The SE US Drought of 2016 and Public Health Impacts of Wildfire Smoke

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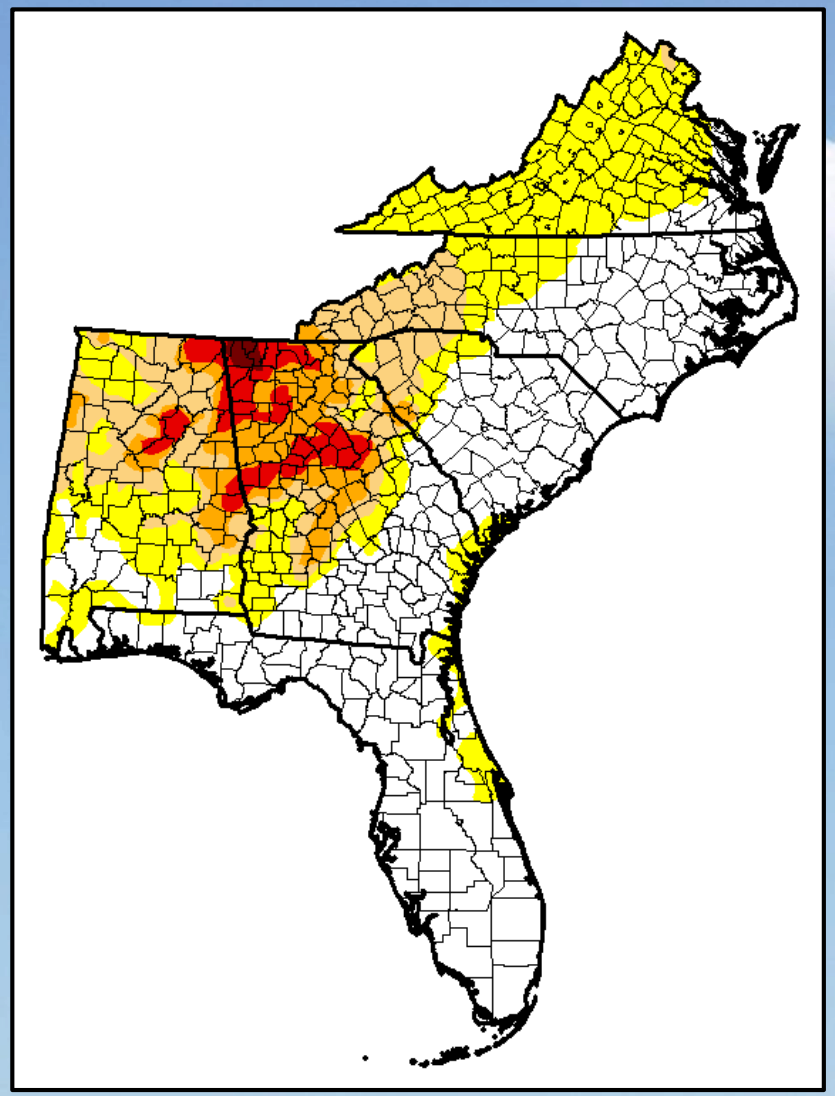
Outline

- Evolution of Drought
- Causes of Drought
- Wildfire Background
- Dispersion of Wildfire Smoke
- Public Health Impacts of the Wildfire Smoke
- Gatlinburg TN Wildfire & Vulnerability

Drought evolution: U.S. Drought Monitor

Late September 2016



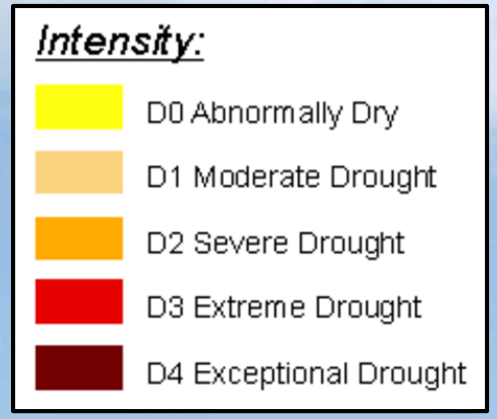
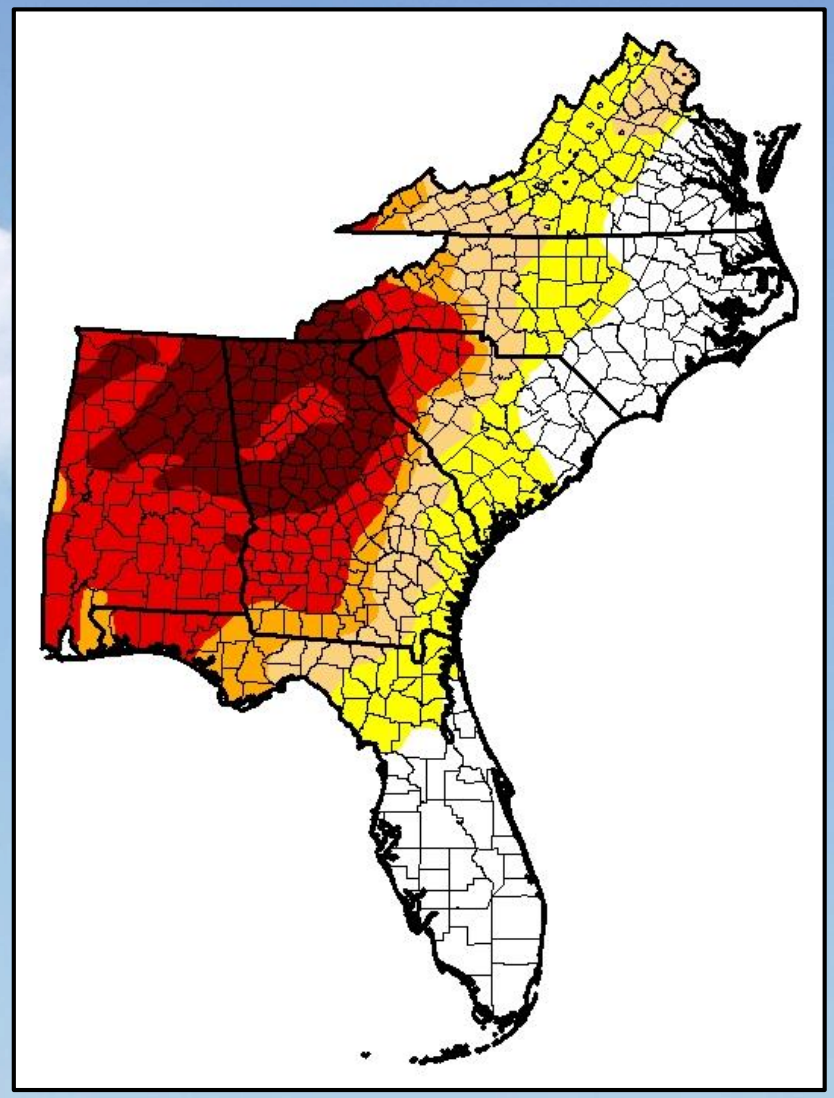


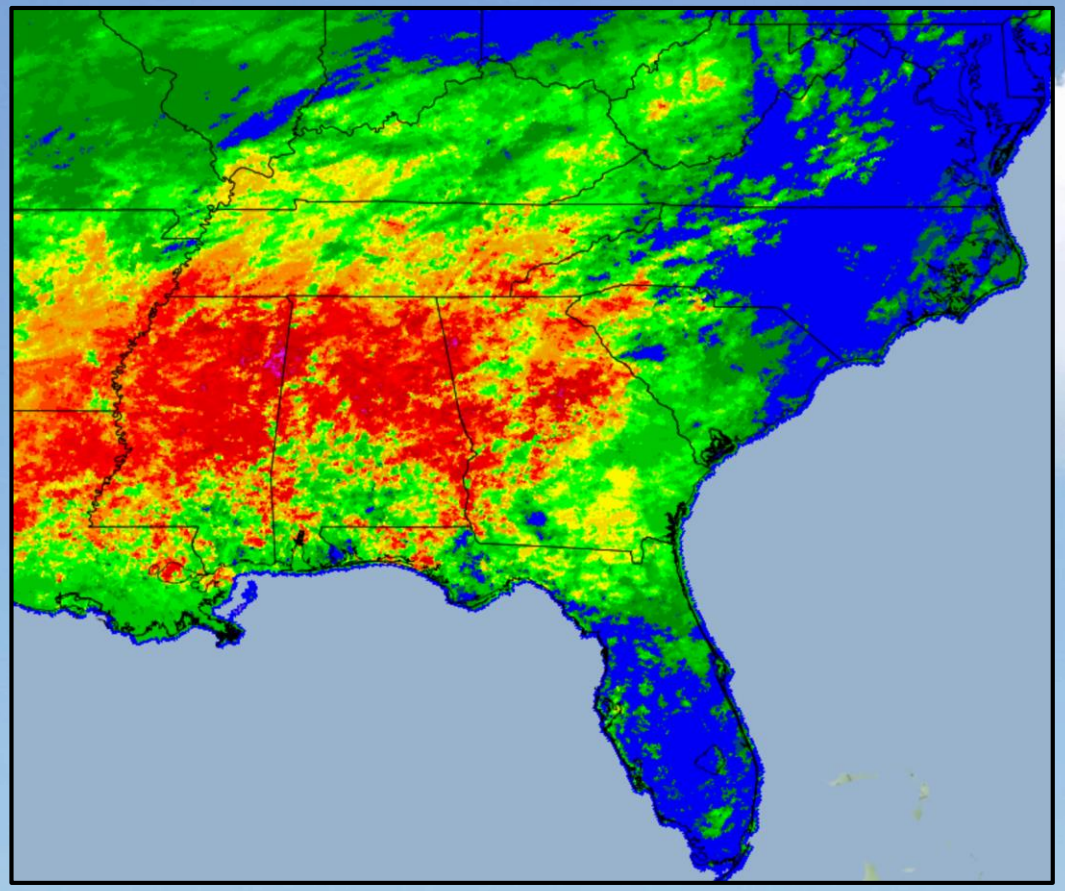
Image source: National Drought Mitigation Center

