Supplement of Atmos. Meas. Tech., 14, 3481–3500, 2021
https://doi.org/10.5194/amt-14-3481-2021-supplement

Atmospheric Measurement Techniques
Open Access

Supplement of

Application of the ECT9 protocol for radiocarbon-based source apportionment of carbonaceous aerosols

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Supplementary Information

Table S1. Individual measurements of OC and EC via ECT9 at ECCC for the references listed in Table 1.

Lab ID	Date	[a]Loaded mass on filter	Carbon fraction OC	PyOC+CC	EC	TC	OC_{total}/TC	EC/TC	TC/loaded mass
		µg		µg/cm^2				%	
Regal Black	(n = 41)								
16-084-04	24-Mar-16	24	0.02	0.69	28.34	29.05	2	98	121
16-098-03	7-Apr-16	22	-0.05	0.48	18.63	19.06	2	98	87
16-098-04	7-Apr-16	23	0.43	0.91	23.89	25.23	5	95	110
16-097-04	6-Apr-16	19	0.44	0.48	20.02	20.94	4	96	110
16-098-06	7-Apr-16	18	0.15	0.49	19.05	19.69	3	97	109
17-052-07	21-Feb-17	21	0.17	0.50	18.42	19.09	4	96	91
17-053-03	22-Feb-17	16	0.14	0.76	13.24	14.14	6	94	88
17-240-06	28-Aug-17	18	0.27	0.59	15.12	15.98	5	95	90
17-243-03	31-Aug-17	20	0.00	0.42	20.22	20.64	2	98	104
17-243-04	31-Aug-17	24	0.14	0.20	18.79	19.13	2	98	79
15-117-07	27-Apr-15	30	0.22	0.95	27.46	28.63	4	96	95
16-094-06	3-Apr-16	32	0.80	0.76	38.23	39.79	4	96	124
16-095-04	4-Apr-16	27	0.39	0.57	26.11	27.07	4	96	100
16-099-06	8-Apr-16	27	0.03	0.87	24.68	25.58	4	96	95
16-099-07	8-Apr-16	26	0.14	0.95	25.37	26.46	4	96	102
17-052-07	21-Feb-17	25	0.12	0.92	23.47	24.51	4	96	98
15-104-08	14-Apr-15	52	0.00	0.85	47.21	48.06	2	98	92
16-095-07	4-Apr-16	47	0.30	1.18	48.19	49.67	3	97	106
16-097-05	6-Apr-16	43	0.32	1.03	39.78	41.13	3	97	96
16-098-08	7-Apr-16	50	0.12	0.67	47.38	48.17	2	98	96
17-052-05	21-Feb-17	53	0.90	1.74	44.31	46.95	6	94	89
17-052-06	21-Feb-17	42	0.22	1.37	35.51	37.10	4	96	88
17-241-07	29-Aug-17	44	0.52	1.51	38.78	40.81	5	95	93
17-241-08	29-Aug-17	49	0.80	0.89	40.80	42.49	4	96	87
17-243-06	31-Aug-17	43	0.00	0.53	38.07	38.60	1	99	91
15-117-10	27-Apr-15	71	0.50	1.59	65.55	67.64	3	97	95

