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Modeling Dust Generation and Deposition

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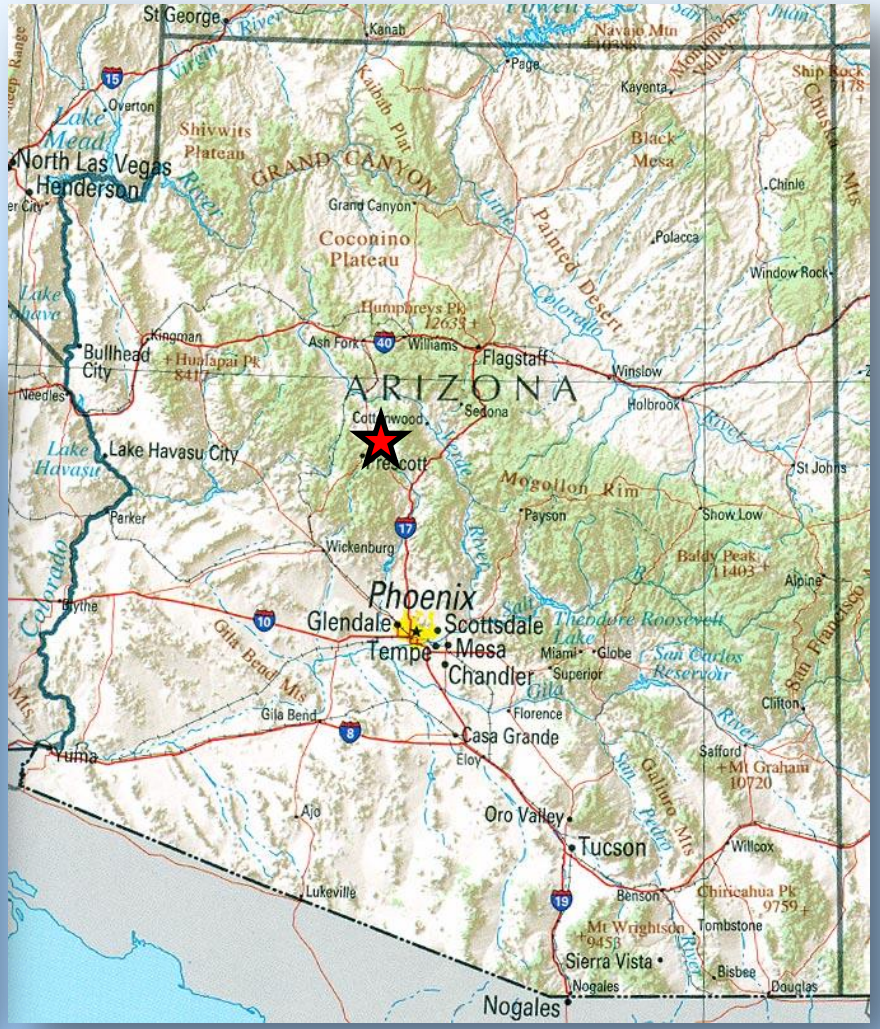
Motivation: The Iron King Site

Iron King tailings impoundment

- Superfund site since 2008
- Directly adjacent to the town of Dewey-Humboldt
- Highly contaminated (As, Pb)



Field site: Instrumentation

Eddy flux towers

- TSI DUSTTRAKs
- Anemometers
- Wind vanes
- Thermometers
- Hygrometers
- Soil moisture probe
- Soil radiometer

