

Bringing Fire and Soil Moisture Worlds Together, Together

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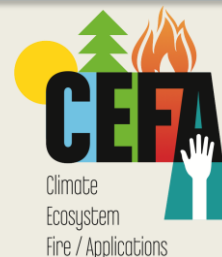
Soil Moisture and Wildfire Prediction Workshop

Albuquerque, NM

29 Apr 2019



Western Regional
Climate Center



The water and fire cycle



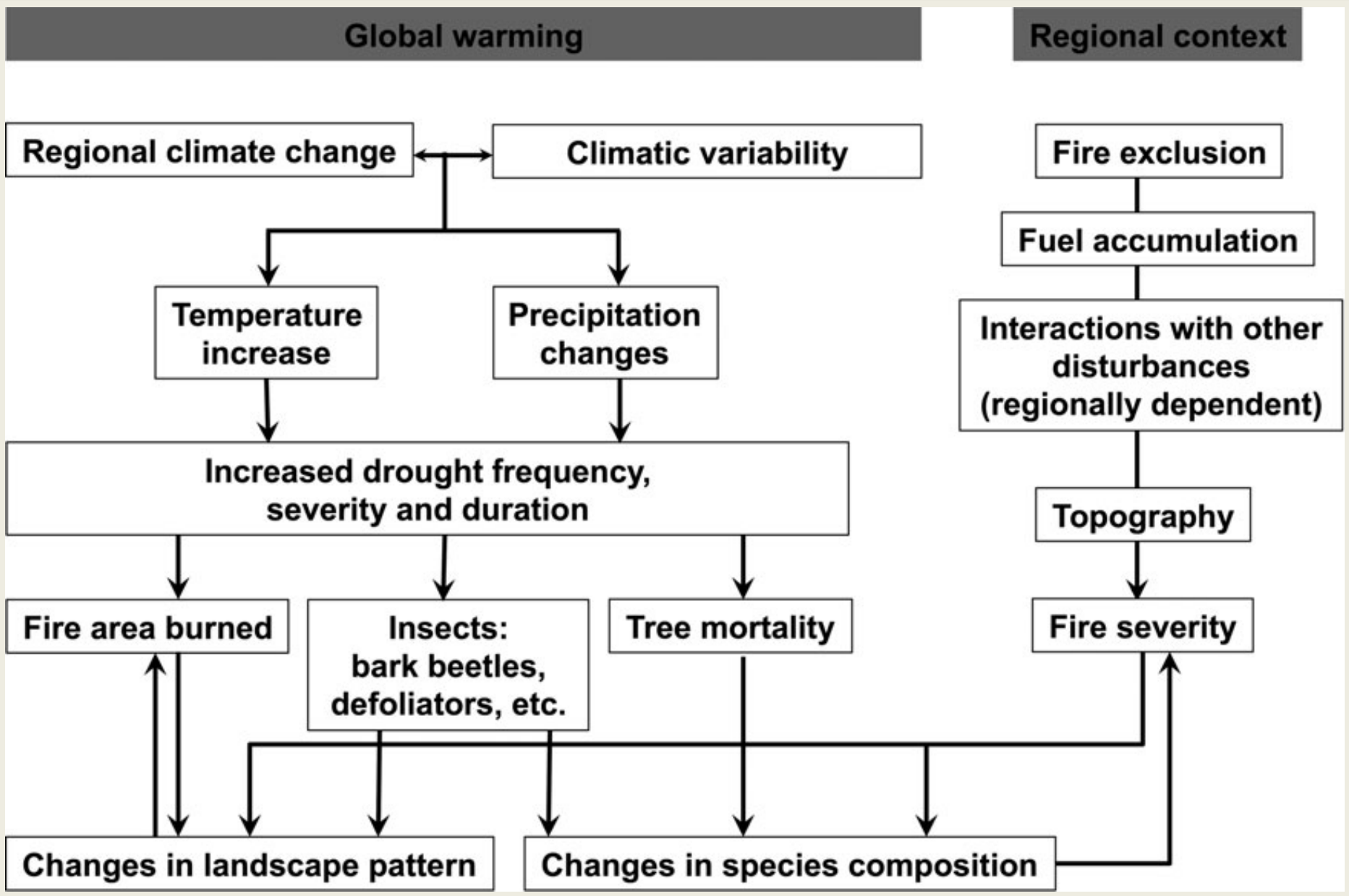
The Spokesman-Review: Crews battle a wildfire in the Palomino Valley, on Wednesday, July 5, 2017, near Reno, Nev. (Jason Bean / AP)

