



August Forecast Update for Atlantic and U.S. Hurricane Activity in 2013

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Forecast Summary

TSR slightly raises its July outlook and predicts North Atlantic and U.S. hurricane activity in 2013 will be about 20% above the long-term (1950-2012) norm. The precision of TSR's August forecasts for upcoming North Atlantic hurricane activity since 2000 is high.

The TSR (Tropical Storm Risk) August forecast update anticipates North Atlantic basin tropical cyclone activity in 2013 will be ~20% above the 1950-2012 long-term norm but ~20% below the recent 2003-2012 10-year norm. U.S. landfalling hurricane activity is forecast to be similar to the recent 10-year norm. The forecast spans the period from 1st June to 30th November 2013 and employs data through to the end of July 2013. TSR's two predictors for basin activity are the forecast July-September trade wind speed over the Caribbean and tropical North Atlantic, and the forecast August-September 2013 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. TSR predicts U.S. hurricane activity using July tropospheric wind anomalies. TSR anticipates all predictors will have a neutral-to-slight-enhancing effect on activity. The TSR basin forecast has increased slightly since early July because North Atlantic August-September sea surface temperatures are now expected to be slightly warmer than thought previously.

Atlantic ACE Index and System Numbers in 2013

		ACE Index	Intense Hurricanes	Hurricanes	Tropical Storms
TSR Forecast (\pm FE)	2013	121 (\pm 38)	3.0 (\pm 1.2)	6.9 (\pm 1.8)	14.8 (\pm 2.9)
63yr Climate Norm (\pm SD)	1950-2012	103 (\pm 59)	2.7 (\pm 1.9)	6.3 (\pm 2.7)	10.8 (\pm 4.4)
10yr Climate Norm	2003-2012	143	3.8	8.1	16.4
Forecast Skill at this Lead	1980-2012	57%	49%	59%	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 1980-2012.

Forecast Skill = Percentage Improvement in Mean Square Error over Running 10-year Prior Climate Norm from Replicated Real Time Forecasts 1980-2012.

There is a 49% probability that the 2013 Atlantic hurricane season ACE index will be above-average (defined as an ACE index value in the upper tercile historically (>121)), a 41% likelihood it will be near-normal (defined as an ACE index value in the middle tercile historically (72 to 121) and only a 10% chance it will be below-normal (defined as an ACE index value in the lower tercile historically (<72)). The 63-year period 1950-2012 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 (1950-2012).

Upper Tercile = ACE index value greater than 121.

Middle Tercile = ACE index value between 72 and 121.

Lower Tercile = ACE index value less than 72.

ACE Index & Numbers Forming in the MDR, Caribbean Sea and Gulf of Mexico in 2013

		ACE Index	Intense Hurricanes	Hurricanes	Tropical Storms
TSR Forecast (\pm FE)	2013	96 (\pm 41)	2.6 (\pm 1.1)	5.0 (\pm 1.5)	10.0 (\pm 2.4)
63yr Climate Norm (\pm SD)	1950-2012	81 (\pm 58)	2.4 (\pm 1.8)	4.4 (\pm 2.5)	7.4 (\pm 3.5)
10yr Climate Norm	2003-2012	119	3.4	6.2	11.1
Forecast Skill at this Lead	1980-2012	47%	52%	64%	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 a 50% probability that the 2013 Atlantic hurricane season ACE index will be above-average (defined as an ACE index value in the upper tercile historically (>96)), a 40% likelihood it will be near-normal (defined as an ACE index value in the middle tercile historically (44 to 96) and only a 10% chance it will be below-normal (defined as an ACE index value in the lower tercile historically (<44)). The 63-year period 1950-2012 is used for climatology.

USA Landfalling ACE Index and Numbers in 2013

		ACE Index	Hurricanes	Tropical Storms
TSR Forecast (\pm FE)	2013	2.9 (\pm 1.8)	1.8 (\pm 1.5)	4.0 (\pm 2.1)
63yr Climate Norm (\pm SD)	1950-2012	2.4 (\pm 2.2)	1.5 (\pm 1.4)	3.1 (\pm 2.0)
10yr Climate Norm	2003-2012	2.9	1.8	3.9
Forecast Skill at this Lead	1980-2012	31%	18%	9%

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.

Landfall 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 a 58% probability that in 2013 the USA landfalling ACE index will be above average (defined as a USA ACE index value in the upper tercile historically (>2.54)), a 26% likelihood it will be near-normal (defined as a USA ACE index value in the middle tercile historically (1.15 to 2.54)) and a 16% chance it will be below-normal (defined as a USA ACE index value in the lower tercile historically (<1.15)). The 63-year period 1950-2012 is used for climatology.

