

Source Apportionment of Fine Particulate Matter In Prince George – Preliminary Results

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(modelling by John Spagnol)

Acknowledgements

- This presentation discusses two studies:
 - A Speciation Study with analysis and speciation modelling by STI (Sonoma Technologies Inc.) funded by the BC Ministry of Environment and Environment Canada
 - A dispersion modelling study overseen by the Prince George Air Improvement Roundtable – Research Working Group conducted at UNBC by Dr. John Spagnol working with Dr. Peter Jackson and research assistants, funded by BC Ministry of Environment, Environment Canada, City of Prince George, Northern Health and Canfor.

Disclaimer

The dispersion modelling results are preliminary – internal review has identified improvements to be implemented and the draft study is currently being externally reviewed.

Air Quality Considerations

Sources → Atmosphere → Receptors

All must be considered!

Most AQ issues are complex and solutions that work can be challenging

What we care about are impacts on Receptors (i.e. people)

Information / Research Needs for Management of PM

- Goal is to reduce both average and episodic levels
- Requires knowledge of which **sources** are contributing
- Routine ambient data is useful but may not provide strong enough evidence
- Several methods exist, each giving different sorts of answers: **none are perfect!**
- Methods can be highly complementary
- If results from different studies point to same results (triangulation), then they increase confidence and strengthen management actions that result

Types of Source ID Studies

1. Receptor Modelling

- based on **ambient AQ data**
- wind sector analysis (Fudge et al, BCMOE)
- chemical mass balance (CMB) – associates source chemical source profiles to ambient data (EC/BCMOE/STI study)
- Positive Matrix Factorization (PMF) - lets the ambient data “speak for themselves” and infers source profile (EC/BCMOE/STI study)

2. Dispersion Modelling

- based on **source emission inventory**, meteorological data
- validated by ambient data and can determine contributions of individual sources at any receptor in the airshed
- Many “levels” of modelling
- Current comprehensive study using Calpuff (Spagnol et al, UNBC – PGAQIC – Research Working Group)