The water and fire cycle

Buffelgrass green-up and curing

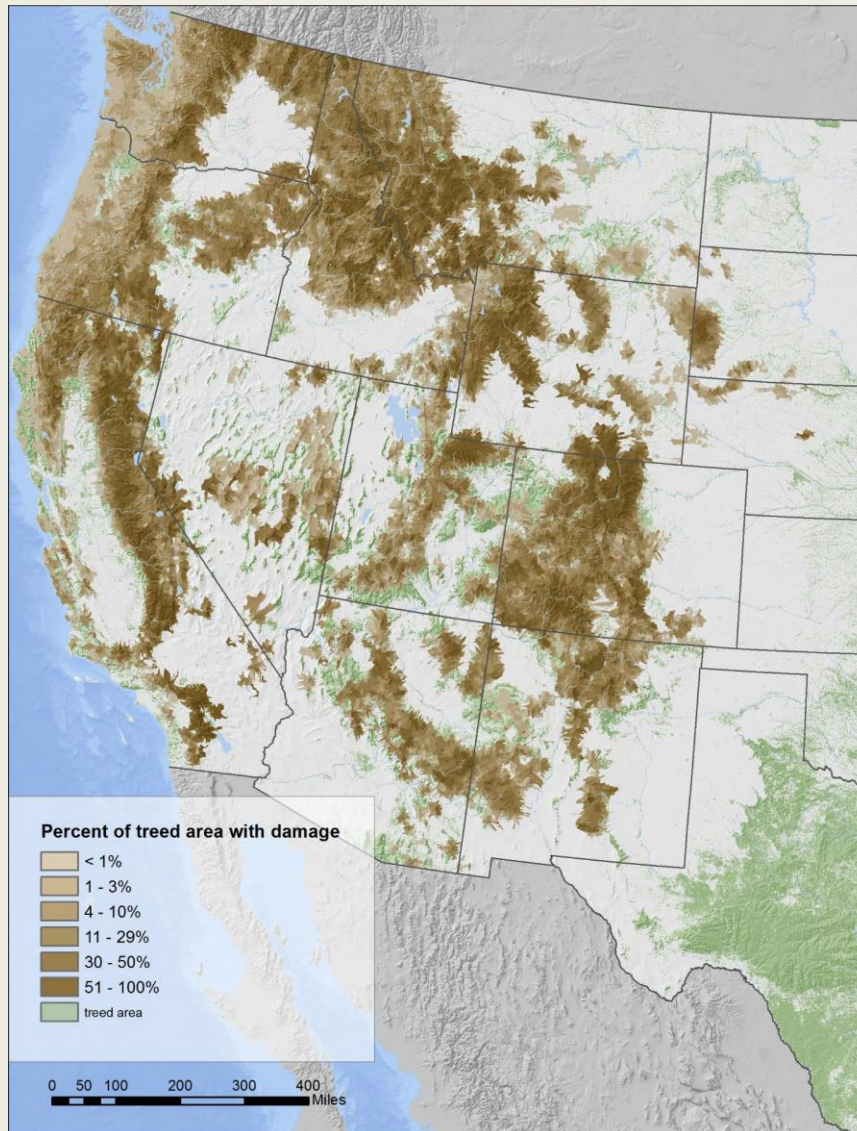


Forest stressor complex

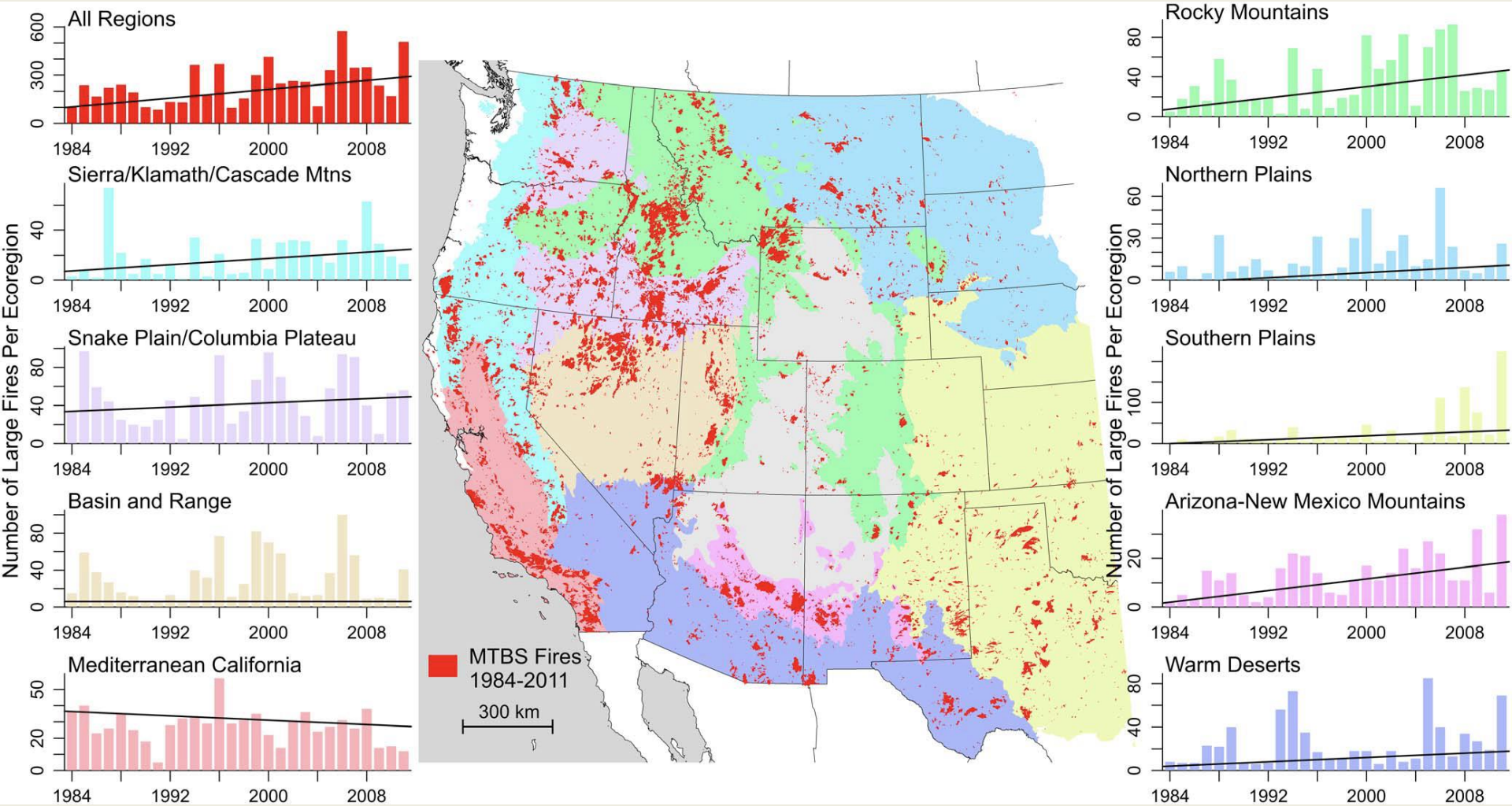


Climate-fire trend

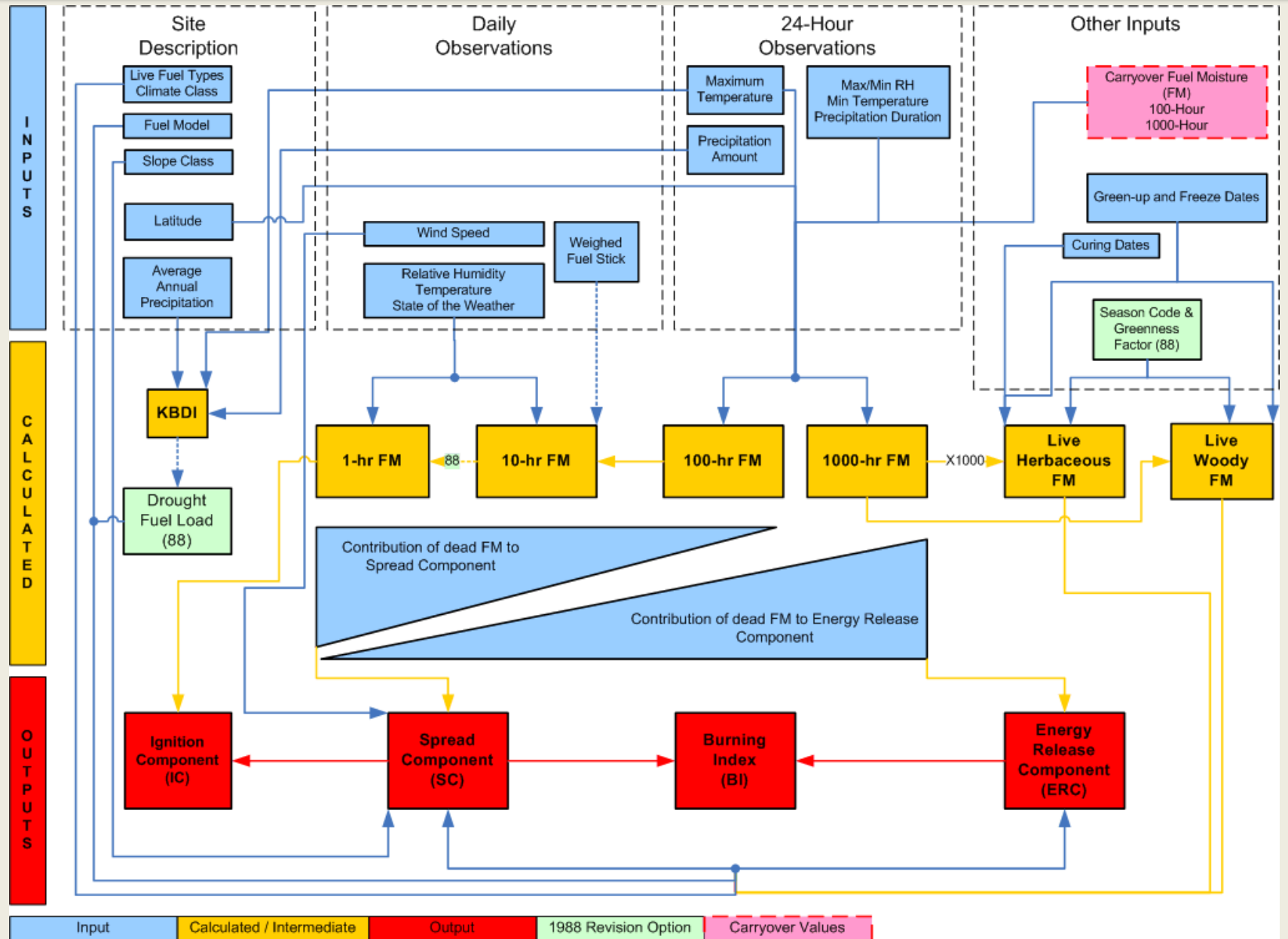
AREA WITH TREE MORTALITY FROM ALL WESTERN BARK BEETLES 2000 – 2016



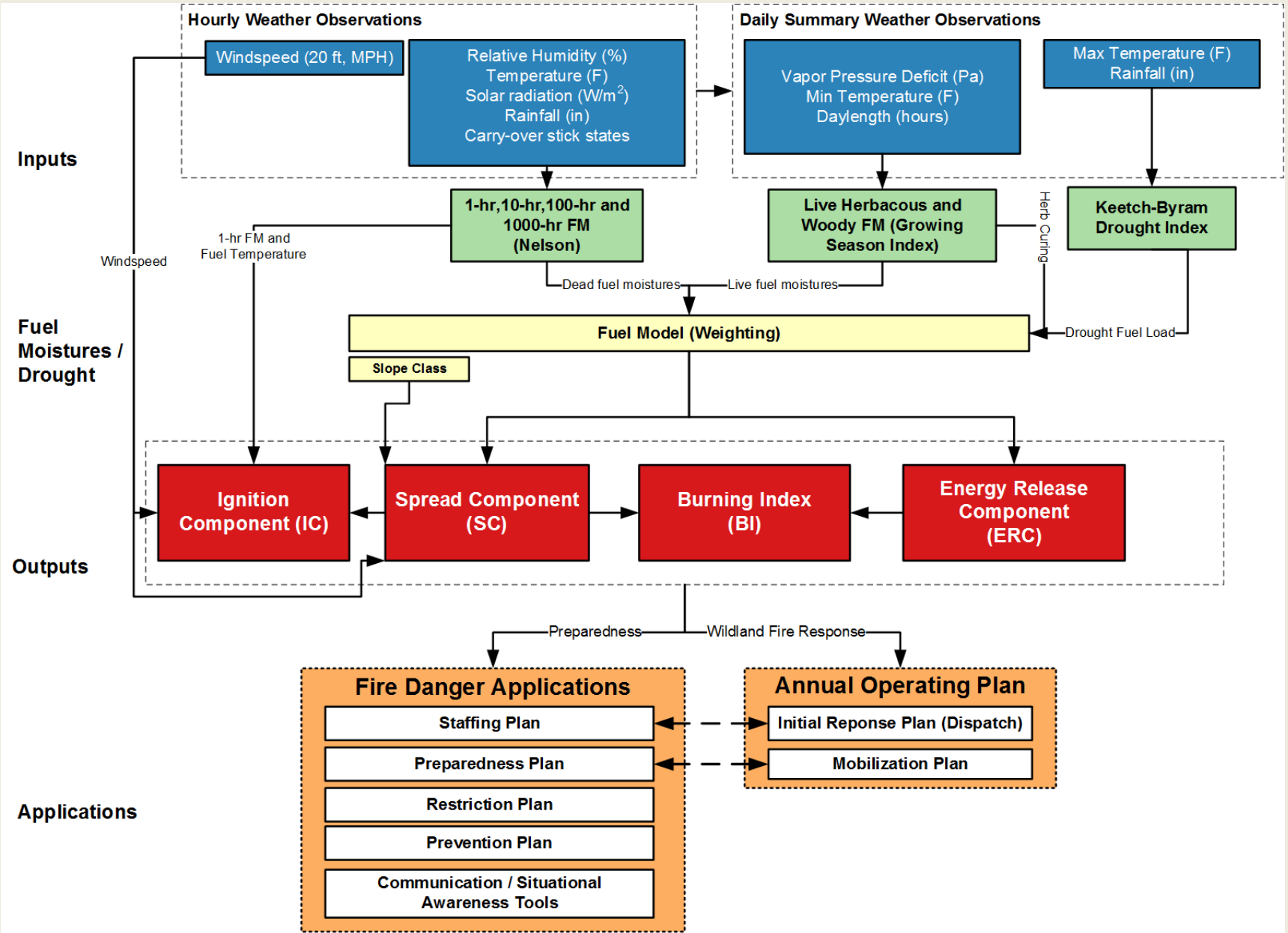
Climate-fire trend



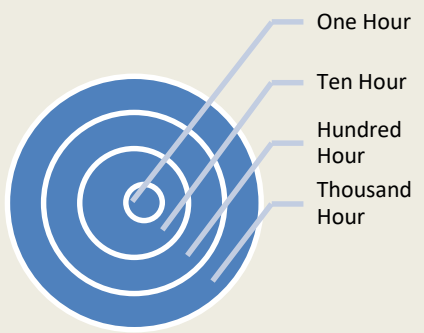
National Fire Danger Rating System



National Fire Danger Rating System

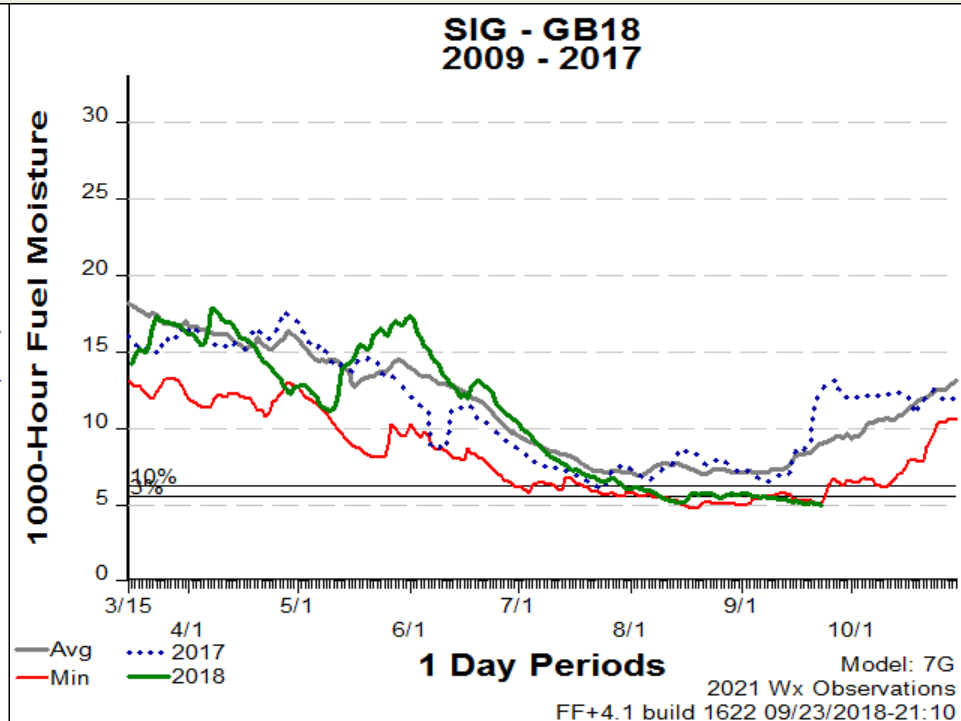
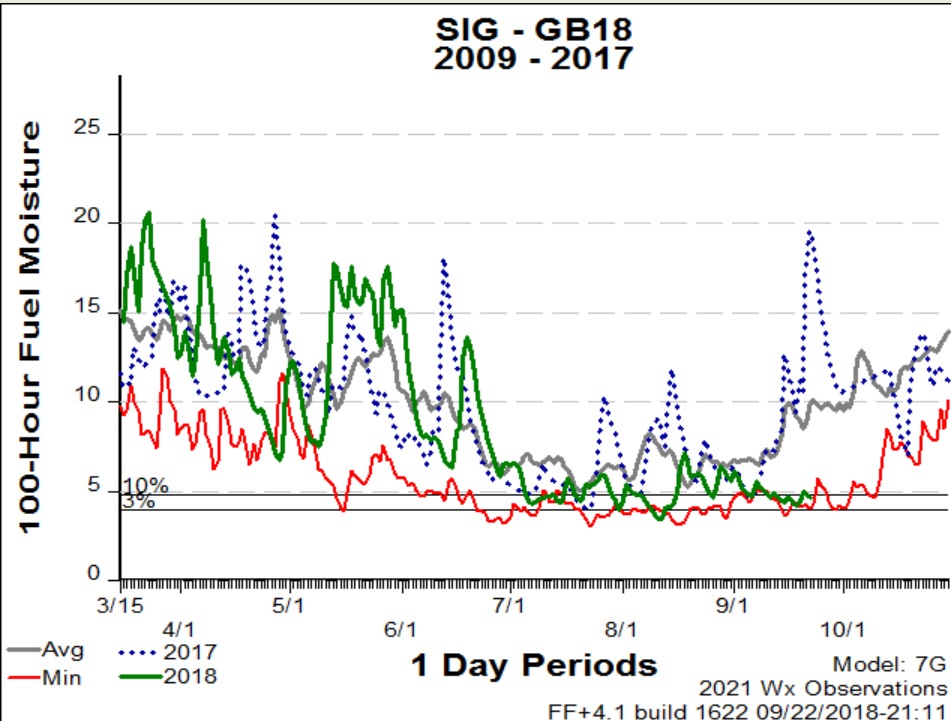


