

Interactive comment on “Intercomparison of Pandora Stratospheric NO₂ Slant Column Product with the NIWA M07 NDACC Standard” by Travis N. Knepp et al.

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Received and published: 15 August 2017

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We appreciate the thorough review from referee #2. The manuscript has been updated to implement the recommendations as described below.

1. Page 1, line 1, Abstract: Add comma: 'In September 2014, a ...'

(a) Comma added.

1. Page 1, line 8, Abstract: Change to '. . . to vertical column density (VCD) is '
C1

(a) "(VCD)" added to text

1. Page 2, line 1: delete 'the' before 'stratospheric'

(a) Deleted.

1. Page 3, lines 13-18 & page 4, lines 2-10: Please add another paragraph to explain in more detail the processing procedure applied to retrieve the NO₂ slant columns discussed in the this paper; the same goes for the NIWA data processing and it would certainly be helpful to have a table summarizing the settings used for both instruments, e.g. wavelength interval used for the fit, which cross section were used, which polynomial, Ring, has an offset correction been applied, are the NO₂ and O₃ cross-sections lo corrected? This will help to understand the similarities and differences in the data processing algorithms applied to each of the data sets.

(a) Additional text added, as well as a table containing retrieval information for both instruments and references to retrieval details.

1. Can you please provide some evidence that shows that the Pandora instrument used here has a high enough light through-put to make sensible measurements at SZA ≥ 90 .

(a) This was part of the intention of the work. Prior to this study, there were no studies conducted to conclusively determine whether Pandoras have the requisite light throughput to make twilight observations. Text was added to clarify.

1. Page 4, line 15: replace ')' with ''

(a) Replaced

1. Page 4, line 21: should be 'similarly'

(a) Changed

1. Page 4, lines 26/27: If these are SCDs please state so clearly in the text.

(a) When the OMI NO₂ product is introduced in the text it is now declared as VCD. The table caption was updated as well to indicate a VCD.

1. Page 5, line 9: '. . . the two sites are in phase . . .'

(a) Corrected

1. Page 7, Figure 2: panel (b): any comments re why the displayed ground-based data is clearly higher? Maybe I missed this somehow but this should be included in the caption and also be discussed in the manuscript text. Also state clearly in the first line of the caption if the OMI NO₂ data product is SCD or VCD.

(a) As mentioned in the text, we have not inverted the surface instruments' SCD to a VCD. Figure 2, panel b presents the OMI VCD and the Pandora/M07 SCD. The three instruments are *not* plotted here to show quantitative agreement, rather it is to demonstrate that the surface instruments are in phase with the OMI seasonal cycle for stratospheric NO₂. Clarification has been added to the text and the figure's caption.

1. Page 8, line 5: '. . . the correlations as seen in Fig. 3'

(a) Corrected

C3

1. Page 8, line 6: '. . . where it peaks at . . . Within each panel of Fig. 3 the data are color ...'

(a) All changes implemented.

1. Page 8, line 6: It would also be helpful to refer here to Table 3 as well.

(a) Reference to table added.

1. Page 8, line 13: '. . . instruments have strikingly . . .'

(a) Verb tense changed

1. Page 9, Tables 3&4: Last column, close with ')' not ']'

(a) It is common mathematical notation to use parentheses to indicate an exclusive range, and square brackets to indicate an inclusive range. Therefore, we chose to use square brackets to indicate the ranges specified in tables 3 & 4 are inclusive of the high SZA.

1. Page 10, Figure 3 caption: Change to '(i.e. red colors represent the upper SZA limit, blue colors represent the lower bounds for each individual panel).'

(a) Hyphenation removed

1. Page 10, line 1: 'The decrease in correlation . . .'

(a) Change implemented

1. Page 10, line 9: How about something like: 'To better understand the seasonal variability seen within the data sets, the data . . .'

C4

- (a) Your wording provides better understanding of what we are doing. Change implemented.
1. Page 10, lines 10-11: This sentence needs to be improved, change to something like: 'Seasonal correlation plots were generated (Fig. 4); they show nearly identical behaviour to the aggregate (Fig. 3) with most of the tailing behaviour being attributed to winter conditions.'
- (a) Again, your wording allows quicker understanding of the text. Change implemented.
1. Page 11, line 11: Change to: '. . . at high SZAs . . . or at very low NO2 . . .'
- (a) Change implemented.
1. Page 11, line 20-22: Can you please address if the observed seasonal dependence can cause issues when using Pandora instruments for satellite validation.
- (a) Seasonal variability in satellite validation is a well known issue. Unfortunately, we cannot determine the seasonal dependence when comparing either Pandora or M07 to SAGE-III until after the observations are made. We can be certain that there will be a seasonal dependence on how well Pandora and M07 agree with SAGE-III, but that seasonality will have to be accounted for at a later time.
1. Page 11, line 24: delete '-' between 'NDACC' and 'standard'
- (a) Hyphen deleted.
1. Page 11, line 25: replace 'on' with 'using'
- C5
- (a) Change implemented.
1. Page 11, lines 26-27: Change to: 'We showed that the data obtained using the two instruments and retrieval algorithms were well . . ., and that the time of the year had just minimal impact on the comparison. ' However, didn't you just state in the paragraph above that there actually is a seasonal impact??
- (a) You are correct. It is clearly demonstrated within the manuscript that the seasonal impact was +/- 10%. The sentence should have said "minimal impact on correlation". Now corrected.
1. Page 11, line 30: The tailing effect should be explained when first mentioned.
- (a) Tailing effect now defined in the conclusions section.
1. Page 12, line1: The SZA range where the Pandora instrument may be useful for SAGE-III validation seems rather limited (around 90 deg, possibly as low as 85 deg) - can you please elaborate a bit on if that is realistic with re to known overpass information for suitable sites.
- (a) A table was added to show SZA statistics for all SAGE-III/ISS observations collected thus far. The SZA were calculated with respect to a potential surface instrument's viewing geometry. The table shows the SZA to be tightly grouped about 90 degrees.
1. Page 12, line 2: I don't understand the sentence: 'Lower SZAs may not . . .'. Can you please explain what you mean here.
- (a) That sentence was superfluous and has been removed.