Supporting Information for

# Emissions measurements from household solid fuel use in Haryana, India: implications for climate and health co-benefits

**Robert M. Weltman[a], Rufus D. Edwards[a*], Lauren T. Fleming[b], Ankit Yadav[c], Cheryl L. Weyant[d], Brigitte Rooney[e], John H. Seinfeld[f], Narendra K. Arora[c], Tami C. Bond[d], Sergey A. Nizkorodov[b], and Kirk R. Smith[g]**

[a] Department of Epidemiology, School of Medicine, University of California Irvine, CA 92697, USA

[b] Department of Chemistry, University of California Irvine, CA 92697, USA

[c] INCLEN Trust International, New Delhi, India

[d] Department of Civil and Environmental Engineering, University of Illinois at Urbana-Champaign, Urbana, IL 61820, USA

[e] Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125, USA

[f] Division of Chemistry and Chemical Engineering, California Institute of Technology, Pasadena

[g] School of Public Health, University of California, Berkeley, CA 94720, USA

***Corresponding author:**

Rufus Edwards

Department of Epidemiology,

Room 1361 SE II

University of California Irvine, CA 92697 USA

edwardsr@uci.edu

**Contents of this file – 8 pages consisting of 4 figures, 2 tables, 2 equations, and references.**

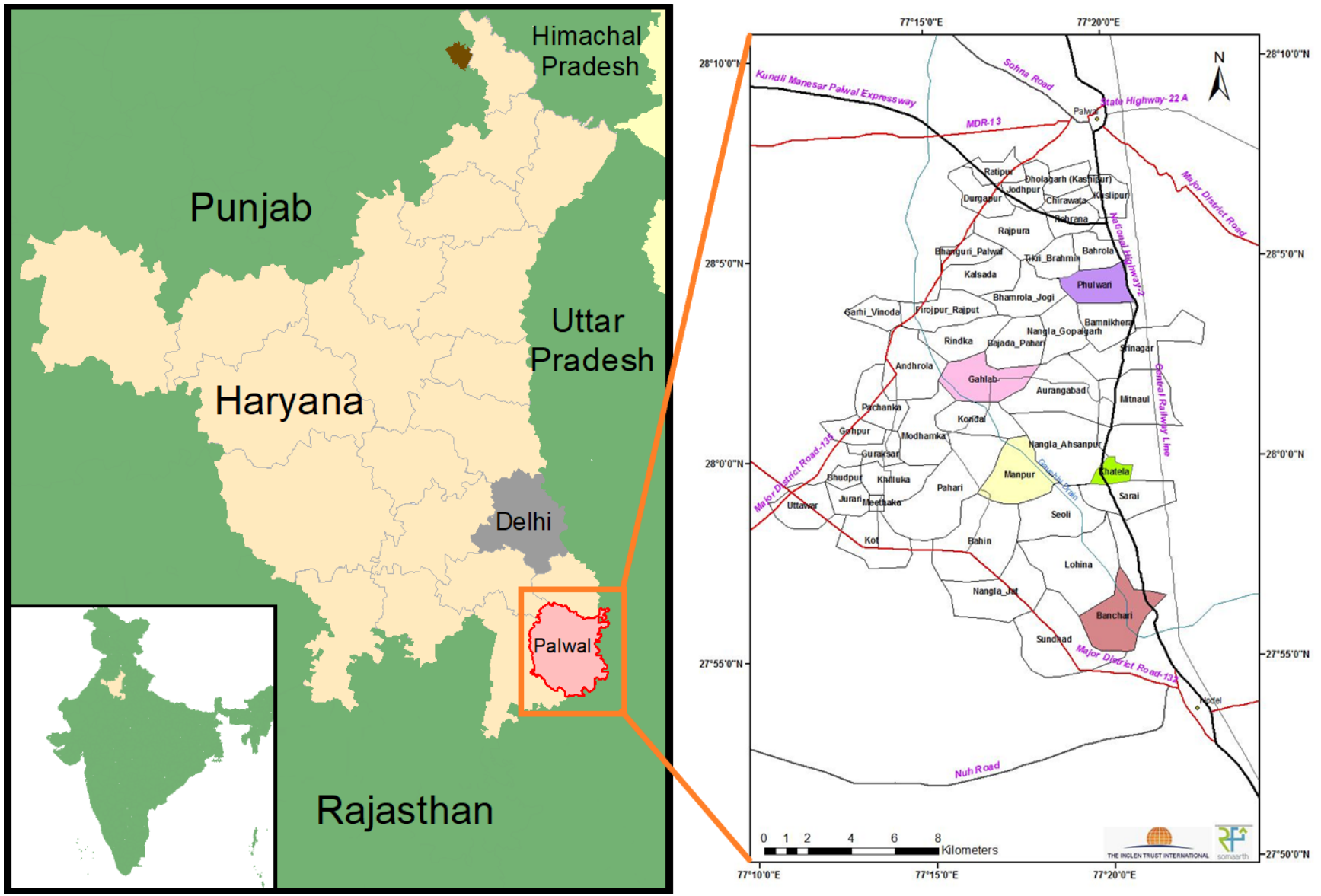
Himachal Pradesh
Punjab
Uttar Pradesh
Haryana
Delhi
Palwal
Rajasthan
77°15'0"E
77°20'0"E
28°10'0"N
28°5'0"N
28°0'0"N
27°55'0"N
27°50'0"N
77°10'0"E
N
Kundli Manesar Palwal Expressway
Sohna Road
State Highway- 22 A
MDR-13
Major District Road
Hathipal Highway-2
Central Railway Line
Major District Road-134
Major District Road-132
Nuh Road
Palwal
Ratipur
Dholagarh (Kashipur)
Jodhpur
Durgapur
Chirawata
Kaslipur
Rohrana
Rajpura
Bhanguri_Palwal
Tikri_Brahmin
Bahrola
Kalsada
Phulwari
Bhamrola_Jogi
Garhi_Vinoda
Firojpur_Rajput
Bamnikhera
Nangla_Gopalgarh
Rindka
Bajada_Pahari
Srinagar
Andhrola
Gahlab
Aurangabad
Mitnaul
Pachanka
Kondal
Gahpur
Modhamka
Nangla_Ahsanpur
Guraksar
Bhudpur
Khiluka
Pahari
Manpur
Ghatela
Sarai
Uttawar
Jurari
Meethaka
Seoli
Kot
Bahin
Lohina
Nangla_Jat
Banchari
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*Figure S1: Map of the Palwal, Haryana, India study sites. The villages where measurements were conducted are in color in the right panel. Lines on maps represent approximate border lines for which there may not yet be full agreement and do not imply the expression of any opinion concerning the legal delimitation of frontiers or boundaries.*

