

2023 Hurricane Season Forecast

MS Amlin

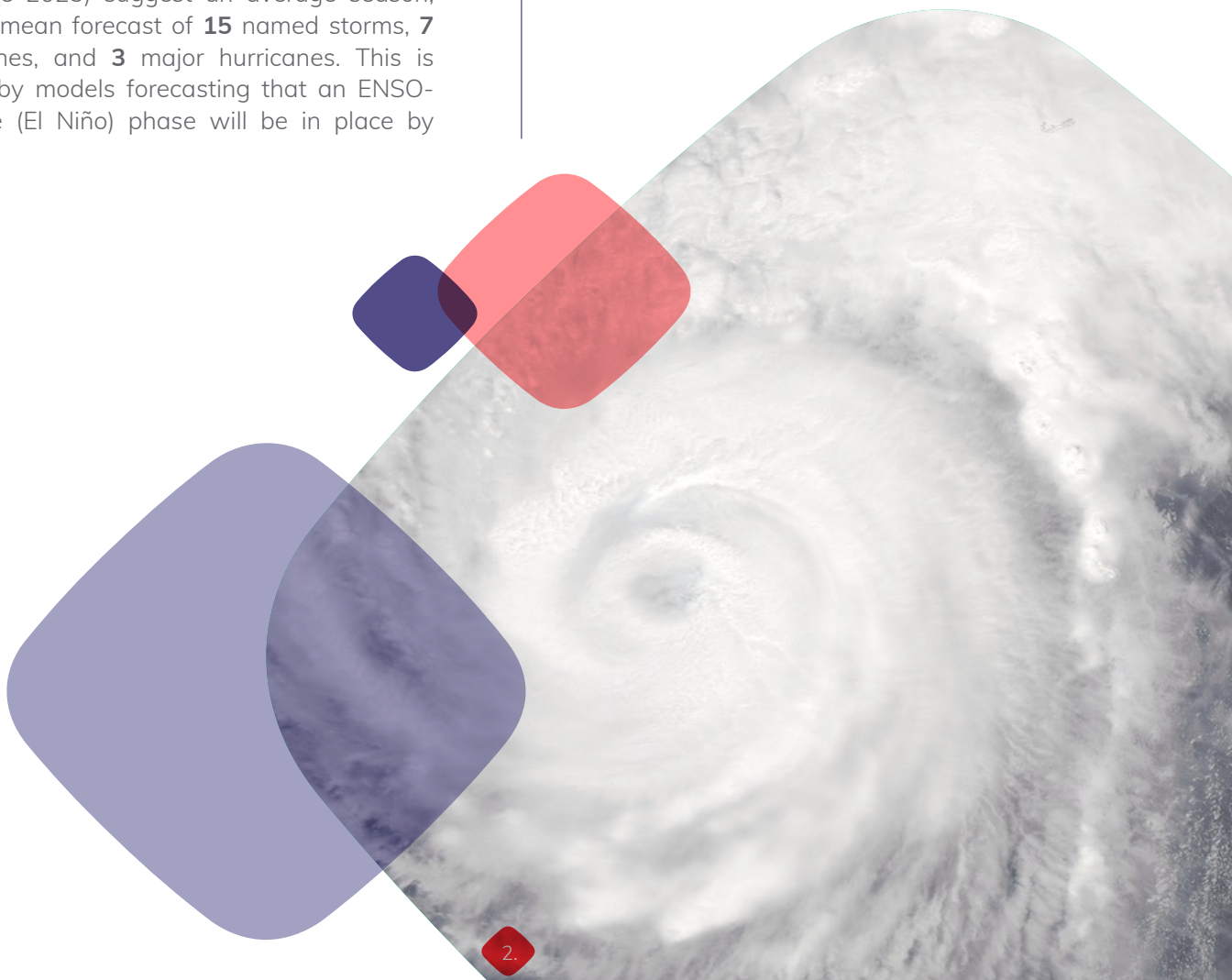
Executive Summary

The current predictions (as at 01 June 2023) suggest an average season, with a mean forecast of **15** named storms, **7** hurricanes, and **3** major hurricanes.

