Airshed Management Tools: Modelling

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Outline

1. Background
   - AQ issue
   - Source attribution methods
2. Dispersion Modelling
   - What it is, what it can do
   - Strengths and limitations
3. Prince George Dispersion Modelling Study
   - Results and comparisons with other studies
   - Strengths and limitations
4. Air-Quest – a visualization tool for AQ managers

It's not all about size…it's about impact

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)

- In managing AQ to protect health, we care about **ambient** air quality where people live and work

Air Quality Management

- Goal is to lower **ambient** levels of particular pollutants to a level sufficient to protect health, environment and quality of life
- To do this effectively we need to attribute the contribution of each source to ambient levels – in order to rank sources and be able to estimate the result of source reduction

Types of Source Attribution 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)
   - PCA / PMF (EC/BCMOE/STI study) - lets the ambient data "speak for themselves" and infers source profile
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
   - Several past studies by gov't / industry
   - Current comprehensive study using Calpuff (Spagnol, Ainslie, Corbel, et al, UNBC – PGAIR – Research Working Group)

Source Attribution

- None of the methods are perfect – all have strengths, weaknesses and limitations
- Receptor modelling and wind sector analysis can give general guidance, but can't draw a direct link from a specific source or emitting unit to ambient levels at a point in the airshed
- Dispersion modelling can make the specific connection between sources and ambient levels making it the preferred tool for ranking and prioritizing sources

Dispersion Modelling

Dispersion models have three components:

1. An **Emission Inventory** that lists, locates, quantifies and characterizes all emissions in an airshed
2. A **Meteorological Model** that characterizes the atmospheric environment by quantifying wind, temperature, turbulence and stability each hour across an airshed
3. A **Dispersion Model** that places emissions from #1 into the atmosphere characterized by #2, and calculates how the emissions are diluted and transported to predict the ambient concentrations at specified points (receptors) in the airshed

Dispersion Modelling – cont'd

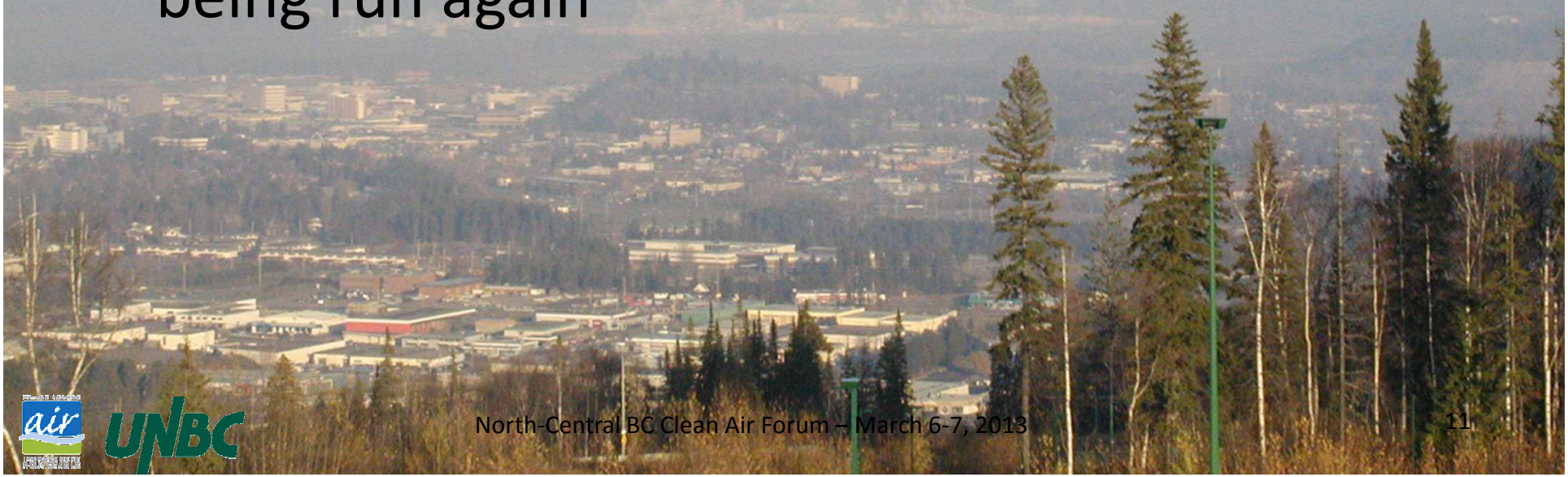
- The link between source and ambient concentration at receptors is maintained
- The model can therefore account for and rank the contributions of all modelled sources at all receptors
- This information is exactly what is needed in air quality management, to prioritize sources for reduction, and to estimate the expected improvement in ambient levels due to source reductions

