NOAA's Industry Proving Grounds Special Webinar: 2024 Hurricane Outlook

Event Summary

Event Overview

On Monday, July 29, 2024, The National Oceanic and Atmospheric Administration (NOAA)'s National Centers for Environmental Information (NCEI) held a special webinar on the 2024 Hurricane Outlook. This was in coordination with industry leaders and NOAA experts as part of the Industry Proving Grounds (IPG) initiative. Funded by the Inflation Reduction Act and launched in January 2024, the IPG effort that launched in January 2024 and is a leading-edge initiative to develop and share actionable climate information and improve the delivery of that information to industry partners.

Early engagements and interactions with industry professionals culminated in this exceptional event, which presented historical hurricane information and demonstrated how this data enables NOAA experts to forecast the 2024 hurricane season and beyond. The NOAA/IPG team invites you to join the discussion with NOAA's expert climatologists and leaders from the re/insurance, retail, energy, and architecture/engineering industries.

Speakers:

- Christopher Landsea (NOAA National Hurricane Center)
- Ken Knapp (absent, NOAA National Centers for Environmental Information)
- Tom Knutson (NOAA Geophysical Fluid Dynamics Laboratory)
- Hiroyuki Murakami (NOAA Geophysical Fluid Dynamics Laboratory)
- Matthew Rosencrans (NOAA Climate Prediction Center)

Key Takeaways

General Session and Speaker Presentations

Overview of the NOAA Industry Proving Grounds - *Mike Brewer (NOAA NCEI)*

- The NCEI IPG team aims to provide products that will last into the future.
- The team is trying new ways to develop and deliver information.
- There is a **new one-stop-shop website:** noaa.gov/climate-industry

NOAA 2024 Hurricane Season - ***Matthew Rosencrans (NOAA Climate Prediction Center)***

- Experts forecast the 2024 hurricane season to be **below normal in the central and eastern Pacific** and **above normal in the Atlantic**.
- A few factors drive the predicted increase in hurricane activity in the Atlantic: forecasted La Niña, ocean temperatures, and wind patterns favoring increased hurricane activity.
- These details are consistent among several forecast models.

NOAA Hurricane Seasonal Outlooks, Predictions, and Long-Term Climate Change - ***Hiroyuki Murakami (NOAA Geophysical Fluid Dynamics Laboratory)***

- The NOAA Geophysical Fluid Dynamics Labratory's Seamless System for Prediction and Earth System Research (GFDL-SPEAR) **predicts an extremely active hurricane season in the North Atlantic in 2024**, consistent with NOAA's hurricane seasonal outlook.
- The anticipated warm sea surface temperatures in the tropical Atlantic Ocean are a primary cause for the predicted active 2024 hurricane season.
- Hurricane seasons in the future climate may be less active than they were in the 2024 season.
- SPEAR projects a decrease in the frequency of tropical cyclones in the North Atlantic, primarily due to the dominant effect of increasing CO_2 levels. In contrast, the past 40 years show an increased frequency of tropical cyclones, which can be partially attributed this to decreased aerosol emissions.

Climate Change and Hurricane Activity - ***Tom Knutson (NOAA Geophysical Fluid Dynamics Laboratory)***

- Atlantic hurricane and tropical cyclone activity **has been increasing** from the 1980s until now; however, many climate model studies **project a decrease in hurricane frequency** over the remainder of the century.
    - A century of observed hurricane data reveal no increase in the number of hurricanes and major hurricanes that make landfall in the U.S.
    - There is no clear evidence that greenhouse gas-induced warming over the last century has significantly impacted Atlantic hurricane frequency. We cannot yet confidently determine the relative contributions of aerosol changes, internal variability, or greenhouse gas-induced climate warming to increased Atlantic hurricane metrics.
- For a 2 degree Celsius rise in global mean temperature, we **project the following to increase** across the Atlantic basin: sea level, coastal inundation, tropical cyclone intensity and rainfall rates, and the proportion of tropical cyclones that reach category 4-5 (severity, not frequency).

Hurricane Data and Information / National Hurricane Center - **Ken Knapp (absent, NOAA NCEI), Christopher Landsea (NOAA National Hurricane Center)**

- HURDAT (North Atlantic Basin's Hurricane Database), IBTrACS (International Best Track Archive for Climate Stewardship), HURSAT (Hurricane Satellite Data), and ADT-HURSAT (Automated Dvorak Technique HURSAT) are **existing products** that NHC and NCEI use to quantify **historical tropical cyclones**.
- HURDAT tracks storm position, intensity, pressure, and wind profiles useful to predictions, climate trends, building codes, and risk assessment.
- IBTrACS provides global multi-sourced data for all recorded tropical cyclones, weekly (provisional) and annually ("best track").
- HURSAT provides storm satellite data (Infrared Satellite imagery) for analysis.
- ADT-HURSAT provides a homogeneous objective intensity estimate for the entire HURSAT period.

