Central Arizona-Phoenix Long-Term Ecological Research CAP LTER

Chemical characterization of time resolved haboob samples from Tempe, AZ

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Introduction

During the summer months in Arizona, very intense dust storms, or haboobs, can occur. A haboob formation occurs suddenly when fast moving downdrafts from dissipating thunderstorms hit the ground and, in arid regions, cause the resuspension of dust. This turbulent air mass travels at approximately 30 mph, can be up to 60 miles wide and are an average of 4 000 – 8 000 feet in height. These dust storms can last from minutes to hours and have the potential to alter the aerosol content greatly on short time scales[1]. Understanding haboobs is of great importance in the Phoenix area as they can increase particulate matter (PM) and bring an influx of PM material from other locations. Deposition of PM may alter soil and water chemistry in the affected areas. In this work, we chemically characterize haboobs and their effect on the air quality in the Phoenix area. During the summers of 2013 and 2014, $PM_{2.5}$ and $PM_{>2.5}$ aerosol samples were collected on the Arizona State University Tempe Campus. Samples were collected before, during, and after haboobs to determine the time resolved effect of haboobs on PM in the Phoenix area. Samples were analyzed for trace metals by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and soluble iron content by a ferrozine/UV-Vis method.

Figure 1 shows a July 2011 haboob in Phoenix, AZ.

Experimental

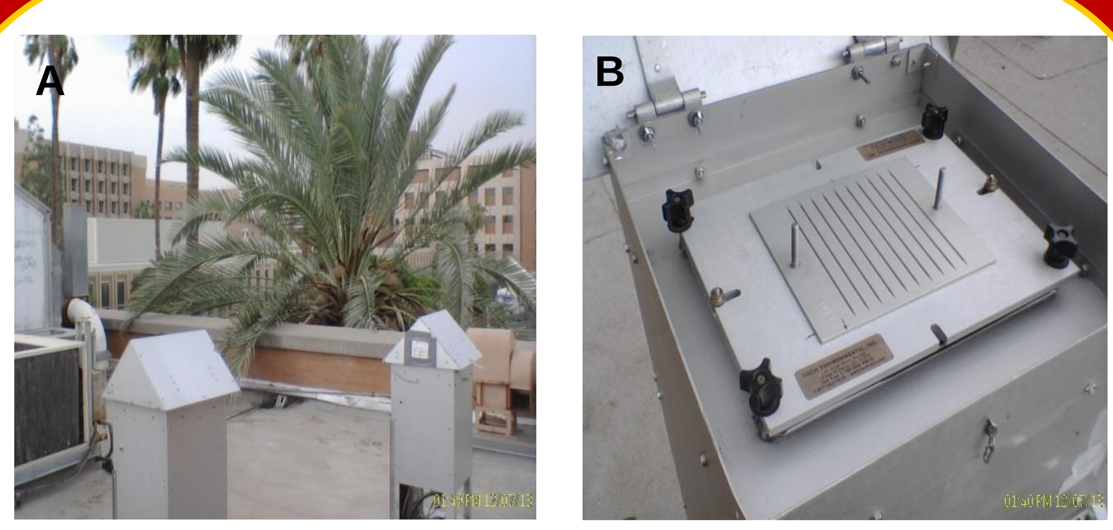

Figure 2 shows the Tisch high volume aerosol samplers (**A**) and the impactor plate (**B**) used in the collection of $PM_{2.5}$ and $PM_{>2.5}$ aerosol samples collected at the ASU Tempe Campus on the roof of the Life Sciences A-Wing building.

Tisch high volume (1.13 m^3 min^{-1}) aerosol samplers were placed on the roof of the Life Sciences A-Wing building at the ASU Tempe Campus. Cellulose filters were used for samples that would be analyzed for metal concentrations. Single stage impactor plates were used to collect size resolved ($PM_{2.5}$ and $PM_{>2.5}$) samples. Samples were collected before, during and after a haboob event. The samplers were run for >1 hour to ensure enough sample mass was obtained.

