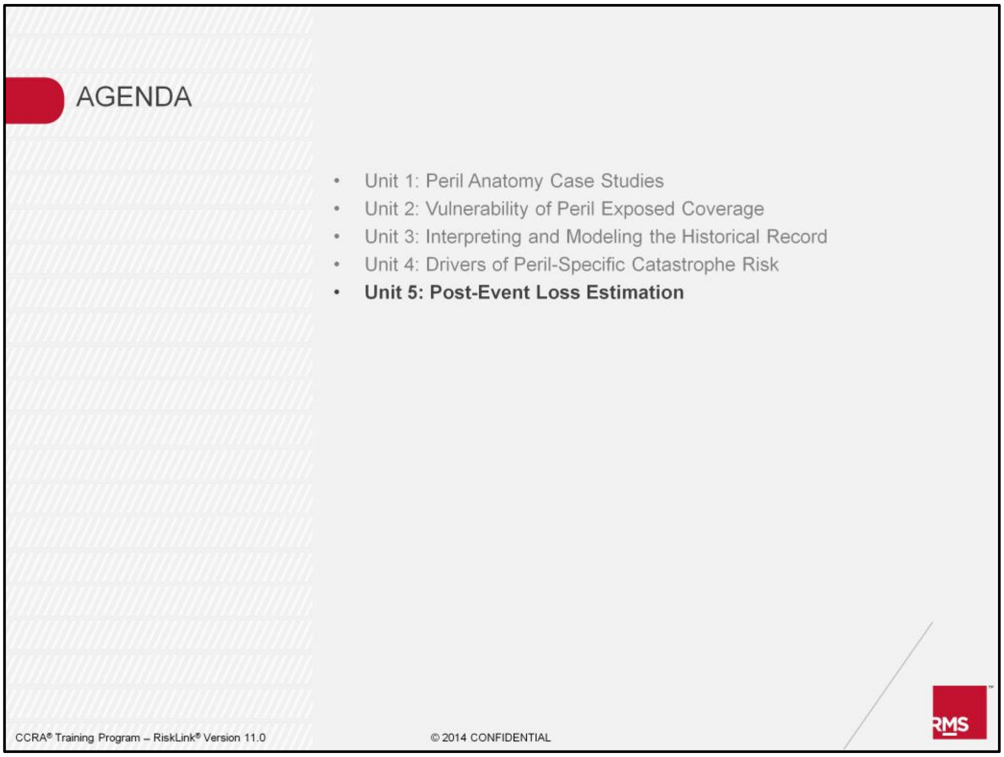
SEVERE CONVECTIVE STORM MODELING

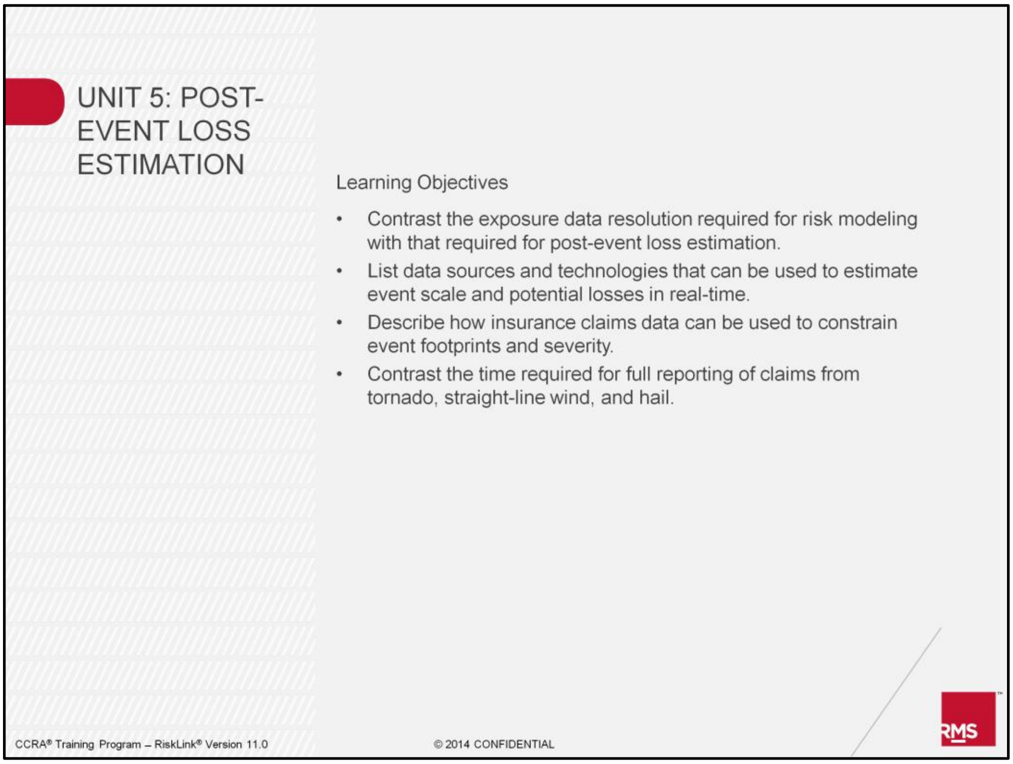
UNIT 5

RMS® CCRA® Training Program

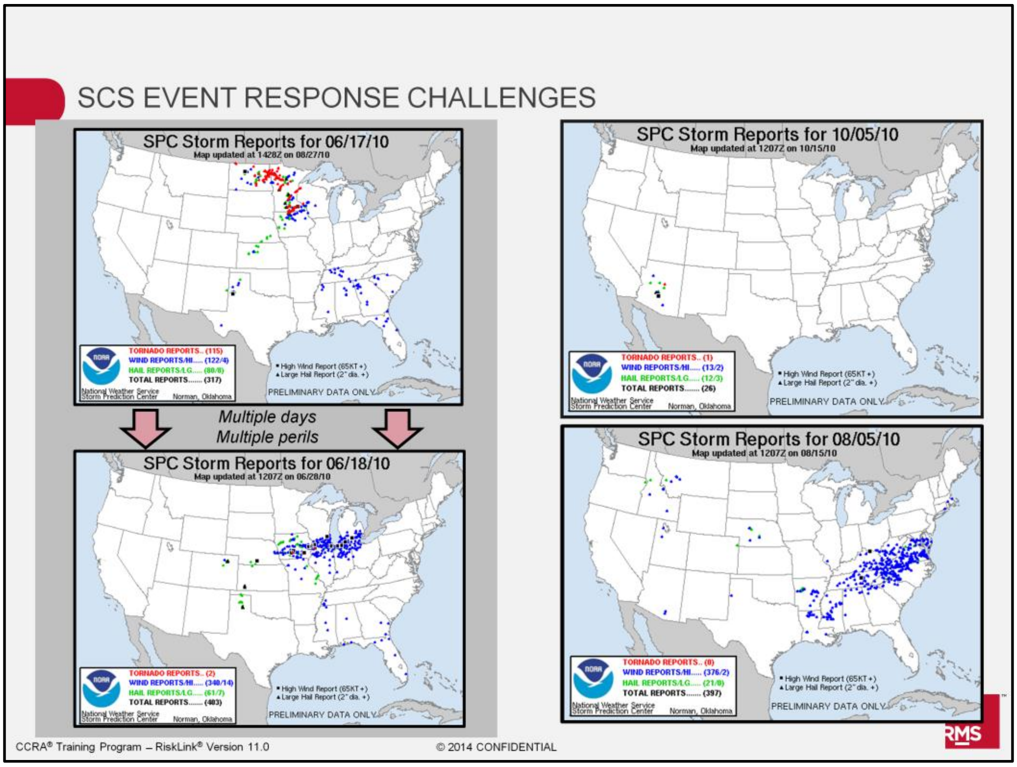
Certified Catastrophe Risk Analyst



This unit discusses the vulnerability module of the severe convective storm model.



