Met Office

Outlook

Seasonal Tropical Storm Outlook
for the North Atlantic

June 2010

Contents

SEASONAL TROPICAL STORM OUTLOOK FOR THE NORTH ATLANTIC

JULY–DECEMBER 2010
ISSUED JUNE 2010

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Seasonal Tropical Storm Outlook for the North Atlantic: July–December 2010

Issued June 2010

SUMMARY:

The latest seasonal forecast indicates an enhanced risk of above-normal tropical storm activity in the North Atlantic during July–December 2010 relative to the 1980–2009 period.

The dynamical model prediction is for 23 tropical storms as the most likely number during July–December 2010, with a two-standard-deviation range of 17–29.

The most likely predicted ACE index is 251 for July–December 2010, with a two-standard-deviation range of 131–371.

Seasonal prediction skill at this range is modest with linear correlations of 0.33 for predictions of tropical storm numbers and 0.61 for ACE index.

The indication for above-normal activity is consistent with the predicted evolution of ENSO to La Niña conditions by July 2010 and a continuation of the present above-normal sea surface temperatures (SSTs) in the tropical North Atlantic into the peak of the hurricane season.

The dynamical prediction system estimates for July–December 2010:

- a 39.0% chance of exceeding 25 tropical storms.
- a 34.1% chance of exceeding an ACE index of 250.

Users should note that the ACE index predicted as most likely has never been observed in the North Atlantic historical record. The reference period used to develop the forecast method contains only three seasons (1995, 2004 and 2005) with an ACE index greater than 200, which suggests that the precise values must be viewed with caution. Nevertheless, the forecast indicates an enhanced risk of an exceptionally active 2010 season.

Please see the glossary for definitions of many terms used in this report.

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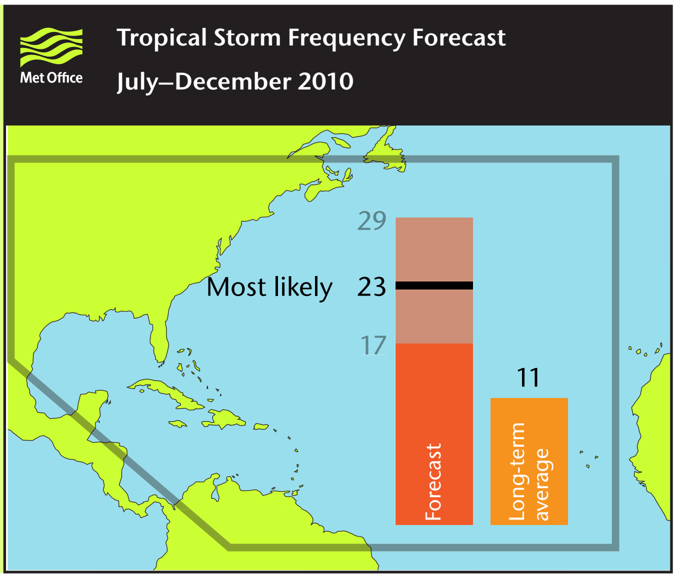
Tropical Storm Forecast for July-December 2010

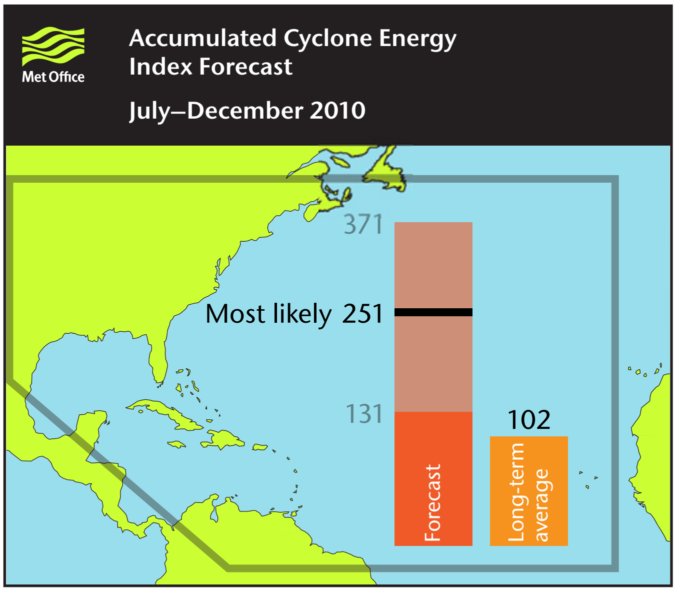
FORECAST:

The most likely number of tropical storms predicted to occur in the North Atlantic during July to December is 23, with a two-standard-deviation range of 17–29. This represents above-normal activity relative to the 1980–2009 long-term average of 11.0.

