



Extended Range Forecast for Atlantic Hurricane Activity in 2016

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Forecast Summary

TSR predicts Atlantic hurricane activity in 2016 will be about 20% below the long-term average. However, the uncertainties associated with this outlook are large and forecast skill at this extended range is historically low.

The TSR (Tropical Storm Risk) extended range forecast for Atlantic hurricane activity in 2016 anticipates a slightly below-normal season. Based on current and projected climate signals, Atlantic basin tropical cyclone activity is forecast to be about 20% below the 1950-2015 long-term norm and about 15% below the recent 2006-2015 10-year norm. The forecast spans the period from 1st June to 30th November 2016 and employs data through to the end of November 2015. TSR's main predictor at this extended lead (6 months before the 2016 hurricane season starts) is the forecast July-September trade wind speed over the Caribbean Sea and tropical North Atlantic. This parameter influences cyclonic vorticity (the spinning up of storms) and vertical wind shear in the main hurricane track region. At present TSR anticipates the trade wind and SST predictor will have a near-neutral effect on activity. The precision of TSR's December outlooks for upcoming Atlantic hurricane activity between 1980 and 2015 is low.

Atlantic ACE Index and System Numbers in 2016

		ACE Index	Intense Hurricanes	Hurricanes	Tropical Storms
TSR Forecast (\pm FE)	2016	79 (\pm 57)	2 (\pm 2)	5 (\pm 3)	13 (\pm 5)
66yr Climate Norm (\pm SD)	1950-2015	101	3	6	11
10yr Climate Norm	2006-2015	94	3	6	14
Forecast Skill at this Lead	1980-2015	14%	9%	0%	0%

- 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.
 SD = Standard Deviation.
 FE (Forecast Error) = Standard Deviation of Errors in Replicated Real Time Forecasts 1980-2015.
 Forecast Skill = Percentage Improvement in Mean Square Error over Running 10-year Prior Climate Norm from Replicated Real Time Forecasts 1980-2015.

There is a 25% probability that the 2016 Atlantic hurricane season ACE index will be above-average (defined as an ACE index value in the upper tercile historically (>118)), a 34% likelihood it will be near-normal (defined as an ACE index value in the middle tercile historically (66 to 118)) and a 41% chance it will be below-normal (defined as an ACE index value in the lower tercile historically (<66)). The 66-year period 1950-2015 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 (1950-2015).
- Upper Tercile = ACE index value greater than 118.
 Middle Tercile = ACE index value between 66 and 118.
 Lower Tercile = ACE index value less than 66.

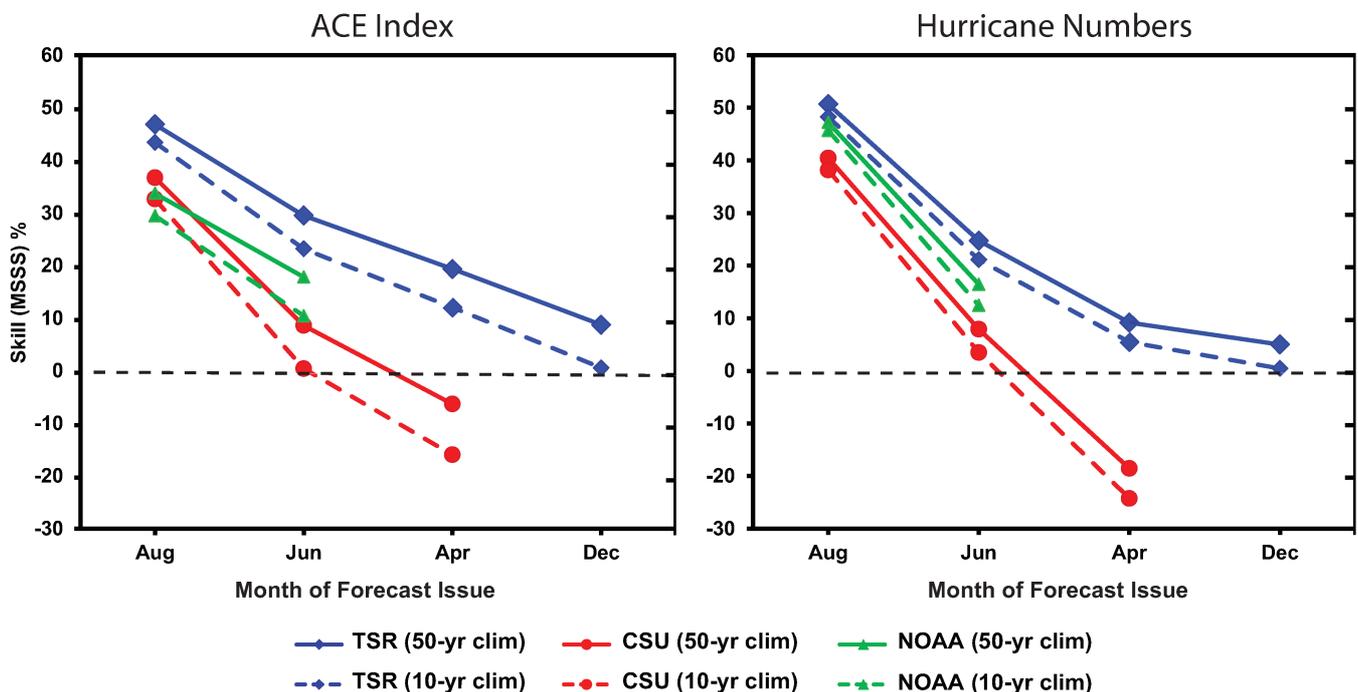
Methodology and Key Predictor(s) for 2016

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 factor underpinning the TSR forecast for 2016 hurricane activity being about 20% below the long term norm is the anticipated near-neutral effect of the July-September 2016 forecast trade wind at 925mb height over the Caribbean Sea and tropical North Atlantic region (7.5°N – 17.5°N, 100°W – 30°W). The current forecast for this predictor is $0.41 \pm 0.89 \text{ ms}^{-1}$ weaker than normal (1980-2015 climatology). The July-September 2016 trade wind prediction is based on an expectation of neutral ENSO conditions in July-September 2016 as forecast by a consensus of dynamical and statistical model ENSO outlooks (http://iri.columbia.edu/climate/ENSO/currentinfo/SST_table-.html) provided by the International Research Institute for Climate and Society. The forecast skill for this predictor at this lead time is 26% assessed for 1980-2015. However, it should be stressed that uncertainties in the forecast July-September 2016 trade wind speed at this extended lead are large due to large uncertainties in ENSO and in North Atlantic and Caribbean Sea SSTs.

Precision of Seasonal Hurricane Forecasts 2003-2015

The figure below displays the seasonal forecast skill for North Atlantic hurricane activity for the most recent 13-year period between 2003 and 2015. 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 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 after 2011. It is clear there is little skill in forecasting the upcoming ACE and numbers of hurricanes from the previous December for the period 2003-2015. Skill climbs slowly as the hurricane season approaches with moderate-to-good skill levels being achieved by early August.

TSR was the best performing statistical seasonal forecast model at all lead times for 2003-2015.

Further Information and Next Forecast

Further information about TSR forecasts and verifications may be obtained from the TSR web site <http://www.tropicalstormrisk.com>. The first TSR forecast update for the 2016 Atlantic hurricane season will be issued on Tuesday 5th April 2016.