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SEVERE WEATHER, HURRICANES AND WILDFIRES

A view of emerging trends in extreme events

James Waller, PhD

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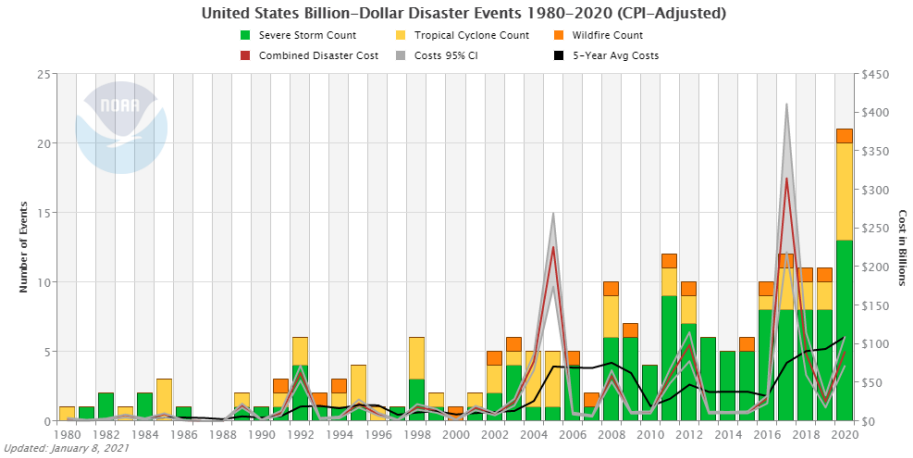
2020 EXTREME EVENTS IN PERSPECTIVE



Number of events is clearly increasing, for a few reasons...

Source: NOAA/NCEI

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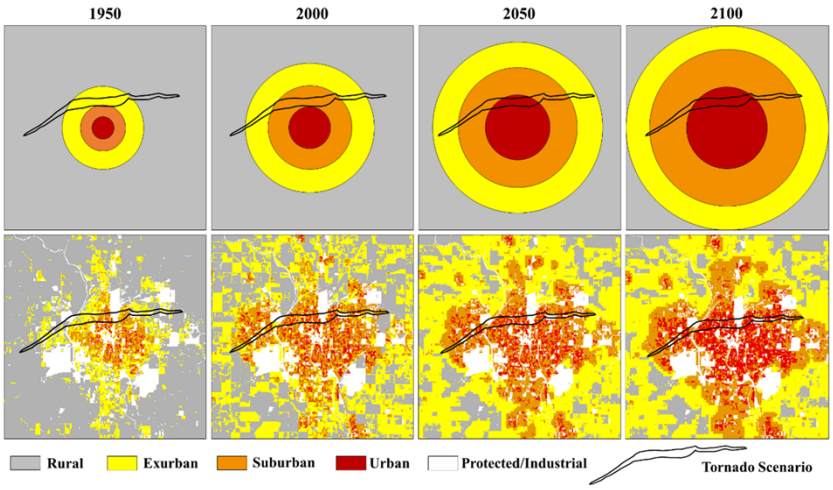
EFFECTS OF POPULATION ON RISK

Increase in population increases risk, regardless of the hazard



Source: Ashley et al., 2014

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SEVERE THUNDERSTORM TRENDS

- Observed *decline* in tornado days
- Observed increased *"productivity"* of tornado days
- Observed spatial shift
- *Projected tornado environments – unclear*

- Observed possible upward drift in 2"+ hail
- Observed spatial shift
- Observed hail environments appear to be occurring more frequently
- *Projected net annual increase in severe hail days by late century*
- *Projected increase in seasonal variability*

- Observed trends in SCS straight-line wind difficult to determine with clarity
- *Projected increase instability (increases thunderstorm intensity)*
- *Projected decrease wind shear (offsets thunderstorm intensity)*
- *What wins???*

Projections for Longer SCS season, earlier start, slight change to means, increased variability
Busier spring, quieter summer

