FREEZING NUCLEUS MEASUREMENTS IN JANUARY 1957*

By E. G. Bowen†

It is well known that the appearance of the ice phase in supercooled clouds is one of the more important phenomena leading to the formation of rain. The formation of ice crystals is itself dependent on the freezing nucleus content of the atmosphere. Little is known about the nature and origin of natural freezing nuclei, but daily measurements of freezing nucleus concentration made in different parts of the world during the month of January in the three years 1954, 1955, and 1956 have suggested that some fraction of them might be of extraterrestrial origin (Bowen 1956). The present note describes a further series of measurements made during January 1957.

If the nuclei were of extraterrestrial origin, one might predict that:

(1) there would be three peaks in the freezing nucleus concentration in the period from January 10 to February 1;

(2) the peaks would occur on approximately the same dates in the northern and southern hemispheres;

(3) they would occur on approximately the same dates as in previous years, namely, January 13, 22, and 30.

It is natural to expect that the date of these occurrences would show a scatter, and in previous years this has averaged ± 2 days. In any one place and in any given year it could obviously exceed this value. The spatial distribution of nuclei through the atmosphere is unknown but it is almost certain to be patchy. All the peaks would not necessarily appear in all localities, therefore, but in previous years they have appeared in 19 out of 27, that is, approximately 70 per cent. of the predicted occasions.

In this particular series of observations, measurements were made at one station only in 1954, at four stations in widely separated parts of the world in

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† Division of Radiophysics, C.S.I.R.O., University Grounds, Chippendale, N.S.W.

1955, and again at four stations in 1956. The 1957 observations were made at eight different stations, six of which were in or around the continent of Australia and two in the U.S.A. These measurements were made at ground level using an expansion type cold chamber designed by Bigg and Warner (Warner 1957). It is known from previous experience that great care must be exercised in the

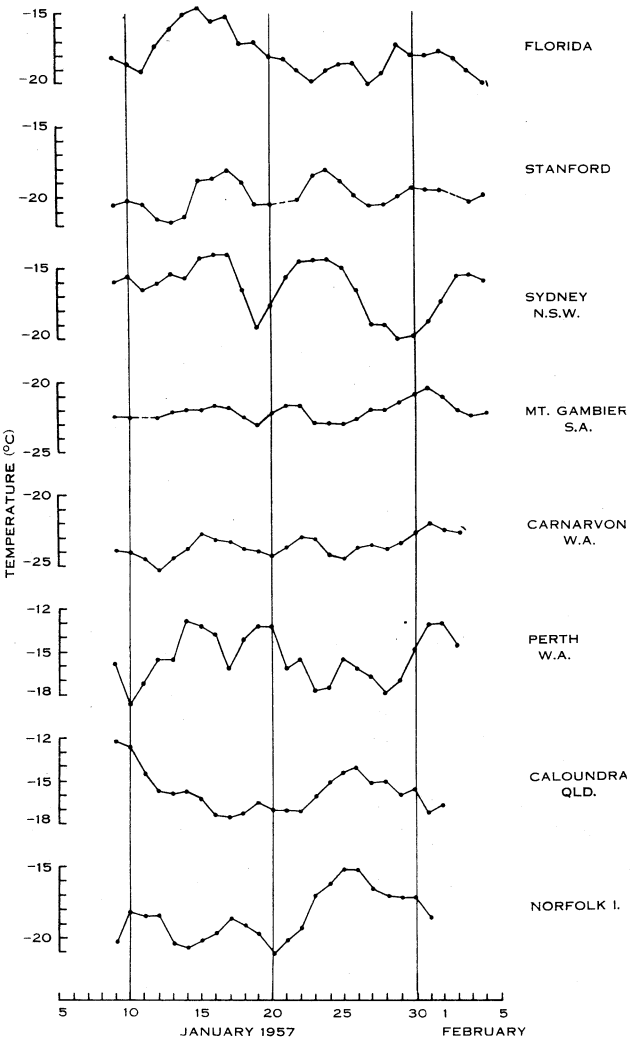

Fig. 1.—Temperatures at which 0·1 freezing nuclei per litre were observed at eight different stations during January 1957.

choice of site so as to be free from the effects of contamination. Broadly speaking, difficulties may arise from: (*a*) terrestrial dust of local origin; (*b*) industrial smoke, which in some cases is known to enhance the nucleus count and in others is suspected of depressing it; (*c*) widespread rain, which might wash the nuclei out of the atmosphere; (*d*) frost or snow particles from trees and vegetation when the temperature is near freezing.

The sites used in 1957 were on or near the sea coast and satisfied most of the above conditions as far as possible.

