

Watching the Weather Since 1885: The Climate Record of the Blue Hill Observatory

Michael J. Iacono

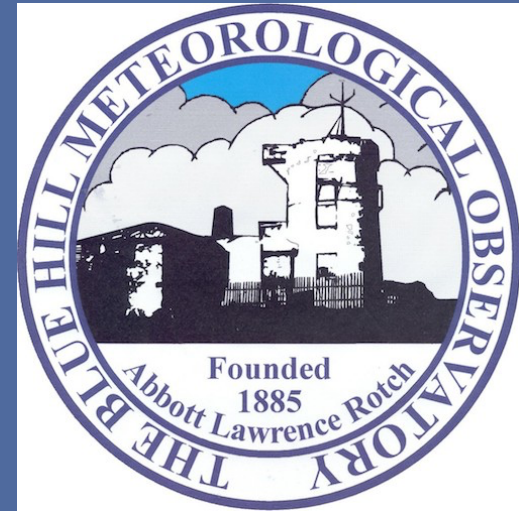
Atmospheric and Environmental Research, Blue Hill Meteorological Observatory

**BHO On-line Seminar Series
20 April 2020**



Outline

- Long View of Climate Change
- Traditional Instruments
- Blue Hill Climate Record

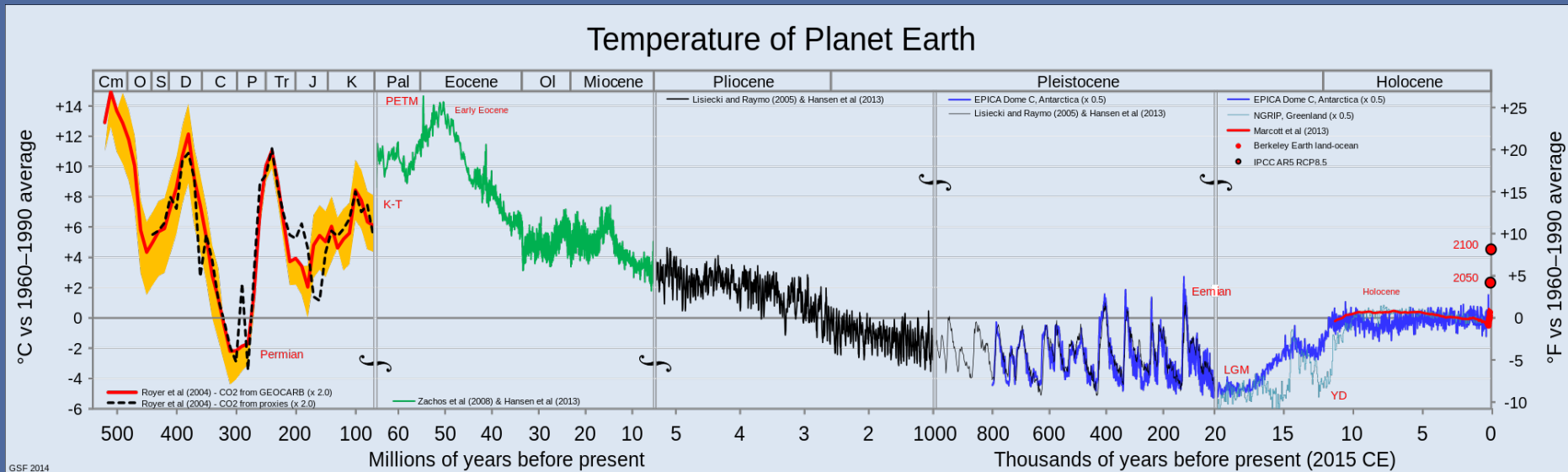


bluehill.org/observatory

BHO Mission:

"To foster public understanding of and appreciation for atmospheric science, while continuing to maintain a meticulous record of weather observations for the long-term study of climate."

Climate Change: What's the Big Picture?

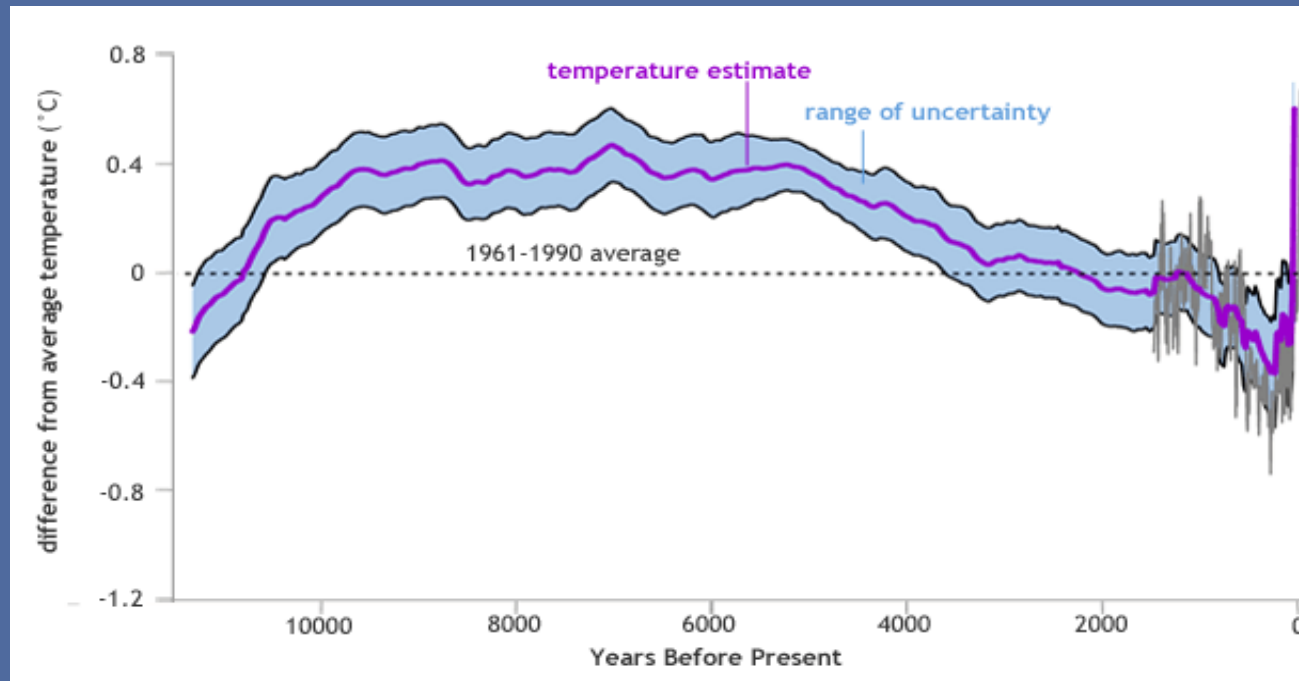


- 5-10 degrees F colder during last Ice Age (20,000 yrs ago)
- 10-20 degrees F warmer during Jurassic Period (65 Mya)
- Stable climate for the last 10,000 years very unusual

Climate Change: What's the Big Picture?

- Large climate changes on long time scales have occurred regularly in Earth's history due to natural factors:
 - Orbital variations (change incoming solar energy)
 - Earth's axis tilt (affects seasonal cycles)
 - Volcanic eruptions (vent greenhouse gases: CO₂)
 - Asteroid impacts (eject material that obscures sun)
 - Continental drift (alters air and ocean circulation)
- Currently in inter-glacial period with some ice cover
- **Human Factor:** Fossil fuel use has increased carbon dioxide to highest level in 3 million years (up from 280 to 415 ppm in 150 years)

Climate Change: What's the Big Picture?



- Global mean temperature down during last 8,000 years
- None of the long-term factors can be causing the upward turn in the last 150 years (instrument record)
- Critical need for high quality observations...

BHO Climate Measurement

Sun pillar
February 7, 2009



Blue Hill Observatory Location



How Does BHO Measure the Climate/Weather?

- “Climate is what you expect...weather is what you get”
- Parameters
 - Temperature
 - Relative Humidity
 - Precipitation
 - Snowfall
 - Snow Depth
 - Wind Speed / Direction
 - Peak Wind Gust
 - Station Pressure
 - Sunshine Duration
 - Cloud Cover
 - Cloud Type
 - Weather Type
 - Pond Freeze/Thaw
 - Visibility, etc.



