

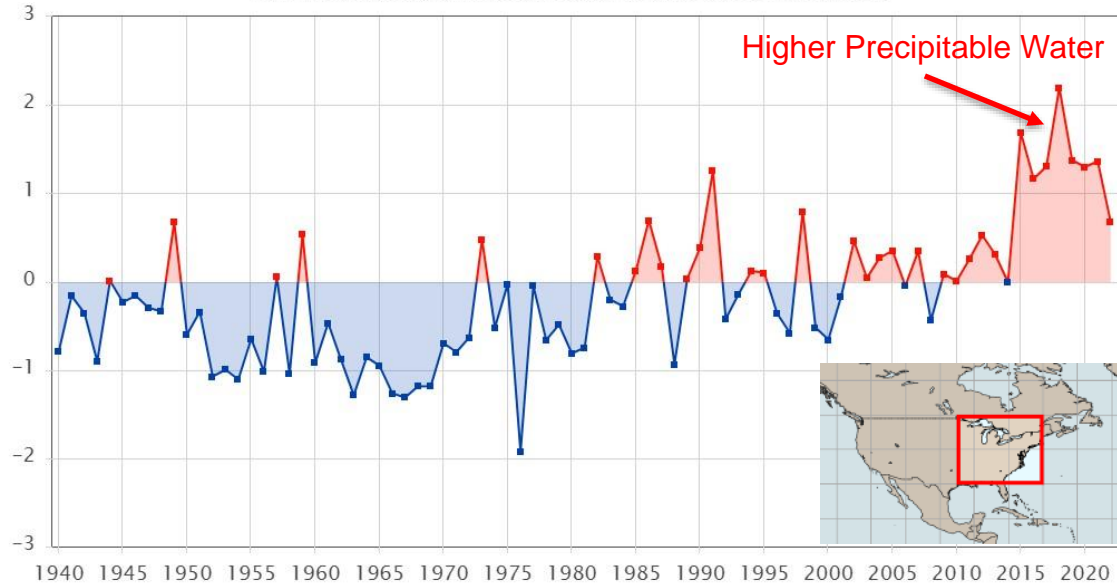
# Extreme Weather Trends



# Trends in Precipitable Water

Annual Total Column Precipitable Water Anomaly (kg/m<sup>2</sup>) [1981–2010]  
Specify Area (30°N–50°N, 95°W–70°W)

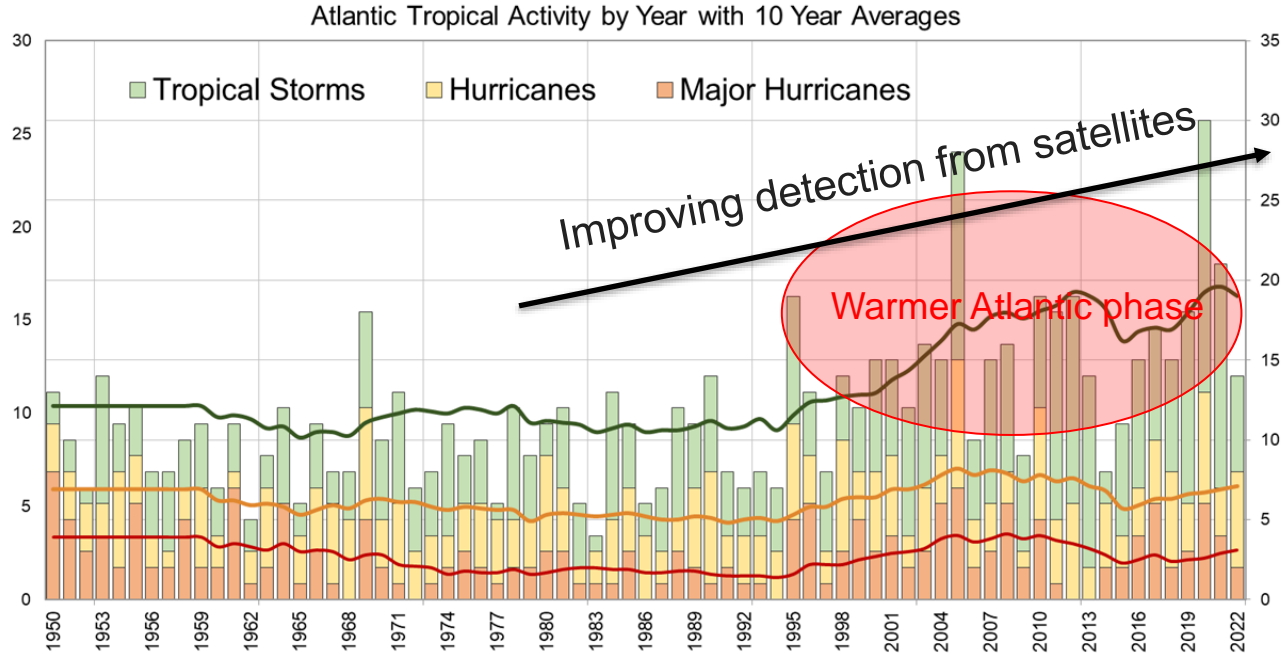
ECMWF ERA5 (0.5x0.5 deg) | ClimateReanalyzer.org, Climate Change Institute, University of Maine



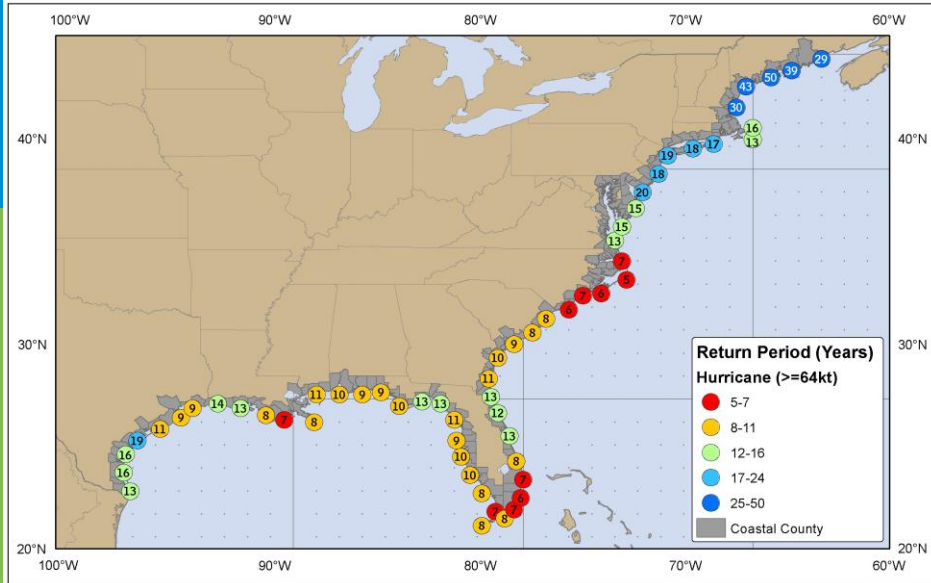
Clear trend toward high precipitable water in the eastern US