National Fire Danger Rating System

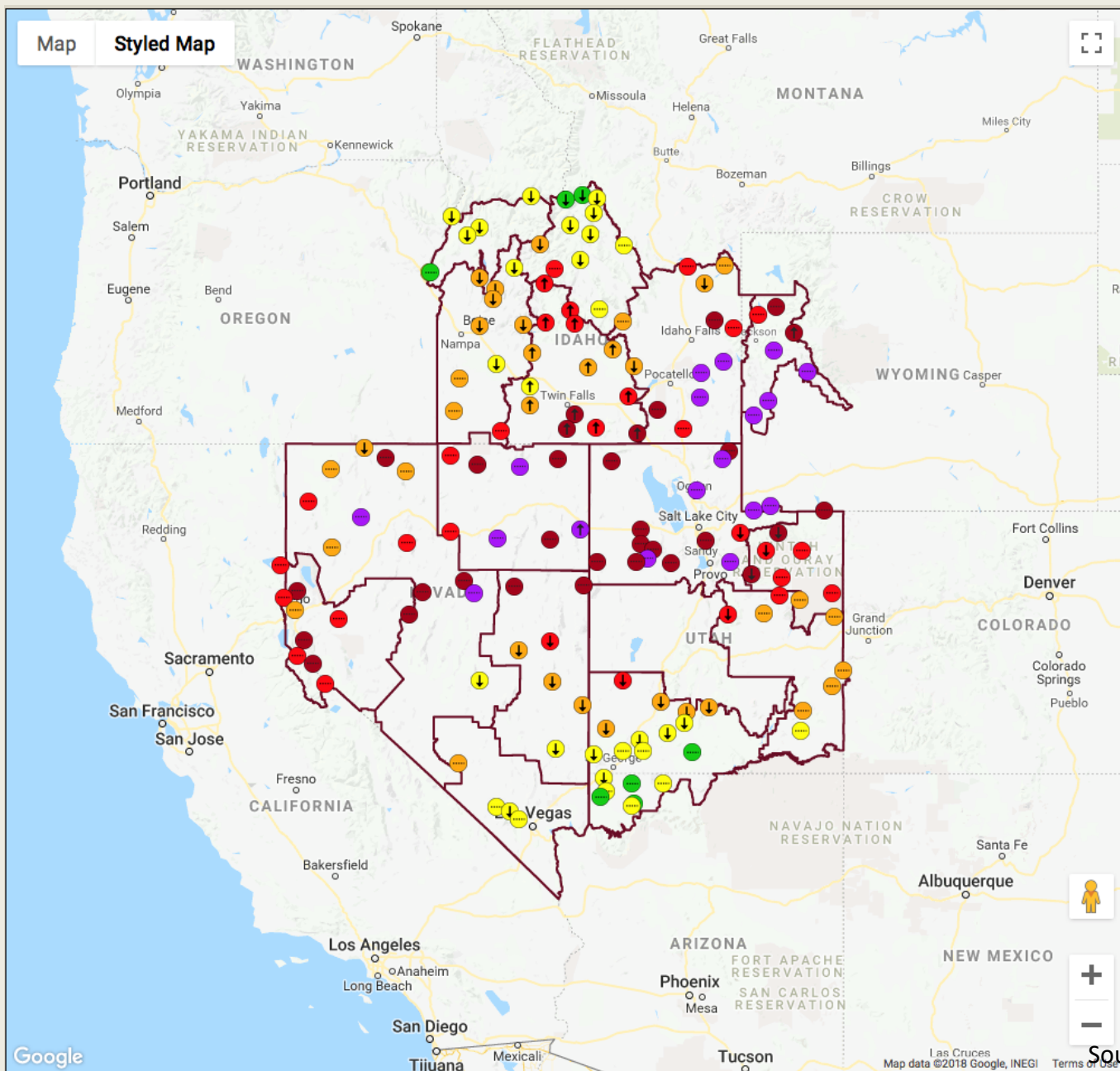


Time Lag	Stick Diameter (inches/cm)
1 hour	0.16 in / 0.4 cm
10 hour	0.5 in / 1.28 cm
100 hour	1.6 in / 4.0 cm
1000 hour	3 in / 7.62 cm

National Fire Danger Rating System



Nevada fuels status 9/23/18



RAWS observations from: 09/23/18

ERC Percentile:

- : below 50th
- : 50th to 69th
- : 70th to 79th
- : 80th to 89th
- : 90th to 96th
- : 97th and above

3-day ERC Trend:

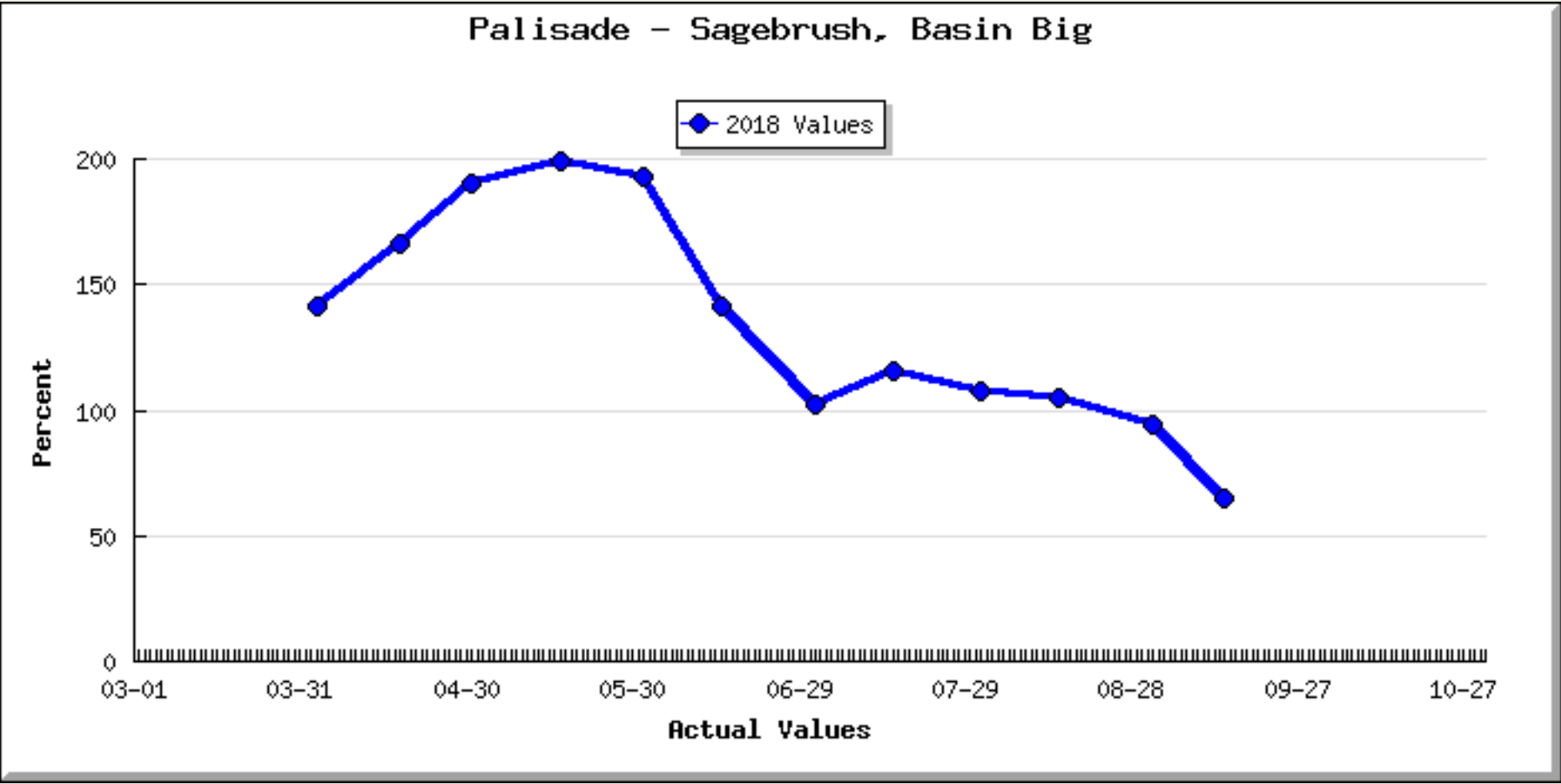
- ↑ : increase of 3 or greater
- ↓ : decrease of 3 or greater
- ⊙ : change of less than 3

Missing a station? Station s will only appear on the map if the 13:00 observation was submitted by the dispatch center the previous afternoon.

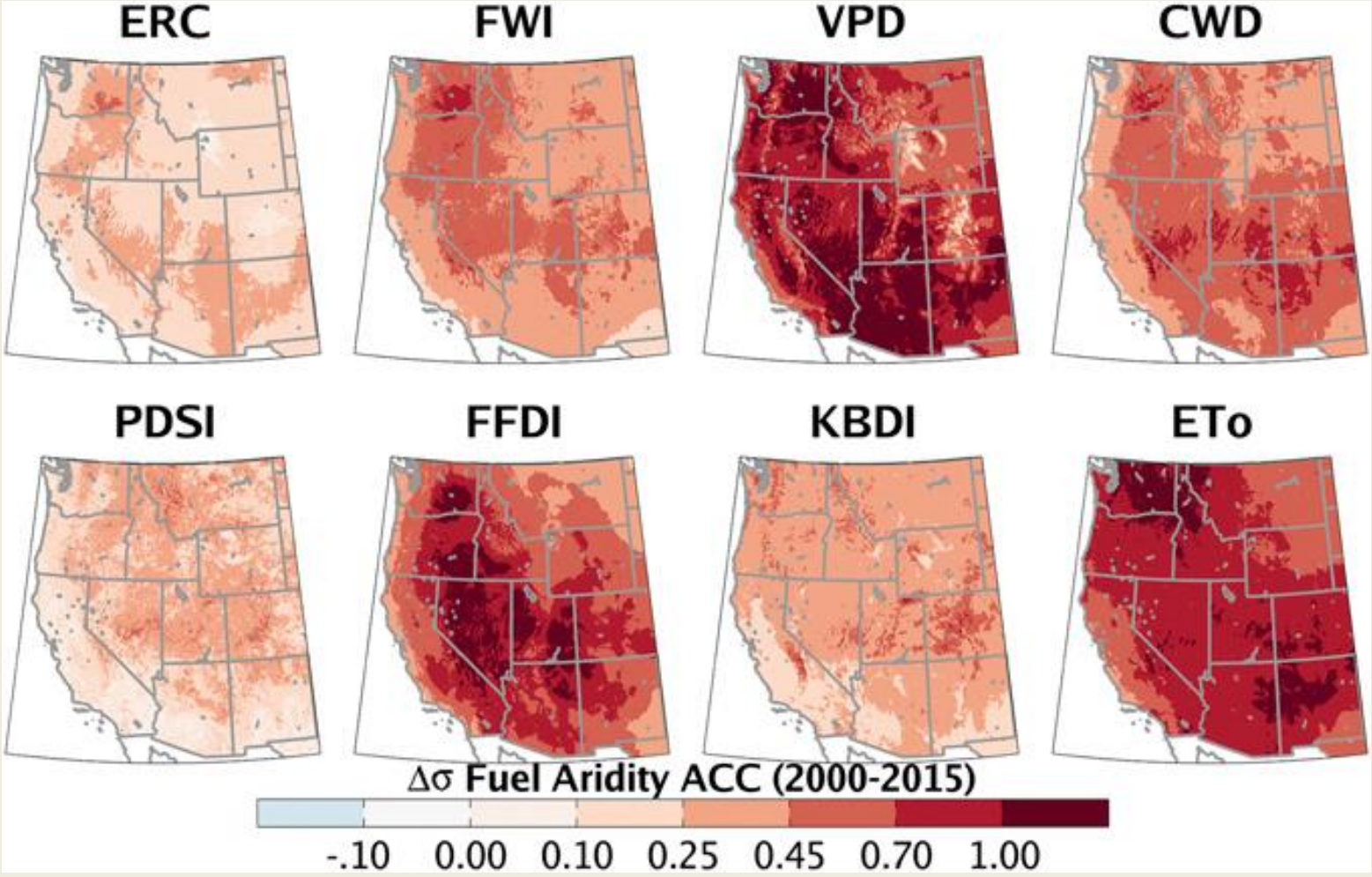
The Energy Release Component (ERC) is an NFDRS (National Fire Danger Rating System) index related to how hot a fire could burn. It is directly related to the 24-hour, potential worst case, total available energy (BTUs) per unit area (in square feet) within the flaming front at the head of a fire.

