Supplementary information

Table S1 Contributions of SIC to SOC plus SIC-derived CO_2 emissions from calcareous soils

Location	Experiment type	Soil type	CO_2 partitioning method	Soil (SIC/STC)/%	CO_2 (SIC/STC)/%	References
USA	Incubation	Desert soil	^{13}C natural abundance	74	13	Stevenson and Verburg, 2006
France	Incubation	Rendosol/Rendzina	^{13}C natural abundance	67	27	Bertrand et al., 2007
		Loess soil		3	35	
Italy	Field	Leptosols	^{13}C natural abundance	65	40	Inglima et al., 2009
					15	
Slovenia	Field	Rendzic leptosol	^{13}C natural abundance	—	17	Cater and Ogrinc, 2011
Israel	Incubation	Typic Calciorthid	^{13}C natural abundance	74	27	Tamir et al., 2011
					56	
Slovenia	Field	Rendzic leptosol	^{13}C natural abundance	—	14	Plestenjak et al., 2012
Canada	Incubation	Typic Hapludalf	^{13}C natural abundance	27	74	Ramnarine et al., 2012
Canada		Typic Hapludalf	^{13}C natural abundance	34	76	
Antarctica	Field	Typic Haploturbels	^{13}C natural abundance	83	76	Shanhun et al., 2012
China	Incubation	Loess soil	^{13}C natural abundance	45	39	Dong, 2013
			^{13}C natural abundance	14	38	
			^{13}C natural abundance	90	65	
Australia	Incubation	Rudosols/Regosol	^{13}C natural abundance	85	95	Lardner et al., 2015
China	Field	—	Soil sterilization at 120℃	46	33	Ma et al., 2015
China	Incubation	Loess soil	Soil sterilization with $HgCl_2$	50	54	Meng et al., 2015
Austria	Incubation	Leptic Histosols	^{13}C natural abundance	—	2	Schindlbacher et al., 2015
					3	
Tunisia	Incubation	Calcari-Leptic Cambisol	^{13}C natural abundance	67	31	Chevallier et al., 2016
					34	
					45	
					47	
China	Field	—	Soil sterilization at 120℃	46	35	Ma et al., 2017
China	Incubation	Loess soil	Soil sterilization at 550℃	42	36	Meng et al., 2017
					28	
					24	
					22	
China	Incubation	Loess soil	^{13}C natural abundance	7	29	Yu, 2018
					32	
					28	
					38	
					24	
France	Incubation	Fluvisol	^{13}C natural	89	25	Cardinael et al.,

			abundance			2020
				89	29	
				91	55	
				91	64	
				87	25	
				89	27	
				90	61	
				91	63	
				78	12	
				87	26	
				91	55	
				92	62	
China	Field	Typic Paleudalfs	^{13}C natural abundance	36	32	Zhang et al., 2019
					28	
					30	
					31	
					33	
					34	
Trinidad and Tobago	Incubation	Aquentic Eutrudepts	^{13}C natural abundance	16	27	Bramble et al., 2020
					24	
					30	
Australia	Incubation	Sodosol	^{13}C natural abundance	13	51	Fang et al., 2020a
Australia	Incubation	Sodosol	^{13}C natural abundance	14	42	Fang et al., 2020b
China	Field	Solonchaks	Soil sterilization at 120℃	42	56	Wang et al., 2020
				50	58	
China	Incubation	Dark loessial soil	^{13}C natural abundance	46	22	Yang, 2020
China	Growth chamber	Cambisol	^{13}C natural abundance	51	30	Sun et al., 2021a
	Field	Fluvic Cambisol		38	35	
China	Field	Typic Paleudalfs	^{13}C natural abundance	36	32	Sun et al., 2021b
					28	
					30	
					31	
					32	
					34	
China	Incubation	—	^{13}C natural abundance	—	2.7	Xu et al., 2022
					3.5	
					3.6	
					2.1	
					2.4	
					2.4	
					2.7	
					2.8	
					2.9	
					3.1	
					3.1	
					3.2	
					3.5	
					3.8	
					4.0	
					3.4	
					3.4	
					3.5	
					3.6	
					4.0	
					4.8	