Receptor Modelling Results Summary

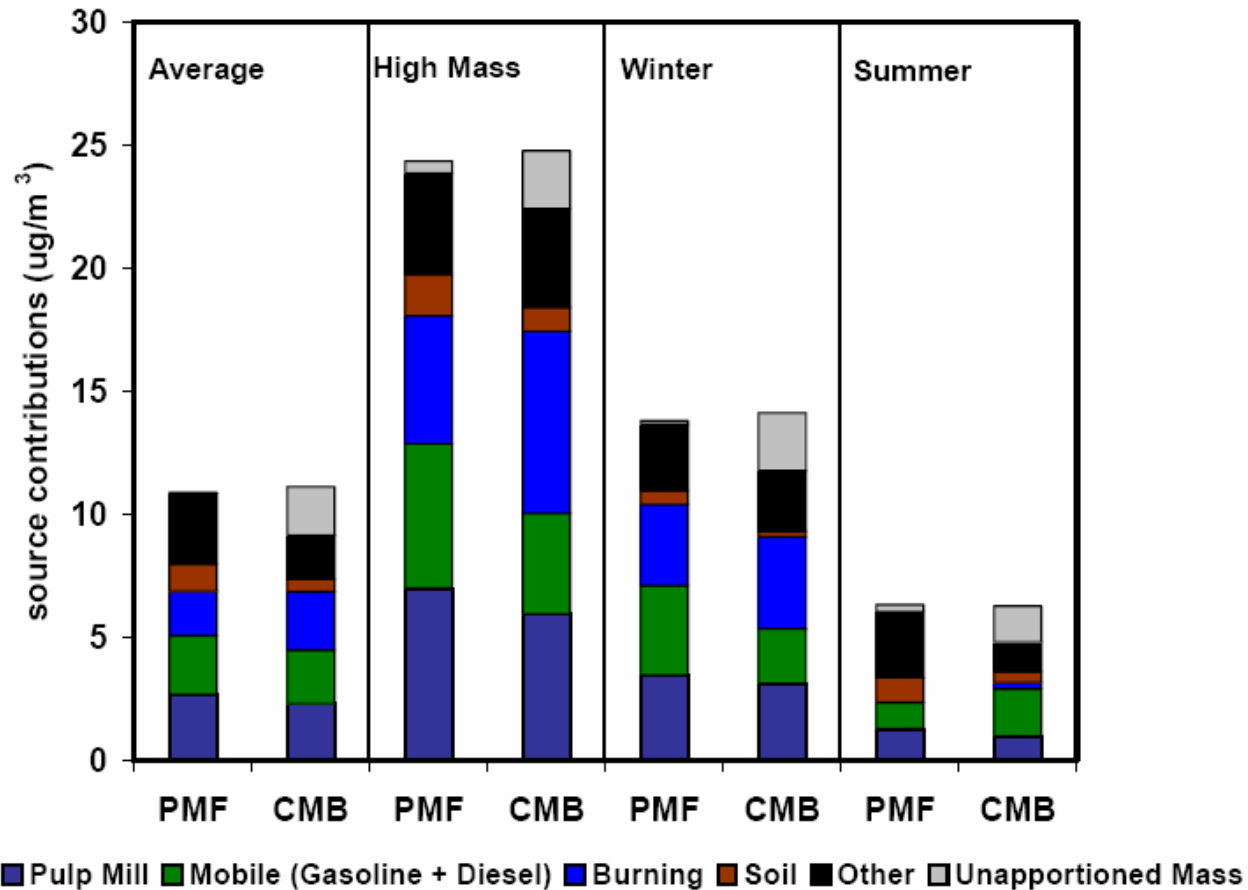


Figure 6-11. Comparison of PMF and CMB source contributions averaged over all data (average), the top 20% $\text{PM}_{2.5}$ mass days (high mass), winter days (winter), and summer days (summer).

PGAQ DispersionModelling Study

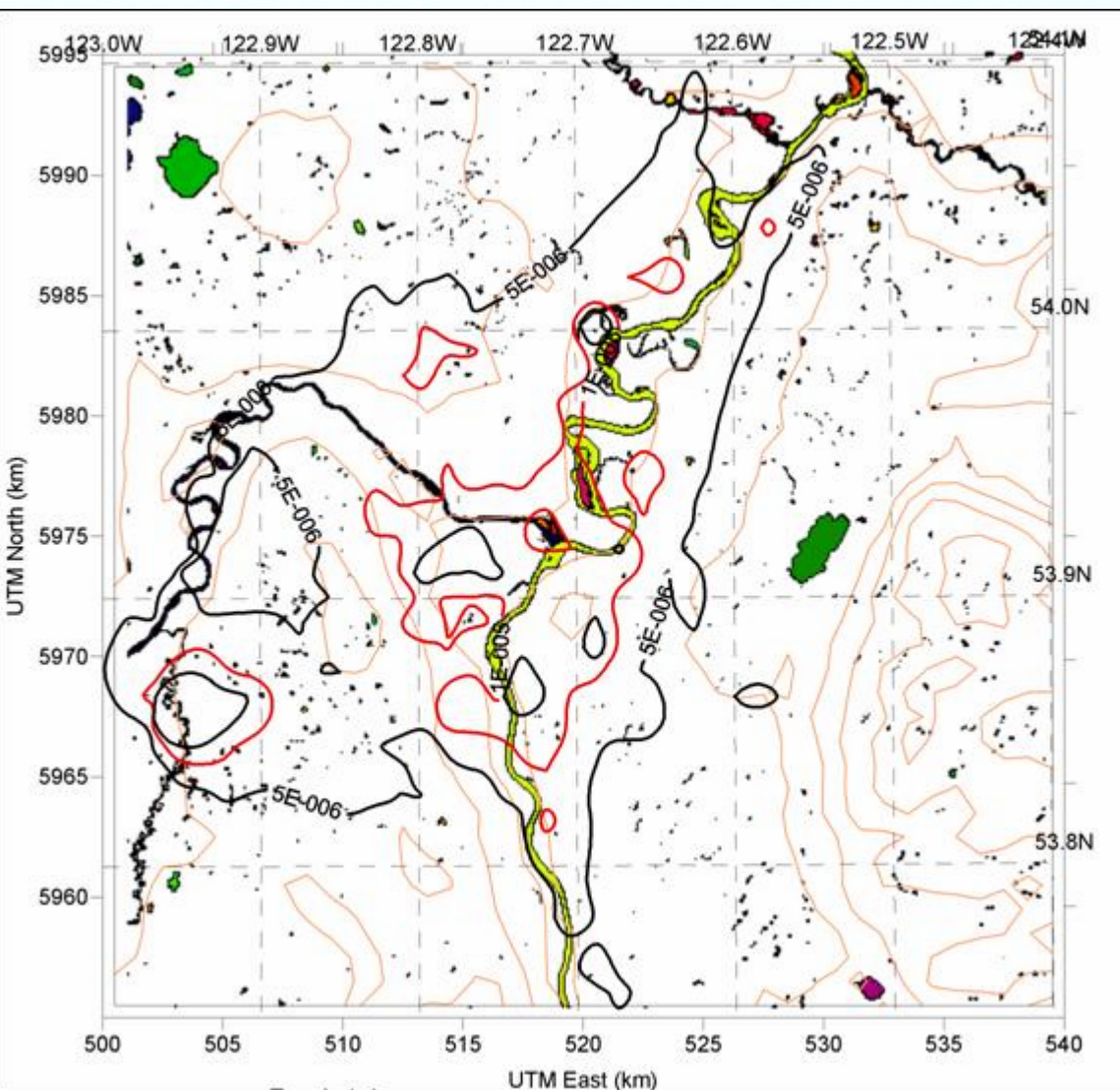
- Partnership between PGAIR – Research Working Group and UNBC (John Spagnol working with Peter Jackson)
- RWG members have been involved in the study, including its design, every step of the way – research has been iterative, allowing feedback and continuous improvements
- Work has undergone RWG review – critical evaluation has resulted in several improvements – currently it is being externally reviewed

