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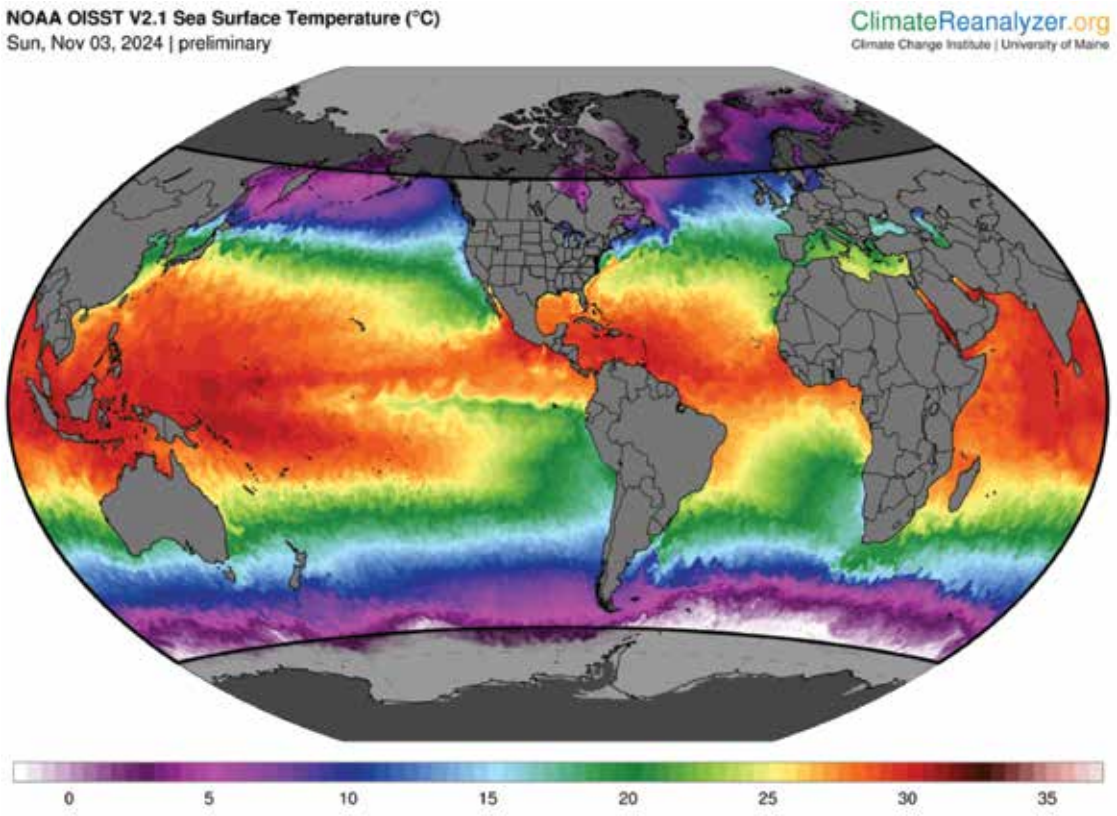
What Causes Hurricanes?

Hurricanes are powerful tropical cyclones that form over warm ocean waters under specific conditions. These massive, rotating storm systems require a sea surface temperature of at least 80°F (27°C) to gain energy. Moist air above the ocean allows clouds to form and grow as warm water evaporates, while consistent wind patterns at all levels of the atmosphere help organize the storm.

Photo by NASA

Hurricane Milton, a Category 5 storm at the time of this photograph, seen from the International Space Station on October 8, 2024.

Climate change plays a major role in the increasing intensity of hurricanes. As global temperatures rise, the oceans absorb more heat, fueling hurricanes and intensifying them more rapidly. Additionally, a warmer atmosphere holds more moisture, which leads to heavier rainfall and increases the risk of severe flooding, as seen during Hurricane Harvey in 2017. Rising sea levels also contribute to more devastating storm surges, such as those caused by Hurricane Helene in 2024, which flooded coastal communities. Lastly, changing wind patterns, including shifts in the jet stream, may slow hurricanes down, prolonging their impact over affected areas and resulting in more significant damage.



Climate Reanalyzer (n.d.). Daily Sea Surface Temperature Climate. Change Institute, University of Maine. Retrieved [11/04/2024], from https://climatereanalyzer.org/

Community preparedness is a critical factor in reducing the damage caused by hurricanes. By understanding the conditions that lead to their formation and the potential risks, communities can take proactive measures to protect themselves and their property. Once these conditions are met, thunderstorms form over the ocean and can grow into a tropical depression. If they intensify, they become a tropical storm and then a hurricane.

