

Supporting Information

Influence of the Inclusion of Ignition Stage Emissions in the Development of Emission Factors for Coal Cookstoves used in India

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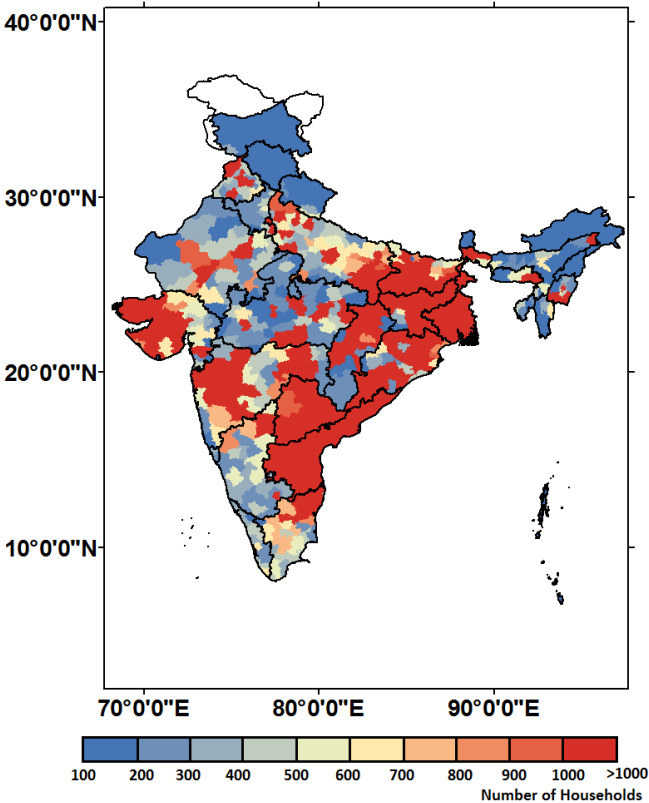


Figure SI 1: Number of households using coal as a fuel for cooking (data taken from ref 3)

Table SI 1: Results of ultimate and proximate analyses for the two types of coals (CL1 and CL2) and coal briquettes (CB) used in the present study.

ULTIMATE ANALYSIS	CL1	CL2	CB
Carbon (%)	59.96	52.90	68.70
Hydrogen (%)	4.46	3.54	1.97
Oxygen (%)	13.39	8.84	7.15
PROXIMATE ANALYSIS			
Moisture (%)	6.64	5.18	4.00
Volatile (%)	26.77	27.60	24.70
Fixed Carbon (%)	42.49	44.72	44.28
Ash (%)	24.10	22.50	27.02
CALORIFIC VALUE (MJ/kg)	23.7	20.0	24.0

48 Table SI 2: Summary of dimensions of coal cookstoves reported in literature, and the two cookstoves used in the present work namely
49 Chandrapur Stove (CS) and Varanasi Stove (VS) (NR = Not Reported).

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	Oanh and co-workers ⁴	Chen and co-workers ⁵	Ge and co-workers ⁶	Zhang and co-workers ⁷	Zhi and co-workers ⁸	Present Study	
						CS	VS
Height (cm)	25	27	inner = 30 outer = 50	NR	NR	18.5	22
Outer diameter (cm)	20	21	24	NR	31-38.5	23	24
Inner diameter (cm)	15	12.5	12	NR	NR	22	20
Double skinned cylinder	Yes	NR	NR	NR	Yes	No	No
Metallic outer cover	Yes	Yes	NR	Yes	Yes	No	No
Thermal insulated ceramic liner	Yes	Yes	NR	NR	Yes	No	Yes
Iron grate inside separating the coal burning zone	Yes	Yes	Yes	NR	Yes	No	Yes
Ash insulating layer	Yes	Yes	NR	NR	Yes	No	No
Chimney	NR	NR	NR	Yes	Yes	No	No
Lid at bottom part for controlling the air supply	NR	6 cm-diameter hole	Yes	NR	Yes	No	No

(a) Chandrapur Stove (CS)



(b) Varanasi Stove (VS)

