

Weather Extremes at the Blue Hill Observatory: How Fast are They Changing?

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Overview

- **Consistent Climate Observations** at BHO
(Began on February 1, 1885)
- Are Long-term Climate Changes Apparent
in Weather Extremes on Daily Time Scales?
- Past Data Provide **Critical Historical Context**
for Response to Future Climate Changes



Website: bluehill.org

BHO Mission:

"Our mission is to foster public understanding of Earth's weather, climate and environmental systems and to continue to produce, maintain, and analyze a meticulous, consistent record of weather and climate observations."

BHO Climate: Observations

- **Parameters**

Temperature

Dew Point / RH

Water Vapor Pressure

Precipitation

Snowfall

Snow Depth

Wind Speed / Direction

Peak Wind Gust

Station Pressure

Sunshine Duration

Visibility

Cloud Cover

Cloud Type

Weather Type

Pond Freeze/Thaw Dates

Ripe Blueberry Date, etc.



Outdoor instrument enclosure at BHO

BHO Climate: Observations

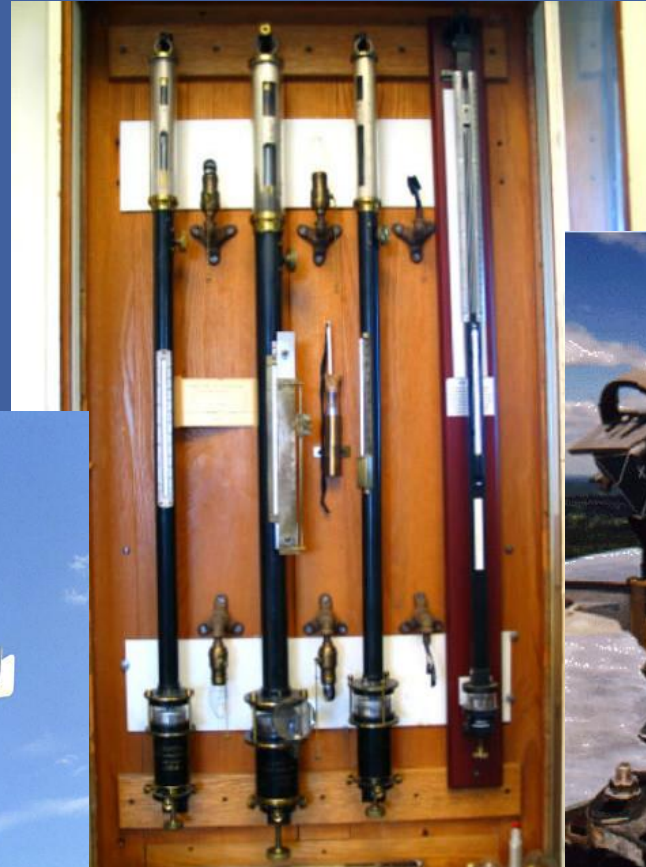
Consistent Measurements with Traditional Instruments and Methods



