Precipitation and Droughts in the Southeast

Exploring Challenges, Impacts, and Perspectives

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Drought Complexity

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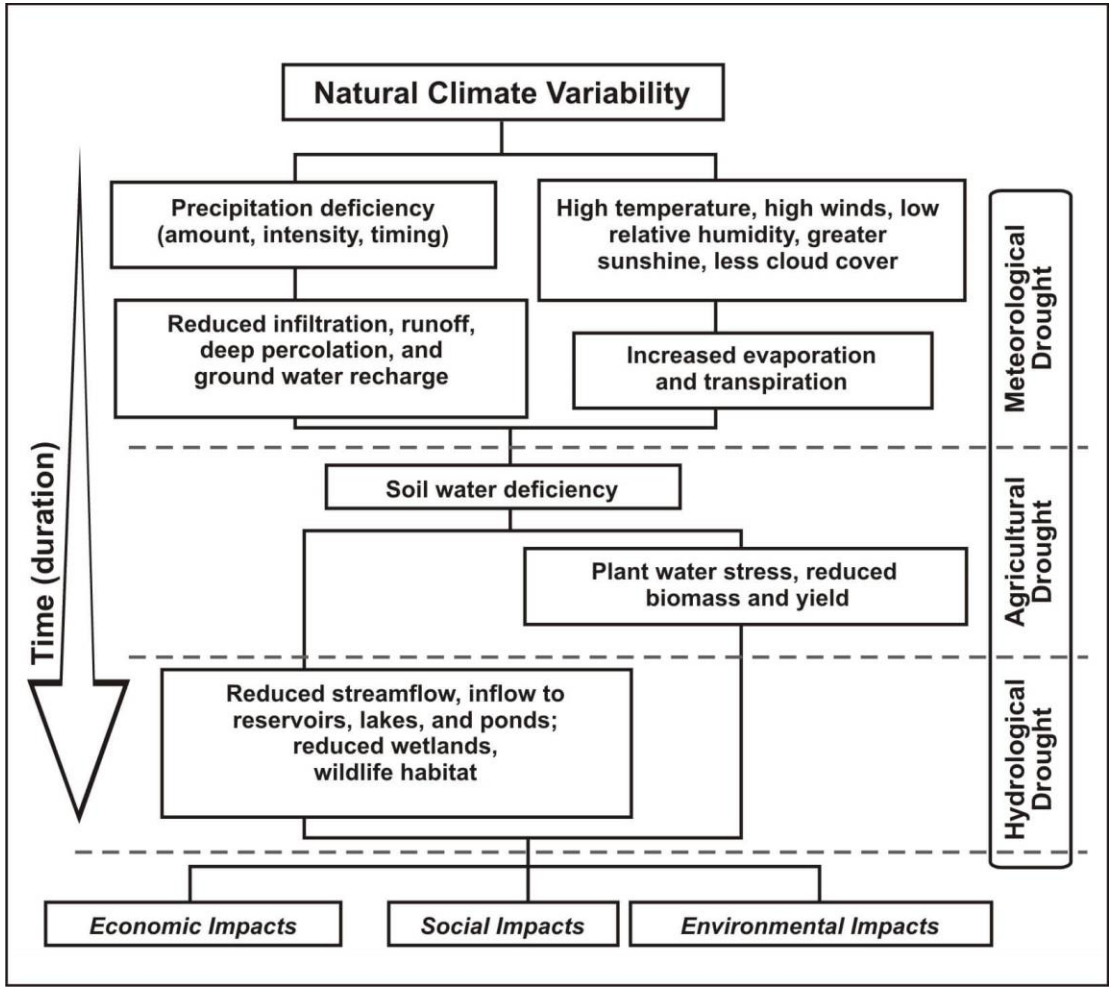
- Drought varies significantly in causes, duration, and impacts
- Interplay of meteorological, hydrological, agricultural, and socio-economic factors
- Complex feedback loops involving climate, land use, and water management
- Framed as an *event*, though is often better characterized as a continuum



Source: USDM

Tools for Drought Monitoring

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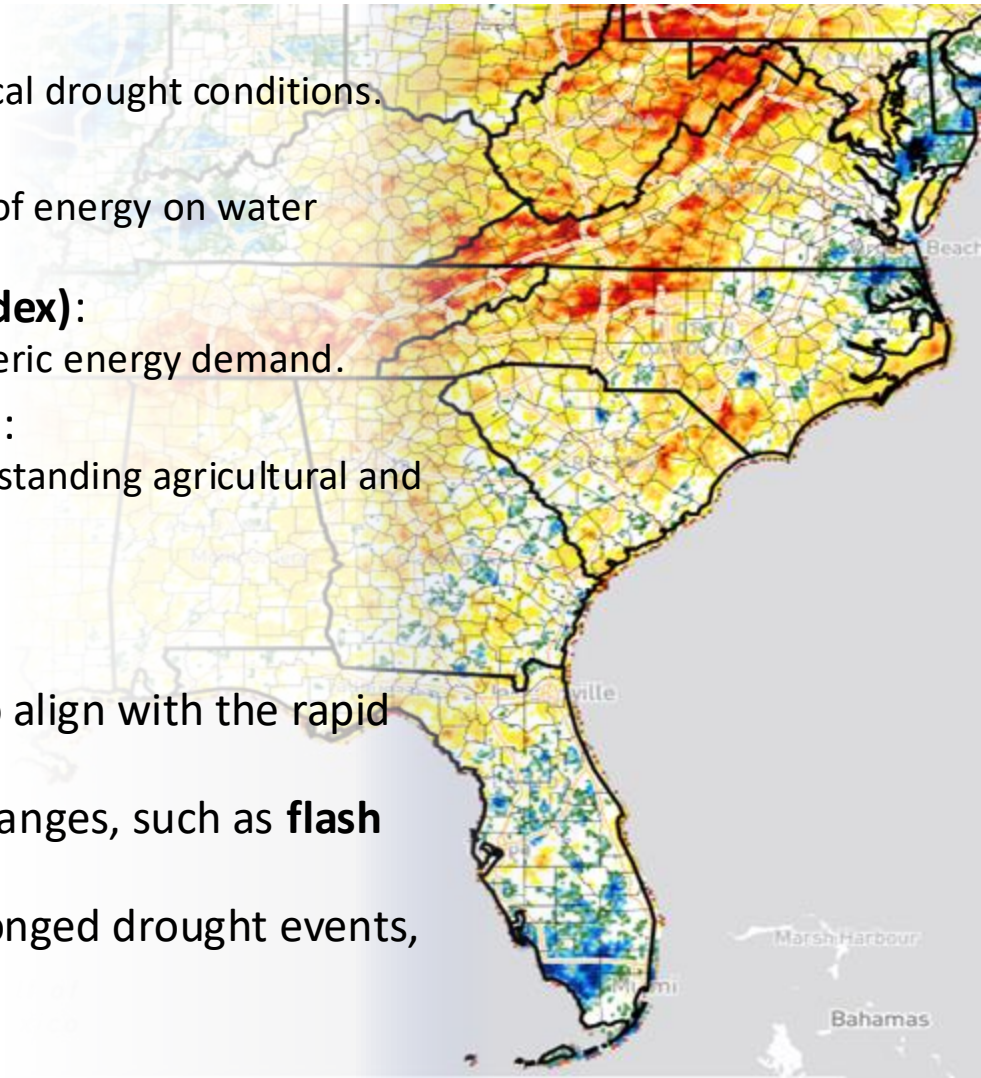
- **SPI (Standardized Precipitation Index)**:
  - Focuses solely on precipitation anomalies, providing insights into meteorological drought conditions.
- **SPEI (Standardized Precipitation Evapotranspiration Index)**:
  - Accounts for both precipitation and evapotranspiration, reflecting the impact of energy on water balance.
- **ESI (Evaporative Stress Index)** and **EDDI (Evaporative Demand Drought Index)**:
  - Highlight drought conditions by emphasizing evapotranspiration and atmospheric energy demand.
- **SMVI (Soil Moisture Vegetation Index)** and **LGI (Landsat Greenness Index)**:
  - Focus on soil moisture availability and effective precipitation, critical for understanding agricultural and ecological drought impacts.

Aggregation Periods:

- Indices are typically aggregated over **30, 60, or 90 days** in the Southeast to align with the rapid hydrologic cycle for real-time monitoring.
- Shorter aggregates (e.g., **14 or 21 days**) are valuable for detecting rapid changes, such as **flash droughts**.
- Longer aggregates (e.g., **multi-season or multi-year periods**) capture prolonged drought events, critical for assessing sustained impacts.



