

STORM SURGE AND HURRICANE SAFETY

With North Atlantic
Tracking Chart



STORM SURGE

The storm surge is a great dome of water often 50 miles wide, that comes sweeping across the coastline near the area where the eye of the hurricane makes landfall. The surge, aided by the hammering effect of breaking waves, acts like a giant bulldozer sweeping everything in its path. The stronger the hurricane, the higher the storm surge will be. This is unquestionably the most dangerous part of a hurricane. Nine out of ten hurricane fatalities are caused by the storm surge. During the infamous Hurricane Camille in 1969, a 25-foot storm surge inundated

Pass Christian in Mississippi. Lesser heights are more usual but still extremely dangerous.

Many factors are involved in the formation and propagation of a storm surge such as the strength of the storm, bottom conditions where the surge comes ashore, and the position of the storm center in relation to the shore. These diagrams, therefore, cannot be representative of all surges for all coastal areas. The surge diagrammed here is typical of those produced by a hurricane approaching the lower-Atlantic or Gulf coastal areas.

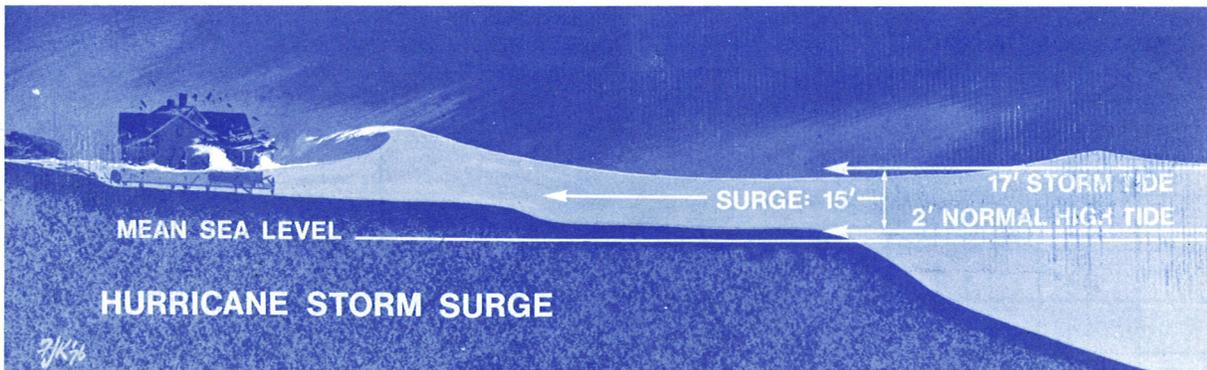


It is a normal beach day. The sea rises and falls predictably with astronomical tidal action. There are the usual small waves. A hurricane has developed and a Hurricane Watch is in effect for the area.



The hurricane now poses a serious threat to this beach area and the Watch has been changed to a Hurricane Warning. The hurricane is 12 hours away. The tide is a little above normal; the water moves further up the beach. Swells are beginning to move in from the deep ocean and breaking waves—some as high as five to eight feet—crash ashore and run well up the beach. The wind is picking up.

* MSL Mean Sea Level



The hurricane is moving ashore close to the beach area. It is high tide time again. This time, however, there is a 15-foot surge added to the normal 2-foot astronomical tide creating a 17-foot *storm tide*. This great mound of water, topped by battering waves, is moving slowly ashore along an area of coastline 50 to 100 miles wide. Winds are now over 130 miles an hour. Much ocean-

front property will be unable to withstand this combined assault of wind and water.

The combination of storm surge, battering waves, and high tide is the hurricane's most deadly killer.

