

# Effects of Recent Weather Extremes on the Insurance Industry: Major Implications for the Atmospheric Sciences



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## ABSTRACT

Frequent and extremely damaging severe weather conditions in the United States during 1991–94 caused \$40 billion in insured losses, creating major impacts and eliciting diverse responses in the weather insurance industry. Population, one reason for the growing national sensitivity to storm damage, explained much of the increase in the number of catastrophes (property losses > \$10 million) as well as the increases in the amount of losses. The largest increases in storms occurred in areas experiencing the greatest population growth (west, southwest, south, and southeast). Shifts in atmospheric variables (particularly in the frequency of extratropical cyclones) explained most of the 1949–94 fluctuations found in the intensity of catastrophic storms (losses divided by storm frequency). The property-casualty sector raised rates, made major changes in insurance availability in high-risk areas, tightened underwriting restrictions in hurricane-prone areas, and is making extensive assessments of weather risks. The reinsurance industry raised rates up to 200%, sought and received funds from the financial markets, and developed new firms. However, some existing firms also withdrew from the marketplace. Crop losses led to major changes in the nation's crop insurance program. The property casualty and reinsurance sectors, which experienced the greatest losses, have gained a greater appreciation of the need to incorporate atmospheric data, information, and expertise into their operations. Assessment of the problems created by recent weather extremes and possible solutions identified ways that the atmospheric sciences community and industry can work together more effectively to deal with future climate conditions and weather extremes.

## 1. Introduction

This paper describes the recent (1991–94) weather extremes in the United States and their effects on the weather insurance industry. Total insured losses for 1991–94 were \$40 billion (\$34.5 billion in property, \$5.4 billion in crops), much greater than in any prior 4-yr period. This paper draws upon an extensive study

that a) evaluated the weather extremes in a historical context; b) measured the impacts of these recent events on the crop insurance sector of the industry, the property and casualty sector, the brokerage sector, and the reinsurance sector; c) identified industry responses; and d) identified the lessons learned and their implications for the field of atmospheric sciences (Changnon et al. 1996).

Each year from 1991 to 1994 had more than 1000 tornadoes; Hurricanes Andrew and Iniki occurred in 1992; record winter storms prevailed, including the Storm of the Century in 1993; and floods of record occurred in the Midwest, Georgia, and Texas. Hail losses in 1992 were the worst ever for the crop-hail industry, with 17 states experiencing loss ratios above 100% (ratio = amount of loss divided by amount of premium income). These extremes affected 75% of the nation's population, creating record crop losses and unprecedented damages to personal and business property, which had a severe impact on the insurance

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industry, leading to increased insurance rates for businesses and homeowners. In 1994, Insurance Research and Publishers stated, "The property insurance industry was staggered by a series of increasingly severe catastrophic losses during the last five years. Even larger catastrophes are possible as population and building development continue to increase in exposed areas" (Corning and Company 1994). Some environmental interests blamed the increase in weather disasters on the greenhouse-induced change in climate (Leggett 1993).

Impacts on all sectors of the weather insurance industry were extreme. Insurance carriers paid \$23 billion in claims in 1992, the most ever in a single year and 10 times the normal amount for 1970–91. The property insurance industry was badly hurt and the cumulative losses went beyond many firms' design levels, and a few insurance firms went bankrupt, leaving some claims unpaid. The enormity of the losses to the crop and property-casualty companies in turn caused great losses to reinsurance firms. Some firms dropped coverage, insisting on better rate determination fueled by improved climate risk information, mergers occurred, and new firms developed.

One critical unanswered question faced by insurance decision makers in attempting to plan for the future is whether the recent events were part of the natural climatic variability or whether they were potentially related to other causes and represent a never-before-experienced continuum of severe weather events in this century. Some scientists speculated that the numerous extremes were a sign of global climate change, whereas others claimed that the aberrations were simply typical of the highly variable climate conditions of the United States (Stix 1996). Clarification of these issues is desperately sought by the insurance industry, which is attempting to grapple with the outcome of these extreme events as it plans for the future and attempts to more effectively integrate weather and climate information into its operations.

## **2. Weather insurance industry and its data**

There are two fundamental types of weather insurance: crop related and property related. Companies selling crop-related insurance range from large to very small, and many of them operate within one or two states. Many firms belong to an association and share their loss data and develop rates (Crop-Hail Insurance

Actuarial Association 1978). Many property insurance companies are larger than most crop insurance companies and provide coverage nationwide. There also is a large reinsurance industry operating nationally and globally, offering financial protection to crop and property insurance firms against major losses due to unusual catastrophic events. Still another sector is the insurance brokers, who attempt to find the best coverage and prices for their clients. The important point is that there are tremendous differences in the character and purposes of firms in the weather insurance industry. Each of the four major sectors of the industry was assessed to define the impacts and responses to the weather extremes and to suggest ways that the atmospheric sciences community could work with and assist the industry.

