

How better hail forecasting can protect solar installations

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Hail can cause millions of dollars in damage to solar installations. New research shows that Vaisala Xweather's lightning-based forecasting detects more severe hail events than other methods and provides operators with more time to protect their panels, potentially reducing damage and insurance costs.



According to industry research cited by kWh Analytics, hail is responsible for a disproportionate share of insured solar losses. Tilting solar panels into a protective stow position can significantly reduce the damage, but operators need sufficient warning to act.

A validation study conducted by Vaisala Xweather found that its lightning-based forecasting system predicted 99.2% of reported severe hail events in the US in the first half of 2026, outperforming the radar-based method used by most commercial hail alerting services by 15.9 percentage points. The findings also suggest that its forecast could give operators more time to act.

The financial impact of severe hail on utility-scale solar projects can be substantial. According to the 2025 Solar Risk Assessment report from kWh Analytics, hail accounts for 73% of total insured losses despite representing just 6% of loss incidents.

VDE Americas reports that hail damage represents only 2% of solar project insurance claims but accounts for more than 50% of the associated costs, averaging approximately \$58 million per claim. AXIS Capital recorded \$340 million in hail damage claims between 2019 and 2024.

PV panels mounted on tracker systems can be tilted towards vertical when severe hail threatens. Moving the panels into a defensive stow position reduces their exposure to damaging impacts. One study found that positioning modules at 60° during a hailstorm increased panel survivability from 81% to 99%.

However, even the most effective stow system depends on knowing when a storm is approaching. Operators need accurate forecasts and enough lead time to move their panels before the hail arrives.

Building a more accurate hail forecast

Forecasting hail remains one of meteorology's more difficult challenges. Conventional weather models and radar have limitations when predicting and observing the complex processes involved in hailstone formation.

Vaisala Xweather has developed an approach that uses lightning activity to help identify storms capable of producing damaging hail. Inside a storm cloud, the convective processes associated with lightning can also contribute to hailstone formation. Detecting lightning provides information about developing storm conditions before hail reaches the ground.

The forecasting system combines lightning detection with radar data, satellite imagery and numerical weather models. It updates every two minutes and can provide up to 60 minutes of warning, giving solar operators additional time to prepare.



Benchmarking hail forecast accuracy

To assess the performance of its approach, researchers conducted a validation study comparing three forecasting methods used to identify severe hail events.

Lightning-based hail forecast: a continuously updated forecast combining lightning data with radar, satellite imagery and numerical weather models. It refreshes every two minutes, providing the probability of severe hail, arrival time, approach direction and up to 60 minutes of lead time.

MRMS MESH 1 inch+: a method using radar data that underpins many commercial hail alerting services. Multi-Radar Multi-Sensor (MRMS) combines data from NOAA's national radar network and other sources. Maximum Estimated Size of Hail (MESH) uses this information to estimate hail diameter. The comparison used a threshold of one inch or greater.

National Weather Service severe thunderstorm warnings: official warnings issued when forecasters determine that a storm meets severe thunderstorm criteria, including hail of at least one inch in diameter and/or winds of 58 mph or more. Each warning contains a hail size and timing estimate that remains in effect for its duration. New warnings may be issued one to three times per hour.

For the validation, researchers examined 3,659 severe hail reports collected by NOAA's Storm Prediction Center between January and June 2026. These reports came from trained weather spotters, sensor networks and public submissions to crowdsourced reporting platforms.

During the first six months of 2026, 68% of utility-scale solar sites across the contiguous United States were within 30 miles of at least one reported severe hail event. The researchers note that reporting is incomplete, particularly in remote areas, so these observations do not represent every hailstorm that occurred.

The 3,659 reports provided observations against which the forecasts could be assessed. Researchers used a buffer extending 30 miles around each reported location to determine whether, and how far in advance, each forecasting method had identified severe hail.

The figures need to be read in the context of the study's methodology. The researchers assessed detection against reported hail events using this geographical buffer, rather than measuring forecast accuracy at every individual solar installation.

Hail forecast accuracy validation results

The validation study found that the lightning-based forecast recorded the highest detection rate of the three methods examined.

Across the first six months of 2026, the system identified 99.2% of the reported severe hail events included in the analysis. National Weather Service severe thunderstorm warnings identified 93.1%, while the MRMS method detected 83.3%.

For solar operators, that difference could mean receiving a warning of an approaching hailstorm rather than having no warning at all.



Justin Deal

In the study, the method using radar data failed to identify approximately one in six reported severe hail events, potentially leaving operators without the warning needed to move their panels into a protective position.

The researchers also compared how much warning each method provided. The lightning-based forecast achieved a mean lead time of 53 minutes, compared with 50 minutes for MRMS and 30 minutes for National Weather Service warnings.

Although the average warning times for the lightning-based forecast and MRMS were relatively close, the radar method showed considerably greater variation. The standard deviation was 28 minutes for MRMS, compared with 13 minutes for the lightning-based system.

