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# *Interactive comment on* "Development of a plume-in-grid model for industrial point and volume sources: application to power plant and refinery sources in the Paris region" *by* Y. Kim et al.

**Anonymous Referee #1**

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The authors extend the sub-grid plume treatment in the Polyphemus air quality modeling platform to include particulate matter and treat volume sources, and they apply the plume-in-grid model to power plant and refinery sources in the greater Paris region. The topic is a good fit for GMD, the analyses appear sound, and the manuscript is generally well written. I would recommend publication after the comments below are addressed.

Main Comments:

1. Section 4.3 should be clarified. First, the name of the sensitivity run "PinG-injection"



is not ideal, because the base PinG simulation also uses an injection approach. Second, the zones discussed in the text are not clear in the Figures, and the results in Figure 5 do not appear to easily fit into radial zones. I recommend labeling the zones in the figures and zooming into the region of interest in the figures (here and elsewhere) so that smaller scale features can be seen. Third, it is stated that earlier injection into grid cells leads to lower concentrations due to greater dispersal into neighboring grid cells in the Eulerian model(p. 5879, lines 22-25). Is this because the column injection approach used here would tend to underestimate horizontal transport by injecting all puff mass into the horizontal cell where it's centroid lies even if part of the puff overlaps a neighboring cell? Also, I would think that early injection into the grid could increase (rather than decrease) concentrations by enhancing mixing to the surface. Fourth, in this section and in the following section, the authors discuss NOx and SO2 in comparing the mixing and transport of pollutants in the different configurations. An inert tracer like CO would be more useful for understanding mixing and transport differences than the reactive species chosen. Fifth, the percent change in concentration due to the change in injection method is given, but the magnitude of this change in relation to the overall impact of using PinG compared with not using PinG is not discussed.

2. Section 4.4 focuses on understanding the impact of horizontal grid resolution but the authors changed the injection criteria along with the grid resolution (p. 5881, lines 27-28). Therefore it is hard to know how much of the differences presented are due to the grid resolution change versus the injection criteria change. Also, this section refers to grid resolution criteria and transport of pollutants in units of meters and km, but the grid resolutions for this study are all provided in degrees. I recommend providing an estimate of the grid resolution in km so that discussions of this type are clear. Also, the authors indicate that the PinG treatment has a greater impact at finer resolution due to issues related to grid-cell averaging (p. 5882, lines 9-10). Does this model have sub-grid sampling capabilities that could be used to eliminate grid-cell averaging effects in the comparison?

Additional Comments:

1. The authors should consider softening some of the language in the first paragraph of the introduction. The volume source considered in the current study is roughly the size of a cell in a high resolution (1km) grid simulation, and so pollutants in a standard photochemical run may not experience more dilution than in a PinG simulation. Also, this paragraph implies that standard gridded simulations would have significant errors near sources that would be reduced using PinG techniques. While this may make sense conceptually, the current study and most studies cited never evaluate model predictions with in-plume observations (i.e., they just illustrate the impacts of the PinG treatment). Given the large number of parameters and algorithms used in PinG models, as well as the lack of fine-scale evaluation, the errors associated with PinG treatments are unclear, and so it should not be assumed that they give better model performance in practice.

2. In the methods section, it would be good to include some language on how concentrations were processed for the model intercomparisons. For example, were pollutants in non-injected puffs merged with the gridded background concentrations before comparing with the reference simulation (or were in-puff concentrations excluded from the comparison)? Also, are there any issues associated with overlapping puffs independently interacting with background species (e.g., if each overlapping puff has access to NH3 in the background field, one could imagine that NH3 could be depleted in excess of its total amount in some situations, since NH3 is in instantaneous equilibrium with the particles)?

3. It would be helpful to add a table with the average altitude of the model grid layers and the emissions for all species from the two PinG sources (possibly as an online supplement).

4. Based on the description in the Korsakissok and Mallet (2010b) study, the column injection approach seems to be less physically realistic than the integrated injection



approach. Conceptually, the column injection approach seems to over-estimate vertical dispersion and under-estimate horizontal dispersion relative to information predicted by the puff model. Why not use the integrated injection method?

5. The ideas in Section 4.2 could be conveyed more clearly with vertical cross-section plots showing how PinG impacts the vertical structure of pollutants near the source and downwind. This would also illustrate how diluted the puffs are in the vertical direction and provide insight on the value of using sub-grid treatments for emissions sources.

6. In the conclusion section, it is not clear how the authors determined that the time criterion is “significant” for the formation of secondary aerosols. It might be better just to state the percentage impact associated with the sensitivity run.

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Interactive comment on Geosci. Model Dev. Discuss., 6, 5863, 2013.