VLB ARRAY MEMO No. 150

Nov. 30, 1982

To: VLBA Project.

From: R. C. Walker

Subject: Hail

The attached document is from the internal memos of the Canadian Long Baseline Array project. It was given to me by Alan Bridle for inclusion in the VLBA Memo series. The author is not known to us at this time but can determined if needed - there is no name on the memo. It seems that we may have to be prepared for damage to the surface of any midwest antenna every decade or so. It might be useful to have data for the U. S. so that especially bad areas could be avoided in the configuration.

Hailfall Characteristics of the Prairie Provinces

Introduction

An extensive study of Alberta thunderstorms and hail has been carried out under the auspices of the Alberta Hail Studies Project since 1956. A less comprehensive study was done in Saskatchewan between 1973 and 1977. Unfortunately no similar studies have been done in Manitoba, though there are enough similarities between the Alberta and Saskatchewan studies to suggest that the results can be extended into this province.

Seasonal Climatology of Hail

Hail is a summertime phenomenon, since it is intimately related to the seasonal nature of thunderstorms. In all three prairie provinces, the thunderstorm season runs generally from April to September.

Thunderstorm activity is heaviest in late July over Manitoba, and in late June and early July in the other two provinces. In Alberta, hail is most common in June and July, following the peak in thunderstorm activity. In Saskatchewan, this does not appear to be the case; the five year hail study showed that most hail fell in May and June.

This may be a result of the relatively short time of the study, and in any event, it did show that large hail fell most commonly in July, in line with the longer average of thunderstorm activity.

Hail activity in Manitoba probably peaks in late July, in line with the convective activity.

Diurnal Variation in Thunderstorm Activity

Most hail falls between 1200 and 2100 CST in Saskatchewan (le. during the afternoon and early evening), with no hour between 1400 and 2000 favoured above any other. This is not the case in Alberta, where the hail study there has shown a considerable activity peak between 1530 and 1830 local time. Both studies do show that large hail tends to fall late in the day, and this conclusion is very likely true in Manitoba.

Hailfalls have a median duration of 6 minutes, and an average duration of 9 minutes, according to the Saskatchewan study. This is typical of all of the high plains of North America.

Hail Point Frequency

Figure 1 shows the annual point frequency of hail in the decade 1951-1960. It incorporates data from nearby American stations, but was not used to derive most of the results in table 1, since a longer point frequency was avail able for most of the stations of interest.

The data used in Figure 1 probably has an accuracy of about 25%.

Hail Size

Hailfalls are usually made up of stones with a variety of sizes, and most studies have concentrated on getting data about the largest stones in a particular fall. The scale is descriptive: shot, pea, grape, walnut, golfball, and larger (occasionally even baseball!).

Both the Alberta and Saskatchewan studies showed that golfball or larger hail (assumed to be 3 cm. or larger) makes up about 6% of the reports. Hail smaller than this is probably unlikely to cause significant damage , except to crops.

Figure 2 shows the size distribution of hailstones in 57 samples collected in buckets and frozen for later analysis. Of interest is the fact that the percentage of larger stones seems to be greater than that reported by field observers on the basis of the largest stones in each fall. This result is probably biased by problems with the preservation method, which allowed the smallest stones to melt.

Impact Energy

The terminal velocity of a hailstone of diameter d (cm.) is given by:

$$V = 16.2\ d^{\frac{1}{2}} \quad \text{m/s}$$

The impact energy is:

$$Ie = \tfrac{1}{2}mv^2 / \text{ area of impact}$$

$$= \tfrac{1}{2}mv^2 / \tfrac{1}{4}\pi d^2$$

Assuming that the stone has a density of 0.9 gm/cm^3, and a spherical shape...

$$Ie = 7.9\ d^2\ \text{joules/metre}^2$$

Frequency of Hail at Specific Sites

Using hail point frequenct estimates based on data collected between 1957 and 1978 (except for Morris), and a figure of 6% for those hailfalls with stones larger than 3 cm., an estimate of the return period for damaging hail can be made (table 1).

The data for Morris was extracted from figure 1, and is probably only within 25% of the value which would result if it had been a reporting station, and the record had extended for 2 decades instead of 1.