MOUDI

- Micro-Orifice Uniform-Deposit Impactor
- Particle Size Fractionation

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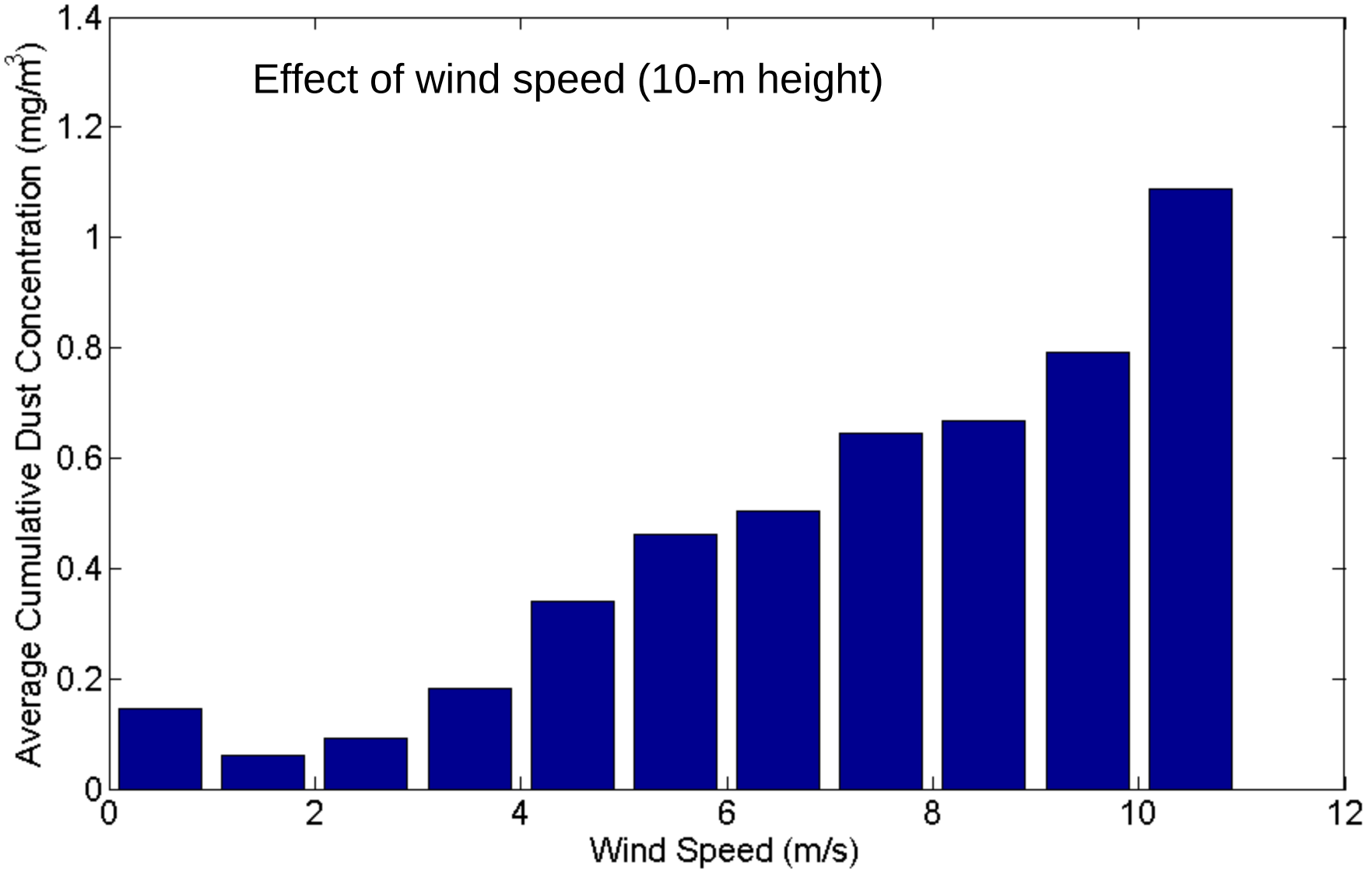
Dust Generation



