Response to the Editor

Overall comments to the editor

The authors would like to express their gratitude for all the comments about the manuscript. Below you will find a detailed answer to all comments made by the **first revisor** and how they were addressed in the text. We reproduce the **first revisor's comments** and add our responses in *red italicized font*. In addition to those points, the authors would like to highlight that the changes throughout the text are in the uploaded marked-up version of the manuscript.

Answers to the FIRST REVISOR's comments:

1) Equation 10: As shown in Equation 10, the calculation of IRF is highly dependent on cloud properties. What are the cloud properties during the reference days in terms of cloud liquid water path (LWP), cloud top and base heights, and cloud droplet number concentrations? According to Twomey effect theory, IRF should be estimated under conditions of constant LWP. How does LWP for low-level clouds vary over the course of the GoAmazon field campaign? Furthermore, how can constant cloud LWP be ensured when estimating IRF?

R: *The parameterization of clouds simulated in LibRadtran was performed after filtering LWC_ground and CTH ([0.2; 0.4] g/m³ and an upper limit of 3 km, respectively), considering only daytime data (06:00 to 18:00, Amazon local time). Based on this filtering, statistics for CBH, CTH, and LWP were obtained for the two clean-atmosphere references (Figures 1, 2, and 3 below); however, this was not possible for N_d due to the absence of its measurements in 2015. Although Figures 1, 2, and 3 show relatively higher clouds with greater LWP for the second clean-atmosphere reference, the LWC_ground statistics presented in Table 1 below demonstrate that the LWC_ground distributions for these low-level liquid clouds varied within a relatively narrow range across each GoAmazon2014/5 scenario. Furthermore, an evaluation of the medians for each scenario reveals that LWC_ground remained relatively constant throughout the campaign (with all medians falling between 0.27 and 0.28 g/m³), ensuring that the IRFaci estimates are attributable to the Twomey effect. An observation regarding the relative constancy of the LWC_ground median in the [0.2; 0.4] g/m³ interval has been added to the first paragraph of Section 4 in the revised version of the manuscript.*

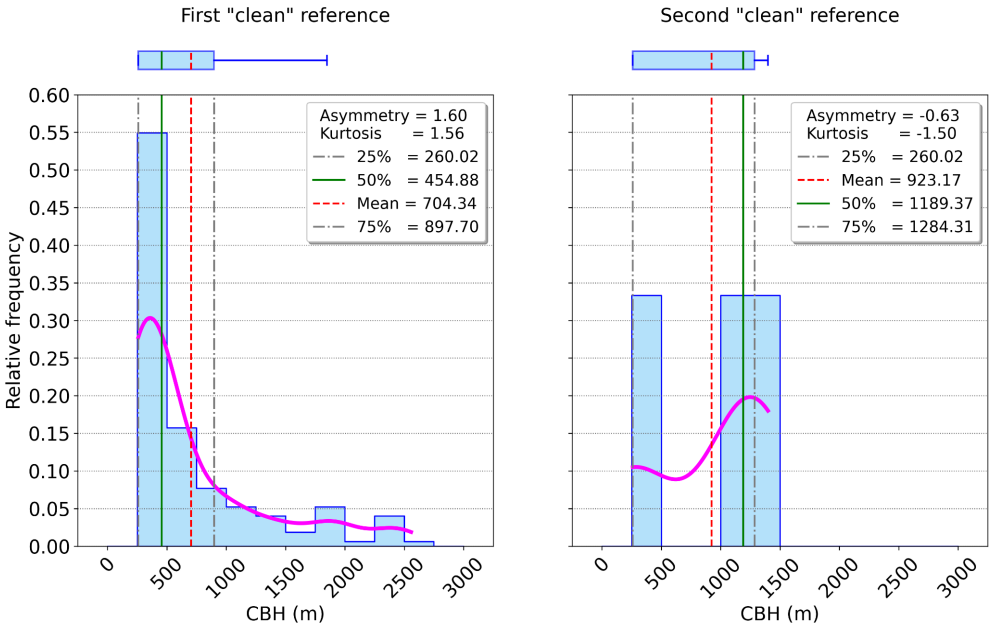

Figure 1: Histograms, PDFs, and statistics of CBH for the two clean references used.

