



Weather
Modification



Importation



Reuse

Water Augmentation

RECLAMATION

Managing Water in the West

Colorado River Basin

Water Supply and Demand Study

Technical Report F — Development of Options and Strategies

U.S. Department of the Interior
Bureau of Reclamation

Water 2120: Securing Our Water Future



Volume I: N

NCAR RESEARCH APPLICATIONS
LABORATORY

WINTER CLOUD SEEDING SNOWFALL ENHANCEMENT

New Opportunities

RAL scientists are implementing recent advances in computer modeling, along with unprecedented observations of seeding impacts, in pursuit of new opportunities to understand the impacts of cloud seeding and more efficiently design and operate cloud-seeding programs.

CLOUD-SEEDING RESEARCH

Sufficient water supply for many mountainous regions depends on the volume of winter snowpack. Cloud seeding is a technology that aims to enhance snowfall by dispersing silver iodide (AgI) particles into clouds, forming ice, and causing (or enhancing), snowfall.



Ground-based generators and/or aircraft are often used to disperse AgI into the clouds.

National Center for Atmospheric Research | RAL | www.ral.ucar.edu

Benefits & Impacts

- Unprecedented observations of cloud-seeding effects
- Models can evaluate cloud seeding efficacy
- Forecasting for cloud-seeding in real time
- Simulations can now inform cloud-seeding program designs

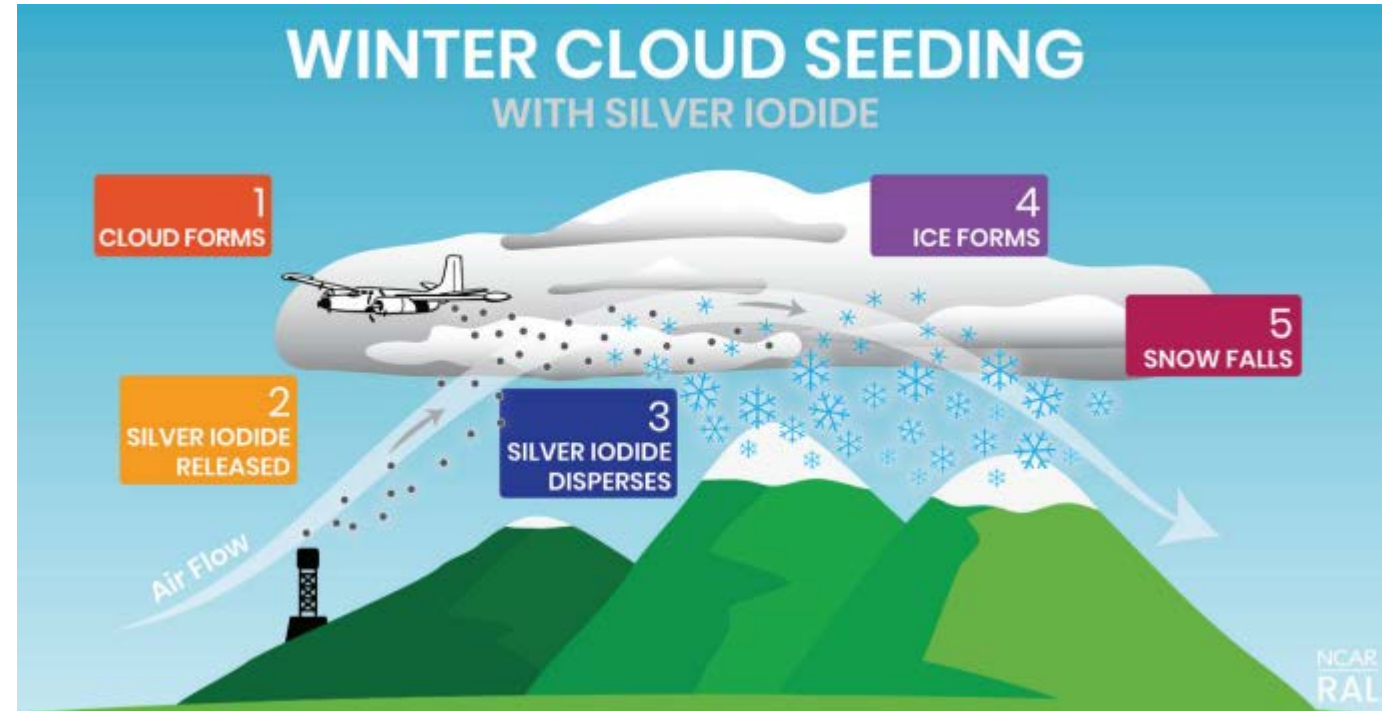
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Reference/Sources

- The Colorado River Basin Study
 - Reclamation, 2012
([Lower Colorado Region | Bureau of Reclamation \(usbr.gov\)](http://www.usbr.gov/lcr/ColoradoRegion/))
- Water 2120
 - The Albuquerque Bernalillo County Water Utility Authority, 2016
([Water_2120_Volume_I.pdf \(abcwua.org\)](http://www.abcwua.org/Water_2120_Volume_I.pdf))
- Winter Cloudseeding Handout
 - NCAR, 2023
([wintercloudseedingbroch202108.pdf \(ucar.edu\)](http://www.ral.ucar.edu/wintercloudseedingbroch202108.pdf))
- Caveats
 - Costs and energy numbers are approximate and have not been adjusted from original source data

Water Augmentation, Weather Modification

- What is it?
 - Apply Silver Iodide to help in the formation of ice
- Advantages
 - Seems like magic – it works
 - Relatively low cost
- Limitations
 - Need moisture – requires a cloud as a starting point
 - Applicable with super-cooled liquid water
 - More precipitation doesn't result in a 1:1 with runoff
 - Advective storm seeding is less certain, needs more study
 - Hasn't been done at a basin scale
- Costs
 - Relatively inexpensive ~\$50/AF
 - Energy
 - 2,000 kWhr/AF

