



Advisor

Seasonal tropical storm forecast verification

Issued November 2010



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Executive summary

The 2010 North Atlantic hurricane season was one of the most active seasons on record with a total of 19 named storms, of which 12 became hurricanes (winds > 74 mph) and 5 became major hurricanes (winds > 111 mph), and a combined accumulated cyclone energy (ACE) index of 170. Monthly forecasts issued by the Met Office for the period April to September 2010 provided good guidance on the number of tropical storms for the following 6-month period; observed numbers of tropical storms fell within the predicted range for all forecasts issued. Observed values of ACE index fell within the predicted range in all but two forecast months.

Forecast verification

A summary of forecast numbers of tropical storms and ACE index issued by the Met Office from April to September 2010 together with observed values is provided in Table 1. Each forecast was based on a world leading dynamical seasonal forecast model for the following 6-month period.

The 2010 season had 19 tropical storms and an ACE index of 170, above the long-term 1950–2000 average of 9.6 and 96.1, respectively. Forecasts of the number of tropical storms provided accurate guidance from April to September with observed values falling within the forecast range. The ACE index forecasts also provided good guidance of above-normal activity; however observed values were typically at the lower end of the predicted range. Two forecasts (issued in May and July) over-predicted the ACE index.

Forecast	Period of forecast	Number of tropical storms		ACE index	
		Forecast	Observed	Forecast	Observed
March*	April–September	11 (8–16)	14	121 (74–169)	135
April	May–October	16 (11–21)	19	186 (98–274)	167
May	June–November	22 (17–28)	19	282 (198–386)	167
June	July–December	23 (17–29)	18	251 (131–371)	160
July	August–January	20 (15–26)	17	272 (169–375)	159
August	September–February	14 (10–18)	13	135 (86–183)	103
September	October–March	7 (4–9)	5	33 (21–45)	33

Table 1. Observed and forecast numbers of tropical storms and accumulated cyclone energy (ACE) index issued monthly from March to September 2010. Forecast best-estimates are calculated from the mean of the 41-member ECMWF (European Centre for Medium Range Weather Forecasts) ensemble. Values in brackets represent ± 1 standard deviation about the ensemble mean. Colours refer to level of forecast skill: green: observed values within the predicted range; amber: observed values outside of the predicted range. * March forecast not issued.

The performance of the forecasting system for each lead time, as measured by the long-term 1987–2009 skill of retrospective forecasts (or hindcasts), is provided in Table 2. Linear correlations between observed and predicted values of tropical storm numbers and ACE index are positive for all forecast lead times.

Forecast	Period of forecast	Forecast skill (linear correlation)	
		Number of tropical storms	ACE index
March*	April–September	0.26	0.14
April	May–October	0.49	0.25
May	June–November	0.59	0.74
June	July–December	0.33	0.61
July	August–January	0.55	0.56
August	September–February	0.50	0.46
September	October–March	0.42	0.17

Table 2. Forecast skill (Pearson’s linear correlation) of ECMWF forecasts issued monthly from March to September. Skill is measured over the corresponding 6-month forecast period using hindcasts for 1987–2009. Perfect forecasts would have a skill of 1.0. Colours refer to level of forecast skill: green: linear correlation ≥ 0.6 ; amber: $0.3 \leq$ linear correlation < 0.6 ; red: linear correlation < 0.3 . * March forecast not issued.

Verification of the Met Office multi-model forecast

A multi-model forecast using output from the ECMWF and Met Office seasonal forecasting systems was issued on the Met Office website on 17th June 2010

(<http://www.metoffice.gov.uk/weather/tropicalcyclone/northatlantic.html>; Table 3). The forecast best-estimate was calculated from the mean of the combined 83 member ensemble. The forecast range represents ± 1 standard deviation about the ensemble mean. The multi-model forecast provided good guidance of above-normal activity of tropical storm numbers and ACE index, with observed values falling within the forecast ranges. The use of multi-model forecasts for the 2011 season is now being assessed for other issue dates.

