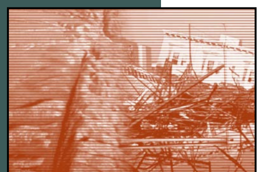
Anatol, Lothar and Martin – When Will They Happen Again?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This December marks the fifth anniversaries of winter storms Anatol, Lothar and Martin, among the most destructive and costliest storms to hit Europe. Winter storms, or extratropical cyclones, are a major contributor to Europe's overall catastrophe risk. After 5 years of relative calm, many corporate risk managers, insurers, reinsurers and intermediaries are asking how frequently they should expect such losses?

BETTER TECHNOLOGY
BETTER DATA
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Anatol, Lothar and Martin

In December 1999, Europe was hit by three devastating windstorms—Anatol, Lothar and Martin. Anatol developed on December 2 in the North Atlantic northwest of Ireland. On December 3, the storm hit northern Europe with record wind gusts of 180–185 kph over the German Bight and southern Denmark. Anatol caused more than 20 fatalities, €2.9bn in economic losses, and left 165,000 households without electricity.

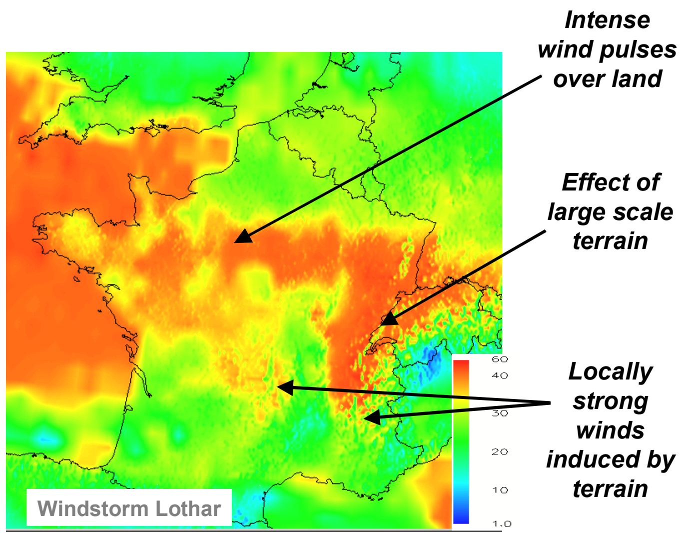
On December 25, Lothar formed over the northeastern Atlantic. Arriving on the Brittany coast on the morning of December 26, Lothar took only nine hours to cross France—a mean propagation of ~100 kph. Lothar led to the closure of Paris' two airports for several hours. Half a dozen people were seriously injured in Paris by falling walls or collapsing roofs and winds were so high that police at one point barred vehicles and pedestrians from the Champs Elysees because of flying roof debris. Many weather stations registered record wind speeds, including gusts of almost 180 kph at Paris-Orly airport and 215 kph atop the Eiffel Tower. As the storm left France, gale-force winds swept through Switzerland with peak gusts of 50 to 100 kph reported in the flatlands and 200 kph atop the Jungfrau peak in central Switzerland. Overall, Lothar was responsible for 110 fatalities, €11.5bn in economic losses, and left over 4 million households without electricity.

Damage to a light steel warehouse from windstorm Lothar.

By the evening of December 26 Lothar had left Western Europe, but another storm, Martin, followed close behind. On December 27, Martin battered the regions around Bordeaux, Biarritz, and Toulouse with gale-force winds of more than 130 kph and affected areas as far as northern Spain, western parts of Switzerland, and Upper Italy. All flights to Bordeaux, Toulouse and Biarritz were canceled and train traffic was suspended throughout the region. Though less damaging than Lothar, Martin nevertheless was responsible for 30 fatalities, €4bn in economic losses, and left over 1 million households without electricity.

Modeling Extratropical Cyclones Using NWP

The purpose of catastrophe modeling is to anticipate the likelihood and severity of catastrophic events before they occur so that companies can appropriately prepare for their financial impact. Windstorms have traditionally been modeled using *statistical* *parameterization*, where local wind speeds are estimated using simplified factors derived from statistical distributions. While often adequate for estimating the overall losses for an event, these techniques lack the realism and high resolution required to produce accurate loss estimates for individual properties or portfolios that often deviate from the industry-wide distribution of exposures. Moreover, they are not optimal for estimating the frequency of events such as European extratropical cyclones, which are infrequent in nature and whose frequency and intensity may be affected by the changing climate regime.



Wind footprint from an NWP simulation of windstorm Lothar.

Numerical Weather Prediction (NWP), which is used by advanced meteorological agencies around the world, replaces the simplified parametric components of statistical models with much more realistic components that embody the actual physics of the Earth's atmosphere. By dynamically solving the mathematical equations that govern atmospheric flow, NWP accurately depicts the time-dependent, three-dimensional structure of extratropical cyclones. Since it is vertical effects—such as 'gravity waves' and convective downdrafts—that typically result in the most serious damage, NWP represents a major advance over the conventional, parametric approach still in use by most catastrophe modelers.

