The Station Fire: An Example of a Large Wildfire in the Absence of Significant Winds

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Introduction

In late August and early September of 2009, the Station Fire affected the Angeles National Forest in the mountains of Los Angeles County. When the fire was finally contained, it had consumed 160,557 acres of national forest land and destroyed 89 residences (USDA 2009). With its current acreage, the Station Fire ranks as the 10th largest fire in California history behind such other notable fires as the Day Fire in September 2006 (162,702 acres) and the Zaca Fire in July 2007 (240,207 acres). Much like the Zaca Fire, the Station Fire consumed most of its acreage in the absence of any significant wind events.

The purpose of this paper is to examine the weather and fuels that contributed to the Station Fire's significant growth. It will be shown that the Station Fire was primarily a fuel-driven fire in which extended periods of very low relative humidity helped encourage large fire growth by keeping the fuels at critically dry levels. The only winds of note across the fire were the typical diurnal terrain-driven winds. At the height of the fire, over 4,600 personnel were assigned to the fire (USDA 2009).

Topography

Figure 1 shows the region affected by the Station Fire. This area includes the mountains and foothill areas of central Los Angeles County. This section of Los Angeles County is very rugged with elevations ranging between 2,000 and 6,000 feet above sea level, producing slopes between 20% and 60%. Complex terrain of this nature is fairly common in Southern California.

Due to the steepness of the topography, this area is very susceptible to extreme fire behavior. The steep slopes and deep drainages promote significant preheating of fuels which can lead to rapid upslope and upvalley fire spread. The orientation of the drainages can produce significant variations in both direction and strength of the typical diurnal terrain-driven winds. Given the effects of the topography, fire suppression efforts can be greatly impacted, especially the use of ground resources.

Fuels

The vegetation in the fire area was typical of much of Southern California foothill and mountain areas. The fuel bed was made up of heavy amounts of ceanothus, chamise, scrub oak and manzanita (USDA 2009). In fact, some of the growth was 15 to 20 feet tall. Per discussions with Los Angeles County Fire Department, this particular fuel bed had not experienced significant fire activity in over 40 years. As a result, there was a significant amount of fuel available at the time of fire ignition.

Not only was the fuel plentiful, it was also greatly stressed by drought. In the last three water years, Los Angeles County received be low normal rainfall, punctuated by the 2008-2009 water year when Mount Wilson only received 29% of its normal rainfall (**Fig. 2**). This consecutive streak of below normal rainfall resulted in severe drought conditions across all of Los Angeles County as observed on the latest U.S. Drought Monitor graphic (**Fig. 3**). Given the severe drought and the extended period since the area last burned, the percentage of dead fuel in the fuel bed was considerably high. In addition to the dead fuel component, the live fuel moistures across the area were at critical levels. **Figure 4** shows the live fuel moisture measurement of the chamise species from the Los Angeles County Fire Department as of August 21, 2009. In the Santa Clarita area, which best represents fuel conditions in the fire area, the live fuel moisture content was already at 60%, which is recognized by the Los Angeles County Fire Department as a near critical level of live fuel moisture. This is particularly noteworthy since critical 60% live fuel moistures are not typically observed until October.

Weather Conditions

With regard to the overall synoptic weather pattern between August 27 and September 3, 2009 (the main period of fire activity), Southern California experienced a typical weather pattern for late summer. A significant heat wave was occurring across all of Southern California. **Figure 5** shows composite images of both the 500 mb geopotential heights and mean sea level pressure for the 8 day period. At upper levels, strong high pressure was entrenched over the desert southwest. Near the surface, a weak sea level pressure pattern remained in place with neither a strong onshore nor offshore flow observed. This produced very warm high temperatures across the fire area: lower elevations in the upper 90s to low 100s and the higher elevations peaked in the 90s. With the warm air mass in place, overnight low temperatures also remained quite warm with some mountain and foothill locations remaining in the 70s to lower 80s. Long durations of single digit relative humidities were observed between August 26 and August 31, 2009. In addition, relative humidity recoveries were very poor with some stations even reporting single digit relative humidities overnight.

Figures 6 through 8 provide a more detailed look at observed weather conditions across the fire area. In each figure, six days of temperature, relative humidity and wind gust observations are graphed for three representative RAWS sites: Little Tujunga (1,390 feet), Acton (2,600 feet), and Chilao (5,450 feet) representing the front country foothills, Highway 14 corridor, and higher mountain elevations respectively. On each graph,

critical thresholds for extreme fire behavior due to wind gusts (blue dashed line) and relative humidity (dashed orange line) are depicted. During the period from August 26th to August 31st, 2009, all three sites exhibited very warm temperatures and extended periods of very low relative humidity. In addition, the typically gusty onshore and upvalley winds can be observed. However for a majority of the time, the wind gusts never exceeded 35 mph for an extended period of time except for a few hourly observations at Chilao. As mentioned previously, these observed conditions at all three RAWS sites were very typical for late summer across Southern California.