Dispersion Modelling

- Dispersion modelling is a useful tool commonly used to manage air quality and consider impacts of sources on AQ
- Three components:
 1. An inventory of all emissions
 2. A meteorological model [**calmet**]
 3. A transport/dispersion/chemistry model that takes the emissions and uses the meteorology to transport and disperse the pollutants, and to consider formation and removal of pollutants in the atmosphere [**calpuff**]
- Model results tell us the expected outdoor levels from each source at each point in the area, every hour from 2000-2005

PGAQ (2005)		Average emission rates (g/sec)			
Sec No		NOx.	SOx	PM10	PM2.5
2	Permitted	40.8	118.9	65.4	44.3
3	On-road dust			131	13.1
4	Railway (orig/ revised)	333.8/ 43.2	7.9/ .9	25.2/ 4.7	23.8/ 4.4
5	On-road mobile	88.9	1.1	1.5	1
6	Residential Heating	0.03	0	0	0
7	Open Burning	0.4	0.04	2.6	2.4
8	Commercial Heating	2.4	0.01	0.2	0.2
9	Res Sources	0.05	0	0.5	0.5
10	Com Sources	32.9	4.2	24.4	10.1
11	Wind-blownPM			100	10
12	Aerosol formation			148	148
	Sum	208.7	125.2	347.3	220.9
MOE-Victoria (2000)		NOx	SOx	PM10	PM2.5
		131.5	192.9	209.2	98.1
MOE-Omenica (1995)					
	without road dust	244.8	138.5	203.3	167.2
	with road dust			906.5	357.5

Draft
Emission
Inventory
(with rail
emissions
revised,
but further
changes
have also
been
identified)

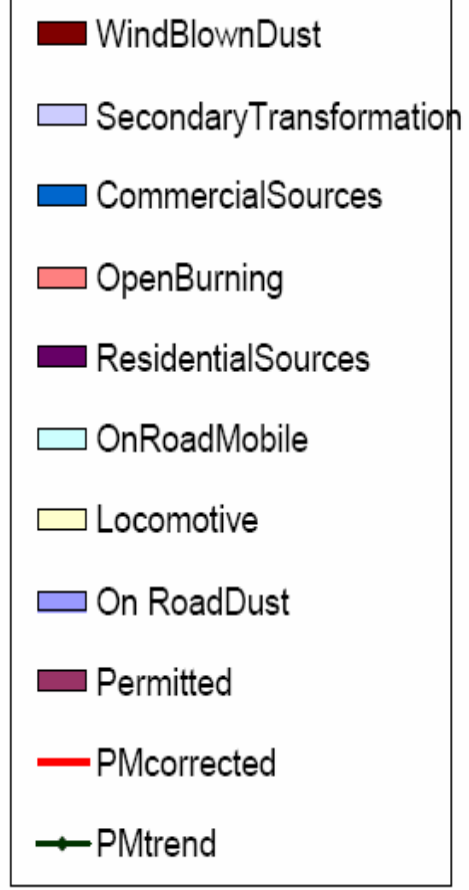
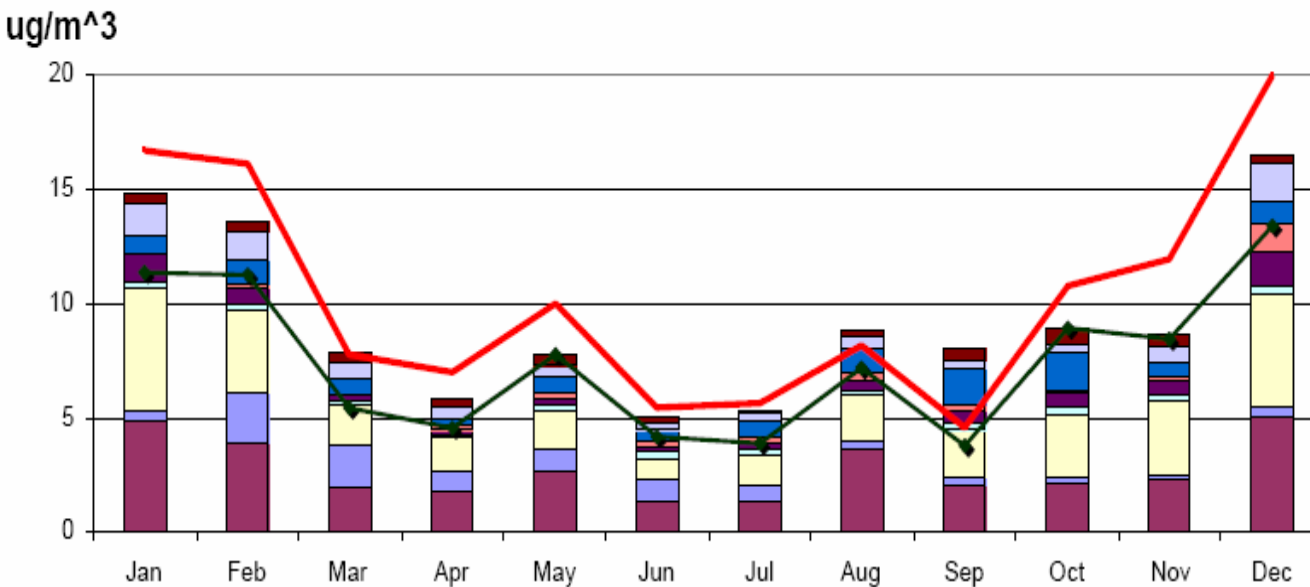


