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Atmospheric Measurement Techniques Discussions

Interactive comment on "Direct sun and airborne MAX-DOAS measurements of the collision induced oxygen complex, O₂O₂ absorption with significant pressure and temperature differences" *by* E. Spinei et al.

Anonymous Referee #2

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Scientific Significance

The scientific significance of this work is high, especially for the DOAS community. This study describes a thorough investigation of the temperature and pressure dependence of the O2-O2 absorption cross section based on data obtained under atmospheric conditions with two very different measurement techniques: ground-based direct-sun DOAS and airborne MAX-DOAS (measurements between 9 and 13.2 km). Noteworthy

is the fact that only the second of the two methods requires RTM.

The work is especially relevant in relation to ground-based MAX-DOAS observations, although such observations are not included in this work. The relevance lies in the fact that several groups working with MAX-DOAS found the need to apply a correction factor in order to bring simulations and measurements of O2-O2 differential slant columns into agreement. This correction factor is introduced for practical purposes and suggests that either the physical understanding of the measurement process (RTM, instrument simulator) is incomplete or possibly that correction factors compensate for errors caused by simplifications (for practical purposes) of the RTM and subsequent analysis.

Application of this scaling factor is undesirable since it causes uncertainty about the MAX-DOAS products where O2-O2 observations play a role, most notably the aerosol products (e.g. AOT, extinction profile estimate) but also products which rely on cloud filtering or air mass factor calculations for trace gases after an aerosol extinction profile has been estimated. The work presented in this manuscript gives direction to the search for the origin of this correction factor, because it can now be excluded that errors in the O2-O2 cross section are the main cause.

Scientific Quality

The scientific quality of the paper is high. A strong aspect is the fact that two very different techniques are used and that results are compared with laboratory observations. Instruments used are of high quality. Observation strategy is well chosen. A thorough error analysis is presented.

Presentation Quality

The presentation quality of the paper is good. Only the visibility of some of the figures could be improved, see below.

Technical Corrections (minor corrections)

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p.10017 l.26-27: Please make notation more consistent: replace "O2O2 \sigma" and "sigma" by "\sigma(O2O2)" Also at other places throughout the document.

p. 10018 l. 21-23: Please add to this sentence that the vertical profile of oxygen is usually quite well known.

p. 10031 l. 21-22: "To investigate .... " This line is possibly confusing. What is to be investigated: the effect of changing surface pressure on the O2O2 VOD, or the effect of pressure on the O2O2 absorption cross section?

p. 10032 l. 26: Please remove "of the" in "of the of the AMAX-DOAS"

p. 10035 l. 7-8: Please rephrase. Suggestion: "When making a DOAS fit with O2O2 cross sections at two temperatures (203 and 293 K), the temperature dependent bias in the measured VCDs is essentially zero within errors at 477 nm."

p. 10035 l. 10-11: "(results including aerosol are better compared to the Rayleigh case)" Please explain this remark in some more detail in a separate sentence.

p. 10035 l. 10-11: "The UV region, ... (203 and 293 K)." Please rephrase the last part of this sentence. E.g. replace "using the two \sigma" by "using O2O2 absorption cross sections at two temperatures"

Table 1: Please include Vlemmix et al. AMT(2011). In this study a correction factor of 0.8 was used. Atmos. Meas. Tech., 4, 2659–2684, 2011 (see page 2667).

Table 2: Please include 'Mean' at the beginning of the caption. "Mean O2O2 vertical column density .... "

Figure 6: open circles representing WSU are poorly visible. Please find alternative that is better visible.

Figure 7 could be improved in terms of layout by increasing the thickness of the box around the figures (A) and (B) and by using thicker lines for the open symbols (e.g. the open squares and triangles are quite poorly visible).

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