BRITISH COLUMBIA | Ministry of Environment and Climate Change Strategy

Levoglucosan

Two studies using this marker of biomass burning in Kamloops

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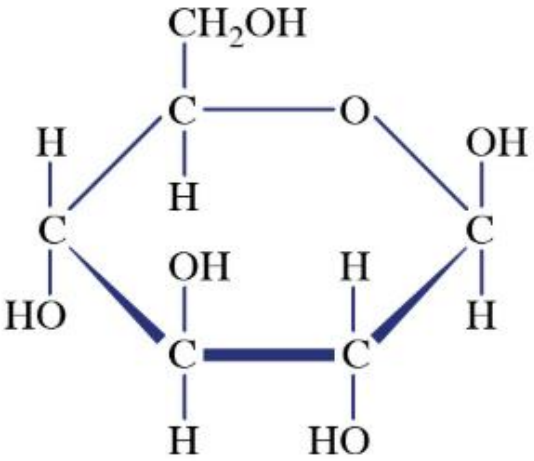
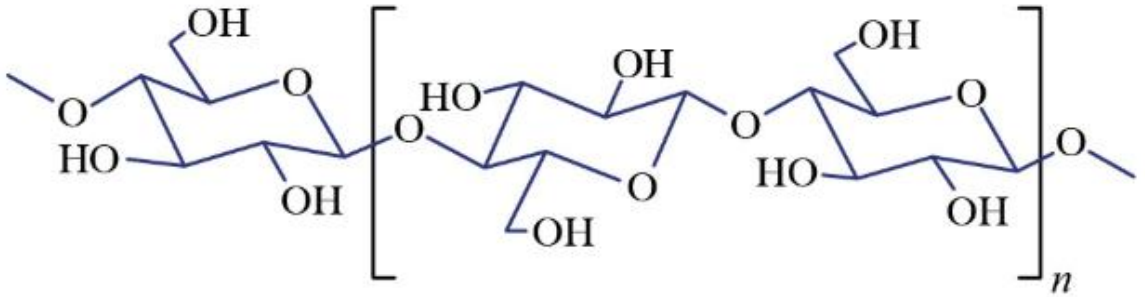
Plants produce sugars from sunlight with photosynthesis, these sugars are used to Produce cellulose. This is the primary material in the cell wall of plants and therefore of biomass (wood, hog-fuel, branches, grass, foliage, etc.)

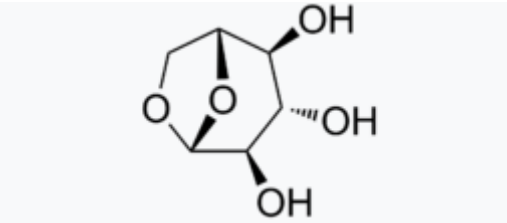


glucose



cellulose

When biomass is burned, a compound called Levoglucosan is produced.



Levoglucosan is a pyrolysis product of cellulose.
Note similarity to glucose that is the building block of cellulose.

Levoglucosan is not a pollutant of concern, its significance is that it can be used as a marker to indicate if fine particulate matter (PM2.5) comes from the burning of biomass.

Health Canada has been conducting a series of studies in Kamloops, Prince George and Courtenay where PM2.5 samples were also analysed for Levoglucosan. In this presentation I am going to show you some of the results of two papers that are based on those measurement.

Biomass Burning as a Source of Ambient Fine Particulate Air Pollution and Acute Myocardial Infarction

Scott Weichenthal,[a,b] *Ryan Kulka,*[b] *Eric Lavigne,*[b,c] *David van Rijswijk,*[b] *Michael Brauer,*[d] *Paul J. Villeneuve,*[e] *Dave Stieb,*[e] *Lawrence Joseph,*[b] *and Rick T. Burnett*[f]

Systematic identification and prioritization of communities impacted by residential woodsmoke in British Columbia, Canada☆

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The measurements:

At the Federal building in downtown Kamloops (where the Provincial AQHI station is sited), a Partisol 2025i was used to measure both 24 hour average PM2.5, and the concentration of Levoglucosan over the same 24 hour period. This instrument ran from 1 January 2014 to 31 March 2015.

