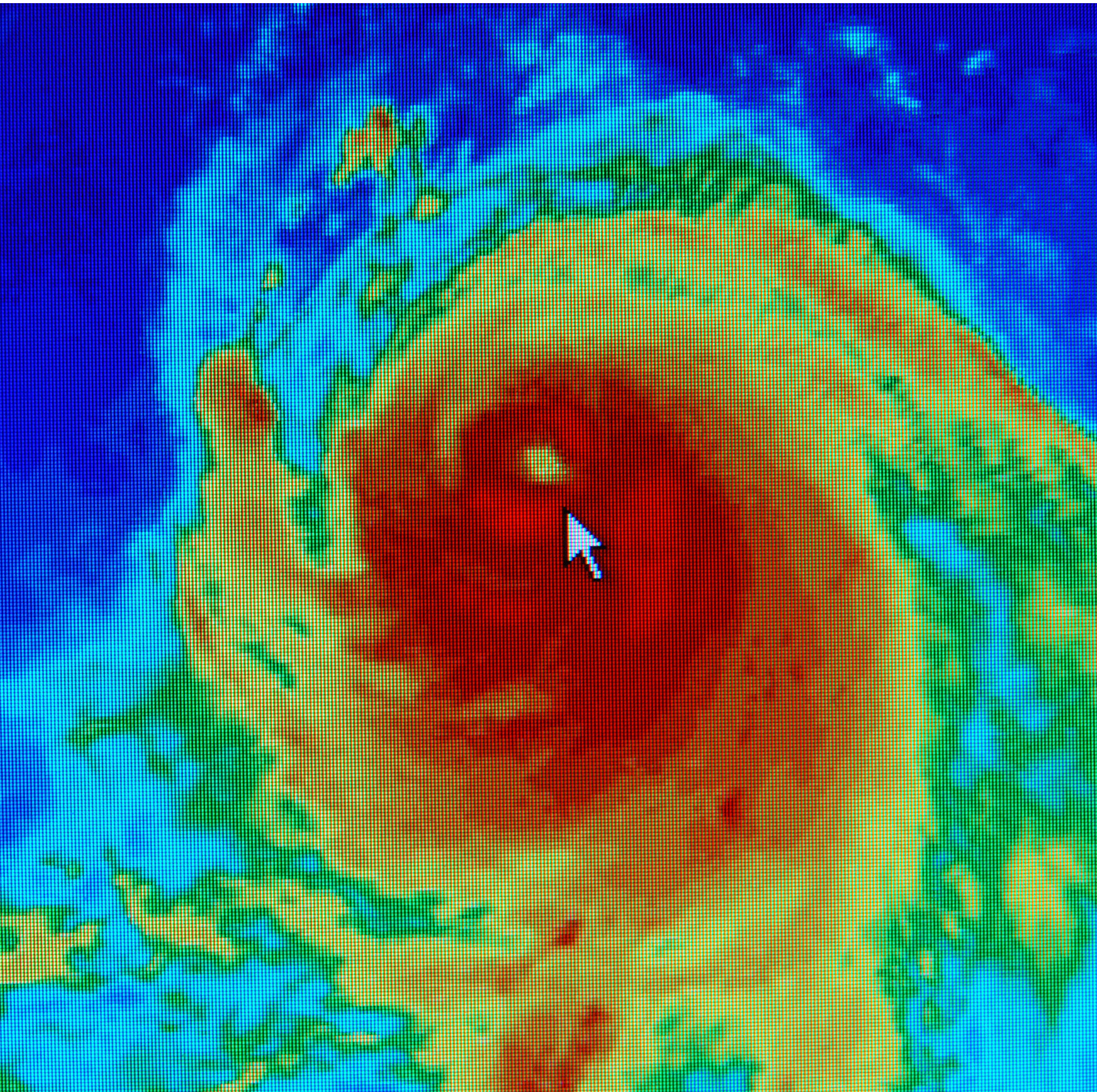
Risk Analytics

MS Amlin

2021 Hurricane Season

Forecast Summary



Executive Summary

The current predictions (as at 21st June 2021) call for an above average U.S. hurricane season, with a mean forecast of 17 named storms, 8 hurricanes and 4 major hurricanes.

The **North Atlantic** hurricane season officially begins on 1st June and ends 30th November, with August, September and October representing the busiest three months. However, tropical cyclogenesis is possible earlier than the 1st June, as demonstrated by the early formation of Tropical Storm Ana on 22nd May, making 2021 the seventh consecutive year that a storm formed before the official start of the season. For this reason, this year the U.S. National Hurricane Center (NHC) began to issue regular Tropical Weather Outlooks on 15th May, two weeks earlier than it did in previous years.

