Here below are our responses to referee #1. The referee's comments are in black while our responses are in blue.

Referee #1

"On the Capability of the Changing Atmosphere Infra-Red Tomography explorer (CAIRT) candidate mission to constrain O3 and H2O in the upper troposphere and lower stratosphere"

Quentin Errera et al.

AMT Discussion started 27Dec25

SUMMARY

The CAIRT instrument was a limb-viewing infrared radiometer proposed for the ESA EE11 mission, one of two instruments which were considered at the final selection. Although not selected ESA encouraged continued scientific studies. This paper focuses on just one aspect of CAIRT which is to improve measurements of O3 and H2O in the UTLS region, in this case via incorporation of profiles into a data assimilation scheme. The improvement is established not only with respect to a control but also the long-established MLS instrument. For both instruments the approach is to sample fields generated by an independent model at the observation locations of the two instruments, apply the instrument averaging kernels to simulate the measured profiles, and incorporate these into a data assimilation scheme based on an different model. The conclusions are that CAIRT shows improvement in the modelled O3 and H2O fields, and is generally better than MLS, but, given the set-up and CAIRT's much higher profile density, any other conclusion would indeed have been surprising.

I have no major criticism with anything presented in the paper although overall I feel it includes too much unecessary technical detail on model settings and geolocation procedures, better suited to appendices or supplementary data. But that's just my preference.

We would like to thank referee#1 for his review. Since not requested by referee #2 nor the editor, we did not change the structure of the manuscript. Below are our responses to the reviewer's general and detailed comments. Note the use of the acronym DA for data assimilation.

GENERAL COMMENTS

I would like the authors to clarify the following points (see detailed comments below for further elaboration)

(a) There is mention of systematic errors but I would like a bit more details on what these are, how they were assessed and how they were handled in the data assimilation.

In this paper, systematic errors are every type of error that is not strictly random. These include (1) radiometric offset, (2) scaling errors, (3) pointing knowledge, (4) spectral responses function (i.e., the apodized instrumental lineshape), (5) system energy distribution function (i.e., the spatial response of the optical system to a spectrally uniform point source), (6) systematic uncertainties due to imperfect knowledge on the CO2 vertical distribution and (7) non-LTE related kinetic rates. Systematic errors (3) to (7) are correlated in the across-track direction, while errors (1) and (2) are uncorrelated in that direction. This has been included in Sect. 4.4.3.

DA is constrained by L2 profiles weighted by the L2 measurement noise error. CAIRT simulated L2 profiles (assimilated by the DA system) include all errors (random and systematic), except for one dedicated test case (AR_Cnosys). In that case, the simulation of CAIRT observations has not considered the terms $\boldsymbol{\epsilon}_{sys\_corr}$ and $\boldsymbol{\epsilon}_{sys\_uncorr}$ of Eq. (1). This has been clarified in Sect. 7.

(b) The handling of cloud-contaminated CAIRT data is unclear, particularly how it relates to "superobbing". I also offer the following suggestions, for the authors consideration, which I think would improve the paper.

The description of computation of superobservation has been clarified in Sect. 4.5.3. See more details below.

(c) There should be a plot of the limb spectrum as observed by CAIRT, identifying features associated with the main molecular species.

There are numerous CAIRT simulated spectra available in the CAIRT Report for Mission Selection, e.g. Figure 4.11 in CAIRT Report for Mission Selection. This reference has been inserted in Sect. 2.

ESA: Report for Mission Selection: Earth Explorer 11 Candidate Mission CAIRT, European Space Agency, Noordwijk, The Netherlands, ESA-EOPSM-CAIR-RP-4797, 230 pp., https://doi.org/10.5281/zenodo.15606819, 2025a.

(d) I appreciate that there is more to data assimilation than simply interpolating retrieved fields, but it would have been interesting to see how a simple gridding/binning of the CAIRT and MLS profiles on the assimilation model grid compares with data assimilation approach (as an extra test case).