Breakout Session Discussions

Webinar participants had the opportunity to join a breakout session specific to their sector of specialty. Breakout sessions focused on how members of each sector utilize climate and weather products, specifically for hurricanes, and included discussions on how NOAA can deliver information in useful, usable formats.

Breakout Session 1: Retail

- Users would like products to provide hurricane data in a **GIS format**.
- **Existing products** are insufficient, and websites hide stated capabilities (e.g., coasts.noaa.gov).
- Users would like to **compare** upcoming seasons (up and surpassing 5 years in advance) with historical seasons (at least 5 years in the past) by El Niño/La Niña cycle (specifically, for the North Atlantic basin). Please provide this data in GIS format and in map form on the retail website.

Breakout Session 2: Re/insurance

- For **better decision making and risk management**, the sector aims to protect populations and assets, particularly those near coasts. Historical, real-time, and projection data are all helpful.
- Multidecadal variability is what will happen over the **next few decades**. The sector is highly interested in how these trends affect regional frequency and severity.
- Reducing **uncertainty** in projections is an important issue to those in industry. What we do and do not know is a crucial distinction.

Breakout Session 3: Architecture & Engineering

- It is important to consider including the **architectural design lens**. For example:
  - How does a building's shape affect high winds?
  - During an emergency rescue, how does a building's design affect those operations?

Breakout Session 4: Energy

- When it comes to obtaining data about hurricane activity, the following are key:
  - **Timing:** The right information will allow people to make important and informed decisions at the right time. Timing too early or too late will not be useful.
  - **Communication:** Effective communication and broad-reaching language will help pertinent information go a long way.
  - **Long-term data** is useful for measuring hurricane activity trends.

Speaker Information

Speakers		
Christopher Landsea *NOAA National Hurricane Center*	Ken Knapp (absent) *NOAA NCEI*	Tom Knutson *NOAA Geophysical Fluid Dynamics Laboratory*
Hiroyuki Murakami *NOAA Geophysical Fluid Dynamics Laboratory*	Matthew Rosencrans *NOAA Climate Prediction Center*	
Facilitators		
Adam Smith *NOAA NCEI*	Liz Cox *North Carolina Institute for Climate Studies*	Russ Vose *NOAA NCEI*
Jenny Dissen *North Carolina Institute for Climate Studies*	Mike Brewer *NOAA NCEI*	Vanessa Escobar *NOAA NCEI*

Question & Answer

Prior to the event, participants had the opportunity to submit questions for the speakers. Below are a selection of the questions our guests asked and the speakers' responses, some of which were not covered during the webinar.

Question: Is there one location for ALL hurricane GIS data, such as tracks, history, NHC outlooks, spaghetti models, etc.? I do a lot of forecasting for hurricanes at [my company] to help determine which stores may be impacted, using GIS data.

Answer: We understand that is a need from the retail sector, and hope to make an integrated information source at the NOAA Industry Website for Retail.

Question: Could you explain NHC Category Rating versus ground truth observations?

Answer: Saffir-Simpson Hurricane Wind Scale: This scale categorizes hurricanes based on their sustained wind speeds. It ranges from Category 1 (least severe) to Category 5 (most severe). Each category describes the potential damage and impacts.

Category 1: Winds 74-95 mph. Minimal damage.
Category 2: Winds 96-110 mph. Moderate damage.
Category 3: Winds 111-129 mph. Extensive damage.
Category 4: Winds 130-156 mph. Catastrophic damage.
Category 5: Winds 157 mph or higher. Catastrophic damage.

Beyond wind speeds, hurricane hazards are also individually quantified and forecasted for ocean waves, rainfall, fresh-water flooding, storm surge flooding, and tornadoes.

Question: How should companies consider and use this information and determine their risk related to hurricanes?

Answer: Companies can use historical and future predictions to determine exposure to facilities, assets and operations from the various hurricane ratings.

Risk and vulnerability of infrastructure and supply chains, equipment can be determined from the NOAA hurricane information.

For example, higher-rated hurricanes necessitate stronger and more resilient infrastructure. Evaluate how different ratings affect building design and construction practices.

Hurricane ratings influence insurance premiums and coverage options. Companies and users can adjust insurance policies to ensure adequate coverage from damages, or set aside reserves for unplanned expenses, disruptions, and emergency needs from extreme event damages.

