Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., editor comment EC1
https://doi.org/10.5194/amt-2020-449-EC1, 2021
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# Comment on amt-2020-449

Piet Stammes (Editor)

Editor comment on "Tropospheric $NO_2$ measurements using a three-wavelength optical parametric oscillator differential absorption lidar" by Jia Su et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2020-449-EC1, 2021

Editor's review of Jia Su et al., amt-2020-449

## General comment

The manuscript discusses a new lidar technique for profiling of NO2, which is important component of air pollution. By using three wavelengths in this new technique instead of two wavelengths, a much better correction for the presence of aerosols in the boundary layer can be achieved. This is a large step forward, since NO2 and aerosols are usually co-emitted by air pollution sources.

The topic of the paper fits well in AMT. The research is novel and convincing. However, the paper is written somewhat sloppy, and should be improved in clarity, textual correctness, and more attention for details, e.g. units for all physical quantities, correct typography, and consistency.

## Specific comments

(1) l. 65-67: This statement on satellite observations is not correct. With the recent high spatial resolution observations of NO2 by TROPOMI on Sentinel-5P since 2017, with 3.5 x 5.5. km2 pixels, plumes of NO2 by cities, power plants, and even ships can be tracked. Appropriate references to the novel TROPOMI NO2 observations should be given, for example:

- Lorente, A., Boersma, K.F., Eskes, H.J. et al., Quantification of nitrogen oxides emissions from build-up of pollution over Paris with TROPOMI. Sci Rep 9, 20033 (2019). https://doi.org/10.1038/s41598-019-56428-5

- Georgoulias et al., Detection of NO2 pollution plumes from individual ships with the TROPOMI/S5P satellite sensor, Environ. Res. Lett. 15, 124037, 2020

(2) l. 74: a reference to an NO2 sonde system should be given: Sluis, W. W., Allaart, M. A. F., Piters, A. J. M., and Gast, L. F. L.: The development of a nitrogen dioxide sonde, Atmos. Meas. Tech., 3, 1753–1762, https://doi.org/10.5194/amt-3-1753-2010, 2010.

(3) Section 2:

Here consistency is needed, and proper introduction of formulae.

- l. 79: 24x7 operation
- l. 85: absorption > absorbing
- l. 87: quant
- l. 82 ff: subscripts that are words, like “on” and “off”, should be in upright font.
- Please give the units of all quantities used: \lambda, \beta, \alpha, etc. etc.
- Eqs. 1-3:
  - Are these relations only valid for an upright pointing lidar?
  - Both capital Z and small z are used as variables. Are they the same height variable?? This consistency question holds throughout the paper.
  - Please give the units of X, C1, C2, C3, \sigma, N, etc.
- l. 124 and other places: acronyms like AED should be in upright font; only symbols are in slant font.
- l. 116: derivatives w.r.t. which variable?
- What does the D mean in AED, MED, OAD ?
- l. 129: unclear sentence. The text of the method description should be clarified.

(4) In comparison to Eqs. 4-9, how does the two-wavelength DIAL NO2 retrieval equation look like? This is relevant for the comparisons shown later on.

(5) The description of the A, B, C methods in Sect. 2 should be improved:

- l. 135-136: These methods A and B have not been introduced yet. Please give a name for the methods: increasing absorption, decreasing absorption, and maximum in absorption

- l. 137: missing reference. Or should it be Liang?

- l. 142-143: please compare to the two-wavelength DIAL equation. Please explain why eq. 12 is better.

- Eq. 12: is the +-sign the most important difference between the three methods?

- l. 152: please first introduce the derivation of Eq. 13.

- l. 153: what does K represent? what is the relation to the earlier equations?

- l. 156: please give some examples for the three wavelengths driven by K.

- Eq. 13: please first show the equation, then discuss it.

(6) Sect. 3:

- l. 169: what about the wavelengths below 400 nm?

- l. 172: what about the relative weight of the two rules/criteria?

- l. 177: how does the two-wavelength NO2 retrieval equation looks like?

- l. 182: please give the physical unit of the lidar ratio.

- l. 190: which HITRAN version?

- l. 191: e in italics

- l. 193-194: this line colour code information belongs in the figure caption.

- l. 200: far less > much smaller

- l. 223: This is a strange order of this section: first instrument description, then simulation, and then again instrument part. Please restructure section 3 into two subsections: (1) instrument description, (2) simulation of the retrieval.

- l. 239: missing words at the end of this sentence ?

(7) Sect. 4:

This section on error analysis requires drastic improvement: clarification, better introduction of equations, consistency with the rest of the paper, correction of grammar and typo's.

- l. 242: … from standard uncertainty: please explain.

- Eq. 14: what is the unit of U?

- l. 246: and not discussed in this work: unclear.

- l. 249: what is the uncertainty function u? please give reference.

- l. 249: how are these equations 15-18 derived? please first show the equations, and then explain the variables in them.

- l. 250: in Section 2 the subscript 'a' means aerosols, and 'm' means molecules. It is very confusing that here 'a' means air. Please be consistent.

- l. 260 ff: 8-hour or eight-hour: be consistent

- l. 272: Fernald's method: give reference.

(8) Sect. 5:

- What is vertical resolution of the measured NO2 profiles?

- l. 327-328: … good agreement between the OMI ... > with the OMI satellite measurements

- Fig. 12: what is the reason of the still large differences between measurement and model ?

**Figures**

- Captions should be self-explanatory!

- Fig. 2: unclear alignment of the wavelengths in the legend. What is the source of this NO2 absorption cross-section spectrum? Caption: …. strong absorption cross-section spectrum ...

- Fig. 3: Are this figure and table taken from the manufacturer's brochure? It should be a new figure for this manuscript, otherwise there is a copyright issue.

- Fig. 5: Please indicate in the legends whether it is 2- or 3-wavelength DIAL. Explain the

quantities in the caption. What is meant with the x-axis label difference of ... ? between what and what?

- Please combine figures 8, 9 and 10. Only e is varying. Explain the legends in the caption.

- Fig. 11, caption: 'except U_s': what does this mean?? explain what e is. what is TU? explain the legends.

- Fig. 12: explain the black error bars in b and d.

**Textual**

There are several typos and grammatical mistakes. Please carefully check the English language throughout the manuscript.

Often, the article is missing, e.g. on l. 36: … from the WRF-Chem model….

The singular/plural should be checked, e.g. l. 42: … the main emission sources …

Check typography of the references.