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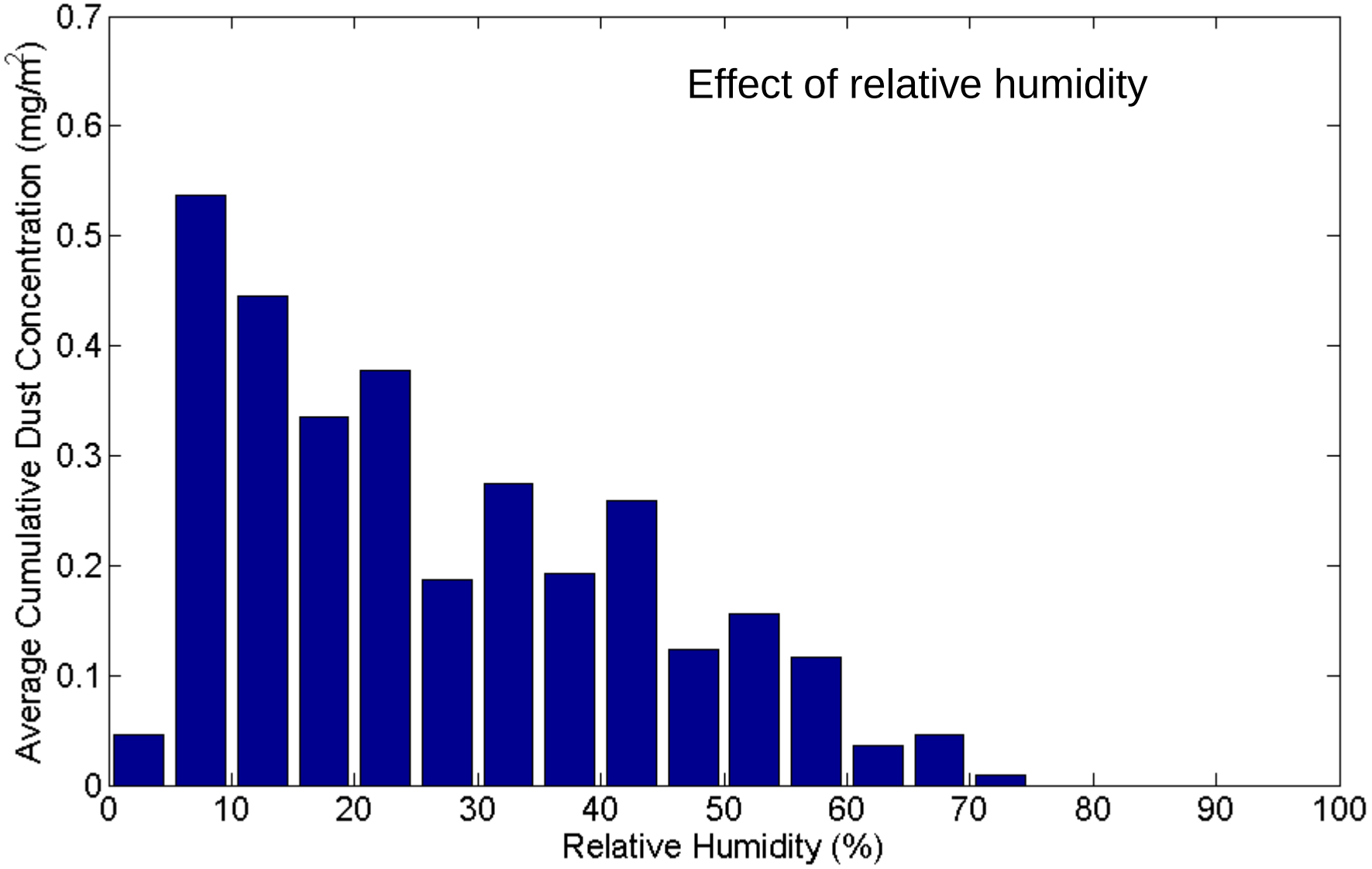
Dust Generation

