2024 NHC Verification Report Preview

Atlantic Basin

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The National Hurricane Center (NHC) is nearing completion of the post-analysis of the 2024 Atlantic and eastern North Pacific basin tropical cyclones. The annual NHC Verification Report uses the post-analyzed information to verify the accuracy and biases of NHC forecasts and real-time model guidance, and the 2024 report will be available in the spring on NHC's website - https://www.nhc.noaa.gov/verification/. This short review provides some of the preliminary highlights of NHC's 2024 forecast performance in the Atlantic basin, which is based on a combination of post-analyzed and real time best track data. If interested in the forecast verification for individual storms, please refer to Tropical Cyclone Reports (as completed) at https://www.nhc.noaa.gov/data/tcr/index.php.

The 2024 Atlantic hurricane season exhibited above normal levels of activity by nearly every metric (total number of tropical storms, hurricanes, major hurricanes, and values of Accumulated Cyclone Energy, a measure of the strength and duration of all tropical cyclones). NHC issued a total of 347 forecasts in the Atlantic basin in 2024, which is a little above the long-term (1990-2023) average of about 325 forecasts. A map of the 2024 Atlantic basin tropical storms and hurricanes is shown in Figure 1 below. As seen in the figure, the western portion of the basin was particularly active.
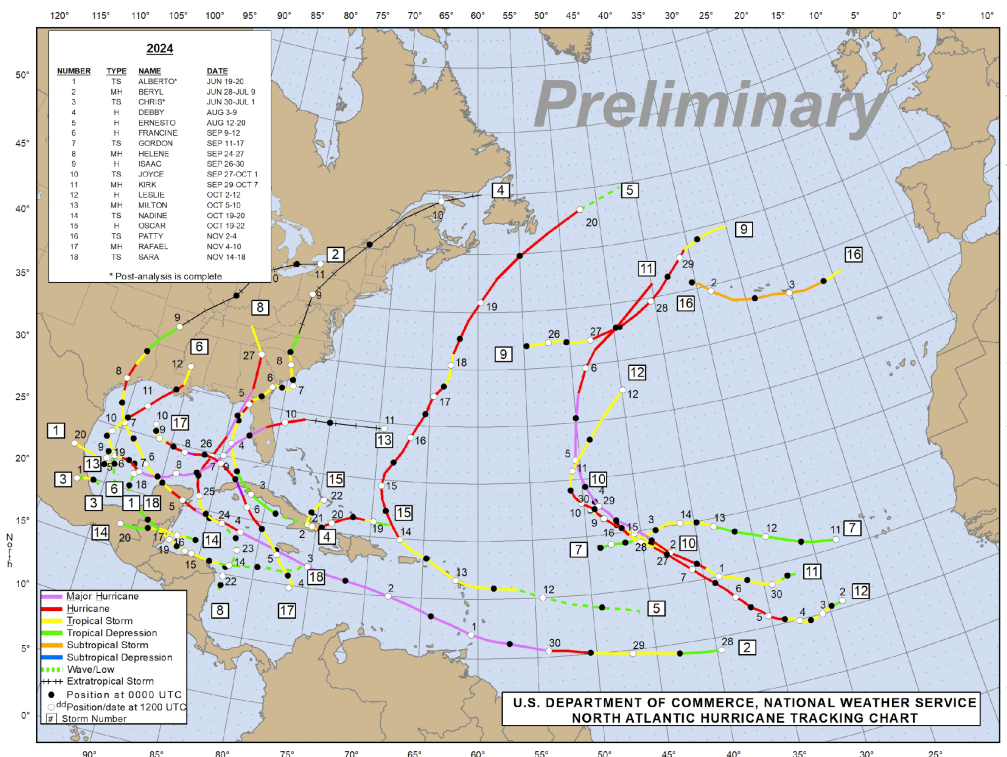

Figure 1 – Map of the 2024 Atlantic basin tropical storms and hurricanes.