At the end of this unit you should have a good understanding of each of the five learning objectives listed on this slide.



There are many challenges with event response for severe convective storms compared to other perils such as earthquakes and tropical storms.

First of all, what is an event? Earthquakes and tropical storms tend to be more discrete in nature – they occur at a given time (or over a period of time) with a defined set of parameters and location. Severe convective storms on the other hand are much more difficult to define. There are multiple ways to define an event: Is it an individual tornado? Hailstorm? Straight-line wind event? Is it a cluster of events in a region? Is it several event clusters over many days? Property Claim Services (PCS) definition of a severe convective storm event is tied to synoptic systems. However, many insurance companies have their own definitions.

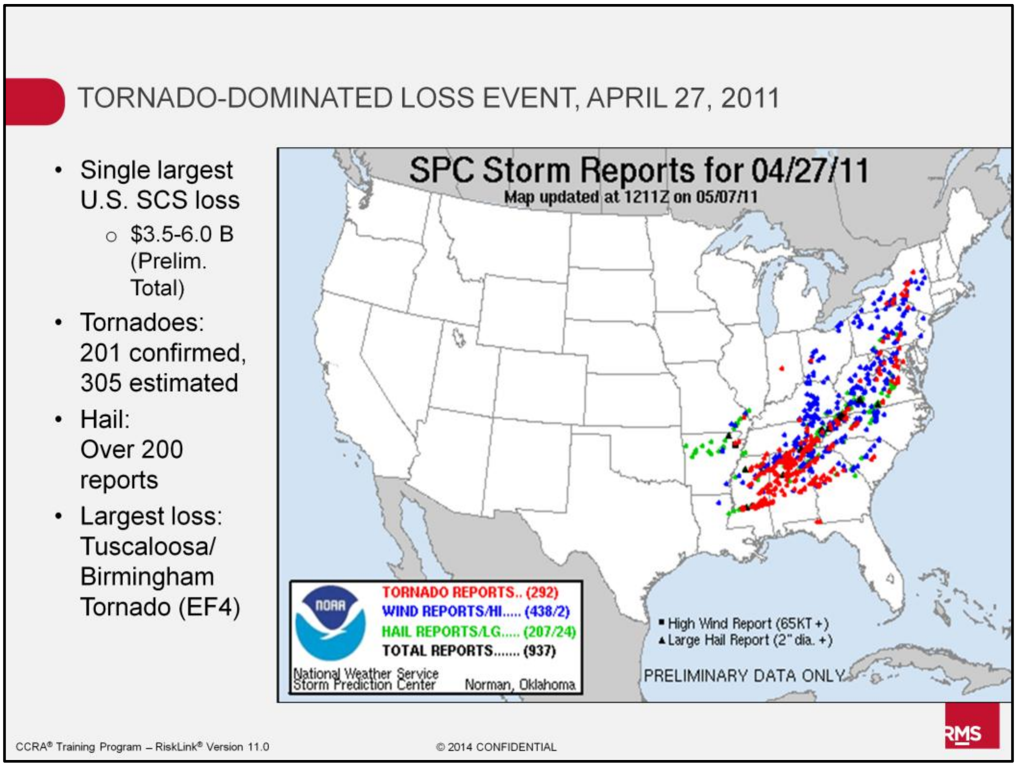
Severe convective storm events can be single-day, single-hazard events or multi-day and multi-hazard outbreaks. They can include tornadoes, hail, and wind, and the consecutive threat days can span from one day to over 10 days. The daily threat area can be quite large and cover multiple states as seen in the maps above. Furthermore, on active outbreak days, there can be hundreds to thousands of severe weather reports on a given day.

The maps on the left are a good example of a multi-day, multi-hazard event. On June 17, 2010 (top left map), this event is dominated by an outbreak of tornadoes in the Northern Plains. On the next day, June 18, you can see the weather system has moved slightly east and is impacting the Midwest with strong winds.

The map in the top right is from the October 5, 2010 hailstorm, which struck Phoenix, Arizona. Looking at this map, and even looking at the accompanying storm reports, you can see that there are very few storm reports: one report of a tornado, 12 reports of hail (largest measured 2.5”), and 13 reports of strong winds. This would lead one to believe that this is not an event that would cause large losses. This lack of reports is misleading - hailstones were actually up to 3” in diameter in some areas, and in combination with strong winds of up to 70 mph and the location of the storm across the urban area of Phoenix, resulted in significant damage. This event actually caused $2.5 billion of loss (PCS), making it the largest U.S. insured loss in 2010, and also the largest U.S. loss from a hailstorm in history. This event is discussed in more detail later in this presentation.

The map on the bottom right is an example of the opposite of the map above it. This map shows over 350 reports of strong winds, mainly across the northern states of the U.S. Southeast. While it looks like a strong wind event, the actual level of losses incurred were very low and localized.

Lastly, availability of storm reports varies around the world. In the U.S., the National Weather Service’s Storm Prediction Center is a valuable resource for storm information and reports. In Australia, the Bureau of Meteorology have a large network of Storm Spotters; however, these reports are not generally made available to the public, which proves challenging for event response.



