Table S1. Average low–order calorific value and carbon emission factor of energy types.

Type of fossil energy	Average low-order calorific value	carbon emissions coefficient
Coal	20934 kJ/kg	26800 kg/TJ
Coke	28470 kJ/kg	29500 kg/TJ
Crude oil	41868 kJ/kg	20000 kg/TJ
Fuel oil	41868 kJ/kg	21100 kg/TJ
Gasoline	43124 kJ/kg	18900 kg/TJ
Coke oven gas	17375 kJ/cu m	13000 kg/TJ
Kerosene	43124 kJ/kg	19600 kg/TJ
Diesel oil	42705 kJ/kg	20200 kg/TJ
Liquefied petroleum gas	50241 kJ/kg	17200 kg/TJ
Natural gas	38979 kJ/cu m	15500 kg/TJ
Electricity	–	2746 t/B kW h

Table S2. Parameters for the panel data models.

Province	β_1	β_2	λ
Anhui	0.6929	0.4619	3.7612
Beijing	0.2109	-0.1406	21.9418
Chongqing	0.4954	0.3303	7.7577
Fujian	1.1179	0.7453	-8.8321
Gansu	0.3398	0.2266	6.5663
Guangdong	0.9476	0.6318	-8.1265
Guangxi	0.8496	0.5664	-2.5757
Guizhou	0.5818	0.3879	4.8311
Hainan	0.8281	0.5520	-3.0173
Hebei	1.1500	0.7666	-10.5230
Heilongjiang	0.6794	0.4530	-0.2272
Henan	0.9621	0.6414	-2.5776
Hubei	0.7196	0.4797	3.2754
Hunan	0.9416	0.6278	-2.4291
Jiangsu	0.7708	0.5138	0.6036
Jiangxi	0.6033	0.4022	3.7016
Jilin	0.8282	0.5522	-0.8376
Liaoning	0.6379	0.4253	0.9984
Inner Mongolia	0.6389	0.4259	3.4447
Ningxia	0.5565	0.3710	5.0068
Qinghai	0.6923	0.4616	1.7835
Shaanxi	0.8807	0.5872	-2.5956
Shandong	1.3769	0.9179	-13.2881
Shanghai	0.6306	0.4204	3.7832
Shanxi	1.0066	0.6711	-3.8326
Sichuan	0.7947	0.5298	-1.9313
Tianjin	1.0025	0.6683	-2.5934

Xinjiang	0.9092	0.6061	-1.1646
Yunnan	0.6890	0.4593	-1.4769
Zhejiang	0.7141	0.4761	1.5366
Tibet	0.6923	0.4616	1.7835

Figure 3b labels the pixels as HG, LG, NG, and HNG. The total pixels corresponding to each of the growth modes for the global context (full study area) and the growth modes at the local scale (city boundary p=1) are shown in Table S3. Then we calculated the $n_{(1)(q)}/n_{(1)}$ for local scale and the $N_{(q)}/N$ for the full area, and finally the r values for the four types of local scale can be obtained according to Eq. (10) (Table S3).

Table S3. The results four contribution roles from the example city p.

Areas	Indicators	HG (q=1)	LG (q=2)	NG (q=3)	HNG (q=4)	Total
Local scale	Number of pixels	6	2	3	3	14
Global context	Number of pixels	33	35	32	19	119
Local scale	$n_{(1)(q)}/n_{(1)}$	0.43	0.14	0.21	0.22	1
Global context	$N_{(q)}/N$	0.28	0.29	0.27	0.16	1
Local scale	$r_{(1)(q)}$	1..54	0.48	0.78	1.31	/
Local scale	Effect	Enhancing	Suppressing	Suppressing	Enhancing	/

HCO_2 in China were calculated for the period 2000–2020. To test the accuracy of the model for HCO_2 estimation, the estimated HCO_2 without correction using provincial HCO_2 statistics of 31 provinces in 2000, 2010 and 2020 were integrated and verified using coefficient of determination (R^2), mean relative error (MRE), and root mean square error (RMSE), and the results are shown in Table S4.

