Fire Weather - Focus on Wind

By Larry L. Pierson Jr.

Introduction:

Firefighters and rescue workers can be some of the best dreamers in the world. We spend our days imagining scenarios that have never happened, add twists to old calls and gain insight into how we may react or if we have the right equipment.

In a wildfire scenario, the most dynamic aspect of fire behavior is often missing current and expected information about weather..... one of the 10 standard Fire Orders *(**R**ecognize current weather conditions and obtain forecasts)*. Not adhering to this particular order has been a factor in many wildland firefighter fatalities.

The Carolinas have a vast array of local influences from the shores and marshes of the East, battling fronts converging over the Piedmont to the steep mountains and altitudes effecting weather of the West. Each of us have the potential to engage in firefighting in another jurisdiction during our career. Become familiar with your region not just your district.

If you are experienced in the subject, review it. If it's new information, absorb and apply it to your next scenario.

The dynamics of weather

Fuel, topography & weather are the three principal factors affecting wildland fire behavior. Fuels (*Trees, bushes, ground cover etc.*) in a given area may change slightly on an annual basis from pest infestation, clearing or thinning projects and other factors but remain relatively the same. Topography (*Lay of the land*) is our most static or never changing factor. Although developments may grade an area or move dirt with heavy equipment, we can predict year to year that a particular mountain or slope will still be there.

Weather (*Wind, temperature, humidity*) is our most dynamic factor. We have seasons, fluctuations on a daily basis and changes minute by minute that will affect our fire spread and containment. Changing these three elements in varying degrees can result from an impossibility for a fire to occur to our personnel facing an extreme fire behavior scenario. With a little observation around your district, knowledge of fuels and topography can be carried with you every day but how do you apply weather information when it's fire time?

Up-Slope & Down-Slope winds

Firefighters learn early in a career that hot air rises and cool air sinks. Each morning sunlight begins to hit your district's surface and warm the ground. Throughout morning, the warmed air begins to rise reaching it's peak at mid-day to early afternoon. On a side of a mountain, these rising convection columns can create an *up-slope wind (Fig.1)* which can add to a fire's spread rate. Temperatures may stabilize during the afternoon resulting in calm conditions. When calm and without another prevailing wind, the fire can then spread normally uphill or spread equally in all directions in flat terrain.

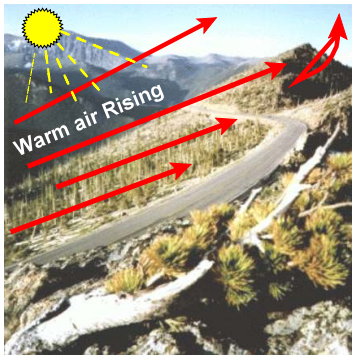

Figure 1

In later afternoon as the sun begins to set, the surface begins to cool and the heavier air begins to sink. These *down-slope winds (Fig. 2)* that may be created can result in a rapid rate of fire spread downhill. Yes, downhill, against the basics of what we are taught that wildfire moves faster uphill. But remember, we are dealing with the most dynamic of the three principal factors.

Figure 2

The situations described above can be greatly affected by other prevailing weather systems discussed later in this article.

Land & Sea breezes

From the same effect as described above, convection patterns develop near the ocean or large lakes.

During the heating period of the day, the land mass (shore) heats quicker than body of water. The increase temperature on land creates a convection column rise and the rising air is replaced by air moving from the body of water. This is known as a *Sea-Breeze (Breeze coming from the sea Fig. 3)*.

During the cooling period of the day, the land mass cools quickly and the heavier, cooler air begins to sink. The heavier air mass flows towards the body of water. This is known as a *Land-Breeze (Breeze coming from land Fig. 3)*

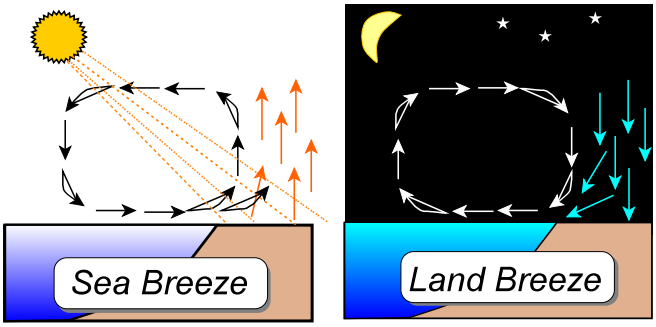

Figure 3

These two effects can have a great impact on timing of strategy & tactics as well as safety of personnel on the line. #4 on the 18 Watchout list - *"Unfamiliar with weather and local factors influencing fire behavior"*.