The most likely predicted ACE index is 251, with a two-standard-deviation range of 131–371. This represents more than twice the 1980–2009 average of 102.

The tropical storm frequency and ACE index forecasts are based on output from the ECMWF seasonal forecasting system issued 15th June 2010.





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Supporting Information

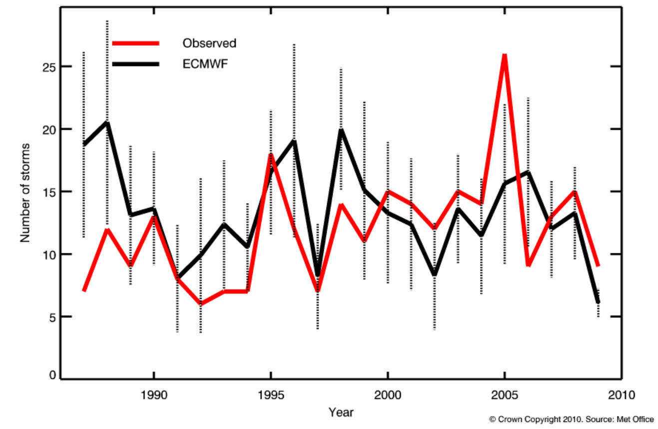
Deterministic Forecast Verification July–December 1987–2009

Verification is presented for ensemble-mean-predicted numbers of tropical storms and ACE index from each June for the period July–December 1987–2009. The assessment is based on retrospective predictions from the ECMWF seasonal forecasting system, which is an 11-member ensemble. The vertical bars on the graphs represent ± 1 standard deviation about the ensemble mean.

Prediction skill for forecasts initialised in June is modest. Linear correlations between predictions and observations are 0.33 for tropical storm numbers and 0.61 for the ACE index.

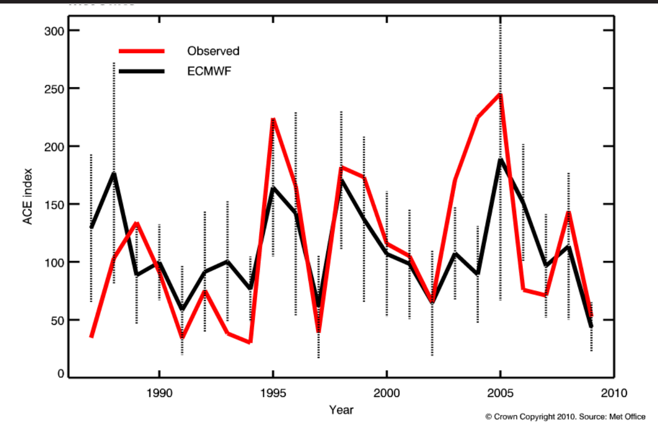
Linear correlation measures the strength of the linear relationship between forecasts and observations; it takes values between -1 and 1 (1 indicates a perfect linear relationship between the datasets).

Tropical Storm Frequency
July–December 1987–2009



Linear correlation: 0.33

Accumulated Cyclone Energy (ACE) index
July–December 1987–2009



Linear correlation: 0.61

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Probabilistic Forecasts

Tropical Storm Frequency

Probability forecast information is derived from the 41-member ECMWF seasonal forecast ensemble. The probability distribution function (PDF) provides the forecast probability (red) that the number of storms will be within discrete ranges. The cumulative distribution function (CDF) provides forecast probabilities (red) for exceeding a given number of storms. The distribution has not been smoothed or fitted to a functional form. Observed numbers of tropical storms for the period 1987–2009 (green) are calculated from the NOAA Hurricane Database (HURDAT). The observed categories over the last 5 years are indicated on the graph.

The probability distribution for the number of tropical storms predicted for July–December 2010 shows a marked shift to the more active categories relative to the climate distribution.

The forecast indicates an enhanced risk (39.0%) of exceeding 25 tropical storms during July–December 2010 (see figure). Users should note that more than 25 tropical storms have only occurred once in North Atlantic historical record (26 tropical storms during July–December 2005).

The predicted probability of exceeding the number of storms observed during July–December

- 2009 (9 storms) is 100.0%, compared to a climate chance of 60.9%.
- 2008 (15 storms) is 95.1% compared to a climate chance of 8.7%.

The predicted probability of 15 or fewer tropical storms during July–December 2010 is 4.9%, compared to a climate chance of 91.3%.

