Using Curated Datasets

NOAA Hurricane Tracks

coast.noaa.gov/hurricanes/

National Oceanic and Atmospheric Administration Hurricane Tracks

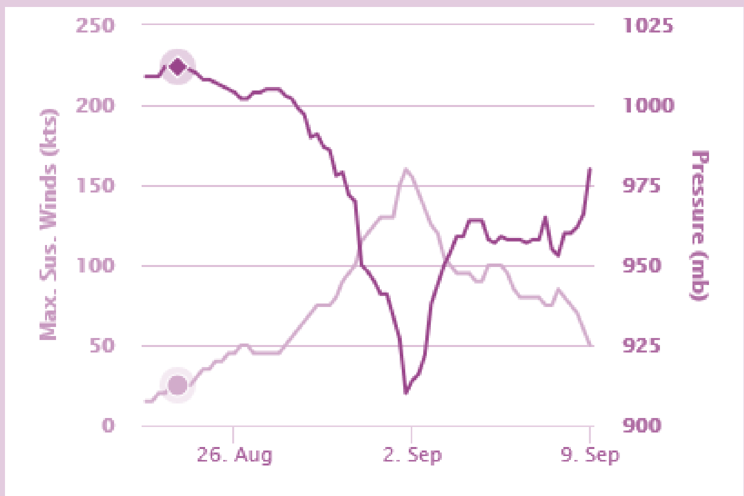
The NOAA Historical Hurricane Tracks is an online database of tropical storm data covering all years of storms between 1842 and the present day. They can be mapped to show their respective paths and their relative strength at different points on that path. Though based in the USA, the data covers all tropical storms worldwide as well as some information on their impact at landfall.

How do I access the data?

The above link takes researchers through to the hurricane track site directly. There they can see a satellite image of the USA with the option to change the base map to a street map. Selecting the **Hurricanes** layer displays all the tracks available to view and zooming the map scale out shows a clear picture of where most tropical storms occur. Alternatively, selecting the **County Strikes** layer shows the number of times a storm has made landfall at the coastline of that particular location (this is only available for the USA).

The menu on the left hand side of the screen gives you the chance to search for particular storms. At the top of the page are three ways of searching: by **Location**, by **Name/Year** and by **Ocean Basin**. Selecting any one of these tabs provides a search box to identify what you wish to view. For example, selecting Name/Year and then typing 2005 in the search box will populate the table at the bottom with any tropical storm that occurred in 2005, as well as show their tracks on the main map. Hovering over the map will highlight particular storms both there and in the table.

Selecting a storm from the table gives you a detailed picture of how the storm grew and died. **Pressure**, **wind speed** and **storm category** are listed in six hourly intervals as well as a wind speed and pressure graph for the storm (shown left for Hurricane Dorian in 2019).



Storms can be selected by clicking the '+' symbol next to the name of the storm and a separate selection can be formed which can be saved for use at another time.

Another useful feature of the populated list of storms is that you can select **Advanced Filters**. This allows researchers to filter storms by **Category**, **Pressure** and **Time Frame** as well as their **Climate** zone.

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How can I use this in my teaching?

Natural Hazards is a popular topic to study in all key stages and the power and force that nature can apply to the Earth and its citizens is both awe-inspiring and fascinating. As well as studying the nature of hazardous events through tectonic processes, doing so through atmospheric and climatic events can add a closer sense of realism to hazards to students who, by virtue of where they live, never experience an earthquake or a volcanic eruption. The links between the impacts felt by a tropical storm and the stage of economic and social development that the suffering country is at are also well-studied and it is relatively easy for teachers to make further connections between the ability of a country to track a storm (as is possible through the National Oceanic and Atmospheric Administration) and their ability to mitigate against their impacts and be better prepared for them.

Studying tropical storms is not confined to the topic of natural hazards though. The body of evidence that suggests that their frequency and intensity is likely to increase with further climate change suggests that it is important to also study tropical storms as part of a wider curriculum into Earth's processes and how they have changed over time. The dynamics of storms (such as their spin and formation) can equally not be fully understood without also having a background knowledge of the global atmospheric circulation model and the thermohaline circulation model.

Curriculum Links

This curated dataset links to a number of parts of the National Curriculum and is relevant to GCSE and A Level Specifications.