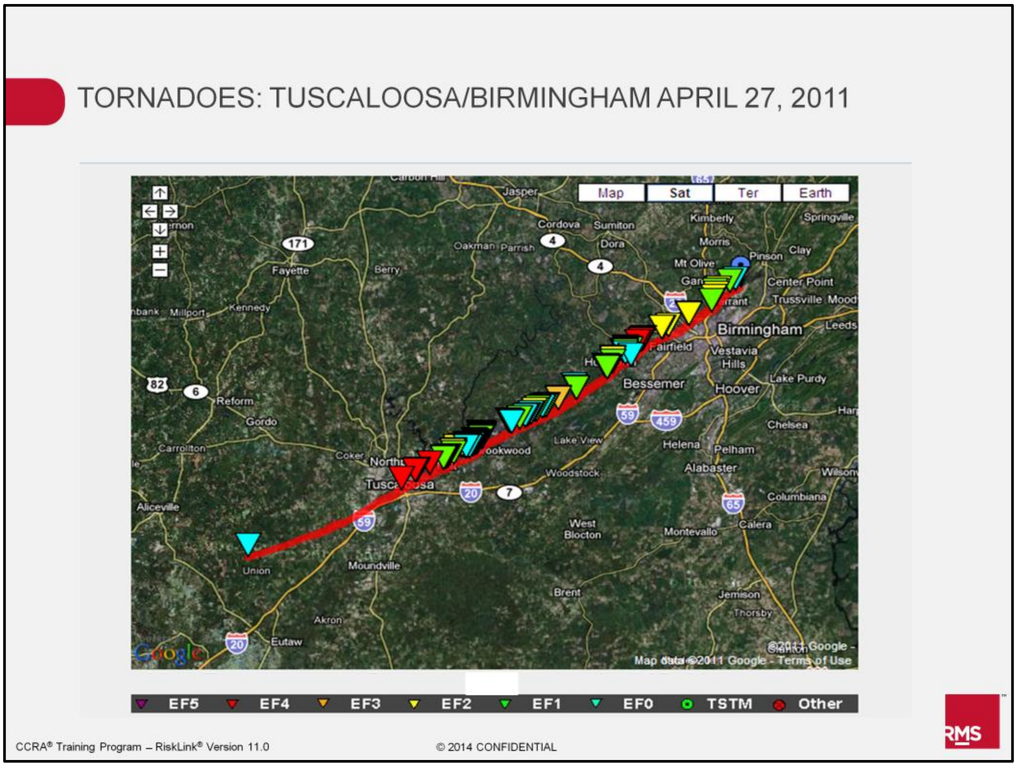
We will now look at two events; a tornado-dominated event and a hail-dominated event.

This slide shows an outbreak discussed earlier in the course. It is a multi-day outbreak that produced $3.5-6.0 billion in total industry loss in the U.S. There was a record number of tornadoes over a four day period from April 25-28, 2011 across the U.S. Although tornadoes were the headline item from this period, there were also a large number of hail and straight-line wind reports across this area.

This map illustrates reports for tornadoes, hail, and straight-line winds, as provided by the Storm Prediction Center. This shows the reports from April 27, as this was the dominant day of the four day outbreak.

Because every day there are severe thunderstorm occurrences in the U.S., RMS uses tools to filter and understand the magnitude of the event in terms of the severity of hail, wind, or tornados that are reported, and whether or not that report intersects a major area of exposure. This helps us to understand if the event is likely to have the potential for catastrophic loss. This is a resource we use when posting information in the cat response part of our website each day.

As soon as these reports are made and logged with the Storm Prediction Center, we download them and review them against our exposure database to begin to understand if there is a tornado or a major hail report in an urban area that requires deeper focus.



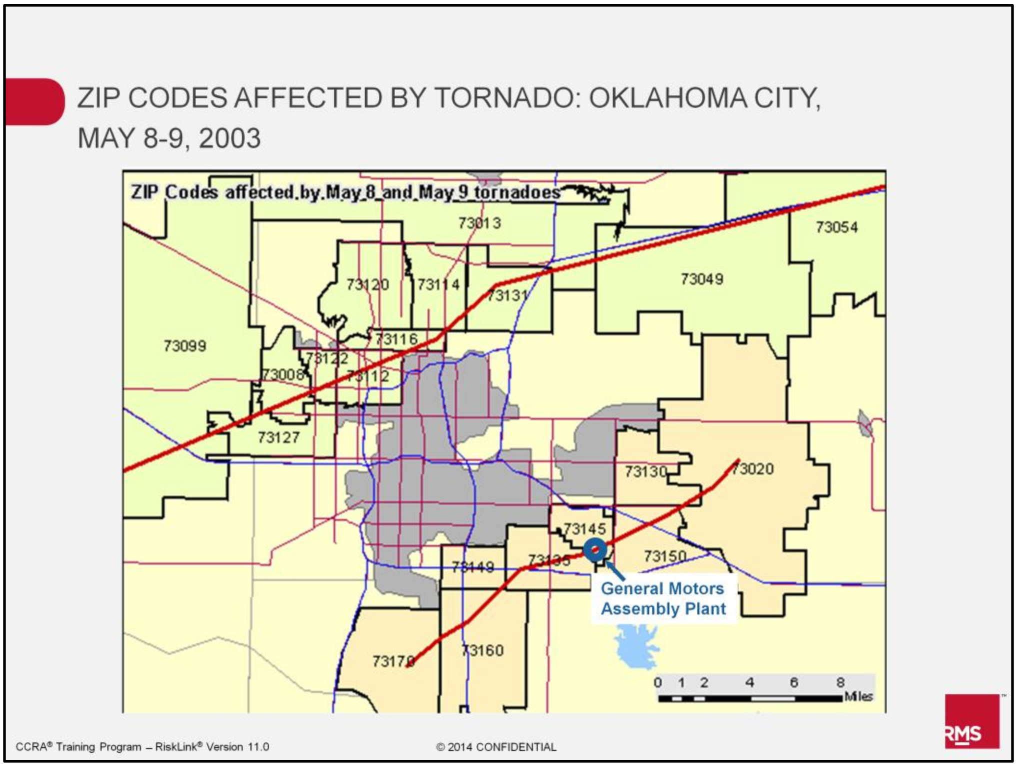
This particular event did have some major considerations for tornadoes. Some of the larger loss tornadoes that occurred in this period hit Tuscaloosa and Birmingham in Alabama.

This image shows the detailed assessment of the tornado path that would be available weeks after an event. This gives some context and contrast with what would be available in the first day or two after an event in the immediate response window.

Weeks after an event, after the National Weather Service (NWS) has been on site and done a detailed survey, RMS would, in most cases, have contours of the Enhanced Fujita Scale or contours of damage that were produced by these events. Most of the severity was fairly low, EF0-EF2 intensity with some small areas of EF3-EF4 intensity tornadoes.

Even though it is an EF4 tornado, the area with EF4 winds was fairly small. Most of the tornado had EF1 or, at most, EF2 intensity.

In a real-time setting, this level of detail is not available. In fact, not every National Weather Service office consistently produces this type of information even weeks after an event.



In a real-time setting the type of data that is available is, at best, an estimate of the possible track of the tornado or tornadoes.

Contrasting what you just saw, let's focus on the upper part of this image from the Oklahoma City event in May 2003.In real time, there would not be a differentiation between damage attributed to straight-line winds and what was tornado related. Also, the path would not be broken in the way it would be developed after a survey was done. The reports that come in are very preliminary so the view of possible damage tends to be conservative. Breaks in the tornado path are not often evident, and the variation in severity is also not often evident.

So the types of detail that we have as a tool to provide information to the market are preliminary assessments of the paths of the tornado, which are often very smooth. And that is what the red line going from southwest to northeast on the upper part of this image represents.

