Review of Bernier et al.

This manuscript presents the analysis of 91 Lidar measurements of ozone across three different field campaigns along the eastern US coast during the summers of 2017 and 2018 via a clustering analysis and model simulations. The goal of this manuscript was to investigate the characteristics of generalized coastal ozone behavior and to assess the ability of model simulations to reproduce ozone in complex coastal areas. The authors use a K-means clustering algorithm driven by 8 features to cluster their ozone measurements into 5 behavior cases, which they analyzed for different meteorological events that help to describe the ozone behavior in each case. To evaluate model ability to reproduce coastal ozone behavior, two chemical transport models (GEOS-Chem and GEOS-CF) were used to simulate these same events. Both models struggled to capture high ozone concentrations, especially in the mid-level altitudes, and GEOS-CF tended to overestimate low-altitude ozone. Much of this model inability to capture these ozone events was attributed by the authors to an inability to successfully capture changing wind speeds and directions.

This manuscript is a unique analysis and within the scope of ACP. I think it could be a good addition to the literature with some revisions, which I have detailed below.

Major comments:

- The clustering analysis methods needs to be laid out in more depth. Please give a brief description of what a K-means clustering algorithm is, along with most things described in the methods section – Hopkins statistic, silhouette method, etc. How are the best number of clusters chosen? Is this based on variance or something similar? There must be some mathematical model behind the decisions you have made, and this would be helpful to include in the supplemental, along with statistical information that led you to your choice of the number of clusters.
- For the underestimate of ozone in the free troposphere by GEOS-Chem, please include further discussion of model updates that may contribute to this beyond just the lack of the UCX mechanism. Here are papers I suggest reading for more information on the low bias in recent versions of the GEOS-Chem model: halogen chemistry (Wang et al., 2021, doi: https://doi.org/10.5194/acp-21-13973-2021); NOy reactive uptake in clouds (Holmes et al., 2019, doi: https://doi.org/10.1029/2019GL081990); lightning-produced oxidants (Mao et al., 2021, doi: https://doi.org/10.1029/2021GL095740).
- The difference in correlations between GEOS-CF and GEOS-Chem (0.69 vs. 0.66) is not large enough to be of any statistical note (both round to 0.7). I suggest removing any discussion of this small difference in correlations. Statistically, the models perform the same.

Minor comments:

Line 57: “set out to address this issue” appears twice in the sentence. Please delete one.

Line 66-69: Ozonesondes are also able to resolve vertical levels. How does the vertical resolution of the lidar measurements compare to ozonesondes? What advantages do lidars have over sondes?

Line 264: “significantly” Please provide a p-value or level of significance.

Line 406: “modeled versus lidar observation spatial O3 differences” This is confusingly worded. The “differences” implies that you are performing a mathematical operation (model – observed), but what you are doing is plotting model vs observations in Figure 7. Please reword to better express that.

Line 589: Is the underestimate in wind speed and failure to reproduce wind shifts by GEOS-Chem explained by the use of offline meteorology? Some variables in MERRA-2 are averaged every 3 hours, and I assume that sea/bay breezes occur more rapidly than that.

Line 652 and 145: “Automatized” should be automated.

Figures:

Figure 5. Can the observed winds be added to this plot, perhaps as a second row of panels?

Figure S1. Remove Table 2 title from the top of the table.

References

Holmes, C. D., Bertram, T. H., Confer, K. L., Graham, K. A., Ronan, A. C., Wirks, C. K., and Shah, V.: The Role of Clouds in the Tropospheric NO_x Cycle: A New Modeling Approach for Cloud Chemistry and Its Global Implications, Geophys. Res. Lett., 46, 4980–4990, https://doi.org/10.1029/2019GL081990, 2019.

Mao, J., Zhao, T., Keller, C. A., Wang, X., McFarland, P. J., Jenkins, J. M., and Brune, W. H.: Global Impact of Lightning-Produced Oxidants, Geophys. Res. Lett., 48, https://doi.org/10.1029/2021GL095740, 2021.

Wang, X., Jacob, D. J., Downs, W., Zhai, S., Zhu, L., Shah, V., Holmes, C. D., Sherwen, T., Alexander, B., Evans, M. J., Eastham, S. D., Neuman, J. A., Veres, P. R., Koenig, T. K., Volkamer, R., Huey, L. G., Bannan, T. J., Percival, C. J., Lee, B. H., and Thornton, J. A.: Global tropospheric halogen (Cl, Br, I) chemistry and its impact on oxidants, Atmospheric Chem. Phys., 21, 13973–13996, https://doi.org/10.5194/acp-21-13973-2021, 2021.