

**DYNAMIC FIRE WEATHER ASSOCIATED
WITH THE JUNE 2011 NEW MEXICO (USA) LAS CONCHAS FIRE**

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1. INTRODUCTION

The Las Conchas Fire began on 26 June 2011 on the Santa Fe National Forest west of Los Alamos, New Mexico. The fire ignited when strong winds blew an aspen tree into a power line. During the initial 14-hour burn period, the fire grew to around 43,000 acres in mainly timber. Sixty-three homes and forty-nine outbuildings were destroyed. The fire growth continued at a steady pace during the next week before the wet phase of the North American Monsoon set in. The fire was eventually contained on 11 August 2011.

The large growth and extreme fire behavior observed on the 26th was the result of several converging weather and fuel variables. Adequate soil moisture during the 2010 growing season provided large amounts of wildland fuel growth. The heavier fuel carried over into 2011. La Nina conditions across portions of the equatorial Pacific helped intensify drought conditions during the winter and spring of 2011 and put stress on the wildland fuels. The fuels became additionally stressed a few days leading up to the start of the wildfire due to abnormally warm and dry conditions associated with a strong mid-level dry intrusion and atmospheric ridging. The energy release component (ERC) value, which is an output of the National Fire Danger Rating System (NFDRS), increased to a record high level. Weather conditions on the 26th were primarily

driven by a slight breakdown of the upper ridge. A shortwave embedded within a larger long wave Pacific trough translated over the area and brought increased atmospheric instability and upper level winds. The unusually high mixing heights and strong winds led to significant amounts of turbulence and loft for fire brands spotting ahead of the main fire front. Air tanker support to the emerging wildfire ceased early due to safety concerns. A northerly wind shift tied to a weak cold frontal passage during the overnight of the 26th/27th led to a change in fire spread thus exposing additional areas to fire growth. The National Weather Service in Albuquerque issued a Red Flag Warning, which highlights conditions suitable for large fire growth and heightened fire behavior. Red Flag Warning issuances are unusual for late June in New Mexico. The Storm Prediction Center and Southwest Coordination Center meteorologists had also highlighted the area for critical fire weather and fuel conditions.

In this paper, several datasets will be used to explain the set-ups and extreme conditions observed on June 26th-27th, 2011.

2. FIRE HISTORY AND PROGRESSION

At approximately 1:00 PM MDT on Sunday, 26 June 011, the Las Conchas Fire ignited on private property west of Los Alamos, NM, (Figs. 1 and 2) then rapidly grew to over 43,623 acres during the initial 14-hour burn period burning – or at an astounding rate of 1.17 acres/second! The fire started when strong winds blew an aspen tree into power lines, causing them to arc.

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Figure 1. New Mexico, the flame icon marks the general location of the Las Conchas Fire. Source: Smart-Traveler.Info.



Figure 2. An overview of the Las Conchas Fire area, with the burn scar shown in bright pink.

Between 1100 to 1400 MST, the nearby Tower RAWS (Remote Automated Weather Station) recorded wind gusts ranging from 34 to 41 mph with the direction mainly varying from the west to the northwest (more in Fig. 10).

Following exceptionally large fire growth the first day (Fig. 3), the Las Conchas Fire continued to grow over the next five weeks, and was eventually contained on 11 August at 156,593

acres, or 245 square miles. Areas impacted by the fire included the Santa Fe National Forest, the Valles Caldera National Preserve, Bandelier National Monument, the Jemez, Santa Clara, Cochiti and Santo Domingo Pueblos, an acre on Los Alamos National Laboratory, and private lands (Fig. 2).



Figure 3. The Las Conchas fire as seen from the International Space Station at 2:30 pm MDT on 20 June 2011. Source NASA.gov.

3. CLIMATOLOGY, WEATHER AND FUELS

Several climatological, weather, and fuel factors aligned and caused extreme fire behavior for the 14-hour explosive fire growth period from the afternoon of 26 June through the overnight hours of 27 June 2011. These factors included a buildup of dense fuels during the 2009-2010 rainy seasons trailed by very dry conditions associated with well below normal precipitation during the 2010-2011 winter seasons.

3.1 Climatological Factors

The impact of below normal precipitation during the winter season of 2010-2011 had an extremely adverse impact on the New Mexico snowpack. On 1 January 2011, snow water equivalent (SWE) ranged from just below to just above normal levels, or from 57% to 163% of normal. Winter storms were scarce and snow pack worsened with most basins reporting SWE of 40% or less (Fig. 4).

