In this paper, a spatiotemporal interpolation method is developed, and a data product with full spatiotemporal coverage is generated by using the XCO_2 data of GOSAT. I'm not particularly aware of the article category for ESSD, but compared to other research papers in ESSD, it's more suitable for technical description articles, at least at this stage. The article has some obvious scientific errors and inappropriate knowledge descriptions, the following points should be considered to improve the quality of the article, especially some major errors. As community comments, I believe these comments will increase the understanding of carbon monitoring satellite data assimilation and improve this research.

1. Although we are very concerned about the carbon cycle and the spatiotemporal distribution of CO_2, for atmospheric inversion models, sparse data observations are sufficient to obtain carbon fluxes. **NOTE I'm not denying that we don't need a spatially seamlessly CO_2 distribution,** but the introduction should explain why we need a spatiotemporally seamlessly CO_2, such as calculating global averages, analyzing seasonal changes.

Dear reviewer, thank you for your kindly suggestions. We have checked the description about carbon fluxes in the manuscript and made some modifications. The following shows the revised description in the latest manuscript：

Obtaining highly accurate and high-resolution spatiotemporal maps of XCO_2 distributions is essential for promoting the study of the carbon cycle, carbon sources, carbon sinks, carbon neutralization, and carbon emissions assessed by top-down theory. In addition, based on seamless XCO_2 data, relevant studies can be carried out, for example, to analyze global seasonal or annual changes (Zhang M et al., 2022), to calculate carbon emissions from wildfires (Guo M et al., 2017) or megacities (Kuze A et al., 2022; Shiomi K et al., 2022), to calculate terrestrial carbon fluxes (Wang H et al., 2019) by combining GOSAT-2 and OCO-2 data.

References:

Frankenberg C, Fisher J B, Worden J, et al. New global observations of the terrestrial carbon cycle from. GOSAT: Patterns of plant fluorescence with gross primary productivity[J]. Geophysical Research Letters, 2011, 38(17).

Guo M, Li J, Xu J, et al. CO2 emissions from the 2010 Russian wildfires using GOSAT data[J]. Environmental pollution, 2017, 226: 60-68.

Kuze A, Nakamura Y, Oda T, et al. Examining partial-column density retrieval of lower-tropospheric. CO2 from GOSAT target observations over global megacities[J]. Remote Sensing of Environment, 2022, 273: 112966.

Shiomi K, Kikuchi N, Suto H, et al. Gosat Partial Column Observation for Better Quantifying Urban CO. 2 Flux[C]//IGARSS 2022-2022 IEEE International Geoscience and Remote Sensing Symposium. IEEE, 2022: 4350-4352.

Wang H, Jiang F, Wang J, et al. Terrestrial ecosystem carbon flux estimated using GOSAT and OCO-2. XCO_2 retrievals[J]. Atmospheric Chemistry and Physics, 2019, 19(18): 12067-12082.

Zhang M, Liu G. Mapping contiguous XCO_2 by machine learning and analyzing the spatio-temporal. variation in China from 2003 to 2019[J]. Science of The Total Environment, 2022: 159588.

2. P6. Line 160. **Equation 1 looks very strange and seems wrong.** What is the difference between coefficients c and e? What is the difference between d and g? The result needs to be checked carefully and even recalculated. In addition, adopting this method to construct time series would lead to significant

drawbacks. I believe the authors may not understand the CO_2 growth rate, please see papers such as Buchwitz. et.al, 2018 and A. Chatterjee et.al, 2017 to understand the significance of CGR in reflecting vegetation, climate, etc. The method of presetting a function to fit will not be able to capture the real change in the CO_2 growth rate, and the function will be directly known after derivation. One of the reasons we want seamless data is to better calculate the global average, and thus the growth rate, that is, the net flux. Fitting with a fixed function would loss this.

Dear reviewer, thank you for your kindly suggestions. The corrected Equation 1, which was misrepresented in the previous manuscript (the code that has been uploaded in the repository is the correct representation), is shown below. The role of parameter *c*, parameter *e*, parameter *d* and parameter *g* are to adjust the month-to-month variation within the year (Fu P et al., 2019) the differences between them are the different terms that are adjusted.

$$F(t) = a + b * t + c * \cos\left(\frac{2\pi t}{f}\right) + d * \sin\left(\frac{2\pi t}{f}\right) + e * \cos\left(\frac{4\pi t}{f}\right) + g * \sin\left(\frac{4\pi t}{f}\right), \quad (1)$$

where a refers to the yearly averaged XCO_2; c , d, e, and g are the coefficients of the seasonal component; b is the coefficient of the interannual component; f is the sampling frequency (f = 12 for a year); and t is the sampling interval.

References:

P. Fu, Y. Xie, C. E. Moore, S. W. Myint, and C. J. Bernacchi, "A comparative analysis of anthropogenic CO2 emissions at city level using OCO2 observations: A global perspective," Earth's Future, vol. 7, no. 9, pp. 1058–1070, Sep. 2019

3. In the abstract and the introduction, the authors claim that the amount of XCO_2 data is mainly affected by factors such as clouds and aerosols. This is wrong, it's actually a swath issue. The design of the width is related to the fluctuation amplitude of atmospheric CO_2 and optical inversion factors. Authors are advised to read the relevant literature and correct the description in this section. While this is not that important for this article, the readers need to understand the real background for this work.

Dear reviewer, thank you for your kindly suggestions. The description of the pointed-out error has been modified in the abstract and introduction. The modified expression is "However, the discrete satellite data provided by GOSAT-2, OCO-2, and OCO-3 have data voids and relatively low efficiency because of narrow swaths and reduced sampling densities due to optically thick clouds and aerosols (Hu Y et al., 2021; Zhang M et al., 2022)."

References:

Hu Y, Shi Y. Estimating CO_2 emissions from large scale coal-fired power plants using OCO-2 observations and emission inventories[J]. Atmosphere, 2021, 12(7): 811.

Zhang M, Liu G. Mapping contiguous XCO_2 by machine learning and analyzing the spatio-temporal variation in China from 2003 to 2019[J]. Science of The Total Environment, 2022: 159588.

4. P3, L65-83. This section overlaps with method descriptions in subsequent part, and it is not appropriate to introduce too much about the methods of this study in the introduction.

Dear reviewer, thank you for your kindly suggestions. The contents of L65-83 were removed from the original manuscript.

5. P4, L98 "...the accuracy of the comparison between the GOSAT data product and the TCCON site was 0.56 ppm", it is not appropriate to use the **"accuracy"** word, it should be stated, such as standard deviation, bias, etc.

Dear reviewer, thank you for your kindly suggestions. By checking the literature (Noël S et al., 2021), this accuracy refers to an overall station-to-station bias. Therefore, the content of L98 has been modified and its modified content is as follows: "...the overall station-to-station bias between the GOSAT data product and the TCCON site was 0.56 ppm ".

