MOODY'S

Insurance Solutions

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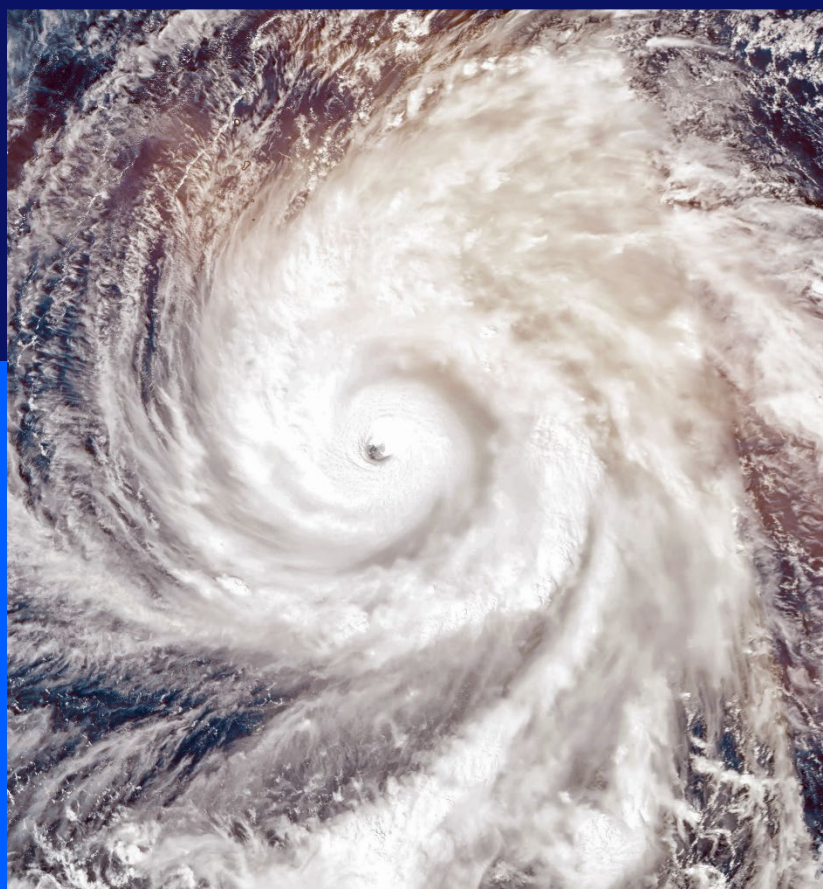
Unlocking risk differentiation in hurricane modeling

How AI-powered property intelligence reveals growth opportunities in hurricane-prone regions



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1. ABSTRACT

Moody's RMS™ Catastrophe Models assess property-level risk and use building and site details to help improve risk assessment and reduce uncertainty. Insurance submissions typically include primary characteristics such as construction class, occupancy type, year built, and number of stories. However, the secondary modifiers that often drive meaningful loss differentiation — including roof age, roof geometry, cladding material, and tree density — are less commonly present, often incomplete, and sometimes unreliable. When these gaps persist across a portfolio, the consequences compound, including mispriced risk, misallocated capital, and business decisions that default to broad geographic or class-level assumptions rather than property-level insight.

This data gap matters now more than ever. After several years of rate increases driven by elevated severe convective storm losses and reduced capacity, the property catastrophe market is softening, with rates moderating, capacity returning, and carriers actively seeking growth. In this environment, the ability to distinguish which properties are higher risk and which are lower risk can shape who grows profitably and who accumulates exposure without sufficient visibility. This paper presents the results of a study in which Moody's analyzed more than 1 million US residential properties, running Moody's RMS™ North Atlantic Hurricane Models first with primary characteristics only, then with secondary modifiers added through AI-powered Exposure Enrichment from Moody's CAPE Property Intelligence.

The results show that when catastrophe models receive the site-level detail they were designed to use, properties that appeared identical under primary-only data separate into distinctly higher- and lower-risk profiles. For hurricane, a home in Fort Myers, Florida, built in 1988 — one that a year-built underwriting guideline may exclude — shows a 53% decrease in modeled loss when enrichment reveals a recently replaced roof and favorable structural geometry. For carriers, this reshuffling can materially affect underwriting strategy. For reinsurers, it can reveal whether a cedant's book is composed of well-maintained properties or deteriorating stock — a distinction invisible in aggregate metrics. For brokers, it provides objective evidence of portfolio quality that can strengthen placement negotiations. Beyond changes in mean modeled loss, Exposure Enrichment reshapes how loss is distributed across individual locations, with implications for portfolio concentration and tail behavior that are not visible in aggregate summaries alone.