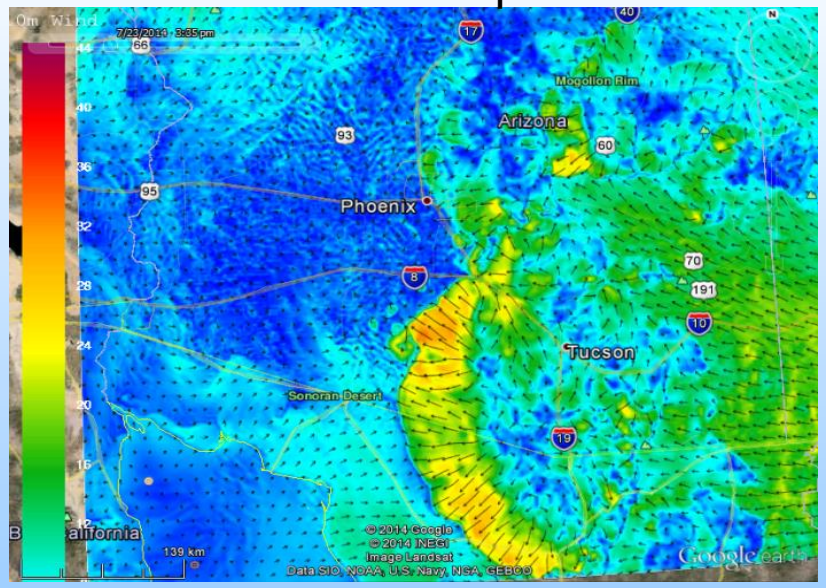


WRF Model

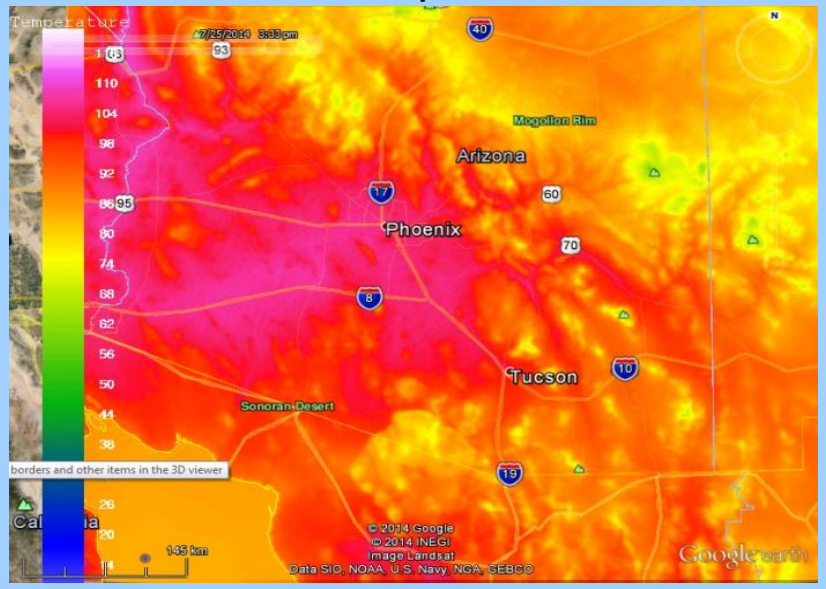
Initialization Weather Forecast

- Operational WRF model
  - 1.8-km spatial resolution (inner domain)
  - Hourly temporal resolution
- Analysis of WRF surface output
  - 10-m Wind Velocity
  - 2-m Temperature
  - 2-m Specific Humidity
  - Surface Pressure

