

HAQAST Tiger Team: High Resolution Particulate Matter Data for Improved Satellite-Based Assessments of Community Health

Pat Kinney, Frank Freedman, Susan O'Neill

Boston University

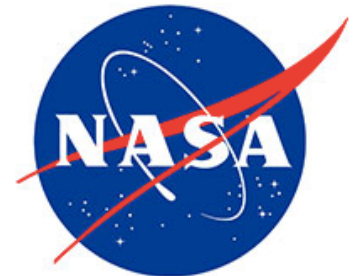
San Jose State University

USDA



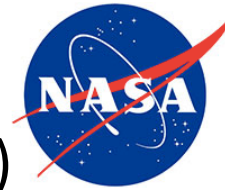
2016-2019

haqast.org



HAQAST Participants

- Pat Kinney (Boston University) and Frank Freedman (San Jose State Univ) – Co-Leads
- Mohammad Al-Hamden (NASA)
- Susan Anenberg (George Washington Univ.)
- Arlene Fiore (Columbia Univ.)
- Daven Henze (Univ. of Colorado – Boulder)
- Jeremy Hess (Univ. of Washington)
- Yang Liu (Emory Univ.)
- Susan O'Neill (US Forest Service)
- Daniel Tong (George Mason Univ.)
- Akula Venkatram (UC Riverside)
- Mark Zondlo (Princeton Univ.)



University
of Colorado
Boulder

EMORY UNIVERSITY

ROLLINS
SCHOOL OF
PUBLIC
HEALTH



SCHOOL OF PUBLIC HEALTH
UNIVERSITY of WASHINGTON



PRINCETON
UNIVERSITY



External Partners

- **Massachusetts Department of Environmental Protection**
 - Thomas McGrath, Chief, MassDEP Air Assessment Branch
- **Boston Department of the Environment**
 - Carl Spector, Director
- **Harvard School of Public Health**
 - Petros Koutrakis, Professor
- **New York City Department of Health and Mental Hygiene**
 - Iyad Kheirbek, Director, Air Quality Program
- **Queens College**
 - Holger Eisl, Barry Commoner Center for Health and the Environment
- **South Coast Air Quality Management District**
 - Sang-Mi Lee (Planning, Rule Development & Area Sources)
- **California Department of Public Health**
 - Paul English (California Environmental Health Tracking Program)
 - Jeff Wagner (Environmental Health Laboratory Branch)
- **California Air Resources Board**
 - Cynthia Garcia (Research Division)
- **Wildland Fire Air Quality Response Program**
 - USFS and NPS Leadership



Objectives

1. Pilot test and validate a novel low-cost sensor for long-term monitoring of $PM_{2.5}$, including elemental composition.

Boston, NYC, San Francisco Bay Area, Seattle

2. Generate hi-resolution $PM_{2.5}$ concentration maps using 1 km MAIAC MODIS/AOD retrievals, surface measurements, land use data, (and air dispersion modeling)*.

