

Weather 101



Fire Weather

Jeremy Michael - Meteorologist - NWS Tucson, AZ

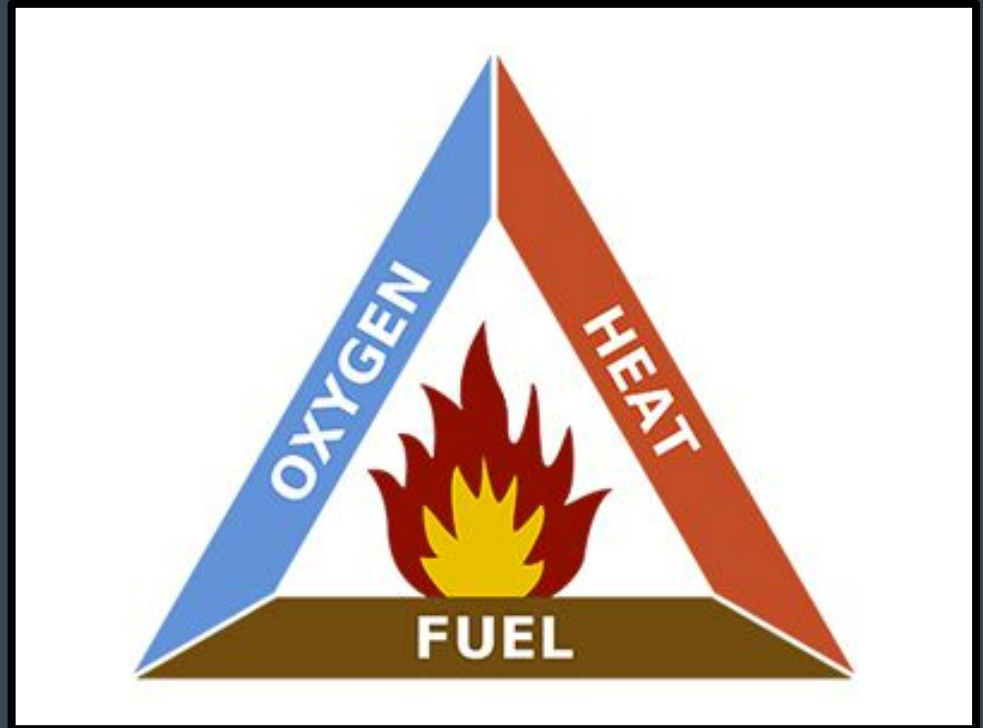
Poll Question

Have you ever seen a wildfire? yes/no



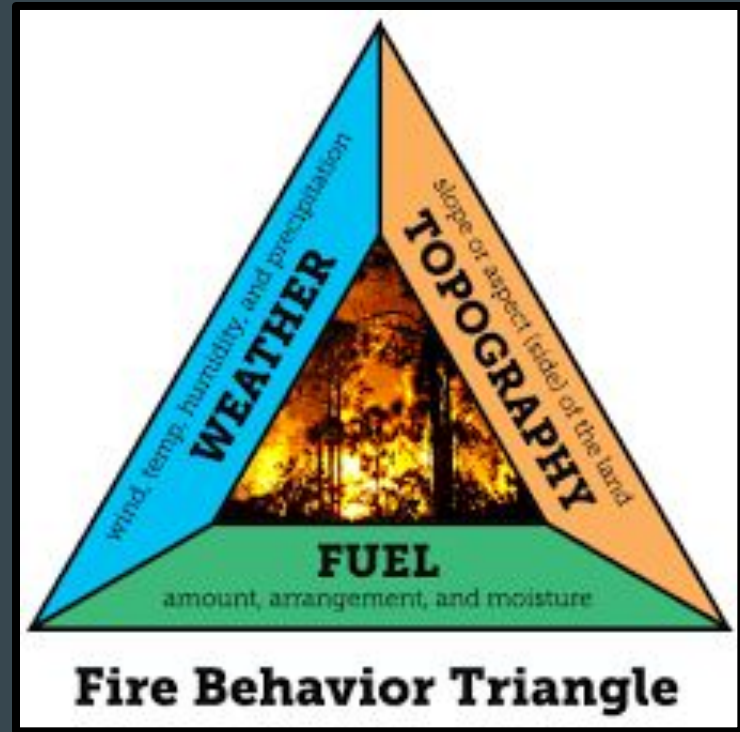
Fire Triangle

- Oxygen
- Heat
- Fuel



Fire Behavior Triangle

- Weather
 - Wind
 - Humidity
 - Temperature
 - Precipitation
- Topography
 - Slope/aspect
- Fuel
 - Amount
 - Arrangement
 - Moisture



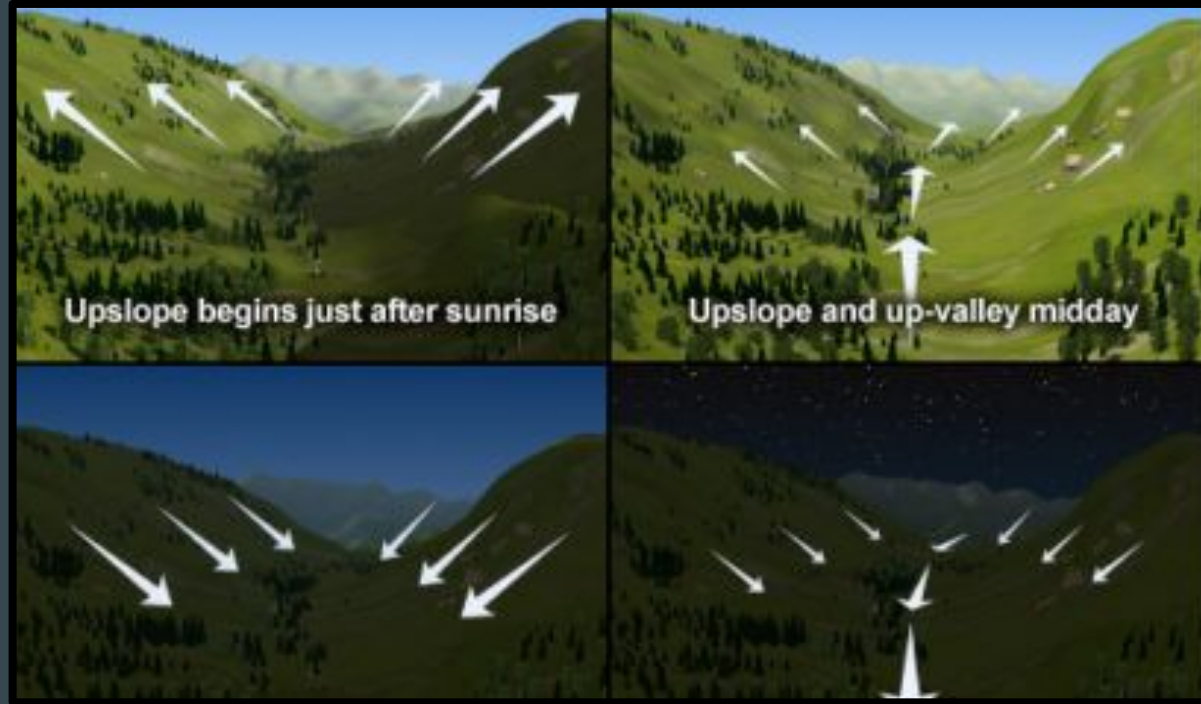
Fuels - Vegetation

- Live fuel moisture
- Dead fuel moisture
 - 1 hr, 10 hr, 100 hr, 1000 hr, 10000 hr fuels
- ERC - Energy Release Component
 - The computed total heat release per unit area (British thermal units per square foot) within the flaming front at the head of a moving fire.
- BI - Burning Index
 - A relative number related to the contribution that fire behavior makes to the amount or effort needed to contain a fire in a specified fuel type.



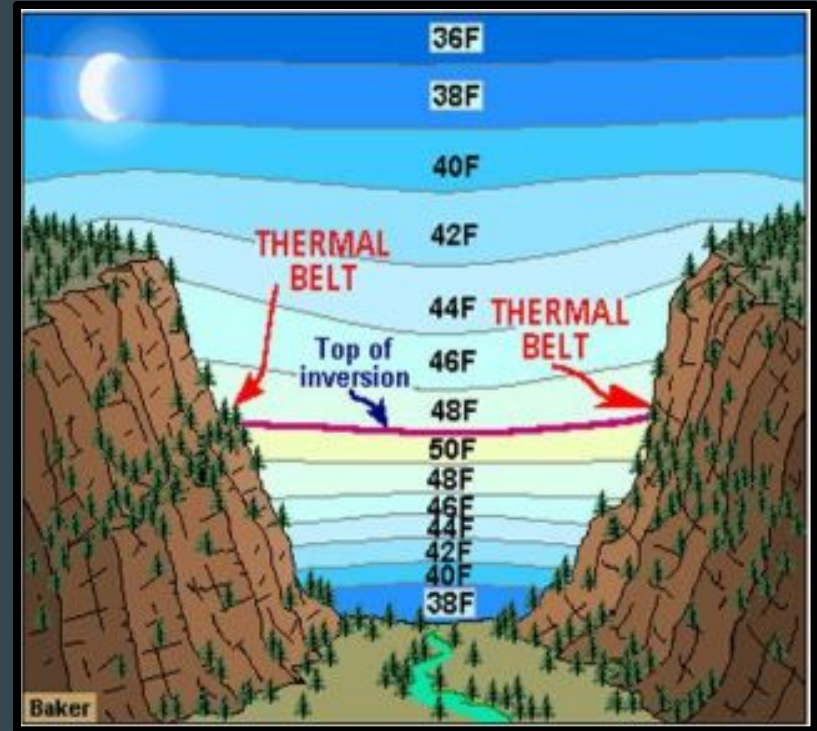
Role of Topography - Mountain and valley wind system

