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Geoscientific Model Development Discussions

Interactive comment on "Ozone air quality simulations with WRF-Chem (v3.5.1) over Europe: Model evaluation and chemical mechanism comparison" *by* K. A. Mar et al.

Anonymous Referee #2

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The submitted manuscript provides an evaluation of the online regional model WRF-Chem over Europe using two chemical mechanisms (MOZART-4 and RADM2) for a full year simulation with focus on near surface ozone and nitrogen oxides. The manuscript has an added value for the WRF-Chem community. I suggest acceptance of the manuscript for publication after taking into consideration the following comments.

Comments 1) lines 50-52: The authors give here three examples of air quality models but maybe they could also refer here to the review article of Baklanov et al. (2014) for the online coupled regional meteorology chemistry models in Europe.

2) lines 62-64: The importance of time variant chemical boundary conditions for simulated near surface ozone over Europe has been also highlighted in other recent regional

modelling studies (see e.g. Akritidis et al., 2013).

3) line 264: Please provide some more information on the selection of the AirBase stations classified as rural background. Do you include stations with class 1–3 according to the Joly-Peuch classification methodology for surface ozone (Joly and Peuch, 2012). This approach has been also applied in a recent study by Katragkou et al. (2015) for the evaluation of MACC reanalysis near-surface ozone over Europe.

4) line 283: You may add one sentence with information for the use and value of SOMO35 index.

5) Looking the Figures 4 and 9 I am wondering why at the lateral boundaries there are such differences between the two simulations with the different chemical mechanisms (RADM2 and MOZART) even though they are constrained with identical O3 chemical lateral boundary conditions.

6) lines 546-551: Normally with NOx titration we mean the first order removal process of O3 through direct reaction with NO which takes place during nighttime and in the vicinity of large NO emission sources. However the presented results refer to summer daytime and maybe this behaviour is related to the saturated NOx conditions (or VOC sensitive conditions) in these areas (which is a different issue). The split between NOx-saturated or NOx-sensitive regimes is driven by the chemistry of odd hydrogen radicals with HNO3 being the dominant sink in the first case and peroxides the dominant sink in the second case. Maybe the authors could also plot the photochemical regimes in their simulations for the month of July using VOC/NOx or H2O2/NOy ratios (see also the study of Beekmann and Vautard, ACP, 2010).

7) lines 558-559: Mind also that the highest sensitivity for ozone production with regards to VOC is at the regions of high NOx emissions as someone would expect for the regions in the VOC limited regime.

8) lines 565-566: Do you think that the different O3 sensitivity to VOC changes in the

two schemes can account for the O3 differences between RADM2 and MOZART (e.g. the lower ozone values in MOZART)? If yes, in which sense?

9) lines 575-578: This is an interesting result which shows that differences in rate constants can account by 40% for the O3 differences between RADM2 and MOZART runs. You may highlight this result a bit more.

10) lines 591-594: Taking into consideration all three (rate constants, deposition and photolysis schemes) it seems that altogether account about 60% for the O3 differences between RADM2 and MOZART runs. Is this correct? You may highlight this conclusion.

11) Figure 3: I guess here the authors refer to wind direction. Please also provide information on the approach calculating the wind direction difference between obs and model.

12) Figure 16: Maybe it would be better to show the sensitivity result in a percentage scale (from -10 to 10 %).

Minor comments line 209: delete double "and". line 239: It is "for" instead of "fo". line 305: Maybe "related" instead of "associated" . line 406: It is "configuration" instead of " configuruation" . lines 427-429: The sentence needs rephrasing. It is not clear.

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