Late November 2016

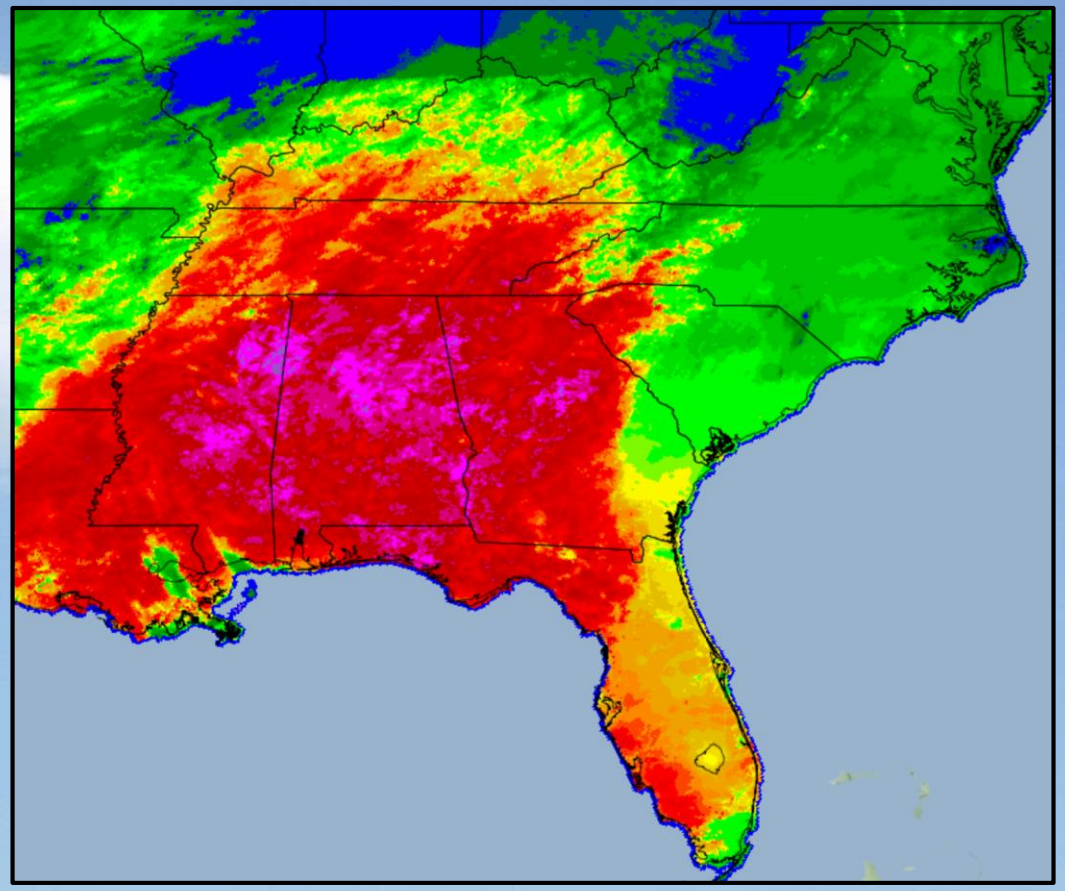


Drought evolution: Keetch-Byram Drought Index

Late September 2016



Late November 2016



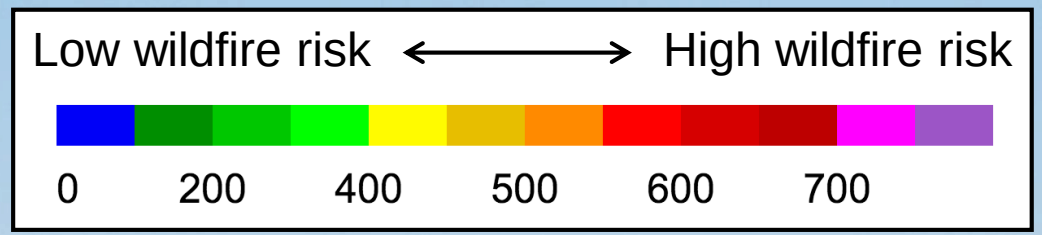
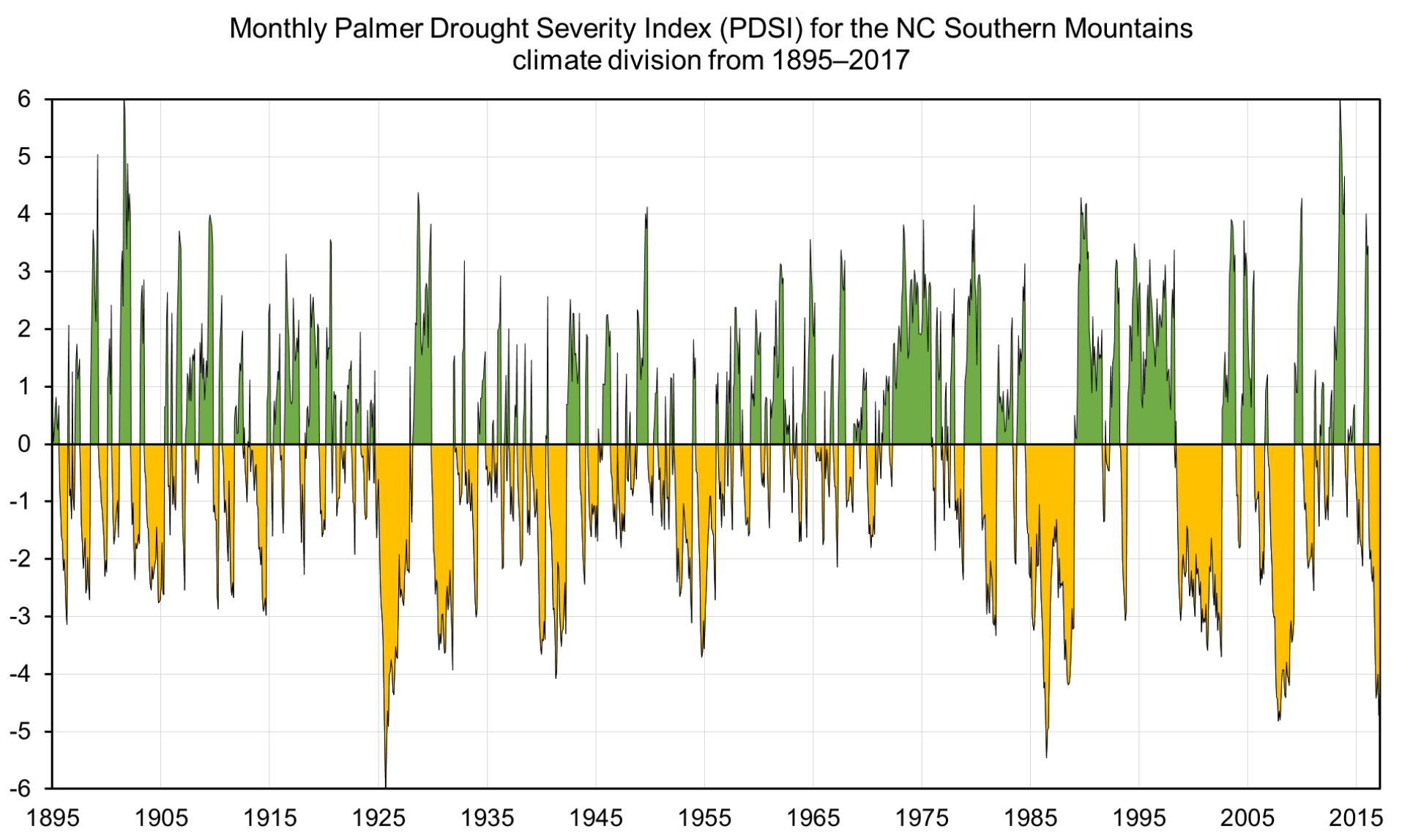