The other tornado, which ultimately was more severe when the surveys were done and the intensity was assessed, had a shorter path length. When you look at these two, the bottom path might not look as ominous as the top, but in fact it was the one that had higher severity and, ultimately, higher loss. The information on the severity of the event is not available in real time, so there is only an estimate of where the path of the tornado went and, where possible, some media photos that would illustrate damages.

Based on that level of information, RMS releases a listing of either counties or ZIP Codes affected by the individual tornadoes as a first step for our clients to do accumulation analysis from tornadoes. Due to the severity of tornado risk, time becomes much more critical when it comes to estimating loss than the specific accuracy. Our clients find it very important to have information as immediately as possible after the event rather than waiting five, seven, or even ten days for the more detailed assessment from the National Weather Service.

Also, where there are major exposures in these regions that have the potential to be affected, accumulation analysis can identify those. This southern tornado hit a major assembly plant for General Motors on May 9, which was a very large percentage of the total loss from that tornado and from those that affected Oklahoma. So doing that accumulation analysis at either the ZIP code level or at finer resolution is very important based on the types of tornado path data that is available to try and identify if there are key exposure locations, like this assembly plant, that could have been affected.

PERCENTAGE OF ZIP CODES AFFECTED: OKLAHOMA CITY, MAY 8, 2003

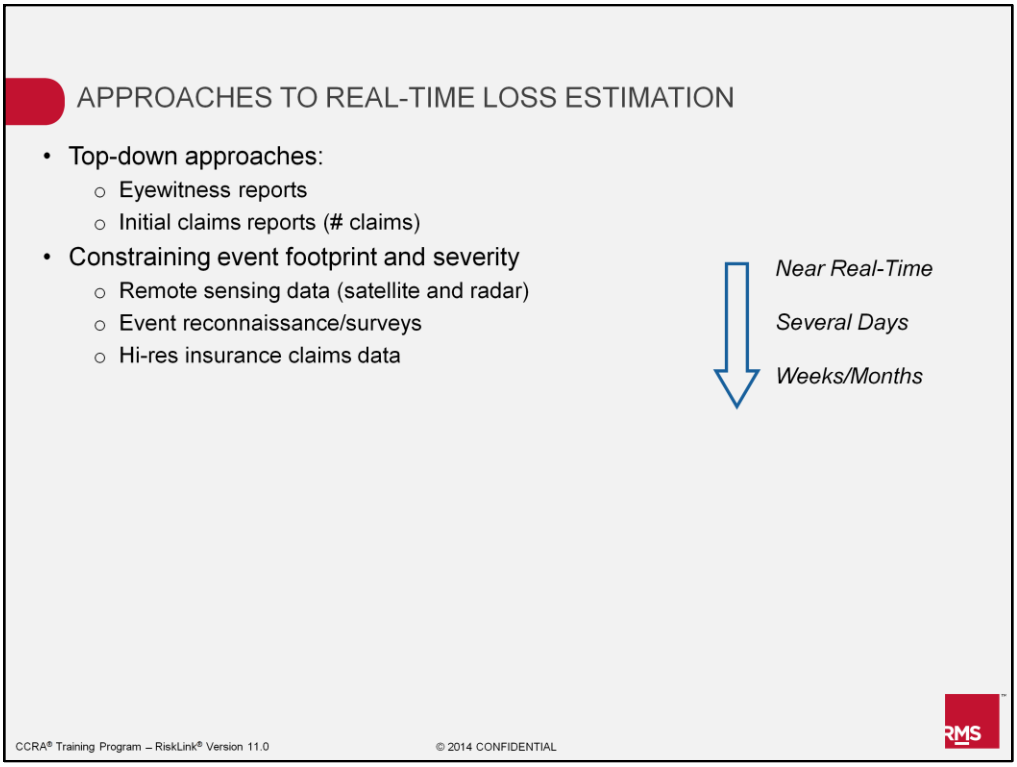
Portion of ZIP Codes Affected by Various Intensity Bands

STATE	ZIP Code	EF0	EF1	EF2	EF3	EF4	
OK	73020	0.00%	0.90%	0.21%	0.02%	0.00%	
OK	73130	0.00%	2.02%	0.00%	0.00%	0.00%	13%
OK	73135	0.00%	5.21%	4.41%	3.49%	0.33%	
OK	73145	0.00%	2.57%	1.71%	0.87%	0.00%	<1%
OK	73149	0.00%	0.47%	0.30%	0.00%	0.00%	
OK	73150	0.00%	3.32%	2.37%	0.56%	0.01%	
OK	73160	0.00%	3.17%	0.98%	0.10%	0.00%	
OK	73170	2.78%	0.07%	0.03%	0.00%	0.00%	

As soon as the more detailed assessments are available, RMS may provide a second-tier product that quantifies the percentage of each ZIP Code we flagged as being affected by the tornado at various intensity bands.

This is an example of that for some of the ZIP Codes in Oklahoma, where the General Motors assembly plant was located. About 2.5% of ZIP Code 73145, which is in the middle of this table, was affected by EF1 winds. A smaller percent of that ZIP Code was affected by EF2 and EF3 level winds.

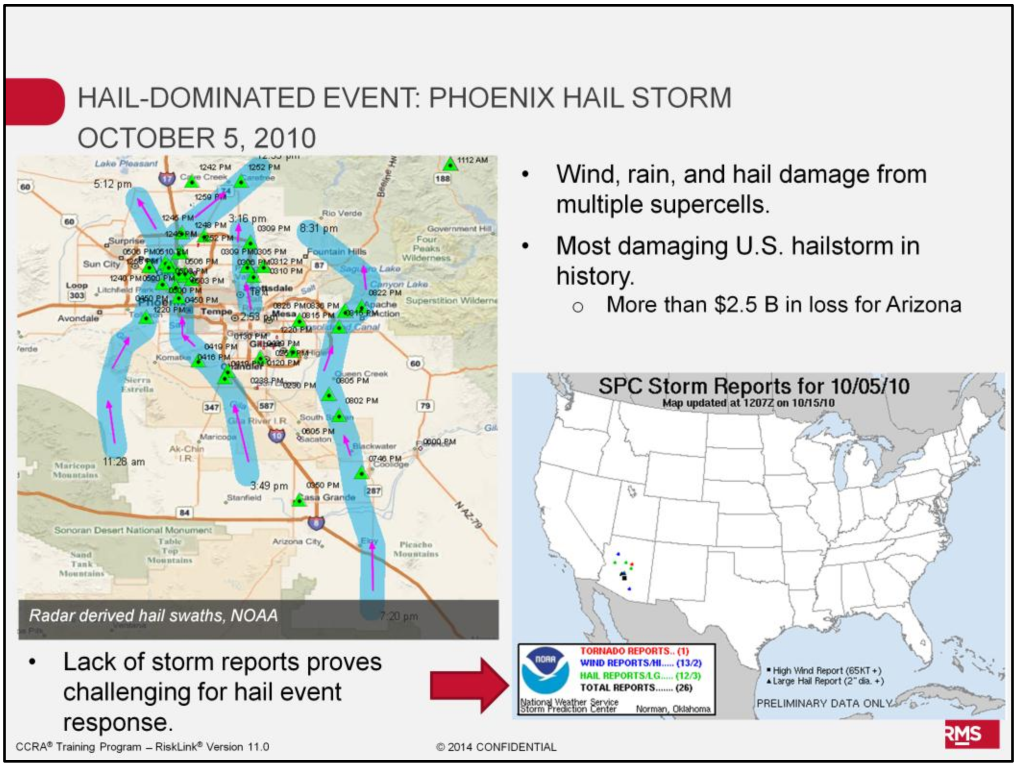
It is important to note that when only a schedule of ZIP Codes that were affected is available, doing accumulation analysis based on those ZIP Codes will be a conservative view of the expected loss, because ultimately in most of these ZIP Codes less than 10% of their area is affected by the tornado with an even a smaller percentage affected by the highest winds (EF2 or greater on the Fujita scale).