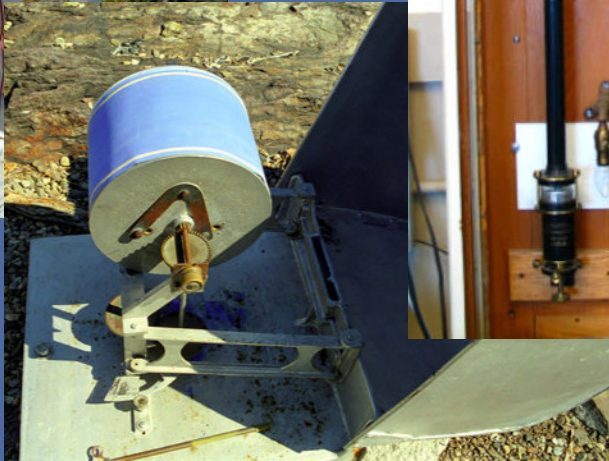
Outdoor instrument enclosure at BHO

How Does BHO Measure the Climate/Weather?

Traditional instruments



Hazen
temperature
shelter



Ombroscope



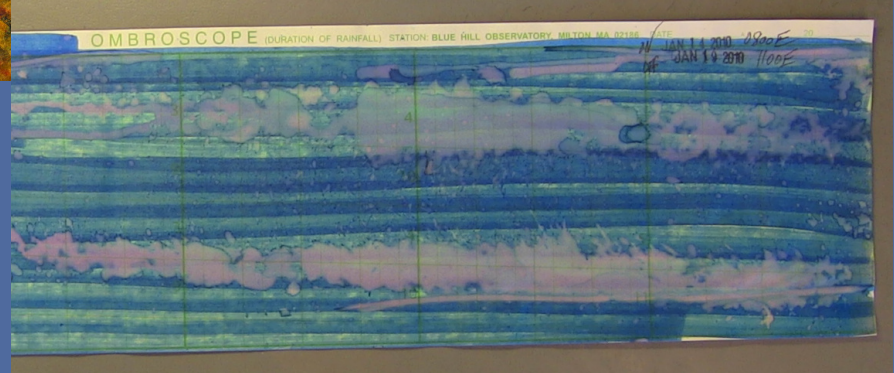
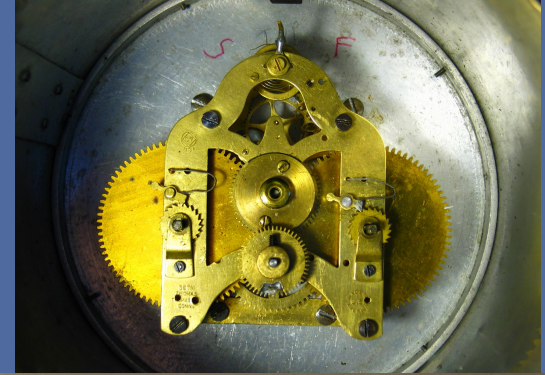
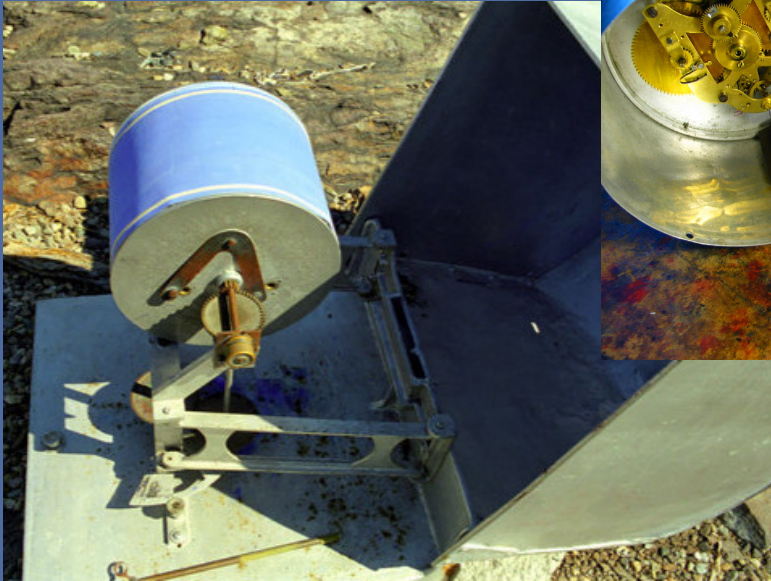
Mercury
barometers



Sunshine recorder

How Does BHO Measure the Climate/Weather?

Ombroscope (1940)



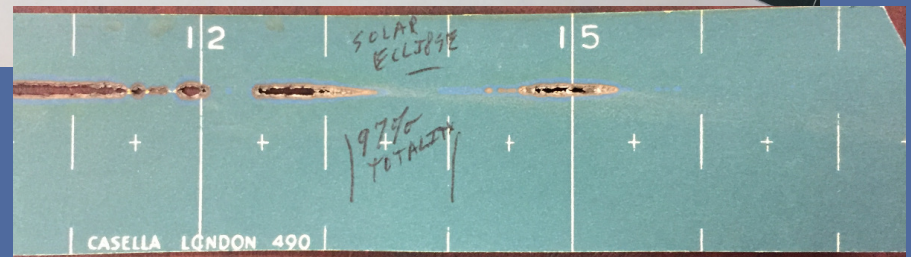
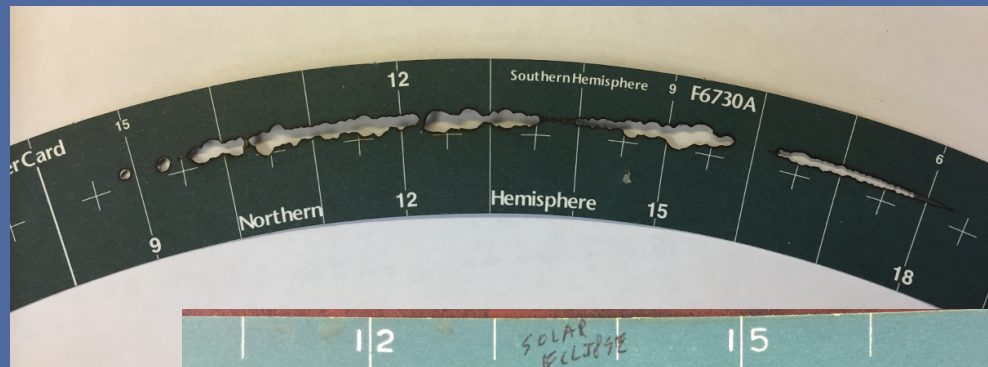
- Records time of precipitation as rain or snow stains paper wrapped around rotating cylinder
- Dual-spring Seth-Thomas clock mechanism inside cylinder

How Does BHO Measure the Climate/Weather?

Sunshine Recorder (1885, 1898, 1993)



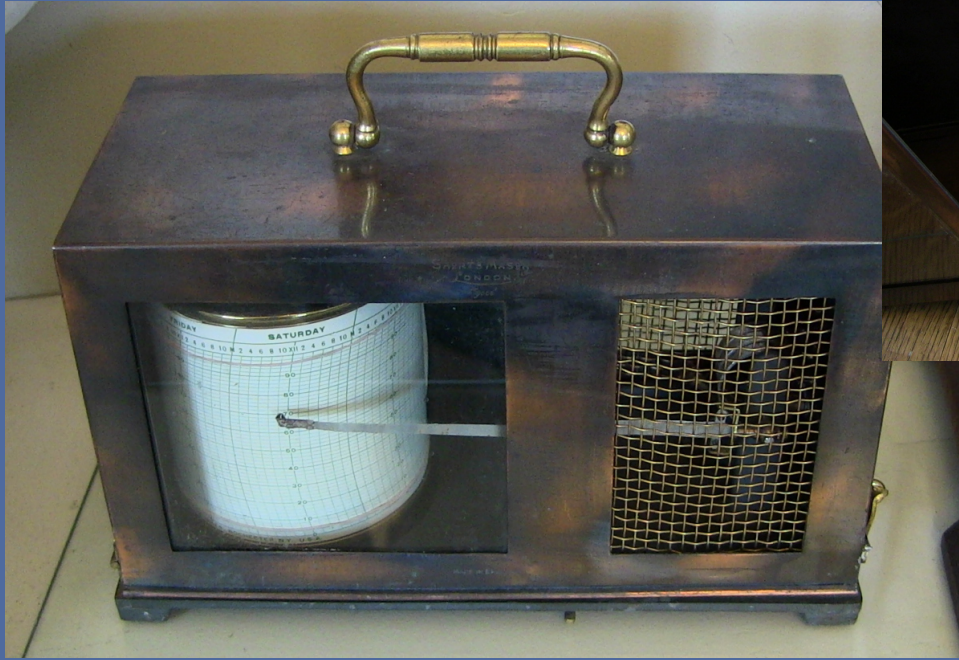
- Records duration of bright sunshine as direct sun burns card below glass
- Works in solar time, must be converted to local time
- No winding needed!



