

***Interactive comment on* “The Contribution of Fires to TES Observations of Free Tropospheric PAN over North America in July” by Emily V. Fischer et al.**

Anonymous Referee #1

Received and published: 16 November 2017

The manuscript by Fischer et al., presents tropospheric measurements of satellite retrieved peroxyacetyl nitrate (PAN) over North America and investigates the changes in concentrations linked to fires. Overall, the manuscript would be a nice addition to the existing literature (e.g. Payne et al., 2014, 2016) as there are limited flight campaigns measuring PAN and MIPAS can only retrieve it in the UTLS. The compositing of TES PAN retrievals under smoke plumes is also an interesting way to investigate potential enhancements of PAN related to fires. Therefore, once the comments below are addressed, this manuscript should be accepted for publication in ACP.

Major comments:

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As TES is the only satellite currently measuring lower tropospheric PAN (to the best of my knowledge anyway), it would be useful to see the spatial distribution of PAN at different tropospheric levels. In neither this paper nor the Payne et al., (2014, 2016) manuscripts, there are very few spatial maps of TES PAN. In Payne et al., (2016), Figure 1a shows a noisy spatial distribution of TES PAN in the tropics. Therefore, it would be useful if this study could add another figure (e.g. between Figure 1 and Figure 2) showing the PAN distribution over N. America (e.g. the July 2006-2009 average on a regular grid instead of individual retrievals on several tropospheric levels) highlighting the average PAN hotspots and potential outflow of PAN from source regions.

The presentation of the manuscript needs to be improved as several of the Figures have been mislabelled in the text and it is difficult to follow. In Figure 7, there is reference to red lines, but all the lines are grey/black, again making it difficult to read the paper.

Section 3.3 needs to be made clearer as discussion of the PAN:CO ratios is rather rushed. For instance, adding some equations into Section 3.3 on how the enhancement ratios are calculated would be useful. Again, as Figure 7 has misleading colours, it is difficult to work out what the authors are trying to say in this section.

Minor comments:

P1 L68: Would be good to reference of Ungermann et al., (2016) who investigate PAN in the summer-time Asian monsoon region using Earth observation measurements. On Line 62-64, the authors states “much of our understanding of the distribution of PAN outside urban areas rests on data from aircraft missions interpreted with global chemical transport models”. I think it would be useful to reference a few papers that have utilised CTMs and satellite data to investigate PAN (e.g. Fadnavis et al., 2014; Pope et al., 2016).

P2 L102: What do the authors mean by “True profiles”? In Figure 1, would the true profile be the retrieved profile? P2 L106-107: “As discussed in Payne et al. (2014),

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the TES PAN retrievals do not provide information on the vertical variation of PAN". This does not make sense. PAN is retrieved at several vertical levels and the AKs will provide information on the vertical sensitivity.

P2 L107-109: IF a $\text{DOF} < 1$ means a retrieval is heavily influenced by the apriori then why do the authors often use the criteria of the $\text{DOF} > 0.6$?

P3 L128-129: The authors state TES has sensitivity to enhanced PBL PAN, but the concentrations are much lower than that of the aircraft?

P3 L127-128: Add tropospheric column definition to the Figure 2 caption.

P4 L 153-154: Please explain "i.e. matching based only on UTC day" more clearly.

P4 L178: Do the authors mean Supplementary Figure (SF) 2 not SF1? Also, why is the red axis (number of attempts) over the Pacific Ocean? This needs to be explained more clearly?

P4 L180: Figure 3c instead of 3a?

P7 L 259: Coloured dots? I can only see purple dots.

Figure 2b: Why is there such a large discrepancy between aircraft (blue) and TES (black) PAN?

Figure 2d: Worth adding equation in main text or caption how the AKs are applied.

Figure 2d: The difference between the red and blue solid lines looks tiny, so how does this show TES has good sensitivity?

Figure 6: Useful to add a CALIPSO track line to the top panel map... i.e. where did CALIPSO cross the domain?

Figure 7: Where are the red lines/dots?

Figure 8: State that the data is from ARCTAS.

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Figure S2: How do the authors define “elevated PAN”?

References:

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Ungermann, J., Ern, M., Kaufmann, M., Müller, R., Spang, R., Ploeger, F., Vogel, B., and Riese, M.: Observations of PAN and its confinement in the Asian summer monsoon anticyclone in high spatial resolution, *Atmos. Chem. Phys.*, 16, 8389–8403, doi:10.5194/acp-16-8389-2016, 2016.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2017-1025>,
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