remote sensing

Article

Detection of Spatiotemporal Extreme Changes in Atmospheric CO_2 Concentration Based on Satellite Observations

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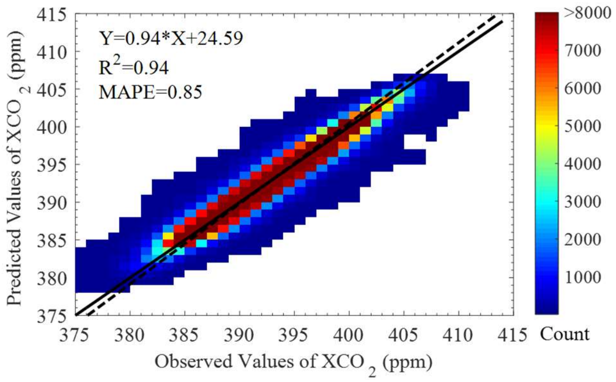
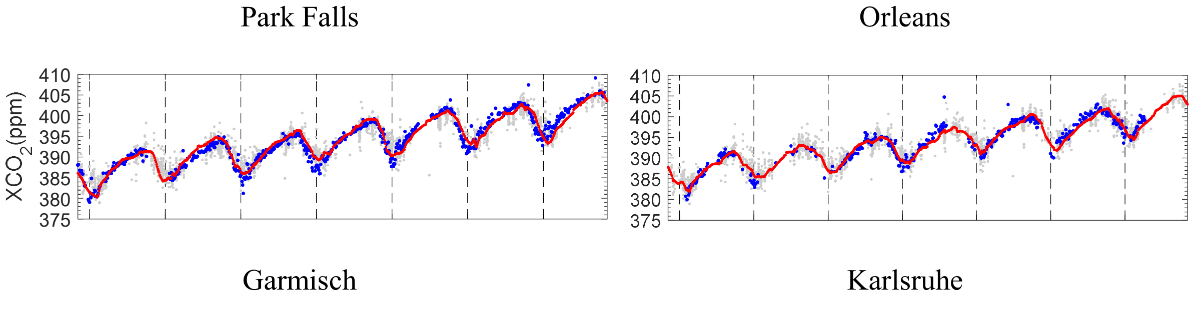


Figure S1. The relationship between predicted XCO_2 and observed XCO_2 values in cross-validation of global land mapping of XCO_2. The color grids represent the density of data distribution. The dotted line is derived from linear regression of predicted values of XCO_2 (Y) and the observed values of XCO_2 (X), which shows a significant linear relationship with R^2 equals 0.94 (p-value < 0.01) and good consistency of observed XCO_2 and predicted XCO_2 with mean absolute prediction error (MAPE) equal to 0.85. The solid line shows the one-to-one line.