Dispersion Model Uncertainties

- Each of the three components of the modelling system has uncertainty and error
- For particulate matter, the emission inventory is especially problematic due to the large number of sources, that can be poorly characterized
- Only some of these sources are measured (e.g. industrial emissions)
- Others must be estimated using emission factors that relate activity to emission amounts
- Emission amounts have a **direct impact** on ambient levels → therefore if an emission estimate is 50% too large, then the ambient levels resulting from that emission will also be 50% too large

Dispersion Model Results

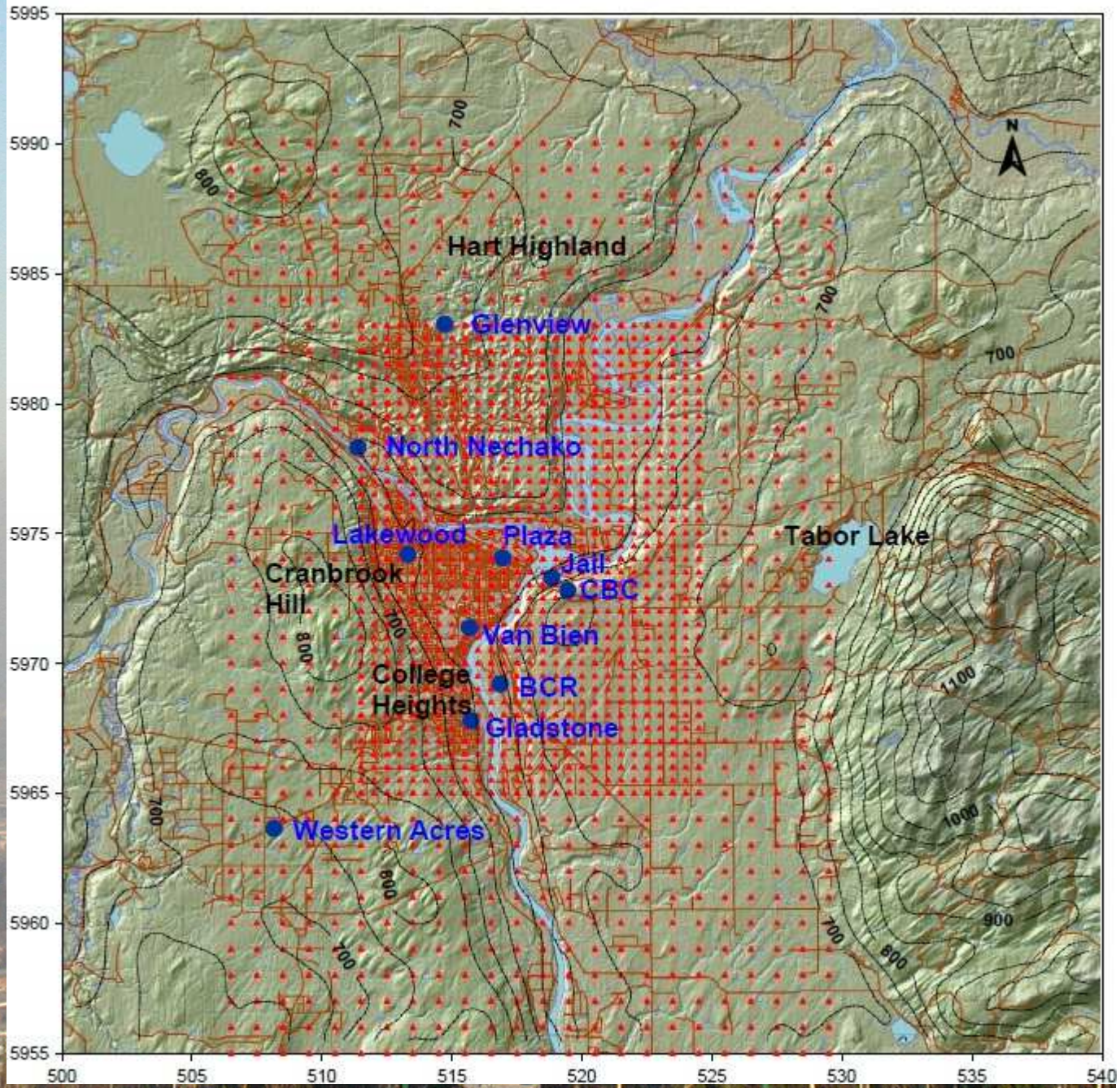
- The current model predictions are summarized in a report by STANTEC (2010)
- A number of limitations were identified in some source categories, so that further refinements are being made and the model is being run again