The extreme events of 1991–94 hit the industry at a time when industry interactions with federal and state government agencies were in a state of flux, but the government felt the impact and responded. For example, there was a change in the government–private sector crop insurance program, and it now provides a basic "catastrophic" level of coverage to farmers. There were calls for implementing federal multihazard mitigation and reinsurance legislation. States hard hit by the weather extremes were attempting to supplement their insurance guarantee funds, which had effectively gone bankrupt.

Various weather conditions create crop and property losses. Droughts harm crops but do not cause property loss, whereas floods damage both crops and property if they occur in the growing season. Small hailstones damage certain sensitive crops, but hailstones larger than 1.9 cm must fall before serious property loss occurs. Such variations between intensity levels and timing of events that cause damage also apply to winds and other weather conditions. Perils vary for crops during the growing season, but there is no seasonal variation in property-related risk due to weather perils. A huge tornado crossing rural Kansas produces different outcomes than the same tornado striking Kansas City. The point is, assessing risk climatically for one sector of the insurance industry is not adequate for all other sectors because the targets at risk are so variable in type and season. Further, there is considerable regional difference in the frequency and intensity of weather occurrences affecting property and crops across the United States (Changnon and Changnon 1992a).

For these reasons, the climatological assessment of temporal changes in storm frequencies, losses, and

intensity utilized insurance-derived measures of storm losses. Events during the 1991–94 period were compared with events during preceding years, going back to the beginning of reliable data in 1949. A unique database derived by a major insurance firm documented all the U.S. weather catastrophes based on estimated property losses exceeding \$5 million since 1949 (Property Claim Services 1995), which was used to study temporal fluctuations in property losses. In this database, industry-estimated losses caused by each catastrophe had been adjusted by insurance experts to current conditions (Changnon and Changnon 1992b). This included adjusting for inflation, changing property values and costs for repairs, adjusting for shifts in the size of the fixed property market in areas affected by storms (relative to current values), and adjusting for relative changes in the share of the fixed property market insured against weather perils.

Crop losses were also assessed for their temporal and spatial changes. Crop-hail insurance data on annual liability and losses collected by the industry since 1948 (Roth 1949) were used to compare the 1991–94 hail losses against those of the 1948–90 period. An industry-derived annual index, the loss cost, which adjusts for changes in dollar value and amount of liability, was used for the time comparisons of state and national losses (Changnon and Changnon 1990). The data on crop losses covered by Multiple Peril Crop Insurance (MPCI) for the 1950–94 period were also analyzed using the annual loss ratios. MPCI covers losses due to all natural perils including overly wet or dry conditions, hail, winds, and frost.

### 3. Weather extremes: 1991–94

Severe weather events during 1991–94 were extremely frequent and caused sizable losses (Table 1). Assessment of the climatological relevance of these events was based on two insurance-derived measures of storms and their losses, with data covering the 1949–94 period: catastrophes (based on property losses) and crop losses. Data analyzed included catastrophes causing > \$10 million in property losses, data available beginning in 1949, and crop-hail loss cost data available since 1948. Three levels of catastrophe values were analyzed: 707 catastrophes during 1949–94 producing \$10 million to \$100 million in losses, 189 catastrophes producing > \$100 million in losses, and the 20 catastrophes causing > \$1 billion in losses. For each class of catastrophes, temporal

analyses of the 1949–94 data were done for the annual number of events, the annual total losses (in dollars), and the annual mean catastrophe intensity defined by the annual losses divided by the number of catastrophes. Several analyses were based on values for past 5-yr periods to provide comparisons with the recent events of 1990–94.

One assessment of the conditions during the 1990–94 period was based on ranks of the conditions during each of the nine independent 5-yr periods from the 1950 to 1994 period (1950–54, 1955–59, etc.). The values of each 5-yr period were ranked (1 = highest, 9 = lowest) for each catastrophe category (number, losses, and intensity), for the crop-hail loss costs, and the MPCI loss ratios.

Results for the three 5-yr periods that achieved the greatest number of “high ranks,” defined as those in the top three ranks, are shown in Table 2. The 1990–94 values rated in the top 3 in 10 of 11 possible loss categories. Close behind were the 1950–54 values, which ranked in the top 3 in 9 of the 11 categories. The 1965–69 period achieved high ranks in four categories, making it the third worst 5-yr period during the 1950–94 period.