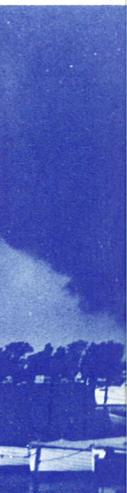
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The floods and flash floods brought by the torrential rains of a hurricane are dangerous killers. Even though hurricanes weaken rapidly as they move inland, the remnants of the storm can bring 6 to 12 inches of rain or more to the area it crosses. The resulting floods have caused great damage and loss of life. Hurricane Diane of 1955 caused little damage as it moved into the continent; but long after its winds subsided, it brought floods to Pennsylvania, New York, and New England that

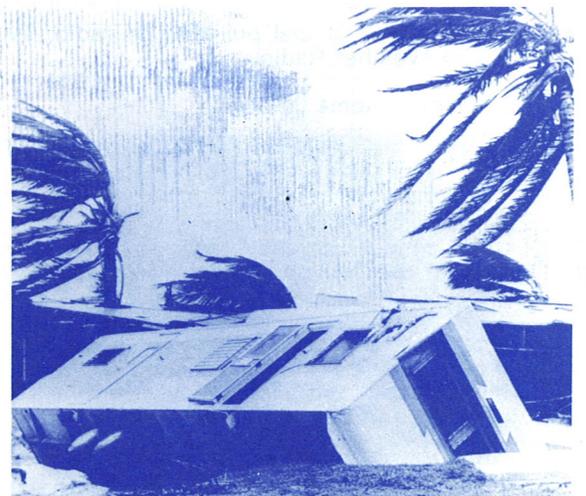
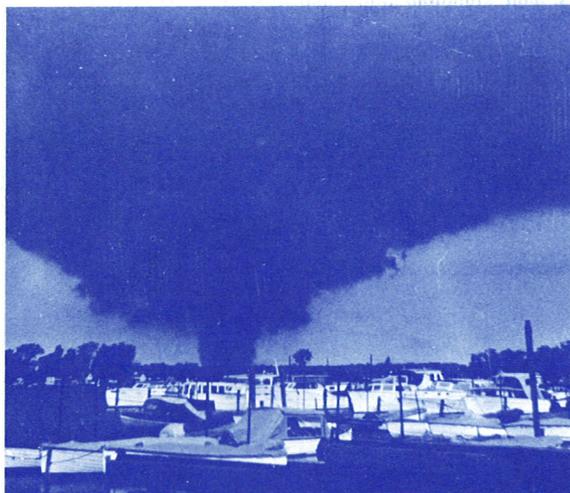
killed 200 persons and cost an estimated \$700 million in damage. In 1972, Agnes fused with another storm system, flooding creek and river basins in the Northeast with more than a foot of rain in less than 12 hours, killing 117 people and causing almost \$3 billion damage. Hurricane Beulah of 1967 brought major floods to southern Texas killing 10 persons and causing millions of dollars damage.



WINDS

The winds of a hurricane—by definition 74 miles an hour or more—can be very dangerous. For some structures, wind force is sufficient to cause destruction. Mobile homes are particularly vulnerable to hurricane winds. Some hurricanes spawn tornadoes which contribute to incredible destruction.

The greatest threat from a hurricane's winds is their cargo of debris—a deadly barrage of flying missiles such as lawn furniture, signs, roofing, and metal siding.



ACTION CHECKLIST

Here is a list of the many things to consider before, during and after a hurricane. Some of the safety rules will make things easier for you during a hurricane. All are important and could help save your life and the lives of others.

Stay or Leave?

When a hurricane threatens your area, you will have to make the decision whether you should evacuate or whether you can ride out the storm in safety at home.

If local authorities recommend evacuation, you should leave! Their advice is based on knowledge of the strength of the storm and its potential for death and destruction.

In general:

- If you live on the coastline or offshore islands, **plan to leave.**
- If you live in a mobile home, **plan to leave.**
- If you live near a river or in a flood plain, **plan to leave.**
- If you live on high ground, away from coastal beaches, **consider staying.**

In any case, the ultimate decision to stay or leave will be yours. Study the following list and carefully consider the factors involved—especially the items pertaining to storm surge.

At Beginning of Hurricane Season (June) Make Plans for Action

- Learn the storm surge history and elevation of your area
- Learn safe routes inland
- Learn location of official shelters
- Determine where to move your boat in an emergency
- Trim back dead wood from trees
- Check for loose rain gutters and down spouts
- If shutters do not protect windows stock boards to cover glass.

