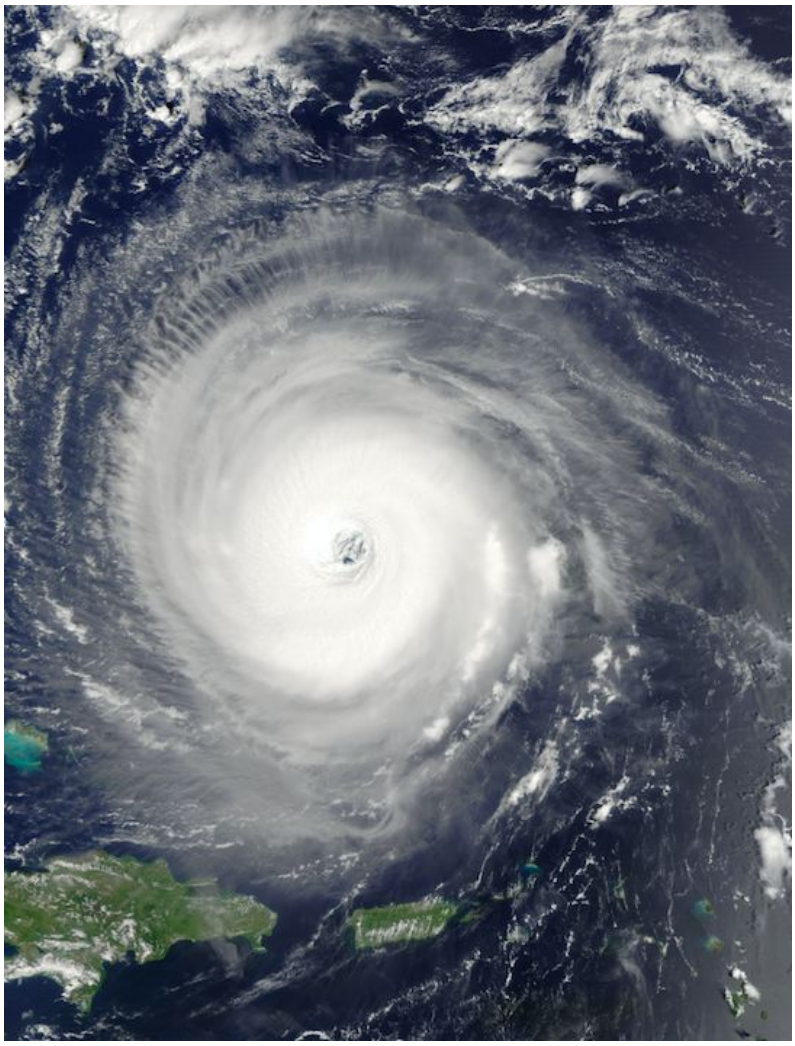
Predicting Hurricane Strength: How Can Someone Predict Changes in Hurricane Wind Speed Over Time?

Introduction

The strongest tropical storms are called hurricanes, typhoons, or cyclones. The different names all mean the same thing but are used to describe tropical storms that originate in different parts of the world. If a huge storm starts off the west coast of Africa in the Atlantic, it is called a hurricane. Hurricanes have strong winds, a spiral shape, and a low-pressure center called an eye. Unlike other natural hazards, such as earthquakes or even tornadoes, we can observe the development of a hurricane over time and track how it moves across the ocean.

A hurricane begins as a tropical disturbance in the ocean off the west coast of Africa. A tropical disturbance forms in an area where the ocean surface temperature is at least 27°C (80°F). The warm humid air at that location rises and creates an area of low atmospheric pressure near the ocean surface. Cooler air in the region then rushes into the area of low pressure. This air picks up evaporated water from the surface, increases in temperature, and moves upward into the atmosphere. This process produces large water-filled thunderclouds around the area of low pressure. The trade winds (which blow from east to west) slowly push the disturbance to the west.

Image of Hurricane Isabel about 400 miles north of Puerto Rico on September 14, 2003, captured by the NASA Terra satellite; the sustained wind speed inside Hurricane Isabel at that time was 155 mph

