Wood-Smoke Source Contribution Along the Wasatch Front

Trends, Contribution & Low-Emission Devices

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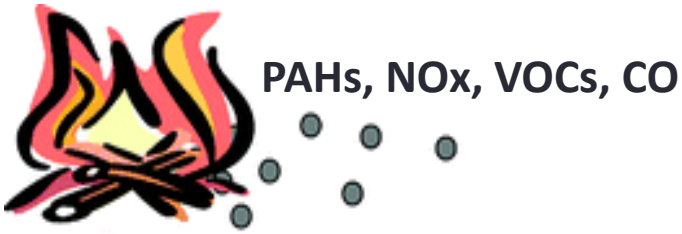
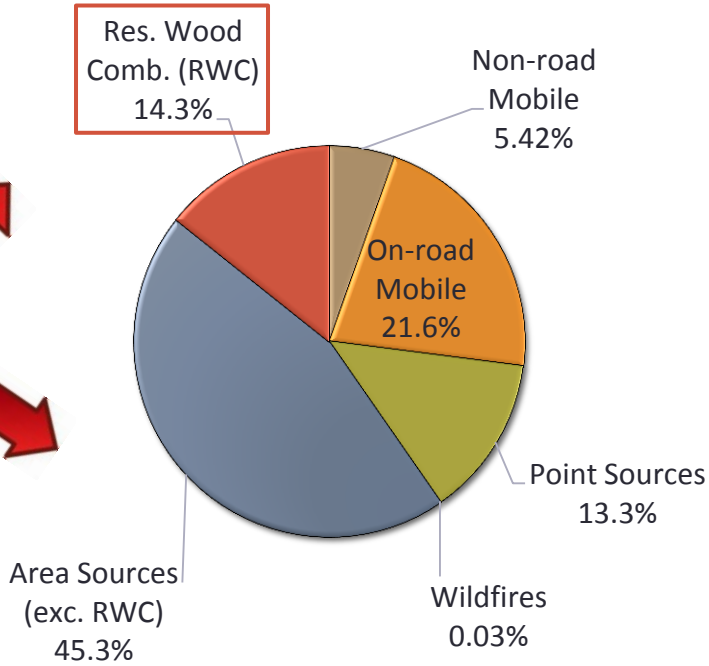
Wood-Smoke: It Takes Your Breath Away!



Wood-Smoke

Primary PM2.5, Salt Lake County



NEI, 2011

Framework

Synopsis
- Trends

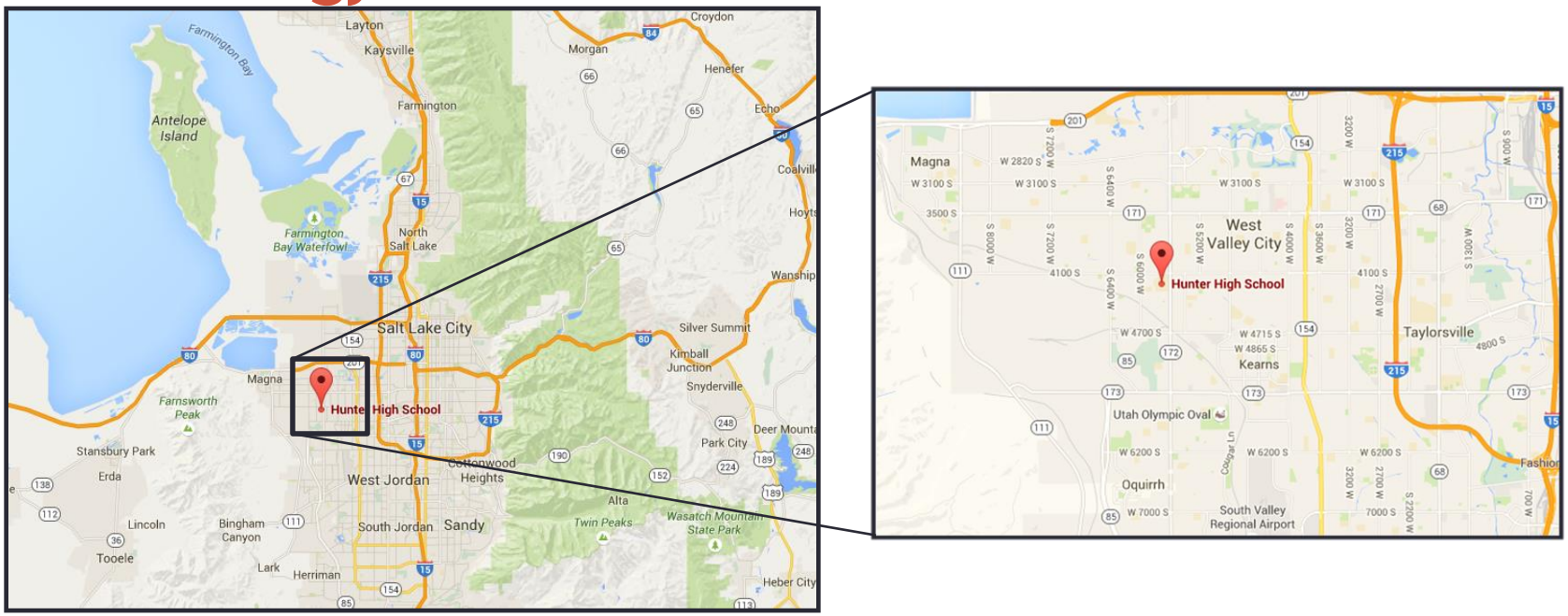
Analysis Plan
- Source Contributions
- Exceedance Days

