Hazardous Weather and Flooding Preparedness

Student Manual

FEDERAL EMERGENCY MANAGEMENT AGENCY
EMERGENCY MANAGEMENT INSTITUTE

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# Table of Contents

**Unit 1: Introduction and Course Overview** .......................................................... I-1

**Unit 2: Weather Overview** .................................................................................. II-1

**Unit 3: Introduction to Hazardous Weather** .................................................... III-1

**Unit 4: Role of the Emergency Manager** ......................................................... IV-1

**Unit 5: NWS Hazardous Weather Products** ................................................... V-1

**Unit 6: Projecting the Impacts of Hazardous Weather and Flooding** .............. VI-1

**Unit 7: Activity** ................................................................................................... VII-1

**Unit 8: Course Summary** .................................................................................. VIII-1

**Appendix A: Glossary** ....................................................................................... APP-1

**Appendix B: Resources** ..................................................................................... APP-21

**Appendix C: Charts and Tables** ........................................................................ APP-25

**Appendix D: Hazards Fact Sheets** .................................................................... APP-33

**Appendix E: NWS Products** .............................................................................. APP-71

**Appendix F: NWS Pennsylvania Resources** ...................................................... APP-83
Unit 1: Introduction and Course Overview
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.

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).
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.

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 an Activity 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
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.

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

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.
Flash Floods

- Over 90 deaths each year
- Nearly half due to driving through flood waters
- Many flash floods occur at night

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.

Severe Thunderstorms

- Damaging hail
- Destructive winds
- Potential tornadoes
- Frequent lightning

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).
Did you know?
Approximately 400 people die each year due to extreme heat. Extreme cold kills approximately 700 people each year.

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

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.
Tropical Cyclones

- Nearly 50 deaths per year
- Over $5 billion in damages per year
- Include:
  - Hurricanes
  - Typhoons
  - Tropical storms
  - Tropical depressions

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

Tsunamis

- Series of ocean waves
- Caused by:
  - volcanic eruptions
  - undersea earthquakes
  - landslides
- High hazard in the Pacific and Caribbean
- Low hazard but high impact for Atlantic and Gulf of Mexico

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.

Did you know?

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

- Solar storms that impact the Earth and our technological systems
- NWS’ Space Weather Prediction Center warns for space weather hazards
- Impacts can include:
  - Radio communications outages
  - Power disruptions
  - Significant GPS errors

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.
Unit 2: Weather Overview
Unit 2: Weather Overview
(Northern Hemisphere & the U.S.)

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.

Objectives

- Define basic components of weather
- Distinguish between high and low pressure areas on a map
- Calculate the dew point using a conversion chart, when given the relative humidity and temperature
- Describe weather patterns

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.
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.

**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).

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

<table>
<thead>
<tr>
<th>Dew Point</th>
<th>Relative Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature to which air must be cooled to be saturated</td>
<td>Percentage of water vapor in air compared to what the air is capable of holding</td>
</tr>
</tbody>
</table>

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.
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 refreezes into ice pellets, commonly called sleet.

**Did you know?**

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

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.
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.
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.

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.
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.

What are the four basic components of weather that contrast sharply in the area of a front?
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?

Unit Summary
- Define basic components of weather
- Distinguish between high and low pressure areas on a map
- Calculate the dew point using a conversion chart, when given the relative humidity and temperature
- Describe weather patterns

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: Introduction to Hazardous Weather
Unit 3: Introduction to Hazardous Weather

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.

Unit Objectives

- Describe various types of hazardous weather
- Summarize potential dangers caused by hazardous weather
- Explain how community and environmental factors can worsen the impact of hazardous weather
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.

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-16
- Flash Floods: Page SM III-25
- River Floods: Page SM III-27
- Coastal and Lakeshore Floods: Page SM III-30
- Extratropical Cyclones: Page SM III-35
- Tropical Cyclones/Hurricanes: Page SM III-37
- Tsunamis: Page SM III-40
- Winter Storms: Page SM III-43
- Excessive Cold: Page SM III-47
- Fog: Page SM III-49
- Excessive Heat: Page SM III-50
- Dust Storms: Page SM III-53
- Wind Storms: Page SM III-55
- Fire Weather: Page SM III-59
- Space Weather: Page SM III-63
- Volcanic Ash: Page SM III-66
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.

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.
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.

Thunderstorms: Damaging Winds

- Straight-line winds
- Downbursts
- Micro bursts
- Gust fronts

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.
Pennsylvania Severe Wind Reports by Hour since 1955.
Notice most severe wind reports peak in the afternoon and evening after peak daytime heating.

Pennsylvania Severe Wind Reports by Month since 1955.
Severe wind reports peak during the summer months when ingredients for thunderstorms are more abundant.
**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.

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.
Pennsylvania Severe Wind Reports by Hour since 1955.
Notice most severe hail reports peak in the afternoon and evening after peak daytime heating.

Pennsylvania Severe Wind Reports by Month since 1955.
Severe hail reports peak during the late spring and early summer months when thunderstorms combine with cold air aloft more often.
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.

**Did you know?**
Each year approximately 1,300 tornadoes touch down in the U.S., the highest frequency in the world.

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.
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
Pennsylvania Tornado Intensity
Since 1950, 95% of PA tornadoes are on the weak side of the scale at EF-2 rating or less.

Pennsylvania Tornadoes by Hour since 1950.
Most tornadoes form during afternoon and evening hours following peak daytime heating.
Pennsylvania Tornadoes by Month
Most tornadoes occur in late spring and early summer as the upper level support and low level ingredients combine more readily during transition from winter to summer. The strongest tornadoes have historically occurred in May-June.

Pennsylvania Tornadoes by Year
Tornado reports tend to spike every several years, with some of the most notable outbreak years highlighted (1985, 1998, 2011). However, prior to the middle 1970s and the advent of weather radars, many tornadoes may have gone un-reported, especially in rural areas.

Did you know?
Pennsylvania’s strongest tornado occurred in Wheatland, Mercer County on the evening of May 31, 1985 as part of the deadliest outbreak in state history. The tornado winds exceeded 200mph, receiving a rating of F-5, the only recorded tornado of this strength in the state’s history since 1950.
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.

<table>
<thead>
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<th>#</th>
<th>Damage Indicator</th>
<th>#</th>
<th>Damage Indicator</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Small barn, farm outbuilding</td>
<td>10</td>
<td>School, elementary</td>
</tr>
<tr>
<td>2</td>
<td>One- or two-family residence</td>
<td>11</td>
<td>School, junior or senior high</td>
</tr>
<tr>
<td>3</td>
<td>Single-wide mobile home</td>
<td>12</td>
<td>Low-rise bldg</td>
</tr>
<tr>
<td>4</td>
<td>Double-wide mobile home</td>
<td>13</td>
<td>Mid-rise bldg</td>
</tr>
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<td>5</td>
<td>Apt, condo, townhouse</td>
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<td>High-rise bldg</td>
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<td>6</td>
<td>Motel</td>
<td>15</td>
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<td>Wmurgy apt, or motel</td>
<td>16</td>
<td>Metal bldg, system</td>
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<td>Small retail bldg</td>
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<td>Small professional bldg</td>
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<td>Strip mall</td>
<td>19</td>
<td>Transmission line tower</td>
</tr>
<tr>
<td>11</td>
<td>Large shopping mall</td>
<td>20</td>
<td>Res. or standing tower</td>
</tr>
<tr>
<td>12</td>
<td>Large, isolated retail bldg</td>
<td>21</td>
<td>Frame-going pole</td>
</tr>
<tr>
<td>13</td>
<td>Automobile showroom</td>
<td>22</td>
<td>Tree, hardwood</td>
</tr>
<tr>
<td>14</td>
<td>Automotive service bldg</td>
<td>23</td>
<td>Tree, softened</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Degree of Damage (DI = 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOD</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
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<td>5</td>
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<td>6</td>
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<td>7</td>
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<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

The DOD when most walls are collapsed would be 8.

- 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
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.

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.

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 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.

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.

Flash Floods

- Heavy rains
- Dam or levee failure
- Water from breakup of ice
- Intense rainfall on impervious areas

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”.

Appendix B
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.

**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.

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

**Coastal and Lakeshore Flooding Terms**
- Surf
- MSL
- Tidal Cycle
- Datum Plane
- Seliche
- Storm Surge
- Swell

**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.

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.
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.

Coastal flood ingredients:
Results from:
- Storm surge and/or seiche reaching land
- Heavy surf
- Tidal piling
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.

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.

### Lakeshore Flooding Hazards
- High winds
- Quickly rising water levels
- Fierce wave action
- Shore erosion
- Debris carried by water

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

- Coastal storms that form within the tropics
- Storm center is warmer than the surrounding air
- Winds are strongest at 10,000 feet

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.

Tropical Cyclone Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Wind Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical Depression</td>
<td>Maximum sustained winds near the surface less than 39 mph</td>
</tr>
<tr>
<td>Tropical Storm</td>
<td>Winds of 39–73 mph</td>
</tr>
<tr>
<td>Hurricanes or Typhoons</td>
<td>Winds of 74 mph or more</td>
</tr>
</tbody>
</table>

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.
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.

Hurricanes can cause several hydrometeorological hazards.

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
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.

Winter Storm Hazards

- Strong winds
- Extreme cold
- Precipitation
- Blizzard conditions

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

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.

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.
January 2016 Snowstorm

The January 2016 snowstorm brought three feet of snow to southern PA while northern Pennsylvania never saw a flake. Snow storms provide diverse hazards to the Commonwealth. This storm resulted in a federal disaster declaration or record snowfall.

Average PA Snowfall

Pennsylvania average snowfall ranges from 8” in Delaware County to 113” in parts of Erie County. Topography, Great Lakes play large roles in snowfall climatology for Pennsylvania.
Excessive Cold

- Varies according to the normal climate of a region
- May accompany or follow winter storms
- Can occur without storm activity

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.

Excessive Cold: Wind Chill

<table>
<thead>
<tr>
<th>Wind</th>
<th>30°</th>
<th>25°</th>
<th>20°</th>
<th>15°</th>
<th>10°</th>
<th>5°</th>
<th>0°</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 mph</td>
<td>19°</td>
<td>13°</td>
<td>6°</td>
<td>0°</td>
<td>-7°</td>
<td>-13°</td>
<td>-19°</td>
</tr>
<tr>
<td>20 mph</td>
<td>17°</td>
<td>11°</td>
<td>4°</td>
<td>-2°</td>
<td>-9°</td>
<td>-15°</td>
<td>-22°</td>
</tr>
<tr>
<td>25 mph</td>
<td>16°</td>
<td>9°</td>
<td>3°</td>
<td>-4°</td>
<td>-11°</td>
<td>-17°</td>
<td>-24°</td>
</tr>
<tr>
<td>30 mph</td>
<td>15°</td>
<td>8°</td>
<td>1°</td>
<td>-5°</td>
<td>-12°</td>
<td>-19°</td>
<td>-26°</td>
</tr>
</tbody>
</table>

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.
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.
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.
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.

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.
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.
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 /fɜːn/) 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:
• Sustained wind of 20mph for more than 2 hours
• Less than 30% Relative Humidity
• Less than 10% 10-hour Fuel Moisture

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)

Fire Weather Hazards
• Destruction of property
• Injury
• Death
• Secondary effects:
  – Erosion
  – Landslides
  – Water quality problems

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.

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### Wildfire Categories

<table>
<thead>
<tr>
<th>Haines Index</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 or 3</td>
<td>Very Low</td>
</tr>
<tr>
<td>4</td>
<td>Low</td>
</tr>
<tr>
<td>5</td>
<td>Moderate</td>
</tr>
<tr>
<td>6</td>
<td>High</td>
</tr>
</tbody>
</table>

---

2002 Colorado “Hayman” Wildfire

Image credit (both photos): NOAA

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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.

**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.
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.
- **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.

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**Space Weather Storm Types**

- Radio Blackouts
- Solar Radiation Storms
- Geomagnetic Storms

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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.
Did you know?

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

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.
Activity: Identifying Potentially Hazardous Situations

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.

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.

<table>
<thead>
<tr>
<th>Event #1:</th>
<th>Event #2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
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<tr>
<td>2</td>
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<td>3</td>
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<td>4</td>
<td></td>
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<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
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: Role of the Emergency Manager
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.

Objectives

- Describe the role of the Emergency Manager in planning and responding to hazardous weather events
- Identify actions Emergency Managers should take to prepare for, and respond to, hazardous weather events
- Develop strategies for improving coordination among State and local communities in the days or hours leading to a hazardous event

Unit 4

This unit will enable you 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?

