the case study discussed in the paper.

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.

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?

Page 10
Second paragraph:

See remarks referring to page 6.

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.

Last line of page 10:

What is the MOD file?

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

Page 12
Second line:

'units are converted from µg m^{-3} to µmoles m^{-3},': A bit too much detail

3 lines before the end of section 9:

What do the authors mean with 'this test'?

Page 15

- 'The SOWC model currently uses the radiation modules developed by the Goddard Space Flight Center (GSFC).' Please add a reference.
- The first paragraph contains very much standard WRF-Chem handling, please shorten this.

References

- Please do some formatting for better readability
- Please give a more detailed reference for (Michalakes and Schaffer, 2004).

Figures

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