Caribbean Lesser Antilles Landfalling Numbers in 2013

		ACE Index	Intense Hurricanes	Hurricanes	Tropical Storms
TSR Forecast (\pm FE)	2013	1.6 (\pm 1.7)	0.3 (\pm 0.3)	0.6 (\pm 0.5)	1.4 (\pm 0.8)
63yr Climate Norm (\pm SD)	1950-2012	1.3 (\pm 2.0)	0.2 (\pm 0.5)	0.5 (\pm 0.7)	1.1 (\pm 1.0)
10yr Climate Norm	2003-2012	1.0	0.1	0.5	1.3
Forecast Skill at this Lead	1980-2012	27%	14%	35%	32%

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.

Landfall Strike Category = Maximum 1 Minute Sustained Wind of Storm Directly Striking Land.
Lesser Antilles = Island Arc from Anguilla to Trinidad Inclusive.

Key Predictors for North Atlantic hurricane activity in 2013

The key factors behind the TSR forecast for a hurricane season with activity ~20% above the long-term norm are the anticipated near-neutral 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 slight enhancing effect of August-September forecast sea surface temperature (SST) for the Atlantic MDR (10°N – 20°N, 20°W – 60°W). The current forecasts for these predictors are $0.01 \pm 0.47 \text{ ms}^{-1}$ weaker than normal (1980-2012 climatology) and $0.04 \pm 0.13^\circ\text{C}$ warmer than normal (1980-2012 climatology). For comparison, July's values for these two predictors were $0.04 \pm 0.61 \text{ ms}^{-1}$ stronger than normal (1980-2012 climatology) and $0.10 \pm 0.17^\circ\text{C}$ cooler than normal (1980-2012 climatology). The July-September 2013 trade wind prediction at this lead is based on the observed July 2013 trade wind speed anomaly. The forecast skills for these predictors at this lead are 73% and 85% respectively.

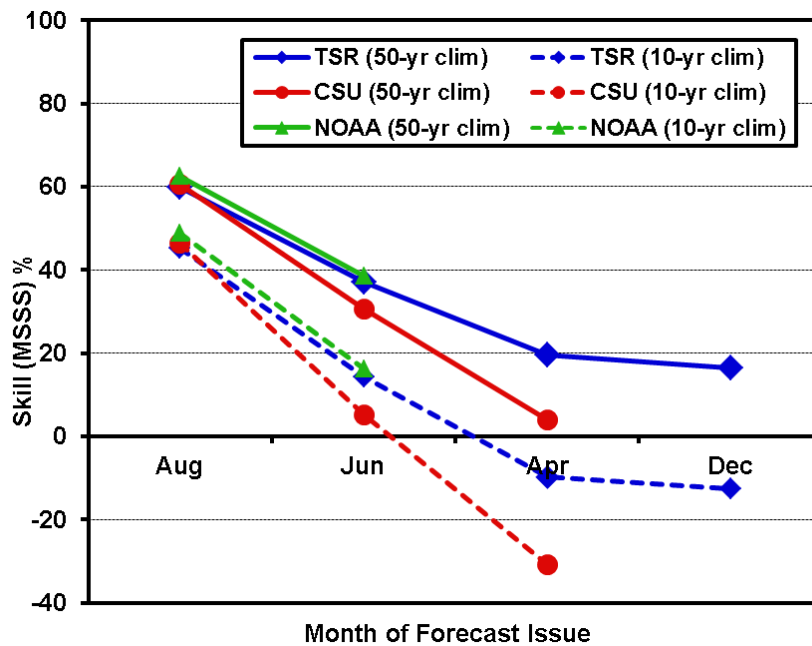
Forecast Model for US ACE Index and US Landfalling Hurricane Numbers

The TSR early August forecast for the US ACE index and US landfalling hurricane and tropical storm numbers in 2013 is predicted from an ensemble of two models: (1) the July 2013 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 2003-2012 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 33-year period 1980-2012.



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 good skill levels being achieved from early August. The precision of the TSR August forecasts 2003-2012 is good and of similar quality to those issued by CSU and NOAA.

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 2013 Atlantic hurricane season. A summary of the 2013 Atlantic hurricane season and a verification of the TSR seasonal forecasts will be issued in early January 2014.

References

- Knaff, J. A. and C. W. Landsea, An El Niño-Southern Oscillation Climatology and Persistence (CLIPER) Forecasting Scheme, *Wea. Forecasting*, **12**, 633-652, 1997.
- Lloyd-Hughes, B., M. A. Saunders and P. Rockett, A consolidated CLIPER model for improved August-September ENSO prediction skill, *Wea. Forecasting*, **19**, 1089-1105, 2004.