- 2005 PM2.5 annual average
- Contours are 5, 10, 20 $\mu\text{g}/\text{m}^3$

**NOTE:
PRELIMINARY
RESULTS – FINAL
RESULTS WILL
DIFFER**

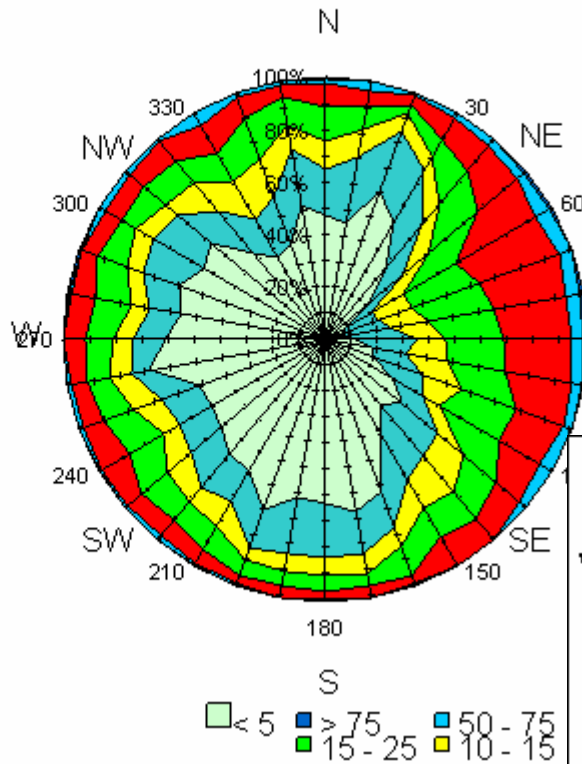
Plaza PM2.5 2005

PLAZA 2000 PM25
Modeled vs. measured



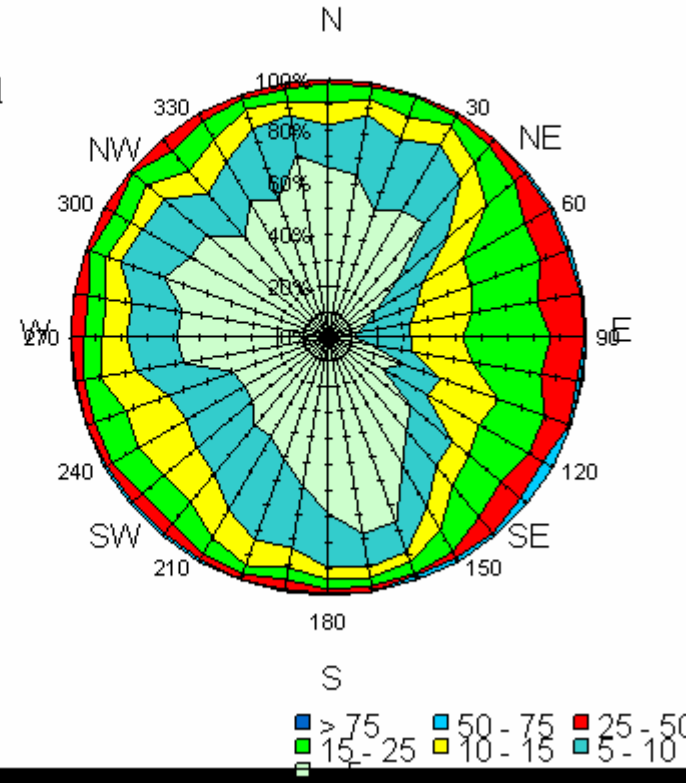
NOTE: PRELIMINARY RESULTS – FINAL RESULTS WILL DIFFER (Locomotives too high)

year 2005
PM2.5
Plaza
measured



Measured and modelled pollution roses

year 2005
PM2.5 Plaza
modeled



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Comparison of CMB with Preliminary Dispersion Modelling

