S-190 Unit 6: Critical Fire Weather

Summary:

Some of the risk involved in fire suppression can be reduced if firefighters understand critical weather events, such as thunderstorms, cold fronts, foehn winds, and the impact they have on fire behavior.

Incident Position Description (IPD) Alignment:

This unit aligns with the following FFT2 IPD specific duties (https://www.nwcg.gov/positions/fft2/position-ipd):

- Apply the knowledge of fuels, terrain, weather, and fire behavior to decisions and actions.

Objectives:

Students will be able to:

- Describe critical fire weather conditions.
- Describe critical fire weather events such as cold fronts, thunderstorms, foehn winds, and other local phenomenon that can impact fire behavior.

Unit at a Glance:

Topic	Method	Duration
Unit Introduction	Presentation	5 Minutes
Critical Fire Weather Conditions	Presentation	15 Minutes
Critical Fire Weather Events	Presentation	40 Minutes
Total Unit Duration		**60 Minutes**

Materials:

- *Incident Response Pocket Guide (IRPG)*, PMS 461, https://www.nwcg.gov/publications/461.
- *NWCG Glossary of Wildland Fire*, PMS 205, https://www.nwcg.gov/glossary/a-z.
- Notebooks for participants.
- Ability to display images and video on large screen.
- White board or easel access for group breakout.

Slide 1


S-190 Unit 6: Critical Fire Weather
S-190 Unit 6: Critical Fire Weather
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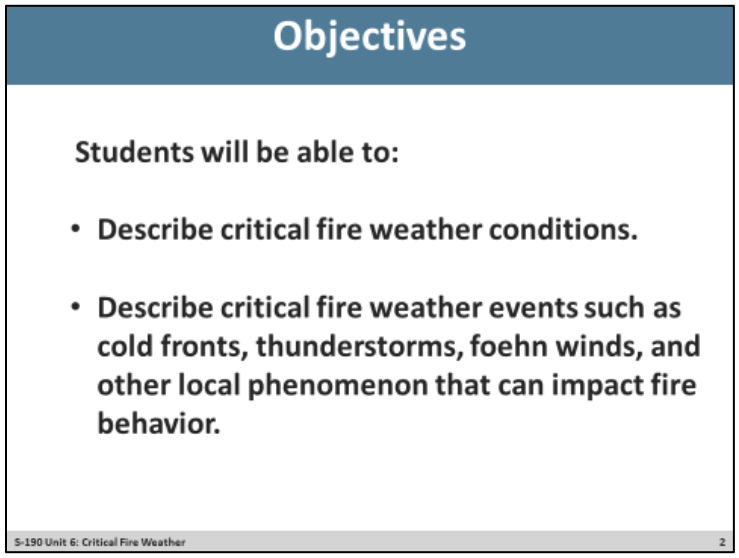
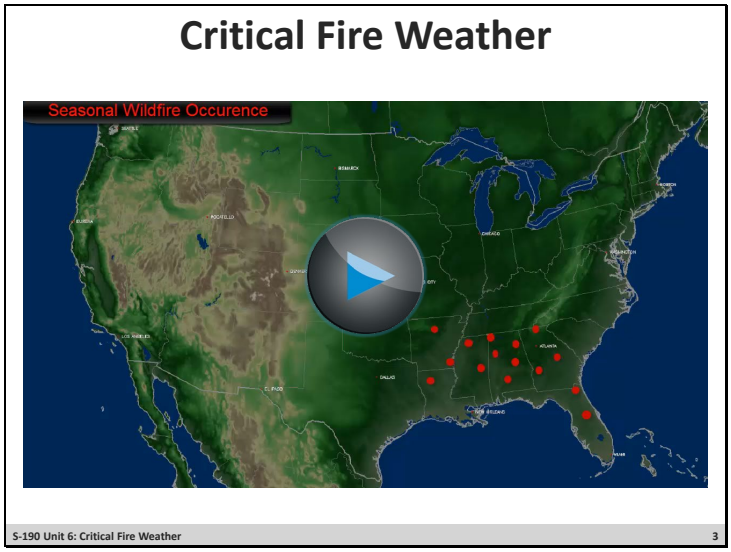
Slide 2



❑ Review unit objectives.

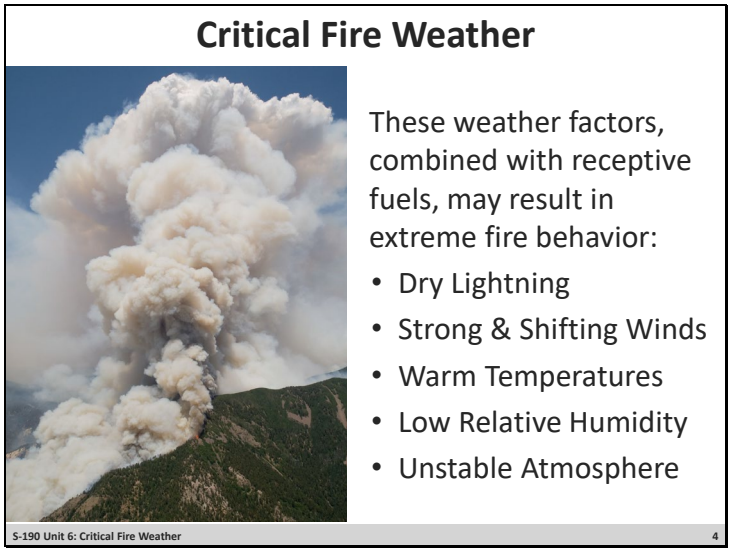
Slide 3



- ❑ **Play Video**

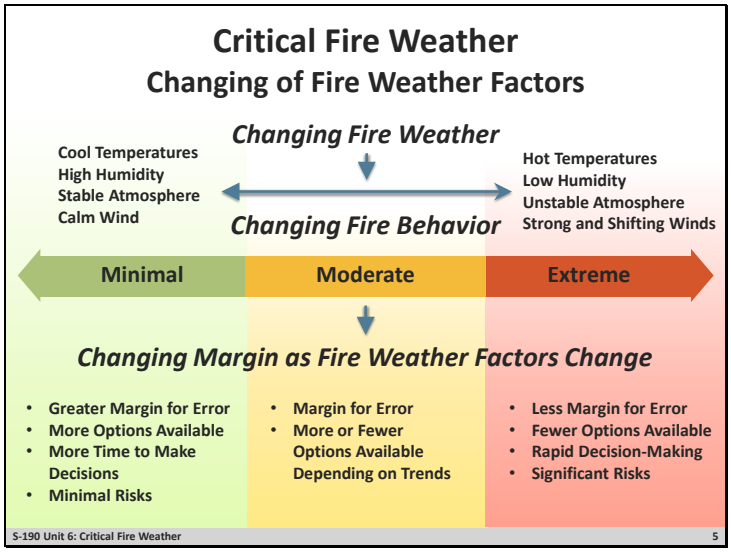
  Title Critical Fire Weather
  Summary Description of how geographic area, time of year, and weather contribute to critical fire weather patterns.
  Time (01:08)
  Audio