Table 1

Location	Annual Point Frequency	Annual Frequency of Large Hail	Return Period (years)
Lethbridge	2.18	.131	7.6
Swift Current	2.05	.123	8.1
Moose Jaw	1.91	.115	8.7
Morris	1.9	.114	8.8

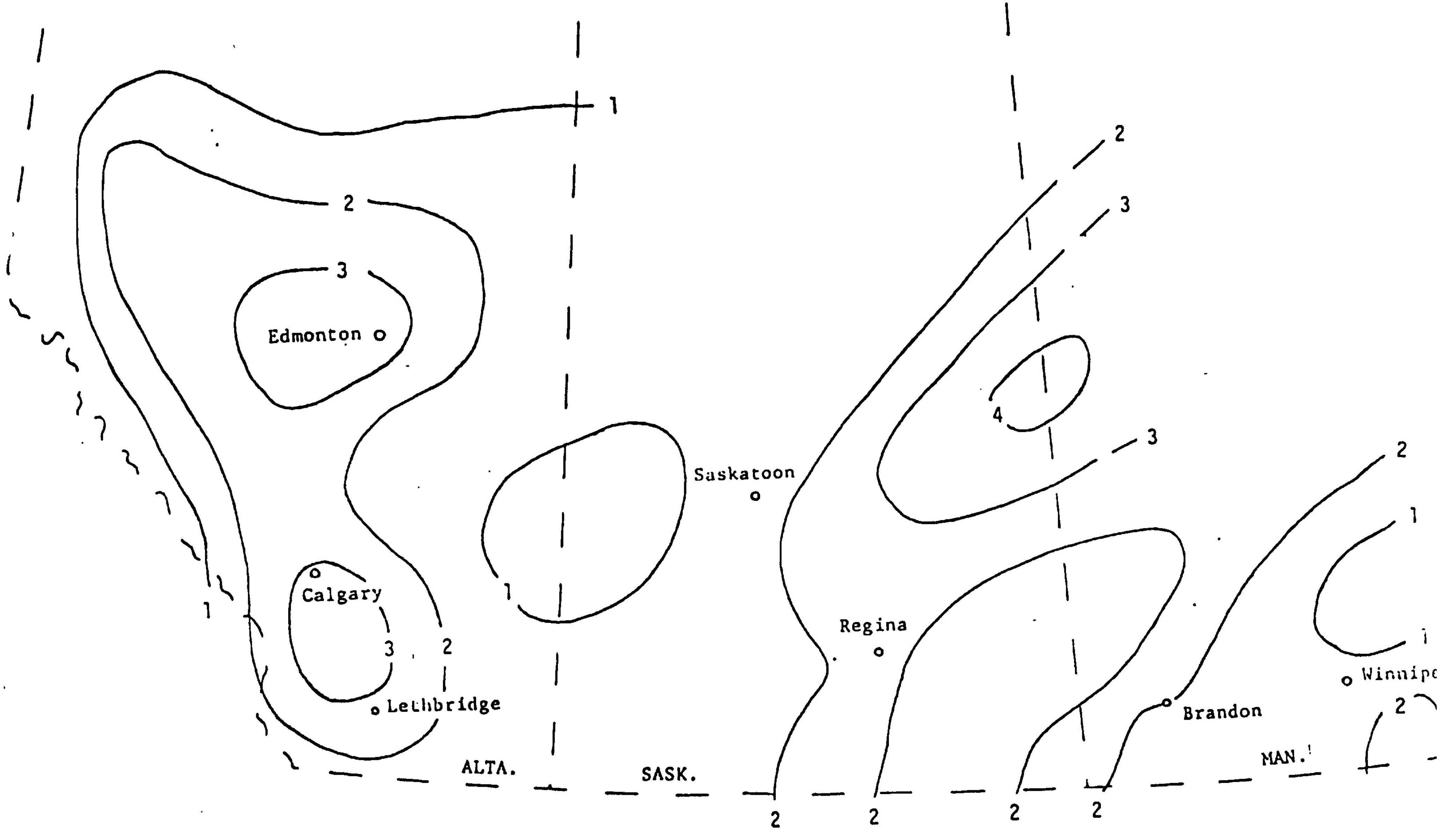

