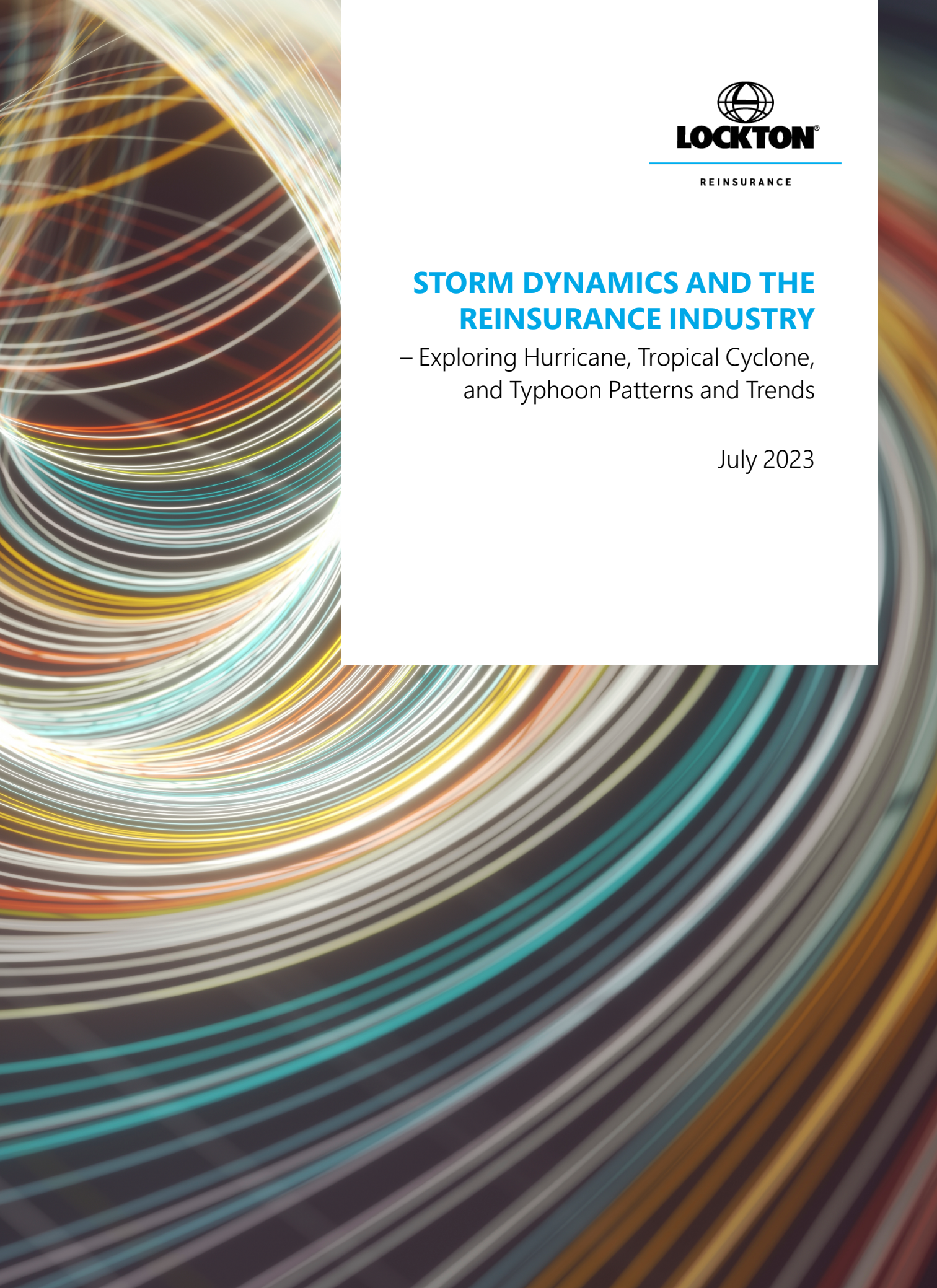


LOCKTON®

REINSURANCE

STORM DYNAMICS AND THE REINSURANCE INDUSTRY

– Exploring Hurricane, Tropical Cyclone, and Typhoon Patterns and Trends

July 2023

HELPING BUSINESSES UNDERSTAND, MITIGATE AND CAPITALIZE ON RISK

Executive Summary

In our February report on Cyber and the use of ILS structuring, we introduced a platform for future articles on industry dynamics. This framework is comprised of four fundamental tenants of the marketplace: perils, exposure (to those perils), risk transfer, and placement (of the risk transfer structure). For this publication, the first in a series of four, we will be focusing on the hurricane peril, discussing our current understanding of hurricanes (including tropical cyclone and typhoon patterns), impacts to climates that could alter the nature of this peril, and our view of storm trends and their potential development.

In three additional follow-up publications, we will cover the industry's exposure to hurricanes and the fast-changing nature of home and building structures and their ability to withstand storms; then on to a unique view of comprehensive risk transfer option creation; and finally, how placement techniques are trending and improving within the property (re)insurance market.

• **Peril** • Exposure • Risk Transfer • Placement

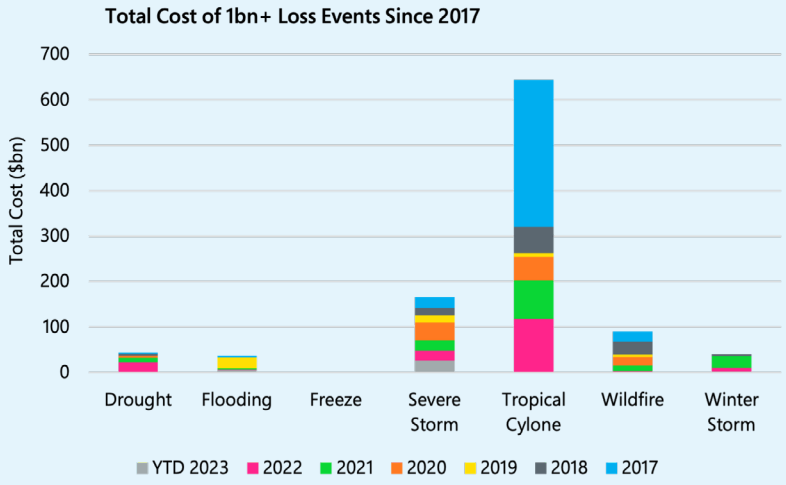
As we examine hurricane/tropical cyclone/typhoon patterns and trends, we can conclude one thing for certain, climate change is impacting weather around the globe.

Climate Change Defined

When considering what is meant by climate, it is important to distinguish the difference between it and weather. Most of those differences come down to the measurement of time, with weather being conditions over short periods (i.e., minutes to months), while climate refers to longer-term weather patterns. Climate is often defined as the average weather for a particular region and time period, usually over 30 years. Climate covers a broad range of elements, including temperature, precipitation, wind patterns, humidity, and atmospheric pressure.

Impacts of Climate Change

As the climate changes, the impacts felt by the (re)insurance industry will be altered based on how the corresponding peril(s) responds. Tropical cyclones (which includes hurricanes) are typically one of, if not the, most likely to cause insured loss globally.



Source: Lockton Re and NOAA Data

Potential Impacts of Climate Change

Change	Increased storm intensity	Increased precipitation	Rising sea levels
Impact	Larger proportion of cat 3-5 tropical cyclones making landfall	Additional rainfall causing flooding	Storm surge pushing farther inland

According to the Intergovernmental Panel on Climate Change (IPCC), it is likely that the global proportion of Major (Category 3-5) tropical cyclone occurrence has increased over the last four decades. As the intensity of these storms increases, so does the potential for insured losses[1].