What action does your Emergency Operations Plan (EOP) require the emergency manager to take when a NWS warning is issued?
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.
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.

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.

What steps should the Emergency Managers have taken?
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.

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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?

During and immediately following the event, how should the Emergency Manager have responded?
Does anyone have any questions about the Emergency Manager’s role during small-scale events?
Did you know?
StormReady can be used toward credit in the NFIP program and can reduce a communities ISO rating?

The StormReady program ensures your community is prepared to detect, warn, and respond to weather disasters. If you don’t meet the criteria, you can still become a StormReady Supporter.

As of July 2017, 58 of Pennsylvania’s 67 counties along with several municipalities, businesses and universities are StormReady.
Did you know?
The Weather-Ready Nation Ambassador program is free to sign up for and takes only a few minutes online.

The Weather-Ready Nation Ambassador program is an effort to build whole community involvement in developing outreach and education initiatives to build a more weather resilient country. Visit: [https://www.weather.gov/wrn/ambassadors](https://www.weather.gov/wrn/ambassadors)

The NWS will provide you with quarterly outreach materials and ideas to assist in building a more weather resilient community.
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.
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: NWS Hazardous Weather Products
Unit 5

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

Unit 5: NWS Hazardous Weather Products

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.

Objectives

- Describe the mission of the NWS
- Describe the basic organizational structure of the NWS
- Explain the purpose of various NWS products
- Explain how Probability of Precipitation is determined
- Select the NWS forecast products and other local resources that are most appropriate for the hazards affecting your community
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.

- Weather Prediction Center (Formerly Hydrometeorological Prediction Center)
  - The Weather 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 Centers for Environmental Information (NCEI)
*Formerly National Climatic Data Center (NCDC)*

NOAA’s NCEI 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 NCEI 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, Hawai. 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.
NOAAPort

Data is...
- Collected by GOES satellite environmental sensors and NWS observing systems
- Processed to create NWS operational data stream
- Routed to the appropriate NOAAPort channel for uplink and broadcast
- Provided in near-real-time to NOAA and external users

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

- Mobile alert service
  - Text messages
  - Email alerts
  - Doppler radar data
- For NWS core partners only
  - Emergency managers
  - Public safety officials
  - SKYWARN amateur radio operators
  - Government partners

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.
NWS Chat

- Situational awareness tool tailored for:
  - Emergency managers
  - Other public safety officials
  - News media
  - Skywarn Net Control Operators
- Provides a direct, operational communication link for information exchange during hazardous weather events

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.

Social Media

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.
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

- P_a = probability that precipitation will occur somewhere in the forecast area during the forecast period
- a_c = percent of the area that will receive measurable precipitation
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%).

**PoP Example**

- A line of thunderstorms is forecast to cover the northern 80% of the forecast area
- The forecaster is confident of the likelihood of the occurrence (100% probability)
- PoP for the forecast area would be 80%
  - 100% x 80% = 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.

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/
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.
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.

**Emergency Manager’s Decision Support Page**

- Local website maintained by many Local NWS Offices
- Provides Emergency Managers with information on:
  - Weather hazards facing the area
  - Preparedness
  - Upcoming workshops

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
Forecasts
Outlooks, Advisories, and Warnings
- Short-term
- Zone
- Extended
- Long range

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 and Discussions
Statements
- Issued during weather events to advise of changing conditions
- Can amplify or cancel previously issued advisories and warnings

Discussions provide rationale for the forecasts

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.
Individual Activity: Selecting a Forecast Product

- Work individually
- List appropriate products and resources for your community
- Refer to information from the earlier Group Activity
- Be prepared to share your responses

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?
Unit 6: Projecting the Impacts of Hazardous Weather and Flooding
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.

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.

Objectives

- List sources of information needed to determine a community’s vulnerability to hazardous weather events
- Identify climatological and community factors that contribute to your community’s vulnerability to hazardous weather and flooding
- Complete a hazard analysis for a hydrometeorological event to which your jurisdiction is vulnerable
- Propose mitigation measures for a hazardous weather or flooding event
What is your community’s state of readiness for responding to hazardous weather and flooding events?

In light of what you now know, what are your concerns about your community’s response capabilities?
An important aspect of preparing for emergency response is understanding your jurisdiction’s vulnerability to hazardous weather and flooding events.

- How bad can it get?
- How often has it occurred?
- How likely is it to happen?
- When are we most vulnerable?
Pennsylvania Tornado Risk
(Through June 2017)

Most Recent Tornadoes*
by county

Pennsylvania: 5.5”
June 26, 1950
A DVD is 4.75”

Largest Hail on Record
## Pennsylvania Snow Records

<table>
<thead>
<tr>
<th>County</th>
<th>City Field Town</th>
<th>6 Day Total Town</th>
<th>3 Day Total Town</th>
<th>2 Day Total Town</th>
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<tr>
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</tr>
<tr>
<td>Wyoming County</td>
<td>Wyoming</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
What are the sources of information you would use to relate each of these factors to your community’s vulnerability?

---

**Community Factors**

- People at risk
- Property at risk
- Local building codes
- Locations of critical facilities
- Locations of key resources
- Condition of infrastructure
- Local geography and topography

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

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 activity.
- 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:** ________________

<table>
<thead>
<tr>
<th>Climatological Factors</th>
<th>Analysis</th>
<th>Area Potentially Impacted</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum probable event or most likely significant threat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worst ever event (Record precipitation, temperature, winds,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>flood crest, flood volume, destruction, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average frequency of occurrence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average loss per year from this type of event</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentile chance of occurrence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Months of peak occurrence</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Area Potentially Impacted:**
  - State
  - Region
  - County
  - Community
## ANALYZING THREATS

### THREAT ANALYSIS WORKSHEETS (CONTINUED)

Threat: __________________________

<table>
<thead>
<tr>
<th>Population Vulnerabilities</th>
<th>Analysis</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentrations in vulnerable areas</td>
<td>Total population:</td>
<td>Concentrated areas:</td>
</tr>
<tr>
<td>Awareness level (for the type of event)</td>
<td>□ Low</td>
<td>Sources for public information:</td>
</tr>
<tr>
<td></td>
<td>□ Medium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ High</td>
<td></td>
</tr>
<tr>
<td>Previous response experience (for the type of event)</td>
<td>□ None</td>
<td>Level of responsiveness to warnings:</td>
</tr>
<tr>
<td></td>
<td>□ Moderate</td>
<td>□ Little</td>
</tr>
<tr>
<td></td>
<td>□ Extensive</td>
<td>□ Moderate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>□ High</td>
</tr>
<tr>
<td>Special needs groups</td>
<td>□ Hearing impaired</td>
<td>Implications for Warning:</td>
</tr>
<tr>
<td></td>
<td>□ Physically impaired</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Non-English speaking</td>
<td>Response:</td>
</tr>
<tr>
<td></td>
<td>□ Elderly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Tourist</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Other:</td>
<td></td>
</tr>
<tr>
<td>Risk associated with population distribution</td>
<td>□ Floodplain</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Storm surge inundation area</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Canyon</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Mudslide area</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Avalanche</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Isolated</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Other:</td>
<td></td>
</tr>
<tr>
<td>Other risk factors affecting the population</td>
<td>□ Seasonal shift</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Time-of-day shift</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Day-of-week shift</td>
<td></td>
</tr>
<tr>
<td>Property Vulnerabilities</td>
<td>Analysis</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------------------</td>
<td>-------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Do building codes promote hazard-resistant construction?</td>
<td>□ Yes</td>
<td>Potential code related issues:</td>
</tr>
<tr>
<td></td>
<td>□ No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Somewhat</td>
<td></td>
</tr>
<tr>
<td>Are the building codes strictly enforced?</td>
<td>□ Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Somewhat</td>
<td></td>
</tr>
<tr>
<td>Are there concentrations of properties that are vulnerable to specific events (e.g.,</td>
<td>□ Yes</td>
<td>Describe (facility, location, and risk):</td>
</tr>
<tr>
<td>beachfront properties)?</td>
<td>□ No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Somewhat</td>
<td></td>
</tr>
<tr>
<td>Are there facilities that pose a risk of “cascading” events (e.g., hazardous materials</td>
<td>□ Yes</td>
<td>Describe (facility, location, and risk):</td>
</tr>
<tr>
<td>facilities)?</td>
<td>□ No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Somewhat</td>
<td></td>
</tr>
<tr>
<td>What critical facilities are located in the community?</td>
<td>□ Fire Stations</td>
<td>Consider:</td>
</tr>
<tr>
<td></td>
<td>□ Police precincts</td>
<td>Location</td>
</tr>
<tr>
<td></td>
<td>□ Public works yards</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>□ Water treatment</td>
<td>Age</td>
</tr>
<tr>
<td></td>
<td>facilities</td>
<td>Use/Population Present</td>
</tr>
<tr>
<td></td>
<td>□ Utilities substations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Government buildings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Shelters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ EOC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Other:</td>
<td></td>
</tr>
<tr>
<td>What other key facilities exist in the community?</td>
<td>□ Hospitals/nursing</td>
<td>Consider:</td>
</tr>
<tr>
<td></td>
<td>homes</td>
<td>Location</td>
</tr>
<tr>
<td></td>
<td>□ Schools/universities</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>□ Convention centers,</td>
<td>Age</td>
</tr>
<tr>
<td></td>
<td>stadiums, arenas</td>
<td>Use/Population Present</td>
</tr>
<tr>
<td></td>
<td>□ Military installations</td>
<td></td>
</tr>
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<td></td>
<td>□ Other:</td>
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### Population Vulnerabilities

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Yes</td>
<td></td>
</tr>
<tr>
<td>□ No</td>
<td>Describe (facility, location, and problem):</td>
</tr>
</tbody>
</table>

#### Analysis

- Are any facilities present special problems for warning, response, or recovery?
  - □ Yes
  - □ No

#### Analysis

- Are any facilities especially vulnerable to this type of hazard?
  - □ Yes
  - □ No

#### Analysis

- Describe (facility, location, and problem): |

### Resources

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

#### Analysis

- Where are your community’s key resources (i.e., people, tools, and equipment) located?

#### Analysis

- Are the key resources located where they will be needed to respond to the main hazardous weather and flooding events?
  - □ Yes
  - □ No

#### Analysis

- Describe location: |

### Infrastructure Vulnerabilities

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Analysis

- Are communication systems vulnerable?
  - □ Yes
  - □ No

#### Analysis

- Describe vulnerability: |

#### Analysis

- Are power systems vulnerable?
  - □ Yes
  - □ No

#### Analysis

- Describe vulnerability: |

#### Analysis

- Are water and/or sewer systems vulnerable?
  - □ Yes
  - □ No

#### Analysis

- Describe vulnerability: |
### Infrastructure Vulnerabilities

<table>
<thead>
<tr>
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<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>□ Yes</td>
<td>Describe vulnerability:</td>
</tr>
<tr>
<td>□ No</td>
<td></td>
</tr>
</tbody>
</table>

**Are transportation systems (including bridges, tunnels, and rail lines) vulnerable?**

- [ ] Yes
- [ ] No

**Is the community dependent on vulnerable transportation routes for evacuation, rescue, etc.?**

- [ ] Yes
- [ ] No

**Does the community’s infrastructure pose any special threats for warning, response, and/or recovery?**

- [ ] Yes
- [ ] No

**Identify vulnerable routes and preparedness options:**

- Identify threats for
  - Warning
  - Response
  - Recovery

### Geography And Topography

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Comments</th>
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<tbody>
<tr>
<td>□ Yes</td>
<td>Describe the impact caused by geography and/or topography:</td>
</tr>
<tr>
<td>□ No</td>
<td></td>
</tr>
</tbody>
</table>

**Do geographic/topographic features add to the jurisdiction’s vulnerability (e.g., mountain effects, floodplains, lake effect, altitude, etc.)?**

- [ ] Yes
- [ ] No
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?)

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
</table>

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? □ □
Debrief: Mitigation Measures

What mitigation measures can your community implement to reduce the impacts of the event you just analyzed?

Mitigation funding resources include:
- Local resources
- State resources
- Federal resources
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.

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

Potential Local Mitigation Funding Resources

- Nonprofit organizations
- Taxes
- Private sector funding

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.

Potential State Mitigation Funding Resources

- Emergency funds
- Conservation and historical preservation initiatives
- Earmarked funds from lottery, taxes, and other sources

Some States have designated funds could potentially be used for mitigation.
Federal Mitigation Funding Resources

- Hazard Mitigation Grant Program (HMGP)
- Pre-Disaster Mitigation (PDM) Program
- Public Assistance (PA) Grant Program
- Flood Mitigation Assistance (FMA) Program
- Repetitive Flood Claims (RFC) Program
- Severe Repetitive Loss (SRL) Program
- HUD’s Community Development Block Grants (CSBG)
- National Tsunami Hazard Mitigation Program (NTHMP)

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.

