THE GREAT STORM OF 1987: 20-YEAR RETROSPECTIVE

RMS Special Report

EXECUTIVE SUMMARY

The Great Storm of October 15–16, 1987 hit northern France and southern England with unexpected ferocity. Poorly forecast, unusually strong, and occurring early in the winter windstorm season, this storm — known in the insurance industry as "87J" — has been ascribed negative consequences beyond its direct effects, including severe loss amplification, and according to one theory, the precipitation of a major global stock market downturn.

Together with other catastrophic events of the late 1980s and early 1990s, the storm brought some companies to financial ruin, while at the same time creating new business opportunities for others. The global reinsurance industry in particular was forced to adapt to survive. In this climate, the way was clear for new capital to enter the market, and for the development of innovative ways to assess and transfer the financial risk from natural hazards and other perils.

Twenty years following the 1987 event, this report chronicles the unique features of the storm and the potential impact of the event should it occur in 2007, in the context of RMS' current understanding of the windstorm risk throughout Europe. The possible consequences of a storm with similar properties taking a subtly different path are also considered.

In 1987, losses from the storm totalled £1.4 billion (US$2.3 billion) in the U.K. alone. RMS estimates that if the Great Storm of 1987 were to recur in 2007, it would cause between £4 billion and £7 billion (between US$8 billion and US$14.5 billion) in insured loss Europe-wide. Over 70% of this loss would be generated in the U.K., with the majority of the remaining loss in France.

INTRODUCTION

Widely acknowledged to be Great Britain's most severe windstorm since 1703, the Great Storm of October 15–16, 1987, labeled "87J" by the U.K. insurance industry, caught the U.K. by surprise. Windy weather was forecast for several days before the event, but the U.K. Met Office did not issue a severe weather warning until 01:20 UTC[1] on October 16, only one to three hours preceding the strongest winds. The storm's rapid development in the Atlantic Ocean west of Portugal made its ultimate strength and path impossible to predict using the forecasting methods and data available at the time. Recent budget cuts meant that there were no longer any weather ships in the Atlantic providing data to feed the forecasting models, and automated offshore observations were not yet in place.

The storm that night was not, strictly speaking, a hurricane, which is a term reserved for a specific type of tropical cyclone, but rather an extreme variant of an extra-tropical cyclone, which is a frontal low pressure system that passes across the region regularly, especially during the winter months. Nevertheless, hurricane-force winds struck the northwest coast of France and the southeast corner of England overnight. Swept along by an exceptionally strong jet stream during the storm's relatively short lifetime (less than 24 hours), the storm caused death and destruction as it advanced. Tree damage, property damage, and transport and infrastructure failures occurred along a track extending across Europe's western margin from Spain and Portugal in the south to Norway in the far north. In France, the coast of Brittany experienced the full force of the wind, with gusts up to 60 m/s (134 mph), while exposed locations in the U.K. recorded gusts approaching 50 m/s (110 mph). The storm passed across the North Sea to cause extensive forest damage, serious river flooding, and a storm surge in southeast Norway. In the central path of the storm, wind gust speeds generally exceeded 45 m/s (100 mph).

In many ways, the effects of the Great Storm of 1987 could have been much worse. For example, if the storm had occurred during the daytime, there would certainly have been more fatalities, or if it had passed only a few tens of kilometers to the north, it would have directly hit the main metropolitan area of Greater London, as occurred in 1703. It was fortunate that more than 80% of the damaging windfield was offshore.

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[1] UTC refers to Coordinated Universal Time, the worldwide zone-independent time system equivalent to what was formerly known as Greenwich Mean Time (GMT).

THE GREAT STORM OF 1987

Origins and Forecasting

The Great Storm of 1987 originated on Thursday, October 15 from a small disturbance along a cold front in the Bay of Biscay north of Spain. The extra-tropical cyclone that developed became the deepest low pressure system to cross England or Wales during the month of October in at least 150 years. The timing of the storm in mid-October was unusually early, as the peak of the European winter windstorm season is in January and February. The intense and fast-moving depression crossed the coast of South Devon shortly after midnight on October 16 and continued to move northeast over the U.K., deepening rapidly. The storm generated exceptionally strong winds around the southern and eastern flanks of the low pressure system, with gusts well in excess of 36 m/s (81 mph) over a wide area of southern England and northern France. The last storm of similar magnitude to strike England occurred in 1703 (RMS, 2003). In France, there was no comparable event since 1896.

Unfortunately for those in the path of the storm, the event was poorly forecast. Forecasting models have a poor track record at predicting the explosive development of rapidly deepening storms off the coast of Europe and elsewhere. This is partly because of the dearth of observations offshore in the Atlantic Ocean, where the most critical development occurs, and partly because of the unpredictable nature of the storms themselves. Additionally, at the time of the 1987 storm, the U.K. had recently lost its weather ship in the Bay of Biscay due to budget cuts. While recent studies show that contemporary forecasting models such as those available to the European Centre for Medium Range Weather Forecasting (ECMWF) are becoming ever more skillful at predicting the development of these systems (Jung et al., 2005), mid-latitude Atlantic windstorms with hurricane-force winds remain the most unpredictable of all extra-tropical cyclones (Sienkiewicz and McFadden, 2004).

