



268Weather 2021 Atlantic Hurricane Season Forecast

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268Weather is projecting that the 2021 Atlantic hurricane season will likely be above normal, with the possibility of being hyperactive—Accumulated Cyclone Energy (ACE) greater than 187. The forecast spans the full season—June to November, plus May. In obtaining the forecast, data available through April 10, 2021 were used.

The main reasons for the above normal forecast are the likely above normal sea surface temperatures (SSTs) across the tropical North Atlantic (TNA), a cold-neutral El Niño Southern Oscillation (ENSO) and the lagging favourable conditions left by what is forecast to be a recently ended ENSO, at the start of the hurricane season. A warmer than usual TNA often translates into lighter than usual trade winds and lower vertical wind shear – both very conducive for an above normal Atlantic hurricane season. La Niñas enhance hurricane activity and warm ENSOs (El Niños) do the opposite. Cold-neutral ENSOs sometimes have a similar effect to La Niñas. Notwithstanding, there are notable uncertainties with the forecast largely due to uncertainties regarding the evolution of ENSO. Models tend to do a poor job of forecasting ENSO at this time of the year, due to what is called the “spring barrier”, which will not be overcome before June.

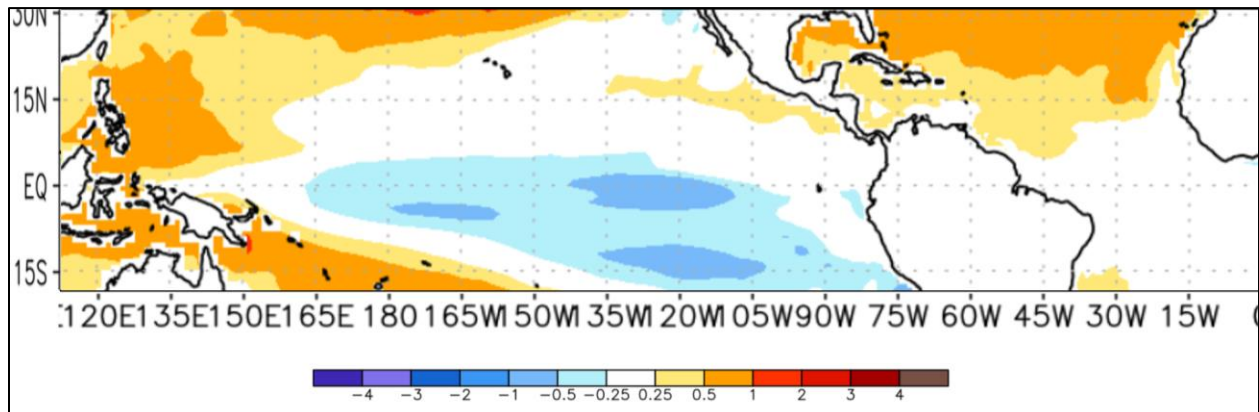


Figure 1: North American Multi-Model Ensemble (NMME) mean SSTs anomalies for Aug to Oct 2021, initialised Apr 2021. Warmer than usual SSTs for the TNA (right top, yellow/orange) – Aug to Oct 2021, and cold-neutral ENSO forecast for the Pacific (middle, blues).

The forecast calls for 21 named storms with 9 becoming hurricanes and 5 becoming major hurricanes. The ACE is forecast to be 184. Further, there is a 70% likelihood/confidence of

- 17 to 30 named storms;
- 6 to 14 becoming hurricanes;

- 2 to 7 becoming major hurricanes and
- 109 to 275 ACE.

The seasonal activity is expected to fall within these ranges in 70% of seasons with similar SST patterns, across the tropical Pacific and Atlantic Oceans, and uncertainties to those expected this year. These ranges do not represent the total possible ranges of activity seen in past similar years. These expected ranges are centred above the 1981-2010 seasonal averages of 106 ACE, 12 named storms, 6 hurricanes and 3 major hurricanes. Most of the predicted activity is likely to occur during the peak of the season—August to September.

