

# Air Quality: An Interface Between Environment, Climate Change and Public Health.

S.M. Mack<sup>1</sup>, K. Bein<sup>1</sup>, Q. Zhang<sup>1</sup>, C.F. Vogel<sup>1</sup>, Humberto Lugo<sup>2</sup>, Maria Garcia<sup>3</sup>, K.E. Pinkerton<sup>1</sup>

<sup>1</sup>University of California, Davis – Davis, CA/US, <sup>2</sup>Comite Civico del Valle – Brawley, CA/US, <sup>3</sup>Calipatria High School – Calipatria, CA/US



## Introduction

In recent years, Imperial County has consistently ranked as the top California County with the highest incidence of asthma in children. Community members are concerned their breathing problems are due to one or more of many sources of pollution that contaminate Imperial Valley (IV). Our goal is to investigate the differences between, and potential harmfulness of airborne particles to which IV residents are exposed. **We hypothesize** different sources and size fractions of particulate matter (PM) in the Imperial Valley will produce differential effects of cellular toxicity.

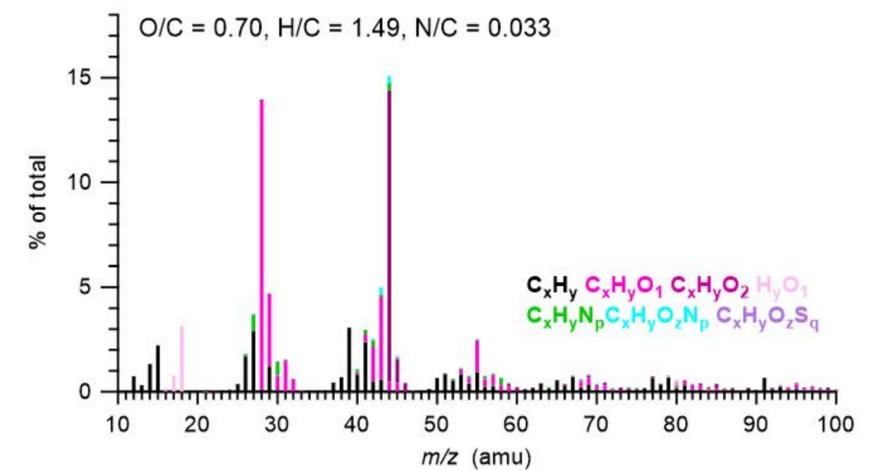
To keep this project community-based, we have established the following:

- Partnership with public health organization, *Comite Civico del Valle*
- Community advisory board
- Collaboration with local high school
- Summer internship at UC Davis (Figure 1: summer internship 2018)



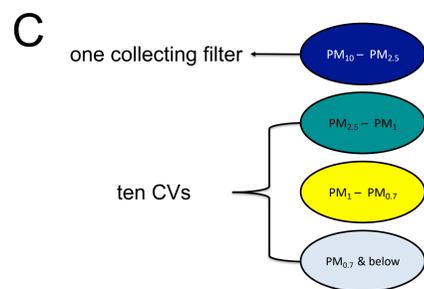
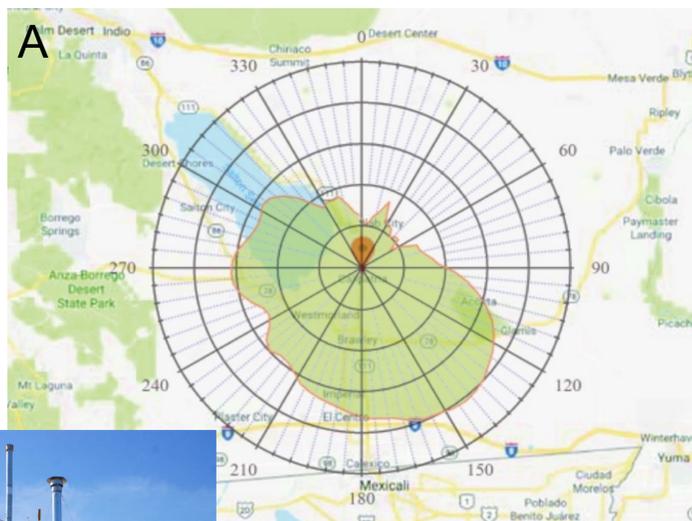
## In vitro Screening: Gene Expression

