

# Radar-Based Characteristics of Dust Storms in Arizona

DUST WORKSHOP 2020

JARET ROGERS<sup>2</sup>

SAMUEL MELTZER<sup>1</sup>

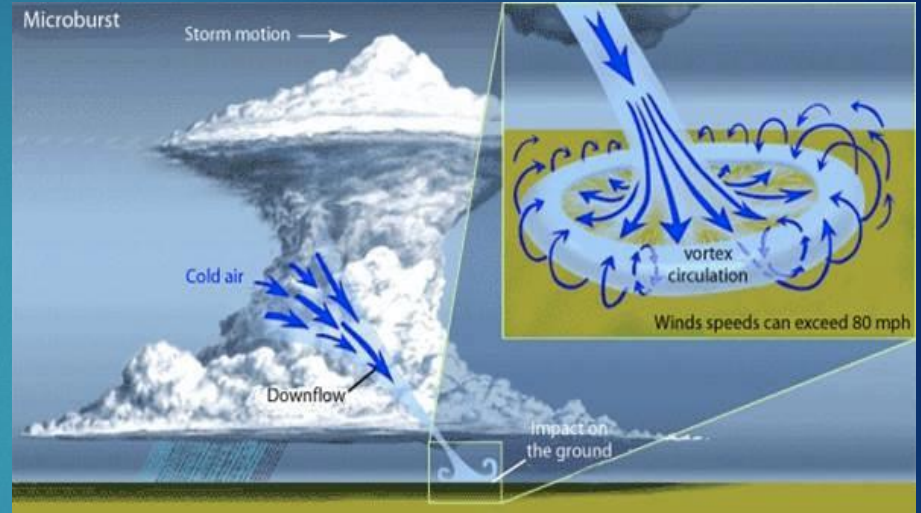
PAUL INIGUEZ<sup>2</sup>

1: Arizona State University, Tempe, AZ

2: National Weather Service, Phoenix, AZ

# Dust Storm (Haboob) Definition

*“An intense sandstorm or dust storm with sand and/or dust often lofted to heights as high as 1500 m (~5000 ft), resulting in a “wall of dust” along the leading edge of the haboob that can be visually stunning.”*  
– AMS Glossary

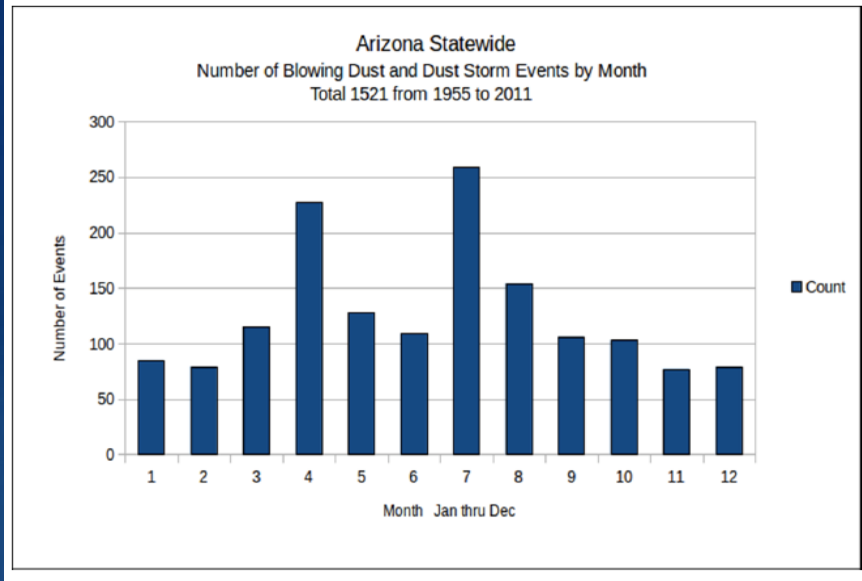


- ▶ **NWS definition:** Dust storm warning is  $\frac{1}{4}$  or less mile visibility.
- ▶ NWS warnings now use polygons (Waters 2018).

