



August Forecast Update for Atlantic Hurricane Activity in 2014

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Forecast Summary

TSR predicts Atlantic hurricane activity in 2014 will be about 30% below the 1950-2013 norm. The precision of TSR's August outlook for upcoming North Atlantic hurricane activity is good.

The TSR (Tropical Storm Risk) August forecast update for Atlantic hurricane activity in 2014 continues to anticipate below-normal activity. Based on current and projected climate signals, Atlantic basin tropical cyclone activity based on the ACE index is forecast to be about 30% below the 1950-2013 long-term norm and about 45% below the recent 2004-2013 10-year norm. U.S. landfalling activity is forecast to be 25% below the long-term norm and 30% below the 10-year norm. The forecast spans the period from 1st June to 30th November 2014 and employs data through to the end of July 2014. TSR's two predictors are the forecast July-September trade wind speed over the Caribbean and tropical North Atlantic, and the forecast August-September 2014 sea surface temperatures in the tropical North Atlantic. The former influences cyclonic vorticity (the spinning up of storms) in the main hurricane track region, while the latter provides heat and moisture to power incipient storms in the main track region. At present, TSR anticipates both predictors will have a small to moderate suppressing effect on activity.

Atlantic ACE Index and System Numbers in 2014

		ACE Index	Intense Hurricanes	Hurricanes	Tropical Storms
TSR Forecast (\pm FE)	2014	70 (\pm 41)	2 (\pm 1)	6 (\pm 2)	12 (\pm 3)
64yr Climate Norm (\pm SD)	1950-2013	102 (\pm 59)	3 (\pm 2)	6 (\pm 3)	11 (\pm 4)
10yr Climate Norm	2004-2013	129	4	8	16
Forecast Skill at this Lead	1980-2013	55%	47%	57%	47%

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 1980-2013.

Forecast Skill = Percentage Improvement in Mean Square Error over Running 10-year Prior Climate Norm from Replicated Real Time Forecasts 1980-2013.

There is only an 11% probability that the 2014 Atlantic hurricane season ACE index will be above-average (defined as an ACE index value in the upper tercile historically (>120)), a 39% likelihood it will be near-normal (defined as an ACE index value in the middle tercile historically (70 to 120)) and a 50% chance it will be below-normal (defined as an ACE index value in the lower tercile historically (<70)). The 64-year period 1950-2013 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 (1950-2013).

Upper Tercile = ACE index value greater than 120.

Middle Tercile = ACE index value between 70 and 120.

Lower Tercile = ACE index value less than 70.

ACE Index & Numbers Forming in the MDR, Caribbean Sea and Gulf of Mexico in 2014

		ACE Index	Intense Hurricanes	Hurricanes	Tropical Storms
TSR Forecast (\pm FE)	2014	47 (\pm 42)	1 (\pm 1)	4 (\pm 2)	7 (\pm 2)
64yr Climate Norm (\pm SD)	1950-2013	81 (\pm 58)	2 (\pm 2)	4 (\pm 3)	7 (\pm 4)
Forecast Skill at this Lead	1980-2013	47%	50%	63%	52%

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 a 14% probability that the 2014 Atlantic hurricane season ACE index will be above-average (defined as an ACE index value in the upper tercile historically (>92)), a 40% likelihood it will be near-normal (defined as an ACE index value in the middle tercile historically (43 to 92) and a 46% chance it will be below-normal (defined as an ACE index value in the lower tercile historically (<43)). The 64-year period 1950-2013 is used for climatology.

USA Landfalling ACE Index and Numbers in 2014

		ACE Index	Hurricanes	Tropical Storms
TSR Forecast (Range)	2014	1.8 (0.4-3.0)	2 (1-3)	3 (1-5)
64yr Climate Norm (\pm SD)	1950-2013	2.4 (\pm 2.2)	1 (\pm 1)	3 (\pm 2)
10yr Climate Norm	2004-2013	2.7	2	4
Forecast Skill at this Lead	1980-2013	29%	17%	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
 Range = Minimum and Maximum Values approximately corresponding to One Standard Deviation in Replicated Real Time Forecasts 1980-2013

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

There is a 36% probability that in 2014 the USA landfalling ACE index will be above average (defined as a USA ACE index value in the upper tercile historically (>2.51)), a 31% likelihood it will be near-normal (defined as a USA ACE index value in the middle tercile historically (1.09 to 2.51)) and a 33% chance it will be below-normal (defined as a USA ACE index value in the lower tercile historically (<1.09)). The 64-year period 1950-2013 is used for climatology.

