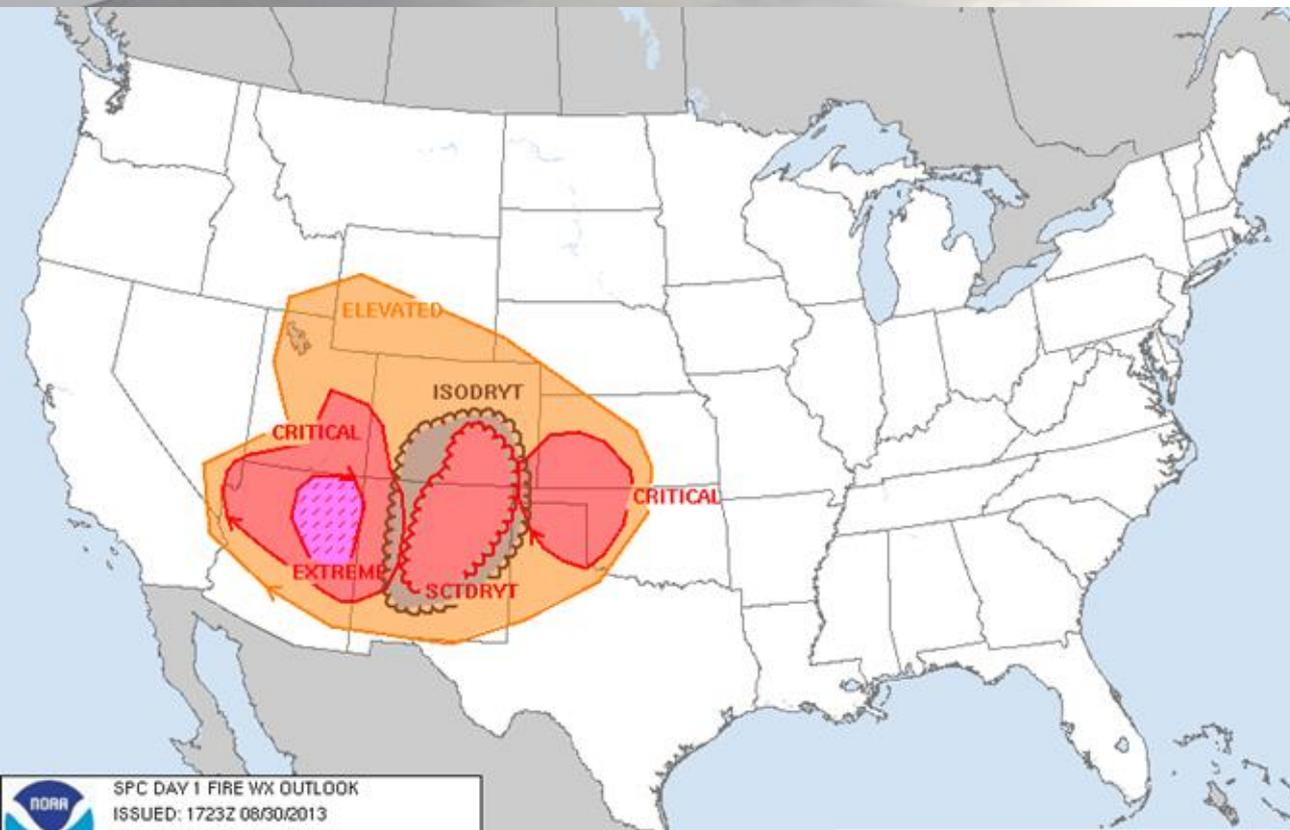


SPC Fire Weather Forecasts



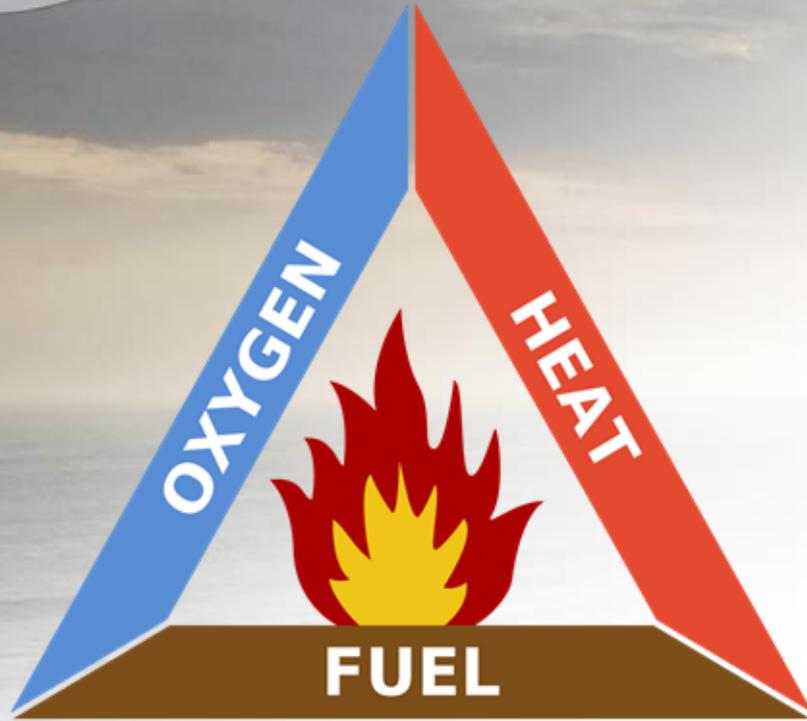
 SPC DAY 1 FIRE WX OUTLOOK
ISSUED: 1723Z 08/30/2013
VALID: 30/1200Z-31/1200Z
FORECASTER: DEAN
NOAA/NWS Storm Prediction Center, Norman, Oklahoma

Fire Weather Outlook Legend:
Elevated Critical Extreme Iso DryT Scattered DryT

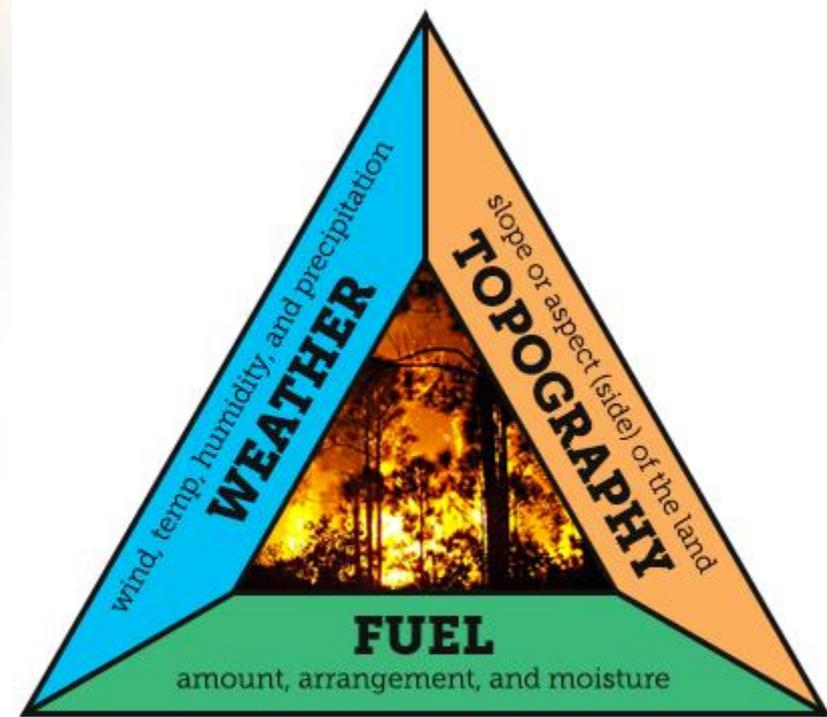
The Basics

- Like severe weather, fire weather can be thought of in an ingredients based framework.
- Ingredients can take several forms but the most common are:
 1. Low relative humidity (High Vapor Pressure Deficit or VPD)
 2. Low fuel moisture/fuel abundance
 3. High winds
 4. Warm temperatures (optional)

The Two Triangles



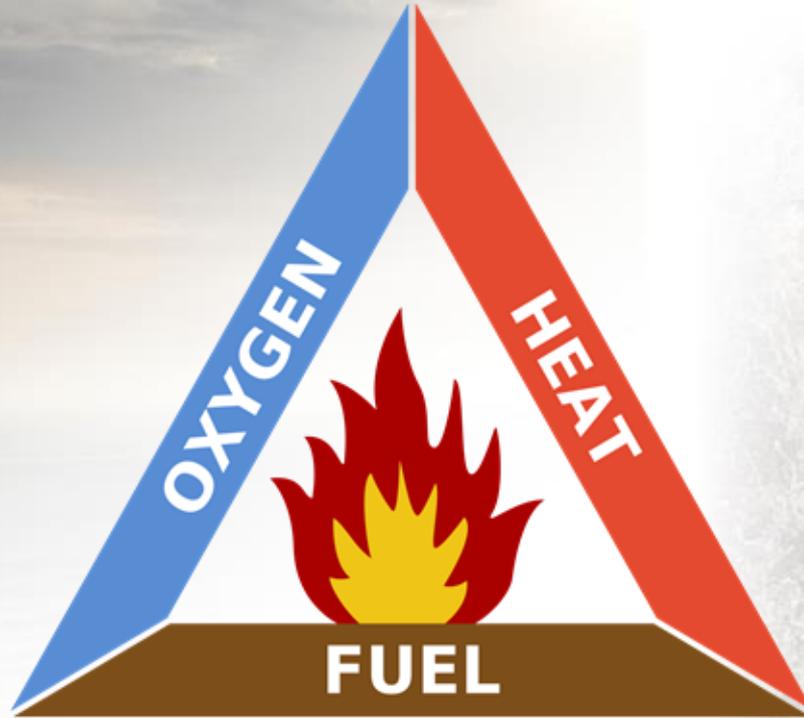
Combustion Triangle



Fire Behavior Triangle

Combustion Triangle

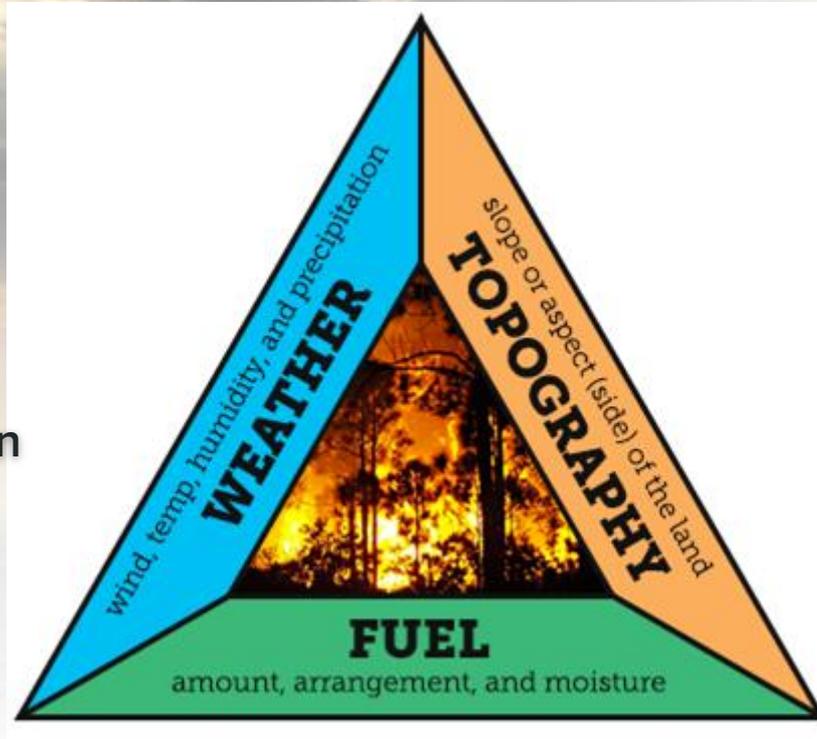
Fire needs oxygen to burn, removing oxygen can extinguish a fire.



Fire requires heat to raise fuels to their ignition temperature. Cooling fuels can suppress a fire.

Fire needs something to burn!
If there is no fuel (sticks, leaves, buildings), there can be no fire.

Fire Behavior Triangle



Weather influences:

- Fire movement
- Plume structure
- Probability of ignition
- Rates of spread

Topography influences:

- Fire movement
- Preheating of fuels
- Fuel dryness

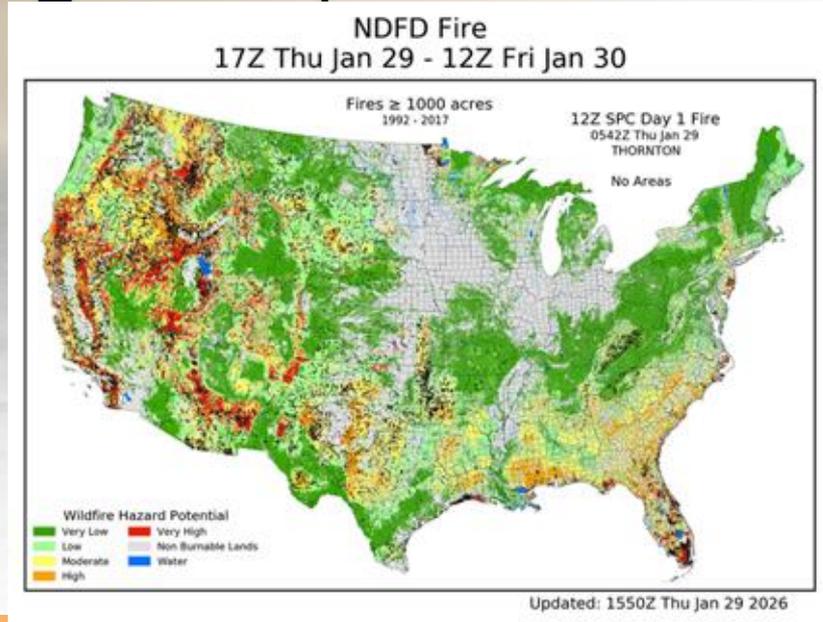
Fuels influence:

- Fire intensity
- Rates of spread
- Probability of ignition

Fire Regimes

Fire Regimes:

- Frequency
- Seasonality
- Fuel types
-



Topography



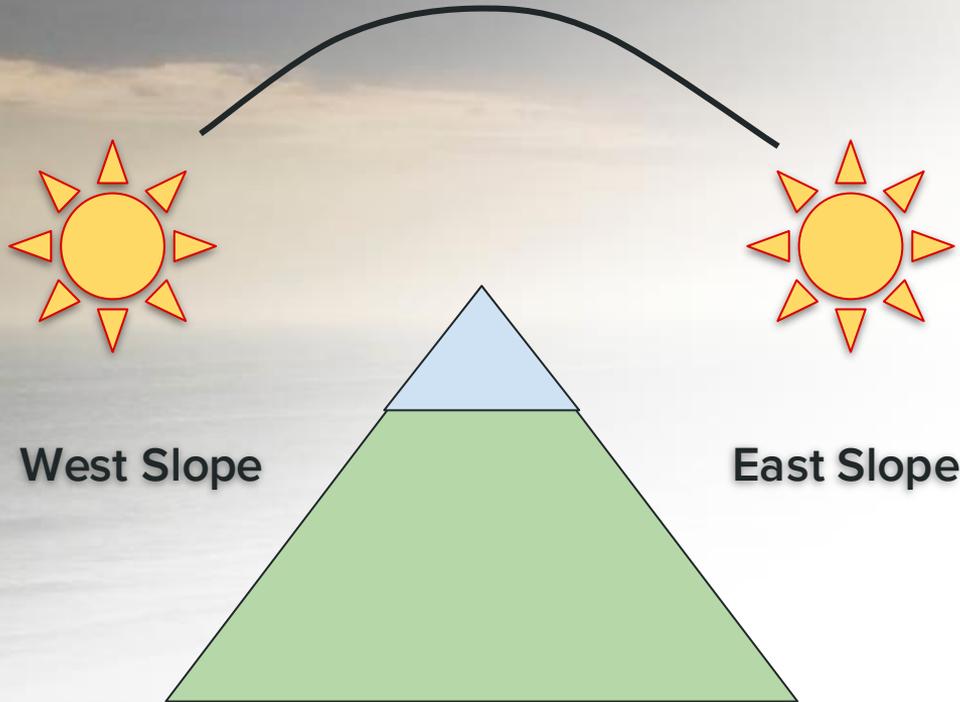
Scale of color is approximately 1:1,000,000

The U.S. Geological Survey (USGS) has completed a scientific observation dataset for the entire United States. The National Elevation Dataset (NED) was produced from over 47 million multi-sensor digital elevation models. NED elevation values are stored as meters in a geographic map projection with a resolution of 3 meters (about 10 meters) for the conterminous U.S., Alaska and Puerto Rico, and 2 kilometers for Alaska. The NED is spatially consistent to the most recent geospatial observation data.

The NED is provided in this profile for a broad range of uses including hydrologic modeling and soil mapping. Online documentation, ordering, and access to the NED are available at the USGS web site (<https://neds.usgs.gov/>).

For more information, contact:
U.S. Geological Survey
300 N. 34th St., Reston, VA 20192
Telephone: (703) 648-4000
Fax: (703) 648-4000
E-mail: neds@usgs.gov

Topographic Influence



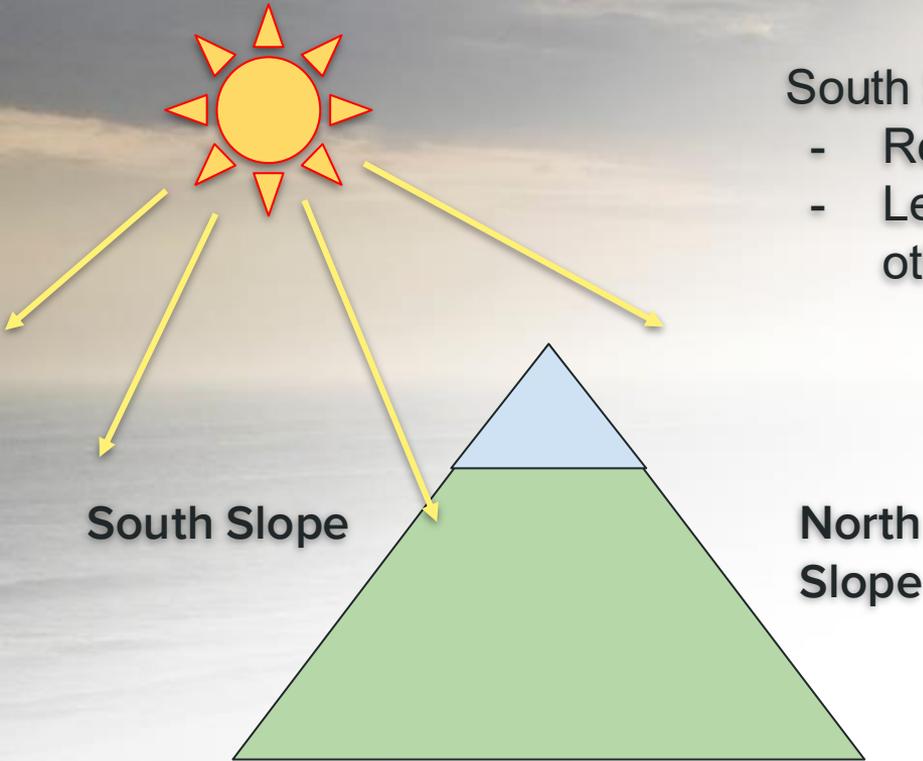
East Slope:

- Warms earlier in the morning
- Cools earlier in the evening.

West Slope:

- Warms later in the morning
- Cools later in the evening.

Topographic Influence



South Slope:

- Receives more sunlight throughout the year*
- Leads to drier, typically lighter fuels than other slopes

North Slope:

- Receives less sunlight throughout the year*
- Leads to more moist, typically heavier fuel types than other slopes

*In the northern hemisphere!

Influence of Slope on Vegetation

Example landscape near Pine, ID
(Southwest ID)

- Evident heavier fuels (mainly Ponderosa Pine) on north slope (north aspect)
- Lighter fuels (sage/grass) on south facing slope (south aspect)

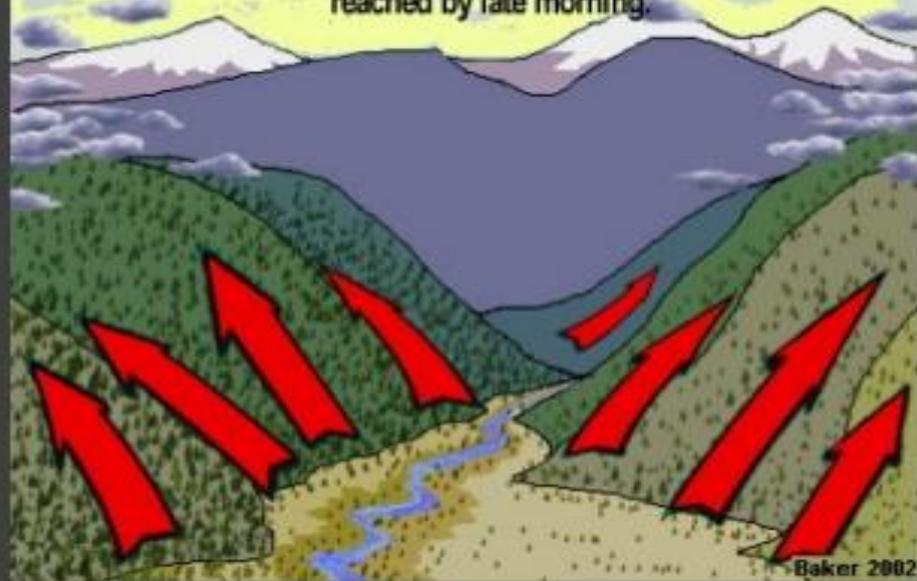


Image Attribution: [Thayne Tuason - Wikimedia Commons](#)
[Effects of aspect on vegetation- SW Idaho.JPG](#)

Local Winds

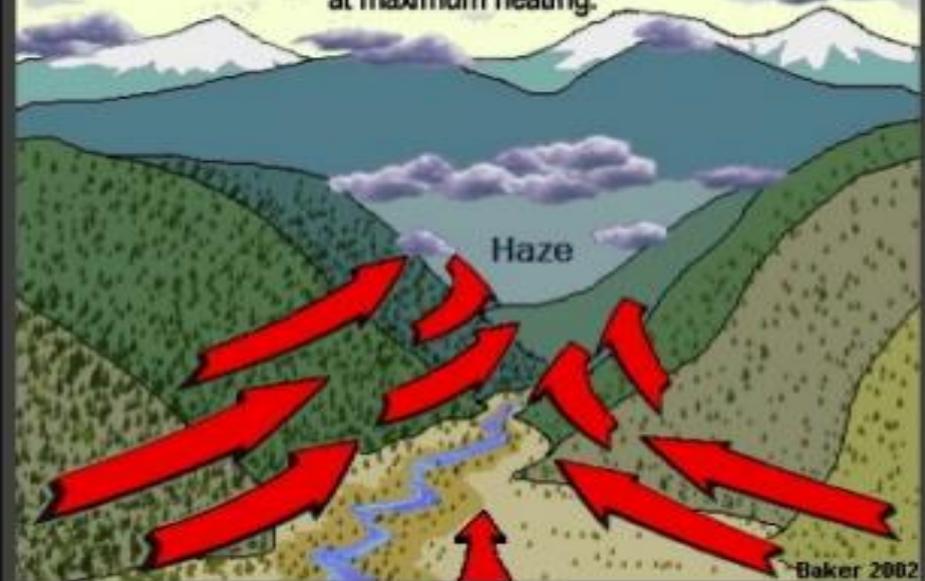
Upslope/Upvalley

Upslope Wind - Forms in the morning with strong solar heating. Maximum strength and depth reached by late morning.



