# Aerosol Association with Severe Weather in Oklahoma

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## Introduction

Aerosols may serve as cloud condensation nuclei (CCN) and therefore play an important role in modulating cloud microphysics. Higher concentration of CCN particles produces smaller cloud droplets (Twomey, 1974), increasing cloud water concentration. This leads to higher liquid water content and ice crystal number concentration, which enhances latent heat release and may help invigorate convection (Yuan et al., 2011; Rosenfeld and Bell, 2011).

## Objectives

- Examine the changes in hail size and wind speed as a function of aerosol concentration.
- Identify the synoptic patterns most common during high, medium, and low aerosol concentration cases.
- Compare the microphysics for thunderstorms that occurred between days of different aerosol concentration using polarimetric radar data.

## Methods

- Identified the biomass burning particles produced from Central American fires. Since most of Central America's landscape is savanna, the biomass burning particles most commonly produced from fires of this type of landscape are organic carbon, fine potassium, fine zinc, and bromine (Echalar et al. 1995).
- Produced an eleven-year climatology (2002-2012) of these biomass burning particles from local sensors at the Ellis and Wichita Mountains sites in western Oklahoma using the Federal Land Manager Environmental Database.
- Produced an average concentration of the biomass burning particles in Western Oklahoma for each day using the two sensors.

Figure 1: Area of study

- Days were classified into high, medium, and low concentrations with the lowest 30% of the values considered low concentration days, the middle 40% considered medium concentration days, and the highest 30% considered high concentration days.
- Days with storms in the study area, severe hail (1"+) and wind reports (50kts+) were obtained using the National Climatic Data Center Database.
- Days with similar thermodynamic (CAPE) and dynamic (shear) environments were chosen as case study days.
- A composite synoptic regime was obtained for each aerosol concentration category.
- Differential Reflectivity ($Z_{DR}$) and Correlation Coefficient ($\rho_{hv}$) were examined for a few case studies to compare the microphysics for thunderstorms that occurred between days of different concentration.