Slide 4



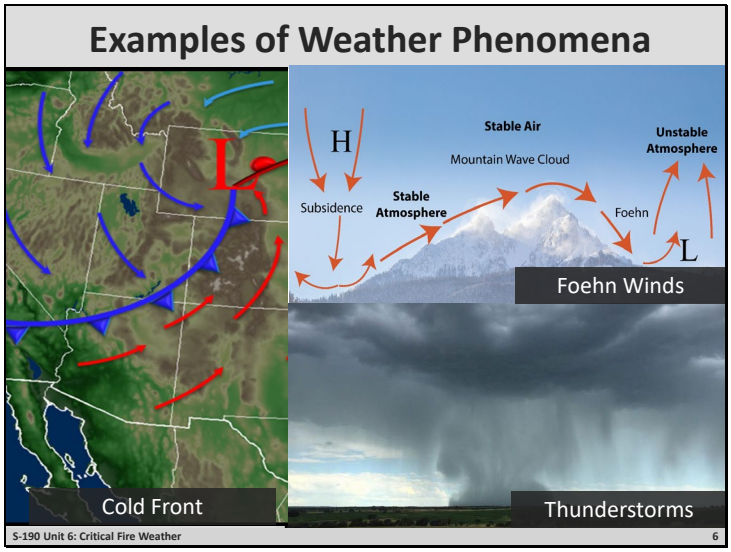
- ❑ Reference Lightning Activity Level (LAL) in the Incident Response Pocket Guide (IRPG), PMS 461, https://nwcg.gov/publications/461.
- If fuels are receptive, an interaction with critical fire weather factors can result in extreme fire behavior.

Slide 5



- It's important to recognize that changing fire weather conditions can result in changes in the environment and fire behavior.
- As changes occur in the fire environment, so does the margin of error for adapting and reacting to those changes.
- Firefighters should be aware of changing weather conditions from morning to afternoon, some of which may be extreme:
  - For example, cool temperatures, high humidity, a stable atmosphere, and calm winds may be present in the morning, but hot temperatures, low humidity, an unstable atmosphere, and strong winds may come ahead of a cold front in the afternoon.
  - In this example, the margin for error will decrease during the day as fewer options and less time cause rapid decision-making and a significant increase in risks.

Slide 6



- ❑ Discuss characteristics of these phenomena relative to the local area where the course is being presented.

Note to Instructor

This is just an introduction to the names of these critical fire weather phenomena. Each will be discussed in more detail in this unit.

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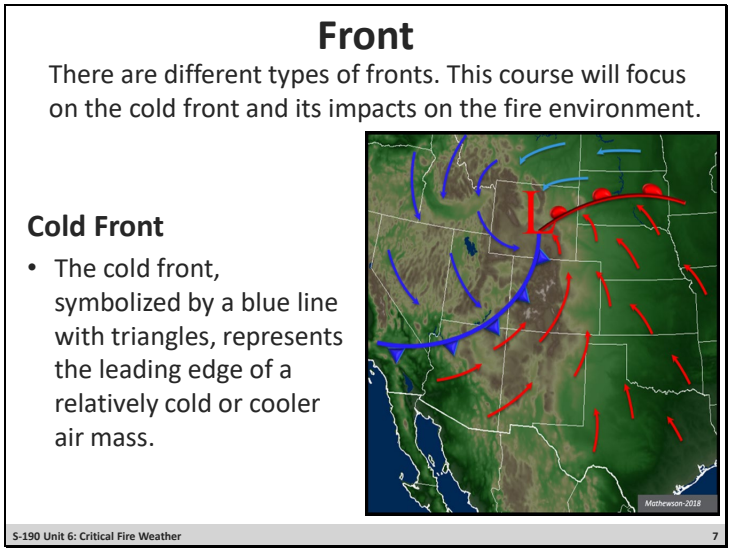
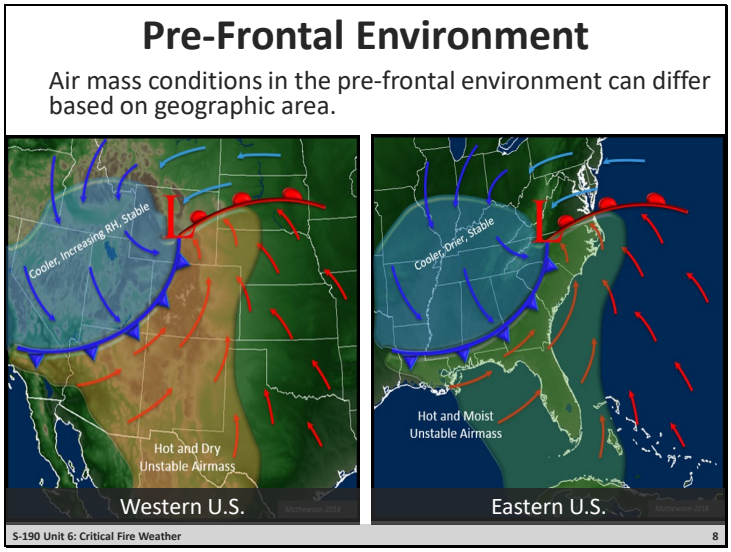


- An approaching cold front can quickly change the fire environment by producing:
  - Strong and shifting winds.
  - Warm and sometimes dry air mass.
  - Unstable conditions.
- Historically, firefighter fatalities have occurred during a pre-frontal environment where winds are strong and shifting and the atmosphere is unstable.

❑ Reference the Common Denominators of Fire Behavior on Tragedy Fires in the *Incident Response Pocket Guide (IRPG)*, PMS 461, https://www.nwcg.gov/publications/461.

