

# HARVESTING THE SKIES

## of the American Southwest

### *Augmenting Rain through Cloud Seeding*

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WRCC ANNUAL MEETING

Tucson AZ

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**AWMS**  
ADVANCED WEATHER MODIFICATION SOLUTIONS

# Key Definition

- ***Weather modification and control***

Changing or controlling,  
*or attempting to change or control,*  
by artificial methods (cloud seeding using aircraft)  
the natural development  
of atmospheric cloud, or precipitation forms,  
that occur in the troposphere






CUMULUS  
CLOUD




# Physics of Seeding


-40C, -40F



 = ice crystal, ice nuclei

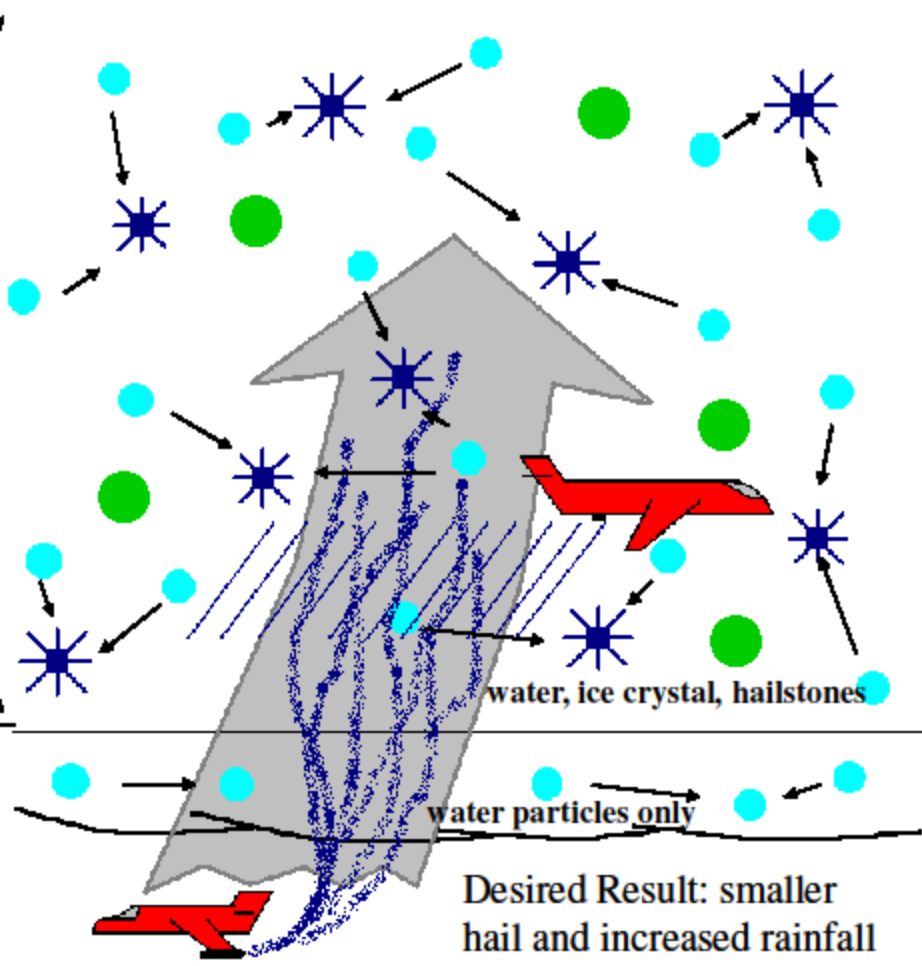
 = hailstone (small)