PM Concentrations

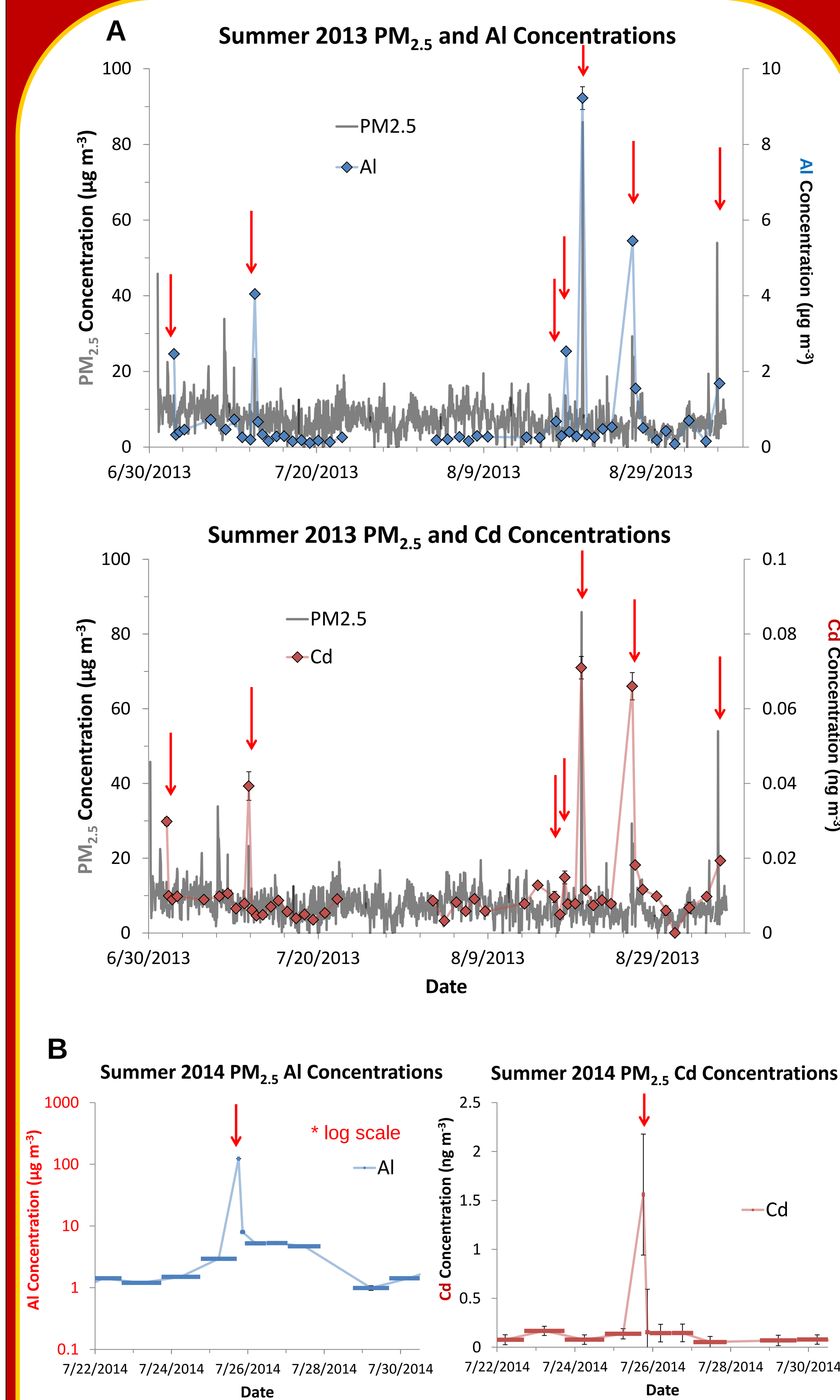

Figure 3 shows particulate matter (PM) concentrations (ng m^{-3}) of Al (Blue) and Cd (Red) in aerosol samples collected during the summer of 2013 (**A**) and 2014 (**B**) at ASU Tempe Campus. Arrows represent periods during which haboobs occurred. $PM_{2.5}$ (gray) concentrations are plotted on the secondary y-axis (µg m^{-3}) [2].