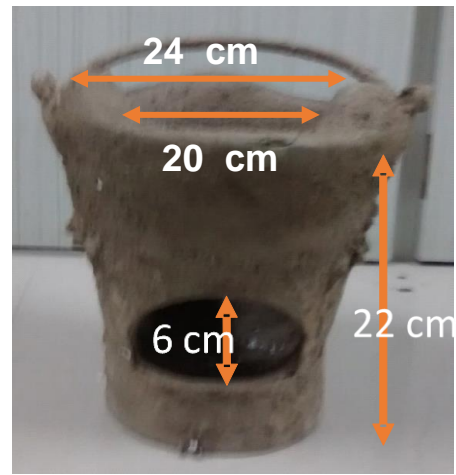


Figure SI 2: Photographs with key dimensions of two types of cookstoves used in the present study: a) Chandrapur Stove (CS) and b) Varanasi Stove (VS).

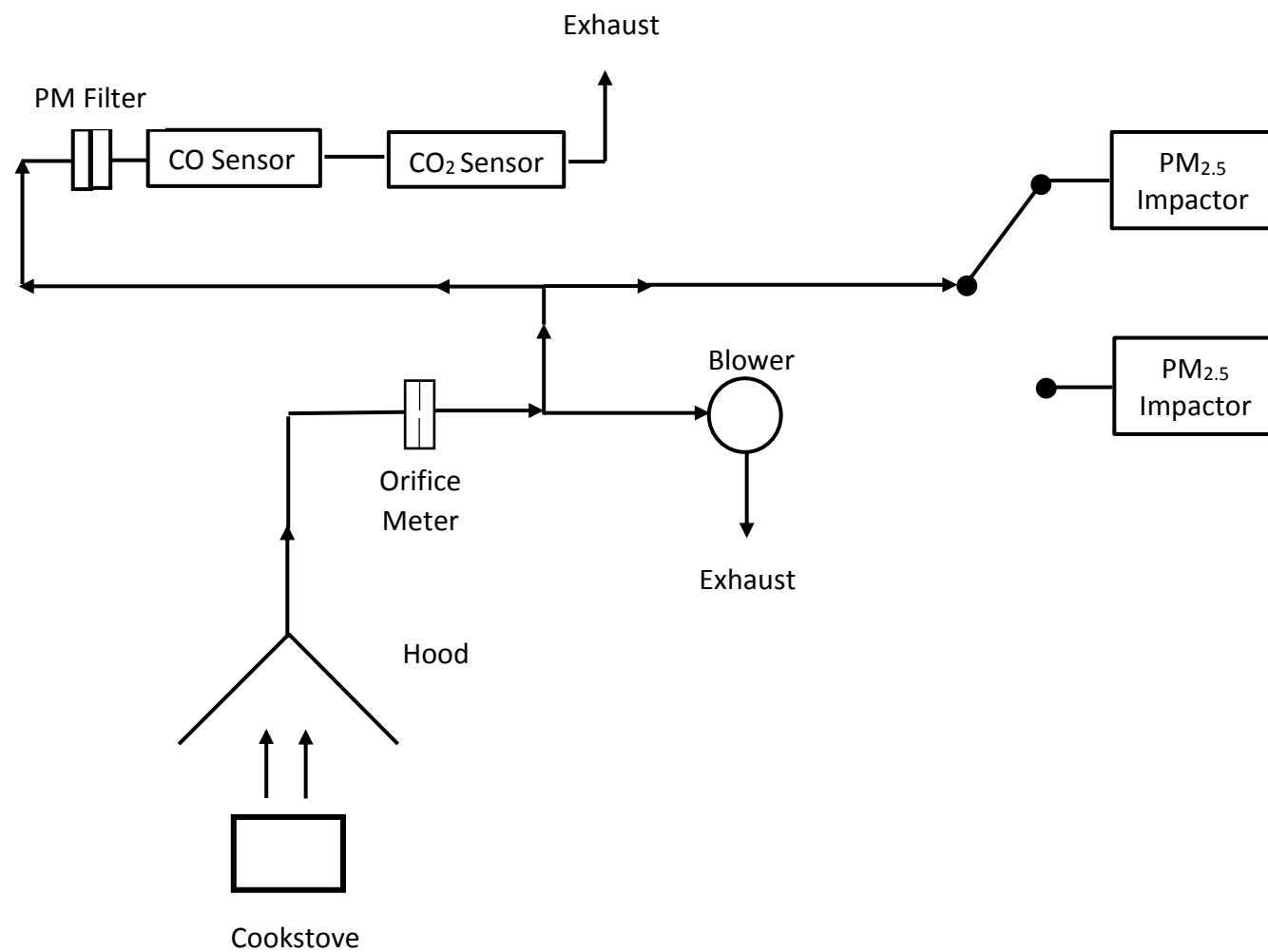


Figure SI 3: Schematic diagram of the measurement setup for sampling of PM<2.5μm, CO and CO₂ emissions from cookstoves used for the present study.