Results

Figure 1 gives the temperature at which a concentration of 0·1 nuclei per litre was observed at each station from day to day during the month of January 1957—the curves have been smoothed by taking 3-day running means. It will be seen that at five of the eight stations (namely Florida, Stanford, Sydney, Mt. Gambier, and Carnarvon) three maxima occurred on approximately the same dates in each locality ; at a sixth (Perth) additional peaks were recorded, but the first and last were in general agreement with those at the above five stations. Two stations, Caloundra and Norfolk Island, clearly differed from the

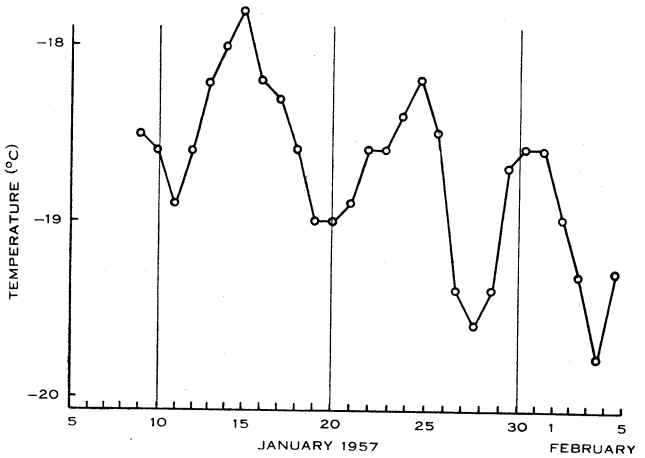

Fig. 2.—The mean temperature for 0·1 freezing nuclei per litre for all eight stations taken together.

remainder, although they agreed amongst themselves in some particulars. Both Caloundra and Norfolk Island were under the influence of a tropical cyclone in the Coral Sea during the latter part of January and it is possible that the extensive cap of ice crystals known to be generated above typical tropical cyclones may have had some bearing on the results obtained at these two stations.

The results for all eight stations have been combined to give the curve of Figure 2, which shows well-defined maxima on January 15, 25, and 31. These are consistently later than those observed in previous years by 2, 3, and 1 days respectively.

The results for the six Australian stations taken together give the mean curve of Figure 3 (*b*), while those for the two American stations give the curve of Figure 3 (*a*). It is apparent that the peak values tend to occur on approximately the same dates in the two different hemispheres.

On the basis of the 1957 measurements it may therefore be concluded that, although variations certainly exist from one locality to another, in the mean the results conform to expectations in that they exhibit three maxima in the latter

part of January and show a similarity as between the northern and southern hemispheres. The actual dates of the maxima differ from the predicted dates by 2, 3, and 1 days respectively. This may be interpreted either as being contrary to expectations or as being due to the normal fluctuations to be expected in the results for any one year. It is hoped that future measurements will show which of these two views is correct.

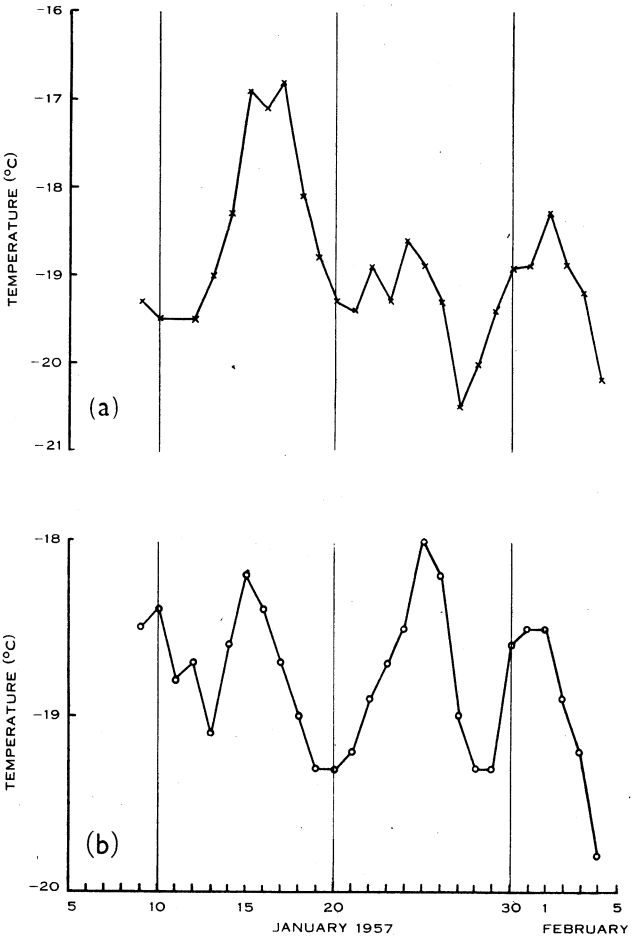

Fig. 3.—The mean curves (*a*) for the two northern hemisphere stations and (*b*) for the six southern hemisphere stations.

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