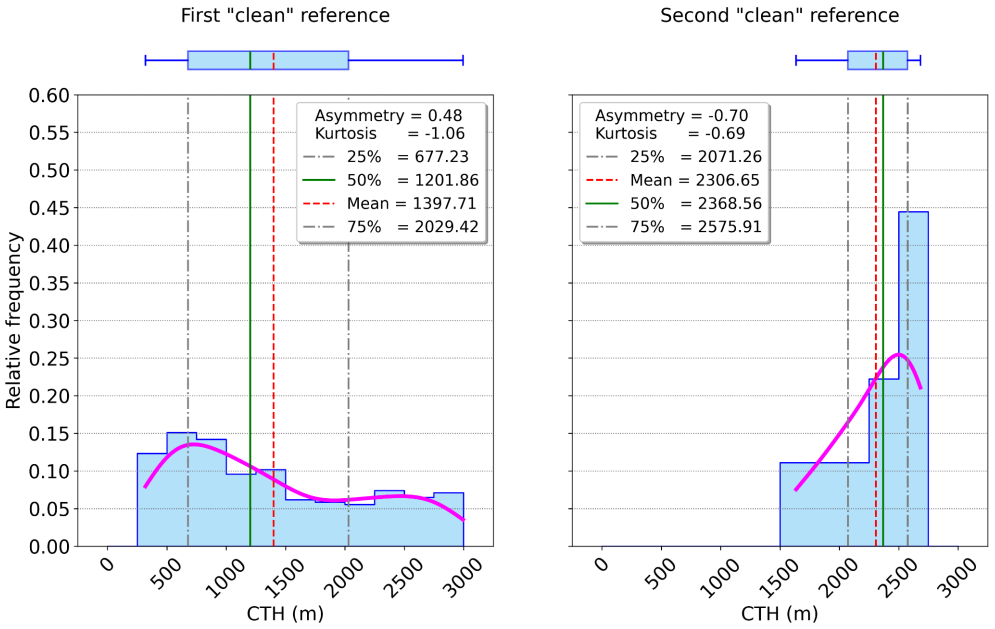

Figure 2: Histograms, PDFs, and statistics of CTH for the two clean references used.

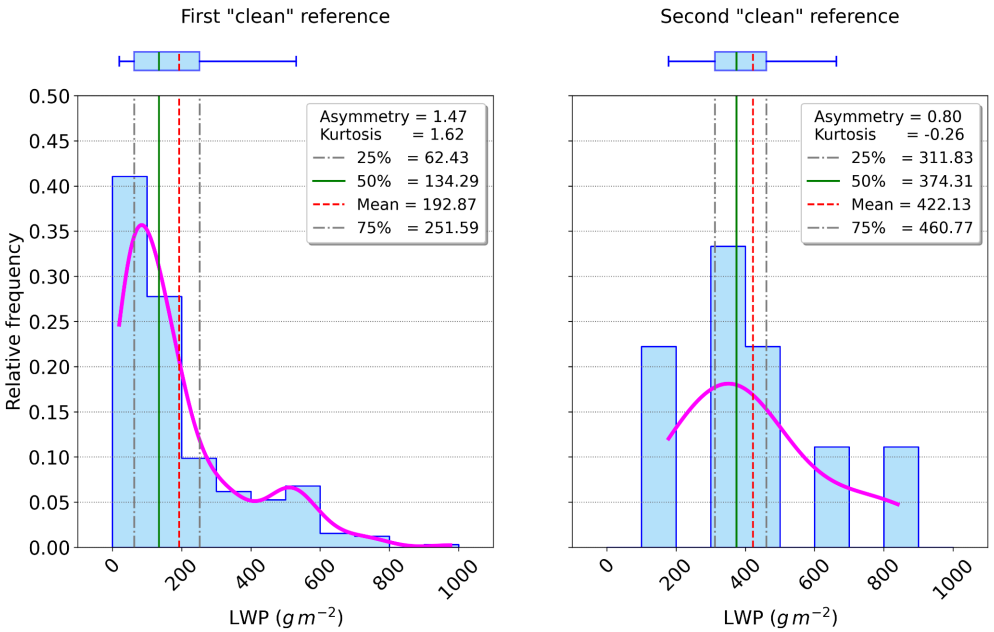

Figure 3: Histograms, PDFs, and statistics of LWP for the two clean references used.

Table 1: Percentiles and means of LWC_ground (g/m³) during 2014 and 2015 seasons.

