

TIME FOR A CHANGE

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*It has been more than forty-four years since I spread six pounds of crushed dry ice into a cloud over the summit of Mount Greylock in Massachusetts and triggered a fall of snow from a supercooled cloud. While the snow probably did not reach the ground, it inaugurated a tremendous amount of publicity, research, entrepreneurship and controversy. Within a few years, preposterous claims were being made to farmers, local governments and others for the control of the local precipitation patterns, rainfall, the reduction of hail damage and other weather related phenomena.*

*Meanwhile, our group had embarked upon an intensive study sponsored by the defense establishment to determine the possibility and limitations of this exciting ability to modify supercooled clouds in a massive way. After five years of field research in the northeast and southwest using B-17s, B-29s, and lesser aircraft, the Korean War needs took away the pilots we had spent a year or more training so we decided to terminate what was called "Project Cirrus". A popular account of our activities along with a Final Report summarized the activities we conducted in carrying out 272 flight operations and much intensive laboratory studies. Few basic changes have occurred in this field since 1952 when we terminated our activities.*

*Many marvelous field instruments, sophisticated cloud physics aircraft and ground based sensing gear such as radar, lidar, computer and similar devices have been developed since those days and control procedures have become available having a precision that was unknown in early days. Despite all of this equipment and the mounting of elaborate programs, controversy still plagues the field. Why is this so?*

*I believe the basic problem lies in the erroneous assumption that it is possible to use statistics to "prove" the effect of cloud seeding activities. Many years ago in a talk before the National Academy of Sciences at Schenectady in discussing his ideas concerning convergent and divergent phenomena (the latter now called "Chaos"), Dr. Irving Langmuir said, "We will be able to control the weather before we can predict it." It is now clear after several years of stagnation in the research field of weather modification that it is quite impossible to find cloud systems which repeat themselves to the degree necessary if random pairs are to be compared to each other. Seeking this illusion has cost the taxpayers millions of dollars but most devastating has been the conclusion that weather modification "doesn't work", "the weather is just too massive", or "there aren't any supercooled clouds anymore".*

*Thus, I believe the time is right to completely abandon the randomization procedures used during the past generation and to embark upon a new effort based on the use of the physical evaluation of seeding effects. In the process of carrying out such field studies it is essential that a thorough understanding is achieved in applying the seeding materials in the right place, the right amount and the right time! Too often one or more of these factors has been disregarded or overlooked and thus the project is headed for failure shortly after it has been started. Over the years other substances besides dry ice and silver iodide have been proposed as substitutes but none have replaced these two substances which were proposed by Schaefer and Vonnegut in 1946. There are many other ways of achieving a localized environment colder than  $-40^{\circ}\text{C}$  ( $\text{F}$ ) than the utilization of solid  $\text{CO}_2$  (dry ice). However, none of these can compare in cost, versatility or availability.*

*The number of viable ice embryos which can be produced under optimum conditions by these two materials is little short of fantastic. These range from  $10^{12}$  to  $10^{16}$  per gram of dry ice or silver iodide. Depending on dilution processes, the number of such embryos which develop may be reduced by one or two orders of magnitude but even they are sufficient to match or surpass Nature in the methods that often initiate or control weather systems. That is why I believe there is high potential in properly understanding and exploiting techniques that can lead to a realistic control of certain types of weather phenomena. As the new approach to divergent phenomena develops, it emphasizes the critical role that trigger the effects which control subsequent development of a process. It is this aspect of weather that offers hope that it may be possible to initiate a massive change in a system constituting a chaotic state and shift it toward a convergent phase.*

*There are many physical effects which can be observed and exploited to establish the effectiveness of an effort to control the direction of a weather system. A few of them include: 1) field observations of snow type, 2) observations of the sizes and concentration of precipitation particles, 3) the concentration of cloud condensation nuclei, 4) the residue of clouds in the atmosphere following the precipitation cycle, 5) the appearance and intensity of radar echoes, 6) the cloud behavior following the seeding operation, 7) the electrical nature and changes in the cloud system, 8) the appearance, type and quantity of cloud remaining in the sky after precipitation has occurred, 9) the timing and shifting of phase (liquid or solid) following the introduction of seeding materials, 10) the timing sequence in the development of radar echoes. Such are some of the physical parameters that merit the attention of exploration minded scientists. The job ahead is still a challenging one, but I am confident that some of the newer young scientists I know are up to these requirements and I am sure will have a fascinating time in achieving meaningful results.*

*I hope that we have a few influential senior scientists in America equal to the job and who have the real imagination, fortitude and leadership qualities necessary to put such a program together. The stakes are high but the results and benefit/cost ratios so advantageous that such efforts will be well worth the efforts expended.*