

Use of molecular markers in biological and environmental monitoring of woodsmoke exposure

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Why do we care about woodsmoke?

- Woodsmoke exposures are associated with adverse respiratory health effects
- Woodsmoke is a major component of fine ambient PM in many communities
 - e.g 30% of SeattlePM_{2.5}

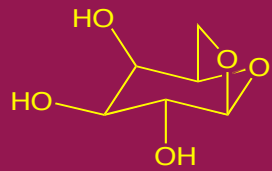
Exposure monitoring issues

- Woodsmoke exhibits significant spatial and temporal variability
- Central monitoring may be a poor surrogate for personal exposure
- Exposure misclassification may be a major confounder for studies assessing health effects of woodsmoke exposure
- A biomarker approach may provide a better measure of personal exposure than traditional monitors.

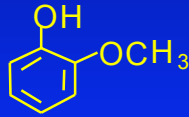
Study Aim

- Examine relationship between woodsmoke markers in urine, and exposure to woodsmoke

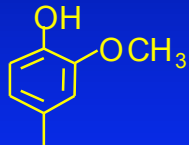
Segregation of tracers into groups: volatile, reactive, tracer of PM



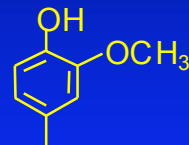
levoglucosan



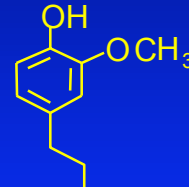
Guaiacol



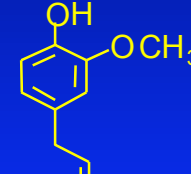
Methylguaiacol



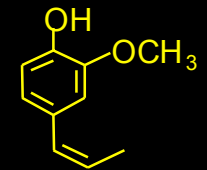
Ethylguaiacol



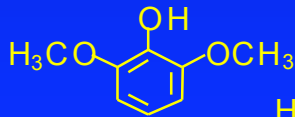
Propylguaiacol



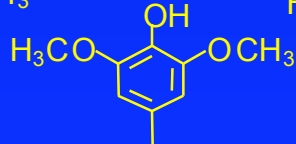
Eugenol



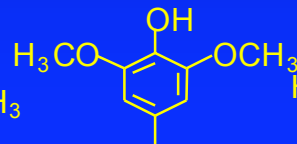
cis-Isoeugenol



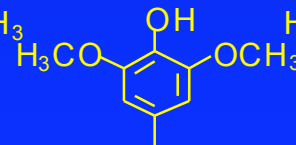
Syringol



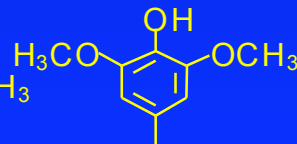
Methylsyringol



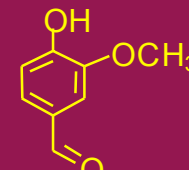
Ethylsyringol



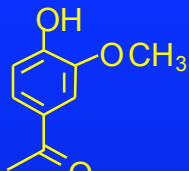
Propylsyringol



