PROJECT REPORT NO. 29

MANITOBA TORNADOES 1960-1973

By T.B. SHANNON

ATMOSPHERIC ENVIRONMENT SERVICE – METEOROLOGICAL APPLICATIONS BRANCH
TORONTO, SEPTEMBER 1976.

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BY

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ATMOSPHERIC ENVIRONMENT SERVICE
DEPARTMENT OF THE ENVIRONMENT
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SUMMARY

All tornado reports available for the years, 1960-1973, were used to develop a climatology of tornado occurrence for southern Manitoba. Results appear to agree well with United States data for the northern plains. Geographical, annual, seasonal, and diurnal distributions are presented. Some of the visual and audio descriptions are also quoted.

ACKNOWLEDGEMENTS

The cooperation of the staff of the Manitoba Provincial Library, Winnipeg, in providing newspapers and microfilm is gratefully acknowledged.

The suggestions and assessments of members of the Scientific Services Unit, Central Region, A.E.S., Winnipeg, and of the Applications and Consultation Division, A.E.S. Headquarters, Downsview (Toronto), Ontario, are also acknowledged.

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INTRODUCTION

"Directly in the path of the storm was the farm home of Stanley Smith, bachelor, and his companion Mr. Clark. According to bystanders, Mr. Smith had stepped to the door to photograph the approaching storm when the house apparently exploded in the vacuum created by the tornado. Mr. Smith's body, entirely stripped of clothing, was found about 150 feet to the south and Mr. Clark regained consciousness partly sheltered by a Selkirk chimney which lodged against the bush about 30 feet north."*

The above report is one concerning a tornado striking just west of the Manitoba-Saskatchewan border on June 30, 1963. Events of this nature are a rarity, but they are a cruel reminder that extreme weather conditions of this type can exist north of the 49th parallel.

Little has been done with the climatology of tornadoes in Western Canada since the work of A.B. Lowe and G.A. McKay (1960). This 1974 survey attempts an updating of their work for the Province of Manitoba. It is concerned primarily with a statistical analysis and does not deal with the meteorological situations.

* The Birtle Eye Witness; Birtle, Manitoba; Tuesday, July 2, 1963.

During the years, 1960-1973, tornado reports for Manitoba varied in number from as few as one to as many as six annually. It is very difficult to establish if the fifty reports discovered adequately represent tornado occurrences. For this reason the analysis of data is being made on "tornado reports" and there is no attempt made to imply that this is a statement of the number of tornadoes actually occurring.

DATA SOURCE

A lot of digging was required to uncover enough tornado reports to allow an acceptable analysis to be made. It was decided that the best method would be to scan the Manitoba weekly newspapers that were available from the Provincial Library on microfilm or in sheet form for the period under consideration. The front pages of newspapers were scanned for the months of May through September, this being the tornado season in Western Canada.

Forty-four different weekly newspapers were scanned in search of data. Those north of 56^{o}N latitude and those with circulations under 1,000 were not reviewed. An interesting fact to note is that almost half of the reports were taken from only seven (16%) of the weeklies. Circulation of these papers ranged between 2,500 and 10,000, so it is evident that the larger papers are more likely to contain comprehensive

tornado reports.* Other important factors in discovering tornado headlines were the format and editing styles of the papers. Some papers were very difficult to scan for any type of information because of the layout of the front page.

The years 1960-1970 were covered completely, but 1971-1973 were only partially done due to a temporary inaccessibility of a number of newspapers. All data was used in the analysis simply because of a need for an adequate number of reports for good statistics. Precautions have been taken to avoid any unjustified conclusions caused by use of data from the 1971-1973 period.

ANALYSIS OF DATA

Once prospective data were gathered, it was necessary to determine if a given report was actually that of a tornado. It was decided to use the criteria developed by Lowe and McKay (1960) as follows:

1. a funnel cloud touching the ground
2. an explosion (windows or walls blown out of buildings)
3. debris so arranged as to indicate the passage of a vortex
4. dense, heavy objects lifted
5. less dense, but large objects (wagons,etc.) carried long distances ($\frac{1}{4}$ mi. or greater)

* Average circulation of Manitoba weekly newspapers is 2,300.

6. substantial buildings sailing through the air or demolished (e.g. "reduced to kindling")
7. roofs taken off buildings along a narrow extended path
8. substantial, well-entrenched trees uprooted or broken off along a narrow, extended path

The presence of one of the above criteria was deemed sufficient evidence for a tornado occurrence. Most reports involved the consideration of property damage; actual sighting of a funnel was rare.

