Response to the Reviewer #3

We thank the Reviewer for the constructive review and address the comments below.

This manuscript presents a retrieval algorithm for OClO slant columns from TROPOMI measurements using the DOAS technique. To improve the accuracy of the retrieved data, the authors introduce additional fit parameters accounting for spectral effects which have previously not been accounted for and they provide a discussion of the uncertainty estimates including a novel application of an autocorrection analysis.

The authors show that their retrieval of TROPOMI OClO slant columns is in good agreement with ground-based zenith sky measurements made at two polar stations. They also compare their TROPOMI product with preliminary data retrieved with the operational TROPOMI OClO retrieval algorithm and discuss the observed differences.

The study is clearly presented in the manuscript, and in addition, the authors also provide substantial material describing relevant retrieval concepts and settings (Appendix A) and an extensive sensitivity study investigating the effect of the different retrieval settings on the OClO slant column data in comparison to a standard scenario (Appendix B). The paper is recommended for publication in AMT.

General comments:

While some of the aspects included in the uncertainty analysis of the retrieval include a novel approach (the application of autocorrelation for the systematic error analysis), stating that this is overall a new retrieval algorithm seems to me somewhat exaggerated since my understanding based on the manuscript is that the difference to existing algorithms is mainly that additional fit parameters have been used. If that is not correct, and the algorithm is indeed novel then please describe this clearer in the text.

Of course the algorithm is still a DOAS algorithm (as reflected in the title) and the concept of DOAS limits the innovation just to using different fit parameters - can there be a novel DOAS algorithm then at all? The algorithm is a new DOAS algorithm for OClO from TROPOMI, also new is that additional fit parameters have been introduced for a DOAS retrieval for the first time. Of course we would not like to pretend to exaggerate and thus agree to replace "novel" in this context in the first sentence in conclusions with "new". We also modify the sentence in the abstract "Here we present a new retrieval algorithm of the slant column densities (SCDs) of chlorine dioxide (OClO) by DOAS" by adding "… from measurements performed by the TROPOspheric Monitoring Instrument (TROPOMI) instrument on board of Sentinel-5P satellite."

Also, in the conclusions, the authors state that 'the detection limit is similar to the detection limits of earlier instruments' – i.e. that this has not really improved – but then, also in the conclusions, they state that 'Including these terms improves the retrieval results especially for low OClO SCDs'. Aren't these 2 statements contradicting each other?

We want to say that the detection limit is similar to the detection limits of earlier instruments if we grid the measurements to 20x20 km2 area which is much smaller than the resolution of previous satellite instruments. Thus TROPOMI measurements provide a clear improvement with respect to previous instruments. Including the additional terms improves the retrieval results especially for low OClO SCDs. This statement is not contradicting as the inclusion of the additional terms improves the error budget and in particular the accuracy of the retrieval.

We modified the mentioned statements in the conclusions to make this more clear:

"Including these terms improves the accuracy of the retrieval results especially for low OClO SCDs."

and:

"Thus a detection limit of about 0.5-1 x10^{14} cm^{-2} at SZA of 90°, similar to the detection limits of earlier instruments, is achieved but at a substantially smaller spatial resolution. Thus TROPOMI OClO measurements provide a clear improvement with respect to previous instruments."

Specific (minor) comments:

Page 1, line 5: Should read 'From the measured spectra, highly resolved …'

The text has been removed according to the suggestion by the Reviewer 1

Page 1, line 11: Just use OClO since this has been already introduced in the paragraph above.

After the removal of the text before, OClO now is introduced here for the first time

All comments below are considered as suggested

Page 1, line 15: '… effects, a higher order …'

Page 1, line 21: typo: 'operational'

Page 10, line 125: left bracket is missing

Page 12, line 250: '… zenith sky …'

Page 12, line 252: '… in a fit window of …'

Page 12, line 252: replace 'considered' with either 'included' or 'used'

Page 17, line 306: '.. are listed: The retrieval …'

Page 17, line 309: '.. terms are applied (or used).'

Page 17, line 311: '... within the 89 ....'

Page 17, line 316: '(Sect. ??)' needs to be fixed

Page 17, lines 318-319: '... with the correlation ... has an offset ...'

Most pages have sentences where commas are missing but I assume that this will be addressed anyway during the proof-reading phase.