Key Stage Three:	An understanding of the key processes in physical geography related to weather and climate.
	An understanding of how human and physical processes interact to change landscapes, environments and the climate.
GCSE:	An understanding of the causes and consequences of extreme weather conditions and natural weather hazards, recognising their changing distribution in time and space.
	An understanding of the spatial and temporal characteristics of climatic change and evidence for different causes.
A Level:	An understanding of the factors driving change in the size of different water stores over time and in space.
	An understanding of the pathways which control water cycling between land, ocean, atmosphere and cryosphere, and the processes which control transfers within and between them at a range of time and space scales.

The following specifications make particular reference to tropical storms:

GCSE:			**A Level:**		
AQA	Edexcel A	Edexcel B	AQA A	CIE	Edexcel
Eduqas A	Eduqas B	OCR A			
OCR B					

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An example data walk-through

A student wishes to investigate the frequency of category 5 storms in different ocean basins. They believe there may be a greater frequency of the most powerful storms in the Caribbean Sea than in the South Pacific off the Eastern Australian coast. They base this assumption on the average ocean temperatures found in each location: the Caribbean Sea tending to have warmer temperatures than the Eastern Australian coast, therefore making the former more likely to generate high intensity storms.

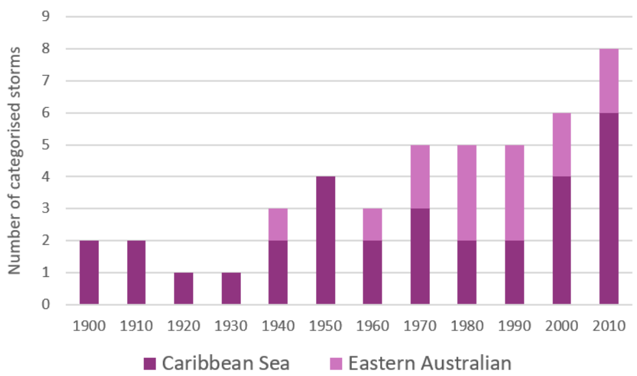
First, the student went to the home page of the NOAA hurricane tracks site. They selected to search hurricanes by **Ocean Basin** and then further selected **Caribbean Sea**. Clicking on the search icon populated the map with colourful tracks of all the storms that have taken place in those that basin in recorded history. Under **Refine Search**, the **Advanced Filters** was chosen and all but **Category 5** storms was selected, followed by the **Apply** button.

This reduced the number of tropical storms on the map and in the table to just those of that category - a total of **28**, stretching from 1924 to 2019. The process was repeated for the **Eastern Australian** ocean basin. This gave a total of **7** storms, from 1992 to 2018. From this data alone the student appears to have been correct in their initial hypothesis. The student noticed the very different time scales over which these high intensity storms occurred, with Australian storms only happening in relatively recent history, and category 5 storms in the Caribbean first being recorded over sixty five years earlier. Having considered that this may be simply due to differentiated recording methods in the two regions, the student was interested to look at the frequency of all categorised storms in the two basins over time.

Having already selected **Caribbean Sea** from the menu of **Ocean Basins**, this time the student used the advanced filters to deselect any storm listed below a **Category 1** storm. They then systematically applied the **Timeframe** filter to select years in ten year intervals, starting with the year 1900, and recorded the number of categorised storms that occurred that year. This method was then repeated for storms in the **Eastern Australian** ocean basin and the table of data on the left was produced.

Year	Caribbean Sea	Eastern Australian
1900	2	0
1910	2	0
1920	1	0
1930	1	0
1940	2	1
1950	4	0
1960	2	1
1970	3	2
1980	2	3
1990	2	3
2000	4	2
2010	6	2

The student then graphed this data in a column chart. While they found that their initial idea still held true, and there was more storm activity in the Caribbean Sea than off the coast of Eastern Australia, they felt that there was too small a sample size to make any meaningful conclusions.



