Present Status of Rainmaking in the Southwest

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YOUR program chairman, Mr. Allred, has asked me to discuss the present status of rainmaking in the southwest. I should emphasize that what I shall say represents my personal view on the current status of rainmaking in the southwest. I emphasize this because there is a high probability of disagreement in this particular field and we shall have to allow time for definite decisions on some points now in question.

The rainmaking programs which have been attracting increasing attention during the last three or four years developed out of a number of well-established facts on the one hand and from definite theories about precipitation on the other hand. It has been assumed that natural processes of precipitation (thunderstorms, for example) necessarily depend upon the prior formation of tremendous numbers of tiny ice particles in the cloud. It appears to be well-established that such ice particles will not form by direct sublimation unless there were tiny nuclei present to give them a start, or unless the temperature were very low, say about 40 degrees below zero. It is assumed that the ice forming nuclei are of the foreign body type, namely, tiny dust particles floating about in the atmosphere.

Rainmaking efforts are based upon the belief that such sublimation nuclei usually are so low in abundance that natural processes of precipitation are inhibited. If one examines samples of the atmosphere from day to day, and makes careful determinations of numbers of effective nuclei present in, say, a cubic foot of air, he finds that the atmosphere does, indeed, lack the kind of nuclei assumed to be essential. The counts which one gets of the abundance of effective sublimation nuclei vary over wide ranges, but I think it is safe to say that sublimation nuclei, of the dust particle type, are not provided reliably by the atmosphere.

Rainmaking technicians have been alerted to this apparent defect of nature and, of course, they have been aware of the fact that a number of laboratory scientists have suggested that a certain artificial nucleus having remarkable properties, silver iodide, may serve as such a nucleating agent. It is quite easy to dispense extremely small particles of silver iodide into the atmosphere. Such particles appear to be effective at relatively warm temperatures, say from minus 8 to minus 12 degrees centigrade. This behavior of silver iodide with respect to temperature presented what appeared to be great advantages because nature rarely provides nuclei suitable for sublimation centers which are effective at such warm temperatures. In general, nature's nuclei do not work until the temperature gets down to something like minus 20 degrees centigrade. In fact, the observed number of effective natural nuclei may be multiplied by something like 10 if one decreases the temperature one degree in the range from minus 21 to minus 30 degrees centigrade.

In view of these considerations it seemed quite natural to expect that if one could provide the atmosphere with

an adequate supply of sublimation nuclei effective at the warmer temperatures, that he would greatly enhance the possibilities of rainfall. It was assumed that silver iodide would work in clouds in about the same way that it works in the laboratory and that it would remain effective for a considerable time, even in the presence of sunlight.

These views, when considered well, make an excellent prospectus for rainmaking effort and many people, including this speaker, have been rather surprised to find that the application of these notions to the atmosphere are disappointing, to say the least. The number of applications of silver iodide smoke to nature's clouds, and the apparent indifference of the clouds to its presence, seems to call for considerable explanation. It is necessary to look at the weak spots in our prospectus. There are several of such weak spots. One, which is suggested immediately, is the possibility that silver iodide in these tiny particles is destroyed by the action of sunlight. This is not such an unreasonable assumption because we know that many of the metallic halides are sensitive to light in that they are "reduced" by light. Silver bromide, you know, is the sensitive material of the photographic plate. A dish of silver iodide placed in the sunlight will change color. We thought that this question should be investigated and, in fact, we did investigate it and it looked to us as if the silver iodide we dispensed lost its effectiveness quite rapidly under the influence of bright sunshine. Other investigators have disagreed with us on the action of sunlight and questions of purity of the particles have been introduced to account for the apparent divergence in results.

Let us leave the silver iodide versus sunlight question to the future and examine our prospectus for other defects. It is our opinion that there is a very important defect and that is that it now appears that many rainstorms, including our own thunderstorms, do not need tiny particles to initiate precipitation. This leaves us with a little more charitable attitude toward natural processes, but it still leaves us with the question of whether ice particles, if artificially induced in nonprecipitating clouds, would enhance rain production in such clouds. Speculation on this question must be based upon a careful statement of how the treatment is applied. We know that silver iodide will modify supercooled clouds and I see no reason to doubt that silver iodide introduced into a cloud of exactly the right condition will cause the cloud to respond in a way consistent with the existence of a large number of ice particles.

I am not in a position to say whether this individualized treatment is likely to become economically valuable in producing increased rainfall. I can only say that I do not know of any procedures of this kind which have been demonstrated to be effective in dollars and cents value.

The expensive procedures involved in the individualized therapy of clouds has made it seem desirable to treat the entire atmosphere over a particular region on the assumption that sublimation nuclei of the silver iodide type would help any cloud to precipitate its moisture. This procedure, I believe, should have much more careful consideration than has been given it up to this time. We must remember that a thunderstorm or any convective storm in this part of the world is necessarily a special event. Only a small fraction, say one to ten percent, of clouds which put in their appearance in the southwest have a chance to rain. This apparent inefficiency develops out of the fact that a thunderstorm requires a lot of room and that its circulation pattern

must include a relatively large amount of space outside the cloud. It is only the occasional cloud which has sufficient energy to develop into a going storm which produces rain. The smaller clouds put in their appearance, tiny water drops form, but the water drops do not grow to large size because the water and energy budget of the cloud are not adequate to satisfy the conditions necessary for precipitation. These clouds are supercooled, however, and it is reasonable to expect that sublimation nuclei introduced into them would be effective in initiating processes of precipitation. This sounds very good until we remember that this cloudbase is going to be a long way from the ground in the southwest, and the precipitation which falls from such an immature cloud usually will not reach the ground.

The evaporation of precipitation in the region between cloud and ground has an interesting bearing on mountain rainfall in the southwest. It is common knowledge that mountain tops are favorable to thunderstorm development, but it is not so well appreciated that the relative proximity of the ground to the cloudbase provides for more efficient raining. That is, more of the precipitation from the cloud reaches the ground. We would be in a bad way for rain on the ground in the southwest if all of our land were near sea level. It is difficult, however, to guess what such a topographic situation might provide because, in that case, we would not have the differentially preferred convection channels provided by our mountain ridges. We might do well to study more the effect of mountains on the thermodynamic properties of the atmosphere.

If we treat all clouds with silver iodide by area-wide "seeding" we induce ineffective precipitation in small clouds and produce little or no effect upon the big cloud, because it was going to rain anyway. At any rate, the big cloud appears to be pretty well organized to rain, because it exhibits a proper energy and moisture distribution. One might be inclined to take a chance and add a pinch of silver iodide, if he could do so without fear that harm would be done. I believe that very serious harm could be done in the case of immature clouds. This is more than a belief on my part, it is the result of a careful consideration of the thermodynamics of thunderstorms. I have developed this argument in considerable detail on other occasions, and this is not the time nor place to enumerate the considerations involved. I think, however, that one can make a general statement which should make us cautious about any haphazard attempt to induce increased rainfall.

I shall close with such a statement. If silver iodide acts like it is supposed to act, and if it is dispensed over a large area in quantities sufficient to be significant for the purposes of rainmaking, it will induce irreversible processes in immature clouds which will decrease the thermodynamic potential of the local system and thereby decrease the probability of the development of a precipitating thunderstorm.