NCAR | RESEARCH APPLICATIONS LABORATORY

WINTER CLOUD SEEDING

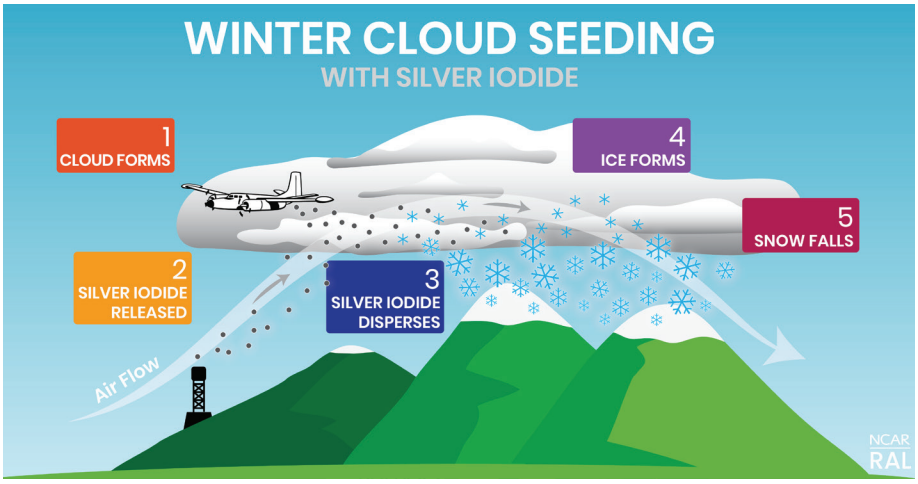
SNOWFALL ENHANCEMENT

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.

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

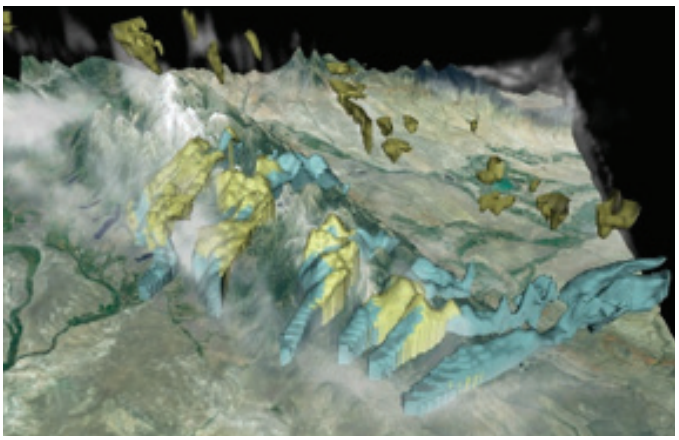
ral.ucar.edu
@NCAR_RAL
info@ral.ucar.edu

Clouds that contain supercooled liquid water are candidates for cloud seeding. However, not every mountain range is the same, nor is every storm the same. Therefore, it is necessary to understand the nature and characteristics of clouds in a region of interest before starting a cloud-seeding program.

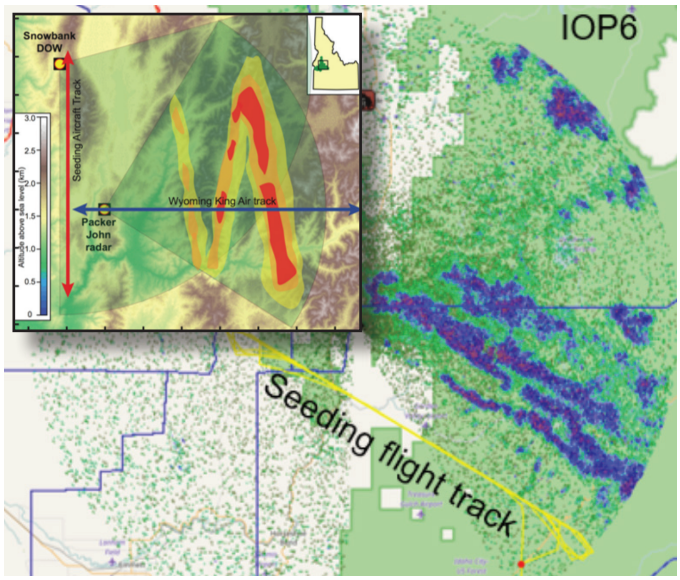
Differentiating the effects of cloud seeding on precipitation amounts, versus those effects caused by natural variability, is a challenge. Historically, cloud-seeding studies used randomized statistical experiments to assess precipitation differences between conditions with and without seeding, but statistically significant results were rarely obtained. This is partly because the impact of seeding is likely small when compared with the large natural variability of the weather. Despite these challenges, several significant advances made during the last decade are bringing us closer to the capability to quantify the impacts of cloud seeding.

COMPUTER MODELING

Supercomputing capabilities and weather models have advanced significantly providing new options for assessing the impact of cloud seeding. Specifically, RAL scientists developed a new computer modeling capability to simulate the effects of AgI in clouds (WRF-WxMod®). Now, WRF-WxMod model simulations can be performed with and without seeding for many storms and locations, which overcome the challenge of obtaining statistically significant findings from only statistical approaches. These advances open the door for numerous applications of WRF-WxMod, including evaluating the impacts of cloud seeding on precipitation; coupling with WRF-Hydro to advance our knowledge of the impact of cloud seeding on streamflow; real-time forecasting for cloud-seeding opportunities; and conducting simulations that inform and improve cloud-seeding program designs.



WRF-WxMod simulation of clouds (white), ice (yellow) and AgI seeding plumes (blue).



Hypothesized (left) and radar-observed effect of cloud seeding in SNOWIE

OBSERVATIONAL STUDIES

While the advances in computer modeling are promising, detailed observations are still needed to verify that models are accurately representing orographic clouds, precipitation formation, and their response to cloud seeding. RAL scientists participated in SNOWIE—Seeded and Natural Orographic Wintertime clouds: the Idaho Experiment in 2017, collecting unprecedented measurements from seeded clouds, using a variety of technologies. Findings include clear evidence that cloud seeding resulted in precipitation, as observed via radar. Specifically, a zig-zag pattern of precipitation was observed mimicking the dispersion pattern of AgI released by a seeding aircraft. These and other SNOWIE data are being used to better understand the physical response of seeded clouds and improve the WRF-WxMod cloud-seeding modeling capability. Together, these observational and modeling advances set the stage for new opportunities to address the research, program design, and evaluation of cloud seeding.

TO ORDER WRF-WXMOD® CONTACT
info@ral.ucar.edu 303.497.8422

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