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**Geoscientific
Model Development
Discussions**

Interactive comment on "Implementation and evaluation of online gas-phase chemistry within a regional climate model (RegCM-CHEM4)" *by* A. K. Shalaby et al.

Anonymous Referee #1

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General comments:

The RegCM-CHEM regional model is newly coupled with chemistry using the CBM-Z mechanism. This manuscript describes the chemistry related components of the RegCM-CHEM, and the evaluation against observations for the August 2003 heat wave event and for a monthly average time series for a 6-year period. The model description section is well written and would be helpful for model users. Although the evaluation sections could be improved in terms of clarity, depth, and conciseness with focus on model uncertainties/biases.

This paper fits the purpose of GMD. From my point of view, this manuscript could

be published after improving the writing and the discussion in the model evaluation sections. Hopefully all my comments are relatively minor.

My detailed comments are as follows:

1) Section 2.3: Since the coupling with chemistry using CBM-Z is the main aspect of the model development, it might be helpful to discuss the CBM-Z mechanism in a little more detail; for example, it is worth pointing out that CBM-Z is using a regime-dependent approach to reduce the overall computational time.

2) On page 155, Lines 1-3: I suggest that you provide specific model names such as WRF-Chem and CMAQ.

3) Transport from the stratosphere is one of the major sources of ozone in the troposphere. How is the stratospheric ozone treated in the model?

4) Sect 3.1: It is not clear why there are temperature biases at those particular areas. I suggest that you at least discuss what temperature biases of 4K really mean for the prediction of ozone in the model. For example, Vieno et al. (2010) concluded that about 5K of temperature biases lead to an about 10ppb increase in ozone prediction in their model during the 2003 heat wave.

5) In Fig. 4: What are the ozone concentrations that correspond to the black circles?

6) Sect 3.2: This part of the discussion is difficult to follow. I suggest that you use less panels (days) in Fig. 4 and clarify the discussion about what happened and what the model captures. Quantify biases whenever possible.

7) Sect 3.3: Most of the ozone monitoring stations have basic meteorological measurements such as temperature and wind. These data might be helpful for diagnosing some model biases compared with observations. The analysis in this section is not fully convincing in its explanation of what leads to larger biases over central and southern Europe in the model predictions. Mean biases over a one month period do not explain the time series since in the time series there are over-predictions at some periods and

under-predictions at others.

8) Page 164: Simulated NO2 concentrations have large biases. Do you have any sense about the NO2 measurement biases? NO2 is source sensitive, and with the coarse model resolution, it is difficult to compare well. I suggest discussing the interpolation of results from NO2 measurement biases/uncertainty (e.g., Lamsal et al., 2008), model spatial resolution, and NO2 source sensitivity rather than stating that 'with monthly emissions, we would not expect to reproduce these daily events with any fidelity'. You probably should consider comparing monthly values according to your statement.

9) Sect. 3.5: During the extreme heat event, it is likely that VOC and NOx sensitivity will change from its typical scenarios. In addition, VOC and NOx sensitivity could have temporal variations during the extreme events. Please refer to Vieno et al. (2010) for some discussion related to the shifting of VOC and NOx sensitivity in the middle of August 2003 over UK.

References: Lamsal, L. N., R. V. Martin, A. van Donkelaar, M. Steinbacher, E. A. Celarier, E. Bucsela, E. J. Dunlea, and J. P. Pinto (2008), GroundâĂŘlevel nitrogen dioxide concentrations inferred from the satelliteâĂŘborne Ozone Monitoring Instrument, J.Geophys. Res.,113,D16308,doi:10.1029/2007JD009235.

M. Vieno, A. J. Dore, D. S. Stevenson, R. Doherty, M. R. Heal, S. Reis, S. Hallsworth, L. Tarrason, P. Wind, D. Fowler, D. Simpson, and M. A. Sutton (2010), Modelling surface ozone during the 2003 heat-wave in the UK , ACP, 10, 7963-7978.

Interactive comment on Geosci. Model Dev. Discuss., 5, 149, 2012.