Weather Forecast Activity

At WFO Los Angeles/Oxnard, the previously mentioned fuel and weather conditions alerted the fire weather forecasters to a potentially significant fire weather event. At 3:48 PM on August 25th, 2009, a Red Flag Warning was issued for the Los Angeles County Mountains until 9:00 PM on August 28th, 2009. This warning was issued for the high likelihood of an extended period (10+ hours) of 10% or less relative humidity along with the expected diurnal terrain-driven winds. As the extended period of hot and dry conditions continued, the Red Flag Warning was extended until 9:00 PM on August 31st, 2009.

Post-event analysis of this event indicated several locations in and around the fire reported extended periods of very low relative humidity (10% or less) ranging between 8 and 15 hours (**Figs. 6 through 8**). In addition, no extended periods of critical wind gusts (35 mph or greater) were observed.

Fire Behavior

Overall, the Station Fire exhibited periods of significant fire growth and extreme fire behavior. **Figure 9** displays a progression map of Station Fire from its ignition date of August 26th to September 4th, 2009. Each shaded contour indicates the estimated fire perimeter at approximately 2:00 am PDT each day. From this map, the greatest day of fire growth occurred on August 28th, 2009 with an estimated increase of 70,243 acres while August 29th, 2009 showed an additional increase of 26,488 acres.

In terms of fire behavior, the activity was just as significant as the fire growth. In the absence of any significant wind event, the Station Fire exhibited some extreme plume dominated fire behavior. The plume dominated activity was most significant on August 28th and 29th with multiple deep plumes observed both from the fire line and local web cams—coinciding with the large fire growth these two days. These plumes produced significant spot fire activity, allowing for fire growth in all directions, with spotting distances up to three-quarters of a mile as the fuels around the fire were very receptive. Based on reports from hand crews on the fire, flame lengths of 200 to 300 feet were observed at the fire front.

Conclusions

The Station Fire was an extremely significant fire in Los Angeles County. With a final acreage of 160,557 acres, the Station Fire burned nearly 25% of the land mass of the Angeles National Forest. In fact, the size of the Station Fire was more than double the previous largest fire in the Angeles National Forest.

The Station Fire was a prime example of a fuel and low relative humidity driven fire, with much of the fire growth occurring in the absence of significant winds. With several years of limited rainfall and no recent fire history, the fuels were extremely drought-stressed, heavy and receptive to fire. The overall synoptic weather pattern produced extremely hot and dry conditions across the fire area. This combination of fuels and weather allowed for significant fire growth and extreme fire behavior which included significant plume-dominated activity.

In retrospect, the Station Fire provided a prime example that a significant wind event, such as a Santa Ana, is not necessary for a large fire in Southern California. The combination of very hot temperatures, extended periods of very low relative humidity and rugged terrain can easily produce critical fire weather conditions that can lead to significant fire growth and extreme fire behavior if the fuels are receptive.

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References

USDA Forest Service, cited 2009: Station Fire Update September 15, 2009 [Available online at http://www.inciweb.org/incident/1856/]