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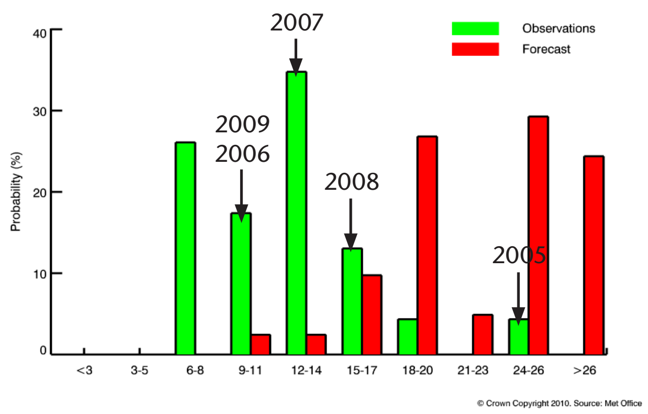
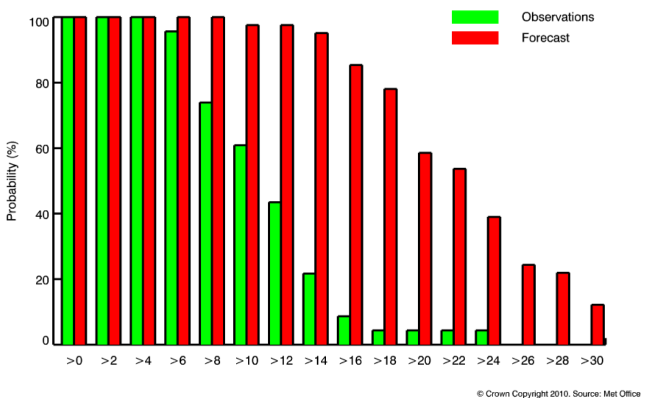
Tropical Storm Frequency
July–December 2010



PDF: Probability that the number of tropical storms will lie within given ranges



CDF: Probability that the number of tropical storms will exceed a given number

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Climate and forecast probabilities that the number of tropical storms will exceed a given threshold. Note: probabilities are given to one decimal place to help preserve a smooth distribution. Accuracy to one decimal place is not implied.

Number of tropical storms	Climate probability 1987–2009	Forecast probability 2010
> 0	100.0	100.0
> 1	100.0	100.0
> 2	100.0	100.0
> 3	100.0	100.0
> 4	100.0	100.0
> 5	100.0	100.0
> 6	95.7	100.0
> 7	78.3	100.0
> 8	73.9	100.0
> 9	60.9	100.0
> 10	60.9	97.6
> 11	56.5	97.6
> 12	43.5	97.6
> 13	34.8	97.6
> 14	21.7	95.1
> 15	8.7	95.1
> 16	8.7	85.4
> 17	8.7	85.4
> 18	4.3	78.0
> 19	4.3	78.0
> 20	4.3	58.5
> 21	4.3	58.5
> 22	4.3	53.7
> 23	4.3	53.7
> 24	4.3	39.0
> 25	4.3	39.0
> 26	0.0	24.4
> 27	0.0	24.4
> 28	0.0	22.0
> 29	0.0	22.0
> 30	0.0	12.2

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Accumulated Cyclone Energy (ACE) Index

July–December 2010

The probability distribution of predictions of ACE index also shows an enhanced probability of a tropical storm season more active than the climatological average.

The forecast indicates a moderate risk (34.1%) of exceeding an ACE index of 250 during July–December 2010 (see figure). As the forecast depends to a degree on training over a historical period which contains only one season with comparable observed activity (an ACE index of 245 was recorded during July–December 2005), the precise predicted values must be viewed with caution. Nevertheless, the forecast indicates an enhanced risk of an exceptionally active 2010 season.

The predicted probability of exceeding an ACE index observed during July–December

- 2009 (50) is 100.0%; the climatological chance is 78.3%.
- 2008 (140) is 92.7%; the climatological chance is 34.8%.

The predicted probability of an ACE index 150 or less during July–December 2010 is 7.3%; the climatological chance is 69.6%.