Hazen temperature shelter



Wind sensors

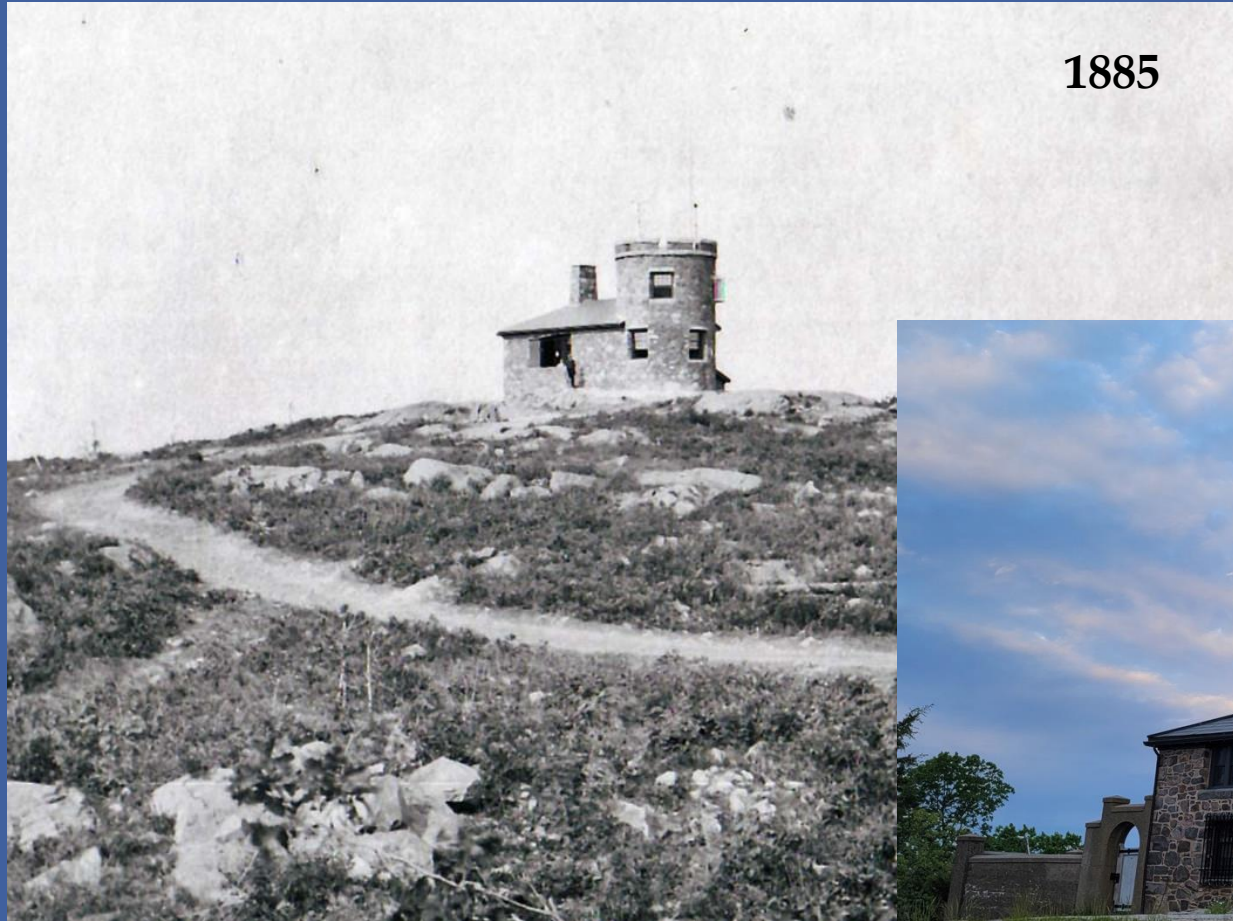


Mercury barometers



Sunshine recorder

BHO Climate: Observatory



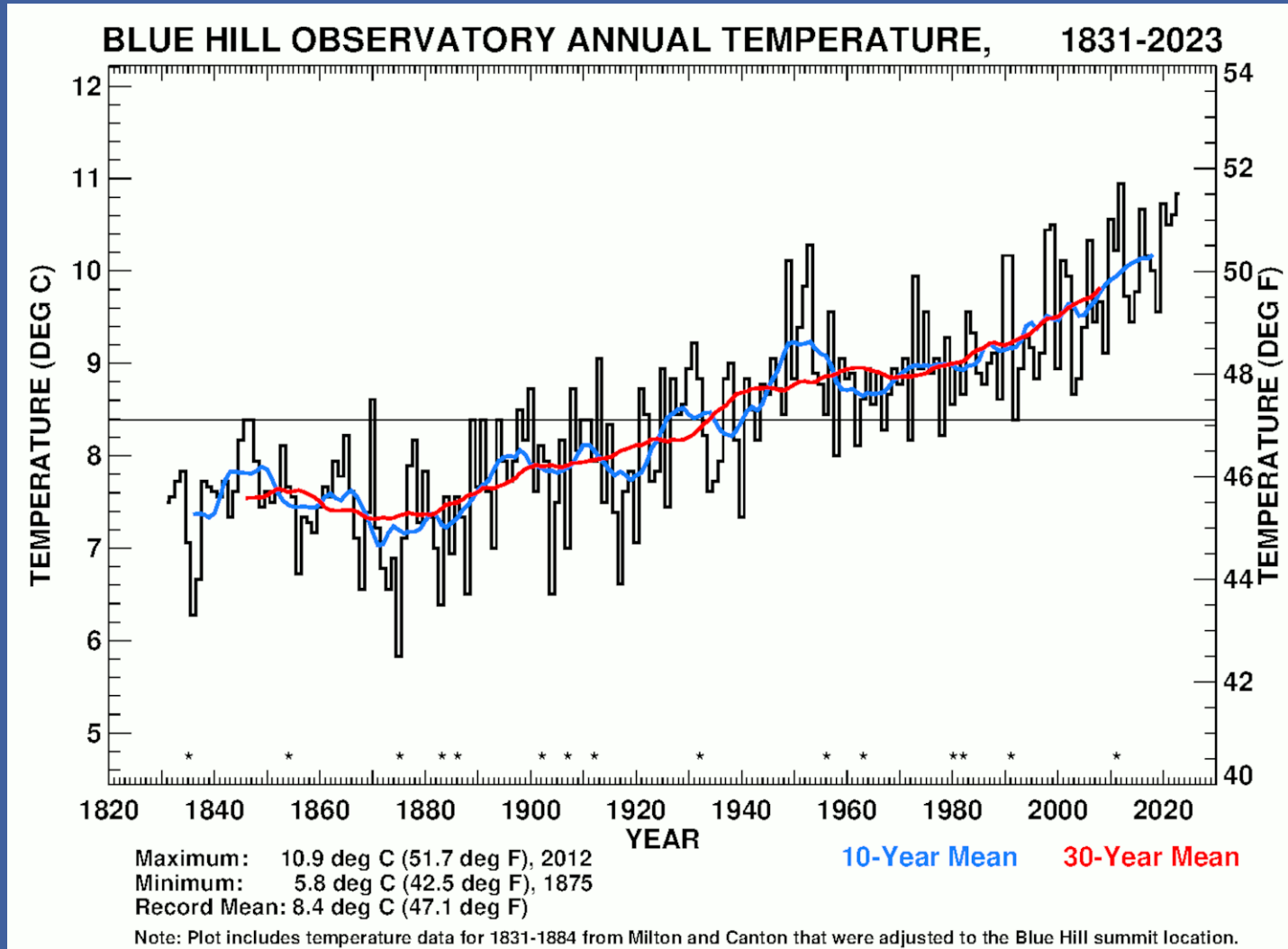
1885

Blue Hill Observatory,
Great Blue Hill, Milton, MA



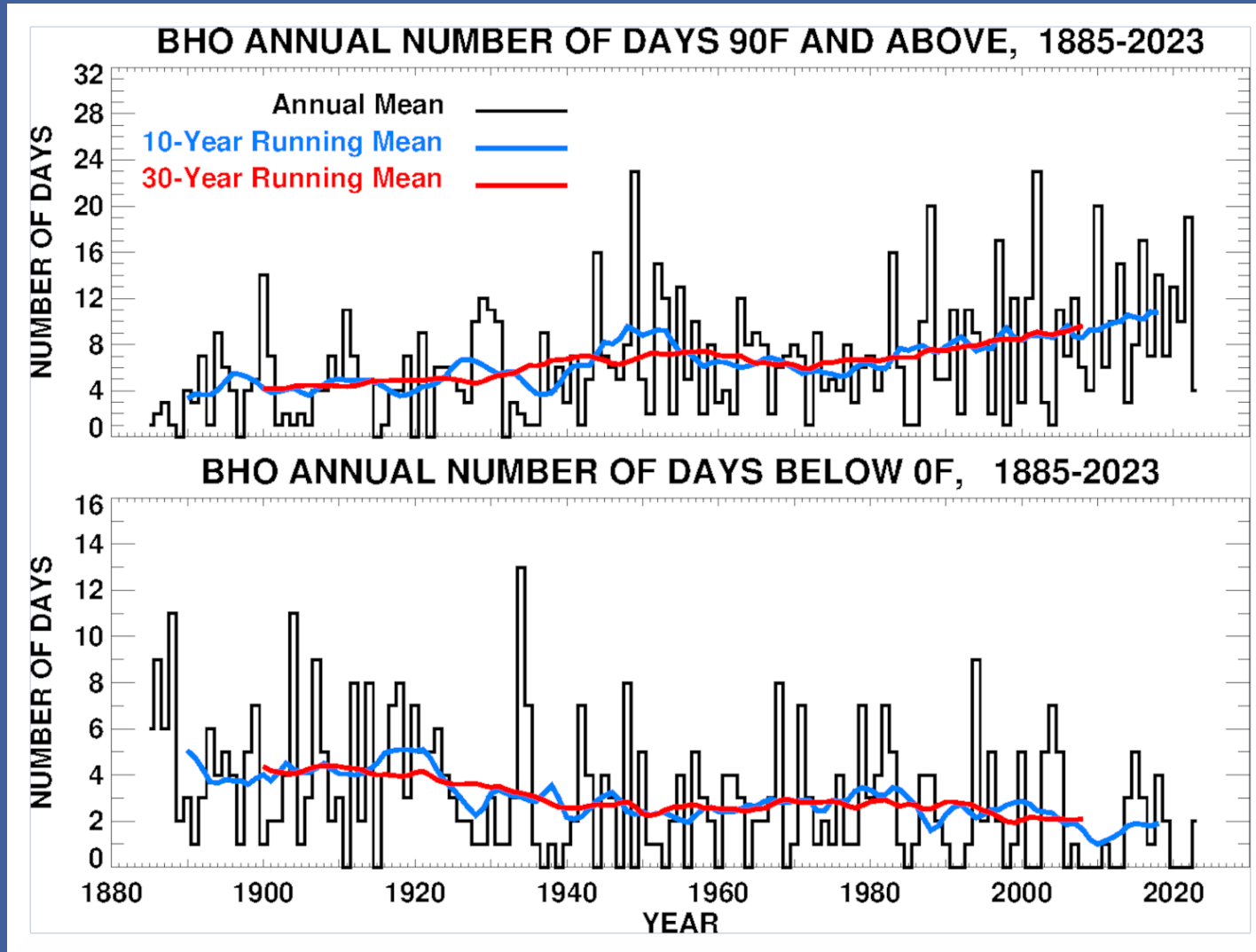
2024

BHO Climate Means: Annual Temperature



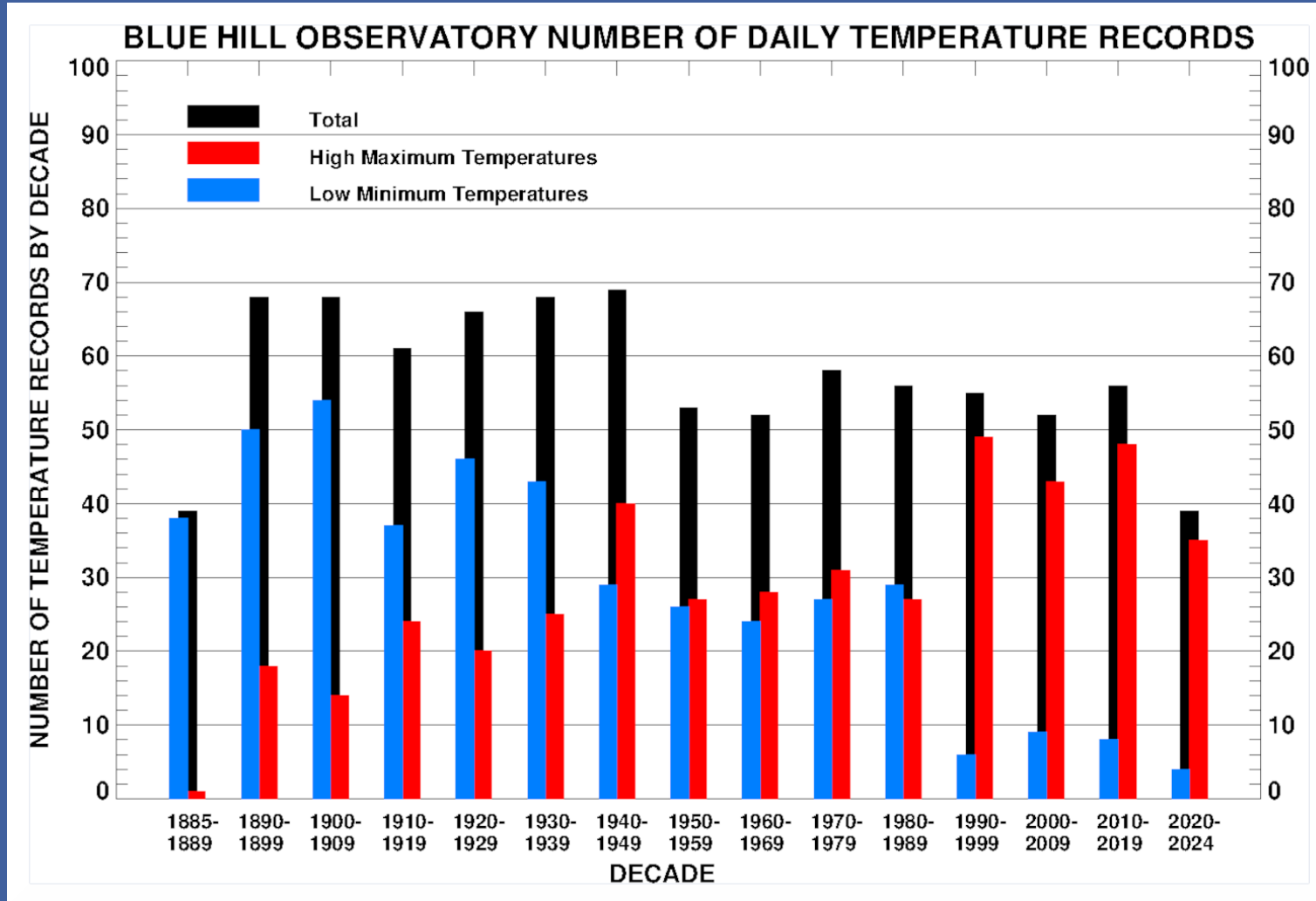
- Upward Trend is approaching +5 deg. F since 1885
- Trend statistically significant due to:
 - a) Long duration
 - b) Size of trend relative to annual variability
- Trend at BHO is larger than national and global temperature changes