What makes the wind?

A combination of the Earth's rotation, Coriolis Force *(Deflection of winds from the Earth's rotation)*, heating and cooling during the rotation and high and low pressure systems all combine to give us our ever changing wind patterns.

The symbols and lines on weather maps *(Fig. 4)* can seem confusing but they hold valuable information for the wildland firefighter. The combination of symbols can help you predict which direction winds will be moving, what the weather will be in the next 24 hours or how long conditions will last.

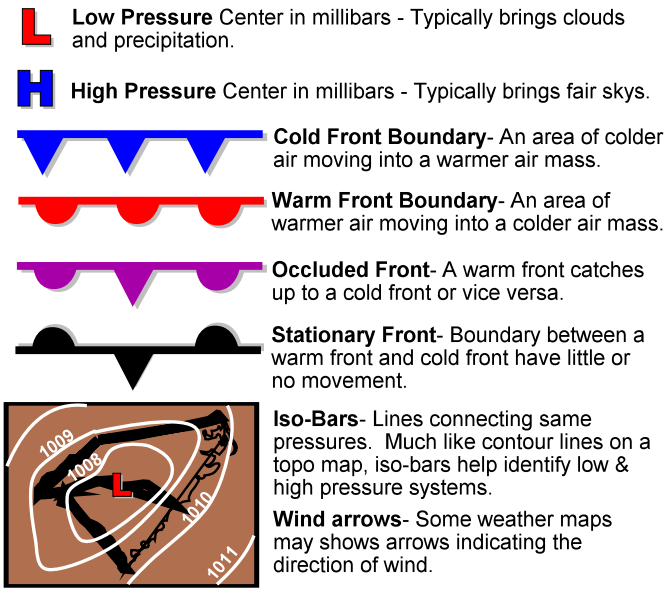

Figure 4

Cold Fronts

Other conditions may put us on high alert but the cold front, combined with the right balances of fire behavior, has been associated with extreme fire behavior, larger acreage loss and a complex set of safety problems for our firefighters.

Warm fronts typically move from the Gulf of Mexico (*South to Southwest*) or the Carribean (*South to Southeast*). These prevailing winds may bring higher relative humidity and without other factors, may push a fire the direction the wind is moving. Winds from the South move fire to towards the North. Winds from the Southeast push fire towards the Northwest. *(Fig. 5)*

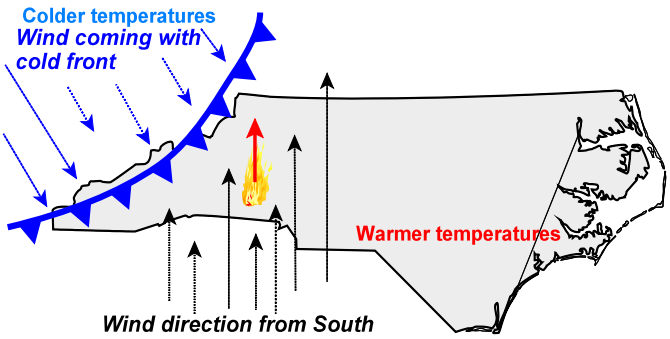

Figure 5

When a cold front is approaching, it will typically be from the Northwest or West. If you look towards that direction, you may see an approaching line of cumulus clouds (puffy appearance). This is a result of a warm and moist air mass coming in contact with the cooler temperatures of the cold front.

As the front begins to move over your area, the fire spread can become erratic. One moment the fire spreads North, then South, then East and constantly shifts directions *(Fig. 6)*. Uninformed firefighters performing direct attack operations may find themselves scrambling for safety zones.

After the front passes, winds behind the cold front increase speed and bring lower relative humidity. Now your direction of fire spread may have switched 180 degrees.

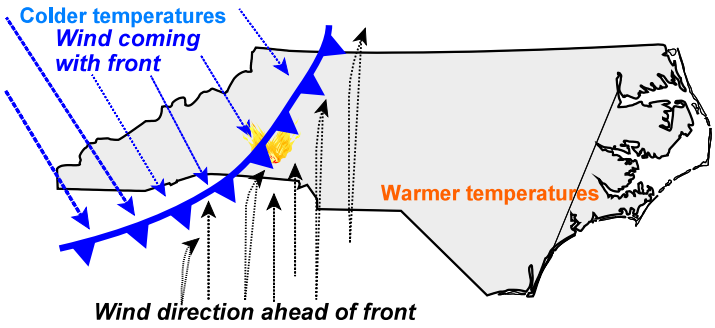

Figure 6

Cold Front Case study

Date: April 11th, 1999

Time of day: 16:20

Location: Christian Creek, Swannanoa

The fire started from debris burning as a cold front began to move into the area. Erratic and gusty winds created spot fires (*fire brands and embers landing outside the control line*) that leapfrogged fire spread faster than an accurate initial size-up could be made in the mountainous terrain. Initially assigned engines protecting homes watched flame fronts cross paved roads and others reported dozer lines that could not hold. A handline crew had to utilize their escape route after a dramatic change of direction occurred.