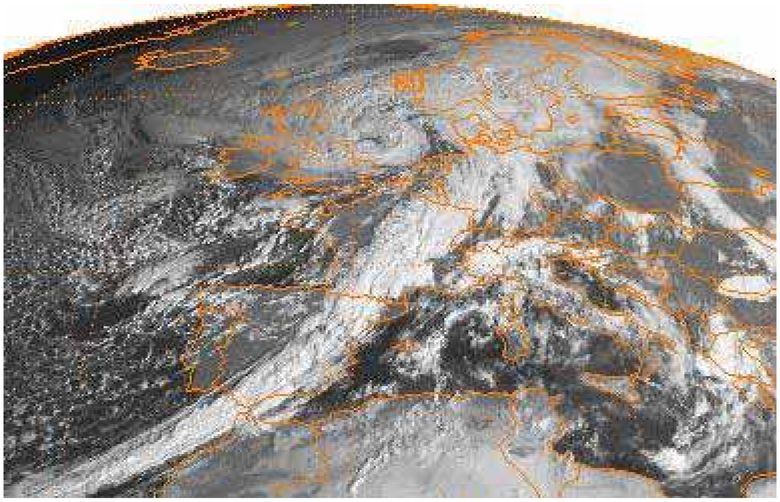

Figure 1: Satellite image of the 1987 storm over the North Sea (Courtesy of NOAA)

Synopsis of the 1987 storm

At 12:00 UTC on October 15, an emerging storm with a central pressure of 970 millibars (mb) was identified over the Bay of Biscay. While satellite imagery showed a fairly typical low pressure system developing, by 18:00 UTC the system had deepened by 6 mb and continued to deepen rapidly while increasing in forward speed. The cause of such deepening was a combination of two key factors: warm air flowing eastward out of Hurricane Floyd, then located just east of the U.S. (Hoskins and Berrisford, 1988) combined with a striking temperature gradient comprising warmer than normal sea surface temperatures in the Bay of Biscay and cold air moving south from Iceland toward Iberia. The southern locality of the storm — a rare occurrence during the month of October — and its rapid forward speed can be attributed to the particularly strong jet stream located south of

50 ° N latitude. This is illustrated in Figure 2(a), which shows the mean zonal winds (at 200 mb)[2], a measure of the upper-atmospheric winds associated with the jet stream.

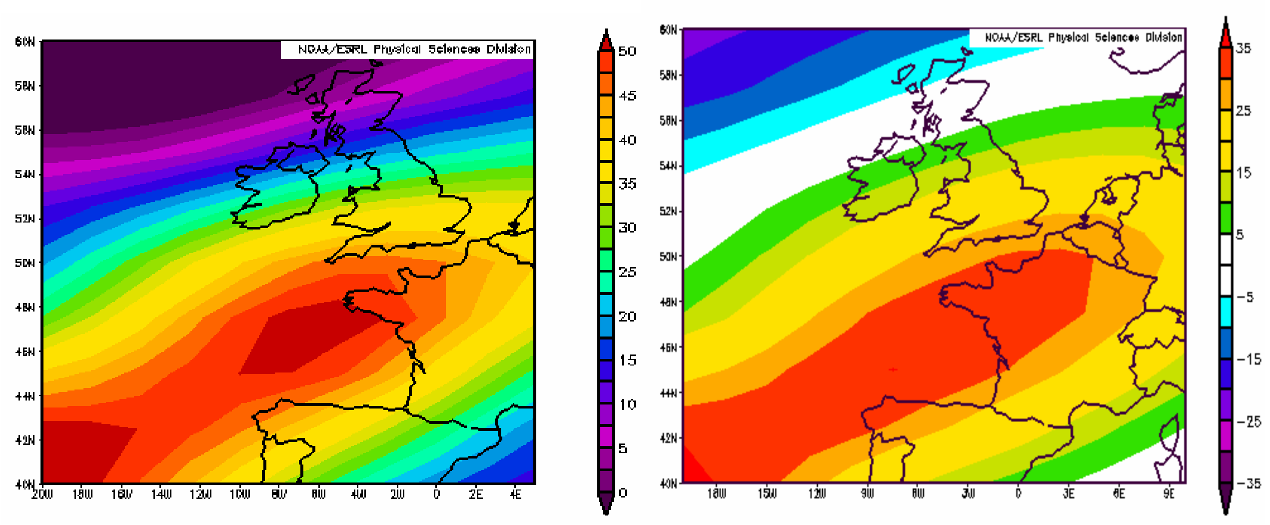

Figure 2: (a) Mean zonal winds at 200 mb on October 15, 1987 and (b) zonal winds anomaly at 200 mb on October 15, 1987 (Courtesy of the NOAA/ESRL Physical Sciences Division at http://www.cdc.noaa.gov/ with dataset source of Kalnay et al., 1996)

The jet stream is a current of upper-atmospheric winds that both steers mid-latitude storms and also plays a role in their rapid development. On October 15, 1987 the jet stream was located much farther south than normal. This is illustrated in Figure 2(b), which shows the zonal wind anomaly, a measure of the difference between the expected upper-atmospheric steering current and the one that was observed. There is a strong positive anomaly over northern France (shown in red), which means that the steering current is in an unexpected place. There is also a strong negative anomaly to the north of Scotland, indicating that the upper-atmospheric winds are much lower to the north of Scotland than expected. This figure therefore suggests that the jet stream would normally be located well to the north of Scotland, and therefore, low pressure systems would be steered well north of the U.K. In this case, however, it was located over northern France, propelling low pressure systems into the heart of the region.