More than 20 research groups, private companies and universities produce seasonal hurricane forecasts each year. The current predictions (as at 21st June 2021) call for an above average season, with a mean forecast of **17 named storms, 8 hurricanes, and 4 major hurricanes.** This is driven by El Niño–Southern Oscillation (ENSO) forecasts, which indicate that ENSO-neutral conditions are likely to dominate this year, which is associated with above average activity (e.g. 2005, 2017).

In the **Pacific Basin**, ENSO-neutral conditions are associated with a smaller number of cyclones. As a result, forecasts indicate a below average season, with **24 tropical storms, 15 typhoons and 9 intense storms**[1].

Table 1: 2021 Atlantic Hurricane Season Forecasts (as at 21st June) for the number of storms and the accumulated cyclone energy index (ACE Index). To date, 15 research groups, private companies and universities have released forecasts. Predictions from the three best-known forecasters are explicitly shown. Not all forecasts provide a prediction for ACE, so an ACE average is not provided. ACE is a measure used to indicate the total seasonal tropical cyclone activity in a basin. It represents the total wind energy, and is calculated as the sum of the squares of the maximum sustained surface wind speed, measured every six hours for all named storms while they are at tropical storm intensity.

Forecast	Named Storms	Hurricanes	Major Hurricanes	ACE Index
National Oceanic and Atmospheric Administration (NOAA)[3]	17	8	4	145
Colorado State University (CSU)[4]	18	8	4	150
Tropical Storm Risk (TSR)[5]	18	9	4	140
Average of 15 forecasts[6]	17	8	4	-
NOAA Historical Mean Average (1991-2020)	14	7	3	122

2021 North Atlantic Forecasts (as at 21st June)

The latest forecasts for the 2021 hurricane season are presented in Table 1 and Figure 1. To date, 15 research groups, private companies and universities have released forecasts, which call for an above average season. These predictions are based on a range of data sources, including seasonal weather forecasts, statistical models, and key atmospheric indices such as the El Niño–Southern Oscillation and North Atlantic Oscillation (NAO).
Note that the forecasts presented here are for basin-wide activity and not landfalling storms. Landfall activity depends on in-season weather patterns, which are often only predictable days or weeks in advance.

The strong consensus for an above average season is due to the latest ENSO forecasts (Figure 2). ENSO has a significant impact on tropical cyclone activity (see "What is ENSO?" breakout box). ENSO-neutral (between -0.5°C and +0.5°C in Figure 2) and La Niña (less than -0.5°C) conditions are associated with an above average North Atlantic hurricane season.

ENSO-neutral conditions are currently in place (Figure 2), with the majority of forecasts indicating that these conditions will persist for much of the Northern Hemisphere summer. The International Research Institute for Climate and Society at Columbia University estimates a 61% probability of ENSO-neutral and 26% probability of La-Niña conditions for the peak of the North Atlantic season (August-October)[2].

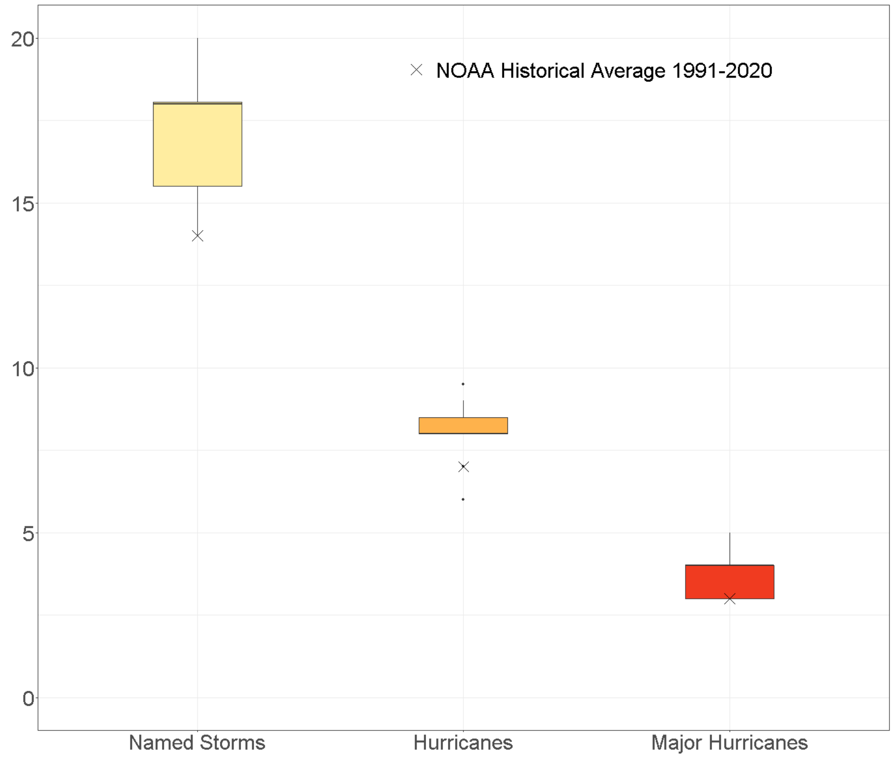


Figure 1: Box plots summarising the 2021 North Atlantic Hurricane forecasts from 15 different research groups, private companies, and universities with forecasts as at 21st June 2021. Historical averages from the National Oceanic and Atmospheric Administration (NOAA) from 1991-2020 are also shown with a cross.