Caribbean Lesser Antilles Landfalling Numbers in 2014

		ACE Index	Intense Hurricanes	Hurricanes	Tropical Storms
TSR Forecast (Range)	2014	0.8 (0.3-1.1)	0 (0-1)	0 (0-1)	1 (1-2)
64yr Climate Norm	1950-2013	1.3	0	0	1
10yr Climate Norm	2004-2013	1.1	0	1	1
Forecast Skill at this Lead	1980-2013	26%	13%	35%	29%

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.
 Lesser Antilles = Island Arc from Anguilla to Trinidad Inclusive.

Key Predictors for 2014

The main factors behind the TSR forecast for a below-norm hurricane season in 2014 are the anticipated moderate suppressing effect 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 the small suppressing effect of August-September forecast sea surface temperature for the Atlantic MDR (10°N – 20°N, 20°W – 60°W). The current forecasts for these predictors are $1.13 \pm 0.47 \text{ ms}^{-1}$ stronger than normal which is similar to the early July forecast value of $1.16 \pm 0.60 \text{ ms}^{-1}$ stronger than normal (1980-2013 climatology), and $0.07 \pm 0.18^\circ\text{C}$ cooler than normal (1980-2013 climatology) which is warmer than the early July forecast value of $0.22 \pm 0.18^\circ\text{C}$ cooler than normal. The July-September 2014 trade wind prediction at this lead is based on the observed July 2014 trade wind speed anomaly. The forecast skills for these predictors at this lead are 73% and 83% respectively.

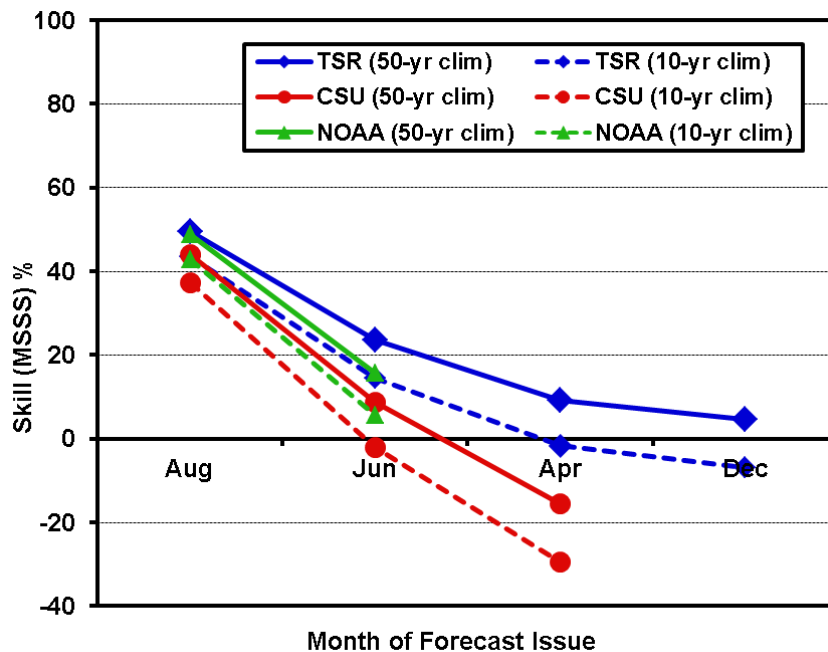
Forecast Model for US ACE Index and US Landfalling Hurricane Numbers

The TSR early August forecast for the US ACE index and US landfalling hurricane and tropical storm numbers in 2014 is predicted from an ensemble of two models: (1) the July 2014 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 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 below displays the seasonal forecast skill as a function of lead time for predicting the number of North Atlantic hurricanes. Skill is displayed for the most recent 10-year period 2004-2013 and is shown for three forecast centres: TSR, NOAA (National Oceanic and Atmospheric Administration) and CSU (Colorado State University). The TSR skills below differ from those on page 1 as the latter are computed for the 34-year period 1980-2013.



Skill of seasonal outlooks for North Atlantic hurricane activity 2004-2013 as a function of issue month and climatology.

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 (1950-1999) 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 skill levels being achieved from early July (especially by TSR) and good skill levels being achieved from early August.

In terms of recent seasonal forecast successes and failures, TSR correctly predicted the tercile (lower, middle, upper) of the North Atlantic hurricane seasons in 2004, 2005, 2008, 2010, 2011 and 2012 from the previous December. In contrast, the TSR extended range forecasts for the 2003, 2006, 2007, 2009 and 2013 hurricane seasons were less impressive.