16-098-05	7-Apr-16	61	0.18	1.17	64.91	66.26	2	98	109
16-099-03	8-Apr-16	71	0.00	0.56	64.60	65.16	1	99	92
16-099-04	8-Apr-16	63	0.00	1.36	54.53	55.89	2	98	89
17-052-09	21-Feb-17	83	0.83	2.08	76.60	79.51	4	96	96
17-243-05	21-Feb-17	74	0.67	1.99	63.36	66.02	4	96	89
17-243-07	31-Aug-17	68	0.00	1.14	57.82	58.96	2	98	87
17-243-09	31-Aug-17	71	0.24	1.49	60.34	62.07	3	97	88
15-117-04	27-Apr-15	134	0.00	0.61	123.52	124.13	0	100	93
16-098-07	7-Apr-16	107	0.64	0.42	99.88	100.94	1	99	94
17-240-03	28-Aug-17	95	0.85	2.30	85.17	88.32	4	96	93
17-241-02	29-Aug-17	101	0.83	2.23	88.23	91.29	3	97	90
17-241-06	29-Aug-17	93	0.43	1.24	82.44	84.11	2	98	91
17-240-05	28-Aug-17	116	0.86	2.85	103.57	107.28	3	97	92
17-243-10	31-Aug-17	123	0.11	2.06	109.73	111.90	2	98	91
17-244-02	1-Sep-17	122	0.63	2.11	108.41	111.15	2	98	91
						mean	**3**	**97**	**96**
						s.d.	**1**	**1**	**9**
C1150	(n = 24)								
06-195-07	14-Jul-06	4	0.05	0.05	3.17	3.26	3	97	81
06-195-09	14-Jul-06	7	0.23	0.00	6.35	6.57	3	97	94
06-195-10	14-Jul-06	10	0.48	0.18	8.91	9.57	7	93	96
06-198-03	17-Jul-06	18	0.12	0.09	18.18	18.39	1	99	102
06-198-04	17-Jul-06	25	0.32	0.42	23.22	23.96	3	97	96
06-198-05	17-Jul-06	42	0.02	0.32	39.75	40.08	1	99	95
06-198-06	17-Jul-06	34	0.48	0.42	32.94	33.84	3	97	100
06-198-07	17-Jul-06	15	0.26	0.41	14.45	15.11	4	96	101
13-225-03	13-Aug-13	25	0.00	0.00	20.29	20.29	0	100	80
13-225-04	13-Aug-13	89	0.28	0.00	91.34	91.62	0	100	102
13-225-05	13-Aug-13	30	0.00	0.00	27.50	27.50	0	100	93
13-225-06	13-Aug-13	46	0.00	0.00	38.35	38.35	0	100	84
13-226-03	14-Aug-13	10	0.05	0.01	7.33	7.39	1	99	78
13-226-04	14-Aug-13	79	0.06	0.00	68.51	68.57	0	100	87
13-226-05	14-Aug-13	14	0.05	0.00	13.73	13.78	0	100	98
13-226-06	14-Aug-13	17	0.11	0.00	20.16	20.27	1	99	116

13-226-07	14-Aug-13	49	0.16	0.03	49.37	49.56	0	100	101
15-122-09	2-May-15	72	0.05	0.00	69.62	69.67	0	100	97
15-122-07	2-May-15	71	0.19	0.00	70.79	70.98	0	100	100
15-122-08	2-May-15	104	0.00	0.00	97.78	97.78	0	100	94
15-123-03	3-May-15	22	0.13	0.00	29.38	29.51	0	100	134
15-123-04	3-May-15	71	0.00	0.00	76.06	76.06	0	100	107
15-123-05	3-May-15	27	0.32	0.00	25.96	26.28	1	99	97
15-123-06	3-May-15	59	0.11	0.15	66.40	66.66	0	99	113
						mean	**1**	**99**	**98**
						s.d.	**2**	**2**	**12**
Sucrose	(n = 117)								
13-332-02	28-Nov-13	20	19.76	0.35	0.00	20.11	100	0	101
13-332-03	28-Nov-13	20	19.77	0.48	0.02	20.27	100	0	101
13-333-02	28-Nov-13	20	19.46	0.44	0.00	19.90	100	0	100
13-332-08	28-Nov-13	40	37.50	1.00	0.00	38.50	100	0	96
13-332-10	28-Nov-13	40	38.77	0.98	0.00	39.75	100	0	99
13-333-03	29-Nov-13	40	39.51	1.11	0.01	40.63	100	0	102
13-333-05	29-Nov-13	80	75.63	1.73	0.22	77.58	100	0	97
13-333-08	29-Nov-13	80	74.25	2.14	0.07	76.46	100	0	96
13-333-07	29-Nov-13	80	76.43	2.05	0.07	78.55	100	0	98
14-129-02	9-May-14	20	19.39	0.29	0.06	19.74	100	0	99
14-129-03	9-May-14	20	19.33	0.16	0.05	19.54	100	0	98
14-132-02	12-May-14	20	19.71	0.00	0.00	19.71	100	0	99
14-133-03	13-May-14	40	39.16	0.66	0.60	40.42	99	1	101
14-133-04	13-May-14	40	39.67	0.53	0.10	40.30	100	0	101
14-134-02	14-May-14	40	39.44	0.31	0.11	39.86	100	0	100
14-134-03	14-May-14	80	80.11	0.80	0.10	81.01	100	0	101
14-134-04	14-May-14	80	79.39	1.01	0.36	80.76	100	0	101
14-134-05	14-May-14	80	78.49	1.86	1.46	81.81	98	2	102
14-231-02	19-Aug-14	20	19.03	0.28	0.12	19.43	99	1	97
14-234-02	22-Aug-14	20	19.20	0.50	0.13	19.83	99	1	99
14-235-02	23-Aug-14	20	19.06	0.55	0.00	19.61	100	0	98
14-233-05	21-Aug-14	40	38.76	0.99	0.20	39.95	99	1	100
14-233-06	21-Aug-14	40	38.22	0.00	0.00	38.22	100	0	96