When a Hurricane Watch is Issued for Your Area

- Check often for official bulletins on radio, TV, or NOAA Weather Radio
- Fuel car
- Check mobile home tie-downs

- Moor small craft or move to safe shelter
- Stock up on canned provisions
- Check supplies of special medicines and drugs
- Check batteries for radio and flashlights
- Secure lawn furniture and other loose material outdoors
- Tape, board, or shutter windows to prevent shattering
- Wedge sliding glass doors to prevent their lifting from their tracks

When a Hurricane Warning is Issued for Your Area

- Stayed turned to radio, TV, or NOAA Weather Radio for official bulletins
- Stay home if sturdy and on high ground
 - Board up garage and porch doors
 - Move valuables to upper floors
 - Bring in pets
 - Fill containers (bathtub) with several days supply of drinking water
 - Turn up refrigerator to maximum cold and don't open unless necessary
 - Use phone only for emergencies
 - Stay indoors on the downwind side of house away from windows
 - Beware of the eye of the hurricane
- Leave mobile homes
- Leave areas which might be affected by storm tide or stream flooding
 - Leave early—in daylight if possible
 - Shut off water and electricity at main stations
 - Take small valuables and papers but travel light
 - Leave food and water for pets (shelters will not take them)
 - Lock up house
 - Drive carefully to nearest designated shelter using recommended evacuation routes.

After the All-Clear is Given

- Drive carefully; watch for dangling electrical wires, undermined roads, flooded low spots
- Don't sight-see
- Report broken or damaged water, sewer, and electrical lines
- Use caution re-entering home
 - Check for gas leaks
 - Check food and water for spoilage

COMMUNITY ACTION

Beyond individual and family actions during a hurricane emergency, there is much to be done at the community level. Many communities on the Atlantic and Gulf coasts have made plans for action in the event a hurricane threatens, such as delineation of areas to be evacuated, shelter-designations, evacuation routes, and emergency operations of fire, police, and other public service units.

But many exposed coastal communities are not prepared for a hurricane, and others have

waited for disaster's expensive lesson before taking corrective steps. To encourage community preparedness, NOAA's National Weather Service has invented a town, named Homeport, and made it a model of hurricane preparedness.

Copies of The Homeport story are available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Stock number 0317-0046. Ask G.P.O. for current price.

