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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A plume-in-grid approach to characterize air quality impacts of aircraft emissions at the Hartsfield-Jackson Atlanta International Airport" *by* J. Rissman et al.

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The study examines the impact of aircraft emissions from the Hartsfield-Jackson Atlanta International Airport on PM2.5 concentrations using a plume-in-grid (PiG) treatment in a regional chemical transport model. The manuscript describes a novel approach for modeling aircraft emissions in a plume-in-grid framework and compares the airport impacts for simulations with the PiG treatment to cases without airport emissions and with a standard Eulerian treatment. In general, the manuscript is well written and is a valuable contribution that advances the state of modeling sub-grid-scale impacts from complex mobile sources such as aircraft. However, I have some important

comments that should be addressed before publication in ACP.

General Comments:

1. The maximum incremental impact of aircraft emissions in the PiG simulation is quite large (42.1 ug/m3), and I have no way of knowing if it is realistic. As the authors mention, their approach of placing fixed emitters at points along flight segments could artificially concentrate emissions and potentially lead to over-estimates of maximum impacts. If the dilution and mixing of the puffs in the airport environment were also underestimated due to use of grid-scale meteorological information, overly concentrated puffs could produce large over-estimates in maximum impacts. The model evaluation in this study (and most other PiG studies) uses routine network observations that do not provide data in highly concentrated regions of the plume, and so the PiG treatment is never evaluated against observations for the conditions where maximum impacts occur. On p. 113 (para. 2) and elsewhere, the authors highlight the value of their approach for examining the maximum impacts on air quality. These types of statement should be better qualified given the wide range of uncertainties in emissions and other inputs along with the general lack of fine-scale evaluation of PiG models in the literature. In section 6, where the authors suggest areas for future work, they should also place an emphasis on evaluating PiG simulations with in-plume data from previous and future field campaigns. If PiG models are to be used for estimating maximum impacts in practical applications, then we need to develop more confidence that the sub-grid-scale algorithms and processes are operating correctly.

2. The literature review section touches on many topics tangential to this study but does not mention the sub-grid-scale capabilities available in CAMx or the development of an APT version of CMAQv5. Since this study is based on the AMSTERDAM model, the aerosol and gas-phase chemistry routines (AERO3 and CB-IV, respectively) used are somewhat outdated compared to the more recent treatments available in CMAQv5 and CAMx (e.g., AERO6 and CB6). In the conclusion section, where the authors suggest future work on the AMSTERDAM model, perhaps they should indicate that future work

should be based on the CMAQv5-APT or CAMx models that host the most recent chemical mechanisms.

Specific Comments:

p. 1092, line 3: As discussed above, attention should be focuses on the PiG approach rather than the AMSTERDAM model specifically because AMSTERDAM does not have the latest chemistry routines.

p. 1095 line 1: The Foley et al. (2010) reference for CMAQ is not appropriate as the version of CMAQ used here pre-dates CMAQv4.7 described by Foley et al.

p. 1095, line 11: The artificial dilution of emissions in grid models could also lead to over-predictions in the case where oxidants from the background environment are artificially mixed into the plume and, e.g., enhance ozone formation.

p. 1096, lines 9-10: The authors state that "when puffs are sufficiently large or dilute, it is no longer worthwhile to track them separately from the surrounding air." Please indicate the physical and chemical criteria used to make this determination in AMSTERDAM.

p. 1096, lines 25-30. Is the version of CMAQ-APT used here publicly available?

p. 1101, lines 23-25: If the authors have 2005-based information to drive the emissions for the airport why choose to model 2002?

p., 1103, lines 20-30: Please identify the 8 TOG components of the emissions input to AMSTERDAM and the amount of mass for each in the emissions table

p. 1107, line 16 (Fig. 2): It would be worthwhile to overlay the observed values in Fig. 2.

p. 1108, lines 3-5: Can this explanation of reduced sulfate due to reduced OH be examined by comparing OH concentration in the different modeled cases?

p. 1108, lines 18-22: Please explain the reasoning here more clearly. I am not sure what reactants are being referred to, and I am not sure how coagulation of EC would increase the total EC mass.

p., 1109 lines 1-5. Please clarify the discussion about different temperatures for the puffs compared to the surrounding grid cell. The methods section indicates that standard gridded meteorological inputs are provided to AMSTERDAM. How is the model obtaining or estimating higher temperatures for the puff compared to surrounding air?

p. 1109, lines 8-9: Looks like the increase in nitrate is dampened by the increase in sulfate that acidifies the particles.

p. 1109. lines 10-22: It is hard to understand exactly what is going on here based on the description. It would help clarify the discussion if the authors could investigate the differences in deposition for the species to determine if that explanation is valid. If coagulation has a significant impact, then I wonder if the emissions size distributions are accurate and if the size resolution of the AMSTERDAM PM routines is adequate to accurately represent these processes.

p. 1109, lines 11-12: Since some of the impacts considered in this paper are very small, one wonders if the combination of the PiG model and host model is mass conservative. Has anyone ever examined the mass conservation characteristics of this model?

p. 1111, line 3. Do all pollutants have the same criteria? Does it make sense in this application to dump elemental carbon to the grid because gas-phase chemical conditions have matured?

Figures 3-5. The units in the captions and on the figures do not match.

Figure 8. This plot is very difficult to read. I would recommend reducing the number of curves in the figure to about 3.