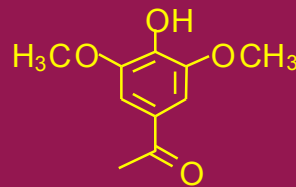
Allylsyringol



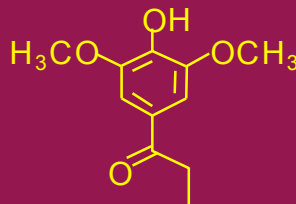
Vanillin



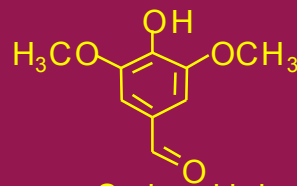
Acetovanillone



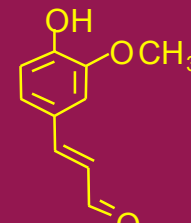
Acetosyringone



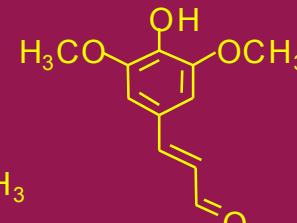
Propylsyringone



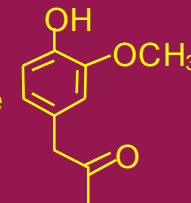
Syringaldehyde



Coniferylaldehyde

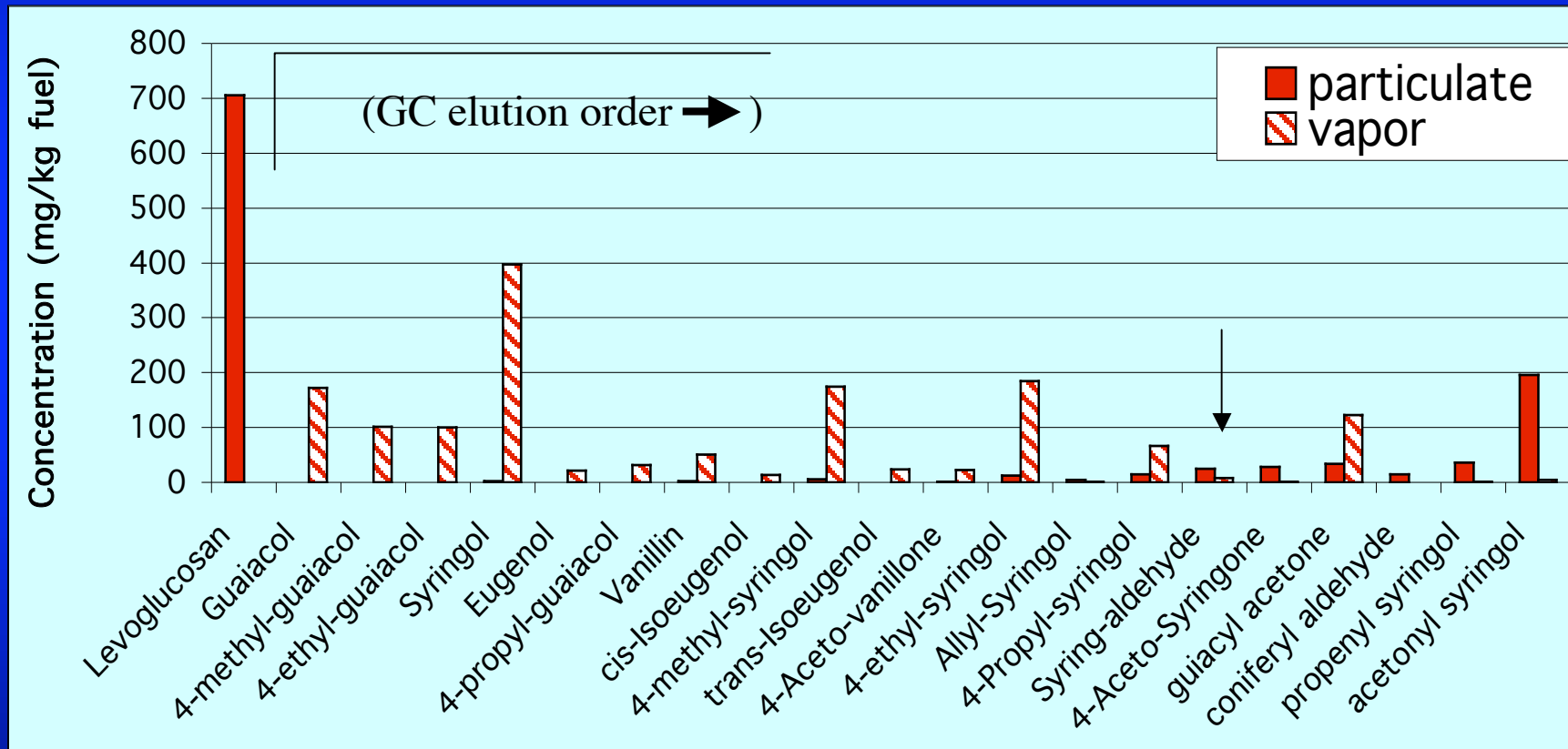


Sinapylaldehyde



Guaiacylacetone

Abundance of molecular markers in smoke from combustion of oak



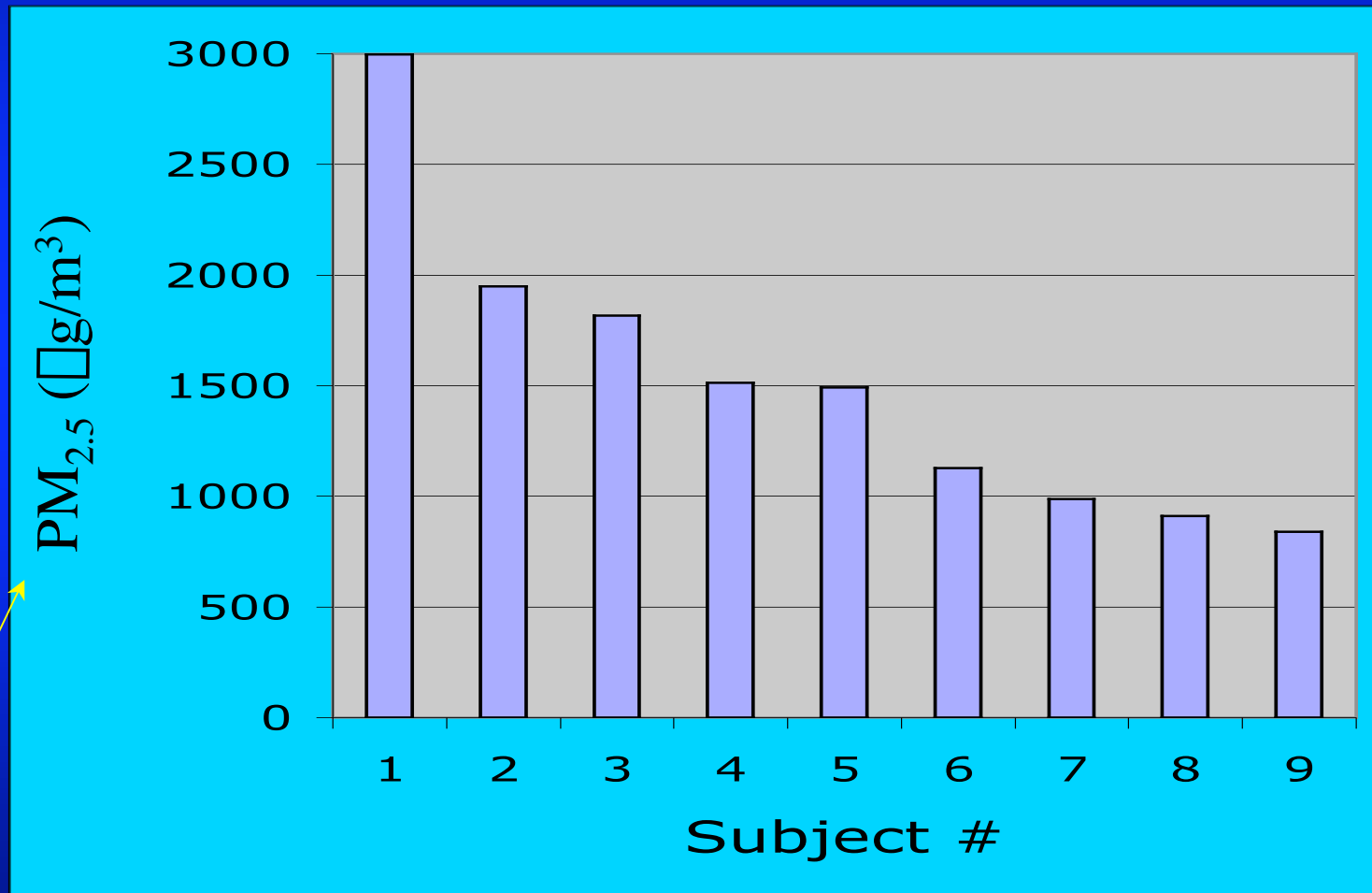
Key features for a woodsmoke biomarker

- Relatively abundant in woodsmoke
- Ideally, should be particle associated
- Should be stable in the atmosphere
- Should not be appreciable metabolized
- Must have low abundance in urine from subjects with low exposures to woodsmoke