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 outlook for the 2014 Atlantic hurricane season. A summary of the 2014 Atlantic hurricane season and a verification of the TSR seasonal forecasts will be issued in January 2015.

Appendix – Predictions from Previous Months

1. Atlantic ACE Index and System Numbers

Atlantic ACE Index and System Numbers 2014					
		ACE Index	Named Tropical Storms	Hurricanes	Intense Hurricanes
Average Number (±SD) (1950-2013)		102 (±59)	11 (±4)	6 (±3)	3 (±2)
Average Number (2004-2013)		129	16	8	4
TSR Forecasts (±SD)	5 Aug 2014	70 (±41)	12 (±3)	6 (±2)	2 (±1)
	4 Jul 2014	74 (±45)	12 (±3)	5 (±2)	2 (±2)
	5 Jun 2014	77 (±50)	12 (±4)	5 (±3)	2 (±2)
	27 May 2014	73 (±53)	12 (±4)	5 (±3)	2 (±2)
	7 Apr 2014	75 (±57)	12 (±4)	5 (±3)	2 (±2)
	12 Dec 2013	106 (±58)	14 (±4)	6 (±3)	3 (±2)
CSU Forecasts	31 Jul 2014	65	10	4	1
	1 Jul 2014	65	10	4	1
	2 Jun 2014	65	10	4	1
	10 Apr 2014	55	9	3	1
NOAA Forecast	22 May 2014	37-93	8-13	3-6	1-2
UK Met Office Forecast	16 May 2014	84 (±37)	10 (±3)	6 (±3)	-
Institute of Meteorology, Cuba	1 Aug 2014	-	9	4	-
	4 May 2014	-	9	4	-

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

MDR, Caribbean Sea and Gulf of Mexico ACE Index and Numbers 2014					
		ACE Index	Named Tropical Storms	Hurricanes	Intense Hurricanes
Average Number (\pm SD) (1950-2013)		80 (\pm 58)	7 (\pm 4)	4 (\pm 2)	2 (\pm 2)
Average Number (2004-2013)		106	11	6	3
TSR Forecast (\pm SD)	5 Aug 2014	47 (\pm 42)	7 (\pm 2)	4 (\pm 2)	1 (\pm 1)
	4 Jul 2014	51 (\pm 43)	7 (\pm 2)	3 (\pm 2)	1 (\pm 1)
	5 Jun 2014	54 (\pm 45)	7 (\pm 3)	3 (\pm 2)	1 (\pm 1)
	27 May 2014	51 (\pm 49)	7 (\pm 3)	3 (\pm 2)	1 (\pm 1)
	7 Apr 2014	52 (\pm 52)	7 (\pm 3)	3 (\pm 2)	2 (\pm 2)

3. US ACE Index and Landfalling Numbers

US Landfalling Numbers 2014				
		ACE Index	Named Tropical Storms	Hurricanes
Average Number (\pm SD) (1950-2013)		2.4 (\pm 2.2)	3 (\pm 2)	1 (\pm 1)
Average Number (2004-2013)		2.7	4	2
TSR Forecasts (Range)	5 Aug 2014	1.8 (0.4-3.0)	3 (1-5)	2 (1-3)
	4 Jul 2014	1.8 (0-3.8)	3 (1-5)	2 (0-3)
	5 Jun 2014	1.9 (0-3.9)	3 (1-5)	1 (0-3)
	27 May 2014	1.8 (0-3.9)	3 (1-5)	1 (0-3)
	7 Apr 2014	1.8 (0.1-3.9)	3 (1-5)	1 (0-3)
	12 Dec 2013	2.6 (0.5-4.7)	4 (2-6)	2 (1-3)

4. Lesser Antilles ACE Index and Landfalling Numbers

Lesser Antilles Landfalling Numbers 2014					
		ACE Index	Named Tropical Storms	Hurricanes	Intense Hurricanes
Average Number (1950-2013)		1.3	1	0	0
Average Number (2004-2013)		1.1	1	1	0
TSR Forecasts (Range)	5 Aug 2014	0.8 (0.3-1.1)	1 (1-2)	0 (0-1)	0 (0-1)
	4 Jul 2014	0.8 (0-2.6)	1 (0-2)	0 (0-1)	0 (0-1)
	5 Jun 2014	0.9 (0-2.7)	1 (0-2)	0 (0-1)	0 (0-1)
	27 May 2014	0.8 (0-2.7)	1 (0-2)	0 (0-1)	0 (0-1)
	7 Apr 2014	0.9 (0-2.8)	1 (0-2)	0 (0-1)	0 (0-1)