					2.4	
					2.7	
					3.1	
					3.2	
					3.5	
					3.9	
					3.3	
					3.6	
					4.1	
China	Incubation	Udic Haplustalf	^{13}C natural abundance	50	36	Zhao et al., 2022

Table S2 Observations of paired SIC and SOC concentrations, and paired SIC/STC ratio and soil depth in cropland and natural vegetation

Land use types	Soil depth	SOC concentration	SIC concentration	STC concentration	SIC/STC	References
	(cm)	(g kg^{-1})	(g kg^{-1})	(g kg^{-1})	(%)	
Cropland	0-10	4.4	0.7	5.1	14	Sartori et al., 2007
	10-30	2.6	0.5	3.1	16	
	30-50	1.1	1.1	2.2	50	
	0-5	37	18.1	55.1	33	Jelinski and Kucharik, 2009
	0-5	26.8	18.5	45.3	41	
	0-5	30.4	21.8	52.2	42	
	0-5	52.4	32.9	85.3	39	
	0-5	30.1	30.7	60.8	50	
	0-5	42.4	6.7	49.1	14	
	5-10	37.4	17.3	54.7	32	
	5-10	25.6	19.9	45.5	44	
	5-10	33.1	18.8	51.9	36	
	5-10	47.9	36.3	84.2	43	
	5-10	30.7	28.8	59.5	48	
	5-10	41.7	6.3	48	13	
	10-25	31.1	20.2	51.3	39	
	10-25	26.2	18.4	44.6	41	
	10-25	26.8	22.9	49.7	46	
	10-25	39.7	34.3	74.0	46	
	10-25	25.8	30.7	56.5	54	
	10-25	38.8	5.5	44.3	12	
	0-20	11.8	9.6	21.4	45	Wang, 2011
	0-20	12.3	7.9	20.2	39	
	0-20	15.5	9.2	24.6	37	
	0-20	16.2	10.0	26.2	38	
	0-20	10.5	8.6	19.1	45	
	0-20	12.0	10.5	22.5	47	
	0-20	11.3	12.7	24.0	53	
	0-20	11.7	10.5	22.2	47	
	0-20	19.5	3.6	23.1	16	
	0-20	20.4	3.6	23.9	15	
	0-20	21.0	3.5	24.5	14	
	0-20	17.0	4.0	21.0	19	
	0-20	6.8	4.1	10.9	37	
	0-20	9.9	3.0	12.9	23	
	0-20	9.2	5.4	14.6	37	
	20-100	4.4	11.7	16.1	73	
	20-100	4.7	11.6	16.3	71	
	20-100	5.0	11.6	16.7	70	
	20-100	5.6	12.9	18.5	70	
	20-100	4.6	11.4	16.1	71	
	20-100	4.1	12.9	17.1	76	
	20-100	2.9	14.9	17.7	84	
	20-100	3.6	14.4	18.0	80	
	20-100	6.9	8.0	14.9	54	
	20-100	8.8	7.4	16.2	46	
	20-100	7.0	8.3	15.3	54	
	20-100	8.2	10.1	18.2	55	
	20-100	5.3	7.6	12.9	59	
	20-100	5.6	5.1	10.7	47	
	20-100	4.3	15.7	20.0	79	
	100-160	2.8	15.3	18.1	85	
	100-160	3.6	17.3	20.9	83	
	100-16	3.8	16.9	20.8	82	