The time distribution of the high ranks per pentad helps define the climatic behavior of extremely damaging storms during this 45 yr period. The number of

TABLE 1. Magnitude of the 1991–94 weather extremes relative to the 1949–90 period.

- 1991: insured property losses of \$3 billion, ranked as fourth highest on record; 1125 tornadoes, third highest; crop-hail losses of \$190 million, below average; and crop insurance losses of \$958 million, above average.
- 1992: insured property losses of \$22 billion, greatest ever with two major hurricanes, Andrew and Iniki; 1297 tornadoes, greatest ever in one year; crop-hail loss of \$380 million, greatest ever; and crop insurance losses of \$910 million, well above average.
- 1993: insured property losses of \$4.4 billion, third highest on record; 1172 tornadoes, second most frequent total; crop-hail losses of \$326 million, 14th highest; and crop insurance losses of \$1.7 billion, related largely to the record Midwestern flood, and second largest value.
- 1994: property losses of \$4.5 billion, second highest on record; 1076 tornadoes; crop-hail losses \$364 million, fourth highest ever; and crop insurance losses of \$600 million, near average.

TABLE 2. The top three ranks for each insurance loss category for the three 5-yr periods during 1950–94 that achieved the greatest number of high ranks, based on values in each independent 5-yr period (rank 1 = largest number).

Period	Catastrophes \$10–\$100 million			Catastrophes > \$100 million			Catastrophes > \$1 billion			Crop-hail loss cost	MPCI loss ratio
	No. <sup>a</sup>	Loss <sup>b</sup>	Int. <sup>c</sup>	No.	Loss	Int.	No.	Loss	Int.		
1990–94	1	1	3	1	1	3	3	1	2	3	—
1950–54	—	—	1	3	2	2	1	2	3	2	2
1965–69	—	—	—	—	3	1	—	3	1	—	—

<sup>a</sup>Rank based on the number of catastrophes in the period.

<sup>b</sup>Rank based on the total losses caused by catastrophes in the period.

<sup>c</sup>Rank based on mean storm intensity (dollar losses divided by number of catastrophes) in the period.

high ranks in each 5-yr period follows: 9 (1950–54); 1 (1955–59); followed by 2, 4, 0, 1, 3, 3, and 10 (1990–94). There were 16 high ranks in the first 20 yrs and 17 in the last 20 yrs, and the distribution was U-shaped. Conditions in 1990–94 rated as the worst of any 5-yr period since 1950 but only slightly worse than those in 1950–54. The results of this study do not suggest a climatic outcome indicative of a major change in climate, but as Karl et al. (1996) point out, the number of extreme events has been increasing during the past 20 yrs.

Many reasons have been offered from various sources to explain the high frequency of catastrophes and excessive losses during 1991–94 (Flavin 1994; Deering 1993). These explanations range from an increasing vulnerability of the nation to storm damage, to a possible shift to a stormier climate, a condition claimed by some scientists to be due to the human-altered greenhouse effect on global climate (Glantz 1995). A limited analysis was pursued to compare the changing societal vulnerability and changing weather conditions with the fluctuations found in the catastrophes and crop losses. Regional and national values of the annual number of extratropical cyclones, population (as a surrogate for property at risk), and annual temperatures were correlated with the temporal changes in catastrophes and crop-hail losses. Two readily available databases on regional weather conditions potentially related to catastrophe incidence and with identifiable significance within the insurance industry were chosen for investigation. Extratropical cyclone frequency data for North America (Changnon et al. 1995) were selected because most catastrophes

(94%) were nontropical storms and were related to cyclonic systems. Annual mean temperature data were selected because an earlier study of the temporal distribution of catastrophic events found a good statistical relationship between temperature and catastrophe frequency (Changnon and Changnon 1992a), and because there has been speculation that a warmer U.S. climate, possibly due to effects of an enhanced greenhouse condition, would result in more catastrophic events (Friedman 1989).