We are not sure to understand this comment. In this paper, data assimilation is used to measure the constraint of CAIRT observations on the BASCOE model. It is not clear how comparing assimilated fields against gridded data would help. This suggestion has not been followed.

(e) While the zonal mean plots can be interpreted in a number of different ways according to the prejudices of the viewer, there should be a summary table quantifying the improvement with a single number or two, e.g. mean bias and SD, or something fancier such as information content added by each instrument. But, anyway, a hard number.

Here below are two tables inserted in the revised manuscript providing such “hard numbers” in three regions (see Table’s caption for their definition): the lower stratosphere, the tropical upper troposphere and the extra-tropical upper troposphere. Sect. 8.1, 8.2 and 9 have been updated accordingly.

Table 4. Mean values of the NMB, NSD and CORR for O_3 in three atmospheric regions of Fig. 10: (1) the lower stratosphere defined by altitude between 18 and 20 km at all latitudes, (2) the tropical upper troposphere defined by altitude between 7 and 12 km and latitudes between ±20°, and (3) in the extra-tropical upper troposphere defined by altitude between 7 and 12 km and latitudes poleward ±30°.

Label	Lower Strato.			Tropical Upper Tropo.			Ex.-Tropical Upper Tropo.		
	NMB	NSD	CORR	NMB	NSD	CORR	NMB	NSD	CORR
CR	14.6	18.8	0.74	-91.1	23.3	0.38	-26.5	27.9	0.73
AR_{MLS}	-0.5	10.9	0.84	-37.8	24.9	0.69	-5.5	18.5	0.81
AR_{CAIRT}	-1.8	9.7	0.87	-13.3	21.2	0.74	-3.3	17.0	0.83
AR_{Cnosys}	-0.7	9.6	0.87	-9.8	20.9	0.75	-0.3	16.9	0.83
$AR_{Cnocloud}$	-0.6	9.7	0.87	-4.9	17.6	0.78	-0.5	16.8	0.84
$AR_{C3tracks}$	-1.9	9.7	0.86	-13.8	21.4	0.74	-3.5	17.1	0.83

Table 5. As Table 4 but for H_2O where the troposphere differs in the altitude definition: the tropical upper troposphere altitude is defined between 10 and 16 km while the extra-tropical upper troposphere is defined between 8 and 14 km.

Label	Lower Strato.			Tropical Upper Tropo.			Ex.-Tropical Upper Tropo.		
	NMB	NSD	CORR	NMB	NSD	CORR	NMB	NSD	CORR
CR	-18.6	6.7	0.71	-68.5	56.3	0.52	-40.5	54.4	0.63
AR_{MLS}	0.2	4.7	0.77	-36.4	48.4	0.62	-26.4	43.8	0.76
AR_{CAIRT}	-0.4	4.8	0.77	-31.0	49.0	0.61	-23.5	44.9	0.79
AR_{Cnosys}	0.6	4.8	0.77	-31.4	49.0	0.61	-24.1	44.9	0.79
$AR_{Cnocloud}$	0.6	4.8	0.77	-24.4	47.4	0.64	-22.2	44.4	0.79
$AR_{C3tracks}$	-0.4	4.8	0.77	-32.2	49.5	0.60	-24.4	45.4	0.78

DETAILED COMMENTS

P3 L76 "review"

Corrected.

Table 1: While I understand that the O3 uncertainty requirements were expressed as ppbv It would be useful to have some indication of actual O3 concentrations in the UTLS region in order to put these values into context (I eventually found this information by inspecting the colour scales in Fig 5).

The following sentence was added in the revised manuscript (old text in normal font, new text in **bold**). “These requirements are designed to ensure sensitivity to stratosphere–troposphere exchange processes, such as stratospheric intrusions. **This is illustrated in Fig. 9a for ozone. The figure shows ozone at 7 km during a stratospheric intrusion which spans from Scandinavia to Algeria. Average ozone at 7 km is around 50 ppbv and exceeds 100 ppbv in the stratospheric intrusion. An uncertainty of better than 30 ppbv is thus reasonable if one wants to observe such kinds of intrusions. Similarly, if horizontal gradients of water vapour at 12 km like those illustrated in Fig. 9e are to be observed, an uncertainty of better (thus smaller) than 10% seems reasonable.”**

P4 L88: Is resolution 0.25cm-1 here specified before or after apodisation?