BHO Weather Extremes: Number of Extreme Temp. Days



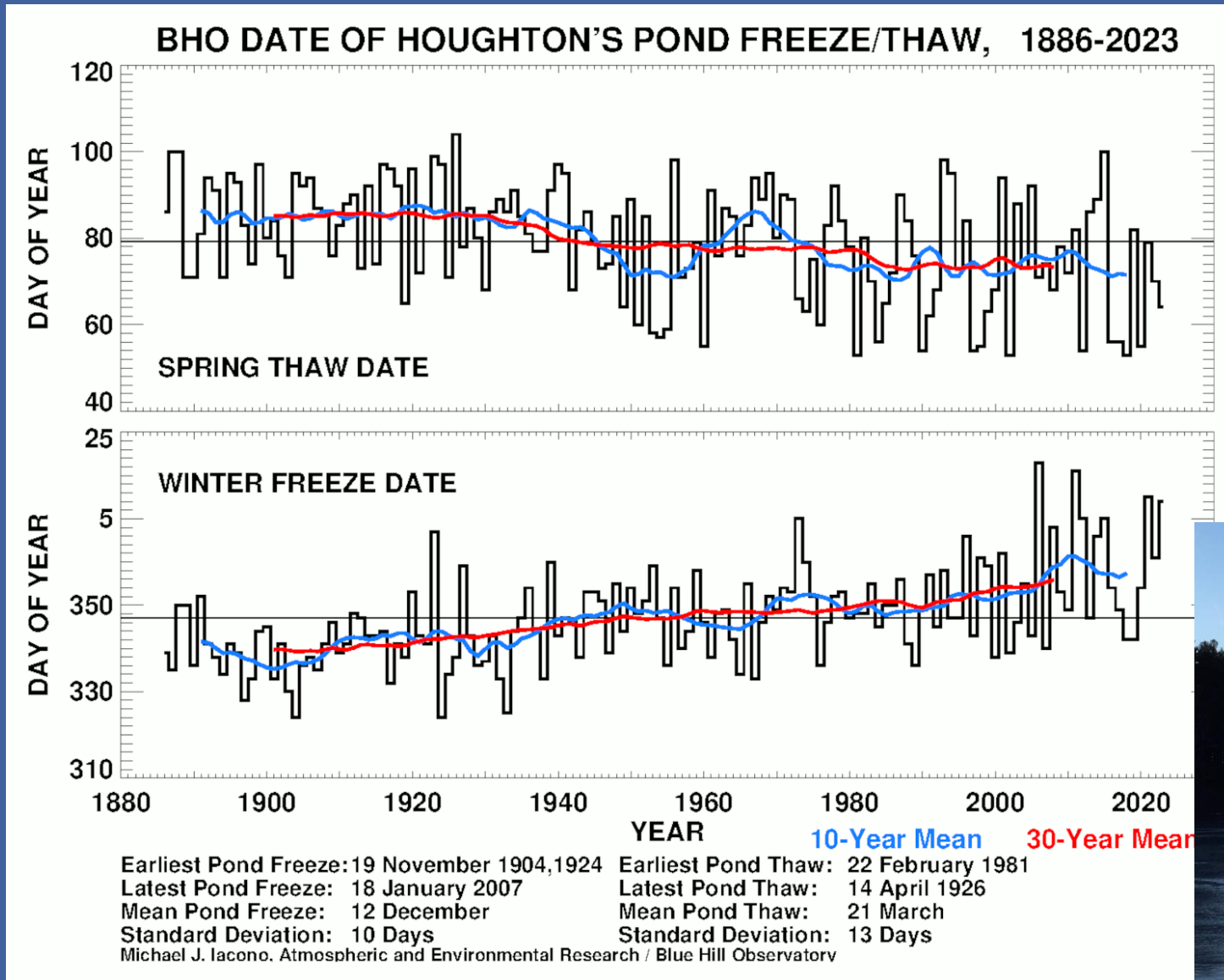
- Annual Number of Days with Temperature ≥ 90 deg F Increased from 4 to 10
- Average: 6 days / year
- Annual Number of Days with Temperature < 0 deg F Decreased from 4 to 2
- Average: 3 days / year

BHO Weather Extremes: Number of Daily Temp. Records



- Daily high temperature records increasing
- 2020's on record pace for record warm days
- Record cold days becoming much less frequent

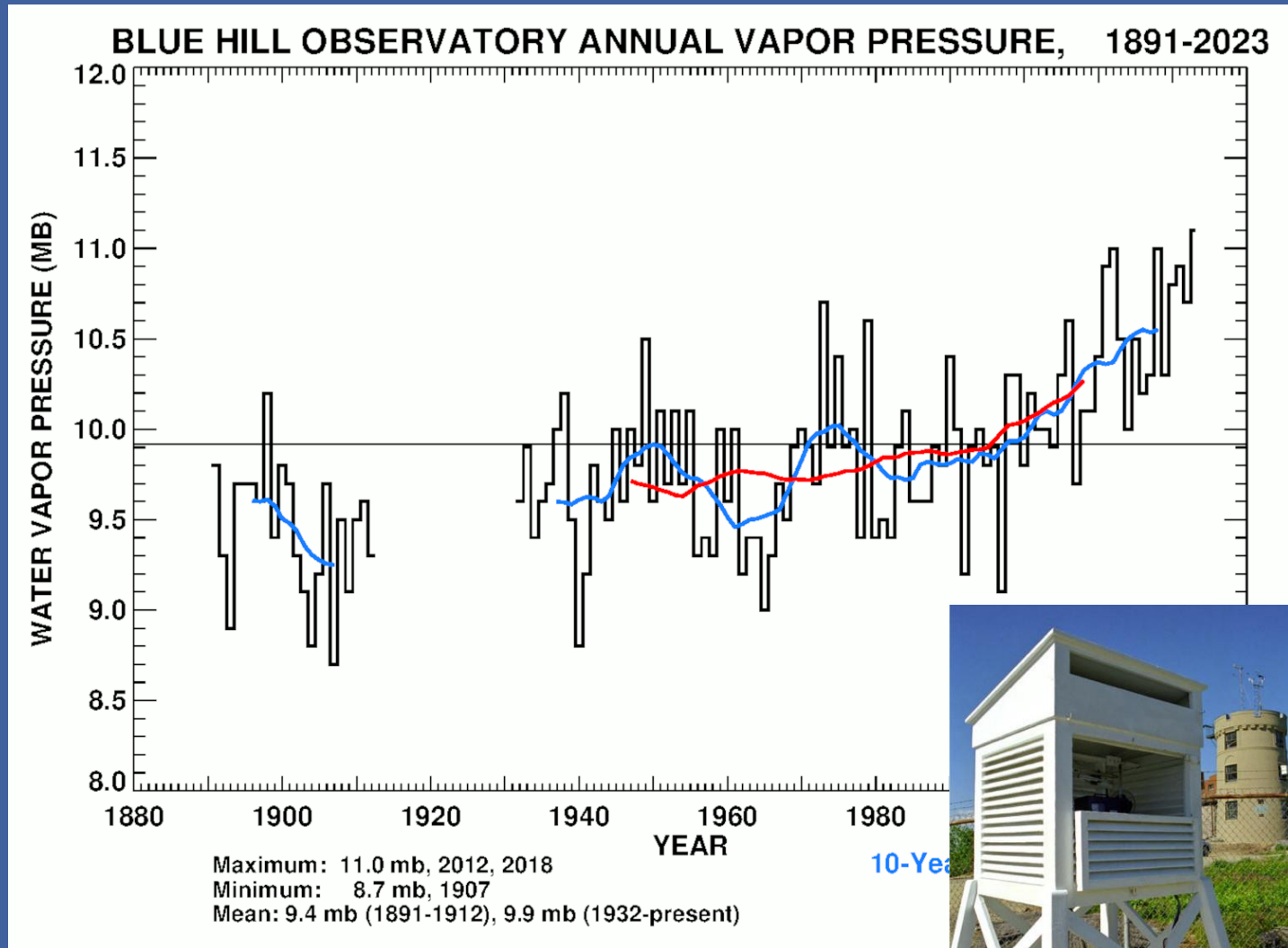
BHO Weather Extremes: Pond Freeze/Thaw Dates



- Local pond remains frozen during winter nearly three weeks less since 1880's
- Represents a natural indicator of local temperature changes



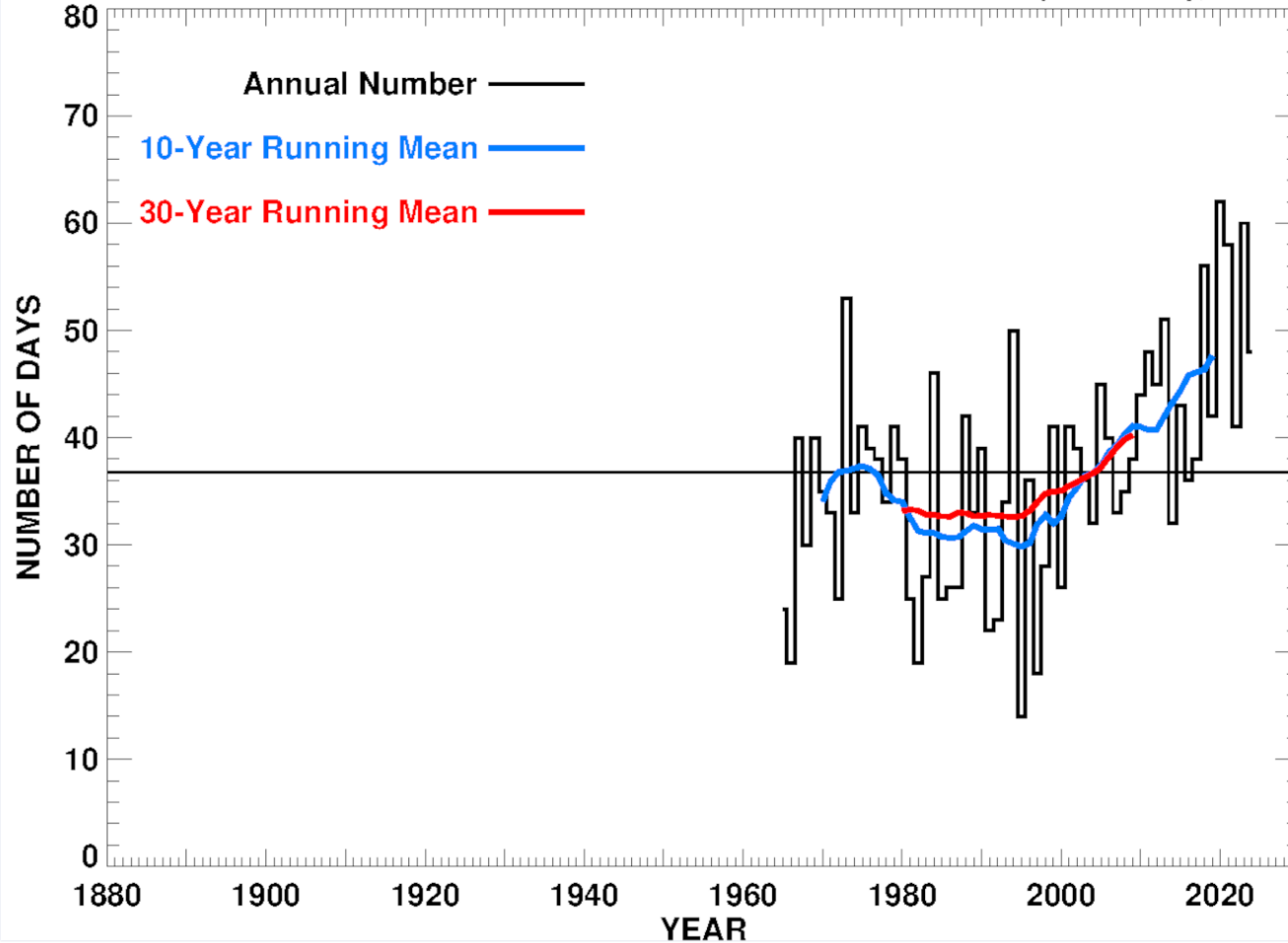
BHO Climate Means: Annual Water Vapor Pressure