Supercooled Region

 = liquid water particle

0C, 32F

**Cold Cloud Micro-physical Changes Due to Cloud Seeding (Hail Suppression)**



water, ice crystal, hailstones

water particles only

Desired Result: smaller hail and increased rainfall

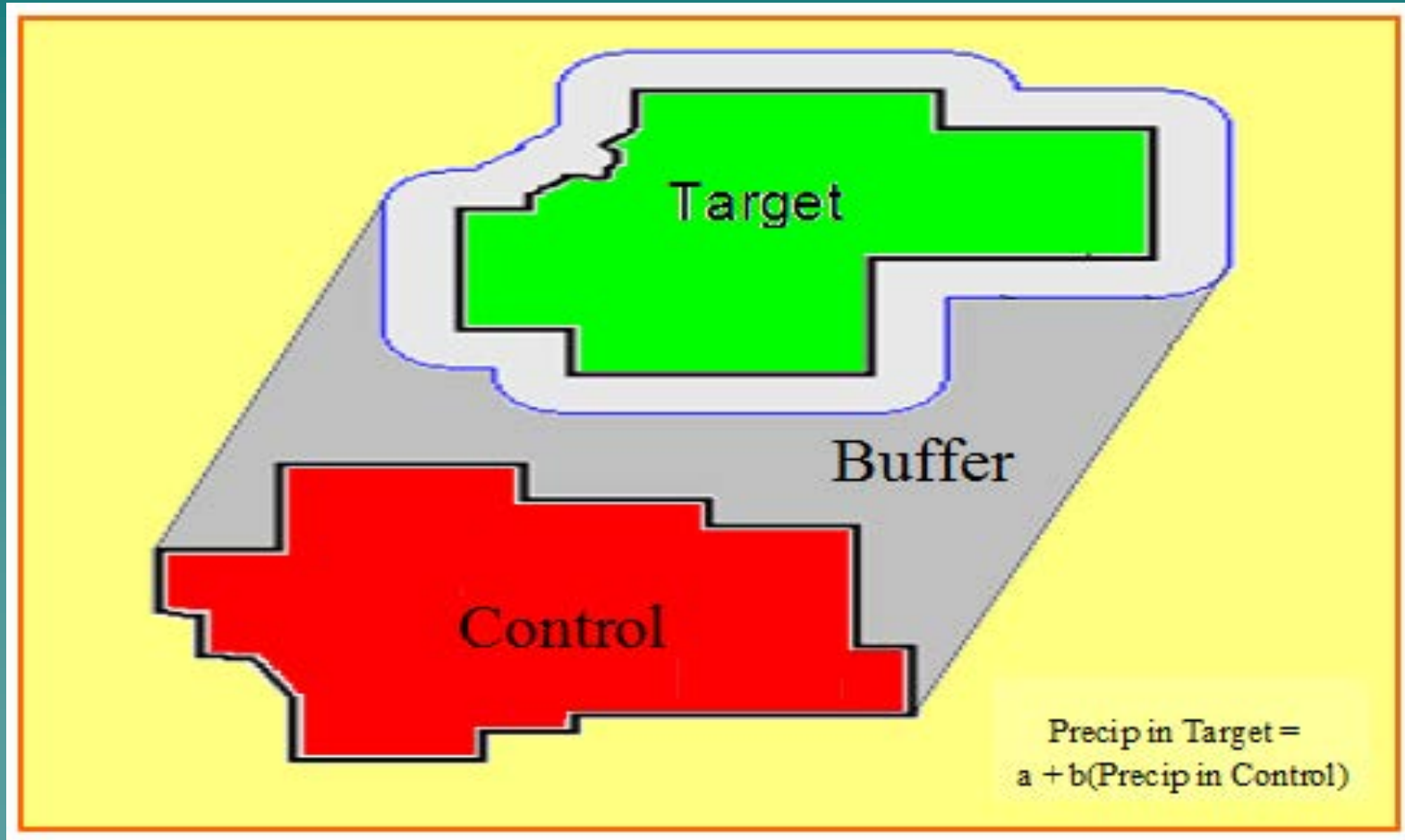


**Ejectable:  
20 gram flare silver iodide**



**Burn in place:  
40 gram flare silver iodide**

# Target and Control Method of Assessment



# *Focused* RESEARCH

## ■ **TEXARC**

*Texas Exercise in Augmenting Rainfall thru Cloud seeding: NOAA (1994-1996)*

- **Cloud microphysical structure strongly dependent on CBTs**
- **Timing and targeting are crucial**

## **SPECTRA**

*Southern Plains Experiment in Cloud seeding of Thunderstorms for Rainfall Augmentation: USBR (2004-2006)*

- **Documented microphysical links between CCN and mechanisms responsible for forming precipitation**
- **Demonstrated that sizes of CCN are critical to formation of rainfall**

