



Supplementary Materials: Data-driven assessment of biosphere-atmosphere interaction impact on seasonal cycle pattern of XCO₂ using GOSAT and MODIS observations

Zhonghua He^{1,2}, Zhao-Cheng Zeng^{1,3,*}, Liping Lei^{1,*} Nian Bie^{1,2}, and Shaoyuan Yang^{1,2}



Figure S1. The global map of coefficient of determination (R²) between fitting-XCO₂ and GM-XCO₂ using equation (1). R² in each grid represents the goodness-of-fit of the grid, such as one fitting shown in Figure 2.



Figure S2. Temporal variation comparison for the 12 TCCON sites. As shown in these panels, the original ACOS-GOSAT XCO₂ retrievals within 500 km of the TCCON site are in gray dots. The TCCON data, smoothed by applying the ACOS-GOSAT averaging kernel, are indicated by blue dots. The data are chosen using coincidence criteria of within ±1 hours of GOSAT overpass time, and a 3-day (one time-unit) mean is calculated for the comparison. The predicted TCCON site XCO₂ time series using the mapping approach are indicated by the red dots.



Figure S3. SCA difference between averaged GM-XCO₂ and CT-XCO₂ in the mapping area from June 2009 to May 2014, which is calculated using GM-XCO₂ shown in Figure 3 minus corresponding values of CT-XCO₂ shown in Figure 9. Negative values indicate GM-XCO₂ SCA is lower than that of CT-XCO₂, and positive values indicate that GM-XCO₂ is higher.



Figure S4. Monthly mean of detrended XCO₂ (dXCO₂) and bottom-up estimation of fossil fuel emissions (FFCO₂) from ODIAC (Open-source Data Inventory for Anthropogenic CO₂) and CDIAC (Carbon Dioxide information Analysis Center) over (a) Cropland in northern of India (CnI) and (b) Cropland in northern of China (CnC), two regions of interest as shown in Figure 1, from June 2009 to May 2014.



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