30 Day SPI (Jun 18, 2024 - Jul 17, 2024)

Tools for Drought Monitoring

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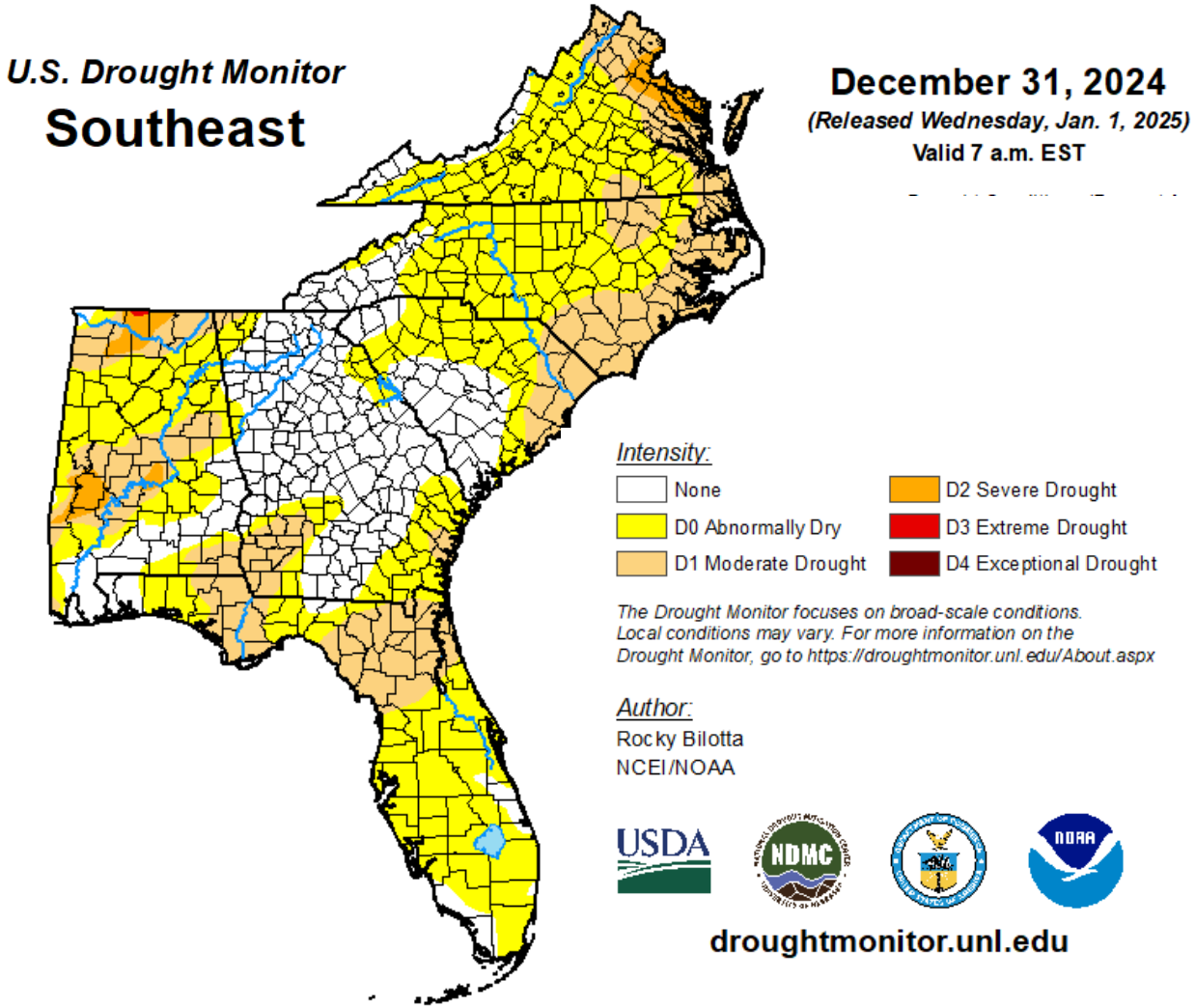

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	26.74	73.26	26.13	2.35	0.03	0.00
Last Week *12-24-2024*	16.56	83.44	27.05	2.85	0.05	0.00
3 Months Ago *10-01-2024*	80.09	19.91	5.69	0.03	0.00	0.00
Start of Calendar Year *01-02-2024*	46.90	53.10	29.74	12.32	2.53	0.00
Start of Water Year *10-01-2024*	80.09	19.91	5.69	0.03	0.00	0.00
One Year Ago *01-02-2024*	46.90	53.10	29.74	12.32	2.53	0.00

Percentiles

D0	D1	D2	D3	D4
21 – 30% ~1 in 3-5 years	11 – 20% ~1 in 5-10 years	6 – 10% ~1 in 10-20 years	3 – 5% ~1 in 20-50 years	1 – 2% ~1 in 50-100 years

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Drought in the Southeast

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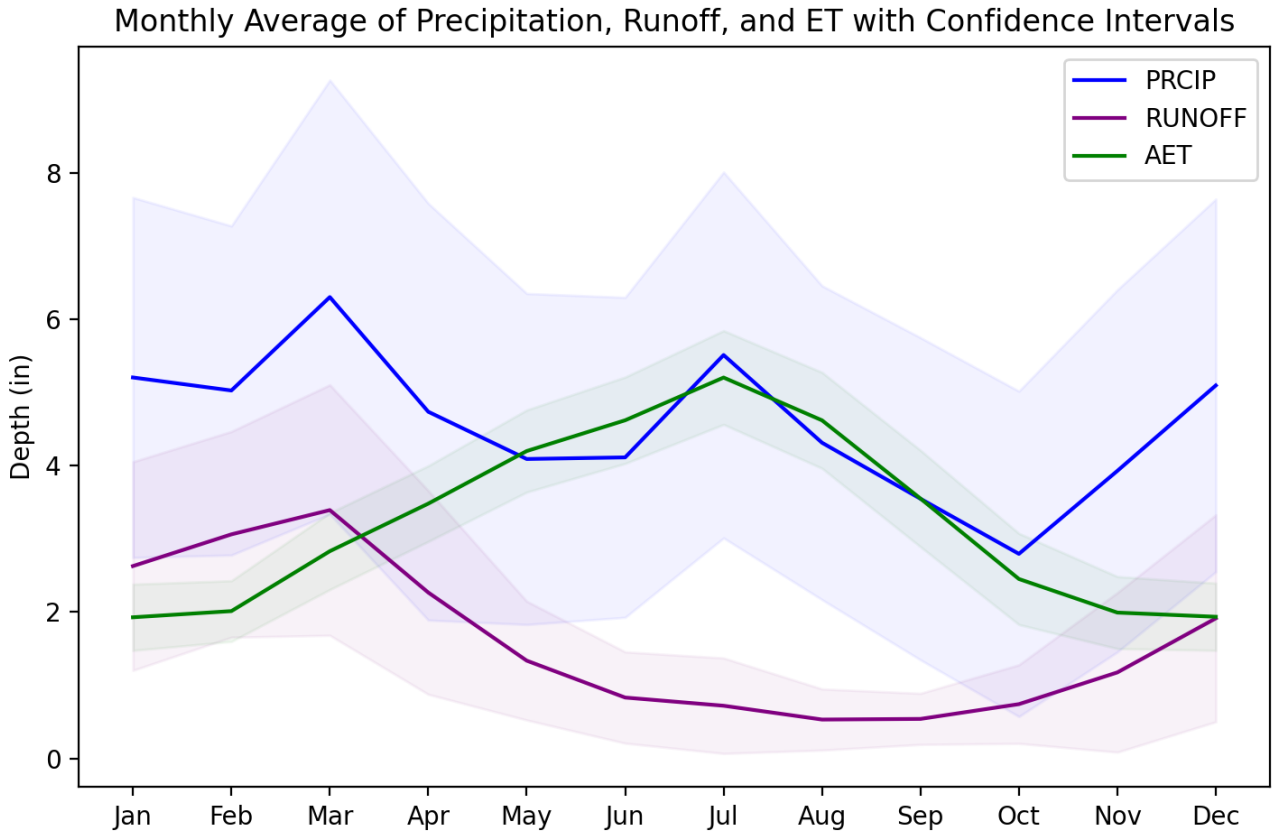
- The Southeast typically experiences abundant precipitation and is often regarded as a water-rich region



Our ecosystems have evolved in this water rich environment.

Southeastern Water Availability

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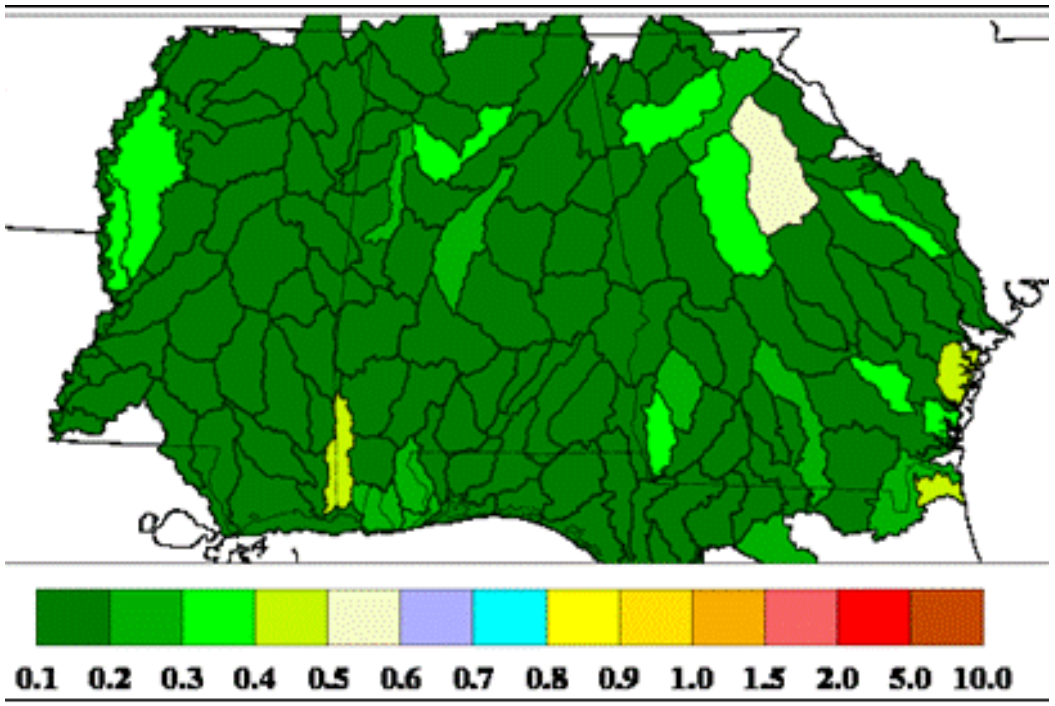
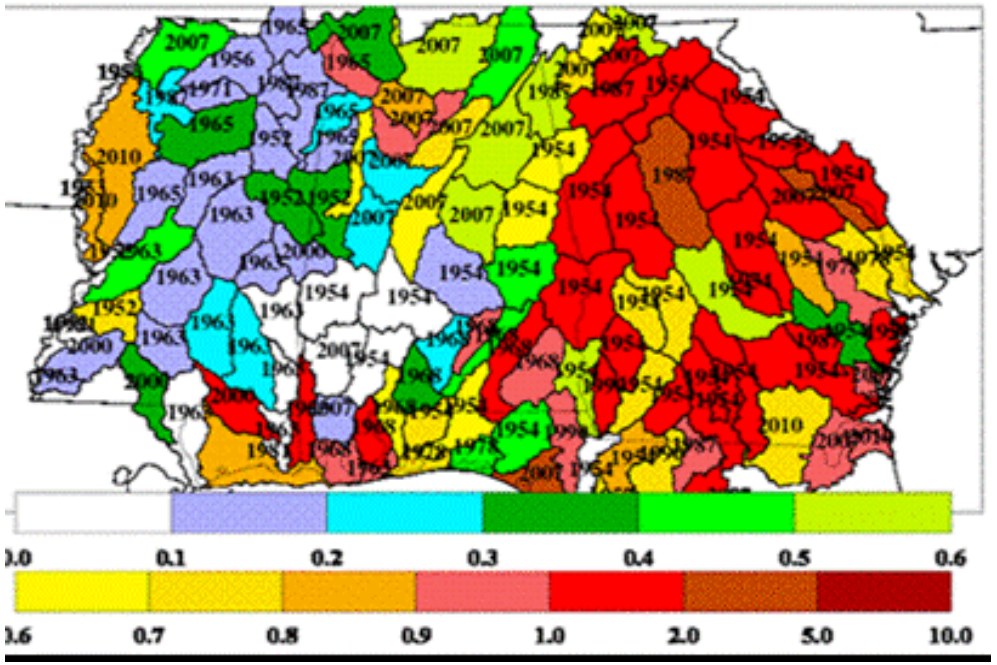
- Water Supply Stress Index

$$WaSSI = \frac{Total\ Water\ Demand}{Water\ Supply}$$

Average WaSSI (195-2015)