The annual number of the 707 catastrophes, each causing from \$10 million to \$100 million in losses from 1949 to 1994, and the annual amount of their losses both peaked during 1991–94, as shown in Table 2. Their ever-increasing values since 1950 were found to be strongly related to population, or changing vulnerability to storms (Fig. 1), and poorly related to the cyclone or temperature fluctuations. These ca-

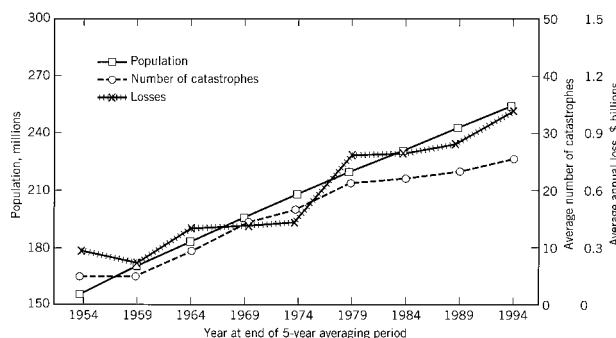


FIG. 1. Average annual number of catastrophes (each causing \$10 million to \$100 million in property losses), the average annual amount of losses, and U.S. population during 1950–1994.

tastrophes were not hurricane-produced events. Furthermore, their increases (in number and amount of loss) occurred predominantly in the southern, western, and southeastern United States, where the population (risk/sensitivity) has grown most rapidly since 1950 (Culliton et al. 1990). The time distribution of the annual intensities of these catastrophes reveals quite a different history (Fig. 2). Those in the earlier years (1950–65) had the highest intensities of the 46-yr period. Intensity of catastrophes declined after 1964 to a minimum in the 1970s and then slowly increased until 1994.

The number of catastrophes causing > \$100 million in losses, and their annual losses, also peaked in 1991–94. However, the 189 events in the 45 yr since 1949 did not exhibit continuing temporal increases (such as shown in Fig. 1 for the \$10 million–\$100 million class). The frequency of the > \$100 million catastrophes had a U-shaped distribution during 1949–94, and their annual losses showed a flat distribution over time with five isolated peak years due to five major hurricanes. The catastrophes' dollar-measured intensities showed the highest values early in the 45-yr period with a general decrease over time, similar to the < \$100 million events (Fig. 2). Temporal fluctuations of the most costly catastrophes related better with the two atmospheric conditions assessed than with changes in population.

Table 3 presents the temporal distribution of the top 10- and top 20-ranked catastrophes, revealing that there were three in 1990–94 and six in 1950–54. The 20 catastrophes causing > \$1 billion in losses also had a U-shaped distribution, and half occurred within 4 yr (1950, 1954, 1983, and 1992). Importantly, 14 were due to hurricanes.

Variations in the annual dollar intensity of catastrophes in all three classes correlated well with weather (cyclone) fluctuations, and not with changes in population as had the frequency of catastrophes. Multiple correlation analyses revealed that the cyclone, temperature, and population values during the 1949–94 period explained 96% of variations in the number of \$10 million–\$100 million catastrophes and 84% of the variations in the > \$100 million catastrophes.

Although crop-hail losses were high during 1992–94, the 3-yr average loss cost was only the third highest 3-yr value since 1948. Annual loss costs during 1948–94 revealed a U-shaped time distribution (high–low–high), one similar to that of catastrophes producing > \$100 million in property damages. The recent high crop-hail losses were largely in the High Plains

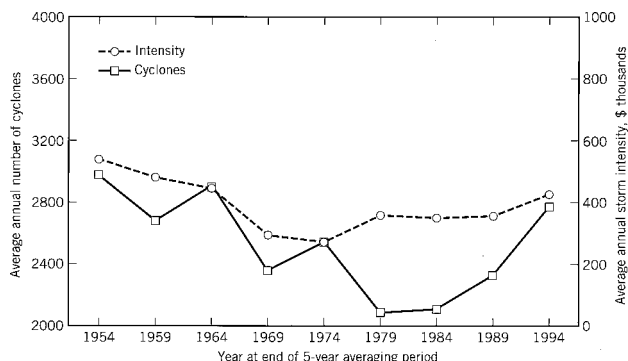


FIG. 2. Average intensity (dollar losses divided by number of storms) for insurance-defined catastrophes causing \$10 million to \$100 million in property losses, and the average annual number of extratropical cyclones active in the United States (Changnon et al. 1995), based on 5-yr values.

and were notably absent in the Midwest. The national loss cost values correlated moderately well with cyclone activity, which explained 62% of the variations since 1948. Crop losses based on MPC1 data have been greatest in extreme droughts, such as those of the 1950s, 1960s, and 1988–89.

In summary, the atmospheric conditions examined helped define the temporal distribution of 1) the major, highly expensive catastrophes (and their annual losses); 2) the intensity of catastrophic storms at all levels of loss; and 3) crop-damaging hail losses.

TABLE 3. Temporal distribution of catastrophic losses produced by the 20 top-ranked (most costly) catastrophes during 1950–94.

