SITE-SPECIFIC HAILSTORM ASSESSMENT

BY

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Introduction

Hurricanes and tornadoes often grab the headlines, but year in and year out, hail causes billions of dollars in losses to U.S. residential and commercial property. In 2005, Hurricane Katrina was the largest weather-related event of the year. However, the largest 2006 weather-related event was the April 14 hailstorm that struck Indianapolis, Indiana, causing over $1.3 billion in loss and generating 282,500 claims filed with insurance carriers (ISO, 2007). Although 2007 was a fairly quiet year for hailstorms relative to the 2006 Indianapolis hailstorm event, significant hailstorms did occur in many metropolitan areas such as Columbus, OH; Fargo, ND; Minneapolis, MN; and Fort Worth and Dallas, TX.

According to National Weather Service statistics, most years, hail is the second overall cause of property loss, next to flooding. Insurance companies do not cover flooding as a "peril" under standard homeowner policies, but they do cover hail.

Amazingly, for every $100 of homeowner premiums collected by the insurance industry, $30 goes to paying for hail and wind claims (Insurance Information Institute). Hail and wind claims are by far the largest category of property-damage expense. For comparison, expenditures per $100 of homeowner premiums collected are: $16 for fire and lightning losses, $11 for water damage and freezing (i.e., coverage for burst pipes, leaking water heaters, etc.), $4 for all other property damage, and $2 for theft.

It is clear that reliable tools are needed to assist engineering consultants as well as insurance claims adjusters in assessing the occurrence, location, and size of hail as it relates to property damage. Weather Decision Technologies (WDT) leverages the latest scientific knowledge of severe storms, available high-resolution Doppler weather radar data, and sophisticated tools developed by expert scientists at the National Severe Storms Laboratory (NSSL) and WDT, and meteorological experts to routinely provide assessments of hail. The science, data, and technology behind WDT's hail assessments are described in this paper, and a hailstorm case scenario is presented.

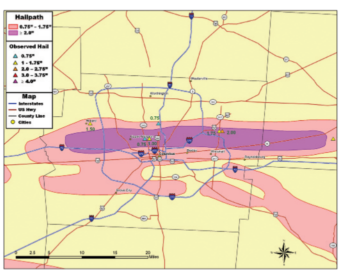

Figure 1 – HailTrax™ hail analysis for Columbus, OH, on October 4, 2006. Locations of human-observed hail are indicated by the triangle-shaped icons. Areas where hail with a diameter equal to or greater than 0.75 in but less than 2 in would most likely have occurred are analyzed within the light red shade. Areas where hail equal to or greater than a 2-in diameter would most likely have occurred are analyzed within the magenta shade.

Hail Assessment Data and Methodology

Verification of hail often relies on observations by weather observers. Fortunately, hail observations are routinely collected and disseminated through the National Oceanic and Atmospheric Administration of the National Weather Service. Although important to the hail verification process, human observations of hail tend to be fraught with ambiguities and errors regarding time and location. As a result, the human observations of hail often require close inspection by expert meteorologists to correct obvious errors in reported time and location. In addition, human observations of hail tend to be sparse relative to the actual area impacted by falling hail.

Early studies of hailstorms demonstrated that relatively dense weather observation networks are required to adequately measure the extent of damaging hail. One such study (Changnon, 1968) concluded that at least one observer is required per square mile of area. Such a dense network of observers on a nationwide scale is simply not feasible. Therefore, other tools such as weather radar and methods for combining multiple weather data types are needed to properly assess the occurrence and impact of hail-producing storms.

The advent of weather radar following World War II provided significant advancements in our understanding of storms and their attendant phenomena, such as hail, tornadoes, damaging winds, and flooding. By emitting rapid bursts of energy into storms, weather radar is capable of measuring the returned energy (reflectivity) from the illuminated hydrometeors, such as hail and raindrops within a storm. This provides valuable information regarding rain intensity, as well as valuable clues regarding the presence of hail.

Although weather radar has expanded our knowledge with regard to recognizing specific characteristics of hail-producing storms (e.g., storm shape, reflectivity magnitude, presence of a rotating updraft, etc.), weather radar alone is not capable of categorically discriminating areas of rainfall from areas of hail fall. Instead, research has shown that a combination of weather radar data with environmental temperature data can significantly improve our ability to identify hailstorms (Waldvogel et al., 1978a; Waldvogel, 1978b; English, 1973; Browning, 1977; Nelson, 1983; Miller et al., 1998; Witt et al., 1998). Developed and tested by NSSL and enhanced by WDT, the Hail Detection Algorithm (HDA; Witt et al., 1998) employs a probabilistic approach to hailstorm identification by comparing a height profile of Weather Surveillance Radar-1988 Doppler (WSR-88D) reflectivity data associated with an identified storm with a height profile of the ambient environmental temperature.

