Alberta's Environmental Monitoring Standards and Protocols

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Monitoring Standards and Technologies

Alberta Environmental Monitoring, Evaluation and Reporting Agency

aemera.org

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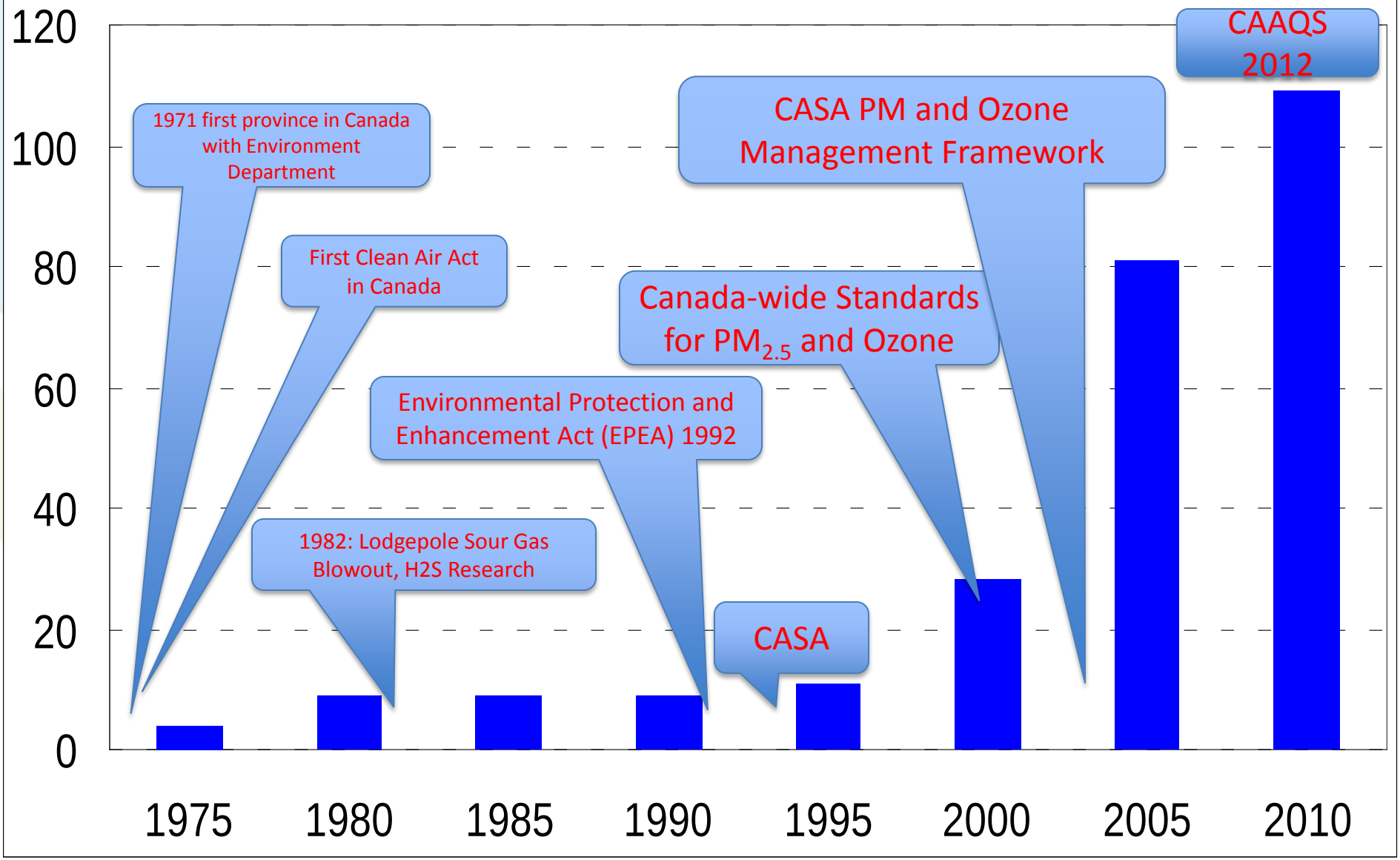
Credible and Relevant Data/Information

- Consistent and comparable Standard Operating Procedures (SOPs).
- Comprehensive data QA/QC programs including independent external audit that are open and transparent.
- Forward looking, take advantage of new/emerging science and technologies.

