

WHITE PAPER

NRF National
Retail
Federation



CLIMATE-PROOFING RETAIL

PROACTIVELY MANAGING THE OPPORTUNITIES
AND RISKS OF WEATHER VOLATILITY

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INTRODUCTION

The climate and, more specifically, the variability of weather conditions that materialize from it, have always added complexity to retail operations. But recently, changes in the climate have accelerated and been more pronounced, as evidenced by record-warm global temperatures and a growing frequency of extreme weather events.

Climate change and the increase in both the severity and the unpredictable nature of weather, in turn, has significant ramifications for retailers on multiple fronts, including:

- Sales – store traffic and demand for specific products often shift due to changing weather.
- Infrastructure – negative weather impacts can force stores or distribution centers to close.
- Supply Chains – weather can affect the cost of products, ports, and shipping routes.

As recent events have shown, sudden weather events can shut down power grids or force city-wide closures, straining retailers' own infrastructure or resulting in temporary closures of stores or distribution centers. And weather events in any part of the world can have wide-ranging implications for the global supply chain, raising the costs for both retailers and consumers and delaying products for days, weeks or even months. And, of course, there is the impact on sales.

According to research published by the American Meteorological Society, an average of 3.4% of retail sales are directly affected by changes in the weather each year. Applying this globally means the weather alone influences about \$1 trillion in retail sales annually.

The weather alone influences about \$1 trillion of global retail sales annually.

Weather volatility is the most impactful climate-related risk retailers face today. After all, no other external factor influences consumer demand as frequently, directly, or meaningfully as changes in the weather. Every day, the weather shapes people's decisions: from the clothes they wear to the activities they pursue, from what they eat and drink to the chores they decide to tackle, and much more.

This paper is a collaboration between the National Retail Federation (NRF), the world's largest retail trade association, and Planalytics, the leading provider of weather-driven demand analytics. While climate change is presenting the industry with significant infrastructure, supply chain, and sales risks, this report will focus on how a changing climate and increasing weather volatility influence retail sales and the practical steps individual companies can take to manage the related opportunities and risks.

The National Oceanic and Atmospheric Administration (NOAA) defines climate as 'the average of the weather patterns in a location over a longer period of time, usually 30 years or more' while the weather is 'the state of the atmosphere at a particular location over the short-term'.

CLIMATE, WEATHER VOLATILITY AND CONSUMER DEMAND



There is nothing permanent except change.

— Heraclitus, Greek Philosopher

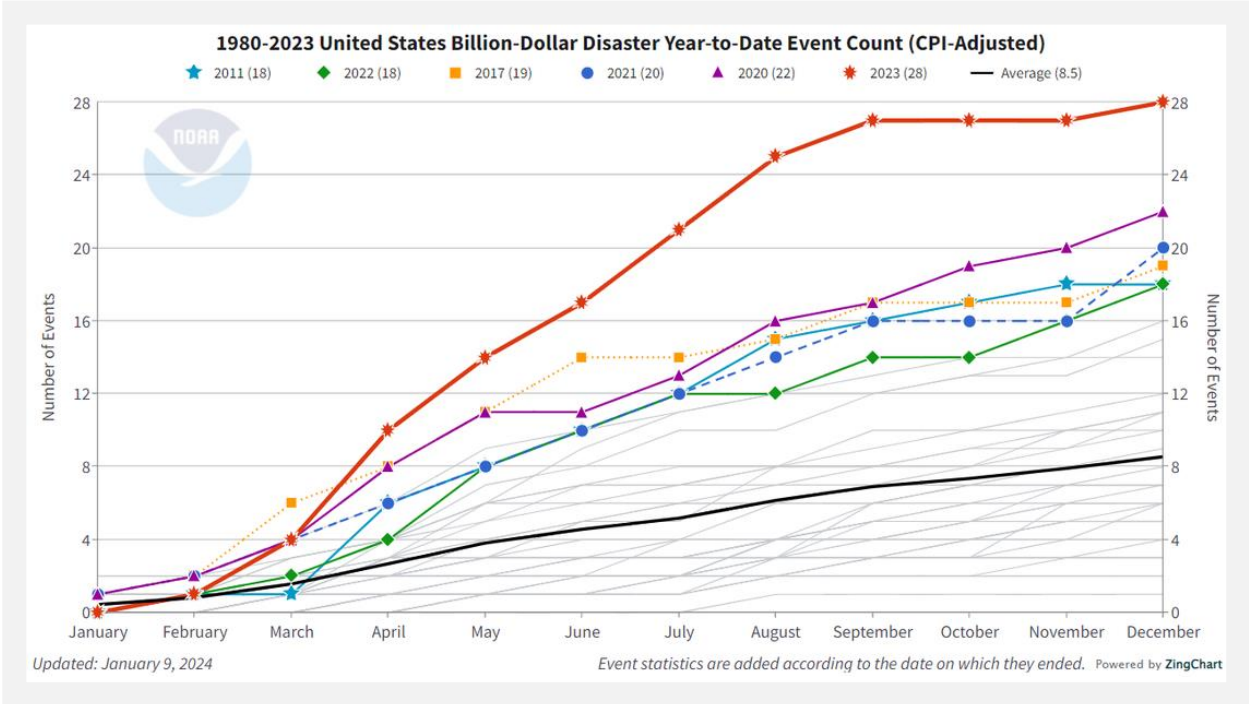
Currently, the climate is changing at a faster pace than at any other point in human history. While the changes in climate are difficult to observe on a day-to-day basis, climate change is disrupting weather patterns, including increasing storm frequency and intensity. These changes in weather patterns have impacts on retail sales that are predictable, measurable, and manageable.