"Unlocking risk differentiation in hurricane modeling: How AI-powered property intelligence reveals growth opportunities in hurricane-prone regions" will be the second of three white papers. Each white paper delivers analysis on how Moody's Exposure Enrichment influences modeled outcomes, revealing distinct insights into market dynamics and peril risk. In addition, each paper presents case studies that show how Exposure Enrichment supports more precise risk differentiation.

2. INTRODUCTION

2.1 The data gap in catastrophe modeling

At Moody's, we designed our catastrophe models to assess risk at the individual property level by using detailed building and site characteristics while also accommodating locations with limited building-specific information. However, when secondary modifiers such as roof age, roof condition, roof geometry, roof material, rooftop equipment, cladding material, and tree density are included in exposure data, the models can produce more precise, defensible loss estimates with reduced uncertainty.

Collecting these attributes through manual inspection is not always possible at the scale required, and site survey data can age quickly. For carriers, this creates a practical problem. Without the data to distinguish between better and worse risks at the property level, business decisions default to broad geographic or class-level assumptions, and the risk differentiation the models can provide remains inaccessible. In practice, secondary modifiers are often populated only for select locations, creating inconsistent exposure treatment across the portfolio and limiting trust in the resulting modeled differentiation.

2.2 Market context: Why property-level differentiation matters now

The property catastrophe market is at a turning point. After several years of hardening, driven by elevated loss activity — including 25 US landfalling hurricanes from 2016 to 2024 — reduced capacity, and corrective rate action, carriers now face a different set of pressures. Rates are changing, capacity is returning, and reinsurance costs have come down. After a relatively benign 2025 loss year, due in part to no US hurricane landfalls, primary carriers have room to grow, and many are actively looking to do so. Insurers can respond to a softening market by using tools that support greater accuracy and precision, while others may rely on traditional blunt underwriting guidelines. Blanket restrictions, such as no new business near the coast, minimum year-built thresholds, and broad geographic exclusions, can exclude good risks alongside bad ones.

Competitors able to evaluate individual properties using observable physical characteristics can assemble portfolios with more favorable underlying risk, whereas less discerning approaches allow vulnerability to accumulate unnoticed. Over time, these effects compound at the portfolio scale, influencing growth strategy, capital efficiency, and how risk concentrates across regions and perils. Solutions that provide objective, up-to-date, property-level data support this shift by allowing consistent risk assessment across catastrophe modeling, portfolio management, and underwriting workflows, helping carriers pursue disciplined growth while avoiding indiscriminate exposure accumulation.

2.3 Who this paper is for

This paper presents findings relevant to multiple roles across the risk transfer chain:

- → **For primary carriers —** The findings show how enriched property data supports more informed underwriting selection at the individual location level, allowing competitive pricing on well-characterized risks and flagging elevated exposures before binding. That location-level discipline compounds into a portfolio-level advantage.
- → **For reinsurers —** The analysis provides a framework for assessing cedant portfolio quality beyond aggregate metrics. A cedant whose portfolio skews toward well-maintained properties with recently replaced roofs represents a fundamentally different risk than one with older, deteriorated stock, even if their aggregate metrics look similar.
- → **For brokers —** Objective, enriched property data moves the conversation from "we believe our book is high quality" to "here is the data that demonstrates it."

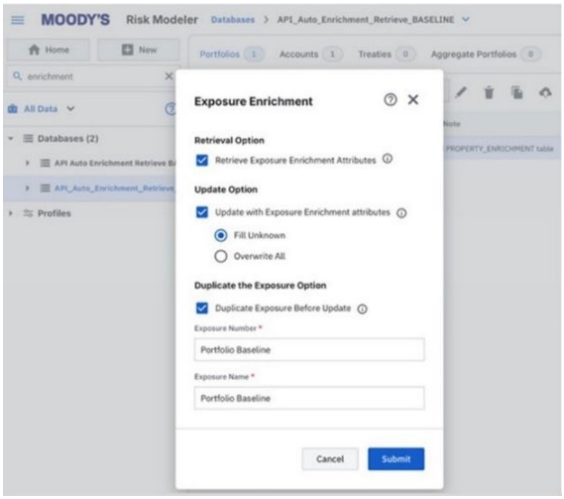
Across all these market segments, catastrophe modeling and portfolio analytics teams play a critical role in interpreting modeled results. For these users, enriched exposure data improves

attribution, stability, and confidence in modeled outcomes by tying loss differentiation directly to observable building characteristics rather than implicit assumptions.

3. THE SOLUTION: MOODY'S EXPOSURE ENRICHMENT

Moody's Exposure Enrichment, part of our Enhanced Risk Data solution, uses AI and aerial imagery to extract key property characteristics, which are then mapped to model-compatible inputs. Available across Moody's Intelligent Risk Platform™, it combines Moody's CAPE Property Intelligence with our catastrophe models to provide the property-level detail that unlocks the differentiation the models were built to deliver with objective, high-resolution data.

