

Atmos. Chem. Phys. Discuss., referee comment RC3
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Comment on acp-2021-167

Anonymous Referee #3

Referee comment on "Impact of stratospheric air and surface emissions on tropospheric nitrous oxide during ATom" by Yenny Gonzalez et al., Atmos. Chem. Phys. Discuss.,
<https://doi.org/10.5194/acp-2021-167-RC3>, 2021

Review of "Impact of stratospheric air and surface emissions on tropospheric nitrous oxide during ATom"

This study develops a N₂O retrieval algorithm for the QCLS airborne instrument that reduces the sensitivity of the measurement to temperature and pressure changes in the aircraft cabin. The performance of the QCLS retrieval of N₂O is evaluated using three additional N₂O instruments during the ATom mission. Anomalies in measured N₂O with respect to background mixing ratios are described. The authors demonstrate how anthropogenic and natural sources of these anomalies can be identified using the suite of chemical tracers collected during ATom. Overall, the paper is well-written and the authors thoroughly characterize a useful dataset. The comments below are minor and are for clarity in the discussion.

Comments:

- Lines 46 – 47: The wording of this sentence is confusing. Did the new retrieval strategy improve measurements by a factor of 3 with respect to previous deployments of the instrument or was spectra collected during previous missions reanalyzed with improved precision? Please reword to clarify.
- Line 76: The list of emission estimates in this paragraph is difficult to process. Could they be summarized more concisely? Also, are there conclusions from the ATom analysis that could be discussed in the context of these studies?
- Line 154: missing comma before "and"
- Line 184 "...with respect to the precision of the original retrievals...": Please clarify if this is with respect to the original ATom-1 retrievals with the damaged instrument or to all QCLS retrievals during ATom. Overall, the discussion of the calibration improvement and damage to the instrument before ATom-1 seems to be mixed together in this section. Did the damage impact the later ATom missions too?
- Line 250: What do you mean by "common sampling locations"? Are these locations that

are representative of the atmospheric background and typically not influenced by anthropogenic emissions? Also, Table S.3 shows median mixing ratios of N₂O measured during ATom, not information about the surface stations as indicated in the text.

- Line 257: Missing "to" in "with respect [to] surface data"
- Line 300: Figure 3f is missing in the figure reference. Strong depletion in N₂O mixing ratios at Southern high latitudes are seen in both Figures 3c and 3f.
- Lines 300 – 302: How does transport in northern high latitudes impact the low mixing ratios of N₂O in the southern high latitudes? Perhaps this is a typo.
- Lines 303 – 306. Please clarify how these percentages are calculated. It does not look like 55% of all observations shown in Figure 3c are depleted in N₂O. Are these percentages calculated for specific latitude ranges?
- Line 310. In Figure 3b and 3e, depleted N₂O is seen in the Northern Hemisphere in March-April, not the Southern Hemisphere.
- Lines 322 – 323: As written, it is not clear what is meant by "range of N₂O-CO mixing lines" and "straight mixing lines". Does this refer to the L-shaped curve, discussed earlier in the paragraph? Are there examples of different mixing timescales shown in Figure 3 that can be used to demonstrate this concept?
- Line 388: Please specify which short-lived trace gases (and their atmospheric lifetimes) were used in this analysis.
- Line 436: The APO axis is flipped in the N₂O-APO correlation panels between Figure 6 and 7, which makes them difficult to compare. Are the N₂O-APO correlations different between the two figures or does the presence of CO₂ and CH₄ indicate a different source for similar correlations observed during two profiles.
- Please state in the caption of Figure 9 that the observed enhancement in N₂O is based on the profile shown in Figure 8.
- Line 452: It would be helpful to show the profiles for N₂O enhancements due to European and Asian EDGAR emissions in Figure 9 to demonstrate this point.
- Line 461: How does Figure S11 support an anthropogenic origin to the N₂O enhancements seen in Figure 8?
- Overall, Figures 5 – 8 contain a lot of information that can be difficult to digest. Having panels consistent between the figures, as suggested by another reviewer, would help. It would also be helpful to explain in the text why information contained in one figure is different from previously shown figures or why altitude ranges discussed in the text do not match up with the correlation coefficient panels shown in the figures.