Supplementary Materials

Analysis of the current situation of CO2 satellite observation

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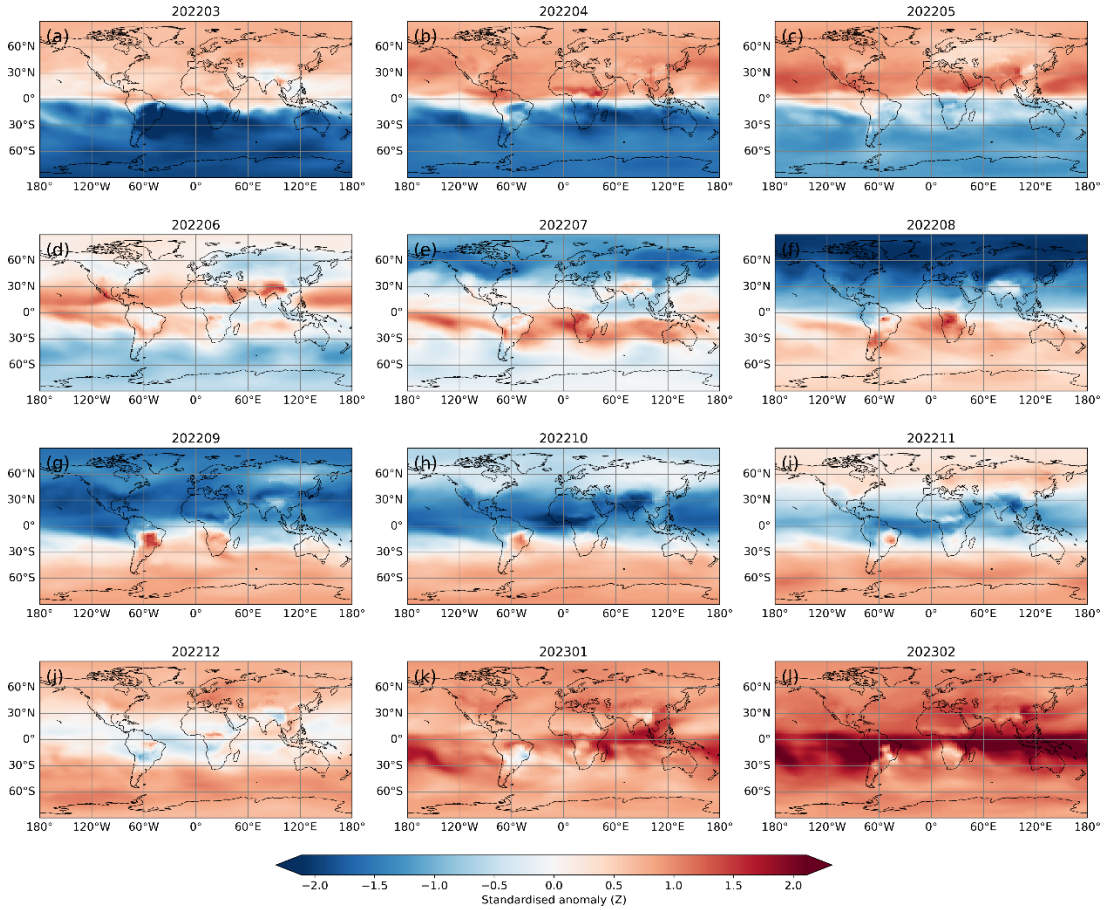


Figure S1. Standardized temporal anomaly of monthly XCO_2 for CT data from March 2022 to February 2023. Here, standardized anomalies are computed individually at each grid point by normalizing its time series.

The standardized temporal anomaly is calculated by

$$Z_{i,j,t} = \frac{X_{i,j,t} - \overline{X_{i,j}}}{\sigma_{i,j}},$$

where i, j, t represent the index of longitude, latitude, and month, respectively.

In Figure S1, The XCO_2 in northern hemisphere experienced combination effect of an increasing trend and seasonal response, whereas only the increasing trend are obvious in southern hemisphere with much weaker seasonal response. Each pattern not only demonstrates the temporal evolution of XCO_2, but also implies the large-scale atmospheric horizontal motion, because the dynamics of XCO_2 is driven by it.