Maximum WaSSI (195-2015) and the year it occurred



On average, we have enough water, sometimes we don't

The Southeast is No Stranger to Drought

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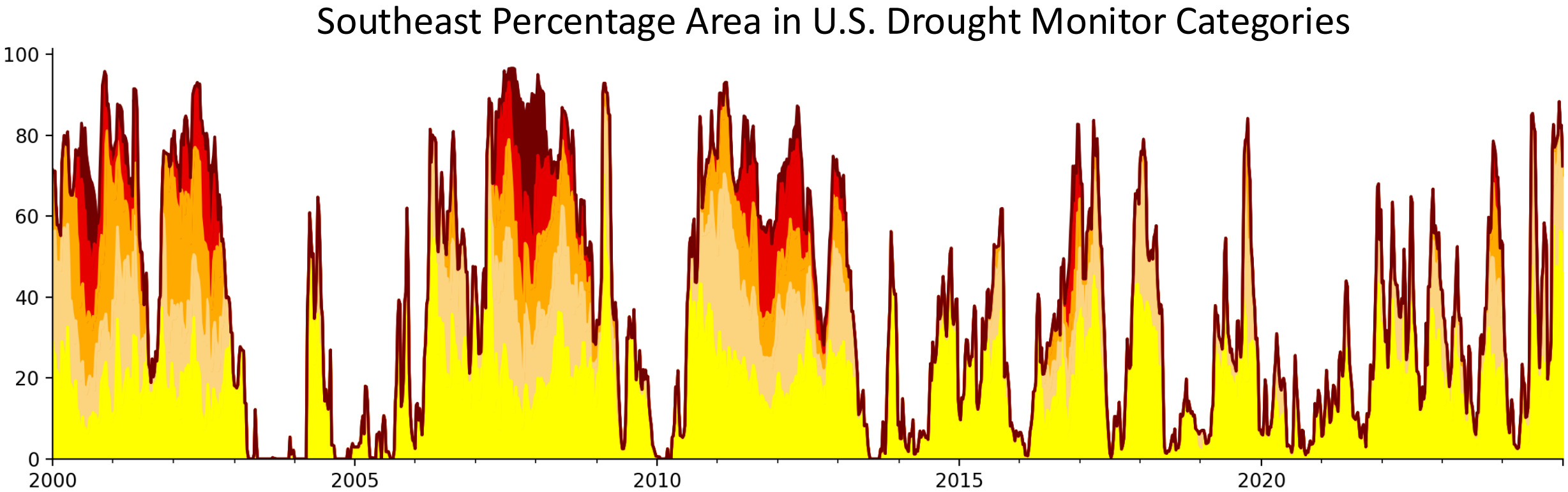

In the past 25 years the SE has experienced several long-term droughts and numerous short-term drought

The Southeast is No Stranger to Drought

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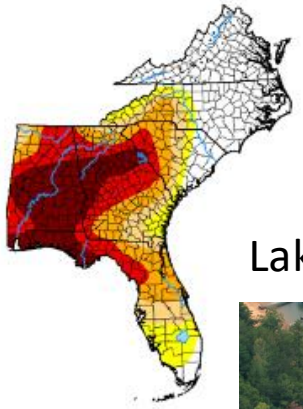
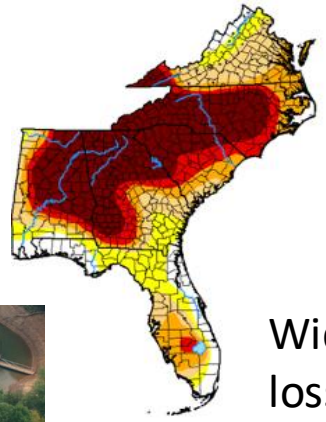
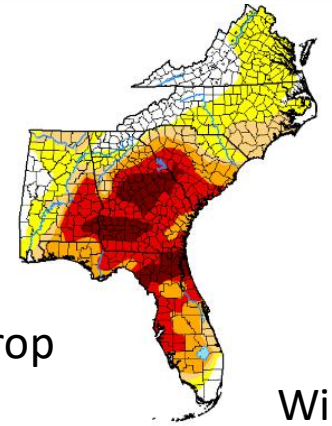
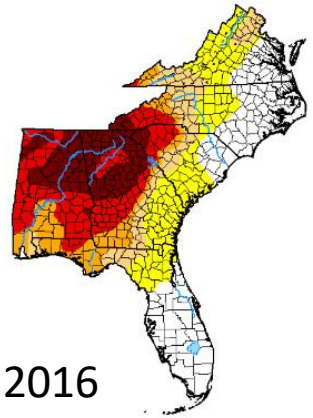
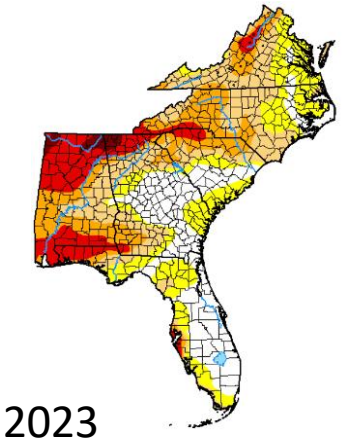








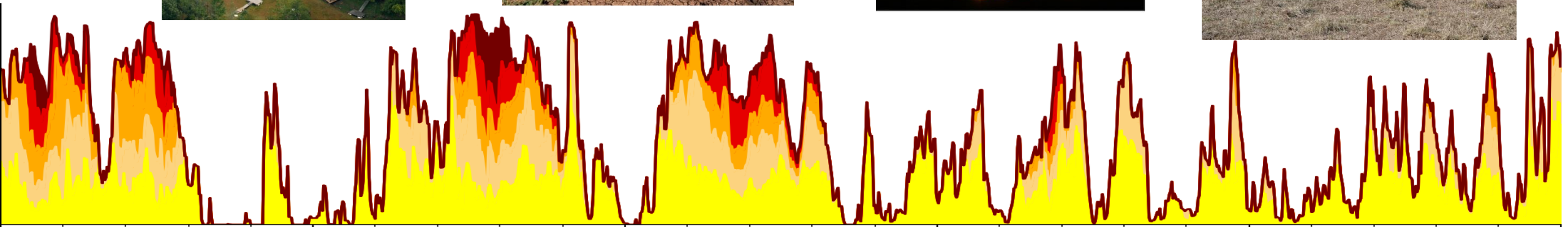


Lake Lanier, 2007

Widespread crop loss, 2011

Wildfires, 2016

Parched Pastures, 2023



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The Southeast is No Stranger to Drought

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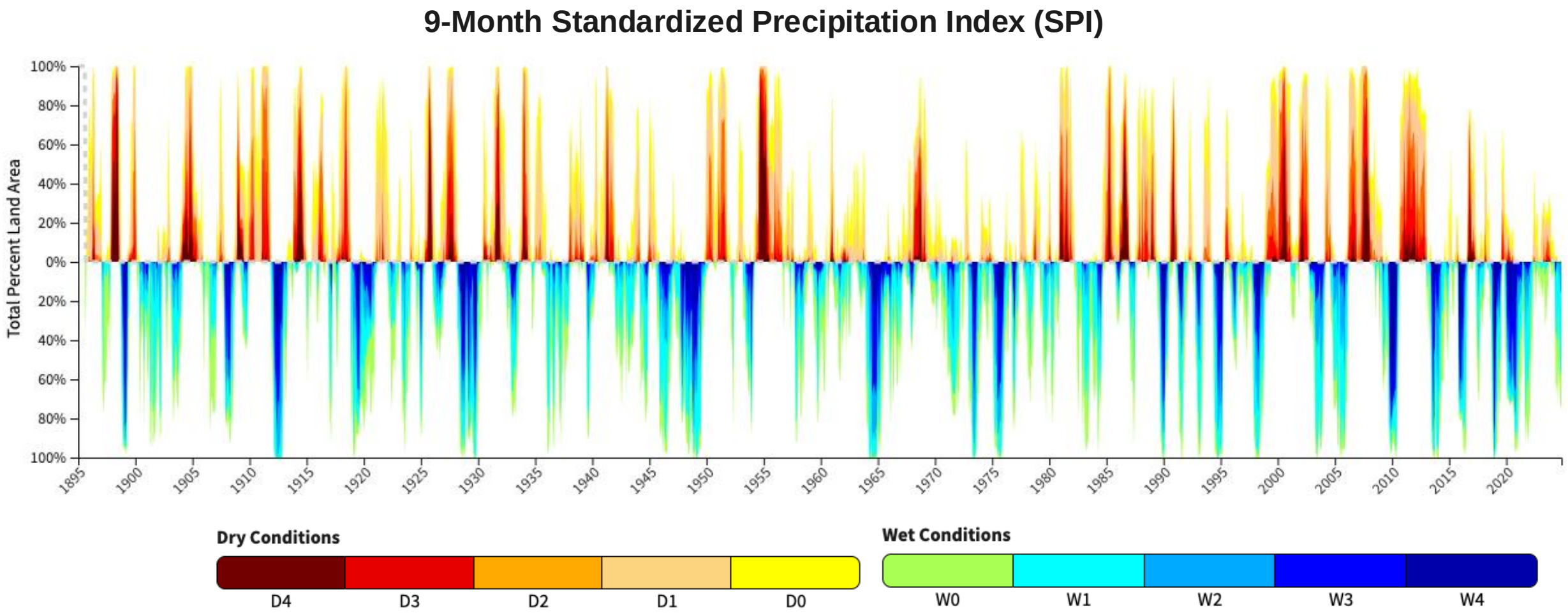