Increased precipitable water means increased moisture that systems can draw from, which increases risk for large precipitation events

# Trends in Tropical Storms & Hurricanes

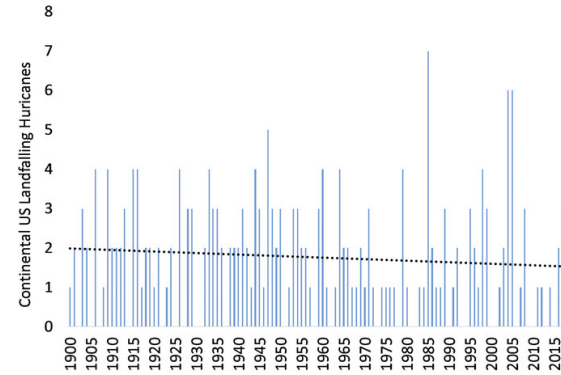


# Trends in Hurricane Landfalls

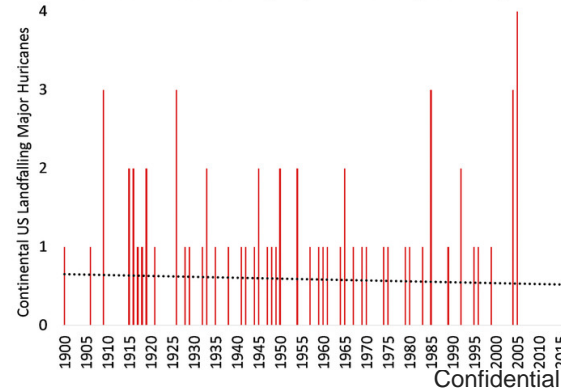


Hurricane Return Period (years)

(a) Continental US Landfalling Hurricanes (1900-2017)

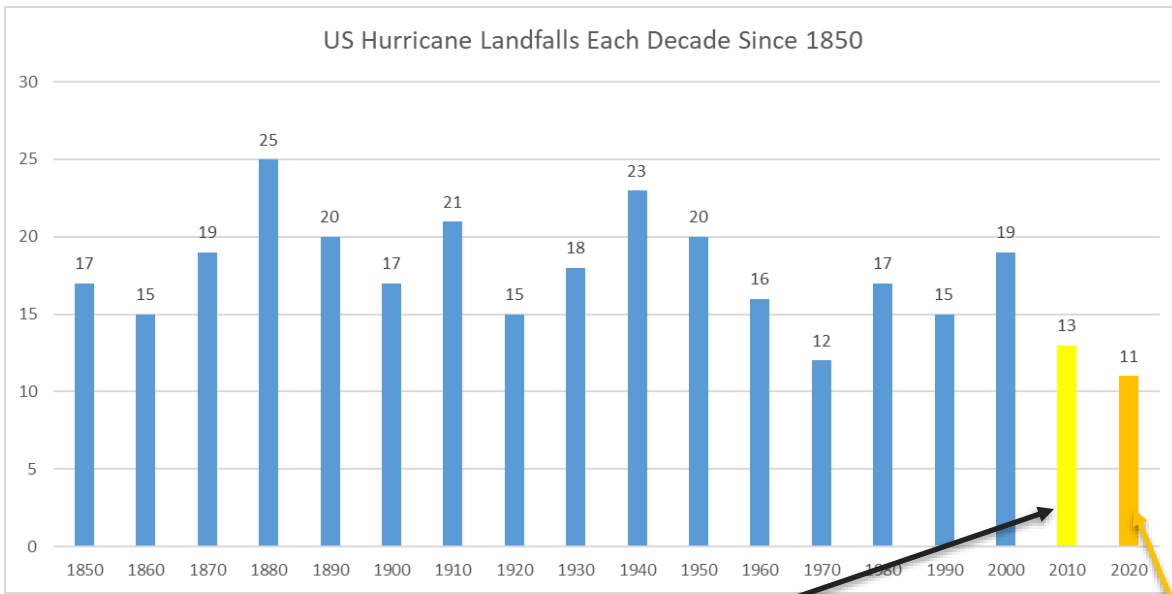


(b) Continental US Landfalling Major Hurricanes (1900-2017)



# U.S. Hurricane Landfalls by Decade (1850-2022)

US Hurricane Landfalls Each Decade Since 1850

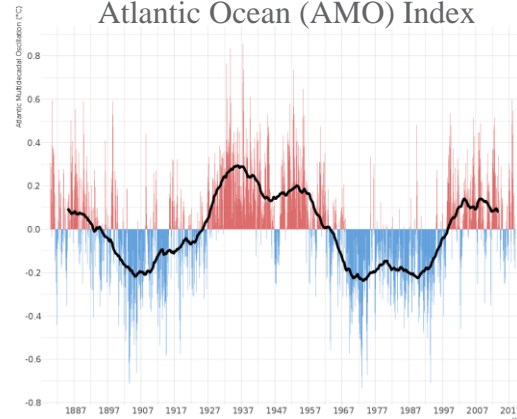


13 in 2010s – below average

2020-2022

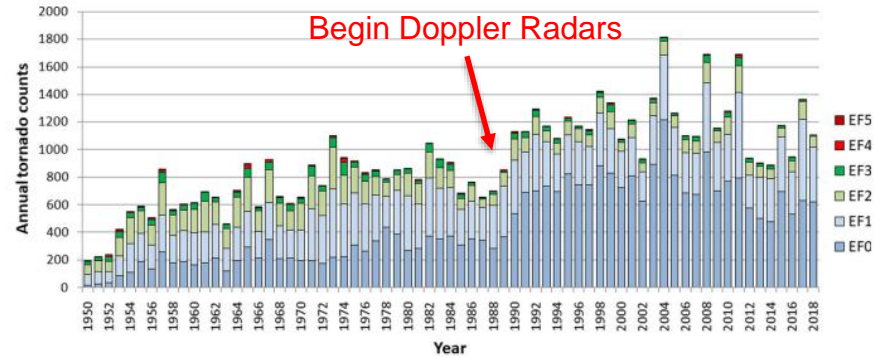
Average = 18/decade  
(1.8/year)

Atlantic Ocean (AMO) Index

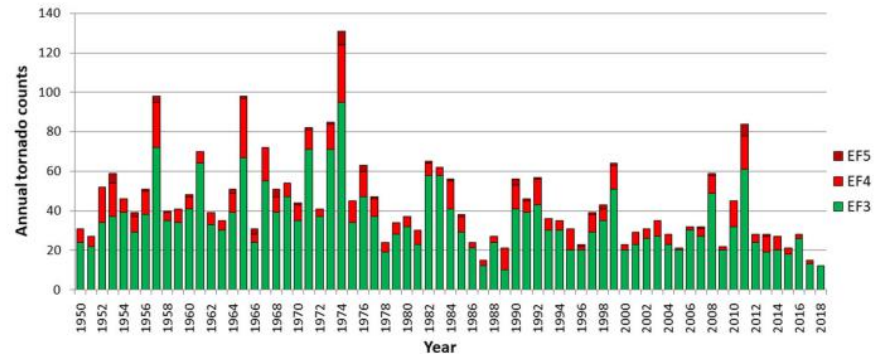


# Trends in U.S. Tornadoes

All Tornadoes



Strong Tornadoes



**Fig. 3** Annual count of all tornadoes (top) recorded in the USA and (bottom) only the strongest ones. ( Source: NOAA data plotted using the layout proposed by [24])



