



Interactive
Comment

Interactive comment on “High resolution air quality simulation over Europe with the chemistry transport model CHIMERE” by E. Terrenoire et al.

Anonymous Referee #3

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GENERAL COMMENTS

The present paper shows the results of an operational evaluation of an improve version of the CHIMERE chemical-transport model (version 2009) for the year 2009 over Europe. The CHIMERE CTM (7 km x 7 km horizontal resolution) is compared against rural and urban background stations from the EMEP and AIRBASE monitoring networks based on O₃, NO₂, PM₁₀ and PM_{2.5} and PM components.

The present work could be of interest to the readers of GMD because it tries to contribute to increase the scientific knowledge about air quality modelling. From my point of view, the novelty of this paper lies in the following facts: (1) the annual modelling of air quality in Europe at urban scale (7 km x 7 km), (2) new methodologies in emission modelling, and (3) testing new parameterization and new meteorological data.

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However, the implication of these facts has not been explicitly quantified in each case. Furthermore, I miss a detail description of the used methodology and a discussion about that with the objective that other users could reproduce it. Even more, the analysis of the evaluation of the results is very descriptive, and does not show anything new about deficiencies in the model. From the format point of view, author should make efforts to highly improve the format of the article (see large list of technical correction above).

In this sense, I recommend the publication of this work after the authors provide a more detailed methodology and a deep discussion of the results, and they improve the format of the paper (typos, acronyms, figures, etc.).

SPECIFIC COMMENTS

Abstract

P4138, line 1: The abstract should be rewritten. It is too generic. It should indicate the name and version of the model and include the novelties of the work. Introduction

P4138, line 20: Introduction. Since you are running a model at urban scale, your introduction should put in context your resolution with other studies already done over Europe and explain the important of increasing resolution.

P4138, line 22: when you say “coarse horizontal”, which range of resolution are you talking about? Provide some references.

P4139, line 6: when you talk about GMES and GMES-MACC, are they used as examples of forecast applications, or are they other application? Rephrase this paragraph accordingly. GMES and GMES-MACC are acronyms and they should be described.

P4140, line 9: replace “assessment” by “evaluation”.

Model description

P4140, line 23: 20 m is mean level or full level? Could you clarify this, please? In this

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sense, how many vertical levels are you using? Which is the top of your configuration?

P4140, line 26: which version of the MEGAN model are you using? Are you assimilating all the species which come from MEGAN? How do you perform speciation for MEGAN species to MELCHIOR chemical mechanism?

Meteorology

P4141: in the section of meteorology authors describe a sensitivity test using IFS vs. WRF, but you do not specify the version of WRF, the number of stations used for the test nor quantified the improvement of using IFS instead of WRF. Also author only focus on wind direction, what about other meteo variable such as T2M and PBL performance?

P4141, line 10-11: how does the urban correction for Kz is applied? Which is the variability of Kz between urban and rural areas? You evaluate this correction in terms of air quality, but what about in terms of wind speed? Why this correction for Kz has more impact for PM than for gases? Have you see any different between PM10 and PM2.5? Anthropogenic emissions

P4142, line 25: Which is the reference year for the emission database used? Please, used EMEP reference corresponding to the report describing the emission you used (usually they have a report for each emission database).

P4143, line 1-11: I think it is well known. Maybe, you could merge this information with table 1. I miss some information about speciation of emission to the chemical mechanism used. If you used MEGAN for biogenic emission, are you double counting emission if you take into account SNAP 11?

P4144, line 3: which version of CHIMERE emission pre-processor are you using or based on? Please, include some information about that in the model configuration. Chemical speciation

P4145, line 10-20: Which chemical mechanism are you using? I guess it is MELCHIOR, but which version? In this section and in the same paragraph authors mix

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information about temporal disaggregation, it is a little bit confusing. SNAP 2 emission temporal modulation

P4145, line 22-26: I do not like the way these two new concepts, degree day indicator (Dj) and the daily modulation factor (Fj), are introduced in the text. It is confusing and hard to follow. Some units are missing and some constants appear without any justification. For example, what about A coefficient? How do you fix this value? Please, number equations.

Observation data

P4147, line 2-17: What about measurement for SO₂? Why do authors omit this pollutant in the evaluation of CHIMERE?

