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The Science Behind How Hail Technologies Work and Their Relevancy to Forensic Verification



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Introduction

Every year, hail fall and its related damage is a significant contributor of insurance claims and losses in the Continental United States. According to the Insurance Information Institute, the average hail damage to property and crops has cost insurers approximately \$1.34 billion over the last five years, with losses exceeding \$2.5 billion in 2012. Defining exactly where on the ground damaging hail has impacted insured properties and assets is critically important to understand exactly what may have suffered damage. With this information, claims adjustors can be quickly mobilized to accurately estimate potential losses, increasing the satisfaction of the insured party, while helping to reduce the number of fraudulent claims. These highly accurate footprints of hail and wind damage are not only useful for contemporary events, but by maintaining a historical database of past event locations, insurers have the ability to verify if pre-existing roof or other damage may be present prior to issuing a new policy.

The Challenge

Thunderstorms are some of the most dynamic phenomenon on earth, resulting in hail sizes that can vary from pea to greater than softballs over a short geographic distance. Additionally, a small number of large hailstones can be present in an area that is mostly made up of smaller hailstones, further complicating the hail size estimate. Both of these issues can cause ground reports from even well-trained spotters to be unrepresentative of the surrounding area. Weather radars can observe the whole storm, but different combinations of rain and hail sizes can look identical. This is problematic for verification purposes which have historically relied on public reports or radar-only methods. With the proprietary Hail Verification Science from CoreLogic®, carriers can compare detailed storm maps and reports with their book of business to better understand the impact of each unique storm. This enables a more proactive approach to claims management. Through the ability to accurately verify and pinpoint affected areas, insurance carriers can develop swifter, more targeted response plans to improve customer satisfaction, catastrophe response efficiency, and confidently detect fraudulent claims.

Purpose

The goal of this paper is to explain how the proprietary Hail Verification Science from CoreLogic works, and to highlight the unique differentiators the CoreLogic method has to offer. By understanding how an array of hail technologies work, industry leaders can confidently choose the appropriate technology to meet specific needs.

Limitations of Verification Methods

In this paper we will explore the following sources of data, and their effectiveness when used for forensic hail verification.

- Public Reports
- Radar-based Estimates
- NWS Algorithms
- Manually Drawn Footprints

Using Public Reports for Hail Verification

Public hail reports provide the only freely available observations of hail sizes on the ground, and therefore are often used by insurers as a source of hail size verification. The National Weather Service (NWS) collects reports relayed to them from a number of volunteers, inclusive of law enforcement, emergency managers, trained spotters, storm chasers, and the general public. Many of these reports are received via phone calls directly to their office, however they also include social media reports posted online. On occasion, in order to verify the viability of a severe thunderstorm warning, they contact residents in rural areas where the storm passed in order to verify severe hail activity.

While these reports are the only publicly available source of ground truth, they have several major limitations. The first, is that the diverse group of volunteers that report hail sizes have varied amounts of training on how to accurately report such findings. Trained spotters complete a class where they are educated on how to accurately measure hailstone sizes, whereas many reports by the public are made without any training. Furthermore, from the time the hailstone hits the ground, it begins to melt due to warm air and contact with the ground, causing the hailstones to be underestimated in size. In combination, they can cause the reported hailstone size to be inconsistent from observer to observer, even for the same initial sized hailstone.

According to several published studies, location reliability and coverage is also a major limitation when using public reports for verification¹. One study found that up to 30 percent of reports were significantly displaced from the actual hail core². The location errors are compounded by the fact that hail sizes can vary substantially over small distances, and many observers report only the closest intersection or town, which results in location variations that can be off by several miles, if not more. Another study found that people usually only report the most impactful weather that occurred at their locations³. For example, if damaging straight-lined winds occurred or a tornado passed nearby, they often failed to report the hailfall, despite its severity. Additionally, due to limited resources, the local NWS offices often only make enough calls to verify each warning, rather than finding enough reports to outline the hail footprint. Therefore, any hail verification technique solely using public records must take into account the listed limitations, or risk introducing substantial location and size errors into the estimated hail-size footprint.