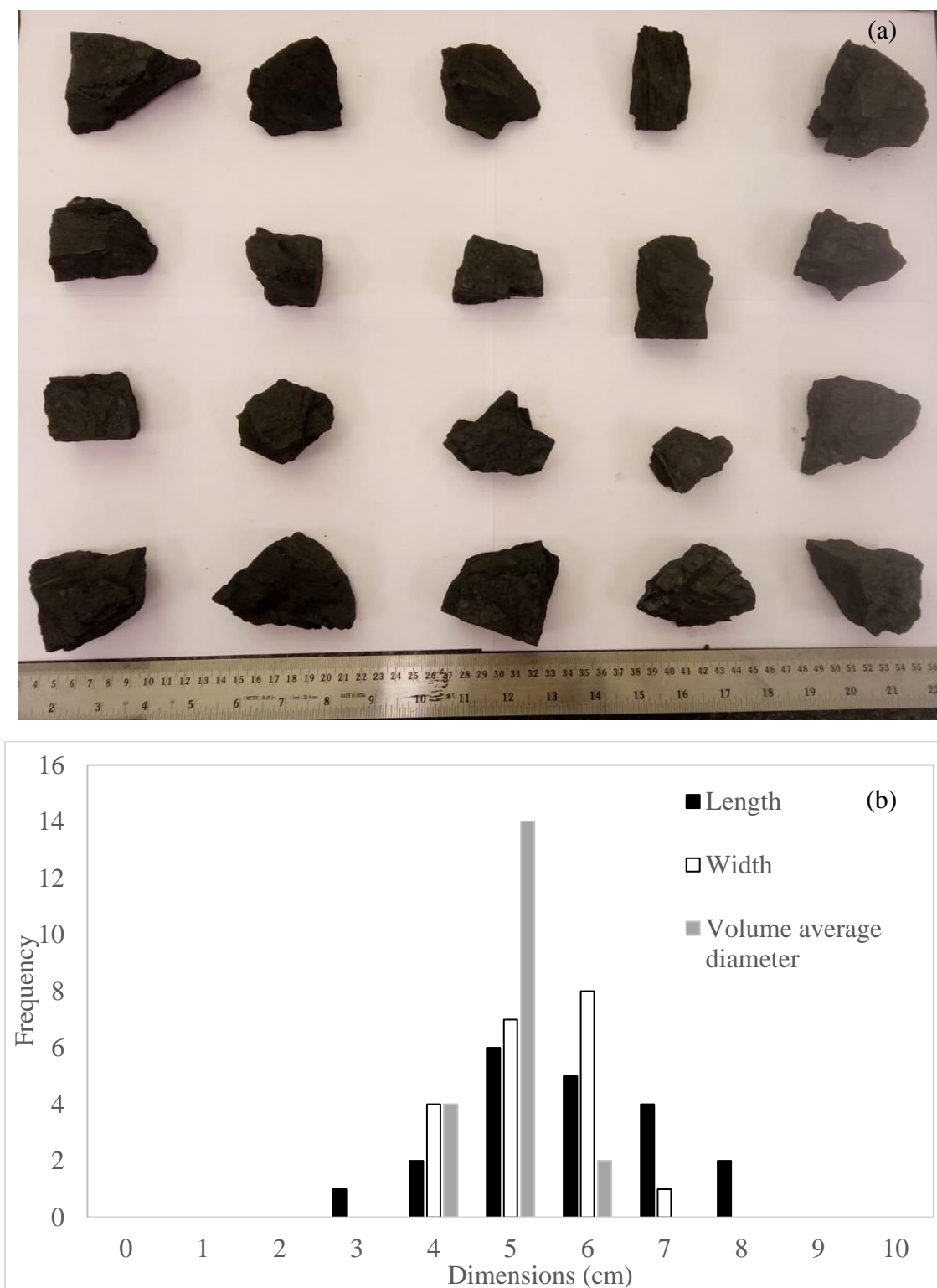


Figure SI 4: Size range of the coal used for the present study (a) Photograph of coal, (b) size frequency distribution plot for length (largest dimension), width (smallest dimension) and volume average diameter.