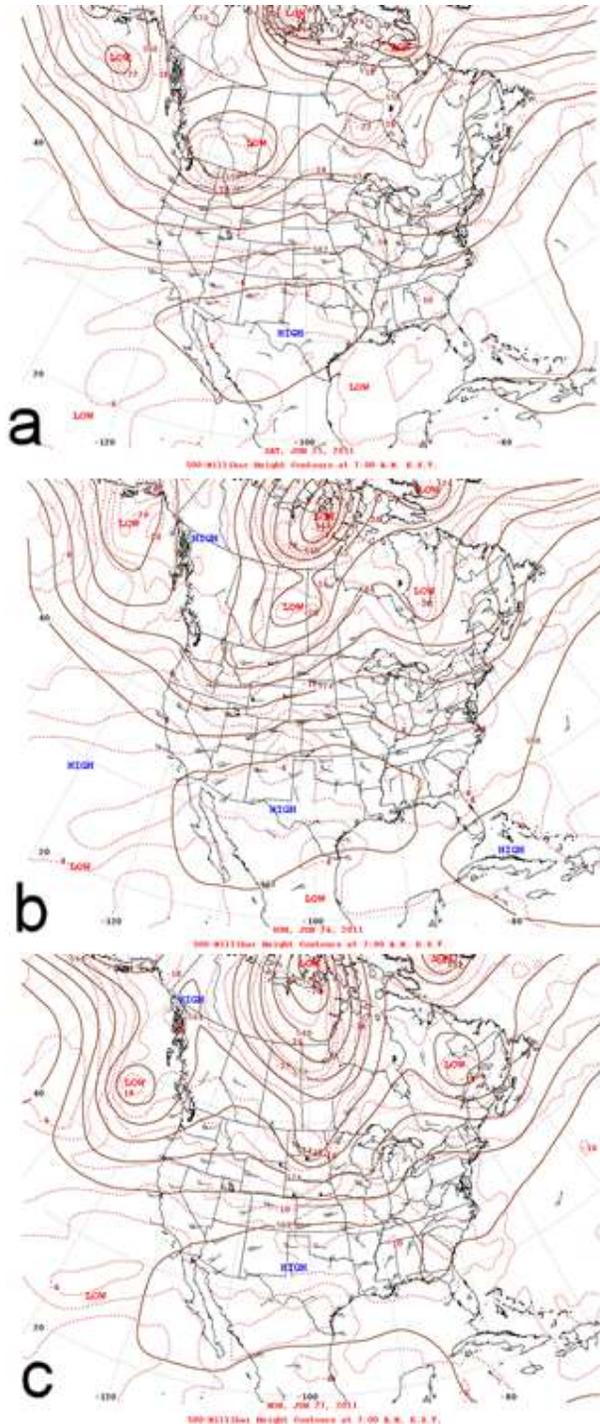


Figure 6. 500mb heights and temperatures at 5:00 am MST on a) 25 June 2011, b) 26 June 2011 and c) 27 June 2011, NOAA archive 2015.

3.2 Synoptic Weather Pattern

One day prior to the start of the Las Conchas fire, the synoptic pattern included a long wave trough upper low tracked slowly to the east over the next 24 hours (Fig. 6b and 6c). The counterclockwise flow around the upper low was initially positioned over British Columbia and Alberta. A series of shortwave troughs moved over the Great Basin and Four Corners Region, intensifying the flow aloft (Fig 6). This change in pattern resulted in a Critical Fire Weather Area designation for the Southwest, including the Las Conchas Fire area, in the SPC Fire Outlooks for 24 June and 26 June 2011. In fact, winds between 700mb and 500mb peaked in strength over northern New Mexico during the afternoon of the 26 June, grounding the air tankers and supporting accelerated fire behavior, all due to the strong turbulence.

In summary, the weather pattern consisted of a subtle breakdown of the upper ridge. The ‘Breakdown of Upper Ridge’ has long been recognized as a critical fire weather pattern by many researchers, e.g. Schroeder (1964) and Hull et al (1966).

3.3 Fuels

Robust El Niño conditions during the winter of 2009/2010 plus an active July 2010 Monsoon led to adequate soil moisture during the 2010 growing season. This resulted in very abundant grass and extra shrub growth which later provided a continuous and more abundant fuel bed during the drought season of 2011.