References:

Noël, S., Reuter, M., Buchwitz, M., Borchardt, J., et al., XCO_2 retrieval for GOSAT and GOSAT-2 based on the FOCAL algorithm, Atmos. Meas. Tech., 14, 3837–3869, (2021)

6. P4, L100, "... three-day temporal resolution. The time resolution of GOSAT-2 satellite is 6 days..." is inappropriate. The correct description is the revisit cycle/repeat cycle. Please differentiate these concepts. (Temporal resolution, time resolution, repeat cycle,)

Dear reviewer, thank you for your kindly suggestions. The content of L100 has been modified and its modified content is as follows: "... and three-day revisit cycles. The revisit cycle of GOSAT-2 satellite is 6 days, IFOV is 9.7km. ".

7. P4, L105. However, the OCO-2_L2_Lite_FP9r provides data locations that are gradually shifted over time by satellite observations. This sentence is difficult to understand. I think you should express that the orbits of the sub-satellite points are evenly distributed? Illustration may be needed.

Dear reviewer, thank you for your kindly suggestions. We want to express that the spatial position of the satellite subsatellite point is gradually shifted under the same position of two adjacent revisit cycles. Fig. 7-1 demonstrates the spatial distribution of XCO_2 data. The data are from the OCO-2 satellite, which was collected on January 1, 2019 in Fig. 7-1a and Fig. 7-1b. Besides, the data are from the OCO-2 satellite, which was collected on January 17, 2019 in Fig. 7-1c and Fig. 7-1d. And the revisit period of OCO-2 satellite is 16 days. From the spatial position distribution of XCO_2 in Fig. d and Fig. b, the satellite orbit is gradually offset in order to collect more data.

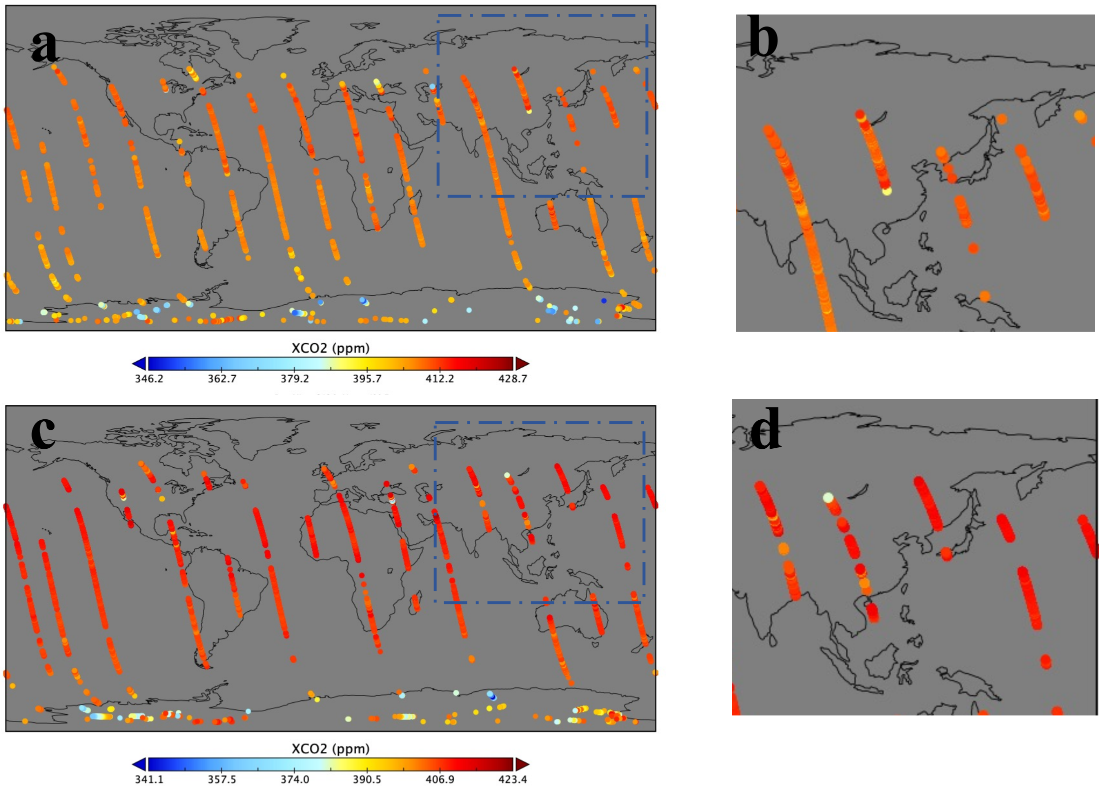

Figure7-1 Spatial distribution of XCO_2 data from OCO-2 satellite.

8．P4, L112 column-averaged XCO_2. This is wrong. And the full name of XCO_2 is wrong, including the title, abstract and etc. I think it should be carefully checked the full text of the corresponding full scientific name.

Dear reviewer, thank you for your kindly suggestions. We have checked the full name of XCO_2 in the manuscript. And the full name of XCO_2 was modified to column-averaged dry-air mole fraction of CO_2 in the whole manuscript. And the new manuscript title is "Carbon dioxide cover dataset: XCO_2 seamlessly distributed globally during 2009-2020".

9. P4. L107, "fixed location" should be clearer. L109. the six data channels are wrong. TANSO-FTS is a 4–band interferometer.

Dear reviewer, thank you for your kindly suggestions. To make it easier to understand for readers, we have removed the description of L107 in the previous manuscript. "The GOSAT_L3 product provides a cumulative observation of a long time series in grid form." was added to the latest manuscript. TANSO-FTS is a four-band interferometer [1], with three bands located in the near-infrared and short-wave infrared [1], and with seven data channels [2-3]. In the latest manuscript, we have added the modified content “TANSO-FTS is a four-band interferometer, with three bands located in the near-infrared and short-wave infrared”。

References:

[1] https://space.oscar.wmo.int/instruments/view/tanso_fts, last access: 10-Nov-2022.

[2] https://www.gosat.nies.go.jp/en/about_%EF%BC%92_observe.html, last access: 10- Nov-2022.
[3]https://seors.unfccc.int/applications/seors/attachments/get_attachment?code=645A2WJLB852G36JR3WM5GECF1HMXXEP, last access: 10-Nov-2022.

10. P4., L123. Please correct for ***column-averaged abundances of CO_2*** expression. And the results showed that R2 was 0.9686, and RMSE was 1.3811. Please indicate the source.

Dear reviewer, thank you for your kindly suggestions. For your question, we have divided the response into two parts.

A． P4., L123. Please correct for column-averaged abundances of CO_2 expression.