Image 1: Exposure Enrichment in Moody's Risk Modeler™



This alignment supports consistent decision-making across underwriting, portfolio analytics, and risk management teams by driving modeled differentiation through shared, transparent inputs.

The solution delivers three distinct advantages:

- → **Flexibility:** Moody's CAPE-derived property characteristics integrate across all locations in a given portfolio, regardless of its size, supporting fast and efficient analysis at portfolio scale. The case study in this paper analyzes 1 million properties across three perils, the kind of scale that manual inspection or survey-based approaches cannot achieve.
- → **Data quality:** Moody's CAPE Property Intelligence derives building and site characteristics from high-resolution aerial imagery, capturing attributes that are objective, current, and independently verifiable. Roof condition, vegetation proximity, cladding type, and structural geometry are observed as they exist today, not as they were recorded at binding or reported by a broker.
- → **Alignment across workflows:** Enriched attributes are formally mapped to the secondary modifier inputs that each Moody's RMS™ Model is calibrated to use. This preserves the integrity of the modeled output and bridges the gap between the data available at the point of underwriting and the data the models need to differentiate risk. Applying enriched secondary modifiers consistently across the full portfolio, rather than selectively across individual high-value risks, reduces bias introduced by partial data capture and supports greater confidence in modeled results across underwriting and risk transfer workflows.

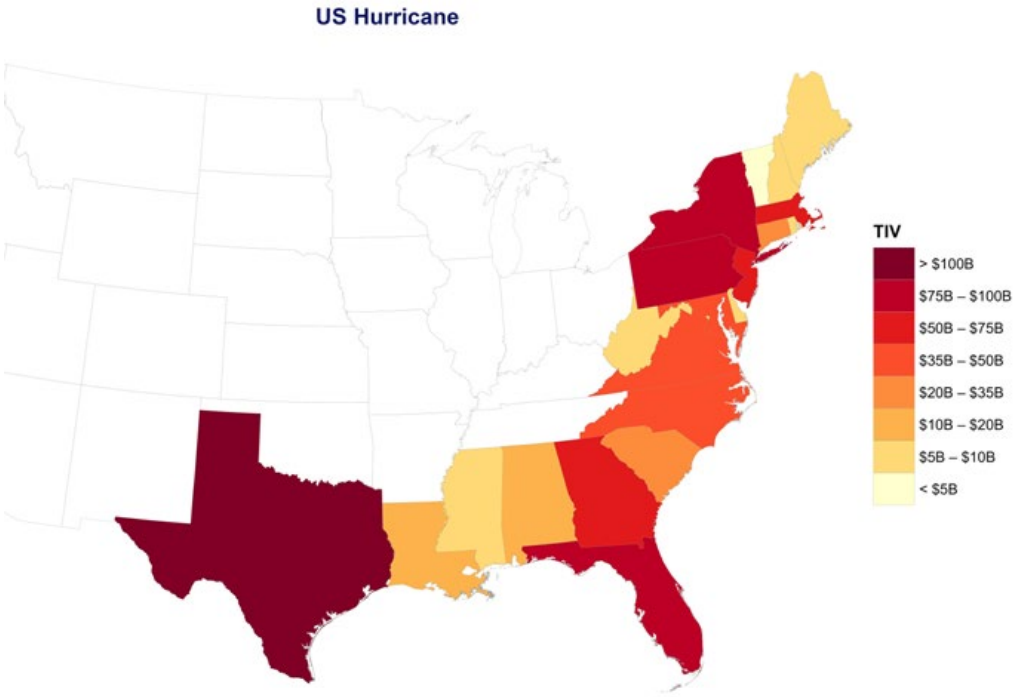
When the model receives the property-level detail it was designed to use, risk differentiation emerges that was available in the model's architecture but not accessible without the data.

4. METHODOLOGY

4.1 Dataset and approach

In this white paper, Moody's analyzed more than 1 million US residential properties using Moody's RMS™ North Atlantic Hurricane Models. We ran the models with only known primary characteristics — construction class, occupancy type, year built, and number of stories — and then reran them with a combination of key secondary modifiers populated through Exposure Enrichment. In both runs, all primary characteristics were held known and constant; only the secondary modifiers changed. Holding a fully populated primary baseline means the resulting change in modeled loss reflects the contribution of the enriched secondary modifiers. Although Exposure Enrichment populates both primary and secondary characteristics, this paper isolates the impact of secondary modifiers only — the attributes that often move a property away from the average assumption, significantly reshaping risk at the location level and, in aggregate, across the book.

