P3.3 WILDFIRE OUTBREAK AND SUPPRESSION: CASES FROM 1998 FLORIDA WILDFIRES

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1. INTRODUCTION

In the wake of an unprecedented fire season, it is important to refine methods for improving particular aspects of wildfire forecasting. These include timing and magnitude of low-level moisture variability and convergence, diurnal circulation characteristics (sea and land breezes), convection, precipitation and lightning initiation. Over 2300 fires scorched nearly a half million acres of Florida during the spring and early summer 1998 at a cost of over 620 million dollars. The Florida Division of Forestry (FDOF) attributes lightning as the primary ignition source during this outbreak (31% during 1998). This study compares the conditions that attended a major outbreak period (19-20 June 1998) and a suppression period (10 June 1998) in order to identify features that may be useful in fire weather forecasts.

During the winter season prior to these events, Florida was influenced by rainy El Nino conditions generating precipitation over 200% of normal for October, December and February (fig. 1.) By April, May, and June, rainfall was less than 50 percent of normal and considerable solar radiation and evaporation dried Florida's vegetation. The first wildfires ignited in the panhandle area during May and by early June, fires were ongoing over north and northeast

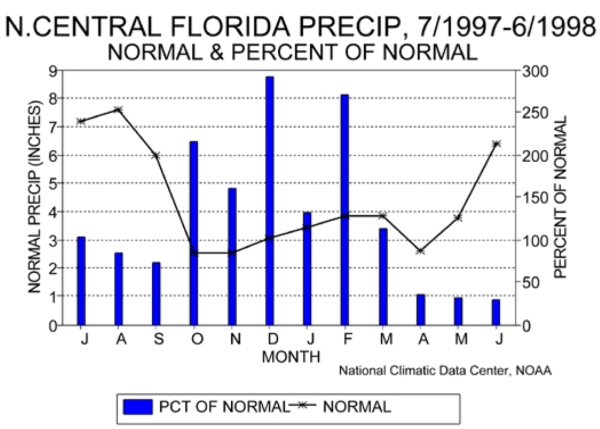

Figure 1. North central Florida precipitation normal and percent of normal July 1997 to June 1998.

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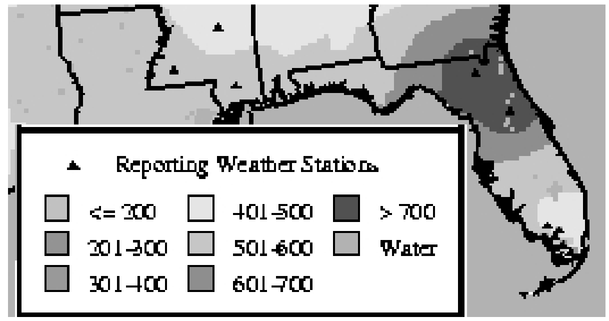

Figure 2. Keetch-Byram index for 10 June 1998.

Florida. The Keetch-Byram drought index (fig 2.) for 10 June 1998 indicated very dry conditions with values over 700. By mid June fires raged southward in the I-95 corridor along Florida's east coast.

At first glance, the two periods of outbreak and suppression show little difference, but considerable contrasts in the atmosphere are evident. Both events were characterized by adequate instability and moisture for convection, light surface wind flows, opposing east and west coast sea breezes, and light winds aloft. The period of suppression was associated with passage of an upper trough and intrusion of subsiding air over much of Florida. In comparison, the fire outbreak was associated with nearly stationary convection with heavy rain and abundant lightning leading to initiation of fires particularly outside rain areas. The next day though, limited convection developed with little or no rainfall. This allowed smouldering lightning fires to develop and spread.

2. WILDFIRE OUTBREAK 19-20 JUNE 1998

A. Synoptic Description

The two day period of 19-20 June 1998 is characterized by a weak surface high pressure area over the Gulf with west to northwest gradient flow. Sea breezes developed along the coasts both days. Low level moisture was typical for June with dew points in the 70s. Although much needed rain occurred on June 19th, over 8000 lightning flashes occurred also. The FDOF recorded many new lightning fires on the 19th and most were started by flashes outside of primary rain areas. By the 20th, many new fires were noted by the FDOF particularly where heavy rain fell the day before.

