KAREN CLARK & COMPANY

KCC White Paper:
The 100 Year Hurricane

Could it happen this year?
Are insurers prepared?

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Early predictions for the 2014 hurricane season are for an average or slightly below average season with respect to storm frequency. But the most destructive hurricanes in the historical record occurred in average or low frequency years, such as the Great Miami Hurricane of 1926 which would cause over $100 billion of insured losses were it to occur today. Hurricane Andrew, the third most intense hurricane to make landfall along the US coastline, occurred during an El Nino year when frequency was well below average.

Frequency does not drive hurricane losses. Eighty percent of average annual losses are driven by the top 20 percent of hurricanes. Average annual hurricane losses are dominated by years when a major storm strikes a populated area. This can happen in any hurricane season.

Satellite image of Hurricane Andrew—the first storm of the season—on August 23, 1992 one day before its Florida landfall

Source: NOAA

While it's clear the largest industry losses will result from an intense hurricane striking a major metropolitan area, such as Houston or Miami, individual insurers may have concentrations of exposures that don't necessarily correspond to peak industry exposures. These concentrations can lead to surprise, outsized and solvency-impairing losses from the 100 year hurricane occurring anywhere along the coast.

Most companies use specific points on the model-generated exceedence probability (EP) curves for risk management decision making and risk tolerance statements—most commonly the one percent and 0.4 percent exceedence probabilities also called the 100 and 250 year PMLs, respectively. But PMLs can give a false sense of security because they don't reveal exposure concentrations that can lead to solvency-impairing losses from events that are not unlikely from a meteorological perspective.

In recognition of the shortcomings in the PML metric, some companies monitor a small set of deterministic scenarios, such as Lloyd's Realistic Disaster Scenarios (RDS) or historical events. But these do not provide full coverage along the coastline, and significant exposure concentrations can be missed. Companies can underwrite around these scenarios and believe they are safe only to find they have built up higher concentrations in other areas making them even more vulnerable to large surprise losses.

This white paper shows how a new risk metric—the 100 year Characteristic Event (CE)—can be used to scientifically identify and manage exposure concentrations in order to reduce the chances of surprise losses. The CEs address a company's "informal" risk tolerance by highlighting where a company can have a larger loss, and perhaps just as importantly, a larger share of the market loss than expected. For most companies, the peak losses from the 100 year CEs are much larger than the 100 year PMLs.

This paper describes the 100 year CEs for hurricanes in Texas, the Gulf and Florida and illustrates the industry losses that would result from these events. It shows that individual companies can have outsized and solvency-impairing losses in areas not characterized by peak industry losses. The 100 year hurricane was chosen for this study because most insurers manage to the one percent probability loss and are interested in the 100 year events.

What is the 100 year hurricane?

The 100 year hurricane is ***not*** the worst case scenario. The 100 year hurricane is defined as the most intense hurricane one should expect in a particular region with about a one percent chance—the one percent probability event. More intense storms can happen in a region but with a lower probability.

There is not a single 100 year hurricane because the characteristics of the one percent probability event change along the coastline. Along the Gulf coast where the ocean waters are warmer and hurricanes are more frequent, insurers should be prepared for an intense hurricane. In the northerly latitudes along the East coast, insurers should be prepared for weaker, but larger and faster moving storms.

The two characteristics of a hurricane that are most important with respect to total damage potential are the intensity and size. The most intense hurricanes tend to be more tightly wound with relatively small eyewalls and radii of maximum winds. But there are notable exceptions, such as hurricanes Carla and Katrina—both relatively large given the intensity.

Scientific expertise and historical data are used to determine the parameters that are characteristic of a 100 year or one percent probability event. This is the 100 year Characteristic Event (CE) that can then be "floated" all along the coastline to uncover significant exposure concentrations and to estimate industry and company losses.