Table S4. Accuracy assessment between the estimated HCO_2 without correction using provincial HCO_2 statistics and statistical HCO_2 for years 2000, 2010 and 2020.

Province	2000		2010		2020	
	$SHCO_2$	$EHCO_2$	$SHCO_2$	$EHCO_2$	$SHCO_2$	$EHCO_2$
Tibet	1.153	1.157	3.168	3.226	4.961	5.057
Hebei	23.176	23.227	53.643	53.683	97.009	96.819
Shanxi	29.889	29.891	67.078	67.314	82.949	83.092
Shaanxi	10.344	10.465	19.940	19.958	36.217	36.096
Hainan	0.929	0.954	2.700	2.741	3.798	3.833
Guangxi	5.503	5.499	11.636	11.641	20.144	20.096
Inner Mongolia	7.798	7.725	32.447	32.106	38.105	37.681
Ningxia	3.102	3.064	6.130	6.038	16.704	16.330
Qinghai	1.153	1.157	3.168	3.226	4.961	5.057
Sichuan	19.268	19.185	36.614	36.735	49.693	49.721
Shanghai	9.316	9.306	19.912	20.078	26.492	26.581

Jilin	7.384	7.414	17.766	17.785	18.061	18.119
Jiangsu	18.022	18.041	43.771	43.878	71.492	71.691
Tianjin	5.514	5.552	13.021	13.069	25.657	25.704
Yunnan	7.324	7.316	13.874	13.947	16.180	16.201
Gansu	1.632	1.658	8.184	8.244	17.999	18.142
Zhejiang	33.120	33.260	49.092	49.415	61.711	61.815
Chongqing	5.373	5.392	9.236	9.306	19.697	19.664
Heilongjiang	18.836	18.808	29.810	29.729	38.800	38.567
Liaoning	21.701	21.684	35.367	35.425	56.778	56.920
Beijin	10.842	10.978	22.813	22.914	18.817	18.868
Shandong	13.728	13.784	45.180	45.325	88.600	88.821
Fujian	6.857	6.780	17.700	17.547	29.058	28.843
Guizhou	7.637	7.736	11.406	11.538	12.770	12.960
Guangdong	23.608	23.690	46.095	46.444	89.762	90.090
Taiwan	4.399	4.419	5.013	5.106	5.902	5.880
Anhui	8.471	8.534	34.295	34.429	65.490	65.658
Henan	26.184	26.260	36.022	36.067	70.515	70.665
Xinjiang	5.737	5.694	13.012	12.902	35.342	35.155
Hubei	14.205	14.493	23.558	23.800	40.198	40.702
Jiangxi	6.760	6.798	11.205	11.248	27.165	27.284
Hunan	13.258	13.162	27.026	26.981	31.313	31.332
R^2	0.996		0.989		0.989	
MRE	0.007		0.006		0.005	
RMSE	0.081		0.144		0.181	

Note: $SHCO_2$ denotes statistical HCO_2; and $EHCO_2$ denotes the estimated HCO_2 (Million tons); R^2 is the coefficient of determination; MRE is the mean relative error; RMSE is the root mean square error.

We calculated the variation rates of HCO_2 in China for the periods 2000–2010, 2010–2020 and 2000-2020. We then classified the variation rates of HCO_2 emissions into four types, HNG, NG, LG and HG during 2000–2010, 2010–2020 and 2000-2020, respectively, based on the methodology mentioned in 2.5. The results are show in Table S5 and Figure 6.

Table S5. The range of values for HNG, NG, LG and HG.

