Supplement to:

Biomass burning aerosol emissions from vegetation fires: particle number and mass emission factors and size distributions,

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The relation between D_g and σ_g from the data listed in Table S1, fitted with the standard regression method as compared to the bivariate fitting used in the paper. The equations are numbered in accordance to the paper.

Fresh: D_g / nm= 260 – 82* σ_g ± 11 (S3)

Aged: D_g / nm= 522 – 200* σ_g ± 29 (S4)

All data: D_g / nm= 670 – 313* σ_g ± 30 (S5)

Table S1. The D_g and σ_g data used to find their mutual relation (Eqs. 3-5 for bivariate fitting and Eqs. S3-S5 for standard fittings) here tabulated together with a short description of fuel, age and the reference for the data. The first 20 lines of the table is referred to as fresh smoke, the 4 next lines are smoke without age reference, the 14 following lines are referred to as aged smoke and the last six lines are not used in the further analysis. A horizontal line divides the table into different smoke ages.

D_g [nm]	σ_g	Fuel	Age	Reference
123	1.5	deforestation fire	minutes	(*Guyon et al.*, 2005)
110	1.65	Forest	minutes	(*Guyon et al.*, 2005)
104	1.78	Forest	minutes	(*Reid and Hobbs*, 1998)
107	1.73	Forest	minutes	(*Reid and Hobbs*, 1998)
111	1.81	Forest	minutes	(*Reid and Hobbs*, 1998)
115	1.74	Forest	minutes	(*Reid and Hobbs*, 1998)
110	1.73	Forest	minutes	(*Reid and Hobbs*, 1998)
135	1.64	Forest	minutes	(*Reid and Hobbs*, 1998)
113	1.70	Forest	minutes	(*Reid and Hobbs*, 1998)
129	1.76	Forest	minutes	(*Reid and Hobbs*, 1998)
127	1.63	Forest	minutes	(*Reid and Hobbs*, 1998)
141	1.65	Forest	minutes	(*Reid and Hobbs*, 1998)
129	1.8	Forest	minutes	(*Reid and Hobbs*, 1998)
100	1.91	Cerrado	minutes	(*Reid and Hobbs*, 1998)
100	1.79	Grass	minutes	(*Reid and Hobbs*, 1998)
100	1.77	smoldering tropical	minutes	(*Reid and Hobbs*, 1998)
130	1.68	flaming tropical	minutes	(*Reid and Hobbs*, 1998)
120	1.73	Forest	fresh	(*Reid et al.*, 1998)
110	1.85	Forest	local	(*Reid et al.*, 1998)
130	1.74	Forest	local	(*Reid et al.*, 1998)
118	1.6	Flaming	?	(*Einfeld et al.*, 1991)
180	1.5	Smoldering	?	(*Einfeld et al.*, 1991)
160	1.55	Flaming	?	(*Hobbs et al.*, 1996)
120	1.5	Smoldering	?	(*Hobbs et al.*, 1996)
230	1.58	Grassland	source region	(*Anderson et al.*, 1996)
200	1.3	Grassland	>5d	(*Anderson et al.*, 1996)
240	1.5	Grassland	Cont. outflow	(*Anderson et al.*, 1996)
285	1.4	boreal forest	6-7d	(*Fiebig et al.*, 2003)
200	1.43	boreal forest	>6d	(*Formenti et al.*, 2002)
230	1.39	North America	4-6 days	(*Cozic et al.*, 2007)
260	1.3	North America	6-9 days	(*Cozic et al.*, 2007)
260	1.31	North America	6-9 days	(*Cozic et al.*, 2007)
270	1.31	North America	6-9 days	(*Cozic et al.*, 2007)
270	1.32	North America	10-13 days	(*Cozic et al.*, 2007)
300	1.3	North America	7-10 days	(*Cozic et al.*, 2007)
180	1.68	Forest	Aged	(*Reid et al.*, 1998)
180	1.63	Forest	2hr-4days	(*Reid et al.*, 1998)
190	1.66	rain forest	2-3d	(*Reid et al.*, 1998)
127	1.69	dambo grass	equiv. area dia.	(*Chakrabarty et al.*, 2008)
188	1.69	pine needles	equiv. area dia.	(*Chakrabarty et al.*, 2008)
181	1.54	poplar wood	equiv. area dia.	(*Chakrabarty et al.*, 2008)
181	1.44	pine wood	equiv. area dia.	(*Chakrabarty et al.*, 2008)
270	1.31	pine needles	equiv. area dia.	(*Chakrabarty et al.*, 2008)
200	1.54	Sagebrush	equiv. area dia.	(*Chakrabarty et al.*, 2008)