The North Atlantic hurricane season officially begins on 1st June and ends 30th November, with August, September, and October representing the peak three months. Tropical cyclogenesis is possible earlier than 1st June. However, no named storm has formed in the North Atlantic earlier than this date in either 2022 or 2023.

More than 20 research groups, private companies, universities and government agencies produce seasonal hurricane forecasts each year. The current predictions (as at 1st June 2023) suggest an average season, with a mean forecast of **15** named storms, **7** hurricanes, and **3** major hurricanes. This is driven by models forecasting that an ENSO-positive (El Niño) phase will be in place by the peak of the hurricane season, supressing activity, whilst warmer than normal sea surface temperatures will increase activity. As a consequence of these competing factors, their relative importance in individual forecast models has resulted in large variability in forecasts.

In the Pacific Basin, an above average season is forecast as a result of the ENSO-positive phase. Here, forecasts indicate **22** tropical storms, **12** typhoons, and **5** intense typhoons.



2023 North Atlantic forecasts (as at 1st June)

The latest forecasts for the 2023 hurricane season are presented in Table 1 and Figure 1. 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 (ENSO) and North Atlantic Oscillation (NAO).

Current predictions call for a near-normal season, with a mean forecast of **15** named storms, **7** hurricanes, and **3** major hurricanes. Note that the forecasts here are for basin-wide activity and not landfalling storms. Landfall activity depends on in-season weather patterns, which are often predictable only weeks or days in advance.

There is a comparative lack of consensus in terms of North Atlantic hurricane activity for the 2023 hurricane season compared with previous seasons (Figure 1). This is a consequence of competing factors forecast to be present during the most active period (August-September-October) of the hurricane season; ENSO-positive conditions (El Niño) and warm sea surface temperatures.

The latest ENSO prediction plume model average is suggesting a strong El Niño will develop for the peak of the hurricane season (≥+0.5 °C in Figure 2). Statistical models generally predict a weaker El Niño. Generally, El Niño conditions are expected to suppress hurricane activity in the North Atlantic (see "What is ENSO?" breakout box) thereby resulting in a below average season across the basin in terms of activity. However, record sea surface temperature across the North Atlantic (Figure 3) from March to June suggest that the 2023 season has the potential to result in above-normal basin activity. This is because warm sea surface temperatures provide the 'fuel', which powers hurricanes. Whether the elevated sea surface temperatures of El Niño comes to dominate weather patterns across the North Atlantic will likely determine the level of activity during the 2023 season.

Of course, it must be remembered that an inactive season only takes one landfalling hurricane to produce sizeable losses and have life changing consequences for those exposed to these powerful weather systems.

Forecast	Named Storms	Hurricanes	Major Hurricanes	ACE Index
National Oceanic and Atmospheric Administration[1]	12 - 17	5 - 9	1 - 4	
Colorado State University (CSU)[2]	13	6	2	100
Tropical Storm Risk (TSR)[3]	13	6	2	90
Average of 30 forecasts	15	7	3	122
NOAA Historical Mean Average (1991 - 2022)	15	7	3	124

Table 1: Atlantic Hurricane Season Forecasts (as at 1st June) for the number of named storms and Accumulated Cyclone Energy (ACE) Index. To date, 30 research groups, private companies, universities and government organisations have released forecasts. Predictions from the three best known forecasters are shown. Not all forecasts provide a prediction for ACE. ACE is a measure used to indicate the total seasonal tropical cyclone activity in the 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.