The graphic below highlights some recent climate and weather volatility trends.



Major storms and extreme events are typically the first thing retailers map to when considering the weather's business impacts. The frequency and severity of these events have risen notably in recent years. As of 2023, weather events with economic impacts of at least \$1 billion (Consumer Price Index-adjusted) now happen every three weeks compared to once every four months in the 1980s. The National Oceanic and Atmospheric Administration (NOAA) noted 28 separate weather and climate disasters in 2023 that cost at least \$1 billion dollars, a record for the U.S. in a single calendar year.

INCREASING FREQUENCY OF EXTREME WEATHER EVENTS



Source: [NOAA, National Centers for Environmental Information](https://www.noaa.gov)

Excessive heat waves, deep freezes, severe floods, frequent hailstorms, widespread tornadoes, stronger tropical cyclones, and other extreme weather events, although typically short in duration, often have significant effects on communities and commercial activity.

Store traffic and the sales of specific products can dramatically increase or decrease before, during, and after extreme weather events, and the impacts often vary across different retail segments. Depending on the type of extreme weather and the severity of the situation, retailers may benefit from demand spikes, suffer lost sales, or see sales pulled forward or delayed.

OPPORTUNITIES AND RISKS EXAMPLES



ACCELERATED SALES

For need-based consumables

- Supermarkets, mass merchants, and drug stores often benefit from elevated traffic and sales in the days just before and after an extreme weather event
- Sales are pulled forward due to “pantry loading” of food and other necessities pre-event
- Although there can be some replenishing of staple items post-event, sales tend to return to normalize quickly, typically within days



INCREASED SALES

For pre-event preparation items and/or post-event recovery

- DIY stores can capture additional pre-event sales when consumers buy products such as ice melt, plywood, batteries, and more to prepare for extreme weather
- Sales can increase post-event as shoppers focus on clean-up, repairs, or buying replacement products and, depending on the degree of damage, sales gains can be significant weeks or months later due to unplanned spending on costly durable goods purchases



LOST SALES

Due to missed transactions

- Restaurants, gas stations, and event venues can all suffer a drop in sales that are not recovered later
- Daily coffee runs or the normal dinners out generally rebound within a few days, but the missed transactions are never made up. Similarly, one less gas fill-up or the extra discretionary purchases consumers fail to make because a canceled concert or sporting event, can all result in permanently lost revenue for retailers



DELAYED SALES (POTENTIALLY LOST)

For discretionary items

- Clothing stores, home décor stores, and other specialty retailers are often deprioritized as shoppers focus on need-based purchases
- These discretionary purchases are usually only delayed, and business returns to normal within a few days or a week or two
- While sales can generally be made up, there is the potential risk for lost sales if consumers must direct their budget to major unexpected repairs, or if it is late in the season, delayed sales can become lost sales and markdowns can erode margins