Southeast Rainfall Patterns

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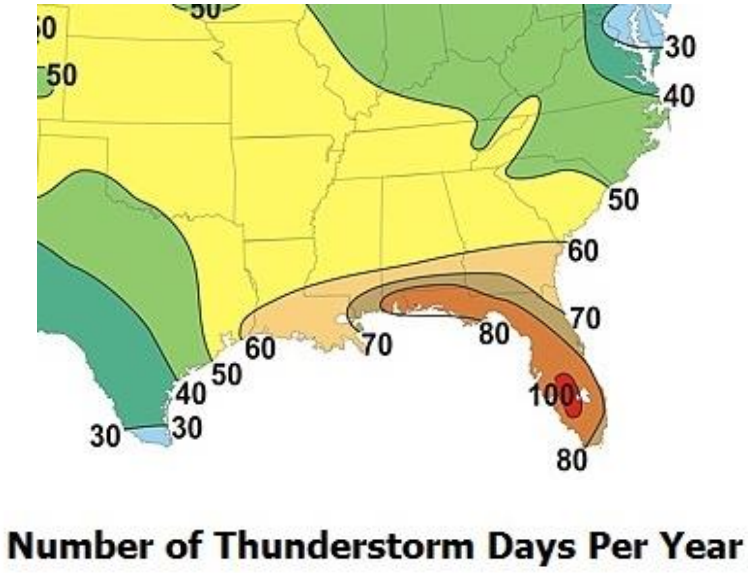
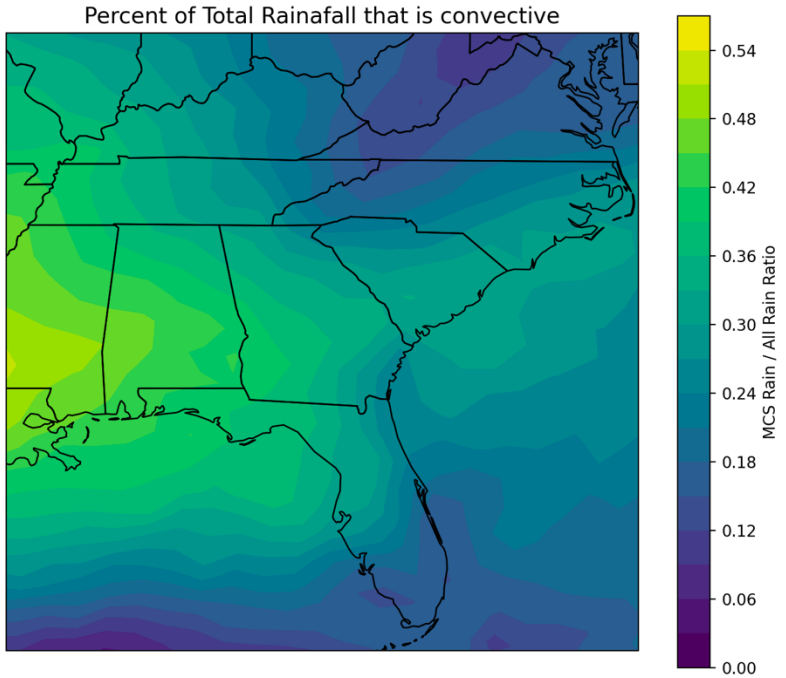
- Rainfall patterns are characterized by their variability
  - Mesoscale Convective System (summer-time thunderstorms)
  - Tropical Systems
- High variability and "hit-and-miss" precipitation skews averages
- Tropical events account for 10-15% of the region's June - November precipitation



Number of Thunderstorm Days Per Year



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Source: Data provided by Haberlie et al. 2023

Southeast Rainfall Patterns

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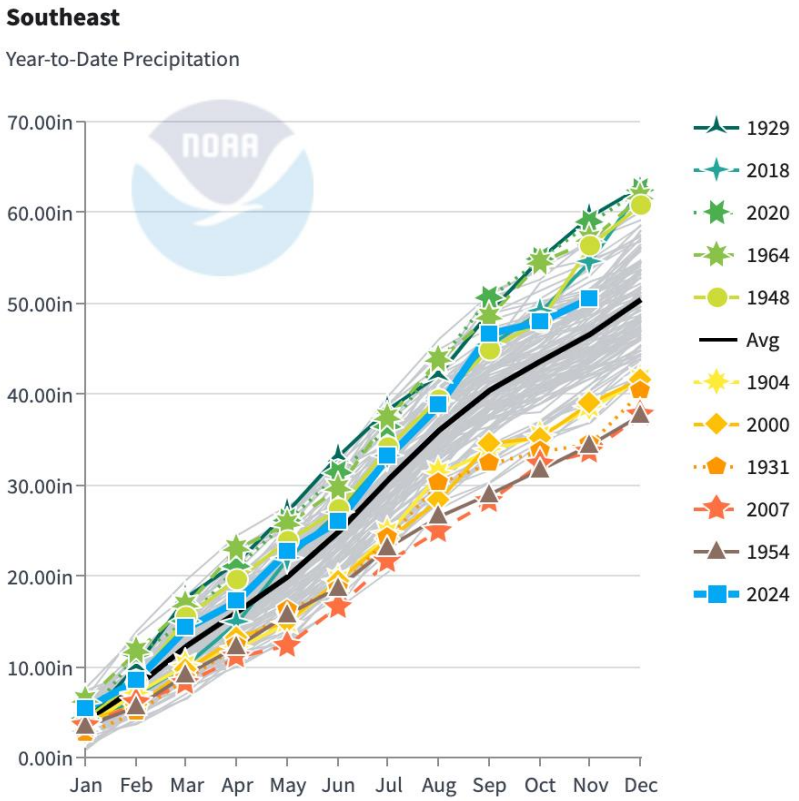
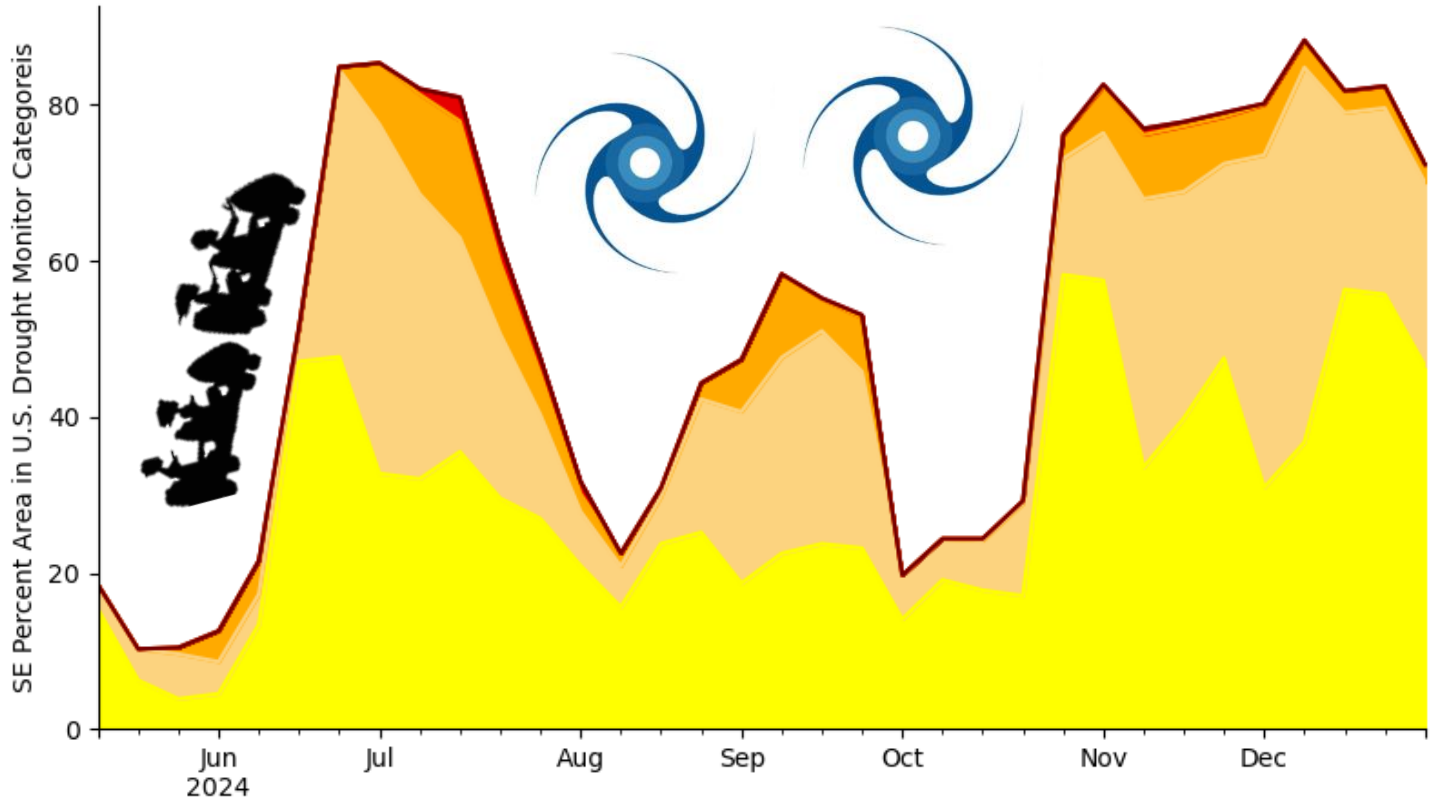
A prime example of extreme variability: The roller coaster of 2024





Year to date 2024 was a normal to slightly above normal for the region. This is far from the full story…