14-233-07	21-Aug-14	40	38.32	0.04	0.00	38.36	100	0	96
14-235-08	23-Aug-14	80	78.25	1.44	0.18	79.87	100	0	100
14-235-09	23-Aug-14	80	79.46	0.27	0.00	79.73	100	0	100
14-238-04	26-Aug-14	80	76.15	1.47	0.38	78.00	100	0	98
15-015-03	15-Jan-15	20	18.67	1.22	0.10	19.99	99	1	100
15-015-04	15-Jan-15	20	18.65	1.51	0.18	20.34	99	1	102
15-019-02	19-Jan-15	20	18.95	1.01	0.01	19.97	100	0	100
15-019-03	19-Jan-15	40	35.12	2.62	1.07	38.81	97	3	97
15-020-02	20-Jan-15	40	36.63	1.84	0.17	38.64	100	0	97
15-020-05	20-Jan-15	40	37.43	2.43	0.29	40.15	99	1	100
15-020-06	20-Jan-15	80	75.34	3.27	0.87	79.48	99	1	99
15-020-07	20-Jan-15	80	76.30	3.42	0.92	80.64	99	1	101
15-020-08	20-Jan-15	80	76.65	2.85	0.72	80.22	99	1	100
15-097-03	10-Apr-15	20	19.79	0.41	0.00	20.20	100	0	101
15-114-02	27-Apr-15	20	17.15	2.41	0.12	19.68	99	1	98
15-108-02	21-Apr-15	20	18.62	1.28	0.00	19.90	100	0	100
15-097-04	10-Apr-15	40	39.35	0.85	0.02	40.22	100	0	101
15-097-05	10-Apr-15	40	38.90	1.80	1.02	41.72	98	2	104
15-097-06	10-Apr-15	40	38.59	1.75	0.88	41.22	98	2	103
15-108-04	21-Apr-15	80	76.10	4.20	0.23	80.53	100	0	101
15-108-03	21-Apr-15	80	76.47	4.13	0.31	80.91	100	0	101
15-108-06	21-Apr-15	80	74.94	4.89	0.70	80.53	99	1	101
15-280-03	8-Oct-15	20	17.56	2.64	0.04	20.24	100	0	101
15-280-04	8-Oct-15	20	17.34	2.95	0.05	20.34	100	0	102
15-280-05	8-Oct-15	20	16.99	3.00	0.00	19.99	100	0	100
15-287-02	14-Oct-15	40	34.13	4.64	0.13	38.90	100	0	97
15-287-04	14-Oct-15	40	34.72	4.81	0.15	39.68	100	0	99
15-288-03	15-Oct-15	40	33.67	4.98	0.17	38.82	100	0	97
15-292-03	19-Oct-15	80	70.58	6.94	1.31	78.83	98	2	99
15-292-04	19-Oct-15	80	69.29	7.36	1.53	78.18	98	2	98
15-292-05	19-Oct-15	80	69.29	7.23	1.47	77.99	98	2	97
16-026-03	26-Jan-16	20	17.74	2.70	0.02	20.46	100	0	102
16-026-05	26-Jan-16	20	16.85	3.37	0.12	20.34	99	1	102
16-027-05	27-Jan-16	20	16.68	3.24	0.10	20.02	100	0	100