- Upslope after sunrise
- Upslope and up-valley around midday
- Downslope after sunset
- Downslope and down-valley later in the night



Role of Topography - Thermal Belts

- Layer of warmer air
 - Drier air and lower RH
- Cooler air near the surface
- Cooler air above the belt
- Acts as a lid on the fire
- Can trap smoke leading to smoke impacts and health concerns
- Can cause fires to flare up or continue to burn well into the night



Common Fire Weather Variables

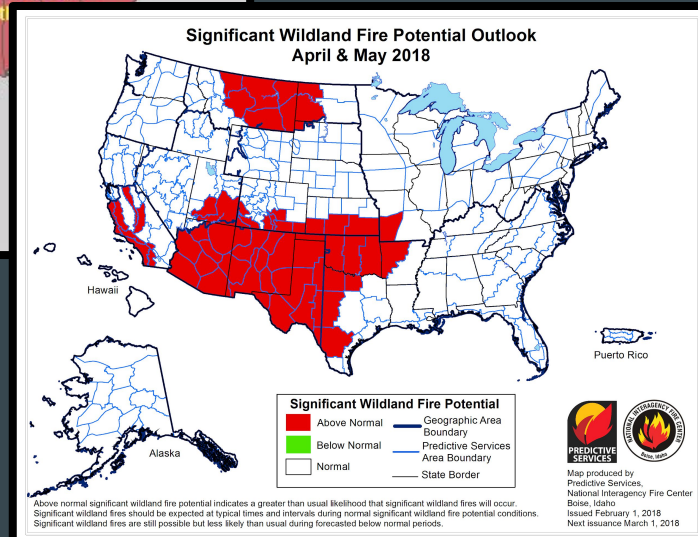
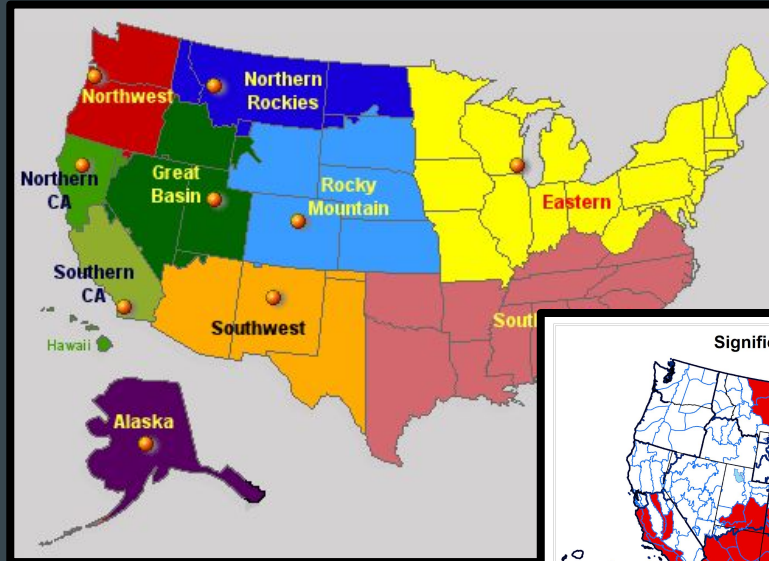
- Sky/Weather
- Temperature - Min/Max/Trend
- Humidity - Min/Max/Trend
- 20-foot wind
- 10,000ft wind
- Chance of precip
- LAL - Lightning Level Level
- Haines
- Chance of Wetting Rains
- Dry or Wet Thunderstorm
- Mixing Heights
- Ventilation Index
- Transport Winds
- DSI - Davis Stability Index
- LVORI - Low Visibility Occurrence Risk Index
- ADI - Atmospheric Dispersion Index

Poll Question

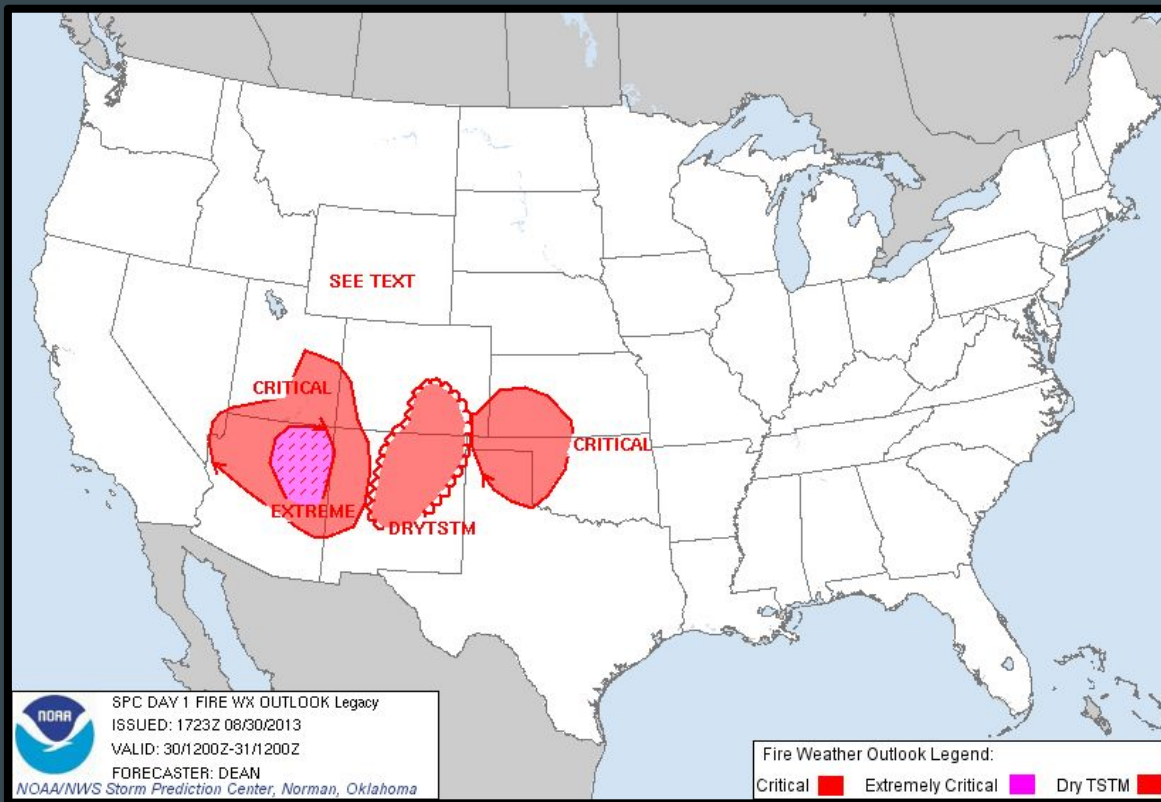
What is a thermal belt?

Fire Weather Products and Services

- National Weather Service
 - Local NWS Offices
 - Storm Prediction Center
- Predictive Services
 - Geographical Coordination Centers
 - USFS
 - BLM
 - BIA
 - Many more



Fire Weather - Storm Prediction Center



Fire Weather Briefings Shared with Fire Community

SOUTHEAST ARIZONA MONTHLY SEASONAL OUTLOOK

National Weather Service
Tucson

Briefing for:
Wildland Fire Agencies

Southeast Arizona Weather Briefing for Wildland Fire Agencies
National Weather Service - Tucson, Arizona

Updated: Sunday, May 17, 2020 - 2:54 PM

Weather Hazard Table	No Significant Weather	Minor	Moderate	Major			
	Mon 5/18	Tue 5/19	Wed 5/20	Thu 5/21	Fri 5/22	Sat 5/23	Sun 5/24
Likelihood of Critical Fire Weather Conditions	None	Chance in < 50% of the Area	None	None	None	None	None
Temperatures	Very Warm (85 to 100°F)	< 95°F	< 95°F	< 95°F	< 95°F	< 95°F	< 95°F
Minimum Humidity	RH < 10%	RH < 10%	RH < 10%	RH < 10%	RH < 10%	RH 10 to 15%	RH 10 to 15%
Sustained 20 ft Wind (Surface)	Wind < 15 mph	Wind 15 to 20 mph	Wind < 15 mph	Wind < 15 mph	Wind < 15 mph	Wind < 15 mph	Wind < 15 mph
Wind - 10,000 ft Sustained	Wind < 20 mph	Wind 20 to 30 mph	Wind < 20 mph	Wind < 20 mph	Wind < 20 mph	Wind < 20 mph	Wind < 20 mph
LAL	1	1	1	1	1	1	1
Haines	5	4	4	4	4	2 or 3	2 or 3
Thunderstorm Outflow Winds	Wind < 30 mph	Wind < 30 mph	Wind < 30 mph	Wind < 30 mph	Wind < 30 mph	Wind < 30 mph	Wind < 30 mph
Hail (Aviation Threat)	No Hail	No Hail	No Hail	No Hail	No Hail	No Hail	No Hail

Weather Forecast Narrative For detailed forecast visit: weather.gov/tucson

Spot Weather

- Specialized for each office and region, but same look/feel.
- Detailed weather forecast for fire personnel.
- Can be used for many disaster types or for events.

Spot Forecast for Peeled Dogwood...USDA Forest Service
National Weather Service Jackson, KY
1004 AM EST Mon Nov 16 2020

Forecast is based on forecast start time of 1000 EST on November 16.
If conditions become unrepresentative...contact the National Weather Service.

