Brazilian Atmospheric Inventories - BRAIN: A comprehensive database of air quality in Brazil

MS No.: essd-2023-305

Dear editor,

We greatly appreciate the reviewer comments and suggestions, which are very constructive and have contributed to enhance the content of the revised manuscript. Please find below the reply to all the reviewer comments.

Best regards

Leonardo Hoinaski and coauthors

Reply to comments of reviewer:

Comment #1: The authors showed that BRAIN estimates are consistent with concentrations in background areas of CO (up to ~ 350 ppb), O3 (up to ~ 0.04 ppm) and NO2 (up to ~ 2.5 µg.m-3). I recommend the authors to mention in the paper the background values for O3 and CO known in the literature for the background regions such as ATTO site. The same approach needs to be followed for T1 site (Manaus city).

According with literature, O3 values to Atto site during wet season (March- April. 2013-2020) are around 7 ppbv ± 2 ppbv [Reference 01] and for TT34 (T0z site) O3 values were 8.5 ± 1.9 ppbv [Reference 02].

For background areas of CO in the Amazon region, especially during the GoAmazon experiment, I recommend the authors the see References [1, 3, 4, 5, 6 and 7]. Previous plume urban index with CO were already discussed for that region.

CO (up to ~ 350 ppbv), O3 (up to ~ 0.04 ppm) are not related with background values for ATTO site, unless a long-range transport event was influencing the site.

According with analysis t1 site, I recommend the authors to discuss about the observation values from CO and NOx previous showed in [Reference 08] and the values from Sentinel-5P TROPOMI and BRAIN data. It is important to point out some spatial-temporal differences when comparing three different kinds of data (model, satellite and ground station).

Reply: Thanks for the recommendation. We have mentioned the background values for O_3 and CO at the T0a and TT34 sites. We also added previous evidence about the CO values in the background region:

"BRAIN estimates are slightly higher than observed concentrations in background areas of CO, O_3, and NO_2 in TT34 (Figure 12) and T0a (Figure 11). While O_3 concentrations simulated by BRAIN range around 18 ppb (average in 2019) at the TT34 site, observed concentrations in 2013 (Artaxo et al., 2013) were around 8.5 ppb ± 1.9 ppb. In T0a, BRAIN simulated concentrations

around 16 ppb, overestimating the observations (7 ppb ± 2 ppb during the wet season from March to April 2013-2020) (Nascimento et al., 2022). Concerning CO, the concentrations simulated by BRAIN are slightly lower, ranging around 73 ppb (average) at TT34 against 130 ppb observed during the GoAmazon experiment from 2010 to 2011 (Artaxo et al., 2013). We emphasize that the BRAIN and GoAmazon datasets are reported in different periods and, consequently, influenced by different emissions rates. For instance, fire emissions have changed significantly since 2011 in Amazon (Copernicus, 2022; Naus et al., 2022).”