Companies, and their customers, can implement design standards and codes that exceed the local codes to invest in resilience; companies and their customers can retrofit existing infrastructure to withstand wind and storm surge, etc.

Emergency preparedness and communication is key; ensuring company and customers are informed of upcoming changes is crucial for evacuation planning.

Retail supply chain organizations can work with their partners to assess and develop plans, disaster risk reduction strategies and continuity strategies.

Just as companies can employ simulation models to predict the impact of hurricanes based on current and historical data, companies can conduct a detailed analysis after a hurricane to assess improvements for preparedness and resilience, and share the key findings with NOAA IPG and others.

Leverage technology and data where possible — Companies can utilize NOAA resources, NOAA Industry webpage, and tools like the National Hurricane Center (NHC) and other meteorological resources to gather, track and analyze hurricane forecasts and updates.

Question: Could you discuss climate modeling?

Answer: See IPCC AR6 Working Group 1 report: https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/

Question: We are interested in weather-informed maintenance of solar assets as SBIR II recipients. Do you equate hurricane severity ratings and cones of influence with asset damage (in $M) as well as degree of loss (total loss vs. other)?

Answer: U.S. damages from landfall tropical storms and hurricanes have been characterized by Saffir-Simpson Hurricane Wind Scale in the paper by Weinkle et al. (2018) *Nature Sustainability*.

Question: Has the gulf stream temperature increase impacted the severity of hurricanes?

Answer: Gulf Stream's temperature increase has had an impact on the severity of hurricanes. Warm sea surface temperature provides an energy source for hurricanes; water waters can lead to increased wind speed and storm surges, creating greater intensity.

Warm ocean waters can enhance convection (the rising of warm air), which can lead to more intense and organized storm systems with higher wind speeds and more intense rainfall. Warmer waters can also lead to higher humidity which adds to the intensity.

Other studies indicate that warmer ocean temperatures are influencing the frequency and duration of hurricanes, and shifting the tracks of hurricanes. It is still difficult to say whether changes in hurricane behavior we have seen in the Atlantic since 1980 are due to changes in aerosol forcing, to internal climate variability, or to greenhouse gas-induced warming. This remains a topic of active research. Warmer ocean temperature in the Gulf can also lead to sea level rise, which contribute to higher inundation levels by storm surges, which then potentially leads to more damage.

Climate models predict that as Atlantic ocean temperatures continue to rise due to greenhouse warming over the coming century, the wind intensity, rainfall rates, and potential impacts from hurricane storm surges are expected to increase, although the exact relationship can vary by region and storm.

Question: How will climate change affect hurricane formation and strength into the future, specifically related to how companies have to assess future climate impact under new SEC reporting (i.e., any thoughts on how we can measure and report this on an individual basis)?

Answer: See the "Key Takeaways" section on Climate Change and Hurricanes for a summary of projections hurricane activity for a 2 degree Celsius global warming scenario. Changes in hurricane

frequency are very uncertain (and could be negative), but sea level rise is expected to lead to greater coastal flood risk due to higher inundation levels for future storms that do occur. Models also project an increase in hurricane rainfall rates by about 14% and an increase in wind intensities by about 3%. I don't have much advice at present for how to satisfy SEC reporting requirements related to climate change. Hopefully the climate projection being provided in the Key Takeaways and the reports that those are based upon will be of some use. For further information on the topic of hurricanes and global warming please see this website: https://www.gfdl.noaa.gov/global-warming-and-hurricanes/

Question: Will NOAA enhance or replace the hurricane "cone" map?

Answer: The National Hurricane Center's "Cone" map will be enhanced starting in mid-August with the depiction of U.S. inland Watches and Warnings. This is an effort to focus more upon hazards (in this case wind-based) in this widely used graphic. Here are the details about the revised cone.

Question: What are some key takeaways for architects and urban planners for future development in face of climate change and extreme sea level rise in the uncertainty?

Answer: See the "Key Takeaways" section on Climate Change and Hurricanes for a summary of projections hurricane activity for a 2 degree Celsius global warming scenario. Changes in hurricane frequency are very uncertain (and could be negative), but sea level rise is expected to lead to greater coastal flood risk due to higher inundation levels for future storms that do occur. Models also project an increase in hurricane rainfall rates by about 14% and an increase in wind intensities by about 3%. I don't have much advice at present for how to satisfy SEC reporting requirements related to climate change. Hopefully the climate projection being provided in the Key Takeaways and the reports that those are based upon will be of some use. For further information on the topic of hurricanes and global warming please see this website: https://www.gfdl.noaa.gov/global-warming-and-hurricanes/

Question: Could you provide some insight into the estimation of the cone of the hurricanes (i.e., how is this computed and if these are based on some statistical significance test)?

