



August Forecast Update for North Atlantic Hurricane Activity in 2018

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Forecast Summary

TSR continues to predict a quiet North Atlantic hurricane season.

TSR (Tropical Storm Risk) maintains its pre-season forecast issued in late May 2018 and anticipates that the 2018 North Atlantic hurricane season will be quiet with hurricane numbers and an ACE Index well below norm. The forecast spans the period from 1st June to 30th November 2018 and employs data through to the end of July 2018. The main factors that influence the forecast are the presence and expected persistence of unusually cool sea waters, enhanced trade winds and enhanced sea level pressures in the tropical North Atlantic and Caribbean Sea where the majority of hurricanes form. These environmental fields are all suppressing for North Atlantic hurricane activity and are associated with an unusually strong Azores high pressure system that occurred during April, May and June 2018. TSR has slightly raised its forecast compared to a month ago due to the environmental fields mentioned above not being quite as strong as anticipated originally and due to the unexpected occurrence of two hurricanes in early July 2018.

Atlantic ACE Index and System Numbers in 2018

		ACE Index	Intense Hurricanes	Hurricanes	Tropical Storms
TSR Forecast	2018	58	1	5	11
68yr Climate Norm	1950-2017	103	3	6	11
10yr Climate Norm	2008-2017	115	3	7	15
Forecast Skill at this Lead	1980-2017	49%	40%	53%	53%

- Key: ACE Index = Accumulated Cyclone Energy Index = Sum of the Squares of 6-hourly Maximum Sustained Wind Speeds (in units of knots) for all Systems while they are at least Tropical Storm Strength. ACE Unit = $\times 10^4$ knots².
- Intense Hurricane = 1 Minute Sustained Wind > 95Kts = Hurricane Category 3 to 5.
 Hurricane = 1 Minute Sustained Wind > 63Kts = Hurricane Category 1 to 5.
 Tropical Storm = 1 Minute Sustained Winds > 33Kts.
 Forecast Skill = Percentage Improvement in Mean Square Error over Running 10-year Prior Climate Norm from Replicated Real Time Forecasts 1980-2017.

There is only an 8% probability that the 2018 Atlantic hurricane season ACE index will be above-average (defined as an ACE index value in the upper tercile historically (>119)), a 33% likelihood it will be near-normal (defined as an ACE index value in the middle tercile historically (69 to 119) and a 59% chance it will be below-normal (defined as an ACE index value in the lower tercile historically (<69)). The 68-year period 1950-2017 is used for climatology.

- Key: Terciles = Data groupings of equal (33.3%) probability corresponding to the upper, middle and lower one-third of values historically (1950-2017).
- Upper Tercile = ACE index value greater than 119.
 Middle Tercile = ACE index value between 69 and 119.
 Lower Tercile = ACE index value less than 69.

ACE Index & Numbers Forming in the MDR, Caribbean Sea and Gulf of Mexico in 2018

		ACE Index	Intense Hurricanes	Hurricanes	Tropical Storms
TSR Forecast	2018	40	1	3	6
68yr Climate Norm	1950-2017	81	2	4	8
10-yr Climate norm	2008-2017	95	3	5	10
Forecast Skill at this Lead	1980-2017	46%	43%	63%	67%

The Atlantic hurricane Main Development Region (MDR) is the region 10°N-20°N, 20°W-60°W between the Cape Verde Islands and the Caribbean Lesser Antilles. A storm is defined as having formed within this region if it reached at least tropical depression status while in the area.

There is only an 11% probability that the 2018 Atlantic hurricane season ACE index will be above-average (defined as an ACE index value in the upper tercile historically (>92)), a 36% likelihood it will be near-normal (defined as an ACE index value in the middle tercile historically (43 to 92) and a 53% chance it will be below-normal (defined as an ACE index value in the lower tercile historically (<43)). The 68-year period 1950-2017 is used for climatology.

USA Landfalling ACE Index and Numbers in 2018

		ACE Index	Hurricanes	Tropical Storms
TSR Forecast	2018	0.9	1	2
68yr Climate Norm	1950-2017	2.4	1	3
10yr Climate Norm	2008-2017	2.2	1	3
Forecast Skill at this Lead	1980-2017	36%	7%	8%

Key: ACE Index = Accumulated Cyclone Energy Index = Sum of the Squares of hourly Maximum Sustained Wind Speeds (in units of knots) for all Systems while they are at least Tropical Storm Strength and over the USA Mainland (reduced by a factor of 6). ACE Unit = $\times 10^4$ knots².

