Review 2:

This work describes a model framework for investigating air quality and sources of pollution in the Los Angeles region. As a region with complex emissions, understanding the sources of air pollution is critical to improving air quality in the area. The model framework and validation against observations is exceptionally well-described and the work fits well within the scope of ACP. While I think the article could essentially be published as is, additional discussion on the limitations of this model framework based on the analysis of model error would provide more context on how to interpret future results. Therefore I would recommend publication and would encourage the authors to consider addressing the following things. I look forward to part 2!

Thank you for your thoughtful response and helpful comments. Each question is addressed individually below.

1. While the evaluation of the model against available measurements is quite thorough and well-described in the text, there is little discussion of how this evaluation impacts the interpretation of the results as well as the strengths and weaknesses of the model. A comprehensive assessment of how all the biases in specific pollutants could affect results would be largely speculative and thus is unnecessary, but I believe a brief discussion on how the model's performance against measurements could affect big picture results would be appropriate. Below I provide a few questions that struck me as meaningful to address, however they need not all be.

- Does the good representation of POA, but poor representation of SOA mean that generally, this model will predict OA better near sources and diminish in its effectiveness further away?
  Yes, this is true. Unfortunately, there are not sufficient observations of OA composition to better characterize this phenomenon. This point has been addressed in the first paragraph of Section 3.3:

  > "The accurate representation of POA and poorer representation of SOA suggests that OA is better represented near source regions and diminishes in its effectiveness with distance from sources."

- Could the poor NOx prediction impact the conclusions surrounding the NOx vs VOC-limited ozone regimes?
  The underestimation of $NO_x$ should not affect the conclusions surrounding the inner basin, $NO_x$-saturated regimes. In that region, a decrease in $NO_x$ results in an increase in $O_3$. If the $NO_x$ were better-predicted (i.e. higher), this would push the regime into an even more $NO_x$-saturated regime, and the conclusion would be the same.
  The impact of better-predicted $NO_x$ in the outer regions is less clear. As our results suggest, those regions fall near the $NO_x$-VOC-$O_3$ ridgeline (i.e., $NO_x$-insensitive regime), but we do not know where along that ridgeline. An increase in modeled $NO_x$ may push the regime to a more $NO_x$-saturated regime, or it could simply move the scenario along the ridgeline and have little impact on model results. This will be important to consider in future work.

- Because of the large biases in certain species does this model's strength lie in predictions of relative changes in species (as the results shown in this work are) rather than predicting absolute values or are there certain species the author's feel confident could be predicted?

Yes, the model likely predicts relative changes and perturbations better than absolute concentrations. This suggests that source apportionment and other studies that compare model scenarios are important.

- Do the large errors in wind speed and direction indicate a systematic bias of air from different areas into the domain region (e.g. higher sea spray aerosol from the ocean vs more agricultural or road sources from in-land) or is the spread too large?
  Wind speed shows a systematic high bias but there is no systematic bias in $PM_{2.5}$ based on location. Unfortunately, there are not sufficient aerosol composition measurements to allow us to investigate whether wind speed bias correlates with bias in specific aerosol species. When wind speed was better-predicted, the bias in $PM_{2.5}$ (and other pollutants) did not improve appreciably (Figure R2), further suggesting that wind speed error does not produce a systematic bias in pollutant concentrations throughout the domain.

2. Are wildfire emissions included? If they are included in one of the emission inventories then that should be made clear.
Wildfire emissions are not included. We chose to model a time period with limited wildfire activity so that the effects of wildfires were insignificant. We have made this more clear in Section 2.1.3:

> "Wildfire emissions were not included as this time period experienced limited wildfire activity."

3. Why were lightning NOx and dust sources not included? Are these just not large emission sources in the area?
Dust makes up a small fraction of total PM loading. Hayes et al. (2013) showed that in Pasadena, dust makes up only 1.6% of total $PM_1$ by mass. Natural emissions are the lowest source of PM emissions (CARB, 2023), so windblown dust is a minor contributor to total PM. However, it is possible that muting the dust scheme could cause underestimations of $PM_{2.5}$ and $PM_{10}$. Previous work suggests that crustal elements, i.e. dust elements, do not have a large impact on modeled ammonium and nitrate concentrations (Ensberg et al., 2013), so omitting these emissions should not have a large impact on other inorganic aerosol or gas-phase species. Previous work (e.g. Choi et al., 2009) has shown that lightning $NO_x$ is nearly negligible over Southern California. Lightning $NO_x$ and windblown dust sources were also omitted to be consistent with prior works investigating the Los Angeles Basin (e.g., Murphy et al., 2017; Qin et al., 2021). This paragraph has been copied into Section 2.1.3.

Technical comments:
1. Caption Fig 2: The caption refers to 2 different resolution scenarios as "d01." I assume this is a typo, but as I don't think this notation is used again, it may be unnecessary.
Thank you for noticing this, it has been updated.

References


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