Cohorts studied

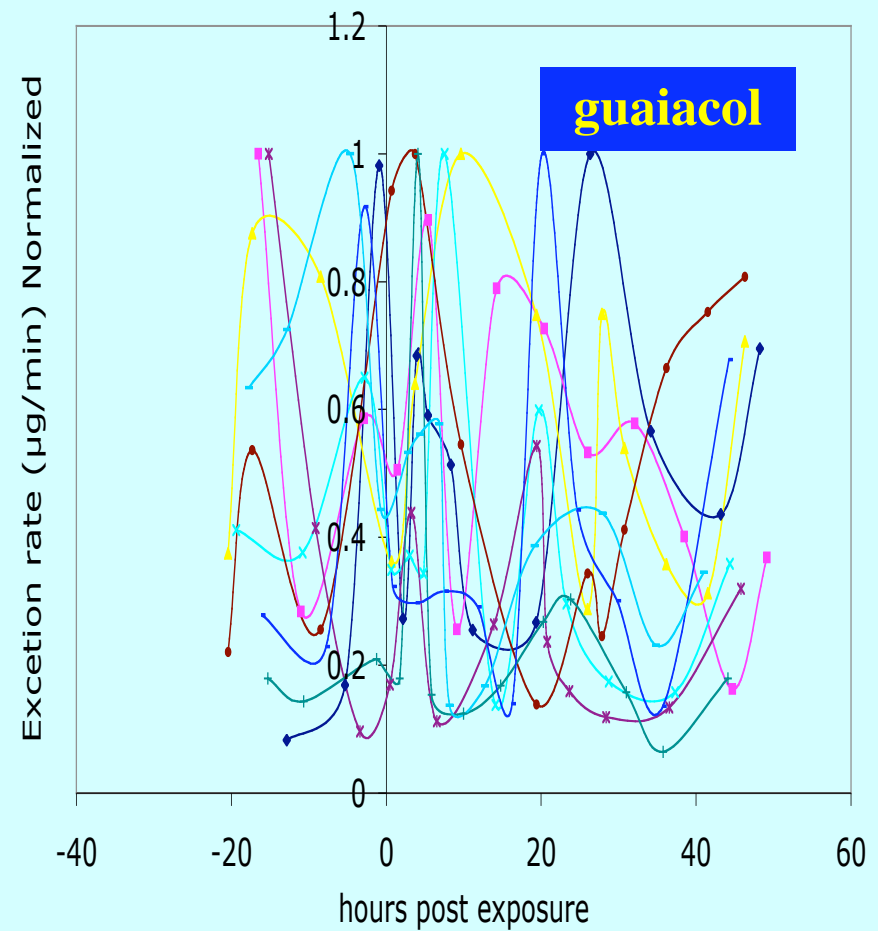
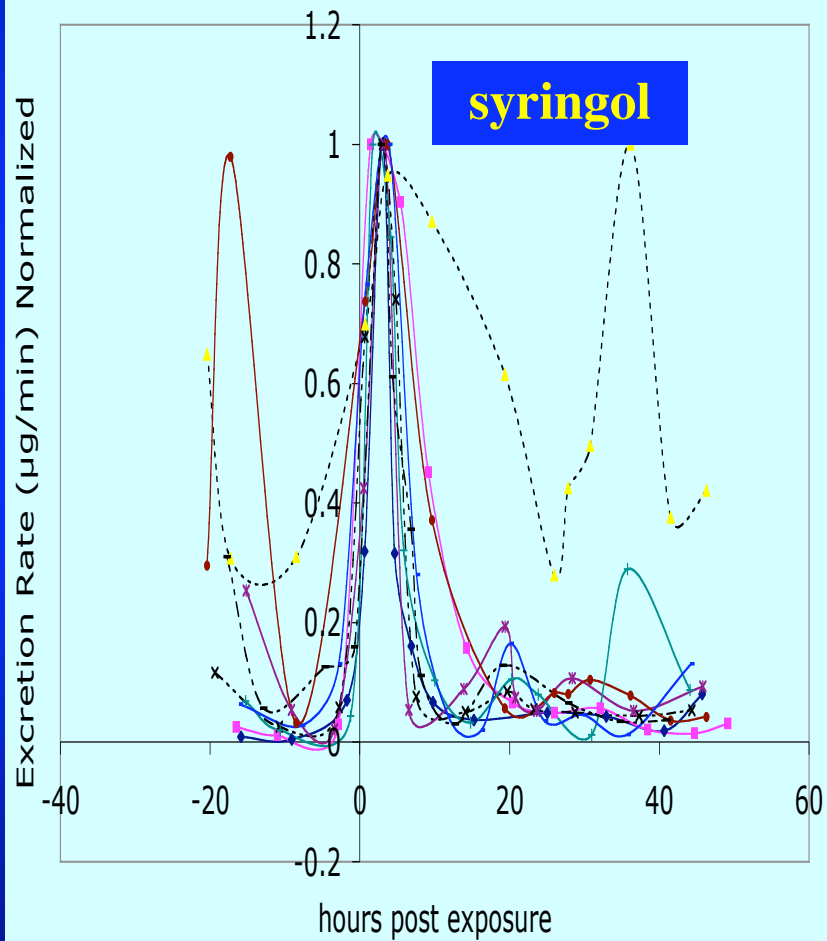
- Managed exposure to woodsmoke
 - PM_{2.5} levels: 840-2997 $\mu\text{g}/\text{m}^3$
- Guatamala cookstove intervention study
 - PM_{2.5} levels: 14-1164 $\mu\text{g}/\text{m}^3$
- Agricultural burning occupational study
 - PM_{2.5} levels: 68-1807 $\mu\text{g}/\text{m}^3$
- Seattle Panel study
 - PM_{2.5} levels: 1.0-29.5 $\mu\text{g}/\text{m}^3$

