Pre-Season Forecast Update for North Atlantic Hurricane Activity in 2024

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TSR continues to predict North Atlantic hurricane activity in 2024 will be hyper-active and around 75% above the 1991-2020 30-year norm.

Summary: The TSR (Tropical Storm Risk) pre-season forecast update for North Atlantic hurricane activity in 2024 continues to anticipate a hyper-active season with activity around 75% above the 1991-2020 climate norm. Although some uncertainties remain, we consider that the more likely scenario is for tropical North Atlantic and Caribbean Sea waters to be warmer than normal by August-September 2024, and for weak La Niña conditions to develop and persist through August-September 2024 and into the autumn. These two factors are both expected to have a strong enhancing influence on the upcoming Atlantic hurricane season.

1. TSR Pre-Season North Atlantic Seasonal Hurricane Forecasts

Further information on the TSR statistical prediction models and adjustments that are used to generate the forecasts below can be found in Section 2 of Supplementary Information.

1.1 Forecast North Atlantic ACE Index and System Numbers in 2024:

		ACE Index	Intense Hurricanes	Hurricanes	Tropical Storms
TSR Forecast	2024	226	6	12	24
30-yr Climate Norm	1991-2020	122	3.2	7.2	14.4
10-yr Climate Norm	2014-2023	132	3.4	7.6	16.9
Forecast Skill at this Lead	2003-2023	6%	6%	9%	7%

The forecast tercile probabilities (1991-2020 data) for the 2024 North Atlantic hurricane season ACE index are as follows: an 88% probability of being upper tercile (>156)), a 12% likelihood of being middle tercile (75 to 156)) and minimal chance of being lower tercile (<75)).

1.2 Forecast US ACE Index and US Landfalling Numbers in 2024:

		US ACE Index	Hurricanes	Tropical Storms
TSR Forecast	2024	4.9	3	5
30-yr Climate Norm	1991-2020	2.7	1.6	3.8
10-yr Climate Norm	2014-2023	3.5	2.1	4.5
Forecast Skill at this Lead	2003-2023	0%	13%	21%

USA landfalling intense hurricanes are not forecast since we have no skill at any lead.

The forecast tercile probabilities (1991-2020 data) for the US ACE index in 2024 are as follows: a 71% probability of being upper tercile (>3.19), a 23% likelihood of being middle tercile (1.18 to 3.19) and only a 6% chance of being lower tercile (<1.18).

1.3 Forecast Probability of Exceedance Plots for the North Atlantic Hurricane Season in 2024:

See Section 3 in the Supplementary Information for motivation behind probability of exceedance charts. Figure 1 displays our pre-season forecast PoE plots for the 2024 North Atlantic hurricane season. The forecast PoE curves are computed using the method described in section 3 of Saunders et al. (2020) while the climatology PoE curves are computed directly from observations. The two forecast PoE plots specify the current chance that a given ACE index and/or hurricane total will be reached in 2024 and how these chances differ to climatology.

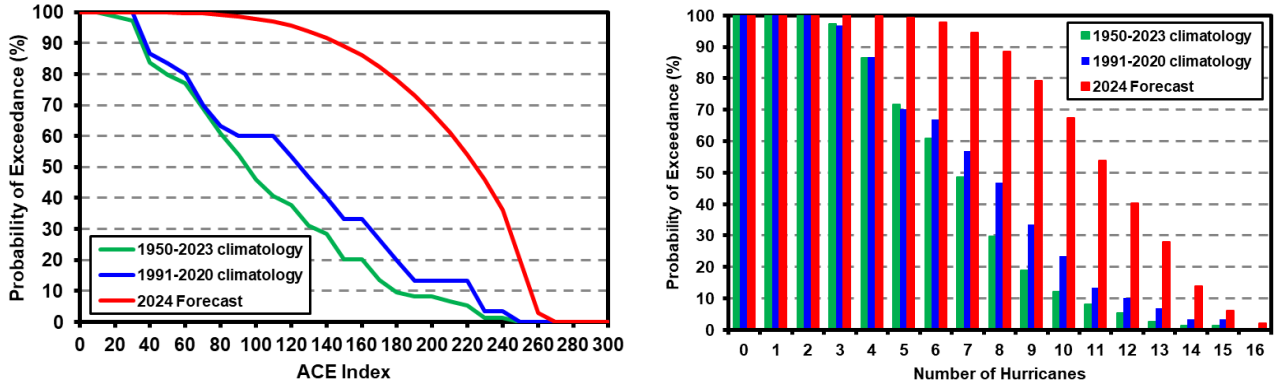

Figure 1. Forecast probability of exceedance (PoE) plots for the North Atlantic ACE index in 2024 (left panel) and for the number of North Atlantic hurricanes in 2024 (right panel). Each plot displays three sets of PoE data comprising the TSR forecast PoE curve issued pre-season and two climatology PoE curves.

2. Factors Influencing the Pre-Season 2024 TSR Forecasts

Atlantic MDR SST: August-September sea surface temperatures in the tropical North Atlantic (region 10°N–20°N, 20°W–60°W) are forecast to be warmer than normal. The current forecast is for 0.8±0.34°C warmer than normal (1991-2020 climatology). Warmer than normal waters provide additional heat and moisture to help power the development of more storms within the hurricane main development region.

