
FIRE DANGER
PERKINS
FIRE DEPT

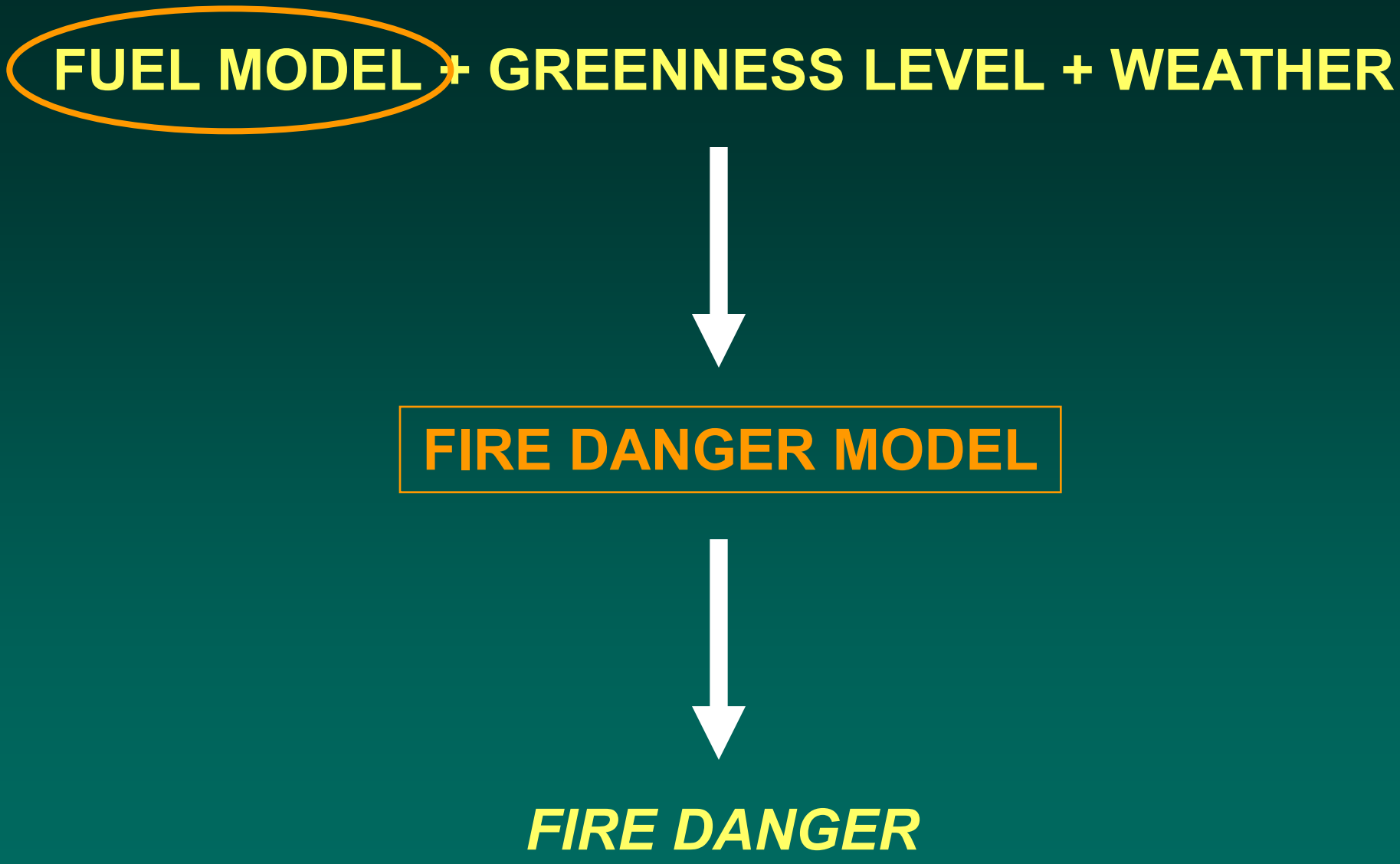
Questions You Should Be Able to Answer by the End of this Module

- What are the three major physical determinants of fire danger?
- What are the differences between dead and live fuels?
- How do 1-h and 10-h dead fuels respond differently to weather conditions than 100-h and 1000-h fuels?
- What is a fuel model and how can I change it on OK-FIRE?
- Why is relative greenness (RG) important to fire danger in OK-FIRE?
- What fire danger variables do fuel model and RG influence in OK-FIRE?

What do we mean by FIRE DANGER?

the ability or potential of a wildland fire to start, spread, resist control, and do damage


Fire Danger
FUEL LOADINGS + FUEL MOISTURE + WEATHER


FUEL MODEL + GREENNESS LEVEL + WEATHER
FIRE DANGER MODEL
FIRE DANGER


Wildland Fuels

Wildland Fuels

- Dead Fuels
- Live Fuels


Dead Fuels

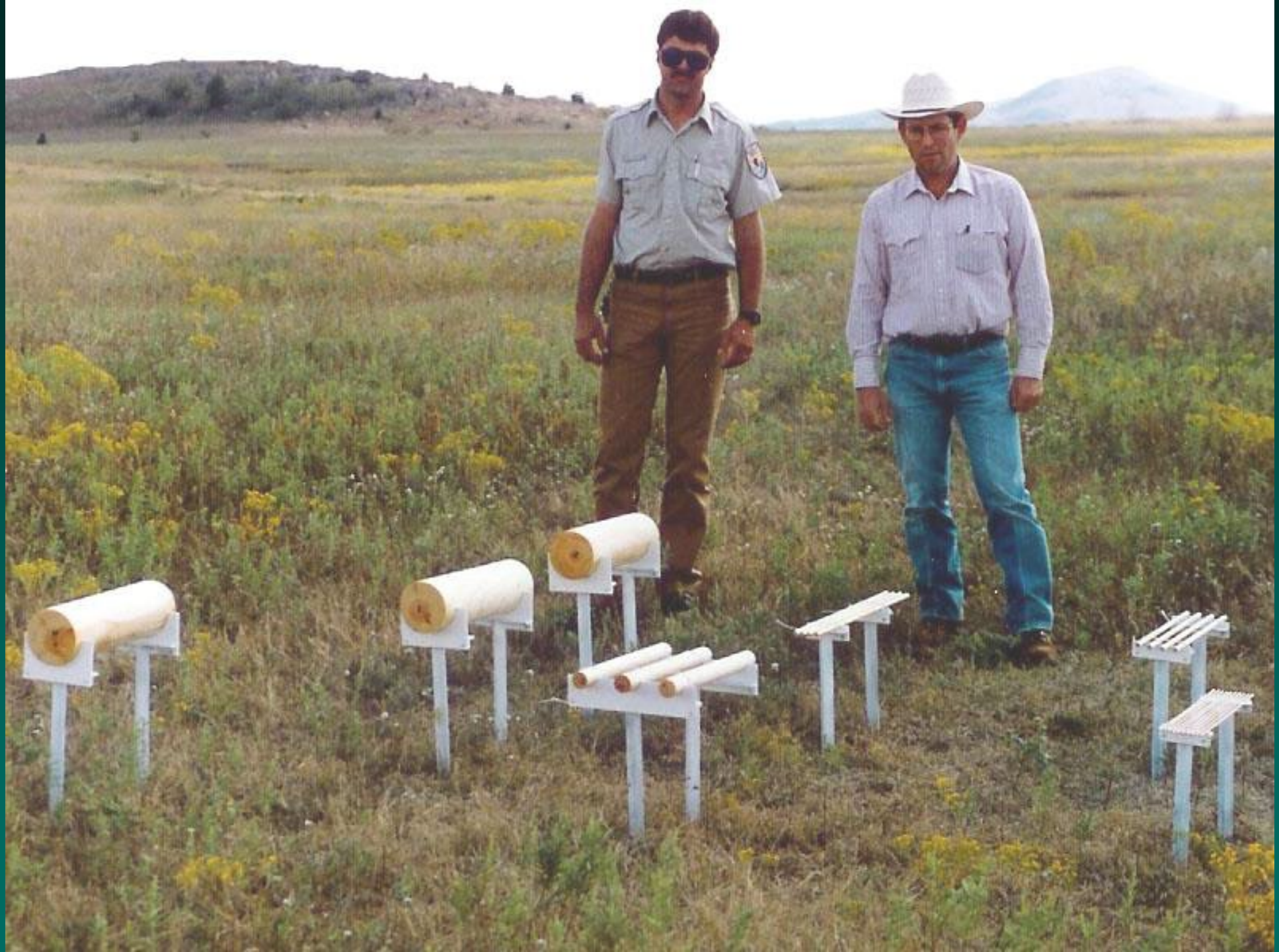
Dead Fuels

(moisture content controlled exclusively by weather conditions)

- **Dead roundwood**
- **Cured/dead vegetation**
- **Litter/Duff**

Classification of Dead Fuels

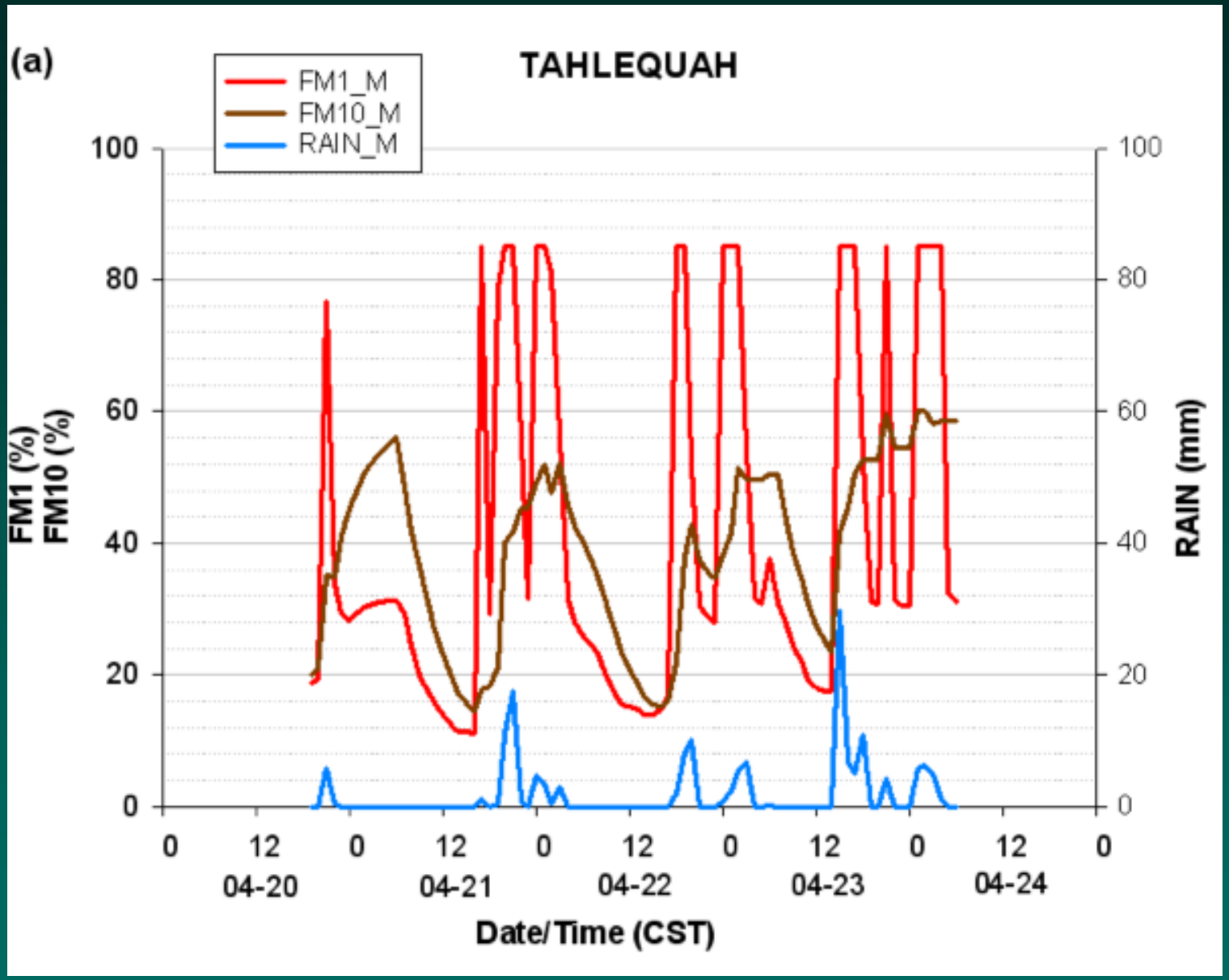
- 1-hour (dia < 1/4”; depth < 1/4”)
- 10-hour (dia = 1/4 - 1”; depth = 1/4 - 1”)
- 100-hour (dia = 1 - 3”; depth = 1 - 4”)
- 1000-hour (dia = 3 - 8”; depth = 4 - 12”)



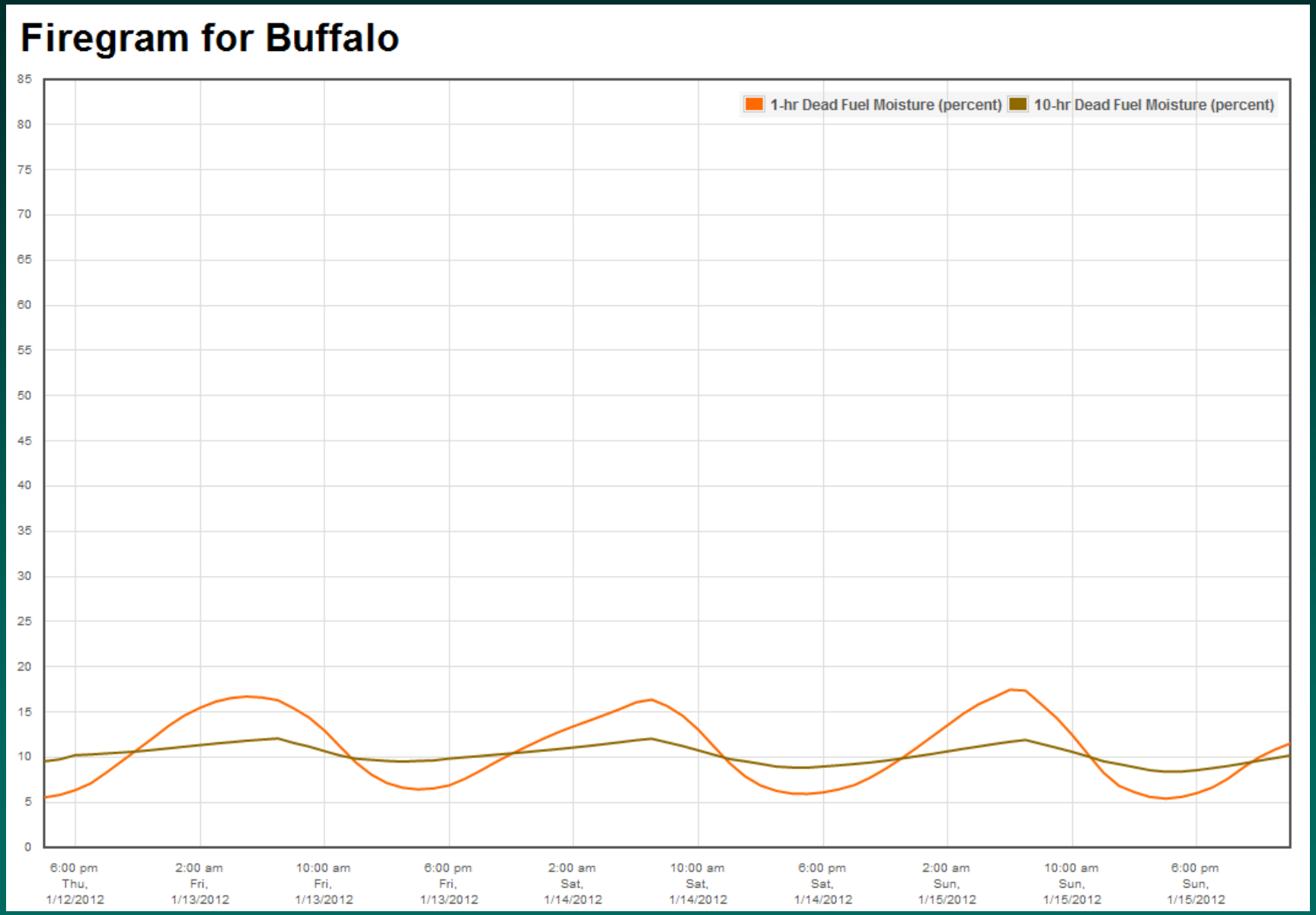
Dead Fuel Moisture
(the "Nelson model")

- **1-hour**
  - 1-85%
- **10-hour**
  - 1-60%
- **100-hour**
  - 1-40%
- **1000-hour**
  - 1-32%

1-h and 10-h Dead Fuel Moisture


(a)
TAHLEQUAH
FM1_M
FM10_M
RAIN_M
100
80
60
40
20
0
FM1 (%)
FM10 (%)
RAIN (mm)
0
12
04-20
04-21
04-22
04-23
04-24
Date/Time (CST)

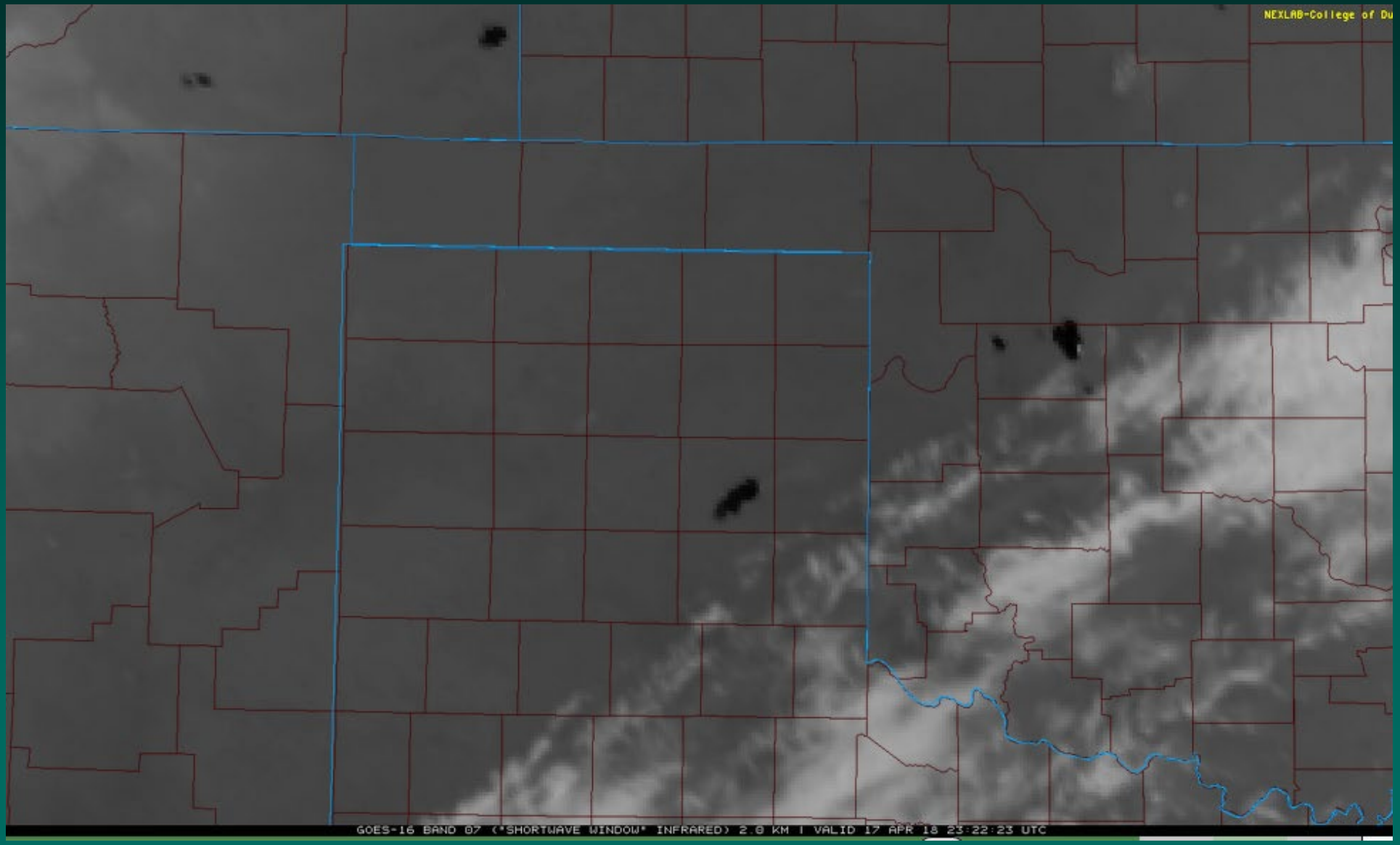
Typical Daily Pattern when No Rain



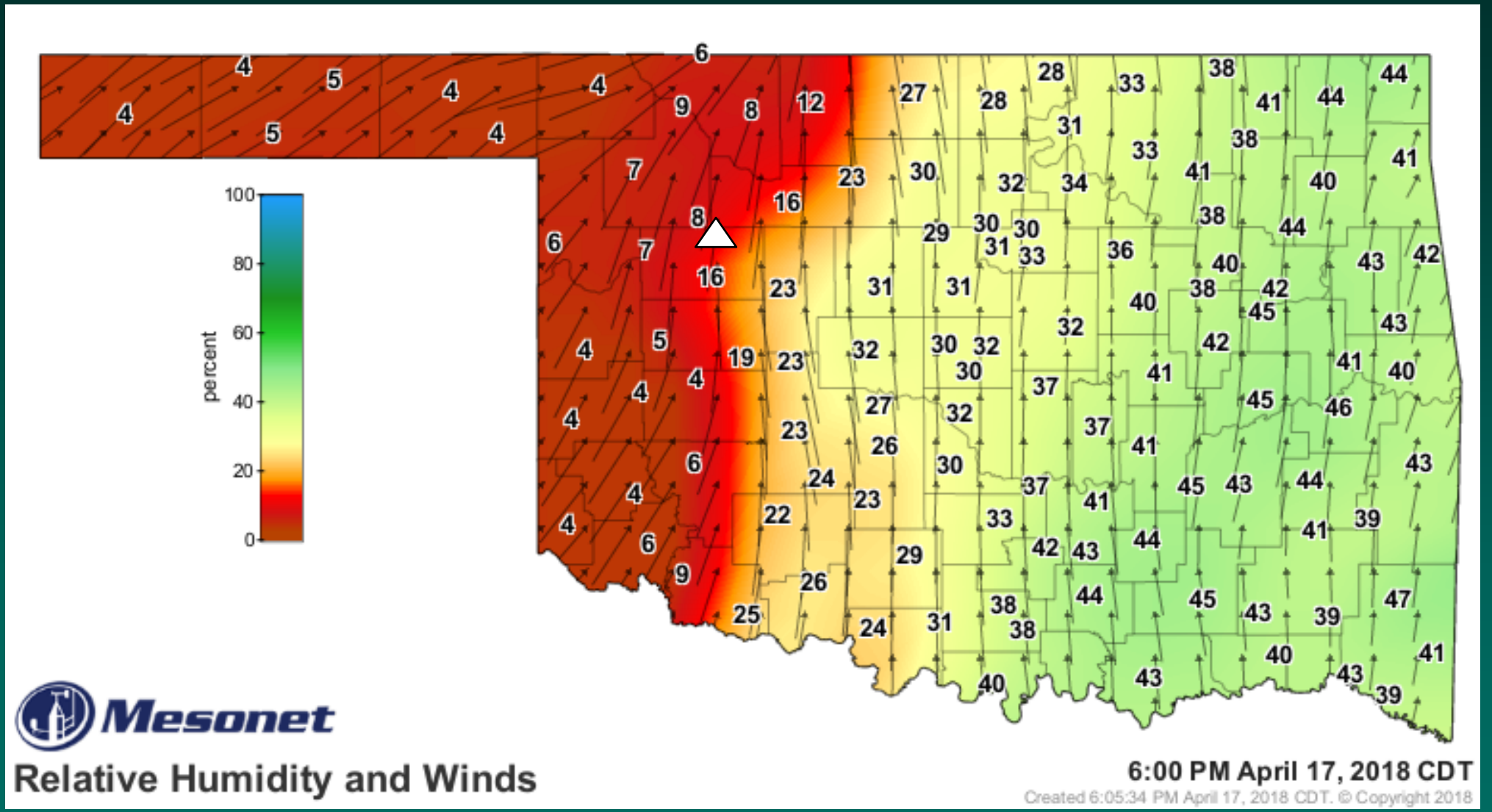
1 and 10-h Dead Fuel Moisture

1-hr fuels	10-hr fuels	Fire Behavior
> 20%	> 15%	Fuels too moist for fire spread; heavy smoke possible
7-20%	6-15%	Normal range for prescribed burning
5-7%	5-6%	Containment difficult; quick ignition; spotfires increase
< 5%	< 5%	Extreme fire behavior; spotfires frequent; burn with extreme caution