When we look at estimating losses from hail in real time, there are different approaches and resources that can be used as a function of time. The key differential between a tornado event and a hail event is that the low severity of hail events make it much less likely that the insurance company will have a good view on the total loss expected from that event immediately or even shortly after the event.

For a tornado case where a small area is impacted and the severity is very high, underwriters often have a viewpoint on what loss is expected very quickly after the event. It takes more time to obtain the same for a hail event.

There are resources available that take more time to obtain data but provide more accurate loss assessments to constrain the event footprint and estimate the severity for a major hail event. One example is remote-sensing data, which includes satellite imagery and weather radar. Another example is on-site reconnaissance or damage surveys. And ultimately, well after the event, insurance claims data can be used to calibrate the approaches that are used in those earlier time windows.



Next we will look more closely at a hail-dominant outbreak example. We will focus on Phoenix, Arizona where major hailstorms affected this urban area on October 5, 2010, and produced significant hail loss; the most damaging U.S. hailstorm in history.

On October 5, an approaching low pressure system, characterized by strong, veering winds and an unstable air mass, caused numerous supercell thunderstorms to develop across central Arizona, several of which tracked across the Phoenix metropolitan area throughout the morning and afternoon. Winds up to 70 mph were reported, and large hail – including the third largest hailstone in Arizona's history, measuring 3 inches in diameter – caused extensive damage to homes, businesses, and automobiles in the city. Heavy rain caused flooding, swamping freeways throughout the area, and some 20,000 households lost power. On the following day, October 6, Arizona experienced further damage when a number of tornadoes broke out north of Phoenix.

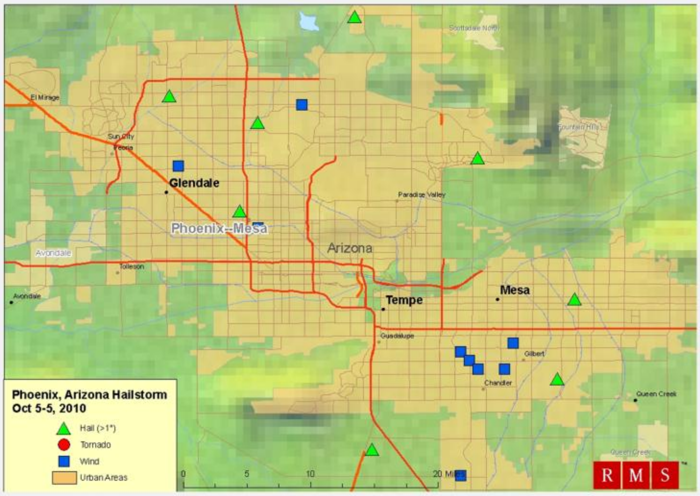
The latest PCS loss for this event (as of April 2011) is USD $2.5 billion, with close to 60% of this loss to personal lines, 30% to commercial lines, and the remainder to automobiles. This loss makes it the largest U.S. insured loss in 2010, and also the largest U.S. loss from a hailstorm in history, and is a 1,000+ year return period loss for severe convective storm events in the United States.

We discussed earlier in this module why the lack of storm reports for this event proved challenging for event response. The full extent of this hailstorm only emerged as claims were assessed and paid out. In fact, claims are still being assessed, and PCS is still updating the total loss for this event.

Hailstorms in particular can take a long time for claims to be assessed and paid out, so significant events such as this one are not immediately obvious. The development of claims over time for the different hazards associated with severe storm events is discussed later in this unit.

EYEWITNESS REPORTS

- Super-set of reports available via NWS
- Prioritize response where high hazard and exposure intersect



CCRA® Training Program – RiskLink® Version 11.0 © 2014 CONFIDENTIAL

In a real-time setting, point-level eyewitness reports made to local National Weather Service offices are available.

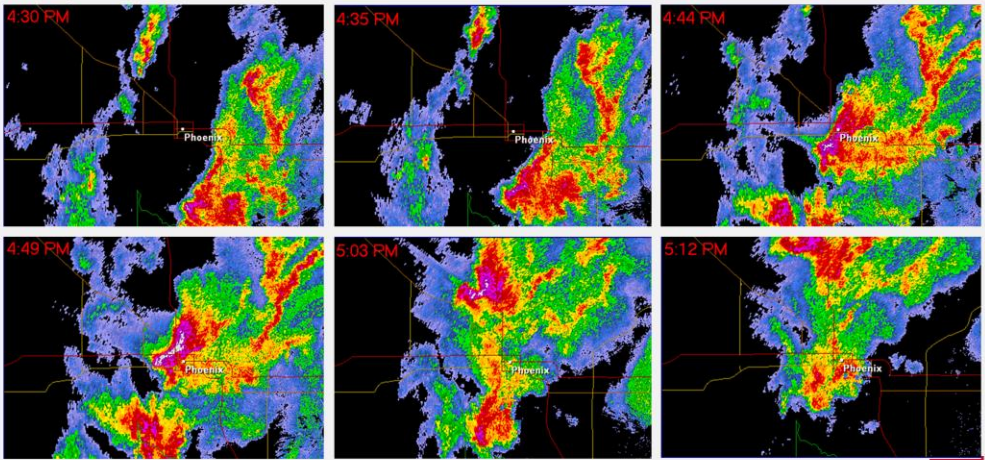
This is a map of those reports that were available in real time immediately after this event, focusing only in the most heavily impacted area of Phoenix.

There are very few data points available in this database so it is difficult to piece together the true spatial characteristics of that hailstorm immediately after an event using this resource.

When you look at this in real time and look at these reports, for example, the day after a catastrophe, it may not be immediately obvious that significant high intensity hail impacted the Phoenix area. This is the area that was shown to have the highest hail damage or the greatest hail size after claims assessments, though there were few eyewitness reports made. Clearly it is important to look at more detailed options to map out the hail boundary for real-time loss estimation.

USE OF RADAR IMAGERY

- Imagery clearly reveals path of intense supercell thunderstorms.
- Reports of storms bearing large hail of one to three inches in diameter driven by up to 70 mph winds.



