Utah

Overview of Utah Propane Seeding Experimentation Winter of 2003/04

The State of Utah Division of Water Resources, with support from the U.S. Bureau of Reclamation, is conducting an experimental project into seeding mountain-induced clouds by expansion of liquid propane. The project will be carried out from late November 2003 until early March 2004 on the Wasatch Plateau of central Utah, east of the town of Fairview. Previous field studies in Utah and elsewhere, together with laboratory investigations, have shown that propane seeding is capable of producing very high ice crystal concentrations under suitable conditions. These ice crystal plumes diffuse to affect a large cloud volume as the plumes are transported by the airflow forced over mountain barriers. The same airflow creates "supercooled liquid water" (SLW) clouds, the necessary "raw material" for cloud seeding to work. Such clouds are colder than the freezing point of bulk water; that is, 0°C (32°F), but consist of tiny droplets still in the liquid state unless ice crystals are introduced by nature or seeding. Such clouds frequently occur near the windward slopes and crestlines of Utah mountain barriers during winter storm passages.

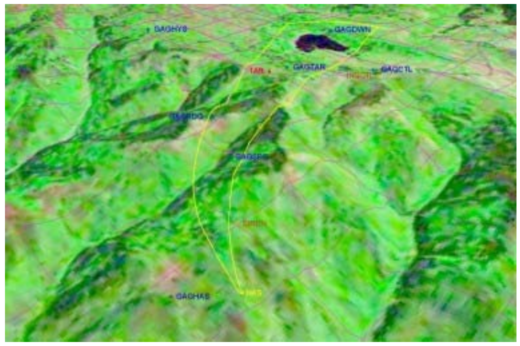
Propane must be released within or just below SLW clouds for the numerous and tiny seeding crystals to survive and grow. Such clouds can also be seeded with silver iodide, the agent used for operational wintertime seeding in Utah and many other locations. Silver iodide seeding is usually ineffective in SLW clouds warmer than about -8°C (+18°F) so propane seeding may be able to augment snowfall in such mildly supercooled clouds, known to be common during winter storms over Utah's mountains.

Propane dispensers must be located well up the windward (usually west-facing) slopes of mountains to be within the SLW clouds. This requirement results in a more expensive installation than locating manually-operated silver iodide generators in mountain valleys. However, this approach results in more certain targeting as shown by many plume tracing experiments. Providing routine transport of adequate concentrations of seeding agent, or resulting ice crystals, into SLW cloud regions is known to be the most serious problem for successful seeding of winter mountain-induced clouds. Propane seeding can be completely automated, on a 24/7 basis, with dispensers turned on only when SLW clouds are detected by a special instrument known as an icing rate sensor. Because some of the most seedable clouds are not associated with major storm passages, they are difficult to forecast. Automated seeding of such clouds is, therefore, another potential advantage of the propane approach.

The overall purpose of the winter of 2003/04 experimentation is to provide much better documentation on propane seeding effectiveness. Propane seeding has been physically shown to produce more snowfall during a limited number of well-instrumented experiments. However, insufficient observations exist to estimate the total seasonal impacts of propane seeding with any precision. The planned experimentation should provide significantly improved knowledge of the value of propane seeding, including the specific meteorological conditions required for it to be most effective. This will be accomplished in part by employing a randomized statistical design, leaving about half the experimental units nonseeded to provide a basis for comparison. Measurements taken crosswind of the seeding plumes will increase the power of the statistical analyses by monitoring natural changes in seedable conditions and associated snowfall rates. Particularly interesting experimental units will be subjected to detailed case study analyses to provide further insight into how and when propane seeding works and the magnitude of resulting seeded snowfalls.

The overall experimental approach is expected to significantly improve knowledge of propane seeding based on both physical and statistical evidence. Even if analyses results unexpectedly indicate propane seeding to be less promising than existing but limited evidence suggests, the experimentation will be considered worthwhile. Rational decisions could then be made whether to further pursue this seeding approach. If, as expected, propane seeding is shown to be capable of producing useful snowfall on a seasonal basis, an important new water resources tool will become available to increase the winter mountain snowpack and subsequent streamflows.

The figure below (click to enlarge) shows a three-dimensional map with a simulated15-degree wide seeding plume following a curved trajectory from the propane release site, over the target gauges and the TAR. The trajectory is curved because the wind direction becomes more westerly with elevation. Actual trajectories will vary in time and space and will be heavily influenced by the local topography. However, considerable past plume tracing has shown that releases from the HAS location routinely result in targeting of the main target location, TAR, when winds are from south through west. Such wind directions are known to occur during most of the significant SLW cloud episodes on the plateau. Grid lines on the figure below are 0.5 miles apart and the view is toward the northeast.



The site names starting with GAG have sensitive precipitation gauges. Four of the gauges will measure seeding effects along the seeding plume trajectory from the GAGSPC, the first gauge downwind of the HAS seeding site, to GAGDWN on the east side of Fairview Lakes, a reservoir on the plateau top. One upwind and two crosswind control gauges will monitor natural snowfalls. Meteorological observations at sites SIREN and INSCTL will provide supporting data for analyses. The primary and most instrumented target location, TAR, will have instrumentation to monitor ice crystal concentrations, sizes and shapes as well as icing rate (SLW cloud availability), winds, temperature and relative humidity. Instrumentation for the TAR has been interfaced by WMI engineers to a sophisticated data acquisition system leased from WMI by the State of Utah.

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