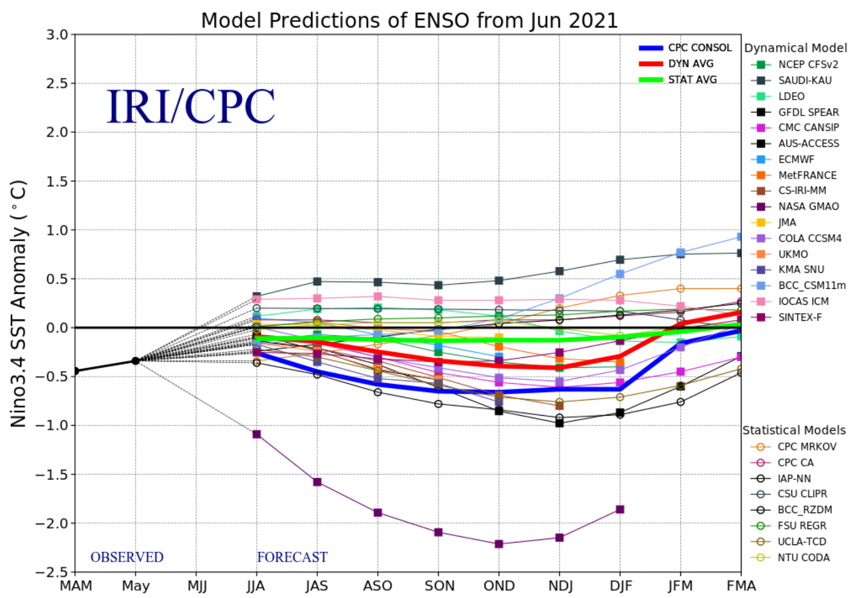


Figure 2: 2021 ENSO forecasts from 25 forecast models (for the NINO 3.4 region) as-at 18th June 2021. Source: https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-sst_table[2].

What Happened Last Year?

The 2020 Atlantic Hurricane Season was a record-breaking year with 30 named storms, surpassing the previous maximum of 28 set in 2005.

Table 2: 2020 North Atlantic June forecasts compared to observations and historical averages.
Source of historical averages: https://www.cpc.ncep.noaa.gov/products/outlooks/Background.html[8].

	Named Storms	Hurricanes	Major Hurricanes	Accumulated Cyclone Energy
Mean Average June 2020 forecast	17.4	8.6	4.2	152.3
Observations	30	13	6	180
1991-2020 Mean Average	14	7	3	122

Atlantic Basin

The 2020 **Atlantic Hurricane** Season was a record-breaking year with 30 named storms, surpassing the previous maximum of 28 set in 2005. The 30 storms exhausted the conventional alphabetical list of 21 names (letters Q, U, X, Y and Z are excluded) and so the Greek alphabet had to be used for only the second time in recorded history. It was also the last time that the Greek alphabet will be used—the World Meteorological Organisation has decided to develop a supplemental list[7] of names for 2021, after the general public confused several storms last year that had similar-sounding Greek names (Zeta, Eta, and Theta). Of the 30 storms in 2020, 13 became hurricanes,

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6 became major hurricanes (Category 3+) and the Accumulated Cyclone Energy (ACE) index was 180. For comparison, an average season has 12 named storms, 6 hurricanes, 3 major hurricanes and an ACE Index of 122. The 2020 season was fuelled by near-record warm sea-surface temperatures in the Tropical Atlantic and Caribbean, combined with below average wind shear anomalies. The actual number of hurricanes and major hurricanes in the North Atlantic was much higher than the June 2020 predictions (Table 2); the average forecast of 17.4 named storms was 42% lower than the number recorded. The actual ACE for the season (180) was also considerably higher than the forecast average value (152.3).

12 of the 30 named storms (including 6 hurricanes) made landfall in the U.S., which exceeded the record set in 1916 of 9 landfalls. The Gulf Coast was particularly affected with 9 named storm landfalls, of which a record 5 were in Louisiana. Hurricane Laura was the costliest landfalling hurricane, generating economic losses of US$18 billion[9]. Some of the most significant activity of the season occurred in October and November; 7 named storms, 5 hurricanes, and 4 major hurricanes formed during this two-month period.