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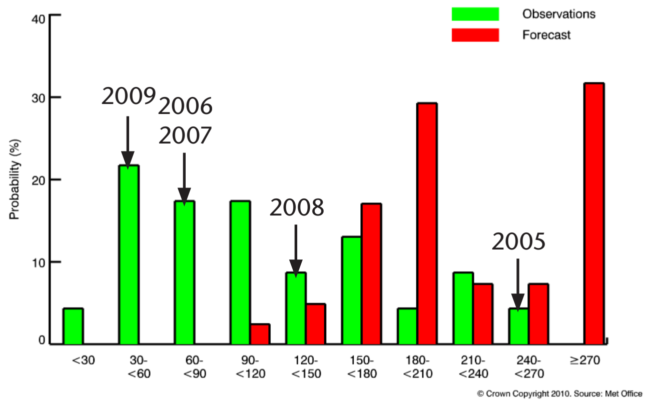
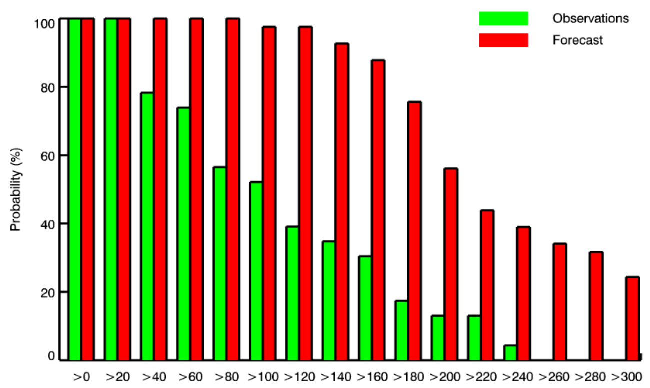
Accumulated Cyclone Energy (ACE) Index
July–December 2010



PDF: Probability that the ACE index will lie within given ranges



CDF: Probability that the ACE index will exceed a given threshold

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Climate and forecast probabilities that the ACE index will exceed a given threshold. Note: probabilities are given to one decimal place to help preserve a smooth distribution. Accuracy to one decimal place is not implied.

ACE Index	Climate probability 1987–2009	Forecast probability 2010
> 0	100.0	100.0
> 10	100.0	100.0
> 20	100.0	100.0
> 30	95.7	100.0
> 40	78.3	100.0
> 50	78.3	100.0
> 60	73.9	100.0
> 70	69.6	100.0
> 80	56.5	100.0
> 90	56.5	100.0
> 100	52.2	97.6
> 110	43.5	97.6
> 120	39.1	97.6
> 130	39.1	97.6
> 140	34.8	92.7
> 150	30.4	92.7
> 160	30.4	87.8
> 170	26.1	80.5
> 180	17.4	75.6
> 190	13.0	63.4
> 200	13.0	56.1
> 210	13.0	46.3
> 220	13.0	43.9
> 230	4.3	43.9
> 240	4.3	39.0
> 250	0.0	34.1
> 260	0.0	34.1
> 270	0.0	31.7
> 280	0.0	31.7
> 290	0.0	26.8
> 300	0.0	24.4

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Sea Surface Temperature: Monitoring and Prediction

El Niño/La Niña

During El Niño events, upper-level westerly winds typically increase across the tropical North Atlantic, leading to above-average vertical wind shear in the main development region (MDR). These conditions inhibit tropical cyclone development and intensification and favour fewer, weaker and shorter-lived systems during the season.

Conversely, during La Niña events, upper-level westerly winds are typically reduced across the North Atlantic, which can lead to an extended area of below-average vertical wind shear across the MDR. This creates favourable conditions for tropical cyclone development and intensification, often leading to enhanced tropical cyclone activity and landfall risk.

In this document references to El Niño and La Niña relate only to SST anomalies in the tropical Pacific Niño3.4 region (120°–170°W, 5°N–5°S). Since the atmospheric response to SSTs is variable in intensity and lag time and the teleconnections are not triggered by precise thresholds, we do not use the terms El Niño and La Niña according to formal definitions (of which there are several). Our references to El Niño, neutral and La Niña conditions generally correspond to SST anomalies >0.5°C, between -0.5 and +0.5°C, and <-0.5°C, respectively.

CURRENT CONDITIONS:
15 June 2010

SSTs in the tropical Pacific Niño3.4 region (not shown) are near-normal or 'neutral', with an area-averaged anomaly of -0.5°C relative to the 1961–1990 period.

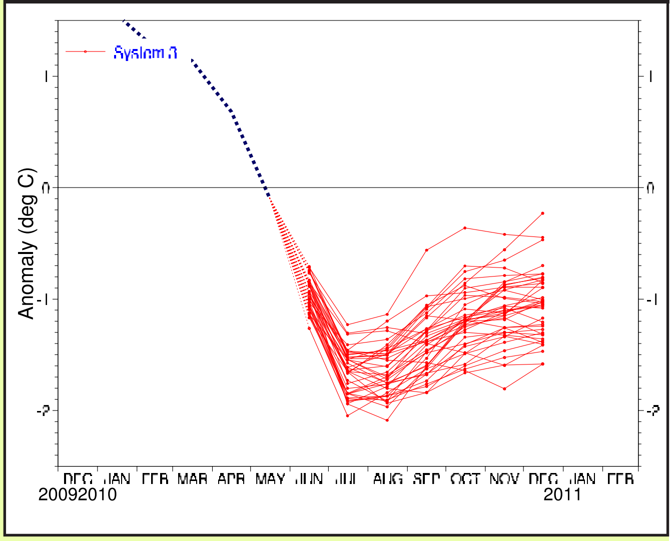
FORECAST:

The ECMWF seasonal forecasting system predicts a further cooling of SSTs to La Niña conditions by July 2010 (see figure).