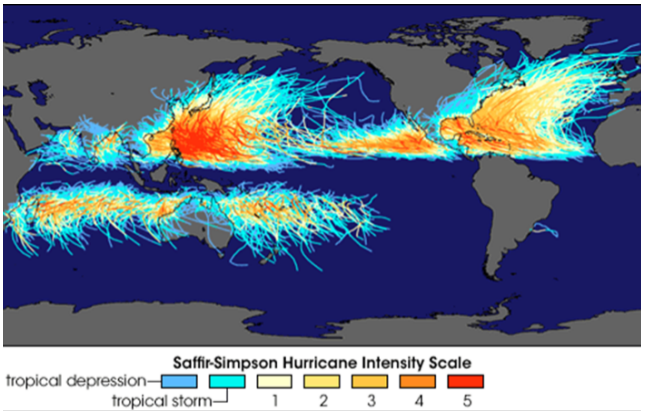
> "Deadly and destructive storm surges, such as those associated with Katrina, Sandy, and Michael, push farther inland than they once did."

According to the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI) and the National Hurricane Center (NHC), two of the six costliest storms to impact the US (all adjusted based on the 2023 Consumer Price Index adjusted cost) occurred in the past two years – Ida in 2021 and Ian in 2022. Both storms were high-end Category 4's when making landfall, Ian in Southwest Florida and Ida at Port Fourchon, Louisiana[2]. Since 2000 almost half of all storms that have formed in the Atlantic Basin have reached a Major Category.

Additionally, the IPCC suggests that human-caused climate change increases heavy precipitation associated with tropical cyclones. Hurricane Harvey, which struck Texas and Louisiana in August of 2017[1], caused catastrophic flooding in Harris County – amounting to more than $125 billion in economic damage according to NOAA. NOAA has pegged this storm as the second costliest to hit the US when adjusted based on the 2023 Consumer Price Index[3]. Five years after Harvey struck, a study published in the journal of Nature Communications stated that it was estimated that up to 50% of the properties flooded would have made it through unscathed if not for increasing precipitation due to climate change[4].

The study went on to estimate that total rainfall was 15% to 38% more than what it would have been if the world was not warming, saying that the "warmer air holds more moisture that is then unleashed as precipitation".

Furthermore, NOAA has stated that due to the increase in global temperatures, sea levels continue to rise around the world. These higher water levels "mean that deadly and destructive storm surges, such as those associated with Katrina, Sandy, and Michael, push farther inland than they once did." And unlike more intense hurricanes that bring stronger winds and therefore tend to produce more loss, storm surge driven events have tended to deviate from this trend. Katrina, the costliest hurricane to impact the US according to the NCEI, was only a Category 3 when making Landfall in Louisiana – weaker than storms such as Ian, Maria, Irma, and Andrew. Sandy, the fifth costliest hurricane to impact the US, was in fact only a Category 1 storm upon landfall. Although wind speeds can play a role in determining the potential storm surge risk, other factors like size of the tropical cyclone, direction, angle of approach, and atmospheric pressure all play a role. For example, the largest storm surge captured before Katrina was 22 feet from Hurricane Camille, a Major Category 5 storm with 190 MPH winds that made landfall back in 1969. Katrina, despite being a Major Category 3 storm with winds of 60 MPH less than Camille, caused storm surges up to 28 feet[5].



Source: NASA Earth Observatory. (n.d.). Historic Tropical Cyclone tracks. https://earthobservatory.nasa.gov/images/7079/historic-tropical-cyclone-tracks

2022 Recap

Globally, 132 tropical systems formed – with 86 of them being named by the various weather agencies around the world.

Strongest

Typhoon Nanmadol, which impacted Japan and South Korea, was the strongest storm during the year by minimum Central Pressure, with a reading of 910 hPA.

Deadliest

Tropical Storm Megi in the Philippines was the deadliest of the year, causing over 200 fatalities.

Costliest

Hurricane Ian was the costliest of all the storms in 2022, with an estimated $113.1 Billion in damages caused throughout its path with impacted Venezuela, Colombia, Trinidad and Tobago, the Greater Antilles, and the Southeastern United States.