Despite the particularly active hurricane season, 2020 was not a record-setter in terms of financial losses from hurricanes. Although the U.S. recorded a record number of landfalls, 3 of the 6 hurricanes struck areas with some of the lowest population densities along the U.S. East and Gulf coasts: Hanna (Kenedy County, lowest density in Texas) and Laura/Delta (Cameron Parish, lowest density in Louisiana). Nearly all major coastal metropolitan areas were largely unaffected by 2020 storms[9].

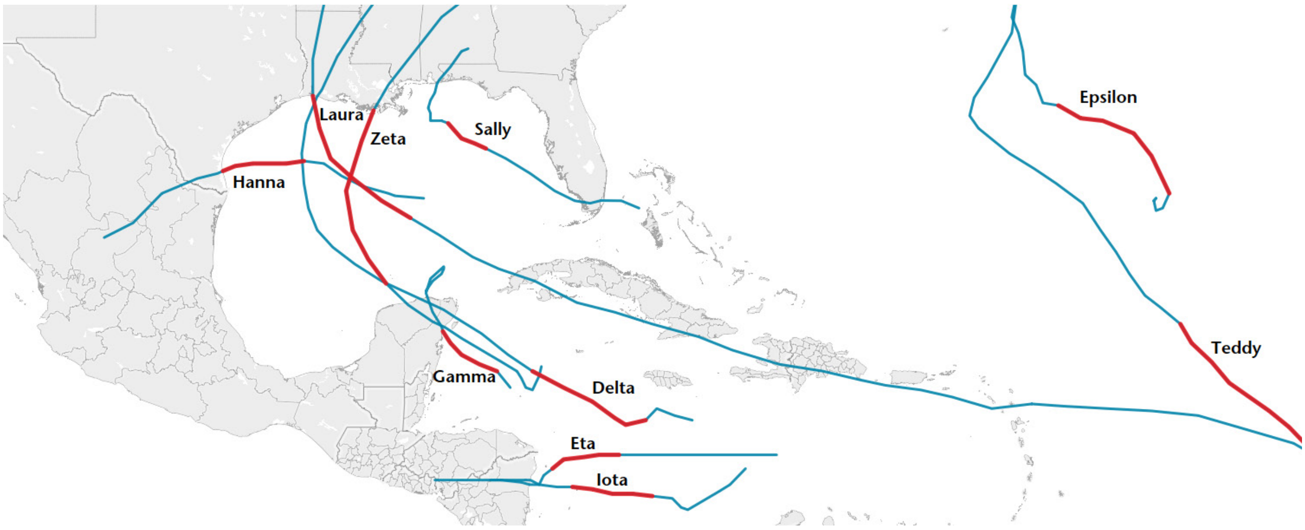

Figure 3: The tracks of rapidly-intensifying 2020 landfalling Atlantic hurricanes (blue) and the period in which they underwent rapid intensification (in red). Source: Aon Benfield[8].

Rapid Intensification

In the **Atlantic Basin**, 10 storms underwent rapid intensification, which is defined as an increase in maximum wind speeds of at least 35 mph over a 24-hour period. Almost all of the storms that underwent rapid intensification did so shortly before making landfall (Figure 3). Rapid intensification of storms is difficult to forecast and recent research has found that both the frequency and rate of rapid intensification has increased in recent years. The reasons behind this are likely linked to natural variability (such as ENSO), but the impact of climate change is expected to become more prevalent with time[10].

2020 was the fifth consecutive year with an above-normal Atlantic hurricane season; there have been 18 above-normal seasons out of the last 26. In the past, this increased hurricane activity has been attributed to a warm phase of the Atlantic Multidecadal Oscillation (AMO)—which began in 1995—and has favoured more, stronger, and longer-lasting storms since then. However, recent research has dismissed the existence of the AMO, and instead has attributed the increase in hurricane activity to human-induced climate change (see AMO break-out box).

Pacific Basins

While the Atlantic Ocean had record activity in 2020, it was a much quieter year in the Pacific Ocean. In the **Western Pacific**, just 23 named storms formed, and 12 reached typhoon status, which is slightly lower than the 1981-2021 average of 26 and 17 respectively. This agreed well with the pre-season forecast from Tropical Storm Risk, which predicted a slightly below average season, with 26 tropical storms, 15 typhoons and 8 intense typhoons. Despite reduced overall basinwide activity, there were still some notable storms such as Super Typhoon Goni which became the strongest landfalling tropical cyclone ever recorded globally when it struck the Philippines with 195mph 1-minute average sustained winds[9]. South Korea was impacted by three consecutive typhoons which caused and exacerbated flooding, and Haishen caused billions of dollars of damage in Japan. Despite these storms, total seasonal economic losses were the lowest since 2010. Activity in the **Eastern Pacific** was also below average with 17 tropical storms and 7 hurricanes forming. However, several damaging storms formed including Tropical Storm Amanda that affected El Salvador, and Hurricane Genevieve that caused damage in the Baja California Peninsula in northwest Mexico.