# Changes in Tornado Environments 1979-2017

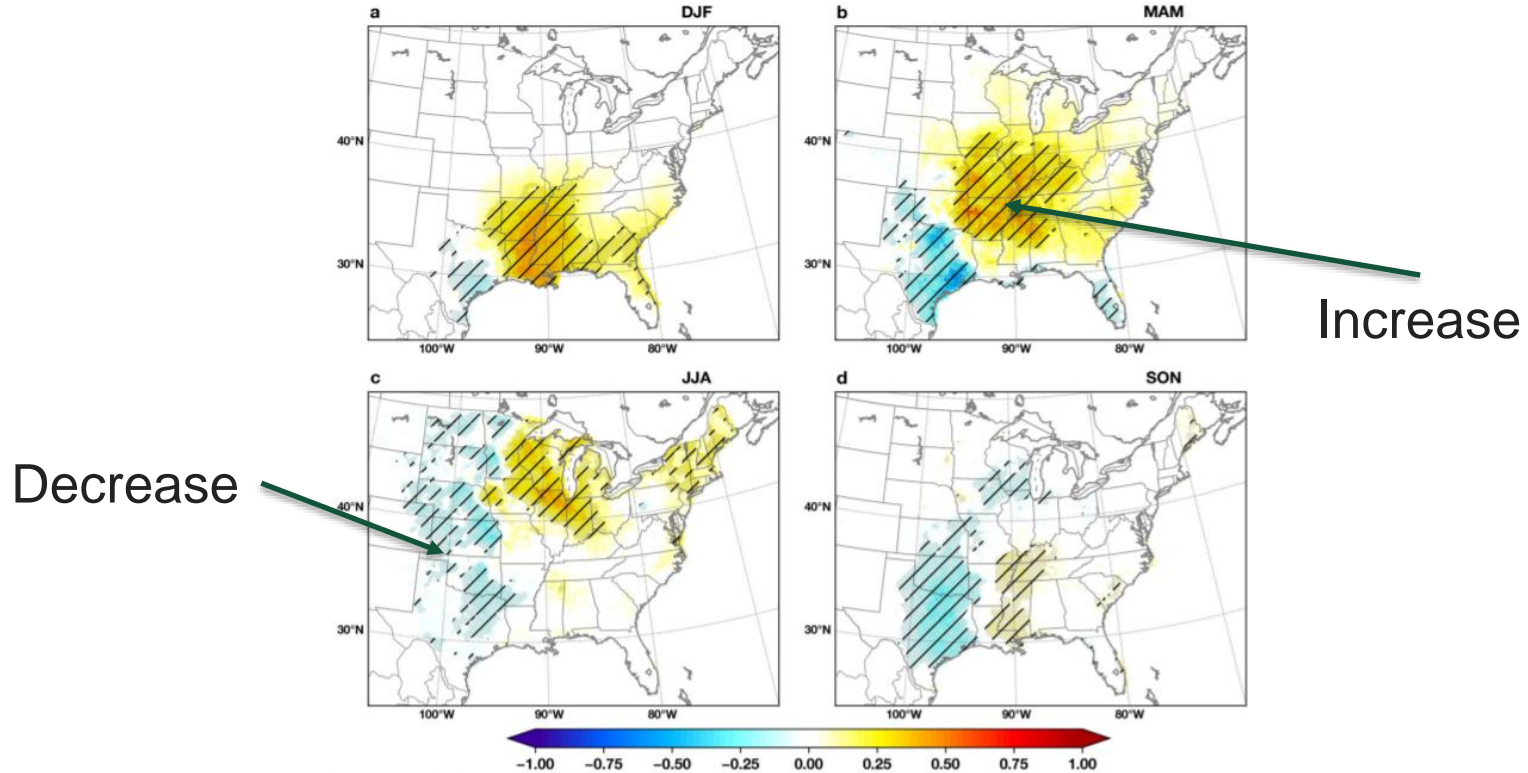
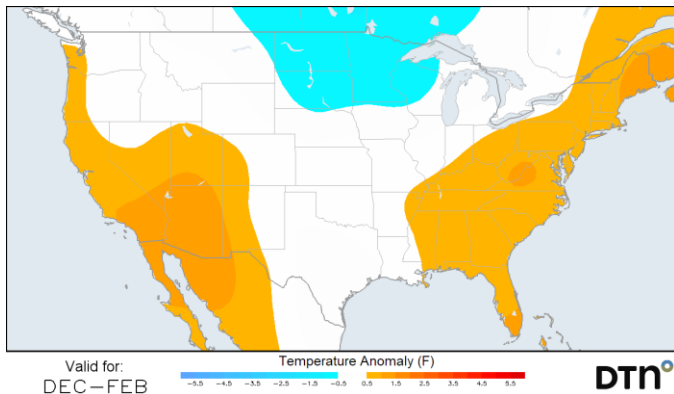


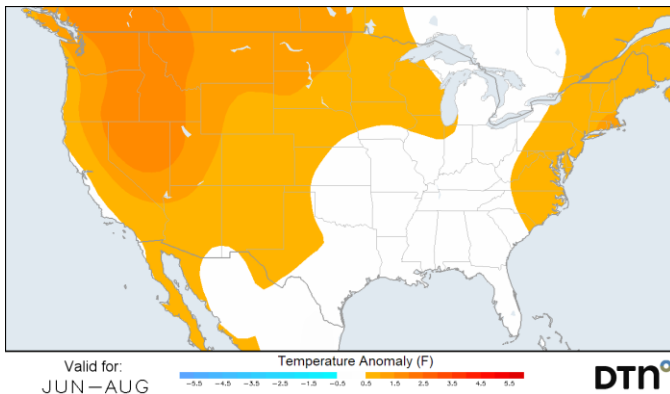
Fig. 6 Theil-Sen slope of 1979–2017 annual grid-point sum of daily max STP for a) December, January, February; b) March, April, May; c) June, July, August; and d) September, October, November.  $p$  values are hatched at values  $\leq 0.05$  significance using Kendall's  $\tau$  statistic. Slope units are sum of daily max STP per year