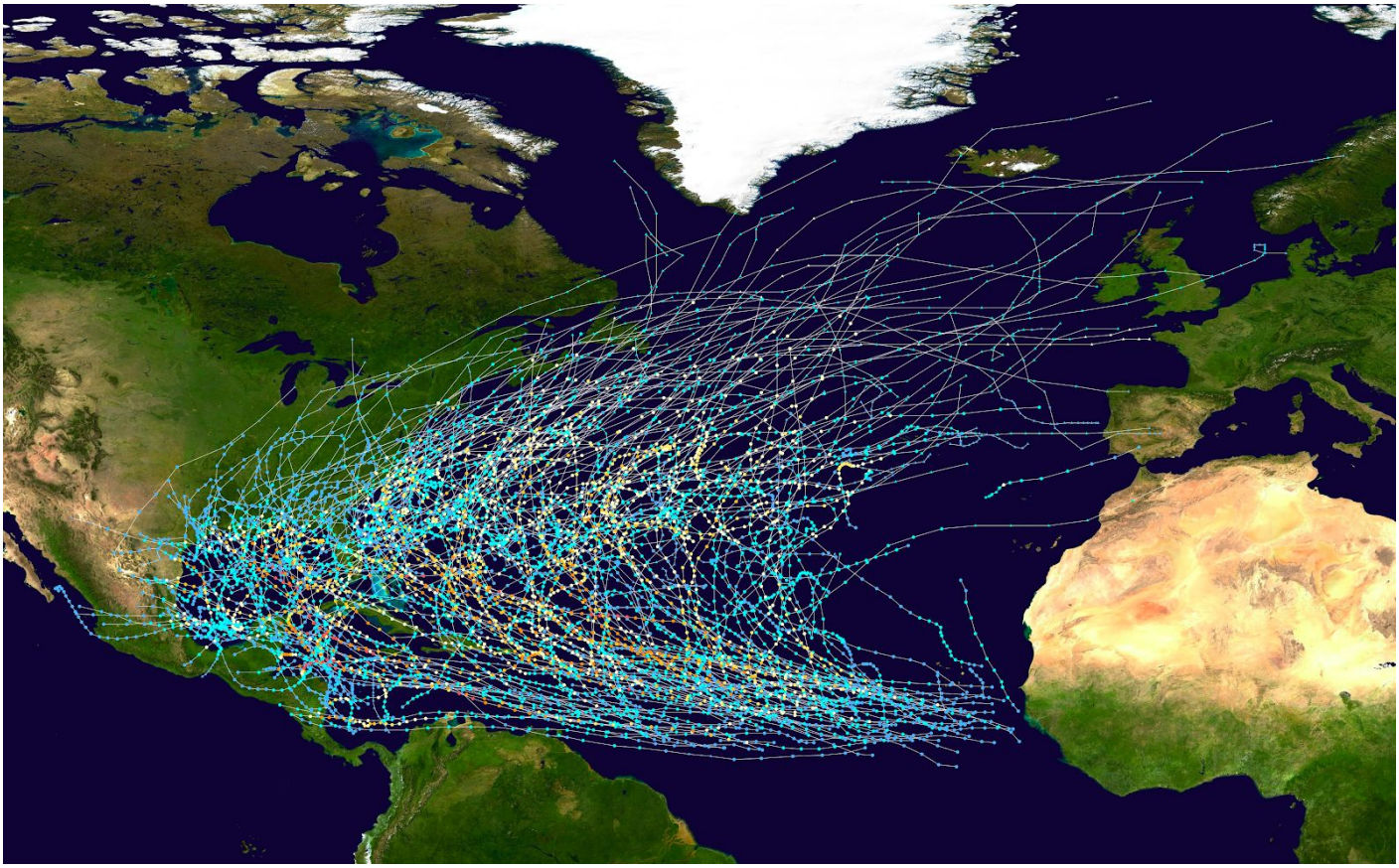


Over the next few days, more warm air will rise and the winds will begin to circulate around the center of the disturbance in counterclockwise (when viewed from above) direction. A layer of clouds called an outflow will also begin to form at the top of the storm. Winds inside the storm will increase in speed over time. When the winds within the storm are between 25 and 38 miles per hour (mph), the storm is called a tropical depression. When the wind speeds reach 39 mph, the storm is classified as a tropical storm rather than as a tropical depression. This is also the point in time when the storm gets a name. In a couple of days, as the system moves across the ocean, the clouds expand and the winds continue to speed up. When the wind speeds inside the storm reach 74 mph, it is classified as a hurricane (see figure to the left).

In an average year, several different hurricanes will form over the Atlantic Ocean and head westward toward the Caribbean, the east coast of Central America, or the southeastern United States. Figure L20.2 shows the tracks of all North Atlantic Ocean hurricanes that

developed between 1980 and 2005. The points on each track represent the location of that storm at six-hour intervals. Hurricanes will often last several weeks before they break down because they tend to move very slowly across the ocean. In fact, hurricanes usually travel across the ocean at only about 24 kilometers per hour (or 15 mph).

Map showing the tracks of all hurricanes in the North Atlantic Ocean from 1980 to 2005; the points show the locations of the storms at six-hour intervals



Scientists use the sustained wind speed inside a hurricane to classify it. The sustained wind speed inside a hurricane, however, can increase or decrease over time. It is therefore important for scientists to understand why the winds inside a hurricane change over time. This type of information is important because scientists are responsible for issuing evacuation warnings, and they need to know if the wind within a hurricane is likely to increase or decrease before it reaches landfall. It is also important to understand the factors that affect the wind speed of a hurricane over time as it moves over water or land; this information helps city planners to establish building codes for cities to ensure that new buildings will be able to withstand the winds of a typical hurricane for that area.

