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Comment on amt-2020-512

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Referee comment on "On the capability of the future ALTIUS ultraviolet–visible–near-infrared limb sounder to constrain modelled stratospheric ozone" by Quentin Errera et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2020-512-RC2>, 2021

General comments:

The study focuses on estimating the potential impact of ALTIUS ozone observations in improving model short-term forecasts and assimilation analysis of the upper troposphere to middle atmosphere ozone field over the globe using an OSSE. The applied approach and evaluation are scientifically sound. Generally, the content is clearly presented, concise, and well organized. On occasion, it would benefit from additional information as indicated below.

Some reframing is recommended, starting with the title. See also related specific comments in the introduction and elsewhere below.

There are minor issues in the grammar in some sections, some of which were considered not worth pointing out. There is the issue of choosing the singular vs plural with 'bias', standard deviation', and 'correlation' especially. The plural would be better in many cases and the choice between the two could be more subjective in others. It would need to be plural when referring to quantities (potentially multiple values).

While the suggested revisions are not very major, the paper would benefit from another review.

Specific comments:

Title: "UV-VIS-NIR" instead?

Title: 'On the capability of UV-VIS limb sounders to ...' is too general in part considering that the content and text of the paper referring essentially to the ALTIUS mission and instrument specifications – even though some implications would admittedly hold anyways to other limb sounders. Many previous studies have already provided some insight on different aspects of this topic. I recommend having the title not refer to 'the capability of UV-VIS limb sounders' and focus on the capability of ALTIUS itself.

Section 1. Introduction

L19: Providing a reference would be good.

L31: Please provide a related reference for the first sentence if possible.

L38-41: Any reference or related document?

L48: Include also the mention and references of OSSES regarding stratospheric chemical composition (including ozone). This is not the first OSSE involving stratospheric ozone measurements. As well conclusions from previous assimilation studies involving actual satellite ozone data (including profile sources such as MLS and others) would also be relevant to this work. It would be important to summarize/mention relevant conclusions from earlier assimilation studies involving simulated and actual ozone measurements from satellites in relation to the objectives of this study. What conclusions from earlier OSSEs and OSEs with satellite ozone data are pertinent to this study and what might all of these lack in answering questions regarding the impact of ALTIUS (this relates to one or two statements in Section 2)?

L55-56: Specifying BASCOE without COPCAT can be misleading as most already familiar with BASCOE may/will assume use of the full chemistry package at this point. Maybe best to mention either both or neither here.

L56: Starting with the mention of BASCOE in the sentence lends to confusion in reading the remainder of the sentence. It is recommend to instead have a paragraph or sentence before L55 to describe/mention the need for a simulation process to provide the measurements used for investigating both questions.

L55-65: Then again, some/much of the content here would fit better in an introduction of a methodology section (e.g. Section 4) instead of the introduction. Some of the content summarizes the methodology as opposed to introducing the subject. Removing some of the methodology details in these paragraphs (if not most these entirety of these two paragraphs) is recommended.

Section 2. The ALTIUS Mission

Section 3. The BASCOE System

L116-117: 'As well, the effective vertical resolution stemming from the averaging effect of the averaging kernels - ... - so that their use' Is this what is meant? (If so, does this actually apply to the ALTIUS ozone product – as this is dependent on the applied retrieval constraints, including the relative effects of the measurement and a priori/constraint error covariances/weights.) Otherwise, the last part of the sentence does not seem to work.

Section 4. The OSSE setup

L120: Please state the assimilation window period and/or interval (e.g. every 6 hours covering +/- 3 hours about each synoptic time?)

L128: 'using a minimum of three'

L131: In OSSEs, one could potentially or often simulate many or all observation sources – this depends on the intent and the setup. So the control run could technically, depending on the setup and what is intended, use simulated observations except for one or more target sets. Maybe some re-phrasing is needed.

L134-135: 'This ensures .. only ...' – maybe not likely. All the 'old instruments' and the common aspect of model physics, etc, would contribute some similarity in results. Please re-phrase. Maybe the intent was to say that the 'increased similarity or agreement between the NR and AR results "as compared to that between the NR and CR" is most likely due to ...'