Enrichment Factors

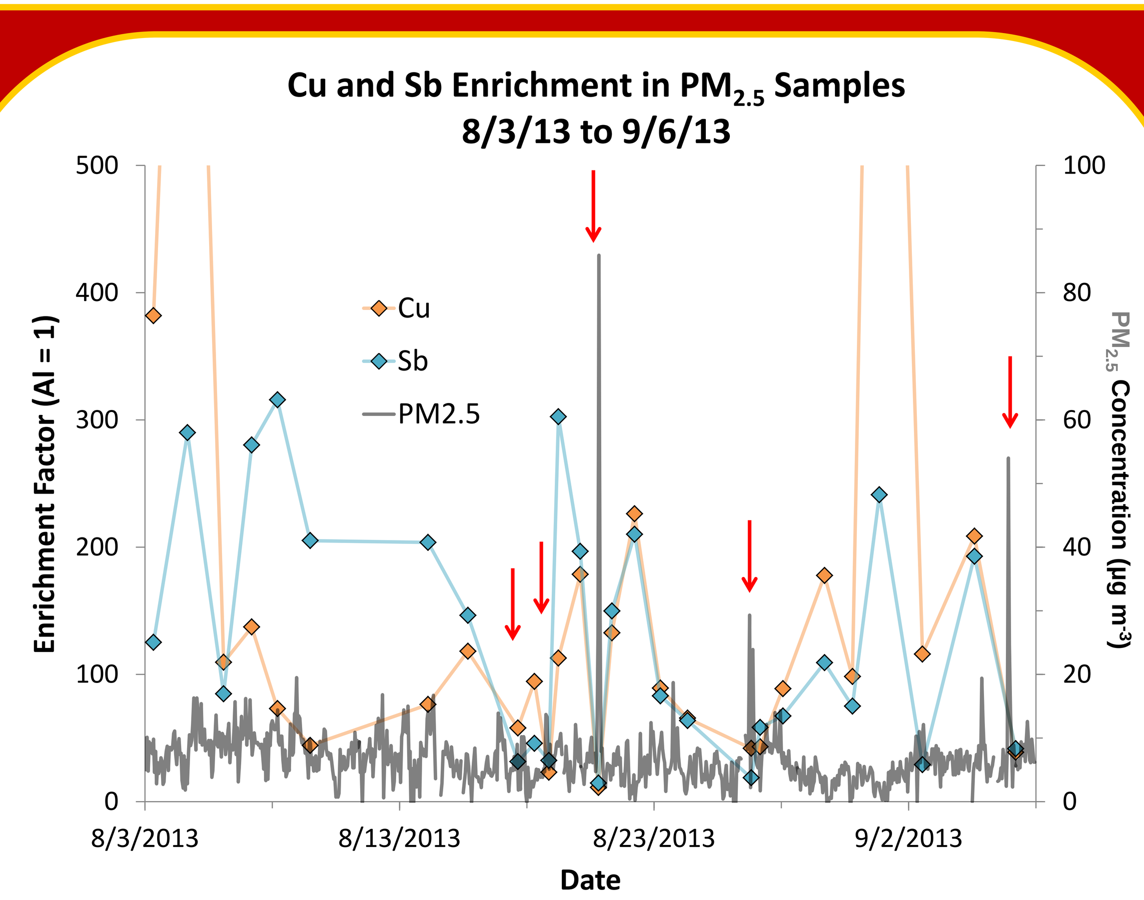

Figure 4 shows enrichment factors (EF) of Cu and Sb in aerosol samples collected during the summer of 2013 at ASU Tempe Campus. EF is calculated using the following formula: EF = (X_{sample} / Al_{sample}) / (X_{crust} / Al_{crust}), where X is the metal of interest and crust is the concentration of the element in the upper continental crust. Arrows represent periods during which haboobs occurred. $PM_{2.5}$ concentrations (gray) is plotted on the secondary y-axis[2].