Before apodisation, this is now mentioned in the paper.

P4 L96: It would be interesting to know the minimum pixel size, i.e. before averaging spectra what is the FOV size of an individual spectrum?

These details can be found in ESA 2025a, Table 5.4, Sect. 5.4.5.3 and Sect. 7.2.3.

We update the sentence for clarification (new text in **bold**): "The Level-1 limb radiance spectra corresponding to multiple across-track spatial samples are averaged to reduce noise before Level-2 retrievals (see Sects. 4.4 and 4.5**, and ESA 2025a, Sect. 7.2.3)"**.

P4 L97: I don't think you can claim a "strong" heritage based on just a single predecessor.

We believe that 10 years of successful in-orbit measurements can be seen as a strong heritage. The word "strong" has been kept.

P4 L99: This could be misunderstood. MIPAS actually had several detectors, covering different spectral ranges, all co-aligned to view the same 'pixel'.

The sentence "MIPAS was an FTS scanning instrument with a single pixel detector, providing …" was replaced by "MIPAS was a FTS scanning instrument with several co-aligned detectors, covering different spectral ranges, providing …"

P4 L100: Also liable to be misunderstood - while MIPAS (and MLS) produced profiles along a single track CAIRT would have produced profiles along multiple tracks so it's unclear whether these figures refer to improvements in sampling along just a single orbital track or, say, total number of profiles per day.

In order to clarify, we added a new sentence after L96 ("The Level-1 limb…"): "For O3 and H2O in the UTLS, the spectra are binned across-track to get a spatial sampling of 100 km. Considering a default swath of 400 km, CAIRT would thus retrieve L2 profiles along 4 orbit tracks separated by 100 km (for O3 and H2O in the UTLS, spatial sampling differs on the basis of species and altitude regions)."

Moreover, the sentences "... providing one retrieved profile approximately every 400 km – over an order of magnitude fewer profiles than CAIRT. CAIRT would deliver roughly 12 times more profiles than MLS, which provides one profile every 167 km along the orbit track (see Sect. 5)." have been replaced by "... providing one retrieved profile approximately every 400 km. Given its 50 km ALT and its four tracks, CAIRT would retrieve ~32 times more profiles than MIPAS, and ~12 times more profiles than MLS which provides one profile every 167 km along the orbit track (see Sect. 5)."

P5 L121: "within which..."

Corrected.

P5 L127 & L138: Since there is quite a bit discussion in the main text based on what these figures in the supplementary data show, they should have been included in the main body of the paper.

These figures are now included in the revised manuscript.

P8 L216: Here it is 0.2cm-1 sampling but on P4 L88 a figure 0.25cm-1 is given for the instrument. At the end of the paragraph it explains that this is after apodisation. Knowing how this works, I assume it therefore represents a convolution of spectra calculated on a much-finer spacing with the apodised instrument lineshape, and sampled at 0.2cm-1, but just reading "computed with 0.2cm-1 spectral sampling" a non-specialist might assume this was the original fine grid spacing.

Indeed, the radiative transfer simulations with KOPRA have been performed at a much finer wavenumber grid of 5e-4 cm-1 and have been convolved to the instrument's resolution. Here, the maximum optical path difference of the interferometer has been assumed as 2.5 cm-1 leading to a grid distance of independent spectral samples of 0.2 cm -1 (i.e. a FWHM of the sinc-function of 0.24 cm-1). This is what has been used for the simulations here, and which is in accordance with the mission requirement of less than 0.25 cm-1 resolution, as stated in the introduction. This will be explained in detail in Funke et al., Linear tomographic performance estimation for the Changing Atmosphere Infra-Red Tomography explorer (CAIRT) mission concept, Atmos. Meas. Tech., in prep.

