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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Iodine monoxide in the north subtropical free troposphere" *by* O. Puentedura et al.

Anonymous Referee #1

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The manuscript by O. Puentedura et al. reports on the first IO observation in the subtropical free troposphere. The relevance of halogen chemistry on e.g. ozone chemistry and oxidation capacity of the atmosphere in combination with the little knowledge on the global distribution of IO renders these findings important and well suited within the scope of ACP. The manuscript describes the measurements of IO column densities by ground based MAX-DOAS. A simple approximation based on O4 observations is used to derive an IO mixing ratio representative for the FT. Radiative transfer calculations and meteorological observations are utilized to analyze instrument sensitivity to IO in the MBL as well as possible transport of IO from the MBL into the FT. The latter part as well as the discussion of the IO diurnal profile needs some further analysis and revisions before final publication in ACP. Also, the paper would benefit if the full information content of the presented measurements was explored with respect to the

vertical distribution of IO.

Proof reading of the final manuscript by an English speaking native is advised.

General comments:

Radiative transfer:

At which wavelength were the Box-AMF calculated? How strong is the sensitivity to SZA? (see also "diurnal cycle" below).

The radiative transfer inside clouds is very complex and an opaque cloud layer is not realistic (Figure 6, cloud case, looks rather like the result of having a ground height of 1000m with a ground albedo of 0.8). Box-AMFs depend on OD and vertical extension of the cloud. The contribution of MBL IO to the measurements also depends on its vertical distribution and whether it is collocated with the clouds. Further sensitivity studies are needed to better constrain a possible IO MBL signal contribution to the measurements.

Diurnal cycle:

The case on a u-shaped diurnal profile based on dSCDs cannot be made without proper AMF correction. It is a good first step to correct the IO dSCDs by O4 measurements to explore the variations seen in the lower elevation angles. However, the overall U-shape in e.g. O4 is caused by a change in AMF due to a change in SZA. A simple correction for the SZA dependence should show a more realistic picture of the diurnal profile of IO.

Generally, any use of O4 to approximate path length should include a discussion on possible differences in vertical profile shapes of both O4 and IO.

IO analysis and detection limit:

Why was a filter applied? Was there a problem with systematic structures in the RMS? The determination of a detection limit based on RMS should also be based on how

statistical the RMS is. Applying a filter could easily lead to underestimating a suitable detection limit. Also, have sensitivity studies been performed to check how robust the IO fit is? Changes in fit settings are a good indicator for the real uncertainty of a SCD measurement and are often higher than the WinDOAS fit error output. In my experience the inclusion of CHOCHO in the IO analysis (that does not include the strong CHOCHO band above 440nm) leads to a negative correlation between CHOCHO and IO. Did the author's observe such a correlation?

Vertical distribution of IO:

Even though the information content of a ground based instrument is somewhat limited with respect to a full vertical profile inversion, some kind of inversion technique should be explored to retrieve the full information content of the measurements. This information would also allow a more profound basis for the discussion on transport and possible precursors.

Discussion on Saharan dust events and Fig. 8:

Since EA 70 is used in the argument for enhanced IO during Saharan dust event periods, EA 70 should be explicitly included in the radiance and optical path length calculations presented in Fig.8. A more explicit quantitative treatment of these observations would also allow for a more quantitative discussion on proposed IO background values, on the additional possible contribution of dust and subsequently on possible precursors.

Specific Comments:

p. 27838, ln.19: why is the time that the sun needs to move between certain SZAs chosen as measurement time?

p. 27840, ln.9: state e.g. AOD or trace gas threshold for "clear and clean days"

p. 27840, ln.12: typically zenith references are chosen at the lowest possible SZA, with a SZA of 49 degrees this does not seem to be the case. Why?

p. 27840, ln.13: dSCDs are already analyzed against a zenith reference. What is the purpose of subtracting dSCDs of EA 70 from dSCDs of lower EAs? Daily mean differences shown in Fig.3 middle panel are equally affected by differences in EA70.

Technical corrections:

p.27835, ln.21 and 24: replace "Schöenhardt et al.," with "Schönhardt et al.,"

p.27837, chapter 3.1. be consistent with using present or past tense

p.27838, ln.2: include value of FOV

p.27840, ln.5: 430nm instead of 43nm

Table 1: Molecule: O3: missing subscript for I zero

Fig.2: lowest panel: rmse instead of ecm

Fig.3: top panel, y-axis: DSCD instead of SCD

Fig4: y-axis: DSCD instead of SCD

Fig.5: both red tones and blue and green(?) are hard to differentiate in a printed copy

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