Iron Solubility

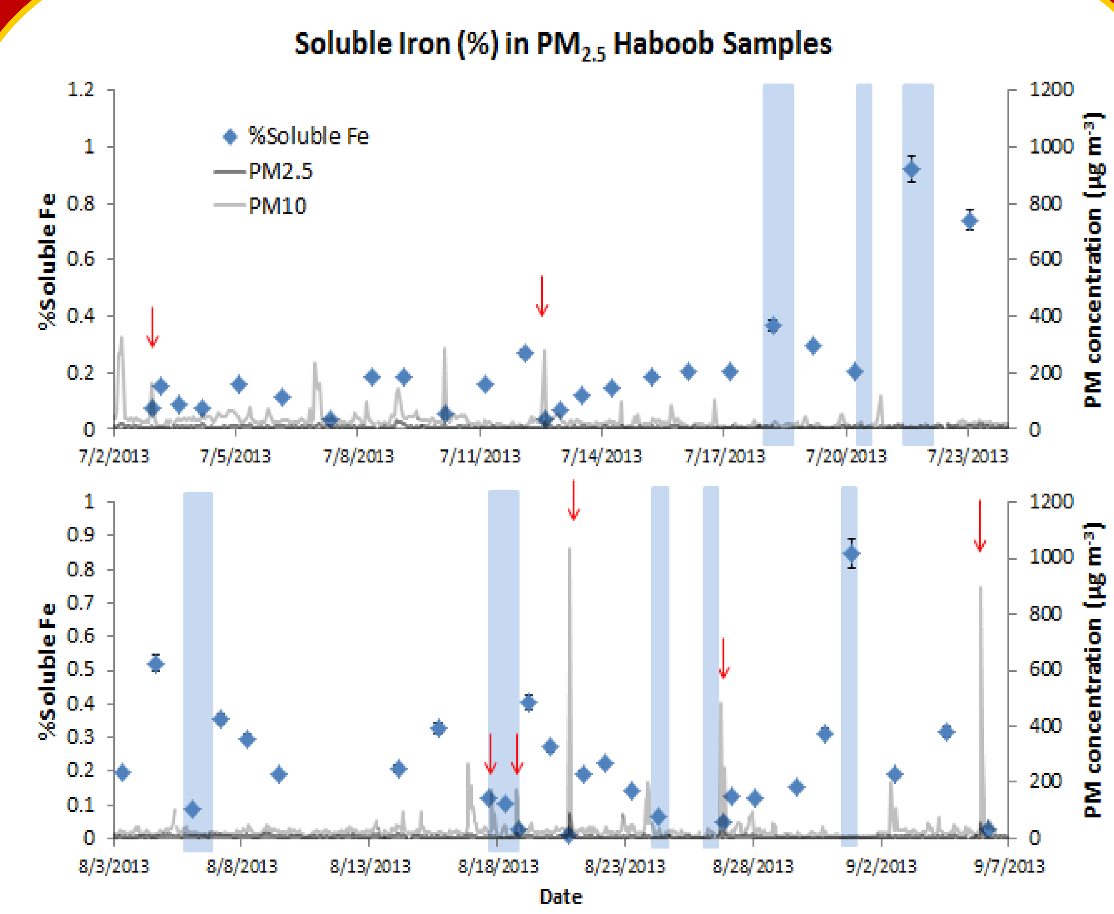

Figure 5 shows percent soluble iron in $PM_{2.5}$ aerosol samples collected at Arizona State University's Tempe Campus. Arrows represent periods during which a haboob occurred. Blue shaded regions represent periods of rain. $PM_{2.5}$ (dark gray) concentrations are plotted on the secondary y-axis (µg m^{-3})[2].

Summary

- During haboob events, PM concentrations increase significantly for a very short period of time with PM_{10} increasing an order of magnitude more than $PM_{2.5}$ *(See Eagar et al. poster #19)*.
- Al (blue) is used as a tracer for crustal material and as a result should increase in concentration during haboob events as PM concentrations increase, which is shown in *Figure 3*.
- Cd (red) can be used as a tracer of anthropogenic activity. In *Figure 3*, Cd concentrations increase during haboob events, but they also increase during other periods.
- Enrichment factors of anthropogenic elements, such as Cu and Sb, decrease during haboob events as more PM and mineral dust is brought into the area. However, their enrichment factors return to previous values within approximately 24 hours after the haboob event as PM and mineral dust particles fall out of suspension (*Figure 4*)
- Other enriched elements (EF > 10) included Zn, Mo, Cd, Sn, W and in some samples Pb *(Not shown)*.
- Soluble iron content of $PM_{2.5}$ aerosols decreased during haboob events and appear to slowly increase after haboob events. Additionally, during periods of rain, soluble iron increases, possibly as a result of increased humidity (*Figure 5*).

References

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$PM_{2.5}$ data is from the Air Quality System.

Acknowledgments

[1] Idso, S. B., R. S. Ingram, J. M. Pritchard, 1972: An American Haboob. *Bull. Amer. Meteor. Soc.*, 53, 930–935.
[2] The Environmental Protection Agency air monitoring site was used to obtain $PM_{2.5}$ and PM_{10} concentrations.