Figure 1: Total insurable value (TIV) by state for the sample portfolio



4.2 Defining material change

In this paper, we define "material change" as a shift of more than 15% in either direction in modeled average annual loss (AAL) when enriched data is applied. An increase means the model identifies characteristics that place the property above the average assumption of risk, and a decrease means the model identifies characteristics that place it below. Neither direction is

inherently good or bad; what matters is that the model can now distinguish between properties that were previously treated the same way.

Exposure Enrichment has a distinct impact on each model because the underlying building stock interacts uniquely with each hazard. In every case, the aggregate change conceals a far more consequential reshuffling at the location level — properties where filling in the known unknowns reveals risk that was previously indistinguishable from neighboring properties.

4.3 Limitations

This study analyzes a portfolio of 1 million US residential properties with exposure relevant to all three perils. The results presented here reflect the characteristics of this specific portfolio — the direction and magnitude of impact will vary for any given carrier depending on how their book skews by geography, construction mix, and building age. For stakeholders interested in understanding how Exposure Enrichment impacts their specific portfolio, Moody's provides the data, model mapping, and analytical support to conduct a tailored analysis available across the Intelligent Risk Platform.

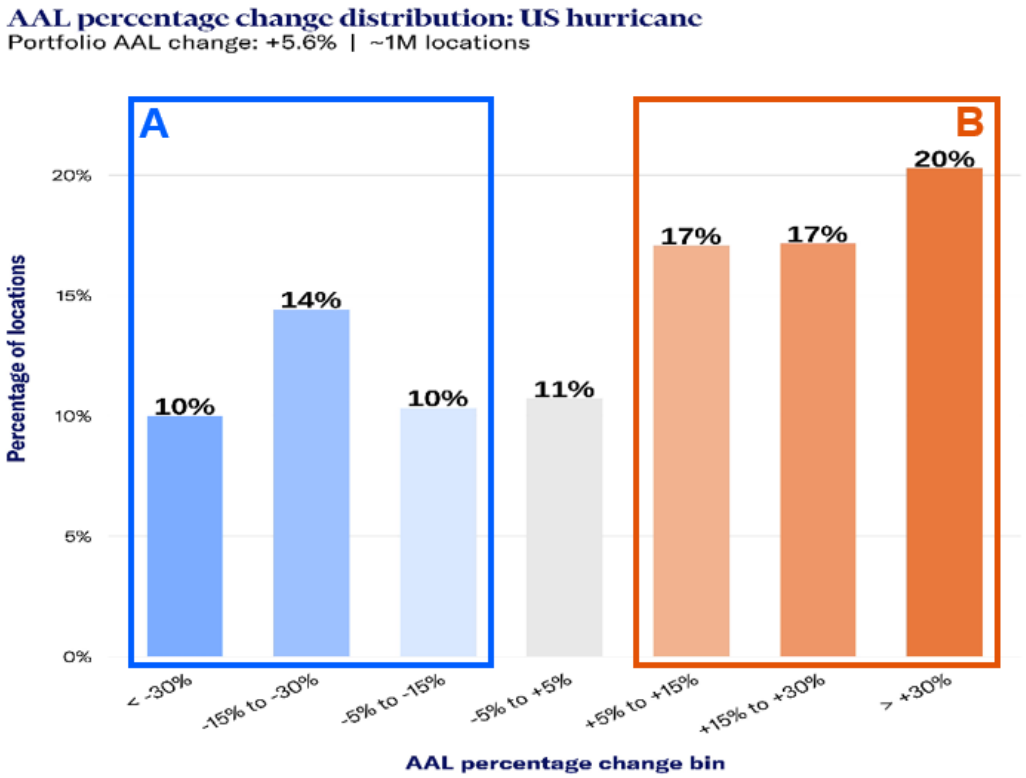
5. KEY FINDING: IMPROVED BUILDING CONSTRUCTION PRESENTS GROWTH OPPORTUNITIES IN HURRICANE REGIONS

5.1.1 Portfolio-level impact

In this study, we selected five key secondary modifiers — roof age, roof geometry, roof system, appurtenant structures, and cladding system — populated through Exposure Enrichment. When applied across the portfolio, enrichment produces a moderate net AAL increase of 6% for this portfolio, reflecting risk that was previously invisible under baseline assumptions while generally reinforcing the robustness of the model default calibration at an aggregate level.