Season	25th	50th	Mean	75th
2014 - Clean	0.232	0.28	0.285	0.333
2014 - Transition 1	0.232	0.273	0.282	0.327
2014 - Polluted	0.236	0.279	0.285	0.33
2014 - Transition 2	0.233	0.282	0.284	0.326
2014 - Transition 3	0.233	0.274	0.283	0.33
2015 - Clean	0.233	0.273	0.282	0.327
2015 - Transition	0.23	0.27	0.28	0.326
2015 - Polluted	0.233	0.274	0.283	0.326

2) Line 200-203 and Figure 3: The motivation for deriving the LWC–r_eff relationship is unclear. The libRadtran radiative transfer model uses cloud properties as inputs to calculate top-ofatmosphere (TOA) irradiance. Lines 200–203 list LWC values, water density, r, N(D), and r_eff—are all of these required as inputs to the radiative transfer model? Additionally, why is the LWC–r_eff relationship used given that the Twomey effect assumes constant LWP? From Equation (4), the LWC–r_eff relationship is essentially determined by N(D). Therefore, fitting the LWC–r_eff data implies the use of a constant 'mean' N(D) for all days (i.e., one value per fitting line). As a result, the derived 'IRF' primarily reflects differences in cloud liquid water content between reference clean days and perturbed days under a constant 'mean' N(D) condition, rather than the IRF arising from the Twomey effect. Why not instead use the N_d– r_eff or AOD–r_eff relationship, which would be more consistent with the Twomey effect framework?

R: *a) The motivation for deriving the LWC–r_eff relationships - We thank the reviewer for this comment, as it made us realize that the text in Section 2.5 required greater clarity. Accordingly, we highlight that the libRadtran code accepts only LWC and r_eff values as input for cloud simulations, excluding water density, r, and N(D). We also emphasize that the modeling relied on statistics derived from measured LWC and r_eff values, rather than values calculated using Equations 4 and 6a. Given that in situ measurements of LWC and N(D) were conducted only during the IOPs—thereby significantly limiting data availability—LWC–r_eff relationships were necessary to extend data coverage to the entire GoAmazon campaign. This discussion was included in the first paragraph of section 2.5, which was totally rewritten. b) The Problem of Fixed N(D) - As noted in Section 2.5 of the revised version, the LWC values used to generate the curves shown in Figure 3 were not calculated using Equation 4 but correspond to values measured in situ during G-1 aircraft flights. Consequently, the fits shown in Figure 3 do not imply a constant N(D). An analysis of the different flights used revealed that low-level liquid clouds with different characteristics were traversed, but formed in scenarios characteristic of aerosol availability, confirming that a constant N(D) was not considered. Furthermore, the fact that N(D) is not constant can also be seen in Figure 15 of the manuscript. This figure shows that, for a given fixed bin of LWC, the N(D) and r_eff values vary differently between the IOPs, confirming that the microphysical mechanism of the Twomey effect occurs. This discussion is in Section 4 of the manuscript. c) The use of the N_d– r_eff or AOD–r_eff relationships - The approach of using relationships between N_d and r_eff or between AOD and r_eff could not be implemented due to the limited availability of N_d and r_eff datasets, which were collected only during the IOPs. Had the N_d–r_eff relationship been used, it would not have been possible to extend the analyses beyond the IOP periods, given the lack of ground-based measurements for either variable—unlike LWP, CTH, and CBH, variables that allow for the calculation of LWC_ground. Regarding the relationships involving AOD, although data were available for nearly the entire GoAmazon period, their influence on low-level liquid clouds was assessed by stratifying the analyses and results according to the clean, transitional, and polluted seasons across 2014 and 2015.*

3) Line 225-229: The previous in situ aircraft measurements were conducted between August and September 1995, under conditions influenced by smoke and biomass-burning aerosols, whereas GoAmazon IOP1 took place from February 1 to March 31 under relatively clean conditions. Given these contrasting aerosol environments, why does the r_eff–LWC distribution from the previous in situ aircraft measurements more closely resemble that observed during GoAmazon IOP1 rather than IOP2?