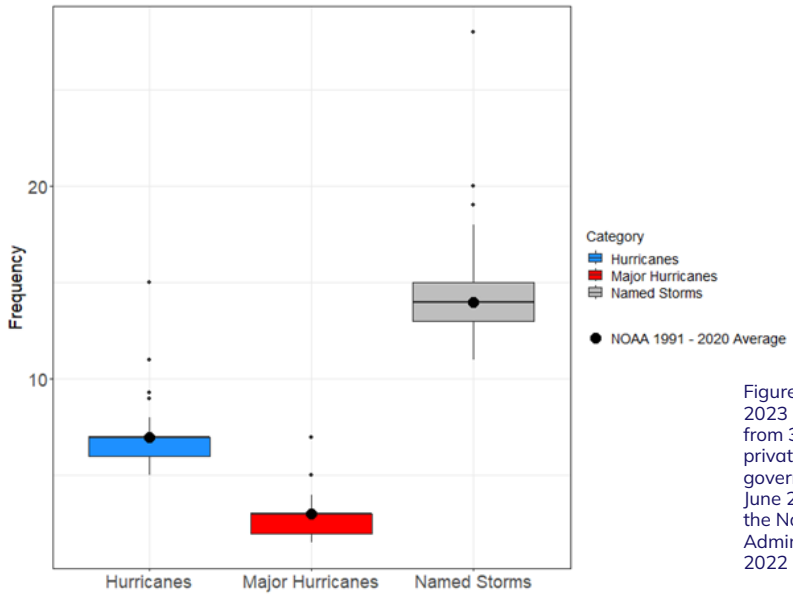


Figure 1: Box plots summarising the 2023 North Atlantic hurricane forecasts from 30 different research groups, private companies, universities, and government organisations as at 1st June 2023. Historical averages from the National Oceanic and Atmospheric Administration (NOAA) from 1991 – 2022 are also shown.

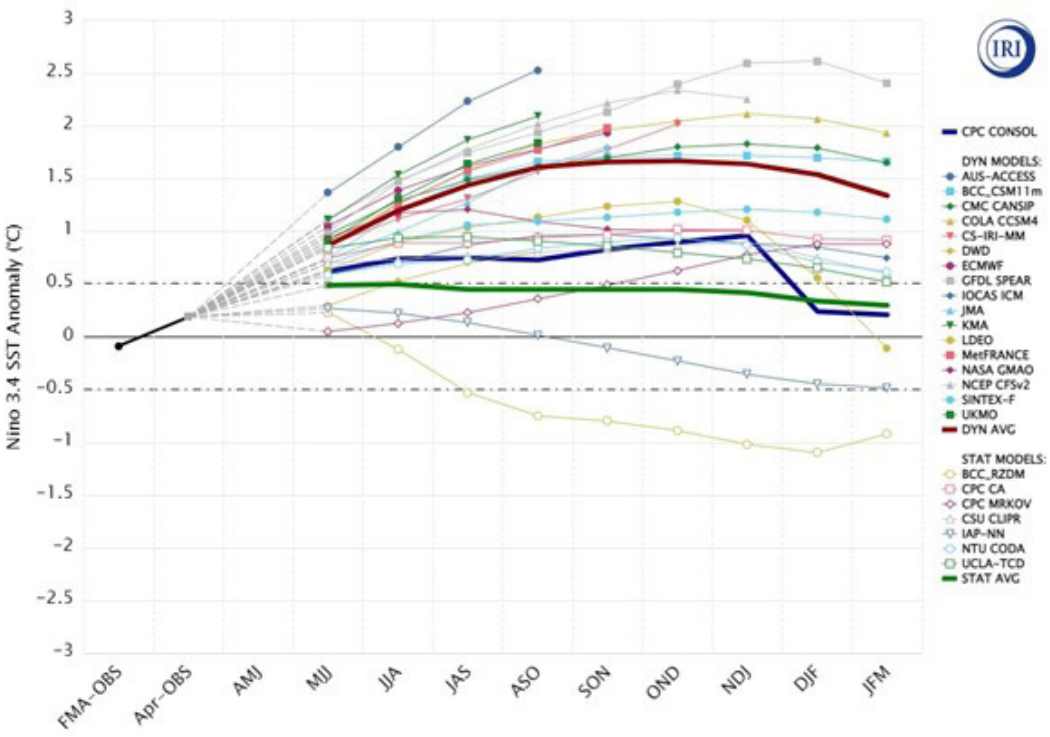


Figure 2: 2023 ENSO forecasts (sea surface temperature deviation from average) from 25 forecast models (for the NINO 3.4 region as-at 1st June 2023. El Niño conditions are declared when the SST anomaly is more than +0.5°C[4]. Forecasts are for three month rolling blocks (i.e. May-June-July; June-July-August). Graph shows forecasts from May-June-July period onward.