There is a 75% probability of an above normal season, 19% probability of a near normal season and a 6% probability of a below normal season, based on the ACE for the climate period 1981-2010. This forecast is to be taken as a guide and not as gospel. Forecasts issued in April of an upcoming hurricane season have only moderate skill, historically. As we get closer to the season, the forecasting skill normally increases.

Figures 1 and 2 show there is good skill in forecasting the season, in this case, using the CanGEM-NEMO model SSTs to predict the ACE.

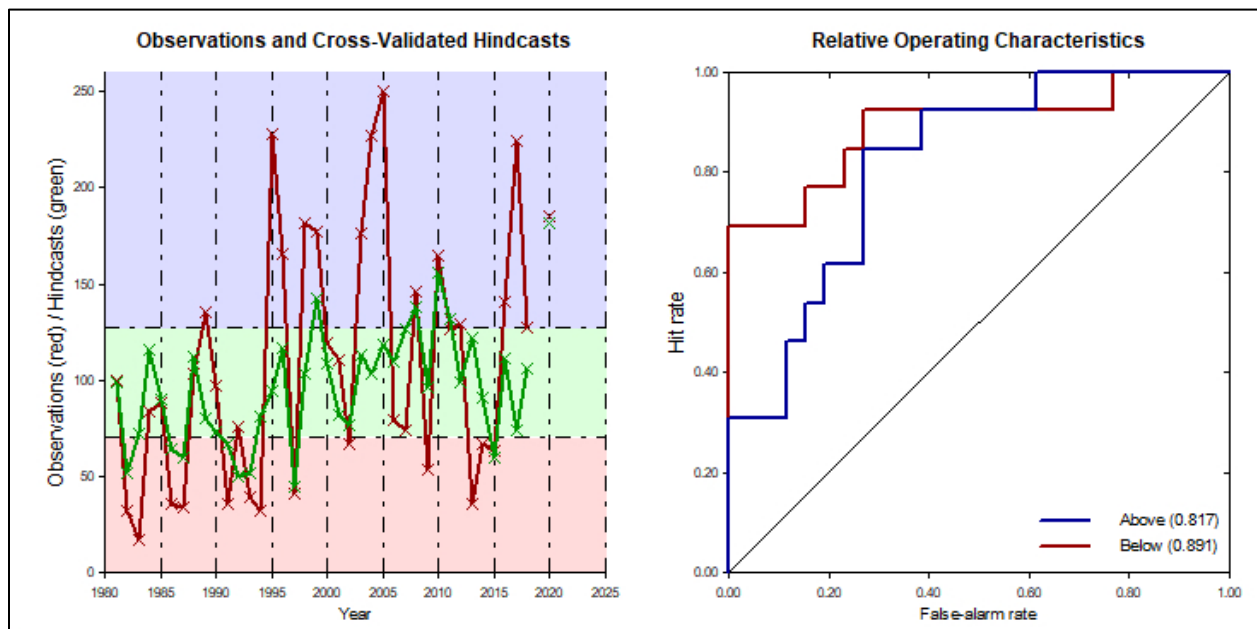


Figure 1a (left): Shows observed vs forecast ACE. The variance is 30%, using CanGEM-NEMO mean SSTs for May to November 1981-2020, as the training period. Figure 1b (right): The ROC diagram shows very high discrimination by the model in forecasting above and below normal ACE for the season using CanGEM-NEMO SSTs.