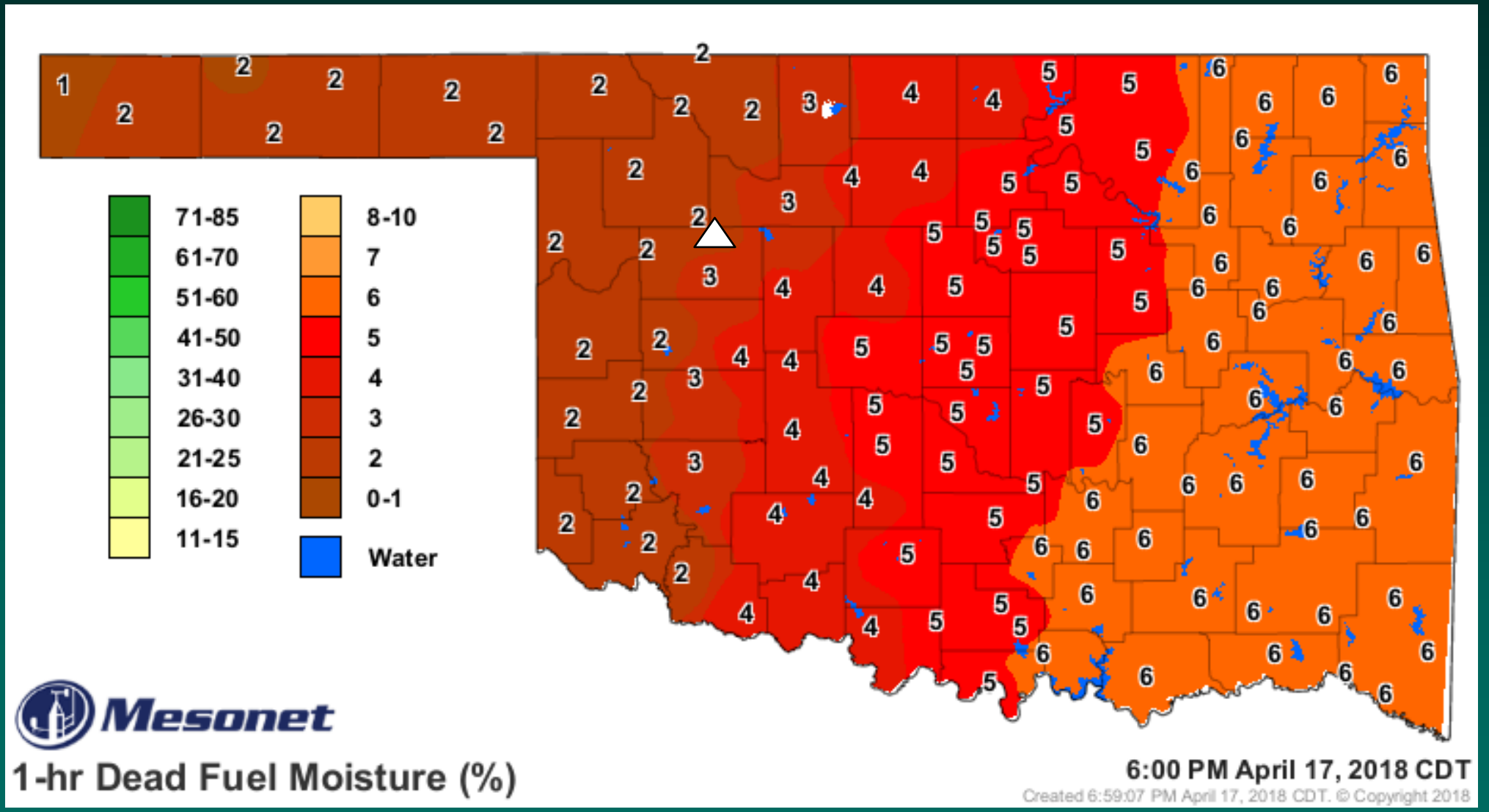
3.9 Micron Infrared – April 17, 2018



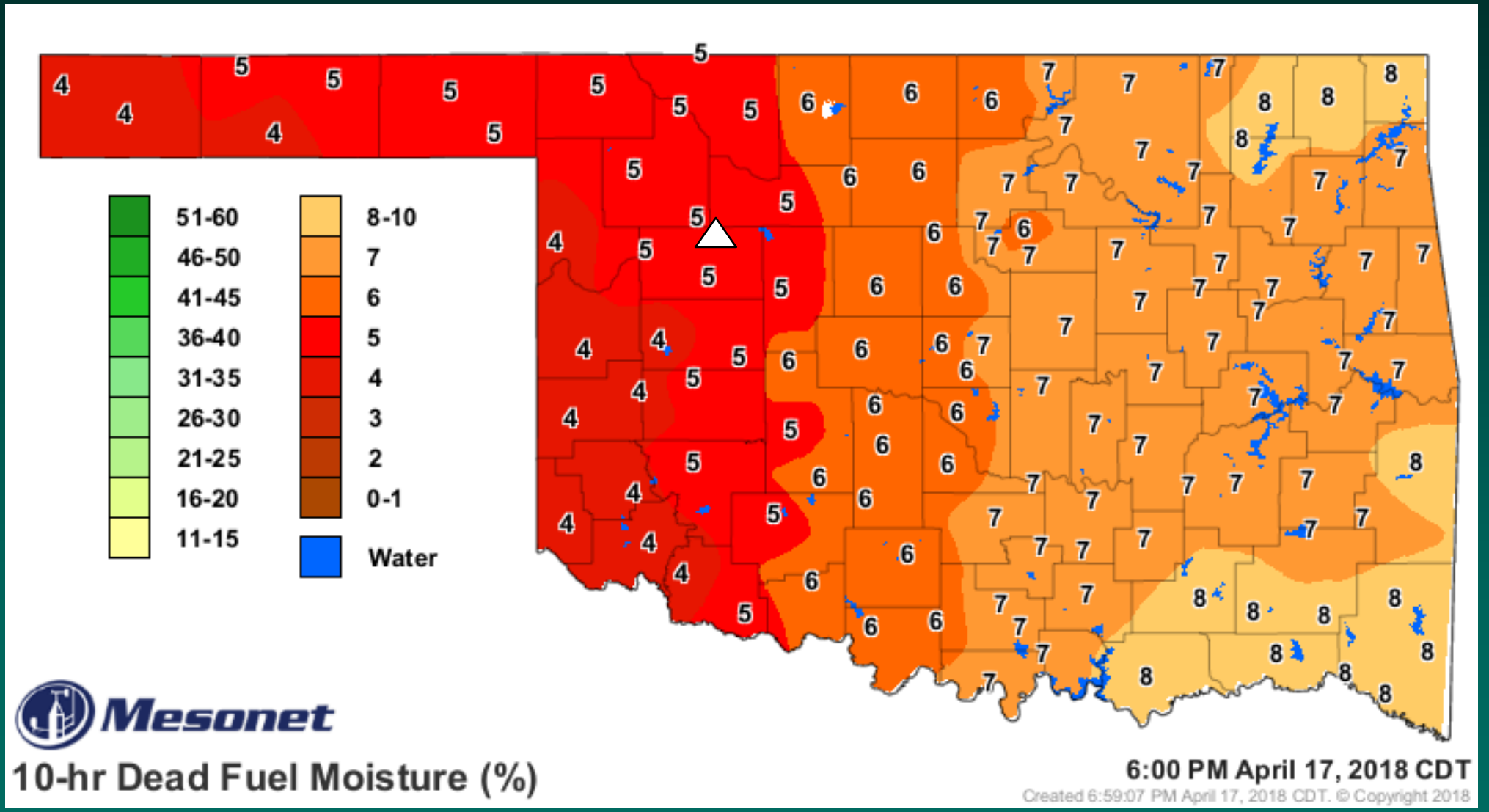
Relative Humidity and Winds



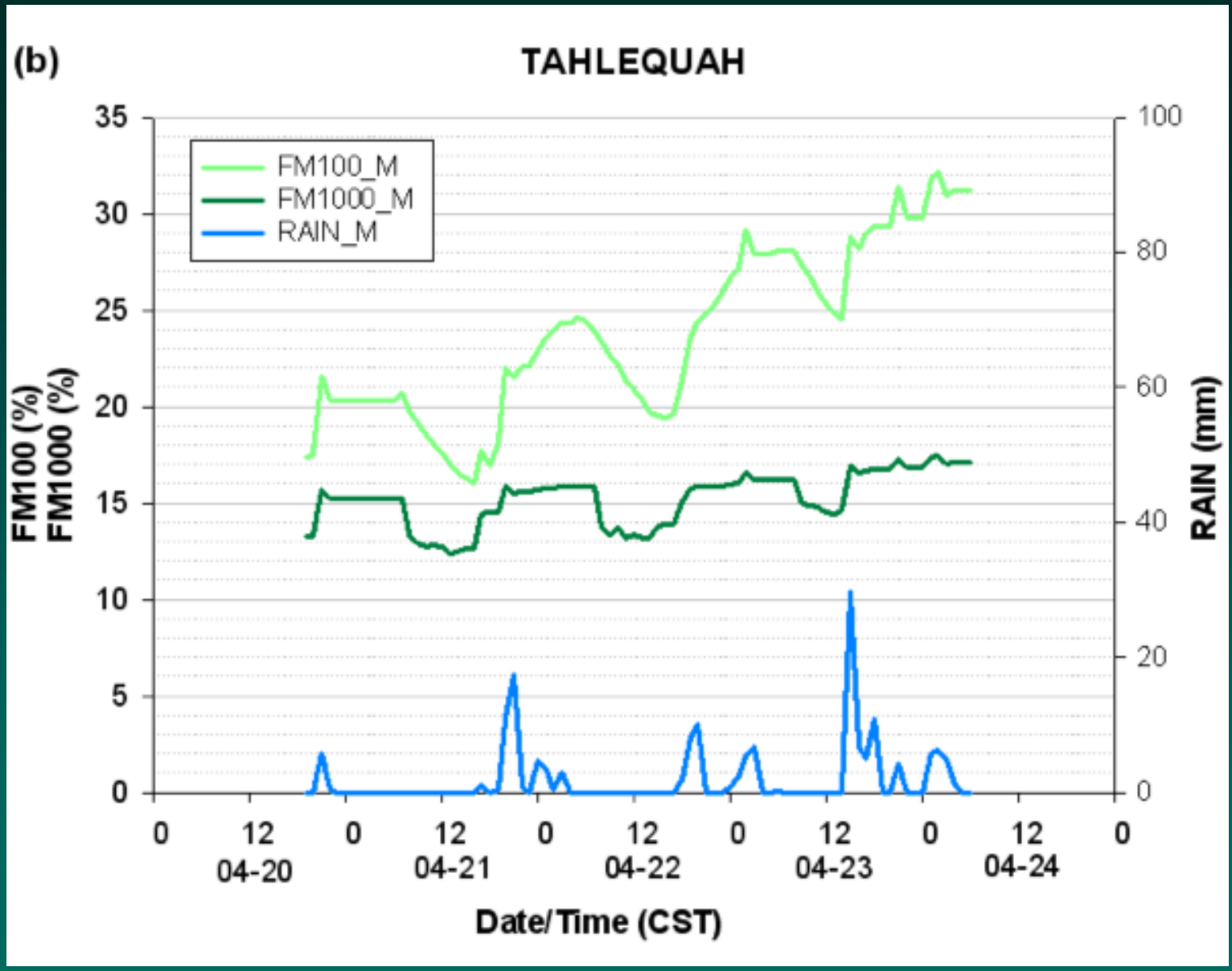
1-hr Dead Fuel Moisture



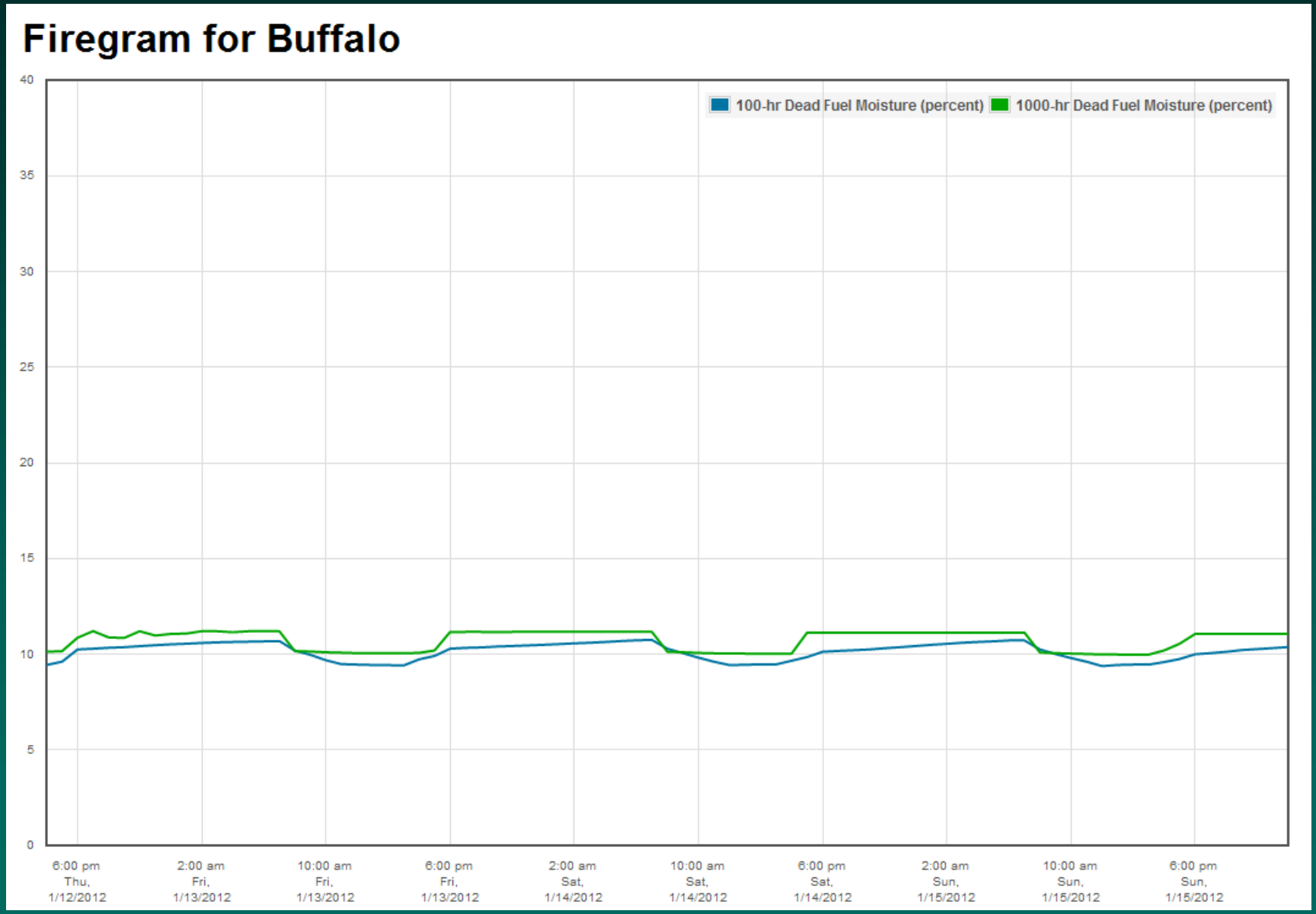
10-hr Dead Fuel Moisture



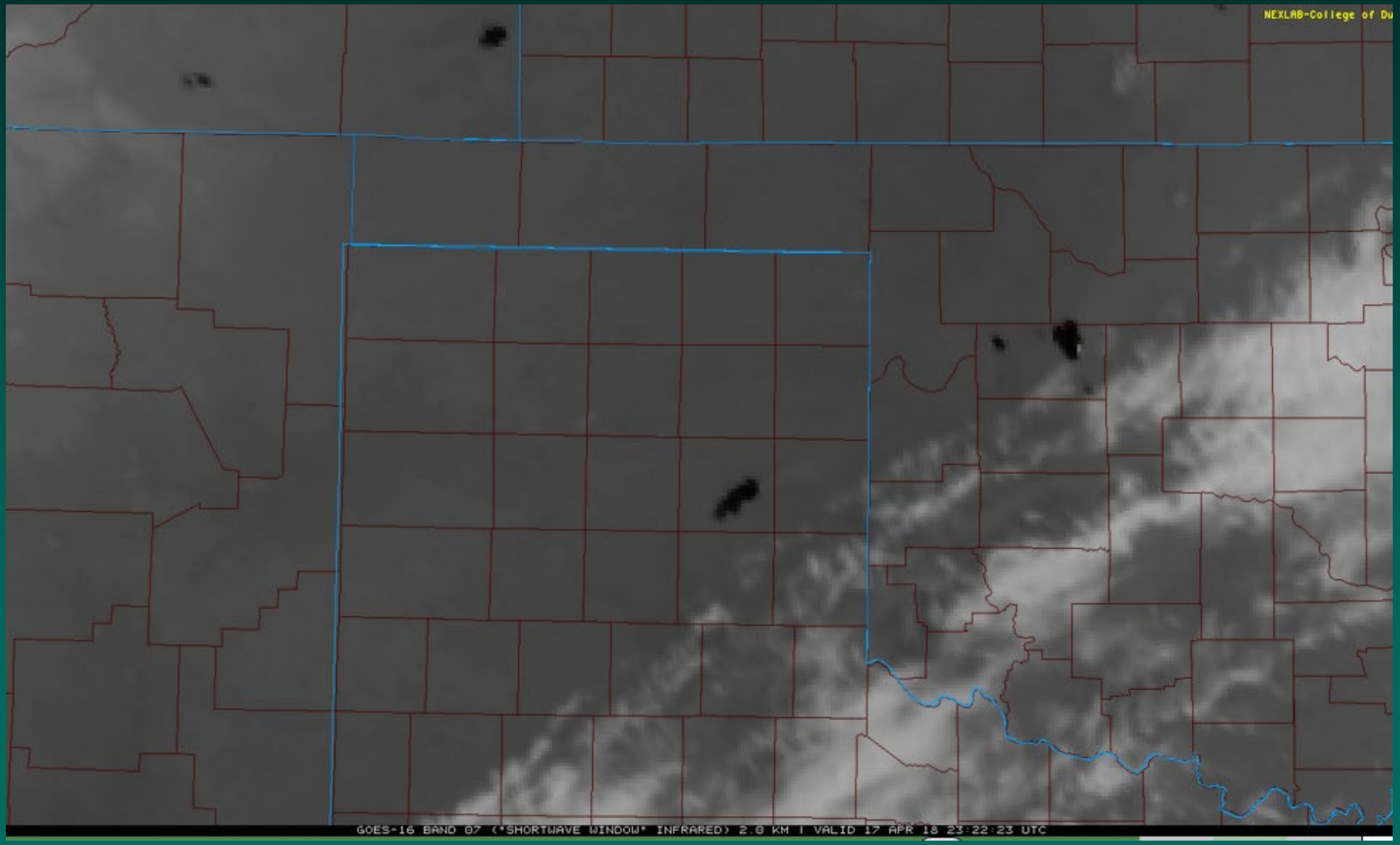
100-h and 1000-h Dead Fuel Moisture


(b)
TAHLEQUAH
FM100_M
FM1000_M
RAIN_M
FM100 (%)
FM1000 (%)
RAIN (mm)
35
30
25
20
15
10
5
0
100
80
60
40
20
0
0
12
04-20
0
12
04-21
0
12
04-22
0
12
04-23
0
12
04-24
0
Date/Time (CST)

