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Interactive comment on "Retrieving the vertical distribution of stratospheric OClO from Odin/OSIRIS limb-scattered sunlight measurements" *by* P. Krecl et al.

Anonymous Referee #2

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General Comments

This paper describes the first measurements of OClO by the OSIRIS instrument on the Odin satellite. Vertical profiles of OClO are retrieved from OSIRIS spectra of sunlight scattered from the limb by applying the maximum a posteriori estimation method (MAP) to effective slant column densities derived using differential optical absorption spectroscopy (DOAS). The paper provides a detailed discussion of the DOAS analysis, the forward model, and the MAP inversion. Some results are presented, primarily for the southern high latitudes, and are compared with previous OClO measurements and

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with the REPROBUS chemical transport model.

Measurements of OClO are few, particularly from space. The work presented in this paper is thus a significant contribution to remote sensing of stratospheric composition. These new results from OSIRIS are very promising for giving us a three-dimensional picture of OClO distributions in the perturbed polar vortex.

Overall, the paper is well written and generally thorough, with a clear explanation of the retrieval method and an assessment of the impact of various spectral corrections on the retrieved effective columns. My major concern is with the extensive overlap between the material in this paper and that in Haley et al. (2004). There is considerable duplication, particularly in the discussion of Methodology (Section 3). Although the repetition of this material makes this paper more complete and self-contained, where the text and figures are almost identical, it would be better to cut the material from this manuscript and simply refer the reader to the Haley et al. paper. I also have some concerns with the discussion of results, as noted below. However, I do recommend publication in ACP after appropriate revisions are made in response to the following comments.

Specific Comments

Section 3 The paper references the previous work of Haley et al. (2004) and Sioris et al. (2003) on applying a combination of DOAS and profile retrieval to OSIRIS spectra, but omits references to earlier papers by the OSIRIS group that initially proposed this approach, including its potential application to OClO (McDade et al., 2002; Strong et al., 2002).

Sections 3.1, 3.3, 3.4 Much of these sections duplicates material in Haley et al. (2004), including several of the equations. While all new material should be retained, this section should be shortened with appropriate references to the relevant text in Haley et al. added.

Figure 1 This is exactly the same as Figure 4 in Haley et al. Either reference this earlier paper in the figure caption, or just refer to the original figure in the text.

Equation 6 How well are estimated errors in the reference and limb spectra, and hence in the error in the observed DOD and its standard deviation known? What are typical values?

Page 2998, lines 20-28 Is a "negative OClO abundance" realistic, regardless of whether it has been observed by others? A negative effective column density is possible if the amount of OClO in the reference spectrum is larger than that in the limb spectrum. However, this seems unlikely for the 40-70 km reference spectrum used in this work - how likely is this outside the polar vortex? If this is not the case, then aren't the negative values more indicative of OClO abundances below the detection limit of OSIRIS? This paragraph should be rewritten with a more careful discussion of the implication/explanation of the negative ECDs.

Page 3001, lines 9-15 Explain why quadratic interpolation was used for the ozone and OClO cross sections. Specify that the quadratic and linear interpolation is in temperature.

Page 3001, lines 18-21 The text states that "a reduction of 1% is observed in the residual RMS and the chi-squared statistics." However, this is misleading as Tables 5 and 6 show that the I-o effect reduces the residual RMS by 1% in 57% of cases and increases it by 1% in 43% of cases, with similar numbers for the chi-squared. This does not seem like a conclusive result in favour of including the Io- effect - the emphasis should perhaps be on the results for the relative error.

Section 3.3.3 Based on the poorer results obtained after removing the Ring effect, was the Ring effect therefore not accounted for in the final spectral fits? This is the implication, but should be explicitly stated if true. Did the authors also try fitting the Ring effect as a pseudo-cross section?

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Page 3003, line 4 Define the OS polarization efficiency parameter.

Page 3003, lines 7-9 The criteria for deciding when a correction can be ignored seem to be somewhat arbitrary. The polarization correction is ignored due to its small (but not negligible) impact on the ECDs. However, it also reduces the RMS residual by 1% for 97% of cases. On page 3001, line 19, a reduction of 1% in the RMS residual for 57% of cases was deemed sufficient to include the Io correction (also taking into account the differences for the other factors). In general, although the assessment of the effect of the spectral corrections is interesting, the application of these results is somewhat unsatisfying.

Page 3004, line 2 For consistency with the real retrievals, shouldn't the reference spectrum here be calculated using the 40-70 km average, rather than a single spectrum at a tangent altitude of 50 km?

Page 3004, lines 8-9 The text states that "The residual RMS decreases by as much as a factor of 1.5 whereas chi-squared_doas diminishes 24% in (ON) average." Table 5 lists an average of -12% for 100% of cases for the residual RMS - this implies a large standard deviation on the 12%? Also, for the chi-squared - this reduction of 24% is for 87% of cases, so not strictly "on average".