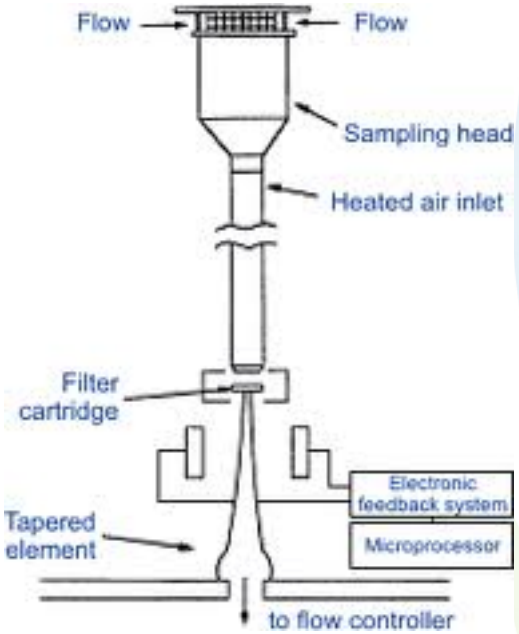
You Can't Manage What You Don't Measure

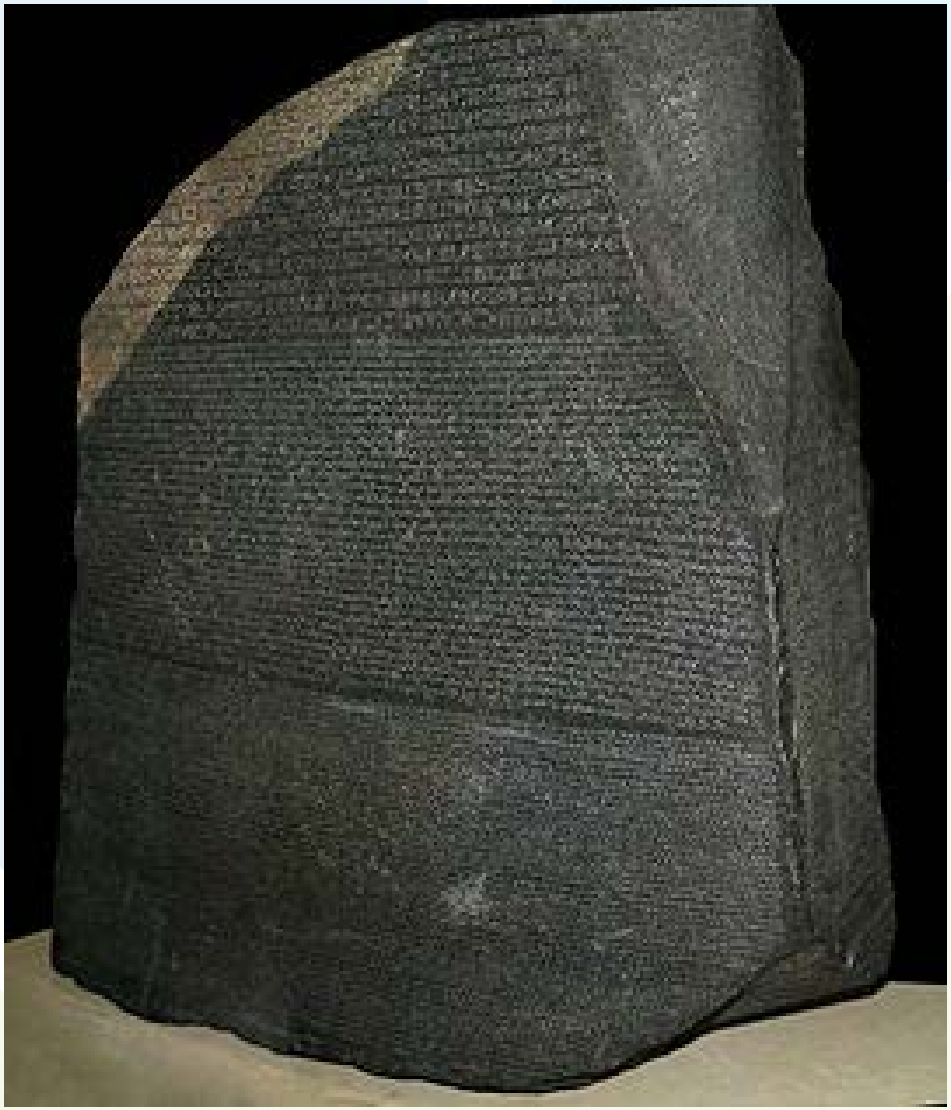


Science Is The Reduction of Uncertainties

- Type I: There is a true value to be determined. SOP execution affects accuracy and precision.
- Type II: Variability (e.g., spatial and temporal variances) + Type I uncertainties.
- Type III: Complex causal relationships and random factors (e.g., Heisenberg's Uncertainty Principle)

Project Rosetta Stone





US EPA Data Quality Objective for Relating FRM and CM to Report AQI

- CM may be used to report AQI if a linear relationship can be established by statistical linear regression against FRM ($R^2 > 0.8$).
- Statistical linear regression can be used to transform CM data into FRM-like data.

PM2.5 Measurements Show significant discrepancies between CM and FRM In Cold Weather Conditions especially in Alberta

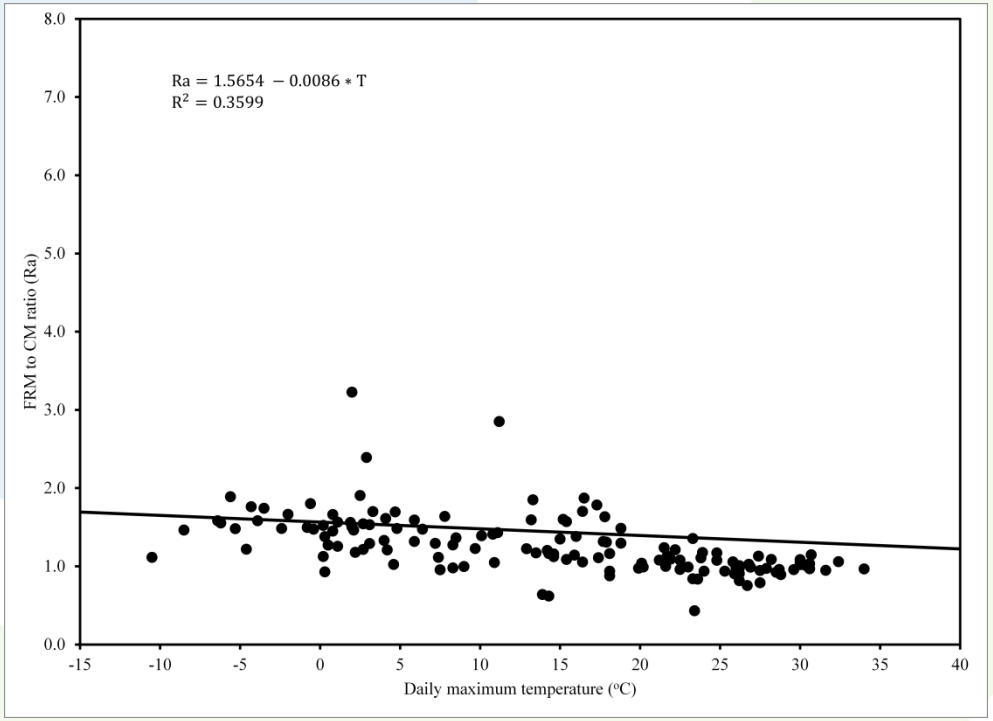
Removal of Type II Scientific Uncertainty for PM2.5 Measurements