Using Radar-Based Methods for Hail Verification

Due to the lack of coverage and consistency in reports, weather radars are used to estimate hail sizes. Weather radars are an invaluable tool in consistently estimating precipitation and wind speeds across larger areas of the country that would otherwise be absent of observations. As a radar spins (Figure 1), it scans the atmosphere at varying angles, starting near the ground and progressively tilting up to higher angles to provide several levels of reflectivity (radar-return echo) information over a two- to ten-minute period. To enhance their capability, the NWS upgraded their radar network between 2012 and 2013 to use dual polarization technology. It works by measuring the difference between horizontal and vertical energy waves that each behave differently depending on the size and shape of the rain drops or hailstones. The upgrade allows the radar to identify areas of hail and rain and even differentiate between big drop and small drops.

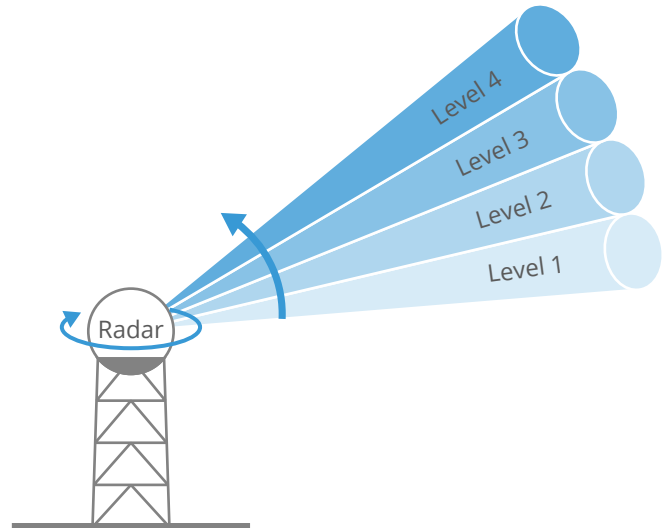


Figure 1. As the radar rotates 360 degrees, it scans the lowest level, then tilts up to scan the next level for a full rotation, and so on.

The primary limitation of using weather radars to estimate the hail-size footprint is that radar reflectivity depends on the size and number of rain drops and hailstones, meaning that a few large hailstones could look like many small hailstones or even moderate rainfall. This is further complicated when rain and hail exist in the same area, which is a common occurrence. Even with dual polarization technology, it is difficult to tell the difference between large hail mixed into regions of heavy rain and moderate hail in moderately heavy rain, limiting the ability to consistently distinguish hail sizes from radar data near the ground.

Therefore, while weather radars provide unparalleled coverage and detail and have been recently upgraded, they cannot alone provide enough information for a radar-based algorithm to directly estimate hail size

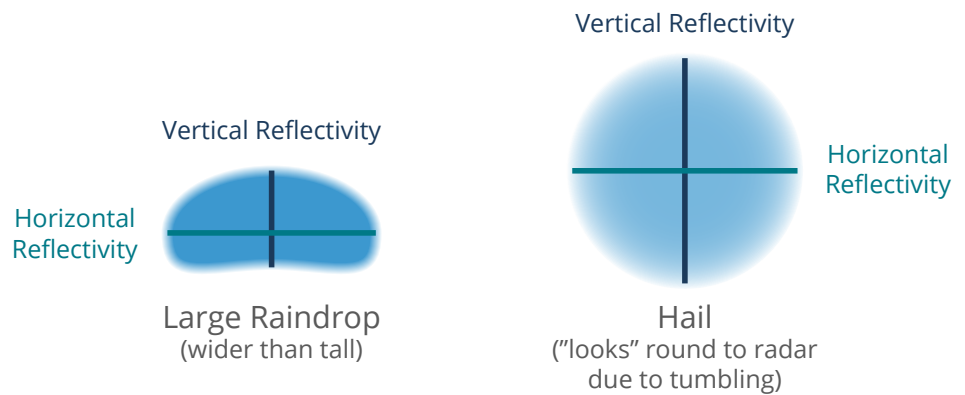


Figure 2. Dual polarization can distinguish between rain and hail by comparing the difference between the vertical and horizontal reflectivities.⁴

Dual polarization offers “no explicit [hail] size estimation.”⁵

with the level of granularity required for insurance related verification.

Using NWS Algorithms for Hail Verification

NWS forecasters are required to estimate the maximum hail size when issuing severe thunderstorm warnings. This is often based on reports, local atmospheric conditions, and radar reflectivity. The National Severe Storm Laboratory (NSSL) developed a radar-based algorithm that estimates the maximum hail size that the storm is capable of producing. This was designed to help forecasters more accurately and consistently decide whether a severe thunderstorm warning is warranted, and subsequently describe the potential hail size associated with the storm. To mitigate the limitations of using reflectivity near the ground in the storm, the algorithm focuses on regions below freezing, where all of the precipitation should be frozen. The volume and magnitude of the reflectivity in the frozen portion of the storm is then turned into a hail size using relationships built on observations from many storms.