Since hail growth is expected in subfreezing regions of a storm, the WSR-88D reflectivity data are compared to the height above ground of the ambient 0˚C (freezing level) and the height above ground of the ambient -20˚C environmental temperature. As a result, the HDA automatically computes the probability of the presence of any size hail within a storm. More importantly, the HDA computes the probability that severe hail (diameter greater than or equal to 0.75) is present at the ground or will be present at the ground within the next 30 minutes and the maximum expected hail diameter. An evaluation of the HDA using a geographically diverse dataset has shown that the HDA reliably identifies hailstorms (Witt et al., 1998 and Witt, 2000).

By combining the output from the HDA with WSR-88D reflectivity data and human observations of hail at the ground, a valuable and insightful assessment of hail can be achieved. The HDA output and WSR-88D reflectivity data are collectively processed to extract the most important information regarding those storms most likely to produce hail equal to or greater than 0.75-inch in diameter. As a result, this information (along with human observations) provides the most necessary data regarding the likely size of hail that occurred as well as the area in which it was most likely to have fallen.

The final rendering of a hail event is achieved by an expert meteorologist collectively displaying, integrating, and analyzing all of these data using geographic information systems (GIS). Recent advancements in GIS have provided robust tools for easy display, analysis, and assessment of weather events. These GIS tools allow efficient quality control of weather data (e.g., correction of obvious errors and ambiguities in human observations of hail) and methods for finding spatial relationships between a hailstorm and any property asset (e.g., which addresses are impacted by the hailstorm). Through GIS, the resulting hail analysis can be blended with accurate geographic data (political boundaries, urban boundaries, rivers, lakes, streets, etc.) to create an even clearer picture of the impact of a hailstorm.

Case Scenario: Columbus, Ohio Hailstorms

Immediately following a hailstorm or other peril, insurance carriers are often required by state laws to set aside funds for anticipated claims that will be generated. Access to data that describe the area extent of a hailstorm provides an indication (particularly when overlaid with policyholder-density data) of the financial impact of a storm and can help catastrophe and claims teams plan for immediate customer-service and claims-processing needs. Roofing contractors, supply companies, and even manufacturers share the same desire to understand the impact of hail so they, too, can respond. This knowledge allows for anticipating the supply and demand needs of the area as well marketing services.

We have chosen Columbus, Ohio, as our case study for real-world applications of hail assessment to assist roofing experts and insurance companies as they strive to evaluate hail damage. The Columbus area has been showered with several major hailstorms over the past half decade. On Easter Sunday, April 20, 2003, a hailstorm in Columbus caused $230 million in insured losses. On October 4, 2006, the same city was struck by a hailstorm that caused $239 million in insured losses – the costliest in recent history (*Figure 1*). Then, on April 11, 2007, a hailstorm generated 29,219 claims totaling more than $105 million, including damage from hail, high winds, and heavy rain (Ohio Insurance Organization). Yet another hailstorm struck the same area on November 5, 2007. (Note: Loss statistics and data for this storm were not available as of press time; however, this storm is likely to be significantly smaller than the others mentioned here.)

The following scenario is presented to illustrate the complexity of properly diagnosing a hail-related property loss. Joe Smith, owner of a home at 123 Main Street, Columbus, Ohio, calls his insurance company, XYZ Insurance Co., on November 6, 2007. Mr. Smith says he wants to file a claim for hail damage. A dutiful adjuster goes to inspect the property and concurs with the homeowner that indeed there is hail damage to his roof. As a result, several roofing contractor companies are called to supply competitive bids. But when did the damage occur? Was the hailstorm from the previous day responsible for the damage? The storm from April 11, 2007 is still within Mr. Smith's 1-year timeframe to file his loss with the carrier. It is also conceivable that other hailstorms in recent years could have impacted Mr. Smith's property. The situation is further exacerbated if, for example, Joe Smith has only been insured by XYZ Insurance Company since May 1, 2007. Hence, if the damage occurred from the April 11, 2007 storm, his previous carrier may be "on the hook" to render payment for damages, and the situation can quickly become a massive finger-pointing opportunity among all the parties involved. This scenario is not uncommon following major hailstorms.

Verification reports are intended for hail (equal to or greater than 0.75 inches in diameter) in the overall assessment and inspection process. Hail verification reports are not damage reports; neither should they replace quality roof inspections and adjustments. Instead, hail verification reports can be useful and complementary tools to assist those tasked with inspecting, engineering, adjusting, and roofing to determine whether the property was impacted by hail.