La Niña conditions are forecast throughout the peak of the hurricane season (August–October), with the majority of the ensemble members lying between -0.8°C and -1.9°C during the period. None of the ensemble members predict a transition back to El Niño conditions before the end of 2010.

Predicted Niño3.4 SST anomalies from 1st June 2010. Anomalies are relative to 1971–2000.

Source: ECMWF



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North Atlantic Main Development Region (MDR)

Abnormally warm SSTs over the tropical North Atlantic main development region (MDR) create favourable conditions for tropical storm development and intensification by directly warming the overlying atmosphere and increasing the vertical instability. Prolonged periods of above-normal SSTs are typical of active hurricane seasons.

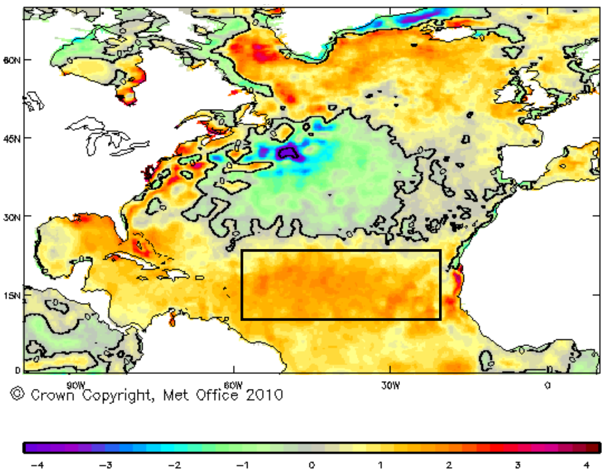
CURRENT CONDITIONS:
8-15 June 2010

SSTs are above-normal in the tropical North Atlantic MDR (shown boxed in figure), with anomalies up to +2.0°C throughout the region. Above-normal SSTs are also present in the Caribbean Sea; near- to above-normal SSTs are present in the Gulf of Mexico.

CHANGES SINCE LAST MONTH:

The Gulf of Mexico has continued to warm with SSTs now higher than average almost everywhere in the region. Smaller regions with SST anomalies up to +2.5°C have also formed around the tip of Florida.

Mean SST anomalies from the Met Office Operational SST and Sea Ice Analyses (OSTIA) for 8–15th June 2010. Anomalies are relative to 1985–2001.

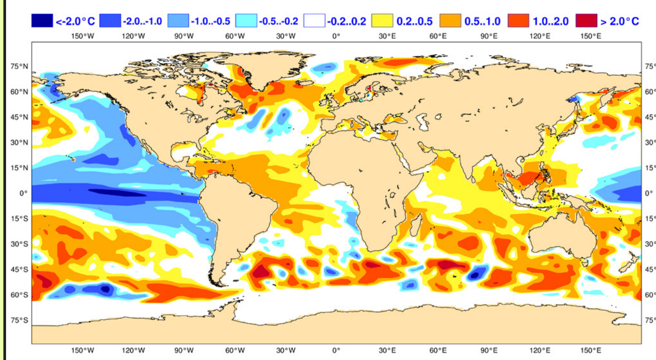


FORECAST:
August-October 2010

The ECMWF and Met Office (not shown) seasonal forecasting systems favour above-normal SSTs in the North Atlantic MDR throughout the peak of the hurricane season (August–October), with anomalies of up to +1.0°C across the eastern half of the region. Above-normal SSTs are also forecast in the Caribbean Sea.

Predicted SST anomaly for August–October 2010 (ensemble mean). Forecast issued 15th June 2010. Anomalies are relative to 1971–2000.

Source: ECMWF



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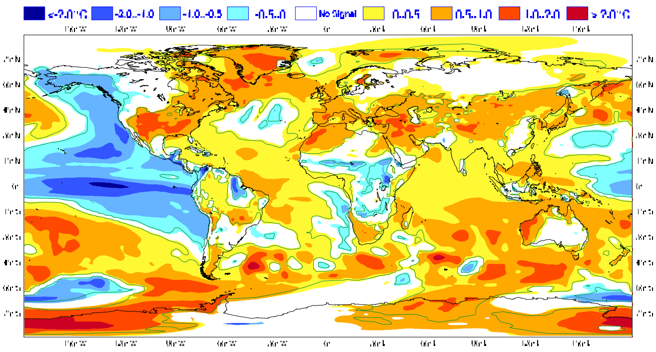
Surface Temperature

A contributing factor to the record hurricane season of 2005 was the increased strength of the African Easterly Jet (AEJ). The AEJ forms over Africa due to the temperature gradient between the Sahara and the equator with a greater temperature difference typically resulting in stronger African Easterly Waves.