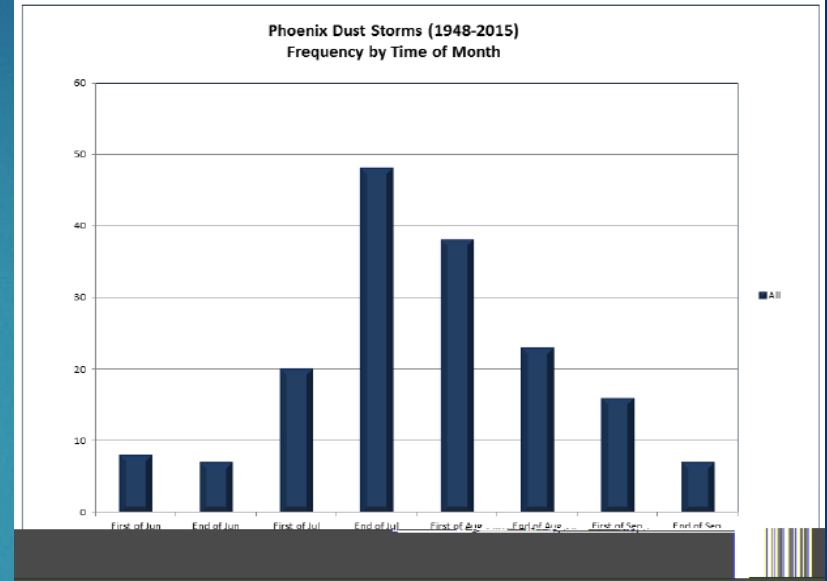
# Impacts

## Past Incidents Due to Dust Storms

- ❖ **28 June 1970** - 12 fatalities after several vehicles collided on Interstate 10 near Casa Grande.
- ❖ **9 April 1995** - 10 fatalities and 20 injured on Interstate 10 near Bowie after 4 different accidents, totaling 24 vehicles.
- ❖ **12 July 1964** - 8 fatalities and 25 injured after 9 cars, 3 trailer rigs, and 1 pickup were involved in a chain reaction collision on Interstate 10 near Red Rock.
- ❖ **4 Oct 2011** - 1 fatality and 15 injured in 25 vehicle crash on I-10