At seven other locations in Kamloops (plus one at the Federal building with the other sensors), which were chosen based on analysis of heath records of MI admissions, cascade-impactors were used to measure 14 day average PM2.5 and Levoglucosan concentrations. These instruments ran from September 2014 until March 2015

The monitors were in the Westsyde, Brocklehurst, North Kamloops, South Kamloops, Valleyview, Upper Sahali and Upper Aberdeen neighbourhoods.

All the filters were sent to Ottawa for analysis at the Health Canada labs.

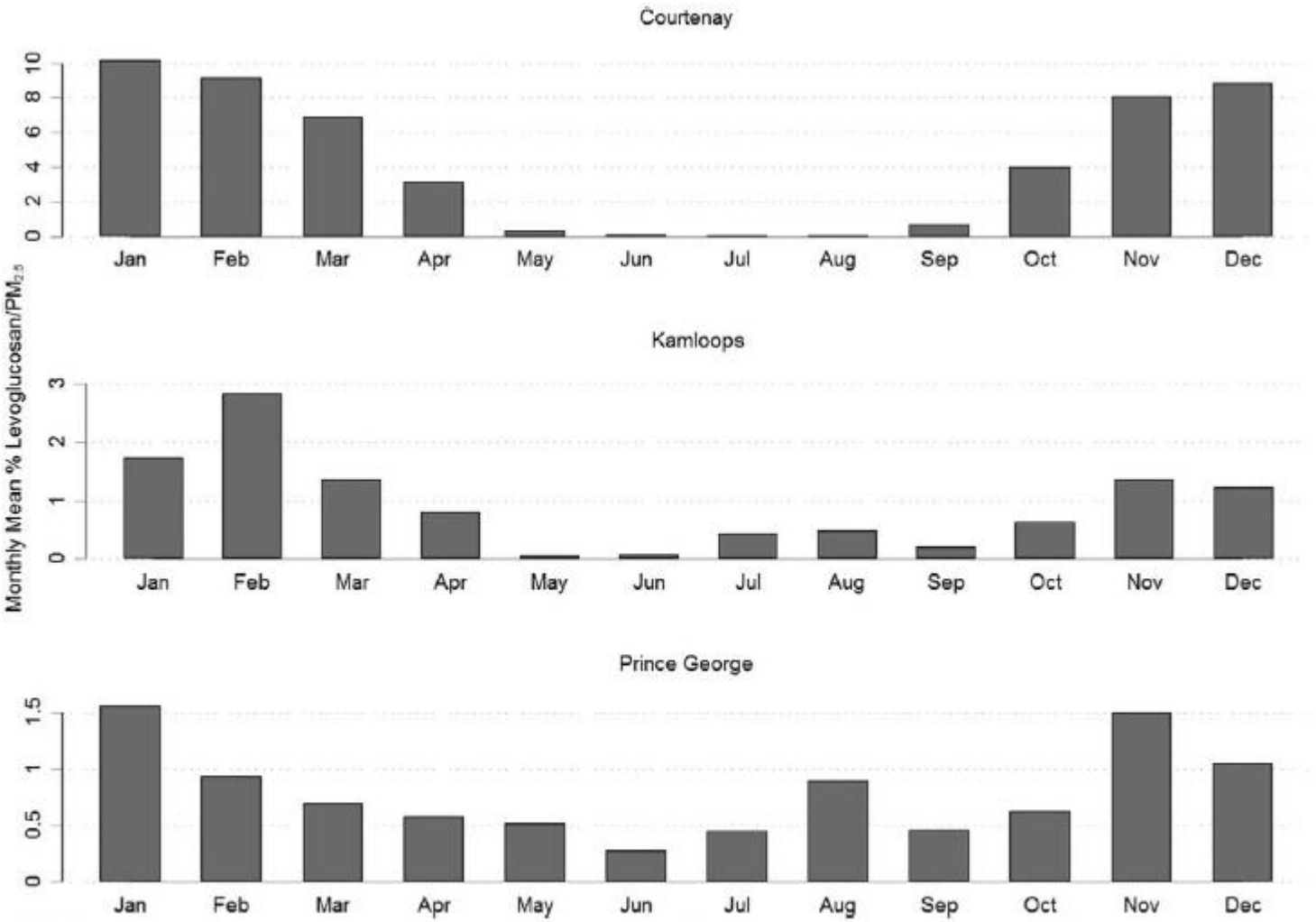


FIGURE 1. Monthly mean biomass contributions (% levoglucosan/$PM_{2.5}$) to 3-day mean ambient $PM_{2.5}$ in Courtenay, Kamloops, and Prince George, British Columbia, Canada (2014–2015).

