Atmos. Chem. Phys. Discuss., 13, C2329–C2335, 2013
www.atmos-chem-phys-discuss.net/13/C2329/2013/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Application of WRF/Chem-MADRID and WRF/Polyphemus in Europe – Part 1: Model description and evaluation of meteorological predictions" *by* Y. Zhang et al.

Y. Zhang et al.

yzhang9@ncsu.edu

Received and published: 15 May 2013

Reply to Interactive comment on "Application of WRF/Chem-MADRID and WRF/Polyphemus in Europe – Part 1: Model description and evaluation of meteorological predictions" by Y. Zhang et al. Anonymous Referee #2 Received and published: 11 April 2013

This paper is written as the first part of a study and will be followed by the second part: "Application of WRF/Chem-MADRID and WRF/Polyphemus in Europe, Part II: Evaluation of Chemical Concentrations, Sensitivity Simulations, and Aerosol-Meteorology

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

Interactions" by Y. Zhang et al. (Companion Paper acp-2012-978).

General Comments:

This paper presents results of comprehensive model evaluation and comparison of two 3D air quality modeling systems applied for Europe. This study is really interesting and scientifically sounding. Such comprehensive analyses and evaluation for Europe are novel and done in such a configuration for the fully online coupled WRF Chem model applied for Europe for the first time (at least to my knowledge). Definitely these papers are very interesting for a reader, give new knowledge/experience of online meteorology-chemistry models applications for meteorology and air quality and the papers are suitable for publication in ACP.

However, I cannot say that the methodology, simulation design and setup for these two models evaluation and comparative analysis are optimal.

These two ACT models considered are very different in their assumptions, resolutions (e.g. vertical) and compositions, and one of them, WRF/Chem-MADRID, is an online coupled ACT-MetM model (with two-way feedbacks) and the second one, WRF/Polyphemus, is an offline ACT model just using meteo-fields from the WRF model outputs (without feedbacks). So, in such a simulation design it is very difficult to analyze and distinguish differences in models behaviors due to the online vs offline coupling and chemistry feedbacks, and due to differences of the models formulations and setup. Of course, it does not mean that the suggested model setup is not suitable.

This Part I of the paper is focusing on the models description, their setup, simulation design, measurement data and evaluation protocol descriptions, and on the evaluation of meteorological predictions by WRF.

A comprehensive analysis of the WRF meteorological predictions for two seasons with different model resolution runs was done in this part of the paper. I think this Part 1 would be much stronger if the performance statistics for meteorological variables for

ACPD
13, C2329–C2335, 2013

both WRF and WRF/Chem-MADRID simulations would be analyzed here (in Part 1) in more details for study of the chemistry feedbacks on the meteorology.

Reply:

We thank the reviewer for valuable comments. We agree with the reviewer that the two models are indeed quite different, making the comparison quite challenging. Given that both types of models are commonly used in the communities and have their own merits to be continuously developed and applied in parallel, we believe that our work is a valid contribution to the community. We've incorporated all the review comments into the revised manuscript. The reviewer made several excellent suggestions, e.g., comparing online and offline model performance using the same model system and using urban canopy model in model simulations, that cannot be addressed under the current scope of this work, however, we will consider those suggestions for our future work. Please see our point-by-point replies below.

Specific comments:

p.3996, lines 20-22: WRF/CMAQ cannot be called an online coupled model as the authors describe, because it uses an interface between WRF and CMAQ, and realize the two-way data exchange not on each time step. It could be conditionally called as an 'online access model'.

Reply:

We consider two types of online-coupled models: (1) One includes two models with an interactive interface in between. The two-way coupled WRF/CMAQ is an example of this type; (2) The other is one unified model system in which meteorology and air quality variables are simulated together in one time step without an interface between the two models. The Weather Research and Forecast model with Chemistry (WRF/Chem) is an example of this type.

To address the reviewer's comments, the relevant text has been changed to:

ACPD

13, C2329–C2335, 2013

"Such an online-coupled AQM may include two models with an interactive interface in between such as two-way coupled WRF/CMAQ (Yu et al., 2011; Wong et al., 2012) (which is also referred to as an online access model) or one unified model system in which meteorology and air quality variables are simulated together in one time step without an interface between the two models such as the Weather Research and Forecast model with Chemistry (WRF/Chem) (which is also referred to as an online integration model) (Grell et al., 2005; Fast et al., 2006; Zhang, 2008; Zhang et al., 2010a; Kukkonen et al., 2011; Baklanov et al., 2013). The model treatments of atmospheric processes for both chemical and meteorological variables are consistent in the online integration models but may be different in the online access models. Note that we added two new references: Kukkonen et al., 2011 and Baklanov et al., 2013.

p.3997, lines 20-22: Zhang (2008) considered mostly US online models, e.g. European models and experience were not analysed in that review. Zhang et al. (2012) gave a nice review of both types of models, but Kukkonen et al. (2011) gave also a comprehensive review of European ACT models.