L137: Saying it is 'solved' may be too strong. Maybe something like 'the concern of the identical twin issue is largely removed' or attenuated (maybe not entirely removed).

L139: If the CR or another AR does not perform assimilation of other ozone profile sources such as MLS or OMPS-LP (NPP) for example, then the target AR will not show the value added benefit of including ALTIUS to one or more other ozone profile sources. Some mention of not doing so would be relevant here - if not also in the conclusions sections.

Section 4.1. The nature run

Figures 1, 3, and 4: Having AR and CR results in the NR section is not ideal. Maybe the text in section 4.1 should indicate that the AR and CR results included in the figures will be discussed in later sections. Additionally, comparing AR and CR to actual measurements, other than MLS maybe as it was assimilated for the NR, is not as meaningful or clean as comparing to the NR itself - since the NR is the truth for the AR and the CR (even MLS itself is not the truth here - it is the NR). It would be worth discussing this. It is good to compare the NR with these observations though to evaluate the realism of the NR and the effectiveness of the MLS assimilation as is done in this section.

Figure 3: Why do correlations reach 1.0 (or nearly 1.0) at upper levels? Is it truly because of consistency or something else? It would be good to provide an explanation somewhere in the text.

Figure 3: Why are mean differences and std. dev. often smaller or near zero above or as about 10hPa? One would/might instead expect larger values at upper levels.

L162: State for which forecast F time(s)/periods (e.g. +/- 3 hours about each synoptic/analysis time/period)?

L165: If these are actually at the times of each assimilation, the statistics may show even more so the assimilation effectiveness of BASCOE, i.e. a sanity check on the assimilation of MLS, when comparing to MLS

L166: How are the correlations calculated? Are these anomaly correlation coefficients (if so provide a reference)? If not, are the denominator standard deviations those prescribed for the forecasts via the ensembles (and observations when involving observations). Please provide some specifics.

L166: Specify vertical ranges of applicability and temper the comment with 'typically', 'mostly' or '.,' when these limits are not satisfied for all latitude bands. The sentence 'These are, however, ...' would not be needed in that case - and it is better for the previous sentence to be precise in its statements.

Section 4.2. The control run

See earlier comments related to Figures 3 and 4 and the NR being the truth for the CR and AR.

Section 4.3.1 Profile geolocation

L210: It might be relevant to mention somewhere that MLS provides limb profiles for both day and night conditions in the event some readers may not be familiar with MLS, hence the larger number of MLS measurements. (maybe this was done earlier in the paper?)

Section 4.3.2. Ozone profiles

I did not notice any mention of the spatial sampling (for the daytime limb measurements) and especially the vertical resolution(s) of the ALTIUS profiles. If not mentioned, it is important to do so.

L218-220: There was no mention of accounting for the geometry of the measurements (limb viewing) and consideration of scattering not just within a vertical column.

L228: This is done to generate the covariance matrix. It needs to be stated before this sentence, saying that covariance matrices are defined first before simulating the final observation profiles.

L231 (or below): 'linear interpolation from the NR to the ALTIUS altitudes'? What are the vertical resolutions? (Do I just miss this in the earlier text?)

L246 (and earlier): What is the ALTIUS space? (resolutions) How was interpolation done? (linear?) Was limb geometry considered in the interpolation? Normally, the latter is not done for simplicity.

Sections 4.4 and 4.5: Combining the two sections into one is recommended, i.e. 'The assimilation runs'

L253: 'A reference assimilation run ... assimilation of all ALTIUS' (or 'reference' replaced by another preferred word)

L262: 'as the reference assimilation'

Section 5. Evaluation of the 'Reference Assimilation 'Run'

L264: 'and the reference assimilation'

L290 or so: Is the COPCAT more chemically fast acting in the upper troposphere than in the stratosphere (as it would/might also be at even higher vertical levels)?

L305-314: This discussion is rather late in the text considering that this pertains to Figs. 3 and 4. As a reader, I was a bit puzzled not seeing this near the beginning of the section. See also earlier points regarding Figs. 3 and 4 in comparing to actual observations in this case.

L310-314: Please discuss cases where CR has smaller standard deviations than for AR in Figure 4.