March 7, 1970 solar eclipse →

How Does BHO Measure the Climate/Weather?

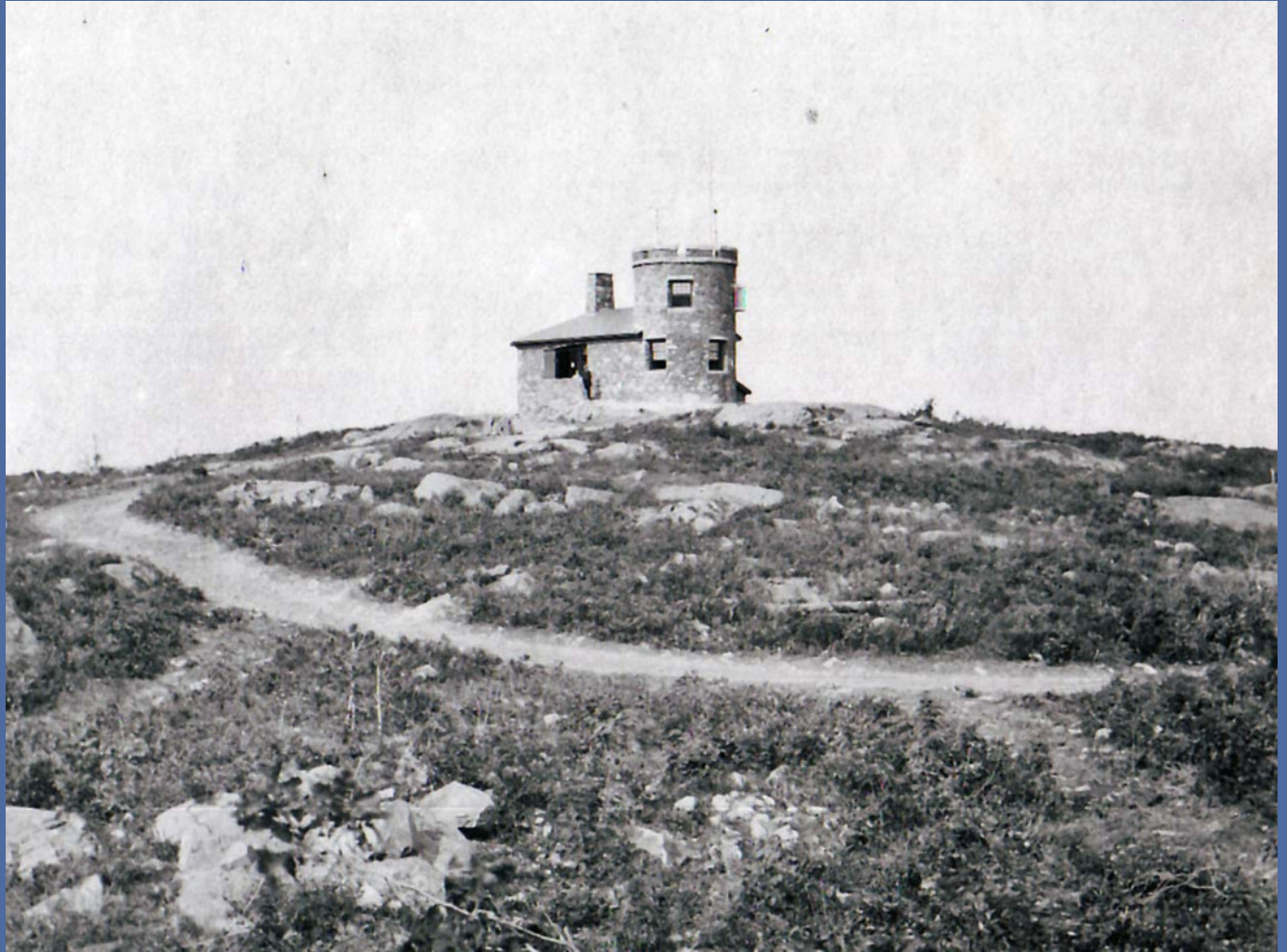
Thermograph (circa 1915)



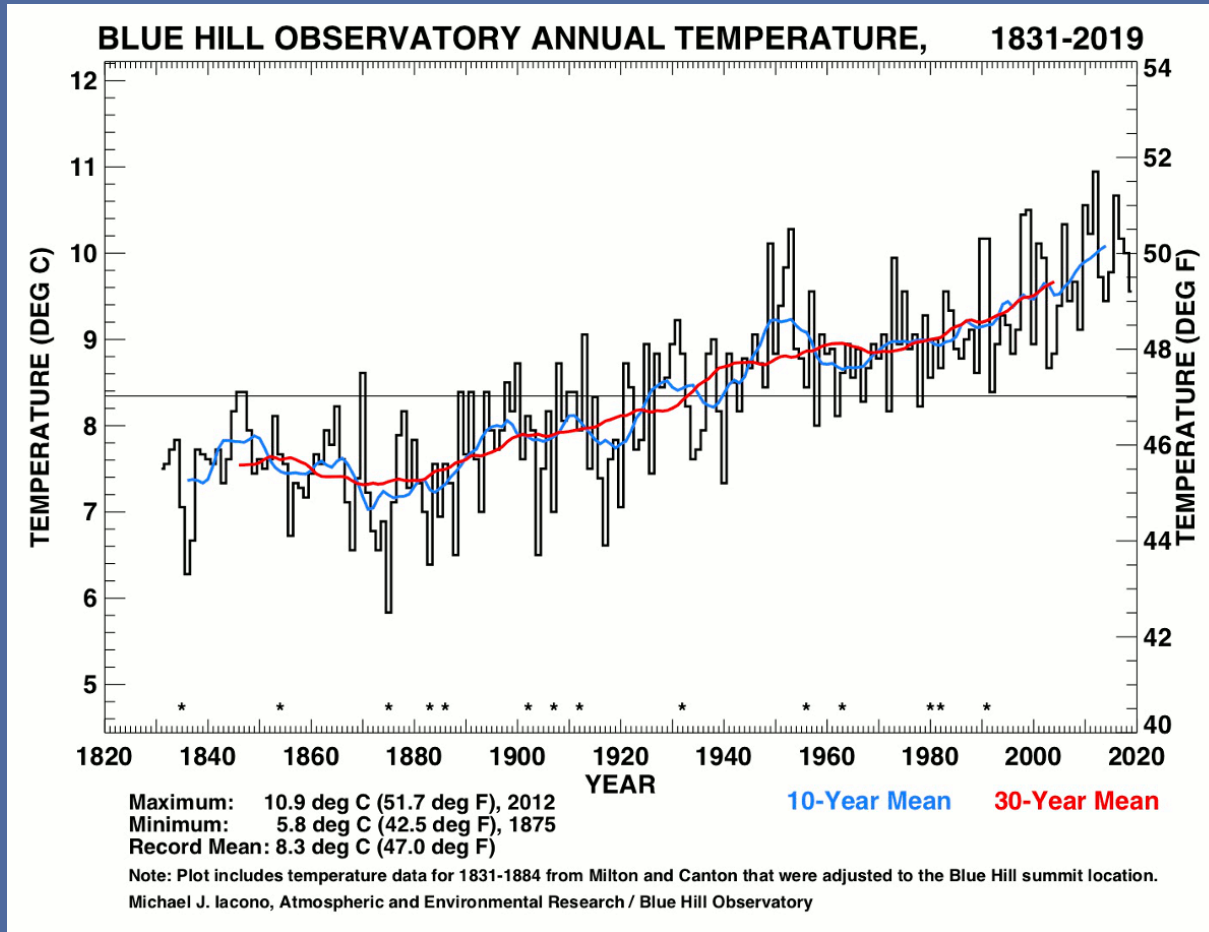
- Converts expansion/contraction of metal coil to temperature as a continuous trace on a clock-driven chart