Year	HNG	NG	LG	HG
2000-2010	$[-0.45,-0.23)$	$[-0.23,0)$	$[0,0.68)$	$[0.68,1.65)$
2010-2020	$[-0.31,-0.19)$	$[-0.19,0)$	$[0,0.53)$	$[0.53,1.46)$
2000-2020	$[-0.43,-0.21)$	$[-0.21,0)$	$[0,0.63)$	$[0.63,1.61)$

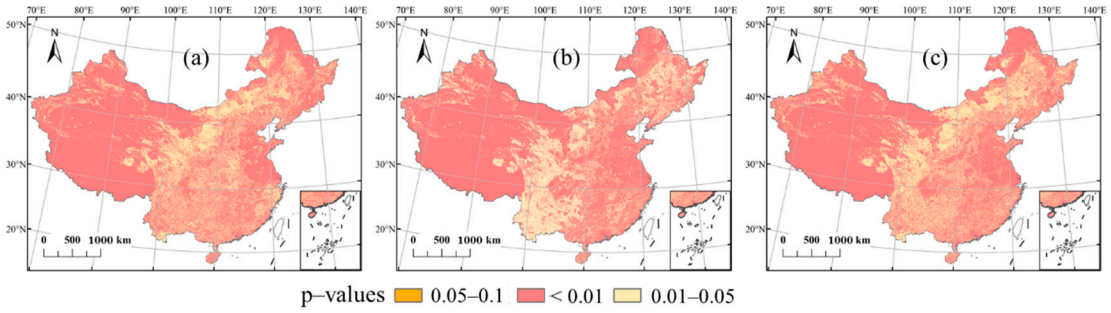


Figure S1. Significance test results of the fitted line for HCO_2 during (a) 2000–2010, (b) 2010–2020 and (c) 2000–2020.

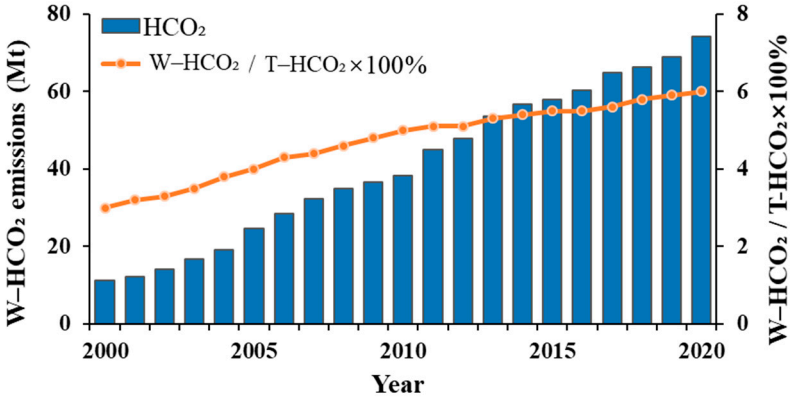


Figure S2. HCO_2 on the west side of the Hu line ($W–HCO_2$) and its share of $T–HCO_2$ from 2000 to 2020.

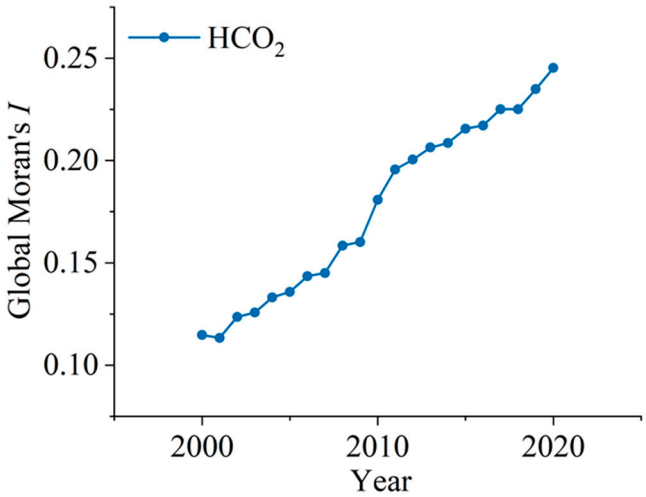


Figure S3. The Global Moran's *I* of HCO_2 at the city level from 2000 to 2020.