The portfolio-level number, however, tells only part of the story. Nearly two-thirds of the portfolio — 618,694 properties — experience material AAL changes greater than ±15%: 244,214 see decreases as enrichment identifies lower risk (Segment A, Figure 2), and 374,480 see increases as enrichment reveals higher risk (Segment B, Figure 2). Properties with better-than-average building characteristics see modeled losses decrease, supporting more competitive pricing opportunities. Properties where enrichment surfaces older roofs, vulnerable cladding, or exposed geometries see modeled losses increase, allowing carriers to reassess before binding. Under primary-only data, these two groups were largely indistinguishable. This reshuffling matters because it changes how loss is distributed across individual locations, influencing portfolio concentration and tail behavior even when aggregate metrics appear stable.

Figure 2: Location-level AAL percentage change distribution in Moody's RMS North Atlantic Hurricane Models across 1 million locations

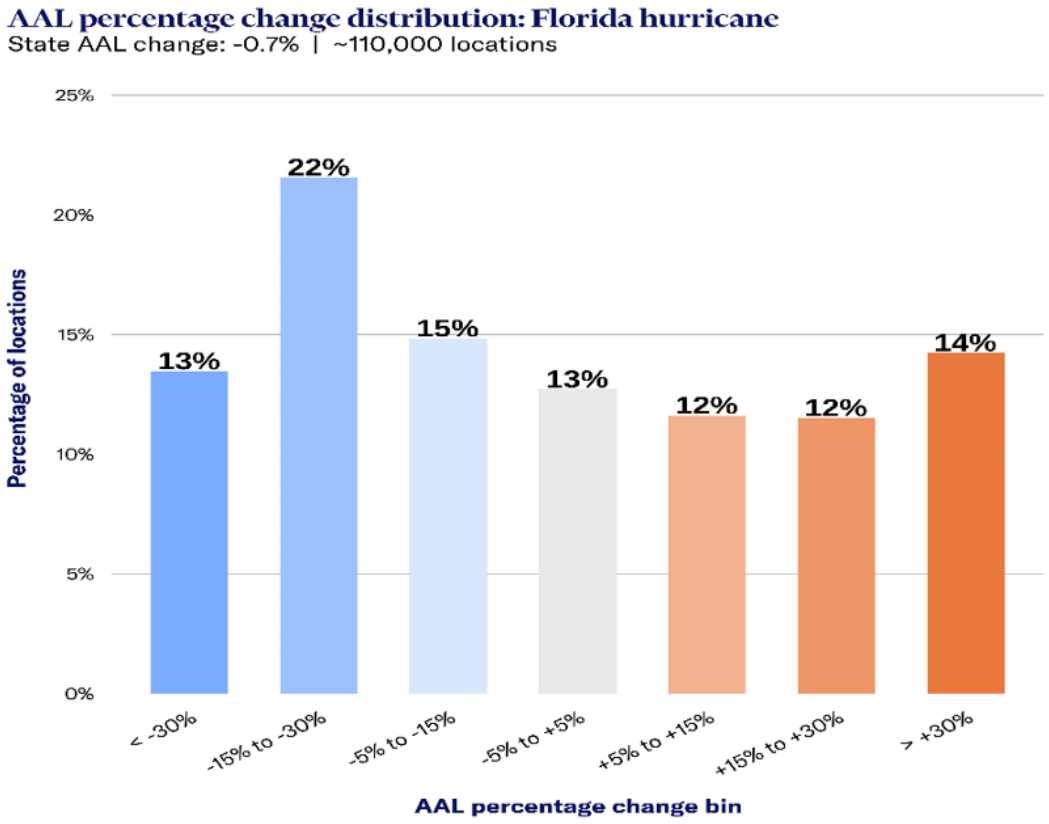


5.1.2 Enrichment analysis: Florida

Florida has experienced more than 10 landfalling or bypassing hurricanes since 2016, including Irma (2017), Michael (2018), Ian (2022), Helene (2024), and Milton (2024). Post-event analysis consistently shows the same pattern: buildings constructed or renovated to current code with wind-rated materials perform significantly better than older structures with aged roofs and vulnerable cladding. Roof performance is the dominant driver of wind claims — below design wind speeds, most insured losses relate to roof damage. This is why roof age has one of the largest impacts on modeled loss differentiation of the five enriched modifiers: in areas affected by recent hurricanes, damaged roofs have been replaced, and Exposure Enrichment captures this through current aerial imagery.