Dynamic La Niña conditions promoted dry and windy weather during the winter season of 2010 and 2011 and on into the spring of 2011. The result was anomalously low soil moisture that impacted the lower atmosphere. This also stressed the live fuels and resulted in additional

drying of dead fuels making them readily available for rapid combustion on 26 June 2011.

Finally, fuels and dry soils contributed to the extreme nature of the fire. The U.S. Drought Monitor from 1 March through 21 June illustrates rapid transition to severe and extreme drought (orange and red shading), as shown in Fig. 7. June 2011 tied as driest June on record for New Mexico.

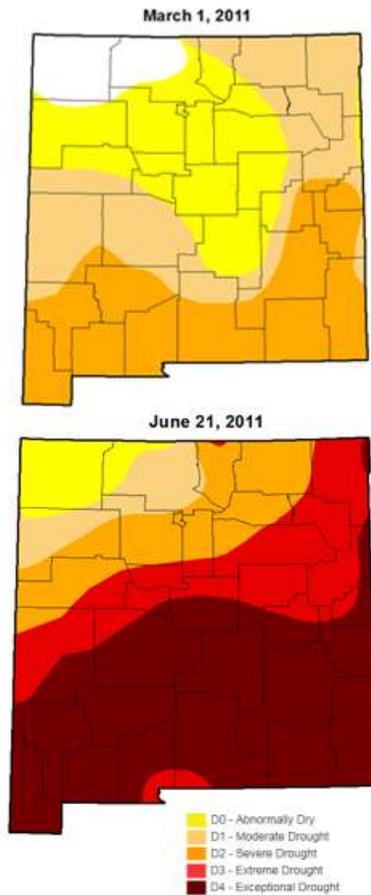


Figure 7. U.S. Drought Monitor classifications for 1 March and 21 June 2011.

Photos of the area taken one year apart (Fig. 8) illustrate a remarkable difference in snowpack. Below normal precipitation during the La Niña winter and spring of 2010/2011 not only brought

about severe drought conditions, but the lack of snowpack had an adverse impact on the dead surface fuels that were already primed for ignition. Rather than being matted down, these fuels in the form of dead grass remained upright, facilitating a rapid spread of fire.



Figure 8. Photos of Valles Caldera National Preserve, located near the burn site, in (a) April 2010 and (b) April 2011.

4. SHORT TERM SETUP

In addition to the strong upper level ridge shown in Fig. 6, a significant mid-level dry intrusion strengthened during the period 22 June to 25 June 2011 (Fig. 9). The brownish and/or orange tint in the water vapor image is the mid-level dry intrusion. This mid-level dry intrusion supported significant mixing, strong gusty winds, and unusually dry air, all of which led to record dry fuel moistures and rapid rates of spread with extreme fire behavior, Mills (2008). The extreme nature of the fire behavior is evident in Fig. 3, taken only 1½ hours after the fire started. The explosively intensifying fire growth is evident by the size and intensity of the smoke column. Recall that this rapidly-developing plume-dominated fire expanded at a rate of just over an acre every second for the initial fourteen hours.

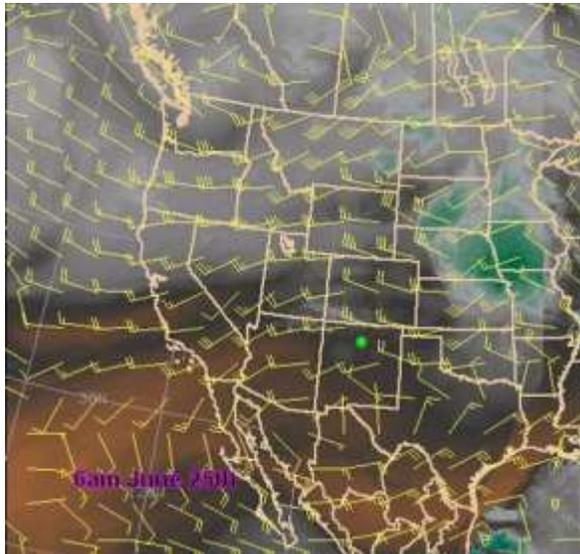


Figure 9. Water Vapor imagery with 700-500mb wind barbs at 6:00 am on 26 June 2011.