At 18:00 UTC on October 15, the U.K. remained under a slack pressure gradient, with light and variable winds extending across the country, and the strongest winds located over northeast Portugal and Spain as well as the Bay of Biscay. The low pressure system continued to move northeast, both increasing in speed and deepening. By 00:00 UTC on October 16, the storm's center was located just to the north of Brittany, with an estimated central pressure of 953 mb.

As the depression approached the U.K., rain spread across the country ahead of the warm front and fresh south to southwesterly winds were evident in the warm front's wake. The map in Figure 3 shows the track of the storm and the associated nadir (central) pressures in millibars (mb). The dots and track are shaded according to the atmospheric pressure. Time labels show the track's location at 6-hour intervals, illustrating the storm's remarkable increase in forward speed between midnight and 06:00 UTC on October 16. Dots illustrate the storm's location hourly between these two points. The system crossed the coast of South Devon sometime between 01:00 and 02:00 UTC and continued to move northeast across the U.K. At 02:00 UTC, it was centered close to Exeter with a central pressure of about 957 mb, making it at that time the deepest depression to be centered over England or Wales in October in at least 150 years (Burt and Mansfield, 1988).

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[2] This refers to a pressure surface where atmospheric pressure equals 200 mb at some elevation above the ground. Because atmospheric pressure varies from place to place, the elevation of this pressure surface will vary from one location to another.

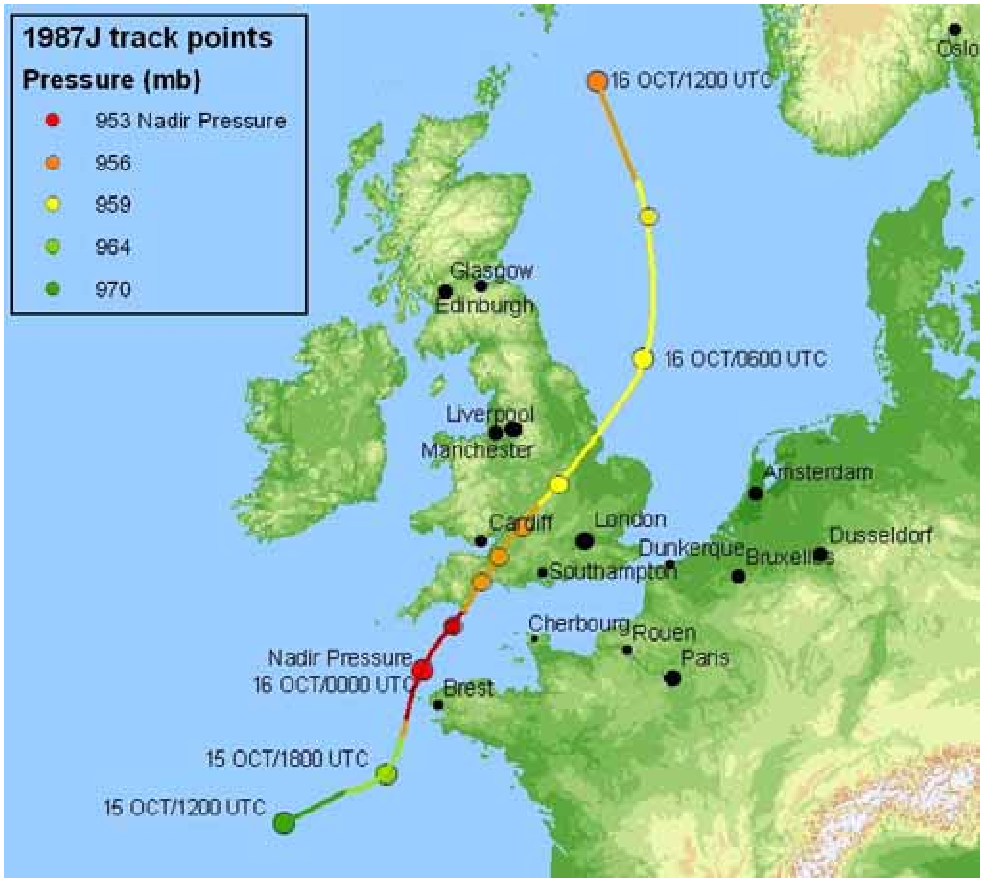

Figure 3: Path of the 1987 storm as it tracked across the region

By 03:00 UTC, the low pressure system was centered over the Somerset Levels, and mean wind speeds over southwest, central southern, and eastern England, as well as much of northern France and the coasts of Belgium and Holland, exceeded 15 m/s (34 mph). The winds were worst over the widest area between 04:00 and 05:00 UTC, with much of southern and southeastern England feeling the storm's full force. Winds exceeded Beaufort Force 10 (24 m/s or 54 mph) over a wide area, extending southward in a line from Hull to Cardiff.

By 07:00 UTC, the storm was centered over the North Sea. With the exception of East Anglia, winds had begun to abate over much of the country and the swath of strongest gusts had moved over the southern North Sea. As the low pressure system tracked north over the North Sea, it gradually weakened toward the evening of October 16.

Unique features of the 1987 storm

The most remarkable feature of the storm was the exceptional strength of the winds over southeast England, an area of high population density and property exposure not usually prone to such winds. Gusts in excess of 36 m/s (81 mph) were recorded continually for 3 to 4 hours, which also coincided with the areas of greatest damage. While the highest gust recorded during the storm was 60 m/s (134 mph) at Pointe du Roc near Granville, Normandy, the highest recorded gust in the U.K. was very close to this maximum at 54.5 m/s (122 mph) at Gorleston. Additionally, the highest hourly mean wind speed was 38 m/s (85 mph) at Shoreham-by-Sea and was sustained for 20 minutes. According to the U.K. Met Office, the gust and mean wind speeds observed southeast of a line extending from Southampton through North London to Great Yarmouth had a return period of 200 years. Storms as severe as this one can be expected more frequently in Northern Scotland, given it is much closer to the main storm tracks of the Atlantic than southeast England.