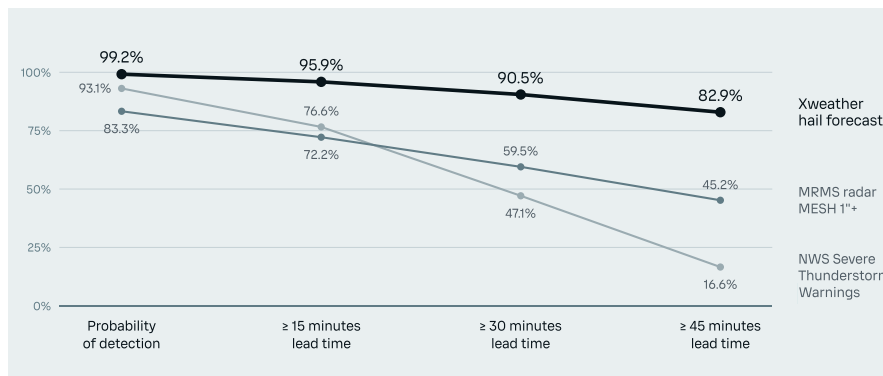
For operators managing automated stow systems, the consistency of warning times can be as important as the average. A forecast that regularly provides sufficient notice makes it easier to establish dependable operating procedures.

In addition, the system provided at least 15 minutes of warning for 95.9% of the reported events, compared with 72.2% for MRMS, a difference of 23.7 percentage points.

The gap widened at longer lead times. The lightning-based forecast provided at least 45 minutes of warning in 82.9% of cases, compared with 45.2% for MRMS and 16.6% for National Weather Service warnings.

Earlier warnings will give operators more time to move their panels into a protective position before severe hail reaches their sites.

Hail forecast performance

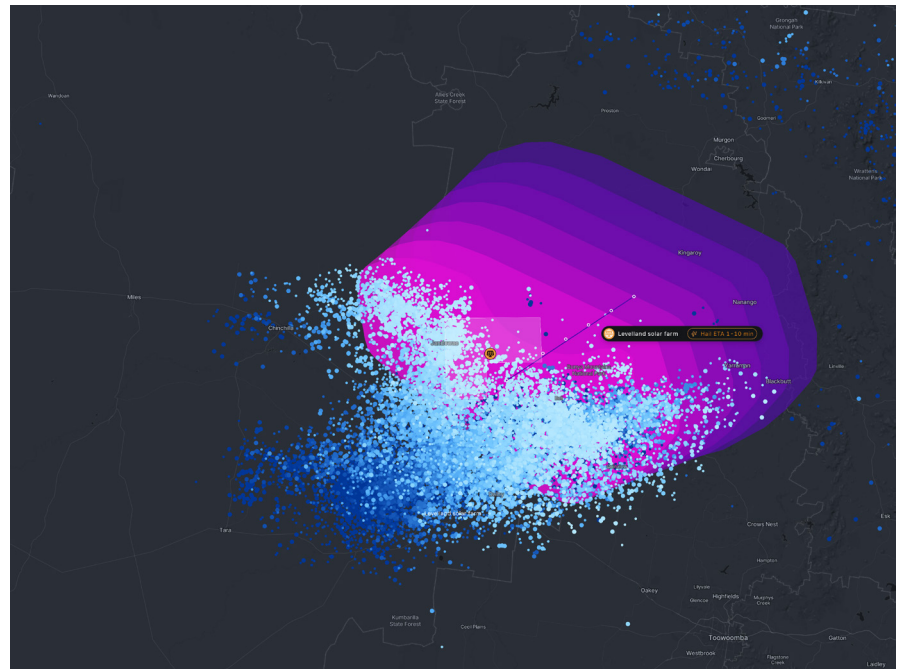


Mean lead time (standard deviation): Vaisala Xweather 53 (13) minutes, MRMS 50 (28) minutes, NWS warnings 30 (15) minutes. Comparison of 3,659 severe hail events reported to NOAA's Storm Prediction Center across the contiguous United States, 1st January to 30th June 2026. Source: Vaisala Xweather validation study

Know when to stow

Accurate hail forecasting becomes particularly valuable when connected to an automated tracker stow system.

Operators can establish a geographical buffer around a solar installation. When the forecast identifies a hailstorm approaching or entering that area, the system generates an alert to



Hail forecast showing storm approach and estimated arrival time. The blue dots mark lightning activity with lighter shades indicating the most recent events

initiate protective stowing. The notification also includes the storm's approach angle and a recommended stow direction.

This reduces dependence on manual weather monitoring and allows operators to respond more consistently to developing conditions. The effectiveness of the response will still depend on the tracker system, its operating procedures and the time available before the storm arrives.

Effective stowing can also reduce the financial impact of hail damage. VDE

the storm, site characteristics and the effectiveness of the protective measures.

Insurers are also taking greater interest in how solar operators manage hail exposure.

According to kWh Analytics, one Texas operator achieved a 72% reduction in its insurance premium after demonstrating a 90% successful stow rate against historical hail events. In Arkansas, a municipal solar project secured a 50% reduction in its severe convective storm deductible after integrating a hail forecasting service with its automated stow system.

These two cases show how effective hail protection can influence insurance terms. However, reductions in premiums or deductibles will depend on individual projects, their claims history and the terms offered by insurers.

For operators, maintaining detailed records of hail alerts, tracker movements and protective actions can help demonstrate how effectively a site responds to severe weather.

When a single hailstorm can cause millions of dollars in damage and leave a solar installation out of operation for months, the quality of weather information matters.

The study found that combining lightning detection with other meteorological data improved the identification of severe hail events and provided more consistent advance warning.

For solar operators, every additional minute of warning can make a difference. Combined with appropriate tracker technology and established stow procedures, more accurate forecasting can help reduce hail damage and protect solar installations.

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