Boston, NYC, Los Angeles Basin, Imperial Valley CA

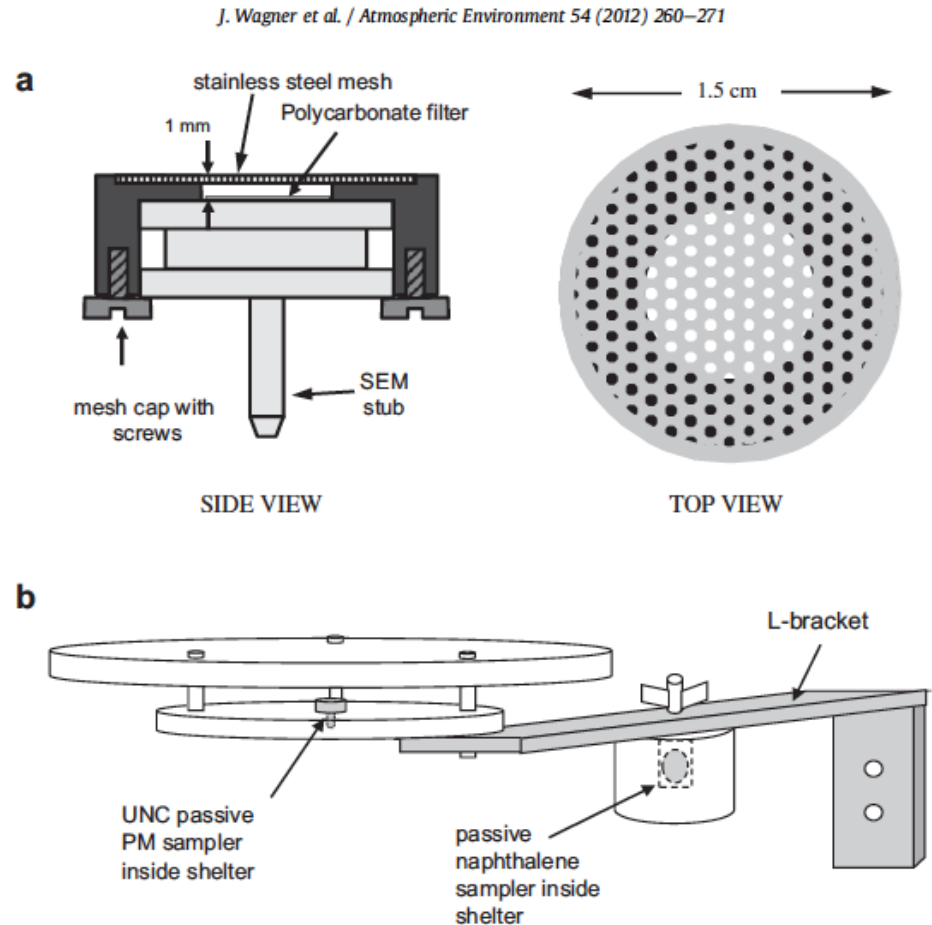
3. Optimize “BlueSky” hi-res smoke dispersion modeling for wildfire PM impacts using 1 km AOD and surface measurements.

Potential wildfire case studies: Rim (2013), King (2014), Klamath and Rough (2015), Sand 2016

4. Compute hi-resolution health impacts of $PM_{2.5}$ based on outputs from above objectives.

Objective 1. Pilot test and validate a low-cost sensor for long-term monitoring of PM_{2.5}

- Most low cost PM sensors are designed for real-time continuous monitoring, and face challenges in measuring reliable, long-term average PM_{2.5} concentrations
- The UNC passive sampler is a simple device that collects particles by gravitational settling and diffusion
- Filters are analyzed for particle size and composition using electron microscopy
- Has been validated for coarse PM, but hasn't been tested extensively for fine PM (PM_{2.5})