The 1987 storm was also associated with striking temperature changes across the U.K. as the storm tracked northeast. Before the storm had formed, a very pronounced thermal gradient was evident over the eastern North Atlantic. Figure 4 demonstrates the steep thermal gradient at 850 mb that was in place on October 15, with temperatures between 10°C (50°F) and 12°C (54°F) at 850 mb over Spain, Portugal and over the Atlantic compared to temperatures of around 0°C (32°F) at 850 mb over Ireland.

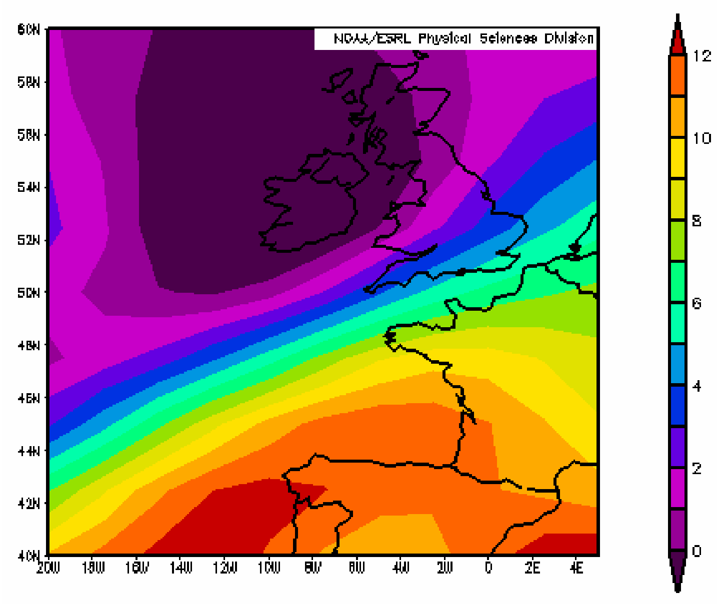

Figure 4. Air temperature at 850 mb on October 15, 1987 (Courtesy of the NOAA/ESRL Physical Sciences Division at http://www.cdc.noaa.gov/ with dataset source of Kalnay et al., 1996)

Ahead of the storm, rapid temperature increases accompanied the passage of the warm front, coinciding with the onset of southerly winds. Temperature increases of more than 6°C (43°F) per hour were recorded in many places south of a line from Dorset to Norfolk. At Heathrow Airport, the temperature rose by around 7°C (45°F) in one hour, the largest one-hour temperature rise in at least 37 years. A particularly notable temperature rise was also recorded at South Farnborough in Hampshire, where the temperature rose from 8.5°C (47°F) to 17.6°C (64°F) in 20 minutes. The U.K. Met Office estimated the return frequency for this rapid a temperature increase to be once in 200 years. Behind the storm, there was a sharp fall in temperature with the passage of the cold front. Winds swung round to the northwest, bringing a cooler airflow over the U.K.

Although the pressure falls ahead of the storm were fairly large, they were not remarkable (Burt and Mansfield, 1988). However, as the storm tracked northeast across the U.K., there was an unprecedented rise in pressure behind the storm. Over much of southern England, increases of more than 8 mb per hour were recorded. The greatest three-hour pressure change ever recorded in the British Isles was seen at Portland Royal Naval Air Station in Dorset, where, between 03:00 and 06:00 UTC on October 16, the rise was over 25 mb. At many places in southern England, the pressure rose more than 20 mb in three hours. Once again, the U.K. Met Office estimated a return period of roughly once in 200 years for such an occurrence.

Impact of the Event

The 1987 storm in the U.K.

Southern England suffered the most extensive destruction. The 1987 storm was the most damaging event to occur in the U.K. since the November 1703 storm, which killed many thousands of people (RMS, 2003). According to a report published by the Association of British Insurers (ABI, 2003), the final clean-up bill paid by the U.K. insurance industry was £1.4 billion (US$2.3 billion)[3]. The storm left 150,000 households without telephone communications and many hundreds of thousands without power, causing a total of 2.3 million power disconnection days, a measure used by the electricity industry to assess the combination of the number of disconnected properties with the length of the disruption (Gittus, 2004).

The storm was notable for its effects on English forests. Britain lost 15 million trees, amounting to over 4 million cubic meters (141 million cubic feet) of timber. The town of Sevenoaks was famously reduced to one oak as six of its eponymous trees fell overnight. Toys Hill in Kent was an extreme example of the scale of treefall, losing 97% of its trees to the gale (Figure 5).

Figure 5: Aerial photograph illustrating the pattern of fallen trees at Toys Hill in Kent (Courtesy National Trust Photo Library at http://www.ntpl.org.uk with photograph by Mike Howarth)

The catastrophic extent of the treefall experienced in the U.K. has been attributed by some to the combination of two factors: previous weeks had been wet so that trees were rooted into soft ground, and the tree population had not yet lost its canopy of leaves, so the wind could not pass relatively harmlessly through branches. As a result, the pressure of wind on the leafy branches of trees rooted in wet ground forced them to topple. However, others point out that in woodland areas, the intact canopy itself can have a sheltering effect on surrounding trees (Grayson, 1990). Nevertheless, much of the damage to property, transport, and infrastructure can be attributed to falling trees and other wind-blown debris.