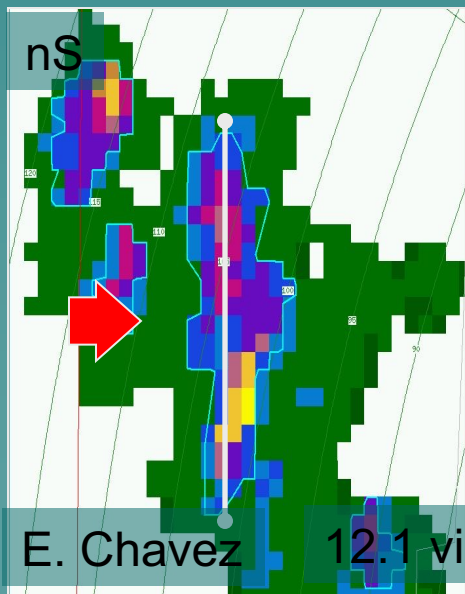
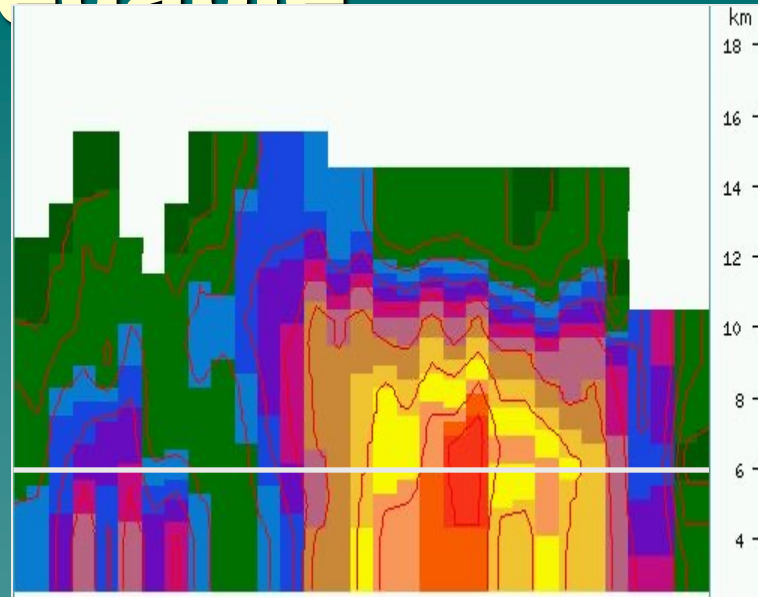
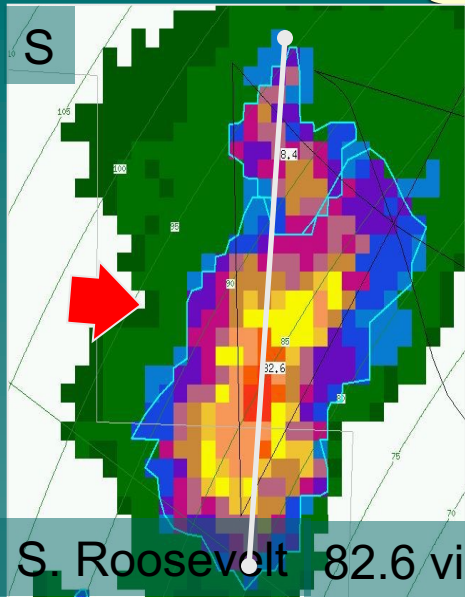


# THE BOTTOM LINE

## Research-Based Predicted Outcomes from Seeding

DURATION	40 percent <i>longer</i>
COVERAGE	35 percent <i>greater</i>
CLOUD VOLUME	41 percent <i>greater</i>
<b>CLOUD TOP</b>	<b>3 percent higher</b>
CLOUD MASS	44 percent <i>greater</i>
<b>RAINFALL MASS</b>	<b>2.3 times more</b>