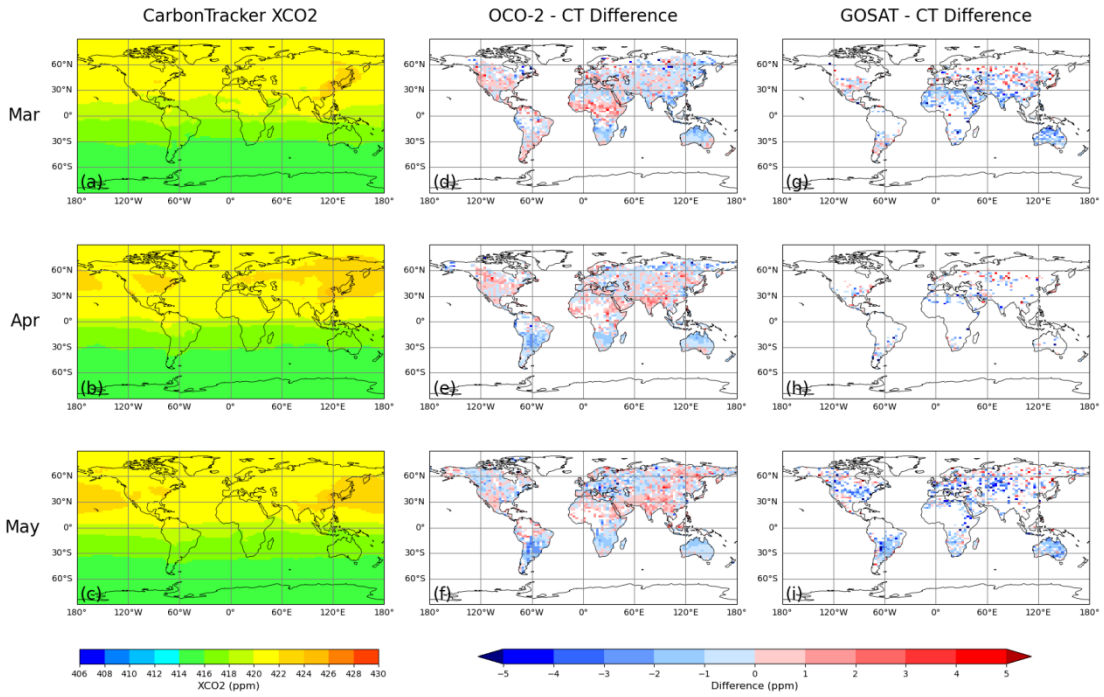


Figure S2. The same as Fig. 7 but in March, April, and May 2023.

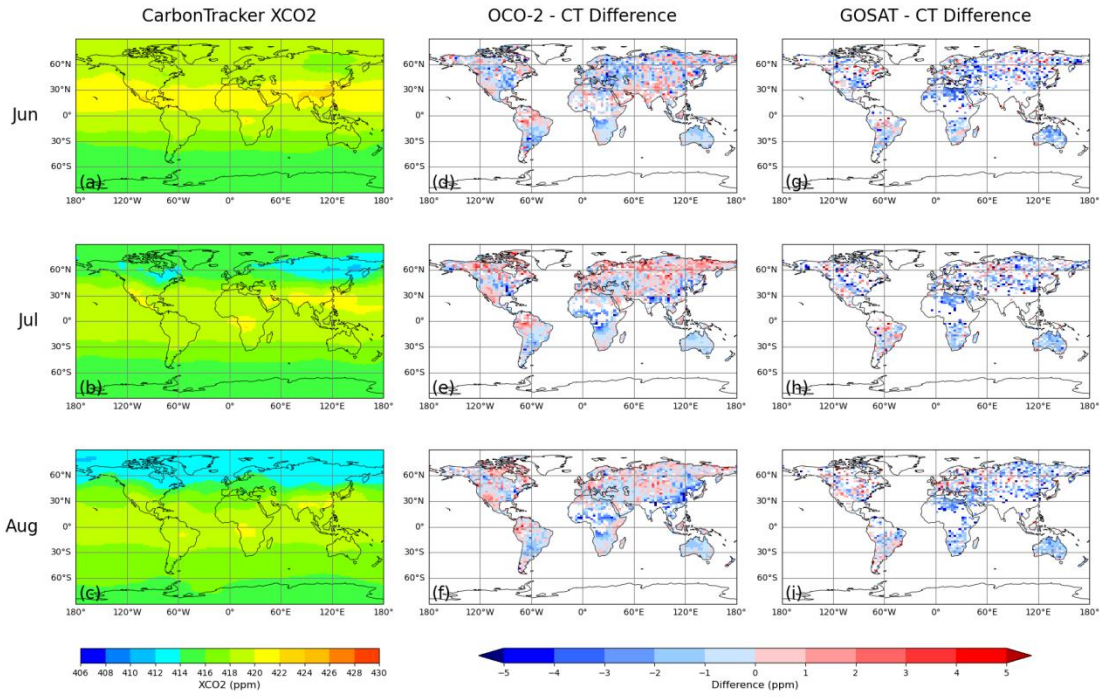


Figure S3. The same as Fig. 7 but in June, July, and August 2023.

