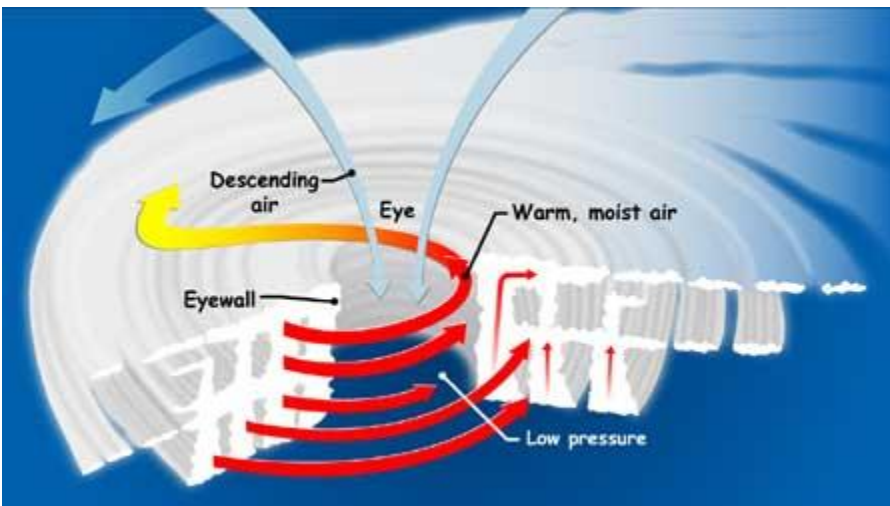


The Science Behind Natural Disasters

Ivan Spodin '26

Lately, we have seen many unprecedentedly damaging natural disasters. Two major hurricanes (Category 3 and up on the Saffir-Simpson Scale) Helene and Milton hit the Southeastern United States, with Milton being more damaging to Florida and Helene to North Carolina and other more northern parts, within less than two weeks of each other. Four devastating fires broke out in California, overwhelming its fire departments, killing 29 people, and causing \$250 billion worth of damages (Bekiempis, 2025). So what causes all of these disasters to occur? What do scientists do to predict them and prepare for them?



Tropical Cyclone is, actually, the scientific name for a hurricane. 'Hurricane' is what a tropical cyclone is referred to when it is formed over the Eastern Pacific Ocean and the

Figure 1: Illustration of how hurricanes work
credit: <https://spaceplace.nasa.gov/hurricanes/en>

Atlantic Ocean.

Meanwhile, if a tropical cyclone is formed in the Western Pacific, it is called a typhoon. A Tropical Cyclone forms when wind blows across warm, tropical water (hence the name tropical cyclone). As warm air is lighter, it rises with vapor from the water (represented by the little red arrows in Figure 1t), causing the pressure to lower at the water surface. The rising air begins to

cool and the vapor condenses into water droplets, forming clouds and thunderstorms, while the dry air, becoming cold and heavier, flows to the low-pressure surface of the water. This process repeats, causing the tropical cyclone to grow. At the same time, the wind that blows across warm water, known as shear wind, starts to rotate around the low-pressure system due to the Coriolis effect that causes wind to curve because of Earth's rotation, to the right in the Northern Hemisphere and to the left in the Southern Hemisphere (University Corporation for Atmospheric Research, n.d.). As a result of these wind movements, a tropical cyclone is formed.

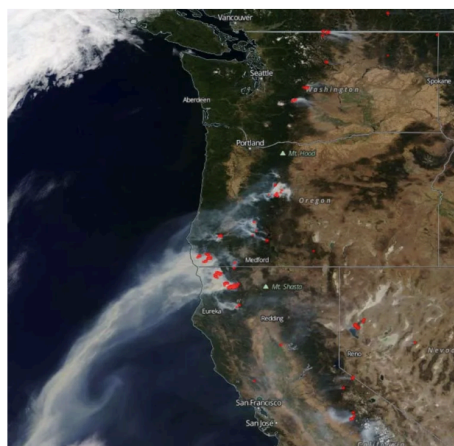
Satellites are typically the main technology used for tropical cyclone forecasts and predictions, as they are the best way to track the movement and progression of hurricanes. There are two main types of orbits used for research satellites: Geosynchronous and low orbit. Geosynchronous is mainly used to track tropical cyclones, as it stays above the same spot on the Earth's surface, allowing for better tracking (University of Rhode Island, 2020). Satellites track hurricanes by taking pictures, allowing meteorologists to predict the hurricanes movement and growth.