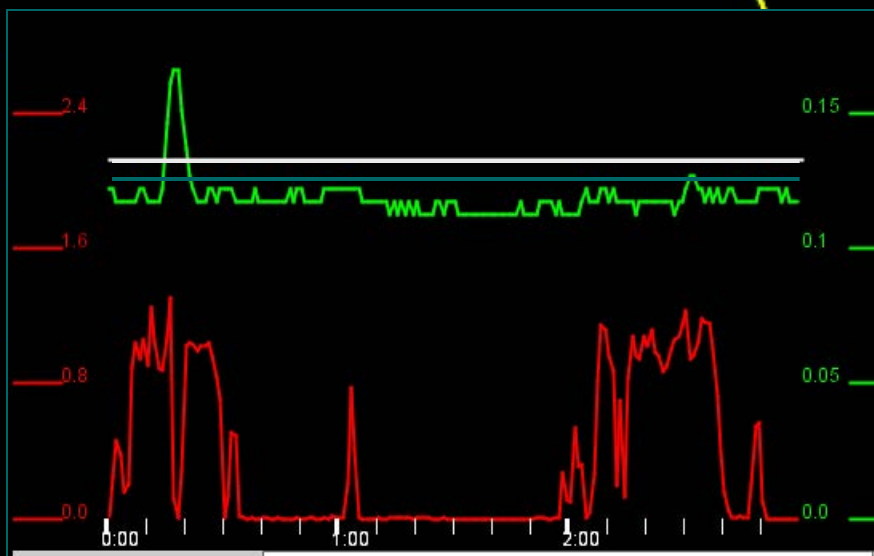
# Seedable vs non-seedable



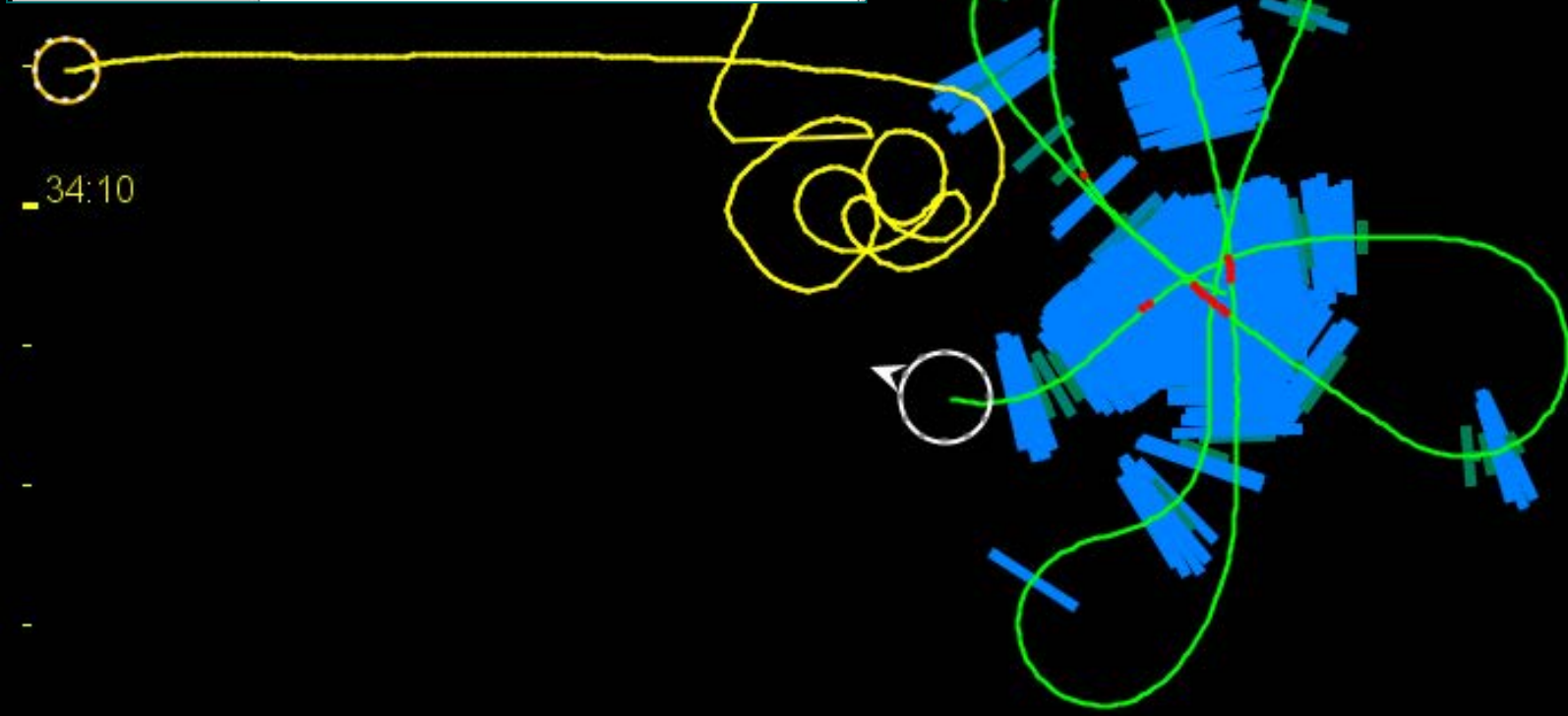
Wind speed: 100degrees, 12m/s  
Altitude: 13585 ft