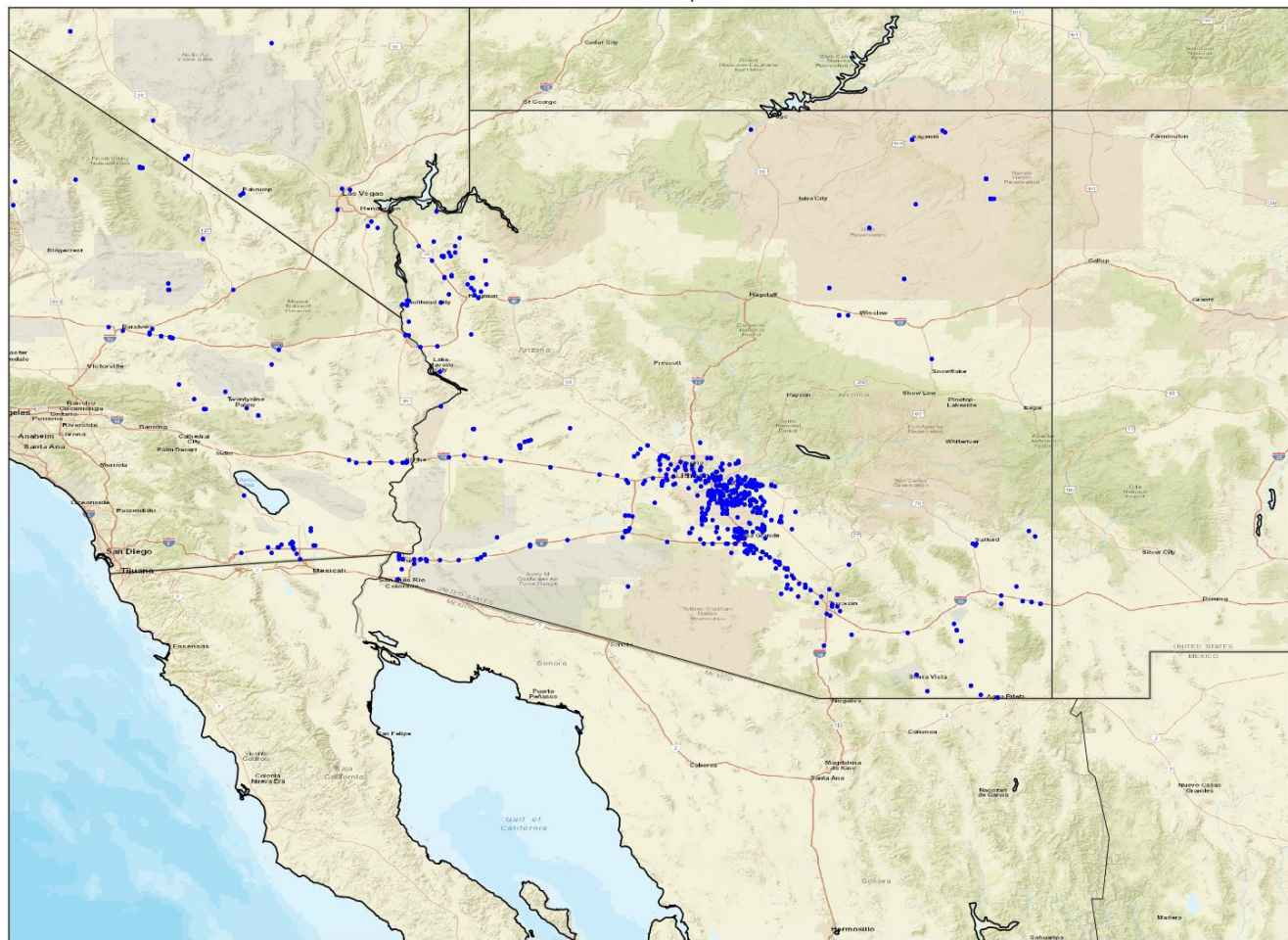


Statewide Arizona dust events  
Adapted from Lader et al. 2016



Phoenix dust events  
Adapted from Lader et al. 2016

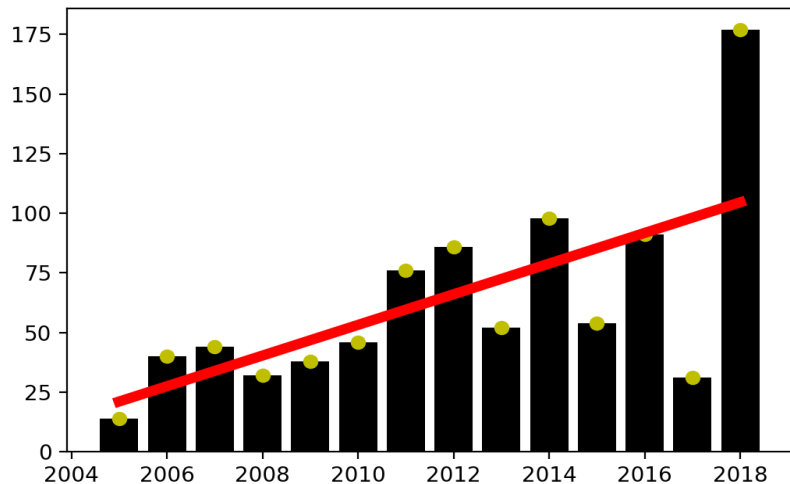
## NWS Local Dust Storm Reports 2005-2018



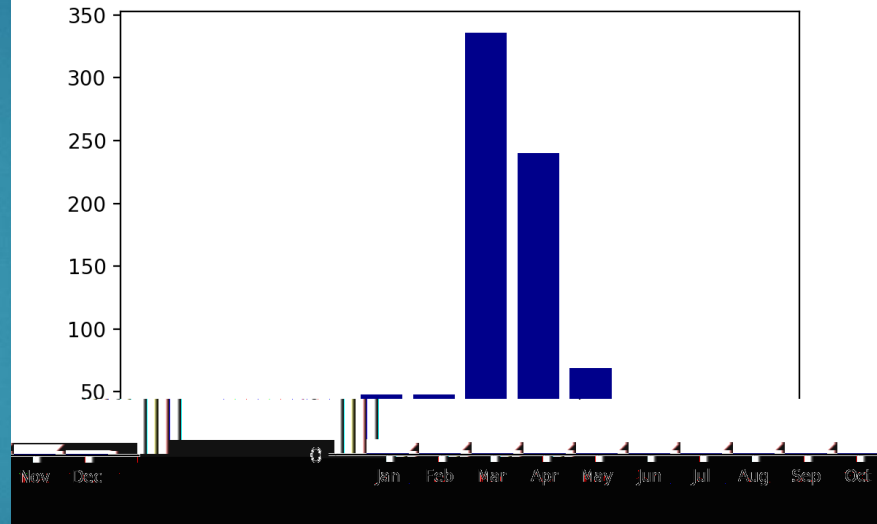
Dust storm NWS local storm reports (2005-2018)