CatNo (as above)	Mapping to STI Categories	PGAQ PM2.5 Concentrations (ug/m ³)	PGAQ PM2.5 %	STI PM2.5 %
1	Pulp mill, hog fuel boiler, asphalt	2.83	31%	31%
2	Wood burning & heating	1.38	15%	27%
3	Heavy duty diesel vehicles	2.61	28%	5%
4	Light duty gasoline vehicles	0.59	6%	17%
5	Road dust & road salt	1.09	12%	6%
6	nitrate/sulfate	0.61	7%	10%
7	Organic Carbon	0.15	2%	4%
Total	Total	9.27	100%	100%

NOTE: PRELIMINARY RESULTS – FINAL RESULTS WILL DIFFER (Heavy duty diesel too high)

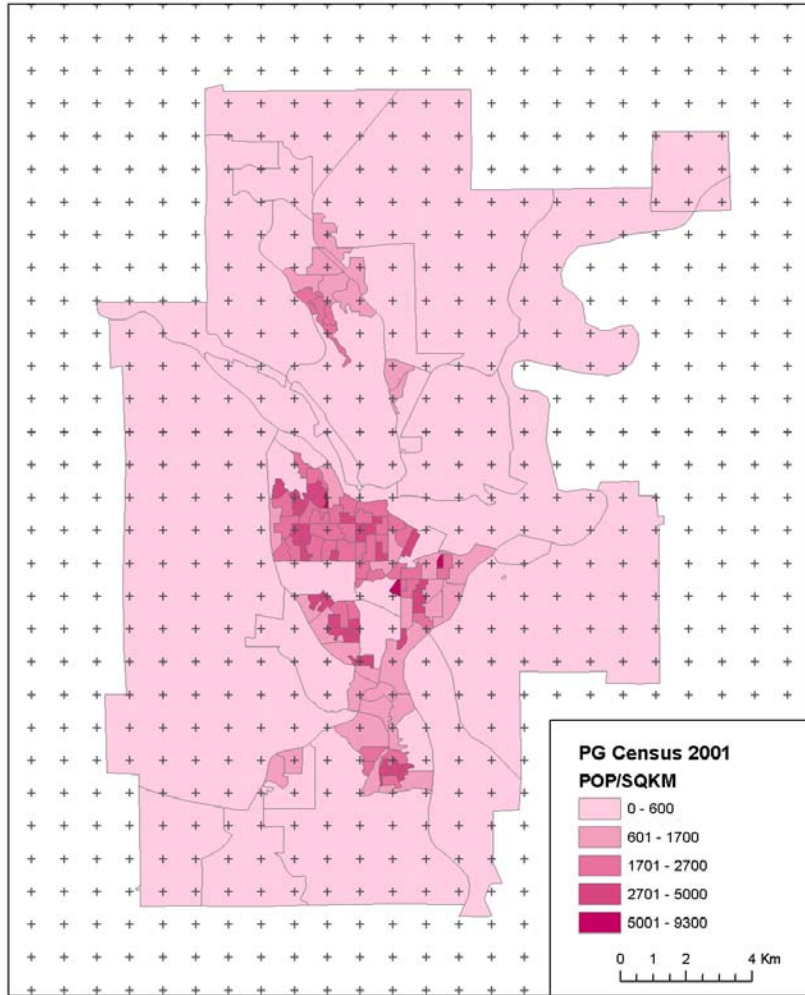
Questions / concerns

- Modelled Rail / locomotive initial emission estimates were too high and have been corrected
- Modelled concentrations at Plaza do not have as high a frequency of the highest values from the industrial wind sector – we may be underestimating industrial contributions somewhat
- Contributions from local / neighborhood sources (e.g. wood stoves) are in the model, but will not be significant at the Plaza site due to distance and elevation (therefore the importance of these sources at the neighborhood level should not be underestimated)