NHC had a successful year for track forecasting for the Atlantic basin in 2024. The mean track errors at every forecast interval (12, 24, 36, 48, 60, 72, 96, and 120 h) broke records for accuracy, meaning that NHC's 2024 forecast track performance was its best in history. Figure 2 shows NHC's annual mean track errors at various forecast times from 1990 to 2024. It can be seen that there is quite a bit of year-to-year variability, but the long-term trends are very pronounced and show significant progress at lowering track errors. Preliminary verification indicates that NHC outperformed all of the individual models in 2024, and its track skill was near or higher than the best-performing consensus aids. Also of note, NHC's forecasts were more consistent, changing less from cycle to cycle, compared to the global models. For more information on NHC's track forecasting progress, see this short video: https://youtu.be/RB1mTkgkI5E?si=sTjYMBZCohMRgQAn.
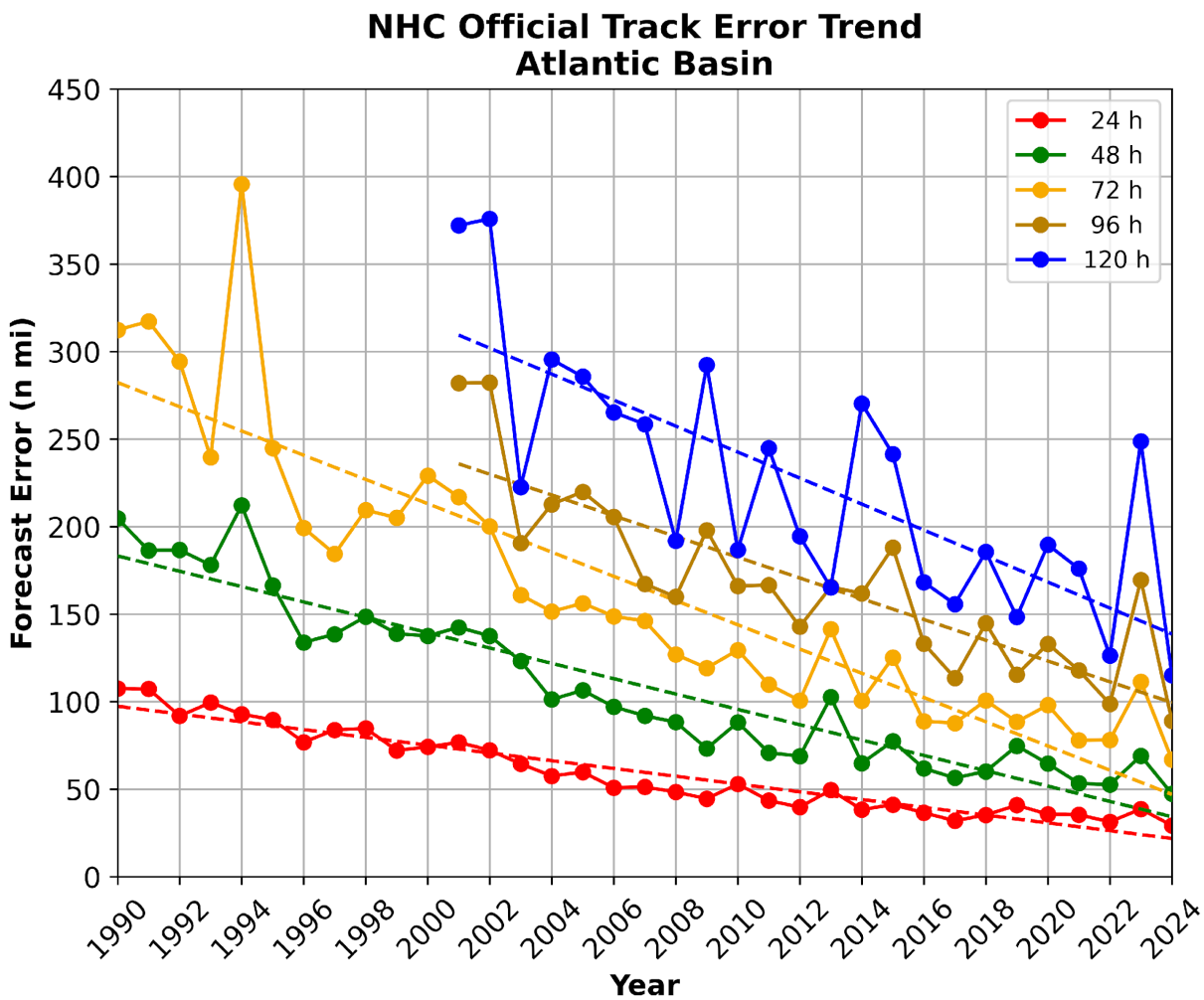

Figure 2 – Trends in NHC official track errors (n mi) from 1990-2024.