# Last 10-year Trend in Seasonal Temperatures

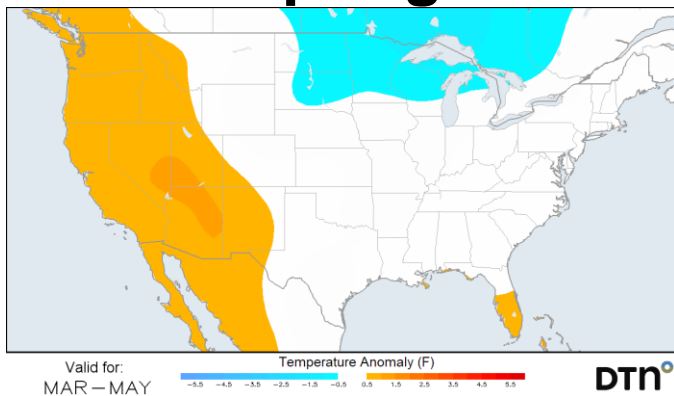
## Winter



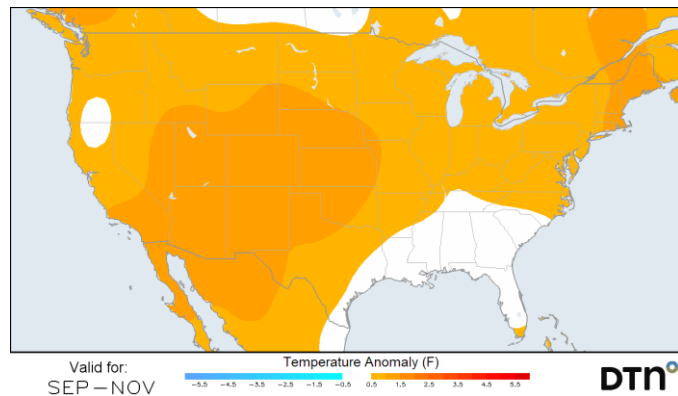
## Summer



## Spring



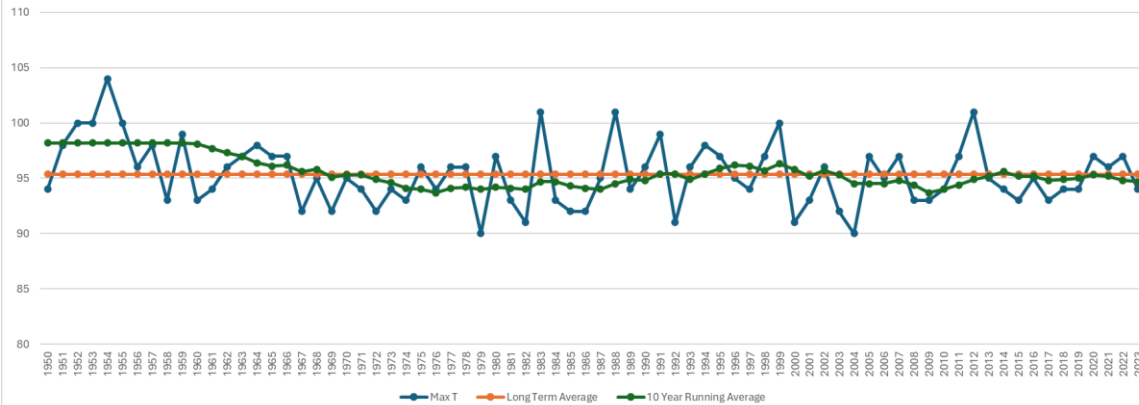
## Fall





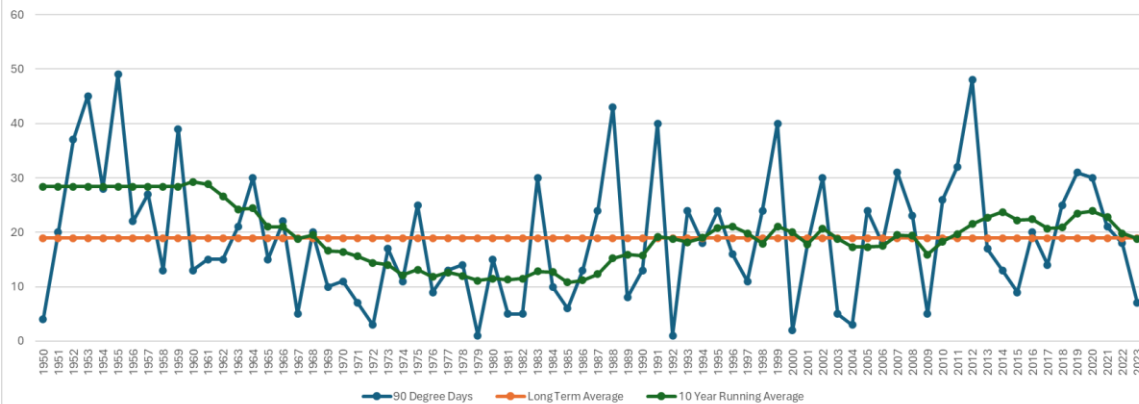
# Max Temperature Trends For Select Cities

Columbus, OH (KCMH) Yearly Max Temperature Since 1950

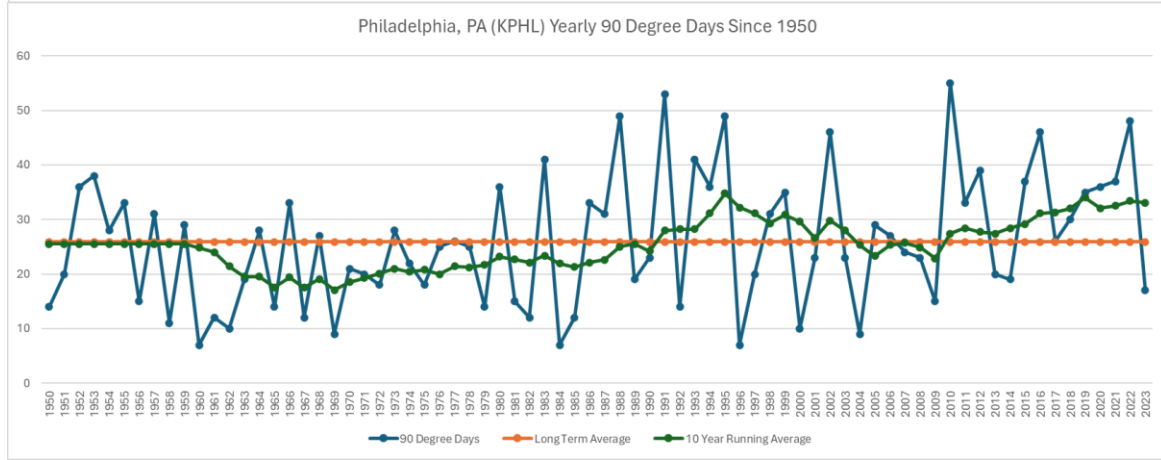
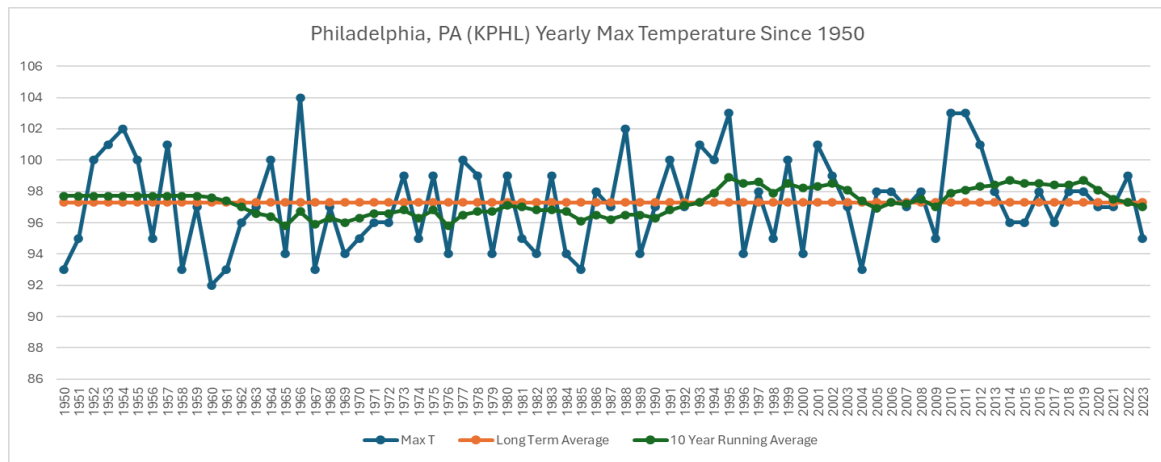


