

The manuscript titled “Cluster-based characterization of multi-dimensional tropospheric ozone variability in coastal regions: an analysis of lidar measurements and model results” by Claudia Bernier et al. developed a clustering analysis of multi-dimensional measurements of ozone in coastal regions. The lidar clusters provided a more comprehensive perspective to evaluate the performance of three-dimensional models. The manuscript provides valuable information for understanding ozone chemistry in complex coastal regions. I would recommend publication if my following comments are well addressed.

For the issue about the models’ poor performance in simulating mid-level O₃, one influential process is the transport of O₃ in the free troposphere from the continent to coastal areas. I wonder whether your model can capture this process accurately.

Lines 513-530: You speculate that the overestimation of O₃ in the morning is because of underestimation of NO titration at night in the cluster MCO. Some evidence should be provided. The verification of modeled NO_x by observed values can help to understand this issue. Also, in Fig. 6 it seems that GEOS-CHEM better captures the O₃ levels in the morning than GEOS-CF for the clusters MCO and HLO. The reason for the discrepancy between the two models’ performance should be clarified.

Lines 531-532: The GEOS-CF model also overestimated the O₃ in the afternoon even if it does not overestimate early-morning O₃ (e.g., LLO and LMO). This means there exist processes other than nighttime NO titration causing the overestimation of O₃ in the afternoon. I suggest to point out this issue and try to explain the potential causes.

In Sec. 3.4.2: The specific effect of the models’ performance simulating wind on O₃ simulation is not clearly explained. For example, how the wind leads to the overestimation of O₃ in MCO case by models, while leads to an underestimation of O₃ in HLO case by GEOS-CHEM. From my understanding, the wind will at least influence the dilution rate and horizontal and vertical transport of O₃.

Lines 623-635: I think this paragraph should focus on how the sea/bay breeze events cause a difference in O₃ profiles between and MCO and HLO cases and how they influence the model simulations. The reason why the two curtains are not in the same cluster is not important for your research objective as it is just an observed phenomenon.

The manuscript is too long and many sentences are redundant. There are a lot of repeated description in the main text, such as the description about the advantage of the lidar measurement and cluster approach, and the models’ performance in low- and mid-levels. This will reduce the readability of the paper. I suggest to remove some redundant sentences. In addition, the conclusion is also too long. I suggest to simplify the conclusion and only convey the key information.

Other comments:

Line 335-336: “the HLO cluster reveals the specific case in which higher O₃ is captured early in the temporal profile 336 in the low-level and translates to the higher O₃ captured in the low-level as well”. This sentence is ambiguous. Please rephrase it.

Lines 339-340: how do you infer that the cluster HMO indicates concentrated residual layers in the mid-level. Can you provide any evidence?

Lines 369-370: I suppose the low vertical mixing may reduce the descending O₃ from above level, leading to lower low-level O₃ concentrations.

Lines 370-371: “Relatively calm wind speeds and lower temperatures indicate other possible meteorological factors such as high cloud cover that could have contributed to the lower O₃ concentrations in LLO”. This sentence is unclear because lower temperature will also lead to lower O₃ production.

The title of Sec. 3.3.3 is not appropriate. You mainly discuss the potential causes that influence the model performance capturing the clusters’ O₃ levels. A better title should be considered.

Line 511: Do you mean “despite having a low correlation in other cases”?

Line 526-527: “In HLO alone, there were 4 (out of 18) of the profiles that were consecutive while in MCO there were 8 (out of 28)”. This sentence is unclear. What do you mean by the word “consecutive”.

Lines 536-547: The structure of this paragraph is weird. Since you mainly discuss the situation in low level, it is not appropriate to discuss the mid-level situation. It is better to move these sentences to the next paragraph where you mainly focus on the mid-level O₃.

Fig. 8. The symbol of wind direction is weird. Ordinary arrows are better to indicate wind direction. The arrows in panel (a) are too dense and the color is unclear. In addition, I didn’t see the shift of wind direction from westerly to easterly winds in the MCO case. I suggest to define the meaning of arrow direction in the Figure legend.

Line 597: “led” should be “led to”.

Lines 599-600: It seems that easterly winds prevail in the early morning and shift to northerly winds in the afternoon at the low level.

Line 630: I do not see that the MCO case has higher afternoon O₃ concentrations captured above 2000 m than the HLO case in Fig. 8d. They seem similar. In Fig. 4, the MCO cluster has lower afternoon O₃ concentrations captured above 2000 m than

the HLO cluster. In addition, does the white color in Fig.8d represent 0 ppb of O₃ or missing data?

Line 660: GEOS-CF has an overall lower unsystematic bias range.