This algorithm has proven to be incredibly useful to forecasters and has improved the quality and consistency of their severe thunderstorm warnings for hailstorms. However, when examined for use as a verification tool, several studies have shown that the algorithm has a tendency to overestimate hail sizes, and lacks the granularity required for accurate hail size verification. The tendency to overestimate hail sizes is by design, as the algorithm is trying to estimate the largest hail size that the storm is capable of producing. While the lack of granularity arises out of the difficulty in correlating hail size high up in the storm with the hailstones reaching the ground. Fortunately, neither of these limitations impact forecasters as warnings are often the size of an entire county.

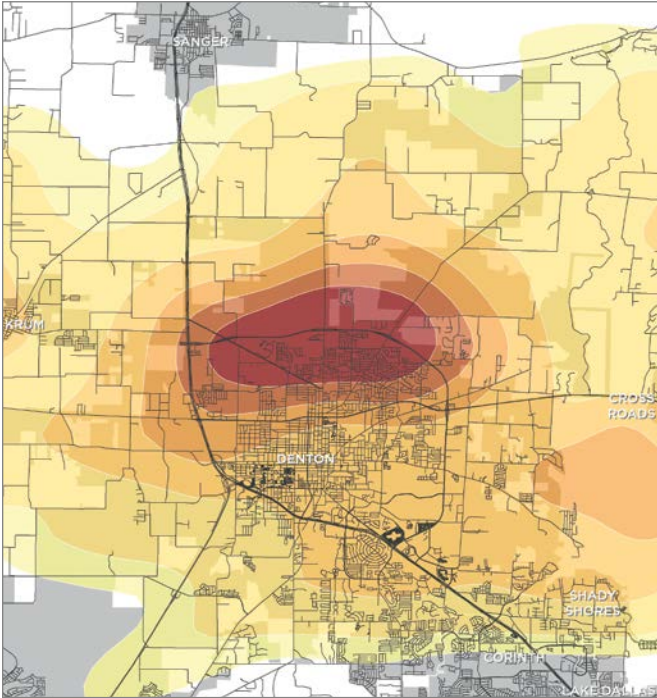
With the recent upgrade to dual polarization, NSSL has developed a new algorithm that classifies hail into three different groups: small (< 1”), large (1-2”), and giant hail (> 2”). It works by examining radar reflectivity and dual-

polarization variables at each height and then selecting the hail size group that best fits all the variables for a specific radar scan. Therefore, unlike the old algorithm, the new one gives a hail group estimate at every level. This provides forecasters with a good estimate of the hail sizes falling near the ground, but also hail high up in the storm that will fall to the ground at some point in the future. Feedback from NWS forecasters indicates that using the new algorithm has given them more confidence in mentioning the possibility of large and giant hail in their warnings. Unfortunately, the limitations of using dual polarization data near the ground are still valid. So while the new algorithm is a major improvement in the detection of hail, the addition of dual polarization data is insufficient to overcome the limitations of a radar-only approach for use as a hail size verification tool.

Using Manually Generated Maps for Hail Verification

Some verification products rely on human expertise to manually draw the hail size footprints in order to overcome the individual limitations of using public reports and radar-based methods. This approach draws on the expertise and experience of individual meteorologists to blend the available information provided by public reports and radar data, into an analysis. Although this method can potentially mitigate the limitations of each data source, its manual nature is also prone to human subjectivity. If used incorrectly, the limitations of each data source may be combined, enhancing, rather than mitigating the problems associated with each data source. The subjectively analyzed maps thus lead to inconsistent hail sizes and footprint granularity from storm to storm. Additionally, timeliness and quality can become an issue at the height of the hail season when a single storm system can impact large areas of the country over a couple days. Altogether, while this process may yield better estimates for an individual storm than either public reports or radar-based approaches, it cannot produce objectively consistent hail size footprints for verification purposes.

By analyzing the unique reflectivity-to-hail size relationship for each storm, the proprietary hail verification model from CoreLogic produces accurate hail path and size information intended for forensic verification.