	0					
	100-160	3.7	18.0	21.7	83	
	100-160	2.2	13.5	15.7	86	
	100-160	3.1	16.3	19.5	84	
	100-160	3.2	21.0	24.2	87	
	100-160	2.7	20.3	23.0	88	
	100-160	4.5	24.2	28.7	84	
	100-160	3.8	24.8	28.7	87	
	100-160	3.3	31.5	34.8	90	
	100-160	3.8	28.0	31.8	88	
	100-160	3.2	26.3	29.5	89	
	100-160	3.0	26.3	29.3	90	
	100-160	2.3	29.3	31.7	93	
	0-20	13.1	10.6	23.7	45	Gonzalez-Ubierna et al., 2012
	20-40	12.5	10.7	23.2	46	
	0-20	38.1	0.0	38.1	0	Civeira, 2013
	0-20	13.8	0.8	14.6	5	
	0-20	12.5	0.0	12.5	0	
	0-20	12.7	1.8	14.5	12	
	20-100	5.1	1.5	6.6	23	
	20-100	3.5	25.1	28.6	88	
	20-100	1.7	5.5	7.2	76	
	20-100	2.5	45.1	47.6	95	
	0-20	10.0	6.2	16.2	38	Dong, 2013
	0-20	11.0	9.1	20.1	45	
	0-20	12.4	10.2	22.6	45	
	60-80	5.8	0.7	6.5	11	
	60-80	4.3	0.5	4.8	10	
	60-80	3.1	0.7	3.8	18	
	0-5	12.5	27.2	39.7	69	
	5-15	12.1	27.3	39.4	69	
	15-30	10.7	27.4	38.1	72	
	30-50	6.2	30.0	36.2	83	
	50-100	3.7	30.4	34.1	89	
	0-20	9.3	10.5	19.8	53	Guo et al., 2016
	20-40	4.3	11.7	16.0	73	
	40-60	3.5	11.6	15.1	77	
	60-80	2.9	12.6	15.5	81	
	80-100	2.4	12.7	15.1	84	
	0-5	6.7	16.1	22.8	71	Liu et al., 2017
	5-10	6.5	16.2	22.7	71	
	10-20	5.6	16.3	21.9	74	
	20-30	4.5	16.3	20.8	78	
	30-50	3.6	16.4	20.0	82	
	50-70	3.7	16.6	20.3	82	
	70-100	3.7	16.6	20.3	82	
	0-20	8.4	7.5	15.9	47	Shi et al., 2017
	0-20	9.5	8.8	18.3	48	
	0-20	10.5	8.1	18.6	43	
	20-40	4.8	8.5	13.2	64	
	20-40	4.0	9.9	13.9	71	