BHO Climate

Original
Observatory,
Great Blue Hill
c. 1885

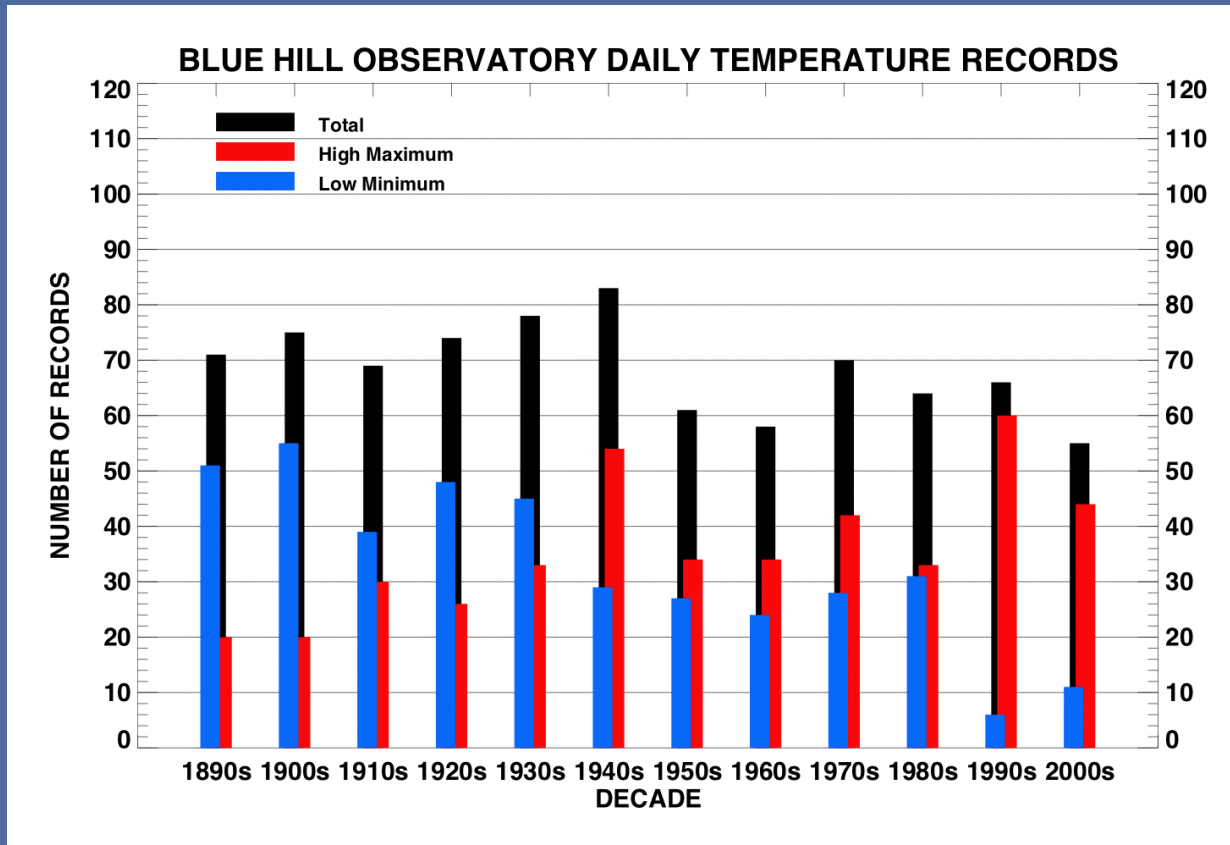


Temperature: Annual Mean



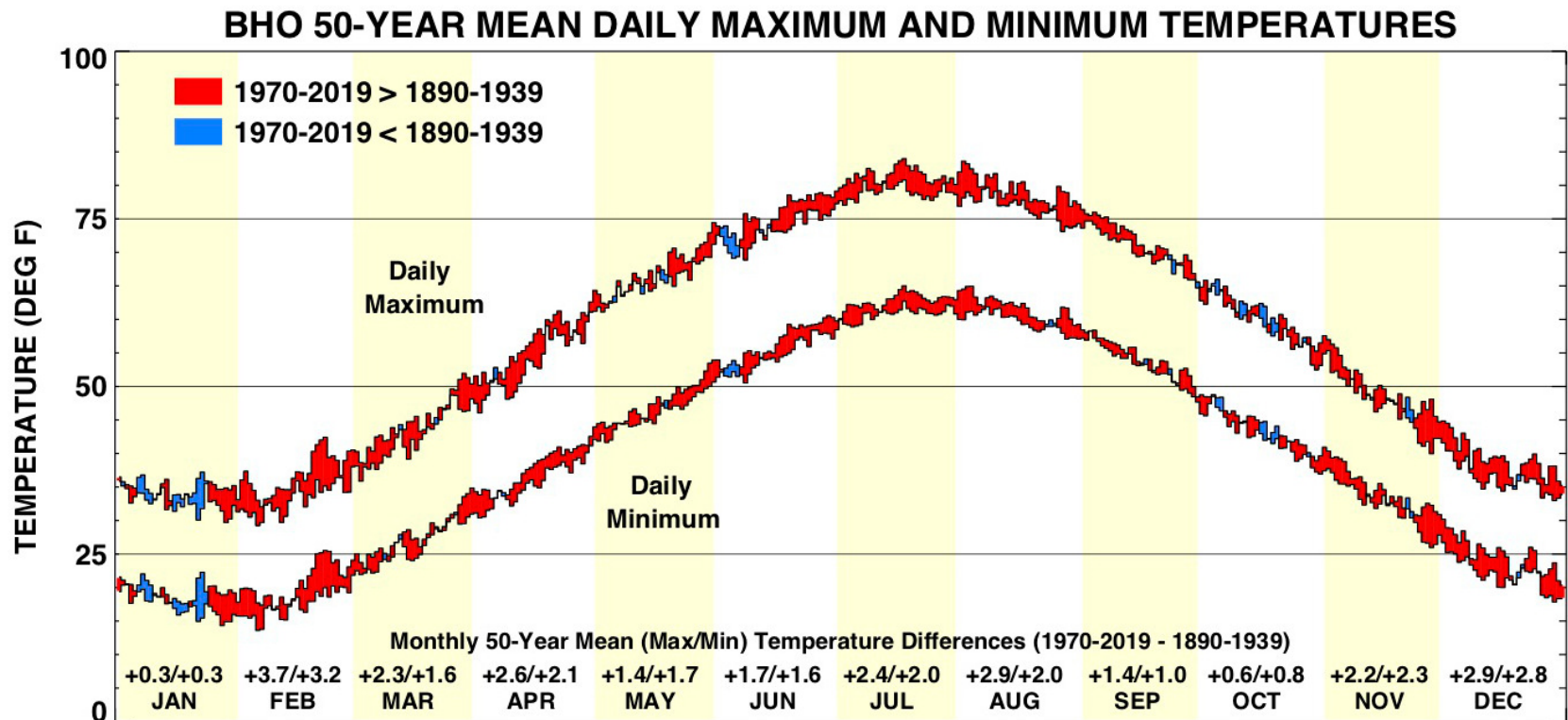
- Upward Trend:
+0.31 deg. F/decade,
+4.0 deg. F since 1885
- Trend statistically significant to 99.9% due to:
 - Long duration
 - Size of trend relative to annual variations
- Warmest: 51.7°F in 2012
- Coldest: 42.5°F in 1875