10-m wind speed



2-m temperature



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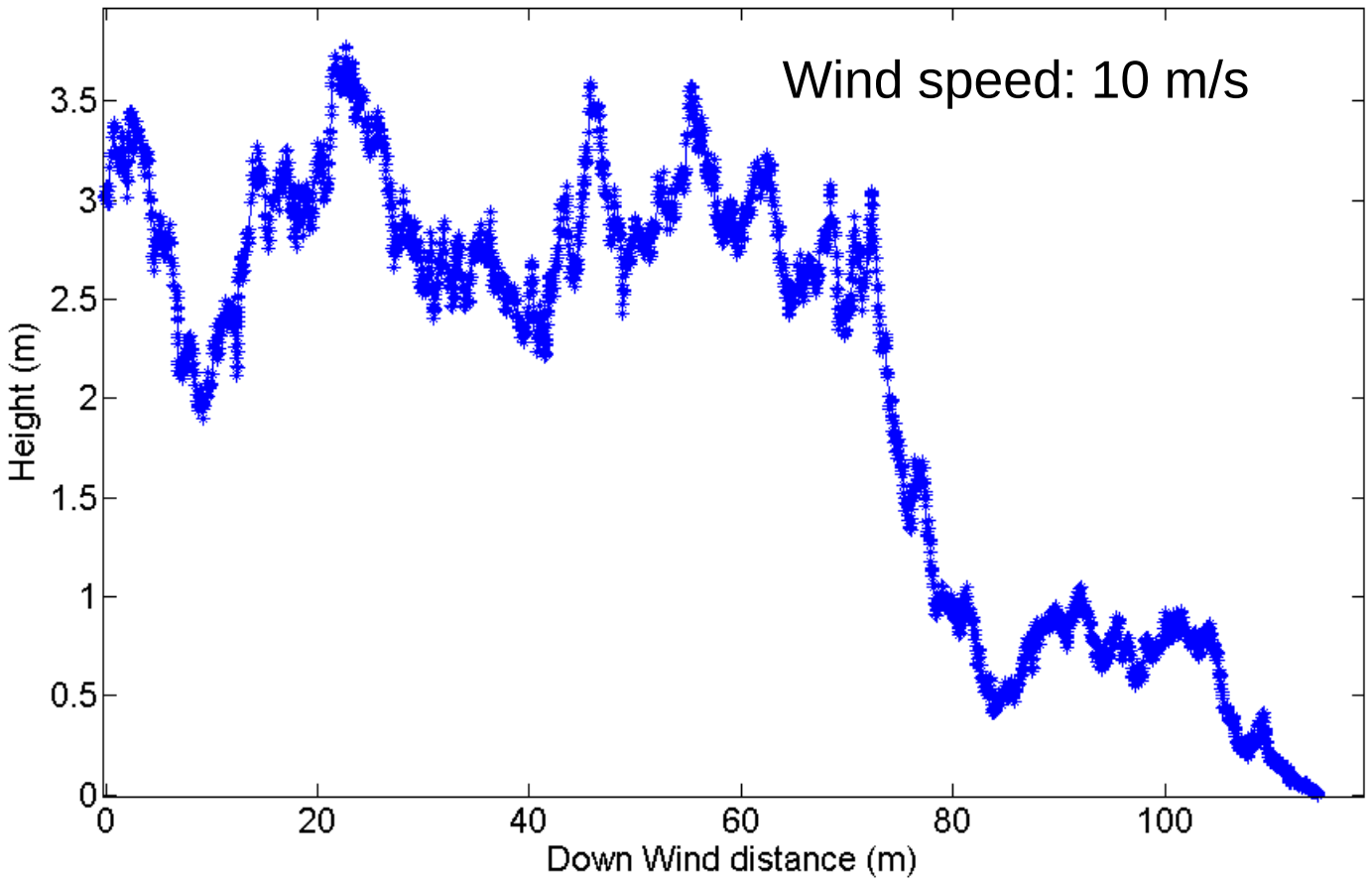
Particle Trajectories