City	Site Id	Spatial Correction Model	Intercept	Beta (95% CI)	Covariates	R^2	RMSE
Kamloops	1	$PM_{2.5}$	-0.17	0.83 (0.27, 1.39)	Fixed Site $PM_{2.5}$	0.56	2.86
	1	levoglucosan	59.6	1.60 (1.04, 2.17)	Fixed Site Levoglucosan	0.82	93.7
	2	$PM_{2.5}$	-1.07	0.89 (0.51, 1.27)	Fixed Site $PM_{2.5}$	0.73	1.99
	2	levoglucosan	9.9	1.05 (0.93, 1.17)	Fixed Site Levoglucosan	0.98	19.9
	3	$PM_{2.5}$	0.28	0.72 (0.40, 1.03)	Fixed Site $PM_{2.5}$	0.74	1.63
	3	levoglucosan	28.2	1.06 (0.81, 1.31)	Fixed Site Levoglucosan	0.91	41.6
	4	$PM_{2.5}$	-2.05	0.78 (0.64, 0.92)	Fixed Site $PM_{2.5}$	0.94	0.75
	4	levoglucosan	-23.2	0.99 (0.82, 1.17)	Fixed Site Levoglucosan	0.94	30.0
	5	$PM_{2.5}$	-2.7	0.75 (0.63, 0.88)	Fixed Site $PM_{2.5}$	0.95	0.65
	5	levoglucosan	-35.3	0.85 (0.66, 1.04)	Fixed Site Levoglucosan	0.91	32.5
	6	$PM_{2.5}$	0.34	0.89 (0.47, 1.31)	Fixed Site $PM_{2.5}$	0.69	2.21
	6	levoglucosan	72.2	1.32 (0.80, 1.85)	Fixed Site Levoglucosan	0.76	89.2
	7	$PM_{2.5}$	-1.79	0.98 (0.52, 1.45)	Fixed Site $PM_{2.5}$	0.69	2.43
	7	levoglucosan	16.8	1.45 (1.24, 1.66)	Fixed Site Levoglucosan	0.96	35.0
	8	$PM_{2.5}$	-2.49	1.04 (0.70, 1.37)	Fixed Site $PM_{2.5}$	0.83	1.75
	8	levoglucosan	8.57	1.42 (1.26, 1.58)	Fixed Site Levoglucosan	0.97	27.2

Conclusions of the Weichenthal et al. paper:

Short term changes in PM2.5 concentrations are associated with hospital admissions for MI among patients over 65 years of age.

There was also evidence that the proportion of PM2.5 that came from biomass burning May modify the association between MI and PM2.5

The next study used the same Levoglucosan data, but used hourly PM2.5 measurements from many other stations in BC.

The objective was to see if a method of classifying communities by how “smoky” they were could be developed.

In this case “smoky” means smoke from winter burning of biomass. The effects of wildfires were removed from the datasets.