Image source: State Climate Office of North Carolina

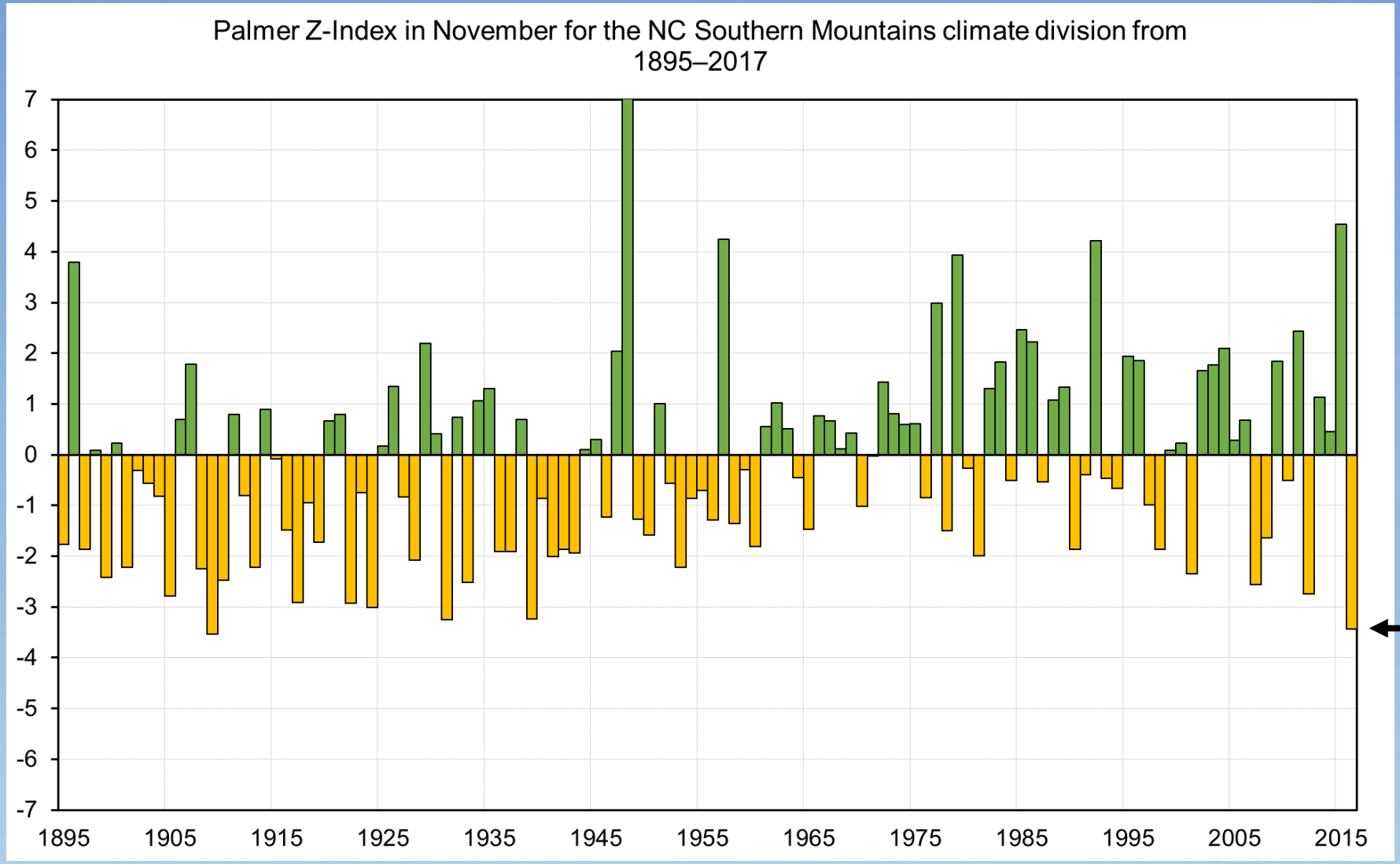
Drought evolution: Palmer Drought Severity Index



4th driest in 120 year period

Data source: NOAA / NCEI

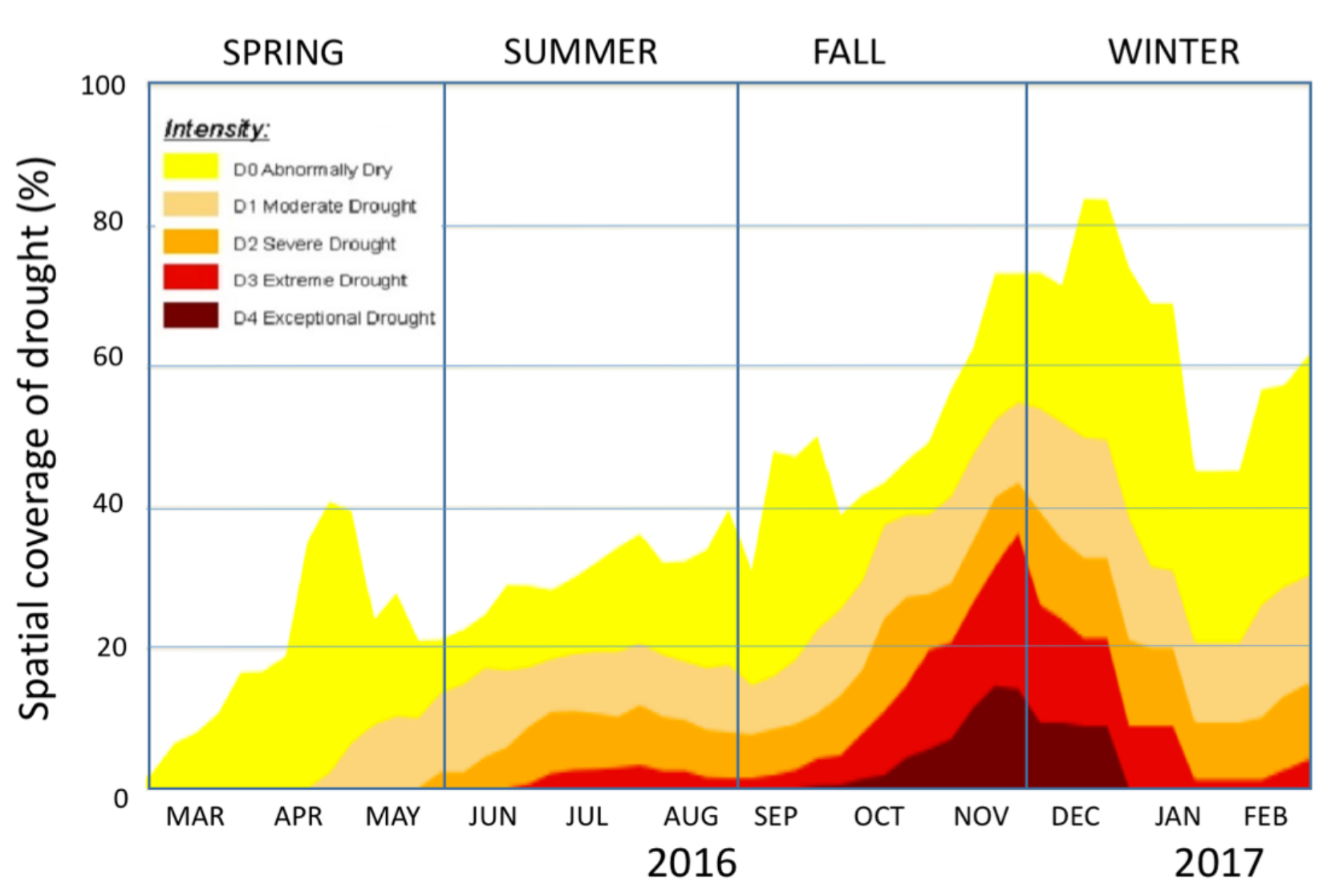
Drought evolution: Palmer Z-Index in November