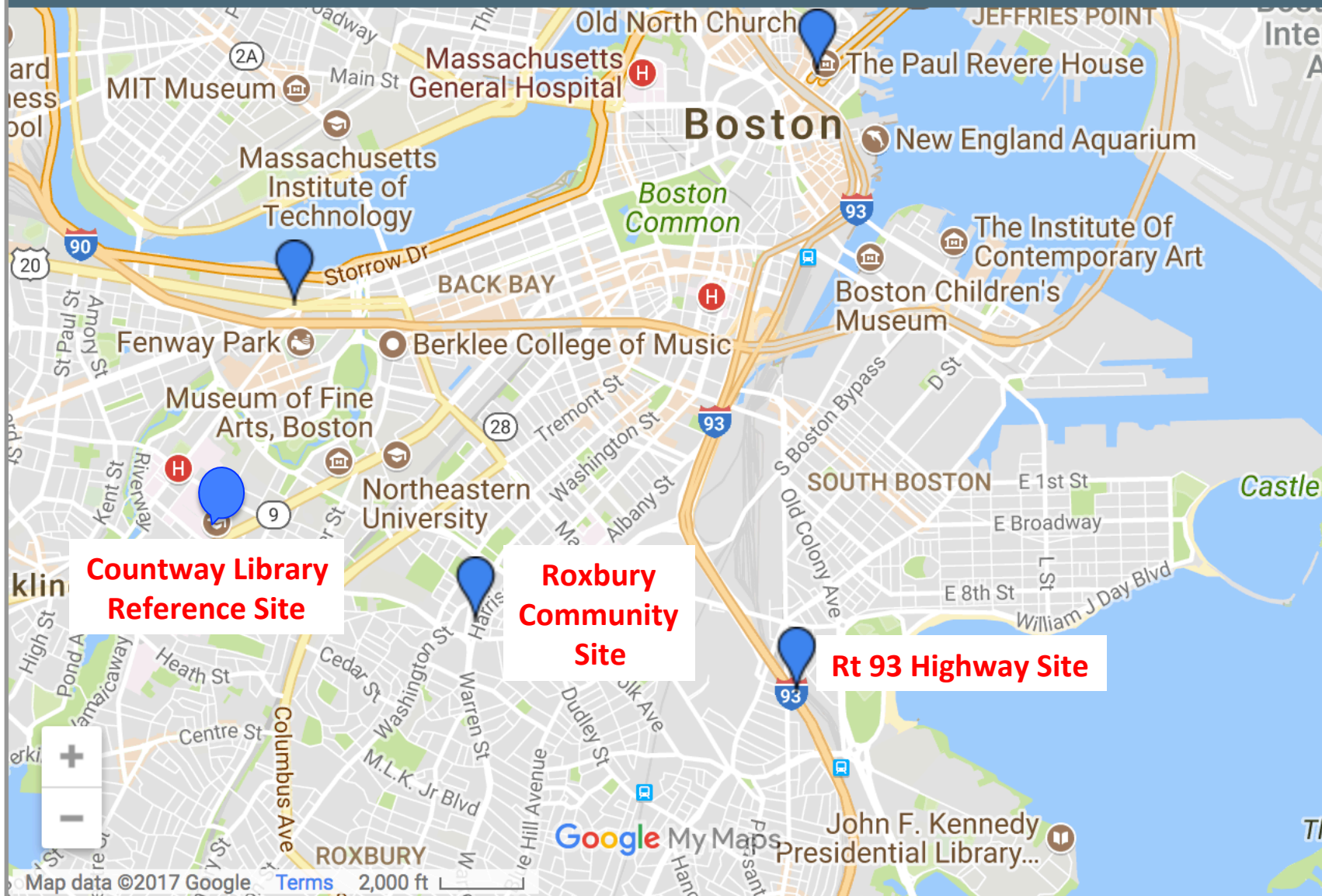


Sampling Strategy

1. Co-locate UNC passive samplers at existing PM_{2.5} monitoring sites in Boston, NYC, San Francisco Bay Area, Seattle, ...
2. Collect sequential monthly and 3-month integrated samples for up to one year.
 1. Two vertical orientations: gravitation vs. diffusion dominated sampling
3. Samples analyzed by electron microscopy:
 1. Count, size and elementally characterize each particle
 2. Estimate PM_{2.5} mass concentration, overall and by components
4. Retrieve PM and elemental composition data from co-located federal reference and speciation monitors
5. Compare monthly, quarterly and longer-term averages from low-cost sampler vs. reference samplers
 1. Aiming for < ±30% accuracy



MA Air Monitoring Stations ★



Rt 93 Mass DEP Site Setup



Objective 2. Generate hi-resolution PM_{2.5} concentration maps using 1 km MAIAC MODIS/AOD retrievals, surface measurements, land use data, and air dispersion modeling

Datasets:

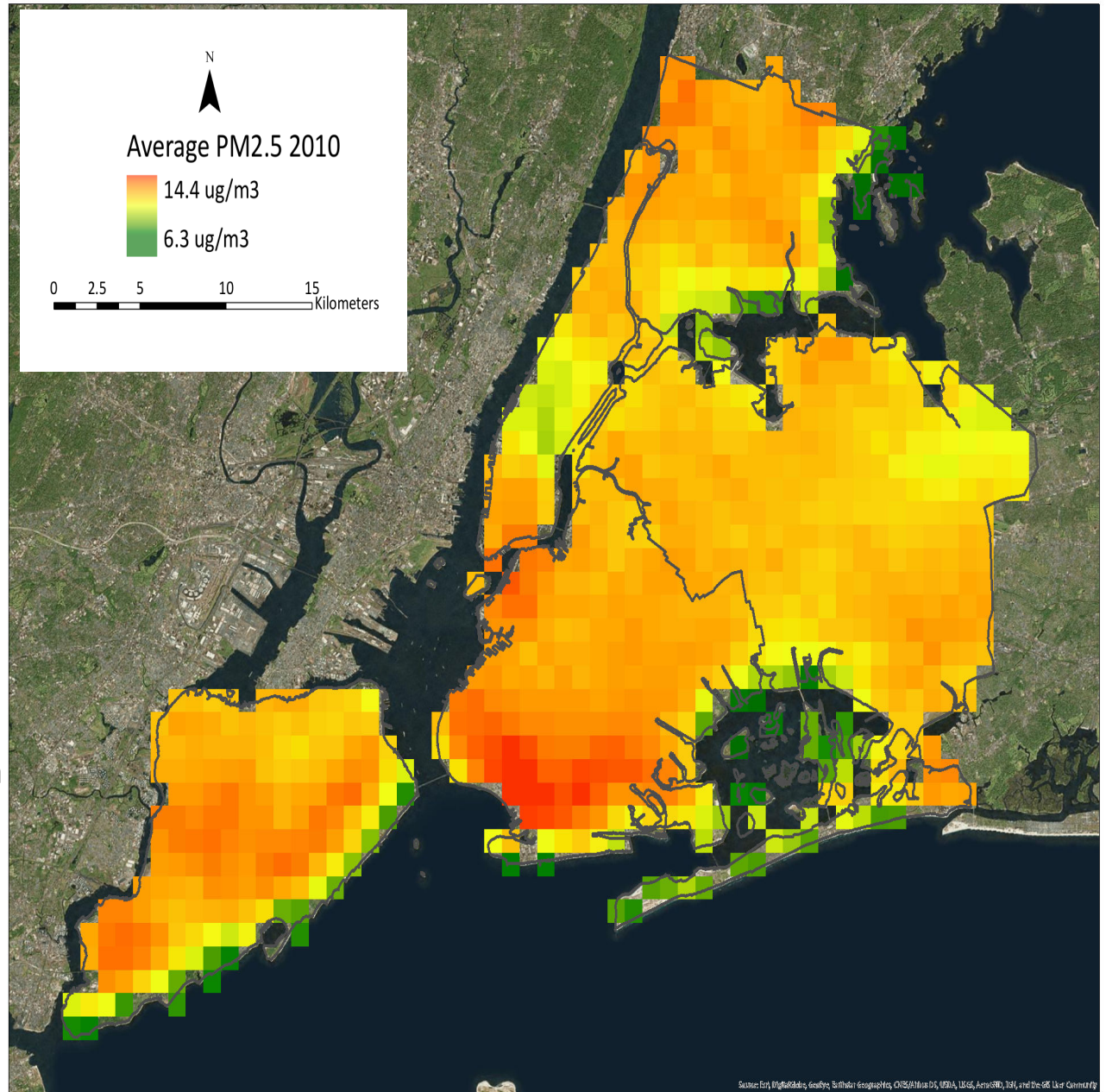
- EPA PM_{2.5} Measurements
- MAIAC AOD Product
- MODIS Fire Count Data
- Meteorological Fields (NLDAS)
- Elevation Data
- Major Roads
- Forest Cover
- PM_{2.5} Point Emissions

Slide courtesy of Yang Liu

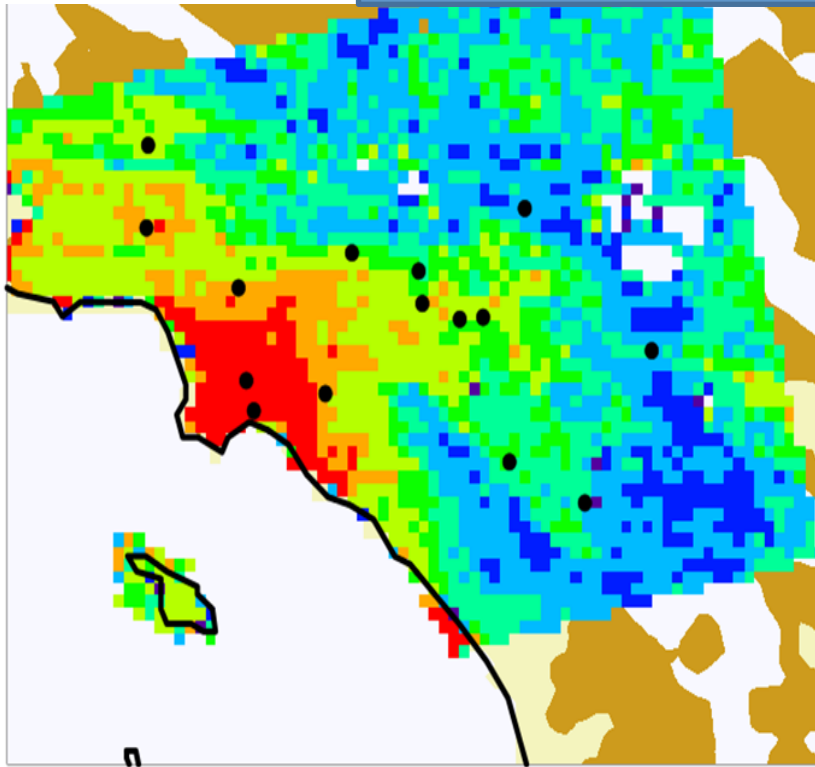


PM_{2.5} 2010 Average for NYC at 0.01 degree (~1km x 1km resolution).