Limited time necessitated a different approach to analysis than that incorporated in the report of 1960. The opportunity to consider tornado situations by the use of weather maps did not present itself, so an analysis of "tornado reports" and "tornado days" was made. Due to the small number of reports received annually, the two different pieces of information are almost identical. For this reason tornado reports and tornado days are considered the same unless indicated as being different in a given section of this paper. Difficulty is often encountered in the case where a number of reports fall within a small area or in a line on the same day. Was it one tornado following an extended path or was it a large system with separate tornadoes developing in different locations?

RESULTS

Geographical Distribution

Figures 1 and 2 show tornado frequency over Manitoba as a function of latitude and longitude, respectively. Maximum frequency appears to be south of 50°N, decreasing to the east and north. Tornadoes are almost unreported in the Interlake, probably because the population density is just too small for detection of these disturbances and the geographical and meteorological conditions between two large lakes are not advantageous for the growth of tornado systems.

The most northerly report was at 51° 51'N and 100° 51'W in the Duck Mountains near Wellman Lake, extending to the Pine River District (July 17, 1966). The tornado may have begun at 51° 56'N and 101° 40'W around Benito.

The decline in tornado reports to the east is no doubt mainly due to the low population density, but it does fit well with recent American data (Court, 1970).

There is no appreciable decrease in frequency to the west. Lowe and McKay (1960) reported greater frequencies in southeastern Saskatchewan than in Manitoba, but the author found that frequencies in south-central Manitoba were significantly higher than the Lowe and McKay figures for

