# Identifying Communities of Vulnerability: Using NASA Earth Observations to Enhance Public Health Tracking of Particle Exposure and Extreme Heat Events in Los Angeles, CA

by

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EXT. SCENE. DAY - VON KARMAN BLDG. 181.

It is early afternoon, on a sunny day in Southern California at the Jet Propulsion Laboratory.  The three participants, KATRINA, ASYA, and CAITLIN of NASA's DEVELOP JPL Program stand in the Von Karman Visitor's Space museum.  All are dressed in business casual clothing, smiling at the camera.

SHOT - FULL (ALSO TRY MEDIUM)

CAITLIN
Hello!

ASYA
And good day!

KATRINA
We are part of the NASA DEVELOP Applied Sciences National Program here at the Jet Propulsion Laboratory in California.

SHOT - PPT SLIDE #1

PPT of Title.

KATRINA (VOICE OVER)
Our Summer 2011 Project is titled: Identifying Communities of Vulnerability: Using NASA Earth Observations to Enhance Public Health Tracking of Particle Exposure and Extreme Heat Events in Los Angeles.

EXT. SCENE. DAY.  BACK IN FRONT OF VON KARMAN VISITOR CENTER. 301

SHOT - MEDIUM

CAITLIN
We worked under the guidance of our science advisors, and would like to thank Benjamin Holt and Dr. David Diner and the MISR team here at the Jet Propulsion Laboratory.

KATRINA

We would also like to acknowledge our end users: The City of Los Angeles, the Los Angeles Conservation Corps, and the Los Angeles Department of Public Health.

STOCK FOOTAGE OF TRAFFIC AND SMOG IN LOS ANGELES

According to the 2011 American Lung Association's State of the Air Report, Los Angeles ranks as the number one most polluted city in the United States for ozone. LA is also ranked in the top four most polluted cities for both short term and year round particle pollution. Air quality is of great concern to our community.

Studies such as those by Gauderman et al from 2007, and Jerrett et al from 2008, link poor air quality with an increased risk of adverse health effects such as asthma. Satellite derived measurements would be especially useful in air pollution studies, since the concentration of interest can change by orders of magnitude over small distances. With current remote sensing technologies, it is difficult to predict pollution levels within small areas.

EXT. SCENE. DAY.  ARROYO SECO BRIDGE

ASYA reports, news-style, to the camera.

SHOT - MEDIUM PAN TO ASYA

ASYA

Ringed by the Santa Monica, Santa Ana, and San Gabriel—Mountains, LA extends straight out to the Pacific Ocean. And, according to the 2010 US Census Report, has roughly 10 millions people making it the second largest metropolitan area in the United States.

INT. SCENE. DAY. BLDG 300- 314E, DEVELOP OFFICE

GIRLS WORKING ON THE COMPUTER AND DISCUSSING RESULTS.

SHOT - MEDIUM DOLLY

KATRINA

The objective of our study, was to enhance the decision making process of our partners in identifying communities susceptible to such major public health concerns in Los Angeles. Together, our end users are taking lead roles in the interagency, government-wide and non-profit response efforts to address such public health concerns.

Our project fits within NASA's Applied Sciences Public Health and Air Quality Applications.

INT. SCENE. DAY. BLDG 168, MISR HALLWAY

KATRINA enters the frame, with the MISR poster in the background.

SHOT - MEDIUM DOLLY

We focused on two satellite remote sensors, MISR, aboard the TERRA satellite, which stands for the Multi-Angle Imaging Spectroradiometer for its L1 radiance measurements, as well as Landsat 5's Thematic Mapper, in order to calculate NDVI.

SHOT - PPT of Study Area with EPA sites or similar.

CAITLIN (VOICE OVER)
We combined these two with data taken from EPA Air Pollution Monitoring sites, SCAG Parks Data, and 2010 US Census Tract level data.

INT. SCENE. DAY. BLDG 168, MISR HALLWAY

SHOT - MEDIUM, ASYA AND CAITLIN WALKING TO MISR TEAM MEETING ROM.

SHOT - FOOTAGE OF DEVELOP SPEAKING WITH MISR TEAM.

KATRINA (VOICE OVER)
The MISR Team at JPL provided us with radiance measurements taken over a 1km by 1km area around each of our EPA stations of interest. There were 13 such stations located throughout our study area. We looked at data taken from the entire year of 2009, as well as through the summer months of June - August of 2000 - 2009, when air pollution was likely to be at its worst due to high temperatures, low amounts of rainfall, and strong inversion layers.

INT. SCENE. DAY. BLDG 300-314E.

CAITLIN is seen sitting at her desk, consulting with our science advisor, BEN.

SHOT - MEDIUM

KATRINA (VOICE OVER)
Comparing MISR radiance measurements to PM2.5 measurements taken from our 13 EPA stations, we used ArcMap to format the data tables.

