Atmos. Chem. Phys. Discuss., 7, S1433–S1437, 2007
www.atmos-chem-phys-discuss.net/7/S1433/2007/

Atmospheric Chemistry and Physics Discussions

ACPD

7, S1433–S1437, 2007

Interactive Comment

Interactive comment on "GEM/POPs: a global 3-D dynamic model for semi-volatile persistent organic pollutants – 1. Model description and evaluations" *by* S. L. Gong et al.

S. L. Gong et al.

Received and published: 26 April 2007

We would like to thank the anonymous reviewer for the detailed review of our manuscript which gives us the opportunity to clarify some points. In the following we quoted each review question in the square brackets and added our response after each paragraph.

[What is missing is the conclusions section, however, may be it will be added later in the second paper which is mentioned to follow this one.]

We will add a conclusion section to this paper.

Specific comments

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[The introduction stated that early POP box models failed to yield the detailed spatial and temporal distribution of particular POPs. Seems to be this is too strong and should be rephrased to reflect that they were developed to investigate processes and fate of POPs in general, without the aim to obtained detailed spatial and temporal information. I would not say this is a limitation in this aspect.]

We have revised our introduction and rephrased as followings:

"There are two parallel modeling frameworks for studying environmental POPs. One type of them divides the globe or a specific region into a few climate zones (MacLeod, 2001; Strand and Hov, 1996; Toose et al., 2004; Wania and Mackay, 1995) with environmental compartments described in each zone. These models could be used to explore rates of global migration of POPs released in certain zonal bands to other latitudes and have been proven useful as a heuristic and policy tool in demonstrating the "grasshopper" effect. However, these (multimedia) models are less suitable to predict the detailed spatial and short-term variability in the distribution of a compound. To overcome the limitation of box-type models, dynamical 3-D models have been developed to describe the atmospheric transport of POPs on both regional and global scales"

[The section 4.3 is discussing the impact of aerosols describing the spatial distribution of the simulated fraction of PCB particulate phase to the gaseous one. In particular, for PCB180 the ratio is almost 100. It is stated that observations have also shown similar pattern of distribution. However, in next several sentences it is written that the range of this ratio for PCB180 is 0.06-4.17 and observations themselves are characterized as rather uncertain (particle phase concentrations are extremely low, see 3406 line 21). It would be reasonable to make this part of the description in a more clear way.]

What we showed in the paper is the ratios of particulate and gaseous PCB loadings. This loading includes the integrated column of PCBs in the atmosphere. As the temperature decreases as the altitude, more partitioning of PCBs to the particulate phase is expected and consequently the model predicts higher ratios than the observation

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where only surface data are collected. We have added following:

“It noted that these ratios were measured under surface conditions while the model predictions were for the entire atmospheric column loadings where colder environments aloft favoured more partitioning of PCBs to the particulate phases.”

[It would be useful if evaluation of modeling results would include some statistics (for instance, comparison of mean annual computed and observed concentrations) and thus would complement the ‘reasonably simulated’ with something like ‘differences are within a factor of 2, 3, or more’ or regression plots where it can be seen that the model underestimated or overestimate measured concentrations.]

We thank for this suggestion and have made scatter plots for the comparisons between model and observations for the IADN stations. Three plots for the averaged monthly PCBs in the IADN area were produced and added to the paper as new Figure 4. A paragraph has bee added to the paper:

“Figure 4 shows the comparisons for the three PCBs between the modeling results from GEM/POPs and the observations averaged over IADN stations for year 2000. The predictions for PCB180 are well within a factor of 2 from the observations. However, for PCB28 and PCB153, there are some over-estimates by GEM/POPs but majority of the results are within a factor of 3. The over-estimate is especially evident for PCB153, indicting some systematic bias in the model.”

Some minor comments

[It might be useful to add some information on physical-chemical properties of selected PCBs used in model parameterization (may be to add it as a table).]

A table has bee added to the manuscript as the new Table 1.

[Page 3400, lines 14-15: references to dynamical 3D models are given, however next paragraph adds one more model reference (Gusev et al., 2005). Does it differ from them significantly as it was not mentioned between them?]

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Gusev et al., 2005 is also a 3D model. It was mentioned in the next paragraph to illustrate the aerosol partitioning of PCBs treated in this model. We have added this reference to the list of 3D models.

[Page 3401, line 11: it is written that NO3 radicals and O3 can also play significant role in the process of POP degradation in the atmosphere. However, there is no any information in the section 2.2.1 if they are included in the model or not.]

Since the reaction with OH is the dominant degradation process, reaction with NO3 was not included in the current study.

[Page 3403, lines 1-7: The soil module of GEM/POPs has three layers (1cm, 3cm, and 7 cm). Is the profile of POP concentrations in the upper 1 cm layer taken into account? Some papers mentioned that the upper thin soil layer can play very significant role in the exchange of POPs between the atmosphere and soil.]

The concentrations of the upper 1 cm layer play a very significant role in the GEM/POPs model. In the air-soil exchange process, the concentrations of the upper 1 cm layer are used to calculate PCB exchange rate between atmosphere and soil. Inside the soil compartment, vertical diffusion of PCBs between 3 layers is calculated by the difference concentrations between the 3 layers.

[Page 3404, line 11-21; it is not rather clear what is the spatial resolution (vertical and horizontal) in the ocean transport module. It might be good to supply reference to the lake module where the reader can find its description.]

The horizontal resolution: 2x2 degrees. The vertical domain of OPA model spreads from the surface to depth of 5000 m and is divided into 31 levels. As mentioned on page 3404, line 21, no lake module is included in this study.

[Page 3406, lines 3-4: it is written that GEM/POPs combines modeling and observed data on soil concentrations of PCBs, what was the methodology for combining/assimilation? Was it done also for seawater concentrations?]

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The method to combine the MSC-East model and the observed distributions of soil concentrations is through a data-assimilation method (3D-Var). The main idea is to minimize the difference between the observations and the modeling results to achieve a more reasonable soil distribution than the original soil concentrations from the MSC-East model.

Due to the lack of observations data to cover global ocean, it is not done for seawater concentrations in this study.

[Page 3407, line 25: it is written that modeling results show a good agreement of the magnitudes of three PCBs. It seems that this paragraph is devoted to the Arctic site Alert. At the same time in the figure only simulated PCB28 is shown for the Alert site.]

In addition to PCB28, PCBs 153 and 180 are shown in the Figure 2b. Due to the lower PCB153 and PCB180 concentrations at Alert compared to other stations, the two bars for PCBs 153 and 180 show very lightly in the plots.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 3397, 2007.

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