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Do ENSO-neutral and La Niña increase U.S. mainland landfall risk?

Yes – there is evidence that both ENSO Neutral and La Niña conditions increase activity in the North Atlantic basin, as well as the U.S. landfall risk.

The North Atlantic historical record shows that on average there have been 7 hurricanes per year when the ENSO phase was neutral or negative since 1950. This decreases to 5 hurricanes per year during El Niño conditions, showing the clear suppression of activity due to increased wind shear. This pattern is observed for both Category 1-5 and Category 3-5 hurricanes (Figure 4).

In terms of landfalls, overall Atlantic basin activity only explains about 25% of the variability in U.S. landfalling storms[1]. This means that an above (or below) average season in the basin does not necessarily directly translate into an above (or below) average season in terms of landfalls, although it increases the probability. That said, 9 of the 10 largest losses since 1960 have occurred during ENSO neutral conditions (Table 3).

In terms of landfall locations, there is some evidence that the probability of landfalls along the U.S. East Coast (Georgia to Maine) is higher during La Niña years when wind shear is low, which allows storms to sustain intensities to higher latitudes[11].

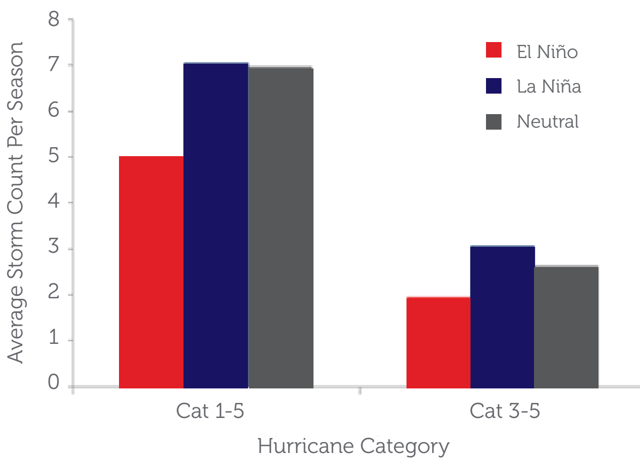


Figure 4: The average number of hurricanes in the Atlantic Basin per season since 1950, split by ENSO phase. Counts are shown for both all (Cat 1-5) and major (Cat 3-5) hurricanes. The analysis was undertaken using the HURDAT2 dataset (https://www.aoml.noaa.gov/hrd/hurdat/Data_Storm.html).

Table 3: Large US Hurricane losses since 1960 and the corresponding August-October ENSO phase. The Oceanic Niño Index (ONI) is the 3 month running mean of ERSST.v5 sea surface temperature anomalies in the Niño 3.4 region, obtained from NOAA . The storms were selected based on insured losses, normalised to 2018 USD.

Year	Storm Name	Oceanic Niño Index, °C (Aug-Oct)	ENSO Phase (Aug-Oct)
2017	Maria	-0.4	Neutral
2017	Irma	-0.4	Neutral
2017	Harvey	-0.4	Neutral
2012	Sandy	0.3	Neutral
2008	Ike	-0.3	Neutral
2005	Katrina	-0.1	Neutral
2005	Wilma	-0.1	Neutral
1992	Andrew	-0.1	Neutral
1989	Hugo	-0.2	Neutral
1965	Betsy	1.9	El Niño

1. Based on MS Amlin analysis of the HURDAT2 dataset for the period 1851-2017. A coefficient of determination (r^2) of 0.25 was found when regressing basin Accumulated Cyclone Energy (ACE) against US landfalls.

How does ENSO affect the Pacific basin?

Similar to the North Atlantic, hurricane forecasts for the Pacific basin are dependent on the state of ENSO. During ENSO-neutral and La Niña years, a smaller number of cyclones form in the central Pacific, and these storms tend be less intense and have shorter durations[12]. As a result of current ENSO forecasts, Tropical Storm Risk has forecast a slightly below average season for 2021, with 24 tropical storms, 15 typhoons and 9 intense typhoons (compared to the historical average of 26, 16 and 9 respectively). Tropical Storm Risk note, however, that large uncertainty remains in this forecast, and ultimately it depends on how ENSO evolves during the year.

What is ENSO?

