AozoraStep

Hurricanes and how this season could still turn out to be disruptive

Tropical cyclones, such as hurricanes, cyclones and typhoons only exist in certain parts of the world, where conditions allow for their creation.[1] This note will only focus on hurricanes. Hurricanes cannot form at the equator, as without the effect of earth's rotation (Coriolis effect), the storm cannot spin.[2] Hurricanes also rarely form in the South Atlantic due to colder water temperatures and stronger vertical wind shear.[3] Therefore, hurricanes mostly form in and around the Gulf of Mexico, the North Atlantic, just slightly north of the equator, where trade winds guide the weather disturbances from West Africa towards the USA. The recipe for a hurricane is created through warm water temperatures, low air pressure and low wind shears. The first condition is warm ocean temperatures of above 26-27 degrees Celsius. Some ocean water is moving up with the air, evaporating into the upper, colder atmosphere, condensing into clouds. The warmer the ocean temperature, the more active the water vapor rises, as the warmer the air particle, the more it gets pushed up by relatively colder air particles. At the same time, the higher the temperature of the air, the more water vapor it can hold.[4] This can only happen in a low air pressure area, where there is lower air pressure in the center than around it, pushing air towards the low-pressure area and moving it up in the center to fill the void.[5] A saturated lapse rate is then often observed, where condensation occurs rapidly, accelerating the upward motion of the air and releasing more latent heat, intensifying the system.[6] Finally, to keep the center stable, enabling the creation of the storm, low wind shears are needed,[7] especially at the top of the storm[8], which means the wind in different altitudes does not move in opposite directions. This also explains that when a hurricane makes landfall, it generally loses strength quickly due to temperatures cooling faster on land than at sea at night, hence creating wind shear and generally greater friction & less water to absorb.[9]

---

1 https://www.weather.gov/source/zhu/ZHU_Training_Page/tropical_stuff/hurricane_anatomy/hurricane_anatomy.html

2 https://www.iflscience.com/theres-a-weird-reason-why-hurricanes-never-cross-the-equator-68082

3 https://earthobservatory.nasa.gov/images/12935/rare-south-atlantic-tropical-cyclone

4 https://sealevel.jpl.nasa.gov/ocean-observation/understanding-climate/air-and-water/

5 https://scied.ucar.edu/learning-zone/how-weather-works/highs-and-lows-air-pressure

6 https://generxgenerators.com/2023/02/24/hurricane-facts/

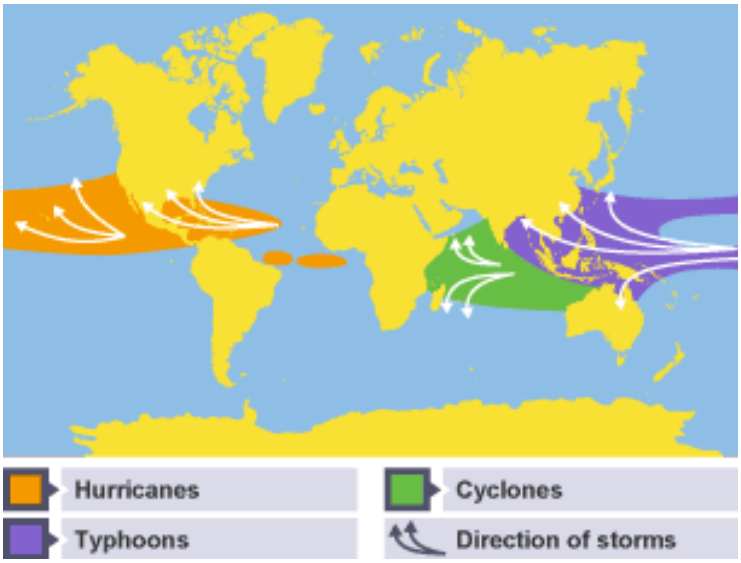
7 https://tropic.ssec.wisc.edu/real-time/windmain.php?&basin=atlantic&sat=wg8&prod=shr&zoom=&time=

8 https://www.scientificamerican.com/article/what-is-wind-shear-and-how-does-it-shape-hurricanes/

9 https://www.faasafety.gov/files/gslac/library/documents/2011/Aug/56407/FAA%20P-8740-40%20WindShear%5Bhi-res%5D%20branded.pdf

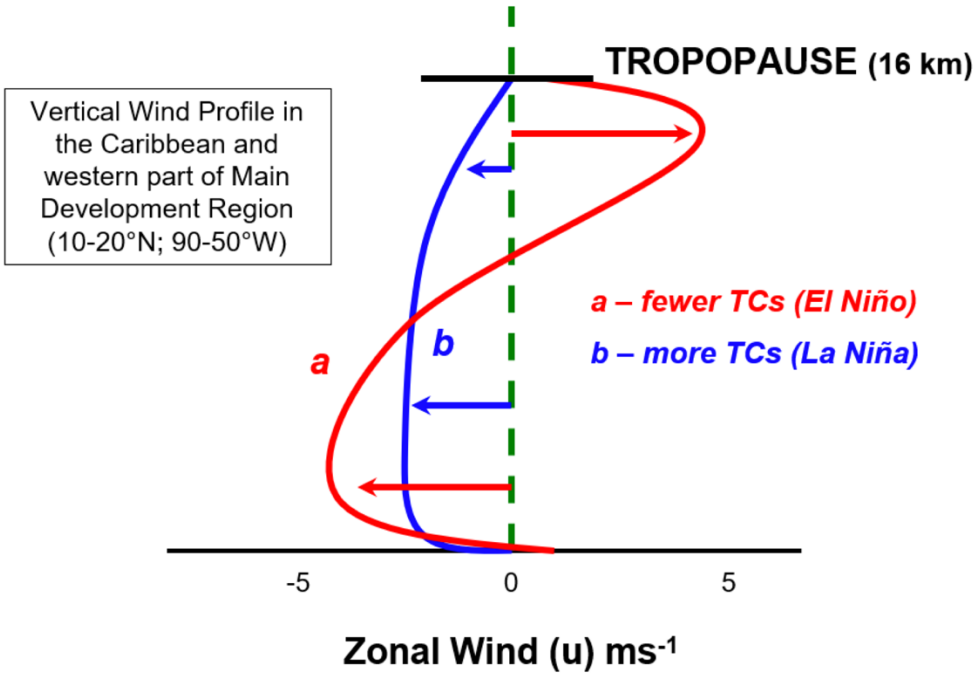
21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Where Hurricanes, Cyclones and Typhoons are created



Source: https://www.bbc.co.uk/bitesize/topics/zn476sg/articles/zk89kty#zrrrcmn

How low wind shears (often during La Nina) are necessary to create hurricanes



Source: https://tropical.colostate.edu/Forecast/2024_0903_seasondiscussion.pdf

21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

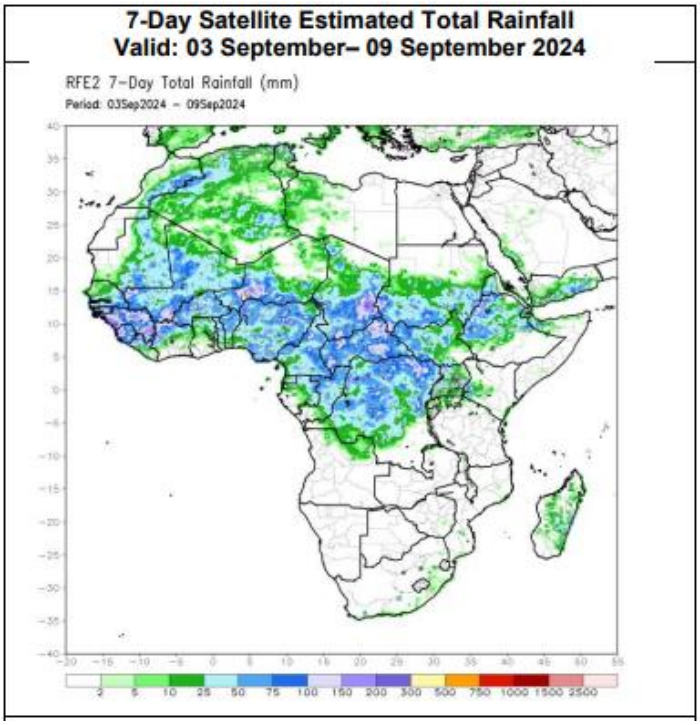
How this year's hurricane season has underwhelmed all expectations (so far)

