RC1

We thank the reviewer for his/her positive appreciation of our manuscript. Below, we detailed our answers to his/her specific comments and technical corrections and describe how they have been accounted for.

Specific comments :

1. **L21 : What is the basis for an overestimation in emissions of 35%? This figure is not mentioned in the main text. In addition, the Conclusion section states that emissions are overestimated by 44%.**

The 35% overestimation of emissions is based on the slope of the best linear approximation in Figure 11. We consider the gradient signal to be a leading indicator of emissions when the wind direction is parallel to the axis between these stations.

44% is a mistake (now corrected) and should have been 34%.

2. **Table 1: Please include the serial numbers (#88, #103, and #179) of the EM27/SUNs used at each station, along with the corresponding periods.**

The information is now available in Table 1 for each station and each instrument until 2024/12. Please note that all stations were still in operation after 2024/12 but our study period ends on 2024/12/31.

3. **Figure 2: Regarding XCO_2, instrument #88, which was deployed at SAC before 2023-05-19 and at GNS after 2023-05-19, appears to have a low bias, while instrument #103, which was deployed at SAC after 2023-05-19, has a high bias. Thus, there seems to be device-specific biases. Can the effect of the exchange of instruments be considered negligible? Additionally, Paris TCCON data are biased low by approximately 0.5 ppm, compared with other EM27/SUN data. Is it acceptable not to consider this bias?**

For this reason, we use the average bias between the two instruments in calculating the overall uncertainty. This takes into account the specific biases of each instrument and the effect of the change between the two stations.

For the Paris TCCON site, we consider this bias in calculating its uncertainty as showed in Table 3.

4. **Figure 4 and L233: Could you please clarify whether the ΔXCO_2 values were calculated for each instrument, as indicated in the legend of Figure 4, or for each station, as described in the main text?**

This precision is indeed important. The ΔXCO_2 values have been calculated for each instrument. A clarification is made in the main text.

5. **L294–295: According to Table 2, a 0.0015 change in XAIR corresponds to a 0.14 ppm change in XCO_2. Which is correct?**

According to Table 2, a change of 4.10^{-3} in XAIR may create a variation of 0.37 ppm in XCO_2. A correction has been done in the main text.

6. **L331: Is the observed growth rate the same at the three stations?**

In order to maximise the number of points used to calculate the growth rate over this period, we use measurements from Saclay (clarification added in the text). The growth rates calculated at Gonesse and Jussieu are slightly different (2.89 and 2.84 ppm/yr, respectively). The difference in growth rate remains small and can be explained by the limited time period and the under-sampling of the time series, in particular during the winter months.

7. **L465–478: Please add discussion of the differences between the simulations and observations, especially why the measured XCO_2 values at Gonessa were, on average, larger than those at Saclay, contrary to the simulations.**

We do mention in the text that the measured gradients appear larger (positive) than the modeled values. We do not have a demonstration for the main cause of this discrepency. Our best hypothesis is that some emissions in the proximity of GNS are not accounted for in the simulation. A mistake has been identified in Figure 9. We modified the figure and wrote the text again, with the required precisions and modifications due to the new figure.

8. **L579: What is the emission inventory used by CAMS? This information would be helpful in understanding the differences between the WRF-Chem and CAMS simulations.**

It is the CAMS-GLOB-ANT, a global inventory produced by the ECMWF for CAMS simulations. We added a reference to a paper published in 2024 describing this inventory.

9. **L587–588: Because the errors in the slopes for JUS-GNS and SAC-JUS are almost the same between CAMS (9 km resolution) and WRF-Chem (1 km resolution) simulations, the difference in the spatial resolution seems to be irrelevant.**

Yes, we deleted the part of this sentence about the spatial resolution.

10. **L589–590: Why is underestimation in the emissions inventory considered more reasonable than overestimation?**

Another study published in 2023 (Lian et al., 2023) indicates that emissions in the Greater Paris region (Paris and its inner suburbs) are underestimated. This study uses in-situ surface measurements taken in this region over a six-year period and has a complete atmospheric inversion framework. Our study assesses the potential of using total column measurements in a possible atmospheric inversion. In view of the results demonstrated previously in the article on measurement uncertainty, which is of the same order of magnitude as the measured signal and the contribution of vegetation in the model, and having demonstrated the limitations of model-measurement comparison, we consider that the underestimation assessed by Lian et al. 2023 is more reasonable than the very significant overestimation that appears to be indicated here.

11. **L615–619: In L402–404, it is stated that emission estimates using in situ surface measurements are subject to significant uncertainty due to the difficulty of modeling the vertical mixing, whereas column measurements are insensitive to this modeling. Could you discuss which approach is more accurate?**

The approach using surface measurements involves a degree of uncertainty due to the modelling of vertical atmospheric transport. This is not (or only slightly) the case for total column measurements. For this reason, total column measurements provided an interesting perspective in the optimisation of emissions inventories. However, other reasons mentioned in this paper (high uncertainties, anthropogenic signal comparable to biogenic signal, and horizontal transport errors) demonstrate the impossibility of using these measurements in a complete atmospheric inversion process as with surface measurements. This comment has been added to the main text.

Technical corrections:

1. **L64: Are the EM27/SUN data at JUS used in this study? Otherwise, it would be better to either state that fact or delete it to avoid confusion.**

No EM27/SUN measurements from JUS are used in this study due to the late installation of the instrument at the station. We deleted the mention to this instrument in the main text.

2. **Table 1: What is the QUALAIR platform?**

QUALAIR is a multi-instrument experimental research platform for observing chemical and dynamic variability in the atmosphere. See http://qualair.aero.jussieu.fr/ (link added to Table 1).

3. **L147: "to be used" is unnecessary?**

Removed.

4. **L157: the radiative transfer code GGG2020 package -> the retrieval software GGG2020**

Modified.

5. **L159: TCCON framework -> TCCON archive**

Modified.

6. **L225–226: we define a reference as the mean XCO_2 over 10:00-14:00 local time. -> we define the mean XCO_2 over 10:00-14:00 local time as a reference.**

Modified.

7. **L240: modelled radiative -> modelled radiative processes**

Modified.

8. **Equations (3.1)–(3.3): What do the double arrows means?**

Here, double arrows mean « equivalent ».

9. **Figure 5: Please change the x-axis label to English.**

Modified.

10. **L266: r_{SAC} = 0.76 et r_{GNS} = 0.75 -> r_{SAC} = –0.76 and r_{GNS} = –0.75**

Modified.

11. **L312: This sentence is almost identical to L314–315, so it is redundant.**

Modified.

12. **Table 3: What is the difference between "-" and "X"?**

No difference, it is a mistake from our side. Modified to « X » only.

13. **L324: According to Section 2.2, TCCON spectra were analyzed with GGG2020.**

Modified.

14. **L392: CO_2 plus -> CO_2 plumes?**

Modified.

15. **L420: Figure 10 is cited before Figure 9 in the main text. Figure 10 should be changed to Figure 9 and vice versa.**

We consider it appropriate to present the upper and lower panels of Figure 10 together (rather than in two separate figures). However, Figure 10 cannot be placed in Section 5.1 because it also presents results simulated by WRF-Chem, and this section precedes the presentation of WRF-Chem. For this reason, Figure 10 is placed after Figure 9.

16. **L504 and 507: et -> and**

Modified.

17. **L560–564: Please add the slopes of the fits as well as the correlation coefficient.**

Added in the text with the Pearson's correlation coefficients.

18. **L584: discrepancies in the simulation of emissions or atmospheric transport -> discrepancies in the atmospheric transport simulations or emissions**

Modified.