Next Steps

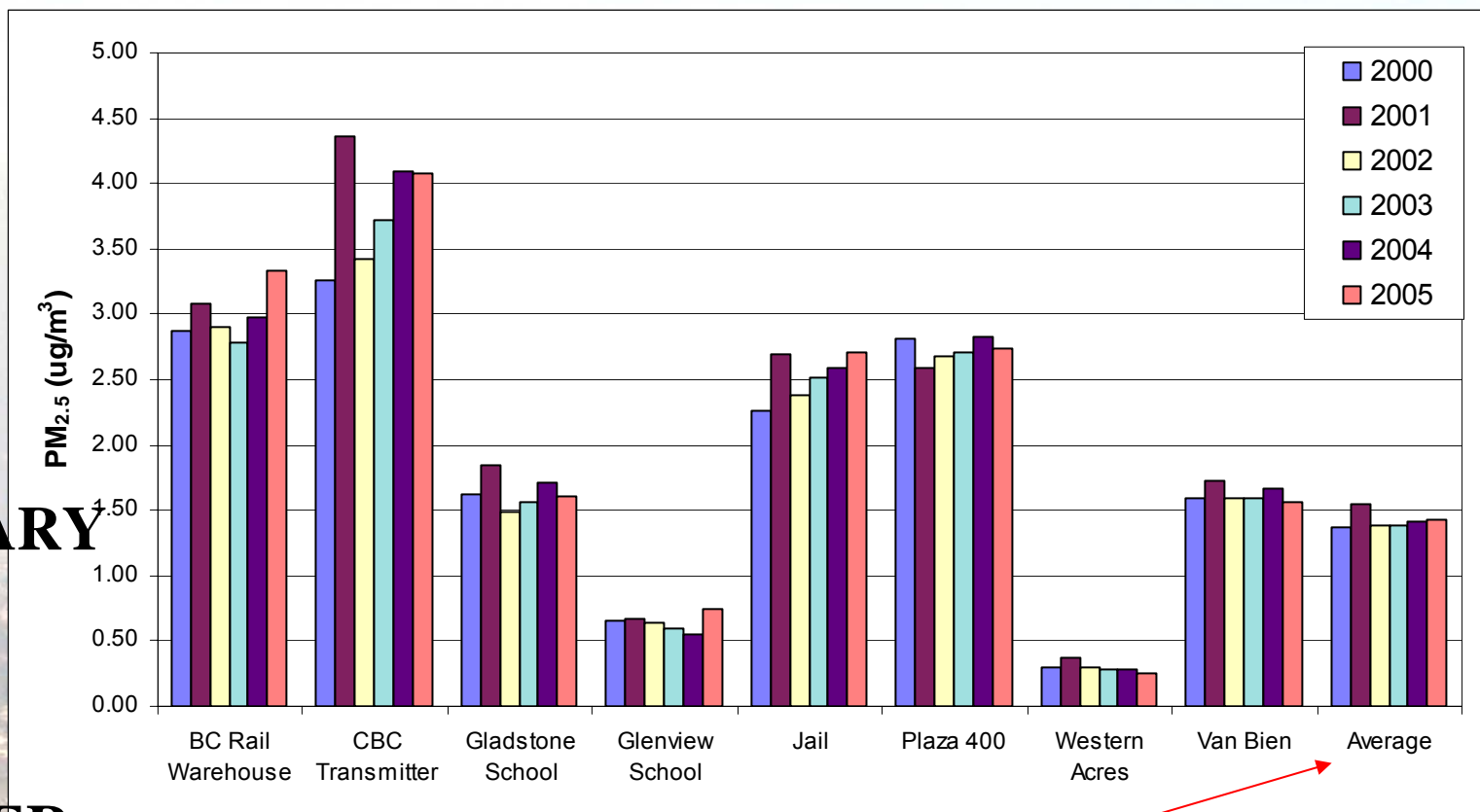
- Report is presently being externally reviewed (an expert 3rd party reviewer has been contracted by PGAIR)
- 3rd party review will be assessed by the RWG, and any additional changes/further work decided upon so that remodelling can be done and study finalized and released
- Results will be used to inform Phase III of the Air Quality Management Plan

Questions?