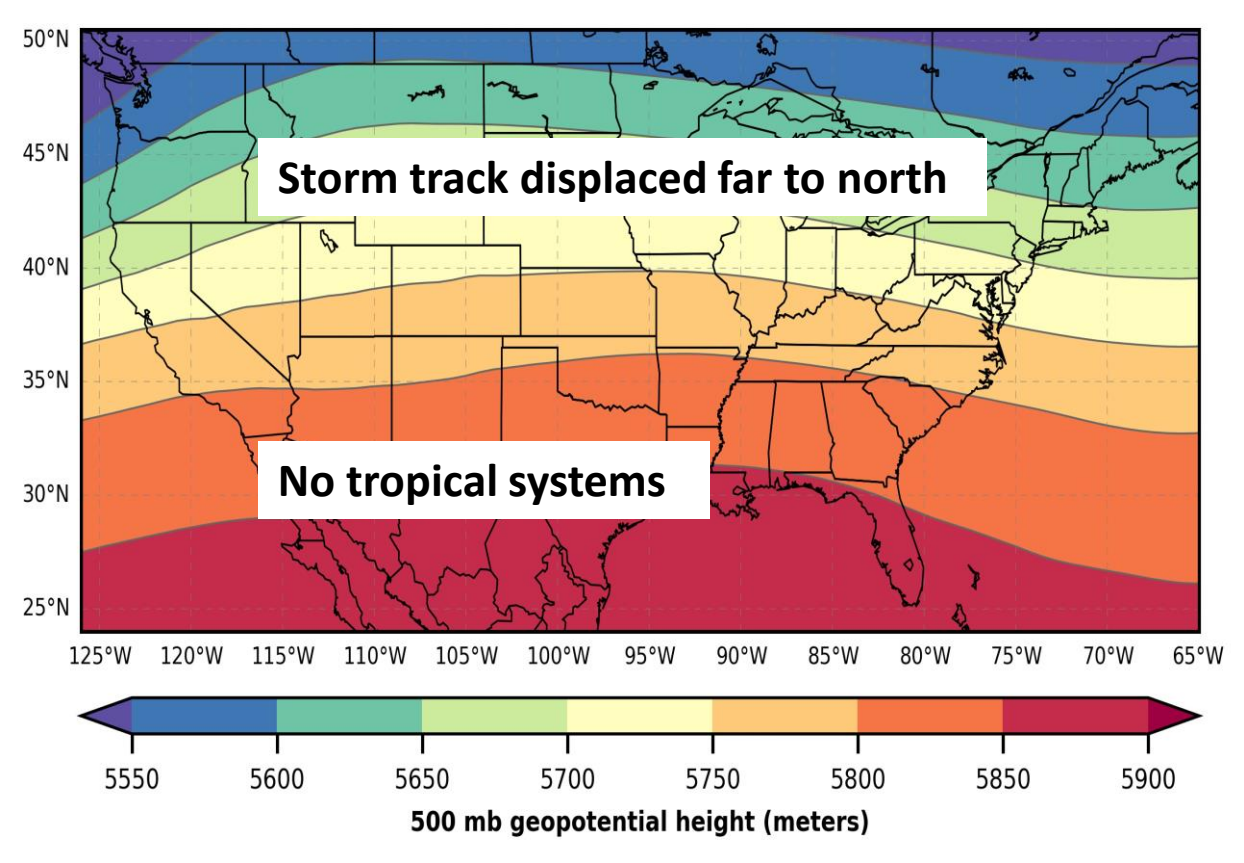
Tied for 2nd driest in 120 year period

Data source: NOAA / NCEI

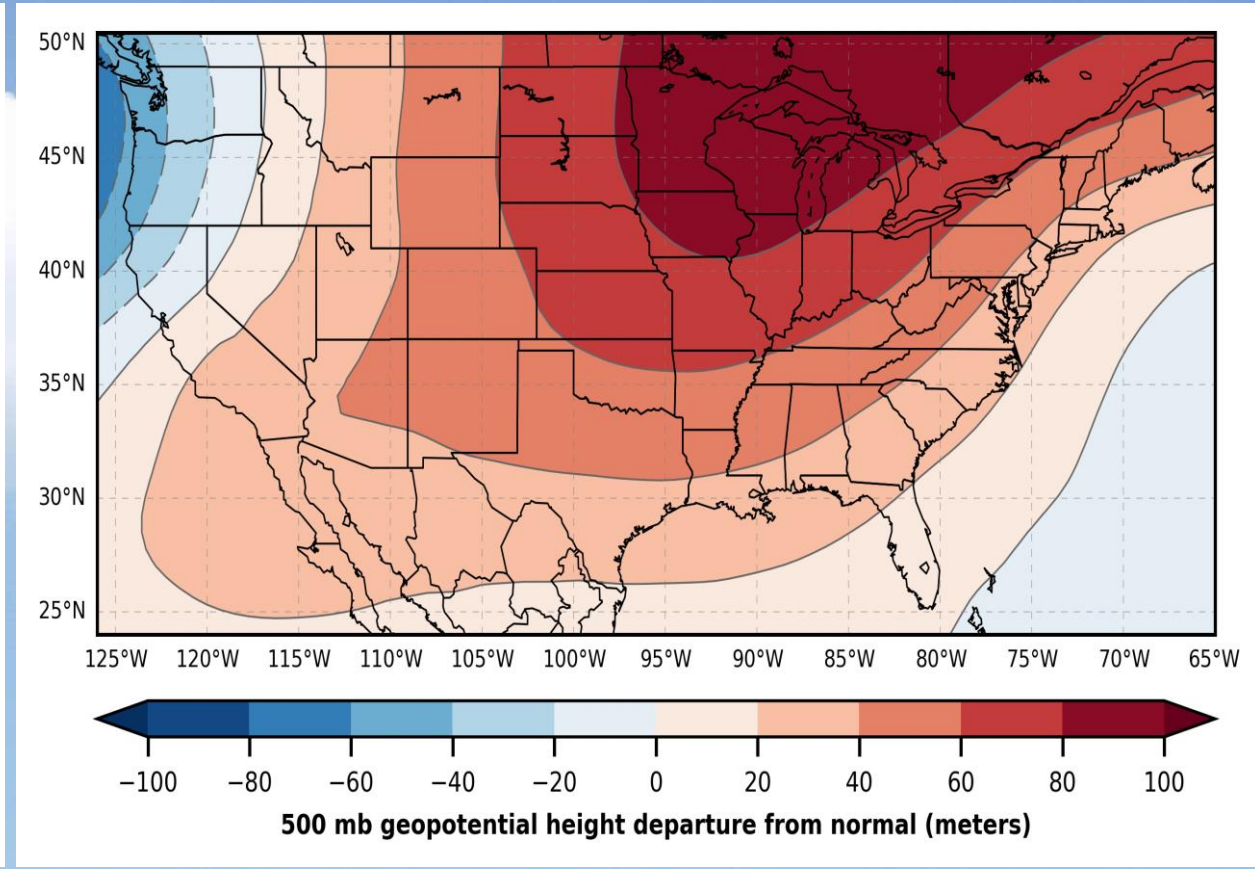
Drought evolution: Spatial coverage



Causes of Drought: Record upper-level ridging



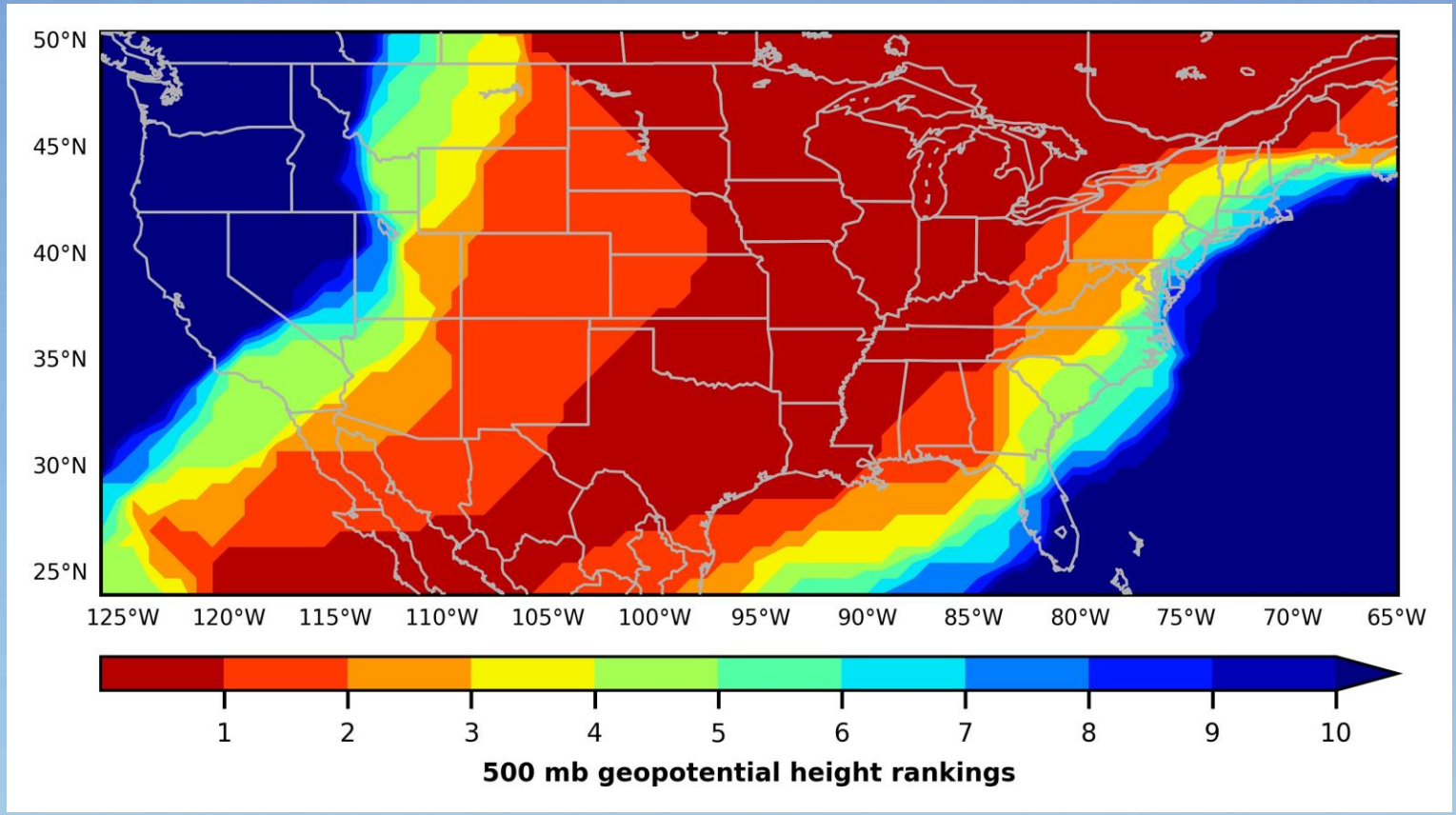
Composite mean



Departure from normal

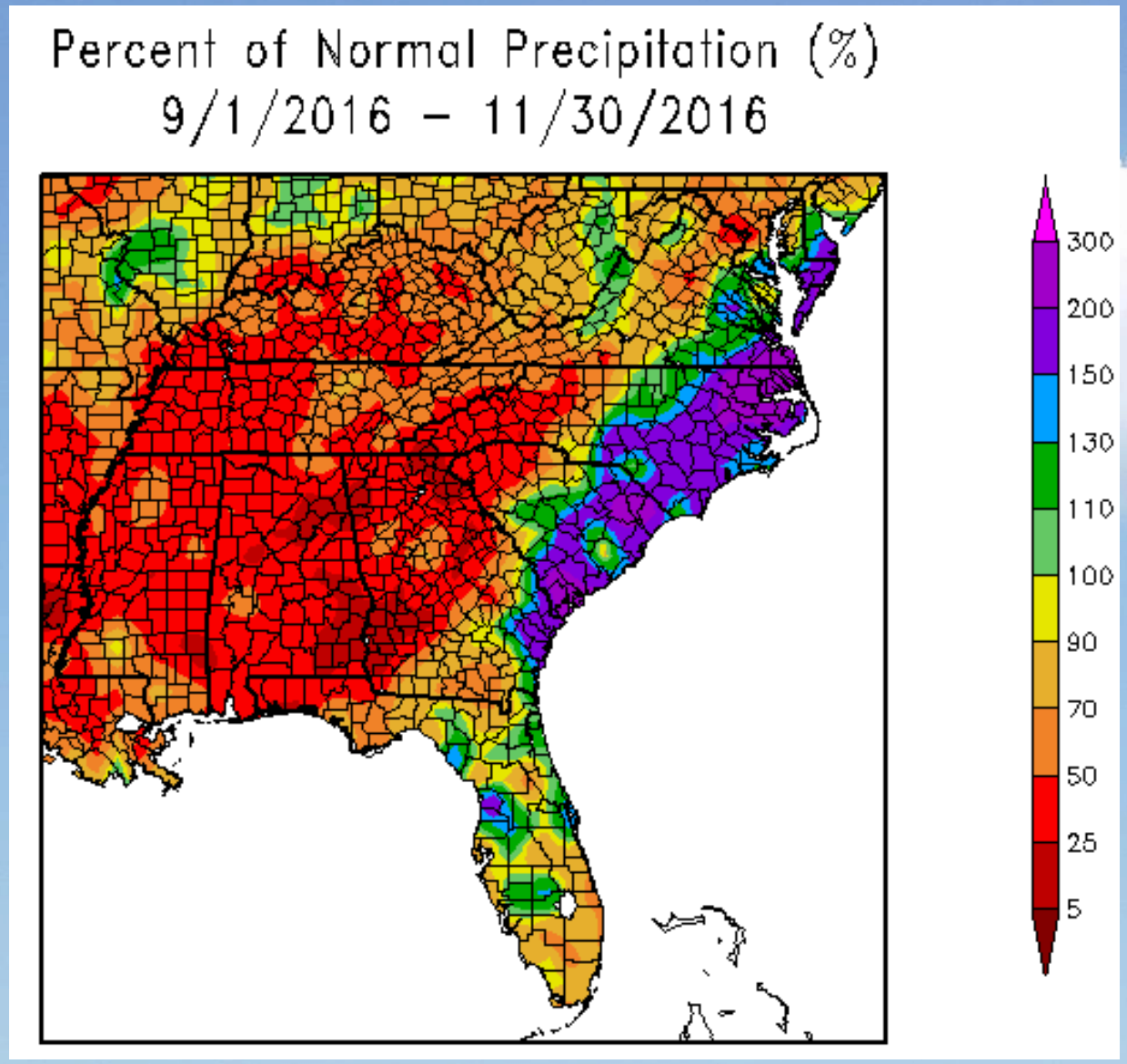
Circulation: Oct–Nov 2016 compared to 1979–2015