- No long-term increase in peak temperature
- 90-degree days are highly variable, but they have increased versus the 70s and 80s

Columbus, OH (KCMH) Yearly 90 Degree Days Since 1950

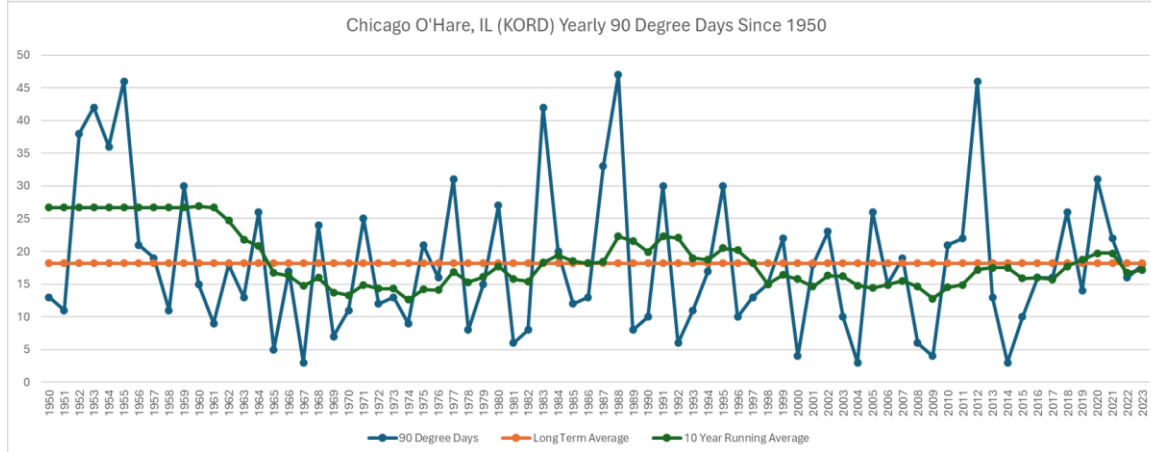
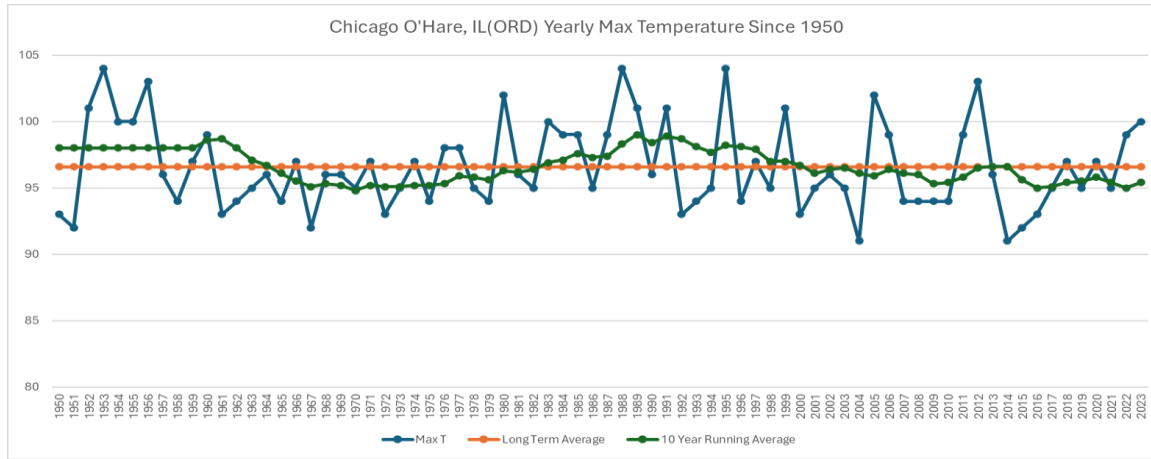