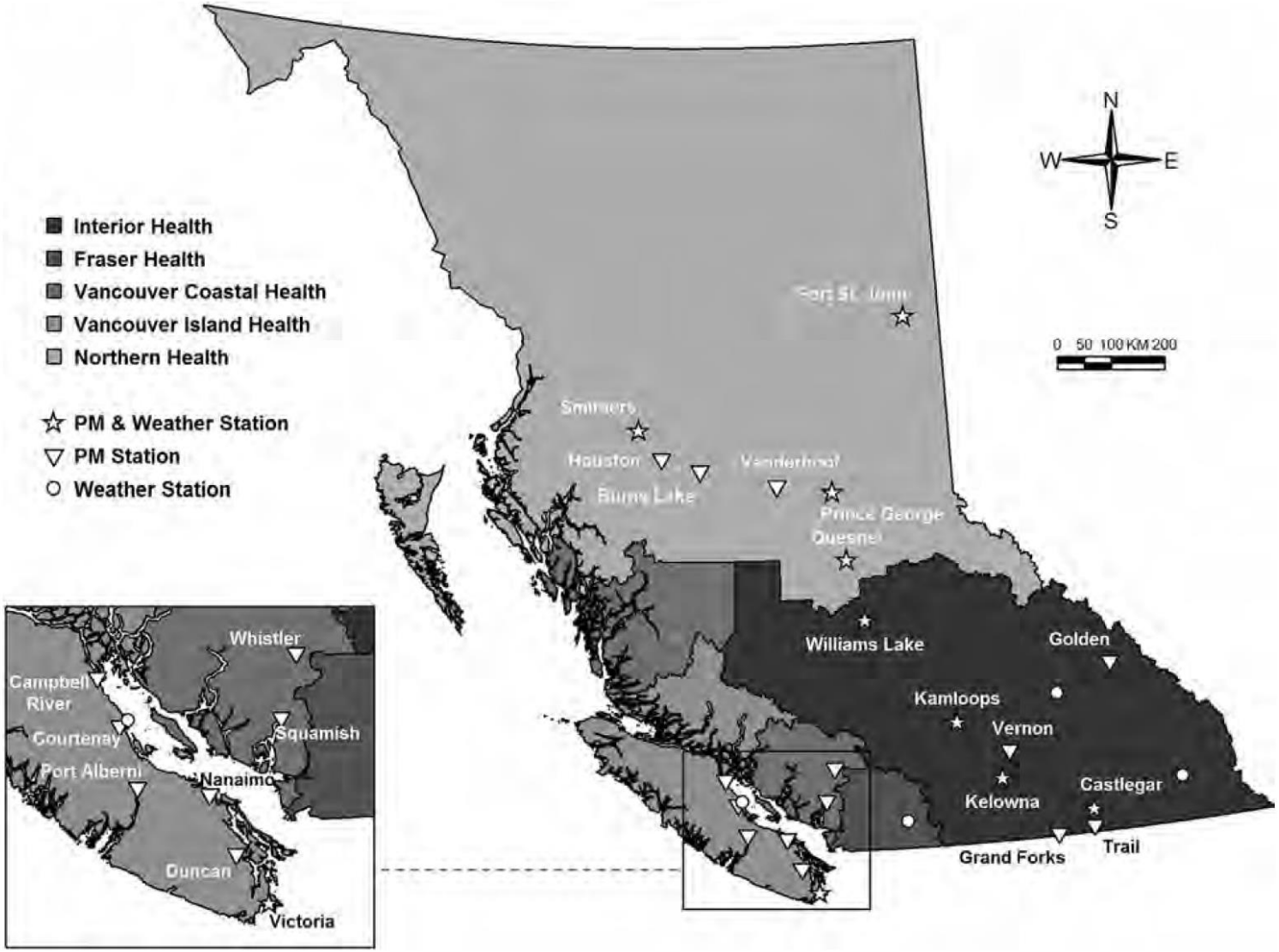
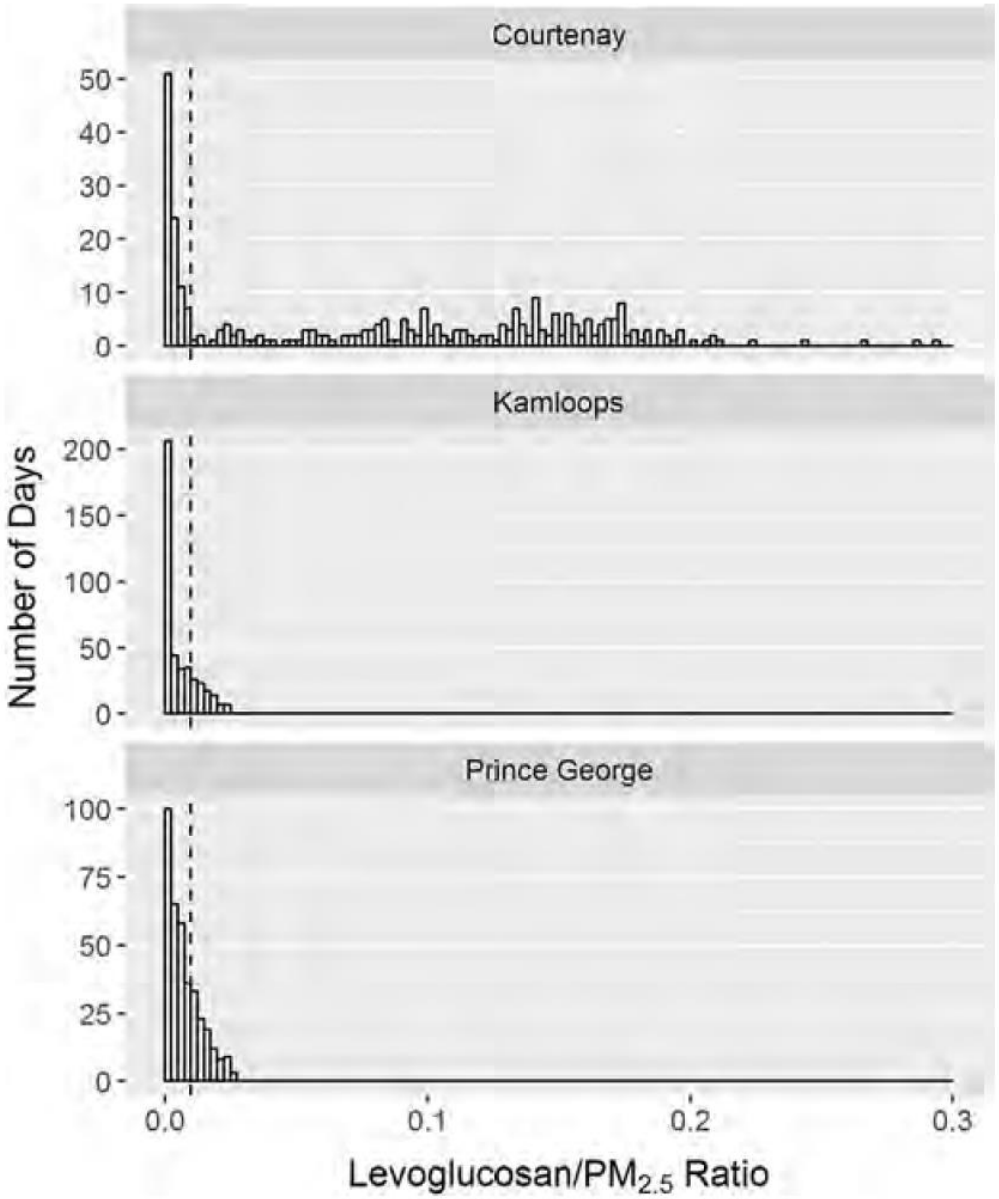