The Discrepancies between CM and FRM is a funciton of temperature

$$FRM = CM + CM*F(T)$$

Temperature induced discrepancies can be corrected

$$FRM/CM = \alpha + \beta T + \varepsilon$$

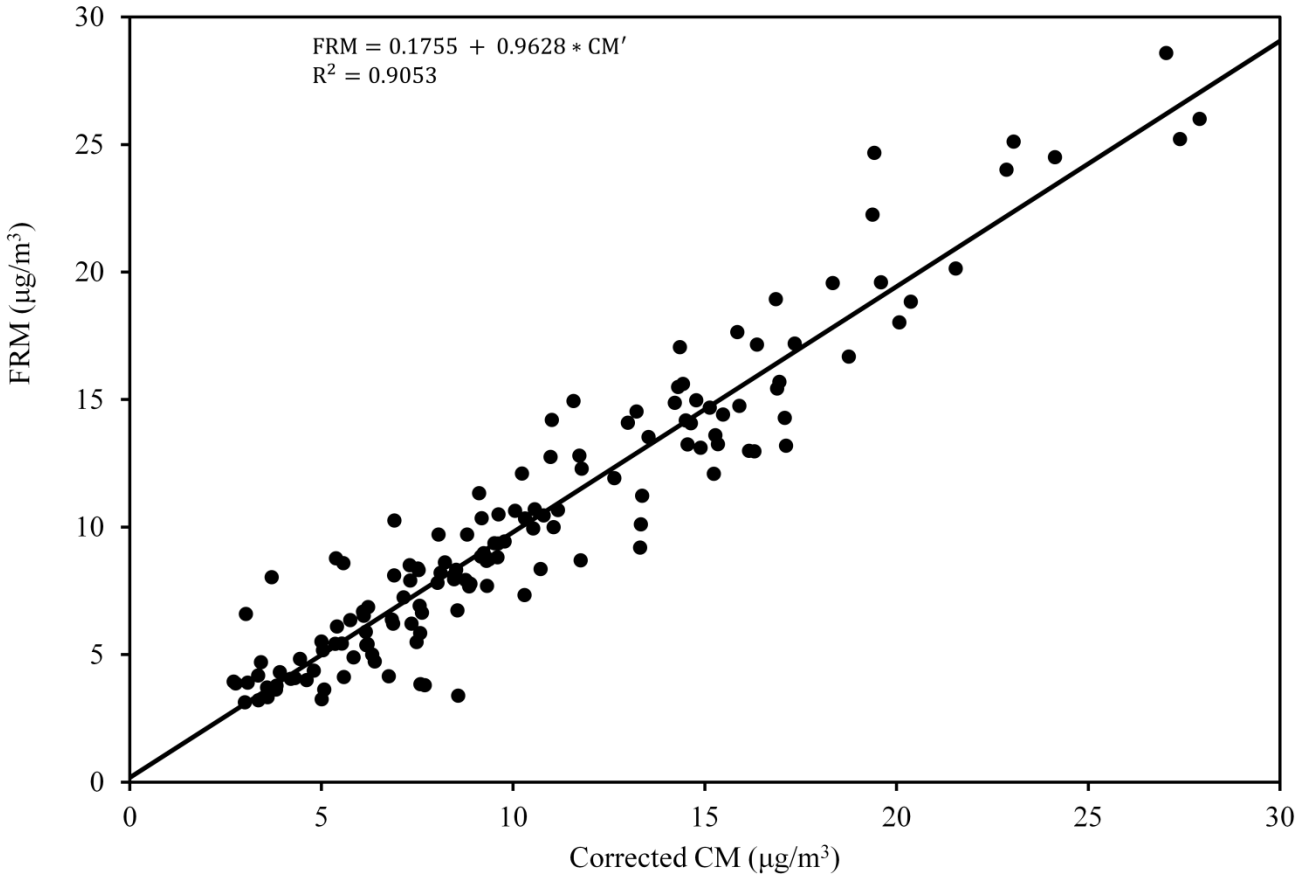


"A two-step approach for relating tapered element oscillating microbalance and dichotomous air sampler PM2.5 measurements"

J of A&WMA September 2014

Co-authors: Long Fu, Thompson Nunifu and Bonnie Leung.