Southeast England's air, road, and railway networks were paralyzed on the morning of Friday, October 16, 1987. Gatwick Airport had no power, while wind-thrown debris littered the roads and railways, making journeys impossible throughout the most badly affected counties of Kent, Surrey, and Sussex. The wind in the U.K. was thought to have been strong enough to overturn train carriages. On October 17, the French newspaper *Le*

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[3] In 1987 values using 1987 exchange rate

Monde reported that in Spain, a train traveling from Madrid to La Coruña was derailed due to the strength of the wind gusts the previous evening, injuring several passengers. British Rail concluded that there were no severe railway accidents in the U.K. from overturned carriages only due to the fact that the storm struck during the night, when no trains were running. In addition, the overnight treefall made it impossible to resume rail operations in the morning (Johnson, 1996).

The Building Research Establishment recorded 1.3 million damage incidents for this event, a record exceeded only by the "Capella" storm of 1976, which covered a wider area of the U.K. and had 1.5 million incidents of damage. Some iconic and noteworthy individual losses included the historic Shanklin pier on the Isle of Wight, and the cross-channel ferry, the *MV Hengist*, that was beached in Folkestone. Most sources attribute between 16 and 19 deaths in the U.K. to the direct effects of the storm. This figure is remarkably low considering the magnitude of the winds and impact of treefall on the transportation network, and would have been much higher if the storm had occurred without warning during the day.

The 1987 storm in France

In France, the northwest coasts, including Normandy and Brittany, were battered by hurricane-force winds in the early hours of October 16, the worst affected being Côtes-d'Armor in Brittany. Cabot (1992) gives vivid and evocative eyewitness accounts of the storm. Following the storm's disastrous consequences for the region's electricity network, 3,700 Éléctricité de France technicians were deployed to restore power to over 1.25 million people whose electricity was cut off in the worst-affected area between Brest and Deauville. Additionally, 36,000 customers were without telephone access. Various sources attribute between 2 and 4 deaths and 18 injuries to the direct effects of the storm. Again, the loss of life was remarkably low considering the wind speeds at the height of the storm.

Many churches suffered damage in Brittany and Normandy. Damage to church towers, steeples, and roofs was reported in many towns, with large blocks of stone falling from great heights from many such buildings, including Bayeux Cathedral. The spire from Saint-Étienne Church in Caen fell onto five cars, and a church in Concarneau was so severely damaged that some years later it had to be demolished. Many boats and pleasure craft moored on the West Coast were damaged or destroyed.

As in the U.K., there was extensive damage to Brittany's forests, with about 20% of the wooded surface affected. Trees that had stood since the French Revolution were uprooted. Overall, 10 million trees were felled, comprising around 6 million cubic meters (212 million cubic feet) of forest. Other crops were also devastated, including 1.6 million apple trees that were reportedly lost in Basse-Normande.

The 1987 storm in Norway

After exiting the U.K., the storm moved rapidly across the North Sea to reach the southern and western coasts of Norway on the evening of October 16, battering these regions with strong gale to violent storm force winds. The Norwegian Hydrographic Service reported that the Nordmarka rain gauge near Oslo registered 11 cm (4 in) of rainfall in 48 hours, flooding many waterways in the region. The force of the wind caused a significant storm surge in the south of Norway. In Oslo, the observed sea level was 255 cm (100 in) above Chart Datum with an estimated 176 cm (70 in) caused by weather effects. The sea level was the highest recorded in the city for over 100 years (Fremming, 1988) and the rising water flooded hundreds of buildings and parked cars in the Oslo and Drammen areas. Norway's forests also suffered with an estimated 2 million cubic meters (71 million cubic feet) of timber lost, around half of which was in the Hedmark region. The Norwegian insurance industry had a property damage bill exceeding 500 million NKr (£45 million or US$75 million)[4].

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[4] In 1987 values using 1987 exchange rate

THE STORM IN PERSPECTIVE

The 1987 Storm in 2007

For the 20th anniversary of the 1987 storm, RMS evaluated the potential impacts of a windstorm of similar magnitude striking the region in 2007. Loss estimates for a repeat of the event were obtained by analyzing property at risk utilizing the RMS® Europe Windstorm Model, which allows a user to run simulations of historical and possible future windstorms against the existing property at risk. For each impact scenario, RMS calculates a range of possible losses that reflects the uncertainty in both the wind speeds and the vulnerability of property within the footprint. The expected (or mean) loss is also presented, which represents the best estimate of the most likely outcome within that range.

Analysis procedure

It is not possible to reach a reasonable estimate of the total loss from a repeat of this event in 2007 by simply inflating the 1987 loss to present-day values; a variety of factors must be considered. The analysis procedure assigns a peak gust wind speed value from a particular event to each location being analyzed. Vulnerability functions relate this peak gust value to the range of associated repair costs for a particular kind of property, as a proportion of the property's total replacement cost. Thus, a range of loss values can be calculated to any property (or group of properties) in any scenario for which both the peak gust wind speed and the total replacement cost is known.

For the analyses performed in this report, a wind footprint was used to assign peak gust wind speeds (Figure 6), while the repair cost values were obtained from the RMS® Europe Industry Exposure Database (IED). This data is based on a wide range of published and proprietary information and represents the best understanding of the present-day value of different classes of insured property in each postal code in Europe. The range of building heights, building ages, and construction classes represented by each category of property is appropriately assigned by accessing an underlying building inventory created by RMS at postcode resolution.

