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Enhancing our ability to track woodsmoke emission reductions

Levoglucosan Measurements

Acknowledgments

➔ **Neil Frank, USEPA, OAQPS**
  - ■ **Project Lead, Funding Lead**

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➔ **PSCAA**

  - ■ **Filters and funding**

➔ **Ecology**
  - ■ **Filters**

Woodsmoke is not just a Region 10 problem

➔ **Woodsmoke drives high PM 2.5 levels in winter and is the chief contributor to non-attainment**

➔ **Measuring OC via speciation network is expensive and to some extent confounded by other emission sources**

➔ **Recent advances in analysis work suggest that Levoglucosan may be a viable marker for wood smoke**

➔ **Existing filter archives can be used to establish baselines**

Levoglucosan (LG) is an indicator of Residential Wood Combustion PM2.5

→ **Puget Sound Study (2004-2007 filters)**

- **300 filters at 2 urban and 3 suburban/rural sites**
- **Ethyl acetate extraction procedure coupled with derivatization and GC/MS analysis using selected ion monitoring (SIM)**

→ **LG can also be measured with water extracts using HPLC-PAD**

- **This approach permits other useful analyses**
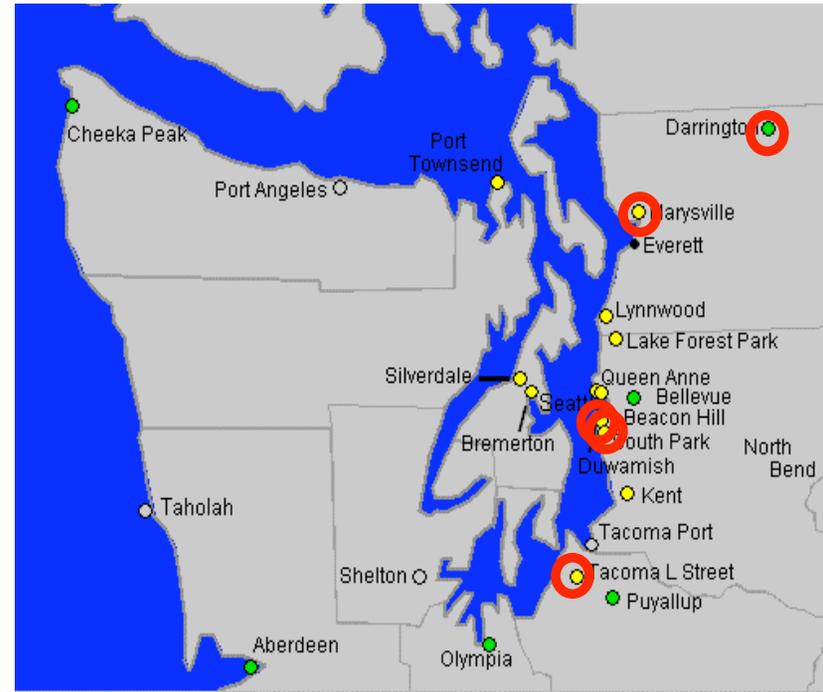
LG% of PM2.5 is highest in Darrington
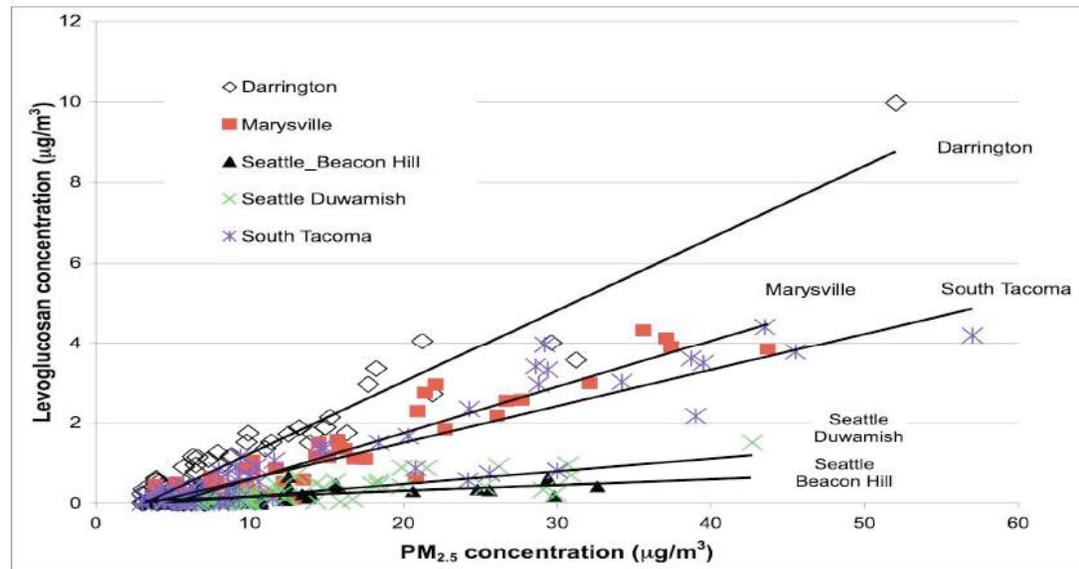## LG varies with local RWC contribution to PM2.5