HOW TO TRACK A HURRICANE

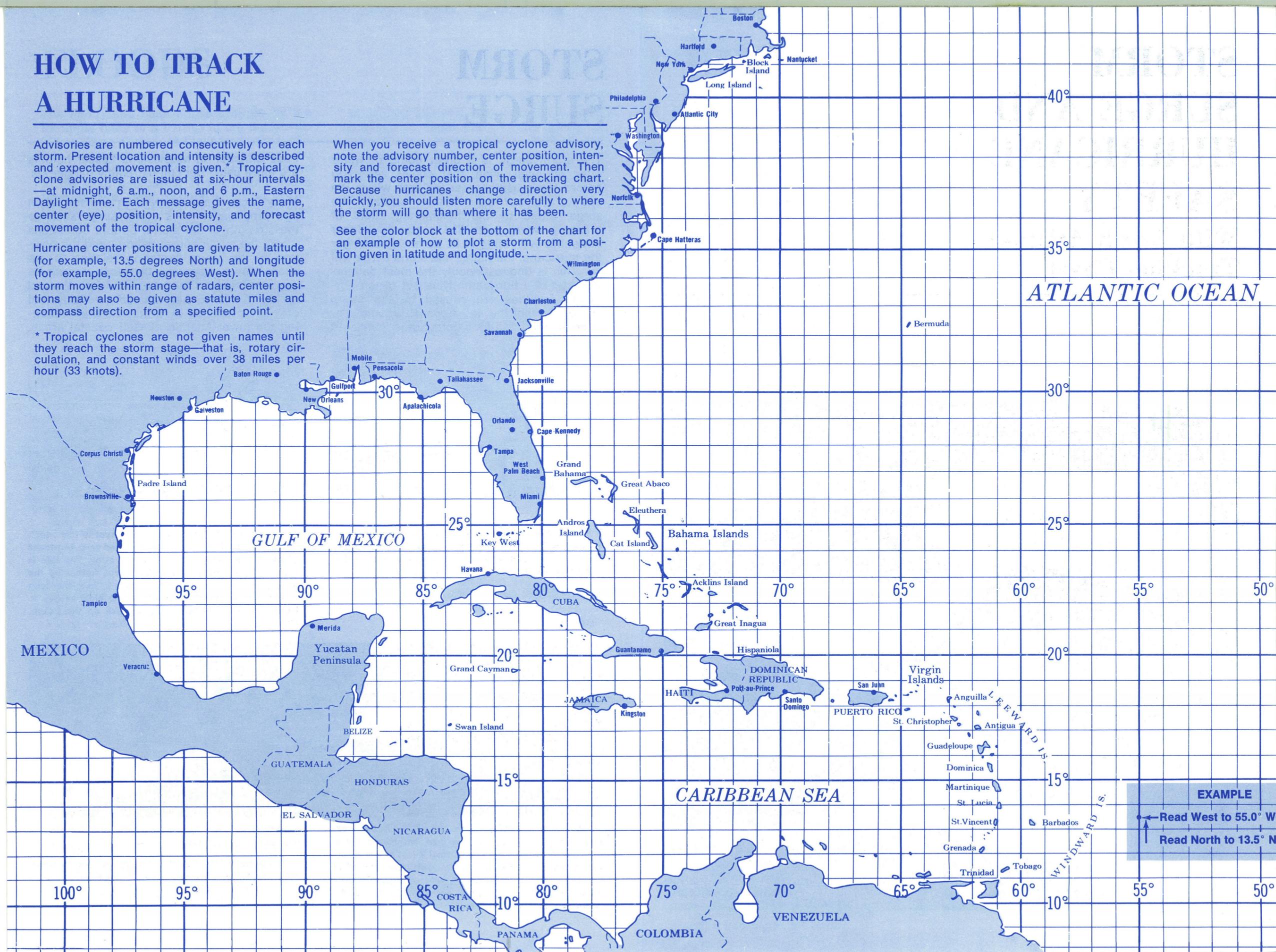
Advisories are numbered consecutively for each storm. Present location and intensity is described and expected movement is given.* Tropical cyclone advisories are issued at six-hour intervals—at midnight, 6 a.m., noon, and 6 p.m., Eastern Daylight Time. Each message gives the name, center (eye) position, intensity, and forecast movement of the tropical cyclone.

Hurricane center positions are given by latitude (for example, 13.5 degrees North) and longitude (for example, 55.0 degrees West). When the storm moves within range of radars, center positions may also be given as statute miles and compass direction from a specified point.

* Tropical cyclones are not given names until they reach the storm stage—that is, rotary circulation, and constant winds over 38 miles per hour (33 knots).

When you receive a tropical cyclone advisory, note the advisory number, center position, intensity and forecast direction of movement. Then mark the center position on the tracking chart. Because hurricanes change direction very quickly, you should listen more carefully to where the storm will go than where it has been.

See the color block at the bottom of the chart for an example of how to plot a storm from a position given in latitude and longitude.



TERMS TO KNOW

By international agreement, **tropical cyclone** is the general term for all cyclone circulations originating over tropical waters, classified by form and intensity as follows:

Tropical disturbance: A moving area of thunderstorms in the Tropics that maintains its identity for 24-hours or more. A common phenomenon in the tropics.

Tropical depression: Rotary circulation at surface, highest constant wind speed 38 miles per hour (33 knots).

Tropical storm: Distinct rotary circulation, constant wind speed ranges 39-73 miles per hour (34-63 knots).

Hurricane: Pronounced rotary circulation, constant wind speed of 74 miles per hours (64 knots) or more.

Small craft cautionary statements. When a tropical cyclone threatens a coastal area, small craft operators are advised to remain in port or not to venture into the open sea.

Gale Warnings may be issued when winds of 39-54 miles an hour (34-47 knots) are expected.

Storm Warnings may be issued when winds of 55-73 miles an hour (48-63 knots) are expected. If a hurricane is expected to strike a coastal area, gale or storm warnings will not usually precede hurricane warnings.