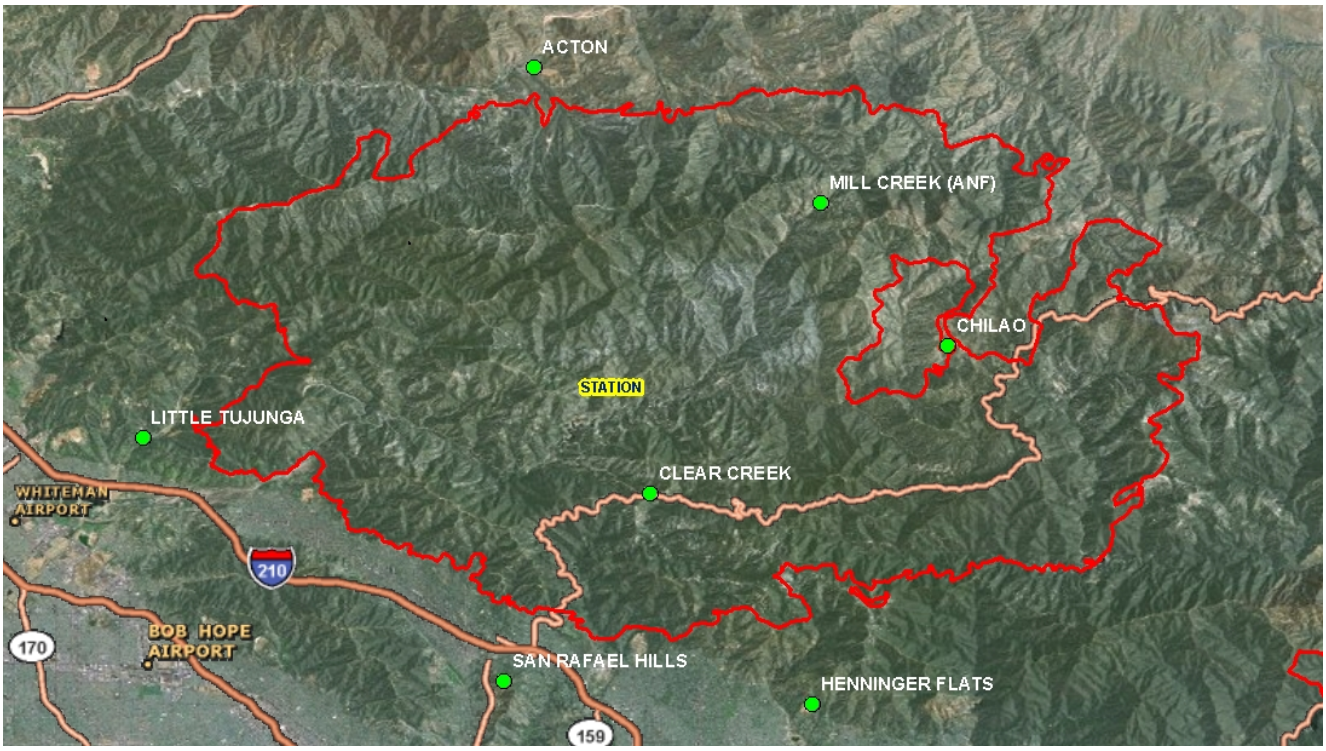

Figure 1

Station Fire Perimeter Map
[Green dots show location of nearest RAWS stations]

LOCATION	PRECIPITATION [inches] [1 JULY 2008 thru AUGUST 2009]		PERCENT OF NORMAL
	REPORTED	NORMAL [30 YR]	
SAN LUIS OBISPO COUNTY			
PASO ROBLES	5.87	13.21	44%
SAN LUIS OBISPO	13.01	24.55	53%
SANTA BARBARA COUNTY			
SANTA MARIA	9.13	14.09	65%
SANTA BARBARA	10.12	17.07	59%
JUNCAL DAM	15.87	31.22	51%
CACHUMA LAKE	13.31	21.90	61%
VENTURA COUNTY			
OXNARD	10.13	15.71	64%
OJAI	11.29	21.90	52%
LOS ANGELES COUNTY			
L.A. AIRPORT	8.13	13.32	61%
L.A. DOWNTOWN	9.08	15.28	59%
LONG BEACH	9.45	13.06	72%
MOUNT WILSON	**11.66e**	**40.74**	**29%**
PALMDALE	5.24	7.55	69%
FAIRMONT	14.46	16.53	87%

Figure 2

This figure shows the amount of rain that fell in the LA/Oxnard County Warning Area from 1 July 2008 through the end of August, 2009. Note that at Mount Wilson, the closest gage to the Station Fire, rainfall in the 14 months leading up to fire was less than 30 percent of normal—less percentage-wise than any other gage in the table.