## Results

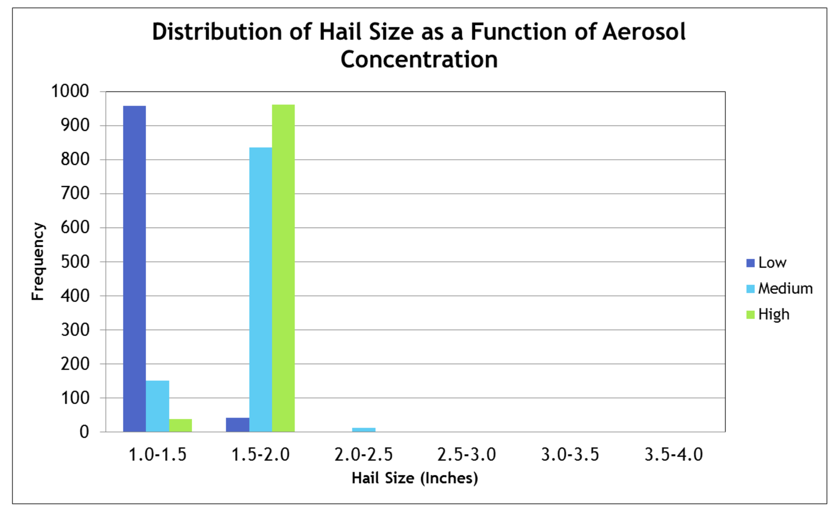


Figure 2a: Distribution of hail size using bootstrapping technique

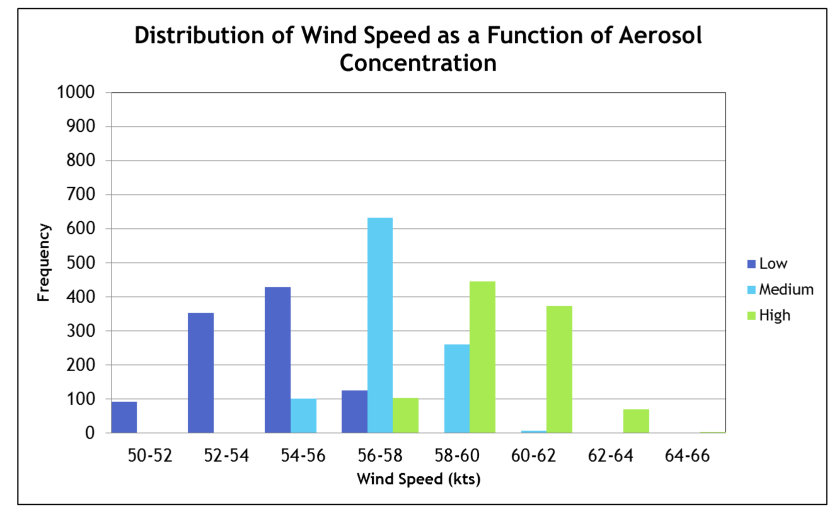


Figure 2b: Distribution of wind speed using bootstrapping technique

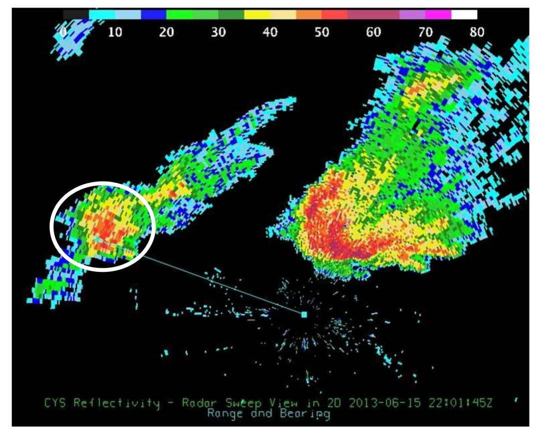

Figure 3a: Radar Reflectivity of a storm near the Cheyenne, WY, WSR-88D radar (KCYS) at 22:01 UTC on 15 June 2013 at 1.5 km above the surface.

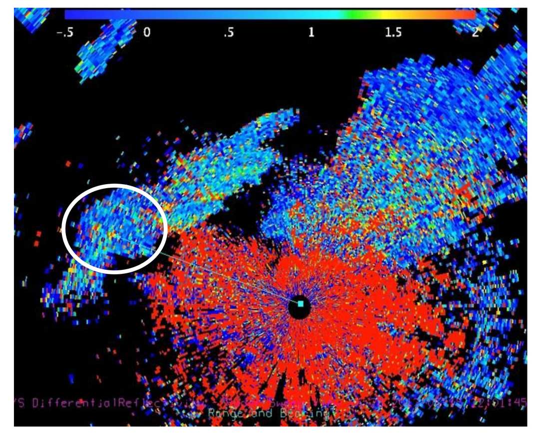

Figure 3b: Differential Reflectivity of the same storm as figure 3a.

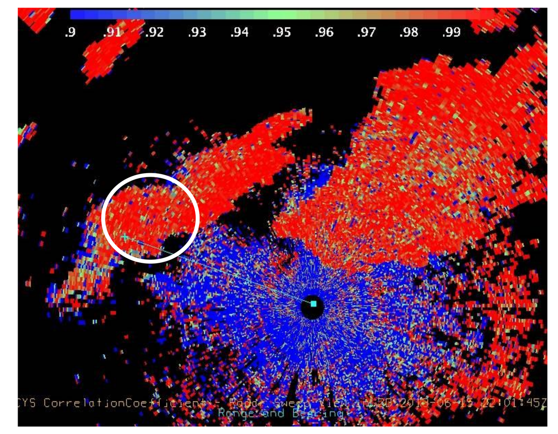

Figure 3c: Correlation Coefficient of the same storm as figure 3a.

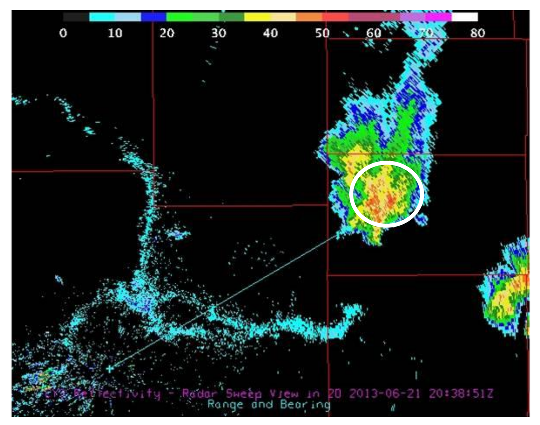

Figure 4a: Radar Reflectivity of a storm east of the Cheyenne, WY WSR-88D radar (KCYS) at 20:38 UTC on 21 June 2013 at 1.5 km above the surface.