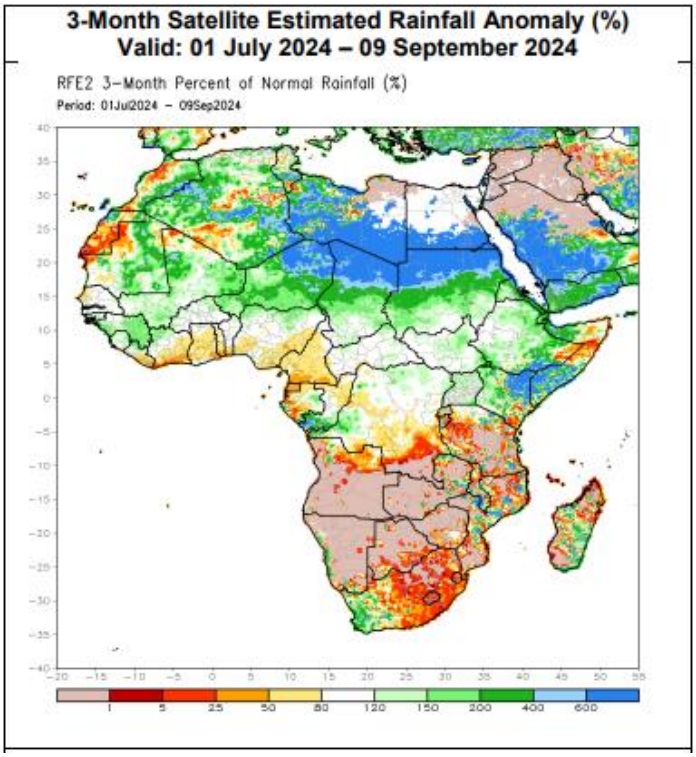
Just at the beginning of August, the National Oceanic and Atmospheric Administration projected this year's hurricane season to be potentially one of the most active.[10] Yet, following one month of nearly no hurricane formation at peak hurricane time in August/September[11], there has been plenty of confusion, with some of the most plausible reasons being named by science researcher Philip Klotzbach[12], Tel Aviv University's Prof Colin Price[13] and the BBC[14]. In summary, it had a lot to do with weather around the globe and specifically in West Africa, where disturbances in the atmosphere cause more than 85% of the most intense hurricanes that affect the US. Here is where the cause-and-effect relationship gets really complex, as you will find yourself in a never-ending slope of chasing down the weather chain. The higher tropical rainfall off the coast of East Africa (Madden-Julian oscillation)[15] caused weather in West Africa to be drier than usual[16]. This could have also led to larger dust storms from the Sahara following the trade winds to as far away as Texas[17], which in turn change temperatures and create higher wind shear, such that temperatures in the upper atmosphere were very warm and strong wind shear leading to the disruption of any possible weather disturbances. The Atlantic la Nina this season is also likely another reason for the low weather disturbances off the coast of West Africa this year – more on this in the next section.[18] Overall, weather patterns in West Africa will be key to watch over the coming weeks, as when Sahara dust storms stop and West Africa is receiving more rainfall, low air pressure areas can form more easily, creating the recipe for potential hurricanes to come. And we have just had the most rainfall in three decades in Nigeria, which could create the recipe for storm formation, if not disturbed by a high-pressure region.[19] In combination with the Eastern Pacific La Nina weather pattern, this could lead to a destructive end of the hurricane season…

[10] https://noaa.gov/news-release/highly-active-hurricane-season-likely-to-continue-in-atlantic
[11] https://www.reuters.com/markets/commodities/where-are-hurricanes-quiet-atlantic-bucks-forecast-super-season-2024-09-06/
[12] https://tropical.colostate.edu/Forecast/2024_0903_seasondiscussion.pdf
[13] https://en-exact-sciences.tau.ac.il/news_hurricanes
[14] https://www.bbc.com/future/article/20201014-the-desert-that-gives-birth-to-the-most-powerful-hurricanes
[15] https://www.metoffice.gov.uk/weather/learn-about/weather/atmosphere/madden-julian-oscillation
[16] https://www.cpc.ncep.noaa.gov/products/international/africa/africa_hazard.pdf
[17] https://www.fox26houston.com/video/1493791
[18] https://www.climate.gov/news-features/event-tracker/atlantic-nina-verge-developing-heres-why-we-should-pay-attention
[19] https://x.com/AozoraStep/status/1838131217637450075

21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

West Africa rainfall anomaly

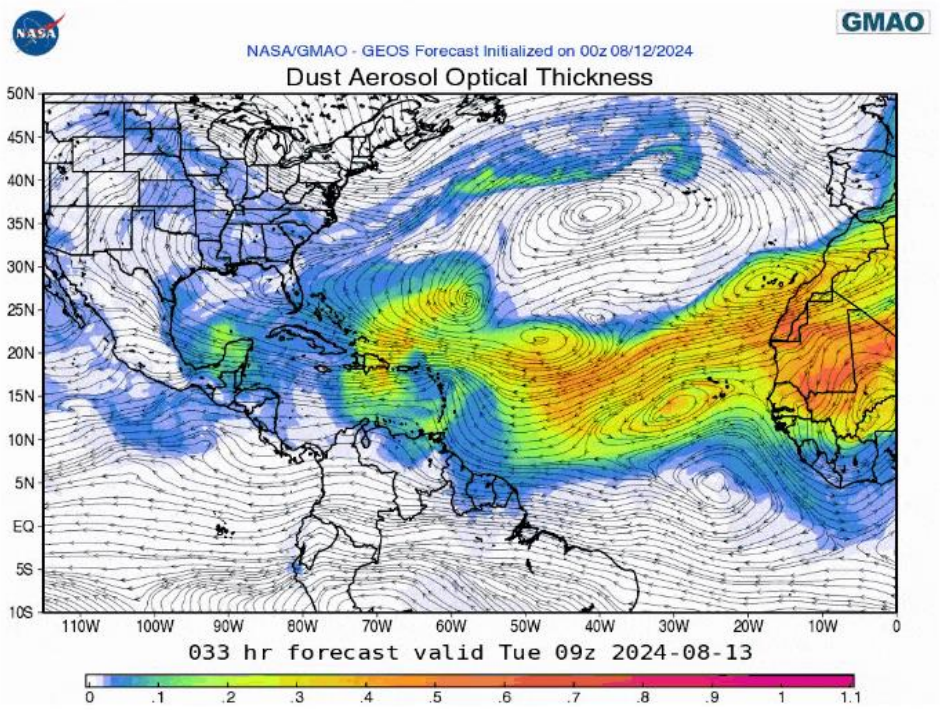




Source: https://www.cpc.ncep.noaa.gov/products/international/africa/africa_hazard.pdf

21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Sahara dust storm in August 2024



00Z Monday, August 12th, 2024, NASA GEOS-5 Dust Extinction Monitoring Tropical Atlantic Dust Aerosol Optical Depth showing Saharan Dust.

Source: https://eu.palmbeachpost.com/story/news/local/2024/06/24/saharan-dust-tamping-down-florida-hurricane-activity-but-it-wont-last/74192271007/

The La Nina weather pattern

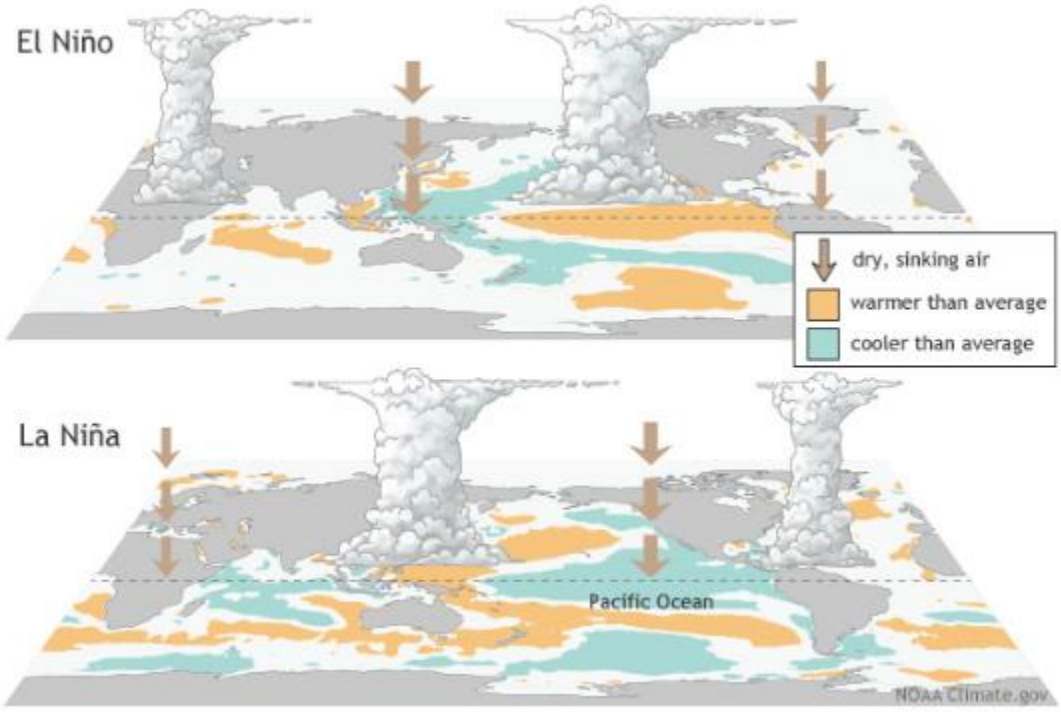
Winds and temperatures are closely linked and when the Eastern Pacific's temperature drops relative to the temperature around it (La Nina), the upper atmosphere winds, which can go in the opposite direction of the trade winds, weaken. This creates weak wind shear, even in the Gulf of Mexico, where the water temperature has not dropped. Together, this can form key conditions for the creation of hurricanes when low pressure areas form off the coast of West Africa or the Caribbean Sea. Almost all of the costliest historic hurricanes formed during a La Nina weather pattern, especially when the water temperatures (in the East Pacific) just began decreasing, i.e. the relative change is important, not the lowest point of water temperature change. There is also another La Nina weather event, the Atlantic Nina[20], which can have the opposite effect and weaken hurricane creation, because it occurs in waters off the coast of West Africa,

[20] https://www.preventionweb.net/news/what-atlantic-nina-how-la-ninas-smaller-cousin-could-affect-hurricane-season

21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

where weather disturbances often start. The key is that relatively colder waters is reducing the chances of hurricanes, but the low wind shears can be carried further away to waters that are warmer, hence increasing the chances of hurricanes in those warmer waters that are separated by a relatively small amount of land, i.e. the Gulf of Mexico during the Eastern Pacific's la Nina.

