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Interactive comment on “Application of WRF/Chem-MADRID and WRF/Polyphemus in Europe – Part 2: Evaluation of chemical concentrations, sensitivity simulations, and aerosol-meteorology interactions” by Y. Zhang et al.

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Interactive comment on “Application of WRF/Chem-MADRID and WRF/Polyphemus in Europe – Part 2: Evaluation of chemical concentrations, sensitivity simulations, and aerosol-meteorology interactions” by Y. Zhang et al. Anonymous Referee #2 Received and published: 11 April 2013

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This paper is written as the second part of a study “Application of WRF/Chem-MADRID and WRF/Polyphemus in Europe” and follows after the first part: “: : Part I: Model Description and Evaluation of Meteorological Predictions” by Y. Zhang et al. (Companion Paper acp-2012-977).

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 on-line coupled WRFChem 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 on-line 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 II of the paper is focusing on the evaluation of chemical concentrations, sensitivity simulations, and aerosol-meteorology interactions. These two models simulate different concentrations in terms of domainwide performance statistics, spatial distribution, temporal variations, and column abundance. In my view this part is well written, it is done in more harmonized style and is well focused on the main goal of two ACP models evaluation for chemical weather prediction.

Reply:

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We thank the reviewer for valuable comments. We've addressed all review comments into the revised manuscript. Please see our point-by-point replies below.

I think the performance statistics for meteorological variables for both WRF and WRF/Chem-MADRID simulations and study of the chemistry/aerosol feedbacks on the meteorology would be better to move from this part to Part 1 where a comprehensive analysis of the WRF meteorological predictions with different model resolution runs is considered.

Reply:

The statistics of major meteorological variables from the WRF only simulations were included in Table 4 in the Part I paper, and the statistics for those meteorological variables from WRF/Chem-MADRID simulations are overall similar to those from WRF only, thus not included. However, in the section in which we discussed the chemistry feedbacks to meteorology in Part I paper, we did mention changes in the simulated meteorological variables in WRF/Chem-MADRID simulations, e.g., T2 and Precip, due to aerosol feedbacks. To address the comment, the feedback plots in the original Figure 13 in the Part II paper have been moved to Figure 5 in the Part I paper. P. 4072: It would be good to add a bit more justification of the selected monitoring sites: why these sixteen and twenty one sites from three observational databases were selected. What criteria were used and were other stations less informative or with incomplete datasets?

Reply:

We selected 16 sites (including 4 co-located sites) for time series comparison for gaseous species (e.g., SO₂, NO₂, and O₃) and 21 sites (including 5 co-located sites) for time series comparison for PM_{2.5} and PM₁₀. The detailed justification was indeed given in page 4073, lines 6-29 and page 4074, lines 1-2. Those sites cover a broad range of geographical and topographical locations in multiple countries including urban vs. suburban background and mountain, hill, and high plain sites vs. flat sites. The considerations include representativeness of those sites in terms of geographical

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and topographical characteristics, emission/chemical conditions, data availabilities and completeness.

To address the comments, we've added some discussions on this point.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 4059, 2013.

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