Wind calculation: Input  
Visible Area: 25.06km

ACFT time: 21:46:41  
SEED time: 21:46:42

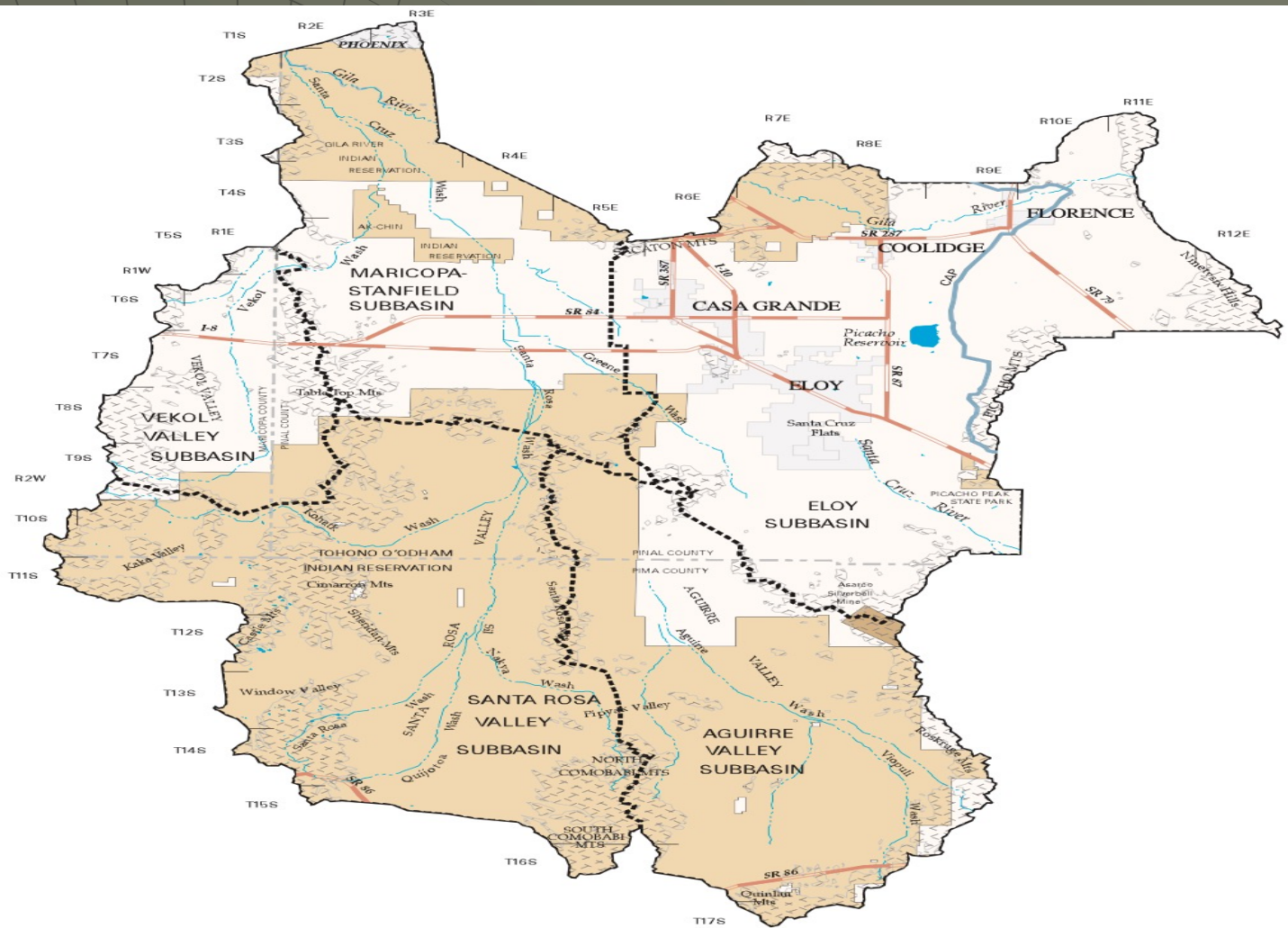


-103:0  
▲

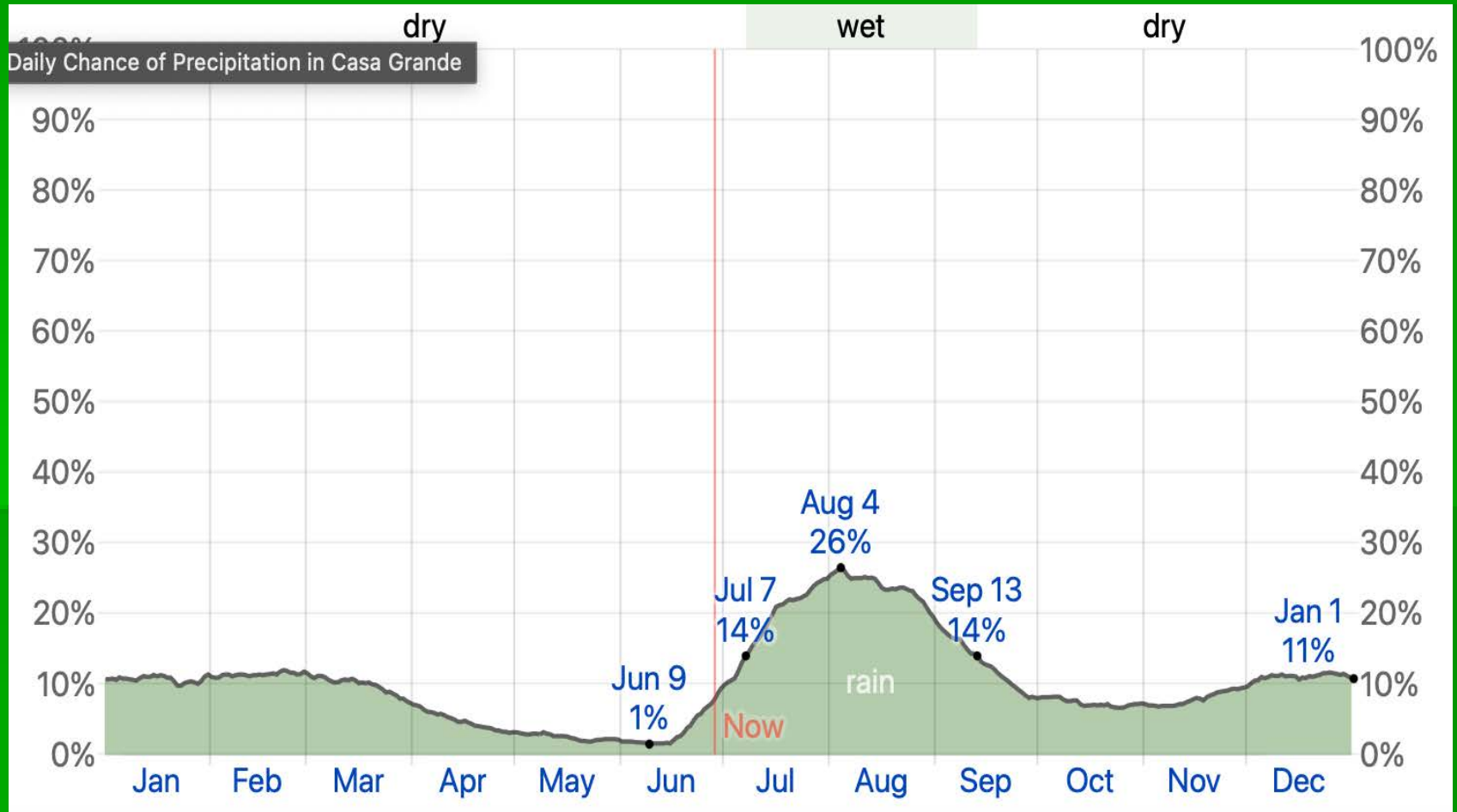


34:10

# Pinal Co. Water Augmentation Authority



# Daily Chance of Rainfall Casa Grande



# *Projected Seeding Opportunities*

During a “window” of  
July through September:

**50 cloud targets**

**160,000 acre-feet of rainwater**

From an assumed **5 percent** increase in rainfall  
from seeded storms

# By seeding *all* available storms

**Using a single aircraft for 3 months  
(at a cost of \$0.47 per acre-foot)**

- ✓ **An average increase of 0.65 in. spread evenly over Pinal County**
- ✓ **Reduction of nearly 13,000 acre-feet of irrigation water, saving residents \$335,000**
- ✓ **Economic impact, including crop production, of nearly \$3 million annually**

