

Interactive comment on “Examination of the atmospheric conditions associated with high and low summer ozone levels in the lower troposphere over the Eastern Mediterranean” by P. D. Kalabokas et al.

Anonymous Referee #2

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The authors have conducted an analysis of MOZAIC ozone profiles over the eastern Mediterranean region to understand the meteorological conditions associated with high and low ozone levels in the lower troposphere. There is significant interest in understanding the impact of transport on tracer distributions over the Mediterranean since the region is influenced by transport of pollution from Europe, Asia, and North America. The manuscript is well written and the analysis is straightforward. I recommend publication of the manuscript in ACP after the authors have addressed my concerns, which are discussed below.

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General Comments

1) A concern with the manuscript is with the discussion of the impact of the meteorological conditions on boundary layer ozone. I found the explanation of this confusing. On page 2469, lines 1–15, the authors explain that under anticyclonic conditions there is northerly flow on the eastern edge of the anticyclone region which transports high ozone from the polluted areas of Europe into the eastern Mediterranean. And that this transport, combined with trapping of the accumulated pollutants in the boundary layer results in high ozone abundances in the boundary layer. However, boundary layer ozone is not higher under anticyclonic conditions. Comparison of Figures 8 and 10 shows that when ozone is high in the lower free troposphere (associated with anticyclonic conditions) ozone in the boundary layer is typically lower than when ozone in the lower free troposphere is low. The difference is especially pronounced over Cairo (Figure 8). When lower tropospheric ozone is high over Cairo, boundary layer ozone is about 30–40 ppb. In contrast, when lower tropospheric ozone is low, boundary layer ozone is about 60 ppb. Over Tel Aviv (Figure 10) high lower tropospheric ozone is associated with surface level ozone as low as 20 ppb. Is it possible that under anticyclonic conditions, the increased stability in the boundary layer results in lower ozone abundances at the surface due to greater ozone loss through deposition at the surface? I appreciate that the authors plan to conduct a more detailed analysis of the boundary layer ozone in a subsequent paper, but the authors need to clarify the discussion here.

2) A conclusion of the study is that low free tropospheric ozone is associated with the “uplifting of boundary layer air, poor in ozone and rich in relative humidity to the lower troposphere.” The discussion on page 2471, lines 1–7, of the CAPE over Cairo gives the impression that this uplift is local. However, that cannot be the case since over Cairo (as shown in Figure 8) ozone levels are higher in the boundary layer when ozone is low in the lower free troposphere. Furthermore, the back trajectories suggest that the low ozone air originated in the central Mediterranean 3 days before. Are the authors suggesting that the instability conditions at Cairo are representative of the entire

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Mediterranean region? The authors need to better explain the influence of this uplift on the lower tropospheric ozone levels. Is it possible that the low ozone and high humidity are due to the uplift of boundary layer air from a more remote location? Could this be ozone poor air that is transported from the eastern Atlantic and uplifted by the topography over northwestern Africa? What would 5-day or 7-day back trajectories show for the origin of the low ozone air?

Specific Comments

- 1) Page 2462, line 22: "10-15% lower" should be "10-15% higher".
- 2) Page 2462 line 24-25: It is stated that the "the relative humidity levels inside the boundary layer are higher than the corresponding lower troposphere level." However, the plot for Antalya in Fig. 1b shows a maximum in relative humidity at 3km.
- 3) Page 2468, lines 25-29: I do not understand the explanation given here. Why would the high boundary layer mixing heights lead to higher ozone in the boundary layer?
- 4) Page 2469, line 1: Change "tapping" to "trapping".
- 5) Page 2470, lines 4-5: "From this analysis it turns out a key factor leading to high upper tropospheric ozone values in the Eastern Mediterranean is the anticyclonic influence." This was not demonstrated in the manuscript. Other studies have shown this, but it is not clear to me how this analysis linked high upper tropospheric ozone to anticyclonic conditions.
- 6) Page 2471, lines 1-7: Please explain how the CAPE and CIN values are calculated.
- 7) Page 2471, line 28: The statement "ozone values in Rhodes, Heraklion and Antalya are inferior to the corresponding in Cairo. . ." is unclear.
- 8) Figures 1, 2, 4, 6, 8, and 10 are too small. Perhaps a four-panel plot for each consisting of two rows and 2 columns might provide more space for the individual panels, so that it will be easier to read the plots.

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