I. 'Campfire' exposures



2 hr TWA values

Excretion rates for syringol and guaiacol

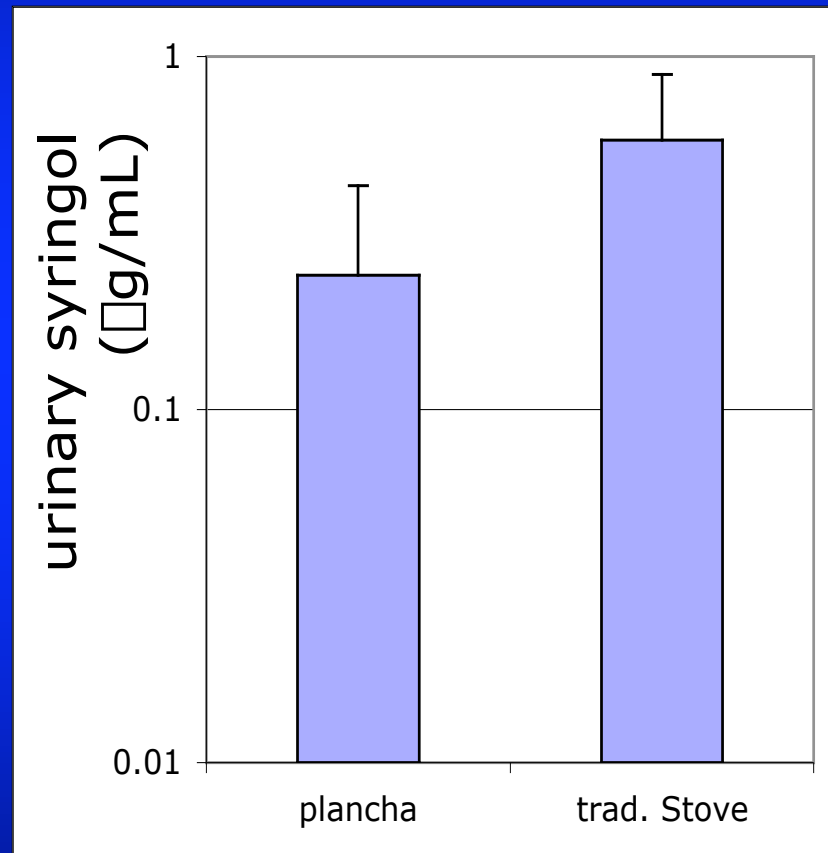
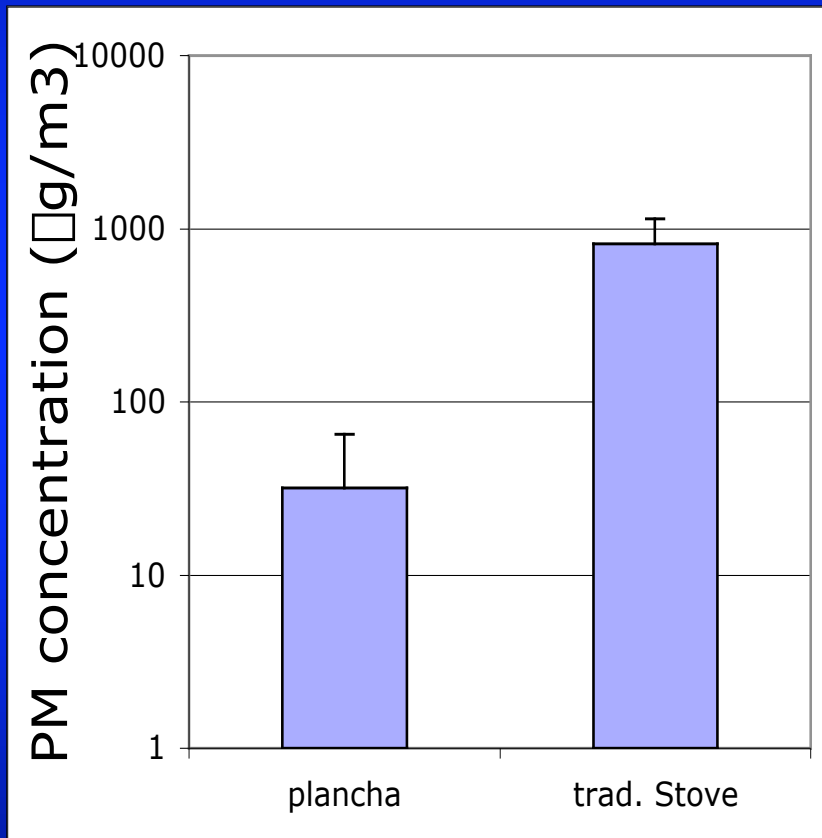


II. Guatemala cookstove study*

- Randomized controlled intervention in rural Guatemala. Subset of 20 subjects.
- 50% of subjects receive an enclosed *plancha* cookstove with chimney that vents to the outside; other use unvented indoor stoves
- PM_{2.5} mass and levoglucosan collected/measured using an indoor filter sampler
- Collect first morning urine void

* Kirk Smith, PI

PM exposure and biomarker levels in subjects exposed to biomass smoke in rural Guatemala



Urinary syringol levels are significantly elevated in subjects from homes using traditional cookstoves, compared to subjects from homes equipped with the *plancha* ($p < 0.001$)