Trade Wind Speed: The July-September forecast trade wind at 925mb height over the Caribbean Sea and tropical North Atlantic (region 7.5°N–17.5°N, 30°W–100°W) is forecast to be weaker than normal. The current forecast for the July-September trade wind is for 1.78±0.79 ms^{-1} weaker than normal (1991-2020 climatology). Weaker than normal trade winds during July-September in the tropical north Atlantic are associated with higher cyclonic vorticity and decreased vertical wind shear over the hurricane main development region. This in turn increases hurricane frequency and intensity.

ENSO: Weak La Niña conditions are currently developing and are anticipated to strengthen and persist through summer and autumn 2024. La Niña conditions typically result in weaker trade winds and decreased vertical wind shear, which typically enhances North Atlantic hurricane activity, especially in the second half of the season.

Spring NAO: During neutral ENSO years, when the April-June North Atlantic Oscillation (NAO) is negative, the upcoming Atlantic hurricane season tends to be active and vice versa. Through April and May 2024, the NAO has been weakly negative, the forecast NAO over the next two weeks is weakly negative and the ENSO state has been transitioning from moderate El Niño to weak La Niña. The spring NAO is therefore not anticipated to have a significant influence on Atlantic hurricane activity in 2024.

Analogue Years: The current sea surface temperature pattern globally is similar to 1970, 2007, 2010 and 2013. Out of those four years only 2010 was an active year for Atlantic hurricane activity. 2007 and 2013 were unusual years in that large-scale atmospheric and oceanic conditions were conducive for active seasons but other factors during the season acted to counter these favourable conditions. In terms of the Aug-Sep Atlantic MDR sea surface temperature and Jul-Sep trade wind anomaly forecasts, historical years since 1950 where the hindcasts for MDR SST and trade wind speed anomaly are similar to 2024 are 1958, 1969, 2005 and 2023, of which the latter three years were active or hyper-active. These analogues are somewhat inconclusive but are consistent with a very active season if unpredictable intra-seasonal suppressing factors such as dry air and subsidence across the MDR do not come into play, otherwise there is the possibility the season will be considerably less active than forecast.

3. Confidence and Uncertainties

There is high confidence that the 2024 Atlantic hurricane activity season will be very active although some uncertainties remain. Contributions to uncertainty due to other factors are described below:

Atlantic MDR SST: There is high confidence that sea surface temperatures in the tropical Atlantic will be much warmer than average which is an enhancing effect for hurricane activity. Sea surface temperatures across much of the Atlantic Ocean have been well above average for several months and there is currently no indication these sea surface temperature anomalies will cool significantly, if at all, over the Spring (see Spring NAO).

ENSO: There is high confidence for a weak or moderate La Niña to be in place through summer and autumn which is an enhancing effect for hurricane activity.

Trade Wind Speed: There is high confidence that Atlantic and Caribbean Sea trade wind speed will be weaker than normal through the upcoming summer. Trade wind speed is weaker than normal when La Niña conditions are in place and Caribbean sea surface temperatures are warmer than normal. We have good confidence both factors will be present through peak hurricane season in August and September.

Intra-seasonal factors: Other factors which are impossible to predict such as the strength and frequency of Saharan air outbreaks, and the frequency of tropical upper tropospheric troughs (TUTT) across the tropical Atlantic (both of which inhibit hurricane activity) are not accounted for. In addition, for a given set of climate factors, a spread in hurricane activity levels can still ensue.

Skill: Historically the skill of the pre-season forecast for North Atlantic hurricane activity is low (see section 4a in the Supplementary Information), however with both primary climate factors very likely to be strongly enhancing for hurricane activity in 2024, the confidence in the forecast for a very active season is higher than what the low skill scores would imply.

4. Forecast Archive and Next Forecast,

The archive of all the TSR publicly released North Atlantic seasonal hurricane forecasts (from 1998 to 2023) may be viewed at *https://www.tropicalstormrisk.com/for_hurr.html*. The next TSR forecast update for the 2024 North Atlantic hurricane season will be issued on Friday 5th July.

5. List of Predictions Issued for the 2024 North Atlantic Hurricane Season

1. Atlantic ACE Index and System Numbers:

Atlantic ACE Index and System Numbers 2024					
		ACE Index	Named Tropical Storms	Hurricanes	Intense Hurricanes
Average Number (1991-2020)		122	14.4	7.2	3.2
Average Number (2014-2023)		132	16.9	7.6	3.4
TSR Forecasts	30 May 2024	226	24	12	6
	8 April 2024	217	23	11	5
	11 December 2023	160	20	9	4
CSU Forecast	4 April 2024	210	23	11	5
NOAA Forecast	23 May 2024	145-237	17-25	8-13	4-7

2. US ACE Index and US Landfalling Numbers:

US Landfalling Numbers 2024				
		ACE Index	Tropical Storms	Hurricanes
Average Number (1991-2020)		2.7	3.8	1.6
Average Number (2014-2023)		3.5	4.5	2.1
TSR Forecasts	30 May 2024	4.9	5	3
	8 April 2024	4.6	5	3