




Source Apportionment as an Air Quality Assessment Tool



**Introduction to Air Quality Assessment Tools
Workshop
March 9, 2011**

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Environment**



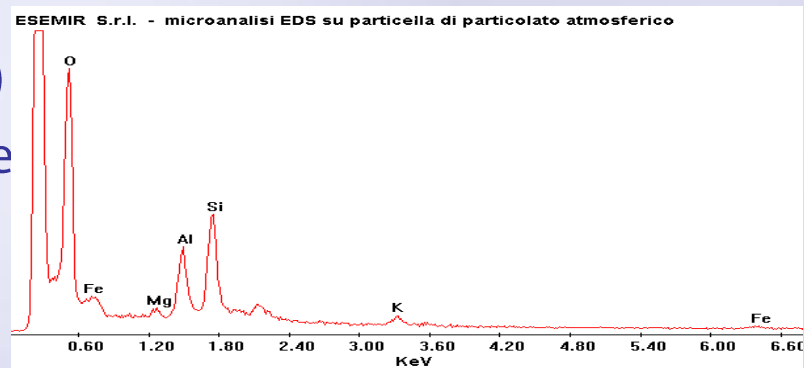
Outline

- What is Source Apportionment? –key definitions and questions.
- Source Apportionment studies in BC – key findings.
- Applications of Source Apportionment in Managing Air Quality.
- Some Source Apportionment resources available to air quality managers and planners

How Do We Identify Sources of Particulate Matter ?

Some Assumptions

- Each Source of PM leaves a Fingerprint (unique set of chemical profiles and other air quality related characteristics)
- If Multiple Sources of PM, then multiple Fingerprints are left in the measurements
- The more sources, the more the measurements to unscramble the identities, and the contribution to PM.





Some Terms

- Speciation is the breakdown of something into its chemical or physical components – in this case particulate matter.
- Receptor models are mathematical models that group speciation results into “factors” or groups that may be interpreted as sources. Examples include PMF, CMB and PCA.
- Source apportionment is the task of determining sources of particulate using the speciation data and receptor model results.

Granny's Christmas Cake



Glucose	Starch	Calcium	Cholesterol	Peroxidase
Fructose	Fiber	Iron	Ethanol	Lipase
Maltose	Proteins	Potassium	Lactose	
Citric Acid			Triglycerides	

CHRISTMAS CAKE

Ingredients:

Butter 14 oz.

Natural brown sugar 14 oz.

Eggs 8

Grated rind of 1 lemon and 1 orange

Treacle 1 tablespoon

Flour 1 lb.

Salt 1 teaspoon

1 teaspoon each of : ground nutmeg,
allspice, cinnamon & ginger

Raisins 2-1/4 lb.

Currants 1 lb.

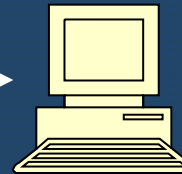
Dates, stoned and chopped 6 oz.

Cooked prunes, stoned and chopped 4 oz.

Almond flakes 8 oz.

Sherry 5 tablespoons

Glucose	Starch	Calcium	Cholesterol	Peroxidase
Fructose	Fiber	Iron	Ethanol	Lipase
Maltose	Proteins	Potassium	Lactose	
Citric Acid			Triglycerides	



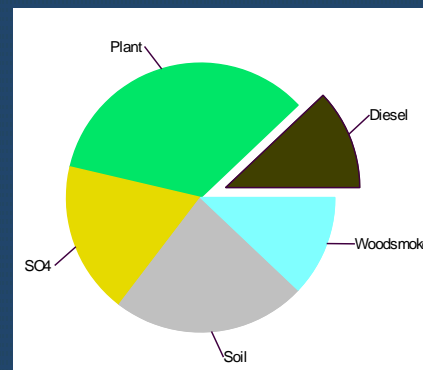
Extend the Analogy to Air Pollution



Organic Carbon	Sulfate	Oxides of Sulfur
Elemental Carbon	Nitrate	Oxides of Nitrogen
	Ammonium	Carbon Monoxide
	Sodium	
	Potassium	
	Iron	
	Silicon	

Factors or Groupings of Sources

Organic Carbon	Sulfate	Oxides of Sulfur
Elemental Carbon	Nitrate	Oxides of Nitrogen
	Ammonium	Carbon Monoxide
	Sodium	
	Potassium	
	Iron	
	Silicon	