What are Hurricane Categories?

Hurricanes are rated using the **Saffir-Simpson Hurricane Wind Scale**, which categorizes them based on their sustained wind speeds and potential for damage. The stronger the hurricane, the more damage it can cause. The scale has five categories:

- **Category 1**: 74-95 mph – Minimal damage, with some power outages.
- **Category 2:** 96-110 mph – Moderate damage, including structural damage and widespread outages.

- **Category 3:** 111-129 mph – Major damage, with some destruction of buildings and severe flooding.
- **Category 4:** 130-156 mph – Catastrophic damage, extensive building damage, and uninhabitable areas for weeks.
- **Category 5:** 157+ mph – Total destruction, widespread building collapse, and flooding, leaving areas uninhabitable for months.

This scale only measures wind speed and potential wind-related damage, not other factors like rainfall or storm surge.

What Are Some Recent Hurricanes?

Recent hurricanes have left a lasting impact on the communities they struck:

- **Hurricane Ian (2022):** A Category 4 hurricane that hit Florida, causing widespread flooding, wind damage, and power outages. Recovery has been slow due to the extent of the destruction. This hurricane was particularly devastating as it struck densely populated areas, leading to significant disruptions in daily life.
- **Hurricane Fiona (2022):** This Category 4 hurricane devastated Puerto Rico, causing severe flooding and power outages. The island, still recovering from 2017's Hurricane Maria, faced additional challenges in rebuilding infrastructure.
- **Hurricane Idalia (2023):** Another Category 4 storm, Idalia, landed on Florida's Gulf Coast, causing massive flooding, downed trees, and power disruptions across multiple states.
- **Hurricane Helene (2024):** Helene made landfall in September 2024 as a Category 4 hurricane with winds up to 140 mph. The storm caused catastrophic flooding and wind damage across Florida, Georgia, and the Carolinas, with over 230 deaths and significant property damage.
- **Hurricane Milton (2024):** Two weeks after Helene, Milton reached as high as a **Category 5** over the Gulf of Mexico before advancing toward Florida's central west coast. Milton, however, hit as a Category 3 storm with winds exceeding 100 mph. The Gulf Coast of Florida was severely affected, and the storm caused additional devastation to areas still recovering from Helene.

Why Tornadoes Form on the Edges of Hurricanes

Tornadoes often form on the outer edges, or **rainbands**, of hurricanes due to the interaction of differing wind patterns. Hurricanes contain multiple layers of wind moving in different directions. These winds can clash with the surrounding environment near the storm's edges, creating a meteorological phenomenon called

'wind shear'— where winds blow at various speeds and directions at different altitudes. This creates instability in the atmosphere, leading to the rotation of air that can eventually spawn tornadoes.

The most likely place for tornadoes to form is in the **front-right quadrant** of the hurricane (relative to its direction of movement). Here, the hurricane's combined forward motion and strong winds provide the conditions for increased shear, making tornado formation more likely.

Tornadoes formed in hurricanes are typically smaller and weaker than those formed by supercell thunderstorms but can still cause significant localized damage. These tornadoes are dangerous because they often come with little warning, adding to the already hazardous conditions caused by the hurricane.

FEMA Response - What Is FEMA?

FEMA (Federal Emergency Management Agency) was established in 1979 by President Jimmy Carter through an executive order that combined several agencies focused on disaster response. FEMA coordinates the federal government's response to natural and artificial disasters when they overwhelm state and local capacities.

FEMA's funding primarily comes from the **Disaster Relief Fund (DRF)**, part of the federal budget. Congress appropriates funds to FEMA annually, but supplemental funding may be approved in the event of a major disaster to meet the needs of affected communities. FEMA also receives specific allocations for disaster mitigation and preparedness efforts.

FEMA's Importance

FEMA is **critical in disaster recovery** by providing emergency relief and financial assistance. It helps rebuild infrastructure, supports individuals with housing and other essentials, and coordinates with state and local governments for disaster preparedness and mitigation. **FEMA (Federal Emergency Management Agency)** is the primary U.S. government agency responsible for responding to natural disasters like hurricanes. FEMA coordinates federal efforts when disasters overwhelm state and local resources. Its main functions include:

- **Providing Shelter:** FEMA works with local governments to set up temporary shelters for those displaced by hurricanes.
- **Disaster Relief** involves helping distribute food, water, and other critical supplies. FEMA also provides financial assistance to individuals for temporary housing and home repairs.
- **Long-Term Recovery:** FEMA collaborates with local governments to repair damaged infrastructure such as roads, bridges, and utilities.