CoreLogic Solution

CoreLogic has built a hail verification model that takes the best aspects of each approach and combines radar data, public and social media reports, and the expertise of experienced meteorologists. The model uses the NWS radar data to generate high-resolution hail footprint patterns that are calibrated to each individual storm as it changes over time. This comprehensive approach consistently provides 500-meter resolution with neighborhood-level detail.

The proprietary radar algorithm was designed to preserve the high-resolution of the radar-based estimates while mitigating their limitations. This is done by focusing on estimating hail near the ground and uniquely taking advantage of the dual polarization data, while not being overly dependent on any one radar variable. However, unlike other approaches, the hail model uses a revolutionary method to generate a storm-

unique and temporally evolving relationship between what the radar is seeing near the ground and the hail sizes being reported on the ground.

The accuracy and usability of publically available reports is automatically assessed so that even suboptimal ground reports can be turned into valuable information. This allows us to include social media reports that would otherwise be excluded, greatly increasing the number of observations near the ground. Furthermore, we are able to preserve the granularity in the radar data by using a sophisticated, physics-based morphing algorithm to continuously fill in the reflectivity data gaps every few seconds.

CoreLogic Hail Verification Advantages

- Advanced quality control process that accounts for and corrects many errors
- in public reports, allowing them to be combined with the radar data.
- Uses radar data nearest the ground, where hail impacts life and property.
- Investigates the unique relationship between what the radar sees in the storm and what people are observing at the ground.
- Eliminates hail-coverage gaps by using a sophisticated morphing algorithm to calculate continuous radar data.
- Calculates unbiased hail size, since it is designed as a comprehensive verification tool.

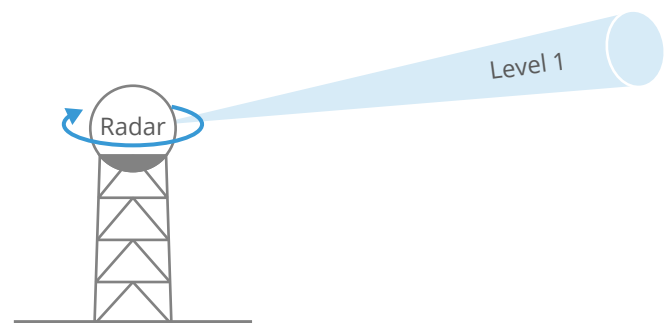


Figure 3. The hail verification model from CoreLogic focuses on hail nearest to the ground.

Industry leaders can confidently choose the hail verification model from CoreLogic for forensic verification.

Summary

The P&C industry is exposed to billions in insured losses every year due to hail. Hail damage can go undetected for months, causing considerable collateral damage and resulting in very long claims tails.

Address-Level, Forensic-Quality Severe Hailstorm Event Data

Hail Verification Reports and Hail Size Maps from CoreLogic provide precise, location-specific historical hail information, enabling insurance adjusters to document claim files with severe hailstorm data. CoreLogic Hail Verification provides verification of hailstorm events back to January 1, 2009, with estimated maximum hail size at the location of interest, as well as within one, three and ten miles of the location.

Verify Hail Claims to Improve Customer Satisfaction and Profitability

With CoreLogic Hail Verification Technology, carriers can compare detailed storm maps to their book of business to better understand the impact of each unique storm, fast-track obvious claims, and allocate appropriate resources toward more difficult or suspicious claims. Because CoreLogic Hail Verification provides precise knowledge of when severe hail likely impacted a specific property, insurance claims adjusters can:

- Objectively handle, document, and communicate hail claim decisions
- Close claims faster for improved customer satisfaction
- Correctly identify losses that were likely caused by pre-policy storms
- Identify suspicious and potentially fraudulent claims

A Powerful Combination

Hail Verification combined with Wind Verification from CoreLogic represent a powerful dataset for property and casualty insurers. With the information provided by these databases, insurance companies can create new solutions and workflows to close claims faster, ultimately increasing customer satisfaction and loyalty, while more accurately identifying suspicious claims.

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About CoreLogic

CoreLogic (NYSE: CLGX), the leading provider of property insights and solutions, promotes a healthy housing market and thriving communities. Through its enhanced property data solutions, services and technologies, CoreLogic enables real estate professionals, financial institutions, insurance carriers, government agencies and other housing market participants to help millions of people find, acquire and protect their homes. For more information, please visit www.corelogic.com.

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