Webinar: ASHES Science to Achieve Results (STAR) Webinar Series #1: Cookstove Emissions, Climate and Health Impacts: An integrated Lab, Field, and Modeling Study

Date/Time: January 14, 2021, 8:00-9:30 Mountain Standard Time

Unasked/answered Panelist Questions

1. Can you discuss the aerosol semi-direct effect on climate?

*Jeff P: Aerosols absorb and scatter radiation, which changes the amount of sunlight absorbed by the earth system (direct effect). However, the absorption and scattering also changes *where* the absorption occurs, e.g., particles may be absorbing the radiation 1 km above the surface, heating the atmosphere there rather than that solar radiation heating the surface. This change in "where does the heating occur" impacts relative humidity and vertical motions in the atmosphere, both impacting cloud formation. The overall effect of SFU aerosols on the semi-direct effect is thought to be a warming (by reducing the amount of cloud cover) such that removing SFU aerosols would lead a cooling via the semi-direct effect. However, all of the uncertainties the apply to the direct effect also impact the semi-direct effect. Further, the semi-direct effect has additional uncertainties associated with models connecting this heating changes to cloud changes.*

2. What causes the spatial patterns in the climate maps?

Jeff P: For the direct effect, not only does the amount of particle scattering vs. absorption matter, the brightness/color of the Earth's surface below matters as well. SFU aerosol will always appear dark over snow/ice when viewed from space, and for these bright surfaces, SFU will always have a net warming effect. Oceans are very dark and absorb most of the incident sunlight, so SFU will always look bright from space over oceans, implying a cooling effect. Other land surfaces are somewhere in between, and the details of these surfaces as well as the aerosol optical properties (scat vs. abs) matter greatly!

For the indirect effect, the net effect is almost always cooling near the source regions, but in some very polluted source regions because the clouds form on polluted aerosol no matter what. For from source regions, we predict some warming effects, and this is due to chemical/physical aerosol feedbacks in the atmosphere related to particle formation and growth.

3. What about looking at specific fuel/stove combinations in different geographies? Could climate benefits be achieved when assessing specific interventions?

Jeff P: Yes, especially if going from a high-BC stove/fuel combination to a high-OC combination. However, as John Volckens pointed out, this may not benefit health though.

4. Regarding climate effects, can uncertainty be reduced with further research? What are the biggest gaps in knowledge?

Jeff P: Yes, this is why I'm excited about the rapid energy transition away from coal heating in China. It gives a chance to at least somewhat isolate the SFU contribution in a real-world scenario. This can be used to constrain the model in ways we didn't have before. Otherwise, I think we need to focus on digesting the field and lab measurements into ways that can be used in the models.

5. When framing climate co-benefits, shouldn't one consider greenhouse gases, not only aerosols?

*Jeff P: Yes, but not that the net effect on GHGs for some transitions are bad. For example, if a location that uses wood as a fuel transitions to a fossil fuel source (e.g., propane or electricity from coal or gas), the net CO2 emissions would *increase* because wood is close to net CO2 neutral as long as the wood is growing back after it's harvested for energy.*

6. Any comments on the impact of fuel choice on climate? For example, the potential impact of cutting less trees when switching to cleaner fuels.

Jeff P: There are certainly many dimensions to understand the full life-cycle impacts of energy sources. I personally have not thought about this, but it certainly needs to be considered.

7. What (short list of) pollutants do you recommend for regular monitoring and measurement?

Kelsey B: I would consider (1) the cost of monitoring a given pollutant, (2) which pollutants are most relevant for human health, and (3) which pollutants that aren't easily predicted by PM & CO. For point #2, I think further work is needed to compare the relative levels of toxicity of stove emissions. For point #3, we found that BC was more well-correlated to particle phase carcinogens, but gas-phase carcinogens (benzene, formaldehyde) weren't as easy to predict with typical measurements.

John V: We still recommend PM mass and CO, but if your budget allows then I would also think about formaldehyde (A1 carcinogen), benzene (A1 carcinogen), black carbon, and oxides of nitrogen (especially, NO_2, an EPA criteria pollutant with known respiratory health impacts).

8. The impact on climate used to be countified in CO2 or CO2e (including respective GWP). Is there a better unit suggested to identify properly the climate impact? what consideration should be undertaken to report the impact on climate?

Jeff P: While I did not present these metrics today, I do think they are a great way to normalize across different species. I think it's important, however, to fully quantify the uncertainties of each species' contributions to CO2e.

9. Do you think Beijing fuel ban is a hammer appropriate for that density of all pollution sources? Outside of rich urban neighborhoods, low-emission coal heating is a cheaper alternative, and other sources of air pollution should be addressed for cheaper alternatives.

Kelsey B: To reduce air pollution in Beijing, the government is targeting many air pollution sources. Air pollution from residential coal is important both because it's a significant contributor to poor air quality in Beijing (especially in the winter) and because it disproportionally leads to exposure, since the source is co-located with people. Although not perfect, my understanding is that the government has been providing stoves and electric subsidies to help people transition to electricity or natural gas.

Jeff P: The Beijing fuel ban is a very unique situation that has many challenges associated with it. I imagine that those type of ban cannot be successfully done universally.

10. How do you prove 50% of SFU pollution contribute to global mortality due to PM pollution?

Christian L: This is a difficult question to answer simply and succinctly. I would encourage you to visit http://www.healthdata.org/gbd/about. They provide good information regarding collection and aggregation of data, works flows used in establishing estimated mortality by risk factor, etc.

