Reply to comments from Referee #2

We would like to thank the referee for the very positive and constructive comments which are addressed individually in the response below. The reviewer's comments are included in italics with the responses in blue.

This is an important study that aims to investigate the inconsistencies in MAX-DOAS measurements of O2-O2 collision induced absorption (CIA) and radiative transfer models. To this end, the authors analyzed two years of observations from a (LP-) DOAS instrument deployed at the Antarctica station. In particular, they investigated the relation between measured and modeled O2-O2 (CIA) over a wide range of temperatures. Especially interesting is their access to the lower temperatures as a point of controversy or lack of data from experimental measurements. They have concluded that the set of laboratory data recently published by Finkenzeller and Volkamer provides the best agreement, however the discrepancies in MAX-DOAS are not completely understood. It is an important paper using field data to evaluate reference spectroscopic information and should be published after following comments are addressed:

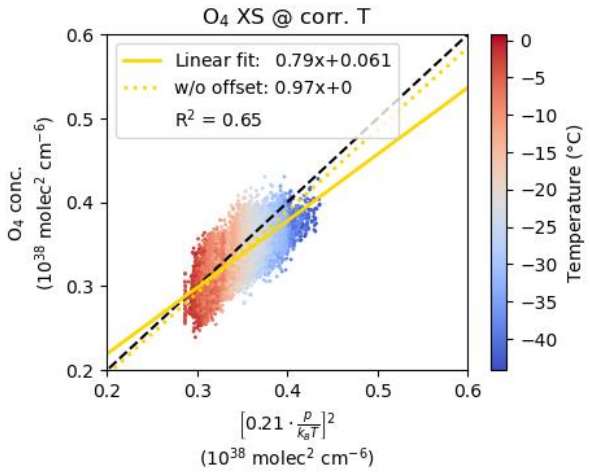
Major comment:

One should not expect constant or even linear dependence of CIA on temperature, whether looking at integrated band absorption or at individual spectral points. In particular for integrated absorption one should expect that the CIA should be more intense at low T because of bound states, and more intense at high T because it's easier for colliding molecules to get close together, and in between there must be some minimum. See, for instance, a paper by Vigasin on the temperature variation of intensity of the CIA underlying oxygen fundamental (https://doi.org/10.1016/j.jms.2004.02.003). In the Figure 1 of that paper you will see that the temperature dependence is not expected to be constant or linear.

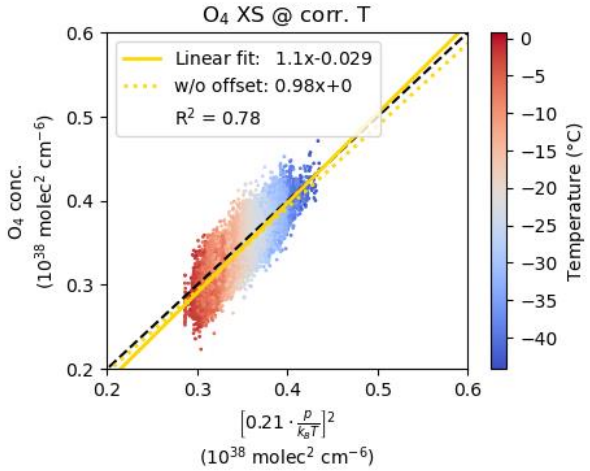
Also, the distribution of the intensity within a band also should vary with temperature because of the Boltzmann population of energy levels.

Could the interpolation potentially be done as a quadratic function combining the data from 2013 and 2022 papers from Volkamer's group? The earlier work can be given enhanced uncertainties but still could be useful. In any case the 2013 data should not be fit to linear function. It would be good to include the figures associated with interpolation

We ran additional analyses testing the quadratic interpolation as suggested. We find no discernible difference in the results if considering the Thalman and Volkamer (2013) or the Finkenzeller and Volkamer (2022) absorption cross-sections separately as done in the paper draft using linear interpolation (compare figures below and in the paper draft).



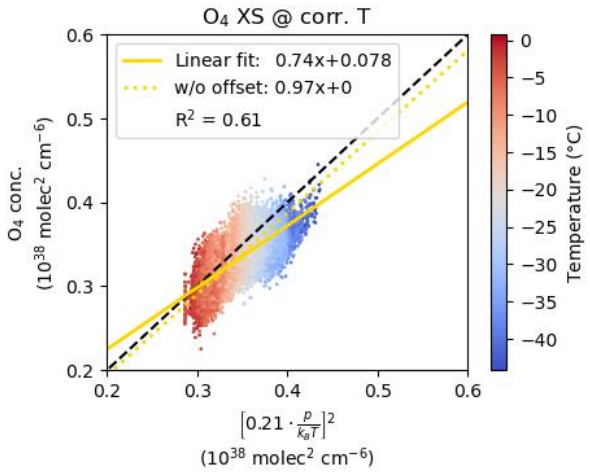
Same as Fig. 7 but for the case of quadratic interpolation of the Thalman and Volkamer (2013) absorption cross-sections.



Same as Fig. 8 but for the case of quadratic interpolation of the Finkenzeller and Volkamer (2022) absorption cross-section.

A combination of both sets of absorption cross-sections by Thalman and Volkamer (2013) and Finkenzeller and Volkamer (2022) leads to a worsening of the correlation (see below). This is probably caused by the strong deviations from the calculated O_4 concentrations at low temperatures when considering the Thalman and Volkamer (2013) version. Especially, since the Finkenzeller and Volkamer (2022) absorption cross-sections alone yield very good results.

Furthermore, it should be noted that the temperatures considered in this work (223 to 293 K) do not show a strong quadratic relation also in the study by Vigasin (2004). A large difference between linear or quadratic interpolation would therefore not be expected.



Same as Fig. 7 and 8 but for the case of quadratic interpolation considering both Thalman and Volkamer (2013) and Finkenzeller and Volkamer (2022) absorption cross-sections.

We have added a note in the manuscript that quadratic interpolation of the given absorption cross-sections does not change the results.

A couple of minor suggestions

You can mention that Thalman and Volkamer CIA is currently recommended by HITRAN

The HITRAN recommendation was added to the introduction (including its respective publications: Karman et al., 2019 and Gordon et al., 2022).

In line 166 change "...a couple.." to "..a few…"

Done.