# THE BOTTOM LINE

Estimated *increased* rain output from seeded (**single-cell**) storms

Avg. for 10-year period ('04-13)     **144,669** acre-feet

**Estimated cost of rainwater produced**

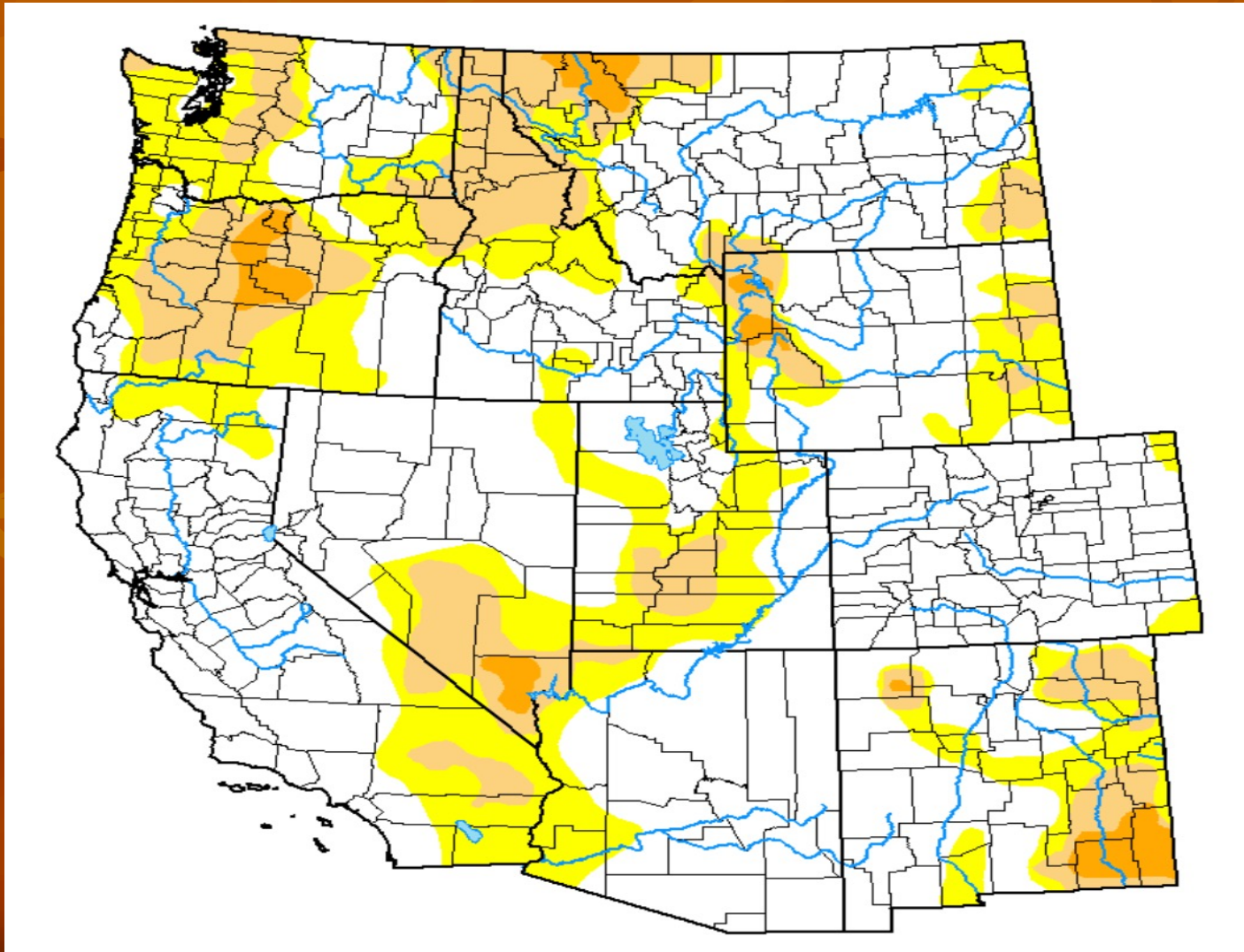
**Avg. for 10-year period     \$ 10.82 per acre foot**

Estimated increased rain output for **multi-cell** storms:

Avg. 10-year period ('04-13):     **1,769,314** acre-feet



# Dealing with *Drought*



**Thank You for Your  
Attention**