# Dust Storm Climatology (LSRs)

Dust Storm LSRs Per Year - Arizona



Dust Storm LSRs Per Month - Arizona

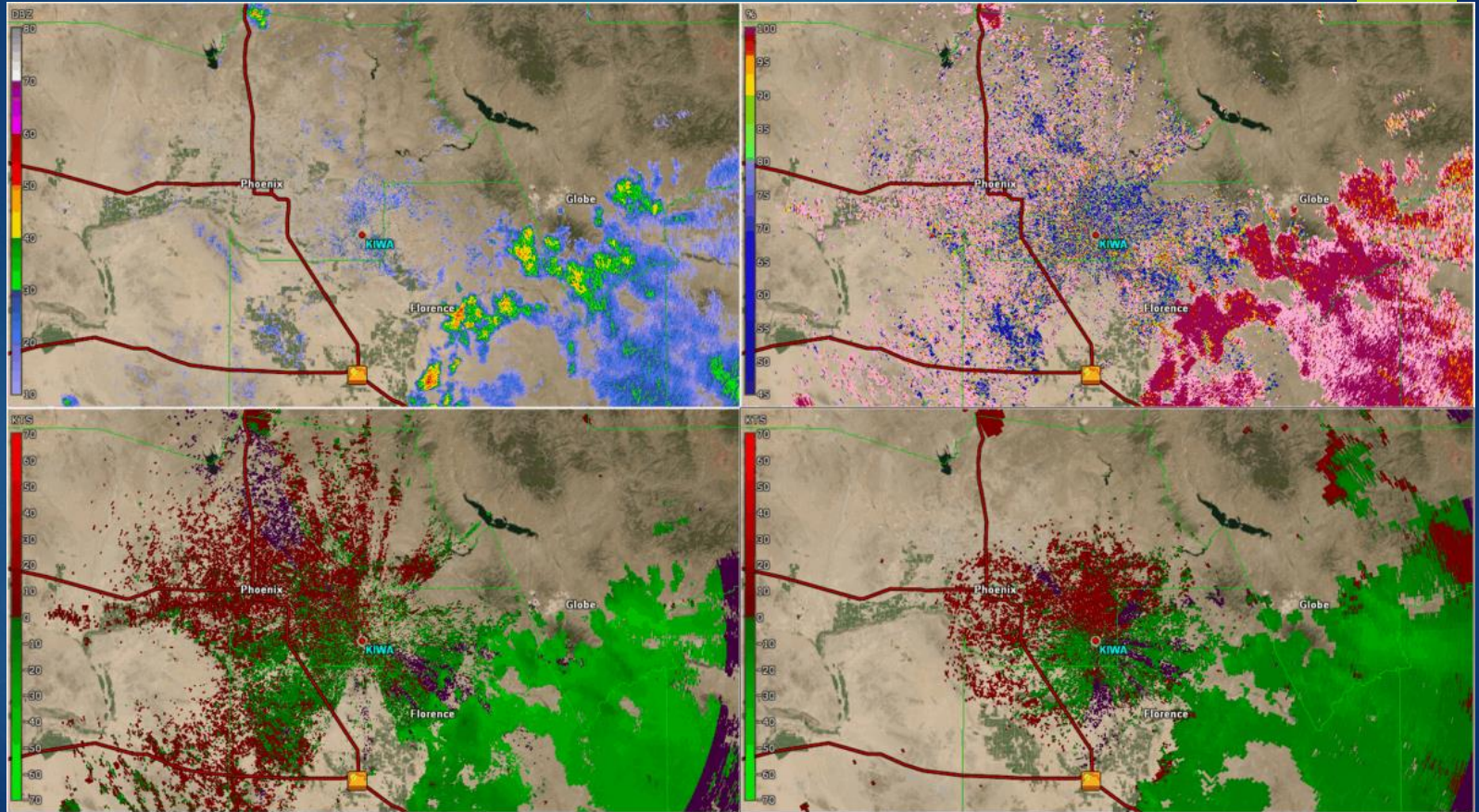


\* 2018 shattered previous record with 175 reports.

# Radar Analysis of Dust Storms

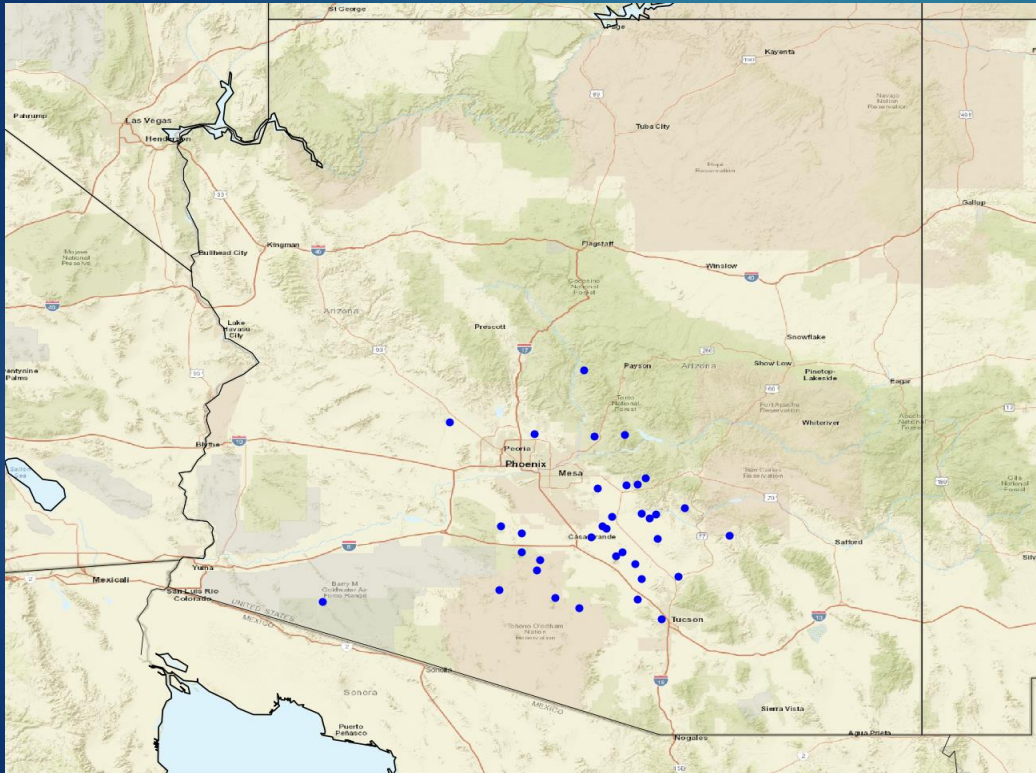
- ▶ **Goal: Create a small climatology of summer haboobs across southern/central Arizona, using combination of radar and storm reports.**
- ▶ Dataset: 35 unique dust storms from 2010 through 2018.
  - ▶  $\geq 3$  dust storm reports (1/4 mile) separated by more than 20 miles.
  - ▶ Most affecting Phoenix-Tucson corridor (radar coverage, report density).