Sensitivity Analysis
- Low-Emission Wood-Burning Devices

Synopsis

Temporal Trends

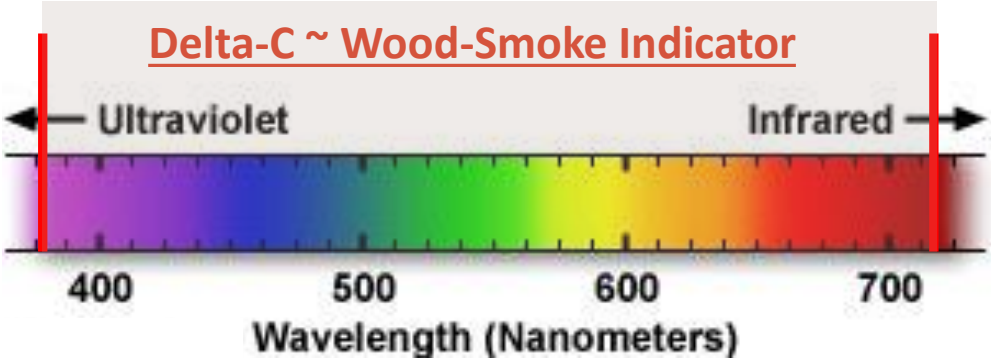
Methodology



Data from Sonoma Tech., Inc.

Measured Parameter	Sampling Method	Sampling Frequency	Sampling duration
Wind speed/Direction	R. M. Young 5305 V	1-min	Aug. 2011-Apr. 2012
Temperature	R. M. Young 41342 VC	1-min	
Black Carbon (BC)	Two-wavelength Aethalometer, AE 22	5-min	

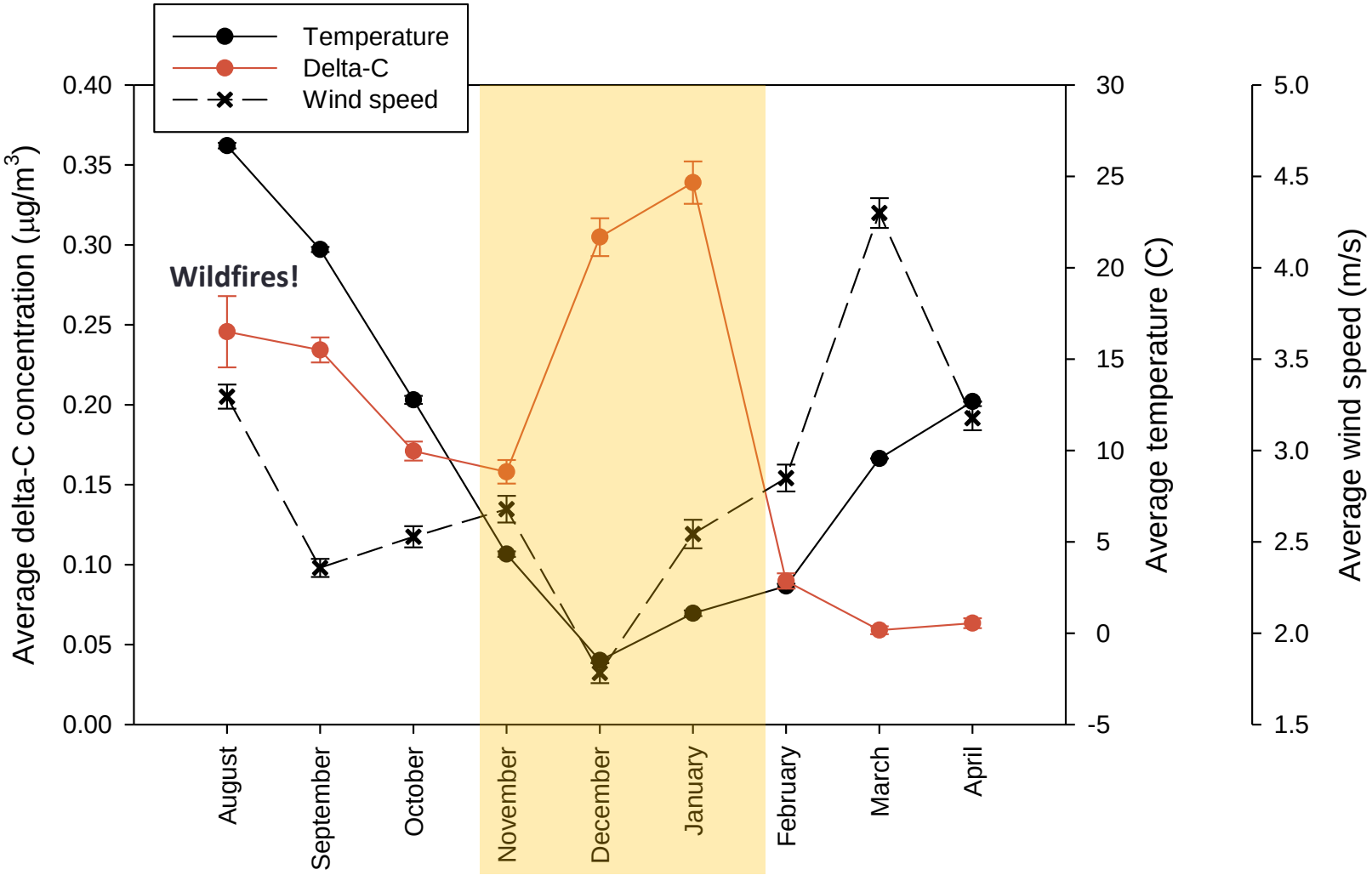
Wood-smoke Characterization: Two-wavelength Aethalometer



