

On the correlation between strong tornado occurrences and severe hailstorms in Saskatchewan

Alec Paul, University of Regina

Ken McInnis, University of Regina

Introduction

Tornadoes have once again become a hot topic on the Canadian prairies in the summer of 2000. Pine Lake, Alberta, with its eleven deaths and hundreds of injuries, rekindled the concern that has been smouldering since the Edmonton disaster in 1987 largely faded from the collective memory. The fact that very large hail preceded the Pine Lake tornado by a few minutes was mentioned by several of the survivors. Thus, thunderstorms that produce both tornadoes and damaging hail are dangerous and represent an important aspect of the thunderstorm hazard. In addition to our observations on the Pine Lake storm, we are aware of the concern expressed by the insurance industry and governmental agencies about the increasing monetary losses from severe thunderstorms. Consequently, we decided to investigate the correlation between tornadoes and large, severe hail in Saskatchewan. First, the tornado and hailstorm databases were examined to determine those thunderstorms that produced both tornadoes and hail. These results were compared to information in the Natural Hazards brochure and in the Atlas of Saskatchewan.

Procedure

During the 1990s databases were developed for southern Saskatchewan on tornadoes and hailstorms. Tornadoes for 1906 to 1991 (Paul, 1995) were documented utilizing the 'official' tornado database produced by the Atmospheric Environment Service (or AES), local newspapers, local histories, and other reports. A hailstorm database for 1979 to 1995 (McInnis, 2000; Paul and McInnis, 1999) was created by documenting the geographic trends of major hailswaths utilizing crop-hail insurance claims, local newspapers, and various reports produced by the AES. An initial comparison of the tornado and hailswath databases for 1979-1991 revealed more than 76 tornadoes associated with 62 major hailswaths. Many of the weaker tornadoes (< F2) were unconfirmed. All the tornadoes rated as F2 or greater in the database were confirmed. Thus, we selected the strong (F2 or greater) events during 1979-91 from the tornado database and looked at the correlation with the hailstorm database.

Results

Sixteen strong tornadoes (Table 1) are listed for 1979-91 in the Saskatchewan database. Twelve of the 16 were produced by storms known to have generated significant swaths of crop-damaging hail. Of these 12 strong tornadoes, eight were spawned by severe thunderstorms known to have produced hailstones of golfball size or larger. In other cases with strong tornadoes, property damage from hail resulted. This usually indicates that golfball-sized hailstones occurred, and suggests an association of the tornadoes with large hail.

Of the four cases where strong tornadoes were reported but swaths of crop-damaging hail were not, one was associated with reports of some very large hailstones. The three other instances include two from the forest fringe north and east of Prince Albert, where hail was not reported but where storm information and cropland are both limited. These four tornadoes represent cases that may or may not be correlated to hail, using the information in our databases it is unclear.

Table 1: Strong (>F2) tornadoes in Saskatchewan, 1979-91.

