



CHEMICAL SPECIATION OF PM_{2.5} IN MAJOR CITIES WORLDWIDE

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April 18th, 2016

SPARTAN Team

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AS3.21 (R. 2.91), Megacities session

GLOBAL SIGNIFICANCE OF PM25 Dhaka Beijing > 50 µg m⁻³ > 70 µg m⁻³ 1 PM_{2.5} particle ≤ 2.5 microns t irritation Rehovot Hanoi igle15-150 µg m⁻³ > 40 µg m⁻³ lung problems, even lung cancer WHO target of $PM_{2.5} = 10 \ \mu g \ m^{-3}$ • Adverse lung, cardiovascular effects ۲ 3 million* annual deaths worldwide (3% of all deaths)

NEED TO EVALUATE SATELLITE-DERIVED PM2.5







SPARTAN = SURFACE PARTICULATE MATTER NETWORK

SPARTAN Headquarters: Dalhousie U, Halifax NS



Urban Areas:

- -Beijing
- -Kanpur
- -Hanoi
- -Buenos Aires
- -Dhaka
- -Manila
- -Rehovot

Ongoing measurements of ground-level PM_{2.5} collocated with AOD measurements (sun photometer)

 Each site collocated with sun photometer (AERONET)



SPARTAN INSTRUMENTS

Each SPARTAN station includes two instruments*:



SPARTAN: DATA PROCESSING SEQUENCE



FILTER WEIGHING



- Cleanroom facility (< 100 particles/cm³)
- Follows USEPA protocols:
 - T-range: 20 25 °C
 - RH-range = 30 40 %
 - Daily mass calibrations











DECONSTRUCTING FILTER MASS



(acid-digested metals) (water-soluble ions)

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Surface reflectance (Black Carbon)

Species	Rel. Composition
Soil = {Mg, Al, Ti, Fe}	<mark>8 – 23</mark> %
Sea Salt = {Na}	I – 10%
Trace Element Oxides = {V, Zn, As, Cd, B	a, Pb} < I %
Ammonium nitrate = {NO ₃ }	2 – 10%
Ammonium sulfate = {SO ₄ , NH ₄ }	5 – 26%
Effective Black Carbon = {Reflectance}	2 – 13%

AEROSOL COMPONENTS



GLOBAL PM_{2.5} COMPOSITION



SPECIATION TRENDS



ESTIMATING PARTICLE-BOUND WATER (PBW)

Hygroscopicity parameter (κ-Kohler theory):

$$\kappa_{m,tot} = \frac{1}{M} \sum_{X} m_X \kappa_{m,X}$$

 $f_m(RH) = 1 + \kappa_{m,tot} \frac{RH}{100 - RH}$

$$PBW = M \times (f_m(35\%) - 1)$$

- I. Average *k* over **PM components**
- 2. Set RH to 35%
- 3. Add to water total mass



0.00 0.05 0.10 0.15 0.20 0.25

Κ

2.0

1.9

1.8 -

1.7 -

1.6

1.5

1.4

 $f(RH)^{1/3}$

____1.3

H 1.2

Duplissy et al. ACP, 11, 1155-65, 2011



WATER-MASS CONTRIBUTION



HOURLY PM_{2.5} ESTIMATES



G. Snider, C. Weagle et al.: ACPD, 2016.

TRACE ELEMENTS: CRUSTAL ENRICHMENT FACTORS



-Crustal Average via Taylor and McLennan, Rev. Geophys., 33(2), 1995. -Snider et al, ACP in prep, 2016

CORRELATIONS OF SPECIES



All-site weighted average:

SUMMARY

- Ongoing PM_{2.5} and AOD measurements in urban areas:
 hourly, seasonal, and multi-year time spans
- Characterizing PM_{2.5} mass, composition at a single facility, using standardized methods
- Aerosol components show multi-site correlations, trends
- We encourage ideas for new partnerships. For more information, please visit **spartan-network.org**



SPARTAN is an IGACendorsed activity



SPARTAN is Funded by NSERC





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THANK YOU/DANKE SCHÖN



Dalhousie Co-op Students



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EXTRAS: SPARTAN DATA ONLINE



www.SPARTAN-network.org/interactive

EXTRAS



