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Increasing major hail losses in the U.S.

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Abstract Property losses due to hailstorms on April 13–14, 2006, resulted in Midwestern property losses that totaled $1.822 billion, an amount considerably more than the previous record high of $1.5 billion set by an April 2001 hail event. The huge April 2006 loss was largely due to multiple severe storms with frequent large hail hitting major metropolitan areas. A highly unstable air mass that developed on April 13 led to several supercell storms and they then produced large hailswaths across portions of Iowa, Illinois, Indiana, and Wisconsin during a 30-h period. This storm event and prior recent major hail losses occurred when several major hailstorms developed and then traveled for hundreds of kilometers. The nation's top ten loss events during 1950–2006 reveal a notable temporal increase with most losses in the 1992–2006 period. Causes for the increases could be an increasing frequency of very unstable atmospheric conditions leading to bigger, longer lasting storms, and/or a greatly expanded urban society that has become increasingly vulnerable to hailstorms.

1 Introduction

A series of very severe hailstorms struck the central Midwest during a 30-h period on April 13–14, 2006. These storms resulted in property losses of $1.822 billion, a new record high hail loss for the nation (Changnon 1999). The April 2006 hail loss total was also the largest catastrophe loss in the U.S. during 2006 (Property Claims Services 2006). This paper examines the April 2006 storm event to assess the causes for the record losses. This recent record high hail loss event was further assessed as an indicator of a strong upward trend in national hail losses, potentially reflecting a symptom of a change in climate.

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2 Storm dimensions and losses

An unseasonably warm, moist air mass spread over the Midwest on April 13 and 14, 2008. A cold front advanced into the 4-state area on April 13, becoming stationary, making the warm air unstable. Synoptically, the hailstorms developed in an area with CAPE values of 3,500 to 4,000. CAPE (convective available potential energy) measures atmospheric instability and the high values that existed on April 13–14 in Iowa and Illinois indicated great instability and the potential for large storms. The Lifted Index values on April 13–14 ranged from −8 to −11, indicating great potential for convective storm activity, and such high indices can lead to major thunderstorms. These atmospheric conditions actually led to several supercells, a convective storm that has a rotating updraft that persists for hours, and the storm is well-organized internally. Supercells form in an area of strong vertical wind shear and great instability such as existed on April 13–14. The long-lasting supercell thunderstorms that developed all produced large, widespread hail.

This great atmospheric instability persisted across the Midwest for nearly 30 h. It led to the development of three large areas of hailstorms, and the resulting storm zones lasted for 5 to 7 h and each moved more than 320 km. Figure 1 shows these three large hailswath areas labeled as A, B, and C, and these are now discussed individually.

Hailswath A began at 1650 LST on the 13th in Iowa, and extended eastward 528 km, ending at 2330 LST in the Milwaukee area. Its width over time ranged from 23 to 52 km. Radar and surface reports indicated the hail area was created by 7 hailstorms. The storms produced considerable hail damage in Madison and Milwaukee, Wisconsin.

Hailswath B began in Iowa at 1815 LST on April 13 and extended to the east-southeast for 488 km, ending at 0100 LST on the 14th in eastern Illinois. Supercells often evolve in a splitting process, with cyclonic (right moving) storms (as B and C) and anticyclonic (left moving) storms as did Hailswath A (Glossary of Meteorology 2000). Hailswath B had widths varying from 18 to 60 km, and during its 6.5-h lifetime it contained 11 hailstorms. The storms produced considerable hail damage in Iowa City and Cedar Rapids, Iowa, and in the metropolitan areas of Moline, Rock Island, and Peoria, Illinois.

Hailswath C began at 1845 LST on April 14 along the Illinois–Indiana boundary and moved southeast for 322 km before ending at the Indiana–Ohio boundary at 2337 LST. It had varying widths along its path, ranging from 23 to 48 km, and it consisted of 10 separate hailstorms during its 5-h lifetime. It created major property damages in the Indianapolis metropolitan area.

These three long and wide hailswaths on April 13–14 exceeded average sizes of hailswaths. Historical data indicate typical lengths ranging from 80 to 330 km with an average of 205 km, and widths that range from 10 to 25 km (Changnon 1977). The prior record-setting hailstorms on April 10, 2001, had a path 585 km long, the longest on record (Changnon and Burroughs 2003).