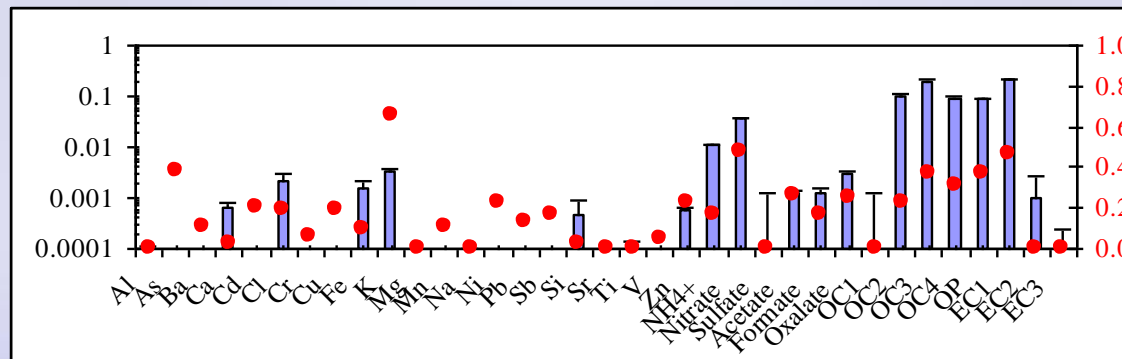
3 Key Elements of Source Apportionment



Speciation (monitoring)



Airshed information (meteorological, emission inventories, source emission patterns)



Receptor Models (CMB, PMF...)



