

Interactive comment on “Summertime free tropospheric ozone pool over the Eastern Mediterranean/Middle East” by P. Zanis et al.

Anonymous Referee #1

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Overview:

The paper deals with the very interesting topic of the high summertime free tropospheric ozone levels over the Eastern Mediterranean and Middle East regions. The paper is scientifically sound and it presents interesting new information on the subject, regarding measurements and modelling. It is also well documented concerning previous literature on the subject and the analysis is written in a clear and straightforward way. I strongly believe that the paper merits publication in ACP, after the following minor comments and technical corrections are taken into account by the authors:

Minor comments:

Page 22028. line: I would suggest the citation Kalabokas et al., 2007 to be trans-
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ferred to line 13 “but also tropospheric subsidence (.” as it is more relevant to tropospheric subsidence.

Page 22052, Fig. 3 and also related text: Is there any explanation about the geographical shift (several hundred of kms to the west) of the maximum in ozone anomalies, when ERA-Interim and TES data are compared? This might differentiate some space details on the issue of lower troposphere-boundary layer interaction over the area, as the discussion of the paper is based only on ERA-Interim data.

Page 22053, Fig. 4 and also related text: The humidity and the vertical velocity seem to be more effective tracers of transport than potential vorticity as they are better associated with corresponding ozone changes (see Fig. 4). This might be due to the fact that the subsidence from the upper troposphere to the lower troposphere might be the most crucial factor on local scale if compared to the stratospheric intrusions occurring over the area. I would suggest that stratospheric dry air, rich in ozone, entering the upper troposphere at other geographical locations, even remote, it could influence as well the lower troposphere and eventually the boundary layer over the Eastern Mediterranean, through the strong and very persistent regional subsidence. It has also to be mentioned that the upper tropospheric ozone reservoir might be additionally enriched by the accumulated ozone production from tropospheric photochemical processes on hemispheric scale during the warm period of the year.

Pages 22056-22057, Figs. 6-7 and also related text: Regarding the tropospheric influence to the boundary layer and to the surface, which is the most crucial point of ozone pollution regarding policy implications, I think that it should be added that according to the presented modeling results at the top of the boundary layer (850-900 hPa) the stratospheric contribution is only around 10 ppb with total levels over the examined region of 80-90 ppb. I think that the remaining tropospheric ozone levels (70 – 80 ppb, after subtracting the direct stratospheric influence), are already sufficient in principle, to create ozone pollution problems in the region given the strong and characteristic regional subsidence.

Page 22037, lines 26-27: I would suggest that the description of the characteristics of ambient measurements (Fig. 8e) should be done independently and before doing the comparison with the modeling, as I think that they deserve priority when dealing with so complicated situations. An interesting characteristic of these measurements is that the Finokalia station in Crete shows significantly higher summer average ozone values in comparison to Cyprus and Malta, which verifies the tendency already reported but based only on the first 4-years of ozone measurements at the same stations (Kalabokas et al., 2008). An additional interesting point, which I think that it deserves discussion here, is that based on several years of measurements, long term rural ozone averages from other stations in central Greece and also at the periphery of Athens (upwind) show comparable high levels with Finokalia (Kalabokas et al., 2008). These comparable high ozone levels seem to extend throughout the Aegean sea up to the north, as it has been reported from an intensive ship campaign (Kouvarakis et al., 2002). In my opinion, the points mentioned above are helpful to the argumentation of the paper on the importance of large scale subsidence occurring during summertime over the area. It has just to be considered that during summertime with the characteristic northern flow occurring over the Aegean Sea, comparable (usually high) levels of ozone are recorded, thus minimizing the role of local and regional photochemistry on ozone levels in comparison to transport (especially in the vertical direction), despite the favorable summertime conditions for photochemistry prevailing over the Mediterranean.

Technical corrections:

Page 22051, Fig. 2: I would suggest mutual exchange of the position of the Figs. j-i (September – October).

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 22025, 2013.

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