B. Radiosonde Data
Soundings from TLH, JAX, and TBW for 19/1200 UTC were consistent from 400 mb up with NW winds up to 25 ms^{-1}. TLH and JAX winds were light westerly to 400mb. The TBW sounding (fig. 3) showed a shallow layer of light westerly wind near the surface then easterly winds 10ms^{-1} to 400 mb. TBW showed an unmodified CAPE of 1126 Jkg^{-1}, storm motion of 078° at 4 ms^{-1}, and precipitable water 38 mm.

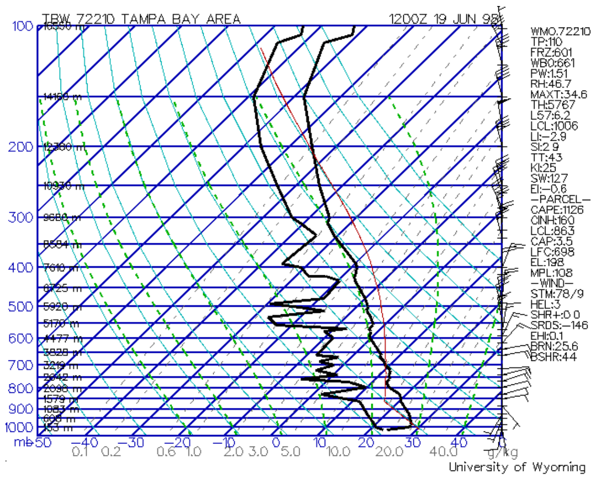

Figure 3. TBW sounding from 1200 UTC 19 June 1998.

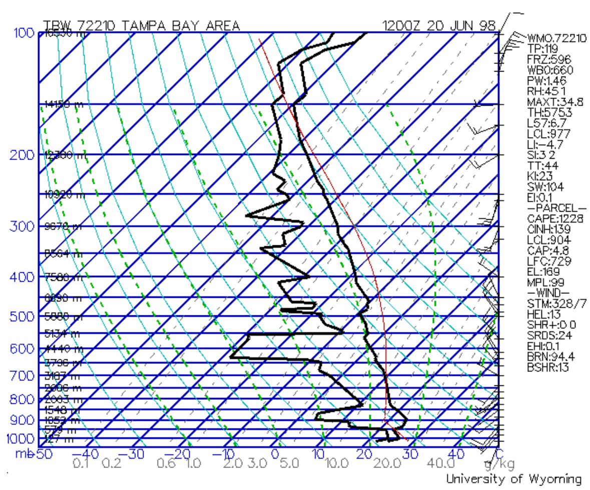

Figure 4. TBW sounding from 1200 UTC 20 June 1998.

By 20/1200 UTC, at TLH, JAX, and TBW, winds were from a varying westerly component from the surface to 150 mb. Wind speeds were less than 5 ms^{-1} near the surface to 10 ms^{-1} at 500 mb and over North Florida, increasing to 15 ms^{-1} at 200 mb. TLH and JAX soundings were much more stable denoting a significant boundary across central Florida. The TBW sounding (fig 4.) shows an unmodified CAPE of 1228 Jkg^{-1}, precipitable water 37 mm, and predicted storm motion 328° at 3.5 ms^{-1}.

C. Mesoscale Analysis
A visual satellite image from 19/2000 UTC (fig 5.) shows anvil convection over the western peninsula and north central interior. A band of developing convection is noted along the east coast sea breeze.

By 19/2200 UTC an infrared satellite image (fig 6.) shows the strongest convection had shifted to northeast Florida along the sea breeze. This convective area remained nearly stationary producing rainfall amounts up to 2 inches with considerable lightning.

Over northeast Florida, June 20 was a dry day with light wind. Convection developed along a Tampa to Cape Canaveral line southward with the storms moving south.