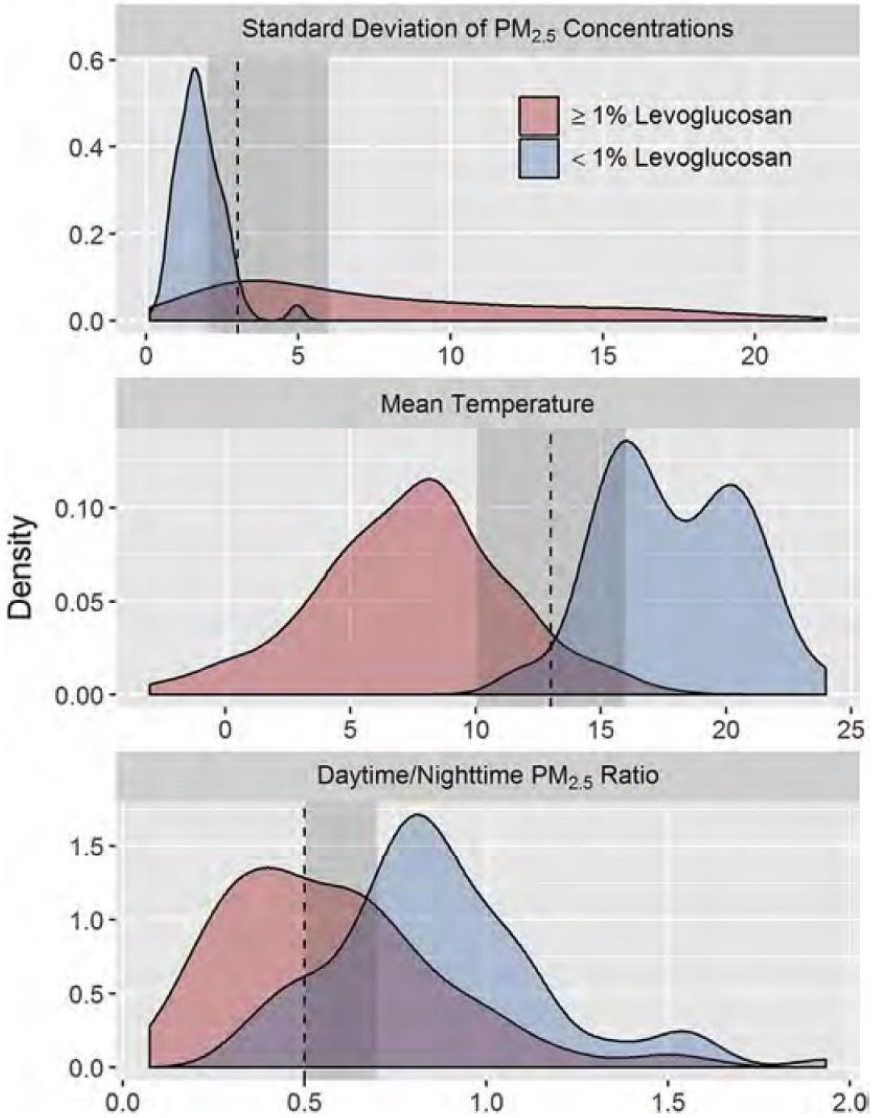