Slide 8



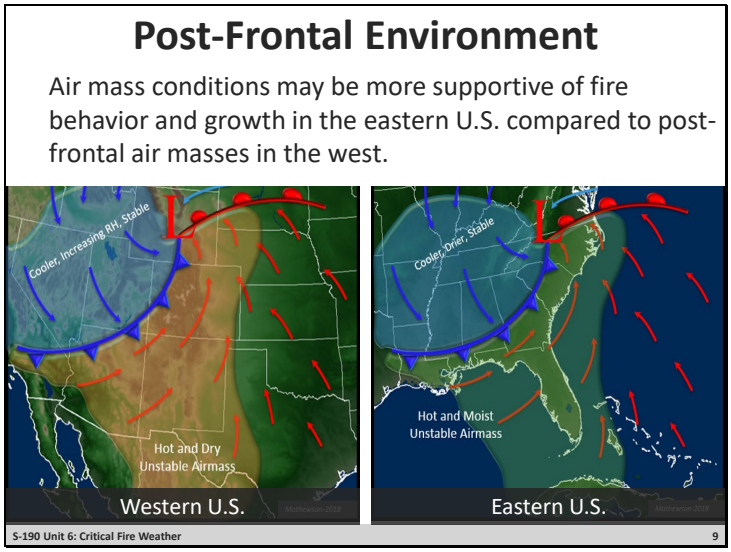
In the western U.S.:

- Usually very warm and dry air ahead of the front. This air typically comes from the desert southwest, creating a dry environment.
- Unstable air mass ahead of the front.
- Overall, the air mass is supportive of an increase in fire behavior.

In the eastern U.S.:

- Warm and moist conditions typically develop ahead of the front. This air typically comes from the Gulf of Mexico, creating a moist environment.
- Overall, the air mass is not supportive of an increase in fire behavior.

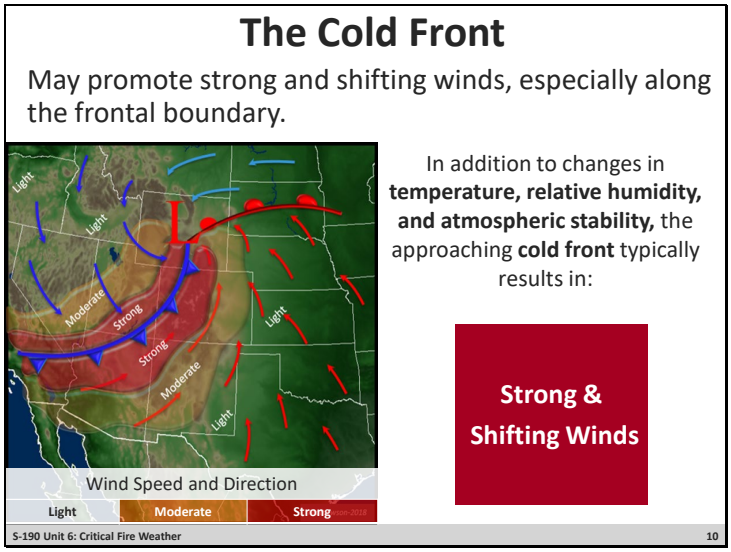
Slide 9



Common post-frontal air mass conditions:

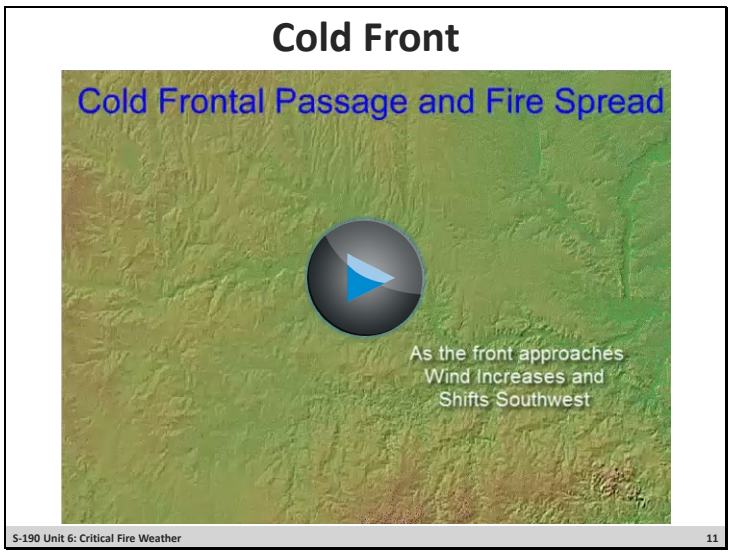
- Air mass behind the front tends to be more stable than the air mass ahead of the cold front.
- Temperatures are cooler.
- Relative humidity is higher.

Slide 10



- Winds associated with the passage of a cold front are dangerous, due to the strength of the wind and shift in wind direction as the front approaches and passes through the area.
- These strong and shifting winds occur along the frontal boundary and are a result of a strong pressure/temperature gradient between the different air masses.

Slide 11



Pre-Video Discussion

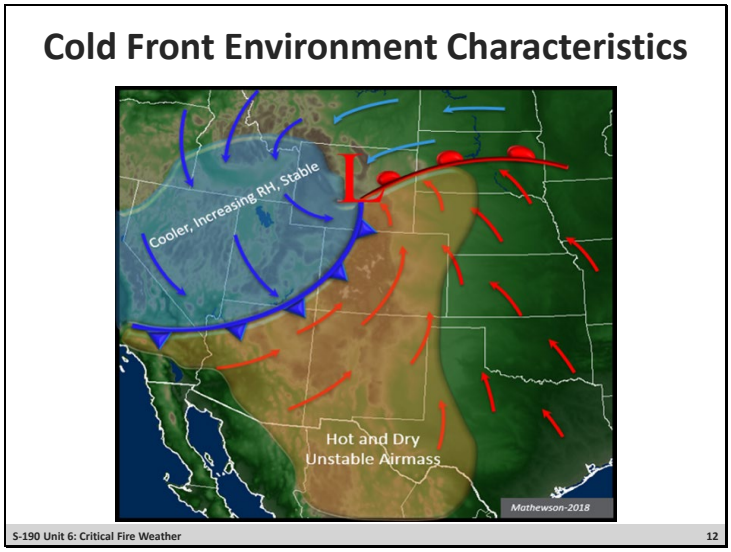
What to expect from a cold front passage:

- 150 miles ahead of the front
  - Wind is usually light and from the southeast direction.
  - Fire behavior may be active in this environment but predictable.
- 50-100 miles ahead of the front
  - As the front approaches, wind speed increases, and shifts from the southwest.
  - Wind speed may range from 15 to 30 mph, but could be stronger.
  - Fire behavior could significantly increase.
- Frontal Passage
  - Wind typically shifts northwest but remains strong (15 to 30 mph) until the front pushes further east.
  - Expect a gradual decrease in fire behavior as temperature decrease and relative humidity increases.