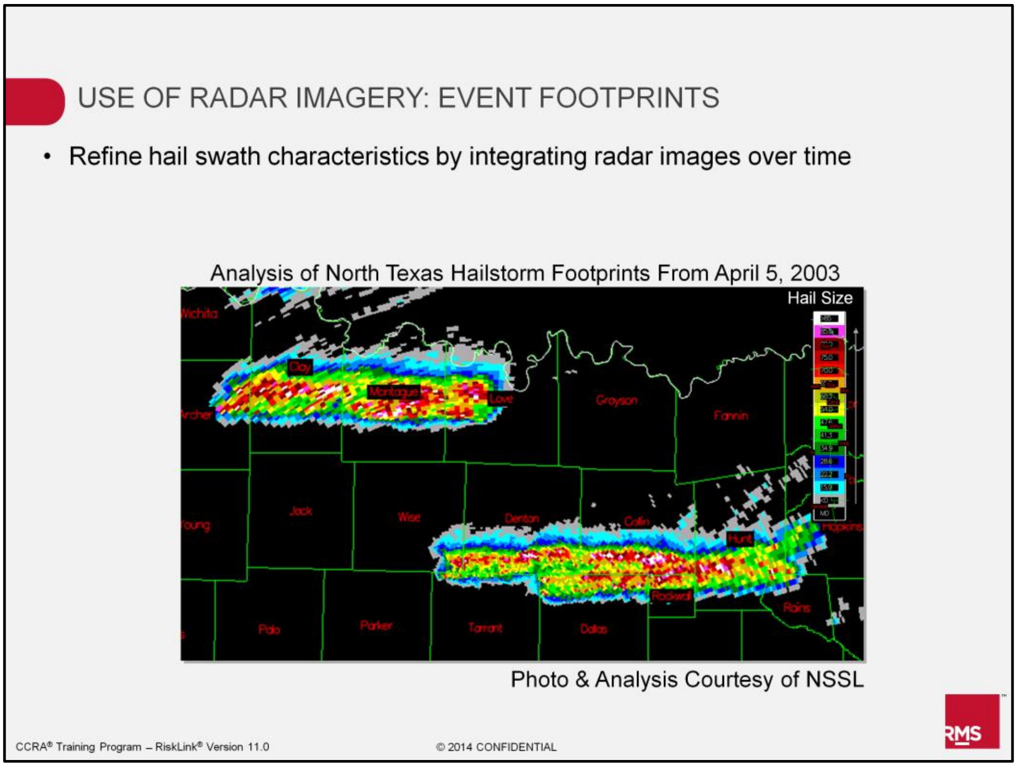
CCRA® Training Program – RiskLink® Version 11.0 © 2014 CONFIDENTIAL

Resources like radar imagery are beginning to be used very early on in the response process to assess the storm boundary, which complements the damage surveys that follow in the days after the storm.

This is a series of snapshots at specific time intervals of the October 5, 2010 thunderstorms that moved across Phoenix, Arizona. These thunderstorms progressed from southeast to northwest, moving across Phoenix producing severe hail.

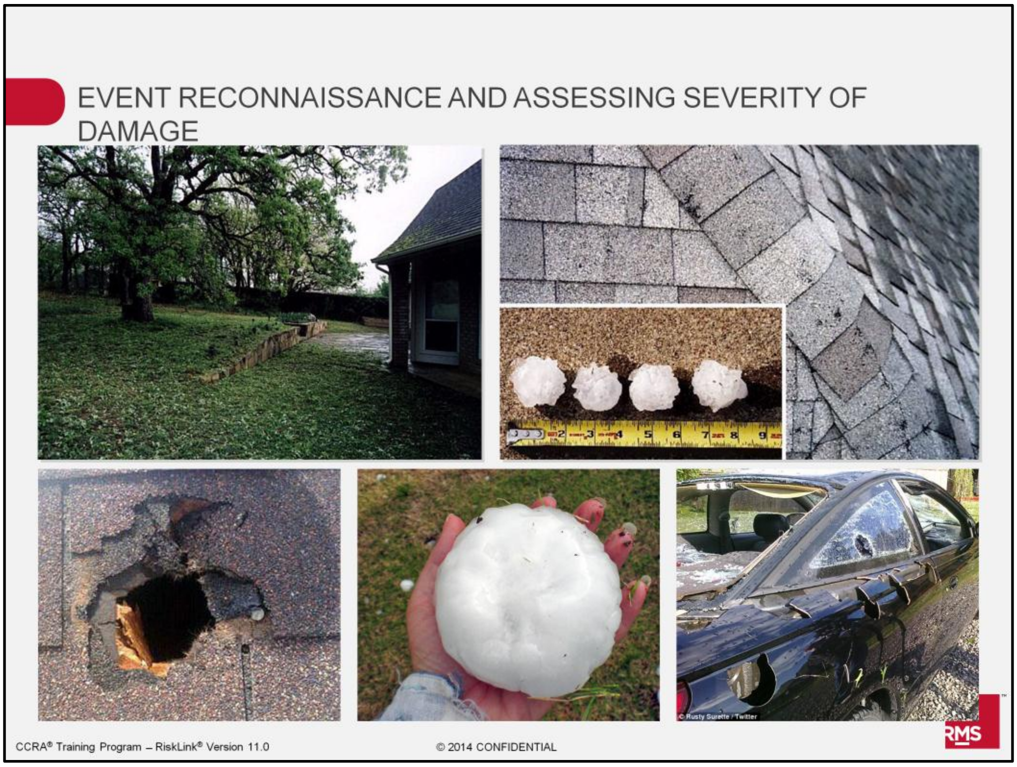
What we do not see when looking at reports from the Storm Prediction Center, is that this event was not produced by one thunderstorm but rather by multiple storms that followed one another sequentially across this region. In the first image you can see the tail end of a thunderstorm moving out of range. As the sequence progresses, you can see the main storm moving southeast to northwest across Phoenix producing severe hail. As this storm moves away from Phoenix, a third storm can be seen heading towards the city from the south-southwest.

An approximate measure of the boundary or footprint of an event can be obtained by using weather radar as a function of time, taking each of these snapshots, integrating them to develop a swath of the storm, and inferring what part of that storm was most likely creating hail. The severe convective storm model parameterizes its hail footprints using data derived from radar.



This exhibit illustrates one example of some techniques that are currently being tested and used in real time at the National Severe Storms Laboratory. This group has pioneered some of the techniques to estimate hail size from weather radar. This is their analysis of an event in North Dallas in April 2003 where they tried to assess the hail severity from these multiple hail storms.