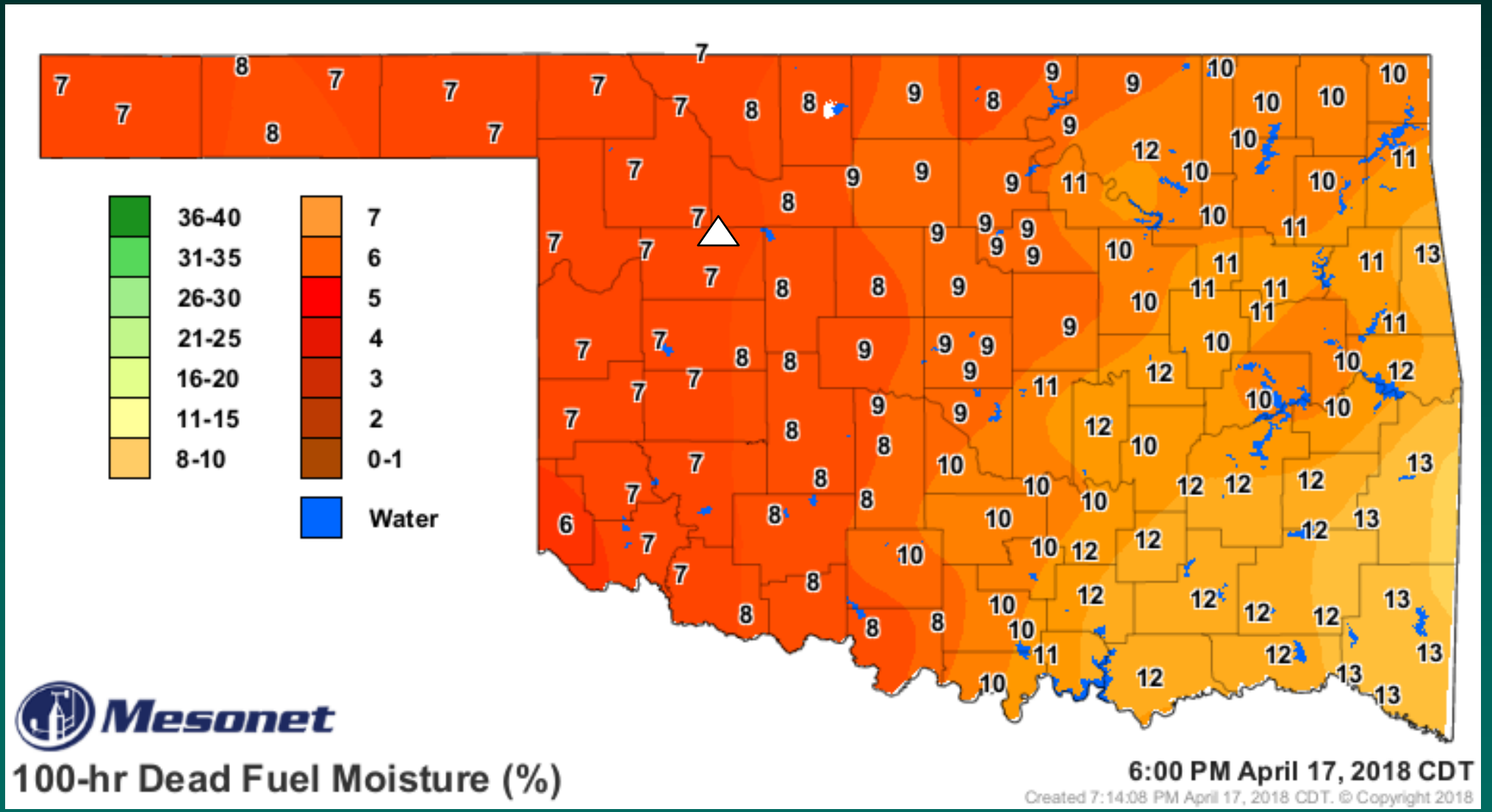
Typical Daily Pattern when No Rain



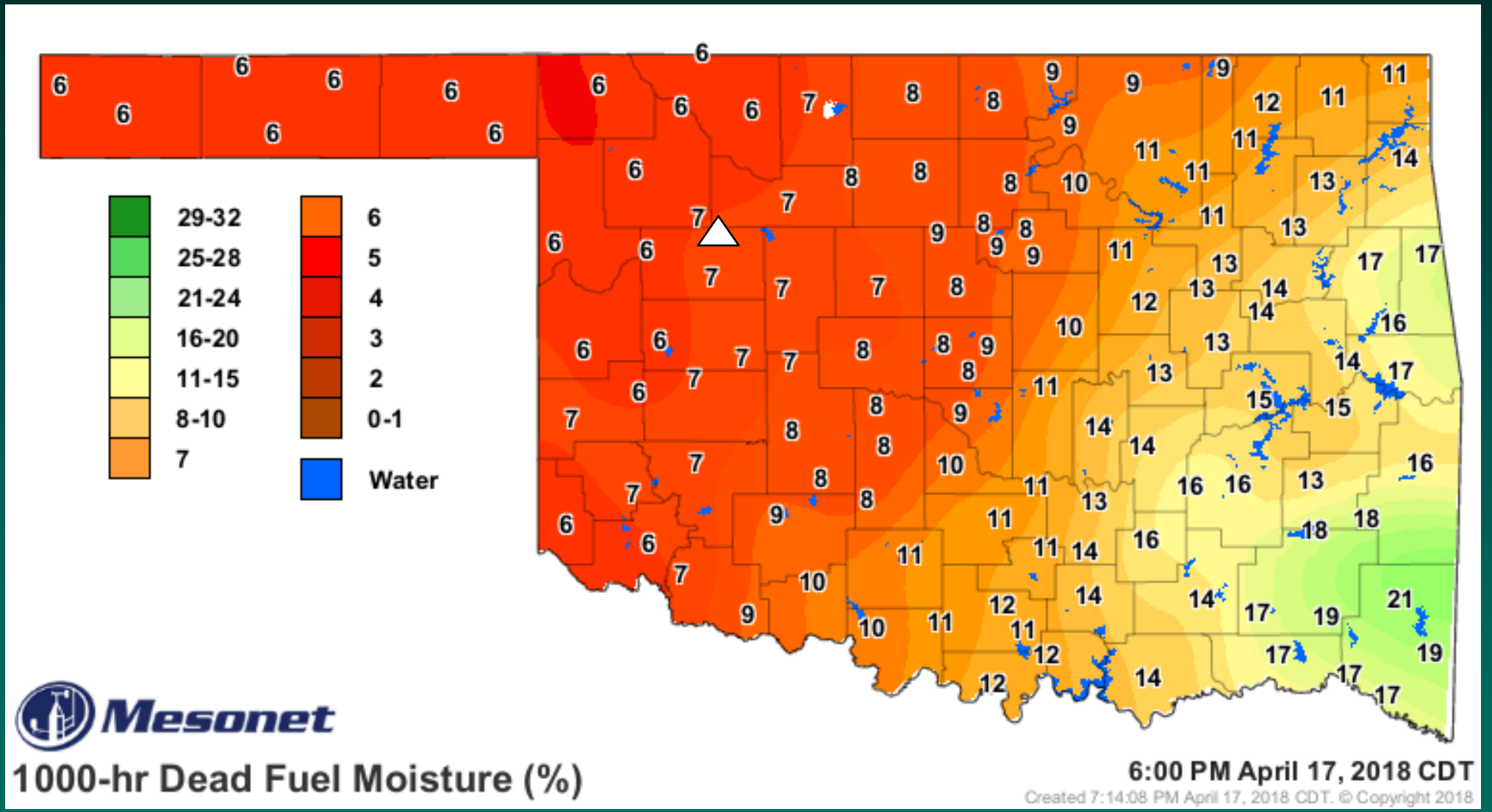
3.9 Micron Infrared – April 17, 2018



100-hr Dead Fuel Moisture



1000-hr Dead Fuel Moisture

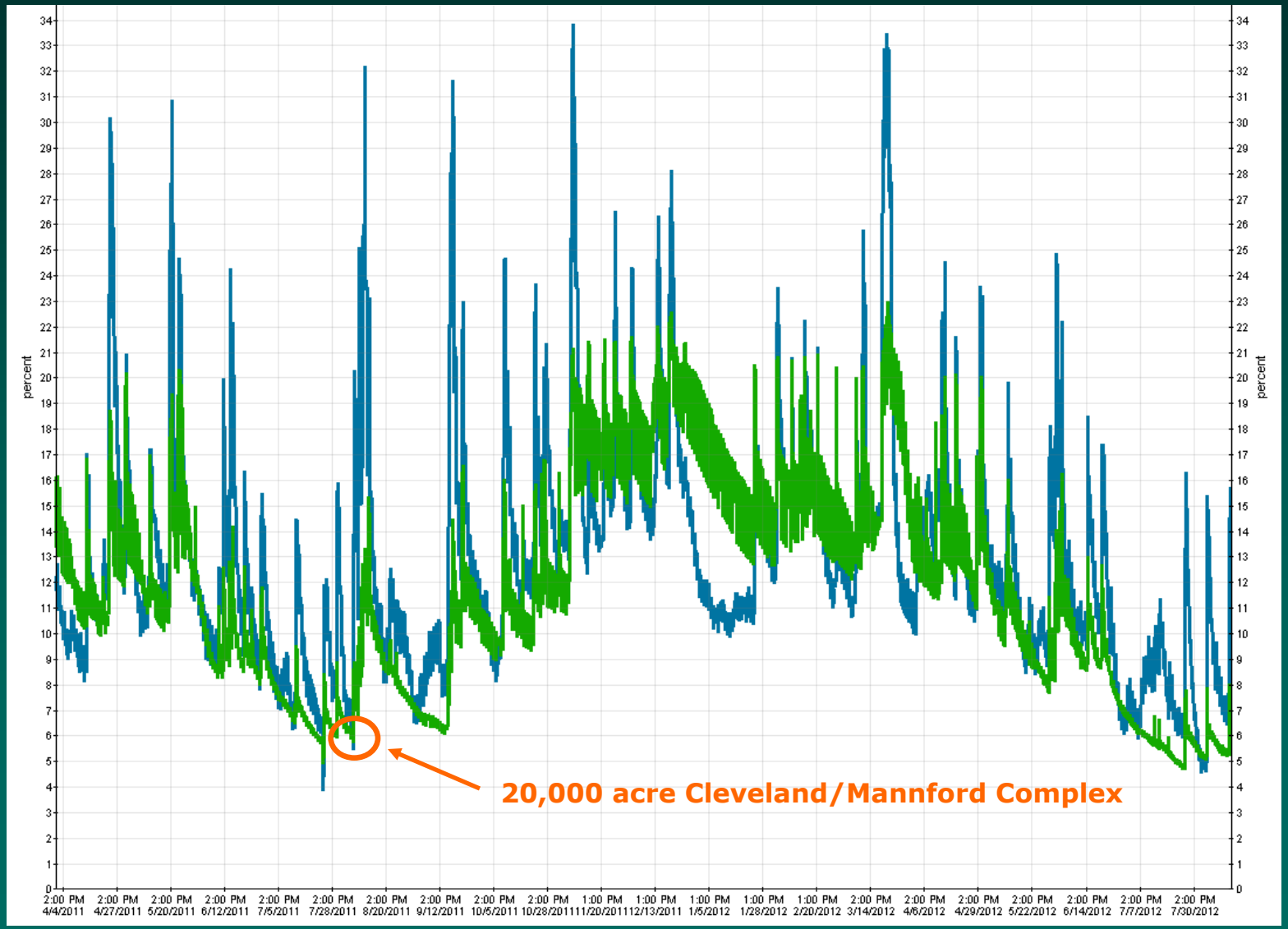


Cleveland/Mannford Complex

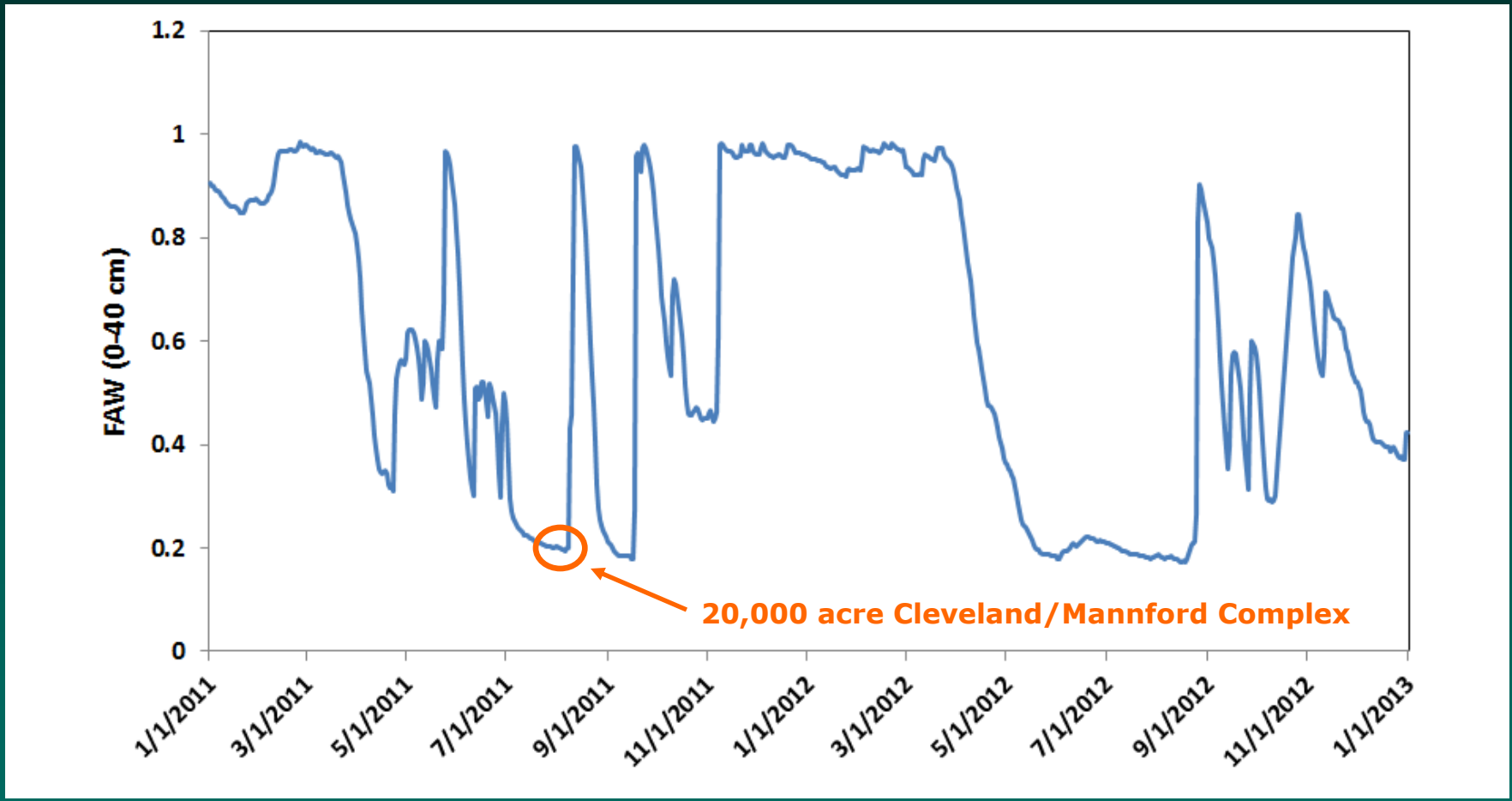
August 5-10, 2011

20,129 acres

100-hr (blue) and 1000-hr (green) Dead Fuel Moisture *(Oilton)*



16” Fraction of Plant Available Water
(Oilton)

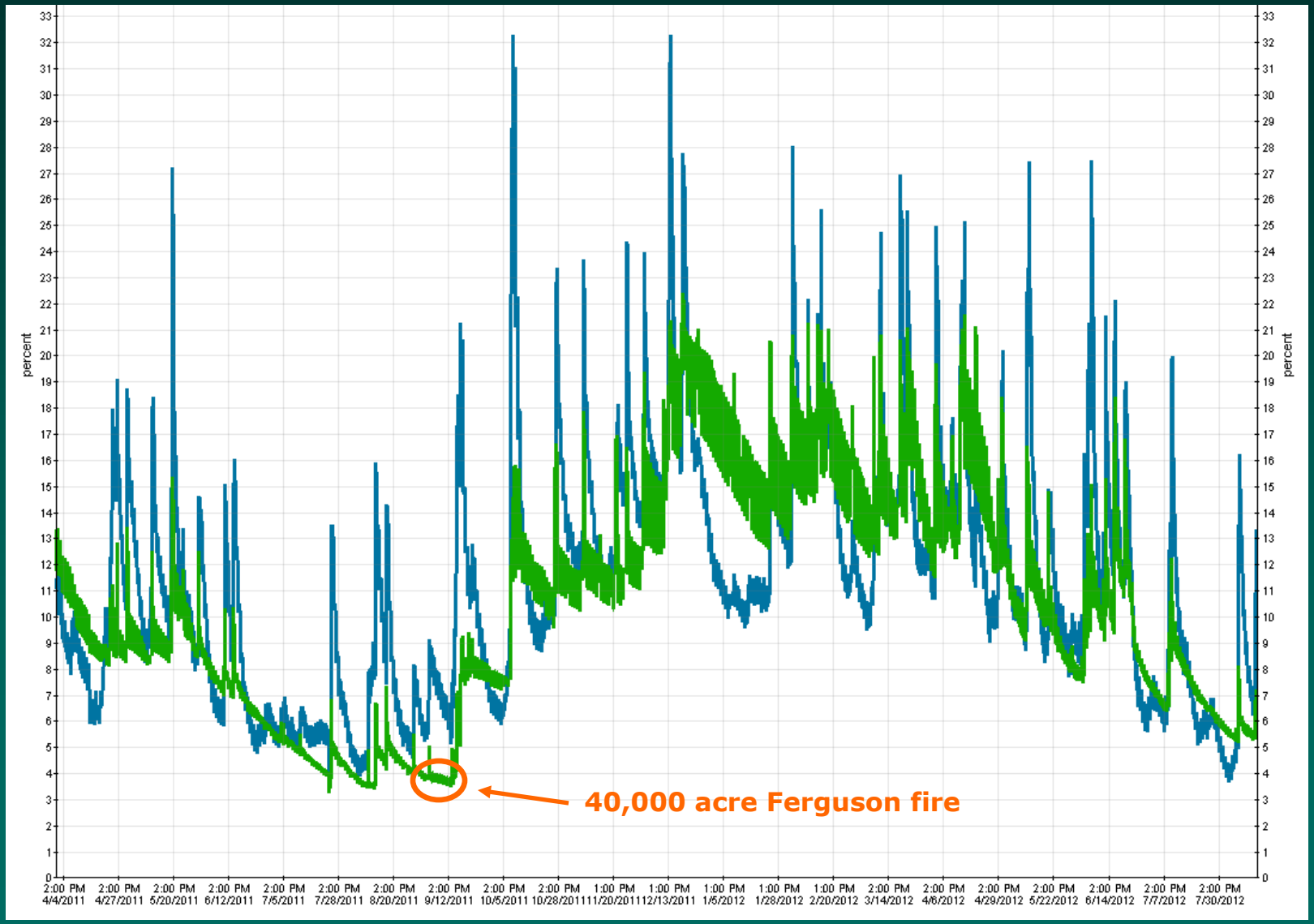


Ferguson Fire

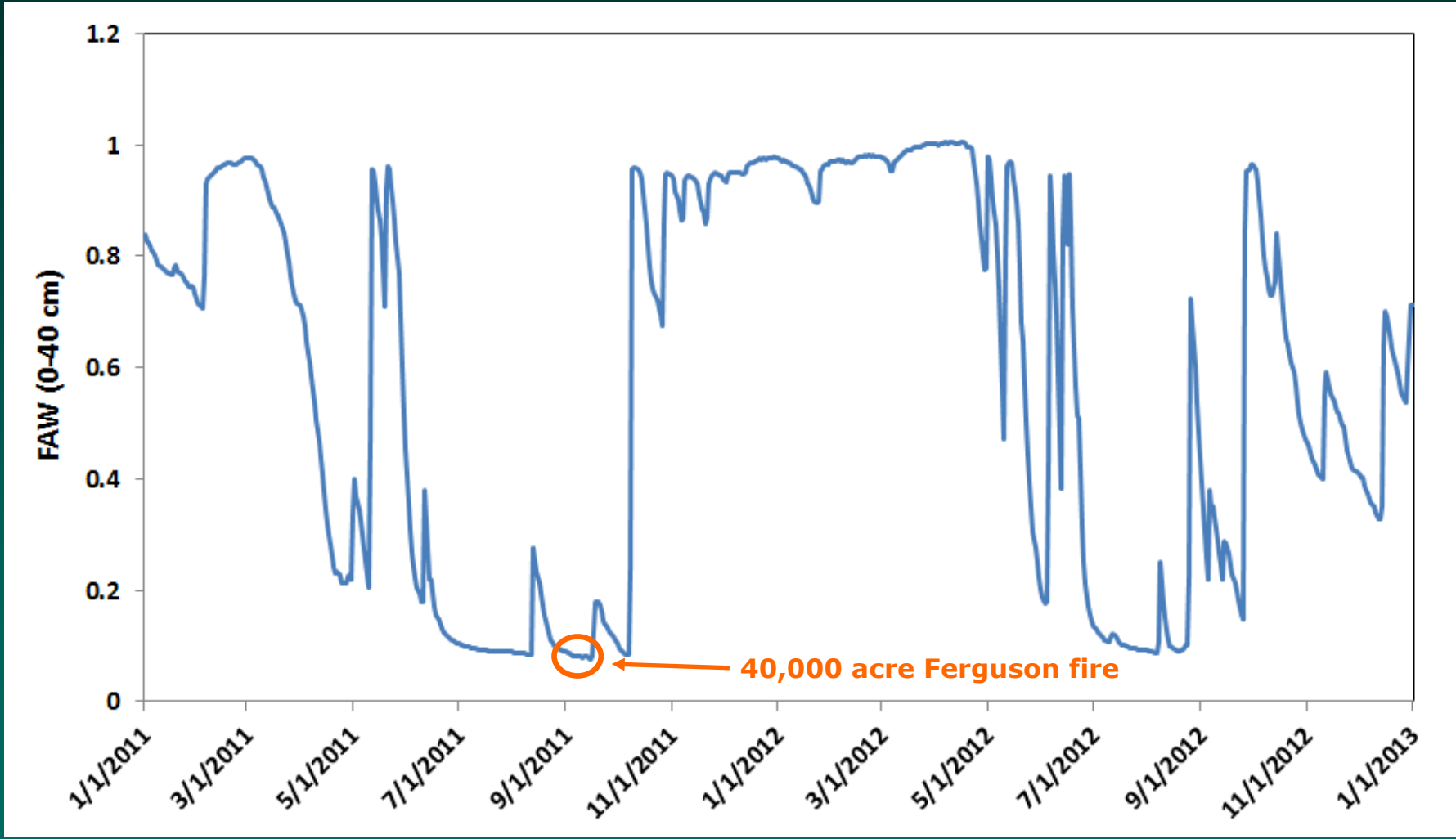
September 1-10, 2011

39,907 acres

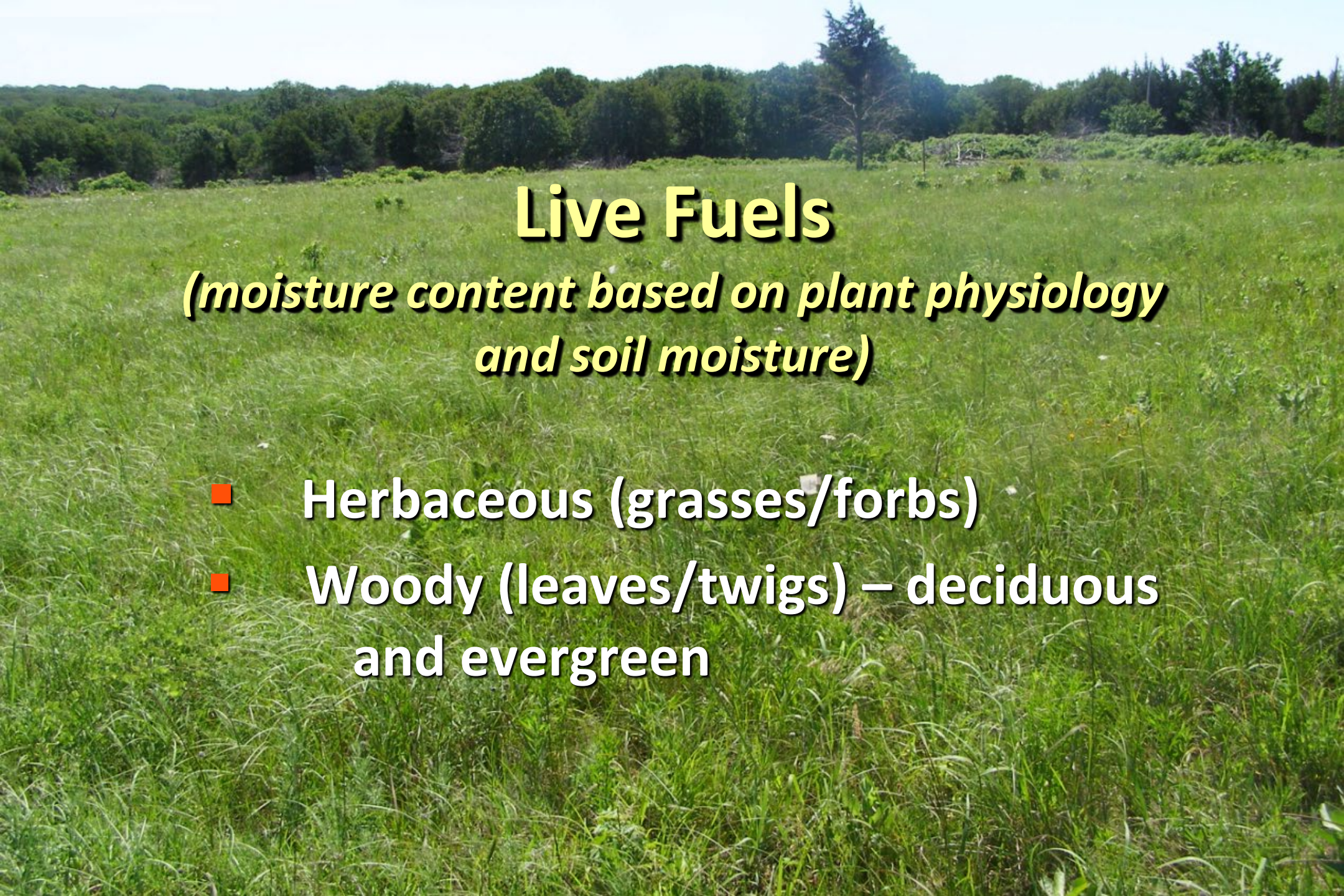
100-hr (blue) and 1000-hr (green) Dead Fuel Moisture *(Medicine Park)*



16” Fraction of Plant Available Water
(Medicine Park)