Model Domain

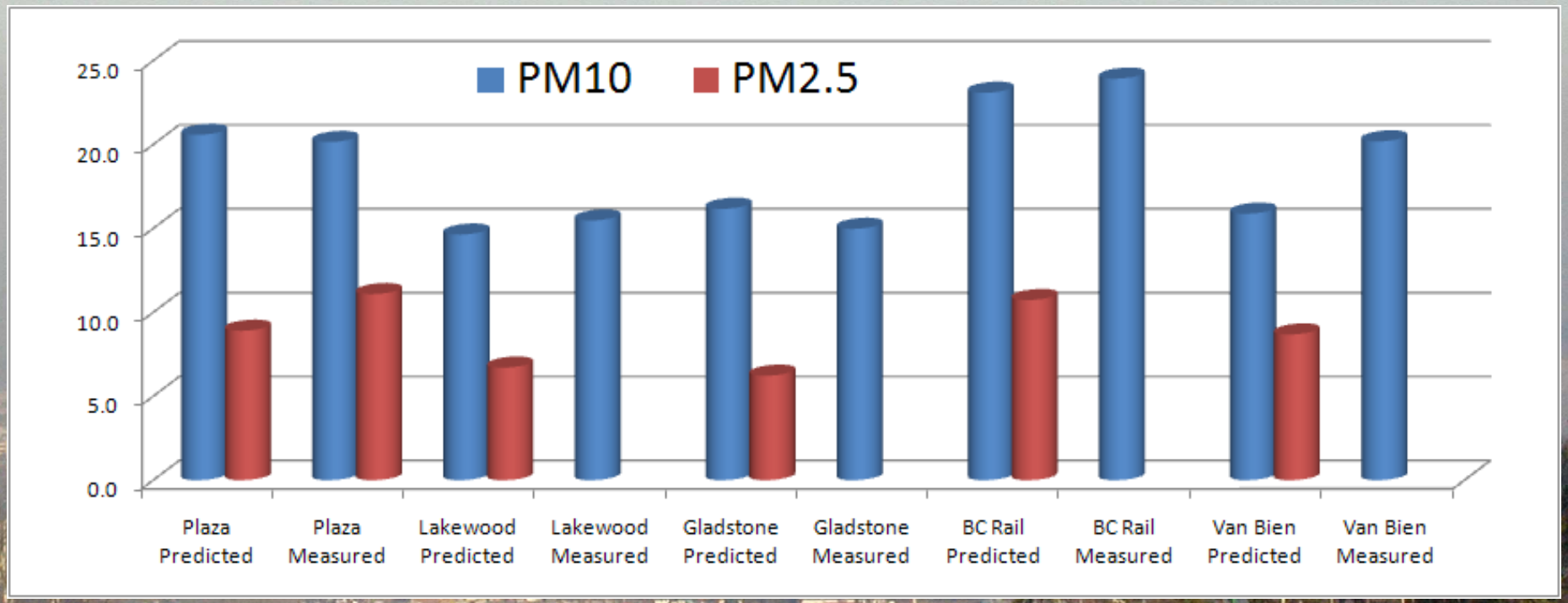
- There were 1883 receptors where ambient pollutant levels were calculated (red dots)
- Every hour between 2003-2005 was modelled
- About 1500 individual sources were modelled, as point, area or lines
- 33 permitted (industrial) sources with about 350 emitting units

Source: Stantec (2010)

