

Advanced Wildland Fire Behavior Calculations, S-490

Pre-Course Study Material

Part 2: Fire Weather Knowledge

Materials Needed:

S-190, 290, and 390 references

Introduction:

Understanding the weather that is affecting the area of a fire is critical to safe and effective fire management. Fire behavior is dictated by the three elements of the fire environment: Fuels, Topography and Weather. Weather is the most rapidly changing of these elements. Weather changes with time (seasonally, daily, and minute to minute), and with space (across the country, the county, the fire scene, from one side of a mountain to another, and up and down in the atmosphere).

You will need to be able to have a very strong understanding of at least the basic weather properties that affect fires and fuels. These basic properties are:

- Temperature and Relative Humidity Relationships
- Atmospheric Stability and Lapse Rates
- Large Scale Circulation, Air Masses and Fronts, and General Winds
- Convective Winds (Land and Sea Breezes, Whirlwinds, Slope and Valley Winds, Thunderstorms)
- Clouds
- Weather and Fuel Moisture
- Fuels and Fuel Properties
- Keeping Current with the Weather

Directions:

Review the Fire Weather, Agriculture Handbook 360 (on the Student CD) to be sure you are comfortable with and understand the basic weather and fuel items described below. A practice test and answers are provided at the end of these descriptions.

Temperature and Relative Humidity Relationships

- Temperature and Relative humidity have an inverse relationship.
- As temperature rises (or falls), RH will fall (or rise).
- As an accepted guideline, for each 20 degree (F) increase (or decrease) in temperature, RH will be cut in half (or double).
- Temperature change on the earth's surface results from many factors: shading, surface properties, time of day, season and many others.

Atmospheric Stability and Lapse Rates

- Stability is a measure of whether the atmosphere's encourages or resists vertical mixing.
- An unstable atmosphere encourages mixing in the atmosphere, gusty winds and is associated with fire build up.
- A stable atmosphere resists mixing, and is associated with inversions.
- The atmosphere's stability changes with elevation, and with time.
- Lapse rates refer to the temperature change with height in the atmosphere.
- Generally, under dry conditions, lapse rates of greater than 5.5 degrees f/1000' of altitude indicate an unstable atmosphere.
- Generally, under dry conditions, lapse rates of less than 5.5 degrees f/1000' of altitude indicate a stable atmosphere.
- Haines Index correlates well with large fire growth in the Rocky Mountains, less so elsewhere.

Large Scale Circulation, Air Masses and Fronts, and General Winds

- Low pressure cells rotate counter clockwise, with a rising motion.
- High pressure cells rotate clockwise, with a sinking motion.
- Cold fronts are associated with low pressure areas.
- The jet stream in the continental U.S. moves from west to east.
- General winds are the broad scale winds affected by local features.

Convective Winds (Land and Sea Breezes, Whirlwinds, Slope and Valley Winds, Thunderstorms)

- Different topographic features heat at different times, and rates.
- Differential heating leads to various local winds.
- Thunderstorms can produce very strong, gusty winds (downdrafts).

Clouds

- Clouds can indicate improving or deteriorating Fire Weather.
- Sufficient atmospheric moisture must be present for clouds to form.
- Cumulus clouds indicate an unstable atmosphere and possible showers or thunderstorms.
- “Cirro” refers to high clouds.
- “Alto” refers to mid-level clouds.
- “Strato(us)” refer to low level clouds.

Weather and Fuel Moisture

- Moisture content of fuels results from the cumulative effects of weather.
- Some fuels react quickly to weather other fuels are very slow to react.
- Timelag Principle refers to how fast a dead fuel absorbs or releases moisture environment, primarily based on its size (diameter).

Fuels and Fuel Properties (S-290 Student Workbook, Units 7+8)

- The four timelag categories are:
 - 1 hour = $< \frac{1}{4}$ inch
 - 10 hour = $\frac{1}{4}$ - 1 inch
 - 100 hour = 1 - 3 inches
 - 1000 hour = > 3 inches
- Fuel properties of size, loading, surface area to volume, compactness, continuity, arrangement, fuel moisture, and chemical content all determine if and how fuels will burn.

Keeping Current with the Weather (S-290 Student Workbook, Unit 9)

- Understanding the different types of Weather Forecasts (General vs. Spot Forecast) is important.
- Red Flag Warnings are issued by weather zone for specific time period.
- Explain Fire Weather Watch vs. Red Flag Warning.

Practice Test

1. The lapse rate of dry stable air is:
 - a. More than $5\frac{1}{2}^{\circ}$ F/1,000 feet
 - b. Less than $5\frac{1}{2}^{\circ}$ F/1,000 feet

2. Which type of weather forecast is tailored to a specific fire area and can be issued at any time and as often as requested.
 - a. Spot Weather Forecast
 - b. General Fire Weather Forecast
 - c. Ventilation Forecast
 - d. Red Flag Warning

3. Which statement is true about large dead fuels?
 - a. They react quickly to changes in weather.
 - b. They have a high surface to volume ratio.
 - c. They react slowly to changes in weather.
 - d. They ignite more quickly than fine fuels.

4. Dead fuels that are less than $\frac{1}{4}$ inch in diameter are considered to be in which timelag category?
 - a. 1 hour
 - b. 5 hour
 - c. 10 hour
 - d. 100 hour

5. Topography can affect local winds by creating which of the following?
 - a. Eddies on leeward side of ridges
 - b. Barriers to general flow
 - c. Channeling of winds up valley
 - d. All of the above

6. Which is most likely to occur on an exposed west facing slope on a sunny afternoon.
- a. surface inversion
 - b. upslope wind
 - c. downslope wind
 - d. sheltered wind
7. Which of the following is NOT a visual indicator of an unstable atmosphere?
- a. clouds in layers
 - b. cumulus clouds
 - c. smoke rises to great height
 - d. dust devils
8. Which is true of thunderstorms?
- a. They always produce rain.
 - b. They always reduce fire behavior.
 - c. They can produce strong, gusty winds.
 - d. Lightning is always associated with rain.
9. Using the general rule, if the morning air temperature is 60 degrees and the relative humidity is 80%, what will be the relative humidity in the afternoon when the temperature reaches 80 degrees?
- a. 60%
 - b. 40%
 - c. 30%
 - d. 20%
10. In naming clouds, “alto” means:
- a. thunderstorm
 - b. layered
 - c. high altitude
 - d. middle altitude

Practice Test Answers

1. b
2. a
3. c
4. a
5. d
6. b
7. a
8. c
9. b
10. d