# Radar example – July 21, 2012





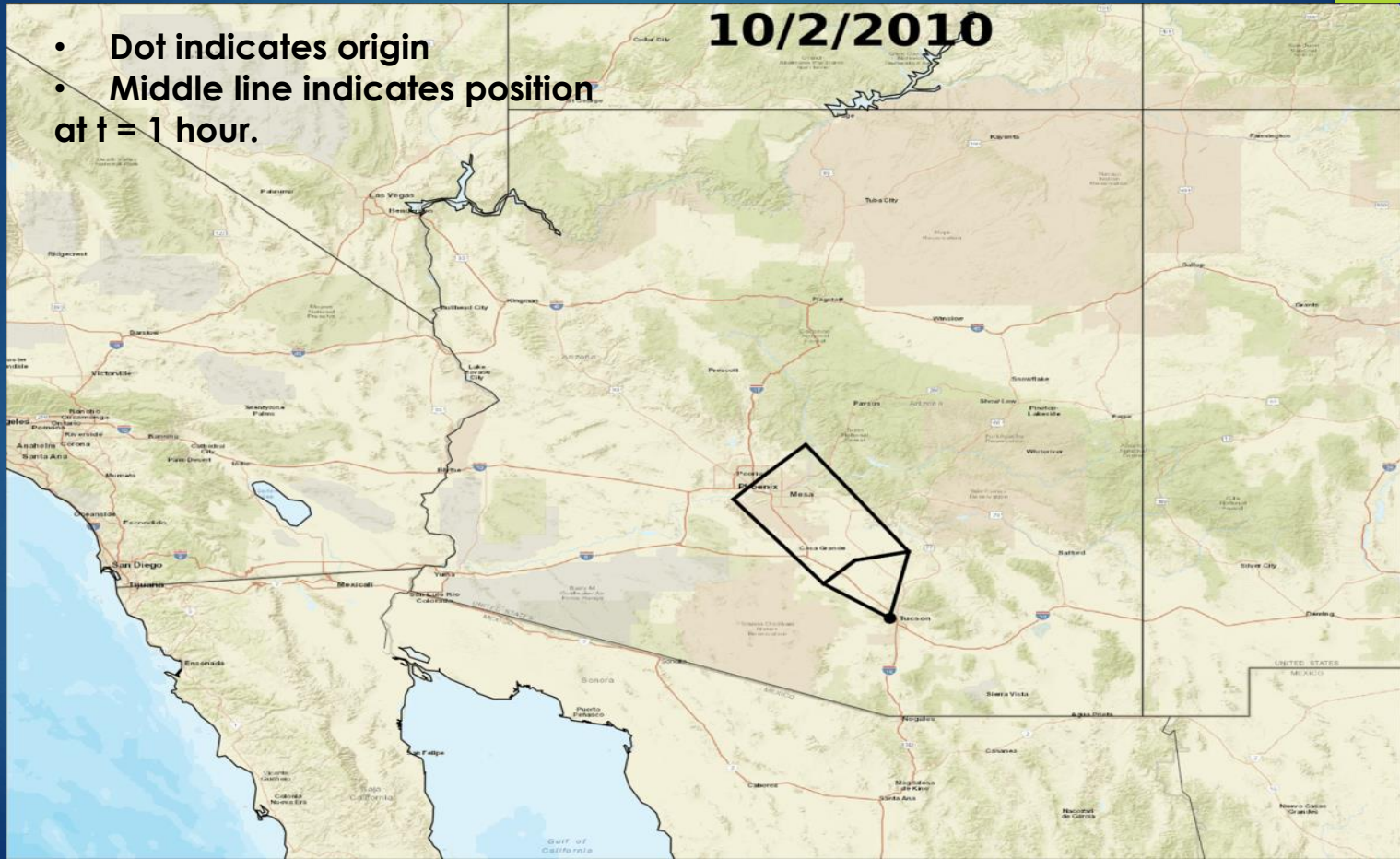
# Origin points



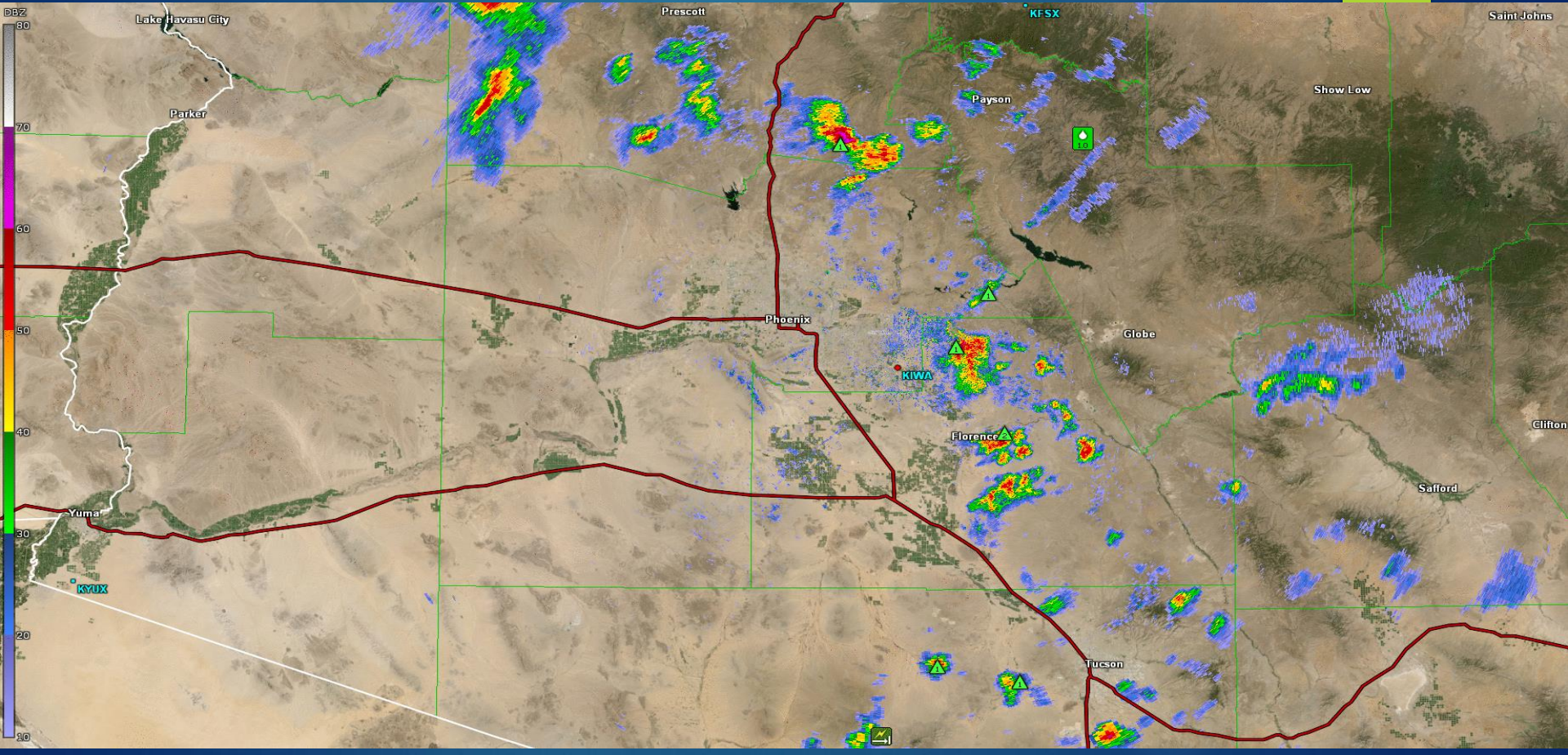
- Origin point of outflow that eventually produces dust storm.
- Clustered south/east of Phoenix.