## Chemical Characterization

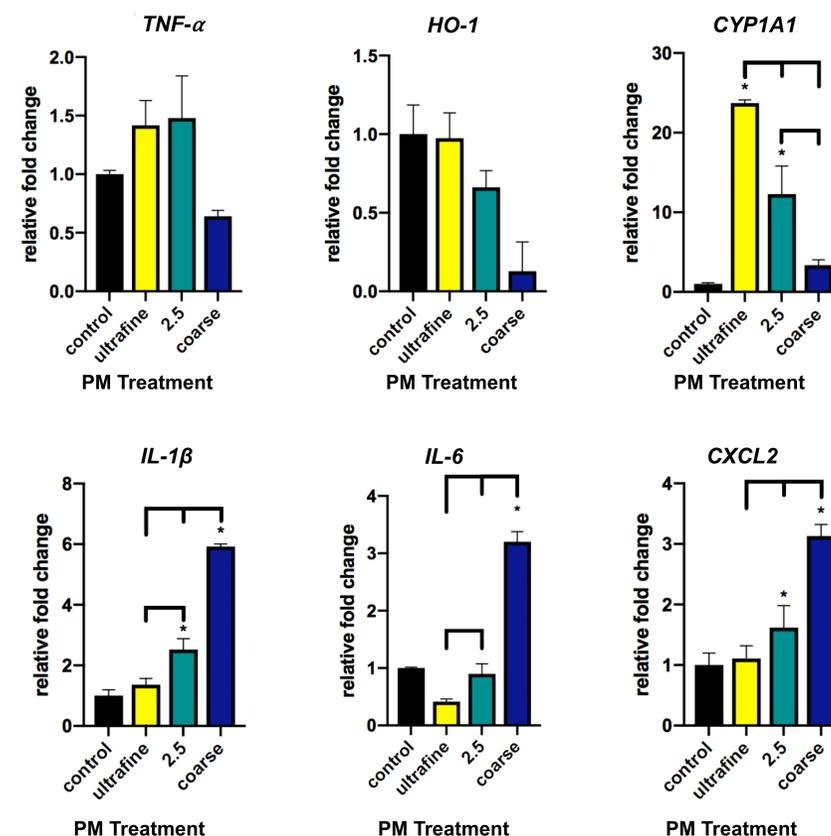


**Figure 4:** Overview of the chemical composition of organic ultrafine particles. Analysis was performed on an aqueous suspension using High-Resolution Time-of-Flight Aerosol Mass Spectrometry. The average atomic ratios of oxygen-to-carbon (O/C), hydrogen-to-carbon (H/C), nitrogen-to-carbon (N/C) in the ONP are displayed in the legend.

## Wind-Directed Sampling



**Figure 2:** **A)** Polar graph of the natural logarithm of the frequency of observed wind speeds greater than 2 m/s as a function of wind direction overlaid on a map of the Imperial Valley, centered about Calipatria. These data were obtained from a mobile sampler **(B)** deployed on the Calipatria High School campus. **C)** PM samples are collected in four different size fractions in 10 separate ChemVols (CVs). The coarse PM fraction is collected onto a single filter before separation into the separate CVs.



**Figure 3:** Gene expression results from quantitative polymerase chain reaction (qPCR). Toxicity and inflammatory-related primers, *TNF-α*, *HO-1*, *IL-1β*, *CYP1a1*, *CXCL2*, and *IL-6* were measured for differences from control and between size fractions. Asterisks (\*) indicate significant difference from control, and brackets indicate significant difference between groups. Measured by a one-way ANOVA and Tukey's multiple comparisons test p value < .001

## Results and Conclusions

The chemical composition of the organic ultrafine particles is highly complex, likely composed of hundreds of carbon-containing compounds. The preliminary results from the chemical analysis indicate:

- ammonium sulfate (37%)
- organic species (58%)
  - $C_xH_yO_z^+$  ion families (59%)
  - $C_xH_y^+$  ion family (34%)
  - nitrogen-containing ions (i.e.,  $C_xH_yN^+$ ,  $C_xH_yO_zN_p^+$ ) (7%)

This breakdown suggests the presence of amines, nitro, or other organic nitrogen compounds. The high average degree of oxidation and the high organic nitrogen contents suggest that this PM is likely toxic and could a major culprit for the health problems in the region.

The gene expression results indicate that the larger size fractions of PM induce an inflammatory response, whereas the smaller size fractions show a trend toward a toxic response. The high expression of *CYP1a1* in the ultrafine fraction indicates the presence of polycyclic aromatic hydrocarbons (PAHs). Further investigation will be done to identify the specific PAHs and look into a potential mechanism involving the aryl-hydrocarbon receptor.

These overall data indicate clear differences in response based upon the size of PM. Further chemical characterization of larger size fractions as well as a comparative in vivo study will be done to corroborate these findings.

## Acknowledgements

Thanks to staff and students in the The Pinkerton Lab, staff at Comite Civico Del Valle, and Calipatria High School. Photos and map from google images and Dr. Keith Bein

Funding Sources: NIEHS P30 ES023513, NIEHS T32 ES007059, NIOSH U54 OH07550