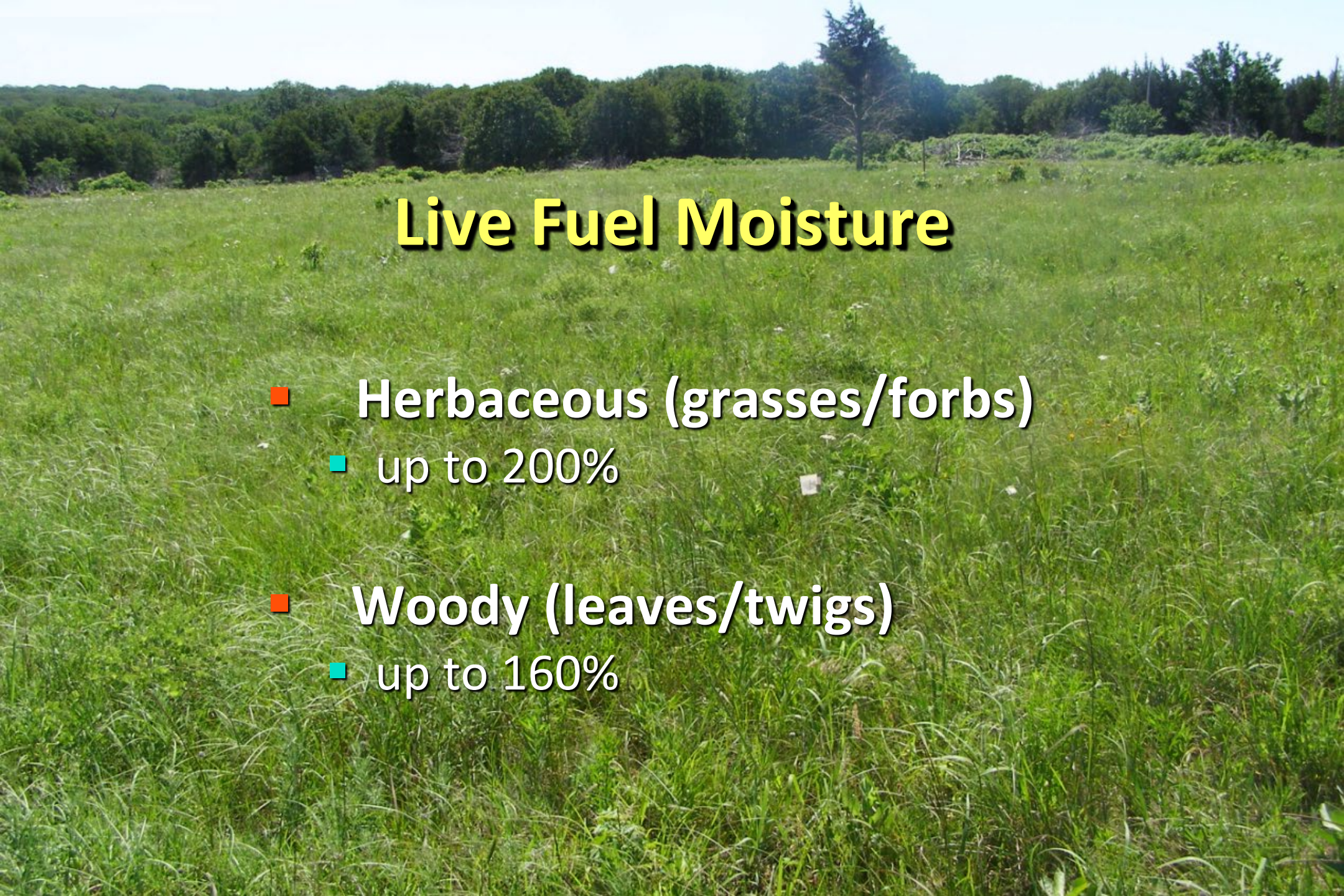

Live Fuels



Live Fuels

(moisture content based on plant physiology and soil moisture)

- **Herbaceous (grasses/forbs)**
- **Woody (leaves/twigs) – deciduous and evergreen**



Live Fuel Moisture

- **Herbaceous (grasses/forbs)**
  - up to 200%
- **Woody (leaves/twigs)**
  - up to 160%

Napa County, California – October 2017 Fires

Web Site Demo:
Fuel Moisture Products in OK-FIRE


Fuel Models

1988 NFDRS Fuel Models (20 Models)

- **Loading of Dead Fuels (tons/acre)**
  - 1-hr
  - 10-hr
  - 100-hr
  - 1000-hr
  - drought
- **Loading of Live Fuels (tons/acre)**
  - herbaceous
  - woody




1988 NFDRS Fuel Model Descriptions

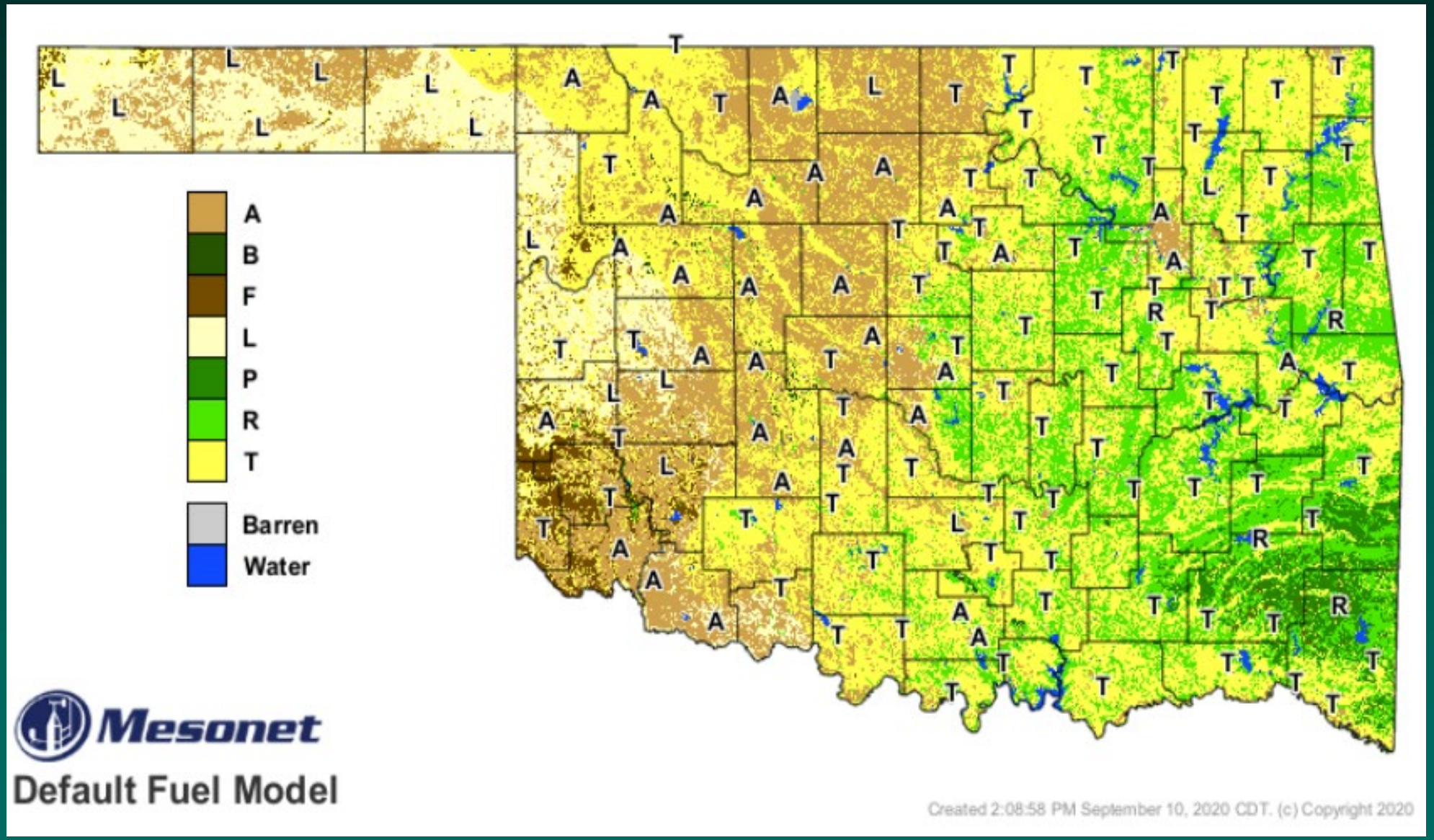
Fuel model parameters	Fuel model A	B	C	D	E	F	G	H	I	J	K	L	N	O	P	Q*	R	S	T	U
Load (tons/acre)																				
1-hour dead	0.2	3.5	0.4	2.0	1.0	2.5	2.5	1.5	12.0	7.0	2.5	0.25	1.5	2.0	1.0	2.5	0.5	0.5	1.0	1.5
10-hour dead	--	4.0	1.0	1.0	0.5	2.0	2.0	1.0	12.0	7.0	2.5	--	1.5	3.0	1.0	5.4	0.5	0.5	0.5	1.5
100-hour dead	--	0.5	--	--	0.25	1.5	5.0	2.0	10.0	6.0	2.0	--	--	3.0	0.5	2.9	0.5	0.5	--	1.0
1000-hour dead	--	--	--	--	--	--	12.0	2.0	12.0	5.5	2.5	--	--	2.0	--	1.0	--	0.5	--	--
Woody	--	11.5	0.8	3.0	1.0	7.0	0.5	0.5	--	--	--	--	2.0	7.0	0.5	3.0	0.5	0.5	2.5	0.5
Herbaceous	0.3	--	0.8	1.0	0.5	1.0	0.5	0.5	--	--	--	0.5	--	--	0.5	1.0	0.5	0.5	0.5	0.5
Drought	0.2	3.5	1.8	1.5	1.5	2.5	5.0	2.0	12.0	7.0	2.5	0.25	2.0	3.5	1.0	3.5	0.5	1.5	1.0	2.0




Oklahoma Default Fuel Models

- Grassy Models
  - Model A
  - Model L
  - Model T
- Brushy Models
  - Model B
  - Model F
- Forest Models
  - Model P
  - Model R

Oklahoma Default Fuel Models



- Current Station Conditions
- Current Maps
- Past & Forecast Animated Maps
- Past & Forecast Charts/Tables
- Fire Prescription Planner
- NWS Forecast Chart (Stillwater)
- NWS Forecast Table (Stillwater)
- Relative Greenness Zoom Map
- Default Fuel Model Zoom Map
- Fire Advisories and Outlooks
- 3.9 µ Infrared Satellite Map
- Recent Lightning Activity
- Oklahoma Burn Bans
- Additional Resources
- Contacts and Learning Tools
- News

Current Fuel Model for Stillwater

T - Tallgrass with open evergreen b

Default is T

Station Fuel Model Options

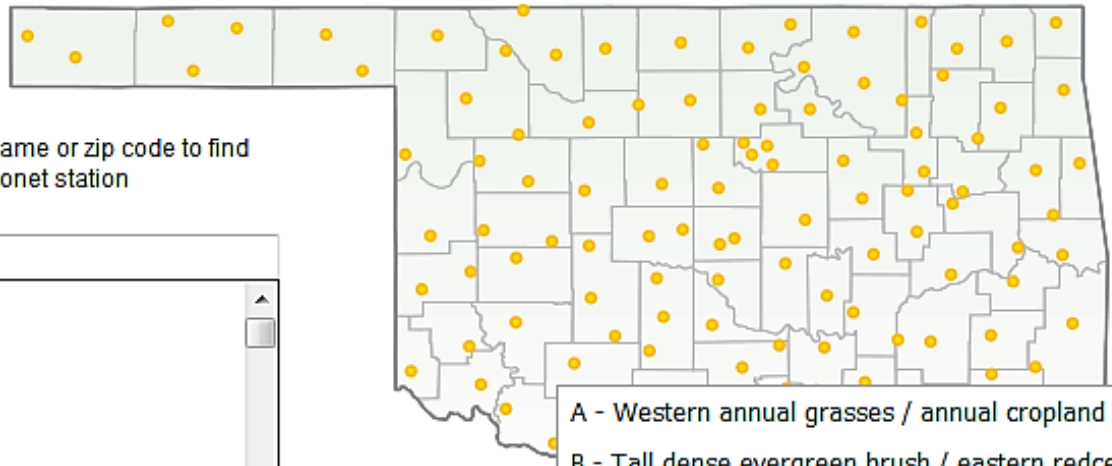
OK-FIRE

Station Fuel Model Options

Share Tweet

Select Mesonet Station

Note that fire MAP products will retain the default models at Mesonet sites



Type in city name or zip code to find nearest Mesonet station

Acme
Ada
Altus
Alva
Antlers
Apache

Station:

Default Fuel Model:

Current Fuel Model:

Fuel Model D

Change Current Fuel Model to: A - Western annual grasses / annual cropland / urban

- A - Western annual grasses / annual cropland / urban
- B - Tall dense evergreen brush / eastern redcedar
- F - Intermediate evergreen brush
- G - Forest with heavy downed fuels
- K - Light slash
- L - Western perennial grasses
- P - Southern pine forest
- R - Hardwood forest
- T - Tallgrass with open evergreen brush

Save Fuel Model

Station Fuel Model Options

Grassy Models

A - Western annual grasses / annual cropland / urban	*(default model)*
L - Western perennial grasses	*(default model)*
T - Tallgrass with open evergreen brush	*(default model)*

Brushy Models

B - Tall dense evergreen brush / eastern redcedar	*(default model)*
F - Intermediate evergreen brush	*(default model)*

Forest Models

G - Forest with heavy downed fuels	
P - Southern pine forest	*(default model)*
R - Hardwood forest	*(default model)*

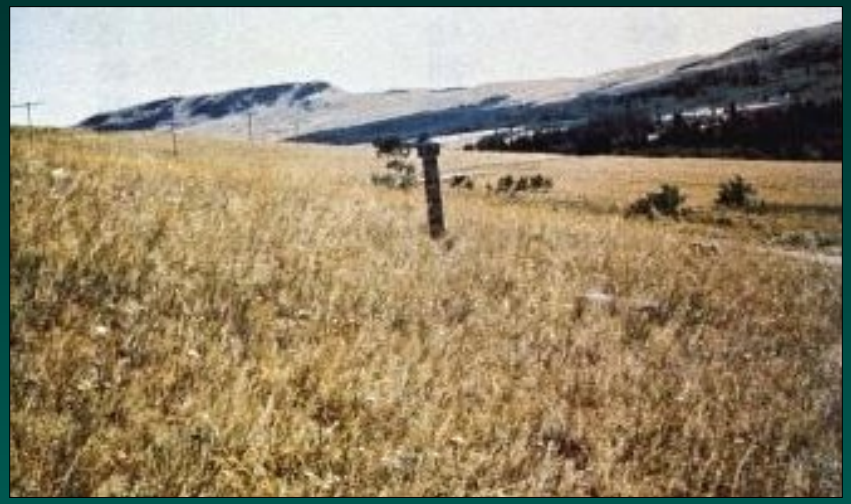
Light Slash

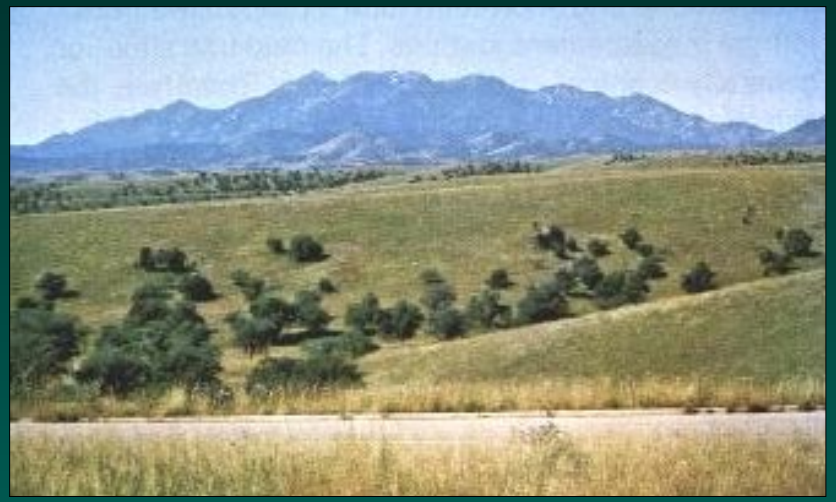
K - Light slash


Grassy Fuel Models

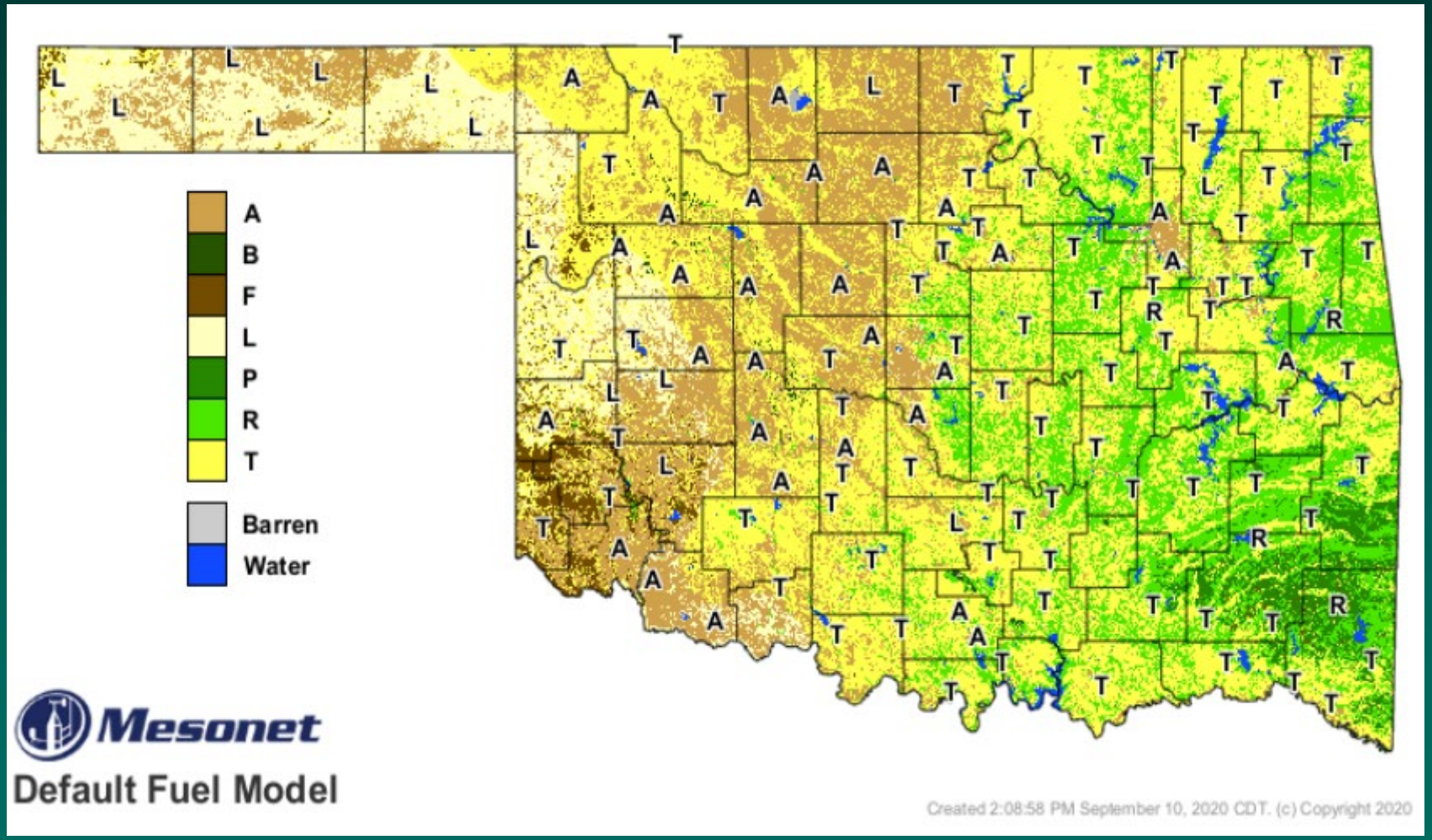
Fuel Model A: Western Annual Grasses

(also used in OK-FIRE for annual cropland and urban areas)



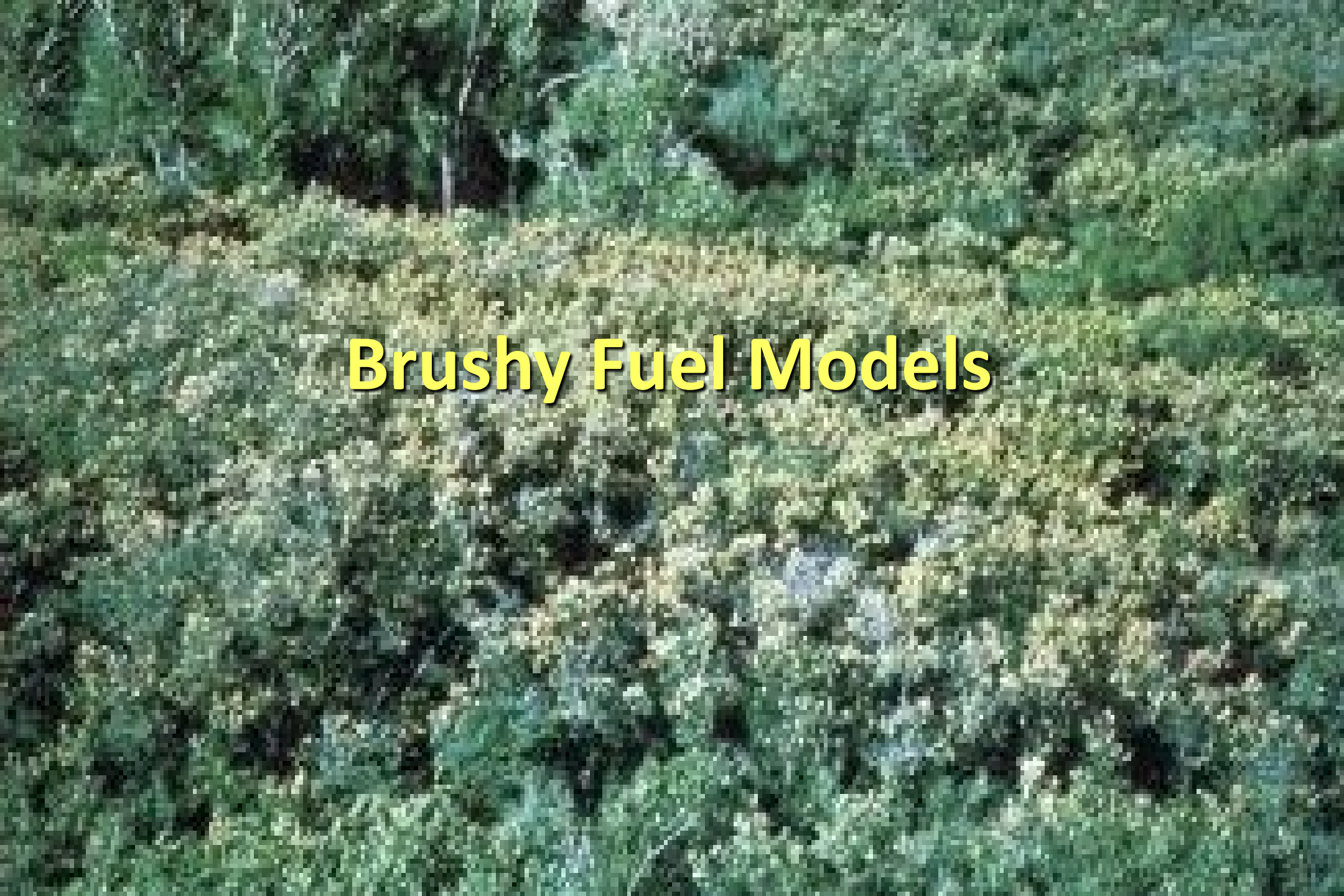


Please note that a LOT of Mesonet stations are assigned Fuel Model A as their default fuel model. In "Station Fuel Model Options" you may wish to change the fuel model for these stations to one (e.g., Model L, Model T) with heavier fuel loads to represent your wildland fuels.