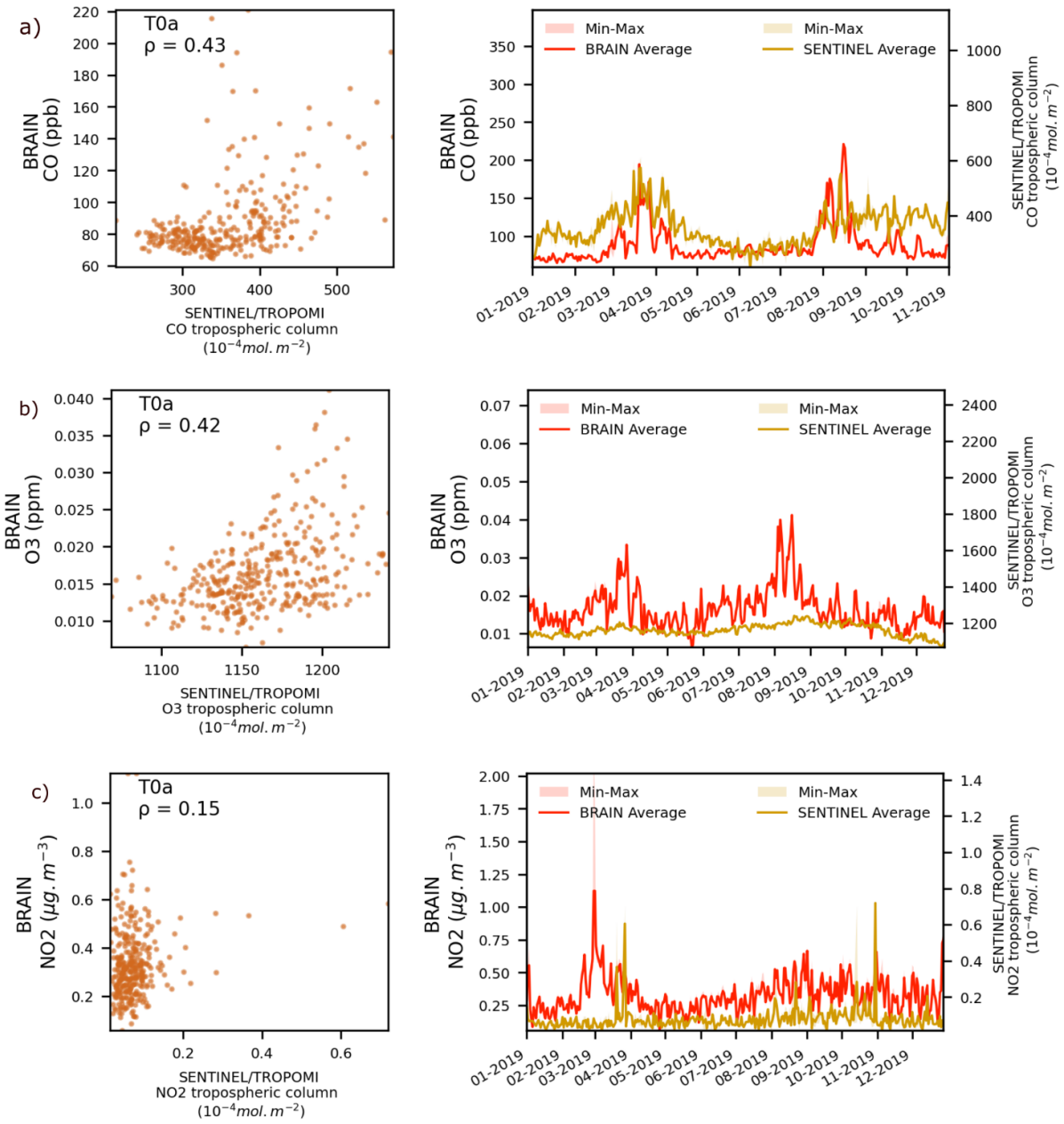

Figure 11. Scatterplot and daily time series of CO (a), O_3 (b), and NO_2 (c) from BRAIN and Sentinel-5P TROPOMI at T0a (GoAmazon reference). Values extracted using a buffer of 0.2° around the site.