The abundance of CO_2 is a measure of the occurrence of the chemical elements relative to all other elements in a given environment. Abundance is measured in one of three ways: by the mass-fraction (the same as weight fraction); by the mole-fraction (fraction of atoms by numerical count, or sometimes fraction of molecules in gases); or by the volume-fraction. Volume-fraction is a common abundance measure in mixed gases such as planetary atmospheres, and is similar in value to molecular mole-fraction for gas mixtures at relatively low densities and pressures, and ideal gas mixtures. And the L123 in the previous manuscript was used to introduce information about the TCCON site data, and this expression is cited on the TCCON website (https://tccondata.org/, last access: 10-Nov-2022.). Therefore, the L123 expression is correct and there is no need to correct the expression of L123. And The expression from the TCCON website is shown below.

TCCON is a network of ground-based Fourier Transform Spectrometers recording direct solar spectra in the near infrared spectral region. From these spectra, accurate and precise column-averaged abundances of CO_2 are retrieved and reported here.

B． And the results showed that R2 was 0.9686, and RMSE was 1.3811. Please indicate the source.

"And the results showed that R^2 was 0.9686, and RMSE was 1.3811." is the comparison result by comparing the predicted data with TCCON for all sites, and this sentence should be located in Section 3.1. Therefore, "And the results showed that R^2 was 0.9686, and RMSE was 1.3811 ppm." was removed in the latest manuscript.

11. P5. 146 EBK theory or EBK method? Please express it in a unified way. such as L150.

Dear reviewer, thank you for your kindly suggestions. We have checked this issue in the paper. And The issue has been uniformly revised to EBK method.

12. In Section 2.4, more indicators for accuracy evaluation should be added. Bias and standard deviation are necessary in the verification of XCO_2.

Dear reviewer, thank you for your kindly suggestions. The bias ($Bias$) and standard deviation (σ) were added as evaluation indicators in Section 2.4. And the $Bias$ and σ can be calculated as follows:

$$\overline{p} = \frac{1}{N}\sum_{i=1}^{N} P_i, \quad (3)$$

$$Bias = \frac{1}{N} \sum_{i=1}^{N} (P_i - R_i), \quad (5)$$

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N} |P_i - \overline{p}|^2}, \quad (6)$$

where N is the number of prediction locations, P_i is the predicted value, and R_i is the observed value.

13. P7. 195. It is not necessary to show the results of each year, only a few examples, such as some months or a specific year, are sufficient. From the analysis of the data, such as some seasonal changes, changes in CO_2 growth, and spatial differences may be more meaningful.

Dear reviewer, thank you for your kindly suggestions. The purpose of this paper is to make a dataset, to introduce the contents of the dataset in detail and to verify the accuracy of the dataset. Therefore, this paper does not focus on seasonal analysis and spatial differences. However, considering that seasonal variation analysis can evaluate the reasonableness of the CDC dataset, we produced the distribution of seasonal variation of XCO_2 in 2010 in Fig 13-1. Fig. 13-1a shows the mean values of XCO_2 data from January to March 2010, Fig. 13-1b from April to June 2010, Fig. 13-1c from July to September 2010, and Fig. 13-1d from October to December 2010.

Besides, the evaluation index of the annual mean growth rate (AMGR) of XCO_2 can indirectly verify the accuracy of our product. Therefore, the AMGR of XCO_2 were calculated for the different TCCON sites and are presented in the Figure 13-2. Figure 13-2 shows the AMGR of XCO_2 from TCCON site and from CDC dataset (The predicted data from this paper) at the 23 TCCON sites. The horizontal axis of the graph represents time and the vertical axis represents the annual mean growth rate (AMGR). The red and blue error bars in the figure represent the standard deviation of the CDC dataset and the TCCON site dataset in the current year data at different sites. For example, the AMGR of XCO_2 in 2010 relative to 2009 is plotted at 2009.5 in the figure, and the standard deviation calculated is from the 2010 data. Site names are abbreviated and different subplots are labeled with the abbreviated site names (as shown in Table 1). In particular, the data for all sites were aggregated and the AMGR were calculated, and the AMGR is shown in the subplot labeled 'all'. The results of the site-by-site comparison indicate that the AMGR of CDC is consistent with the AMGR of TCCON, and there is only a slight deviation at a few sites. The reason for this slight deviation may be due to insufficient data. In addition, in the subplot where all data are aggregated (namely, the subplot marked with 'All'), it also shows that the trends of the two indicators (AMGR and standard deviation) are consistent for both CDC data and TCCON data.

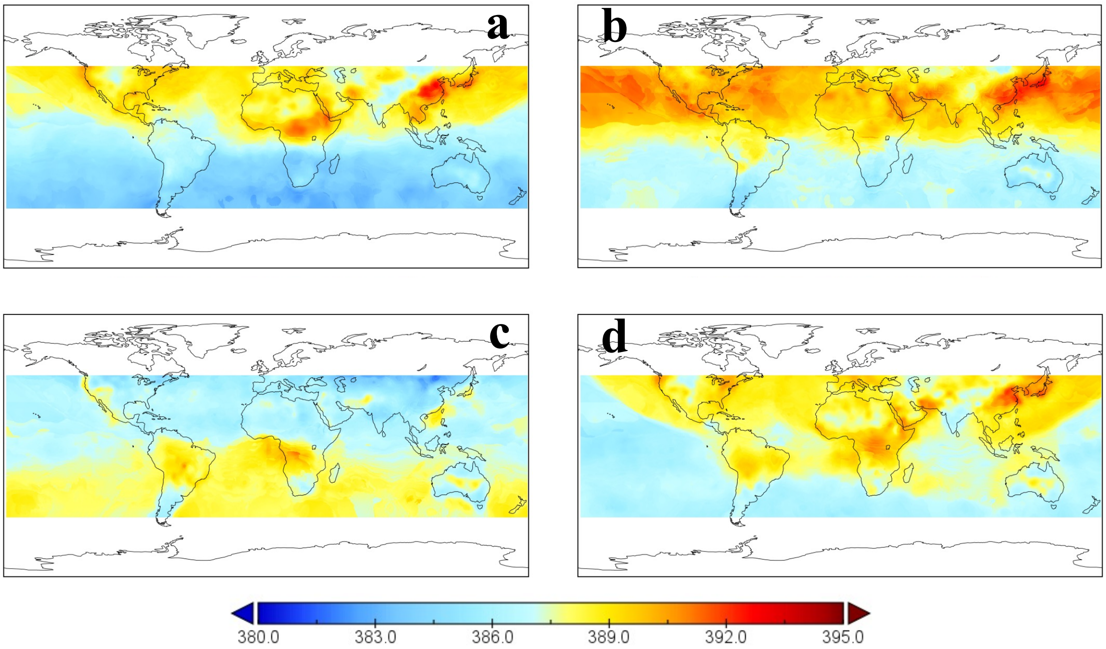

Fig. 13-1 The distribution of seasonal mean XCO_2 in 2010

Table 1. Geographic locations of TCCON sites used for validation and the statistics used to compare predicted XCO_2 and TCCON XCO_2 observations.