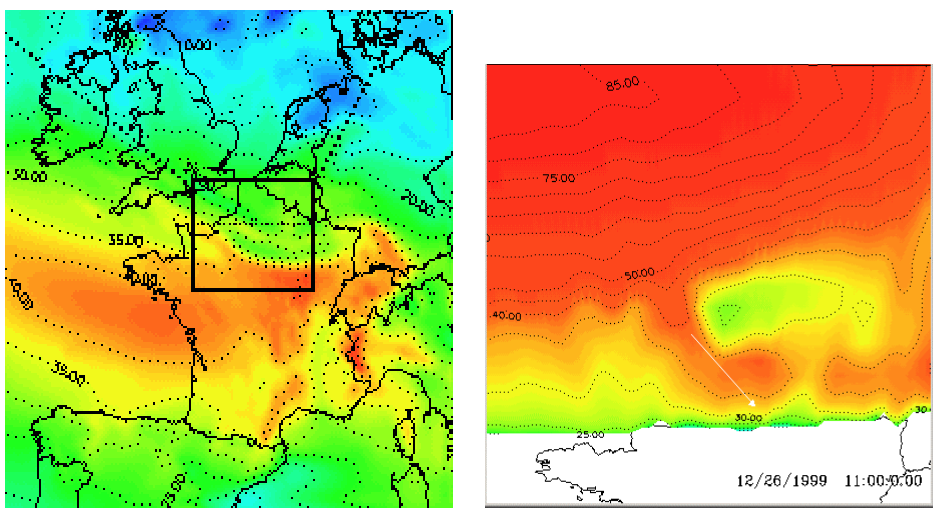
NWP-Based Probabilistic Catastrophe Risk Models

To create a fully probabilistic model that estimates the likelihood and severity of catastrophic events, catastrophe modelers simulate thousands of potential events to represent the entire spectrum of possible storm experience.

Statistical models generate events by drawing from probability distributions developed for a small subset of storm characteristics. Any natural correlations between these storm characteristics must be externally imposed using rough approximations. Moreover, when based solely on limited historical data, a statistical model will not incorporate the full range of events that can occur in nature.

With a physical model, the laws of nature that govern the model enforce appropriate correlations between storm characteristics and outputs, such as local wind speeds. Since extratropical cyclones are greatly influenced by surrounding atmospheric conditions such as high-pressure ridges, low-pressure troughs and the jet stream, any changes to these “initial” conditions will result in a different windstorm—one that can potentially be quite different in effect. This natural phenomenon can be used to generate hypothetical storms that have not yet occurred. By repeatedly perturbing the initial conditions of actual storms by small, but equally likely amounts, a very large set of potential storms can be generated that will reflect all possible combinations of intensity, spatial footprint and temporal evolution—an *ensemble* in meteorological terms.

In this fashion, a very large catalog of realistic storms is produced that reflects the true likelihood of various combinations of atmospheric conditions and resulting storm characteristics. As is observed in the historical record, most of the simulated storms are of minimal intensity and cause little damage. However, a reasonable number are of moderate intensity and a few represent the extreme storms that result from the simultaneous combination of low probability (but still possible) extremes in storm intensity, vertical transfer of energy, and jet stream strength and position.



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Planar surface (A) and vertical cross-section over Paris (B) from an NWP simulation of windstorm Lothar. Accurate damage estimates requires a three-dimensional, physical model that incorporates the vertical elements that can produce the most damaging winds.

Thus the frequency of the most extreme events from NWP-based models results from the probability of critical atmospheric conditions all occurring simultaneously, which is a natural output of an NWP-based ensemble. In contrast, the frequency of events from traditional parameterized models is based on idealized statistical distributions, which are mathematical approximations of nature, at best. Therefore, NWP-based models are much better suited for the creation of fully probabilistic extratropical cyclone models.

Lessons for Today

Although it has been only five years since these storms wreaked havoc on Europe, the insured losses from a recurrence of these windstorms today would be higher simply due to changes in property values and the costs of repair and replacement. Moreover, these storms could have easily been worse. Although Lothar's most damaging winds were quite close to Paris, the AIR model indicates a shift of the storm just 60 km to the northeast would have produced insured losses nearly 25% higher than the actual event.

Of course, the real purpose of catastrophe models is not to estimate losses from historical storms, but to anticipate the likelihood and severity of future events so companies can appropriately prepare for their financial impact. The AIR European Extratropical Cyclone Model indicates that European losses on the order of €7bn (approximately the size of Lothar) have a return period of 10 to 15 years, while losses on the order of €3bn (approximately the size of Anatol and Martin) have a return period of approximately 5 years.

These frequencies appear quite reasonable when compared with the last 30 years of actual data, as shown in Table 1. Table 1 contains the actual insured losses for the ten major European windstorms since 1976 adjusted for inflation, population growth and other factors influencing property values. There are three storms—Capella, Daria and Lothar—that would have caused European losses in excess of €5bn at current exposed property values. The occurrence of three storms about 30 years indicates that a return period of approximately 10 years is reasonable for a loss of this size or greater. Similarly, a €3bn loss should be expected about once every five years since this size loss has been experienced five times since 1976.

Table 1. Total Adjusted Losses for Major European Windstorms since 1976

Storm Name	Year	Original Loss (€000,000)	Adjusted Loss[1] (€000,000)
Capella	1976	1,225	5,211
87J	1987	1,695	3,816
Daria	1990	4,505	8,577
Herta	1990	1,110	2,113
Vivian	1990	1,820	3,465
Wiebke	1990	1,180	2,247
Anatol	1999	2,000	2,340
Lothar	1999	5,754	6,731
Martin	1999	2,450	2,866
Jeanette	2002	1,550	1,550

1. Losses are adjusted to 2002 to take into account inflation, population growth and other factors influencing property values

Conclusion

Since 1999, Europe has experienced a period of relative calm. However, as population density continues to increase, so does the potential for large losses. NWP-based catastrophe risk models are the best tools for estimating the likelihood and severity of extratropical cyclone risk, which is required by corporations, insurers and reinsurers to engage in the proactive decision-making and strategic planning necessary for financial stability in the face of such extreme events.