FIGURE 1 : ANNUAL AVERAGE POINT FREQUENCY OF HAIL, 1950's

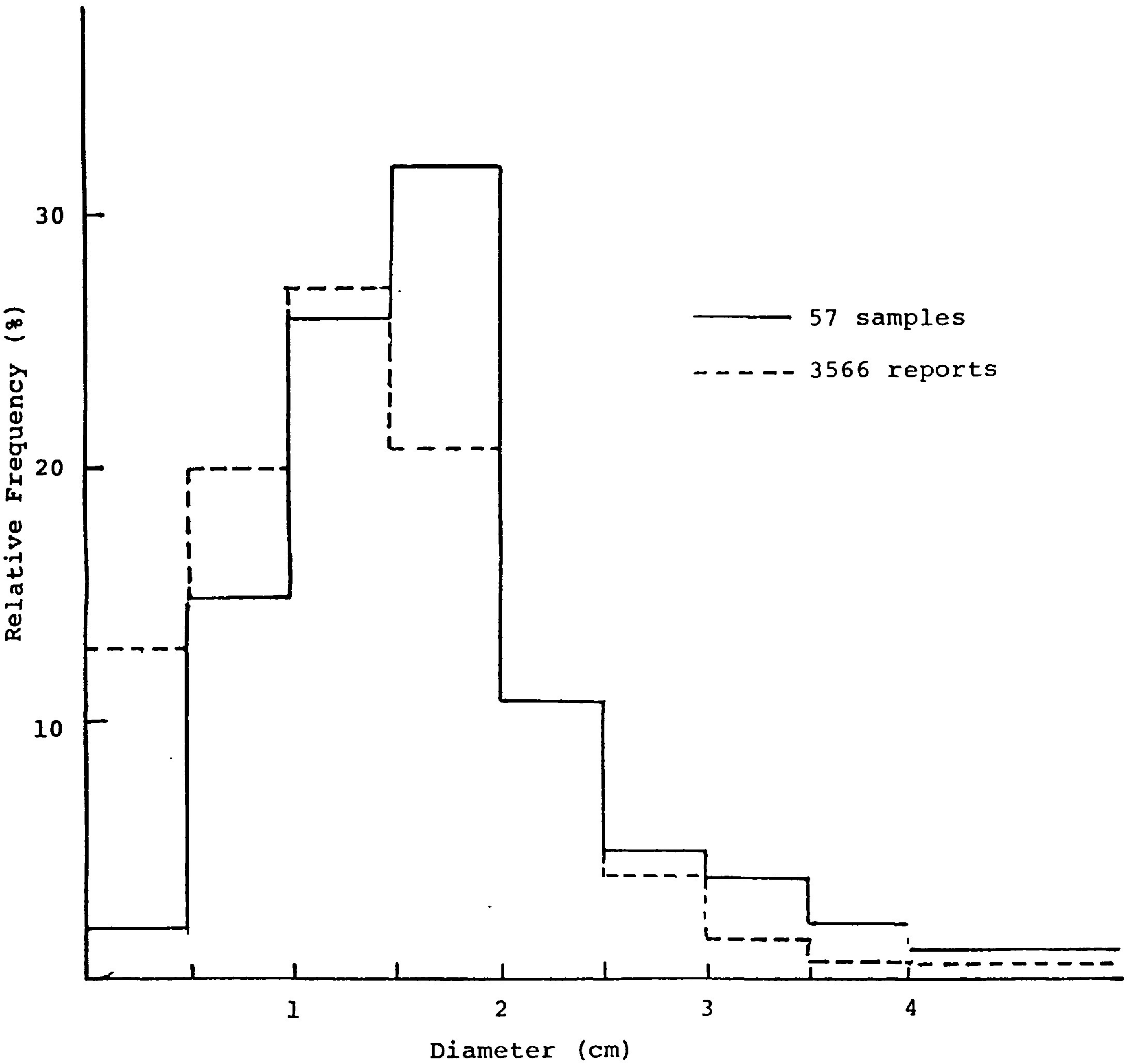

Figure 2: Histogram of maximum hailstone diameter as observed in 57 samples, and as reported by farmers on 3566 occasions.