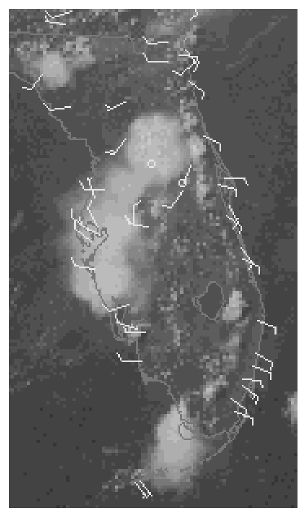

Figure 5. 2000 UTC 19 June 1998 visible satellite image with wind plots.

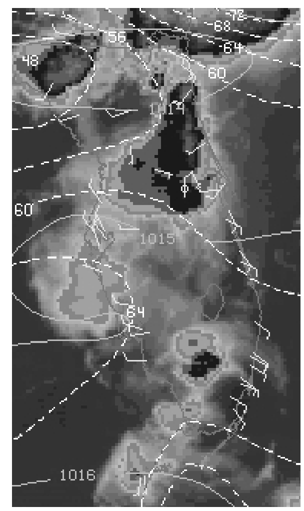

Figure 6. 2200 UTC 19 June 1998 IR satellite image with wind plots, isobars, and relative humidity contours.

D. Comparison of rainfall, lightning and fire initiation.
Figure 7 shows 24 hour rainfall from 1200 UTC 19 June to 1200 UTC 20 June overlaid, with DOF derived locations of fires initiated by lightning, and cloud to ground lightning flashes. Interestingly, the most of the fires developed outside areas of heavy rain. Figure 8 shows 24 hour rainfall from 1200 UTC 20 June to 1200 UTC 21 June, overlaid with DOF derived locations of fires initiated by lightning, and cloud to ground lightning flashes. On the 20th, many more fires flared from lightning that struck the day before in areas temporarily dampened by more than 19 mm of rain the previous day. Even though considerable rain fell over the area, it did not quell the ignitability in this area characterized by pine, palmetto, and gallberry vegetation.

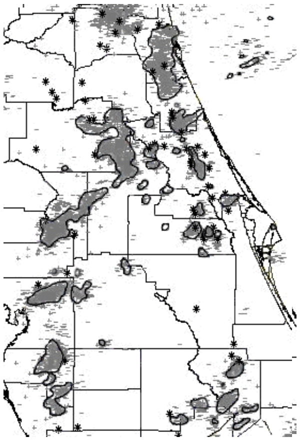

Figure 7. 19 June 1998 1200 UTC to 20 June 1998 1200 UTC. **Rainfall >0.75 inch (solid contours), cloud to ground lightning (+,-), and locations of fire initiation (*).**

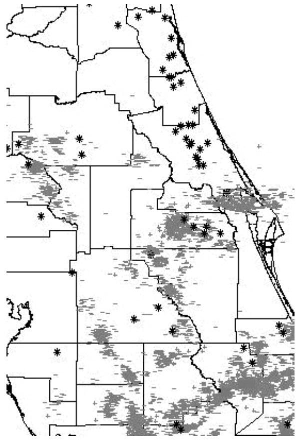

Figure 8. 20 June 1998 1200 UTC to 21 June 1998 1200 UTC. **Cloud to ground lightning (+,-), and locations of fire initiation (*).**

3. WILDFIRE SUPPRESSION 10 JUNE 1998

A. Synoptic Description

A weak mid to upper level trough passed the previous day producing a subsident northwesterly flow. On the surface, the subtropical ridge extended from the Atlantic westward across Florida creating a light wind scenario with wind directions southeast over the south, northerly central, and westerly over the north. Surface dewpoints were typical for June in the 70s.

B. Radiosonde Data

Soundings from10/1200 UTC at TLH and TBW (figs. 9 and 10), show similar northwesterly winds above 500 mb. Below 500 mb, TLH winds have less southerly component. Both locations are stable in the lower layers with susidence inversions 600-700 mb.