Early to Mid-Morning - 3 to 8 mph

Upvalley Wind - Begins to form when the valley floor becomes warmer than the valley walls. Greatest speeds at maximum heating.

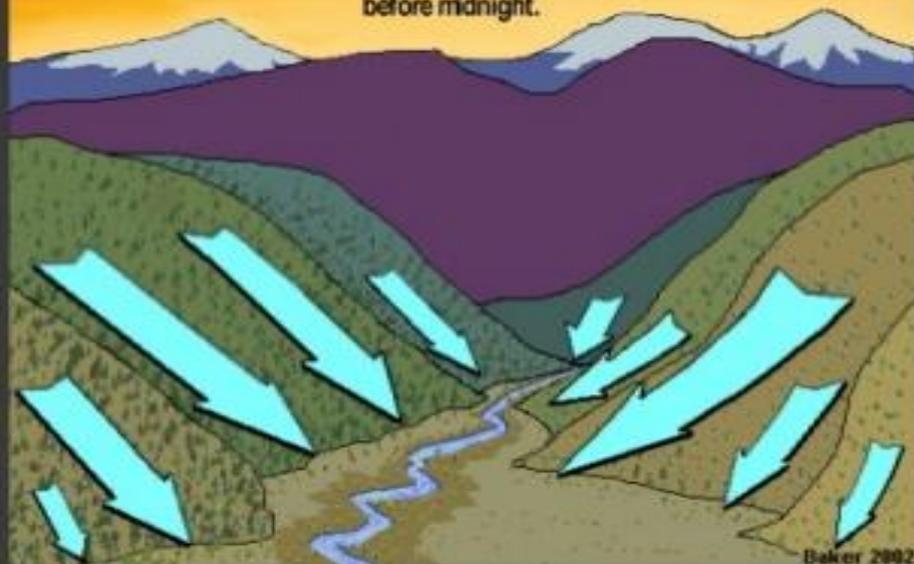


Late Morning and Afternoon - 10 to 15 mph

Local Winds

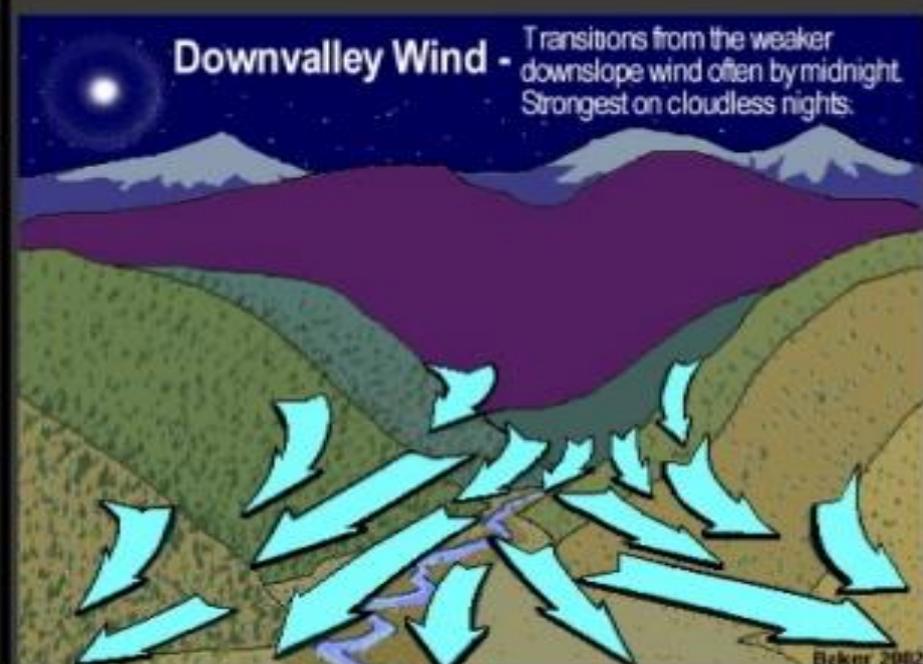
Downslope/Downvalley

Downslope Wind - Forms when slopes begin to cool around sunset or under heavy daytime cloud cover. Strongest before midnight.



Late Afternoon and Evening- 2 to 5 mph

Downvalley Wind - Transitions from the weaker downslope wind often by midnight. Strongest on cloudless nights.



Late Evening and Overnight- 5 to 10 mph

Slope affects fire behavior



The background of the slide features a sunset over the ocean. The sky is filled with soft, golden clouds, and the sun is partially visible on the horizon. In the top left corner, there is a logo consisting of a blue circle and a white swoosh. The text is overlaid on this background.

Quiz Time!

I'll show you a picture - you decide where in the U.S. the picture is from.

A close-up photograph of dry, cracked earth, showing a network of irregular, polygonal cracks in the soil. The soil is a light brown color, and there are some small, dry, scrubby plants growing in the cracks. This image is positioned on the right side of the slide, partially overlapping the sunset background.

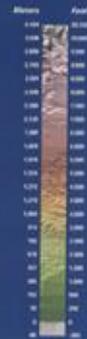
Picture 1



The Geographic Face of the Nation – Elevation



Southern CA



Scale of meter is approximately 1:4,000,000

The U.S. Geological Survey (USGS) has completed a scientific elevation dataset for the entire United States. The National Elevation Dataset (NED) was produced from over 47 million individual digital elevation models. NED elevation values are stored as meters in a geographic map projection with a resolution of 3 meters (about 10 meters) for the conterminous U.S., Alaska and Puerto Rico, and 2 kilometers for Canada. The NED is suitable for scientific use in computer-aided geographic information systems.

The NED is provided in the public for a broad range of uses including hydrologic modeling and other geographic, utility, transportation, planning, and access to the NED are available at the USGS web site: <http://hydro.usgs.gov/ned/>

For more information, contact:
U.S. Geological Survey
3000 Foothill Drive
Menlo Park, CA 94025
Telephone: (650) 326-4871
Fax: (650) 326-4879
E-mail: ned@usgs.gov

Picture 2



The Geographic Face of the Nation – Elevation

Smoky Mtns. National Park



Scale of color is approximately 1:2,000,000

The U.S. Geological Survey (USGS) has completed a scientific elevation dataset for the entire United States. The National Elevation Dataset (NED) was produced from over 47 million one-meter digital elevation models (DEM) collected between 1984 and 2009 by a geographic map producer with a resolution of 3 meters (about 10 meters) for the conterminous U.S., Alaska and Puerto Rico, and 2 kilometers for Canada. The NED is spatially consistent to the companion newly generated elevation data.

The NED is provided in the public for a broad range of uses including hydrologic modeling and other geographic, climate, environmental, planning, and access to the NED are available at the USGS web site <https://neds.usgs.gov/>

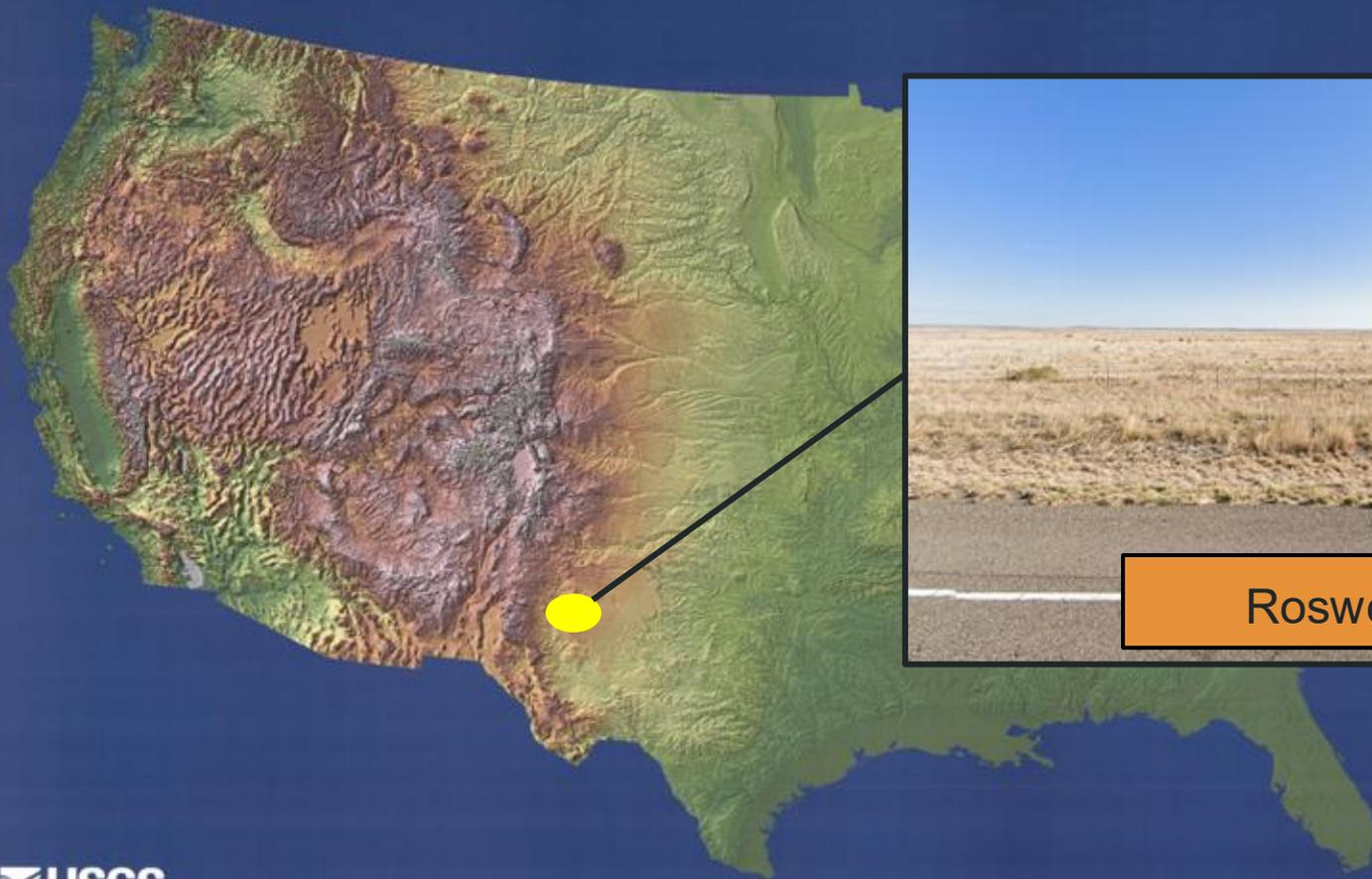
For more information, contact:

U.S. Geological Survey
300 N. 34th St., Sioux Falls
Sioux Falls, SD 57104
Telephone: (605) 338-4331
Fax: (605) 338-4339
E-mail: neds@usgs.gov

Picture 3



The Geographic Face of the Nation – Elevation



Roswell, NM

Scale of meter is approximately 1:1,000,000

The U.S. Geological Survey (USGS) has completed a scientific expedition dataset for the entire United States. The National Elevation Dataset (NED) was produced from over 40 million one-meter digital elevation models. NED elevation values are stored as meters in a geographic map projection with a resolution of 1 arc-second (about 30 meters) for the conterminous U.S., Alaska, and Puerto Rico, and 2 arc-seconds for Alaska. The NED is updated biennially to incorporate newly generated elevation data.

The NED is provided in the public for a broad range of uses including hydrologic modeling and land planning. Online documentation, viewing, and access to the NED are available at the USGS web site: <https://neds.usgs.gov/>

For more information, contact:
U.S. Geological Survey
300 N. 19th St., Room 2000
Menlo Park, CA 94028
Telephone: (415) 933-4371
Fax: (415) 933-4370
E-mail: neds@usgs.gov

Picture 4



The Geographic Face of the Nation – Elevation



Southern FL



Scale of meter is approximately 1:2,000,000

The U.S. Geological Survey (USGS) has completed a scientific elevation dataset for the entire United States. The National Elevation Dataset (NED) was produced from over 47 million high-resolution digital elevation models (DEM) collected between 1992 and 2000 by a geographic information system with a resolution of 30 meters (about 100 feet) for the conterminous U.S., Alaska and Puerto Rico, and 2 kilometers for Canada. The NED is available to the public for a broad range of uses including hydrologic modeling and other geographic information system, mapping, and access to the NED are available at the USGS web site (<http://ned.sed.gov>).

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For more information, contact:
U.S. Geological Survey
300 N. 17th St., Reston, VA 20192
Telephone: (703) 648-5000
Fax: (703) 648-8000
E-mail: ned@usgs.gov

Picture 5



The Geographic Face of the Nation – Elevation



Willamette National Park, OR

The U.S. Geological Survey (USGS) has completed a scientific elevation dataset for the entire United States. The National Elevation Dataset (NED) was produced from over 47 million individual digital elevation models. NED elevation values are stored as meters in a geographic map projection with a resolution of 3 meters (about 10 meters) for the conterminous U.S., Alaska and Puerto Rico, and 2 kilometers for Alaska. The NED is spatially consistent to the companion vector geospatial elevation data.

The NED is provided in the public for a broad range of uses including hydrologic modeling and other geographic, climate, environmental, planning, and access to the NED are available at the USGS web site (<https://data.usgs.gov/>).

For more information, contact:
U.S. Geological Survey
300 N. 3rd St., Data Center
Menlo Park, CA 94025
Telephone: (650) 346-4871
Fax: (650) 346-4899
E-mail: ned@usgs.gov

Fuels - Will they burn?



Forecasting Fuels: Fuel Types

- A fuel's time lag classification is proportional to its diameter and is loosely defined as the time it would take for 2/3 (67%) of the dead fuel to respond to atmospheric moisture.
- For example, if a fuel had a "1-hour" time lag, one could expect its wildfire susceptibility to change after only 1 hour of humid weather.

TIME LAG	FUEL SIZE	DETERMINATION
1-hour	<0.25 inch diameter	Fine flashy fuels that respond quickly to weather changes. Computed from observation time temperature, humidity, and cloudiness.
10-hour	0.25 to 1 inch diameter	Computed from observation time temperature, humidity, and cloudiness. Can also be an observed value, from a standard set of fuel sticks that are weighed as part of the fire weather observation.
100-hour	1 to 3 inches diameter	Computed from 24-hour average conditions composed of day length, hours of rain, and daily temperature/humidity ranges.
1000-hour	3 to 8 inches diameter	Computed from a 7-day average conditions composed of day length, hours of rain, and daily temperature/humidity ranges.

Spring – Grass Calibration

GRASS (Spring)	ISI < 2.0	ISI 2 to 5.9	ISI 6.0 to 7.9	ISI 8.0+
FFMC < 86.0	LOW	MODERATE	MODERATE	VERY HIGH
FFMC 86.0 to 91.9		MODERATE	HIGH	VERY HIGH
FFMC 92.0+ & FWI < 36.0			VERY HIGH	VERY HIGH
FFMC 92.0+ & FWI 36.0+				EXTREME

Fuel/Fire Weather Indices

Fuel Moisture and Loading

- 1000/100/10/1 hour
- Live Fuel Moisture
- Fuel Loading (i.e. lbs/acre)

Fire Danger Indices

- Energy Release Component (ERC)
- Burning Index (BI)
- Spread Component (SC)
- Ignition Component (IC)
- Severe Fire Danger Index (SFDI)

Fire Weather Indices

- HDWI (Hot Dry Windy Index)
- Fosberg Index
- Large Fire Potential Index (Rolinski, et al. 2016)

As with severe parameters, use with caution! Composites can lead you astray!



Fire Weather Indices: ERC, SC and BI

Energy Release Component (ERC) - is a calculated output of the National Fire Danger Rating System (NFDRS). The ERC is a number related to the available energy (BTU) per unit area (square foot) within the flaming front at the head of a fire.

Spread Component (SC) - "the spread component is numerically equal to the theoretical ideal rate of spread expressed in feet-per-minute.

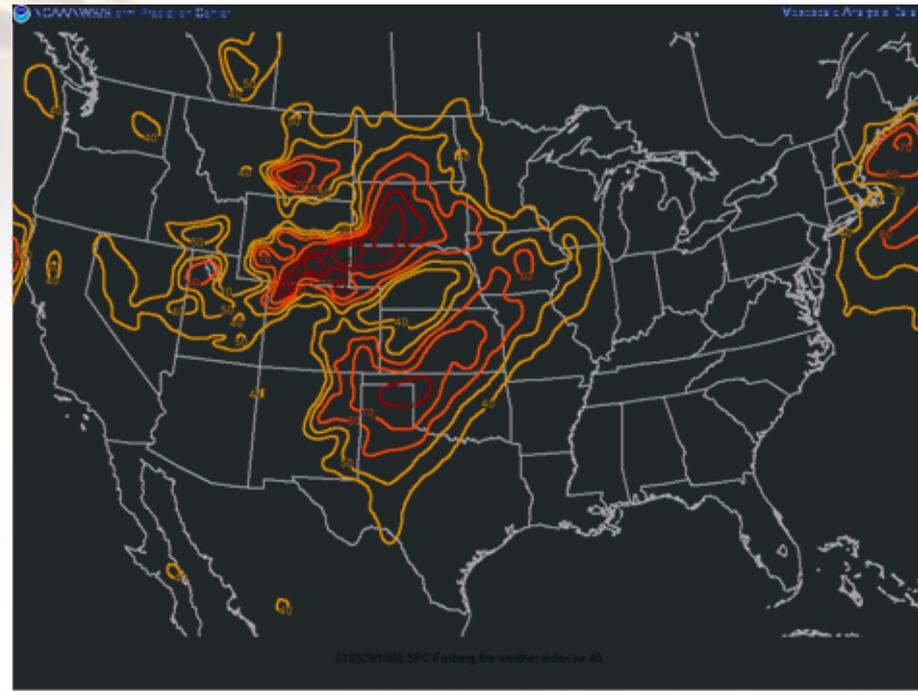
Burning Index (BI) - is a number used by the [National Oceanic and Atmospheric Administration](#) (NOAA) to describe the potential amount of effort needed to contain a single fire in a particular fuel type within a rating area. The [National Fire Danger Rating System](#) (NFDRS) uses a modified version of Bryam's equation for flame length – based on the Spread Component (SC) and the available energy (ERC) – to calculate flame length from which the Burning Index is computed.^[1]

$$BI = j_1 F_L$$

$$F_L = j \left[\left(\frac{SC}{60} \right) (25(ERC)) \right]^{0.46}$$

Fire Weather Indices: Fossberg FWI

- It is a non-linear filter of meteorological data developed by first transforming temperature and relative humidity to equilibrium moisture content, then transforming the equilibrium moisture content to combustion efficiency. The index is approximated by $F = D((\text{Rate of Spread}) (\text{Energy Release}))^{0.46}$
- Scaled to represent 0% moisture with a 30 mph wind.
- Values of 0-100, greater than 50 is considered significant.
- Most commonly used for strong wind



Fire Weather Indices: HDWI Hot Dry Windy Index

“HDW was designed to be very simple – a multiplication of the maximum wind speed and maximum vapor pressure deficit (VPD) in the lowest 50 or so millibars in the atmosphere. Because HDW is affected by heat, moisture, and wind, seasonal and regional variability can be found when comparing HDW values from different locations and times.”

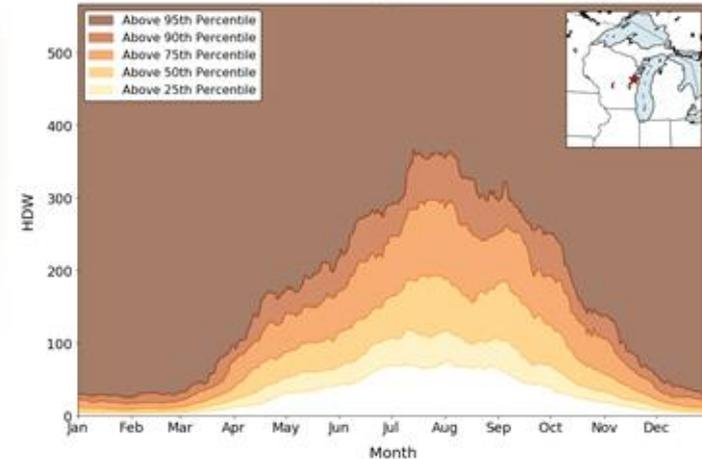
$$\text{HDW} = W_{\text{max}} * \text{VPD}$$

$$W_{\text{max}} = 50 \text{ mb max wind}$$

VPD (T,q) = $e_s(T) - e(q)$: Vapor Pressure deficit is *difference* between Saturation vapor pressure and absolute vapor pressure. Not a *ratio* like RH.