The abnormally warm and dry conditions resulted in record high Energy Release Component (ERC) values for the Santa Fe National Forest (Fig. 10). The ERC is based on the estimated potential available energy released per unit area in the flaming front of a fire. The day-to-day variations

of the ERC are caused by changes in the moisture contents of the various fuel classes, including the 1,000 hour timelag class. The ERC is derived from predictions of (1) the rate of heat release per unit area during flaming combustion and (2) the duration of flaming, SWCC (2014).

By comparing the 2011 ERC five-day average (black) to the long-term historical average (brown) and other extreme years, the ERC trace in Fig. 10 indicates the worst case wildland fuel scenario besting the previous 2002 record high during late June.

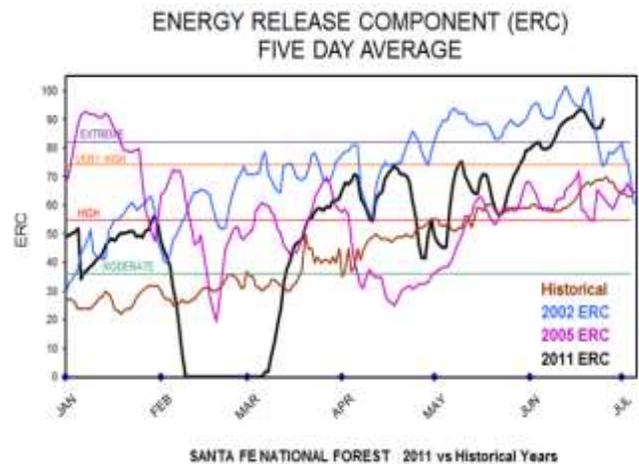


Figure 10. Energy Release Component five-day running averages for 2011 (black), 2002 (blue), 2003 (purple), and long-term historical values (brown), for January through early July. Source: USDA, USFS.

The radiosonde sounding from Albuquerque (Fig. 11), located approximately 50 miles south of the Las Conchas burn site provides additional details of the atmospheric conditions that help to support explosive fire growth. The dry air intrusion shown in the satellite imagery is readily apparent in the Albuquerque sounding as the 700mb dewpoint depression was 31° C. Additionally, the 700 to 500mb temperature difference was 27° C. The data revealed a very dry and well mixed atmosphere, with a Haines value of 6 (Haines 1998).

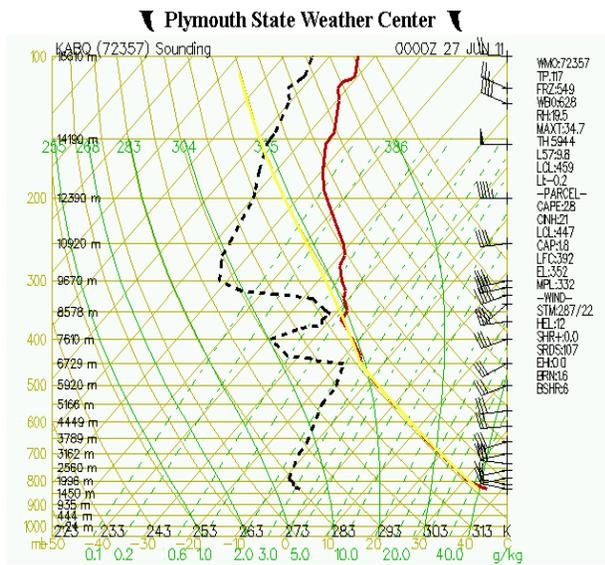
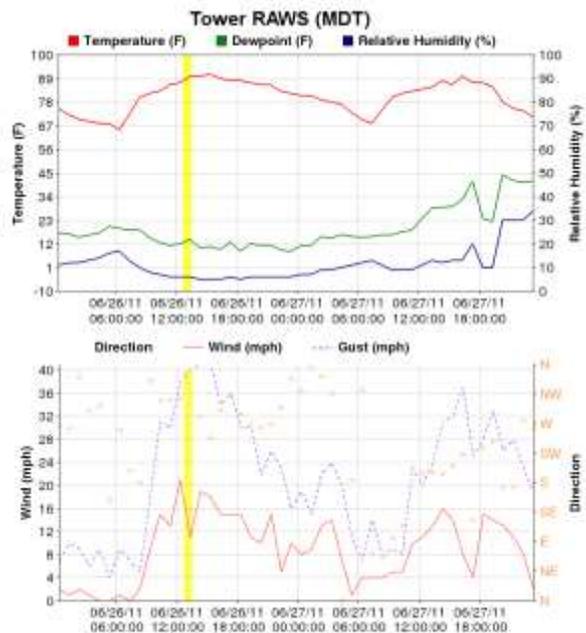


Figure 11. Skew-t sounding for Albuquerque at 0000 UTC 27 June 2011. Source: Plymouth State Weather Center.