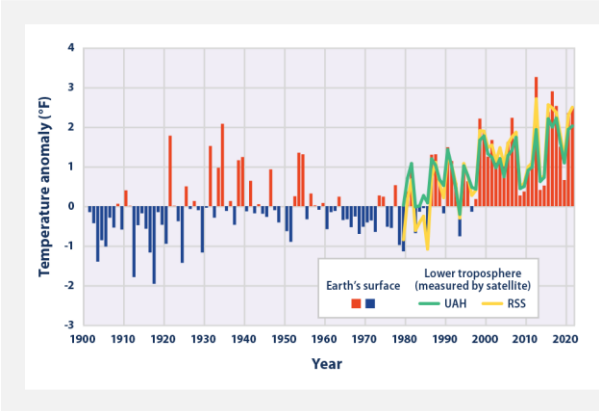
CLIMATE-PROOFING RETAIL

While extreme weather events are undoubtedly important, everyday weather changes have the greater impact on retail performance. In fact, Planalytics’ detailed analysis across tens of thousands of different products indicates that over 90% of weather-based sales volatility results from day-to-day changes in temperature and precipitation.

NOAA’s data confirms that the U.S. is warming overall, with average temperatures in the contiguous 48 states rising more rapidly in recent decades. Nine of the top 10 warmest years on record have been recorded in the last 25 years.

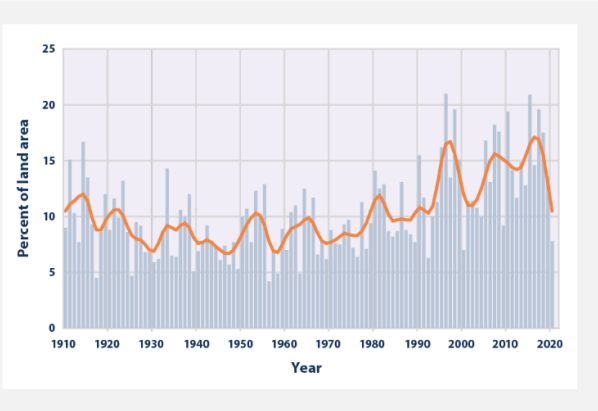
From a precipitation standpoint, we are experiencing more powerful rain and snow events. For most of the 20th century, NOAA reports that the prevalence of extreme single-day precipitation events was fairly steady. These instances have become more common in the last 40 years, with nine of the top 10 years having occurred since 1996.

TEMPERATURES IN THE CONTIGUOUS U.S. 1901-2021



Source: [U.S. EPA](#)

EXTREME ONE-DAY PRECIPITATION EVENTS IN THE CONTIGUOUS U.S. 1910-2020



Source: [U.S. EPA](#)

Increasing weather volatility has, at times, manifested itself in larger and more abrupt demand swings. With dramatic fluctuations between hot and cold extremes, the phrase “weather whiplash” has become more common. As an example, Denver has had frequent instances of freezing temperatures and snowfall followed by temperatures over 60°F within a day or two. Rapid reversals in weather conditions happen in regions around the U.S.; when they do, consumer demand patterns tend to pivot just as quickly.

In analyzing historical weather-driven demand (a measurement of how much the weather alone influences demand), Planalytics has noted growing sales volatility in many categories and regions. Below are just a few examples where the magnitude of weather-driven demand fluctuations has increased over the last decade:

- Weather-driven demand volatility for snow shovels increased 28% for the U.S. overall
- Weather-driven demand volatility for fans increased 30% for the U.S. overall
- In the U.S. Southwest region, demand variances due to the weather have increased for winterwear, heaters, and other cold weather categories, as well as for summertime products such as air conditioners and pool chemicals
- In the U.S. Northwest and South-Central regions, the influence of weather on restaurant traffic levels has grown more pronounced

Increasing sales volatility is not only showing up for seasonal products as some food and other consumer staples are also demonstrating increased weather-driven demand volatility. For example, weather-driven volatility has grown in the Southwest for categories including beer, salads, and tortilla chips and, in the Northeast and Southeast, demand for cleaning products has become increasingly more volatile to changes in the weather.