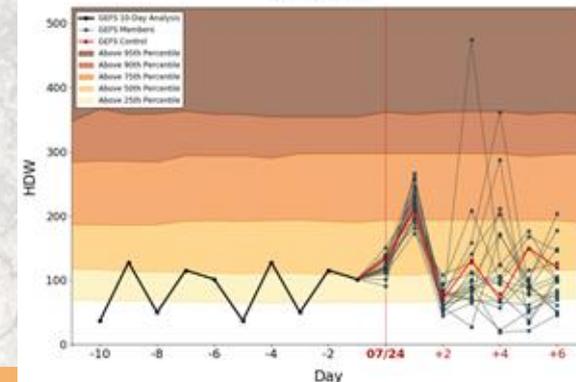
Max Daily HDW, 1981-2010 CFSR Climatology

44.5°N, 88.0°W



Max Daily HDW

GEFS Analysis and Forecast & 1981-2010 CFSR Climatology
44.5°N, 88.0°W

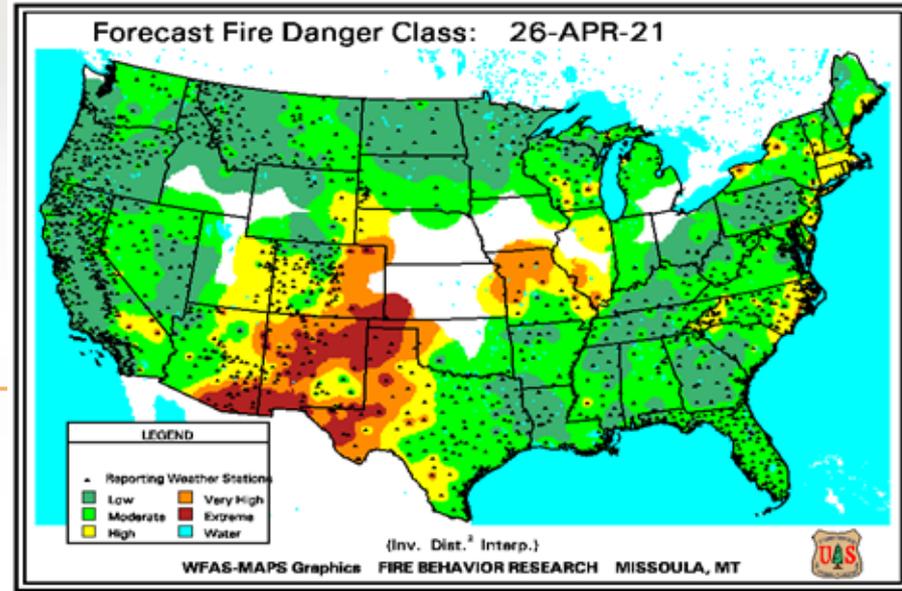


National Fire Danger Rating System (NFDRS)

A fire assessment system used to provide a daily estimate of wildfire risk.

This uses a system of equations with variables that include weather inputs, topography, and fuel types to determine the fire danger category.

Easy-to-interpret categories allow for easier communication of fire risk.



Forecasting Fuels

National GACC Website Portal

Geographic Area Coordination Centers

[Alaska \(AICC\)](#) ☺
[Eastern Area \(EACC\)](#)
[Great Basin \(GBCC\)](#)
[Northern California \(ONCC\)](#)
[Northern Rockies \(NRCC\)](#)
[Northwest \(NWCC\)](#)
[Rocky Mountain \(RMCC\)](#)
[Southern Area \(SACC\)](#)
[Southern California \(OSCC\)](#)
[Southwest \(SWCC\)](#)

National

[National Interagency Fire Center \(NIFC\)](#) ☺

[National Coordination Center \(NCCC\)](#) ☺
[Predictive Services](#) ☺

[Intelligence](#)
[Weather](#)
[Fuels / Fire Danger](#)
[Outlooks](#)



GACC Name	Level
Alaska Interagency Coordination Center	1
Eastern Area Coordination Center	1
Great Basin Coordination Center	1
Northern Rockies Coordination Center	1
Northwest Interagency Coordination Center	1
ONC - Operations Northern California	1
OSC - Operations Southern California	1
Rocky Mountain Area Coordination Center	1
Southern Area Coordination Center	3
Southwest Coordination Center	1

Preparedness Levels

National Preparedness level:	1
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Preparedness Level 1 (PL 1)



Preparedness Level 2 (PL 2)



Preparedness Level 3 (PL 3)



Preparedness Level 4 (PL 4)

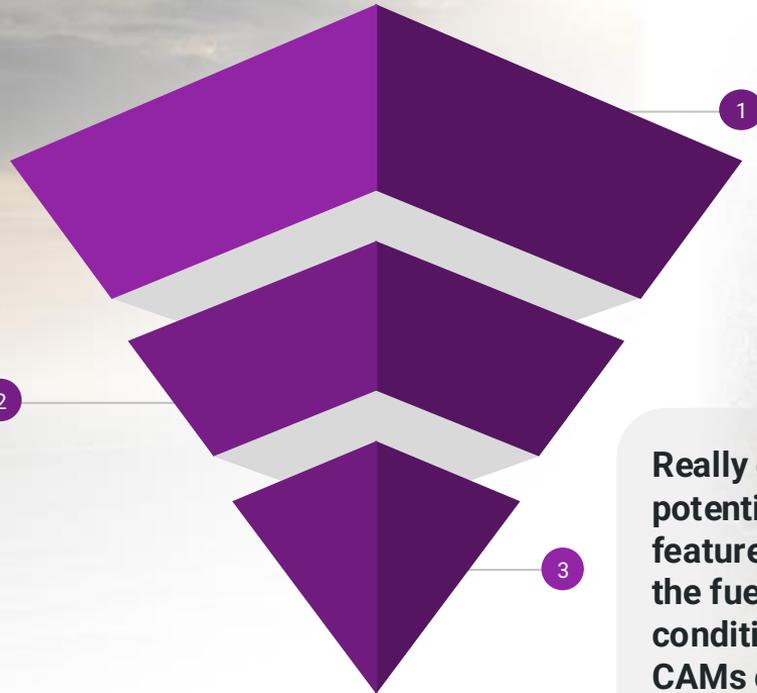


Preparedness Level 5 (PL 5)



- Geographic Area Coordination Centers predictive service specialists produce fuel and fire forecasts for specific areas of the US.
- Controlled by the National interagency Fire Council (NIFC)
- Planning levels determine the threat on a scale of 1 to 5.

Basic Fire Weather Forecasting Workflow



The “Big Picture”

Start with a broad overview of the synoptic weather conditions. Know the climo. Find your major features. Do a quick fuels assessment. Look for favorable fuel areas. Get rid of any areas with QPF greater than .25 inches over the last 1-2 days.

The details

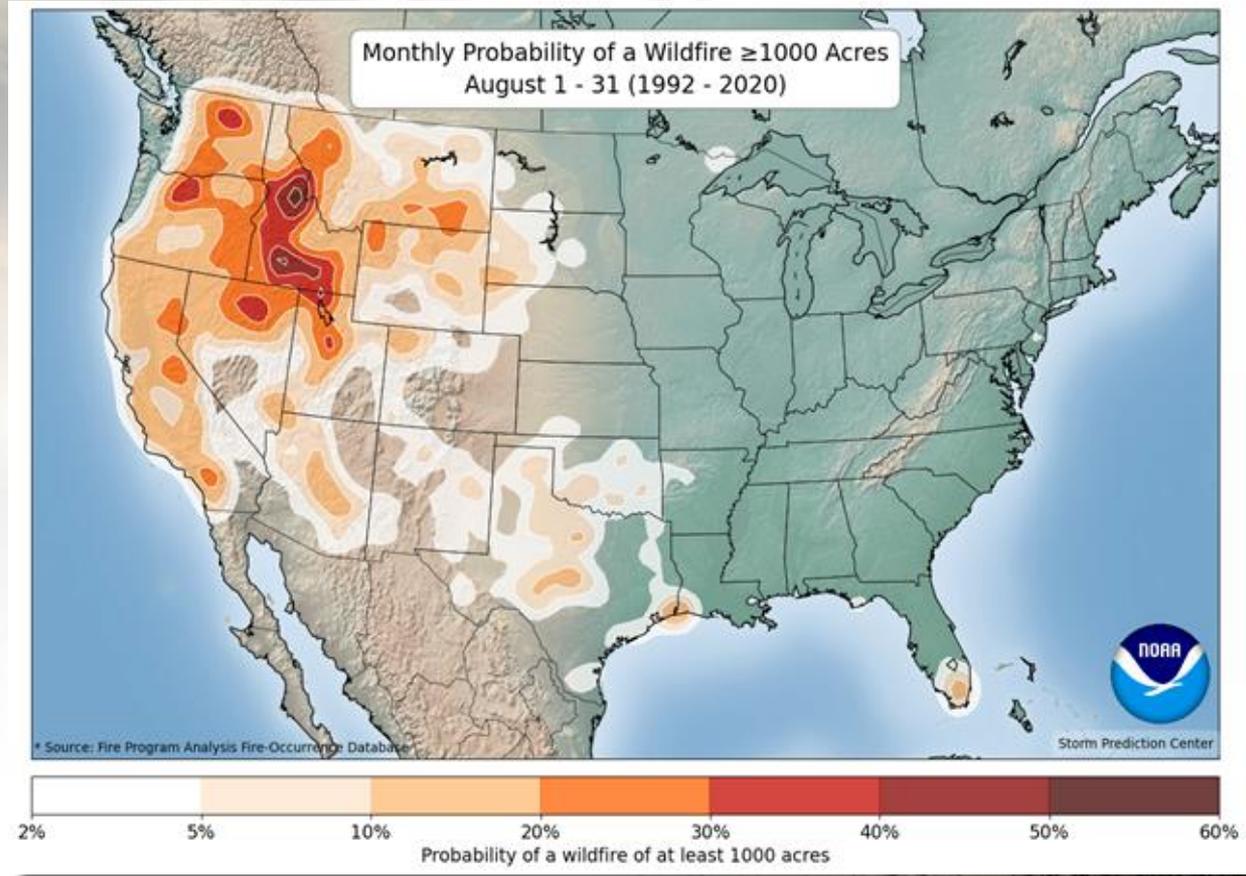
Really dive into the areas of potential concern. Look for terrain features using land-use maps. Find the fuel rich areas and assess the conditions over them. HREF and CAMs can give you powerful details on wind/RH joint probabilities. Remember to only draw where fuels can burn. Urban/wilderness

Narrow your focus

Begin looking for more focused/intense fire weather corridors. Forecast soundings offer a great tool to quickly assess stability and fire danger. Look more closely at the fuels. How dry are they?

Wildfire Climatology

When and where do big fires occur?



<https://youtu.be/Zr5-H6j9f7A>

Fire Weather Regimes

Critical Fire Weather Patterns of the United States



Reference: National Weather Service's (NWS) Fire Weather Forecasters Course Presented at Boise March 30 – April 2, 1999.

Disclaimer: This document was scanned into a WORD document and converted to a PDF format. Care was taken to ensure conversion was accurate but errors may have introduced by the OCR process.

- See [this document](#) for an excellent dive into different types of fire weather patterns.
- A variety of fire weather regimes exist across the CONUS.
- Every state has some sort of fire weather pattern or response.
- Much of the western CONUS is the “big leagues” for fire weather forecasting.
- Internationally: Australia, Brazil, Portugal/Spain, Russia, Indonesia, and others are among some of the most active fire weather areas in the world.

Fire Weather Regimes

Critical Fire Weather Patterns of the United States



Reference: National Weather Service's (NWS) Fire Weather Forecasters Course Presented at Boise March 30 – April 2, 1999.

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Keep in mind the fire weather ingredients:

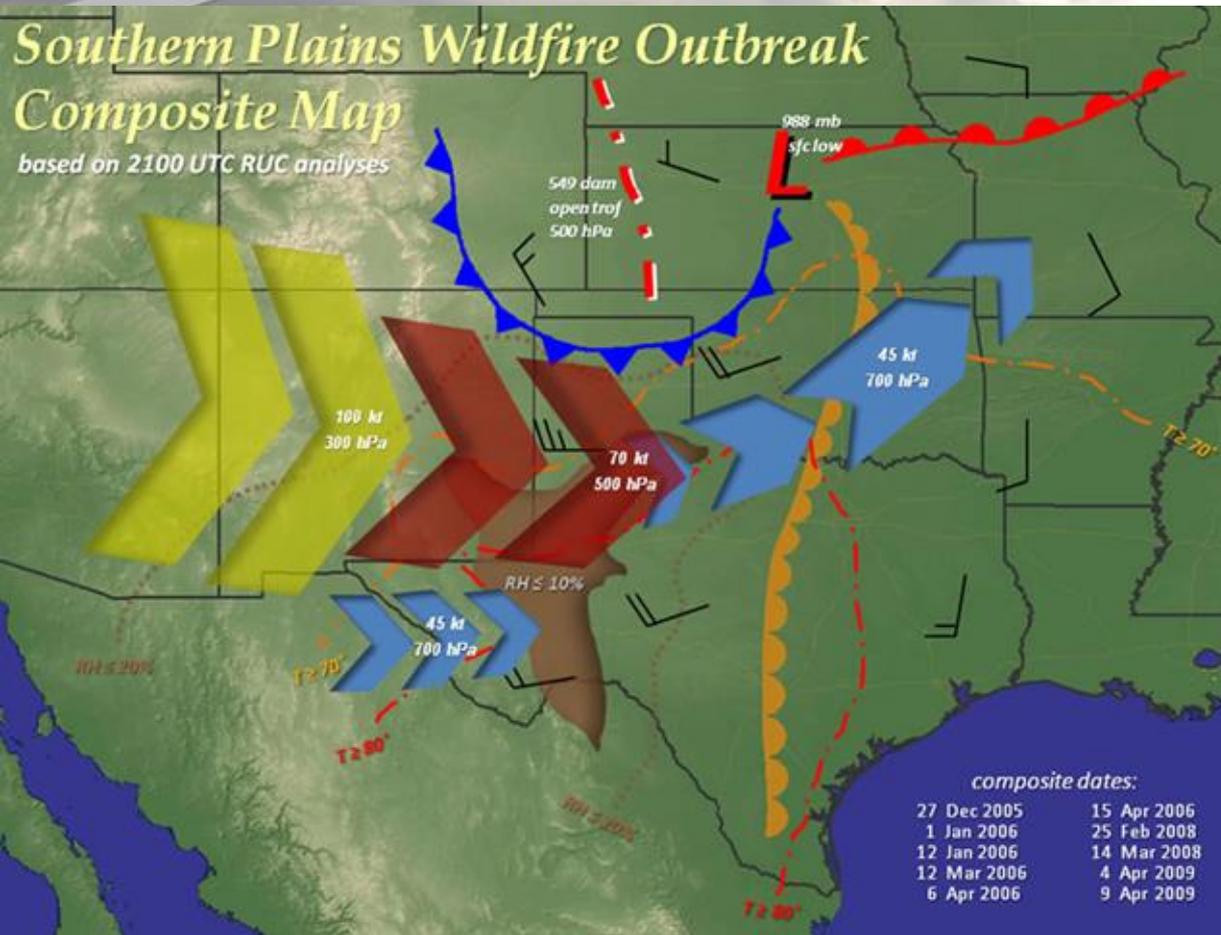
1. Low humidity (High Vapor Pressure Deficit or VPD)
2. Low fuel moisture/fuel abundance
3. High winds
4. Warm temperatures (optional)



RH thresholds for critical designation overlaid on a landuse map

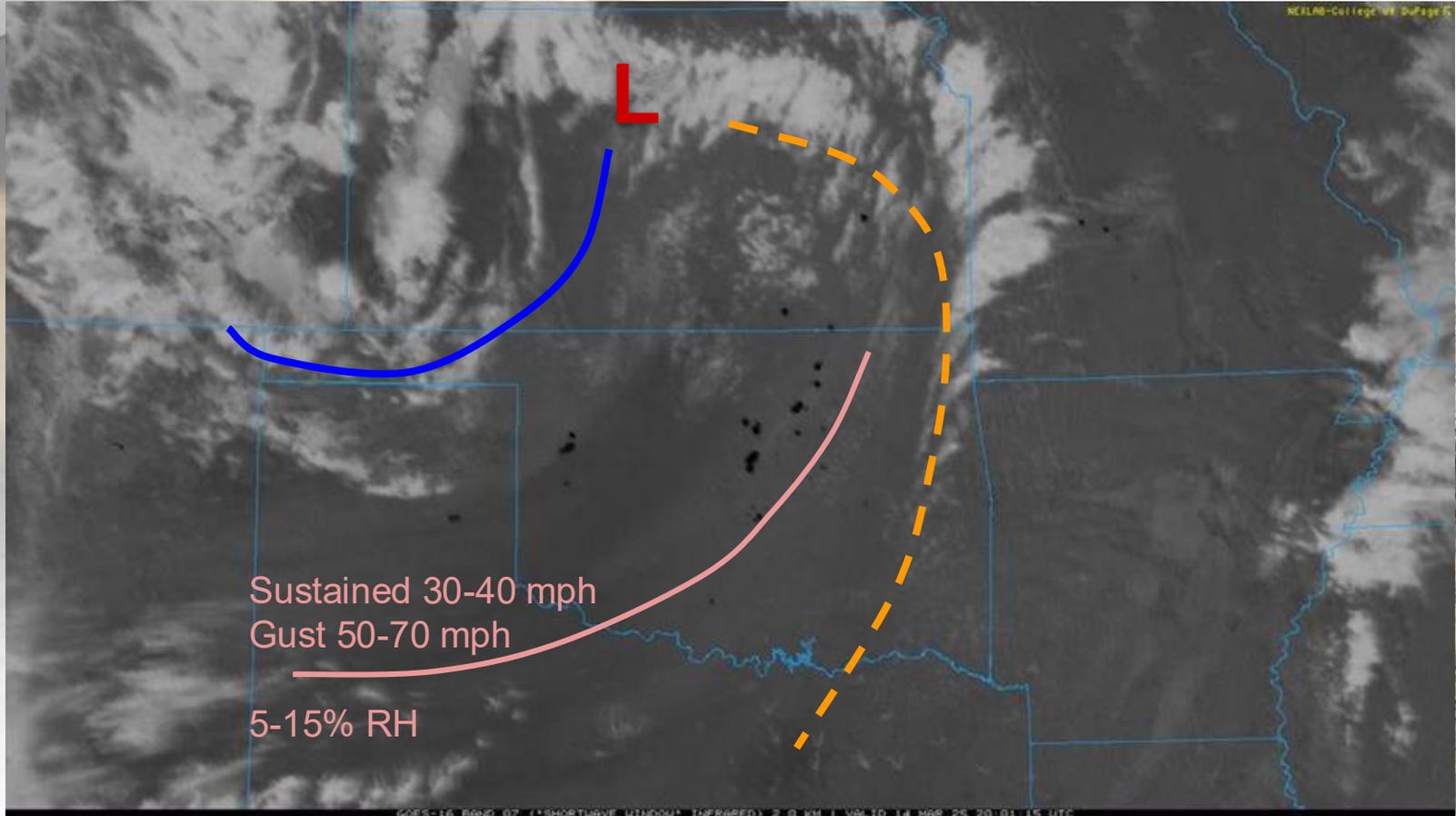
- Red Flag Warnings have different thresholds for different areas of the country.
- Why?
 - Variety of fuels
 - Variety of land use
- These differences are driven by:
 - Terrain
 - Precip distributions

Southern Plains



- Dominated by fast moving shrub and grass fires.
- Occur ahead of deep 500 mb troughs with strong low and mid-level flow.
- Dryline acts as eastward boundary.
- Most common during the “pre and post greenup ” periods of late winter/ early spring and early to mid fall.
- Western US drought usually a significant predictor.

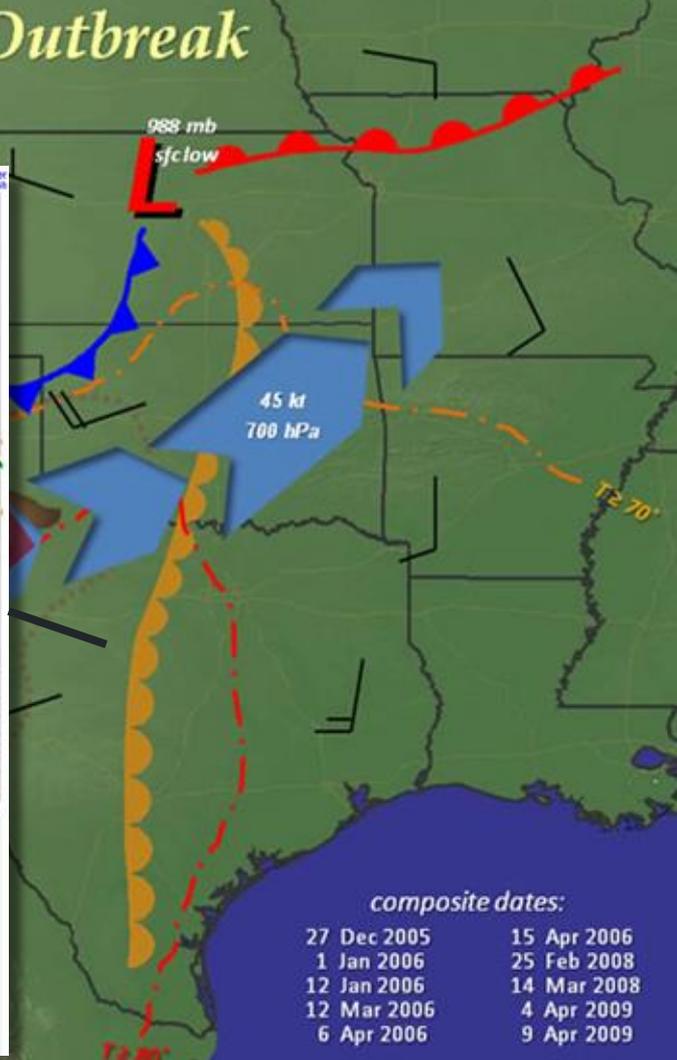
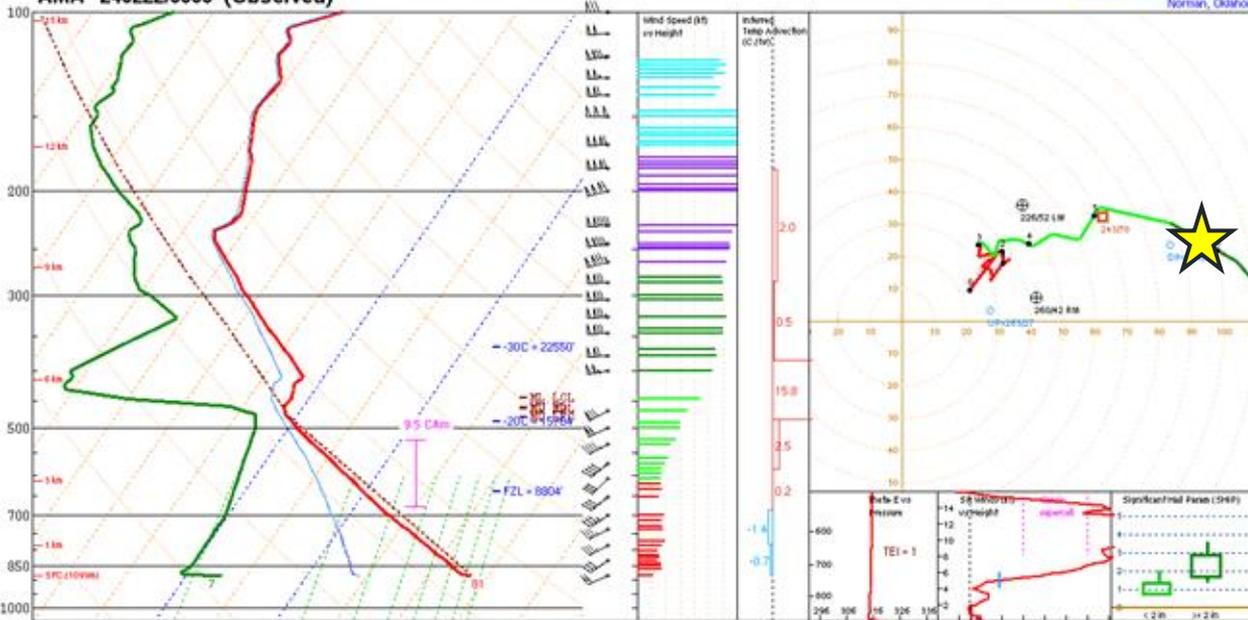
Southern Plains Fire Outbreak - March 14, 2025