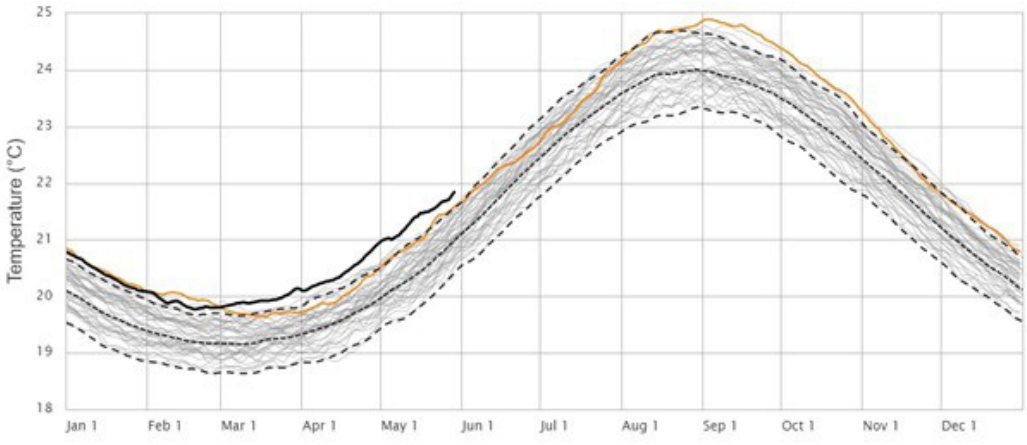


Figure 3: Daily average sea surface temperature for the North Atlantic from 0 – 60 °N and 0 – 80 °W. Sea surface temperatures for the North Atlantic are shown for 2022 in orange, and 2023 by the continuous black line. The small dashed line indicates the 1982-2011 mean sea surface temperature. Data are generated through NOAA's Optimum Interpolation Sea Surface Temperature (OISST) climate data record. Source: ClimateReanalyzer, Climate Change Institute, University of Maine.

What Happened Last Year?

Atlantic basin

The 2022 **Atlantic Hurricane season** generated an average number of named storms (**14**). Of the 14 storms in 2022, **eight** became hurricanes and **two** became major hurricanes (Category 3+). The major hurricanes were Fiona and Ian. The season reached an Accumulated Cyclone Energy (ACE) index of 95 which is **76%** of the long-term (1991-2020) average.

Pre-season forecasts predicted an above average season in terms of the number of named storms generated, the number of major hurricanes and the accumulated cyclone energy (ACE) index. These forecasts were based on forecasted warm sea surface temperatures and suggestions that El-Niño Southern Oscillation (ENSO) negative conditions would persist until the peak (August – October) of the North Atlantic hurricane season[5]. ENSO-negative, or La Niña, conditions favour hurricane development in the North Atlantic due to weaker vertical wind shear, weaker trade winds, and less atmospheric stability. However, early season cyclogenesis was inhibited by three factors. First, below normal sea surface temperatures developed in the subtropical Atlantic. Second, an abundance of Saharan dust was present over the main development region of the North Atlantic. Dry, sinking, dust-laden air from the Sahara Desert is a common factor in hurricane development suppression in the early part of a hurricane season. However, during the 2022 season, this persisted until mid-August and pushed as far west as the Caribbean. Third, a tropical upper tropospheric trough was present over the central Atlantic. This trough provided dry air and greater windshear, both of which are key factors in suppressing hurricane activity. As a consequence only three named storms (Alex, Bonnie, and Colin) had developed by September 2022.

Post-August, conditions in the North Atlantic reverted to those favourable for hurricane cyclogenesis. As a consequence **seven** hurricanes formed between 2nd September 2022 and 2nd November 2022. This has only occurred six times since 1966 (modern satellite era), with a further hurricane (Nicole) developing in mid-November.