Sample Data from Toronto – Etona Region

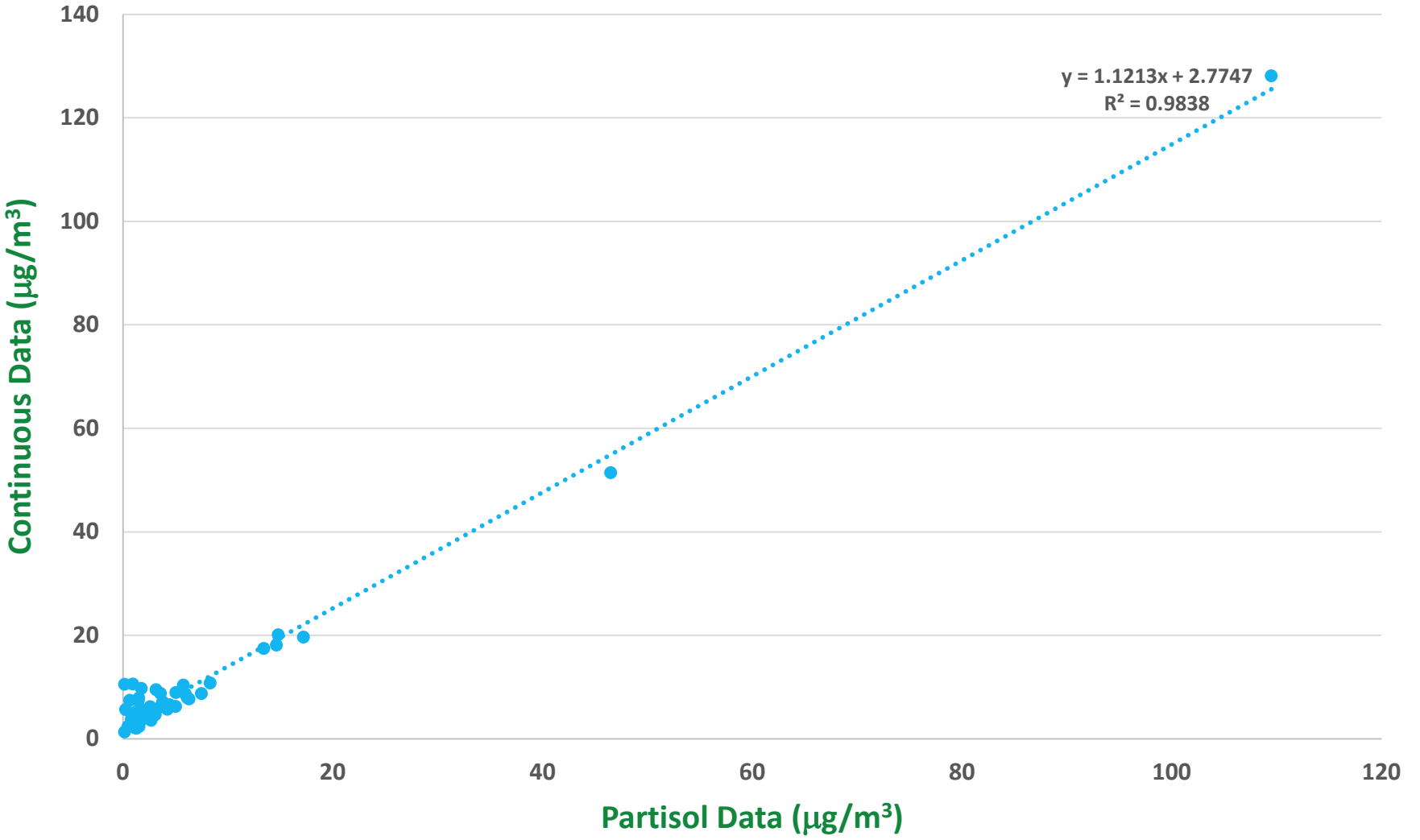


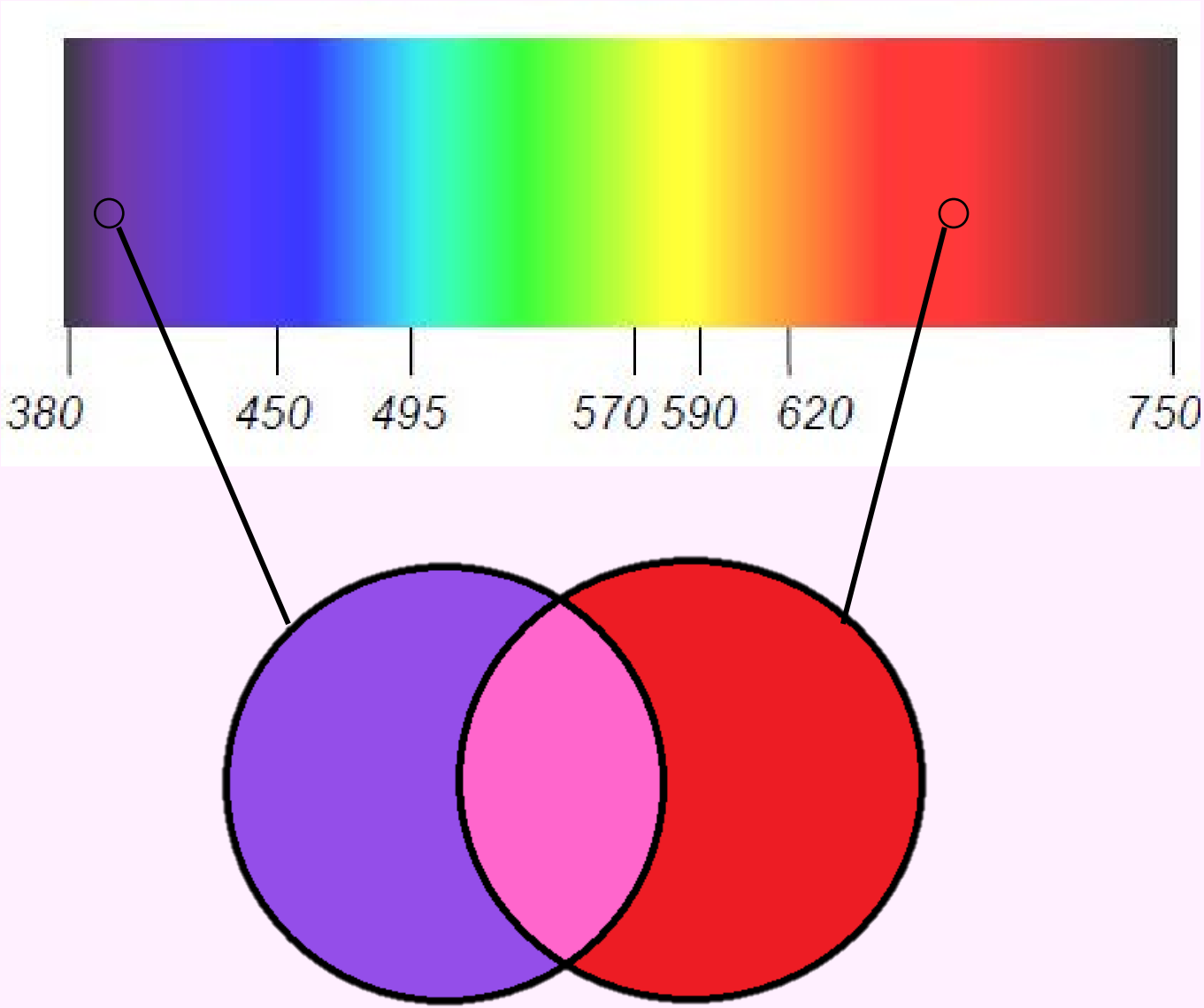
Data Quality Issues In The Oil Sands Region

- LICA Reference #291462, #291464, #291461
- Elk Point TEOM FDMS had less than 90% operational time during the month of September 2014
- For the month of July and September 2014, St. Lina TEOM FDMS had less than 90% uptime.
- LICA-AEMERA Joint PM Data Quality Study for 2014-2016

Particulate Matter Data at Cold Lake South

(December 2014 - October 2015)

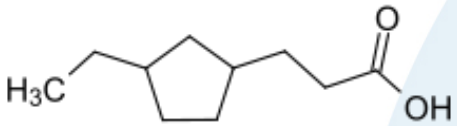


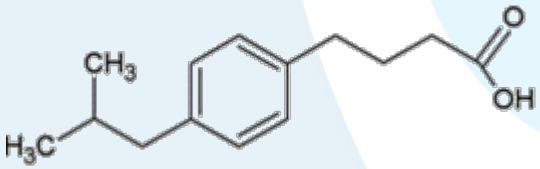


Project Color Pink

Naphthenic acids (NAs)

- Unspecific mixture of cyclic carboxylic acids



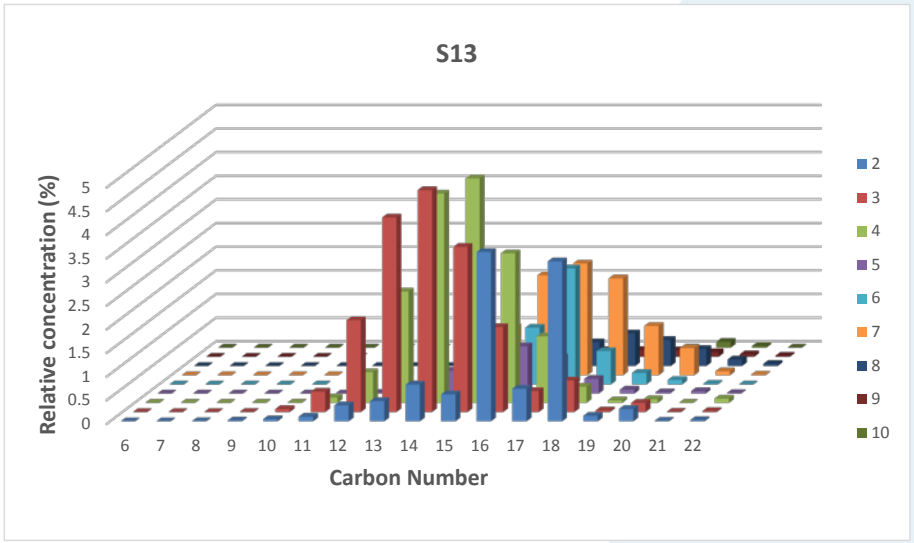


- Formed during oil sands extraction process
  - NAs show toxicity to fish and other organisms