16-026-06	26-Jan-16	40	34.15	4.79	0.18	39.12	100	0	98
16-027-04	27-Jan-16	40	33.69	4.98	0.51	39.18	99	1	98
16-027-06	27-Jan-16	40	33.14	5.39	0.75	39.28	98	2	98
16-027-07	27-Jan-16	80	69.99	7.15	2.28	79.42	97	3	99
16-028-03	28-Jan-16	80	71.40	7.34	1.98	80.72	98	2	101
16-028-04	28-Jan-16	80	71.87	7.06	1.91	80.84	98	2	101
16-243-03	30-Aug-16	20	16.69	3.24	0.65	20.58	97	3	103
16-243-04	30-Aug-16	20	17.35	3.35	0.07	20.77	100	0	104
16-244-02	31-Aug-16	20	16.80	2.92	0.85	20.57	96	4	103
16-244-05	31-Aug-16	40	35.61	3.87	1.26	40.74	97	3	102
16-244-06	31-Aug-16	40	35.76	3.87	1.29	40.92	97	3	102
16-244-07	31-Aug-16	40	35.81	4.20	1.85	41.86	96	4	105
16-250-02	6-Sep-16	80	77.54	3.94	1.34	82.82	98	2	104
16-250-03	6-Sep-16	80	77.77	3.81	1.26	82.84	98	2	104
16-250-04	6-Sep-16	80	77.95	3.81	1.25	83.01	98	2	104
17-038-04	7-Feb-17	20	14.57	4.14	0.93	19.64	95	5	98
17-039-02	8-Feb-17	20	14.99	3.88	0.84	19.71	96	4	99
17-039-03	8-Feb-17	20	14.74	4.31	0.79	19.84	96	4	99
17-039-04	8-Feb-17	40	32.68	5.47	1.20	39.35	97	3	98
17-039-05	8-Feb-17	40	34.09	5.70	1.00	40.79	98	2	102
17-039-06	8-Feb-17	40	33.22	5.89	2.47	41.58	94	6	104
17-041-02	10-Feb-17	80	74.47	7.17	1.59	83.23	98	2	104
17-041-03	10-Feb-17	80	73.71	5.02	1.61	80.34	98	2	100
17-041-05	10-Feb-17	80	70.96	8.04	2.31	81.31	97	3	102
18-037-03	6-Feb-18	20	20.31	0.00	0.21	20.52	99	1	103
18-032-04	1-Feb-18	20	20.06	0.00	0.11	20.17	99	1	101
18-036-03	5-Feb-18	20	20.01	0.00	0.16	20.17	99	1	101
18-033-06	2-Feb-18	40	37.87	1.66	1.71	41.24	96	4	103
18-037-04	6-Feb-18	40	39.36	1.17	1.39	41.92	97	3	105
18-037-08	6-Feb-18	40	39.02	1.30	1.58	41.90	96	4	105
18-037-09	6-Feb-18	80	73.37	2.92	2.15	78.44	97	3	98
18-037-10	6-Feb-18	80	74.15	3.26	2.33	79.74	97	3	100
18-037-11	6-Feb-18	80	73.89	2.90	2.07	78.86	97	3	99
18-129-02	9-May-18	20	19.45	0.37	0.03	19.85	100	0	99

18-129-03	9-May-18	20	19.81	0.35	0.07	20.23	100	0	101
18-129-04	9-May-18	20	20.06	0.59	0.14	20.79	99	1	104
18-129-05	9-May-18	40	38.26	1.72	1.19	41.17	97	3	103
18-129-06	9-May-18	40	40.03	1.37	0.79	42.19	98	2	105
18-129-07	9-May-18	40	38.42	1.79	1.21	41.42	97	3	104
18-130-02	10-May-18	80	80.93	0.95	0.58	82.46	99	1	103
18-130-03	10-May-18	80	81.34	1.02	0.28	82.64	100	0	103
18-131-08	11-May-18	80	81.52	1.86	0.72	84.10	99	1	105
18-297-02	24-Oct-18	20	19.44	0.45	0.03	19.92	100	0	100
18-302-03	29-Oct-18	20	19.09	0.84	0.36	20.29	98	2	101
18-298-06	25-Oct-18	20	19.17	0.71	0.13	20.01	99	1	100
18-302-06	29-Oct-18	40	39.37	0.89	0.17	40.43	100	0	101
18-298-07	25-Oct-18	40	39.68	0.42	0.29	40.39	99	1	101
18-309-08	5-Nov-18	40	41.22	0.25	0.00	41.47	100	0	104
18-309-11	5-Nov-18	80	78.46	0.81	0.20	79.47	100	0	99
18-309-14	5-Nov-18	80	78.26	1.56	0.15	79.97	100	0	100
18-310-03	6-Nov-18	80	82.01	1.75	0.50	84.26	99	1	105
18-355-02	21-Dec-18	20	22.04	0.99	0.24	23.27	99	1	116
18-355-03	21-Dec-18	20	21.48	1.11	0.15	22.74	99	1	114
18-355-04	21-Dec-18	20	21.17	1.31	0.26	22.74	99	1	114
18-361-04	27-Dec-18	40	42.02	1.29	0.13	43.44	100	0	109
18-361-05	27-Dec-18	40	41.56	0.93	0.00	42.49	100	0	106
18-361-06	27-Dec-18	40	41.06	1.85	0.23	43.14	99	1	108
18-361-07	27-Dec-18	80	85.76	2.27	0.75	88.78	99	1	111
18-361-08	27-Dec-18	80	86.49	2.48	0.78	89.75	99	1	112
18-361-09	27-Dec-18	80	85.98	2.63	0.61	89.22	99	1	112
						mean	**99**	**1**	**101**
						s.d.	**1**	**1**	**4**
Adipic Acid	(n = 5)								
15-062-06	3-Mar-15	34	13.67	0.09	0.00	13.76	100	0	40
15-062-05	3-Mar-15	102	47.47	0.00	0.00	47.47	100	0	47
15-100-02	13-Apr-15	n/a	5.25	0.00	0.05	5.30	99	1	n/a
19-137-05	17-May-19	253	120.68	1.05	0.07	121.80	100	0	48
19-137-06	17-May-19	28	10.62	0.00	0.00	10.62	100	0	38