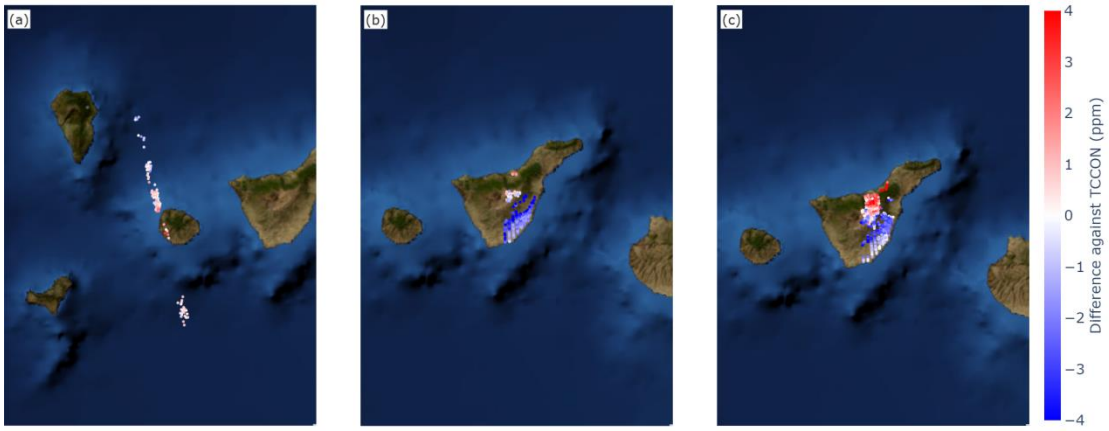


Figure S4. Difference of OCO-2 observations with respect to TCCON measurement over Izaña on (a) 18 July 2022, (b) 17 August 2022, and (c) 20 October 2022 plotted on a map.

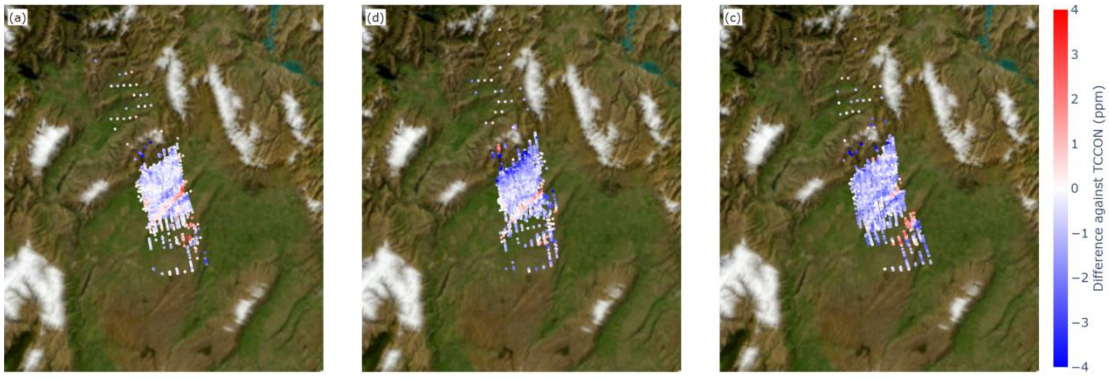


Figure S5. The same as Fig. S4 but over Lauder on (a) 9 April 2022, (b) 25 October 2022, and (c) 8 January 2023.