The El Niño-Southern Oscillation is a periodic climate pattern which involves changes in the temperature of waters in the eastern and central tropical Pacific Ocean. Over timescales from three to seven years, the surface water across areas of the Pacific Ocean warms or cools, and the temperature changes can range from 1°C to 3°C compared to average sea surface temperatures. The oscillating pattern of warming and cooling (ENSO cycle) impacts rainfall distribution across the tropics and can influence weather patterns across the world, including tropical cyclone activity.

There are three phases to the ENSO phenomenon. The two opposite phases, ‘El Niño’ and ‘La Niña’ are the extreme phases of the ENSO cycle where where waters are warmer and cooler than average respectively, and the third ‘neutral’ phase is where the sea surface temperatures in the Pacific Ocean are close to average conditions.

ENSO influences tropical cyclone activity primarily via vertical wind shear, which refers to the change in wind speed and direction high in the atmosphere (1,500-10,000 meters above the ground). Strong vertical wind shear tends to break down storms or prevent them from forming in the first place.

El Niño (ENSO Positive) is when above-average sea surface temperatures occur in the central and eastern tropical Pacific Ocean. El Niño favours strong hurricane activity in the central and eastern Pacific basins due to lower wind shear, whilst it tends to suppress activity in the Atlantic basin due to higher wind shear (Figure 5, top).

La Niña (ENSO Negative) is when below-average sea surface temperatures occur in in the central and eastern tropical Pacific Ocean. La Niña tends to suppress hurricane activity in the central and eastern Pacific basins and enhance it in the Atlantic basin (Figure 5, bottom).

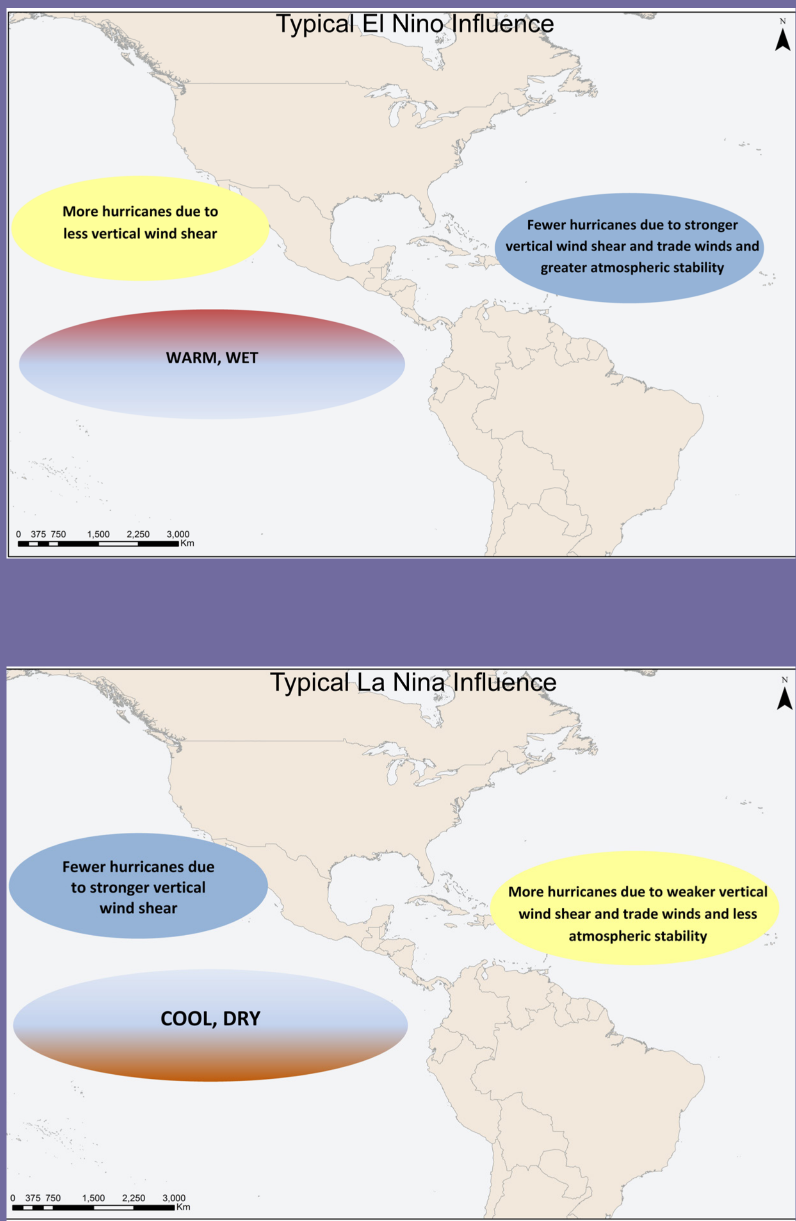


Figure 5: Typical influence of El Niño (top) and La Niña (bottom) on Pacific and Atlantic seasonal hurricane activity. Map based on originals by Gerry Bell.