- Subset of dust storm outflows originate over higher terrain north and east of Phoenix.

# Radar-Analyzed Dust Storm Events

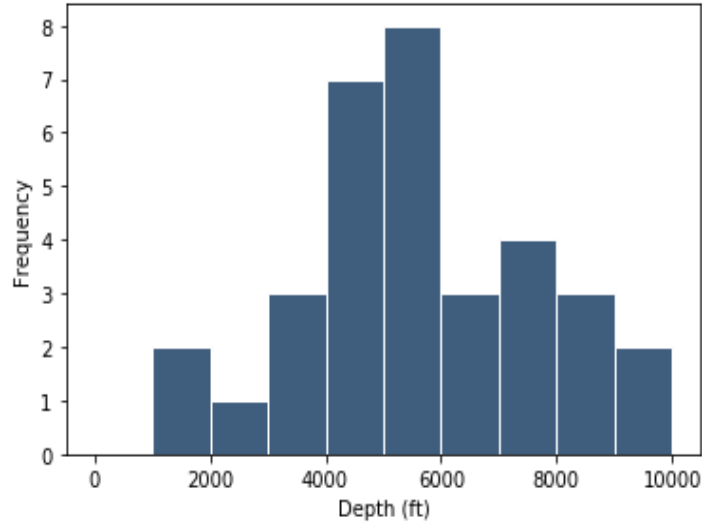
- Dot indicates origin
- Middle line indicates position at  $t = 1$  hour.