R: *We thank the reviewer, as this comment once again drew our attention to inaccuracies in the text throughout Section 2.5. Although Reid et al. (1999) considered measurements taken during the most polluted period in the Amazon, the function those authors used to fit their data could also be used to fit the medians relative to both IOPs, and not just for IOP 1. The information that the hyperbolic arc cosine function proved to be the most suitable for fitting the median pairs of IOP 2 too has been added to the third and fourth paragraphs of Section 2.5. Furthermore, those paragraphs have been completely rewritten in order to add various details regarding the procedure used to derive the points, curves, and equations presented in Figure 3 of the manuscript. All changes can be viewed in the marked-up version.*

4) Line 230: Why was r_eff calculated using LWC/N_d for IOP2? Why not apply a consistent calculation method for both IOP1 and IOP2? Additionally, were cumulus and stratocumulus clouds distinguished in this study? If not, which equation—Equation 7 or Equation 8—was used for the r_eff calculation?

R: *A consistent calculation method was applied for both IOP1 and IOP2, although the results obtained throughout its use led to some adjustments for IOP2. As described in the last four paragraphs of Section 2.5 of the revised version, this method basically consisted of: 1) using measured values of N(D) to calculate r_eff from equation 6b; 2) making scatter plots (calculated r_eff versus measured LWC) and attempting to fit a known curve; 3) if fitting was not possible, calculating the medians for each of the LWC bins and attempting to fit again. This procedure was applied equally for both IOP. The adaptation for IOP 2 occurred given that, for both scatter plots (r_eff vs. LWC and the median pairs of these variables) any easily identifiable pattern was shown. This led to the use of the LWC/N_d ratios, as well as equations 7 and 8 instead of equation 6b, not distinguishing between cumulus and stratocumulus clouds. All these details and explanations were included in the Section 2.5 of the revised version of the manuscript.*

Comments to the editor

Below you will find a detailed answer to all comments made by the **second revisor** and how they were addressed in the text. We reproduce the **second revisor's comments** and add our responses in *red italicized font*.

Answers to the SECOND REVISOR's comments:

1) The manuscript should continue using cautious wording wherever site-specific results near T3 are discussed in broader Amazonian terms.

R: *We thank the reviewer for this point. After a careful re-reading of the manuscript, we maintained using cautious wording wherever site-specific results near T3 are discussed in broader Amazonian terms. Moreover, we have emphasized that the results obtained refer to a specific region of the central Amazon. These occur in the Abstract and in the Section 5 of the revised version.*

2) The aerosol-sensitivity conclusion should remain clearly conditional, since the revised statistical support appears robust only for 2014.

R: *As pointed by the revisor, the aerosol-sensitivity conclusion remains clearly conditional to the 2014 sensitivity tests. The parts related to this point (the last paragraph of the Section 3.3 and the 5th paragraph of the conclusions section, for example) were not changed in the revised version of the manuscript.*

3) The link for accessing the HALO data set (https://halo-db.pa.op.dlr.de/mission/5) as stated in the data availability section did not function as expected. Please double-check and update if necessary.

R: *We performed a double-check, and despite an unusually long wait, the link https://halo-db.pa.op.dlr.de/mission/5 worked. Should it fails, we note that all data can also be accessed via https://zenodo.org/records/20610494, which contains the folders "Aviao_HALO" and "Aviao_G1" (within "00-Dados"), corresponding to data collected by instruments onboard HALO and G-1 aircraft, respectively. The link https://zenodo.org/records/20610494 is already included in the data availability section of the revised manuscript.*

4) A final language and style pass would still be beneficial, as some awkward phrasing remains in the revised text. Here are some examples: Figure 3 caption: “The adjustments (hyperbolic arc cosine function) originated the equations shown in the graph’s legend.” — “originated the equations” is unusual phrasing. L433: “when compared to the most polluted days of 2014 (August and September), the second reference can still be considered relatively clean.” — “can still be considered relatively clean” is understandable but slightly colloquial; “remains relatively clean” is tighter. L327: “seasonal contamination due to dynamics on macrophysical characteristics of clouds” — “contamination due to dynamics” is odd; please revise accordingly. L465: “the second clean-atmosphere reference yielded IRFaci values closer in order of magnitude to the estimate…” — “closer in order of magnitude” is redundant; “closer in magnitude” would suffice.

R: *We thank the reviewer for this point. After a careful re-reading of the manuscript, we improved the text style of all the examples given. Other writing improvements were made throughout the text, like in the first and in second paragraphs of Section 2.6. All changes can be seen in the marked-up version.*