FIG. 1: TORNADO FREQUENCY OVER MANITOBA AS A FUNCTION OF LATITUDE

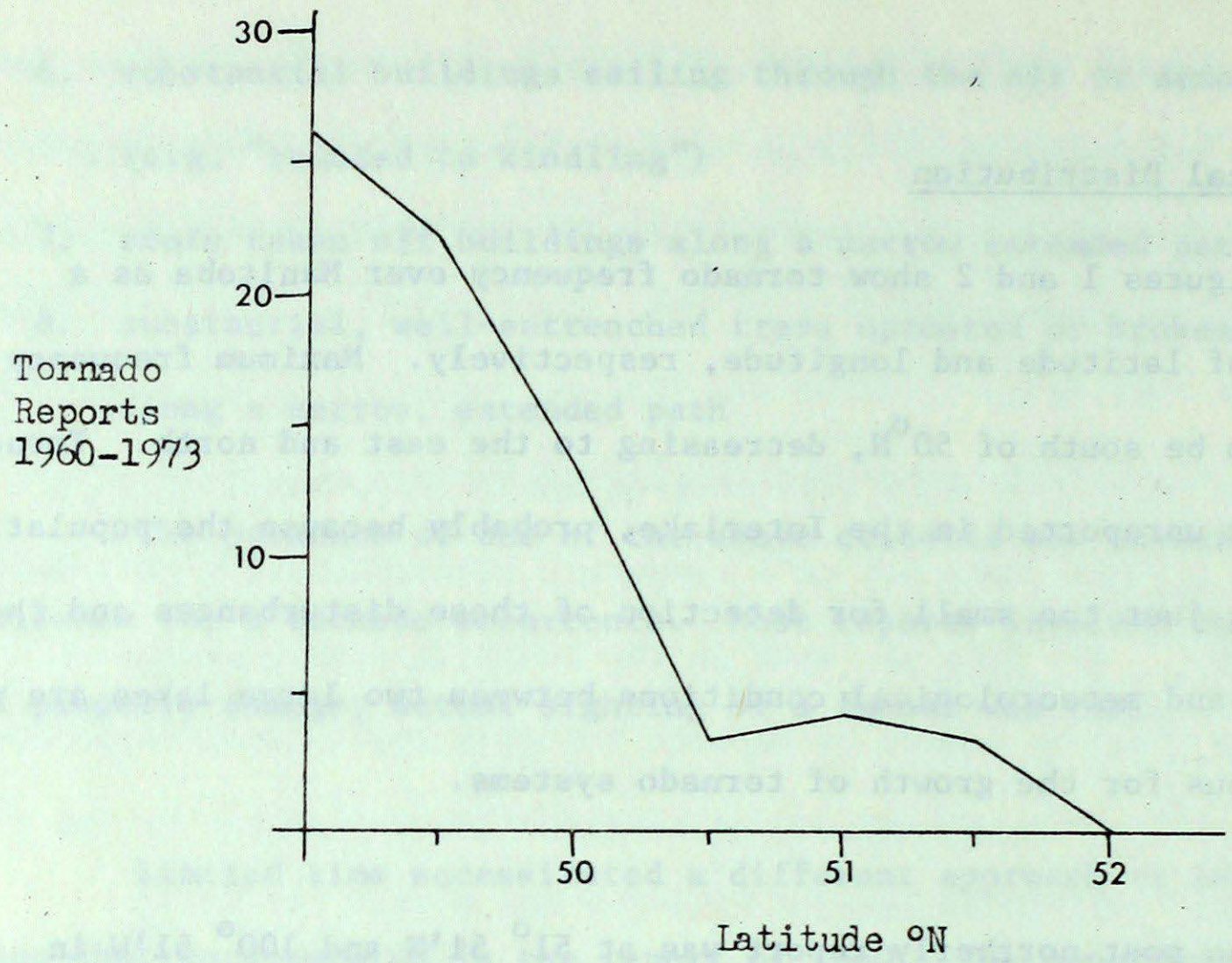
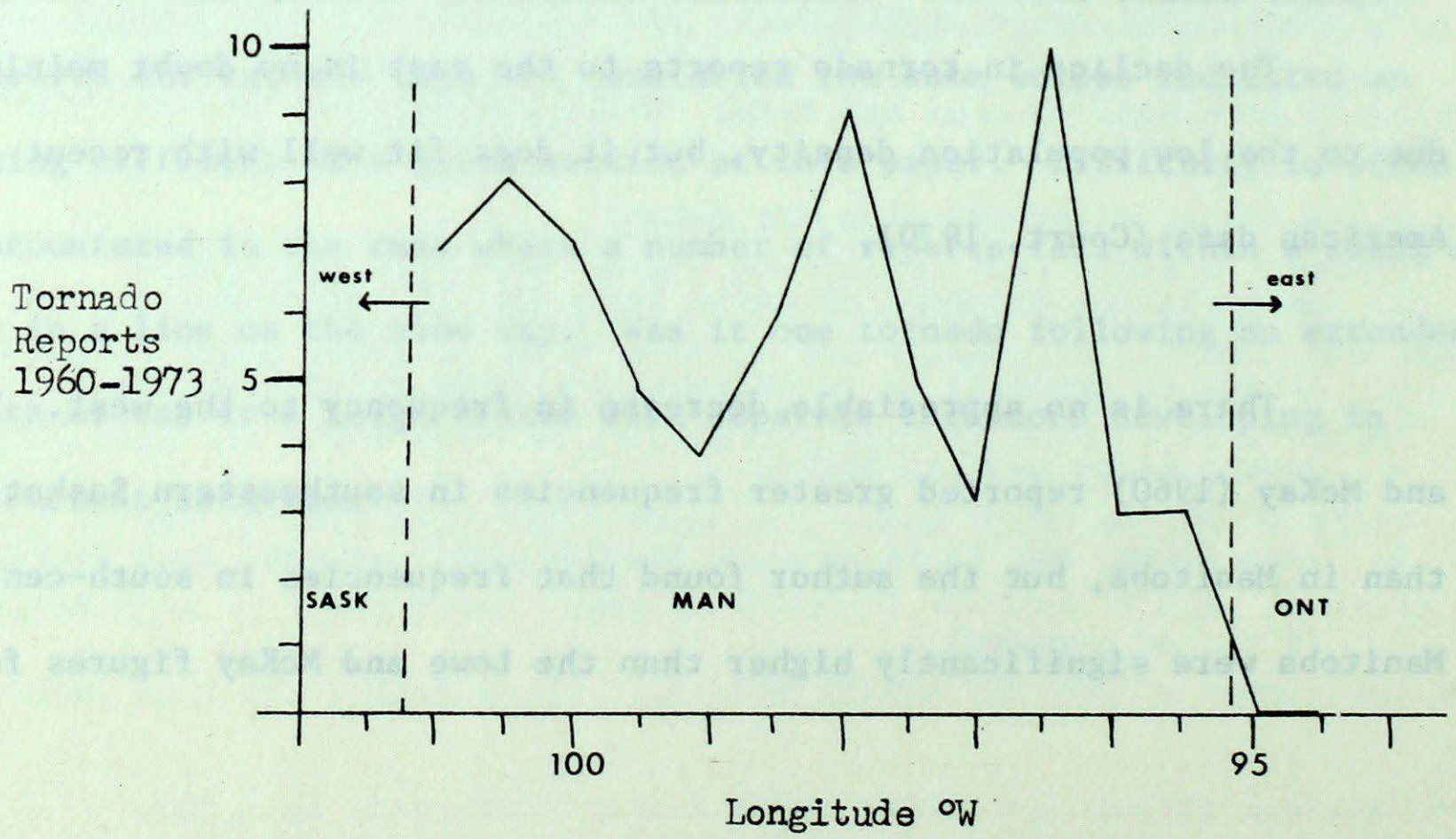


FIG. 2: TORNADO FREQUENCY OVER MANITOBA AS A FUNCTION OF LONGITUDE



either Province. According to Winston (1956), when the meteorological conditions favorable for severe thunderstorm and tornado development are considered, southern Manitoba should be expected to exhibit a maximum of tornado activity. Further research is needed to substantiate this point.