Texas

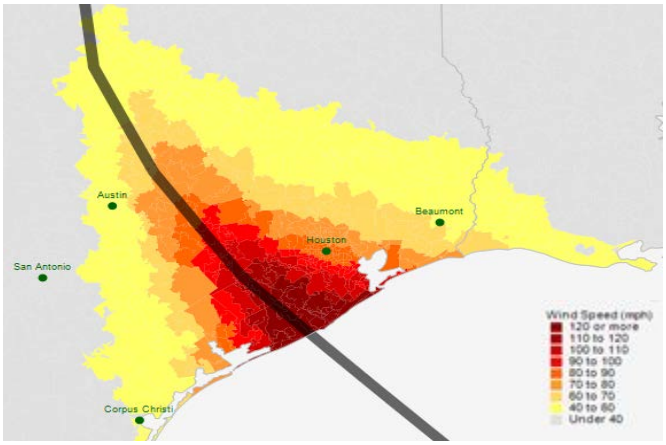
Since 1900, there have been 35 hurricanes to make landfall in Texas. Four of these were Category 4 storms with wind speeds of 140 mph or greater. The most intense storm was Beulah in 1967 that made landfall near Port Isabel with peak winds estimated at 150 mph.

Even though Texas has not experienced a Category 5 hurricane since 1900, Camille was an intense Category 5 storm that made landfall near Bay St. Louis, Mississippi. There is no meteorological reason why Camille could not have made landfall in Texas, and given the number of Category 4 hurricanes that have impacted Texas since 1900 (implying a return period of about 25 years), a credible 100 year hurricane is a Category 5 storm.

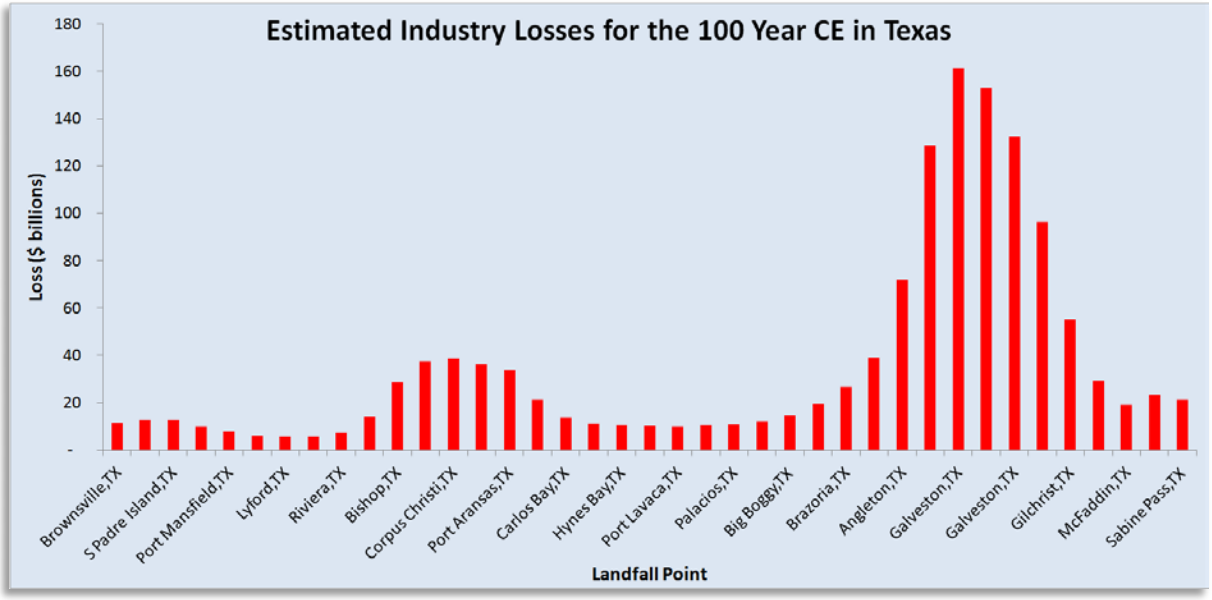
A Category 5 hurricane is defined as a storm for which peak sustained winds exceed 155 mph. Three Category 5 hurricanes have struck the US coastline since 1900—peak wind speeds for these storms have

been estimated between 165 and 180 mph. Because the wind recording equipment failed during these storms, precise wind speed measurements are not available.