Summary

Hailstorms contribute significantly to annual property losses from natural hazards. Furthermore, hailstorm assessment professionals are often faced with a challenging task. Reliable and high-resolution weather data, as well as unique, scientifically sound, and sophisticated technology can provide valuable insight in the assessment of the occurrence, location, and size of hail as it relates to property damage. Advancements in our scientific understanding of severe storms come from improved technology in the identification of hailstorms. These provide meteorologists with the necessary tools and components for such value-added products as HailTrax™. As a result, a clearer picture of the impact of hailstorms at any given location across the U.S. can be achieved.

References

Browning, K.A., "Hail: A Review of Hail Science and Hail Suppression," *Meteorological Monograph No. 38*, American Meteorological Society, 1–43, 1977.

English, M., "Part II: Growth of Large Hail in the Storm," *Alberta Hailstorms, Meteorological Monograph No. 36*, American Meteorological Society, 37–98, 1973.

Insurance Services Office (ISO) 2007, Jersey City, New Jersey.

Insurance Information Institute based on data from ISO and the National

Association of Insurance Commissioners (NAIC). www.iii.org/media/facts/statsbyissue/homeowners/

Miller, L.J., J.D. Tuttle, and C.A. Knight, "Airflow and Hail Growth in a Severe Northern High Plains Supercell, *Journal of the Atmospheric Sciences*, 45, 736–762, 1988.

Nelson, S.P., "The Influence of Storm Flow Structure on Hail Growth," *Journal of the Atmospheric Sciences*, 40, 1965–1983.

Ohio Insurance Institute, Columbus, Ohio. Press Release – "Ohio October Hailstorms Make Major Dent In Insurer Claims," November 9, 2006. www.ohioinsurance.org/newsroom/newsroom_full.asp?id=387

Waldvogel, A., W. Schmid, and B. Federer, "The Kinetic Energy of Hailfalls. Part I: Hailstone Spectra." *Journal of the Atmospheric Sciences*, 17, 515–520, 1978a.

Waldvogel, A., B. Federer, W. Schmid, and J.F. Mezeix, "The Kinetic Energy of Hailfalls. Part II: Radar and Hailpads, *Journal of the Atmospheric Sciences*, 17, 1680–1693, 1978b.

Witt A., M.D. Eilts, G.J. Stumpf, J.T. Johnson, E.D. Mitchell, K.W. Thomas, "An Enhanced Hail Detection Algorithm for the WSR-88D," *Weather and Forecasting*, 13: 286-303, 1998b.

Witt, A., "The WSR-88D Hail Detection Algorithm: A Performance Update." In *Preprints of the 20th Conference on Severe Local Storms*, Orlando, FL, American Meteorological Society: 378-381, 2000.

DeWayne Mitchell

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Lynne Lawry

Lynne Lawry is vice president of sales and marketing for Nimbus Weather Technology and serves as director of WDT forensics sales. Lynne holds a bachelor's degree in business administration from the University of Phoenix. She teamed with WDT in 2000 to develop and market products for the WDT Weather Forensics Division. Previously, Lynne worked for Global Atmospherics, Inc. (now Vaisala) from 1991-2000, where she developed the company's StrikeFax and StrikeNet forensic lightning verification reports.

Michael Eilts

Michael Eilts, president and CEO of Weather Decision Technologies, Inc. (WDT), received his BS and MS degrees in meteorology and an MBA from the University of Oklahoma. Eilts and four others founded Weather Decision Technologies in 1999 in Norman, Oklahoma. Before founding WDT in April 2000, Mr. Eilts worked at the National Severe Storms Laboratory (NSSL) in Norman, OK, for 18 years, the last seven as the assistant director. While at NSSL, Mike managed a division that grew from 20 people to 100 people upon his resignation in 2000. Mike has written over 75 papers in meteorological journals and conference proceedings and is internationally recognized for his knowledge of Doppler radar and its application to precipitation estimation and hydrology, severe weather warning, and aviation hazard detection and prediction.

New Building Produces Ice Shower

Ice rained from the façade of the iconic sun screen of the New York Times Building in Manhattan on December 14, 2007, pelting pedestrians before the sidewalk was roped off by its owners. Some pieces were reportedly 2.5 ft long. The screen of the building, designed by award-winning architect Renzo Piano of Italy, consists of 170,000 horizontal ceramic rods.

The building's curtain-wall supplier, Benson Industries LLC, Portland, Oregon, had been required by architectural specifications to consider ice loads on the rods, which "amounted to six times the half-ton weight of a typical curtain-wall unit," noted John Frank, Benson eastern region general manager. The Wiss Janney Elstner Chicago office ran freeze-thaw cycle tests for Benson, but only for the effect of ice on the rods' integrity, *ENR* reported.

The building owner's spokesman said an independent lab had concluded there was no more danger of falling ice or snow from the nine-month-old building than "any other high-rise." The spokesman said the Times will temporarily close its sidewalks to allow accumulated snow and ice to fall from its perches in the future.

— *ENR*