❑ **Play Video**

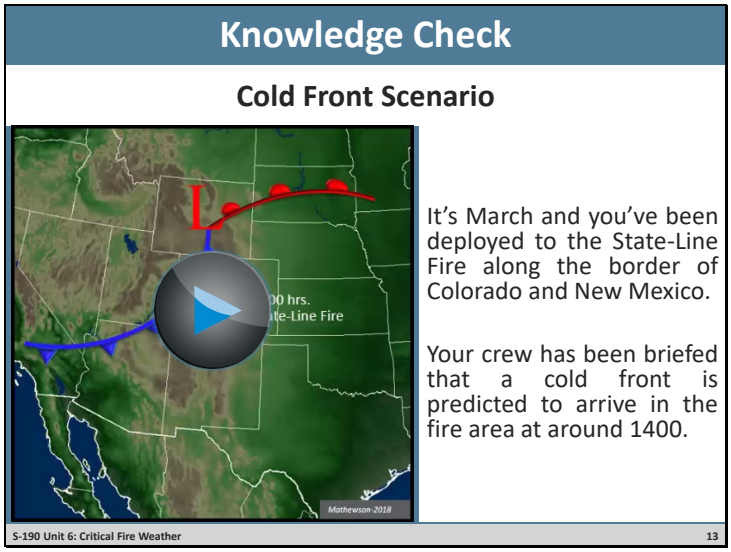
Title Cold Front Passage and Fire Spread
Summary Animation of a cold front moving toward a fire and shifting the wind from northeast to southwest.
Time (00:08)
No Audio

Slide 12



- Increasing winds along the leading edge and just behind the front.
- Pre-frontal conditions are hot, dry, and, unstable – favorable for extreme fire behavior.
- Extreme fire behavior may continue for a short period as the front moves through or when temperature decreases and relative humidity increases.

Slide 13



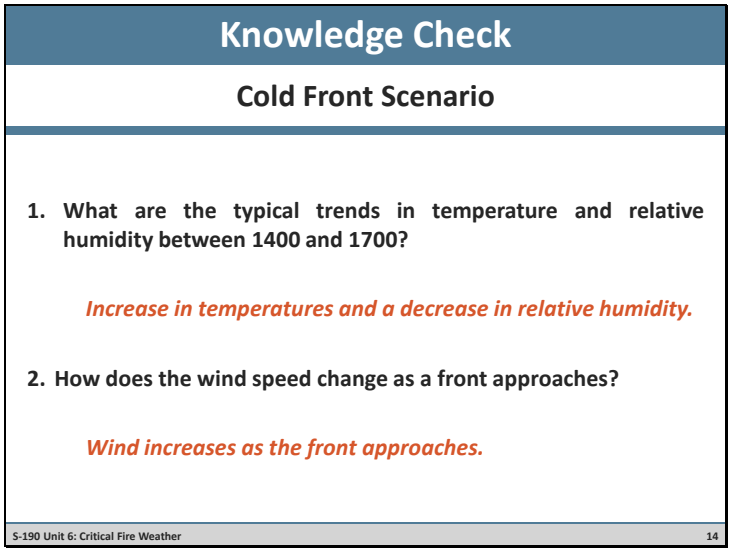
- ❑ **Play Video**

  Title Cold Front Scenario
  Summary Animation of a weather map showing a cold front moving over the western states.
  Time (00:03)
  No Audio

Note to Instructor

Students will answer questions on the next two slides based on when the front is predicted to arrive in the area.

Slide 14



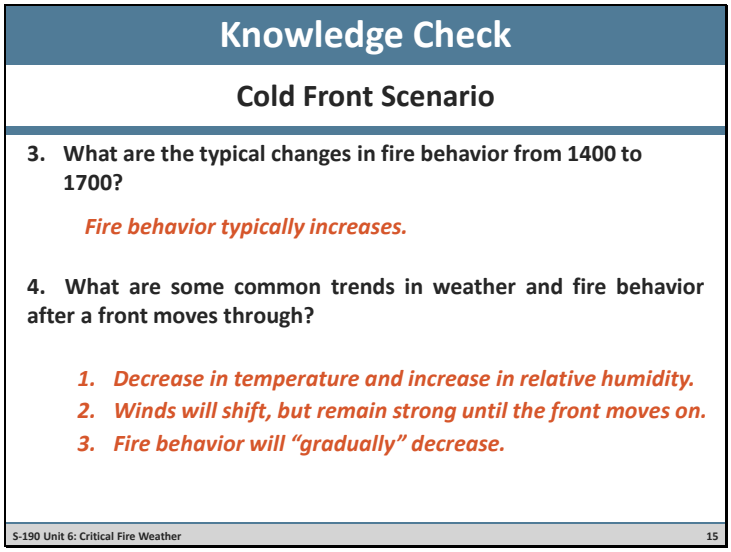
Question 1: What are the typical trends in temperature and relative humidity between 1400 and 1700?

Answer: Increase in temperatures and a decrease in relative humidity.

Question 2: How does wind-speed change as a front approaches?

Answer: Wind increases as the front approaches.

Slide 15



Question 3: What are the typical changes in fire behavior between 1400 and 1700?

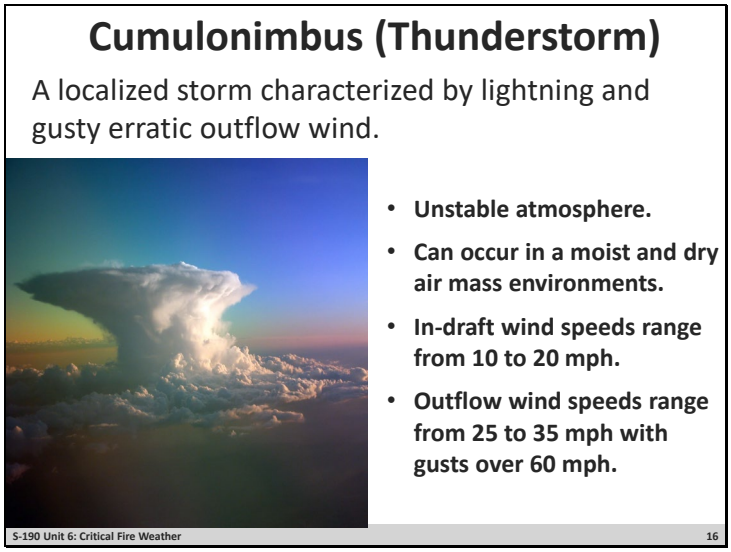
Answer: Fire behavior typically increases.

Question 4: What are some common trends in weather and fire behavior after a front moves through?

Answers:

- *Decrease in temperature and increase in relative humidity.*
- *Winds will shift, but remain strong until the front moves on.*
- *Fire behavior will gradually decrease.*

Slide 16



- Thunderstorms are usually of short duration, seldom more than 2 to 3 hours.
- The direction of thunderstorm movement is generally in the direction of the winds aloft.
- The direction of movement can be determined by the direction the anvil shaped top is pointing.

❑ Reference Thunderstorm Safety in the *Incident Response Pocket Guide (IRPG)*, PMS 461, https://www.nwcg.gov/publications/461.

Slide 17

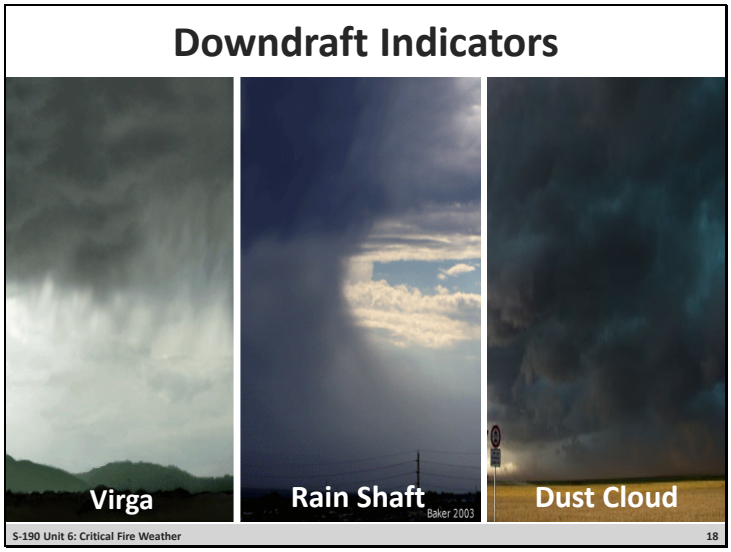
Pre-Video Discussion

- Characteristics of a thunderstorm can include:
  - Strong winds.
  - Heavy rain.
  - Hail.
- Downdrafts are a primary concern.
  - The winds generated by a downdraft reach the ground and spread radially in all directions.
  - Downdraft wind velocities will often be 25 to 35 mph and can reach as high as 70 mph.

❑ **Play Video**

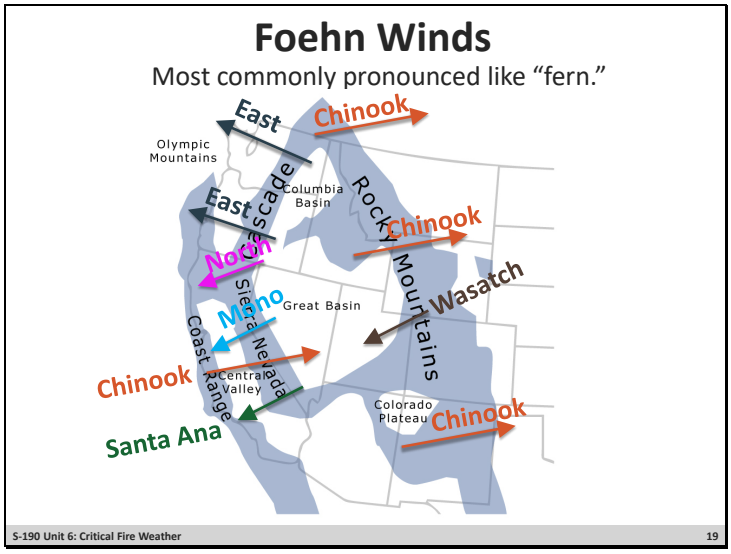
Title Thunderstorm Characteristics
Summary Time lapse of a thunderstorm moving over a valley.
Time (00:49)
No Audio

Slide 18



- Virga is precipitation falling out of a cloud but evaporating before reaching the ground.
- A rain shaft is a dark vertical shaft of heavy rain, localized over a small area. Unlike virga, the precipitation reaches the ground.
- Dust clouds are a result of an incoming front stirring up the sediment from the ground and creating a dust cloud that will travel in front of the incoming front.
- As a front moves in, if rain drops are felt, the downdraft has begun.

Slide 19

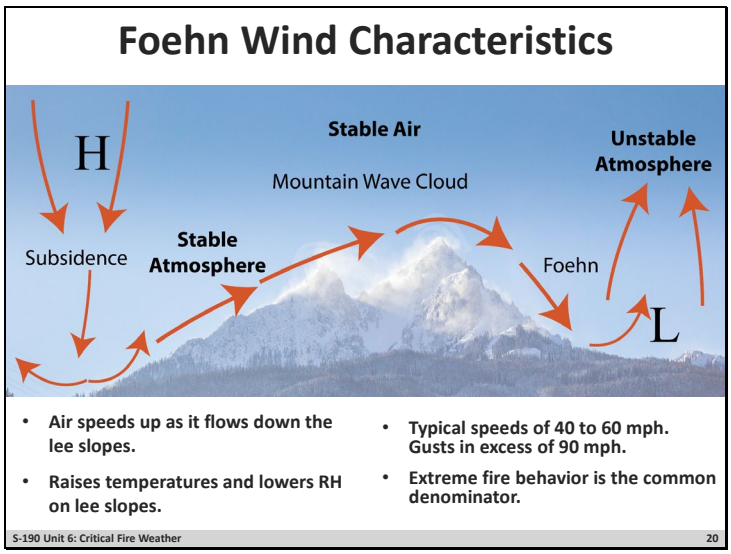


- Strong, dry winds caused by the compression of air as it flows down the lee side of a mountain range.
- The names of the most common vary from one location to the next. The Santa Ana winds are one of the more famous winds, producing extreme fire behavior in southern California.
- Foehn winds can persist for days and frequently reach speeds of 40 to 60 mph but can be as high as 90 mph.
- Relative humidity will usually drop with the arrival of foehn winds.
- The combination of high wind speeds and low relative humidity can cause high rates of fire spread.

Note to Instructor

The pronunciation can be best described as 'fern' with a slightly weaker 'r'.

Slide 20

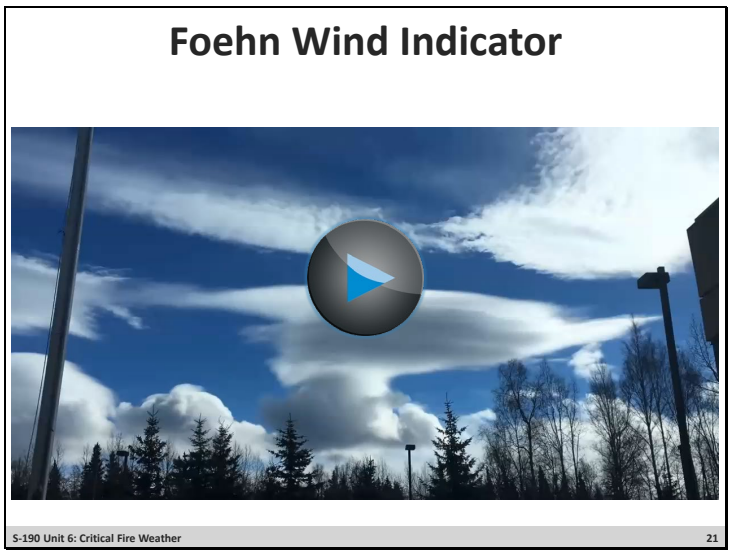


Question: What causes air to move down the lee side of the mountain range?

Answer:

- *Foehn winds occur under high pressure and stable conditions.*
- *The air parcel on the windward side of the mountain range is forced up to the top of the ridge.*
- *When the air gets to the top of the ridge, it wants to return back to its original elevation and does so on the lee side of the mountain.*
- *The air quickly moves down the slope at speeds ranging from 40 to 60 mph (strong wind).*

Slide 21



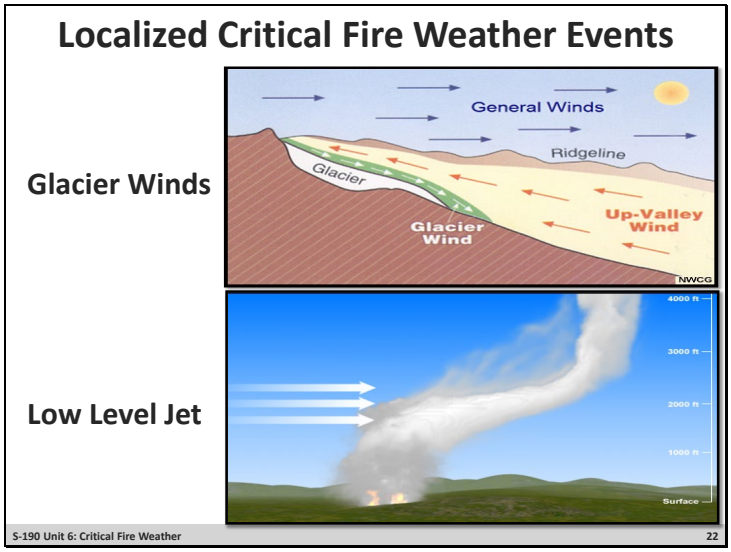
Pre-Video Discussion

- Wave Clouds (Altocumulus Standing Lenticular) are indicators of a foehn wind event occurring.

❑ **Play Video**

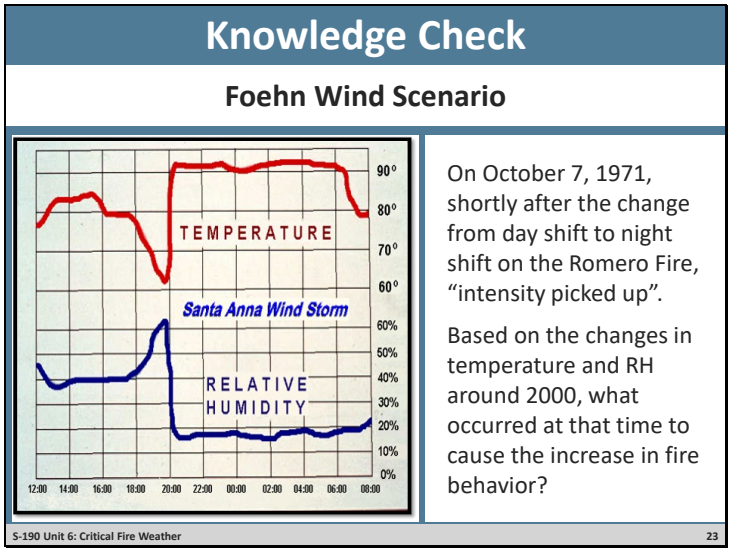
Title Foehn Wind Indicator
Summary Time lapse of clouds indicating foehn winds.
Time (00:09)
No Audio

Slide 22



- In addition to foehn winds, there are other localized weather events that occur in different regions or geographic areas that can impact wildland fire behavior.
- Glacier Winds – can be experienced in the spring across the west where snowpack and snow fields linger over the higher elevations. Strong, shifting winds are characteristic of glacier or snow fields.
- Low Level Jet – a region of relatively strong winds in the lower part of the atmosphere commonly found across the plains at night.