Appendix – Predictions from Previous Months

1. Atlantic ACE Index and System Numbers

Atlantic ACE Index and System Numbers 2013					
		ACE Index	Named Tropical Storms	Hurricanes	Intense Hurricanes
Average Number (\pm SD) (1950-2012)		103 (\pm 59)	10.8 (\pm 4.4)	6.3 (\pm 2.7)	2.7 (\pm 1.9)
Average Number (2003-2012)		143	16.4	8.1	3.8
TSR Forecasts (\pm SD)	6 Aug 2013	121 (\pm 38)	14.8 (\pm 2.9)	6.9 (\pm 1.8)	3.0 (\pm 1.2)
	5 Jul 2013	112 (\pm 44)	14.5 (\pm 3.4)	6.7 (\pm 2.2)	3.1 (\pm 1.4)
	4 Jun 2013	134 (\pm 47)	15.6 (\pm 3.6)	7.7 (\pm 2.4)	3.5 (\pm 1.5)
	24 May 2013	130 (\pm 51)	15.3 (\pm 3.9)	7.5 (\pm 2.7)	3.4 (\pm 1.5)
	5 Apr 2013	131 (\pm 55)	15.2 (\pm 4.1)	7.5 (\pm 2.8)	3.4 (\pm 1.6)
	5 Dec 2012	134 (\pm 56)	15.4 (\pm 4.3)	7.7 (\pm 2.9)	3.4 (\pm 1.6)
CSU Forecasts	2 Aug 2013	150	18	8	3
	3 Jun 2013	165	18	9	4
	10 Apr 2013	165	18	9	4
NOAA Forecast	23 May 2013	111-190	13-20	7-11	3-6
UK Met Office Forecast	15 May 2013	130 (\pm 54)	14 (\pm 4)	9 (\pm 5)	-
Institute of Meteorology, Cuba	1 Aug 2013	-	18	9	-
	4 May 2013	-	17	9	-

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

MDR, Caribbean Sea and Gulf of Mexico ACE Index and Numbers 2013					
	ACE Index	Named Tropical Storms	Hurricanes	Intense Hurricanes	
Average Number (\pm SD) (1950-2012)	81 (\pm 58)	7.4 (\pm 3.5)	4.4 (\pm 2.5)	2.4 (\pm 1.8)	
Average Number (2003-2012)	119	11.1	6.2	3.4	
TSR Forecast (\pm SD)	6 Aug 2013	96 (\pm 41)	10.0 (\pm 2.4)	5.0 (\pm 1.5)	2.6 (\pm 1.1)
	4 Jul 2013	88 (\pm 42)	9.2 (\pm 2.4)	4.8 (\pm 1.7)	2.7 (\pm 1.3)
	4 Jun 2013	110 (\pm 43)	10.3 (\pm 2.6)	5.8 (\pm 1.9)	3.1 (\pm 1.3)
	24 May 2013	106 (\pm 48)	10.0 (\pm 3.0)	5.6 (\pm 2.2)	3.0 (\pm 1.4)
	5 Apr 2013	72 (\pm 52)	7.4 (\pm 3.3)	3.9 (\pm 2.4)	2.3 (\pm 1.5)

3. US ACE Index and Landfalling Numbers

US Landfalling Numbers 2013				
	ACE Index	Named Tropical Storms	Hurricanes	
Average Number (\pm SD) (1950-2012)	2.4 (\pm 2.2)	3.1 (\pm 2.0)	1.5 (\pm 1.4)	
Average Number (2003-2012)	2.9	3.9	1.8	
TSR Forecasts (\pm SD)	6 Aug 2013	2.9 (\pm 1.8)	4.0 (\pm 2.1)	1.8 (\pm 1.5)
	4 Jul 2013	2.8 (\pm 2.0)	4.1 (\pm 2.1)	1.8 (\pm 1.5)
	4 Jun 2013	3.3 (\pm 2.0)	4.5 (\pm 2.2)	2.0 (\pm 1.5)
	24 May 2013	3.2 (\pm 2.0)	4.4 (\pm 2.1)	2.0 (\pm 1.5)
	5 Apr 2013	3.2 (\pm 2.1)	4.4 (\pm 2.2)	1.9 (\pm 1.5)
	5 Dec 2012	3.2 (\pm 2.1)	4.5 (\pm 2.2)	2.0 (\pm 1.5)

4. Lesser Antilles ACE Index and Landfalling Numbers

Lesser Antilles Landfalling Numbers 2013					
	ACE Index	Named Tropical Storms	Hurricanes	Intense Hurricanes	
Average Number (\pm SD) (1950-2012)	1.3 (\pm 2.0)	1.1 (\pm 1.0)	0.5 (\pm 0.7)	0.2 (\pm 0.5)	
Average Number (2003-2012)	1.0	1.3	0.5	0.1	
TSR Forecast (\pm SD)	6 Aug 2013	1.6 (\pm 1.7)	1.4 (\pm 0.8)	0.6 (\pm 0.5)	0.3 (\pm 0.3)
	4 Jul 2013	1.4 (\pm 1.8)	1.4 (\pm 0.9)	0.6 (\pm 0.6)	0.3 (\pm 0.3)
	4 Jun 2013	1.8 (\pm 1.8)	1.6 (\pm 0.9)	0.6 (\pm 0.6)	0.3 (\pm 0.4)
	24 May 2013	1.8 (\pm 1.9)	1.5 (\pm 1.0)	0.6 (\pm 0.6)	0.3 (\pm 0.4)
	5 Apr 2013	1.8 (\pm 2.0)	1.5 (\pm 1.0)	0.6 (\pm 0.6)	0.3 (\pm 0.4)