# Max Temperature Trends For Select Cities



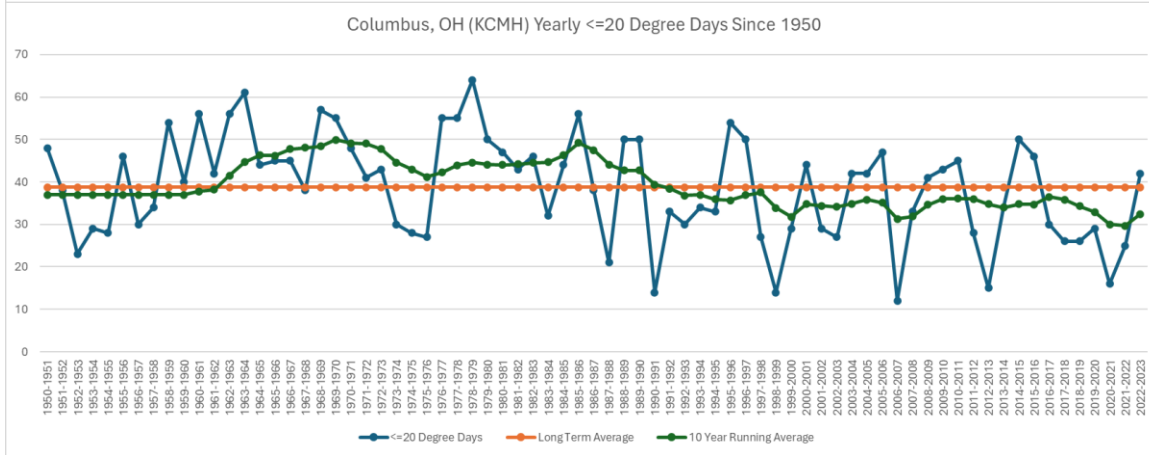
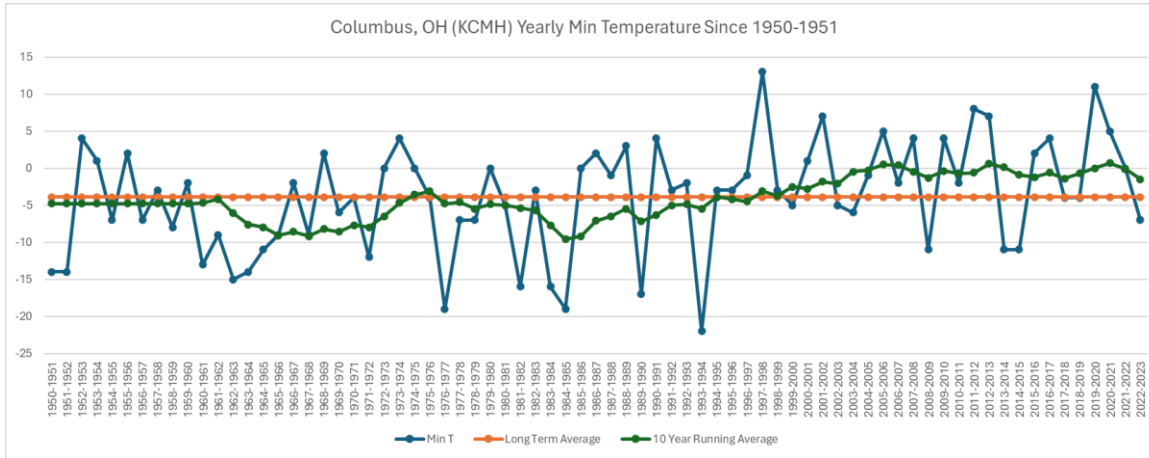
- No long-term increase in peak temperature
- An overall increase in 90-degree days has been observed
- 90-degree days are highly variable year to year

# Max Temperature Trends For Select Cities



- No long-term increase in peak temperature
- 90-degree days are highly variable, but they have increased versus the 70s and 80s

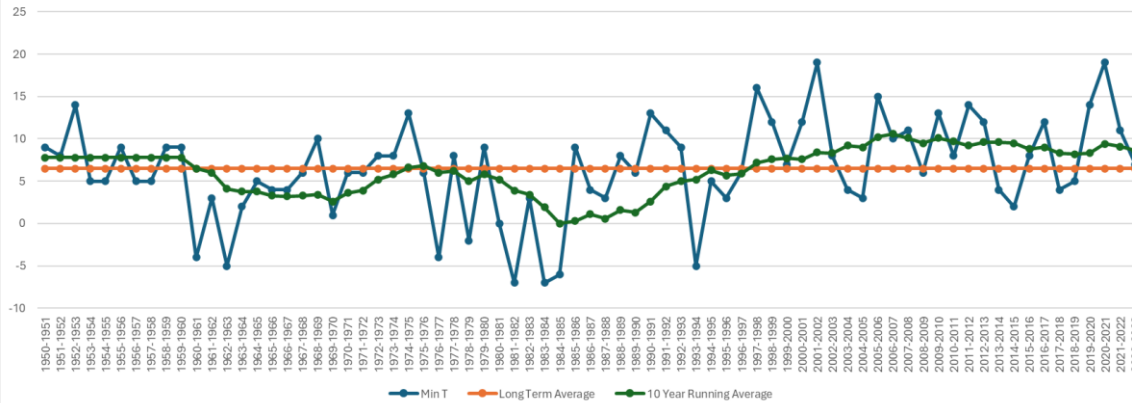
# Min Temperature Trends For Select Cities



- Clear upward trend in minimum temperatures starting in the 1990s
- Clear downward trend in 20-degree or colder days since the 1990s
- There are a few individual years that rival some of the colder years in the 1970s

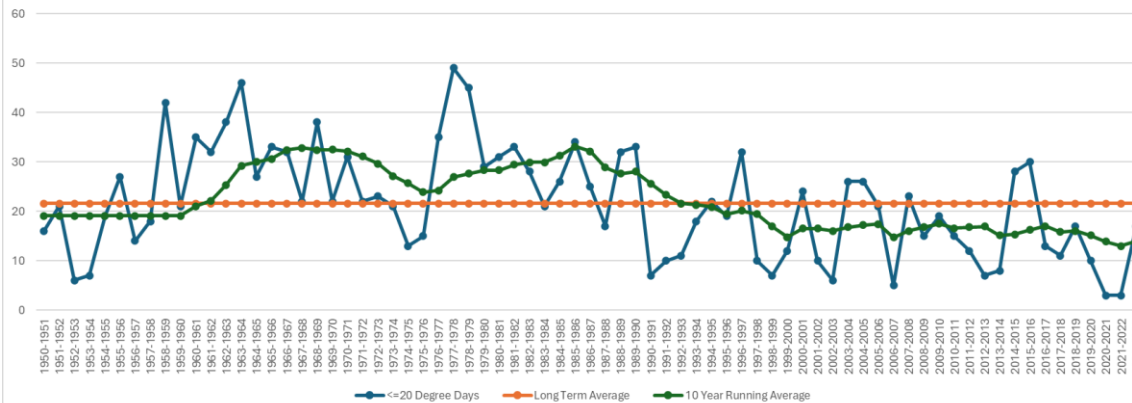
# Min Temperature Trends For Select Cities