Source: van Donkelaar, A., R.V Martin, M.Brauer, N. C. Hsu, R. A. Kahn, R. C Levy, A. Lyapustin, A. M. Sayer, and D. M Winker, **Global Estimates of Fine Particulate Matter using a Combined Geophysical-Statistical Method with Information from Satellites, Models, and Monitors**, *Environ. Sci. Technol*, doi: 10.1021/acs.est.5b05833, 2016. [\[Link\]](#)



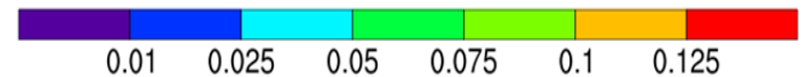
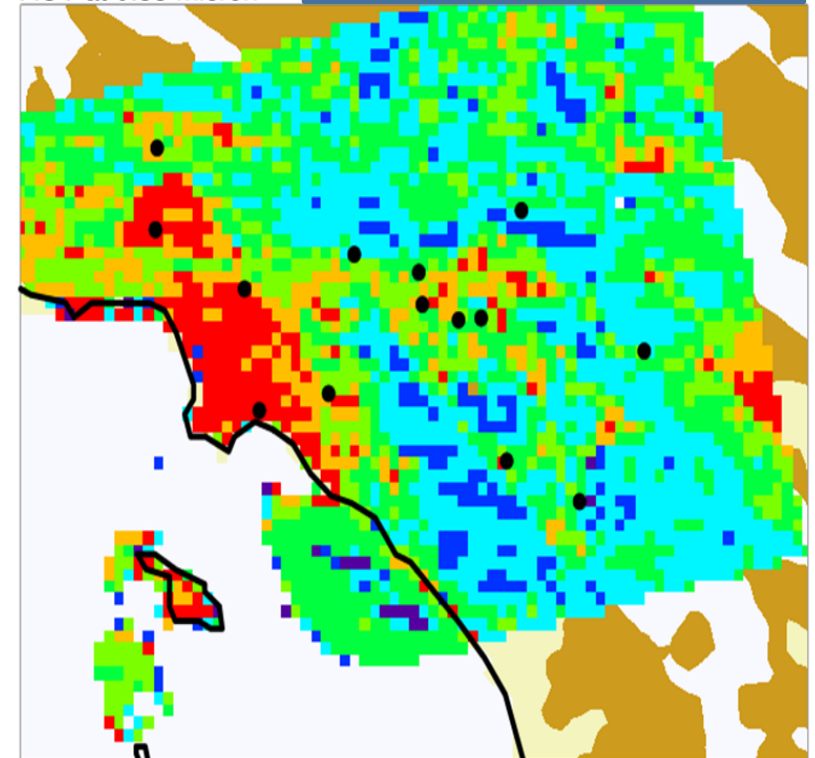
Feb. 4, 2015
TERRA (1845 GMT)



MAIAC AOD
(1-km retrievals)