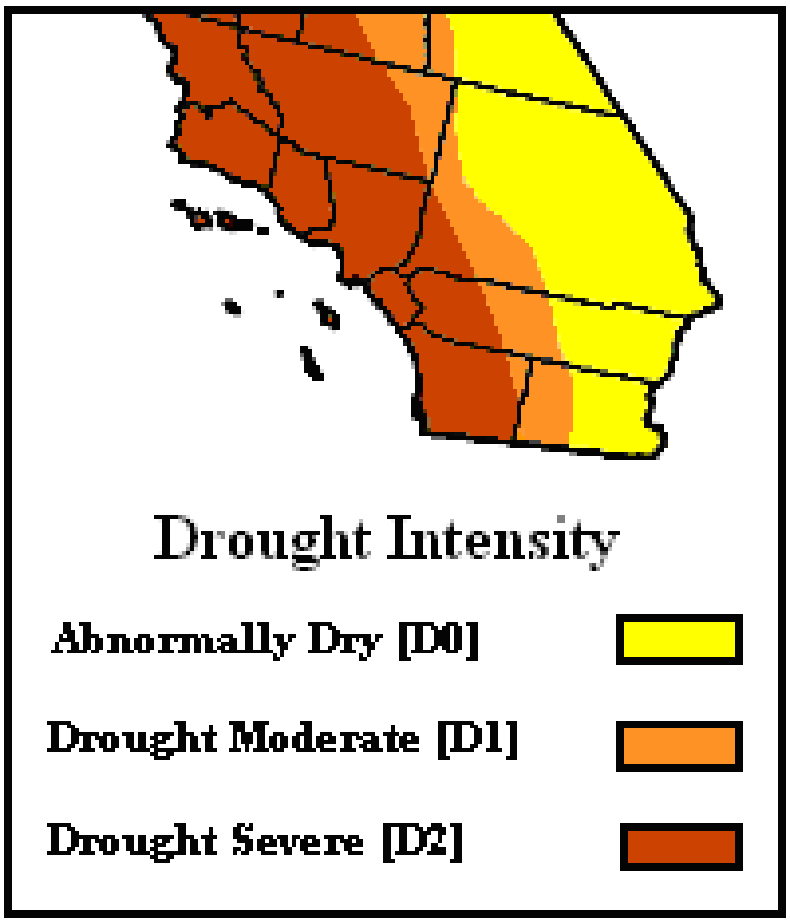

Figure 3

This figure is from the NOAA Climate Prediction Center analysis as of 7 am EST, on 8 September, 2009. It shows the Drought Intensity over Southern California with widespread severe drought conditions over Los Angeles County.

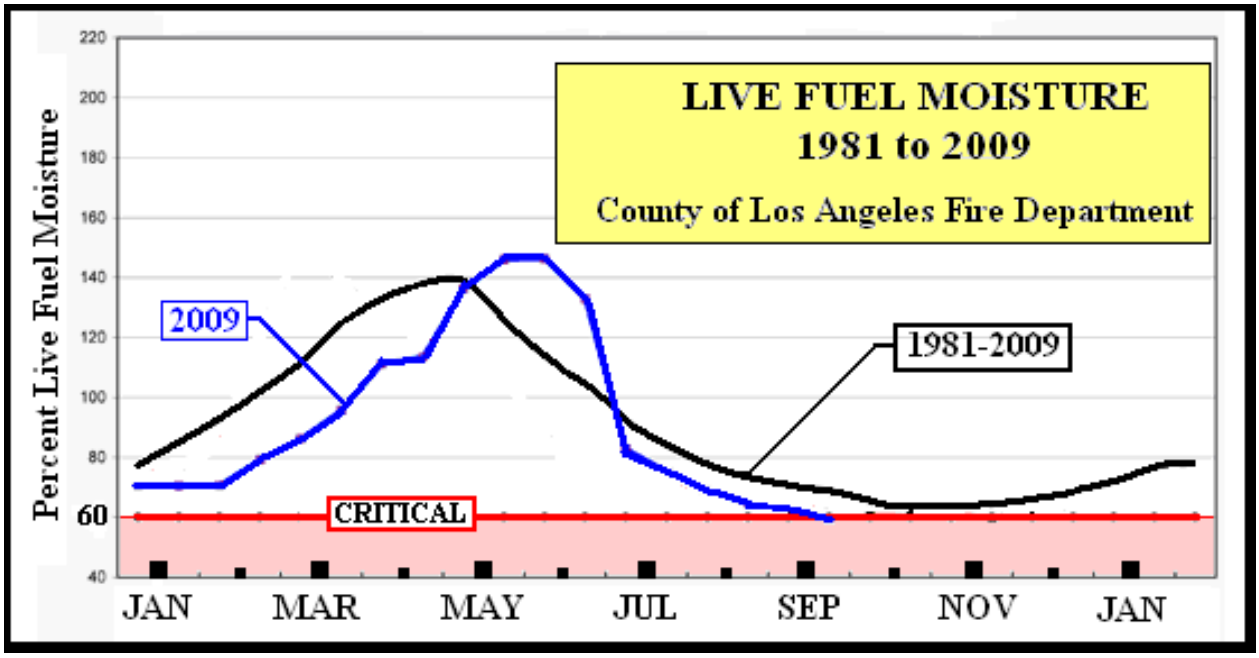

Figure 4

This figure shows the Live Fuel Moisture [LFM] readings for the Santa Clarita Valley based on observations taken by the County of Los Angeles Fire Department. Note that, at the time of the fire, LFM readings were already at critical levels [LFM = 60 %]. In addition, the readings for 2009 were already below those normally seen in late October—the normal height of the annual fire weather season.