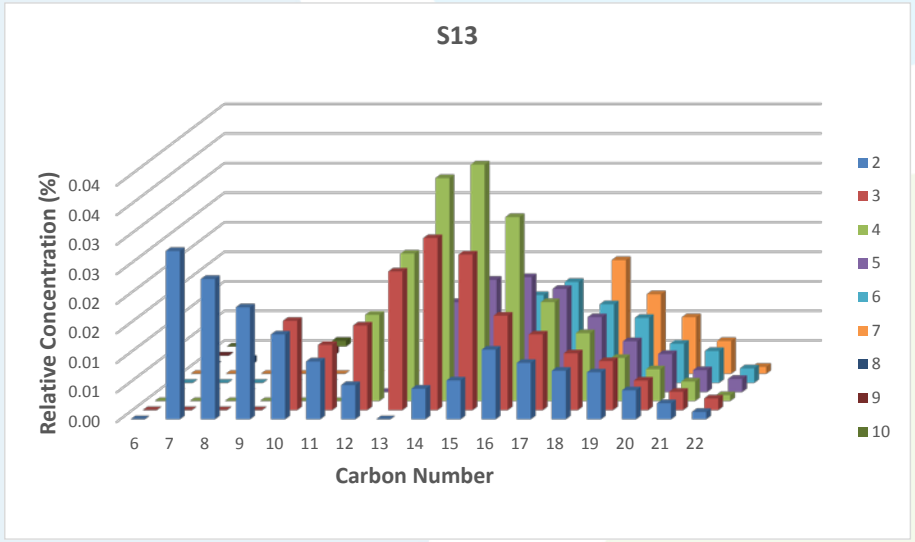
Liquid tailings, a by product of the oil sands mining process, contain naphthenic acids

Photo from: http://www.desdemonadespair.net/2009/09/environmental-impacts-of-oil-sands.html