Figure 3 shows tornado frequency data for both southern Manitoba and the north-central United States. The American data (Court, 1970) cover a thirteen-year period and are stated as the absolute frequency over this period. Althought the Manitoba data cover a fourteen-year period and, therefore, are not strictly compatible with the American data, reasonable comparisons can be made. The 10-isohyet just barely extends into southern Manitoba.

Annual and Seasonal Variation

Figure 4 shows the annual frequency of Manitoba tornadoes from 1944 to 1973. Data up to and including 1959 are taken from Lowe and McKay (1960). The number of weekly newspapers reviewed each year is also plotted from 1960 to 1973. Because data for 1971 to 1973 are incomplete, the actual tornado frequencies for these years may be greater. Assuming that is the case, there seems to have been a gradual increase in the number of tornado reports over the past 30 years, probably largely due to increased public recognition and increased population density.

FIG. 3: TORNADO FREQUENCY BY ONE DEGREE RECTANGLES OVER SOUTHERN MANITOBA (1960-1973) AND THE NORTH-CENTRAL UNITED STATES (1955-1967)

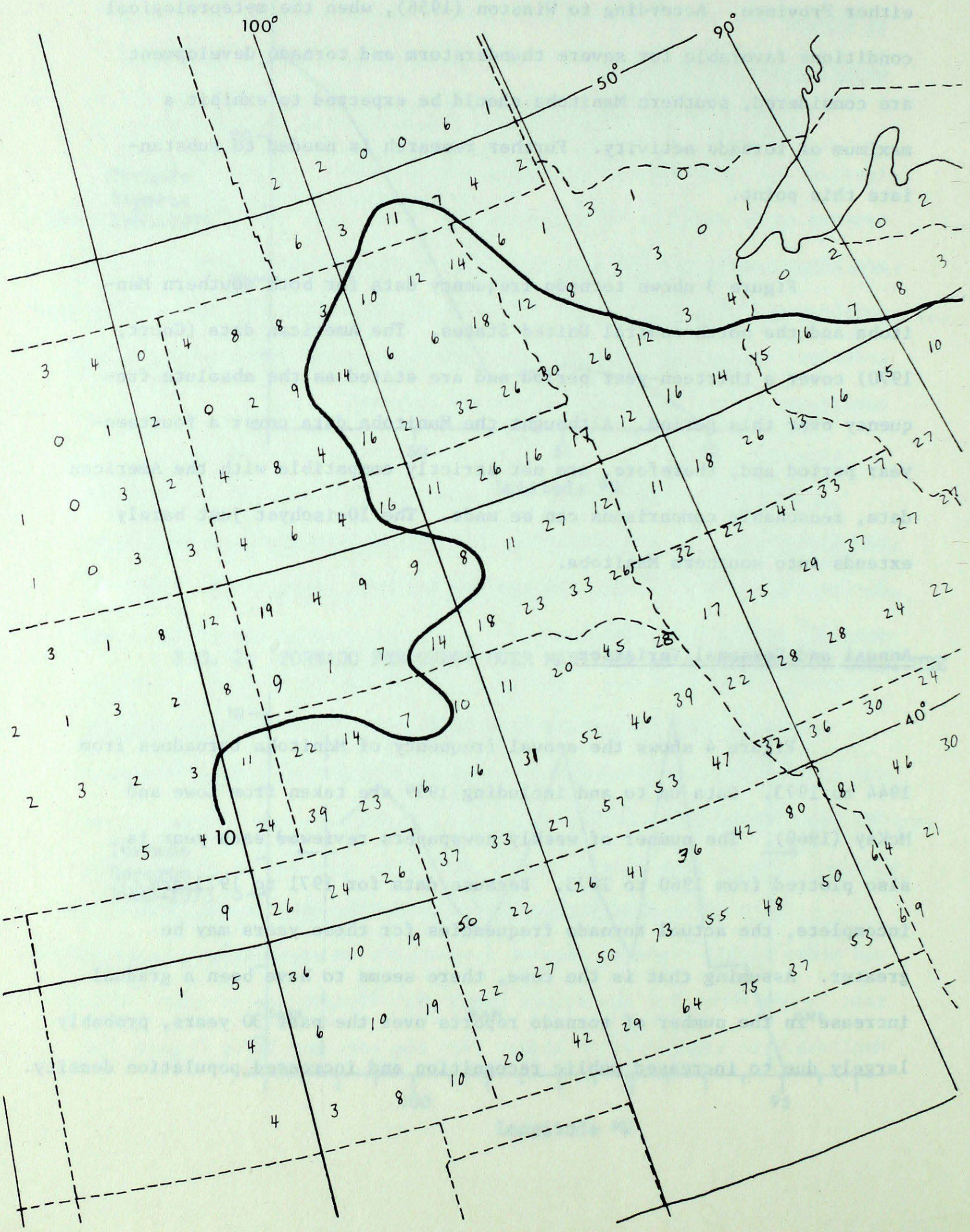
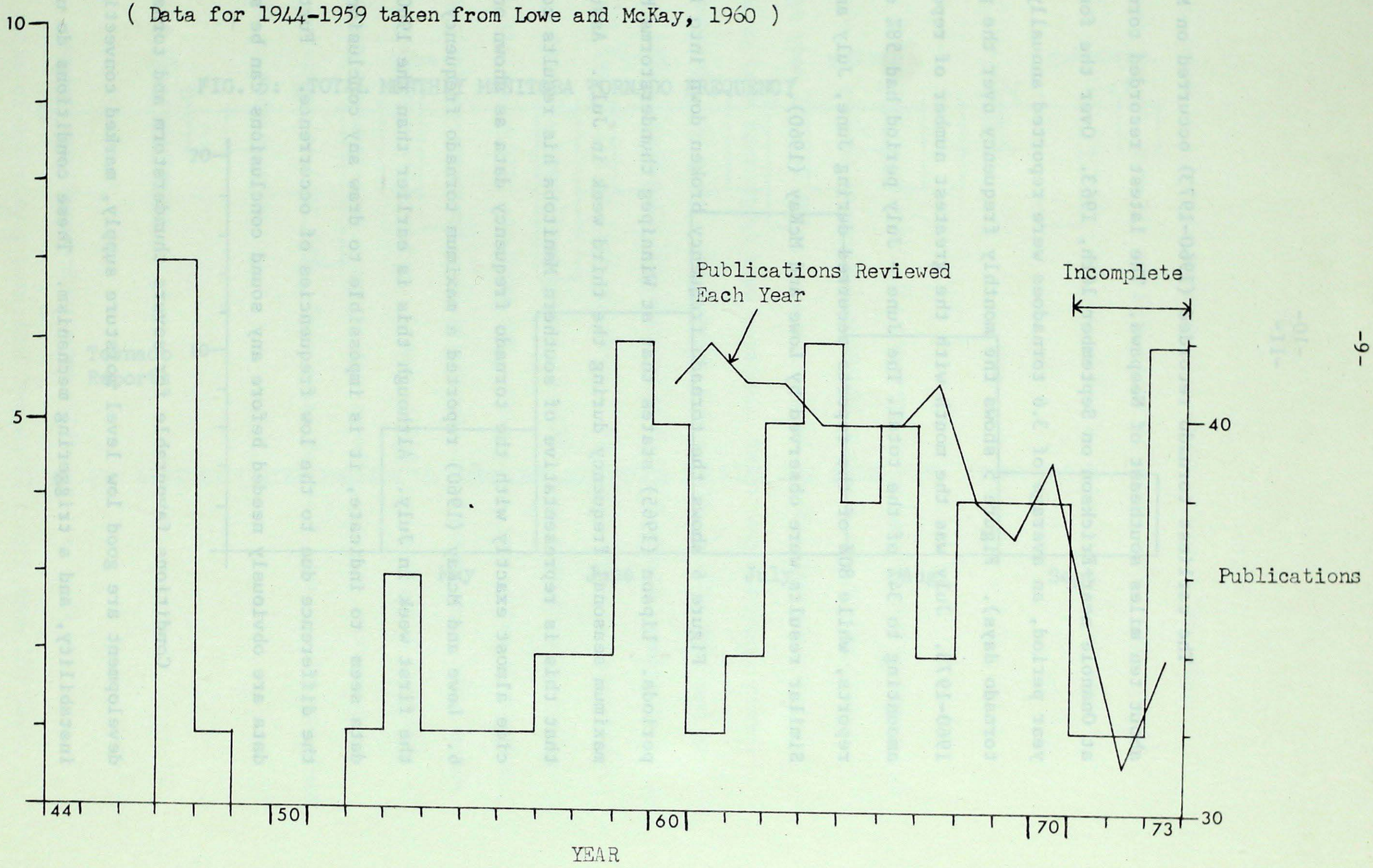


FIG. 4: ANNUAL FREQUENCY OF MANITOBA TORNADO REPORTS
(Data for 1944-1959 taken from Lowe and McKay, 1960)



The earliest tornado recorded (1960-1973) occurred on May 5th,1965, about ten miles southeast of Neepawa. The latest recorded tornado occurred at Onanole near Erickson on September 16th, 1963. Over the fourteen-year period, an average of 3.6 tornadoes were reported annually (3.4 tornado days). Figure 5 shows the monthly frequency over the period 1960-1973. July was the month with the greatest number of reports, amounting to 34% of the total. The June - July period had 58% of the reports, while 80% of the reports occurred during June, July and August. Similar results were observed by Lowe and McKay (1960).