Figure 7: Associations between levoglucosan and PM mass at five monitoring sites in the Puget Sound Airshed.

Table 4: Empirically derived scaling factors indicating the relationship between levoglucosan and $PM_{2.5}$ mass for woodsmoke dominated periods and locations in the Puget Sound Airshed.

	Average % levoglucosan per μg $PM_{2.5}$	95% confidence interval
Darrington	13.9	12.7-15.2
South Tacoma	9.6	8.6-10.5
Marysville	10.0	9.1-10.7

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Measurement of LG in archived FRM filters

➔ **LG is reliably measured in archived FRM filters**

➔ **Good agreement is observed between organic solvent extraction/GCMS and aqueous extraction/HPLC-PAD methods.**

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

LG and source apportionment

➜ **LG is strongly correlated with the putative "woodsmoke source" factor in PMF-derived source apportionment models, and is not correlated with other factors in the model.**

➜ **This provides confidence that the woodsmoke source factor has been correctly identified in the model**
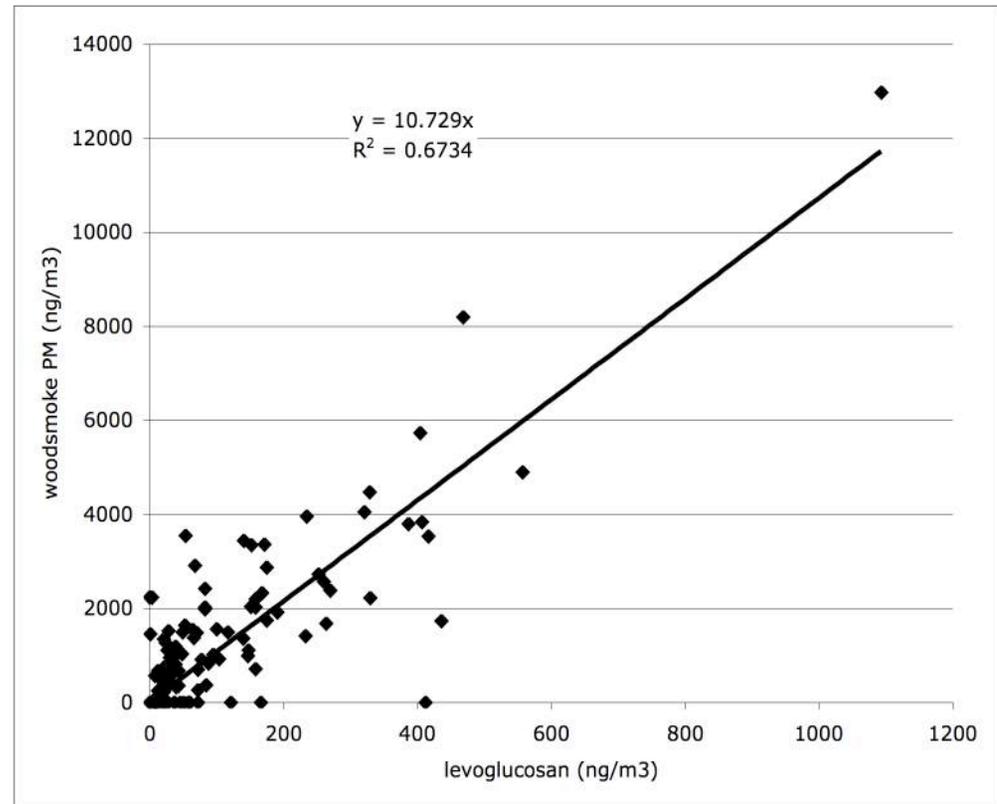
LG and source apportionment