Fuel Model L: Western Perennial Grasses

Fuel Model T: Tallgrass with Open Evergreen Brush


Brushy Fuel Models

Fuel Model B: Tall Dense Evergreen Brush

(also can be used for eastern redcedar forests)

Fuel Model F: Intermediate Evergreen Brush


Forest Fuel Models

Fuel Model G: Forest with Heavy Downed Fuels

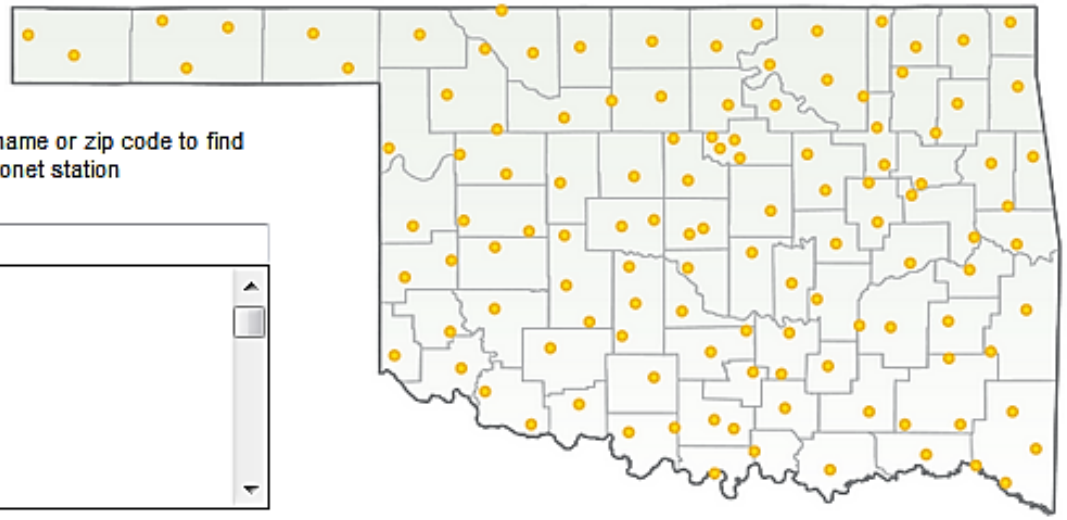
Fuel Model P: Southern Pine Forest

Fuel Model R: Hardwood Forest


Slash Model

Fuel Model K: Light Slash

Select Mesonet Station



Type in city name or zip code to find nearest Mesonet station

Acme
Ada
Altus
Alva
Antlers
Apache

Display Mode:

(•) Charts ( ) Tables

Time Mode:

( ) Past (•) Forecast

Selected Station:

Stillwater

Variable(s) Burning Index (BI) Duration Next 84 Hours Interval 1 Hr

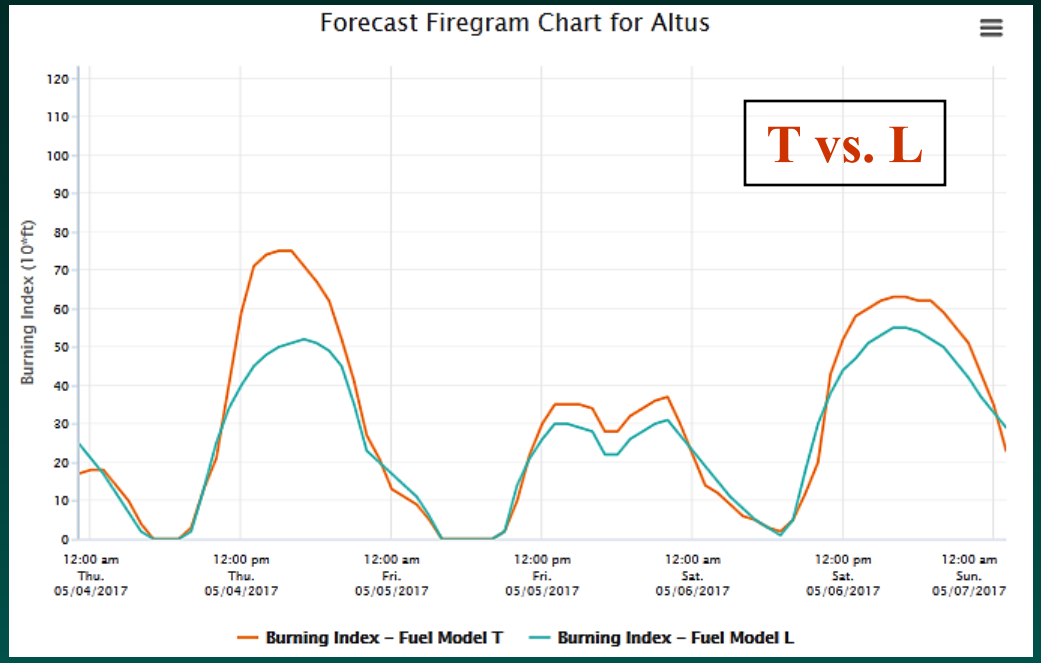
Default Fuel Model: T - Tallgrass with open evergreen brush

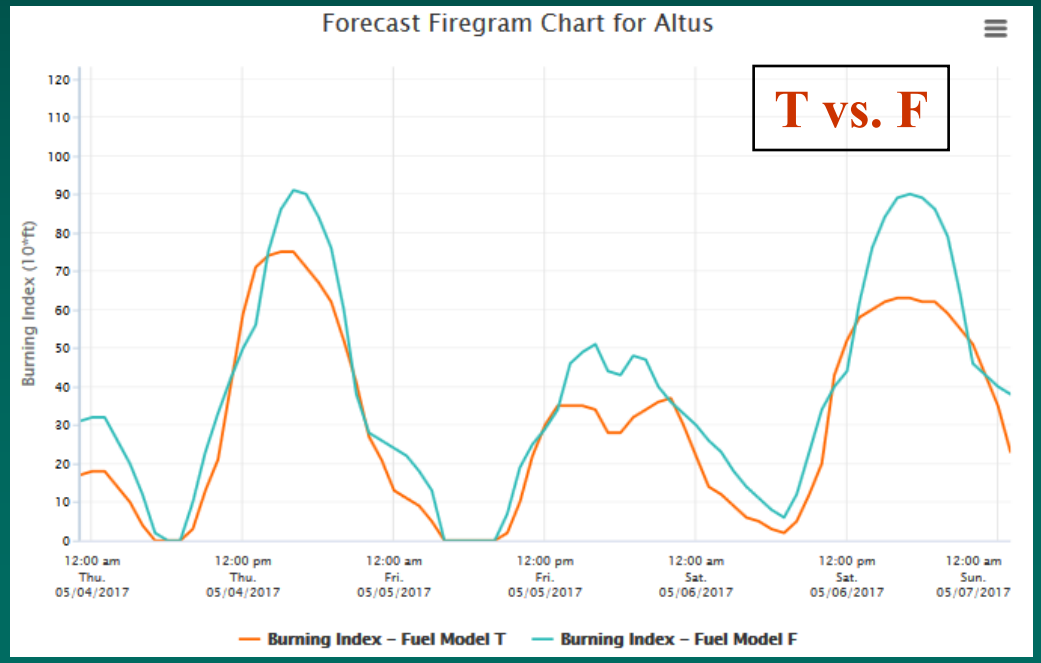
Current Fuel Model: T - Tallgrass with open evergreen brush

Fuel Model Descriptions

Add Second Fuel Model: F - Intermediate evergreen brush

Get Data


Forecast Firegram Chart for Altus
T vs. L
Burning Index (10*ft)
120
110
100
90
80
70
60
50
40
30
20
10
0
12:00 am Thu. 05/04/2017
12:00 pm Thu. 05/04/2017
12:00 am Fri. 05/05/2017
12:00 pm Fri. 05/05/2017
12:00 am Sat. 05/06/2017
12:00 pm Sat. 05/06/2017
12:00 am Sun. 05/07/2017
Burning Index – Fuel Model T
Burning Index – Fuel Model L


Forecast Firegram Chart for Altus
T vs. F
Burning Index (10*ft)
120
110
100
90
80
70
60
50
40
30
20
10
0
12:00 am Thu. 05/04/2017
12:00 pm Thu. 05/04/2017
12:00 am Fri. 05/05/2017
12:00 pm Fri. 05/05/2017
12:00 am Sat. 05/06/2017
12:00 pm Sat. 05/06/2017
12:00 am Sun. 05/07/2017
Burning Index – Fuel Model T
Burning Index – Fuel Model F

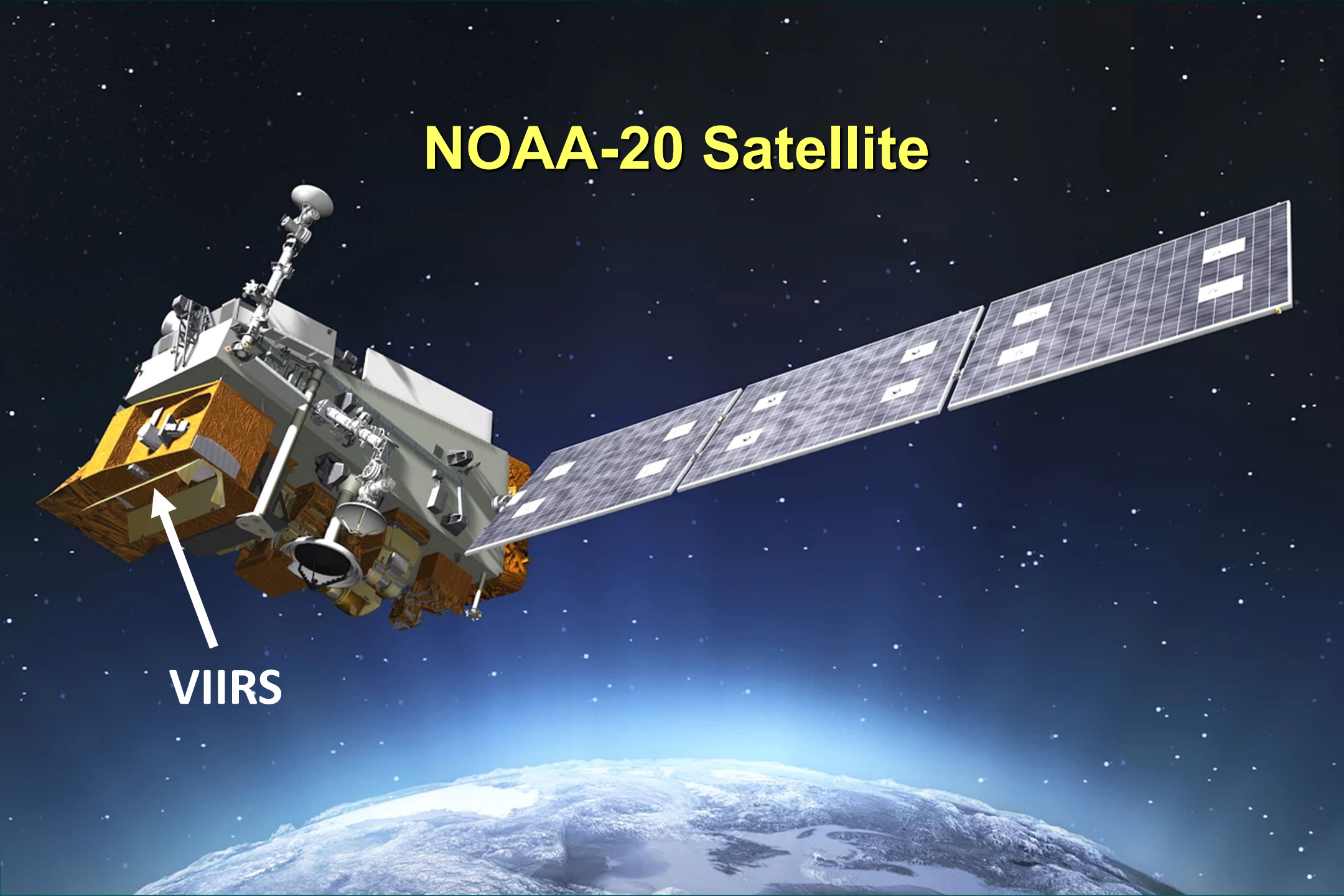
Web Site Demo:
Fuel Models in OK-FIRE

FUEL MODEL + GREENNESS LEVEL + WEATHER

FIRE DANGER MODEL

FIRE DANGER

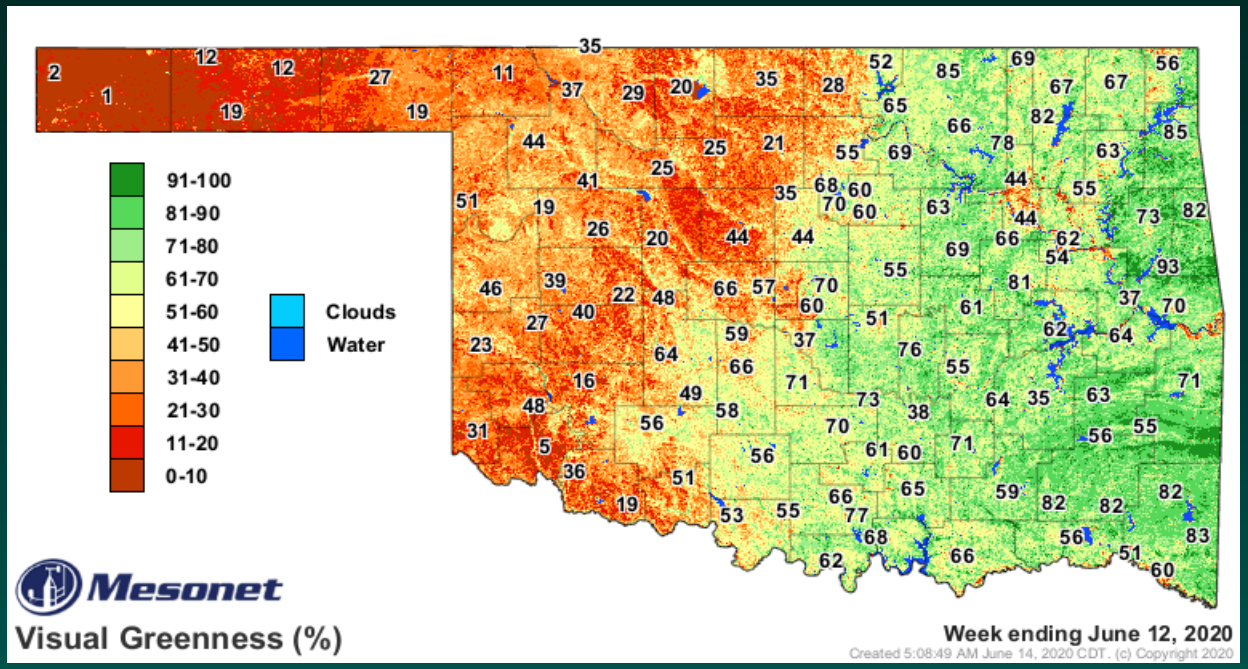

Daily Satellite Assessment
of Surface Greenness


NOAA-20 Satellite
VIIRS

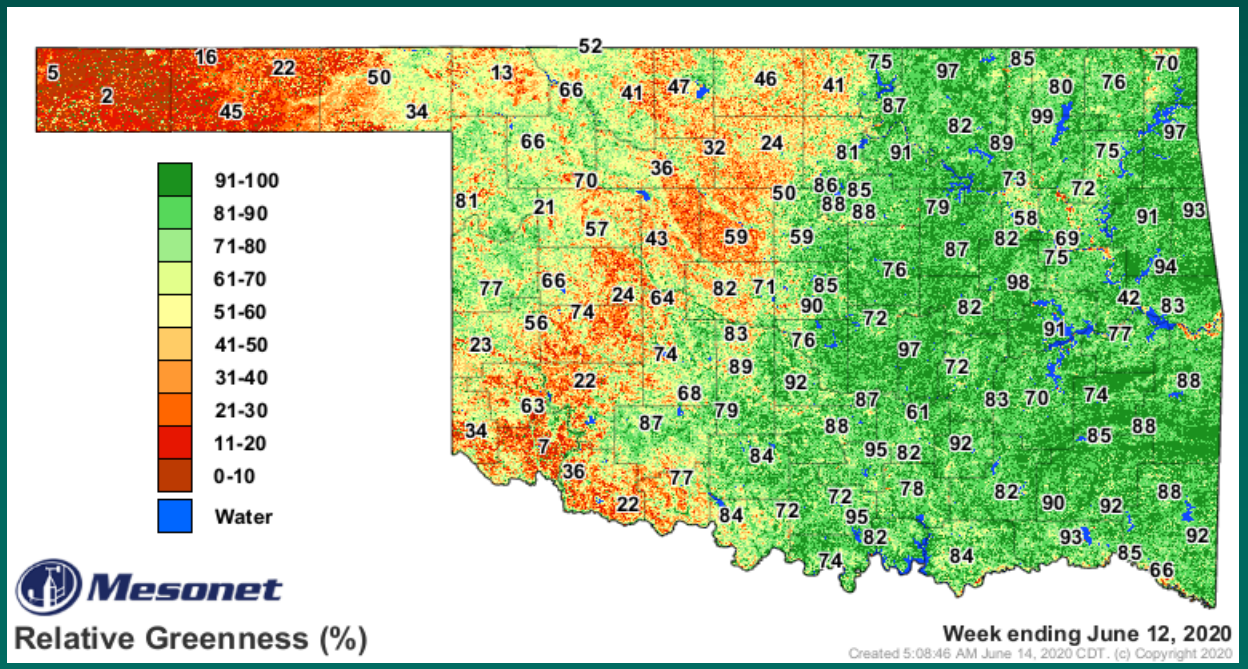
Utilization of Satellite Data

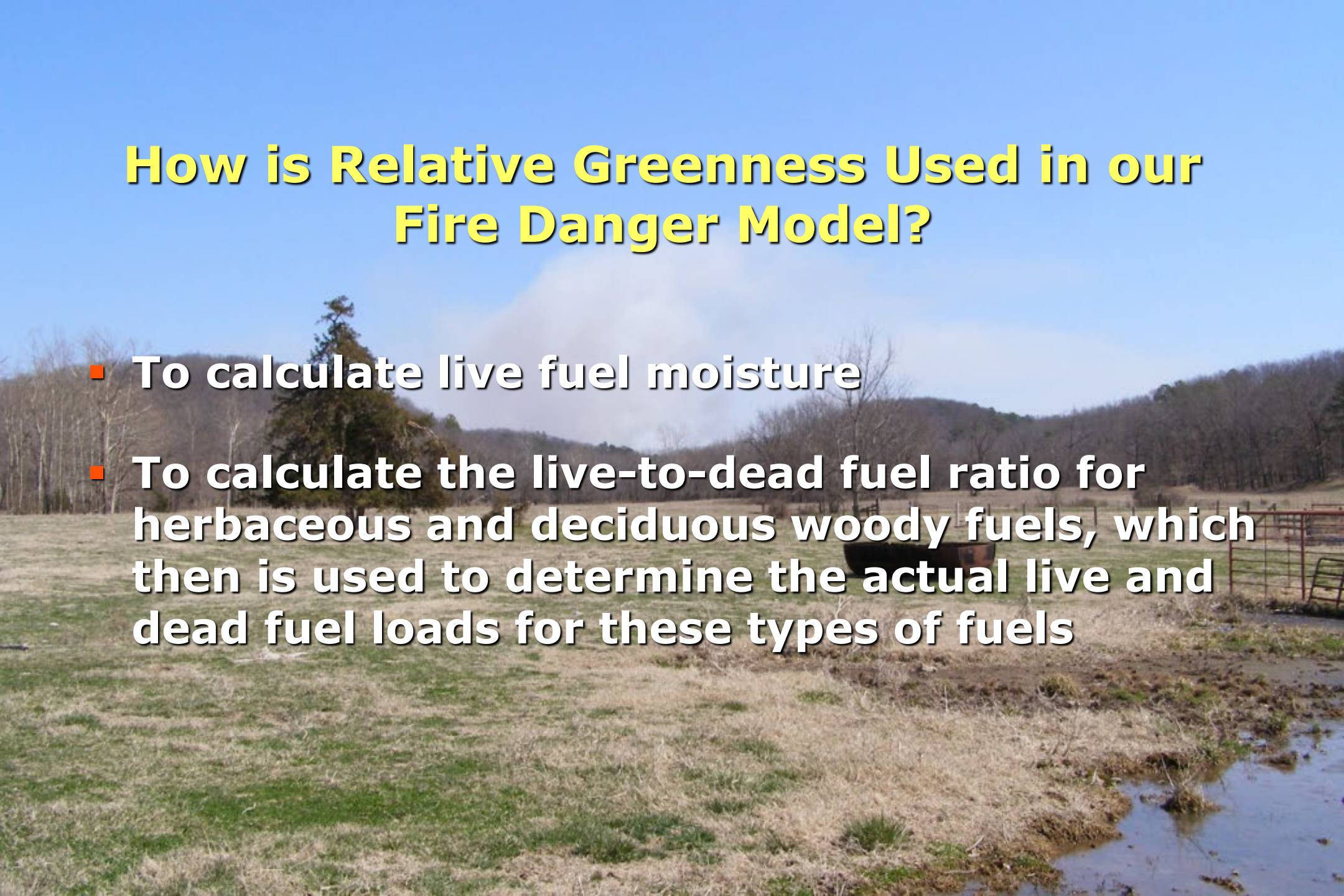
- **Daily updates of NDVI 500-m pixel data from the VIIRS sensor aboard NOAA-20**
  - Past 7-day NDVI composites (highest valid NDVI)
- **Visual Greenness (VG)**
  - Greenness (0-100%) as it would be perceived by the eye
- **Relative Greenness (RG)**
  - Greenness (0-100%) relative to 10.5 year historical range (2012-2022) of NDVI values for that pixel

VISUAL GREENNESS



RELATIVE GREENNESS



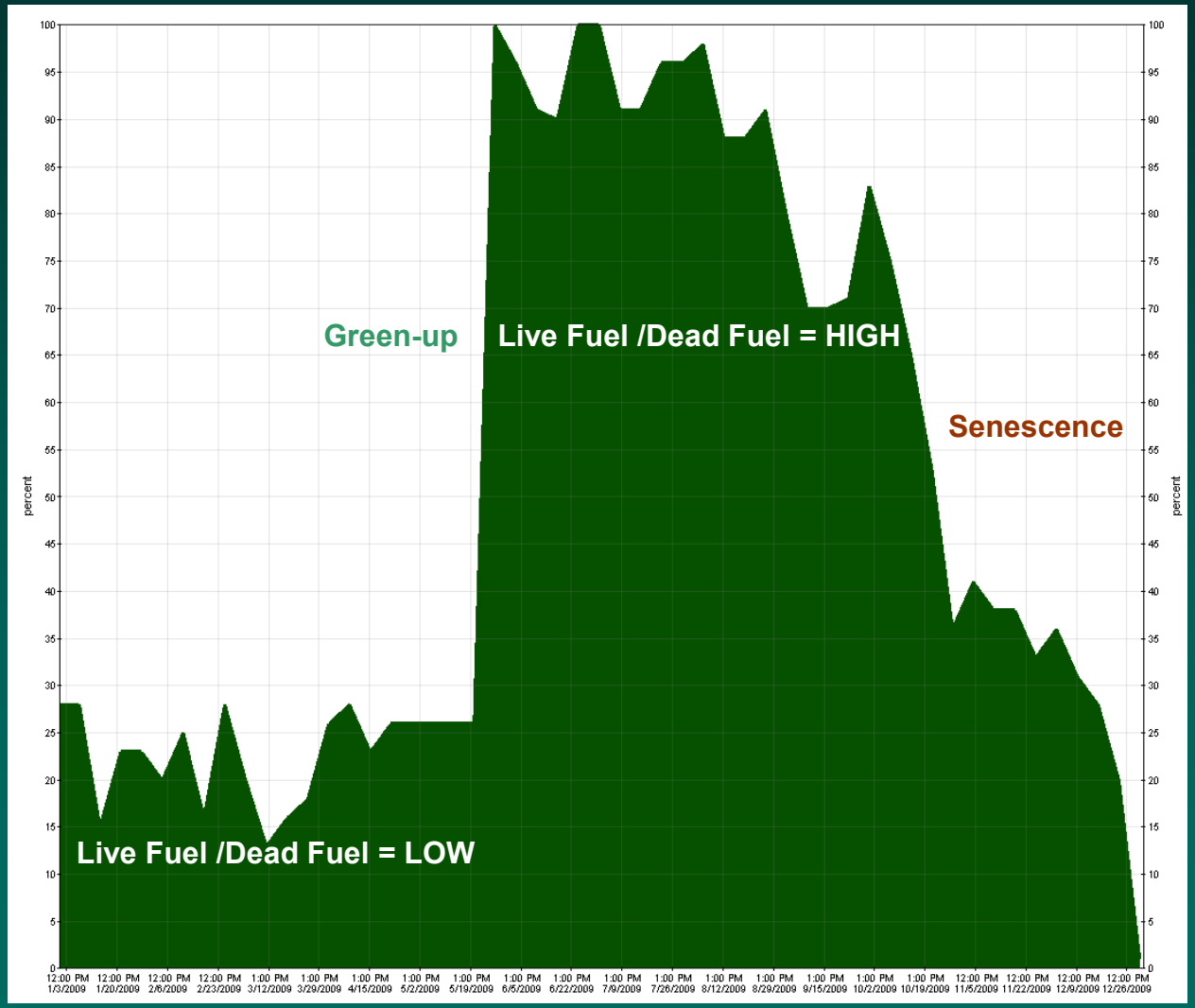


How is Relative Greenness Used in our Fire Danger Model?

