SPATIO-TEMPORAL ANALYSIS OF AEROSOL OPTICAL DEPTH IN THE TWO MOST POLLUTED METROPOLITANS

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Objective

This study aims to shed new light upon how temporal and spatial patterns of AOD respond to the dynamic urban environment.

(Los Angeles Metropolitan Area, and Phoenix Metropolitan Area)

1. both areas are among the most polluted areas in terms of air pollution (U.S. EPA, 2015) in the Northern America;

2. they are geographically close to each other but have different surrounding environment;

3. a comparative long-term spatio-temporal AOD analysis over these two areas is absent; and

4. potential negative AOD-PM association in this region.
Study areas: (a) the LAMA and (b) the PMA, and locations of monitoring stations
MODIS Terra Atmosphere Aerosol Level 2 Product (MOD04_3K)
• Spatial resolution of 3 km starting from February 24, 2000
• It has been validated globally (Livingston et al., 2014; Remer et al., 2013)

Historical daily PM$_{10}$ and PM$_{2.5}$ data collected by local environmental monitoring stations were retrieved from the US-EPA.


2001 & 2011 NLCD data were used to generate percent Built-Up areas.

Temporal Pattern of Monthly Mean AOD values

(a) LA

(b) Phoenix
Relationship between Monthly Mean AOD of LA and PHX
Trends of annual mean AOD in (a) LAMA and (b) PMA

(a) LA

(b) Phoenix
Spatial Pattern of Mean AOD for 2001–2015

(a) LA  
(b) Phoenix
## Comparison of measured PMs concentrations and components

<table>
<thead>
<tr>
<th></th>
<th>LAMA</th>
<th>PMA</th>
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<tbody>
<tr>
<td>Mean PM$_{2.5}$ concentration ($\mu g/m^3$)</td>
<td>14.806</td>
<td>7.741</td>
</tr>
<tr>
<td>Mean PM$_{10}$ concentration ($\mu g/m^3$)</td>
<td>34.698</td>
<td>35.922</td>
</tr>
<tr>
<td>Mean difference between concentrations of PM$<em>{2.5}$ and PM$</em>{10}$ ($\mu g/m^3$)</td>
<td>19.700</td>
<td>28.181</td>
</tr>
<tr>
<td>Fine mode aerosol ratio (%)</td>
<td>42.670</td>
<td>21.551</td>
</tr>
<tr>
<td>Mean AOD</td>
<td>0.152</td>
<td>0.173</td>
</tr>
</tbody>
</table>
Relationships between mean AOD over the entire study period and elevation (asl)

(a) LA

(b) Phoenix
Relationships between Mean AOD and Percent Built-up

(a) LA

\[ y = 4.9 \times 10^{-5} x + 0.153 \]
\[ R^2 = 0.008, \ p\text{-}value < 0.05 \]

(b) Phoenix

\[ y = -7.8 \times 10^{-5} x + 0.180 \]
\[ R^2 = 0.015, \ p\text{-}value < 0.01 \]
Relationships between Mean AOD and NDVI

(a) LA

\[ y = -0.025x + 0.161 \]
\[ R^2 = 0.003, p\text{-value} > 0.05 \]

(b) Phoenix

\[ y = -0.308x + 0.239 \]
\[ R^2 = 0.030, p\text{-value} < 0.05 \]
Relationships between AOD and Measured PMs

(a) LA

- Monthly Mean AOD in the LAMA vs. Monthly Mean PM$_{2.5}$
  - Linear regression: $y = 0.001x + 0.144$
  - $R^2 = 0.002$, p-value > 0.05

(b) Phoenix

- Monthly Mean AOD in the PMA vs. Monthly Mean PM$_{2.5}$
  - Linear regression: $y = -0.006x + 0.217$
  - $R^2 = 0.028$, p-value < 0.05

- Monthly Mean AOD in the LAMA vs. Monthly Mean PM$_{10}$
  - Linear regression: $y = -0.002x + 0.081$
  - $R^2 = 0.134$, p-value < 0.01

- Monthly Mean AOD in the PMA vs. Monthly Mean PM$_{10}$
  - Linear regression: $y = 0.001x + 0.151$
  - $R^2 = 0.011$, p-value > 0.05
Conclusion

- Strong similarity is found between the temporal trends of AOD in the two study areas, as a result of similar seasonal pattern of both natural and anthropogenic aerosol emissions.

- The correlation shows that the topography strongly modulates the AOD spatial pattern.

- Urbanization can be beneficial to air quality in desert areas.

- The effect of vegetation on lowering air pollution via dry and wet depositions can outweigh its potential organic emissions.

- No strong positive AOD-PM$_{2.5}$ associations is observed, and AOD in Phoenix is even strong negatively correlated with PM$_{2.5}$ measurements.

Thank you!