L317: Maybe not so evident (if not that likely). Any demonstrable proof from other work (e.g. from CAMS itself)? If so, a reference would be good. If not, maybe better to exclude that statement.

Section 6. Added value of the different ALTIUS modes of observation

Section 7. Conclusions

L334-335: Suggest removing the commas or re-writing to refer specifically to ALTIUS, e.g. 'from the ALTIUS UV-VIS-NIR limb sounder' which would be better.

L335: 'analyses'. So are the F of FmO analyses?

L348: 'Several assimilation experiments' or 'A few assimilation experiments'

Technical corrections:

L5: 'limb-scattered'. As well the paper also uses 'bright-limb' and 'bright limb'

Section 1. Introduction

L31-32: Proposed and supported by agencies (of countries) and not the countries themselves (minor point though)

L34-35: 'with a latency of less than 3 hours from the sensing to the retrieval product delivery to operational services'

L38: The removal of comma is suggested as it cuts the actual phrasing.

L41: ': measurements ... '

L45: 'systems using data assimilation'

L53: 'measurements) in particular' (remove comma) or 'measurements) with some emphasis on the polar night'

Section 2. The ALTIUS Mission

Section 3. The BASCOE System

L113: It is worth referring to FGAT (first guess at appropriate time) here?

L113: 'It is used to save'

L115-116: 'Averaging kernels have not been applied in this study since the BASCOE ...'

L119-120: 'in BASCOE, the four-dimensional variational method (...) and the EnKF ...'

L123: "using Desrozier's method" or "using the Desrozier method"

L123: 'based on requiring' instead of ', allowing to have'

L124: 'model forecasts weighted'

L125: 'covariances; m_k is the number ...'

L136: 'setup' as used elsewhere.

L146: Remove or re-phrase the added ', done, detailed hereafter as well'.

Section 4.1. The nature run

L148: 'the BASCOE ...'

L151: 'given in Livesey et al. (2015).'

L166: biases, standard deviations, and correlations (plural)

Section 4.2. The control run

Section 4.3.1 Profile geolocation

L195: 'than a 1.5 visual magnitude' or 'than a visual magnitude of 1.5'

L206: 'tangent altitudes of the lines of sight'

Figure 7: 'The color code indicates' ... 'error standard deviation profiles correspond to' (twice) ... 'MLS single profile precision error standard deviations' (also plural) ... 'with a range of' 'is shown in panels ...'

Section 4.3.2. Ozone profiles

L218-220: 'would be used', 'would then be used', 'data would undergo', 'would be retrieved'

L228: 'a set of sample ozone profiles ... was produced.'?

L231: 'sample set'

L234: 'for bright'

Sections 4.4 and 4.5: Combining the two sections into one is recommended, i.e. 'The assimilation runs'

L261: Table 2 has SuSt and not SoSt.

Section 5. Evaluation of the 'Reference Assimilation 'Run'

L269: 'agreements and differences between the NR and the CR and AR is provided' (or '... NR and {CR,AR} ...')

L270: 'Above the South'

L273: 'underestimates'

L277-278: 'biases', 'standard deviations' and 'correlations'

L278: 'mean values'

L282-...: Better to use plural form again maybe unless referring to the concepts of bias, ... (including Fig. captions)

L294: 'such cases' or 'such a case' ... 'Finally, we have also checked ...'

Figure 11: 'runs', 'standard deviations', 'red and blue envelopes' – if not others.

Section 6. Added value of the different ALTIUS modes of observation

L323: 'differences are also shown'

L325: Remove 'remember that' Also, how about 'limb profiles; solar' instead

L326: 'using only bright limb'

L328: 'At the South Pole'

L329: 'LSt'

Section 7. Conclusions

L334: 'evaluate the level of influence of'

L337-339: Use past tense instead of present tense.

L340-341: 'assimilation runs' ', and all runs used the'

L347 and earlier/elsewhere: alternating use of 'bright-limb' and 'bright limb'. Consistency would be preferred.

Acknowledgments

L363-364: As the source of ozonesondes is provided, how about for MLS as well (if not others)?

References not checked.