C. Mesoscale Analysis

An IR satellite image from 10/2000 UTC (fig 11.) shows convection over the southern peninsula with scattered low and mid clouds over central and north Florida.

By 10/2300 UTC an IR satellite image (fig 12.) shows the convection over south Florida has moved little and one small thunderstorm complex has developed over central Florida just east of Cape Canaveral.

4. DETAILED SOUNDING COMPARISON

Table 1. shows 18 sounding parameters for TLH, JAX, and TBW for 1200 UTC on 10, 19, and 20 June 1998. Additionally to show the difference between the more stable conditions north and unstable atmosphere south on 20 June, the table shows parameter averages for TLH and JAX, and sounding parameters for TBW.

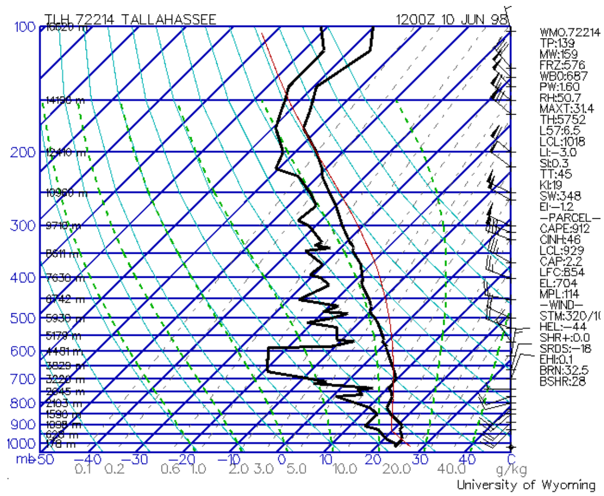

Figure 9. 1200 UTC 10 June 1998 TLH Sounding

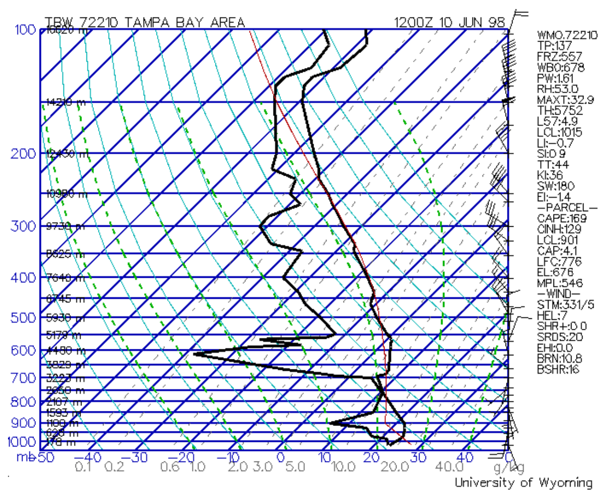

Figure 10. 1200 UTC 10 June 1998 TBW Sounding

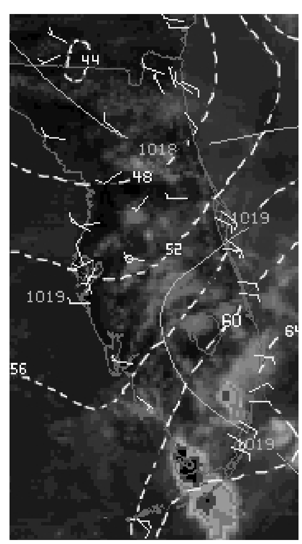

Figure 11. Same as fig. 6 except 2000 UTC 10 June 1998.

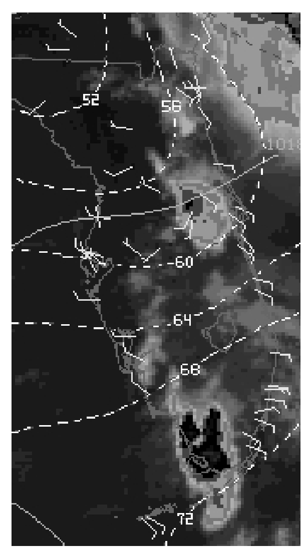

Figure 12. Same as fig. 6 except 2300 UTC 10 June 1998

Table 1. Average 1200 UTC sounding parameters for TLH, JAX, and TBW for 10, 19, and 20 June 1998 and average parameters for TLH and JAX with individual parameters for TBW for 20 June.