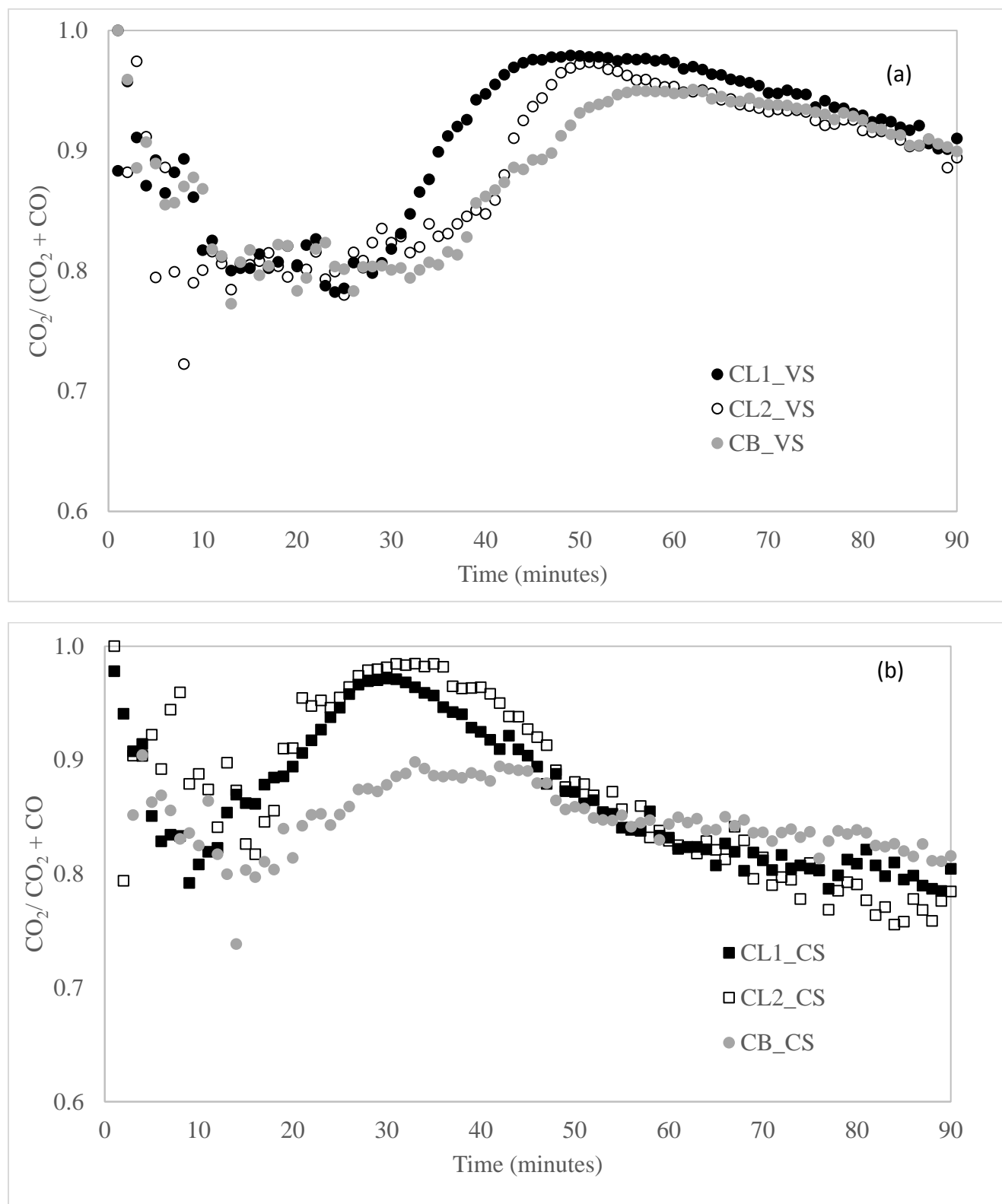


Figure SI 5: MCE based on one-minute resolution of CO and CO_2 measurements of CL1, CL2 and CB in (a) VS and (b) CS

Varanasi Stove (VS)

Chandrapur Stove (CS)