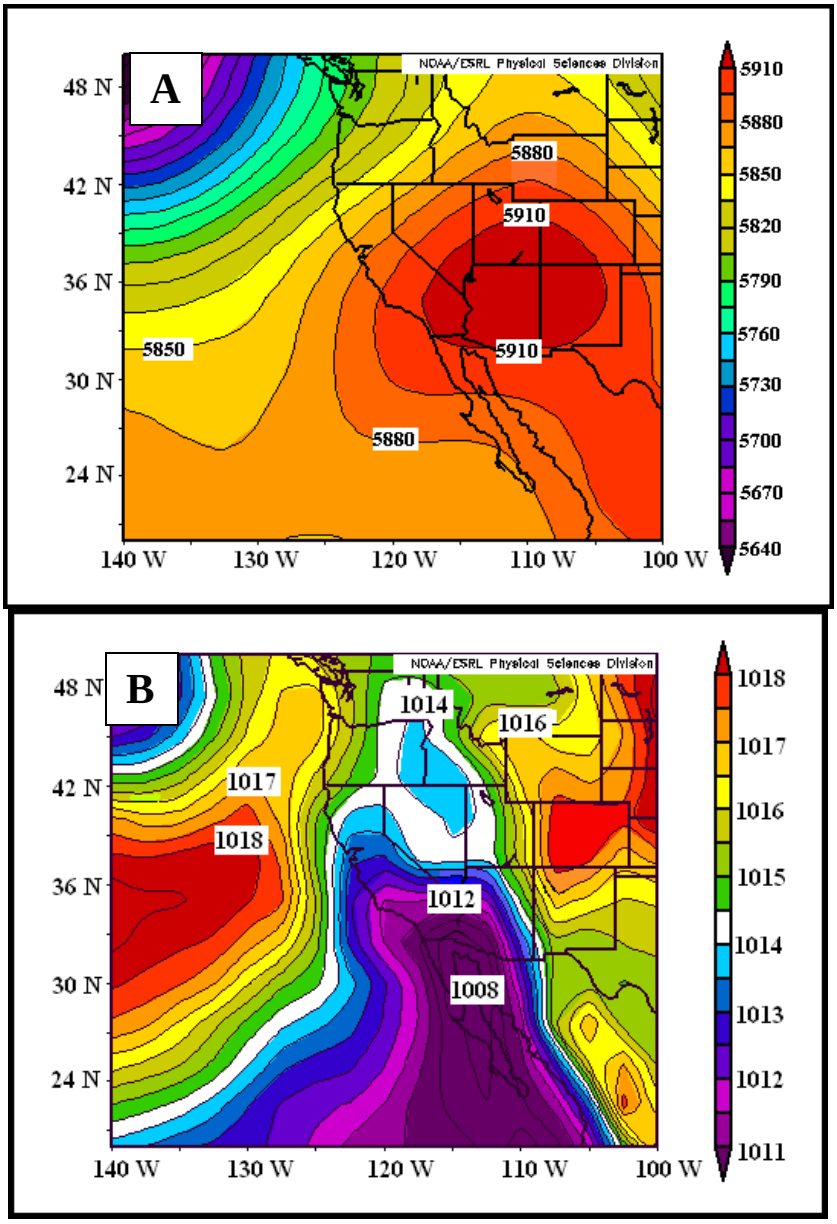

Figure 5

This figure shows the composite 500 mb and mean sea level patterns for the period from 27 August through 3 September, 2009. Frame **A** clearly shows the dominant upper ridge which extends from the four corners through Southern California. Frame B shows the very weak surface pressure gradient pattern that persisted over the region.