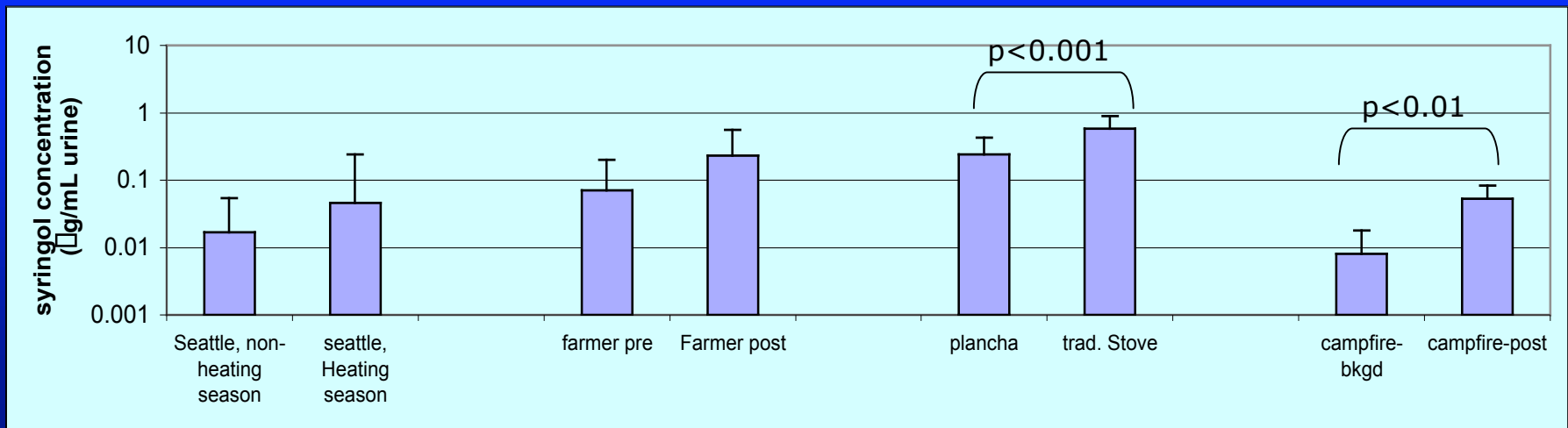
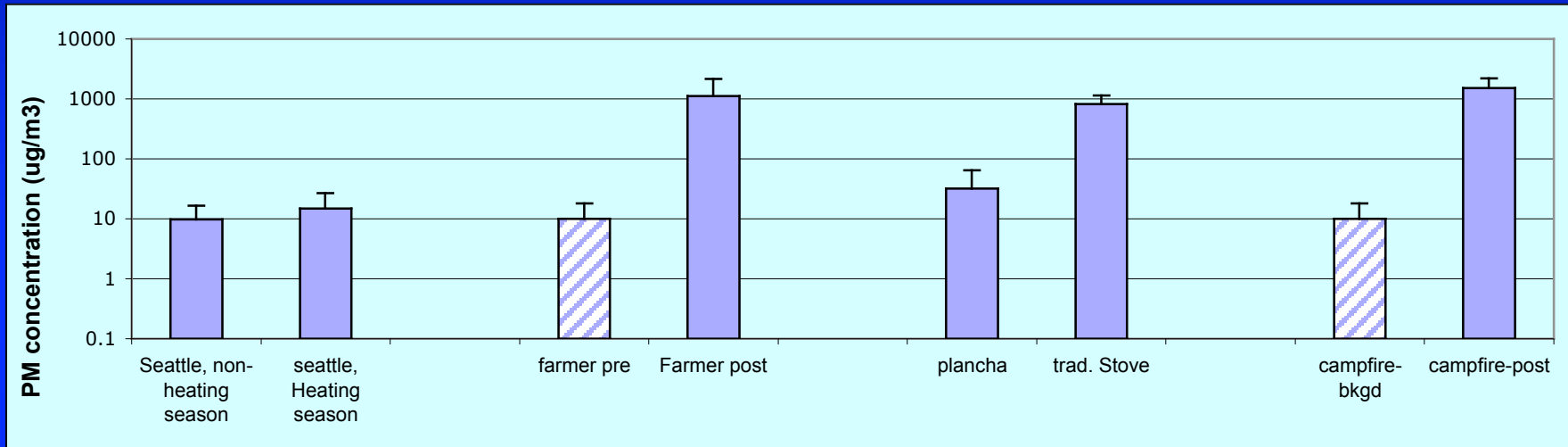
IV. Seattle panel study results

- Selected ~30 individuals with high and low PM exposures for extensive chemical analysis
- Up to 14 individual methoxyphenols detected in 60 urine samples
- Moderately high degree of correlation between different compounds

Urinary markers and exposure

- Mean urinary biomarker levels not significantly higher in heating vs non-heating season
- Individual markers not significantly associated with levoglucosan (outdoor) or personal $PM_{2.5}$; stratifying by LG (o) doesn't help.
- Longitudinal r for markers vs levoglucosan (outdoor) or personal $PM_{2.5}$ doesn't indicate strong associations