Hurricane Fiona formed on September 14. After making landfall in the Dominican Republic as a Category 1 hurricane, it strengthened to a Category 4 hurricane. Later it made landfall in Nova Scotia with a central pressure of 931 mb. This was the lowest central pressure for a Canadian landfalling storm on record. It became the costliest insured hurricane loss in Canada (US$591 million[6]).

Hurricane Ian developed during the period of heightened activity, making landfall in southwestern Florida on September 28. Hurricane Ian is tied as the fifth strongest hurricane to make landfall in the United States and was the 6th Category 4+ storm to make landfall in the contiguous United States since 2017. Initial estimates for industry insured losses from Hurricane Ian were between US$30 bn and US$ 74 bn. Current estimates suggest that insured losses will be between **US$50 bn** and **US$65 bn**[7]. Damage resulting from Hurricane Ian was generated by the strong wind speeds, inland flooding and severe storm surge. The low pressure associated with Ian, and the Category 4 winds, combined with the shallow bathymetry offshore the southwestern Florida coastline resulted in a 10 – 15 ft surge[8].

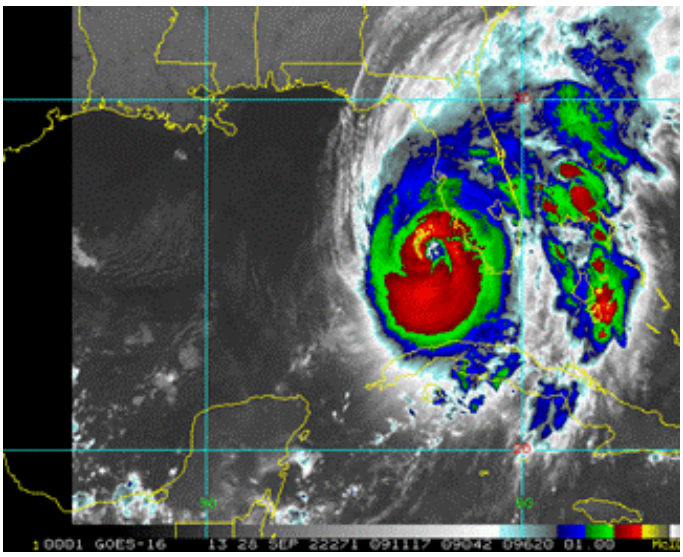


Figure 4: Hurricane Ian prior to making landfall. Enhanced Infrared image. 09:00 UTC 28 September 2022[9].

	Named storms	Hurricanes	Major hurricanes	ACE Index
Mean average June 2022 forecasts	19	8	4	161
Observations	14	8	2	95.1
1991 – 2020 mean average	14.4	7.2	3.2	125

Table 2: 2022 North Atlantic June forecasts compared to historical averages (NOAA, 2023)