Two Common Receptor Models

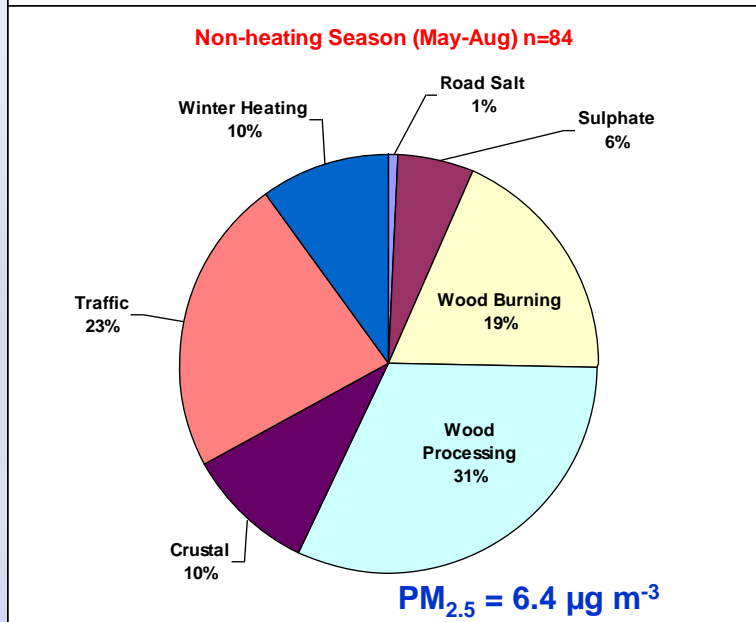
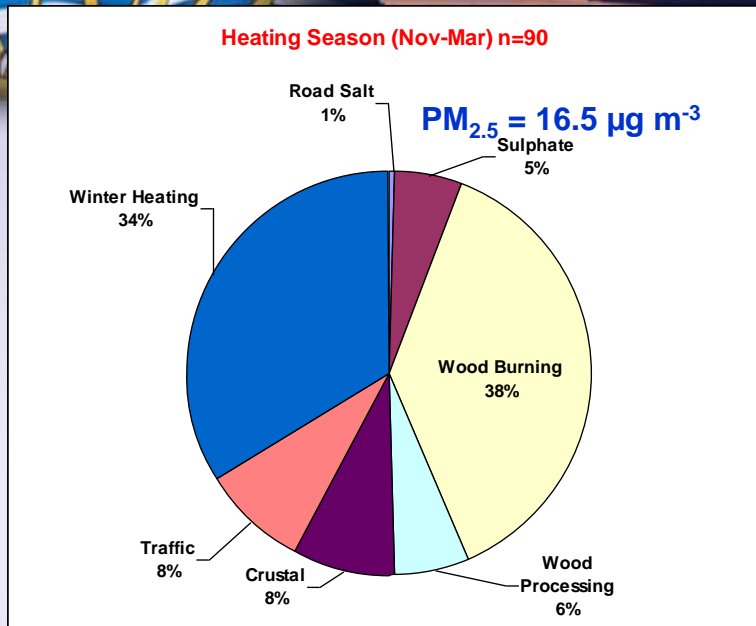
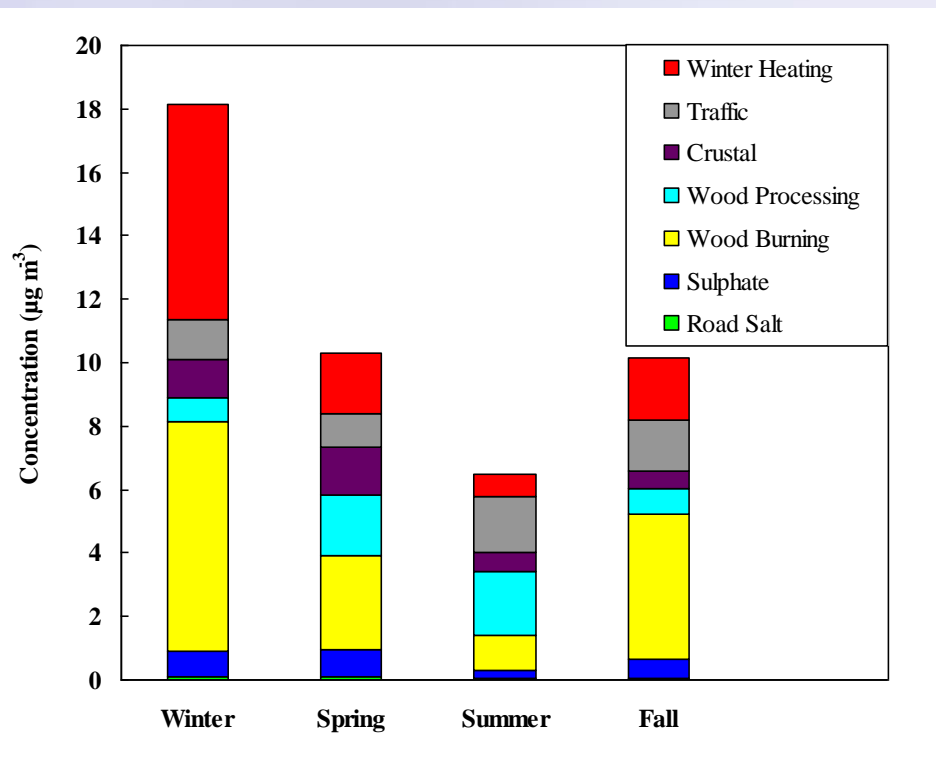
- **CMB** – Chemical Mass Balance – single sample modeling requiring a minimum of one ambient sample and a complete source profile for each know source.
- **PMF** – Positive Matrix Factorization- multivariate model that determines source profiles and contributions based on multiple data points

BC Source Apportionment Studies

- REVEAL I and II Studies – Fraser Valley - mid 1990's
- Golden (2004- 2006) PM2.5
- Prince George (2005-2007) PM2.5
- Kelowna/Prince George- (2006-2007) Coarse and Fine PM/Endotoxin.
- Quesnel – ?

