

Comment on amt-2022-133

Anonymous Referee #1

Referee comment on "An improved OSIRIS NO₂ profile retrieval in the upper troposphere–lower stratosphere and intercomparison with ACE-FTS and SAGE III/ISS" by Kimberlee Dubé et al., Atmos. Meas. Tech. Discuss.,
<https://doi.org/10.5194/amt-2022-133-RC1>, 2022

This paper presents the new version (v7.2) of the OSIRIS NO₂ retrieval. Compared to version v6.0, the sensitivity in the UTLS is improved and the previously observed low bias is reduced. Good agreement (within 20%) is found with ACE/FTS and SAGE III/ISS data sets. The OSIRIS NO₂ monthly zonal mean data also show a variability in time which is very similar to ACE/FTS and SAGE III/ISS at most altitudes and latitudes.

This study fits well with the scope of AMT and the manuscript is well written and clearly structured. I recommend publishing the paper in AMT after addressing the following specific comments:

Page 2, Section 2.2: This Section is a bit difficult to follow. I would recommend the authors to summarize all those validation results in a table including the following entries (or something similar): OSIRIS retrieval version, ancillary data + version, local time/SZA used for the comparison, altitude range, comparison results.

Page 3, Section 2.3: The authors should describe in the first paragraph how the temperature dependences of the O₃ and NO₂ cross-sections are treated in their retrieval. Also, are the absorptions by O₄ and water vapour included in the retrieval? Again, a table summarizing the main retrieval settings could be helpful for the reader here.

Page 4, lines 80-82: The threshold value of 1.01 should be justified.

Page 5, lines 112-113 and page 6, lines 126-127: the new retrieval version allows to retrieve negative number density values. Is any quality-control criterion applied on these profiles with negative values? For instance, do you reject profiles with negative values which are below a given threshold?

Figure 3, page 7: Why the 10°S-30°S and 10°N-30°N latitude bands are not considered in this figure? Also, nothing is said about the probability densities of both retrieval versions at high (>50°) latitudes. If not included in Figure 3, both aspects should be at least discussed here. Another option would be to put the figures with the missing latitude bands in an annex.

Figure 4(a): Why not showing an example of averaging kernel peaking at an altitude below 15km, i.e. with a difference between the nominal altitude and the altitude derived from the Gaussian fit which is larger than the threshold value of 1.5km? This would better illustrate your kernel filter approach.

Page 11, lines 216-227: the photochemical correction applied to all data sets and which consists in shifting all of them to 12:00 pm is a critical point and to my opinion, the uncertainty associated to this correction should be better characterized. The 1% uncertainty on NO₂ obtained by perturbing the main input of the model is likely correct but this is clearly a lower estimate of the photochemical correction uncertainty. In order to get a better estimate, I recommend to make some sensitivity tests on the rate constants (and their respective uncertainties) of the main reactions involving NO₂. Also, nothing is said about the stratospheric aerosols. Did you include them in your photochemical box model simulations? If yes, are they those simultaneously retrieved from the OSIRIS measurements (see page 3, lines 67-70) ?

Figure 7, page 12: Why not including also mid-latitude bands?

Page 13, line 251-252: The lower bias in the SH is attributed to the sampling of coincident profiles. I think this point should be further discussed in a quantitative way, i.e. how different are the SH and NH samplings?

Page 14, lines 255-257 + Figure 9: The application of the kernel filter can have a huge impact on the retrieval results below the tropopause. What is at the end the official v7.2 product? Is it with or without applying this filter?

Figure 12, page 17: How did you select the altitude and latitude ranges shown in this figure? Are they representative of other altitude and latitude ranges? Maybe you could show the plots for all the altitude/latitude range combinations in an annex? This could be useful for those readers interested in stratospheric NO₂ trend analysis.

Technical corrections:

The date format is not consistent throughout the manuscript (e.g. we can find 06:30 am, 06:30 a.m, 06:30 AM). Please check.