Naphthenic Acids Speciation

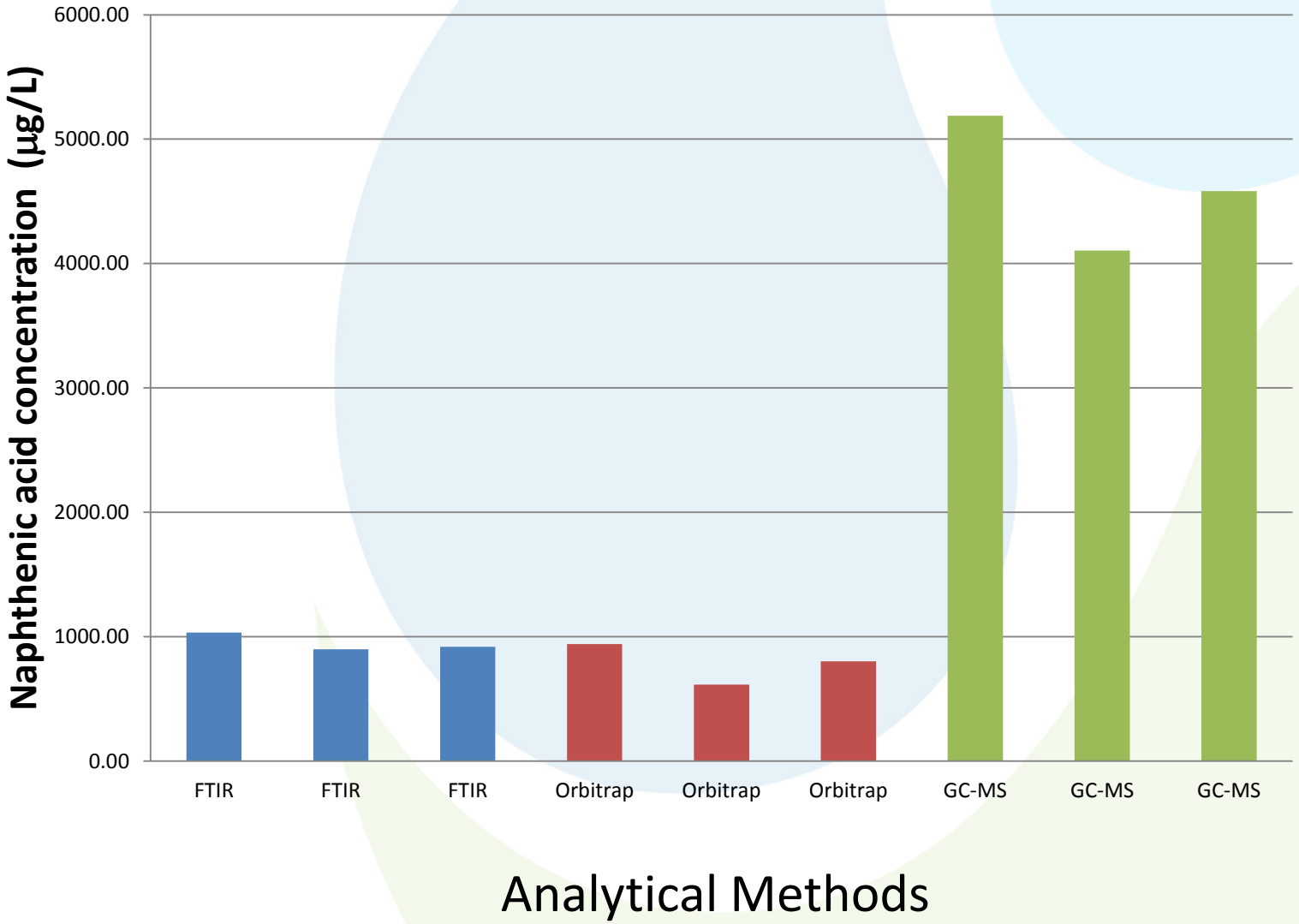


Orbitrap-MS

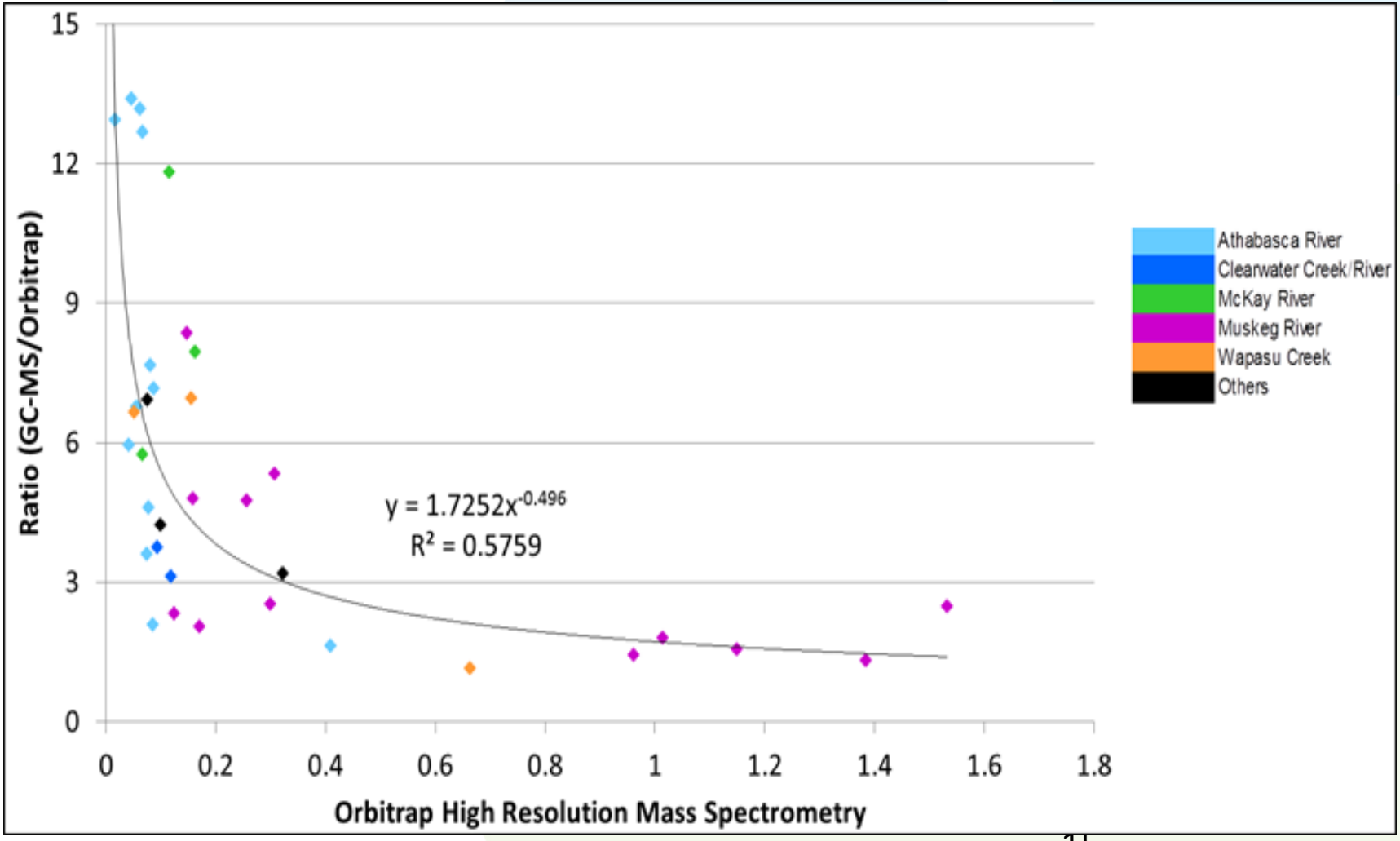


GC-MS

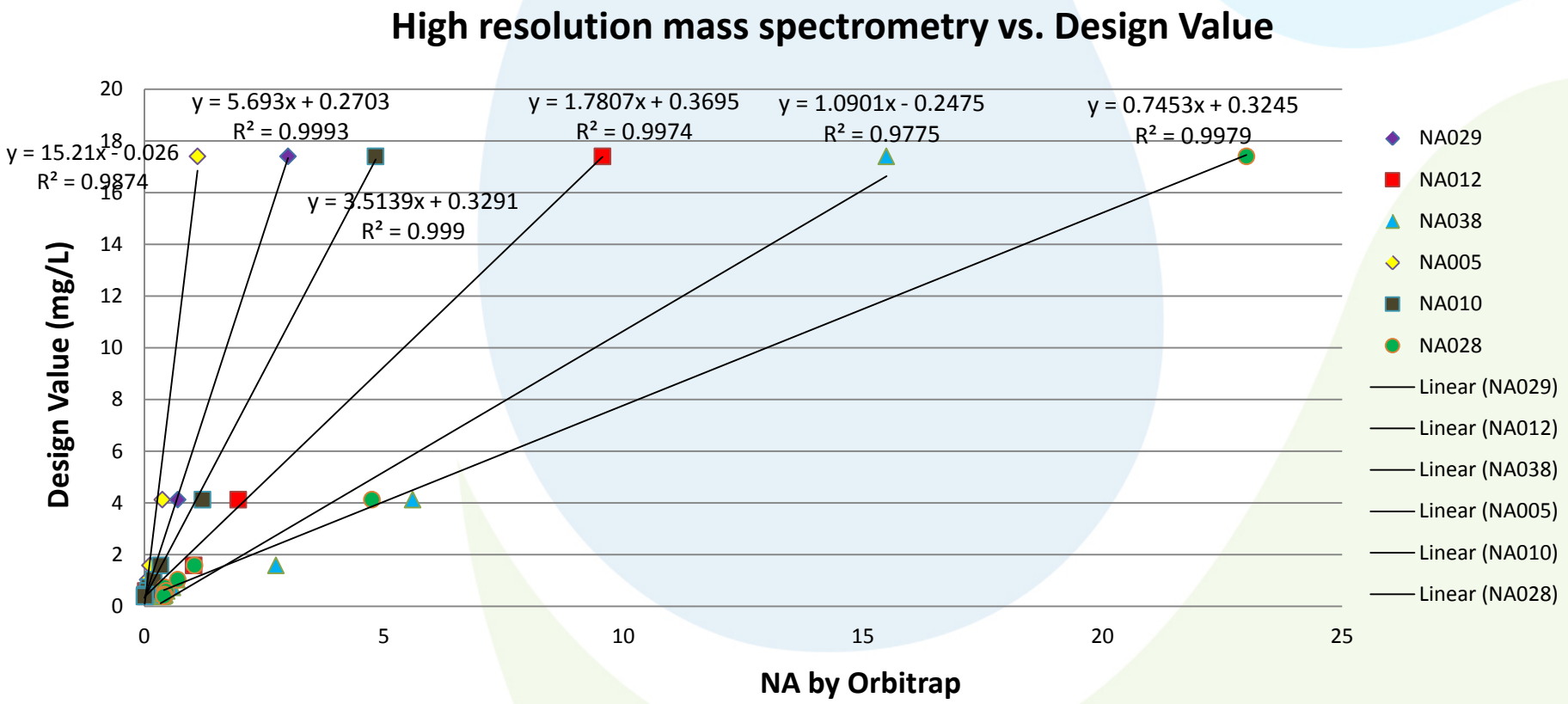
Comparison of FTIR, GC-MS and Orbitrap (ESI-)