Page 3007, lines 4-5 and Equation 14 The text says that the natural log of the concentrations, ln(n), is inverted, but the subsequent inversion equations are for n, not ln(n). Which is correct? The equations should be modified appropriately if it is ln(n). Also, are the weighting functions calculated for ln(n)? From the units in Figure 8 (K in cm), it looks like K is for n.

Page 3007, last paragraph Explain briefly why two inversion strategies were used. Why not just use the L-M scheme from the start?

Page 3008, line 12 Why 30 degrees of freedom in particular - corresponding to tangent heights from 10 to 40 km? Could make this explicit.

Page 3013, lines 4-6 There is an inconsistency here. Four error components are identified in the preceding paragraphs and the text says that "The total retrieved error covariance is obtained by adding the covariance matrices of the four error sources." However, the preceding sentence states that two of these four were NOT estimated, and the following sentence states that Ŝhat is the sum of S_s and S_m. Correct this sentence. Also, comment on the expected increase in the total retrieval error if the forward model and forward model parameter errors were included. i.e., are these expected to be significant (although difficult to calculate) or likely to be neglible? There is also some debate in the community as to whether smoothing error should be included in an error budget. Strictly, equation 21 should use S_epsilon rather than S-_a, where the former is the covariance matrix of a real ensemble of states, and so the smoothing error could be calculated differently by users having a different estimate for S_epsilon. This is a comment rather than a request for revision.

Section 4 This section title should be revised to something more informative: "Comparison" with what? "Evaluation of retrieved OCIO profiles"? The differences in location, date, and time of day between OSIRIS and the other OCIO measurements makes the comparisons in this section problematic. The difficulty in validating the OSIRIS profiles lies in the lack of coincident data (which is what makes this new measurement capability so valuable). The authors should be up-front about this difficulty and should revise the discussion in this section accordingly. For example, is the 3% difference with REPROBUS really meaningful given the retrieval error?

Figure 11b (text on page 3016, line 6) Could add a vertical line for the 196 K temperature to clearly show the PSC threshold.

Section 5, paragraph 1 and Figure 12 What is the horizontal extent/smearing for the OCIO profiles? Points A and B are the average location of the scans - state the length of these scans.

Technical Corrections

The order of Sections 3.3.4 and 3.3.5 should be switched for consistency with the sequence of corrections as listed in Tables 3 to 6.

Page 3002, line 26 The McLinden et al. reference looks like it should be 2002b, not 2002a.

Page 3003, line 16 Change to "in the short waveLENGTH range"

Page 3005, line 11 Change "and the use" to "THEN the use"

Page 3008, lines 15-16 Rewrite as "AT different tangent heightS"

Page 3009, lines 2 and 8 SSA is used in line 2 but not defined until line 8

Page 3015, line 21 Change to "were found TO BE higher than TWILIGHT ?? measurements" (is twilight more appropriate here than diurnal - what is meant by a diurnal measurement?)

Page 3017, line 14 (i.e.,)

Page 3019, line 3 Should this be "hr" rather than "h_r"?

References

Haley, C. S., Brohede, S. M., Sioris, C. E., Griffioen, E., Murtagh, D. P., McDade, I. C., Eriksson, P., Llewellyn, E. J., Bazureau, A., and Goutail, F.. Retrieval of stratospheric O3 and NO2 profiles from Odin Optical Spectrograph and Infrared Imager System (OSIRIS) limb-scattered sunlight measurements, J. Geophys. Res., 109 (D16303), doi:10.1029/2004JD004588, 2004.

McDade, I.C., Strong, K., Haley, C.S. Stegman, J., Murtagh, D.P. and Llewellyn, E.J.. A method for recovering stratospheric minor species densities from the Odin OSIRIS scattered sunlight measurements. Can. J. Phys., 80 (4), 395-408, 2002.

Sioris, C.E., Haley, C.S., McLinden, C.A., von Savigny, C., McDade, I.C., McConnell, J.C., Evans, W.F. J., Lloyd, N.D., Llewellyn, E.J., Chance, K.V., Kurosu, T.P., Murtagh,

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D., Frisk, U., Pfeilsticker, K., Bösch, H., Weidner, F., Strong, K., Stegman, J., and Mégie, G.. Stratospheric profiles of nitrogen dioxide observed by Optical Spectrograph and Infrared Imager System on the Odin satellite. J. Geophys. Res., 108 (D7), 4215-4218, 2003.

Strong, K., Joseph, B., Dosanjh, R., McDade, I.C., McLinden, C.A., McConnell, J.C. Stegman, J., Murtagh, D.P. and Llewellyn, E.J.. Retrieval of vertical concentration profiles from OSIRIS UV-visible limb spectra. Can. J. Phys., 80 (4), 409-434, 2002.

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