ID #	Tornado Data:		Hailswath Data:		W [mi(km)]	Comments	
	Storm Date	Tornado Location	F-Scale	Time/Bearing			Direction/Bearing
7/27/79	Spruce Home	F2	18:00; 180°	Hailswath Information N/A		Forest Fringe area	
15	7/5/79	Killdeer	F2	22:30; 300°	N (340°)	55 (90) up to 12 (20)	Woodrow; U.S. border T1 R3 W3; signif. Hall damage in Wood Min., Fir, Min. & Killdeer; >softball; 55 mi in SK; into MT; evening upto 5" rain, houses damaged; F2 Killdeer
28	8/8/79	Regina Torch River	F2	18:00; 280° N/A	NW (300°)	215 (350) mostly 15 (25)	8 mi W of Aylesbury; NB border; T7-T8 line; continues into NB; famous storm; Regina N side hit by tornado; 17:00 Chamberlain; 18:00 Regina; 22:00-2:30 into NB; swath very wide; F2 & F1 Regina
154	8/11/82	Ponteix	F2	9:00; N/A	N (290°)	55 (90) up to 6 (10)	Forest Fringe Area 6 mi SW of Ponteix; 5 mi S of Morse; F2 Ponteix tornado 21:00
163	8/14/82	Derholm Lloydminster	F2	18:00; 240° N/A; 225°	W (250°)	160 (260) 8-10 (13-16)	AB border 3 mi NW of Maclelin; 12 mi W of Macdowall; tornado Ruddled 18:00 continues on to hit P.A. @ 19:00 with lots of rain; no info in AB; F2 Derholm (Ruddled) Reports of very large hailstones
190	7/20/83	Pennant	F2	16:35; 240°	SW (240°)	170 (275) 10-12 (16-20)	AB border in T11; 3 mi W of Eyebrow; >= 20 mi in AB; 16:35 F2 Pennant tornado; direction change @ (50° 35' N, 108° 15' W; 250°;
295	8/30/85	Okla	F2	19:15; 240°	W (250°)	140 (225) 6-10 (10-16)	6 mi NW of Kenaston; 8 mi N of Luthow; major storm; F2 Okla tornado
298	6/1/86	Langham	F2	21:10; N/A	NW (300°)	70 (115) <=6 (10)	10 mi W of Balgonie; N end of Saskatoon; 22:30 in Saskatoon; hail & lots of wind damage; F2 Langham & F1 Saskatoon
347	6/6/87	Arcoia	F2	N/A; N/A	W (280°)	30 (50) 2-4 (3-6)	5 mi S of Talmage; Sloughton; F2 Arcoia tornado
421	6/30/89	Poundmaker	F2	18:30; 225°	SW (230°)	90 (145) 5-6 (8-10)	Senlac; 6 mi NW of Medstead; F2 Poundmaker tornado; very large hail; \$5.7 million; maybe from Maclelin and Alla.
435	7/28/89	2 in Regina Beach Area	F2 & F2	18:30; N/A; 19:00; N/A	NW (300°)	135 (220) 5-15 (8-24)	3 mi E of Chamberlain; Handsworth; -18:15-22:00; lots of hail; two F2 tornadoes Regina Beach Area; F9 Condit; hits Regina rural areas.
424	7/8/89	Peebles Regina	F3	16:00; 260° 20:30; N/A	W (270°)	75 (120) 5-8 (8-13)	Lajord; 8 mi. N of Kipling; F3 Peebles tornado, etc.; 15:00-17:00 Hail reported in vicinity

We suggest therefore that in southern Saskatchewan a correlation exists between strong tornado events and severe thunderstorms with large hail. This correlation is also known to exist in the United States (Agee et al., 1976; Davies-Jones, 1985). Davies-Jones (1985: 204) states that “large hail (golfball size and larger) often falls near the tornado....” Studies in Alberta have documented several cases that suggest a relationship between hail and tornadoes (eg. Charlton *et. al.*, 1998, 1995).

Comparisons for Saskatchewan

We also looked at some other sources of recently published and widely disseminated information on hail and tornadoes in southern Saskatchewan. The 1996 Natural Hazards brochure for Canada published by Emergency Preparedness Canada/Canadian Geographic (EPC/CG) has sections on both phenomena, as does the new *Atlas of Saskatchewan* (Fung, 1999).

The Natural Hazards brochure includes maps of annual number of tornadoes (Figure 1 in this paper highlights the southern Saskatchewan portion of this map) and of annual days with hail (Figure 2 here, again for southern Saskatchewan). These two spatial distribution patterns are somewhat different from one another. The tornado map exhibits a maximum close to Regina which is part of a 100-200 km wide band of high frequency (2.5-4.9 per 10 000 sq km per year) shown extending southeast to northwest across the province of Saskatchewan. Lower numbers are indicated to the southwest of this band and also to its north and east. The hail map does not show this pattern. Instead it displays values of more than 3 days with hail per year in the extreme south-centre and southwest of the province, 1-3 over most of the agricultural belt, and less than 1 in the north and east. Indeed in eastern Saskatchewan this area of low hail frequency is represented as extending as far south as the Kipling-Moosomin district.

The *Atlas of Saskatchewan* also includes maps of annual hail days and tornado numbers, shown in figure 3 and 4 respectively, in the form of representations of three-dimensional surfaces. Again the spatial distributions differ from one another, although they are similar to those of the Natural Hazards brochure. The Atlas places

