THE
ATMOSPHERIC RESERVOIR
Examining the Atmosphere and Atmospheric Resource Management

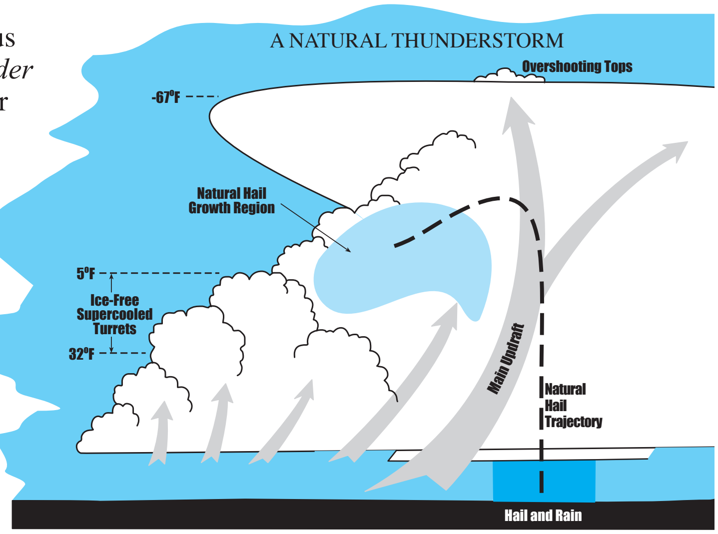
Cloud Seeding 101: Thunderstorm Development

By Aaron Gilstad

For nearly 50 years the North Dakota Cloud Seeding Project (NDCMP) has been conducted in western North Dakota from June 1 - August 31. The purpose of the NDCMP is to increase rainfall and decrease hail damage in the coverage areas, throughout the growing season. One of the challenges we encounter each year is simply explaining to the public how cloud seeding works. After all, how can such small aircraft, with so little seeding material hope to have any effect on thunderstorms that stretch for several miles? A big question requires a big answer; a bigger answer than the space I am allotted.

First, it is important to understand how a cloud and precipitation in that cloud is formed. In thunderstorms, a freezing process is almost always required to make rain. That is to say, all the rain that falls from a thunderstorm was frozen at some point, either as snow or hail or something in between. Partly because of the freezing process, clouds are also very inefficient at making rain. When water freezes, it prefers to freeze onto something, a speck of dust (or *nuclei*), a blade of grass, or your car. In a thunderstorm, the condensed water is very pure, and oftentimes, there is a lack of naturally occurring, efficient *nuclei*. Updrafts will bring some dust into the cloud as the thunderstorm continues to grow, but much less than would be needed to use up all the water.

Next, one must understand that thunderstorms are not made up of just one cloud, or *cell.* Mature thunderstorms are typically made up of one main cell and a trailing line of smaller cumulus clouds, called *feeder clouds*. The feeder clouds are new clouds, on the southern flank of the main cell, which will eventually develop into the main cell. Rain and hail will begin their development in the feeder cloud and begin to fall out as they mature into the main cell.



Cumulus clouds, which are the type usually seeded on the NDCMP, develop when warm, moist, surface air is forced upward into cooler air. That warm moist air condenses to form the cloud that we see. If the storm is big enough and the updraft is strong enough, this condensing water will grow increasingly colder, without freezing, as it rises in the cloud and becomes *super-cooled*. In fact, super-cooled liquid water has been observed at temperatures near -40°F in thunderstorms in both Texas and Argentina.

Rain and hail, which form in exactly the same way, begin to form as water droplets come in contact with the dust in the air. First, the water droplets must freeze to form a snowflake. The snowflake will then be blown around by the wind in the cloud and collect other snowflakes and more water droplets to form small snowballs called *graupel*. The *graupel*, if it is too heavy to be supported by the updraft, will fall out of the cloud and melt to form rain. Otherwise, the *graupel* may continue to circulate through the storm allowing more water to freeze to it, and grow into a hailstone. Once the hailstone is too heavy to be supported by the updraft, it will fall and either hit the ground as hail or melt and form rain if the hail is small enough. (The largest hailstone on record to date measures seven inches in diameter and 18.75 inches around, which fell in Aurora, NE, on June 22, 2003).

In describing how thunderstorms, rain, and hail are formed I hope to have laid some groundwork for future articles on cloud seeding. In upcoming issues I will attempt to explain the method for targeting and seeding clouds, the theory of how cloud seeding actually works, and the economic benefits to those areas with cloud seeding projects.

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