Strike Category = Maximum 1 Minute Sustained Wind of Storm Directly Striking Land.

USA Mainland = Brownsville (Texas) to Maine.

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

There is an 18% probability that in 2018 the USA landfalling ACE index will be above average (defined as a USA ACE index value in the upper tercile historically (>2.08)), a 28% likelihood it will be near-normal (defined as a USA ACE index value in the middle tercile historically (0.83 to 2.08)) and a 54% chance it will be below-normal (defined as a USA ACE index value in the lower tercile historically (<0.83)). The 68-year period 1950-2017 is used for climatology.

Caribbean Lesser Antilles Landfalling Numbers in 2018

		ACE Index	Intense Hurricanes	Hurricanes	Tropical Storms
TSR Forecast	2018	0.7	0	0	1
67yr Climate Norm	1950-2017	1.5	0	0	1
10yr Climate Norm	2008-2017	1.9	0	1	2
Forecast Skill at this Lead	1980-2017	19%	7%	20%	21%

Key: ACE Index = Accumulated Cyclone Energy Index = Sum of the Squares of hourly Maximum Sustained Wind Speeds (in units of knots) for all Systems while they are at least Tropical Storm Strength and within the region 10°-18°N, 63°-60°W (reduced by a factor of 6). ACE Unit = $\times 10^4$ knots².

Strike Category = Maximum 1 Minute Sustained Wind of Storm Directly Striking Land.

Lesser Antilles = Island Arc from Anguilla to Trinidad Inclusive.

Methodology and Key Predictors for 2018

The TSR statistical seasonal hurricane forecast model divides the North Atlantic into three regions and employs separate forecast models for each region before summing the regional hurricane forecasts to obtain an overall forecast. For two of these three regions (tropical North Atlantic, and the Caribbean Sea and Gulf of Mexico) the forecast model pools different environmental fields involving August-September sea surface temperatures (SSTs) and July-September trade wind speed to select the environmental field or combination of fields which gives the highest replicated real-time skill for hurricane activity over the prior 10-year period. The nature of this process means that the details of the seasonal forecast model can vary subtly from year-to-year and also with lead time within the same year. Separate forecast models are employed to predict the July-September trade wind speed and to predict the August-September SSTs. Finally bias corrections are employed for each predictand based on the forecast model performance for that predictand over the prior 10 years.

The main factors behind the TSR forecast for a quiet hurricane season in 2018 are the anticipated suppressing effects of 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), and of the August-September forecast sea surface temperature for the North Atlantic MDR (10°N–20°N, 20°W–60°W). The current forecast for the July-September trade wind is $0.59 \pm 0.39 \text{ ms}^{-1}$ stronger than normal (1980-2017 climatology) which is weaker than our early July forecast value of $1.92 \pm 0.67 \text{ ms}^{-1}$ stronger than normal. None of the 11 years since 1980 with a July-September trade wind speed as high as our forecast for 2018 have experienced more than five hurricanes. The current forecast for the August-September MDR SST is $0.31 \pm 0.13^\circ\text{C}$ cooler than normal which is warmer than our early July forecast value of $0.55 \pm 0.29^\circ\text{C}$ cooler than normal (1980-2017 climatology). None of the nine years since 1980 with an August-September MDR SST as cool as our forecast for 2018 have experienced more than five hurricanes. The July-September 2018 trade wind prediction uses the current (18th July 2018) consensus expectation for borderline weak El Niño conditions in July-September 2018 provided by the dynamical and statistical model ENSO outlooks (http://iri.columbia.edu/climate/ENSO/currentinfo/SST_table-.html) assembled by the International Research Institute for Climate and Society. Stronger than normal trade winds during July-August-September are associated with below-average vorticity and above-average vertical wind shear over the hurricane main development region, and thus with below-average hurricane activity. Cooler than normal waters in August and September between the west coast of Africa and the Caribbean where many hurricanes develop means there is less heat and moisture to aid the formation and intensification of tropical cyclones.