➜ **When LG is explicitly included as a variable in the PMF model, a more accurate apportionment is achieved.**

➜ **Based on this model, LG comprises ~ 9% of woodsmoke-derived PM mass. This is consistent with values previously reported in a number of source testing studies.**

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Data from Beacon Hill monitoring site in Seattle, WA

Spatial distribution of woodsmoke concentrations

→ **Measurement of LG indicates that temporal and spatial variation in woodsmoke-PM is greater than variation in total PM$_{2.5}$ concentrations.**

→ **This information assists local agencies to identify areas where woodsmoke drives air quality concerns, and thence to implement appropriate, targeted interventions.**
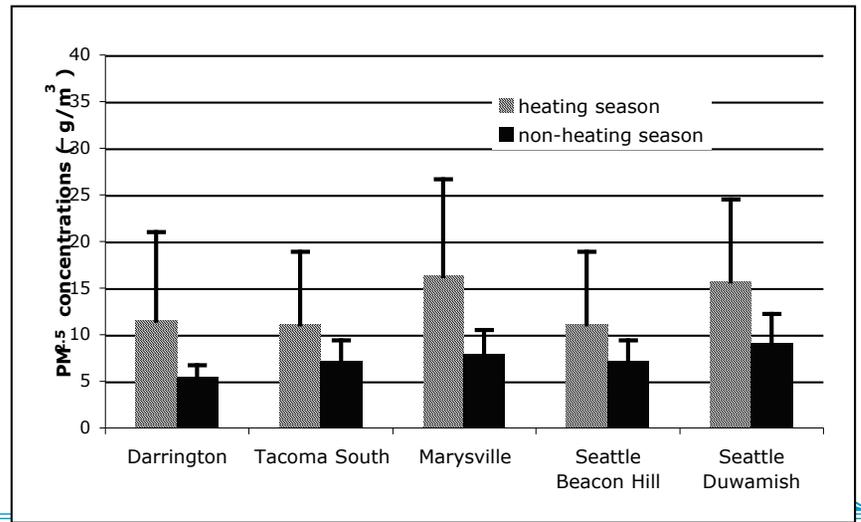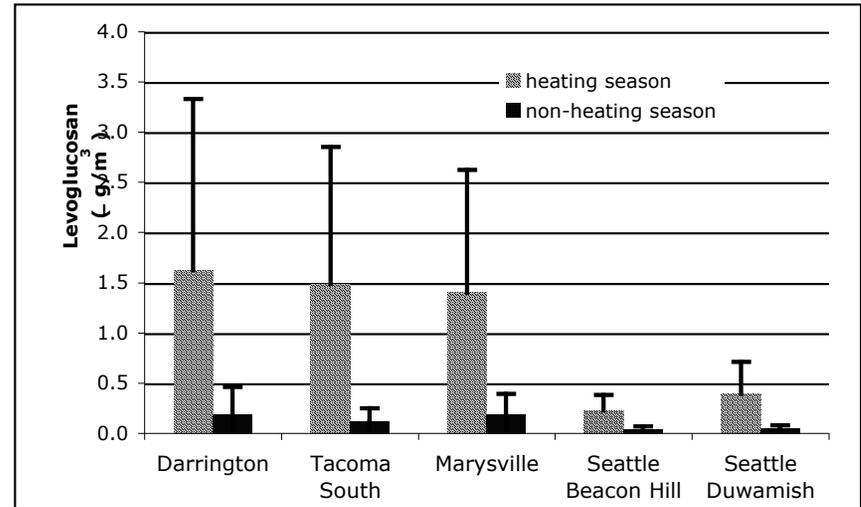
LG to woodsmoke PM scaling factors
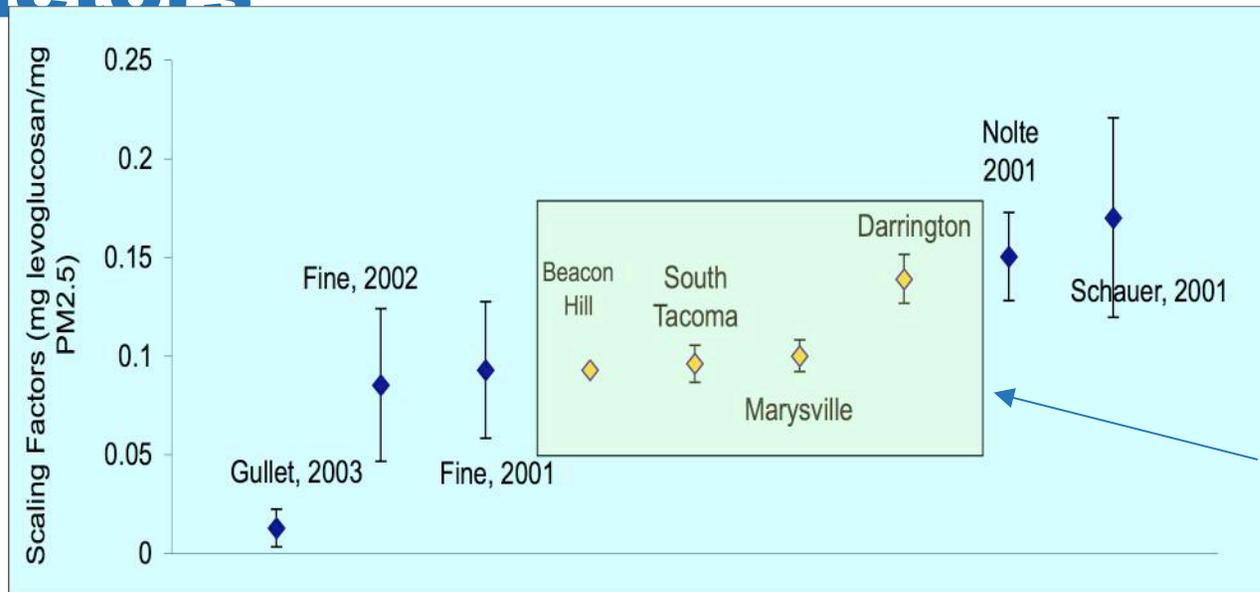
Scaling factors obtained from ambient samples