Answer: Here are the details about how the hurricane cone from the National Hurricane Center is developed. Note that the graphic will undergo a significant change later in the hurricane season by the inclusion of U.S. Watches/Warnings. Here is documentation about the revision.

Question: Can you talk about operational AI track and intensity models? Where does the NHC see future intersection of AI and tropical forecasting and data collection?

Reinventing the cone of uncertainty - dynamic cone weighted toward track risks; graphics that combine track, wind, flooding impacts

Answer: AI models are being tested currently for forecasting of hurricane track and intensity. Thus far these are competitive, but do not outperform the traditional equations-of-motion approach. In the near future, there will likely be AI forecasts of rainfall, ocean waves, storm surge, tornados, and fresh-water flooding. These will have to be thoroughly tested to see if they provide additional skill over what is currently available.

As for the Cone, it will undergo a significant change later in the hurricane season by the inclusion of U.S. Watches/Warnings. Here is documentation about the revision. Making a dynamic cone has been proposed, but has not yet been adopted.

Question: I am particularly interested in understanding how the advancements in climate modeling and data analytics are enhancing the accuracy of hurricane forecasts. Specifically, I would like to learn about:

1. Improvements in Predictive Models: How have predictive models for hurricane paths and intensities evolved in recent years, and what specific advancements have contributed to these improvements?

2. Integration of Historical Data: How is historical hurricane data being utilized to refine and validate current forecasting models? Are there specific case studies or examples where historical data has significantly improved forecast accuracy?

Answer: 1. Improvements in Predictive Models:

High-Resolution Models:

Recent prediction models have evolved to use high-resolution grids due to increased computational power. This allows for more detailed simulations of hurricane structures, improving the accuracy of track and intensity forecasts.

Advancements in Data Assimilation: Improvements in data assimilation techniques, along with the incorporation of satellite observational data into models, have enhanced the accuracy of initial conditions, leading to better forecast accuracy.

Integration of AI and Machine Learning:

The incorporation of AI and machine learning algorithms into traditional physics-based models has provided new insights, further enhancing prediction accuracy. Incorporating statistical methods into dynamical forecasts also improves forecast skill.

2. Integration of Historical Data:

Specific case studies, such as Hurricane Katrina, Hurricane Sandy, and Hurricane Ida, have been used as benchmarks for model forecasts and provide further insight into model biases and improvements.

Accumulating reliable historical hurricane data is not only important for understanding climate change but also essential for establishing the relationship between large-scale environments and storm activity on a seasonal time scale, which ultimately improves prediction skill in statistical forecasts.

Question: Could you talk about warnings broadcasts for mariners?

Answer: Traditionally, mariners over the open ocean were warned via radio technology: radiofax for graphics, VOBRA for voice broadcasts, and NAVTEX for text forecasts. However, with the advent of cheaper, reliable, and globally available internet capabilities, the NWS is moving toward providing gridded and polygon-based information via the S-100 project. The International Maritime Organization (IMO), amended its Electronic Chart Display and Information System (ECDIS) standard to leverage S-100 based information beginning in 2026. This way mariners can get the official NWS forecasts and warnings right on their navigation system

Question: What is the current research status/consensus on seasonal hurricane forecasting capabilities with respect to landfall activity rather than just basin-wide activity?

Answer: Unlike basin-wide storm activity, predicting landfall storms on a seasonal time scale remains challenging. Only a limited number of studies have examined the skill of seasonal forecasts in predicting landfall over the North Atlantic. These results suggest that the Caribbean region is a particularly predictable area of the North Atlantic.

Reference:

Takaya, Y., L. Caron, E. Blake, F. Bonnardotd, N. Bruneau, J. Camp, J. Chan, P. Gregory, J. J. Jones, N. Kang, P. Klotzbach, Y. Kuleshov, J. Lockwood, H. Murakami, A. Nishimura, D. R. Pattanaik, T. Philp, Y. Ruprich-Robert, R. Toumi, F. Vitart, S. Won, and R. Zhan, 2023: Recent advances in seasonal and multi-annual tropical cyclone forecasting. Trop. Cyclone Res. Rev., 12, 182-199. http://dx.doi.org/10.1016/j.tcrr.2023.09.003

NOAA has internal research to determine our ability to make landfall predictions given the current tools and understandings, as well as planned updates to some of those.