The average radius of maximum winds for hurricanes with peak winds of 140 mph or greater and making landfall in Texas and the Gulf region is 15 miles. This radius is used for the 100 year event in Texas along with a maximum wind speed of 165 mph. These parameters define the 100 year CE and using standard meteorological formulae produce the wind footprint shown in the graphic below.



What kind of losses would this storm produce? By floating the 100 year CE along the coast and estimating losses for landfall points spaced at 10 mile increments, the following picture emerges for the industry loss potential from the 100 year hurricane in Texas.

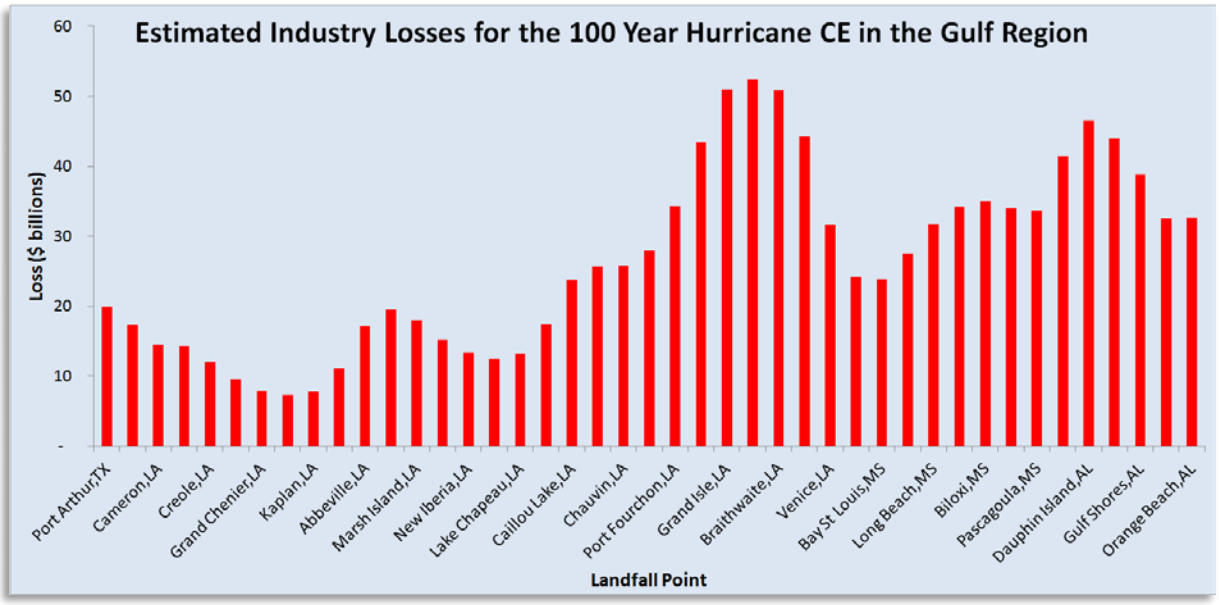


As one would expect, the key driver of loss is the landfall point. If the 100 year CE makes landfall near Galveston, the industry losses are likely to exceed $100 billion. Insurers with only a one percent market share in this area will experience losses over $1 billion from this event, and companies that have not closely monitored and managed their market shares may not survive the 100 year hurricane.

Gulf region (Louisiana, Mississippi, Alabama)

The Gulf region is also characterized by high hurricane frequency, and as discussed previously, one of the most intense storms to make landfall in the US since 1900 occurred in this region. There's no meteorological reason why the 100 year hurricane in the Gulf Region should be different from the Texas event in terms of intensity and size, and similarly-derived CEs produce the losses shown below.