Forecast	Period of forecast	Number of tropical storms		ACE index	
		Forecast	Observed	Forecast	Observed
June	July–November	20 (13–27)	19	204 (90–319)	170

Table 3. Observed and multi-model forecast numbers of tropical storms and accumulated cyclone energy (ACE) index. Colours refer to level of forecast skill: green: observed values within the predicted range.

The 2010 hurricane season

A summary of tropical storm activity in 2010 together with a corresponding plot of storm tracks is provided in Table 4 and Figure 1 of the appendices. The 2010 hurricane season was joint 2nd highest for named storms (19), joint 2nd highest for hurricanes (12), joint 8th highest for major hurricanes (5) and joint 10th highest for ACE index (170), based on historical records since 1944. No hurricanes or major hurricanes made landfall in the United States.

Concluding remarks

- The ECMWF forecasting system captured the signal for above-normal activity in 2010 as far ahead as March 2010.
- There was a systematic bias in the ACE index forecasts towards an extremely active season (i.e. comparable to or more active than 2005), which did not occur. It would be useful to assess the reasons as to why this was the case.
- The 2010 hurricane season was active in keeping with the known influences of the environmental factors during the period (e.g. La Niña conditions in the tropical Pacific and high sea surface temperatures in the tropical North Atlantic).
- Despite being the joint second most active season on record since 1944 in terms of tropical storm and hurricane numbers, no hurricanes made landfall in the U.S. However, storms did make landfall in Central America and the Caribbean Islands causing substantial damage (e.g. Hurricane Tomas in St. Lucia).
- The 2010 season is an example of when the total numbers of named storms and ACE index are not good indicators of landfall or damages in the United States. Therefore, work is needed to assess the mechanisms that control landfall in the United States and their predictability on seasonal timescales.