- To calculate live fuel moisture
- To calculate the live-to-dead fuel ratio for herbaceous and deciduous woody fuels, which then is used to determine the actual live and dead fuel loads for these types of fuels

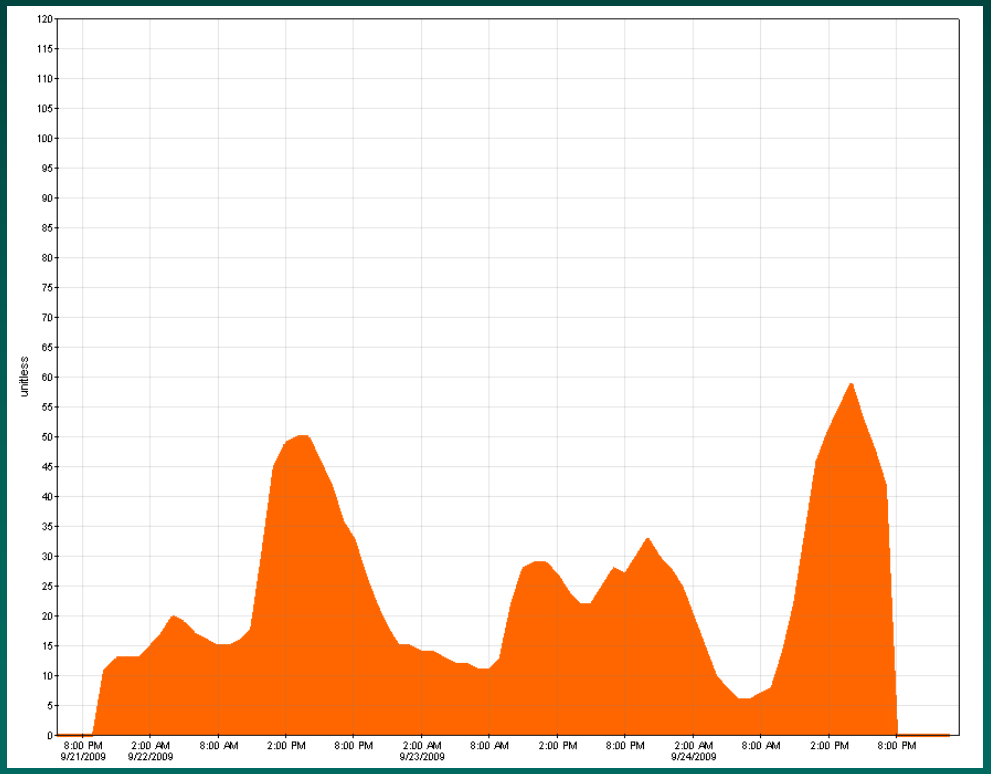
Napa County, California – October 2017 Fires

Annual Relative Greenness Cycle: Foraker 2009 *(Tallgrass Prairie)*

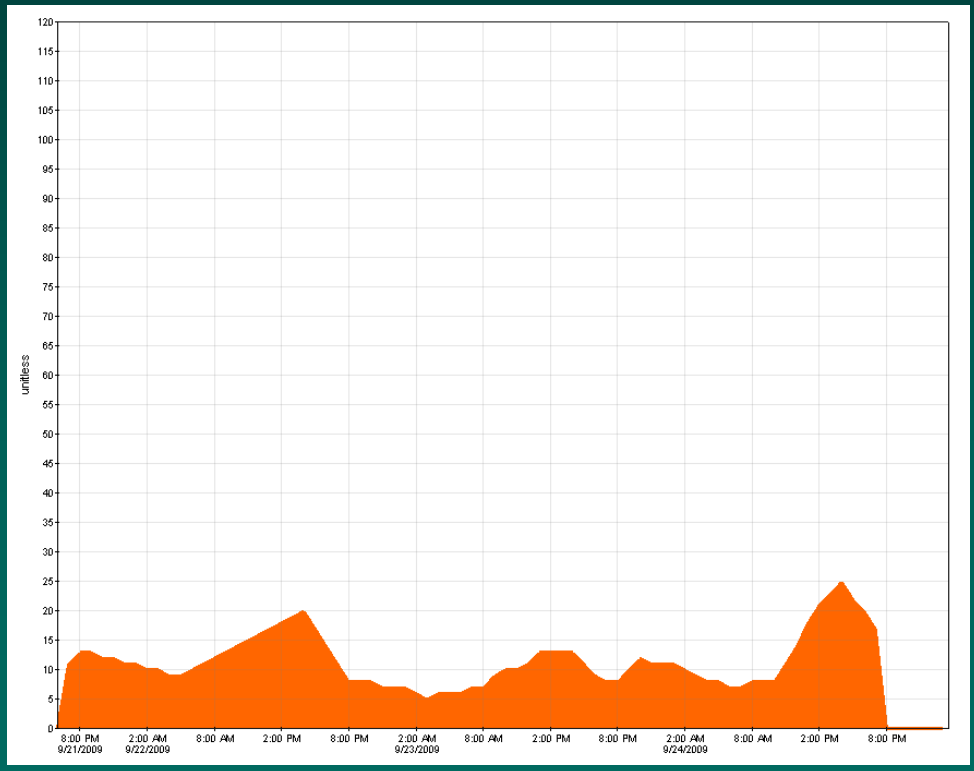


Forecast Burning Index with Different RG Values (Same Fuel Model = T; Same Weather)

Lahoma (RG = 21%)

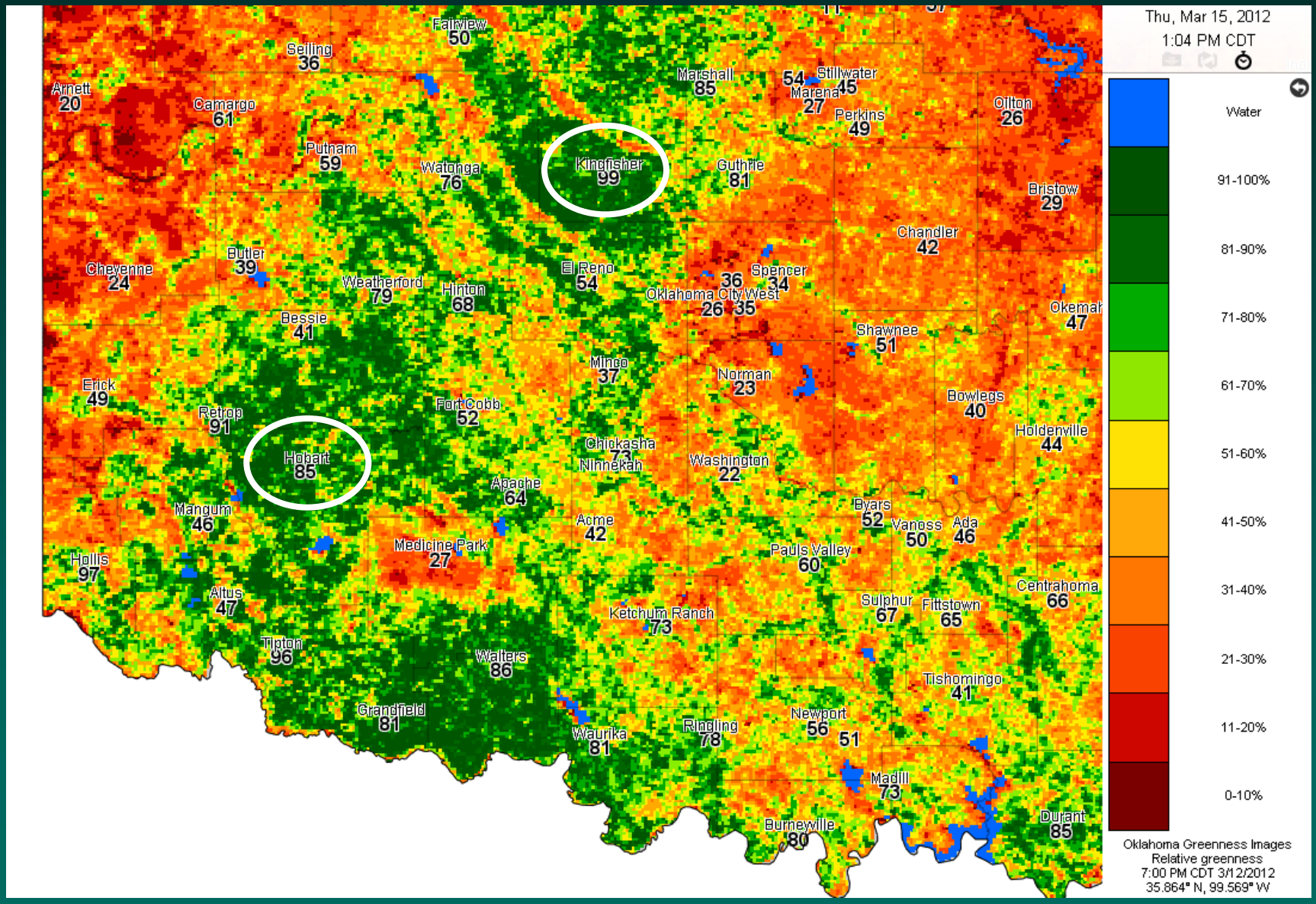


Blackwell (RG = 59%)

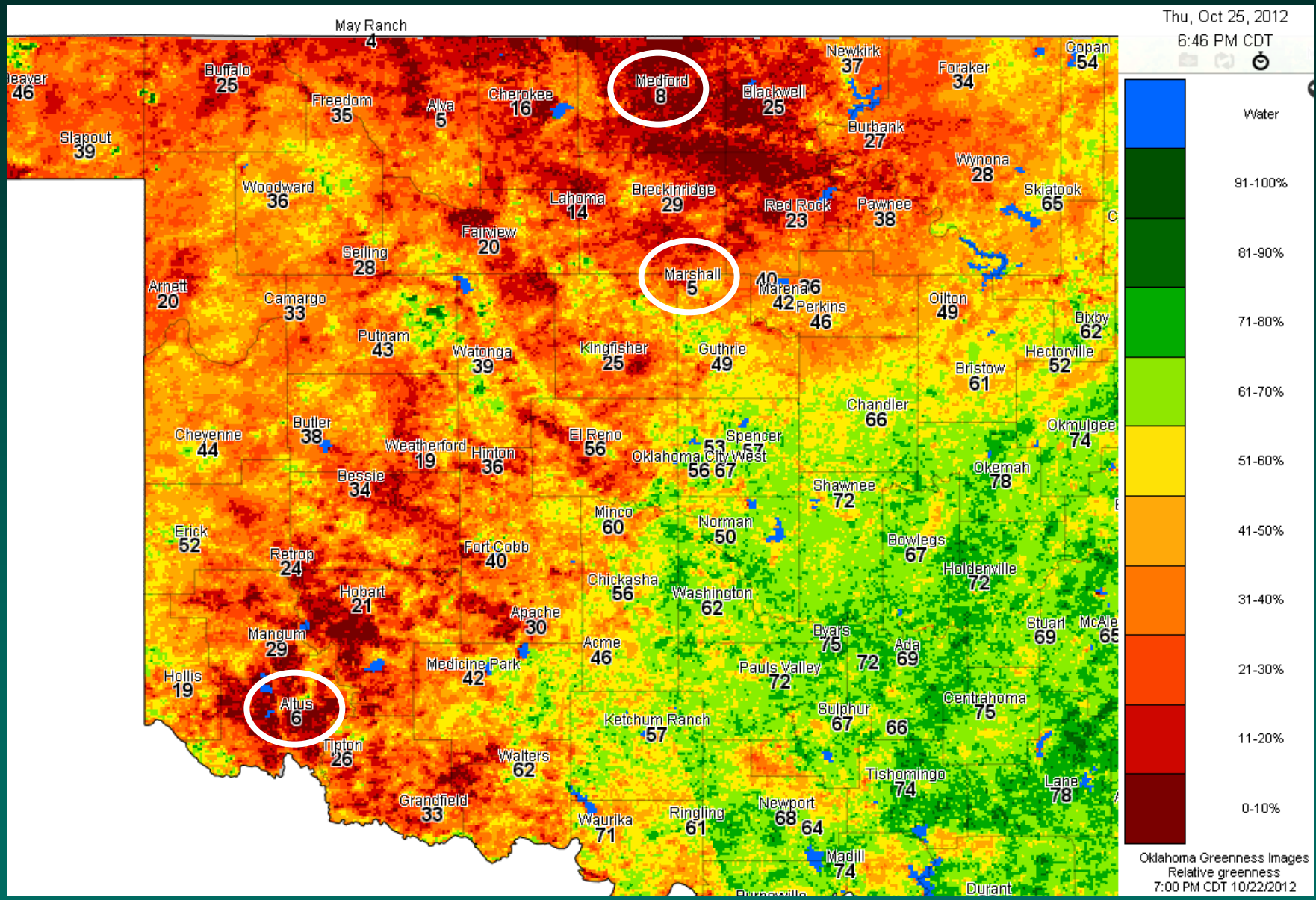


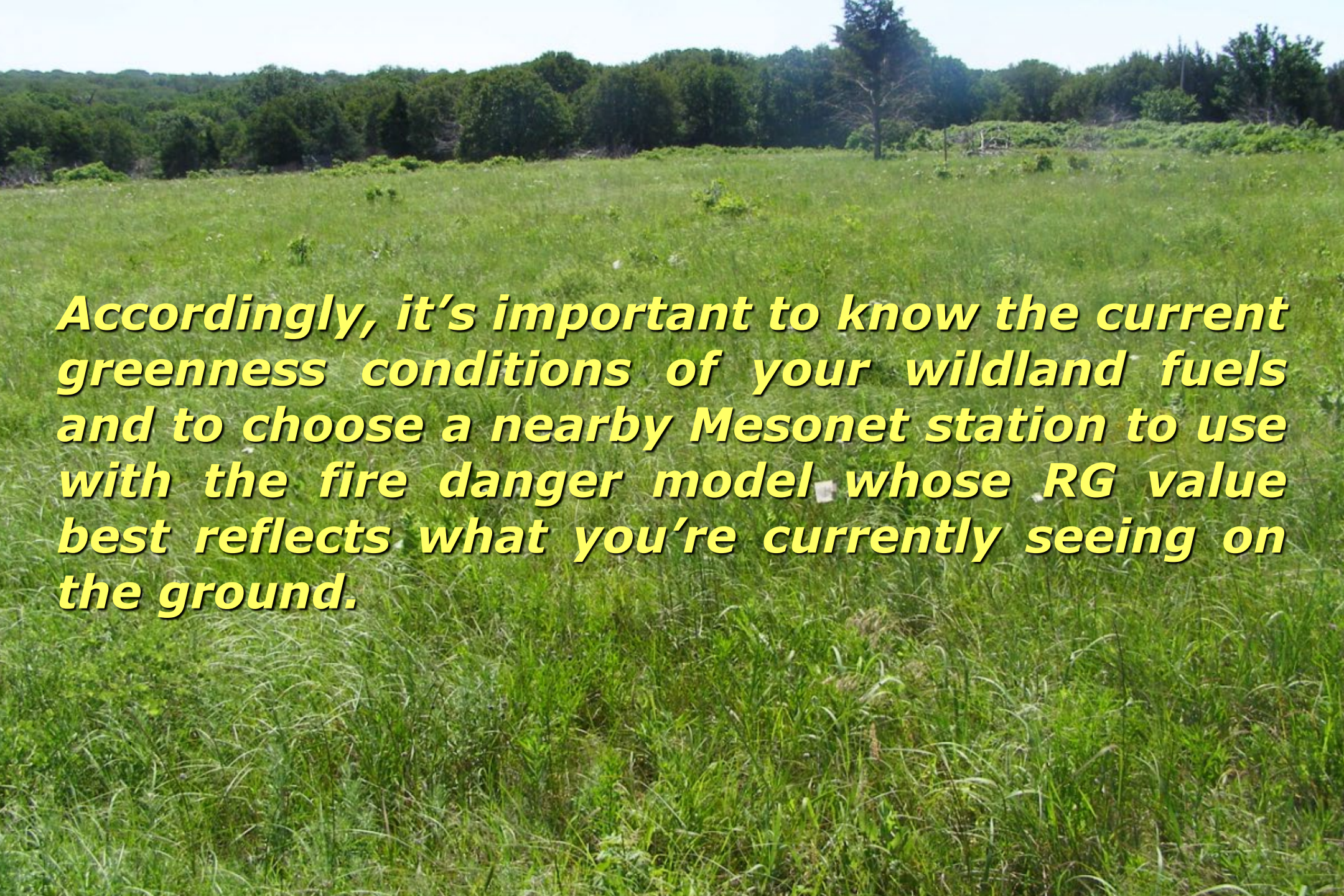

Satellite “sees” composite vegetation in each 500-m pixel; if you are in an agricultural or urban area, the nearest Mesonet station RG value may not properly represent the greenness of the wildland fuels in your area

Agricultural Examples



Agricultural Examples




Accordingly, it's important to know the current greenness conditions of your wildland fuels and to choose a nearby Mesonet station to use with the fire danger model whose RG value best reflects what you're currently seeing on the ground.

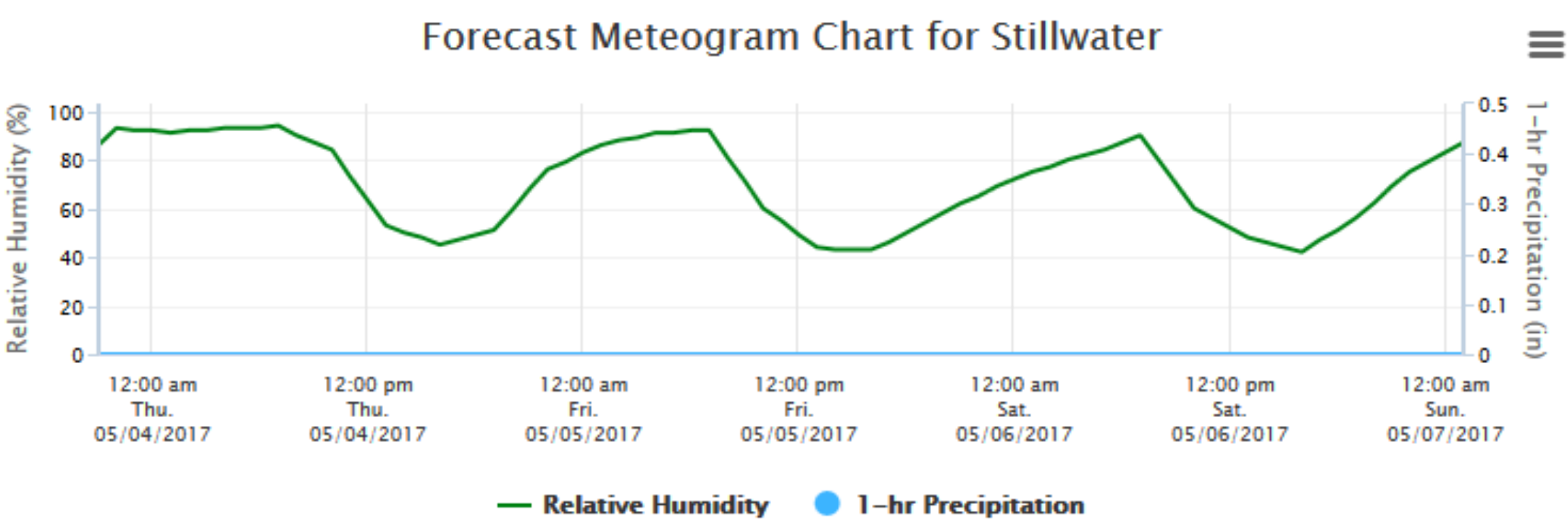
Web Site Demo:
Relative Greenness Products in OK-FIRE

FUEL MODEL + GREENNESS LEVEL + WEATHER

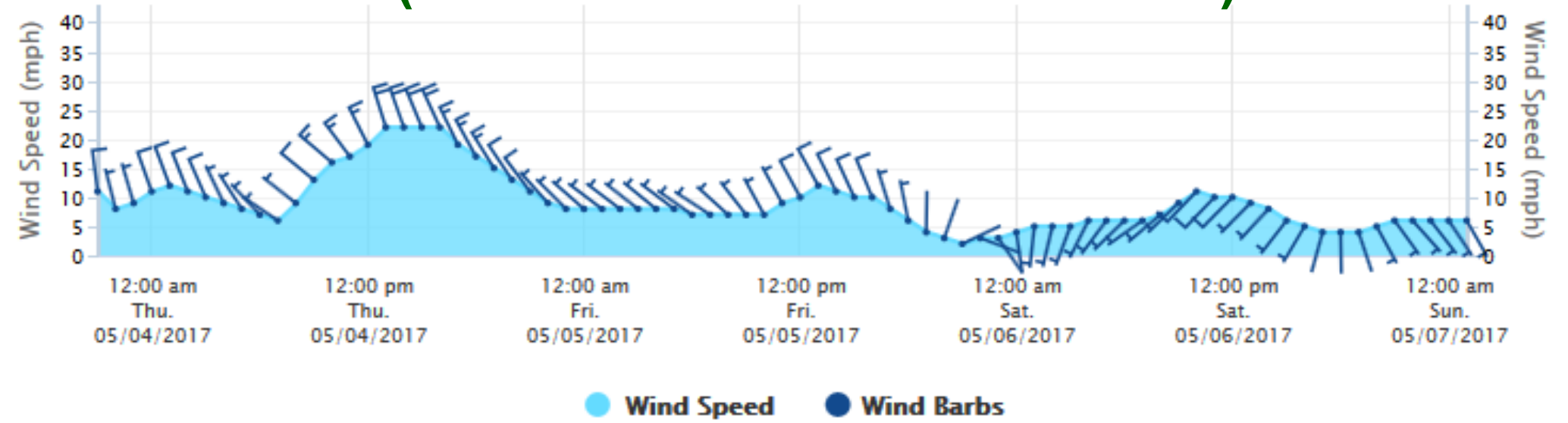
FIRE DANGER MODEL

FIRE DANGER


The OKLAHOMA MESONET
(current and past weather conditions)



84-h Output from the NAM Model (forecast weather conditions)




Fire Danger

What do we mean by FIRE DANGER?

