Reviewer 2:

This manuscript presents a timely and potentially valuable high-resolution daily XCO_2 dataset by combining multi-mission satellite retrievals with a hybrid Transformer–BiLSTM framework, followed by a bias-correction step. The topic is well suited to ESSD, and the dataset has clear potential applications in carbon-cycle analysis, emission monitoring, and climate studies. Overall, the manuscript is well written, and I have several suggestions to further improve the study.

Specific comments:

(1) The spatial scope of the dataset should be described more consistently. The title and several sections of the manuscript give the impression of a fully global XCO_2 product, whereas the abstract states that the dataset characterizes XCO_2 "over global land surfaces." This scope should be made consistent across the title, abstract, main text, and dataset description.

Response: We have revised the manuscript to consistently describe the dataset as a global land XCO_2 product. The title and the corresponding descriptions in the Abstract, Introduction, Conclusions, and data description have been updated accordingly.

(2) The description of the Bi-LSTM architecture needs clarification. The statement that the model "consists of 64 hidden layers with a dimension of 128" is difficult to interpret and seems unlikely in its current form. It would be helpful to clarify whether this refers to hidden units, hidden states, or stacked layers.

Response: We have revised the description of the Bi-LSTM architecture to: "The temporal encoder was implemented as a one-layer bidirectional LSTM (Bi-LSTM) with 64 hidden units in each direction, resulting in a 128-dimensional output feature." .

(3) To enhance readability, Figure 5 should include a corresponding legend.

Response: We have added a corresponding legend to Figure 5 in the revised manuscript to improve its clarity and readability.

(4) Several language and wording issues should be refined. For example, "till 2012" should be revised to "until 2012," and "Electric power plant in Algerian" should be corrected to "in Algeria." A careful language edit would improve overall readability.

Response: We have corrected the noted language issues and have carefully proofread the entire manuscript to improve overall readability.

(5) The ENSO discussion contains a minor numerical inconsistency. A reported correlation of R = 0.55 corresponds to approximately 30% explained variance rather than ~34%. Please check the correlation coefficient or revise the corresponding statement accordingly.

Response: The explained variance has been corrected from 34% to 30% to accurately reflect the reported correlation (R = 0.55).

(6) The performance metrics reported in the abstract and main text would benefit from clearer interpretation. Different statistics are presented for independent TCCON validation, bias-corrected results, and various cross-validation strategies, but the abstract may give the impression that all values correspond to a single evaluation setting. It would be helpful to explicitly indicate which metric corresponds to which validation framework.

Response: To improve clarity, we have revised the abstract to explicitly distinguish between different validation frameworks as follows:

"Independent validation of the data-fused XCO_2 product against Total Carbon Column Observing Network (TCCON) measurements shows excellent agreement, with a correlation coefficient (R) of 0.99, a root mean square error (RMSE) of 1.10 ppm, and a mean bias of 0.01 ppm. After bias correction, the product further improves cross-satellite consistency, achieving an R^2 of 0.99 and an RMSE of 0.36 ppm in the sample-based ten-fold cross-validation."

(7) In the caption for Figure 7, the years are listed as "May 30, 2009, 2013, 2020." For grammatical correctness, this should be revised to "May 30, 2009, 2013, and 2020."

Response: We have corrected the figure caption as suggested.

(8)The seasonal averages should be presented in a consistent format, for example (MAM; average = 395.36 ± 2.20 ppm).

Response: We have standardized all seasonal-average expressions to a consistent format throughout the manuscript as suggested.

(9) The terminology used for the reconstructed product should be standardized. Terms such as "seamless," "gap-free," and "gapless" are used interchangeably; selecting one consistent term would improve clarity.

Response: We have revised the manuscript to use "seamless" consistently throughout when referring to the reconstructed product.

(10) Some minor grammatical issues should also be corrected, for example "Sample-based CV show" should be revised to "Sample-based CV shows."

Response: We have corrected this grammatical error and carefully revised similar minor grammatical issues throughout the manuscript.

(11) The model name should be used consistently throughout the manuscript. In most sections it is referred to as "Transformer–BiLSTM," whereas in the XAI section it appears as "4D-STransformer-BiLSTM," which may confuse readers.

Response: We have unified all model references to "Transformer-BiLSTM" throughout the manuscript.

(12) It would also be helpful to clarify whether coarser-resolution products were regridded prior to comparison in Figure 7.
Response: We have clarified in the manuscript that no regridding was applied to Figure 7, as the coarser-resolution products are plotted at their native resolutions for qualitative comparison.

(13) The interpretation of localized XCO_2 hotspots should be phrased more cautiously. Some descriptions appear overly definitive for a column-integrated quantity that can also be influenced by atmospheric transport and meteorological conditions. Expressions such as "consistent with localized enhancements associated with…" would be more appropriate unless supported by stronger independent evidence.
Response: We have revised this sentence as "These patterns are consistent with localized regions of relatively high XCO_2 concentrations associated with fossil-fuel combustion and extraction-related activities."

(14) The formatting of several references should be carefully checked, as there are minor issues such as missing spaces or compressed publisher/year formatting.
Response: We have carefully checked and corrected the formatting of all references throughout the manuscript, including missing spaces and compressed publisher/year formatting issues.

(15) In Table 2, it would be beneficial to include comparisons with the most recent relevant studies to better position the dataset within the current literature.
Response: We have expanded this table to include several recent global XCO_2 studies, and the associated text in Section 3.3.2 has been revised accordingly. These additions better position our dataset within the context of the current literature.

(16) Finally, the names of datasets and networks should be presented consistently. For example, "ObsPack" and "Obspack" appear in different places and should be unified.
Response: We have standardized all dataset and network names throughout the manuscript, correcting "Obspack" to "ObsPack" as suggested.