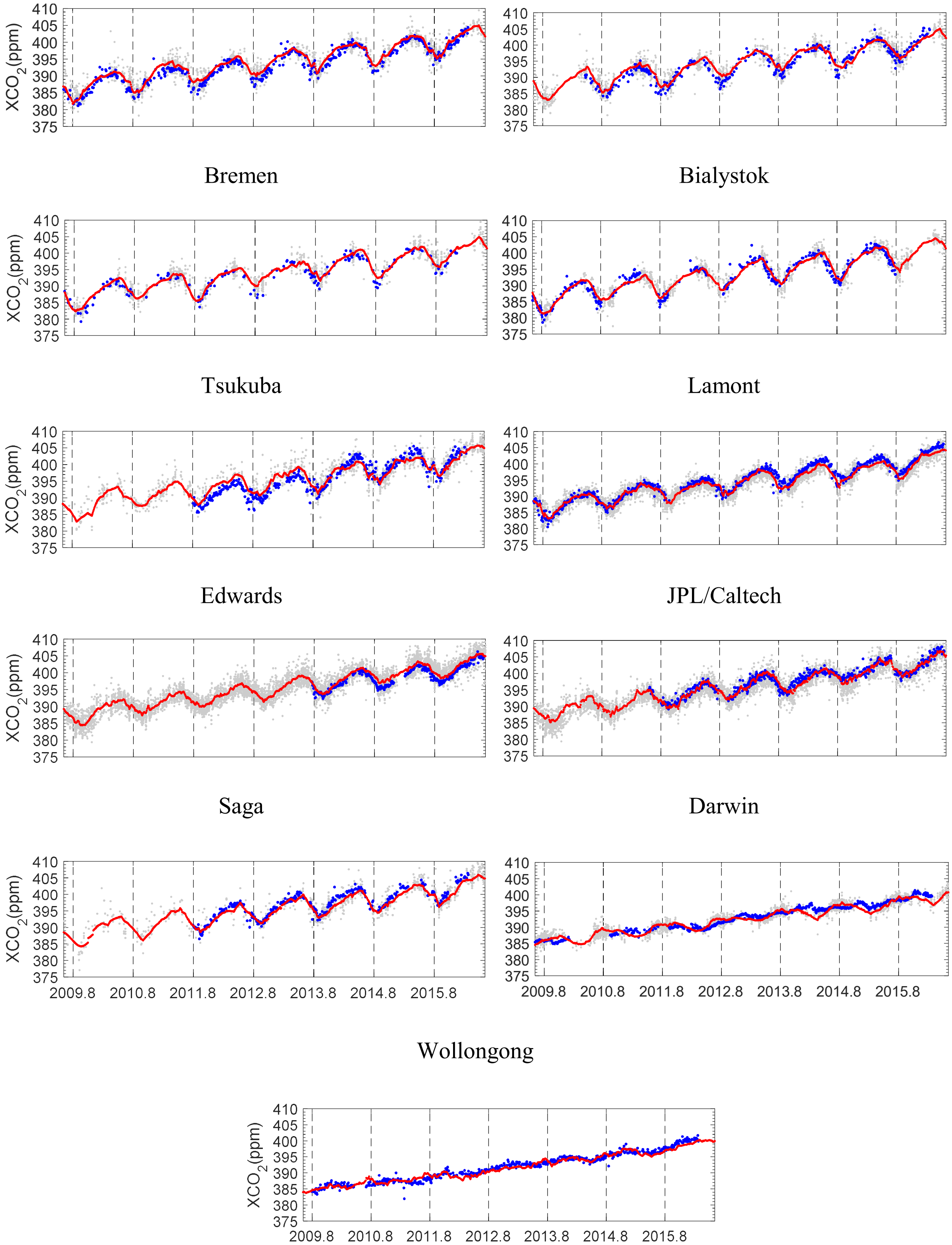
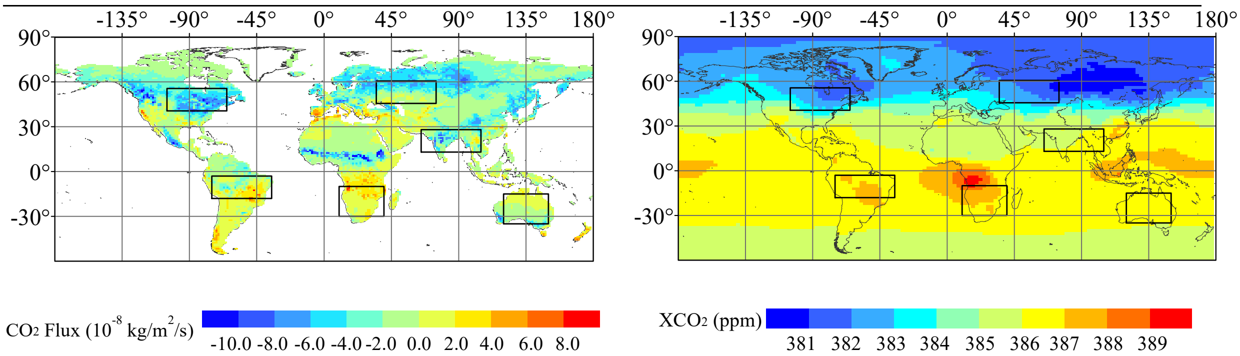


Figure S2. Temporal variation comparison for the 13 Total Carbon Column Observing Network (TCCON) sites. As shown in these panels, the original ACOS-GOSAT XCO_2 retrievals within 500 km of the TCCON site are in gray dots. The TCCON data, smoothed by applying the ACOS-GOSAT averaging kernel, are indicated by blue dots. The data are chosen using coincidence criteria of within ±2 hours of GOSAT overpass time, and a 3-day (one time-unit) mean is calculated for the comparison. The predicted TCCON site XCO_2 time series using the mapping approach are indicated by the red dots.