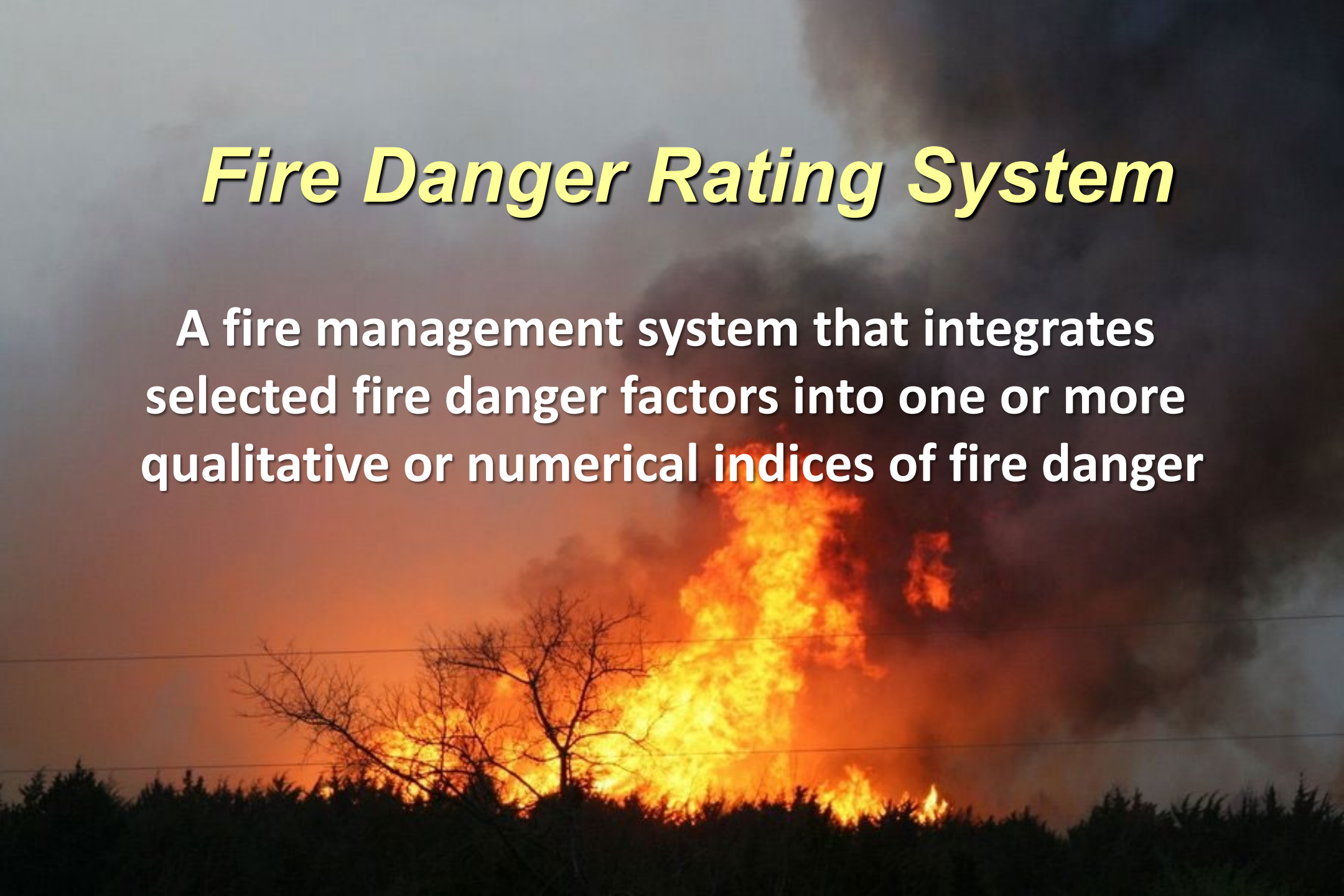
the ability or potential of a wildland fire to start, spread, resist control, and do damage

Fire Danger Rating
Assumptions and Limitations

- Not meant to be used for fire behavior on a specific landscape
- Within each fire danger rating area (e.g., pixel of land), fuels, weather, and topography are assumed homogeneous
- Average fire danger over the rating area

Fire Danger Rating
Purposes

- Provide public warnings
- Set preparedness levels
- Provide good indication of the difficulty of fire suppression over wide range of conditions
- Help fire managers make wise management decisions in both real-time and the future

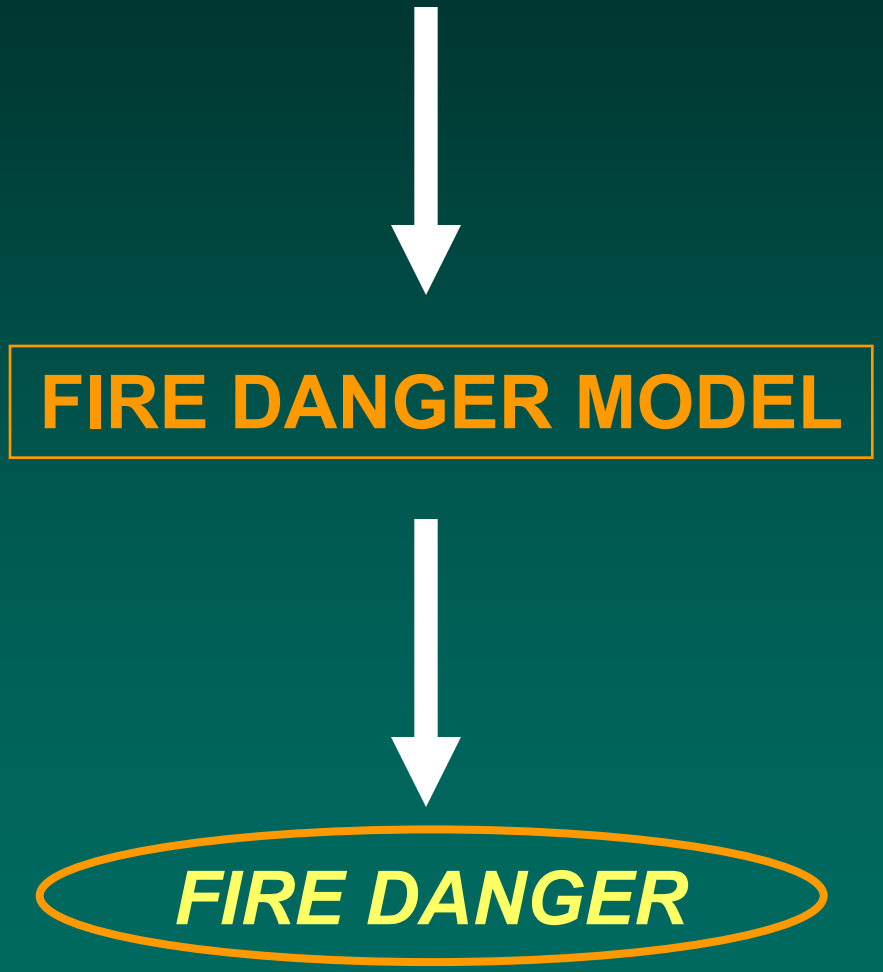


Fire Danger Rating System

A fire management system that integrates selected fire danger factors into one or more qualitative or numerical indices of fire danger

National Fire Danger Rating System *(NFDRS)*

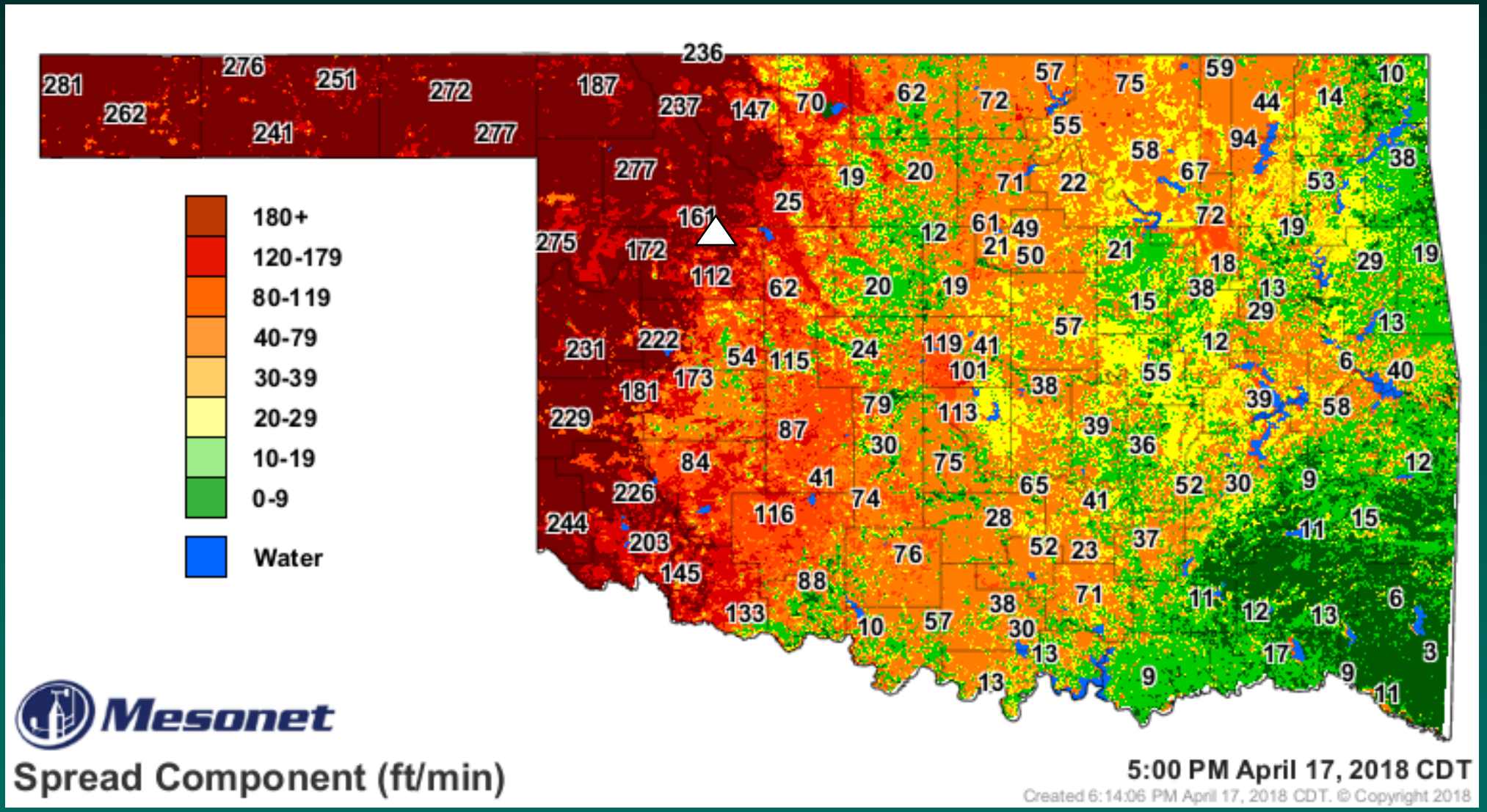
FUEL MODEL + GREENNESS LEVEL + WEATHER



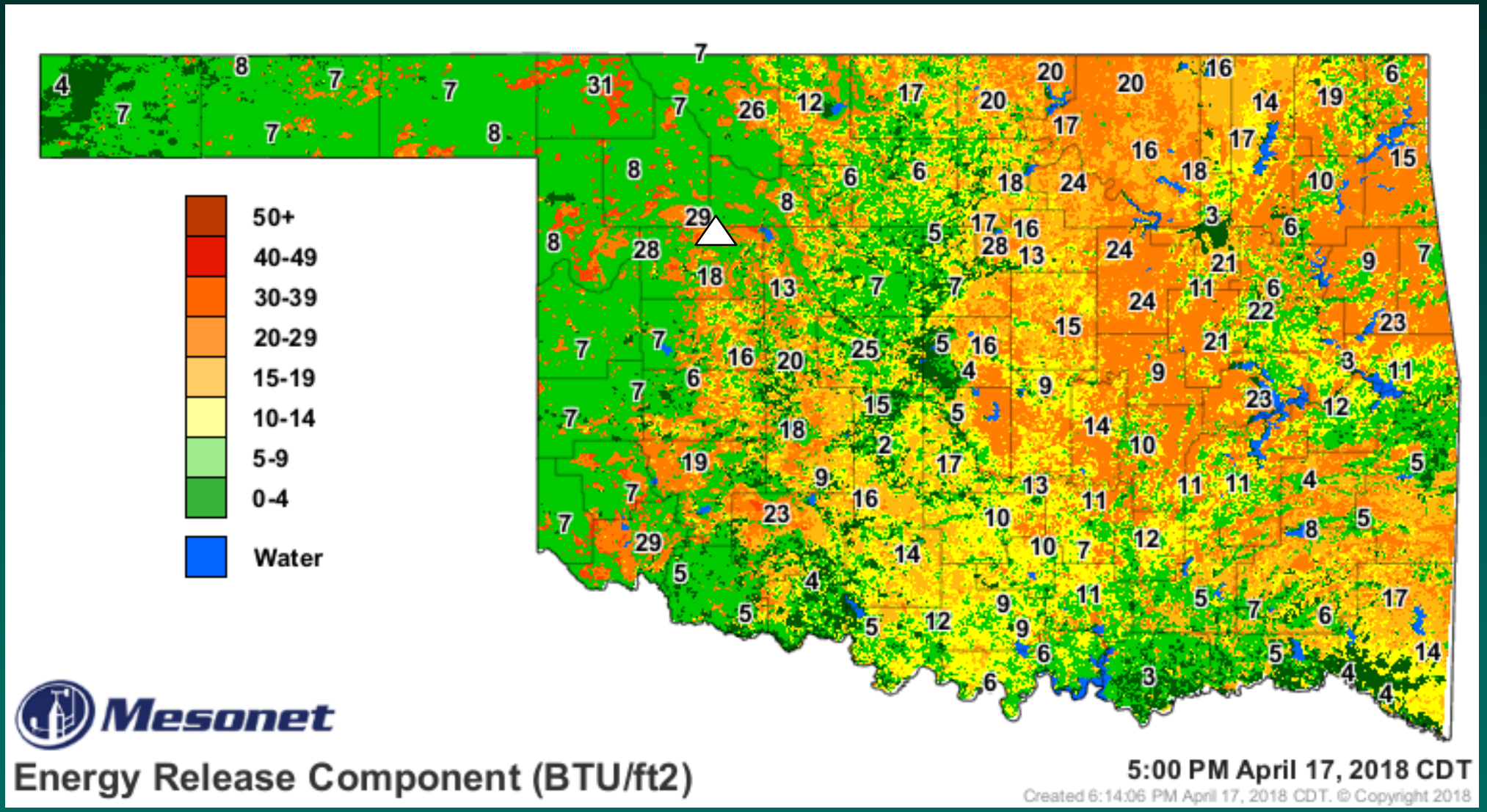
NFDRS Fire Danger Indices

- **Spread Component (SC)**
  - relates to forward speed of fire (ft/min)
- **Energy Release Component (ERC)**
  - relates to heat release per unit area in flaming zone
- **Burning Index (BI)**
  - based on both SC and ERC
  - relates to fireline intensity and flame length (BI/10 ft)

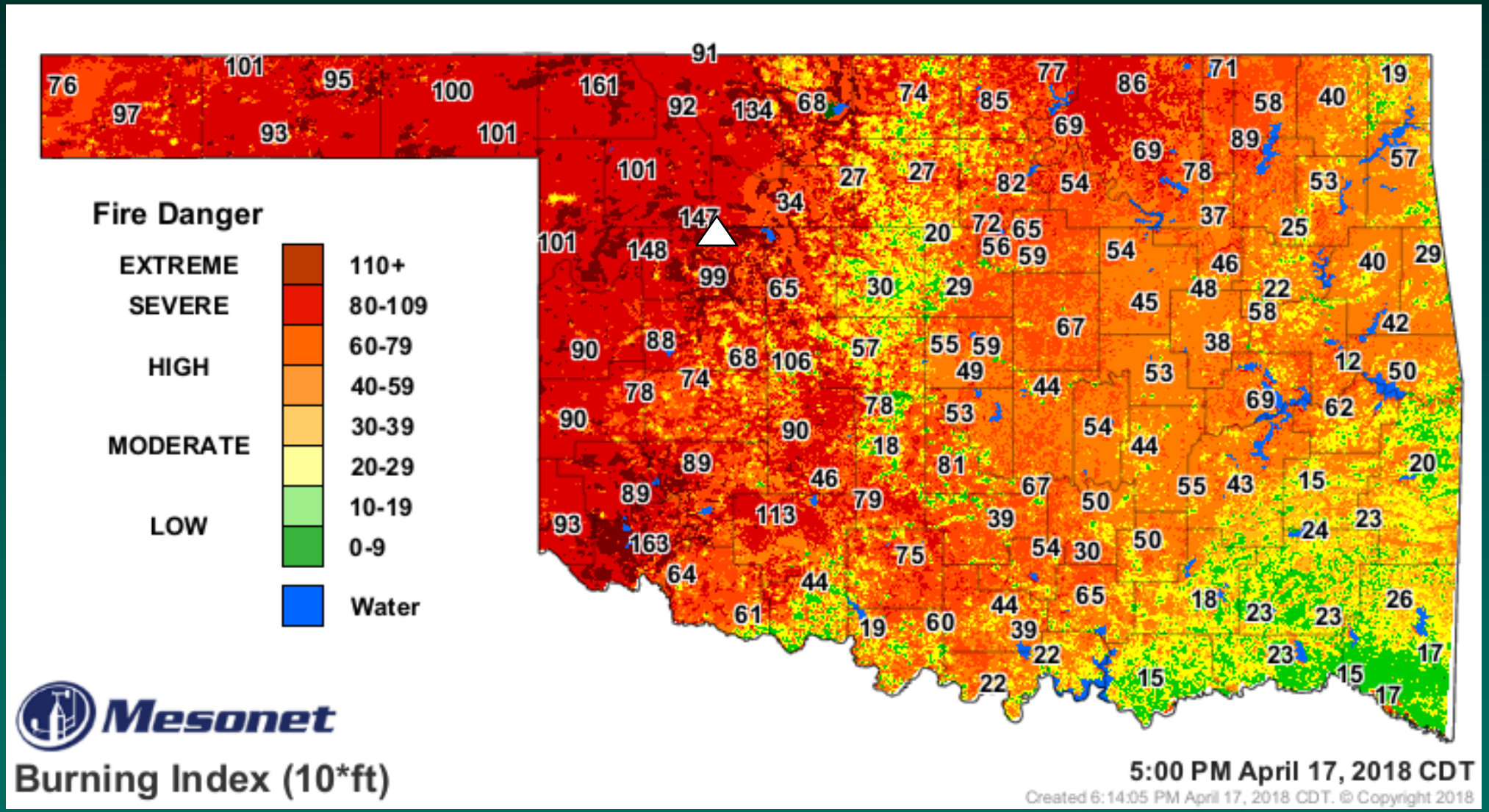
Spread Component



Energy Release Component



Burning Index



Burning Index Interpretation

Flame Length (ft)	Fireline Intensity (Btu/ft/s)	Interpretations
<4 (BI <40)	<100	Fires can generally be attacked at the head or flanks by persons using handtools. Hand line should hold the fire.
4-8 (BI=40-80)	100-500	Fires are too intense for direct attack on the head by persons using handtools. Hand line cannot be relied on to hold fire. Equipment such as dozers, pumpers, and retardant aircraft can be effective.
8-11 (BI=80-110)	500-1,000	Fires may present serious control problems--torching out, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
> 11 (BI > 110)	> 1,000	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

Fire Danger Level

LOW (0-20) to MODERATE (20-40) (BI < 40)

HIGH (BI = 40-80)

SEVERE (BI = 80-110)

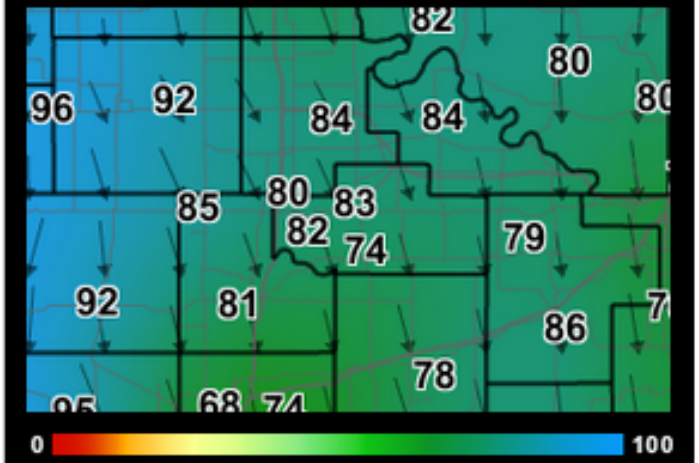
EXTREME (BI > 110)