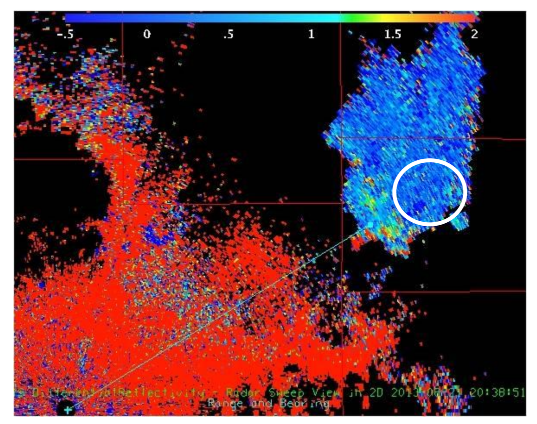

Figure 4b: Differential Reflectivity of the same storm as figure 4a.

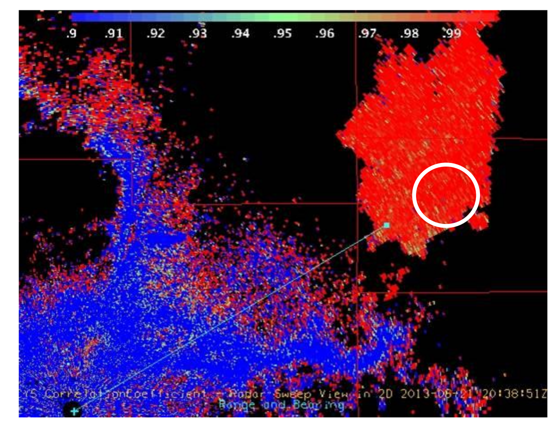

Figure 4c: Correlation Coefficient of the same storm as figure 4a.

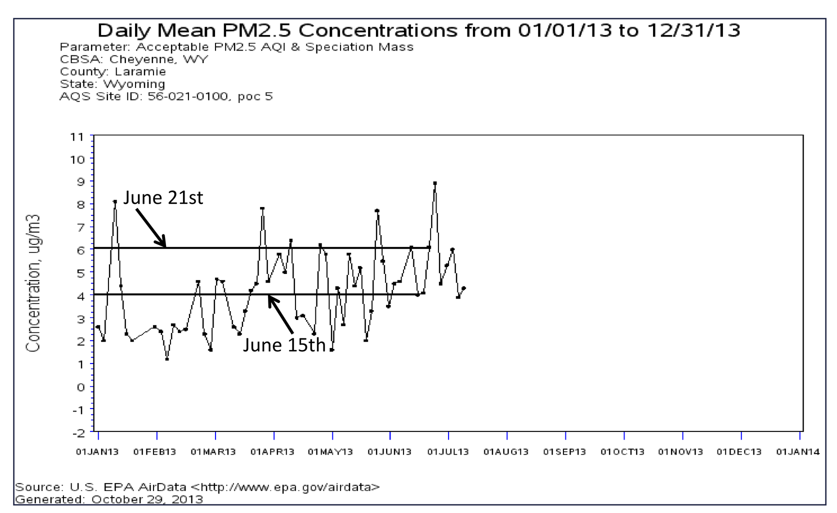


Figure 5a: PM 2.5 Concentration for Laramie County, WY for June 15th and June 21st, 2013.

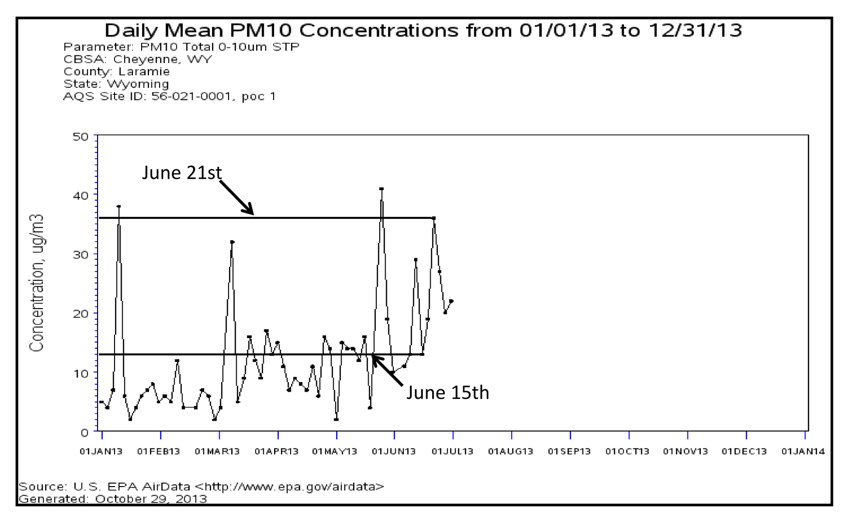


Figure 5b: PM 10 Concentration for Laramie County, WY for June 15th and June 21st, 2013.