	20-40	3.4	10.6	14.0	76	
	40-60	3.1	9.0	12.0	74	
	40-60	3.4	12.0	15.4	78	
	40-60	2.8	11.2	13.9	80	
	60-80	2.5	10.2	12.7	80	
	60-80	3.9	13.5	17.4	78	
	60-80	2.8	11.6	14.4	81	
	80-100	2.2	10.3	12.6	82	
	80-100	3.9	14.3	18.1	79	
	80-100	2.6	11.8	14.4	82	
	0-30	10.7	0.7	11.4	6	Shi, 2017
	0-30	12.7	0.5	13.2	4	
	0-30	12.6	0.2	12.9	2	
	0-30	14.9	0.5	15.4	3	
	0-30	13.2	0.9	14.1	6	
	0-30	15.0	0.5	15.6	3	
	30-60	5.2	0.9	6.2	15	
	30-60	6.7	0.5	7.2	7	
	30-60	6.6	1.2	7.8	15	
	30-60	6.7	1.0	7.7	13	
	30-60	8.0	0.4	8.4	5	
	30-60	7.5	1.8	9.3	19	
	60-90	4.1	0.6	4.8	13	
	60-90	5.2	0.8	6.0	13	
	60-90	4.4	2.0	6.4	31	
	60-90	5.0	1.8	6.8	26	
	60-90	3.9	2.2	6.1	37	
	60-90	5.4	1.5	6.8	22	
	0-15	17.1	2.7	19.8	14	Hussai et al., 2019
	15-30	15.5	3.1	18.6	17	
	30-50	13.8	4.0	17.8	22	
	0-5	24.4	1.8	26.2	7	Badagliacca et al., 2020
	0-5	26.2	2.6	28.8	9	
	0-5	10.1	20.9	31	67	
	0-5	12.2	15.2	27.4	55	
	0-5	12.8	16.8	29.6	57	
	0-5	15.8	3.7	19.5	19	
	5-30	13.3	2	15.3	13	
	5-30	16.7	1.2	17.9	7	
	5-30	8.0	17.2	25.2	68	
	5-30	10.7	16.9	27.6	61	
	5-30	10.2	16.4	26.6	62	
	5-30	12.1	2.3	14.4	16	
	0-10	7.4	54.9	62.3	88.1	Cardinael et al., 2020
	10-30	7.6	62.9	70.5	89.2	
	70-100	5.3	48	53.3	90.1	
	0-10	8.1	58.4	66.5	87.8	
	10-30	8.1	58.8	66.9	87.9	
	70-100	5.3	50.1	55.4	90.4	
	0-10	16.9	9.5	26.4	36.0	
	10-30	8.5	9.6	18.1	53.0	
	70-100	5.1	8.2	13.3	61.7	
	0-240	2.7	48.3	51.0	95	Kim et al., 2020
	0-240	3.2	43.0	46.2	93	
	0-240	2.3	13.4	15.7	85	
	0-240	3.3	9.3	12.6	74	
	0-240	0.9	5.5	6.4	87	
	0-240	0.7	5.4	6.1	89	
	0-240	2.5	7.5	10.0	75	
	0-240	2.9	6.9	9.8	71	
	0-240	2.7	4.8	7.5	64	
	0-240	2.9	7.6	10.5	72	
	0-15	23	0.4	23.4	2	Sainju et al., 2020
	15-30	19.7	12.6	32.3	39	

	30-60	35.3	97.7	133	73	
	60-90	37.5	95.8	133.3	72	
	90-120	45.4	77.4	122.8	63	
	0-15	13.4	0.1	13.5	1	
	15-30	10.4	1.3	11.7	11	
	30-60	23.2	29.7	52.9	56	
	60-90	23.1	46.1	69.2	67	
	90-120	23.1	40.2	63.3	64	
	0-20	2.5	13.4	15.9	84	Yu et al., 2020
	20-60	1.8	13.4	15.2	88	
	60-100	1.5	13.1	14.5	90	
	100-200	2.0	12.7	14.7	86	
	0-20	7.5	7.1	14.5	49	Yang, 2020
	0-20	7.0	7.1	14.1	50	
	0-20	7.0	8.2	15.2	54	
	0-20	6.7	8.7	15.4	56	
	0-20	8.5	11.8	20.3	58	
	0-20	7.8	11.8	19.6	60	
	20-60	5.8	5.4	11.3	48	
	20-60	5.2	4.1	9.3	44	
	20-60	6.1	4.7	10.7	44	
	20-60	6.3	4.5	10.8	42	
	20-60	7.9	6.6	14.5	46	
	20-60	6.7	6.0	12.7	47	
	60-150	5.1	2.7	7.8	35	
	60-150	5.6	2.1	7.8	28	
	60-150	5.5	1.4	6.8	20	
	60-150	5.7	1.4	7.1	20	
	60-150	5.5	1.1	6.6	17	
	60-150	4.9	3.1	8.0	39	
Natural vegetation	0-10	2.5	2.6	5.1	51	Sartori et al., 2007
	10-30	1.2	2.4	3.6	67	
	0-10	3.0	2.2	5.2	42	
	0-10	3.7	1.7	5.4	31	
	0-10	3.9	2.0	5.9	34	
	0-10	4.9	1.2	6.1	20	
	0-10	6.3	0.9	7.2	13	
	0-10	8.2	0.8	9.0	9	
	10-30	0.2	2.7	2.9	93	
	10-30	1.6	1.3	2.9	45	
	10-30	1.8	1.2	3.0	40	
	10-30	2.6	0.3	2.9	10	
	10-30	1.4	1.5	2.9	52	
	10-30	2.3	0.6	2.9	21	
	0-5	43.8	39.4	83.2	47	Jelinski and Kucharik, 2009
	0-5	44.5	6	50.5	12	
	0-5	50.9	1.6	52.5	3	
	0-5	78.2	16.1	94.3	17	
	5-10	37.1	45.9	83	55	
	5-10	43.5	7.3	50.8	14	
	5-10	47.3	1.5	48.8	3	
	5-10	62.1	20.2	82.3	25	
	10-25	29.9	35.4	65.3	54	
	10-25	33.9	11.1	45	25	
	10-25	41.6	1.9	43.5	4	
	10-25	51.3	23.1	74.4	31	
	0-5	4.2	12.3	16.5	75	Wang et al., 2015
	5-15	3.1	11.2	14.3	78	
	15-30	1.8	11.3	13.1	86	
	30-50	1.2	8.5	9.7	88	
	50-100	1.4	8.5	9.9	86	
	0-5	11.9	20.8	32.7	64	
	5-15	9.4	22.4	31.8	70	