March 27, 2017 - A new OK-FIRE module within the main Mesonet v

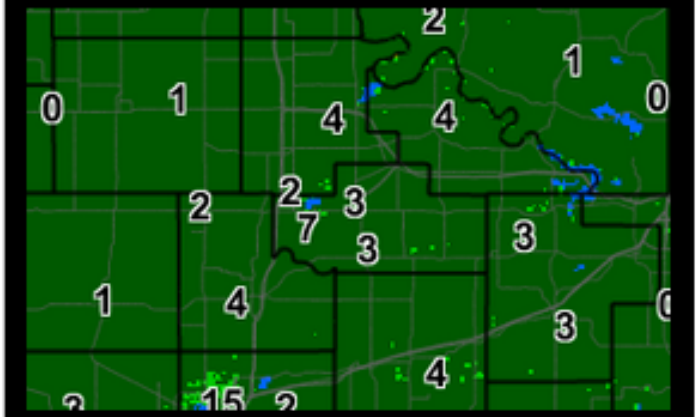
OK-FIRE

Share Tweet

Current Relative Humidity and Wind Direction

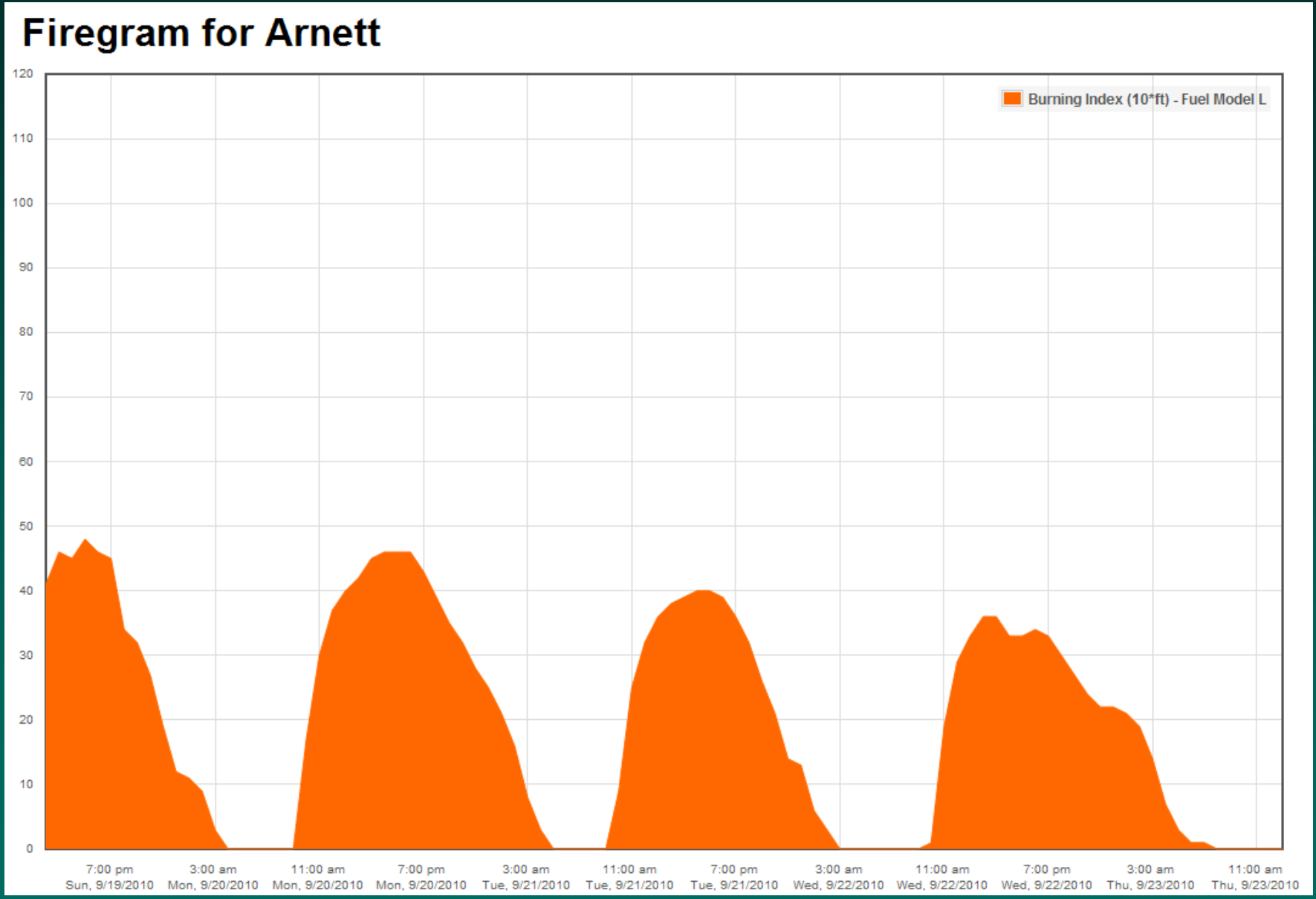


Current Burning Index

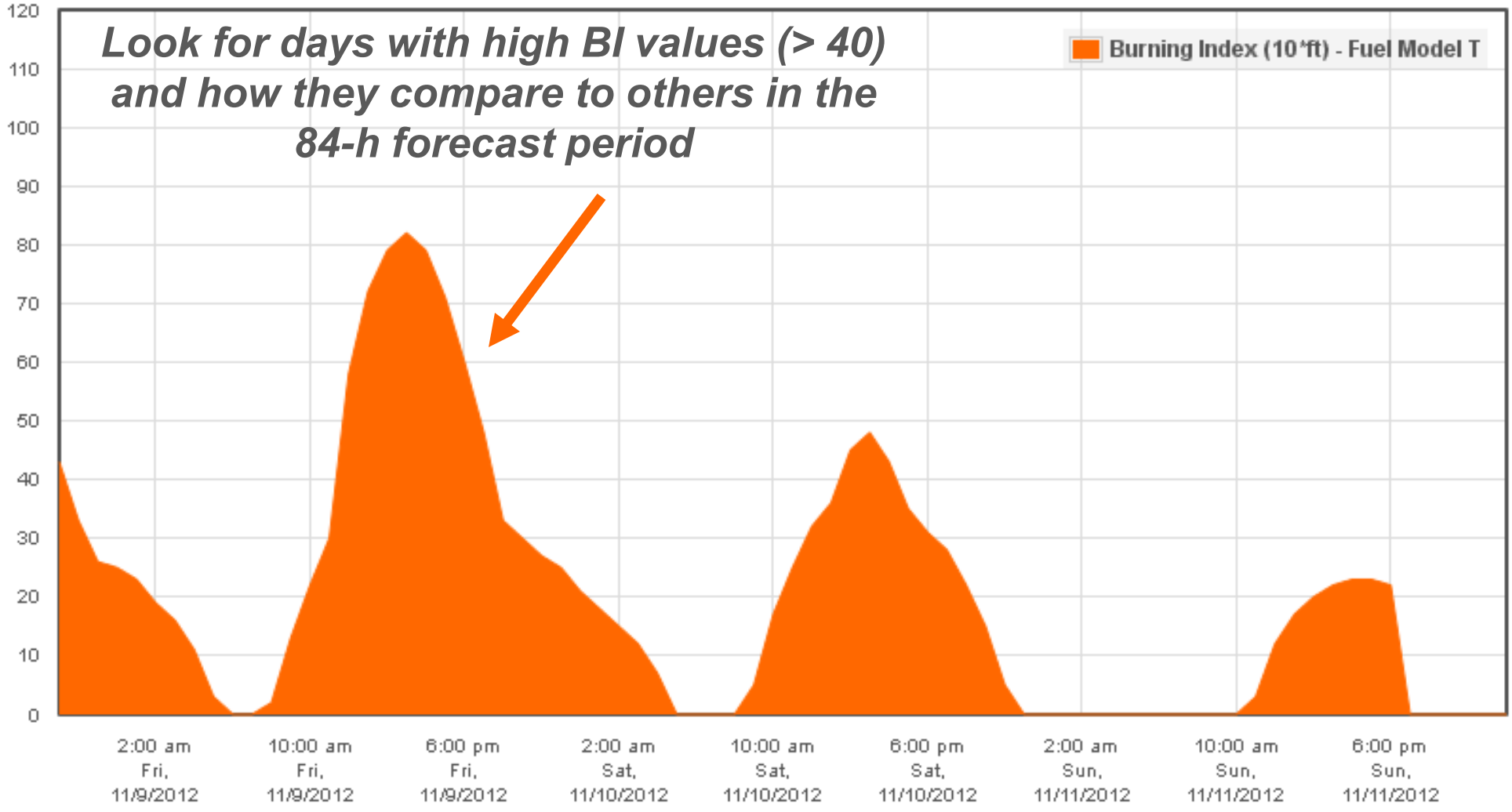


Station:	Stillwater	Oilton
Weather	Wed 5/03/17 10:20 pm CDT	Wed 5/03/17 10:20 pm CDT
Relative Humidity:	83%	79%
Past 1-hr RH Change:	+4%	+1%
10-m Wind:	NNW at 8 mph	NNW at 7 mph
Max Wind Gust:	10 mph	14 mph
Temperature:	50°F	50°F
24-hr Rainfall:	0.46 in	0.22 in
Dispersion:	Moderately Poor	Moderately Poor
Sunrise / Sunset:	6:34 am / 8:17 pm	6:31 am / 8:15 pm
Fire Danger	Wed 5/03/17 10:00 pm CDT	Wed 5/03/17 10:00 pm CDT
Current Fire Danger:	LOW	LOW
Burning Index:	1	3
Spread Component:	0	0
Ignition Component:	1%	2%
NFDRS Fuel Model:	T	R
1-hr Fuel Moisture:	14%	15%
10-hr Fuel Moisture:	16%	17%
Soil Moisture:	98%	98%
KBDI:	0	16
Relative Greenness:	87%	89%

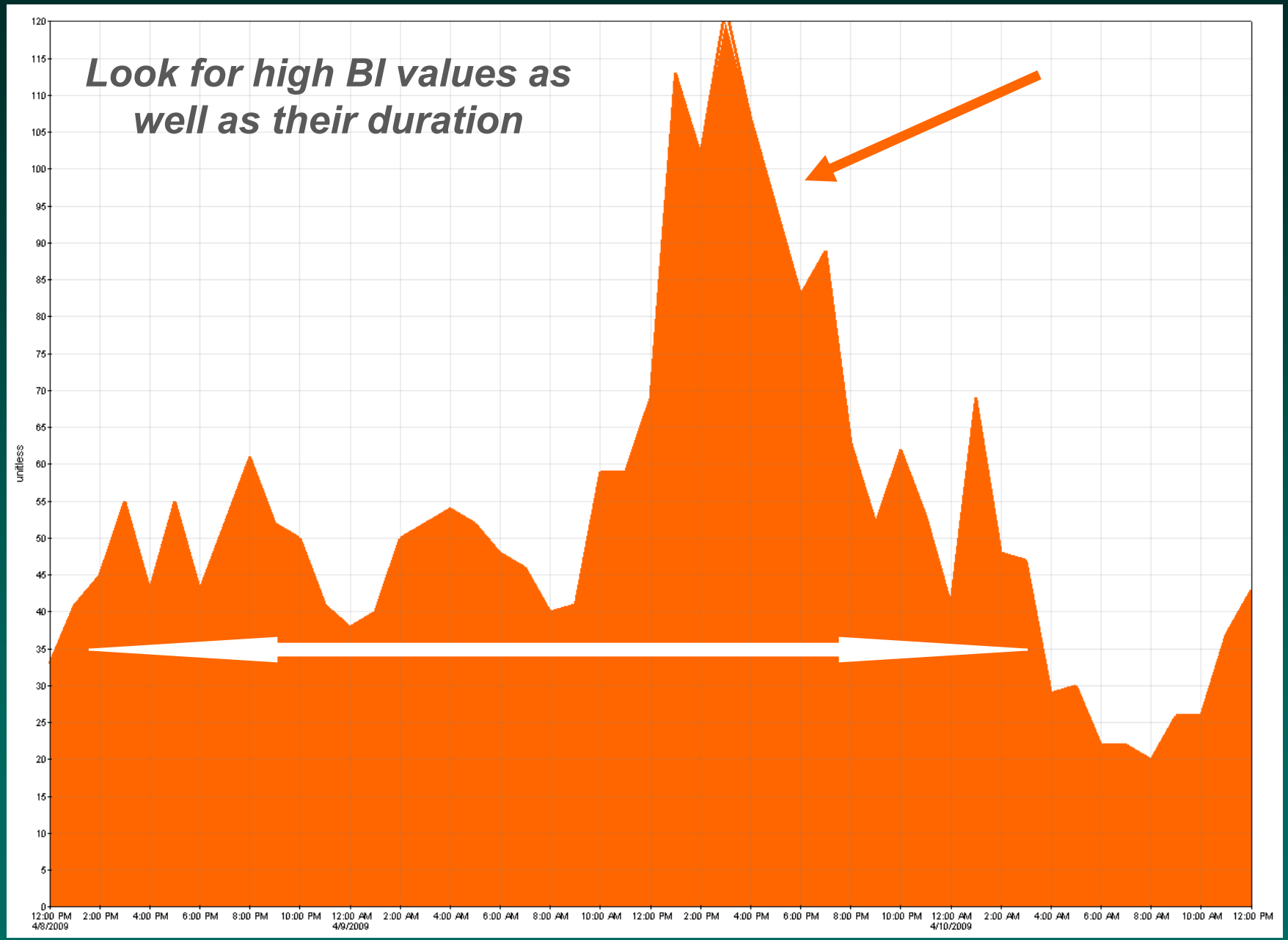
Typical Daily Cycle (Burning Index)



Firegram for Burbank



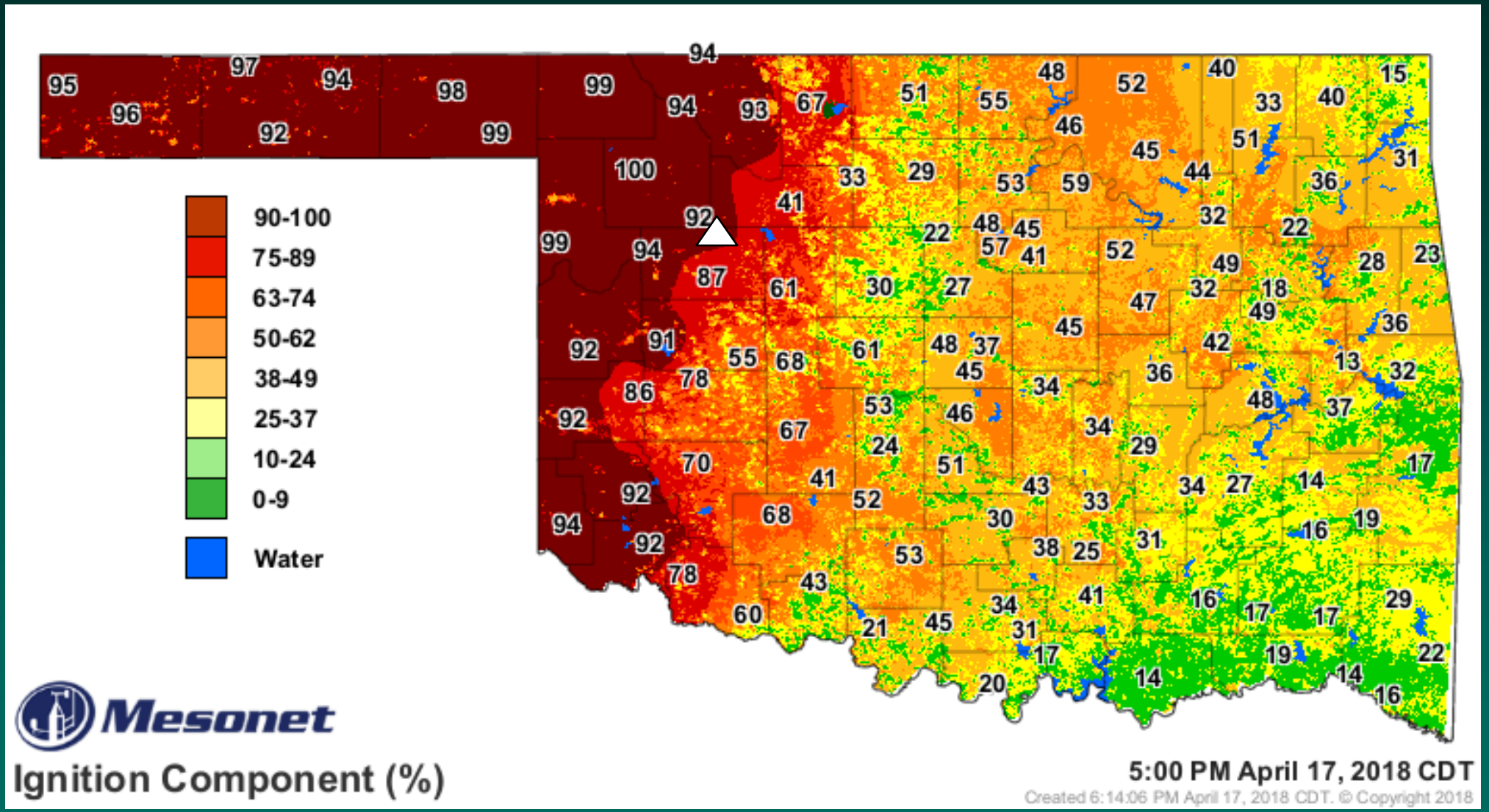
Waurika: Burning Index (April 9-10, 2009)



NFDRS Fire Danger Indices

- **Ignition Component (IC)**
  - relates to probability of reportable fire resulting from a firebrand; says nothing of intensity

Ignition Component

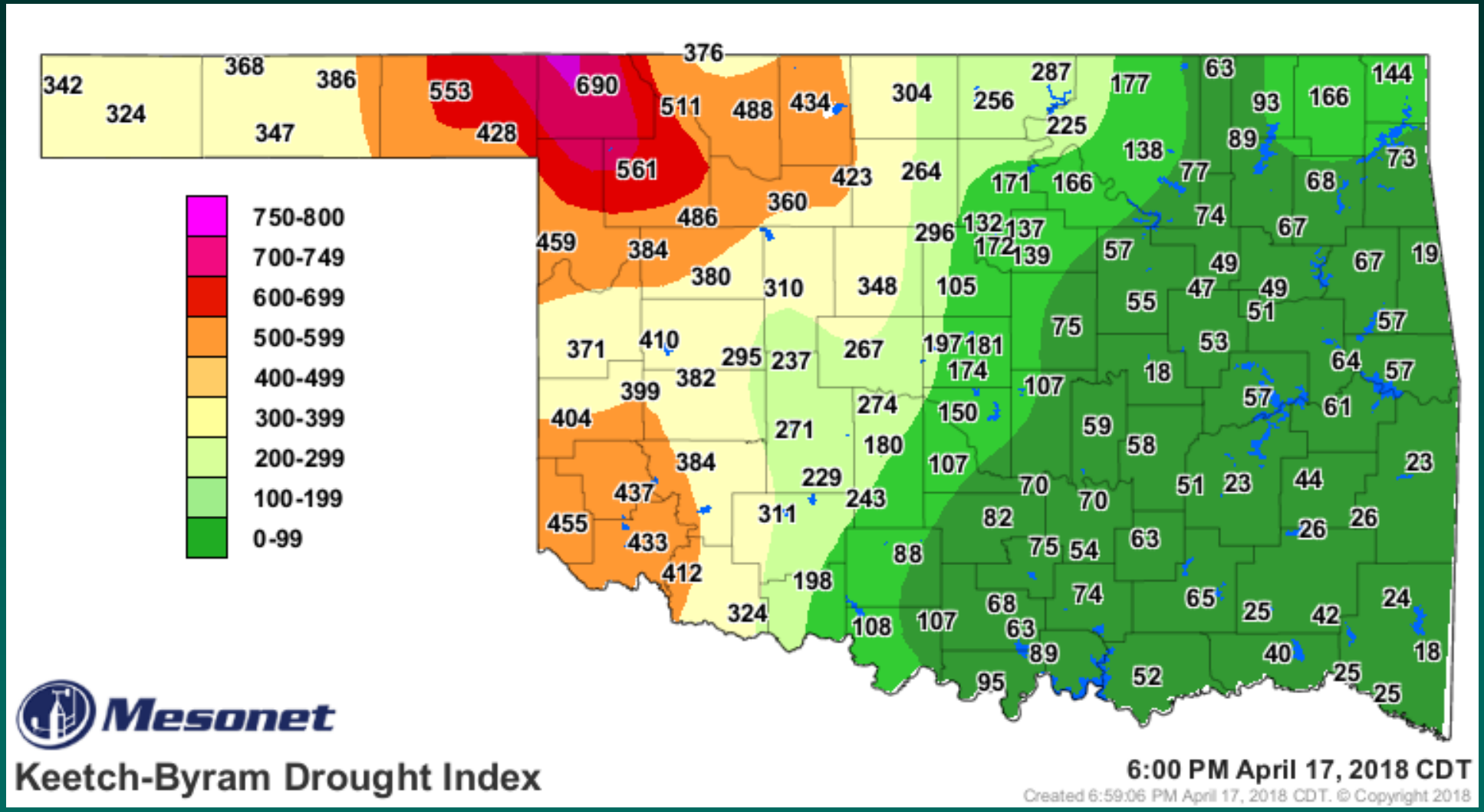


Keetch-Byram Drought Index

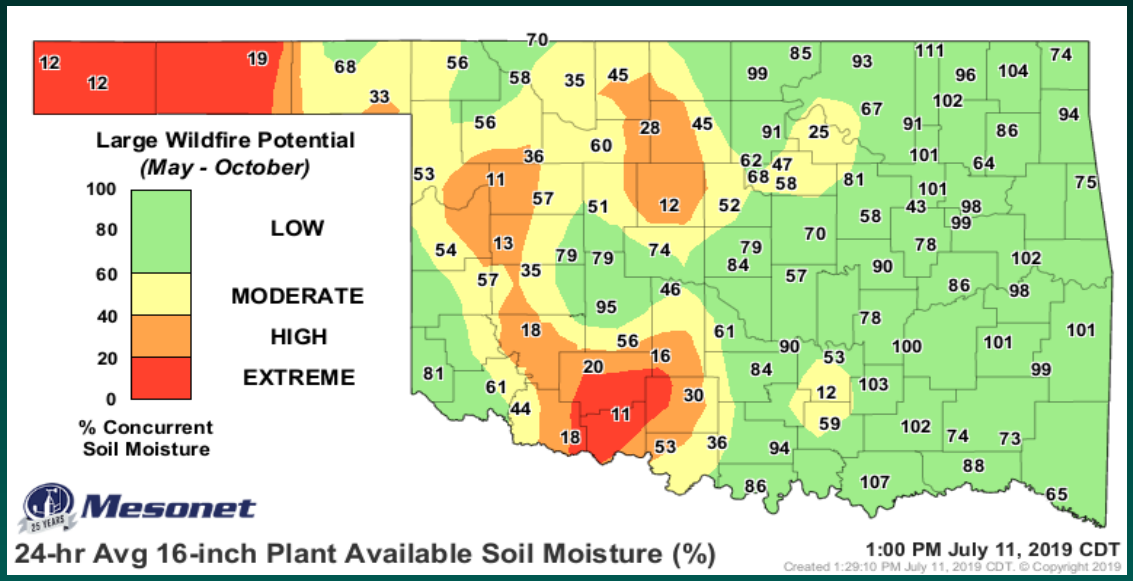
- Index (0-800) added to NFDRS in 1988
  based on simple model to estimate water content in soil column

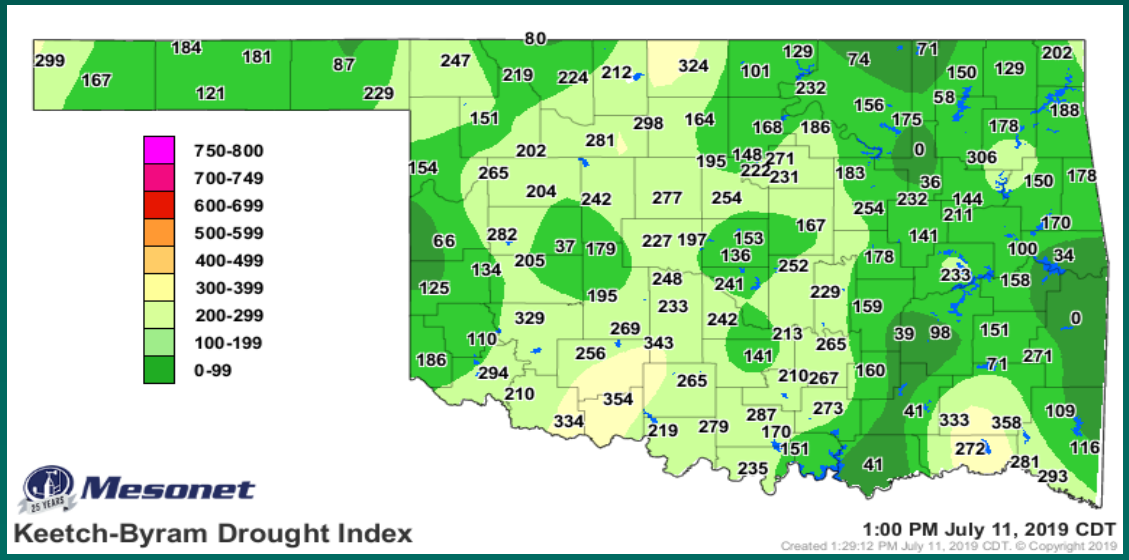
[0 = saturated (8” water); 800 = no water]

Keetch-Byram Drought Index (KBDI)



Comparison of Soil Moisture and KBDI Maps
July 11, 2019






The Oklahoma Fire Danger Model

Oklahoma Fire Danger Model

- Model is run every 15 minutes with Mesonet data
- Colored maps (500-m resolution) of BI, SC, ERC, and IC
- Colored maps of 1-h, 10-h, 100-h, 1000-h dead fuel moisture (every 15 minutes), live fuel moisture (daily), and KBDI (daily)
- Charts and tables for Mesonet sites

Questions You Should Be Able to Answer by the End of this Module

- What are the three major physical determinants of fire danger?
- What are the differences between dead and live fuels?
- How do 1-h and 10-h dead fuels respond differently to weather conditions than 100-h and 1000-h fuels?
- What is a fuel model and how can I change it on OK-FIRE?
- Why is relative greenness (RG) important to fire danger in OK-FIRE?
- What fire danger variables do fuel model and RG influence in OK-FIRE?

Web Site Demo:
Fire Danger Model Output


QUESTIONS ?