IS SOMETHING HAPPENING TO OUR SUPPLY OF SUPERCOOLED CLOUDS?

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On October 19, 1977, on a flight from Albany, New York to Reno, Nevada, I spent most of the trip on the sunny side of the jet aircraft watching the world go by.

The flight route from Chicago to Reno went past Cheyenne, Elk Mountain, Flaming Gorge Reservoir, just north of the Bingham Copper Pit, and then across the Bonneville Salt Flats into Nevada. Much of the region west of Chicago was cloudless but shortly after we crossed the Nevada state line, the first batch of cumulus clouds appeared as we approached the Ruby Mountains. Proceeding west southwest, convective clouds increased in concentration until they obscured the ground. The sky above our plane was cloudless and there were no middle clouds.

Proceeding westerly, I was interested to see that many of the clouds, which consisted of large strato cumulus, were shifting to ice crystals and in a number of instances they were entirely glaciated. Bright undersuns could be seen at a suitable angle with the sun wherever the plane passed across the ice crystal areas.

With the massive cloud modification pattern that was visible, I was extremely interested to determine, if possible, the source of the ice nuclei. As we neared the Reno area, it was easily seen that the pollution plume from the city had moved into the area where the glaciation was observed. It is almost certain that the cloud modification seen was being caused by something in the air from the city.

I have made this flight into Reno at least once a year during the October-November period for more than fifteen years, and this is the first instance when I have seen such a massive glaciation occurrence.

In the early sixties, much of the pollution visible in the Reno basin consisted of the smoke from saw mills, a brick works, and other industrial operations. These sources are no longer present (or visible), the main pollution is now produced by automobile traffic. This has burgeoned with the rapid growth of the city and its surrounding area.

The mountains surrounding Reno, particularly to the southwest, west and northwest are responsible for the development of a strong nighttime inversion in the region occupied by the city. This generally disappears after the sun has heated the ground for a few hours, the prevailing westerly winds carrying the accumulated pollution easterly into the region where I observed the glaciation. The city haze that appears over Reno during the night has
recently been described and illustrated by Hallett. The increase in intensity of this accumulation of air pollution has become apparent to many local residents over the past few years.

As I pointed out some time ago, I believe the major component in a city plume producing ice nuclei consists of the sub-microscopic particles of lead coming from the exhaust of automobiles. Such lead particles react with trace amounts of iodine to form lead iodide. Over past years, I have seen extensive glaciation effects similar to that described, downwind of Seattle, San Francisco and the Los Angeles Basin areas, as well as major cities in the East. The Los Angeles effect often extends as far as Phoenix, Arizona.

On another flight from Albany to Chicago this past fall (October 10, 1977), I saw a similar low level glaciation of clouds occurring between Detroit and Chicago. The cloud pattern in this instance was more complex than the simple stratocumulus system which existed in Nevada. As with the Nevada observation, there were no cirrus clouds above that might serve as a source of ice embryos. The sky at our level of 37,000 ft. was devoid of clouds, the air being quite dry as evidenced by the lack of persistent contrails.

Detroit was cloudless, so I was able to see from several power plant plumes that there was a strong westerly wind. A short distance west of Detroit we flew above the cloud system. The upper level of patchy altostratus at 11,500 ft. was supercooled without any trace of undersun or virga. A lower region of clouds, which appeared to consist mostly of stratocumulus with tops of 8,000 ft. and a temperature of -8°C were extensively glaciated, showing a bright undersun whenever the sun penetrated the patchy clouds above at the right angle. I received information on the cloud heights and temperatures from the engineer of our American Airlines flight.

These two recent examples are cited to draw attention to an increasingly apparent change in the nature of clouds over a considerable area of the United States. In regions where noticeable glaciation occurred when temperatures reached -20°C or colder, a complete change in phase now frequently occurs over extensive areas when temperatures are -10°C or warmer.

I am aware, of course, that ice crystals have frequently been found in clouds at these warmer temperatures, but in most instances the concentration of such particles are not more than a few crystals per liter. The concentrations I am observing are frequently several orders of magnitude higher and could reach 10,000 per liter or more.

In routine measurements I have been making in moderately polluted air, I frequently find concentrations of submicroscopic lead particles higher than 100 per cc at -20°C.

While it is also possible for extensive glaciation to occur from massive dust storms such effects require temperatures of -12°C to -18°C and ice crystal concentrations are rarely higher than 10 per liter.

In most instances when extensive areas of low level ice crystals in high concentration are seen, visibility is generally poor and of the type frequently
seen above and downwind of large cities. Lower concentration of ice embryos much more distant from the city source could occur without the circumstantial evidence of polluted air.

With the ever-increasing numbers of automobiles and the extensive network of highways over the United States, even in areas that are sparsely settled, it is of considerable importance that attention be paid to this extensive source of potential ice nuclei. While lead compounds alone will not produce such nuclei, the trace amounts of iodine found in maritime air from some industrial processes and the burning of certain organic substances, produce enough free iodine to convert the lead to lead iodine.

Since most cloud and weather modification operations depend on the presence of unstable supercooled clouds, I believe it is important to determine whether these anthropogenic effects are as pervasive as I believe they are, so that we can properly and intelligently assess the situation as it relates to weather modification.

REFERENCES