We then ran linear regression models using R statistical software on a station to station basis, and then over all stations to identify a possible linear relationship between our L1 radiance satellite data and the EPA ground measurements.

INT. SCENE. DAY. JPL HUB LIBRARY.

ASYA

Our regressions presented us with a mystery. Regressions ran from station to station were a much better fit than regressions ran for all 13 stations together. However, this made sense because air pollution varies greatly over small distances.

R-squared accounts for the measure how well our linear regression approximate real EPA PM2.5 data points.

However, our models taken from January through December of 2009 was a much better fit than summer months of 2000 through 2009.

Also, certain stations showed a much better fit than other stations. What could cause this?

SHOT(S) - PPT of Excel Graphs [dialogue subject to change]

CAITLIN (VOICE OVER)

To solve this mystery, we refined our regressions. First, we took out all measurements for days where the skies were cloudy, assuming that this may affect MISR's accuracy. This improved our predictions for all dates and stations.

We then plotted weight versus channel to see if certain MISR bands had stronger associations with measured PM2.5 than others and therefore should be a focus.

Finally, we investigated why certain stations had better models than others, and why taking all the summer months together was a worse prediction than just the year 2009.

SHOT(S) - PPT of NDVI and Excel Visuals [dialogue subject to change]

CAITLIN (VOICE OVER)

To get to the heart of this issue, we calculated NDVI around each of our 13 stations. We did this to see if green-space played a role in how accurately MISR could predict air pollution.

We also wanted to see if only a portion of our data was throwing off the rest, such as a single "bad" year. Thus, we took our model and applied it to each summer individually. Summer months proved to have low R-squared values. However, 2009 had a better value than all the other years.

INT. SCENE. DAY. JPL HUB LIBRARY.

KATRINA is sitting on the orange couch and tables.

SHOT - MEDIUM

KATRINA

But let's not forget the important issue of heat stress. After conducting an intensive literature review, we were able to identify certain demographic factors that have been associated with greater susceptibility to heat stress as well as asthma.

SHOT(S) - PPT of Demographic Data

CAITLIN (VOICE OVER)

All census data was acquired from the recently released results from the 2010 US Census. Census tract 2010 TIGER files were downloaded through the US Census portal. NDVI results and census data were combined to generate a map characterizing overall vulnerability to health risks by census tract within the study region.

Since socioeconomic status plays a role in a community's vulnerability to heat, it is an important variable to consider for this project.

Using ArcGIS, we conducted a multicriteria analysis using all variables to identify census tracts that would have populations most vulnerable to health risks. Risk factors, from 0 to 8, were determined based on the mean value for each variable within a census tract compared to the global mean for all census tracts within the study area.

When we finally finished running our regression models on our MISR L1 and EPA PM2.5 data, we found some interesting results. Though we were expecting certain wavelengths, such as the near infrared, to contribute more strongly to the prediction capabilities, no discernible pattern existed among the MISR channel weights.

In addition, NDVI values within a 1-mile radius and 5-mile radius were not associated with the R-squared value. However, MISR radiances did a good job at predicting PM2.5 for the year 2009, with R-squared values above 0.93 for individual station models. Models did not perform as well when data from summer months between 2000 and 2009 were combined.

KATRINA (VOICE OVER)

Air pollution varies greatly over small distances. Thus, models are more accurate when regressions are run on a station to station basis instead of together. Clouds impede MISR's ability to accurately predict air pollution, and thus measurements gathered from cloudy days should be factored out.

Future work will involve the investigation using different months and years in order to refine our regression model. We almost must factor in meteorological variables of the Los Angeles basin in order the better understand and assess heat stress and air quality. Additional US Census tract data from 2010 must be collected to give a broader picture of all areas of susceptibility.

Errors and uncertainty include resolving the differences in point measurements versus area measurements. And finally, further investigation must be conducted into the average measurements of EPA stations versus instantaneous measurements of MISR.

Remote sensing continues to play a larger role in the public health sector. Future work is needed to refine our model and to apply it to larger study areas. As always, we hope the community will continue to be involved with our research applicable to many societal benefit areas.

Ultimately, this is Earth science in service to society. We reside in Los Angeles, along with 10 million other people. We breathe this air everyday and we want to improve the community's health and safety. The goal is to serve as that bridge between science and the public. What will be the future of Earth observations? How will our work affect the community in the long run? Over the next few decades? These are questions we seek to solve.

EXT. SCENE. DAY. "WELCOME TO OUR UNIVERSE" SIGNAGE AT THE FRONT OF JPL.

SHOT - MEDIUM.  NASA sign in background.

CAITLIN

This concludes our Summer 2011 DEVELOP Project at the Jet Propulsion Laboratory. We hope you enjoyed our presentation, and thanks for stopping by!