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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impacts of anthropogenic and natural sources on free tropospheric ozone over the Middle East" *by* Z. Jiang et al.

Z. Jiang et al.

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This is a nice little paper, clearly laid and well-presented, that provide some valuable insight into the title topic. It should be published, once the authors have addressed the few comments below.

Thank you for the valuable comments and suggestions!

Q1: Abstract: The Abstract needs a careful proofreading. For example, the authors state that "the global total contribution of lightning NOx on middle free tropospheric O3 over the Middle East is about three times larger than that from global anthropogenic

sources." In fact, Table 1 indicates a factor of two, not three.

Thank you for pointing out this issue. Multiple places have been changed.

Q2: In the next sentence, by "summertime free tropospheric" I think they mean "summertime middle free tropospheric".

Multiple modifications have been made for discussions associated with "free troposphere".

Q3: They then add "In the Middle Eastern lower free troposphere, emissions from European and North American anthropogenic activities and from lightning NOx are the primary sources of O3", but Table 2 says that European plus North American lightning NOx is number 1, followed by local anthropogenic emissions, and then Asian lightning NOx.

Thank you for pointing out this point. We have modified the text to indicate: "In the Middle Eastern lower free troposphere, lightning NOx from Europe/North America and anthropogenic NOx from Middle Eastern local emissions are the primary sources of O3".

Q4: The transport analysis is puzzling, and needs some explanation, at least. Why did the authors choose to transport a long-lived tracer, rather than one with a lifetime similar to NOx? Is CO being used as a proxy for PAN? Perhaps the authors want simply to elucidate transport patterns, but surely the NOx lifetime would affect the result?

Our original objective is to show the transport patterns associated with Asian summer monsoon. One-month lifetime is also good for long lifetime tracers, such as O3 and PAN.

As indicated by the reviewer, the shorter lifetime of NOx really has important influence on O3 production. In the new Figure 5, we release combustion CO emissions from surface (1-day lifetime, Figure 5g-5i) and middle free troposphere (7-day lifetime, Figure 5j-5l). The results suggested that free tropospheric NOx sources have larger impacts

than surface sources on free tropospheric O3.

Minor points:

Q5: The Conclusions read a lot like the Abstract (and repeat some of the same errors).

The errors in the conclusion have been fixed.

Q6: The text refers to “European and North American”, which implies separate sources“European plus North American” would be unambiguous.

A good suggestion! In order to keep consistency, we use “Europe/North America” to substitute all “Europe and North America” in this manuscript.

Q7: P. 35525 l. 5: “...tropospheric O3 peaks in the summer...”. This is true of surface ozone over Europe and the US, but over large areas of the NH it peaks in the spring, especially in the middle troposphere. Not an important point, since it does peak over the Middle East in summer.

Based on Figure 2, free tropospheric O3 peaks in summer in broad regions, such as East North America, Europe, Middle East and Central Asia. However, as indicated by the reviewer, it doesn’t peak in summer in the whole northern hemisphere middle latitude.

The description has been changed to “Tropospheric O3 peaks in the summer in broad region of northern hemispheric middle latitude” .

Q8: P. 35527 l. 19: “in tropics” âĂŤ> “in the tropics”

Changed.

Q9: P. 35528 l. 4: “seasaonlity”

Changed.

Q10: P. 35528 l. 17: “over a 10o latitude” âĂŤ> “over 10o latitude”

Changed.

Q11: P. 35529 l. 3: “distribution” âĂŤ> “distributions”

Changed.

Q12: P. 35529 l. 19: “precursors” âĂŤ> “precursor”

Changed.

Q13: P. 35530 l. 27: “are produced in free troposphere” âĂŤ> “is produced in the free troposphere”

Changed.

Q14: P. 35531: “The contribution from Middle Eastern local emissions is much small (0.12 ppb), only representing 13% of Asian contribution. In contrast, Liu et al. (2009) indicated that O3 production (as opposed to emissions) over the Middle East and Asia has similar contributions on free tropospheric O3...” âĂŤ> “The contribution from Middle Eastern local emissions is much smaller (0.12 ppb), representing only 13% of Asian contributions. In contrast, Liu et al. (2009) found that O3 production (as opposed to emissions) over the Middle East and O3 production over Asia make contributions to free tropospheric O3 of similar magnitude ...”

Thank you for this suggestion! The text has been modified.

Q15: P. 35533 l. 17: “Observatoins”

Changed.

Q16: P. 35534 l. 13: “a analysis in” âĂŤ> “an analysis of”

Changed.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 35523, 2015.