Period	Top 10 losses	Top 20 losses
1950–54	3	6
1955–59	0	0
1960–64	1	4
1965–69	1	1
1970–74	1	2
1975–78	0	1
1980–84	0	2
1985–89	1	1
1990–94	3	3

Conversely, shifting societal vulnerability (using population as an index) was the major factor explaining the distribution of the number of damaging (nonhurricane) catastrophic storms producing losses that ranged from \$10 million to \$100 million. The considerable effect of temporal changes in vulnerability on the catastrophic losses in the United States is revealed in Fig. 3. It is based on the annual losses of all 896 catastrophes producing > \$10 million in losses divided by the annual U.S. population for 1949–94. Such normalization to eliminate the influence of growing risks to storm damage reveals that the distribution of catastrophic losses over time has been essentially unchanging, with isolated high values (due to large hurricane losses) in 1950, 1954, 1965, 1988, and 1992.

#### 4. Crop insurance: Impacts and responses

The crop insurance industry is a \$2.1 billion annual business and an important part of U.S. agriculture, providing crop-hail insurance and MPCI. Relevant to interpreting and understanding what happened to the insurance industry as a result of the weather extremes of 1991–94 was the financial state of the industry before and during the 4-yr period. Walter (1993) indicated that the crop insurance industry had been unprofitable in recent years and explained that questionable ratemaking was a key factor. For example, the MPCI industry before 1991 was having a difficult time for several reasons. The private insurance industry had decided in the late 1970s

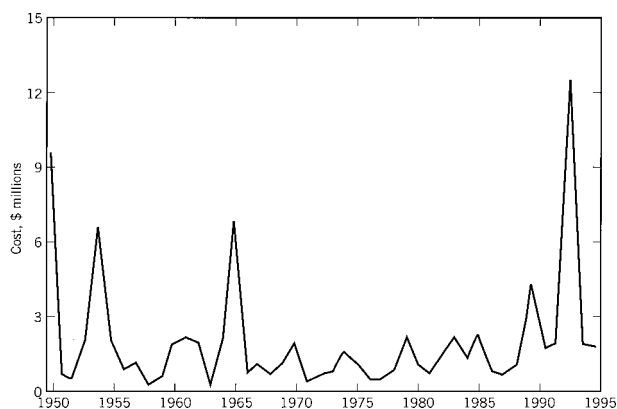


FIG. 3. Normalization of the amount of catastrophe losses by population. These are annual values of loss due to catastrophes (causing > \$10 million in losses) divided by U.S. population.

to actively join the federal government and its Federal Crop Insurance Corporation (FCIC) in providing for the nationwide sales of MPCI. However, sales were detrimentally affected because when weather extremes such as the 1988 drought hit, major disaster relief payments were made to all affected farmers in disaster-declared counties, negating the rationale for buying insurance. Many farmers tended to self-insure, ignoring purchases of MPCI, but farmers in high-risk areas with frequent losses did buy insurance. In essence, the federal government treated the MPCI program as a form of subsidy and part of the nation's farm program, making it a nonprofitable operation for the private sector.

##### a. Crop-hail insurance

Although the national experience for 1991–94 was severe, this period ranked third highest nationally since 1948, well within normal historical variability. Insured losses during 1991–94 were \$1.3 billion, representing roughly 65% of all crop-hail losses in the nation. A factor amplifying the impacts of the 1991–94 hail losses was that they occurred after a 10-yr period of low losses nationally. Interestingly, very little occurred within the hail insurance industry in response to the major losses. For example, in previous years the rating organization might have done some “emergency rating” to revise state rate structures prior to routine rate revisions, but that did not occur during 1991–94. Individual companies did adjust rates in areas where rates were inadequate even before this adverse period, however. For several reasons (pricing versus rating for several years prior to 1992), the crop-hail insurance industry had not been following adequate rate-based insurance practices.

##### b. Multiple peril crop insurance (MPCI)

With the exception of 1993 (when major midwestern flooding and a southeastern drought occurred), the 1991–94 experience was more a continuation of adversity rather than a series of anomalies. Recent (1991–94) MPCI losses of \$4.1 billion were not as severe as those in the 1950s and late 1980s. Ad hoc disaster payments and low-cost emergency loans authorized by Congress accounted for greater expenditures than the financial losses of MPCI (losses beyond the premium income). These combined huge loss payouts (for relief, loans, and MPCI losses) prompted Congress to enact “reform” legislation applicable to the 1995 crop year (Changnon 1996). The act had several main features: 1) no more ad hoc disaster pay-

ments, 2) provision of a level of coverage for catastrophes at little cost to the farmer client, and 3) existing MPCCI coverage available at levels above the catastrophe level as an option. Neither the hail insurance nor the MPCCI experiences during 1991–94 suggested a trend toward a changed climate (Changnon et al. 1996).