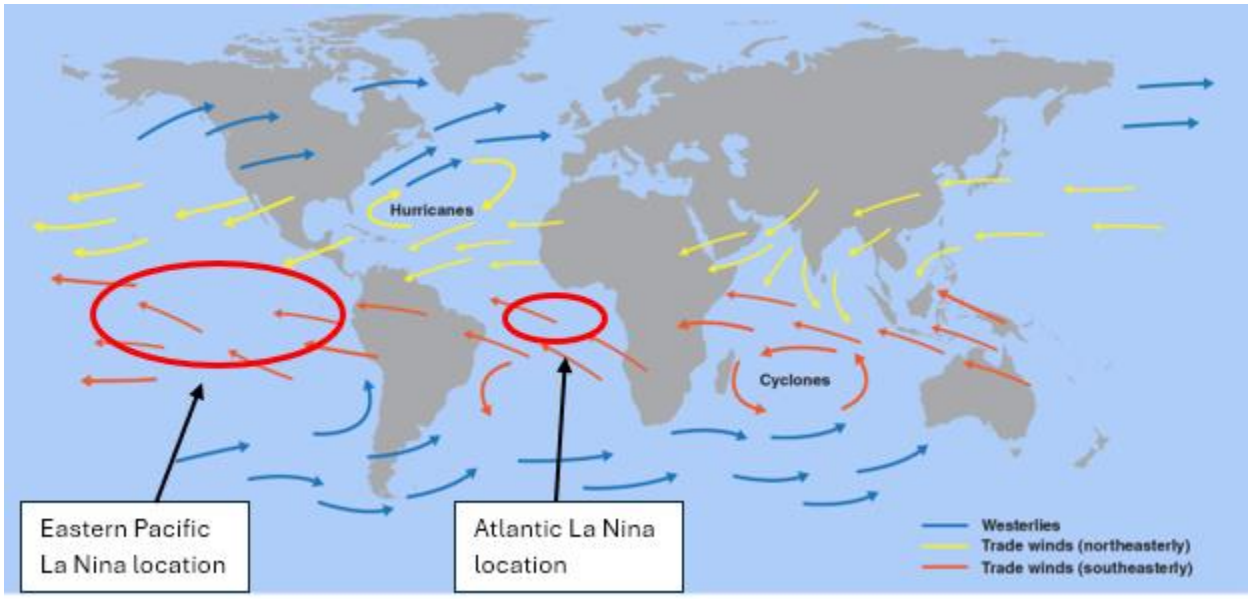
El Nino/La Nina & rainfall patterns



Source: https://www.climate.gov/enso

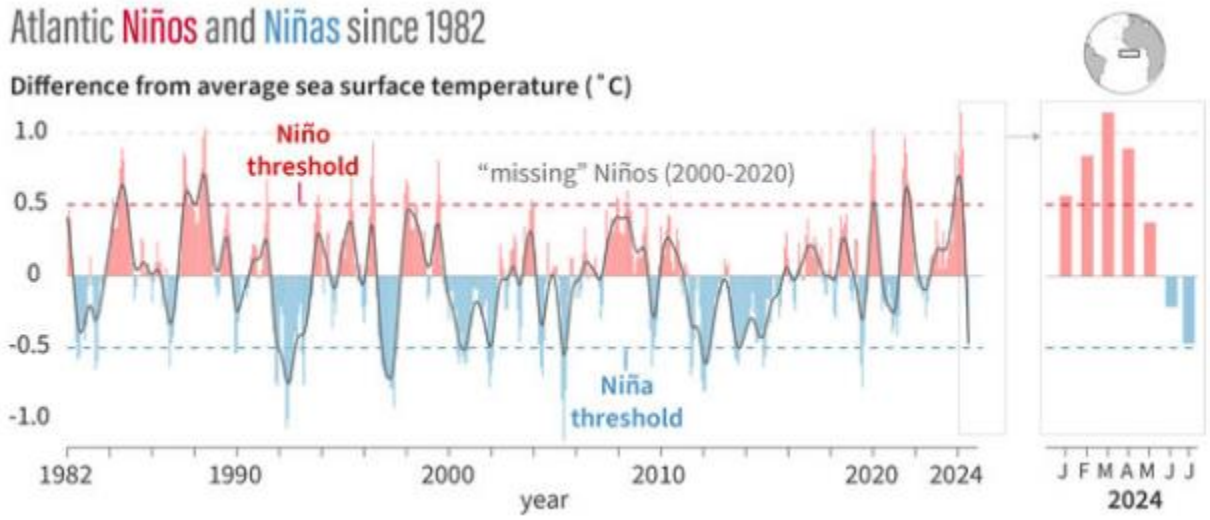
21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Trade winds & La Nina/El Nino locations



Source: https://scijinks.gov/trade-winds/

The Atlantic La Nina event can affect West African atmospheric disturbances



Source: https://www.climate.gov/news-features/event-tracker/atlantic-nina-verge-developing-heres-why-we-should-pay-attention

21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Cold & warm water temperature changes and most costly hurricanes

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.7	-1.4	-1.1	-0.8	-0.7	-0.6	-0.6	-0.5	-0.5	-0.6	-0.7	-0.7
2001	-0.7	-0.5	-0.4	-0.3	-0.3	-0.1	-0.1	-0.1	-0.2	-0.3	-0.3	-0.3
2002	-0.1	0.0	0.1	0.2	0.4	0.7	0.8	0.9	1.0	1.2	1.3	1.1
2003	0.9	0.6	0.4	0.0	-0.3	-0.2	0.1	0.2	0.3	0.3	0.4	0.4
2004	0.4	0.3	0.2	0.2	0.2	0.3	0.5	0.6	0.7	0.7	0.7	0.7
2005	0.6	0.6	0.4	0.4	0.3	0.1	-0.1	-0.1	-0.1	-0.3	-0.6	-0.8
2006	-0.9	-0.8	-0.6	-0.4	-0.1	0.0	0.1	0.3	0.5	0.8	0.9	0.9
2007	0.7	0.2	-0.1	-0.3	-0.4	-0.5	-0.6	-0.8	-1.1	-1.3	-1.5	-1.6
2008	-1.6	-1.5	-1.3	-1.0	-0.8	-0.6	-0.4	-0.2	-0.2	-0.4	-0.6	-0.7
2009	-0.8	-0.8	-0.6	-0.3	0.0	0.3	0.5	0.6	0.7	1.0	1.4	1.6
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2010	1.5	1.2	0.8	0.4	-0.2	-0.7	-1.0	-1.3	-1.6	-1.6	-1.6	-1.6
2011	-1.4	-1.2	-0.9	-0.7	-0.6	-0.4	-0.5	-0.6	-0.8	-1.0	-1.1	-1.0
2012	-0.9	-0.7	-0.6	-0.5	-0.3	0.0	0.2	0.4	0.4	0.3	0.1	-0.2
2013	-0.4	-0.4	-0.3	-0.3	-0.4	-0.4	-0.4	-0.3	-0.3	-0.2	-0.2	-0.3
2014	-0.4	-0.5	-0.3	0.0	0.2	0.2	0.0	0.1	0.2	0.5	0.6	0.7
2015	0.5	0.5	0.5	0.7	0.9	1.2	1.5	1.9	2.2	2.4	2.6	2.6
2016	2.5	2.1	1.6	0.9	0.4	-0.1	-0.4	-0.5	-0.6	-0.7	-0.7	-0.6
2017	-0.3	-0.2	0.1	0.2	0.3	0.3	0.1	-0.1	-0.4	-0.7	-0.8	-1.0
2018	-0.9	-0.9	-0.7	-0.5	-0.2	0.0	0.1	0.2	0.5	0.8	0.9	0.8
2019	0.7	0.7	0.7	0.7	0.5	0.5	0.3	0.1	0.2	0.3	0.5	0.5
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2020	0.5	0.5	0.4	0.2	-0.1	-0.3	-0.4	-0.6	-0.9	-1.2	-1.3	-1.3
2021	-1.0	-0.9	-0.8	-0.7	-0.5	-0.4	-0.4	-0.5	-0.7	-0.8	-1.0	-1.0
2022	-1.0	-0.9	-1.0	-1.1	-1.0	-0.9	-0.8	-0.9	-1.0	-1.0	-0.9	-0.8
2023	-0.7	-0.4	-0.1	0.2	0.5	0.8	1.1	1.3	1.6	1.8	1.9	2.0
2024	1.8	1.5	1.1	0.7	0.4	0.2	0.1					

Hurricane Katrina
08-Aug-2005 ($200bn)

Hurricane Ike
28-Aug-2008 ($43bn)

Hurricane Sandy
11-Oct-2012 ($88.5bn)

Hurricane Maria
12-Sep-2017 ($115bn)

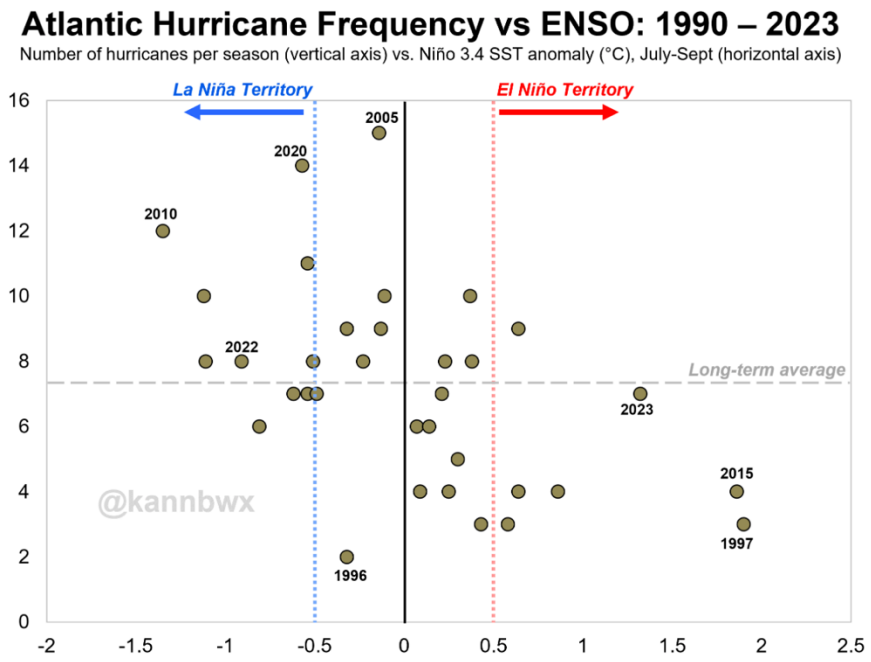
Hurricane Harvey
12-Aug-2017 ($160bn)
Hurricane Irma
27-Aug-2017 ($64.5bn)