Forecast Model for US ACE Index and US Landfalling Hurricane Numbers

The TSR early August forecast for the US ACE index and US landfalling hurricane and tropical storm numbers in 2018 is predicted from an ensemble of two models: (1) the July 2017 tropospheric wind anomalies between heights of 925mb and 400mb over North America, the east Pacific and the North Atlantic (Saunders and Lea, 2005). Wind anomalies in these regions in July are indicative of persistent atmospheric circulation patterns that either favour or hinder evolving hurricanes from reaching US shores during August and September; (2) thinning from the forecast of total Atlantic basin activity.

Saunders, M. A. and A. S. Lea, Seasonal prediction of hurricane activity reaching the coast of the United States, *Nature*, 434, 1005-1008, 2005.

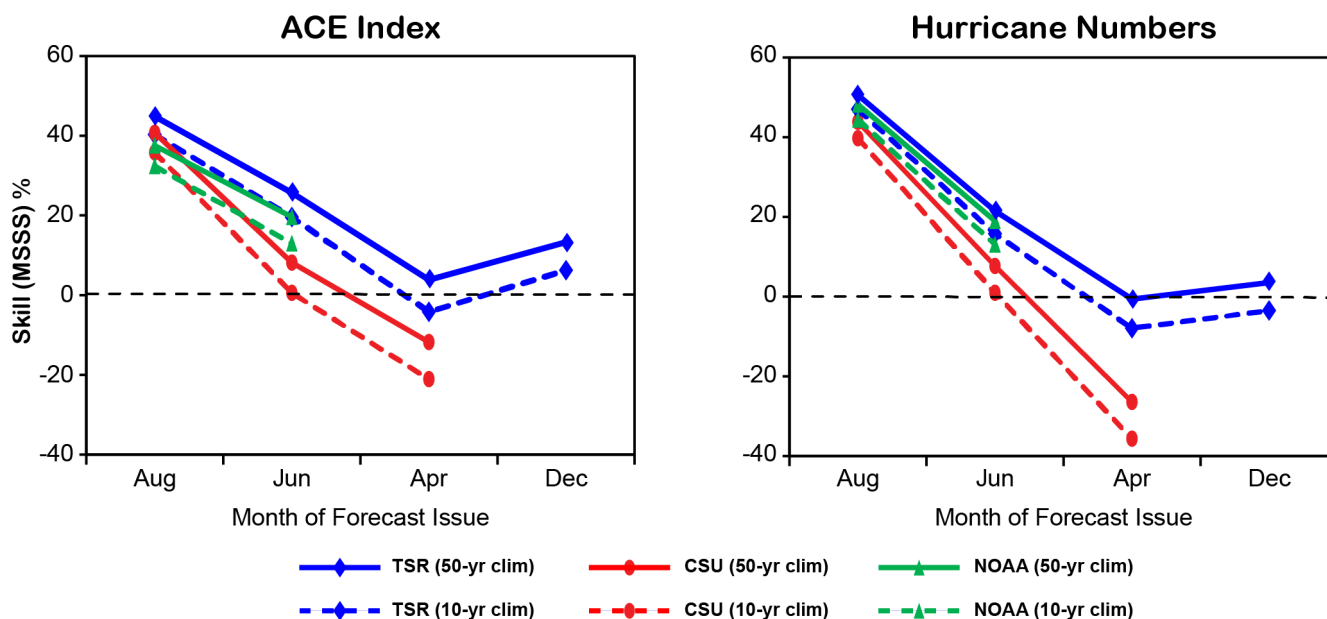
The Precision of Seasonal Hurricane Forecasts

The figure on the next page displays the seasonal forecast skill for North Atlantic hurricane activity for the 15-year period between 2003 and 2017. This assessment uses the seasonal forecast values issued publicly in real-time by the three forecast centres TSR, NOAA (National Oceanic and Atmospheric Administration) and CSU (Colorado State University). Skill is assessed as a function of lead time for two measures of hurricane activity: ACE and basin hurricane numbers.

Forecast precision is assessed using the Mean Square Skill Score (MSSS) which is the percentage improvement in mean square error over a climatology forecast. Positive skill indicates that the model performs better than climatology, while a negative skill indicates that it performs worse than climatology. Two different climatologies are used: a fixed 50-year (1951-2000) climatology and a running prior 10-year climate norm.