For instance, after **Hurricane Helene**, FEMA provided emergency food, water, and temporary shelters. FEMA also coordinated long-term recovery efforts by assisting with rebuilding infrastructure and offering financial support for individual home repairs.

fema.gov

Additionally, during the aftermath of **Hurricane Milton**, FEMA mobilized resources, set up emergency shelters, and aided survivors. The agency was critical in coordinating response and recovery efforts, ensuring survivors had access to food, shelter, and medical care.

FEMA's extensive programs, from individual assistance to public infrastructure repair and flood mitigation, play a vital role in helping communities recover from disasters like **Hurricane Helene**. The agency's expanding role in disaster preparedness and mitigation, along with evolving legislation and funding mechanisms, is critical for reducing future risks and supporting recovery. By providing immediate relief and long-term recovery resources, FEMA ensures that states like North Carolina can rebuild and become more resilient against future storms, offering a sense of reassurance and support to the affected communities.

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Human Response - Preparation, Recovery and Rebuilding

In response to hurricanes, communities, and governments work together to prepare, recover, and rebuild.

Things We Build/Prepare to Reduce Hurricane Damage:

- **Improving Building Codes:** In hurricane-prone areas, building codes have been strengthened to require homes and buildings to withstand high winds and flooding. For example, many homes have reinforced structures, hurricane shutters, and impact-resistant windows.
- **Upgrading Infrastructure:** Cities in vulnerable areas raise roads, improve drainage systems, and reinforce levees to protect against flooding. Coastal cities are also investing in seawalls, bulkheads, and other barriers to reduce the impact of storm surges.
- **Natural Barriers:** Coastal cities are restoring ecosystems like wetlands, mangroves, and sand dunes, which act as natural buffers against hurricanes. These ecosystems help absorb stormwater and dissipate storm energy.
- **Early Warning Systems:** Governments and communities are enhancing early warning systems that give residents more time to prepare and evacuate. These systems include hurricane tracking, weather alerts, and evacuation planning.

Recovery and Reconstruction Efforts:

- **Debris Removal and Power Restoration:** After hurricanes, local governments, utility workers, and volunteers collaborate to clear debris, restore power, and reopen roads. Teams from across the country often come to assist with restoration.
- **Rebuilding Homes and Infrastructure:** The recovery process includes rebuilding homes, schools, businesses, and essential public infrastructure. This reconstruction helps restore normalcy and strengthens the community's ability to withstand future storms.
- **Community Involvement:** Volunteers and relief organizations such as the Red Cross provide vital support during recovery. Local groups help distribute food and water and offer emotional support to those affected by the storm.

Questions

1. What conditions are necessary for a hurricane to form?

   Hurricanes need warm ocean water (at least 80°F), moist air, and consistent wind patterns at different atmospheric levels to form.

2. How are hurricanes categorized, and what is the scale used?

   *Hurricanes are categorized using the **Saffir-Simpson Wind Scale**, which ranges from Category 1 (74-95 mph winds) to Category 5 (157+ mph winds), based on wind speed and the damage potential.*

3. Name two recent hurricanes and describe their impact on the affected areas.

   ***Hurricane Helene (2024)** caused significant flooding and wind damage in North Carolina, while **Hurricane Milton (2024)** led to severe flooding and wind damage in Florida's Gulf Coast, disrupting power and damaging infrastructure.*

4. What is FEMA's role in hurricane recovery efforts?

   FEMA provides immediate relief, including shelter, food, and water, helps with long-term rebuilding, and offers financial assistance for home repairs and temporary housing after hurricanes.

5. How do local communities contribute to recovery after a hurricane?

   Local communities help with debris removal, power restoration, aid provision, and rebuilding efforts. Volunteers and local authorities also play critical roles in assisting residents to return to normalcy.

6. Why do tornadoes often form on the edges of hurricanes?

   Tornadoes form on the edges due to wind shear, where winds at different altitudes blow in different directions, causing rotation. The front-right quadrant of the hurricane is most prone to tornado formation.

7. What role does climate change play in the increasing intensity of hurricanes?

   Climate change causes warmer ocean temperatures, which fuel stronger hurricanes. It also leads to more moisture in the air, heavier rainfall, and rising sea levels, which contribute to more severe storm surges.