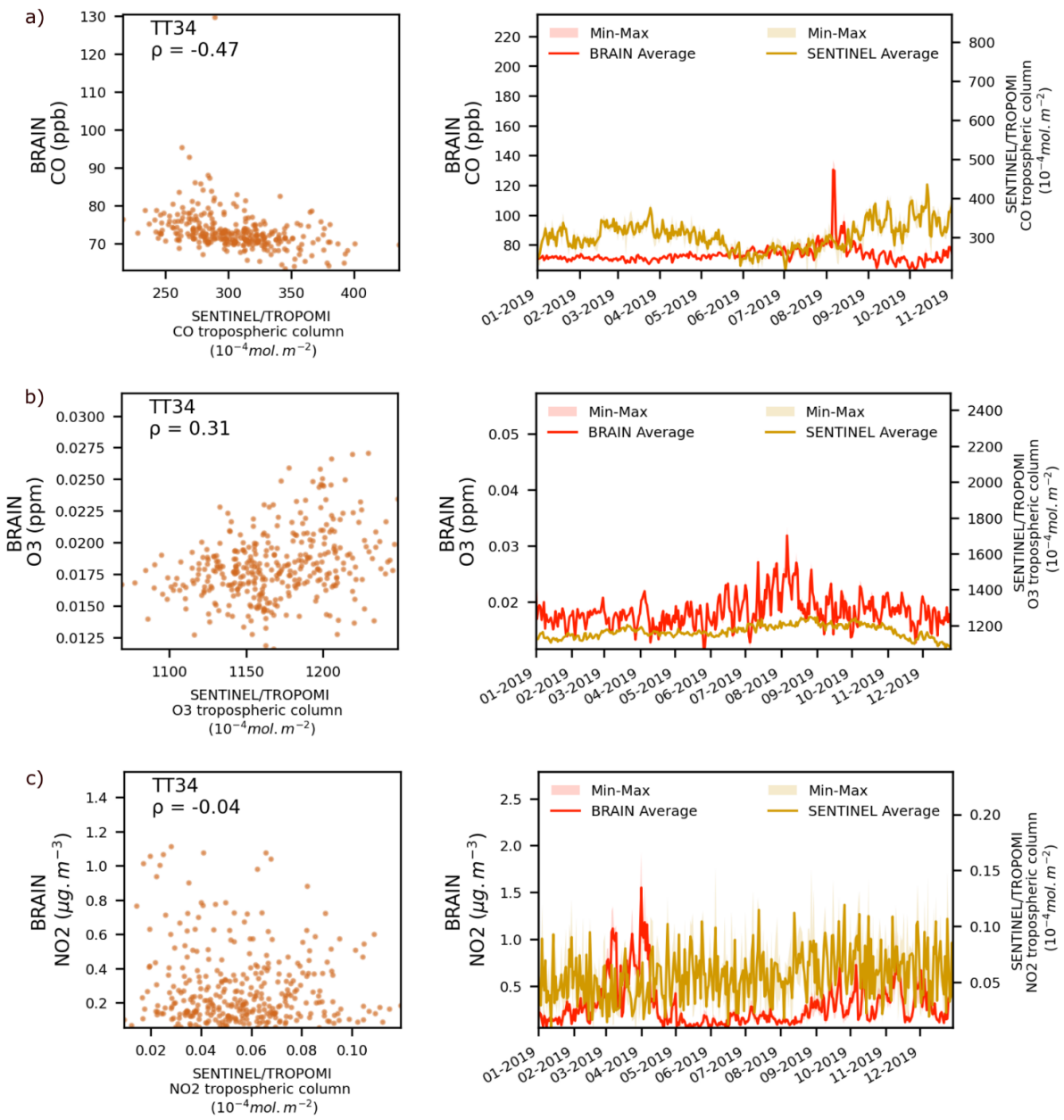

Figure 12. Scatterplot and daily time series of CO, O_3, and NO_2 from BRAIN and Sentinel-5P TROPOMI at T0t/TT34 (GoAmazon reference). Values extracted using a buffer of 0.2° around the site.

In addition, we have added new sentences in the revised manuscript to discuss the differences between observations and BRAIN simulations at the T1 site:

"Rafee et al., (2017) reported mean concentrations of 88.7 ppb of NOx and 382.6 pbb of

CO in the Manaus urban area, while BRAIN reached 79 ppb and 99 ppb (maximum of 383 ppb), revealing an underestimation in this area. Again, the sampling campaign presented by Rafee et al. (2017) and BRAIN simulations uses different base year. Comparing BRAIN at T0a/TT34 (background sites) and T1 (urbanized), the database has reached consistent results with lower concentration levels in preserved areas."