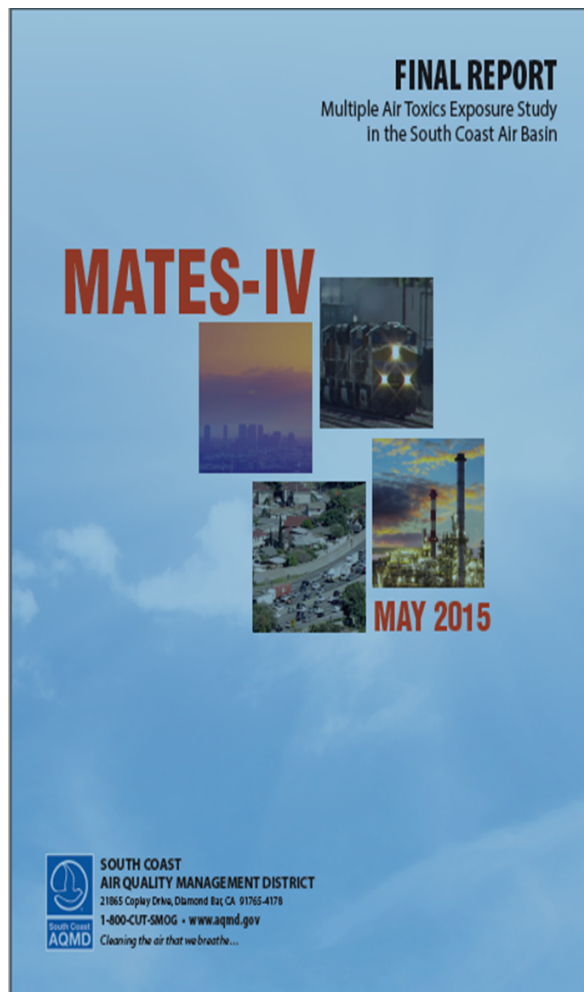
November 5, 2016
TERRA (1845 GMT)

AOT at 0.55 micron



MAIAC AOD
(1-km pixels)

Support for MATES V (HAQAST ↔ SCAQMD)



Background

- **MATES IV** Air Toxics Risk Assessment Study (Released May 2015)
- SCAQMD preparing MATES V
- Community scale risk assessment planned
- Interest in higher Resolution PM surfaces & satellite support

Tiger Team Activity

- Generate MAIAC 1-km PM_{2.5} surfaces over Southern California
- Key HAQAST Participants: Yang Liu, Mohammad Al-Hamdan
- Method: Hu et al. 2014: Remote Sens. Environ. 2014, 140, 220–232.

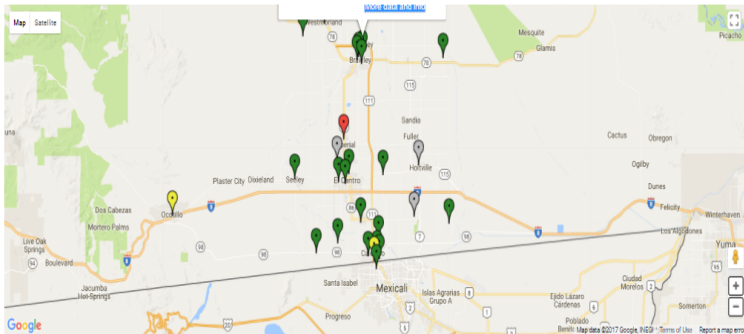
Support for Imperial Valley / U.S. Mexican Border PM Activities (HAQAST ↔ CalDPH & CARB)

re <https://ivan-imperial.org/air/map>

Map of Monitors

Select a monitor location on the map for more information about current air quality at that location. Learn what the Community Air-Quality Level (CAL) colors mean. Gray monitors are [offline](#).

Sunday, November 26, 2017 at 03:59 PM



<https://ivan-imperial.org/air>

Background

- **IVAN:** 40 low-cost PM_{2.5} and PM₁₀ air monitors
- Throughout Imperial County.
- Motivated by community health concerns.
- Developed through community group & multi-agency partnership ([Comite Civico del Valle](#), [California Env Health Tracking Program](#), [University of Washington School of Public Health](#) ...)

