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Atmospheric Measurement Techniques Discussions

Interactive comment on "Glyoxal retrieval from the Ozone Monitoring Instrument" *by* C. C. Miller et al.

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We thank the reviewer for taking the time to review and help improve our paper. Please see below for detailed responses to their individual points.

1. **Recently a paper on ground based observations of glyoxal in the marine environments has been published (Mahajan et al., 2014). The measurements from the ground seem to compare well with the new algorithm estimates. A detailed comparison between the two datasets should be presented to see where the estimates match, and where they do not. The results and discussions section should also include a comparison between ground based and satellite observations in the remote environments.**

   We will add a comment in the paper about the agreement of the two datasets.

   We hope to do a comparison between the two datasets in the future.

2. **Although there is a brief discussion on the differences between the retrieval routines from the past estimates, no direct comparison of the retrieved VCDs is done. A detailed comparison with the past methods should be included, with quantified differences over different environments – if possible, include a figure of the differences.**

   To the authors' knowledge, the satellite products from the other studies are still "research products" not in the public domain. We welcome a future study that would involve an intercomparison of existing satellite measurements.

3. **Have the authors checked the sensitivity of the retrieval to different O4 cross-sections (Greenblatt et al., 1990; Thalman and Volkamer, 2013)? The ground-based data appears to be sensitive to the cross-section used, and it would be interesting to know how sensitive the satellite retrievals are to the O4.**

   In an earlier version of the retrieval we used the O4 cross section of Herman et al. (1999). We did not find any significant differences switching to Thalman and Volkamer (2013). Typical OMI O4 SCDs are $\sim 2-3\times10^{43}$ cm^5 molec^{-2} corresponding to peak optical depths of $1-1.5\times10^{-3}$ in the glyoxal fit region. Looking at the difference between Thalman et al. and Herman et al. corresponds to a small change in O4 optical depth (within $1-1.5\times10^{-4}$). There is a systematic difference between the Greenblatt et al. and Thalman et al. O4 spectrum around 450nm that lies near the strongest glyoxal band. In the satellite retrieval, this feature would correspond to an optical depth of $2-3\times10^{-4}$ and thus could moderately impact the results. Note that the Greenblatt et al. O4 cross section was derived from experiment at 55 atm pressure, so the systematic residual at 450nm could be a result of pressure broadening. In consideration of this and the agreement between the other two O4 spectra, we believe that Thalman and

Volkamer (2013) is the appropriate choice.

4. **Please provide more details on the GEOS-Chem glyoxal profiles – especially over regions where the glyoxal is very close to the detection limit.**

   We have updated the paper to include references for the specific NMVOC chemistry updates. We have also made it clear that the model does not currently simulate any significant oceanic glyoxal source.

5. **What is the detection limit estimated in the different environments?**

   The 1-sigma random uncertainty associated with individual pixels is $0.5 - 2 \times 10^{15}$ molec cm^{-2} and largely depends on surface reflectivity. This uncertainty can be reduced through averaging. Assuming that the Sahara reference region represents background, then the standard deviation of the grid cells within the region provides a measure for the detection limit in the seasonal averages. The standard deviation of the reference sector grid cells is 2.35×10^{13} molec cm^{-2}. This is consistent with what we would expect from the central limit theorem (there are ~ 2500 observations per pixel, so assuming an error of $\sim 1 \times 10^{15}$ molec cm^{-2} suggests that the random uncertainty should be $\sim 2 \times 10^{13}$ molec cm^{-2}). The number of observations per grid cell typically range between 500-2500 depending on cloud cover, so we expect 1-sigma uncertainties to range between $2 - 5 \times 10^{13}$ molec cm^{-2} for the seasonal averages.

6. **Include missing past publications: (MacDonald et al., 2012; Mahajan et al., 2014)**

   We will add references to these publications

7. **What are the errors on the AMF – have these been propagated?**

   At present we have not estimated errors associated with AMFs because the glyoxal profile uncertainties in GEOS-Chem are not well characterized. We plan

   to do this in the future. Lerot et al. (2010) have characterized AMF errors for GOME-2. They ascribed fairly large uncertainties to the glyoxal profiles and estimated absolute errors of 3×10^{14} molec cm^{-2}. We expect similar AMF errors for OMI, given that the uncertainties in the datasets going in to AMF computation have similar uncertainties. We have updated the manuscript with reference to the previous analysis.

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