Reply to Referee #2

This manuscript presents the development of a new data set on tropospheric ozone concentration, focusing on the lowest troposphere over the oceans and polar regions. It is being developed as part of the TOAR-II project, and is based on observations from ship campaigns, drifting buoys, aircraft and balloon soundings, as well as surface measurements on islands and at coastal stations. A selection of observations weakly influenced by continental emissions uses HYSPLIT trajectories and a land mask
The authors state that this paper does not constitute an exhaustive analysis of the processes controlling tropospheric ozone for oceanic or polar regions. The objective is limited to a presentation of data sources, their consistency and the main characteristics of ozone measurements in 10 regions presented in figure 1. I recommend publication of this work after clarification of the methodology for selecting the last land contact at 72 hours (LCL72) and after improving the readability of figure 1 and tables 1, 2 and 3.

We are grateful to the referee for his/her comments. A point-by-point response is given below (in blue).

Major comments:
1. line 96 to 103. Please provide the order of magnitude of loss terms (photochemical destruction and dry deposition) and photochemical production terms. Long-range transport of ozone in the free troposphere is also an important source in the ozone budget in remote regions. As the document provides a global assessment of ozone observations, expected differences between tropical and mid-latitude ocean regions could be mentioned.

In the revised manuscript, the order of magnitude of production and loss terms were given from Line 99 in the Track Changes version:
The overall budget of tropospheric ozone is dominated by the photochemical production and loss terms, estimated at 4500–5000 and 3900–4500 Tg y^{-1}, respectively, rather than by the stratosphere-troposphere exchange (270–540 Tg y^{-1}) or surface deposition (800–1000 Tg y^{-1}) for decades around 2000 or 2010 (Griffiths et al., 2021; Young et al., 2018). The net ozone production mainly occurs over regions with NOx pollution and depends on the abundance of volatile organic compounds (VOCs).

As our focus is on the boundary layer rather than the free troposphere, the long-range transport of ozone in the free troposphere is not mentioned. The roles of tropical and mid-latitude regions in the ozone sink have not been clearly understood, in our opinion, and rather it is the topic we could study using the dataset collected here.

2. line 110 to 113. Cite the contribution of the 2007-2009 International Polar Year project, e.g. see the POLARCAT ACP special issue (https://acp.copernicus.org/articles/special_issue182.html)

The POLARCAT special issue is mentioned in the revised manuscript.

L117: During the previous International Polar Year 2007–2008, extensive studies on ozone were conducted and published (Atmospheric Chemistry and Physics (ACP) POLARCAT (Polar Study using Aircraft, Remote Sensing, Surface Measurements and Models, of Climate, Chemistry, Aerosols, and Transport) special issue, 2015).

3. line 134 Add a reference to the long term trend study in the marine boundary layer carried out by Parrish et al. (ACP 2009)

Parrish et al. (ACP 2009) is cited in the revised manuscript.

4. Figure 1 is useful, but its quality is not very good: the font size is too small in the top panel (especially for region names R1 to R11), and the grid lines between regions are not sufficiently marked. The ozone scale is quite nice in the middle and bottom panels, but an upper altitude of 2000 m is more useful than an upper limit at 5000 m in the bottom panel. This will improve the comparability of surface and aircraft/ozonesonde data. The 2000m-5000m altitude range is strongly controlled by long-range transport and is sensitive to stratosphere-troposphere exchange (STE), so processes specific to global oceans and polar regions cannot be discussed very well.

We agree with the reviewer. In the revised manuscript, the airborne panel only included data from surface to 2000 m. The font size and grid lines are improved.

5. line 156 The total number of hourly observations is not very significant for illustrating the temporal coverage of the data. Tables 1, 2 and 3 should show the number of measurement days. It is also difficult to assess the contribution of each season to the data variability included in the 10 selected regions. An additional 10x4 region/season table with the number of observations might be useful to assess the representativeness of the database.

We thank the reviewer for the important suggestion. In the revised manuscript, we added a table (Table S6) listing the number of days of observations per region and season for ship/buoy, airborne, and ozonesonde observations. And we added a short section (Section 3.2) discussing the seasonal coverage.

L317: 3.2 Seasonal coverage
Table S6 summarizes the number of observation days per region and season. For the ship/buoy data set, the four seasons were relatively well sampled, but the frequencies were higher for boreal or austral summer than winter for mid- and high-latitude regions (R1, 3, 7, 9, 10, and 11). For the airborne data, coverage was less in summer than in winter over the Pacific, while the opposite was true for the Atlantic. The ozonesonde data set appeared to have relatively uniform seasonal coverage, except that frequent observations were made during SON over the Antarctic (R11).

6. Line 191 : I am confused by the criteria to define the land mask. Do you really consider air mass over land above 2500 m as being not controlled by continental emission ? This is not true for areas with biomass burning, fast uplifting of polluted air masses or large aircraft NOx emissions. For example grey trajectories are visible in Fig. 2a above Siberia. Will they remain grey if you still consider land mask when the air mass is above 2500m ?