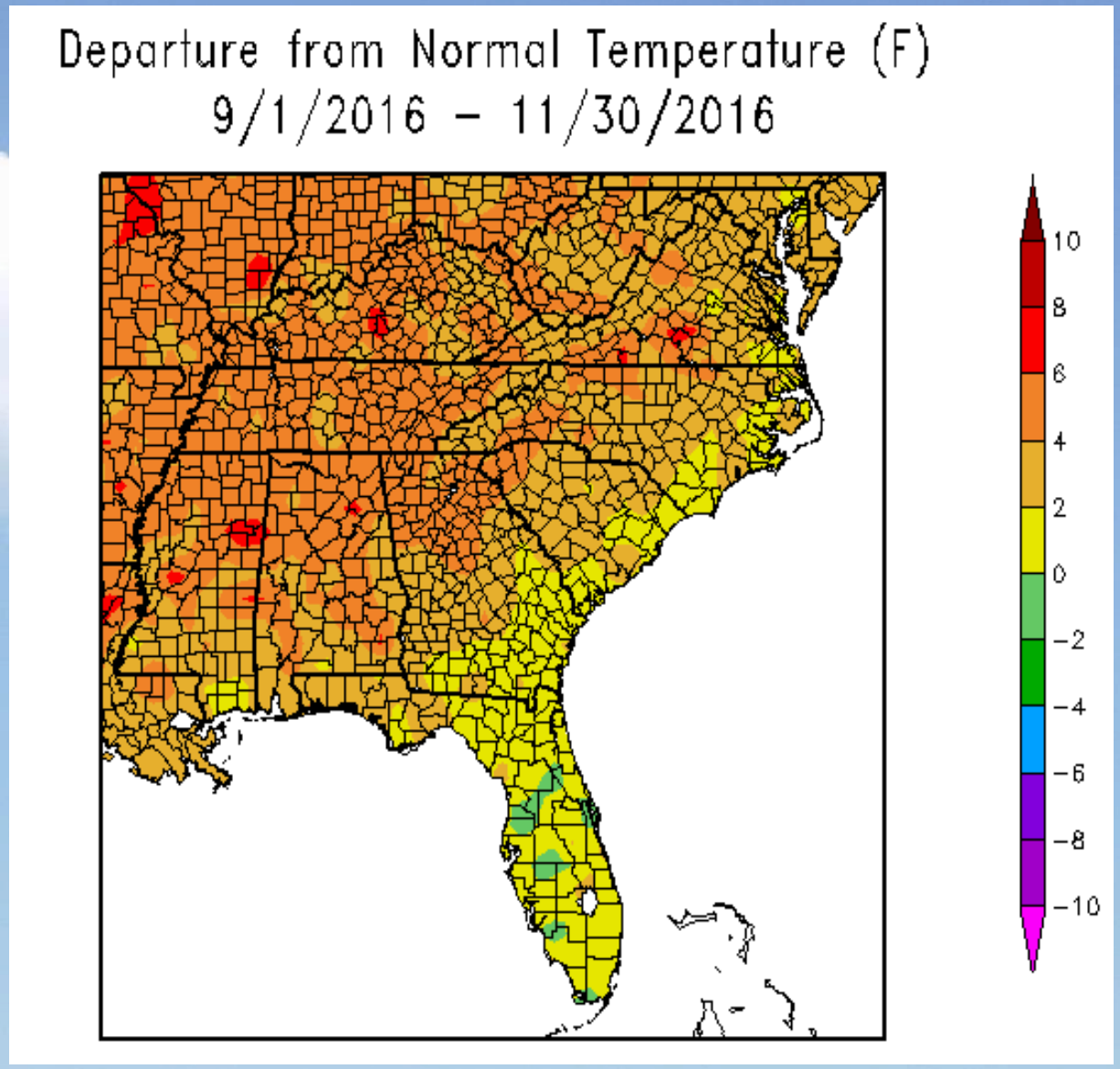
Causes of Drought: Record upper-level ridging



Atmospheric Circulation: Ranking of 500 mb heights during Oct–Nov 2016 compared to 1979–2015

Causes of Drought





Causes of Drought

	Extreme Dryness and Warmth				
	Atlanta GA	Asheville NC	Greenville SC	Chattanooga TN	Knoxville TN
Length of record	140 years	149 years	134 years	139 years	147 years
Total Precipitation (inches)					
One month 10/28-11/27/17					
Amount	0.00	0.00	0.20	0.06	0.27
Deficit	-4.00	-3.60	-3.50	-4.80	-3.60
Ranking	1st driest	1st driest	2nd driest	1st driest	1st driest
Three months 8/28-11/27/16					
Amount	3.59	1.10	1.72	2.24	1.87
Deficit	-8.40		-8.90	-9.90	-7.40
Ranking	8th driest	1st driest	1st driest	1st driest	1st driest
Mean Temperature (°F)					
Three months 8/28-11/27/16					
Observed	69.9	61.9	67.2	68.4	66.4
Departure	+5.2	+4.1	+4.1	+5.5	+5.0
Ranking	1st warmest	1st warmest	2nd warmest	1st warmest	1st warmest

Statistics derived from SERCC Climate Perspectives http://www.sercc.com/perspectives.

Wildfire Background

Major Wildfires during November 2016

Rough Ridge Fire
Acres burned: 27,870
Cause: lightning

Rock Mountain Fire
Acres burned: 24,725
Cause: human

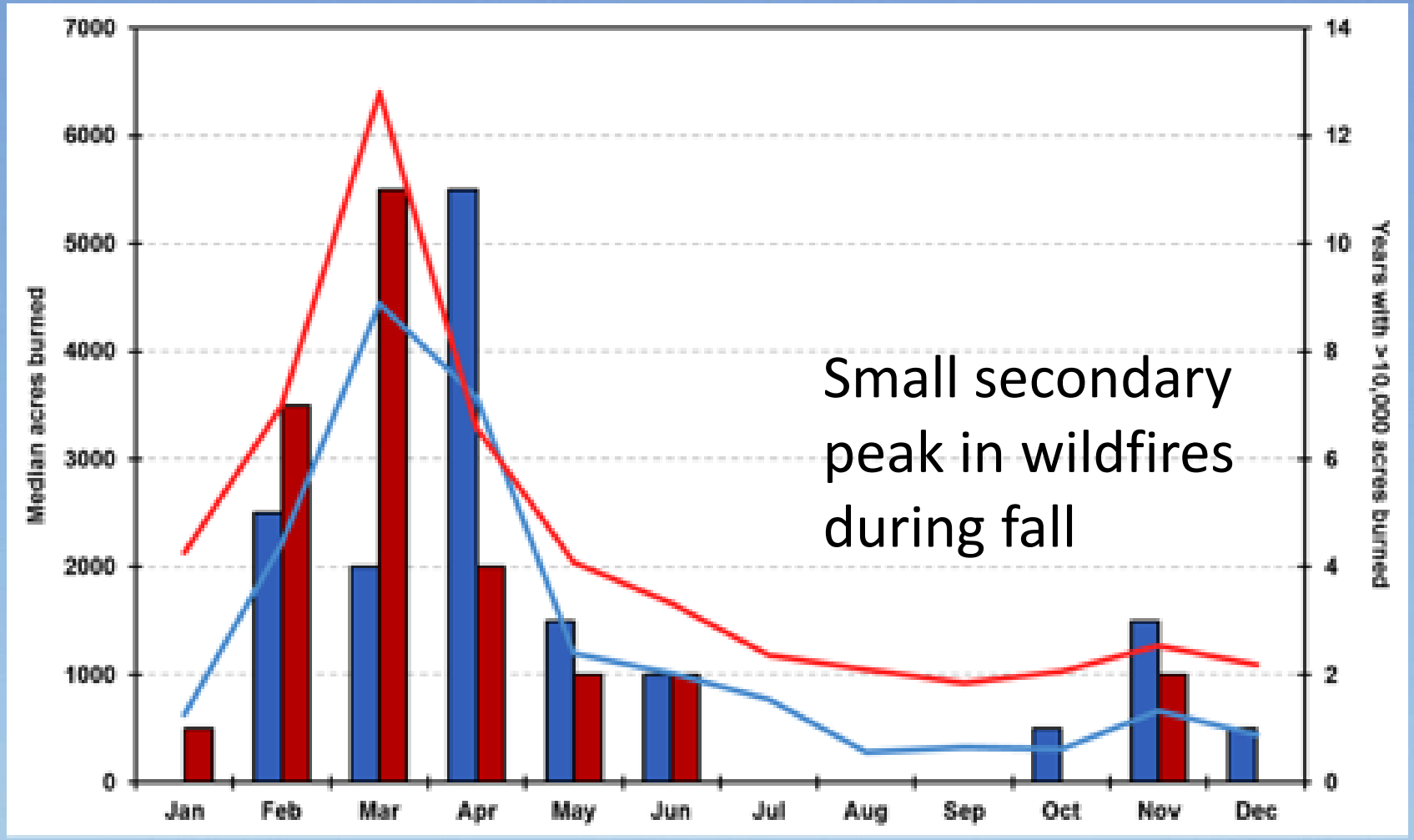
Pinnacle Mountain Fire
Acres burned: 10,623
Cause: human