Reply:

The reviewer is correct that Kukkonen et al. (2011) provided a comprehensive review of European ACT models. Another review paper for ACT models has been published recently on ACPD (i.e., Baklanov et al., 2013). Both references have been added in the list of references in those lines, and also in the relevant discussion section as follows: The strengths and limitations of offline- and online-coupled models are summarized in several reviews (e.g., Grell et al., 2004; Zhang, 2008; Baklanov, 2010; Baklanov et al., 2011, 2013; Kukkonen et al., 2011), among which Zhang (2008) reviewed several online-coupled models used over North America and Kukkonen et al. (2011) and Baklanov et al. (2013) provided a comprehensive review of online-coupled models used over Europe. p.3999, lines 23-25: Authors write: "To minimize differences in model predictions, the same or similar modules are chosen for both model simulations whenever possible". However, the models are different, and the differences between the models

ACPD
13, C2329–C2335, 2013

include not only the way of coupling and chemistry feedbacks on meteorology. So, it is possible to evaluate them as two different models. In my view it would be very interesting to consider one model (WRF/Chem) with the same grid, but with two setups: one fully online with feedbacks, and other with offline coupling without feedbacks.

Reply:

We agree with the reviewer that even though we tried to use the same or similar modules in the simulations, the two host models are quite different. We also agree that it would be ideal to use the same model with both offline-coupled or online-coupled WRF to illustrate the differences caused by online and offline models. However, to our knowledge, an offline version of WRF/Chem was based on an older version and is not available for public release. Also, the main purpose of our comparison is not to show the differences with online and offline-coupled meteorology-chemistry models, but to compare the overall model performance of two major types of models that are currently used in the air quality community, i.e., offline vs. online models. Nevertheless, we did include a small section to show the impact of chemistry (both gases and PM species) feedbacks on meteorology in terms of performance statistics in this Part I paper and the impact of chemistry (PM species only) feedbacks on meteorology in terms of spatial distribution of several major meteorological variables in the Part II paper (i.e., Figure 13) (note that Figure 13 in Part II has been moved to be Figure 5 in Part I in the revised manuscripts).

We also agree with the reviewer's suggestions, i.e., the comparison of offline vs. online model simulations using one model system such as WRF/Chem should be performed in the future, when such versions become available. Such a comparison will offer insights into the importance of chemistry feedbacks to meteorology.

In my opinion there are many possibilities to shorten the paper, e.g. (p.4000, lines 23-25) for what reasons in the models description section to specify different options for nucleation, if the nucleation is not taken into account in this work.

ACPD
13, C2329–C2335, 2013

Reply:

This sentence has been shortened to be as follows:

Although SIREAM in Polyphemus may be used with two different parameterizations for nucleation, nucleation is not taken into account in this work.

In addition, we also moved Table 5 in Part I and Table 3 in Part II to Appendix.

However, four new figures (Figures 16-19) were added to address Reviewer 1's comments, and one figure (Figure 13) from Part II was moved to be Figure 5 in Part I.

p.4009, lines 10-13: Authors write very shortly that: "The meteorological fields generated from online-coupled WRF/Chem-MADRID are slightly different from those generated by WRF, because of the feedbacks between meteorology and chemistry". However, it is important to extend such analysis and comparison of both models runs.

Reply:

We've expanded this part a bit. In addition, Figure 13 from Part II was moved to be Figure 19 in Part I to illustrate the feedbacks of aerosols to major meteorological variables predictions. p.4016, lines 20-25: It is not clear was the WRF simulations in this paper done with the coupled UCM or not? If so, it would be good also to extend / include additional analysis of the urban features and parameterization on the meteorological prediction over urban areas with different resolution runs.

Reply:

No, UCM was not used in our WRF simulations in this work. As indicated in our original paper, section 4.3.2, lack of an accurate representation of urban canopy was one of the reasons for underpredictions of nighttime temperatures: "The nighttime temperatures at other urban sites such as Madrid 1/Madrid 2, Milan 1/ Milan 2, and Paris Orly are generally underpredicted, due to a poor representation of urban canopy and urban heat island in the default treatments of WRF." We agree that it would be useful to include

ACPD
13, C2329–C2335, 2013

UCM in future work. As a matter of fact, UCM has been included in our ongoing AQMEII model comparison over the continental U.S.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 3993, 2013.