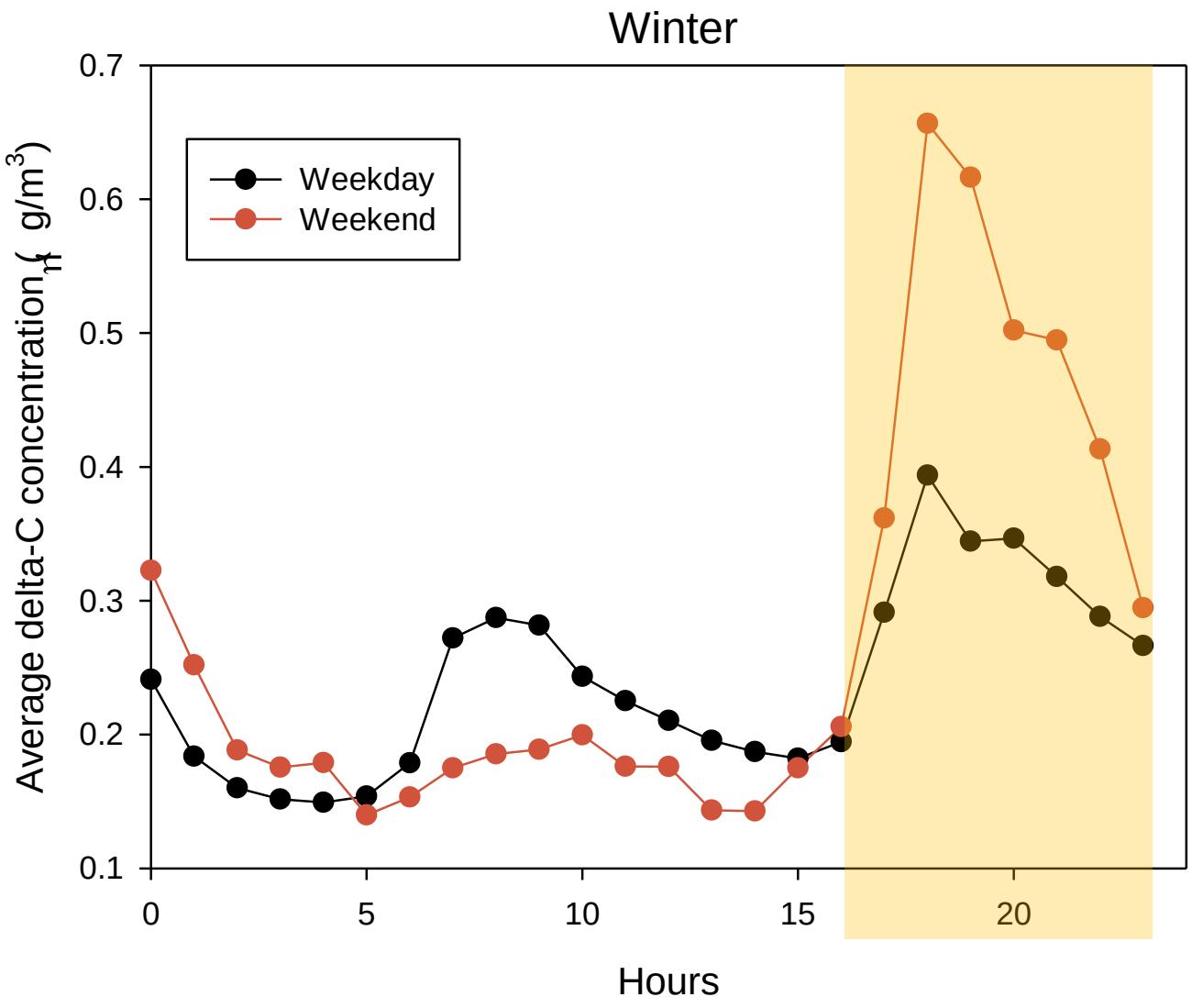
!! But delta-C is ONLY a QUALITATIVE measurement!!