Temperature: Daily Record Extremes



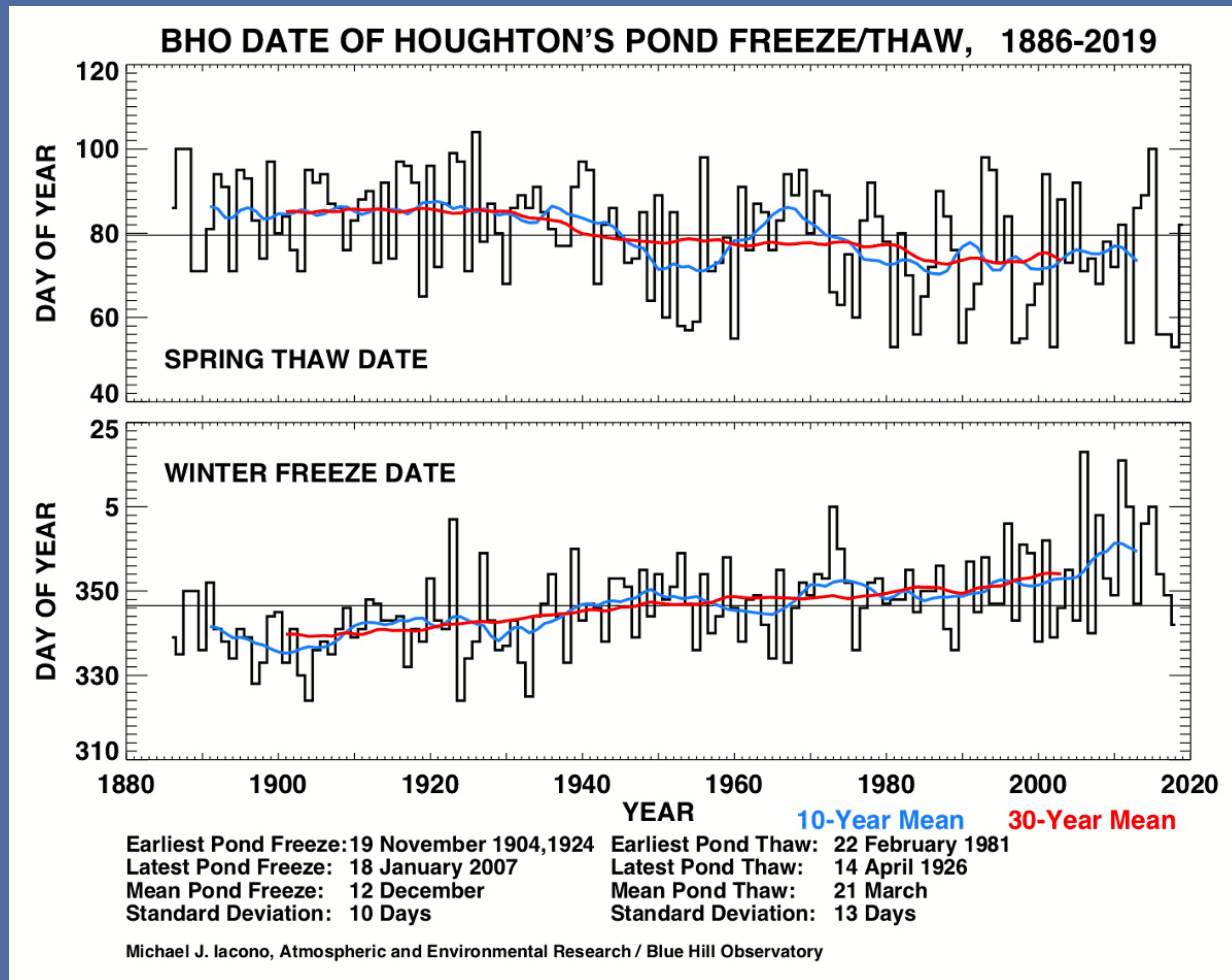
- Number of daily record high temperatures has increased
- Number of daily record low temperatures has decreased

Temperature: Averaged for each Day of the Year



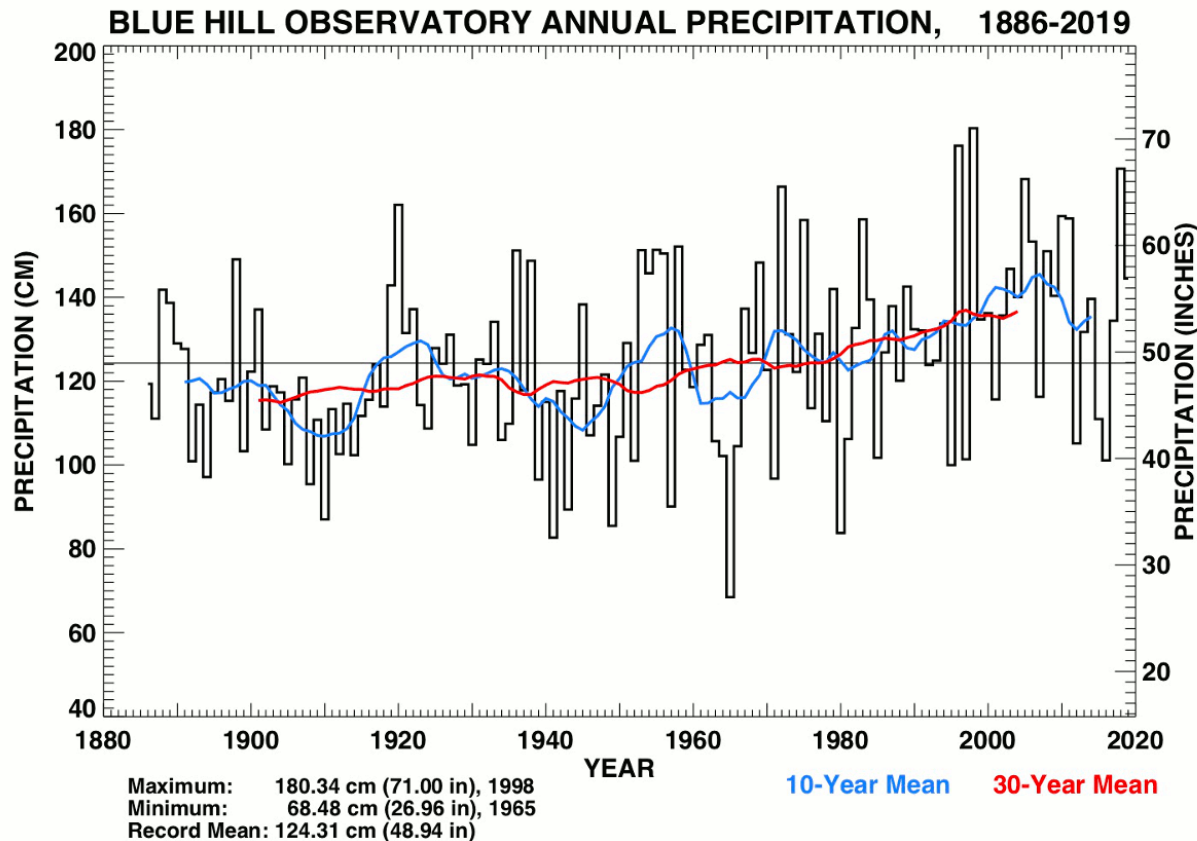
- Daily means over two 50-year periods: 1890-1939 and 1970-2019
- Recent period warmer (red); recent period colder (blue)
- Minimal changes in early January; February now much warmer

Temperature: Pond Freeze/Thaw Dates



- Length of time local pond remains frozen in winter has decreased by two weeks since 1880s
- Represents a natural indicator of climate change