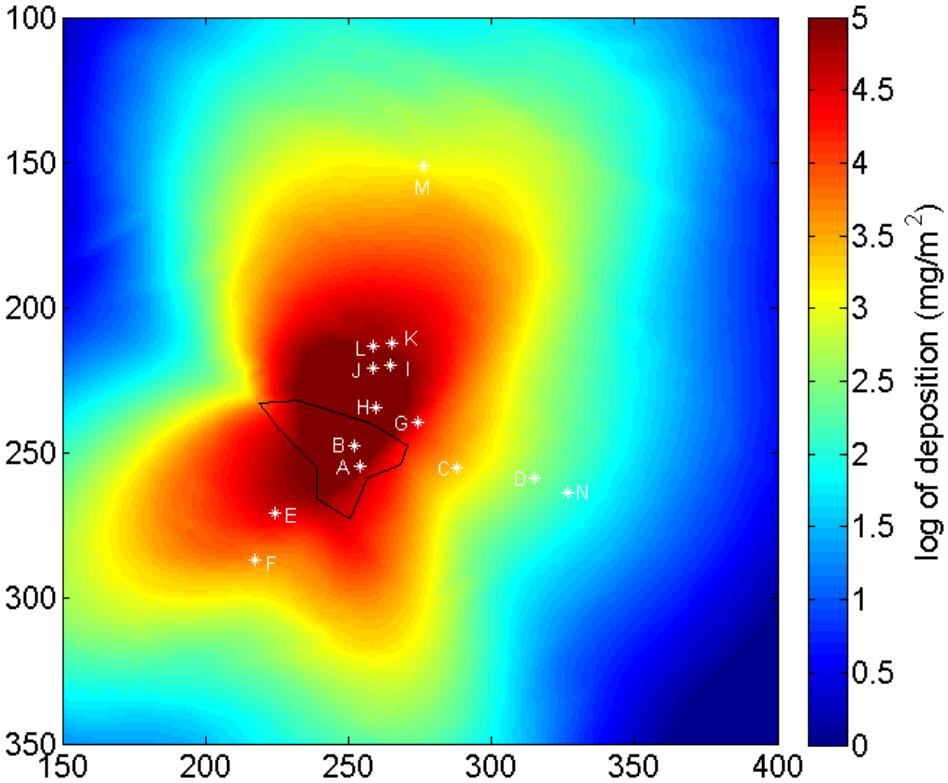
Equations of motion for individual particles coupled to WRF model predictions allow for determination of particle trajectories. Example: 10-μm particle

Deposition Forecasting Model

In situ verification

- Inverted-disc (Frisbee) samplers
  - Weight
  - Chemical composition
  - Lead isotopes
- Month long sampling campaigns
  - May and June, 2014