						mean	**100**	**0**	**43**
						s.d.	**0**	**0**	**5**
Rice Char	(n = 6)								
18-158-05	7-Jun-18	112	4.27	3.25	49.54	57.06	13	87	51
18-164-05	13-Jun-18	212	8.73	6.22	96.87	111.82	13	87	53
18-165-06	14-Jun-18	79	2.96	2.86	35.46	41.28	14	86	52
18-169-04	18-Jun-18	71	2.76	2.70	30.18	35.64	15	85	51
18-172-05	21-Jun-18	150	5.74	4.28	70.40	80.42	12	88	54
18-176-06	25-Jun-18	121	4.83	4.67	56.43	65.93	14	86	54
						mean	**14**	**86**	**52**
						s.d.	**1**	**1**	**1**
SRM-1649a	(n = 6)								
04-271-04	27-Sep-04	690	29.94	9.65	36.46	76.05	52.1	47.9	16.5
04-322-10	17-Nov-04	490	25.82	7.18	30.41	63.41	52.0	48.0	19.4
04-322-12	17-Nov-04	880	40.28	11.25	47.71	99.24	51.9	48.1	16.9
05-046-02	15-Feb-05	1101	51.66	16.59	67.16	135.41	50.4	49.6	18.5
05-046-03	15-Feb-05	441	21.06	6.41	25.35	52.82	52.0	48.0	18.0
05-046-04	15-Feb-05	855	40.33	12.37	51.22	103.92	50.7	49.3	18.2
						mean	**51.5**	**48.5**	**17.9**
						s.d.	**0.8**	**0.8**	**1.1**

[a]Loaded mass are the weighed mass (for Regal black, C1150, Adipic acid, Rice char and SRM-1649a) or injected mass (sucrose) on the filter.

Table S2. Radiocarbon content of bulk reference materials, expressed as fraction modern carbon (FM) with and without background correction. CO_2 isolation and $^{14}C/^{12}C$ analysis were carried out at KCCAMS, UCI (the method is described in Table 2).

UCI AMS #	Size	Corrected FM		Uncorrected FM	
	µg C		±		±
Sucrose					
150230	735	1.0597	0.0021	1.0597	0.0021
150231	769	1.0575	0.0017	1.0574	0.0017
AdipicAcid					
123428	876	0.0002	0.0005	0.0020	0.0001
123430	851	0.0001	0.0005	0.0019	0.0001
123431	934	-0.0001	0.0005	0.0016	0.0001
123432	1053	-0.0003	0.0005	0.0015	0.0001
123433	740	-0.0001	0.0005	0.0016	0.0001
Regal Black					
150228	717	0.0004	0.0005	0.0019	0.0001
150229	752	-0.0005	0.0005	0.0011	0.0000
C1150					
150232	88	0.0026	0.0005	0.0042	0.0001
150233	64	0.0035	0.0005	0.0050	0.0002
150234	560	0.0019	0.0005	0.0035	0.0001
RiceChar					
123434	924	1.0683	0.0023	1.0683	0.0023
123435	913	1.0670	0.0018	1.0670	0.0018
123436	961	1.0673	0.0019	1.0672	0.0019

Table S3. Stable isotopic composition ($^{13}C/^{12}C$) of OC and EC fractions or bulk materials. CO_2 isolation and $^{13}C/^{12}C$ analysis were carried out at the CAIR lab, CRD, ASTD/ECCC (the method is described in Table 2).