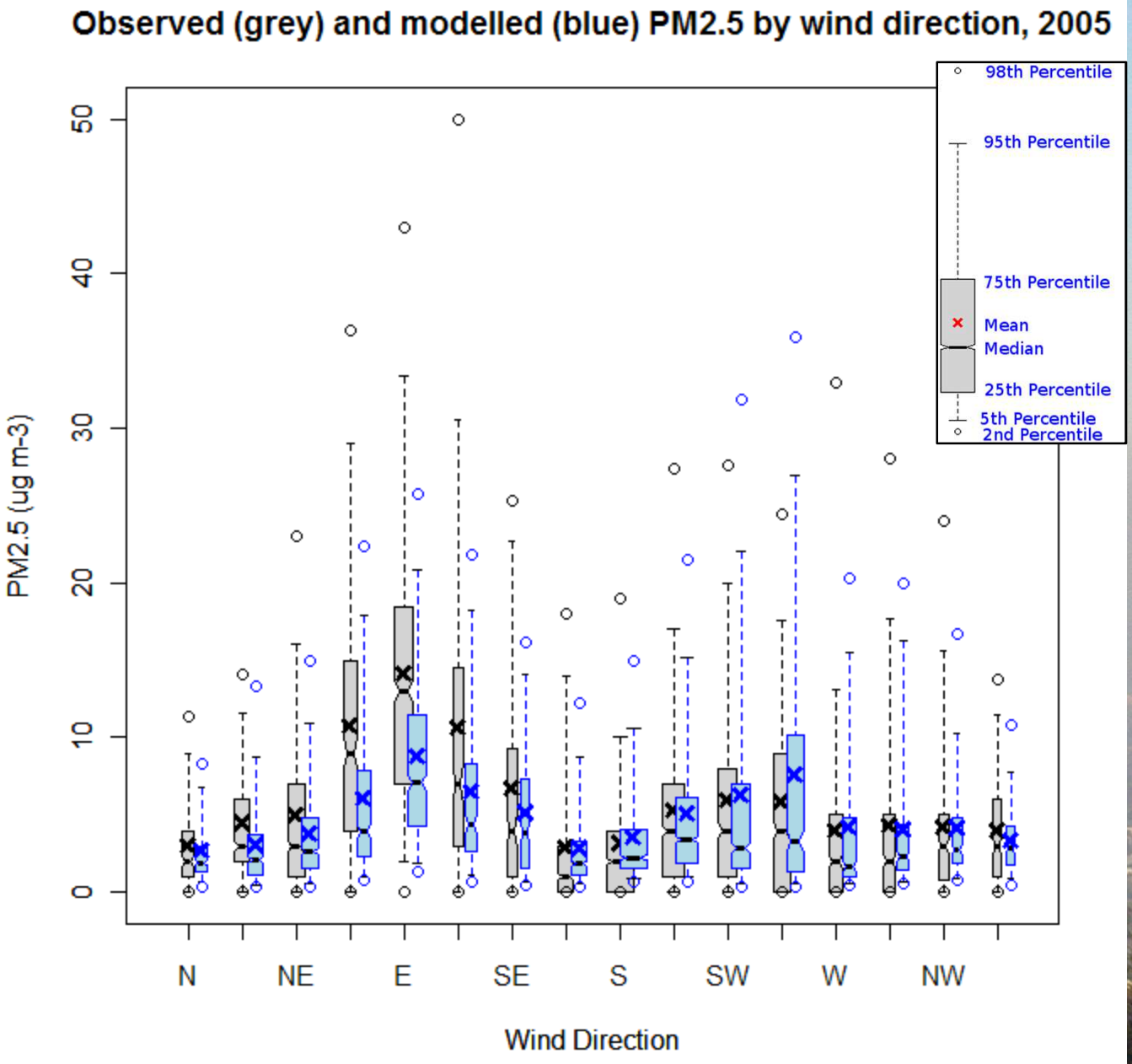


Model Performance

- 2003-2005 Average Predicted vs Measured PM_{10} & $PM_{2.5}$
- The mean is reasonably well predicted at most locations



Stantec (2010) results, to be updated



Plaza **observed** and **modelled** $PM_{2.5}$

- Model under-predicts from the easterly quadrant
- We think this is a model windfield issue
- Could also be underestimating the sources in the industrial sector (e.g. condensable PM, secondary PM, fugitive dust)
- (Stantec 2010 results, to be updated)

Comparison between STI source apportionment of $PM_{2.5}$ and Calpuff dispersion modelling for Plaza 2005 (Stantec 2010 results – to be updated)

STI categories	CMB STI (2008)	PMF STI (2008)	Calpuff Stantec (2010)	Stantec Categories
Pulp Mill	25 %	24%	21%	Permitted
Burning	26%	18%	25%	Restaurants Res. Heating Open Burning Res. Other
Carbon (HDDV, LDGV, OC)	24%	22%	22%	Locomotives, On-road mobile, Com. heating
Soil	5%	10%	30%	On-road dust Com. dust Background
Other	20%	26%	2%	Com. misc.

Air-Quest

- We would like to make the modelling results available to AQ managers in an easily digestible form, that can allow scenarios to be produced and tested
- Over 300 GB of model output and the need to be a modeller makes this prohibitive
- Therefore, with BC-CLEAR support, we have developed a web-based visualization and scenario tool called Air-Quest http://weather.unbc.ca/airquest


Questions?