Nevada fuels 9/23/18 status

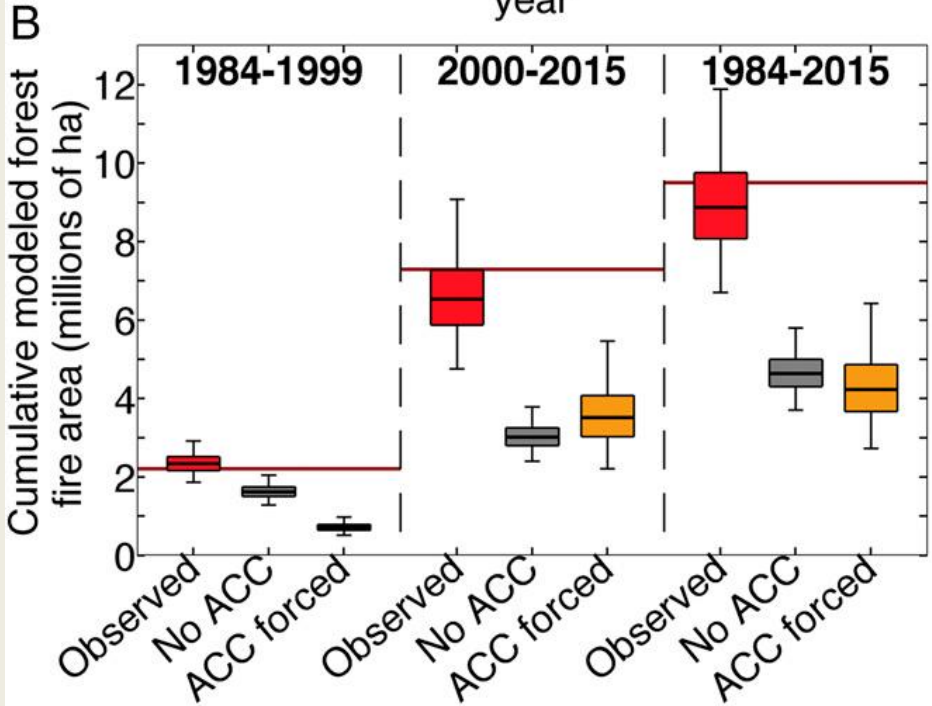
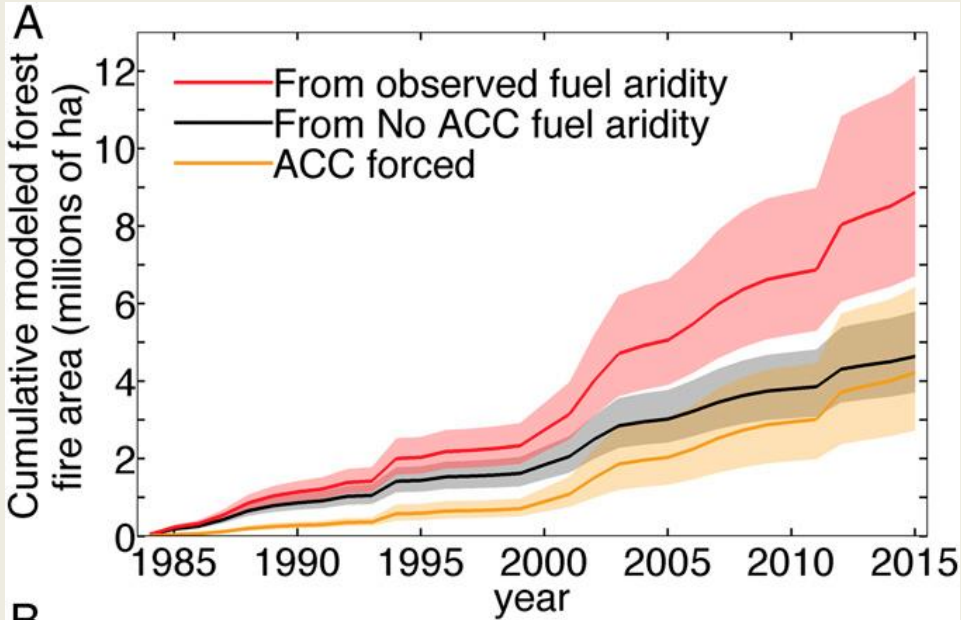
Live fuel moisture



Climate-fire trend

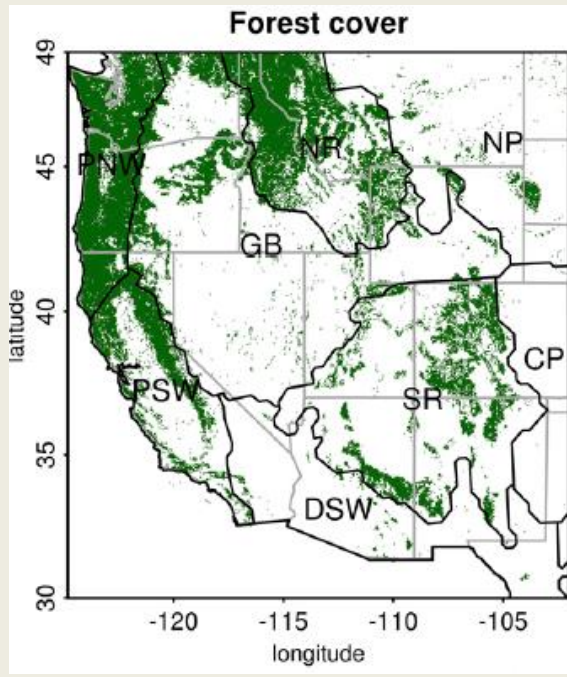
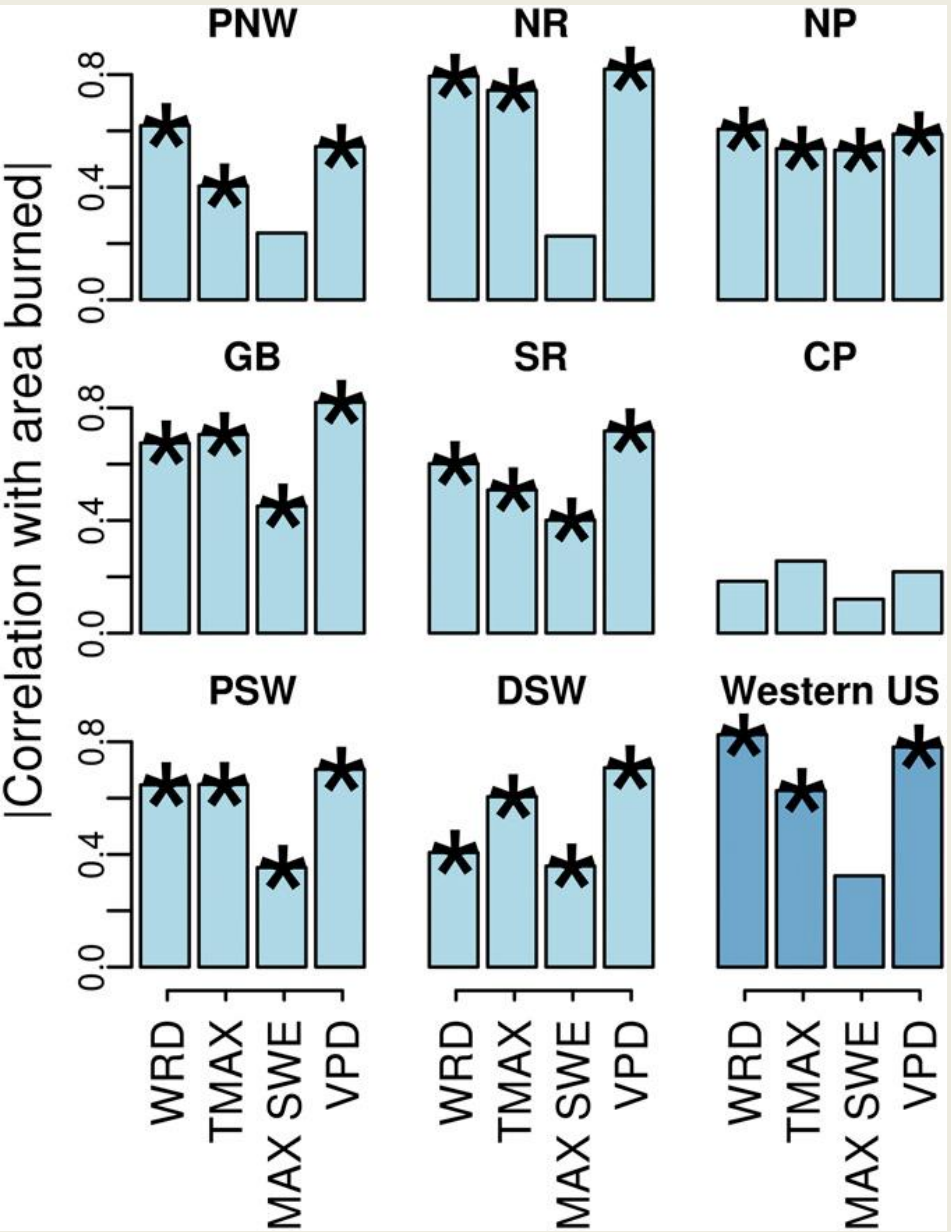