Spatial Variation of GC-MS/Orbitrap Ratio



The Needs for a Standard Reference Material and Better Extraction Process



Recommendations from the NA Method Workshop – March 14, 2016

ECCC, AEMERA, COSIA, AER, AEP

- A simple NA definition: simple carboxylic acids with two oxygen atoms detected using ESI negative-ion mode; R group can be multi-cyclic and aromatic, but does not include heteroatoms, nor any other functionalities.

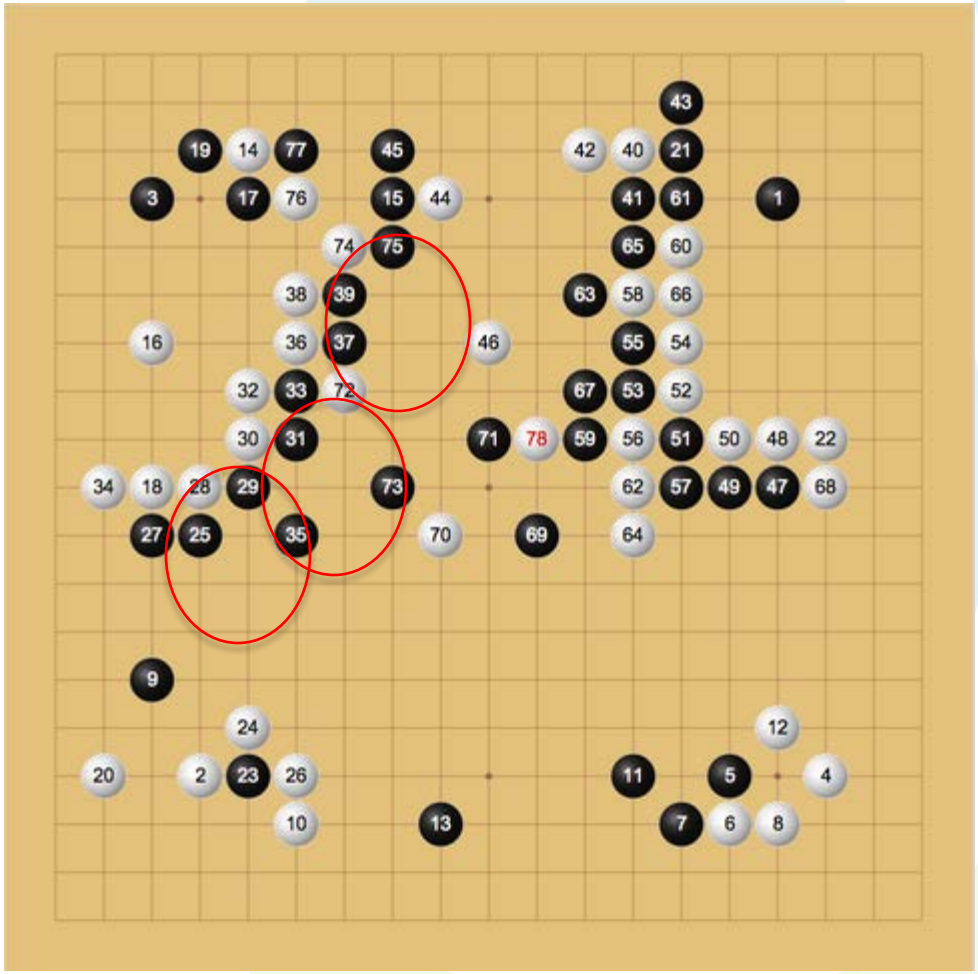
- The current GC/MS method should be replaced with more suitable technologies such as FTIR, QToF, and Orbitrap. NA quantification methods and field sampling procedures are priorities for development.

- Bitumen relevant standard reference materials for method development and toxicity tests were highlighted as a current “ultra high” priority.

Machine Intelligence: Enigma Code, Deep Blue, Watson, and AlphaGo

- Enigma code
  - 1.59×10^{20}
- Deep Blue
  - Chess: 50 digits
- Watson
  - Wiki: 4 TB RAM
- AlphaGo
  - Value Network
  - Policy Network
  - Monte Carlo Tree Search
  - Go: 80 digits