Slide 23

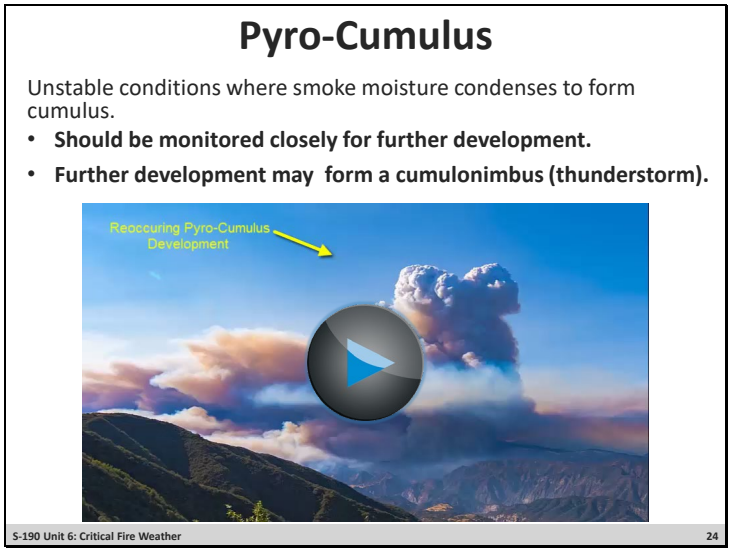


Question: Based on the changes in temperature and RH around 2000, what occurred at that time that to cause the increase in fire behavior?

Answer:

- *A Santa Ana foehn wind storm occurred at around 2000.*
- *In a period of about 15 minutes, temperatures increased by 30° and RH dropped by about 50%, from 60 to 15.*
- *Because of the general characteristics of foehn winds, this change in temperature, and RH was most likely accompanied by a strong downslope wind.*

Slide 24



Pre-Video Discussion

- A phenomena that can be generated from large wildfires. The intense heating of the air caused by wildfires induces convection and causes the air mass to rise.
- If the fire grows large enough, the pyro-cumulus cloud may continue to grow and can develop into a type of cumulonimbus cloud (thunderstorm).
- The development into a thunderstorm can generate lightning. When this occurs, the smoke column is generating its own weather.

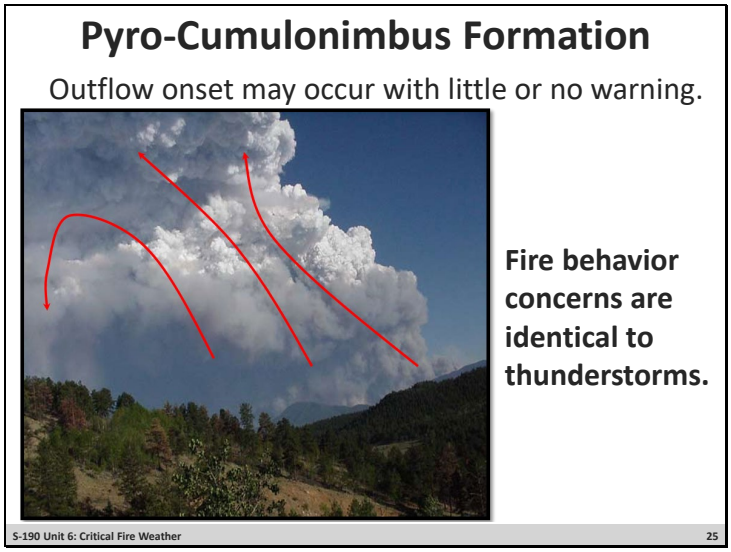
❑ **Play Video**

Title Pyro-Cumulus
Summary Time lapse of pyro-cumulus development.
Time (00:30)
No Audio

Note to Instructor

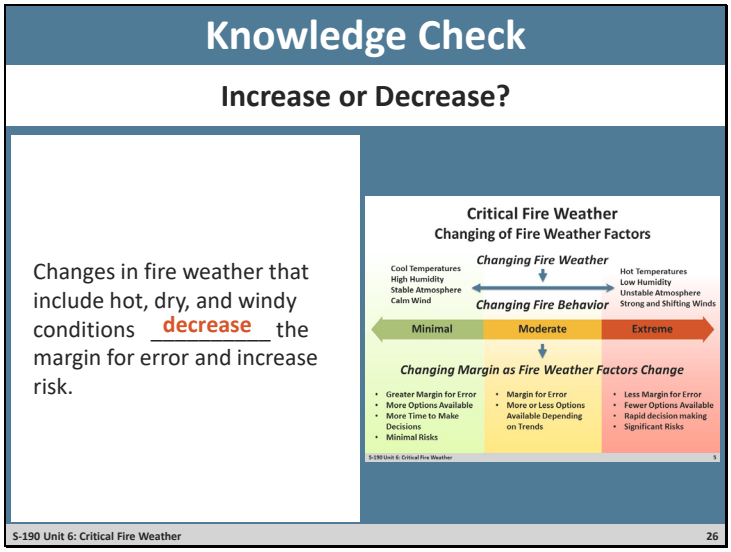
The atmospheric conditions shown in this video are not favorable for further development into a cumulonimbus (thunderstorm). The video shows an example of potential development that needs to be monitored closely.

Slide 25



- Outflow (gusty and erratic wind) onset may occur with little or no warning.
- A period of relative calm may be observed prior to outflow onset.
- Visual indicators such as virga or a rain shaft will likely be obscured by smoke.
- Lightning is possible along with rain.

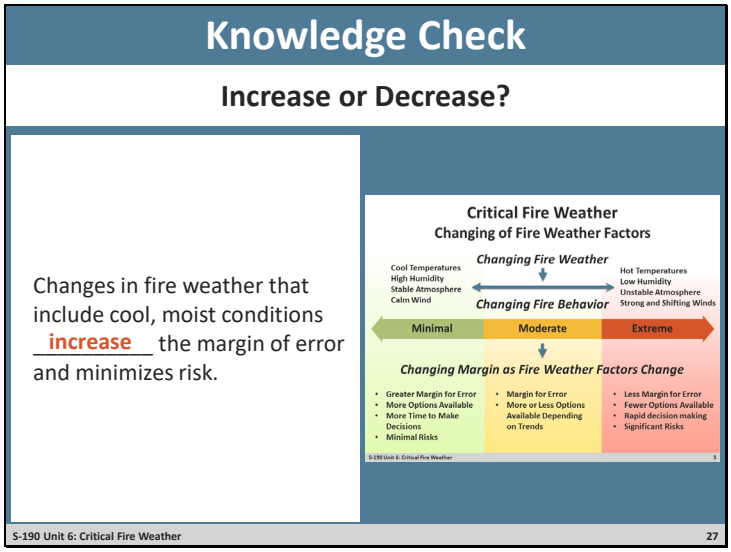
Slide 26



Question: Changes in fire weather that include hot, dry, and windy conditions _____ the margin for error and increase risk.