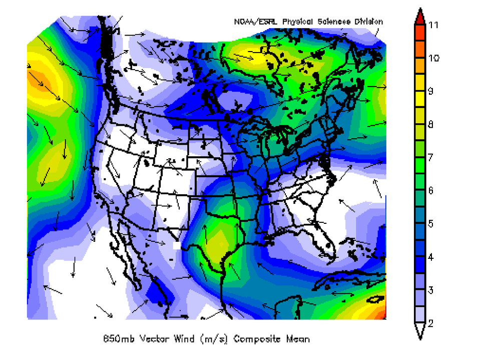

Figure 6a: 850 mb average wind for low aerosol days.

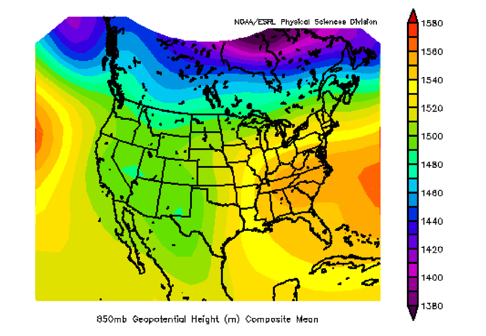

Figure 6b: 850 mb height pattern for low aerosol days.

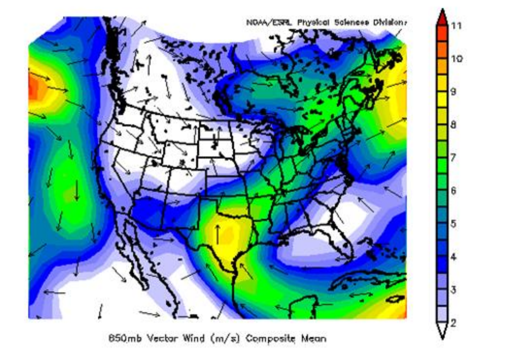

Figure 7a: 850 mb average wind for medium aerosol days.

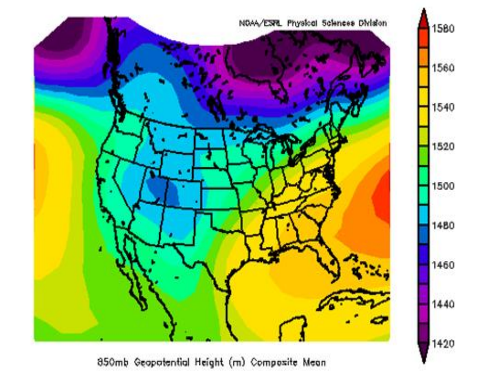

Figure 7b: 850 mb height pattern for medium aerosol days.

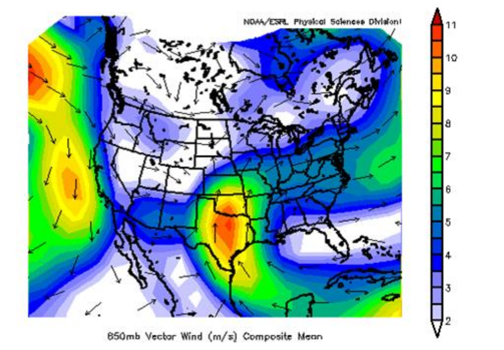

Figure 8a: 850 mb average wind for high aerosol days.

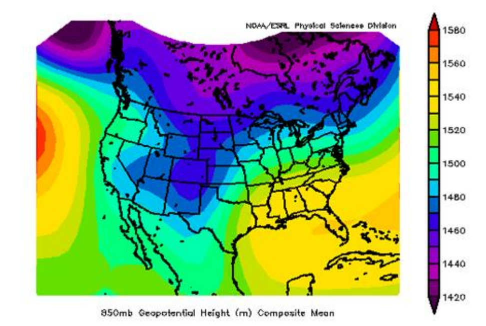

Figure 8b: 850 mb height pattern for high aerosol days.

## Conclusions

- Larger hail size and higher wind speeds appear to occur with higher aerosol concentration.
- Lower $Z_{DR}$ and higher $\rho_{hv}$ occurred during the high aerosol day in Wyoming suggesting that there is a higher concentration of smaller cloud droplets.
- The average 850 mb flow and western trough are stronger with higher aerosol concentration.

## References

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