Intensity forecasting in 2024 for the Atlantic basin was more challenging. There were 34 episodes of Rapid Intensification (RI), which is defined as an increase in maximum winds of at least 30 kt/35 mph within a 24-hour period. This number of RI events was nearly double the average of the past 10 years, and RI remains one of the most significant challenges in hurricane forecasting. NHC's intensity errors in 2024 were a little higher than that of the past couple of years, and no records were set for accuracy. Figure 3 shows that despite the slightly higher intensity errors in 2024, the long-term trends of decreasing intensity errors (dotted lines) remain intact.
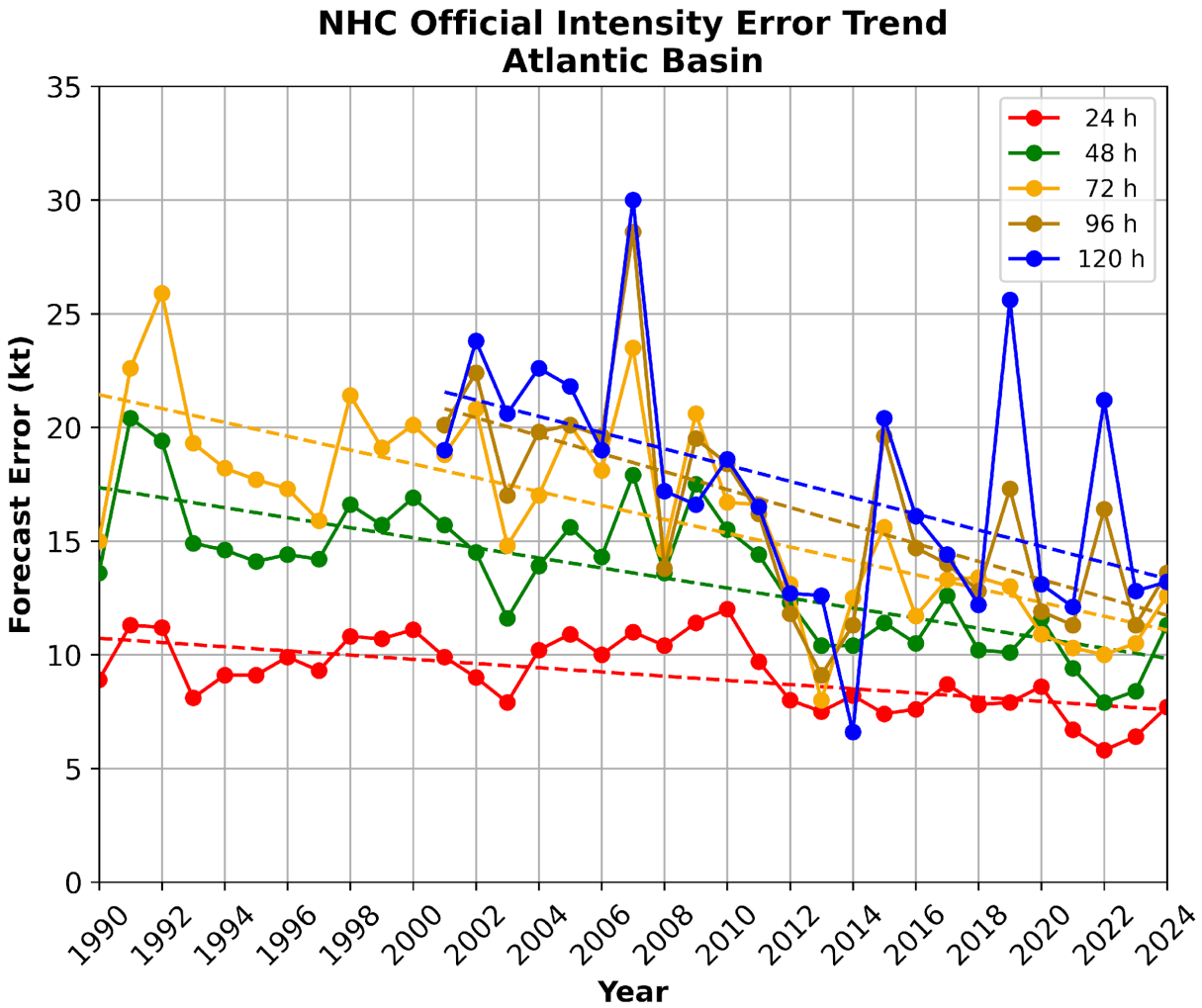

Figure 3 – Trends in NHC official intensity errors (kt) from 1990-2024.