Tccon sites (Site abbreviations)	Longitude	Latitude	R^2	RMSE (ppm)	Mean Bias(ppm)
Jet Propulsion Laboratory (JC)	-118.18	34.20	0.98**	1.07	-0.89
Caltech (CI)	-118.13	34.14	0.97**	0.95	-1.21
Edwards (DF)	-117.88	34.96	0.98**	0.82	0.72
Four Corners (FC)	-108.48	36.80	0.96**	0.31	-0.75
Lamont (OC)	-97.49	36.60	0.98**	1.04	-1.79
Park Falls (PA)	-90.27	45.94	0.98**	1.24	-0.62
Manaus (MA)	-60.60	-3.21	0.88**	0.64	-1.53
Izana (IZ)	-16.48	28.30	0.98**	1.18	-0.96
Ascension Island (AE)	-14.33	-7.92	0.94**	0.93	-0.84
Orléans (OR)	2.11	47.97	0.99**	0.95	0.13
Zugspitze (ZS)	10.98	47.42	0.92**	1.52	-0.40
Garmisch (GM)	11.06	47.48	0.98**	1.05	0.36
Nicosia (NI)	33.38	35.14	0.93**	0.73	-1.38
Réunion Island (RA)	55.49	-20.90	0.96**	1.23	-1.33
Hefei (HF)	117.17	31.90	0.87**	1.51	-1.82
Burgos (BU)	120.65	18.53	0.89**	1.01	-1.58
Anmeyondo (AN)	120.65	36.54	0.90**	1.20	-0.58
Saga (JS)	130.29	33.24	0.97**	1.26	-1.14
Edwards (DB)	130.89	-12.43	0.99**	0.75	-1.03
Tsukuba (TK)	140.12	36.05	0.91**	1.89	0.48

Rikubetsu (RJ)	143.77	43.46	0.95**	1.17	0.19
Wollongong (WG)	150.88	-34.41	0.99**	0.82	-0.58
Lauder01&02&03 (LL)	169.68	-45.04	0.97**	1.44	-0.70
All sites	-	-	0.97**	1.38	-0.65

** At the 0.01 level (two-tailed), the correlation is significant.

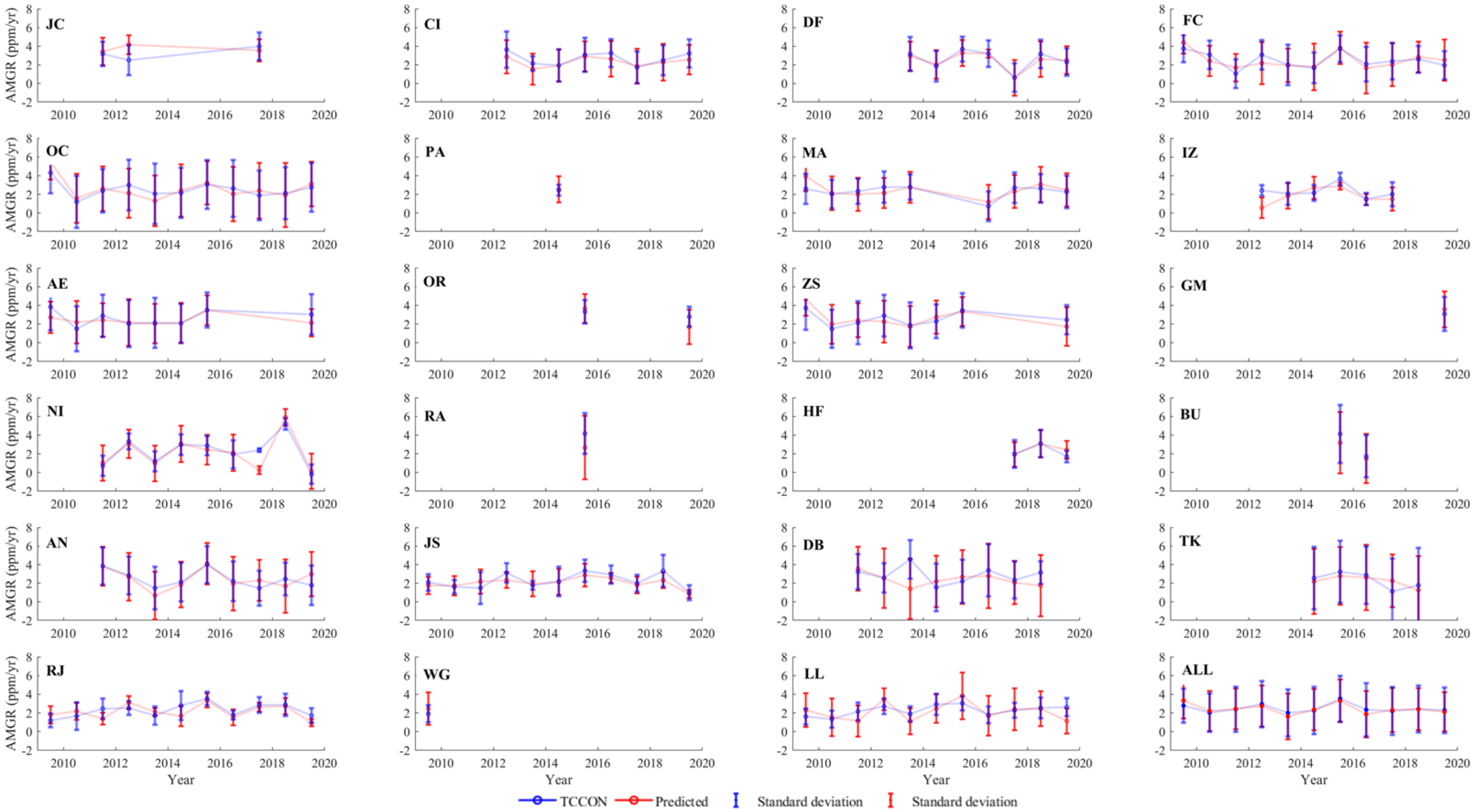

Fig. 13-2 XCO_2 growth rate from TCCON site and from CDC dataset (The predicted data from this paper). The horizontal axis of the graph represents time and the vertical axis represents the annual mean growth rate (AMGR).

14．Figure 6, As said at the beginning, of course we know that CO_2 is rising, but its growth rate is more meaningful, and it is recommended to draw a related graph of the growth rate. If it does not reflect reasonable fluctuations, but a fully sinusoidal pattern, the study would be significantly flawed.

