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Interactive comment on “Biogenic VOC oxidation and organic aerosol formation in an urban nocturnal boundary layer: aircraft vertical profiles in Houston, TX” by S. S. Brown et al.

Anonymous Referee #1

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This paper describes aircraft observations of concentrations of NO₃, N₂O₅, NO, NO₂, O₃, biogenic VOCs, CO and other compounds together with a range of aerosol parameter in the lower atmosphere made over a couple of months in the autumn of 2006. The emphasis is on profiles from the ground through the boundary layer. Three distinct cases are chosen based on the composition of the airmasses and are explored in depth. These cases are then summarized. Finally a box model is used to investigate the impact of NO₃ oxidation on biogenic VOCs for aerosol production.

General comments. My major comment about the paper is that it contains a significant amount of work but little summary or synthesis. A summary of sections 3-5 would be

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useful. What has been learnt by all of this analysis? How has the picture changed from what was expressed in the introduction? What are the features seen in the data interpretation sections that the model is focusing on? What are we trying to analyse with the model? Some form of summary would be useful.

Case studies How were the case studies selected? Do they represent the extremes of the campaigns, representative examples of all the data etc. Something here to explain why they have been chosen would be very useful.

Box model studies. The final section of the paper is the box modeling study. It's not obvious that the paper requires this study. The interpretation of the field measurements is good and provides insight into the problem. The box modeled feels a little 'tagged on' at the end. The authors should strongly consider the extra insight that the modeling study provides and whether the paper would be cleaner and stronger without the box model.

If the authors would like to keep in the box modeling this section needs to be significantly improved. It is not obvious how much chemistry is included in the model. What reactions are included? Where do the rate constants come from? Where does the mechanism come from? The model seems to include a detailed monoterpene chemistry but then a simplified SOA production where $\text{Mono-terpene} + \text{NO}_3$ or $\text{O}_3 \rightarrow \text{SOA}$? How does the complex gas phase oxidation chemistry interact with the simplified SOA chemistry? There needs to be significantly more detail here or a reference to a paper that provides such detail.

The authors describe a series of idealized simulations using the box model and discuss the ability of the model to produce SOA for a rural airmass and an urban airmass. The initial conditions used in these simulations are different and the author's don't describe this in any detail. Comments made about $\text{P}(\text{NO}_3)$ are much easier to understand if the initial conditions are described. For example the urban airmass (Fig 18) has different initial conditions as well as different emissions than the rural airmass (Fig 17) however

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this doesn't seem to be discussed in the text. A clear description of the model, the initial conditions and the objectives of the modeling would be very useful here.

However, overall I'm not convinced that the box modeling adds anything significant to the paper. There isn't any really conclusions here, other than the model is in some general sense consistent with the observations based on some generic yield from the NO₃+VOC reactions. Given the lack of detail given about the model simulations themselves I'm not convinced of the usefulness of this section.

Minor points. 1) Getting 'NO₃' into the title some where would be good.

2) The paper refers to primary and secondary aerosol but doesn't give a clear description of what is meant here. Different people do have different meanings for this and it would be useful for the authors to explain early in the text their definition. 3) P 11866 Line 23. Primary NO would also react with NO₃. I don't think the separation of photochemically produced and by implication non-photochemically produced NO is useful here.

4) P 11867 Line 2. I think the details of the emissions around Houston are probably best put into the description of the field campaign rather than in the introductory text.

5) P11870 Line 5 is there a missing 'and' between isoprene ___ a factor of two for..

6) P11872 Line 11. Tau(NO₃)-1 is said to be enhanced but compared to what. Presumably the 'free troposphere' but it would be useful to clarify that.

7) P11872 Line 18. The authors use the term 'levels' often in the text. I'm not a big fan of this and perhaps concentration or mixing ratio would be a more precise phraseology.

8) P11873 Line 13. 'Which would undergo rapid and nearly exclusive oxidation with nitrate radicals'. The authors offer little direct evidence for this. Perhaps the language could be softened or more clarity given to how this conclusion was come to.

9) P11880 Line 7 'Well to the north of'. This phrase is used multiple times in the text

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but it isn't obvious what this means. Could the authors be more quantitative (x km north of etc).

10) P11882 Line 3. Its not obvious to me why night time oxidation of SO₂ is negligible. Cloud processing via H₂O₂ and O₃ would probably continue. Do they mean that gas phase oxidation of SO₂ and so the potential to increase H₂SO₄ on existing aerosol would be slow. The authors should provide a reference here to justify the statement.

11) P11883 Line 10. Figure 16 doesn't explain the change of scale clearly. This was confusing until I'd read the text. Can the figure caption be improved?

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