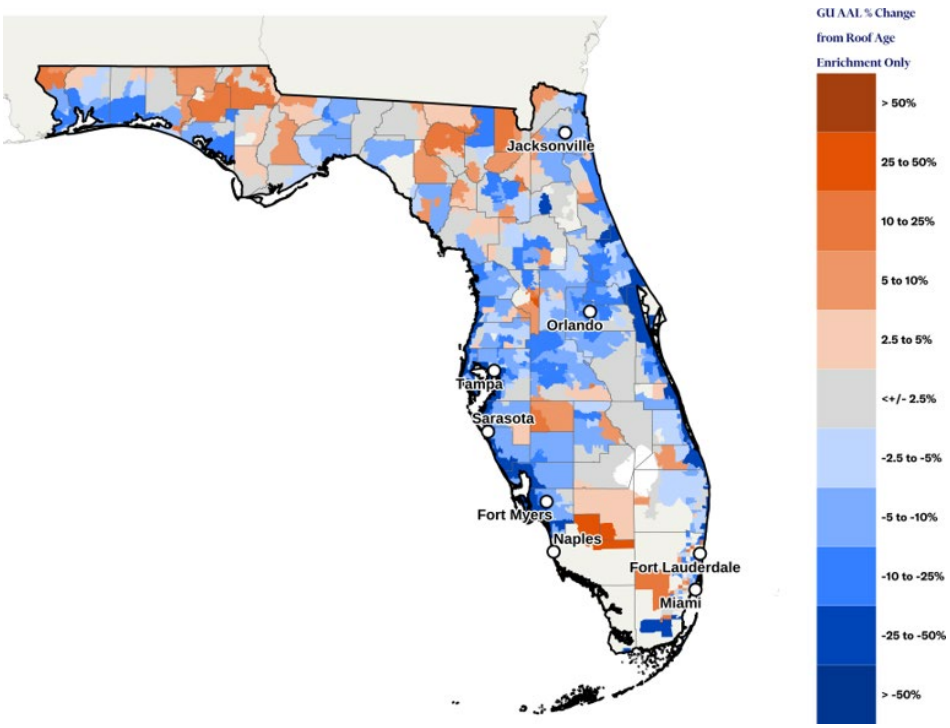
At the state level, Florida's total AAL change remains flat — less than 1% — when all five enriched secondary modifiers are applied together, reflecting a combinatorial effect in which location level increases and decreases partially offset one another (Figure 3). However, the distribution beneath this headline result shows substantial reshuffling, with properties moving in both directions as enrichment distinguishes between homes and roofs that have been rebuilt and those that have not. This pattern indicates that the model is responding to the physical characteristics that drive hurricane vulnerability, supporting meaningful location level differentiation even when aggregate results appear stable.

Figure 3: Florida location-level percentage change distribution (combination of all five enriched secondary modifiers)



To isolate and highlight the effect of roof age, Figure 4 shows the postal code-level AAL change when roof age alone is enriched relative to a primary-only portfolio. In this roof age-only view, Florida's portfolio-level AAL decreases by approximately 15%, reflecting the extent to which up-to-date roof replacement information reshapes modeled hurricane risk.

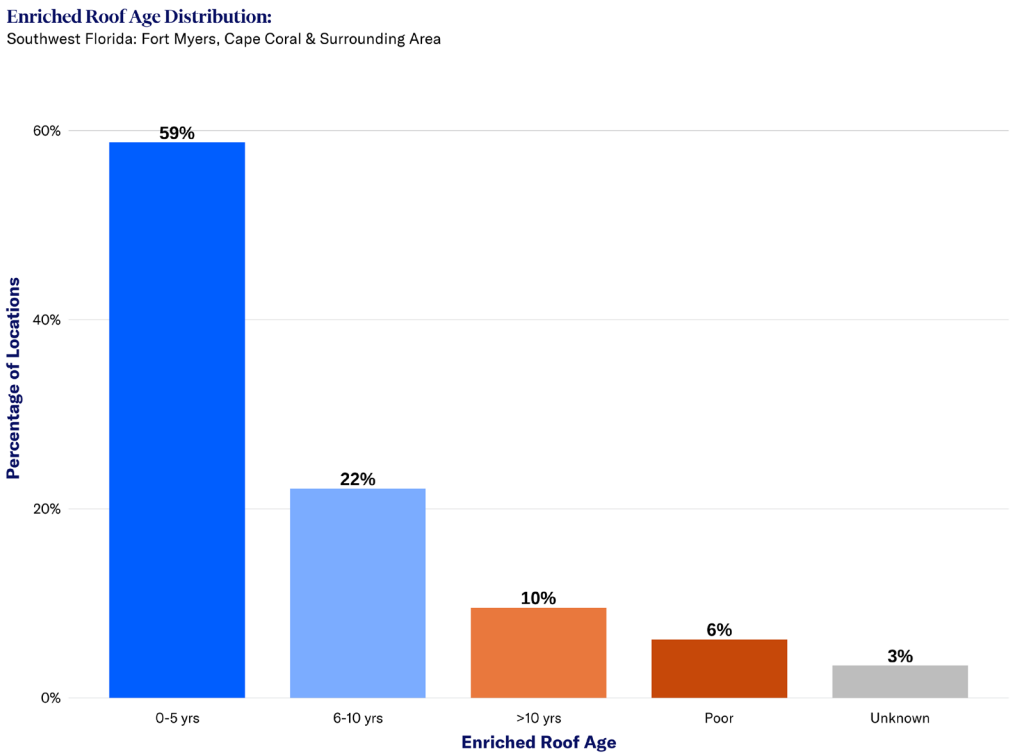
Figure 4: Postal code AAL percentage change across Florida from roof age enrichment only relative to a primary only portfolio



