Interactive comment on “Evaluation of the GEM-AQ model in the context of the AQMEII Phase 1 project” by J. Struzewska et al.

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The authors would like to thank Referee #2 for comments and suggestions.

General Comments

Referee #2 comment:
1) Rather than providing a comprehensive summary of model performance in all seasons for all sub-regions, the authors may want to consider focusing on the most interesting aspects, such as model behavior that differs from other AQMEII groups and can be tied to unique aspects of the GEM-AQ modeling system, or model behavior that confirms findings from other AQMEII groups.

Authors’ reply:

Our primary objective was to undertake an evaluation of the GEM-AQ model and not an in-depth comparison with other models. Such a comparison would have been a speculative, one as not all information on model setup (process level and selected parameterizations) was provided in the literature. Such an analysis would amount to a sizeable undertaking that is well outside our abilities at present.

We find that presenting model performance stratified by seasons and regions provides an interesting insight into the ‘behaviour’ of the modelling system. Thus, contributing to the body of knowledge on model performance. In general, GEM-AQ performance was better than most of the models participating in the AQMEII-P1 project (as shown in the attached diagram).

Referee #2 comment:
The authors may also want to consider combining Sections 3 and 4, i.e. providing a discussion of results whenever they are presented rather than presenting the discussion later in the manuscript.

Authors’ reply:
Indeed, it was a very difficult task. Sections 3 and 4 were reorganised several times to make the outcome ‘more clear’. In the final version of the manuscript, Section 3 contains description of the results and Section 4 the interpretation of the results and the comparison with what was reported in other publications related to AQMEII-P1.

Referee #2 comment:
2) Including results for meteorological variables, ozone precursors and possibly speciated PM concentrations may allow the authors to determine potential reasons for the GEM-AQ ozone and PM10 results, adding a diagnostic evaluation dimension to the manuscript.

Authors’ reply:
The focus of the presented analysis is on the 'operational' evaluation as defined in the AQMEII-P1 project protocol. With regard to ozone, a discussion of ozone

formation during the heat wave over Europe in 2006, using the GEM-AQ model, is given in Struzewska ad Kaminski (2008). A 'diagnostic' evaluation of PMs seems worthwhile. We think that this issue could be more adequately addressed at a higher horizontal resolution, due to a strong local component.

We have undertaken the evaluation of meteorological variables from the GSOD/NOAA archive during the air quality episodes (e.g. Fig1 – daily temperature). We will consider a publication focused on the analysis of episodic periods in the context of the meteorological model performance.

Fig. 1

Referee #2 comment:
3) Given that GEM-AQ did not use the ECWMF GEMS fields used as boundary conditions by most other AQMEII groups, it would be of interest to compare the GEM-AQ results to the GEMS fields in inflow regions for the European analysis domain. This may allow the authors to determine to which extent the different boundary conditions may be the cause of differences in model performance between GEM-AQ and that reported by other groups.

Authors' reply:

Although the suggestion is interesting, there is a large body of literature dealing with impacts of boundary conditions, nesting methods, and model resolution on results inside a limited area domain. Such an analysis would amount to a sizeable undertaking that is well outside the scope of our research at present.

Moreover, it would be difficult to define "inflow regions" and to select species for boundary condition analysis to keep the manuscript consistent, as PM10 is not a prognostic but a diagnostic species. PM10 is computed as a sum of 5 chemical species with given size distributions.

Specific Comments:

Referee #2 comment:
Page 1472, line 21: change "Galmarini et al. (2012)" to "(Galmarini et al., 2012)"

Authors' reply:
Will change in the revised paper.

Referee #2 comment:
Page 1473, line 14: wasn't the DEHM model participating in AQMEII Phase 1 also a hemispheric-to-regional model?

Authors' reply:
We do acknowledge the value and contribution of the DEHM model. It is explicitly stated that DEHM is a hemispheric model and GEM is a global model.

We will change the sentence on line 14 to: "… a multiscale model that can cover entire globe using a uniform lat/long grid, global variable resolution grid, or a limited area extent."

Referee #2 comment:
Page 1474, line 11: please provide additional details on the height of the lowest level and the approximate number of levels within the PBL.

Authors' reply:
Will provide these in the revised paper.
The height of the lowest level is ~40m. There are ~8 levels is the PBL.

Referee #2 comment:
Page 1475, line 26 – 28: why weren't the North American emissions compiled for AQMEII used over North America in the global GEM-AQ simulations?

Authors' reply:
Our simulations are focused over Europe and were done on the global variable grid designed according to AQMEII-P1 protocol for the European domain. The grid resolution over North America was quite coarse (approx. 1.5 deg) and irregular. The high resolution emissions would have to be degraded, not bringing any added value to the simulation. A separate simulation was undertaken for the NA region. Moreover, as the methodology of EU and NA inventory was different, it would have been difficult to combine, in a consistent way, the treatment of the temporal variability and height distribution of emission fluxes (based on the SNAP classification over Europe).

Referee #2 comment:
Page 1477, line 9 (also page 1478, line 4): suggest rewording the beginning of this sentence as "Spatial distributions of model data and model performance statistics for maximum 8-h running"

Authors' reply:
Will change in the revised paper.