It’s Not Just a Lack of Rainfall

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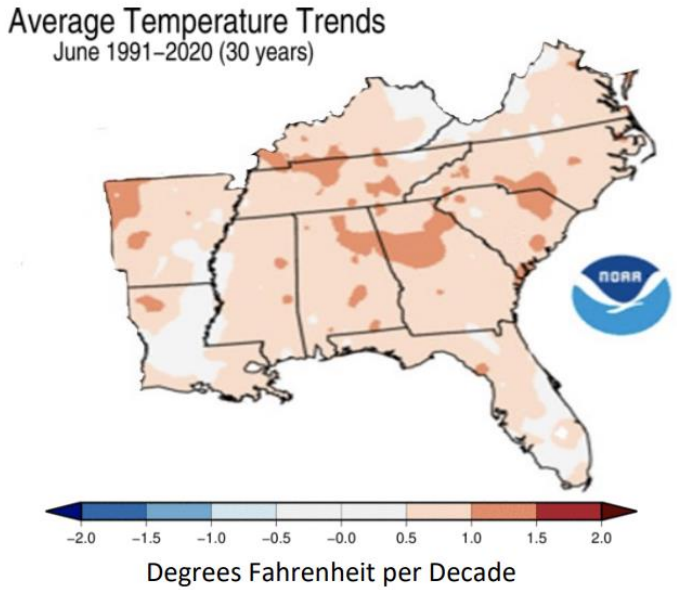
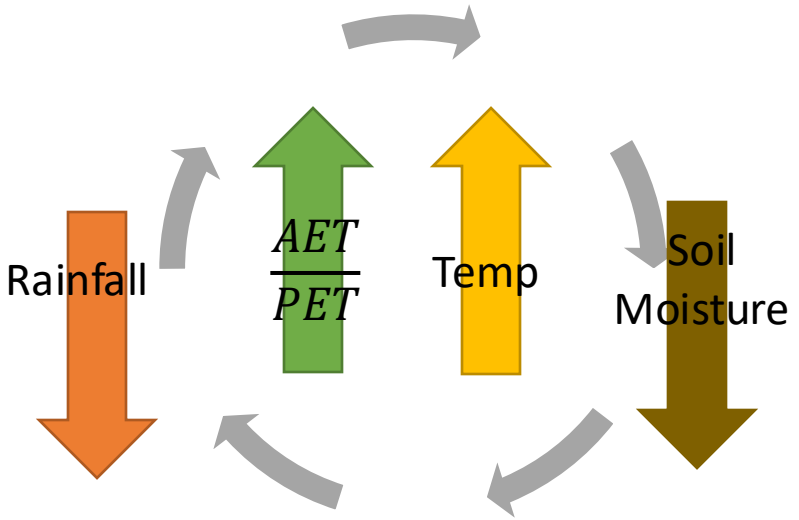
- Rising temperatures, as indicated by climate trends, may lead to more severe and extreme droughts in the region.
- Sustained above-normal temperatures or heatwaves frequently accompany flash droughts.





2019 North Carolina Flash Drought

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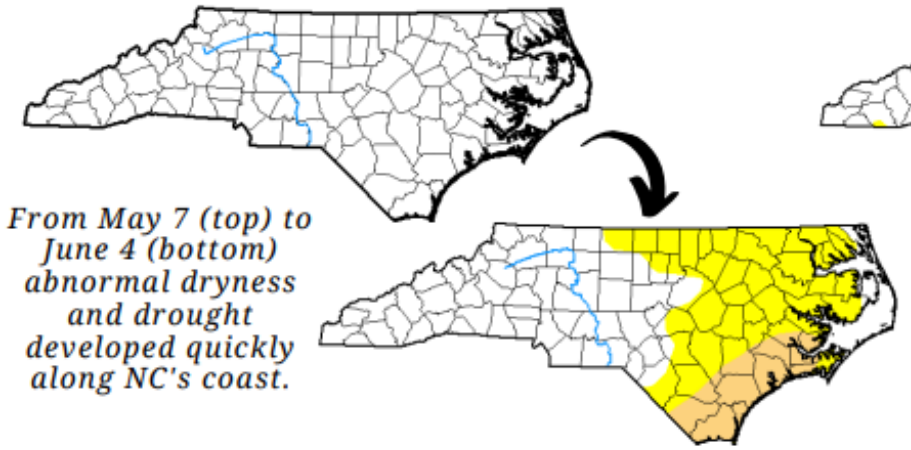
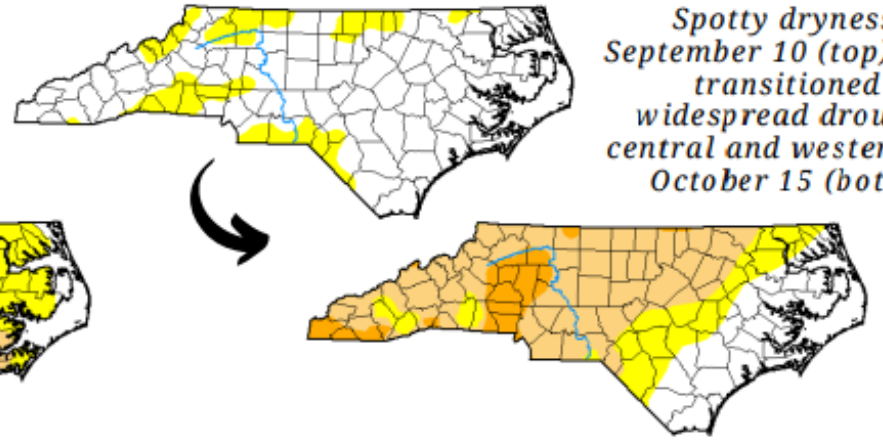
2019			DM
Jan	+1.9°	-0.06"	0%
Feb	+6.2°	+1.16"	0.6%
Mar	-0.5°	-1.07"	2.0%
Apr	+3.3°	+1.66"	2.0%
May	+5.7°	-1.71"	17.7%
Jun	+0.5°	+1.25"	34.9%
Jul	+2.1°	-0.92"	30.0%
Aug	+1.4°	-0.14"	24.8%
Sep	+4.6°	-1.20"	34.8%
Oct	+5.0°	+1.63"	66.5%
Nov	-2.0°	+0.32"	25.6%
Dec	+5.0°	+0.89"	3.8%
Annual	+2.8°	+1.80"	



From May 7 (top) to June 4 (bottom) abnormal dryness and drought developed quickly along NC's coast.



Spotty dryness on September 10 (top) quickly transitioned to widespread drought in central and western NC by October 15 (bottom).

Monthly Temperature Rankings:

Record Coolest	Coolest 10%	Coolest 33%	Near Normal	Warmest 33%	Warmest 10%	Record Warmest

Monthly Precipitation Rankings:

Record Driest	Driest 10%	Driest 33%	Near Normal	Wettest 33%	Wettest 10%	Record Wettest

US Drought Monitor Categories:

D0: Abnormally Dry	D1: Moderate Drought	D2: Severe Drought	D3: Extreme Drought	D4: Exceptional Drought

Source: NC Climate Office and CISA

A Region Prone to Flashy and Unpredictable Droughts

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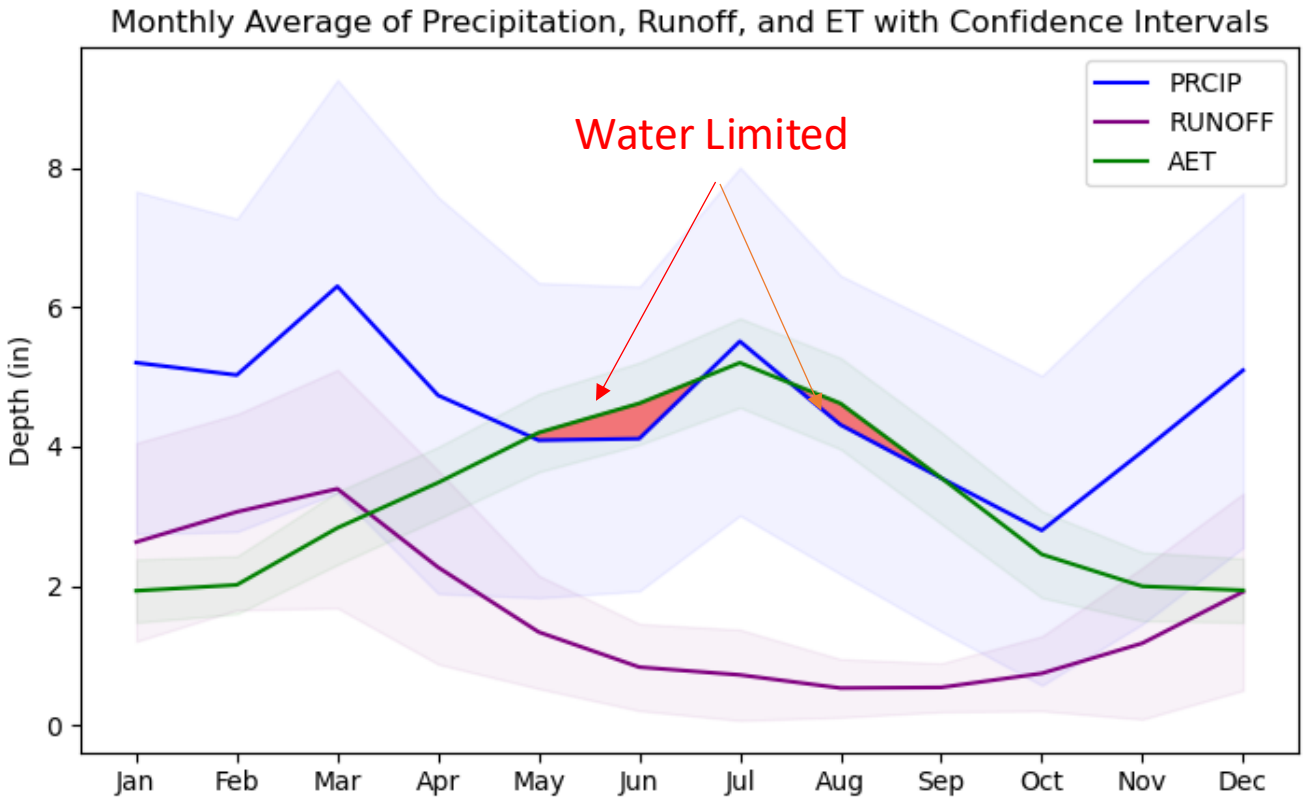
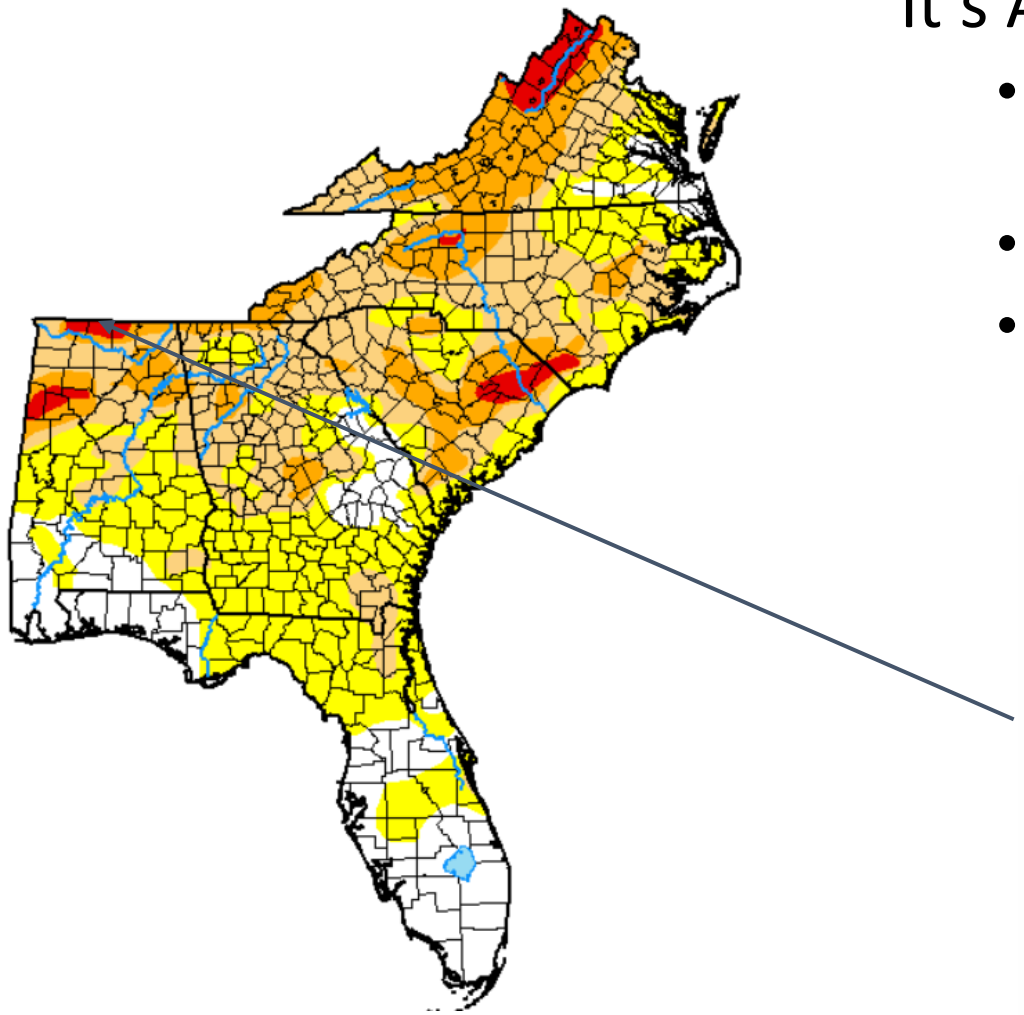
- Rapid drought development is common in the Southeast, driven by a combination of limited rainfall and elevated temperatures that heighten soil water evapotranspiration