SOURCES: Diffenbaugh Scherer Trapp 2013, Trapp et al 2018

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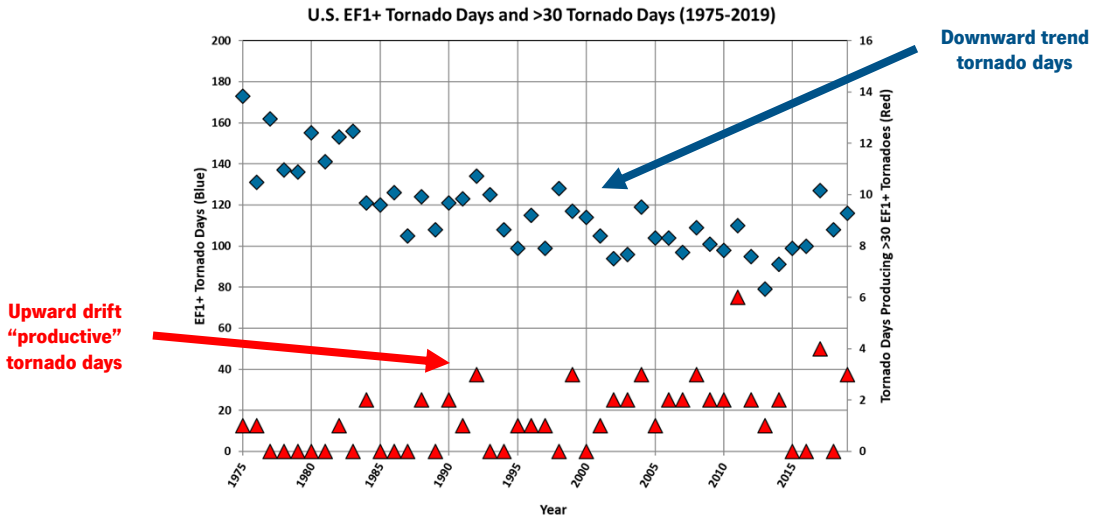
US TORNADO DAYS, DAYS WITH 30+ TORNADOES



SOURCE: NOAA, Brooks et al., 2015

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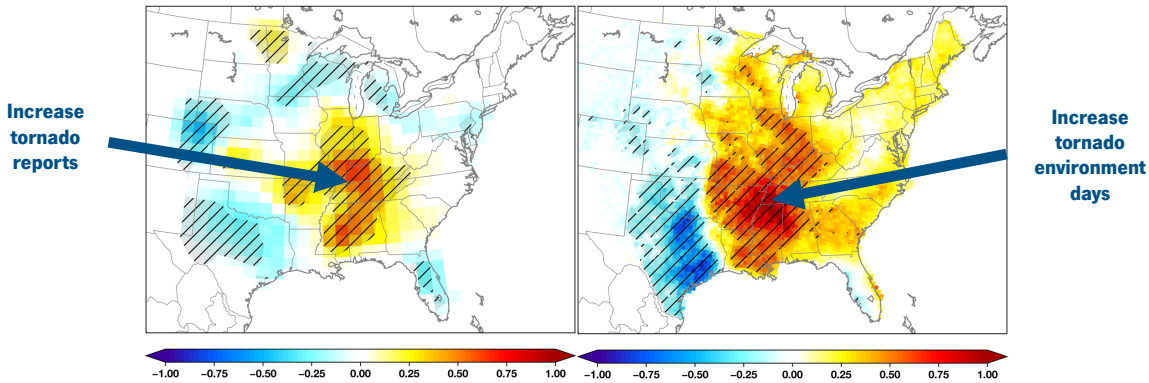
SPATIAL TRENDS IN TORNADO FREQUENCY

- Analyzed shift in gridded tornado reports (left) and significant tornado environments (right) as analyzed from 1979-2017 (slope units are reports or daily max per year).
- Hatched regions indicate statistical significance.
- Not all days with significant tornado environments produce significant tornadoes.



SOURCE: Gensini & Brooks 2018

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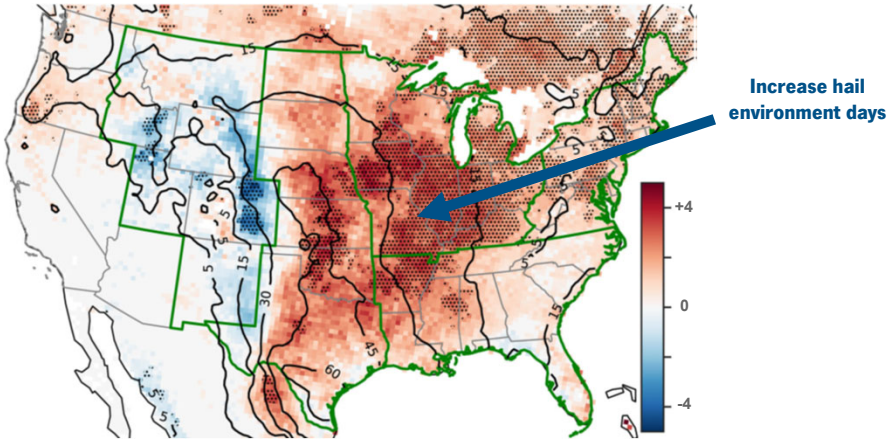
SPATIAL TRENDS IN HAIL FREQUENCY

- Trends in annual large hail environment days (shaded) with observed annual mean number of large-hail-parameter days (contoured) 1979-2017
- Statistically significant increase in days that could produce large hail from Southern Plains and Lower Mississippi Valley through Midwest and Northeast (red-speckled regions)



SOURCE: Tang, Gensini et al., 2019

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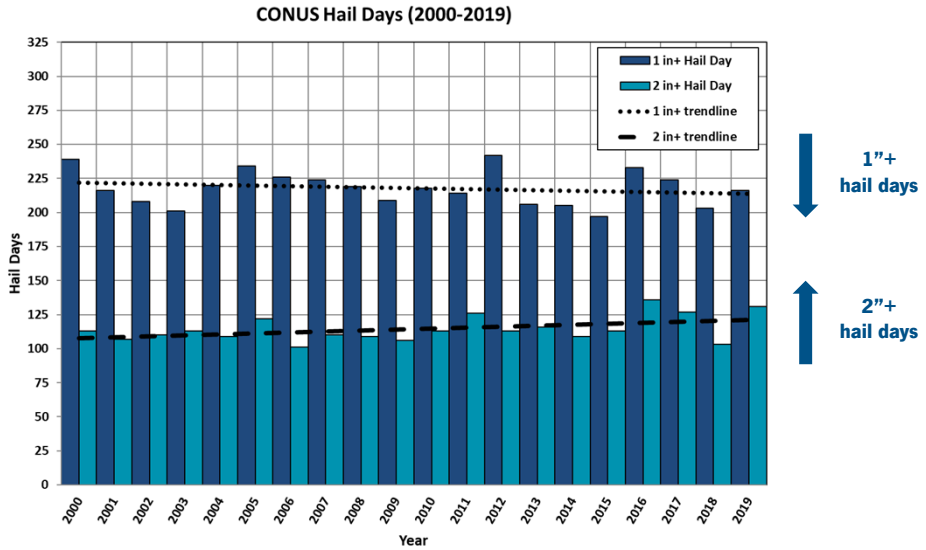
US HAIL DAYS (2000-2019)



SOURCE: NOAA/SPC

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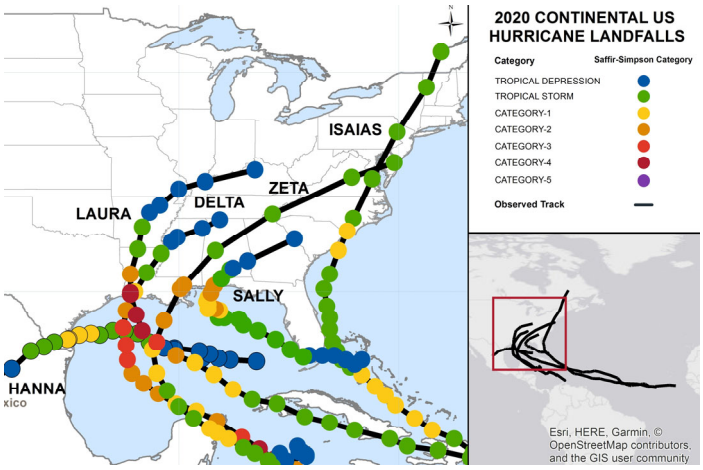
2020 US HURRICANE LANDFALLS



Six hurricane landfalls - Ties prior known records 1985 1886.

SOURCE: NOAA/NHC

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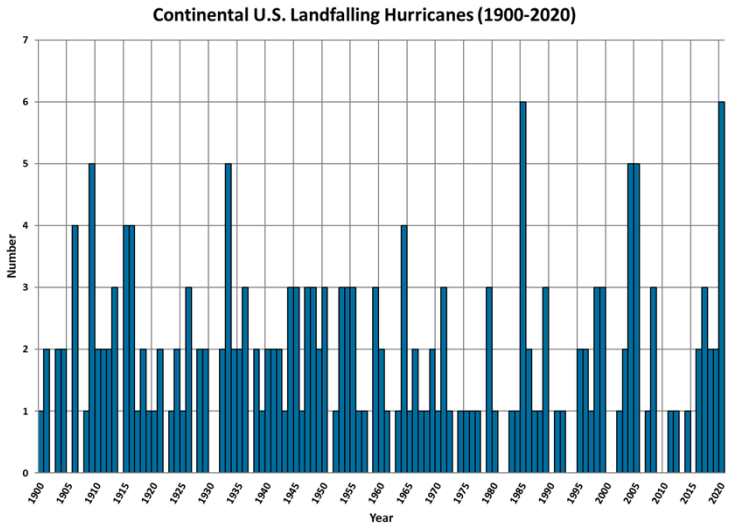
US HURRICANE LANDFALLS (1900-2020)



SOURCE:NOAA/HRD

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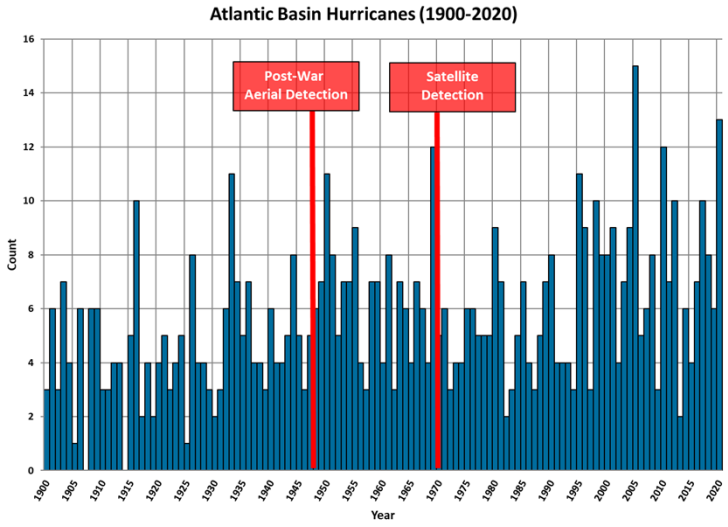
ATLANTIC BASIN HURRICANES (1900-2020)



SOURCE:NOAA/HRD

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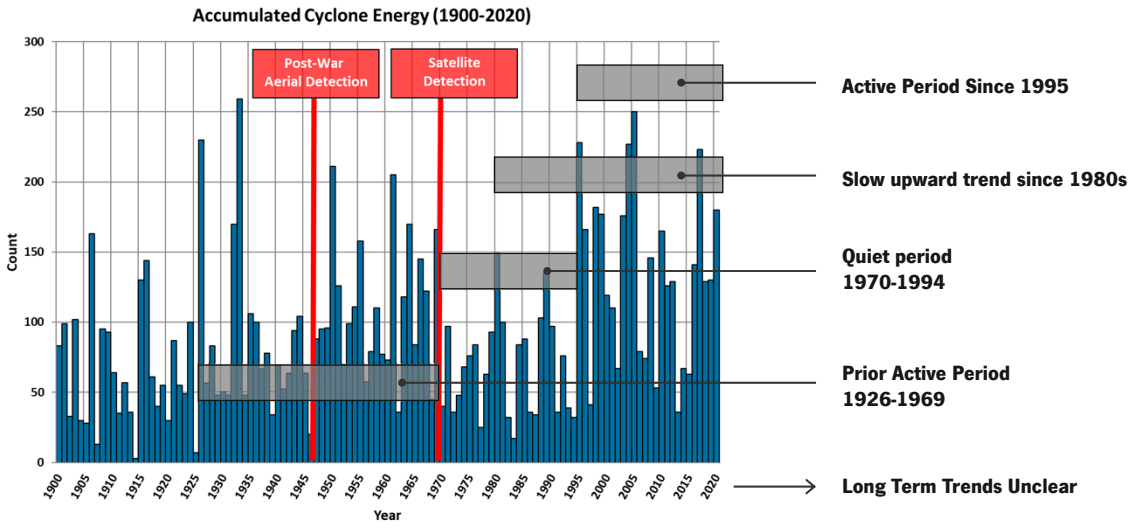
ACCUMULATED CYCLONE ENERGY (1900-2020)



SOURCE:NOAA/HRD, CSU

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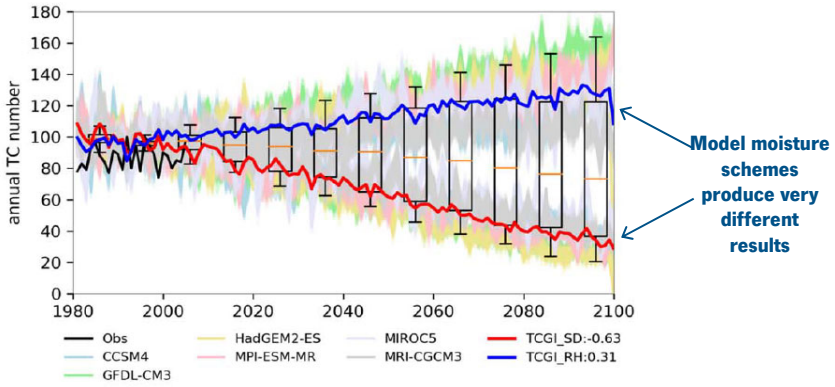
HURRICANE FREQUENCY/SEVERITY

- No observed long-term trends...*but clear increase since 1980s*
- Some increase in *intensity* expected (more severe hurricanes, higher "ceiling" on wind speeds)
- Possible increase in hurricane rainfall intensity, slower forward speed, inland flood effects
- Uncertain change in *frequency* projected over the long term (example to the right)
- Some regional shifts possible



TC Frequency projections with two different moisture treatment assumptions
SOURCE: Lee & Camargo 2020

SOURCES: IPCC/NCA

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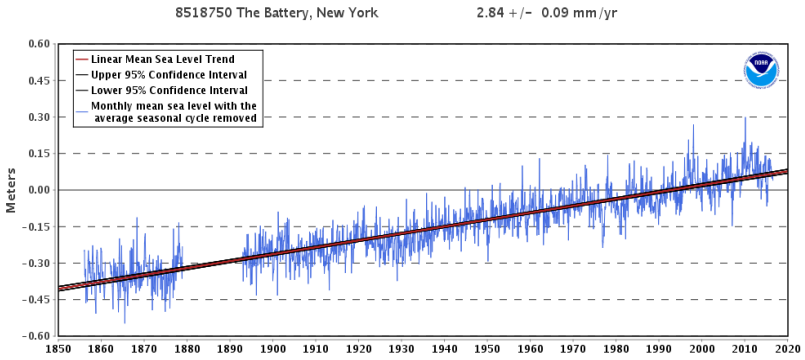
SEA-LEVEL AND STORM SURGE

- Observed sea-level trend of about 0.93 feet over 100 years (The Battery, New York)
- Projected increase of 1-4 feet by 2100. Ice sheet instability may increase these numbers
- Compacts return periods of all coastal flood threats including hurricane, nor'easters
- Coastal urban and agricultural areas face increasing risk
- Significant threat from a property perspective, especially with higher coastal property concentration



Observed Mean Sea Level and Trend
The Battery, New York
SOURCE: NOAA

SOURCES: NCA, IPCC, NOAA

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RESILIENCE MEASURES

- **Coastal flood –** elevated foundations, coastal flood defenses, near-shore wetlands.
- **Inland flood –** stormwater management and retention systems, land use.
- **Wind –** structural resilience measures, roof properly attached and sealed, continuous load path from roof through walls to foundation, secure garage doors (IBHS).

