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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Regional pollution potentials of megacities and other major population centers" *by* M. G. Lawrence et al.

Anonymous Referee #1

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This paper explores the dynamical pathways for pollutant export from the high-intensity source regions associated with major cities around the globe. By focusing on relatively small, 200-km scale regions the study provides more detail on the nature of outflow than has been possible from previous global model studies which have typically focused on continental-scale outflow. The study quantifies the extent of megacity influence at the surface and in the free troposphere, and explores how the balance between these varies for different source regions, identifying significant intraregional differences as well as the expected differences by latitude.

The topic is scientifically interesting, very relevant to the increased research and policy interest in the environmental effects of megacities, and worthy of publication in ACP. However, I believe that significant improvements are needed in a number of areas

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Interactive Discussion
Discussion Paper

before the paper is ready for publication:

(1) There is no discussion of the role of prevailing meteorological conditions (e.g., persistent high-pressure systems, on/off-shore flow) in contributing to the differences between MPCs seen here. Classification of MPCs based on these conditions would allow intraregional differences to be clearly explained. Currently the paper just notes the presence of "substantial intraregional differences" in a qualitative manner without providing any explanation or quantification.

(2) The major contributions of this study are not brought out strongly enough in the conclusions and abstract. The important new conclusions (reasons for intraregional differences, relationships between long-range export and near-source build-up) are difficult to separate from the more obvious ones (effects of latitude and convection).

(3) The general layout of the paper is clear, but the discussion of results in section 3 is too long-winded. The detailed analysis for specific MPCs is valuable (and well executed), but needs to be separated from the more general discussion; in its present form, the results are not easy to discern from the detail, and the section is therefore difficult to follow. Separating the case studies for specific MPCs from the general discussion in sections 3.2-3.4 would allow the reader to be led through the main arguments in a more logical manner, and would make the section more coherent. Coherence would also be improved by removal of forward references in this discussion section (e.g., p.13334 l.13, p.13335 l.18). In general, arguments of the type "Processes X,Y,Z affect the metrics, and the effect on the ranking is..." are easier to follow than "There are differences in rank..., and these are due to processes...". (e.g., see p.13337 l.24).

(4) The relevance of the study for real-world pollutants is unclear. The tracers used in this study are related to real pollutants in the introduction to justify their use, but the results for these tracers are not then related back to real pollutants in the discussion or conclusions. The paper would be more valuable if it discussed the applicability of the chosen metrics to real pollutants, or suggested how variations in lifetime or scavenging

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processes might affect them.

(5) It is not clear how robust the results are. The metrics are well-chosen, but how sensitive are they to the meteorological fields used? Would a different year produce similar results or would rankings vary markedly? This needs to be tested before the metrics can be determined to be useful, and it would be relatively easy to do this for at least one or two of the selected regions.

(6) The scale limitations of this study (resolution/orography/local circulations) are acknowledged in the conclusions. Might these errors be sufficient to invalidate the results? Comparison of these global model results with fine-scale nested or regional model should be a priority; intercomparison with other coarse-scale models (as suggested) would not be very helpful.

Specific Comments:

One of the conclusions of the paper is to confirm the sensitivity of outflow characteristics to latitude, and it would therefore be useful to plot how the metrics ELR_1km and E_UT vary with latitude, and to determine how much of the variance can be attributed to this alone. In practice, latitude is not an independent variable (it reflects differing meteorology); can this relationship be reformulated using convection (and other lifting processes if diagnosed) or other meteorological variables such as temperature or sea level pressure?

Page 13329, line 6: Are emissions supplied /m2 or /grid square? I assume the latter (so that emissions are the same for each region), but this should be stated here, along with any temporal characteristics (continuous?)

Page 13335, line 27 costs -> coasts

Page 13338, lines 1-5: this secondary convective entrainment is very clear from the UT Column plots for the coastal east asian megacities in the supplementary material; it would be worth referencing these here.

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The megacity footprints presented in the supplementary material are very interesting, and it is appropriate that they are included with the paper in this form.

Page 13348, line 19: The caveat is not that the results are model-based, but that they are based on a model for which the temporal and spatial scales that can be resolved are significantly coarser than those on which some of the key transport processes operate (convection, basin-scale flows, coastal breezes)

Table 4 would be easier to understand if the minimum and maximum values in the rank columns were provided as ranges: '(1-4)' rather than '(1,4)'.

Table 4 lists the standard deviations of the monthly means to provide a measure of the temporal variability of the chosen metrics. It would be interesting to consider some additional measure of spatial variability, particularly where the direction of outflow differs significantly with season.

Figs 2/3: Approximately how do the area metrics A_1, A_10 and A_100 relate to the surface-density contours shown in these figures? It would be easier to visualize the metrics if a rough correspondence was provided.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 13323, 2006.

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