PROJECT SUNSHINE

by

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The effectiveness of the utilization of the sun's energy to provide heat for buildings is dependent on the direct unimpeded flux of its rays onto or into solar cells, heat panels, windows and similar units which utilize radiation and convert it into some useful form of energy.

The presence of clouds, especially of the stratus type, greatly reduces the periods of sunshine received at a specific location, especially in the Northeast United States and much of the Mid West. Such clouds of the strati-form type, often cover vast areas of the earth with a continuous deck of stable, slow moving clouds. In the wintertime, when sunshine would be most useful, such clouds often persist for many days.

Over a considerable portion of the United States stratus clouds in the wintertime are often supercooled. Quite frequently they are less than a kilometer thick, and in fact are often less that three hundred meters (1000 feet). Unfortunately the scattering effectiveness of the droplets in such clouds is extremely efficient so that with cloudiness the usable radiative flux from the sun is reduced to only a small fraction of the potential energy that would reach the earth under cloudless skies.

Whenever the temperature at ground level is near 0°C (32°F), there is a strong likelihood that these clouds will be in a supercooled state. Whenever this occurs, such clouds could easily be removed by seeding them with small fragments of dry ice.

Of all the things that can possibly be done by cloud seeding, the removal of a deck of supercooled clouds is the easiest. While some aspects of cloud seeding are still controversial, there is no argument whatever that supercooled stratus clouds and ground fog can be profoundly modified. In fact, this type of operation is now routine in the vicinity of commercial airports affected by supercooled fogs and low stratus throughout the United States and in many other counties throughout the world.

The first cloud seeding, which I carried out on November 13, 1946, transformed an alto-stratus cloud to a mass of falling ice crystals. On the 25th of the same month, I seeded a supercooled ground fog and saw it disappear. The following spring, under the aegis of Project Cirrus, we produced extensive holes and parallel, one mile wide strips of cloud-free air by seeding them with crushed dry ice, using about a pound (454 grams) per mile of flight. Shortly after conducting these demonstrations, I prepared recommendations for removing extensive areas of stratus clouds by flying back and forth between two fixed points on the ground, the length of the flight path depending on the rate of movement of the cloud deck. The seeding flight was planned to be at right angles to the direction of cloud movement, scheduled so that at the end of the round trip the cloud deck would have moved one mile. Thus, if the plane had a ground speed of 120 miles per hour, and the cloud was moving 6 miles per hour, the plane should return to its starting point every 10 minutes. Thus, each leg of the flight would be 5 minutes long, or 10 miles. By flying for five hours, the plane should modify an area 30 miles by 10 miles, or 300 square miles. Seeding with dry ice at the rate of a pound per mile would require 600 pounds of dry ice costing about $ 72. If the flight cost was $ 75/hour, the total cost for providing sunshine for perhaps a half day would be considerably less than $500.00 dollars. In an area like New York City or the Capital District of New York State as examples, from one to ten million persons would enjoy sunshine on a day that normally would be overcast. Whether such cloud decks would re-form would depend on the dynamic factors present at the particular time.

As with any operation related to natural phenomena, there are likely to be problems which might nullify the effectiveness of such an effort. If there were several layers of clouds rather than a single deck, such an effort would be much more complicated and perhaps impossible to carry out effectively. If the atmosphere had a convergence of moist air occurring at cloud level, new cloud might form as fast as the other cloud was removed. Occasionally, with the ground temperature at 0°C, the air aloft might be warmer so that the cloud was not supercooled and thus could not be affected by seeding.

However, the type of stable stratiform cloud deck which is of common occurrence over extensive portions of the United States in the wintertime is thin, supercooled, stable and persistent, and above it the sun shines brightly without any higher clouds present. I have often flown from Albany to Chicago and even to Denver with nothing but this type of cloud covering the earth. Last winter I observed such a cloud covering all of northern Arizona and extending at least as far into Utah as Salt Lake City. It was ideal for a dry ice modification operation. Satellite photos show this type of cloud pattern to be a common winter feature over the northern United States. I believe there are exciting possibilities that should be actively explored for their potential of increasing the supply of solar energy received in the mid-latitudes of the United States.

The removal of such clouds would be most useful if they could be eliminated for the period of 0900 - 1600. Ideally one would like to have the clouds reform in the late afternoon to prevent night time radiative cooling!

To be most effective and practical it is important that the plane used for the dry ice seeding operation should be equipped with suitable navigational aids so that it can be flown between two specific geographic reference points. In addition it should be equipped with a dry ice dispenser which can reduce sheets of dry ice to fragments that are pea size and smaller in a continuous and reliable manner. The dry ice fragments to be most effective must have such a size that most of them will fall a minimum distance of 300 meters (1000 ft.) before they have evaporated. Particles should not be larger than 1 cm (3/8"). To be most effective and economical they should range in size from 1 cm, as a maximum, to 1mm, average size being about 0.5cm (3/16").

Dry ice powder will be wasted unless the plane is partially immersed within the top of the cloud. The most effective procedure is to have a dry ice fragmenting device which dispenses between one and two pounds of suitable sized fragments per mile of flight.

Our field studies at Yellowstone have indicated that the concentration of particles in a modified cloud should not exceed 200 per liter. Crystals formed in a supercooled cloud having such concentrations, produces particles of 100 microns and larger which have fall velocities of 30cm per second and more. It is desirable if at all possible, that the ice crystals formed from dissipating a cloud deck fall to the ground or evaporate within 1 hour after the seeding run has been made.

With the increasing need to develop alternative sources of energy for heating and cooling buildings such as homes, greenhouses, factories and offices the possibilities of increasing the sunshine reaching the earth is a challenging objective. Quite apart from the additional energy that would attend a successful engineering operation are the less tangible but equally important sociological effects likely to occur.

Since we know how to conduct such an operation I hope someone will come forth to see whether such an operation is worthwhile!