

Precipitation Enhancement

By

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Weather Modification Purposes

- Precipitation enhancement—to produce more rain and snow.
- Hail suppression—mostly in midwest and some foreign countries like France, Greece and Russia.
- Fog clearing, mostly Alaska and Montana— only effective when fog is below freezing temperature.
- The ASCE has manuals on WM practice.

In California

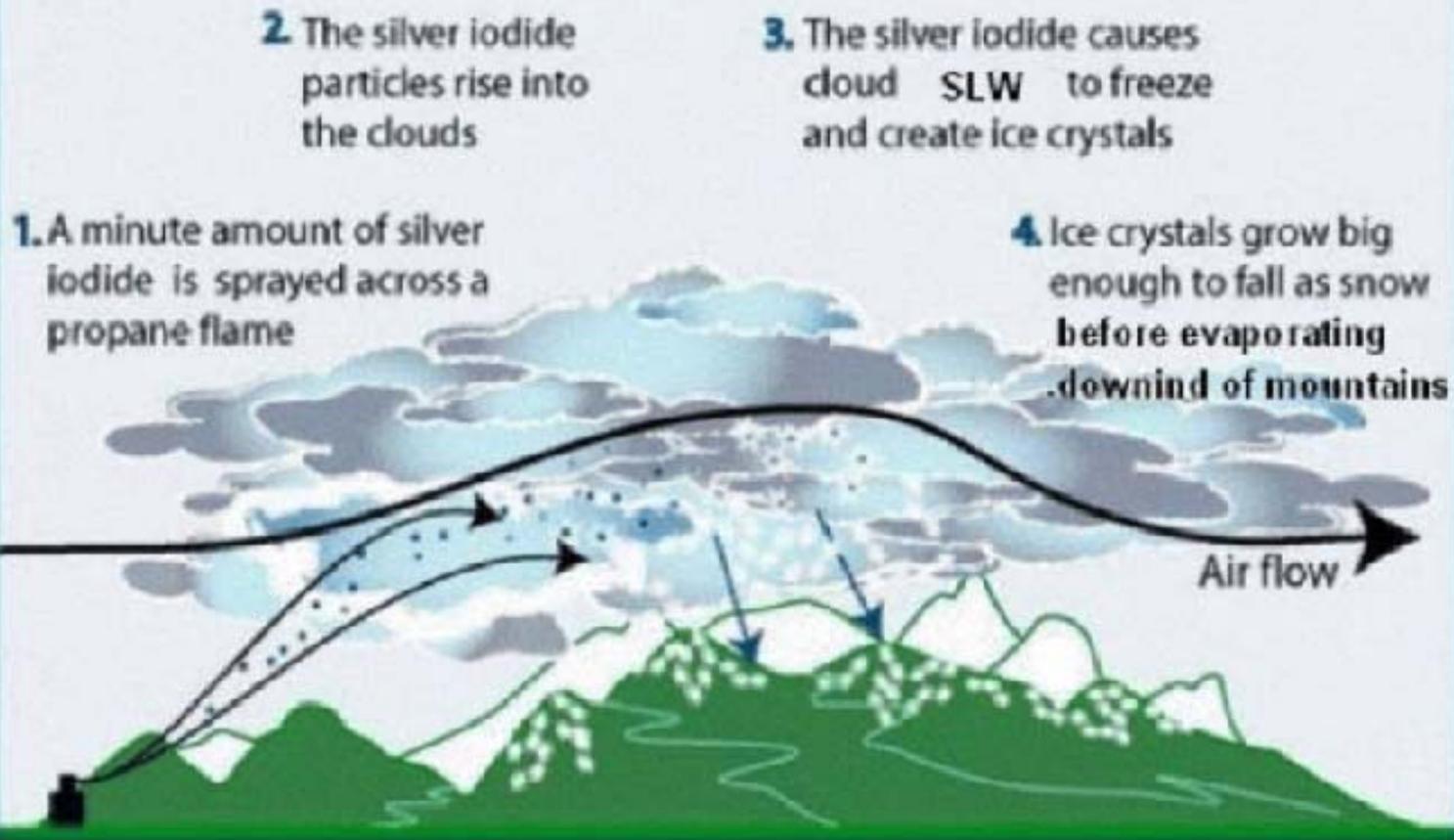
- 12 or more weather modification projects have operated in California in recent years. Several have operated for nearly 50 years—

Lake Almanor

Upper San Joaquin

Kings River

Winter Seeding - Silver Iodide



Courtesy of WET International, Denver, Colorado, USA

Cloud Seeding

- Cloud seeding--- by airplane or ground generator.
- Ground generators cheaper, but may not be as effective.
- Common seeding agents: silver iodide and dry ice. Liquid propane has been used a little. In recent years some hygroscopic substances used.

**RAIN AND SNOW ENHANCEMENT PROGRAMS
IN CALIFORNIA, 2005-2007 SEASONS**



PROJECT

1. Lake Almanor
2. Tahoe-Truckee
3. Upper American River
4. Upper Mokelumne River
5. Carson and Walker Rivers
6. Tuolumne River
7. San Joaquin River
8. Eastern Sierra
9. Kings River
10. Kaweah River
11. Kern River
12. Santa Barbara County
13. Monterey County
14. North Fork Stanislaus River

SPONSOR

- Pacific Gas & Electric Company
- Desert Research Institute
- Sacramento Municipal Utility District
- Pacific Gas & Electric Company
- Desert Research Institute
- Turlock and Modesto Irrigation Districts
- Southern California Edison Company
- City of Los Angeles
- Kings River Conservation District
- Kaweah Delta Water Conservation District
- North Kern Water Storage District
- Santa Barbara County
- Monterey County
- Northern California Power Agency

Ground-Based Seeder





Walker Basin: Willow Flat Site 2002





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Results

- Estimated 300 – 400 TAF per year produced.
- Potential – About the same amount.
- Generally storage needed to make use of additional runoff.
- Costs: Probably not more than \$ 20 per AF.

Probable New WM Projects

- Colorado River basin—several states are planning to fund additional cloud seeding projects, or longer operational seasons, in the upper basin above Lake Powell.
- PG & E, a major northern California electric utility, is planning to begin a project next year on the Pit and McCloud River basins above Shasta Reservoir.

Research Needs

- Analyze comprehensively results of existing projects for increases and the weather conditions most favorable for production of added precipitation.
- Better understanding of targeting.
- Evaluate new seeding materials.

Concerns about Impacts

- Downwind effects.
- Toxicity of silver iodide long term use.
- Added snow removal costs.
- Benefits to flatlanders vs inconvenience to mountain area dwellers.

Possible State Involvement

- Support continuation of existing projects.
- Support research to try to evaluate projects in California and other states.
- Support efforts to augment Colorado River supply by cloud seeding.
- Provide matching funds to help existing sponsors do research on their projects.
- Push for more federal research dollars in this field.

Nature Editorial in June 2008

- *Nature* is an international science journal
- WM has suffered from a negative bias
- Silver iodide seeding produces a small but significant amount of added precipitation
- A renewed push for scientific research into WM technologies is long overdue
- It is time to invest modest funds in basic research