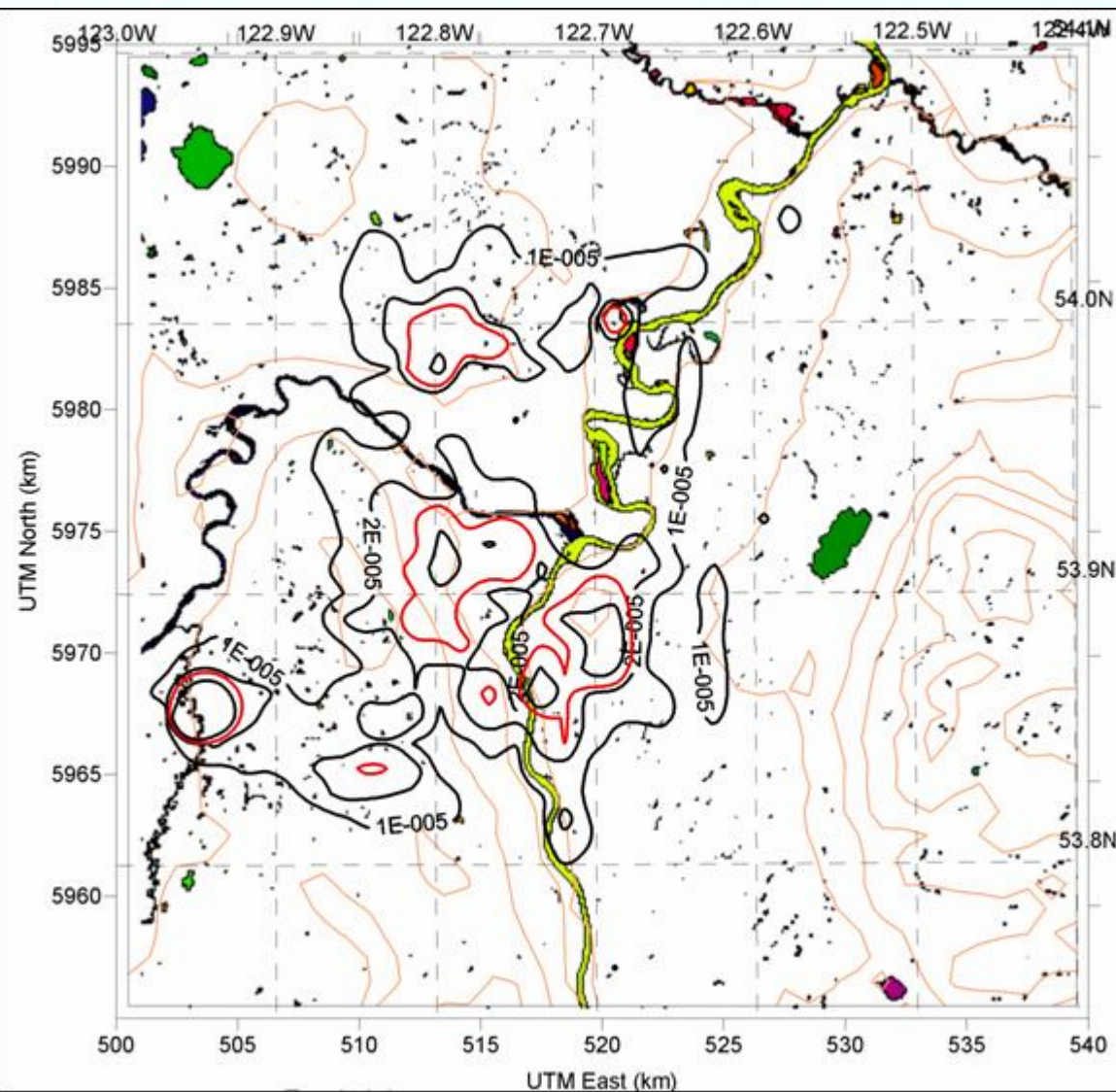
- Which site should be used to make management decisions?
- We have monitoring at a number of sites – often located to pick up high values
- One measure would be a **population weighted average...**

PM2.5 Modelled annual average levels for permitted (Industrial) sources only



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Population weighted

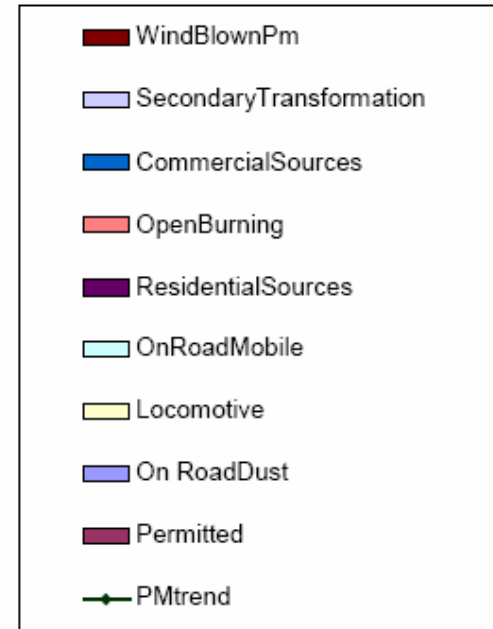
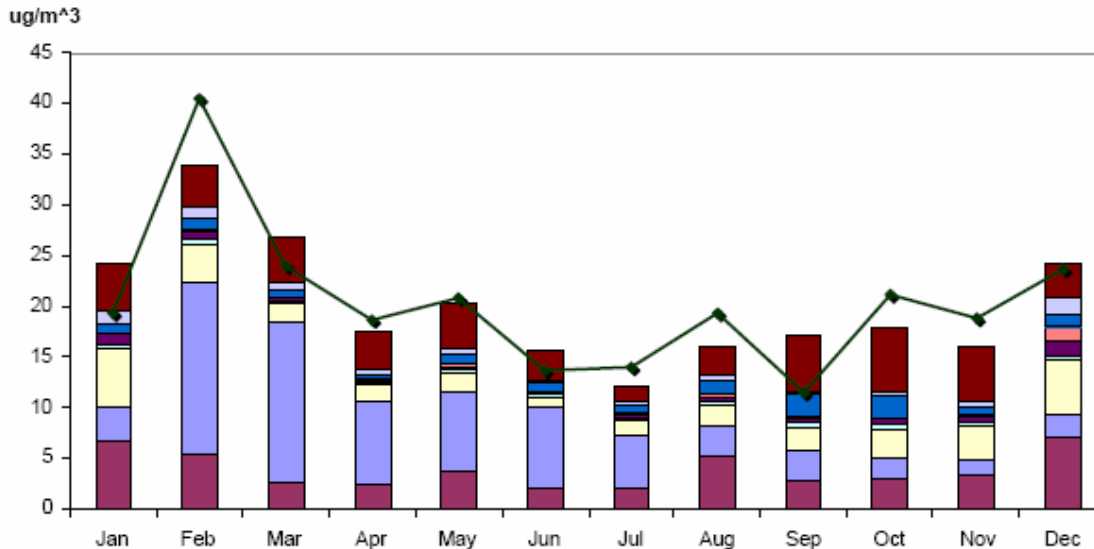