Table S1: Particulate and CO $GWP_{100}$ values used in this study are taken from Bond et al. 2013[1]. The $GWP_{20}$ value for CO used in this study is taken from Myhre et al. 2014[2] using the value for South Asia for CO.

| Substance | $GWP_{100}$ | $GWP_{20}$ |
|---|---|---|
| $CO_2$ | 1 | 1 |
| CO | 2.8 | 5.7 |
| EC | 911 | 3204 |
| OC | -51 | -180 |

*Equation S1. $GWC_{100}$ EFs are calculated by summing the $GWC_{100}$ EFs for each species ($CO_2$, CO, EC, and OC). The equation for summing the individual $GWC_{100}$ EFs is listed below:*

$$EFGWC_{100} = EF_{CO2}*f_{nr} + EF_{CO}*f_{nr}*2.8 + EF_{CO}*(1-f_{nr})*(2.8-1) + EF_{EC}*911 - EF_{OC}*-51$$

*Where $f_{nr}$ is the fraction of the fuel that is from non-renewable biomass.*

*Equation S2. $GWC_{20}$ EFs are calculated by summing the $GWC_{20}$ EFs for each species ($CO_2$, CO, EC, and OC). The equation for summing the individual $GWC_{20}$ EFs is listed below:*

$$EFGWC_{20} = EF_{CO2}*f_{nr} + EF_{CO}*f_{nr}*5.7 + EF_{CO}*(1-f_{nr})*(5.7-1) + EF_{EC}*3204 - EF_{OC}*-180$$