## **5. Property-casualty insurance: Impacts and responses**

The 1991–94 period contained an abnormal number of property catastrophes, many caused by thunderstorms and winter storms, but the greatest impact on the insurance industry was Hurricane Andrew's \$16 billion in insured losses, which were much greater than the expected record high of \$7 billion that industry experts had predicted in 1986 (All Industry Research Council 1986). The 4-yr insured-property losses amounted to an estimated \$34 billion.

Since 1987 the property insurance industry has faced a dramatic increase in claims due to population increases, a higher standard of living, a greater concentration of people and goods in highly exposed areas, an increase in insurance density, and a change in environmental regulations (Berz 1993). The total U.S. capacity of insurers and reinsurance is \$100 billion dollars. If Hurricane Andrew had hit 50 miles farther north (Miami proper), the expected losses would have been three to five times greater than the \$16 billion experienced, a situation that would drive even the major insurance companies toward bankruptcy. Property development along the Atlantic and Gulf Coasts soared during the 1960–90 period, doubling and tripling the insurance exposure. Furthermore, this was an era of few catastrophes and fewer hurricanes, the proverbial "lull" before the storm, something the industry failed to recognize.

The property insurance industry, in general, had not related insurance exposure to potential weather perils, and the industry has lacked adequate data (experience) related to weather perils. Other problems that surfaced in the 1990s included a lack of attention and support for building code enforcement and state reinsurance regulators failing to allow for development of adequate rates. Consequently, the extremes of 1991–94 caused nine smaller insurance firms to become insolvent.

Losses during the period since 1991 led to several major responses, including a major reassessment of

risk, shifts in insurance availability in high risk areas, and severe underwriting restrictions for hurricane-prone areas. This brought three reactions: states passed legislation to delay withdrawals of insurance coverage in high risk areas, policies written by residual markets increased dramatically (residual markets provide coverage to those unable to obtain coverage in the voluntary market), and some states established funds to provide additional capacity for insurers to write insurance. Another major response, as expected, were requests by insurance companies for substantial rate increases in many states.

The losses brought home an important lesson: the property insurance industry finally appreciated that weather hazards were a key issue, and this new awareness led to several actions (Corning and Company 1994). One was the creation of the Insurance Institute for Property Loss Reduction, which initiated three key activities: development of a building codes grading system, initiation of a database of claims paid on catastrophes, and development of databases relating weather perils to the potential for damage (Insurance Institute for Property Loss Reduction 1995). Insurers also began a greater use of models projecting potential losses over insured areas. This has led to the development of varying rate regions for hail risk in some states, such as Kansas. Major insurers now assume a greater amount of the risk than before. There is also greater awareness of climate change as an important issue, although the industry has varying attitudes about its reality (Lecomte 1993; Linden 1994).

## **6. Reinsurance industry: Impacts and responses**

Hurricane Andrew and the 138 other catastrophic storms during 1991–94 caused major financial losses in the reinsurance industry. The exact amount of loss in the United States on the reinsurance market is difficult to measure because the industry's market is global in nature, and major reinsurance firms have to contend with all worldwide catastrophic events, including earthquakes and fires. However, approximately 70% of the \$40 billion in U.S. property and crop losses during 1991–94 were ultimately handled by the reinsurance industry. Premium incomes of the top 59 U.S. firms jumped 40%, from \$11.6 billion in 1991 to \$16.3 billion in 1994. Huge storm losses also led to greater interest and attention focused on weather problems, leading to assessments of the damage po-

tential for various regions (Conning and Company 1995). Representatives of certain reinsurance companies believed that climate change was the reason for the increased number of catastrophes (Flavin 1994).

The reinsurance industry began experiencing major difficulties in the 1980s as a host of problems surfaced, including environmental issues such as asbestos. Recognition of the fact that available capital was not adequate to cover potential megacatastrophes led the nation's 59 major reinsurance firms to establish a company benchmark of \$100 million in surpluses to hedge against increasing losses. By 1992, 40 firms had met this level. The catastrophic events of the early 1990s led the industry to select an even higher benchmark for company surpluses, \$200 million, and by 1994, 27 of the 59 firms had achieved this goal. These actions brought investors into the reinsurance market. Cash flow grew continuously during the 1990s, ranging from a low of \$1.1 billion in 1992 to a high of \$2.4 billion in 1994. The growing surplus of funds and return of equity values of the reinsurance market exceeded those of the primary insurance industry, both key signals that the reinsurance industry had remained financially healthy during the 1990s.