Source: Supportstorm. (2022). Tropical Cyclone Summary Map. Wikimedia Commons. https://commons.wikimedia.org/wiki/File:2022_tropical_cyclone_summary_map.png#fileFile:2022_tropical_cyclone_summary_map.png

> In 2022, eight of the 86 named storms globally reached "Major" category. Three of these storms reached category 5 (Ian, Hinnanmoor, Noru). The US had an average season overall, with 14 named storms, eight of which became Hurricanes.

Storm Frequency vs. Loss & Exposure

While 2022 was average in terms of hurricane activity in the North Atlantic, it was the third costliest on record, with Hurricane Ian resulting in an estimated $50-$65B of insured losses. Ian made landfall in western Florida as a category 4 storm and impacted an area that has seen significant population growth and development expansion. The increase of exposure in the path of the storm is a critical driver of the loss from this event, and as society continues to expand into risk-prone areas that are starting to experience more intense events because of the changing climate, the potential for large losses will continue to rise.

Source: National Oceanic and Atmospheric Administration, National Environmetal Satellite Data, and Information Service, & Center for Satellite Applications and Research. (2023, April 3). GOES-16 GEOCOLOR IMAGE FROM 28 SEPTEMBER 2022 AT 1910 UTC NEAR THE TIME OF IAN'S LANDFALL IN SOUTH WESTERN FLORIDA. https://www.nhc.noaa.gov/data/tcr/AL092022_Ian.pdf

2023 Outlook

The 2023 hurricane season is being called an "average" year for the Atlantic Basin. The prediction calls for 11-15 named storms, 4-8 hurricanes, and 1-3 major hurricanes, with the highest chance for direct/significant impacts in Florida/ Carolinas, and the lowest chance over the Western Gulf of Mexico and Northeastern US[7-8]. Warm waters could lead to one or two storms being very strong/intense (as discussed in the Climate Change section).

> "While 2022 was average in terms of hurricane activity in the North Atlantic, it was the third costliest on record."

Forecaster	Named Storms	Hurricanes	Major Hurricanes
NOAA	12-17	5-9	1-4
Colorado State University	18	9	4

Sources: NOAA predicts a near-normal 2023 Atlantic hurricane season. (2023b, May 25). National Oceanic and Atmospheric Administration. https://www.noaa.gov/news-release/2023-atlantic-hurricane-season-outlook

CSU Hurricane seasonal forecasting. (n.d.). https://tropical.colostate.edu/Forecast/2023-07-pressrelease.pdf

To put these predictions into perspective, we can look at prior hurricane season predictions versus actual results to see how reliable they were. Since 2010, NOAA's prediction for named storms in a year is off by an average of 3.77, while Colorado State University's (CSU) prediction error is slightly larger at 4.77. Removing 2020 from the predictions, when the Atlantic basin saw 30 named storms – a large discrepancy compared to the 16 named storms predicted by both NOAA and CSU – the average error per season goes to 2.92 for NOAA and 4.00 for CSU. Additionally, since 2010 both NOAA and CSU predictions for named storms have been lower than the actual number in 10 of those 13 years. Interestingly, both NOAA and CSU align directionally year by year. In terms of the number of named storms that reach Hurricane status, the margin of error for both NOAA and CSU decreases. Since 2010 NOAA has been off by just over 2 storms a year on average while CSU has been off by just over 3 storms a year. We see a similar trend to the total number of named storms, with both NOAA and CSU predictions for Hurricane formation to be lower than what was actually observed[9-13].

Looking Ahead

Before moving on to our next publication in the series, which will deal with trends in property exposures, It's clear that underlying, climate related changes are making it challenging to predict storm dynamics. Past focus on frequency and severity of storms may have missed more fundamental global climate changes. Some of those changes are becoming more evident as the likelihood of loss causing storms has increased, particularly in the last 5 years. Wind speed alone is no longer a good predictor of damages. As climate change has increased precipitation and made storm surge more likely, even lower categorized storms (as a function of wind speed), can create material loss. We will explore how property construction and location are being impacted by these changing storm elements in our next report.