Conditions at the surface are shown in Fig. 12 for Tower RAWs, approximately 15 miles from the Las Conchas Fire origin. Relatively high night temperatures resulted in poor relative humidity recoveries, with 40 continuous hours of relative humidity less than 20%. Additionally, gusty winds with a west to northwest component were in progress prior to the fire start and continued through the evening hours. Warm daytime temperatures are also apparent at the Tower RAWs. In fact, maximum temperature at the Albuquerque airport hit 100 degrees (F), which was the 6th warmest temperature on record for that date. This surface daytime heating contributed to the deep mixing that is shown in the sounding for Albuquerque.



values are near record heights.

Figure 12. Surface observations for Tower RAWs for the period midnight MDT on 26 June through midnight on 27 June. The yellow bar represents the start time of the Las Conchas Fire. Source: ROMAN, WR NWS.

Mixing heights reached over 19,000 feet MSL on the afternoon of 25 June 2011 and just over 21,000 feet MSL a day later, the start date of the Las Conchas Fire. Although a long record for mixing heights is not available, a comparison of these values to eight years of daily mixing heights from 1984 to 1991 are shown in Fig. 13. Clearly, these June 2011 values of mixing heights are near record values.

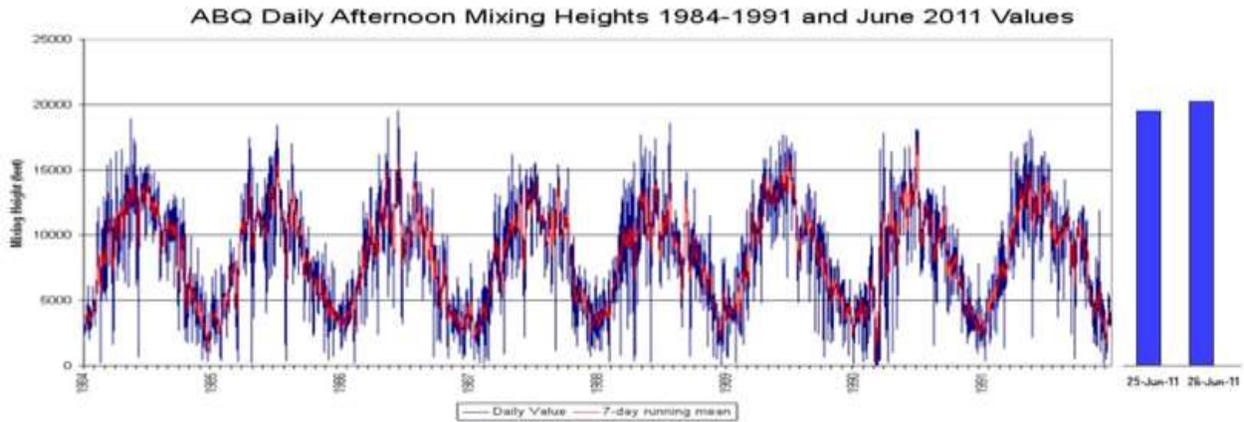


Figure 13. Albuquerque, NM Daily Afternoon Mixing Heights (blue), 10-day running means (red) from 1984 to 1991, with mixing heights for 25 and 26 June 2011 (blue bars).

