A Study of Organic Compounds in Haboob Particulate Matter

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Introduction

Each July marks the beginning of the summer monsoon season in the southwestern United States. In Phoenix, thunderstorms are frequently preceded by dust storms, or haboobs. Haboobs suspend sand and dust in the air, allowing them to commingle with urban particulate matter (PM).

The chemical composition of haboob dust is not well known and it remains unclear whether the composition of haboob dust significantly impacts background urban PM. Comparisons of the carbonaceous compositions of background urban PM and haboob PM can provide useful information regarding potential mutual sources as well as potential scavenging and agglomeration activity during dust storms.

Experimental Procedures

Sample Collection

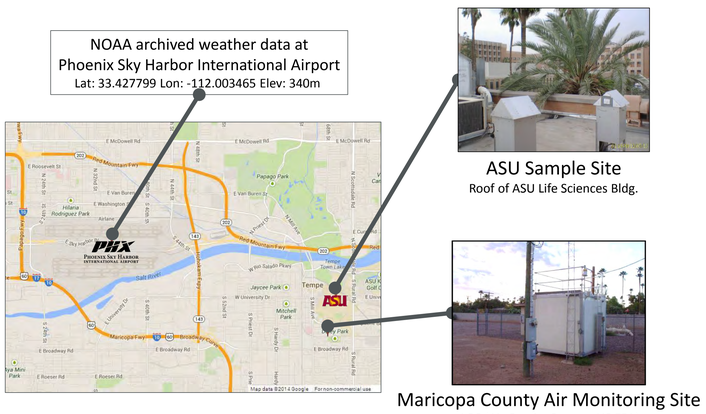
Haboob PM and background urban PM samples were collected during the July 2013 – September 2013 monsoon season at the ASU campus in Tempe, Arizona using high-volume aerosol samplers.

Analysis

PM2.5 fractions (PM with aerodynamic diameters less than 2.5 micrometers) were analyzed by thermal optical transmittance (TOT) to determine differences in atmospheric concentrations of organic and elemental carbon in background urban PM and haboob PM. The samples were then analyzed by GC/MS to identify polycyclic aromatic hydrocarbons (PAH). The PM>2.5 fractions (PM with aerodynamic diameters greater than 2.5 micrometers) were analyzed by TOT to determine differences in atmospheric concentrations of total carbon in background urban PM and haboob PM.

Weather Data

Weather and air quality data were obtained from NOAA and the US EPA Air Quality System at two locations close to the Tempe ASU campus (see map below).

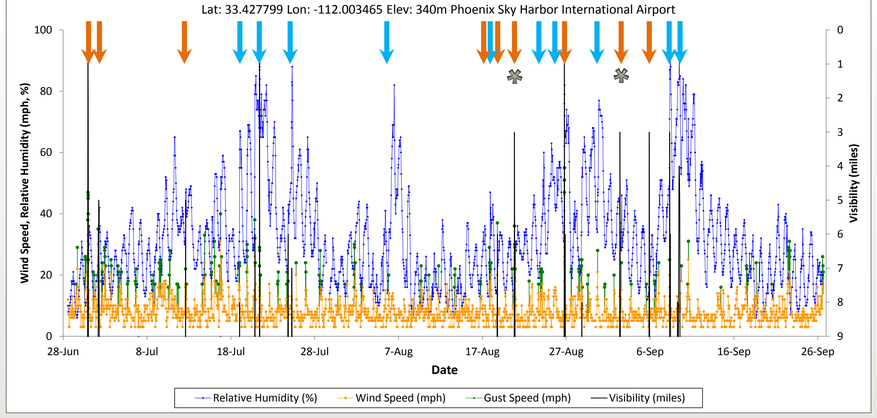


ASU Sample Site
Roof of ASU Life Sciences Bldg.