Figure 1 shows that there were ten other smaller hailswaths on April 13–14. Some were single hailstorms and some consisted of 2 or 3 hailstorms (hailswaths 2, 5, 11, and 12). Hailswaths 2, 4, and 12 brought major damages to Chicago and its suburbs. An important aspect of most hailstorms was the production of large hailstones. More

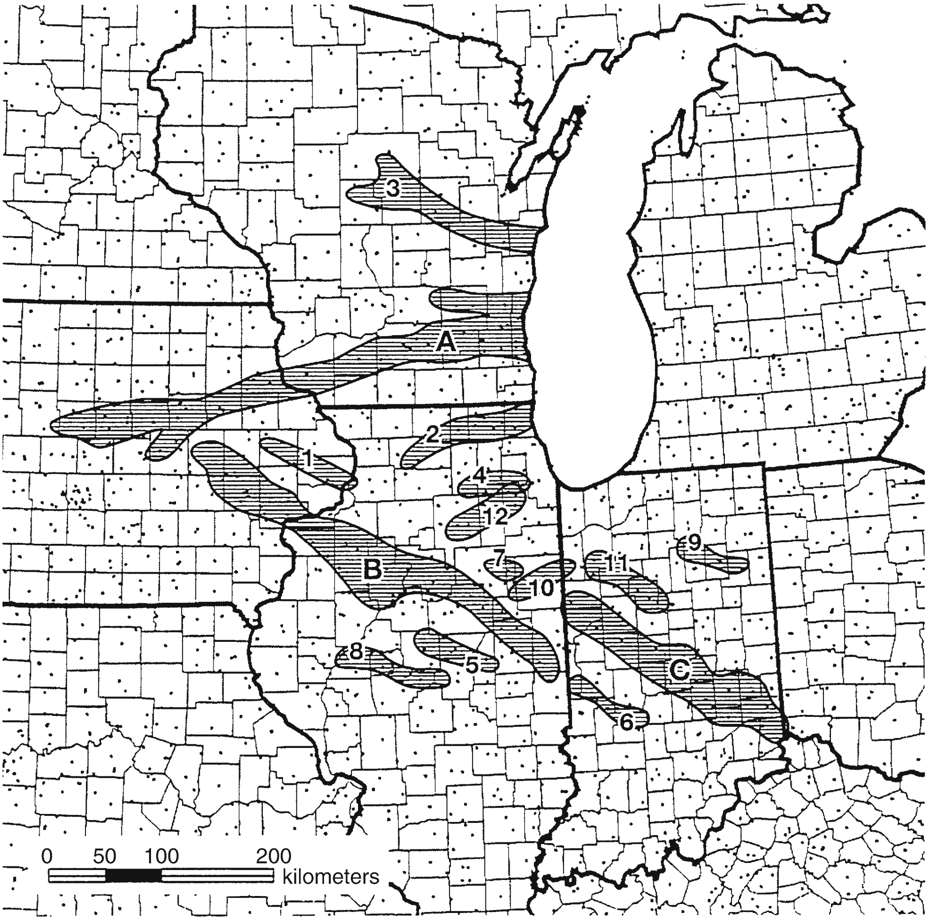

Fig. 1 The hailswaths that occurred on April 13–14, 2006

than 390 locations reported damaging hail and 286 had hailstones with diameters of 2.5 to 5 cm. Hailstones with diameters of 7.5 to 10 cm also fell in Illinois at 19 locales. In contrast, the average Midwestern hailstone size is 0.65 cm (Changnon 1977). Radar indicated that these smaller hail-producing storms in Illinois and Indiana were mini-supercells with features similar to a supercell but they were smaller in height and width (Glossary of Meteorology 2000).

Data on the insured property losses in each state (Property Claims Services 2006) revealed 404,000 claims of hail damage. The losses in each state and for the types of property damaged are shown in Table 1. Indiana had the greatest losses totaling $684 million, followed closely by Illinois with $648 million. Personal property (homes, apartments, furnishings) suffered the greatest losses in all four states. The major losses came in three large metropolitan areas: Chicago ($328 million), Indianapolis ($514 million), and Milwaukee ($318 million).

Table 1 Insured property losses from hail on April 13–14, 2006, showing losses for various types of property and for each state

Type of property	Indiana	Wisconsin	Iowa	Illinois	Total
Personal	374	300	37	301	1,012
Commercial	130	50	21	160	361
Vehicles	180	70	12	187	449
Total	684	420	70	648	1,822

Amounts are in millions of 2007 dollars

3 Major hail losses since 1950

The ten largest hail-caused property losses in the United States during 1951–2006 are listed in Table 2. The previous highest hail loss event occurred on April 10, 2001, when losses in a 3-state area reached $1.5 billion (Changnon and Burroughs 2003). That event was the result of massive supercell storms that began in Kansas and created $290 million damages in Kansas City and losses of $1.18 billion in the St. Louis area.