DFM results for May 2014

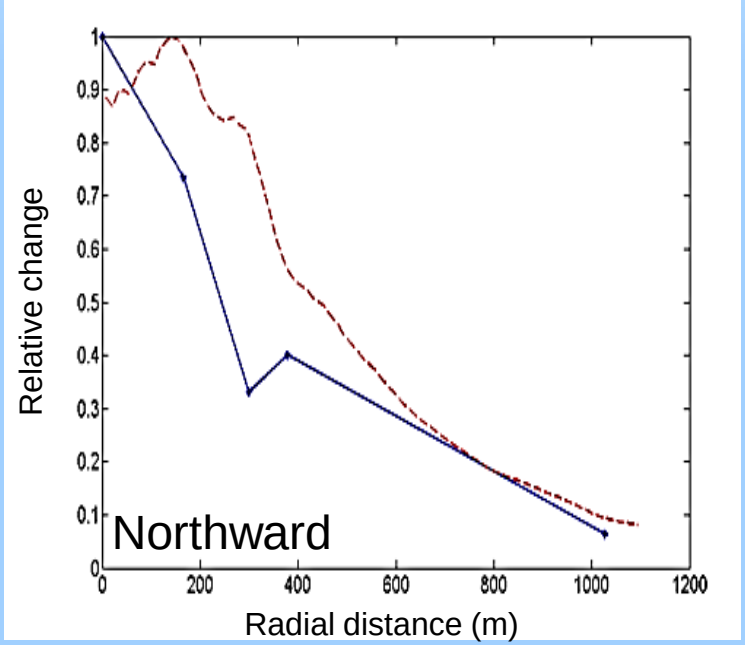


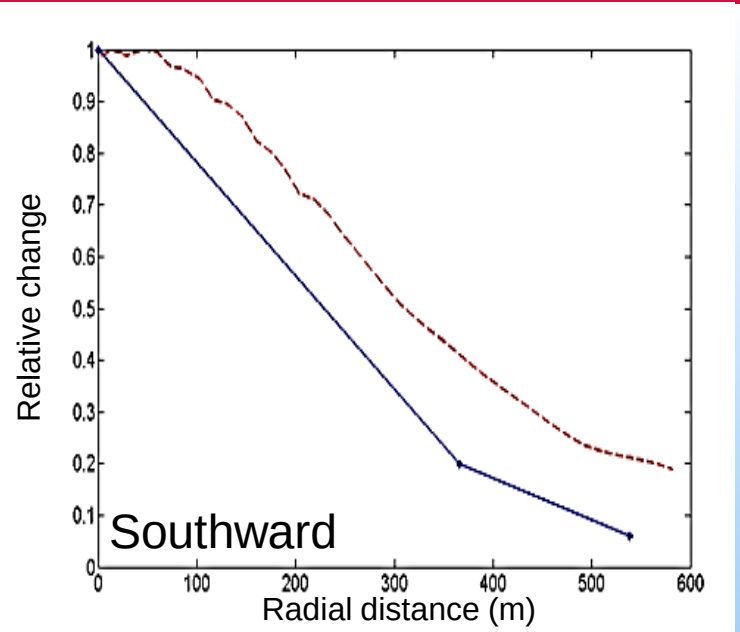
Inverted-disc sampling results

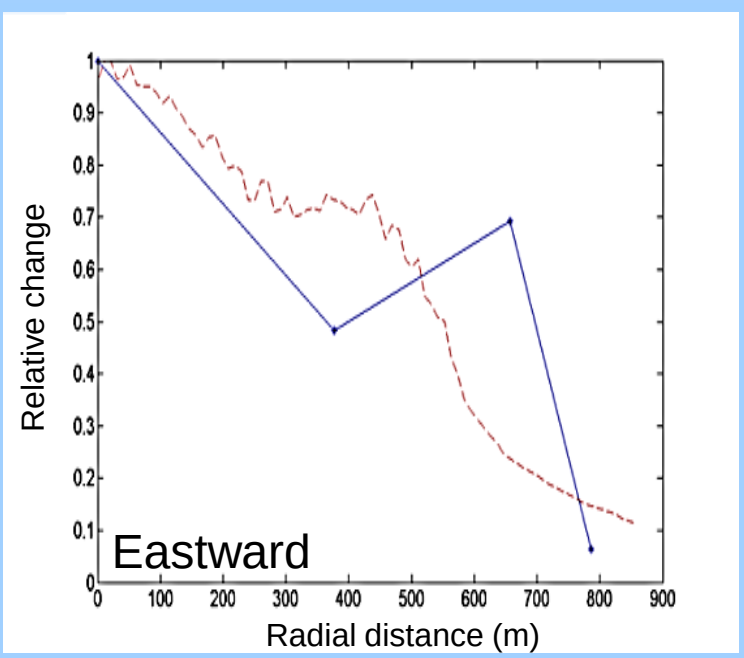
Model (DFM PM27)

vs

Observed (lead concentration)