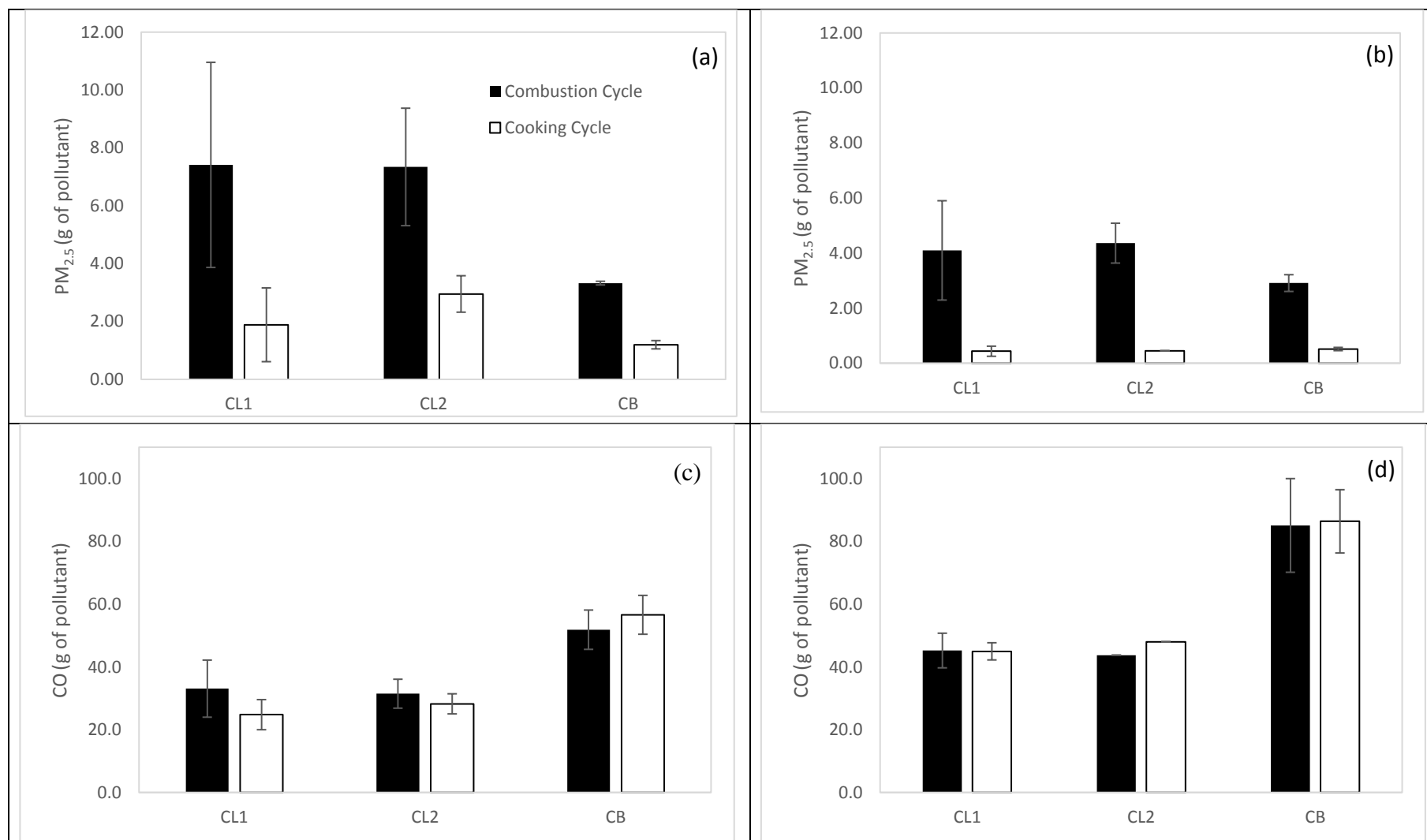


Figure SI 6: Results of the measurements of PM_{< 2.5μm} and CO for the complete combustion cycle and the cooking cycle (flaming + smoldering) for the two types of stoves: (a) and (b) for PM; (c) and (d) for CO.

Table SI 3: Summary of measurements for PM<2.5 μ m, Carbon Monoxide (CO), Elemental Carbon (EC) and Organic Carbon (OC) for Varanasi Stove (VS) and Chandrapur Stove (CS). The last two rows in each sub-table include the average Emission Factor (EFs) for the respective species.

Varanasi Stove (VS)												
	PM<2.5			CO			OC			EC		
	CL1	CL2	CB	CL1	CL2	CB	CL1	CL2	CB	CL1	CL2	CB
Ignition (g)	5.53 \pm 2.27	4.39 \pm 1.46	2.13 \pm 0.21	16.55 \pm 5.31	12.64 \pm 2.02	14.13 \pm 1.51	1.67	1.59	0.83	0.63	0.52	0.25
Flaming (g)	1.66 \pm 1.09	2.75 \pm 0.54	0.61 \pm 0.09	8.64 \pm 2.12	10.88 \pm 0.28	20.54 \pm 1.80	0.22	1.40	0.15	0.22	0.64	0.01
Smoldering(g)	0.23 \pm 0.21	0.20 \pm 0.10	0.59 \pm 0.09	7.88 \pm 0.96	7.95 \pm 1.46	17.19 \pm 1.12	0.03	0.09	0.04	0.00	0.03	0.00
