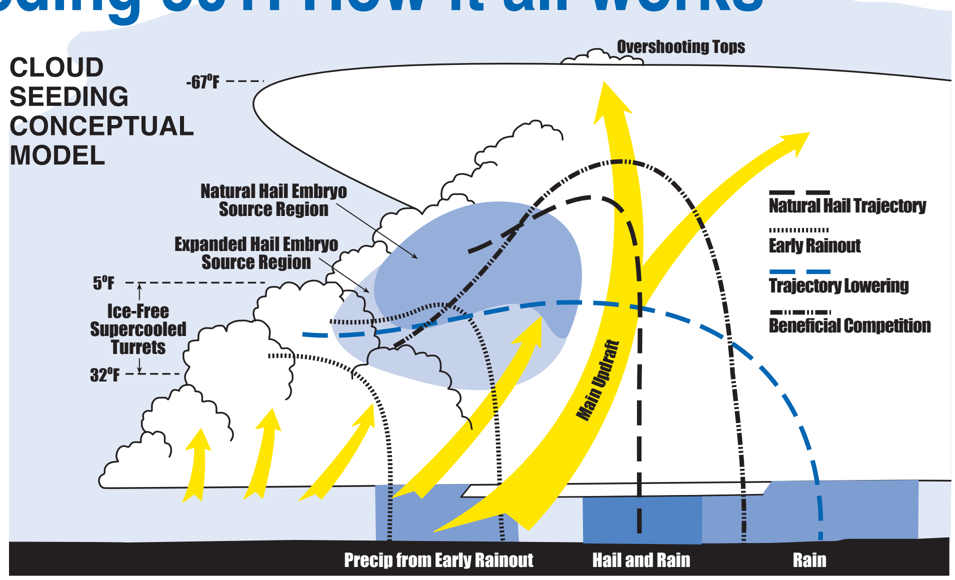
THE
ATMOSPHERIC RESERVOIR
Examining the Atmosphere and Atmospheric Resource Management

Cloud Seeding 301: How it all works

By Aaron Gilstad



In my last two articles on cloud seeding, I described the processes by which thunderstorms and precipitation develop and how operations are conducted. Now that you have some understanding of how natural thunderstorms work, and how seeding is done, I can begin to explain why cloud seeding works.

There are several theories behind modern cloud seeding, which are based on what we know about thunderstorm and precipitation development. We use these theories as a basis for targeting thunderstorms as we do. When seeding is done, a change is forced upon the cloud to increase its efficiency and the developing precipitation follows a slightly different path of growth. The figure here shows a simplified version of the changes believed to take place after seeding is started.

The most widely accepted theory behind cloud seeding for hail suppression is that of *beneficial competition*. Beneficial competition depends upon hail embryos competing for the limited amount of super-cooled liquid water contained within the cloud at any given time. The beneficial competition concept states that seeding adds ice nuclei to the cloud, significantly increasing the number of hail embryos present, and expanding the region in the cloud where hail embryos develop. These embryos then compete with the natural embryos for the supercooled liquid water in the cloud, thus making the resulting hailstones smaller. It is the same as cutting a pie to feed 30 people versus six people; everyone will get a much smaller piece. The increased number of hail embryos may also result in *updraft loading* and reduce the cloud's updraft speed. With such a large number of hail embryos, it becomes significantly less likely that the overloaded updraft of the thunderstorm will be able to keep the embryos aloft. This results in *trajectory lowering,* where hail embryos are kept at a warmer, lower level in the cloud and thus are less likely to grow to large sizes. The hail must then fall out of the cloud, both smaller and earlier than would have occurred naturally.

Rain enhancement is accomplished with the concept of e*arly rainout* in mind. The idea being that seeding will initiate ice production earlier and thus improve the potential for rain to form. An added benefit may be a slight increase in life span of the cloud, which means it would rain over an expanded area as compared to a naturally occurring localized rain cloud. Early rainout is also part of the conceptual model for hail suppression, as it may increase the growth of the cloud, cause it to precipitate earlier than it would naturally, thus reducing its ability to produce damaging hail. That cloud will be putting water on the ground rather than holding it aloft to form large hail. Additionally, if this seeded cloud grows bigger, faster than it would naturally, it will begin competing for the energy that may be supporting severe thunderstorm activity nearby, affecting a decrease in hail potential.

Clouds are far more complex than the diagram and my description would imply, but the concepts put forth are sound. Seeding affects the cloud in several different ways from beneficial competition to early rainout, basically making small adjustments to the cloud to improve the efficiency and manage the energy budget of that cloud system. Each component of the conceptual model is taken into effect in conducting the operational seeding that takes place around the world.

Atmospheric Resource Board
North Dakota State Water Commission
900 East Boulevard, Bismarck, ND 58505
(701) 328-2788
www.swc.state.nd.us/ARB/

ND Weather Modification Association
PO Box 2599, Bismarck, ND 58502
(701) 223-4232