	15-30	6.2	24.6	30.8	80	
	30-50	4.9	26.2	31.1	84	
	50-100	4.2	26.2	30.4	86	
	0-5	12.0	11.7	23.7	49	Liu et al., 2017
	5-10	7.9	12.4	20.3	61	
	10-20	5.9	12.8	18.7	68	
	20-30	4.5	13.0	17.5	74	
	30-50	3.2	14.1	17.3	82	
	50-70	2.2	11.7	13.9	84	
	70-100	1.9	12.1	14.0	86	
	0-5	11.0	12.0	23.0	52	
	5-10	8.4	12.5	20.9	60	
	10-20	7.4	13.0	20.4	64	
	20-30	5.7	13.2	18.9	70	
	30-50	4.8	13.3	18.1	73	
	50-70	4.1	13.5	17.6	77	
	70-100	3.9	13.3	17.2	77	
	0-5	15.2	11.8	27.0	44	
	5-10	10.5	12.4	22.9	54	
	10-20	7.3	13.0	20.3	64	
	20-30	6.3	13.6	19.9	68	
	30-50	5.6	13.8	19.4	71	
	50-70	5.6	14.0	19.6	71	
	70-100	5.1	13.3	18.4	72	
	0-20	3.4	41	44.4	92	Raheb et al., 2017
	20-35	1.7	50	51.7	97	
	35-60	1.7	76	77.7	98	
	60-130	0.4	91	91.4	100	
	0-16	4.7	56	60.7	92	
	16-45	2.9	80	82.9	97	
	45-80	1.0	117	118	99	
	80-120	0.2	179	179.2	100	
	0-22	4.2	106	110.2	96	
	22-50	2	186	188	99	
	50-83	1.5	143	144.5	99	
	83-130	1	159	160	99	
	0-26	9.3	21	30.3	69	
	26-57	6.1	92	98.1	94	
	57-150	3.3	480	483.3	99	
	0-14	14.9	17	31.9	53	
	14-35	8.2	76	84.2	90	
	35-80	5.1	184	189.1	97	
	15-45	8.4	31	39.4	79	
	45-80	3.9	180	183.9	98	
	80-110	3.7	240	243.7	98	
	0-40	9.8	161	170.8	94	
	40-110	3.5	190	193.5	98	
	110-150	1.8	210	211.8	99	
	0-20	9.5	184	193.5	95	
	20-60	4.7	193	197.7	98	
	60-110	3.1	210	213.1	99	
	0-21	11.5	125	136.5	92	
	21-90	10	125	135	93	
	90-170	4.6	154	158.6	97	
	0-15	24.3	4.1	28.4	15	Hussai et al., 2019
	15-30	22.1	4.4	26.5	17	
	30-50	20.2	6.7	26.9	25	
	0-5	26.6	9.6	36.2	27	Badagliacca et al., 2020
	5-30	10.2	8.7	18.9	46	
	0-240	3.8	46.4	50.2	92	Kim et al., 2020
	0-240	2.6	10.4	13.0	80	
	0-240	3.3	15.1	18.5	82	
	0-240	3.5	6.0	9.5	63	