*Where $f_{nr}$ is the fraction of the fuel that is from non-renewable biomass.*

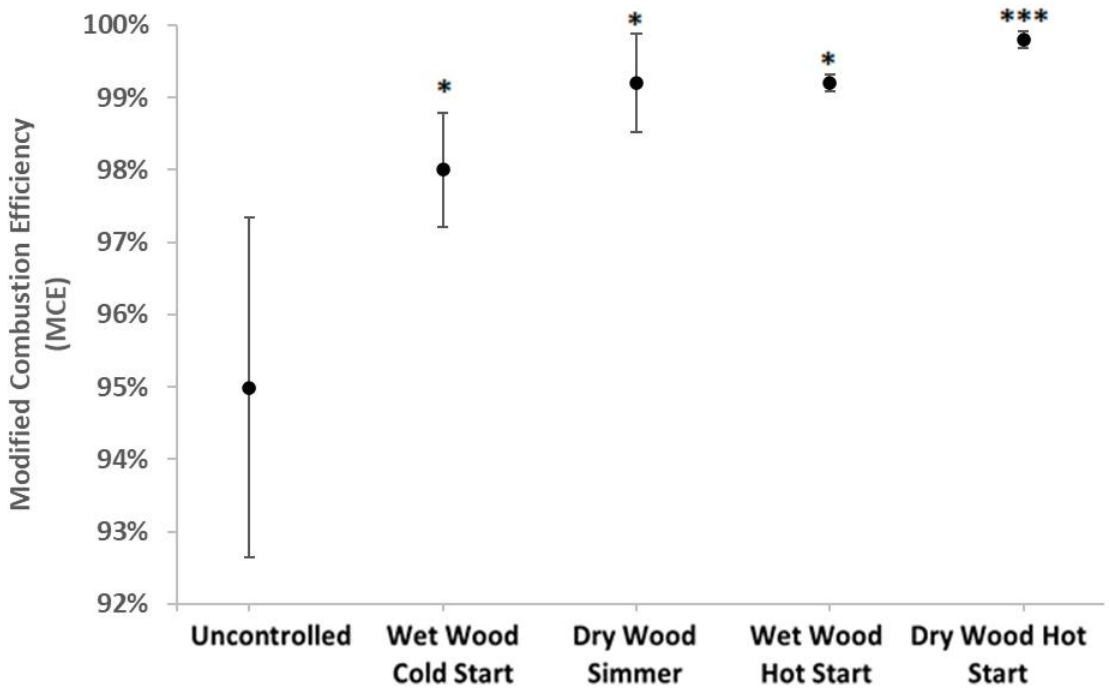


*Figure S2: A comparison of the mean MCE for the Philips stove during uncontrolled testing in village homes and select laboratory[3] results. Standard error of the means as 95% approximate confidence intervals are shown as error bars. Asterisks indicate significant differences with the uncontrolled testing according to Welch's two-sided t tests (*: p <0.05, ***: p<0.01).*

*Table S2: Additional geometric mean EFs and ERs for the uncontrolled in-home and minimally directed tests of mixed-fuel use in the chulha cookstove alongside differences in the arithmetic mean values and two-sided t tests. Sample sizes were n=7 and 13 for the uncontrolled and controlled cooking tests respectively. Values for the uncontrolled and controlled tests are listed as geometric mean (arithmetic mean; arithmetic standard deviation). *: Sample size reduced by one due to a damaged filter.*

| | Uncontrolled | Minimally Directed | Difference in Mean | P(T<=t) Two-Tail |
|---|---|---|---|---|
| $CO_2$ EF g/kg Dry Fuel | 1092 (1093;36) | 967 (968;43) | 125 | **<0.01** |
| $CO_2$ EF g/kg Carbon | 3213 (3214;88) | 3165 (3166;90) | 48 | 0.27 |
| $CO_2$ ER g/min | 25.7 (27.4;10.3) | 25.0 (25.1;2.7) | 2.3 | 0.58 |
| CO EF g/kg Dry Fuel | 84.0 (84.3;7.6) | 95.5 (97.1;18.4) | -12.8 | **0.04** |
| CO EF g/kg Carbon | 247.1 (248.0;22.8) | 312.5 (317.1;57.4) | -69.1 | **<0.01** |
| CO ER g/min | 2.0 (2.1;0.9) | 2.5 (2.5;0.5) | -0.4 | 0.33 |
| $PM_{2.5}$ EF g/kg Carbon | 25.7 (32.3;22.3) | 40.4 (41.4;7.8)* | -8.7 | 0.35 |

| | | | | |
|---|---|---|---|---|
| $PM_{2.5}$ ER mg/min | 206 (311;271) | 320 (327;69)* | -16 | 0.88 |
| EC EF g/kg Carbon | 1.3 (1.7;1.5)* | 2.1 (2.2;0.8)* | -0.5 | 0.47 |
| EC ER mg/min | 10 (17.6;23)* | 17 (17.8;7)* | -0.2 | 0.98 |
| OC EF g/kg Carbon | 11.6 (17.6;16.8)* | 18.5 (18.7;3.1)* | -1.1 | 0.88 |
| OC ER mg/min | 88 (175; 186)* | 147 (149; 27)* | 26 | 0.74 |