Southern Plains Wildfire Outbreak Composite Map

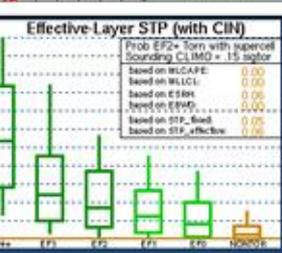
AMA 240222/0000 (Observed)

NCA/NWS Storm Prediction Center
Norman, Oklahoma



PARCEL	CAPE	CINH	LCL	LI	LFC	EL	SRH(m2)	Shear01	MixWind	SRW	
SURFACE	2	0	4923m	0	4923m	1700'	SFC - 1 km	54	13	239/31	120/17
MIXED LAYER	0	0	5460m	2	M	1790'	SFC - 3 km	48	14	237/34	129/17
FCST SURFACE	0	0	5670m	1	M	1859'	SFC - 6 km	78	245/42	157/15	
MU (854 mb)	2	0	4923m	0	4923m	1700'	SFC - 8 km	100	248/40	181/13	
							LCL - EL (Cloud Layer)	9	243/70	219/32	
FW = 0.17 in	3CAPE = 0.3kg	WZL = 4986'	FZL = 8804'	ESP = 0.0			BRN Shear = 15 m/s	225/29 kt			
K = 6	QCAPE = 811 J/kg	FZL = 8804'	ESP = 0.0				4-km SR Wind =				
MixRH = 18%	DownT = 47 F	ConvT = 103F	MMP = 1.00				Storm Motion Vectors				
LowRH = 5%	MesW = 0.9 g/kg	MesT = 83F	NCAPE = 0.01				Bankers Flight =	260/42 kt			
SigSevere = 0 m/s/3							Bankers Left =	226/52 kt			
							Corfil Downshear =	254/66 kt			
							Corfil Upshear =	263/27 kt			

*** BEST GUESS PRECIP TYPE ***	
Rain.	
Based on sfc temperature of 81.0 F.	
SARS - Sounding Analogs	
SUPERCCELL	SGFNT MAIL
No Quality matches	No Quality matches



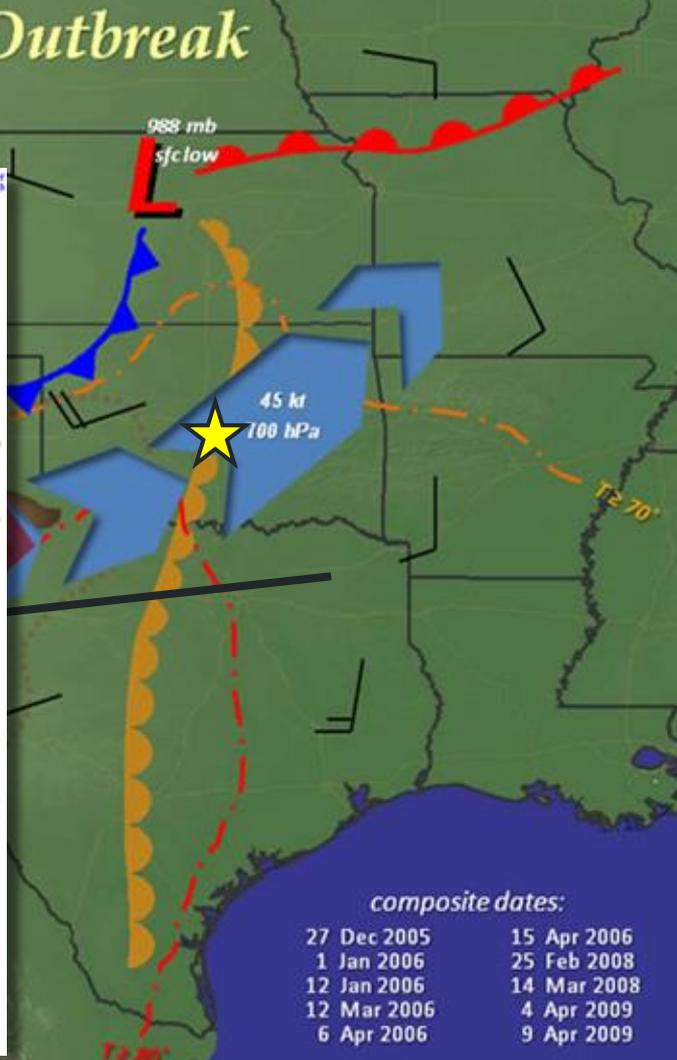
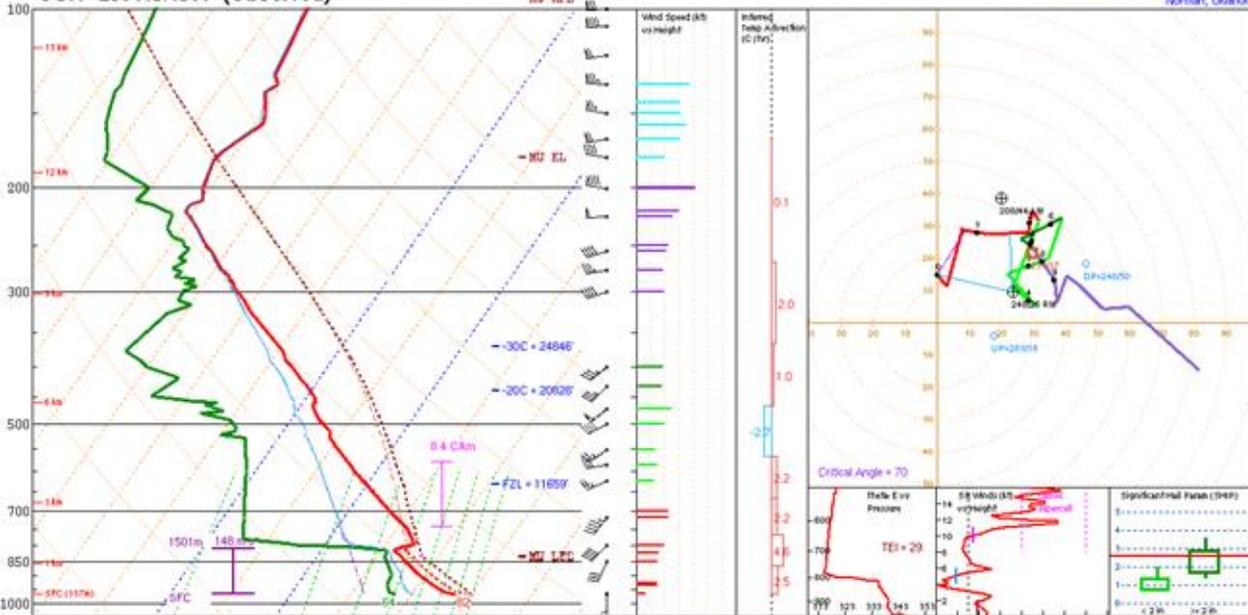
composite dates:

- 27 Dec 2005
- 15 Apr 2006
- 1 Jan 2006
- 25 Feb 2008
- 12 Jan 2006
- 14 Mar 2008
- 10 Mar 2006
- 4 Apr 2009
- 6 Apr 2006
- 9 Apr 2009

Southern Plains Wildfire Outbreak Composite Map

OUN 230419/1900 (Observed)

NOAA/NWS Storm Prediction Center
Norman, Oklahoma



PARCEL	CAPE	CIN	LCL	LI	LFC	EL	Sfc W (m/s)	Shear (kt)	MixWind	SIW
SURFACE	3668	0	1250m	-10	1250m	4054'	18	198/27	137/22	
MIXED LAYER	2661	-18	1237m	-8	2350m	4031'	31	212/33	163/19	
FCST SURFACE	3134	-2	1475m	-8	2037m	4031'	26	202/28	143/21	
MU (988 mb)	3668	0	1250m	-10	1250m	4054'	39	221/32	171/15	
FW = 0.92 in	3CAPE = 37 J/kg		WBZ = 7902'		WINDG = 1.1					
K = 18	DCAPE = 819 J/kg		FZL = 11659'		ESP = 0.5					
MidRH = 29%	DownW = 54 F		ConvT = 83F		MMP = 0.91					
LowRH = 72%	MixW = 12.2 g/kg		MixT = 83F		NCAPE = 0.33					
SigSevere = 53068 m/s/h										

SFC - 1 km	100	18	198/27	137/22
SFC - 3 km	193	31	212/33	163/19
EFF Inflow Layer	148	26	202/28	143/21
SFC - 6 km	39	221/32	171/15	
SFC - 8 km	33	222/33	173/15	
LCL - EL (Cloud Layer)	43	234/37	208/14	
EFF Shear (EBWD)	35	221/32	170/15	
BRN Shear = 29 m/s				
4-6m SR Wind =	222/10 kt			

Storm Motion Vectors	Storm Motion Vectors
Bunkers Flight =	246/26 kt
Bunkers Left =	208/44 kt
Corrid Downshear =	240/50 kt
Corrid Upshear =	283/19 kt

*** BEST GUESS PRECIP TYPE ***

None.
Based on sfc temperature of 81.7 F.

SARS - Sounding Analogs

SUPERCELL	SGFNT MAIL
0107261070 SO	0121300 JAN 3/83
0400101 FCO VEA4	0181800 SEP 5/90
0600401 TMI VEA4	0182012 1/81 3/80
0600401 STM VEA4	0704190 MAR 2/75
06002113 AD HCH	0504190 MAR 2/75
0601010 BSL HCH	0504190 MAR 2/75
060102214 BSL HCH	0604010 SEP 2/74
	0601210 JUN 1/75
	0604200 MAR 1/74
	0601100 JUN 1/71

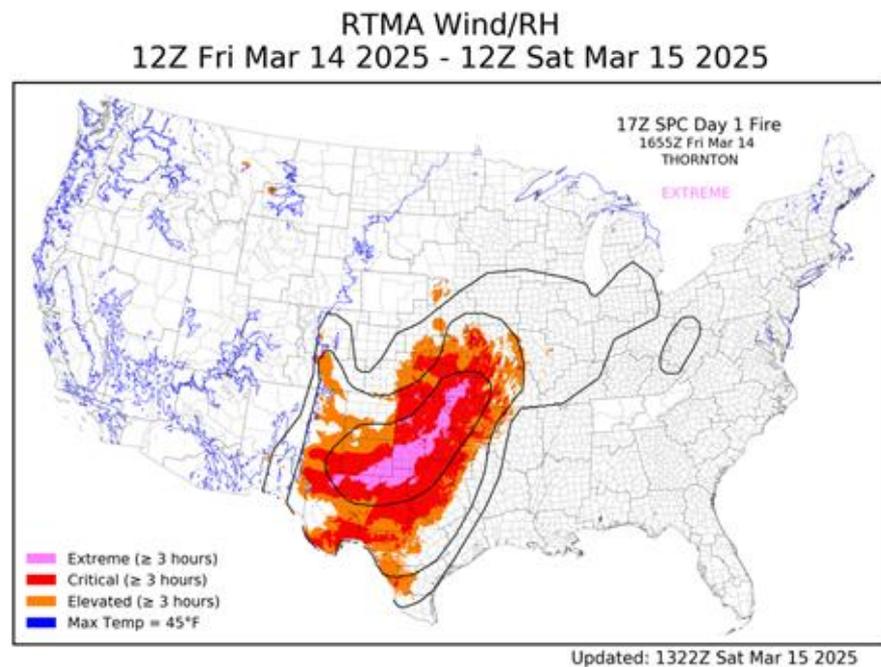
1/5 SOUN 843704
SARS: 58% TOR

028 SOUN 843704
SARS: 72% SIG

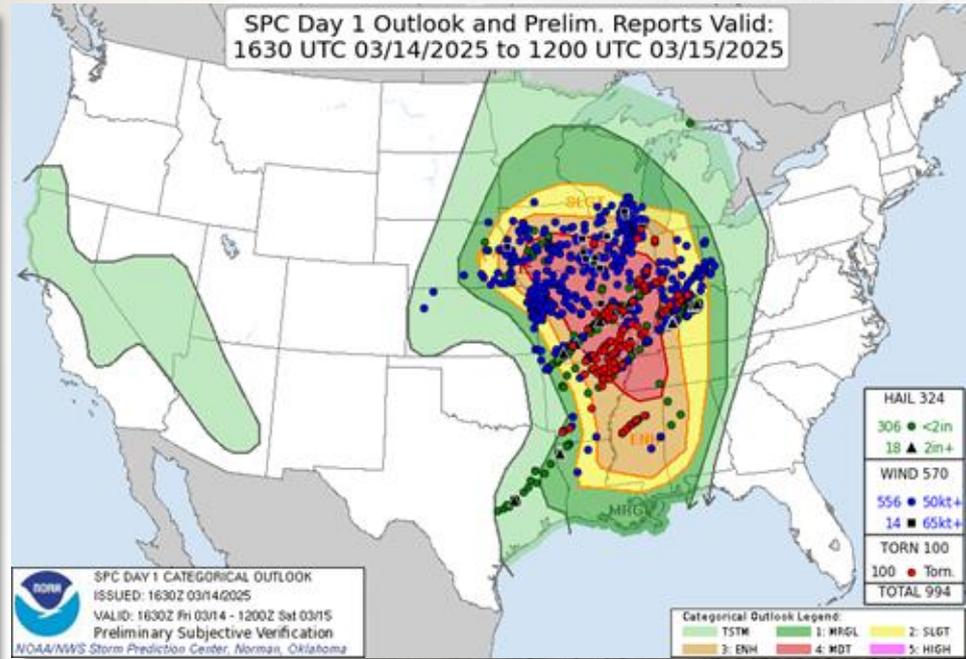
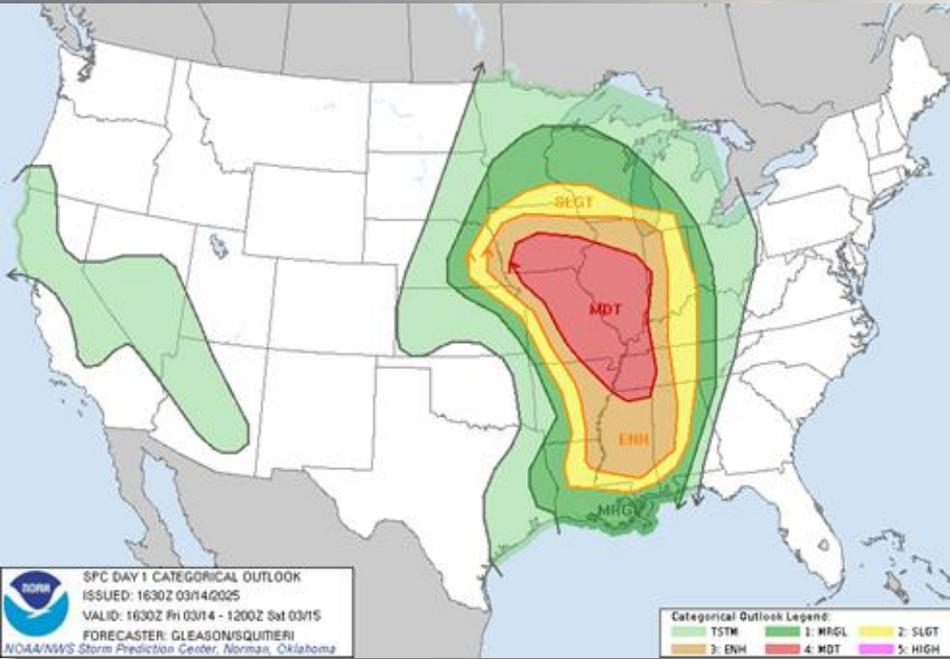
composite dates:

- 27 Dec 2005
- 1 Jan 2006
- 12 Jan 2006
- 12 Mar 2006
- 6 Apr 2006
- 15 Apr 2006
- 25 Feb 2008
- 14 Mar 2008
- 4 Apr 2009
- 9 Apr 2009

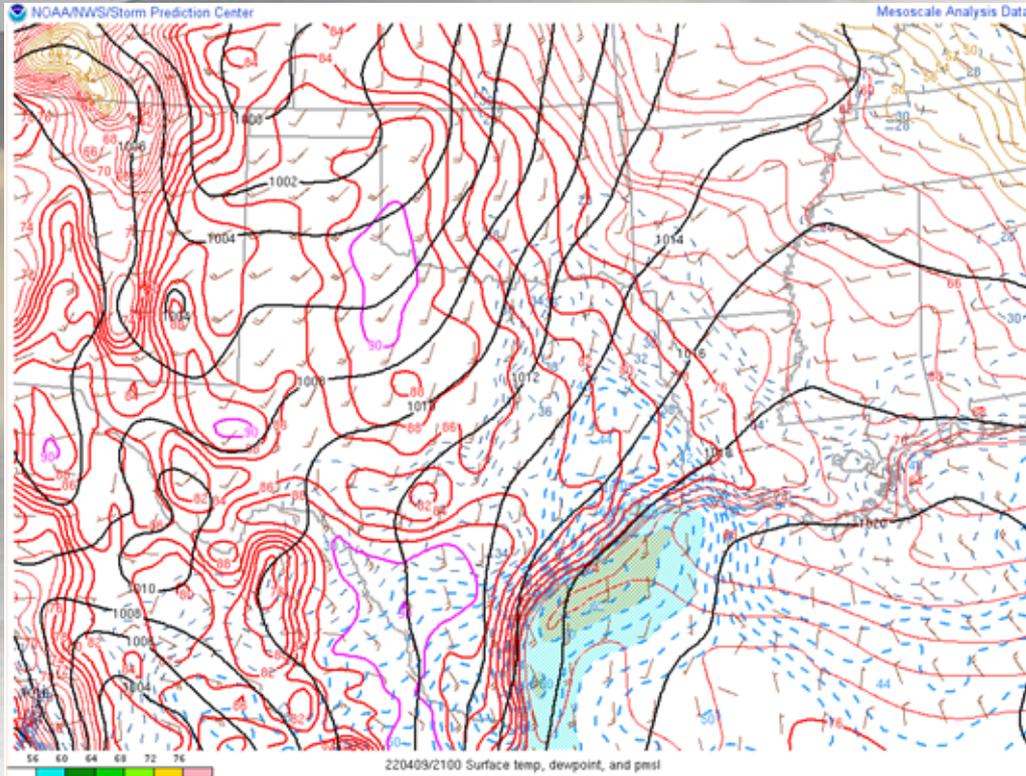
March 14, 2025 Day 1 SPC Fire Weather Outlook



March 14, 2025 Day 1 SPC Convective Outlook

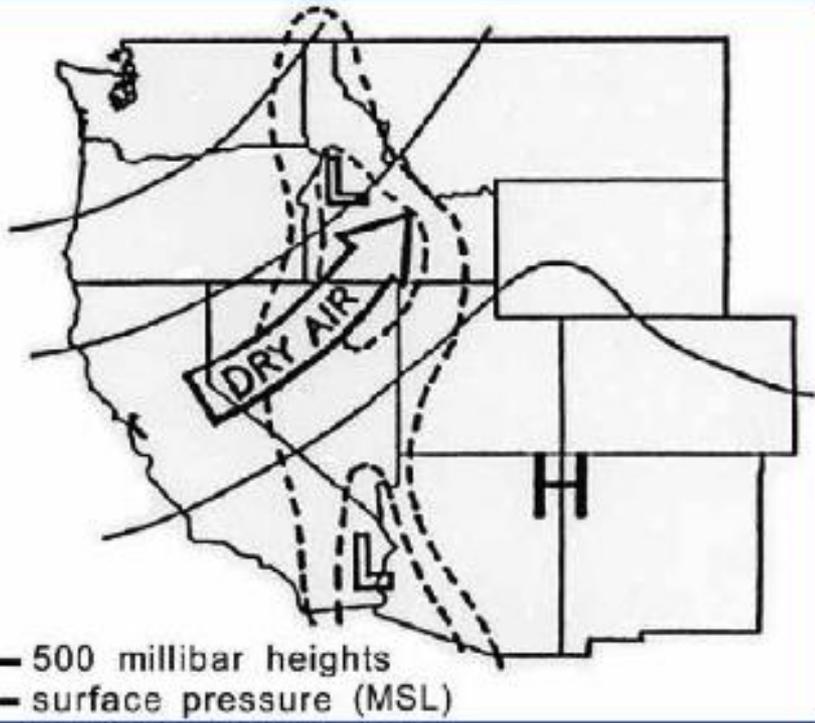


Southern Plains - Dry Return Flow



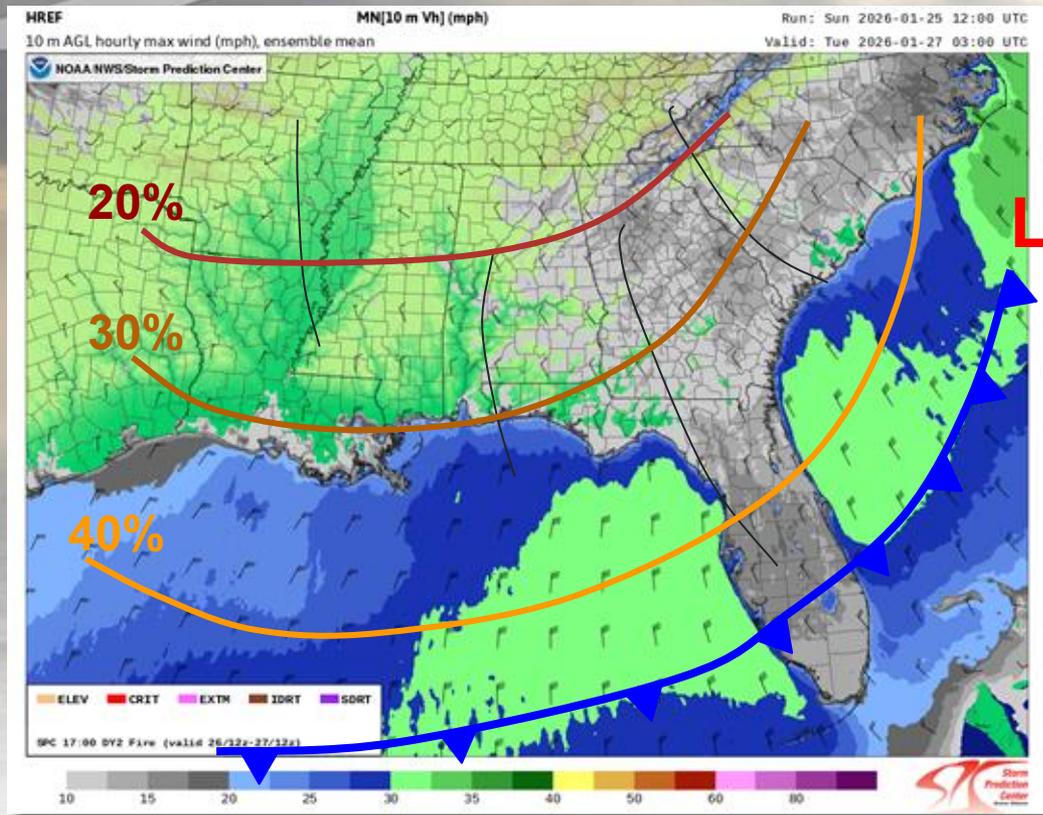
- Dry return flow is characterized by gusty southerly winds across the southern and central High Plains in the absence of deep gulf moisture.
- Usually driven by low-amplitude mid-level troughs crossing the Rockies.
- Enhanced by lee troughing/cyclogenesis, surface winds of 20-30 mph are common.
- Low-level thermal ridge contributes to low RH (<20%)