Philadelphia, PA (KPHL) Yearly Min Temperature Since 1950-1951

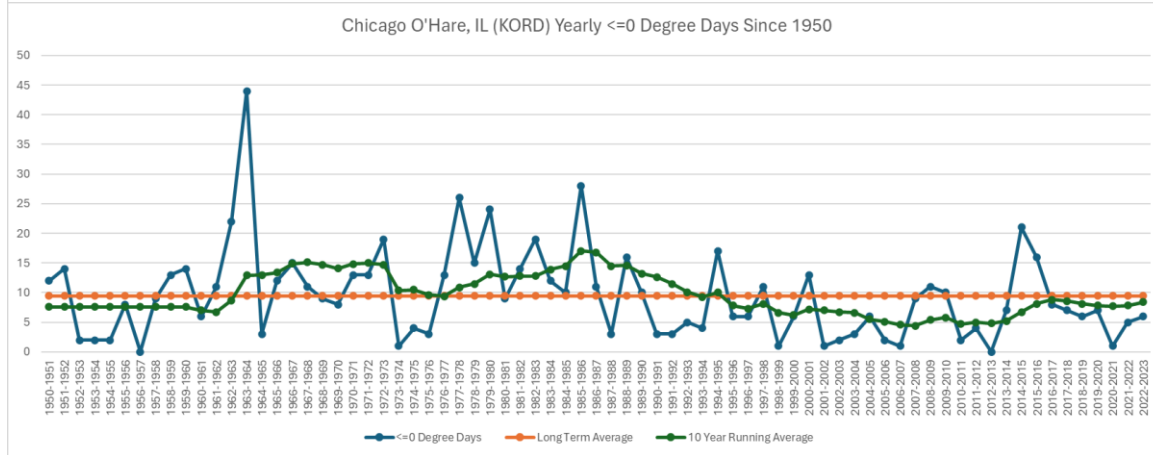
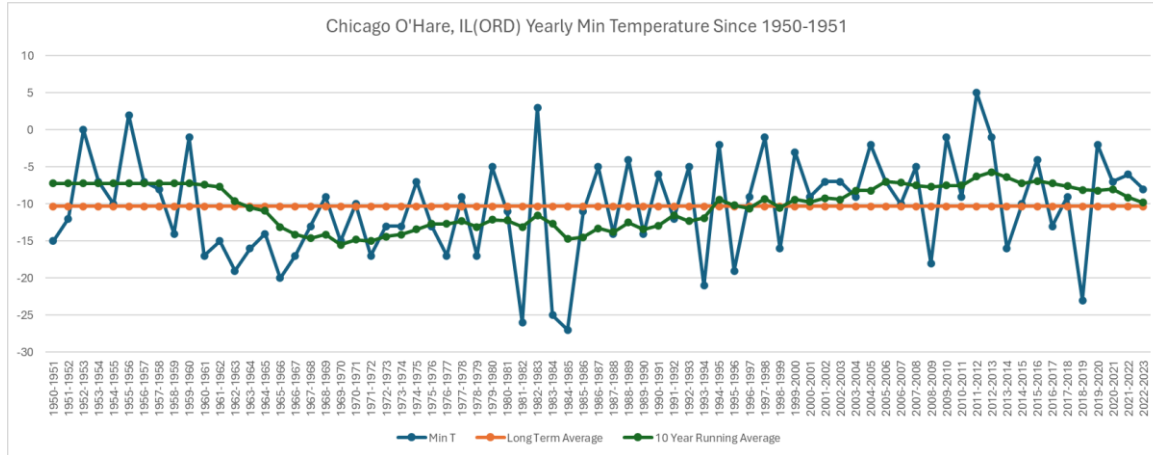


- Clear upward trend in minimum temperatures starting in the 1990s
- Clear downward trend in 20-degree or colder days since the 1990s

Philadelphia, PA (KPHL) Yearly <=20 Degree Days Since 1950

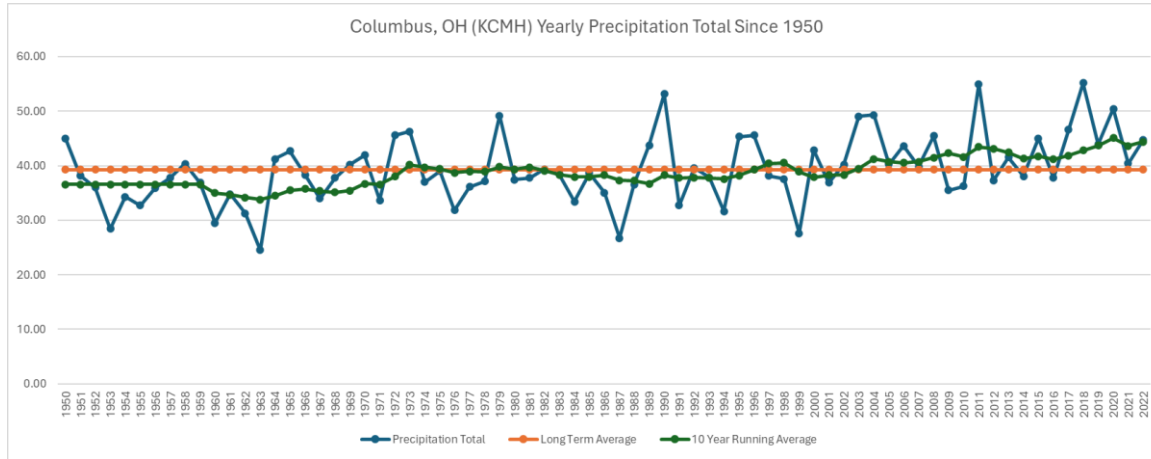


# Min Temperature Trends For Select Cities

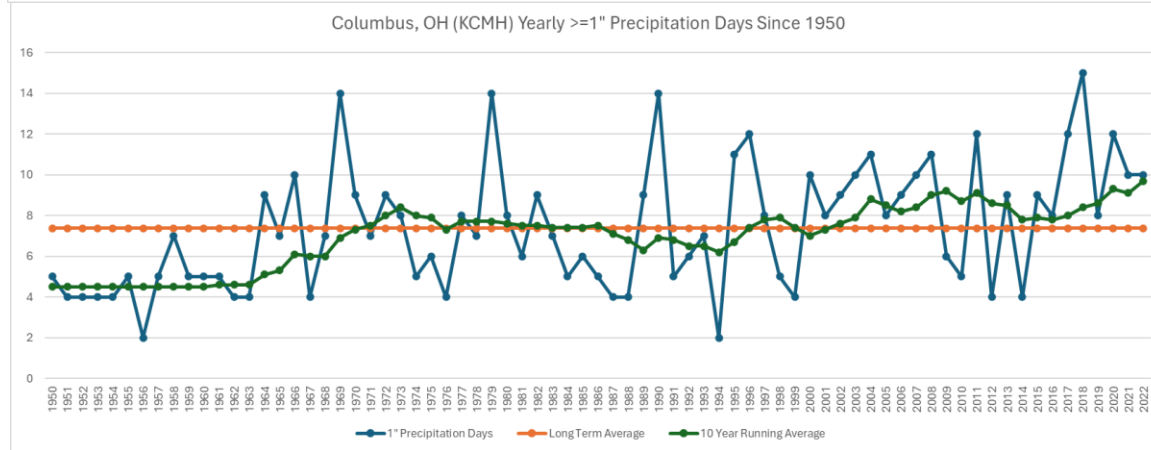


- Clear upward trend in minimum temperatures starting in the 1990s
- Clear downward trend in 20-degree or colder days since the 1990s
- There are still individual years that can see a peak temperature almost as cold as what was observed in the 1980s