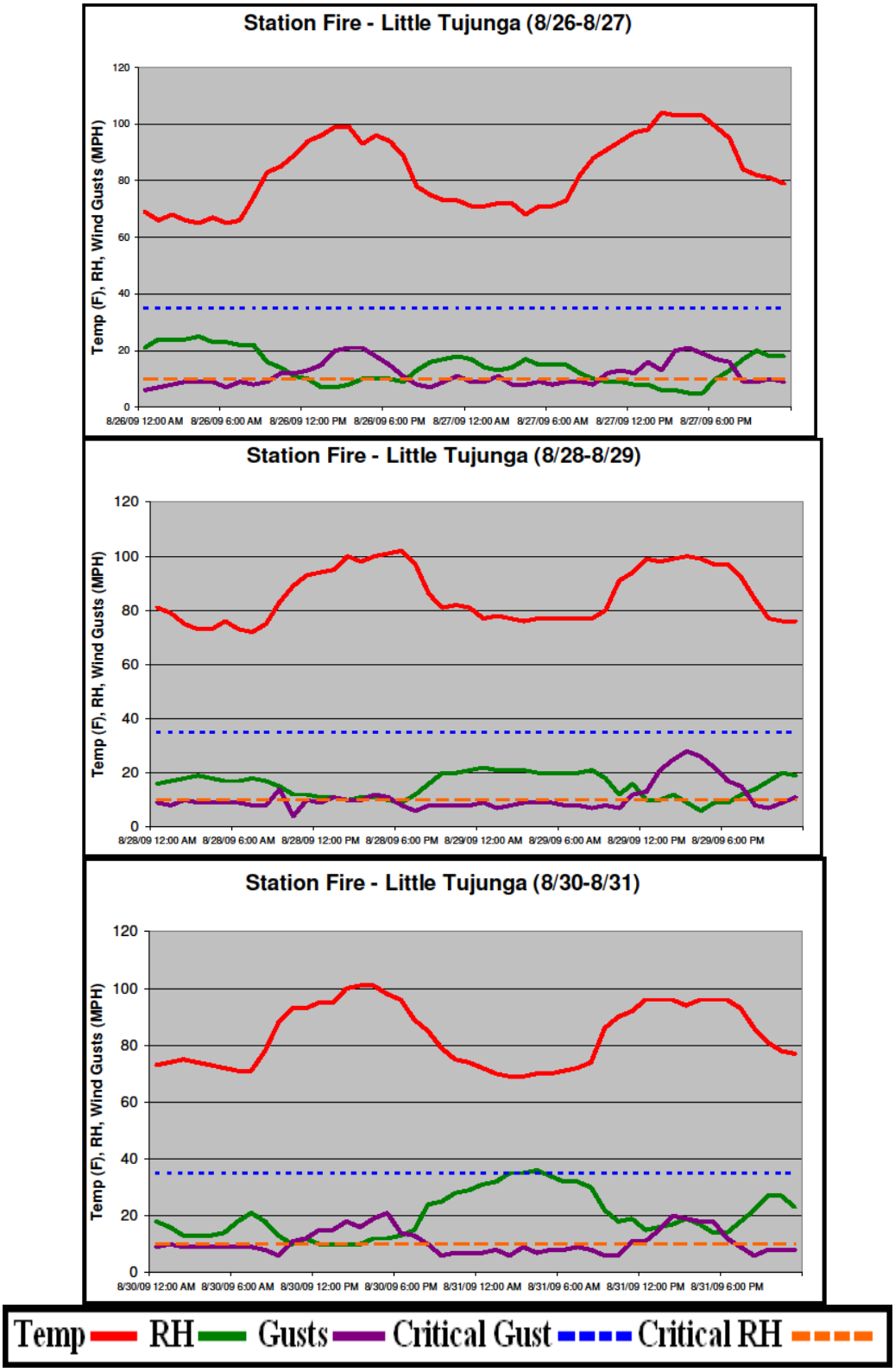

Figure 6
Little Tujunga RAWS Observations

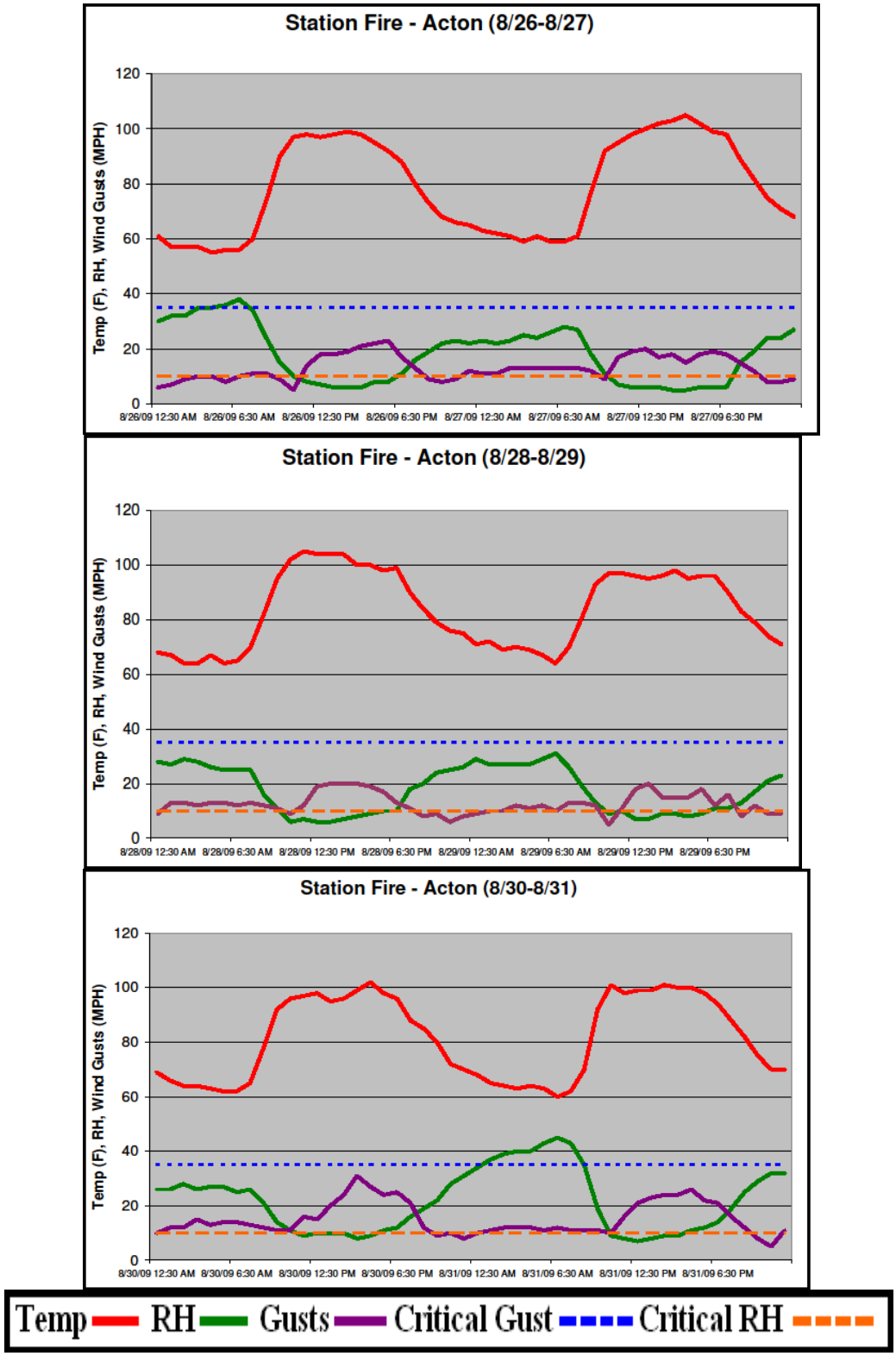

Figure 7