.DISCUSSION... Plenty of sunshine will allow drier air to mix down from aloft this afternoon, leading to min rh near 25 percent for the wildfire. Sustained winds should remain less than 10 mph, however a few gusts to near 15 mph are expected between 1400 and 1600. A cold front will approach the area tonight, and drop south of the commonwealth on Tuesday. High pressure building into the area behind the front will usher in a colder airmass for Tuesday on gusty west to northwest winds. However, with colder temperatures expected, rh should not be as low on Tuesday. Dry weather will continue through the week.

.REST OF TODAY...

Sky/weather.....Sunny.
Chance of pcpn.....0 percent.
LAL.....1.
Max temperature....Around 56.
Min humidity.....25 percent.
Dewpoint.....Around 31 decreasing to around 23 in the afternoon.
Wind (20 ft).....West to southwest 4 to 8 mph, with gusts up to 15 mph in the afternoon.
Ridgetop wind.....West to southwest 5 to 9 mph.
Mixing height.....1700-3000 ft AGL.
Transport winds....West 12 to 15 mph.
Ventilation rate....Fair to good (22100-35200 knot-ft).
LVORI.....1.
ADI.....33 to 41 in the morning, increasing to 44 in the afternoon.
Haines Index.....4 to 5 OR low to moderate potential

Incident Meteorologist Products



Woodward Fire Weather Forecast



FORECAST NO: 20
PREDICTION FOR: Sunday Day/Night
SHIFT DATE: 9/13

NAME OF FIRE: Woodward
UNIT: CA-RNP

SIGNED:

Jeremy Michael
Incident Meteorologist

FORECAST ISSUED: 9/12/2020 at 1500

WEATHER DISCUSSION: An area of smoke is forecast to move across the fire today. This may keep temperatures slightly cooler with an increase in moisture. Fog and stratus should still clear between 1000-1200 hours at the Bear Valley Visitor Center with clearing along the Inverness Ridge from 1200-1400 hours. This pattern will continue into early next week with a downward trend in regional smoke. By the middle to end of next week, a passing storm system will bring increased moisture and occasional drizzle as onshore flow increases.

SUNDAY:

WEATHER: Possible localized dense smoke and morning fog, clearing late morning into early afternoon.

TEMPERATURES: Coast: 55-62°F. Ridges/Inland: 65-75°F.

HUMIDITY: Coast: 80-95%. Ridges/Inland: 60-75%. Possibly dropping to 50% Ridgetops.

20 FT WINDS: West-northwest to northwest 4-9 mph, gusting to 15 mph.

MARINE LAYER DEPTH/TIMING: 900-1200 ft. Stratus/fog clearing 1000-1200 hrs. Along the Inverness Ridge possibly 1100-1300 hrs.

Woodward Fire General Weather Outlook

See the IAP for the Official Forecast



Forecast made Sunday, September 06 - Incident Meteorologist Jeremy Michael

Afternoon Conditions	MON	TUE	WED	THU	FRI	SAT
	7-Sep	8-Sep	9-Sep	10-Sep	11-Sep	12-Sep
Clouds @ 1500 (%)	10	30	40	45	60	70
Max Temp (F)	85	82	77	74	72	67
Aftn Min RH (%)	30	35	50	55	60	65
Night 800 ft RH (%)	30	45	70	80	100	100
Marine Layer (ft)	300	800	1200	1300	1400	1400
Marine Erosion (hr)	900	1000	1200	1300	1400	1400
Precip Chance (%)	0	0	0	0	0	0
Ridge Wind (mph)	12	13	10	10	14	15
Wind Direction*	NW to NE	NE to NNW	WSW-W	WNW	WNW	WNW
LAL	1	1	1	1	1	1

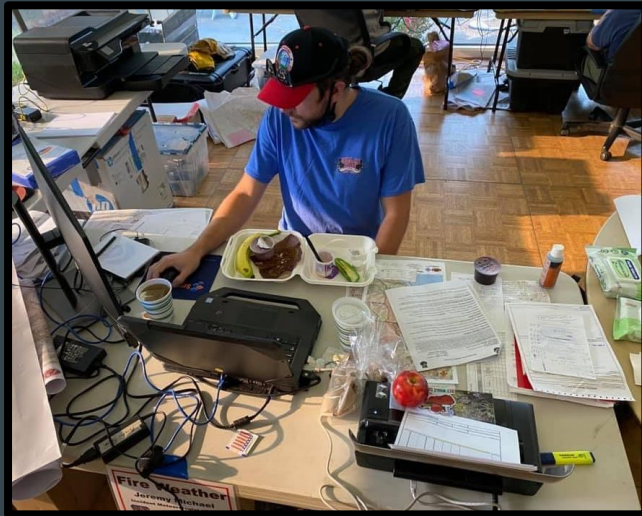
Matrix most representative for active burning areas

KEY:	Moderate Burning Conditions	Elevated Burning Conditions	Extreme Burning Conditions
Clouds	> 51 %	31 to 50 %	< 30 %
Avg Max Temp	< 69 F	70 to 75 F	76 F or warmer
Precip Chance	50 % or greater	0 to 29 %	
LAL	3, 4, 5	2	6
Ridge Wind	14 mph or less	15 to 24 mph	25 mph or more
*Wind Direction	Critical wind direction highly dependent on burn operations and/or structures threatened		
Min/Max Humidity	60% or more	40 to 59 %	39% or less
Marine Depth	1300 ft or greater	600 ft - 1300 ft	None/500 ft or less
Marine Erosion	After 1300 hrs or NONE	1100 hrs to 1300 hrs	Before 1100 hrs

5 EXTREME blocks in a day signals potential for a Critical Weather Day

Incident Meteorologist Program

- Deployed to wildfires for two weeks, sometimes longer.
- Provides all weather forecast and support for the incident management team.
- Specialized training to be ready on a moments notice to deploy anywhere in the US. Even Australia when they have a busy season.



Fire Weather Watch and Red Flag Warning

...FIRE WEATHER WATCH IN EFFECT FROM WEDNESDAY MORNING THROUGH WEDNESDAY AFTERNOON FOR GUSTY WINDS AND LOW RELATIVE HUMIDITY FOR FIRE WEATHER ZONES 227...228...229...230...231...232...233...234...235...236 AND 237...

The National Weather Service in Pueblo has issued a Fire Weather Watch for gusty winds and low relative humidity, which is in effect from Wednesday morning through Wednesday afternoon.

* Affected Area...Fire Weather Zones 227...228...229...230...231...232...233...234...235...236 and 237.

* Winds...Southwest 10 to 20 mph with gusts up to 30 mph.

* Relative Humidity...As low as 13 percent.

* Impacts...Conditions will be favorable for rapid rates of fire growth and spread.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A Fire Weather Watch means that critical fire weather conditions are forecast to occur. Listen for later forecasts and possible Red Flag Warnings.



RED FLAG WARNING

Information Updated on October 26, 2019 1:40 PM PDT

THIS WILL BE A LONG DURATION EXTREME EVENT ACROSS THE NORTH BAY!

	North Bay/East Bay 8 PM Saturday through 11 AM Monday Mountains: 15-35 mph, gusts 45-60 mph, & up to 65-80 mph highest peaks Valleys/Coast: 15-25 mph, gusts to 45 mph
	San Francisco Peninsula Coast 3 AM Sunday through 11 AM Monday 15-30 mph with gusts to 35-55 mph late Saturday night into Sunday morning
	Santa Cruz Mountains 3 AM Sunday through 11 AM Monday 15-30 mph with gusts to 35-55 mph late Saturday night into Sunday
	<ul style="list-style-type: none">• Extreme fire behavior• Gusty and potentially strong, damaging north to northeast winds• Low relative humidity



San Francisco Bay Area/Monterey
weather.gov/bayarea

Fire Weather Watch and Red Flag Warning????

Red Flag Warning

The NWS issues a Red Flag Warning, in conjunction with land management agencies, to alert people to an ongoing or expected **critical fire weather** pattern.

Critical fire weather conditions are either **occurring now, or will shortly**. Be extremely careful with open flames.

Take action.

Fire Weather Watch

A Fire Weather Watch alerts land managers and the public that upcoming weather conditions could result in extensive wildland fire occurrence or extreme fire behavior.

A watch means critical fire weather **conditions are possible** but not imminent or occurring.

Be prepared.

[weather.gov/fire](https://www.weather.gov/fire)



Fire Warning

- Rarely issued.
- In coordination with local emergency managers.
- Issued when a rapidly developing and moving wildfire is threatening a town.
- Activates the warning tone alarms, similar to tornado or severe thunderstorm warnings.



Tornado Warning - Fire Tornado



TORNADO WARNING
NATIONAL WEATHER SERVICE RENO NV
235 PM PDT SAT AUG 15 2020

THE NATIONAL WEATHER SERVICE IN RENO HAS ISSUED A

- * TORNADO WARNING FOR...
SOUTHEASTERN LASSEN COUNTY IN NORTHERN CALIFORNIA...
- * UNTIL 330 PM PDT.
- * AT 228 PM PDT, A PYROCUMULONIMBUS FROM THE LOYALTON WILDFIRE IS CAPABLE OF PRODUCING A FIRE INDUCED TORNADO AND OUTFLOW WINDS IN EXCESS OF 60 MPH WAS LOCATED SOUTH OF CHILCOOT, AND IS NEARLY STATIONARY.

HAZARD...TORNADO.

SOURCE...RADAR INDICATED ROTATION.