Hurricane Ida
14-Aug-2021 ($84.6bn)

Hurricane Ian
14-Sep-2022 ($119bn)

Source: https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com



Source: https://www.reuters.com/markets/commodities/where-are-hurricanes-quiet-atlantic-bucks-forecast-super-season-2024-09-06/

Damages from Hurricanes in 2024 (so far)

As of 30th September 2024, the estimated insured loss from the four major hurricanes that made landfall range from $9.5bn to $18.5bn, with a wide range due to hurricane Helene amidst the higher-than-expected storm surge in Tampa, Florida, affecting economic property losses included uninsured property losses by as much as $15bn to $26bn[21]. What makes this year unique is that we had 4 major US Gulf Coast hurricanes making landfall with only 5 other years of 4 or more Gulf hurricanes making landfall[22], yet the costs were comparatively relatively minimal as no major populated area was affected – this somewhat changed with hurricane Helene though. The areas where reinsurers are active, are also more likely those that are more heavily populated, which protects reinsurers to a certain degree. What is interesting is that despite the very low hurricane activity during August/beginning September, the number of hurricanes as of 3rd September 2024 still exceeded the average between 1991-2020 (table below).

[21] https://www.artemis.bm/news/hurricane-helene-economic-loss-in-20bn-34bn-range-moodys-analytics/
[22] https://x.com/philklotzbach/status/1839507522358550856

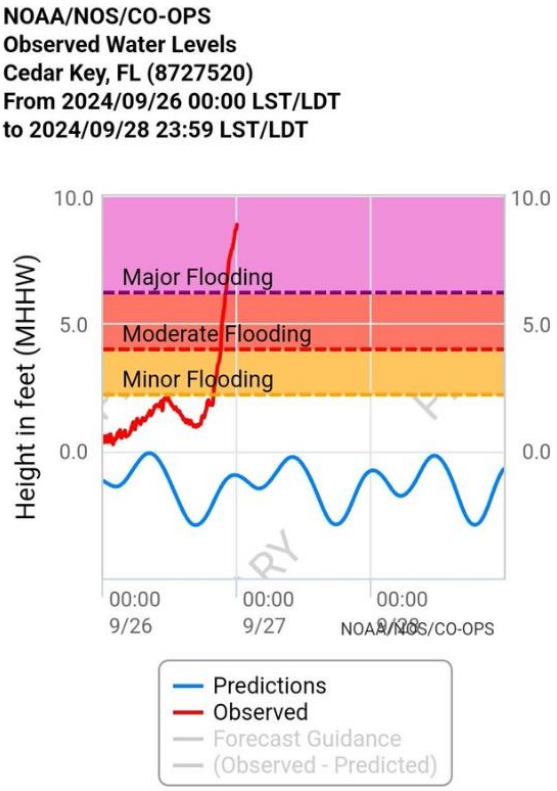
21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Costliest Hurricanes of 2024 as of 30th September 2024 (insured losses)

Hurricane	Low loss $bn estimate	High loss $bn estimate
Beryl	2.5	4.5
Debby	1	2
Francine	1	3
Helene	5	9

Source: Artemis.bm, Reinsurancene.ws

Projections can often be very wrong: Tampa, Florida storm surge from hurricane Helene



Source: https://x.com/MichaelRLowry/status/1839519162344800629 , https://tidesandcurrents.noaa.gov/inundationdb/

21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Forecast for 2024 Hurricane Activity compared to 3rd September count

Forecast Parameters	CSU Forecast for 2024*	Average for 1991-2020	Count as of 3rd September 2024	% of 1991-2020 average
Named Storms	23	14.4	5	71%
Named Storm Days	120	69.4	24.5	89%
Hurricanes	12	7.2	3	111%
Hurricane Days	50	27	12	135%
Major Hurricanes	6	3.2	1	91%
Major Hurricane Days	16	7.4	4.5	188%
Accumulated Cyclone Energy (ACE)+	230	123	55	128%
ACE West of 60 degrees longitude	140	73	46	164%

Source: https://tropical.colostate.edu/forecasting.html ,
https://tropical.colostate.edu/Forecast/2024_0903_seasondiscussion.pdf

Historic hurricanes

When it comes to the historical hurricanes, it is very hard to find a common pattern other than the main reasons, such as water temperature, low pressure and low wind shear. What made these hurricanes causing so much damage can be summarized as follows:

1. The hurricane needs to hit an area that is highly populated
2. The hurricane is in all but one case (Hurricane Sandy) a category 4 or 5 hurricane
3. The most damage is generally caused by storm surge and heavy rains, i.e. flooding, followed by structural damages from wind
4. Nearly 90% of all hurricanes causing more than $20bn in damages have originated off the coast of West Africa
5. From a tropical depression it generally took only very few days to form a major hurricane

The full list, including details of the hurricanes' paths can be found below. In conclusion, while the forecasts of an above average hurricane season initially appeared unwarranted after low activity in August/September, chances are that October, and perhaps even November, could be a lot more active.

21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Historic Hurricanes with damages worth >$20bn

Hurricane	Total Cost US$ bn (inflation adjusted)	Year	Hurricane Formation Date	Origin	Highest Catogory	Pressure	Top Wind Speed	Rainfall (Highest)	Storm Surge (Largest Recorded)	Location	Main Damage Causes
Katrina	200	2005	25-Aug-05	West Africa	5	902 mbar	162 mph	380mm	8.2 metres	Florida, Louisiana, Mississippi Border	High Storm Surge and failure of levees failures caused extensive flooding. High winds (Cat 5) and high rainfall
Harvey	160	2017	24-Aug-17	West Africa	4	937 mbar	130 mph	1539mm	2.4 metres	Texas	Extreme Rainfall, made worse by the storm stalling and remaining over Houston for several days, caused extensive flooding. High winds (cat 4) and
Ian	118.5	2022	26-Sep-22	West Africa	5	937 mbar	160 mph	800mm	3.8 metres	Cube, Florida, Carolina	Storm Surge, Heavy Rain, multiple landfalls
Maria	115.2	2017	18-Sep-17	West Africa	5	908 mbar	175 mph	459mm	1.8 metres	Puerto Rico	Extreme Winds, structural damages.
Sandy	88.5	2012	24-Oct-12	West Africa	3	940 mbar	115 mph	180mm	4.0 metres	Jamaica, Cuba	Unusual path took storm north to northeast coast of america. Storm Surge in New Jersey and New York cause major property damage
Ida	84.6	2021	27-Aug-21	West Africa	4	929 mbar	150 mph	510mm	4.1 metres	Cuba, Louisiana	High winds and storm surge caused widespread property damage
Irma	64	2017	31-Aug-17	West Africa	5	914 mbar	180 mph	610mm	3.0 metres	Barbuda, Cuba, Florida x 2	Extreme Winds, structural damages. Major infrastructure damage in florida
Andrew	60.2	1992	22-Aug-92	West Africa	5	922 mbar	175 mph	360mm	5.2 metres	Bahamas, Florida, Louisiana	Extreme Winds, structural damages. High storm surge in florida causing major property damage

21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Ike	43.2	2008	03-Sep-08	West Africa	4	935 mbar	145 mph	322mm	6.1 metres	Bahamas, Cuba, Texas	Low category by the time it reached USA, although still brought a large storm surge which caused wide property damage in Texas and Louisiana
Ivan	34.2	2004	05-Sep-04	West Africa	5	910 mbar	165 mph	200mm	3.8 metres	Grenada, Jamaica, Cuba, Alabama	High winds and storm sure caused wide coastal damage, with an oil dproduction platform being completely destroyed in the Gulf of Mexico
Michael	31	2018	08-Oct-18	Caribbean Sea	5	919 mbar	160 mph	295mm	3.5 metres	Cuba, Florida	High winds and coastal flooding
Florence	30	2018	04-Sep-18	West Africa	4	937 mbar	150 mph	913mm	2.5 metres	Carolinas	Storm stalled as it made landfall, leading to high rainfall and flooding. Made worse by storm surge
Wilma	30	2005	18-Oct-05	Caribbean Sea	5	882 mbar	185 mph	1633mm	2.7 metres	Mexico x2, Florida	High intensity, holdin grecord for lowest pressure in the Atlantic. Extreme rainfall and high winds
Rita	29.2	2005	20-Sep-05	West Africa	5	895 mbar	180 mph	406mm	5.5 metres	Florida Keys, Louisiana & Texas Border	High winds and storm surge caused widespread property damage
Laura	28.1	2020	25-Aug-20	West Africa	4	937 mbar	150 mph	242mm	2.8 metres	Cuba, Louisiana	High winds, large storm surge in coastal areas
Charley	26.6	2004	11-Aug-04	West Africa	4	941 mbar	150 mph	252mm	4.0 metres	Cuba, Florida x2	High winds and coastal flooding, rapid and unexpected turn in direction
Hugo	22.7	1989	13-Sep-89	West Africa	5	918 mbar	160 mph	447mm	6.2 metres	Guadeloupe, Puerto Rico, South Carolina	High winds, large storm surge in coastal areas