Delta-C of 0.5 µg/m^3 ✗ 0.5 µg/m^3 of wood-smoke

Delta-C & Temperature/Wind

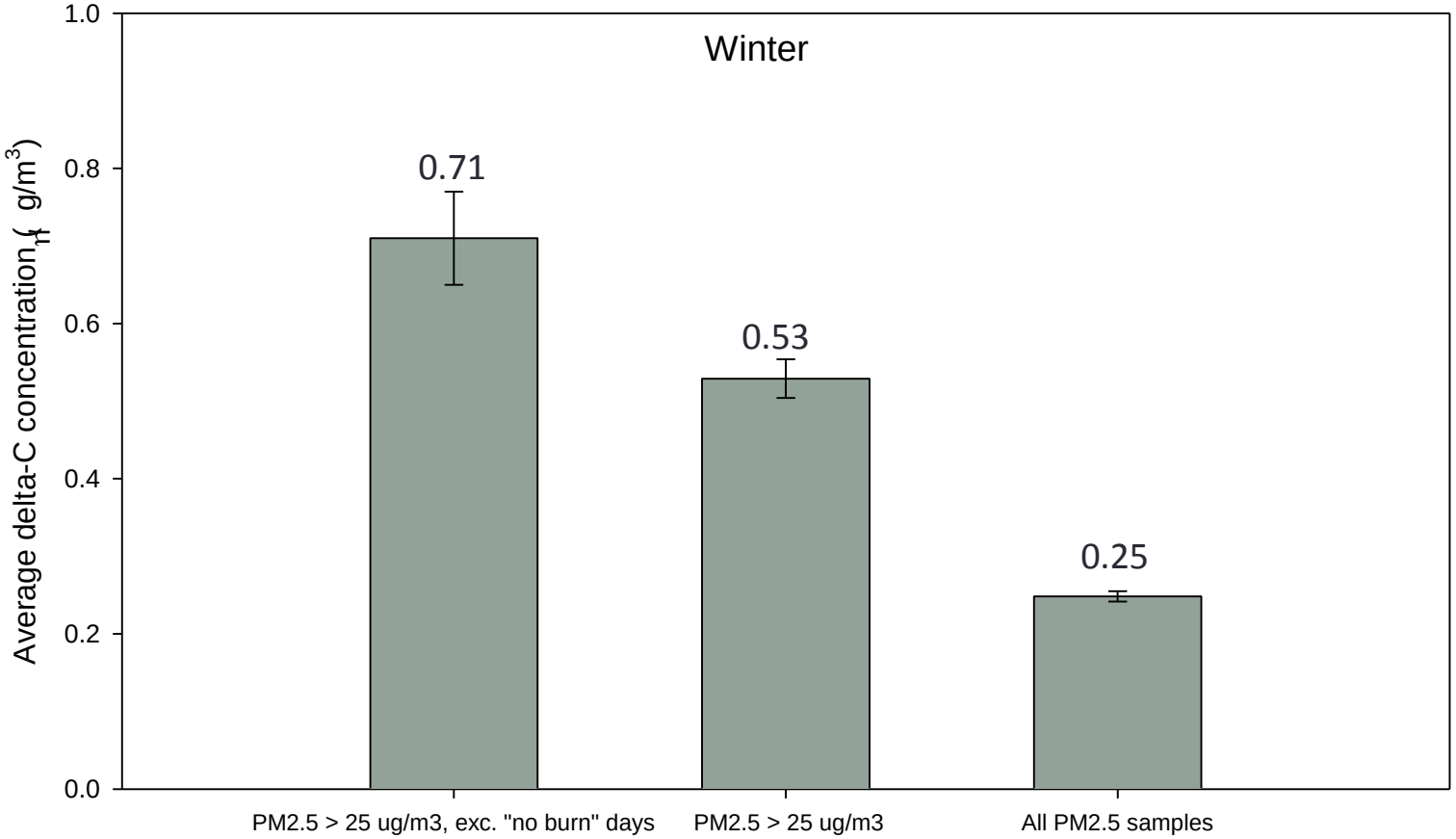


Delta-C - Diurnal Variation



High Delta-C ➡ High PM2.5?

