Interactive comment on "Analysis of ozone vertical profile day-to-day variability in the lower troposphere during the Paris-2022 ACROSS campaign" by Gérard Ancellet et al.

The manuscript by *Ancellet et al.* (2024) analyzes results from the summer 2022 ACROSS (Atmospheric ChemistRy Of the Suburban foreSt) measurement campaign. This field campaign was conducted in, and around, the city of Paris and focused on observations of the diurnal and day-to-day variability of ozone (O_3) in the lower troposphere. Vertical profiles of atmospheric constituents were obtained from O_3 and aerosol lidars and commercial aircraft and were combined with radiosondes, IASI satellite retrievals, and CAMS model simulations to understand the processes driving spatiotemporal variability, vertical distributions, and magnitudes of O_3 in the planetary boundary layer (PBL). The manuscript presents in detail the physicochemical characteristics of numerous high O_3 events which occurred between June 13 and July 13, 2022. The text goes to great lengths to describe the agreement in different features (e.g., PBL and RL heights, O_3 concentrations, etc.) observed or simulated by the numerous measurement and modeling tool applied in this study. Four main O_3 events were intercompared for the physicochemical associated with the observed pollution values. The work highlights the importance of ground based O_3 lidars for better understanding air quality. I appreciated the effort the authors have gone through to provide all the details of results from the observations and modeling tools used during the campaign; however, the text does become dense at times. It would be nice if the authors could focus more on the main results of the study without discussing and intercomparing each observation/modeling data source for all 4 pollution events. Also, the novelty of this study is not immediately apparent. The manuscript is generally well-written; however, numerous typos were identified. Please see the minor and major comments below which I think would improve the overall manuscript.

Minor Comments

1. Line 1. "profile" not "profiles"

2. Line 10. "shows" not "show"

3. Line 48. "relative contribution *of*"…

4. Line 57. Is the last comma in this line supposed to be a period? The sentence between Line 55-60 needs some work. It is very hard to follow.

5. Line 62. The impact of long-range transport of O_3 has been shown in studies using ground-based lidar and satellites as well (e.g., Langford et al., 2019, 2022; Johnson et al., 2021).

6. Line 121. "remnants" instead of "remain".

7. Line 151. There is an extra ")".

8. Line 154. "The" Copernicus…; and "concentration" should be "concentrations".

9. Line 151. 10 km × 10 km

10. Line 156-157. Does the author mean “In this work, CAMS model analysis was conducted at 3 daily time steps…? This sentence needs some editing.

11. Line 157. October needs to be capitalized.

12. Line 202. “and” not “or”.

13. Line 229. The authors start to use “O_3” for ozone about halfway through the paper. For consistency, it would be good to just use the chemical formula throughout the manuscript.

14. Line 158. I don’t think you need “downloaded in october 2023” in this sentence. This information is better for the Data Availability section at the end of the manuscript.

15. Line 352. Missing a “)”.

Major Comments

1. How were the IAGOS and lidar O_3 partial columns calculated? Was the IASI observational operator (averaging kernel and a priori profile) used to calculate these values from IAGOS and lidar data? Same question about the CAMS data shown in Fig. 13. This is an important step in order to have directly comparable information between satellite products and other observed/modeled data.

2. Figure 13. The authors compare IASI 0-3 km partial O_3 columns to IAGOS, lidar, and CAMS 0-3 km and 1.2-3 km partial O_3 columns. This figure shows that IASI 0-3 km partial O_3 columns are much lower compared to the IAGOS, lidar, and CAMS 0-3 km products; however, are more comparable to the 1.2-3 km partial O_3 columns from these three products. I am confused why the authors state this is such a good agreement. The IASI 0-3 km partial O_3 columns compared to IAGOS, lidar, and CAMS 0-3 km data suggests nearly a 100% underestimation by satellite data. The authors state that satellites have limited sensitivity to lower tropospheric O_3, which is true; however, the a priori information in the retrievals still exists. The limited sensitivity only limits the retrieval from deviating from the a priori state. The text reads as if the authors are saying the lowermost tropospheric O_3 values in the satellite retrievals will be near zero due to the limited sensitivity. Is this why the authors focus on the comparison of IASI 0-3 km partial O_3 columns to IAGOS, lidar, and CAMS 1.2-3 km partial O_3 columns? This is not correct.

3. Line 305-310. The authors are starting to touch on the true limitations of satellite sensitivity to lowermost tropospheric O_3 here; however, don’t quite complete the statement. A main reason the satellite data agrees with observations on low O_3 days is that the a priori information for IASI is likely based on climatological information. Given the limited sensitivity of satellites to PBL pollution, the retrieval will result in values very similar to the a priori. The authors should expand upon this and reference the numerous studies that have been published on this.

4. For back-trajectory calculations, are there higher spatial resolution meteorological data that could be used to drive these simulations? 1° × 1° ECMWF meteorological data cannot capture the

city-scale features being observed during ACROSS. The entire domain shown in the supplemental figures only encompasses ~2 × 4 ECMWF grids.

5. This work highlights the importance of O_3 lidar data to better understand air quality and PBL dynamics throughout the day. It would be good to reference the many studies in the literature that have demonstrated this in the past especially those from observations made by the Tropospheric Ozone Lidar Network (TOLNet, https://tolnet.larc.nasa.gov/) (e.g., Langford et al., 2017, 2019, 2022; Sullivan et al., 2016, 2017; Johnson et al., 2021). Similar to the work here, these past studies, many conducted during large field campaigns, have shown the impact of local emissions, long-range transport of pollution, PBL heights, RL heights, meteorological conditions, and other physicochemical elements on local O_3 concentrations. These referenced works have focused on UV O_3 lidar observations, combined with ancillary observations and model simulations, to study nearly identical topics focused on in this work. It would be good for the authors to review these past studies and determine the similarities and differences between them and the work presented here by the authors.

6. The authors go through great lengths to discuss the physicochemical conditions observed and simulated during the ACROSS. However, the manuscript lacks discussion about what new has been found compared to past field campaigns and publications. The authors state at the end of the paper that "…interaction between the urban layer dynamical development and the O_3 plume formation during the day, this work is a first study". However, there are many studies which have discussed the impact of PBL/RL dynamics, local emissions, and long-range transport on observed O_3 formation. Just a small sample of these studies are referenced above. I think the authors could reduce the very lengthy text describing and intercomparing each observation/modeling tool for all four O_3 events in order to expand more on the novelty of this study. What new results were found during ACROSS? How does this advance the understanding of air quality? This needs to be discussed in detail because it is not clear to this reviewer that any novel findings were found. The authors should do a much more thorough literature review of this topic in order to identify the novelty of this work.

7. At times it feels there are too many figures in the paper. All 14 figures in the main text have multiple panels and become overwhelming. It would be easier for the reader if the authors focused their discussion on new findings and condense the figures in order to show the main results. The text is very dense when intercomparing every measurement and modeling tool for each case study. Perhaps the authors could improve the readability of the manuscript by only focusing on main findings instead of discussing every piece of information for every day throughout the campaign. At times it starts to read more like a field campaign report and less like a journal manuscript.

8. The final version of the paper should improve the quality of the figures. Some of the figures appear to have low resolution and some of the symbols used in them are not easy to see.

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