Source: Wikipedia

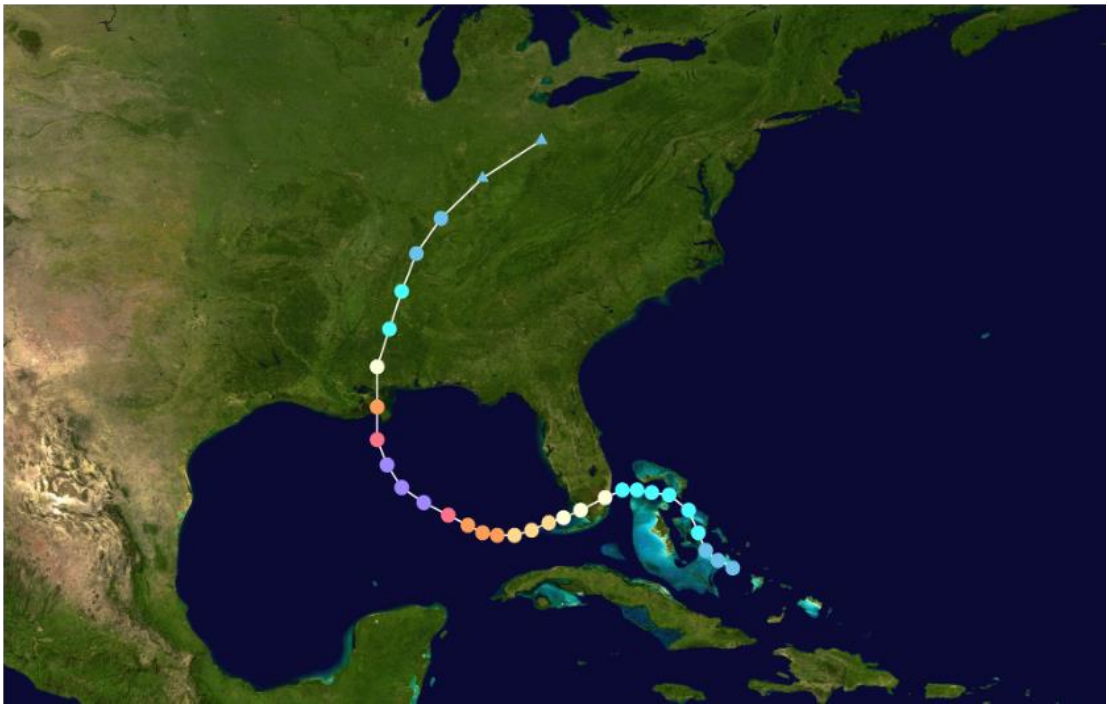
21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Number of days from Disturbance to Hurricane

	Days to form Hurricane		
Hurricane	Disturbance to Tropical Depression	Tropical Depression to Tropical Storm	Tropical Storm to Hurricane
Katrina	15	1	1
Harvey	12	1	0
Ian	10	0	2
Maria	4	1	1
Sandy	11	0	2
Ida	13	0	1
Irma	3	0	1
Andrew	3	1	5
Ike	4	0	2
Ivan	2	1	2
Michael	6	0	1
Florence	3	1	3
Wilma	3	2	2
Rita	11	0	2
Laura	4	1	4
Charley	5	1	2
Hugo	1	1	2