A clear spatial pattern emerges in the roof age only results: many coastal postal codes exhibit the largest modeled AAL decreases, with some ZIP codes showing reductions exceeding 25% (Figure 4). This pattern is consistent with concentrated roof replacement and rebuilding activity along hurricane affected coastal corridors, while inland areas show a more mixed response reflecting a combination of newer development and locations where older roof stock persists. Postal codes inside Hurricane Ian's landfall corridor near Fort Myers show the strongest credits, consistent with post-event rebuilding. Credits elsewhere in the state reflect newer building stock from different sources: areas like The Villages corridor west of Orlando show new construction driven by population growth and residential development, built to current code with modern materials. Where increases appear — particularly in parts of southeast Florida and some inland areas — they reflect locations where enrichment identifies older roof stock that has not been renewed by recent storm events or new construction. Enrichment captures both: whether the roof is new because it was replaced after a hurricane or because the building was recently constructed, the model responds to what is there today.

In southwest Florida, where Hurricane Ian made landfall in 2022, imagery derived roof characteristics captured in late 2025 indicate that approximately 60% of residential locations in the Fort Myers and Cape Coral area have roofs estimated to be less than five years old. This pattern is consistent with widespread post storm reconstruction and roof replacement activity following recent major hurricane events, and it drives some of the strongest modeled AAL credits observed in the portfolio.

Figure 5: Sampled enriched roof age distribution in the Ian landfall area captured in late 2025

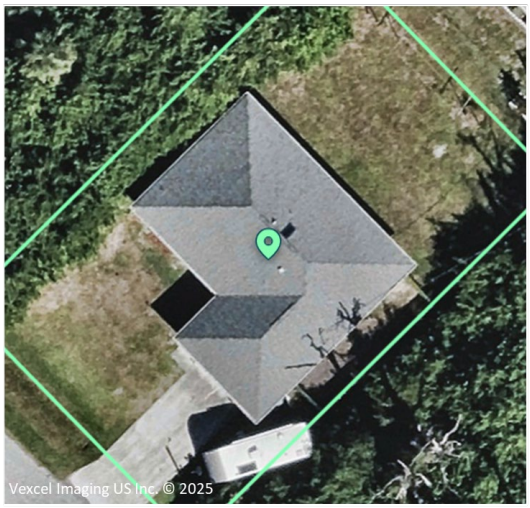


For carriers evaluating re-entry into coastal wind markets, this pattern has direct implications. A common approach is to apply blanket underwriting guidelines — no properties built before 2000, or no properties within a certain wind zone. These filters are simple to implement but blunt, excluding renovated, resilient properties alongside older, more vulnerable ones. Rather than filtering by vintage alone, a carrier can evaluate the actual building characteristics: Has the roof been replaced? Is the geometry hip or gable? Is the cladding wind-resistant? Year built cannot answer these questions. Enriched property characteristics can, and the distinction matters.

5.1.3 Case study: Fort Myers — what post-event rebuilding looks like in the data

A single-story home in Fort Myers, built in 1988, carries a high baseline loss cost under primary-only data. Under a year-built underwriting guideline, this property might be excluded or penalized. But enrichment reveals a home that has been re-roofed with high-wind shingles and has hip geometry — resilient building characteristics that current aerial imagery captures and a year-built filter would miss entirely. When these secondary modifiers are provided to the model, modeled loss decreases by 53% (Figure 6).

Figure 6: Fort Myers property — built 1988, modeled loss decreases 53% with enrichment



Attribute	Value
Roof age	0-5 years (recently replaced)
Roof geometry	Hip roof (slope </=6:12)
Roof system	High-wind rated shingle
Appurtenances	None
Floor area	1,359 square feet
Number of stories	1

AAL decrease (-53%)

The year built has not changed, but the building vulnerability has. For carriers relying on year built alone, this property is indistinguishable from an unrenovated home of the same vintage in the same neighborhood. For firms using Exposure Enrichment, it is identifiable as a competitive opportunity.