After sunset, the fire switched directions several times and flame lengths reached well above the Laurel, Oak trees and other Eastern hardwoods. This fire included 31 structures endangered, 300 firefighters, 29 FDs, 61 pieces of apparatus, 1 helicopter, 1 spotter plane and 1 CL-215 air tanker.

This was not just a district problem. A cold front will affect a large area or entire region. This multi-jurisdictional effect on resource availability will make a tough situation even tougher.

The NC Department of Environment and Natural Resources released this quote on April 13th 1999.

"Since the recent outbreak of fires began on Friday, April 10 there have been a total of 113 fires that burned 1,927 acres in Western North Carolina. Over 1,500 fire fighters including state and federal crews and local fire departments have been involved in the suppression effort. The fires threatened a total of 142 structures with an estimated value of $6.7 million. Four homes and two other structures were damaged."

Below is a table representing basic temperature readings taken from a weather station near the Christian Creek Fire.

Date	Day °F	Night °F
04/09/1999	75	53
04/10/1999	76	45
04/11/1999	74	47
04/12/1999	53	32
04/13/1999	57	28

Notice on the night of 4/11, temperatures dropped and became cooler throughout the next day. Initial attack and your sweating, the cold front passes and everyone is looking for nomex jackets and coats to wear.

Cold fronts can be extremely dangerous. What resources are available to predict when a cold front is coming, when it will pass and conditions during the entire event?

Weather resources

Let's divide these resources into regional or national, local area and spot weather. The distance from your fire's location that weather readings have been taken from will have an impact, but all of them useful.

On a regional or national scale, weather readings have been taken from hundreds of miles away and compared to local readings. These will be more useful for letting you know what is coming in a few days or tomorrow. News stations, internet sites and other resources will allow you to anticipate the potential and prepare resources in an informal way. What these readings do not tell you is what is happening where you are right now.

Local area weather may come from local news stations, the nearest airport or other weather stations and give you a picture of what may be happening in a few hours. Local information gives more insight as to the impact a weather system will have on your district and allow a more accurate ordering of firefighting resources for standby or alert. One example of local area weather is a link provided by the NC Forest Service. If available in your area, you may access information from a RAWS (Remote Access Weather Station)or from ROMAN (Real time Observation Monitor and Analysis Network).

http://www.dfr.state.nc.us/fire_control/fire_stations.htm

Spot weather readings are taken at your location. They may be taken by a person in the command staff or by a firefighter working on a division. These readings tell you what changes are happening and give immediate feedback to adjust strategy & tactics.

Basic weather Instruments

One of the instruments used for spot weather is a *Sling Psychrometer*. It contains two thermometers, one with a cloth on the end that is moistened. One measures the temperature of the air, the other measures the temperature of the moisture in the air. The two readings, known as the *dry bulb* and *wet bulb* are combined on charts or a slide ruler that give an accurate reading of the Relative Humidity. Also described as RH% or what percent of the air contains moisture. Not only for it's value at reading the RH%, it can aid in the tell tale signs that come and go with various cold or warm fronts.

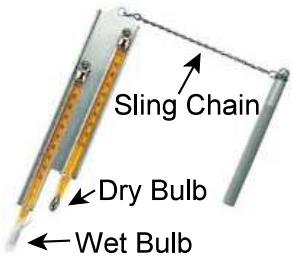

Figure 7

An *Anemometer* is a gauge that measures wind speed. Readings may be reported as average wind speed over a given time period, a report of wind gusts or fastest wind speeds recorded during that time.

There are several handheld units available on the market that combine humidity sensors, anemometers, barometric pressure gauges and several other useful functions. They can usually retrieve weather readings quickly but you should check the specifications of the unit carefully. Different units may have a wide margin of error such as +/- 10% while others give you an very accurate reading.

Weather stations can be installed economically in your fire station to give each person a constant look at what is happening. Some can upload weather data to a website which makes it available to every member with a computer or even access by cellular phone if it is equipped with a web browser.

Summary

The weather has tremendous impact on your firefighting skills and safety. Knowledge of these special wind patterns and fronts, having access to regional, local and spot weather readings and knowing when to adjust tactics is essential. Add these elements to your next daydream or scenario and put it into action on the your next fire.

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