Unit Summary

- List sources of information needed to determine a community’s vulnerability to hazardous weather events
- Identify climatological and community factors that contribute to your community’s vulnerability to hazardous weather and flooding
- Complete a threat analysis for a hydrometeorological event to which your jurisdiction is vulnerable
- Propose mitigation measures for a hazardous weather or flooding event

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.
Unit 7: Activity
The purpose of this unit is to give you the opportunity to make decisions based on what you’ve learned throughout the course.

Unit 7: Activity

This unit consists of an activity 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.

Unit Objectives

- Describe factors that influence the selection of emergency response options
- Determine response priorities
- Propose appropriate emergency responses
Activity: Severe Summer Storms

Activity Notes
- Work in your table group
- Role-play as the affected emergency management agency
- Consider your own EOP
- Use NWS forecasts and graphics

Activity Information
- This activity is based on a simulated, but realistic event for the Commonwealth.
- As a group, you will be playing the part of the Emergency Management Agency as assigned.
- 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 activity.
Scenario: Severe Summer Storms

As the emergency manager, you have dodged severe impacts from a few recent storms for July, including a tropical system. Streams and rivers are running high, but no serious impacts have faced your community as of early July.

By middle July, the NWS has issued convective outlooks indicating a complex weather scenario is expected to develop and impact the Commonwealth. A potent line of severe storms is anticipated, with accompanying threats for large hail, damaging winds, tornadoes, and flash flooding. You stay tuned in to local television news stations and keep an eye on NWS information throughout the week.

On Wednesday, July 12, severe storms produce damaging hail and winds in Ohio. You breathe a sigh of relief, but you know you are up next with severe weather forecast for Thursday, July 13. You continue to monitor the situation Wednesday night into Thursday morning.
Activity Scenario
- After a period of heavy rain from a recent tropical system, local waterways are running high.
- Several days of very warm and muggy weather have surged into the Commonwealth which is about to be interrupted by a potent storm system.
- Very warm and moist air is streaming in against a stalled front over New York and the Great Lakes region.
- The stage is set for some storm development along a cold front draped through Ohio.

Weather Brief #1
Wednesday, July 12
11:00 AM

Weather Brief #1
- Severe storms are likely in the afternoon hours on, Thursday, July 13
- There is a potential for a severe wind driven event known as a derecho to move across the state
- SPC has the region under a moderate risk for severe weather
  - Risk for widespread winds 60-75mph
  - Risk for 2” diameter hail
  - Risk for a few tornadoes
- Local streams and creeks running high and ground is very saturated = flash flood risk
Day 2 Convective Outlook

Risk Categories for Convective Outlooks

Understanding Severe Thunderstorm Risk Categories

Day 2 Severe Probability
Activity Information

- See full text on page SM VII-7.

Instructions

- Work in your table group
- Consider:
  - Community information
  - Maps
  - NWS products provided
- Discuss questions and record responses
- Be prepared to share
Full Hazardous Weather Outlook Text

➢ From Slide 12.

FLUS41 KCTP 231202
HW0CTP
Hazardous Weather Outlook
National Weather Service
11:00 AM EDT Wed Jul 12 2017
This Hazardous Weather Outlook is for Pennsylvania.
.DAY ONE...Today and Tonight.
The probability for widespread hazardous weather is low.
.DAYS TWO THROUGH SEVEN...Thursday through Sunday.
Severe thunderstorms...including the threat of dangerous tornadoes...are expected across Pennsylvania between 12 pm and 8 pm Thursday.
All modes of severe weather are possible...tornadoes...damaging winds...large hail... and locally heavy rain which may produce flash flooding and small stream and creek flooding.
Based on the latest data...it appears the severe thunderstorm threat may evolve into a large squall line known as a derecho. Beginning in the west as early as 12 pm Thursday and lasting until 6-8 pm in the east. Atmospheric parameters appear favorable for the development of a squall line with embedded areas of winds in excess of 70 mph. Thunderstorms may produce strong tornadoes or large hail.
Although the greatest threat for severe weather will progress from west to east, do not focus on any particular hour...be prepared for activity at any time. Review your preparedness action plans and be ready to take action when watches and warnings are issued. Stay tuned to further updates on this potential hazardous weather outbreak.
.SPOTTER INFORMATION STATEMENT...
Activation of storm spotters...emergency management personnel...and ham radio operators is expected Thursday.
Activity: Severe Summer Storms

General Notes
Please read the following general notes about this activity before you begin:

- This activity has been developed to emphasize important elements associated with hazardous weather planning and preparedness.
- Consider your own EOPs as if they were for the affected area.
- While working through the discussion questions in this activity, 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 activity 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.

Scenario: Discussion Questions #1
1. What course of action would you take considering 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)?
Weather Brief #2
Thursday, July 13
11:00 AM

- Severe storms have fired in eastern Ohio.
- A severe wind driven event known as a derecho is likely and will move across the state after 2PM.
- SPC has the region under a moderate risk for severe weather:
  - Risk for widespread winds 60-75mph
  - Risk for 2.0” diameter hail
  - Risk for a few tornadoes
- Local streams and creeks running high and ground is very saturated = flash flood risk with heavy rain 2-3” per hour.

Day 1 Convective Outlook
Day 1 Probability to Categorical Outlook Conversion

Flash Flood Guidance

11 A.M. Radar Image
Scenario: Discussion Questions #2

1. What course of action would you take considering the updated convective outlooks and additional weather information?

2. Based on the scenario, would you consider this forecasted weather event “routine” or “unusually strong” for your area?

3. If you have not yet activated any portion of your EOP, would you activate it now? If so, which portions?

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

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

6. What public entities would you notify of the current hazards? How will you notify them?

7. What additional preparedness actions would you take with your community (outside of those in your EOP)?
Weather Brief #3
Thursday, July 13
12:30 PM

Activity Information
Full Severe Thunderstorm Watch Text

From Slide 21.

URGENT - IMMEDIATE BROADCAST REQUESTED

Severe Thunderstorm Watch Number 105
NWS Storm Prediction Center Norman OK
1230 PM EDT THU JUL 13 2017

The NWS Storm Prediction Center has issued a
Severe Thunderstorm Watch for portions of
- Extreme Eastern Ohio
- All of Pennsylvania
- Northern West Virginia
- Northern Maryland

Effective this Thursday afternoon and evening from 12:30 pm until 800 pm EDT.

...THIS IS A PARTICULARLY DANGEROUS SITUATION...

Widespread damaging winds
- Thunderstorm wind gusts to 80mph
- Isolated hail to 2 inches in diameter
- Isolated tornadoes
- Dangerous lightning

The severe thunderstorm watch area is approximately 300 statute miles west to east along a north and south line from Ashtabula Ohio to 35 miles east of Parkersburg West Virginia. For a complete depiction of the watch see the associated watch outline update (wous64 kwns wou6).

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.

Discussion...Intense MCS has developed n/s across eastern Ohio and continues to develop as it moves ewd. The storm environment downstream features strong instability and sufficient deep-layer flow/shear to maintain an organized MCS...and there will be the potential for widespread very damaging winds with this bowing system through this afternoon. In addition brief tornadoes are still possible but widespread damaging winds and isolated large hail are the dominant threats.

Aviation...A few severe thunderstorms with hail surface and aloft to 2 inches. Extreme turbulence and surface wind gusts to 80 knots. A few cumulonimbi with maximum tops to 550. Mean storm motion vector 24540.
Scenario: Discussion Questions #3

1. What course of action would you take with the issuance of the PDS Severe Thunderstorm Watch?

2. What specific hazards are you concerned with based on the watch text and storm arrival timeline?

3. If you have not yet activated any portion of your EOP, would you activate it now? If so, which portions?

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

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

6. How will you continue to notify your partners and the public as warnings are issued? How does this change with loss of critical infrastructure such as power and radio systems?

7. What additional preparedness actions would you take with your community (outside of those in your EOP)?
Weather Event
Thursday, July 13
2:00-7:00PM

Severe Event Timeline

• Storms fire in Ohio in the morning hours of July 13
• The storms merge into a line and push eastward reaching western Pennsylvania by 2PM.
• The line of severe storms expands from north to south and travels across the state between 2-7PM.
• The storm line moves east at 60mph
• Storm winds reach 60-75mph.
• Rainfall rates reach 2-3”/hr.

Severe Event Timeline
Scenario: Discussion Questions #4

1. Numerous severe thunderstorm warnings and several flash flood warnings are issued for your area. What challenges do you face with the following?
   
   a. Flooded roadways

   b. Downed trees & power lines

   c. Loss of communications (radio and cellular)

2. If you have not yet activated any portion of your EOP, would you activate it now? If so, which portions?

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

4. How will you continue to notify your partners and the public?

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

6. Did you feel you had enough information to prepare for what is occurring?
Activity Debrief

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.

Group Reporting

• What actions did you take?
• What worked well?
• What didn’t work well?
• How did you address communication and coordination with NWS and others?
Storm Summary

- The line leaves a widespread path of wind damage from west to east across the state.
- Damage includes extensive power outages, downed trees and limbs, and sporadic structural damage.
- Some areas experience hail damage with 1.5"-2.0" hail stones.
- 2.0-3.5" of rain over 45 minutes to 1 hour results in extensive flash flooding in hundreds of local municipalities.

Simulated Derecho Timeline

Preliminary Damage Reports
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?
Unit Summary

- How has this activity made you think differently about your emergency management responsibilities during hazardous weather events?
- How can you improve coordination with NWS and others during hazardous weather events?

You should now be able to...

- Describe factors that influence the selection of emergency response options during a hazardous weather event
- Determine response priorities for a hazardous weather event
- Propose appropriate emergency responses for a hazardous weather event in a given scenario
Unit 8: Course Summary
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 Objectives Review
For each unit objective, consider:
- Did we cover it?
- Can you do it?
- Do you have any questions?
Unit 1: Introduction and Course Overview

This unit focused on preparing you to:

Recognize the importance of planning for hazardous weather and flooding events

Unit 2: Weather Overview

This unit focused on preparing you to:

Analyze how the components of weather interact to create hazardous weather
Unit 2 Review Question #1

What is the significance of a dew point greater than 60°F?

Unit 2 Review Question #2

With what type of pressure system are cloudy skies associated?
Unit 3: Introduction to Hazardous Weather

This unit focused on preparing you to:

Anticipate the impact of hazardous weather events to enhance preparedness

Unit 3 Review Question #1

What are some hazards associated with a winter storm? What effects might they have on the community?
Unit 3 Review Question #2

What are three basic factors that contribute to thunderstorm development?

Unit 3 Review Question #3

What are some community factors that contribute to the risk level of hazardous weather events?
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

Unit 4 Review Question #1

What are the five primary responsibilities of the emergency manager related to hazardous weather events?
Unit 4 Review Question #2

What are some ways that emergency managers can prepare for hazardous weather in advance?

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
Unit 5 Review Question #1

What is the difference between a Watch and a Warning?

Unit 5 Review Question #2

What two values are multiplied to figure the Probability of Precipitation?
Unit 5 Review Question #3

Which type of NWS office directly supports local/state emergency management response to hazardous weather?

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
Unit 6 Review Question #1

How can you help your community be ready for hazardous weather events?

Unit 6 Review Question #2

What potential resources may be used to help fund mitigation measures?
Unit 7: Activity
This unit focused on preparing you to:

Evaluate the effectiveness of emergency response actions for a given scenario

Unit 7 Review Question #1
In the Unit 7 activity, what did you learn about your community’s ability to respond to real events?
Thank you for attending!

- Final Exam
- Closing Remarks
- Course Evaluation
  - Must complete on TrainPA to release course certificate
- Certificate
  - Visit TrainPA to save

Hazardous Weather and Flooding Preparedness

October 2013

SM VIII-12
G0271

Hazardous Weather and Flooding Preparedness

Appendices

Student Manual

FEDERAL EMERGENCY MANAGEMENT AGENCY
EMERGENCY MANAGEMENT INSTITUTE

October 2013
Table of Contents

Appendix A:  Glossary
Appendix B:  Resources
Appendix C:  Charts and Tables
Appendix D:  Hazards Fact Sheets
Appendix E:  NWS Products
Appendix F:  NWS Pennsylvania Resources
## Appendix A: Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advection</td>
<td>The horizontal transport of air, moisture or other atmospheric properties. Commonly used with temperatures, i.e., &quot;warm air advection.&quot;</td>
</tr>
<tr>
<td>Advisory</td>
<td>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.</td>
</tr>
<tr>
<td>AFWS</td>
<td>Automated Flood Warning Systems</td>
</tr>
<tr>
<td>Air Mass</td>
<td>A large body of air that has similar horizontal temperature and moisture characteristics.</td>
</tr>
<tr>
<td>Air Pressure</td>
<td>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.</td>
</tr>
<tr>
<td>ALERT</td>
<td>Automated Local Evaluation in Real Time</td>
</tr>
<tr>
<td>All Hazards Emergency Message Collection</td>
<td>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.</td>
</tr>
<tr>
<td>AMBER Alert™ Program</td>
<td>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.</td>
</tr>
<tr>
<td>America's Weather and Climate Industry</td>
<td>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.</td>
</tr>
<tr>
<td>ARES</td>
<td>Amateur Radio Emergency Services</td>
</tr>
<tr>
<td>ARRL</td>
<td>Amateur Radio Relay League</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>The mass of air surrounding Earth's surface and bound to it more or less permanently by Earth's gravitational field.</td>
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<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td><strong>Aurora Borealis</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>AWC</strong></td>
<td>Aviation Weather Center</td>
</tr>
<tr>
<td><strong>AWIPS</strong></td>
<td>Advanced Weather Interactive Processing Systems</td>
</tr>
<tr>
<td><strong>AWP</strong></td>
<td>Area Warning Point</td>
</tr>
<tr>
<td><strong>Blizzard</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>CAPE</strong></td>
<td>Convective Available Potential Energy</td>
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<td><strong>CDBG</strong></td>
<td>Community Development Block Grant</td>
</tr>
<tr>
<td><strong>Cell</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Chinook Winds</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Circulation</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Climate</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Cloudburst</strong></td>
<td>A sudden, intense rainfall that is normally of short duration.</td>
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<tr>
<td><strong>CMAS</strong></td>
<td>Commercial Mobile Alert System</td>
</tr>
<tr>
<td><strong>Coastal Flood</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Cold Front</strong></td>
<td>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.</td>
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<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>Commercial Mobile Alert System (CMAS)</td>
<td>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).</td>
</tr>
<tr>
<td>Community Rating System (CRS)</td>
<td>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.</td>
</tr>
<tr>
<td>Convective Available Potential Energy (CAPE)</td>
<td>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.</td>
</tr>
<tr>
<td>Convection</td>
<td>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.</td>
</tr>
<tr>
<td>Coronal Mass Ejection (CME)</td>
<td>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.</td>
</tr>
<tr>
<td>CME</td>
<td>Coronal Mass Ejection</td>
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<tr>
<td>CPC</td>
<td>Climate Prediction Center</td>
</tr>
<tr>
<td>CRS</td>
<td>Community Rating System</td>
</tr>
<tr>
<td>CWA</td>
<td>Center Weather Advisory</td>
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<tr>
<td>CWP</td>
<td>County Warning Point</td>
</tr>
<tr>
<td>CWSU</td>
<td>Center Weather Service Unit</td>
</tr>
<tr>
<td>Cyclone</td>
<td>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.</td>
</tr>
<tr>
<td>Datum Plane</td>
<td>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.</td>
</tr>
<tr>
<td>Debris Cloud</td>
<td>A rotating &quot;cloud&quot; of dust or debris near or on the ground, often appearing beneath a condensation funnel and surrounding the base of a tornado.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td><strong>Derecho</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Dew Point</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>DHS</strong></td>
<td>Department of Homeland Security</td>
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<tr>
<td><strong>DI</strong></td>
<td>Damage Indicator</td>
</tr>
<tr>
<td><strong>DNR</strong></td>
<td>Department of Natural Resources</td>
</tr>
<tr>
<td><strong>DOC</strong></td>
<td>Department of Commerce</td>
</tr>
<tr>
<td><strong>DOD</strong></td>
<td>Department of Defense; Degree of Damage</td>
</tr>
<tr>
<td><strong>Doppler Radar</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>DOT</strong></td>
<td>Department of Transportation</td>
</tr>
<tr>
<td><strong>Downburst</strong></td>
<td>Localized current of air blasting down from a thunderstorm, which induces an outward burst of damaging wind on or near the ground.</td>
</tr>
<tr>
<td><strong>Downdraft</strong></td>
<td>A column of generally cool air that rapidly sinks to the ground, usually accompanied by precipitation as in a shower or thunderstorm.</td>
</tr>
<tr>
<td><strong>Drought</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Dryline</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Dual-Polarization Radar</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Dust Devil</strong></td>
<td>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.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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</tr>
<tr>
<td>Dust Storm</td>
<td>An area where high surface winds have picked up loose dust, reducing visibility to less than 1/2 mile.</td>
</tr>
<tr>
<td>EAS</td>
<td>Emergency Alert System</td>
</tr>
<tr>
<td>EF</td>
<td>Enhanced Fujita</td>
</tr>
<tr>
<td>El Niño</td>
<td>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).</td>
</tr>
<tr>
<td>EM</td>
<td>Emergency Management</td>
</tr>
<tr>
<td>Emergency Alert System (EAS)</td>
<td>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.</td>
</tr>
<tr>
<td>Emergency Managers Weather Information Network (EMWIN)</td>
<td>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.</td>
</tr>
<tr>
<td>EMWIN</td>
<td>Emergency Managers Weather Information Network</td>
</tr>
<tr>
<td>Enhanced Fujita (EF) Scale</td>
<td>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.</td>
</tr>
<tr>
<td>EOC</td>
<td>Emergency Operations Center</td>
</tr>
<tr>
<td>EOP</td>
<td>Emergency Operations Plan</td>
</tr>
<tr>
<td>ERP</td>
<td>Emergency Response Plan</td>
</tr>
<tr>
<td>Extratropical Cyclones</td>
<td>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.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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</tr>
<tr>
<td>Eye</td>
<td>The low pressure center of a tropical cyclone. Winds are normally calm and sometimes the sky clears.</td>
</tr>
<tr>
<td>FAA</td>
<td>Federal Aviation Administration</td>
</tr>
<tr>
<td>Family of Service (FOS)</td>
<td>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.</td>
</tr>
<tr>
<td>FEMA</td>
<td>Federal Emergency Management Agency</td>
</tr>
<tr>
<td>FIRM</td>
<td>Flood Insurance Rate Map</td>
</tr>
<tr>
<td>Flash Flood</td>
<td>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.</td>
</tr>
<tr>
<td>FMA</td>
<td>Flood Mitigation Assistance</td>
</tr>
<tr>
<td>Foehn Winds</td>
<td>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.</td>
</tr>
<tr>
<td>Fog</td>
<td>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).</td>
</tr>
<tr>
<td>FOS</td>
<td>Family of Service</td>
</tr>
<tr>
<td>Forecast</td>
<td>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.</td>
</tr>
<tr>
<td>Front</td>
<td>The boundary or transition zone between two different air masses. The basic frontal types are cold fronts, warm fronts, and occluded fronts.</td>
</tr>
<tr>
<td>Frostbite</td>
<td>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.</td>
</tr>
<tr>
<td>Funnel Cloud</td>
<td>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.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>Geostationary Operational Environmental Satellite (GOES)</td>
<td>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.</td>
</tr>
<tr>
<td>Geostationary Satellite</td>
<td>A satellite positioned over the equator that rotates at the same rate as Earth, remaining over the same spot.</td>
</tr>
<tr>
<td>GOES</td>
<td>Geostationary Operational Environmental Satellite</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning Systems</td>
</tr>
<tr>
<td>Gust</td>
<td>A brief sudden increase in wind speed. Generally the duration is less than 20 seconds and the fluctuation greater than 10 mph.</td>
</tr>
<tr>
<td>Gust Front</td>
<td>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.</td>
</tr>
<tr>
<td>Hail</td>
<td>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.</td>
</tr>
<tr>
<td>Haines Index</td>
<td>Also known as the Lower Atmospheric Severity Index (LASI), a numerical value from 2 to 6 that indicates the potential for large fire growth.</td>
</tr>
<tr>
<td>HazCollect</td>
<td>All Hazards Emergency Message Collection Service</td>
</tr>
<tr>
<td>Heat Index (HI)</td>
<td>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.</td>
</tr>
<tr>
<td>HI</td>
<td>Heat Index</td>
</tr>
<tr>
<td>High</td>
<td>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.</td>
</tr>
<tr>
<td>HMGP</td>
<td>Hazard Mitigation Grant Program</td>
</tr>
<tr>
<td>Hook Echo</td>
<td>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.</td>
</tr>
<tr>
<td>HPC</td>
<td>Hydrometeorological Prediction Center</td>
</tr>
<tr>
<td>Humidity</td>
<td>The amount of water vapor in the atmosphere.</td>
</tr>
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<td>Term</td>
<td>Definition</td>
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<tr>
<td>Hurricane</td>
<td>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.</td>
</tr>
<tr>
<td>Hydrology</td>
<td>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.</td>
</tr>
<tr>
<td>Hydrometeorological Event</td>
<td>A weather-related event such as tropical cyclones (hurricanes, typhoons, cyclones), windstorms, winter storms, tornadoes, and floods.</td>
</tr>
<tr>
<td>Hydrometeorology</td>
<td>The branch of meteorology that deals with the occurrence, motion, and changes of state of atmospheric water.</td>
</tr>
<tr>
<td>Hyperthermia</td>
<td>High body temperature; an acute condition that occurs when the body absorbs more heat than it can handle.</td>
</tr>
<tr>
<td>Hypothermia</td>
<td>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.</td>
</tr>
<tr>
<td>IAEM</td>
<td>International Association of Emergency Managers</td>
</tr>
<tr>
<td>Ice Jam</td>
<td>An accumulation of broken river ice caught in a narrow channel that frequently produces local floods during a spring breakup.</td>
</tr>
<tr>
<td>Ice Storm</td>
<td>Liquid rain falling and freezing on contact with cold objects creating ice buildups of 1/4th inch or more that can cause severe damage.</td>
</tr>
<tr>
<td>Instability</td>
<td>A state of the atmosphere in which convection takes place spontaneously, leading to cloud formation and precipitation.</td>
</tr>
<tr>
<td>Integrated Public Alert and Warning System (IPAWS)</td>
<td>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.</td>
</tr>
<tr>
<td>Integrated Warning Team</td>
<td>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.</td>
</tr>
<tr>
<td>Inversion</td>
<td>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.</td>
</tr>
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<td>Term</td>
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<tr>
<td>iNWS</td>
<td>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.</td>
</tr>
<tr>
<td>Ionosphere</td>
<td>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.</td>
</tr>
<tr>
<td>IPAWS</td>
<td>Integrated Public Alert and Warning System</td>
</tr>
<tr>
<td>ISO</td>
<td>Insurance Services Organization</td>
</tr>
<tr>
<td>Isobar</td>
<td>A line of equal barometric pressure on a weather map.</td>
</tr>
<tr>
<td>Jet Stream</td>
<td>Strong winds concentrated within a narrow band in the upper atmosphere. It normally refers to horizontal, high-altitude winds. The jet stream often &quot;steers&quot; surface features such as fronts and low pressure systems.</td>
</tr>
<tr>
<td>Joint Polar Satellite System (JPSS)</td>
<td>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.</td>
</tr>
<tr>
<td>JPSS</td>
<td>Joint Polar Satellite System</td>
</tr>
<tr>
<td>Knot</td>
<td>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.</td>
</tr>
<tr>
<td>LASI</td>
<td>Lower Atmospheric Severity Index.</td>
</tr>
<tr>
<td>La Niña</td>
<td>A cooling of the equatorial waters in the Pacific Ocean.</td>
</tr>
<tr>
<td>LETS</td>
<td>Law Enforcement Telecommunications System</td>
</tr>
<tr>
<td>LI</td>
<td>Lifted Index</td>
</tr>
<tr>
<td>Lifted Index (LI)</td>
<td>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.</td>
</tr>
<tr>
<td>Low</td>
<td>An area of low pressure, usually accompanied by cyclonic and inward wind flow. Also known as a cyclone.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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</tr>
<tr>
<td>Lower Atmospheric Severity Index (LASI)</td>
<td>Commonly known as the Haines Index, a numerical value from 2 to 6 that indicates the potential for large fire growth.</td>
</tr>
<tr>
<td>Macroburst</td>
<td>Large downburst with a 2.5 mile or greater outflow diameter and damaging winds lasting 5 to 20 minutes.</td>
</tr>
<tr>
<td>Mean Sea Level (MSL)</td>
<td>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.</td>
</tr>
<tr>
<td>Mesocyclone</td>
<td>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.</td>
</tr>
<tr>
<td>Meteorologist</td>
<td>A person who studies meteorology. Some examples include research meteorologist, climatologist, operational meteorologist, television meteorologist.</td>