IMPACT...EXTREME FIRE BEHAVIOR WITH STRONG OUTFLOW WINDS CAPABLE OF DOWNING TREES AND STARTING NEW FIRES. THIS IS AN EXTREMELY DANGEROUS SITUATION FOR FIRE FIGHTERS.

Fire Tornado Damage



Fire Weather Forecast

- Issued 1-2 times daily.
- Intendent for fire partners.
- Vary from office to office. Based on needs of fire partners in the region.
- A more generalized forecast based on a zone.
- A discussion is included, which is read over the radio to fire crews during fire season.

Fire Weather Planning Forecast for Southeast Arizona
National Weather Service Tucson AZ
150 PM MST Mon Nov 16 2020

+++++
20-FOOT WIND FORECAST OF `LIGHT WINDS` INDICATES MAINLY
TERRAIN DRIVEN WINDS
+++++

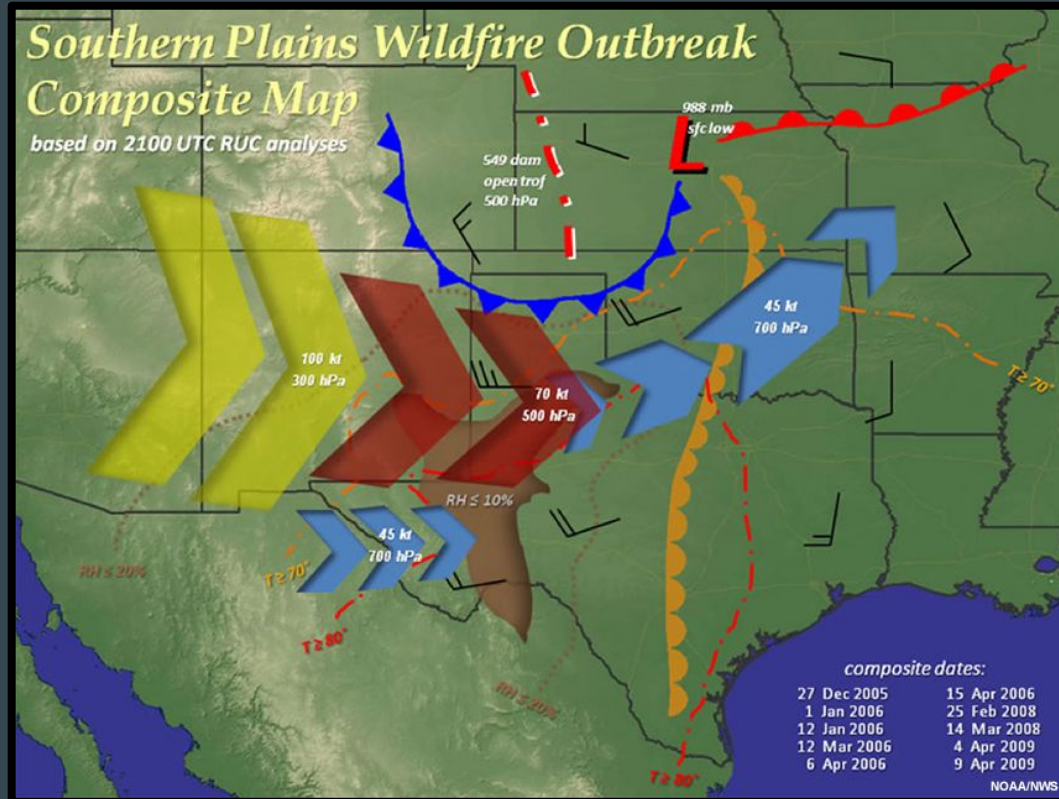
.DISCUSSION...No fire weather concerns through the work week. Dry weather is expected across southeast Arizona the next 7 days. A strong warming trend will continue through Thursday, with near record to record high temperatures Tuesday through Thursday. 20-foot winds will be less than 15 mph through the work week, with easterly winds into Tuesday morning then normal diurnal wind trends through Friday. Some elevated westerly winds may occur over the weekend.

AZZ150-171415-
Arizona Fire Weather Zone 150
Sonoran FDRA-Most of Pima County-South Central Pinal County-
Tohono O'odham Nation-Tucson Metropolitan area-TDC-
150 PM MST Mon Nov 16 2020

.TONIGHT...
* Sky/Weather.....Mostly clear.
* Min Temperature.....51 to 61 degs.
* 24 hr Trend.....Up 3 to 6 degs.
* Max Humidity.....24 to 34 pct.
* 24 hr Trend.....Little change.
* Wind (20 ft/10-min avg)..Southeast 10 to 15 mph.
* 10000 ft MSL Wind.....South 15 to 20 mph.
* Chance of Precip.....0 pct.
* LAL.....1.
* Haines Index.....5 or moderate.

Poll Question

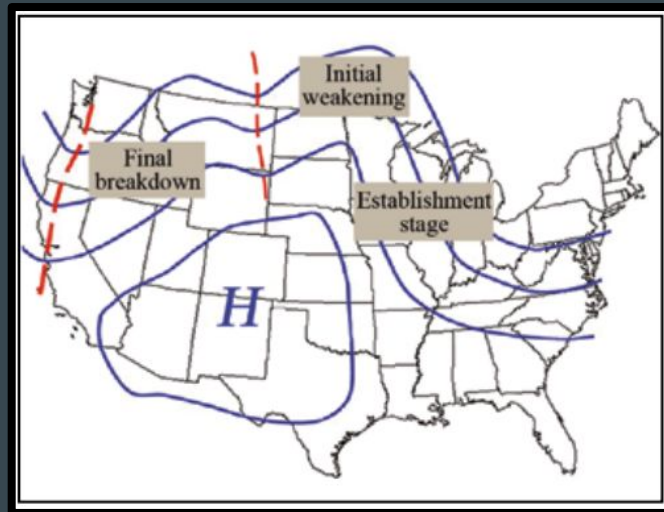
Common Fire Weather Patterns



Breakdown of 4-Corners High Pressure

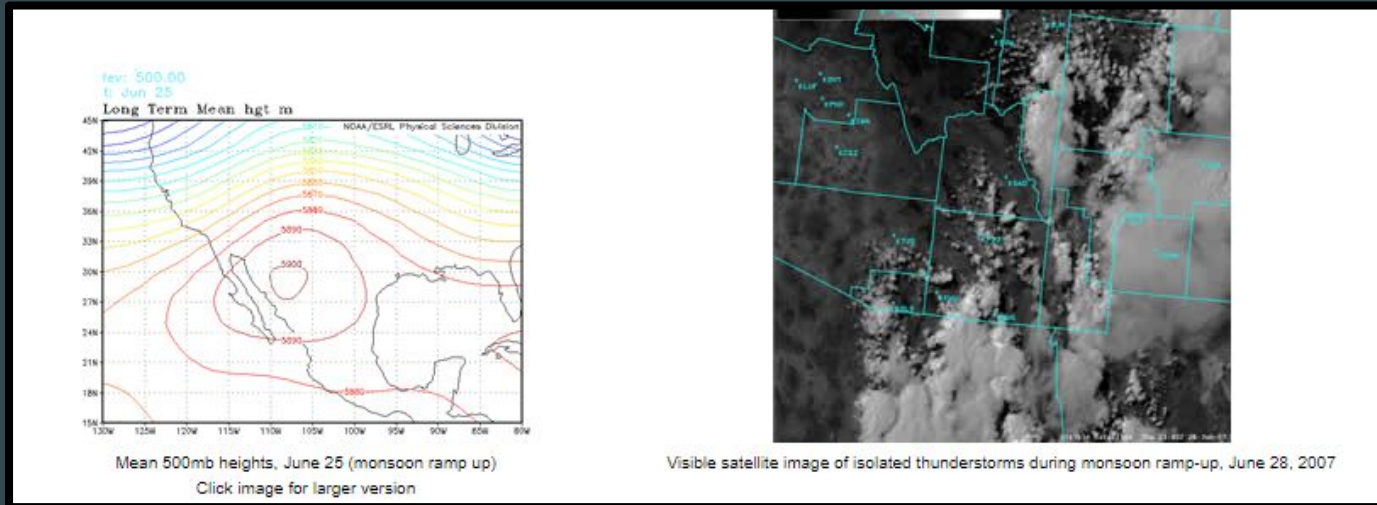
Breakdown of Upper Ridge and Cold Frontal Passage

- Stage 1 - warm, dry, breezy and unstable conditions.
- Stage 2 - wind speeds will increase while conditions remain warm-dry and unstable.
- Stage 3 - defined by a cold frontal passage.
 - Sometimes results in dry thunderstorms across the Great Basin. Can lead to widespread fire outbreaks. Strong winds behind the front worsens the situation.