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Suggested delivery activities

Track the Storm

Teachers can select a historically significant storm such as Hurricane Katrina in 2005 or Typhoon Haiyan in 2013 and download the six-hourly tracking data for the students. Longitude and latitude data is found by using the NOAA Hurricane Tracks map and recording the position of each point on the track as the cursor hovers over it. Giving this data to students, along with a blank paper world map allows students to practise using coordinates to plot the path of the storms. Students can create a key for each category of storm, using choropleth shading to signify the growing and receding intensity.

Once complete, students can check their plot against that on the website.

Comparing GIS layers

Students can use GIS applications like ArcGIS to plot the starting points of different storms alongside a variety of other physical measures such as average ocean temperatures, average pressure at sea level, average lateral load etc. Much of this data will need to come from secondary sources. Alternatively students might like to plot on GIS the starting point of storms against their landfall position to help them to recognise the typical paths that storms take as they travel.

Further data can be layered onto GIS, including number of deaths or the amount of homelessness caused as a result of a tropical storms in the region and students can start to find relationships between the data to further their understanding of the processes and impacts.

Landfall Strikes

Students can study the landfall strike data which is available through a block choropleth layer on the NOAA Hurricane Tracks site. This is available for Florida, the Gulf of Mexico and the east coast of the USA. Students can take the data for storms in another ocean basin such as the Western Pacific and create similar plots in countries there - shading the country according to the number of times (in a predetermined time period) a storm makes landfall there.

In a group of five students, each could each take a storm of a particular category and plot the landfall sites in an ocean basin for just that category. Students can then compare the land fall sites for different intensity storms and formulate a risk map based on the data.

Simpson’s Diversity Index

Though traditionally used for studies involving flora and fauna species, Simpson’s Diversity Index is a statistical method used to measure the degree to which an area or a time period is diverse with regards to a certain geographical variable. It looks at the number of individual readings of a particular variable, statistically compares it to the total number of individuals within a given sample and gives the result as a value on a scale between 0 and 1. Students might like to study how diverse a single year’s worth of storms are (in terms of their spread across the different intensity categories) when compared to another year’s. Equally they might wish to compare the diversity of categories witnessed in one location with another. A guide to Simpson’s Diversity Index appears on the next page.

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A Guide to Calculating Simpson's Diversity Index using NOAA Hurricane Tracks data

Simpson's Diversity Index is a statistical measure of how diverse a set of data is. It is calculated by comparing the frequency of different variables found in one sample (which could be a location or a time frame) with the frequency found in another sample. The Index is given as a value on a scale of 0 to 1 where 0 represents absolute uniformity and 1 represents absolute diversity.

Using the data from the NOAA Hurricane Tracks site, a student might wish to investigate whether the diversity of storms (in terms of the frequency of different categories) is different in one year to another.

Worked example:

The student decided to investigate whether the witnessed storm intensity was becoming more or less diverse over time. They took storm data from the NOAA Hurricane Tracks site covering each decade between 1950 and 2010. This data was subdivided by storm category showing the frequency of storms in each category in each decade.

Category	1950s	1960s	1970s	1980s	1990s	2000s
1	18	22	20	20	18	24
2	16	8	9	7	16	6
3	13	11	6	6	10	12
4	14	9	4	6	11	12
5	2	3	2	3	2	8
TOTAL (N)	63	53	41	42	57	62

For each decade, these individual frequencies of storms (n) were divided by the total number of storms in that decade (N). This result was then squared and the total of the squares noted. The Simpson's Diversity Index value (D) for each decade is then calculated using the following equation:

$$D = 1 - (\Sigma (n/N)^2)$$

Category	1950s $(n/N)^2$	1960s $(n/N)^2$	1970s $(n/N)^2$	1980s $(n/N)^2$	1990s $(n/N)^2$	2000s $(n/N)^2$
1	0.082	0.172	0.238	0.227	0.100	0.150
2	0.064	0.023	0.048	0.028	0.079	0.009
3	0.043	0.043	0.021	0.020	0.031	0.037
4	0.049	0.029	0.010	0.020	0.037	0.037
5	0.001	0.003	0.002	0.005	0.001	0.017
TOTAL	0.239	0.270	0.319	0.300	0.248	0.251
D	0.761	0.730	0.681	0.700	0.752	0.749

These results show that there is actually very little difference between the different decades in terms of storm diversity and it is not the case from these results that storms have become more or less diverse in their intensity over time between 1950 and 2010.

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