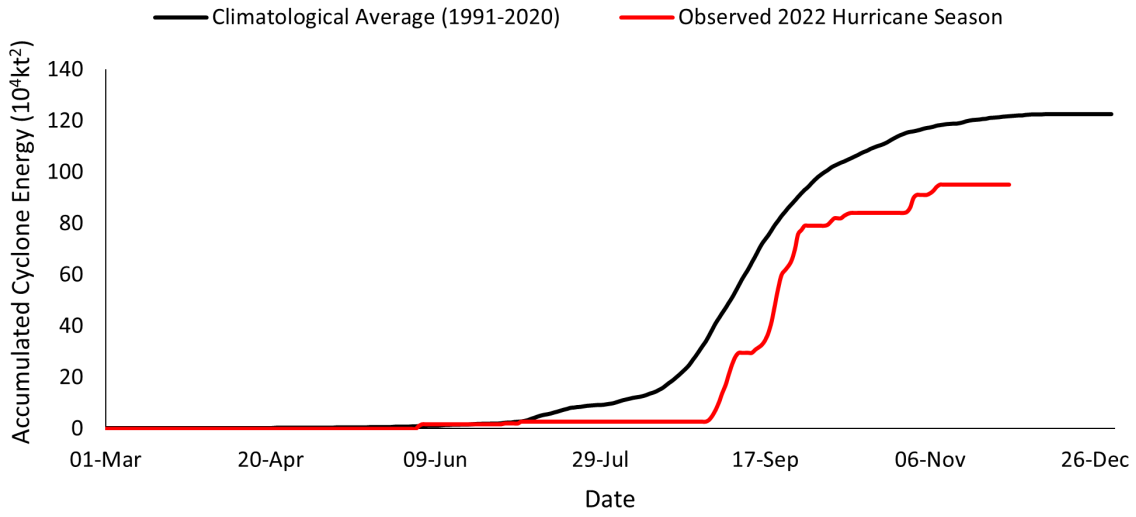


Figure 5. 2022 North Atlantic Ocean accumulated cyclone energy compared to the long-term climatological average. Measurements demonstrate the 2022 hurricane season activity was below the long-term average despite the pre-season forecasts. Data source: Colorado State University.

Pacific Basin

Western Pacific

La Niña conditions resulted in **below normal** activity in the Northwest Pacific. Losses from tropical cyclones were 75% and 91% below their 21st Century averages for Asia and Oceania, respectively[10]. In the Northwest Pacific there were **22** named storms, **12** typhoons, and **five** major typhoons. The accumulated cyclone energy (ACE) value for the Northwest Pacific of 163 was the 5th lowest for the basin since 1991; those years with lower ACE also occurring in La Niña years.

Notable typhoons to occur in the Northwest Pacific include Super Typhoon Hinnamnor, which lasted as a typhoon for 8 days. Typhoon Nanmadol resulted in about US$928 million in insured losses in Japan[11]. Whilst Typhoon Muifa became the strongest typhoon on record to strike Shanghai, China.

Eastern Pacific

The ongoing La Niña conditions resulted in the Eastern Pacific Hurricane season being an above average season in terms of activity and was slightly more active than the 2021 season. It had an above-normal number of named storms (**19**), **10** hurricanes, and **four** major hurricanes. The aggregate ACE was 116.5, which was more than 20 units above the previous year. Despite this, most storms did not track near land.

Of the storms that did make landfall, four made landfall on the Pacific coast of Mexico. This was the third time the record number of Pacific landfalling hurricanes in Mexico was reached. Agatha became the strongest hurricane to make landfall during the month of May in the eastern Pacific since records began in 1949[10].

Non-modelled losses – changes to Florida litigation

Reported industry losses include a number of non-modelled perils and effects. For example, these may include losses from perils such as tropical cyclone induced precipitation (Harvey, 2017 and Ida, 2021), or social inflation driven by litigation (Irma, 2017 and Michael, 2018). Insured losses in Florida, in particular, were subject to social inflation. This was a consequence of Assignment of Benefits (AOB), one-way attorney fees, and a low threshold for roof repairs (under the '25% roof' rule). The latter stated that if at least 25% of a roof, which was non-compliant with current building codes was damaged, the insurer was liable to pay for the entire roof to be replaced.

In response to the levels of litigation which had occurred in Florida, the misuse of AOB, the increased cost to policyholders and carriers, and the resulting unavailability of private policies, the Florida legislature has introduced and updated legislation since 2019. The latest update was legislation passed in December 2022. This eliminates AOB from policies issued after 1st January 2023. It also makes Florida the 40th US state to no longer allow one-way attorney fee provision for property insurance contracts[12]. Given the potential impact of these shifts, MS Amlin will be monitoring how these changes impact claims made in Florida in the next 12 to 24 months.



Rapid intensification – An impact of climate change?

MS Amlin reported on hurricane rapid intensification in 2021 based on the 2020 North Atlantic hurricane season[13]. During the 2020 season, 10 storms underwent rapid intensification, which is defined as an increase in maximum wind speeds of at least 35 mph over a 24-h period[13]. Hurricane Ian also underwent rapid intensification prior to landfall in west Florida; windspeeds increasing from 115 mph at 12 pm 27 September to 155 mph at 12 pm 28 September.

