Geoscientific
Model Development
Discussions

Open Access

EGU

# *Interactive comment on* "Concentration Trajectory Route of Air pollution with an Integrated Lagrangian model (C-TRAIL model v1.0) derived from the Community Multiscale Air Quality Modeling (CMAQ model v5.2)" *by* Arman Pouyaei et al.

**Anonymous Referee #2**

Received and published: 19 March 2020

Review This paper introduces and demonstrates how C-TRAIL can be used to enhance the value existing back trajectories calculation techniques for understanding long range transport of trace gases. In addition to the meteorological information that is already included to compute the trajectory, C-TRAIL incorporates trace gas concentration changes throughout the path of the trajectory. The authors applied this technique for the KORUS-AQ time period and demonstrated it's performance during various meteorological conditions. This new technique has the potential to be of high value for

scientist evaluating long range transport, scientists involved in model development, and air quality regulators. This paper fits the criteria for publication in GMD, but some methodological issues need to be addressed before accepting for publication.

Major comments

The authors make reference to "packets" starting on line 83 and the term is used throughout the paper. Is this considered to be a grid cell, a certain part of the concentration profile, the integrated profile or would the term air parcel be more appropriate? This should be clarified further because in some readers minds this term is unclear.

There is no mentioned about how well the meteorological model performs during the campaign period. Is there any previous work that compared surface and upper level winds to the model? During this campaign there were radiosondes launched (due to ozonesondes) that could provide some seamless validation of the model in the vertical and the usual stationary meteorological stations to verify the winds at least over land. I don't expect the authors to go ahead with a full scale meteorological validation, but I believe this is important to mention in more detail and include some references on the quality of wind outputs from WRF.

It is not clear what altitude these packets are arriving at over Seoul or if these packets started at various altitudes and descended to the surface via subsidence. This needs clarification considering this paper is discussing surface air quality impacts. This applies to lines 186-187, 21, and the discussion in lines 198-205. Additionally, while understanding the concentration change along the trajectory is a notable accomplishment of this study, the altitude of these packets needs to be included somehow in Figure 6b.

Lines 239-240: Wouldn't it be expected that almost all long distance packets would show lower concentrations because these are at higher altitudes, with stronger wind speeds, and not likely impacted from surface based CO sources? Are there convective processes considered in WRF that would transport surface CO at the altitudes considered here?

Line 254-255: Using the word "indisputable" is a strong statement and I believe needs some further justification. Since this application of C-TRAIL is based on understanding CO at the surface, it is important to know how well the modeled CO is relative to the surface measurements of CO. The model comparison to aircraft measurements gives an overview of the performance at numerous altitudes. However, since many of the high concentration CO packets remain close to the surface throughout their trajectory, it would be ideal to see how well the model performed when compared against surface monitor data.

Minor comments

There are some grammar issues that should be addressed in this paper. There were a few instances of present tense being used in combination with past tense and some sentences that should be restructured to better communicated the science presented in this paper. I suggest the authors give this a few reads to increase all the grammatical issues.

Line 63-66: In this sentence, it is not clear why the amount of pollution in an airmass would affect the reliability of the meteorology used in the trajectory calculation.

Line 138: A couple references to those papers would be ideal to include

Figure 4: the number of data points (n=##) should be included with these plots, especially to underscore the contrast between the number of samples for each of these conditions. This is especially relevant to the statement made on 148, where the highest correlation was found with the meteorological set up that had the least number of data points.

Line 158-159: It is not clear what point is being conveyed in this sentence. Isn't the sensitivity of CO source regions relevant for all conditions?

Line 162: I would suggest the complexity of the model is increased under stagnant conditions due to the lack of dispersion and one is further relying on getting the chemistry

C3

right in the model. Please comment on this.

Figure 7-10: The plots in (b) and (c) should be expanded vertically and with x and y grids added to better see the changes in concentrations and distances. In some instances it is difficult to see the increases or decreases mentioned in the discussion.

Specifically in Figure 9, since most of the packets do not extend over a large distance, it would be helpful to have a more zoomed in map projection to show the detail in the path of these packets. This suggestion applies for the other figures (7-10). Additionally, if each of these packets that start at an altitude higher than the surface do indeed end up descending to the surface, another plot with the zoomed in domain over South Korea would be helpful for further understanding how these packets closer to the receptor site. Additionally, there are no units mentioned for the altitude colorbar in figures 7-10.

While the highlight of this paper is the role of LRT of pollution from China on Seoul air quality, it would be helpful to have a zoomed in view of just South Korea to see the variability of surface packets.

Line 248: The text says Figure 9, but this should be Figure 10.

Figure 12a and 12b: Why are some of the clusters partially colored or not colored at all? Visually, it would be ideal to have all of them colored so it is obvious which cluster is which.

Line 264-266: