September 2012

G271 Hazardous Weather & Flooding Preparedness

Student Manual

FEMA

Federal Emergency Management Agency
Emergency Management Institute

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Weather Service

G 271

Hazardous Weather and Flooding Preparedness

Student Manual

FEDERAL EMERGENCY MANAGEMENT AGENCY
EMERGENCY MANAGEMENT INSTITUTE

September 2012

Acknowledgements

The preparation of this course was made possible through the assistance and cooperation of individuals from the National Weather Service (NWS), the Federal Emergency Management Agency (FEMA), and emergency managers who volunteered their time to participate in the development.

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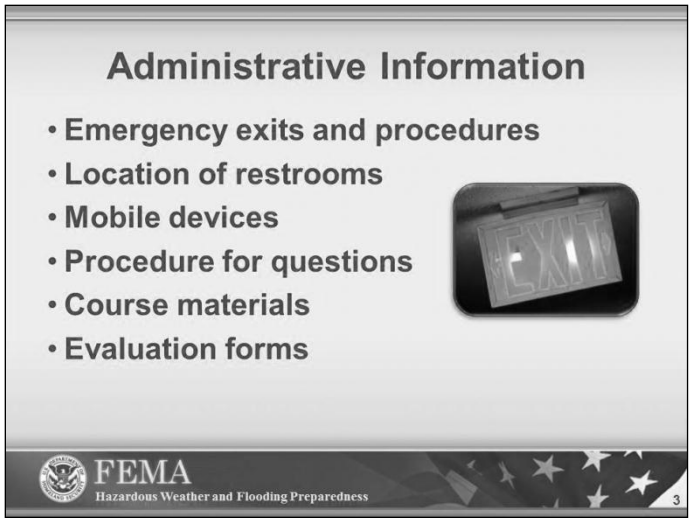
Student Manual
Table of Contents

This course will provide you with the necessary training to respond to hazardous weather situations and help your community avoid some of the destruction associated with these events.

This course was produced in cooperation between the Federal Emergency Management Agency (FEMA) and the National Weather Service (NWS).

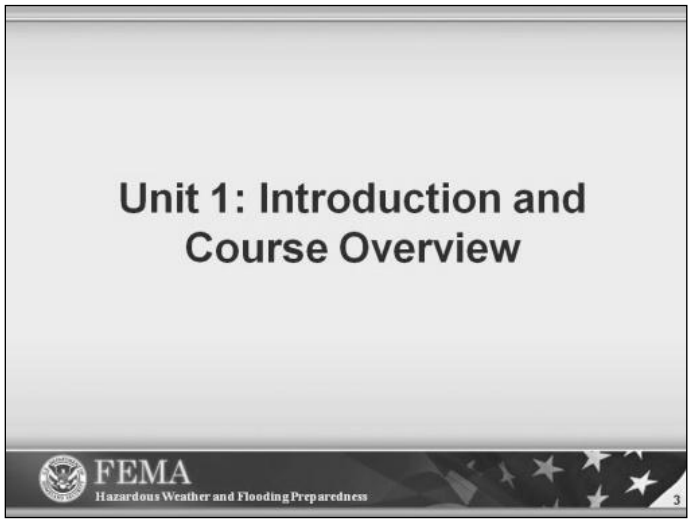
About the Student Manual

There is added space on the right side of the page for you to take notes. Large bold text on this side of the page indicates the beginning of a new unit. Occasionally, special notes will be inserted on this side of the page.



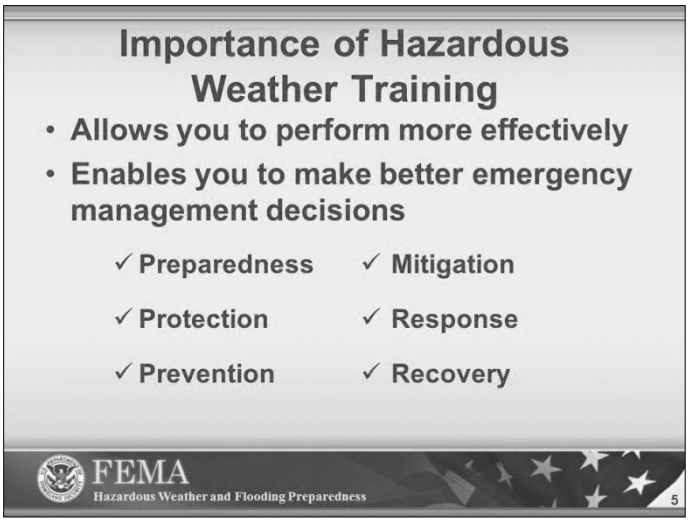
The appendices to the Student Manual contain many helpful resources related to hazardous weather and flooding preparedness, including a link to the NWS Products and Services Reference Guidebook. If this Guidebook has not been provided for you with these course materials, you should download it from the link provided in Appendix B.

Appendix B

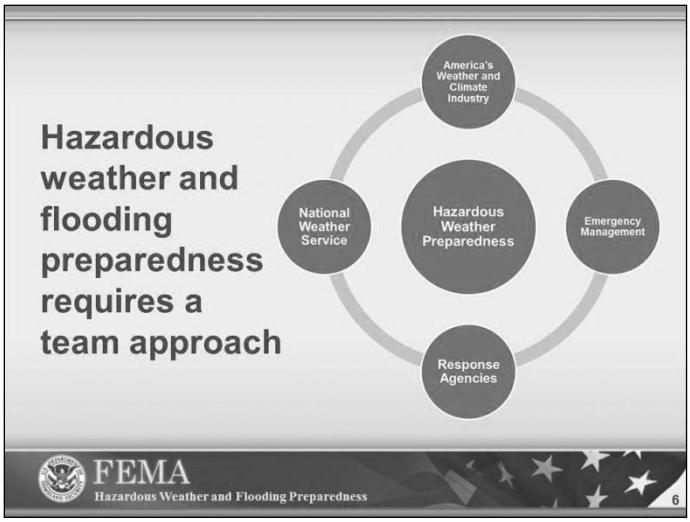


Unit 1

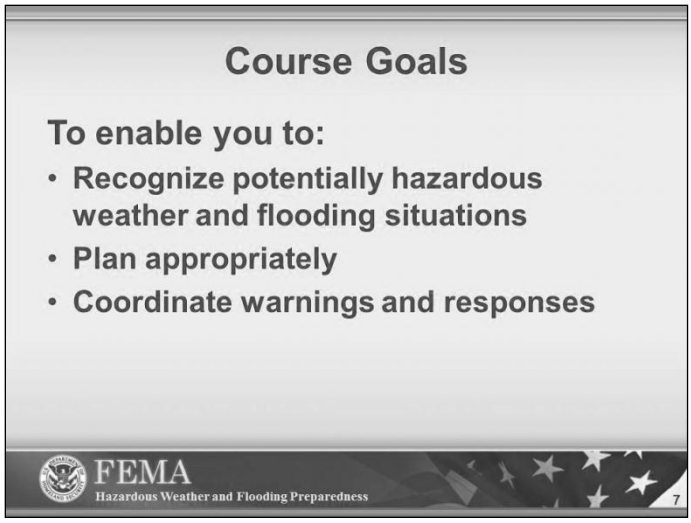
The purpose of this unit is to ensure that you recognize the importance of planning for hazardous weather and flooding events.



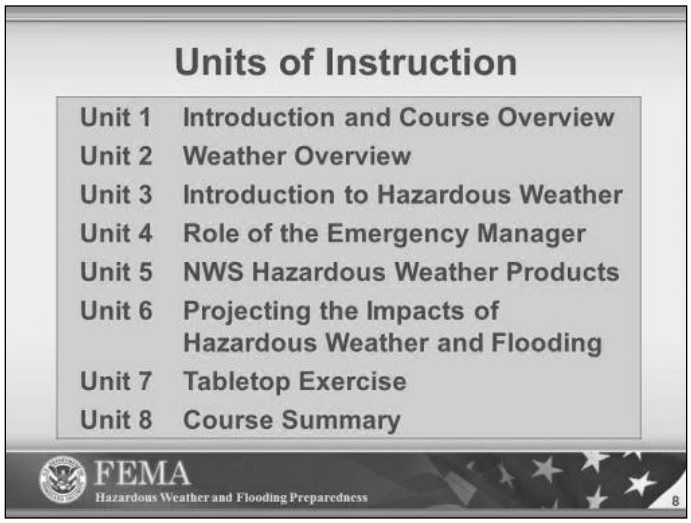
This course will help you do your job more effectively because you will learn to obtain and analyze hydrometeorological information to make better emergency management decisions.



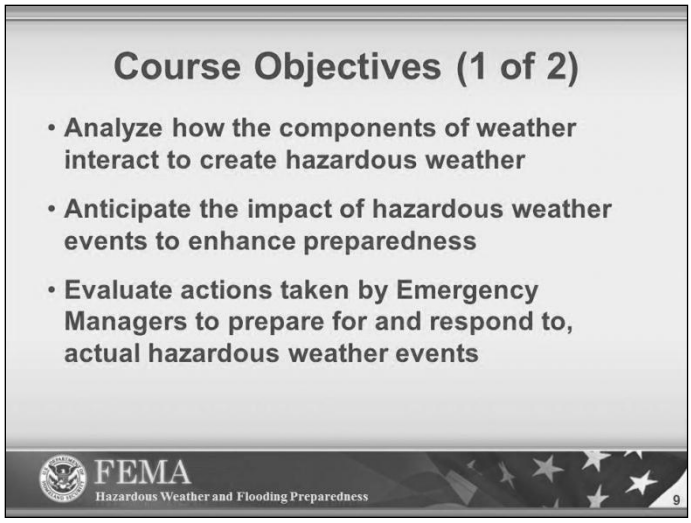
Effective hazardous weather and flooding preparedness requires a team approach. This course is designed to promote partnership and coordination among the National Weather Service, Emergency Managers, response agencies, and America's Weather and Climate Industry (members of the media and private forecasting companies).



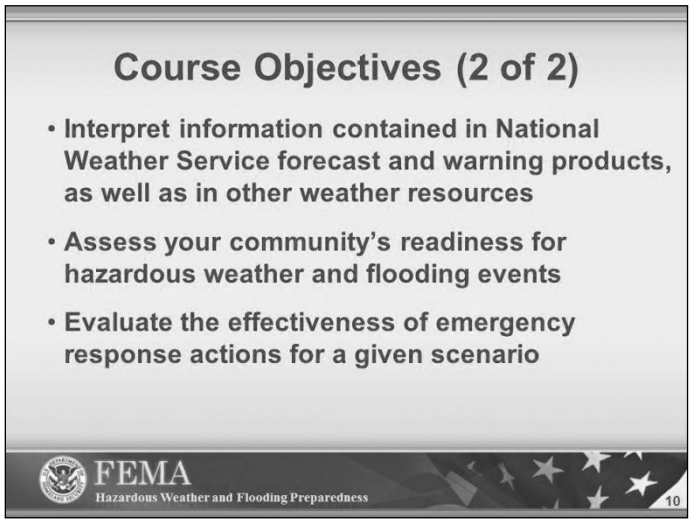
The goal of this course is to enhance your ability to recognize potentially hazardous weather and flooding situations. This will equip you to plan appropriately and coordinate effective warnings and responses.



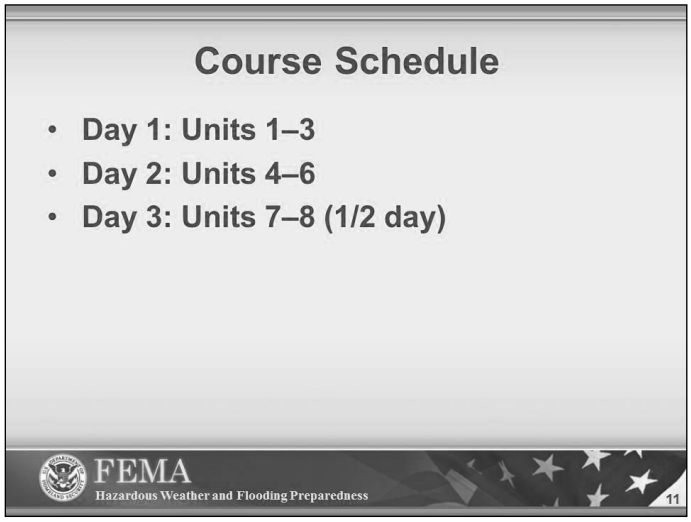
The course consists of eight units, which are listed on the visual.



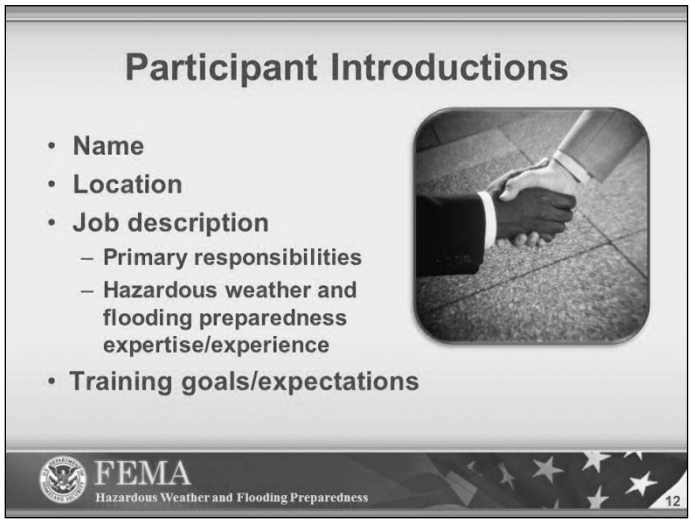
In this course, you will learn how various components interact to create hazardous weather. Understanding how hazardous weather forms will help you anticipate the impact of hazardous weather events so you are better prepared. You will have opportunities to review case studies of actual hazardous weather events and evaluate actions taken by emergency management in those cases.



You will also learn about the different forecast and warning products available from NWS and interpret the information contained in them. You will be asked to assess your community's readiness for hazardous weather and flooding events. Finally, you will participate in a Tabletop Exercise during which you will make emergency response decisions for a hazardous weather scenario and later evaluate the effectiveness of those actions.

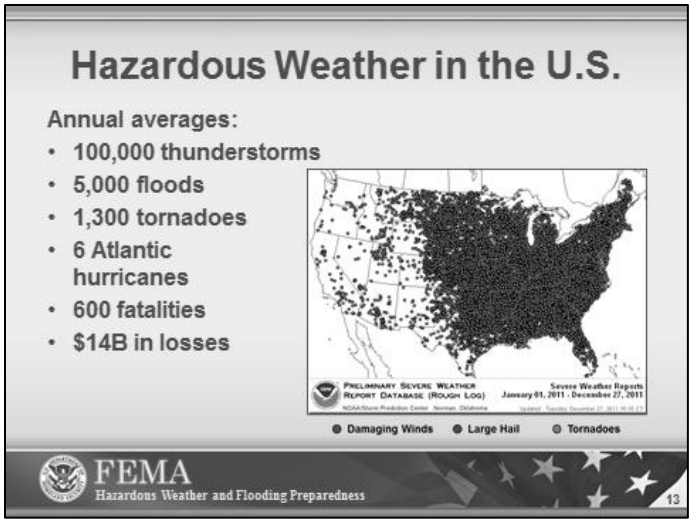


The course schedule you will receive is approximate. Precise times are subject to change depending on the progress of the class.



Please share:

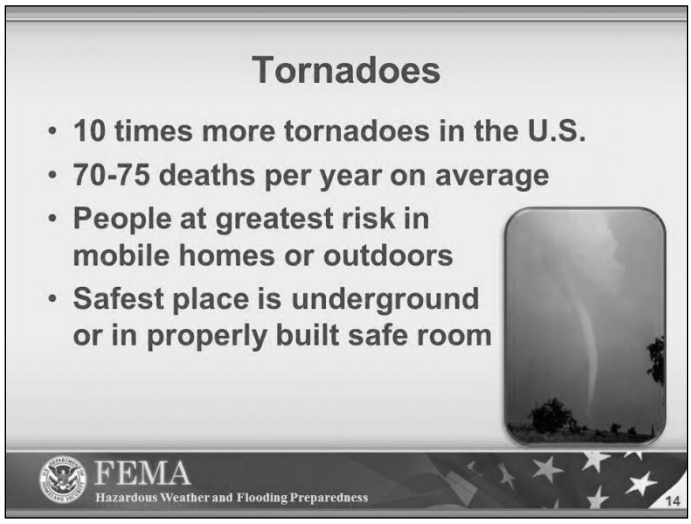
- Your name
- Where you are from
- Your job description, to include:
  - Primary responsibilities
  - Expertise/experience with hazardous weather and flooding preparedness
- What you hope to gain from the course



The United States experiences more severe weather than any other nation. Our weather creates many hazards that you, as responders, need to be able to recognize and respond to appropriately.

Did you know?

In 2011, the number of Presidentially declared disasters set a new record, with 99. Of all Presidentially declared disasters, over 95% are weather-related.

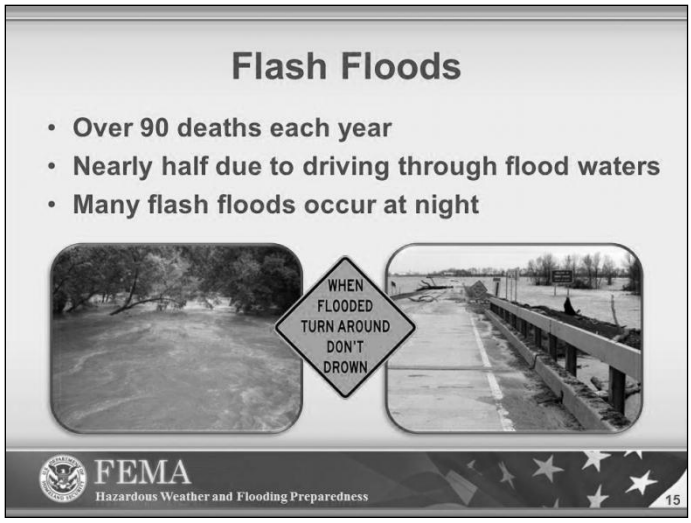


There are 10 times more tornadoes in the United States than any other nation. In them, people are hurt and/or killed from flying debris and the destruction of buildings.

People are at the greatest risk to tornadoes when in mobile homes and when caught outdoors.

Did you know?

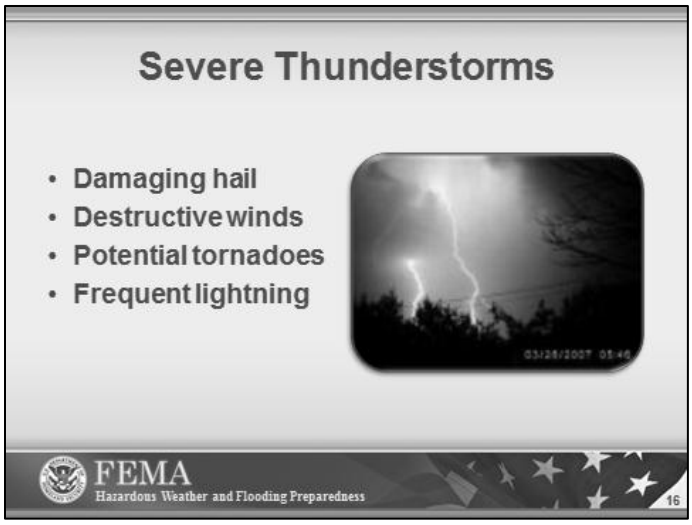
In 1925, one tornado resulted in 695 deaths and left a continuous 219-mile track across Missouri, Illinois, and Indiana.



Did you know?

Two feet of moving water can sweep most vehicles away. Six inches of fast moving water can knock a person off his feet.

Flash floods in urban areas are a particular threat to personal safety. Development and paving decrease the absorption of rain and increases runoff 2 to 6 times beyond what would occur in natural areas. Urban floods cause streets to become swiftly moving rivers, taking many citizens by surprise.

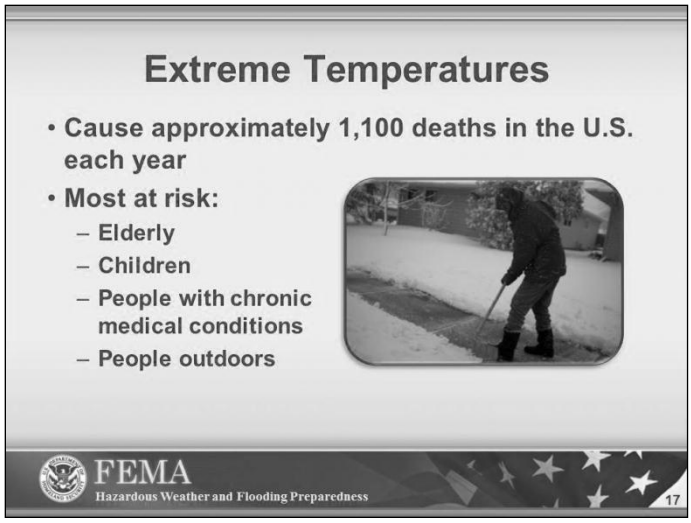


Did you know?

On average every year, lightning causes nearly 60 deaths and 400 injuries, and hail causes nearly $2 billion in damages to property and crops.

The National Weather Service considers a thunderstorm severe if it produces hail at least one-inch in diameter, winds 58 mph or stronger, or a tornado.

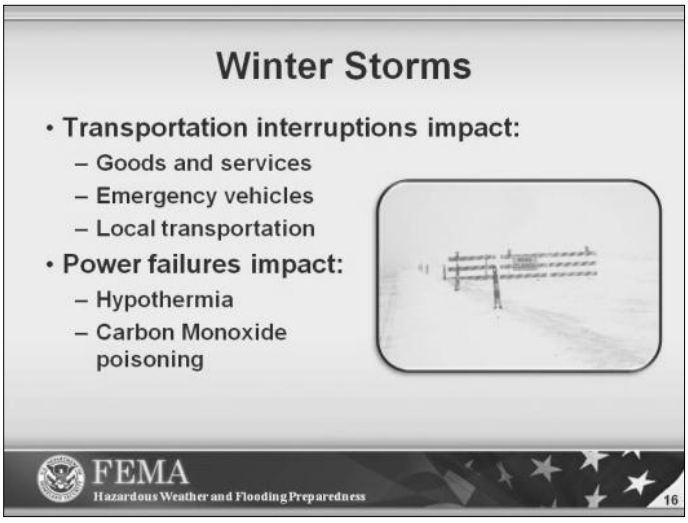
Straight-line winds are responsible for most thunderstorm wind damage and can create as much damage as an EF-2 tornado (wind gusts in excess of 110 mph).



Many other weather events, such as extreme heat and cold, threaten personal safety.

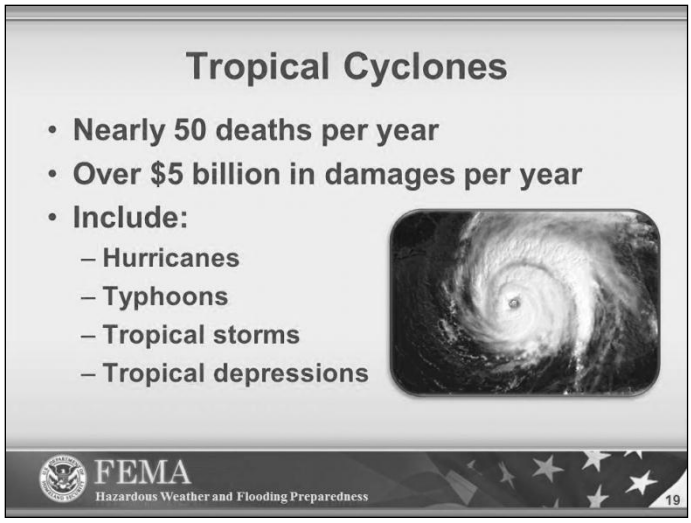
Did you know?

Approximately 400 people die each year due to extreme heat. Extreme cold kills approximately 700 people each year.



Transportation of goods is threatened by winter storms, as is local transportation, inhibiting emergency vehicles.

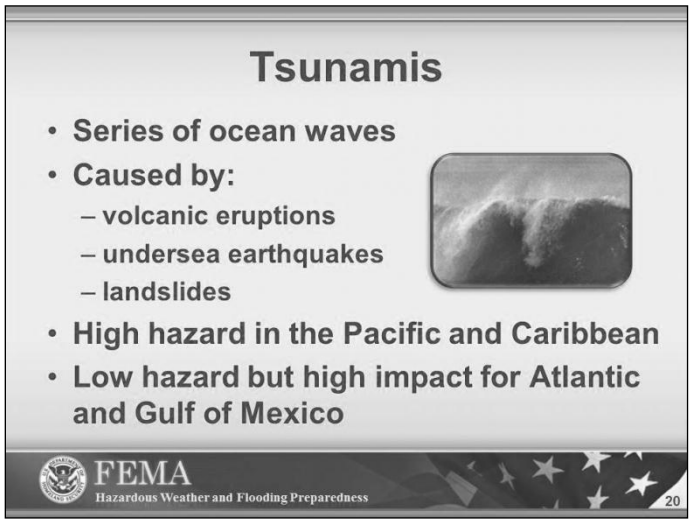
Winter storms can also lead to power failure, which in turn can affect public facilities, hospitals, and telecommunications. Extended outages can lead to inhabitants suffering from hypothermia or even carbon monoxide poisoning, if they rely on alternative heat sources that are unsafe.



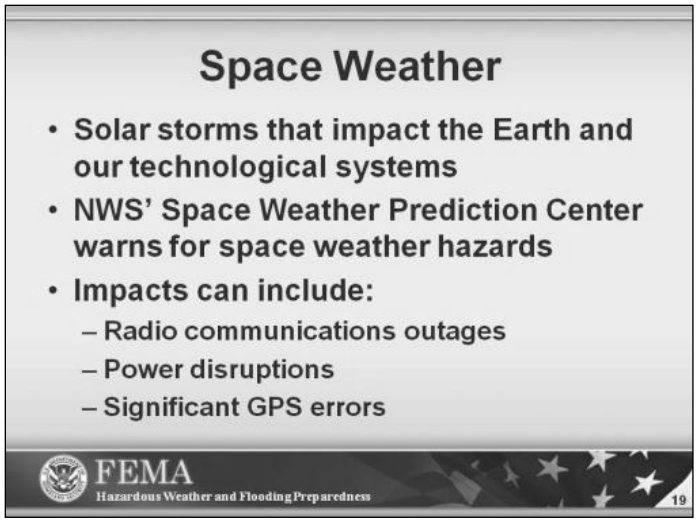
Every year tropical cyclones damage and destroy coastal property, emphasizing the importance of weather predictions and warning systems.

Did you know?

In 2005, Hurricane Katrina caused over 1,000 deaths and over $125 billion in damages.



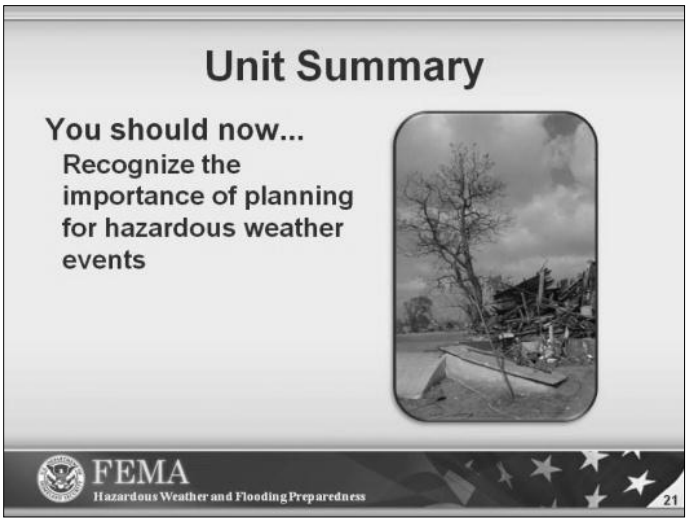
Tsunamis are a series of ocean waves typically generated primarily from strong undersea earthquakes. As they reach the shallow waters of the coast, the waves slow down and the water can pile up into a wall of destruction 30 feet or more in height.



Space Weather describes the conditions in space that affect Earth and its technological systems. Space weather is a consequence of the behavior of the Sun interacting with the Earth's magnetic field and atmosphere. The National Weather Service's Space Weather Prediction Center monitors and warns for space weather hazards.

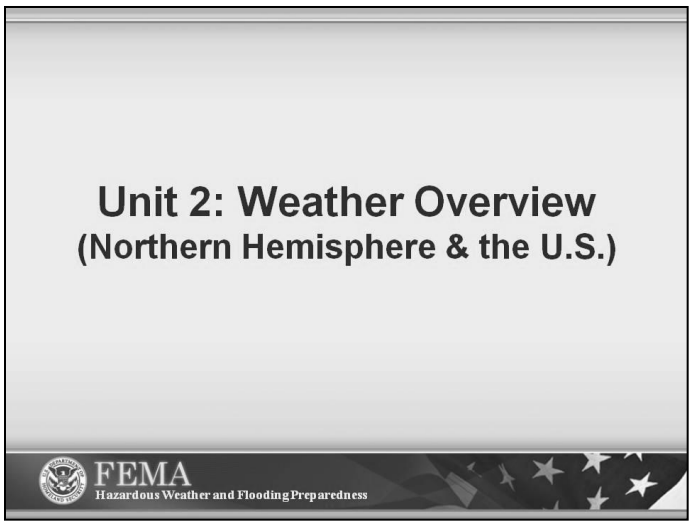
How might the Emergency Manager have reduced the impact of this event?

The instructor will share information about this case study. Consider the question next to the visual and jot down a few ideas.

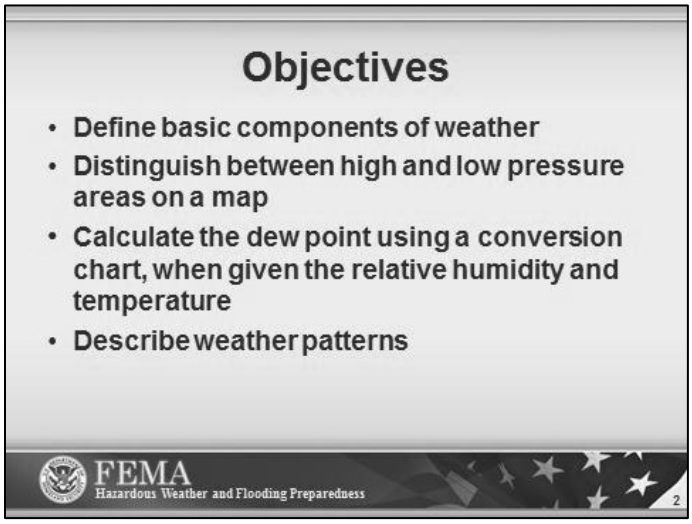


This unit has shown you what to expect from this course and introduced you to the importance of planning for hazardous weather events.

Throughout this course, we will discuss more ways that Emergency Managers can prepare for and protect against the impacts of hazardous weather events.



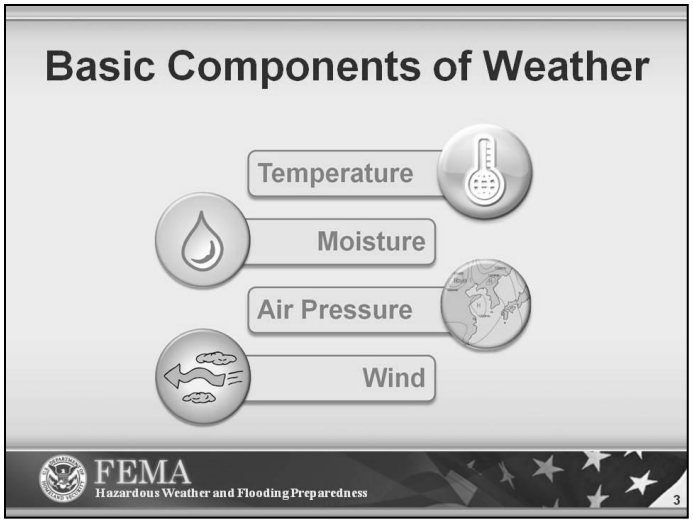
This unit provides an overview of general climate and weather concepts, especially as they relate to the Northern Hemisphere and the United States. These concepts are important so you can more fully understand weather forecasts and take advantage of the products offered by the National Weather Service (NWS) and America's Weather and Climate Industry.



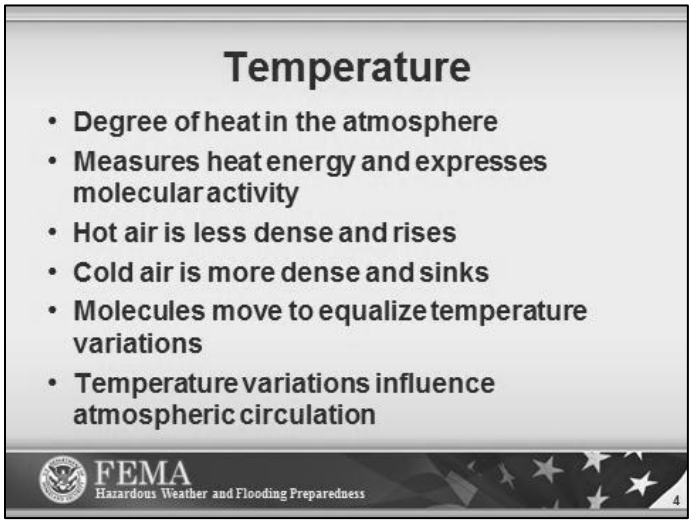
In this unit, you will learn about the basic components that interact with each other to form weather. You will practice using isobars to distinguish between high and low pressure areas on a map, and you will learn to calculate the dew point. Finally, you will learn about various weather patterns, particularly those affecting the Northern Hemisphere and the United States.

Unit 2

In this unit, you will analyze how the components of weather interact to create hazardous weather.



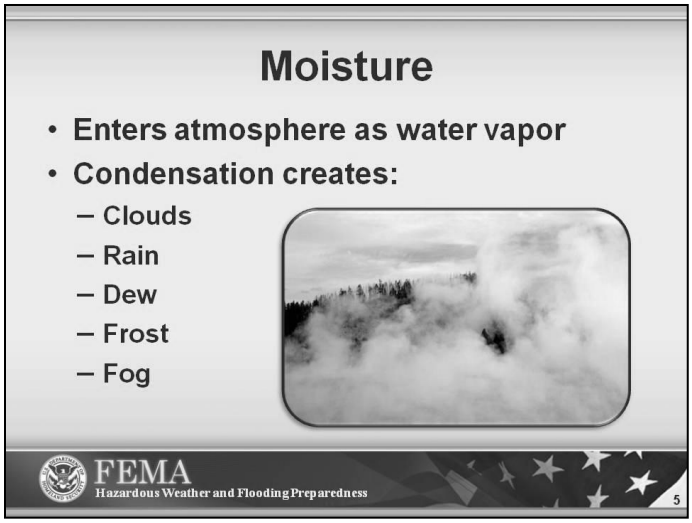
The four components shown on the visual interact with each other to form weather. The current meteorological conditions are described as the weather. The historical conditions characteristic of a particular region are described as its climate. When referring to forecasts, meteorology is the expected weather conditions in the next two weeks. Climate forecasts refer to projections beyond two weeks.



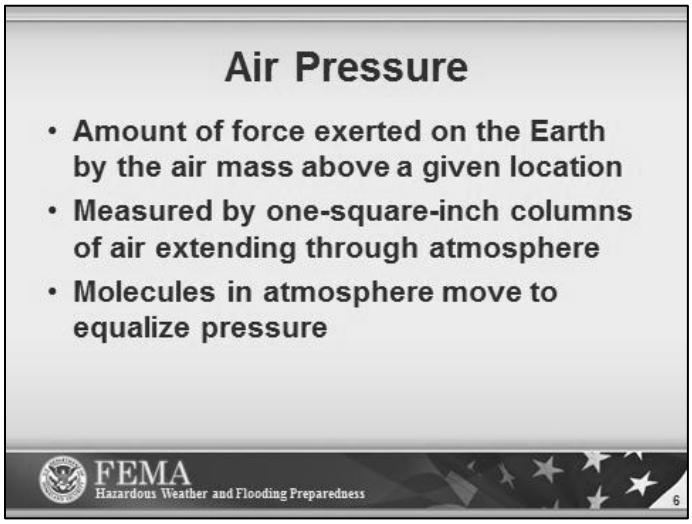
Variations in temperature create forces that influence the circulation of the atmosphere because molecules in the atmosphere move to equalize the temperature.

Did you know?

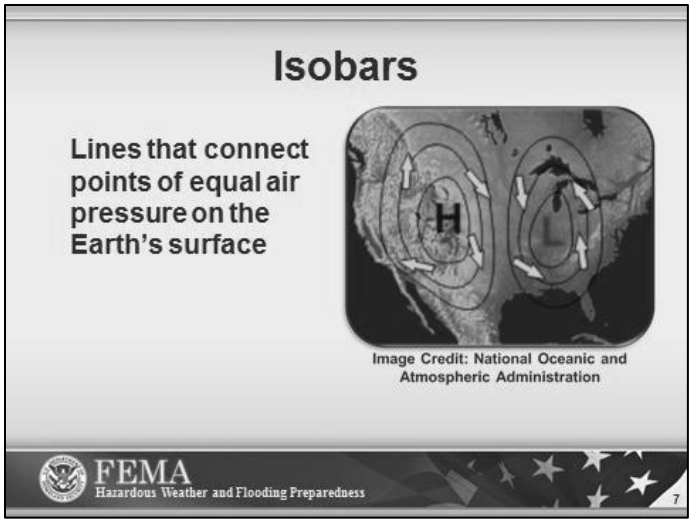
Because different substances have different molecular structures (e.g., land and water), equal amounts of heat applied to equal volumes of two different substances will cause one substance (land) to get hotter than the other (water).



Moisture enters the atmosphere as water vapor, mostly from water evaporating from the oceans. When the air becomes saturated, the moisture condenses due to low temperatures at higher altitudes, creating clouds and rain (as water molecules coagulate), as well as dew, frost, or fog, depending on the temperature.

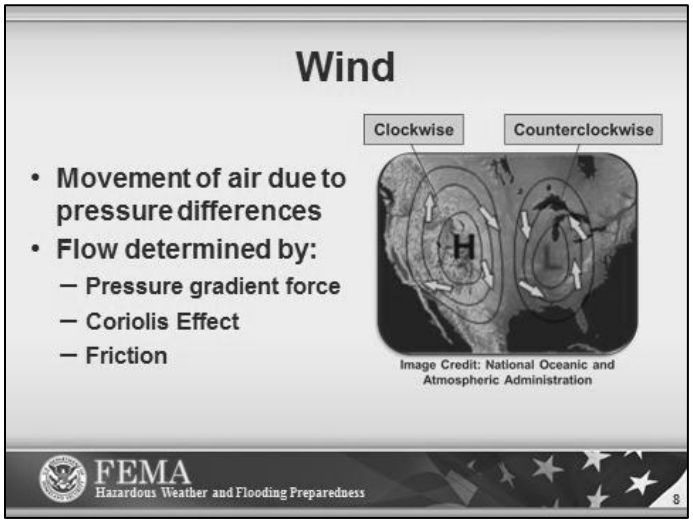


Air pressure is defined as the amount of force exerted on the Earth by the air mass above a given location. It is measured by a one-square-inch column of air extending through the atmosphere. Although the changes are usually too slow to observe directly, air pressure is almost always changing. This change in pressure is caused by changes in air density, and air density is related to temperature.



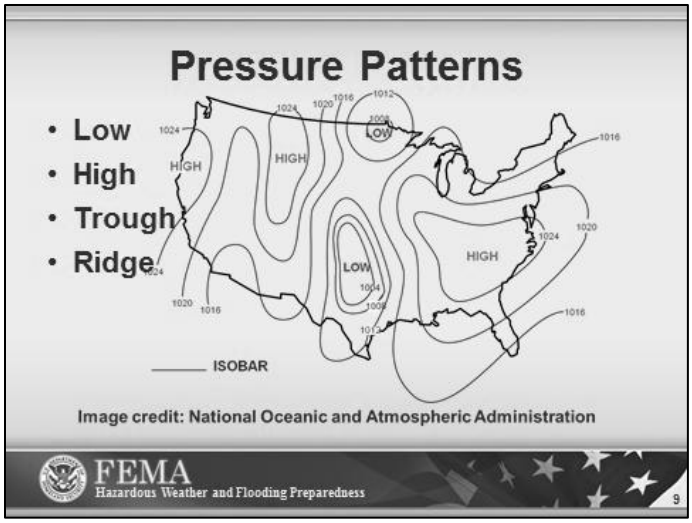
A surface pressure map shows locations of equal pressure connected with lines called **isobars**.

Close spacing of isobars indicates a rapid change in pressure and faster air flow. The closer spacing of isobars, the stronger the wind.



Three forces cause the wind to move as it does:

1. The **pressure gradient force** (Pgf) is a force that tries to equalize pressure difference.
2. The rotation of the Earth pushes winds to the right in the Northern Hemisphere. This is known as the **Coriolis Effect**.
3. **Friction** slows the wind down while causing the diverging winds from highs and converging winds near lows.



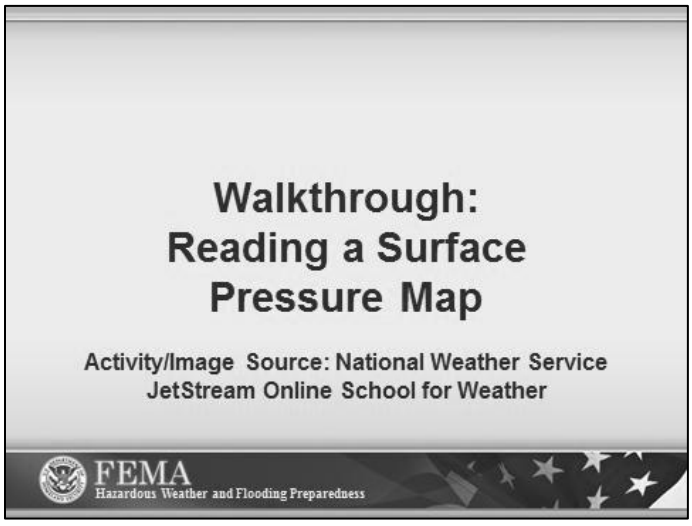
Meteorologists distinguish organized pressure patterns on surface pressure maps.

A **low** is a center of pressure that is surrounded on all sides by higher pressure. Air is rising in areas of low pressure.

A **high** is a center of pressure that is surrounded on all sides by lower pressure. Air is sinking in a high-pressure area.

A **trough** is an elongated area of low pressure.

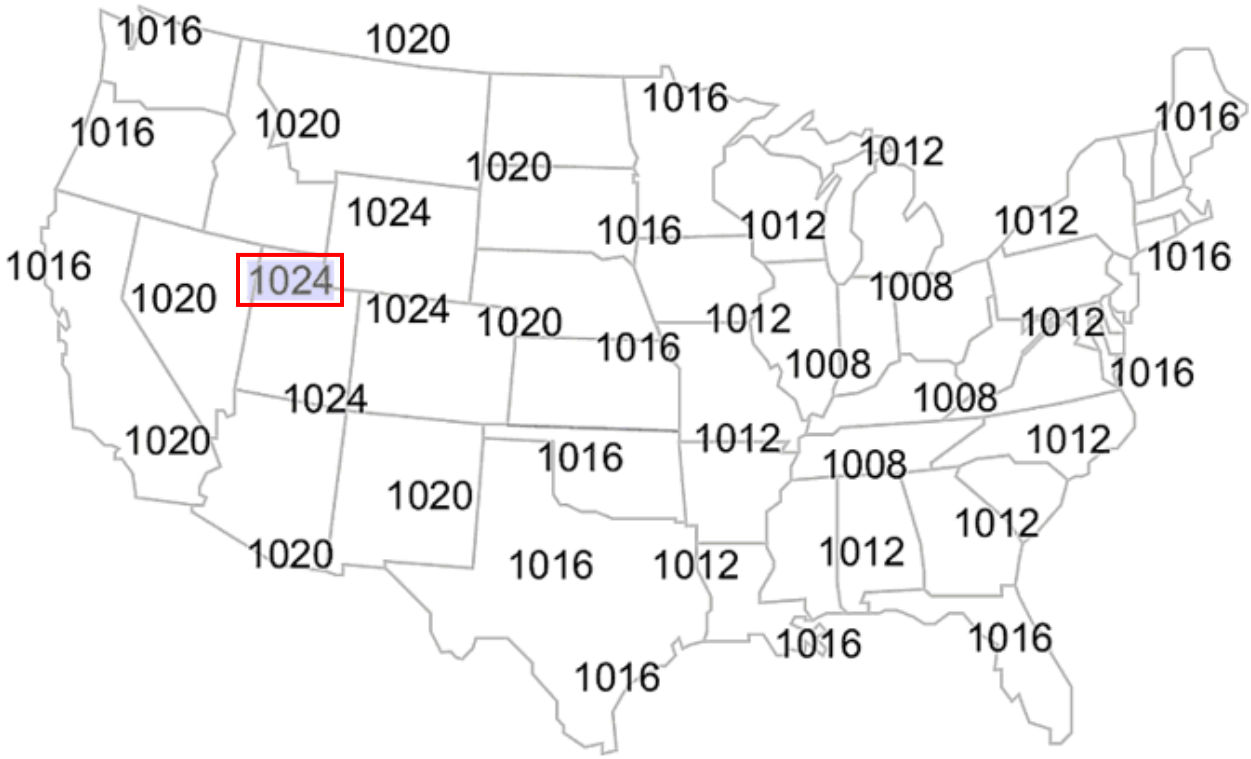
A **ridge** is an elongated area of high pressure.



For this activity, you will need the surface pressure map on the following page in your Student Manual.

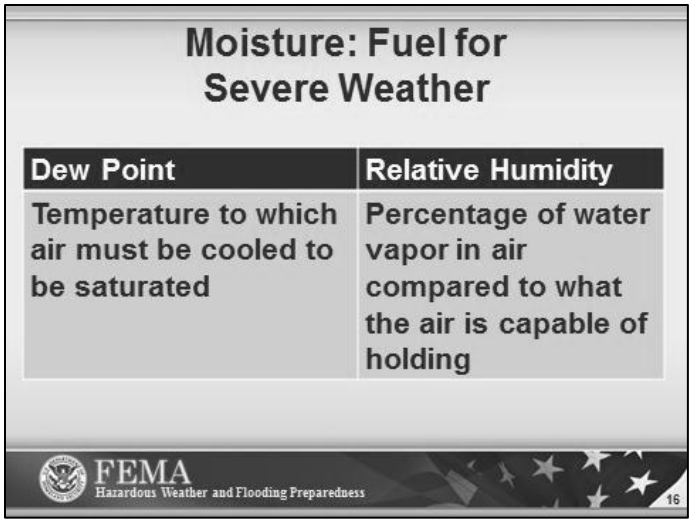
WALKTHROUGH ACTIVITY: READING A SURFACE PRESSURE MAP

Follow the steps given by the instructor to complete the activity. Start at the outlined point on the map.

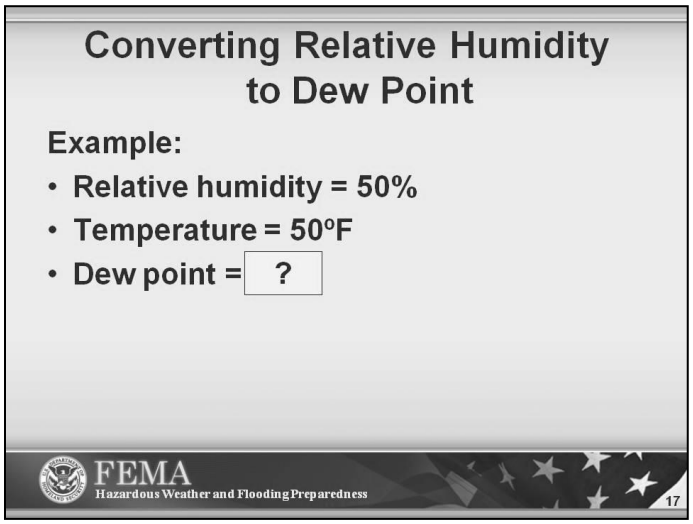


Source: This activity is courtesy of the National Weather Service's JetStream online school for weather. http://www.srh.noaa.gov/jetstream//synoptic/ll_analyze_slp.htm.

There are many weather lessons available from the NWS JetStream website you are interested in learning more: http://www.srh.noaa.gov/jetstream//index.htm.



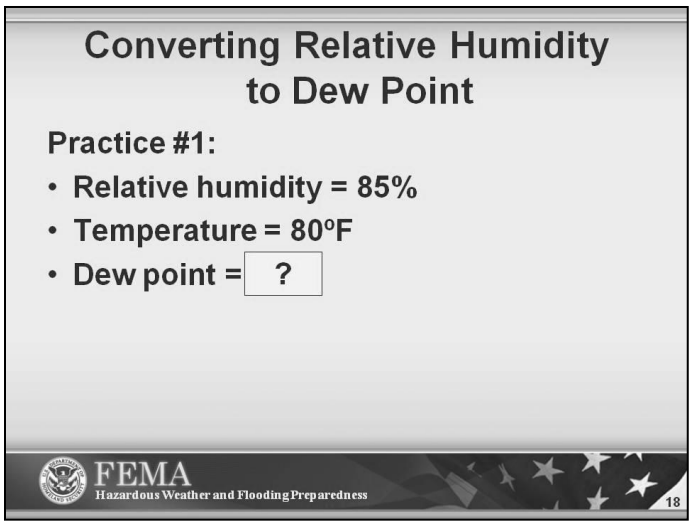
Moisture is the fuel for severe weather, and a high moisture content increases the likelihood of thunderstorms and severe weather.



If the relative humidity is 50% and the temperature is 50˚F, you can see on the Dew Point Conversion Chart that the dew point is T-20 (temperature minus 20) or 30˚F.

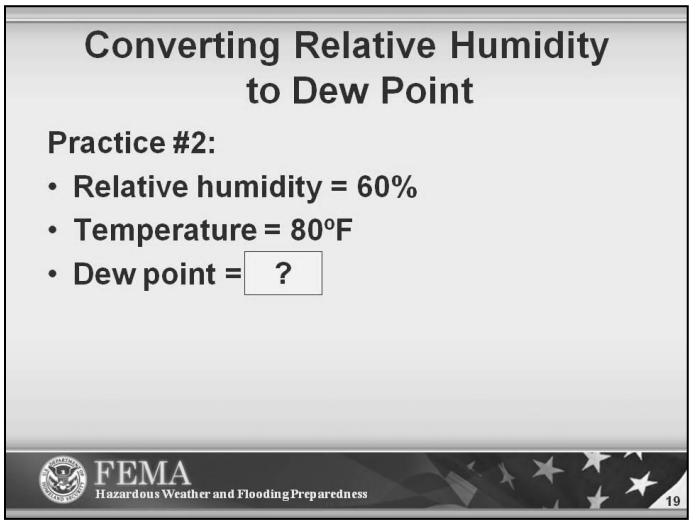
This table is included in Appendix C.

Appendix C
Dew Point Conversion Chart



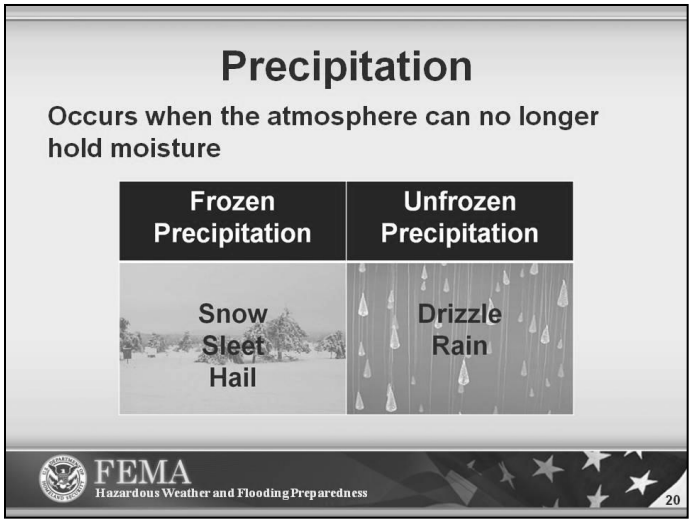
Given this example, what is the dew point?

What kind of weather could be expected?

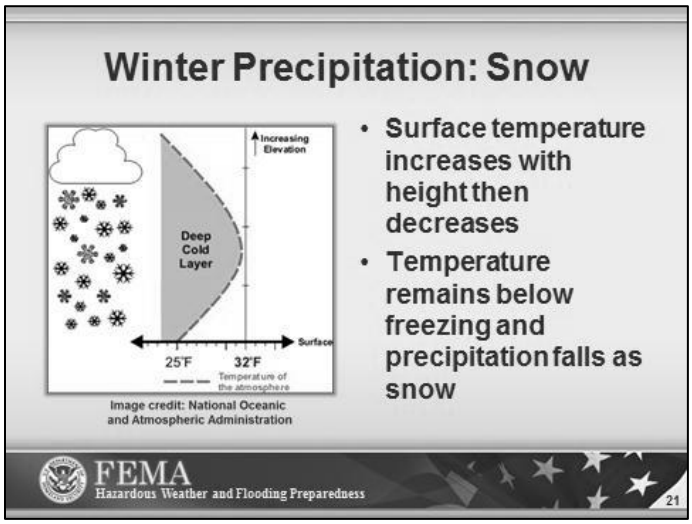


Given this example, what is the dew point?

What kind of weather could be expected?

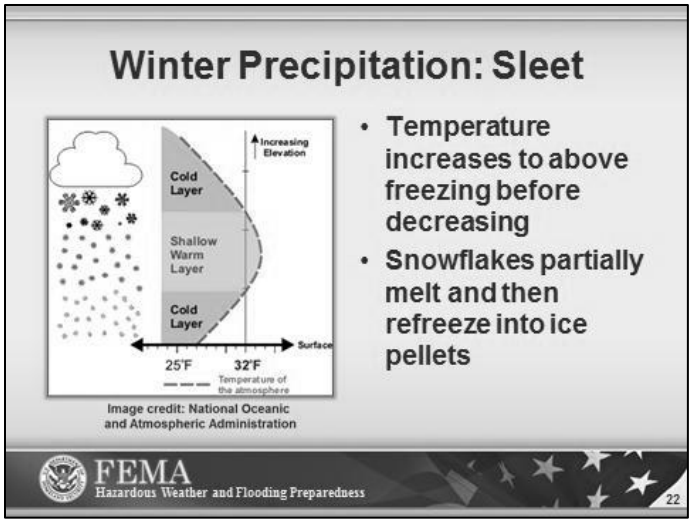


Precipitation occurs when moisture particles in the clouds have grown in size and weight until the atmosphere no longer can suspend them and they fall.

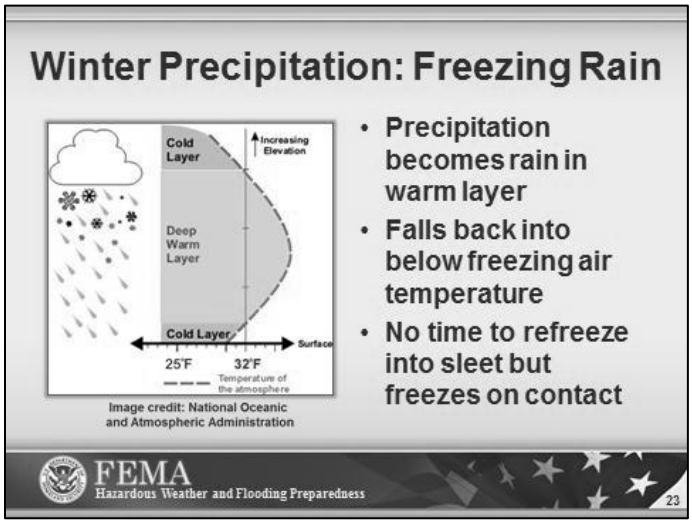


Air temperature often increases with height, many times by several degrees, before decreasing, in a process known as inversion.

When the temperature remains below freezing, any precipitation will fall as snow.



Snow partially melts as it falls into the layer of air where the temperature is above freezing. Then the precipitation reenters the below-freezing air and re-freezes into ice pellets, commonly called sleet.

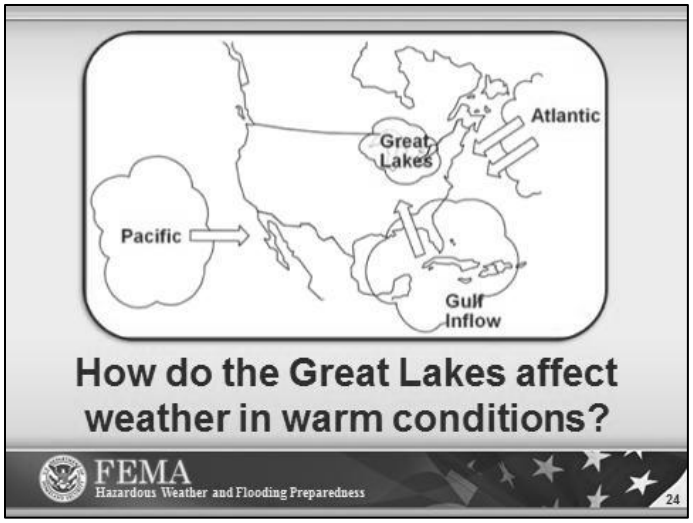


Freezing rain happens when the warm layer in the atmosphere is deep, with only a shallow layer of air at the surface that is below freezing. Precipitation may begin as rain, snow, or a mix of the two, but it all becomes rain in the warm layer. The rain falls back into below-freezing air, but since the depth is shallow, it does not have time to freeze into sleet.

When this type of precipitation hits the ground (or objects such as trees, bridges, and vehicles), it freezes on contact.

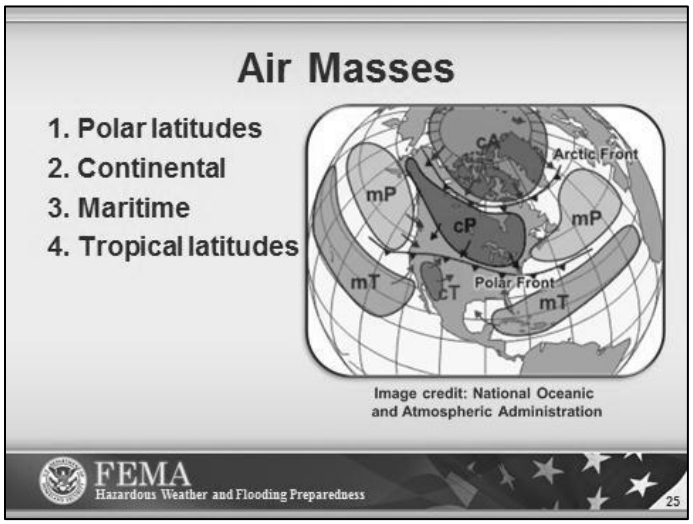
Did you know?

The most likely place for freezing rain and sleet is to the north of warm fronts.



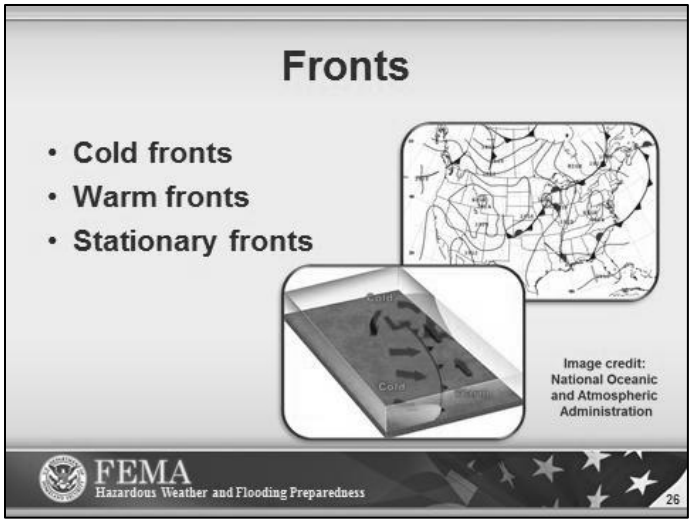
Land and water surfaces greatly affect cloud and precipitation development. In early winter cold air often moves over relatively warm lakes. The warm water adds heat and water vapor to the air, causing showers to the leeward (i.e., the side toward which the wind is blowing) side of the lake.

How do you think the Great Lakes impact weather in warm conditions?



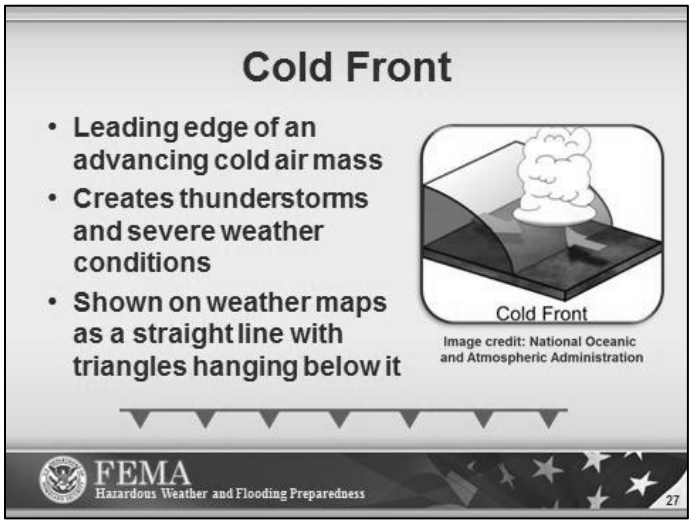
When a body of air comes to rest or moves slowly over an extensive area that has fairly uniform properties of temperature and moisture, the air takes on those properties and is known as an air mass.

As these air masses move around the earth they can begin to acquire additional attributes.



As air masses move out of the area in which they formed they come in contact with other air masses with different properties, forming fronts. All fronts are areas of lower pressure that separate different air masses.

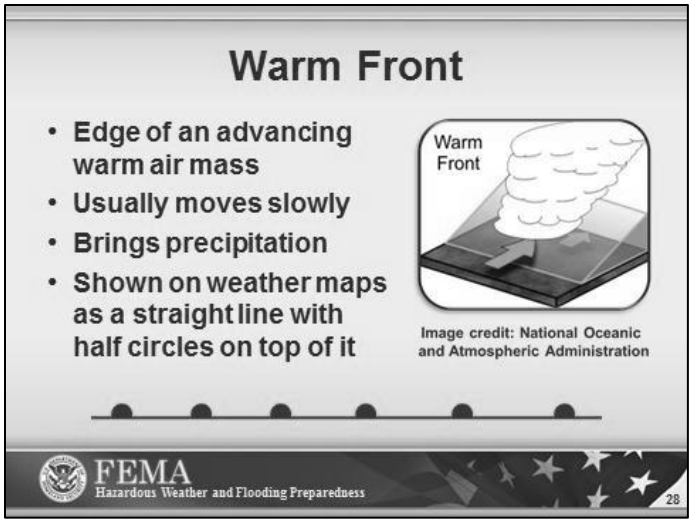
Across a front, temperature, moisture, pressure, and wind often change rapidly over short distances.



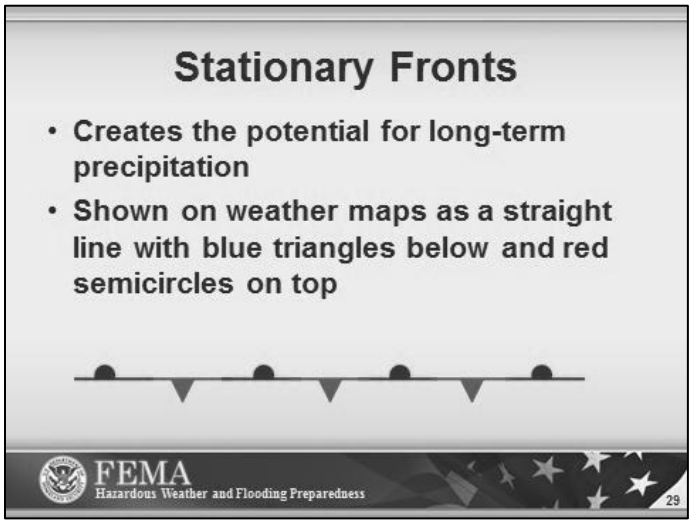
A **cold front** is the leading edge of an advancing cold air mass. At the surface, the cold air behind the front is denser than the warm air in front of it.

Did you know?

The term “front” came into use after World War I because it describes a clash of air such as the clash of soldiers at a battle front.

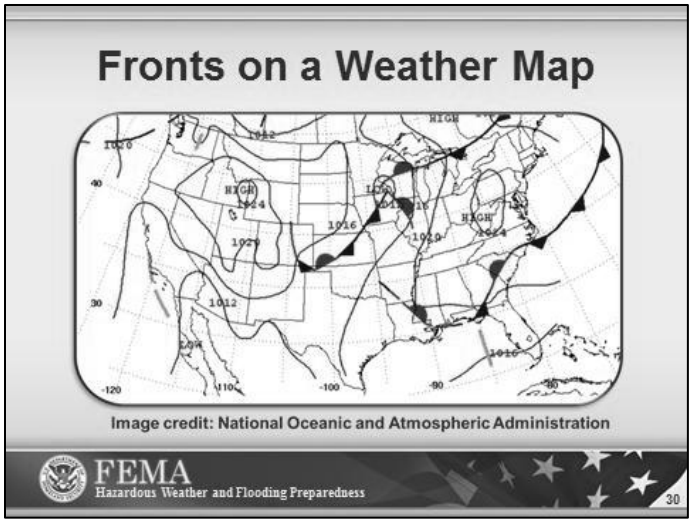


The edge of an advancing warm air mass is a **warm front**. At the surface, the warm air behind the front is less dense than the cold air in front of it. The warm front pushes the warm air upward into the atmosphere. This lifting along the front on such a large geographic scale causes rising warm air to cool to saturation. Clouds and precipitation result.

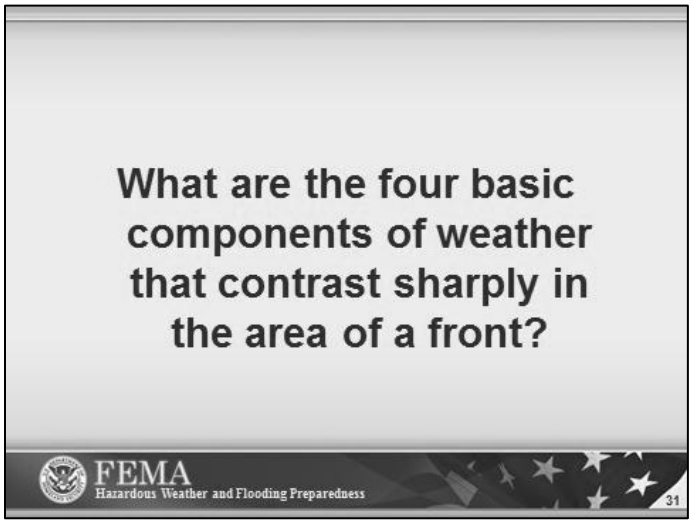


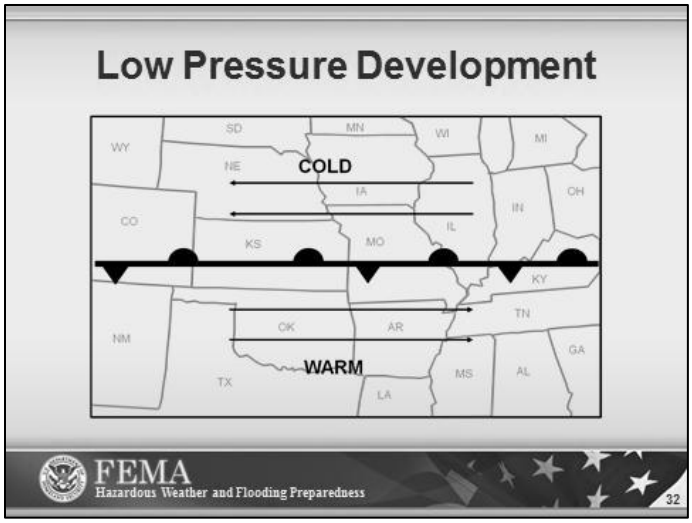
When neither air mass is replacing or moving past the other, the front is stationary. With **stationary fronts**, the opposing forces exerted by adjacent air masses of different densities are such that the frontal surface between them moves little or not at all.

Stationary fronts create the potential for long-term precipitation.

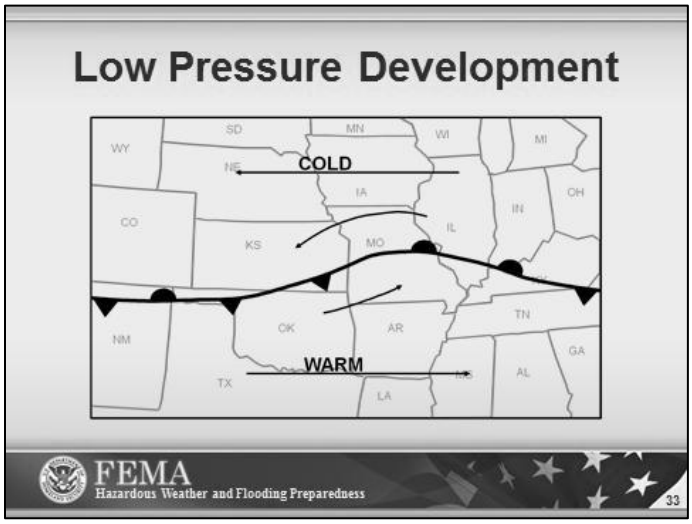


Based on this map, severe weather could occur in the vicinity of Iowa, where the fronts all meet. Showers and thunderstorms could occur near all of the stationary fronts.

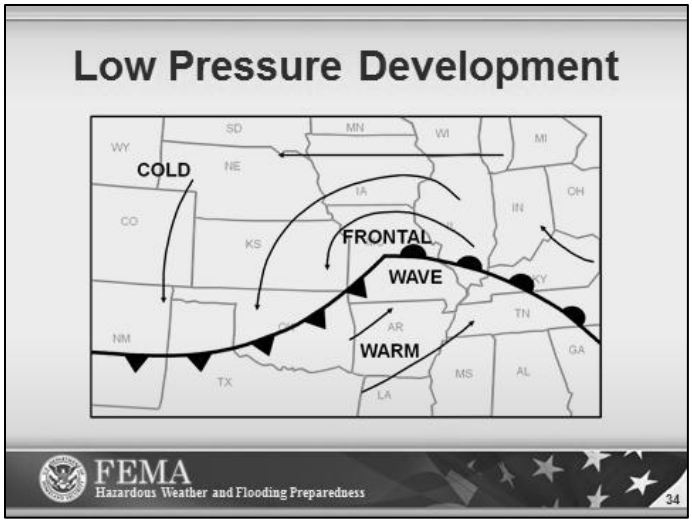




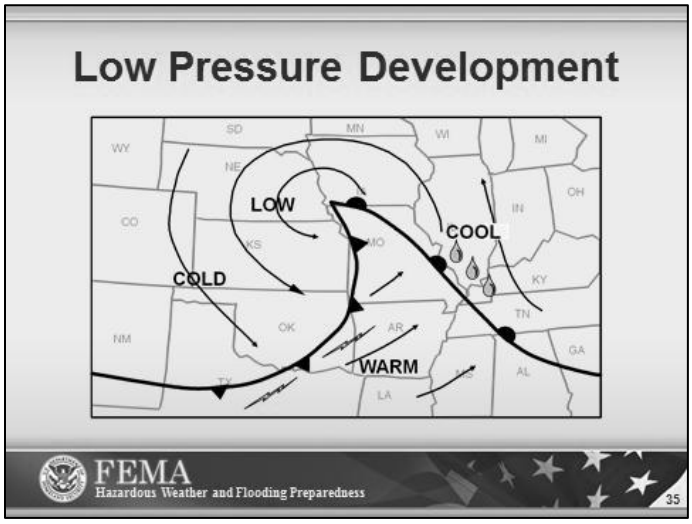
Low-pressure systems often develop along fronts. A low can form on a slow-moving cold front or on a stationary front, as shown on the slide.



In the area of a front, the atmosphere is out of balance because of the changes in temperature, moisture, pressure and wind, which may start a wave-like bend in the front.

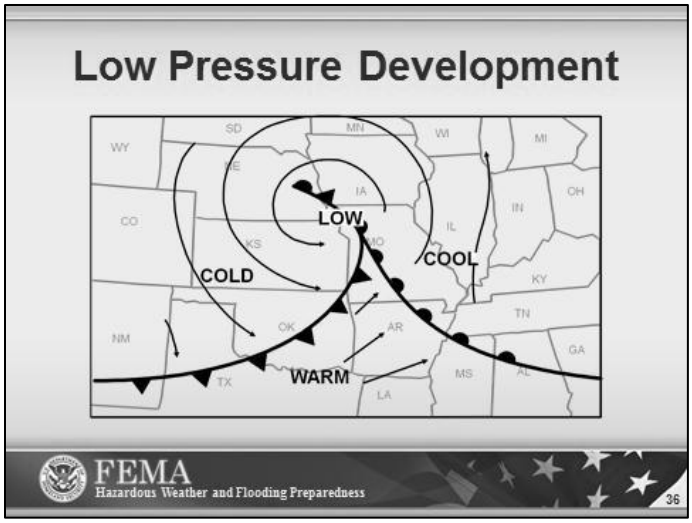


If this tendency continues, the wave will increase in size, and a cyclonic circulation will develop. One section of the front will begin to move as a warm front, while the other section will begin to move as a cold front, developing a frontal wave.



The pressure at the peak of the frontal wave falls, and a low-pressure system forms.

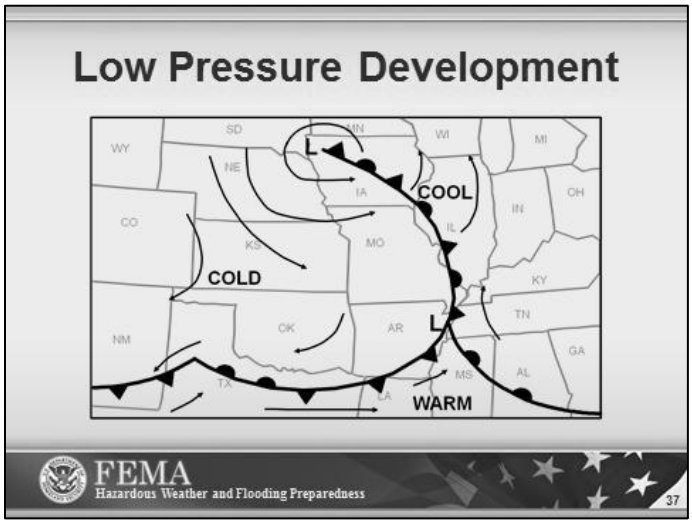
The cyclonic circulation becomes stronger, and the surface winds are now strong enough to move the fronts, with the cold front moving faster than the warm front.



When the cold front catches up with the warm front, an occlusion is formed. An **occlusion** is a composite front that is created when a cold front overtakes a warm front and forces it to a higher position.

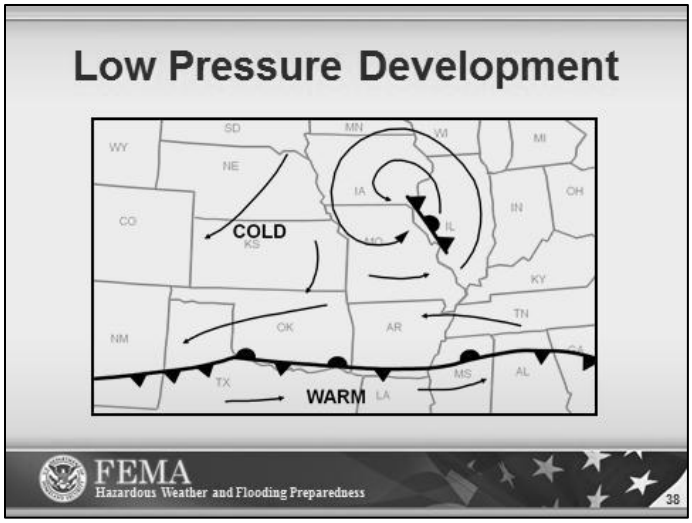
Where is precipitation likely to occur?

Where is severe weather likely to occur?

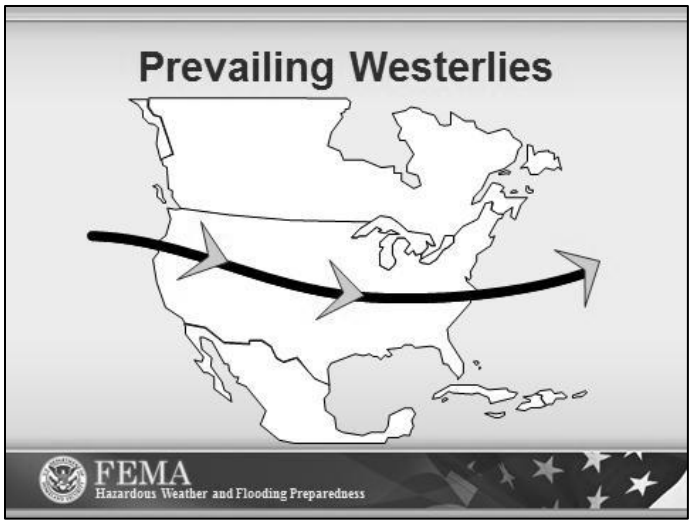


As the occlusion continues to grow in length, the cyclonic circulation diminishes and the frontal movement slows. At the triple point (where cool, cold, and warm air meet), a secondary low-pressure system can develop or a new frontal wave can form on the long westward-trailing portion of the cold front.

Where is the next low likely to form?

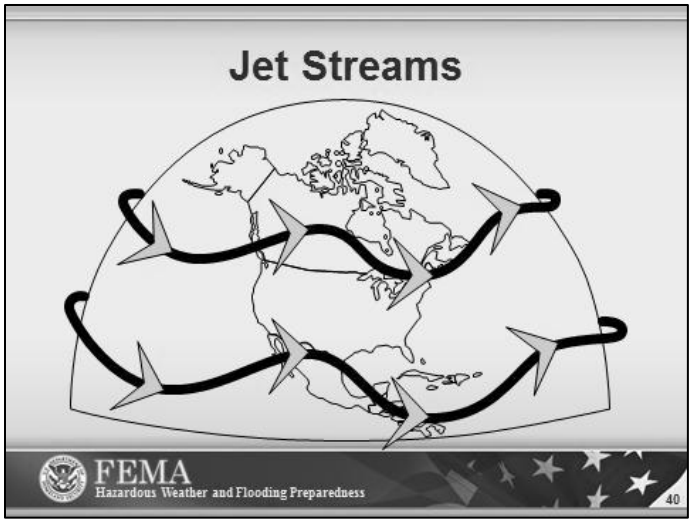


If the secondary front does not develop, the occlusion loses intensity and may become a stationary front again.



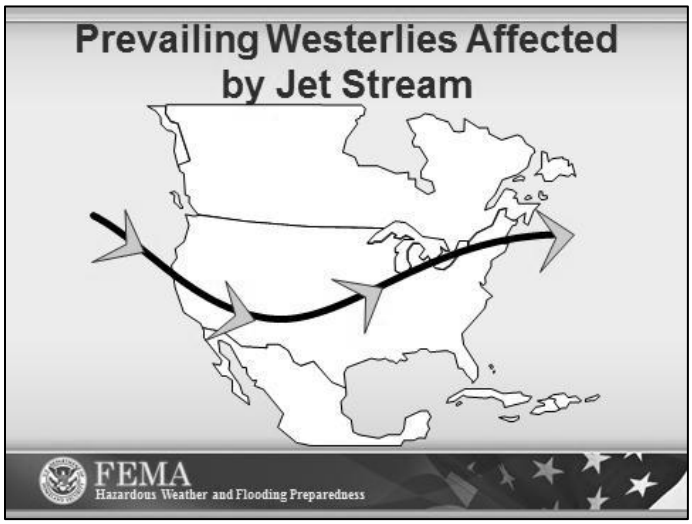
Because of the Coriolis effect and other forces, there is a strong flow of wind across the United States from the west to the east, known as the **prevailing westerlies**.

The prevailing westerlies bring moderate cool, moist air over the Western United States and the Rocky Mountains.

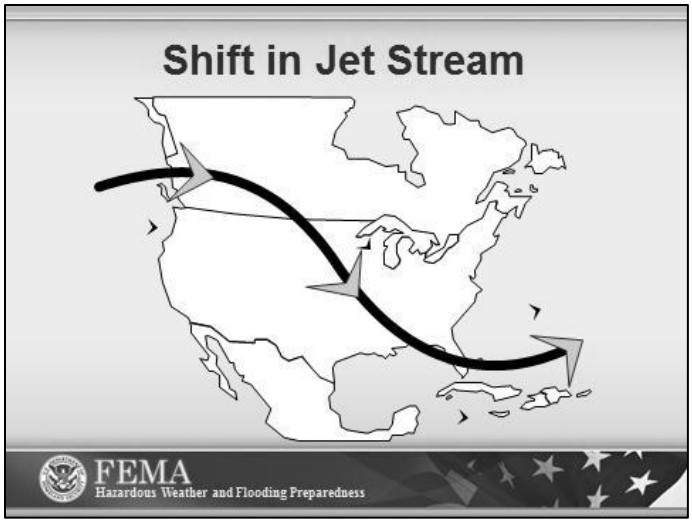


Winds tend to increase with height, reaching their maximum several miles above the Earth's surface, at or just below the tropopause.

As conditions change because of variations in temperature and pressure, large troughs and ridges may develop in the jet stream. These shifts can change the wind patterns that affect the United States, as shown on the slide.



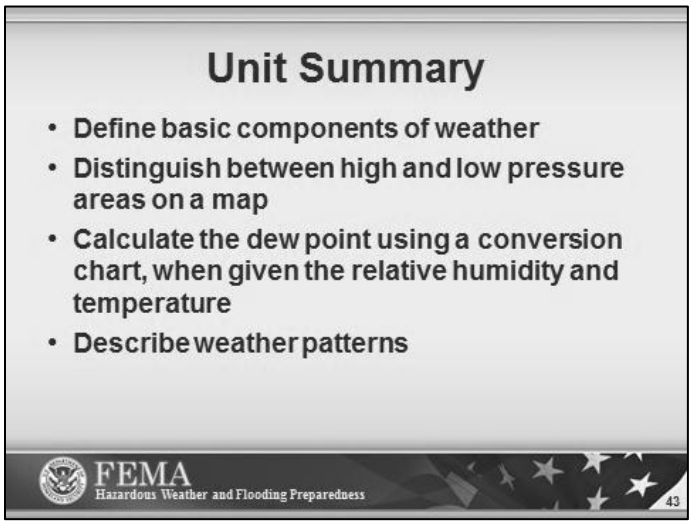
How do you think this airflow pattern could affect the weather in the United States?



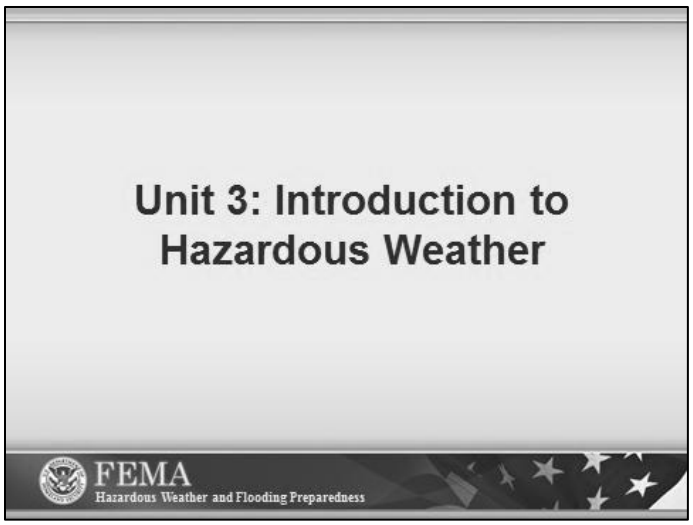
What kind of weather might you expect from this airflow pattern?

Where would a low likely form?

Where would a high likely form?



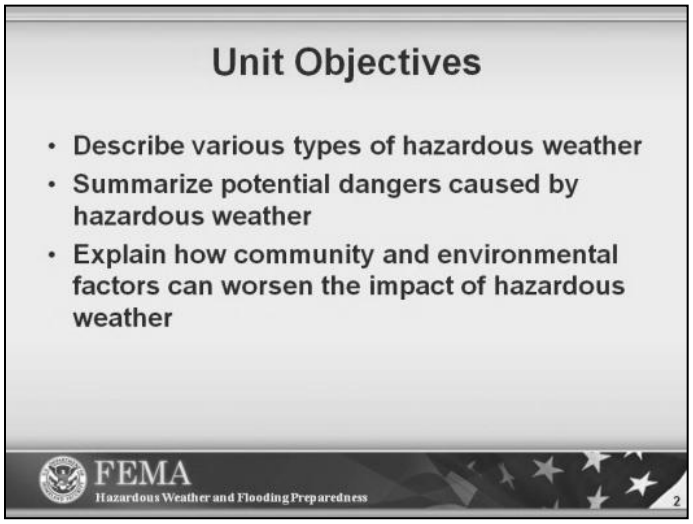
In this unit, you analyzed how the components of weather interact to create hazardous weather. Having a basic understanding of what causes hazardous weather will help you anticipate it and prepare for its impact.



Unit 3

This unit will enable you to anticipate and prepare for the impact of hazardous weather.

In this unit, we will discuss the characteristics and dangers associated with various types of hazardous weather events that may affect your community.



Not all weather topics will be covered by the instructor in this course. However, information about each weather topic is included in the Student Manual for your reference.

This section contains information on the most common natural hazards that occur in the United States.

We will cover the types of events that are most relevant to your area.

For each event we will review:

- A definition of the event
- Characteristics common to the event, including hazards and dangers
- Historical examples of the types and amounts of damage that each event may cause

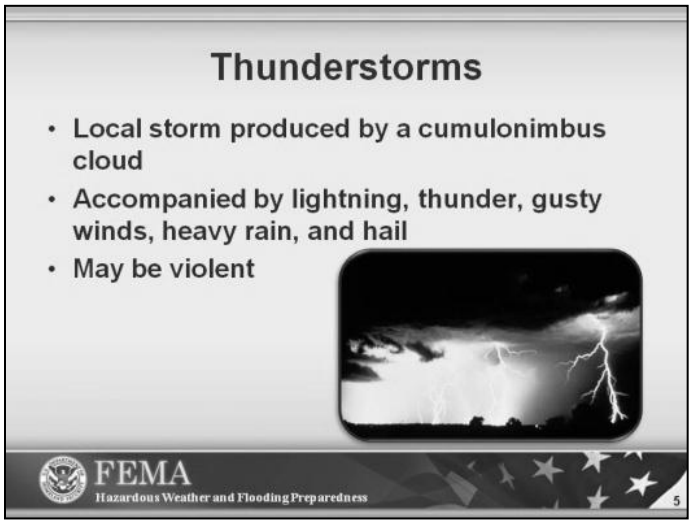
Appendix D contains fact sheets with information about the most common hazardous weather events experienced in the United States. Fact sheets are also included for non-weather hazards including tsunamis, volcanic ash, and hazardous materials.


Appendix D

Each fact sheet includes a definition of the event, impacts and associated hazards, and characteristics common to the event, as well as a list of related NWS products.

Refer to the following page numbers for each type of event:

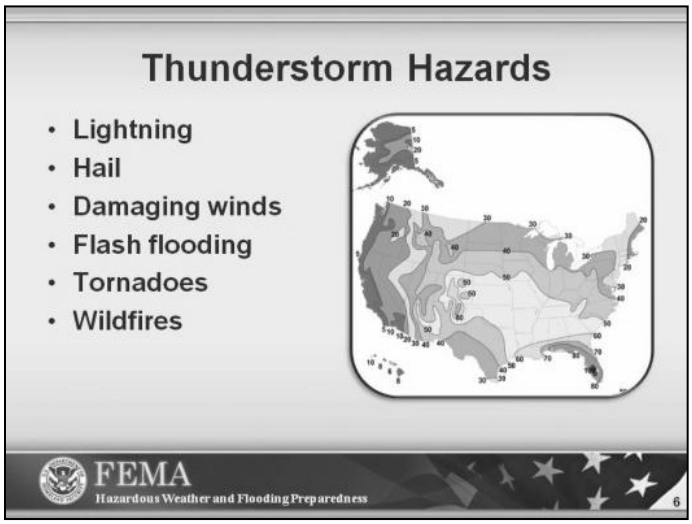
- Thunderstorms: Page SM III-5
- Tornadoes: Page SM III-12
- Flash Floods: Page SM III-19
- River Floods: Page SM III-21
- Coastal and Lakeshore Flood Terms: Page SM III-24
- Coastal Floods: Page SM III-26
- Lakeshore Floods: Page SM III-27
- Extratropical Cyclones: Page SM III-29
- Tropical Cyclones/Hurricanes: Page SM III-31
- Tsunamis: Page SM III-34
- Winter Storms: Page SM III-37
- Excessive Cold: Page SM III-40
- Fog: Page SM III-42
- Excessive Heat: Page SM III-43
- Dust Storms: Page SM III-46
- Wind Storms: Page SM III-48
- Fire Weather: Page SM III-52
- Space Weather: Page SM III-56
- Volcanic Ash: Page SM III-59



Did you know?

Of the estimated 100,000 thunderstorms that occur each year in the U.S., about 10 percent are classified as severe.

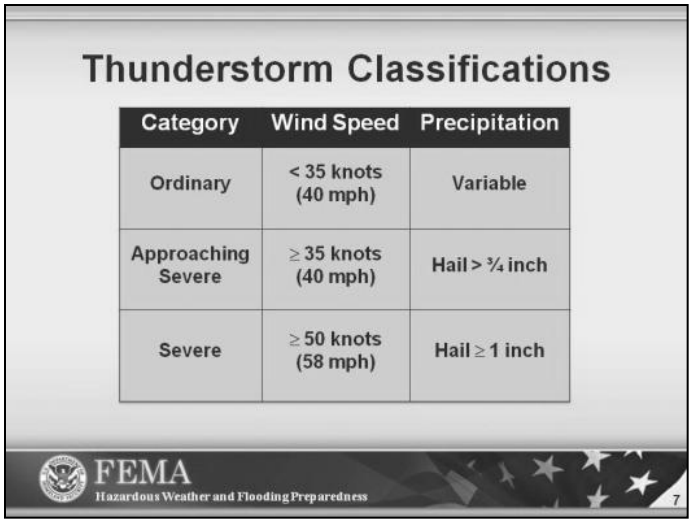
Thunderstorms most often occur in the spring and summer, during maximum heating in the afternoon and evenings, but can occur at any time.



Did you know?

Lightning causes nearly 60 deaths and 400 injuries per year in the U.S. and destroys thousands of acres of forests and crops by fire.

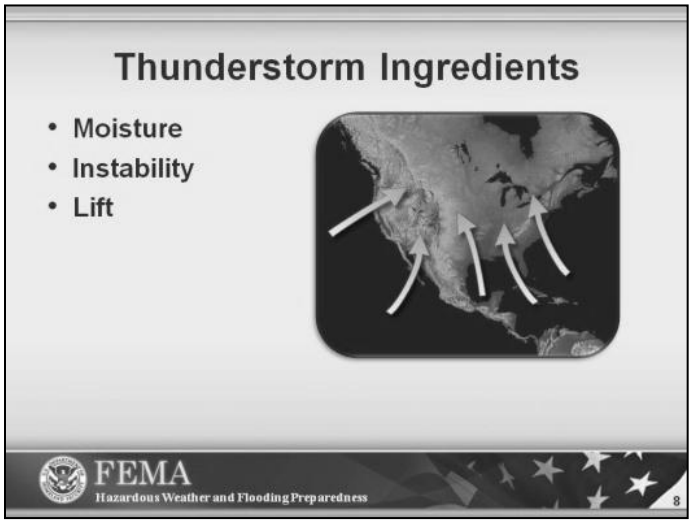
There are several hazards related to thunderstorms. Some hazards are related to others, such as, lightning and lightning-ignited wildfires, hail, heavy rain, and tornadoes and damaging winds.



Thunderstorms may be classified as ordinary, approaching severe (or non-severe), or severe. Thunderstorm categories, as classified by wind speed and precipitation, are shown in the table on the slide.

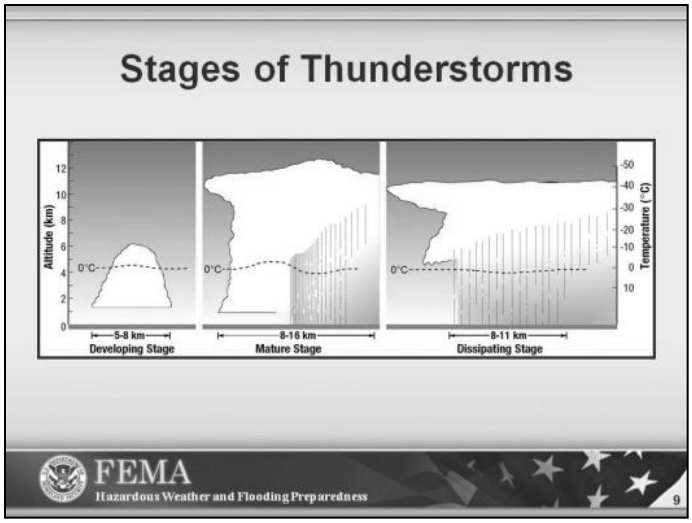
This table is also included in Appendix D, with the fact sheet for thunderstorms.

Appendix D



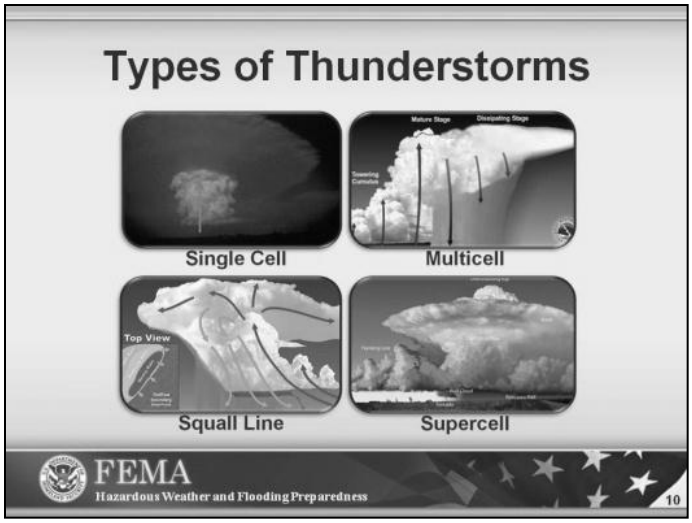
The characteristics of thunderstorms depend on the type of storm that develops.

Three basic factors contribute to thunderstorm development: moisture, instability, and lift.



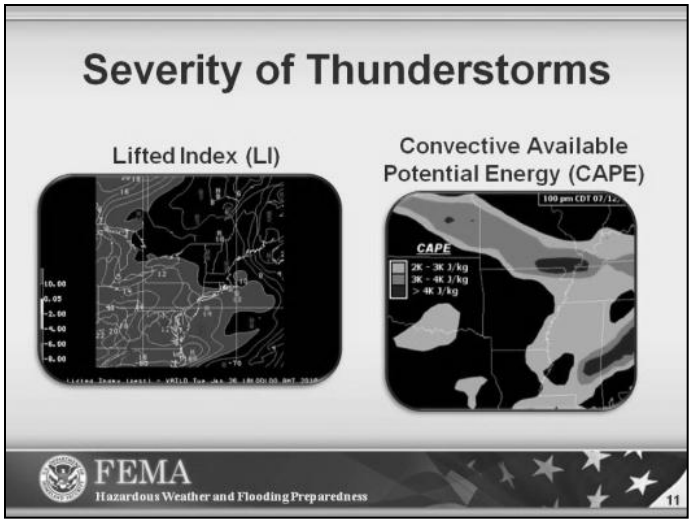
These factors combine to develop into thunderstorms in three stages.

1. Developing Stage. A towering cumulus cloud forms as air rises. The cloud extends to about 20,000 feet above the level of freezing temperatures.
2. Mature Stage. During this stage, the storm builds to heights of 40,000 feet or more.
3. Downdrafts begin to choke off the supply of air that feeds the storm, and the storm stops building, loses height, and dissipates.

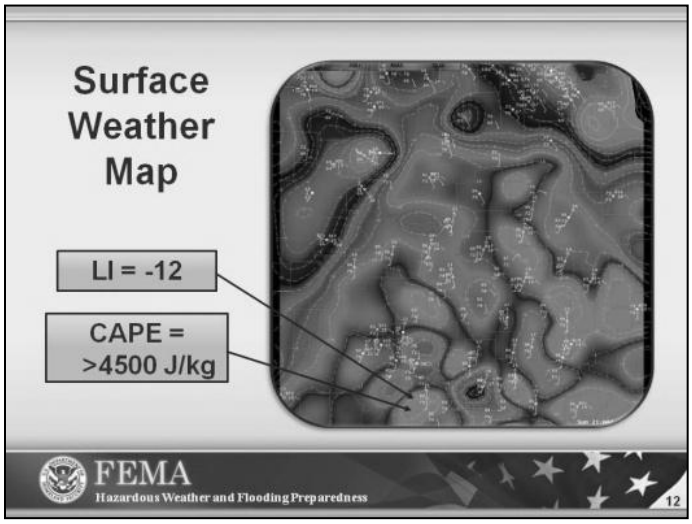


Thunderstorms are categorized into four types.

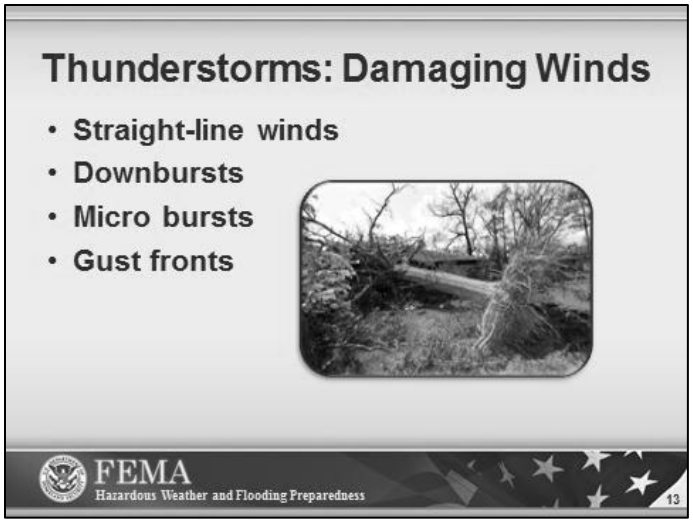
1. Single Cell. Single cell, or ordinary cell, thunderstorms are short lived (i.e., generally lasting up to 20-30 minutes) and are stifled by intensifying downdrafts.
2. Multicell cluster. Multicell storms are most common, and are an organized cluster of two or more single cell storms.
3. Squall line. A line or narrow band of active thunderstorms, a squall line may extend over 250 to 500 miles, 10 to 20 miles wide, and consist of many laterally aligned cells that do not interfere with one another.
4. Supercells are relatively uncommon but produce the most severe weather and longest lasting (1 to 6 hours) weather.



NWS models use indicators such as the Lifted Index (LI) and Convective Available Potential Energy (CAPE) to forecast atmospheric instability and the potential severity of thunderstorms.



The areas shown on the map had received strong to severe thunderstorms earlier in the day. At this time, the skies had cleared somewhat, helping to refuel the atmosphere for more oncoming storms which would produce tornadoes.



The damaging winds of thunderstorms include straight-line winds, downbursts, micro bursts, and gust fronts.

Straight-line winds are high winds across a wide geographic area.

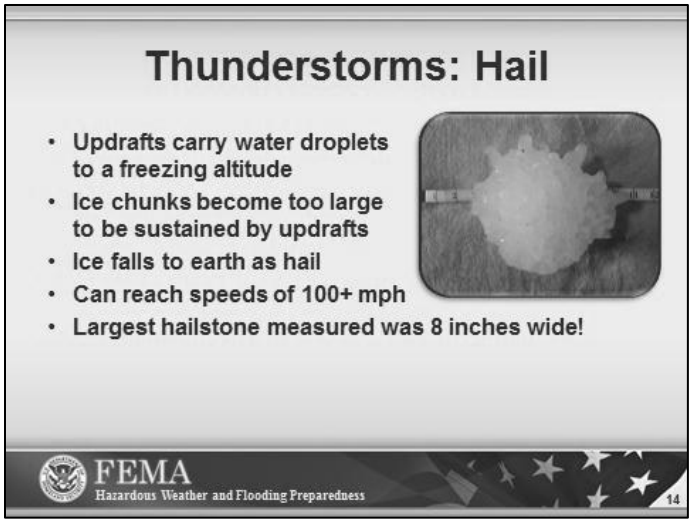
Downbursts are localized currents of air blasting down from a thunderstorm, which induce an outward burst of damaging wind on or near the ground.

Microbursts are minimized downbursts less than 2.5 miles across. They induce a strong wind shear (a rapid change in the direction of wind over a short distance) near the surface. Microbursts may or may not include precipitation, and can produce winds over 150 miles per hour.

Gust fronts occur when cool, dense air flows out of the base of a thunderstorm. It spreads along the ground ahead of the actual thunderstorm cell.

Did you know?

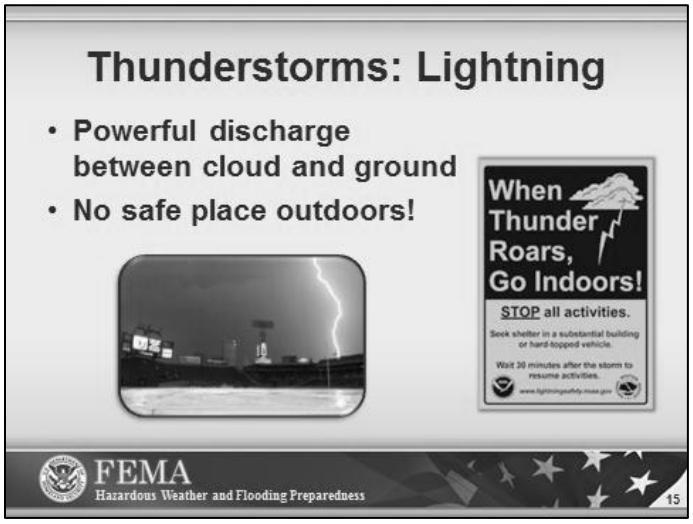
A gust front was blamed for the outdoor stage collapse at the Indiana State Fair in August, 2011, that resulted in seven deaths and 58 injuries.



Strong rising currents of air within a thunderstorm, called updrafts, carry water droplets to a height where they freeze. Ice particles grow in size, becoming too heavy to be supported by the updraft and fall to the ground as hail.

Did you know?

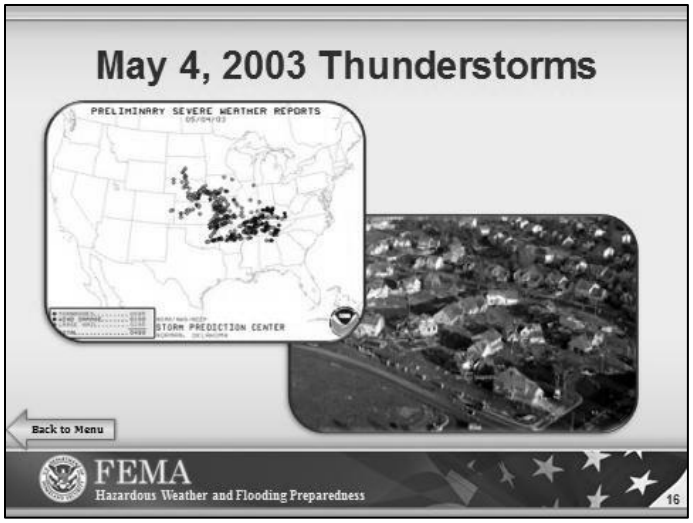
The largest hailstone ever recovered in the United States was an 8-inch wide chunk of ice that landed in Vivian, South Dakota, in July, 2010. Its circumference was 18.625 inches, and it weighed 1.9375 pounds.



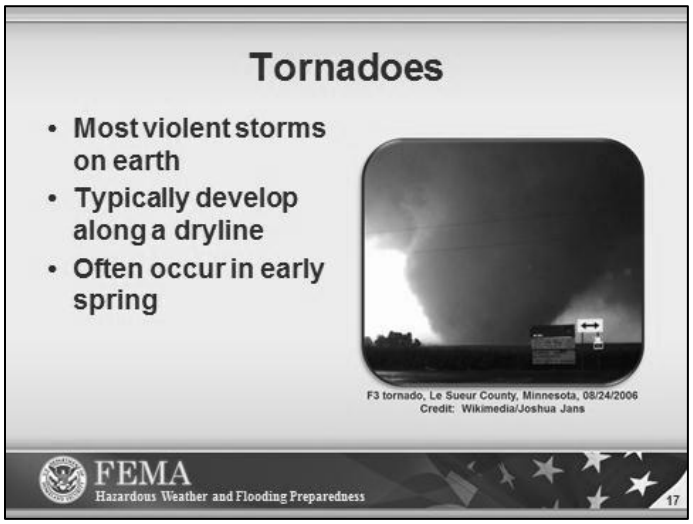
Collisions of ice crystals in thunderstorms cause the top of the cloud to become positively charged. The middle to lower part of the cloud becomes negatively charged. When the charge difference between the ground and the cloud becomes too large, a conductive channel of air develops between the cloud and the ground. A small amount of charge (step leader) moves toward the ground. When it nears the ground, if an upward leader of opposite charge connects with the step leader a powerful discharge occurs between the cloud and the ground – lightning!

Did you know?

More than 80% of lightning fatality victims are male, typically between the ages of 15 and 40.



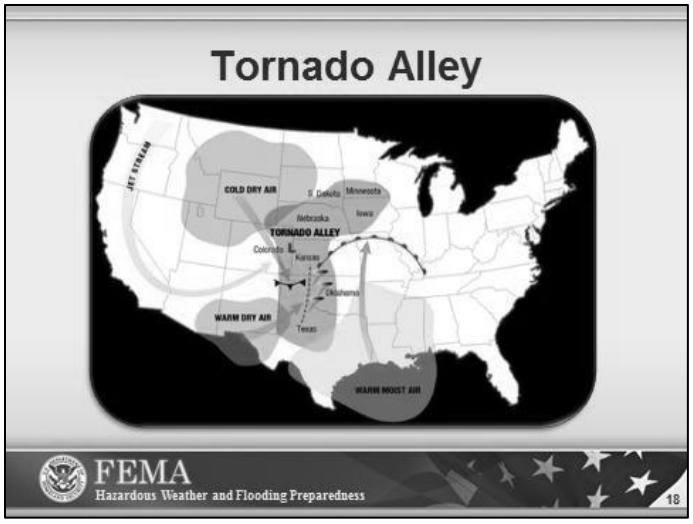
On May 4, 2003, an outbreak of thunderstorms occurred across the southern Plains when cold dry air from the Rockies collided with warm, moist air from the Gulf of Mexico.



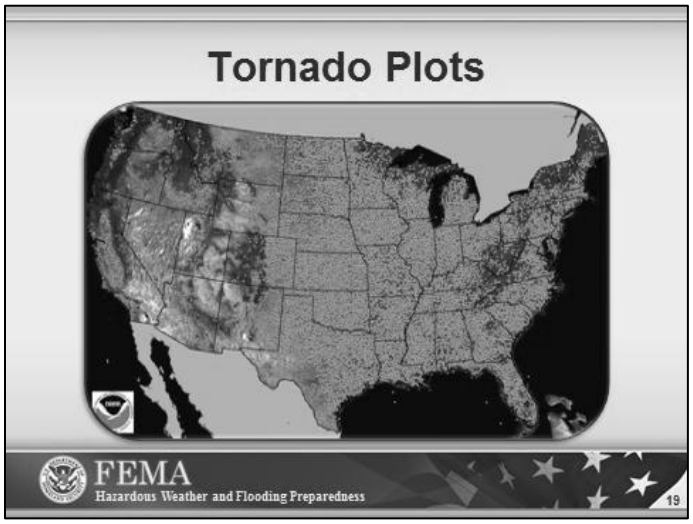
Tornadoes can be the most violent natural hazard on earth, with estimated wind speeds of 200 miles per hour or more. A tornado is a violently rotating column of air that extends from the base of a thunderstorm and comes in contact with the ground. The spinning motion of a tornado is almost always counterclockwise.

Did you know?

Each year approximately 1,300 tornadoes touch down in the U.S., the highest frequency in the world.



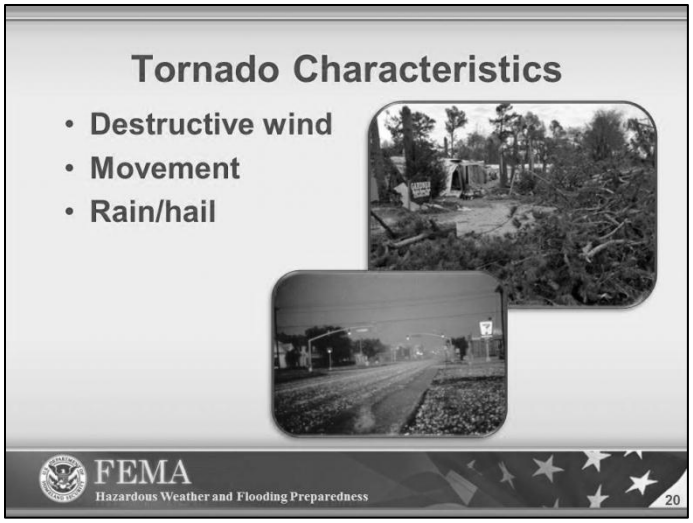
Tornadoes in the winter and early spring are often associated with strong frontal systems that form in the Central States and move southeast. Occasionally, large outbreaks of tornadoes occur with this type of weather pattern. Several states may be affected by numerous severe thunderstorms and tornadoes.



During the spring in the Central Plains, thunderstorms frequently develop along a “dryline.”

Along the front range of the Rocky Mountains, in the Texas panhandle, and in the southern High Plains, thunderstorms frequently form as air near the ground flows “upslope” toward higher terrain.

In the late summer and early fall months, tornadoes occasionally accompany tropical storms and hurricanes that move over land.



Tornadoes possess the following characteristics:

Destructive wind

Tornadoes consist of strong, destructive winds. The winds in extreme tornadoes are the fastest winds experienced anywhere on earth, in excess of 200 mph.

Movement

Tornadoes can appear from any direction. Their average forward speed is about 30 mph but can vary from nearly stationary to 70 mph. Most move from southwest to northeast or west to east, but **tornadoes can move in any direction**. Some tornadoes have changed direction mid path, or even backtracked.

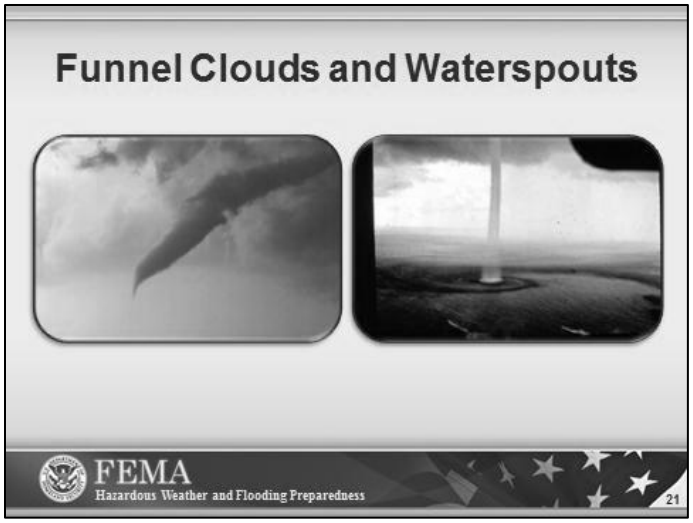
Rain/hail

Tornadoes are associated with thunderstorms, so they may be preceded or followed by heavy rainfall or hail. Depending on the hydrological conditions, flash flooding may also occur.

Obstacles to Response

- Destruction of homes, businesses, and vehicles
- Extensive tree damage
- Extensive damage to power and telephone lines
- Damaged or destroyed radio and television towers

Large amount of debris is left behind

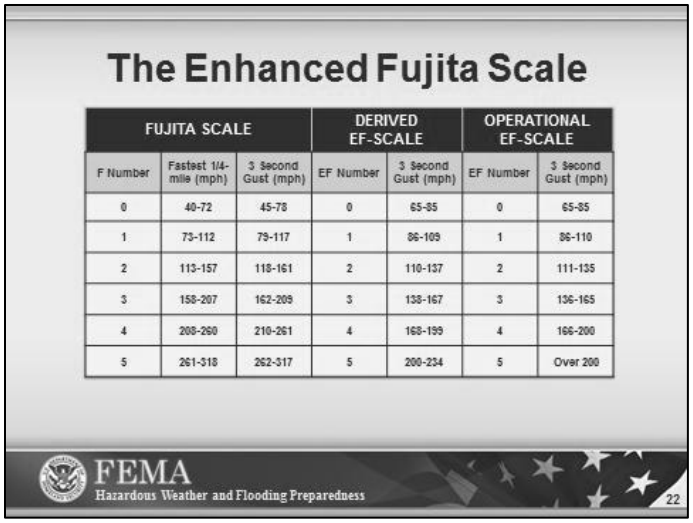


A rotating column of air is not necessarily a tornado. By definition, a tornado must be in contact with the ground.

A funnel cloud is a condensation funnel extending from the parent cloud and is associated with a *rotating* column of air that is not in contact with the ground (and hence different from a tornado).

Waterspouts are small, relatively weak columns of air over water, beneath a cumulonimbus or towering cumulus cloud.

If a waterspout moves onshore, the NWS issues a tornado warning. Fair weather waterspouts generally dissipate quickly when they make landfall.

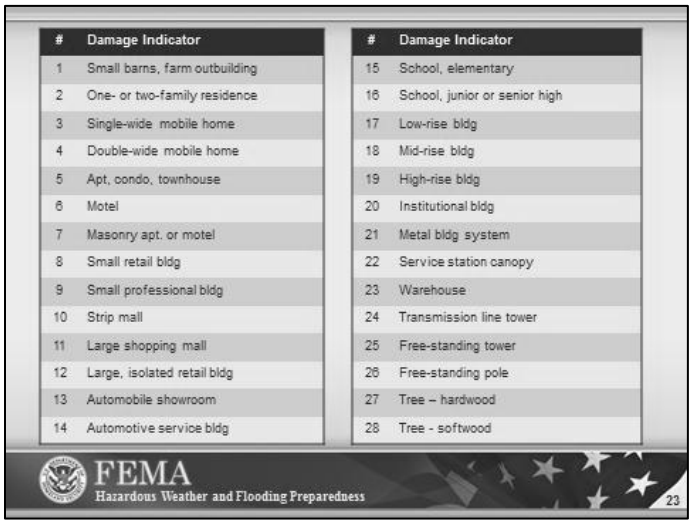


The damage left in a tornado's path is categorized by the Fujita Scale (F-scale).

Because of the challenges of the F-scale, it has been replaced with an Enhanced Fujita Scale (EF-scale), which is more realistic because it classifies F0-F5 damage across 28 different types of damage indicators such as various types of buildings.

The Enhanced Fujita Scale is included in Appendix C, while a link to the scale and associated charts is included in the Appendix B.

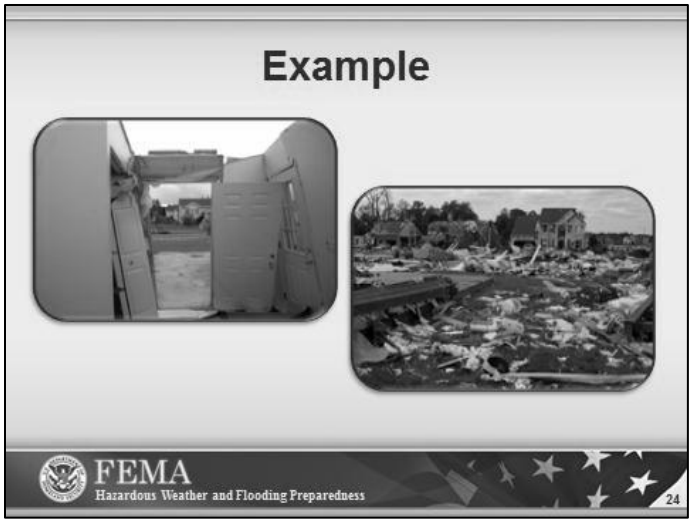

Appendix B and C



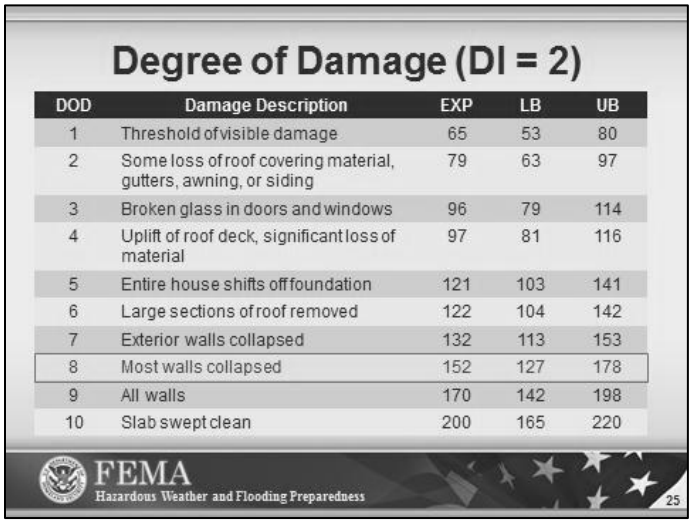
#	Damage Indicator
1	Small barns, farm outbuilding
2	One- or two-family residence
3	Single-wide mobile home
4	Double-wide mobile home
5	Apt, condo, townhouse
6	Motel
7	Masonry apt. or motel
8	Small retail bldg
9	Small professional bldg
10	Strip mall
11	Large shopping mall
12	Large, isolated retail bldg
13	Automobile showroom
14	Automotive service bldg

#	Damage Indicator
15	School, elementary
16	School, junior or senior high
17	Low-rise bldg
18	Mid-rise bldg
19	High-rise bldg
20	Institutional bldg
21	Metal bldg system
22	Service station canopy
23	Warehouse
24	Transmission line tower
25	Free-standing tower
26	Free-standing pole
27	Tree – hardwood
28	Tree - softwood

Damage indicators are used to help rate the damage on the EF scale. Various types of structures and trees are assigned a number which corresponds to a particular chart on which to rate the damage.



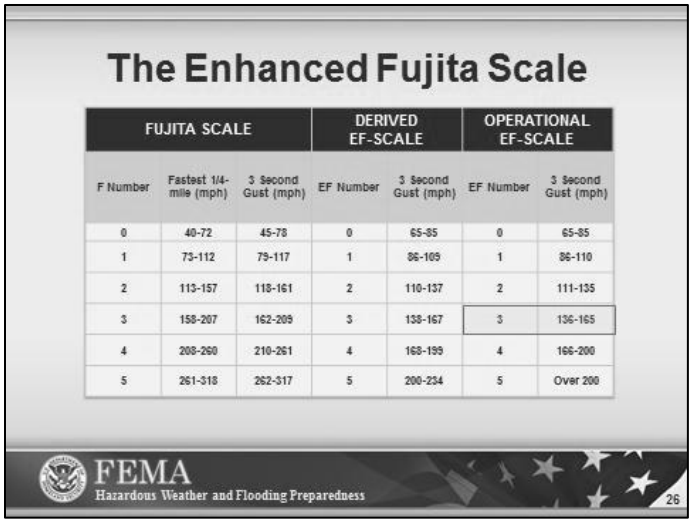
Consider as an example - a tornado that moved through a neighborhood, severely damaging many single-family homes. Most of the walls on the bottom floor of the homes have been knocked down. The idea is to find the severity of the tornado on the EF Scale.



DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	65	53	80
2	Some loss of roof covering material, gutters, awning, or siding	79	63	97
3	Broken glass in doors and windows	96	79	114
4	Uplift of roof deck, significant loss of material	97	81	116
5	Entire house shifts off foundation	121	103	141
6	Large sections of roof removed	122	104	142
7	Exterior walls collapsed	132	113	153
8	Most walls collapsed	152	127	178
9	All walls	170	142	198
10	Slab swept clean	200	165	220

- LB =lower bound, the lowest wind speed that will likely cause this type of damage.
- UB = upper bound, the highest wind speed that would cause this type of damage.
- The LB and UB provide the most likely range of wind speeds required to produce this type of damage.
- EXP = expected wind speed
- DI = Damage Indicator

The DOD when most walls are collapsed would be 8.



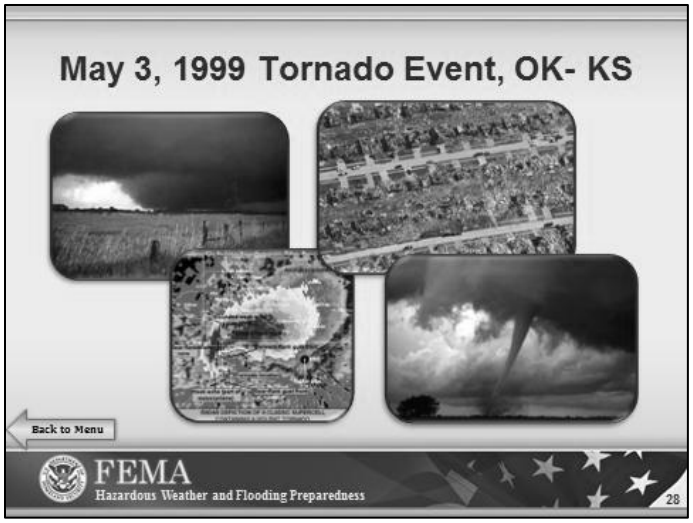
Thus, the estimated winds would be 127 - 178 mph with the expected wind speed of 152 mph.

Now, taking this number to the EF-Scale, the damage would be rated EF-3 with winds between 136 - 165 mph.

On a hot and humid Sunday afternoon on May 22, 2011, a supercell thunderstorm tracked from extreme southeast Kansas into far southwest Missouri. This storm produced an EF-5 tornado over Joplin, Missouri, causing incredible devastation and tragic loss of life. This storm, along with others, generated additional tornadoes, wind damage and flash flooding across far southwest Missouri.

Did you know?

The Joplin tornado is the deadliest since modern record keeping began in 1950 and is ranked 7th among the deadliest tornadoes in U.S. history.



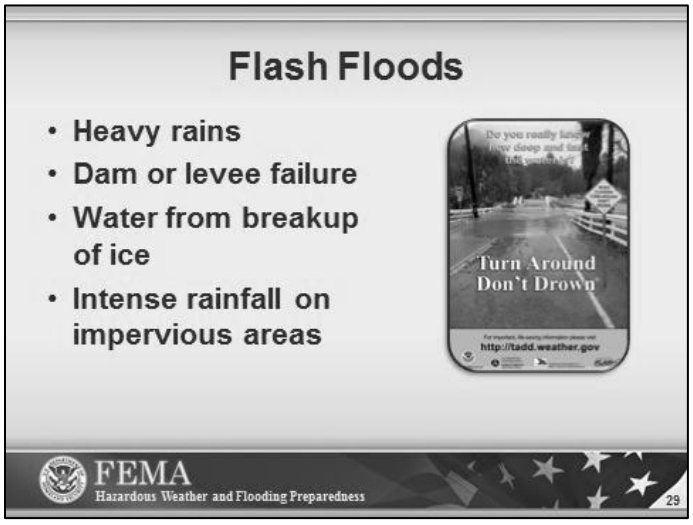
During the late afternoon and evening of May 3, 1999, an outbreak of severe thunderstorms and tornadoes occurred across Oklahoma and southern Kansas. This outbreak affected the Oklahoma City, Oklahoma, and Wichita, Kansas, metropolitan areas with several violent tornadoes (F4-F5).

A link to NWS's Weather-Ready Nation is included in the Appendices section of your Student Manual.

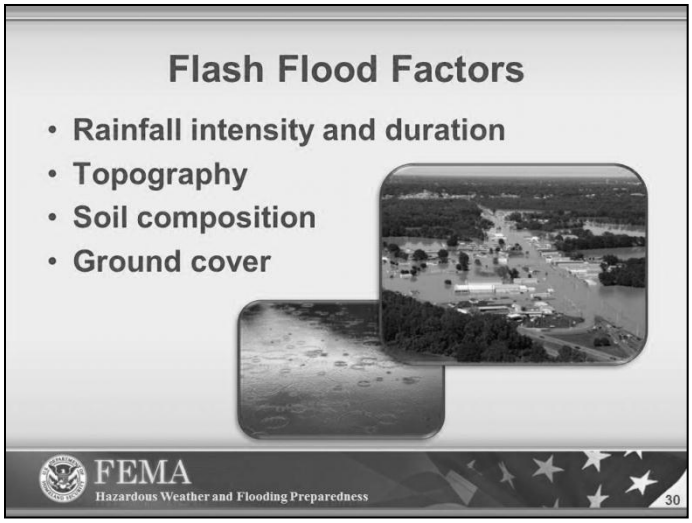
Did you know?

The most damaging tornado of this outbreak was the Bridge Creek-Moore F5 tornado that tracked for approximately 40 miles and left a damage path over a mile wide in some places.

Appendix B



Flash floods are one of the top weather-related killers in the U.S. Nearly half of all flash flood fatalities are caused when people attempt to drive through flood waters. Our preparedness message for this is "Turn Around, Don't Drown".

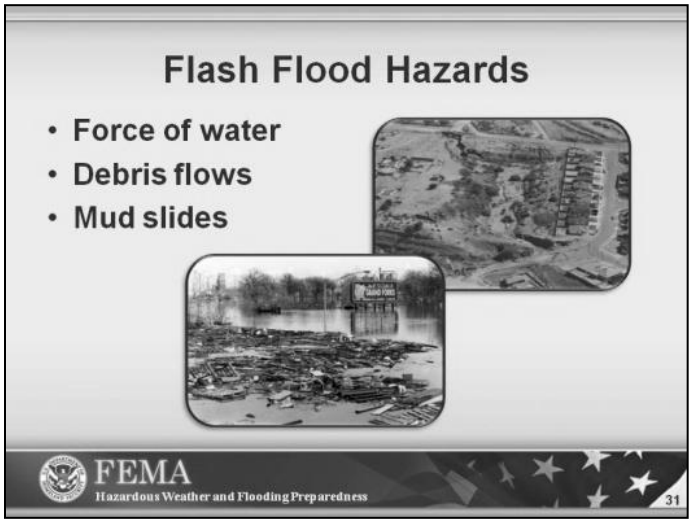


Rainfall intensity and duration affect the potential for flash floods.

Topography is important, especially when there are steep slopes.

Some soils can absorb runoff more effectively (e.g., sand compared to clay) and reduce surface runoff.

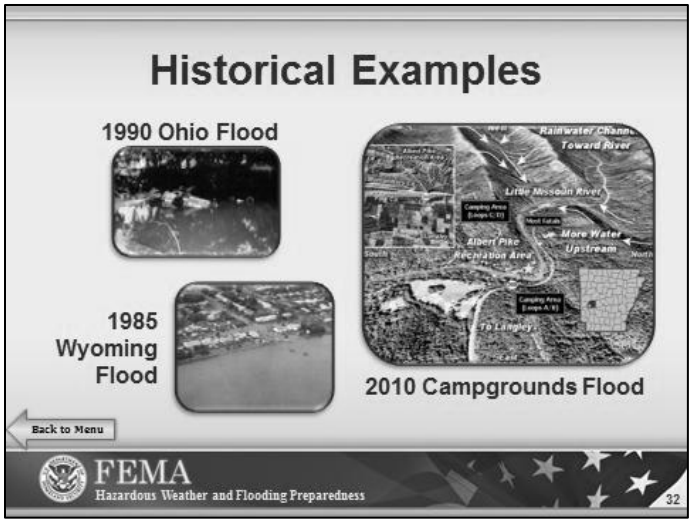
Areas covered with dense vegetation with thick underbrush tend to greatly reduce surface runoff compared to those that are not.



The most severe flash floods can roll boulders, tear out trees, destroy buildings and bridges, and scour out new channels.

Did you know?

Two feet of moving water can sweep most vehicles away. Six inches of fast moving water can knock you off your feet.

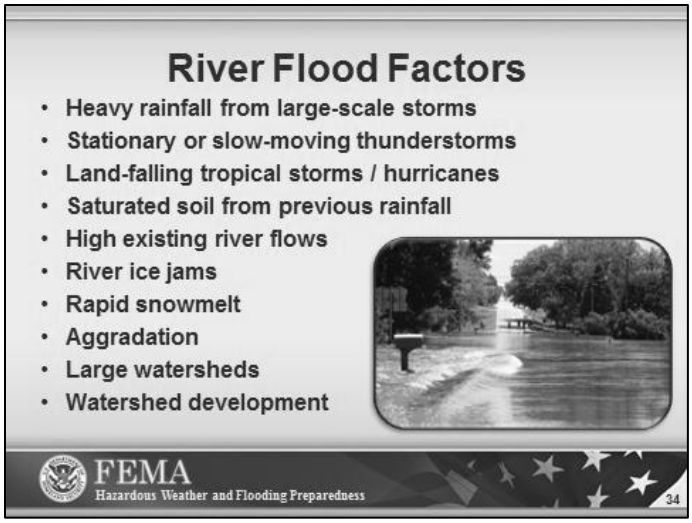


In June 1990, four inches of rain fell in less than two hours at Shadyside, Ohio, producing a 30-foot high wall of water. It caused 26 deaths and $6 to $8 million in damages.

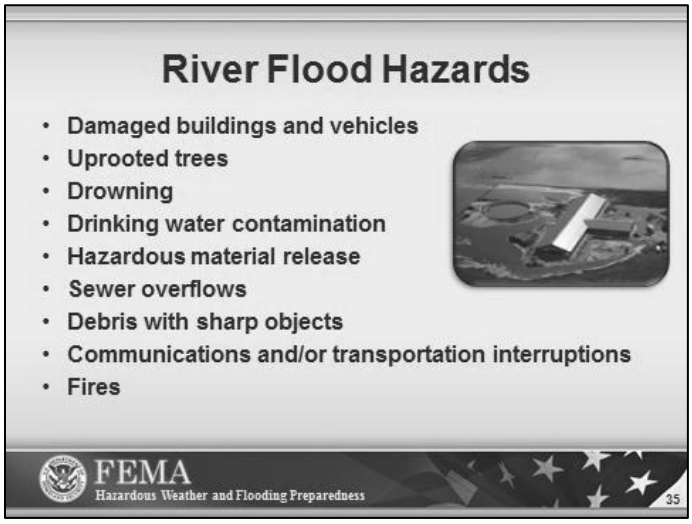
In Cheyenne, Wyoming, six inches of rain fell in three hours in August 1985. The flash flood left 12 dead and caused $61 million in damages.

In June 2010, a rapid 20 foot rise between 1200 AM CDT and 530 AM CDT resulted in 20 fatalities at the Albert Pike Campgrounds.

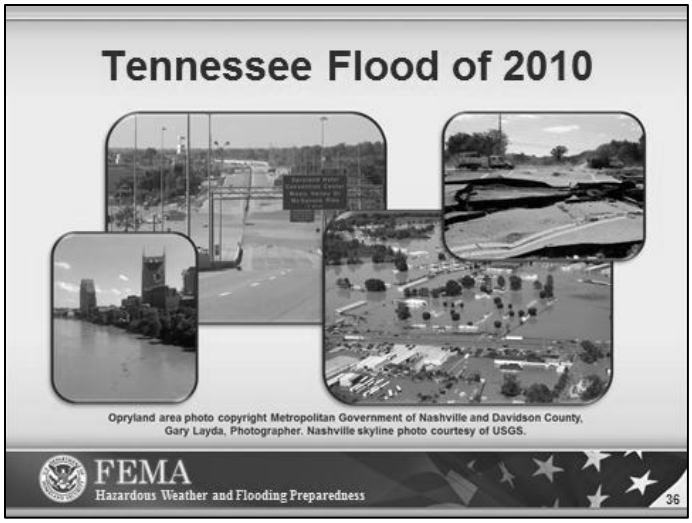
Flooding along rivers and streams is natural and inevitable. Some floods occur seasonally when winter or spring rains, coupled with melting snows, fill river basins with too much water, too quickly. Torrential rains from hurricanes or tropical systems also can produce river and stream flooding.



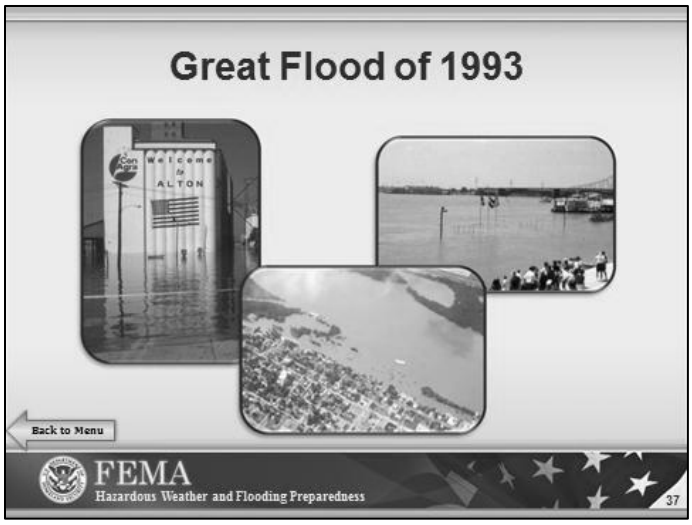
Riverine flooding is normally the result of a combination of meteorological and hydrological factors. Although excessive rainfall alone can cause flooding, the most severe river floods usually have multiple causative factors.



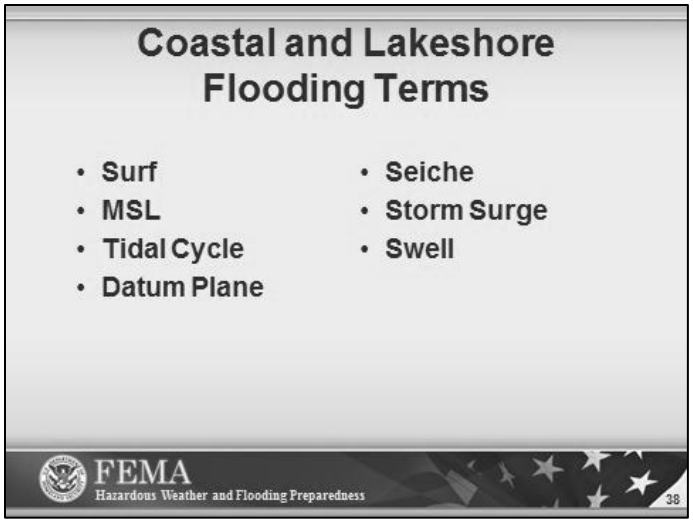
The dangers of riverine floods are similar to other types of floods.



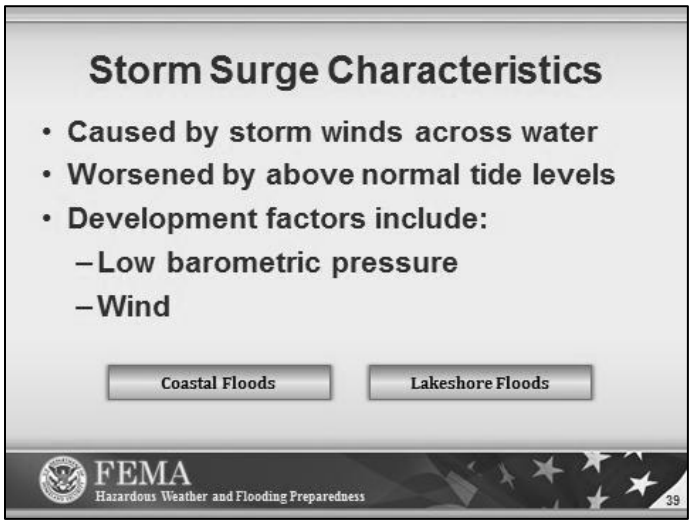
In May of 2010, a record 13.57 inches of rain fell in two days over West and Middle Tennessee. The Cumberland River, which runs through Nashville, crested at its highest point in 73 years. The flooding caused billions of dollars in damages, destroyed thousands of homes, and killed 24 people.



The Great Flood of 1993 in the Mississippi Valley affected nine States, resulted in 31 deaths, and caused $15 billion to $20 billion in damage.



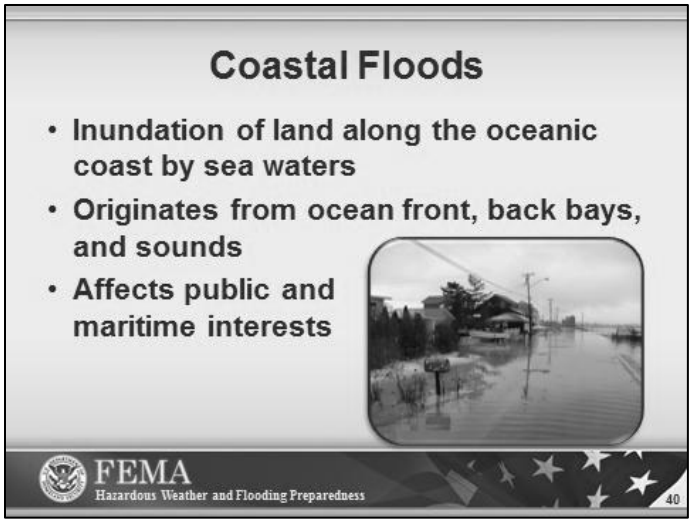
Before discussing coastal or lakeshore flooding, let us review some basic terminology.



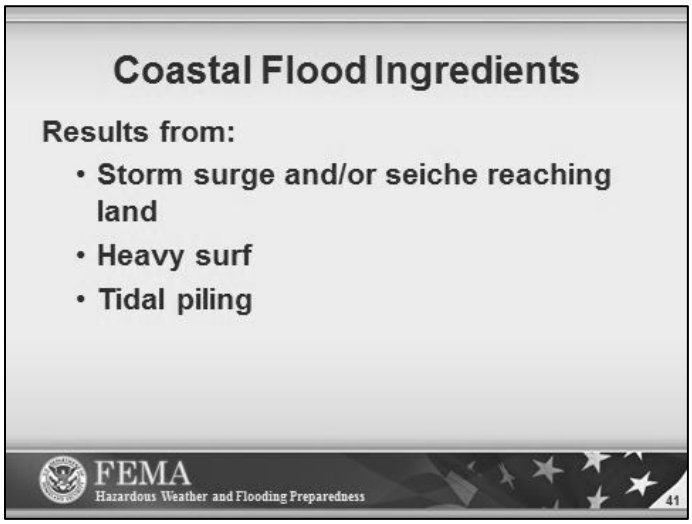
A storm surge is caused by powerful coastal storms that move toward or adjacent to the coastline. It may be worsened by higher than normal astronomical tide levels.

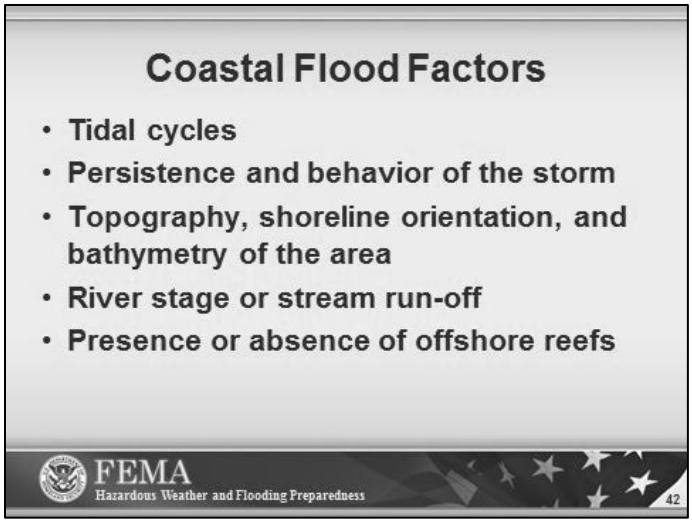
Did you know?

Storm surges can reach heights well over 20 feet, can travel several miles inland and can span hundreds of miles of coastline.

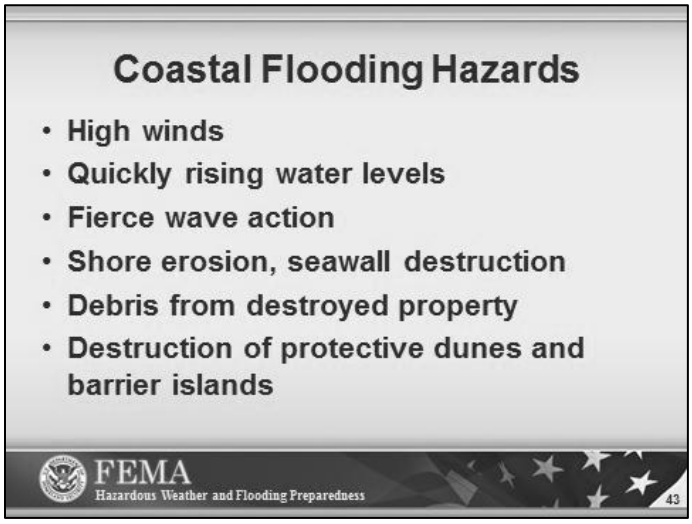


Coastal flooding affects the general public and maritime interests along much of the U.S. coastline, extending from the shoreline beaches to inland tidal waterways and the tidal portions of river mouths.

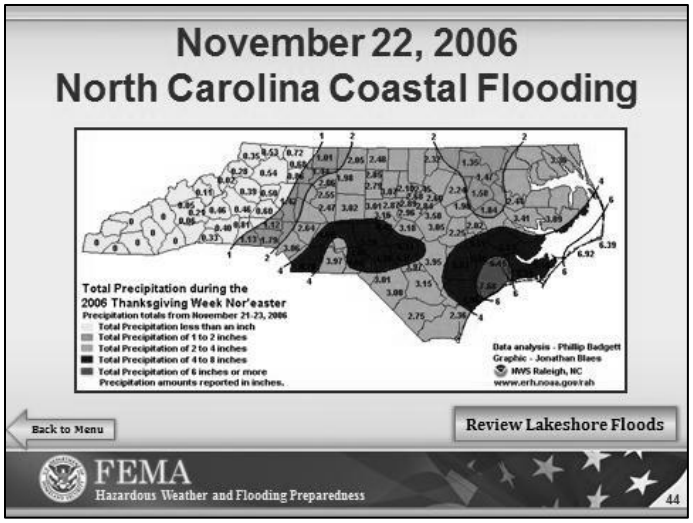




Bathymetry is water depth relative to sea level, which can be used to determine topography of the sea floor. Elevations (topography) are the corresponding terminology for above or below the sea level.



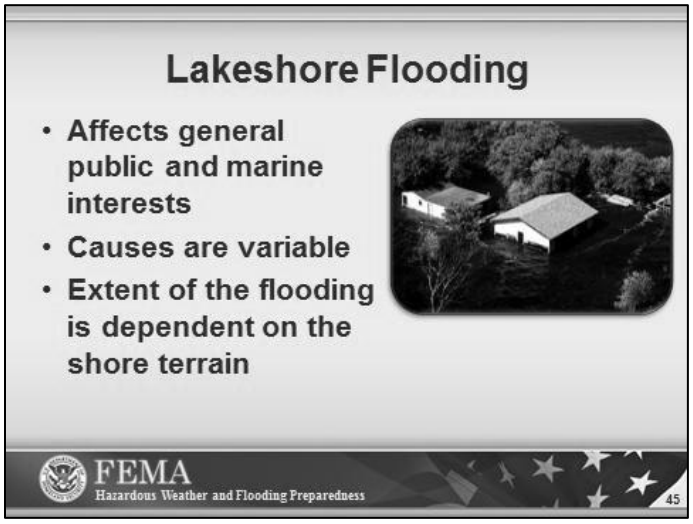
Storm surges, together with heavy rains from the storm that produced the surge, will cause extensive coastal and inland flooding.



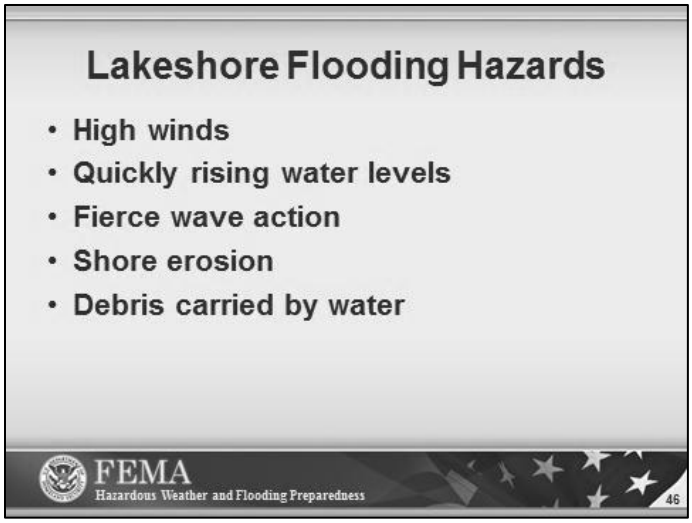
The storm system produced heavy rains of 4 to 8 inches, very strong winds of 40 to 60 mph, and significant coastal flooding across eastern North Carolina as it approached the region. Significant coastal flooding was reported across Outer Banks Dare county, mainly for areas north of Buxton. Water levels of 4 to 6 feet above normal were reported with significant beach erosion and ocean overwash.

Did you know?

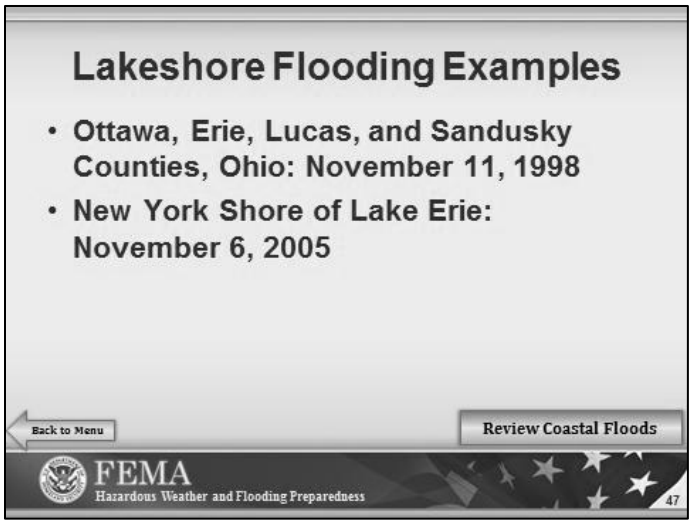
Approximately $2.1 million in damages occurred from this flooding.



Lakeshore flooding affects the general public as well as marine interests in some areas of the Great Lakes. These areas extend from beaches, to portions of rivers flowing into the lakes, to larger lake plains. The causes of flooding are variable and the extent of the flooding will be highly dependent on surrounding shore terrain.



There are several hazards related to lakeshore flooding that can occur rapidly as flooding increases.

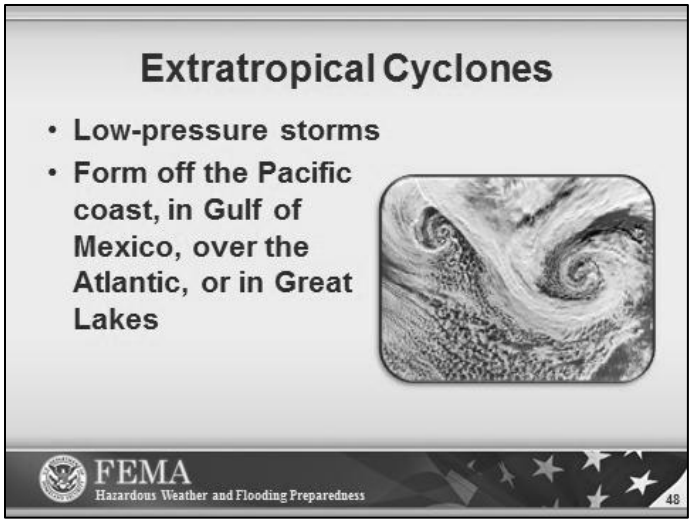


Ottawa, Erie, Lucas, and Sandusky Counties, Ohio: November 11, 1998

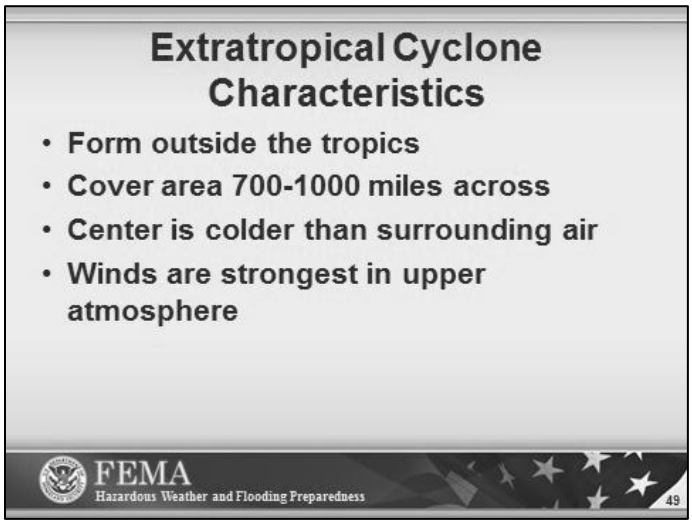
Northeast gales of 35 knots and water levels that peaked just below 100 inches above low water datum produced 10 to 14 foot waves that caused major damage along the lakeshore.

New York Shore of Lake Erie November 6, 2005

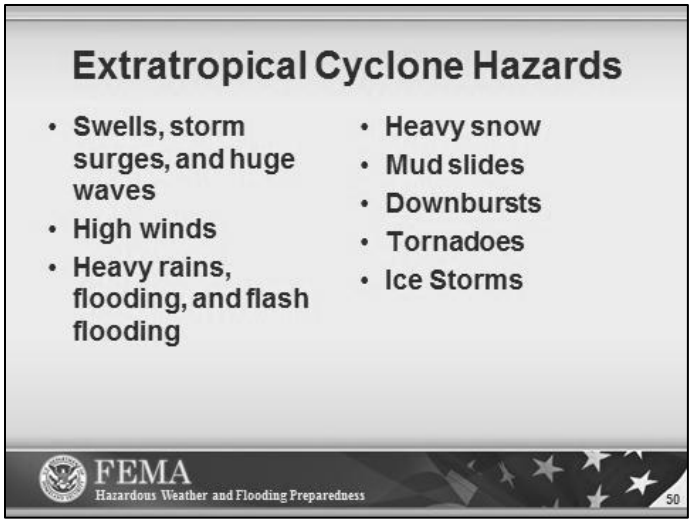
Strong winds following the passage of a cold front caused the Lake Erie water level to rise several feet from Ripley to Buffalo. The Lake Erie water level rose above its 8 foot flood stage for nearly three hours, peaking at 8.5 feet above low water datum at 7 p.m.



Extratropical storms may cover a larger area than tropical cyclones. Their storm centers are colder than the surrounding air and their strongest winds are in the upper atmosphere.

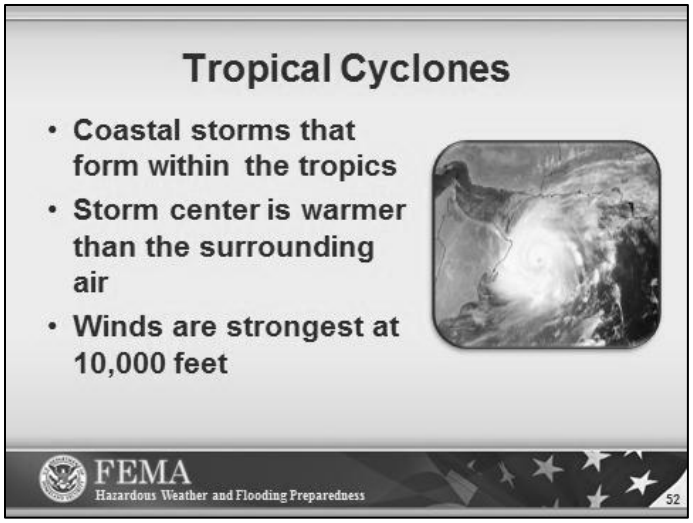


Extratropical cyclones tend to deepen quickly near the shore, which shortens the time available for communities to respond.

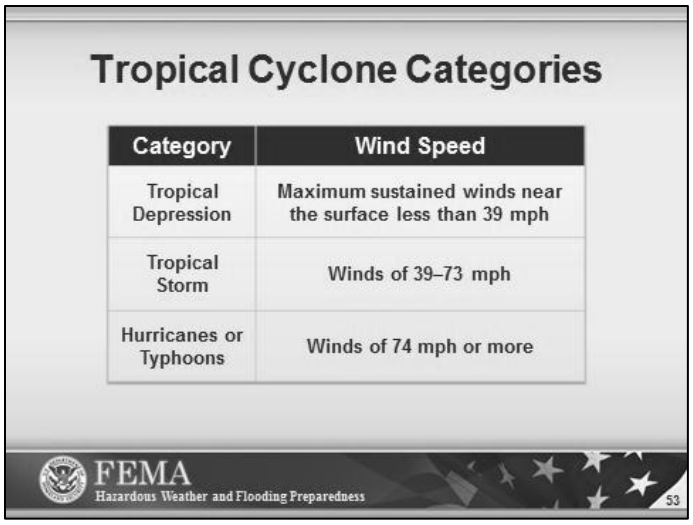


Cyclone hazards are numerous as can be seen on the slide. Some can occur without warning while others will occur over time and last a significant amount of time.

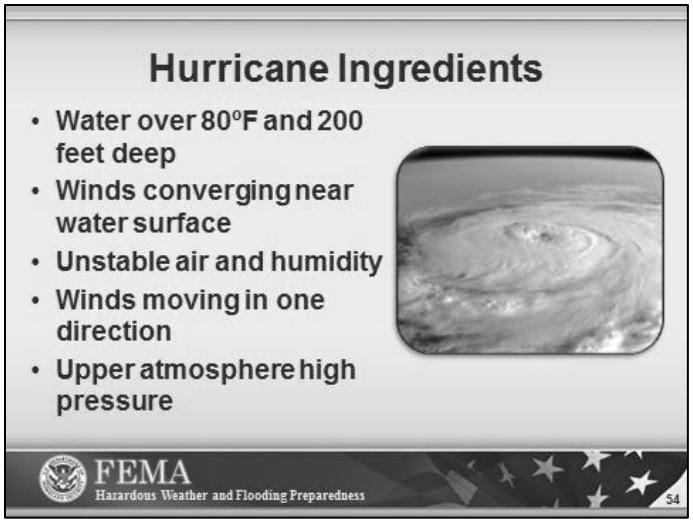
The 1993 extratropical coastal cyclone nicknamed the Storm of the Century formed in the Gulf of Mexico and affected 22 States. It produced deadly 12-foot storm surges that flooded the gulf coast of Florida. It generated thunderstorms, wind gusts over 80 mph, and tornadoes.



Tropical cyclones are coastal storms that form over the ocean, within the tropics. These storms cover a smaller area than extratropical coastal cyclones. The storm center is warmer than the surrounding air, and the strongest winds are about 10,000 feet above the ground.

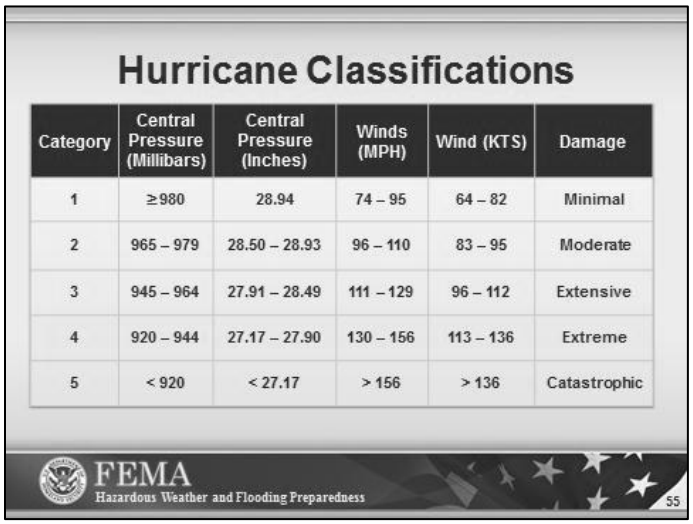


In the northern Hemisphere, intense tropical cyclones are called hurricanes or typhoons (west of the Pacific dateline). The storms are products of the tropical ocean and atmosphere, powered by the easterly trades and temperate westerlies, and their fierce energy.



Hurricanes are generated by the rising and cooling of humid air over the ocean. They need certain ingredients to develop.

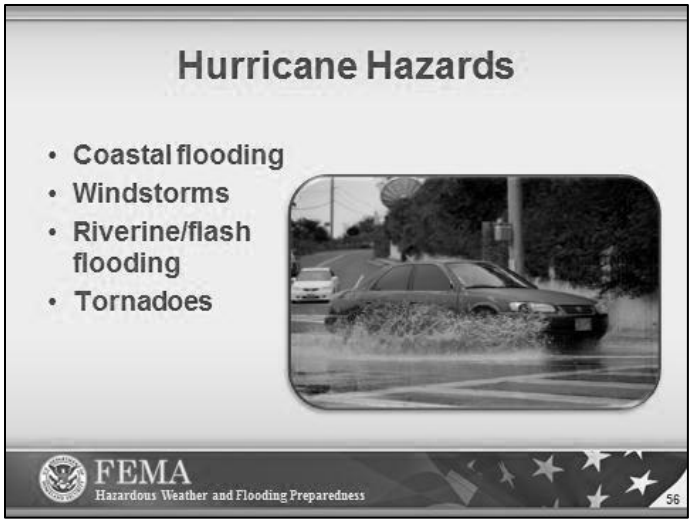
Hurricane winds blow counterclockwise around the center, or eye, of the storm and air currents carry the storm along. Most Northern Hemisphere hurricanes move from east to west in the trade winds.



Hurricanes are classified using the Saffir-Simpson Hurricane Wind Scale, based on central barometric pressure and wind speed.

The Saffir-Simpson Scale is included in Appendix C of your Student Manual, as well as in the NWS Products and Services Reference Guidebook.

Appendix C



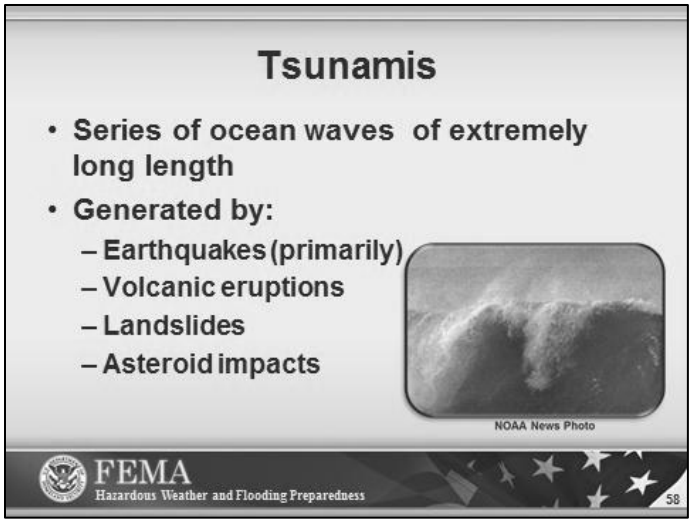
Hurricanes can cause several hydrometeorological hazards.

Did you know?

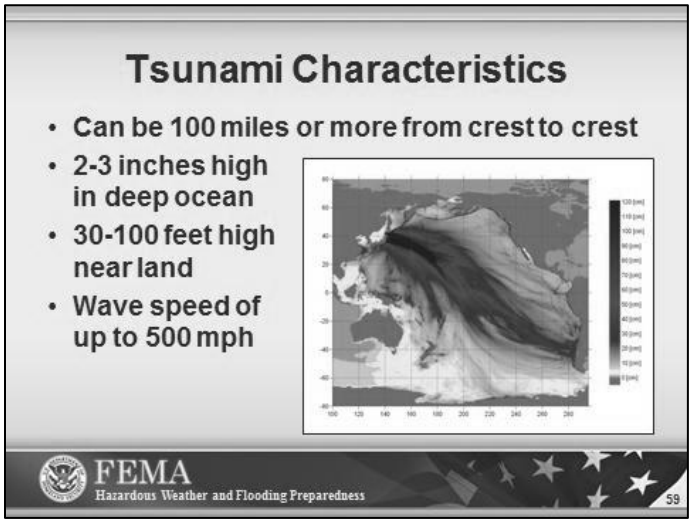
The strongest winds in a hurricane occur from 10 to 30 miles from the center of the eye, in a region called the eyewall.

On August 28th, 2005, Hurricane Katrina struck the southern coast of the United States with sustained wind speeds of 125 mph.

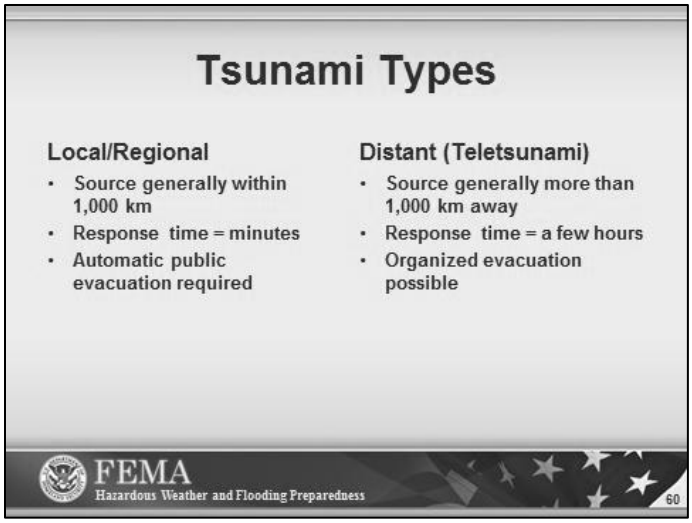
Hurricane Katrina is responsible for approximately 1800 reported deaths, and more than $81 billion in damages. It is the most costly U.S. hurricane on record.



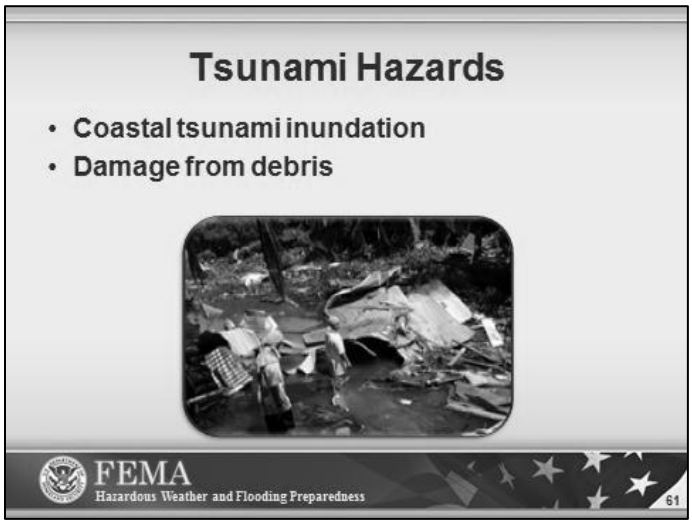
A tsunami is a series of ocean waves of extremely long length primarily generated by disturbances in the ocean floor due to undersea earthquakes. Tsunamis can also be generated by volcanic eruptions, landslides or even asteroid impacts.



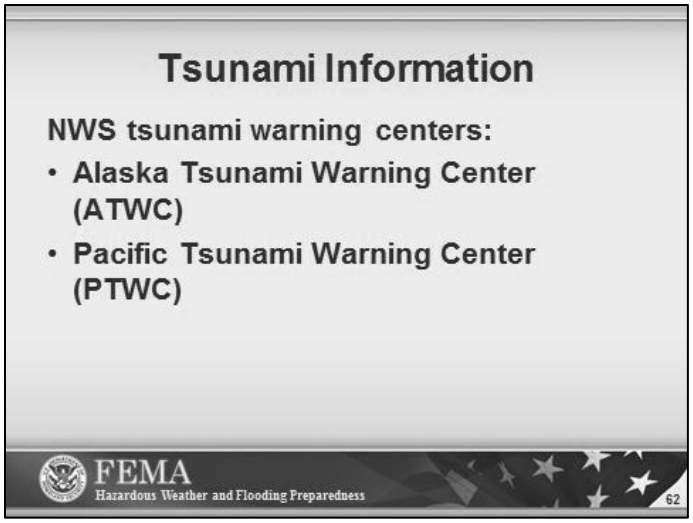
The subduction zones off the coasts of the Aleutian Islands (Alaska), Japan, and South America are known for their undersea earthquakes. They are the source for many tsunamis that have impacted our Pacific states and territories. A similar tsunami hazard exists with the Cascadia subduction zone off the Pacific Northwest coast and in the Caribbean due to the Puerto Rico Trench subduction zone.



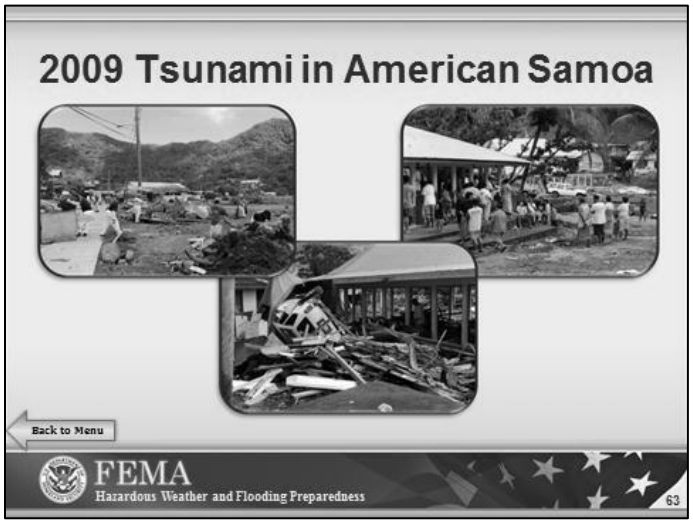
These two types of tsunamis must be considered by coastal emergency managers when developing your communities' hazard mitigation and emergency response plans.



Hazards from tsunamis include coastal tsunami inundation and damage from debris. The flood inundation area from a tsunami may be extensive, as tsunamis can travel several miles up rivers and streams that lead to the ocean.



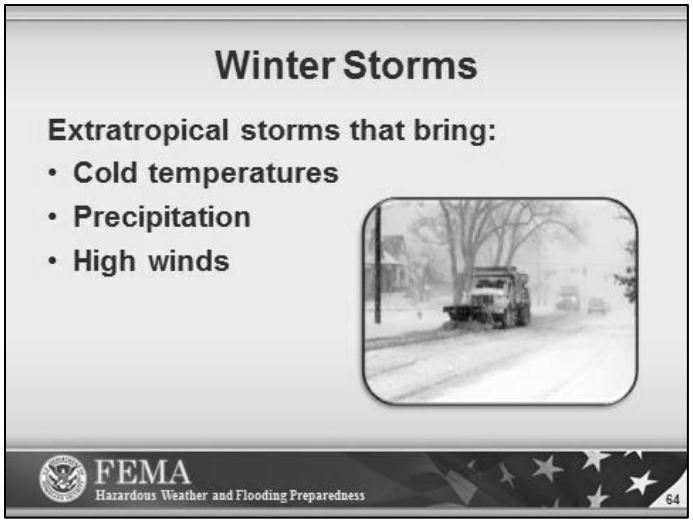
NOAA NWS operates two tsunami warning centers – the Alaska Tsunami Warning Center and the Pacific Tsunami Warning Center.



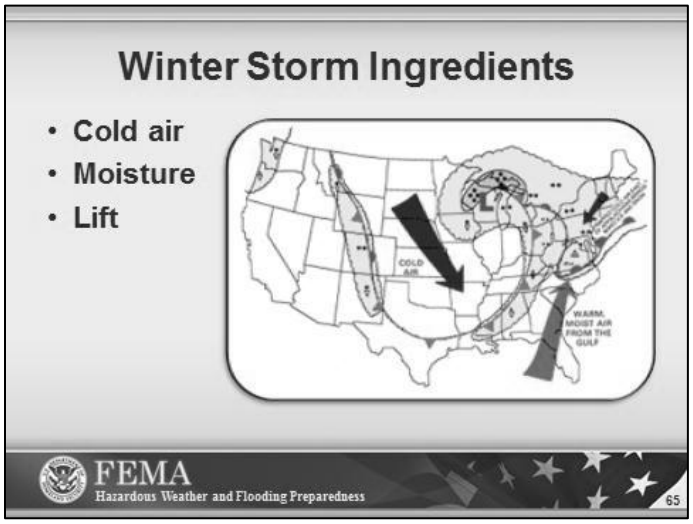
On September 29, 2009, a magnitude 8.3 earthquake occurred southwest of American Samoa, and a destructive basin-wide tsunami was generated.

The tsunami was measured at a number of coastal tide stations and the highest observed wave height was measured at 15 feet.

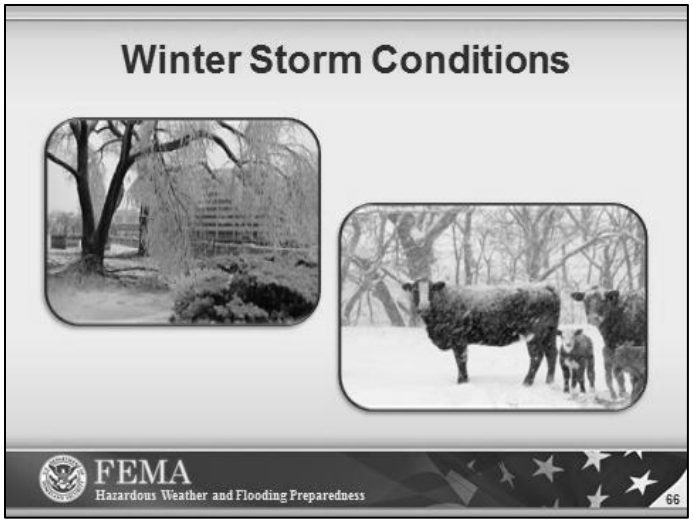
The event left 129 dead and did an estimated $147 million dollars worth of damage.



Winter storms are extratropical storms that bring cold temperatures, precipitation, and possibly, high winds.

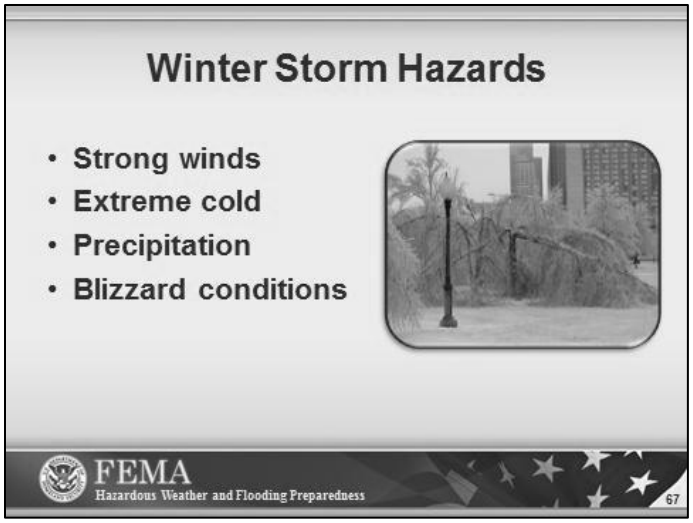


The development of a winter storm requires cold air, moisture, and lift.



The following conditions can occur during winter storms:

Snow
Heavy Snow
Snow Squalls
Snow Shower
Snow Flurries
Blowing Snow
Drifting Snow
Blizzard
Freezing Rain or Drizzle
Ice Storm
Sleet
Freeze
Frost
Wind Chill



Winter storm hazards include strong winds, extreme cold, precipitation, and blizzard/heavy snow conditions.

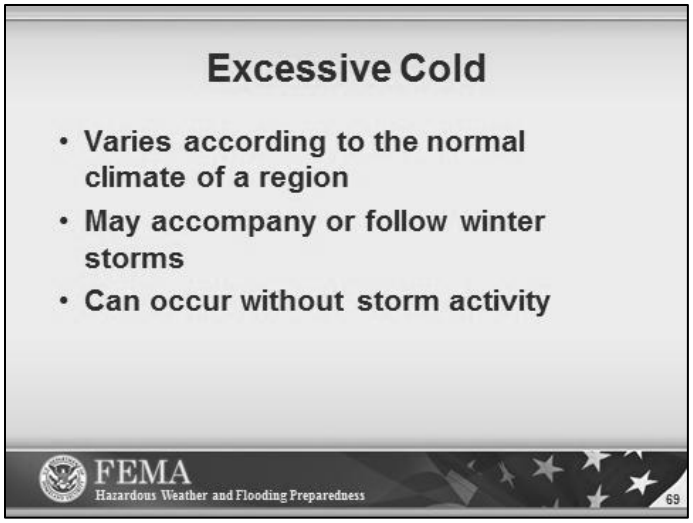
Did you know?

In the West and in Alaska, winds descending off the mountains can gust to 100 miles per hour or more, causing extensive damage.

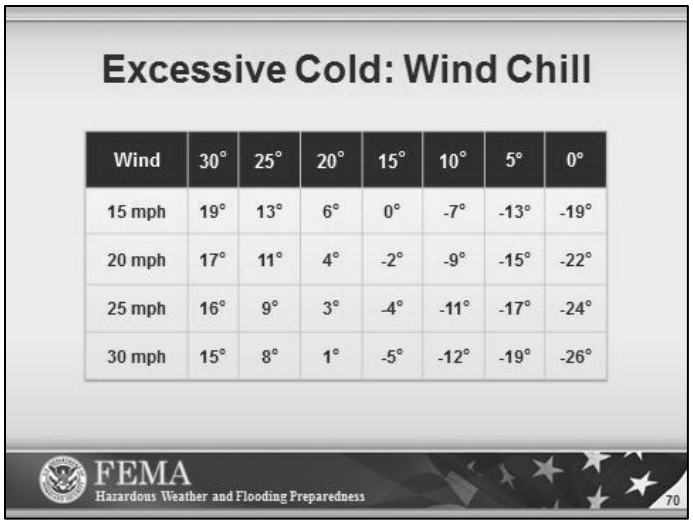
The 1993 “Storm of the Century” dumped massive amounts of snow from the Gulf Coast States northeastward through New England. Many cities experienced record low barometric pressure readings, indicative of a hurricane-force storm. Wind gusts were recorded at 110 mph in Florida.

Did you know?

For the first time, every major airport on the east coast was closed at one time or another by the 1993 superstorm.



What is considered an excessively cold temperature varies according to the normal climate of a region (e.g., in a relatively warm climate, temperatures just below or at freezing can be hazardous). Excessive cold may accompany or follow winter storms. They can also occur without storm activity.

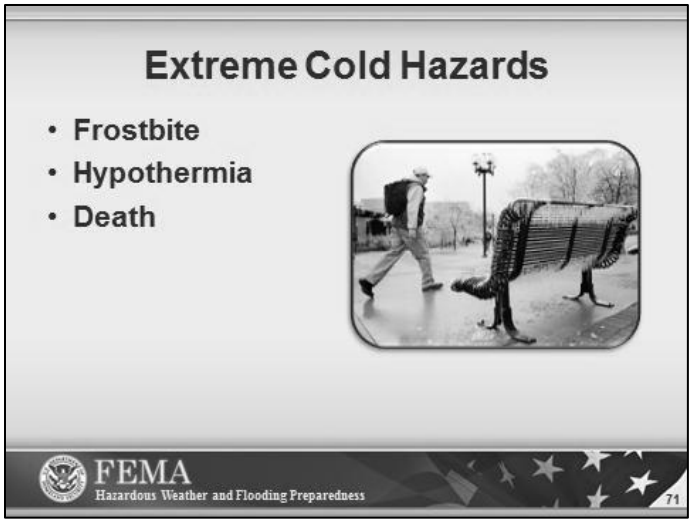


Wind	30°	25°	20°	15°	10°	5°	0°
15 mph	19°	13°	6°	0°	-7°	-13°	-19°
20 mph	17°	11°	4°	-2°	-9°	-15°	-22°
25 mph	16°	9°	3°	-4°	-11°	-17°	-24°
30 mph	15°	8°	1°	-5°	-12°	-19°	-26°

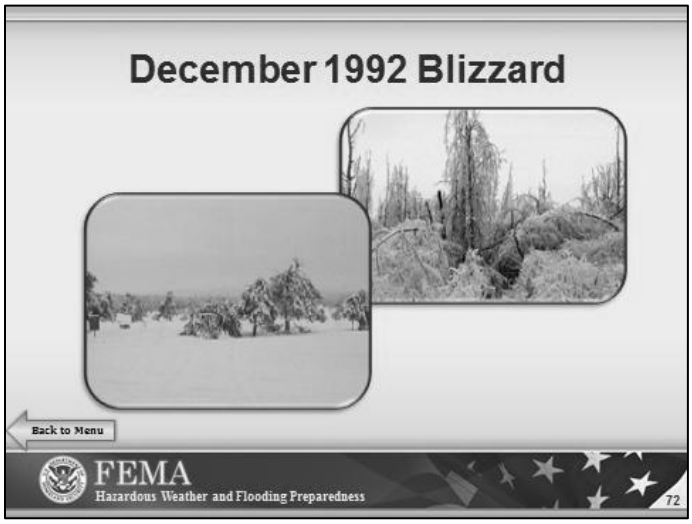
Forecasters use a wind-chill index as a guide to heat loss resulting from wind and cold. This slide shows a portion of the chart.

The complete wind chill index is included in the "Tables and Definitions" section of the NWS Products and Services Reference Guidebook.

NWS Products and Services Reference Guidebook

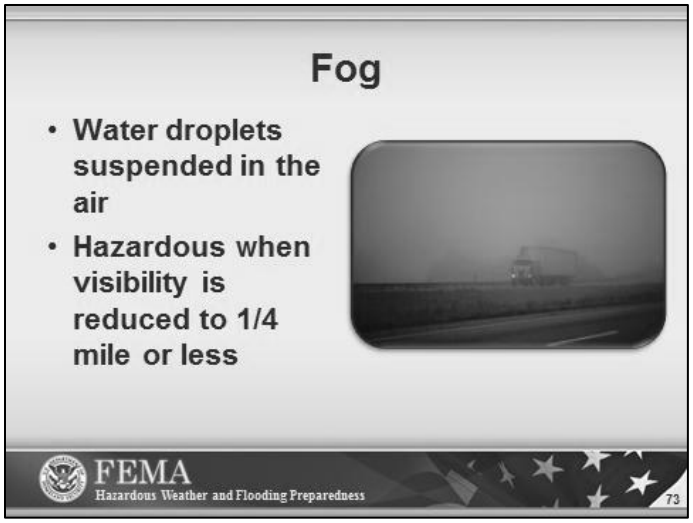


Prolonged exposure to extreme cold can lead to frostbite, hypothermia, and death.

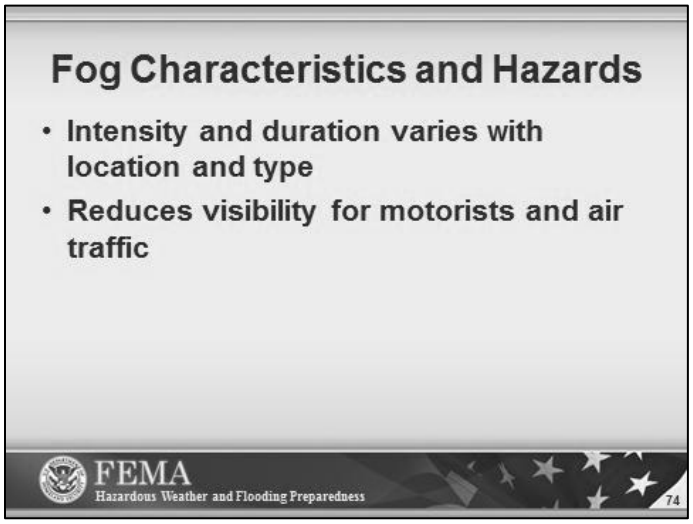


In December 1992, a couple and their 4-month old baby got caught in their pick-up truck during a blizzard in Nevada. They waited 2 days for help then set out on foot. After 2 days of walking, the woman and baby stayed in a cave and the man continued walking for 3 more days before reaching help.

The baby survived unscathed. The parents lost toes to frostbite and spent 2 months in wheelchairs and casts regaining their strength and the use of their legs.



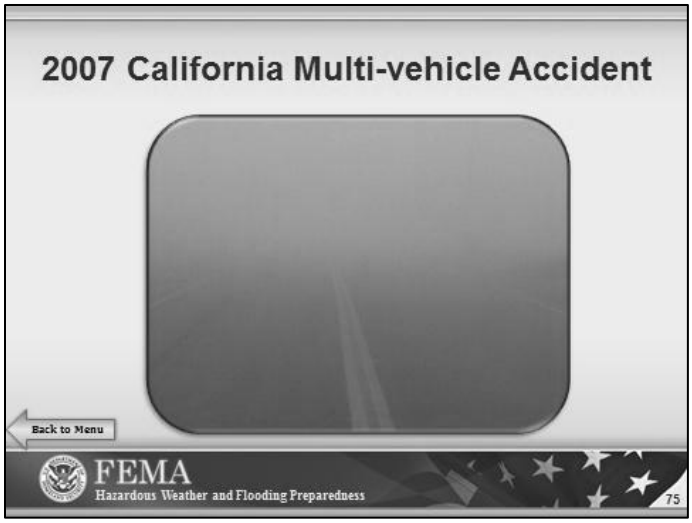
Fog is defined as water droplets suspended in the air at the earth's surface. Fog is often hazardous when the visibility is reduced to 1/4 mile or less.



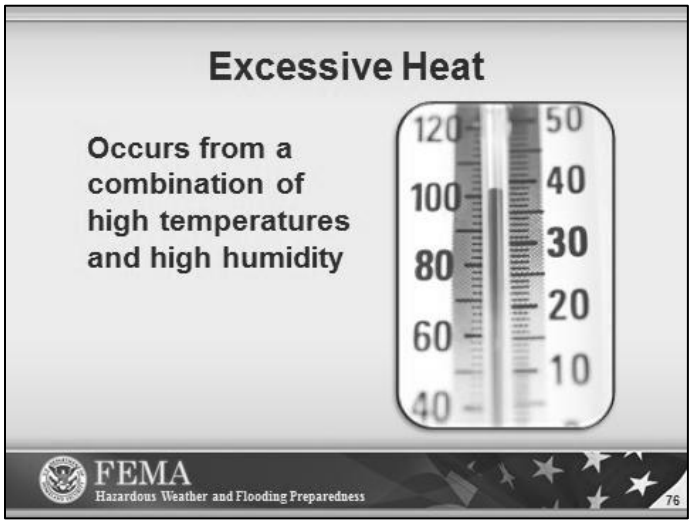
The intensity and duration of fog varies with the location and type of fog—from early morning ground fog that burns off easily to prolonged valley fog that lasts for days. Generally, strong winds tend to prevent fog formation.

Appendix D contains a fact sheet with a table that summarizes several scenarios for the formation, intensity, and duration of fog.

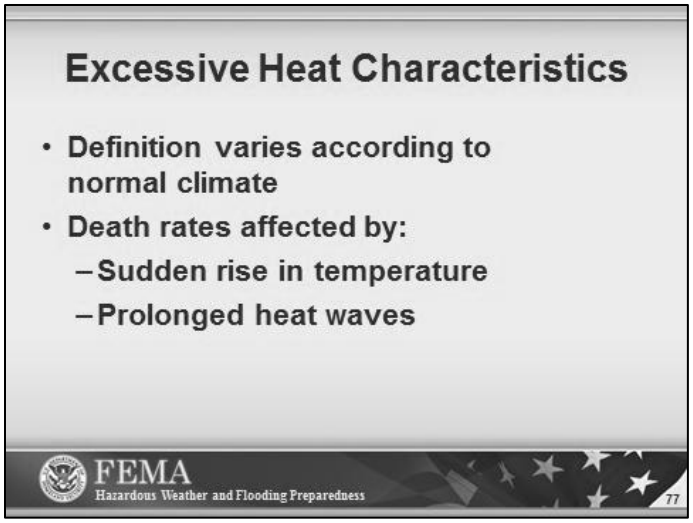

Appendix D



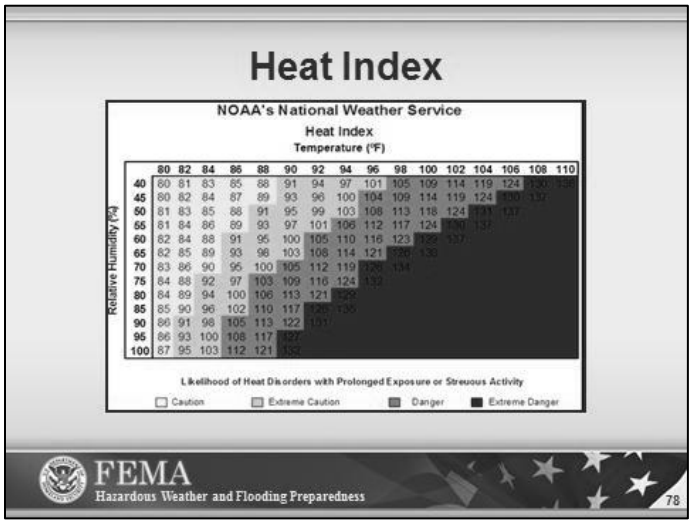
On the morning of November 3, 2007, Tule fog caused a massive pile-up that included 108 passenger vehicles and 18 big rig trucks on Northbound State Route 99 between Fowler and Fresno. Visibility was about 200 feet at the time of the accident. There were 2 fatalities and 39 injuries in the crash.



At certain levels, the human body cannot maintain proper internal temperatures and may experience heat stroke. The “Heat Index” (HI) is a measure of the effect of the combined elements on the body.



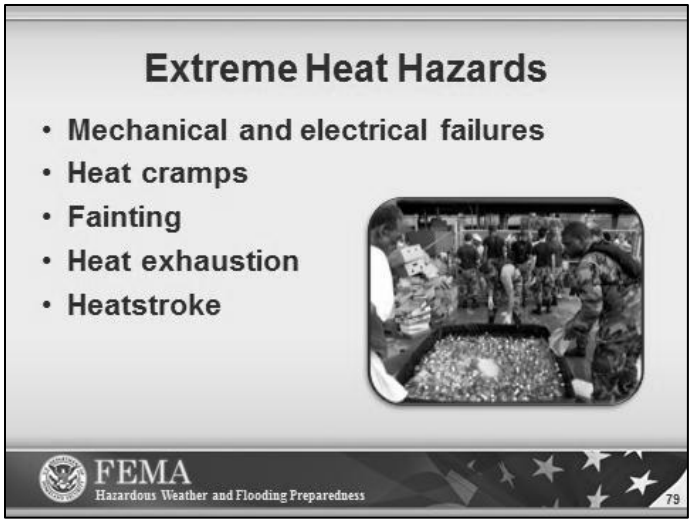
What is considered excessive heat varies according to the normal climate of a region. Tropical air masses can raise summer temperatures high above the average for an area. Sudden rises in temperature–when people do not have a chance to acclimatize–or prolonged heat waves increase death rates.



Forecasters use the Heat Index to show apparent temperature.

Heat Index charts using Relative Humidity and Dewpoint are included in the "Tables and Definitions" section of the NWS Products and Services Reference Guidebook.

NWS Products and Services Reference Guidebook



As with extreme cold, however, the major danger of extreme heat is to humans and animals. Heat-related ailments can range from annoying conditions to life-threatening situations.

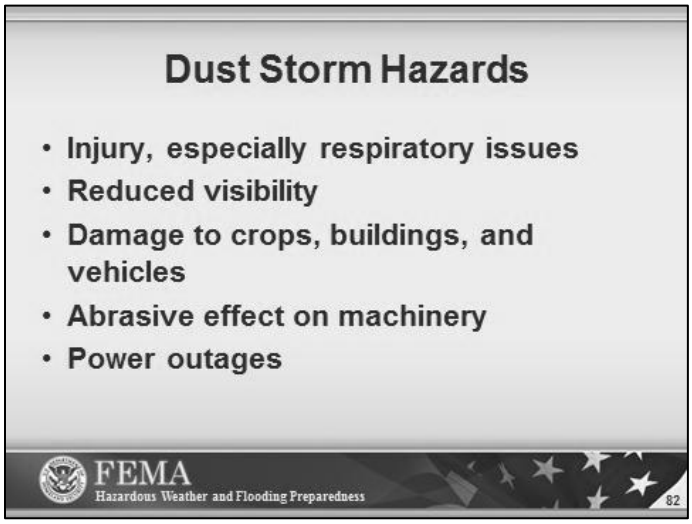
An example is that diabetics must adjust their insulin intake therefore hospitals must adjust their supplies. According to the Centers for Disease Control and Prevention, approximately 400 people die each year due to extreme heat.

In July 1995, a heat wave hit the Eastern and Midwestern U.S. Over 475 heat-related deaths occurred in Chicago alone, and the overall toll in the central U.S. was over 1,000.

Did you know?

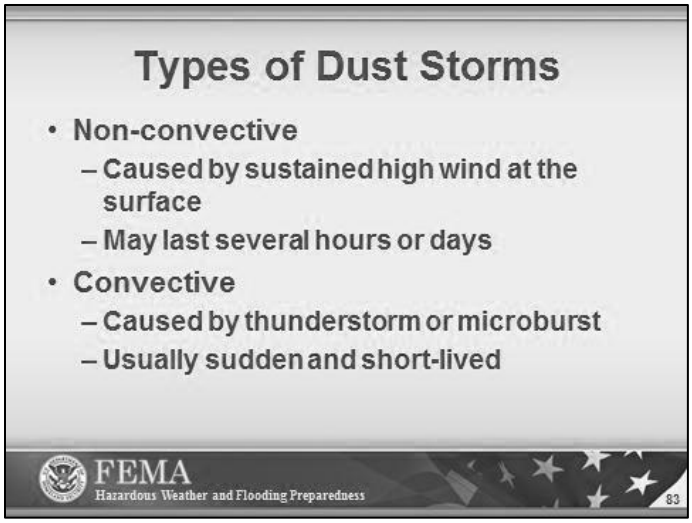
Each year, dozens of children left in parked vehicles die from hyperthermia. Hyperthermia is an acute condition that occurs when the body absorbs more heat than it can handle.

Strong winds over dry ground that has little or no vegetation can lift particles of dust or sand into the air. These airborne particles can reduce visibility (to 1/4 mile or less), cause respiratory problems, and have an abrasive effect on machinery.

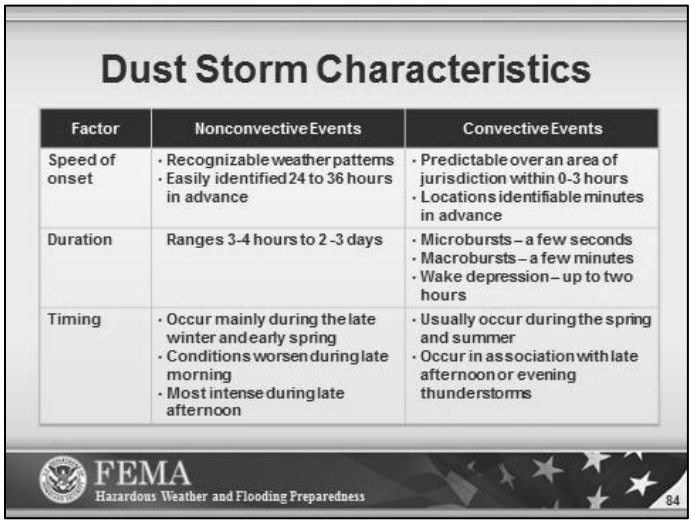


Dust storms involve horizontal high winds or wind gusts and blowing dust and/or sand.

When dust storms occur with winter storms, the mixture of snow and dust may bring travel to a standstill. For convective dust storms, all elements associated with severe thunderstorms may occur.



There are two situations that lead to the development of blowing dust or sand, creating two types of dust storms.

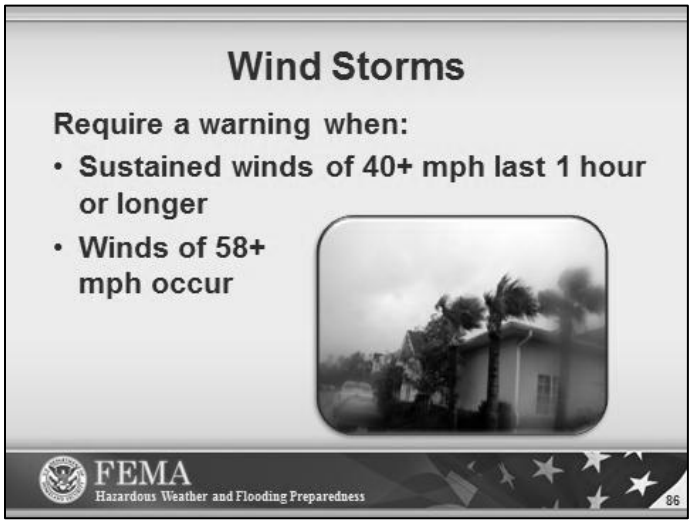


Factors affecting both non-convective and convective events are shown in the table on this slide.

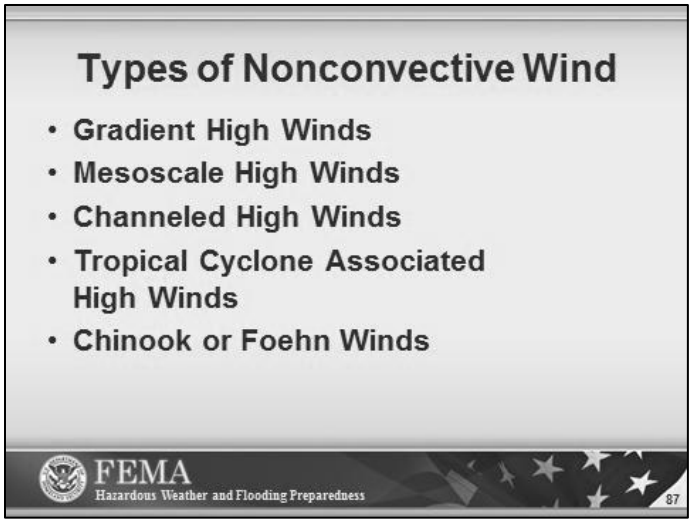
This table comparing nonconvective and convective events is included with the Dust Storm fact sheet in Appendix D.

Appendix D

In April, 1995, a dust storm caused a 24-car wreck in Arizona that killed 10 people. Swirling dust reduced visibility to less than a car length.



The above thresholds generally are increased for locations at higher elevations because of the lower air density and subsequent reduction in damage from less force.



The types of wind that do not involve the mechanism of convection include:

Gradient High Winds

These high winds usually cover a large area and are due to large-scale pressure systems.

Mesoscale High Winds

These high winds usually follow the passage of organized convective systems and are associated with wake depressions or strong mesoscale (small-scale) high pressure.

Channeled High Winds

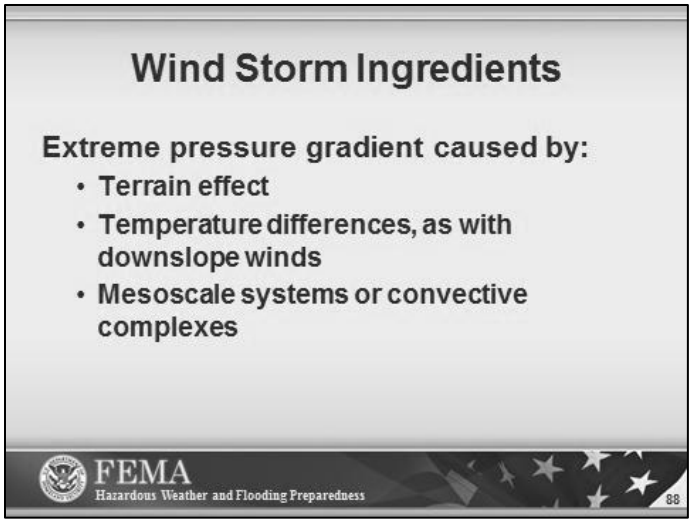
These high winds usually occur in mountainous areas or in cities with tall buildings, air can be channeled through constricted passages producing high winds. Channeled high winds are local in nature, and can be extremely strong.

Tropical Cyclone Associated High Winds

These high winds can occur a few hundred miles from the coast of a landfalling tropical cyclone. These inland winds are forecasted independent of the tropical cyclone.

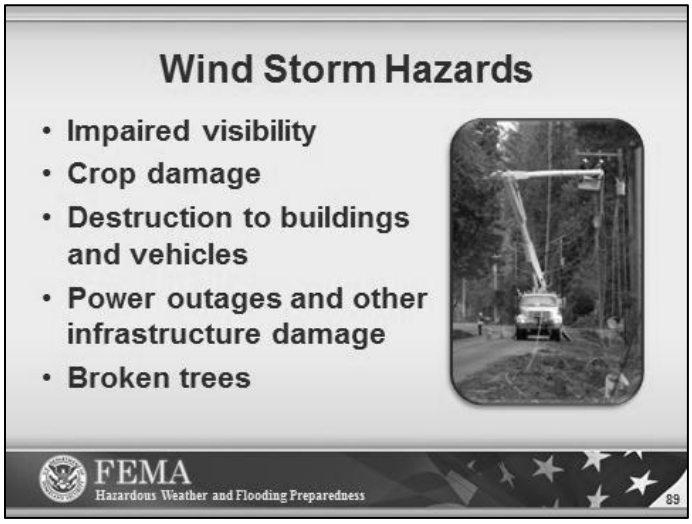
Chinook or Foehn (pronounced \fern\) Winds

These are warm, dry winds that occur in the leeward side of high mountain ranges. They are fairly common in the mountainous west and sections of Alaska during the winter months. These winds develop in well defined areas and can be quite strong.



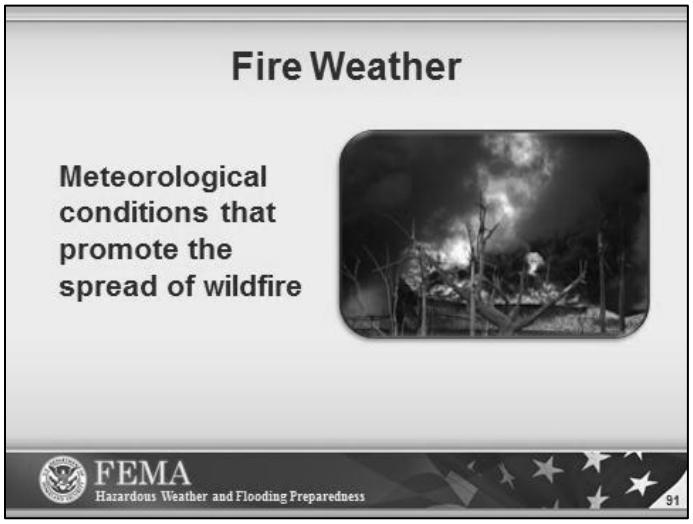
Wind storms are caused by an extreme pressure gradient (difference in pressure over a small distance).

High winds may accompany major winter or early spring blizzards.

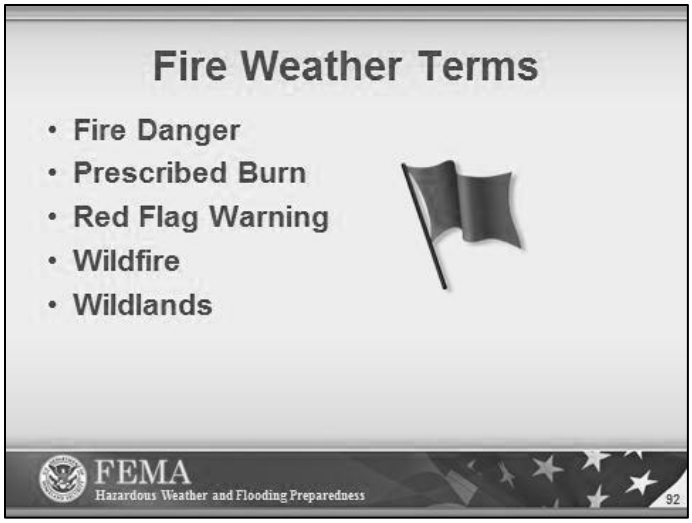


Wind storms involve sustained, potentially damaging, high winds.

A wind and dust storm along a California highway in November 1991 caused a wreck leaving 17 dead and 150 injured. This storm came during the sixth year of a drought.



Fire weather is a term used for the meteorological conditions that promote the spread of wildfire. Hydrological, topographical, and vegetation conditions also impact the spread of fire.



Fire Danger

The result of both constant factors (fuels) and variable factors (primarily weather) that affect the ignition, spread, and difficulty of control of fires, and the damage they cause

Prescribed Burn

Fire applied to wildland fuels in a definite place, for a specific purpose, under exacting weather and fuel conditions, to achieve land management objectives

Red Flag Warning

NWS will issue a “Red Flag Warning” for the following dangerous fire weather conditions:

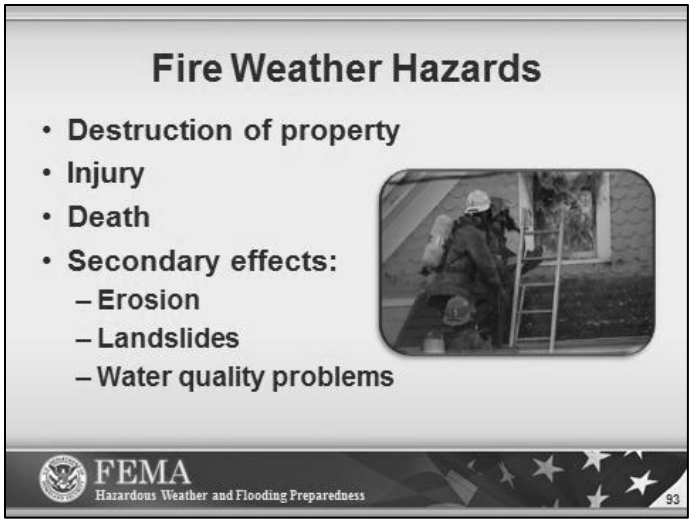
- Lightning after an extended dry period
- Significant dry frontal passage
- Strong winds
- Very low relative humidity.
- Dry thunderstorms

Wildfire

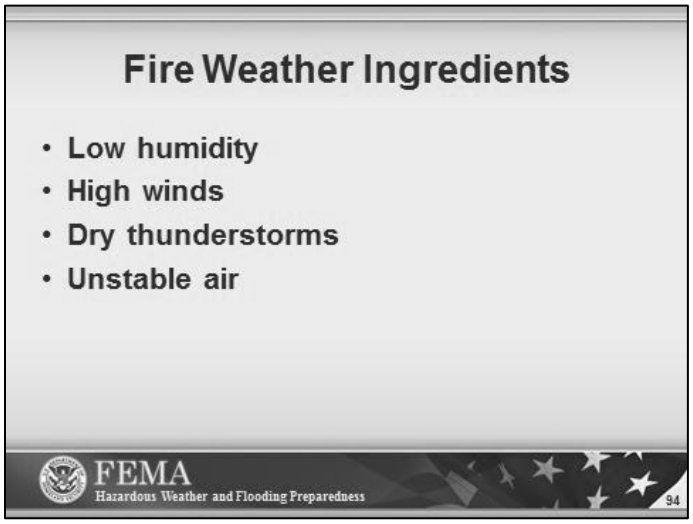
Any free-burning and uncontainable wildland fire not prescribed for the area that consumes the natural fuels and spreads in response to its environment

Wildlands

Any non-urbanized land not under extensive agricultural cultivation (e.g., forests, grasslands, rangelands)



The dangers associated with smoke and fire hazards are destruction to property, and injury or death.



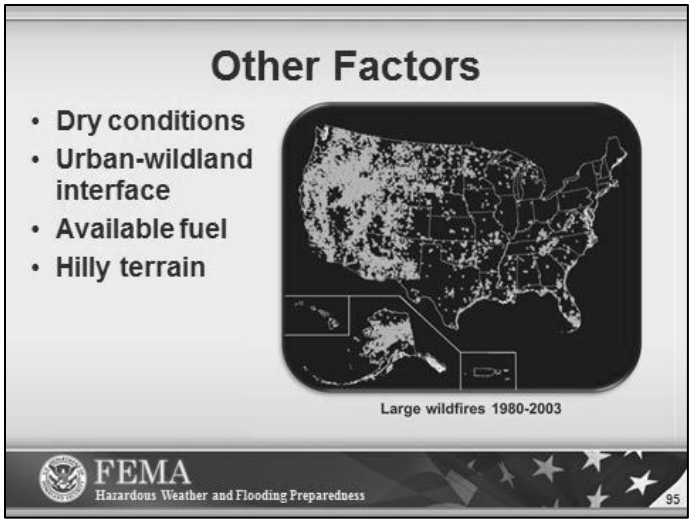
The following weather conditions promote ignition and rapid spread of fires:

Low relative humidity

High winds (over 10-20 mph)

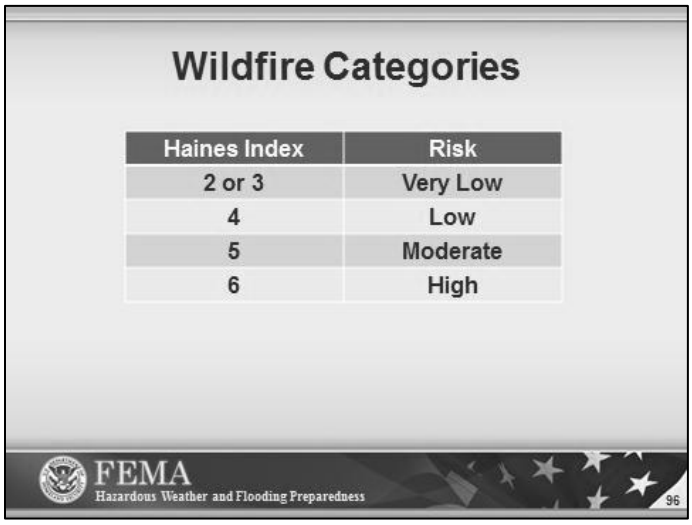
Dry thunderstorm (i.e., lightning without rain)

Unstable air



Other factors that impact the spread and severity of fires include:

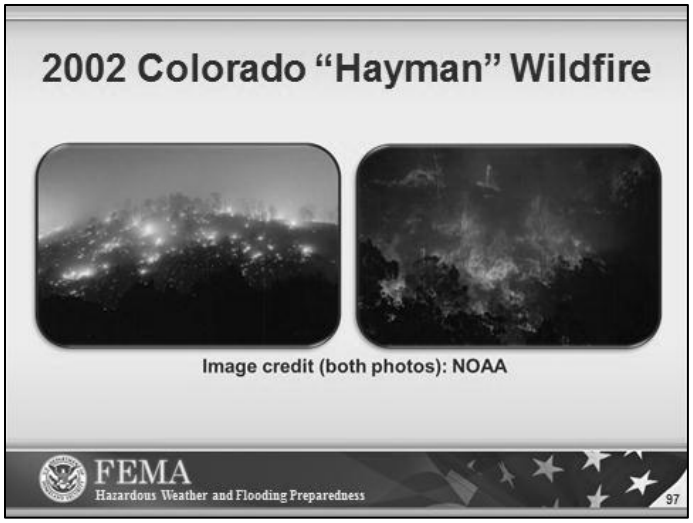
- Dry antecedent conditions
- Urban-wildland interface
- Available fuel
- Hilly terrain



The Lower Atmospheric Severity Index (LASI), commonly known as the Haines Index, combines both the instability and dryness of the air by examining the lapse rate between two pressure levels in the atmosphere and the dryness of one of the pressure levels.

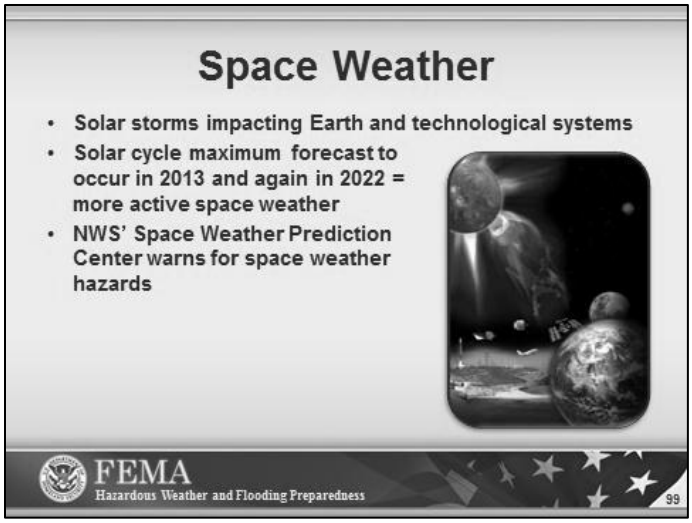
The Haines Index shown on this slide is included with the Wildfire fact sheet in Appendix D.

Appendix D

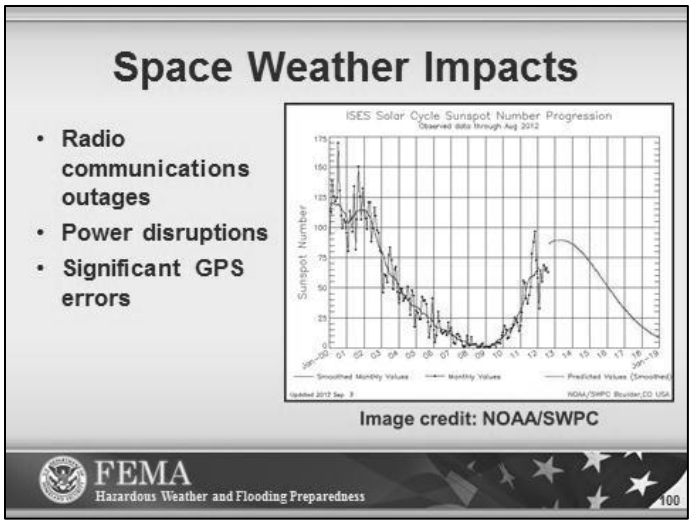


In June 2002, a lightning-triggered wildfire impacted over 138,000 acres of the Colorado Front Range. Fuel moisture content of the large dead logs and stems was extremely low (less than 10%). Windy and dry conditions occurred throughout the three weeks that this fire ran its course. 600 structures were burned, resulting in real property losses of $24 million.

In October 1991, brush fires swept through the Oakland, California suburbs, which abutted a grassland area. Many analysts attributed the extensive damage to the century-old practice of planting eucalyptus trees in the area. Strong winds and extended drought contributed to the rapid spread of this fire. Preliminary estimates put damages between $2.5 and $5 billion. Twenty-three people died and 148 were injured.



Space Weather describes the conditions in space that affect Earth and its technological systems. Space weather is a consequence of the behavior of the Sun interacting with the Earth's magnetic field and atmosphere, and our location in the solar system.



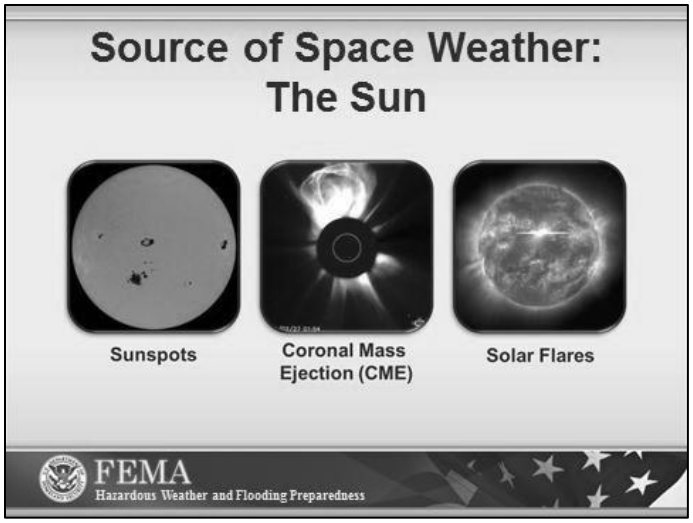
Solar storms that result in geomagnetic field disturbances may damage power systems, disrupt communications and degrade high-tech navigation systems like GPS.

A link to the NOAA Space Weather Scales is included in the Appendices section of your Student Manual.

Did you know?

Approximately every 11 years there is a maximum in sunspot numbers and space weather activity. The polarity of the sun's magnetic field reverses with each cycle.

Appendix B



- Sunspots

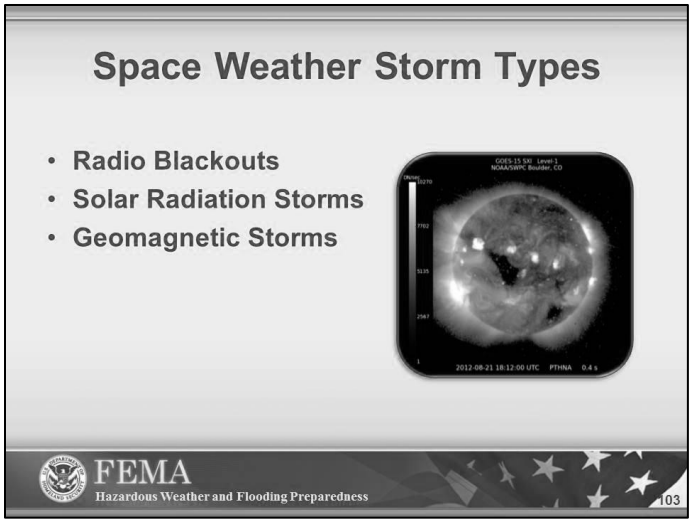
  Sunspots are dark areas on the solar surface that contain strong magnetic fields that are constantly shifting. Sunspots form and dissipate over periods of days or weeks.

- Solar Flares

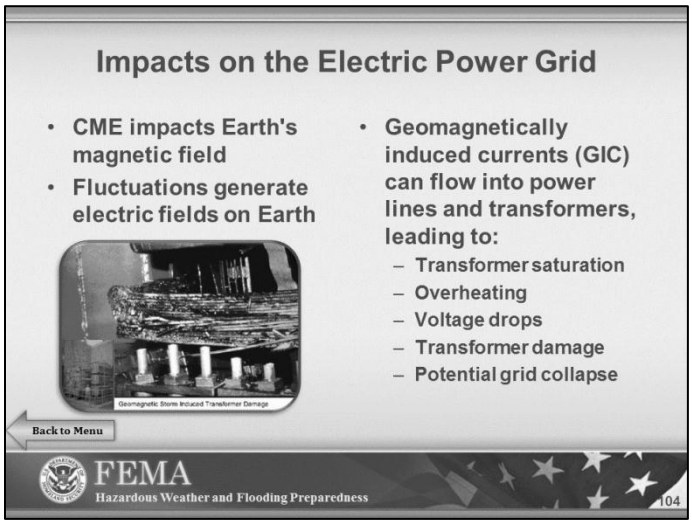
  Solar flares are intense, short-lived releases of energy. They are seen as bright areas on the Sun in optical wavelengths and as bursts of noise in radio wavelengths; they can last from minutes to hours.

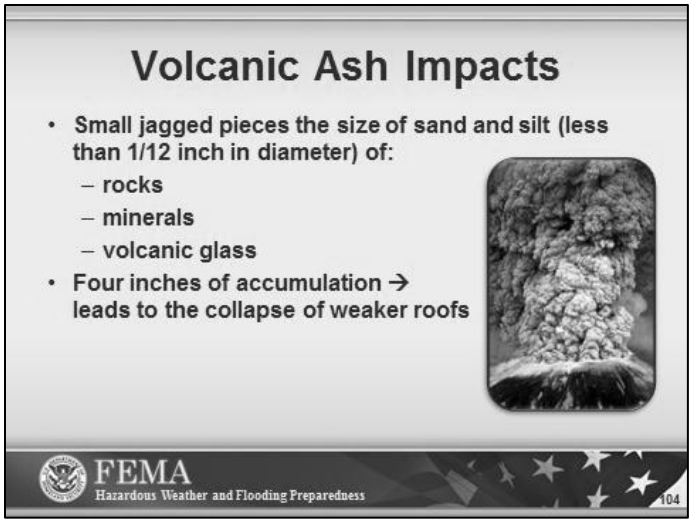
- Coronal Mass Ejections (CME)

  The outer solar atmosphere, the corona, is structured by strong magnetic fields. Where these fields are closed, often above sunspot groups, the confined solar atmosphere can suddenly and violently release bubbles or tongues of gas and magnetic fields called coronal mass ejections.

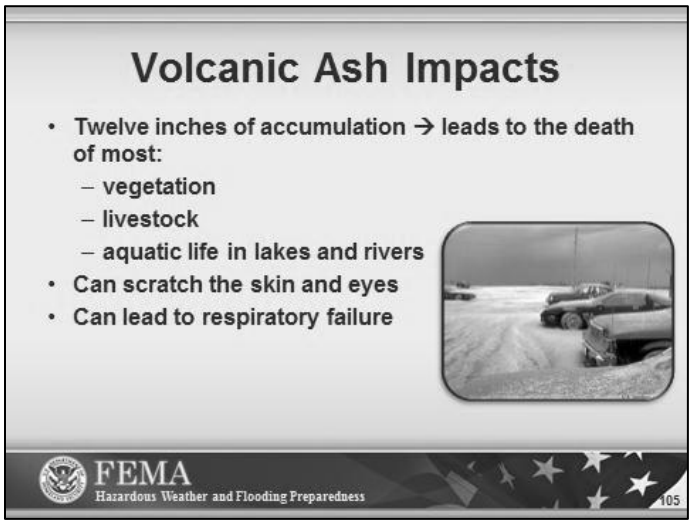


Space weather storm types are categorized by their impacts. The three main types are shown on the visual.

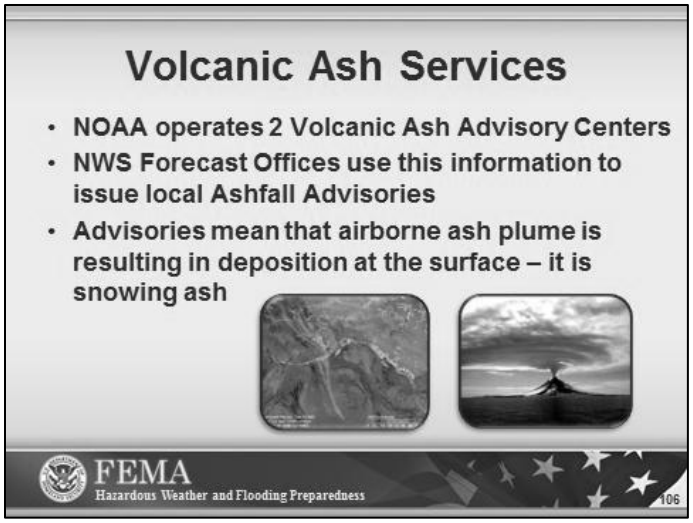




Volcanic ash can cause the engines of aircraft, motor vehicles, and ocean vessels to fail.

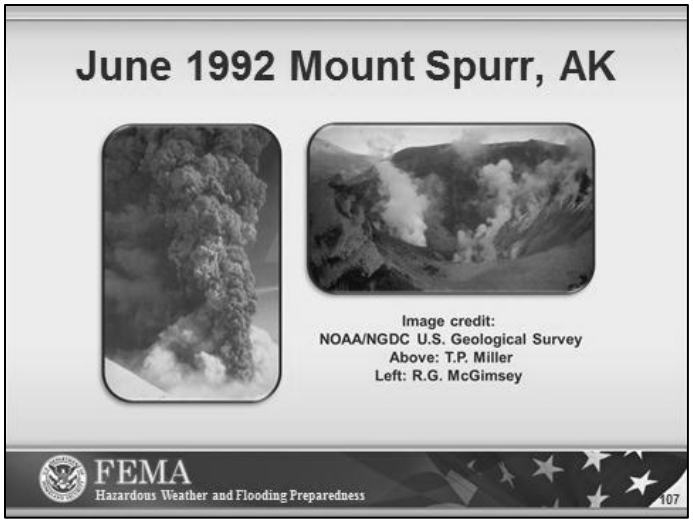


Accompanied by rain and lightning, ashfall leads to power outages, prevents communication, and disorients people.

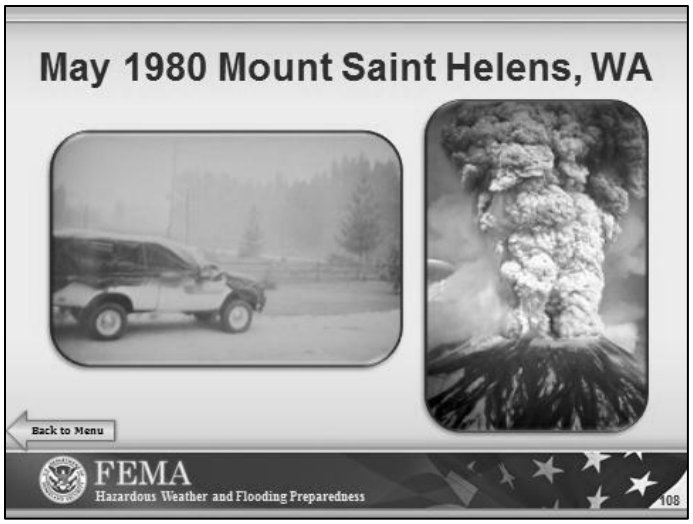


NOAA operates two Volcanic Ash Advisory Centers – one in Anchorage, Alaska and the other in Camp Springs, Maryland. The centers issue regional advisory statements, including graphics and text messages about the location and size of the ash clouds. Their primary role is to coordinate with the FAA to ensure aircraft safety.

NWS Forecast Offices use this information to issue local Ashfall Advisories.



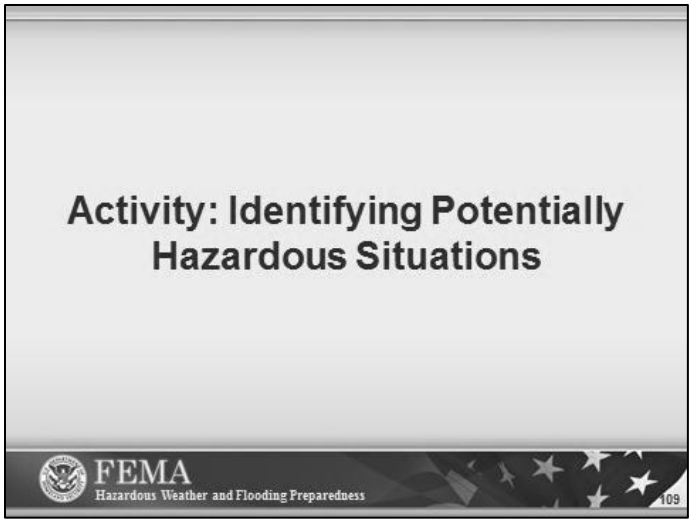
On June 27, 1992, Crater Peak vent on the south flank of Mount Spurr volcano in Alaska burst into eruption after 39 years of inactivity. Subsequent eruptions occurred in August and September of that same year. The August 18 eruption produced troublesome ash falls in Anchorage, 124 km distant, causing nearly $2 million in damage, office closures, and cleanup costs.



On May 18, 1980, an earthquake occurred seconds before the explosion that began the eruption of Mount St. Helens volcano. This eruption and blast blew off the top of the volcano (reducing its elevation by 396 meters), killed 31 people, and caused an estimated property damage of between $500 million and $2 billion.

Did you know?

The International Airport at Anchorage was closed for 20 hours by the ash fall.



In this activity, you will work individually to list community or environmental factors or conditions that may worsen the impact of hydrometeorological events in their communities.

Refer to the worksheet titled, "Identifying Potentially Hazardous Situations," located in Appendix A of your Student Manual. This worksheet is also included on the next page of this guide for your reference.

Appendix A

You will have 10 minutes to complete the activity.

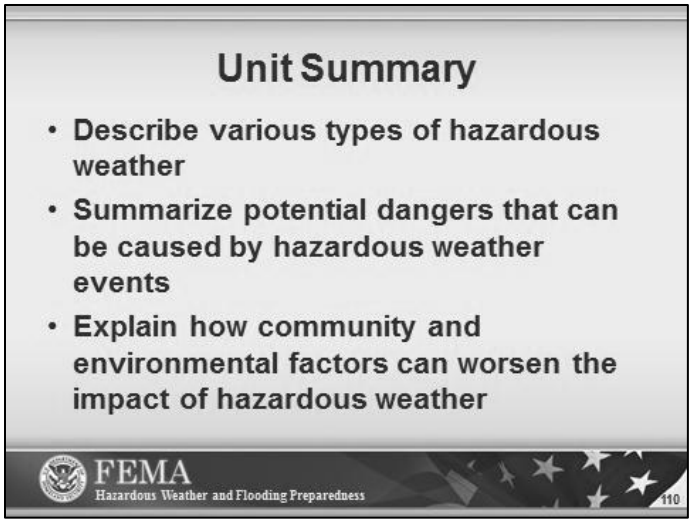
Individual Activity: Identifying Potentially Hazardous Situations

Choose two of the hydrometeorological events discussed earlier in this unit and record them in the first row.

For each event, list five community or environmental factors or conditions that may worsen the impact of the event. For example, extensive development and paved surface prohibit water absorption, which worsens the impact of flooding.

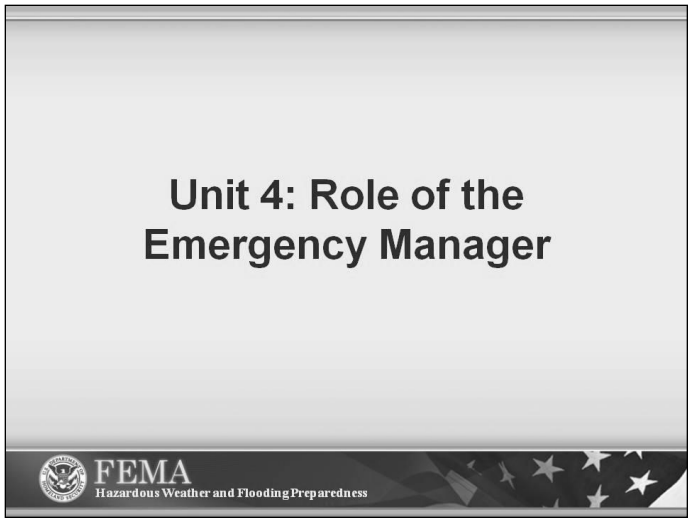
Circle the factors or conditions that are present in your community.

	Event #1:	**Event #2:**
1		
2		
3		
4		
5		



It is the combination of the hazardous weather or flooding event and the community at risk that determines the nature and extent of the impact.

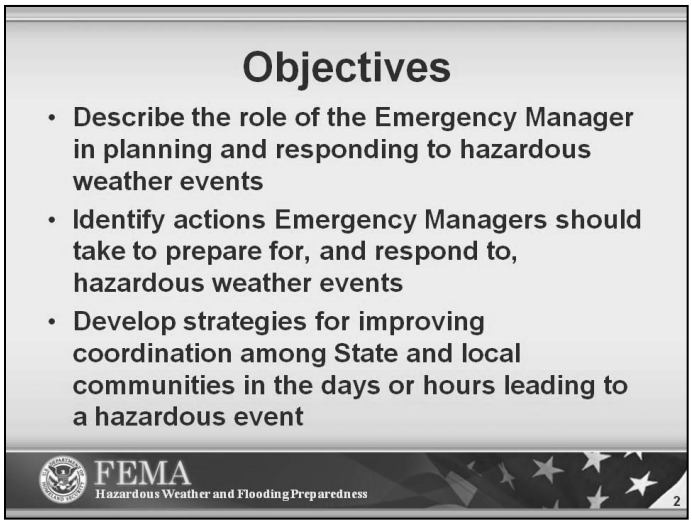
Natural hazards are unavoidable and inevitable. However, their adverse impacts can, and should, be reduced by proper preparedness and response to warnings.

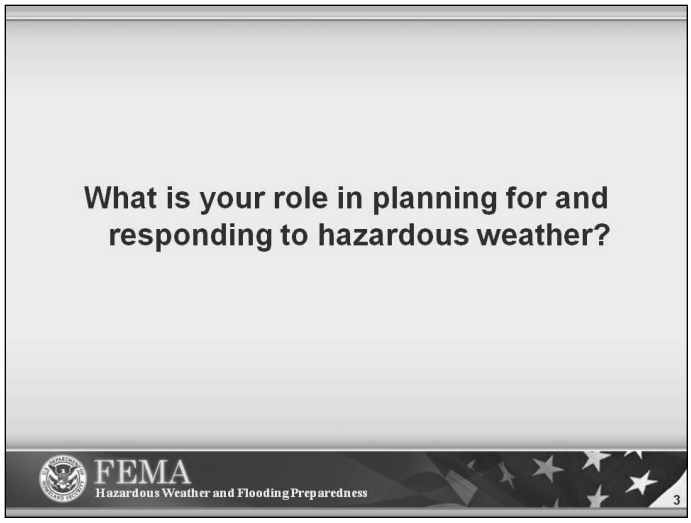


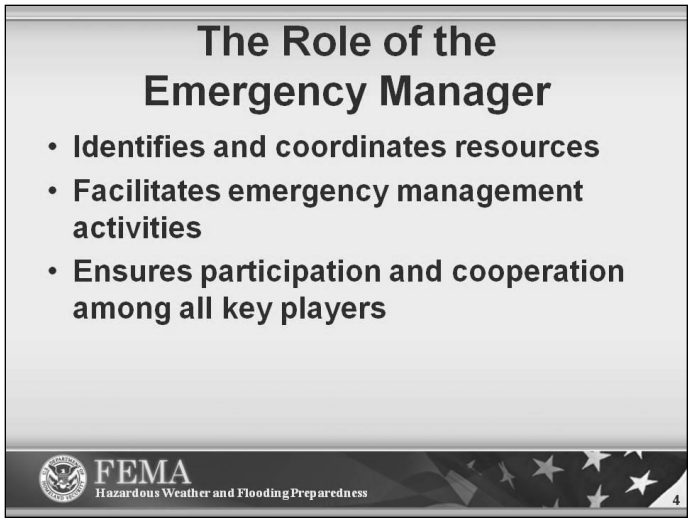
Unit 4

This unit will enable you to improve coordination and communication with State and local agencies when hazardous weather threatens.

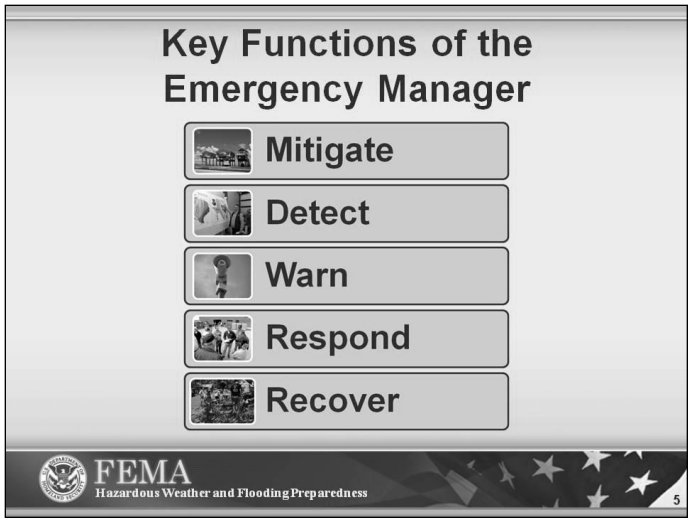
In this unit we will discuss the role of Emergency Managers in preparing for and responding to hazardous weather events. We also will learn ways to improve coordination and communication with State and local agencies when hazardous weather threatens.





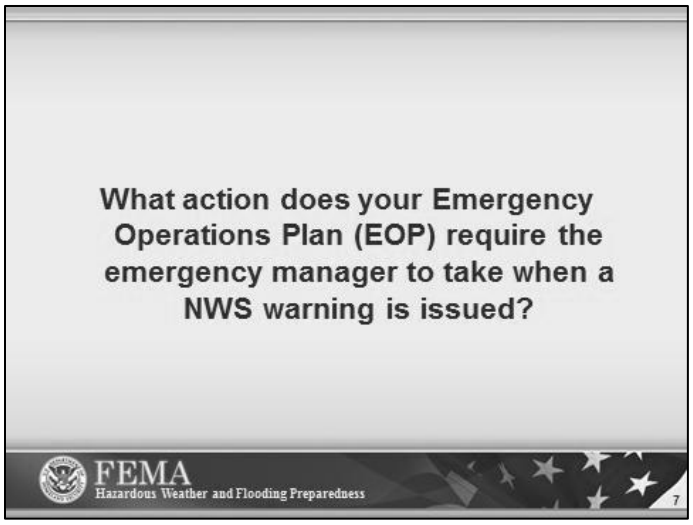


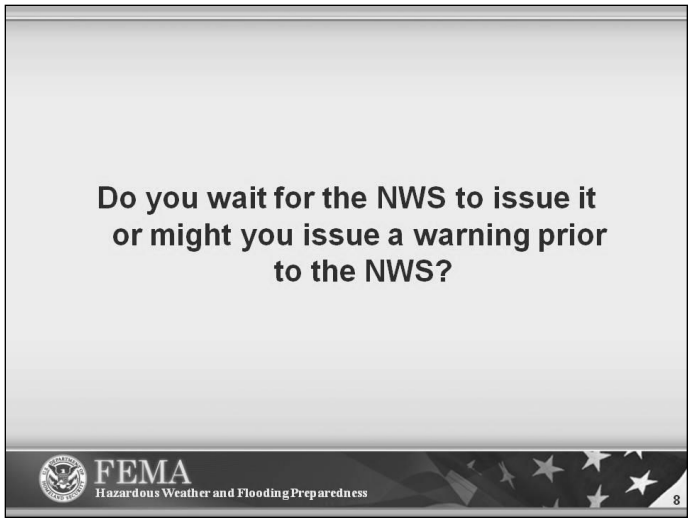
The Emergency Manager has the day-to-day responsibility of overseeing emergency management programs and activities. This role entails coordinating all aspects of a jurisdiction's mitigation, preparedness, response, and recovery operations.

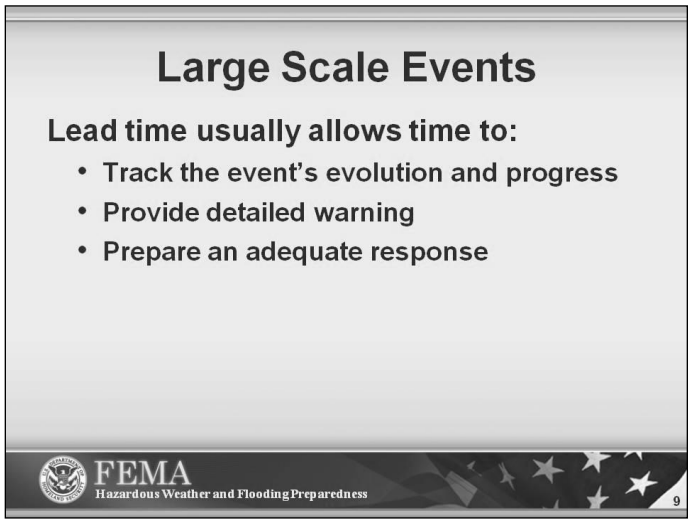


- Mitigate. You are responsible for developing mitigation techniques to reduce the long-term impact of hazardous weather events.
- Detect. You must be able to determine when and where a potentially hazardous weather situation may occur—and the risks that it may pose to life and property in that area.
- Warn. You must provide warning to the population so that residents have adequate information in time to prepare themselves and their property for the event.
- Respond. You must enable your community to respond to the event—before it occurs, if possible.
- Recover. You must enable your community to respond to recover from the impacts of the event.


What mitigation actions has your community taken for hazardous weather events?
FEMA
Hazardous Weather and Flooding Preparedness
6


What action does your Emergency Operations Plan (EOP) require the emergency manager to take when a NWS warning is issued?
FEMA
Hazardous Weather and Flooding Preparedness
7



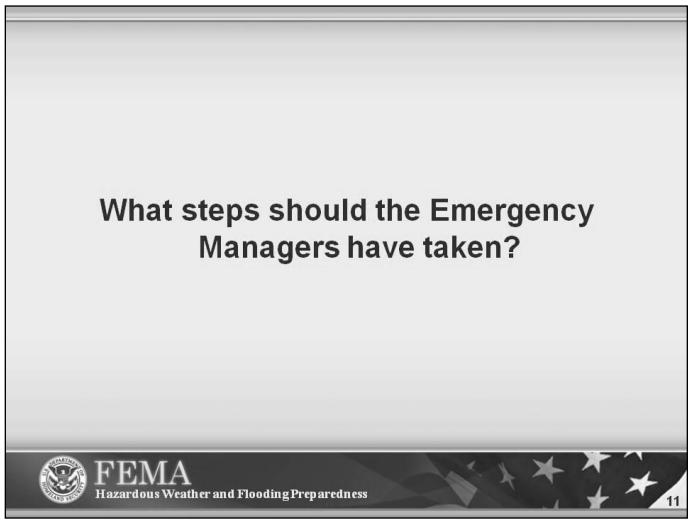


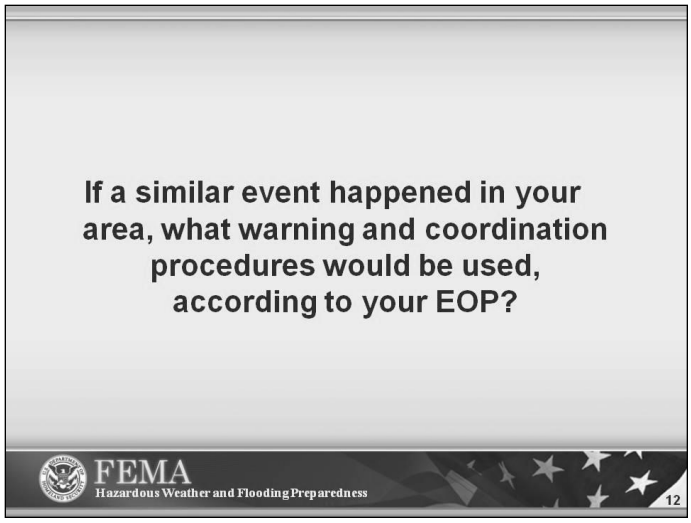
There are situations where you will likely have a longer lead time (and, therefore, a longer preparation period) before large-scale events. However, some events, such as tornadoes, do not allow much lead time.

In March, 1993, a "Storm of the Century" blasted 22 states along the East Coast of the United States. Blizzard conditions descended over the Mid-Atlantic and New England states, and heavy flooding hit Florida and other southern states. The superstorm was created by a series of hydrometeorological events.

Did you know?

The storm's impact included at least 197 fatalities that were directly or indirectly attributed to the storm and over $2 billion in property damage.

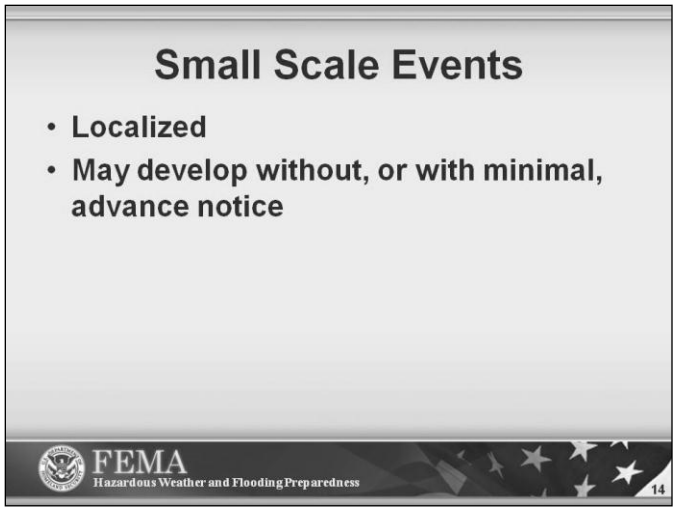




Did you know?

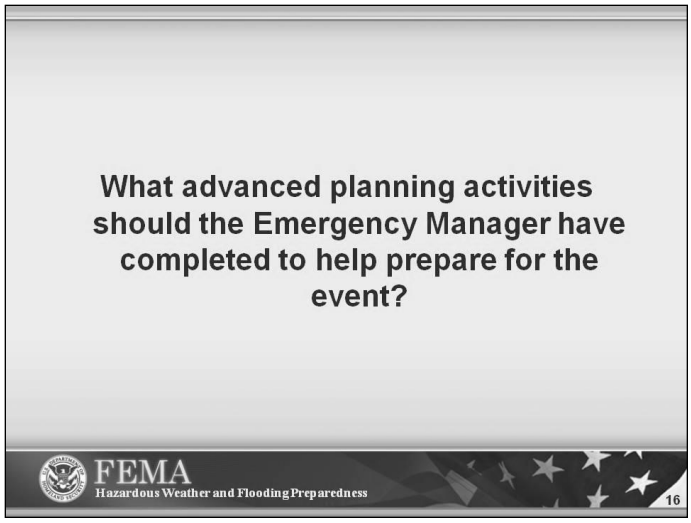
The entire State of Iowa and large sections of eight other states were declared Federal disaster areas.

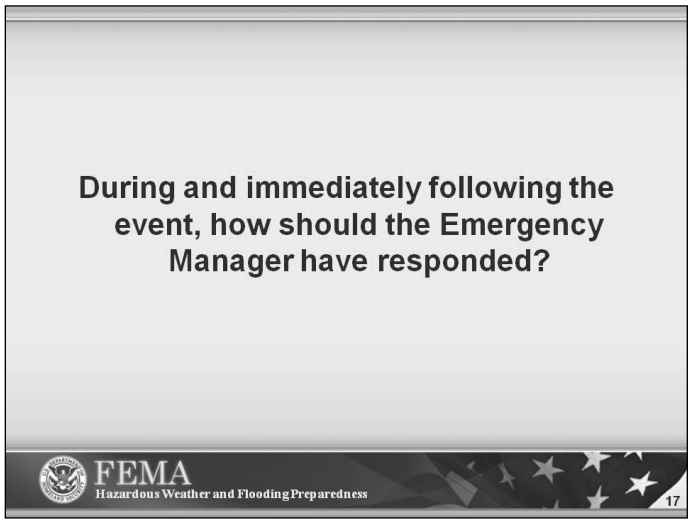
Another example of a large-scale event is the flooding that struck the Midwest during the summer of 1993. Referred to as the Great Flood of 1993, it was an unprecedented hydrometeorological event which had not been seen since the U.S. started to provide weather services in the mid-1800s. In terms of precipitation amounts, record river stages, areal extent of flooding, persons displaced, crop and property damage, and flood duration, this event surpassed all U.S. floods during modern times.

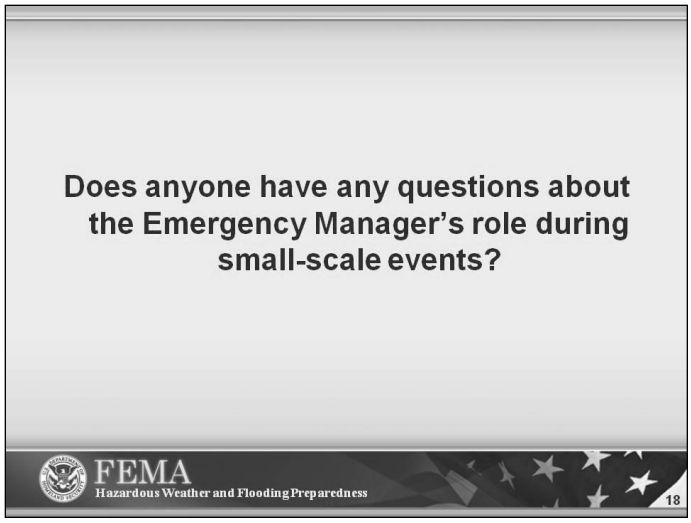


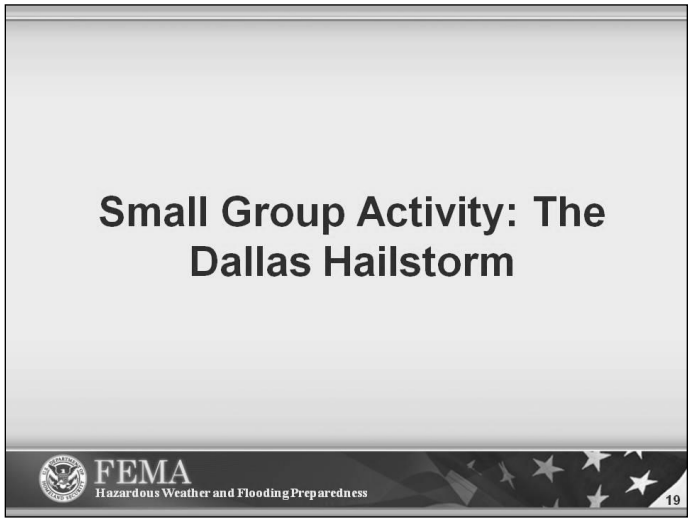
With knowledge of the types of hazardous weather that are likely to affect your community and some experience using the Weather Service products, you can be aware of conditions that are likely to cause hazardous weather events and take the necessary precautions.

Big Thompson Canyon is a steep canyon north of Denver. In 1976, a devastating flash flood killed 139 people and caused $35.5 million in damage.


What advanced planning activities should the Emergency Manager have completed to help prepare for the event?
FEMA
Hazardous Weather and Flooding Preparedness
16


During and immediately following the event, how should the Emergency Manager have responded?
FEMA
Hazardous Weather and Flooding Preparedness
17





Working with your table group, read the information on the following page about the May 5, 1995, Dallas–Ft. Worth hailstorm event.

For the two questions that appear after the case study, record your responses on your group's flipchart.

Be prepared to share your responses with the class.

Small Group Activity: The Dallas Hailstorm

- Working with your table group, read the information on the following page about the May 5, 1995, Dallas-Ft. Worth hailstorm event.

- For the two questions that appear after the case study, record your responses on your group's flipchart.

- Be prepared to share your responses with the class.

Scenario: May 5, 1995

On Friday, May 5th 1995, a powerful Springtime North Texas thunderstorm complex struck in the worst possible place (a major metropolitan area) during the worst possible time (a Friday evening during a major outdoor event). The Dallas-Fort Worth Metroplex endured its worst hailstorm ever and its most deadly flash flooding ever. The staggering results included a total of 21 fatalities and 510 injuries—all from a storm that was well forecast. The damages were estimated at $2 billion, making this one of the costliest hail storms in U.S. history. While most of the damage was unavoidable (large hail falling on automobiles and structures), the fatalities and injuries were mostly the result of people failing to respond appropriately to warnings.

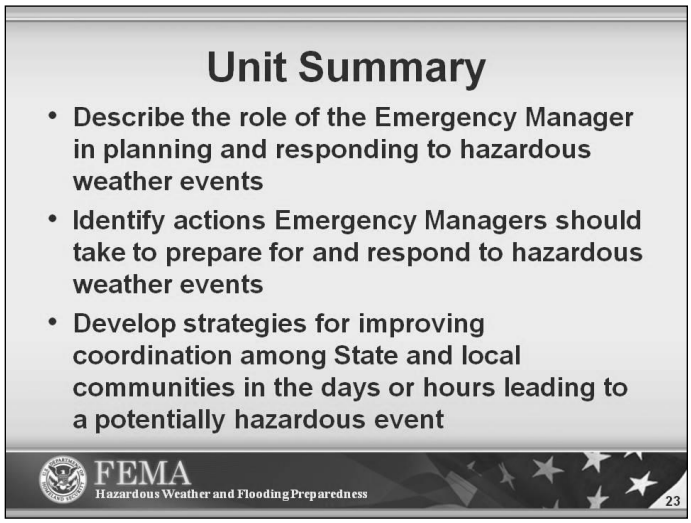
In the late afternoon, an isolated thunderstorm formed in a warm, moist, highly unstable air mass ahead of a squall line approaching Tarrant County. (See the radar images on the following page.) Favorable winds in the lower and middle levels of the atmosphere (from the surface to around 12,000 feet) helped the thunderstorm develop storm-scale rotation and a powerful, sustained updraft. A supercell capable of generating one or more tornadoes was born. Additionally, the squall line, a solid line of strong thunderstorms, was overtaking the supercell and exhibited a “bow echo” signature, indicative of damaging straight-line winds. The supercell generated baseball- to softball-sized hail across downtown Fort Worth. More than 500 people were injured by hail at the annual Mayfest celebration, an outdoor event in downtown Fort Worth, when they were caught without shelter.

The NWS Office in Ft. Worth issued a severe thunderstorm warning for Tarrant County 15 minutes before the first reported hail fell. They issued frequent statements updating the storm’s movement.

That evening the squall line overtook the supercell in eastern Tarrant County and the storm complex slowed. As night fell the slower movement of the merged supercell/squall line caused torrential downpours from eastern Tarrant County across most of Dallas County. Rainfall rates of more than three inches per ½-hour resulted in flash flooding. Many who drowned were attempting to drive through flooded low-water crossings or were abandoning their stalled vehicles.

1. As an Emergency Manager, what responsibilities would you have for detecting, warning, and responding to this event?

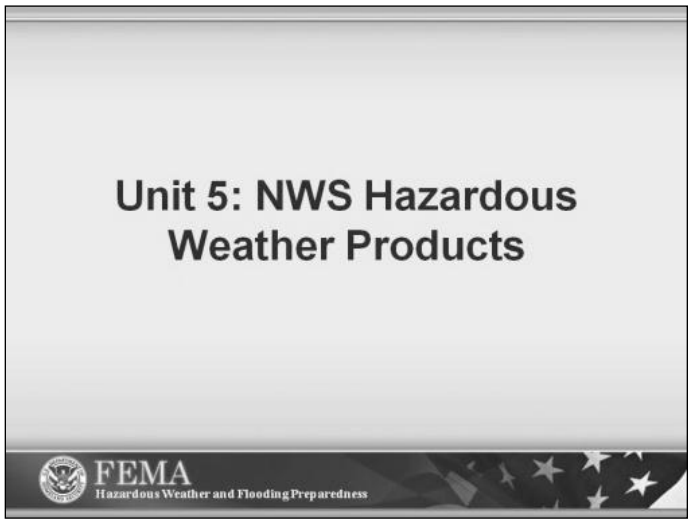
2. What personnel or agencies would you have coordinated with prior to and during this event? Why?



The purpose of this unit was to discuss the role of Emergency Managers in preparing for and responding to hazardous weather events. This unit also discussed ways to improve coordination and communication with State and local agencies when hazardous weather threatens.

Fact sheets on specific weather events and the hazards they can cause are included in the Appendices section of your Student Manual.


Appendix D



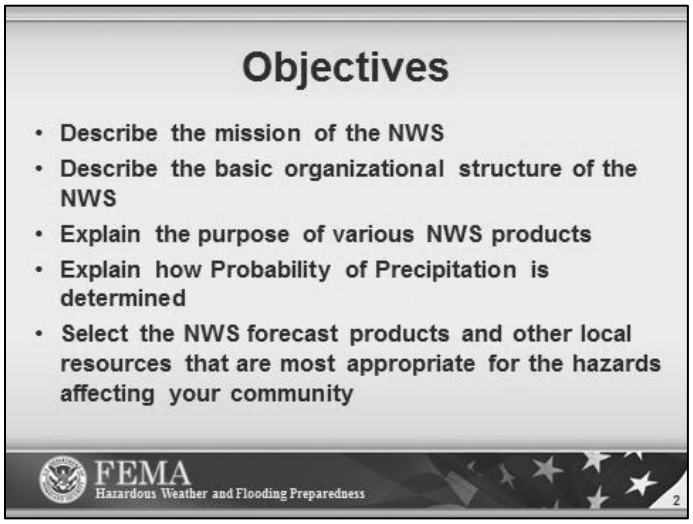
Unit 5

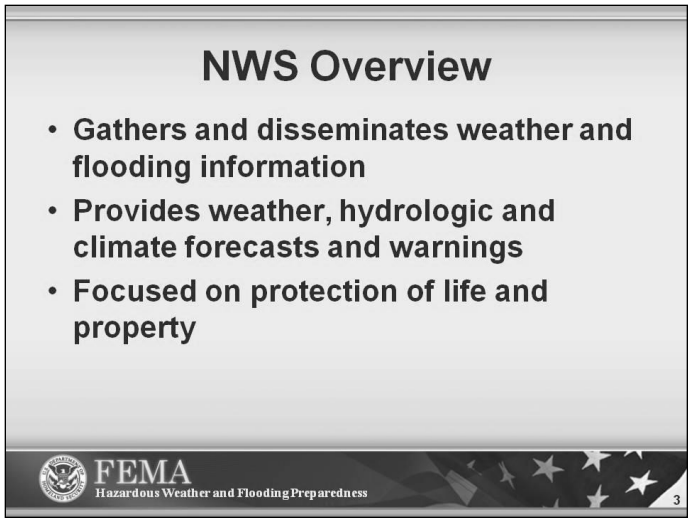
In this unit you will interpret information contained in National Weather Service forecast and warning products and other weather resources.

This unit will address how to select, obtain, and interpret locally relevant information about hazardous weather and flooding, especially information that is available through the National Weather Service (NWS).

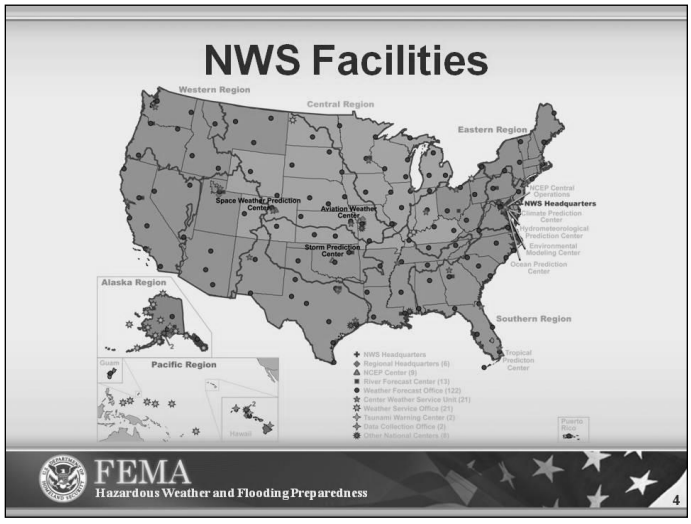
The NWS Products and Services Reference Guidebook provides information about NWS hazardous weather products, including tables that indicate under what conditions the products will be issued and the typical lead times.

NWS Products and Services Reference Guidebook

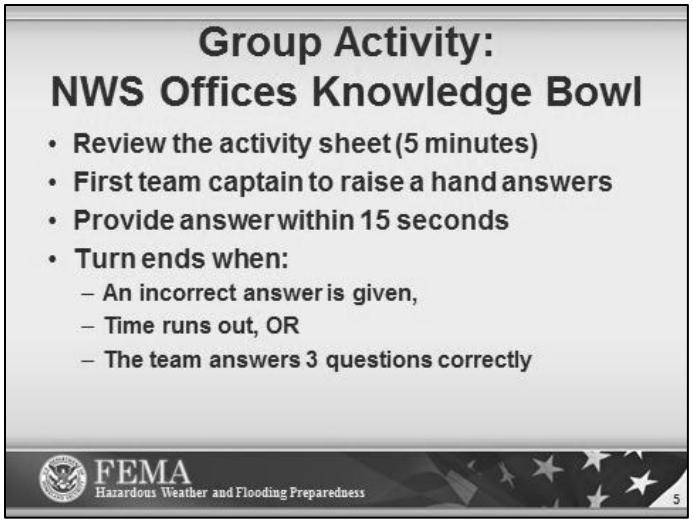




The National Weather Service's (NWS) mission is to provide weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure, which can be used by other governmental agencies, the private sector the public, and the global community.



NWS gathers and disseminates hazards information through a network of local offices and specialized national centers. This topic will identify the NWS network of offices, local resources, and dissemination methods.



The class will be separated into two groups. Each will choose a team captain who will relay the group's answer.

Your group will review the information on the NWS Offices Knowledge Bowl Activity sheet in the Student Manual.

Your group will have five minutes to familiarize themselves with the NWS offices.

The first group whose team captain raises his/her hand gets to answer the question.

If the team gets the question right, they get to answer another question. If the team gets the question wrong, the other team has the opportunity to answer.

Once a team has answered a total of three questions in a row correctly, the next question automatically goes to the other team.

Teams earn one point per question answered correctly. The instructor will keep score and announce the winning team at the end of the activity.

Group Activity: NWS Offices Knowledge Bowl

NWS Offices

Center Weather Service Units (CWSUs)

There are 21 Center Weather Service Units (CWSUs) that operate in cooperation with the Federal Aviation Administration (FAA). There are four CWSUs in the Eastern Region, five in the Central Region, seven in the Southern Region, four in the Western Region, and one in the Alaska Region.

The main responsibility of a CWSU is to provide weather support and consultation to FAA air traffic managers and controllers. Rerouting of aircraft around hazardous weather is based largely on forecasts provided by the CWSU meteorologist. Special emphasis is given to those weather conditions that would be hazardous to aviation or would impede the flow of air traffic in the National Airspace System. CWSU meteorologists also issue Center Weather Advisories (CWA). CWAs are aviation weather warnings for thunderstorms, icing, turbulence, and low ceilings and visibilities.

National Center for Environmental Prediction (NCEP)

The National Center for Environmental Prediction (NCEP) is made up of the following offices:

- Aviation Weather Center
  - The Aviation Weather Center provides aviation warnings and forecasts of hazardous flight conditions at all levels within domestic and international air space.
- Climate Prediction Center
  - The Climate Prediction Center monitors and forecasts short-term climate fluctuations and provides guidance information on the long-term global effects climate patterns can have on the nation.
- Environmental Modeling Center
  - The Environmental Modeling Center develops and improves numerical weather, climate, hydrological and oceanic predictions through programs of applied research in data analysis, modeling, and product development in partnership with the broader research community.
- Hydrometeorological Prediction Center
  - The Hydrometeorological Prediction Center provides analysis and forecast products, specializing in quantitative precipitation forecasts to five days in advance, weather forecast guidance to seven days in advance, real-time weather model diagnostics discussions, and surface pressure and frontal analyses.

- National Hurricane Center
  - The National Hurricane Center provides official NWS forecasts of the movement and strength of tropical weather systems and issues the appropriate watches and warnings for the US and surrounding areas. The National Hurricane Center is located in Miami, Florida.
  - **NOTE:** The NWS also operates a **Central Pacific Hurricane Center**, co-located with the WFO in Honolulu, HI, that provides information concerning tropical cyclones in the Central Pacific basin, between 140 degrees West to the International Dateline, including Hawaii. The U.S. Navy operated **Joint Typhoon Warning Center** monitors the Pacific Region west of the International Dateline as well as the Indian Ocean.
- NCEP Central Operations (NCO)
  - The NCEP Central Operations sustains and executes the operational suite of the numerical analysis and forecast models and prepares NCEP products for dissemination. It also links all nine of the national Centers together via computer and communications-related services.
- Ocean Prediction Center
  - The Ocean Prediction Center issues weather warnings and forecasts out to five days in advance, in graphic, text, and voice formats for the Atlantic and Pacific Oceans.
- Space Weather Prediction Center
  - The Space Weather Prediction Center provides space weather alerts and warnings for disturbances that can affect people and equipment working in space and on earth. The Space Weather Prediction Center is located in Boulder, Colorado.
- Storm Prediction Center
  - The Storm Prediction Center (SPC) provides tornado and severe weather watches for the contiguous United States along with a suite of hazardous weather forecasts, mesoscale guidance products, and a continuous watch on mesoscale atmospheric processes. The SPC works closely with NOAA's National Severe Storms Laboratory (NSSL). NSSL applies research to advance the understanding of weather processes, improve forecasting and warning techniques and to develop operational applications. Both SPC and NSSL are located in Norman, Oklahoma.

National Climatic Data Center (NCDC)

NOAA's NCDC is the world's largest active archive of weather data. Its mission is to provide access and stewardship to the nation's resource of global climate and weather-related data, and also to assess and monitor climate variation and change. This effort requires the acquisition, quality control, processing, summarization, dissemination and preservation of a vast array of climatological data generated by the national and international meteorological services. The NCDC maintains our nation's snow climatology which is applied in FEMA's snow policy in the disaster declarations process.

National Operational Hydrologic Remote Sensing Center (NOHRSC)

Located in Chanhassen, Minnesota, the NOHRSC provides remotely-sensed and modeled hydrology products for the conterminous U.S. and Alaska. NOHRSC airborne, satellite, and modeled snow data and products are used by NWS RFCs, WFOs, as well as other government agencies to support operational and research hydrology programs. Their observed snow data maps are useful for the disaster declaration process.

National Weather Service (National) Headquarters (NWSH)

NOAA NWS maintains a national headquarters in Silver Spring, MD. This is where the Director and Deputy Director of the NWS oversee the organization. There are several offices within NWSH that work policy, service and operational issues. These offices include: the Office of Operational Systems, NWS Communications, NWS Public Affairs, the Office of Strategic Planning and Policy, the Office of Science and Technology, the Office of Hydrological Development, and the Office of Climate, Weather, and Water Services (OCWWS). It is OCWWS that works national issues with FEMA, the National Emergency Management Association (NEMA), the International Association of Emergency Managers (IAEM) and other national partners.

National Weather Service Regional Headquarters

There are six Regional Headquarters in the NWS: Eastern (Bohemia, NY), Southern (Fort Worth, TX), Central (Kansas City, MO), Western (Salt Lake City, UT), Alaska (Anchorage, AK) and Pacific (Honolulu, HI). Each Regional Headquarters has its own Director. The NWS Regional Headquarters oversee policy, service and operational issues for the NWS offices in their Regional areas of responsibility. They represent and coordinate regional issues to NWS national headquarters.

River Forecast Centers (RFCs)

There are 13 River Forecast Centers (RFCs). Responsibilities of the RFCs include:

- Issuing river stage and flood guidance based on computer models
- Providing hydrologic forecast guidance and technical support to Weather Forecast Offices (WFOs)
- Running dam break models, providing expert assistance, and performing dam failure analyses for dams that pose an imminent threat to the safety of the residents downstream from the dam
- Providing water supply outlooks to water resource managers

The following RFCs are currently in operation:

- Alaska/Pacific RFC
- Arkansas-Red Basin RFC
- California-Nevada RFC
- Colorado Basin RFC
- Lower Mississippi RFC
- Middle Atlantic RFC
- Missouri River Basin RFC
- North Central RFC
- Northeast RFC
- Northwest RFC
- Ohio RFC
- Southeast RFC
- West Gulf RFC

Tsunami Warning Centers (TWCs)

There are two NOAA NWS Tsunami Warning Centers: The West Coast/Alaska Tsunami Warning Center (WC/ATWC) in Palmer, Alaska, and the Pacific Tsunami Warning Center (PTWC) in Ewa Beach, Hawaii. It is their responsibility to provide reliable tsunami detection, forecasts, and warnings and to promote community resilience.

Weather Forecast Offices (WFOs)

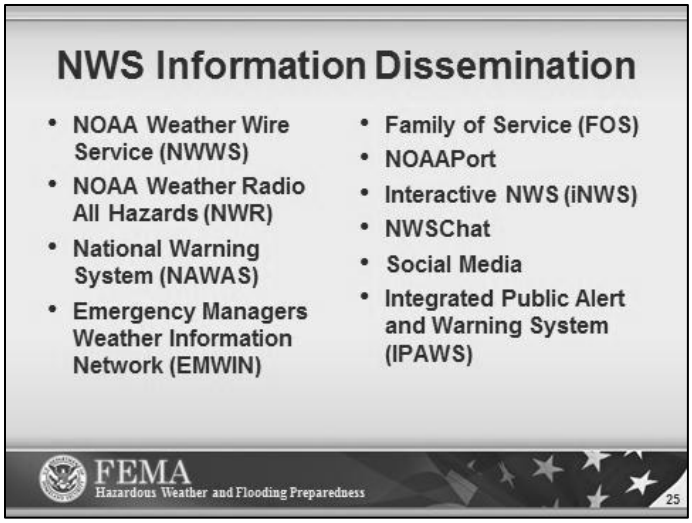
There are 122 Weather Forecast Offices (WFOs) across the country. Responsibilities of the WFOs include:

- Issuing all local forecasts and warnings
- Providing operational decision support to emergency managers
- Building and maintaining working relationships with local and state governments and the news media.
- Soliciting customer feedback on products and services
- Conducting community outreach and education programs
- Training volunteer observers and storm spotters

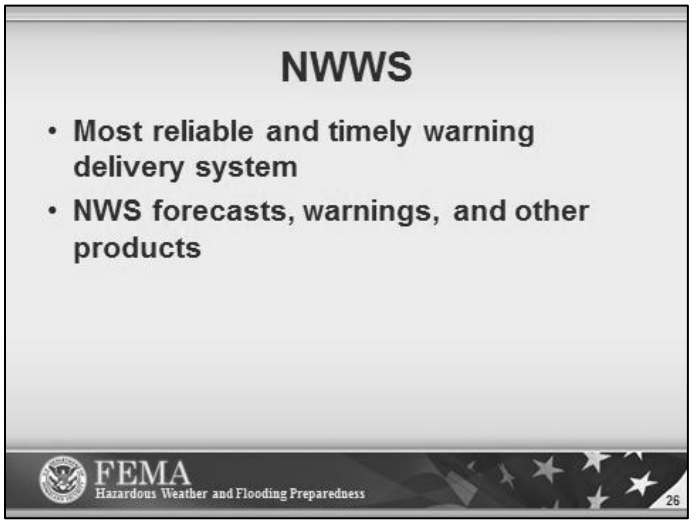
Weather Service Offices (WSOs)

There are 21 Weather Service Offices (WSOs). There is one WSO located in the Eastern Region, two in the Central Region, 12 in the Alaska Region, and six in the Pacific Region.

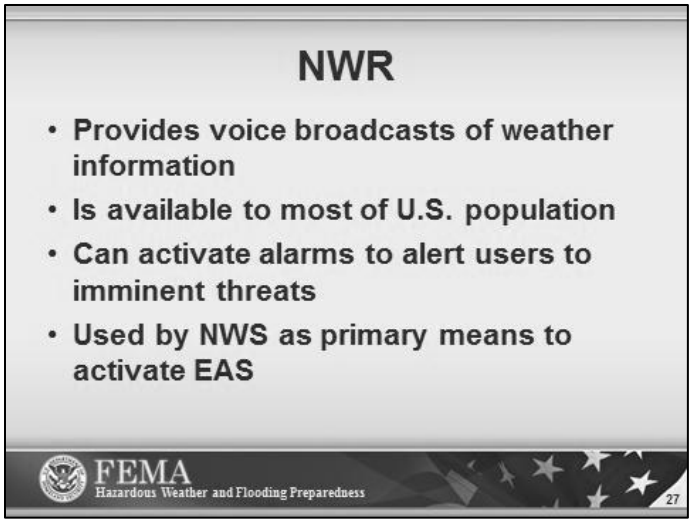
A WSO is an office that serves as a seamless extension of the Weather Forecast Office (WFO), providing their customers and partners with a high level of service and supporting the short term forecast and warning operations of the WFO through collaboration, coordination, observations, and outreach.



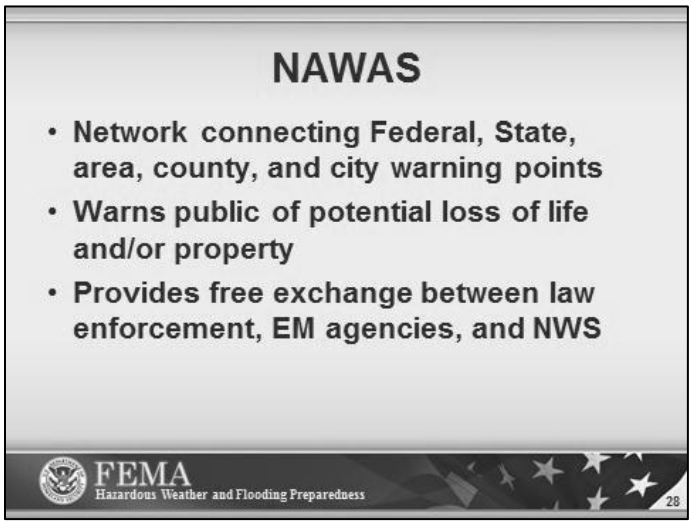
There are several methods used to disseminate NWS information.



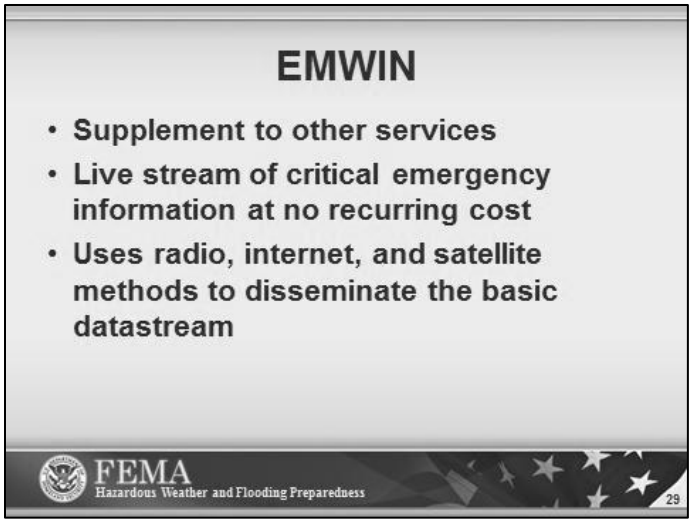
The NOAA Weather Wire Service is the primary telecommunications network for NWS forecasts, warnings, and other products to the mass media and emergency management agencies.



NOAA Weather Radio All Hazards provides voice broadcasts of weather information. During severe weather, National Weather Service forecasters can interrupt the routine weather broadcasts and insert special warning messages concerning imminent threats to life and property. These messages can activate built-in alarms on most weather radio receivers to alert the user of an imminent threat.

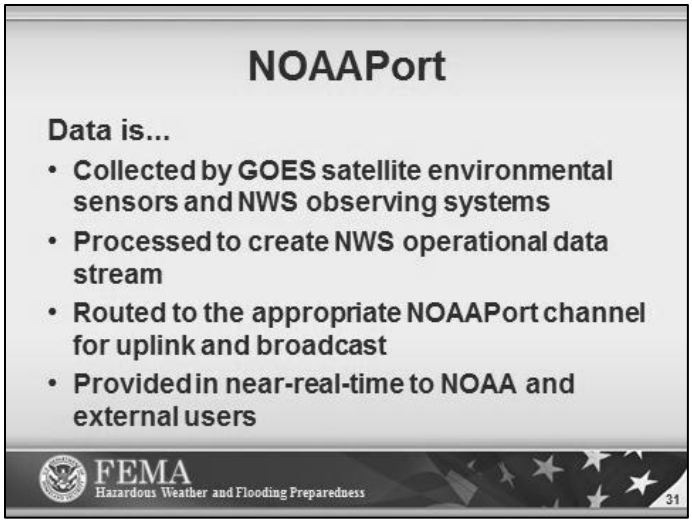


The National Warning System is a comprehensive party-line network of telephone circuits connecting Federal, State, area, and some county and larger city warning points throughout the U.S. FEMA uses NAWAS to warn the public, through local governments, about potential loss of life and/or property as a result of hazardous weather or other events.

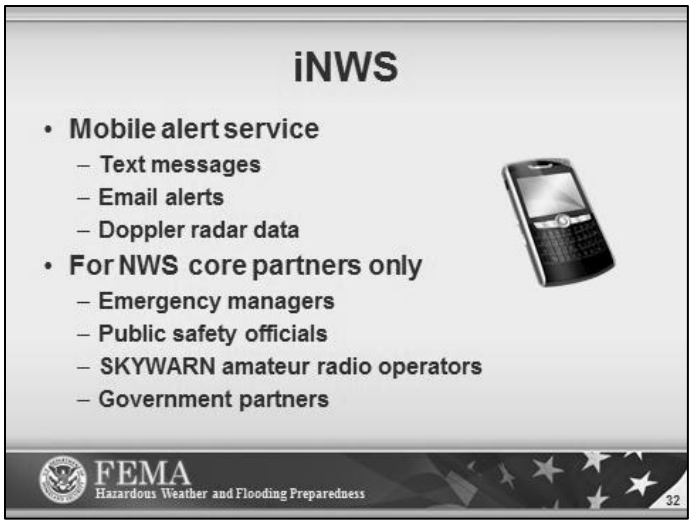


The Emergency Managers Weather Information Network is a supplement to other NWS dissemination services, intended to provide data to users who currently have none or who can afford very little. It also can provide EOCs with low-cost, redundant method for receiving weather information.

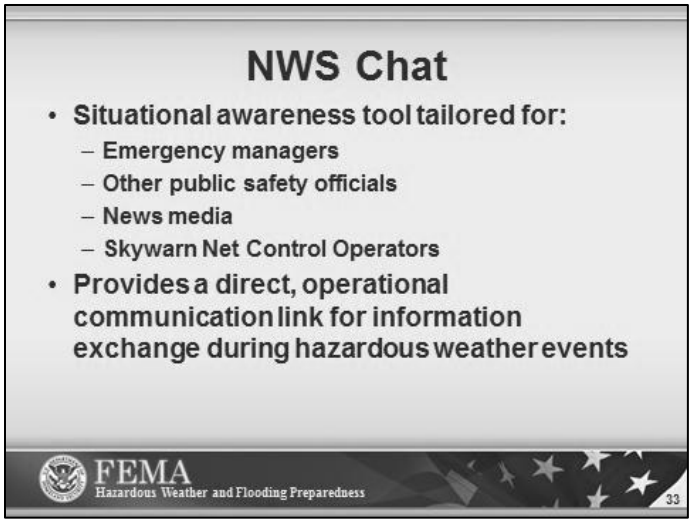
In 1983, the NWS Family Of Services (FOS) was established to make weather information available to external users. The FOS provides users access to near-real-time weather information on the NWS Telecommunications Gateway (NWSTG) using the Office of Operational System Network (OPSnet) located at NWS headquarters in Silver Spring, MD.



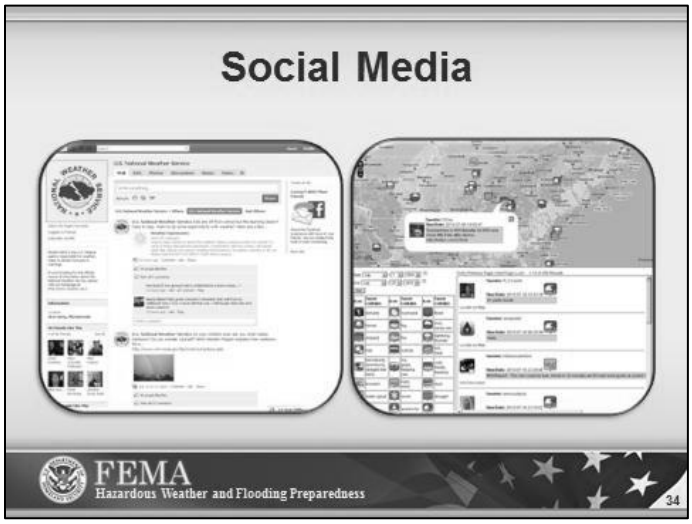
The NOAAPORT broadcast system provides a one-way broadcast communication of NOAA environmental data and information in near-real time to NOAA and external users. This broadcast service is implemented by a commercial provider of satellite communications utilizing C-band.



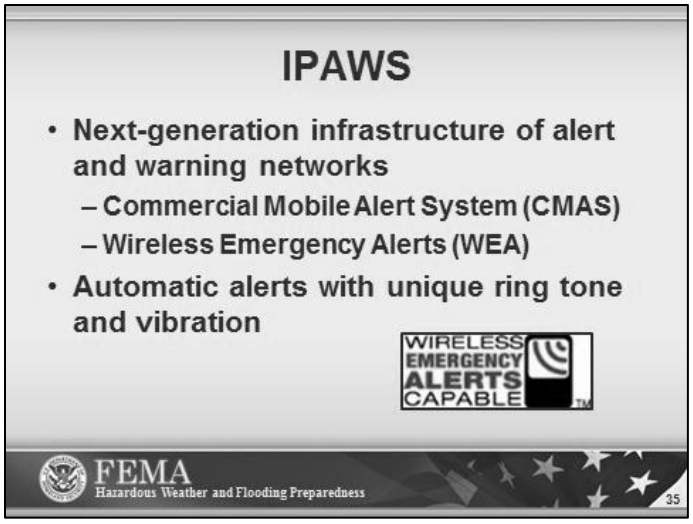
iNWS alerts allow users to configure and receive text message alerts and e-mail message alerts when the NWS issues a watch, warning or advisory that affects them.



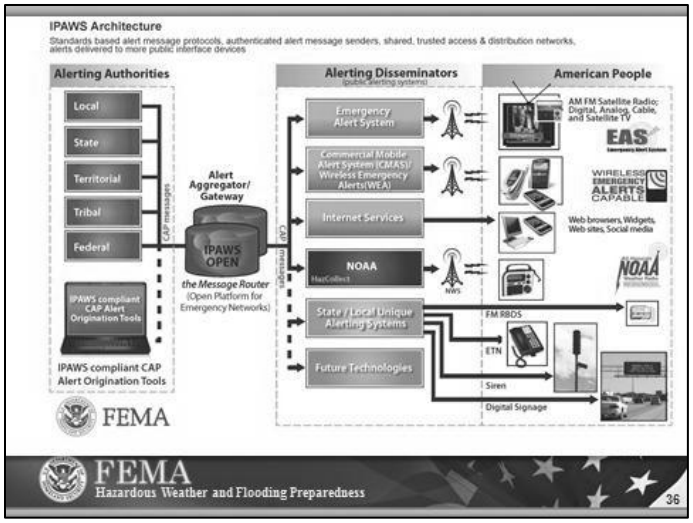
NWSChat is a situational awareness tool developed as a means of direct communication between the local NWS forecast office and broadcast meteorologists, emergency managers, other public safety officials, and Skywarn Net Control Operators.



NWS was working to create Facebook pages for each of its 122 Weather Forecast Offices. The NWS also has established an 'experimental' Twitter Storm Reports tool. All NWS Weather Forecast Offices also allow for weather spotter reports to be e-mailed to their office during and after events.



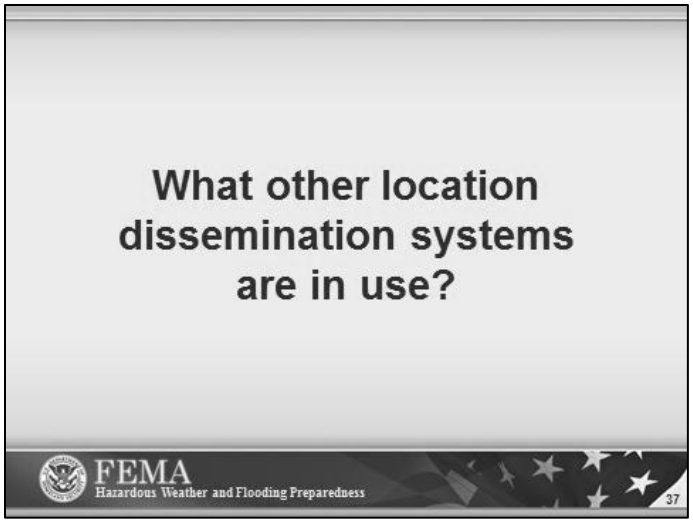
IPAWS is a comprehensive, coordinated, integrated system that can be used by authorized public officials, such as the NWS, to deliver effective alert messages to the American public.

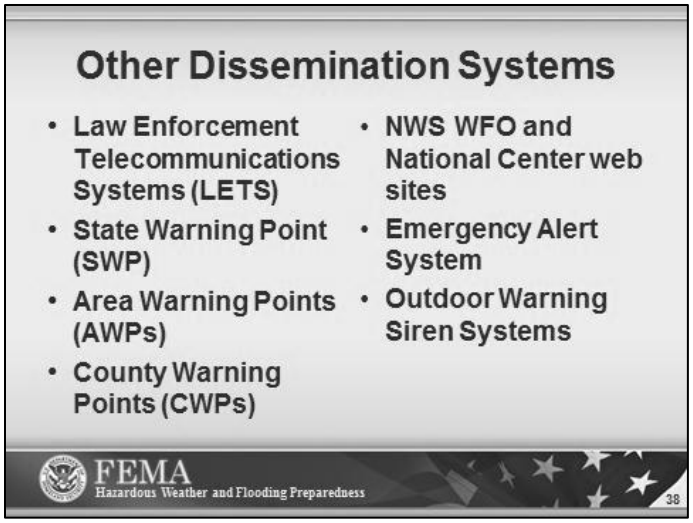


NWS warnings can be received through all IPAWS efforts including the Commercial Mobile Alert System (CMAS)/Wireless Emergency Alerts (WEA).

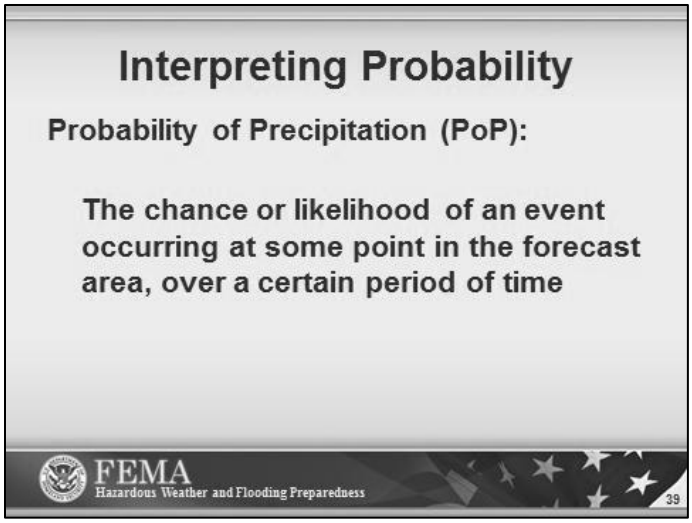
A list of websites for warning coordination and communication is included in the Appendices section of your Student Manual.

Appendix B

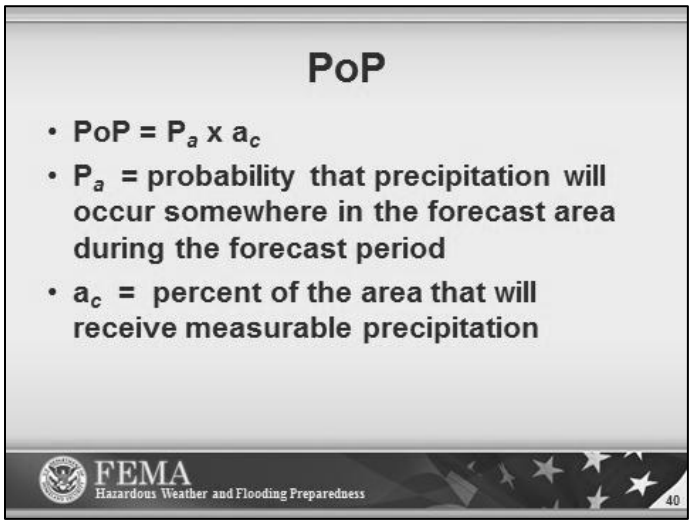




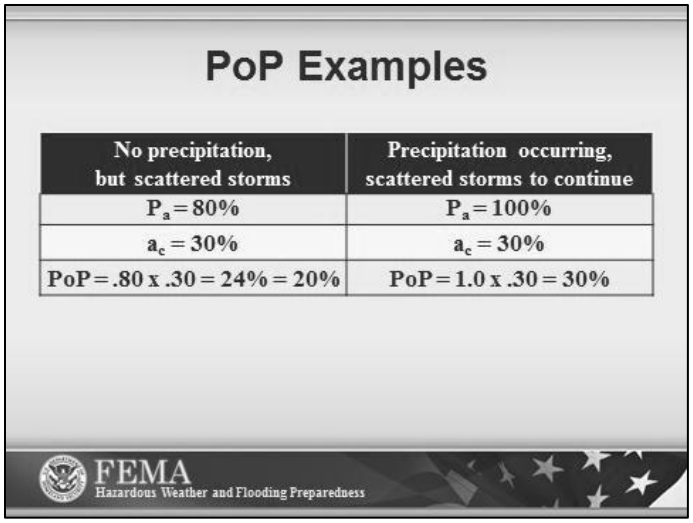
In many states, the local WFOs are able to disseminate forecast and warning products to the Law Enforcement Telecommunications System (LETS). This system automatically delivers critical weather information to multiple law enforcement offices across the state.



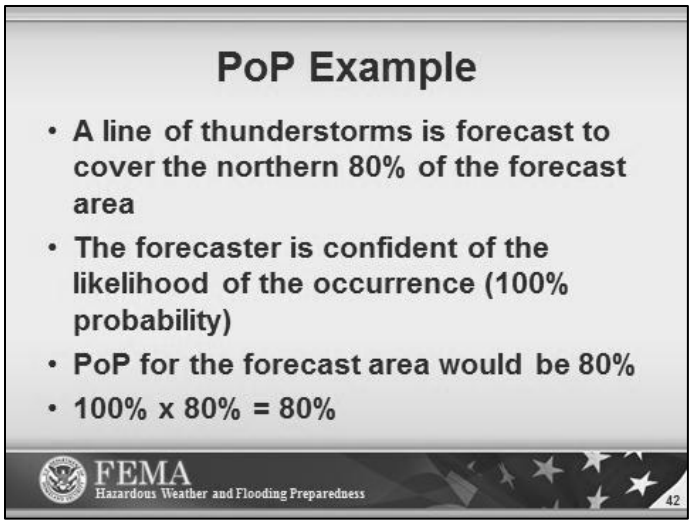
Probability of Precipitation (PoP) describes the chance or likelihood of an event occurring at some point in the forecast area over a certain period of time, usually 12 hours.



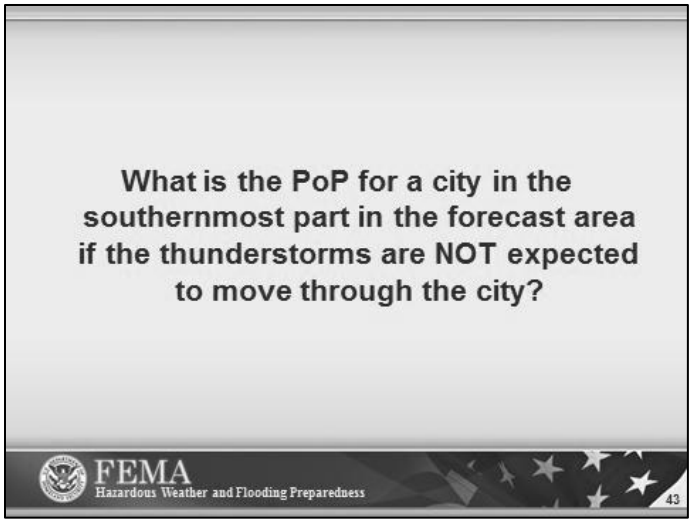
Mathematically, PoP is defined as: PoP = P_a x a_c



The probability of the event is determined by the forecaster based upon data received. For example, when no precipitation is occurring, but scattered storms are expected to develop, the NWS forecaster may be rather confident that precipitation will develop (probability 80%).

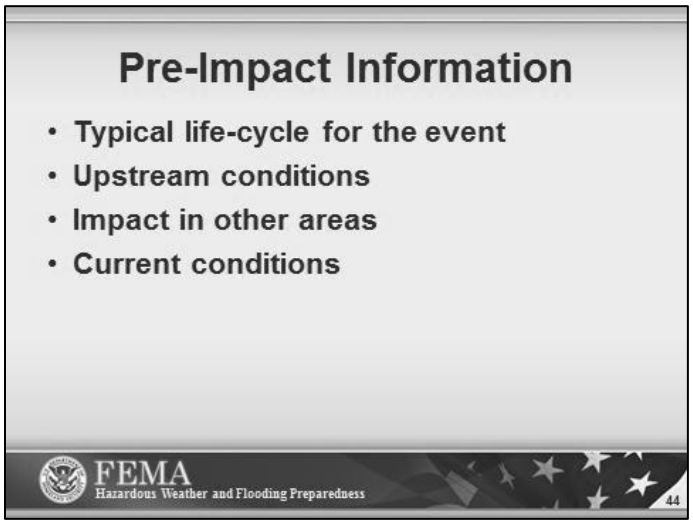


Use the information above to answer the question below.

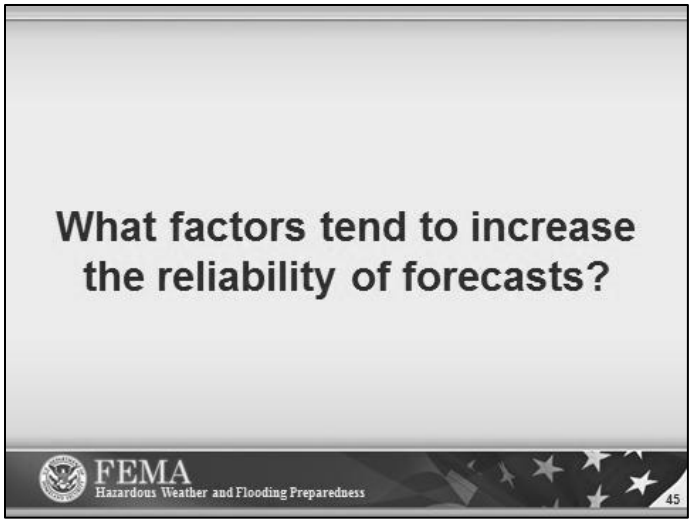


A table with descriptions of how different PoPs may be expressed in NWS forecast products (e.g., 20% probability = "slight chance" and/or "isolated") is included in the "Tables and Definitions" section of the NWS Products and Services Reference Guidebook.

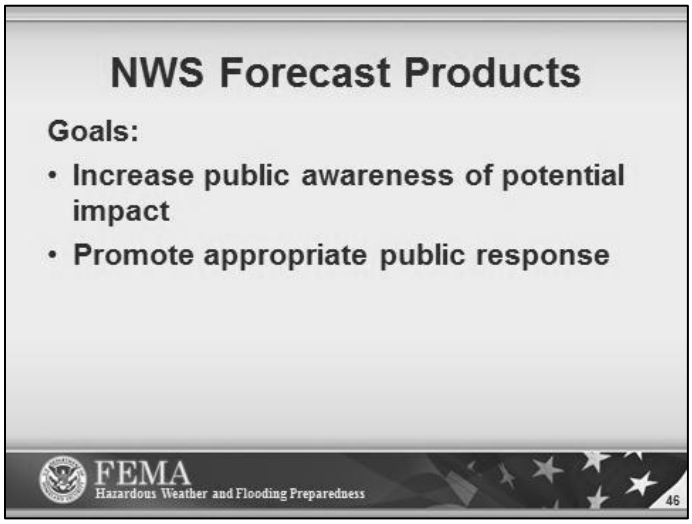
NWS Products and Services Reference Guidebook



In determining probability, also consider information that is available prior to the impact of an event. Information about the effects in areas that have already been struck by an event can give you a good idea of what your community might face.



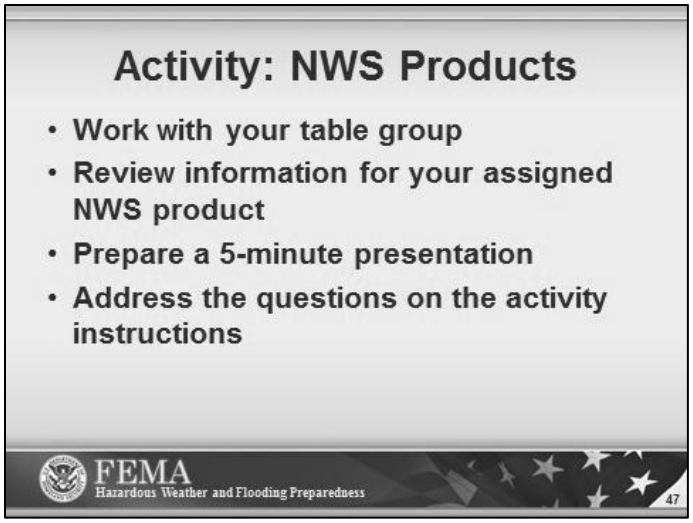
Technological advances have increased forecast reliability greatly over the past couple decades. Radar, satellite, and computer technology have made forecasting more reliable than ever before. Weather and atmospheric conditions now are also being observed from multiple perspectives providing more complete coverage.



NWS uses a tiered approach to inform the public about the probability of a hazardous weather event.

The NWS Products and Services Reference Guidebook, November 2010, includes a set of tables that breaks down every NWS watch, warning and advisory product: http://www.weather.gov/om/guide/

NWS Products and Services Reference Guidebook



In this activity, your class will be divided to work in your table groups. Each group will be assigned a different NWS product to examine and outline its features and uses for emergency managers.

Each group will review the information and sample product provided in Appendix E of the Student Manual corresponding to their product.

Appendix E

Group Activity: NWS Non-routine Products

In this activity, your table group will be assigned one of the NWS products to examine and outline its features and uses for emergency managers. When you are finished you will report-out what you have learned.

Review the information in Appendix E that corresponds to the non-routine product your group was assigned.

You will have 20 minutes to familiarize yourselves with the product your group was assigned, and then you will give a 5-minute presentation to the class outlining its features and uses for emergency managers.

Your presentation should answer the following questions:

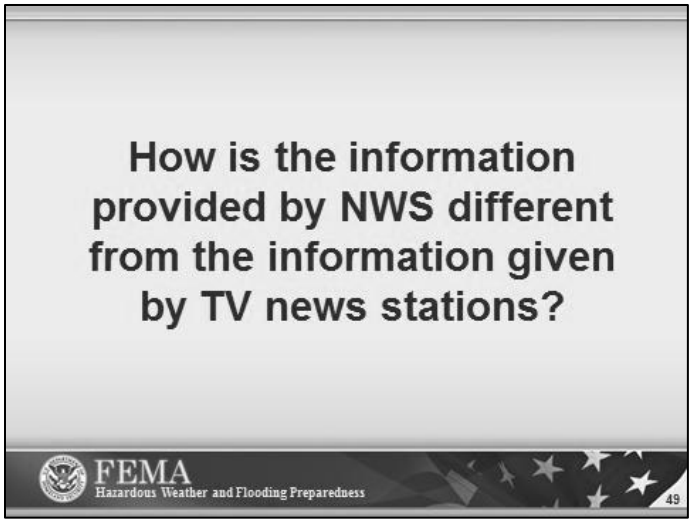
- ***Who issues the product?***

- ***What is the purpose of the product?***

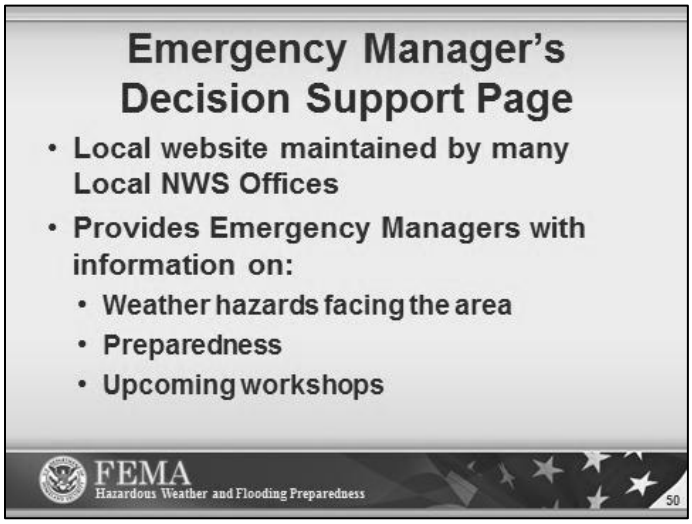
- ***Under what circumstances is the product issued?***

- ***How far into the future does the product project the forecast?***

- ***How can the product be used by Emergency Managers?***



While the organizational goals are different, the NWS relies on the news media as partners in hazardous weather warning dissemination.

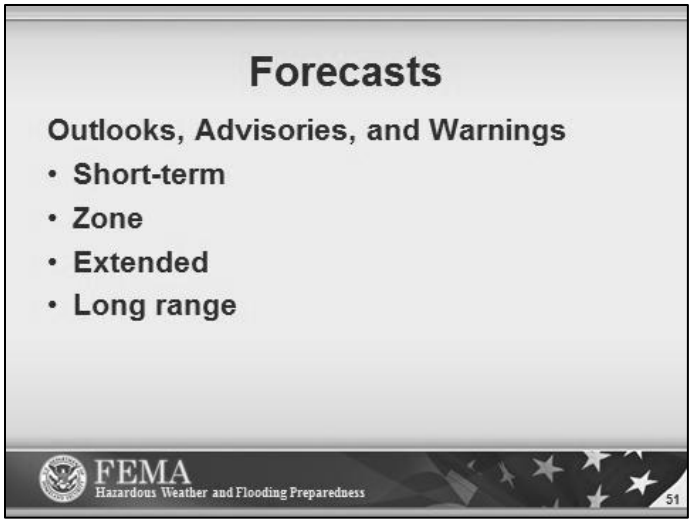


The Emergency Manager's Decision Support Page is a local website maintained by many local NWS offices. Examples are provided in Appendix B.

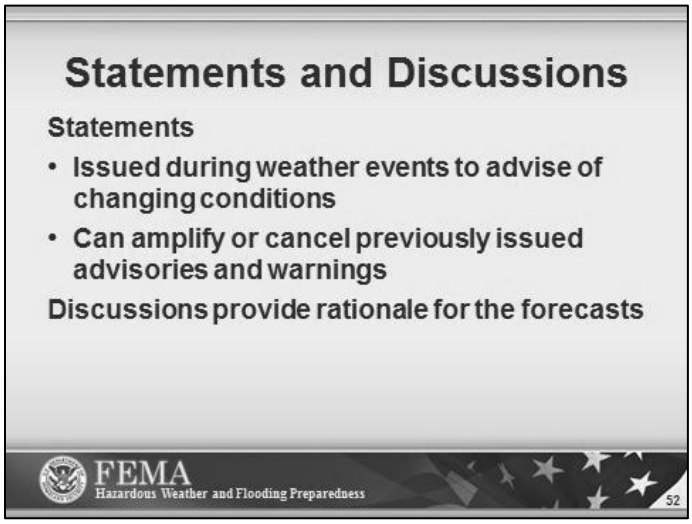
NWS issues other products that can help you monitor the weather situation on an ongoing basis. These products include:

- Forecasts
- Statements
- Discussions

Appendix B

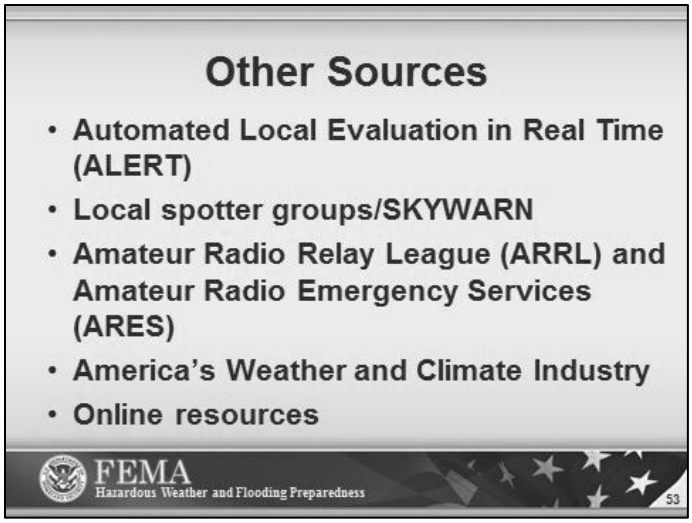


NWS issues a variety of forecasts that may include outlooks, advisories, watches, or warnings. The forecasts cover different lengths of time and are used for different purposes.

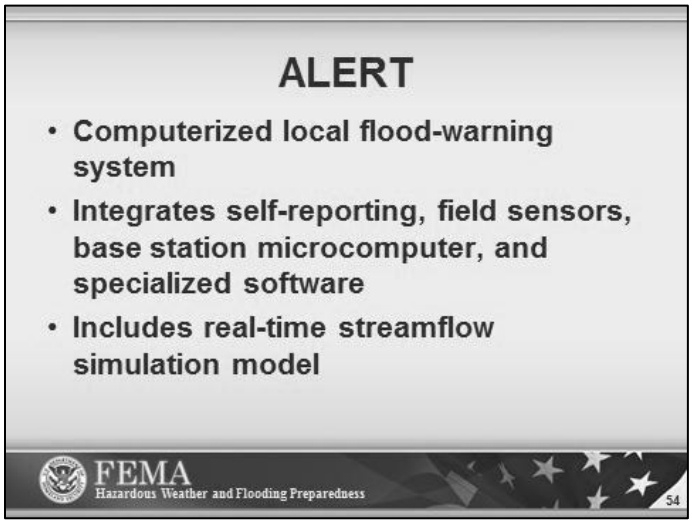


Statements are issued at frequent intervals during weather events to keep the public informed of changing conditions.

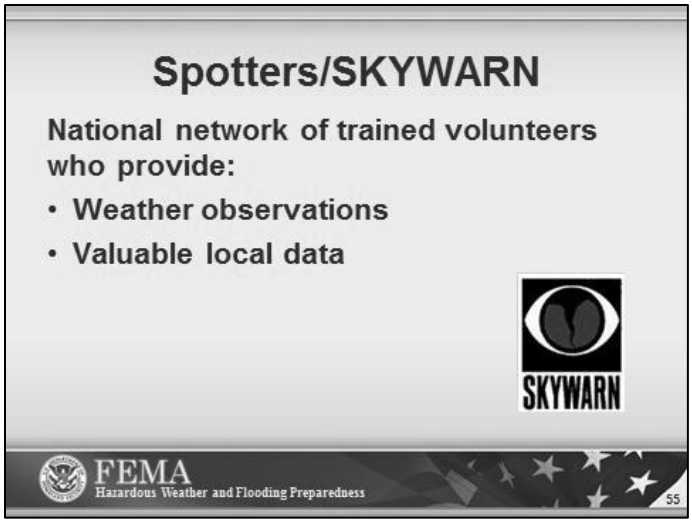
Discussions are intended for forecasters or those with a good understanding of hydrometeorology.



These sources are available at the local level, and several can be essential to improving your preparedness and response capabilities.

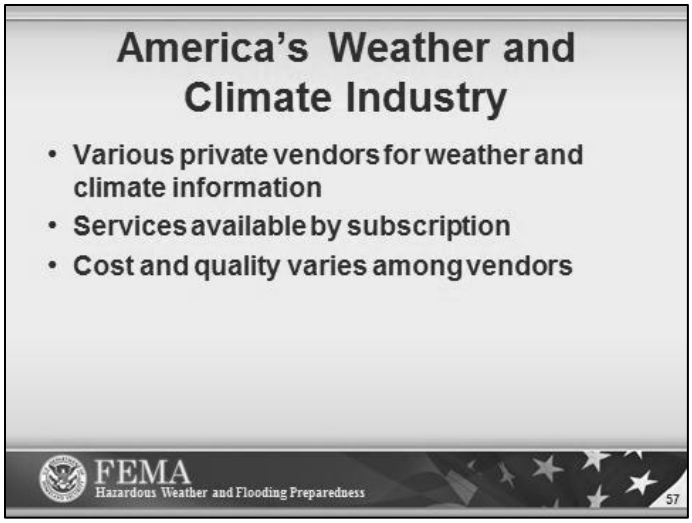


Automated Local Evaluation in Real Time (ALERT) is a computerized local flood-warning system developed by the California-Nevada River Forecast Center. The system integrates self-reporting field sensors, a base station microcomputer, and specialized software that includes a real-time streamflow simulation model into a zero-lag-time local flood warning system.

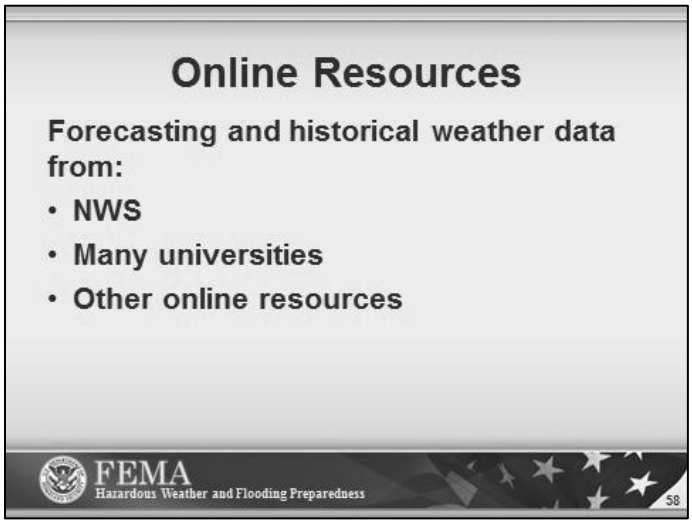


Local spotter groups or the SKYWARN network of spotters can provide valuable local data. SKYWARN is a national network of volunteer weather observers, law enforcement personnel, and other individuals who provide current weather observations to the local NWS office via phone or amateur radio.

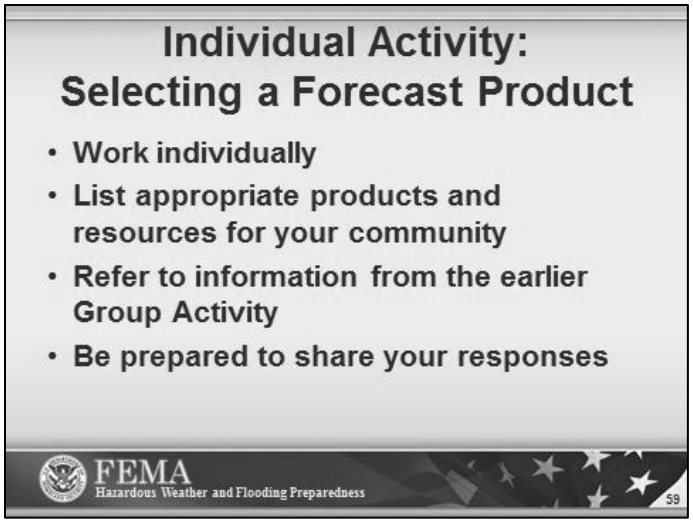
During an emergency, your local ARRL and ARES groups can provide one of the most valuable resources you'll need: communication. Amateur radio operators, also known as "hams," can open the lines of communication at a time when traditional methods are likely to be nonoperational.



There are also many various types of private vendors for weather and climate information. These vendor services are available by subscription. The cost of the subscription and the quality of forecast products vary among the vendors. Be sure to consider all factors carefully when selecting a private vendor.



The Internet provides a vast amount of forecasting and historical weather data. The NWS and many universities maintain their own weather-related sites.



You can find the instructions for this activity located on the next page of this Student Manual.

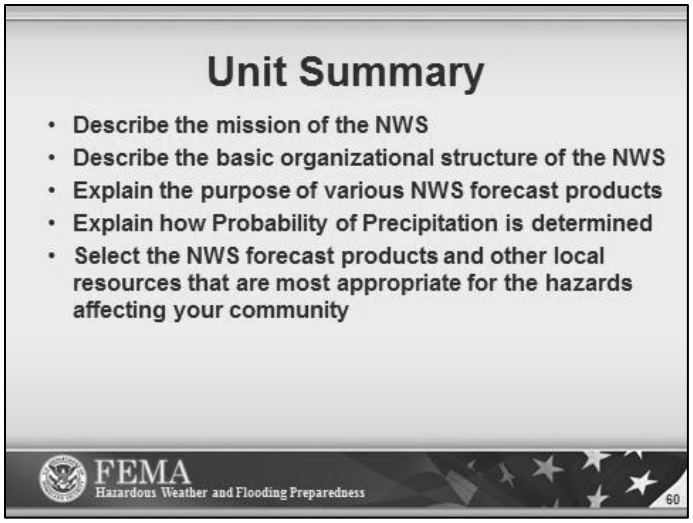
Individual Activity: Selecting Forecast Products and Resources

In this activity, you will work individually to choose products that are appropriate for use in your community. Use the information provided by each group during their *Group Activity: NWS Non-routine Products* presentations as a reference. You will have 10 minutes to complete this activity. Be prepared to share your responses in a group discussion when you are finished.

- ***List three hazardous weather events to which your community is particularly vulnerable.***

- ***List the forecast products that will help you be prepared for those events.***

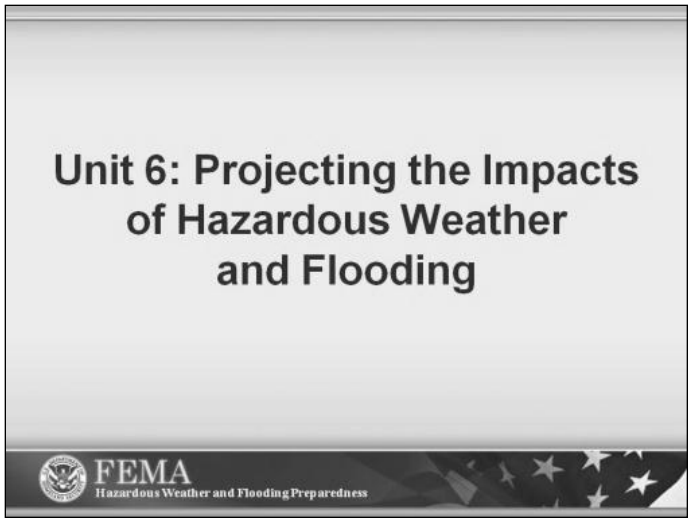
- ***List the local resources that will help you be prepared for those events.***



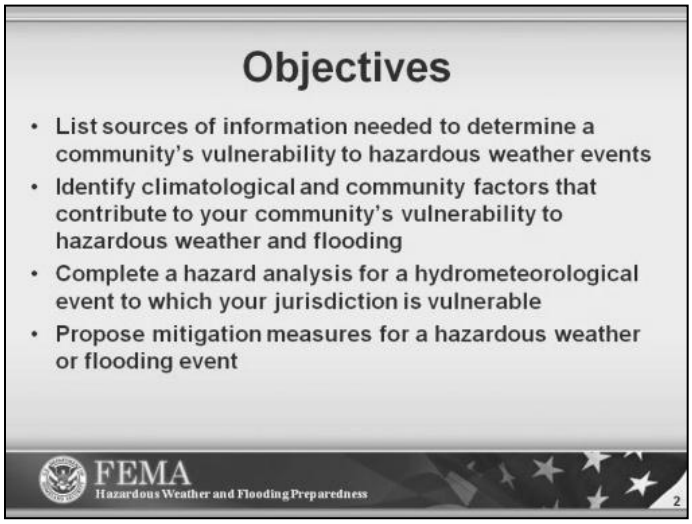
The purpose of this unit was to help you learn to interpret the information contained in the National Weather Service forecast products and other weather resources.

Questions for Consideration

- ***What office is your primary access point for obtaining NWS weather information?***
- ***What NWS office is best equipped to provide guidance on flooding and flash floods?***
- ***From what office do you obtain watches, warnings, and advisories for the local area?***
- ***Name four dissemination networks for NWS information?***
- ***What is the main factor that limits forecast accuracy?***
- ***As an Emergency Manager, what steps would you take after you receive a Tornado Watch?***
- ***As an Emergency Manager, what steps would you take after you receive a flood warning?***

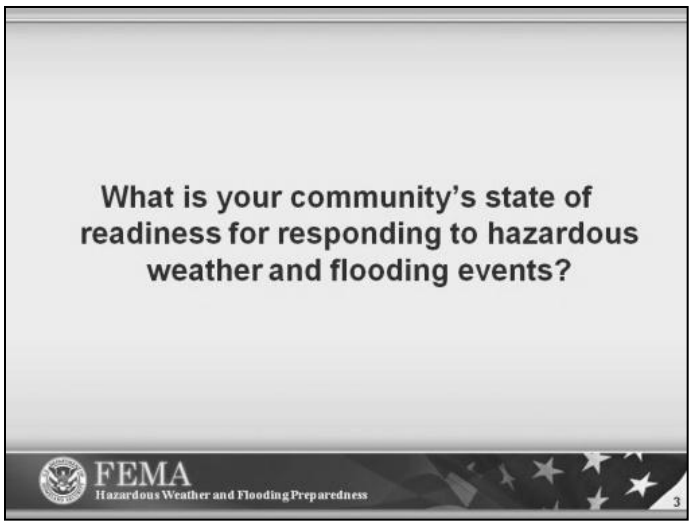


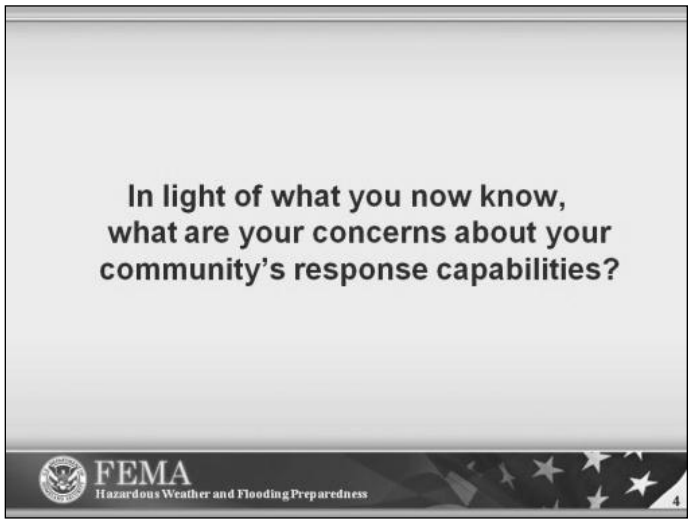
In this unit, you will have an opportunity to consider local factors that contribute to the risk that your communities face from hazardous weather and flooding events.

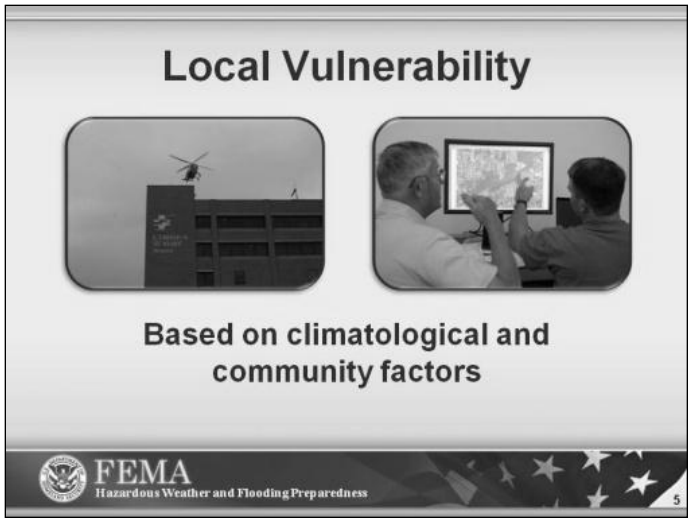


Unit 6

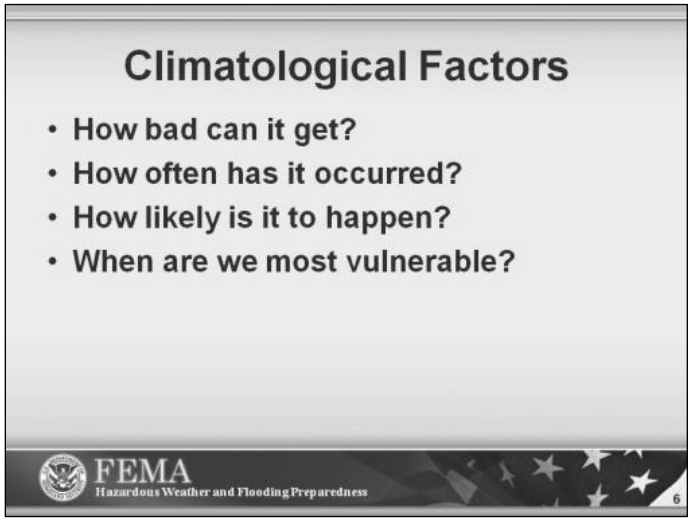
The purpose of this unit is to give you an opportunity to consider local factors that contribute to the risk that your communities face from hazardous weather events.

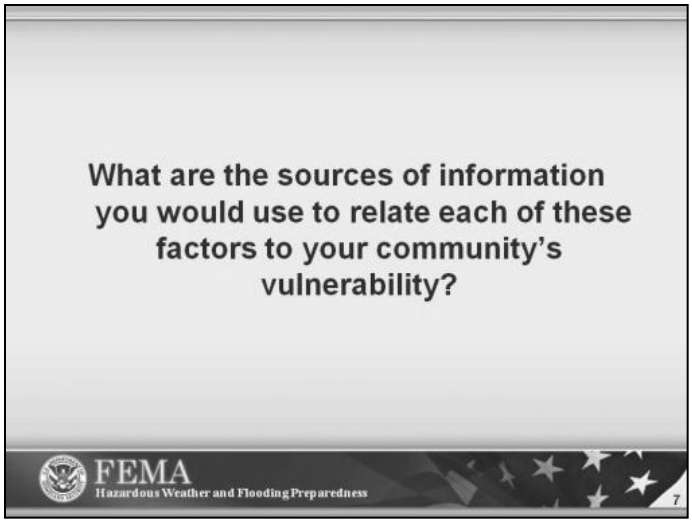

What is your community's state of readiness for responding to hazardous weather and flooding events?
FEMA
Hazardous Weather and Flooding Preparedness
3


In light of what you now know, what are your concerns about your community's response capabilities?
FEMA
Hazardous Weather and Flooding Preparedness
4



An important aspect of preparing for emergency response is understanding your jurisdiction's vulnerability to hazardous weather and flooding events.





You must also consider community factors when assessing the potential impact of hazardous weather and flooding in your communities.

You will find the instructions and worksheets for this activity located on the next several pages of the Student Manual.

Individual Activity: Analyzing Threats

During this activity, you will work independently to complete an analysis of a specific hydrometeorological event using threat analysis worksheets. Then, you will evaluate how effective your community's EOP is for addressing the event.

You may refer to your local EOP, the Student Manual Appendices, and any other references you wish to complete this activity, following the instructions below:

- Complete the Analyzing Threats worksheets for the hydrometeorological event selected for this exercise.
- For each factor listed, complete the analysis and comment in the columns provided on the worksheets.
    - Note: To fully and accurately complete the analysis, you will need access to historical data for your jurisdiction. For the purposes of this class, complete the tables to the best of your ability with all known information.
    - These tables can serve as a good starting point for a full analysis when you return home to your jurisdiction.
- When you have completed the worksheets, answer the questions on the Summary Worksheet about your community's local planning and response capability.
- Be prepared to discuss your responses with the class.
- You will have 45 minutes to complete this activity.

ANALYZING THREATS

THREAT ANALYSIS WORKSHEETS

Threat: _____

Climatological Factors	Analysis	Area Potentially Impacted	Comments
Maximum probable event or most likely significant threat		□ State □ Region □ County □ Community	
Worst ever event (Record precipitation, temperature, winds, flood crest, flood volume, destruction, etc.)	Record levels: Duration: Deaths: Injuries: Damage:	□ State □ Region □ County □ Community	
Average frequency of occurrence		□ State □ Region □ County □ Community	
Average loss per year from this type of event	Deaths: Injuries: Property: Other:	□ State □ Region □ County □ Community	
Percentile chance of occurrence		□ State □ Region □ County □ Community	
Months of peak occurrence	J F M A M J J A S O N D	□ State □ Region □ County □ Community	

ANALYZING THREATS

THREAT ANALYSIS WORKSHEETS (CONTINUED)

Threat: _____

Population Vulnerabilities	Analysis	Comments
Concentrations in vulnerable areas	Total population:	Concentrated areas:
Awareness level (for the type of event)	□ Low □ Medium □ High	Sources for public information:
Previous response experience (for the type of event)	□ None □ Moderate □ Extensive	Level of responsiveness to warnings: □ Little □ Moderate □ High
Special needs groups	□ Hearing impaired □ Physically impaired □ Non-English speaking □ Elderly □ Tourist □ Other:	Implications for Warning: Response:
Risk associated with population distribution	□ Floodplain □ Storm surge inundation area □ Canyon □ Mudslide area □ Avalanche □ Isolated □ Other:	
Other risk factors affecting the population	□ Seasonal shift □ Time-of-day shift □ Day-of-week shift	

Property Vulnerabilities	Analysis	Comments
Do building codes promote hazard-resistant construction?	□ Yes □ No □ Somewhat	Potential code related issues:
Are the building codes strictly enforced?	□ Yes □ No □ Somewhat	
Are there concentrations of properties that are vulnerable to specific events (e.g., beachfront properties)?	□ Yes □ No	Describe (facility, location, and risk):
Are there facilities that pose a risk of “cascading” events (e.g., hazardous materials facilities)?	□ Yes □ No	Describe (facility, location, and risk):
What critical facilities are located in the community?	□ Fire Stations □ Police precincts □ Public works yards □ Water treatment facilities □ Utilities substations □ Government buildings □ Shelters □ EOC □ Other:	Consider: Location Construction Age Use/Population Present
What other key facilities exist in the community?	□ Hospitals/nursing homes □ Schools/universities □ Convention centers, stadiums, arenas □ Military installations □ Other:	Consider: Location Construction Age Use/Population Present

Population Vulnerabilities	Analysis	Comments
Do any facilities present special problems for warning, response, or recovery?	☐ Yes ☐ No	Describe (facility, location, and problem):
Are any facilities especially vulnerable to this type of hazard?	☐ Yes ☐ No	Describe (facility, location, and vulnerability):

Resources	Analysis	Comments
Where are your community's key resources (i.e., people, tools, and equipment) located?		Describe location:
Are the key resources located where they will be needed to respond to the main hazardous weather and flooding events?	☐ Yes ☐ No	Describe:

Infrastructure Vulnerabilities	Analysis	Comments
Are communication systems vulnerable?	☐ Yes ☐ No	Describe vulnerability:
Are power systems vulnerable?	☐ Yes ☐ No	Describe vulnerability:
Are water and/or sewer systems vulnerable?	☐ Yes ☐ No	Describe vulnerability:

Infrastructure Vulnerabilities	Analysis	Comments
Are transportation systems (including bridges, tunnels, and rail lines) vulnerable?	☐ Yes ☐ No	Describe vulnerability:
Is the community dependent on vulnerable transportation routes for evacuation, rescue, etc.?	☐ Yes ☐ No	Identify vulnerable routes and preparedness options:
Does the community's infrastructure pose any special threats for warning, response, and/or recovery?	☐ Yes ☐ No	Identify threats for Warning Response Recovery

Geography And Topography	Analysis	Comments
Do geographic/topographic features add to the jurisdiction's vulnerability (e.g., mountain effects, floodplains, lake effect, altitude, etc.)?	☐ Yes ☐ No	Describe the impact caused by geography and/or topography:

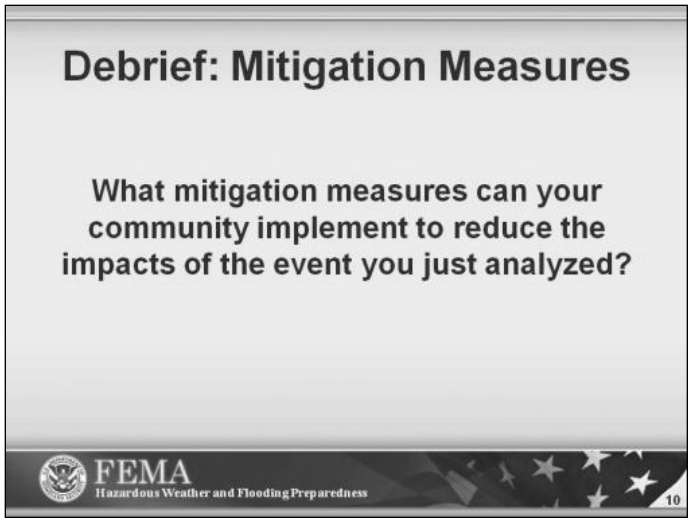
ANALYZING THREATS

SUMMARY WORKSHEET

Based on your analysis of the event, as completed on the previous pages, review your community's Emergency Operations Plan (EOP) and answer the questions below.

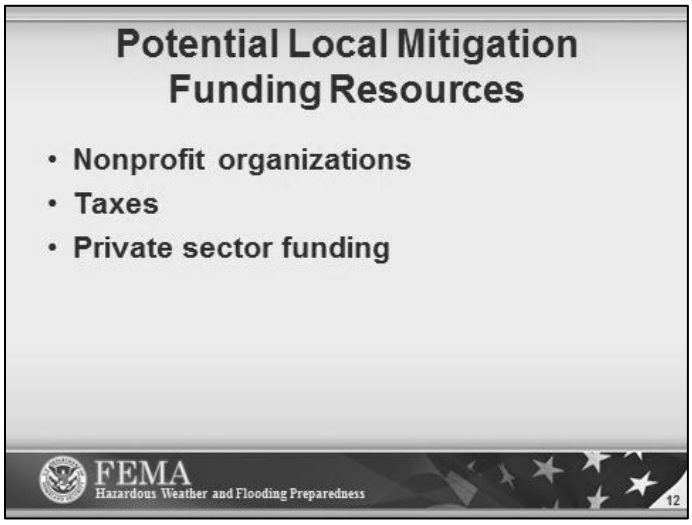
Is the event that you analyzed part of the EOP's hazard analysis? (If yes, under what category of hazard does it fall?)

	YES	NO
Does your EOP adequately address your community's ability to:		
Warn the public of the risk?	☐	☐
Notify the public of the actions they should take?	☐	☐
Respond to the event?	☐	☐
Does your EOP include timeframes for all key decision points required to respond to this event (e.g., notification of key personnel, warnings to the public, deployment of resources, etc.)?	☐	☐
Do you have access to the main sources of information about the event? (If no, what sources of information do you need? How can you gain access to them?)	☐	☐
Is access available only at a single point? If yes, how is it disseminated?		



Mitigation funding resources include:

- Local resources
- State resources
- Federal resources



Communities should consider creating a local funding source that can be used to match Federal, State, and private sector funding for hazard mitigation projects.

Something to think about...

Consider local sources of funding are available in your community for hazard mitigation projects. Jot down any additional sources that could be pursued.

Some States have designated funds could potentially be used for mitigation.

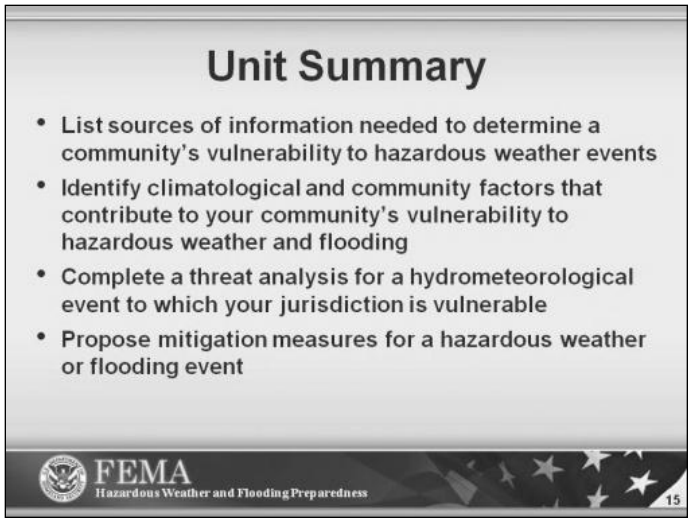
Something to think about...

Consider State sources of funding available to your community for hazard mitigation projects. Jot down any additional sources that could be pursued.

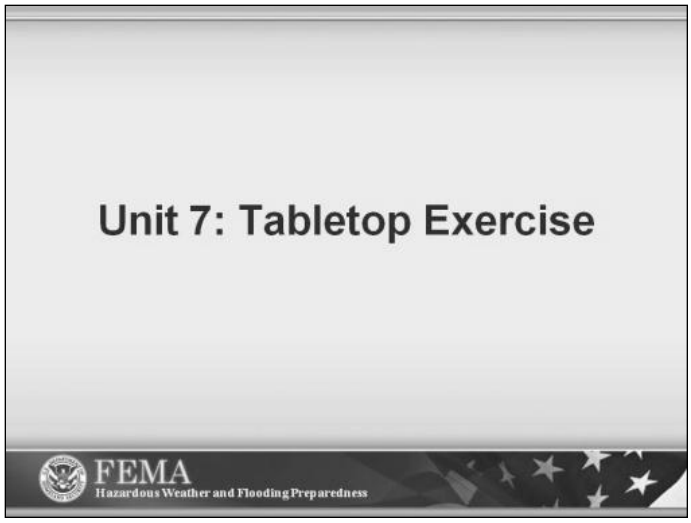
Federal resources include:

- Hazard Mitigation Grant Program (HMGP). Funds from the Hazard Mitigation Grant Program (HMGP) are available in the aftermath of a presidentially declared major disaster for mitigation projects.
- Pre-Disaster Mitigation (PDM) Program. Available for States, territories, tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event.
- Public Assistance (PA) Grant Program. provide assistance to State, Tribal and local governments, and certain types of Private Nonprofit organizations so that communities can quickly respond to and recover from
- Flood Mitigation Assistance (FMA) Program. Funds from the FMA Program are available to assist States and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program.
- Repetitive Flood Claims (RFC) Program. Up to $10 million is available annually in RFC funds to assist States and communities in reducing flood damages to insured properties that have had one or more claims to the National Flood Insurance Program (NFIP).

- Severe Repetitive Loss (SRL) Program. Provides funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP)
- National Tsunami Hazard Mitigation Program (NTHMP). The NTHMP is a partnership between NOAA, the United States Geological Survey (USGS), the Federal Emergency Management Agency (FEMA), the National Science Foundation (NSF), and the 28 U.S. Coastal States Territories, and Commonwealths.
- Community Development Block Grants (CDBG). Works to ensure decent affordable housing, to provide services to the most vulnerable in our communities, and to create jobs through the expansion and retention of businesses.



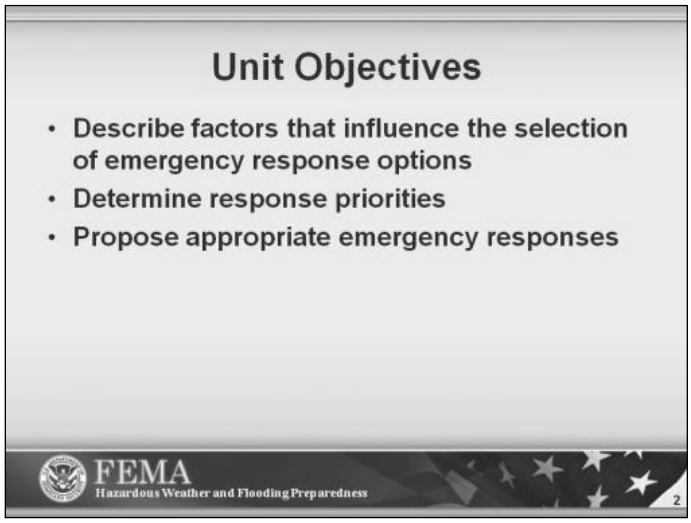
The purpose of this unit was to give you an opportunity to consider local factors that contribute to the risk that your communities face from hazardous weather events.

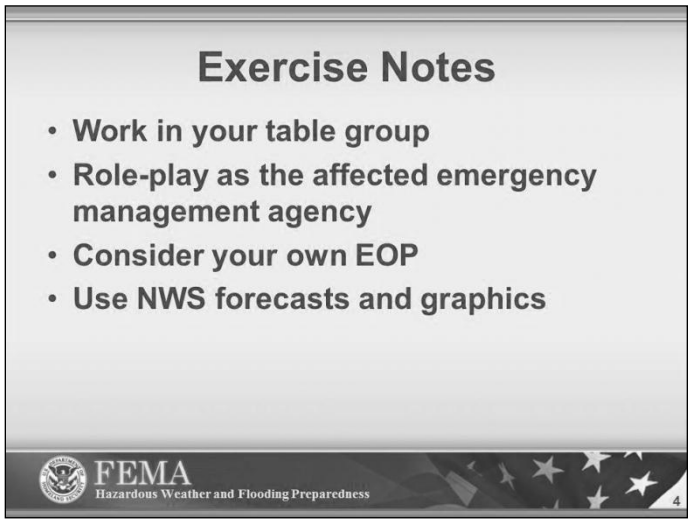


The purpose of this unit is to give you the opportunity to make decisions based on what you've learned throughout the course.

This unit consists of a tabletop exercise in which you will work with your group to make decisions about how to respond to a hazardous weather event.

In this unit, you will determine emergency response actions for a given scenario.





Did you know?

Chickasha (pronounced "**chik**-*uh*-shey") comes from the Choctaw word for Chickasaw, reflecting the Native American heritage of the area.

Exercise Information

This exercise is based on a real event, although certain details may have been altered for instructional purposes.

The exercise is not intended to portray the actual emergency management organizations for the affected area.

As a group, you will be playing the part of the Emergency Management Agency for the small city of Chickasha, Oklahoma.

You should consider your own EOP as if it were for the affected area.

NWS forecasts and graphics will be the primary means for situation awareness and decision making.

New information will be introduced throughout the exercise.

Scenario Information: Chickasha, Oklahoma

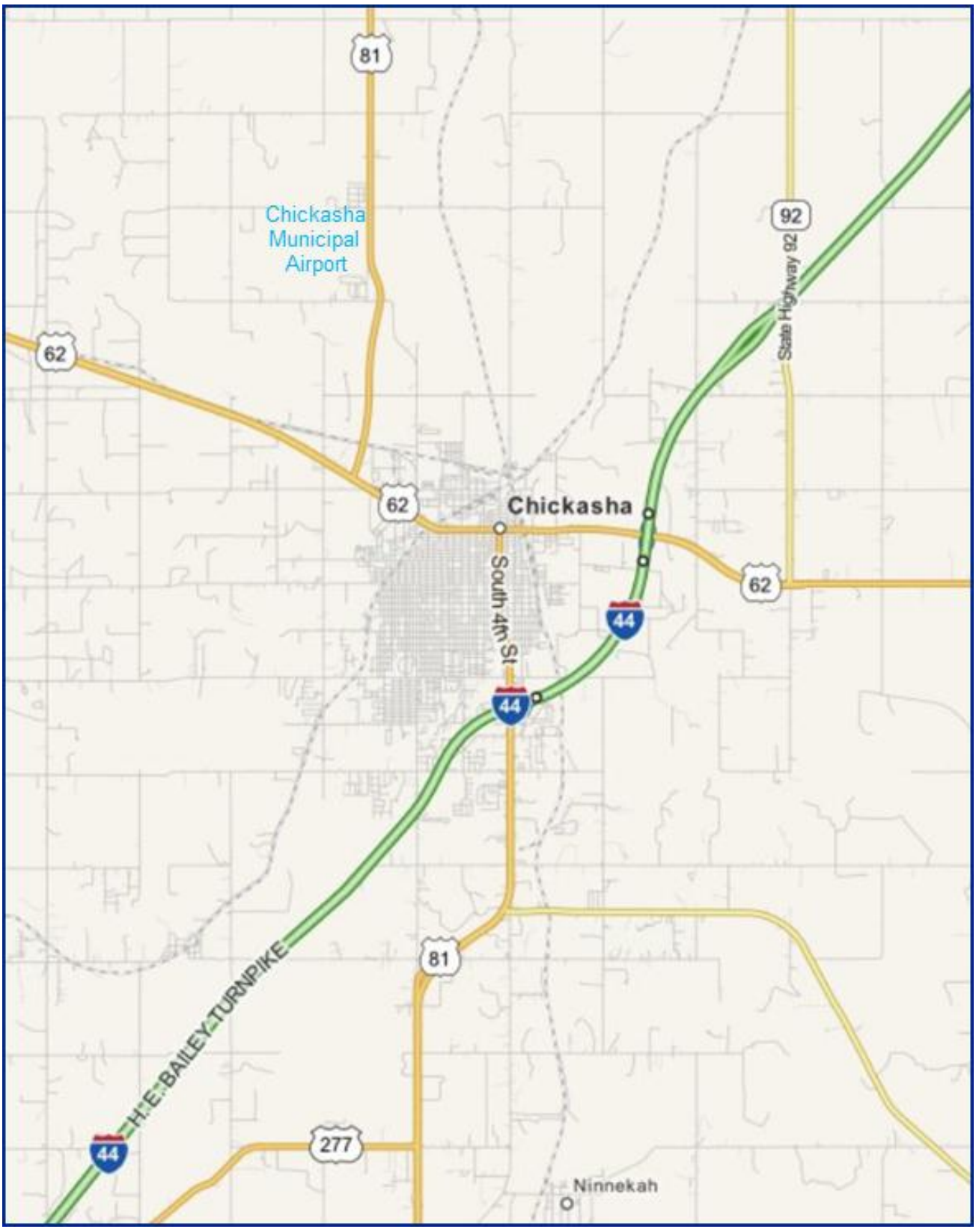
General Information

Chickasha is a small city in northern Grady County, Oklahoma, located approximately 40 miles southwest of Oklahoma City. The most populous city in this primarily rural county, Chickasha is the county seat.

The land area of the city is approximately 22 square miles, with 728 persons per square mile. The land area of Grady County is 1,100 square miles, with 48 persons per square mile.

Demographics

The population of Grady County is 52,431 with 16,036 within the city of Chickasha itself. Approximately 77% of the city's population is white (non-Hispanic), with approximately 5% of the population speaking a language other than English at home (predominantly Spanish). The median household income is just under $34,000, and nearly 22% of the city's population is below the poverty level. Persons 65 or older make up approximately 15% of the population.


81
Chickasha
Municipal
Airport
92
State Highway 92
62
62
Chickasha
62
South 4th St
44
44
81
H.E. BAILEY TURNPIKE
44
277
Ninnekah

Transportation

U.S. Highway 62 runs roughly east/west along the northern part of the city. This highway is known as Choctaw Avenue within the city limits, is home to part of the downtown business area as well as city and county buildings, and serves the primary industrial sites in the city.

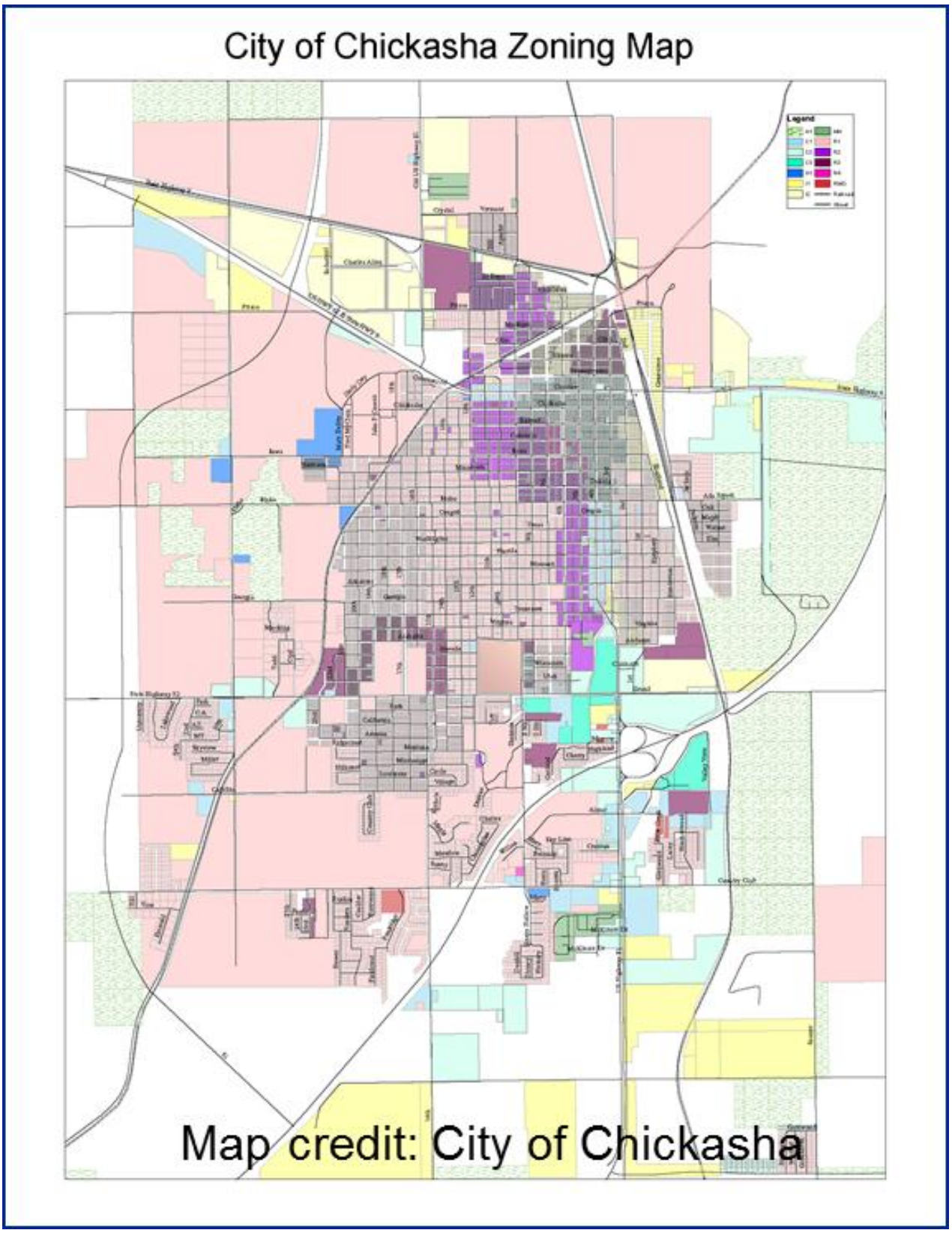
U.S. Highway 81 runs north/south and is known as 4th Street within the city limits. The city has expanded over the years along 4th Street, and much of the city's commerce is located along that route, as well as some industrial areas.

A major interstate highway (I-44) crosses Grady county and portions of Chickasha (between mile markers 80 and 84), running northeast/southwest. The interstate provides a travel route from Wichita Falls, TX through Oklahoma City and Tulsa OK, to St. Louis, MO. Both U.S. Highways in Chickasha have access to the interstate.

Chickasha has two major railroad routes and multiple rail crossings. Union Pacific operates a freight railroad that runs north/south, and Stillwater Central Railroad runs east/west.

A private transit service operates 12 vehicles (7 of which are handicap accessible) and provides service to Chickasha as well as other cities and communities in the county.

The Chickasha Municipal Airport is located north of the city along U.S. HWY 81. This small airport has 3 runways and covers approximately 720 acres. 36 single engine aircrafts, 6 multi-engine aircrafts, and 1 helicopter operate from this airport.


City of Chickasha Zoning Map
Legend
Map credit: City of Chickasha

Land Use

There are 5,487 acres of residential land within the Chickasha city limits:

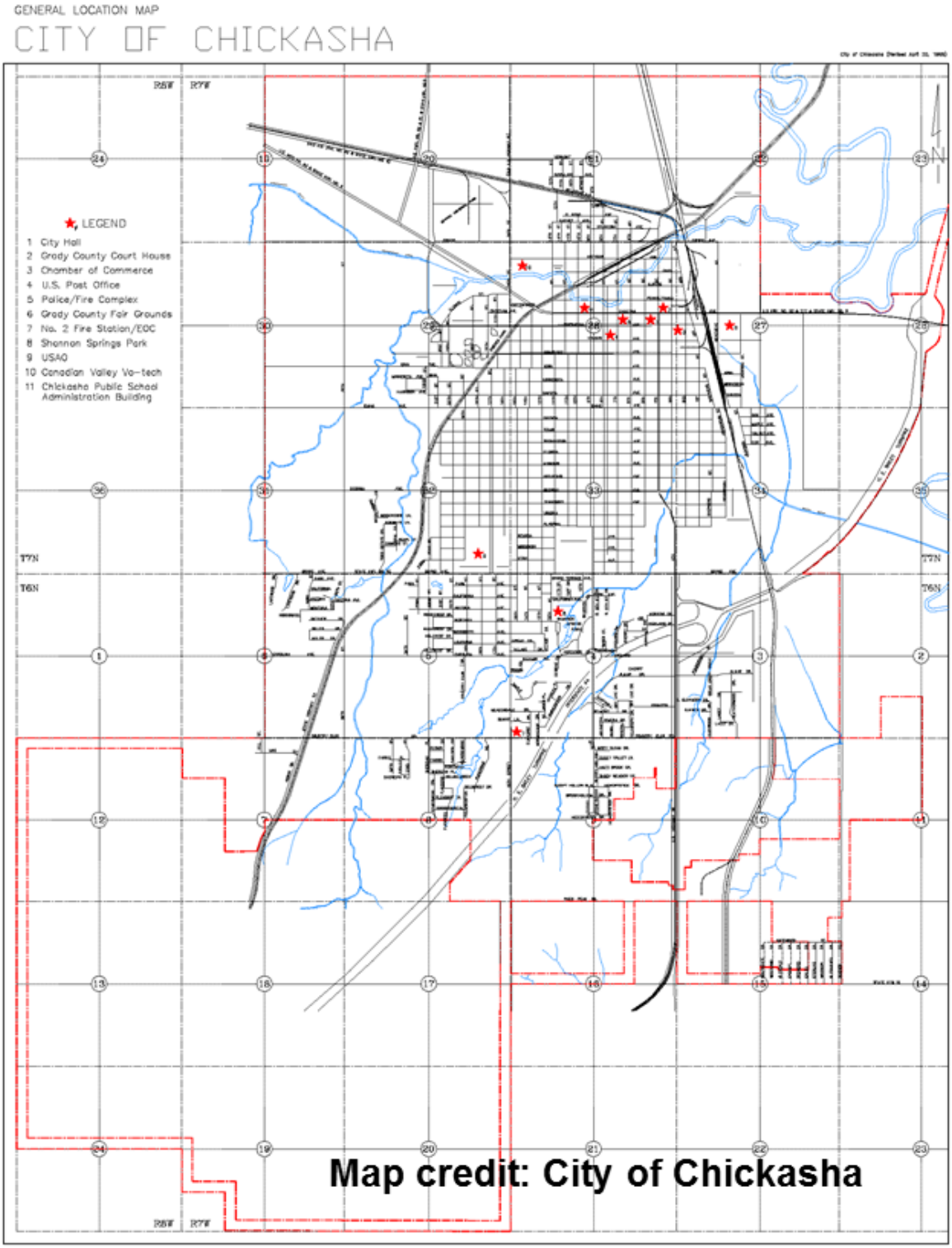
- 5,002 acres of single-family residential land
- 428 acres of multi-family land
- 57 acres zoned for mobile homes (3 mobile home parks)

There are 951 acres of commercially zoned land, primarily located in the downtown business area (along Choctaw and Chickasha Avenues) and 4th Street. Much of the downtown area is located at a lower elevation and is subject to flooding during of heavy rains.

There are 2,262 acres of industrial land, located predominantly in the northwest portion of the city. This includes:

- Methvin Industrial Part
- Airport Industrial Park
- Other industrial areas near the railroad tracks that are adjacent to Livestock Nutrition Center
- Consolidated sites along 4th street

There are 3,094 acres of agricultural land and nine parks covering over 2,000 acres.


GENERAL LOCATION MAP
CITY OF CHICKASHA
LEGEND
1 City Hall
2 Grady County Court House
3 Chamber of Commerce
4 U.S. Post Office
5 Police/Fire Complex
6 Grady County Fair Grounds
7 No. 2 Fire Station/EOC
8 Shannon Springs Park
9 USAO
10 Canadian Valley Vo-tech
11 Chickasha Public School Administration Building
N
R6W
R7W
T7N
T6N
Map credit: City of Chickasha

Medical and Nursing Facilities

Grady Memorial Hospital is a general medical and surgical hospital, with a 24-hour emergency center, located in the northwestern part of the city at Iowa and S. 21st Streets. The hospital has 52 beds and is the only hospital in the county. There are also five nursing homes in the city serving approximately 225 patients.

Educational Facilities

Chickasha is home to the University of Science and Arts of Oklahoma, located at Grand Avenue and S. 17th Street. USAO has an average student enrollment of 1,000 students and covers approximately 75 acres.

In addition, a vocational/technical school, the Canadian Valley Technology Center, is located on the north side of the city and serves approximately 350 high school and adult students per year.

One high school, one middle school, and four elementary schools (including an early childhood center) serve approximately 2,570 children in the district.

Beginning Scenario: Monday Evening

As the emergency manager for Chickasha, things have been fairly quiet for you during the first three weeks of May, comparatively speaking. After all, it is tornado season in Oklahoma.

By the weekend beginning the fourth week in May, NWS has issued convective outlooks indicating a complex weather scenario expected to develop over a period of several days. Severe supercell storms are anticipated, with accompanying threats for large hail, damaging winds, and tornadoes. You stay tuned in to local television news stations and keep an eye on NWS information throughout the weekend, but fortunately, weather in your area remains somewhat uneventful.

On Monday, storms produce record-breaking 6-inch hail in nearby Kiowa county (two counties to the west), but the storm weakens before reaching Grady County. You breathe a sigh of relief, but you know you're not out of the woods yet, so you continue to monitor the situation throughout the evening on Monday. At 8:00 pm, NWS issues a convective outlook.

Day 1 Convective Outlook, Monday, 8:00 pm – Categorical Graphic

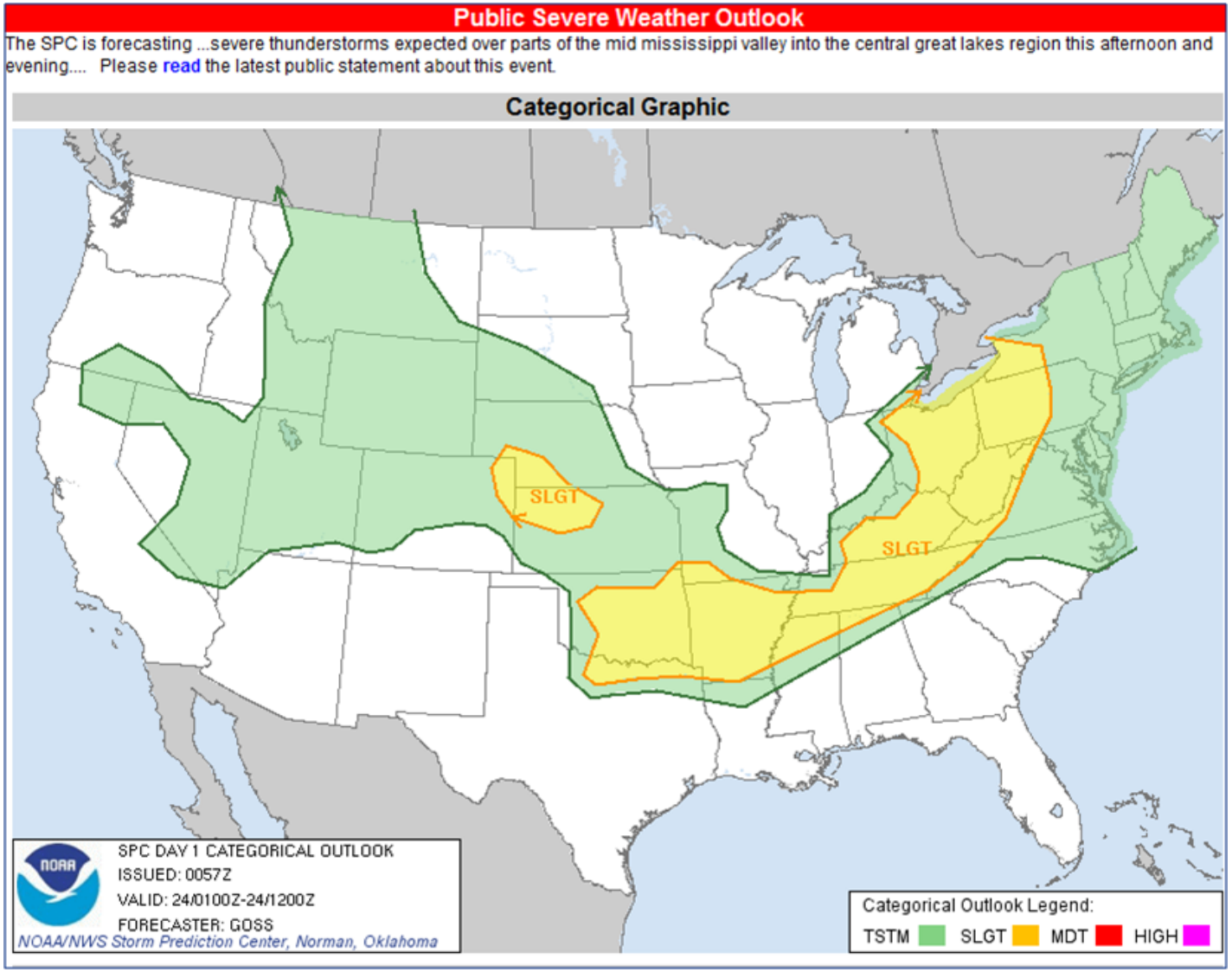


Table 1: Risk Categories for Convective Outlooks

Risk Categories for Convective Outlooks	
SLGT	A **slight** risk implies that well-organized severe thunderstorms are expected but in relatively small numbers/coverage, or it could signify a small chance of a more significant severe event. Not all severe storm events will be covered with a SLGT risk, especially during the summer when short-lived, "pulse-type" severe storms are relatively common during the afternoon.
MDT	A **moderate** risk implies a greater concentration of severe thunderstorms, and in most situations, greater magnitude of severe weather and greater forecaster confidence compared to a SLGT risk. A MDT risk is usually reserved for days with substantial severe storm coverage, or an enhanced chance for a significant severe storm outbreak. Typical MDT risk days include multiple tornadic supercells with very large hail, or intense squall lines with widespread damaging winds.
HIGH	A **high** risk implies that a major severe weather outbreak is expected, with large coverage of severe weather and the likelihood of extreme severe weather (i.e., violent tornadoes or very damaging convective wind events). The HIGH risk category is reserved for the most extreme events with the least forecast uncertainty, and is only used a few times each year.

Table 2: Day 1 Probability to Categorical Outlook Conversion

Day 1 Probability to Categorical Outlook Conversion			
Outlook Probability	**TORNADO**	**WIND**	**HAIL**
2%	**SEE TEXT**	**NOT USED**	**NOT USED**
5%	**SLGT**	**SEE TEXT**	**SEE TEXT**
10%	**SLGT**	**NOT USED**	**NOT USED**
15%	**MDT**	**SLGT**	**SLGT**
30%	**HIGH**	**SLGT**	**SLGT**
45%	**HIGH**	**MDT**	**MDT***
60%	**HIGH**	**HIGH***	**MDT**

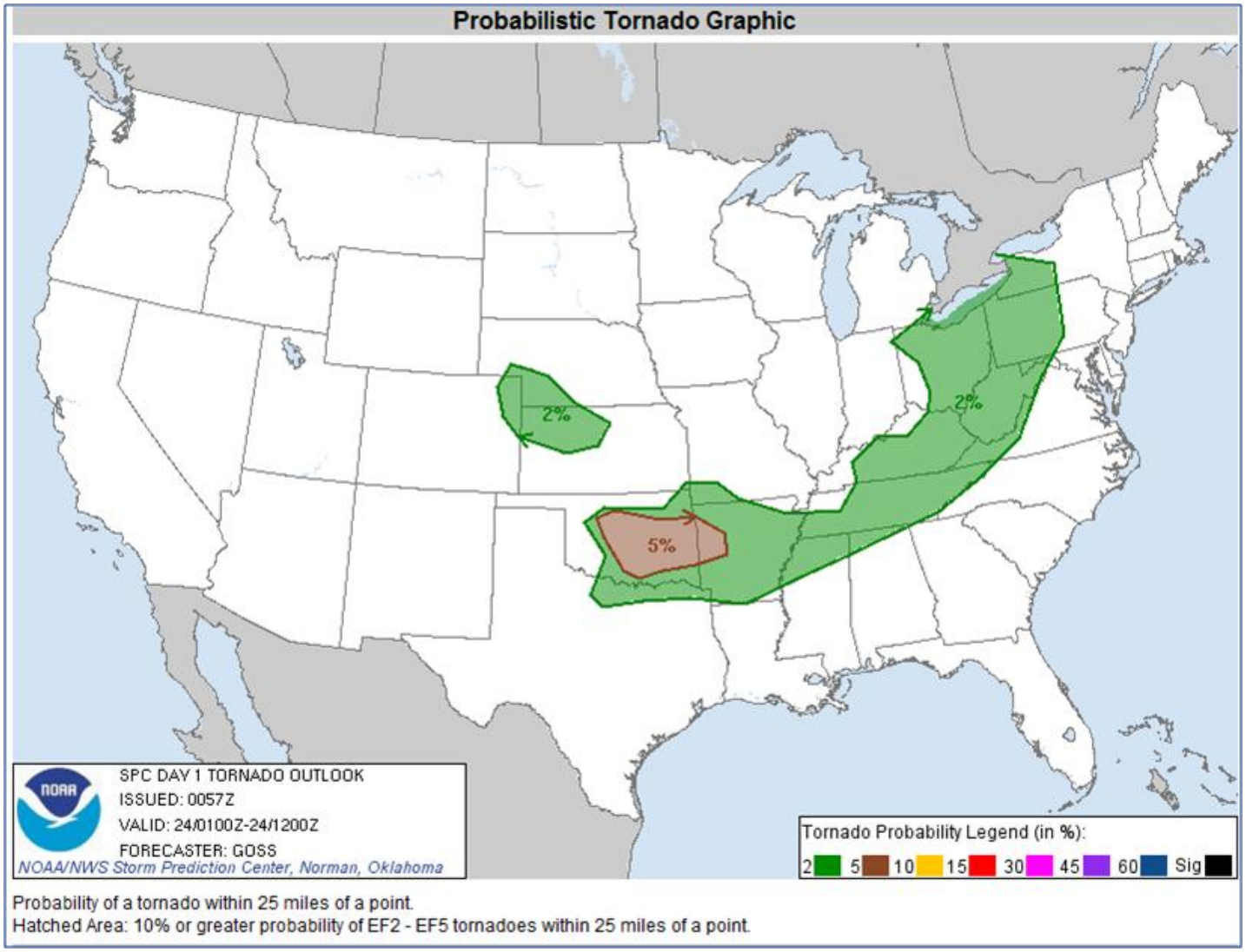
*SIGNIFICANT SEVERE area needed – otherwise default to next lower category.

More information can be found online at the following websites:

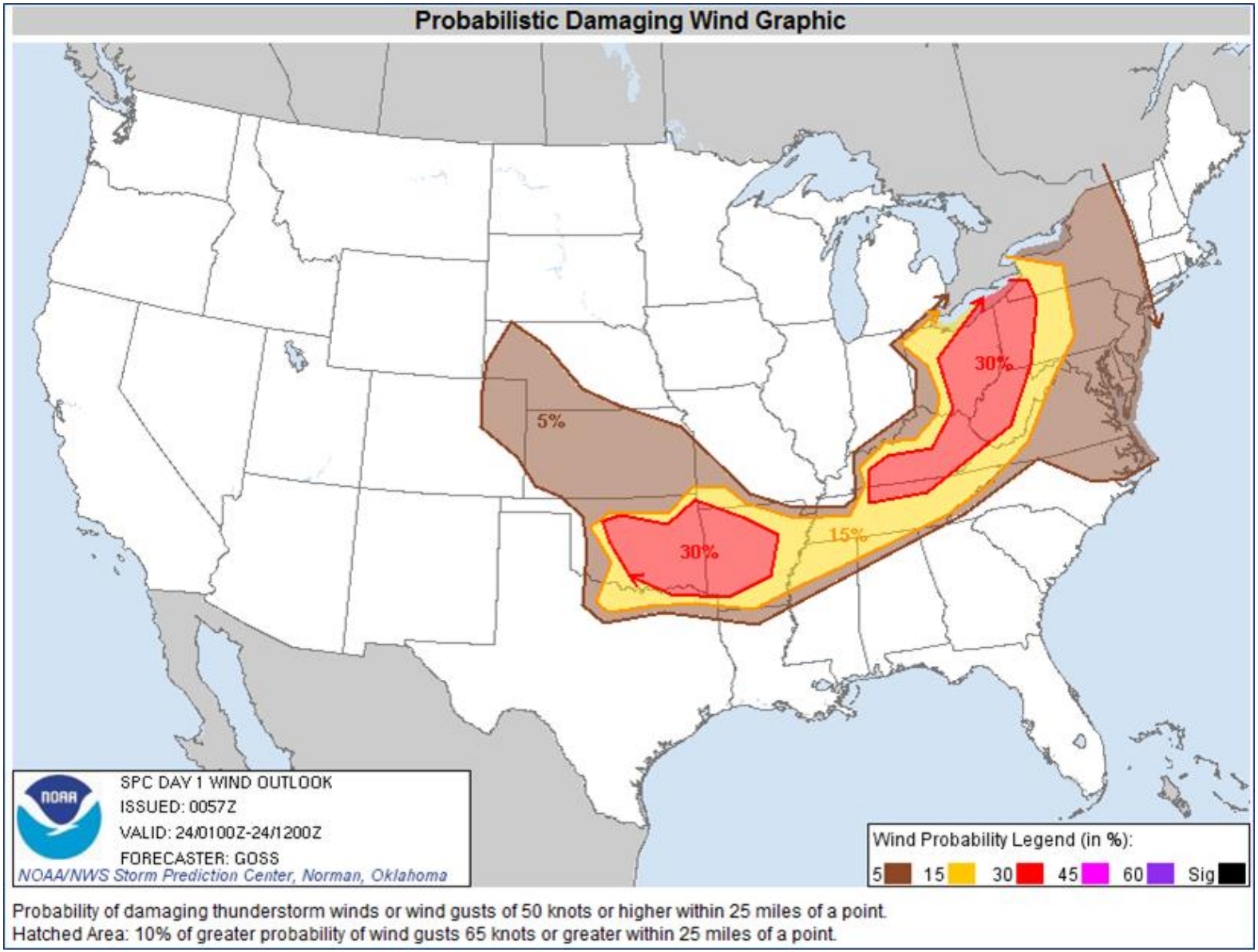
http://www.spc.noaa.gov/misc/SPC_Prob_Conv_Otlk_Change_20060214.html

http://www.spc.noaa.gov/products/outlook/probinfo.html

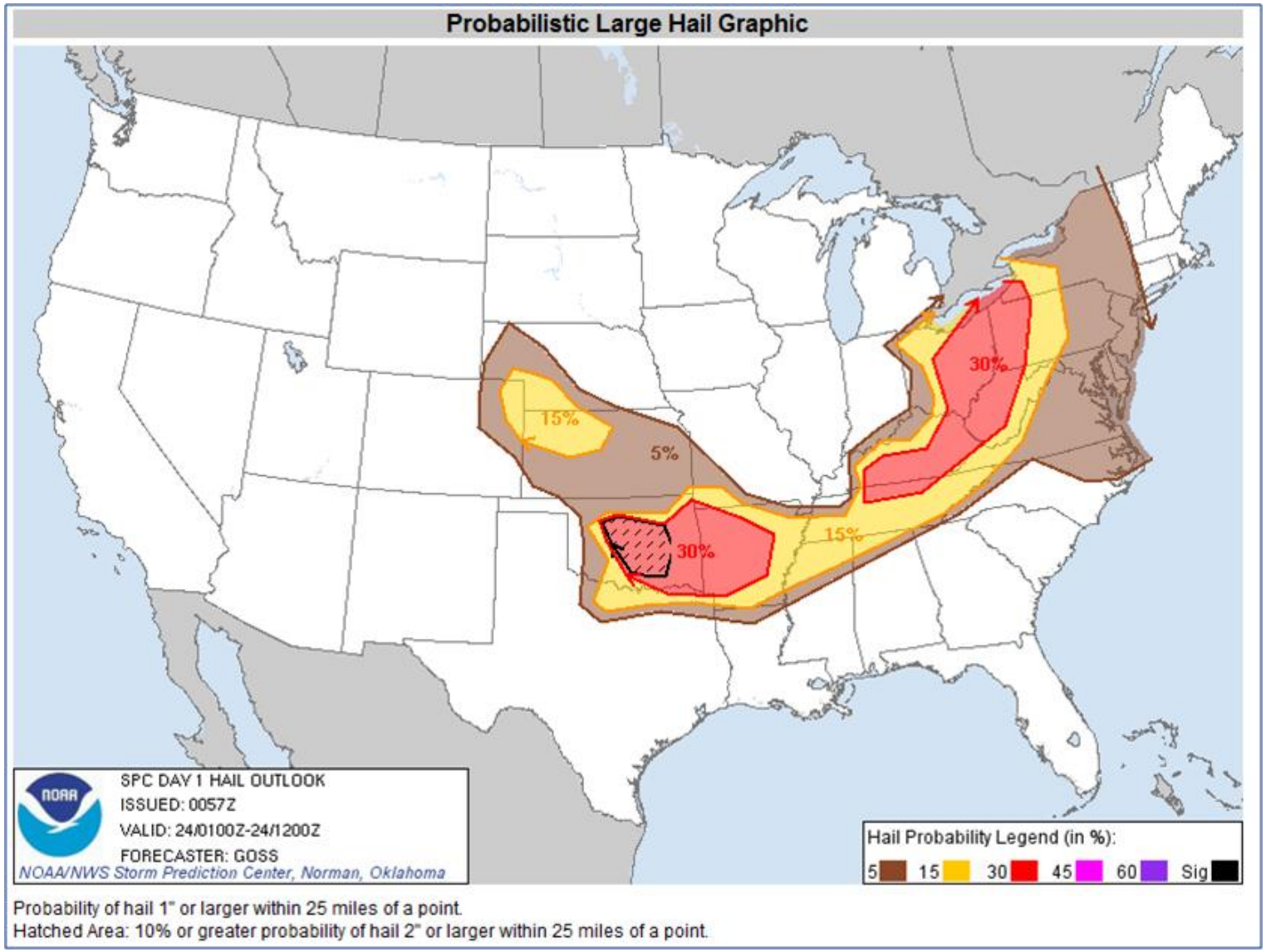
Day 1 Convective Outlook, Monday 8:00 pm – Probabilistic Tornado Graphic



Day 1 Convective Outlook, Monday 8:00 pm – Probabilistic Damaging Wind Graphic



Day 1 Convective Outlook, Monday 8:00 pm – Probabilistic Large Hail Graphic



SPC AC 240057

DAY 1 CONVECTIVE OUTLOOK
NWS STORM PREDICTION CENTER NORMAN OK
0757 PM CDT MON MAY 23 2011

VALID 240100Z - 241200Z

...THERE IS A SLGT RISK OF SVR TSTMS FROM TEH LOWER GREAT LAKES/UPPER OH VALLEY WSWWD INTO OK AND VICINITY...

...THERE IS A SLGT RISK OF SVR TSTMS ACROSS A PORTION OF THE CENTRAL HIGH PLAINS...

...OK/AR AND VICINITY...
STORMS WHICH DEVELOPED EARLIER ACROSS SWRN OK AND ADJACENT NWRN TX CONTINUE TO DISSIPATE...WITH MOST PERSISTENT CONVECTION NOW ACROSS THE NRN HALF OF OK. THESE STORMS APPEAR TO BE ORGANIZING INTO AN MCS...WHICH IS EXPECTED TO SHIFT EWD/ESWD ACROSS OK AND INTO AR OVER THE NEXT SEVERAL HOURS. DAMAGING WINDS AND HAIL ARE EXPECTED TO ACCOMPANY THE MCS...ALONG WITH THE POTENTIAL FOR A TORNADO OR TWO. STORMS MAY REACH THE MID MS VALLEY REGION LATE TONIGHT...BUT ATTM IT APPEARS THAT SEVERE THREAT SHOULD DIMINISH LATE IN THE PERIOD.

...LOWER GREAT LAKES/OH AND TN VALLEYS...
BROKEN BAND OF STORMS -- WITH EMBEDDED BOWS/LEWPS -- CONTINUES MOVING EWD ACROSS THE LOWER GREAT LAKES/OH VALLEY/TN VALLEY REGION ATTM. INSTABILITY AHEAD OF THE ONGOING CONVECTION REMAINS SUFFICIENT -- GIVEN ORGANIZED NATURE OF THE CONVECTION -- TO SUPPORT A CONTINUATION OF STORMS FOR SEVERAL MORE HOURS. WITH 40 TO 50 KT WLYS AT MID-LEVELS...CONTINUED/RAPID EWD MOVEMENT OF ORGANIZED/SEVERE STORMS IS EXPECTED...WITH DAMAGING WIND/HAIL THREAT POSSIBLY EXTENDING INTO THE OVERNIGHT HOURS.

...CENTRAL HIGH PLAINS...
ISOLATED SEVERE/SUPERCELL STORMS ARE ONGOING ATTM ACROSS PORTIONS OF NERN CO/SWRN NEB/NWRN KS...AND MAY CONTINUE FOR THE NEXT SEVERAL HOURS AS LOW-LEVEL JET INTENSIFIES ACROSS THIS REGION PROVIDING PERSISTENT ASCENT. LARGE HAIL WILL BE THE PRIMARY SEVERE THREAT THROUGH THE EVENING.

...NC/SERN VA...
STORMS PERSIST ACROSS NERN NC AND SERN VA ATTM...AS UPPER SHORT-WAVE TROUGH MOVES SLOWLY EWD ACROSS THIS AREA ATOP ZONE OF MODERATE CAPE. WITH SHEAR SUFFICIENT FOR ORGANIZED STORMS...HAIL AND LOCALLY DAMAGING WIND GUSTS WILL BE POSSIBLE OVER THE NEXT FEW HOURS...BEFORE CONVECTIVE THREAT BEGINS SHIFTS PRIMARILY OFFSHORE.

..GOSS.. 05/24/2011

CLICK TO GET WUUS01 PTSDY1 PRODUCT

NOTE: THE NEXT DAY 1 OUTLOOK IS SCHEDULED BY 0600Z

Tabletop Exercise: Spring Storm

General Notes

Please read the following general notes about this exercise before you begin:

- This exercise has been developed to emphasize important elements associated with hazardous weather planning and preparedness. The exercise is **not** intended to portray the actual emergency management organizations for the Grady County/Chickasha area. Some geographic and organizational inaccuracies may exist in these materials.
- Because the planning and preparedness points illustrated by this exercise are not unique to the Grady County/Chickasha area or even to "Tornado Alley," you should consider your own EOPs as if they were for the affected area.
- While working through the discussion questions in this exercise, you may refer to the NWS Reference Guidebook, your local EOP, or any other materials at your disposal.
- You will receive updates as the situation evolves.

Instructions

This exercise presents a scenario that will require you to make decisions about how to respond to a hazardous weather event.

- Consider the community information and refer to the maps and NWS products provided.
- Discuss the following questions and record your group's responses.
- Choose a spokesperson to share your group's responses.

Beginning Scenario: Discussion Questions

1. What course of action would you take in light of the convective outlooks?

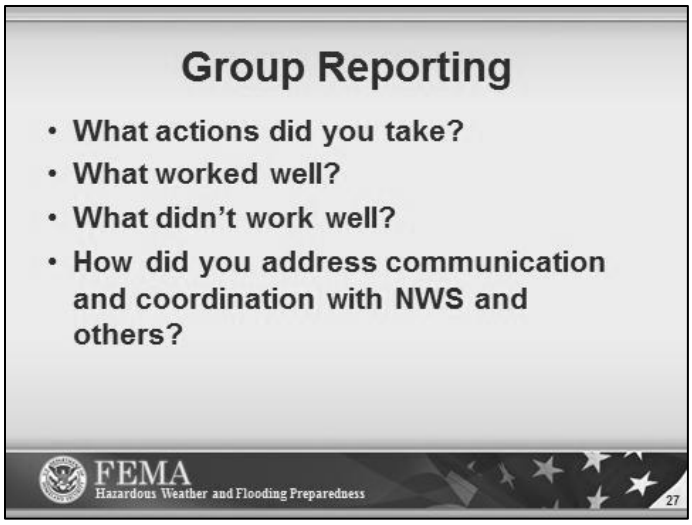
2. Would you activate any portion of your EOP? If so, which ones?

3. What would you do to continue to monitor this situation?

4. Would you be in contact with your local NWS office? If so, how would coordination take place?

5. What preparedness actions would you take with your community (outside of those in your EOP)?

Each group will be asked to share its responses to the discussion questions and actions taken during the event. Keep in mind that there are no absolute "right" or "wrong" answers, and take notes about strategies that other groups mention that may be of use during actual responses in your community.

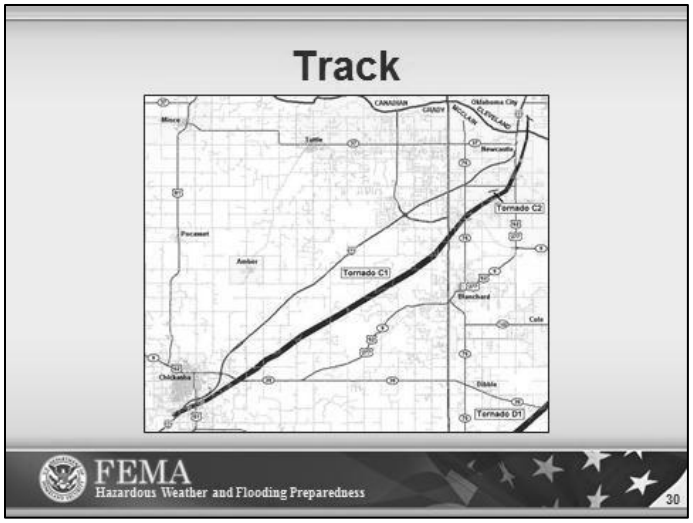


When the damage reports were done, the tornado that ripped through Chickasha on May 24, 2011, was determined to be an EF4. The most devastating damage was done at a mobile home park, where one woman lost her life and 75 homes were damaged or destroyed.

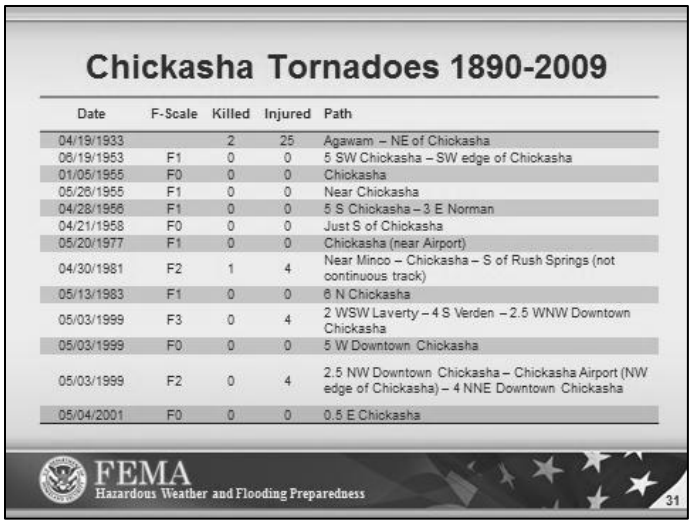
In addition, 38 other homes in the city were damaged or destroyed, and 16 apartment buildings were damaged. 16 businesses were damaged or destroyed.

Total damages in Chickasha are estimated to be at $8,260,000.

Beyond the city limits, 261 homes in the county were damaged or destroyed, 1 additional business was destroyed, and many cattle operations were affected.



Beyond the city limits, 261 homes in the county were damaged or destroyed, one additional business was destroyed, and many cattle operations were affected.



Chickasha is in the heart of "Tornado Alley" and is no stranger to the tornado threat. However, historically, the city (proper) has not been directly affected by strong tornadoes.

Something to think about...

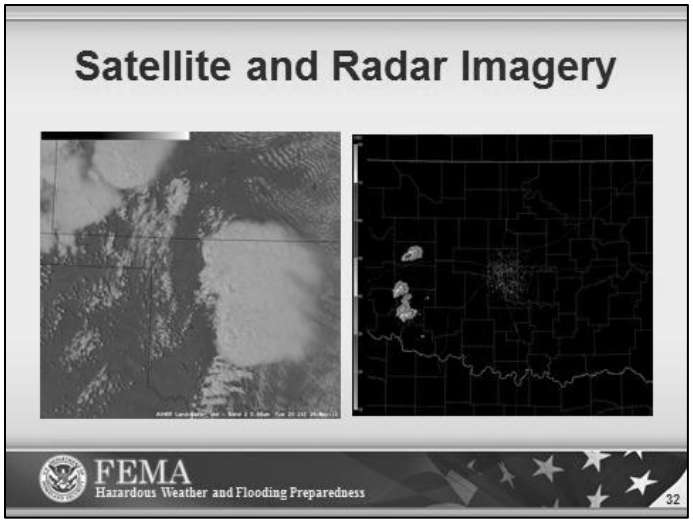
How could local history, social factors, and attitudes impact the response actions of your community's residents in a hazardous weather event?

Table 3: Chickasha, Oklahoma Tornadoes (1890-2009)

SPC ID#	Date	Time (CST)	Path Length (miles)	Path Width (yards)	F-Scale	Killed	Injured	County	Path
33-1	04/19/1933	1900	15	880		2	25	Grady	Agawam – NE of Chickasha
53-39	06/19/1953	1730	6	880	F1	0	0	Grady	5 SW Chickasha – SW edge of Chickasha
55-1	01/05/1955	0500	n/a	n/a	F0	0	0	Grady	Chickasha
55-37	05/26/1955	0230	n/a	n/a	F1	0	0	Grady	Near Chickasha
56-20	04/28/1956	1420	35	n/a	F1	0	0	Grady	5 S Chickasha – 3 E Norman
58-6	04/21/1958	1605	n/a	n/a	F0	0	0	Grady McClain Cleveland	Just S of Chickasha
77-33	05/20/1977	1543	3	90	F1	0	0	Grady	Chickasha (near Airport)
81-12	04/30/1981	2015	29	5	F2	1	4	Grady	Near Minco – Chickasha – S of Rush Springs (not continuous track)
83-44	05/13/1983	2245	0.1	50	F1	0	0	Grady	6 N Chickasha
	05/03/1999	1646	9	880	F3	0	4	Caddo Grady	2 WSW Laverty – 4 S Verden – 2.5 WNW Downtown Chickasha
	05/03/1999	1707	1	75	F0	0	0	Grady	5 W Downtown Chickasha
	05/03/1999	1712	4	500	F2	0	4	Grady	2.5 NW Downtown Chickasha – Chickasha Airport (NW edge of Chickasha) – 4 NNE Downtown Chickasha
	05/04/2001	1805	0.2	25	F0	0	0	Grady	0.5 E Chickasha

Records taken from the Storm Prediction Center archive data, "Storm Data", and data from the National Weather Service office in Norman. Data modified as described in NOAA Tech Memo NWS SR-209 (Speheger, D., 2001: "Corrections to the Historic Tornado Database").

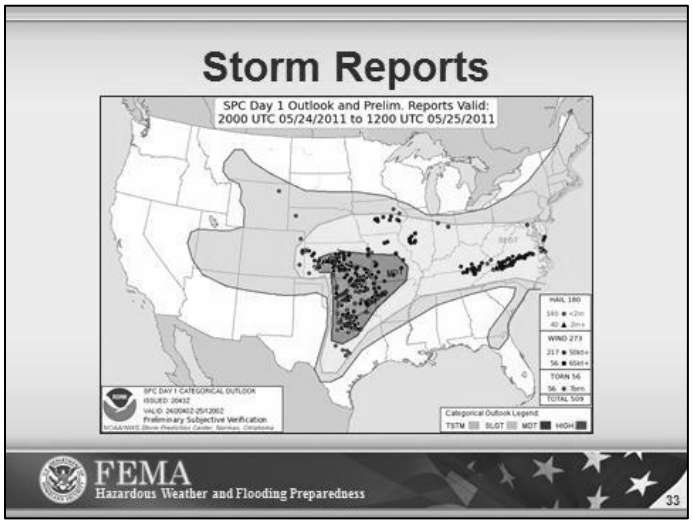
Historic data, especially before 1950, are likely incomplete.



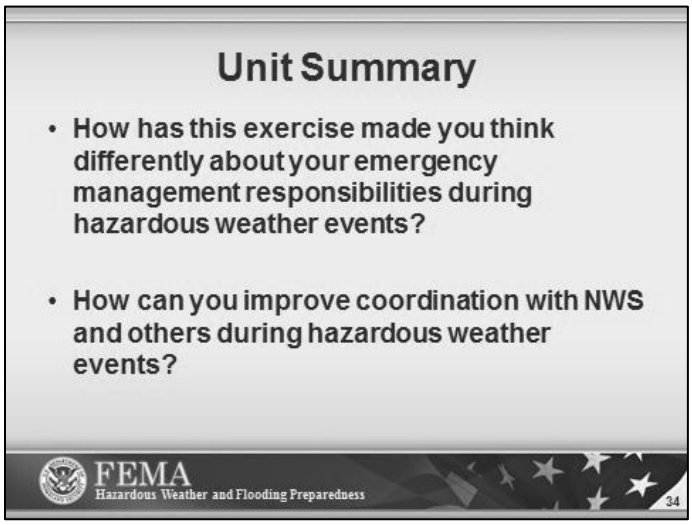
Actual satellite imagery loops and radar data from the event can be viewed by visiting the following links:

http://www.srh.noaa.gov/oun/?n=events-20110524-satellite

http://www.srh.noaa.gov/oun/?n=events-20110524-radar



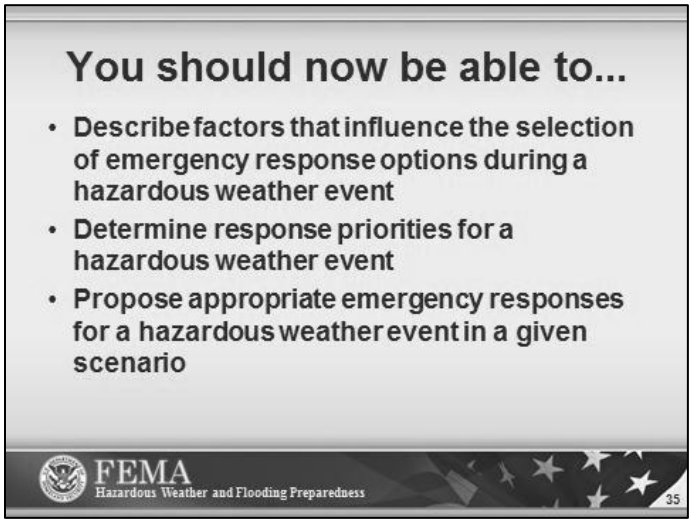
This slide shows how well the outlooks predicted the actual outcome. According to this map, 54 out of 56 tornadoes on May 24, 2011, occurred within the area predicted to have a moderate-to-high risk of severe weather, primarily northern Texas, central Oklahoma, and southern Kansas.



Even if your community is not often affected by tornadoes, there are lessons to be learned within this case study.

Something to think about...

Consider the questions on the slide and jot down your ideas as action items.



The purpose of this unit was to give you the opportunity to make decisions based on what you've learned throughout the course.

Information Sources for This Unit

This unit was developed with assistance from the Emergency Manager for the City of Chickasha, Steve Chapman, whose serves in this position as a volunteer. His service and his cooperation with the creation of this training are greatly appreciated.

Additional sources of information are listed below. All websites were accessed in June, 2012.

Population and Demographics

2010 U.S. Census
http://quickfacts.census.gov

Land Use and City Maps

Used with permission from the City of Chickasha
Chickasha 2030: Shaping Our Future, Land Use Section.
http://www.chickasha.org/comdev/

Nursing Facilities and Hospitals

U.S. News Health
http://health.usnews.com/best-hospitals/grady-memorial-hospital-6730155

Educational Facilities

U.S. News & World Report
http://colleges.usnews.rankingsandreviews.com/best-colleges/university-of-science-and-arts-of-oklahoma-3167.

Canadian Valley Area Report 2011
http://www.cvtech.edu/information-center/district-information

SchoolDigger®
http://www.schooldigger.com/go/OK/district/07560/search.aspx

Airport Information

http://www.city-data.com/airports/

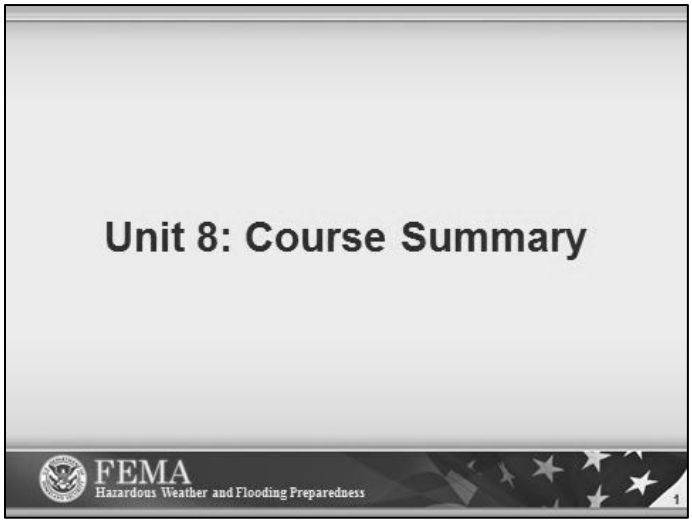
http://www.pilotoutlook.com/airport/oklahoma/ok91

NWS GraphiCast

http://www.srh.noaa.gov/oun/?n=events-20110524-graphicasts

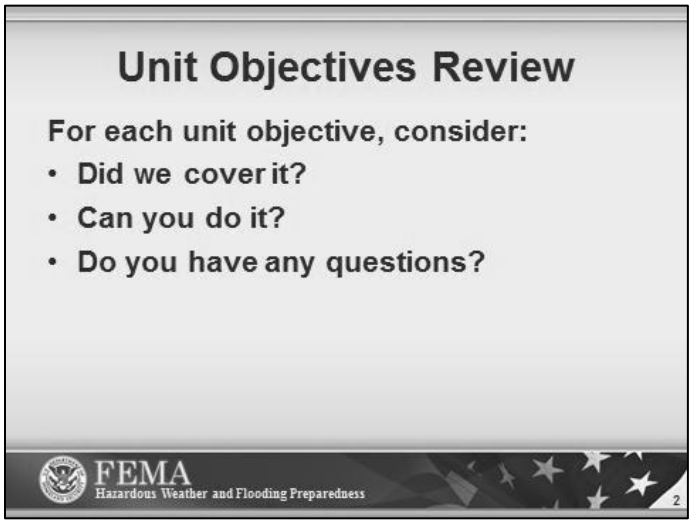
Actual Event Information

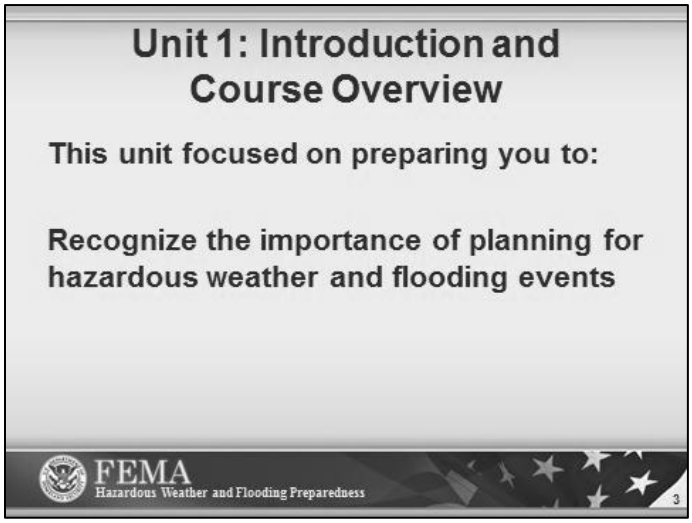
"May 24 Tornado: A Year Later," by Karen Brady. *Chickasha Leader*, May 23, 2012.



Unit 8

This unit provides a review of the overall objectives for each unit of the course, with review questions that reinforce the information and concepts learned and provide practice for the exam.




Unit 1: Introduction and Course Overview
This unit focused on preparing you to:
Recognize the importance of planning for hazardous weather and flooding events
FEMA
Hazardous Weather and Flooding Preparedness
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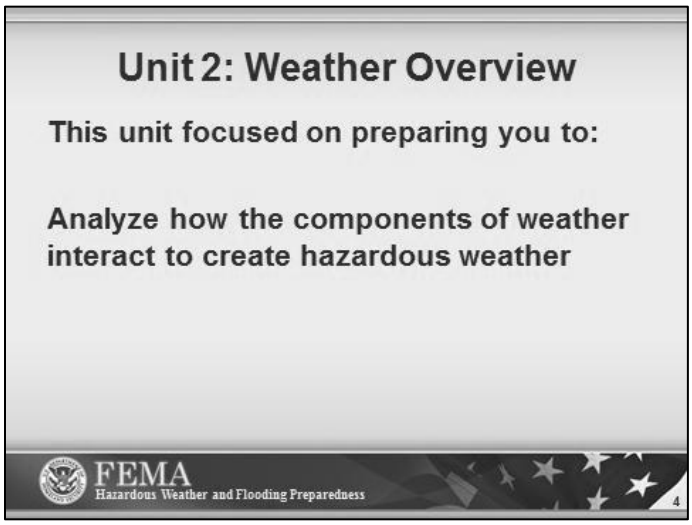
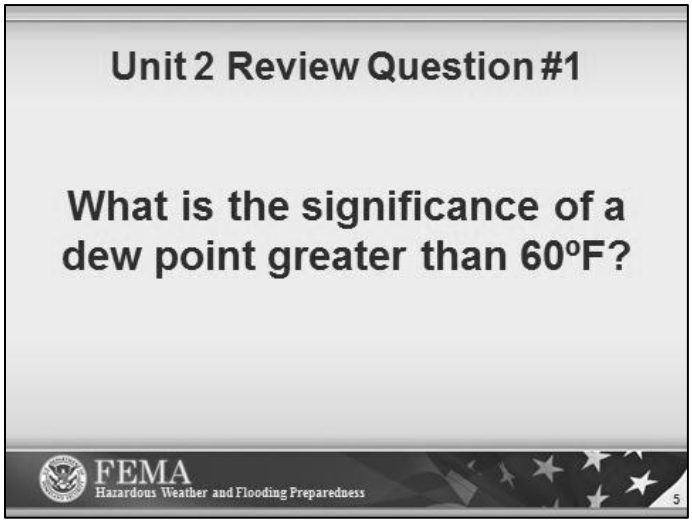

Unit 2: Weather Overview
This unit focused on preparing you to:
Analyze how the components of weather interact to create hazardous weather
FEMA
Hazardous Weather and Flooding Preparedness
4


Unit 2 Review Question #1
What is the significance of a dew point greater than 60ºF?
FEMA
Hazardous Weather and Flooding Preparedness
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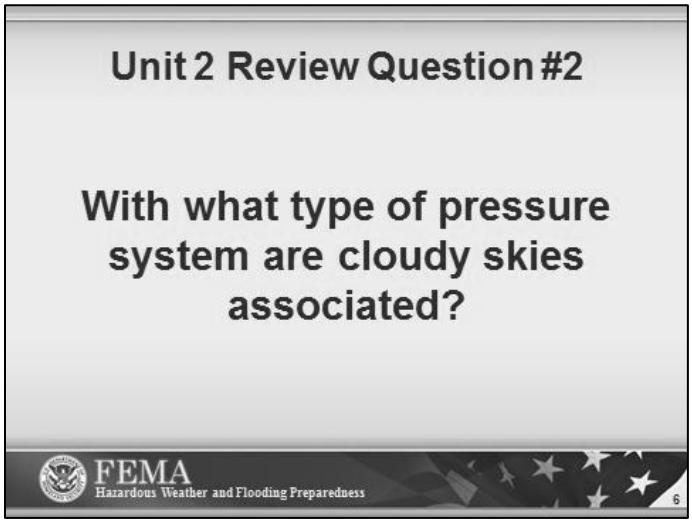
Unit 2 Review Question #2
With what type of pressure system are cloudy skies associated?
FEMA
Hazardous Weather and Flooding Preparedness
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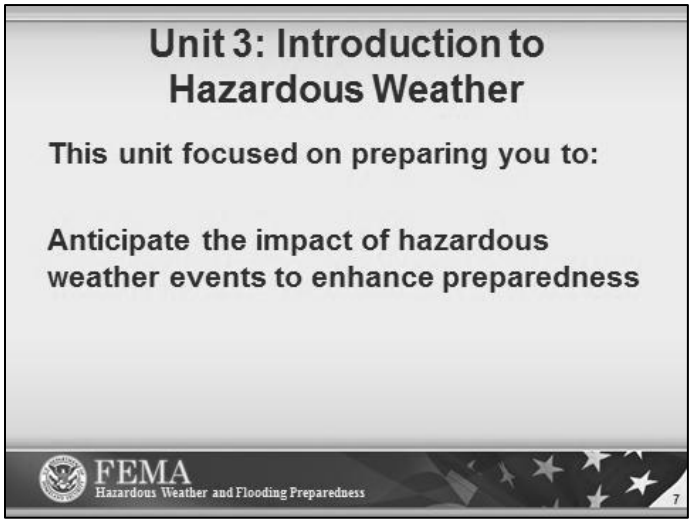
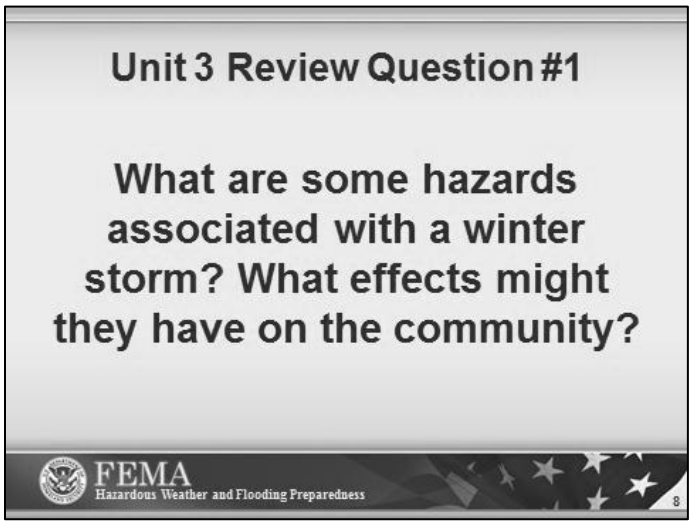

Unit 3: Introduction to Hazardous Weather
This unit focused on preparing you to:
Anticipate the impact of hazardous weather events to enhance preparedness
FEMA
Hazardous Weather and Flooding Preparedness
7


Unit 3 Review Question #1
What are some hazards associated with a winter storm? What effects might they have on the community?
FEMA
Hazardous Weather and Flooding Preparedness
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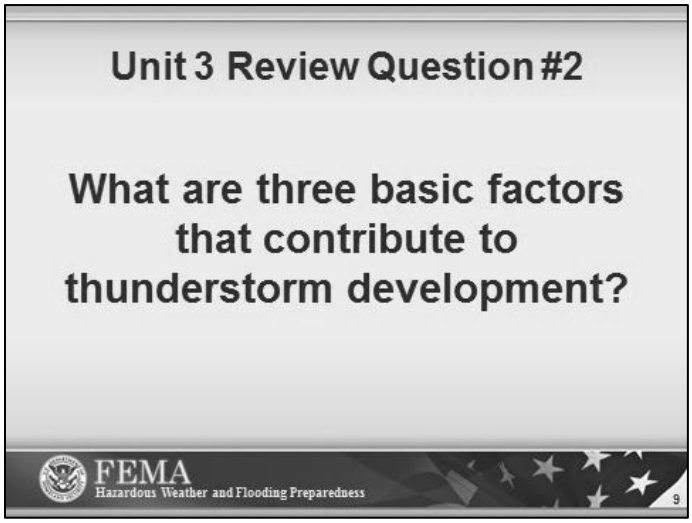
Unit 3 Review Question #2
What are three basic factors that contribute to thunderstorm development?
FEMA
Hazardous Weather and Flooding Preparedness
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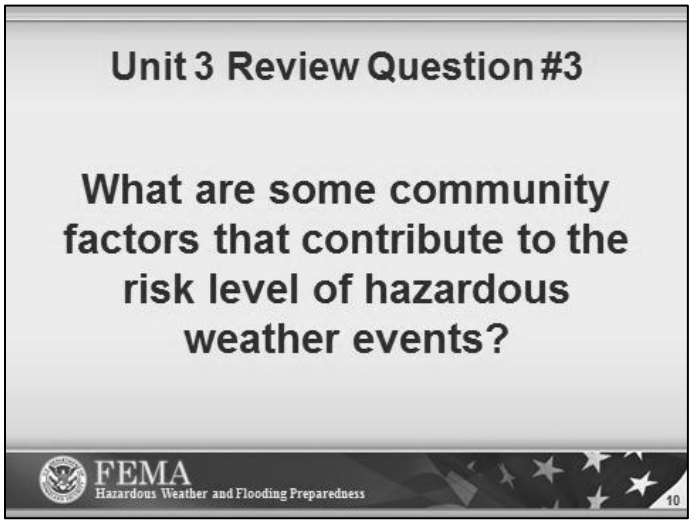
Unit 3 Review Question #3
What are some community factors that contribute to the risk level of hazardous weather events?
FEMA
Hazardous Weather and Flooding Preparedness
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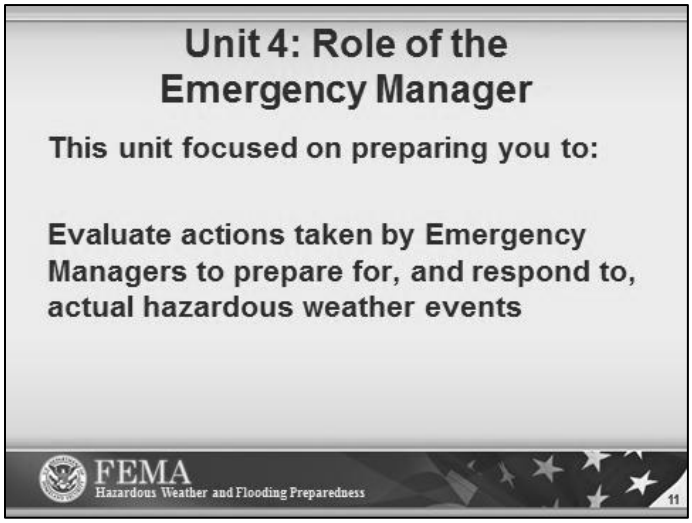
Unit 4: Role of the Emergency Manager
This unit focused on preparing you to:
Evaluate actions taken by Emergency Managers to prepare for, and respond to, actual hazardous weather events
FEMA
Hazardous Weather and Flooding Preparedness
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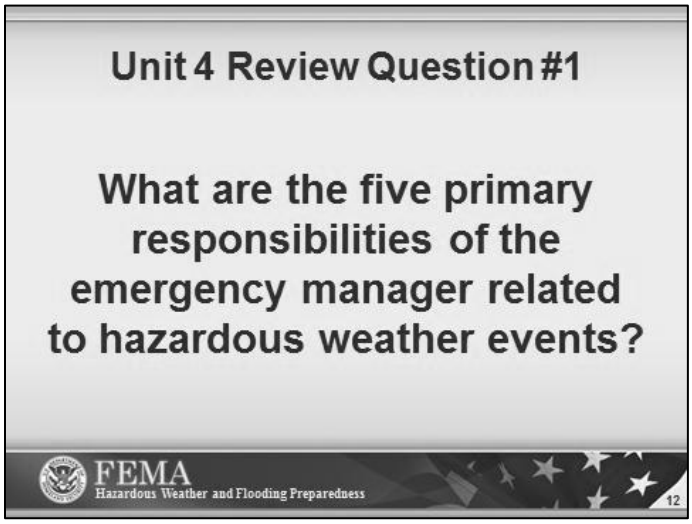
Unit 4 Review Question #1
What are the five primary responsibilities of the emergency manager related to hazardous weather events?
FEMA
Hazardous Weather and Flooding Preparedness
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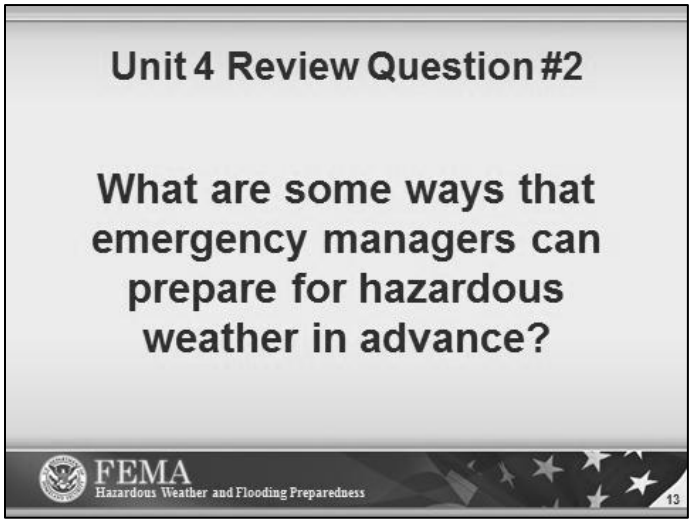
Unit 4 Review Question #2
What are some ways that emergency managers can prepare for hazardous weather in advance?
FEMA
Hazardous Weather and Flooding Preparedness
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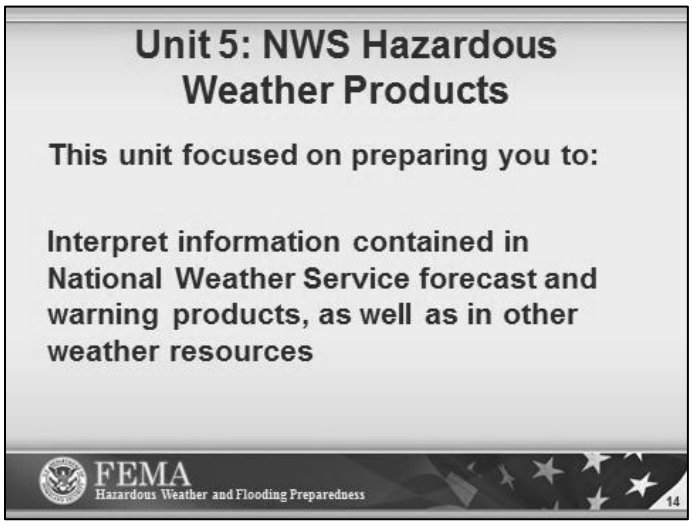
Unit 5: NWS Hazardous Weather Products
This unit focused on preparing you to:
Interpret information contained in National Weather Service forecast and warning products, as well as in other weather resources
FEMA
Hazardous Weather and Flooding Preparedness
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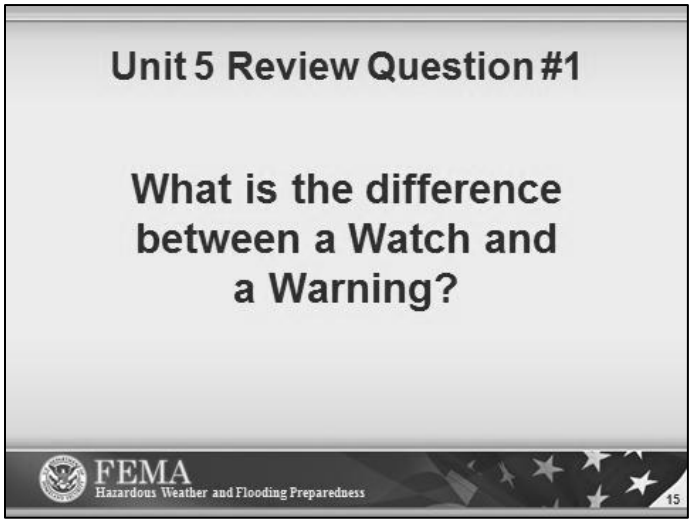
Unit 5 Review Question #1
What is the difference between a Watch and a Warning?
FEMA
Hazardous Weather and Flooding Preparedness
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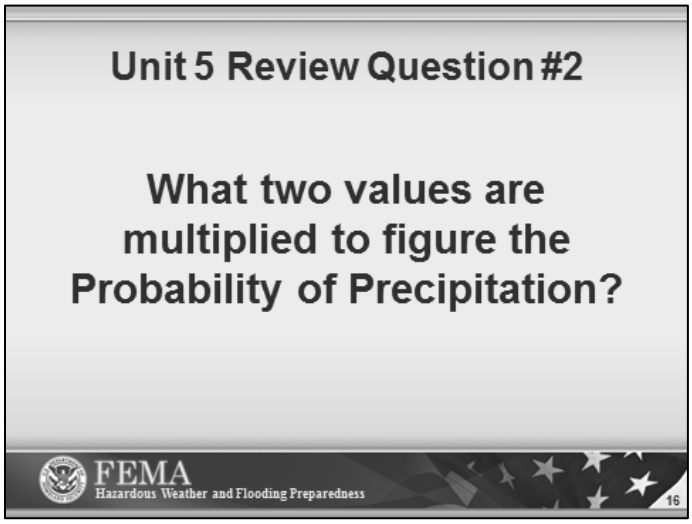
Unit 5 Review Question #2
What two values are multiplied to figure the Probability of Precipitation?
FEMA
Hazardous Weather and Flooding Preparedness
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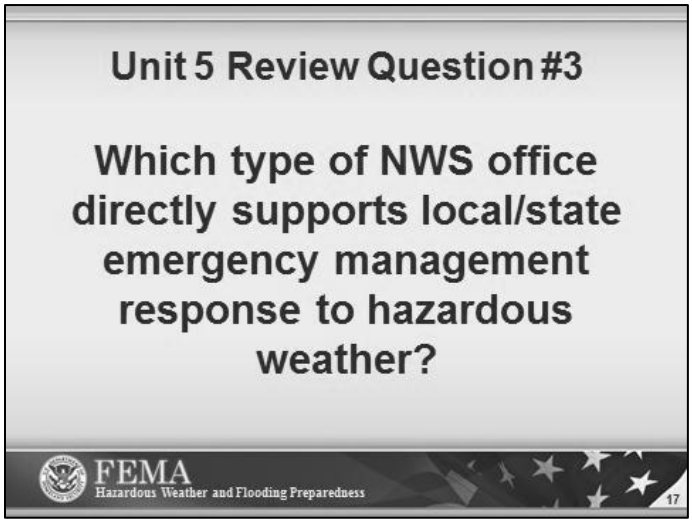
Unit 5 Review Question #3
Which type of NWS office directly supports local/state emergency management response to hazardous weather?
FEMA
Hazardous Weather and Flooding Preparedness
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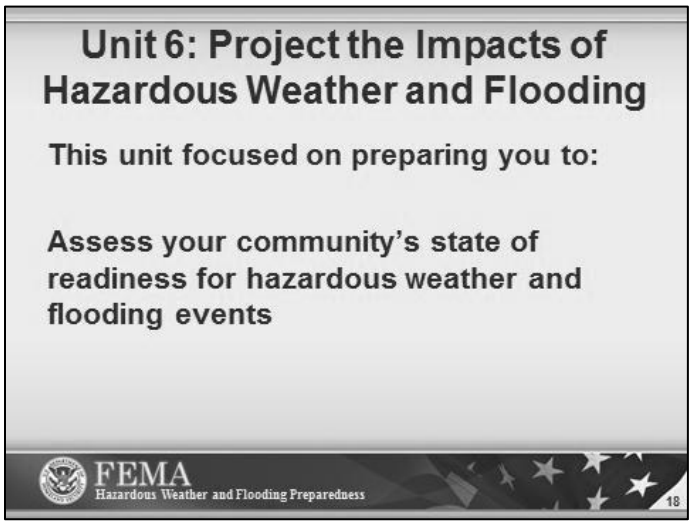
Unit 6: Project the Impacts of Hazardous Weather and Flooding
This unit focused on preparing you to:
Assess your community's state of readiness for hazardous weather and flooding events
FEMA
Hazardous Weather and Flooding Preparedness
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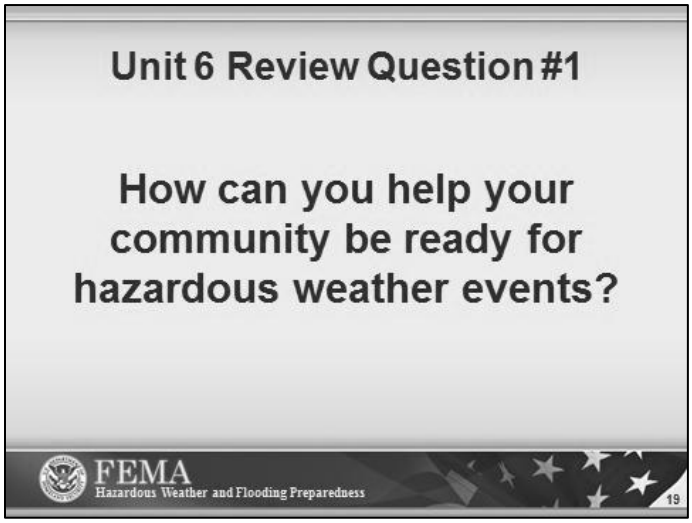
Unit 6 Review Question #1
How can you help your community be ready for hazardous weather events?
FEMA
Hazardous Weather and Flooding Preparedness
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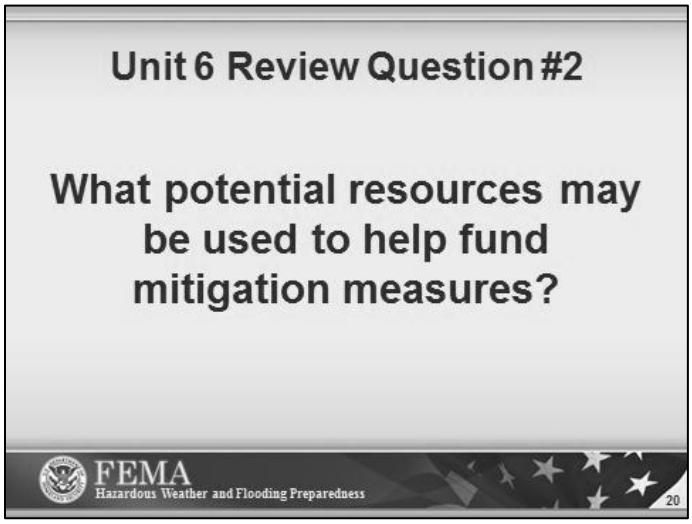
Unit 6 Review Question #2
What potential resources may be used to help fund mitigation measures?
FEMA
Hazardous Weather and Flooding Preparedness
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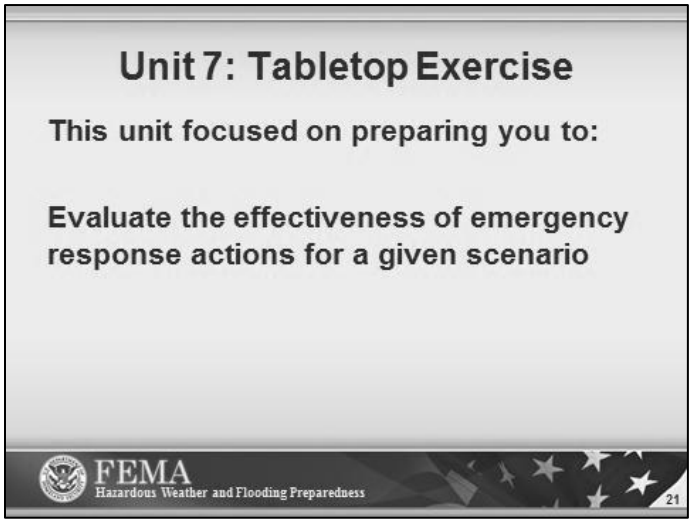
Unit 7: Tabletop Exercise
This unit focused on preparing you to:
Evaluate the effectiveness of emergency response actions for a given scenario
FEMA
Hazardous Weather and Flooding Preparedness
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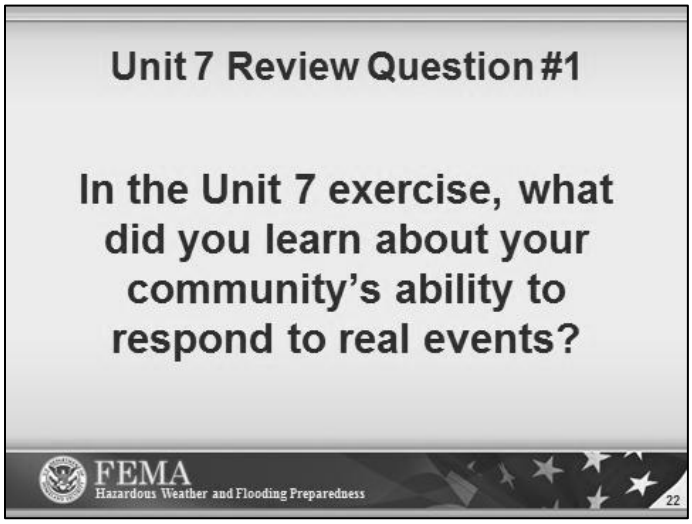
Unit 7 Review Question #1
In the Unit 7 exercise, what did you learn about your community's ability to respond to real events?
FEMA
Hazardous Weather and Flooding Preparedness
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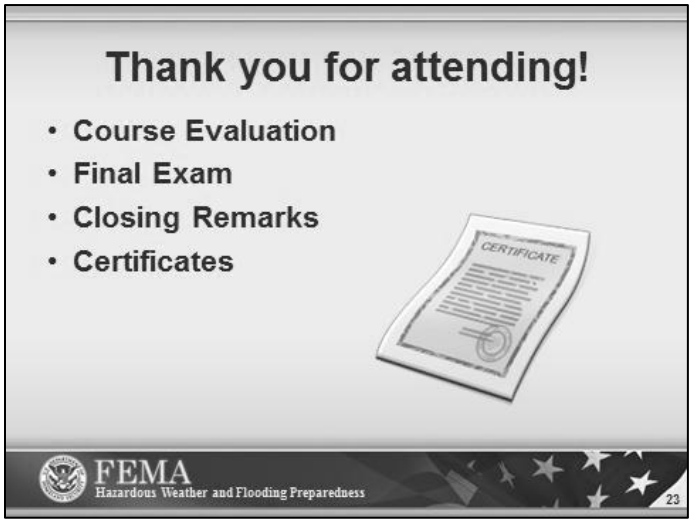
Thank you for attending!
• Course Evaluation
• Final Exam
• Closing Remarks
• Certificates
CERTIFICATE
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G271

Hazardous Weather and Flooding Preparedness

Appendices

Student Manual

FEDERAL EMERGENCY MANAGEMENT AGENCY
EMERGENCY MANAGEMENT INSTITUTE

September 2012

Table of Contents

Appendix A: Glossary

Term	Definition
Advection	The horizontal transport of air, moisture or other atmospheric properties. Commonly used with temperatures, i.e., "warm air advection."
Advisory	Product issued by the National Weather Service for weather situations that cause significant inconveniences but do not meet warning criteria and, if caution is not exercised, could lead to life-threatening situations. Advisories are issued for significant events that are occurring, are imminent, or have a very high probability of occurrence.
AFWS	Automated Flood Warning Systems
Air Mass	A large body of air that has similar horizontal temperature and moisture characteristics.
Air Pressure	The amount of force exerted on the Earth by the air mass above a given location. It is measured by a one-square-inch column of air extending through the atmosphere.
ALERT	Automated Local Evaluation in Real Time
All Hazards Emergency Message Collection Service (HazCollect)	Commonly known as HazCollect, this service provides an automated capability to streamline the creation, authentication, collection and dissemination of non-weather emergency messages in a quick and secure fashion. It is a comprehensive solution for the centralized collection and efficient distribution of Non-Weather Emergency Messages (NWEMs) to the NWS dissemination infrastructure, the Emergency Alert System (EAS) and other national systems.
AMBER Alert™ Program	A voluntary partnership between law-enforcement agencies, broadcasters, transportation agencies, and the wireless industry to activate an urgent bulletin in the most serious child-abduction cases.
America's Weather and Climate Industry	America's Weather and Climate Industry includes all elements of the private sector (including media, consultants, equipment providers, etc.) which provide services to the public in the areas of climate, water, and weather. The term does not exclude foreign-owned companies which provide services to the American public.
ARES	Amateur Radio Emergency Services
ARRL	Amateur Radio Relay League
Atmosphere	The mass of air surrounding Earth's surface and bound to it more or less permanently by Earth's gravitational field.

Term	Definition
Aurora Borealis	Also known as the northern lights. The luminous, radiant emission from the upper atmosphere over middle and high latitudes and centered around Earth's magnetic poles. These mostly silent displays are often seen on clear winter nights in a variety of shapes and colors.
AWC	Aviation Weather Center
AWIPS	Advanced Weather Interactive Processing Systems
AWP	Area Warning Point
Blizzard	Includes winter storm conditions of sustained winds or frequent gusts of 35 mph or more that cause major blowing and drifting of snow, reducing visibility to less than 1/4 mile for 3 or more hours. Extremely cold temperatures often are associated with dangerous blizzard conditions.
CAPE	Convective Available Potential Energy
CDBG	Community Development Block Grant
Cell	Convection in the form of a single updraft, downdraft, or updraft/downdraft couplet, typically seen as a vertical dome or tower as in a cumulus or towering cumulus cloud. A typical thunderstorm consists of several cells.
Chinook Winds	Also known as Foehn [fern] Winds, warm, dry winds that occur in the leeward side of high mountain ranges. These winds develop in well-defined areas and can be quite strong.
Circulation	The pattern of the movement of air. General circulation is the flow of air of large, semi-permanent weather systems, while secondary circulation is the flow of air within more temporary weather systems.
Climate	The prevalent long-term weather conditions in a particular area. Climatic elements include precipitation, temperature, humidity, sunshine, and wind velocity, and phenomena such as fog, frost, and hail storms. Climate cannot be considered a satisfactory indicator of actual conditions since it is based upon a vast number of elements taken as an average.
Cloudburst	A sudden, intense rainfall that is normally of short duration.
CMAS	Commercial Mobile Alert System
Coastal Flood	The inundation of land areas along the oceanic coast that is caused by sea waters over and above normal tidal action. Such flooding can originate from the ocean front, back bays, sound, etc.
Cold Front	A narrow transition zone separating advancing colder air from retreating warmer air. The air behind a cold front is cooler and typically drier than the air it is replacing.

Term	Definition
Commercial Mobile Alert System (CMAS)	A partnership between FEMA, the FCC, and wireless carriers to enhance public safety by allowing public safety authorities to use the IPAWS Open Platform for Emergency Networks to send geographically targeted, text-like Wireless Emergency Alerts (WEA) to the public. Also see Wireless Emergency Alert (WEA).
Community Rating System (CRS)	The National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements.
Convective Available Potential Energy (CAPE)	Indicates the amount of buoyant energy available to accelerate an air parcel vertically. It is a measure of the potential intensity of deep, moist convection.
Convection	The transfer of heat within the air by its movement. The term is used specifically to describe vertical transport of heat and moisture, especially by updrafts and downdrafts in an unstable atmosphere.
Coronal Mass Ejection (CME)	A bubble or tongue of gas and magnetic fields that results when the strong magnetic fields in the corona are closed, often above sunspot groups. CMEs significantly increase the density and speed of the solar wind.
CME	Coronal Mass Ejection
CPC	Climate Prediction Center
CRS	Community Rating System
CWA	Center Weather Advisory
CWP	County Warning Point
CWSU	Center Weather Service Unit
Cyclone	An area of low pressure around which winds blow counterclockwise in the Northern Hemisphere. Also the term used for a hurricane in the Indian Ocean and the Western Pacific Ocean.
Datum Plane	The horizontal plane, unique to each individual tidal station, to which soundings, ground elevations, or water surface elevations for that station are referred. The plane is called a tidal datum when it is defined by a certain phase of the tide.
Debris Cloud	A rotating "cloud" of dust or debris near or on the ground, often appearing beneath a condensation funnel and surrounding the base of a tornado.

Term	Definition
Derecho	A widespread and usually fast-moving windstorm associated with convection. Derechoes include any family of downburst clusters produced by an extratropical MCS, and can produce damaging straight-line winds over areas hundreds of miles long and more than 100 miles across.
Dew Point	The temperature to which air must be cooled to become saturated by the water vapor that is already present (assuming there is no drastic change in pressure and moisture content) to condense and form fog or clouds.
DHS	Department of Homeland Security
DI	Damage Indicator
DNR	Department of Natural Resources
DOC	Department of Commerce
DOD	Department of Defense; Degree of Damage
Doppler Radar	Radar that can measure radial velocity, the instantaneous component of motion parallel to the radar beam (i.e., toward or away from the radar antenna). Also see Dual-Polarization Radar.
DOT	Department of Transportation
Downburst	Localized current of air blasting down from a thunderstorm, which induces an outward burst of damaging wind on or near the ground.
Downdraft	A column of generally cool air that rapidly sinks to the ground, usually accompanied by precipitation as in a shower or thunderstorm.
Drought	Abnormally dry weather in a region over an extended period sufficient to cause a serious hydrological (water cycle) imbalance in the affected area. This can cause such problems as crop damage and water-supply shortage.
Dryline	A boundary that separates warm, dry air from warm, moist air. The differences in the two air masses may be significant. The dryline is usually a boundary of instability along which thunderstorms form.
Dual-Polarization Radar	Upgrade to existing WSR-88 Doppler radar systems providing information on both vertical as well as horizontal properties of atmospheric constituents. Dual-pol radar can help forecasters distinguish very heavy rain from hail and provide more accurate precipitation estimates. The upgraded systems also provide more accurate data related to wind speed and direction.
Dust Devil	A small, rapidly rotating wind that is made visible by the dust, dirt, or debris it picks up. Also called a whirlwind. Dust devils usually develop during hot, sunny days over dry and dusty or sandy areas.

Term	Definition
Dust Storm	An area where high surface winds have picked up loose dust, reducing visibility to less than 1/2 mile.
EAS	Emergency Alert System
EF	Enhanced Fujita
El Niño	A major warming of the equatorial waters in the eastern Pacific Ocean. El Niño events usually occur every 3 to 7 years and are related to shifts in global weather patterns. (Spanish for the "Christ Child," named this because it often begins around Christmas.) One phase of the El Niño Southern Oscillation (ENSO).
EM	Emergency Management
Emergency Alert System (EAS)	A national public warning system that requires broadcasters, cable television systems, wireless cable systems, satellite digital audio radio service (SDARS) providers, and direct broadcast satellite (DBS) providers to provide the communications capability to the President to address the American public during a national emergency. The system also may be used by state and local authorities to deliver important emergency information, such as AMBER alerts and weather information targeted to specific areas.
Emergency Managers Weather Information Network (EMWIN)	Commonly known as EMWIN, this suite of data access methods make available a live stream of weather and other critical emergency information. EMWIN offers an economical way to receive all products available on the NWWS, plus graphical forecasts and select satellite data.
EMWIN	Emergency Managers Weather Information Network
Enhanced Fujita (EF) Scale	Update to original tornado damage classification system developed by Dr. Theodore Fujita. Involving the input of both meteorologists and wind engineers, the EF Scale ranks tornado strength from EF0 (weakest) and EF5 (strong) corresponding to wind estimates that are based on observed damage. In the U.S., nationwide use of the Enhanced Fujita scale began in 2007.
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
ERP	Emergency Response Plan
Extratropical Cyclones	Deep, low-pressure storms that form outside the tropics off the Pacific coast, in the Gulf of Mexico, over the Atlantic Ocean, or in the Great Lakes. Extratropical storms may cover a larger area than tropical cyclones. Their storm centers are colder than the surrounding air and their strongest winds are in the upper atmosphere.

Term	Definition
Eye	The low pressure center of a tropical cyclone. Winds are normally calm and sometimes the sky clears.
FAA	Federal Aviation Administration
Family of Service (FOS)	A collection of data services accessible to external users. The FOS provides users access to near-real-time weather information on the NWS Telecommunications Gateway (NWSTG) using the Office of Operational System Network (OPSnet) located at NWS headquarters in Silver Spring, MD.
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
Flash Flood	A flood that occurs within a few hours (usually less than 6) of heavy or excessive rainfall, dam or levee failure, or water released from an ice jam.
FMA	Flood Mitigation Assistance
Foehn Winds	Also known as Chinook Winds, warm, dry winds that occur in the leeward side of high mountain ranges. These winds develop in well-defined areas and can be quite strong.
Fog	Water that has condensed close to ground level, producing a cloud of very small droplets that reduces visibility to less than one km (less than about 3,000 feet).
FOS	Family of Service
Forecast	A statement of prediction. As used in this course, a forecast is a product issued by the NWS that provides a description of the most significant weather conditions expected during the current and following days. The exact content depends upon the intended user, such as the Public or Marine forecast audiences.
Front	The boundary or transition zone between two different air masses. The basic frontal types are cold fronts, warm fronts, and occluded fronts.
Frostbite	Damage to body tissue caused by that tissue being frozen. Frostbite causes a loss of feeling and a white or pale appearance in the extremities.
Funnel Cloud	A rotating, cone-shaped column of air extending downward from the base of a thunderstorm but not touching the ground. When it reaches the ground it is called a tornado.

Term	Definition
Geostationary Operational Environmental Satellite (GOES)	A satellite orbiting at 22,370 miles above the Equator with the same rotational velocity as the Earth; therefore, the satellite remains over the same location on the Earth 24 hours a day. GOES imagery is also used to estimate rainfall during the thunderstorms and hurricanes for flash flood warnings, as well as estimate snowfall accumulations and overall extent of snow cover.
Geostationary Satellite	A satellite positioned over the equator that rotates at the same rate as Earth, remaining over the same spot.
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning Systems
Gust	A brief sudden increase in wind speed. Generally the duration is less than 20 seconds and the fluctuation greater than 10 mph.
Gust Front	The leading edge of the downdraft from a thunderstorm. A gust front may precede the thunderstorm by several minutes and have winds that can easily exceed 80 mph.
Hail	Precipitation in the form of balls or irregular lumps of ice produced by liquid precipitation freezing and being coated by layers of ice as it is lifted and cooled in strong updrafts of thunderstorms.
Haines Index	Also known as the Lower Atmospheric Severity Index (LASI), a numerical value from 2 to 6 that indicates the potential for large fire growth.
HazCollect	All Hazards Emergency Message Collection Service
Heat Index (HI)	An index that combines air temperature and humidity to give an apparent temperature (how hot it feels). A measure of the effect of the combined elements of high temperature and high humidity on the body.
HI	Heat Index
High	A center of pressure that is surrounded on all sides by lower pressure. An area of high pressure, usually accompanied by anticyclonic and outward wind flow. Also known as an anticyclone.
HMGP	Hazard Mitigation Grant Program
Hook Echo	A radar pattern sometimes observed in the southwest quadrant of a tornadic thunderstorm. Appearing like a fishhook turned in toward the east, the hook echo is precipitation aloft around the periphery of a rotating column of air 2-10 miles in diameter.
HPC	Hydrometeorological Prediction Center
Humidity	The amount of water vapor in the atmosphere.

Term	Definition
Hurricane	A severe tropical cyclone with sustained winds over 74 mph (64 knots).Normally applied to such storms in the Atlantic Basin and the Pacific Ocean east of the International Date Line.
Hydrology	The study of water on Earth including the effects of precipitation and evaporation upon the water in streams, rivers, lakes, and its effect on land surfaces.
Hydrometeorological Event	A weather-related event such as tropical cyclones (hurricanes, typhoons, cyclones), windstorms, winter storms, tornadoes, and floods.
Hydrometeorology	The branch of meteorology that deals with the occurrence, motion, and changes of state of atmospheric water.
Hyperthermia	High body temperature; an acute condition that occurs when the body absorbs more heat than it can handle.
Hypothermia	Low body temperature. When body temperature drops to 95ºF, immediate medical help is needed. Hypothermia also can occur with prolonged exposure to cold temperatures above freezing.
IAEM	International Association of Emergency Managers
Ice Jam	An accumulation of broken river ice caught in a narrow channel that frequently produces local floods during a spring breakup.
Ice Storm	Liquid rain falling and freezing on contact with cold objects creating ice buildups of 1/4th inch or more that can cause severe damage.
Instability	A state of the atmosphere in which convection takes place spontaneously, leading to cloud formation and precipitation.
Integrated Public Alert and Warning System (IPAWS)	Initiated after September 11, 2001, and directed by the Secretary of Homeland Security by Executive Order 13407, IPAWS will provide an integrated interoperable environment for alert and warning and will diversify and modernize the EAS. The goal of IPAWS is to reach all Americans, including those with disabilities or who do not have an understanding of the English language, at all times, over more communications channels, in all locations, throughout the United States during an emergency.
Integrated Warning Team	A partnership made up of local, State, and Federal emergency management officials, the NWS, and America's Weather and Climate Industry. This combination of sources must effectively communicate a consistent warning message to the public, because inconsistent warning messages lead to inaction or incorrect action by the public.
Inversion	An increase in temperature with height. The reverse of the normal cooling with height in the atmosphere. Temperature inversions trap atmospheric pollutants in the lower troposphere, resulting in higher concentrations of pollutants at ground levels than would usually be experienced.

Term	Definition
iNWS	Interactive NWS, an application suite that allows users to configure and receive text message alerts and e-mail message alerts when the NWS issues a watch, warning or advisory that affects them. iNWS is intended for NWS core partners, including emergency managers, community leaders and other government agencies.
Ionosphere	Also known as the thermosphere. A layer in the atmosphere above the mesosphere extending from about 80 km above Earth's surface. It can be considered a distinct layer due to a rise in air temperature with increasing height. Atmospheric densities here are very low.
IPAWS	Integrated Public Alert and Warning System
ISO	Insurance Services Organization
Isobar	A line of equal barometric pressure on a weather map.
Jet Stream	Strong winds concentrated within a narrow band in the upper atmosphere. It normally refers to horizontal, high-altitude winds. The jet stream often "steers" surface features such as fronts and low pressure systems.
Joint Polar Satellite System (JPSS)	The Joint Polar Satellite System (JPSS) is the restructured civilian portion of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) that will make afternoon observations as it orbits Earth. The system includes the satellites and sensors supporting civil weather and climate measurements and a shared ground infrastructure with the Department of Defense weather satellite system.
JPSS	Joint Polar Satellite System
Knot	A measure of speed. It is 1 nautical mile per hour (1.15 mph). A nautical mile is 1 minute of 1 degree of latitude.
LASI	Lower Atmospheric Severity Index.
La Niña	A cooling of the equatorial waters in the Pacific Ocean.
LETS	Law Enforcement Telecommunications System
LI	Lifted Index
Lifted Index (LI)	A common measure of atmospheric instability. Its value is obtained by computing the temperature that air near the ground would have if it were lifted to some higher level (around 18,000 feet, usually) and comparing that temperature to the actual temperature at that level. Negative values indicate instability—the more negative, the more unstable the air is, and the stronger thunderstorms are likely to be if they develop.
Low	An area of low pressure, usually accompanied by cyclonic and inward wind flow. Also known as a cyclone.

Term	Definition
Lower Atmospheric Severity Index (LASI)	Commonly known as the Haines Index, a numerical value from 2 to 6 that indicates the potential for large fire growth.
Macroburst	Large downburst with a 2.5 mile or greater outflow diameter and damaging winds lasting 5 to 20 minutes.
Mean Sea Level (MSL)	The average height of the sea surface, based upon hourly observation of the tide height on the open coast or in adjacent waters that have free access to the sea.
Mesocyclone	A storm-scale region of rotation often found in the right rear flank of a supercell (or often on the eastern flank or front flank of an HP storm). The circulation of a mesocyclone covers an area much larger than the tornado that may develop within it.
Meteorologist	A person who studies meteorology. Some examples include research meteorologist, climatologist, operational meteorologist, television meteorologist.
Meteorology	The study of the physics, chemistry, and dynamics of the atmosphere and the direct effects of the atmosphere upon the earth's surface, the oceans, and life in general.
Microburst	A strong, localized downdraft from a thunderstorm with peak gusts lasting 2 to 5 minutes.
Millibar	A metric unit of atmospheric pressure. 1 mb = 100 Pa (pascal). Normal surface pressure is approximately 1013 millibars.
Mitigation	As defined by PPD-8, those capabilities necessary to reduce loss of life and property by lessening the impact of disasters. Mitigation capabilities include, but are not limited to, community-wide risk reduction projects; efforts to improve the resilience of critical infrastructure and key resource lifelines; risk reduction for specific vulnerabilities from natural hazards or acts of terrorism; and initiatives to reduce future risks after a disaster has occurred.
MSL	Mean Sea Level
Multicell Cluster Thunderstorm	A thunderstorm consisting of two or more cells, of which most or all are often visible at a given time as distinct domes or towers in various stages of development.
National Flood Insurance Program (NFIP)	The National Flood Insurance Program (NFIP) is a Federal program created by Congress to mitigate future flood losses nationwide through sound, community-enforced building and zoning ordinances and to provide access to affordable, federally backed flood insurance protection for property owners. The NFIP is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.
NCEP	National Center for Environmental Protection

Term	Definition
NCO	NCEP Central Operations
NFIP	National Flood Insurance Program
National Hurricane Center (NHC)	This National Weather Service center maintains a continuous watch on tropical cyclones over the Atlantic, Caribbean, Gulf of Mexico, and the Eastern Pacific from 15 May through November 30. The Center prepares and distributes hurricane watches and warnings for the general public, and also prepares and distributes marine and military advisories for other users. During the "off-season" NHC provides training for U.S. emergency managers and representatives from many other countries that are affected by tropical cyclones. NHC also conducts applied research to evaluate and improve hurricane forecasting techniques, and is involved in public awareness programs.
National Oceanic and Atmospheric Administration (NOAA)	A branch of the U.S. Department of Commerce, NOAA is the parent organization of the National Weather Service.
National Polar-orbiting Operational Environmental Satellite System (NPOESS)	The NPOESS was to be the next generation of low earth orbiting environmental satellites; to provide global coverage, monitoring environmental conditions, collecting, disseminating and processing data about the Earth's weather, atmosphere, oceans, land, and near-space environment. Replaced by the Joint Polar Satellite System (JPSS) and the Department of Defense Weather Satellite System (DWSS).
National Volcano Early Warning System (NVEWS)	A proposed national-scale plan to ensure that volcanoes are monitored at levels commensurate to their threats. The plan was developed by the U.S. Geological Survey Volcano Hazards Program (VHP) and its affiliated partners in the Consortium of U.S. Volcano Observatories (CUSVO).
National Warning System (NAWAS)	Commonly known as NAWAS, this comprehensive automated telephone network connects state and Federal warning points throughout the United States.
National Weather Service (NWS)	The official US government agency for weather, hydrologic, and climate forecasts.
NAWAS	National Warning System
NCDC	National Climatic Data Center
NCF	Network Control Facility
NEMA	National Emergency Management Association
NEXRAD	Next Generation Weather Radar

Term	Definition
Next Generation Weather Radar (NEXRAD)	The Next Generation Weather Radar system (NEXRAD) comprises 159 Weather Surveillance Radar-1988 Doppler (WSR-88D) sites throughout the United States and select overseas locations. This system is a joint effort of the United States Departments of Commerce (DOC), Defense (DOD), and Transportation (DOT). The controlling agencies are the National Weather Service (NWS), Air Force Weather Agency (AFWA) and Federal Aviation Administration (FAA), respectively. The system is comprised of Doppler radars, telecommunications, computer data communications, data processing hardware and software, display and data entry equipment, documentation and certain facilities and support capabilities required to detect, process, distribute, and display weather information in a manner which allows the DOC, the DOD and the DOT to fulfill their mission needs.
NHC	National Hurricane Center
NOAA	National Oceanic and Atmospheric Administration
NOAAPort	A broadcast system that provides a one-way broadcast communication of NOAA environmental data and information in near real time to NOAA and external users.
NOAA Weather Radio (NWR)	A nationwide network of radio stations broadcasting continuous weather and water information directly from the nearest forecast office. It offers continuous, 24-hour-a-day VHF broadcasts of weather observations and forecasts directly from National Weather Service offices. A special tone allows certain receivers to sound an alarm when watches or warnings are issued.
NOAA Weather Wire Service (NWWS)	A satellite data collection and dissemination system operated by NWS that provides state and federal government, commercial users, media, and private citizens with timely delivery of meteorological, hydrological, climatological, and geophysical information. As of the date of this publication, the NWWS is transitioning to the next-generation system known as the Weather Radio Improvement Project (WRIP).
NOHRSC	National Operational Hydrologic Remote Sensing Center
Nor'easter	A low-pressure disturbance forming along the South Atlantic coast and moving northeast along the Middle Atlantic and New England coasts to the Atlantic Provinces of Canada. It usually causes strong northeast winds with rain or snow. Also called a Northeaster or Coastal Storm.
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NSSL	National Severe Storms Laboratory
NTHMP	National Tsunami Hazard Mitigation Program
NVEWS	National Volcano Early Warning System
NWR	NOAA Weather Radio

Term	Definition
NWS	National Weather Service
NWSChat	An instant messaging program used by NWS operational personnel to share critical warning decision expertise and other types of significant weather information essential to the NWS's mission of saving lives and property. NWSChat provides direct communication between the NWS office and television meteorologists, emergency managers, Department of Natural Resources (DNR), and other specific partner organizations.
NWSH	National Weather Service Headquarters
NWSTG	NWS Telecommunications Gateway
NWWS	NOAA Weather Wire Service
Occlusion	A complex frontal system that occurs when a cold front overtakes a warm front. Also known as an occluded front.
OPC	Oceans Prediction Center
OPSnet	Operational System Network
Outlook	A product issued by the National Weather Service, used to indicate that a hazardous weather or hydrologic event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event.
PA	Public Assistance
Particularly Dangerous Situation (PDS)	Particularly Dangerous Situation (PDS) wording is used in rare situations when long-lived, strong and violent tornadoes are possible. This enhanced wording may also accompany severe thunderstorm watches for intense convective wind storms.
PDM	Pre-Disaster Mitigation
PDS	Particularly Dangerous Situation.
PETS Act	The Pets Evacuation and Transportation Standards Act of 2006
Pets Evacuation and Transportation Standards Act of 2006 (PETS Act)	This Act, which amended Section 403 of the Stafford Act, requires that household pets and service animals are included in the emergency preparedness operational plans for State and local officials following a major disaster or emergency. The Act also authorizes FEMA to provide rescue, care, shelter, and essential needs for individuals with household pets and service animals, and to the household pets and animals themselves following a major disaster or emergency.
PIO	Public Information Officer
PoP	Probability of Precipitation

Term	Definition
PPD-8	Presidential Policy Directive 8: National Preparedness
Preparedness	The National Incident Management System (NIMS) defines preparedness as "a continuous cycle of planning, organizing, training, equipping, exercising, evaluating, and taking corrective action in an effort to ensure effective coordination during incident response." As defined by PPD-8, “national preparedness” refers to the actions taken to plan, organize, equip, train, and exercise to build and sustain the capabilities necessary to prevent, protect against, mitigate the effects of, respond to, and recover from those threats that pose the greatest risk to the security of the Nation.
Pressure Gradient Force (Pgf)	Force acting on air that causes it to move from areas of higher pressure to areas of lower pressure.
Prevailing Westerlies	Winds in the middle latitudes (approximately 30 degrees to 60 degrees) that generally blow from west to east.
Prevention	As defined by PPD-8, those capabilities necessary to avoid, prevent, or stop a threatened or actual act of terrorism. Prevention capabilities include, but are not limited to, information sharing and warning; domestic counterterrorism; and preventing the acquisition or use of weapons of mass destruction (WMD). For purposes of the prevention framework called for in this directive, the term "prevention" refers to preventing imminent threats.
Probability of Precipitation (PoP)	Probability forecasts providing estimates of the chances of encountering measurable precipitation at some time during the forecast period. Specifically defined as the probability that a given point in the forecast area will receive measurable precipitation.
Protection	As defined by PPD-8, those capabilities necessary to secure the homeland against acts of terrorism and manmade or natural disasters. Protection capabilities include, but are not limited to, defense against WMD threats; defense of agriculture and food; critical infrastructure protection; protection of key leadership and events; border security; maritime security; transportation security; immigration security; and cybersecurity.
PTWC	Pacific Tsunami Warning Center
Public Information Officer (PIO)	Under the Incident Command System (ICS), a Command Staff position consisting of a single person who has responsibility for all interaction between Command and the media and who coordinates the release of information on the incident situation and response efforts from Command to the media. A Public Information Officer may designate one or more assistants from either the same or another assisting agency or jurisdiction.
Radar	An instrument used to detect precipitation by measuring the strength of the electromagnetic signal reflected back. (RADAR= RAdio Detection And Ranging)

Term	Definition
Radar Product Services (RPS)	Part of the Family of Service (FOS), RPS provides direct user access to WSR-88D products in real time. All radar products that the NWS is centrally collecting will be available on the RPS.
Rain	Liquid water droplets that fall from the atmosphere, having diameters greater than drizzle (0.5 mm).
Recovery	As defined by PPD-8, those capabilities necessary to assist communities affected by an incident to recover effectively, including, but not limited to, rebuilding infrastructure systems; providing adequate interim and long-term housing for survivors; restoring health, social, and community services; promoting economic development; and restoring natural and cultural resources.
Relative Humidity (RH)	The amount of water vapor in the air compared to the amount the air could hold if it was totally saturated. Expressed as a percentage.
Response	As defined by PPD-8, those capabilities necessary to save lives, protect property and the environment, and meet basic human needs after an incident has occurred.
RFC	River Forecast Center (Also, Repetitive Flood Claims)
RH	Relative Humidity
Ridge	An elongated area of high pressure in the atmosphere.
RPS	Radar Product Services
SAS	Server Access Service
SBN	Satellite Broadcast Network
Seiche	An effect caused by winds that push lake water to one end of the lake. When the storm ends or moves on, the water sloshes to the other end of the lake, causing water level changes of up to several feet.
Server Access Service (SAS)	Part of the Family of Service (FOS), SAS provides access to all NWS data and information including warnings, watches, forecasts, and observational data.
SKYWARN®	SKYWARN® is a volunteer program of trained weather spotters, established by the National Weather Service. These volunteers help keep their local communities safe by providing timely and accurate reports of severe weather to NWS.
Sleet	Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects. Forms when snow enters a warm layer of air above the surface and melts and then enters a deep layer of sub-freezing air near the surface and refreezes.

Term	Definition
SOGs	Standard Operating Guidelines
Solar Flares	Intense, short-lived releases of energy. They are seen as bright areas on the Sun in optical wavelengths and as bursts of noise in radio wavelengths; they can last from minutes to hours. Flares are our solar system's largest explosive events.
Solar Wind	The outward flow of solar particles and magnetic fields from the Sun.
SOPs	Standard Operating Procedures
Space Weather	The conditions in space that affect Earth and its technological systems. Space weather is a consequence of the behavior of the Sun interacting with the Earth's magnetic field and atmosphere, and our location in the solar system.
SPC	Storm Prediction Center
SRL	Severe Repetitive Loss
Squall	A strong wind characterized by a sudden onset in which the wind speed increases at least 16 knots and is sustained at 22 knots or more for at least one minute.
Squall Line	Any non-frontal line or narrow band of active thunderstorms. The term is usually used to describe solid or broken lines of strong or severe thunderstorms.
Stationary Front	The boundary between cool and warm air masses that are not moving.
StormReady	A voluntary "grass roots" program sponsored by the National Weather Service that focuses on improving communication and severe weather preparedness in communities.
Storm Surge	A rise of the sea level alone the shore that builds up as a storm (usually a hurricane) moves over water. It is a result of the winds of the storm and low atmospheric pressures.
Sunspots	Dark areas on the solar surface that contain strong magnetic fields that are constantly shifting. A moderate-sized sunspot is about as large as the Earth.
Supercell Thunderstorm	A severe thunderstorm whose updrafts and downdrafts are in near balance allowing the storm to maintain itself for several hours. Supercells often produce large hail and tornadoes.
Surf	The waves in the area between the shoreline and the outermost limit of breakers.

Term	Definition
Swell	Wind-generated waves that have travelled out of their generating area. Swells characteristically exhibit smoother, more regular and uniform crests and a longer period than wind waves. Swells can contribute to coastal flooding even if the originating storm never reaches the coast.
SWP	State Warning Point
SWPC	Space Weather Prediction Center
Temperature	The degree of heat, originating with the sun's rays, in the atmosphere. Temperature is a measure of heat energy and it expresses the degree of molecular activity of an object.
Thunderstorm	A storm with lightning and thunder, produced by a cumulonimbus cloud, usually producing gusty winds, heavy rain and sometimes hail.
Tidal Cycle	The periodic change in the intensity of tides that is caused primarily by the varying relations among the earth, moon, and sun.
Tornado	A violent rotating column of air, in contact with the ground, pendant from a cumulonimbus cloud. A tornado does not require the visible presence of a funnel cloud. It has a typical width of tens to hundreds of meters and a lifespan of minutes to hours.
Tornado Alley	The area of the United States in which tornadoes are most frequent. It encompasses the great lowland areas of the Mississippi, the Ohio, and lower Missouri River Valleys. Although no state is entirely free of tornadoes, they are most frequent in the Great Plains area between the Rocky Mountains and Appalachians.
Tropical Cyclones	Coastal storms that form over the ocean, within the tropics. These storms cover a smaller area than extratropical coastal cyclones. The storm center is warmer than the surrounding air, and the strongest winds are about 10,000 feet above the ground. Tropical cyclones may be categorized as tropical depressions, tropical storms, or hurricanes/typhoons.
Tropopause	The boundary between troposphere and the stratosphere.It is usually characterized by an abrupt change in temperature with height from positive (decreasing temperature with height) to neutral or negative (temperature constant or increasing with height).
Troposphere	The layer of the atmosphere from Earth's surface up to the tropopause, characterized by decreasing temperature with height. It is the layer of the atmosphere where most of the weather occurs.
Trough	An elongated area of relatively low atmospheric pressure on the surface or aloft. Usually not associated with a closed circulation, and thus used to distinguish from a closed low.
TPC	Tropical Prediction Center

Term	Definition
Tsunami	A series of ocean waves of extremely long length primarily generated by disturbances in the ocean floor due to undersea earthquakes. Tsunamis can also be generated by volcanic eruptions, landslides or even asteroid impacts. Tsunamis are categorized as local (caused by an undersea earthquake near the impacted coast) or distant (caused by an undersea earthquake far away from the impacted coast). A distant tsunami may also be known as a teletsunami.
TsunamiReady	A voluntary “grass roots” program sponsored by NOAA that focuses on improving communication and tsunami preparedness in communities.
TWC	Tsunami Warning Center
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UTC	Coordinated Universal Time. The time in the 0° meridian time zone (Greenwich, England).
Volcanic Ash	Small jagged pieces of rocks, minerals, and volcanic glass the size of sand and silt (less than 1/12 inch in diameter) erupted by a volcano.
Wall Cloud	A local and often abrupt lowering of a rain-free cumulonimbus base into a low-hanging accessory cloud, from 1 to 4 miles in diameter. The wall cloud is usually situated in the southwest portion of the storm below an intense updraft marked by the main cumulonimbus cloud and associated with a very strong or severe thunderstorm. When seen from several miles away, many wall clouds exhibit rapid upward motion and rotation in the same sense as a tornado, except with considerably lower speed. A rotating wall cloud usually develops before tornadoes or funnel clouds by a time which can range from a few minutes up to possibly an hour.
Warm Front	A narrow transitions zone separating advancing warmer air from retreating cooler air. The air behind a warm front is warmer and typically more humid than the air it is replacing.
Warning	Product issued by the National Weather Service when a particular weather or flood hazard is imminent or already occurring (e.g., tornado warning, flash flood warning). A warning is used for conditions posing a threat to life or property. The term “warning” can also refer to the messages that the emergency management community uses to inform the public to initiate appropriate protective actions.
Warning Communication	Messages and statements that are transmitted from the emergency management community to the public. Warning communication needs to be tailored to the population that is being affected by the event.
Warning Coordination	Organized activity that occurs within the emergency management community to ensure that the message that is delivered is appropriate, consistent, and understandable.

Term	Definition
Warning System	Any system, whether manual or automatic, made up of people and/or technology, designed to notify people of impending danger. The goal is to maximize the number of people who take appropriate and timely action to minimize injury, death, and property damage due to hazardous weather and flooding.
Watch	Product issued by the National Weather Service well in advance to alert the public of the possibility of a particular weather-related hazard (e.g., tornado watch, flash flood watch). The occurrence, location, and timing of the weather event may still be uncertain.
Waterspout	A rapidly rotating column of air extending from a cumulonimbus cloud with a circulation that reaches the surface of the water (i.e., a tornado over water).
WC/ATWC	West Coast/Alaska Tsunami Warning Center
WCM	Warning Coordination Meteorologist
Weather Forecast Office (WFO)	This type of National Weather Service office is responsible for issuing advisories, warnings, statements, and short term forecasts for its county warning area.
Weather Spotters	Volunteers that support the warning process with their observational data. They are often the first to report worsening weather conditions.
Weather Surveillance Radar 88 Doppler (WSR-88D)	The instrument used in NEXt Generation RADar (NEXRAD), operated at local Weather Forecast Offices nationwide by the National Weather Service. Doppler radar systems provide information about both precipitation and wind.
WFO	Weather Forecast Office
Wind	The movement of air due to pressure differences.
Wind Chill	The additional cooling effect resulting from wind blowing on bare skin. The wind chill is based on the rate of heat loss from exposed skin caused by the combined effects of wind and cold. The (equivalent) wind chill temperature is the temperature the body "feels" for a certain combination of wind and air temperature.
Wind Chill Factor	The apparent temperature that describes the cooling effect on exposed skin by the combination of temperature and wind, expressed as the loss of body heat. Increased wind speed will accelerate the loss of body heat.
Wind Storm	High winds not associated with convective events (severe thunderstorms, hurricanes, and winter storms) that require a warning when one of the following occurs: sustained wind speeds of 40 mph or greater, lasting for 1 hour or longer OR winds of 58 mph or greater for any duration.

Term	Definition
Wireless Emergency Alert (WEA)	Geographically targeted, text-like alerts used to relay Presidential, AMBER, and Imminent Threat alerts to mobile phones using cell broadcast technology. Most CMAS/WEA alerts are issued by NWS for the most imminent and severe weather conditions, such as tornado warnings. Also see Commercial Mobile Alert System (CMAS).
WRIP	Weather Radio Improvement Project
WSO	Weather Service Office
WSR-88D	Weather Surveillance Radar - 1988 Doppler. Also see NEXRAD.
Zulu Time	Same as UTC, Universal Coordinated Time. It is called Zulu because "Z" is often appended to the time to distinguish it from local time.

Appendix B: Resources

NOTE: FEMA EMI has provided this list of resources to provide information related to hazardous weather and flooding preparedness that may be of interest to course participants.

EMI does not guarantee that outside websites and non-government documents listed in this Appendix comply with the accessibility requirements of Section 508 of the Rehabilitation Act.

This Appendix may contain URLs that were valid when originally published but now link to sites or pages that no longer exist.

- **National Weather Service Reference Guidebook**
  http://www.weather.gov/om/guide/
- Best Practices for Outdoor Warning Sirens
  http://skywatch.org/ows.pdf (610 kb download)
- Commercial Mobile Alert System
  http://www.fema.gov/commercial-mobile-alert-system
- EMWIN
  http://www.weather.gov/emwin/
- Enhanced Fujita Scale
  http://www.spc.noaa.gov/efscale/
- Family of Service (FOS)
  http://www.nws.noaa.gov/datamgmt/fos/fosindex.html
- FEMA Safe Room Information
  www.fema.gov/plan/prevent/saferoom/fema320.shtm
- HazCollect
  http://www.weather.gov/os/hazcollect/
- Hurricane Evacuation Planning and Decision-Making
  http://www.hurrevac.com/
- Integrated Public Alert and Warning System (IPAWS)
  http://www.fema.gov/emergency/ipaws/index.shtm
- iNWS
  http://inws.wrh.noaa.gov/
- National Hurricane Center
  http://www.nhc.noaa.gov/
- National Tsunami Hazard Mitigation Program (NTHMP)
  http://nthmp.tsunami.gov/index.html
- National Tsunami Hazard Mitigation Program (NTHMP) FY2012 Guidance
  http://nthmp.tsunami.gov/2011annualmeeting/briefings/BudgetandGrants012011.ppt
  (130 kb download)

- National Warning System (NAWAS)
  http://www.srh.noaa.gov/cwwd/faqs/nawas.htm
- NOAA Space Weather Scales
  http://www.swpc.noaa.gov/NOAAscales/index.html
- NOAA Weather Radio
  http://www.weather.gov/nwr/
- NOAA Weather Wire Service (NWWS)
  http://www.weather.gov/nwws/
- NOAA's National Climatic Data Center
  http://www.ncdc.noaa.gov/oa/climateresearch.html#dandp
- NOAAPort
  http://www.nws.noaa.gov/noaaport/html/noaaport.shtml
- NWS Advanced Hydrologic Prediction Service (AHPS)
  http://water.weather.gov/ahps
- NWS Heat Safety
  http://www.nws.gov/om/heat/
- NWS JetStream Online School for Weather
  http://www.srh.noaa.gov/jetstream//
- NWS National Operational Hydrologic Remote Sensing Center
  http://www.nohrsc.nws.gov/
- NWS Weather-Ready Nation Initiative
  http://www.nws.noaa.gov/com/weatherreadynation/
- NWSChat
  https://nwschat.weather.gov/
- Select Social Media
  http://www.noaa.gov/socialmedia/
- SKYWARN®
  http://www.weather.gov/skywarn/
- StormReady
  http://www.stormready.noaa.gov/
- TsunamiReady
  http://www.tsunamiready.noaa.gov/
- Wireless Emergency Alerts
  http://www.ctia.org/consumer_info/safety/index.cfm/AID/12082
- Wind Chill Index and Calculator
  http://www.nws.noaa.gov/os/windchill/index.shtml
- Your Local NWS Weather Forecast Office and River Forecast Center
  http://www.weather.gov/organization.php
- Your State Climatologist
  http://www.stateclimate.org/

Related Training

- IS-271 *Anticipating Hazardous Weather & Community Risk*
  http://training.fema.gov/EMIWeb/IS/is271.asp
- SKYWARN® Spotter Training
  http://www.meted.ucar.edu/training_course.php?id=23
- IS-247 *Integrated Public Alert and Warning System (IPAWS)*
  http://training.fema.gov/EMIWeb/IS/is247.asp
- IS-324.a *Community Hurricane Preparedness*
  http://training.fema.gov/EMIWeb/IS/is324a.asp
- IS-326 *Community Tsunami Preparedness*
  http://training.fema.gov/EMIWeb/IS/is326.asp
- G365 *Partnerships for Creating and Maintaining Spotter Groups*.
  http://training.fema.gov/stcourses/
  Check with State Training Agency for availability
- G272 *Warning Coordination*
  http://training.fema.gov/stcourses/
  Check with State Training Agency for availability

Case Studies and Examples

- Arkansas Campground Flash Flooding
  http://www.srh.noaa.gov/lzk/?n=rain0610.htm
- Dallas Hailstorm
  http://www.srh.noaa.gov/fwd/?n=mayfest15
- Palm Sunday Tornado Event, 1994
  http://www.srh.noaa.gov/bmx/?n=palmsunday94stormdata
- Oklahoma Tornado Event, 2011
  http://www.srh.noaa.gov/oun/?n=events-20110524
- Napa River Flood Protection Project
  http://friendsofthenapariver.org/
- Tulsa Partners
  http://tulsapartners.org/tpi/
- Green Bay, WI Decision Support Page
  http://www.crh.noaa.gov/grb/?n=emnews
- Paducah, KY Decision Support Page
  http://www.crh.noaa.gov/pah/?n=incidentsupport
- Sterling, VA Decision Support Page:
  http://www.erh.noaa.gov/lwx/em/empage.php
- Tulsa, OK Decision Support Page
  http://www.srh.noaa.gov/tsa/dsp/dsp.php

Appendix C: Charts and Tables

This section contains the following charts and tables:

- Dew Point Conversion Chart
- Haines Index
- Enhanced Fujita Scale
- Tropical Cyclone Categories
- Hurricane Classifications

For more weather charts and tables, see the NWS Products and Services Reference Guidebook.

Dew Point Conversion Chart

To convert relative humidity and temperature to dew point, find the closest value in the table for relative humidity. Use the corresponding formula with temperature to calculate dew point.

RH = relative humidity **DP** = dew point **T** = temperature (ºF)

RH (%)	DP (ºF)
97	T – 1
94	T – 2
91	T – 3
88	T – 4
85	T – 5
82	T – 6
79	T – 7
76	T – 8
73	T – 9
70	T – 10
68	T – 11
66	T – 12
64	T – 13
62	T – 14
60	T – 15
58	T – 16
56	T – 17
54	T – 18
52	T – 19
50	T – 20

For example, if relative humidity is 70% and the temperature is 65ºF the dew point can be calculated by using the formula in the chart row corresponding to RH = 70, which is T-10. This gives a dew point of 65ºF - 10ºF = 55ºF.

Haines Index

Forecasters use the Haines Index (HI) to indicate the potential for large fire growth. The HI combines both the instability and dryness of the air by examining the lapse rate between two pressure levels in the atmosphere and the dryness at one of the pressure levels.

HAINES INDEX	RISK
2 or 3	Very low
4	Low
5	Moderate
6	High

The Enhanced Fujita Scale

The EF Scale is a set of wind estimates (not measurements) based on damage. For more information, see the link provided in Appendix B.

Fujita Scale		Derived EF-Scale			Operational EF-Scale	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

Tropical Cyclone Categories

CATEGORY	WIND SPEED
Tropical Depression	Maximum sustained winds near the surface less than 39 mph.
Tropical Storm	Winds of 39–73 mph.
Hurricanes or Typhoons	Winds of 74 mph or more.

Hurricane Classifications

As of the date of this publication, the SSHWS is undergoing a minor modification which broadens the Category 4 wind speed range by one mile per hour (mph) at the end of each range. This change is reflected in these tables. For more information, see the National Hurricane Website, listed in Appendix B.

Category	Central pressure (millibars)	Central pressure (inches)	Winds (mph)	Winds (kts)	Damage
1	≥ 980	28.94	74 - 95	64 - 82	Minimal
2	965 - 979	28.50 – 28.93	96 - 110	83 - 95	Moderate
3	945 - 964	27.91 - 28.49	111 - 129	96 - 112	Extensive
4	920 - 944	27.17 - 27.90	130 - 156	113 - 136	Extreme
5	< 920	< 27.17	> 156	> 136	Catastrophic

Saffir-Simpson Hurricane Wind Scale

Category	Winds	Effects
One	74-95 mph	**Very dangerous winds will produce some damage:** Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
Two	96-110 mph	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
Three	111-129 mph	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
Four	130-156 mph	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
Five	greater than 156 mph	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Appendix D: Hazards Fact Sheets

This section contains fact sheets for the most common hazardous weather events experienced in the United States. Fact sheets are also included for non-weather hazards including tsunamis, volcanic ash, and hazardous materials.

Each fact sheet includes a definition of the event, impacts and associated hazards, and characteristics common to the event, as well as a list of related NWS products.

NOTE: The National Weather Service often adds new products (particularly graphical ones) and changes old ones. The products in this section may not be the only representations of the information. Check with your local Warning Coordination Meteorologist for updates.

The following fact sheets are included in this section:

- Thunderstorms
- Tornadoes
- Flash Floods
- Riverine Floods
- Coastal Floods
- Tropical Cyclones
- Extratropical Cyclones
- Drought
- Winter Storms
- Excessive Cold
- Excessive Heat
- Fog
- Dust Storms
- Wind Storms
- Fire Weather
- Space Weather
- Tsunamis
- Volcanic Ash
- Hazardous Materials Release

Thunderstorms

Definition

A thunderstorm is a local storm that is:

- Produced by a cumulonimbus cloud
- Accompanied by lightning and thunder
- Often accompanied by gusty winds, heavy rain, and occasionally by hail
- Sometimes violent at the surface

Classifications

CATEGORY	WIND SPEED	PRECIPITATION
Ordinary	< 35 knots (40 mph)	Variable
Approaching Severe	≥ 35 knots (40 mph)	Hail > ¾ inch
Severe	≥ 50 knots (58 mph)	Hail ≥ 1 inch

Impacts/Associated Hazards

Thunderstorm hazards can contribute to property damage and, in some cases, injuries or fatalities. Associated hazards include:

- Lightning
- Hail
- Damaging winds
- Heavy rain causing flash flooding
- Tornadoes
- Lightning-caused fires
- Power outages

Characteristics

Thunderstorms have distinct life cycles and can only form in the presence of an adequate moisture supply combined with lift. Although thunderstorms can occur in nearly any part of the U.S., they are much more frequent in some geographic areas. They are also much more frequent during certain times of the year. The peak thunderstorm season will vary from location to location.

Contributing Factors

- Moisture comes from large bodies of water, large vegetated or irrigated areas, or previous storms.
- Instability is related to the temperature profile of the atmosphere relative to the moisture of the air mass. If the mid to upper atmosphere is cool (more dense) while the lower atmosphere is warm or moist (less dense), then the lower atmosphere becomes buoyant and unstable and begins to rise, initiating convection. The more unstable the air mass, the more severe the convection. The National Weather Service uses Lifted Index (LI) and Convective Available Potential Energy (CAPE) to indicate atmospheric instability.
- Lift is required to initiate convection. Lift can be caused by fronts, heat rising from the earth's surface, topography (upslope flow), dryline boundaries, outflow boundaries from previous storms, and sea breezes.

Stages of Development

- Developing—A towering cumulus cloud develops as air rises. Usually there is little if any rain, but occasionally lightning occurs during this stage, which lasts about 10 minutes.
- Mature—During this stage, the storm builds to heights of 40,000 feet or more. This is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The mature stage lasts an average of 10 to 20 minutes but may last much longer.
- Dissipating—Downdrafts begin to choke off the supply of air that feeds the storm; the storm stops building, loses height, and dissipates. Rainfall decreases in intensity, but some thunderstorms produce a burst of strong winds, and lightning remains a danger.

Types

- Single Cell—Short-lived storms (20 to 30 minutes) that cover a limited area (a few square miles). These storms are relatively uncommon.
- Multicell—The most common type, multicell thunderstorms are an organized cluster of two or more single cell storms. Air flowing out of one storm fuels other storms, causing new storms to develop on the right or rear storm flank every 5 to 15 minutes.
- Mesoscale Convective System (MCS)—A well-organized system of thunderstorms extending on the order of 60 miles (97 km) or more in at least one direction. MCSs occur commonly over the United States and are particularly frequent in early and mid-summer. Because these systems are characterized by ongoing convection, they can bring torrential rainfalls.
- Supercell—Extremely strong type of thunderstorms capable of producing very severe weather, lasting from 1 to 6 hours, and traveling 200 miles (320 km) or more. These storms can cause winds of more than 78 mph (68 kt), very large hail (e.g., 2 inches [5 cm]), and significant tornado activity. Supercells produce updrafts of 56 to 112 mph (49-97 kt) that coexist with sustained downdrafts. Together, the updrafts and downdrafts act to extend the storm's duration.
- Squall Lines—A line or band of active thunderstorms, a squall line may extend over 250 to 500 miles (400-800 km), may be from 10 to 20 miles (16-32 km) wide, and consist of many laterally aligned cells that do not interfere with one another. The cells may be any combination of types (ordinary to severe, single cell to supercell). Squall lines may form along cold fronts, but often form as much as 100 miles (160 km) ahead of an advancing cold front in the warm sector of an extratropical storm. They often trail a large, flat cloud layer that brings significant rain after the storms pass.

Thunderstorm Winds

Non-tornadic, damaging winds from thunderstorms include four common types:

- Straightline winds—Winds having little or no curvature or rotation, capable of affecting a larger geographic area than a tornado.
- Downbursts—Localized downward gusts of air from a thunderstorm. These winds can be very damaging on and near the ground and tend to cover areas of just a few miles.
- Microbursts—Minimized downbursts affecting areas less than 2.5 miles (4 km) in diameter. Microbursts induce a strong wind shear and can produce winds over 150 mph (130 kt).
- Gust fronts—Cool, gusty air that flows out of the base of a thunderstorm and spreads along the ground ahead of the thunderstorm cell. A gust front was blamed for an outdoor stage collapse in Indiana in August 2011 that killed five people and injured several others.

Related National Weather Service Products

The following table lists some common products issued for Severe Thunderstorms or the possibility of a Severe Thunderstorm. Consult your Warning Coordination Meteorologist for updated types of information specific to hazards in your area.

Longer-term	Shorter Timeframe	Immediate
Convective Outlooks (Day 1, Day 2, Day 3, Day 4-8) Public Weather Outlook Hazardous Weather Outlook	Severe Thunderstorm Watch SPC Mesoscale Discussion Short-term Forecast	Severe Thunderstorm Warning Special Marine Warning Special Weather Statement Severe Weather Statement

Tornadoes

Definition

A tornado is a violently rotating column of air that extends from the base of a thunderstorm and comes in contact with the ground. A funnel cloud is a similar column of air that is not in contact with the ground. A water spout is a tornado that is over water. When either a funnel cloud or a water spout comes in contact with the ground, it becomes, by definition, a tornado. The spinning motion of a tornado is almost always counterclockwise. Tornadoes are the most violent storms on earth, with estimated wind speeds up to or exceeding 200 to 300 mph (174-260 kt).

Impacts/Associated Hazards

Tornadoes can cause significant damage to trees, buildings, and power infrastructure. They can also cause fatalities, particularly when people are unable to get to protective shelter. In many cases, the only protective shelter might be below ground, which can be problematic for persons in housing without basements. Associated hazards include:

- Wind—Tornadoes consist of strong, often destructive winds that can uproot trees and damage buildings and cars.
- Rain/Hail—Tornadoes are associated with thunderstorms and may be preceded or followed by heavy rainfall or hail. Depending on the hydrological conditions, flash flooding may occur.
- Obstacles to Response—Damage or destruction of public facilities, including hospitals, can complicate emergency response efforts. Additionally, debris may block roadways, there may be extensive damage to electric and telephone lines, utility lines may be broken, and communication may be cut off because of damaged or destroyed radio and television towers.

Characteristics

Tornadoes form from thunderstorms, which develop in warm, moist air usually in advance of eastward-moving cold fronts. These thunderstorms often produce large hail, strong winds, funnel clouds, and tornadoes. Tornadoes in the winter and early spring are often associated with strong, frontal systems that form in the central states and move east. Occasionally, large outbreaks of tornadoes occur with this type of weather pattern, affecting several states by numerous severe thunderstorms and tornadoes.

During the spring in the Central Plains, thunderstorms frequently develop along a "dryline," which separates very warm, moist air to the east from hot, dry air to the west. Tornado-producing thunderstorms may form as the dryline moves east during the afternoon hours.

Along the front range of the Rocky Mountains, in the Texas panhandle, and in the southern High Plains, thunderstorms frequently form as air near the ground flows "upslope" toward higher terrain. If other favorable conditions exist, these thunderstorms can produce tornadoes.

Tornadoes occasionally accompany tropical storms and hurricanes that move over land. Tornadoes are most common to the right and ahead of the path of the storm center as it comes onshore.

The visible column of a tornado is composed of water droplets formed by condensation in the funnel. The fast-moving winds (either flowing into the tornado or in the main tornadic circulation) cause most of the damage. The vortex (or multiple vortices) pulls in air from near the ground, along with dirt and debris. The dirt and debris block light, giving the tornado a dark color.

Damage Scale

Tornadoes are defined in terms of the Enhanced-Fujita Scale, which ranks tornadoes on the basis of wind speed and damage potential. The Enhanced-Fujita (EF) Scale replaces the original Fujita Scale used since 1971. A correlation between the two scales has been developed to preserve the historical database. The EF Scale provides more accurate wind speed ranges in each category and an increase in the amount of detail that goes into determining a tornado rating to improve consistency. The wind speed and damage ratings are shown in the following table:

Category	Wind Speed	Effects
EF0	65-85 mph (56-74 kt)	Light damage: Some damage to chimneys; branches break from trees; shallow rooted trees pushed over; sign boards damaged
EF1	86-110 mph (75-96)	Moderate damage: Roof surfaces peeled off; mobile homes pushed from foundations or overturned; cars pushed off roads
EF2	110-135 mph (97-117 kt)	Considerable damage: Roofs torn off frame houses; mobile homes demolished; large trees snapped or uprooted
EF3	136-165 mph (118-143 kt)	Severe damage: Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted
EF4	166-200 mph (144-174 kt)	Devastating damage: Well-constructed houses leveled; structures with weak foundations blown off some distance
EF5	>200 mph (>174 kt)	Incredible damage: Strong frame houses lifted off foundations and carried considerable distance to disintegrate

EF0 and EF1 tornadoes comprise 70% of all tornadoes that occur in the U.S. They usually touch down briefly and cause minor damage. However, forecasting these tornadoes is less reliable than for stronger tornadoes, so less than 50% occur during tornado watches.

EF2 and EF3 tornadoes comprise about 28% of the tornadoes in the U.S. They can cause significant damage, injuries, and deaths.

EF4 and EF5 tornadoes comprise about 2% of the tornadoes in the U.S. and cause 70% of the death and destruction. Fortunately, the National Weather Service has identified precursor conditions for the more damaging tornadoes. Over 95% of these tornadoes, therefore, occur during tornado watches.

Development and Seasonality

Tornadoes develop as an outgrowth of thunderstorms. Large, strong, and long-lasting tornadoes are spawned by supercells. Once a thunderstorm has formed, given the right ingredients, a tornado can develop.

- A thunderstorm needs rising air for a tornado to form.
- The rising air begins to rotate due to strongly changing (veering) winds in the lower part of the atmosphere.

Each year, approximately 800 to 1200 tornadoes are reported in the U.S., a higher frequency than anywhere else in the world. Tornadoes occur most often when the lower layer of the atmosphere is warm and unstable, which varies according to the time of year:

- April, May, and June: Midwestern U.S.
- May, June, July, August, and September: Southwest and North Central U.S.
- March, April, May, and June: Southeastern U.S.
- April, May, June, July, and August: Western U.S.

Related National Weather Service Products

The following table lists some common products issued for tornadoes or the possibility of a tornado. Consult your Warning Coordination Meteorologist for updated types of information specific to hazards in your area.

Longer-term	Shorter Timeframe	Immediate
		Tornado Warning
Convective Outlooks	Tornado Watch	Tornado Emergency
Public Weather Outlook	Severe Thunderstorm Watch	Severe Thunderstorm Warning
Hazardous Weather Outlook	SPC Mesoscale Discussion	Special Marine Warning
Severe Weather Outlook	Short-term Forecast	Special Weather Statement
		Severe Weather Statement

Flash Floods

Definition

A flash flood is extremely rapid flooding usually resulting from heavy rainfall. Flash floods affect both low-lying areas and steep mountainous drainages. They occur suddenly (within only minutes to less than 6 hours after a causative event). Flash floods are one of the top weather-related killers in the U.S. Nearly half of all flash-flood fatalities involve vehicles.

Causative events include heavy rains from slow-moving thunderstorms, dam or levee failure, or the sudden release of water from the breakup of an ice jam. Intense, short-duration rainfall on impervious areas, such as urban areas or certain soils, also causes flash floods.

Flash floods are most prevalent on small streams, generally draining areas ranging in size from a few square miles to several hundred square miles. The most dangerous flash floods usually occur in steep mountain streams, canyons, and desert washes where they can look like a wall of water traveling downstream.

Impacts/Associated Hazards

Flash floods can very quickly inundate roadways, washing away vehicles caught in the path and cutting off traffic routes and access to affected areas. Flood waters can affect homes and businesses in low-lying areas, requiring fast action for timely evacuations and potential water rescues. The most severe flash floods can roll boulders, tear out trees, destroy buildings and bridges, and scour out new channels. However, less serious flash flooding is still capable of taking lives. As little as a foot of moving water is enough to sweep a car into deeper flood waters. Also, children playing in flood waters, especially near culverts and drainage pipes, can be swept away. Associated hazards include:

- Debris flows—Debris caught in the water flow acts as battering rams, causing additional destruction.
- Mud slides—Flash floods can also trigger mud slides in areas with clay soils, saturated soils, or little ground cover.

Characteristics

Rainfall intensity and duration affect the potential for flash floods. Other non-meteorological factors that could affect an area's ability to absorb water include the topography, soil conditions, and ground cover.

Topography is important, especially where there are steep slopes. Gravity rapidly moves the water to lower elevations, reducing the time runoff can be absorbed by the ground. Water can accumulate and rise very rapidly in the lower-elevation areas, especially if it is being funneled from multiple locations uphill.

Some soils can absorb water more effectively (e.g., sand is better than clay) and reduce runoff. Soils covered with vegetation tend to retard runoff and mitigate rapid accumulation of water at low points. In contrast, wet soils and frozen soils have limited capability to absorb runoff, so flooding is more likely to result. Likewise, “hydrophobic” soil can lead to flash flooding after a wildfire. The burned soils develop a waxy coating that hinders absorption of runoff and sets up potentially dangerous conditions, particularly in mountain regions. Finally, some soils, such as clay, that have been "baked" by long periods of hot, dry conditions, often have little capability to absorb runoff.

Related National Weather Service Products

The following table lists some common products issued for flash floods or the possibility of a flash flood. Consult your Warning Coordination Meteorologist for updated types of information specific to hazards in your area.

Longer-term	Shorter Timeframe	Immediate
Flood Potential Outlook Hydrologic Outlook	Flash Flood Watch Hydrometeorological Discussion	Flash Flood Warning Flash Flood Statement Urban & Small Stream Flood Advisory

Riverine Floods

Definition

Unlike flash floods that occur quickly after an upstream event, riverine flooding is a longer-term event that can last a week or more.

Flooding along rivers and streams is natural and inevitable. Some floods occur seasonally when winter or spring rains, combined with melting snows, fill river basins with too much water too quickly. Torrential rains from hurricanes or tropical systems also can produce river and stream flooding.

Flooding on a non-leveed stream occurs when overbank flows are large enough to inundate land and roads. Flooding on a leveed stream occurs when the stream level rises above the levee. Flooding also can occur if the levee fails. The ability of the levee to withstand flooding depends on the design standards used when constructing the levee. Many private (mostly agricultural) levees are not intended to withstand major floods.

Impacts/Associated Hazards

Riverine floods can cause drowning fatalities (especially in vehicles), damage to buildings and vehicles, and power and utility outages. Associated hazards include:

- Property and agricultural damage
- Contamination of drinking water
- Dispersion of hazardous materials
- Interruption of communications and/or transportation systems

Characteristics

Riverine flooding is normally the result of a combination of meteorological and hydrological factors. Although excessive rainfall alone can cause flooding, the most severe riverine floods usually have multiple causative factors, including:

- Heavy prolonged rainfall from large-scale storms
- Heavy rainfall from a slow-moving thunderstorm complex
- Saturated soil conditions from previous rainfall events
- Already high river flows from previous rain or snow events
- Extreme cold temperatures followed by thawing, leading to river ice jams
- Rapid snowmelt—Snowmelt floods can develop over periods ranging from several hours to several days, depending upon the part of the country, the water content of the snow, and temperatures during the melting period.
- Silt buildup in river channels—Silt deposited during previous storm events reduces the capacity of the river to carry water and can result in flooding.

Related National Weather Service Products

Types of information related to riverine flood threats are listed below. Consult with your Warning Coordination Meteorologist for updated types of information specific to your area.

Longer-term	Shorter Timeframe	Immediate
Flood Potential Outlook Excessive Rain Outlook Hydrologic Outlook	Flood Watch Hydrometeorological Discussion	Flood Warning Flood Statement River Statement River Ice Statement

Coastal Floods

Definition

Coastal flooding is the inundation of land areas along the ocean's coast by sea waters over and above normal tidal action. Such flooding can originate from the ocean front, back bays, sounds, and other shoreline areas. Coastal flooding affects the general public and maritime interests along much of the U.S. coastline, extending from the shoreline beaches to inland tidal waterways and the tidal portions of river mouths.

Impacts/Associated Hazards

Coastal flooding affects fisheries, agriculture, transportation, and natural resources. Associated hazards include:

- Transportation disruptions in low-lying areas
- Quickly rising water levels
- Dangerous wave action
- Shore erosion and seawall destruction
- Debris from destroyed property carried by the water
- Depending on the flooding cause, possible high winds associated with an approaching weather system

Characteristics

Coastal flooding basically results from one or a combination of the following:

- A storm surge and/or seiche affecting land
- Heavy surf
- Tidal piling

Other factors affecting the local severity, extent, and duration of coastal flooding include:

- Tidal cycles
- Persistence and behavior of the storm that is generating the flooding
- Topography, shoreline orientation, and bathymetry of the area
- River stage or stream runoff
- Presence or absence of offshore reefs or other barriers

Terminology that forecasters might use to describe coastal flooding includes:

- Storm Surge—A storm surge is an abnormal rise of water generated by a storm's winds. In the northern hemisphere, the highest surge values typically occur in the right front quadrant of a hurricane coincident with onshore flow. The surge height is the difference of the observed water level minus the predicted tide.

- Seiche—A seiche is caused by winds that push lake water to one end of the lake. When the storm ends or moves on, the water sloshes to the other end of the lake, causing water level changes of up to several feet.
- Surf—Surf refers to the waves in the area between the shoreline and the outermost limit of breakers.
- Tidal Effects—The tidal cycle is the periodic change in the height of tides that is caused primarily by the varying relations among Earth, moon, and the Sun.
- Mean Sea Level (MSL)—Mean sea level is the average height of the surface of the sea at a particular location for all stages of the tide over a 19-year period.
- Tidal Datum—The datum plane (tidal datum) is the horizontal plane, unique to each individual tidal station, to which soundings, ground elevations, or water surface elevations for that station are referred. The plane is called a tidal datum when it is defined by a certain phase of the tide.

Related National Weather Service Products

Types of information available for coastal flood threats are listed below. Consult your Warning Coordination Meteorologist for updated types of information specific to your area.

Longer-term	Shorter-term/Immediate
	Coastal Flood Warning
	Coastal Flood Advisory
	Coastal Flood Statement
	High Surf Warning
Coastal Flood Watch	High Surf Advisory
Lakeshore Flood Watch	Marine Weather Statement
Short-term Forecast	Lakeshore Flood Warning
	Lakeshore Flood Advisory
	Lakeshore Flood Statement
	Low Water Advisory
	Rip Current Statement

Tropical Cyclones

Definition

Tropical cyclones are non-frontal storms having organized shower and thunderstorm activity and a closed surface wind circulation around a well-defined low pressure center that is warmer than the surrounding air. These storms originate over tropical and subtropical waters and typically cover an area 200-500 miles (320-800 km) in width.

Impacts/Associated Hazards

Tropical cyclones can cause widespread damage to homes (especially mobile homes) and businesses and result in injuries and fatalities. Associated hazards include:

- High winds
- Storm surge-related flooding
- Freshwater flooding from rainfall
- Tornadoes
- Power outages
- Blocked roadways
- Damaged communications equipment

From an economic standpoint, fisheries, oil production, shipping, and other coastal enterprises can all be harmed as a result of a tropical cyclone.

Characteristics

Tropical cyclones are categorized by wind speed.

Category	Wind Speed
Tropical Depression	Maximum sustained winds near the surface less than 39 mph (34 kt)
Tropical Storm	Winds of 39-73 mph (34-53 kt)
Hurricane	Winds of 74 mph (64 kt) or more

Intense tropical cyclones are called hurricanes in the Northern Hemisphere, typhoons in the Western Pacific, and cyclones when they form in the Indian Ocean and southwestern Pacific Oceans. Although tropical depressions and tropical storms do not produce winds and storm surge as severe as those of hurricanes, they can still result in damaging winds, high rainfall amounts that cause freshwater flooding, and tornadoes.

Hurricanes are generated by the rising and cooling of humid air over the ocean, in combination with the following ingredients:

- Warm ocean water over 80°F (27°F) and about 200 feet deep (60 m)
- Winds converging near the water surface
- Unstable air, so the warm air will continue rising
- Ample moisture in the lower atmosphere, to supply heat energy
- Steering winds moving in one direction at upper levels, to move the storm along without breaking it up
- Upper atmosphere high pressure, to help move out the rising air of the storm

Hurricane winds blow counterclockwise around the center, or eye, of the storm in the Northern Hemisphere, and air currents carry the storm along. Most Northern Hemisphere hurricanes move from east to west in the trade winds. They may turn north or northwest out in the Atlantic, then curve toward the northeast. Storms that move up the east coast usually pick up speed around North Carolina and may travel at speeds up to 70 mph (60 kt).

Hurricanes are classified using the Saffir-Simpson Wind Scale. (See Appendix C.)

Historically, the worst damage and highest potential for fatalities from hurricanes comes from coastal flooding caused by storm surge. Storm surge is an abnormal rise of water generated by a storm's winds. More intense and larger hurricanes produce larger surge, which can exceed 20 ft (6 m) heights and span hundreds of miles of coastline. Higher storm surge inundation can also result from shallower offshore waters. In the Northern Hemisphere, the largest storm surge heights typically occur in the right front quadrant of a hurricane coincident with onshore flow; in the Southern Hemisphere, the largest heights are in left front quadrant.

Hurricane-force winds can also cause extensive damage and death. The strongest winds in a hurricane occur 10 to 30 miles (16-48 km) from the center of the eye, in a region called the eyewall. Strong winds will affect land well before the most damaging winds of the eyewall. Winds that extend outward from the eyewall in the front right quadrant of the storm are the most devastating.

When a hurricane reaches land, it begins to weaken as it loses its warm-water energy source and encounters greater surface friction over land. This weakening process is gradual, so even though wind speeds may be reduced by 50 percent within 12 hours, hurricane-force winds can penetrate far inland in that timeframe. Additionally, tropical storm-force winds can extend far beyond the storm center and, although weaker, can cause significant damage.

Related National Weather Service Products

Many types of information are available to provide updated guidance on hurricane threats. Check with your Warning Coordination Meteorologist to learn more about specific products useful in your area.

Local Weather Forecast Office Products Specific to Tropical Cyclones

Text Products	Graphical Products
Hurricane Local Statement (HLS) Extreme Wind Warning (EWW)	Graphic Hurricane Local Statement (gHLS) Video Hurricane Local Statements (vHLS)

National Hurricane Center (NHC) Products:

Text Products	Graphical Products
Tropical Depression Advisory Tropical Storm Advisory Hurricane/Typhoon Advisory Tropical Cyclone Public Advisory Tropical Cyclone Forecast Advisory Tropical Cyclone Discussion Tropical Cyclone Wind Speed Probabilities Tropical Weather Outlook Tropical Weather Discussion	Tropical Cyclone Track Forecast Cone and Watches/Warnings Wind Speed Probability Storm Surge Probability Tropical Cyclone Surface Wind Field Tropical Cyclone Cumulative Wind History Graphical Tropical Weather Outlook

Multipurpose National Weather Service Products Often Used during Tropical Cyclones

Text Products	Graphical Products
Public Information Statement (PNS) Short Term Forecast (NOW) Special Weather Statement (SPS) Hazardous Weather Outlook (HWO) Preliminary Post-Storm Report	Web graphics (point and click map, graphicasts, etc.)

Hurricane Wind and Storm Surge Forecasts

The National Hurricane Center (NHC) produces probabilistic graphics that depict the risk of strong winds or storm surge at specific locations. The Tropical Cyclone Surface Wind Speed Probability table and graphic convey the chances that tropical storm-force, 58 mph (50 kt), and hurricane-force winds will occur at particular locations over the next five days. These products take into account NHC's official track, intensity, and size forecasts, as well as the degree of confidence in the track forecast. Unlike the Tropical Cyclone Track Forecast Cone graphic (see Chapter 3), these products actually depict the areas at risk for strong winds associated with the tropical cyclone.

In addition, the National Hurricane Center produces Storm Surge Probability Graphics that depict the chances that a storm surge of a specified height will occur at particular locations during the next three days. Because dangerous storm surge can extend along the coast well away from the center of the tropical cyclone and beyond the area encompassed by the Track Forecast Cone, the Storm Surge Probability graphics more effectively convey the areas at risk from storm surge.

Extratropical Cyclones

Definition

Deep, low-pressure storms that form off the Pacific coast, in the Gulf of Mexico, over the Atlantic Ocean, or in the Great Lakes are often referred to as extratropical cyclones, meaning “outside of the tropics." Most of the storms that affect U.S. weather are extratropical. Extratropical cyclones typically cover an area 700 to 1000 miles (1130-1610 km) across (often larger than tropical cyclones).

Impacts/Associated Hazards

Extratropical cyclones can cause property damage, travel disruptions, injuries, and fatalities. Associated hazards include:

- High winds generated by strong pressure gradients
- Heavy rain or snow
- Flooding or flash flooding
- Swells, storm surges, and large waves
- Mud slides
- Thunderstorm downburst winds
- Lightning
- Tornadoes

Characteristics

Under ideal wind and temperature conditions, an extratropical storm system can develop rapidly. Because these storms often form over water, which has a smoother surface than land, wind speeds pick up rapidly. Fewer weather observations are available from the ocean areas, so detection can lag behind storm development.

Related National Weather Service Products

Refer to fact sheets on winter storms, thunderstorms, coastal floods, or riverine floods as appropriate for your location and season. Also check with your Warning Coordination Meteorologist for products related to extratropical cyclones affecting your region.

Drought

Definition

Drought is a persistent and abnormal moisture deficiency having adverse impacts on agriculture, the environment, and people. The National Drought Mitigation Center defines drought, in part, as "...a deficiency of precipitation over an extended period of time, usually a season or more." Drought is most often defined by its impacts, which are typically economic, environmental, or societal in nature. For instance, an agricultural drought is identified when crop production becomes adversely impacted, while a hydrological drought is linked to a very substantial and potentially damaging reduction in water supplies.

Impacts/Associated Hazards

Drought impacts depend upon the severity (duration) of the drought and on the vulnerability and needs of local ecosystems and human populations. The impacts of drought most often begin as crop loss. Water shortages can also be an early impact. As drought persists, associated hazards and socioeconomic impacts can include:

- Soil loss
- Dust storms
- Wildfires
- Changes in utility production
- Increased food & commodities prices
- Civil unrest based on resource scarcity
- Population migrations

Characteristics

The onset of drought is slow, making it difficult to determine start and end times. Often, the onset of drought is not realized until the impacts of the event have been ongoing for some time. Likewise, the end of drought is not always ascertained until the event has already passed.

Droughts can span a range of timescales—from monthly or seasonal durations affecting agriculture to multi-year or multi-decade or even century events that dramatically change water quantities. Drought can also span very large spatial areas, encompassing larger parts of the country at a given time. And drought in one place might affect food prices in another, making the impacts of drought even more widespread.

Drought depends on weather factors including temperature, precipitation, wind speed, and solar radiation, which vary with time of year, the local environment, and regional climate. A range of indices offer information about drought and the moisture deficit conditions leading to drought. Many of these indices are combined in a Drought Intensity scale, which is illustrated in the U.S. Drought Monitor. This product is updated weekly and provides information about how drought is progressing across different regions. Your local Weather Forecast Office and the U.S. Drought Portal can also provide guidance about drought conditions and impacts in your area.

U.S. Drought Monitor Intensity Scale

Index	Description	Impacts
D0	Abnormally Dry	Crop growth slowed Fire risk elevated
D1	Drought - Moderate	Damage to croplands & pastures High fire risk Low stream/reservoir levels Water shortages developing or imminent.
D2	Drought - Severe	Likely losses of crops or pastures Very high fire risk Water shortages common leading to voluntary or mandated restrictions
D3	Drought - Extreme	Substantial crop/pasture losses Extreme fire risk Widespread water shortages requiring ongoing restrictions.
D4	Drought - Exceptional	Widespread crop/pasture losses Catastrophic fire risk Water shortages resulting in water emergencies (*Texas experienced D4 Drought in 2011*)

Products related to Drought

Check with your Warning Coordination Meteorologist for updated types of information specific to your area.

- Drought Information Statement: Issued by local Weather Forecast Office, provides up-to-date information on a current drought situation in a forecast office county warning or forecast area
- U.S. Seasonal Drought Outlook from Climate Prediction Center (CPC): Seasonal prediction of drought status across the country through a map and accompanying seasonal assessment and outlook discussion
- Drought Impact Reporter: Graphical depiction of impacts by state, county, and impact type, compiled by the National Drought Mitigation Center
- U.S. Drought Monitor: Weekly product from the National Drought Mitigation Center, provides a broad-scale look at drought conditions and severity across the U.S.

Winter Storms

Definition

Winter storms are extratropical storms that bring cold temperatures, precipitation, and sometimes high winds. Heavy snow is common component of winter storms and is defined as a steady fall of snow for several hours or more. The definition of heavy snow depends on region and elevation but is generally defined as:

- Snowfall accumulating to 4 inches (10 cm) or more in depth in 12 hours or less, or
- Snowfall accumulating to 6 inches (15 cm) or more in depth in 24 hours or less

The accumulations and timeframes for defining heavy snow will vary depending on location, so check with your Warning Coordination Meteorologist to find out the criteria for your region. It is also helpful to be familiar with terminology forecasters use to describe different types of winter weather. Some commonly used terms are:

- Snow Squalls—Periods of moderate to heavy snowfall, intense, but of limited duration, accompanied by strong, gusty surface winds and possibly lightning
- Snow Shower—Short-period moderate snowfall
- Snow Flurries—Intermittent light snowfall of short duration with no measurable accumulation
- Blowing Snow—Wind-driven snow that reduces surface visibility; can be falling snow or snow that already has accumulated but is picked up and blown by strong winds
- Drifting Snow—An uneven distribution of snowfall/snow depth caused by strong surface winds that may occur during or after a snowfall
- Blizzard—The following conditions are expected to prevail for a period of 3 hours or longer:
- Sustained wind or frequent gusts to 35 mph (30 kt) or greater
- Considerable falling and/or blowing snow reducing visibility to less than 1/4 mile (0.4 km)
- Freezing Rain or drizzle—Rain or drizzle that freezes on surfaces such as the ground, trees, power lines, motor vehicles, streets, and highways
- Ice Storms—Damaging accumulations of ice during freezing rain situations
- Sleet—Pellets of ice composed of frozen or mostly frozen raindrops or refrozen, partially melted snowflakes
- Freeze—Occurs when the surface air temperature is 32°F (0°C) or below over a widespread area for a significant period of time
- Frost—Formation of thin ice crystals on the ground or other surfaces in the form of scales, needles, feathers, or fans. Frost develops under conditions similar to dew, except the temperatures of Earth's surface and objects on the ground fall below 32°F (0°C), even though air temperatures might be slightly warmer.
- Wind chill—The cooling of a body by air motion. Increased wind speeds accelerate heat loss from exposed skin. The wind chill index (discussed in the Excessive Cold fact sheet) provides an estimate of this additional wind-induced cooling.

Impacts/Associated Hazards

The hazards involved with winter storms include hypothermia or death resulting from exposure, compromised driving conditions, blocked roadways, stranded residents, and power outages. Associated hazards include:

- Strong winds
- Extreme cold
- Heavy precipitation, including ice
- Blizzard conditions

Characteristics

The development of a winter storm requires cold air, moisture, and lift. Cold air includes subfreezing temperatures (below 32°F, 0°C) in the clouds and/or near the ground are needed to make snow and/or ice. The air must contain moisture in order to form clouds and precipitation. Air blowing across a body of water, such as a large lake or an ocean, is an excellent source of moisture. A mechanism to raise the moist air to form the clouds and cause precipitation must be present. Lift can be provided by any or all of the following:

- The flow of air up a mountainside
- Fronts, where warm air collides with cold air and rises over the cold dome
- Upper-level low pressure troughs

Related National Weather Service Products

Types of information related to winter storms are listed below. Check with your Warning Coordination Meteorologist for updated products and information specific to your area.

Longer-term	Shorter-term/Immediate
Winter Storm Outlook	Winter Storm Warning
Winter Storm Watch	Heavy Snow Warning
	Ice Storm Warning
	Winter Weather Advisory
	Short-term Forecast
	Severe Weather Statement

Excessive Cold

Definition

The criterion for excessively cold temperature varies according to the normal climate of a region (e.g., in a relatively warm climate, temperatures just below or at freezing can be hazardous). Excessive cold often accompanies or follows winter storms, but it can also occur without storm activity.

Impacts/Associated Hazards

The greatest dangers of excessive cold involve frostbite, hypothermia, and death. Associated hazards include:

- Burst pipes and water line breaks
- Automobiles unable to start

Definitions related to excessive cold are:

- Frostbite—Damage to body tissue caused by that tissue being frozen. Frostbite causes a loss of feeling and a white or pale appearance in the extremities.
- Hypothermia—Low body temperature. Normal body temperature is 98.6°F (370°C). When body temperature drops to 95°F (350°C), immediate medical help is needed. Hypothermia can occur with prolonged exposure to even above-freezing temperatures.

Of winter deaths attributed to exposure to cold:

- 50 percent are people over 60 years old
- Over 75 percent are male
- About 20 percent occur in the home

Characteristics

Extreme cold can be particularly dangerous when accompanied by wind, creating an effect known as wind chill. Wind chill is based on the rate of heat loss from exposed skin caused by combined effects of wind and cold. As the wind increases, heat is carried away from the body at an accelerated rate, driving down the body temperature. Forecasters use a wind-chill index as a guide to heat loss resulting from given temperatures and wind speeds. A copy of the wind chill index chart can be found in the NWS Products and Services Reference Guidebook or online. See Appendix B for links.

Related National Weather Service Products

Types of information related to excessive cold are listed below. Check with your Warning Coordination Meteorologist for updated products or information specific to your area.

Longer-term	Shorter-term/Immediate
Winter Storm Watch	Wind Chill Advisory Wind Chill Warning Short-term Forecast Hard Freeze Warning Extreme Cold Warning (regional)

Excessive Heat

Definition

Excessive heat can involve sudden rises in temperature to extreme levels—taking away people's chance to acclimate—or prolonged heat waves. Either of these cases can cause heat-related fatalities. Excessive heat varies according to the normal climate of a region. For example, what is considered excessive heat in Seattle would differ from excessive heat in Tucson.

Impacts/Associated Hazards

Practical problems resulting from high temperatures include overheated car engines, "brown-outs" from overuse of electricity for air conditioning, and changes in airplanes' performance. However, as with extreme cold, the major danger of extreme heat is to humans and animals. Heat-related ailments can range from annoying conditions to life-threatening situations, such as:

- Heat cramps—Muscle cramps, especially in the legs after exercising, are caused by imbalances in body salt.
- Fainting—Exercising in the heat can cause a rapid drop in blood pressure, resulting in fainting.
- Heat Exhaustion—Loss of fluid and salt through excessive sweating can lead to dizziness, overall weakness, and a rise in body temperature. Heat exhaustion can result from normal activity during several days of a heat wave or strenuous activity in extreme temperatures.
- Heat stroke—If heat exhaustion is not treated, the body temperature may rise to 105°F (41°C) or more and heat stroke may occur. A heat stroke victim may exhibit lethargy, confusion, or unconsciousness and is at risk of dying.

Characteristics

Excessive heat typically involves a combination of high temperatures (significantly above normal) and high humidities. When the air is humid, the "apparent" temperature is even higher. The Heat Index (HI), also called the Humidity Index, is a measure of the effect of the combined elements on the body. This chart can be found in the NWS Products and Services Reference Guidebook.

A daytime Heat Index reaching 105°F (41°C) or above, with nighttime lows at or above 80°F (27°C), for two consecutive days may significantly impact public safety. The local National Weather Service office will generally issue an advisory or warning for these conditions.

Related National Weather Service Products

Types of information related to excessive heat are listed below. Check with your Warning Coordination Meteorologist for updated products and information specific to your area.

Longer-term	Shorter-term/Immediate
Excessive Heat Outlook Excessive Heat Watch	Excessive Heat Advisory Excessive Heat Warning Short-term Forecast

Fog

Definition

Fog is defined as water droplets suspended in the air at Earth's surface. Fog is often hazardous when the visibility is reduced to 1/4 mile (0.4 km) or less.

Impacts/Associated Hazards

Thick fog reduces visibility, creating a hazard to motorists as well as to air traffic. Airports may close because of heavy fog.

Characteristics

The intensity and duration of fog varies with the location and type of fog—from early morning ground fog that burns off easily to prolonged valley fog that lasts for days. Generally, strong winds tend to prevent fog formation. The table below summarizes several scenarios for the formation, intensity, and duration of fog.

Type of Fog	Factors	Description	Effects
Ground Fog	• Clear nights • Stable air (winds less than 5 mph or 4 kt) • Small temperature-dewpoint spread	Heat radiates away from the ground, cooling the ground and surface air. When the air cools to its dewpoint, fog forms (usually a layer less than 100-200 ft [30-60 m] deep).	Common in many areas, ground fog burns off with the morning sun. Visibility, particularly for vehicles on roadways, may be limited while the fog persists.
Valley Fog	• Cold surface air and weak winter sun • May follow a winter storm or prolonged nighttime cooling	Fog can build to a height of more than 1,500 ft (457 m). Weak sun might evaporate lower levels of the fog but leave upper levels in place.	Valley fog can last for days, until winds are strong enough to push out the cold air. Valley fog is particularly common in the West in winter and can reduce visibility for both vehicles and aircraft.
Advection Fog	• Horizontal wind • Warm, humid air • Winter temperatures	Wind pushes warm humid air over the cold ground or water, where it cools to the dewpoint and forms fog.	Advection fog can cover wide areas of the central U.S. in winter. It may be thick enough to close airports.
Upslope Fog	• Winds blowing up hills or mountains • Humid air	As humid air pushes up hills and mountains, it cools to its dewpoint and forms fog, which drifts up the mountain. Upslope fog is common and widespread in the Great Plains, where land slopes gently upward toward the Rockies.	Upslope fog has similar impacts as other fog types in terms of reducing visibility.

Type of Fog	Factors	Description	Effects
Sea Smoke, Steam Fog	• Body of water • Air much colder than water • Wind	As cold air blows over warmer water, water evaporates into the cold air, increasing the humidity to the dewpoint. Vapor condenses, forming a layer of fog 1 to 2 ft (0.3-0.6 m) thick over the water. This type of fog typically forms on fall days over ponds and streams. In Alaska, it may be present any time there is open water.	In most of the contiguous U.S., steam fog does not pose much hazard unless the fog layer is thick enough to affect visibility for mariners. Because it forms over open water near shores, steam fog can limit nautical operations.
Precipitation Fog	• Warmer air • Cool rain	Precipitation fog forms on cool, rainy days. Some rain evaporates, and fog is formed when the air temperature reaches its dewpoint.	Precipitation fog can affect visibility for motorists and aircraft operations for as long as it persists.
Freezing Fog	• Sufficient conditions for fog formation • Air temperature below 32°F (0°C)	Freezing fog consists of supercooled water droplets that freeze on contact with exposed cold objects, including roadways, trees, and power lines.	Freezing fog forms a coating of rime or glaze and can lead to driving

Related National Weather Service Products

Types of information related to fog and fog hazards are listed below. Check with your Warning Coordination Meteorologist for updated products and information specific to your area.

Longer-term	Shorter-term/Immediate
Fog Outlook Fog Watch	Fog Advisory Freezing Fog Advisory Dense Fog Advisory Fog Warning Short-term Forecasts

Dust Storms

Definition

Strong winds over dry ground that has little or no vegetation can lift particles of dust or sand into the air. These airborne particles can reduce visibility, cause respiratory problems, and have an abrasive effect on machinery.

Impacts/Associated Hazards

Dust storms that reduce the visibility to 1/4 mile (0.4 km) or less often pose hazards for travelers, cause damage and injury, and affect commerce. The hazards and damage caused by these storms include:

- Impaired visibility and breathing difficulties, especially for outdoor workers, people in recreational activities, and motorists
- Crop damage
- Damage to buildings, vehicles, and anything outdoors
- Power outages and other infrastructure damage
- Broken trees
- Damage to computers and communications equipment from accumulated dust

Characteristics

Dust storms involve horizontal high winds or wind gusts or blowing dust, sand, or both. Two situations lead to the development of blowing dust or sand:

- Sustained high winds at the surface pick up dust and sand in dry environments. This condition may last for several hours or even days and may occur simultaneously with a wind storm. (Refer to the fact sheet on wind storms for more information.) These events are *nonconvective*.
- Thunderstorm outflow or microbursts create a local dust storm. In this situation, the event is usually sudden and over in a matter of minutes. These events are referred to as *convective* events.

Factors affecting both nonconvective and convective events are shown in the table below:

Factors	Large Scale, Nonconvective Events	Convective Events
Speed of onset	Recognizable weather patterns are easily identified 24 to 36 hours in advance	Predictable over an area within 0 to 3 hours Specific locations identifiable only minutes in advance
Duration	3 to 4 hours up to 2 to 3 days, usually with nocturnal lulls	Microbursts - a few seconds Macrobursts - a few minutes Larger system - up to two hours
Timing	Occur mainly during the late winter and early spring when pressure gradients are extreme Conditions worsen during late morning and are most intense during late afternoon	Associated with late afternoon or evening thunderstorms, usually during the spring and summer

High winds that may accompany major winter or early spring blizzards can include a mixture of snow and dust that brings travel to a standstill. For convective dust storms, all elements associated with severe thunderstorms may occur. Refer to the fact sheet on thunderstorms for more information.

Related National Weather Service Products

Types of information related to dust storms are listed below. Check with your Warning Coordination Meteorologist for updated products and information specific to your area.

Longer-term	Shorter-term/Immediate
Blowing Dust or Sand Outlook Blowing Dust/Sand Watch	Blowing Dust/Sand Advisory Blowing Dust/Sand Warning Local Dust Storm Warning Short-term Forecast

Wind Storms

Definition

Wind storms are sustained, potentially damaging high winds not associated with convective events (severe local storms, hurricanes, and winter storms) in which one of the following occurs:

- Sustained wind speeds of 40 mph (35 kt) or greater lasting for 1 hour or longer
- Winds of 58 mph (50 kt) or greater for any duration

These thresholds are generally increased for locations at higher elevations because of the lower air density and subsequent reduction in damage from less force.

Impacts/Associated Hazards

Wind storms can cause the following hazards and damage:

- Impaired visibility
- Crop damage
- Destruction to buildings and vehicles
- Power outages and other infrastructure damage
- Broken trees

Characteristics

Wind storms occur with or without the mechanism of convection. Some types of winds include:

- Gradient High Winds—Usually cover a large area and are due to large-scale pressure systems
- Mesoscale High Winds—Usually follow the passage of organized convective systems and are associated with wake depressions or strong mesoscale high pressure
- Channeled High Winds—In mountainous areas or in cities with tall buildings, air can be channeled through constricted passages producing high winds. Channeled high winds are local in nature but can be extremely strong.
- Tropical Cyclone Associated High Winds—Can occur a few hundred miles inland from a landfalling tropical cyclone. These inland winds are forecasted independent of the tropical cyclone.
- Chinook or Foehn Winds—Warm, dry winds that occur in the lee of high mountains ranges. They are fairly common in the mountainous West and sections of Alaska during the winter months. These winds develop in well-defined areas and can be quite strong.

Wind storms are caused by an extreme pressure gradient (difference in pressure over a small distance). The pressure gradient itself may be caused by one or a combination of:

- Terrain effect
- Temperature differences, as with downslope winds
- Mesoscale systems or convective complexes

High winds can accompany major winter or early spring blizzards. Major high-wind events frequently affect multiple jurisdictions and can extend horizontally for hundreds of miles. Wind storms are nonconvective events and the speed of onset is slower than for convective events, such as those causing dust storms. Recognizable weather patterns are easily identified 24 to 36 hours in advance of a large-scale, nonconvective storm. The National Weather Service may issue a High Wind Watch during this period.

The duration of an event can range from about 4 hours up to 2 to 3 days, often, but not always, with nocturnal lulls. The storms occur mainly during the late winter and early spring, when pressure gradients are extreme and soils are bare. They worsen during the late morning and become most intense during the late afternoon, when atmospheric mixing is most pronounced.

Related National Weather Service Products

Check with your Warning Coordination Meteorologist for updated types of information specific to your area.

Longer-term	Shorter-term/Immediate
High Wind Watch	High Wind Advisory High Wind Warning Short-term Forecast

Fire Weather

Definition

Fire weather is a term used for the meteorological conditions that promote the spread of wildfire. Hydrological, topographical, and vegetation conditions are also factors. Terms related to fire weather are described below:

- Fire danger—The combination of both constant factors (fuels) and variable factors (primarily weather) that affect the ignition, spread, and difficulty of control of fires
- Prescribed burn—Fire applied to wildland fuels in a specific place for a specific purpose under prescribed weather and fuel conditions in order to achieve land management objectives
- Wildfire—Any free-burning and uncontainable wildland fire that is not a prescribed burn and that consumes the natural fuels and spreads in response to its environment
- Wildlands—Non-urbanized land areas not under extensive agricultural cultivation (e.g., forests, grasslands, rangelands)
- Urban-wildland interface—Areas where structures and other human development meet or intermingle with undeveloped wildlands or vegetative fuel

Impacts/Associated Hazards

Wildfires present immediate as well as longer-term hazards, including:

- Property damage
- Loss of life
- Livestock fatalities
- Infrastructure damage
- Habitat losses, wildlife displacement
- Impaired air quality
- Impaired visibility
- Respiratory concerns
- Long-term ecosystem effects
- Soil impermeability and risk of flooding

Characteristics

The following weather conditions promote ignition and rapid spread of fires:

- Low humidity
- High winds (over 10-20 mph, 9-17 knots)
- Dry thunderstorm (i.e., lightning without rain)
- Unstable air

Other factors that impact the spread and severity of fires include:

- Dry antecedent conditions—Prolonged hot, dry conditions greatly increase fire danger. In drought conditions, forests can ignite with a weak source that would normally not be a threat.
- Development and urban-wildland interface—The spread of residential areas into wildlands means the population faces a greater risk of forest fires. Coordination is necessary between urban emergency responders and land management agencies, including the U.S. Forest Service, the National Park Service, Bureau of Indian Affairs, and the Bureau of Land Management.
- Available fuel—The spread of fire depends on the amount of burnable material. Trees that contain oily sap, such as eucalyptus, can be a tremendous fuel source.
- Hilly terrain—When other factors are even, fire spreads faster uphill than downhill.

One measurement that forecasters use to indicate the potential for wildfire growth is the Haines Index. The Haines Index combines an atmospheric stability calculation with the moisture content of the lower atmosphere into a number that correlates well with large fire growth where surface winds do not dominate fire behavior.

Haines Index	Risk of Large Fire Growth
2 or 3	Very low
4	Low
5	Moderate
6	High

Related National Weather Service Products

Types of information related to fire weather and wildland fire are listed below. Check with your Warning Coordination Meteorologist for updated products and information specific to your area.

Longer-term	Shorter-term/Immediate
Fire Weather Watch Fire Weather Discussion Extended Forecast Rangeland and Fire Danger Statement	Red Flag Warning Fire Weather Forecast Spot Forecast

Space Weather

Definition

Space weather involves perturbations in Earth's extended atmosphere based on changes in solar activity. Space weather most directly affects Earth's ionosphere, which is the part of the atmosphere where atoms and molecules are electrically charged by solar radiation. The ionosphere extends from about 30 mi (50 km)in height to more than 620 mi (1000 km). Variations in solar radiation enhance or decrease the ionization. These variations can also influence Earth's geomagnetic field, which extends tens of thousands of miles into space and deflects most of the charged particles from the Sun back to space.

Geomagnetic storms refer to disturbances in the geomagnetic field caused by energized plasma from the Sun blowing by Earth. More violent episodes of solar energy release include solar flares, coronal mass ejections (CMEs), and solar prominence eruptions.

Impacts/Associated Hazards

Radio blackout events, solar radiation storms, and geomagnetic storms can cause:

- Radio/communications disruptions lasting up from a few minutes to several hours
- Radiation exposure to airline crews/passengers and astronauts
- Disruption of power grids, energy blackouts
- Disruption of telecommunications and Global Positioning Systems (GPS)
- Rerouting of aircraft to avoid communications losses or elevated radiation levels
- Flight delays and associated economic costs
- Damage to satellites

Characteristics

Essentially, there are three ways in which space weather affects Earth.

First, a solar flare or x-ray/electromagnetic emission from the Sun can cause a radio blackout on Earth, affecting communications. X-ray emissions can reach Earth in just eight minutes, and the effects can last for a few minutes up to several hours.

Second, a solar radiation storm can elevate radiation levels near Earth. Solar radiation storms can arrive at Earth in about 30 minutes, and can persist for one or more days.

Third, a geomagnetic storm can disturb Earth's magnetic field and ionosphere, interfering with radio and satellite signal propagation and causing auroras. These disturbances take one to four days to reach Earth and typically last for one to two days.

Related National Weather Service Products

NOAA's Space Weather Prediction Center (SWPC) provides 24/7 space weather information and provides Space Weather Scales for understanding and anticipating impacts based on various alerts. A link is provided in Appendix B.

Radio Blackouts (R-scale)	Solar Radiation Storm (S-scale)	Geomagnetic Storming (G-scale)
X-ray Flux Alert (R2), X-ray Flux Summary (R1 through R5)	Proton Flux Warning (S1-S5) Proton Flux Alert (S1-S5) Proton Flux Summary (S1-S5)	Geomagnetic Sudden Impulse Warning Geomagnetic K-index Warning (G1-G3 or greater) Geomagnetic K-index Alert (G1-G5) Geomagnetic A-index Watch (G1-G4 or greater)

Tsunamis

Definition

A tsunami is a series of ocean waves of extremely long length, generated by disturbances from earthquakes, underwater volcanic eruptions, or landslides occurring below or near the ocean floor.

The wavelength of a tsunami—from wave crest to wave crest—may be 100 miles (160 km) or more in the deep ocean, with a wave height of only a few feet or less. In the open ocean, the waves can travel at speeds of up to 500 mph (805 kph). As tsunamis approach land and the water depth decreases, wave heights may increase to between 30 and 100 feet (9-30 m).

Tsunamis from nearby earthquakes may take only a few minutes to reach coastal areas, but may take up to 24 hours from distant earthquakes. The deep ocean trenches off the coasts of the Aleutian Islands, Japan, and South America are known for their underwater earthquakes and are the source for many tsunamis.

Impacts/Associated Hazards

Hazards from tsunamis include coastal flooding and damage from debris. Loss of life and extensive property and harbor damage can occur. The flood inundation area from a tsunami may be extensive, as tsunamis can travel up rivers and streams that lead to the ocean.

Characteristics

Although tsunamis have been mistakenly called tidal waves, they have nothing to do with tidal forces. The different causes of tsunamis produce different characteristics than other waves. Tsunamis typically do not have the curling wave form that wind waves do. Most often, they act more like a rapidly rising flood or surge. Tsunamis are usually multiple waves, and the first wave is often not the largest. The time between waves can be minutes or even hours.

A tsunami's arrival is sometimes signaled by receding water. In these cases, the tsunami arrives trough-first, and the water withdraws, often uncovering parts of the seabed that aren't typically exposed. This retreat is immediately followed by the water coming back in, often as a turbulent surge or a wall of water. If the tsunami arrives crest-first, the first signs will be a quick and unusual rising of the water, which can be anything from a gentle increase above expected tides to a fast-moving wall of turbulent water. Even though tsunamis are usually smaller than wind waves, their long wavelength provides more momentum for inundation and they are more capable of flooding low-lying coastal regions.

Related National Weather Service Products

Tsunami information and products are provided by the National Weather Service West Coast/Alaska Tsunami Warning Center in Palmer, Alaska and the Pacific Tsunami Warning Center in Ewa Beach, Hawaii. Information about threats to your area will also be distributed by your local Weather Forecast Office.

Longer-term or Information Only	Shorter-term/Immediate
Tsunami Information Statement	Tsunami Advisory
Tsunami Watch	Tsunami Warning

Volcanic Ash

Definition

Volcanic eruptions do not have meteorological sources, but they can release ash and sulfuric gases into the atmosphere where weather plays a large role in transport and dispersion.

Impacts/Associated Hazards

Volcanic eruptions are often violent events, releasing magma, ash, and debris. Ash and gases can be transported and dispersed by prevailing air currents, eventually settling out of the atmosphere and accumulating on property. Associated hazards and impacts include:

- Lahars (volcanic mudflow or debris flow)
- Immediate and/or later onset health problems, including deaths
- Air and water quality issues
- Property damage, including structure collapse
- Air travel disruptions
- Economic losses, potentially spanning large parts of globe

Characteristics

Volcanoes have distinct shallow “plumbing systems” usually with a magma chamber that is connected to the surface by a conduit system. During an eruption, magma rises through more than one crack in the volcano's interior; some of the magma pushes up the strata layers while other magma moves to the top opening(s) of the volcano. The raised opening that emits magma is called the cone and the crack that reaches to the top of the cone is called the central vent. Along with the magma, the volcano emits a cloud of tephra, which is fragmented material with sizes ranging from ash particles to rocks.

Volcanic eruptions are often categorized into four main types, characterized in part by their ash dispersion patterns during the eruption:

- Hawaiian—Produces little volcanic ash
- Strombolian—Short-lived eruption and the ash is not ejected to great heights
- Vulcanian—Produces large quantities of ash that can be dispersed for miles downwind
- Plinian—Produces large quantities of ash that can be ejected high into the stratosphere and circle the globe

Related National Weather Service Products

Information related to volcanic eruptions and volcanic ash is listed below. Check with your Warning Coordination Meteorologist for updated products and information specific to your area or situation.

Immediate Timeframe
Volcano Warning Volcanic Ash Advisory

Hazardous Materials Release

Definition

Hazardous materials include explosives, flammable and combustible substances, toxic chemicals, and radioactive materials. Releases of these materials are most commonly caused by transportation accidents or chemical accidents in manufacturing plants. Biological, chemical, or nuclear terrorism can also send harmful dispersants into the air, and a terrorist attack or bombing might result in large amounts of airborne debris, posing respiratory dangers for populations downwind.

Impacts/Associated Hazards

Hazardous materials releases can pose significant threats to human health, including immediate and/or later onset health problems and deaths. Associated hazards include:

- Air and water quality issues
- Environmental contamination

Characteristics

Hazardous materials releases can occur multiple times a year in communities that are home to refining facilities, manufacturing plants, or major transportation corridors. In other communities, these events might be quite infrequent. When these situations do occur, knowledge of the wind direction and how it might change are extremely important. Other weather factors also play a role.

When a hazardous substance is released into the atmosphere, the material forms a plume or cloud that spreads downwind from the source. Appropriate response to the event requires knowing where the cloud will be before it gets there. This quick response becomes particularly crucial if schools, day care facilities, nursing homes, hospitals, or other “sensitive receptors” are in the path. A plume’s dispersion can be affected by precipitation, atmospheric stability, temperature, humidity, cloud cover, local circulations, and additional weather factors—all of which can be obtained by contacting your local forecast office. The forecasters on staff can run models to provide dispersion forecasts projecting the transport of hazardous materials in the atmosphere.

Related National Weather Service Products

Information related to hazardous materials releases is listed below. Check with your Warning Coordination Meteorologist for updated products and information specific to your area or situation.

Immediate Timeframe
Hazardous Materials Warning
Radiological Hazard Warning
Shelter in Place Warning
Evacuation Immediate (issued when flammable or explosive gas release might result in casualties)

Appendix E: NWS Products

This section contains the following tables and examples, to be used with the Unit 5 activity:

- NWS Non-Routine Products and Services (Tables)
  - Convective
  - Hydrology
- Example: Severe Thunderstorm Watch
- Example: Tornado Warning
- Example: Urban and Small Stream Flood Advisory
- Example: Flash Flood Watch

This appendix provides limited information for the purposes of an activity within the course. Additional information about these and other NWS products is available in Chapter 2 of the NWS Products and Services Reference Guide.

NWS Non-Routine Products and Services

	Convective						
	Headline	Issuance Criteria	Typical Lead Time	VTEC Code	Product ID	Follow-up Product	Issued By
Watches	Severe Thunderstorm Watch	Conditions are favorable for thunderstorms containing 1 inch or larger hail and/or wind gusts of at least 58 mph (50 knots).	2 to 8 hours	SV.A	SELx	Watch County Notification	SPC (updates/ cancellations issued by WFO)
	PDS Severe Thunderstorm Watch	Conditions are favorable for widespread, significant, non-tornadic thunderstorms. Example: convective winds greater than 75mph (65knots). *Note: "PDS" does not appear in the watch headline, but as a special line within the initial watch product.*	2 to 8 hours	SV.A	SELx	Watch County Notification	SPC (updates/ cancellations issued by WFO)
	Tornado Watch	Conditions are favorable for thunderstorms producing tornadoes. Hail and strong winds are also possible.	2 to 8 hours	TO.A	SELx	Watch County Notification	SPC (updates/ cancellations issued by WFO)
	PDS Tornado Watch	Conditions are favorable for thunderstorms producing destructive tornadoes. Hail and strong winds are also possible. Typically issued when there is a likelihood of multiple strong (damage of EF2 or EF3) or violent (damage of EF4 or EF5) tornadoes. *Note: "PDS" does not appear in the watch headline, but as a special line within the initial watch product.*	2 to 8 hours	TO.A	SELx	Watch County Notification	SPC (updates/ cancellations issued by WFO)

	Convective						
	Headline	Issuance Criteria	Typical Lead Time	VTEC Code	Product ID	Follow-up Product	Issued By
Warnings	Severe Thunderstorm Warning	A thunderstorm producing 1 inch or larger hail and/or wind gusts of at least 58 mph (50 knots) is occurring or imminent.	10 to 30 minutes	SV.W	SVR	Severe Weather Statement	Local WFO
	Special Marine Warning	A thunderstorm producing 3/4 inch hail, and/or wind gusts to 34 knots and/or waterspouts. In addition, short duration, non-thunderstorm wind gusts to 34 knots.	30 to 90 minutes	MA.W	SMW	Marine Weather Statement	Local WFO
	Tornado Warning	A tornado has been reported or is highly likely to occur based on Doppler radar signatures.	10 to 30 minutes	TO.W	TOR	Severe Weather Statement	Local WFO
	Tornado Emergency	Added to tornado warning in exceedingly rare situations, when a severe threat to human life and catastrophic damage from a tornado is imminent or ongoing,	10 to 30 minutes	TO.W	TOR	Severe Weather Statement	Local WFO
Advisories	Significant Weather Advisory	Issued under the Special Weather Statement product for strong thunderstorms producing winds between 40 and 57 mph, and/or hail less than 1 inch in diameter, and/or frequent or continuous lightning and/or funnel clouds or cold air funnels.	Up to 1 hour	N/A	SPS	Special Weather Statement	Local WFO

	Hydrology						
	Headline	Issuance Criteria	Typical Lead Time	VTEC Code	Product ID	Follow-up Product	Issued By
Watches	Flash Flood Watch	Rapidly developing and life-threatening flooding is possible due to a hydrologic event (e.g. heavy rain) or dam or levee failure.	6 to 24 hours	FF.A	FFA	Flash Flood Watch	Local WFO
	Flood Watch	**Flood Watch (Areal):** Flooding of land and/or rivers and streams is possible. **Flood Watch (Forecast Point):** Flooding is possible at a particular point on a river or stream.	6 to 48 hours	FA.A (areal), FL.A (forecast point)	FFA	Flood Watch	Local WFO
Warnings	Flash Flood Warning	A) Flash flooding is reported; and/or B) A dam or levee failure is imminent or occurring; and/or C) A sudden failure of a naturally-caused stream obstruction (including debris slide, avalanche, or ice jam) is imminent or occurring; and/or D) Precipitation capable of causing flash flooding is indicated by radar, rain gages, and/or satellite; and/or (continued on next page)	30 minutes to 2 hours	FF.W	FFW	Flash Flood Statement	Local WFO

	Hydrology						
	Headline	Issuance Criteria	Typical Lead Time	VTEC Code	Product ID	Follow-up Product	Issued By
Warnings	Flash Flood Warning, continued	E) Precipitation as indicated by radar, rain gages, satellite and/or other guidance is capable of causing debris flows, particularly (but not only) in burn areas; and/or F) Local monitoring and prediction tools indicate flash flooding is likely; and/or G) A hydrologic model indicates flash flooding for locations on small streams.	30 minutes to 2 hours	FF.W	FFW	Flash Flood Statement	Local WFO
	Flash Flood Emergency	In exceedingly rare situations, when a severe threat to human life and catastrophic damage from a flash flood is imminent or ongoing.	30 minutes to 3 hours	FF.W	FFW	Flash Flood Statement	Local WFO
	Flood Warning	Human life and catastrophic damage from a flood is imminent or ongoing.	6 to 12 hours	FA.W (areal), FL.W (forecast point)	FLW	Flood Statement	Local WFO
Advisories	Flood Advisory	**Flood Advisory (Areal/Forecast Point/Urban and Small Stream):** Issued when flooding is expected to be of inconvenience, but not necessarily life-threatening.	30 minutes to 2 hours	FA.Y	FLS	Flood Statement	Local WFO

Example: Severe Thunderstorm Watch

SEL9

URGENT - IMMEDIATE BROADCAST REQUESTED
SEVERE THUNDERSTORM WATCH NUMBER 639
NWS STORM PREDICTION CENTER NORMAN OK
450 PM EDT SAT SEP 8 2012

THE NWS STORM PREDICTION CENTER HAS ISSUED A
SEVERE THUNDERSTORM WATCH FOR PORTIONS OF

CONNECTICUT
MASSACHUSETTS
SOUTHWEST MAINE
NEW HAMPSHIRE
RHODE ISLAND
COASTAL WATERS

EFFECTIVE THIS SATURDAY AFTERNOON AND EVENING FROM 450 PM UNTIL
1100 PM EDT.

HAIL TO 1 INCH IN DIAMETER...THUNDERSTORM WIND GUSTS TO 70
MPH...AND DANGEROUS LIGHTNING ARE POSSIBLE IN THESE AREAS.

THE SEVERE THUNDERSTORM WATCH AREA IS APPROXIMATELY ALONG AND 55
STATUTE MILES EAST AND WEST OF A LINE FROM 100 MILES NORTH
NORTHEAST OF BERLIN NEW HAMPSHIRE TO 20 MILES SOUTH SOUTHEAST OF
WINDSOR LOCKS CONNECTICUT. FOR A COMPLETE DEPICTION OF THE WATCH
SEE THE ASSOCIATED WATCH OUTLINE UPDATE (WOUS64 KWNS WOU9).

REMEMBER...A SEVERE THUNDERSTORM WATCH MEANS CONDITIONS ARE
FAVORABLE FOR SEVERE THUNDERSTORMS IN AND CLOSE TO THE WATCH
AREA. PERSONS IN THESE AREAS SHOULD BE ON THE LOOKOUT FOR
THREATENING WEATHER CONDITIONS AND LISTEN FOR LATER STATEMENTS
AND POSSIBLE WARNINGS. SEVERE THUNDERSTORMS CAN AND OCCASIONALLY
DO PRODUCE TORNADOES.

OTHER WATCH INFORMATION...CONTINUE...WW 635...WW 636...WW
637...WW 638...

DISCUSSION...COLD FRONTAL SQUALL LINE OVER ERN NY WILL CONTINUE TO
MOVE EWD AND IMPACT THE WATCH AREA THROUGH LATE EVENING. THOUGH
INSTABILITY IS NOT AS LARGE COMPARED TO AREAS FARTHER TO THE W...THE
STORM ENVIRONMENT SHOULD REMAIN SUFFICIENT TO MAINTAIN A RISK FOR
DAMAGING WINDS FOR THE NEXT FEW HOURS.

AVIATION...A FEW SEVERE THUNDERSTORMS WITH HAIL SURFACE AND ALOFT
TO 1 INCH. EXTREME TURBULENCE AND SURFACE WIND GUSTS TO 60 KNOTS.
A FEW CUMULONIMBI WITH MAXIMUM TOPS TO 400. MEAN STORM MOTION
VECTOR 25030.

...THOMPSON

Example: Tornado Warning

```
000
WFUS51 KALY 082144
TORALY
MAC003-NYC021-082215-
/O.NEW.KALY.TO.W.0007.120908T2144Z-120908T2215Z/

BULLETIN - EAS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE ALBANY NY
544 PM EDT SAT SEP 8 2012

THE NATIONAL WEATHER SERVICE IN ALBANY HAS ISSUED A

* TORNADO WARNING FOR...
  SOUTHWESTERN BERKSHIRE COUNTY IN WESTERN MASSACHUSETTS...
  SOUTH CENTRAL COLUMBIA COUNTY IN EAST CENTRAL NEW YORK...

* UNTIL 615 PM EDT

* AT 541 PM EDT...NATIONAL WEATHER SERVICE DOPPLER RADAR INDICATED A
  SEVERE THUNDERSTORM CAPABLE OF PRODUCING A TORNADO NEAR COPAKE...OR
  13 MILES SOUTHWEST OF GREAT BARRINGTON...MOVING NORTHEAST AT 40
  MPH.

* THE TORNADO WILL BE NEAR...
   EGREMONT PLAIN...NORTH EGREMONT AND SOUTH EGREMONT BY 555 PM
   EDT...

PRECAUTIONARY/PREPAREDNESS ACTIONS...

THE SAFEST PLACE TO BE DURING A TORNADO IS IN A BASEMENT. GET UNDER A
WORKBENCH OR OTHER PIECE OF STURDY FURNITURE. IF NO BASEMENT IS
AVAILABLE...SEEK SHELTER ON THE LOWEST FLOOR OF THE BUILDING IN AN
INTERIOR HALLWAY OR ROOM SUCH AS A CLOSET. USE BLANKETS OR PILLOWS TO
COVER YOUR BODY AND ALWAYS STAY AWAY FROM WINDOWS.

IF IN MOBILE HOMES OR VEHICLES...EVACUATE THEM AND GET INSIDE A
SUBSTANTIAL SHELTER. IF NO SHELTER IS AVAILABLE...LIE FLAT IN THE
NEAREST DITCH OR OTHER LOW SPOT AND COVER YOUR HEAD WITH YOUR HANDS.

PLEASE REPORT HAIL SIZE... DAMAGING WINDS AND REPORTS OF TREES DOWN
TO THE NATIONAL WEATHER SERVICE BY EMAIL AT ALB.STORMREPORT@NOAA.GOV
OR ON FACEBOOK AT
WWW.FACEBOOK.COM/US.NATIONALWEATHERSERVICE.ALBANY.GOV.

A TORNADO WATCH REMAINS IN EFFECT UNTIL 1000 PM EDT SATURDAY EVENING
FOR NORTHERN CONNECTICUT AND WESTERN MASSACHUSETTS AND EASTERN NEW
YORK AND SOUTHERN VERMONT.

LAT...LON 4223 7344 4215 7337 4204 7354 4209 7361
TIME...MOT...LOC 2144Z 219DEG 35KT 4210 7352

BGM
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Example: Urban and Small Stream Flood Advisory

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000
WGCA82 TJSJ 112228
FLSSJU

FLOOD ADVISORY
NATIONAL WEATHER SERVICE SAN JUAN PR
628 PM AST TUE SEP 11 2012

PRC001-055-079-093-111-121-125-153-120030-
/O.NEW.TJSJ.FA.Y.0326.120911T2228Z-120912T0030Z/
/00000.N.ER.000000T0000Z.000000T0000Z.000000T0000Z.OO/
GUANICA PR-LAJAS PR-MARICAO PR-PENUELAS PR-SABANA GRANDE PR-
SAN GERMAN PR-YAUCO PR-ADJUNTAS PR-
628 PM AST TUE SEP 11 2012

THE NATIONAL WEATHER SERVICE IN SAN JUAN HAS ISSUED AN

* URBAN AND SMALL STREAM FLOOD ADVISORY
  FOR THE FOLLOWING MUNICIPALITIES...

  IN PUERTO RICO
     GUANICA...LAJAS...MARICAO...PENUELAS...SABANA GRANDE...SAN
     GERMAN...YAUCO AND ADJUNTAS

* UNTIL 830 PM AST

* AT 620 PM AST...DOPPLER RADAR INDICATED SHOWERS AND THUNDERSTORMS
AFFECTING THE ADVISORY AREA. THIS AREA OF SHOWERS AND
THUNDERSTORMS WILL HAVE THE CAPABILITY OF PRODUCING MODERATE
TO HEAVY RAINFALL WHICH WILL LEAD TO RAPID RISES ON SMALL STREAMS
AND CREEKS...AS WELL AS MINOR FLOODING ALONG ROADWAYS THROUGH AT
LEAST 8:30 PM AST.

MOST FLOOD DEATHS OCCUR IN AUTOMOBILES. NEVER DRIVE YOUR VEHICLE INTO
AREAS WHERE THE WATER COVERS THE ROADWAY. FLOOD WATERS ARE USUALLY
DEEPER THAN THEY APPEAR. JUST ONE FOOT OF FLOWING WATER IS POWERFUL
ENOUGH TO SWEEP VEHICLES OFF THE ROAD. WHEN ENCOUNTERING FLOODED
ROADS MAKE THE SMART CHOICE...TURN AROUND...DONT DROWN.

&&

LAT...LON 1808 6704 1819 6688 1817 6684 1817 6682
      1814 6679 1811 6681 1809 6680 1805 6682
      1795 6696

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FIGUEROA
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Example: Flash Flood Watch

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000
WGUS61 KILN 050800
FFAILN

FLOOD WATCH
NATIONAL WEATHER SERVICE WILMINGTON OH
400 AM EDT SAT MAY 5 2012

INZ073>075-080-KYZ089>100-OHZ070>073-077>082-088-052000-
/O.CON.KILN.FF.A.0002.000000T0000Z-120505T2000Z/
/00000.0.ER.000000T0000Z.000000T0000Z.000000T0000Z.OO/
RIPLEY-DEARBORN-OHIO-SWITZERLAND-CARROLL-GALLATIN-BOONE-KENTON-
CAMPBELL-OWEN-GRANT-PENDLETON-BRACKEN-ROBERTSON-MASON-LEWIS-
BUTLER-WARREN-CLINTON-ROSS-HAMILTON-CLERMONT-BROWN-HIGHLAND-ADAMS-
PIKE-SCIOTO-
INCLUDING THE CITIES OF...VERSAILLES...LAWRENCEBURG...
RISING SUN...VEVAY...CARROLLTON...WARSAW...BURLINGTON...
INDEPENDENCE...ALEXANDRIA...OWENTON...WILLIAMSTOWN...FALMOUTH...
BROOKSVILLE...MOUNT OLIVET...MAYSVILLE...VANCEBURG...HAMILTON...
LEBANON...WILMINGTON...CHILLICOTHE...CINCINNATI...MILFORD...
GEORGETOWN...HILLSBORO...WEST UNION...PIKETON...PORTSMOUTH
400 AM EDT SAT MAY 5 2012

...FLASH FLOOD WATCH REMAINS IN EFFECT THROUGH THIS AFTERNOON...

THE FLASH FLOOD WATCH CONTINUES FOR

* PORTIONS OF SOUTHEAST INDIANA...KENTUCKY AND OHIO...INCLUDING
  THE FOLLOWING AREAS...IN SOUTHEAST INDIANA...DEARBORN...OHIO...
   RIPLEY AND SWITZERLAND. IN KENTUCKY...BOONE...BRACKEN...
  CAMPBELL...CARROLL...GALLATIN...GRANT...KENTON...LEWIS...
  MASON...OWEN...PENDLETON AND ROBERTSON. IN OHIO...ADAMS...
  BROWN...BUTLER...CLERMONT...CLINTON...HAMILTON...HIGHLAND...
  PIKE...ROSS...SCIOTO AND WARREN.

* THROUGH THIS AFTERNOON

* OCCASIONAL SHOWERS AND THUNDERSTORMS WILL CONTINUE TO PUSH
  SLOWLY EAST ACROSS THE AREA THROUGH THE EARLY MORNING HOURS.
  ADDITIONAL THUNDERSTORMS ARE EXPECTED TO DEVELOP THROUGH THIS
  AFTERNOON AHEAD OF A SLOW MOVING FRONTAL BOUNDARY. THESE
  STORMS WILL BE CAPABLE OF PRODUCING LOCALLY HEAVY RAINFALL
  RATES AS HIGH AS 1 TO 2 INCHES IN AN HOUR.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A FLASH FLOOD WATCH MEANS THAT FLOODING OF SMALL STREAMS...
CREEKS AND OTHER DRAINAGE AREAS IS POSSIBLE WITHIN THE WATCH
AREA. PEOPLE IN THE WATCH AREA SHOULD KEEP AN EYE ON THE WEATHER
AND BE PREPARED FOR IMMEDIATE ACTION SHOULD HEAVY RAINS AND
FLOODING OCCUR OR A FLASH FLOOD WARNING BE ISSUED.

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