# July 9<sup>th</sup>, 2018 Dust Storm Event

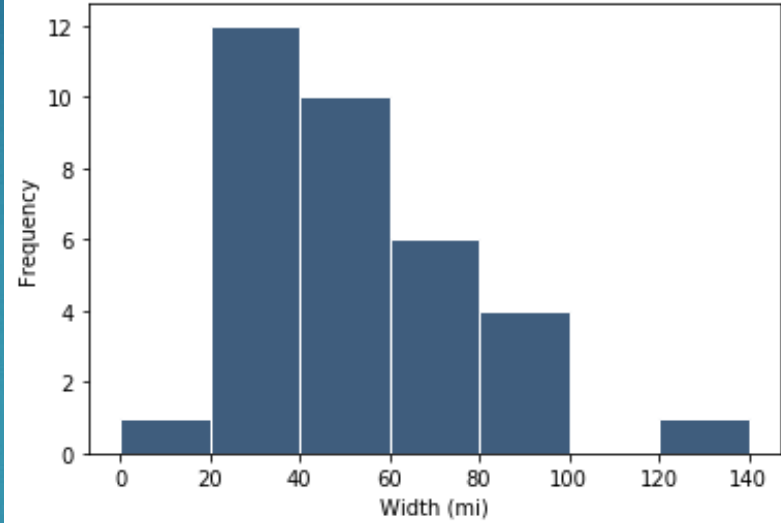


Dust Storm Depth  
1-hr After Formation



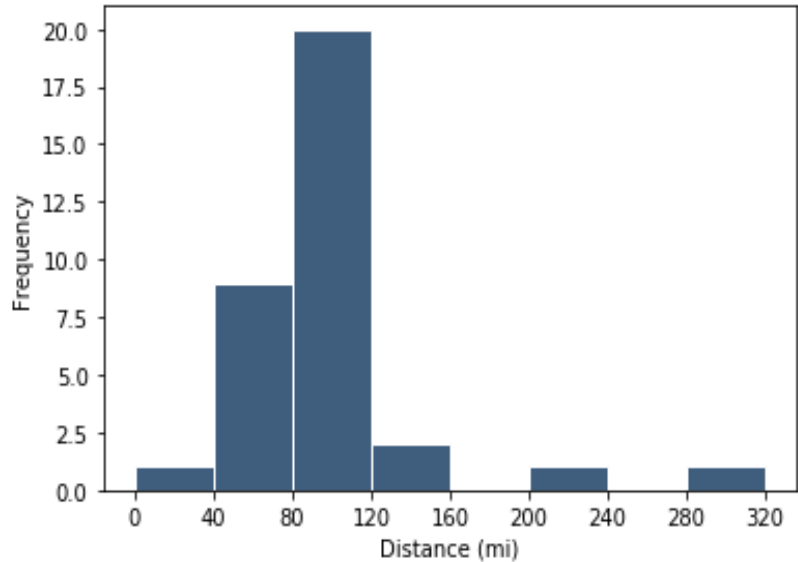
- Median depth: 5600 ft.
- Maximum depth: 9900 ft.

Dust Storm Width  
1-hr After Formation



- Median width: 48 mi.
- Often reflects most intense portion of thunderstorm outflow boundary.

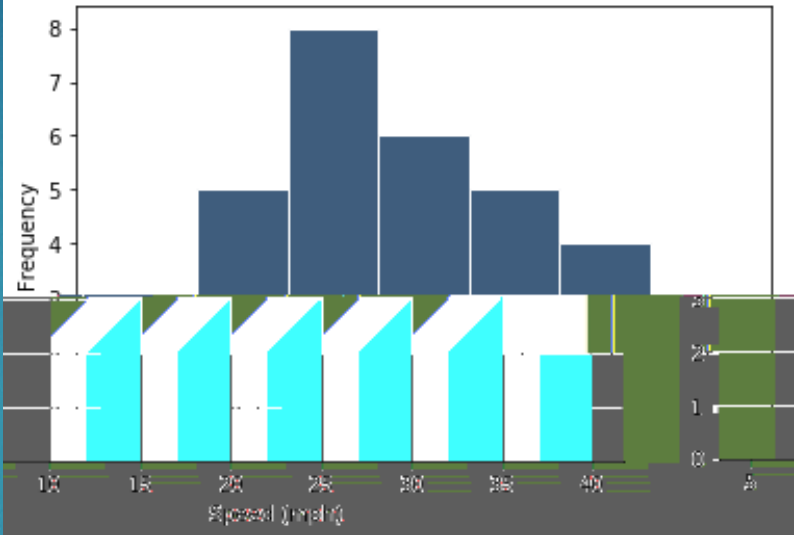
## Dust Storm Distance Traveled



- **Median distance:** 89 mi.
- **Maximum distance:** 303 mi.\*
- Longest-traveled dust storms generally move west to east.