</tr>
<tr>
<td>Meteorology</td>
<td>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.</td>
</tr>
<tr>
<td>Microburst</td>
<td>A strong, localized downdraft from a thunderstorm with peak gusts lasting 2 to 5 minutes.</td>
</tr>
<tr>
<td>Millibar</td>
<td>A metric unit of atmospheric pressure. 1 mb = 100 Pa (pascal). Normal surface pressure is approximately 1013 millibars.</td>
</tr>
<tr>
<td>Mitigation</td>
<td>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.</td>
</tr>
<tr>
<td>MSL</td>
<td>Mean Sea Level</td>
</tr>
<tr>
<td>Multicell Cluster Thunderstorm</td>
<td>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.</td>
</tr>
<tr>
<td>National Flood Insurance Program (NFIP)</td>
<td>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.</td>
</tr>
<tr>
<td>NCEP</td>
<td>National Center for Environmental Protection</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>NCO</td>
<td>NCEP Central Operations</td>
</tr>
<tr>
<td>NFIP</td>
<td>National Flood Insurance Program</td>
</tr>
<tr>
<td>National Hurricane Center (NHC)</td>
<td>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 &quot;off-season&quot; 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.</td>
</tr>
<tr>
<td>National Oceanic and Atmospheric Administration (NOAA)</td>
<td>A branch of the U.S. Department of Commerce, NOAA is the parent organization of the National Weather Service.</td>
</tr>
<tr>
<td>National Polar-orbiting Operational Environmental Satellite System (NPOESS)</td>
<td>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).</td>
</tr>
<tr>
<td>National Volcano Early Warning System (NVEWS)</td>
<td>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).</td>
</tr>
<tr>
<td>National Warning System (NAWAS)</td>
<td>Commonly known as NAWAS, this comprehensive automated telephone network connects state and Federal warning points throughout the United States.</td>
</tr>
<tr>
<td>NAWAS</td>
<td>National Warning System</td>
</tr>
<tr>
<td>NCDC</td>
<td>National Climatic Data Center</td>
</tr>
<tr>
<td>NCF</td>
<td>Network Control Facility</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Emergency Management Association</td>
</tr>
<tr>
<td>NEXRAD</td>
<td>Next Generation Weather Radar</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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</tr>
<tr>
<td>Next Generation Weather Radar (NEXRAD)</td>
<td>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.</td>
</tr>
<tr>
<td>NHC</td>
<td>National Hurricane Center</td>
</tr>
<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>NOAAPort</td>
<td>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.</td>
</tr>
<tr>
<td>NOAA Weather Radio (NWR)</td>
<td>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.</td>
</tr>
<tr>
<td>NOAA Weather Wire Service (NWWS)</td>
<td>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).</td>
</tr>
<tr>
<td>NOHRSC</td>
<td>National Operational Hydrologic Remote Sensing Center</td>
</tr>
<tr>
<td>Nor’easter</td>
<td>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.</td>
</tr>
<tr>
<td>NPOESS</td>
<td>National Polar-orbiting Operational Environmental Satellite System</td>
</tr>
<tr>
<td>NSSL</td>
<td>National Severe Storms Laboratory</td>
</tr>
<tr>
<td>NTHMP</td>
<td>National Tsunami Hazard Mitigation Program</td>
</tr>
<tr>
<td>NVEWS</td>
<td>National Volcano Early Warning System</td>
</tr>
<tr>
<td>NWR</td>
<td>NOAA Weather Radio</td>
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<td>Term</td>
<td>Definition</td>
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<tr>
<td>NWS</td>
<td>National Weather Service</td>
</tr>
<tr>
<td>NWSChat</td>
<td>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.</td>
</tr>
<tr>
<td>NWSH</td>
<td>National Weather Service Headquarters</td>
</tr>
<tr>
<td>NWSTG</td>
<td>NWS Telecommunications Gateway</td>
</tr>
<tr>
<td>NWWS</td>
<td>NOAA Weather Wire Service</td>
</tr>
<tr>
<td>Occlusion</td>
<td>A complex frontal system that occurs when a cold front overtakes a warm front. Also known as an occluded front.</td>
</tr>
<tr>
<td>OPC</td>
<td>Oceans Prediction Center</td>
</tr>
<tr>
<td>OPSnet</td>
<td>Operational System Network</td>
</tr>
<tr>
<td>Outlook</td>
<td>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.</td>
</tr>
<tr>
<td>PA</td>
<td>Public Assistance</td>
</tr>
<tr>
<td>Particularly Dangerous Situation (PDS)</td>
<td>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.</td>
</tr>
<tr>
<td>PDM</td>
<td>Pre-Disaster Mitigation</td>
</tr>
<tr>
<td>PDS</td>
<td>Particularly Dangerous Situation.</td>
</tr>
<tr>
<td>PETS Act</td>
<td>The Pets Evacuation and Transportation Standards Act of 2006</td>
</tr>
<tr>
<td>Pets Evacuation and Transportation Standards Act of 2006 (PETS Act)</td>
<td>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.</td>
</tr>
<tr>
<td>PIO</td>
<td>Public Information Officer</td>
</tr>
<tr>
<td>PoP</td>
<td>Probability of Precipitation</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>PPD-8</td>
<td>Presidential Policy Directive 8: National Preparedness</td>
</tr>
<tr>
<td>Preparedness</td>
<td>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.</td>
</tr>
<tr>
<td>Pressure Gradient Force (Pgf)</td>
<td>Force acting on air that causes it to move from areas of higher pressure to areas of lower pressure.</td>
</tr>
<tr>
<td>Prevailing Westerlies</td>
<td>Winds in the middle latitudes (approximately 30 degrees to 60 degrees) that generally blow from west to east.</td>
</tr>
<tr>
<td>Prevention</td>
<td>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 &quot;prevention&quot; refers to preventing imminent threats.</td>
</tr>
<tr>
<td>Probability of Precipitation (PoP)</td>
<td>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.</td>
</tr>
<tr>
<td>Protection</td>
<td>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.</td>
</tr>
<tr>
<td>PTWC</td>
<td>Pacific Tsunami Warning Center</td>
</tr>
<tr>
<td>Public Information Officer (PIO)</td>
<td>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.</td>
</tr>
<tr>
<td>Radar</td>
<td>An instrument used to detect precipitation by measuring the strength of the electromagnetic signal reflected back. (RADAR= RAdio Detection And Ranging)</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td><strong>Radar Product Services (RPS)</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Rain</strong></td>
<td>Liquid water droplets that fall from the atmosphere, having diameters greater than drizzle (0.5 mm).</td>
</tr>
<tr>
<td><strong>Recovery</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Relative Humidity (RH)</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Response</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>RFC</strong></td>
<td>River Forecast Center (Also, Repetitive Flood Claims)</td>
</tr>
<tr>
<td><strong>RH</strong></td>
<td>Relative Humidity</td>
</tr>
<tr>
<td><strong>Ridge</strong></td>
<td>An elongated area of high pressure in the atmosphere.</td>
</tr>
<tr>
<td><strong>RPS</strong></td>
<td>Radar Product Services</td>
</tr>
<tr>
<td><strong>SAS</strong></td>
<td>Server Access Service</td>
</tr>
<tr>
<td><strong>SBN</strong></td>
<td>Satellite Broadcast Network</td>
</tr>
<tr>
<td><strong>Seiche</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Server Access Service (SAS)</strong></td>
<td>Part of the Family of Service (FOS), SAS provides access to all NWS data and information including warnings, watches, forecasts, and observational data.</td>
</tr>
<tr>
<td><strong>SKYWARN®</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Sleet</strong></td>
<td>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.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>SOGs</td>
<td>Standard Operating Guidelines</td>
</tr>
<tr>
<td>Solar Flares</td>
<td>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.</td>
</tr>
<tr>
<td>Solar Wind</td>
<td>The outward flow of solar particles and magnetic fields from the Sun.</td>
</tr>
<tr>
<td>SOPs</td>
<td>Standard Operating Procedures</td>
</tr>
<tr>
<td>Space Weather</td>
<td>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.</td>
</tr>
<tr>
<td>SPC</td>
<td>Storm Prediction Center</td>
</tr>
<tr>
<td>SRL</td>
<td>Severe Repetitive Loss</td>
</tr>
<tr>
<td>Squall</td>
<td>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.</td>
</tr>
<tr>
<td>Squall Line</td>
<td>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.</td>
</tr>
<tr>
<td>Stationary Front</td>
<td>The boundary between cool and warm air masses that are not moving.</td>
</tr>
<tr>
<td>StormReady</td>
<td>A voluntary “grass roots” program sponsored by the National Weather Service that focuses on improving communication and severe weather preparedness in communities.</td>
</tr>
<tr>
<td>Storm Surge</td>
<td>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.</td>
</tr>
<tr>
<td>Sunspots</td>
<td>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.</td>
</tr>
<tr>
<td>Supercell Thunderstorm</td>
<td>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.</td>
</tr>
<tr>
<td>Surf</td>
<td>The waves in the area between the shoreline and the outermost limit of breakers.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Swell</td>
<td>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.</td>
</tr>
<tr>
<td>SWP</td>
<td>State Warning Point</td>
</tr>
<tr>
<td>SWPC</td>
<td>Space Weather Prediction Center</td>
</tr>
<tr>
<td>Temperature</td>
<td>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.</td>
</tr>
<tr>
<td>Thunderstorm</td>
<td>A storm with lightning and thunder, produced by a cumulonimbus cloud, usually producing gusty winds, heavy rain and sometimes hail.</td>
</tr>
<tr>
<td>Tidal Cycle</td>
<td>The periodic change in the intensity of tides that is caused primarily by the varying relations among the earth, moon, and sun.</td>
</tr>
<tr>
<td>Tornado</td>
<td>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.</td>
</tr>
<tr>
<td>Tornado Alley</td>
<td>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.</td>
</tr>
<tr>
<td>Tropical Cyclones</td>
<td>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.</td>
</tr>
<tr>
<td>Tropopause</td>
<td>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).</td>
</tr>
<tr>
<td>Troposphere</td>
<td>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.</td>
</tr>
<tr>
<td>Trough</td>
<td>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.</td>
</tr>
<tr>
<td>TPC</td>
<td>Tropical Prediction Center</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Tsunami</td>
<td>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.</td>
</tr>
<tr>
<td>TsunamiReady</td>
<td>A voluntary “grass roots” program sponsored by NOAA that focuses on improving communication and tsunami preparedness in communities.</td>
</tr>
<tr>
<td>TWC</td>
<td>Tsunami Warning Center</td>
</tr>
<tr>
<td>USACE</td>
<td>United States Army Corps of Engineers</td>
</tr>
<tr>
<td>USGS</td>
<td>United States Geological Survey</td>
</tr>
<tr>
<td>UTC</td>
<td>Coordinated Universal Time. The time in the 0° meridian time zone (Greenwich, England).</td>
</tr>
<tr>
<td>Volcanic Ash</td>
<td>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.</td>
</tr>
<tr>
<td>Wall Cloud</td>
<td>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.</td>
</tr>
<tr>
<td>Warm Front</td>
<td>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.</td>
</tr>
<tr>
<td>Warning</td>
<td>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.</td>
</tr>
<tr>
<td>Warning Communication</td>
<td>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.</td>
</tr>
<tr>
<td>Warning Coordination</td>
<td>Organized activity that occurs within the emergency management community to ensure that the message that is delivered is appropriate, consistent, and understandable.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Warning System</td>
<td>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.</td>
</tr>
<tr>
<td>Watch</td>
<td>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.</td>
</tr>
<tr>
<td>Waterspout</td>
<td>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).</td>
</tr>
<tr>
<td>WC/ATWC</td>
<td>West Coast/Alaska Tsunami Warning Center</td>
</tr>
<tr>
<td>WCM</td>
<td>Warning Coordination Meteorologist</td>
</tr>
<tr>
<td>Weather Forecast Office (WFO)</td>
<td>This type of National Weather Service office is responsible for issuing advisories, warnings, statements, and short term forecasts for its county warning area.</td>
</tr>
<tr>
<td>Weather Spotters</td>
<td>Volunteers that support the warning process with their observational data. They are often the first to report worsening weather conditions.</td>
</tr>
<tr>
<td>Weather Surveillance Radar 88 Doppler (WSR-88D)</td>
<td>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.</td>
</tr>
<tr>
<td>WFO</td>
<td>Weather Forecast Office</td>
</tr>
<tr>
<td>Wind</td>
<td>The movement of air due to pressure differences.</td>
</tr>
<tr>
<td>Wind Chill</td>
<td>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 &quot;feels&quot; for a certain combination of wind and air temperature.</td>
</tr>
<tr>
<td>Wind Chill Factor</td>
<td>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.</td>
</tr>
<tr>
<td>Wind Storm</td>
<td>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.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Wireless Emergency Alert (WEA)</td>
<td>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).</td>
</tr>
<tr>
<td>WRIP</td>
<td>Weather Radio Improvement Project</td>
</tr>
<tr>
<td>WSO</td>
<td>Weather Service Office</td>
</tr>
<tr>
<td>WSR-88D</td>
<td>Weather Surveillance Radar - 1988 Doppler. Also see NEXRAD.</td>
</tr>
<tr>
<td>Zulu Time</td>
<td>Same as UTC, Universal Coordinated Time. It is called Zulu because “Z” is often appended to the time to distinguish it from local time.</td>
</tr>
</tbody>
</table>
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  
- Best Practices for Outdoor Warning Sirens  
  [http://skywatch.org/ows.pdf](http://skywatch.org/ows.pdf) (610 kb download)
- Commercial Mobile Alert System  
- EMWIN  
- Enhanced Fujita Scale  
- Family of Service (FOS)  
  [http://www.nws.noaa.gov/datamgmt/fos/fosindex.html](http://www.nws.noaa.gov/datamgmt/fos/fosindex.html)
- FEMA Safe Room Information  
- HazCollect  
- Hurricane Evacuation Planning and Decision-Making  
- Integrated Public Alert and Warning System (IPAWS)  
- iNWS  
- National Hurricane Center  
- National Tsunami Hazard Mitigation Program (NTHMP)  
  [http://nthmp.tsunami.gov/index.html](http://nthmp.tsunami.gov/index.html)
Resources

- 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
- 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

- Wind Chill Index and Calculator

- Your Local NWS Weather Forecast Office and River Forecast Center

- Your State Climatologist
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
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
- New SPC Convective Outlook Tables

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.

\[
\text{RH} = \text{relative humidity} \quad \text{DP} = \text{dew point} \quad T = \text{temperature (ºF)}
\]

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

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.

[Click here to go back to Unit 3 Dew Point Exercises]
**Haines Index**
Forecasts 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.

<table>
<thead>
<tr>
<th>HAINES INDEX</th>
<th>RISK</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 or 3</td>
<td>Very low</td>
</tr>
<tr>
<td>4</td>
<td>Low</td>
</tr>
<tr>
<td>5</td>
<td>Moderate</td>
</tr>
<tr>
<td>6</td>
<td>High</td>
</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>Fujita Scale</th>
<th>Derived EF-Scale</th>
<th>Operational EF-Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>F Number</td>
<td>Fastest 1/4-mile (mph)</td>
<td>3 Second Gust (mph)</td>
</tr>
<tr>
<td>0</td>
<td>40-72</td>
<td>45-78</td>
</tr>
<tr>
<td>1</td>
<td>73-112</td>
<td>79-117</td>
</tr>
<tr>
<td>2</td>
<td>113-157</td>
<td>118-161</td>
</tr>
<tr>
<td>3</td>
<td>158-207</td>
<td>162-209</td>
</tr>
<tr>
<td>4</td>
<td>208-260</td>
<td>210-261</td>
</tr>
<tr>
<td>5</td>
<td>261-318</td>
<td>262-317</td>
</tr>
</tbody>
</table>

**Tropical Cyclone Categories**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>WIND SPEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical Depression</td>
<td>Maximum sustained winds near the surface less than 39 mph.</td>
</tr>
<tr>
<td>Tropical Storm</td>
<td>Winds of 39–73 mph.</td>
</tr>
<tr>
<td>Hurricanes or Typhoons</td>
<td>Winds of 74 mph or more.</td>
</tr>
</tbody>
</table>
Hazardous Weather and Flooding Preparedness

October 2013

APP-31

Charts and Tables

G0271

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.

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

Saffir-Simpson Hurricane Wind Scale

<table>
<thead>
<tr>
<th>Category</th>
<th>Winds</th>
<th>Effects</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>74-95 mph</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Two</td>
<td>96-110 mph</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Three</td>
<td>111-129 mph</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Four</td>
<td>130-156 mph</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Five</td>
<td>greater than 156 mph</td>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>
New SPC Convective Outlook Tables
(Update to pp. 69-70 of NWS Reference Guide Document)

Convective outlooks for days 1, 2, and 3 consist of categorical and probabilistic graphics that
depict severe and general thunderstorm threats across the continental United States, along with
a text narrative.

Understanding Severe Thunderstorm Risk Categories

Day 1 Outlook Probability to Category Conversion
### Day 2 Outlook Probability to Category Conversion

<table>
<thead>
<tr>
<th>Day 2 Outlook Probability</th>
<th>Combined TOR, WIND, HAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>MRGL</td>
</tr>
<tr>
<td>15%</td>
<td>SLGT</td>
</tr>
<tr>
<td>15% with Significant Severe</td>
<td>SLGT</td>
</tr>
<tr>
<td>30%</td>
<td>ENH</td>
</tr>
<tr>
<td>30% with Significant Severe</td>
<td>ENH</td>
</tr>
<tr>
<td>45%</td>
<td>ENH</td>
</tr>
<tr>
<td>45% with Significant Severe</td>
<td>MDT</td>
</tr>
<tr>
<td>60%</td>
<td>MDT</td>
</tr>
<tr>
<td>60% with Significant Severe</td>
<td>HIGH</td>
</tr>
</tbody>
</table>

### Day 3 Outlook Probability to Category Conversion

<table>
<thead>
<tr>
<th>Day 3 Outlook Probability</th>
<th>Combined TOR, WIND, HAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>MRGL</td>
</tr>
<tr>
<td>15%</td>
<td>SLGT</td>
</tr>
<tr>
<td>15% with Significant Severe</td>
<td>SLGT</td>
</tr>
<tr>
<td>30%</td>
<td>ENH</td>
</tr>
<tr>
<td>30% with Significant Severe</td>
<td>ENH</td>
</tr>
<tr>
<td>45%</td>
<td>ENH</td>
</tr>
<tr>
<td>45% with Significant Severe</td>
<td>MDT</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>WIND SPEED</th>
<th>PRECIPITATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinary</td>
<td>&lt; 35 knots (40 mph)</td>
<td>Variable</td>
</tr>
<tr>
<td>Approaching Severe</td>
<td>≥ 35 knots (40 mph)</td>
<td>Hail &gt; ¾ inch</td>
</tr>
<tr>
<td>Severe</td>
<td>≥ 50 knots (58 mph)</td>
<td>Hail ≥ 1 inch</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Longer-term</th>
<th>Shorter Timeframe</th>
<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convective Outlooks (Day 1, Day 2, Day 3, Day 4-8)</td>
<td>Severe Thunderstorm Watch</td>
<td></td>
</tr>
<tr>
<td>Public Weather Outlook</td>
<td>SPC Mesoscale Discussion</td>
<td></td>
</tr>
<tr>
<td>Hazardous Weather Outlook</td>
<td>Short-term Forecast</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Severe Thunderstorm Warning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Special Marine Warning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Special Weather Statement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Severe Weather Statement</td>
</tr>
</tbody>
</table>
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:

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

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.

<table>
<thead>
<tr>
<th>Longer-term</th>
<th>Shorter Timeframe</th>
<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convective Outlooks</td>
<td>Tornado Watch</td>
<td>Tornado Warning</td>
</tr>
<tr>
<td>Public Weather Outlook</td>
<td>Severe Thunderstorm Watch</td>
<td>Tornado Emergency</td>
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<tr>
<td>Hazardous Weather Outlook</td>
<td>SPC Mesoscale Discussion</td>
<td>Severe Thunderstorm Warning</td>
</tr>
<tr>
<td>Severe Weather Outlook</td>
<td>Short-term Forecast</td>
<td>Special Marine Warning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Special Weather Statement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Severe Weather Statement</td>
</tr>
</tbody>
</table>
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.
- Mudslides—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.

<table>
<thead>
<tr>
<th>Longer-term</th>
<th>Shorter Timeframe</th>
<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood Potential Outlook</td>
<td>Flash Flood Watch</td>
<td>Flash Flood Warning</td>
</tr>
<tr>
<td>Hydrologic Outlook</td>
<td>Hydrometeorological Discussion</td>
<td>Flash Flood Statement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urban &amp; Small Stream Flood Advisory</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Longer-term</th>
<th>Shorter Timeframe</th>
<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood Potential Outlook</td>
<td>Flood Watch</td>
<td>Flood Warning</td>
</tr>
<tr>
<td>Excessive Rain Outlook</td>
<td>Hydrometeorological Discussion</td>
<td>Flood Statement</td>
</tr>
<tr>
<td>Hydrologic Outlook</td>
<td></td>
<td>River Statement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>River Ice Statement</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Longer-term</th>
<th>Shorter-term/Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal Flood Watch</td>
<td>Coastal Flood Warning</td>
</tr>
<tr>
<td>Lakeshore Flood Watch</td>
<td>Coastal Flood Advisory</td>
</tr>
<tr>
<td>Short-term Forecast</td>
<td>Coastal Flood Statement</td>
</tr>
<tr>
<td></td>
<td>High Surf Warning</td>
</tr>
<tr>
<td></td>
<td>High Surf Advisory</td>
</tr>
<tr>
<td></td>
<td>Marine Weather Statement</td>
</tr>
<tr>
<td></td>
<td>Lakeshore Flood Warning</td>
</tr>
<tr>
<td></td>
<td>Lakeshore Flood Advisory</td>
</tr>
<tr>
<td></td>
<td>Lakeshore Flood Statement</td>
</tr>
<tr>
<td></td>
<td>Low Water Advisory</td>
</tr>
<tr>
<td></td>
<td>Rip Current Statement</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Category</th>
<th>Wind Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical Depression</td>
<td>Maximum sustained winds near the surface less than 39 mph (34 kt)</td>
</tr>
<tr>
<td>Tropical Storm</td>
<td>Winds of 39-73 mph (34-53 kt)</td>
</tr>
<tr>
<td>Hurricane</td>
<td>Winds of 74 mph (64 kt) or more</td>
</tr>
</tbody>
</table>

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°C) 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).

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**

<table>
<thead>
<tr>
<th>Text Products</th>
<th>Graphical Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hurricane Local Statement (HLS)</td>
<td>Graphic Hurricane Local Statement (gHLS)</td>
</tr>
<tr>
<td>Extreme Wind Warning (EWW)</td>
<td>Video Hurricane Local Statements (vHLS)</td>
</tr>
</tbody>
</table>
**National Hurricane Center (NHC) Products:**

<table>
<thead>
<tr>
<th>Text Products</th>
<th>Graphical Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical Depression Advisory</td>
<td>Tropical Cyclone Track Forecast Cone and Watches/Warnings</td>
</tr>
<tr>
<td>Tropical Storm Advisory</td>
<td>Wind Speed Probability</td>
</tr>
<tr>
<td>Hurricane/Typhoon Advisory</td>
<td>Storm Surge Probability</td>
</tr>
<tr>
<td>Tropical Cyclone Public Advisory</td>
<td>Tropical Cyclone Surface Wind Field</td>
</tr>
<tr>
<td>Tropical Cyclone Forecast Advisory</td>
<td>Tropical Cyclone Cumulative Wind History</td>
</tr>
<tr>
<td>Tropical Cyclone Discussion</td>
<td>Graphical Tropical Weather Outlook</td>
</tr>
<tr>
<td>Tropical Cyclone Wind Speed</td>
<td></td>
</tr>
<tr>
<td>Probabilities</td>
<td></td>
</tr>
<tr>
<td>Tropical Weather Outlook</td>
<td></td>
</tr>
<tr>
<td>Tropical Weather Discussion</td>
<td></td>
</tr>
</tbody>
</table>

**Multipurpose National Weather Service Products Often Used during Tropical Cyclones**

<table>
<thead>
<tr>
<th>Text Products</th>
<th>Graphical Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Information Statement (PNS)</td>
<td>Web graphics (point and click map, graphicasts, etc.)</td>
</tr>
<tr>
<td>Short Term Forecast (NOW)</td>
<td></td>
</tr>
<tr>
<td>Special Weather Statement (SPS)</td>
<td></td>
</tr>
<tr>
<td>Hazardous Weather Outlook (HWO)</td>
<td></td>
</tr>
<tr>
<td>Preliminary Post-Storm Report</td>
<td></td>
</tr>
</tbody>
</table>

**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**

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

**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.

<table>
<thead>
<tr>
<th>Longer-term</th>
<th>Shorter-term/Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter Storm Outlook</td>
<td>Winter Storm Warning</td>
</tr>
<tr>
<td>Winter Storm Watch</td>
<td>Heavy Snow Warning</td>
</tr>
<tr>
<td></td>
<td>Ice Storm Warning</td>
</tr>
<tr>
<td></td>
<td>Winter Weather Advisory</td>
</tr>
<tr>
<td></td>
<td>Short-term Forecast</td>
</tr>
<tr>
<td></td>
<td>Severe Weather Statement</td>
</tr>
</tbody>
</table>

October 2013
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.

<table>
<thead>
<tr>
<th>Longer-term</th>
<th>Shorter-term/Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter Storm Watch</td>
<td>Wind Chill Advisory</td>
</tr>
<tr>
<td></td>
<td>Wind Chill Warning</td>
</tr>
<tr>
<td></td>
<td>Short-term Forecast</td>
</tr>
<tr>
<td></td>
<td>Hard Freeze Warning</td>
</tr>
<tr>
<td></td>
<td>Extreme Cold Warning (regional)</td>
</tr>
</tbody>
</table>
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, "brownouts" 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.

<table>
<thead>
<tr>
<th>Longer-term</th>
<th>Shorter-term/Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive Heat Outlook</td>
<td>Excessive Heat Advisory</td>
</tr>
<tr>
<td>Excessive Heat Watch</td>
<td>Excessive Heat Warning</td>
</tr>
<tr>
<td></td>
<td>Short-term Forecast</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Type of Fog</th>
<th>Factors</th>
<th>Description</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Fog</td>
<td>• Clear nights</td>
<td>Heat radiates away from the ground, cooling the ground and surface air.</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>• Stable air (winds less than 5 mph or 4 kt)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Small temperature-dewpoint spread</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valley Fog</td>
<td>• Cold surface air and weak winter sun</td>
<td>Fog can build to a height of more than 1,500 ft (457 m). Weak sun</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>• May follow a winter storm or prolonged</td>
<td>might evaporate lower levels of the fog but leave upper levels in place.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>nighttime cooling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advection Fog</td>
<td>• Horizontal wind</td>
<td>Wind pushes warm humid air over the cold ground or water, where it</td>
<td>Advection fog can cover wide areas of the central U.S. in winter. It may be thick enough to close airports.</td>
</tr>
<tr>
<td></td>
<td>• Warm, humid air</td>
<td>cools to the dewpoint and forms fog.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Winter temperatures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of Fog</td>
<td>Factors</td>
<td>Description</td>
<td>Effects</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Upslope Fog</td>
<td>• Winds blowing up hills or mountains</td>
<td>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.</td>
<td>Upslope fog has similar impacts as other fog types in terms of reducing visibility.</td>
</tr>
<tr>
<td>Sea Smoke, Steam Fog</td>
<td>• Body of water</td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td>Precipitation Fog</td>
<td>• Warmer air</td>
<td>Precipitation fog forms on cool, rainy days. Some rain evaporates, and fog is formed when the air temperature reaches its dewpoint.</td>
<td>Precipitation fog can affect visibility for motorists and aircraft operations for as long as it persists.</td>
</tr>
<tr>
<td>Freezing Fog</td>
<td>• Sufficient conditions for fog formation</td>
<td>Freezing fog consists of supercooled water droplets that freeze on contact with exposed cold objects, including roadways, trees, and power lines.</td>
<td>Freezing fog forms a coating of rime or glaze and can lead to driving</td>
</tr>
<tr>
<td></td>
<td>• Air temperature below 32°F (0°C)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>Longer-term</th>
<th>Shorter-term/Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fog Outlook</td>
<td>Fog Advisory</td>
</tr>
<tr>
<td></td>
<td>Freezing Fog Advisory</td>
</tr>
<tr>
<td></td>
<td>Dense Fog Advisory</td>
</tr>
<tr>
<td></td>
<td>Fog Warning</td>
</tr>
<tr>
<td>Fog Watch</td>
<td>Short-term Forecasts</td>
</tr>
</tbody>
</table>
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:

<table>
<thead>
<tr>
<th>Factors</th>
<th>Large Scale, Nonconvective Events</th>
<th>Convective Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed of onset</td>
<td>Recognizable weather patterns are easily identified 24 to 36 hours in advance</td>
<td>Predictable over an area within 0 to 3 hours Specific locations identifiable only minutes in advance</td>
</tr>
<tr>
<td>Duration</td>
<td>3 to 4 hours up to 2 to 3 days, usually with nocturnal lulls</td>
<td>Microbursts - a few seconds Microbursts - a few minutes Larger system - up to two hours</td>
</tr>
<tr>
<td>Timing</td>
<td>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</td>
<td>Associated with late afternoon or evening thunderstorms, usually during the spring and summer</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Longer-term</th>
<th>Shorter-term/Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blowing Dust or Sand Outlook</td>
<td>Blowing Dust/Sand Advisory</td>
</tr>
<tr>
<td>Blowing Dust/Sand Watch</td>
<td>Blowing Dust/Sand Warning</td>
</tr>
<tr>
<td></td>
<td>Local Dust Storm Warning</td>
</tr>
<tr>
<td></td>
<td>Short-term Forecast</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Longer-term</th>
<th>Shorter-term/Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Wind Watch</td>
<td>High Wind Advisory</td>
</tr>
<tr>
<td></td>
<td>High Wind Warning</td>
</tr>
<tr>
<td></td>
<td>Short-term Forecast</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Haines Index</th>
<th>Risk of Large Fire Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 or 3</td>
<td>Very low</td>
</tr>
<tr>
<td>4</td>
<td>Low</td>
</tr>
<tr>
<td>5</td>
<td>Moderate</td>
</tr>
<tr>
<td>6</td>
<td>High</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Longer-term</th>
<th>Shorter-term/Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Weather Watch</td>
<td>Red Flag Warning</td>
</tr>
<tr>
<td>Fire Weather Discussion</td>
<td>Fire Weather Forecast</td>
</tr>
<tr>
<td>Extended Forecast</td>
<td>Spot Forecast</td>
</tr>
<tr>
<td>Rangeland and Fire Danger Statement</td>
<td></td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Radio Blackouts (R-scale)</th>
<th>Solar Radiation Storm (S-scale)</th>
<th>Geomagnetic Storming (G-scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray Flux Alert (R2), X-ray Flux Summary (R1 through R5)</td>
<td>Proton Flux Warning (S1-S5) Proton Flux Alert (S1-S5) Proton Flux Summary (S1-S5)</td>
<td>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)</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Longer-term or Information Only</th>
<th>Shorter-term/Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tsunami Information Statement</td>
<td>Tsunami Advisory</td>
</tr>
<tr>
<td>Tsunami Watch</td>
<td>Tsunami Warning</td>
</tr>
</tbody>
</table>

Hazardous Weather and Flooding Preparedness

October 2013

APP-69
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.

<table>
<thead>
<tr>
<th>Immediate Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volcano Warning</td>
</tr>
<tr>
<td>Volcanic Ash Advisory</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Immediate Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous Materials Warning</td>
</tr>
<tr>
<td>Radiological Hazard Warning</td>
</tr>
<tr>
<td>Shelter in Place Warning</td>
</tr>
<tr>
<td>Evacuation Immediate (issued when flammable or explosive gas release might result in casualties)</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Convective</th>
<th>Headline</th>
<th>Issuance Criteria</th>
<th>Typical Lead Time</th>
<th>VTEC Code</th>
<th>Product ID</th>
<th>Follow-up Product</th>
<th>Issued By</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Watches</strong></td>
<td><strong>Severe Thunderstorm Watch</strong></td>
<td>Conditions are favorable for thunderstorms containing 1 inch or larger hail and/or wind gusts of at least 58 mph (50 knots).</td>
<td>2 to 8 hours</td>
<td>SV.A</td>
<td>SELx</td>
<td>Watch County Notification</td>
<td>SPC (updates/cancellations issued by WFO)</td>
</tr>
<tr>
<td></td>
<td><strong>PDS Severe Thunderstorm Watch</strong></td>
<td>Conditions are favorable for widespread, significant, non-tornadic thunderstorms. Example: convective winds greater than 75mph (65knots). Note: &quot;PDS&quot; does not appear in the watch headline, but as a special line within the initial watch product.</td>
<td>2 to 8 hours</td>
<td>SV.A</td>
<td>SELx</td>
<td>Watch County Notification</td>
<td>SPC (updates/cancellations issued by WFO)</td>
</tr>
<tr>
<td></td>
<td><strong>Tornado Watch</strong></td>
<td>Conditions are favorable for thunderstorms producing tornadoes. Hail and strong winds are also possible.</td>
<td>2 to 8 hours</td>
<td>TO.A</td>
<td>SELx</td>
<td>Watch County Notification</td>
<td>SPC (updates/cancellations issued by WFO)</td>
</tr>
<tr>
<td></td>
<td><strong>PDS Tornado Watch</strong></td>
<td>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: &quot;PDS&quot; does not appear in the watch headline, but as a special line within the initial watch product.</td>
<td>2 to 8 hours</td>
<td>TO.A</td>
<td>SELx</td>
<td>Watch County Notification</td>
<td>SPC (updates/cancellations issued by WFO)</td>
</tr>
<tr>
<td>Headline</td>
<td>Issuance Criteria</td>
<td>Typical Lead Time</td>
<td>VTEC Code</td>
<td>Product ID</td>
<td>Follow-up Product</td>
<td>Issued By</td>
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<td></td>
</tr>
<tr>
<td><strong>Warnings</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe Thunderstorm Warning</td>
<td>A thunderstorm producing 1 inch or larger hail and/or wind gusts of at least 58 mph (50 knots) is occurring or imminent.</td>
<td>10 to 30 minutes</td>
<td>SV.W</td>
<td>SVR</td>
<td>Severe Weather Statement</td>
<td>Local WFO</td>
<td></td>
</tr>
<tr>
<td>Special Marine Warning</td>
<td>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.</td>
<td>30 to 90 minutes</td>
<td>MA.W</td>
<td>SMW</td>
<td>Marine Weather Statement</td>
<td>Local WFO</td>
<td></td>
</tr>
<tr>
<td>Tornado Warning</td>
<td>A tornado has been reported or is highly likely to occur based on Doppler radar signatures.</td>
<td>10 to 30 minutes</td>
<td>TO.W</td>
<td>TOR</td>
<td>Severe Weather Statement</td>
<td>Local WFO</td>
<td></td>
</tr>
<tr>
<td>Tornado Emergency</td>
<td>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,</td>
<td>10 to 30 minutes</td>
<td>TO.W</td>
<td>TOR</td>
<td>Severe Weather Statement</td>
<td>Local WFO</td>
<td></td>
</tr>
<tr>
<td><strong>Advisories</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significant Weather Advisory</td>
<td>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.</td>
<td>Up to 1 hour</td>
<td>N/A</td>
<td>SPS</td>
<td>Special Weather Statement</td>
<td>Local WFO</td>
<td></td>
</tr>
<tr>
<td>Headline</td>
<td>Issuance Criteria</td>
<td>Typical Lead Time</td>
<td>VTEC Code</td>
<td>Product ID</td>
<td>Follow-up Product</td>
<td>Issued By</td>
<td></td>
</tr>
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<td>------------------------</td>
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<td></td>
</tr>
<tr>
<td><strong>Watches</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash Flood Watch</td>
<td>Rapidly developing and life-threatening flooding is possible due to a hydrologic event (e.g., heavy rain) or dam or levee failure.</td>
<td>6 to 24 hours</td>
<td>FF.A</td>
<td>FFA</td>
<td>Flash Flood Watch</td>
<td>Local WFO</td>
<td></td>
</tr>
<tr>
<td>Flood Watch</td>
<td><strong>Flood Watch (Areal):</strong> Flooding of land and/or rivers and streams is possible. <strong>Flood Watch (Forecast Point):</strong> Flooding is possible at a particular point on a river or stream.</td>
<td>6 to 48 hours</td>
<td>FA.A (areal), FL.A (forecast point)</td>
<td>FFA</td>
<td>Flood Watch</td>
<td>Local WFO</td>
<td></td>
</tr>
<tr>
<td><strong>Warnings</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Flash Flood Warning</td>
<td>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)</td>
<td>30 minutes to 2 hours</td>
<td>FF.W</td>
<td>FFW</td>
<td>Flash Flood Statement</td>
<td>Local WFO</td>
<td></td>
</tr>
<tr>
<td>Hydrology</td>
<td>Headline</td>
<td>Issuance Criteria</td>
<td>Typical Lead Time</td>
<td>VTEC Code</td>
<td>Product ID</td>
<td>Follow-up Product</td>
<td>Issued By</td>
</tr>
<tr>
<td>-----------</td>
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<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td><strong>Warnings</strong></td>
<td>Flash Flood Warning, continued</td>
<td>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.</td>
<td>30 minutes to 2 hours</td>
<td>FF.W</td>
<td>FFW</td>
<td>Flash Flood Statement</td>
<td>Local WFO</td>
</tr>
<tr>
<td></td>
<td>Flash Flood Emergency</td>
<td>In exceedingly rare situations, when a severe threat to human life and catastrophic damage from a flash flood is imminent or ongoing.</td>
<td>30 minutes to 3 hours</td>
<td>FF.W</td>
<td>FFW</td>
<td>Flash Flood Statement</td>
<td>Local WFO</td>
</tr>
<tr>
<td></td>
<td>Flood Warning</td>
<td>Human life and catastrophic damage from a flood is imminent or ongoing.</td>
<td>6 to 12 hours</td>
<td>FA.W</td>
<td>FL.W (areal), FLW (forecast point)</td>
<td>Flood Statement</td>
<td>Local WFO</td>
</tr>
<tr>
<td><strong>Advisories</strong></td>
<td>Flood Advisory</td>
<td><strong>Flood Advisory (Areal/Forecast Point/Urban and Small Stream):</strong> Issued when flooding is expected to be of inconvenience, but not necessarily life-threatening.</td>
<td>30 minutes to 2 hours</td>
<td>FA.Y</td>
<td>FLS</td>
<td>Flood Statement</td>
<td>Local WFO</td>
</tr>
</tbody>
</table>

**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.

**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.

**Flood Warning**
Human life and catastrophic damage from a flood is imminent or ongoing.

**Flood Advisory (Areal/Forecast Point/Urban and Small Stream):** Issued when flooding is expected to be of inconvenience, but not necessarily life-threatening.
Example: Severe Thunderstorm Watch

SEL9

URGENT - IMMEDIATE BROADCAST REQUESTED
Severe Thunderstorm Watch Number 299
NWS Storm Prediction Center Norman OK
1240 PM EDT Tue May 30 2017

The NWS Storm Prediction Center has issued a

* Severe Thunderstorm Watch for portions of
  Central and Western New York
  Central and Western Pennsylvania

* Effective this Tuesday afternoon and evening from 1240 PM until 800 PM EDT.

* Primary threats include...
  Scattered large hail and isolated very large hail events to 2
  inches in diameter possible
  Scattered damaging wind gusts to 70 mph possible
  A tornado or two possible

SUMMARY...Scattered thunderstorms will continue to develop across
the watch area this afternoon and early evening, posing a risk of
hail and damaging winds in the strongest cells.

The severe thunderstorm watch area is approximately along and 75
statute miles east and west of a line from 45 miles south southwest
of Altoona PA to 55 miles north of Syracuse NY. For a complete
depiction of the watch see the associated watch outline update
(WOUS64 KWNS WOU9).

PRECAUTIONARY/PREPAREDNESS ACTIONS...

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.

AVIATION...A few severe thunderstorms with hail surface and aloft to
2 inches. Extreme turbulence and surface wind gusts to 60 knots. A
few cumulonimbi with maximum tops to 450. Mean storm motion vector
25030.

...Hart
Example: Tornado Warning

826
WFUS51 KCTP 191727
TORCTP
PAC041-043-071-075-107-133-191815-
/O.NEW.KCTP.TO.W.0009.170619T1727Z-170619T1815Z/

BULLETIN - EAS ACTIVATION REQUESTED
Tornado Warning
National Weather Service State College PA
127 PM EDT MON JUN 19 2017

The National Weather Service in State College PA has issued a
*Tornado Warning for...
Northwestern Lancaster County in south central Pennsylvania...
South central Schuylkill County in central Pennsylvania...
Northwestern York County in south central Pennsylvania...
Southeastern Dauphin County in south central Pennsylvania...
East central Cumberland County in south central Pennsylvania...
Lebanon County in south central Pennsylvania...

* Until 215 PM EDT

* At 126 PM EDT, a severe thunderstorm capable of producing a tornado
was located over Dillsburg, moving northeast at 35 mph.

HAZARD...Tornado and quarter size hail.
SOURCE...Radar indicated rotation.
IMPACT...Flying debris will be dangerous to those caught without
shelter. Mobile homes will be damaged or destroyed.
Damage to roofs, windows, and vehicles will occur. Tree
damage is likely.

* This dangerous storm will be near...
Mechanicsburg and Siddonsburg around 130 PM EDT.
New Cumberland, Lower Allen, Lemoyne, Camp Hill, Valley Green,
Shiremanstown and Wormleysburg around 140 PM EDT.
Middletown, Hummelstown, Steelton, Progress, Colonial Park,
Highspire, Royalton, Bressler-Enhaut-Oberlin, Rutherford and
Lawnton around 150 PM EDT.
Hershey, Elizabethtown, Campbelltown, Lawn and Skyline View around
200 PM EDT.
Other locations impacted by this tornadic thunderstorm include York Haven, Three Mile Island, Deer Lake, Mount Gretna, Reinholds, Ono, Schoeneck, Lewisberry, Goldsboro and Avon Heights.

This includes the following Interstates...
The Pennsylvania Turnpike from mile markers 234 to 285.
Interstate 78 from mile markers 0 to 8.
Interstate 81 from mile markers 87 to 89.
Interstate 83 from mile markers 26 to 48.
Interstate 283 from mile markers 0 to 2.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

TAKE COVER NOW! Move to a basement or an interior room on the lowest floor of a sturdy building. Avoid windows. If you are outdoors, in a mobile home, or in a vehicle, move to the closest substantial shelter and protect yourself from flying debris.

LAT...LON 3998 7700 4002 7702 4003 7707 4006 7711
  4013 7716 4065 7607 4058 7603 4058 7607
  4053 7617 4051 7635 4042 7632 4036 7620
  4024 7604
TIME...MOT...LOC 1726Z 237DEG 37KT 4010 7701

TORNADO...RADAR INDICATED
HAIL...1.00IN

$$

Grumm/Dangelo
Example: Urban and Small Stream Flood Advisory

129
WGUS81 KCTP 150032
FLSCTP
Flood Advisory
National Weather Service State College PA
832 PM EDT FRI JUL 14 2017
PAC041-043-150330-/O.NEW.KCTP.PA.Y.0072.170715T0032Z-170715T0330Z/
/00000.N.ER.000000T0000Z.000000T0000Z.000000T0000Z.OO/
Dauphin PA-York PA-Cumberland PA-832 PM EDT FRI JUL 14 2017
The National Weather Service in State College PA has issued a
* Urban and Small Stream Flood Advisory for... Southwestern Dauphin County in south central Pennsylvania...
   Northwestern York County in south central Pennsylvania...
   Northeastern Cumberland County in south central Pennsylvania...
* Until 1130 PM EDT
* At 831 PM EDT, Doppler radar indicated heavy rain due to thunderstorms. This will cause urban and small stream flooding in the advisory area. Up to one inch of rain has already fallen over eastern Cumberland County. The heavy rain will move into the Harrisburg metropolitan area, and widespread minor flooding of poor drainage areas is expected.

* Some locations that will experience flooding include...
   Mechanicsburg, Camp Hill, Colonial Park, Middletown, Harrisburg, New Cumberland, Linglestown, Lower Allen, Progress and Steelton.

PRECAUTIONARY/PREPAREDNESS ACTIONS...
Turn around, don't drown when encountering flooded roads. Most flood deaths occur in vehicles.

Please report flooding to your local law enforcement agency when you can do so safely.

&

LAT...LON 4029 7713 4030 7710 4031 7697 4034 7691
   4036 7675 4018 7668 4012 7703

$$
DeVoir
Example: Flash Flood Watch

209
WGUS61 KPbz 302133
FFAPBZ

URGENT - IMMEDIATE BROADCAST REQUESTED
Flash Watch
National Weather Service Pittsburgh PA
533 PM EDT Fri Jun 30 2017

PAZ007-008-013-010800-
/O.NEW.KPBZ.FF.A.0005.170630T2200Z-170701T0800Z/
/00000.0.ER.000000T0000Z.000000T0000Z.000000T0000Z.0O/
Mercer-Venango-Lawrence-
Including the cities of Sharon, Hermitage, Grove City, Oil City, Franklin, New Castle, and Ellwood City
533 PM EDT Fri Jun 30 2017

...FLASH FLOOD WATCH IN EFFECT UNTIL 4 AM EDT SATURDAY...

The National Weather Service in Pittsburgh has issued a


* Until 4 AM EDT Saturday

* Scattered showers and thunderstorms will develop after 6 PM and quickly become more numerous and heavy.

* Successive rounds of heavy showers and thunderstorms are expected through much of the night in the area, leading for an increased risk of flash flooding, especially after the heavy rainfall received in some areas on Thursday evening.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A Flash Flood Watch means that conditions may develop that lead to flash flooding. Flash flooding is a VERY DANGEROUS SITUATION.

You should monitor later forecasts and be prepared to take action should Flash Flood Warnings be issued.

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Appendix F: NWS Pennsylvania Resources

This section contains information on resources for Pennsylvania Emergency Managers to utilize outside this course.
Map: Pennsylvania NWS Weather Forecast Offices and Warning Coordination Meteorologist Contacts
Local National Weather Service Weather Forecast Offices are your primary point of contact for county specific weather and climate information.

- **National Weather Service – Binghamton, NY**
  - Bradford, Lackawanna, Luzerne, Pike, Susquehanna, Wayne and Wyoming counties
  - [http://www.weather.gov/bgm/](http://www.weather.gov/bgm/)

- **National Weather Service – State College, PA**
  - Adams, Bedford, Blair, Cambria, Cameron, Centre, Clearfield, Clinton, Columbia, Cumberland, Dauphin, Elk, Franklin, Fulton, Huntingdon, Juniata, Lancaster, Lebanon, Lycoming, McKean, Mifflin, Montour, Northumberland, Perry, Potter, Schuylkill, Snyder, Somerset, Sullivan, Tioga, Union, York and Warren counties
  - [http://www.weather.gov/ctp/](http://www.weather.gov/ctp/)

- **National Weather Service – Mounty Holly, NJ**
  - Berks, Bucks, Carbon, Chester, Delaware, Lehigh, Monroe, Montgomery, Northampton and Philadelphia counties

- **National Weather Service – Pittsburgh, PA**
  - Allegheny, Armstrong, Beaver, Butler, Clarion, Fayette, Forest, Greene, Indiana, Jefferson, Lawrence, Mercer, Venango, Washington and Westmoreland counties
  - [http://www.weather.gov/pbz/](http://www.weather.gov/pbz/)

- **National Weather Service – Cleveland, OH**
  - Crawford and Erie counties
  - [http://www.weather.gov/cle/](http://www.weather.gov/cle/)

Additional pertinent information can be found on these websites:

  - Excessive Rain Outlooks

- **Storm Prediction Center** – [http://www.spc.noaa.gov/](http://www.spc.noaa.gov/)
  - Severe Weather Outlooks

- **Climate Prediction Center** – [http://www.cpc.ncep.noaa.gov/](http://www.cpc.ncep.noaa.gov/)

Information can be found on rivers and hydrology through the River Forecast Centers:

- Mid-Atlantic River Forecast Center – http://www.weather.gov/marfc/
- Ohio River Forecast Center – http://www.weather.gov/ohrfc/

Climatology information can be found using the following resources:

- Pennsylvania State Climatologist – http://climate.met.psu.edu/  Phone: 814-865-8732
- National Centers for Environmental Information (NCEI) – https://www.ncei.noaa.gov/
- Climate.gov – https://www.climate.gov/
- Storm Prediction Center – http://www.spc.noaa.gov/climo/online/
- National Hurricane Center – http://www.nhc.noaa.gov/climo/

Additional information can be found through the following resources:

- Flood Insurance Rate Maps (FIRMs) – http://www.pafloodmaps.com/
  - PA Department of Community & Economic Development
- FEMA Flood Map Service Zone – https://msc.fema.gov/portal
  - US Geological Survey
  - National Operational Hydrologic Remote Sensing Center