Three major reactions of the reinsurance industry to the catastrophic losses of the 1990s included: 1) raising rates (sometimes by more than 200%), 2) imposing stricter underwriting terms (risk assumption) on insurance companies, and 3) withdrawing from the market. Other responses included attracting new investors, expanding existing markets, changing types of insurance, more careful auditing of activities, more thorough analysis of the spatial distribution of risk (for a given company), and increasing the aforementioned benchmark surplus funds. At the close of the 1991–94 period, the property-oriented catastrophe reinsurance market had experienced major changes resulting in an exodus of some of the industry from the market. By raising, the expectations of improved underwriting (risk assessment), better spread of the risk among firms, and higher reinsurance pricing collectively resulted in a market that saw an overall increase of funds and available reinsurance.

As a result of the stresses of the 1990s and concerns over handling future major catastrophes, different catastrophe risk management tools have evolved. One includes risk exchanges, the indexing of exposure and the swapping of that risk between companies from different regions of traditional markets. Another involves increased capitalization as financial markets continue to invest and as pricing remains attractive and

offers strong returns. More traditional reinsurance solutions include separating catastrophe exposure from other primary insurance products, creating a catastrophe product with its own rating structure and underwriting guidelines, mandating a new catastrophe product exist in all high-risk areas, and establishing a federal government catastrophe reinsurance pool using federal funds (Bipartisan Task Force 1995).

## **7. Brokers: Impacts and responses**

A soft market, which began in 1987, continued through the severe weather period (1991–94) without change, the first time that major economic stress had not changed the insurance market to a hard one (a soft market exists when insurance premiums and rates decrease and coverage is readily available). In many respects, the extreme weather events did not hurt the brokerage industry. In fact, the overall economic conditions throughout the insurance industry were much more important factors than the weather losses in dictating what happened within the insurance industry.

Several industry responses to the losses affected the brokerage sector. In general, brokers profited from the weather catastrophes in the 1990s because the events increased business, resulting in mergers and several acquisitions. Significant among these changes were the new catastrophe markets that had been established in Bermuda (to escape U.S. regulations), new insurers and reinsurers that moved into the property business, and more frequent reviews of the financial conditions of insurers.

## **8. Need for weather and climate information**

This assessment has shown there is a great need for closer interactions between the atmospheric sciences community and the insurance industry, especially through collaborative work and outreach efforts to educate the industry about available data and information and how it can be used. For example, all facets of the insurance industry could benefit significantly from the development of more accurate long-range forecasts, especially ones that address the likelihood of extremes. In the meantime, there could be major benefits from the use of climatologically based probabilities and models for future trends in insurance-related losses. The current practice of several experts



issuing widely different seasonal forecasts is confusing to the industry and reveals the inexact nature of the science. In the insurance industry, this situation has also affected the credibility of the entire atmospheric sciences community.

The general areas where atmospheric assistance is needed include insurance efforts to mitigate weather losses, to assess risk in space and time, to measure critical perils and their damages, to educate the public about risks, and to learn about major atmospheric issues and advances in the field. For example, the climate change issue has great relevance to the weather insurance industry: a shift in the climate to more or fewer storms would create major problems since rates and their justification are traditionally based on historical data, not on future expectations (Fosse and Changnon 1993). This is why the industry needs reliable information about the potential onset of a change in climate and its dimensions that relate to crop and/or property damaging weather. Some examples of recent weather-insurance collaborations done to address the needs of the insurance industry for atmospheric data, information, and expertise are as follows.

- Defining the rainfall regions of the United States, based on hourly rain rates, to revise inadequate rain insurance rates (Changnon and Changnon 1989).
- Assessing the incidence of thresholds of subfreezing temperatures in the southern United States (Lamb 1995), where frozen pipes are a major problem (Insurance Institute for Property Loss Reduction 1996a).
- Defining the damaging aspects of hailstones, needed for assessing roofing materials for input to improved building codes for roofing (Insurance Institute for Property Loss Reduction 1996b).
- Conducting workshops for insurance leaders on topical issues like climate change and climate predictions (Centre Cat 1995), and involving insurance leaders in the research planning for the U.S. Weather Research Program.
- Assessing the regional risk of damage to property from hail, lightning, tornadoes, winds, and winter storms (Changnon and Changnon 1990).
- Developing means to measure peak winds within hurricane-damaged areas to have more representative data needed to assess property damages and to deal with the assessors of damaged property who are often comparing wind values from distant locations with quality of building methods.