Acton RAWS Observations

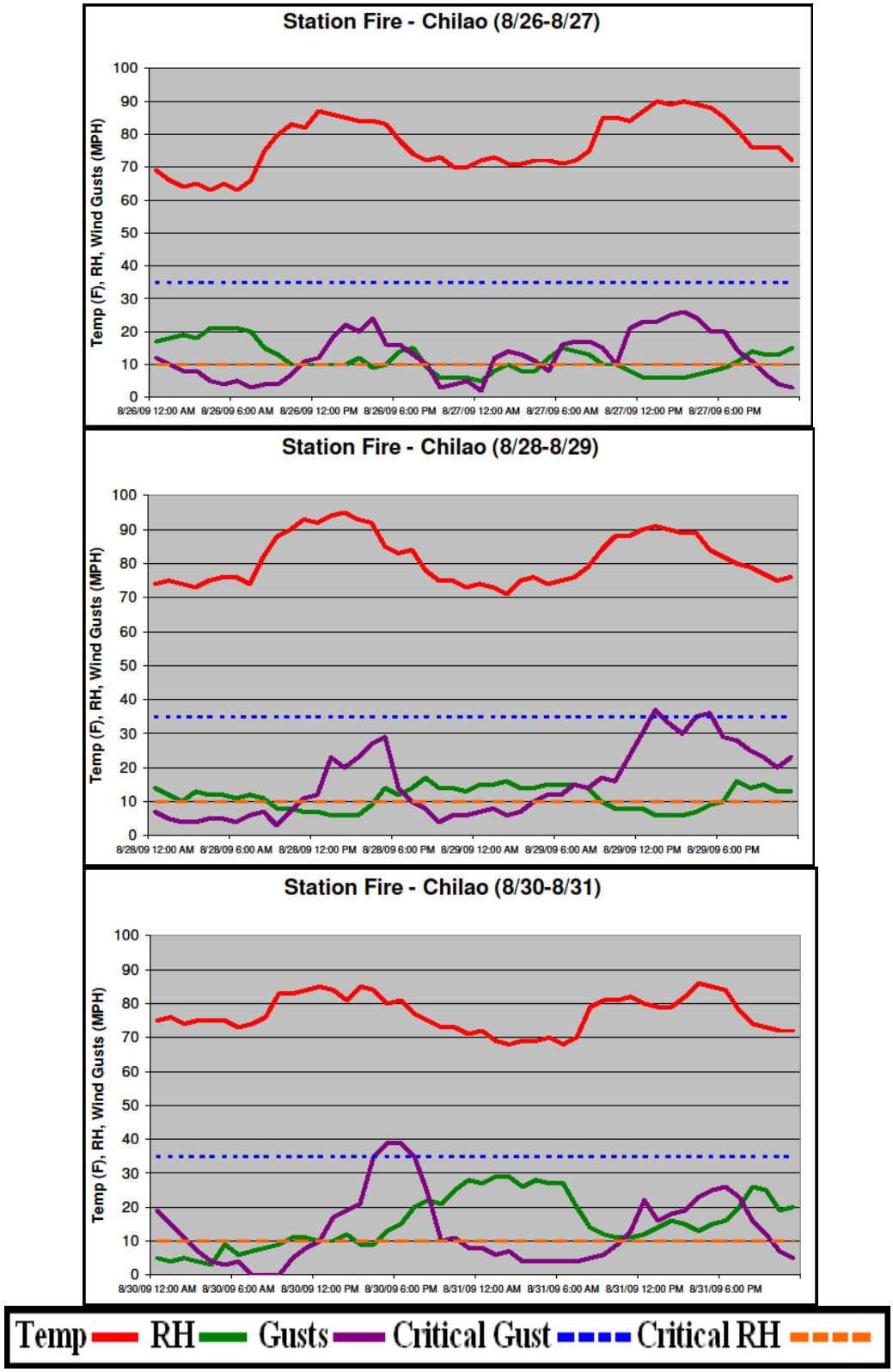

Figure 8
Chilao RAWS Observations

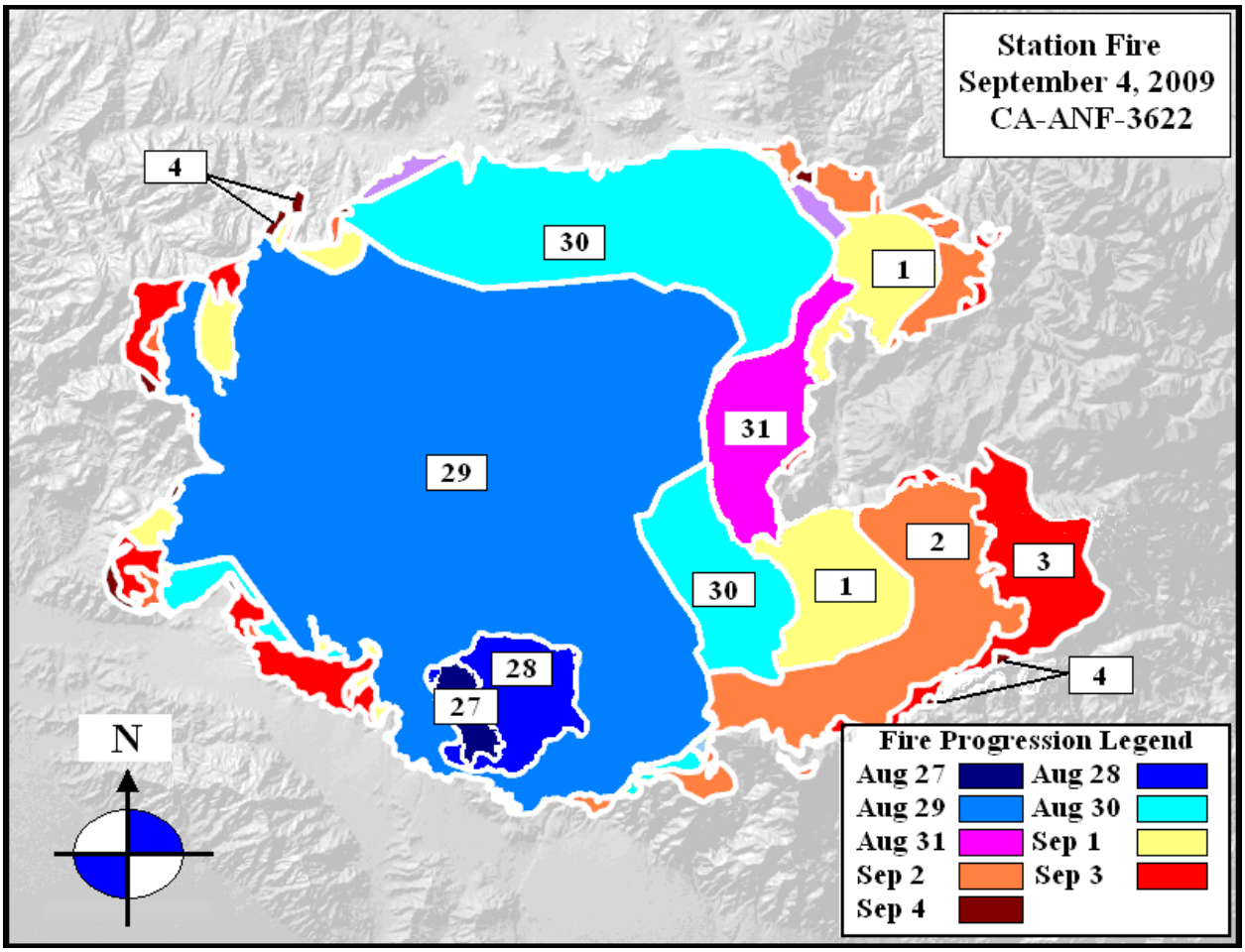

Figure 9

This figure shows the day-to-day progression of the Station Fire from August 27th through September 4th, 2009. [Courtesy United States Forest Service]