The rise and fall of the AMO

Over two decades ago, the term the "Atlantic Multidecadal Oscillation" was coined to describe an internal oscillation in the climate system that led to alternating decades-long intervals of warming and cooling centred in the extra-tropical North Atlantic. This 40-60 year oscillation in sea surface temperatures was thought to be partly responsible for periods of increased and supressed Atlantic hurricane activity[13]. Figure 6 shows the AMO index and the five-year average annual Atlantic hurricane counts. More recently, the scientists responsible for first identifying and naming this phenomenon have claimed that the AMO does not exist, and the observed temperature variations are due to competing anthropogenic drivers during the historical era (greenhouse warming and sulphate aerosol cooling), and the impact of volcanic dust emitted into the atmosphere in earlier periods[14]. It is thought that the AMO has been used by some scientists to dismiss, among other things, the impact climate change is having on increasingly active and destructive Atlantic hurricane seasons, attributing the increase in recent decades to a supposed upturn in the AMO.

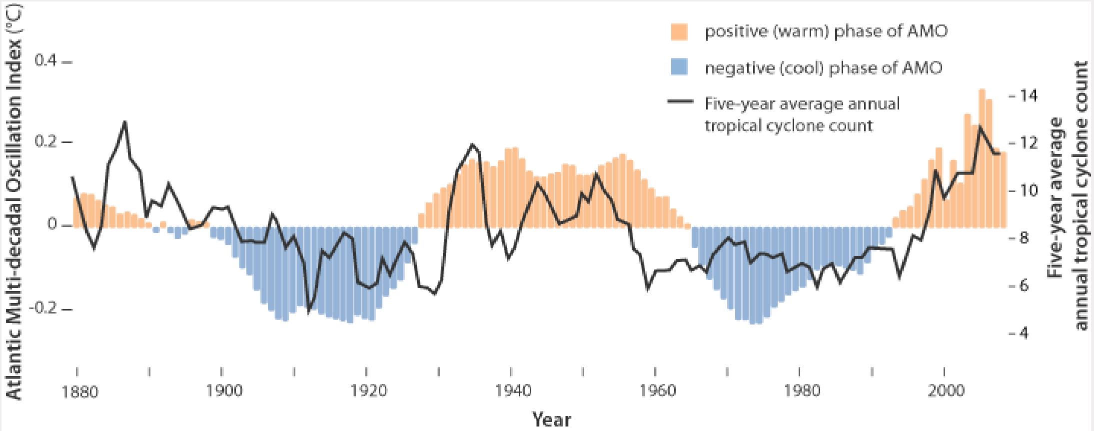


Figure 6: A bar graph of the Atlantic Multidecadal Oscillation Index and five-year average annual Atlantic hurricane counts. Source: https://www.climate.gov/sites/default/files/AMO_and_TCCounts-1880-2008_0.png [15].

How reliable are the forecasts?

The accuracy of a particular prediction varies depending on how long before the start of the season it was generated, with those closer to the peak of the season having higher accuracy. Figure 7 shows the skill of three forecasters for the Atlantic basin over the period 2003-2015. As can be seen, predictions issued in August generally have higher accuracy (as reflected by the rank correlation score) than predictions issued in May or June.

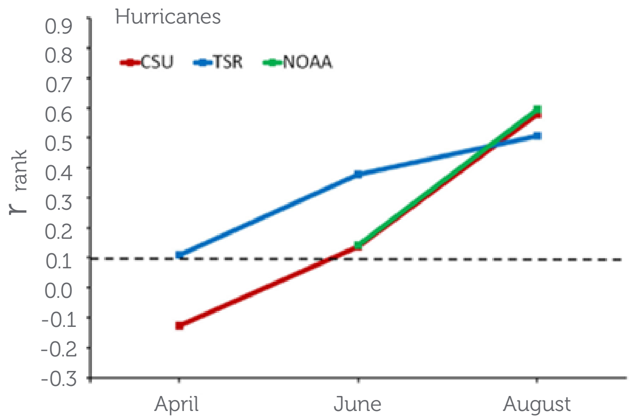
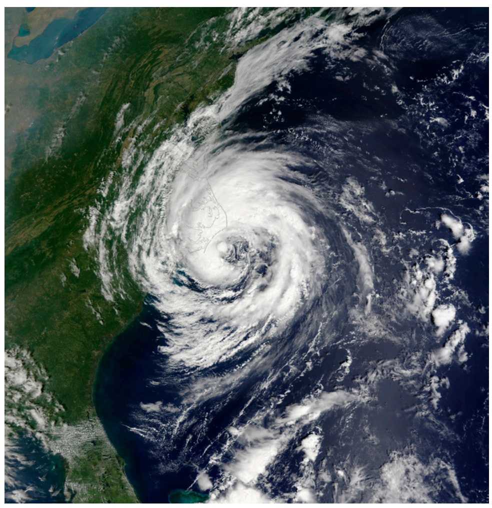