The emission factors for particle number based only on the forest data from Guyon et al, 2005, and Kuhn et al, in prep, with and without forcing through zero. This data is with a lower size detection limit below the accumulation mode, but also only including forest fires.

$$EF_{PN,forest} / [kg^{-1}] = -40.4*10^{15}*MCE + 40.0*10^{15} \pm 0.9*10^{15} \qquad (S6a)$$

$$EF_{PN,forest,forced} / [kg^{-1}] = 32.0*10^{15}*(1 - MCE) \pm 0.8*10^{15} \qquad (S6b)$$

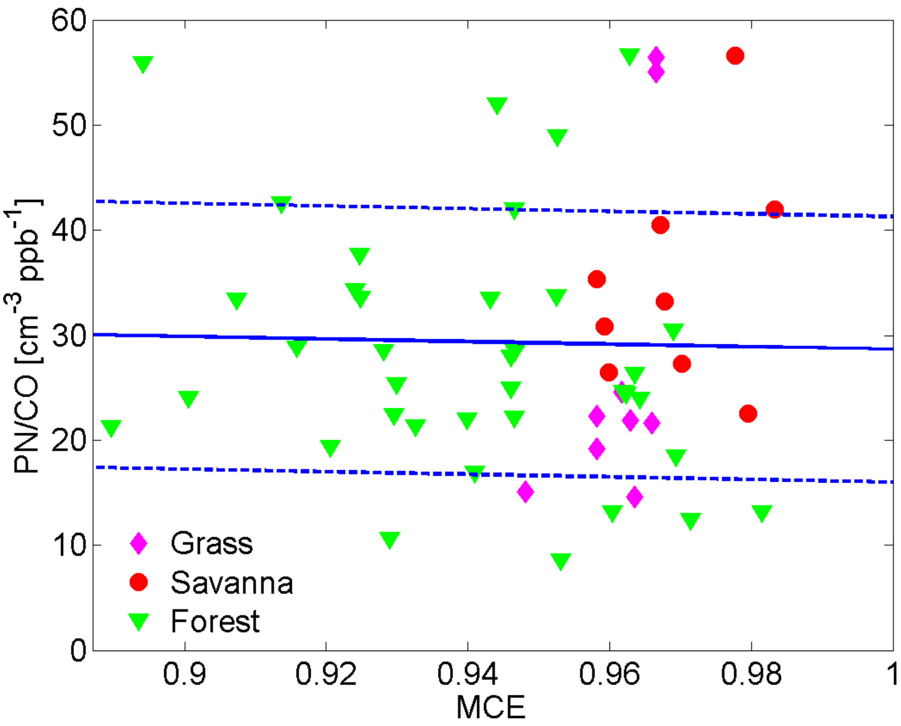

Figure S1. Particle number to CO emission ratios versus modified combustion efficiency (MCE) for three studies (*Guyon et al.*, 2005) (forest), (*LeCanut et al.*, 1996) (savanna, grass), and Kuhn et al., in prep. (forest). A standard fitting method is used and the dotted lines show the y-error from the fitting. Savanna and grass data was measured only above ~100 nm diameter and has been corrected as described in Section 4.1; the CO emissions have been calculated from MCE and an assumed emission factor of CO_2 of 1580 g kg^{-1}.