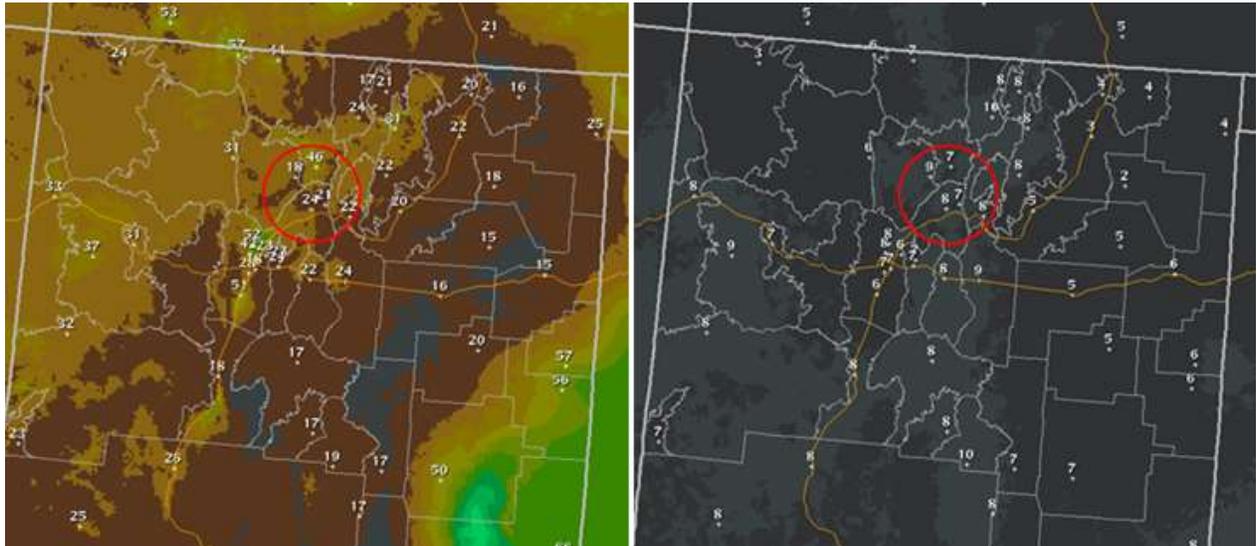


Figure 14. Observed maximum relative humidity on the morning of 26 June 2011 (left) and observed minimum relative humidity (right) on the afternoon of 26 June 2011. The red circle marks the area near the Los Conchas Fire.

With temperatures at least 10 degrees above seasonal averages, the strong dry air intrusion and record deep mixing, relative humidities were exceptionally low (Fig. 14). Thus, relative humidity recoveries on the day of ignition were poor across much of New Mexico and especially the area around the Las Conchas Fire, averaging

around 20%. This potent combination of atmospheric factors set the stage for extreme fire behavior. A 1962 paper by Robert Bates titled "Blowup Conditions in the Southwest?" theorized that the day after the highest nighttime temperature followed by warm to hot temperatures leads to the most extreme fire

potential or fire growth if there is an ongoing fire. This was most certainly the case for several days leading up to the Las Conchas Fire. Growth was indeed explosive, as evident in Fig. 15. Another contributing factor to the rapid spread was a gradual wind shift as a cold front approached from the north. The Tower RAWS site, located near the ignition site, reported winds from the west southwest just prior to ignition and for the next hours. But winds then veered becoming west northwest. This wind shift, combined with another night of poor relative humidity recoveries, exposed the fire to additional fuel for a continued rapid spread. A significant fire column went well into the nighttime hours.



Figure 15. Photo of the Las Conchas Fire from air attack plane at 1:33pm MDT 26 June 2011, or just 33 minutes after ignition. Photo by Manny Mendoza.