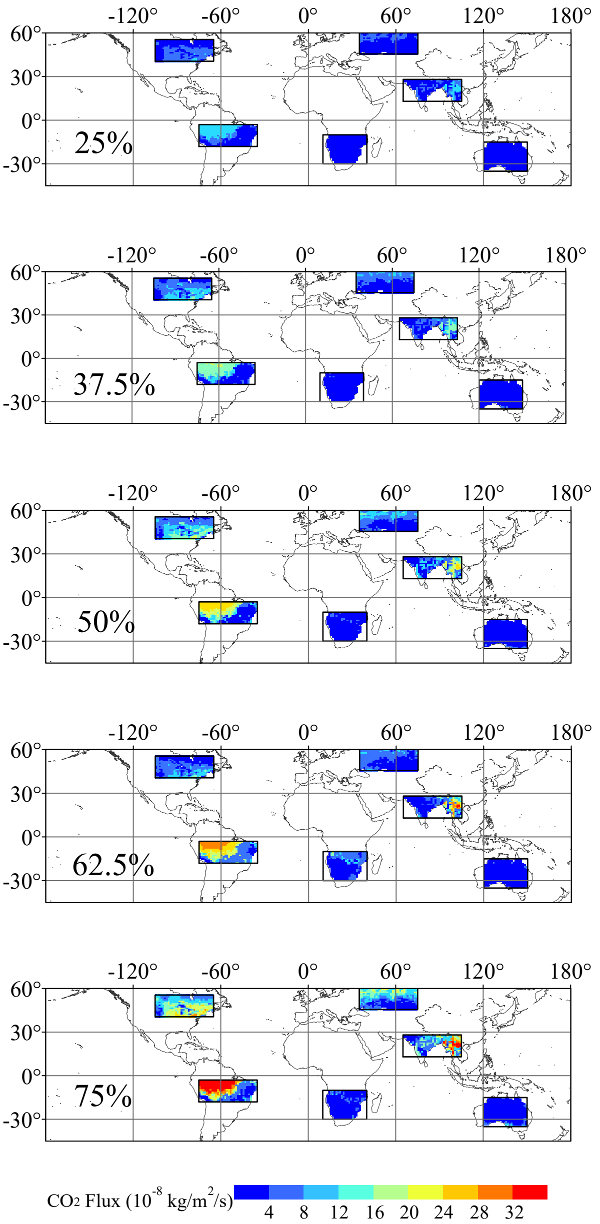
Table S1. Statistics of comparison between GM-XCO2 and TCCON data (smoothed by applying the ACOS-GOSAT averaging kernel). Bias is calculated using GM-XCO2 minus TCCON XCO2 for each coincident data pair and averaged for each site.

Sites	Location (Latitude, longitude)	Coincident Data Pairs	Averaged Biases (ppm)	Averaged Absolute Bias (ppm)	Standard Deviation (ppm)
Bialystok	(53.23, 23.02)	377	0.09	0.96	1.68
Bremen	(53.1, 8.85)	191	0.67	1.15	1.75
Karlsruhe	(49.1, 8.44)	346	0.64	1.29	2.09
Orleans	(47.97, 2.11)	411	-0.05	0.89	1.41
Garmisch	(47.48, 11.06)	478	0.90	1.19	1.37
Park Falls	(45.94, −90.27)	665	0.11	1.02	1.76
Lamont	(36.6, −97.49)	761	-0.57	0.92	1.02
Tsukuba	(36.05, 140.12)	412	0.60	1.66	3.61
Edwards	(34.96 -117.88)	297	1.07	1.10	0.45
PL/Caltech	(34.2, −118.18)	584	-0.20	0.86	1.14
Saga	(33.24, 130.29)	329	-0.71	0.96	1.01
Darwin	(−12.43, 130.89)	612	-0.25	1.02	1.46
Wollongong	(−34.41, 150.88)	609	-0.19	0.77	0.93
Overall		6072	0.16	1.06	1.51