Interior Health
Fraser Health
Vancouver Coastal Health
Vancouver Island Health
Northern Health
PM & Weather Station
PM Station
Weather Station
N
W
E
S
0 50 100 KM 200
Smithers
Houston
Burns Lake
Prince George
Quesnel
Williams Lake
Golden
Kamloops
Vernon
Kelowna
Castlegar
Grand Forks
Trail
Whistler
Campbell River
Courtenay
Squamish
Port Alberni
Nanaimo
Duncan
Victoria

Table 1
The 23 communities included in the analyses with 2011 census populations and the percentage of households that burn wood estimated by the wood burning survey (Mustel Group, 2012).

Location	2011 Population	Estimated Wood Burning
Burns Lake	2029	54%
Campbell River	31,186	21%
Castlegar	7816	–
Courtenay	24,099	20%
Duncan	4932	36%
Fort St. John	18,609	–
Golden	3701	50%
Grand Forks	3985	36%
Houston	3147	54%
Kamloops	85,678	8%
Kelowna	117,312	10%
Nanaimo	83,810	18%
Port Alberni	17,743	25%
Prince George	71,974	15%
Quesnel	10,007	35%
Smithers	5404	54%
Squamish	17,158	42%
Trail	7681	–
Vanderhoof	4480	–
Vernon	40,000	–
Victoria	80,017	33%
Whistler	9824	42%
Williams Lake	10,832	36%


Courtenay
Kamloops
Prince George
Number of Days
50
40
30
20
10
0
200
150
100
50
0
100
75
50
25
0
0.0
0.1
0.2
0.3
Levoglucosan/PM2.5 Ratio