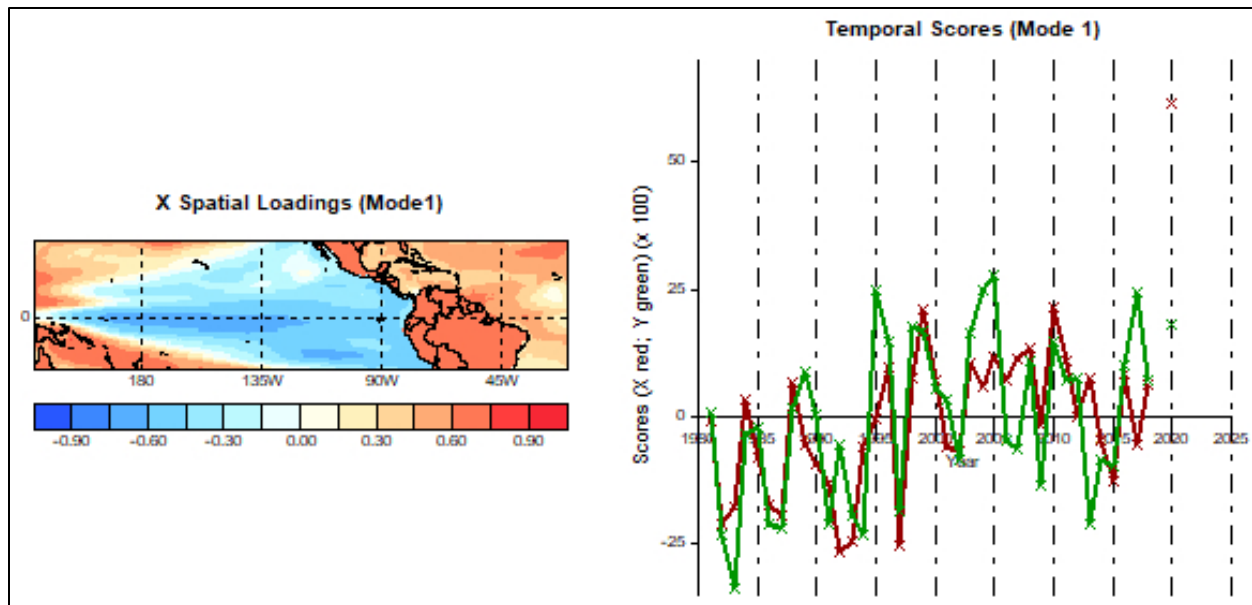


Figure 2: The X special loadings (mode 1) shows the most dominant pattern in SSTs correlation associated with above normal ACE; the reverse pattern is true for below normal ACE. The canonical correlation for this pair of variables (SSTs and ACE) is over 0.63. From the temporal scores (mode 1), warm SSTs across the tropical Atlantic Ocean simultaneously with cool SSTs across the tropical Pacific Ocean tend to coincide with above normal ACE (or season) and vice versa. Obtained using CanGEM-NEMO mean SSTs for May-November 1981-2020, as the training period.

Methodology

This forecast was obtained with the use of the Climate Predictability Tool ([CPT](#)) version 15.7.11, 2019 by Simon J. Mason, Michael K. Tippett and Lulin Song. The software was viewed in canonical correlation analysis (CCA) mode. Input explanatory (X) files used were NOAA NCDC ERSSTv5 mean observed SSTs for: March 1971-2021 and January to March 1971-2021; CanCM4i 1981-2021; CanGEM-NEMO 1981-2021; CanSIPsv2 1981-2021; CFS2 1982-2021 and NCAR CCSM4 1982-2021 mean forecast SSTs for May to November, initialized early April 2021. Also, ECMWF SEAS5 May to July forecast mean SSTs. The SSTs for the models were ensembled (6 Model Ensemble) by finding the simple arithmetic mean of the output i.e. the response (Y) variable of all six. The X domain used was 20°S to 30°N and 140°E to 20°W. The Y variables were ACE values, named storms, hurricanes and major hurricanes for the Atlantic Basin (including the Caribbean Sea and the Gulf of Mexico) for the period 1971 to 2020.

The following CPT settings were used:

- X modes: maximum was 8 and the minimum was 1
- Training period (observed SSTs and Y variables): 1971-2020, 50 years.
- Training period (forecast SSTs and Y variables): 1981/82-2020, 39/40 years.
- Climatological period – 1981-2010
- Transformation setting: Gamma distribution
- Confidence level: 70%
- Missing value replacement: best near-neighbor

- Target season: May to November
- All other settings are by default

Results

Three sets of forecasts were produced, and the final forecast issued is based on the simple arithmetic mean of the three – see tables 1 and 2 below. Note that the forecast spread may not be symmetric around the mean value, given the historical distribution of tropical cyclone activity.