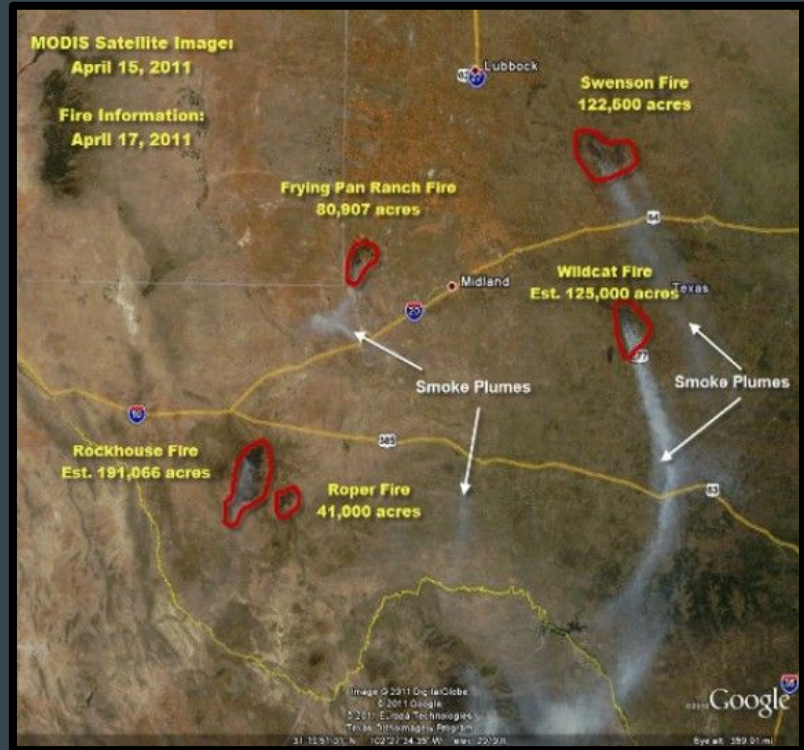
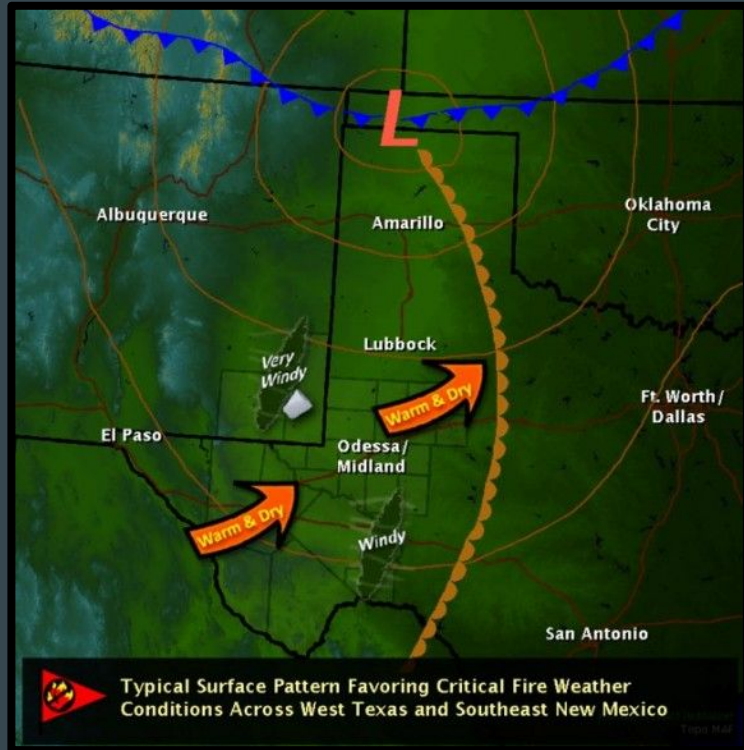


Early Monsoon Moisture Surges - Southwest Fire Weather

Early season surges of moisture in June when fuels are still dry. Can lead to new fire starts in the Southwest.



Cold Frontal Passages and Fire Danger



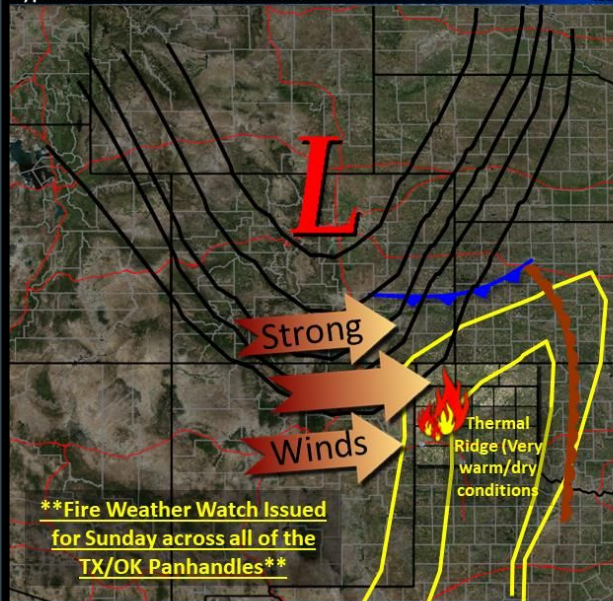
Cold Frontal Passages and Fire Danger

Increased Fire Weather Concerns Sunday

Typical Pattern for Wildfire Outbreaks

Weather Forecast Office
Amarillo, TX

Issued Mar 01, 2018 6:40 AM CST



- Latest guidance continues to suggest a pattern favorable for fire outbreaks in portions of the TX/OK Panhandles on Sunday.

Will largely depend on:

- *Timing of wave*
 - *Location of strongest winds aloft*
 - *Coverage of high clouds*
- This pattern usually results in:
 - Strong downslope winds at 25-35+ mph gusting to 50+ mph
 - Min RH values below 15%
 - Well above average temperatures
 - Fire officials should stay updated with the latest forecast as details are better refined in the next 1-2 days

****Fire Weather Watch Issued for Sunday across all of the TX/OK Panhandles****



Downslope Winds



Diablo and Santa Ana Winds

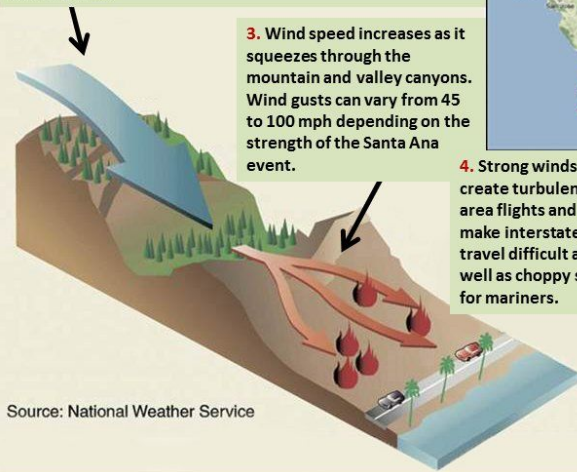
What Drives a Santa Ana Wind?

1. High surface pressure builds over the Great Basin region with lower pressure off Southern Cal Coast. (Fall-mid Spring)

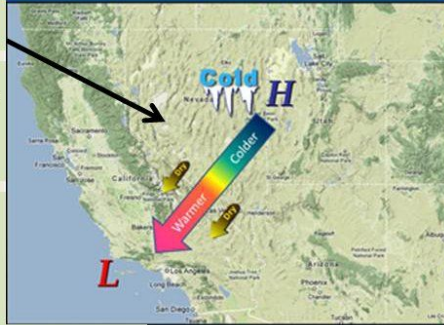
2. Air remains relatively cold across the deserts. As the air extends through the mountain passes...it become compressed and warms. (See lower right map) Lower relative humidity also occurs helping to dry out vegetation and can fan any existing fires.

3. Wind speed increases as it squeezes through the mountain and valley canyons. Wind gusts can vary from 45 to 100 mph depending on the strength of the Santa Ana event.

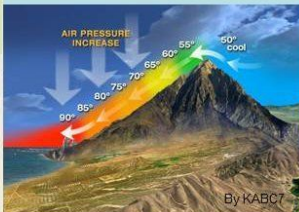
4. Strong winds create turbulence for area flights and can make interstate travel difficult as well as choppy seas for mariners.



Source: National Weather Service



Cross Section over the Los Angeles and Ventura County Mountains to the Pacific Ocean



By KABC7

What creates dangerous winds

The Diablo winds that were forecast for Northern California usually come in the fall, but their behavior is hard to predict because mountains, valleys and even cloud formations can alter their speed and direction.

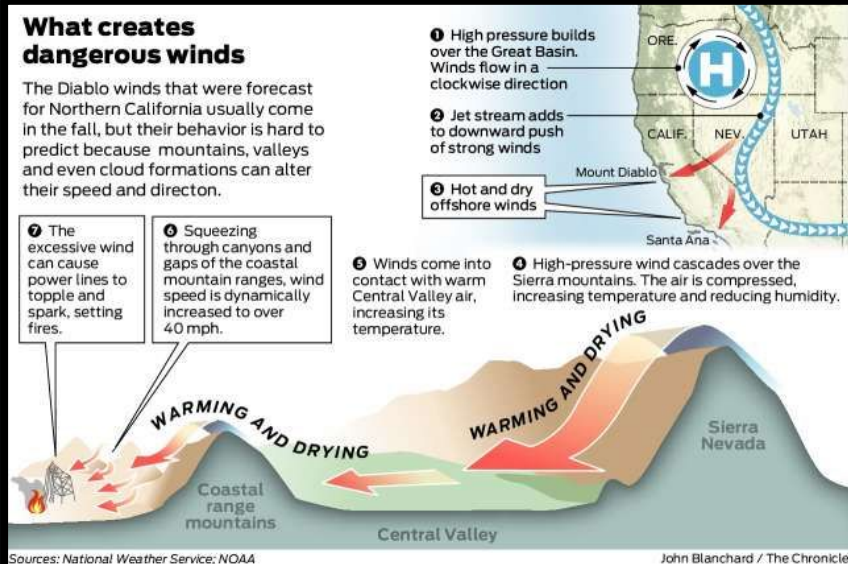
1 High pressure builds over the Great Basin. Winds flow in a clockwise direction

2 Jet stream adds to downward push of strong winds

3 Hot and dry offshore winds

4 Winds come into contact with warm Central Valley air, increasing its temperature.

5 High-pressure wind cascades over the Sierra mountains. The air is compressed, increasing temperature and reducing humidity.