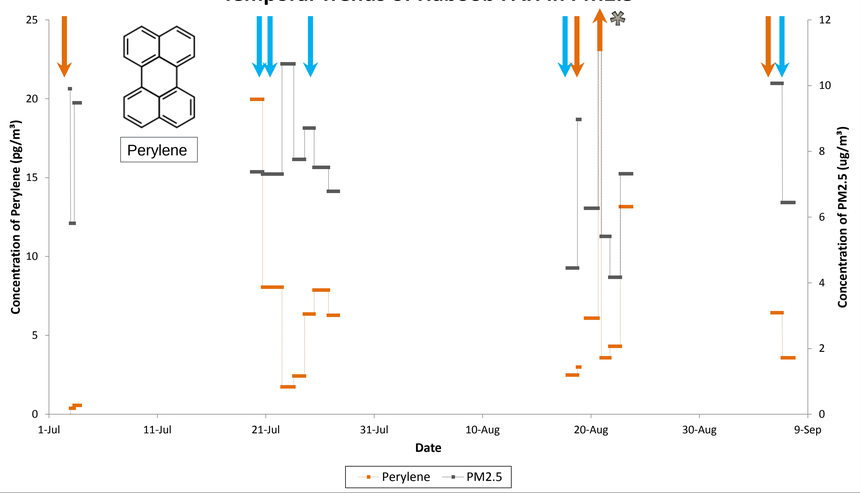
Maricopa County Air Monitoring Site
AQS (Air Quality System, US EPA)
AQS Site ID: 04-013-4004
Lat: 33.4124 Lon: -111.93474 Elev: 352m

Weather Conditions (US NOAA)

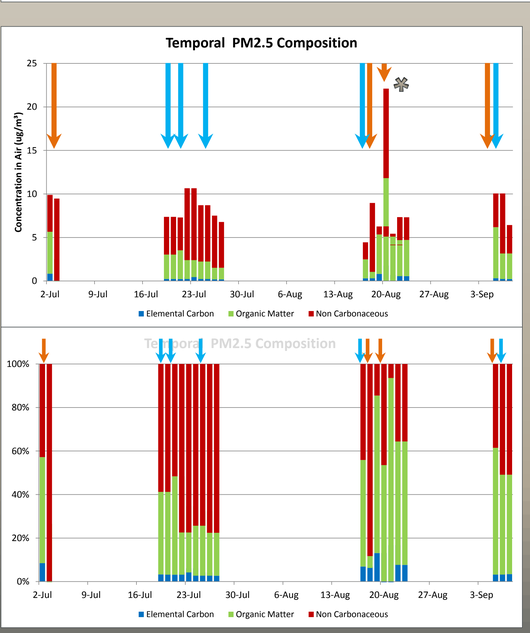
Lat: 33.427799 Lon: -112.003465 Elev: 340m Phoenix Sky Harbor International Airport



Temporal Trends of Haboob PAH in PM2.5



Temporal PM2.5 Composition



Legend

- Rain
- Haboob (Dust storm)
- Haze

Photos

Above: A view of a high volume sampler with its lid open and the filter stage visible.
Right: An approaching Haboob on the horizon behind the buildings.

Above: View of high-volume samplers the day following a rain and thunder storm.

Main Observations

Haboob events are characterized by short spikes in PM2.5 and PM>2.5 concentrations. Following the event, concentrations go down to typical summer urban levels rather quickly. The PM2.5 shows small spikes during the Haboob events since most of the dust is in larger size fractions.

Elemental (EC) and Organic carbon (OC) are significant components on fine particulate matter (PM2.5) in Phoenix, AZ (approximately 10 – 60 %).

The relative contributions of OC and EC in PM2.5 decrease during most Haboob events, an indicator that most Haboob aerosol material is inorganic or non-carbonaceous, consistent with soil components.

The total carbon concentrations in PM>2.5 is low (often about 1ug/m³; data not shown). This is consistent with larger particulate matter consisting of mainly mineral soil dust. The PM>2.5 also did not change significantly during Haboob events.

Perylene, a 5 ring PAH from combustion sources and an example organic compound, is ubiquitous in urban air. Its concentration decreases during most Haboob events but then quickly goes back to typical levels. However, when hazy conditions preceded a dust event (annotated by ✱), the concentration of Perylene and PM2.5 increased significantly (74pg/m³ and 22ug/m³ respectively). Such an increase can be linked to resuspension of road and urban dust containing PAHs.

Rain events can also impact carbonaceous aerosol but did not seem to have altered the ratio of organic components to inorganic components in PM2.5.

Outlook on Further Experimental Work

Additional sample analyses are currently ongoing and chemical composition data will be available for more time periods.

The chemical analysis will be extended to other organic molecules that are used as tracers for specific carbonaceous aerosol sources including biogenic (plant and bacterial materials) as well as anthropogenic (vehicle emissions) or mixed (biomass burning).

Additional data analysis will be performed by combining organic and inorganic/metal aerosol data (see companion poster, Aurelie Marcotte *et. al.*)

Acknowledgments

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