Figure 6 shows the tornado frequency broken down into five-day periods. Lipson (1965) states that at Winnipeg thunderstorms have a maximum seasonal frequency during the third week in July. Assuming that this is representative of southern Manitoba his results coincide almost exactly with the tornado frequency data as shown on Figure 6. Lowe and McKay (1960) reported a maximum tornado frequency during the first week in July. Although this is earlier than the 1960-1973 data seem to indicate, it is impossible to draw any conclusions about the difference due to the low frequencies of occurrence. Further data are obviously needed before any sound conclusions can be stated.

Conditions favourable for severe thunderstorm and tornado development are good low level moisture supply, marked convective instability, and a triggering mechanism. These conditions do not

FIG. 5: TOTAL MONTHLY MANITOBA TORNADO FREQUENCY

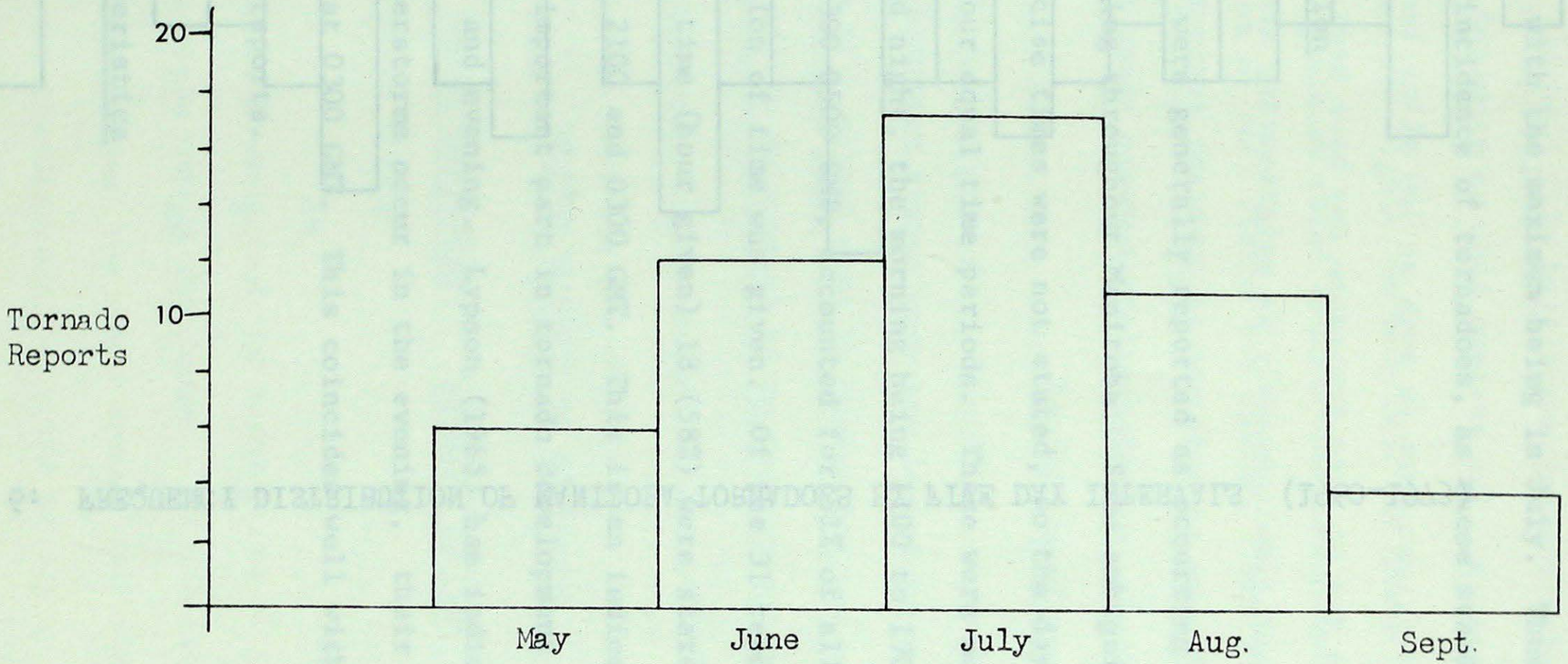
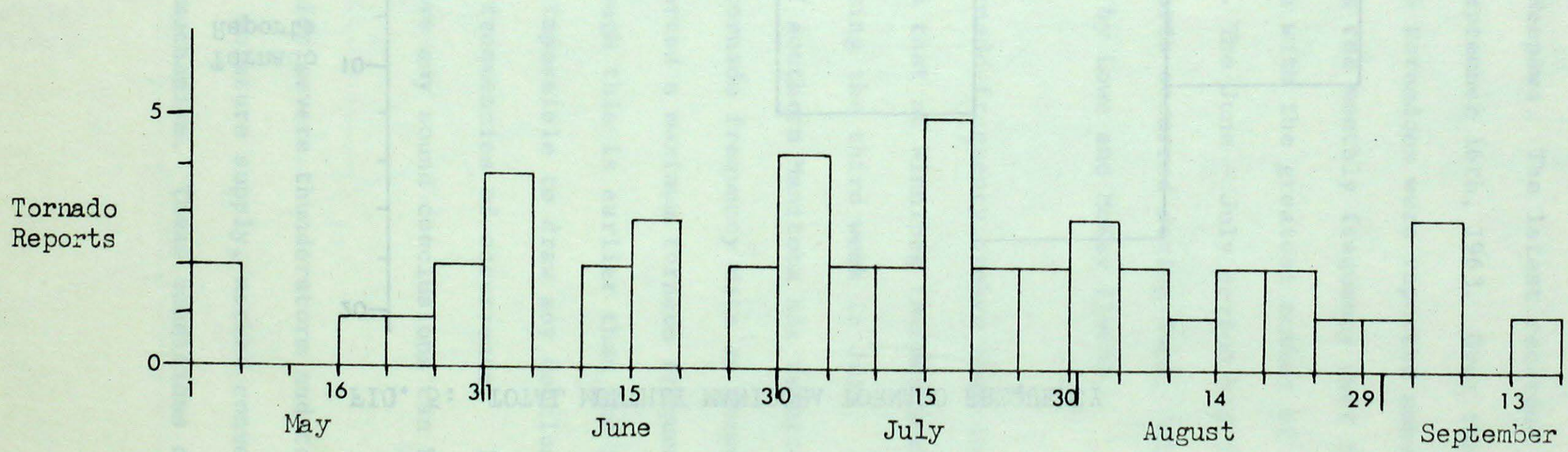


