"NON-REVIEWED"

BACK TO BASICS?

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A recurring theme heard in recent years among atmospheric scientists is that maybe the time has come when the practioners in the field of weather modification should take a fresh look at their current activities to determine whether or not some of their techniques and seeding operations are effective in producing ice nuclei.

I have an uneasy feeling that when statisticians evaluate a seeding operation they assume the silver iodide was properly dispersed at the right time, in the proper quantity and in the best place within a cloud system to produce an optimum effect. It is also assumed that the silver iodide generator, whether burning a silver iodide solution or using pyrotechnic flares for producing ice crystal embryos is as effective and efficient as was found at some earlier time in a testing laboratory. Silver iodide nuclei are very unusual particles. If dispersed in an area permeated with ozone, most of their effectiveness as ice nuclei may be destroyed. If the pyrotechnic material used to vaporize the silver iodide produces large smoke particles they may absorb many of the smaller potential ice nuclei of silver iodide before they are dispersed beyond the smoke trail. If the concentration of primary ice nuclei is too high they will coagulate before being dispersed.

What should be done?

I strongly urge that the effectiveness of specific seeding materials be determined under field conditions. This can be done most effectively in the mid west and the northeast sections of the United States during winter. Extensive supercooled decks of stratus and/or cumulus clouds which are relatively thin; 1/2 to 1 km (1500 ft. - 3000 ft.) frequently develop in those areas.

By flying within the top of such clouds the seeding plane should dispense dry ice fragments and then silver iodide (or other seeding substances) followed again with dry ice. The dry ice should be dispensed as a mixture of powder and pellets with the largest of them being about 1/2" (1.3cm) using a seeding rate of 1 pound (1/2 kg) per mile. Each of the three seeding zones should be one mile long with a 1/4 mile unseeded strip separating the three paths.

Of course, there is a possibility that if the plane remains within the top of the cloud that a line of ice crystals may develop from the wing tip and propeller vortices. Such effects should be much less effective than the dry ice comparison runs since the zone of ice crystal formation would be a line rather than a vertical sheet. If this occurs the effect should be more like that produced by the silver iodide seeding.

The sequence described should be repeated at the end of the second dry ice seeding. These seeding runs should have a total length of about eight and one-half miles (15 km).

The plane could then be flown back parallel to the original tracks but two or three miles away in this return flight different seeding material could be tested again using two zones of dry ice seeding for comparison purposes at either end of the material being tested.

After making the seeding runs (which should take less than 20 minutes) the plane can climb high enough to photograph the resulting pattern. Of course, it would be better if a second plane could be used for control and photography, flying high enough so as to photograph the entire test area in a single photo. Pictures should be taken at five minute intervals for a period of at least an hour. This would insure obtaining information on seeding effectiveness, clearing speed, horizontal diffusion of material, cloud reformation, convective developments, etc.

A bonus from such testing activities would be the information gained on the feasibility and reliability of possible cloud dissipation. Such knowledge is particularly important for areas where sunshine reaching the ground has a high value in the form of solar radiation for activating ground based solar collectors on days when they would normally be inoperative. Another useful feature of such a study would be the first-hand knowledge and field experience gained by some of the younger atmospheric scientists working on weather modification programs.

If it were feasible to obtain replicas of the ice crystals produced by the seeding at ground level, such information would be of much scientific value. There is a strong likelihood, however, that only virga would form so that the crystals produced by the seeding would not reach the ground.

Such a testing program would be relatively inexpensive since small twin engine planes could be used in the operation. The experience and knowledge gained from such activities would be extremely valuable and highly practical. It might help to explain some of the puzzling problems which have arisen over the past years where little or no noticeable effects have followed the seeding operations.

In seeding with dry ice it is essential that the particles be released within the supercooled region. Unless air is supersaturated with respect to ice and colder than $0^{o}C$ ($32^{o}F$) the dry ice will evaporate and the exercise will be a complete waste of effort, time and money! It is also important that the dry ice fragments be protected from moisture before being used otherwise they will become ice coated and could easily solidify into a mass. Plastic bags are effective containers.

The rate of seeding with dry ice in a supercooled stratus cloud should not be more than about a pound per mile (1 kg/3km). There is a strong tendency to believe that "more is better" when such inexpensive seeding material is used. If too much dry ice is dispensed it produces a localized zone of very cold and "heavy" air thus generating a downdraft so strong as to take most of the ice crystal embryos to lower levels where both the dry ice and the ice nuclei would evaporate.

I believe such a field testing program is long overdue and that if properly conducted it would not only be of great value to our younger scientists but it might lead to a far more effective cloud seeding process. The unique opportunity that we have of initiating a massive change in the nature of a supercooled cloud system is something that is extremely rare in geophysical processes. We should be certain that our efforts in initating and achieving such a change are as effective as they can be, so that subsequent attempts to detect the effects of such efforts are based on reality rather than supposition!

REFERENCES

Schaefer, V. J., Project Sunshine. Journal of Weather Modification, Vol. 7, No. 1. 1975.