- Vapor pressure is the contribution of water vapor to total surface pressure (about 1%)
- Vapor pressure of 10 mb = 50 deg F dew point
- Consistent with expected change in moisture caused by increase in temperature based on thermodynamics

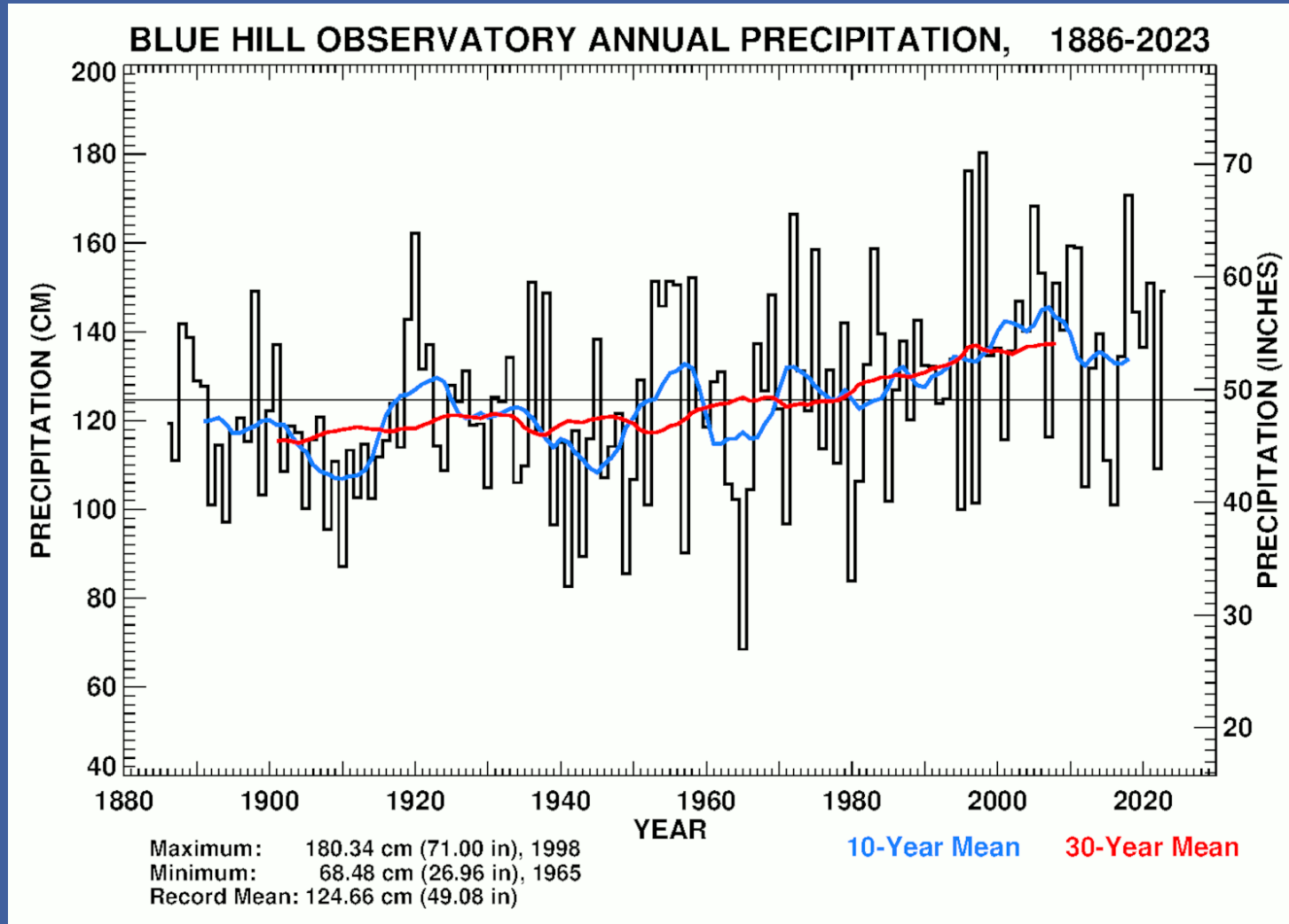
BHO Weather Extremes: Days with High Vapor Pressure

BHO ANNUAL NUMBER OF HIGH VAPOR PRES. DAYS (>20 MB), 1965-2024



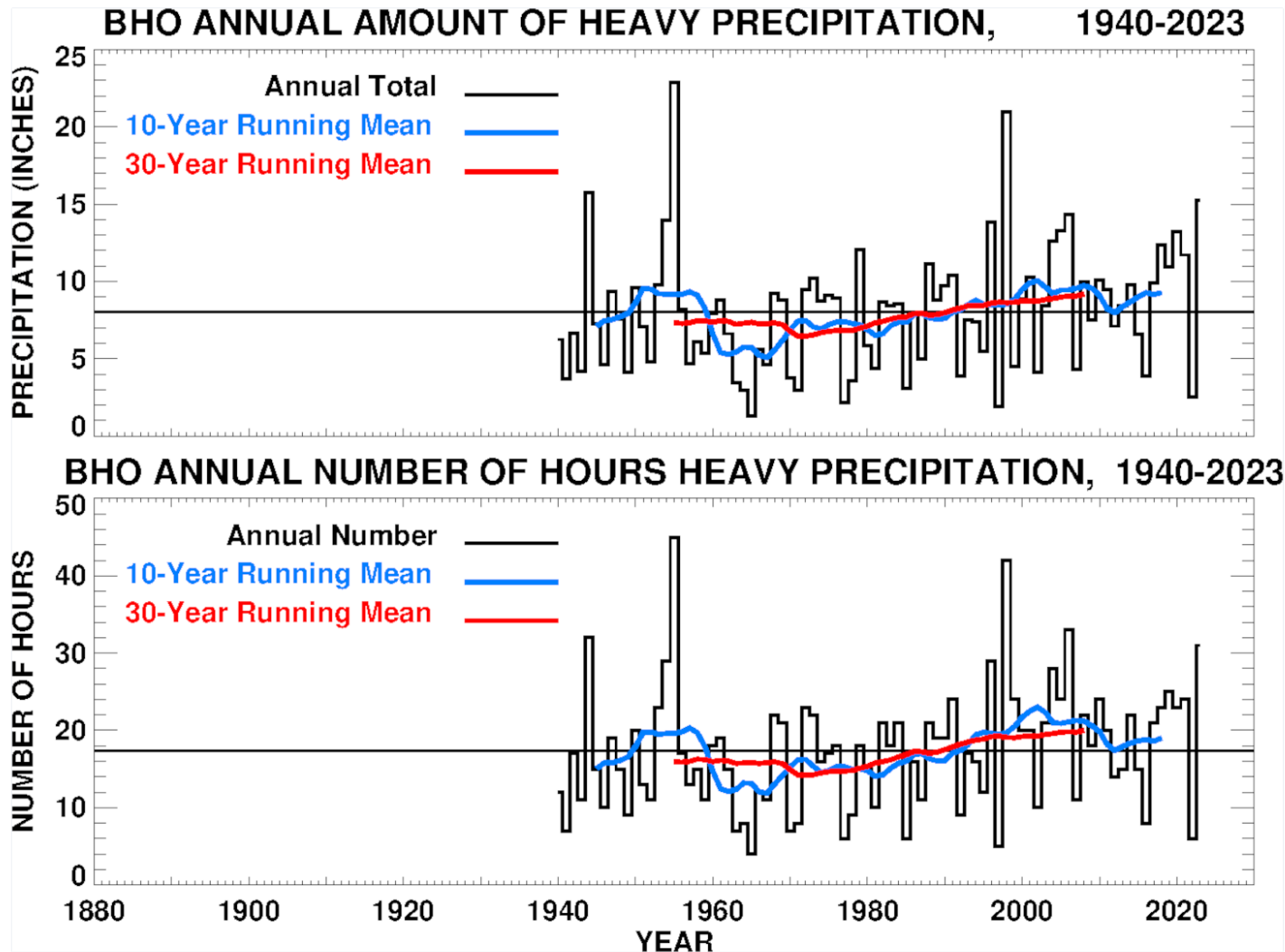
- Annual Number of Days with Extreme Vapor Pressure (> 20 mb)
- Equivalent to dew point > 64 deg F
- Sharply increasing for last 25-30 years
- Higher temperature and moisture causes higher "Heat Index"