Climate-fire trend



Source: Abatzoglou and Williams, PNAS 2016

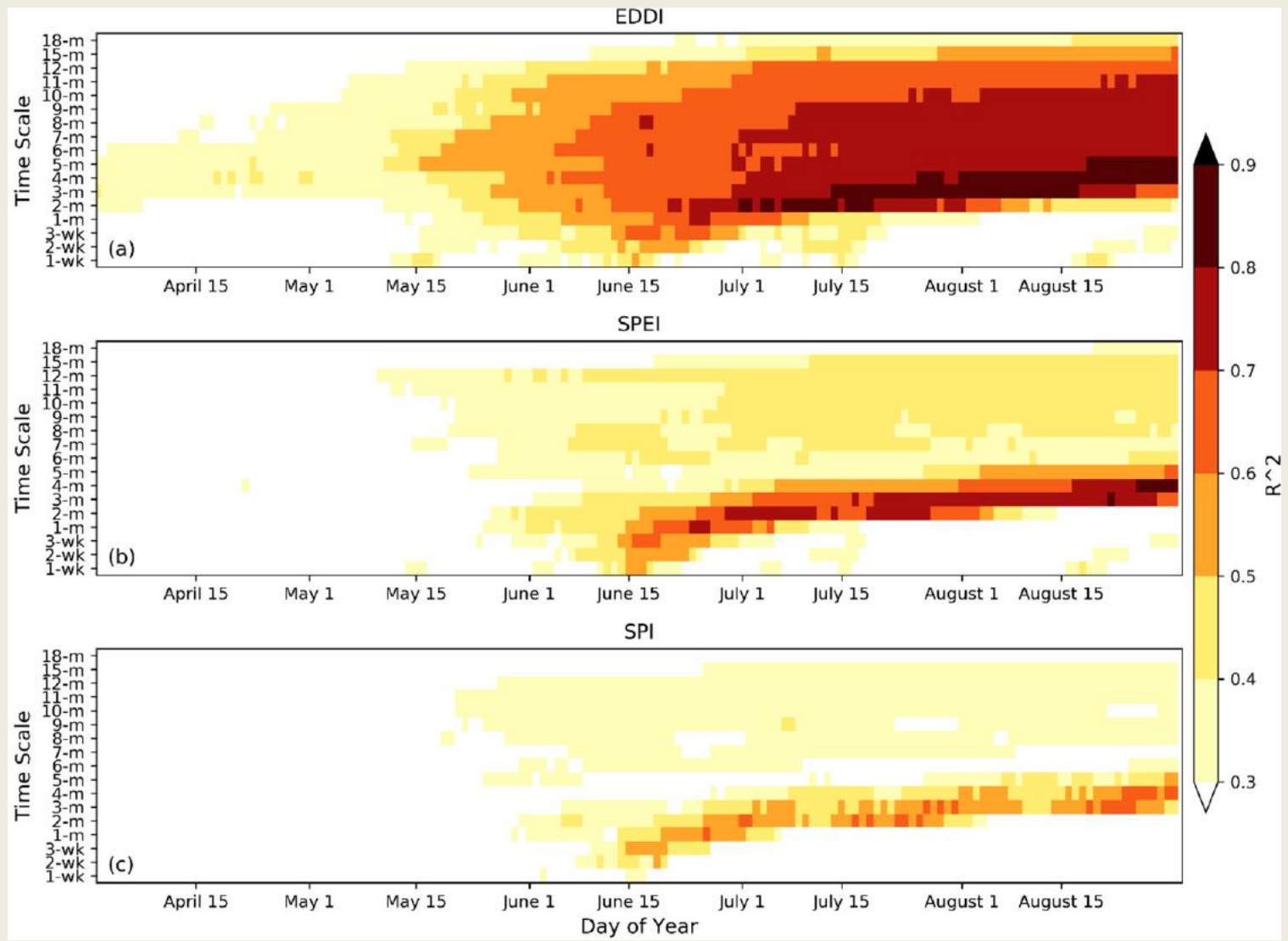
Climate-fire trend



1984-2015

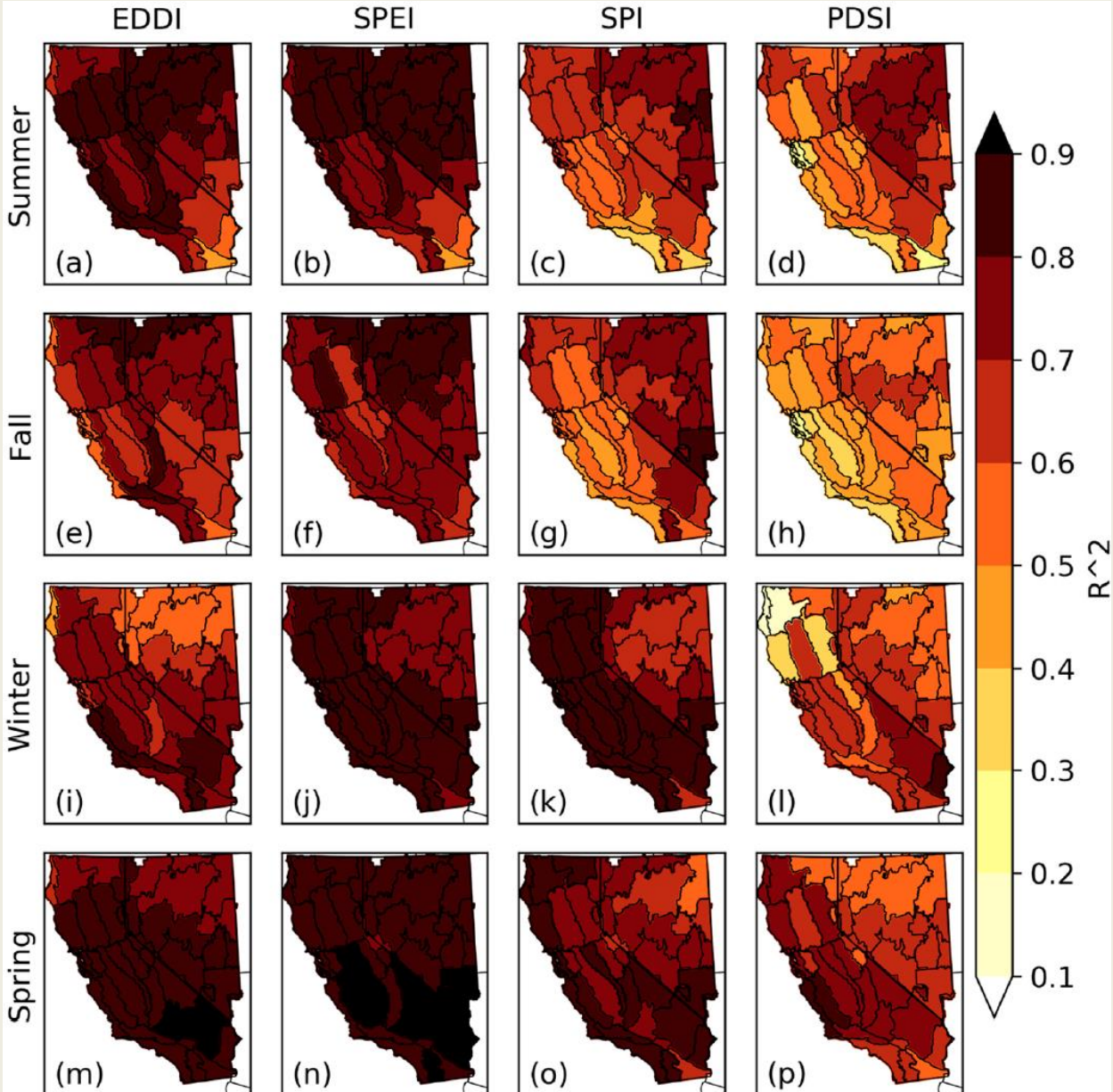
Source: Holden et al., PNAS 2018

Drought and fire



1000-hour dead fuel moisture

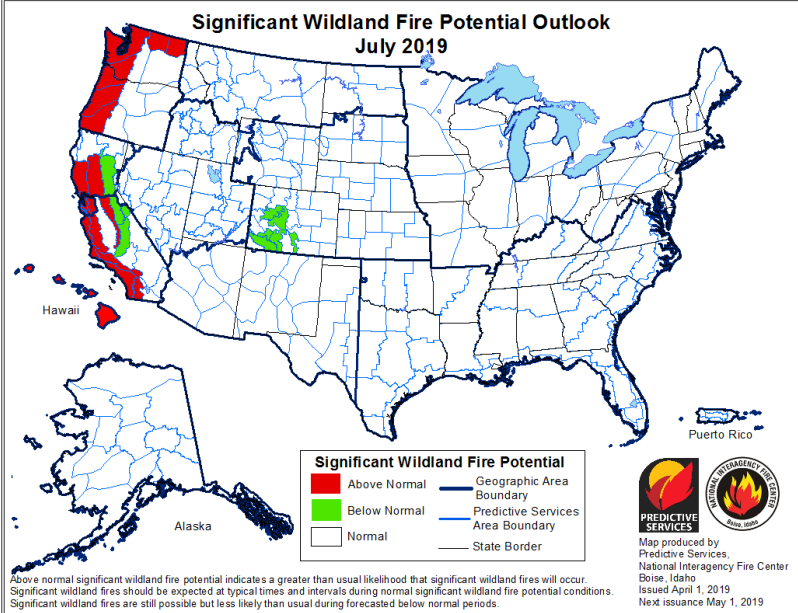
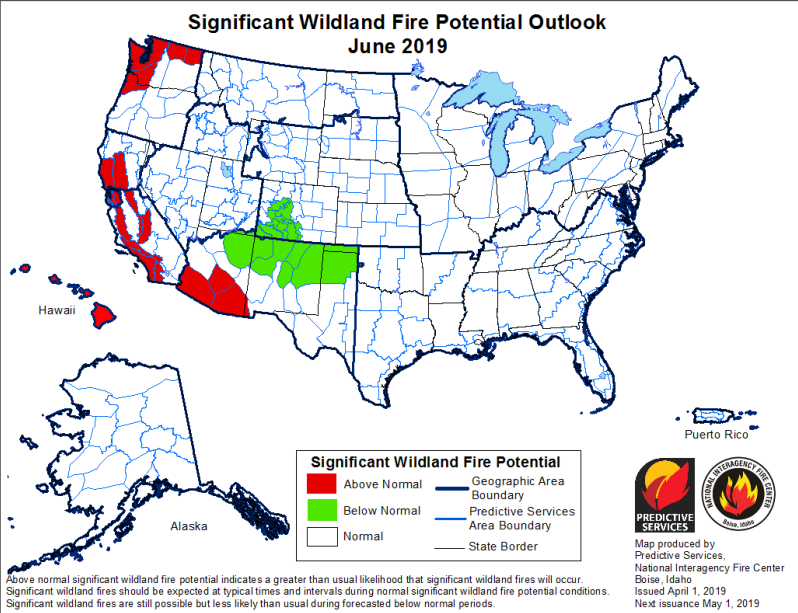
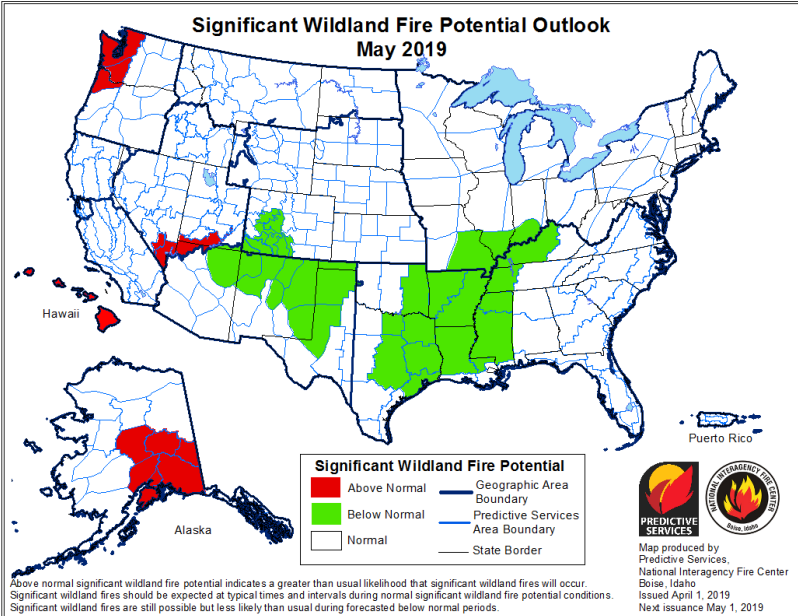
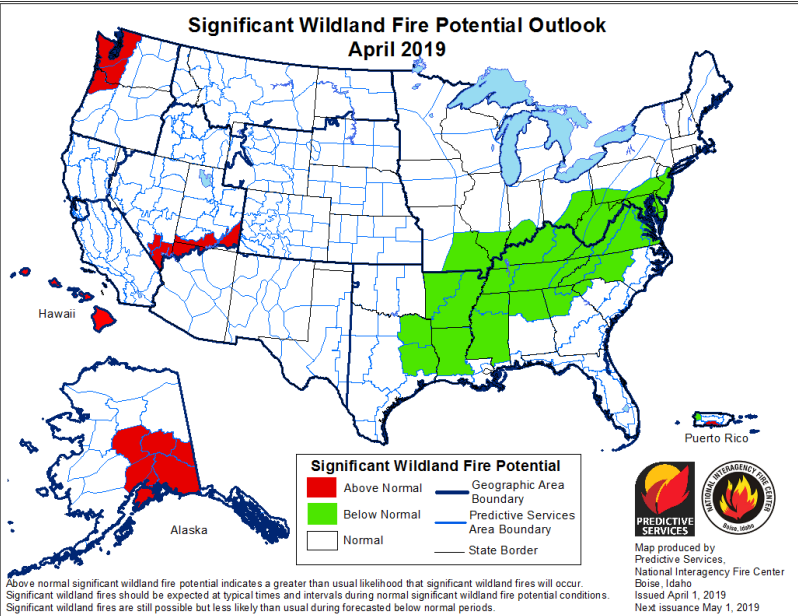
Drought and fire