JUNE 1998	10 JUN AVG	19 JUN AVG	20 JUN AVG	20 JUN TLH JAX AVG	20 JUN TBW
PW	1.7	1.6	1.6	1.6	1.5
SFC-500 RH	53.4	48.7	55.3	60.5	45.1
SFC LCL	1013	990	997	1008	977
CCL	861	798	786	762	835
LCL	924	867	875	861	903
LFC	816	702	669	640	728
CONV TEMP	32.7	36.7	35.9	36.6	34.5
CAP	2.7	3.6	4.9	5.0	4.9
LI	-2.3	-3.8	-0.9	1.1	-4.7
CAPE	815	1402	443	50	1228
MAX UVV	37.7	51.5	23.2	10.0	49.6
CIN	76.7	172.7	260.0	320.5	139.0
0-6K M DIR	298	210	297	297	298
0-6K M SPD	7.5	4.7	6.6	7.5	4.8
EHI	0.3	0.1	0.1	0.0	0.1
BRN	22.9	130.3	38.7	10.8	94.4
BR SHEAR	32.4	22.3	10.5	9.3	13.0
HAINES	3.0	4.3	4.3	4.0	5

Many sounding parameters varied little but in this comparison. Brotak and Reifsnyder (1977) documented major contributors to wild fire spread including: surface wind greater than 7 m/s, low low-level jets within 3 km of the surface, and instability below 850 mb.

Excessive wind speed did not play a role in these cases but sea breeze convergence provided mechanical lift for lightning storms on the 19 June and the steering wind kept those storms nearly stationary. The significant parameters are those associated with stability. The outbreak was associated with low stability but most important was the ignition agent lightning. Greater stability the following day, as evidenced by CAPE, CIN, and LI values, led to sunny dry conditions permitting smouldering fires from the prior day to burn freely.

The Lower Atmospheric Severity Index (LASI), Haines (1988), is used to quantify the atmosphere's contribution to the growth potential of wildland fires. Also known as the "Haines Index", LASI combines a stability and moisture factor. Low stability promotes organized smoke columns that lead to faster burn rates. Low relative humidity, will also increase the rate of fire spread. Wind, fuel moisture, terrain slope, fuel continuity, or ignition elements such as lightning. are not taken into account. The stability and moisture terms are related to an index number ranging from “2" - a moist and stable airmass with very low fire growth potential to “6" a dry and unstable airmass with high fire growth potential. In this case LASI ranged from a a value of 3 (very low fire growth potential) on the suppression day to 5 Moderate Fire Growth Potential at TBW on both outbreak days.

5. CONCLUSIONS

The three days examined during this exceptional period of drought and wildfires represent the difficulty in trying to predict conditions associated with outbreaks and suppression. For these cases, the dominant feature was the ongoing rainfall deficit. Of significance to forecasters are stability parameters, lightning prediction, and airmass boundaries.

Accompanying the suppression event, a stable subsident airmass moved over Florida. In this broad area of subsidence only a few clouds developed, and thus no lightning for fire ignition. Ongoing fires were few and with less intense fires, firefighters were able to contain them.

The outbreak began with a intense convection and heavy rain but not enough rain to significantly decrease the chance of lightning ignited fires. Instead of a broad area of rain sweeping across the state, intense lightning storms with limited nearly stationary heavy rainfall developed. The second day of the outbreak period, stable air moved over the northern half of Florida with a boundary slicing across the central peninsula.

Lightning frequency prediction is still more art than science. Perhaps future work will examine the relationship between lightning frequencies and sounding parameters.

6. ACKNOWLEDGMENTS

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