Dear reviewer, thank you for your kindly suggestions. Therefore, the annual mean growth rate (AMGR) of XCO_2 were calculated for the different TCCON sites and are presented in the Figure 14-1. Figure 14-1 shows the XCO_2 growth rate from TCCON site and from CDC dataset (The predicted data from this paper) at the 23 TCCON sites. The horizontal axis of the graph represents time and the vertical axis represents the annual mean growth rate (AMGR). The red and blue error bars in the figure represent the standard deviation of the CDC dataset and the TCCON site dataset in the current year data at different sites. For example, the AMGR of XCO_2 in 2010 relative to 2009 is plotted at 2009.5 in the figure, and the standard deviation calculated is from the 2010 data. Site names are abbreviated and different subplots are labeled with the abbreviated site names (as shown in Table 1). In particular, the data for all sites were aggregated and the AMGR were calculated, and the AMGR is shown in the subplot labeled 'all'.
Figure 14-1 compares the AMGR of the TCCON and CDC datasets. The results of the site-by-site comparison indicate that the AMGR of CDC is consistent with the AMGR of TCCON, and there is only a slight deviation at a few sites. The reason for this slight deviation may be due to insufficient data. In addition, in the subplot where all data are aggregated (namely, the subplot marked with 'All'), it also shows that the trends of the two indicators (AMGR and standard deviation) are consistent for both CDC data and TCCON data.

Table 1. Geographic locations of TCCON sites used for validation and the statistics used to compare predicted XCO_2 and TCCON XCO_2 observations.

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All sites	-	-	0.97**	1.38	-0.65

** At the 0.01 level (two-tailed), the correlation is significant.

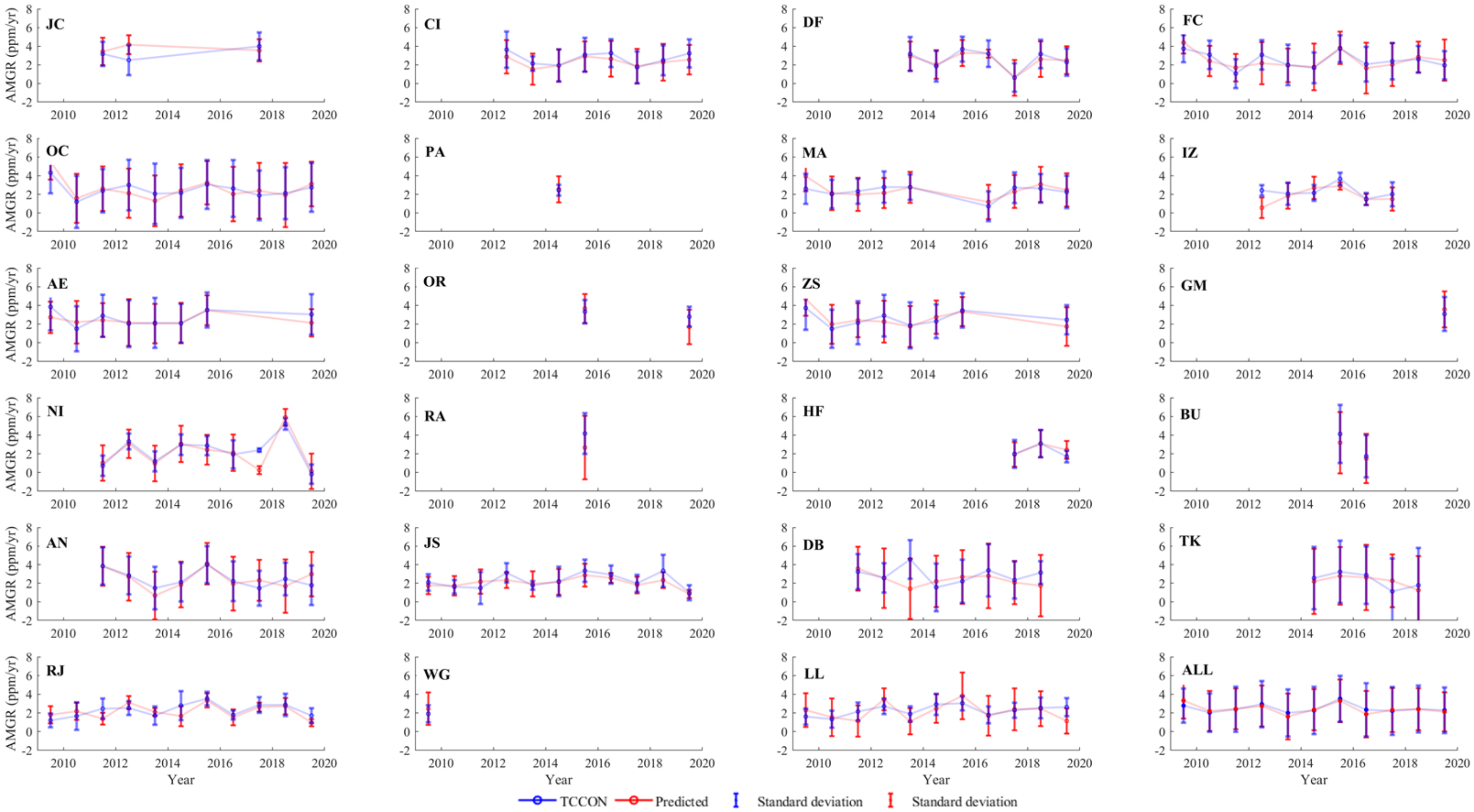

Fig. 14-1 XCO_2 growth rate from TCCON site and from CDC dataset (The predicted data from this paper). The horizontal axis of the graph represents time and the vertical axis represents the annual mean growth rate (AMGR)

15. From the research point of view, averaging kernel and the prior profile should be considered in comparison with OCO-2. Although they may be ignored in some cases and not important on monthly validation where accuracy is not required, the article should mention it.

Dear reviewer, thank you for your kindly suggestions. The averaging kernels indicate the vertical resolution of the measurements and represent the sensitivity of the retrieval to the ‘‘true’’ state (Ohyama et al., 2021). But, according to the current research, this difference is about a few tenths of ppmv, which is smaller than their measurement error (Inoue et al., 2013; Liang et al., 2017). Therefore, In the latest manuscript, "The effect of averaging kernel and the prior profile is ignored when comparing results with OCO-2" has been added to Section 3.2.

References:

Inoue, M., Morino, I., Uchino, O., Miyamoto, Y., Yoshida, Y., Yokota, T., et al., 2013. Validation of XCO2 derived from SWIR spectra of GOSAT TANSO-FTS with aircraft measurement data. Atmos. Chem. Phys. 13, 9771–9788.

Liang, A.L., Gong, W., Han, G., Xiang, C.Z., 2017. Comparison of satellite-observed XCO2 from GOSAT, OCO-2, and ground-based TCCON. Remote Sens., 9.

Ohyama H, Morino I, Nagahama T, et al. Column-averaged volume mixing ratio of CO2 measured with ground-based Fourier transform spectrometer at Tsukuba[J]. Journal of Geophysical Research: Atmospheres, 2009, 114(D18).