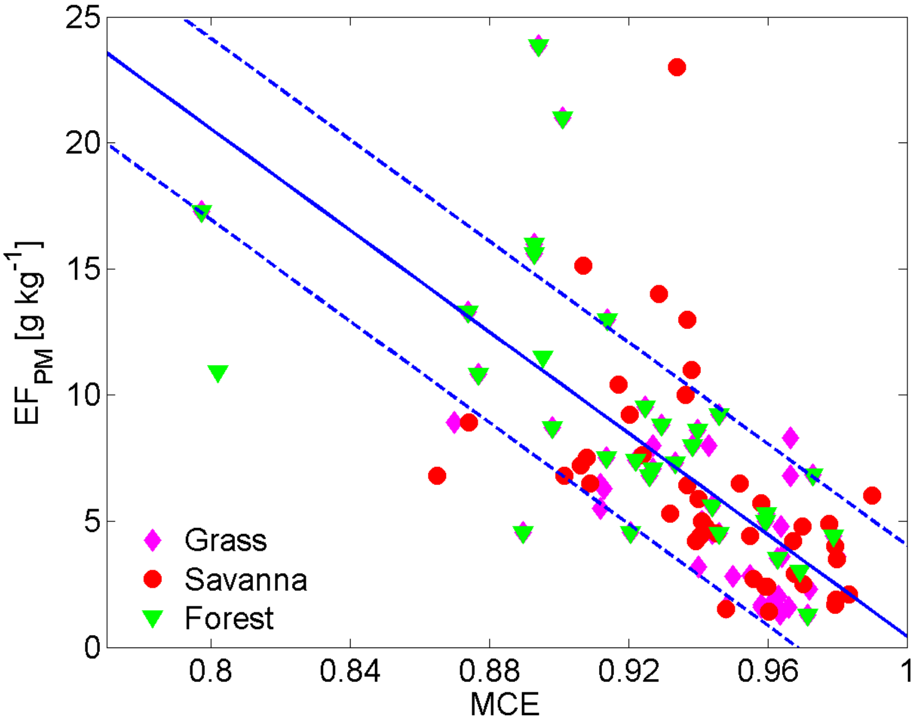

Figure S2. Fitting of all emission factors for particle mass, for all fuels and for particles sizes between $PM_{0.5}$ and PM_4, related to the modified combustion efficiency (MCE). The 50 data points in this plot are taken from 15 different studies, and the y- error is shown as dotted lines.

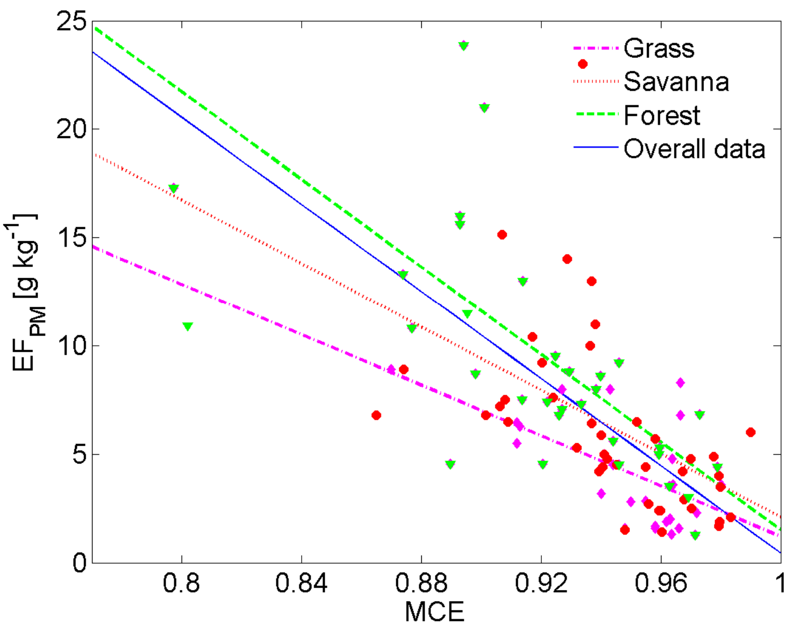

Figure S3. Emission factors for particle mass for the three fuel cases as well as for the overall data set, calculated from the fitted equations given in Table S2.

Table S2. The equations describing the linear fittings (standard method) between particle mass emission factors (EF_{PM}(MCE)) for the overall data set and the three types of fuel and the standard error of the fit. n is the number of data points, n_s is the number of different studies used in the fitting procedure, while n_{mean} is the number of data points used to calculate the mean value. MCE is the arithmetic mean ± standard deviation of the MCE for each dataset, EF_{PM} is given as an arithmetic mean ± standard deviation of the EF_{PM} for each fuel type, $\Delta EF_{PM0.5\text{-}4}$ is the standard error of the fit and the $EF_{PM,0.5\text{-}4}$ mean is the arithmetic mean ± the standard deviation of EF_{PM}.

Fuel	n (n_s) n_{mean}	MCE	$EF_{PM,0.5\text{-}4}$(MCE) [g kg^{-1}]	$\Delta EF_{PM0.5\text{-}4}$ [g kg^{-1}]	$EF_{PM,0.5\text{-}4}$ mean [g kg^{-1}]
Overall data	104 (15) *117*	0.94±0.04	101 – 101*MCE	±3.6	7.0±4.9
Forest	28 (7) *39*	0.92±0.04	103- 101*MCE	±3.8	8.7±4.9
Savanna	42 (9) *43*	0.94±0.03	75.2 – 73.1*MCE	±3.8	6.2±4.3
Grass	25 (7) *26*	0.95±0.03	59.4– 58.2*MCE	±2.0	4.2±2.4

Table S3. The correlation coefficient (R^2), the F-statistic (F) and the probability that the F-statistic erroneously shows a relationship (P_{err}) are reported for the emission factor for particle mass ($EF_{PM,0.5\text{-}4}$) and the emission ratio ($PM_{0.5\text{-}4}$/CO) for all fuel types. n is the number of data points in each subset, and CO_{calc} is the part of the data where CO emissions for the ratio calculation are based on MCE and assumed CO_2 emissions. Data reporting neither MCE nor CO emission factors have been excluded from this analysis.