BHO Climate Means: Annual Precipitation



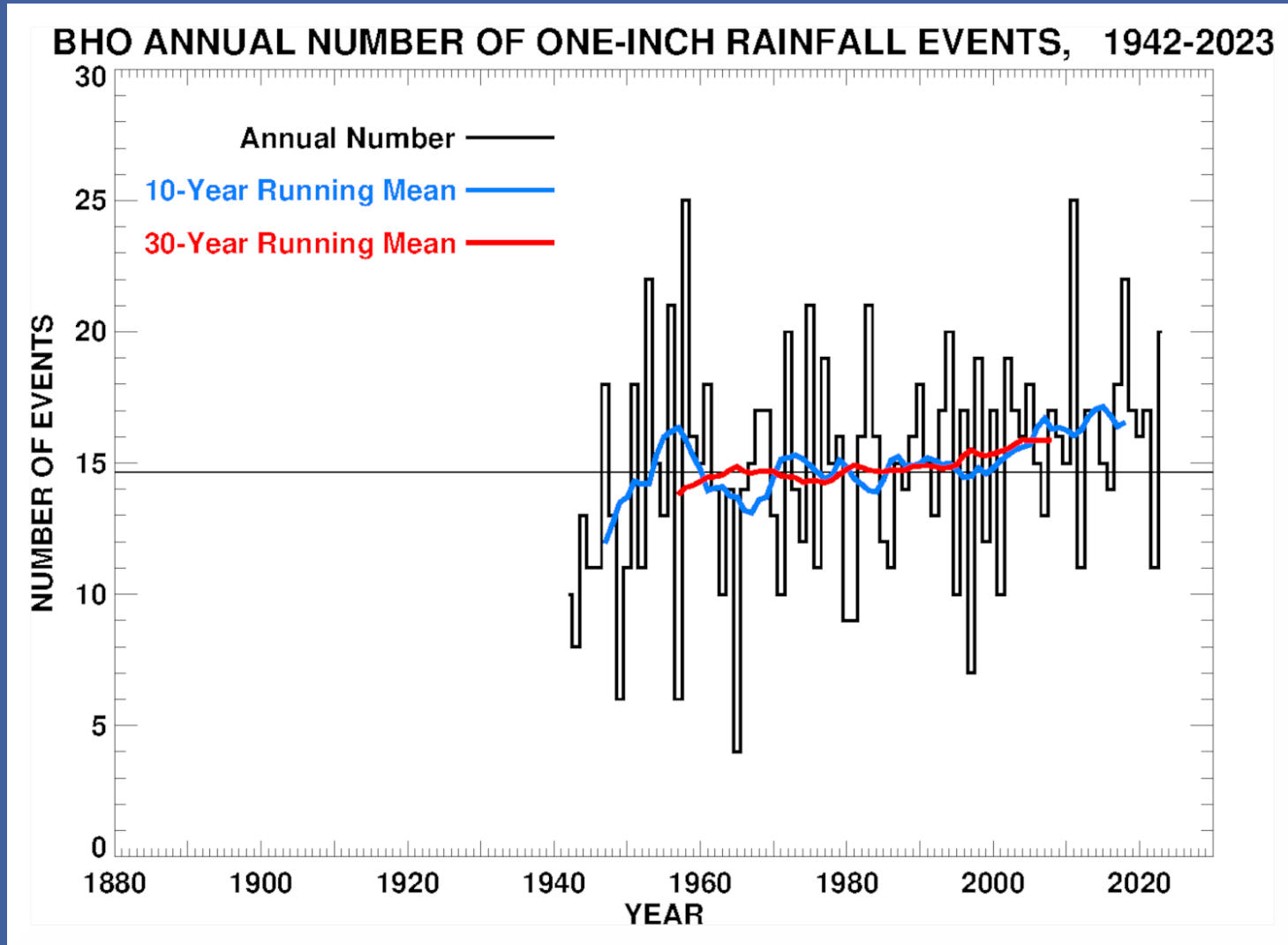
- Total precipitation (rain plus melted snow) is increasing +0.67 in/decade +8.7 inches since 1885
- High variability from year to year
- Consistent with increase in water vapor
- Highest: 71.00" in 1998

BHO Weather Extremes: Heavy Precipitation



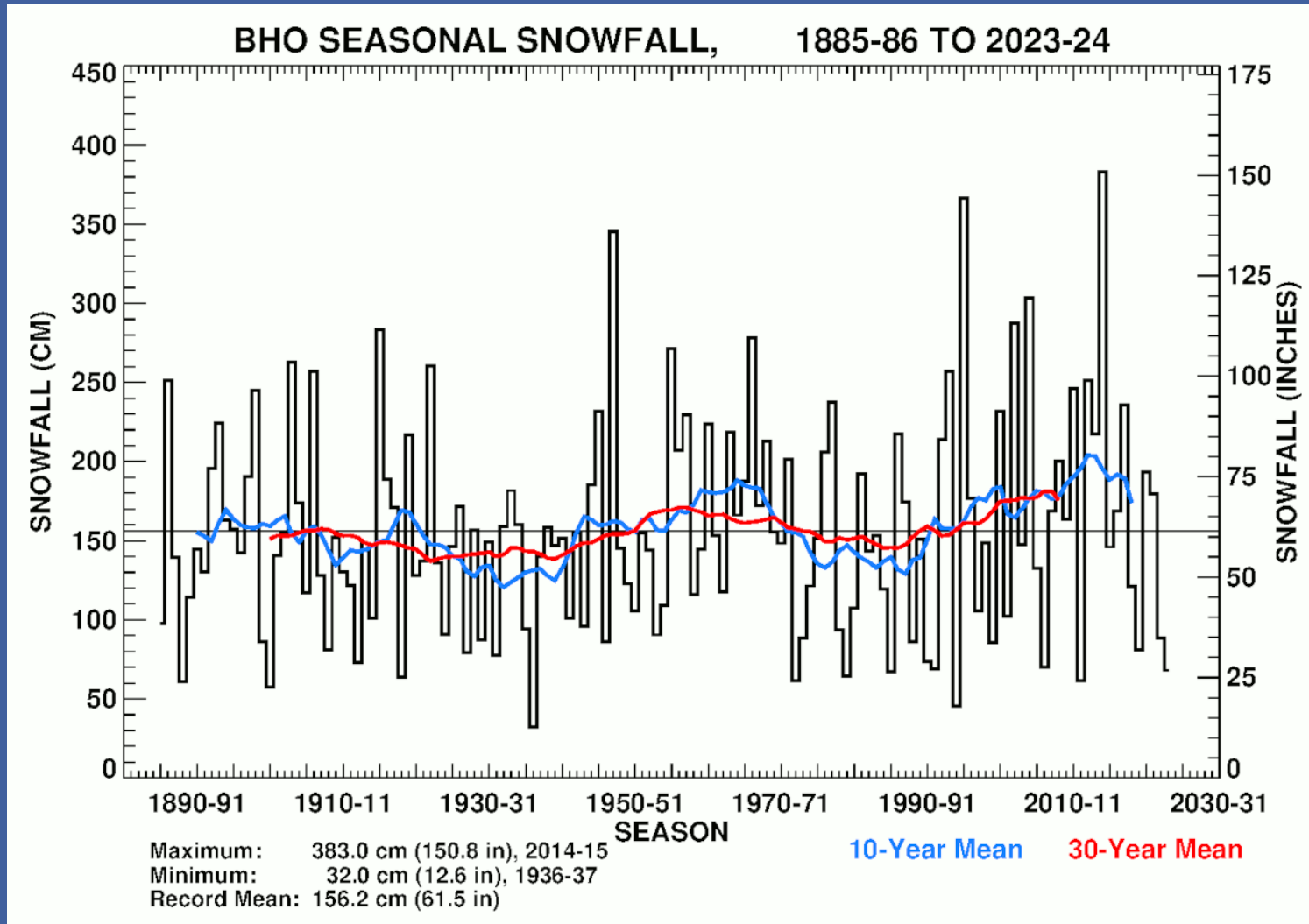
- Heavy Precipitation (> 0.30 inches per hour):
- Amount of heavy precipitation gradually increasing
- Number of heavy hours gradually increasing
- Highest:
1955 (T.S. Diane)
1998 (wettest year)

BHO Weather Extremes: Precipitation Extreme Events



- Annual Number of Extreme Precipitation Events (≥ 1.00 inch)
- Slow increase from about 13 to 17 since 1940's
- Highest: 25 events in 1958, 2011