Reference m	Lab ID	Date	Fraction	Loaded mass on filter µg or µg C[a]	$\delta^{13}C_{VPDB}$ ‰
Regal Black	16-036-04	5-Feb-16	EC	16	-27.67
(n = 5)	16-036-05	5-Feb-16	EC	27	-27.49
	16-036-06	5-Feb-16	EC	22	-27.67
	16-036-08	5-Feb-16	EC	59	-27.62
	16-036-09	5-Feb-16	EC	68	-27.57
				mean	**-27.61**
				s.d.	**0.08**
C1150	13-013-05	13-Jan-13	EC	50	-23.01
(n = 5)	13-013-07	13-Jan-13	EC	22	-23.16
	13-013-08	13-Jan-13	EC	48	-22.96
	16-036-06	5-Feb-16	EC	30	-23.14
	16-036-07	5-Feb-16	EC	46	-23.05
				mean	**-23.06**
				s.d.	**0.08**
Sucrose[b]	15-146-07	26-May-15	OC	20	-12.08
(n = 9)	15-148-03	27-May-15	OC	20	-12.40
	15-148-04	27-May-15	OC	20	-12.31
		5-Oct-17	OC	20	-12.44
		18-Apr-18	OC	20	-12.04
		18-Apr-18	OC	20	-12.30
		26-Feb-19	OC	20	-12.21
		26-Feb-19	OC	20	-12.16
		26-Feb-19	OC	20	-12.04
				mean	**-12.22**
				s.d.	**0.15**
Rice Char	04-328-06	23-Nov-04	OC	n/m	-24.42
(n = 1)	04-328-07	23-Nov-04	PyOC	n/m	-26.67
	04-328-05	23-Nov-04	EC	n/m	-26.94

		fraction weighted	TC	160	**-26.74**
SRM-1649a (n = 2)	04-330-03	25-Nov-04	OC	n/m	-26.38
	04-338-08	3-Dec-04	OC	n/m	-26.29
	04-330-05	25-Nov-04	PyOC	n/m	-25.51
	04-338-07	3-Dec-04	PyOC	n/m	-25.66
	04-330-06	25-Nov-04	EC	n/m	-25.56
	04-338-09	3-Dec-04	EC	n/m	-25.43
		fraction[c] weighted	TC	~ 600	**-25.84 ± 0.07**

[a]Sucrose was loaded as a solution (µg C), Regal Black, C1150, Rice char, and SRM-1649a as a powder (µg dry mass); [b]$\delta^{13}C_{VPDB}$ of bulk material (sucrose) via off-line method: -12.0 ± 0.2‰ (Satoshi, 2008); [c]Mean fraction (of two measurements) weighted isotopic composition of TC; n/m = not measured.

Table S4. Stable isotopic compositions of $^{13}C/^{12}C$ in OC and EC fractions from mixtures of reference materials. OC and EC fractions were isolated with the ECT9 protocol (Huang et al., 2006), purified in a vacuum system and analyzed on a MAT253 (Huang et al., 2013) at the CAIR lab, CRD, ASTD/ECCC.

Reference mate	Lab ID	ate	Initial mass		Measured fraction	$\delta^{13}C_{VPDB}$
			Sucrose	Regal Black		
			µg C	µg		(‰)
Regal Black	15-148-08	28-May-15	10	22	EC	-27.49
n = 9	15-148-05	28-May-15	15	26	EC	-27.73
	15-149-07	29-May-15	20	50.4	EC	-27.34
	15-148-09	28-May-15	30	66	EC	-27.32
	16-224-04	11-Aug-16	20	57	EC	-27.31
	16-224-07	11-Aug-16	20	53	EC	-27.27
	16-224-08	11-Aug-16	20	58	EC	-27.37
	16-225-07	12-Aug-16	10	20	EC	-27.57
	17-248-08	30-Aug-17	20	53	EC	-27.47
					mean	**-27.43**
					s.d.	**0.15**
Sucrose	15-149-04	29-May-15	10	22	OC	-12.82
n = 9	15-148-06	28-May-15	15	26	OC	-12.54
	15-149-05	29-May-15	20	50.4	OC	-12.54
	15-149-06	29-May-15	30	66	OC	-12.29
	16-224-05	11-Aug-16	20	57	OC	-13.04
	16-224-06	11-Aug-16	20	53	OC	-12.36
	16-225-03	12-Aug-16	20	58	OC	-12.72
	16-225-04	12-Aug-16	10	20	OC	-12.86
	17-242-06	30-Aug-17	20	53	OC	-12.34
					mean	**-12.61**
					s.d.	**0.26**

Table S5. Calculated stable isotopic composition ($^{13}C/^{12}C$) in a two-end-member-mixing system with endmember #1 being Sucrose ($\delta^{13}CV_{PDB}$ =-12.22‰) and end member #2 being Regal black ($\delta^{13}CV_{PDB}$=-27.61‰) and where endmember #1 is mixed into endmember#2.

