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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Phenomenology of summer ozone episodes over the Madrid Metropolitan Area, central Spain" *by* Xavier Querol et al.

Anonymous Referee #1

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Overview: The paper deals with the phenomenology of the summer ozone episodes over the greater area of Madrid, Spain. I think that it is a very interesting study, analyzing atmospheric measurements of ozone and fine particles together with many other atmospheric parameters and giving further insight to the complicated atmospheric mechanisms related with air pollution over the area. In my opinion, the document deserves publication in ACP, after the recommendations listed below are taken into account.

General comments: A weak point of the paper is that the levels of measured surface ozone are mainly related (or attributed) to the photochemical ozone production over the metropolitan area of Madrid. On the other hand, I think that the variations of

the background ozone levels within the boundary layer and the free troposphere are not discussed with sufficient detail. In relation to that comment and based on research results carried out on the other side of the Mediterranean basin, in the Eastern Mediterranean, it comes out that the regional background ozone levels in the free troposphere and the boundary layer during summer, regularly exceeding 60 ppb, contribute on the average to the greatest part of the surface ozone levels measured in large urban areas like Athens (Kalabokas et al., 2000; Kourtidis et al., 2002; Kouvarakis et al., 2002; Lelieveld et al., 2002; Kalabokas and Repapis, 2004; Gerasopoulos et al., 2005). The main origin of these high ozone background levels over the Eastern Mediterranean is tropospheric ozone subsidence, which seems to be strongly related with specific synoptic meteorological conditions, occurring very frequently during summer at the Eastern side of the Mediterranean basin (Kalabokas et al., 2013; Zanis et al., 2014; Kalabokas et al., 2015; Akritidis et al., 2016). In addition, recent research shows that during springtime ozone episodes (April – May) over the western Mediterranean similar synoptic meteorological patterns might also occur and which are linked with regional episodes mainly induced by large scale tropospheric ozone subsidence, influencing (or fumigating) the boundary layer as well as the ground surface ozone concentrations (Kalabokas et al., 2017).

Even if the typical meteorological conditions prevailing over the Iberian Peninsula during summer are quite different than in the Eastern Mediterranean, as it is very well described in the introduction of the manuscript, occasionally such conditions might occur. In fact, I think that this is the case of the ozone episode of 11-15 July 2016, which is the most studied period in the manuscript (when the intensive measuring campaign has taken place). As shown in Figs 3 and 12, the free tropospheric ozone levels are much higher on July 13, 2016 than the two weeks before and after and at the same time the relative humidity values in the lower troposphere are close to zero (and being in sharp contrast with the periods before and after). In fact, this feature is a very common characteristic of deep and large-scale tropospheric subsidence in summertime ozone vertical profiles over the Eastern Mediterranean, indicating an origin of air

masses from the upper tropospheric or stratospheric layers (Kalabokas et al., 2013; Kalabokas et al., 2015).

Therefore, for a better assessment of the free tropospheric influence as well as the reported fumigation events over the area, I would suggest putting more emphasis on the analysis of the synoptic conditions during this most studied period, when the intensive measurement campaign has taken place (11-15 July 2016). A figure could be added including at least the daily meteorological maps of geopotential height, omega vertical velocity and specific humidity at 700hPa pressure level (representative for the free troppposphere), which I think that they would be sufficient to follow satisfactorily the evolution and the geographical extent of the subsidence phenomenon (the subsiding air mass seems to originate from N-NW Atlantic). If this parameter is taken into account, then I think that the discussion concerning the origin of the fumigation events during 11-16 July 2016 would be more complete (tropospheric ozone subsidence in addition to the local ozone photochemical production associated with valley-breeze recirculation and ozone residual layers, as mentioned many times in the manuscript). So, I would suggest modifying accordingly the respective paragraphs, where sometimes the high ozone values recorded at the top of the boundary layer are not fully explained (e.g.: Page 5, lines 175-187; Page 9, lines 348 – 352, 362-365; Page 12, lines 470 – 473, 483-487; Page 14, lines 570 – 582).

In addition, I think that it would be more appropriate to refer to “Western Mediterranean” ozone when analyzing ozone in Spain (instead of “Mediterranean” or “S. Europe” in general) as, according to the above mentioned papers, the phenomenology of the summertime ozone over the Eastern Mediterranean seems to be is quite different than the typical ozone phenomenology over the Western Mediterranean.

I would strongly recommend taking these considerations into account, which have been made in the spirit to further improve this good quality manuscript, by modifying the respective paragraphs. After responding to these remarks, I think that the paper is ready for publication.

Technical comments: Fig. 4: Very condensed and difficult to follow, especially on printed paper. I would suggest splitting into two parts and eventually using gridlines.

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