- 1-2 weeks without rain during water limited seasons, can mean quickly drying conditions
  - High Evaporative Demand
  - Low water holding soils
    - High sand content
    - Low organic matter

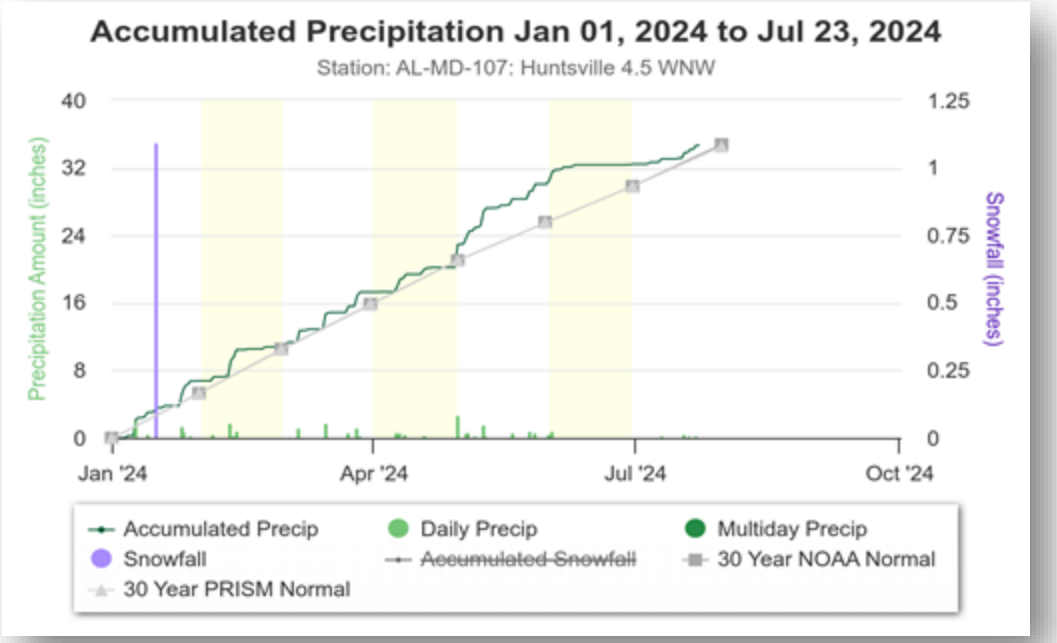


Beyond Rainfall Amounts



It's About Timing, Intensity, and Location

- Rainfall distribution (temporal and spatial) is more critical than totals
- Droughts can be isolated
- Impacts can vary widely based on timing



Beyond Rainfall Amounts

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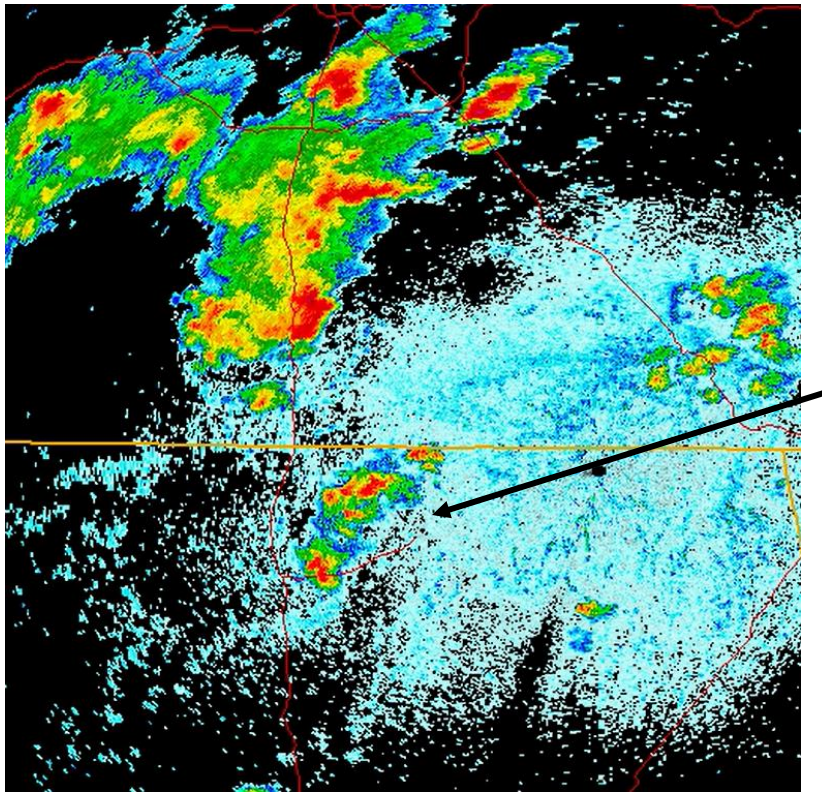
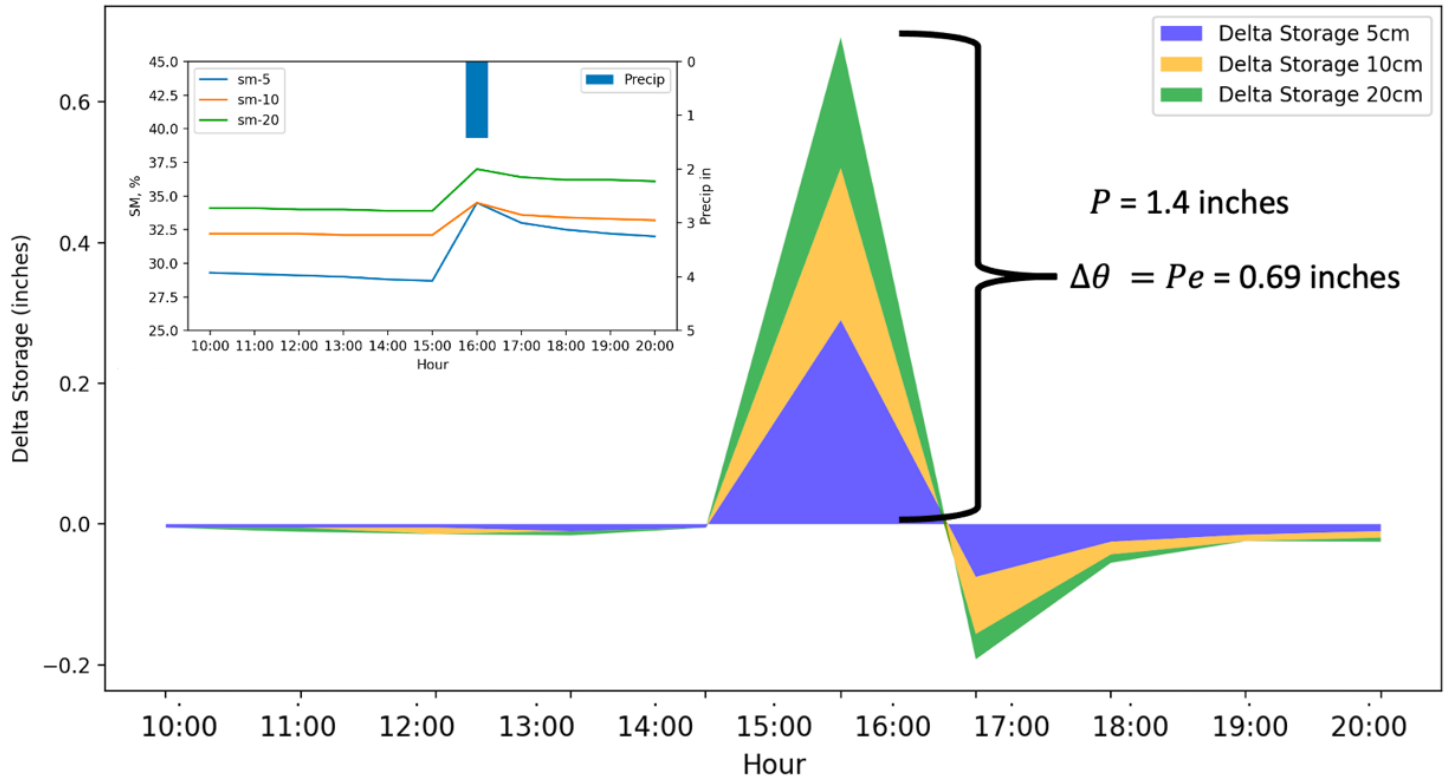
It's About Timing, Intensity, and Location