It should be noted that NOAA does not issue seasonal hurricane outlooks before late May and that CSU stopped providing quantitative extended-range hurricane outlooks from the prior December in 2011. It is clear from the figure that there is little skill in forecasting the upcoming number of hurricanes from the previous December. Skill climbs slowly as the hurricane season approaches with moderate-to-good skill levels being achieved from early August.

TSR was the best performing statistical seasonal forecast model at all lead times for 2003-2017.



Further information about the accuracy of the TSR seasonal outlooks and the long-term validity of the TSR seasonal model may be obtained from these two new publications:

1. Klotzbach, P. J., M. A. Saunders, G. D. Bell and E. S. Blake (2017), North Atlantic seasonal hurricane prediction: underlying science and an evaluation of statistical models, in *Climate Extremes: Patterns and Mechanisms*, Geophys. Monogr. Ser., vol 226, edited by S-Y. Wang et al., pp. 315-328, American Geophysical Union, John Wiley & Sons. doi/10.1002/9781119068020.ch19/pdf (Please see section 19.2.5 – pages 323-325).
2. Saunders, M. A., P. J. Klotzbach and A. S. R. Lea (2017), Replicating annual North Atlantic hurricane activity 1878-2012 from environmental variables, *J. Geophys. Res. Atmos.*, 122, 6284-6297, doi:10.1002/2017JD026492.

Further Information and Next Forecast

Further information about TSR forecasts and verifications may be obtained from the TSR web site <http://www.tropicalstormrisk.com>. This is the final TSR forecast update for the 2018 North Atlantic hurricane season. TSR will issue its extended range outlook for the 2019 North Atlantic hurricane season in early December 2018.

Appendix – Predictions from Previous Months

1. Atlantic ACE Index and System Numbers

Atlantic ACE Index and System Numbers 2018					
		ACE Index	Named Tropical Storms	Hurricanes	Intense Hurricanes
Average Number (1950-2017)		103	11	6	3
Average Number (2008-2017)		115	15	7	3
TSR Forecasts	6 Aug 2018	58	11	5	1
	5 July 2018	36	9	4	1
	29 May 2018	43	9	4	1
	5 Apr 2018	84	12	6	2
	7 Dec 2017	117	15	7	3
CSU Forecasts	2 Aug 2018	64	12	5	1
	2 July 2018	60	11	4	1
	31 May 2018	90	14	6	2
	5 Apr 2018	130	14	7	3
NOAA Forecast	24 May 2018	60-134	10-16	5-9	1-4
UK Met Office Forecast	25 May 2018	105	11	6	-

2. MDR, Caribbean Sea and Gulf of Mexico ACE Index and Numbers

MDR, Caribbean Sea and Gulf of Mexico ACE Index and Numbers 2018					
		ACE Index	Named Tropical Storms	Hurricanes	Intense Hurricanes
Average Number (1950-2017)		79	7	4	2
Average Number (2008-2017)		82	12	5	2
TSR Forecasts	6 Aug 2018	40	6	3	1
	5 July 2018	17	5	2	1
	29 May 2018	23	4	2	1
	5 Apr 2018	65	8	4	2

3. US ACE Index and Landfalling Numbers

US Landfalling Numbers 2018				
		ACE Index	Named Tropical Storms	Hurricanes
Average Number (1950-2017)		2.4	3	1
Average Number (2008-2017)		2.2	3	1
TSR Forecasts	6 Aug 2018	0.9	2	1
	5 July 2018	0.4	2	1
	29 May 2018	0.5	2	1
	5 Apr 2018	1.5	2	1

4. Lesser Antilles ACE Index and Landfalling Numbers

Lesser Antilles Landfalling Numbers 2018					
		ACE Index	Named Tropical Storms	Hurricanes	Intense Hurricanes
Average Number (1950-2017)		1.5	1	0	0
Average Number (2008-2017)		1.9	2	1	0
TSR Forecasts	6 Aug 2018	0.7	1	0	0
	5 July 2018	0.4	1	0	0
	29 May 2018	0.6	1	0	0
	5 Apr 2018	1.4	1	0	0