The bottom line is that staying a step ahead of consumer demand is not getting any easier for retailers as the climate continues to evolve. People adapt as they acclimate to their environments and the weather continually moves consumers in and out of their comfort zones and guides their activities and purchasing decisions.

Retailers have long acknowledged and referenced the impact of weather on store and website traffic and the demand for specific products. **However, climate risk and weather-related sales volatility remain the least understood, the least measured, and the least acted upon external factors affecting retail performance.**

The good news is that retailers now have access to detailed consumer data and advanced analytics, including emerging artificial intelligence (AI) and machine learning (ML) capabilities, to understand and proactively address the impact of climate and weather on the business and to pursue an unmatched opportunity to improve sales, margins, and the customer experience.

TRANSFORMING WEATHER DATA INTO ACTIONABLE ANALYTICS



Before you say you can't do something. . . try it.

— Sakichi Toyoda, Japanese Inventor and Industrialist

While the weather itself is uncontrollable, retailers can control how it affects their business.

Many variables are outside the control of businesses; however, companies should not dismiss the idea of proactively managing weather impacts more readily than other external factors. For example, it is commonplace for retailers to consider interest rates, consumer confidence levels, gas prices, and other economic metrics and projections in business planning. Retailers have a significant opportunity to also include the impact of weather and climate in their reporting and planning activities.

Addressing the weather's impacts in an operationally consistent manner requires more than simply loading weather data into systems, databases, and models. Unlike other common time series data sets, the weather is geo-diverse, and it has unique characteristics that make developing reliable, granular, and scalable demand analytics challenging.

Retailers can capture better results by translating the weather into a usable retail demand metric for use across core functions including planning, demand forecasting, personalization, reporting, and other key activities. Typically, this includes a detailed modeling process that marries multiple years of performance data, such as product or category sales, overall or departmental transactions, and store or website traffic, with the corresponding historical weather data by location and time period. This process is often referred to as a "Weather Impact Analysis" and it will produce a new, weather-informed perspective on customer purchasing behavior and the variability that exists across products, markets, and timeframes.

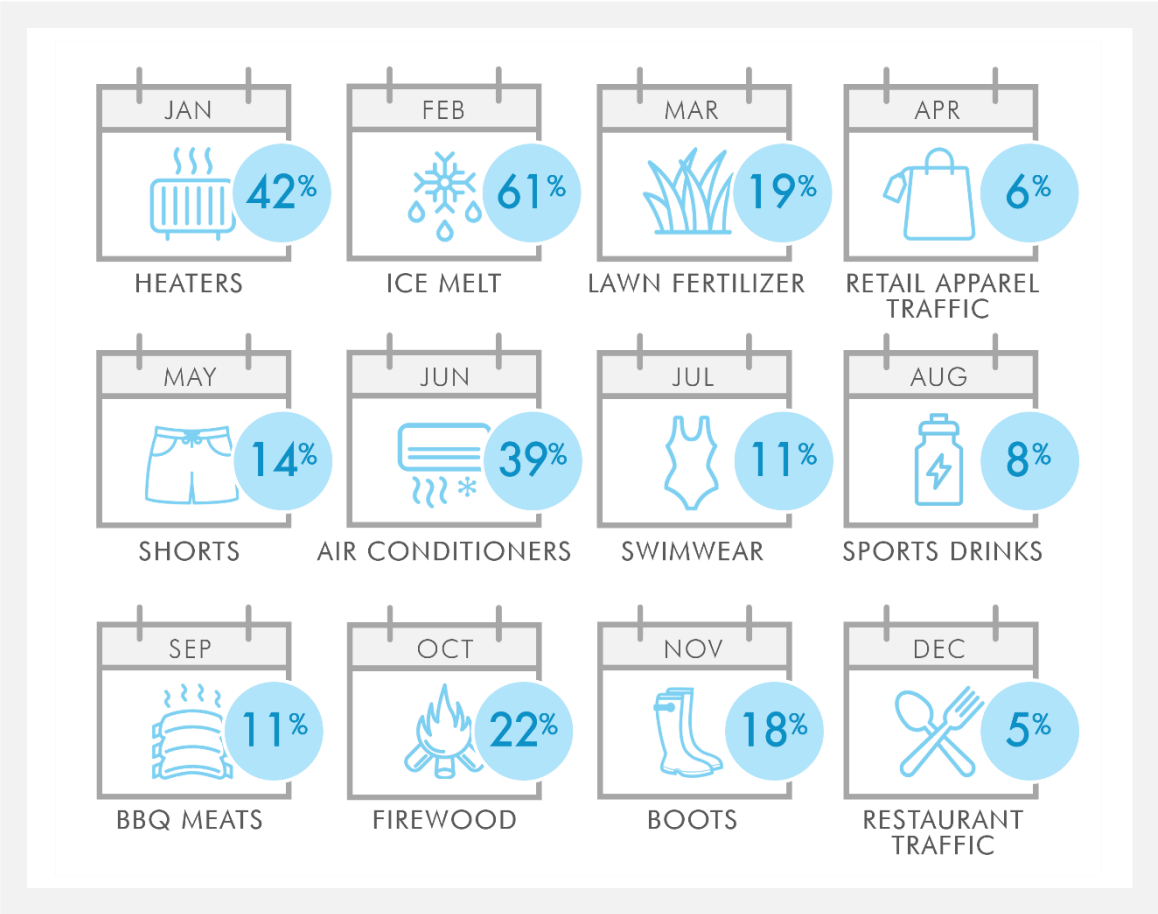
Insights from a Weather Impact Analysis typically include:

- **Weather Sensitivity:** the percentage of total topline, departmental, or product-specific sales directly attributable to weather changes. Sensitivity calculations vary by product, geography, and time period and indicate how much sales can fluctuate due to the weather.
- **Weather Drivers:** a measure of the relative levels of influence that various meteorological conditions (maximum temperatures, minimum temperatures, rainfall, snow, etc.) have on demand. The weather components that drive demand also vary by product, geography, and time period.

These metrics enable a retailer to move from subjective, inconsistent, and anecdotally-driven assumptions to a more understandable, fact-based, and quantifiable picture of how the weather influences consumer demand and business performance.

With initial weather impact models in place, a retailer can move from informative, historically based insights to the operational phase, where weather-driven demand analytics are applied to core processes like planning, allocation, replenishment, digital marketing, and reporting.

WEATHER SENSITIVITY EXAMPLES BY MONTH (U.S.)
 Percentage of category sales or store traffic
 that are attributable to changes in the weather



Source: Planalytics, Inc.

OPERATIONALIZING WEATHER ANALYTICS: USE CASES AND BENEFITS

Once a weather impact analysis is complete, companies can now leverage these insights and incorporate them into ongoing activities and operations.

To operationalize weather analytics at scale and maximize efficiencies and value return, retailers often look to integrate weather-driven demand metrics into existing technologies and solutions. Once integrated into enterprise resource planning (ERP) solutions, data lakes, AI/ML models, demand forecasting solutions, advertising or marketing platforms, and other technologies, weather-driven demand analytics are applied in the following areas:



Incorporating weather-driven demand analytics represents a huge, untapped opportunity for retailers to better understand and engage their customers, capture additional sales, and enhance profits. And, given the rapid evolution of retail technology and growing accessibility of advanced analytics and forecasting capabilities, operationalizing weather analytics across a retail enterprise has never been more attainable.

The following use case examples highlight common ways retailers can use weather impact analytics to better understand performance, more effectively align inventories and operational resources to meet changing consumer demand, and optimize campaigns, promotions, and pricing strategies.





Understanding How the Weather Impacted Performance



[Weather analytics] enable the business to unlock much better accuracy and a much better understanding of what our sales and transactions are.