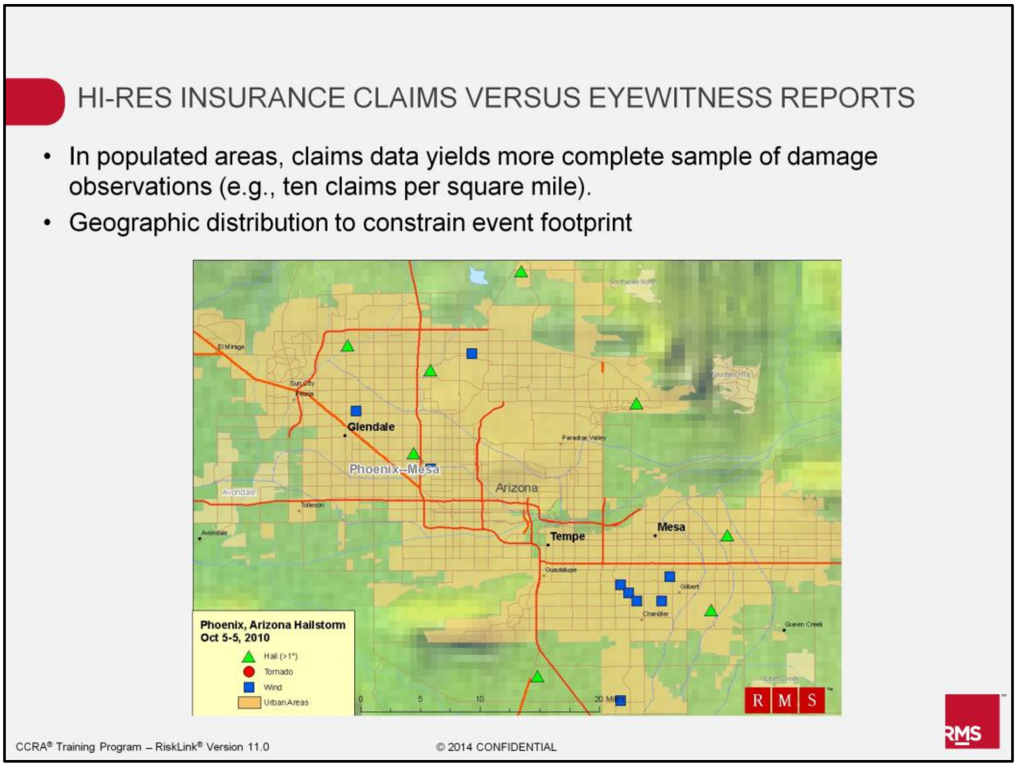
Dallas County is at the lower center part of this image and Tarrant County, just to the west, is where Fort Worth is located. These two swaths across the northern part of those counties reflect the combination of each of these three storms producing hail. The colors reflect hail size, with hail size in red and white approaching three inches in diameter as they are estimated using this weather radar outlook. This is a technique that has been developed and refined relatively recently, and has the potential to be very instructive in the real-time setting for defining and reducing the uncertainty in hail footprints that could be used in post-event analysis.



Reconnaissance surveys are also frequently used for major hail events. The process can involve actually climbing up onto the roof and inspecting the damage using techniques developed by engineers to assess the quality of the construction material. The hail size is then estimated based on the damage observed. This is a medium-term effort that can be done within several days of an event to better define the footprint.

The image in the upper right is an example of reviewing damage to roof shingles and then estimating the size of the hail at that location based on the level of damage.

The bottom images, from the May 2010 hailstorm that hit Oklahoma City, are examples of damage caused by softball size hail.

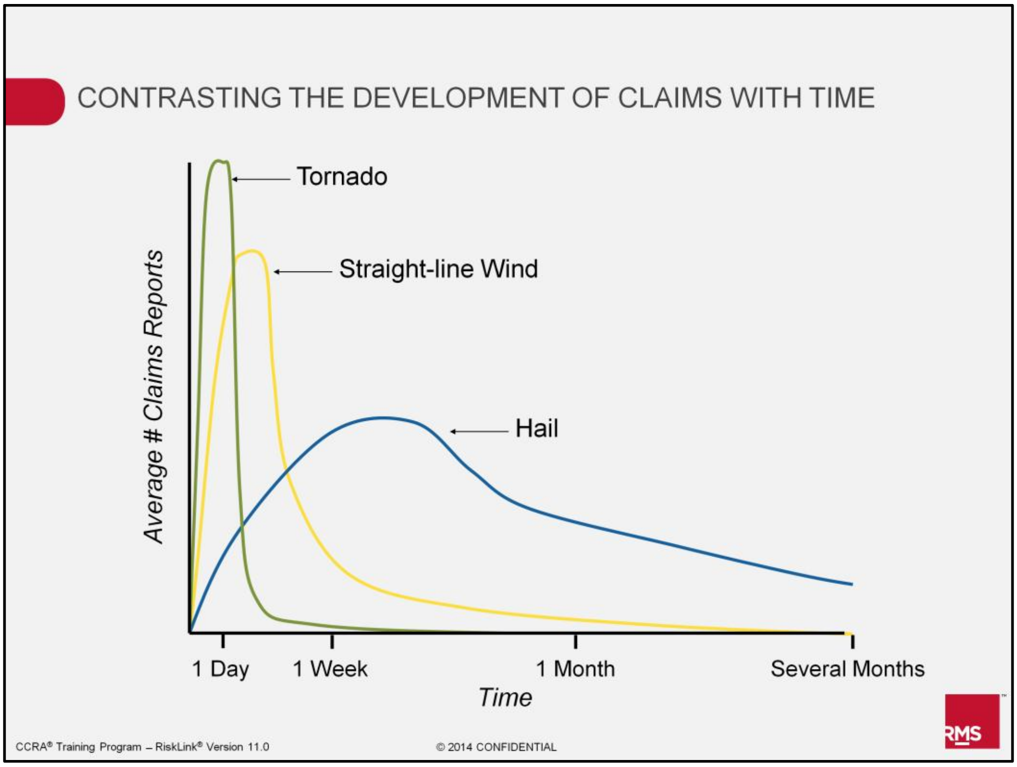


Further out on the time horizon, claims information can be used to define an event and ultimately calibrate back assumptions that are used when we are working with these less-detailed resources. This slide gives a sense of the detail and the quantity of claims data that is available relative to this snapshot of the Storm Prediction Center's reports of hail in this event.

From one company, the density of claims information that can be obtained is up to 90 claims for an affected postcode relative to what you see in these eyewitness reports. We were fortunate to have up to eight eyewitness reports in Maricopa County, which contains 188 postcodes and has an area over 9,000 square miles. While not all postcodes were affected by this event, the difference in resolution between storm reports and claims data is clear.

Claims information is of much greater density and can be used to constrain and define the values of an event and the variation in severity within it. Ultimately it can be used to calibrate back assumptions that are used initially in that event's response window.

Each of these resources from a hail point of view is used to provide our clients with the best estimation and our best understanding of the extent of the event in real time. As you can see for hail, it is less definitive and less accurate than it would be for a major tornado event.