6. LOOKING AHEAD: ROAD MAP FOR ENHANCED RISK DATA AND EXPOSURE ENRICHMENT

Exposure Enrichment is one part of Moody's broader Enhanced Risk Data offering on the Intelligent Risk Platform. Enhanced Risk Data brings together two complementary types of model-ready data for underwriting and portfolio risk management: hazard data across perils including hurricane, flood, wildfire, and earthquake, and exposure data delivered through Exposure Enrichment, the capability discussed in this paper. Enhanced Risk Data is continually strengthened through model updates, new attributes extracted from aerial imagery and other data sources, and enhancements to platform applications such as Moody's Risk Modeler™, ExposureIQ™, and UnderwriteIQ™. Within that offering, Exposure Enrichment today delivers residential property attributes in the US, enriching the secondary modifiers used by the US severe convective storm and hurricane models. From here, the Exposure Enrichment road map expands along three dimensions.

- → **Occupancy:** From residential to commercial properties in the US
- → **Peril:** Bringing aerial-imagery-based enrichment to more catastrophe models, including wildfire, flood, and earthquake
- → **Geography:** Extending beyond the US to Canada, Australia, New Zealand, and Europe

7. CONCLUSION

7.1 Cross-peril synthesis

Across both Exposure Enrichment white papers, a consistent pattern emerges: The secondary modifiers with the greatest impact on modeled loss — roof age for hurricane and roof condition for severe convective storm — are also the attributes most likely to change over time and most objectively measurable through modern aerial imagery. Roofs age or get replaced. Vegetation grows or is cleared. Cladding deteriorates. As a result, the physical characteristics driving loss today may differ materially from those captured when exposure data was originally collected.

This dynamic creates challenges across portfolio management, catastrophe modeling, and risk management workflows when analyses rely on static exposure data that is infrequently refreshed. When modeled results reflect averages or assumptions that no longer align with current building conditions, it becomes difficult to attribute changes in loss to observable drivers on the ground. This is particularly important for severe convective storm risk, where high frequency, lower severity events can compound small and medium sized losses into material impacts on (re)insurance balance sheets.

Moody's CAPE Property Intelligence addresses this by deriving current building characteristics from aerial imagery, providing an objective, repeatable view of the building stock as it exists today. By enriching exposure data used in catastrophe modeling and portfolio analysis, this helps provide a more consistent and explainable assessment of risk across workflows, supporting informed portfolio strategy, capital decisions, and underwriting actions within applications on the Moody's Intelligent Risk Platform, such as the ExposureIQ, Risk Modeler, and UnderwriteIQ tools.

7.2 Relevance across the risk transfer chain

The findings in this paper demonstrate that when catastrophe models receive the secondary modifiers they were designed to use, properties that appeared identical under primary only exposure data separate into distinctly higher and lower risk profiles. Crucially, this differentiation is most meaningful when enriched attributes are applied consistently across the full portfolio rather than selectively across a subset of locations. In many existing workflows, secondary modifiers are captured only for perceived high risk or high value locations, or primarily when they generate mitigation credits. This selective coding can bias portfolio results and reduce confidence in the modeled output, particularly in risk transfer discussions.

- → **Carriers** can update their underwriting rules using enriched information on underlying physical risk, pricing competitively where enrichment reveals favorable profiles and exercising caution where it does not. Over time, portfolios assembled and actively steered through enrichment informed decisions exhibit measurably different risk characteristics in terms of concentration, volatility, and resilience.
- → **Reinsurers** can benchmark cedant portfolio quality with objective exposure characteristics rather than selective, biased coded modifiers or aggregate metrics alone. A portfolio enriched systematically across all locations provides a clearer view of underlying vulnerability, concentration, and resilience, supporting greater confidence in cedant submissions and more transparent risk transfer discussions.
- → **Brokers** can substantiate portfolio quality with verifiable, enriched data, demonstrating to markets that a book has been objectively characterized. For carriers, reinsurers, and brokers alike, the value is the same: systematically enriching the full portfolio reduces uncertainty and grounds risk transfer discussions in complete, unbiased data that identifies both credits and penalties. It delivers not just data, but model-ready intelligence applied consistently across every location.

7.3 Call to action

The findings in this paper are based on a single portfolio of more than 1 million US residential properties. The direction and magnitude of impact will vary depending on each carrier's portfolio composition, geographic footprint, and building stock mix. The patterns identified here represent signals within this specific book, not universal prescriptions.

For industry participants looking to understand how enriched data impacts their own portfolios, Moody's Exposure Enrichment — now available on the Intelligent Risk Platform — can help users enhance residential portfolios, reduce uncertainty, and improve their catastrophe modeling outcomes by leveraging CAPE-enriched property data and formal model mapping.

To discuss a portfolio-specific assessment or learn more about Exposure Enrichment, contact us.