Clearly, there are not anemometers in every postal code and there are many local effects that can influence the wind experienced at a particular site. For example, winds coming directly off the sea will generally be stronger than those coming from the land, particularly over big cities or forests, where there are lots of obstacles slowing the wind down through frictional effects. Therefore, to obtain the wind footprint, the measured peak gusts are corrected so that these values become equivalent to those that would be experienced under a defined standard terrain condition. This removes local biases from the measurements. The corrected values are interpolated onto a grid with up to 1 km (0.6 mi) resolution. Finally, the gridded wind speeds are themselves adjusted to account for the local terrain conditions upstream of each grid cell. The final peak gust value assigned to each postcode is a weighted average of the gridded values within it.

By following this procedure, the wind speeds assigned to each location are the best possible estimates, given what is known about the storm. Nevertheless, there are still a great many uncertainties about the ind speeds experienced between observations, particularly in northern France, where the density of anemometers is relatively low.

Results

RMS estimates that should this storm recur in 2007, it would result in between £4 billion and £7 billion (between US$8 billion and US$14.5 billion)[5] in insured loss Europe-wide, with a mean loss of £5 billion (US$10 billion). Of this expected amount, over 70% (£4 billion or US$8 billion) would be generated in the U.K. alone, with the majority of the remaining loss in France.

This increase in loss over the 1987 loss of £1.4 billion is not driven merely by inflation. U.K. housing statistics, published by the U.K. Office for National Statistics, show that there has been an approximately 20% increase in the number of households in the areas of Britain that were affected by the storm (i.e., London, the Southeast and East of England), from 7.5 million to 9 million households. While some of this increase can be attributed to

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[5] In 2007 values using 2007 exchange rate

conversions of the existing dwelling stock to accommodate decreasing household sizes, this is nonetheless a symptom of the growing concentration of property value in this region. Additionally, since 1987, the Building Cost Information Service of the U.K. Royal Institution of Chartered Surveyors estimates an increase in the cost of construction by, on average, a factor of 2.5.

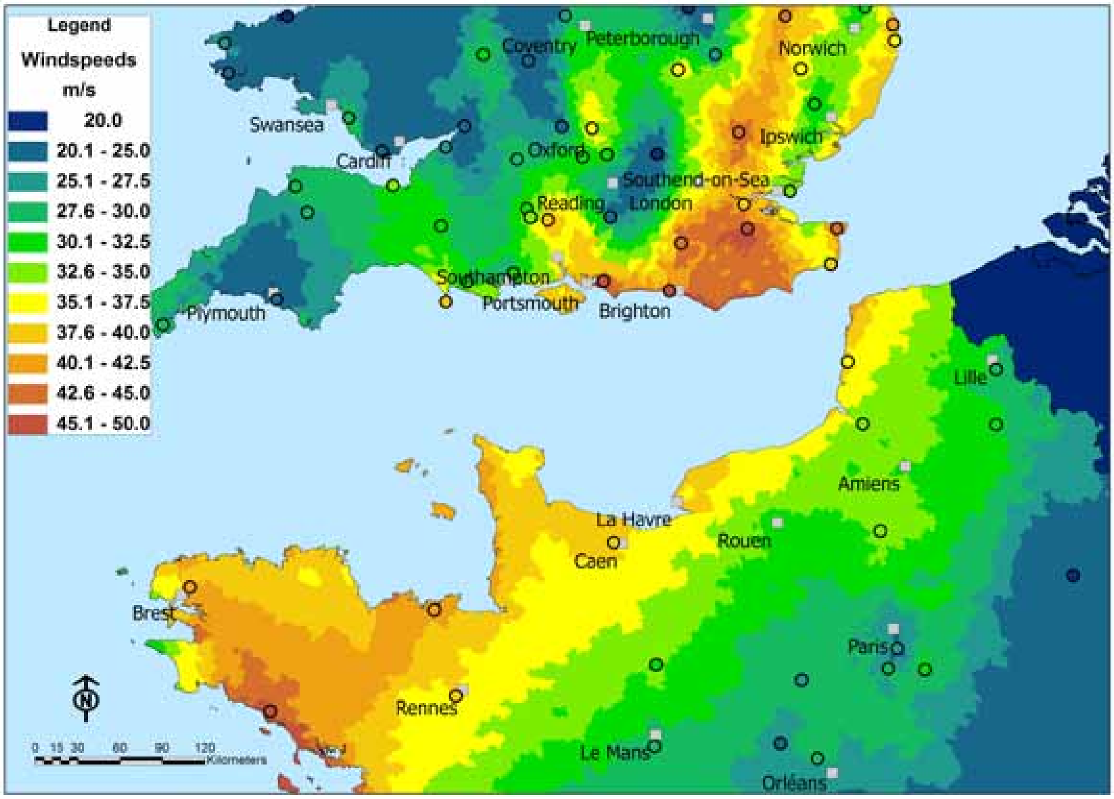

Figure 6: Postcode resolution peak gust wind footprint for the 1987 storm as modeled by the RMS® Europe Windstorm Model: colored dots show the wind observations (in meters per second or m/s), shaded according to the peak gust wind speed

Sensitivity of Loss to the Storm's Path

The sensitivity of the loss results to the exact path followed by the storm is explored by moving the peak gust footprint. Observations are moved and then all the appropriate location-specific corrections are reapplied to the new footprint. From this analysis, it is concluded that the insured losses experienced during the passage of such an event are extremely sensitive to the precise path followed, primarily due to the density of exposure in the Greater London area. Losses would have been far higher if the storm had struck only a few tens of kilometers to the north and west of its actual path. In this case, there would be a direct hit on London and the densely populated M4 corridor to the west beyond London Heathrow Airport.