Although 2024 was a challenging year for intensity forecasting, a closer inspection of the mean errors shows progress in some areas. Figure 4 shows the critical success index of official and model forecasts for storms in 2024 that strengthened by 25 kt/30 mph over a period of 24 hours. There are 214 cases that are included in this analysis. Critical success index is a metric used to evaluate how well a forecast aligns with actual outcomes and ranges from 0 to 1, where 1 represents perfect accuracy. It can be seen that NHC intensity forecasts (OFCL/black dot) had a higher probability of detection (vertical axis) and higher critical success index (curved/shaded lines) for the subset of significantly strengthening storms compared to the real time model guidance (other colored symbols).
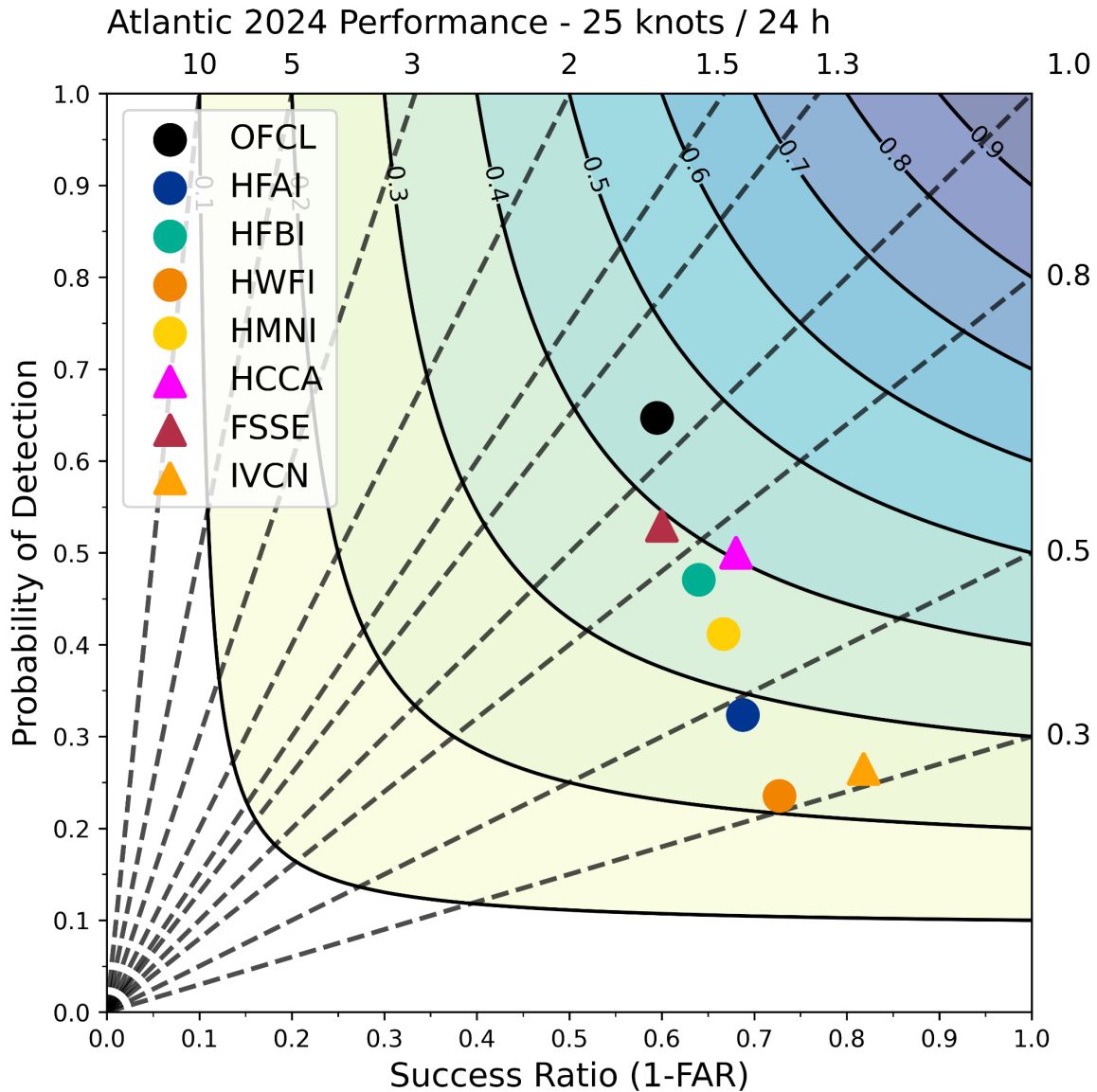

Figure 4 – Roebber performance diagram of NHC official forecast (OFCL) and intensity models of significantly strengthening storms (25 kt/30 mph within a 24-hour period). Probability of detection is given by the ratio of hits to the total number of times the events occurred. False Alarm Ratio (FAR) is given by the ratio of false alarms to the total number of forecast events.