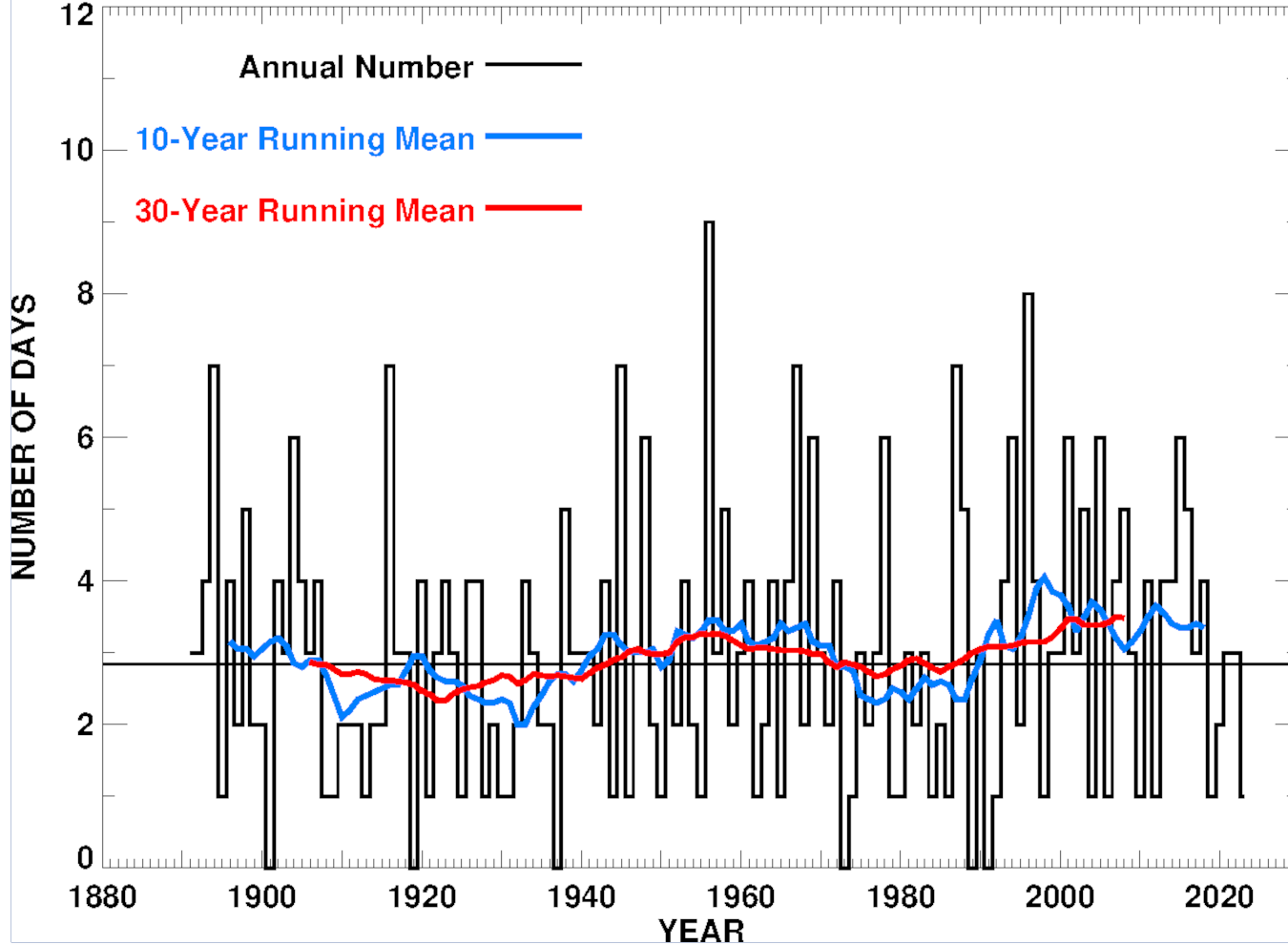
BHO Climate Means: Seasonal Snowfall (Oct-May)



- Seasonal snowfall: little if any trend
- Large seasonal and decadal variations
- Highest:
150.8" in 2014-15
144.4" in 1995-96

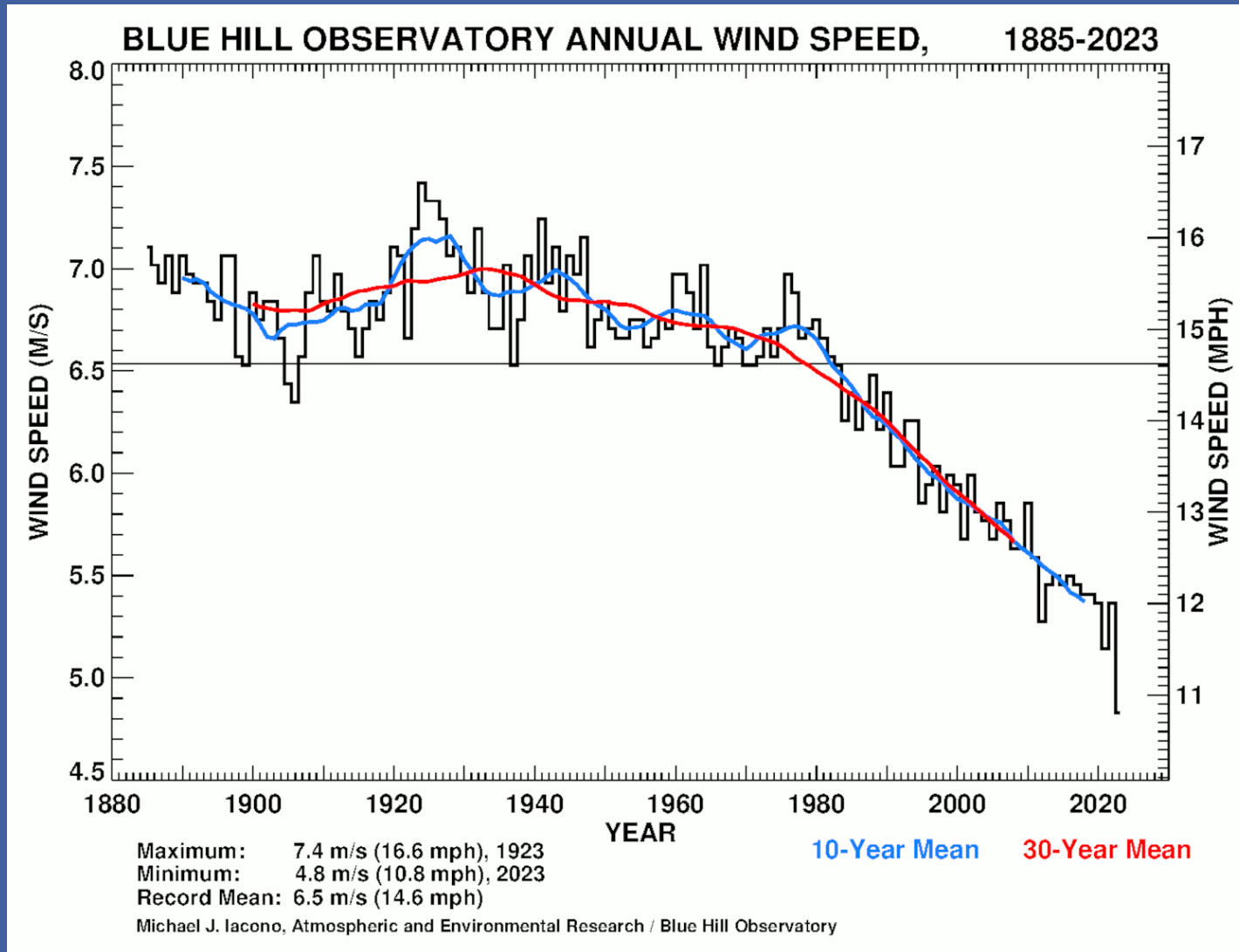
BHO Weather Extremes: High Snowfall Days

BHO ANNUAL NUMBER OF DAYS WITH SIX-INCH SNOWFALL, 1891-2023



- Annual Number of Days with Snowfall ≥ 6 inches
- Average: 3 per year
- No significant trend
- Highest:
9 in 1956
8 in 1996