- Measuring weather-damaged areas rapidly after the event with new sensors like NEXRAD to provide guidance for teams of field adjustors and for early assessments of loss (Hooke 1995).
- Evaluating the potential damage by winds and developing a PC program so insurers can use this wind information in underwriting and in advising property owners about risk, so as to reduce susceptibility to damage (Roth 1996).
- Assessing hail frequency and estimating intensity from historical hail-day records for many decades before crop-hail insurance records began (Changnon 1995).

## 9. Summary

The recent national upsurge in major weather losses is largely related to increased catastrophes caused by thunderstorm-related conditions and winter storms, not to increased numbers of hurricanes and tropical storms. Furthermore, the upsurge has been confined mainly to the nation's southern sections, plus the northeast. Growth of weather-caused property losses is closely related to the growth in population, a surrogate for the shifting risk, and to population shifts into the southern sections of the nation. Fluctuations in storm intensity (dollar losses divided by storm frequency) and losses from major (> \$100 million) catastrophes also related well to the fluctuations in extratropical cyclone activity and temperatures.

The 1991–94 weather extremes caused major financial losses in the insurance industry. Nine property firms went bankrupt, some insurers suffered serious attrition of surplus, reinsurance firms suffered major losses, and insurers faced increased problems with state regulators. Farmers and the general public suffered, especially those without insurance; rural economies suffered from reduced incomes; and taxpayers paid more for the added disaster relief payments, for subsidized emergency loans, and for the insured losses in excess of premiums.

The magnitude of the 1991–94 losses cuts across all sectors of the insurance industry and had profound effects on that industry, as reflected by their responses. The losses got everyone's attention. The chief executive officer of the Insurance Institute for Property Loss Reduction said, "Business as usual just won't work," a fitting statement about the insurance industry's need to respond to the catastrophes of the 1990s with new concepts of doing business (Lecomte 1994).

Responses from the insurance industry were diverse. One major action was the reduction of storm coverage, particularly in storm-prone areas. State insurance regulators fought back, insisting that companies maintain coverage; some companies simply let their existing coverage “lapse” without selling new coverage. Another industry response has involved specialization by firms, attempting to focus on less damage-prone sectors and to readjust their distribution of coverage. Companies have struggled to restore their surplus. Because the demand for coverage exceeded the supply, the position of the reinsurance industry has improved, resulting in higher rates, stricter conditions, and increased deductibles (Berz 1993). A resulting goal of the reinsurance industry has become to shift more of the financial burden for catastrophe coverage to the insurers and the insured. Events during 1991–94 caused some firms offering reinsurance to withdraw, and others insisted that insurance companies do a better job of assessing the weather risk before reinsuring them.

Escalating costs of the weather-induced losses in the 1990s also threaten the private supply of insurance. Premiums have been too low to provide the capital needed to meet the losses of frequent catastrophes. Furthermore, the reinsurance industry alone cannot handle a multitude of catastrophic losses. As a result, six broad areas of responses have developed.

First, reinsurers are making major adjustments, including increasing their rates (doubling them in some cases), dramatically increasing the insured’s retentions (amount of loss insurers are obliged to pay before reinsurance takes effect), cutting the amount of reinsurance available to any buyer, and more closely scrutinizing underwriting practices of insurance firms.

Second, insurers have withdrawn coverage in storm-sensitive areas, raised underwriting standards, and capped coverage limits in disaster-prone areas.

Third, federal involvement is being explored with possible legislation that would help alleviate insurers’ losses from catastrophes. This comes amid fears of government involvement and regulation of the insurance industry.

Fourth, state activities have begun designed to establish state disaster prefunding programs and basic coverage plans to improve access to insurance protection and improve availability of coverage in high-risk areas.

Fifth, private money markets have begun to provide funding for catastrophic risks, thereby spreading

the risk to sectors of the economy beyond the insurance industry.

Finally, there is growing attention to the weather threat, to mitigation, and to the improvement and enforcement of thousands of existing, widely varied building codes. Standards for rating community codes, as a means of encouraging enforcement of codes and making insurance affordable, are underway.

In summary, the weather extremes of the 1990s served several useful purposes. Benefits included a better business environment for brokers, new reinsurance facilities and better practices, better laws at state and federal levels, enhanced business of certain reinsurance and insurance firms, building code improvements and added enforcement, increased awareness of weather as a problem, reorganization of MPCI, recognition by the property industry that it should have better data on catastrophes, and a new organization established by the property industry to help improve mitigation. These major changes in the industry since 1991 have made it stronger and smarter (CNA Insurance Group 1996). The effect of the weather extremes may be considered a net benefit to the weather insurance industry. The events awakened the insurance industry to the need to more wisely address weather hazards. This outcome offers excellent opportunities for the atmospheric sciences to develop new interactions with the insurance industry to provide data, information, and expertise.

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