1000-hour dead fuel moisture

Source: McEvoy et al. 2019

Seasonal fire outlooks

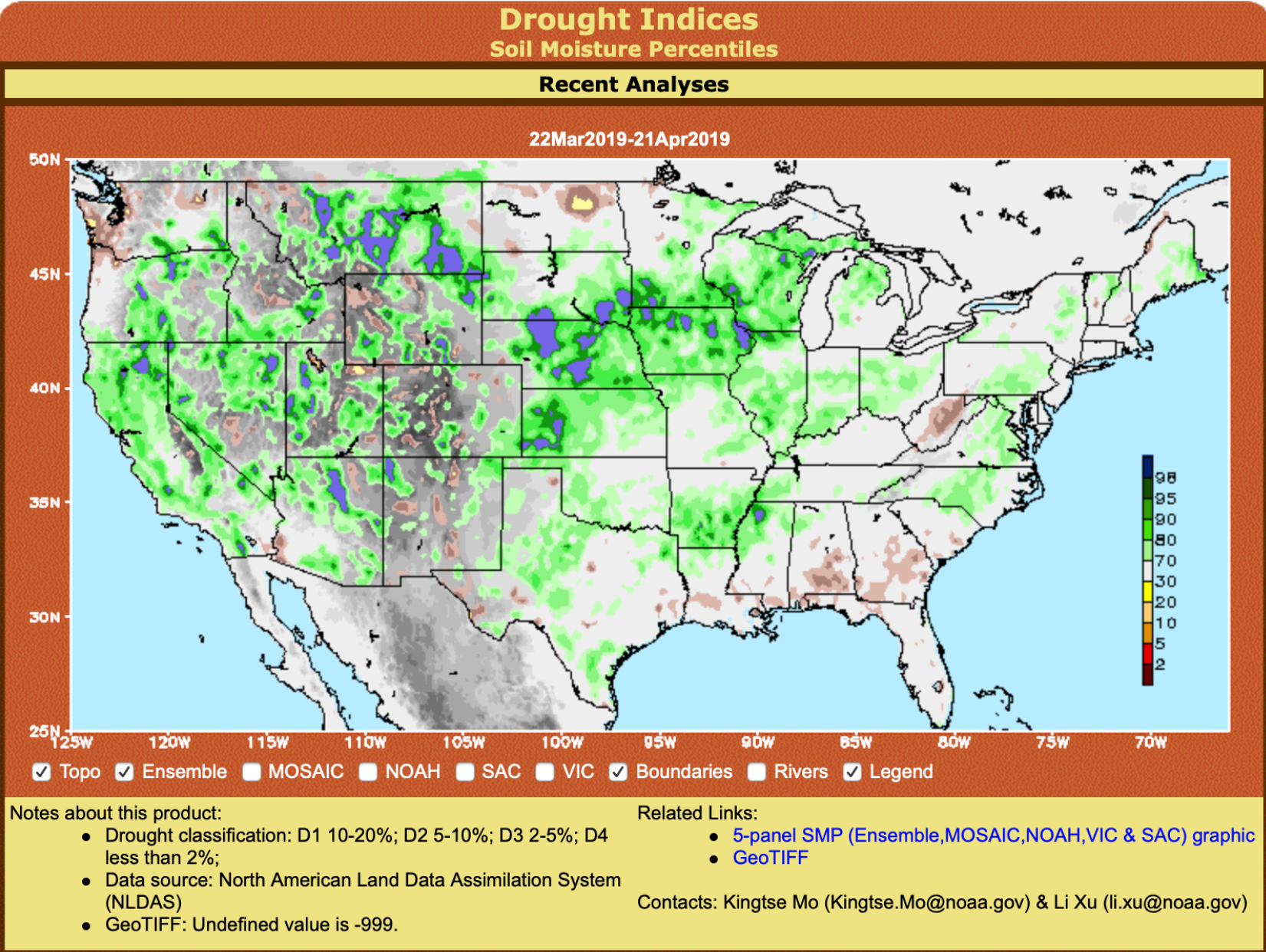


Predictive Services

Soil moisture proxy for:

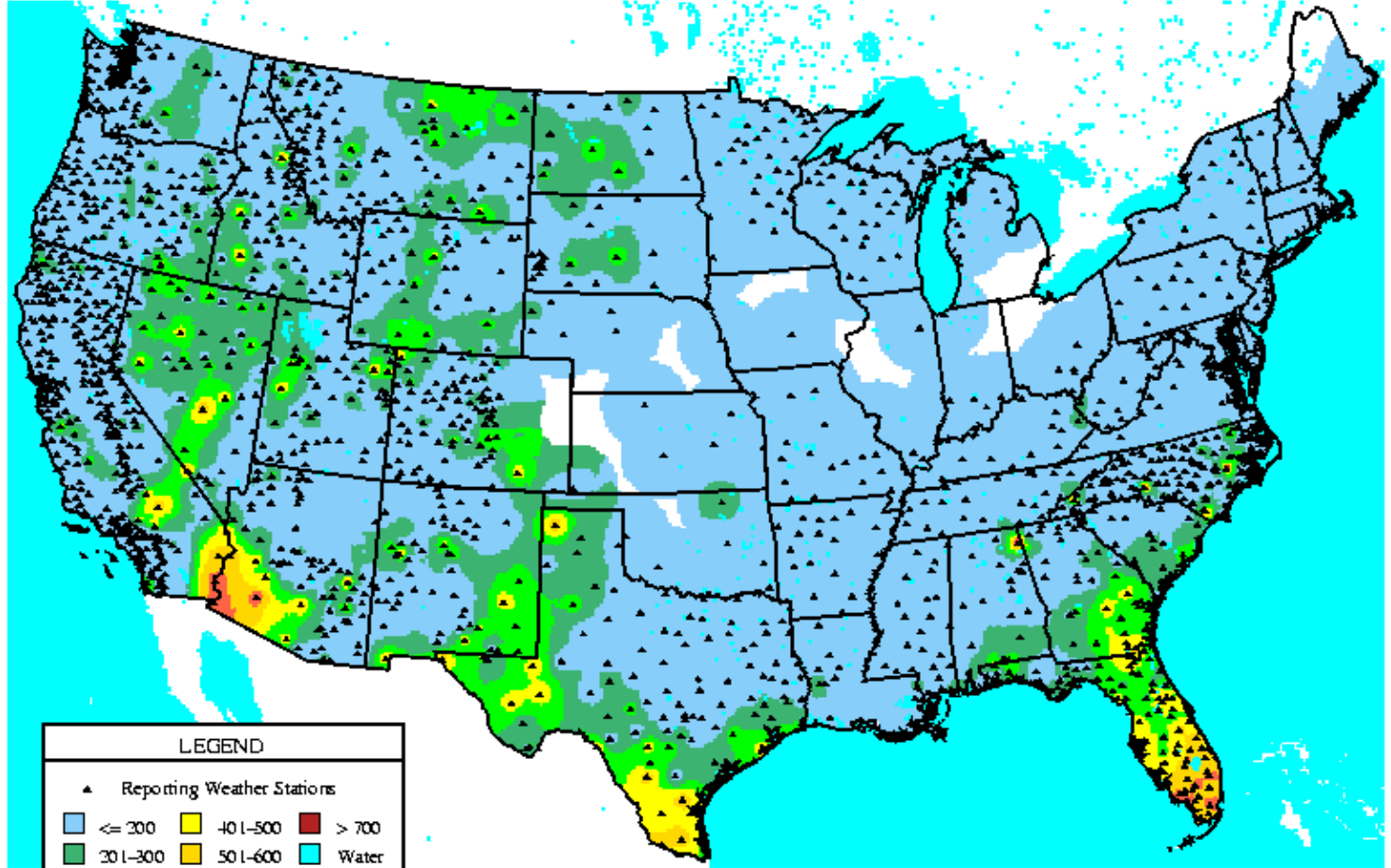
- Fine fuel growth
- Fine fuel curing and accelerated drying
- Heavy fuel vegetation stress and drying

Seasonal fire outlooks



Seasonal fire outlooks

Keetch-Byram Drought Index: 25-Apr-19



LEGEND		
▲	Reporting Weather Stations	
Light Blue	401-500	> 700
Green	501-600	Water
Yellow	601-700	
Dark Green		
Orange		
Red		

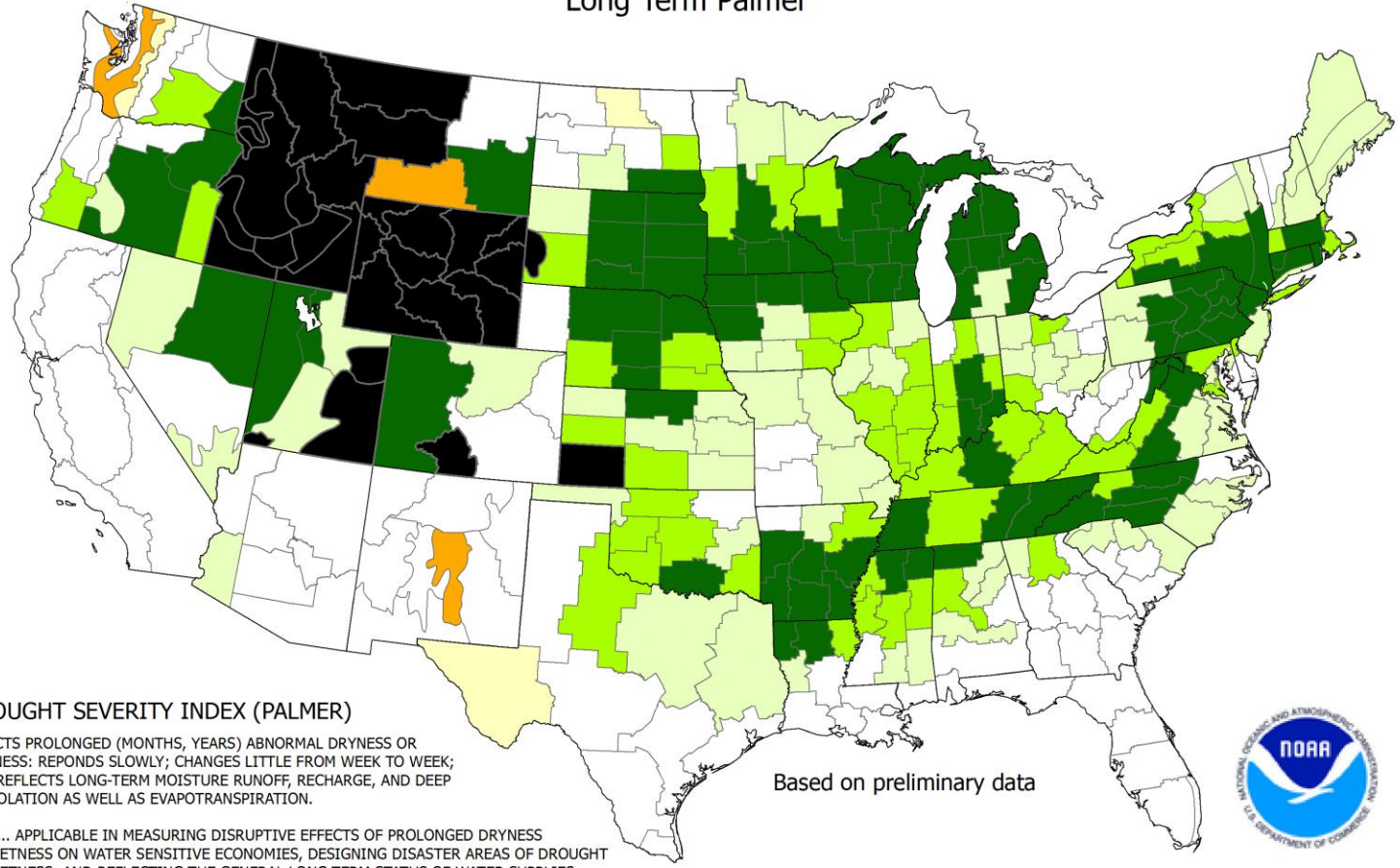
(Inv. Dist.² Interp.)

WFAS-MAPS Graphics FIRE BEHAVIOR RESEARCH MISSOULA, MT



Seasonal fire outlooks

Drought Severity Index by Division
 Weekly Value for Period Ending Apr 20, 2019
 Long Term Palmer



DROUGHT SEVERITY INDEX (PALMER)

DEPICTS PROLONGED (MONTHS, YEARS) ABNORMAL DRYNESS OR WETNESS; REponds SLOWLY; CHANGES LITTLE FROM WEEK TO WEEK; AND REFLECTS LONG-TERM MOISTURE RUNOFF, RECHARGE, AND DEEP PERCOLATION AS WELL AS EVAPOTRANSPIRATION.

USES... APPLICABLE IN MEASURING DISRUPTIVE EFFECTS OF PROLONGED DRYNESS OR WETNESS ON WATER SENSITIVE ECONOMIES, DESIGNING DISASTER AREAS OF DROUGHT OR WETNESS; AND REFLECTING THE GENERAL LONG-TERM STATUS OF WATER SUPPLIES IN AQUIFERS, RESERVOIRS AND STREAMS.