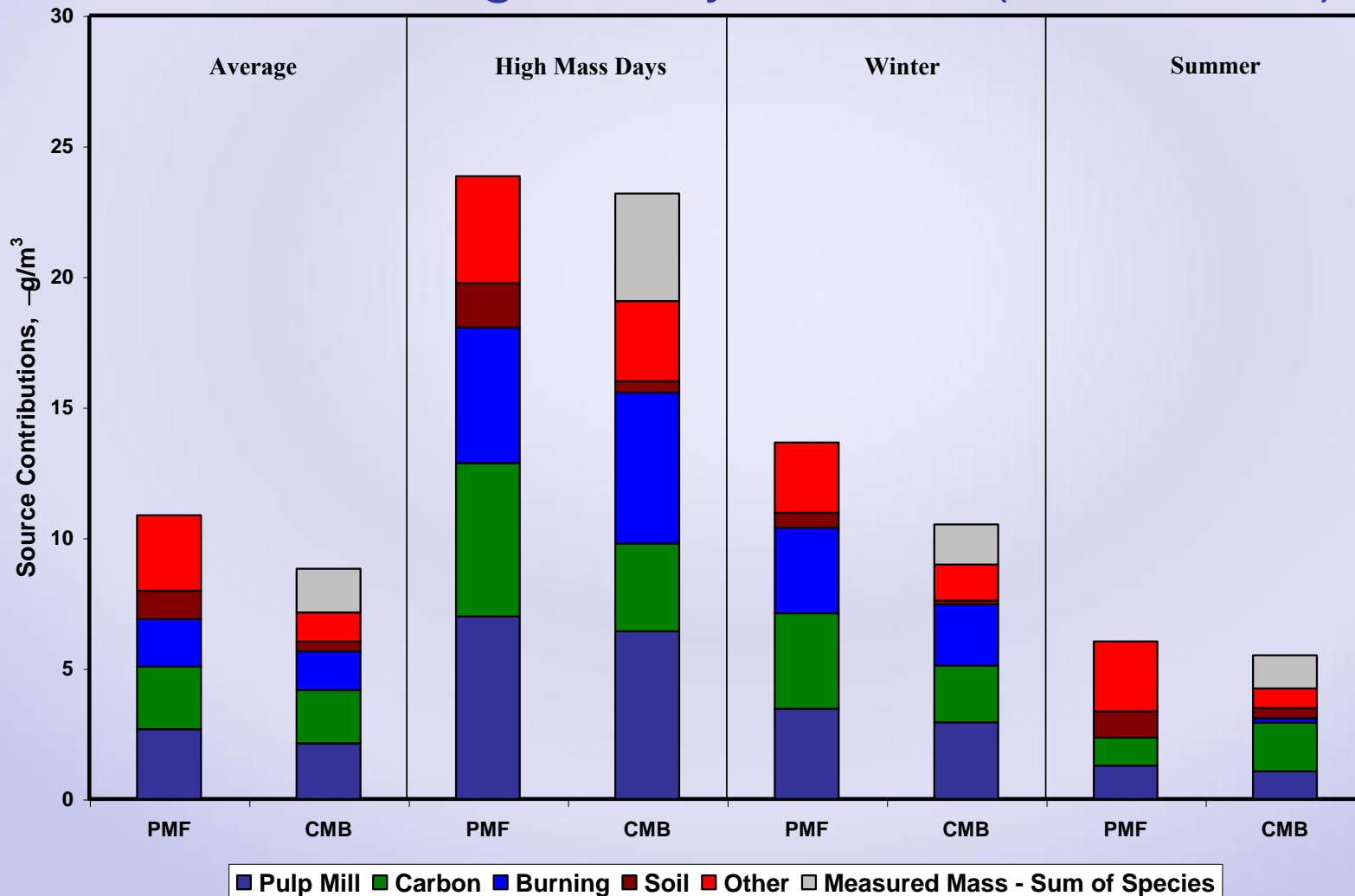
Golden Study Results (2004-2006)

Evans, G, Jeong, C., *Data Analysis and Source Apportionment of PM_{2.5} in Golden, British Columbia using Positive Matrix Factorization (PMF), 2007*





Prince George Study Results (2005-2006)





Applications of Source Apportionment in BC

- To identify sources in an airshed in order to improve air quality. e.g. Golden
- To accentuate or correlate with results from dispersion modeling. e.g. Prince George
- To pinpoint a source or constituent that is difficult to do with other models and is easily identified by a unique species. e.g. Endotoxin – Agricultural Dust, Levoglucosan – Woodsmoke.

Source Apportionment Resources

- Environment Canada NAPS Data and Reports – <http://www.etc-cte.ec.gc.ca/NapsAnnualRawData/Default.aspx?ReturnUrl=%2fNapsAnnualRawData%2fMain.aspx>
- BC MOE Reports – <http://bcairquality.ca/reports/index.html>
- General primers on Source Apportionment
<http://www.epa.gov/heads/sources/> (EPA),
<http://www.arb.ca.gov/research/abstracts/00-332.htm> (ARB)
- PMF and CMB models <http://www.epa.gov/heads/products/pmf/pmf.html>
http://www.epa.gov/scram001/receptor_cmb.htm



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