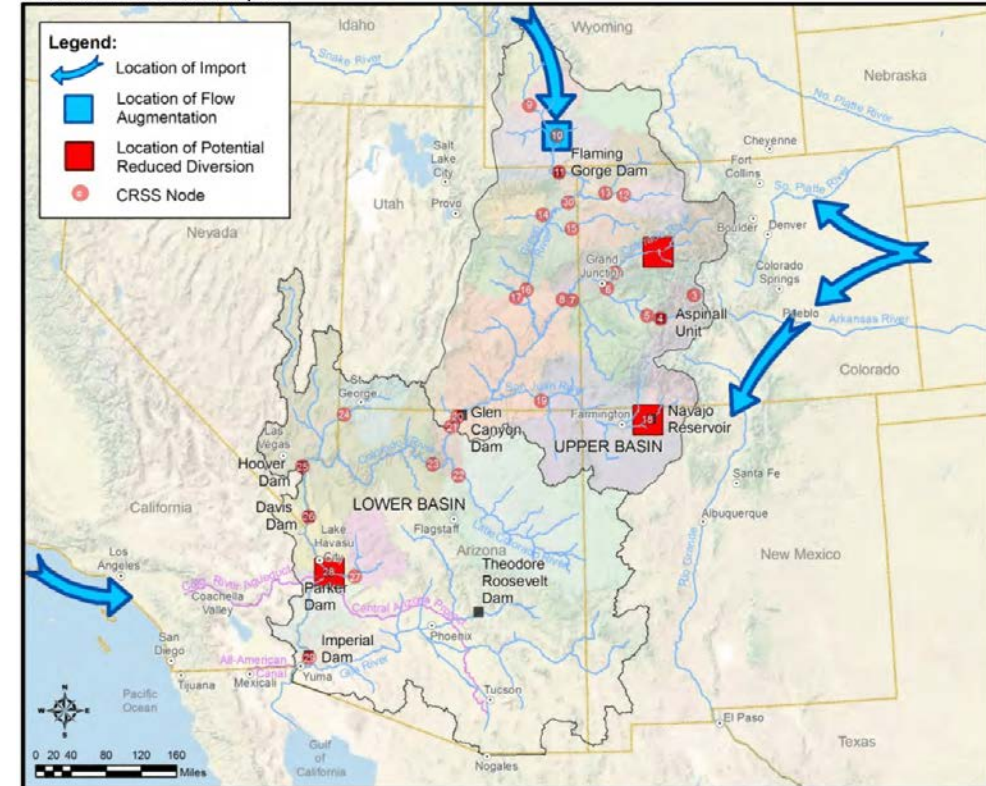


Weather
Modification

Water Augmentation, Importation

- Example Concept
 - **Mississippi River pipeline**
 - *From CRBS – 600,000 AFY of supply, including 150,000 AFY to upper Rio Grande (800 cfs out of more than 200,000 cfs)*
- Advantages
 - **Completely new supply of water, can be used to extinction**
- Limitations
 - **Political, social, and environmental costs**
 - **High energy use**
- Costs
 - *Mississippi river pipeline >\$15B with \$1.5B just for the spur to NM*
 - *>\$2,000/AF life cycle cost*
- Energy
 - *12,000 kWhr/AF of energy use annually >\$500M per year in annual cost*

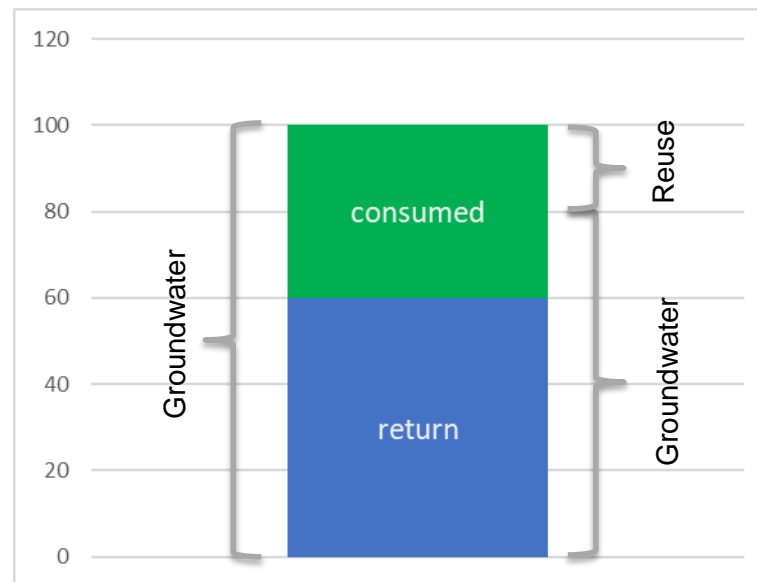
FIGURE F4-1
Generalized Locations of Imports



Importation

Water Augmentation, Reuse

- Example Concept
 - CR – basin wide
 - From CRBS – 600,000 AFY of supply
- Advantages
 - Optimizes local resources/multiplies effectiveness of current sources
 - Incorporates feedback
- Limitations
 - Water rights
 - Uncertainty around IDPR/DPR
- Costs
 - 600,000 AFY >\$5B or \$1,500-\$1,900/AF life cycle
 - Energy
 - IDPR/DPR - 4,500 kWhr/AF of energy use annually
 - Non-potable 500 kWhr/AF



Reuse

all
things
water®
Hazen