- Rainfall intensity can mask the effective precipitation

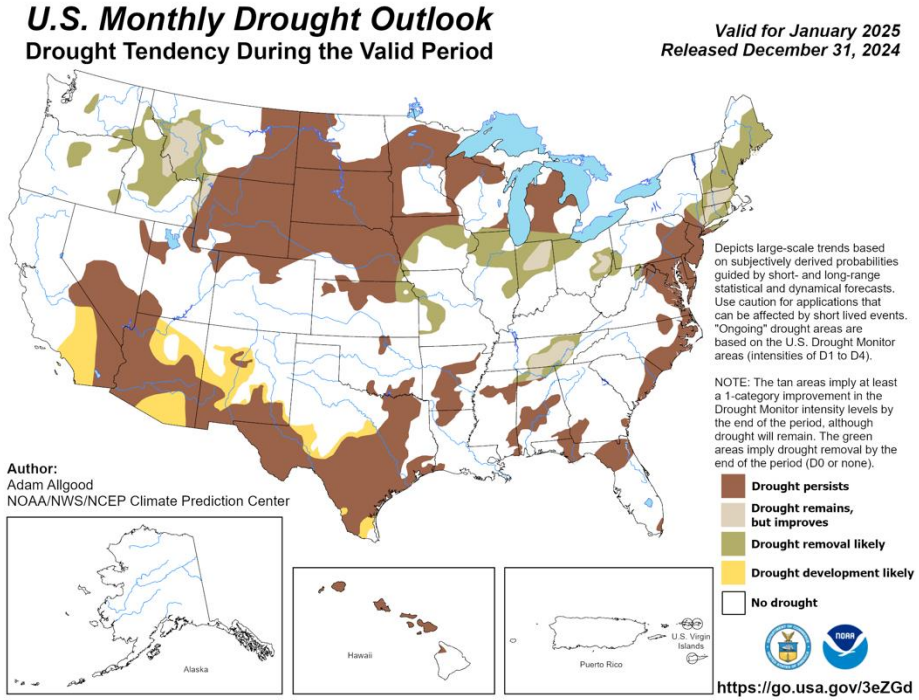




The Limits of Predictability

- Forecasts for drought prediction are limited, with reliable forecasting constrained to the short-term (10-15 days). Pattern recognition at 3-5 weeks
- Even short-term forecasts struggle with accuracy for convective events due to their localized and unpredictable nature.

Facebook Post from a local meteorologist in AL



The Limits of Predictability

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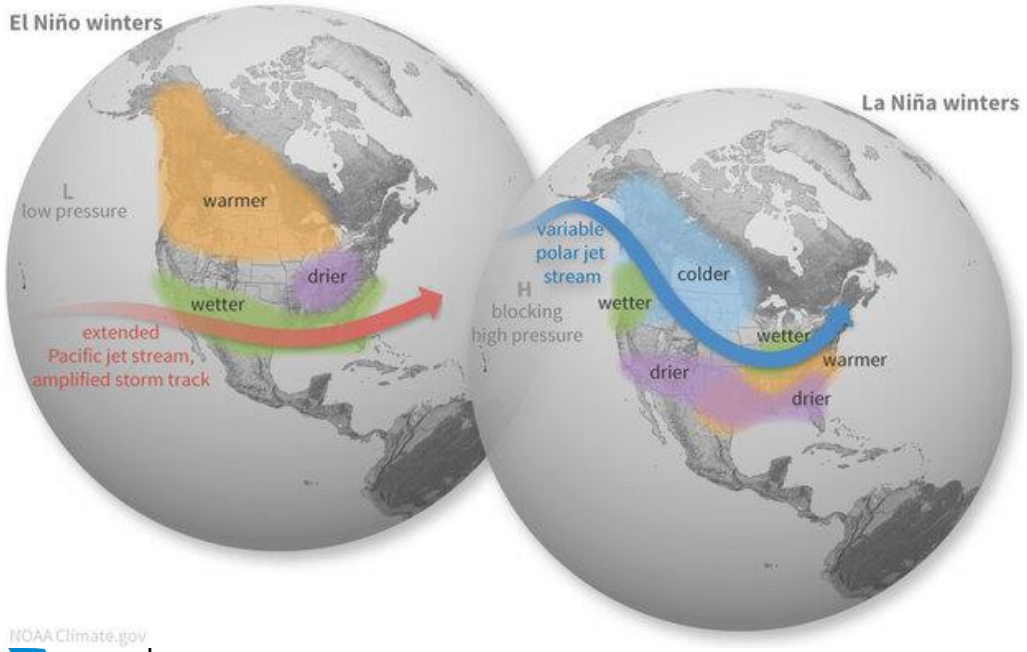
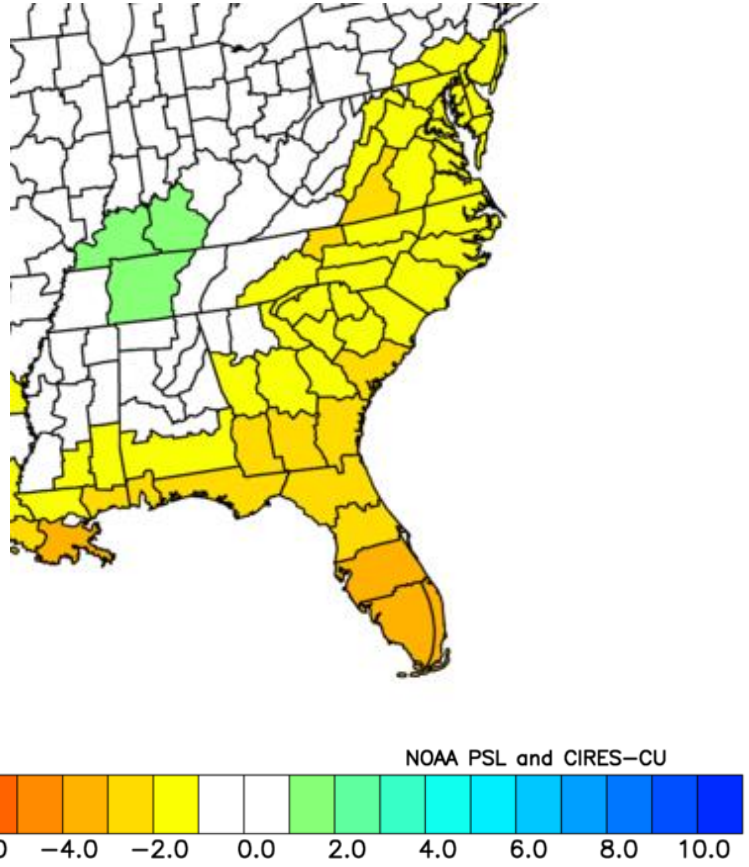
- Seasonal trends offer some reliability, especially when linked to ENSO cycles, but early forecast can be unreliable especially in early spring-time forecasts
- ENSO is the most commonly used climate indicator for decision-making, despite its variability and limitations.



La Nina Winter Precipitation Anomalies



Drought Impacts

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- An increasing interest in the climate and weather community to link drought and precipitation timing with socio-economic and ecosystem impacts.
- Making strides in the Agriculture and Forestry Communities

Ecosystem Impacts: A Critical Gap

- Ecosystem impacts of drought remain underrepresented in current monitoring efforts.
- Addressing this gap is vital for a more holistic understanding of drought impacts.