The peak losses from the 100 year hurricane are much lower in the Gulf than in Texas because the largest metropolitan area in the Gulf region is only one-fifth the size of Houston, but there is a higher chance of a loss in excess of $30 billion in the Gulf. It's important to note that the losses in this report are wind only, and the addition of storm surge would increase losses in the Gulf by a higher percentage than in Texas.

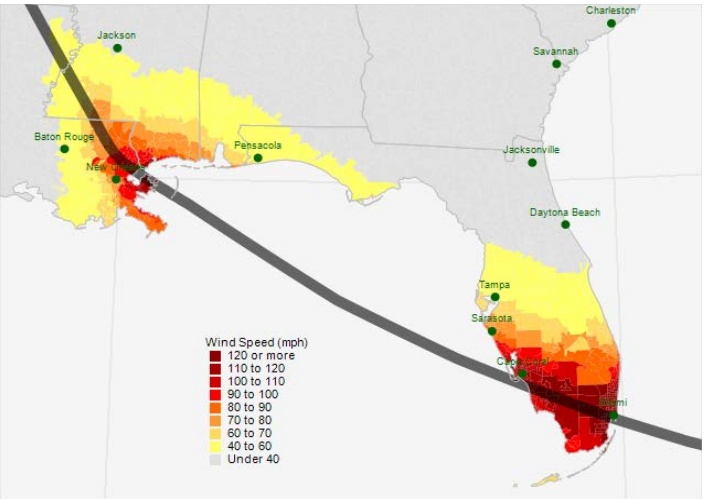


Florida

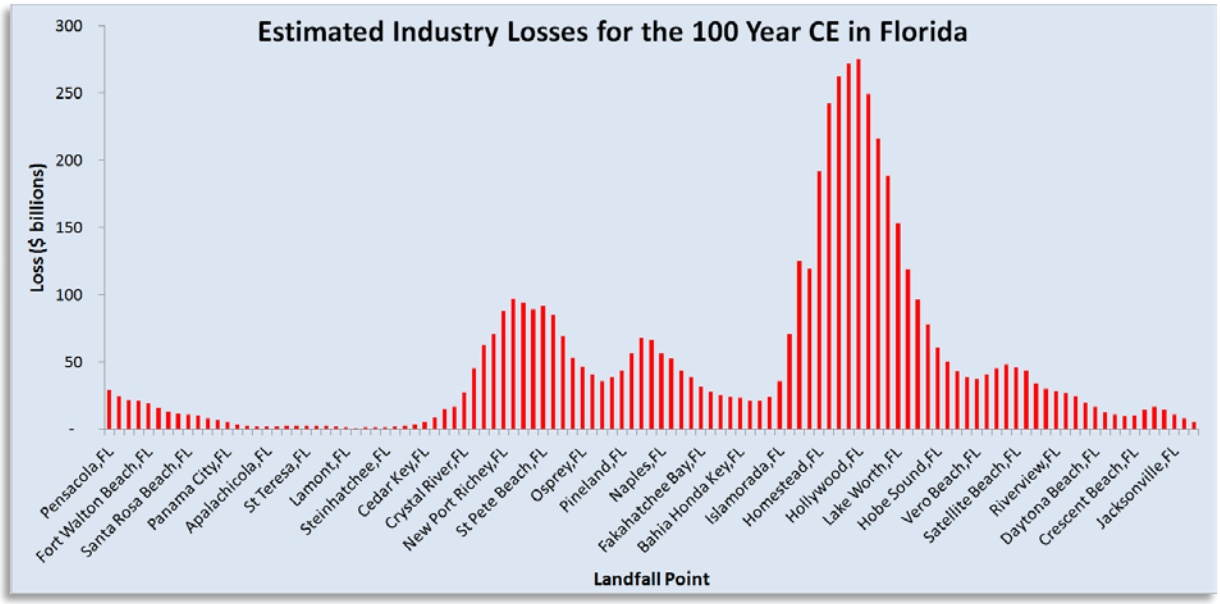
Florida has a 1,350 mile coastline (second in length only to Alaska) and hurricane risk varies considerably along the coast. It is highest in the southern part of the state where 31 hurricanes have made landfall since 1900, including two Category 5 storms.