Tiger Team Activity

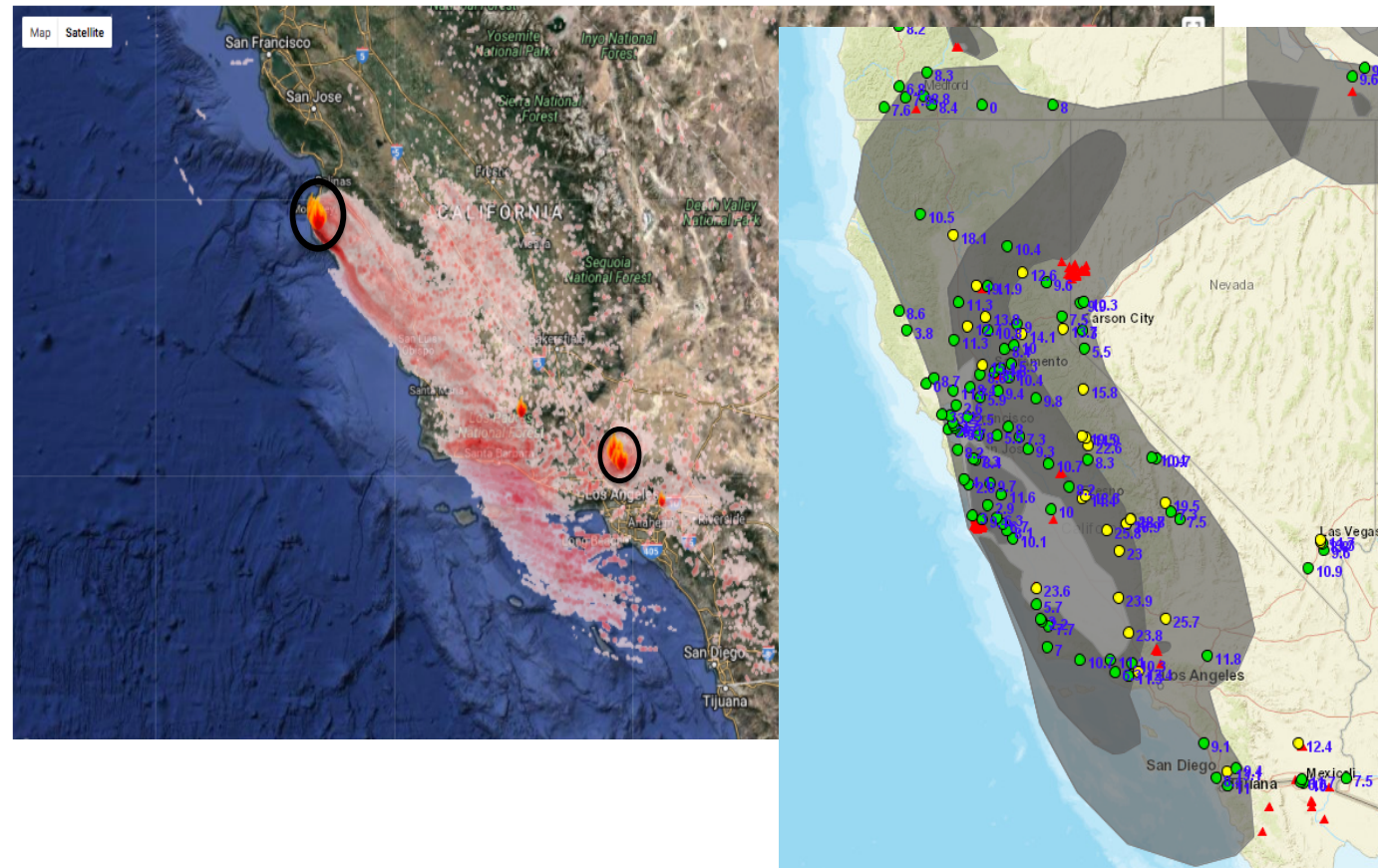
- MAIAC satellite & Dispersion Modeling support
- Understand measurements -> better discern local sources
- Key HAQAST Participants: Y. Liu, F. Freedman, A.Venkatram
- Methods (satellite): Hu et al. (2014)
- Methods (dispersion modeling): Venkatram and Horst (2006) & Pournazeri et al. (2014)