\* 7/30/2016

## Dust Storm Forward Speed 1-hr After Formation

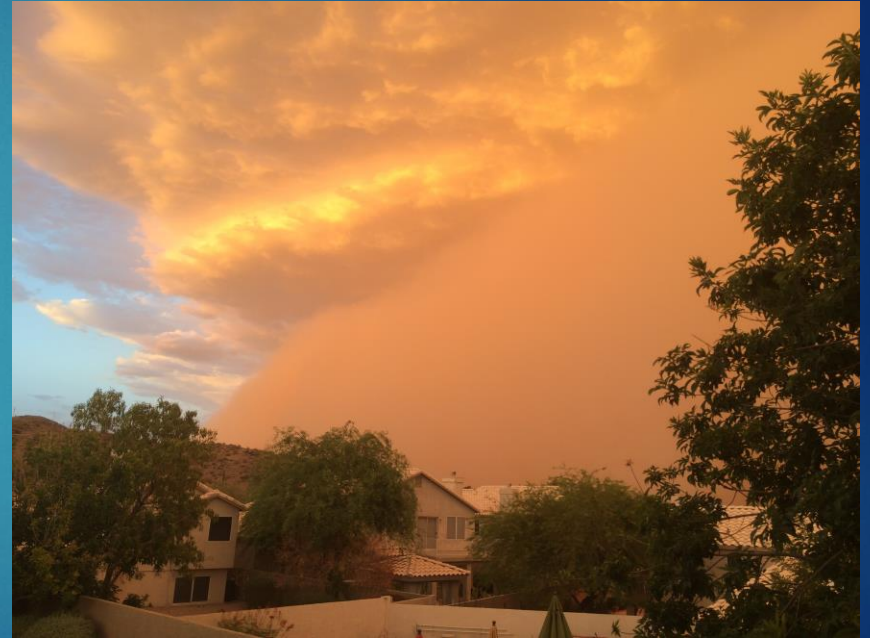


- **Median forward propagation speed:** 22 mph.
- **Maximum speed:** 37 mph.

# Predictability of Dust Storms

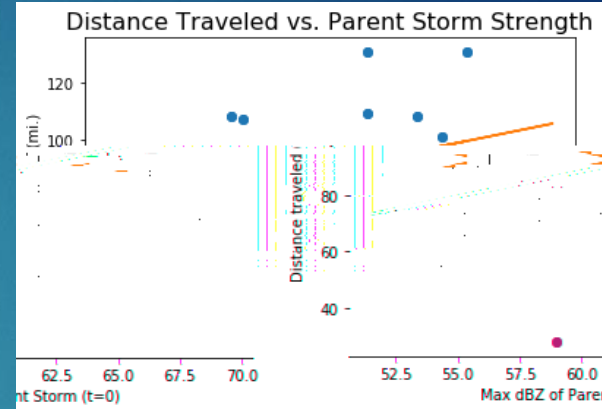
## Factors Influencing Dust Storms

- ▶ Location of formation
  - ▶ Availability of loose dust
- ▶ Population
  - ▶ Reports
- ▶ Strength of parent storms?
- ▶ Meteorological environment
  - ▶ (e.g., greater boundary layer mixing)
- ▶ Orientation of steering flow
- ▶ Convection regenerating behind outflow



# Predictability of Dust Storms

- ▶ Potential Ways to Characterize Dust Storm Intensity:
  - ▶ Dust Storm depth ( $t = 1$  hr)
  - ▶ Dust Storm path length
    - ▶ Dependent on orientation of flow.
  - ▶ Regeneration of convection
  - ▶ Environment (not covered).



- Very small influence of parent storm strength (surface reflectivity) vs. length traveled.
- Otherwise, predictability via storm-scale characteristics is very low.

# Conclusions

- ▶ Dust storms maximized between Phoenix and Tucson corridor.
- ▶ Most travel <100 mi. On occasion (once every 4 years on average), can travel > 200 mi.
- ▶ Predictability of characteristics using storm-scale attributes is low.
- ▶ Future work to consider incorporating environmental information, null cases, and population weighting.



Credit: Chris Frailey. 2 July 2014



# Thank you!

- ▶ **Jaret.Rogers@noaa.gov** (Lead forecaster, NWS Phoenix)
- ▶ **Samuel Meltzer** (sjmeltze@asu.edu, Arizona State University / NWS North Platte, NE)
- ▶ **Paul.Iniguez@noaa.gov** (Science and Operations Officer, NWS Phoenix)