Title implies “Everything but the Kitchen Sink”...

... so here’s the Kitchen Sink!

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Ulaanbaatar, Mongolia
January 2023
Our Work in Asia

- Mongolia
  - Heating stove replacement program impact assessment (US Gov’t)
  - Forecasting health impacts of air pollution control scenarios (Mongolian Gov’t)
  - Children’s exposures to air pollution (UNICEF)... Zhiyao Li dissertation

- Central Asia
  - US State Department Air Quality Fellow supporting US Embassy Tashkent
  - Central Asian Universities Air Quality Knowledge Hub (US State Dept through American Councils)
  - Air Quality Conceptual Models for Uzbekistan (McDonnell Academy Global Incubator Seed Grant)... Xuan to Tashkent, June 2023
  - Health and social impacts of air pollution in Bishkek, Kyrgyzstan (UNICEF)
  - Feasibility of air quality low-cost sensor networks in Tajikistan (UNEP – pending)

UNICEF Kyrgyzstan Project with:
- M-Vector
- Rufus Edwards, University of California-Irvine
- Rahat Sabyrbekov, American University in Central Asia
High intraurban variability in many Central Asian cities...

KyrgyzHydromet/Asian Development Bank low-cost sensor network

...variability largely driven by residential coal combustion
From Ambient Concentrations to Exposures

population exposures to outdoor PM$_{2.5}$

ambient PM$_{2.5}$ concentrations, PM$_{2.5}$ indoor/outdoor ratios, and time-activity data $\rightarrow$ exposures
Reflection #1 – “Low-Cost Sensors” (LCS)

• Nephelometer-based LCS now well understood
• PM$_{2.5}$ measurements
  • Accumulation mode truncation (cannot see the small particles)
  • Insensitivity above $\sim$1 $\mu$m (cannot quantify the large particles)
• PM$_{10}$ measurements (and dust contributions to PM$_{2.5}$)
  • Interpret AQ-SPEC test results with extreme caution!

![Graph showing comparisons of low-cost sensor data with reference site data for Mongolia and St. Louis, USA. The graphs illustrate the data points for MetOne 1020 BAM and PurpleAir device, highlighting known “dust” events.]
Reflection #1 – “Low-Cost Sensors” (LCS) for PM$_{10}$

- Many issues, e.g., particle size and wind speed dependent aspiration efficiency
- QuantAQ (QAQ) Modulair-PM
  - Two LCS – nephelometer and optical particle counter
  - Not a low-cost device, ~$1,500 + $300/year

Testing in St. Louis, MO

Adjust for LCS-to-reference monitor bias AND PM$_1$/PM$_{10}$ bias

Tyler Cargill and Zhiyao Li
Reflection #2 – “Computer-Controlled SEM (CCSEM)

Discussed at 2022 Spartan Meeting

Manganese Smelter
Meyerton, South Africa

Mass Distribution by Average Diameter (microns)

<table>
<thead>
<tr>
<th>Classes</th>
<th>Mass %</th>
<th>1.0</th>
<th>2.5</th>
<th>5.0</th>
<th>10.0</th>
<th>20.0</th>
<th>50.0</th>
<th>75.0</th>
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<tbody>
<tr>
<td>Mn-Si-S-Ca</td>
<td>1.7</td>
<td>2.4</td>
<td>5.8</td>
<td>31.6</td>
<td>60.2</td>
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<td>Mn-Si-S-Fe</td>
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<td>0.6</td>
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<td>Mn-S-Si</td>
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<tr>
<td>Mn-S-Ca</td>
<td>0.1</td>
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<td>95.7</td>
<td>0.0</td>
<td>0.0</td>
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<td>Mn(Si-Al)</td>
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<tr>
<td>Mn-Fe-Cl</td>
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<tr>
<td>Si-Al(Mn)</td>
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<td>3.1</td>
<td>10.2</td>
<td>86.6</td>
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<td>Fe-Si-Mn</td>
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<td>Fe-S-Mn</td>
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<td>Mn(Fe)</td>
<td>0.1</td>
<td>1.7</td>
<td>95.0</td>
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<td>4.5</td>
<td>15.8</td>
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<td>Totals</td>
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<td>0.0</td>
<td>0.0</td>
<td>1.0</td>
<td>4.8</td>
<td>16.7</td>
<td>77.3</td>
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Carbon is from the substrate, not the PM
Reflection #2 – “Computer-Controlled SEM (CCSEM)"

Following the 2022 Spartan meeting...

• Improvement to substrates, now better measure carbon (RJ Lee Group, USEPA)
• Access to considerable time on USEPA’s CCSEM
• Tashkent, Uzbekistan
  • Two-week integrated sampling
  • Collected ten (10) samples in Tashkent
  • Will be collecting samples in Bukhara and Nukus (near Aralkum Desert)
• CCSEM analysis in August 2023

Perhaps CCSEM of interest for Select Spartan sites?

Modulair-PM and PM passive sampling at TIIAME-NRU

Uzbekistan AQ monitoring stations
2 as of 2021
6 more delivered
Spartan Core Measurements and Ancillary Projects (Measurements)

- Leverage Spartan sites infrastructure
- Add to data or support interpretation of data towards meeting Spartan objectives
- Provide additional context for Spartan data/sites
- More broadly contribute to global AQ estimation and impacts