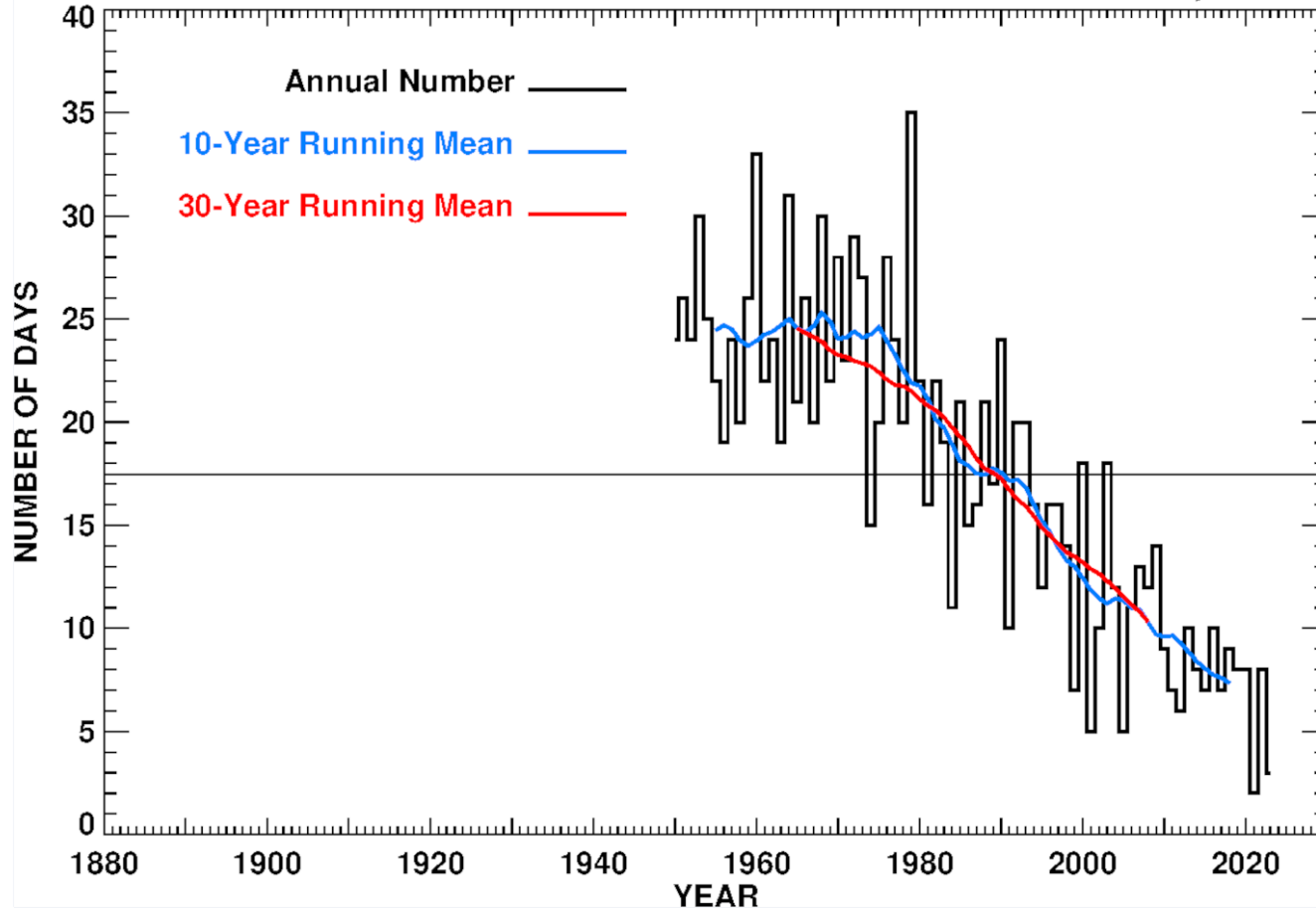
BHO Climate Means: Annual Wind Speed



- Annual wind speed falling dramatically since 1980
- Uncertain cause:
 - reforestation
 - global circulation
 - storm track location
- Wind speed declines becoming apparent elsewhere in Northern Hemisphere

BHO Weather Extremes: Number of Days with High Wind

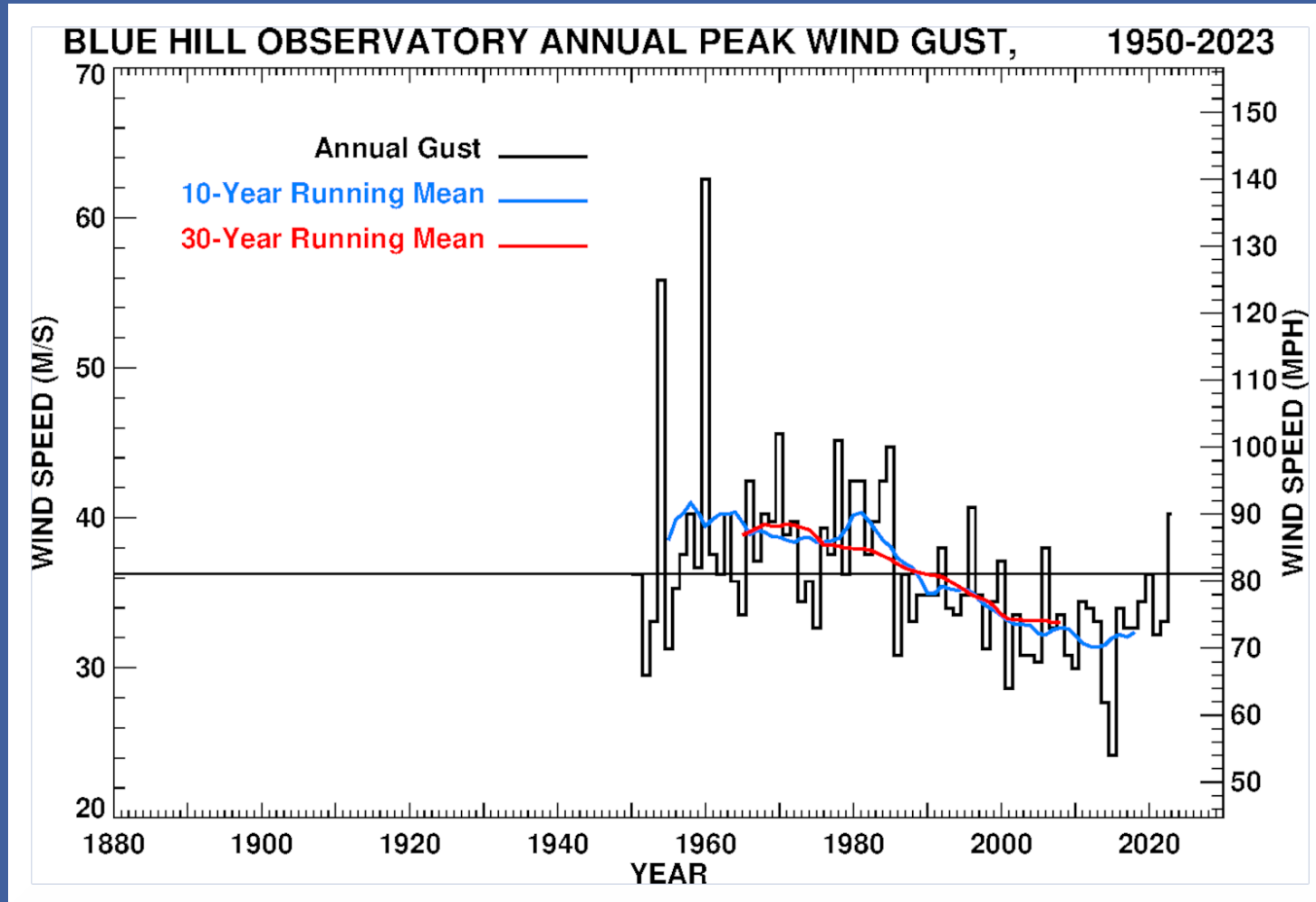
BHO WINTER DAYS WITH MEAN WIND SPEED ABOVE 20 MPH, 1950-2023



- Number of Winter Days with High Wind Speed (> 20 mph)
- Once nearly 1 in 3 days; now fewer than 1 in 10