The Amazon of North America

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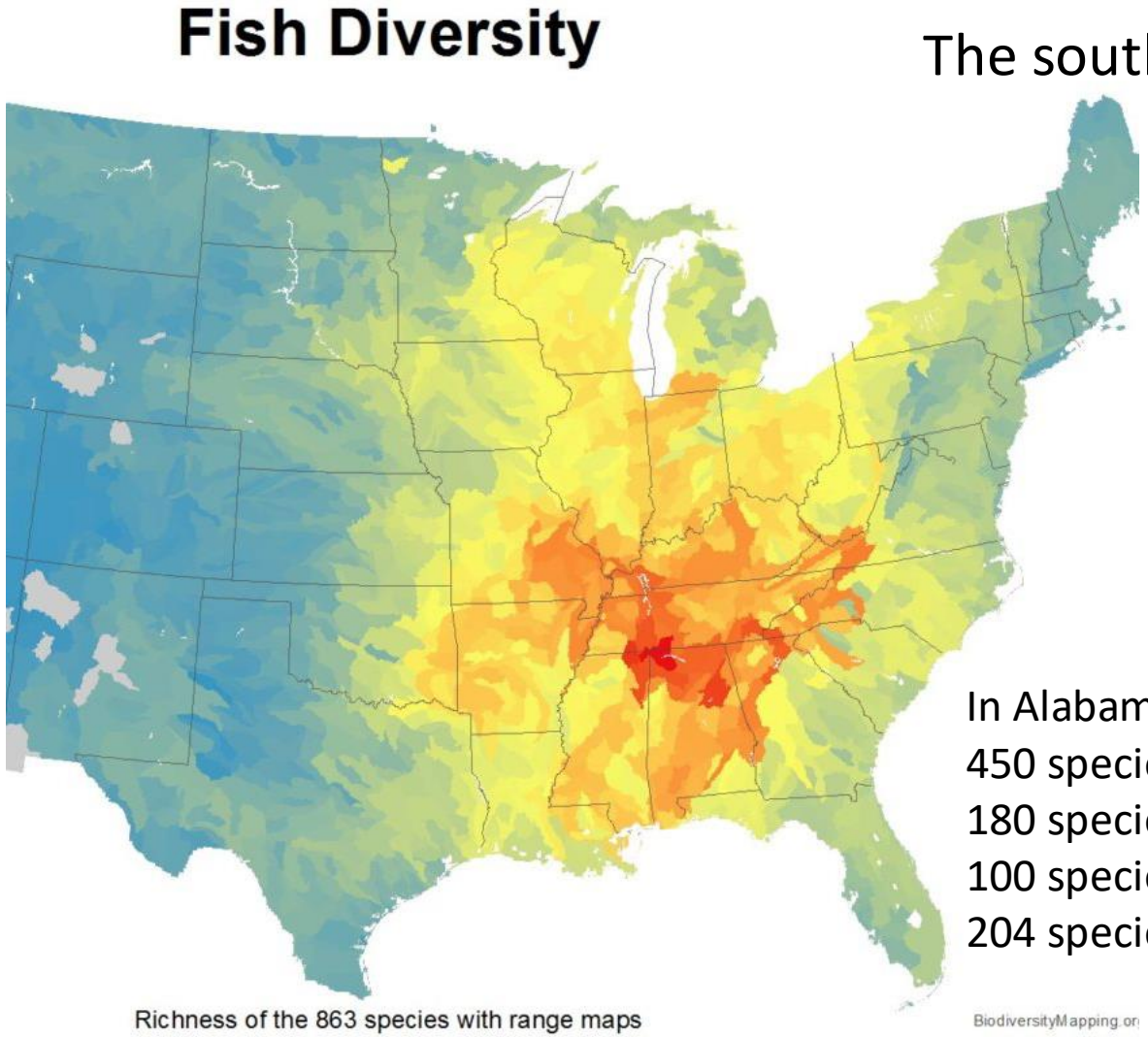


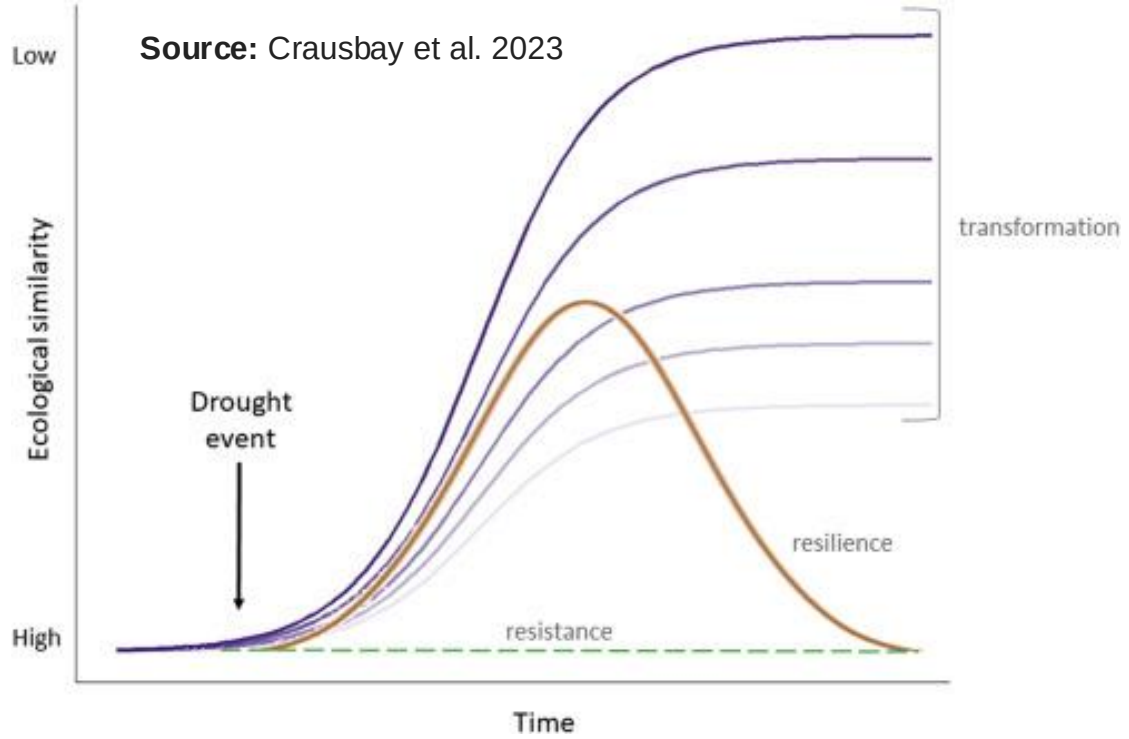
The southeast is host to incredibly diverse ecosystems

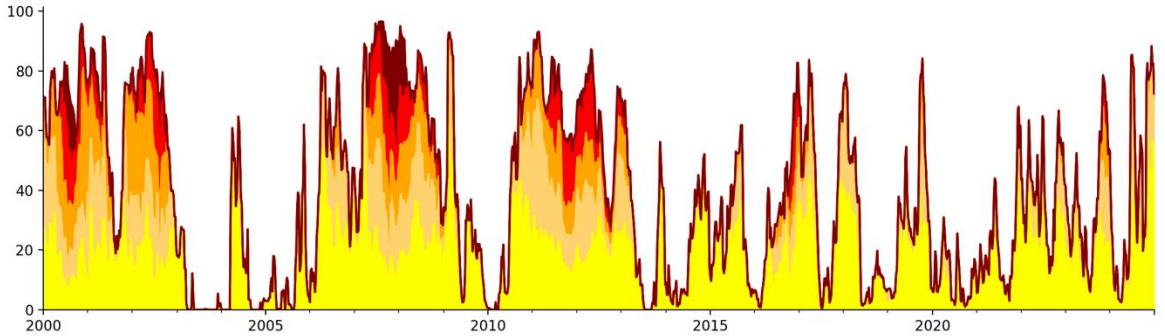
In Alabama Alone:
450 species of fish
180 species of mussels
100 species of crayfish
204 species of snails

The Cahaba Lilly, only found in Alabama, Georgia, and South Carolina

Ecosystem Impacts

- Ecosystems respond slower than agriculture and water resources
- Ecosystems see drought as a continuum, not necessarily specific events
- Ecosystems respond differently and can be transformed by episodic droughts
    - Local species reduction or extinction
    - Land conversion
    - Change in flow regimes
- Drought declarations and relief often overlook ecosystem needs





Droughts in The Southeast

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Drought is Complex and Unique in the Southeast

- Rapid hydrologic cycle, flashy droughts, and high variability make droughts in the Southeast particularly challenging to predict and monitor.

Understanding Drought Timing and Impacts is Critical

- The timing, duration, and location of drought events are vital for better understanding drought in the region.

Ecosystem Drought Impacts Remain a Gap

- There is a strong need to improve the integration of ecosystem impacts into drought monitoring

The Hydro 'Illogical' Cycle

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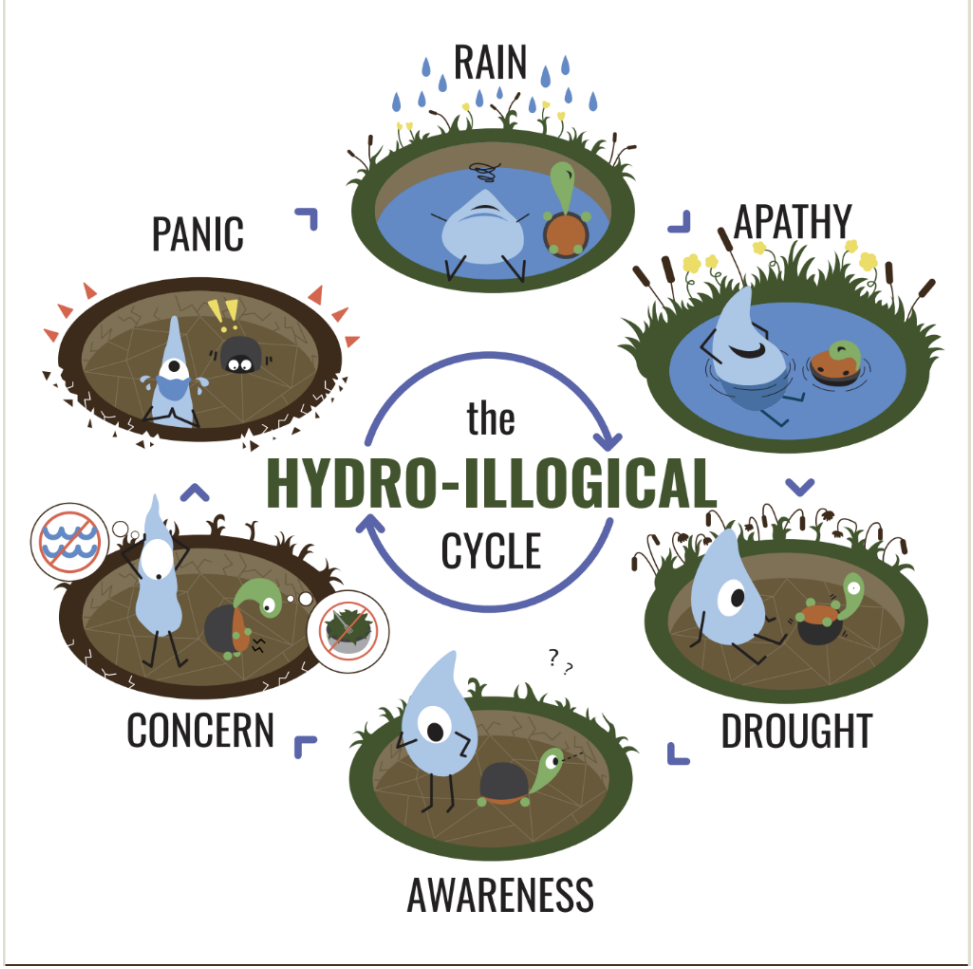
Though we have a storied history of drought, it is tough maintaining interest in a 'Wet' Region

- Difficult to sustain awareness in non-drought periods
- Public perception often dismisses drought risks
- Impacts can vary for short-term vs long-term droughts

It’s important to plan and prepare

- Updated drought contingency plans in place




Thank You