Map source:
WSPA 7 News

Wildfire Character & Unique Aspects

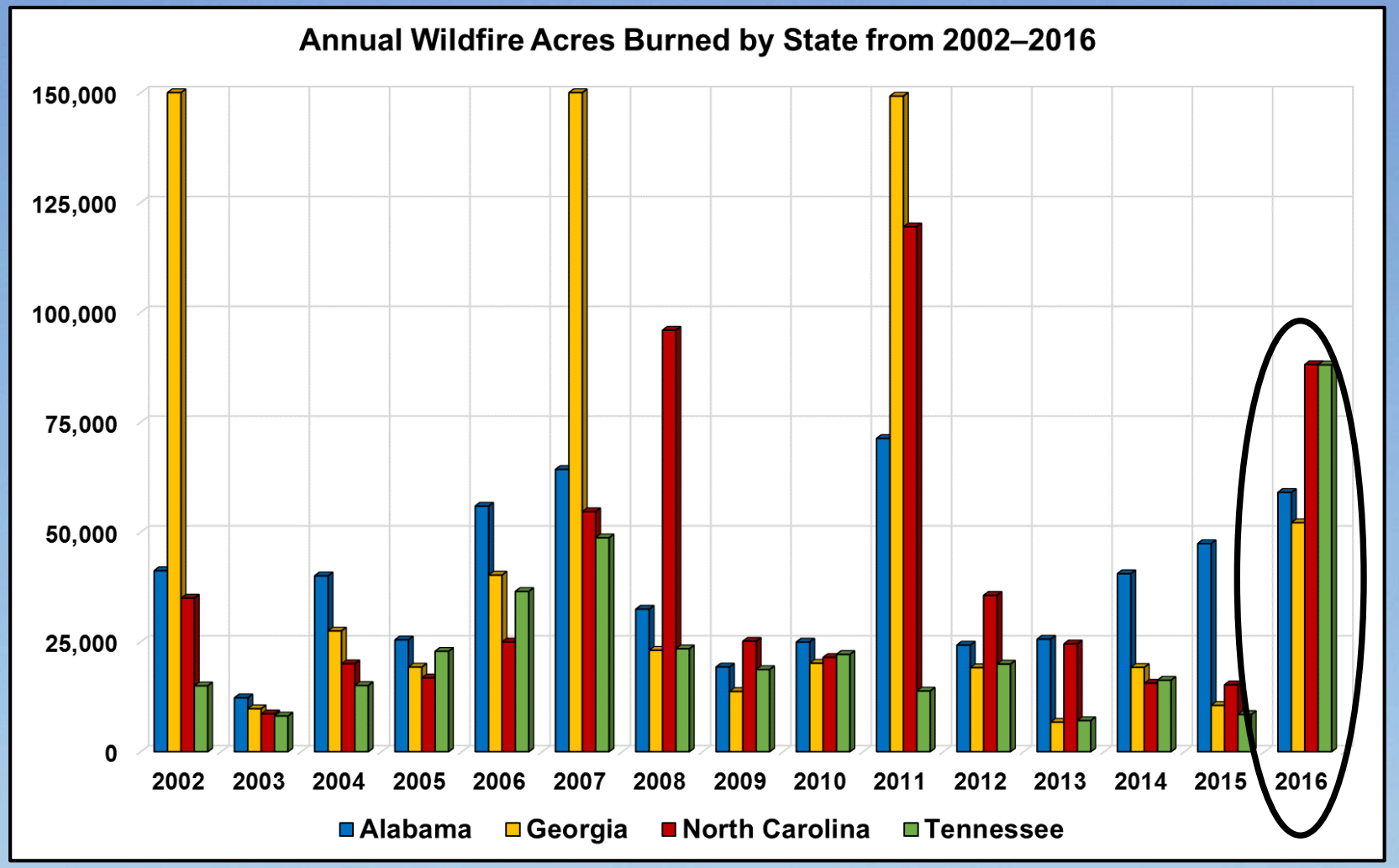
- Majority of major fires ignited by arsonists.
- Most fires were slow burning and well-behaved
- Due to absence of dew & fog & rain, abundant dry, unpacked leaf litter provided ample fuel & oxygen
- Underlying duff dried out making fires hotter & smokier. Greater tree mortality
- Fires difficult to bring under control due to the following:
    - Many fires hard to reach due to steep terrain and remote locations
    - Long & slow litter fall covered over firebreaks
    - Low supply of firefighters as many had fought fires in western U.S.

Wildfire Background



The median number of acres burned annually (lines) by wildfires and the number of years with large wildfires (bars) in state forests and private lands by month for the states of Georgia (red) and North Carolina (blue) from 1980-2016[17]

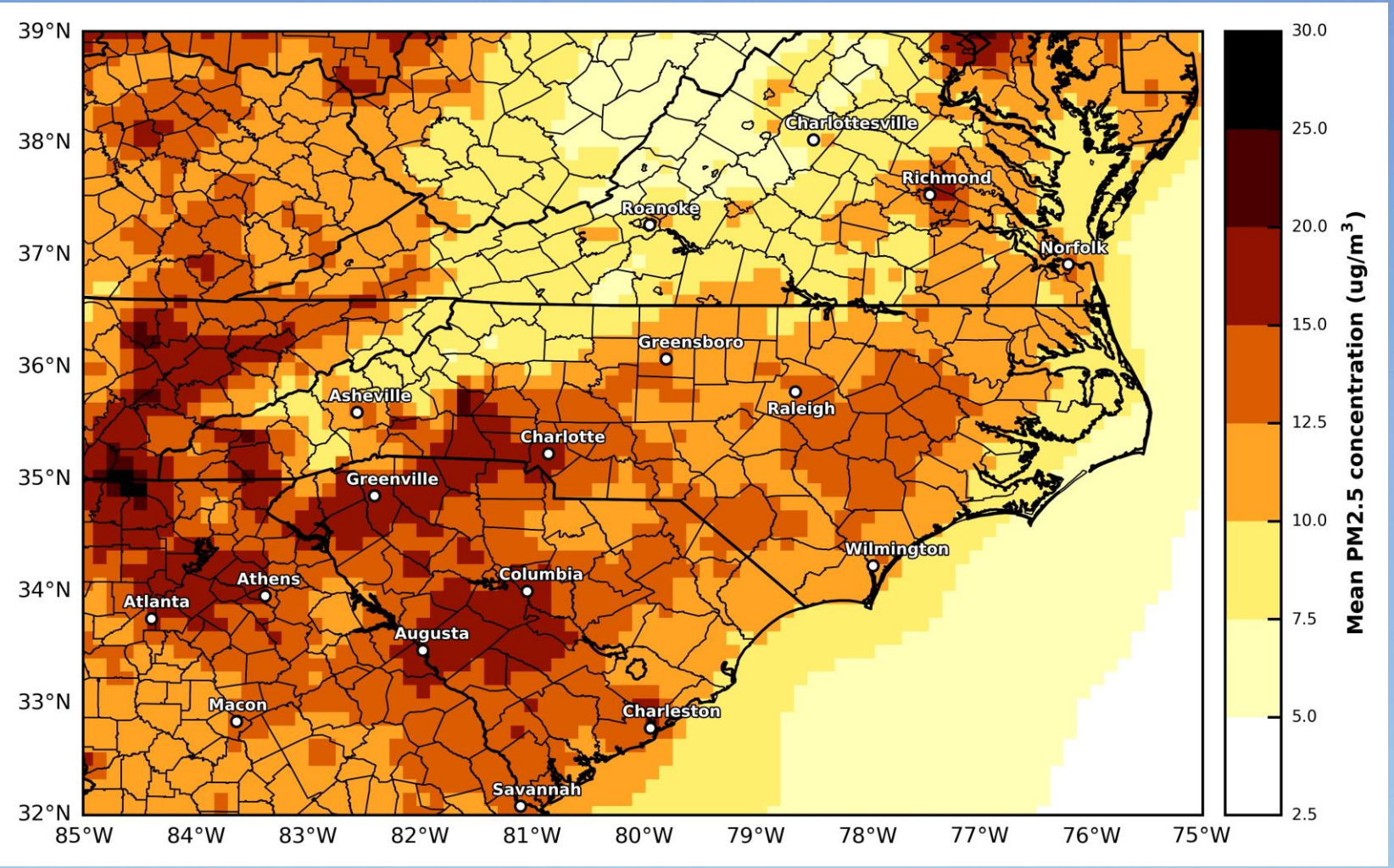
Wildfire Background



Data source: National Interagency Fire Center

Acres burned in 2016 not that exceptional – why?

Wildfire smoke dispersal



Average PM2.5 concentration (ug/m^3) from November 5–19, 2016

Generated from EPA from grids provided by EPA

Wildfire Smoke: dispersal

Daily air quality index (AQI) values for PM2.5 for first 29 days of November. Code yellow, orange, and red days are highlighted[12].