# Precipitation Trends For Select Cities

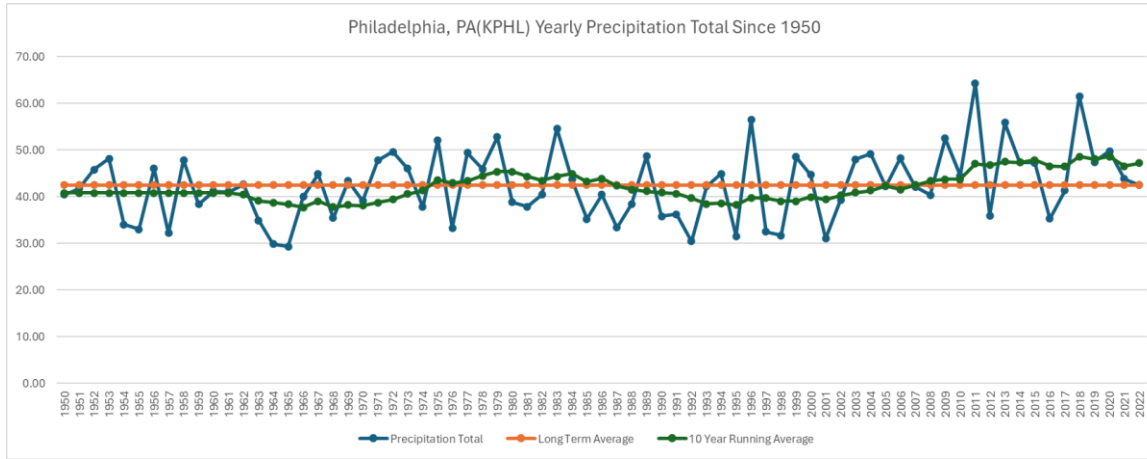


- Clear upward trend in precipitation totals during the 2000s onward
- Clear upward trend in 1”+ rainfall days

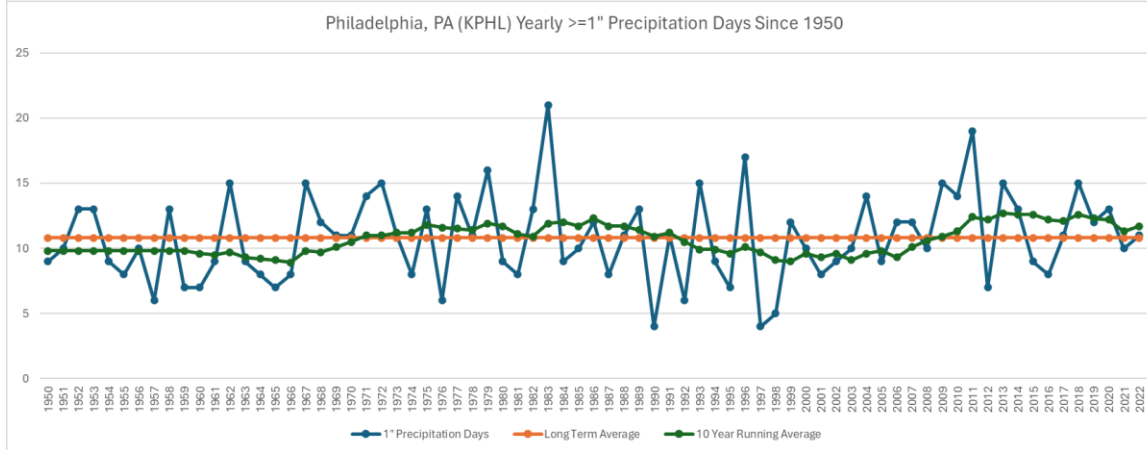




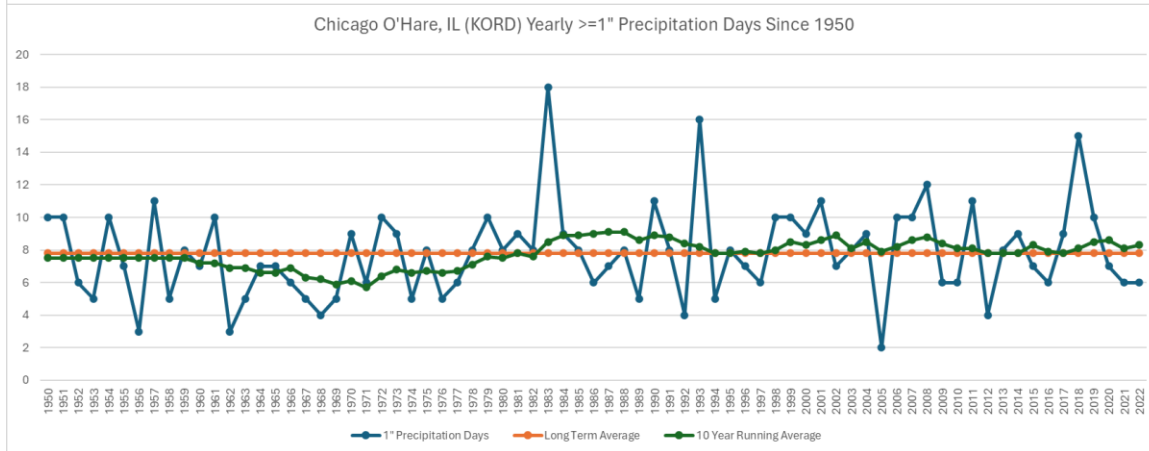
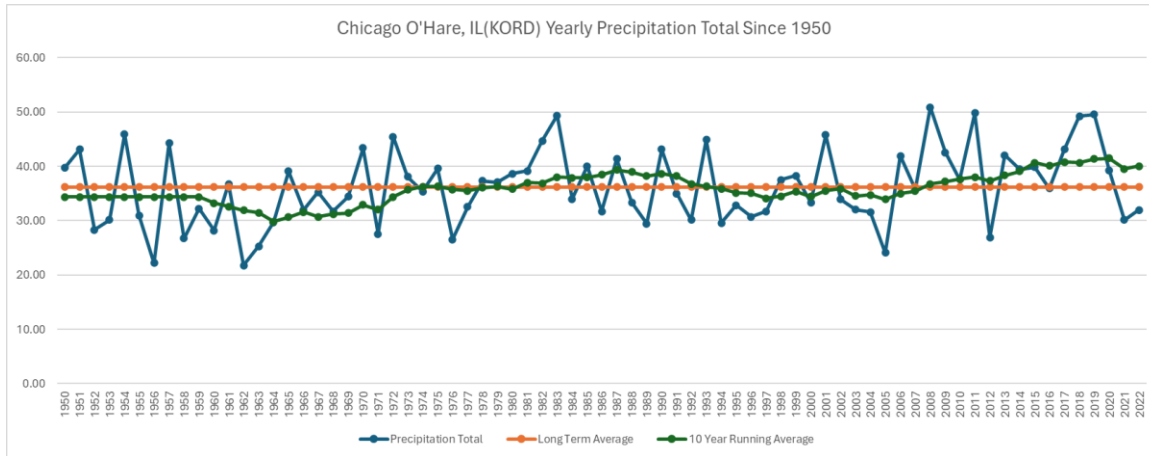
# Precipitation Trends For Select Cities



- Clear upward trend in precipitation totals during the 2000s onward
- No large signal in the 1”+ rainfall days



# Precipitation Trends For Select Cities



- Clear upward trend in precipitation totals during the 2000s onward
- No large signal in the 1"+ rainfall days