Once meteorologists have an idea of where a tropical cyclone is going, the US government will release hurricane warnings and in some cases hold mandatory evacuations. Despite there being no way to avoid the chaos that tropical cyclones may bring, there are several ways to avoid property damage. When it comes to vehicles like boats and cars, people will sometimes move them out of the area or put them in an elevated area to avoid damage from water surge, a side effect of tropical cyclones characterized by up to several feet of flooding. For protection of housing and other buildings, sandbags are used to put under garage and entrance doors to prevent water from coming inside. Metal window shutters can be set up on the outside

to prevent damage from flying debris. As seen, a lot of preparation happens before there is a tropical cyclone threat in the first place.

Wildfires are another natural disaster that can bring havoc, and they are more man-made than the name implies. According to a study of wildfire records in the years 1992-2012 by University of Colorado, 84% of wildfires in the US were ignited by human actions (University of Colorado, 2017). Human actions—like discarded cigarettes, improperly extinguished campfires and yard fires, and malfunctioned infrastructure—can start wildfires by producing a spark that sets vegetation on fire. Natural phenomena also start wildfires with a spark. The most common natural phenomena that causes wildfire is lightning strikes. When the conditions are right, lightning will typically strike a tall tree, which is more likely to be hit by lightning, and can ignite a fire. According to a BBC article, in August of 2022 in California, lightning strikes started 650 wildfires and burned 1.5 million acres of land (Stallard, 2022). However, to ignite and spread, wildfires need certain conditions. Unlike tropical cyclones, wildfires can happen in almost any climate zone, but needs hot and dry weather to start. Windy conditions will allow the wildfire to spread further.

Similar to tropical cyclones, wildfires can be tracked by satellites. Since wildfires occur on a lower scale than tropical cyclones, in addition to geosynchronous satellites, low orbit



Satellite image of West Coast United States showing wildfire smoke. Red dots represent heat detected by the satellite. Credit: <https://wildfiretoday.com/2017/09/01/smoke-map-and-satellite-photo-of-northwest-wildfires/>

satellites are also used to take closer images of wildfires. Satellites track how wildfires are spreading and how much progress is made in extinguishing them (Western Fire Chiefs Association, 2023). There are also different sensors that allow detection of wildfires in their early stages. Traditionally, optical

and thermal sensors have been used to “see” the wildfires; however, in late 2019, researchers began developing sensors detecting particular matter, compounds, chemicals, and gases associated with wildfires that would “smell” the fires (US Department of Homeland Security, 2024). Once the combination of these technologies detect the fires, firefighters, including some called up from neighboring districts (depending on the severity of the wildfire, in the 2025 January California fires, for example, firefighters from 7 different states and Canada were called up), work to extinguish the fire on land, but also in the air. Airplanes collect water from bodies of water nearby and drop it on the wildfires. Fire retardant, a chemical that reduces the flammability of surrounding vegetation, is also dropped from the airplanes to prevent wildfires from spreading further.

While natural disasters like tropical cyclones and wildfires have different ways of being managed, the science of the two phenomena have considerable overlap. For both, scientists rely on satellites to track development and estimate the toll on human lives in the regions. In the typical sense, the two seem to be opposites, one is a disaster of fire and another is a disaster of water. However, as discussed, both tropical cyclones and wildfires seem to be products of warmer climates, a thing to keep in mind with the climate change the world has been facing in recent years.

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