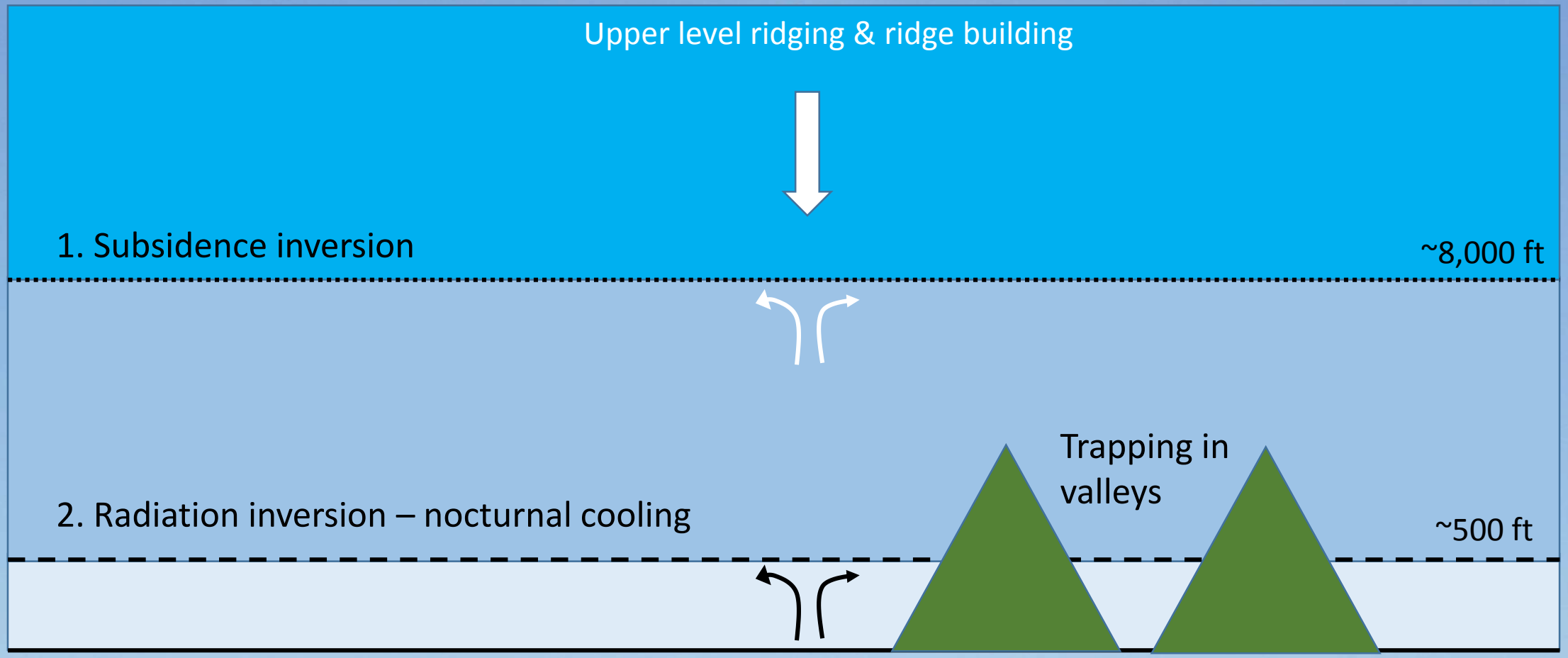
Date	Asheville, NC	Knoxville, TN	Greenville, SC	Atlanta, GA	Chattanooga, TN	Columbia, SC	Hickory, NC	Charlotte, NC	Charleston, SC	Athens, GA
11/1	52	68	58	68	58	44	55	55	28	54
11/2	61	78	50	57	58	50	55	55	31	41
11/3	44	64	58	59	47	55	53	56	38	41
11/4	20	23	38	54	38	52	20	33	40	33
11/5	53	59	39	52	54	43	24	50	35	52
11/6	55	52	70	70	70	59	22	67	39	58
11/7	72	152	59	62	57	45	29	39	60	33
11/8	113	169	45	62	58	45	75	51	37	25
11/9	79	56	38	76	52	63	70	47	56	44
11/10	9	36	93	112	90	34	27	30	24	116
11/11	38	64	132	82	55	94	38	78	102	162
11/12	152	59	30	76	152	27	21	33	61	16
11/13	167	112	106	60	174	25	85	51	21	32
11/14	158	164	188	151	177	86	153	65	37	120
11/15	141	131	173	112	82	168	152	82	155	154
11/16	65	79	126	63	57	155	93	154	158	113
11/17	52	67	91	64	70	85	94	99	117	88
11/18	86	66	99	70	62	76	133	83	78	68
11/19	64	53	52	50	27	58	57	58	61	29
11/20	17	26	45	45	11	32	12	23	27	13
11/21	11	49	52	53	25	40	14	29	41	22
11/22	149	54	53	68	68	53	59	71	40	40
11/23	156	105	67	66	62	64	71	59	39	50
11/24	56	96	49	52	48	64	54	52	35	30
11/25	46	53	53	55	34	65	53	55	33	27
11/26	38	49	25	59	45	54	33	38	36	36
11/27	92	59	48	63	53	62	47	56	33	28
11/28	89	57	57	53	38	47	58	52	28	31
11/29	15	24	20	41	27	24	17	22	36	16
MEAN	**74**	**73**	**69**	**67**	**64**	**61**	**58**	**57**	**53**	**54**

Wildfire smoke: dispersal

Modis image on 11/14/2016

Image credit: NASA Worldview

Wildfire smoke dispersal: Mechanisms for concentrating smoke



Public Heath Impacts of the Wildfire Smoke

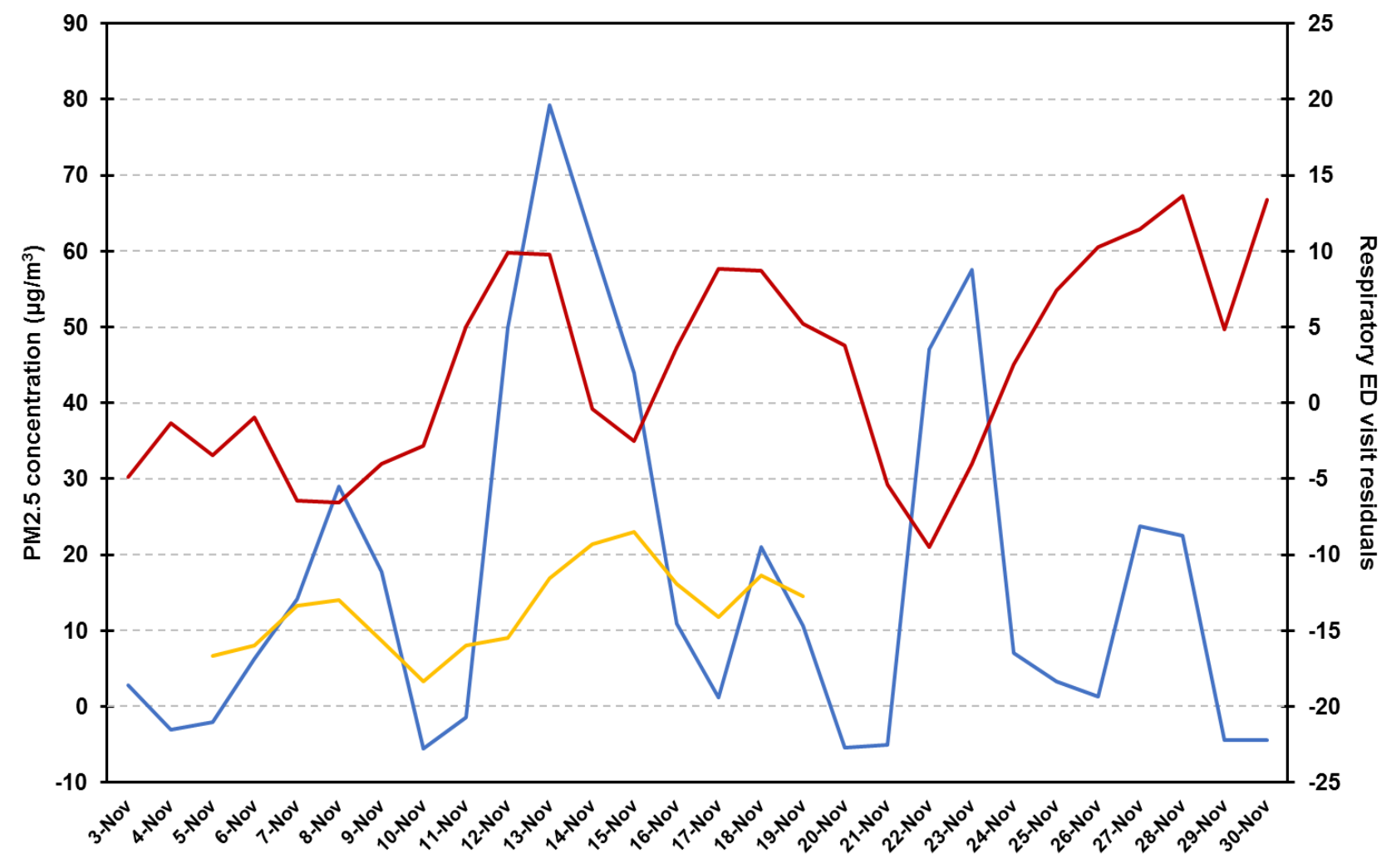
- No systematic analyses of health impacts has been carried out.
- However, a number of reports of increases in hospitalizations, emergency room visits, especially for those with asthma & preexisting conditions

According to the Times-Press, more than 200 patients have been hospitalized in Chattanooga, Tennessee, since Friday for shortness of breath and other respiratory difficulties related to the wildfires that have encircled the city.

Medical professionals in East Tennessee told WATE that there had been a spike in patients complaining of breathing troubles.