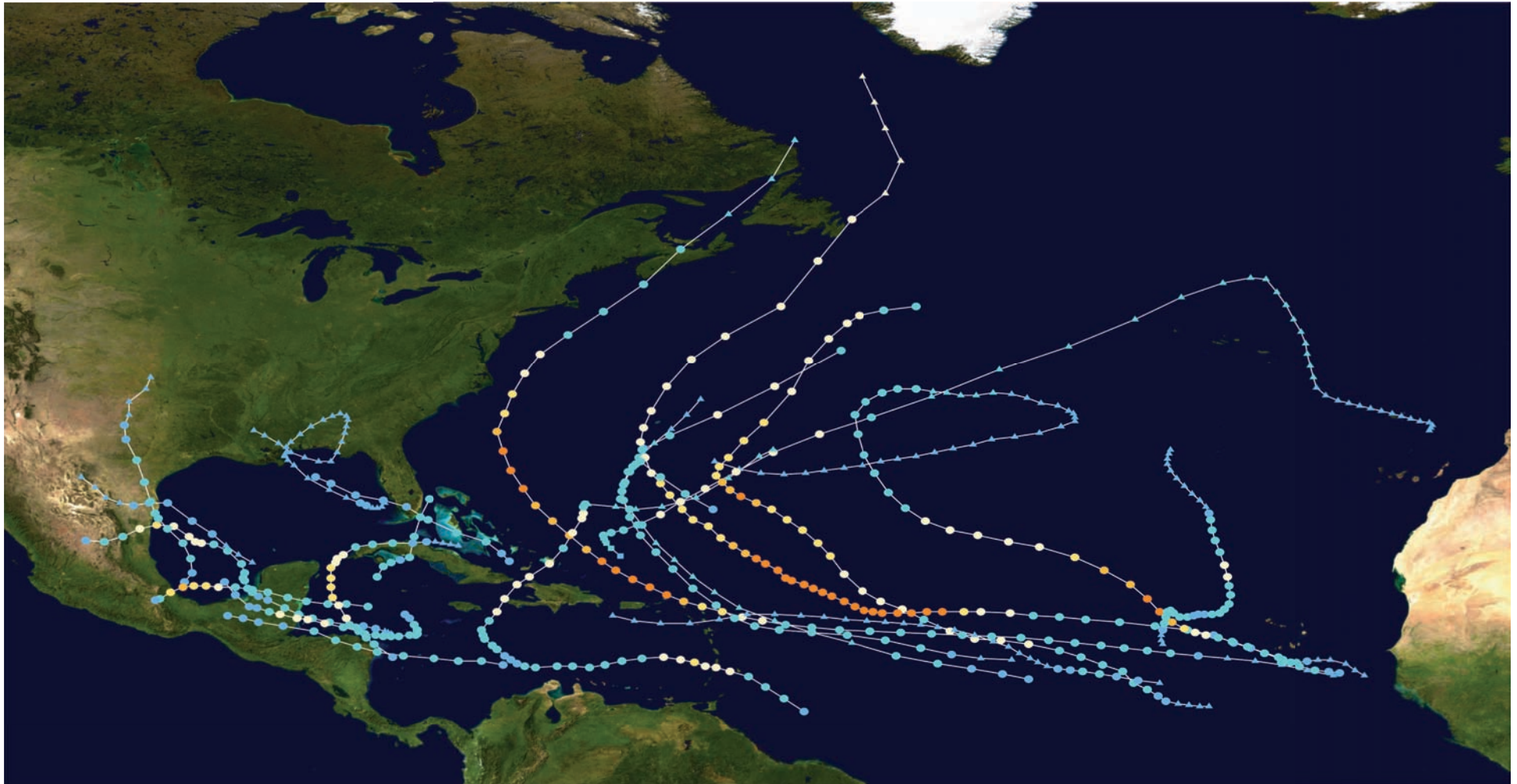
Appendices

Storm name	Active dates	Category	Maximum wind speed (mph)	Minimum central pressure (hPa)	ACE index (10^4 kt^2)
Alex	25 June–2 July	H2	110	946	7.4
Bonnie	22–24 July	TS	40	1007	0.5
Colin	2–8 August	TS	60	1005	2.6
Danielle	21–30 August	H4	135	942	21.8
Earl	25 August–4 September	H4	145	928	28.0
Fiona	30 August–4 September	TS	65	998	3.2
Gaston	1–2 September	TS	40	1005	0.4
Hermine	5–9 September	TS	70	989	1.4
Igor	8–21 September	H4	155	925	42.8
Julia	12–20 September	H4	140	948	14.5
Karl	14–18 September	H3	120	956	6.0
Lisa	20–26 September	H1	85	982	4.2
Matthew	23–26 September	TS	60	998	1.3
Nicole	28–30 September	TS	40	995	0.1
Otto	6–10 October	H1	85	976	6.6
Paula	11–15 October	H2	100	981	7.1
Richard	20–26 October	H1	90	978	4.7
Shary	28–30 October	H1	75	989	2.5
Tomas	29 October–7 November	H2	100	982	11.8

Saffir–Simpson hurricane wind scale

■ Tropical depression (0–39 mph)
■ Tropical storm (39–73 mph)
■ Category 1 (74–95 mph)
■ Category 2 (96–110 mph)
■ Category 3 (111–130 mph)
■ Category 4 (131–155 mph)
■ Category 5 (> 155 mph)

Table 4. Summary of tropical cyclone activity during the 2010 hurricane season. Please note that final details may change during post-analysis of the season and details of tropical depressions (wind speeds of approximately 30 mph) have been excluded. Colours refer to maximum storm intensity (based on the Saffir–Simpson hurricane wind scale).



Saffir-Simpson hurricane wind scale

- Tropical depression (0–39 mph)
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- Category 3 (111–130 mph)
- Category 4 (131–155 mph)
- Category 5 (> 155 mph)

Figure 1. Preliminary tracks of all tropical depressions (wind speeds of approximately 30 mph) and named storms which occurred during the 2010 hurricane season. Colours refer to storm intensity (based on the Saffir-Simpson hurricane wind scale) at each 6 hour interval. Source: http://en.wikipedia.org/wiki/2010_Atlantic_hurricane_season.

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