Rockies and Southwest



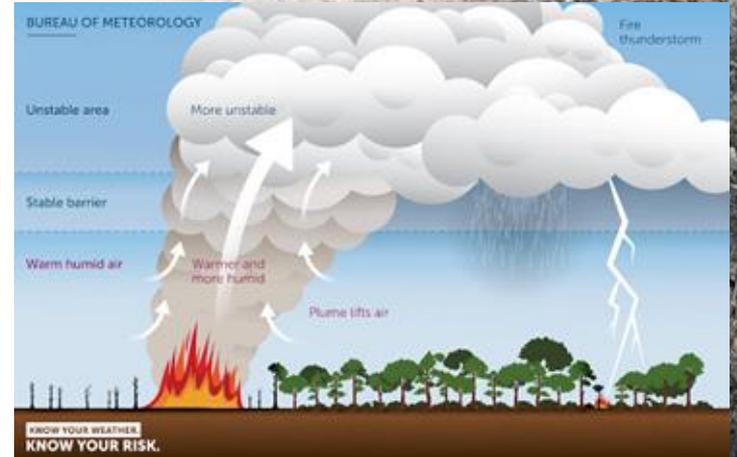
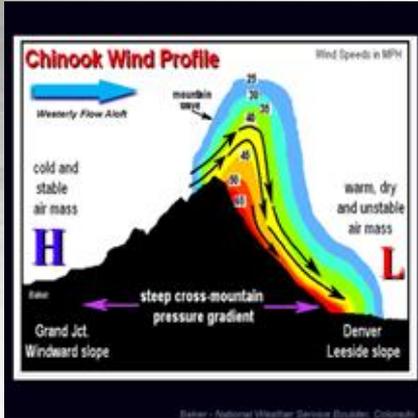
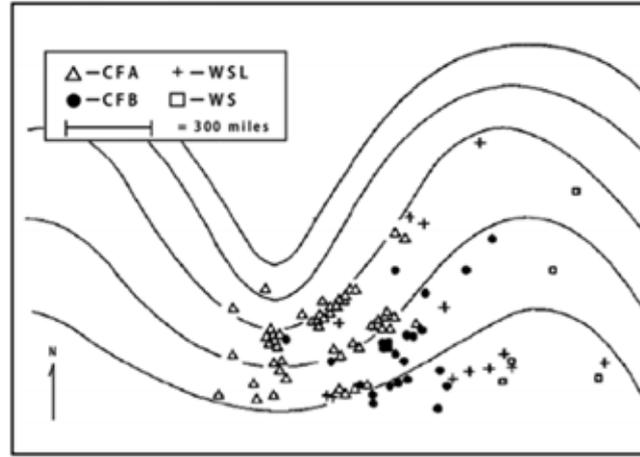
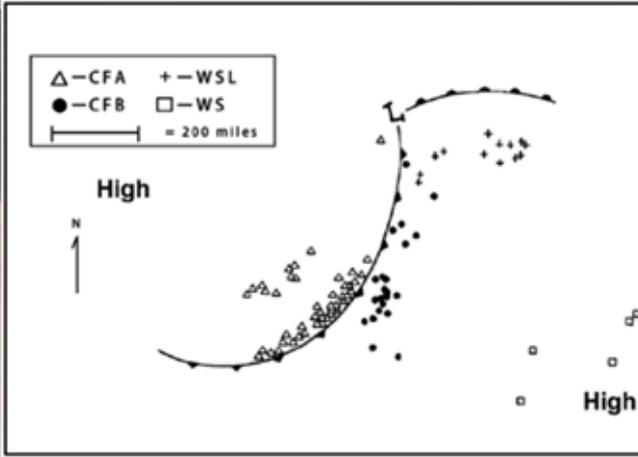
- “Big Bubble no Trouble” -An old forecasterism also known as ridge breakdown
- A mid-level ridge is broken down (partially or fully) by an advancing shortwave trough.
- A deceptive pattern with important implications for fire potential.
 - Winds aloft may not be that strong.
 - Quiescent but hot weather
 - Dry frontal passages
 - Dry Thunderstorms and gusty outflow
- **Very common throughout summer and early fall before and after Monsoon.**

Southeastern U.S.

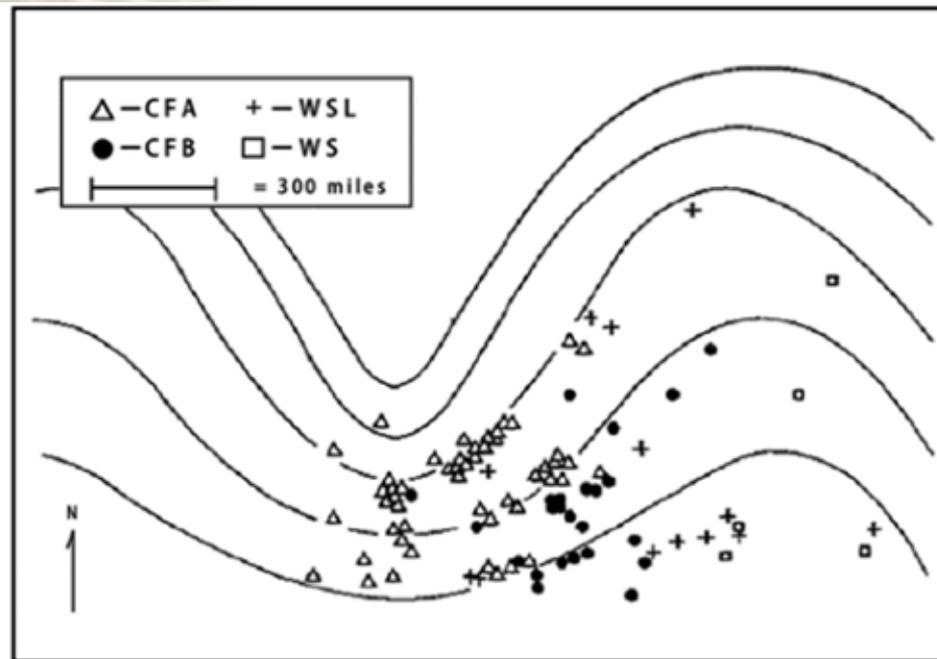
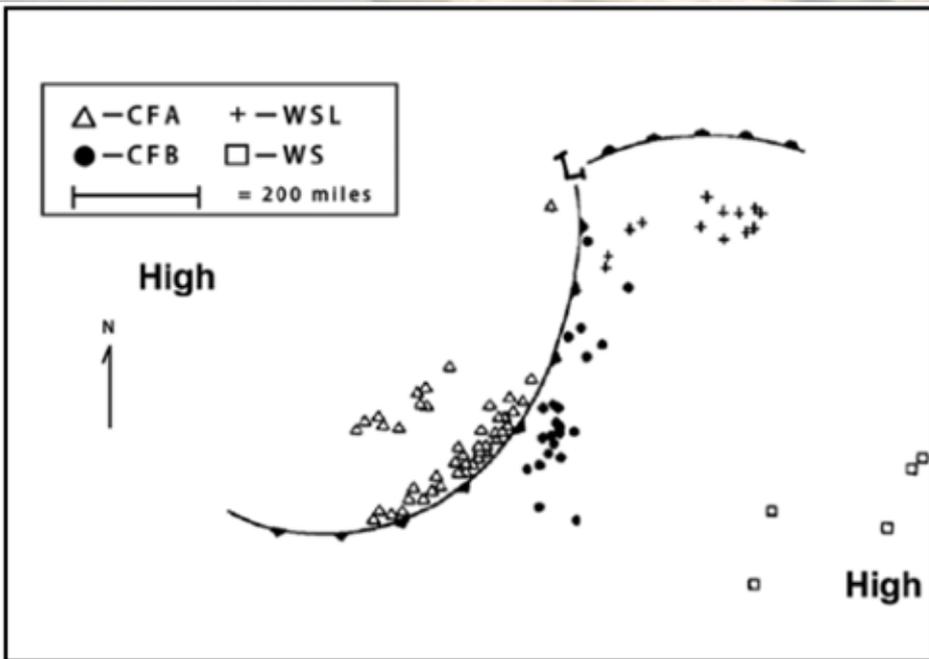


- Northerly winds behind a cold frontal passage ushers in drier air.
- Relative Humidity values may be higher than you would expect (30-40%)
- Winds may be lighter than normally expected (15-20 mph)

Smaller-Scale Details

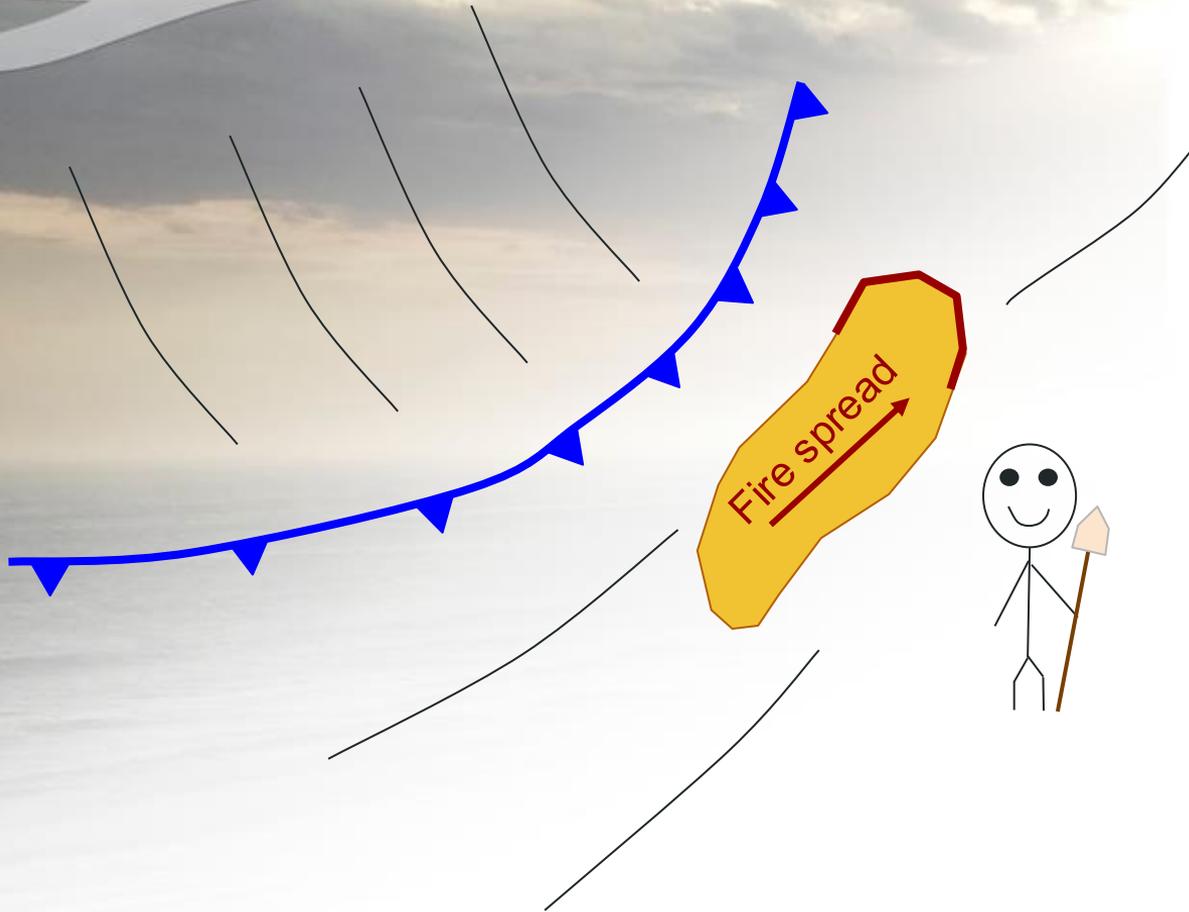


Dry Cold Fronts

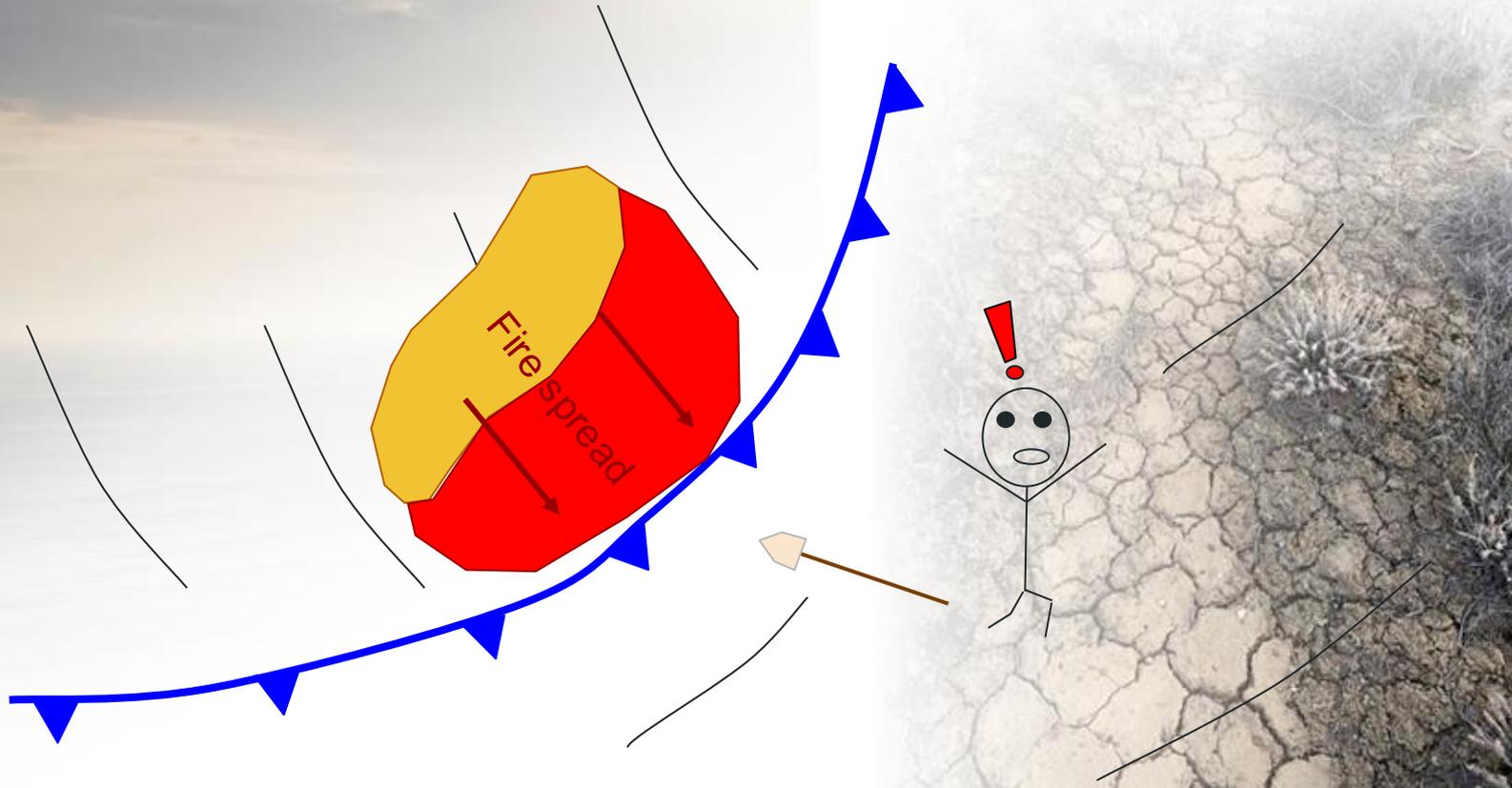


- Cold fronts producing very little rainfall but strong wind shifts.
- Common across the western US and southern Plains.
- Can cause rapid fire spread/spotting.
- South Canyon Fire (Storm King Mountain Colorado burnover 14 smoke jumpers killed)

Dry Cold Front Fire Direction Changes



Dry Cold Front Fire Direction Changes



Dry Cold Front Fire Direction Changes

February 26, 2024 Smokehouse Creek Fire - TX



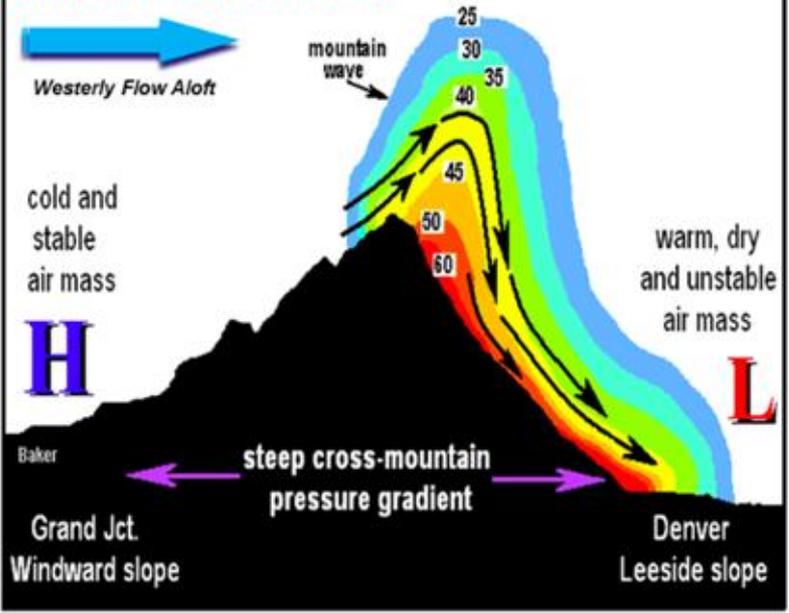
https://cimss.ssec.wisc.edu/satellite-blog/wp-content/uploads/sites/5/2024/02/G16CONUSFireTRGB-20240227_1506_to_0228_0331anim.gif

<https://www.youtube.com/watch?v=h11A0zbCrM0&t=1s>



Lee of the Rockies

Chinook Wind Profile



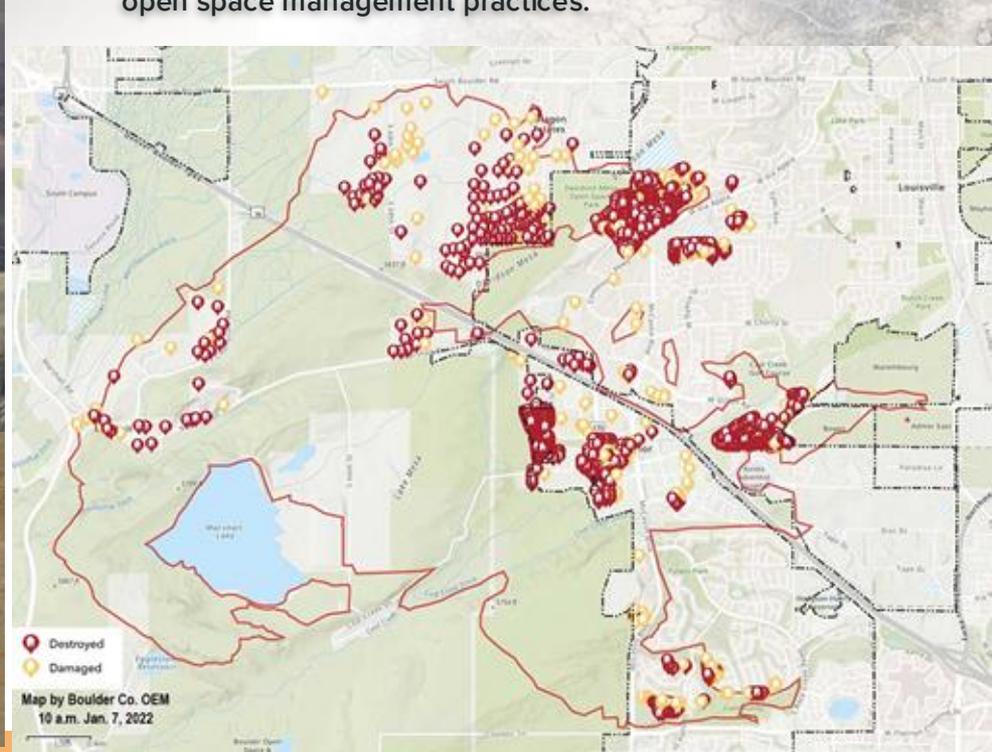
Chinook Wind

Steep pressure gradient (or large horizontal difference in air pressure) between a pressure maxima or high pressure (H) in western Colorado and a pressure minima or low pressure (L) in northeast Colorado is necessary for the formation of strong and gusty Chinook winds on and near the east face of the Front Range. Strong westerly flow aloft will further strengthen this downslope wind.

- Downslope winds
- Common through Colorado Wyoming and Montana.
- Weaker during the summer when flow retreats northward but early/ late Season Events (Aug-Oct & May-June) can drive very strong wildfire events.
- Winds may exceed 150 mph through terrain gaps and at ridge top level.