16. Figure 3,4 and 5. PXCO2 TXCO2 P XCO2 should be described uniformly (note the space). Other than that, I would suggest that it would be better to do time series validation on a monthly basis. Specifically, the horizontal axis is time, and the vertical axis is parameters such as error, which can also be filled with error distribution, which is more intuitive.

Dear reviewer, thank you for your kindly suggestions. We have unified the descriptions of PXCO2 TXCO2 and P XCO2 in the full paper. And the P XCO_2 and T XCO_2 are unified descriptions. In addition, we supplemented the experiments according to the requirements, and the results are shown in Fig. 16-1, Fig. 16-2 and Fig. 16-3.

The Fig. 16-1 shows a group diagram about the monthly-averaged XCO_2. The vertical axis of Fig.16-1a is the bias of the calculated monthly-averaged XCO_2 through the TCCON values and the CDC dataset at the mid- and low- latitude stations. Fig.16-1b shows the visualized histogram from the data in Fig. 16-1a, where the red line in Fig. 16-1b is the fitted curve of the Gaussian function. The yellow line is the fitted line. Fig. 16-1a show that our bias data are within two standard deviations, and very few points are outside the two standard deviation range. And the mean bias is -0.65pmm for Fig16-1a. The histogram in Fig. b shows that the bias of the CDC data set with the TCCON data is normally distributed with a mean of -0.63 ppm and a standard deviation of 1.4 ppm. Fig. c shows that the R^2 of the CDC data set is 0.97 and the RMSE is 1.38 ppm.

Fig.16-2 has the same representation as Fig.16-1, with the difference that Fig.16-2 is comparing the OCO-2 data and the CDC data set. The experimental results showed that the mean bias was -1.57 ppm in Fig. 16-2a. The Gaussian fit model of Fig. 16-2b shows that the mean of the Gaussian model is -1.57 ppm and the standard deviation is 1.40 ppm. Fig.16-2c shows that the evaluation metric R^2 is 0.91 ppm and RMSE is 1.35 ppm for the CDC dataset and the OCO-2 dataset.

Fig.16-3 has the same representation as Fig.16-1, with the difference that Fig.16-3 is a verification of the vacancy strategy. Vacancy strategy means that some data are pre-removed from the original input data. The pre-removed data are used as the validation set to verify the predicted results. The experimental results showed that the mean bias was -0.0043ppm in Fig. 16-3a. The Gaussian fit model of Fig. 16-3b shows that the mean of the Gaussian model is -0.0043ppm and the standard deviation is 0.6842 ppm. Fig.16-3c shows that the evaluation metric R^2 is 0.9907 ppm and RMSE is 0.6842 ppm for the CDC dataset and the validation set. **In general, the mean bias of the CDC data set relative to the TCCON, OCO-2, and GOSAT validation sets is -0.65ppm, -1.57ppm, and -0.0043ppm, respectively, with evaluation metrics R^2 of 0.97, 0.91, and 0.99.**

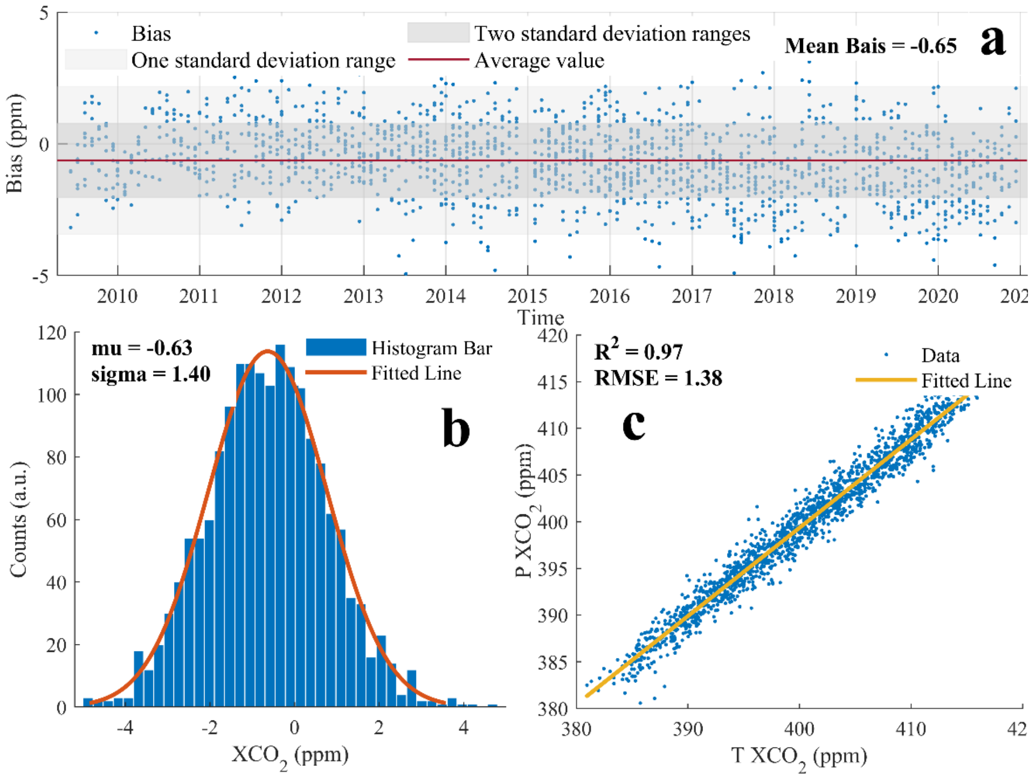

Figure 16-1 Monthly-averaged XCO_2 validation results for TCCON data and CDC dataset at global mid- and low-latitude TCCON sites from 200906 to 202012.