By contrast, hurricane frequency is low in Northeast Florida, particularly near the Georgia border where only one hurricane has made a direct landfall since 1900. This is because storms heading toward Northeast Florida tend to get caught up in the Gulfstream, and as tropical storms enter the mid-latitudes they tend to recurve in a northerly and then northeasterly direction.

In Southeast Florida, insurers should be prepared for a Category 5 hurricane that will travel clear across the state and likely make a second landfall along the Panhandle or in the Gulf region. However, the intensity of the 100 year hurricane decreases when moving up the coast toward Jacksonville because of the lower probability of a hurricane in this area.



In Southwest Florida, the 100 year hurricane is a Category 5 storm that also decreases in intensity when moving up the coast toward Tampa where it a strong category 4 storm that further decreases to a minimal Category 4 in the Big Bend area. The industry losses for the 100 year Florida hurricanes are shown in the chart below. Note that the losses are the total event losses for all landfalls.

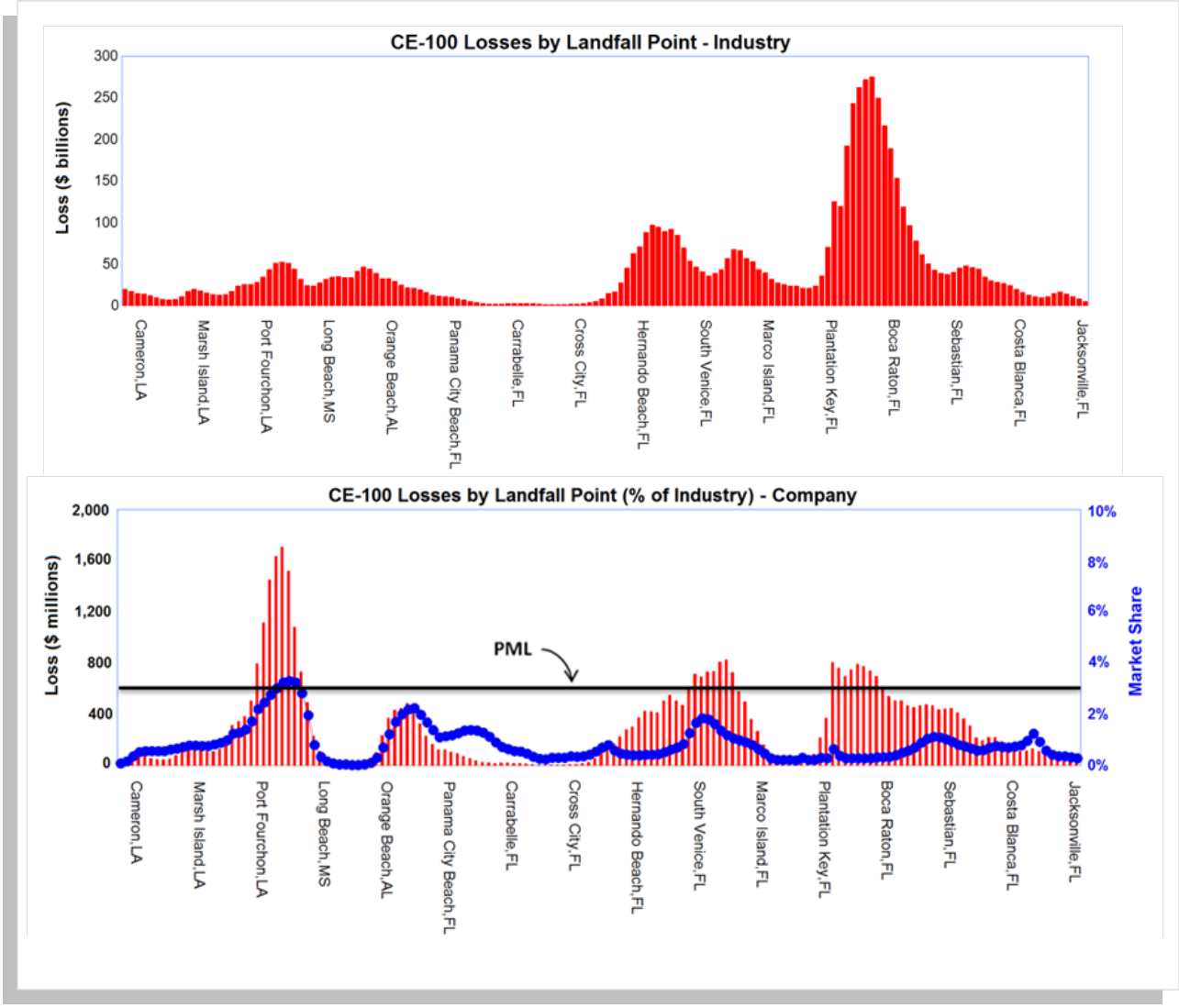


It's not surprising that the largest losses for the 100 year hurricane are in the Miami area where there is a segment of coastline over 100 miles long for which this event will cause over $100 billion in insured losses and a 60 mile stretch for which the losses will exceed $200 billion.