2022 Marshall Fire boulder County, CO

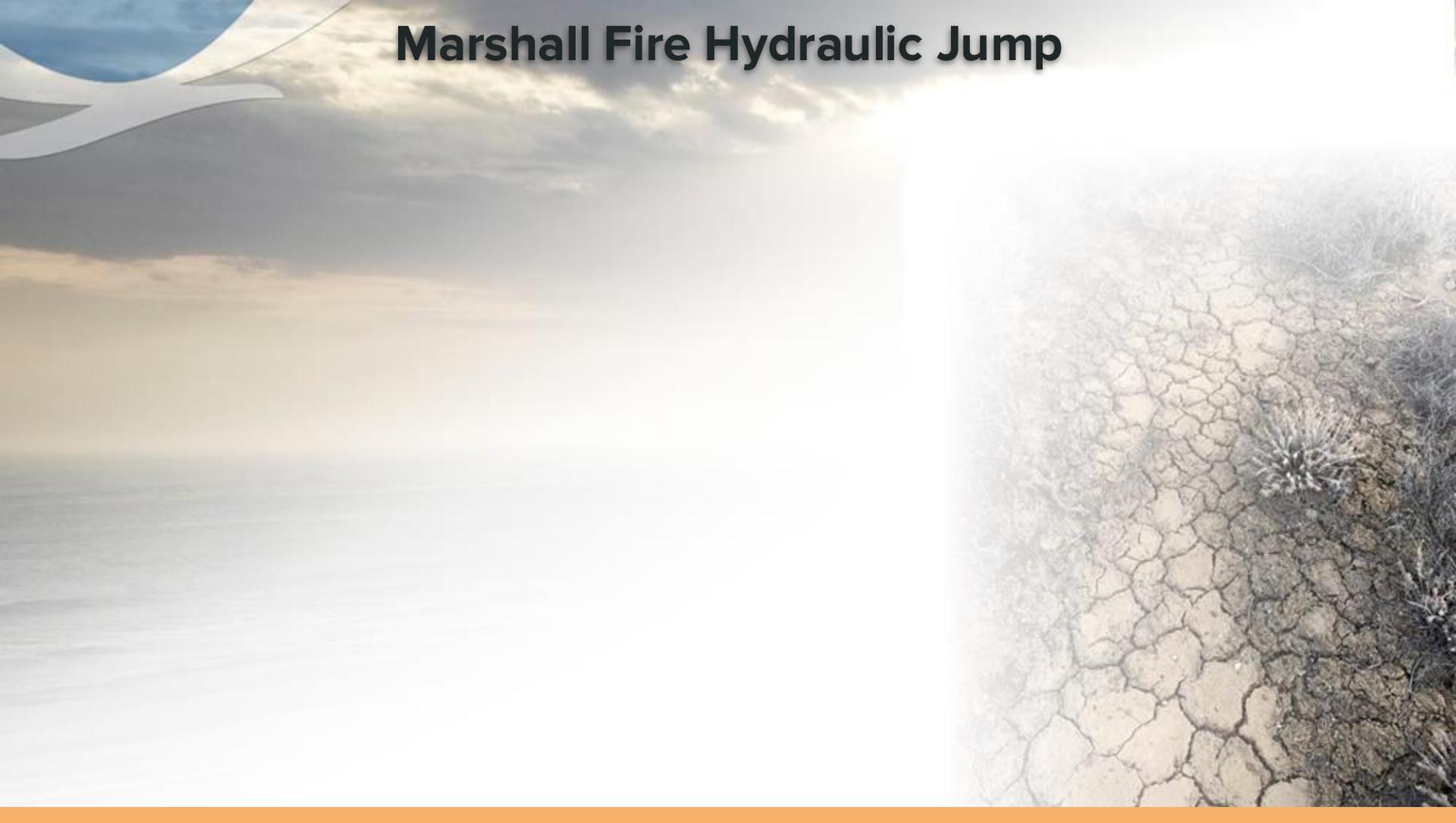
- Unusual time of year Dec 31-Jan downslope wind storm gusts to 115 mph supported rapid spread.
- \$513+ million in damages.
- 1k structures destroyed and 6k acres 2 fatalities.
- Most damaging fire in CO history after only 12 hours.
- Exacerbated by expanding Wildland Urban Interface and poor open space management practices.





Hy

Marshall Fire Hydraulic Jump



California



Santa Anas

Santa Ana winds



- A localized type of Foehn wind driven by offshore pressure gradients.
- Adiabatic drying and advective drying over the Great Basin produce extremely low RH as low as 1-3%
- Winds may exceed 80 mph through terrain and gaps.
- Extreme fire behavior develops as a combination of very combustible fuels and extreme winds.

Critical Winds

Foehn Winds

Santa Ana Winds

- Originates in the high deserts of southern California.
- steep pressure gradient exists between high pressure in the Great Basin and low pressure off the coast of southern California.
- Downslope off shore flow develops.
- Can create critical fire weather situations in southern California.

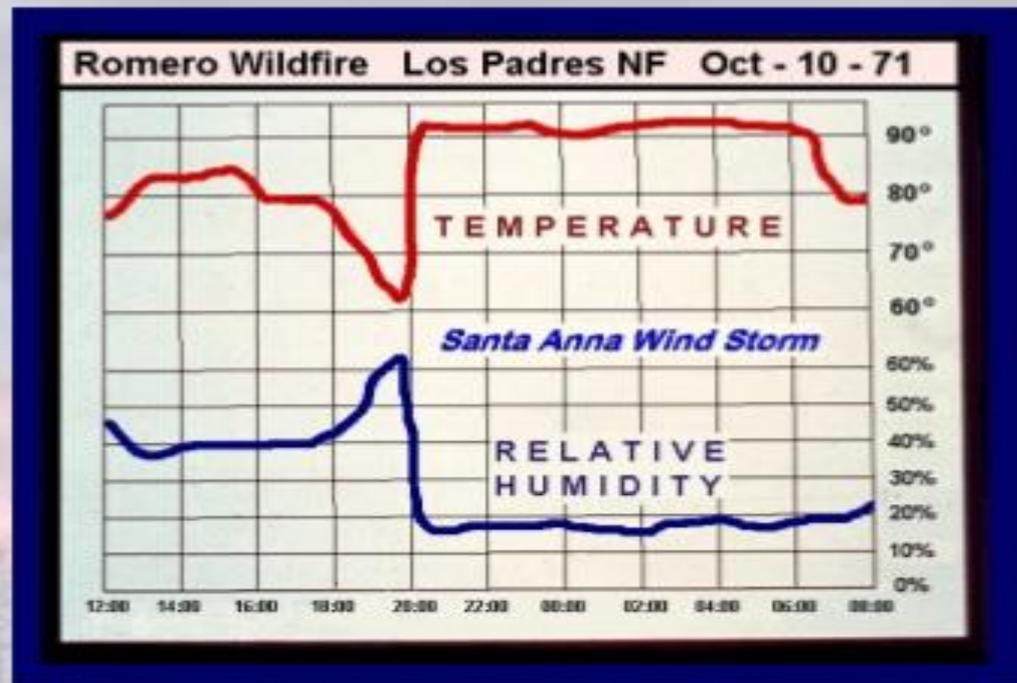


Critical Winds

Santa Ana Wind Storm

Santa Ana Wind Storm

- Romero fire October 10, 1971
- Note the sudden temperature rise and RH drop when the Santa Ana winds develop



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

Mount Diablo

Santa Ana

CALIF.

NEV.

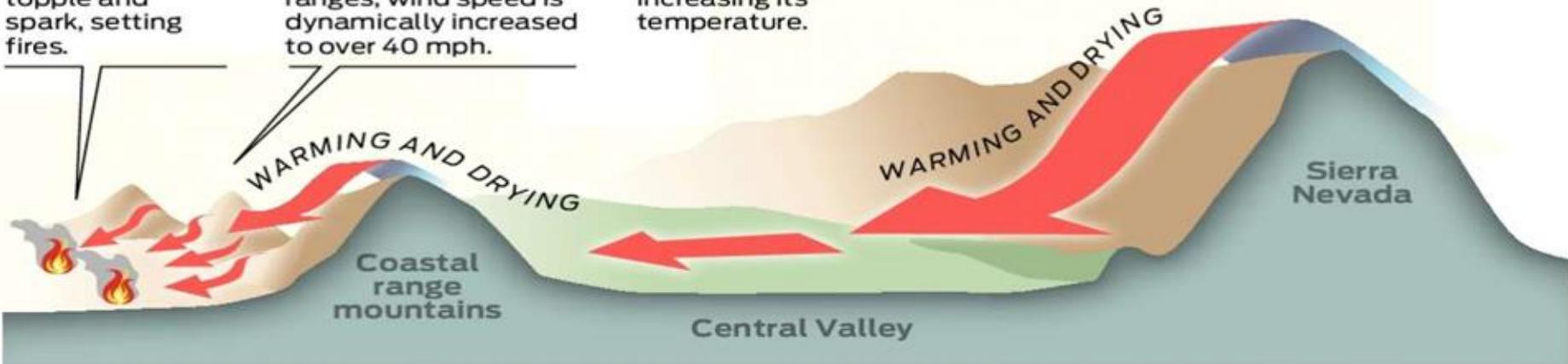
UTAH

7 The excessive wind can cause power lines to topple and spark, setting fires.

6 Squeezing through canyons and gaps of the coastal mountain ranges, wind speed is dynamically increased to over 40 mph.

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

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



Sundowners

Sundowner winds



- Special case of Santa Ana winds with an offshore low
- Small but very impactful area with high population

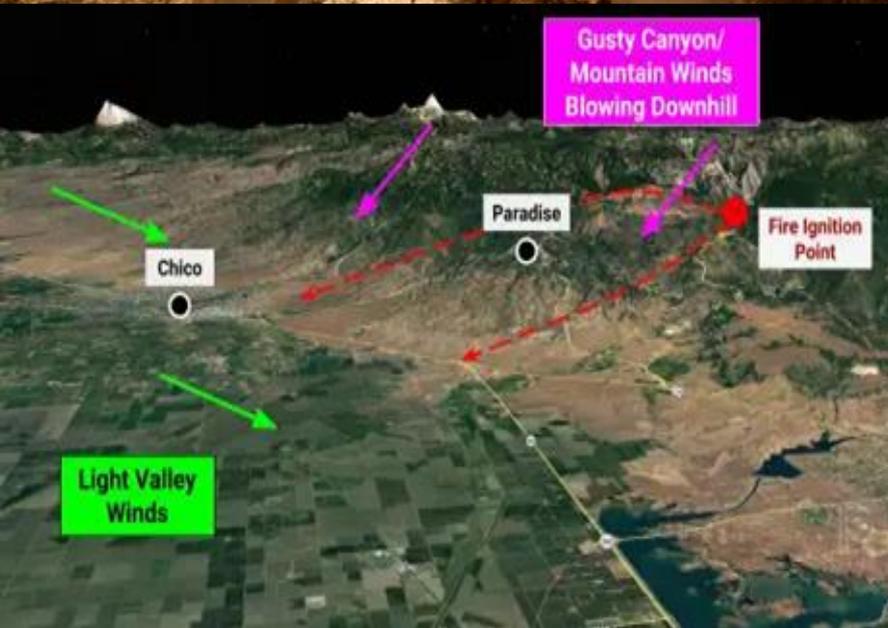


Camp Fire Nov 2018

153,000 Acres

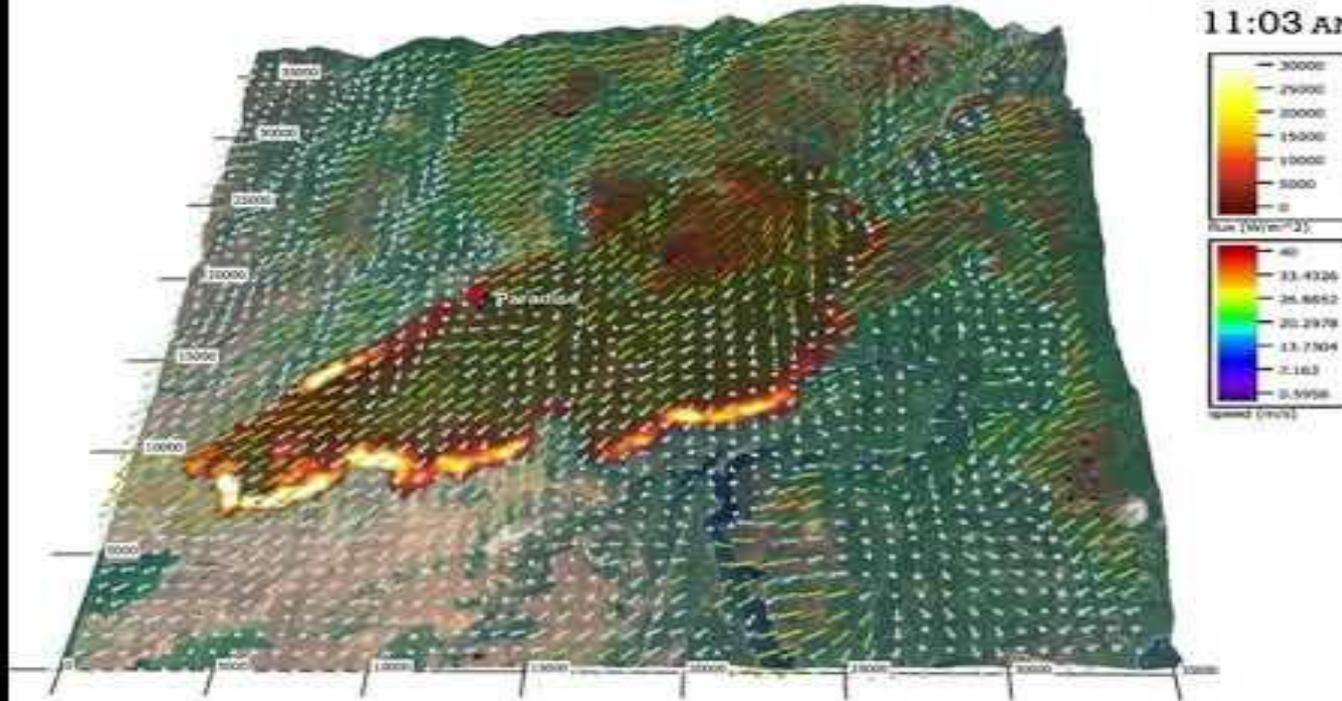
18,000 Buildings Destroyed

85 Fatalities \$16.5 Billion

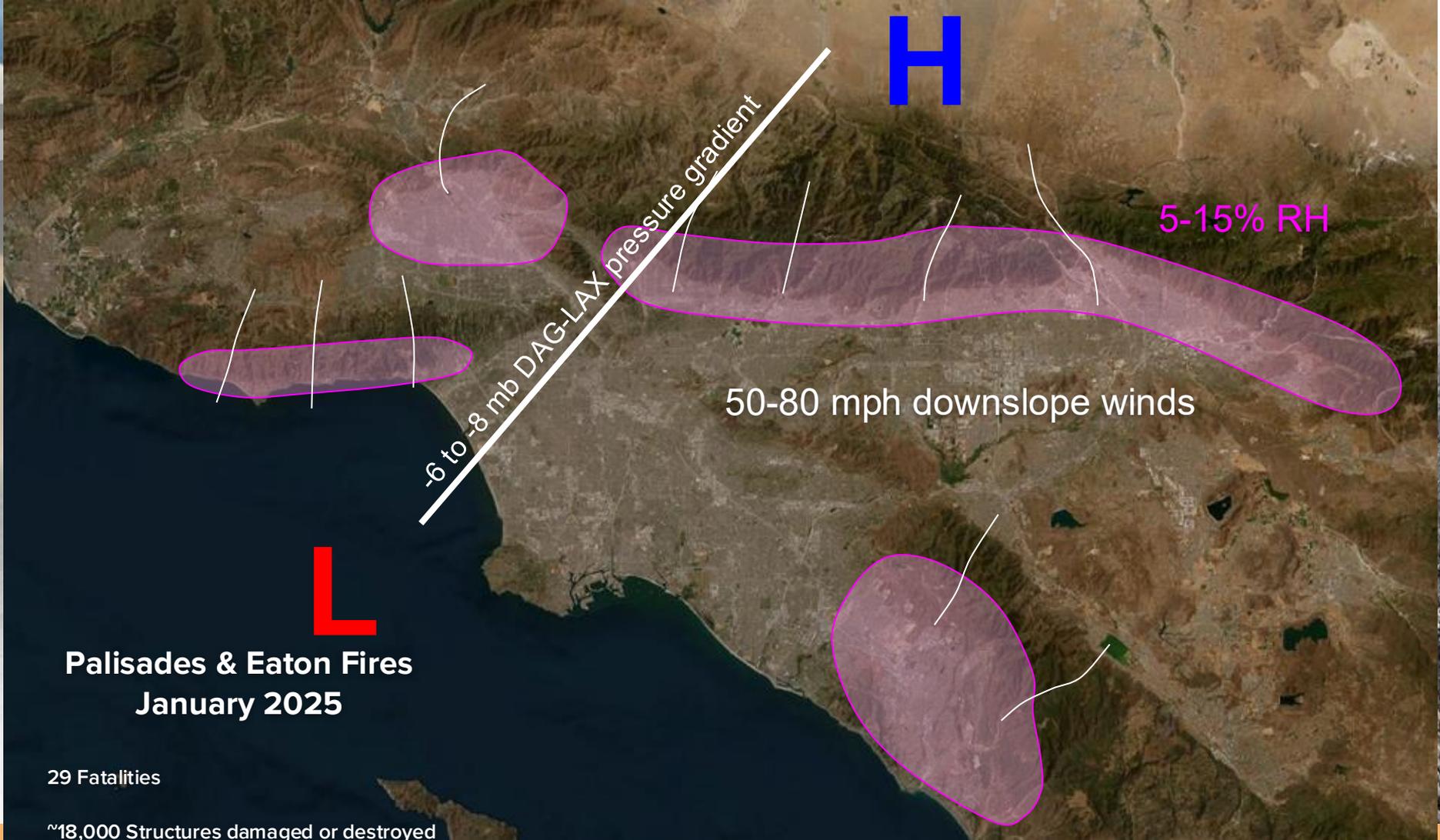


Nov. 8 2018

11:03 AM



<https://www.youtube.com/watch?v=dyfJYOZgiyA>



H

-6 to -8 mb DAG-LAX pressure gradient

5-15% RH

50-80 mph downslope winds

L

Palisades & Eaton Fires January 2025

29 Fatalities

~18,000 Structures damaged or destroyed



Palisades

Eaton

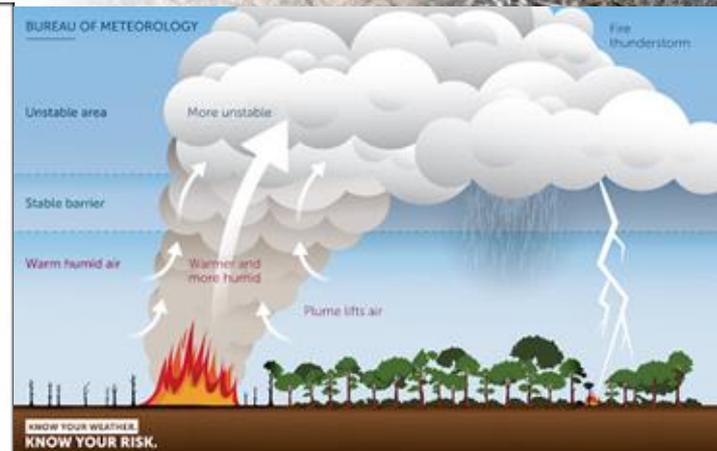
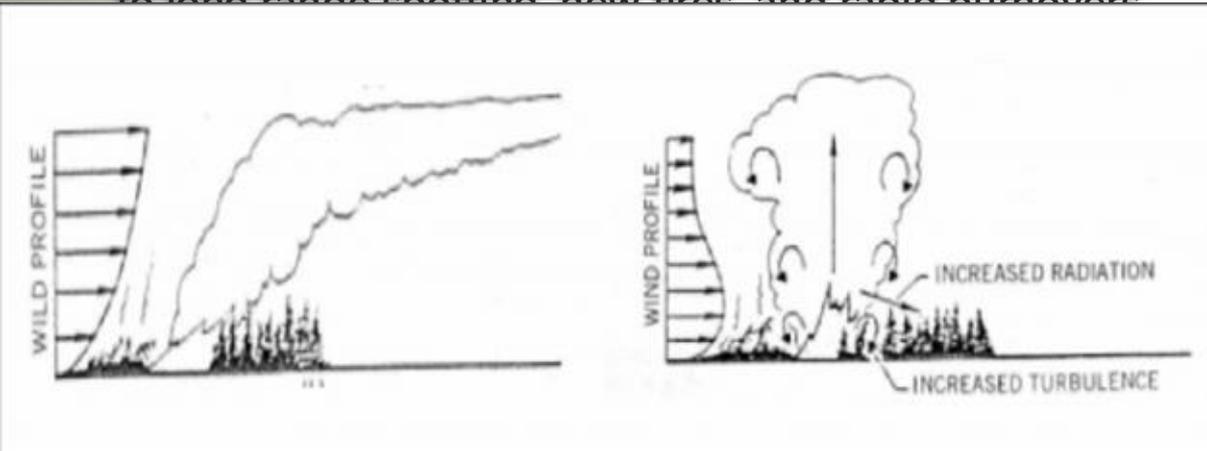
Palisades & Eaton Fires January 2025

29 Fatalities

~18,000 Structures damaged or destroyed

“Plume Dominated” vs “Wind Driven” events

- Prototypical fire regimes are often characterized by warm temperatures, low relative humidity, and strong boundary-layer winds. AKA “Hot Dry Windy”
- Low RH cures fuels by increasing the potential energy of a material. High winds bring oxygen and spread flames/sparks creating spot fires. Literally fanning the flames.
- Just like thunderstorms atmospheric instability can also drive fire weather. Hot dry and unstable conditions can be just as dangerous as hot dry and windy.
- Fires can create their own environment from strong buoyant updrafts collapsing and reforming.
- Plumes can loft embers for miles and create strong inflow/outflow winds on collapse leading to long range spotting, new fires, and rapid burnovers.