As pointed out, we have neglected air masses over land above 2500 m, and thus some cases classified as marine air masses may have been affected by biomass burning plumes that were transported over land above 2500 m and by biomass burning that occurred 72 or more hours prior to the observations (since we used LCL72 as the criterion). As this is the first comprehensive study of marine air masses, the criterion that is likely to be meaningful for the entire globe is still tentative and will be revised after detailed analysis to be performed in the assessment study.

7. line 224 : The total number of data records is not very useful as said hereabove. The number of fligth days is really the key parameter.

The number of observation days from airborne observations was included in the Figure S6 in the revised manuscript.

8. Line 231 and 244 : It is odd to find more LCL72 air masses in the 0-5000 m layer than in the 0-2000m layer. Is it still the same with a land mask extended above 2500 m ?

The larger fraction of significant marine air masses in the 0-5000 m data set is partly due to the fact that the altitude above 2500 m was not considered land. However, it is also true that the observed air masses from the 0-2000 m altitude range tend to originate from the lower altitude terrestrial region and are thus affected by pollution; the altitude range above 2500 m may not always be polluted. The recalculated fractions of LCL72, after removing the 2500 m altitude boundary, were 61% for both 0-2000 m and 0-5000 m, suggesting the validity of our calculations. For consistency with the ship/buoy data, we chose to present the original LCL with the 2500 m altitude boundary. After the data are analyzed in the assessment paper, we may revisit the criteria.

9. Line 237 : Geopotential heigths can be easily calculated with the ozonesonde pressure and temperature data. It is a pity to drop historical data based on this criteria.

We appreciate this comment. We hope to be able to consider extending the data set and the period to cover next time. Please note that the original ozonesonde data with longer record are available.

10. Line 240 : Undersampling the sonde data at point every 200 m is not a very good option and vertical filtering is a better way to keep fine scale features.

We agree with the referee that a better dataset will be produced without undersampling. However, the (1/e) ozone sensor response time (~30 s) gives the ozonesonde a vertical resolution of about 150 m for a typical balloon ascent rate (van Malderen et al., 2025) and thus we do not believe that much information is lost even if we sample only one point every 200 m. For reasons of efficiency, we did not choose to use averaging. Note that the original ozonesonde data are available in a separate paper.

11. Line 290 : What do you mean by flat ? Neither the latitudinal plot nor the longitudinal plot show constant ozone concentrations. The interhemispheric gradient and the proximity of continental emissions are clearly seen in these two very nice plots.

The longitudinal plot has less variation than the latitudinal plot. This is clarified in the revised manuscript (L308).

12. Line 302 : Could you also provide the number ratio winter/summer of data at mid-latitudes or the number ratio dry-wet season of data in the tropical regions ?

In the revised manuscript, Table S6 provided number of days of observations per season per region.

13. Line 312 : R9 also shows and interesting east/west gradient. For the elevated values in R8 it is worth considering african biomass burning emissions transported by the trade winds. I guess it is not always filter out by the LCL72 criteria.

We thank the reviewer for the comments and interpretations. The detailed analysis will be given in the assessment and subsequent papers.

14. Line 319-321 : The boundary layer diurnal growth is also weak above the ocean and less ozone is transported from the free troposphere as it is often observed over land.

We thank the reviewer for the comments. This study describes the data and does not include a detailed process study. Such analysis is considered in the assessment paper.

15. Line 339 : The Izana case should be removed as it is difficult to compare a moutain station with the ozonesonde value at the mountain altitude. Ozonesonde observations below the moutain site altitude would take into account upslope transport and would reduce the bias between the two datasets.

We dropped the comparison at Izana in the revised manuscript.

16. Fig. 2a Grey lines are barely visible above land. Use another color for marine air masses.

The color is changed to light blue in the revised manuscript.

17. Fig. 5. Please use the same ozone scale (0-120 ppb) for all the regions even if outliers are not always present. Axis thicknesses are too small. A grid would help.

The scale is unified to 0-120 ppb, and a grid (every 20 ppb) is added.

We thank the referee again for the important comments and suggestions to improve the manuscript.

References

Van Malderen, R., Thompson, A. M., Kollonige, D. E., Stauffer, R. M., Smit, H. G. J., Maillard Barras, E., Vigouroux, C., Petropavlovskikh, I., Leblanc, T., Thouret, V., Wolff, P., Effertz, P., Tarasick, D. W., Poyraz, D., Ancellet, G., De Backer, M.-R., Evan, S., Flood, V., Frey, M. M., Hannigan, J. W., Hernandez, J. L., Iarlori, M., Johnson, B. J., Jones, N., Kivi, R., Mahieu, E., McConville, G., Müller, K., Nagahama, T., Notholt, J., Piters, A., Prats, N., Querel, R., Smale, D., Steinbrecht, W., Strong, K., and Sussmann, R.: Global Ground-based Tropospheric Ozone Measurements: Reference Data and Individual Site Trends (2000–2022) from the TOAR-II/HEGIFTOM Project, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2024-3736, 2025.