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NEW ZEALAND METEOROLOGICAL SERVICE

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## WEATHER MODIFICATION

At the Seventh World Meteorological Congress held in Geneva, 23 April-23 May 1975, the World Meteorological Organization adopted a statement for use as a basis for replying to relevant enquiries. The Statement appears as Annex II to the Abridged Report with Resolutions, Seventh World Meteorological Congress and is reproduced here for information.

(J.F. de Lisle)
Director

New Zealand Meteorological Service
P.O. Box 722
Wellington.

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NEW ZEALAND METEOROLOGICAL SERVICE

# STATEMENT ON "PRESENT STATE OF KNOWLEDGE AND POSSIBLE PRACTICAL BENEFITS IN SOME FIELDS OF WEATHER MODIFICATION"

## 1. General.

It has been demonstrated that ice crystals may be caused to form in supercooled clouds by seeding them with dry ice, silver iodide and other nucleants. Ice crystals are known to play an important role in the process of formation of precipitation; cloud seeding therefore provides a means of modifying the precipitation process in some types of supercooled clouds. The seeding of a supercooled cloud converts it to ice, releasing latent heat which can have important dynamical effects. The varied and controversial results of seeding experiments appear to be due to the complexities of the dynamics and microphysics of the precipitation process. An encouraging beginning in the understanding of these processes has been made through the development of numerical models which incorporate both the dynamics and microphysics and their interactions. Such models and their successors may be expected to define more clearly the most favourable seeding situations and the observations needed for the evaluation of the results. Although some experiments have apparently yielded positive results, the possible practical benefits of weather modification can be realized only through an increased research effort. This research should be directed primarily at cloud dynamics and mesoscale dynamics and the interactions of dynamics with microphysics, since knowledge of the latter is relatively more complete. There is a great need for simultaneous measurements of dynamical and microphysical parameters.

Some experiments have been made to test the possibility of seeding warm clouds with hygroscopic particles or water droplets in order to increase precipitation. The results obtained from these experiments have not been conclusive or sufficiently positive.

It appears that the most sophisticated statistical procedures are an inadequate substitute for more complete knowledge of the atmospheric mechanisms. However, statistical design and evaluation of experiments are both necessary to increase our understanding of physical aspects in the further development of weather modification, particularly in connexion with the evaluation of the practical results of experiments.

It is important to emphasize that weather modification is still largely at the research stage. For this reason, operations should be undertaken only after the most careful study by experts of the particular situation, and on the understanding that the desired end results may not always be achieved.

Brief summaries of the current status of weather modification in several categories are given below.

2. Stimulation of precipitation

Of the many experiments conducted in this field, only a few have clearly demonstrated that seeding has increased the precipitation; in some cases, there is evidence of a decrease. However, these apparent contradictory results seem to emerge from the fact that, in different geographical locations, clouds have different cloud-droplet spectra and different ice-crystal properties and concentrations. There is some evidence that wintertime orographic precipitation can be somewhat increased over mountain ranges. Similar results have also been obtained in subtropical, continental cumulus clouds in winter.

There is some evidence that certain subtropical convective clouds become taller and larger, with a tendency to merge, when they are heavily seeded to release latent heat.

In view of the high correlation between the size of convective clouds and the rainfall from them, the seeded clouds presumably give more rain than if they had not been seeded. Confirmation is required from further suitably designed experiments.

3. Dissipation of fog

Supercooled fog and stratus can be dissipated by growth and sedimentation of ice crystals, induced by seeding the fog with ice nucleants or by means of cooling agents. This has been brought into operational use at several airports at which there is a relatively high incidence of supercooled fog. The more common warm fog may be dissipated by the use of heat, hygroscopic particles and the down-wash of helicopters. Successful experiments have been reported with each of these techniques, but only the use of heat seems operationally viable at present.

4. Hail suppression

Many countries have focused considerable attention on hail-suppression projects in the last decade or so. In spite of the complexity of the hail-forming processes and the extremely large variability in hail occurrence which make hail-suppression experiments very difficult to assess, there appear to be promising prospects of success in the near future.

Impressive reports of successful reduction in hail damage to crops, with resulting economic benefit, have provided impetus to many experiments and large, mainly operational projects. As yet, there are no universally recognized methods and the results to date are not unambiguous. The seeding methods produce different effects on different storms, and it is essential that detailed understanding of the structure and the processes of various types of storms be obtained so that seeding procedures specially tailored to the specific atmospheric conditions can be determined. The development of numerical models is of great importance for the future understanding of the processes within cumulonimbus clouds. These models should incorporate proper dynamics and thermodynamics with details of the mircophysics and water-phase transition processes and their interaction. This approach should be tested against detailed direct measurements of cloud properties.

More basic research is required to resolve questions on various hailstorm theories, models and suppression techniques. Development of more reliable evaluation methods based on both physical and economic indicators is also needed.

5. Hurricane modification

The seeding of hurricanes has been followed by reduced maximum wind velocities. Confirmation is required from further experiments which should include an increased number of measurements in pertinent regions of the storm. This is because assessment will largely depend upon physical methods, rather than statistical ones. There is also need for improved numerical hurricane models to provide guidance for future experiments.

6. Other aspects

Exploratory investigations are being conducted into the suppression of forest and bush fires, the inducement of downdraughts in developing convective clouds and the prevention of lightning. Attempts are also being made to seed cold ice-supersaturated layers of the atmosphere, in order to produce clouds, with the object of preventing the formation of radiation fog.