*Jeff P: Great question. We cannot *prove* this. Rather, when using the methods developed by the Global Burden of Disease studies, our estimate of mortality attributable to indoor and outdoor exposure to SFU PM is roughly half of our estimate of mortality attributable to indoor and outdoor exposure to all anthropogenic PM.*

11: Where can I get the full FST protocol?

Kelsey B: Here! There is an outline for the full protocol in the supplement. https://onlinelibrary-wiley-com.ezproxy2.library.colostate.edu/doi/full/10.1111/ina.12497
If you need free access to the manuscript text, it's here: https://www.researchgate.net/publication/326984202_The_Firepower_Sweep_Test_A_Novel_Approach_to_Cookstove_Laboratory_Testing

12. Any comments on charcoal making stoves?

Christian L: The research presented here did not specifically look at charcoal production or cookstoves designed to produce charcoal. There have been some studies looking at the climate implications of charcoal usage and production, but I do not know of any studies specifically looking at charcoal producing cookstoves. An element which would be important to modeling this type of cookstove would include (1) estimation of potential market size, (2) efficiency of these stoves during the charcoal production and usage phases, and (3) the type of cookstove this technology would be replacing. It certainly could be an interesting investigation, but a good deal of additional information would be needed to incorporate this type of technology into the models.

13: Do you think stove standards will help prevent super emitting stoves?

Kelsey B: I think lab tests that include operating conditions that tend to lead to high emissions (e.g., refueling, ignition) could help provide more insights about potential superemitters. However, it will be hard to identify all superemitting stoves or events before stoves are tested in the real-world.

14. Will future studies also examine NOX emissions from different fuels?

Christian L: This webinar was the first in a series of presentations on the work conducted by the EPA funded STAR cookstove projects. I cannot guarantee what information the other presentations will include but I know at least one of the groups (that Hannigan group from CU Boulder) were looking at including NO/NO2 measurements as part of their study.

15: After CO, PM parameter which one do you think should be measured in priority?

Kelsey B says: See question #7 above.

16: I don't understand the comment that CO2 is the worst. Kirk Smith said in 2000, "If one is going to put carbon in the atmosphere anyway, CO2 is the least harmful form from both climate and health viewpoints."

Jeff P: I do not recall saying that CO2 is the worst, and certainly did not mean to. I was trying to say that the CO2 effects can go in a lot of different ways. If transitioning from biomass energy to fossil energy, there will be a net increase in CO2 from this transition (because biomass production reduces CO2 so it's close to net neutral), but if the transition is from coal to something more efficient, then CO2 will be a benefit. Regardless, the max CO2 impact is not that larger <~0.1 W m-2 over 100 years.

17. Question for Kelsey: I was somewhat surprised by the low PM2.5 estimates from kerosene stoves as other reports have shown them to be rather dirty. can you comment on these studies relative to others?

Kelsey B says: This could depend on many things (e.g., stove type, fuel, stove age, lab vs field).

18: Should new resources be targeted toward understanding real-world field emissions or deeper understanding of laboratory-based metrics?

Kelsey B says: I think it depends on what question you want to answer. I would lean towards a better understanding of field data, since laboratory tests will never perfectly represent real-world conditions. There are many exciting new field studies coming online, but I think there is still relatively little data compared to the number of stoves, fuels, and cooking practices used throughout the world.

John V says: I would rather see more resources put into clean energy technologies and demonstrating health and welfare benefits that follow from the uptake of those technologies. That is the type of data that will drive investment to increase by orders of magnitude.

19: Based on the lab and field test results, how much should we trust performance of stove with high tier rating of stove?

Christian L: I think it is important for us to keep in mind what the tiers are trying to achieve. The tiers/voluntary performance targets are not a replacement for field validation, assessment of user cooking habits, etc. Instead, they are a resource to help benchmark and differentiate cookstoves as one aspect of users/dissemination programs/etc. making informed decisions. I think you can put great trust in a cookstove with a high tier being able to have good performance in certain situations; however, the performance is very dependent on the "drive cycle" used during the test. A goal of the ISO 19867 protocols was for them to serve as a starting point for countries/programs to build from as needed in order to have a "drive cycle" which matches the needs of a specific region. So, I think trust can be put in the tiers if someone is making decisions on the tiers with an appropriate understanding of the generalizability and limitations of them.

20: Are you aware of studies that look at population scale analyses of "super-emitters?? or suggestions on how to define these to support research and policy?

John V says: I am not aware of this and it's a difficult thing to identify in the field. My opinion is that (1) all solid-fuel technologies have the potential to be super-emitters and (2) solid fuel technologies will have a difficult time achieving desired health benefits and, therefore, (3) we need to focus on near-zero-emission technologies (near-zero because thermodynamics will never let us get to zero). That is to say - solar/electric/hydrogen. These are clearly a challenge to achieve but we need to think bigger if we are to make a sustained (and meaningful) impact here.

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Title: Quantifying the climate, air quality and health benefits of improved cookstoves: An integrated laboratory, field and modeling study

Publications:

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3. Bilsback, K.R., Baumgartner, J., Cheeseman, M., Ford, B., Kodros, J.K., Li, X., Ramnarine, E., Tao, S., Zhang, Y., Carter, E. and Pierce, J.R. (2020). Estimated Aerosol Health and Radiative Effects of the Residential Coal Ban in the Beijing-Tianjin-Hebei Region of China. Aerosol Air Qual. Res. 20: 2332–2346. doi:10.4209/aaqr.2019.11.0565. https://www.researchgate.net/publication/326984202_The_Firepower_Sweep_Test_A_Novel_Approach_to_Cookstove_Laboratory_Testing
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