

Interactive comment on “On the role of tropopause folds in summertime tropospheric ozone over the eastern Mediterranean and the Middle East” by Dimitris Akritidis et al.

Anonymous Referee #2

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The authors have used the ECHAM5/MESy Atmospheric Chemistry model (EMAC) to quantify the influence of ozone transported from the stratosphere (through tropopause folds) on tropospheric ozone abundances over the eastern Mediterranean and the Middle East. This is a region that is a crossroads for transport of pollution from Europe, Asia, and North America and where there is persistent high summertime abundances of tropospheric ozone. In recent years there has been an increasing number of studies focusing on ozone in this region. This manuscript is a valuable addition to this growing body of literature. It helps establish the importance of tropopause folding events as a key mechanism driving the summertime buildup of ozone over the Mediterranean and the Middle East. I would therefore recommend the manuscript for publication after the

C1

authors have addressed my comments below.

Main Comments

1) The model resolution is 2.8 x 2.8 degrees, which is coarse compared to studies such as Lin et al. (JGR, doi:10.1029/2012JD018151, 2012), who used a model with a resolution of 0.5 x 0.5 degrees to study stratospheric intrusions. Although the EMAC model is nudged toward ECMWF ERA-Interim data, it would be helpful to see how the model compares to the ERA-Interim fields. On page 5, lines 2-4, it states that “a more extensive comparison . . . suggest that both spatial and temporal characteristics of tropopause fold frequencies are well captured by the EMAC modeling system (not shown).” However, given the coarse model resolution used here, I believe that it is important to show the results of these comparisons to establish the fidelity of the model in capturing tropopause folds.

2) It is unclear how the anomalies that are shown in Figures 5-7 are calculated. More information than what is given in line 3 on page 6 would be helpful and would make it easier to interpret the results that are presented.

Minor comments

1) Page 1, lines 13-16: This is a long sentence. Please try breaking it into two sentences, separately addressing the long-range transport and radiative effects.

2) Page 1, lines 16-18: The sentence starting with “Tropospheric ozone originates. . .” is long and difficult to read. Also, What about methane? It is not a volatile organic compound, but it is an important precursor of tropospheric ozone.

3) Page 2, line 2: Li et al. (GRL. Vol. 28, 3235-3238, 2001), which first highlighted the summertime ozone buildup over the Middle East, should be referenced here.

4) Page 4, line 6: “Optimal” in what sense? How was it determined that the vertical resolution should be for optimal tropopause fold representation?

C2

5) Page 6, line 5: At what level is this 7 ppb increase found? What is the maximum increase in ozone at 700 hPa? The values at 700 hPa seem to be much less than 7 ppb.

6) Figure 6: What do the negative values in the stratosphere mean in panels c) and d)?

7) Figure 6: The anomalies seem to be descending across the potential temperature surfaces, indicating that the downward transport is not purely isentropic. In this region descent is also associated with radiative cooling. How consistent is the rate of cross-isentropic transport with the cooling rates in this region and the timescale for downward transport in these folding events?

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