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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 #1

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In the two manuscripts, Zhang et al. compare two air quality models, an offline-coupled model and an online-coupled model to assess their capabilities and differences in simulating air pollutants and aerosol-meteorology interactions over Europe. In the second part, the model performance is evaluated, model sensitivity is investigated and aerosol and meteorology interactions simulated by online model are quantified.

Although the method of this research is solid, the results are not surprising and do not

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contribute significant scientific understanding. Differences between two models with different vertical layers and inputs are expected without doing simulation. Simulation of sensitivity to grid resolution is a meaningless effort to prove what already known to the scientific field. Also, more investigation is needed to explain the feedbacks of aerosols. Thus, I don't recommend the publication of this manuscript in ACP without major revisions according to following comments.

Major comments: 1) Comparison of the two models is far-fetched. The differences are expected and you can attribute the differences to anything since there are too many differences as the authors do: "The differences in model predictions are caused by differences in the heights of the first model layers and thickness of each layer that affect vertical distributions of emissions, model treatments such as dry/wet deposition, heterogeneous chemistry, and aerosol and cloud, as well as model inputs such as emissions of soil dust and sea-salt and chemical boundary conditions of CO and O₃ used in both models." 2) It is well known to the field that finer grid resolution gives better model performance. This part is of no scientific interests. 3) How does biogenic emission generating method affect SOA? How much is the effect to anthropogenic SOA and biogenic SOA? The change is due to the increase of oxidants or VOC precursors? 4) Feedbacks of aerosols to meteorology and so as to the pollutants concentrations are interesting. It seems that with or without aerosol feedbacks makes large differences to pollutants concentrations especially sulfate and nitrate (Figure 14). In Figure 14, the maximum difference for nitrate is 15 ug/m³, for sulfate is 9 ug/m³. The difference due to aerosol feedbacks can be such larger? The changes are close to the predicted sulfate and nitrate (check the numbers in Figure 2). It is hard to believe. 5) What are the mechanisms for aerosol feedbacks, what cause the large difference? -34 to 18 m change of PBL height in Figure 13 is not likely to explain large change of nitrate. Does this change happen during day time or night time?

Specific comments: 1) Figures 1-2, the cover area of D01 and D02 are different and the color bars are different. It is very difficult to see the differences. Please change to

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same color bar for same species. The numbers of color bar for column 3 of Figure 2 has some problem. Also the quality of each field plot is very low. It is hard to get a clear look no matter how much I zoom in. 2) Figure 10, it is hard to tell the difference between each column, it is better to show the difference. 3) Figure 14, the color bar should be changed. For example, the nitrate panel, the range of nitrate is -0.1 to 15, why the color bar is -20 to 20, it is difficult to get the values from color bar. Same for other plots.

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