Sources: National Weather Service; NOAA

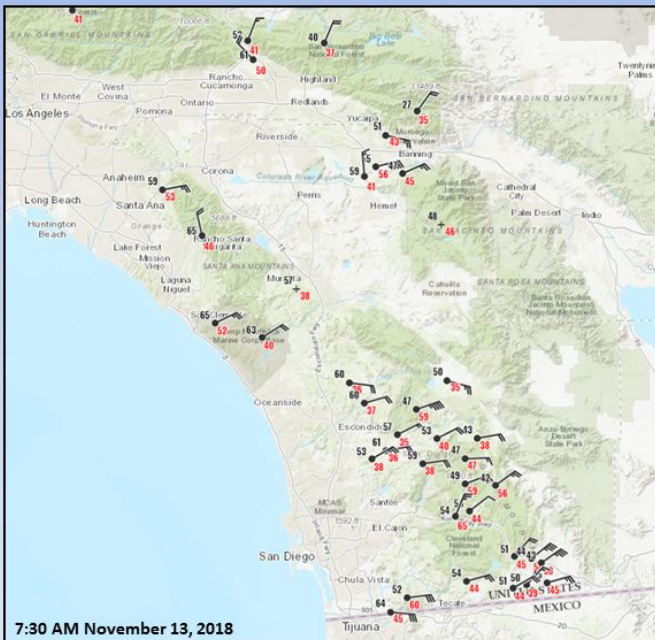
John Blanchard / The Chronicle

Diablo and Santa Ana Winds



Santa Ana Winds Cranking in SoCal

Strong winds Through/Below Passes and on the Mountain Slopes

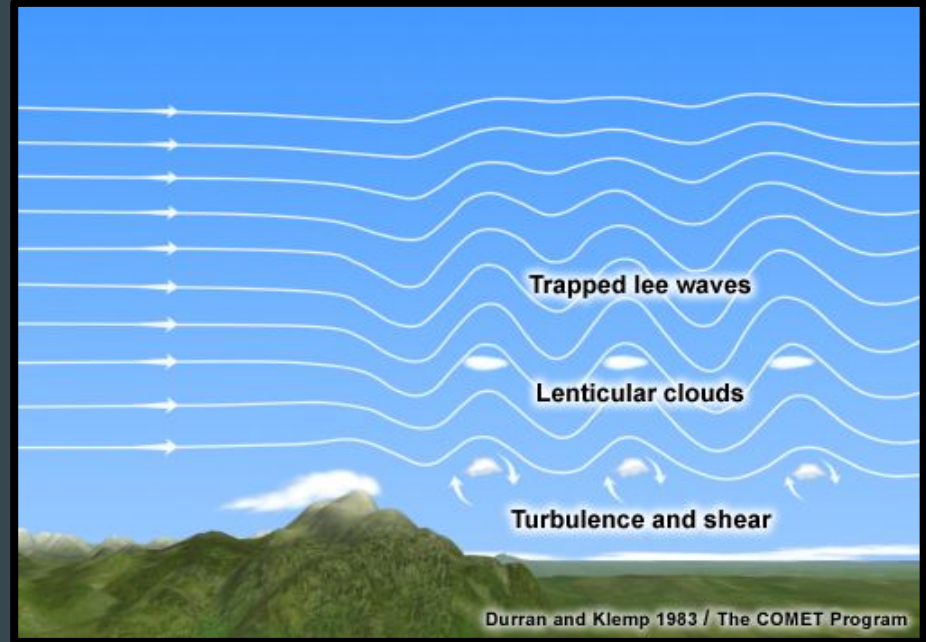


Peak Wind Gusts So Far

Location	Wind Speed (MPH)
Sill Hill	86
Boulder Creek	69
Santiago Canyon	69
Lucky Five Ranch	68
Alpine	65
8 WNW Santa Ysabel	65
Highland Springs	64
Santa Ysabel Ranch	64
La Posta	63
N Boulder Creek	63

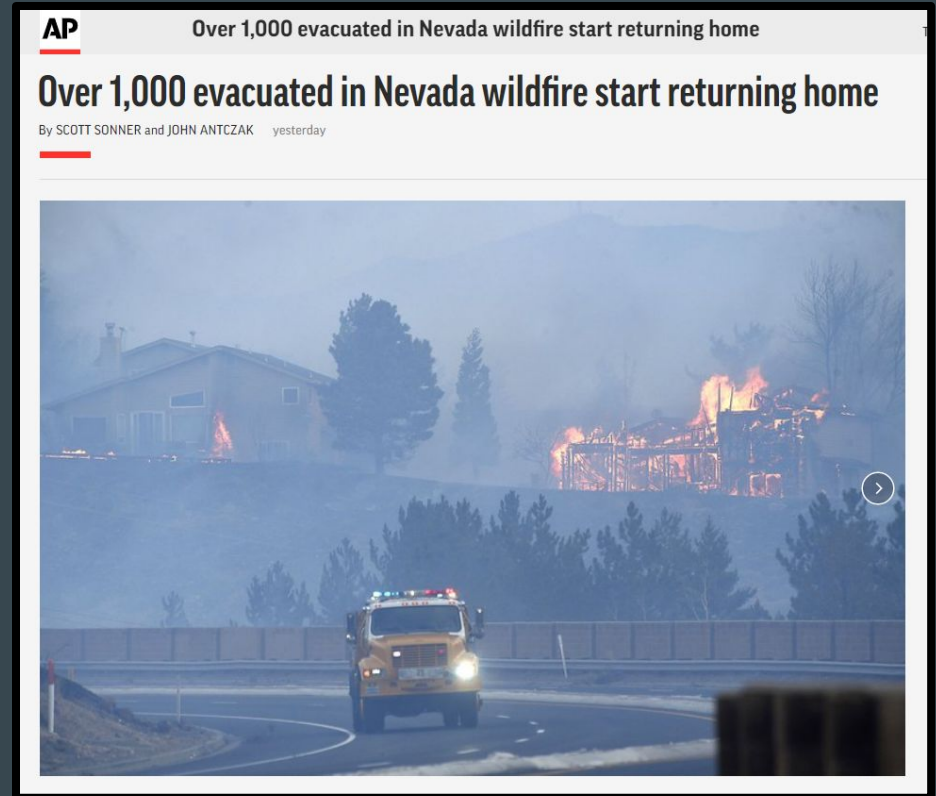
Sierra Nevada Downslope Windstorm

- Different mechanism compared to Santa Ana.
- Wind forced downslope with a cap around the mountain peak.
- Wave breaking, jumps, rotor winds.
- Winds in excess of 100 mph at times, even in the valleys.
- Also common in the western high plains like Colorado and Montana.



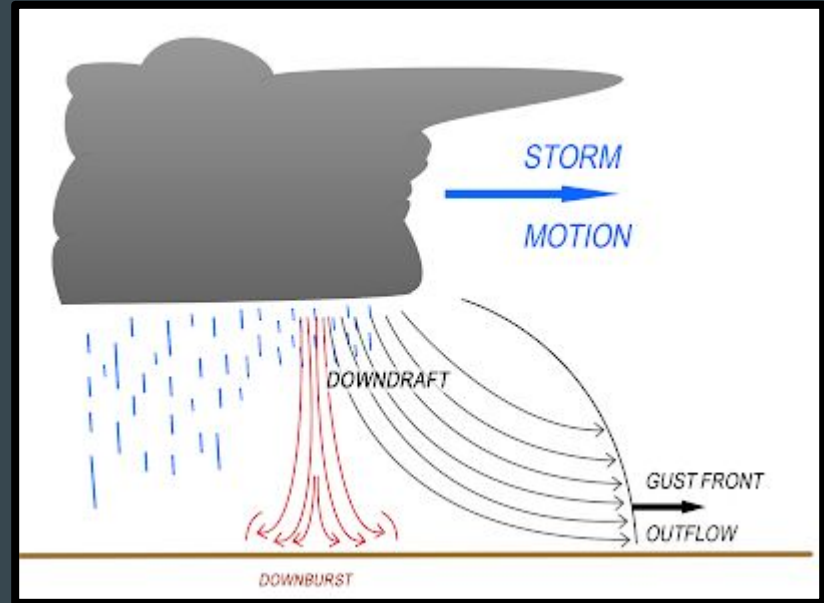
Sierra Nevada Downslope Windstorm

- Occurred in November in a downslope windstorm.
- Numerous wind gusts over 60 mph in the Reno area.
- Higher gusts 80+mph higher elevations.
- Fires spread rapidly in the wind.



Dangers of Thunderstorms and Fire Weather/Behavior

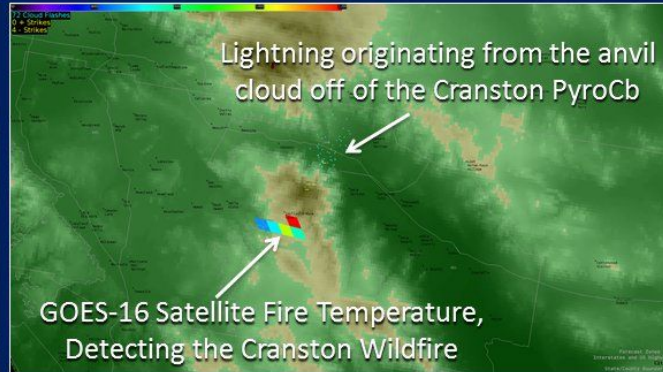
- Gust fronts and microbursts - strong, gusty, and erratic winds.
- Lightning which can lead to new fire starts.
- Heavy rain and debris flows.
Complicating firefighting efforts.
Incident within an incident.