	Summer	Fall	Winter	Spring
R (PM2.5-deltaC)	-0.01	0.40	0.55	0.34



Summary

Peak delta-C concentrations	Consistent with expected trends for domestic heating emissions

→ Evidence of Wood-Burning Emissions

Analysis Plan

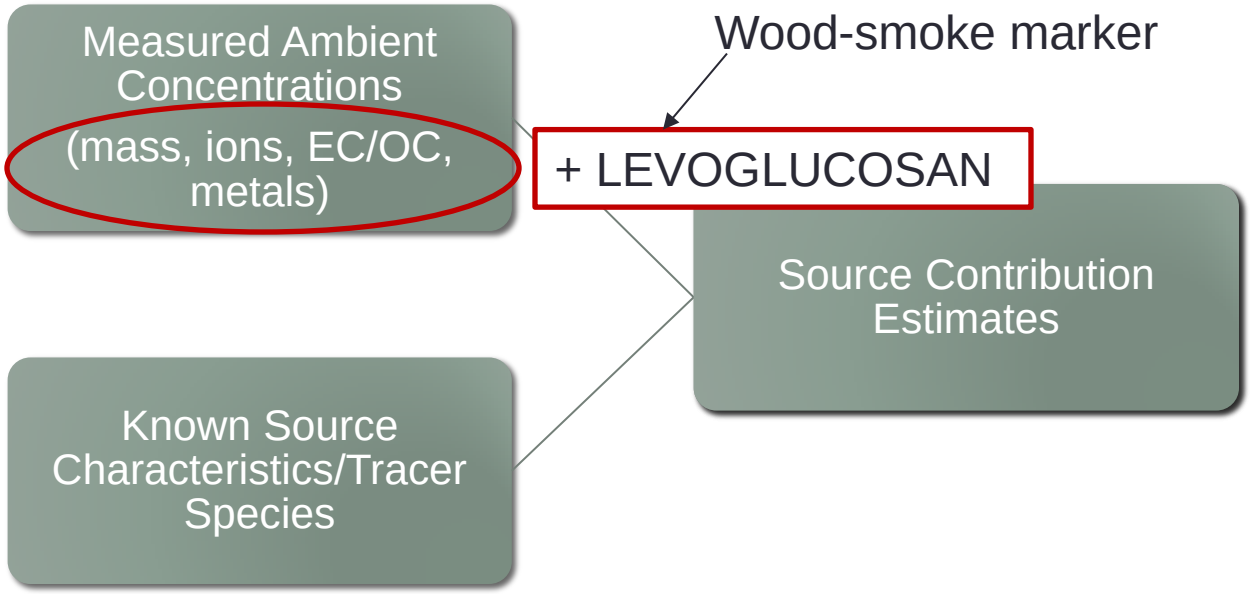
Source Contributions, Exceedance Days

Going Forward: Wood-Smoke Characterization

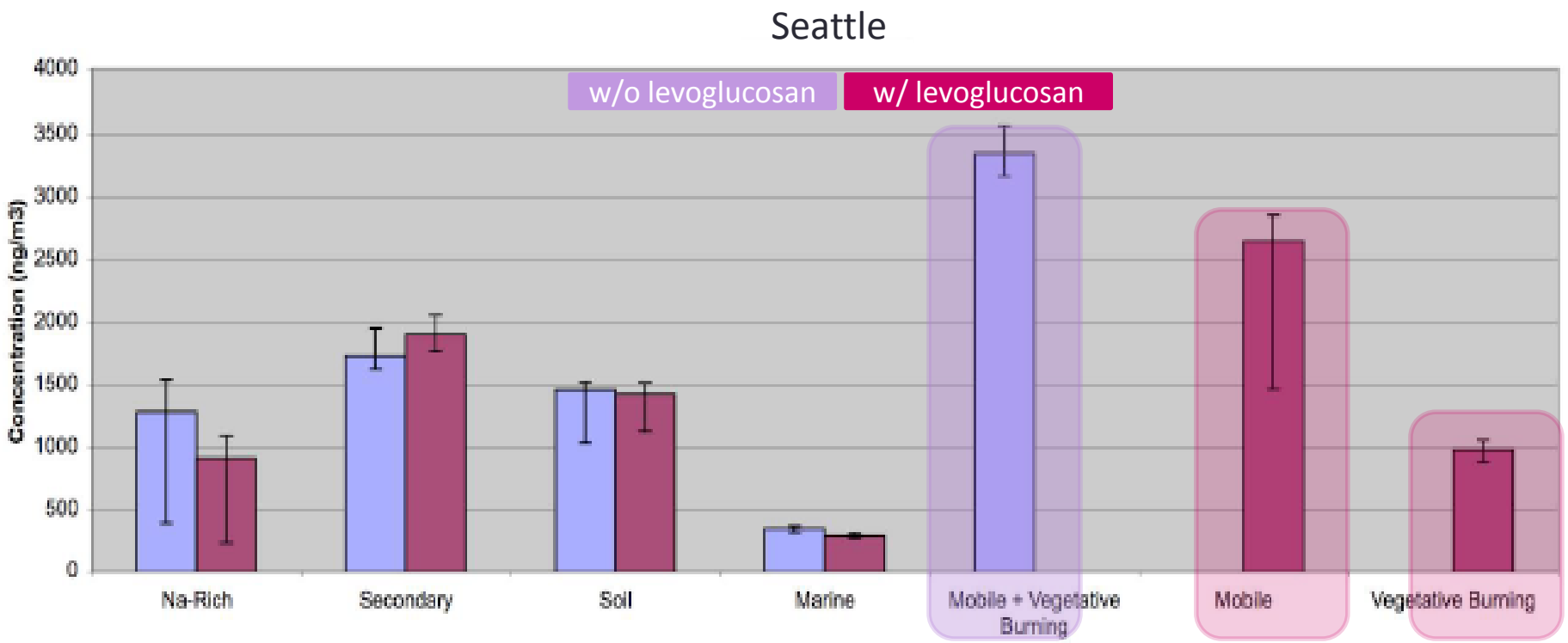
Objectives	Quantify wood-smoke contribution
	Investigate exceedance days
	Compare to other source contributions