The 2m temperature forecast for August–October 2010 shows positive temperature anomalies over the Sahara and negative anomalies further south over the Sahel region. This will promote development of the AEJ and associated African easterly waves during the three busiest months of the hurricane season.

Predicted 2m temperature anomaly for August–October 2010 (ensemble mean). Forecast issued 15th June 2010. Anomalies are relative to 1971–2000.

Source: ECMWF



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Vertical Wind Shear

Vertical wind shear is a measure of the variation of the horizontal wind with height. In this instance the shear is measured between the 200 hPa and 850 hPa pressure surfaces. Low levels of vertical wind shear, typically below 10ms^{-1}, are considered favourable for tropical storm development and intensification. Above this threshold, wind shear causes the displacement of moisture away from the low-level circulation inhibiting tropical cyclone genesis and intensification.

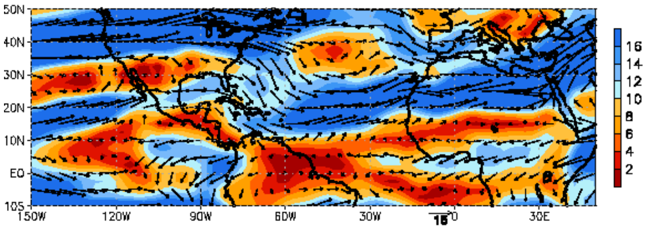
Low vertical wind shear, particularly in the western main development region and the Caribbean Sea, was considered a factor in the above-normal activity during 2005.

Wind shear across the North Atlantic MDR has been below normal throughout the first half of June 2010 (see bottom plot), continuing the trend of anomalously low vertical wind shear observed in this region since March 2010. Anomalously low vertical wind shear is also present over the Caribbean Sea and the Gulf of Mexico.

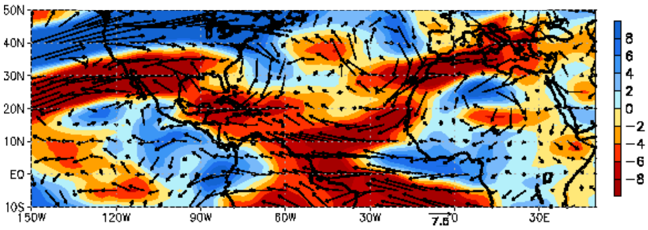
The magnitude of the wind shear (top plot) has continued to decrease across the tropical North Atlantic since mid-May 2010, with small regions of wind shear < 12 ms^{-1} developing off the east coast of Florida during the first half of June. A strong disturbance developed in the North Atlantic MDR during this period, which came close to becoming a tropical depression (wind speeds of approximately 30 mph), but wind shear has inhibited its development so far.

Observed conditions
2–12 June 2010

Vertical wind shear magnitude (ms^{-1})



Vertical wind shear anomalies (ms^{-1})



11-day averaged 200–850 hPa vertical wind shear magnitude (top) and anomalies (bottom) for 2nd –12th June 2010. Anomalies are relative to 1971–2000.

Source: CPC/NCEP

Seasonal forecasts of wind shear of relevance to cyclogenesis cannot be derived presently from global dynamical forecasting models. Wind shear is known to be connected to the phase of ENSO, but is also influenced by other local factors. Predictions of La Niña during the period of interest are likely to lead to lower than average wind shear in the MDR.

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Met Office Public Seasonal Tropical Storm Forecast for the North Atlantic