	0-240	4.4	18.1	22.5	81	
	0-240	3.5	14.1	17.6	80	
	0-20	7.3	15.0	22.2	67	Yu et al., 2020
	20-60	3.9	17.2	21.1	81	
	60-100	2.4	17.4	19.8	88	
	100-200	2.5	16.3	18.8	87	
	0-20	3.3	14.3	17.6	81	
	20-60	2.9	14.0	16.9	83	
	60-100	2.4	14.4	16.8	86	
	100-200	2.1	14.8	16.8	88	
	0-10	29.6	25.9	55.5	47	Wilsey et al., 2020
	10-20	23.8	25.4	49.2	52	
	20-30	22.5	25.8	48.3	53	
	30-40	21.9	25.8	47.7	54	
	40-50	21.9	26.1	48.0	54	
	50-60	20.2	26.2	46.4	56	
	60-70	19.1	27.1	46.2	59	
	70-80	19.4	27.5	46.9	59	
	80-90	19.6	27.6	47.2	58	
	90-100	18.5	29.1	47.6	61	
	0-10	44.7	41.8	86.5	48	
	10-20	38.1	42.7	80.8	53	
	20-30	37.7	43.8	81.5	54	
	30-40	36.8	46.8	83.6	56	
	40-50	35.8	48.3	84.1	57	
	50-60	36.5	48.7	85.2	57	
	60-70	36.5	51.8	88.3	59	
	70-80	36.6	52.7	89.3	59	
	80-90	32.4	54.1	86.5	63	
	90-100	41.8	51.1	92.9	55	
	0-10	6.6	0.5	7.0	6	Leogrande et al., 2021
	10-20	5.8	0.5	6.3	8	
	20-30	5.3	0.5	5.9	9	
	30-40	4.3	0.6	4.9	12	
	40-50	3.2	0.7	3.9	19	
	50-60	2.4	0.8	3.1	24	
	60-70	1.1	0.8	1.9	40	
	0-10	8.6	0.6	9.1	6	
	10-20	7.3	0.6	7.9	7	
	20-30	6.0	0.6	6.5	9	
	30-40	5.8	0.6	6.4	10	
	40-50	4.6	0.6	5.2	12	
	50-60	3.9	0.7	4.5	15	
	60-70	1.7	0.7	2.4	29	
	0-10	10.2	0.4	10.6	4	
	10-20	9.1	0.5	9.6	5	
	20-30	8.2	0.4	8.6	5	
	30-40	8.1	0.5	8.6	6	
	40-50	5.1	0.6	5.6	10	
	50-60	2.7	0.7	3.3	20	
	60-70	1.2	0.7	2.0	38	
	0-10	11.5	0.4	11.9	3	
	10-20	8.6	0.4	9.0	5	
	20-30	8.8	0.5	9.2	5	
	30-40	7.1	0.5	7.7	7	
	40-50	5.5	0.6	6.1	10	
	50-60	4.2	0.6	4.8	13	
	60-70	3.6	0.7	4.3	15	
	0-10	14.2	0.5	14.7	3	
	10-20	12.0	0.5	12.5	4	
	20-30	8.8	0.5	9.3	5	
	30-40	8.0	0.6	8.6	7	

	40-50	5.6	0.6	6.2	10	
	50-60	4.1	0.7	4.8	14	
	60-70	2.1	0.7	2.8	25	
	0-10	18.2	0.4	18.6	2	
	10-20	14.7	0.5	15.1	3	
	20-30	9.1	0.5	9.6	5	
	30-40	7.8	0.5	8.3	6	
	40-50	5.7	0.6	6.3	9	
	50-60	3.2	0.6	3.9	16	
	60-70	2.0	0.7	2.7	25	