PyroCb - Column collapse - Lightning

Cranston Wildfire “Pyrocumulonimbus”

Pyrocumulonimbus (PyroCb) is a cloud generated from the heat and intense upward motion from a large wildfire



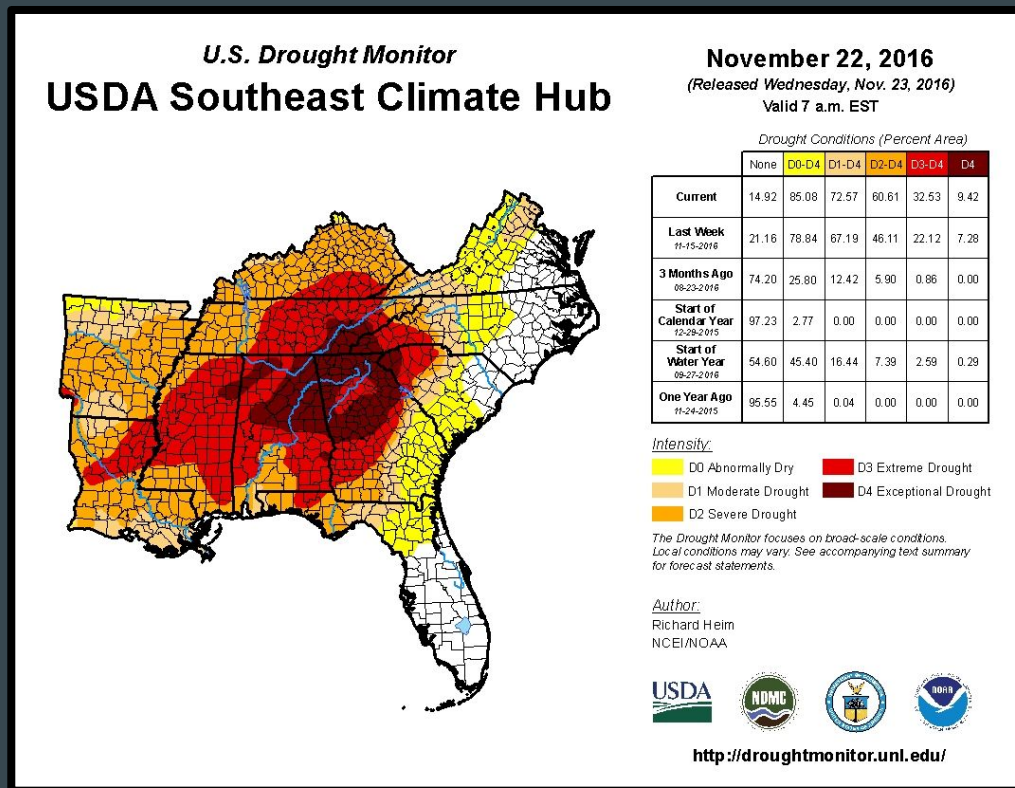
National Weather Service
San Diego, California

Follow us on:

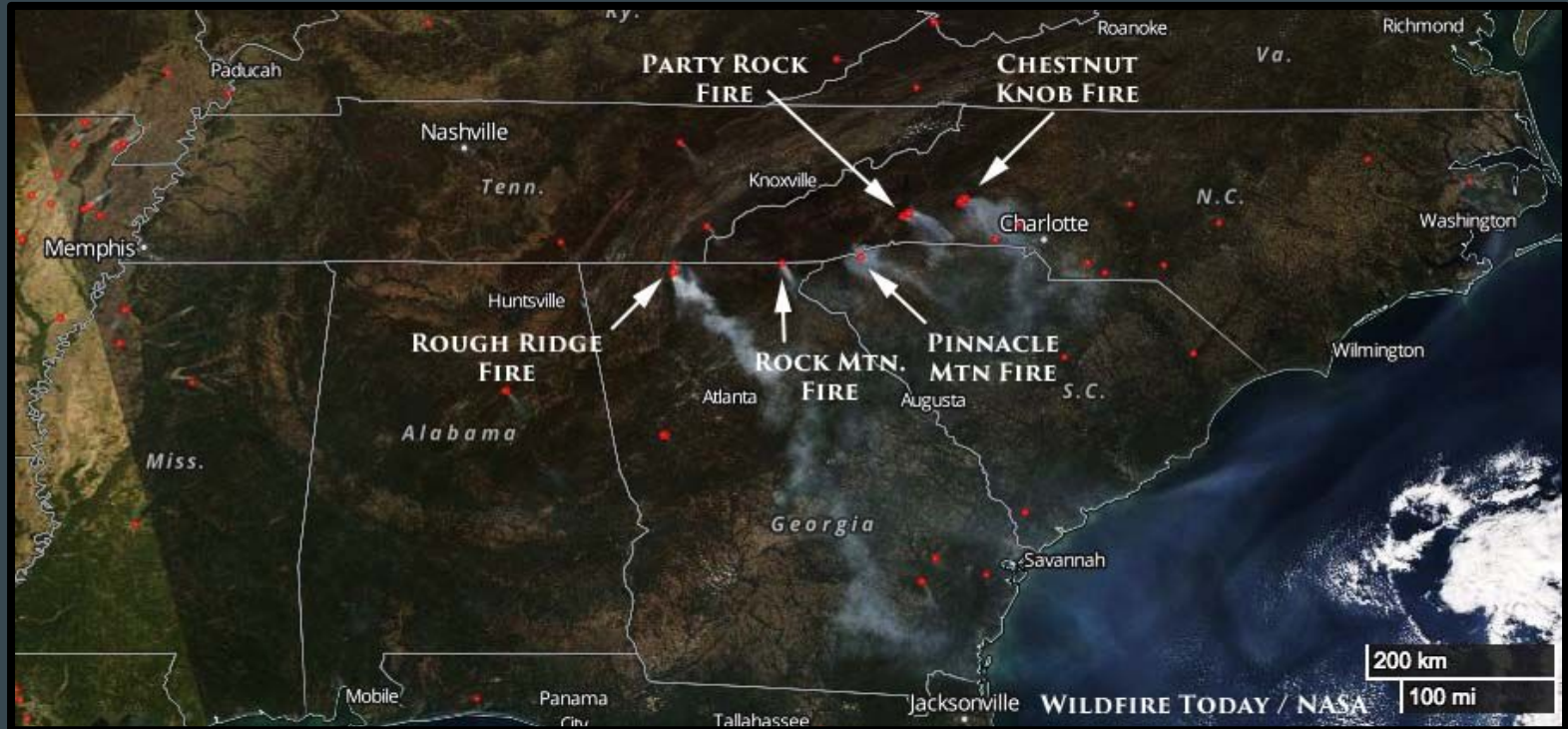


Drought

- Can kill trees.
- Worsen beetle/disease kill.
- Stress vegetation.
- Can set the stage for other regions of the US to see wildfires, like the 2016 southern Appalachian Wildfires.

