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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Source attribution and radiative impacts of the Mediterranean summertime ozone maximum: a satellite and model perspective" *by* N. A. D. Richards et al.

**Anonymous Referee #1**

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Review of the ACPD 2012-554 paper entitled "Source attribution and radiative impacts of the Mediterranean summertime ozone maximum: a satellite and model perspective"by Richards et al. ACPD, 12, 27219-27254, 2012.

General comments: The paper constitutes an interesting contribution to understand and assess the tropospheric ozone budget, and its radiative effects, over the Mediterranean basin, a region of complex meteorology and climatological features, where pollution processes and regional climate seem to impact each other and are subject of intricate feedbacks. The combined use of modeling with TOMCAT and satellite (TES and GOME-2) allows the authors to approach the well known problem of high ozone



over the Mediterranean in summertime overcoming the limited number of ground stations sparsely distributed on the coasts. Furthermore, the analysis made with modeling and satellite observation permits ozone budget estimate and evaluation in the vertical column considering contributions from different local and remote sources. However the paper lacks discussion about important aspects related with ozone production/transport, and the limits of the troposphere domain that must be introduced in the paper before publishing.

I have also provided some minor corrections and comments below that I suggest the authors should consider in revising this paper.

Major Revisions:

1. Large scale aspects as the position of the descending branch of the Hadley cell in summer over the Mediterranean (J.J. Liu et al., 2009 –JGR) leading a generalized strong subsidence (with ozone enriched air masses from upper levels) with associated free cloud conditions and high radiation, should be mentioned in the introduction.

2. A major concern is the total lack of comments and references about the potential role played by natural processes, such as tratosphere-troposphere exchange, in the ozone budget over the Mediterranean region. This prevents proper assessment results on the agreements found between observations (mainly from satellite) and modeling. Specifically, the TOMCAT model considers folding tropopause processes associated to deep lows, cut-off-lows (COL) or to the subtropical jet?

3. Associated with the previous question, Nieto (2005) produced a climatology of cut-off lows over the northern hemisphere from 1958-1998 which showed a favorable area for COLs over three areas of the Northern hemisphere being one of them located over the Eastern Mediterranean Sea where closed cyclones were more prevalent (see Nieto et. al Fig. 8). As you know COLs can ozone enrich the middle and upper troposphere, and consequently the tropospheric column These results agree others obtained by Gerasopoulos et al. (2006) and Akritidis et al.,(2010) in which they show that the

stratospheric intrusions can even affect the O3 mixing ratios at the ground over the Mediterranean (Northern Greece and Athens, respectively).

4. Weigel et al. (2012; ACP) also documented stratospheric intrusions associated to the subtropical jet (STJ) over the Mediterranean. The STJ can be found over North Africa and the southern edge Mediterranean basin in summer time, and might favor stratospheric ozone-rich air masses transport into the upper troposphere.

5. It would have been appropriate to have included an ozonesonde stations (ie. Thessaloniki) for both model validation and ozone vertical structure assessment since most of results refer to levels well above the marine boundary layer. Why ozonesonde statistics have not been used?

6. Concerning the anthropogenic emissions you have used IPCC R5 2000 emissions set. Does it take into account the emissions from crude oil refineries, phosphate-based fertilizer industry and power plants settled in North Africa (Morocco, Algeria, Tunisia). See Rodriguez et al (2011, ACP).

7. Concerning the TOMCAT model experiments, you have eight sensitivity runs, each with 20% reductions in different local and global ozone precursor emissions detailed in Table 2. My first question is, what are the criteria to choose 20% reduction and not 15% or 25%?. It should be explained. My second question: a higher reduction, for example of 30% in anthropogenic VOCs, would be result in major/significant impact on ozone?

8. Concerning the sensitivity runs, the Asian emissions constitute a very interesting and novel bet. However, I wonder you have not considered the North America emissions taking into consideration the high number of publications dedicated to the impact of ozone and precursors transport from North America into the Mediterranean. You have referenced the importance of ozone and precursors abundances enhancement in upper and middle troposphere over the western Mediterranean by large-scale westerlies in summer (Rodwell and Hoskins, 1996,2001).



9. In Section 4.2 (Global contributions) you give impact of ozone in pressure levels that are close to the tropopause or well above it. According to NCEP reanalysis, the tropopause is found at pressure levels higher than 150hPa in the north Mediterranean (computed for Jun-August of 2005-2008 period).For example you estimate an ozone impact from anthropogenic NOx of 1.94 ppbv at around 150hPa in the north and east. In case of Asian emissions, ozone changes of up to 6.09 ppbv are shown for an altitude of 130hPa. In case of anthropogenic emissions (page 27231, line 20) you give ozone change increases of 0.69 ppbv at 100 hPa, and in case of biogenic VOCs, you report an increase of 3.44 ppbv at 100 hPa, as well, levels clearly in the stratosphere. Does it make sense?, do you mean that this impact is observed in the lower stratosphere?. Do you account for troposphere-to-stratosphere transport? These results should be reviewed because, although the eastern Mediterranean, further south, shows in summer a high tropopause (with pressure less than 130hPa, typical from subtropical latitudes), the rest of the Mediterranean (Central and Western) show a mean-latitude tropopause with mean pressure levels above 150hPa. In case you refer to the lower stratosphere a detailed explanation should be provided.

Minor comments/corrections:

Page 27221, line 27: . . . ozone measured in Crete, Eastern Mediterranean. . . should says: . . . ozone measured in Crete ( Eastern Mediterranean). . .

Page 27222, Line 9:..suggest that his local. . . should says: suggest that this local. . .

Page 27223 and the rest of the text, I would replace “Sect.” by “Section”.

Page 27228, Lines16-18: It seems the bias or the SD is missing. Please, revise the sentence is quite confusing.

Page 27234, Line 3: “A monthlyaverage. . .” should says “A monthly average. . .”

Page 27247, Table 2 caption: Replace “mWm-3” by “mWm-2”.

Page 27251, Figure 5: Latitudinal ozone cross section doesn’t fit the latitude range

marked by the white box.

Page 27252, Figure 6: The same as before.

Page 27254, Figure 8: Remove decimals in the color scale

Font size should be increased in axis and labels of Figures 1, 2, 3, 5, 6 and 7, and especially in lower panels of Figures 2 and 3. It is really very hard to read numbers!

In general: the ozone concentration, expressed in hundredths of ppbv not make much sense because the more accurate ground equipment is accurate to + / - 1ppbv.

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Interactive comment on Atmos. Chem. Phys. Discuss., 12, 27219, 2012.