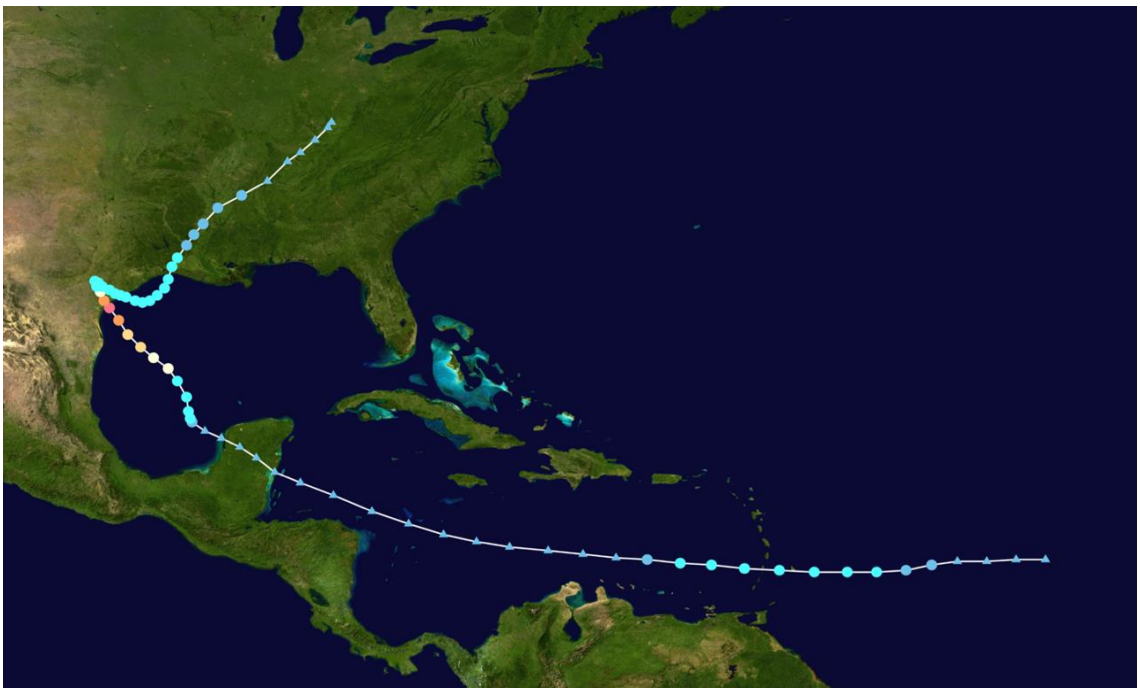
Source: Wikipedia

Katrina

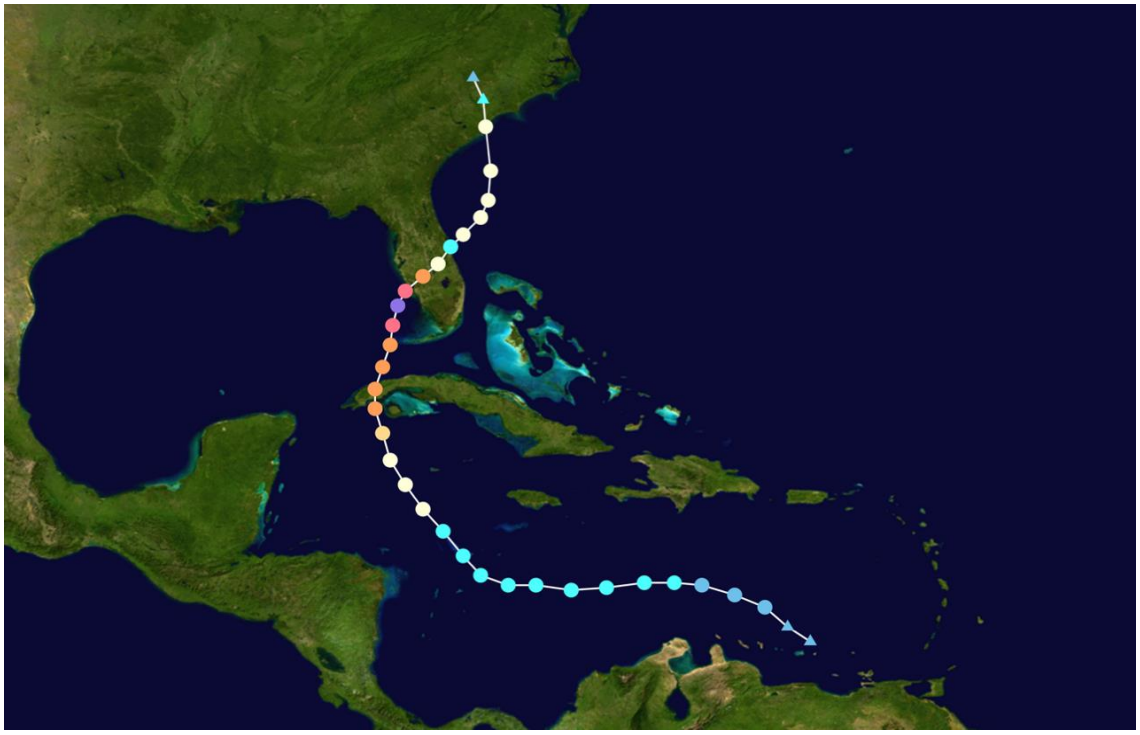


21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Harvey

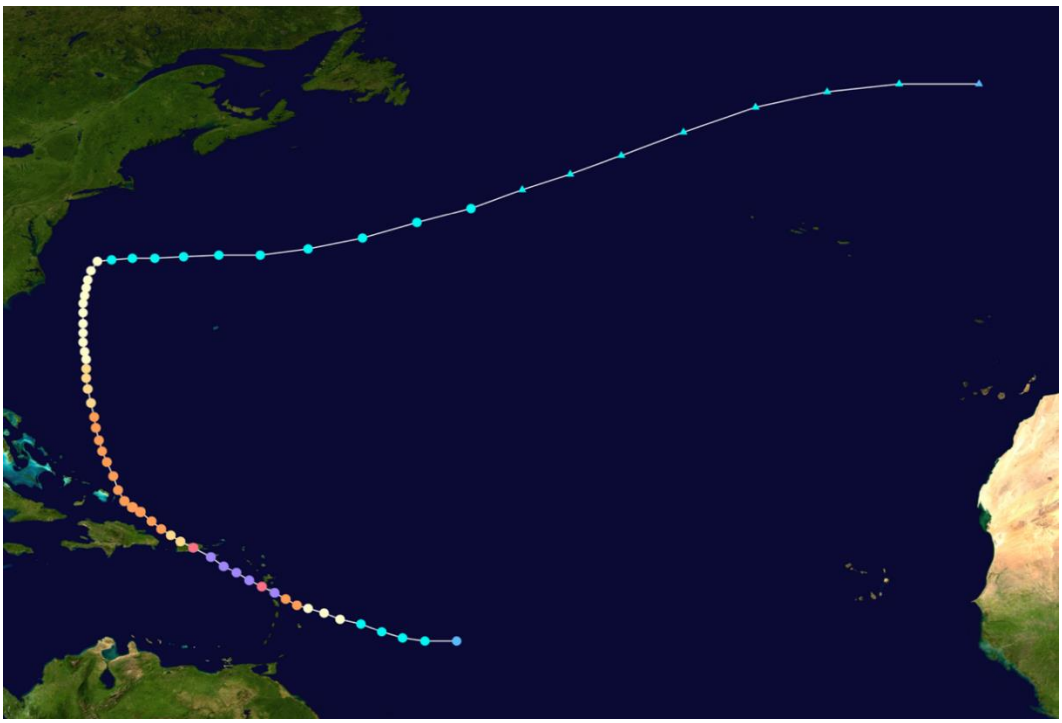


Ian

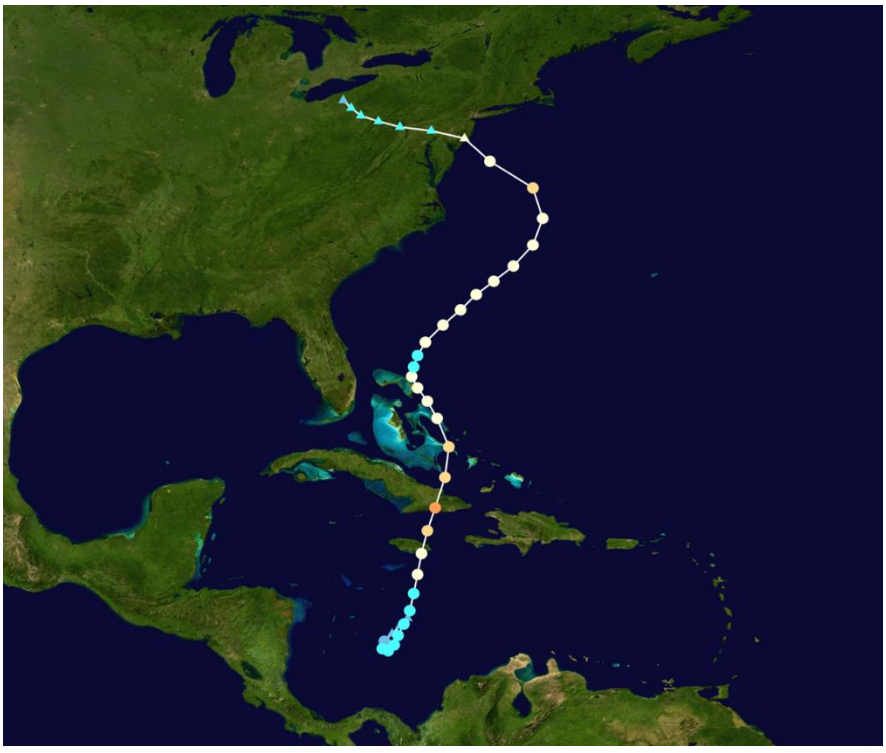


21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Maria

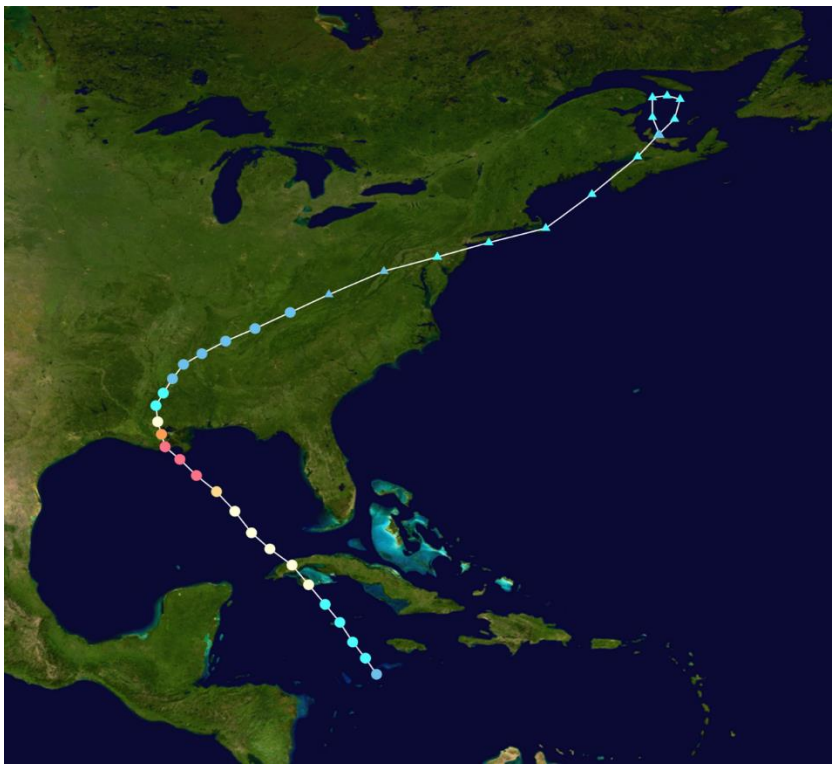


Sandy

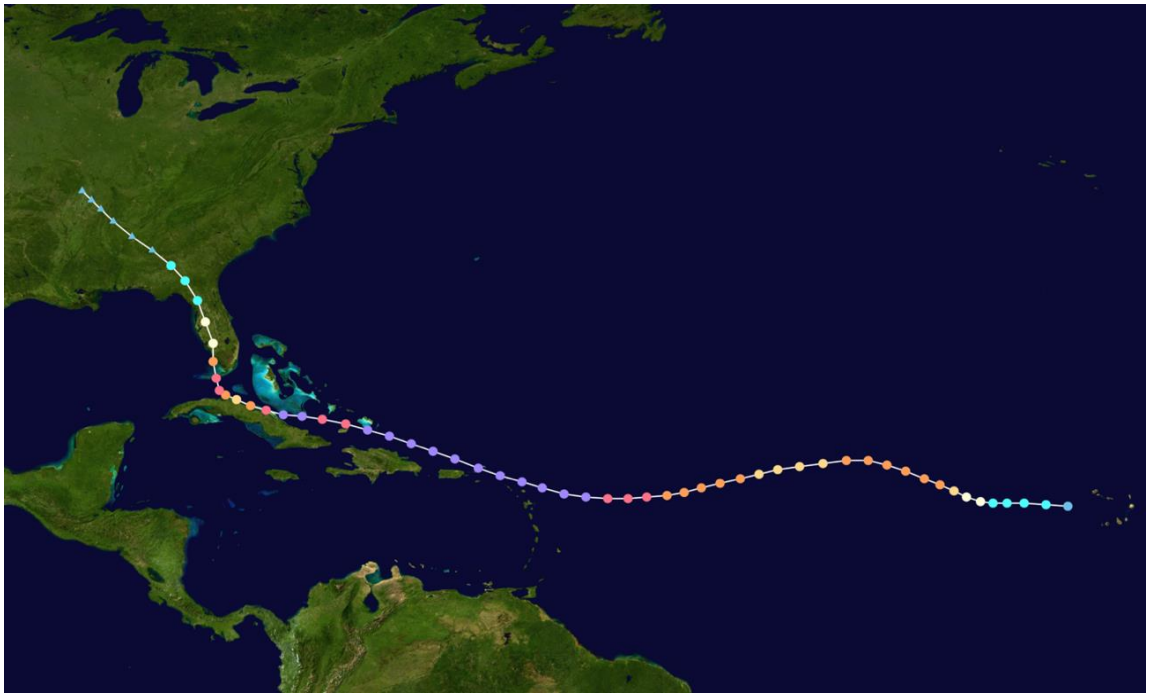


21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Ida



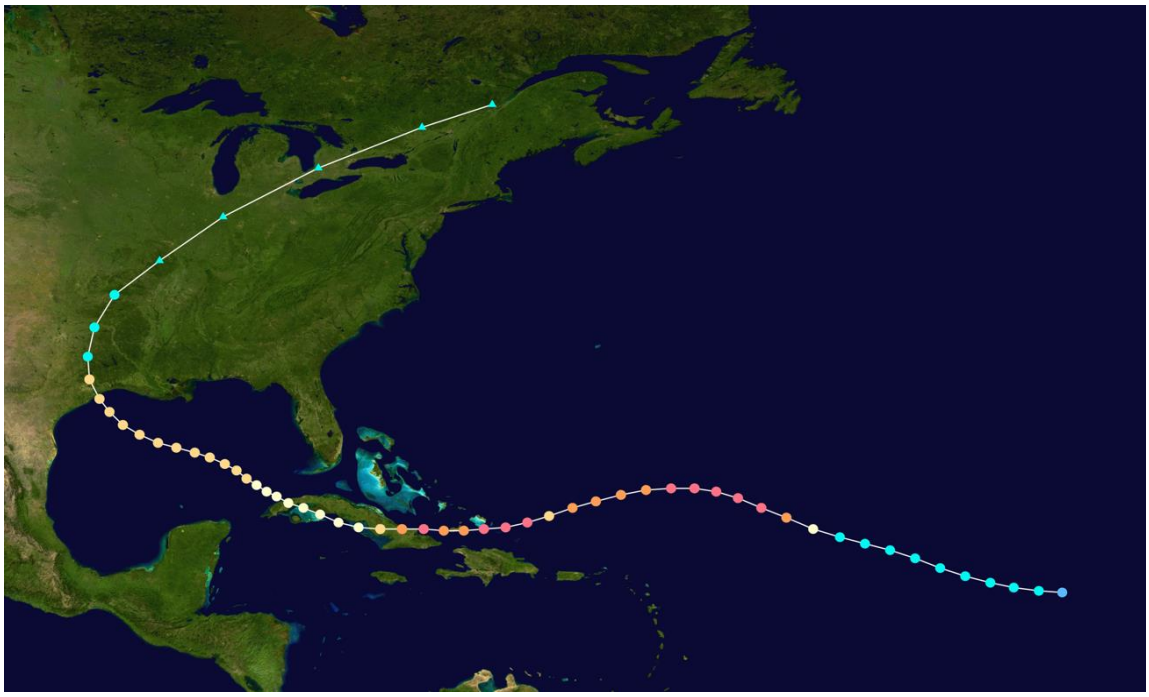
Irma



21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

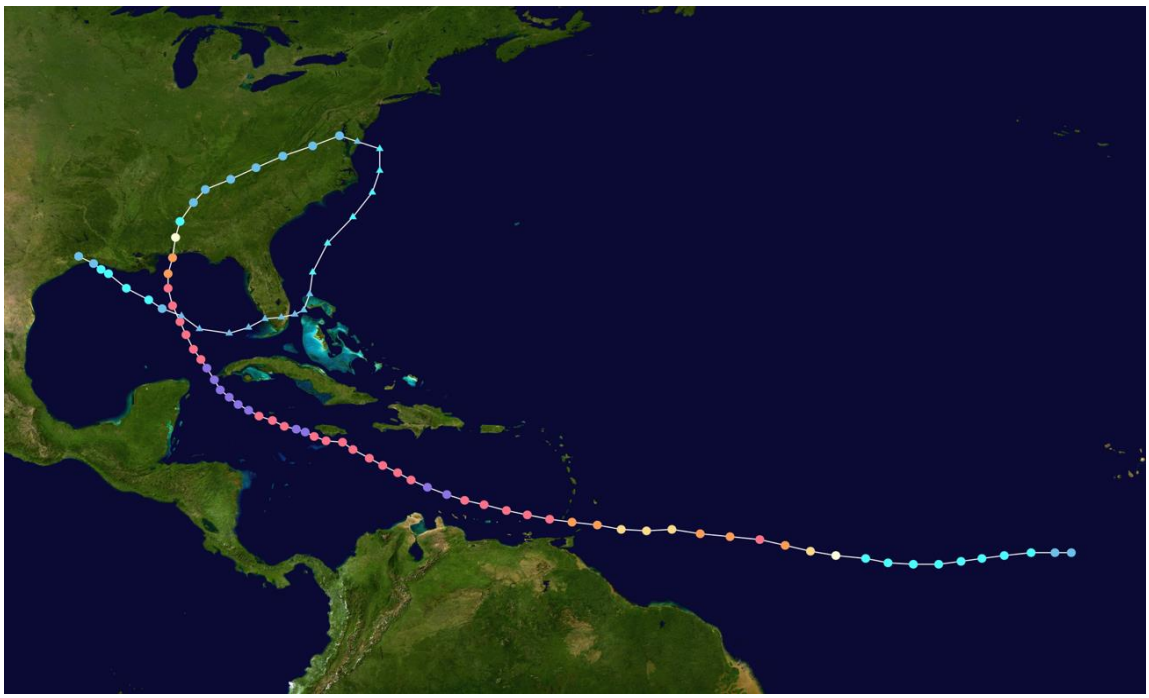
Andrew

Ike

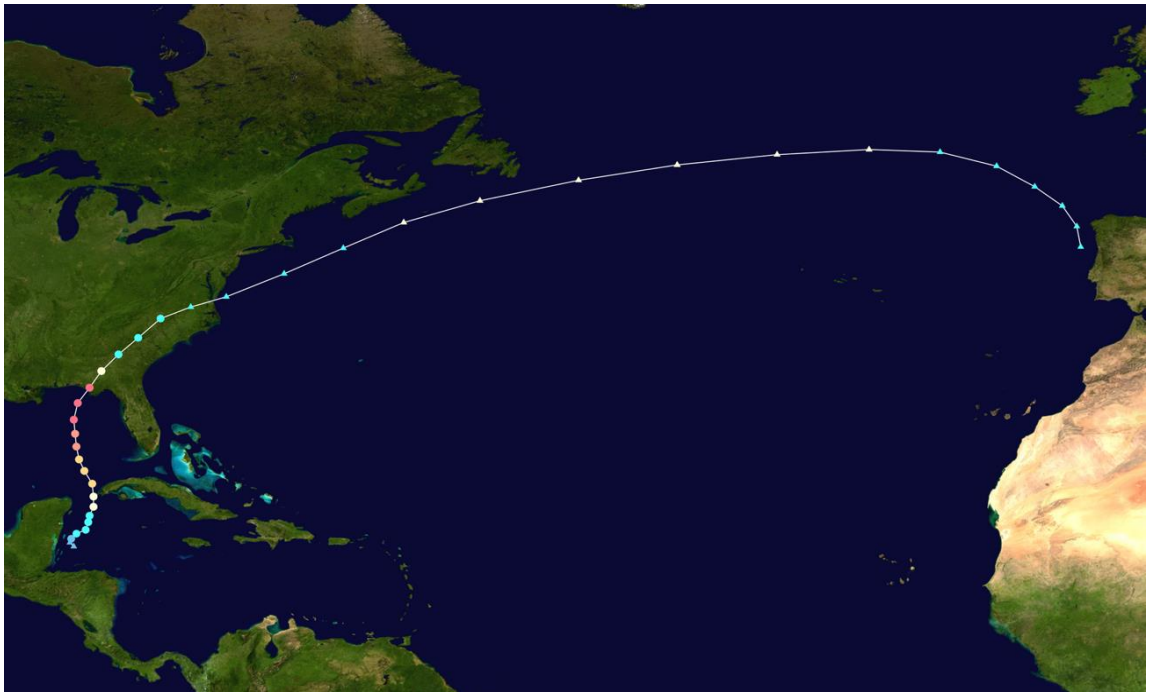


21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Ivan

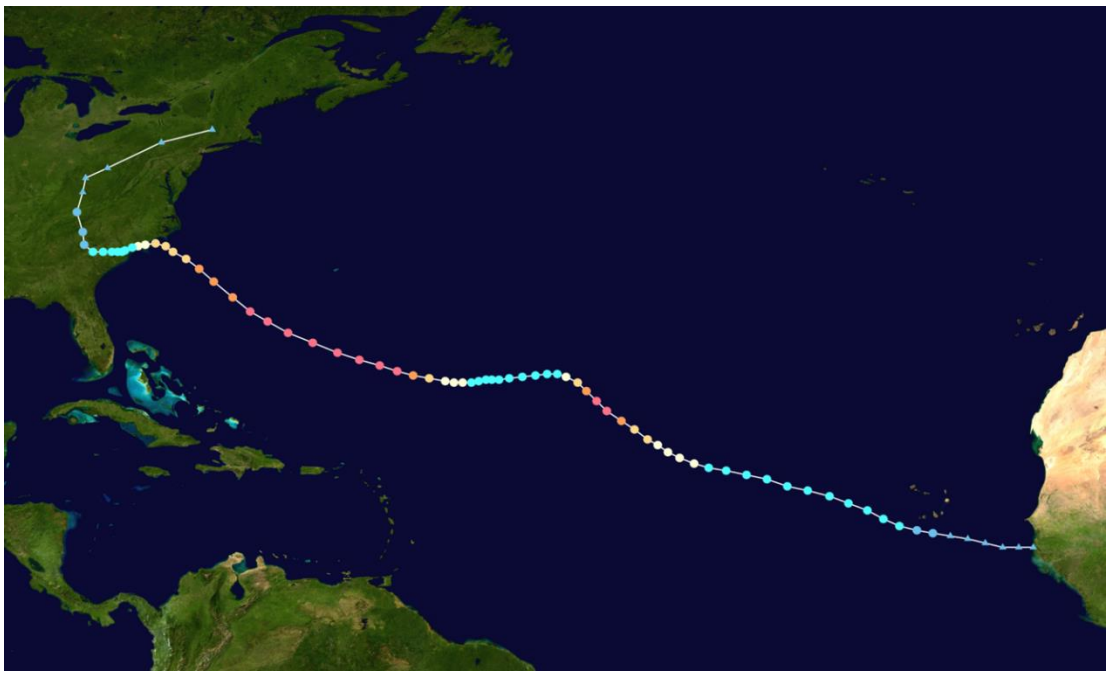


Michael

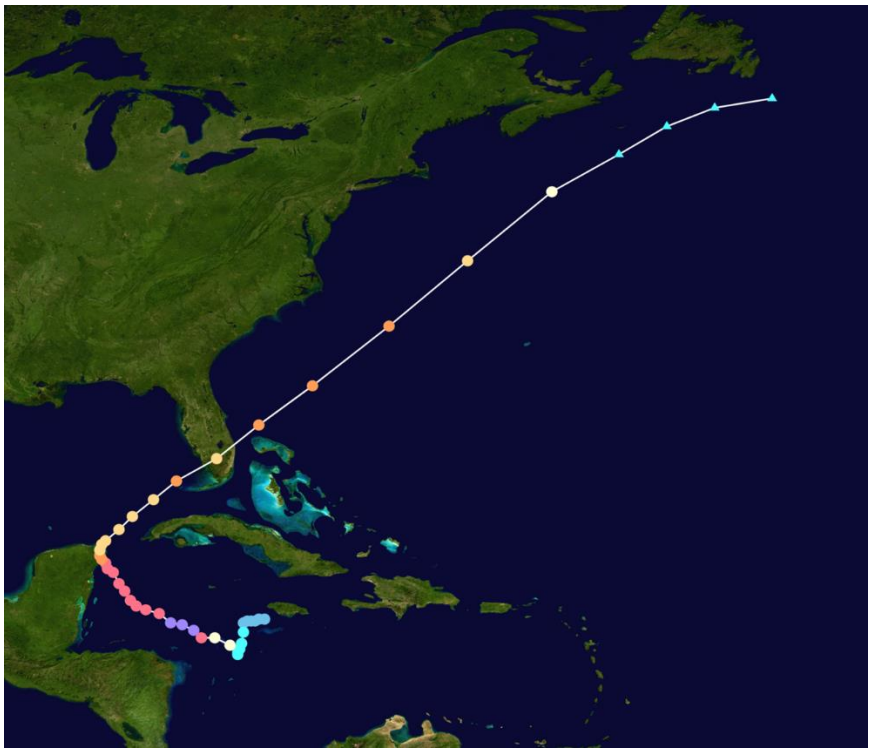


21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Florence

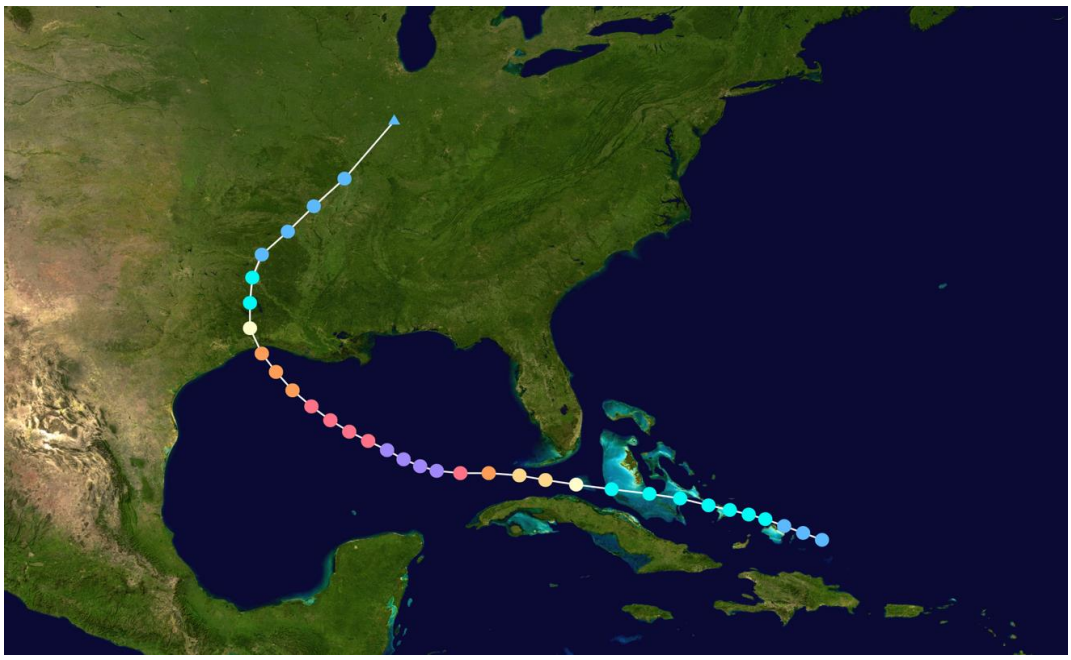


Wilma

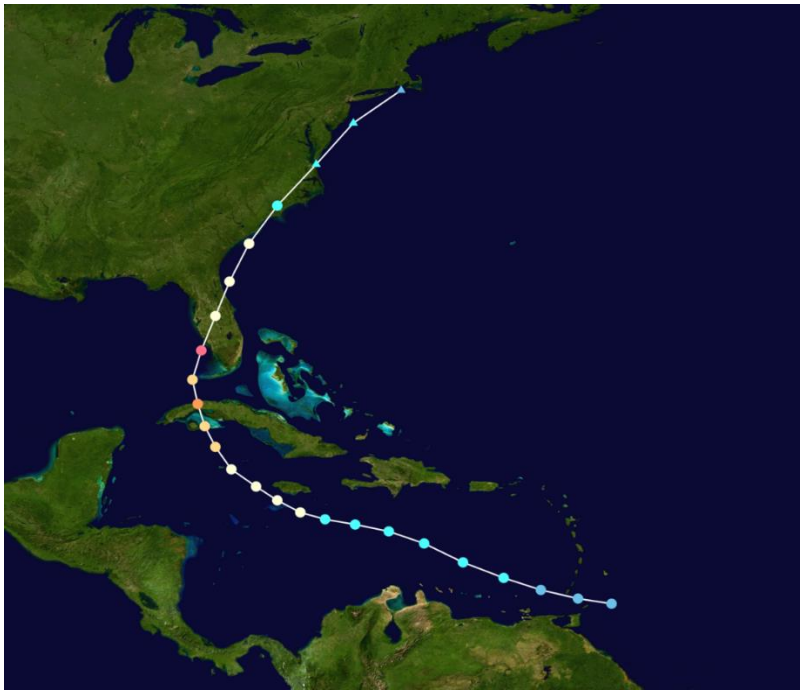


21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Rita