Wood-smoke Quantification: PMF Receptor Modeling

- Apportions ~ all major sources
- Uses speciation data
- Higher accuracy if data complemented by levoglucosan



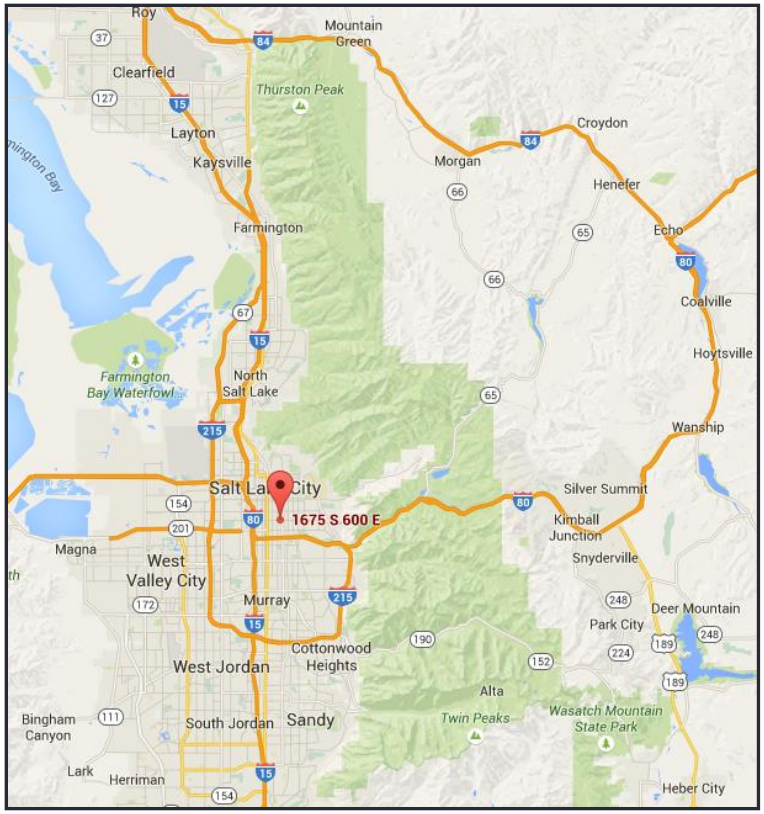
Levoglucosan Vs. Potassium



Levoglucosan = Wood-smoke marker

Onstad and Simpson. Puget Sound Clean Air Agency report, 2008

Wood-smoke Quantification: Methodology



- Hawthorne (speciation site)
- 24-hr PM2.5 FRM + SPECIATION samples
- Jan 2015-Jan 2016

Levoglucosan Analysis

↓

Levoglucosan + Chemical Speciation Data

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PMF

↓

Wood-smoke & Major Source Contributions

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Importance of Wood-Smoke in PM2.5

