Anonymous Referee #2

"Here the difference metrics for $\beta = 0$ and optimal β cannot be directly compared, because they are evaluated over different statistical ensembles."
This makes the interpretation of the results presented in Figures 3-11 extremely difficult. The penetration depth alone does not seem to be a strong argument, particularly when $\beta = 0$ often provides more data above 1 km. It would be more useful to show the subset of refractivity values common to all retrievals.

Following the suggestion of the Reviewer we performed some further study and found another important property of CT2A, as discussed below.

In addition, the text says that the method mitigates systematic errors, but the metric shown in these figures combines systematic and random errors. I suggest that the systematic and random error estimates should be plotted separately. These points and the specific comments given below should be addressed before publication.

The statement about the mitigation of the bias was made in a preliminary study, which was based on a much smaller volume of data. After the full study, we made a conclusion that it is the mean square difference between the RO and ECMWF refractivities that can be minimized by using the modified algorithm. Therefore, based on this additional finding, we refined the formulation in the abstract.

Line 225: "don't" should be "do not".

OK.

Line 293: "The angular component of the momentum pd coincides with the ray impact parameter p, which is invariant in a spherically layered medium, but is perturbed by the horizontal gradients (Gorbunov and Lauritsen, 2009)". Healy (2001) also pointed this out.

Healy (2001) refers to the technical report (Gorbunov, 1996), where the derivation of the impact parameter variation using the Hamiltonian form of ray trajectory equation was first presented.

Line 299: [Gorbunov2019] not listed in references. Format of reference in text.
The references appear to change format e.g., line 306 "[Zou2019]" and line 310 "[Gorbunov2009a, Zou2019]". These should be (Zou et al., 2019) and (Gorbunov and Lauritsen, 2009).

We corrected the references (cf. the similar remarks of Reviewer #1). That was related to technical corrections regarding the LATEX.

Line 364: "co-located ECMWF refractivity profiles". It would be useful to give more detail here. For example, does this computation include the tangent point drift? Do you compute the refractivity directly from the ECMWF P, T and Q fields? Are they ECMWF forecasts or analyses? What resolution?

We used ECMWF analyses at 1-degree latitudinal and 1-degree longitudinal resolution, with 91 vertical level covering the altitude range up to about 80 km. The refractivity was evaluated from pressure, temperature, and humidity fields. The tangent point drift was taken into account. We checked that this is also noted in the manuscript so that it is clear to the readers.

Line 366: It would be useful to split this metric into to systematic and random errors instead of combining them, particularly if the transform is likely to improve systematic errors, as noted in the abstract.

We preferred to correct the statement about the systematic errors.

Line 373: "The CT2A algorithm also improves the penetration increasing the number of data in the altitude range below 0.5 km."
This is correct, but $\beta = 0$ appears to provide more data above 1 km. Why is this? Are you using the transformed amplitude to cut-off the data? Please explain.

This is linked to the QC procedure and still needs further investigation that will be performed beyond the scope of this initial introduction study of the CT2A.

Line 374: "Here the difference metrics for $\beta = 0$ and optimal β cannot be directly compared, because they are evaluated over different statistical ensembles.".
This really makes it difficult for the reader to judge whether the new transform is an advantage or not in all the subsequent figures. Is it possible to present the results for a dataset common to all β values to help the reader interpret the results?

As noted above, we evaluated the statistics for the common dataset and found another important property of CT2A. The statistical differences between refractivity retrieved with $\beta = 0$ and other values of β is vanishingly small (never exceeding a level of 0.0005%), but increasing β provide decreasing deviation from ECMWF and decreasing number of data. This indicates that CT2A allows the implementation of a QC procedure not involving any external data and only based on the internal

properties of observed signals. This can be interpreted as follows. By extracting inversions that are common for different values of β we look at the ray manifold in the phase space from different directions and only choose events, where the ray manifold structure is stable. We modified the abstract and the respective parts of the text accordingly.