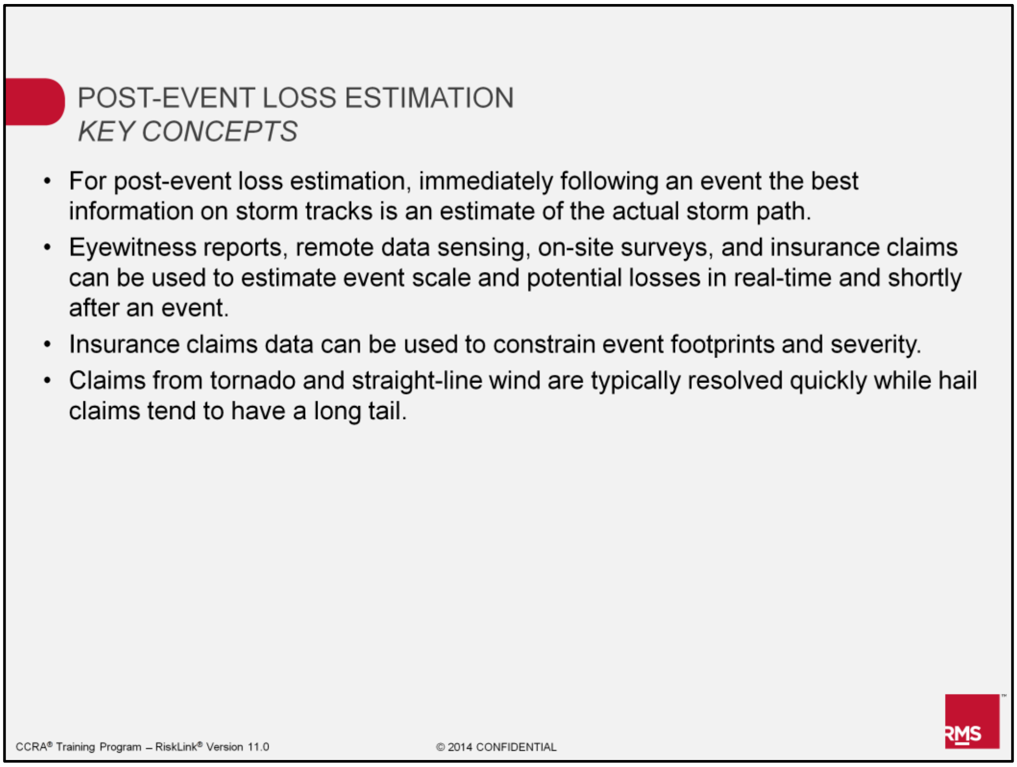


Finally, we will look at a viewpoint on the development of claims with time.

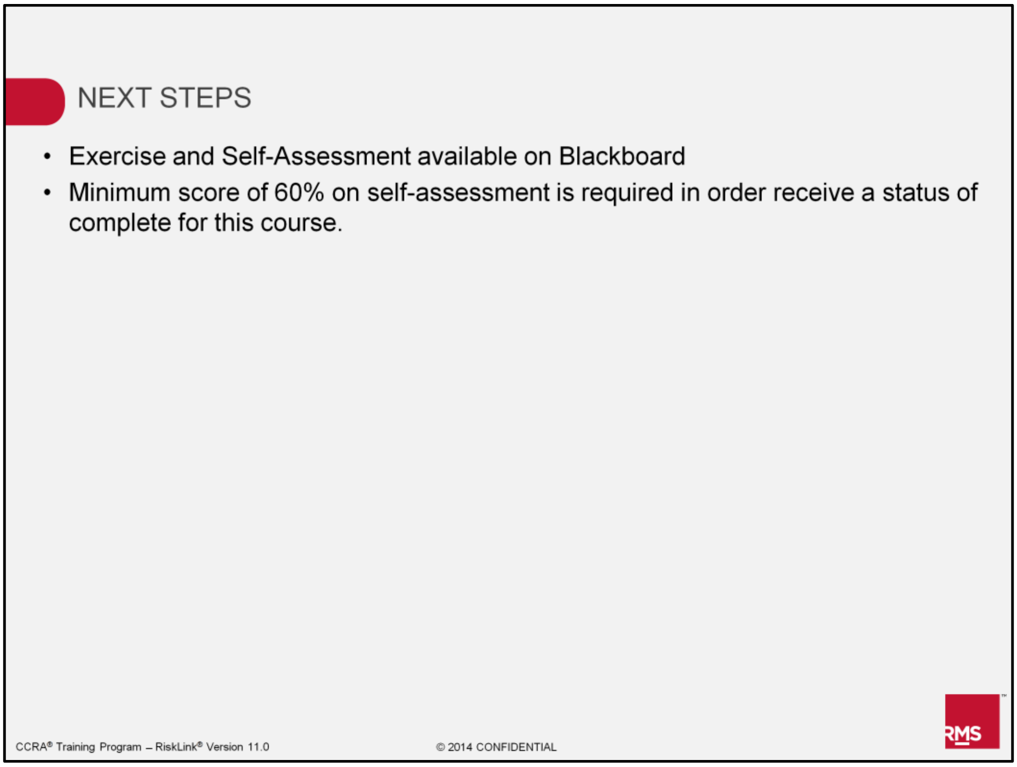
When we talked about vulnerability, we talked about hail loss adjustment and that there is consumerism and other aspects involved in how hail claims develop, how they are adjusted, and how they accumulate as a function of time. Within the loss adjustment circle of insurance companies, it is known that it takes a long time for hail claims to close. The phrase "hail has long tails" is often used to reflect the fact that claims can continue to be open and the hail event may not close for a long period of time. It can take several months, or in many cases years, for the events' claims to completely close out and for that loss figure to be stable. Although in a real-time setting the loss information or hazard information that is available in that one to two day period is often not of extremely high quality, those hail events can continue to develop over a long period of time. Continuing to strive for better resources and to provide our clients with better information, even if it takes a week or several weeks, still has considerable value. Understanding it from a hazard and modeling point of view can be very valuable when the actual number of claims that will open is an unknown.

The October 5 Phoenix Hailstorm discussed earlier is a good example of how the full extent of hail events can take a long time to emerge. Initially, this event did not appear to be a big event based on storm reports and newspaper damage surveys. However, this event is actually the largest U.S. insured loss for 2010, and is also the largest hailstorm loss in the U.S. in history. The long time it takes to assess and pay out claims from hail events is the reason why such a significant event as this did not initially appear to be a big event at all. In fact, as of April 2011, claims are still being assessed and paid out for this event, and PCS is still updating their loss estimate from this storm.

This delay in loss adjustments is not as prevalent for straight-line wind and tornado events. Locations with a claim tend to be known much earlier and can be resolved fairly quickly. With these events it becomes much more critical to have an immediate or very near-term resource for our clients to use. The accumulation analysis and those resources are much more important and the constant surveys are less necessary for tornado and straight-line events relative to hail events.



This slide summarizes the key points from Unit 5. If any of these points are unclear, please revisit the associated slides within the unit.



In order to fully complete the course work for this peril, complete the exercise and self-assessment available on the Blackboard. You must score a minimum of 60% on the self-assessment in order to receive credit for completing this course.

Completion of three peril model courses is mandatory in order to be eligible to sit for the CCRA® exam.