Fuel	n	CO_{calc}	$PM_{0.5\text{-}4}$/CO [g g^{-1}]	R^2	F	P_{err}	$EF_{PM,0.5\text{-}4}$ [g kg^{-1}]	R^2	F	P_{err}
Overall data	104	32%	0.11 ± 0.07	0.01	1	0.23	7 ± 5	0.51	108	$6*10^{-26}$
Forest	28	68%	0.12 ± 0.06	0.01	1	0.81	9 ± 5	0.49	25	$9*10^{-7}$
Savanna	42	26%	0.11 ± 0.09	0.10	5	0.02	6 ± 4	0.24	13	$4*10^{-5}$
Grass	25	42%	0.08 ± 0.07	0.03	1	0.47	4 ± 2	0.34	12	$3*10^{-4}$

Table S4. The linear fittings of each study, using a standard method, i.e., the equation fitted to the data, as EF_{PM} = Intercept + Slope * MCE, and the arithmetic mean and standard deviation of the emission factor (EF_{PM}) and the modified combustion efficiency (MCE).

Intercept	Slope	EF_{PM}	MCE	n	R^2	Size	Fuel	Reference
-44.4	51	5.4 ± 0.8	0.98 ± 0.01	2	-	PM3	savanna	(*Anderson et al.*, 1996)
-43.452	63.603	12.2 ± 4.2	0.87 ± 0.02	4	0.14	PM2.5	lab	(*Bertschi*, 2003)
85.026	-82.908	8.00 ± 0.93	0.93 ± 0.06	10	0.44	PM	lab	(*Chen et al.*, 2007)
563.01	-574.59	22.8 ± 26.5	0.94 ± 0.04	5	0.823	PM2.5	lab	(*Christian*, 2003)
132.12	-135.12	5.9 ± 5.7	0.93 ± 0.04	3	0.802	PM2.5	lab	(*Dhammapala et al.*, 2006)
146.35	-151.8	11.8 ± 7.6	0.9 ± 0.05	8	0.94	PM2.5	agri	(*Dhammapala et al.*, 2007)
139.76	-144.06	10.2 ± 7.4	0.89 ± 0.05	11	0.926	PM2.5	labagri	(*Dhammapala et al.*, 2006) and 2007
114.52	-115.06	7.3 ± 6	0.93 ± 0.05	2		PM3	forest	(*Einfeld et al.*, 1991)
96.423	-95.093	8.5 ± 3.5	0.92 ± 0.03	4	0.829	PM4	All fuels	(*Ferek et al.*, 1998)
1449.9	-1471.4	14.8 ± 12.1	0.98 ± 0.01	7	0.708	PM2.5	lab	(*Freeborn et al.*, 2008)
126.96	-128.06	7.6 ± 5.7	0.93 ± 0.02	12	0.31	PM0.5	forest	(*Guyon et al.*, 2005)
81.183	-80.439	8.8 ± 2	0.9 ± 0.02	3	calc	PM2.5	forest	(*Battye and Battye*, 2002)
141.82	-145.63	15.1 ± 16.3	0.87 ± 0.11	7	0.97	PM10	lab	(*Iinuma et al.*, 2007)
28.615	-25.606	4.2 ± 0.6	0.95 ± 0.01	4	calc	PM2.5	lab	(*Battye and Battye*, 2002)
218.48	-218.18	8.3 ± 6.7	0.96 ± 0.03	3	0.98	PM2.5	savannaforest	(*Kaufman et al.*, 1998)
124.05	-126.01	5.7 ± 3.4	0.94 ± 0.02	12	0.577	PM2.5	svannagrass	(*Korontzi et al.*, 2003)
75.924	-76.18	4.1 ± 2	0.94 ± 0.03	6	0.959	PM2.5	grass	(*Korontzi et al.*, 2003)
211.11	-217.93	7.4 ± 3.9	0.93 ± 0.02	6	0.735	PM2.5	savanna	(*Korontzi et al.*, 2003)
-21.472	25.418	3.1 ± 2	0.97 ± 0.01	19	0.014	PM3	savannagrass	(*LeCanut et al.*, 1996)
1.9078	-1.1481	0.9 ± 0.89	0.89 ± 0.06	2	-	PM2.5	forest	(*Lee et al.*, 2005)
66.439	-56.067	14.6 ± 5.5	0.92 ± 0.03	12	0.092	PM3.5	forest	(*Nance et al.*, 1993)
428.24	-434.48	40.5 ± 48.8	0.89 ± 0.11	2	-	PM	agri	(*de Zarate et al.*, 2000)
82.677	-72.54	15.6 ± 6	0.92 ± 0.03	10	0.156	PM2	forest	(*Radke et al.*, 1991)
68.392	-58.923	13.9 ± 5.5	0.92 ± 0.03	10	0.122	PM3.5	forest	(*Radke et al.*, 1991)
50.818	-48.182	6.3 ± 3.7	0.92 ± 0.08	2	-	PM2.5	All fuels	(*Scholes et al.*, 1996)
286.13	-290.03	10.1 ± 7.5	0.93 ± 0.02	7	0.745	PM4	savannagrass	(*Sinha et al.*, 2003)
453.17	-440.28	55 ± 27.3	0.95 ± 0.06	3	0.85	PM5	forest	(*Susott et al.*, 1991)
137.49	-136.74	8.4 ± 0.9	0.9 ± 0.05	3	0.98	PM2.5	forest	(*Ward et al.*, 1991)
58.133	-56.154	6.2 ± 2.9	0.94 ± 0.03	13	0.359	PM2.5	savanna	(*Ward et al.*, 1992)
87.54	-88.405	5.1 ± 2.3	0.92 ± 0.02	10	0.56	PM2.5	grasslitter	(*Ward*, 1996)
75.86	-73.458	12.3 ± 7.1	0.93 ± 0.1	2	-	PM2.5	forest	(*Ward and Hardy*, 1991)
841.07	-862.52	10 ± 13.7	0.87 ± 0.01	4	0.16	PM2.5	lab	(*Yokelson et al.*, 1996)
153.95	-154.07	11.1 ± 6.1	0.96 ± 0.03	5	0.473	PM2.5	forest	(*Yokelson et al.*, 2007b)
120.56	-112.87	17.8 ± 4.1	0.93 ± 0.02	9	0.336	PM10	forest	(*Yokelson et al.*, 2007a)