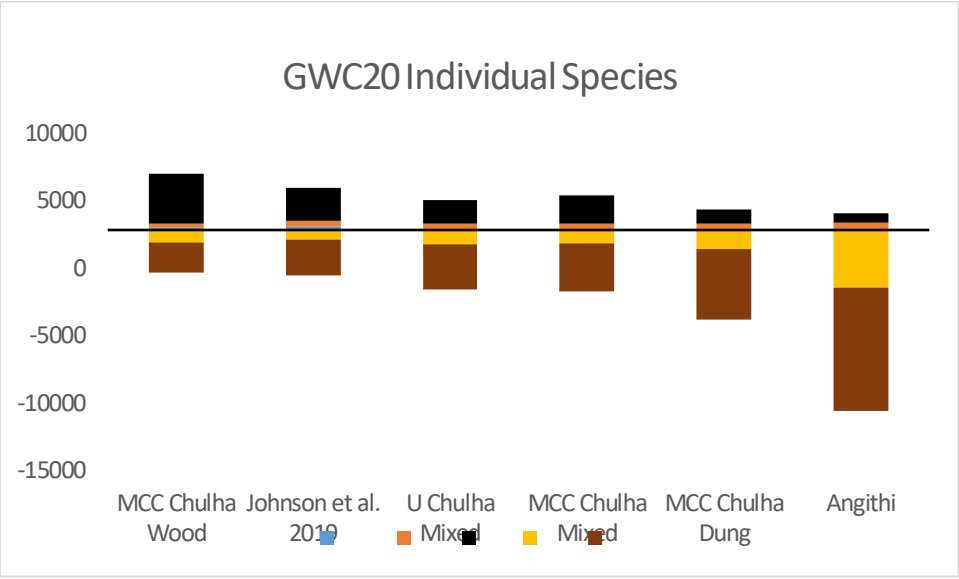


*Figure S3: A stacked bar chart of the contribution of each species to total $GWC_{20}$.*

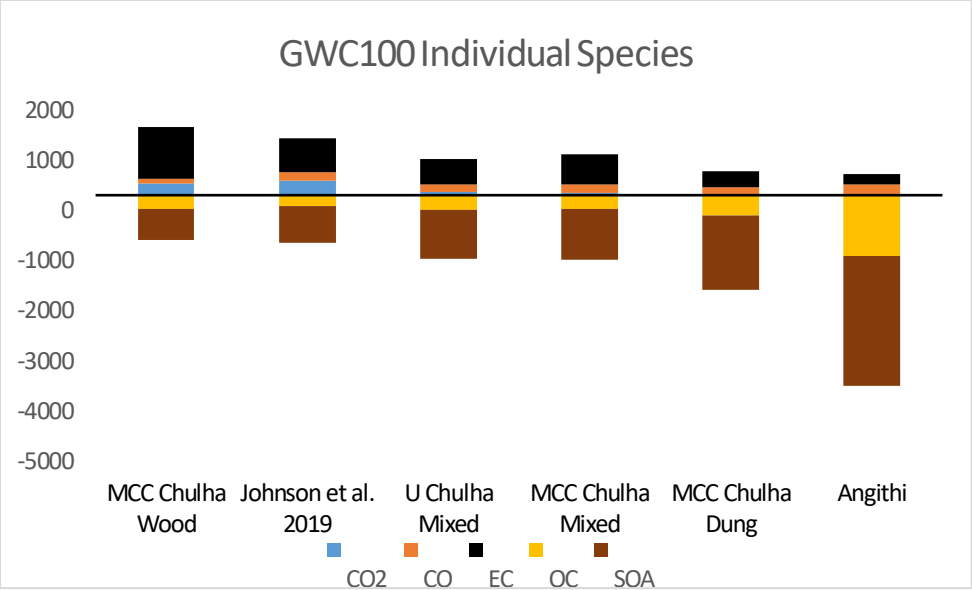


*Figure S4: A stacked bar chart of the contribution of each species to total $GWC_{100}$.*

**References**

1. Bond, T. C.; Doherty, S. J.; Fahey, D. W.; Forster, P. M.; Berntsen, T.; DeAngelo, B. J.; Flanner, M. G.; Ghan, S.; Kärcher, B.; Koch, D., Bounding the role of black carbon in the climate system: A scientific assessment. *Journal of Geophysical Research: Atmospheres* **2013,** *118*, (11), 5380-5552.
2. Myhre, G.; Shindell, D.; Pongratz, J., Anthropogenic and natural radiative forcing. *Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* **2014**.
3. Jetter, J.; Zhao, Y.; Smith, K. R.; Khan, B.; Yelverton, T.; DeCarlo, P.; Hays, M. D., Pollutant emissions and energy efficiency under controlled conditions for household biomass cookstoves and implications for metrics useful in setting international test standards. *Environmental science & technology* **2012,** *46*, (19), 10827-10834.