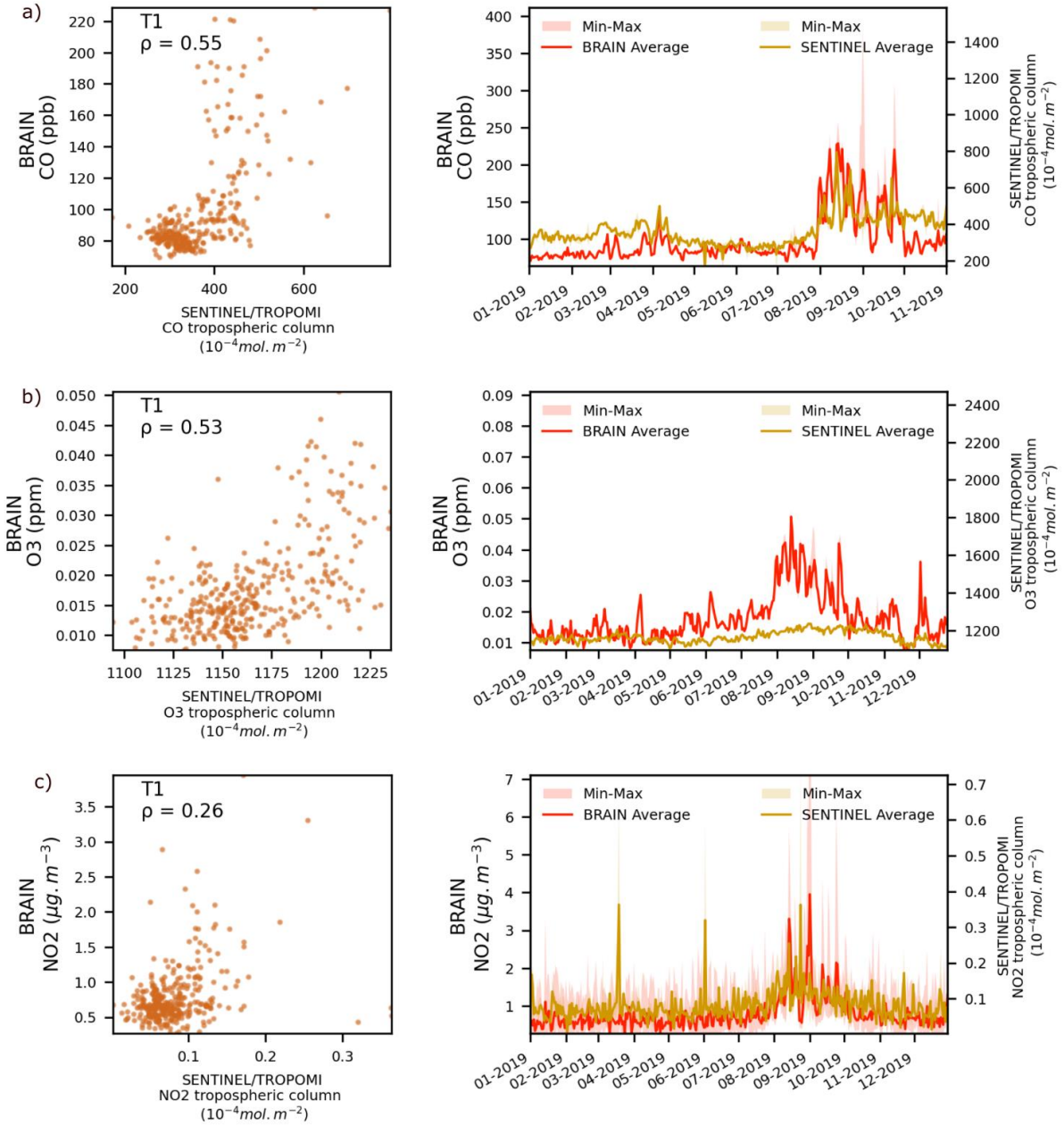

Figure 13. Scatterplot and daily time series of CO (a), O_3 (b), and NO_2 (c) from BRAIN and Sentinel-5P TROPOMI at T1 (GoAmazon reference). Values extracted using a buffer of 0.2° around the site.

References

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Comment #2: In Figure 11 and others, the units of the BRAIN result and Sentinel-5P TROPOMI should be the same to facilitate comparison between the data sets. If you cannot convert the Sentinel/TROPOMI data into PPB, integrate the BRAIN column and convert it to mol m^-2. Also, in these figures there is a hidden offset that is not mentioned, eg in figure 11 a on the right, the bottom of both y axes are not zero. This further increases the difficulty of comparing the datasets.

Reply: Unfortunately, we provide only surface concentrations in BRAIN, therefore, we cannot integrate it vertically. Our choice was to provide multiple species rather than layers. Files with multiple species and vertical layers are too large to store in long-term repositories. Also, keeping these files along modeling would require a super large storage capacity. The comparison of BRAIN

and SENTINEL/TROPOMI shows the similarities between the variables' variances.

Cloud coverage influences Sentinel measurements, reproducing negative values in the time series. Our previous idea was to compare the raw versions of the datasets. We agree that removing these low-quality values in the SENTINEL/TROPOMI products could reproduce a more consistent analysis. We revised all figures derived from SENTINEL/TROPOMI data, removing values smaller than 0.

