Understanding how Wood-burning's Contributions to Particulate Matter Concentrations have Changed over Time

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Background. Wood burning is a significant contributor to $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5 µm and less) levels along the Wasatch Front. On a typical winter day, wood burning contributes approximately 16 to 22% to $PM_{2.5}$ levels. Policy makers have devoted significant effort and funds to reducing wood burning during poor air quality episodes. However, it is difficult to determine whether these policy efforts are having the desired effect because meteorological conditions can confound the interpretation of the study results that rely on chemical makers.

Goal. The goal of this study is to understand whether wood-burning's contributions to $PM_{2.5}$ concentration data have been changing over time. We would anticipate that increased public awareness, wood-stove conversion programs, and improved enforcement will cause a decrease in woodburning. However, assessing whether these changes are challenging because meteorological factors can confound the interpretation of results. The study will evaluate temporal patterns in primary and secondary wood smoke contributions and their associations with temperature, heat deficit, and day of week. This study will include both primary and secondary contributions from wood burning. Wood burning emits $PM_{2.5}$ directly, and it also releases volatile organic carbon (VOC) emissions that transform in the atmosphere into secondary organic aerosols.

TECHNICAL APPROACH

Dr. Robert Kotchenruther (EPA region 10) has been studying primary and secondary contributions of wood smoke to PM levels in the intermountain west, using positive matrix factorization (PMF) (Kotchenruther 2016), and he is completing a study of primary and secondary contributions to wood smoke at several chemical speciation

network (CSN) sites, including Bountiful, Hawthorne, and Lindon. This study will complement Dr. Kotchenruther current source attributionwork, which covers the years of 2007 – 2018 in the by completing the following tasks:

Task 1: PMF Factors and Meteorology (Dr. Jaramillo)

This includes Analyzing the PMF factors (from Kotchenruther) along with meteorological parameters to understand whether apparent decreases in woodburning contributions are due to atmospheric conditions or decreases in activity. This will be achieved by normalizing the PMF factors:

- by heat deficit. This would include calculating heat deficit for 2007 – 2017. Heat deficit provides an indication of the strength of a cold air pool (Whiteman).
- by temperature. Colder temperatures are typically associated with increased wood burning (REF).
- Considering the burn and no burn dates in each location. DAQ will provide the historical DAQ burn conditions.
- Dr. Kotchenruther has agreed to provide his PMF inputs and results.

Task 2: Identifying local and regional contributions to wood burning (Dr. Jaramillo)

Attempt to determine if wood burning is coming from local sources or more valley-wide sources by examining back trajectories. This will include determining the daily average back trajectories for the CSN collection dates from Hysplit.

Task 3: Wood-burning contributions over time (Drs. Kelly and Jaramillo)

Develop a timeline to present the contributions from wood burning (primary and secondary PMF factors) including increased efforts to reducing wood burning, including changing the levels when no burn days are called, change out programs, Salt Lake County's no-burn day policy). The Univeristy of Utah will work with DAQ to identify the timing of these efforts.

Task 4: PMF Refinements or wood-burning compliance (Dr. Jaramillo)

Depending on the results of the Kotchenruther study, the final task will address one of two needs:

4a. In Kotchenruther's previous study (Kotchenruther 2016) covering 2007 - 2014, he was unable to resolve wood burning from vehicle emissions at the Hawthorne site. It is unknown whether he will be able to resolve a wood-burning factor for this site with additional data (2007 – 2018). If re-running PMF is necessary, his would include adding additional measurements from the Hawthorne site (beyond $PM_{2.5}$ composition.

4b. If 4a is not necessary, we will develop a strategy for estimating wood-burning compliance using hourly 7-channel aethalometer data (available from winter 2019) and heat-deficit information (Whiteman et al. 2014). This work will be performed in partnership with Dr. Daher at DAQ.

Task 5. Quality Assurance (Drs. Kelly and Jaramillo)

Dr. Kelly and Dr. Jaramillo are responsible for the overall quality assurance. The quality of the data will be assessed in terms of completeness, uncertainty, and representativeness.

- **Data types.** The collected data will include days of wood burning bans and chemical composition from EPA's CSN. Note that we will request this from YDAQ.
- **Data uncertainty.** We will follow standard source attribution methods for estimating and including the uncertainty for each of the species in the PMF analysis.
- **Data management and analysis.** The data will be stored on University of Utah computers and will be backed up regularly.

Task 6: Reporting and Presentation of results (Dr. Kelly)

This task includes regularly reporting, as required by the UDAQ, presentation at the annual Air Quality: Science for Solutions meeting, and if the results are suitable preparing a peer-reviewed publication. We also archive the results in the University of Utah's Hive database.

Project Timeline

Task	1	2	3	4	5	6	7	8	9	10	11	12
1: Meteorology	X	X										
2: Local and regional contributions		x	x	x								
3: Contributions over time				x	x							
4: Refinements or compliance					x	x						
5: Quality assurance	x	x	x	x	x	x						
5: Presentation of results				x		x	x					x

BUDGET

(see accompanying spreadsheet)

REFERENCES

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