Conclusions

1. The deposition forecasting model can be used to predict transport and deposition of PM_{27} tailings dust

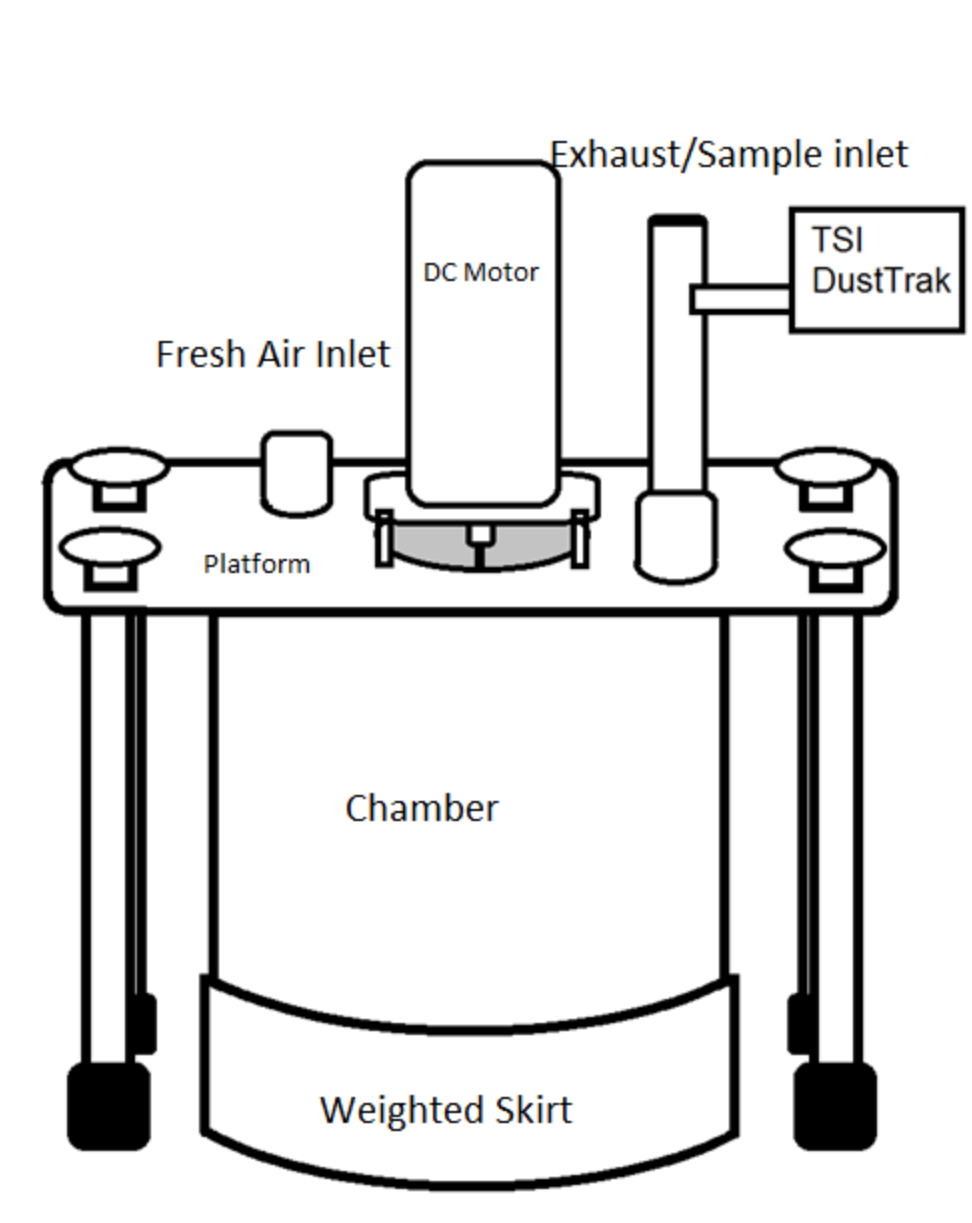
2. Arsenic and lead contaminants can be used as tailings dust tracers

3. DFM captured the spatial variations of the deposition patterns up to 1 km distance from the tailings

Next: Develop a realistic model for dust generation.

First step: Measurement of threshold friction velocities

Portable Dust Generator



- Based on PI-SWERL (Etyemezian et al., 2007)
- A rotating annular ring provides shear to generate dust
- Wind speeds measured by a calibrated Irwin sensor
- Objective: to measure threshold friction velocities for dust generation

PDG: Preliminary data