P4147, line 2-17: In the same line, if the author evaluate PM components, why organic carbon or elemental carbon is not evaluate? At least there is four stations providing measurement for black carbon in the EMEP network.

P4147, line 2-17: Looking at Table 3, any EMEP ozone station is used in your evaluation. However, you used NO₂ data from this network. Any explanation for that?

Model results

P4148, line 6-13: When you compare chemical components for PM, which range of diameter are you using? PM₁₀ or PM_{2.5}? Some measurements do not take into account the size of the aerosol, just chemistry.

Nitrogen dioxide

P4148, line 21-25: Could you provide more reasons to justify that NO₂ underestimation in UB is due to emission lack? Could you provide reference to support that? Furthermore, later in P4149, line 10-13 you say that the reasons are unclear. So, in the end everything is confusing. I guess to go more in detail with NO₂ urban underestimation author should study NO₂ daily cycle to see when the underestimations take

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place, maybe it could be a problem of PBL, and mixing ratio. Please, try to verify your hypothesis.

Ozone

P4149, line 22: to be consistent, use RB for rural as you use UB site.

P4150, line 1-2: the highest overestimations are found for autumn at RB and UB sites, in relative (30.6 and 36.9%, respectively) and absolute values, not in winter. Any explanation for that?

P4150, line 3: replace “maxima” by “maximum concentration”. Instead of winter, you could say the colder seasons.

P4150, line 5-7: CHIMERE overestimates concentration at rural background sites. Has the O3 boundary condition from LMDz any impact? Have any explanation for that overestimation. Did you check how the O3 daily cycle? Any idea about how the model performance during the day/night?

PM10 and PM2.5

PM10 and PM2.5: this section should be rewritten. Evoid adjective as “good”, “worse”. Have you think about measurements uncertainty? Please discuss more in detail the source of uncertainty in your evaluation.

P4150, lines 26 - P4150, lines 6 make reference to Table 6, corresponding to EMEP data. But in the text you say they are airbase station. The message is confusing, you are using two networks but what are they telling you? Also units at P4151, line 3-4 should be ugm-3.

P4151, lines10-11: this is not true, because FBs for PM2.5 at EMEP sites are bigger than PM10.

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P4152, line 16: replace “Valencia” by “Valentia”

Particulate and total nitrate

P4152, line 23: replace “Nitrogen dioxide (NO₂)” by “Ammonia (NH₃)”

P4154, line 1-2: this sentence means that nitrate underestimation is due to NO_x emission underestimation. NO₂ Emission underestimation is not well demonstrated in previous section. Please, go more in detail with the reason why NO₃ is underestimated.

Spatio-temporal variability of the modelled concentration fields

P4155, line 26-28: O₃ shows high concentration over the sea because of the low dry deposition over the oceans. Have a look at O₃ dry deposition in CHIMERE.

P4156, line 1-2: also along shipping routes along northern Europe and Strait of Gibraltar.

P4156, line 6: please quantify “nicely modelled” and “slight underestimation”.

P4156, line 12-13: the mean concentrations of PM₁₀ in the maps do not reach 40 µg/m³. How desert dust is implemented in the boundaries? Could you say anything about the contribution of sea salt in PM₁₀?

P4156, line 20-24: the complex topography of the Po valley together with a complex emission pattern are reasons of the high concentration of PM₁₀ (and PM_{2.5}). These conditions generate a complex situation where the models present difficulties to reproduce correctly the air quality dynamic there.

P4157, line 5-11: how is the level of confidence in SO₂ pattern? You have not evaluated the concentration with available EMEP measurements.

P4157, line 8-9: any explanation for this maximum along African coast? shipping?

P4157, line 9-11: also due to the meteorological condition in summer which favour high temperature and accumulation and recirculation of pollutant in the Mediterranean

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basin. Conclusions

P4157, line 21: replace “(7 x 7 km)” by “(7 km x 7 km)”. Check it in the whole manuscript.

P4158, line 24-26 and P4158, line 1-2: the implication of each of the improvements implements should be discuss more in detail. Overall, conclusions are poor. In terms of CHIMERE community, which are the benefits respect previous CHIMERE versions?. Which are your recommendations about horizontal resolution?

TECHNICAL CORRECTIONS

Used correlation coefficient instead of correlation index.

P4139, line 9: replace “assessment” by “evaluation”.