While the magnitudes of these losses are large, they are consistent with historical data. The Great Miami hurricane of 1926 was a Category 4 storm for which sources peg the losses today between $100 and $150 billion—a Category 5 hurricane would be expected to produce double those losses.

Individual company losses versus industry losses

The areas of peak industry losses along the Gulf, Texas, and Florida coasts are not surprising because they correspond to areas of highest population density and property exposure. But this will not likely be the case for individual companies that have their own areas of specialization and concentration, which is why a small set of deterministic scenarios focusing on major metropolitan areas is not sufficient for risk management purposes. The charts below compare the industry losses with the losses for a sample company.

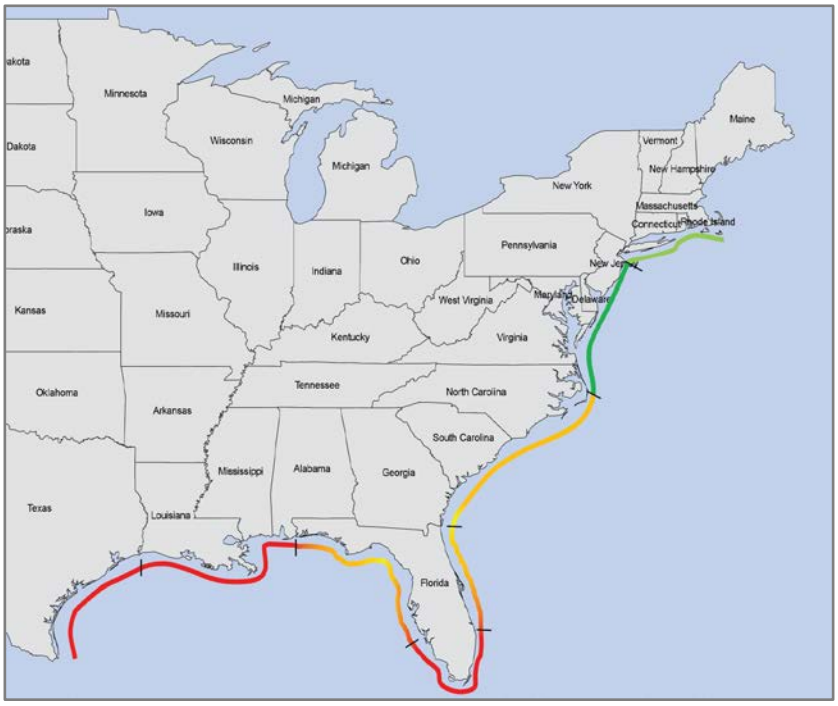


While the industry losses are highest in the Miami area, the company has effectively controlled its hurricane loss potential in Florida—the area driving the PML. However, the company has built up significant exposure concentrations in Louisiana, and if the 100 year CE occurs, this company will experience a loss almost three times higher than its estimated PML.