Referee #2 comment:
Page 1478, line 19: suggest adding "modeled" before "ozone concentrations" for clarity.

Authors' reply:
Will change in the revised paper.

Referee #2 comment:
Page 1481, line 18: suggest adding "modeled" before "daily averaged PM10 concentrations" for clarity.

Authors' reply:
Will add in the revised paper.

Referee #2 comment:
Page 1483, lines 5-6: Suggest rewording as follows: "The lowest modeled PM10 concentrations (lower than 20 ug/m3) occur over Scandinavia and over the .."

Authors' reply:
Will change in the revised paper.

Referee #2 comment:
Page 1483, line 9: replace "is modeled" with "occurs"

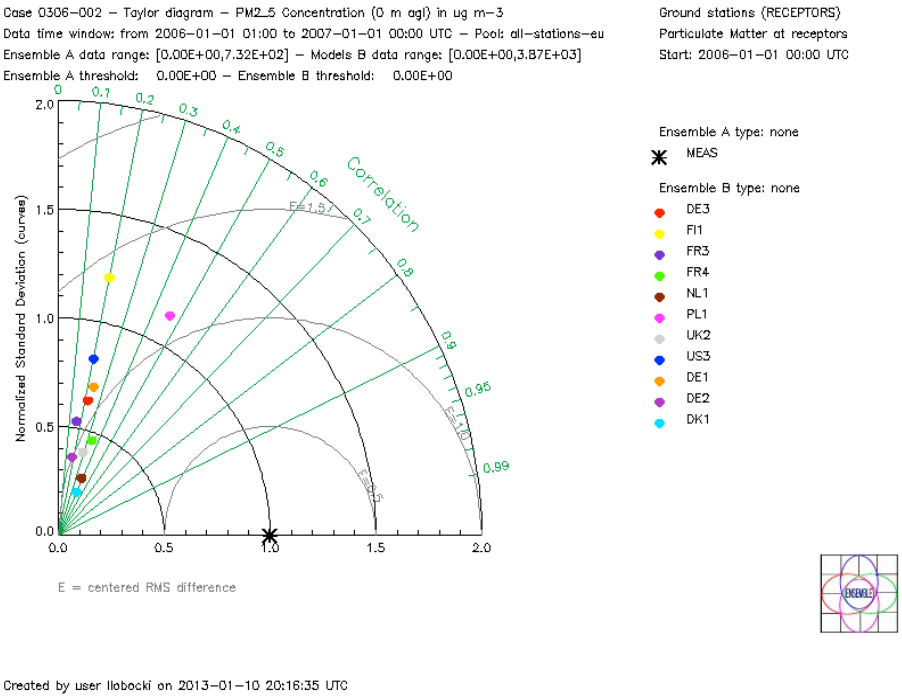
Authors' reply:
Will replace in the revised paper.

Referee #2 comment:
Page 1485, line 18: could the authors provide a hypothesis why GEM-AQ behaves different from other AQMEII models in this respect?

Authors' reply:
Insufficient information on station selection and model configuration for other models was provided in the literature. One could speculate that the differences are due to different treatment of surface processes, vertical diffusion, and number of levels. However, any comparison at individual 'process level' is rather difficult, as there is not enough information on the setup and characteristics of individual models.

Referee #2 comment:
Page 1492, line 22 – Page 1493, line 4, also Page 1490, lines 12 -29: Here and in the discussion section, can the authors provide a hypothesis why this overestimation was not seen or at least not as pronounced in other AQMEII simulations over Europe that used the same emission inventories (e.g. Figure 8, Appel et al., 2012; Figures 4/6/7/ and Table 3, Wolke et al., 2012; Figure 2, Pirovano et al., 2012. All of these articles were published in the AQMEII special issue, Atmospheric Environment, Volume 53,
Pages 1-224)?

Authors' reply:
In general, GEM-AQ (coded as PL1) performance in terms of PM10 and PM2.5 was better than most of the models participating in the AQMEII-P1 project.



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The rest of the models show similar spatial patterns. However, results for PMs are underestimated. The possible hypothesis could relate to a different aerosol module (CAM) or different treatment of surface emissions (via the vertical diffusion equation and higher number of model levels). Explanation of differences in modelling results on the process level is very difficult, as not all information is provided (disclosed) in the literature for all the models that participated in the AQMEII-P1 project. The hypothesis of emission overestimation refers to the former Eastern Block counties i.e. Eastern Germany, Czechoslovakia, and Poland.

Referee #2 comment:

Page 1493, lines 5 – 12: Given that large-scale dynamics are important for these seasonal fluctuations, it would be interesting to contrast the global GEM-AQ results with the ECMWF GEMS fields used as boundary conditions for the other AQMEII simulations and compare both sets of data to available observations in inflow regions for the continental-scale analysis.

Authors' reply:

There was no separate "global GEM-AQ simulation" – the simulation was done on a global variable resolution grid. Results over Europe are presented in the manuscript.

We could compare seasonal fields from GEM-AQ (with a wider margin) with a "window" from ECMWF GEMS; however, the resolution would be different and the scientific value of such comparison would be questionable (different resolution, different emissions). Such an analysis would amount to a sizeable undertaking that is well outside the scope of our research at present.