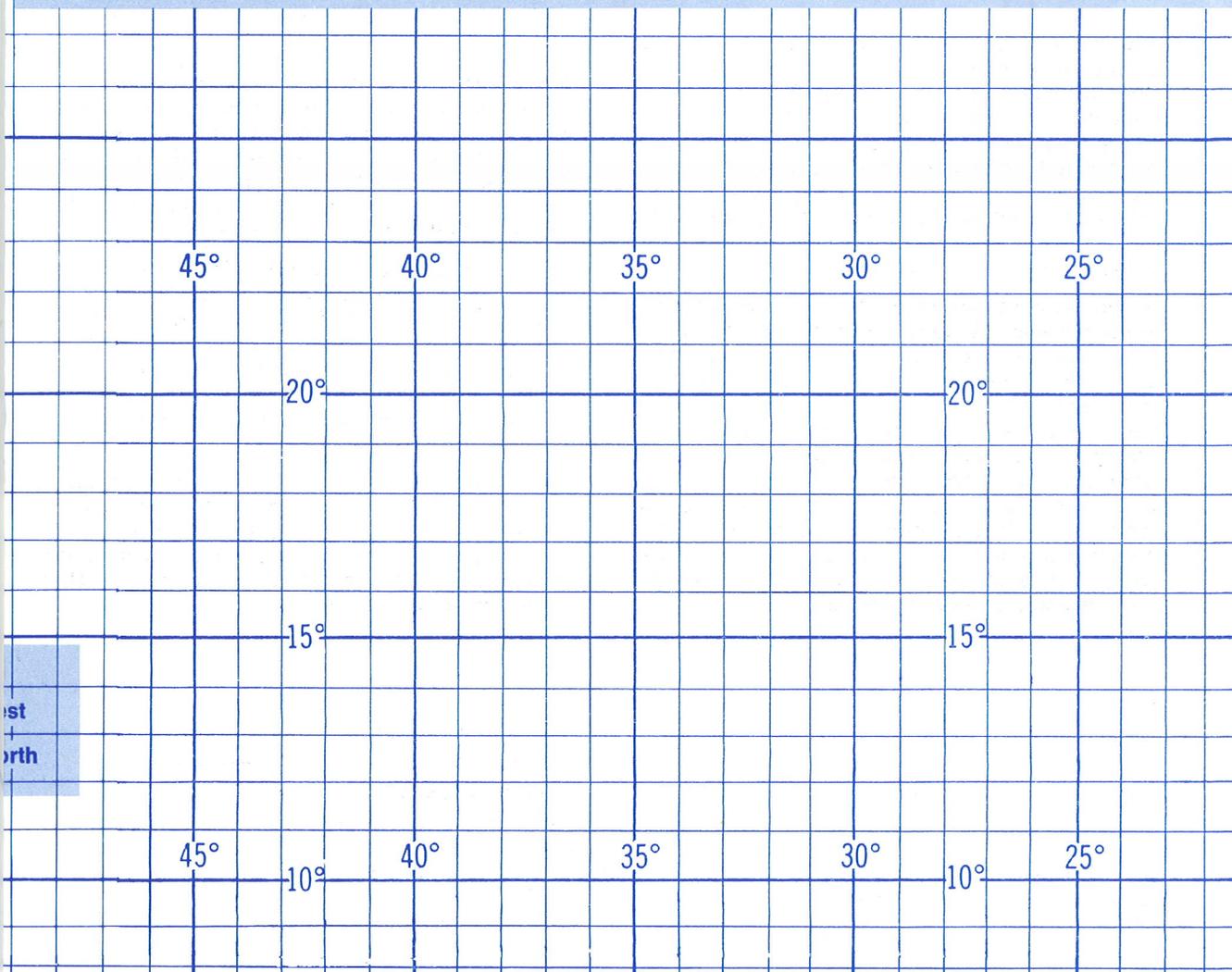
A **Hurricane Watch** is issued for a coastal area when there is a threat of hurricane conditions within 24-36 hours.

A **Hurricane Warning** is issued when hurricane conditions are expected in a specified coastal area in 24 hours or less. Hurricane conditions include winds of 74 miles an hour (64 knots) and/or dangerously high tides and waves. Actions for protection of life and property should begin immediately when the warning is issued.

