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Dependence of Snowfall on Temperature

D'Ooge has reported¹ a correlation between amount of snowfall in inches and temperature at the time of snowfall. His data showed that maximum depth of snowfall occurred at a daily mean temperature of -11°C .; Bossolasco² correlated frequency of occurrence of snowfall with temperature and found maximum occurrence at approximately the same temperature. These observers assumed that the mean daily temperature recorded at the level of observation was a reasonable estimate of the temperature at the level of formation of the snow. From the data presented, conclusions were drawn concerning nucleation of snow crystals.

The dependence observed by D'Ooge was checked by analysing, on a monthly basis, data collected by the Canadian Meteorological Service at Old Glory Mountain (elevation 7,700 ft.) over the period 1947-55. The observed dependence of inches of snowfall on the mean daily temperature is shown in Fig. 1. Assuming that the distributions are due to a real dependence of the amount of snowfall on the temperature at which the snow is forming, Fig. 1 indicates that only during the midwinter months are

Fig. 1. Dependence of monthly snowfall on temperature at Old Glory Mountain for period 1947-55
* Total snowfall in inches, 1947-55

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the temperatures measured at the level of observation likely to be a reasonable estimate of the temperature at the level of formation. The distributions for the remaining months are shifted to higher temperatures, as would be expected when the effect of the annual variation in mean temperature at the ground is taken into account.

It was pointed out to us by members of the Canadian Meteorological Service that these distributions do not necessarily show a true correlation of amount of snowfall on temperature. Other possible explanations exist; for example, the observed distribution may be a reflexion of the frequency distribution of the temperatures at the fixed level of observation. Data were available from observations taken at Montreal during the winter of 1951-52³ which gave the depth of snowfall and the temperature at the level of formation as estimated from the meteorological records. The distribution obtained from these data is shown in Fig. 2. The area enclosed in the distribution corresponds to 89 in. of the winter total of 124 in. Assuming that air masses in which the snow forms will not produce precipitation until conditions are favourable, Fig. 2 should be a true correlation between amount of snowfall and the temperature at the level of formation. From this distribution it is seen that the greatest amount of snow is likely to come from cloud between -10°C. and -20°C. One interesting feature of the Montreal observations was that the majority of snow crystals were irregular assemblages of columns and plates⁴. The distribution in inches for the snowfalls observed was: 59.0 in., irregular crystals (usually associated with frontal storms); 15 in., dendrites; and the remainder, columns and needles. According to Nakaya, irregular assemblages of columns and plates form over the temperature-ranges -9°C. to -14°C.

Fig. 2. Dependence of snowfall on temperature from observations made at Montreal

and -17°C. to -20°C. ; dendrites form in the temperature range -14°C. to -17°C.

Since it is very difficult to estimate the temperature of formation of the snow, and since this temperature is not likely to remain constant throughout a snowfall, any conclusions drawn based on details in the observed distributions must indeed be speculative.

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¹ D'Ooge, C. L., *Nature*, **175**, 465 (1955).

² Bossolasco, M., *Geofisica Pura e Applicata*, **28**, 203 (1954).

³ Gold, L. W., and Power, B. A., *J. Meteor.*, **11**, No. 1, 35 (1954).

⁴ Nakaya, U., "Snow Crystals: Natural and Artificial" (Harvard Univ. Press, 1954).