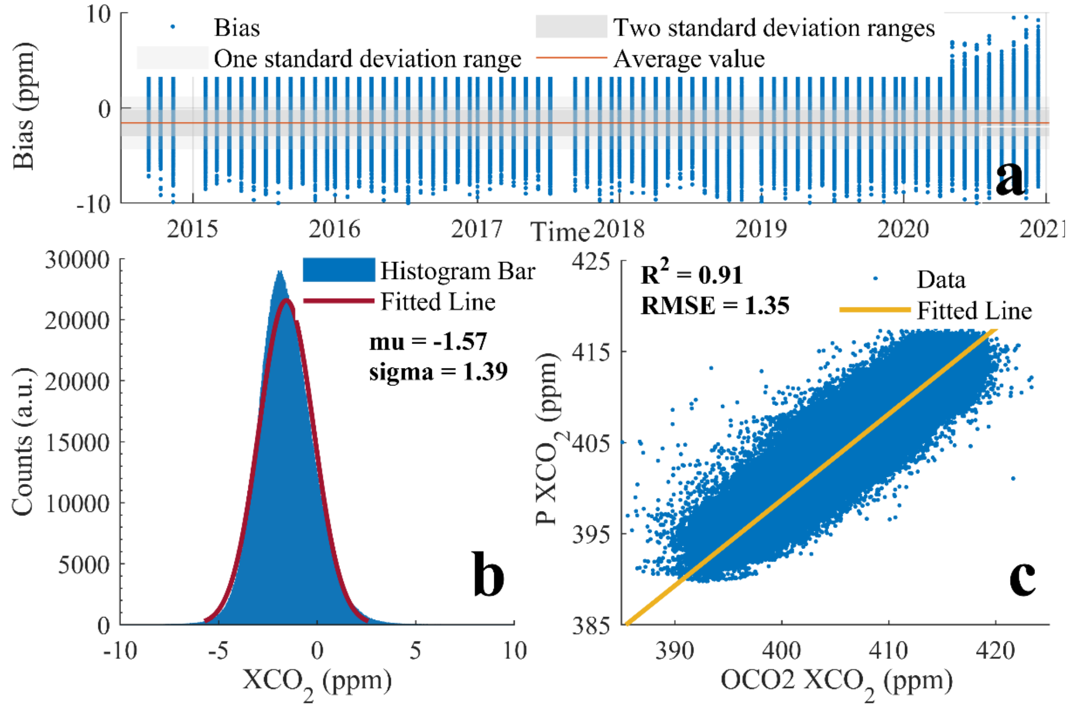

Figure 16-2 Monthly-averaged XCO_2 validation results for OCO-2 data and CDC dataset at global from 2014 to 2020.

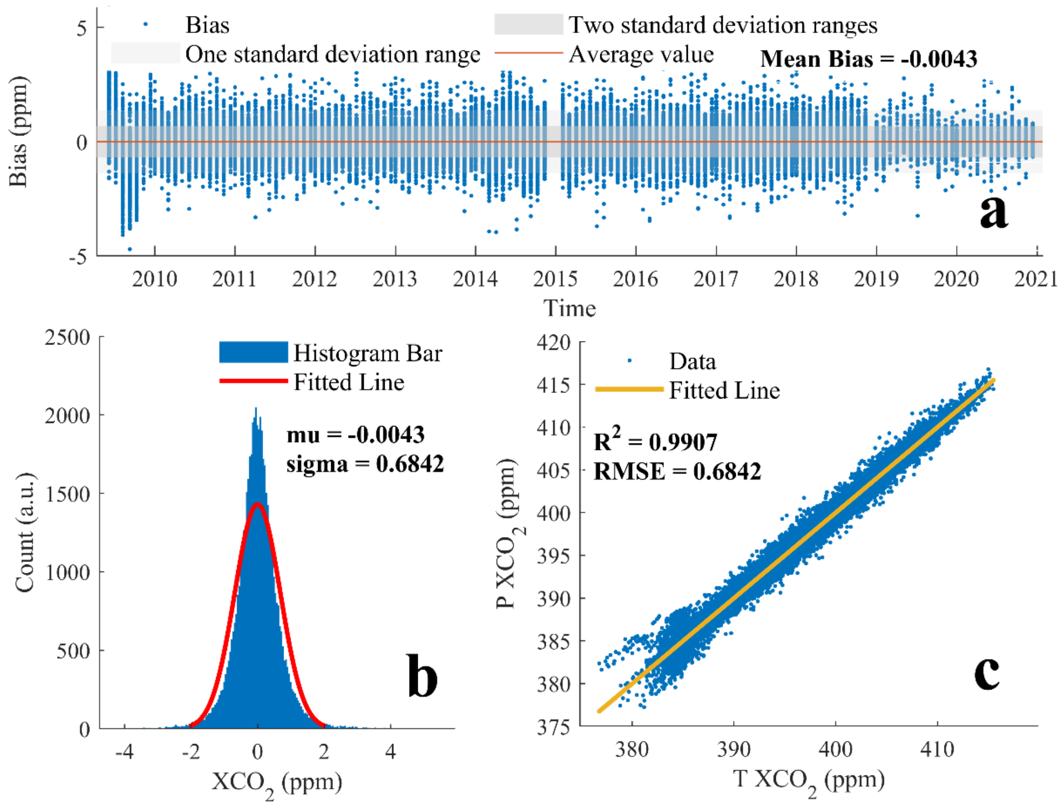

Figure 16-3 Monthly-averaged XCO_2 validation results based on GOSAT vacancy validation strategy from 200906 to 202012.

17. Figure 7~17. It looks like this resolution may be trapped in a highly smooth phenomenon, which means it may not really be 0.25 degrees. It is recommended to draw a detailed map of some regions to show that the method does have this good resolution and can capture reasonable and sufficient spatial gradient changes. It is also recommended to compare the results of models, such as CarbonTracker or the L4B model products of GOSAT-NIES, to demonstrate the rationality of the results.

Dear reviewer, thank you for your kindly suggestions. Because CarbonTracker is a modeling system, it does not acquire data from direct measurements by satellite or ground station instruments. Besides, we have enough validation experiments from top to bottom (for example, the OCO-2 validation in Section 3.2 and the GOSAT vacancy validation in Section 3.3) and from bottom to top (for example, TCCON data validation in Section 3.1). Moreover, the data for the validation experiments are obtained based on direct measurements from satellites or ground stations in our manuscript. Therefore, there is no need to add new validation experiments in this manuscript. However, we can add a qualitative comparison to demonstrate that the spatial resolution of the CDC dataset is 0.25 degrees and the existence of XCO_2 spatial gradient variation in the CDC dataset. Fig. 17-1 shows the distribution of XCO_2 in January 2010. The data are from the CarbonTracker (CT2019B version, https://gml.noaa.gov/aftp/products/carbontracker/co2/CT2019B/molefractions/co2_total_monthly/, Last Access:2022/11/15) dataset in Fig. a and b. And Fig. b is a zoom in for a specific region of Fig. a. The data are from the CDC dataset in Fig. c and d. And Fig. d is a zoom in for a specific region of Fig. c. We can learn from Figure d that the spatial resolution of the CDC dataset is 0.25 degrees and there is a spatial gradient variation.