Rapid intensification can occur when a group of environmental conditions exist in combination[14]. First, a hurricane has to have some degree of organisation. Second, atmospheric wind shear must remain low. Third, warm sea surface temperatures must be present along its storm track. All of these elements were in place after Hurricane Ian moved north of Cuba. Hurricane Ian completed an eye wall replacement cycle between the 27th and 28th September allowing the hurricane to intensify[8]. This eye wall expansion lead to both an expansion of the damaging wind field as well as an expansion of the storm surge region as the hurricane's central pressure dropped. Atmospheric wind shear in the Gulf of Mexico and off the Florida west coast remained low during this period and thus did not disrupt the replacement cycle nor the subsequent intensification. Last, sea surface temperatures were about 1°C above normal conditions providing the 'fuel' to allow the storm to intensify.

Rapid intensification often leads to destructive landfalls. This is because it frequently leads to the strongest storms, but also because accurately forecasting rapid intensification remains a huge challenge. As a result, emergency services and at-risk communities can face evacuation and other measures with little warning[15].

About 90% of the excess heat resulting from anthropogenic ('man-made') induced climate change has been absorbed by the World's oceans. Most of this added energy is stored at the surface, from depths of 0 to 700 m. As a consequence of the increased presence of warm sea surface temperatures, hurricanes are more likely to encounter conditions favourable for rapid intensification. It is therefore more likely that this process may occur[14]. Given the warm sea surface temperatures currently present in the North Atlantic, rapid intensification is something to watch out for during the 2023 season.

But what about climate change?

In order to answer this question, it is important to first outline what we know:

- **Climate change will alter the risk profile. The** latest scientific evidence tells us that tropical cyclones are likely to increase in intensity, cause increased rainfall, and have larger storm surges. The frequency of the strongest storms (Category 4+) is expected to increase, but the overall frequency (Category 1 – 5) might decrease[16]. Beyond, the hurricanes alone, changes in relative sea level resulting from glacier and ice sheet melting, the steric effect (thermal expansion of the ocean as it warms), and local subsidence also have the potential to increase the severity of impacts.
- **So far the effect has been gradual**. Since 1990 the number of North Atlantic hurricanes has increased by 0.6 per decade, and the number of major hurricanes by 0.5 per decade. At the same time, the proportion of storms intensifying to Category 4+ has increased by 5% per decade[17].
- **Damages are rising due to other factors.** Since 1990 economic losses have increased by around $22 Billion USD per decade, primarily due to population growth and the increased value of coastal assets [17].

Climate change and its impact on hurricane frequency and severity is an active area of research for MS Amlin. We are engaged in a number of research projects to build appropriate climate change stress test scenarios as well as to understand what role climate change has played in driving historical losses. We have also evaluated our in-house view of risk to ensure that it adequately represents present-day conditions.

Pacific basin

Pacific basin tropical cyclone forecasts are also dependent on the state of ENSO. During ENSO-neutral and La Niña years, a smaller number of tropical cyclone form in the central Pacific. These storms also tend to be less intense and have shorter durations[18]. However, given the current ENSO forecasts of a moderate to strong El Niño developing, Tropical Storm Risk has forecast an **above-normal activity season** for 2023. With El Niño conditions persisting through August, September, and October, **29** tropical storms, **19** typhoons, and **13** intense typhoons are forecast (compared to the historical average of 26, 16, and 9, respectively for the period 1991 – 2020)[19]. The 2023 season has already seen the development of Super Typhoon Mawar, which originated on 17 May. It became one of three Northwest Pacific typhoons to record winds in excess of 180 mph in May.



What is ENSO?