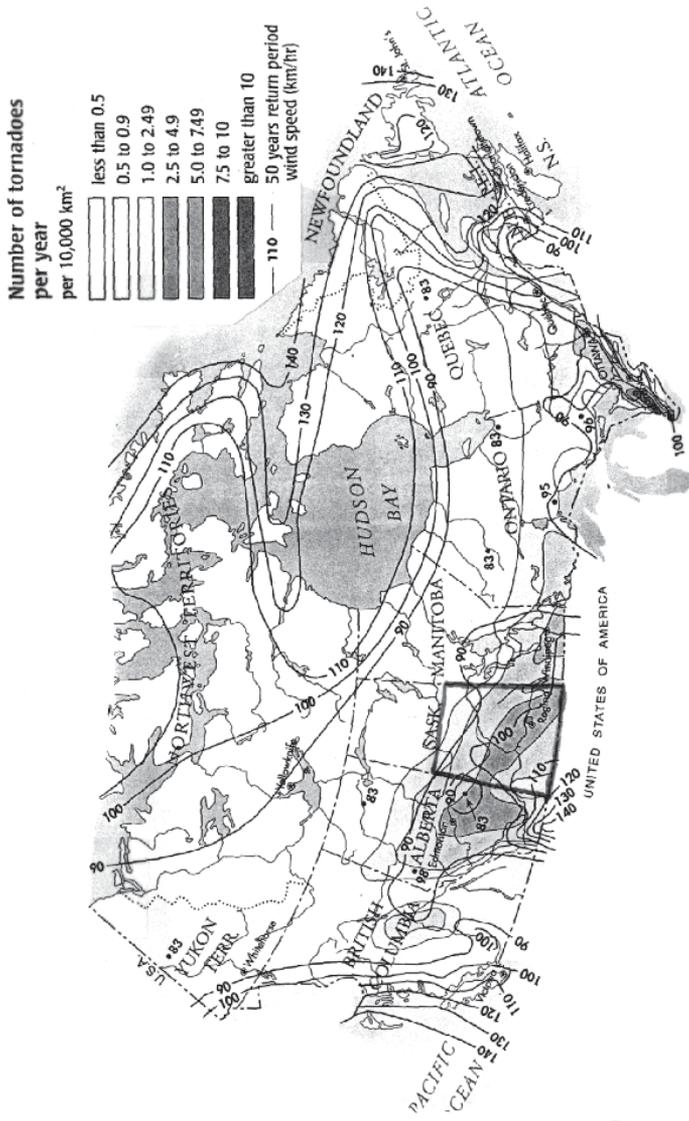


Figure 1: Number of tornadoes per year in Canada (Emergency Preparedness Canada/Canadian Geographic, 1996).

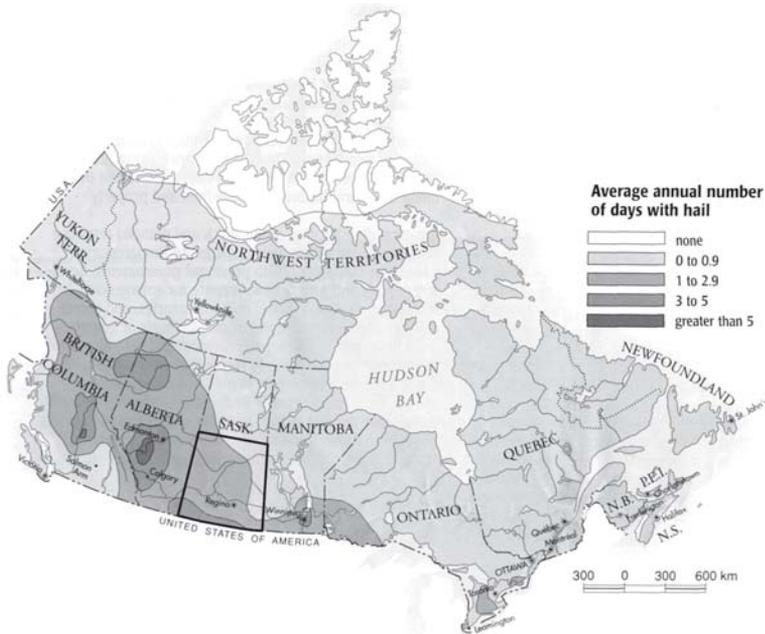


Figure 2: Average annual number of days with hail in Canada (Emergency Preparedness Canada/Canadian Geographic, 1996).

the hail-day maximum at the Alberta border west of Swift Current. This is close to Saskatchewan's southwestern corner, where the Atlas indicates the lowest tornado frequencies in the southern part of the province. Highest values for tornado frequency, exceeding 3 per 10 000 sq km per year, are shown in a southeast to northwest band as in the Natural Hazards brochure.