→ **A wide range of scaling factors have been reported in the literature from source-testing studies, scaling factors calculated from ambient measurements show less variability.**

→ **This indicates that it is feasible to use measurements of LG to reliable estimate the woodsmoke contribution to ambient PM$_{2.5}$.**

→ **Data from the Darrington site (above) suggest that significant regional differences exist in the LG to woodsmoke PM scaling factors..**

Conclusions- U of WA

➔ LG can be reliably measured on archived FRM (Teflon) filters Two analytical methods have been validated for this purpose, and have been shown to give excellent agreement:

- Organic extraction followed by GC/MS analysis
- Aqueous extraction followed by HPLC (ion exchange) with PAD detection

➔ Measurement of LG allows agencies to identify seasons and locations where woodsmoke drives PM concentrations (and potential NAAQS violations). This in-turn permits implementation of appropriately targeted interventions to reduce PM concentrations.

➔ Within a geographic area the scaling factors between LG and ambient woodsmoke-derived $PM_{2.5}$ mass is relatively precise. Therefore, woodsmoke-derived $PM_{2.5}$ mass can be estimated with acceptable precision from a limited number of measurements of LG.

LG and other analyses using archived Teflon filters to track emission reductions

➔ **Percent LG will help determine relative contribution of RWC**

■ **As RWC decreases, LG will also decrease**

▲ **If % LG decreases, then RWC is responsible for reduced PM2.5**

▲ **If %LG stays the same, then other sources may also be decreasing**

▲ **If %LG increases, than other sources are responsible**

Recommendation

➜ **NWAIRQUEST should further evaluate**

➜ **If warranted seek new funding for adding routine analysis of Levoglucosan into Region 10 monitoring networks.**

➜ **Include in SIP/attainment plans to track emission reduction and effectiveness of wood stove change out programs**

LG and other analyses using archived Teflon filters to track emission reductions

➔ **For further information, see**

  ■ **Zhang and Hecobian --** http://www.atmos-chem-phys-discuss.net/papers_in_open_discussion.html

  ■ **Frank** [Levoglucosan and Water Soluble Organic Carbon from PM2.5 Teflon Filters (PDF)](), **Natl Air Monitoring Conference (2009) http://www.epa.gov/ttnamti1/files/ambient/2009conference/frank.pdf**