EF for Combustion Cycle (g/kg)	13.64 \pm 3.86	10.82 \pm 1.85	5.70 \pm 0.46	46.08 \pm 6.08	50.98 \pm 6.11	88.22 \pm 2.14	3.12	4.99	1.64	1.38	1.94	0.43
EF for Cooking Cycle (g/kg)	2.48 \pm 1.51	4.39 \pm 0.64	2.03 \pm 0.12	34.97 \pm 3.66	42.37 \pm 0.48	96.32 \pm 1.55	0.41	2.42	0.31	0.36	1.10	0.02

Chandrapur Stove (CS)												
	PM<2.5			CO			OC			EC		
	CL1	CL2	CB	CL1	CL2	CB	CL1	CL2	CB	CL1	CL2	CB
Ignition (g)	3.66 \pm 1.62	3.76 \pm 0.88	2.40 \pm 0.29	15.25 \pm 3.08	11.73 \pm 0.00	27.49 \pm 6.70	1.02	2.09	0.79	0.85	1.21	0.34
Flaming (g)	0.37 \pm 0.14	0.60 \pm 0.14	0.36 \pm 0.06	13.59 \pm 0.18	12.77 \pm 0.00	28.77 \pm 2.57	0.16	0.13	0.04	0.06	0.26	0.00
Smoldering(g)	0.06 \pm 0.04	0.01 \pm 0.01	0.16 \pm 0.00	16.38 \pm 1.31	19.23 \pm 0.00	28.82 \pm 2.92	0.03	0.04	0.03	0.01	0.00	0.00
EF for Combustion Cycle (g/kg)	6.52 \pm 2.60	8.03 \pm 1.33	5.08 \pm 0.97	72.82 \pm 4.39	80.53 \pm 0.00	145.42 \pm 9.11	2.02	4.16	1.40	1.52	2.71	0.56
EF for Cooking Cycle (g/kg)	0.69 \pm 0.26	1.12 \pm 0.29	0.90 \pm 0.18	72.53 \pm 0.83	88.40 \pm 0.00	148.29 \pm 1.63	0.33	0.31	0.11	0.11	0.49	0.00