P4139, line 21: replace “Particles” by “particulate matter”. The same for line 22.

P4140, line 8: replace: “module; Vautard et al.” by “module and Vautard et al.”.

P4140, line 18: replace: “whole of Europe” by “whole Europe”.

P4140, line 20: replace: “0.125 x 0.0625°” by “0.125 x 0.0625°” (7 km x 7 km).

P4140, line 22: replace: “Data for comparison” by “Modelled concentration for comparison”.

P4141, line 4: describe the ECMWF-IFS acronym.

P4142, line 1: replace “(Kz coefficient)” by “(dispersion coefficient, Kz)”. Consequently, replace: “dispersion coefficient (Kz)” by “Kz”.

P4142, line 17: insert a “,” after “However”

P4142, line 22: the tonne the International System of Units (SI) is used as “t”.

P4143, line 20: replace: “US Geological Surve (USGS) Land Uses database” by “US Geological Surve (USGS) land-use database”.

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P4143, line 21: replace “Twenty height” by “Twenty eight”

P4144, line 5: replace “SNAP 2 emissions sector” by “SNAP 2 emissions”.

P4144, line 7: replace “0.083 x 0.083°” by “0.083° x 0.083°”

P4144, line 8: PPM acronym is not defined

P4144, line 21-23: the sentence “The picture show the . . .” is repeat (see line 20-21).

P4145, line 16-20: check the punctuation.

P4147, line 2 and line 6: be careful with “Airbase” or “AIRBASE”. Be consistent in the whole document, also in figures and tables.

P4147, line 8-9: I suggest: “The spatial distribution of the stations” instead of “The stations spatial repartition”

P4147, line 16: remove “s” in “different measurements techniques” References omitted in the Reference section:

P4147, line 19: Dennis et al. (2010) is omitted in Reference section.

P4147, line 23: replace “, agreement” by “index of agreement”.

P4147, line 23: use correlation coefficient instead of correlation index in the whole document.

P4159 and P4160: This section “Appendix A” is not relevant since description of statistic is well known. As you use AEMET tool for calculating you statistics, I recommend you just reference AEMET software. However, you are using thresholds in the observation when you calculate the statistics. I think it is worth mentioning this fact in the section 2.5 Data analysis methodology, and even explain how these thresholds have been chosen.

Table 1: To be consistent whit the text, use SNAP 1, SNAP 2, etc instead of S1, S2, etc.

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Table 2: To be consistent with the text, use SNAP 1, SNAP 2, etc instead of S1, S2, etc. I guess these values are in %.

Table 3: Replace “TNH3” by “TNH4“. Describe what “UB”, “RB”, and “X” mean. Be consistent with “AIRBASE” name along the manuscript.

Table 4: Please indicate the units for standard deviation of the observation and modelled concentration. The same for RMSE. Replace “Automn” by “Autumn”. Be consistent along the text with “Root Mean Square Error”, capital letter or lowercase?. Replace “PM25” by “PM2.5”

Table 5: Replace “PM25” by “PM2.5”

Table 6. In Table 3 you have said you evaluate NO₂ from EMEP, but in this table this pollutant does not appear. I guess you use EMEP just for chemical composition, in that case remove NO₂ for Table 3. However, in my opinion, it is hard evaluate PM components without evaluate the gas precursors. This could help you in the analysis of your results.

Figure 1: Indicate the number of station, the date, if the evaluation is hourly or daily.

Figure 2: remover “for four main pollutants”

Figure 3: Be careful with subscripts for NO_x, SO_x, and NH₃. Replace “profils” by “profiles”. Tonnes in the International System of Units is “t”. Please, when you use EMEP in this case, use as “EMEP emission database” because you have also EMEP measurements. In this flowchart, where the vertical disaggregation is?

Figure 4: be consistent between units in y-axis “kg/inhab.” (in the graphic) or “kginb-1 yr-1” (in the caption).

Figure 5: units are reference to the year 2009. Please indicate that.

Figure 6: replace in the caption “emission” by “emissions”. Use subscript for F_j.

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Figure 7. Move the title of the figure to the caption.

Figure 12: Use subscript for pollution in figure titles.

Figure 13: For O₃, the summer is right and winter is the left. Please correct the figure or the caption.

Figure 14: For PM₁₀ and PM_{2.5} the summer pattern is the right column. Please correct the figures of the caption.

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