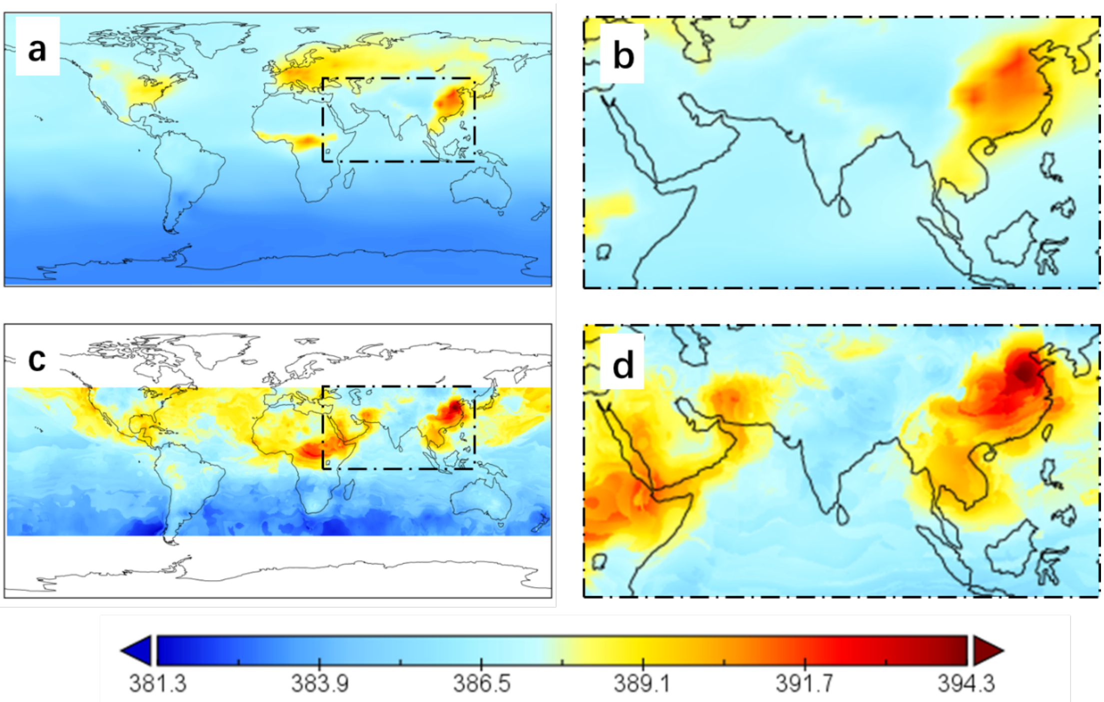

Figure 17-1 XCO_2 distribution maps in January 2010, Fig. a and b show global and local XCO_2 maps from CarbonTracker data (CT2019B version), and Fig. c and d show global and local XCO_2 maps from the CDC dataset.

18. As mentioned above, in addition to the error evaluation in the time dimension, the error in the spatial dimension should also be evaluated to illustrate the reliability of the data.

Dear reviewer, thank you for your kindly suggestions. CarbonTracker data are simulated data and not observed data based on satellites or ground stations. Therefore, CarbonTracker data as a validation dataset will have a large uncertainty in the validation results. Although there is a large uncertainty in this validation result, it still has a reference value for evaluating the distribution of spatial errors. The CT2019B version of CarbonTracker data was used and can be downloaded from the official website. (https://gml.noaa.gov/aftp/products/carbontracker/co2/CT2019B/molefractions/co2_total_ monthly/, Last Access:2022/11/18).
There is a difference in data resolution, namely 3°by 2° for the CarbonTracker data and 0.25°by0.25° for the CDC dataset. Thus, the resolution of the CDC dataset was resampled from 0.25°by0.25° to 3°by 2°. And multiple pixel values are averaged is the method of CDC data resampling. Besides, it is worth noting that CarbonTracker data is 25 layers at different heights. Therefore, the CarbonTracker data were averaged directly based on the different height layers data. Figure 18-1 shows the calculated bias based on the CarbonTracker data and the CDC dataset in January 2010. From Figure 18-1, we can see that the bias is [-2.5,2.5] in most of the area, and the bias is more than 2.5 ppm in a few areas. Furthermore, the mean bias is 0.1202 ppm. Therefore, the spatial bias distribution of the CDC data is within a reasonable range.

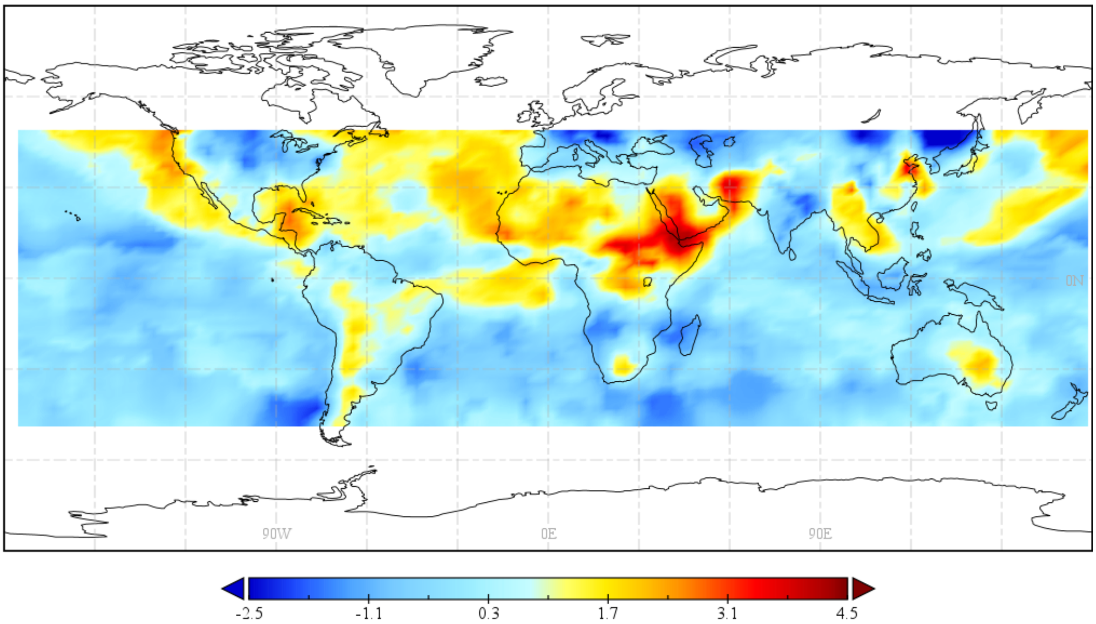

Figure 18-1 Spatial bias between CDC dataset and CarbonTracker data (CT2019B version) in January 2010**.**

19. I am not a Native English speaker. But I believe that the English of this article should be greatly improved, including scientific names of many nouns, and descriptions in scientific language.

Buchwitz, Michael, et al. "Computation and analysis of atmospheric carbon dioxide annual mean growth rates from satellite observations during 2003–2016." Atmospheric Chemistry and Physics 18.23 (2018): 17355-17370.

Chatterjee, A., et al. "Influence of El Niño on atmospheric CO2 over the tropical Pacific Ocean: Findings from NASA's OCO-2 mission." Science 358.6360 (2017): eaam5776.

Dear reviewer, thank you for your kindly suggestions. We checked and revised the language, professional nomenclature, and units in charts and graphs in the paper. In addition, we have read the literature mentioned in your question.