Comparison of PM_{2.5} exposure and urinary biomarker



Conclusions

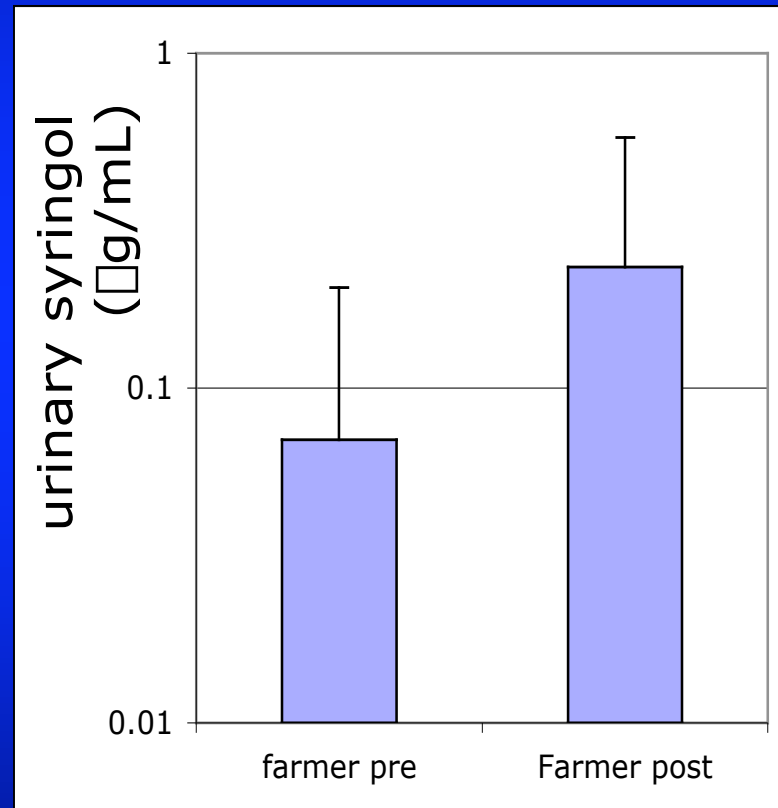
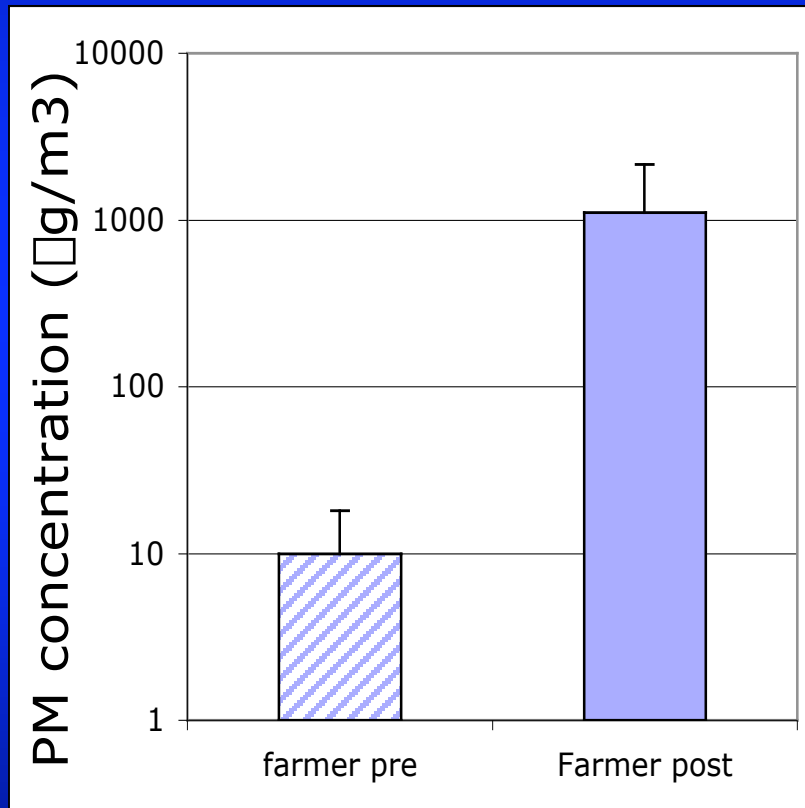
- Specific urinary methoxyphenols were clearly associated with exposures to woodsmoke $>\sim 500 \mu\text{g}/\text{m}^3$
- Urinary methoxyphenols were not clearly associated with ambient PM exposures in the 3-40 $\mu\text{g}/\text{m}^3$ range
 - Contribution from diet overwhelms contribution from ambient woodsmoke PM in Seattle urban air
- We expect that the urinary methoxyphenol biomarker will be a useful marker for woodsmoke exposure in highly exposed populations.