The Hand of God – considering Types I, II, and III uncertainties



Credible and Relevant Data/Information

The Changing Environment

Natural Environment

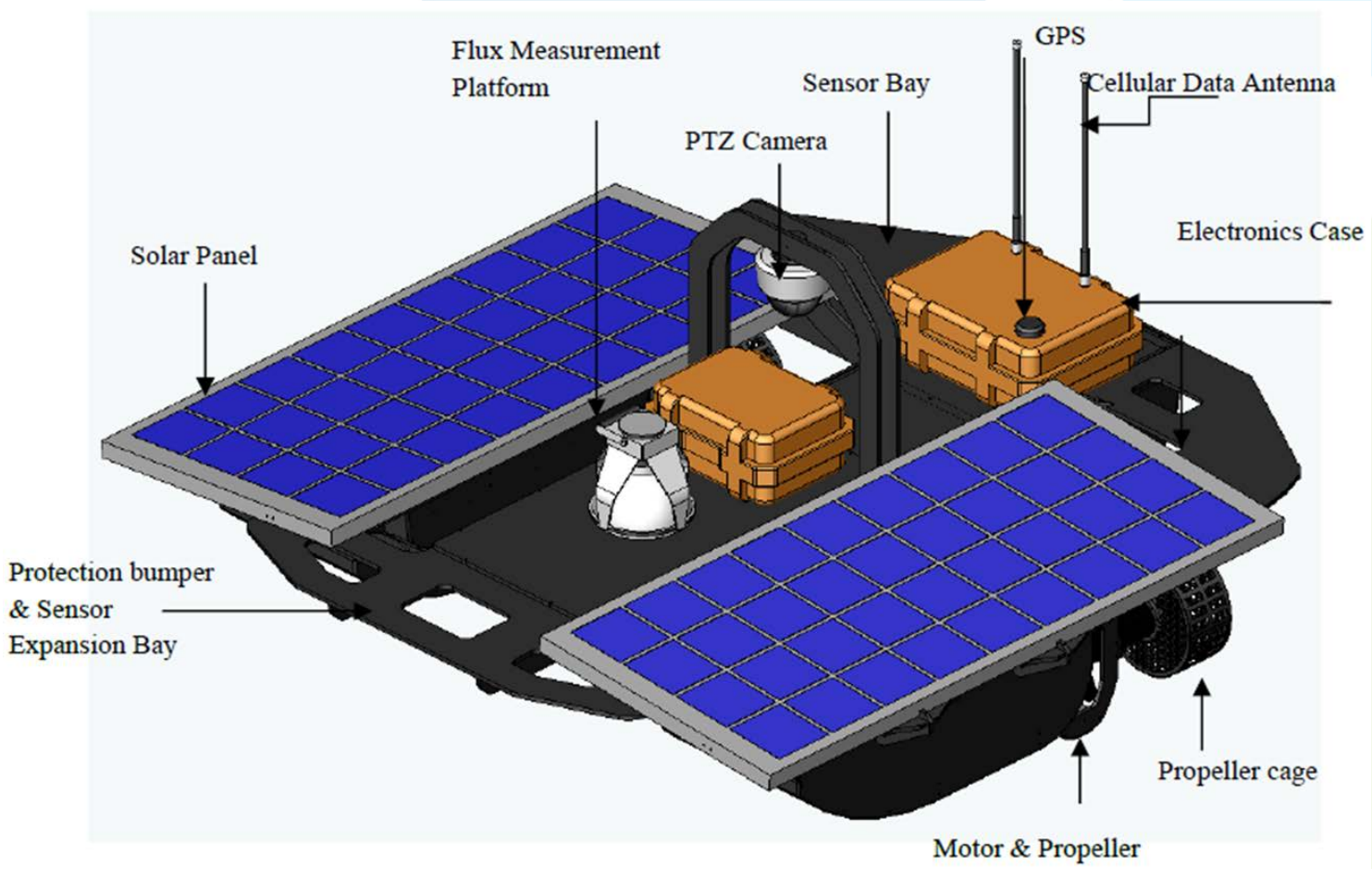
Built Environment

Augmented Environment

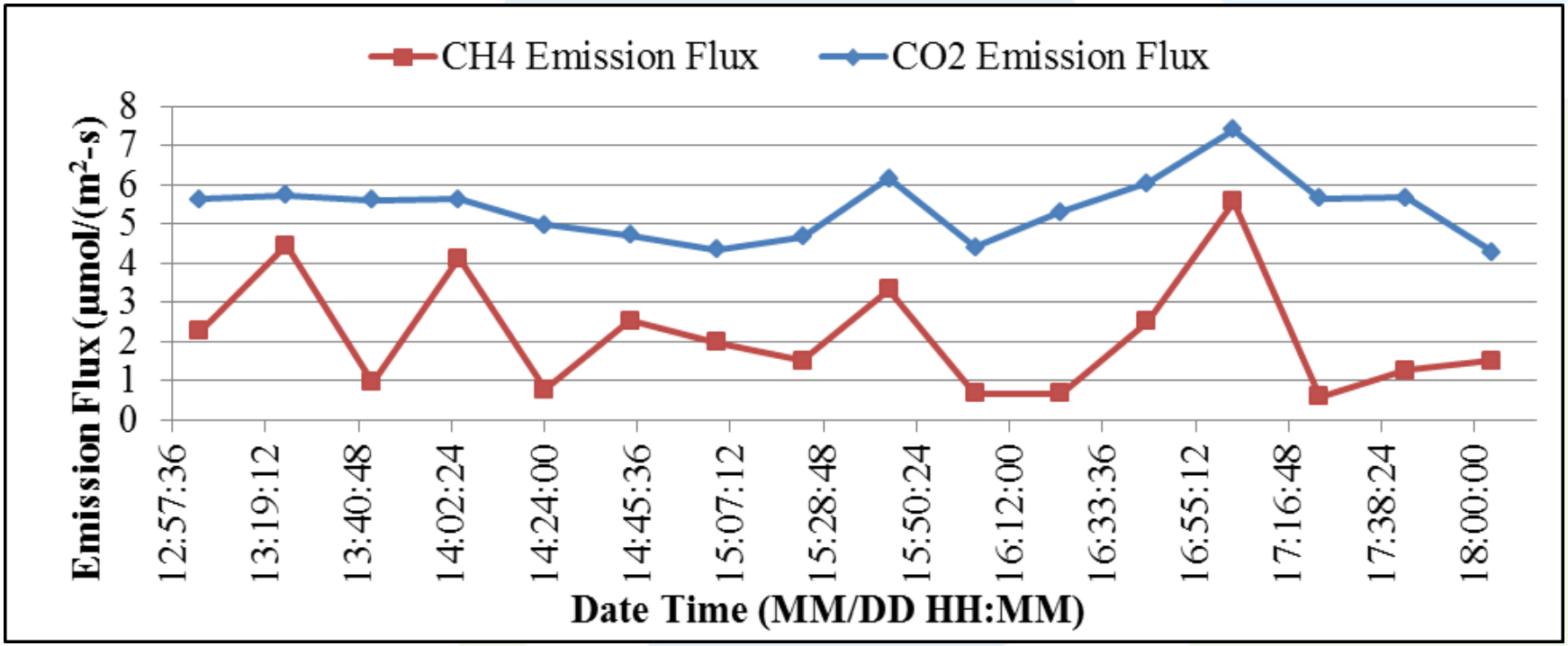
What Big Science Has to Offer?

- Big Data and Supercomputers
- Remote Sensing and Advanced Sensor Technology
- Epigenetics and Advanced DNA Technology
- Intelligent Machines and Robotics
- Social Network

The Little Robot That Could



Time Series of CH4 and CO2 Fluxes



Science offers little in the way of cheap thrills. The standards of evidence are strict. But when followed they allow us to see far, illuminating even a great darkness.

Carl Sagan, *Pale Blue Dot: A Vision of the Human Future in Space* (1994)