FIG. 6: FREQUENCY DISTRIBUTION OF MANITOBA TORNADOES BY FIVE DAY INTERVALS (1960-1973)



normally occur in southern Manitoba together except in the June-to-August period, with the maximum being in July. Thus, July should have the highest incidence of tornadoes, as these statistics show.

Diurnal Distribution

Tornadoes were generally reported as occurring in the late afternoon or evening throughout Manitoba. Some ambiguity was present when precise times were not stated, so the day was divided up into four equal time periods. These were morning, afternoon, evening, and night, the morning being 1100 to 1700 GMT, and so on. The hours, 2300-0500 GMT, accounted for 51% of all reports in which any indication of time was given. Of the 31 reports which included a specific time (hour given) 18 (58%) were stated as occurring between the hours 2100 and 0300 GMT. This is an indication that solar heating plays an important part in tornado development on a local scale in late afternoon and evening. Lypson (1965) has indicated that 40% of Winnipeg thunderstorms occur in the evening, their maximum frequency occurring at 0300 GMT. This coincides well with results obtained from the tornado reports.

Paths and Characteristics

Tornado path length is a very difficult item with which to deal. Paths of individual tornadoes ranged in length from 200 feet

to 20 miles and averaged about five miles. In some cases there seemed to be a number of tornadoes associated with a squall line or other severe weather system. The systems had, as expected, longer paths, averaging 33 miles, but were as much as 150 miles long. There were many cases where two or more tornadoes may have been responsible for damage done almost simultaneously in neighbouring areas. This could also be caused by one tornado not in constant contact with the surface. It is very difficult to differentiate between these two cases unless the funnel(s) have been sighted.

Direction of travel was very poorly reported; only 40% of the reports gave any indication of this factor. It was established either by direct observation or by inspection of the path of destruction left by the tornado.

DIRECTION OF TORNADO MOTION

Direction from	No. of Reports	Direction from	No. or Reports
N	0	S	1
NW	3	SE	1
W	9	E	0
SW	6	NE	0

Tornadoes in Manitoba move from a more westerly direction than do those in the U.S.A., although the tendency to come from the southwest is still strongly evident.