Forecast Parameters and 1981-2010 Average in [brackets]	SSTs			Ensemble Mean Forecast
	Mar 1971-2021	Jan to Mar 1971-2021	May to Nov 5 Model Ensemble 1981/82-2021	
ACE [105.6]	151 (87-222)	162 (91-243)	238 (148-361)	184 (109-275)
Named Storms [12]	18 (14-24)	19 (15-27)	27 (22-38)	21 (17-30)
Hurricanes [6]	8 (5-12)	8 (5-12)	12 (8-18)	9 (6-14)
Major Hurricanes [3]	4 (2-6)	4 (2-6)	6 (3-9)	5 (2-7)

Table 1: Forecast parameters with 70 percent confidence intervals in (parentheses)

Forecast Parameters	SSTs			Ensemble Mean Forecast
	Mar 1971-2021	Jan to Mar 1971-2021	Jun to Nov 5 Model Ensemble 1982-2021	
ACE	A 67, N 26, B 7	A 71, N 22, B 7	A 88, N 9, B 3	A 75, N 19, B 6
Named Storms	A 85, N 13, B 2	A 90, N 9, B 1	A 96, N 3, B 1	A 90, N 9, B 1
Hurricanes	A 61, N 27, B 12	A 63, N 25, B 12	A 84, N 12, B 4	A 70, N 21, B 9
Major Hurricanes	A 63, N 27, B 10	A 67, N 25, B 8	A 82, N 14, B 4	A 71, N 22, B 7

Table 2: Forecast parameters expressed probabilistically. A - above normal; N - near normal and B - below normal.

Verification of previous forecasts

The tables contain the forecast for each parameter with the 70 percent confidence interval in (parentheses) i.e. 70% of forecasts are likely to fall in this range. ACE is Accumulated Cyclone Energy index. So, for example, the 2017, July 5 (best) forecast is for 16 named storms with a 70% confidence that the number of named storms will be in the range 11-22.

2017	Apr	May	Jun	Jul 5 ¹	Update Aug 4	Obs.
Named Storms	-	-	-	16 (11-22)	18 (13-22)	17
Hurricanes	-	-	-	7 (4-10)	7 (4-10)	10
Major Hurricanes	-	-	-	4 (2-5)	3 (2-5)	6
ACE	-	-	-	140 (75-216)	152 (84-222)	223

Table 3: ¹My maiden forecast of the hurricane season

2018	Apr 10	Update May 10	Update Jun 11	Update Jul 15	Update Aug 10	Obs.
Named Storms	15 (11-19)	13 (10-17)	11 (8-15)	12 (8-15)	11 (9-15)	14 ²
Hurricanes	7 (4-10)	6 (4-10)	5 (3-8)	5 (3-8)	5 (3-8)	8
Major Hurricanes	4 (2-5)	3 (1-4)	2 (1-4)	3 (1-4)	2 (1-4)	2
ACE	135 (70-200)	119 (63-190)	93 (48-153)	99 (51-167)	93 (51-151)	130 ³

Table 4: ²There were 15 named storms in 2018 with an ACE of 132³ (2.4 from Alberto), which formed in May, outside the range of my forecasts of the hurricane season proper – June 1 to Nov 30.

2019	Apr 10	Update May 16	Update Jun 12	Update Jul 15	Update Aug 15	Obs.
Named Storms	13 (10-18)	12 (9-17)	13 (10-17)	13 (9-16)	12 (9-16)	17 ⁴
Hurricanes	7 (4-10)	7 (4-10)	6 (4-9)	6 (4-9)	6 (4-9)	6
Major Hurricanes	3 (1-5)	2 (1-5)	3 (1-5)	3 (2-5)	3 (2-5)	3
ACE	124 (67-201)	113 (62-184)	114 (62-181)	127 (71-198)	136 (77-209)	131

Table 5: ⁴There were 18 named storms in 2019 with an ACE of 131 (0.245 from Alberto), which formed in May, outside the range of my forecasts of the hurricane season proper – June 1 to Nov 30.