— Panelist from Chipotle @ NRF's Big Show

Weather-driven demand analytics can help retailers better understand their performance and to make weather-neutral comparisons across different locations, divisions, formats, and channels. Utilizing weather analytics helps retailers ascertain the degree to which the weather influenced demand and exactly how much it affected their traffic patterns and sales results. This weather impact perspective is valuable for both internal and external reporting and for more accurately gauging the effectiveness of promotions, marketing campaigns, and other operational initiatives. Here are some examples:

USE CASE	ACTION	BENEFITS
 <p>Quarterly Reporting (External)</p>	A publicly traded retailer cited the specific impacts of weather on results, reporting that negative weather during the period impacted fourth quarter comp sales by 85 basis points	The retailer was able to precisely answer analyst questions about the impact of weather on the quarterly earnings call, providing important context to the financial community
 <p>Performance Analysis (Internal)</p>	A multinational fashion retailer incorporated positive and negative weather impacts into weekly sales results by market, region, country, and store type	Management had weather-neutral results to provide a true read on performance and enable comparisons between geographies and formats
 <p>Promotional Analysis</p>	A quick service restaurant (QSR) chain evaluated market-by-market sales lifts for a beverage promotion through a weather-adjusted perspective	By factoring in favorable or unfavorable weather conditions across markets, the company was able to analyze the promotion's performance more clearly
 <p>Sustainability Reporting</p>	A food retailer tracked the perishable waste savings that were captured by reducing replenishment volumes for stores that would see lower sales in the coming days due to unfavorable weather	Conversion of perishable waste improvements into carbon emission savings supported sustainability reporting initiatives. On average, a 12% reduction in waste corresponded to a 4% in decreased emissions

Source: Planalytics' Client Case Studies





Proactively Managing Weather-Based Demand Volatility



We're talking about consumer demand here, not weather data. We're talking about the money and talking about making sure the product is in the store.

— Panelist from H-E-B @ NRF's Big Show

Forward-looking weather-driven demand calculations can also help retailers position the business for expected weather impacts. With enhanced insights into upcoming consumer purchasing behaviors, retailers can better align inventories with demand through improved planning, allocation, and replenishment. Retailers can also adjust staffing and store operations to better address customer service needs. Benefits around forecast accuracy improvement, better availability, reduced inventory costs, and improving the shopper’s experience are common. Here are some examples:

USE CASE	ACTION	BENEFITS
 <p>Warehouse Replenishment</p>	A hardware and home improvement retailer pushed snow shovels into select regional DCs ahead of a snowy period in anticipation of increased orders from stores	Sales increased sixfold due to increased availability in affected markets, and overall, chain-wide end-of-season stocks fell 35% by positioning inventory where demand spikes would occur
 <p>Store Replenishment</p>	A supermarket chain integrated weather-driven demand analytics for thousands of products into its demand forecasting solution at the item/store/day level	Improved store in-stock position by 25% while at the same time reducing backstock by 16%
 <p>Waste Reduction</p>	A grocer adjusted replenishment volumes for perishable categories in stores forecasted to have unfavorable weather and reduced demand in the coming days	Reduced perishable shrink by 18%
 <p>Daily Sales Forecasting</p>	A restaurant chain enhanced its ML-based forecast model with a daily update of actualized and 14-day projected weather impacts	Incorporation of daily, localized weather impacts generated a 10% reduction in forecast error

Source: Planalytics’ Client Case Studies



Leveraging Weather Impact Analytics for Marketing, Pricing, and Promotions



We're really trying to put the data, the tools, and the processes in place so we can react quickly but have a real scalable approach to what we're trying to do in terms of onsite personalization. That's where weather-driven demand models play really nicely.

— Panelist from Dick’s Sporting Goods @ NRF’s Big Show

Companies can also leverage weather-driven demand projections to optimize marketing and advertising campaigns, promotions, and pricing strategies. By aligning campaigns and promotions with periods of favorable weather, retailers can capture a synergistic benefit in which there is a larger than expected consumer demand response than the expected marketing lift and positive weather lift would suggest. Retailers can also preserve margin by reducing, delaying, or eliminating markdowns when favorable weather will support demand and inventory drawdown. Here are some examples:

USE CASE	ACTION	BENEFITS
 <p>E-Commerce/ Email Marketing</p>	An outdoor apparel brand identified an opportunity to promote its spring products to customers in regions that were finally warming up after a cool start to the season	By timing the campaign to capitalize on pent-up demand, items featured in the email saw a 267% sales increase for the week
 <p>Markdown Planning</p>	A clothing chain opted for a lower markdown percentage than usual due to a favorable weather environment toward the end of the selling season	By reducing the markdown to 20% instead of 50%, the retailer increased profit while achieving end-of-season inventory targets
 <p>Paid Social Media</p>	A home center retailer used weather-driven demand projections to optimize campaigns over a 21-week period for key spring/summer categories	The campaigns improved click through rates (CTR) by 353% and return on advertising spend (ROAS) by 43% compared to campaigns that were not optimized for weather impacts

Source: Planalytics’ Client Case Studies

CONCLUSION

As NOAA has put it, “climate is what you expect, weather is what you get”. The weather is what one experiences on a particular day, while the climate is the average of the weather. While retailers are actively reducing their climate change emissions, they must also manage the impacts of changing weather patterns caused by climate change. Retailers now face different weather patterns, increased day-to-day weather volatility, and more extreme weather events, all of which affect retail sales.

Climate is what you expect, weather is what you get.

The ability to put a precise number on weather impacts across all products, times, and locations has become increasingly important as it enables retailers to better measure operational performance and proactively address demand variability. And, as the focus on environmental, social and governance (ESG) grows, so too does the need to quantify climate-related risks including the impacts of weather volatility.

Regulatory bodies are pushing for greater visibility into businesses’ climate risk picture and the potential operational and financial ramifications they face. In the U.S., the Securities & Exchange Commission is evaluating legal challenges to a rule that would require companies to report Scope 1 and Scope 2 emissions and the climate-related risks that could have a “material impact” on their bottom line as well as losses incurred due to severe weather. Weather-driven demand analytics can be used in reporting Scope 3 emissions, which includes reduction of waste generated in operations, transportation, and purchased goods and services.

By proactively incorporating weather analytics into demand forecasting, dynamic pricing models, and personalized marketing campaigns, retailers can optimize inventory management and improve customer satisfaction. These innovations enable retailers to respond swiftly to changing weather conditions, ensuring that the right products are available at the right time. Furthermore, supply chain optimization through predictive analytics can prevent disruptions and maintain the seamless flow of goods, even during adverse weather events.

In conclusion, the path to climate-proofing retail lies in embracing technological advancements and innovative planning strategies. By staying ahead of weather-related challenges and committing to sustainable practices, retailers can protect their businesses from the impacts of a changing climate and thrive in a future where adaptability and resilience are key to success. As the retail landscape continues to evolve, those who invest in climate resilience today will be well-positioned to meet the demands of an ever-changing consumer and retail marketplace.

ABOUT THE NATIONAL RETAIL FEDERATION

The National Retail Federation passionately advocates for the people, brands, policies and ideas that help retail succeed. From its headquarters in Washington, D.C., NRF empowers the industry that powers the economy. Retail is the nation’s largest private-sector employer, contributing \$5.3 trillion to annual GDP and supporting more than one in four U.S. jobs — 55 million working Americans. For over a century, NRF has been a voice for every retailer and every retail job, educating, inspiring and communicating the powerful impact retail has on local communities and global economies. [nrf.com](https://www.nrf.com)

ABOUT PLANALYTICS

Climate and weather-driven sales volatility is one of the biggest challenges retailers face daily, making it the most mission-critical and financially impactful issue a business can address. Planalytics provides predictive analytics that allow retailers to address climate resilience and capitalize on the opportunities created by weather-influenced changes in consumer purchasing. By leveraging machine learning, advanced statistical modeling, and unmatched retail-specific expertise gained from analyzing over one million categories and over 15 trillion sales transactions, Planalytics generates localized, product-specific weather-driven demand metrics that are easily incorporated into a retailer’s existing solutions and AI/ML forecasting environments. Planalytics’ suite of enterprise applications uniquely apply weather weather-driven demand analytics to improve demand forecasting, planning, inventory management (replenishment and allocation), financial reporting, digital marketing and operations management in severe weather. Retailers that proactively plan for and optimize the business to take advantage of weather-driven sales volatility can grow profit by 2-6%, capture up to 2% in additional sales and double the effectiveness of digital marketing campaigns. Visit [planalytics.com](https://www.planalytics.com) to learn more.