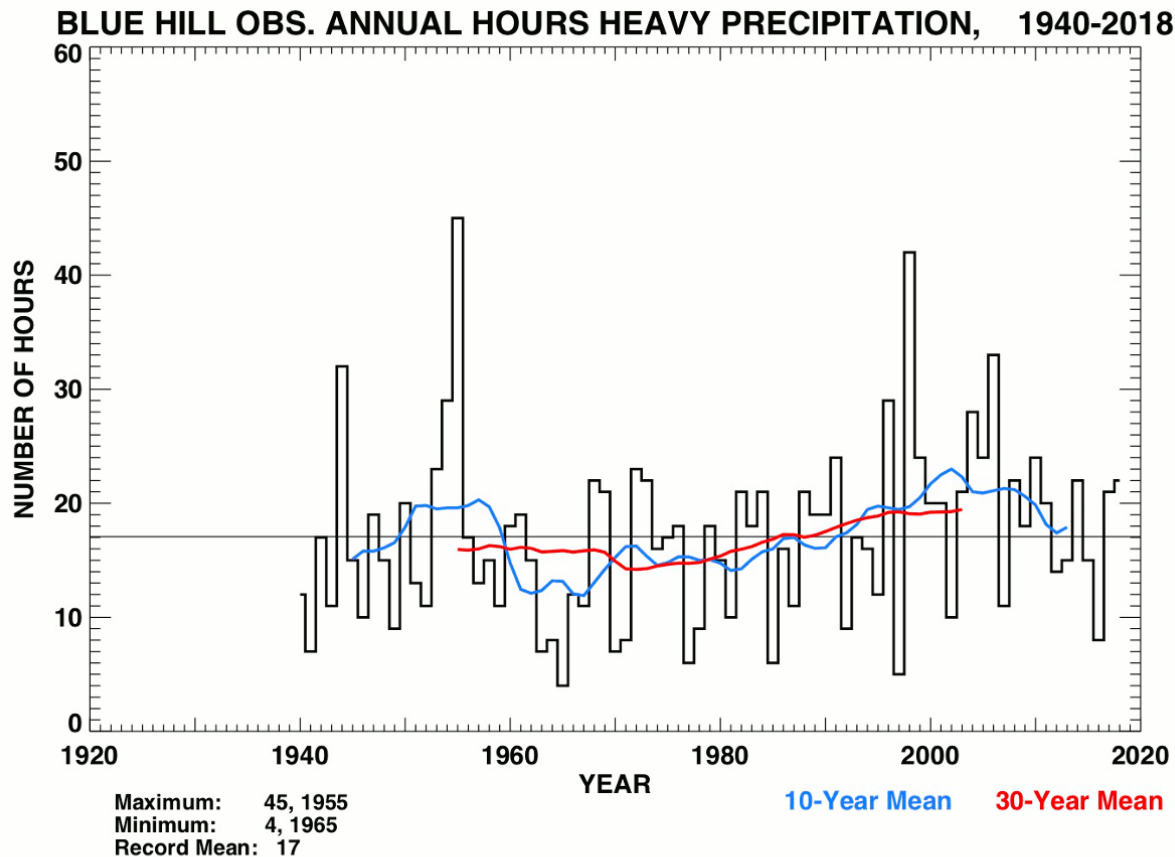
Precipitation: Annual Total



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- Total precipitation (rain plus melted snow) is increasing +0.60 in/decade
- High variability from year to year, upward trend is statistically significant
- Highest: 71.00" in 1998
- Lowest: 26.96" in 1965

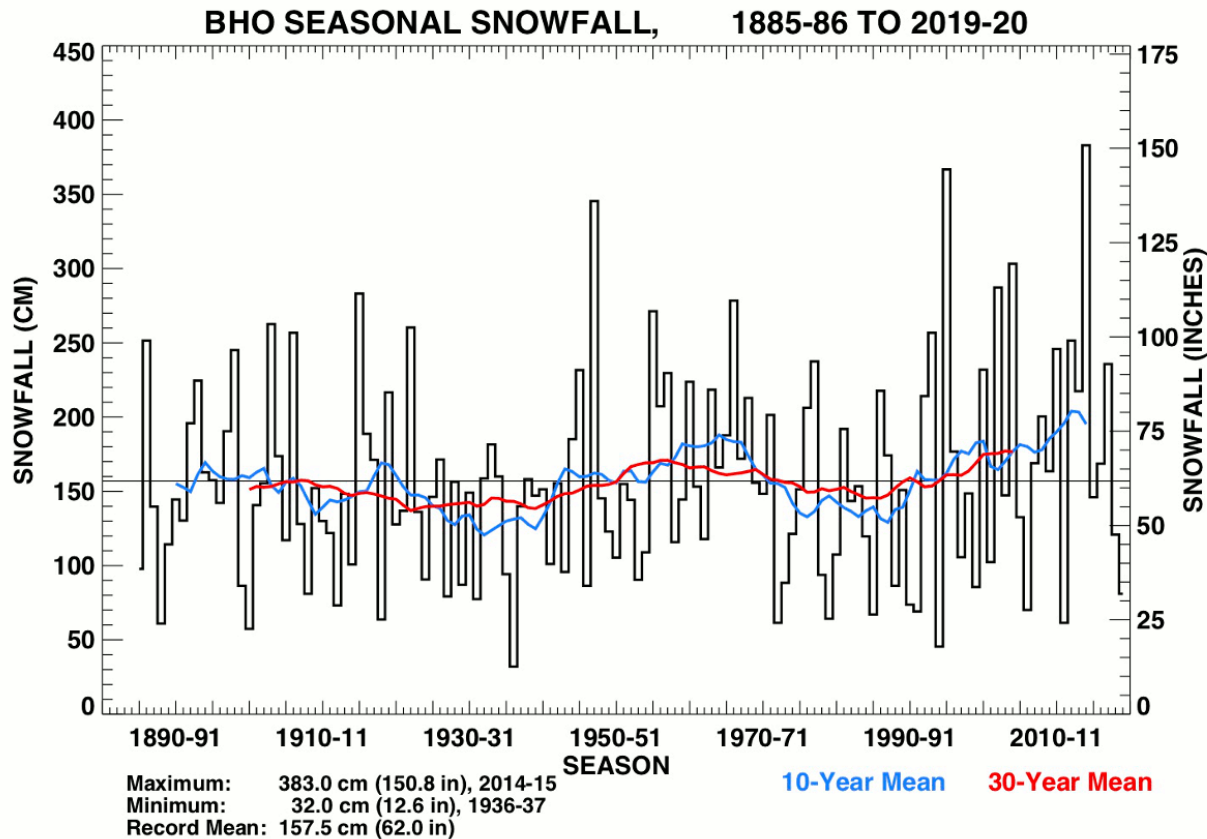
Precipitation: Annual Hours Heavy Rainfall



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- Heavy Rain: $>0.30''/\text{hour}$
- Slight increase in hours 1970 to 2000
- Return to long-term average in recent years