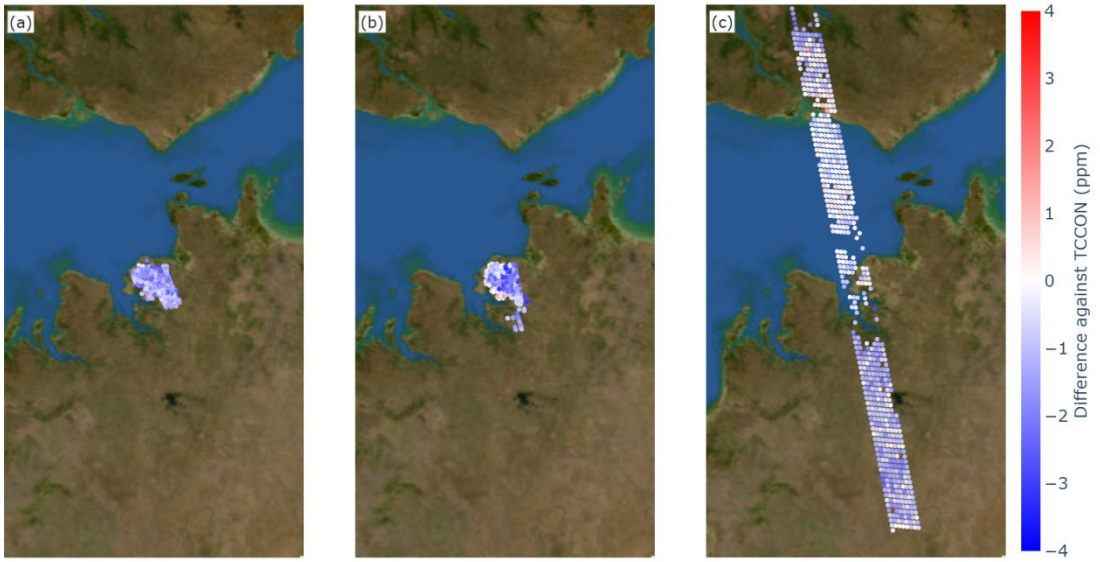


Figure S6. The same as Fig. S4 but over Darwin on (a) 2 May 2022, (b) 12 July 2022, and (c) 28 July 2022. Notably, 28 July 2022 is the only day with a sufficient number of ocean observations. The other two days with ocean measurements are 25 October 2022 and 3 December 2022. However, the number of footprints on each day was no more than 17.

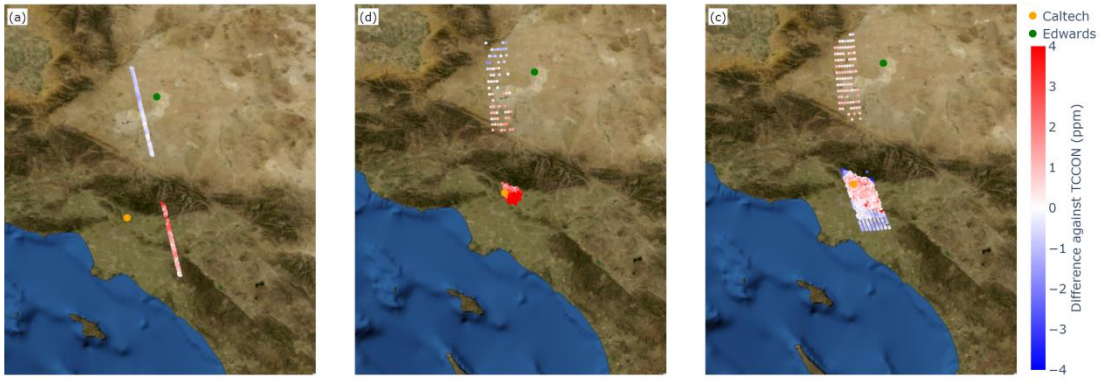


Figure S7. The same as Fig. S4 but over Caltech and Edwards on (a) 9 July 2022, (b) 4 September 2022, and (c) 26 January 2023. The location of Caltech and Edwards sites are also shown by orange and green points, respectively. The clear contrast can be observed. The observations over Edwards are significantly better than those over Caltech.

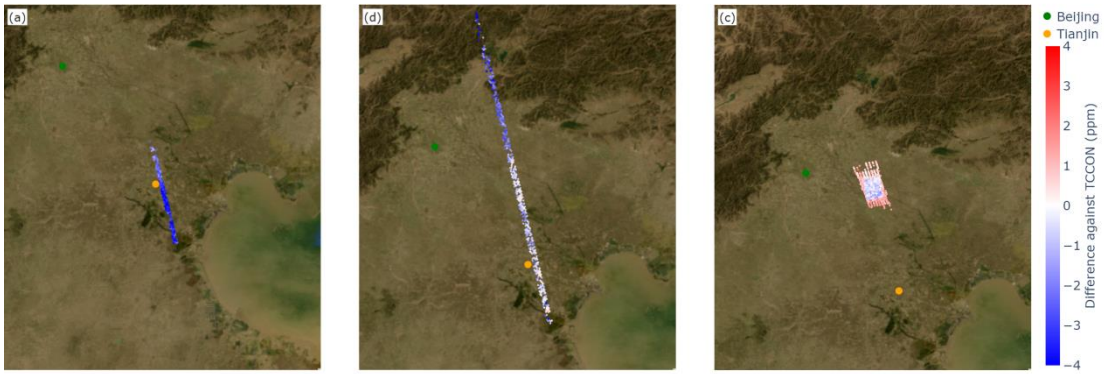


Figure S8. The same as Fig. S4 but over Xianghe on (a) 28 September 2022, (b) 1 December 2022, and (c) 28 February 2023. The approximate location of Tianjin and Beijing, which are two large cities, are also demonstrated by orange and green points, respectively.