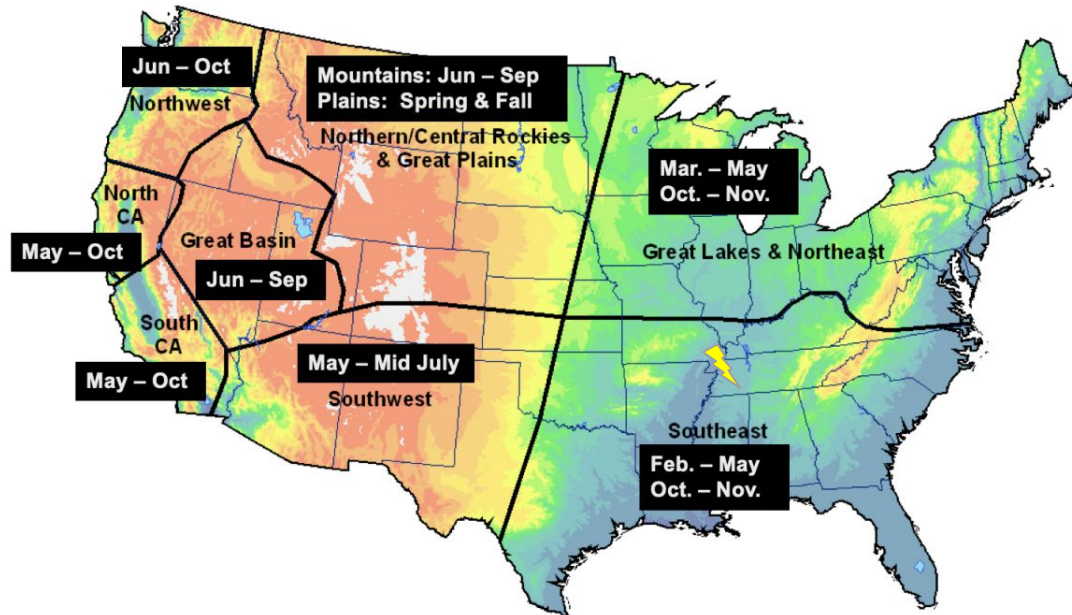


Drought - 2016 Southern Appalachian Wildfires



Fire Weather Season Where You Live

Peak Regional Fire Seasons



Alaska (not shown): May - August

Fire Weather Season Where You Live



  **National Weather Service Burlington, VT**  
www.weather.gov/btv

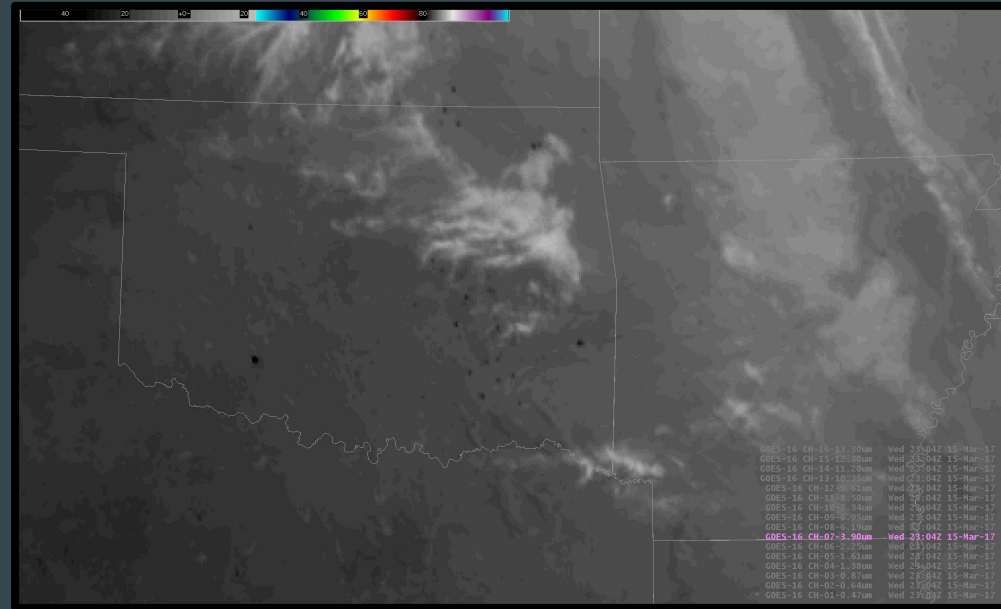
Did you know 75% of all fires in Vermont during a given year occur in April and May? Also, did you know 54% of all fires in New York during a given year occur in April and May as well? That is why this time period is known across the area as **PEAK FIRE SEASON**.

Poll Question

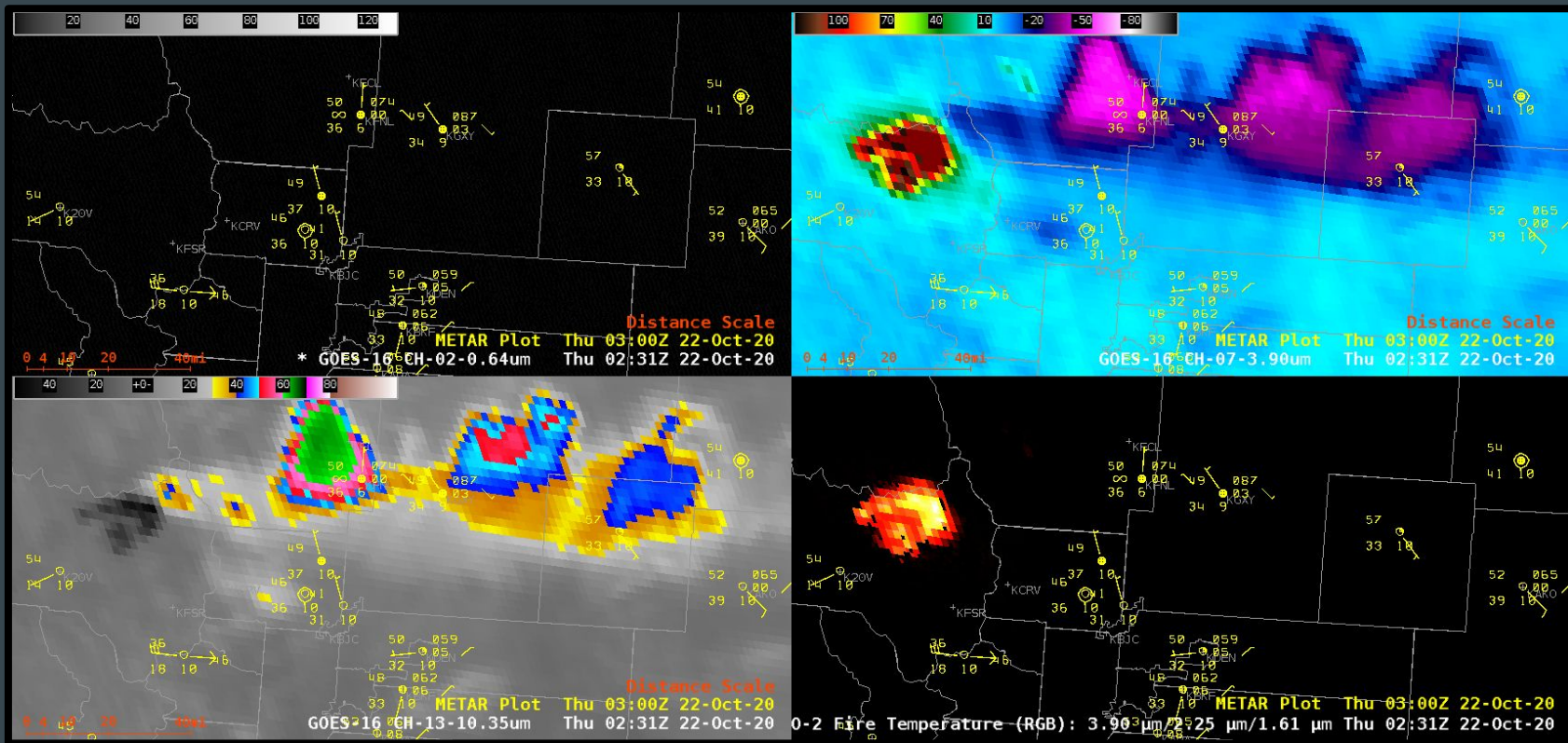
On average, how big does a fire have to be before GOES-16 or GOES 17 can detect?

Exciting Satellite Advancements

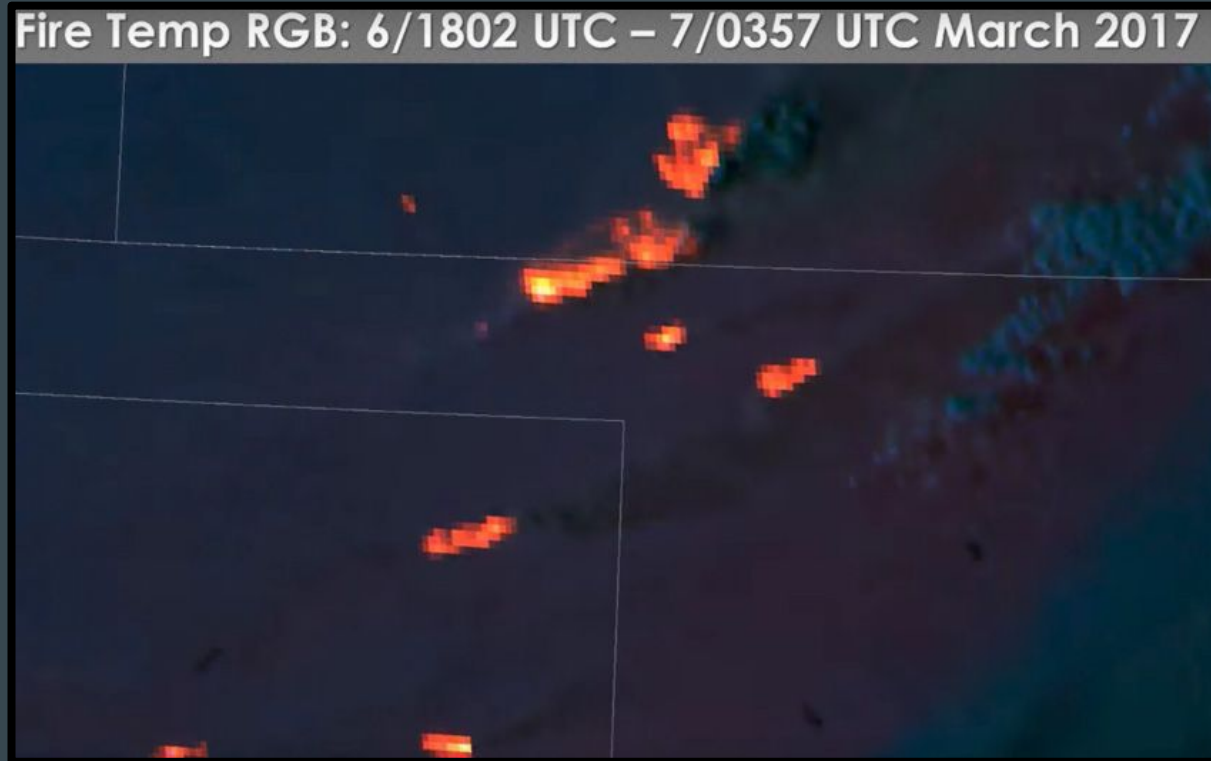
- New GOES satellite can show images every 30-60 seconds.
- New satellite techniques using RGBs to detect and monitor fires.
- JPSS satellites show high resolution imagery during afternoon/night.
- High resolution satellites can give information for burn scars and post fire debris flows.
- Detect fires around 15 acres, sometimes smaller.



Exciting Satellite Advancements



Exciting Satellite Advancements



Thank You for Attending!

Questions?

Contact: Jeremy Michael - jeremy.michael@noaa.gov

Or Scott Unger – Scott.unger@noaa.gov

There are lots more classes to attend this fall/winter!

Sign up: weather.gov/ohx/weather101

Presentation: weather.gov/ohx/weather101presentations