Pyro Cumulus

www.brandonriza.com BRANDONRIZA.COM
PHOTOGRAPHY | 3D VISUAL EFFECTS | MUSIC

Starion/Oak Glen/ Angeles National Forest Fire | 08.30.2019



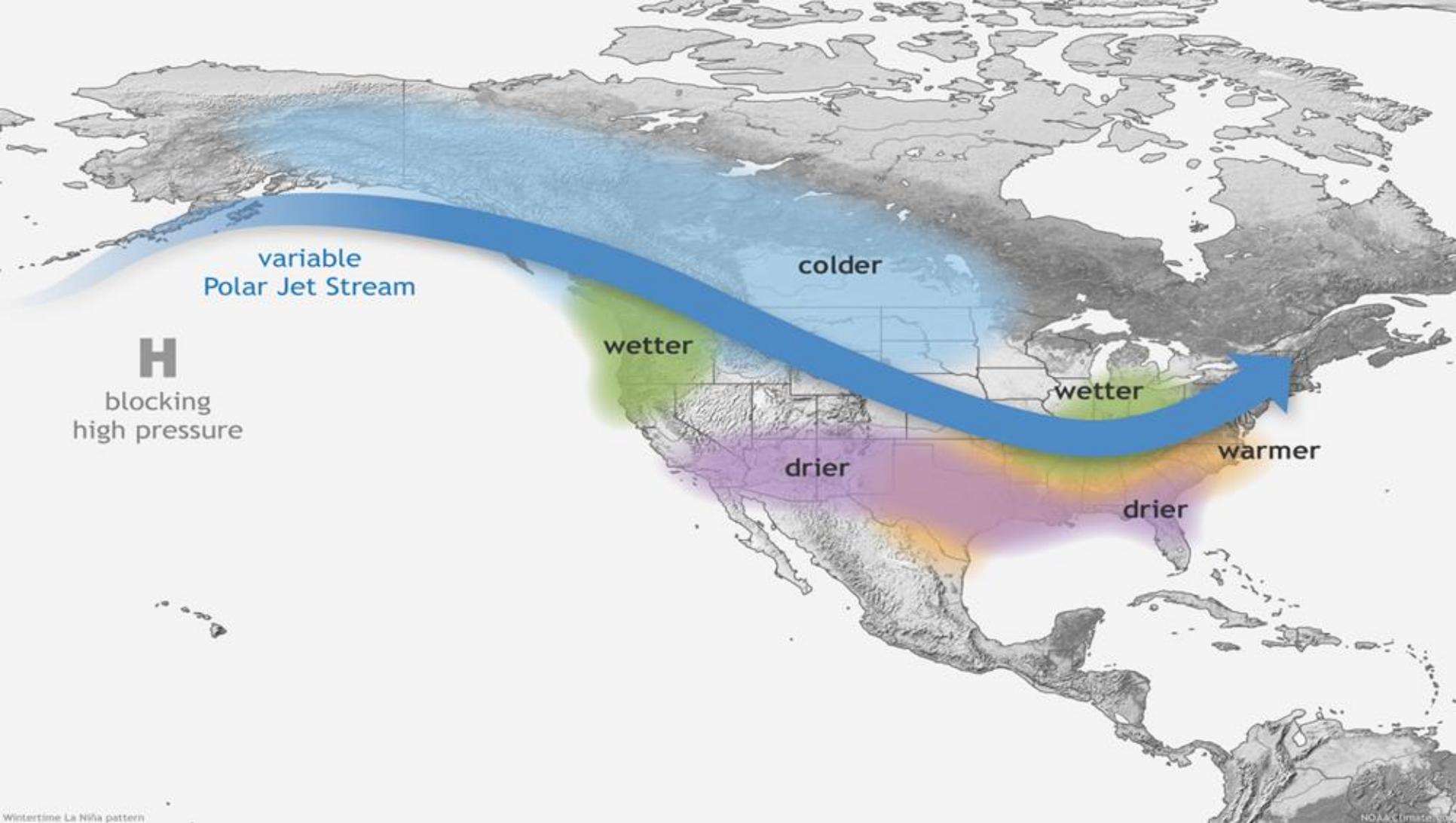
www.brandonriza.com



Other less common patterns

- In the northern plains, Great Lakes, and the northeastern US, pre-frontal high pressure from the Pacific, Northwestern Canada, and Hudson Bay all can produce very dry conditions. Cold fronts produce relatively short lived periods of high winds and instability that can produce extreme fire behavior.
- In the southeastern US, drought is frequently associated with the La Niña state of the southern oscillation pattern or a blocking ridge aloft near the Atlantic coast. Often critical weather patterns follow the frontal passage that brings extremely dry air due to a strong westerly or northwesterly flow. Look for strong winds that accompany the flow. Beware of advancing tropical storms as well as sea breeze boundaries across Florida.





variable
Polar Jet Stream

H
blocking
high pressure

wetter

colder

wetter

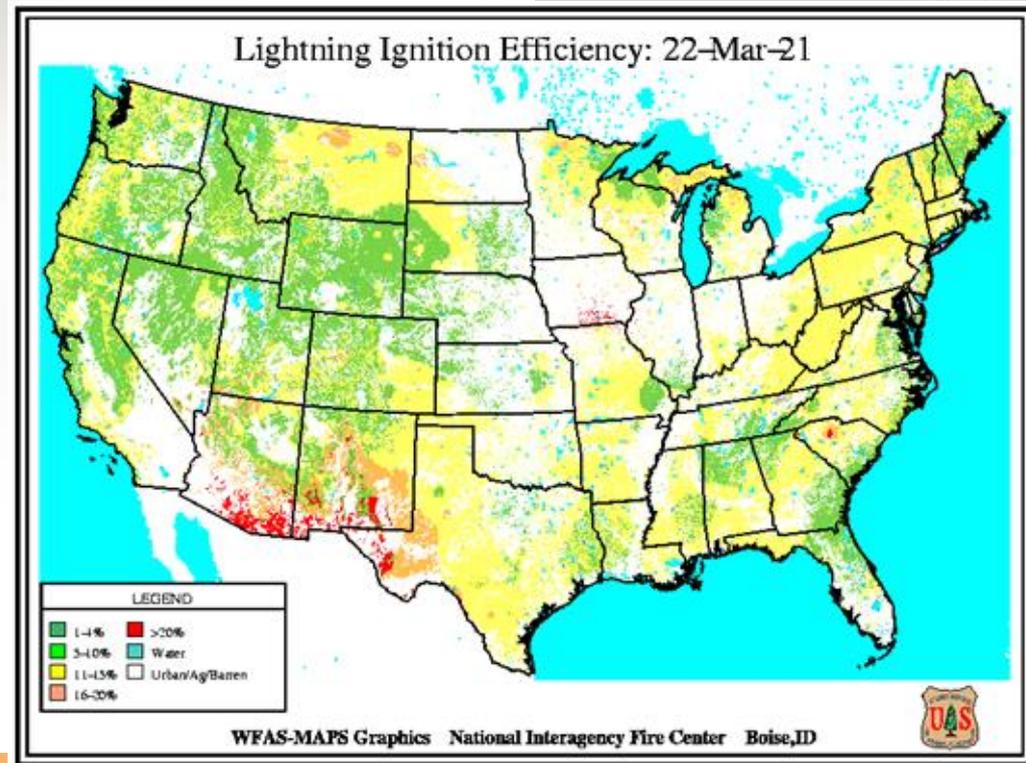
drier

warmer

drier

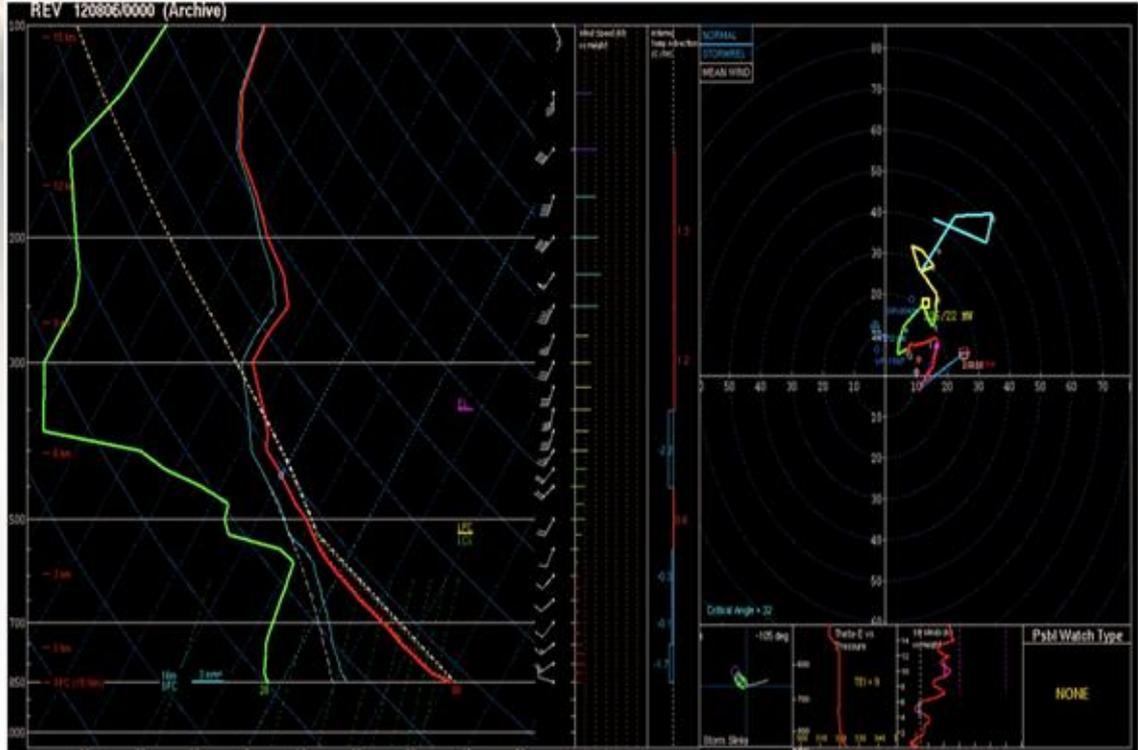
Dry Thunderstorms

- A fast moving or high based thunderstorm producing cloud to ground lightning and less than 0.10 inches of precipitation accumulation in 1 hour.
- Lightning ignitions account for a significant fraction of wildfires.
- Climate change suggests dry thunder/lightning ignition outbreaks may increase.



Dry Thunderstorms

- Deep and dry boundary layer. As much as 5-600 mb!
- Mid Level moisture advection results in destabilization. PW values of 0.5 to 0.75 inches most common
- Low CAPE and low shear (storms move slowly)
- Mixed storm modes most frequent



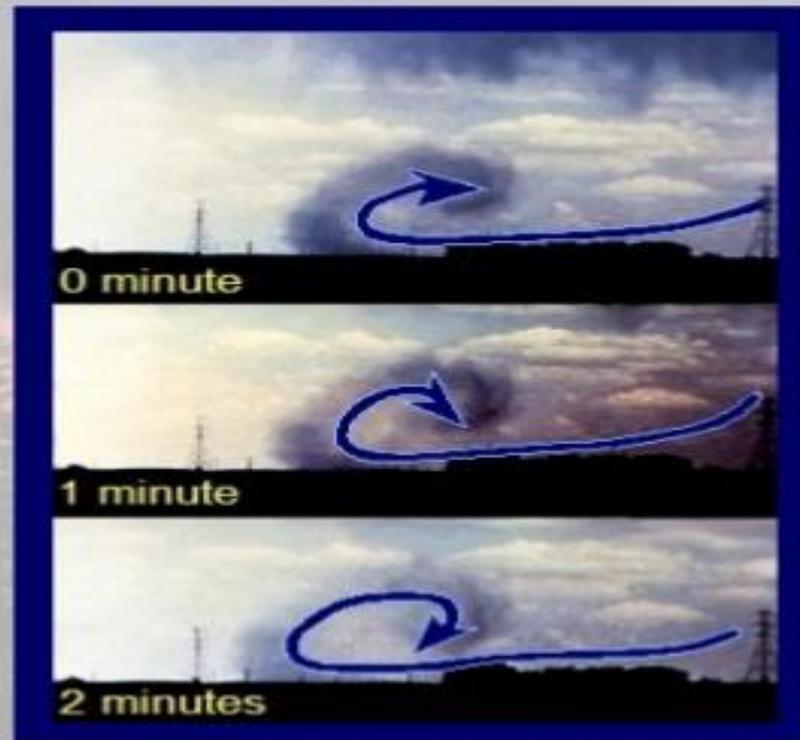
Thunderstorm Mode	Precipitation Amounts (in.)	Characteristic PW Values (in.)
Dry	0.00-0.10	0.50-0.75
Mixed Wet-Dry	0.10-0.20	0.75-1.00
Wet	>0.20	>1.00

Critical Winds

Thunderstorm Winds

Gust Front

- Leading edge of the downdraft
- Boundary between two dissimilar air masses, similar to a cold front
- Most of the time, marked by a wind shift, decrease in temperature and increase in RH



Critical Winds

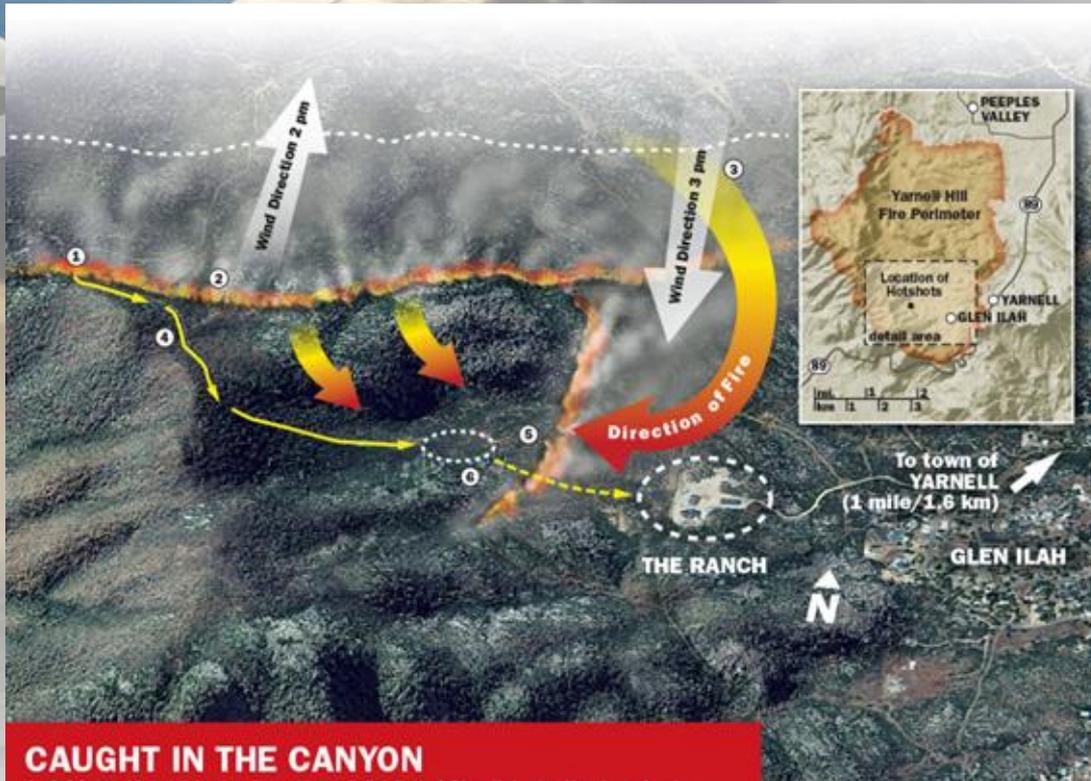
Thunderstorm Winds

Outflow Winds

- Outflow wind strongest in the direction the storm is moving
- Outflow wind weakest in the opposite direction the storm is moving



Yarnell Hill Fire June 30, 2013



CAUGHT IN THE CANYON

1. 9:30 AM: After hiking up from the subdivision of Glen Ilah, the Hotshots begin digging lines and clearing brush to contain the fire, which at this point had burned 150 acres. **2.** Until 3 PM a wind from the southwest pushed the flames north. **3.** The wind shifts direction and begins blowing from the northeast, propelling the fire down toward the Hotshots. Lookout Brendan McDonough's position comes under threat, and he is instructed to leave his post. **4.** Approximately 4 PM: The Hotshots leave the fireline and head east. They drop into the canyon toward the safety of the ranch, a half mile away, losing their view of the blaze as the fire accelerates. **5.** Fire reaches the eastern end of the canyon, trapping the firefighters



- Ignited by dry lightning
- Erratic behavior on June 30th due to outflow winds

SPC Fire Products

Fire Weather Outlooks

The Fire Weather Outlooks are intended to delineate areas of the continental U.S. where pre-existing fuel conditions, combined with forecast weather conditions during the next 8 days, will result in a significant threat for the ignition and/or spread of wildfires. This product is designed for use in the NWS, as well as other federal, state, and local government agencies.

Each outlook consists of a categorical forecast that graphically depicts fire weather risk areas across the continental United States, along with a text narrative. Through various labels and colors on the graphic, the five types of Fire Weather Outlook risk areas are:

ELEVATED (orange) - Elevated risk from wind and relative humidity

CRITICAL (red) - Critical risk from wind and relative humidity

EXTREME (magenta) - Extremely Critical risk from wind and relative humidity

ISODRYT (brown) - Elevated risk from dry thunderstorms

SCTDRYT (red) - Critical risk from dry thunderstorms

Fire Weather Outlooks

Updated: Sun Mar 7 17:01:03 UTC 2021 (2h 8m ago)

Storm Prediction Center Mesoscale Assistant/Fire Weather Forecaster Ariel Cohen describes the SPC fire weather forecast process for a meteorology class at the University of Oklahoma. You can view the YouTube video: <https://youtu.be/Xy9AdUaUynU>.

Current Fire Weather Outlooks (Product Info)

Current Day 1 Fire Weather Outlook



Forecaster: SQUITIERI
Issued: 071659Z
Valid: 071700Z - 081200Z
Forecast Risk of Fire Weather: **Critical Risk**
Note: Critical Fire Weather Criteria document in [MS-Word](#) or [PDF](#).

Current Day 2 Fire Weather Outlook



Forecaster: MOORE
Issued: 070729Z
Valid: 081200Z - 091200Z
Forecast Risk of Fire Weather: **Elevated**
Note: Critical Fire Weather Criteria document in [MS-Word](#) or [PDF](#).

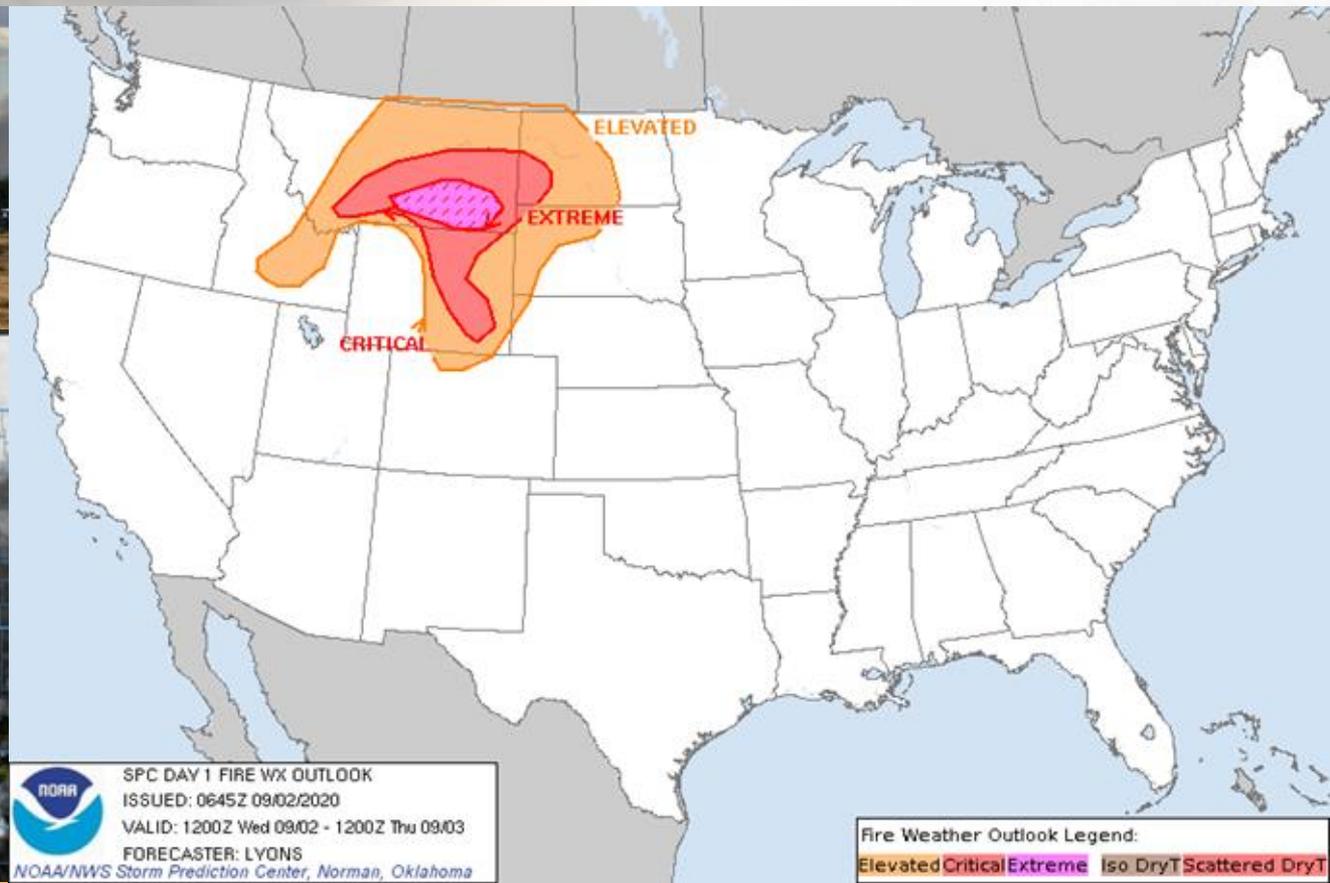
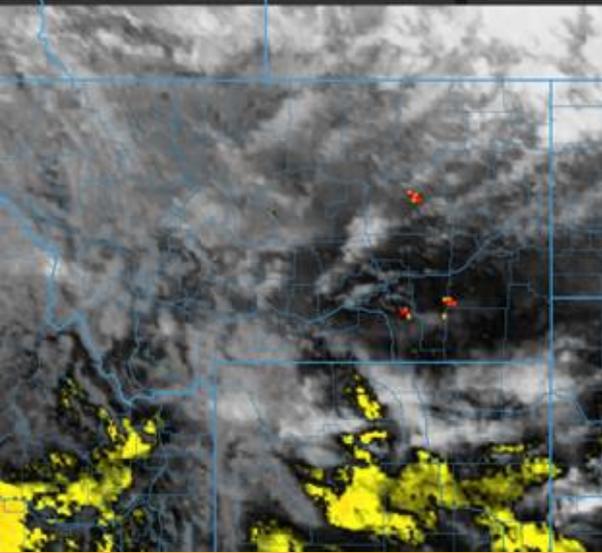
Day 3-8 Fire Weather Outlooks (Product Info)