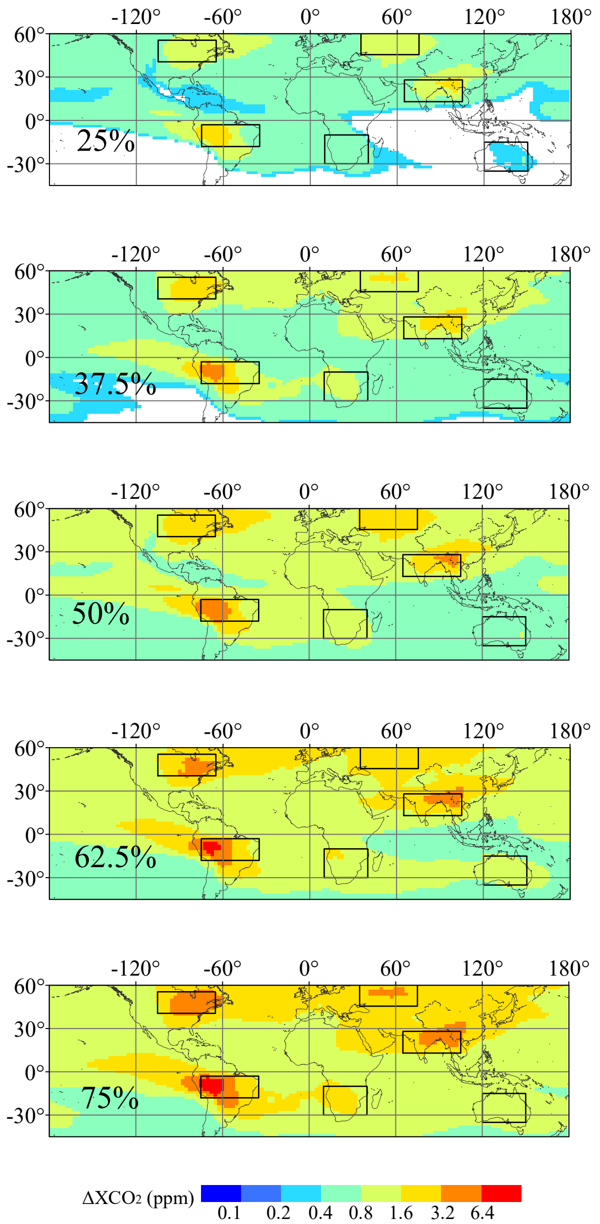


(a) Mean biosphere CO_2 fluxes from SiB3 over July 1 to September 31 of 2009

(b) Mean GEOS-XCO_2 using original SiB3 over July 1 to September 31 of 2009

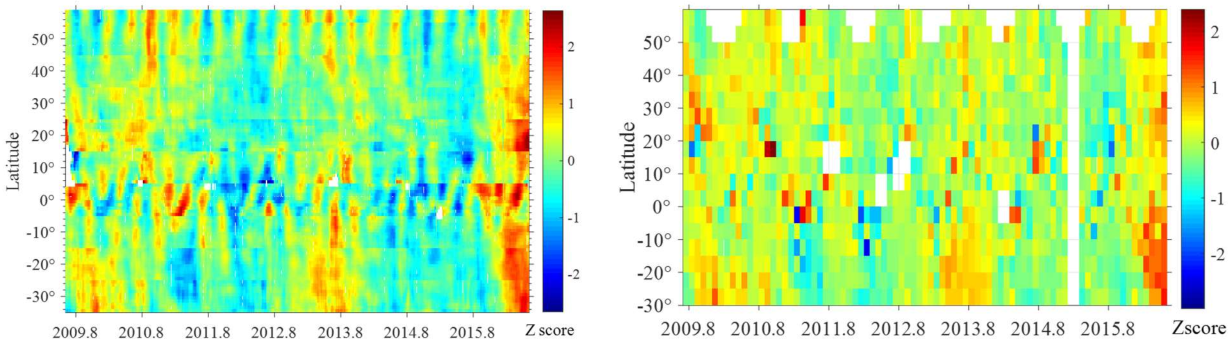


(c) Different ratio (25%; 32.5%; 50%; 62.5%; 75%) of biospheric CO_2 fluxes as CO_2 emission



(d) Different GEOS-CO_2 response to different ratio of CO_2 fluxes change in (c).

Figure S3. Different biospheric CO_2 fluxes influence on XCO_2 from GEOS-Chem model simulation. They are mean biospheric CO_2 fluxes and corresponding XCO_2 output shown in (a) and (b). Different enhancements of local biospheric CO_2 fluxes as emission input for simulating different carbon sources/sinks changes are shown in (c). Different XCO_2 output for different CO_2 flux change are shown in (d).



(a) Z score of GM-XCO_2 (b) Z score of original ACOS-XCO_2

Figure S4. Latitudinal-temporal Z score of XCO_2 fitting residuals from GM-XCO_2 (a) and original ACOS-XCO_2 (b). Red represents high posibility of extreme highly increased XCO_2.