Figure 7: Skill scores for three different forecasting agencies for the period 2003-2015. A rank correlation (r^{rank}) of 1 would indicate a perfect prediction of the number of North Atlantic hurricanes. Source: http://seasonalhurricanepredictions.bsc.es/skill

What about climate change?

Scientific theory and computer modelling indicate that climate change will increase the intensity of across the world, as well as the frequency of very intense storms (Category 4+)[16]. In addition, the risk from both inland and coastal flooding associated with tropical cyclones is likely to increase due to greater rainfall and sea level rise.

What does this mean for 2021? The answer is complicated. While we know that climate change is likely to have played a role in recent tropical cyclones[17], large uncertainties remain around quantifying this role. In addition, changes in insured losses are due not only climate change, but also to changes in exposure and additional factors such as loss adjustment expenses. As an example, a reoccurrence of Hurricane Andrew today would result in an insured loss in the region of US$50-60 billion[18]. Whilst it is probable that climate change would contribute to this increase in loss (e.g. due to sea level rise), Miami has also seen huge population growth since 1992 and this would certainly be a significant – if not the primary – factor influencing the increased loss potential for this storm.



What Happens Next?

The major research groups and universities will release updated forecasts in July/August. If there are any material changes to the outlook then MS Amlin's team will release an updated forecast summary.

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References

1. TSR, "Extended Range Forecast for Northwest Pacific Typhoon Activity in 2021," URL (Accessed: 3 June 2021), 2021.
2. IRI, "IRI ENSO Forecast," URL (Accessed: 3 June 2021), 2021.
3. NOAA, "NOAA 2021 hurricane forecast," URL (Accessed: 28 May 2021), 2021.
4. CSU, "Forecast for 2021 Hurricane Activity," URL (Accessed: 3 June 2021), 2021.
5. TSR, "Extended Range Forecast for Atlantic Hurricane Activity in 2021," URL (Accessed: 3 June 2021), 2021.
6. BSC, "Seasonal Hurricane Predictions," URL (Accessed: 3 June 2021), 2021.
7. WMO, "Supplemental list of tropical cyclone names in RAIV," URL (Accessed: 3 June 2021), 2021.
8. NOAA, "Background Information: North Atlantic Hurricane Season," URL (Accessed: 3 June 2021), 2021.
9. Aon Benfield, "Weather, Climate & Catastrophe Insight: 2020 Annual Report," URL (Accessed: 3 June 2021), 2021.
10. K. V. G. K. T. e. a. Bhatia, "Recent increases in tropical cyclone intensification rates.," Nature Communications, no. URL 2019.
11. S. R. Smith, J. Brolley, J. J. O'Brien and C. A. Tartaglione, "ENSO's impact on regional US hurricane activity," Journal of Climate, vol. 20, p. 1404–1414, 2007.
12. S. J. Camargo and A. H. Sobel, "Western North Pacific tropical cyclone intensity and ENSO," Journal of Climate, vol. 18, 2005.
13. M. E. Mann, J. Park and R. S. Bradley, "Global interdecadal and century-scale climate oscillations during the past five centuries," Nature, vol. 378, p. 266–270, 1995.
14. M. Mann, "The Rise and Fall of the "Atlantic Multidecadal Oscillation"," URL (Accessed: 3 June 2021), 2021.
15. climate.gov, "Atlantic Multidecadal Oscillation," URL (Accessed: 3 June 2021), 2021.
16. T. Knutson, S. J. Camargo, J. C. L. Chan, K. Emanuel, C.-H. Ho, J. Kossin, M. Mohapatra, M. Satoh, M. Sugi, K. Walsh and others, "Tropical cyclones and climate change assessment: Part II: Projected response to anthropogenic warming," Bulletin of the American Meteorological Society, vol. 101, 2020.
17. G. J. Van Oldenborgh, K. Van Der Wiel, A. Sebastian, R. Singh, J. Arrighi, F. Otto, K. Haustein, S. Li, G. Vecchi and H. Cullen, "Attribution of extreme rainfall from Hurricane Harvey, August 2017," Environmental Research Letters, vol. 12, 2017.
18. Swiss Re, "15 years after Katrina: Would we be prepared today?," URL (Accessed: 3 June 2021), 2020.