Tornadoes are highly concentrated and immensely powerful phenomena, leaving almost total destruction along their path. Although information on path widths was sparse, there was a range of between 50 and 150 feet. The path width is representative of the size of the funnel which has touched the ground. Depending on the type of terrain and surface conditions, the path will generally be slightly larger than the actual width of the funnel.

In the funnel, winds have been estimated to travel at incredible speeds. Authorities on tornadoes in the United States (Pearson, 1976) have suggested that winds could exceed 225 miles per hour in some cases. Tornadoes reported in Manitoba are usually less violent than those in the States, but even so, it is possible to expect maximum winds in the 150 mph range. Hydro poles able to withstand winds of 100 mph have been blown over or twisted off.

The rate of movement of the tornado is, of course, much slower than that of the winds within the funnel. No relevant data was available for Manitoba, although one could assume that since the tornado is associated with the thunderstorm, it would travel at a rate of 20-50 mph, average about 30 mph.

Visual Descriptions

The funnels associated with tornadoes come in various shapes and sizes, depending on the age or maturity of the tornado and the size or severity of the system. The moisture of the air also has an effect on the tornado shape: the higher the humidity the thicker the funnel. Dry air is associated with a thin rope-like funnel. Squall lines generally bring the more severe tornadoes.

Visual descriptions were infrequent, but a number of quotes are listed to give an indication of the conditions associated with tornadoes:

"The clouds gradually funneled into a twister. It was very dark and grey with a pink sky on the horizon underneath. It looked terrible."

"rolling black clouds"

"Funnel-shaped clouds rolled in, striking from two directions in some places."

"wall of solid water"

"tail-like funnels"

"Tornado was overshadowed by a low-hanging, shelf-like cloud."

"cloud of smoke rising from the distance"

"looked like a spiral of smoke"

"a churning, twisting weather disturbance"

"greyish-white funnel"

"A small tornado uncoiled from black thunderhead clouds."

"It appeared to be a swirling dust storm; as it came closer it changed to what looked like a steaming turmoil."

Sounds

A tornado which is touching the ground can often be heard for miles. The noise caused by the destruction of the winds is usually described as a dull roar. Often there is a sumultaneous roar due to falling hail as well as to thunder, which is far more severe than in ordinary thunderstorms. The following are some statements of the sounds heard by people involved with tornadoes:

"The roar of the storm was heard as far as 20 miles away."

"rush of wind"

"The tornado's roaring could be heard over a mile away."

"Sounded like 1,000 freight trains coming, the roar was so loud."

"a great roaring noise"

"deep roar"

"It sounded as though a jet were coming."

"Roar of the wind was deafening."

Damage

The type of damage done by a tornado is indicative of the severity of the storm. The amount of destruction is generally dependent on the amount and type of settlement along the tornado's path. Manitoba, being sparsely populated, rarely reports the immense losses sometimes reported in urban areas. No attempts have been made to estimate the total loss due to tornadoes in the fourteen years in question, although it would probably be in millions of dollars. Most frequently damaged were barns and other farm buildings, power and telephone lines, ice rinks, and hydro transmission lines. Trees twisted off above ground level are a sure indication of tornado damage, although uprooted trees are often reported as well. Often damage is due to the combined effects of rapid pressure change and high winds, as exemplified in the first paragraph of this report.

CONCLUSIONS

A tornado frequency maximum was found to exist in south-central Manitoba, which fits well with published reports for the northern plains of the United States. July was found to be the month in which tornado reports were most numerous, with the June-to-August period containing 80 per cent of the reports. The earliest report occurred in May and the latest in September. The majority of tornadoes occurred during the late afternoon and evening, with the highest frequency being between

2100 and 0300 GMT. It is difficult to make any firm conclusion on path lengths or direction of movement from this data; however, the majority of the storms did appear to move from the west.

RECOMMENDATIONS

1. An attempt should be made to update tornado data for Saskatchewan and Alberta.
2. Closer communication with American services is desirable in order that information may be exchanged. There is a definite need for some type of standarization of reports and analysis on an international basis.
3. A desirable situation would be to have tornadoes reported currently rather than the present system of going through old records. Requests for observations could be sent out to:
   a) newspapers
   b) climatological stations
   c) synoptic stations
   d) airlines
   e) grain elevators (closely associated with farmers)
   f) hydro and telephone repair and maintenance offices
4. A form could be supplied to those organizations mentioned in #3 as an aid as to what to look for when reporting a tornado. Along with this information, one could include a pamphlet describing the best precautions to take when a tornado is expected.

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