The sentence “Using the climatology … computed with 0.2cm-1 spectral sampling.” has been replaced by “Using the climatology and the Karlsruhe Optimized and Precise Radiative transfer Algorithm (KOPRA, Stiller, 2000), an ensemble of radiance spectra and their Jacobians were computed at a fine spectral sampling of 5e-4 cm-1. Subsequently these spectra were resampled to 0.2 cm-1 by convolution with a sinc-function representing an ideal Fourier-Transform spectrometer of 2.5 cm-1 maximum optical path difference.”

P9 L223: "factorized random error covariance matrices". I don't understand what "factorized" means in this context. If I had to guess I would say some sort of EOF/SVD decomposition of the L2 random error covariance.

This is actually a Cholesky decomposition. “factorized random error covariance matrices” has been replaced by “decomposed random error covariance matrices”.

P9 L224: Non-LTE effects can be a problem for modelling stratospheric H_2O lines. Were these included as part of the systematic error?

Yes, Non-LTE effect has been considered. Uncertainties of the non-LTE modeling (e.g. uncertainties of rate constants or atmospheric profiles such as atomic oxygen, relevant for the modeling of collisional processes) are considered within the systematic error budget. This is mentioned in Sect. 4.4.3.

P9 L241: I didn't understand the statement setting y_a to zero to avoid any a priori bias. Isn't this going to bias all terms in the simulated L2 profile towards zero?

The regularization used in the retrievals is a Tikhonov 1st order constraint, such that with y_a=0 it acts as a simple smoothing constraint without any influence of the a priori profile shape.

The sentence has been replaced by "In our computation, y_a has been set to zero such that the regularization (Tikhonov first order) acts as a simple smoothing constraint without any influence of the a priori profile shape."

P9 L245: I didn't understand this. How do clouds influence retrievals beyond the physical cloud boundary (unless you are just referring to partly cloud-filled pixels containing a cloud-contaminated component).

In nadir geometry, the observed geolocation coincides with the geolocation of the observer's footprint on the surface. In contrast, in limb geometry, each line of sight is characterized by a tangent point, which represents the location from which the dominant contribution to the measured signal originates.

A key difference between nadir and limb observations lies in how spatial information is sampled. Despite the fact that there is a one-to-one relationship between a detector pixel and a line of sight in both geometries, in nadir viewing, each pixel collects information from a specific ground location. In limb viewing, however, a given atmospheric volume is typically intersected by multiple lines of sight. The tomographic retrieval exploits this redundancy to improve the accuracy and stability of the solution.

This characteristic of limb geometry has two important implications. First, information about a given location can be retrieved from multiple viewing directions. Second, some lines of sight with tangent points outside the cloud location may still intersect the cloud along their path and therefore be affected by it.

P9 L246: I assume the CAMS cloud fraction is the fraction in the CAMS model grid cell containing cloud of any sort, i.e. horizontal fraction over some indeterminate but presumably large area compared with CAIRT horizontal FOV extent. It is unclear how this maps into a limb-view.

We consider the scene observed in limb geometry. For each point of the two-dimensional (vertical x ALT) retrieval grid, we evaluate the corresponding CAMS cloud fraction. If the cloud fraction at a given grid point exceeds 0.2, the cloud at that location is assumed to be sufficiently opaque to affect the measured spectra.

To realistically simulate the reduction in valid retrieval points caused by thick clouds, we have simulated spectra affected by clouds and have evaluated the impact of clouds extending vertically from the cloud-top altitude down to 5 km and horizontally along the satellite track over 50 km, corresponding to the along-track L2 grid spacing. The procedure consisted of first removing all spectra whose lines of sight intersect the cloud volume, then computing the retrieval averaging kernels and identifying the grid points for which the diagonal elements of the averaging kernel fall below a specified threshold.

Based on this analysis, a set of lookup-table masks was derived for different cloud-top altitudes and applied in the a posteriori filtering of L2 products. A conservative assumption of vertically extended (column) clouds was adopted instead of clouds with limited vertical thickness. This approach allows the effect of clouds spanning multiple horizontal grid cells to be represented as the cumulative contribution of individual retrieval grid points.