2020	Apr 10	Update May 10	Update Jun 10	Update Jul 13	Update Aug 15	Obs.
Named Storms	20 (14-25)	19 (14-23)	21 (17-26)	23 (17-28)	26 (20-32)	30
Hurricanes	9 (6-12)	9 (6-12)	9 (6-13)	9 (6-13)	10 (7-15)	13
Major Hurricanes	5 (3-8)	4 (2-7)	5 (2-7)	5 (3-7)	4 (3-7)	6
ACE	191 (106-288)	189 (112-276)	202 (122-289)	200 (122-283)	218 (141-305)	185

Table 6: Record number of named storms, two (Arthur and Bertha) before the official hurricane season, which were not captured in the April and May forecasts. ACE accumulation by the two storms amounted to 1.99

Definitions and acronyms

Accumulated Cyclone Energy (ACE) – A measure of a named storm’s potential for wind and storm surge destruction defined as the sum of the square of a named storm’s maximum wind speed (in 10⁴ knots²) for each 6-hour period of its existence. The 1981-2010 average value of this parameter is 106 for the Atlantic basin.

Atlantic Basin – The area including the entire North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico.

El Niño – A 12-18-month period during which anomalously warm sea surface temperatures occur in the eastern half of the equatorial Pacific. Moderate or strong El Niño events occur irregularly, about once every 3-7 years on average.

ERSSTv5 – Extended Reconstructed Sea Surface Temperature version five.

CCSM4 – Community Climate System Model version 4.

CFSv2 – Climate Forecast System version 2 GCM.

CMC4 – Canadian Meteorological Centre version 4 GCM.

EMC – Environmental Modeling Center of the United States.

GCM – General Circulation Model.

GFDL-FLOR – Geophysical Fluid Dynamics Laboratory-Forecast-Oriented Low Ocean Resolution GCM.

Hurricane (H) – A tropical cyclone with sustained low-level winds of 74 miles per hour (33 ms⁻¹ or 64 knots) or greater.

Major Hurricane (MH) – A hurricane which reaches a sustained low-level wind of at least 111 mph (96 knots or 50 ms⁻¹) at some point in its lifetime. This constitutes a category 3 or higher on the Saffir/Simpson scale.

Named Storm (NS) – A hurricane, a tropical storm or a sub-tropical storm.

NCAR – US National Centre for Atmospheric Research.

NCDC – National Climate Data Center of the United States

NCEP – National Centers for Environmental Prediction of the United States.

NOAA – National Oceanic Atmospheric Administration of the United States.

Saffir/Simpson Hurricane Wind Scale – A measurement scale ranging from 1 to 5 of hurricane wind intensity. One is a weak hurricane; whereas, five is the most intense hurricane. Tropical North Atlantic (TNA) index – A measure of sea surface temperatures in the area from 5.5-23.5°N, 57.5-15°W.

SSTs – Sea surface temperatures.

Tropical Cyclone (TC) – A large-scale circular flow occurring within the tropics and subtropics which has its strongest winds at low levels; including hurricanes, tropical storms and other weaker rotating vortices.

Tropical Storm (TS) – A tropical cyclone with maximum sustained winds between 39 mph (18 ms⁻¹ or 34 knots) and 73 mph (32 ms⁻¹ or 63 knots).

Vertical Wind Shear – The difference in horizontal wind between 200 mb (approximately 40,000 feet or 12 km) and 850 mb (approximately 5000 feet or 1.6 km).

268Weather will issue an update to this forecast for the 2021 Atlantic Hurricane Season (June 1 to November 30, plus May) around the 10th of every month until August. The first update will be issued around May 10, 2021.