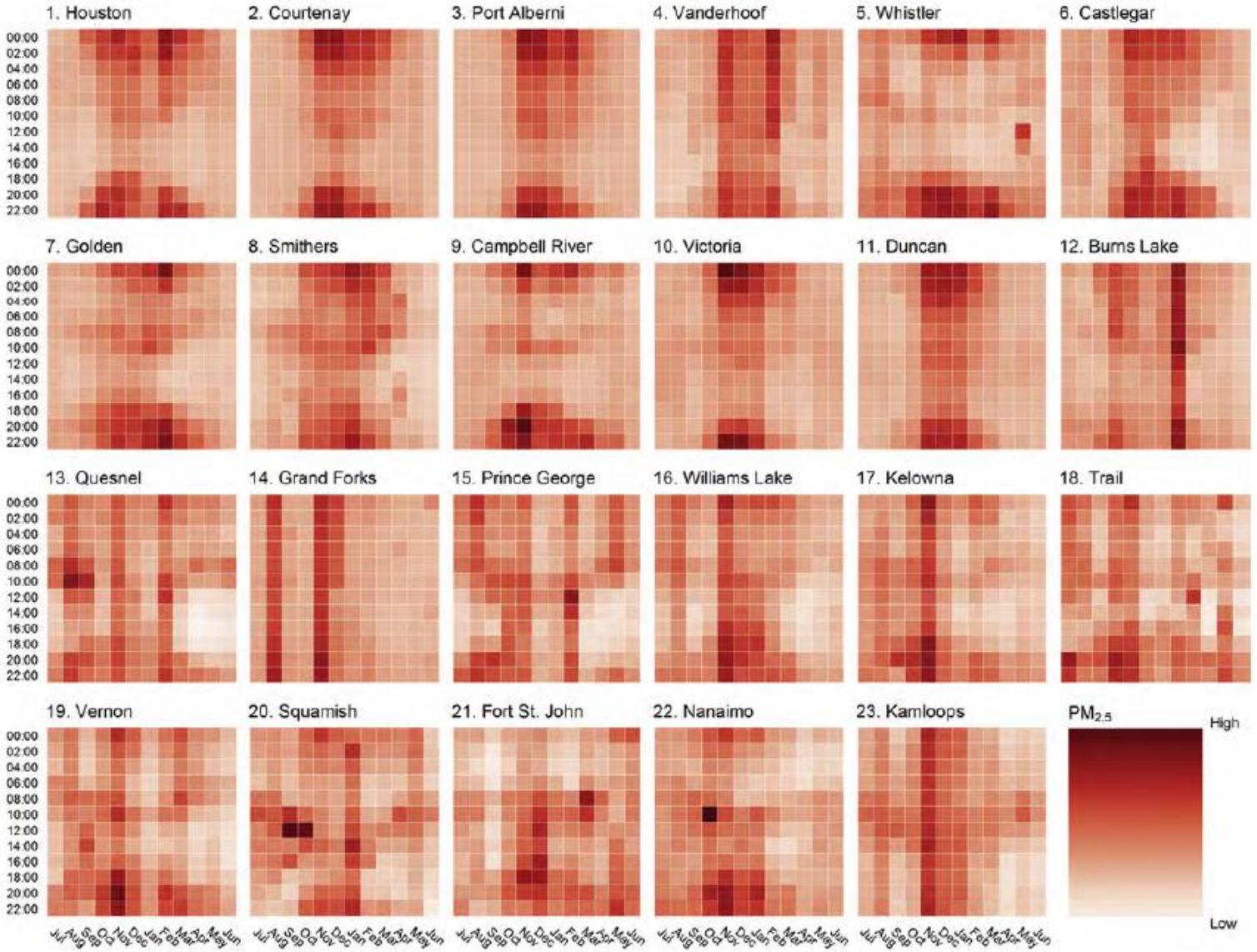


This is for Courtenay. What they are doing is looking for the best values of the three parameters (sd of PM2.5 conc., mean air temperature, and ratio of daytime to nighttime PM2.5) to separate smoky and non-smoky days. Smoky days are those with less than 1% levoglucosan.

Table 2
The number of smoky days within the most recent two years of available data for each community as classified by the algorithm using the most informative parameter values.

Location	# Smoky Days	# Days with Data (730 max)	% Smoky Days
Houston	277	623[a]	0.445
Courtenay	211	716	0.295
Port Alberni	143	729	0.196
Vanderhoof	136	712	0.191
Whistler	125	705	0.177
Castlegar	124	710	0.175
Golden	116	722	0.161
Smithers	107	721	0.148
Campbell River	102	720	0.142
Victoria	97	730	0.133
Duncan	91	727	0.125
Burns Lake	89	514[a]	0.173
Quesnel	80	714	0.112
Grand Forks	58	711	0.082
Prince George	52	706	0.074
Williams Lake	41	729	0.056
Kelowna	25	720	0.035
Trail	17	705	0.024
Vernon	17	698	0.024
Squamish	16	702	0.023
Fort St. John	12	728	0.016
Nanaimo	8	717	0.011
Kamloops	5	711	0.007

[a] Data were missing during summer months, so the percentage of smoky days will be higher than if data were missing at random.


1. Houston
2. Courtenay
3. Port Alberni
4. Vanderhoof
5. Whistler
6. Castlegar
7. Golden
8. Smithers
9. Campbell River
10. Victoria
11. Duncan
12. Burns Lake
13. Quesnel
14. Grand Forks
15. Prince George
16. Williams Lake
17. Kelowna
18. Trail
19. Vernon
20. Squamish
21. Fort St. John
22. Nanaimo
23. Kamloops
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
PM2.5
High
Low

Conclusions.

The system for classifying communities based on PM2.5 and temperature measurements is sound.

But a bigger question is, given that it has been done for Kamloops, what are the implications for airshed planning?

Comments/questions?

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