$\delta^{13}C_{VPDB}$ of pure endmember		***fraction of sucrose* in mixture (Sucrose + Regal black)**	**$\delta^{13}C_{VPDB}$ of the mixture calculated**
Sucrose	Regal black		
‰		%	‰
		0	-27.610
		1	-27.456
		2	-27.302
		3	-27.148
		4	-26.994
		5	-26.841
		10	-26.071
		20	-24.532
		30	-22.993
		40	-21.454
		50	-19.915
		60	-18.376
-12.22	-27.61	70	-16.837
		80	-15.298
		90	-13.759
		91	-13.605
		92	-13.451
		93	-13.297
		94	-13.143
		95	-12.990
		96	-12.836
		97	-12.682
		98	-12.528
		99	-12.374
		100	-12.220

Table S6. Radiocarbon content, expressed as fraction modern carbon (FM), of total (TC), organic (OC), and elemental (EC) carbon fractions with and without background correction following Santos et al. (2010). OC and EC fractions were isolated with the ECT9 protocol (Huang et al., 2006) from pure reference materials (into the form of CO_2), then purified cryogenically and sealed in ampoules at the CAIR lab, ECCC. CO_2 is reduced to graphite (Santos et al., 2007b, 2007a) and analyzed at the KCCAMS facility.

UCIAMS#	Fraction	Mass after ECT9 µgC	Mass atKCCAMS µgC	Corrected FM	±	Uncorrected FM	±
Adipicacid							
153279	TC	10	14	-0.0050	0.0367	0.0593	0.0010
153280	TC	17	16	-0.0116	0.0325	0.0465	0.0009
153281	TC	23	29	-0.0043	0.0165	0.0268	0.0005
153282	TC	37	37	-0.0102	0.0125	0.0140	0.0006
mean				-0.0078			
s.d.				0.0037			
Sucrose							
153283	TC	5	7	1.0041	0.0885	0.8766	0.0101
153284	TC	5	7	1.0031	0.0878	0.8759	0.0051
153285	TC	5	7	1.0346	0.0938	0.8960	0.0064
153286	TC	10	11	1.0529	0.0516	0.9652	0.0045
153287	TC	10	11	1.0360	0.0511	0.9510	0.0070
153288	TC	10	12	1.0571	0.0510	0.9702	0.0056
153289	TC	20	21	1.0477	0.0265	1.0006	0.0069
153290	TC	20	21	1.0429	0.0257	0.9971	0.0058
153291	TC	20	21	1.0470	0.0262	1.0000	0.0056
153292	TC	40	41	1.0405	0.0127	1.0170	0.0034
153293	TC	40	38	1.0543	0.0139	1.0282	0.0034
153294	TC	40	42	1.0509	0.0125	1.0272	0.0026
153295	OC	20	20	1.0844	0.0290	1.0305	0.0041
mean				1.0427			
s.d.				0.0213			
C1150							
153303	TC	7	10	0.0310	0.0535	0.1154	0.0020
153304	TC	16	23	0.0278	0.0205	0.0644	0.0012
153305	TC	34	36	-0.0012	0.0131	0.0237	0.0006
153306	TC	45	55	0.0041	0.0083	0.0201	0.0003

153307	EC	32	33	-0.0072	0.0144	0.0202	0.0004
mean				0.0109			
s.d.				0.0174			
RegalBlack							
153308	TC	16	23	0.0161	0.0209	0.0540	0.0008
153309	TC	47	53	-0.0008	0.0087	0.0160	0.0004
153310	EC	28	41	-0.0057	0.0112	0.0159	0.0004
mean				0.0032			
s.d.				0.0114			
Ricechar							
153299	TC	6	7	0.9383	0.0830	0.8272	0.0097
153300	TC	12	15	1.0463	0.0390	0.9784	0.0057
153301	TC	24	22	1.0823	0.0254	1.0348	0.0046
153302	EC	13	15	1.0621	0.0383	0.9940	0.0046
mean				1.0323			
s.d.				0.0643			
OxalicacidII[a]							
153316	TC	n/a	7	1.3141	0.0398	1.2411	0.0203
153315	TC	n/a	17	1.3365	0.0137	1.3080	0.0063
153314	TC	n/a	45	1.3342	0.0051	1.3235	0.0027
mean				1.3283			
s.d.				0.0123			
Adipicacid[a]							
153318	TC	n/a	6	-0.0020	0.0313	0.0544	0.0031
153317	TC	n/a	16	-0.0016	0.0115	0.0205	0.0011
153278	TC	n/a	56	-0.0014	0.0033	0.0051	0.0003
mean				-0.0017			
s.d.				0.0003			

[a]Reference standards that underwent combustion and graphitization process only for blank determination at KCCAMS (without ECT9); n/a. = not applicable

Table S7. Radiocarbon content, expressed as fraction modern carbon (FM), of total (TC), organic (OC), and elemental (EC) carbon fractions with and without background correction following Santos et al. (2010). OC and EC fractions were isolated with the ECT9 protocol (Huang et al., 2006) from mixtures of reference materials (into the form of CO_2), then purified cryogenically and sealed in ampoules at ECCC. CO_2 is reduced to graphite (Santos et al., 2007b, 2007a) and analyzed at KCCAMS facility.