Going Forward: Routine Network Analysis

Measured Levoglucosan → ? → $PM_{2.5,\ wood\text{-}smoke}$

Going Forward: Routine Network Analysis

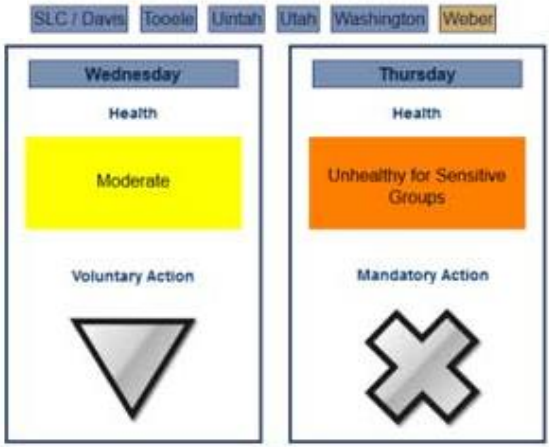
Measured Levoglucosan → Emission Ratio: PM2.5/Levoglucosan → $PM_{2.5,\ \text{wood-smoke}}$

$$PM_{2.5,\text{wood-smoke}} = \frac{PM_{2.5}}{levog.} \times levog._{meas.}$$

<u>From PMF-resolved wood burning profile</u>

To Burn or Not to Burn?