LIMITATIONS... IS NOT GENERALLY INDICATIVE OFFSHORT-TERM (FEW WEEKS) STATUS OF DROUGHT OR WETNESS SUCH AS FREQUENTLY AFFECTS CROPS AND FIELD OPERATIONS (THIS IS INDICATED BY THE CROP MOISTURE INDEX).

Based on preliminary data

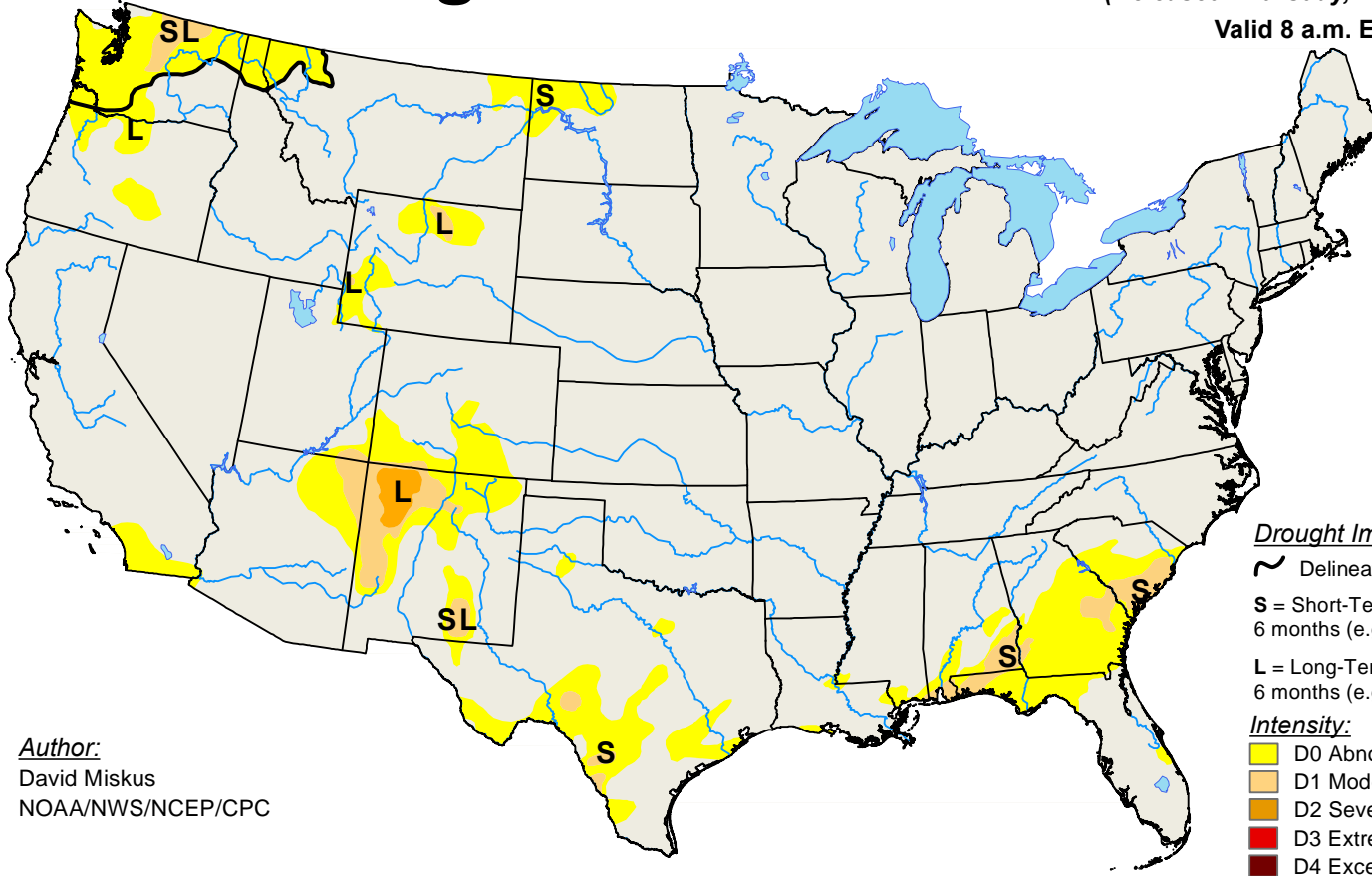


- 4.0 or less (Extreme Drought)
- 3.0 to -3.9 (Severe Drought)
- 2.0 to -2.9 (Moderate Drought)
- 1.9 to +1.9 (Near Normal)
- +2.0 to +2.9 (Unusual Moist Spell)
- +3.0 to +3.9 (Very Moist Spell)
- +4.0 and above (Extremely Moist)
- Missing/Incomplete

Seasonal fire outlooks

U.S. Drought Monitor

April 23, 2019
 (Released Thursday, Apr. 25, 2019)
 Valid 8 a.m. EDT

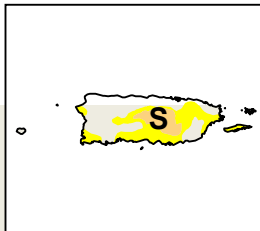
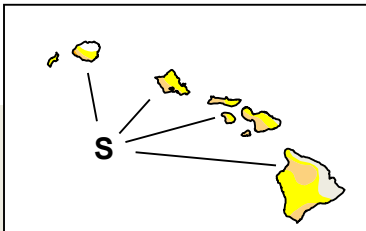
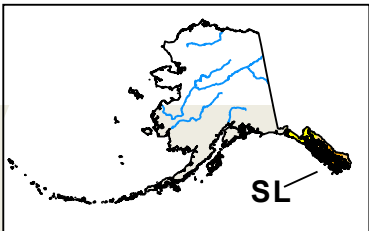


Author:
 David Miskus
 NOAA/NWS/NCEP/CPC

Drought Impact Types:
 ~ Delineates dominant impacts
 S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
 L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:
 Yellow = D0 Abnormally Dry
 Light Orange = D1 Moderate Drought
 Orange = D2 Severe Drought
 Red = D3 Extreme Drought
 Dark Red = D4 Exceptional Drought

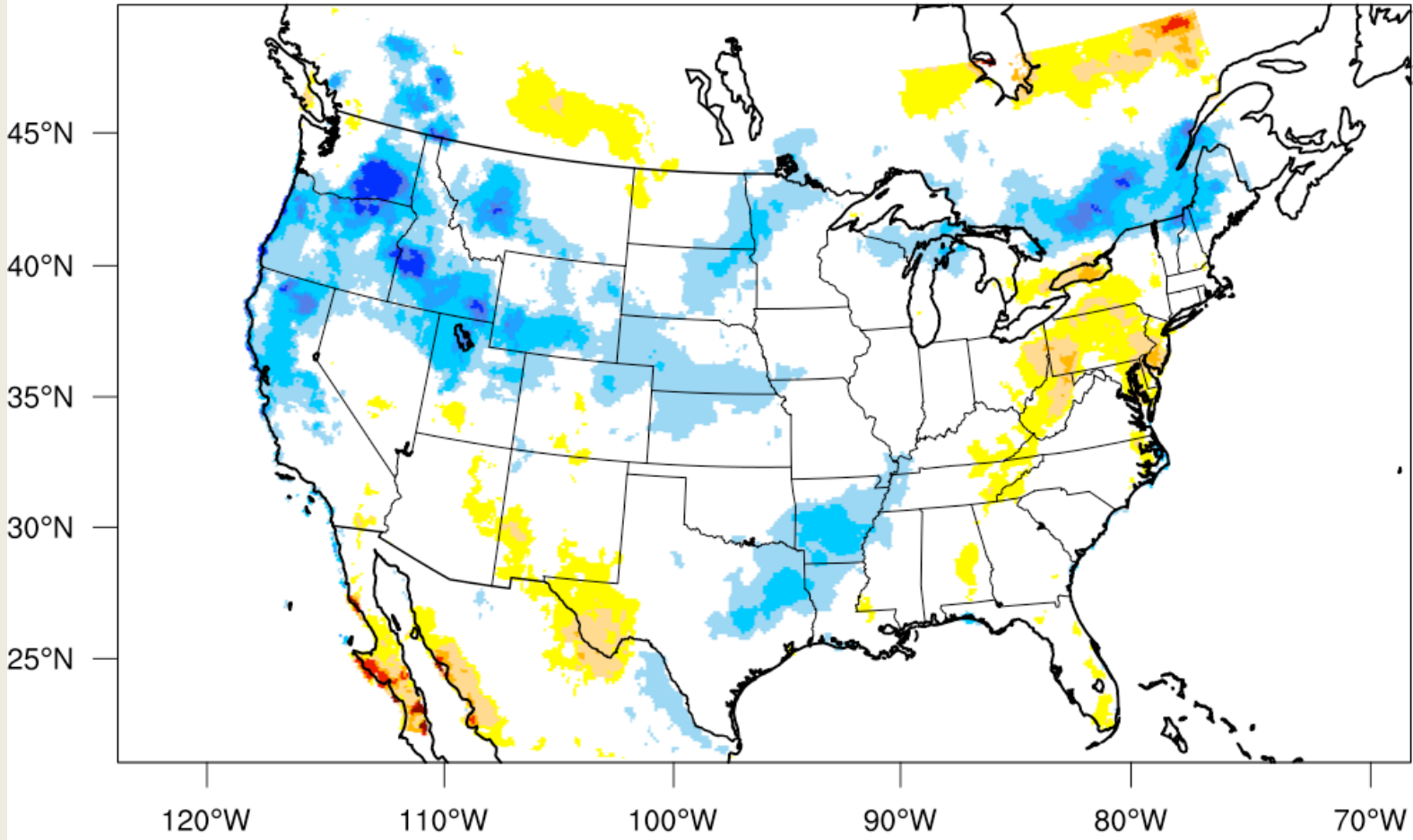
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.



<http://droughtmonitor.unl.edu/>

Seasonal fire outlooks

1-month EDDI categories for April 20, 2019



Drought categories

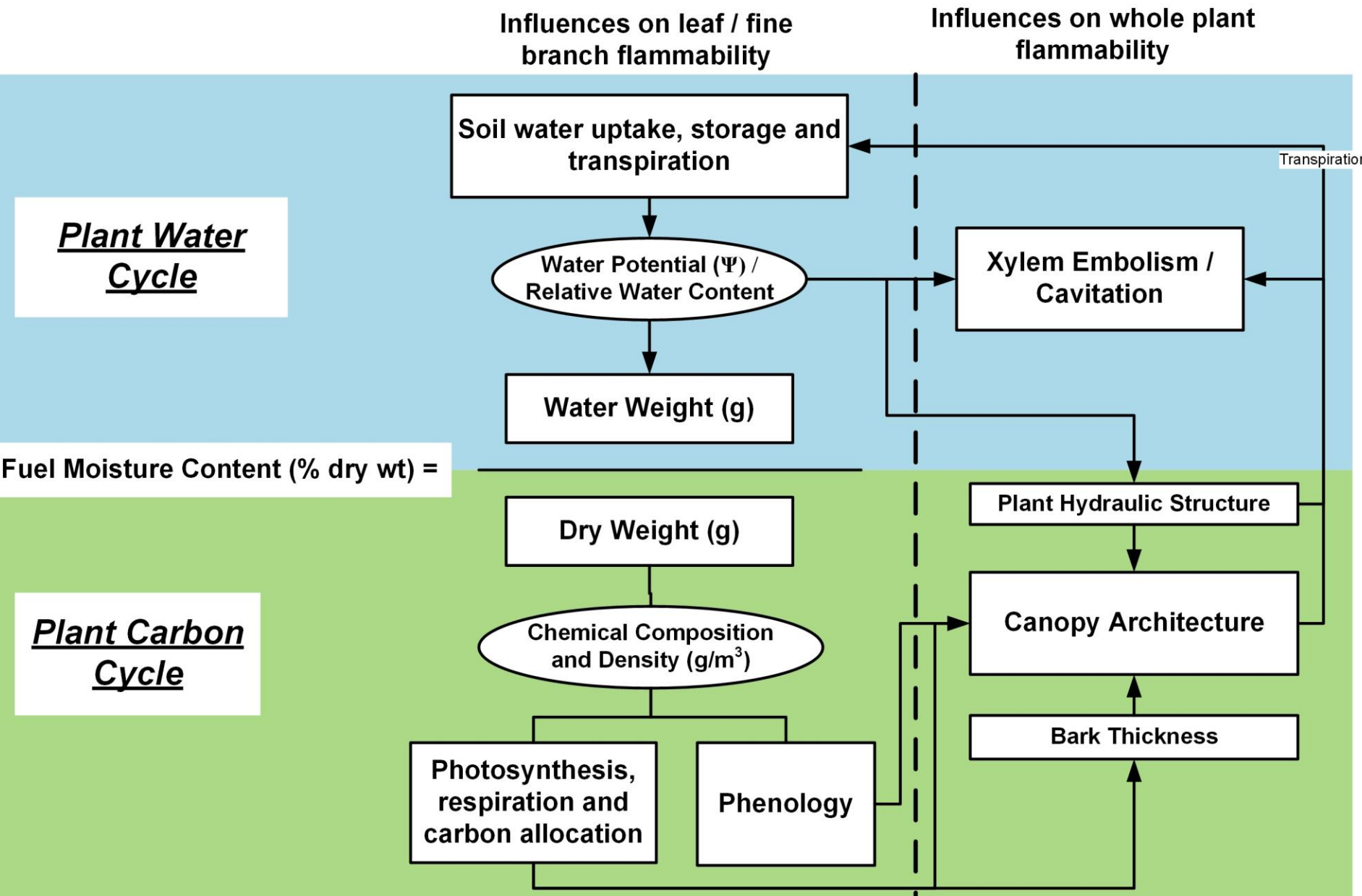
Wetness categories



100% 98% 95% 90% 80% 70% 30% 20% 10% 5% 2% 0%

(EDDI-percentile category breaks: 100% = driest; 0% = wettest)

