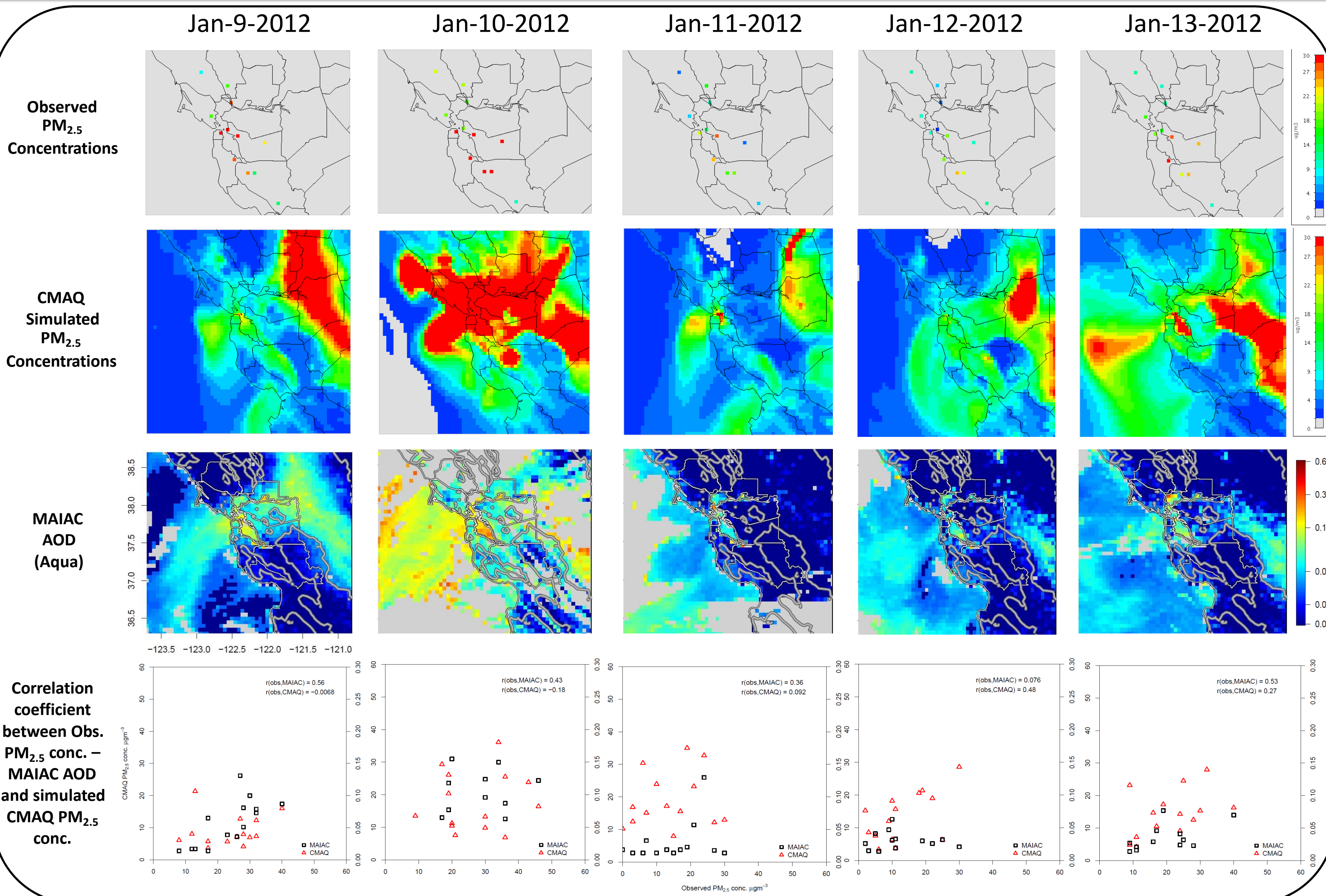# Utilizing Satellite-Based Observations to Improve PM$_{2.5}$ Simulations for Air Quality Management and Health Impact Assessment in the San Francisco Bay Area

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Columns: Jan-9-2012, Jan-10-2012, Jan-11-2012, Jan-12-2012, Jan-13-2012

Rows:
- Observed PM$_{2.5}$ Concentrations
- CMAQ Simulated PM$_{2.5}$ Concentrations
- MAIAC AOD (Aqua)
- Correlation coefficient between Obs. PM$_{2.5}$ conc. – MAIAC AOD and simulated CMAQ PM$_{2.5}$ conc.

Correlation values:
- Jan-9-2012: r(obs,MAIAC) = 0.56, r(obs,CMAQ) = −0.0068
- Jan-10-2012: r(obs,MAIAC) = 0.43, r(obs,CMAQ) = −0.18
- Jan-11-2012: r(obs,MAIAC) = 0.36, r(obs,CMAQ) = 0.092
- Jan-12-2012: r(obs,MAIAC) = 0.076, r(obs,CMAQ) = 0.48
- Jan-13-2012: r(obs,MAIAC) = 0.53, r(obs,CMAQ) = 0.27

Motivation
The Bay Area features a complex terrain and emission patterns. As a result, PM$_{2.5}$ concentrations vary daily from location to location. Though the District's modeling domain covers the entire Bay Area, uncertainty exists in the regional CMAQ* simulated PM$_{2.5}$ concentrations.

Summary
This work presents progress on a collaborative pilot study between BAAQMD, HAQAST and NASA ARC scientists to demonstrate how 1-km satellite-based MAIAC** AOD data can be used to support BAAQMD's air quality management and health risk evaluation. For the first phase of the study, satellite AOD data was processed for a five-day cloud-free period (January 9-13, 2012) when PM$_{2.5}$ was relatively high across the Bay area, AOD spatial coverage was largely complete, and a reasonable raw linear correlation exists between AOD and PM$_{2.5}$ measurements. For these selected days, CMAQ simulated PM$_{2.5}$ concentrations and AOD were compared against observed PM$_{2.5}$ values in the Bay Area to determine the predictive skill of both the model and the AOD. This first-phase case-study analysis will then provide guidance for the second phase, which will evaluate CMAQ performance using a mixed-effects statistical model for estimating PM$_{2.5}$ based on a longer series of wintertime AOD and PM$_{2.5}$ observations. WRF*** model outputs and the MAIAC Water Vapor variable will be used to convert the total column AOD measurements to 2D. The goal of the second phase is to determine more comprehensively whether the predictive skill of an advanced MAIAC-based AOD analysis for winter PM$_{2.5}$ conditions in the Bay Area is sufficient to be used to guide improvements to BAAQMD CMAQ modeling, improve input emission estimates, and be incorporated alongside CMAQ fields into health-risk analyses at data-sparse areas of the San Francisco Bay Area.

*CMAQ - Community Multiscale Air Quality Modeling System (EPA)   **MAIAC – MultiAngle Implementation of atmospheric Correction   ***WRF – Weather Research and Forecasting