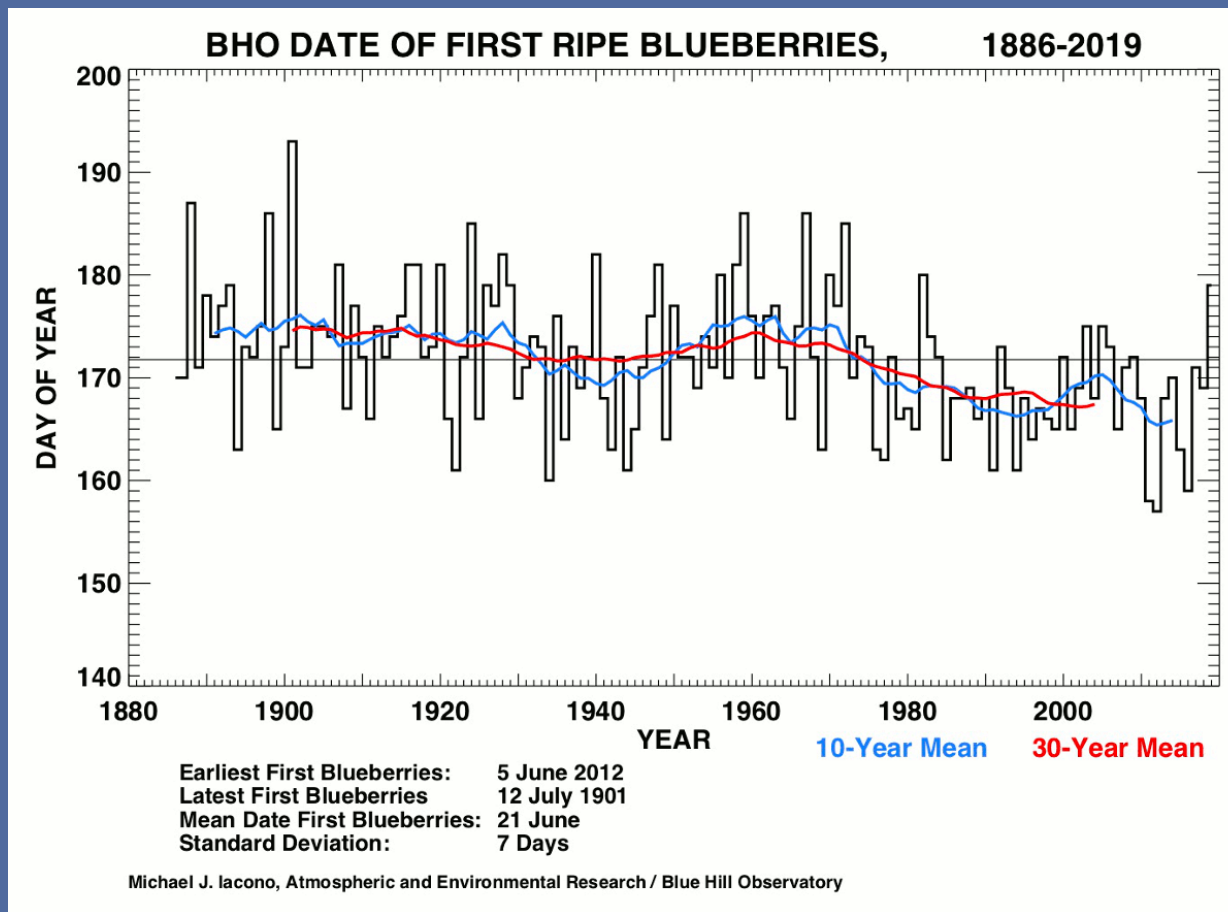
Snowfall: Seasonal Total



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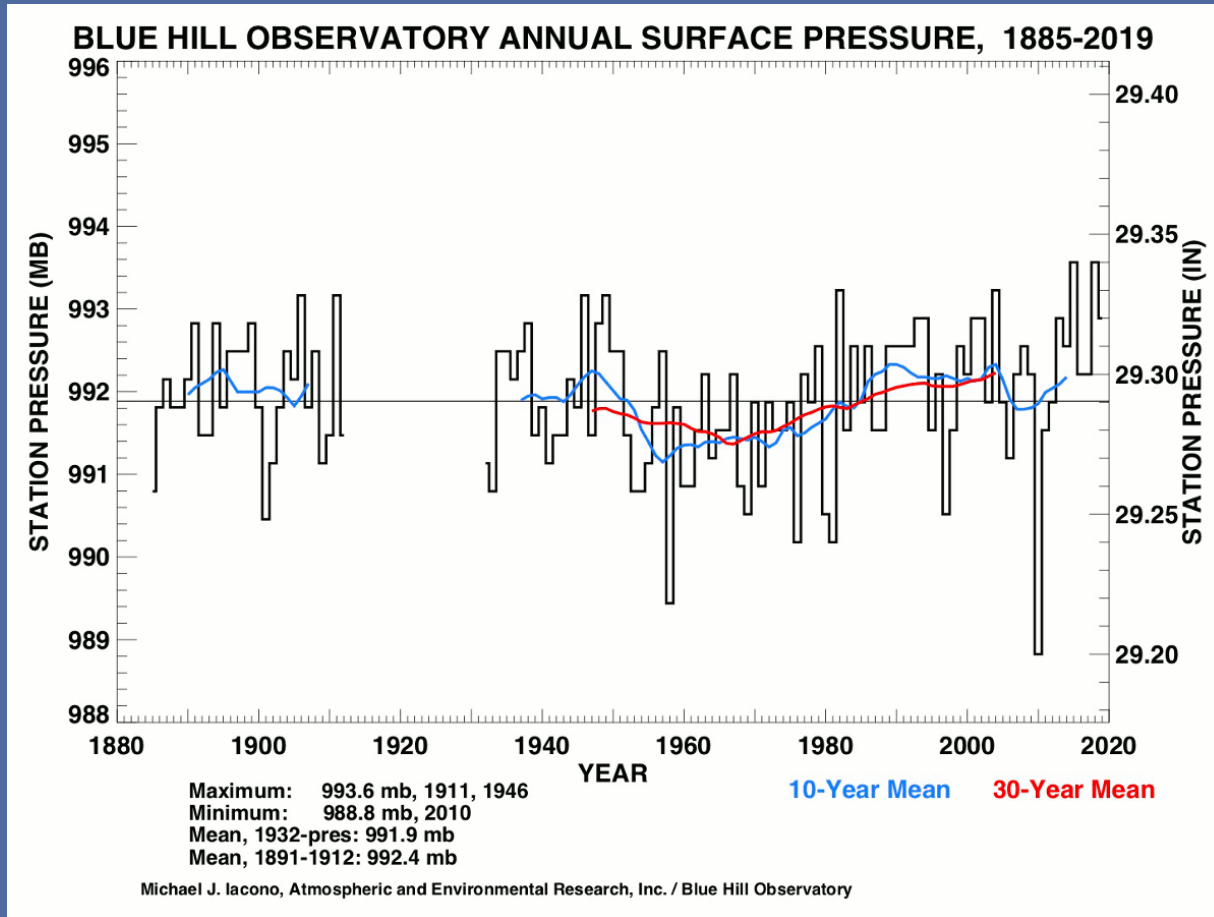
- Seasonal snowfall shows no significant trend
- Very high variation from year to year
- Decadal variability
- Highest: 150.8" in 2014-2015
- Lowest: 12.6" in 1936-1937

Phenology: Date of First Ripe Blueberries



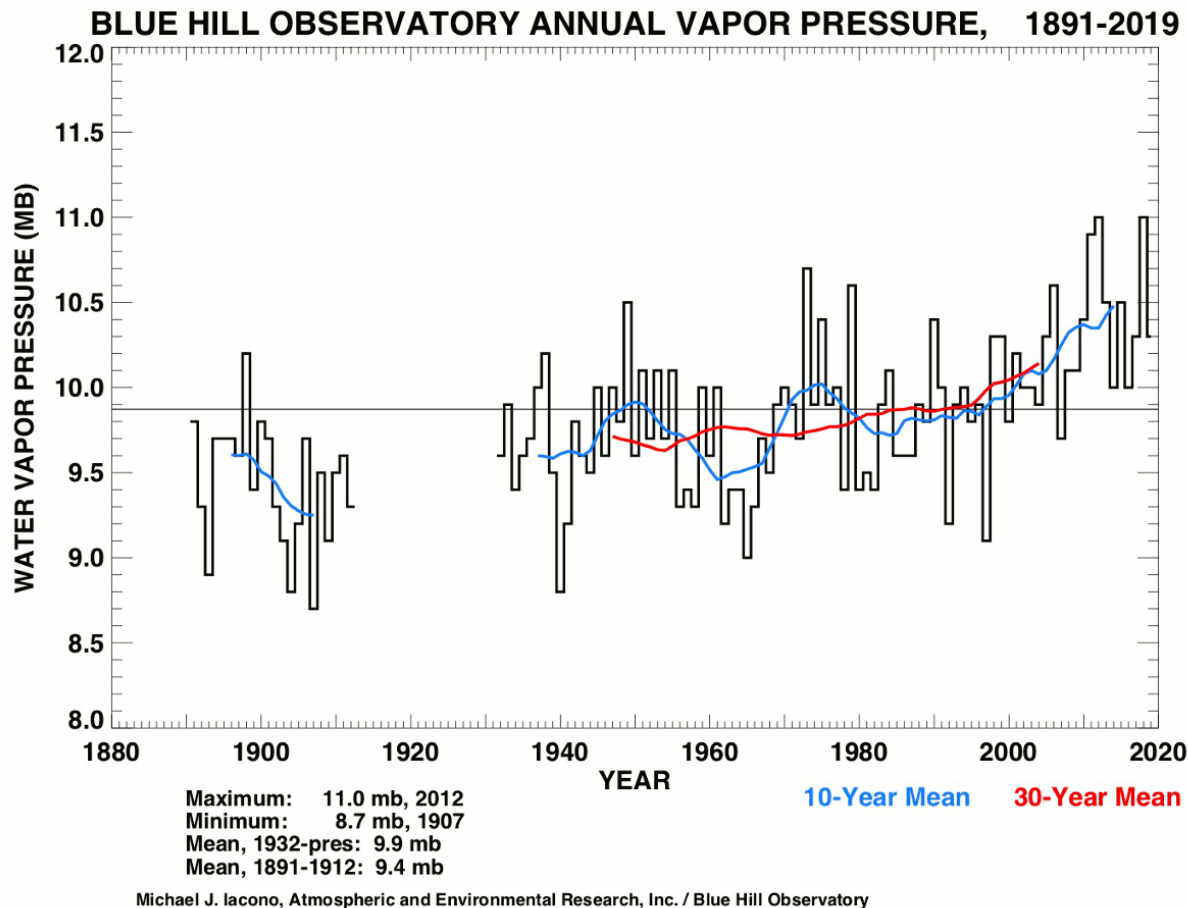
- Date of the first ripe blueberries in the instrument enclosure on the summit
- One week earlier since the 1880's
- Likely due to warming temperatures