Chattanooga Times Press

Public Heath Impacts of the Wildfire Smoke



Daily values of PM2.5 (blue line) at a monitoring site in Asheville and EPA modeled PM2.5 (gold line) for Buncombe County, North Carolina and residuals of respiratory emergency department (ED) visits (red line) for Buncombe County, North Carolina during the period of wildfires

Public Heath Impacts of the Wildfire Smoke: Challenges

- Much local variation in wildfire smoke concentrations thus difficult to predict.
- Difficulty in translating air quality index (AQI) and warnings into preventive actions.

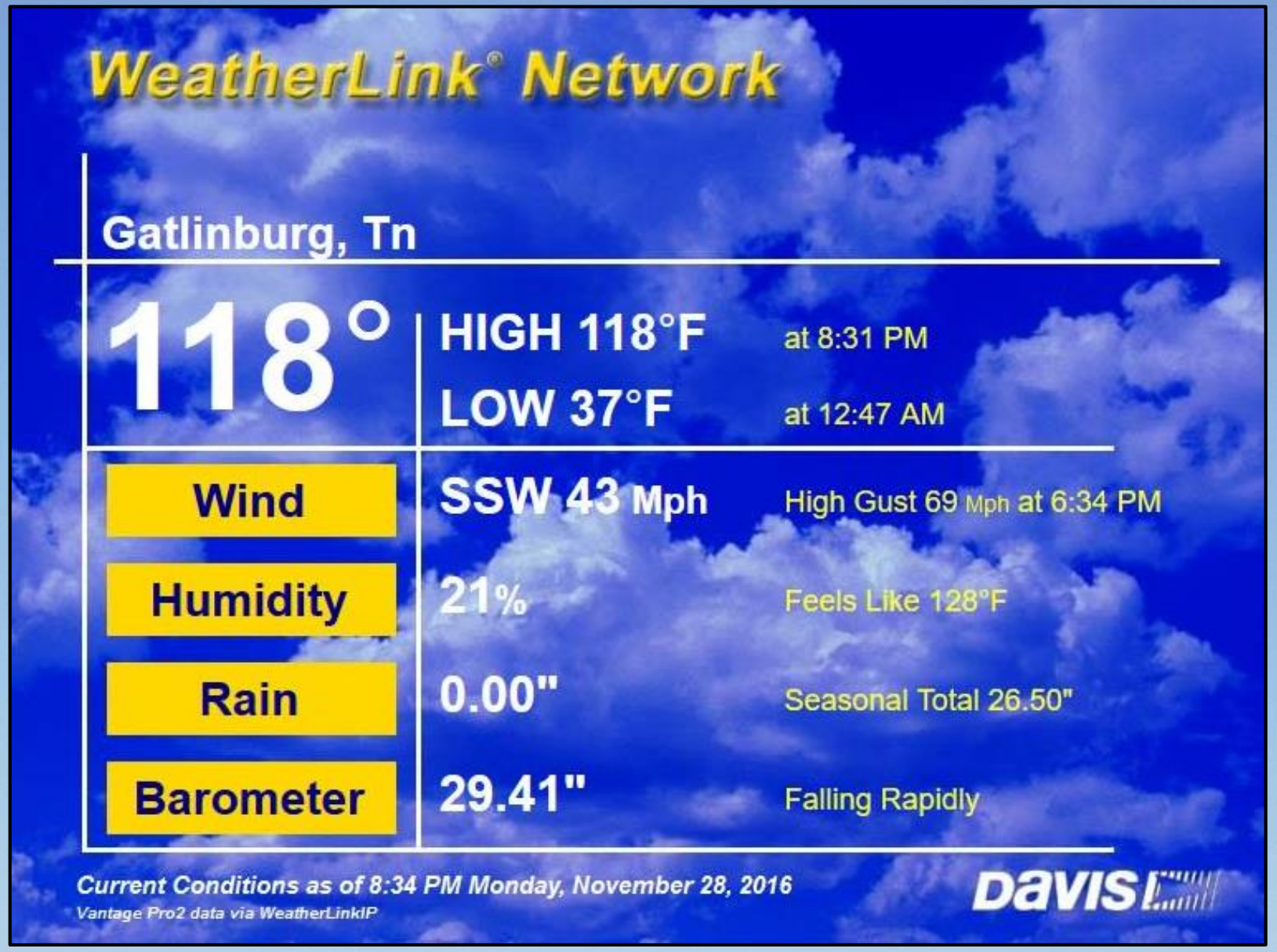
Example: Should schedule public events (e.g. running races, high school football games etc) be canceled/postponed?

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health warnings of emergency conditions. The entire population is more likely to be affected.
Hazardous	301 to 500	Health alert: everyone may experience more serious health effects

Gatlinburg, TN wildfire 11/28/2016

- **Acres burned: 17,140**
- **Casualties: 14 fatalities and over 130 injuries**
- **Nearly 1,700 structures were damaged or destroyed**
- **14,000 people were forced to flee/evacuate**

Gatlinburg wildfire



Gatlinburg wildfire

- Strong south-southeasterly winds, with gusts exceeding 50 mph, blew burning embers more than 5 miles from the Chimney Tops wildfire into portions of Gatlinburg.
- Downsloping winds descended more than 3,000 feet into Gatlinburg, further enhancing warming and drying of the surface.
- Numerous power lines knocked down by high winds, sparking additional fires that spread rapidly.

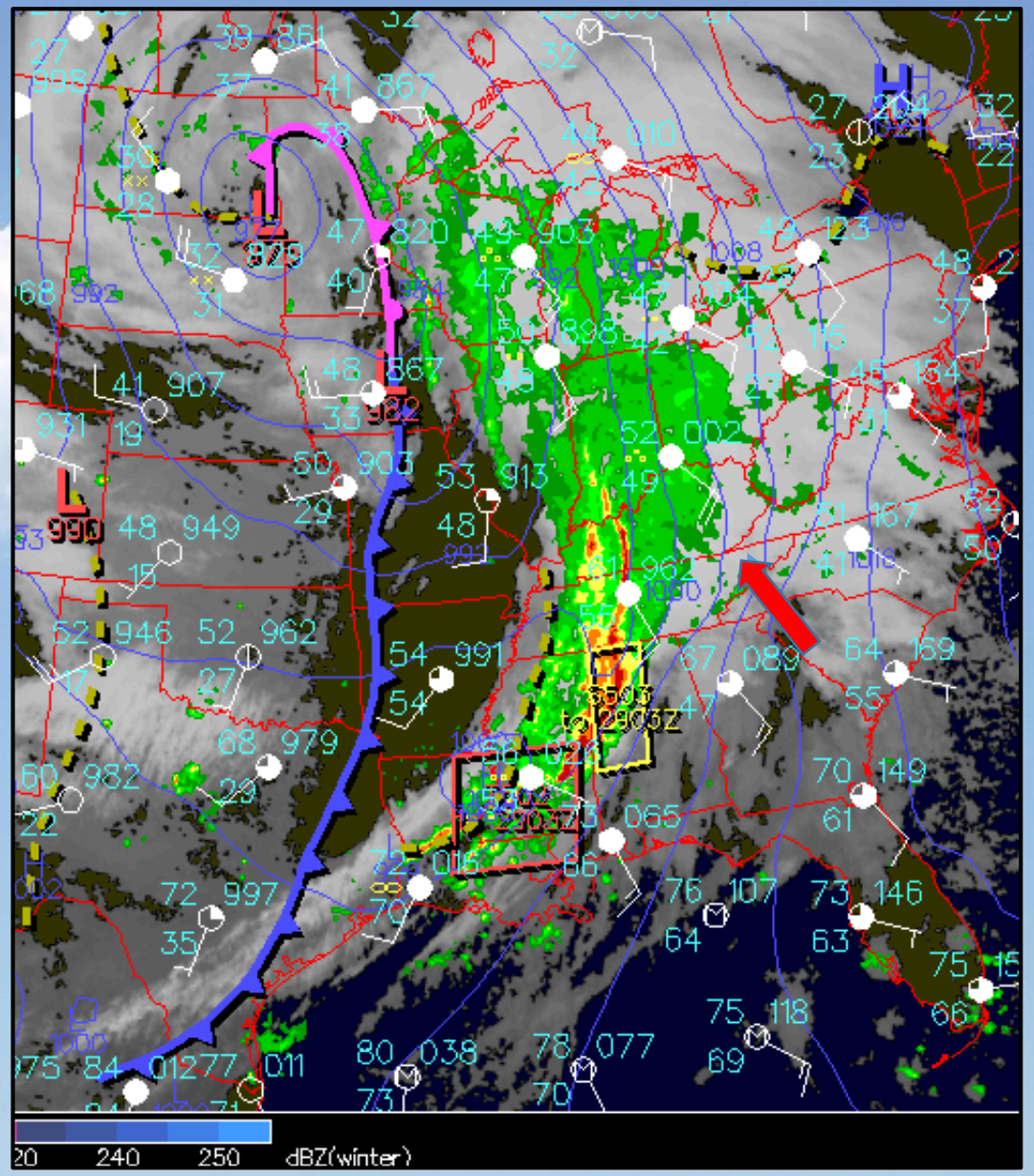


Image sources: UCAR MMM archive; Scott Dimmich

Gatlinburg Wildfire Vulnerability

- Steep mountain slopes & lush vegetation.
- Rapidly developing tourism town. Extensive & expanding wildland-urban interface
- Many buildings constructed of flammable material (e.g. rustic building like log cabins). Less than a year after, over 200 permits had been issued to rebuild structures using same materials
- Dense, flammable understory vegetation (rhododendron or mountain laurel) due to fire suppression efforts
- No prior experience with fast-moving wildfires, hence threat underestimated in spite of NWS forecasts of very strong winds

Contacts
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Publication
The Southeastern Drought and Wildfires of 2016
http://www.sercc.com/NIDISDroughtAssessmentFINAL.pdf

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The EPA

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