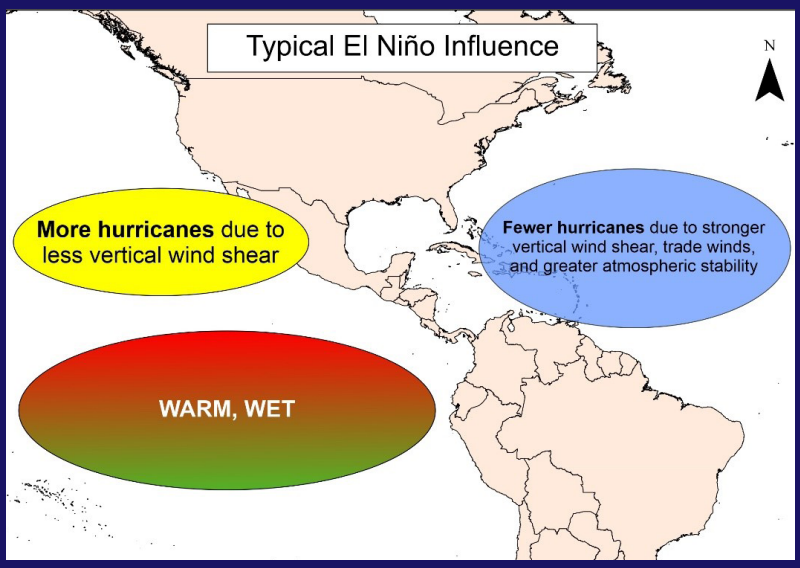
The El Niño-Southern Oscillation (ENSO) is a periodic climate pattern, which involves changes to the temperature of waters in the eastern and central tropical Pacific. Over timescales of three to seven years, the surface waters across the Pacific Ocean warm or cool, with temperature changes ranging from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

There are three phases of the ENSO phenomenon. The two opposite phases are 'El Niño' and 'La Niña'. During El Niño surface waters are warmer than average. During La Niña surface waters are cooler than average. The third 'neutral' phase is where sea surface temperatures are close to the long-term average in the Pacific Ocean.

ENSO influences tropical cyclone activity primarily through its impact on wind shear. Wind shear refers to the change in wind speed and direction in the atmosphere between 1,500 and 10,000 meters above the surface. Strong vertical wind shear leads to reduced tropical cyclone activity as storm energy is dissipated reducing the likelihood of storm development.

El Niño (ENSO-positive) is when above-average sea surface temperatures occur in the central and eastern tropical Pacific Ocean. El Niño favours **above average** hurricane activity in the central and eastern Pacific basins due to lower wind shear. In contrast, activity is ***supressed*** in the North Atlantic basin due to higher wind shear (**Figure 6** upper panel).

La Niña (ENSO-negative) is when below-average sea surface temperatures occur in the central and eastern tropical Pacific Ocean. La Niña favours **below average** hurricane activity in the central and eastern Pacific basins due to higher wind shear. In contrast, activity is ***enhanced*** in the North Atlantic basin (**Figure 6** alongside).



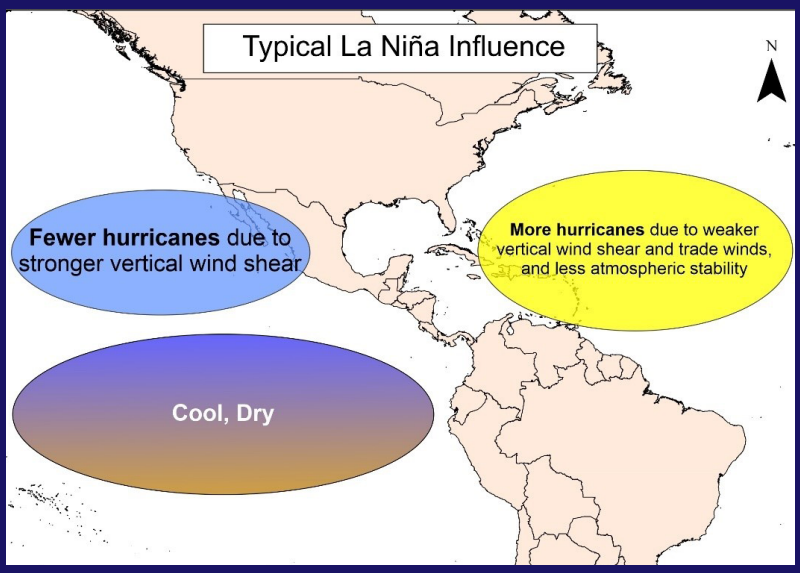


Figure 6: Typical influence of El Niño (top) and La Niña (bottom) on the east Pacific and North Atlantic hurricane activity. Map based on originals by Gerry Bell.

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 the MS Amlin's Risk Analytics team will release an updated forecast summary.

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