Here below are our responses to referee #2. The referee's comments are in black while our responses are in blue.

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.