- 2005 PM10 annual average
- Contours are 10, 20, 30, 50 $\mu\text{g}/\text{m}^3$

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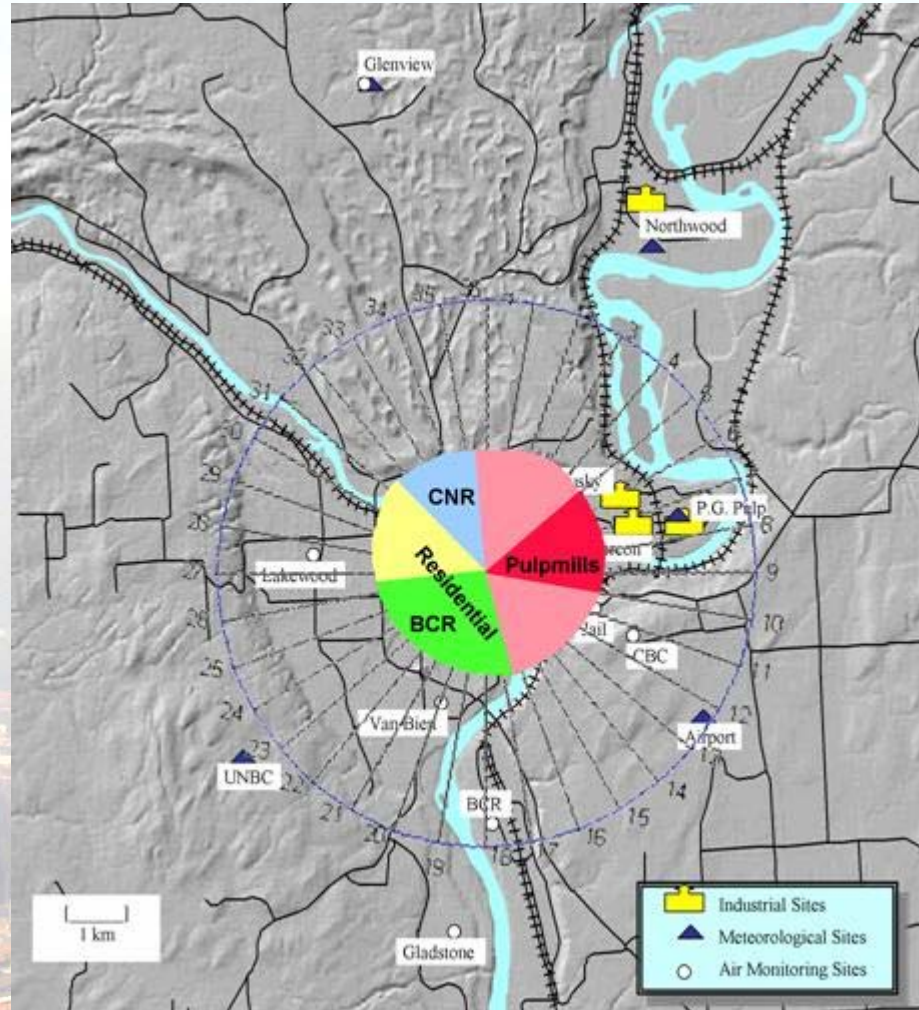
Plaza PM10 2005 (validation year)

PLAZA 2005 PM10
Modeled vs. measured



NOTE: PRELIMINARY RESULTS – FINAL RESULTS WILL DIFFER (Locomotives too high)

Comparison with BCMOE wind sector analysis



Comparison with wind sector analysis

PM2.5 Cases		Pulp Mill	Residential	BCR	CNR	Other (background)
	Sector	0-160°	170-310°	170-260°	320-360°	
MOE Study 2000-2002	% PM2.5 in sector	44%	17%	7%	2%	30%
Year 2005 measured	% PM2.5 in sector	53%	45%	39%	3%	
Year 2005 modeled	% PM2.5 in sector	55%	41%	36%	4%	