Discussion

Intuitively we expected to find a correlation between the spatial distribution patterns of hail and tornadoes. As demonstrated earlier, severe hail and tornadoes are correlated in our study. Perhaps “number of days with hail” and “number of days with severe hail” are unrelated in Saskatchewan. This seems unlikely, however, for the two variables are known to be correlated in Alberta, the neighbouring province to the west (Wojtiw, 1975a; 1975b).

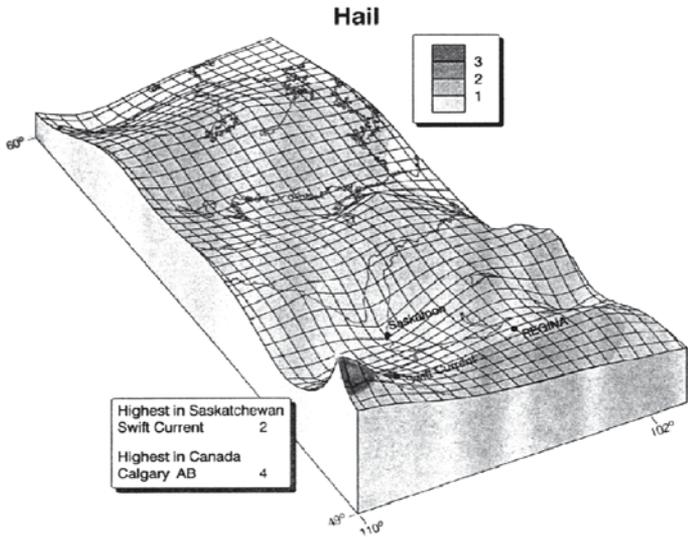


Figure 3: Average annual number of days with hail in Saskatchewan (Fung, 1999).

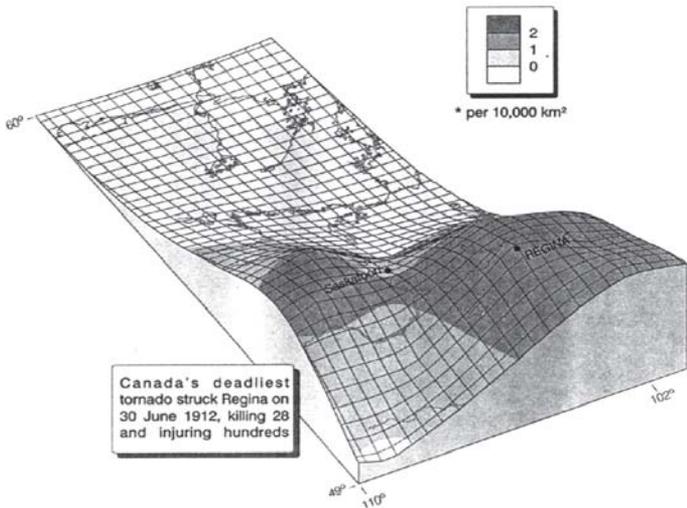


Figure 4: Annual number of days with tornadoes in Saskatchewan (Fung, 1999).

Thus we believe that the geographic distribution pattern of number of tornadoes should approximate that of number of hail days, although the actual frequency of tornadoes is much lower. We are concerned that the Natural Hazards brochure and the Atlas of Saskatchewan, which have been widely disseminated, do not show such a correlation.

Conclusion

Further research examining the relationship between tornadoes and hailstorms in Saskatchewan might be challenging for the thunderstorm seasons beyond 1995. Detailed accounts of tornadoes are not well documented after 1991. Similarly, the hailswath database reports hailstorms up to the 1995 thunderstorm season. Thus, for the 1991-1995 period one can employ the hailswath archive as a basis to chase tornadoes. However, for research beyond 1995 data must be collected. Although this task may be labour intensive the authors suggest more research would be helpful as these storms (those that produce both tornadoes and damaging hail) are capable of causing vast amounts of destruction and even fatalities.

Even though we have some reservations about using annual average point frequencies to develop geographic distributions for a feature as spatially and temporally variable as hail, we believe that the hail-day maps are reasonably realistic (Paul, 1980). Thus the problem most likely lies in the tornado maps. However, the frequency distributions discussed in this paper might be improved with contributions from additional sources of information on hail and tornadoes. We conclude that further work needs to be done to improve our knowledge of tornado hazard in Saskatchewan.

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