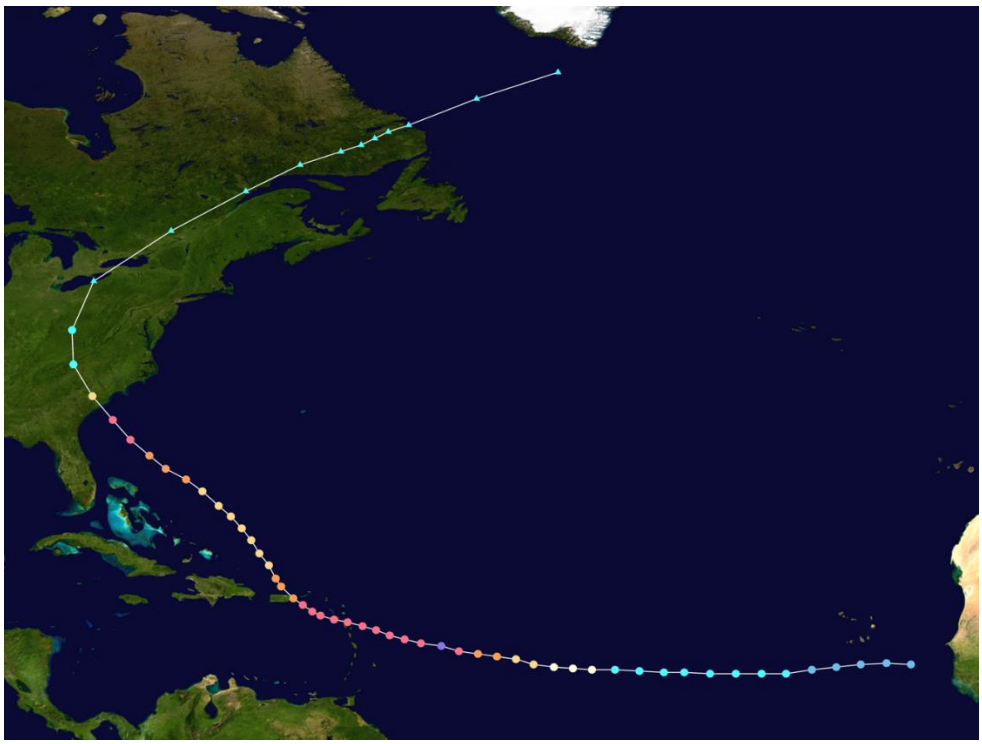


Charley



21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Hugo



21 Knightsbridge, London SW1X 7LY
www.aozorastep.com · david@aozorastep.com

Legal Disclaimer

The contents of this publication have been prepared solely for the purpose of providing information about AozoraStep Capital LLP and the services and products it is intending to offer, which are targeted for professional investors only. The opinions and views expressed are those of AozoraStep Capital LLP, may change without notice and should not be construed as investment, tax, legal or other advice. AozoraStep Capital LLP does not guarantee the completeness and accuracy of the information provided and all content can become out of date. Products or services mentioned in this publication are subject to legal and regulatory requirements in applicable jurisdictions and may not be available in all jurisdictions. Accordingly, persons are required to inform themselves and observe any such restrictions. In respect to investments described in this document, past performance is not a guide to future performance. The value of investments and the income of any financial instruments mentioned in this document may fall as well as rise and may have tax consequences. The performance of the investment strategy of AozoraStep Capital LLP is based on a personal track record of its managing partner and approved by Sedulo for the time period Q1 2019 - Q1 2021 and by HiCloud Accounting for the time period 2020 - 2023, only with further examinations being done on an occasional basis. AozoraStep Capital LLP is currently not authorized and regulated by the FCA, and therefore, is not allowed to provide financial products and services. AozoraStep Capital LLP is registered in England and Wales with registered number OC436835. Registered Office: 21 Knightsbridge, London SW1X 7LY, United Kingdom. Reproduction or distribution of any materials obtained in this publication or linking to this publication without written permission is prohibited.