Although RI remains one of the biggest challenges at NHC, it is worth noting that advancements in hurricane modeling and understanding of the science are making a difference in improving forecasts for even the most challenging cases. Figure 5 shows NHC's intensity forecast bias for RI events binned in 5-year spans. NHC's forecast intensity bias has been steadily decreasing from 26 kt (30 mph) too low in 2010-14 to 16 kt (18 mph) too low from 2020-24. Although there is still work to do, progress is clearly underway. Part of this improvement is due to more aggressive intensity forecasts being made by NHC forecasters when RI is anticipated. In 2024, for the first time ever NHC explicitly forecast a system that was not yet a tropical cyclone (pre-Helene potential tropical cyclone) to become a 100-kt (115 mph) major hurricane within 72 hours (Potential Tropical Cyclone Nine Advisory 2). Advances and increased trust in NWS regional hurricane models have aided in increased forecaster confidence to make these types of aggressive intensity predictions.
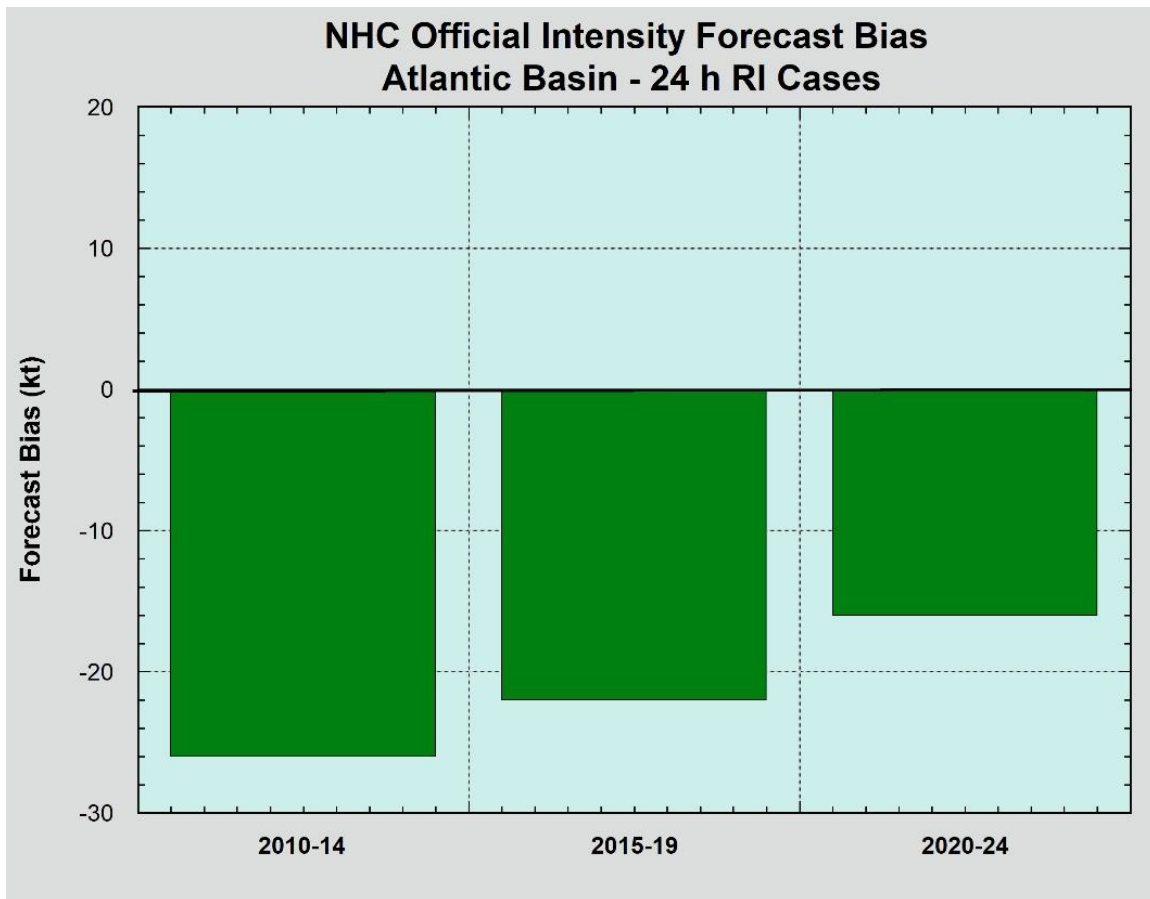

Figure 5 – NHC's 24-hour intensity forecast bias (kt) for RI events in the Atlantic basin binned in 5-year spans.

The final report will include a more comprehensive analysis of NHC's and models' tropical cyclone forecast accuracy and biases, NHC's genesis predictions, and forecasts for systems near the U.S. that had watches and warnings. The report will also include data from the eastern North Pacific basin. For more information, visit https://www.nhc.noaa.gov/verification/.