UCI AMS #	Fraction measured	Initial loaded mass		Mass after ECT9	Mass at KCCAMS	Corrected FM		Uncorrected FM	
		µg C	µg	µg C			±		±
Sucrose + Regal black		Sucrose	Regal black						
159800	OC	5	10	5	6	1.0568	0.0648	0.9738	0.0107
159802	OC	10	21	11	10	1.0542	0.0337	1.0057	0.0049
159804	OC	15	29	16	15	1.0629	0.0216	1.0298	0.0037
159806	OC	20	39	21	20	1.0436	0.0156	1.0201	0.0034
159808	OC	30	63	32	29	1.0563	0.0107	1.0395	0.0025
mean						1.0548			
s.d.						0.0070			
159801	EC	5	10	10	11	-0.0361	-0.0502	0.0535	0.0014
159803	EC	10	21	20	19	-0.0189	-0.0270	0.0317	0.0007
159805	EC	15	29	28	36	-0.0091	-0.0136	0.0172	0.0005
159807	EC	20	39	38	44	0.0014	0.0110	0.0226	0.0004
159809	EC	30	63	61	56	0.0019	0.0085	0.0186	0.0003
mean						-0.0122			
s.d.						0.0159			
Adipic acid + Bulk rice char		Adipic acid	Bulk rice char[a]						
159822	OC	5	11	6	6	0.1009	0.0856	0.2279	0.0027
159824	OC	10	22	12	11	0.0759	0.0450	0.1516	0.0021
159826	OC	15	35	18	17	0.1078	0.0278	0.1558	0.0013
159828	OC	20	44	23	22	0.1072	0.0204	0.1432	0.0014
159830	OC	25	51	29	23	0.1552	0.0185	0.1868	0.0011
159832	OC	30	60	34	32	0.1013	0.0138	0.1263	0.0009
mean						0.1081			
s.d.						0.0250			
159823	EC	5	11	5	5	1.1063	0.0887	0.9903	0.0063
159825	EC	10	22	10	8	1.0981	0.0486	1.0263	0.0052
159827	EC	15	35	16	14	1.0559	0.0231	1.0211	0.0034

159829	EC	20	44	20	17	1.0619	0.0190	1.0328	0.0040
159831	EC	25	51	23	22	1.0625	0.0143	1.0400	0.0027
159833	EC	30	60	27	24	1.0633	0.0131	1.0426	0.0028
mean						1.0747			
s.d.						0.0216			
Adipic acid + Rice char_EC[b]		Adipic acid	Rice char_EC						
159810	OC	5	13	5	6	-0.0605	-0.1166	0.1212	0.0032
159812	OC	10	19	10	10	-0.0324	-0.0558	0.0655	0.0015
159814	OC	15	34	15	15	-0.0075	-0.0345	0.0556	0.0008
159816	OC	20	38	20	20	0.0107	0.0248	0.0568	0.0011
159818	OC	25	49	25	25	-0.0009	-0.0198	0.0366	0.0005
159820	OC	30	60	30	29	0.0103	0.0168	0.0421	0.0006
mean						-0.0134			
s.d.						0.0280			
159811	EC	5	13	6	5	1.0926	0.0931	0.9755	0.0094
159813	EC	10	19	8	7	1.0702	0.0506	0.9997	0.0058
159815	EC	15	34	15	16	1.0709	0.0203	1.0392	0.0037
159817	EC	20	38	17	20	1.0726	0.0162	1.0471	0.0038
159819	EC	25	49	22	21	1.0749	0.0152	1.0505	0.0029
159821	EC	30	60	27	27	1.0723	0.0116	1.0535	0.0024
mean						1.0756			
s.d.						0.0085			

[a]The bulk rice char contains 52% of TC, on which 14% is OC and 86% EC, respectively; [b]Adipic acid was injected after the OC of rice char is removed through combustion at 870°C via ECT9. Thus, adipic acid was mixed only with rice char-EC, and the OC of the mixture is only from Adipic acid and EC of the mixture is only from Rice char.

References

Irei, S., Laboratory study of stable carbon isotope ratio of secondary particulate organic matter in the gas-phase, PhD thesis, York University, Toronto, Canada, Sept. 2008.