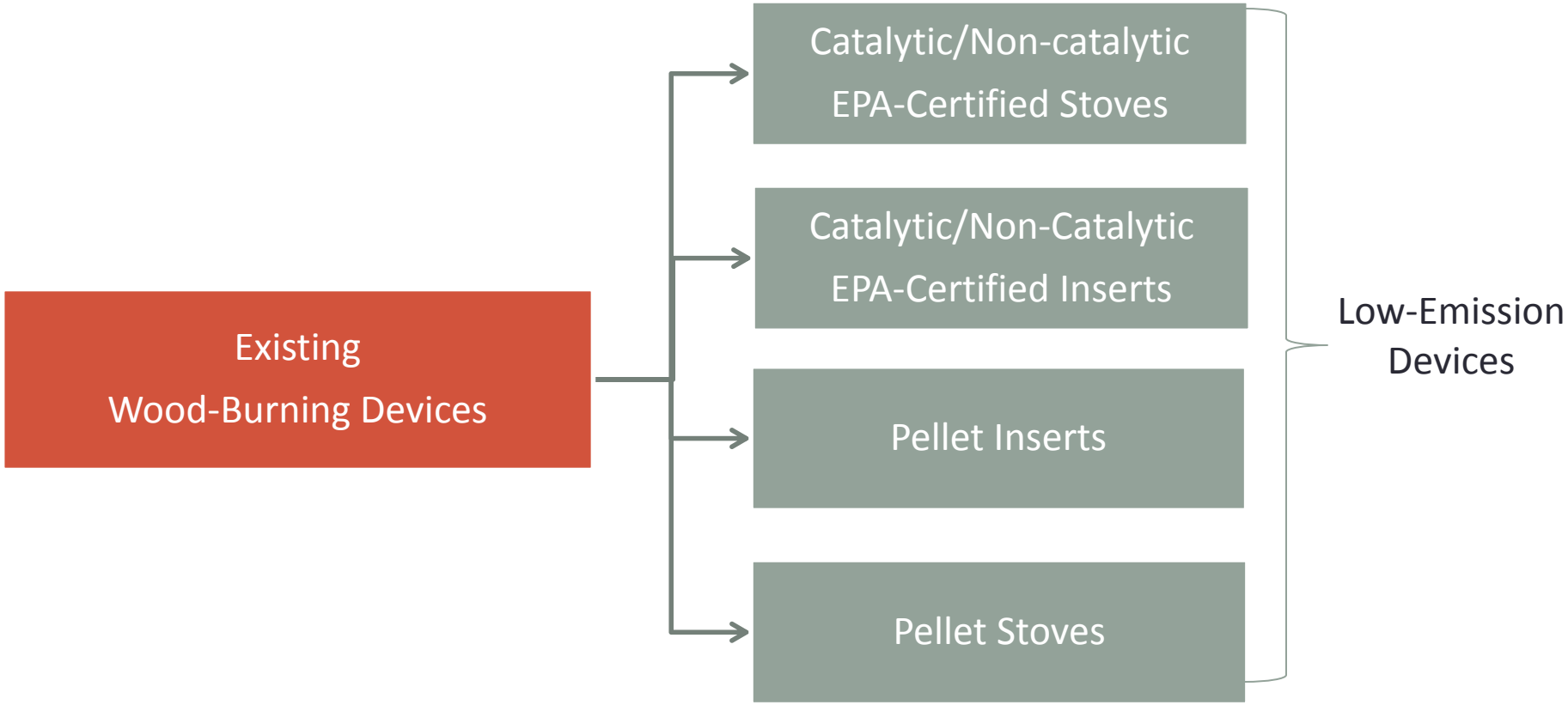
Impact of low-emission devices



Low-Emission Wood-Burning Devices

<u>Hypothetical CHANGE-OUT program:</u>

Existing wood-burning devices replaced by low-emission ones



Low-Emission Wood-Burning Devices

<u>Hypothetical CHANGE-OUT program:</u>

Existing wood-burning devices replaced by low-emission ones

$$E_{pre} = \sum E_i$$

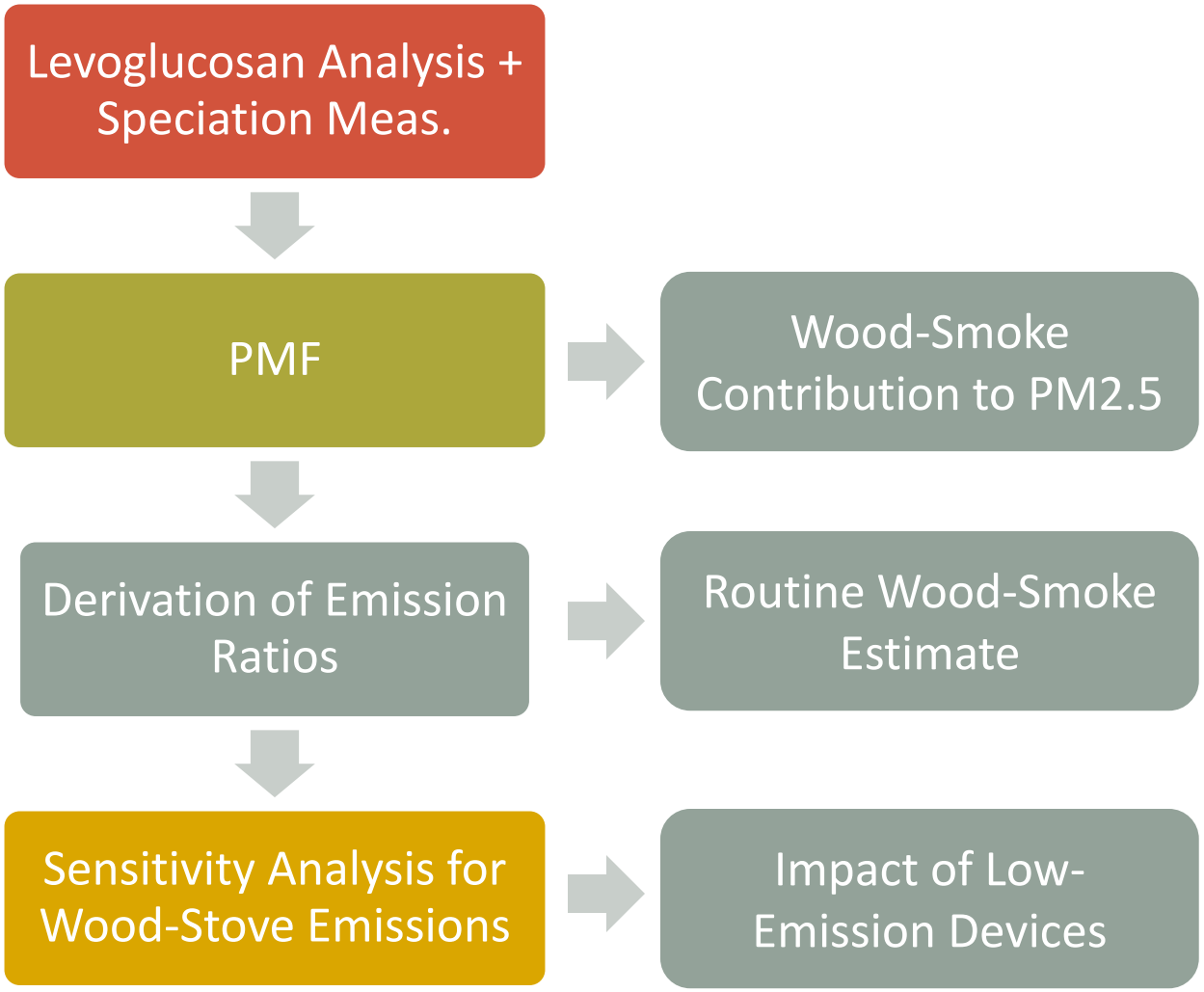
$$E_i = cords\ use_i \times wood\ density\ \times EF_i \times N_i$$

$$E_{post} = cords\ use_i \times wood\ density \times \frac{\varepsilon_i}{\varepsilon_{cert}} \times EF_{cert} \times N_i$$

$CMAQ$

$$E_{reduction} = E_{pre} - E_{post}$$

Wrapping Up


Levoglucosan Analysis + Speciation Meas.
PMF
Wood-Smoke Contribution to PM2.5
Derivation of Emission Ratios
Routine Wood-Smoke Estimate
Sensitivity Analysis for Wood-Stove Emissions
Impact of Low-Emission Devices

Thank you!

Questions?