Flash Flood Watch means a flash flood is possible in the area; stay alert.

Flash Flood Warning means a flash flood is imminent; take immediate action.

Tornadoes spawned by hurricanes sometimes produce severe damage and casualties. If a tornado is reported in your area, a warning will be issued.



HURRICANES

Major hurricanes are relatively rare events at any location. Coastal residents from Brownsville, Tex., to Eastport, Me., have a good chance of living many years without experiencing one. But none of our coastal areas are immune. "Not here! We haven't had a hurricane in years," could be the most dangerous words you'll ever hear. It's best to be prepared. This could be the year.

Hurricanes are tropical cyclones in which winds reach constant speeds of 74 miles per hour or more, and blow in a large spiral around a relatively calm center—the eye of the hurricane. Every year, these violent storms bring destruction to coastlines and islands in their erratic path.

Stated very simply, hurricanes are giant whirlwinds in which air moves in a large tightening spiral around a center of extreme low pressure, reaching maximum velocity in a circular band extending outward 20 or 30 miles from the rim of the eye. This circulation is counterclockwise in the Northern Hemisphere, and clockwise in the Southern Hemisphere. Near the center, hurricane winds may gust to more than 200 miles per hour. The entire storm dominates the ocean surface and lower atmosphere over tens of thousands of square miles.

The eye, like the spiral structure of the storm, is unique to hurricanes. Here, winds are light and skies are clear or partly cloudy. But this calm is deceptive, bordered as it is by maximum force winds and torrential rains. Many persons have been killed or injured when the calm eye lured them out of shelter, only to be caught in the maximum winds at the far side of the eye, where the wind blows from a direction opposite to that in the leading half of the storm.

Hurricane winds do much damage, but drowning is the greatest cause of hurricane deaths. As the storm approaches and moves across the coastline, it brings huge waves, and storm tides which may reach 25 feet or more above normal. The rise may come rapidly, flooding coastal lowlands. Waves and currents erode beaches and barrier islands, undermine waterfront structures, and wash out highway and railroad beds. The torrential rains that accompany the hurricane produce sudden flooding as the storm moves inland. As its winds diminish, rainfall floods constitute the hurricane's greatest threat.

The hurricanes that strike the eastern United States are born in the tropical and subtropical North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. Most occur in August, September, and October, but the six-month period from June 1 to November 30 is considered the Atlantic hurricane season.

The principal regions of tropical cyclone origin vary during the season. Most early (May and June) storms originate in the Gulf of Mexico and western Caribbean. In July and August, the areas of most frequent origin shift eastward, and by September are located over the larger area from the Bahamas southeastward to the Lesser Antilles, and thence eastward to south of the Cape Verde Islands, near the west coast of Africa. After mid-September, the principal areas of origin shift back to the western Caribbean and Gulf of Mexico.

On average, six Atlantic hurricanes occur per year. However, there are significant deviations from this average. In 1916 and 1950, 11 hurricanes were observed, and no hurricanes were observed in 1907 and 1914. During 1893, 1950, and 1961 seasons, four hurricanes were observed in progress at the same time.

Some hurricanes (usually weaker than their Atlantic counterparts) may strike Southern California and bring torrential rains to the southwest U.S.

Hurricanes begin as relatively small tropical cyclones which drift gradually to the west-northwest (in the Northern Hemisphere), imbedded in the westward-blowing, tradewinds of the tropics. Under certain conditions these disturbances increase in size, speed, and intensity until they become full-fledged hurricanes.

The storms move forward very slowly in the tropics, and may remain almost stationary for short periods of time. The initial forward speed is usually 15 miles per hour or less. Then, as the hurricane moves farther from the Equator, its forward speed tends to increase; at middle latitudes it may exceed 50 miles per hour in extreme cases.

The great storms are driven by the heat released by condensing water vapor, and by external mechanical forces. Once cut off from the warm ocean, the storm begins to die, starved for water and heat energy, and dragged apart by friction as it moves over the land.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric
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National Weather Service

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