SOURCES: NOAA/IPCC/NCA/FEMA/IBHS

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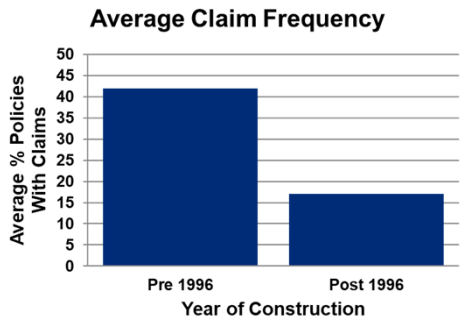
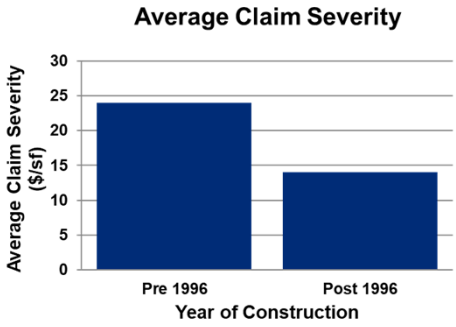
IBHS CLAIMS STUDY POST-CHARLEY (2004)





Post-Andrew building codes clearly have a positive influence on claims frequency and severity

SOURCE: Insurance Institue for Business and Home Safety

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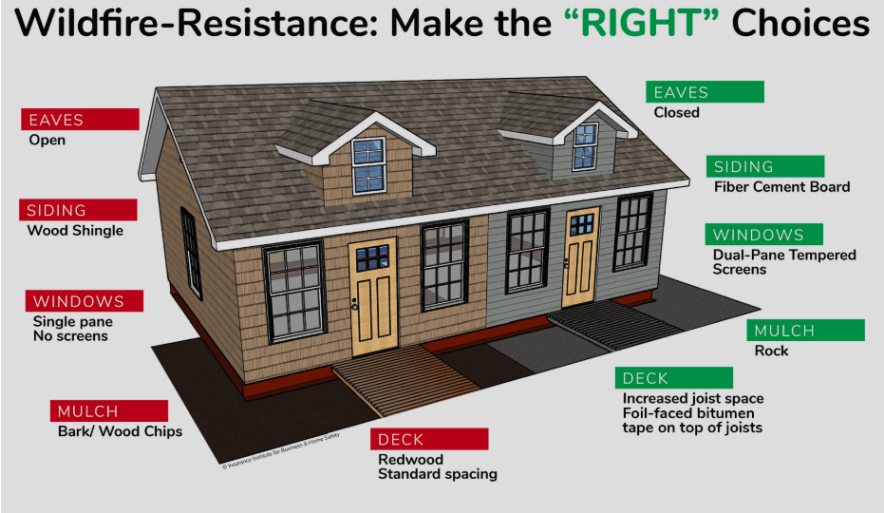
IBHS WILDFIRE RESILIENCE



SOURCE: IBHS

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WILDFIRE TRENDS

WINTER/SPRING	SUMMER	FALL
Rainy Season Shorter but Wetter	Hotter, Dryer, *Longer*	Windy, Delayed Rainy Season
More Precipitation	More Evaporation, Drying	Longer Fire Season

Expected Trends Affect Wildfire Differently Season to Season

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HISTORIC 2020 WILDFIRE SEASON

California Lightning (August)

- A lightning siege from August 16-18 ignited Numerous fires in northern CA
- CalFire estimates 4.3M acres burned in the state in 2020
- Five of the 6 largest fires (acres) in the state occurred in 2020
- Six of the 20 most destructive fires (structures destroyed) occurred in 2020
- CalFire estimates over 10,000 structures destroyed in 2020

CALIFORNIA FIRE NAME	DATE	ACRES	RANK	STRUCTURES	RANK
CAMP FIRE	2018	153,336	9	18,804	1
TUBBS	2017	36,807	18	5,636	2
NORTH COMPLEX★	2020	318,935	4	2,352	5
WOOLSEY	2018	96,949	10	1,643	8
CARR	2018	229,651	7	1,614	9
GLASS FIRE★	2020	67,484	15	1,520	10
LNU LIGHTNING COMPLEX★	2020	363,220	3	1,491	11
CZU LIGHTNING COMPLEX★	2020	86,509	12	1,490	12
NUNS	2017	54,382	16	1,355	13
THOMAS	2017	281,893	5	1,063	14
AUGUST COMPLEX ★	2020	1,032,649	1	935	17
CREEK FIRE ★	2020	377,693	2	856	19
ATLAS	2017	51,624	17	783	20

SOURCE: Cal Fire

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