P9 L247: If a cloud is assumed to have finite vertical extent below the cloud top, it is not obvious why 50km extent along the line-of-sight prevents any retrieval beneath cloudy regions. If the cloud were high enough (eg PSCs or high-level cirrus) you would presumably still be retrieving along the line-of-sight through the cloud-free paths below it?

This is correct: limb observations are, in principle, capable of sensing atmospheric layers below a cloud, provided that the cloud's bottom height is above the lowest tangent altitude of the limb measurements.

However, our objective was to adopt an approach that allows us to parameterize the impact of clouds on L2 profile a posteriori, with the cloud top height available at each point of the L2 grid. In particular, the method needs to account for clouds extending over multiple horizontal grid cells, enabling their effect to be represented as the cumulative contribution from several retrieval grid points.

To achieve this, we adopted a conservative assumption of vertical columnar clouds, with their vertical extent defined by the cloud top height derived from the CAMS cloud fraction. This approach provides a consistent and computationally practical framework to quantify the cloud contribution within the tomographic retrieval scheme.

The description of how the cloud impact has been taken into account has been modified as follows:

"The influence of clouds on the simulation of L2 profiles was also taken into account. Clouds can affect spectra and introduce artefacts that can significantly degrade the quality of the L2 products. Therefore, in infrared retrievals, spectra strongly affected by optically thick clouds are typically excluded prior to retrieval in order to avoid instabilities and errors in the retrieval of trace-gas concentrations.

CAIRT adopts a two-dimensional (2D, vertical x ALT) tomographic retrieval approach. On the one hand, this allows information at a given location to be retrieved from multiple viewing directions. On the other hand, lines of sight with tangent points outside the cloud location may still intersect the cloud along their propagation path and therefore be affected by it.

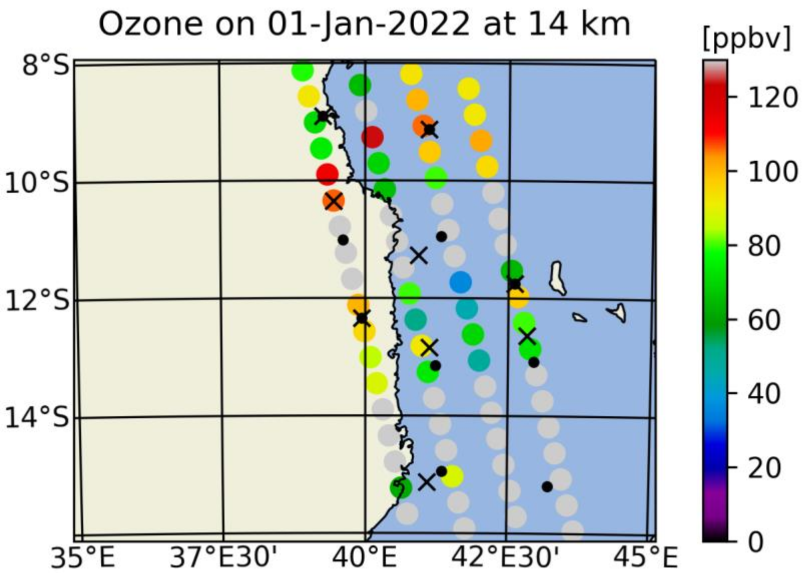
The impact of thick clouds on the number of valid retrieval points has been studied by conducting 2D simulations of retrieval with a cloud in the line of sight. The cloud extends vertically from its top altitude to 5 km, and horizontally along the satellite track for 50 km, which corresponds to the along-track retrieval grid spacing. The procedure consisted of first removing all spectra whose lines of sight intersect the cloud volume, then computing the retrieval averaging kernels and identifying the grid points for which the diagonal elements of the averaging kernel fall below a specified threshold. This was repeated for clouds with different cloud-top heights.

