

Review of the paper "Tropospheric ozone retrieval by a combination of TROPOMI/S5P measurements with BASCOE assimilated data" by Klaus-Peter Heue et al.

The manuscript presents a new way to retrieve global tropospheric ozone by mainly using TROPOMI NRTI total ozone and BASCOE assimilated stratospheric ozone profiles. A bias correction climatology was used to reduce BASCOE deficits in the upper stratosphere. The retrieved ozone column is mapped on the TROPOMI measurement spatial resolution by interpolating BASCOE sub columns in space and time to TROPOMI. Results are validated with ozone sondes, TROPOMI CCD tropical ozone columns, and OMPS-MERRA2 data. A short section discusses the results for different regions of the Earth. I recommend publication after addressing the comments given below.

Does the paper address relevant scientific questions within the scope of AMT?

Yes

Does the paper present novel concepts, ideas, tools, or data?

Yes

Are substantial conclusions reached?

Yes

Are the scientific methods and assumptions valid and clearly outlined?

This needs to be improved. See comments below.

Are the results sufficient to support the interpretations and conclusions?

Yes

Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?

No formula was given in the paper.

Do the authors give proper credit to related work and clearly indicate their own new/original contribution?

Yes

Does the title clearly reflect the contents of the paper?

Yes

Does the abstract provide a concise and complete summary?

Yes but it should be upgraded a bit: Some typos (TROMOMI,..) and missing information (tropopause level?)

Is the overall presentation well structured and clear?

The presentation is OK but can be improved (see comments).

Is the language fluent and precise?

Quite some errors throughout the paper that need to be taken care of.

Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

No formulae, symbols/units must be streamlined (see comments)

Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?

The subsection in section 5 are rather short, could be compressed into one? Otherwise see comments below.

A table/overview of bias/dispersion of BF vs OS, CCD, OM2 might help to get a clear view on accuracy/precision.

Are the number and quality of references appropriate?

Yes

Is the amount and quality of supplementary material appropriate?

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Questions/Comments:

Lines:

6: OMPS-MERRA-2 data (globally? time span?)

11: exceptional larger positive deviation (where?)

12: expected spatial and temporal pattern (what is expected?)

24: beginning of the mission in 2018 = wrong, 2018 op. phase E2

33: MERRA-2 = citation?

65: It makes use = the dataset? sounds strange

72: ozone sonde will be explained briefly = data?

77: total ozone column is retrieved = use of op. data? which one?

75: maybe reorder chapter 2.1 and 2.2

94: TROPOMI data were reprocessed internally at DLR = full mission reprocessing to 2.1?

101: to prepare the EU Copernicus Atmospheric Monitoring Service = for what?

102: reduced, as expected for the austral spring = few words of explanation can help

112: Is there a change in BASCOE bias over time or is the early version not used anymore?

118: climatology: explain (e.g. resolution in time/space)

Fig1: add resolution to caption (mixingratio in title)

120: Where does the PV/PT data comes from?

121: Outside the tropics = which latitude? Is there a sharp cut or a mixed region?

Fig.2: what is the bias/dispersion of MLS stratospheric columns? Can longitudinal variations be neglected?

127: BASCOE ozone deficit above 4 hPa = citation available?

131: 5.5 x 3.5 km² = not in 2018! pixel size switch at 2019/08/06

132: observation time = UTC time changing for every pixel?
Fig3: BASCOE, right? add resolution to caption, corrected for bias?
where does the jump in column near date line (~170°) come from?
Why only show stratospheric column and not tropospheric in section 2.4?
142: Dec.2021: inspection date?
150: to correct what? what climatology was used and how?
151: Does the correction depend on difference between reference and cloud height?
152: Tropical clouds are not on average at 10km, especially convective clouds.
The S5P cloud retrieval underestimates the height in comparison to e.g. CALIPSO.
155: what is the defined correction height? 10km or 280hPa.
The operational S5P product is adjusted to 270hPa?
157: why certain bands?
168: climatology the same as used for cloud height correction?
170: who is responsible for the product?
177: what version 2.1 algorithm means?
191: Reference for sonde comparisons?
213: why the two step approach and not grid directly to the reference grid?
217: S5P ATBD says 270hPa?
Fig4: Latitudes missing.
220: looks like there is a land-sea contrast as positive bias is mostly over land
221: where is it documented?
224: negative bias and variability of about 4 DU. => bias = 4DU?
224: three peaks are found = and that means?
Fig5: checked how subset of OMPS-M2 in tropics compared?
annual pattern vs CCD: are there explanations for it?
Daily values? Global mean?
235: mean difference 3-4DU: why no exact value?
244: 3.5PVU means BASCOE will have higher columns, right?
246: which year
Fig6: figures too small, hard to read
Fig6: difference in North Atlantic can be up to 15DU.
Large BASCOE trop. column mostly over oceans, any explanations?
Fig7: Date? difference 3.5-2.5?
252: that means the 3.5 PVU is too high and adds a lot of
stratospheric ozone into the BASCOE tropospheric column?
258: which tropopause definition here? what does mean pressure mean?
264: where is the sonde station? I wouldn't call 25DU "slight".
270: Reference?
Fig8: which satellite sample a 100 km circle? S5P has a higher resolution.
271: how and why is the sonde data scaled?
273: how large are those biases? ~8DU is not that small.
relative differences are used in S5P to describe biases.
what is the overall bias/dispersion? is there a time dependency?
278: end of sentence is missing.
285: typical enhancements are e.g. Mediterranean: rephrase. why are they typical?

290: columns correlated with other parameter e.g. cloud height?

Fig12: same map borders would be good

302: how much can be attributed to the positive bias?

304: The Berlin 20d mean has a lower dispersion than Athens from my point of view.

Fig14: Monthly mean?

320: small bias ($\sim 2-4\text{DU} = 5-10\%$, $\text{max} \sim 15\text{DU}$)? Total columns or tropopause definition?

CCD similar bias $\sim 4\text{DU}$

323: what does variability in difference means?

325-327: doubling of sentences. slight bias $\sim 5\text{DU}$ (fig10)?

- Conclusions should be carefully revised

GENERAL ISSUES

Errors: quite a few typos, misspellings. Text needs to be heavily redacted.

units = sometimes no space between number and unit

nouns = capital first letter e.g. Tropopause?

deg or $^{\circ}$ = unify

reference = needs to be checked thoroughly (e.g. German verbs not shown correct, spacing at wrong places)

ERRORS (only subset, thorough inspection necessary):

5: extend these data record into the future = ?

8: ozone sonde data = sub columns?

20: IPCC, 2013(@)

72: next section = number?

77: The second step includes = rephrase, hard to understand

80: place = space?

88: (Clouds as Layers Loyola et al., 2018).

104: the changes * 3, rephrase

145: OFL -> OFFL

166: to the 380 K level 80 to 130 hPa for

225: 2* periods

228: Tropospheric ozone columns from OMPS-MERRA-2 are described = misleading, retrieval is described