Author response to reviewer 1 on AMT-2023-15

Many thanks again to reviewer #1 for taking the time to review the revised manuscript and provide valuable feedback that helped us to further improve the manuscript.

Below are reviewer #1's comments, in black, with an in-line corresponding reply from the authors in blue.

1. Please replace the name of the section "Flight planning" by a more general one so that it can cover the content of the following subsections, in particular of the 3.8.
   Sections have been renamed as follows (section number in brackets):
   "*MOASA capability*" >> "*Measurement capability*" (2)
   "*Instrumentation – general setup*" >> "*Instrument overview*" (2.1)
   "*Flight planning*" >> "*Observation and data strategy*". (3)
   "*The MOASA measurement database*" >> "*The measurement database*" (3.7)
   "*Flight data examples*" >> "*Example case studies*" (4)
   "*Conclusion and future plans*" >> "*Summary and conclusions*" (5)
2. … I recommend the authors to include the discussion and summary of results in 4.2.4 and 4.3.3 in the section 5 at the end, which should be renamed as "Results and conclusions" or "Summary and conclusions". Agreed and appreciate the guidance. Text amended as per recommendation.
3. The few sentences in the 3.7 section do not deserve a summary subsection and should be included in the introductory text just before 3.1. Agreed – text has been moved.
4. Line 354 *" (see case study in Appendix C)*". It actually seems to be Appendix B. The equations inside are by the way still numbered as C1, C2 etc. Thank you – these have now been updated correctly.
5. The basic principle of the O_3 formation and the relation with NO_2 is confusing and/or chemically wrong in:
   a. Line 633:"*Assuming the simplest chemical setup, whereby chemistry in the vertical is controlled by O_3 titration (O_3 + NO_2=> NO)*". Corrected to NO + O_3 => NO_2 + O_2
   b. Figure caption of Figure 13: "*odd oxygen* (*O_3 + NO_2= NO)"* The equation has been removed from the figure caption.
   c. Line 703: "*As expected, given that NO2 is photochemically split during the formation of O3, observed O3 aloft (not shown) is inverse to the NO2 observations*," Here would be by the way very informative to see the O3 concentrations this statement refers to. This has been reworded to "*In contrast, observed O_3 aloft (not shown) is inverse to the NO_2 observations… "*.
   d. Line 754: "*Comparison of odd oxygen implies that ozone titration is the dominant chemical process throughout the atmosphere and helps explicate the complex vertical structures of O3 and NO2 observed throughout the column.*" In particular, revise thoughtfully the scientific part of this statement, which seems to be wrong and difficult to see on the data shown. What is the meaning of "complex vertical structures" and how are they explained with a simple titration? How can you justify the statement that "*ozone titration is the dominant chemical process throughout the atmosphere"*?
   The applicable text in section 4.2.3 has been simplified and clarified, to read:
   "Assuming the simplest mechanism linking chemistry at the ground to that aloft, whereby NO emitted at the surface reacts with O_3 via titration to form NO_2 (NO + O_3 => NO_2 + O_2), odd oxygen (O_x, in this case defined as the sum of O_3 plus NO_2 (Bates and Jacob, 2019)) is expected to be conserved throughout the atmospheric profile. Figure 13 shows a comparison of O_x observed at the surface versus aloft for the London sites which yields a regression model gradient of near 1. These results – noting that this simple model neglects mixing, O_3 production,

deposition, and other loss mechanisms - are broadly consistent with chemistry via O_3 titration being dominant for the cases observed here and indicate that the airborne air masses were coupled to the surface, conducive to the findings of the $PM_{2.5}$ analysis. An r^2 of 0.87 also provides confidence that the observations are comparable, regardless of observation technique employed…"

And the summary (now in section 5, Summary and Conclusions) reads:
"….For NO_2 and O_3, chemical processing in the atmospheric column yields an intricate, poorly correlating relationship between airborne and ground-based observations. In contrast, odd oxygen (O_x = NO_2 + O_3) at the ground and aloft strongly agree (r^2 = 0.87, gradient = 1), suggesting that, for the cases analysed here, ozone titration played a dominant role in the chemistry of these species throughout the atmospheric column. A slight offset in the regression model indicates O_3 is higher aloft, suggesting processes unrepresented by this simple model (recalling the limitations noted in section 4.2.3) may also be present. "

6. The units of concentration and density are systematically wrong all over the text (e.g. such as □g m3 or g cm3 instead of □g m-3 and g cm-3). Please revise carefully the text. Revised throughout.
7. Line 584: "*Here, the HIL AURN site, observed at 84 µgm3 (fig 11 left: grey 585 square and right: red triangle) is significantly higher than both other ground-sites in the region and the range of (…)"* Do you mean : "Here, the 84 µgm-3 NO_2 observed at HIL AURN site, (fig 11 left: grey 585 square and right: red triangle) is significantly higher than (…)"? Text amended to *"Here, the 84 µgm^3 NO_2 observed at the HIL AURN site (fig 11 left: grey square and right: red triangle) is significantly higher than both other ground-sites in the region and the airborne data (boxplot whiskers in fig 11 left, and track colour in fig 11, right)."*
8. Line 674 Please remove " *who, as discussed in sec.1, reported positive model ozone biases during a ground site AQUM comparison*" It is redundant and makes the sentence unnecessarily long. Agreed and removed.
9. Figure caption of Figure 13 is not complete and ends with: "is shown as a". Please complete. Done What is the meaning of a 1-2-1 line? The text "*representative of a perfect linear relationship*" has been added to the figure 12 and 13 captions.
10. Line 738: "Conclusion and future plans" Please remove "future plans" from the title since they are not evident in the text. This section has been renamed as "Summary and conclusions" as per #1 above.

Author response to reviewer #2 on AMT-2023-15

We would like to thank reviewer #2 for taking the time to review this manuscript and for suggestions that helped us to further improve the manuscript. We have revised the manuscript accordingly. Please see in line responses below, in blue.

Technical corrections:
Page 12, line 442:
gcm3 to gcm-3
Amended throughout the document.

Page 54, Table C1 header:
gcm3 to gcm-3
Amended throughout the document.

Page 55, line 340:
gcm3 to gcm-3

Amended throughout the document.

Page 23, line 853:
You write: “Data is openly available.”
However, no link is given. Add data link.
Link is available.