In this investigation, you will have an opportunity to learn more about the factors that affect wind speed within hurricanes. Your goal is to develop a conceptual model that you can use to not only explain why the wind speed within a hurricane changes over time as it moves over water or land but also predict how the strength of a hurricane will increase or decrease over time based on the path that it follows.

Your Task

Develop a conceptual model that can be used to explain why wind speed inside a hurricane changes over time as it moves over water or land. Your conceptual model must be based on what we know about natural hazards; weather; the importance of tracking how energy flows into, within, and out of a system; and cause-and-effect relationships. Once you have developed your

model, you will need to test it to see if you can use it to make accurate predictions about how the strength of several hurricanes changed over time in the past.

The guiding question of this investigation is: ***How can someone predict changes in hurricane wind speed over time?***

Materials

You may use any of the following materials during your investigation:

- Computer with Internet access
- Some Major Hurricanes handout
- Hurricane Track A—Black and White handout (use to test your model)
- Hurricane Track A—Color handout (use to check your predictions)
- Hurricane Track B—Black and White handout (use to test your model)
- Hurricane Track B—Color handout (use to check your predictions)

Getting Started

The first step in this investigation is to determine how the strength of a hurricane changes over time as it travels over water and land. To accomplish this goal, you will need to examine several different historical hurricane tracks and look for patterns that you can use to explain and predict changes in wind speed. You can access historical hurricane track maps from the National Oceanic and Atmospheric Administration (NOAA) at *https:// coast.noaa.gov/hurricanes*. The tracks on the maps are color-coded using the Saffir-Simpson Hurricane Scale (see table below) so you can keep track of how the strength of a storm changed over time.

Types of tropical storms classified by wind speed according to the Saffir-Simpson Hurricane Scale and by colors used on historical hurricane track maps from the National Oceanic and Atmospheric Administration

Classification	Wind Speed			Color Used on Historical Hurricane Track Maps
	mph	kn	km/h	
Category 5 Hurricane	≥157	≥137	≥252	purple
Category 4 Hurricane	130-156	113-136	209-251	pink
Category 3 Hurricane	111-129	96-112	178-208	red
Category 2 Hurricane	96-110	83-95	154-177	orange
Category 1 Hurricane	74-95	64-82	119-153	yellow
Tropical Storm	39-73	34-63	63-118	green
Tropical Depression	25-38	22-33	40-62	blue

You can then examine how hurricane wind speed is related to the surface temperature of the ocean (also called sea surface temperature, or SST). Information about current SSTs in the North Atlantic can be found at *https://www.ospo.noaa.gov/Products/ocean/sst/contour/index.html*. You can also find information about monthly SSTs for 1984–1998 at *https://www.ospo.noaa.gov/Products/ocean/sst/monthly_mean.html*. Finally, you may want to compare land surface temperature to SSTs. Information about land surface temperature during the daytime by month can be found at *http://earthobservatory.nasa.gov/GlobalMaps*.

Once you finished analyzing this data, you can develop your conceptual model. A conceptual model is an idea or set of ideas that explains what causes a particular phenomenon in nature. People often use words, images, and arrows to describe a conceptual model. Your conceptual model needs to be able to explain why hurricanes wind speed changes over time. The model also needs to be consistent with what we know about natural hazards, weather, and how energy flows into, within, and out of systems.

The last step in this investigation is to test your model. To accomplish this goal, you can use your model to make predictions about how the wind speed of past hurricanes changed over time using the Hurricane Track A and Hurricane Track B handouts. The black-and-white track maps include letters that mark specific locations along these tracks. You goal is to predict the category of these hurricanes at these locations. Your teacher will then give you color versions of these hurricane track maps. The color versions include information about the strength of these hurricanes at each location. You can use these maps to determine if your predictions were accurate. If you are able to make accurate predictions about how the wind speed within these two hurricanes changed over time, then you will be able to generate the evidence you need to convince others that the conceptual model you developed is valid or acceptable.

Report

Once you have completed your research, you will need to prepare an investigation report that consists of four sections (be sure to have section headings):

1. Introduction: Give some background information on the topic. Explain what question you were trying to answer and include a hypothesis. (Background info, research question and hypothesis)
2. Procedure: What did you do during your investigation and why did you conduct your investigation in this way? (How you collected and analyzed data)
3. Data: Include a data table and/or graph to show your results. Be sure to include a title for your table or graph with labels for the variables.
4. Conclusion: What is your argument? (Claim - Evidence - Reasoning)

Your report should answer these questions in two pages or less. The report must be typed, and any diagrams, figures, or tables should be embedded into the document. Type your report on Google Docs (12 point font, double-spaced) and share it with your teacher. Your report will be graded based on the rubric in the class syllabus.