

HIGHLIGHTS OF THE CLOUD SEEDING TECHNICAL ADVISORY  
GROUP MEETING  
June 17, 2004

The fifth monthly meeting of the TAG was held June 17 at the Santa Fe Area Home Builders Association offices. Present were Duncan Axisa, David Jones, Francis West, Mary Helen Follingstad, Wayne Bundy, Walt Chapman, Bob Vocke, John Brown, James Stalker, Sig Silber, Roy Stoesz (Chair) and our two out-of-town guest speakers, Dr. Joe Warburton from the Desert Research Institute in Reno, Nevada, and Dr. Bill Woodley, President of Woodley Weather Consultants in Denver, Colorado.

The Chair passed out copies of an email sent by Don Griffith, President of North American Weather Consultants concerning chemical tracers. Don made the point that silver detection in snowfall was a useful measure, but it is a ground-based measurement, like precipitation. It would also be helpful to make in-cloud measurements of the seeding plumes themselves. NCAR developed the NCAR Counter, which detects silver iodide nuclei and provides qualitative measurements with a time lag. Another tracer, sulfur hexafluoride, provides quantitative measurements with less than a one-second time lag. These data can be used to validate computer models which predict transport and diffusion of the seeding plumes. Comments from experts concerning Don's comments are welcome in the Expert's Forum (see Agenda Item 4 below). Thanks for sharing this with us, Don.

Agenda Item 1) Summary of Funding and Operating Committee activities: Sig Silber

The F&O Committee has formed a corporation, the New Mexico Weather Modification Association (NMWM) and is applying for 501 © (3) tax status.

The NMWMA submitted a cloud seeding proposal to the Governor Richardson's Water Innovation Fund, a \$10 million fund looking to develop short-term pilot projects that will help to alleviate New Mexico's water shortage. The proposal calls for an initial \$150,000 for collection and analysis of climatologic data and for design of a pilot cloud seeding project, and for \$400,000 for the first year of cloud seeding, beginning in late 2005. We expect to hear by July whether this proposal meets with approval; if so, we will be asked to submit a detailed proposal. Although the timing is not certain, funds will probably not be made available until Fall, 2004. The two-page proposal is attached.

The F&O Committee continues actively to solicit funds from other sources. Meetings are scheduled this month with the Espanola Public Works Committee, the Santa Fe City Council, the Santa Fe Realtor's Association and the Legislative Interim Water and Natural Resources Committee.

## Agenda Item 2) Discussion of chemical tracers: Dr. Joe Warburton

The early part of Dr. Warburton's presentation covered the history of the use of chemical tracers in atmospheric studies, beginning some 45 years ago. He has participated in related research at the Desert Research Institute for over 35 years.

Measurements of silver content in snow are used to investigate the transport and dispersion of silver iodide (AgI). Dr. Warburton summarized his work in Central Sierra Nevada from 1978-1992. Background concentration of silver in snow samples is very low, close to 2 parts per trillion (2ppt), so that silver from AgI seeding with ground-based generators is readily detectable. Analysis of snow samples over several years shows that only 20% of the precipitation in the target area during seeding periods contained AgI above the background value. Snow with silver above background values occurred in only a few sites. He concluded from this that many winter seeding projects suffered from poor targeting of the seeding agent.

The stable isotopes of water have been used for many years in studies of water and ice in clouds. When water freezes, the isotopes of oxygen,  $^{16}\text{O}$  and  $^{18}\text{O}$  are trapped so that no exchange occurs between them. The ratio of the two isotopes has been found to vary linearly as a function of temperature. Knowing the cloud temperature gradient, one can calculate the altitude at which the super cooled liquid (SLW) water froze. His studies in the Sierras indicated that 75% of the snow samples were frozen at temperatures between minus 10 degrees and minus 15 degrees, which is about 1 km above the surface. In Australia, the SLW crystallized at temperatures warmer than minus 9 degrees, again within 1 km of the surface. Cloud seeding projects can benefit from these analyses by knowing at what altitude the seeding agent should be injected. The method also aids planning efforts; in the cases he mentioned, the altitude is too low for safe aircraft flights, so that seeding from ground-based generators is required.

A particularly promising method using indium and silver as tracers offers the possibility of calculating directly the amount of enhanced precipitation. Indium oxide ( $\text{In}_2\text{O}_3$ ) is a non-ice nucleating agent with about the same particle size as ice-nucleating AgI. The two agents are released from ground-based generators at the same place and time. At snow gauging stations the snow is sampled for the amount of indium and silver. The excess amount of silver over indium is a measure of the amount of enhanced precipitation. In the Lake Alomar example the Ag/In ratio showed about four times as much silver as indium. This ratio is then used to calculate the amount of enhanced precipitation. The cost of  $\text{In}_2\text{O}_3$  is about the same as AgI.

Along the way, Dr. Warburton dropped some interesting observations and rules-of-thumb:

- If we plan to use AgI, we need to sample for silver in snow for base-line data

before we seed.

- One gram of AgI precipitates 420 cubic meters of water on the ground.
- One AgI generator in the Sierras is required to seed 40 square miles.
- AgI in snow is non-toxic because it occurs in such minute quantities-four orders of magnitude below toxic levels.
- Using oxygen isotope ratios and measuring chemical tracers in amounts of ppt requires expensive lab facilities; we are fortunate to have those facilities available in nearby labs and universities.

Dr. Warburton impressed us all with his ability to convey complex data and ideas, with a background of drilling, sawing and hammering from the cabinet makers in the end of the conference room-undoubtedly a first for him and, we hope, the last for us. He graciously accepted our invitation to join the TAG.

### Agenda Item 3) Discussion of AgI as a tracer: Dr. Bill Woodley

The Denver Water Board conducted a control/target area cloud seeding program along the Front Range the past two winters. The operator claimed a 14% to 17% increase in precipitation for the first winter. Bill was asked to verify this by measuring the silver content in snow. Bill's thesis is that the presence of silver in snow in the target area is not proof that the snow came from seeding, but the absence of silver is proof that the nucleant was not delivered to the target area. He had 10 sampling sites and 3 control sites. The data indicated that only 2 sites had silver in amounts higher than background values. He concluded that the enhanced precipitation resulted not from the winter storms they seeded, but from a single very large storm in March. He believes that the generators were placed in the wrong location and that the seeding project failed. Interestingly, the DWB did not contract Bill to conduct a silver tracer study for the second year (a case of killing the messenger bearing bad news?).

### Agenda Item 4) Other

The Chair reported on the progress of new cloud seeding Rules and Regulations working their way through the ISC. Conrad Keyes said the final version is to be reviewed at a hearing in July. The Rules could be approved soon after, or, if there is a separate hearing, the ISC could approve them at their next meeting following the hearing..

The TAG has started an Expert's Forum in which experts are exchanging views. Sig Silber has volunteered to transfer the comments to the JyS web site at [http://eweb.lanl.gov/jemezysangre\\_meetings.htm](http://eweb.lanl.gov/jemezysangre_meetings.htm). Bob Vocke has entered Highlights of the past four TAG meetings on the web site.

### Agenda Item 5) Next meeting

We'll meet again July 15 at 9:00 AM at the Santa Fe Area Home Builders

Association offices. Bruce Boe with Weather Modification, Inc. in Fargo, ND will discuss their experiences in cloud seeding this past winter in Nevada, California and Idaho.