Station Pressure: Annual Mean



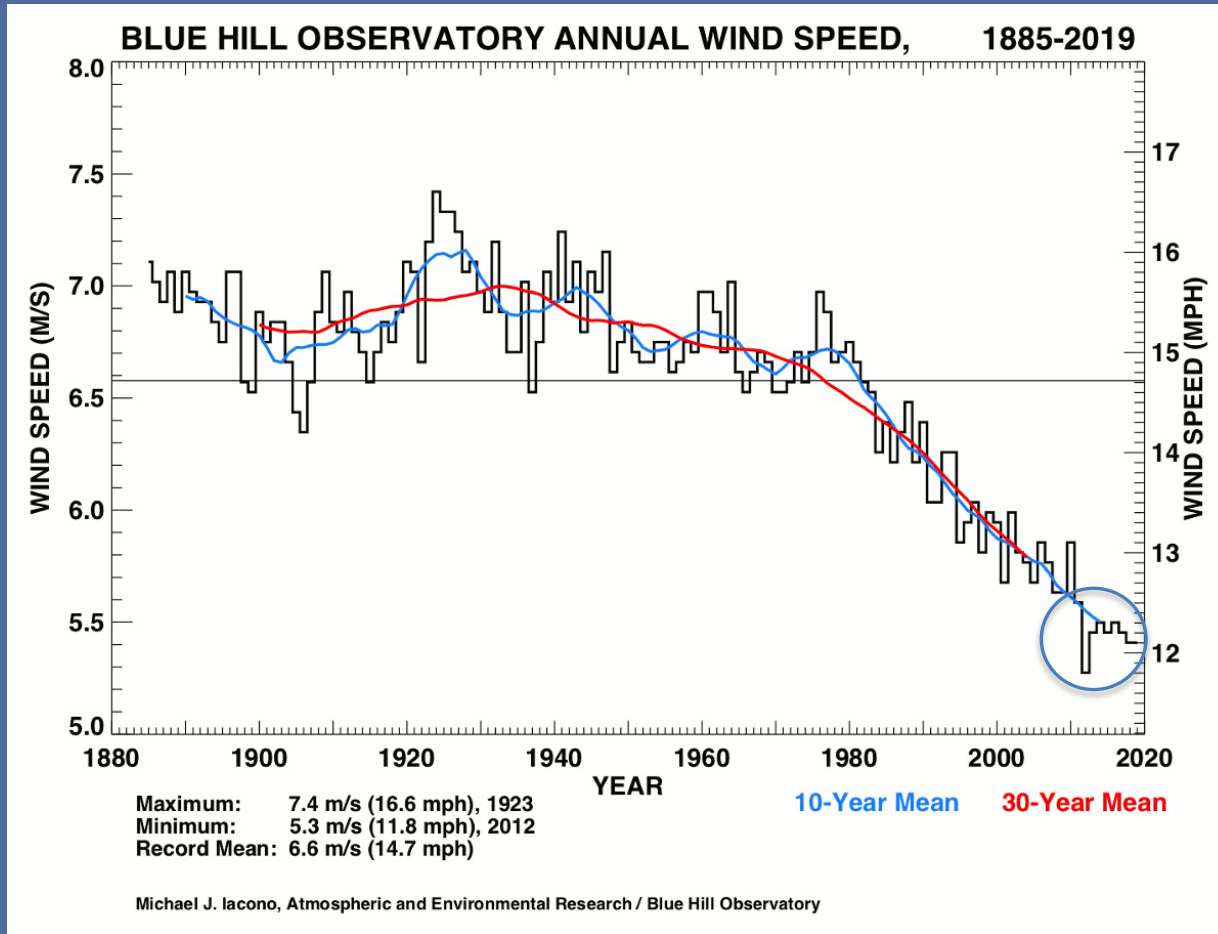
- Slight increase in station pressure noted over the last five decades
- Continuity of pressure data from the 1920's is under review

Water Vapor Pressure: Annual Mean



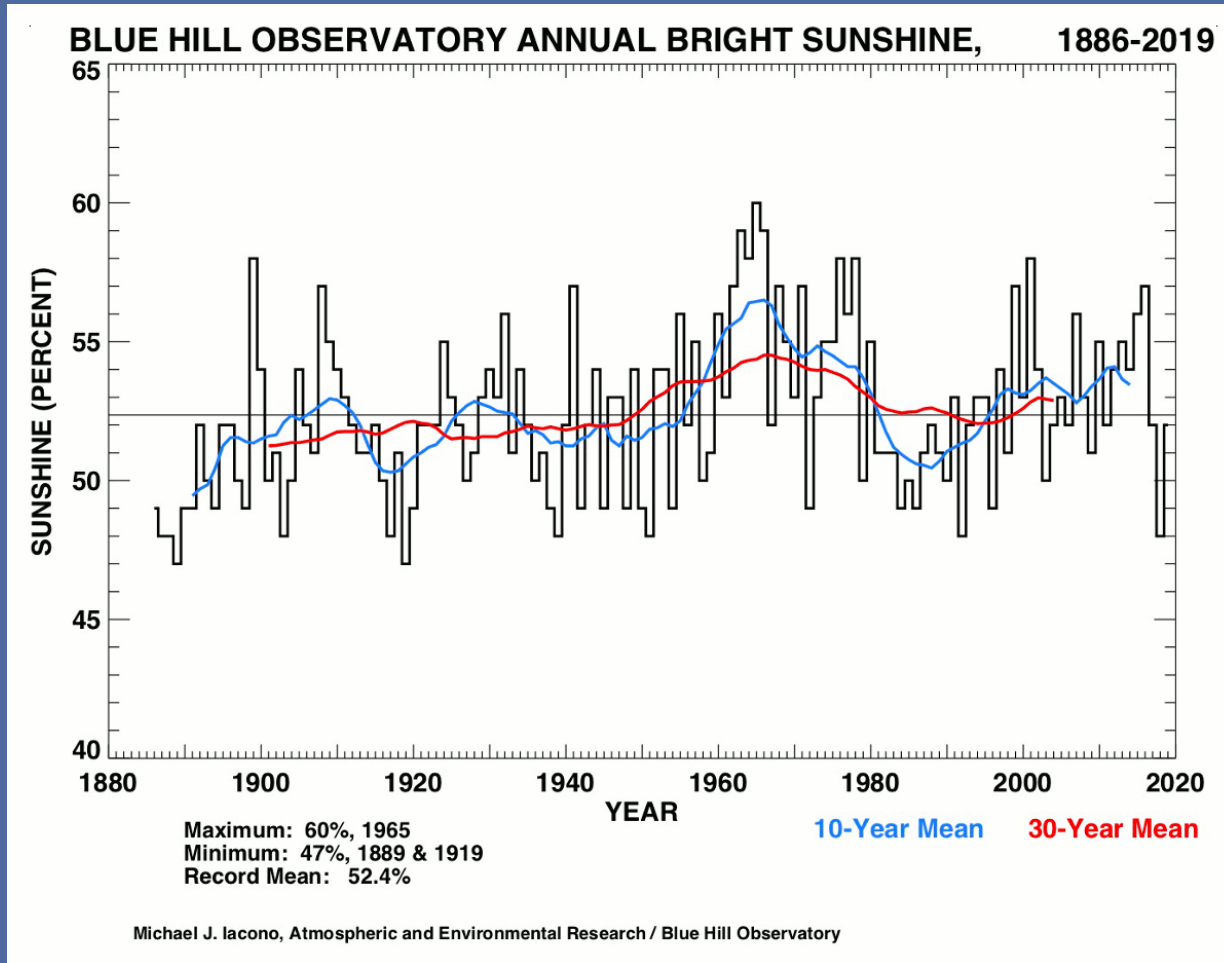
- Vapor pressure is the contribution of water vapor to total surface pressure (about 1%)
- Absolute measure of atmospheric moisture
- Increasing since the 1960's

Wind Speed: Annual Mean



- Annual wind speed falling dramatically since 1980
- Uncertain cause:
 - reforestation
 - global wind pattern changes
- Global stilling since 1960's reported in the literature has stalled in the last five years

Sunshine Duration: Annual Mean



- Reflects changes in both cloud cover and aerosols
- Sunshine dropped during 1960's and 1970's due to more pollution/aerosols
- Sunshine has increased since 1990's due to less air pollution



Thank You!

Questions? (miacono@bluehill.org)