Based on this analysis, a set of lookup-table masks was derived for different cloud-top altitudes and applied in the a posteriori filtering of L2 products. A scene is classified as cloudy when the cloud fraction from the CAMS dataset, interpolated at the corresponding L2 geolocation, exceeds 0.2. The

L2 simulated profiles are thus filtered a posteriori using the masks derived from the cloud-impact analysis described above. This will be described in more detail in Funke et al. (in prep.)."

Fig 2: It looks like this box spans the coast of East Africa. It would have been nice to add some geographical features and maybe a length scale to give a better impression of the spatial sampling of CAIRT.

Figure 2 has been reprocessed, adding the continents and oceans, see below. Because of the scale of the figure, only people familiar with the geography of the east coast of Africa will be able to identify it. On the author's side, we believe this to add too much information to the figure and we have kept the original figures in the updated manuscript. We also recall that Fig. 3 provides an illustration of the spatial sampling of CAIRT, compared to MLS and MIPAS.



P10 L254: With the reference to interferograms here I am now uncertain whether the assimilation is of CAIRT L2 profiles, L1C spectra, or L1A interferograms?

"Interferograms" replaced by "acquisition".

P10 Eqs 2 & 3: This is confusing. You're using bold font for y, as in Eq 1, suggesting each y_i is a profile. Yet discussion of excluding cloud contaminated values suggests this averaging is performed level-by-level, ie y_i are the set of profile values at a single altitude. If it is level-by-level does all the off-diagonal information in the the L2 random error covariance get ignored in the superobbing?

The definition of superobservations has been revised, including an update of the equations.

P11 L276: Missing Section reference ("??").

This should read "Sect. 4.2", now corrected.

P11 L292: It is stated that the CAIRT data for the tropics is representative of other latitudes. But cloud heights and frequency in the tropics are probably higher than other latitudes, and tropopause temperatures lower, so this seems pessimistic rather than representative.

Indeed. The sentence “... the displayed values correspond to January in the tropics and are representative of other months and latitudes” has been replaced by “... the displayed values correspond to January. This provides a conservative view of the CAIRT performances compared to other latitudes (not shown).”

P12 L296: I don't know how valid it is to compare systematic errors without a consistent definition of systematic errors for the two instruments.

Indeed. The sentence “The systematic error profile of MLS is generally larger than that of CAIRT but remains much lower than the random error for both instruments and species (Fig. 6b).” has been removed.

P12 L303: Isn't Fig 6 the H_2O equivalent of Fig 5? (rather than Fig S3)

Indeed, however, the text “(a similar figure for H_2O is provided in Fig.~S3)” has been removed.

Figs 5 and 6: Given the superficial similarity between CAMS and the two instruments, it would have been informative to add a 3rd column showing the differences Instrument-CAIRT.

A panel showing the difference between CAMS and the two instruments has been included in the revised manuscript.

P14 L327: I was not aware that systematic errors could be included in data assimilation, except as a fudge by simply inflating the random error. Can you explain a bit more how this was achieved?

The sentence “Since the simulated MLS profiles do not include any systematic error, an additional assimilation run was performed using CAIRT superobservations excluding the contribution of systematic error (ARCnosys).” does not say that systematic error was included in data assimilation. It says that a DA experiment was done using a set of CAIRT superobservations without taking into account the systematic error in the simulation of L2 profiles. This should be clearer in the revised manuscript.

P16 Section 8: Which of the four CAIRT assimilation runs listed in Table 2 was being used for the results shown in this section? From the text on P18 L354-360 I would guess AR_CAIRT.

This is now clarified using the labels AR_MLS and AR_CAIRT in Figure 7 and in the first § of section 8.

P16 Section 8: It would be useful, at the start of this section, to have the equations which define the NMB, NSD and correl.coefficient. For example, I can think of two different ways of normalising the SD, based on instrument random error or atmospheric variability.