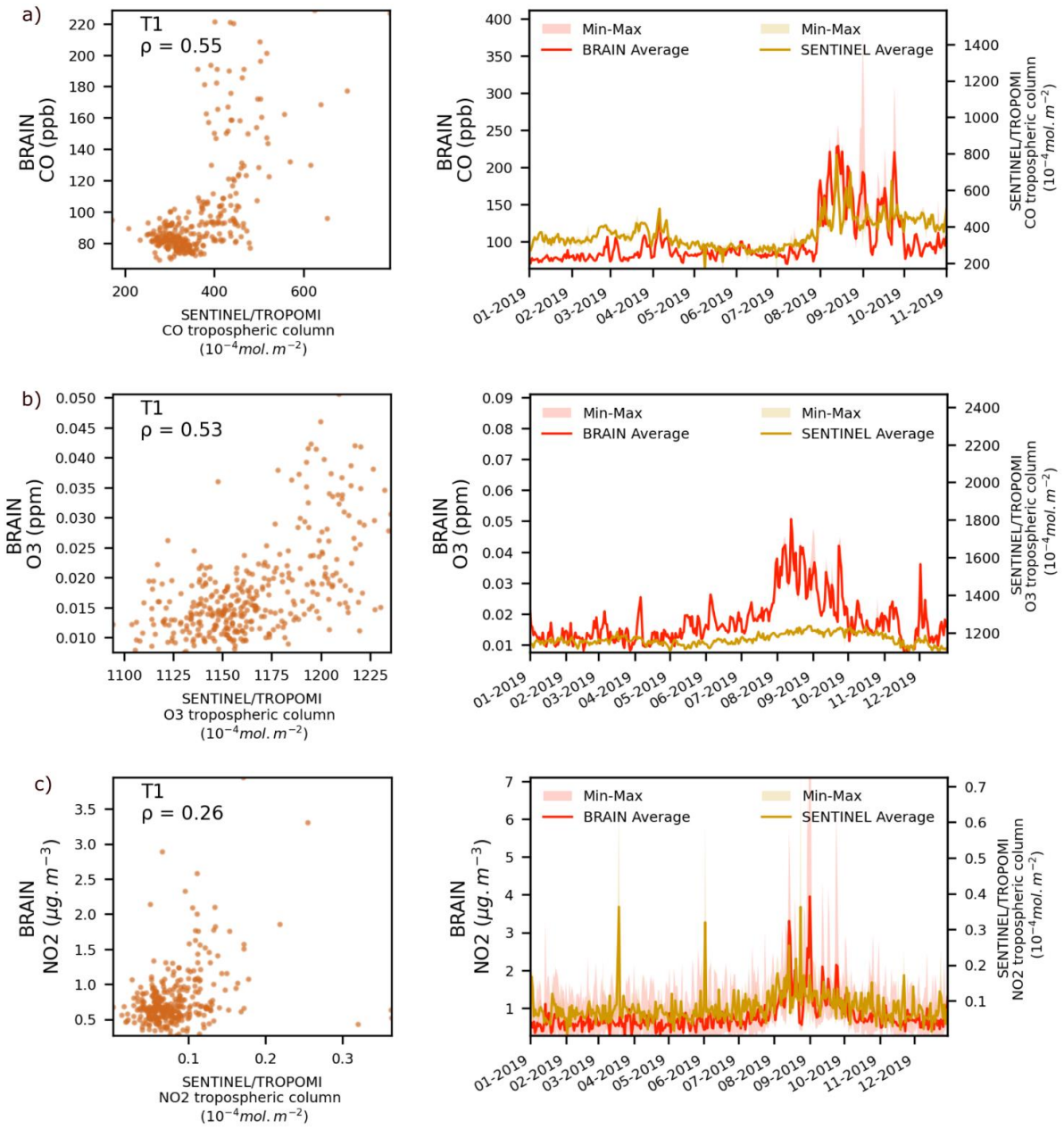

Figure 13. Scatterplot and daily time series of CO (a), O_3 (b), and NO_2 (c) from BRAIN and Sentinel-5P TROPOMI at T1

(GoAmazon reference). Values extracted using a buffer of 0.2° around the site.