Water relation to fuel flammability



Source: Jolly and Johnson, Fire 2018

Water relation to fuel flammability

Fuel Moisture Content (FMC) = Water Weight/Dry Weight

Dead fuels: dry weight is relatively constant, but does change slowly as a function of decomposition

Live fuels: Both the water weight and dry weight changes diurnally, seasonally, and inter-annually

Both quantities of FMC can contribute to flammability and both vary independently over space and time

Drought preconditions fuel flammability

Drought and fire

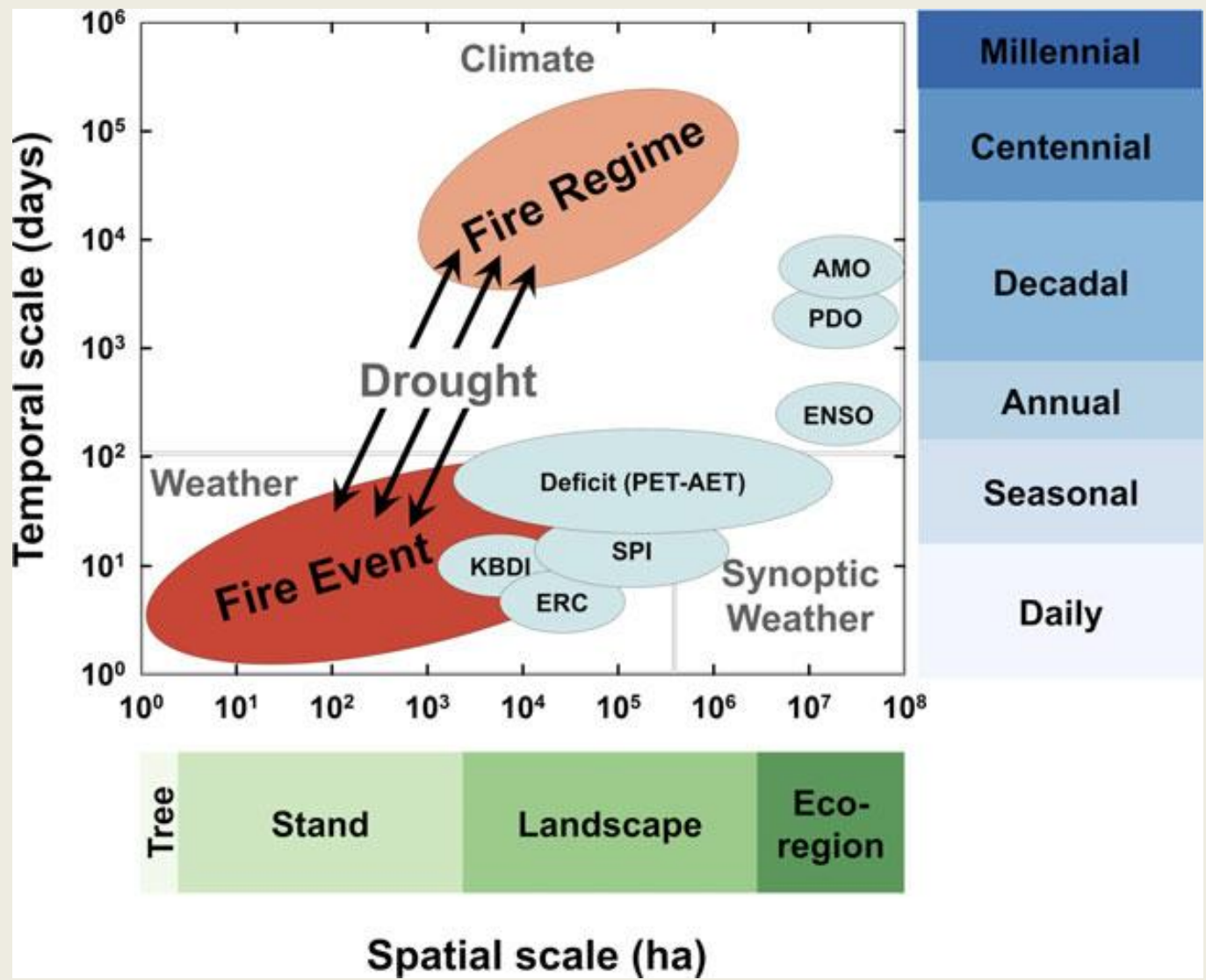


Table 1 Temporal scale and mechanisms of fire-related drought

Temporal scale	Drought indicator/variable	Physical mechanism	Fire response mechanism(s)
Days	Synoptic meteorology	Atmospheric pressure: blocking ridges	Increased PET, VPD: decreased foliar and dead fuel moisture, increased fuel flammability
		Atmospheric pressure: ridge-trough interactions	Lightning, ignition potential; Foehn winds
	Flash drought	Low precipitation	Decreased soil moisture: decreased foliar and dead fuel moisture, increased fuel flammability
		High temperature	Increased PET, VPD: decreased foliar and dead fuel moisture, increased fuel flammability
	Fire weather	High surface winds	Increased PET: decreased foliar and dead fuel moisture, increased fuel flammability
		Low relative humidity	Increased fire spread
			Increased PET, VPD: decreased foliar and dead fuel moisture, increased fuel flammability
Meteorological drought	Low precipitation	Decreased soil moisture: decreased foliar and dead fuel moisture, Increased fuel flammability	
Hydrological drought	Low runoff	Correlation with decreased soil moisture: decreased foliar and dead fuel moisture, increased fuel flammability	
Seasons	Snow drought	Low winter precipitation as snow	Longer snow-free season, decreased soil moisture: decreased foliar and dead fuel moisture, increased fuel flammability
		Early snow melt	Longer snow-free season, decreased soil moisture: decreased foliar and dead fuel moisture, increased fuel flammability
	Global-change-type drought	High temperature for given low precipitation anomaly	Decreased soil moisture: decreased foliar and dead fuel moisture, increased fuel flammability Increased PET, VPD: decreased foliar and dead fuel moisture, increased fuel flammability
Years	Ecological drought	Water availability deficit	Drives ecosystems beyond thresholds of vulnerability, impacts ecosystem services, and triggers feedbacks in natural and/or human systems
Decades to centuries	Persistent or frequent seasonal and interannual droughts	Atmosphere/ocean interactions: ENSO, PDO, etc.	Increased (drier) or decreased (wetter) frequency of above events; long term changes in fuel availability and distribution

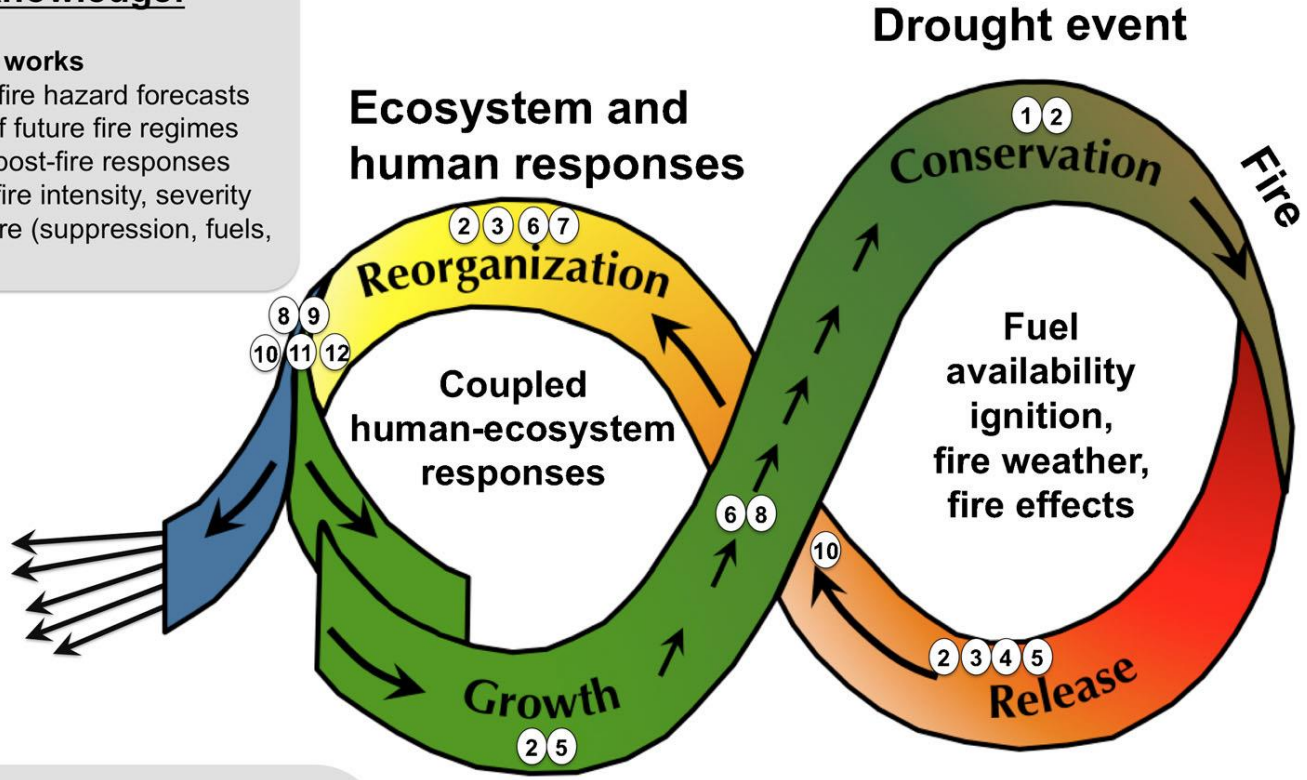
For consideration

Systems Knowledge:

How it works

1. Better drought and fire hazard forecasts
2. Better projections of future fire regimes
3. Drought effects on post-fire responses
4. Drought effects on fire intensity, severity
5. Human effects on fire (suppression, fuels, ignitions)

Future desired trajectories



Target Knowledge:

How it could be different

6. Ways to strategically manage fuels
7. Ways to respond to novel fire regimes and risks
8. Ways to manage and use fire to achieve desired conditions
9. Better scenarios of coupled human-natural systems

Transformation Knowledge:

How the system developed and how it can change

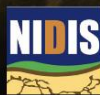
10. Coping with, adapting to, or managing fire impacts
11. How can the system be changed with existing or new tools?
12. How are uncontrolled components planned for?



**THE NATIONAL INTEGRATED
DROUGHT INFORMATION SYSTEM
DROUGHT AND WILDLAND FIRE
NEXUS (NDAWN) STRATEGIC PLAN:
2018-2022**



*Improving the utilization
of drought information in
wildland fire management
for ecological health, public
health, and firefighter safety*



SEPTEMBER 2018

Greetings From Reno!

Fire near Tim's house