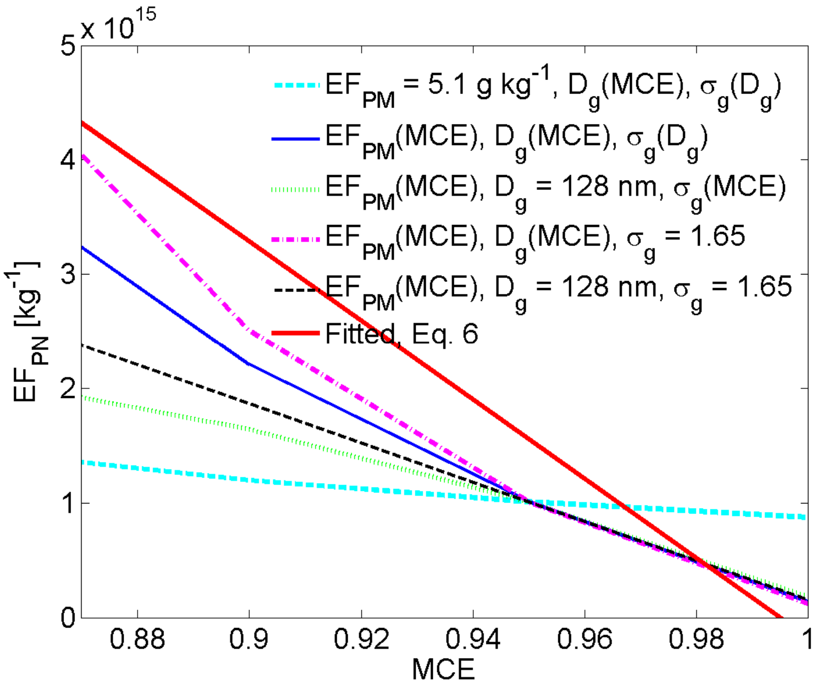

Figure S4. Particle number emission factors, EF_{PN}, related to mass of dry fuel burned, calculated from EF_{PM}(MCE=0.95) for overall data, see equation in Table 4. EF_{PM} is held constant at EF_{PM} = 5.1 g kg^{-1} dry mass, or allowed to vary with MCE. The particle sizes are held constant at D_g = 128 nm and σ_g = 1.65, or allowed to vary with MCE as described in Eqs. 2 and 3. The constant values are taken from the equations for MCE = 0.95, i.e., the average MCE in the data used in the measurement-based EF_{PN} in Eq. 6.

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