Major hailstorm events during 1951–2006 were identified using their insured property losses. Their losses had been carefully adjusted for time changes in property values, costs of repairs, sizes of the property market in the storm area, inflation, and share of the property market insured. These loss adjusted data have been identified as the best natural hazard data in the nation (National Research Council 1999). Inspection of the dates of the nation's top ten hail loss events reveals seven have occurred in the last 21 years, 1986–2006. Figure 2 shows the temporal distribution of the 10 events and the loss amounts of each. This distribution indicates a major increase in hail loss events with time and in their losses over time. The top three losses occurred in the 1995–2006 period and two more in 1992. The third ranked event on May 5–6, 1995 created massive losses in Ft. Worth, Texas. It too was the result of supercell thunderstorms (Hill 1996). The April 1992 event listed in Table 2 created major losses that were greater than the $420 million in Wichita, Kansas (Changnon and Burroughs 2003).

Table 2 Highest ten insured property losses from hail catastrophes during 1951–2006. (Loss values are in 2007 dollars)

Rank	Date	Loss, $millions	States with losses
1	4/13–14/06	1,822	IL, IN, IA, WI
2	4/10/01	1,515	IL, KS, MO
3	5/5–6/95	905	NM, TX
4	4/11/87	835	IL, IN, OH, WI
5	4/28/92	828	TX, OK
6	6/21/53	656	KS
7	6/19–20/92	621	OK, KS
8	8/24/86	611	IL, IN, OH
9	6/8/63	582	MI, OH
10	5/11/70	538	TX

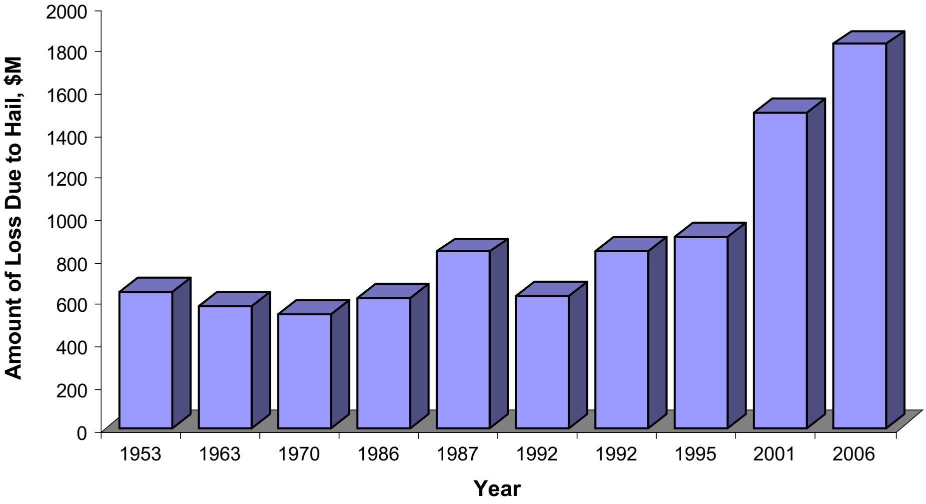

Fig. 2 Losses from the hail events causing the ten highest losses in the nation during 1951–2006

4 Summary

The insured property losses in the Midwest due to hail on April 13–14 totaled $1.8 billion, an amount 20% more than the previous record of $1.5 billion set by the April 2001 hail event. The losses from these two storms were much higher than the third ranked storm (Table 2).

The huge losses during a 30-h period in April 2006 were largely due to multiple severe storms with frequent large hail. Excessive storm damages occurred in the metropolitan areas of Chicago, Indianapolis, and Milwaukee. A highly unstable, moist air mass that developed on April 13 led to a large number of hailstorms in a relatively small region, with several supercell storms that produced large hailswaths across portions of Illinois, Indiana, Iowa, and Wisconsin.

Assessment of the ten greatest hail losses in the nation revealed an increase over time in frequency and losses with most major events occurring since 1990. Two factors could have affected this increase. First, would be more frequent occurrences of major cases of strong atmospheric instability, leading to the development of supercell thunderstorms capable of persisting for many hours, covering large areas, and producing large hailstones. However, this has not been measured and can not be verified. A second factor is the expansion of the nation's metropolitan areas, enhancing the target for hail damages to property. Urban population in the U.S. since 1960 increased by 56% and urban areas grew by 154% (World Almanac 2008).

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