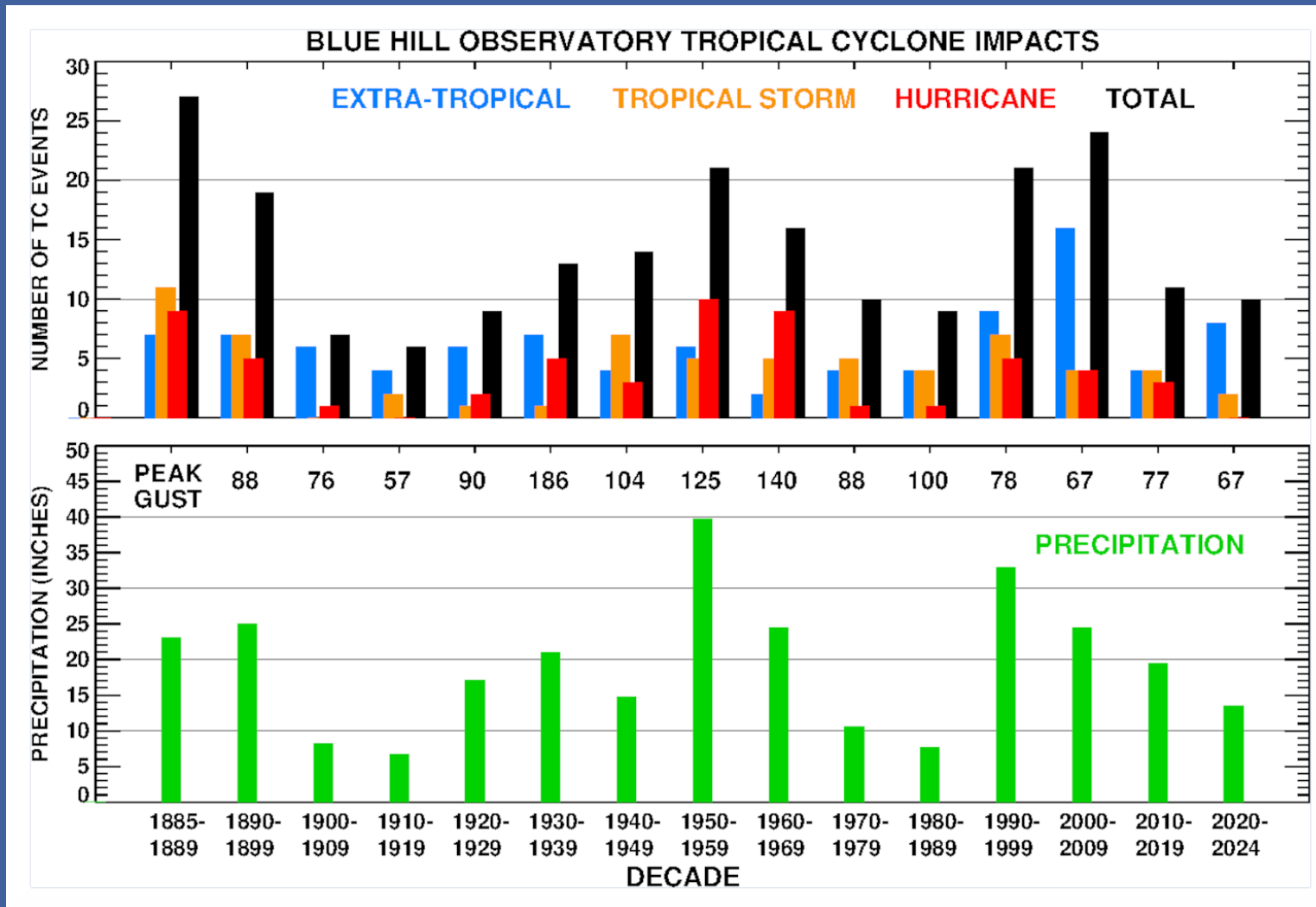


BHO Weather Extremes: Annual Peak Wind Gusts



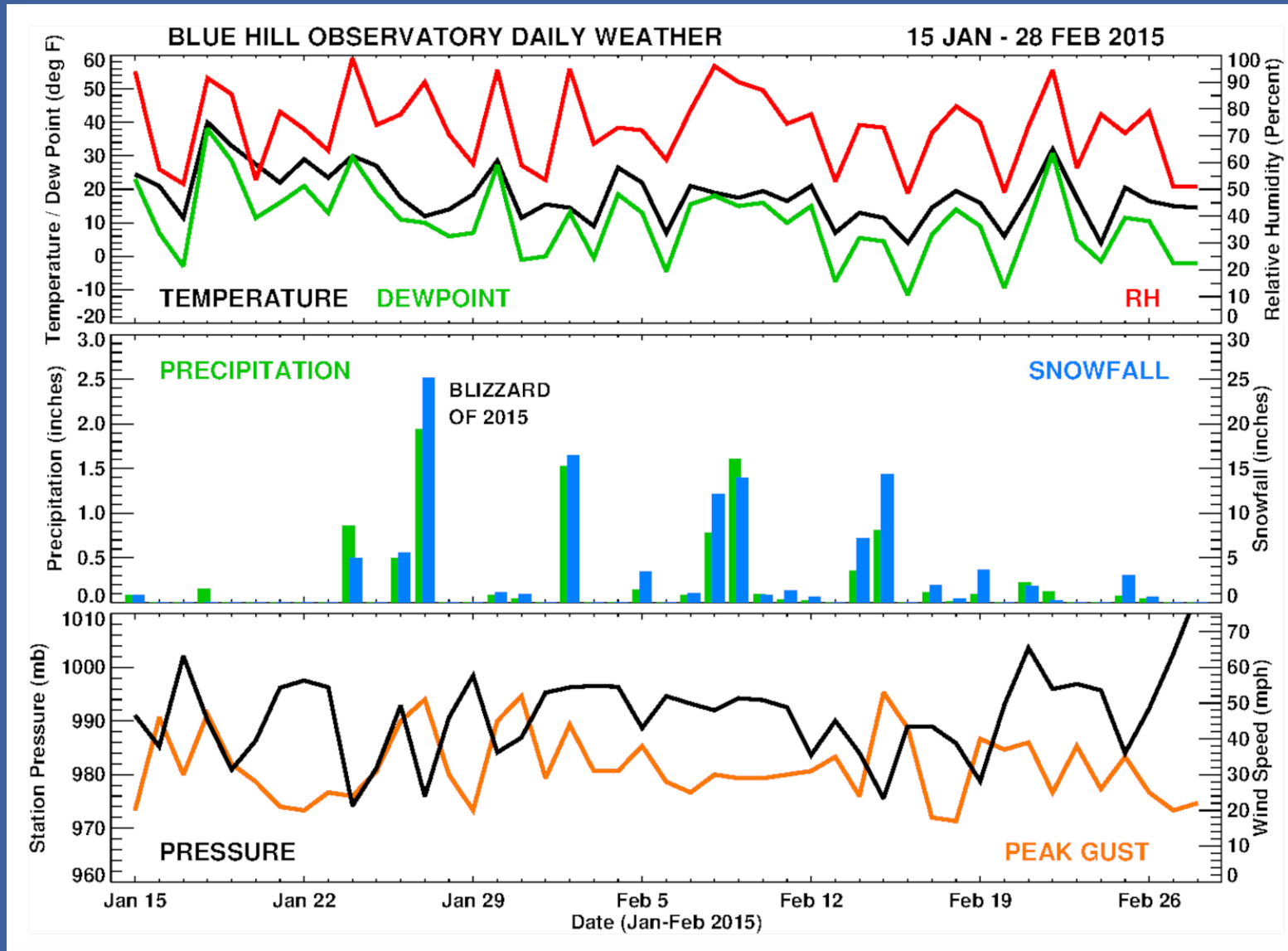
- Annual Peak Gust: Large decline since 1950's
- Last gust to 100 mph at Observatory in September 1985 (Hurricane Gloria)

BHO Weather Extremes: Tropical Cyclone Impacts



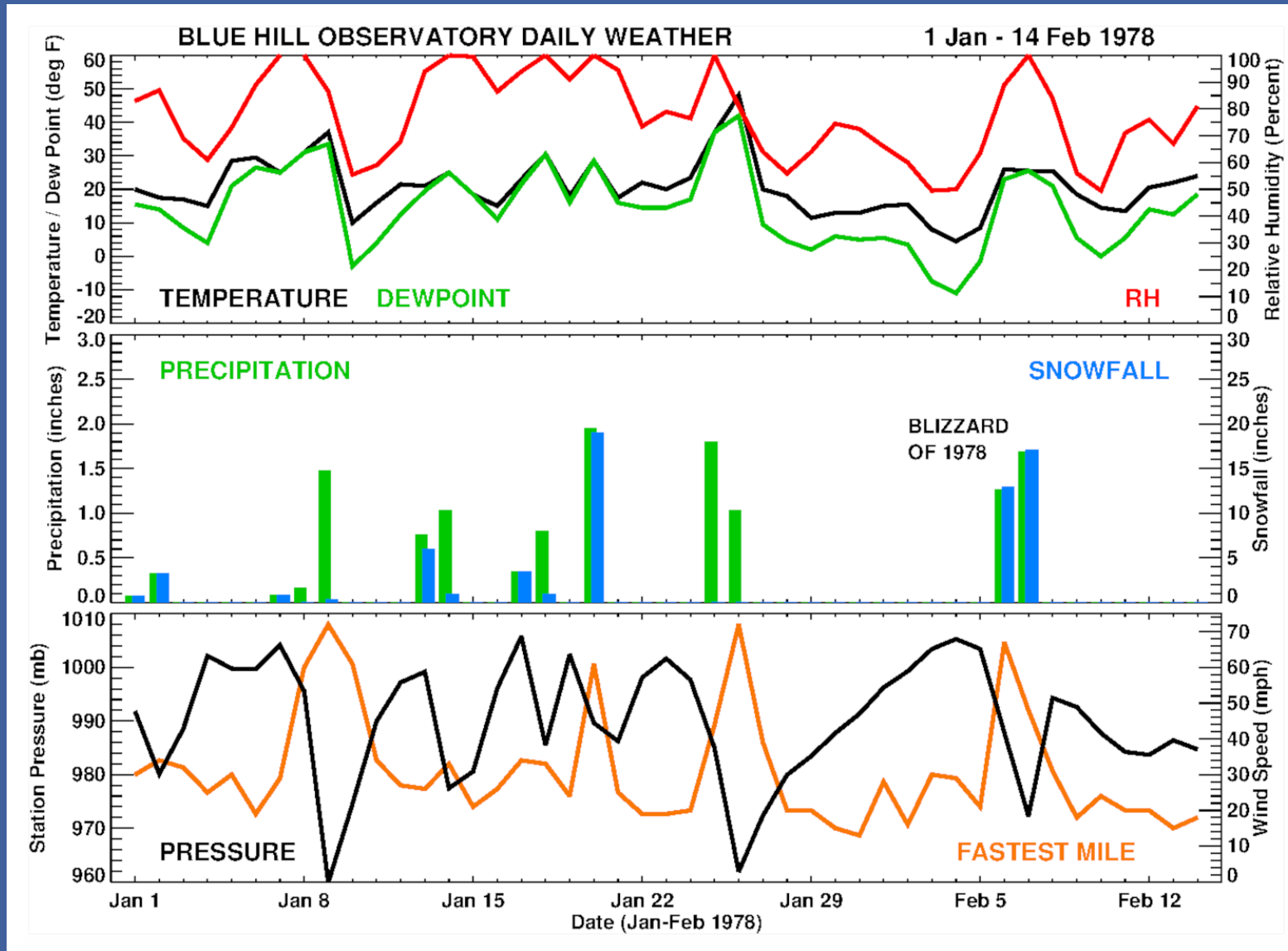
- Decadal number of tropical cyclones in southern New England: **No trend**
- Decadal amount of precipitation at BHO from tropical cyclones: **No trend**
- Large decadal swings in TC activity
- Full list of BHO TC impacts available at bluehill.org

BHO Weather Extremes: Daily Winter Weather (2015)



- Now able to plot multiple daily parameters in one graphic
- 15 Jan – 28 Feb 2015
- Four major snowstorms in three weeks
- Record snowfall in February 2015 and 2014-15 season

BHO Weather Extremes: Daily Winter Weather (1978)



- 1 Jan - 14 Feb 1978
- Four major rain and snowstorms in four weeks ending with Blizzard of 1978
- Lowest pressures and highest winds during rain events (due to inland storm tracks)

BHO Weather Extremes: Summary

- **Consistent measurements** critical for effective climate and weather analysis and provide **historical context** for evaluating future projections
- Daily high temperature records show sharp increase
- Atmospheric moisture increasing with temperature
- Precipitation and extreme rainfall events show gradual increases; extreme snowfall shows no trend
- Daily high wind speed days, peak gusts, and mean wind speed show sharp decrease in last fifty years
- Tropical cyclone impacts show decadal variability but no trends



Website: bluehill.org

A photograph of a sunset over a hill. The sky is filled with horizontal bands of color, ranging from deep purple and blue at the top to bright orange and yellow near the horizon. The hill in the foreground is dark and silhouetted, with a radio tower visible on its peak. The text is overlaid on the lower part of the image.

Thank You!

Questions and Volunteers are Welcome
(Email: miacono@bluehill.org)