Day 3-8 Fire Weather Outlook



Forecaster: SQUITIERI
Issued: 062159Z
Valid: 08/1200Z-14/1200Z

September 2nd 2020 Montana fire outbreak

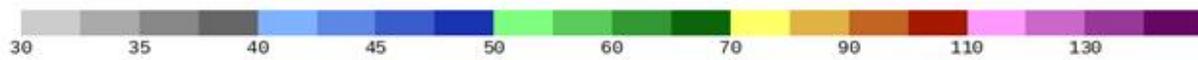
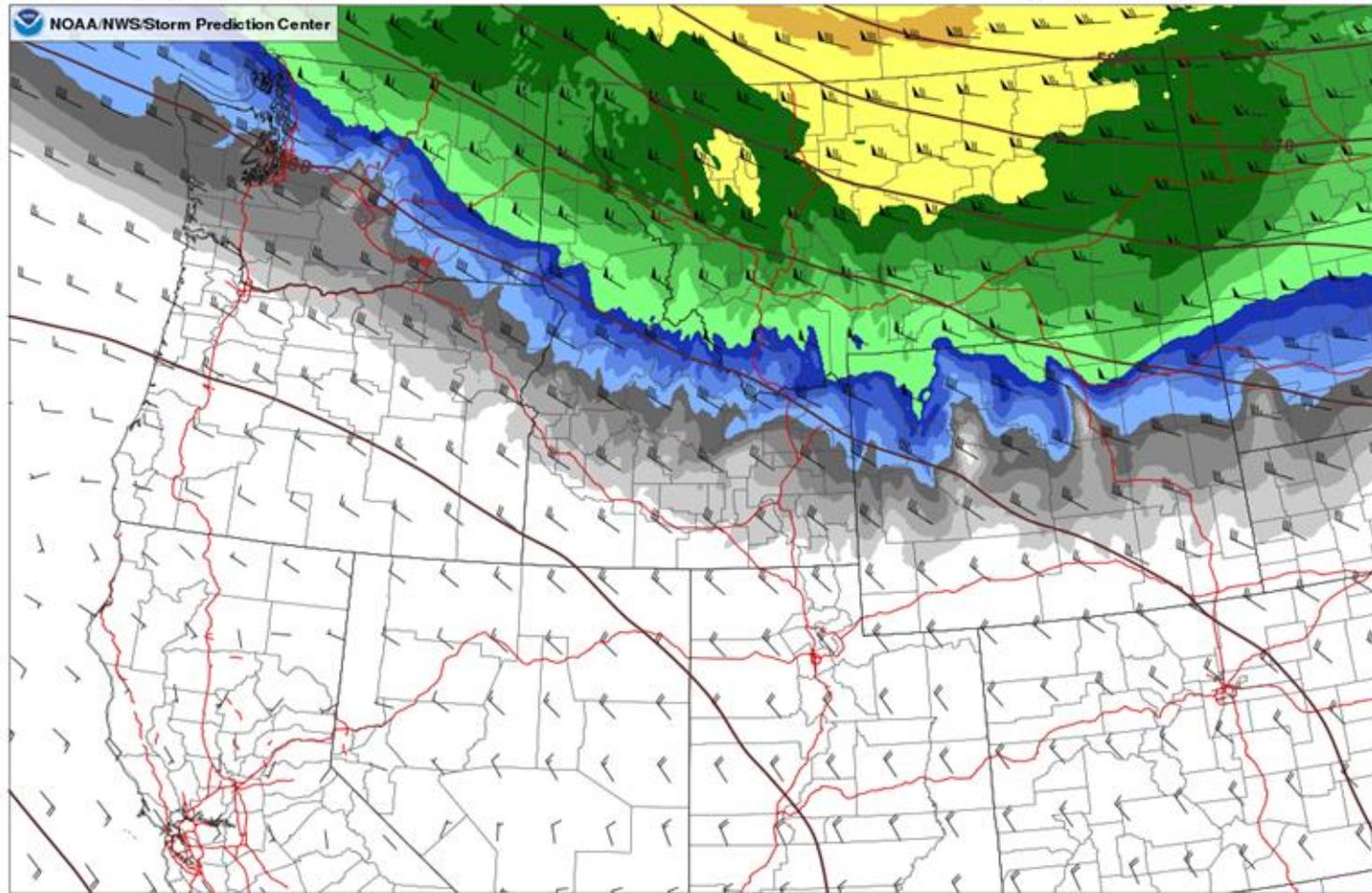


HREF MN[500 mb Z] (dam)

Run: Wed 2020-09-02 12:00 UTC

500 mb wind (kts), ensemble mean

Valid: Wed 2020-09-02 21:00 UTC



HREF

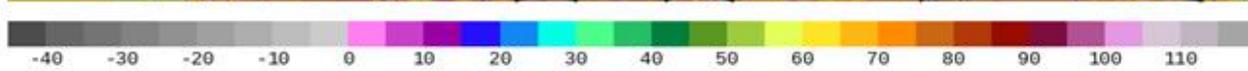
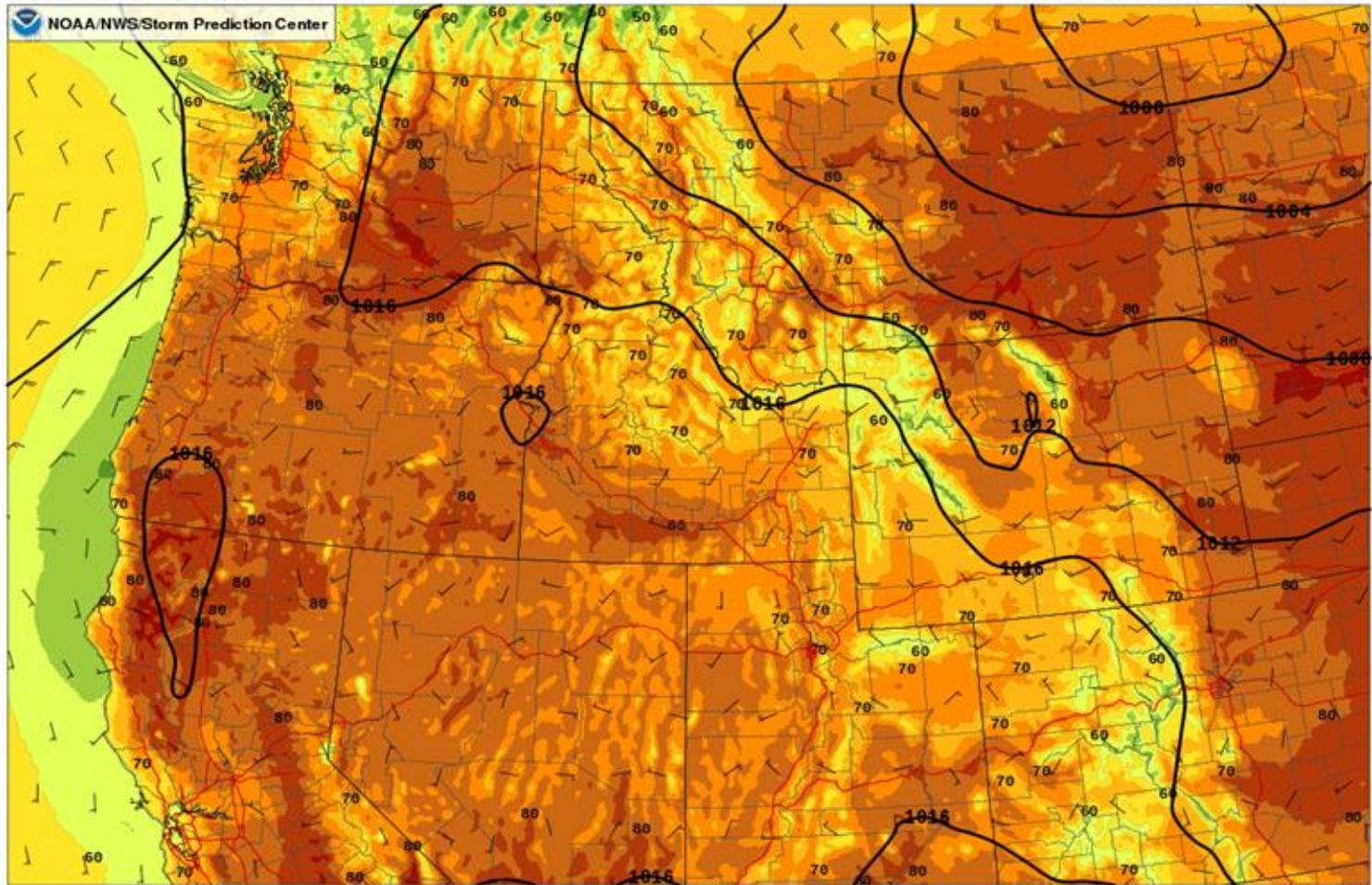
MN[MSLP] (mb)

MN[10 m Vh] (kt)

Run: Wed 2020-09-02 12:00 UTC

2 m AGL Temperature (F), ensemble mean

Valid: Wed 2020-09-02 18:00 UTC



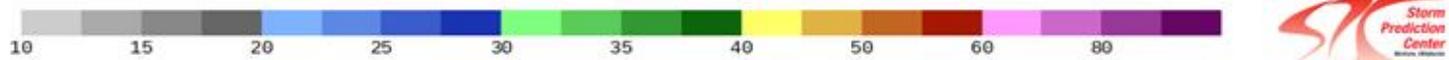
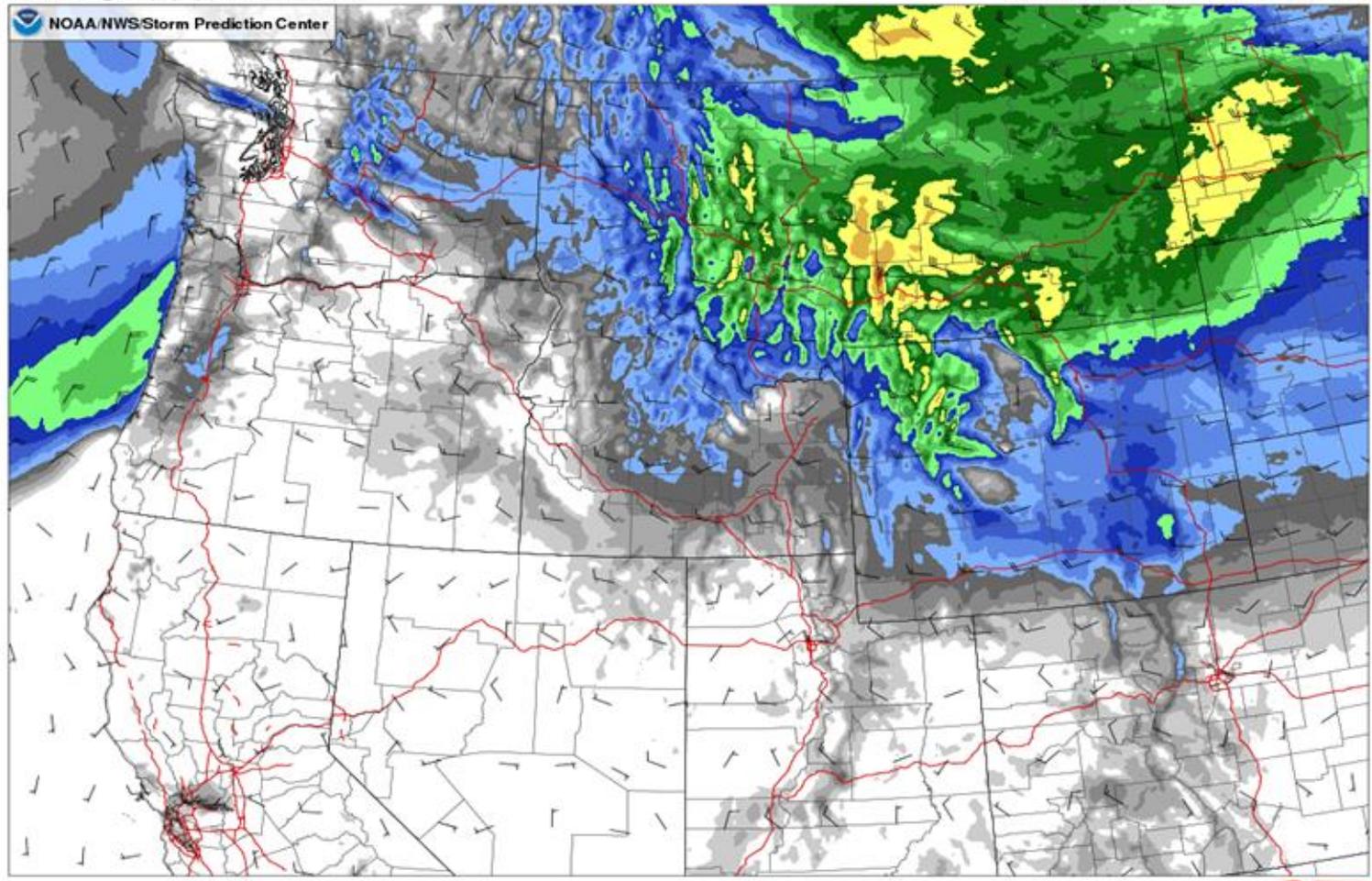
HREF

MN[10 m Vh] (mph)

Run: Wed 2020-09-02 12:00 UTC

10 m AGL gust (mph), ensemble mean

Valid: Wed 2020-09-02 21:00 UTC



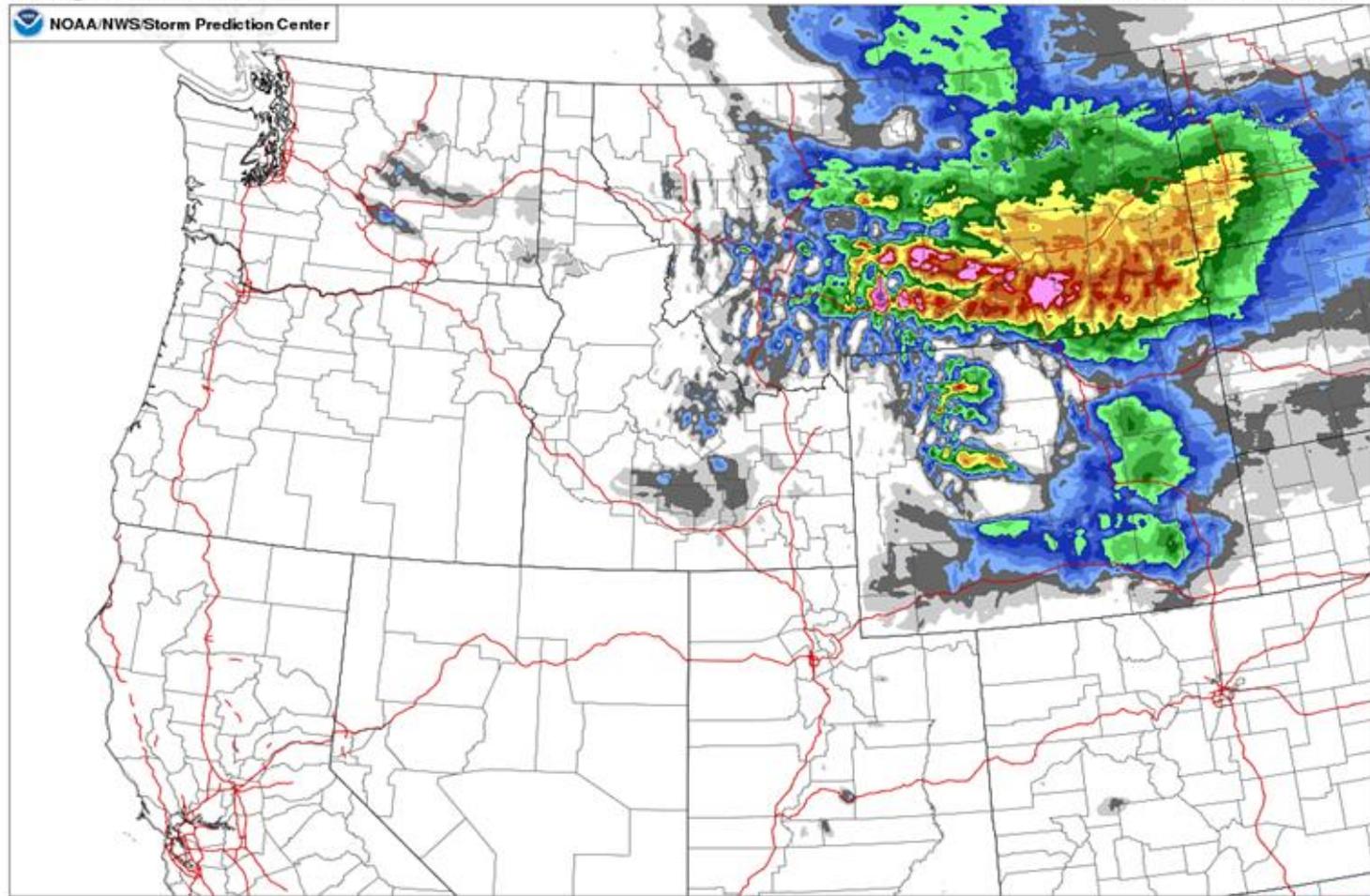
HREF

Fosberg index, ensemble mean

Run: Wed 2020-09-02 12:00 UTC

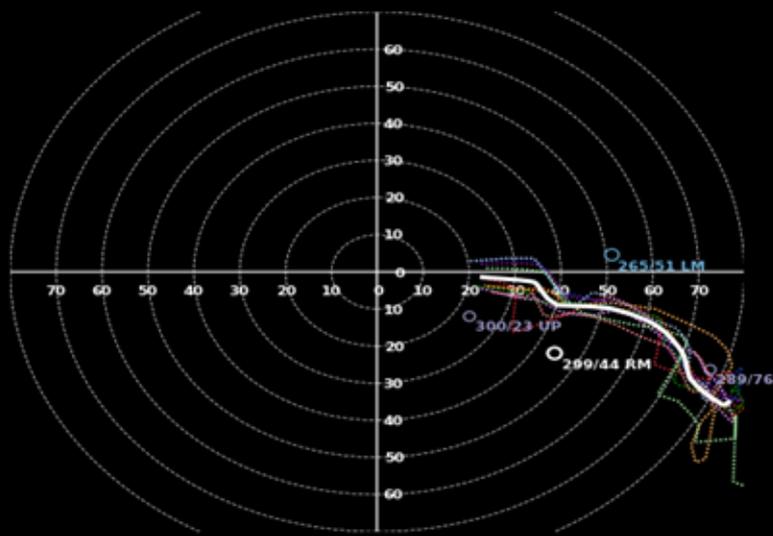
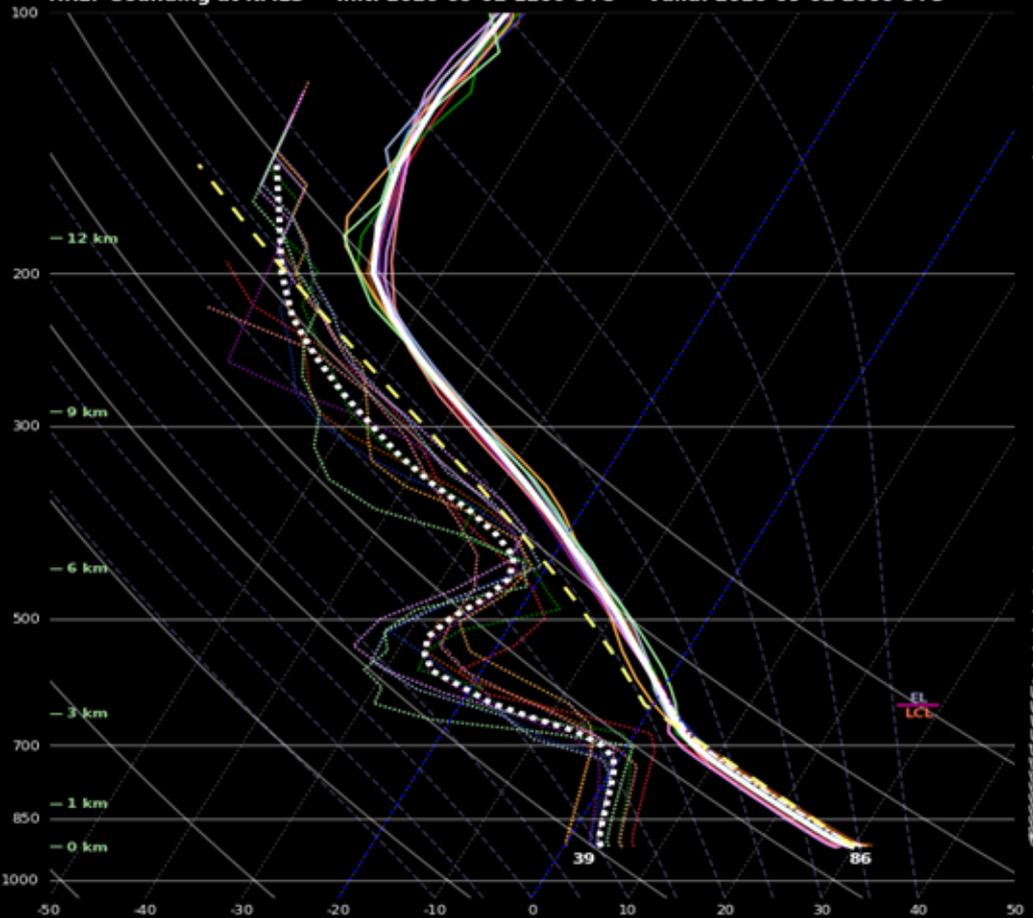
Valid: Wed 2020-09-02 22:00 UTC

NOAA/NWS/Storm Prediction Center



Storm Prediction Center





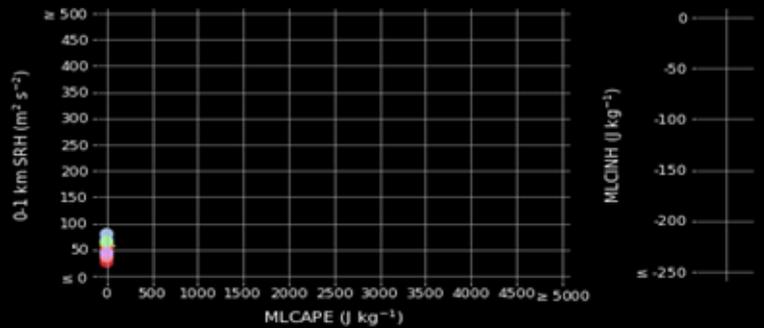
Ensemble member legend

- HRRR
- HRW NSSL
- HRW ARW
- HRW NMMB
- NAM Nest
- HRRR -6h
- HRW NSSL -12h
- HRW ARW -12h
- HRW NMMB -12h
- NAM Nest -12h

Parcel	CAPE	CINH	LCL (m)	LI	LFC (m)	EL (m)
SFC	0.0	0	3205	3	-	3205
ML	0.0	0	3172	3	-	3172
MU	0.0	0	3205	3	-	3205

LR (C/km) 700-500: 5.9 | 0-3km: 7.4 | 3-6km: 6.0

	SRH ($m^2 s^{-2}$)	Shear (kt)	MnWind	SRW
SFC-1 km	55	11	274/32	161/21
SFC-3 km	88	22	277/35	167/18
SFC-6 km	-	48	280/43	194/15
Eff Inflow Layer	-	-	-/-	-/-



Wrap Up

- **Fire weather can be thought of in an ingredients based framework.**
- **Fuels are one of the most important but difficult aspects of forecasting.**
- **Forecasting should follow a similar flow to severe weather.**
 - **Big Picture**
 - **Narrow your focus**
 - **The details**
- **Fire weather regimes vary widely across the CONUS.**
- **Fire weather is one of the most difficult and poorly understood aspects of severe weather forecasting.**

2024 Rancher Liaison Season Outlook

Meteorologist - Derek Williams
February 29, 2024