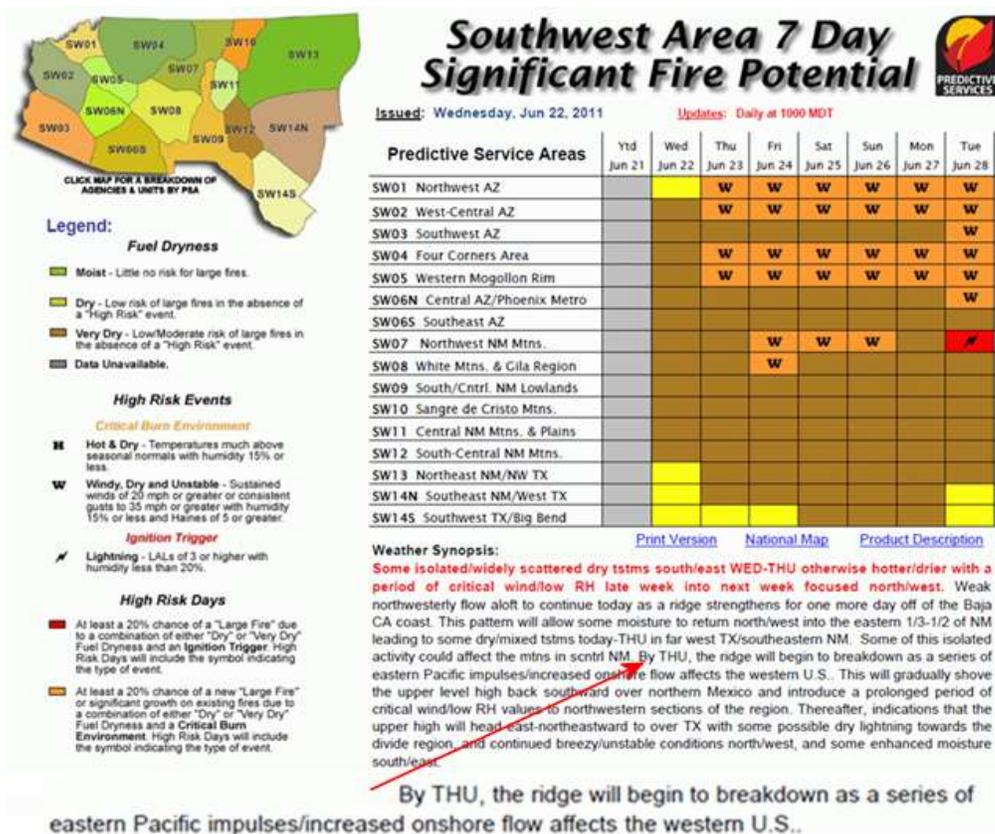


Figure 16. Seven day SWCC Significant Fire Potential Outlook issued on 22 June 2011.

5. OPERATIONAL PRODUCTS

Given the extreme conditions in place by June 2011, forecasters were anticipating extreme weather and fuel alignment periods. Several NWS weather products and services highlighted the severe fire weather and fire behavior conditions preceding the Las Conchas Fire. A change in the synoptic pattern was expected, as evidenced by the synopsis included in the 7 Day Significant Fire Potential Product issued by the Southwest Coordination Center on Wednesday, 22 June 2011. The intent of this product is to highlight periods of potential significant fire weather and/or fire behavior conditions such that they can be anticipated several days in advance (Fig. 16). In this outlook, issued four days prior to the ignition of the Las Conchas Fire, the synopsis describes the breakdown of the upper level ridge as “ a series of eastern Pacific impulses/increased onshore flow affects the western U.S.. Although the breakdown of the ridge was not extreme, the combination of the weakening ridge and upper level disturbances were sufficient to support both the ignition of the fire and its explosive fire behavior.

Forecasters at the NWS Albuquerque office also anticipated the critical fire weather conditions and issued a Fire Weather Watch at 6:31 am MDT on 25 June 2011. The watch was upgraded to a Red Flag Warning at 3:00 pm MDT that afternoon (Fig. 17). The overview section of the product stated “critical fire weather conditions are expected to develop from late Sunday morning and continue through early Sunday evening. The combination of strong winds...extremely dry humidities...high Haines Indices and near record high temperature will create an environment favorable for explosive fire growth given ignition.”

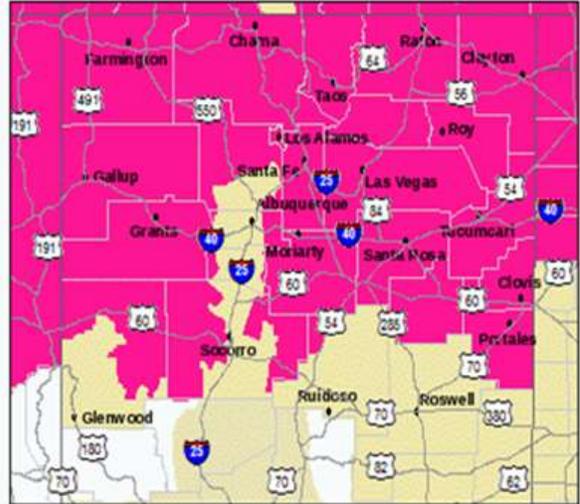


Figure 117. Area of Red Flag Warning issued by NWS Albuquerque at 3:00 pm MDT 25 June 2011.

The Storm Prediction Center (SPC) was also focused on areas within northern Arizona and New Mexico. The Day 2 fire weather outlook issued at 2:51 am MDT (0951Z) on 26 June 2011 is shown in Fig. 18.

It highlighted a “Critical” area and called for sustained surface winds of 20 to 30 mph to become common during the afternoon with gusts from 30 to over 40 mph.

Thus, in the days preceding the ignition of the Las Conchas Fire, awareness for a significant threat existed. The awareness did not allow the firefighting resources the ability to stop the devastating fire, but did lead to a safe fire fighting effort. Recall that air tanker support was suspended early on the first day of the fire due to safety considerations.

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