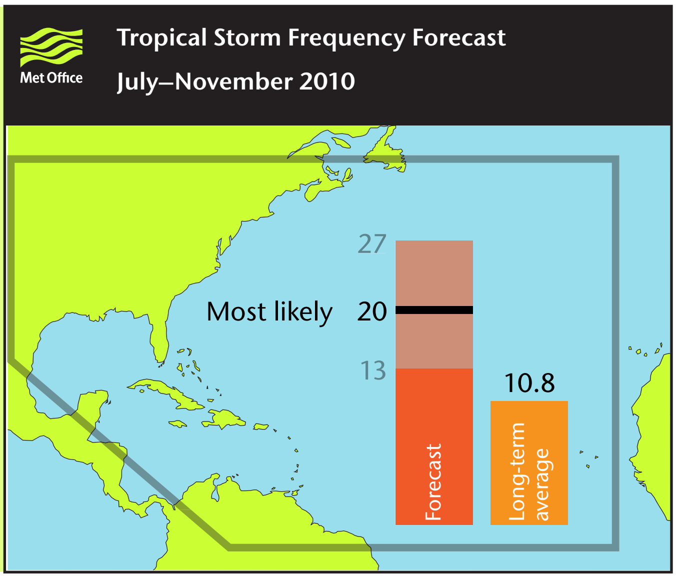
July–November 2010

On 17 June 2010 the Met Office issued a forecast for the most likely number of tropical storms and ACE index on the public website. This forecast is based on a combination of two dynamical models: ECMWF and the Met Office seasonal forecasting system GloSea4 (for details see http://www.metoffice.gov.uk/weather/tropicalcyclone/northatlantic.html).

FORECAST:

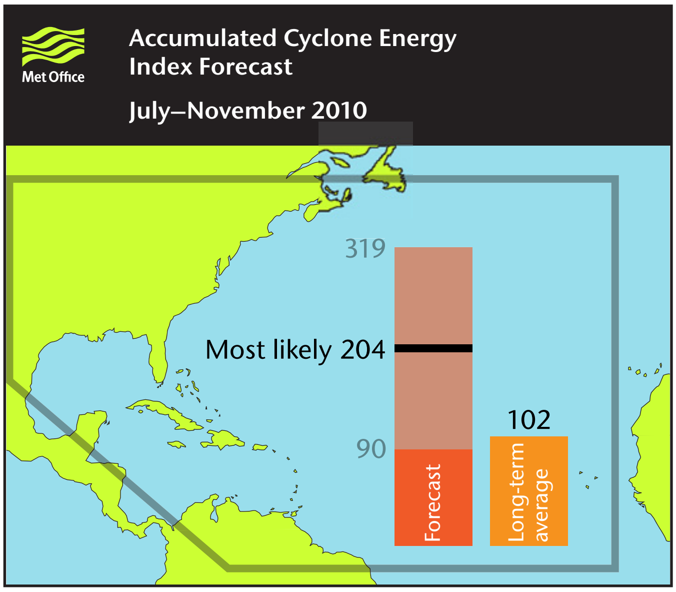
The most likely number of tropical storms predicted to occur in the North Atlantic during July to November is 20, with a two-standard-deviation range of 13–27. This represents above-normal activity relative to the 1980–2009 long-term average of 10.8.

The most likely predicted ACE index is 204, with a two-standard-deviation range of 90–319. This represents twice the 1980–2009 average of 102.



Note this forecast is for the shorter period July–November 2010. The ECMWF forecast and analysis provided in this report is for the period July–December 2010. A comparison of the number of tropical storms and ACE index predicted by the two individual models are provided in the next section ‘forecasts from other centres’.

A full assessment of the multi-model combination is pending.



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Forecasts from Other Centres

Seasonal forecasts of tropical storm activity have been issued by Colorado State University (CSU), Tropical Storm Risk (TSR), Florida State University (FSU) and the National Oceanic and Atmospheric Administration (NOAA) and are compared with the ECMWF, Met Office GloSea4 and multi-model forecasts in the table below.

The predictions from CSU, TSR and NOAA are based on statistical forecasting methods; the forecasts from ECMWF, the Met Office and FSU are produced using dynamical prediction methods. Note the statistical and the FSU forecasts are for the full season, whereas the ECMWF, Met Office and multi-model dynamical forecasts are for a specific period.

Statistical forecasts				
Centre	Issued	Tropical storms	Hurricanes	ACE index
NOAA	27 May 2010	14–23	8–14	136–236
Florida State University	1 June 2010	17 (±2)	10 (±1)	157 (±23)
Colorado State University	2 June 2010	18	10	185
Tropical Storm Risk	4 June 2010	17.7 (±3.5)	9.5 (±2.5)	182 (±48)
Long-term average (1950–2000)		**9.6**	**5.9**	**96.1**

Dynamical forecasts				
Centre	Issued	Forecast period	Tropical storms	ACE index
Florida State University	1 June 2010	Season	17 (±2)	157 (±23)
ECMWF	June 2010	July–Dec	23 (±6)	251 (±120)
Met Office GloSea4	June 2010	July–Nov	16 (±6)	158 (±88)
Multi-model (ECMWF* and GloSea4 forecasts)	June 2010	July–Nov	20 (±7)	204 (±115)
Long-term average (1950–2000)			**9.6**	**96.1**

* The ECMWF forecast for the 5-month period July–November is the same as that for the 6-month period July–December as no tropical storms are detected in the ECMWF forecast for December.