The NMB and NSD are normalized by the mean of the nature run for the considered period. This is clarified as follows (new text in **bold**): “The statistics displayed are the normalized mean bias (NMB)

between NR and {CR,AR}, the *associated* normalized standard deviation (NSD), and the correlation coefficient **between NR and {CR,AR}. NMB and NSD use the mean values of NR for normalization.**"

The caption of Fig. 8 has also been updated, replaced by: "(left column) Zonal mean of the mean bias (NR-\{CR,AR\}) normalized by the mean of NR (NMB, in %) for ozone and the period October 2021 – February 2022. Each line corresponds to a different BASCOE experiment labelled at the right. (Middle column) The zonal mean of the associated normalized standard deviation (NSD, in %) of the differences shown in the left column. (Right column) The correlation between the nature run and the BASCOE runs."

Typography:

Note the distinction (available in LaTeX) between -, --, and --- for different sorts of punctuation, as well as $-$ for a minus sign. Here they seem to have been used interchangably and randomly.

Corrected.

Also: undesirable paragraph indentation immediately following equations (1) and (4). In LaTeX this can be avoided by not leaving blank line after the equation.

Corrected.

Referee #2

This paper demonstrates the capability of the recently proposed satellite instrument CAIRT to measure atmospheric trace gases at unprecedented scales. Although the instrument was designed for ESA's Earth Explorer 11 programme and was ultimately not selected, its concept remains highly relevant for future missions and international collaborations. The core component of CAIRT is an imaging Fourier Transform Spectrometer that provides a two-dimensional tomographic view of atmospheric limb emissions. The maturity of this concept builds on the success of the MIPAS mission, which performed limb scanning along a single line-of-sight, as well as on the heritage of GLORIA, which has flown on balloon and aircraft platforms. In addition, CAIRT measurements are co-registered with those from the MetOp second-generation nadir-viewing instruments, such as IASI-NG, enabling them to observe the same air mass from complementary viewing geometries. The sampling density of CAIRT is approximately an order of magnitude higher than that of MLS and MIPAS. Owing to its fine horizontal resolution and high data density, CAIRT would represent a step change relative to existing limb-sounding instruments. It is particularly well suited for investigating fine-scale atmospheric structures, such as stratosphere-troposphere exchange in the UTLS region, thereby addressing a key observational need of the atmospheric research community.

To simulate and evaluate the CAIRT observations, the authors designed a processing chain comprising nature runs, control runs, and assimilation runs. State-of-the-art models were employed together with realistic instrument parameters, and the results were evaluated through comparison with MLS data. The methodology is well structured, logically organized, and clearly presented. The examples are representative, and the results are convincing, meeting the stated objectives.

Despite the extensive scope of the study, the manuscript is concise, follows a logical progression, and is easy to understand. I therefore recommend the manuscript for publication.

We would like to thank referee#2 for his review. Below are our responses to its request for minor corrections.

Minor corrections:

Line 18: Typo. "The results show that CAIRT (1) …" should be "The results show that (1) CAIRT …".

Corrected.

Line 19: Typo. "than MLS –" should be "than MLS; " .

Corrected.

Line 76: Typo. "reveiw" should be "review".

Corrected.

Line 276: Typo. "see Sect. ??" should be "see Sect. 4.2".

Corrected.

Line 280: Typo. “into account The …“ should be “into account. The …”.

Corrected.

Table 2 (between Lines 333 and 334): “BASCOE-CTM” may include the full expression “BASCOE-CTM (Chemistry Transport Model”. Similarly, “BASCOE-EnKF” may include the full expression “BASCOE-EnKF (Ensemble Kalman Filter)”.

These information are now provided in Sect. 7 (new text in bold): “The first is a control run (CR) using **the BASCOE Chemistry Transport Model (CTM)** without data assimilation. **The five other experiments are all assimilation runs using the BASCOE Ensemble Kalman Filter (ENKF)..**.”

Line 375: The acronym “NWP” appears here for the first time; the full expression “Numerical Weather Forecast (NWP)” should be provided.

NWP was defined at line 44.

Line 400: Use only the acronym “NWP”, as it has already been defined earlier.

Corrected.

Line 456: “Walker, and K.:” should be “Walker, K.:”.

Corrected.

Line 537: Typo. “reveiw” should be “review”.

Corrected.