Sand Wildfire, Soberanes Wildfire July 28, 2016

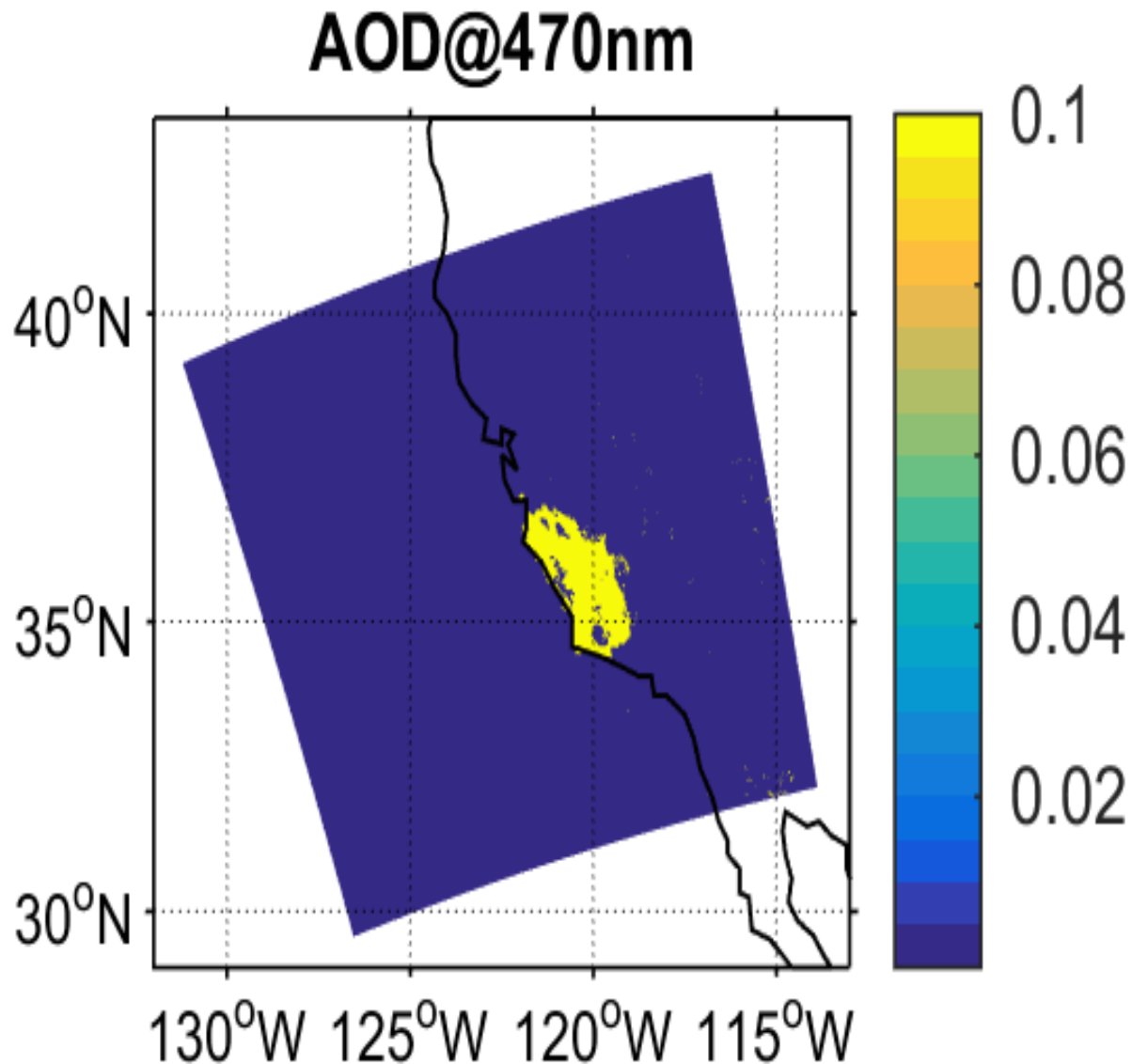
- BlueSky Forecast 1-hr $\text{PM}_{2.5}$ Concentrations
- EPA AIRNOWTech 24-hr $\text{PM}_{2.5}$ Concentrations
- NOAA Hazard Mapping System Smoke Plume Analysis

CANV 2km 72hrs BlueSky Daily Run initialized at 2016-07-27 00Z and run for 71hours

7/28/2016 14:00 Pacific Daylight Saving



MAIAC Aqua July 28, 2016



Current Status and Next Steps

1. **Low-cost sensors:**
 - Partnerships established with relevant air monitoring agencies
 - 3 sites in Boston set up in August.
 - 2 sites in NYC set up in October.
 - 3 sites in Bay area to be set up this month.
 - Seattle setups to be discussed.
 - Initial analytical data should be forthcoming
2. **Initial Phone meetings** have been held between HAQAST participants and California and NYC stakeholders regarding satellite PM work
 - **Spatial and temporal domains for satellite-based PM discussed**
3. **Research Assistant – Maria Castillo** - being hired at BU to coordinate low cost sensor sampling, data analysis, and communications
4. **Doctoral student – Xiaomeng Jin** -at Columbia helping with webinar scheduling and note taking
5. **Doctoral student – Raquel Jimenez Celsi** - at Boston University is obtaining and processing land use and remote sensing data for Boston and NYC
6. **Health impact methods being developed Susan Anenberg**
 - **Will test methods over winter using preliminary concentration data**
 - **Final estimates in spring 2018 pending completion of PM surfaces**