III. Occupational exposures to smoke from field burning

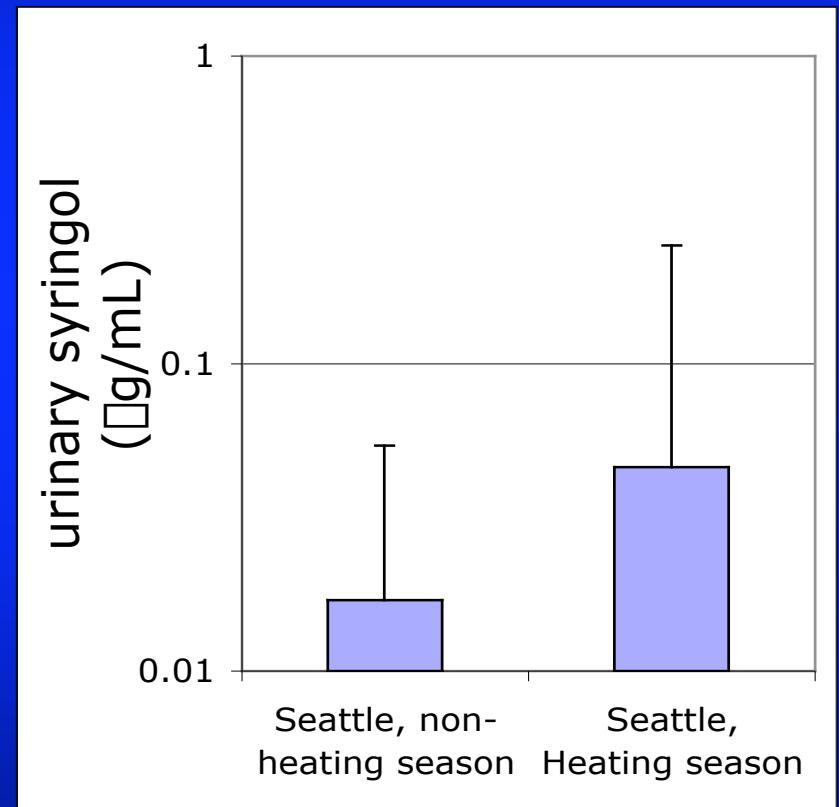
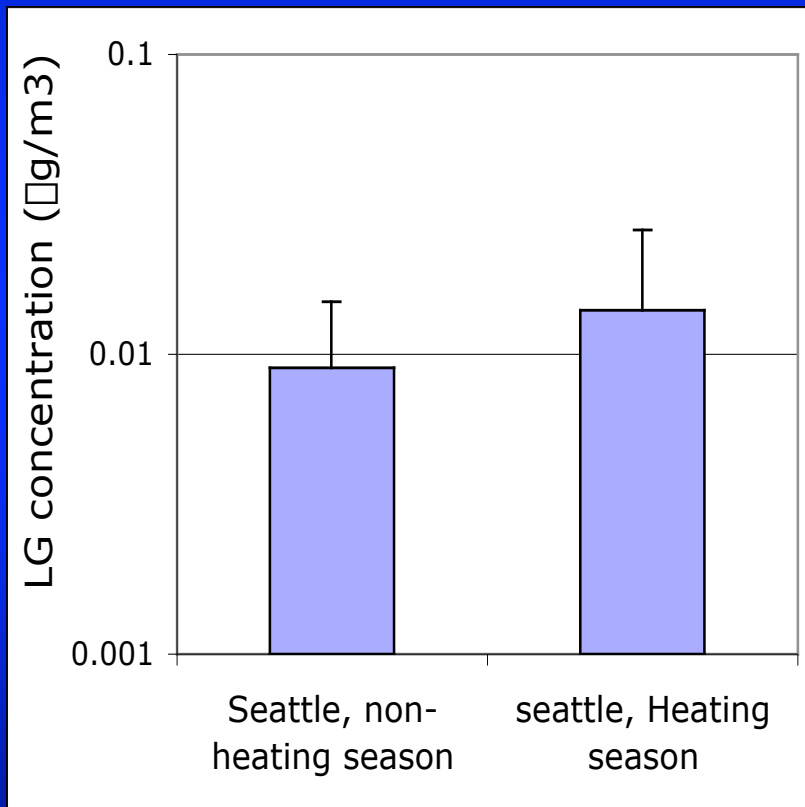
- 6 farmers involved in field burning
- Exposure duration: 0.6-3.0 hr
- PM_{2.5} mass and levoglucosan collected/measured using personal (HPEM_{2.5}) sampler
- Collected last pre-exposure and first post-exposure urine voids

PM exposure and biomarker levels in farmers exposed to smoke from field burning



Urinary syringol levels are elevated in post exposure samples, but the difference is not statistically significant ($p=0.26$)

Levoglucosan exposure and biomarker levels in residents of Seattle in heating and non- heating seasons



Urinary syringol levels are elevated in post exposure samples, but the difference is not statistically significant ($p=0.26$)