All the seasonal forecasts are for above-average numbers of tropical storms and ACE index for the 2010 Atlantic hurricane season, relative to the 1950–2000 long-term average. Of the two systems used for the Met Office public (multi-model) forecast, the Met Office best estimate (16) is at the lower end of the predicted range (13–27) and ECMWF (23) at the upper end.

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Future Forecasts

The next Met Office seasonal tropical storm outlook will be issued on Monday 26 July 2010.

Contact Point

For further information please contact matt.huddleston@metoffice.gov.uk.

We would welcome comments from users on this briefing material.

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Glossary and Definitions

ACE (ACCUMULATED CYCLONE ENERGY) INDEX

A measure of the collective strength and duration of tropical cyclones during the season, defined by NOAA as the sum of the squares of the 6-hourly maximum wind speed for all named systems whilst they are at least tropical storm strength (winds >39 mph). Units of ACE index are 10^4 knots^2. See also http://www.cpc.noaa.gov/products/outlooks/background_information.shtml

CPC

U.S. Climate Prediction Center.
See http://www.cpc.noaa.gov/products/hurricane/

ECMWF

The European Centre for Medium Range Weather Forecasts

EL NIÑO

The warm phase of ENSO associated with a warming of the central and eastern equatorial Pacific Ocean. El Niño events occur irregularly every 2–7 years and typically last between 12 and 18 months. During El Niño events, upper-level westerly winds generally increase across the tropical North Atlantic resulting in above-average vertical wind shear in the MDR. These conditions are unfavourable for tropical cyclone development and often lead to reduced tropical cyclone activity during the hurricane season. See also http://www.cpc.noaa.gov/products/analysis_monitoring/ensostuff/ensofaq.shtml

ENSO (EL NIÑO-SOUTHERN OSCILLATION)

A large-scale, natural fluctuation of the ocean-atmosphere system centred in the tropical Pacific region; warm (El Niño) and cold (La Niña) phases recur every few years. Through teleconnections to higher latitudes, ENSO impacts can extend to near-global dimensions.

EUROSIP (EUROPEAN SEASONAL TO INTER-ANNUAL PREDICTION)

Multi-model seasonal prediction system comprising the dynamical seasonal prediction systems of ECMWF, Met Office (GloSea4) and Météo-France. The combined forecast ensemble size for the multi-model is 124.

GLOSEA4 (GLOBAL SEASONAL FORECASTING SYSTEM VERSION 4)

The Met Office seasonal forecasting system used operationally since September 2009. Forecasts are generated monthly with a 42-member ensemble. The first tropical storm forecast using this system will be made in June 2010.

HURDAT (HURRICANE DATABASE)

The observed record of all tropical cyclones in the North Atlantic basin maintained by NOAA.
See http://www.aoml.noaa.gov/hrd/hurdat

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HURRICANE

A tropical cyclone with maximum sustained wind speeds of 74 mph or greater (categories 1–5 on the Saffir-Simpson hurricane wind scale).

IRI

International Research Institute for Climate and Society

LA NIÑA

The cold phase of ENSO leading to extensive cooling of the central and eastern Pacific, typically lasting between 12 and 18 months. During La Niña events, upper-level westerly winds are reduced across the tropical North Atlantic, leading to an extended area of below-normal vertical wind shear across the MDR. This creates favourable conditions for tropical cyclone development and intensification often leading to enhanced tropical cyclone activity and landfall risk.

MDR (MAIN DEVELOPMENT REGION)

A region in the tropical North Atlantic between Africa and the Caribbean Sea between 10°–20°N, 20°–60°W where most major hurricanes (winds ≥111 mph) develop.

MAJOR HURRICANE

A tropical cyclone with maximum sustained wind speeds of 111 mph or greater (categories 3–5 on the Saffir-Simpson hurricane wind scale).

NCEP

U.S. National Centers for Environmental Prediction

NOAA

U.S. National Oceanic and Atmospheric Administration

SAFFIR-SIMPSON HURRICANE WIND SCALE

A scale ranging from 1 to 5 (one being the weakest category and 5 the greatest) used to categorise hurricanes based on their maximum sustained surface wind speed. Category 1 hurricanes have maximum sustained wind speeds of at least 74 mph; category 5 hurricanes have winds of at least 155 mph. Details of hurricane damage and impacts for these categories can be found at http://www.nhc.noaa.gov/sshws.shtml

SST

Sea surface temperature

TROPICAL CYCLONE

The generic term for a non-frontal low pressure system that originates over tropical or sub-tropical waters, with organised convection and maximum winds at low levels, circulating either anti-clockwise in the northern hemisphere or clockwise in the southern hemisphere.

TROPICAL STORM

A tropical cyclone with maximum sustained wind speeds between 39 and 73 mph.

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