Answer: Decrease

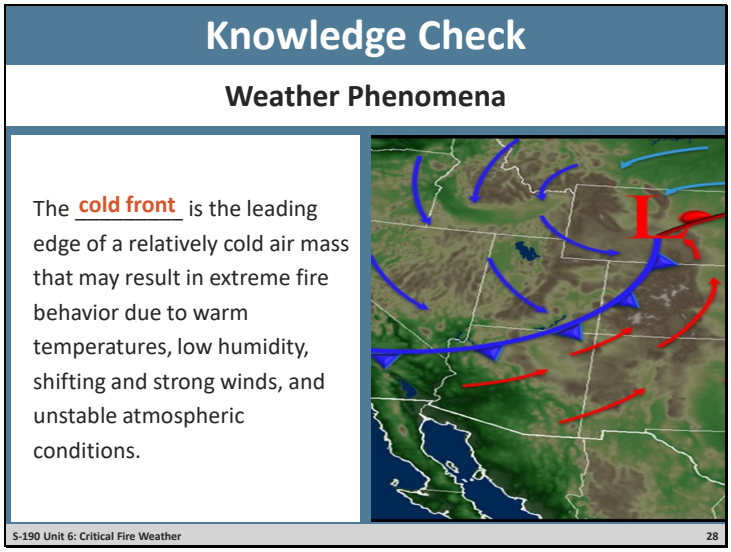
Slide 27



Question: Changes in fire weather that include cool, moist conditions _____ the margin of error and minimize risk.

Answer: Increase

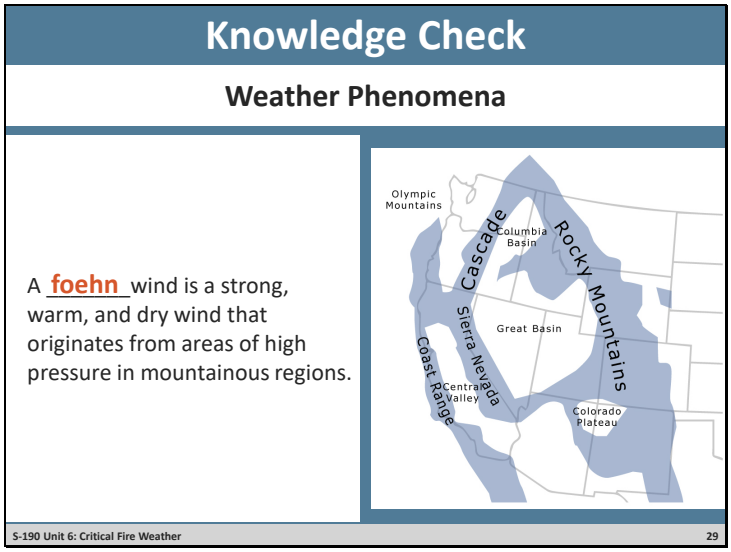
Slide 28



Question: The _____ is the leading edge of a relatively cold air mass that may result in extreme fire behavior due to warm temperatures, low humidity, shifting and strong winds, and unstable atmospheric conditions.

Answer: Cold front

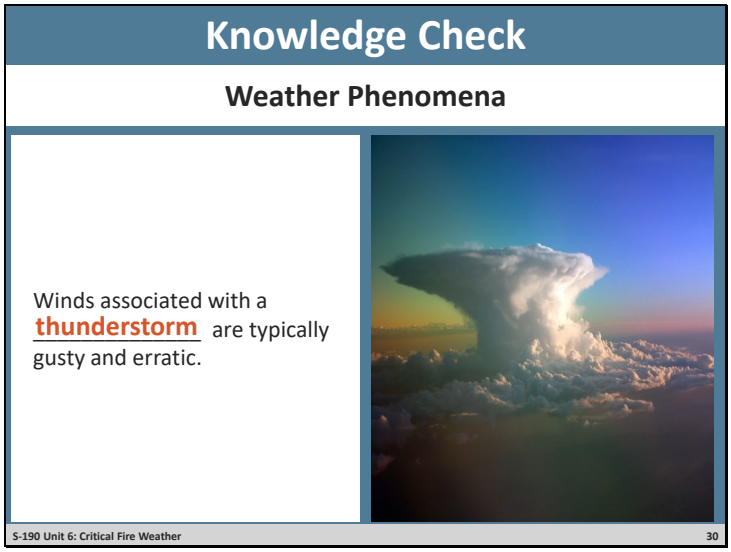
Slide 29



Question: A _____wind is a strong, warm, and dry wind that originates from areas of high pressure in mountainous regions.

Answer: Foehn

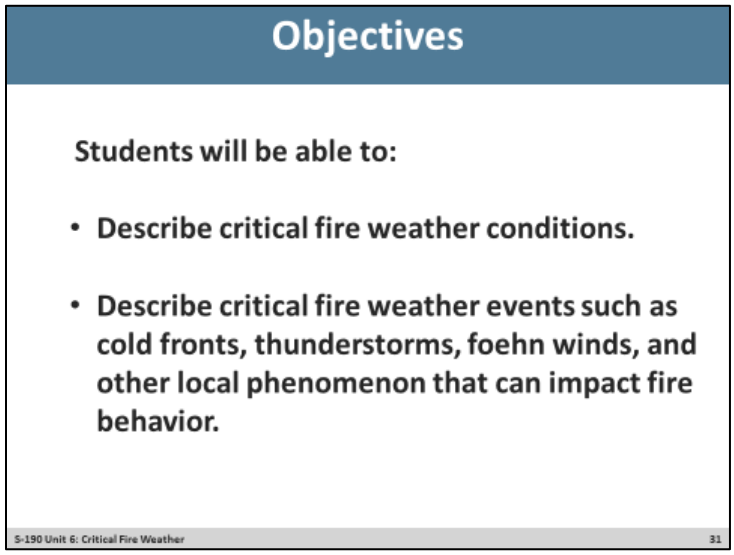
Slide 30



Question: Winds associated with a _____ are typically gusty and erratic.

Answer: Thunderstorm

Slide 31



❑ Review unit objectives.