As shown in Table 1, in the worst-case analysis, with a footprint striking 40 km (25 mi) north and 20 km (12 mi) west of the original footprint, losses in the U.K. alone are estimated between £5 billion and £9 billion ($US10 billion and $US18.5 billion) with a mean value of £7 billion ($US 14.5 billion).

Table 1. Range of insured losses in the U.K. from a repeat of the 1987 storm in 2007 and from selected analyses of the event striking slightly to the north and west of the 1987 location[6]

Sensitivity Test Assumptions (wind footprint location in 2007)	Range of Expected U.K. Insured Loss (in billions)	Mean U.K. Insured Loss (in billions)
Estimated 1987 footprint	£2.5 to £5.0	£4.0 ($US8.0)
Estimated 1987 footprint 25 km north	£4.0 to £7.0	£5.5 ($US11.0)
Estimated 1987 footprint 50 km north	£4.5 to £8.0	£6.0 ($US12.0)
Estimated 1987 footprint 40 km north and 20 km west	£5.0 to £9.0	£7.0 ($US14.5)

The magnitude of these possible losses comes as no surprise. In 1999, Windstorm Lothar, which was very close in intensity to the 1987 event, struck Paris with widespread winds in excess of 40 m/s (90 mph) across northern France. RMS estimates that a repeat of Lothar in 2007 would cause losses in excess of €5.5 billion (£4 billion or $US8 billion) in France alone with further losses in Germany and Switzerland, bringing the total up to around €7 billion (£5 billion or $US10 billion). In a similar analysis to that performed above, RMS also conducted tests considering the impact of this event striking the U.K. Windstorm Lothar footprints were simulated in various configurations across the country, giving losses of up to £6.5 billion ($US13 billion) in the worst case.

Return Period of the Event

Such sensitivity tests give a valuable picture of what could possibly happen in the future. However, they do not indicate the likelihood of such future events. In order to fully assess the windstorm risk in Europe, it is necessary to look not just at the footprints and associated losses of historical events, but also at the losses generated by an exhaustive set of stochastic events that assign probabilities of occurrence to different windstorm scenarios. By comparing the losses generated by the 1987 storm with those generated by stochastic events, the return period of loss can be assessed.

The wind speeds experienced in some locations (e.g., Shoreham-on-Sea on the South Coast of England) were the highest ever recorded, and many meteorological records were also broken in other locations, causing some to consider the 1987 storm to be a 200-year return period event. However, although the storm's return period exceeded 200 years in some locations, the storm did not hit the whole of the U.K. There are other past and possible future events whose effects could be even more devastating because they cover a wider area with damaging gusts. In fact, if the storm had hit much farther north (e.g., in northern England, Wales, Scotland, or Northern Ireland), then the meteorological return period of the wind speeds would have been much lower (on the order of 30 to 40 years), because these regions are typically subject to strong winds more frequently than the southeast of England (Burt and Mansfield, 1988).

Comparing the losses generated by the 1987 storm with those generated from other possible future events in the RMS® Europe Windstorm Model, it is clear that an expected loss of £4 billion ($US8 billion) in the U.K. is not that unusual, with a return period for exceedance of only around 35 years. Indeed, insurance loss estimates from other noteworthy storms exceed this value. For example, the RMS model estimates that if Windstorm Daria — the first and most damaging of a sequence of severe windstorms in Europe in early 1990 — were to reoccur in 2007, expected insured losses would reach £4.5 billion ($US9 billion) in the U.K. alone with a return period of 44 years and a further £3 billion ($US6 billion) spread across at least 7 other countries. The return period for such a Europe-wide loss is estimated at around 30 years, while the return period for an event with a Europe-wide loss of £5 billion ($US10 billion) is estimated at only around 17 years.

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[6] Analysis determinations obtained by translating the 1987 wind footprint to distances listed in Table 1.

The return period for a £7 billion ($US14.5 billion) expected loss in the U.K., the highest value generated by a recurrence of the 1987 storm in the sensitivity testing performed by RMS, is around 80 years. In order to generate a 200-year return period loss of around £15 billion ($US30.5 billion), the 1987 event would have to be either more widespread or more severe at its peak than was actually the case.

The return periods presented in this study are based on the RMS probabilistic catastrophe model, which assigns storm frequencies based on the long-term average of historical storms between 1950 and 2006. This averaging period reflects the fact that the potential consequences of global climate change for storm activity in this region are not yet clear. The 1987 storm was relatively unexpected primarily due to the fact that storm activity in the 1960s and 1970s had been relatively low compared to other periods in history. As a result, there were few events in living memory with such catastrophic consequences in the regions affected. Various recent publications (e.g., Alexandersson et al., 2000; Weisse et al., 2005; Matulla et al., 2007) have shown that, using different approaches, the 1987 storm heralded a period of increasing storm activity in the European region, associated with relatively high values of the North Atlantic Oscillation Index (NAOI). This increase in storm activity through the early 1990s was followed by a decline toward 2007, so that windstorm activity in Europe is currently similar to the long term average from 1950 to the present day. This situation is thought likely to persist over the next few years.