Focusing on the PML as the primary risk metric can lead companies to develop dangerous exposure concentrations in areas not driving the PMLs. An additional line of sight provided by the CE approach is necessary to protect companies from negative surprise losses exceeding their informal risk tolerance levels and possibly leading to financial impairment.

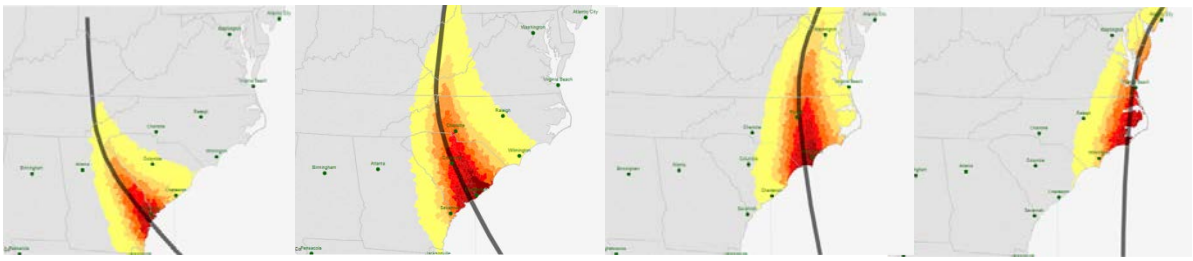
Other regions

The colors in the image below indicate how the intensity of the 100 year hurricane changes along the coastline with dark green representing the weakest and red the strongest. The risk is lowest along the Mid-Atlantic coast with respect to a direct hit from a landfalling storm such as Sandy. Sandy was a borderline tropical storm-Category 1 hurricane, and the losses were driven primarily by the enormous size of the storm and the storm surge. There is no known major hurricane to have made landfall in the Mid-Atlantic region.



In the Northeast region the 100 year CE is similar to the most intense historical event--the 1938 Great New England Hurricane. It's only a Category 3 hurricane but it is very large and fast moving, meaning it will impact thousands of square miles. Landfall points along western Long Island will result in industry losses exceeding $100 billion.

In the Southeast region, the 100 year hurricane CE transitions in terms of intensity and track as shown in the images below. Defining the characteristics of the 100 year hurricane—including the storm track—by landfall point ensures that no pockets of exposure concentration are missed.



Are companies prepared for the 100 year hurricane?

The 100 year hurricane can happen in any year, including this year. Many companies may not be prepared for the 100 year hurricane because they have been relying most heavily on the 100 year PML—the one percent exceedence probability loss from the model-generated EP curves—for risk management purposes.

While the PML is a useful and important risk metric, it can give a false sense of security because it does not capture exposure concentrations that can lead to solvency-impairing losses. Analyses of dozens of actual portfolios have shown that there is typically a big difference between the 100 year PML and the largest losses from the 100 year event—the latter is much greater for most companies.

While many companies do monitor their exposure concentrations, there has not been a systematic and scientific technique until the CE approach. Lloyd's RDS are an attempt to make sure syndicates are not overly exposed to a major event, but it's already been shown that this set of events is too limited to effectively monitor hurricane loss potential. Companies can build up dangerous concentrations around the RDS events.

Historical events are also not sufficient because future events will not be exactly like past events. The 100 year CEs provide complete coverage along the coast so no concentrations are missed. Using the RiskInsight® loss modeling platform, companies can determine how much each policy contributes to each CE loss and can effectively manage their exposure concentrations.

Many of the surprise losses of the past several years have resulted from events that occurred where they were not expected. PMLs do not inform companies on "hot spots" and where they can have an outsized loss relative to their peer companies and expected market share. Most boards of directors and CEOs would not want an unexpected large market share of a large loss event. CEs are the right metrics for monitoring solvency and informal risk tolerances.