About Lockton Re (locktonre.com)

Lockton Re, the global reinsurance business of Lockton Companies, helps businesses understand, mitigate, and capitalize on risk. With over 300 colleagues in 16 locations globally, the business is continuing to grow, pushing the reinsurance industry forward with smarter solutions that leverage new technologies—delivered by people empowered to do what's right for clients.

Lockton Re Insights

Lockton Re's reports, market commentary and insights focus on key topics, occurrences or changes in the (re) insurance and broking market place which impact our clients and partners. In order to help guide relevance for the reader we categorize this content in four areas – Perils, Exposures, Risk Transfer and Placement.

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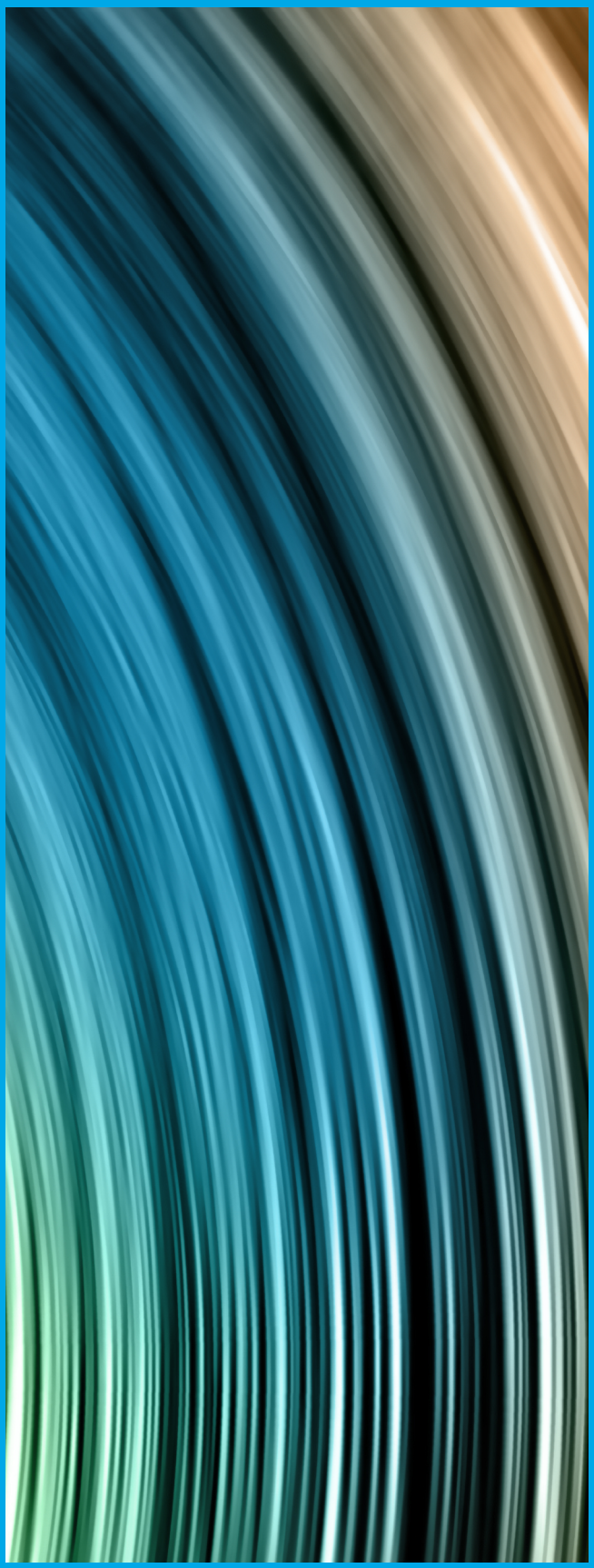

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[13] Damaging 2022 Atlantic hurricane season draws to a close. (2022, November 29). National Oceanic and Atmospheric Administration. https://www.noaa.gov/news-release/damaging-2022-atlantic-hurricane-season-draws-to-close

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