ECONOMIC AND INSURANCE IMPLICATIONS OF THE STORM

Economic Consequences of the Storm

Like the weather forecasters, the U.K. insurance industry was totally unprepared for a storm of this magnitude, and scrambled to respond. In 1987, insurers' claims offices were only open 9 a.m. to 5 p.m., five days a week, and because telephone lines were cut off in the worst-affected areas, communicating with the insurance company was initially impossible.

Overwhelmed by the number of claims, one insurance company placed coupons in a daily newspaper to be filled in by the insureds, by which they could make claims up to £1000 without scrutiny. Loss amplification related to economic demand surge (associated with a shortage of roofers and tree clearers) was severe. Even more significantly, as the systems for handling claims were totally overwhelmed, claims inflation became rampant, as the ability of insurance adjusters to inspect properties was impeded due to the number of claims. It is still necessary to employ the claims data from this event with caution when estimating losses from more moderate storms. Similar issues were reported following Windstorm Lothar in France in 1999.

One in six households in southeastern England submitted insurance claims after the 1987 storm, resulting in 1.3 million reported damage incidents. In the previous major U.K. windstorm, which occurred in 1976, 1.5 million damage incidents were reported by the Building Research Establishment, but with an average claims cost of only £150 (US$270)[7]. While fewer incidents were reported in 1987, the average claims cost in the 1987 storm was six to eight times as high, and even after allowing for the rapid inflation of the early 1980s, was three to four times that of the 1976 storm. A number of factors may have caused this dramatic increase, including the much greater values of homes in Southeast England compared to those in the area affected in 1976, which was chiefly the East Midlands and East Anglia. The 1980s also saw a much higher proportion of property ownership once renters began to purchase homes owned by local government authorities. Not surprisingly, frustrations caused by lifeline interruptions such as power outages and blocked roads often were also deflected onto insurers.

Implications of the Great Storm of 1987 for the Financial and Insurance Markets

The Great Storm of 1987 was in many ways the first insurance catastrophe of the "modern era." It presaged a run of record catastrophes that continued with the July 1988 Piper Alpha explosion and fire, Hurricane Hugo in September 1989, the October 1989 Loma Prieta Earthquake, the January and February 1990 European windstorms, Hurricane Andrew in August 1992, and culminated in the January 1994 Northridge Earthquake. It then took eleven years before the record single catastrophe losses of Andrew and Northridge were exceeded by Hurricane Katrina in 2005.

This persistent run of exceptional catastrophe losses came close to destabilizing the Lloyds insurance market, and can be clearly linked to the creation of the first "Class of 1994–1995" Bermuda reinsurers with their focus on property catastrophe business. It occurred at a time when advancements in the science of natural catastrophes, improvements in computing technology and the emergence of desktop Geographical Information Systems (GIS) converged to make a new breed of accessible catastrophe modeling technology possible, fueling the emergence of specialized catastrophe modeling companies, and of new financial vehicles for the transfer of risk.

Some analysts suggest that the unprecedented hiatus in the London market, a consequence of the transport and infrastructure disruption created by the storm, contributed to the panic selling and precipitous fall in market valuations that took place on Monday, October 19, 1987 ("Black Monday") in both the London and New York stock markets, and quickly spread to all markets thereafter. "Black Monday" saw the second largest percentage of stock market decline in history, the largest being when stock markets reopened after the outbreak of the First World War. This was not an outbreak of volatility but a step change in valuations, so that

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[7] In 1976 values using 1976 exchange rate

by the end of October 1987 markets had fallen by 23% in Canada, 23% in the U.S., 26% in the U.K., 31% in Spain, 42% in Australia, and 46% in Hong Kong.

CONCLUSIONS

The Great Storm of 1987 was an unexpected and poorly forecast reminder of the possible severity of winter windstorms in the densely inhabited areas of Western Europe and their potential human, financial, and environmental costs. The event was associated with anomalous meteorological conditions such as exceptional temperature gradients and a strong and unusually southern jet stream track, and therefore broke many meteorological records, including exceptionally powerful winds in the south of England and north of France, and unprecedented local temperature and pressure changes in southern England. This was the first modern-day insurance catastrophe, which together with other losses of the late 1980s and early 1990s, changed the shape of the insurance market, leading to the emergence of new players in the traditional markets, innovative risk transfer vehicles, and catastrophe modeling technology.

While the impact of the storm was felt over a path that led from Spain in the south to Norway in the north of Europe, damage was most severe in the U.K. and northern France, where together nearly 20 people lost their lives. Over 25 million trees were felled, and exceptional transport and infrastructure failures and property damage led to profound economic consequences. At the time, the storm caused insured losses of £1.4 billion (US$2.3 billion) in the U.K. alone. If an identical storm occurred today, losses in the U.K. would be in the range of £2.5 billion to £5 billion ($US5 billion to US$10 billion). This increase in loss is not due only to inflation, but results from a variety of factors, including increasing concentrations of property value along the storm's path.

Because the implications of climate change for future such storm activity in Europe are not yet clear, RMS examined this event in the context of the long-term historical average of storm activity. On this basis, according to the RMS® Europe Windstorm Model, such a loss has a return period of around 35 years. If the same storm followed a slightly more unfortunate path, U.K. losses would be in the range £5 billion and £9 billion ($US10 billion and US$18.5 billion), with a return period of around 80 years. Although the meteorological conditions during this violent storm were locally unprecedented, other less severe but more widespread events can cause more catastrophic insured losses, as demonstrated by Windstorm Daria only two and a half years later.

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