

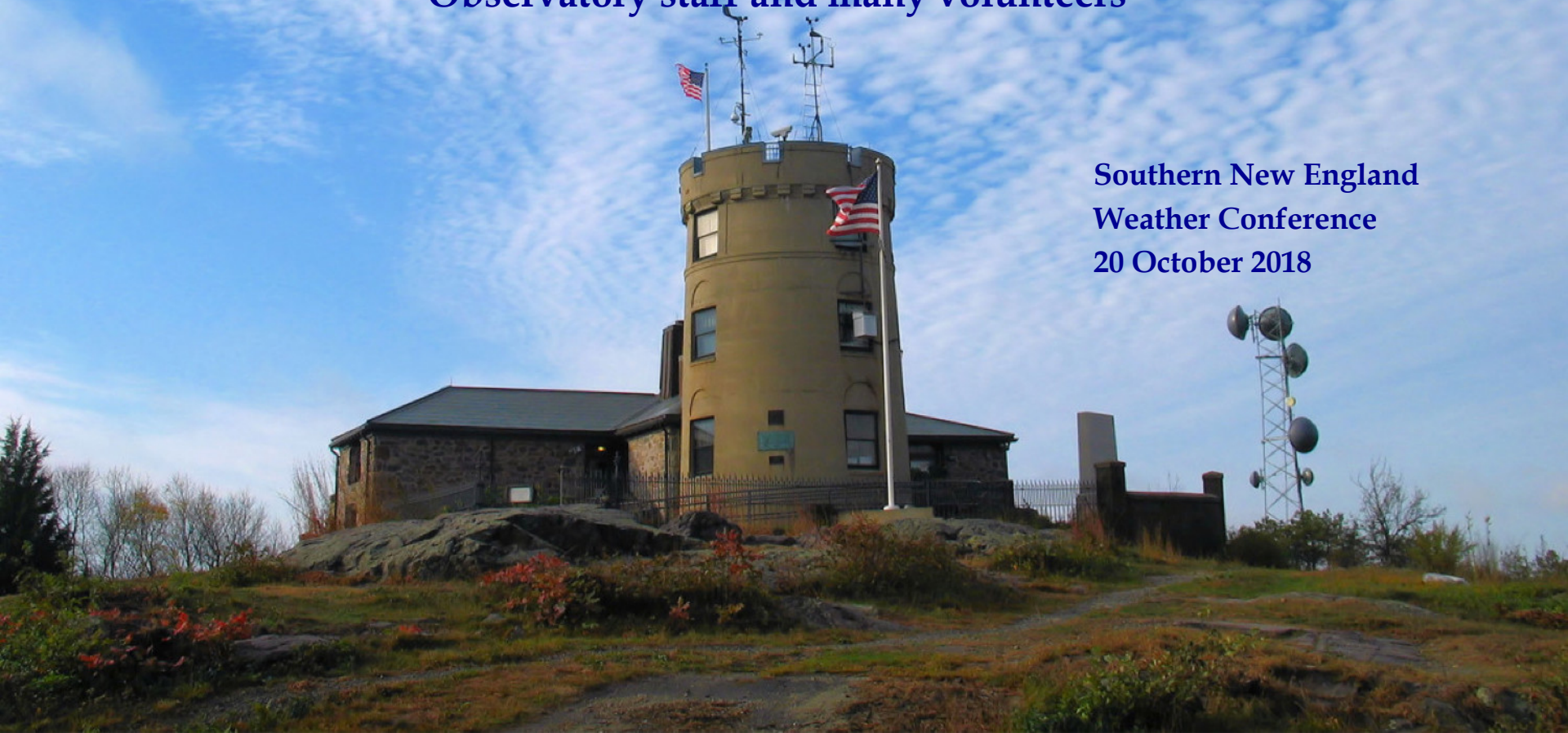
Preserving the Weather Since 1885: The History and Climate Record of the Blue Hill Observatory

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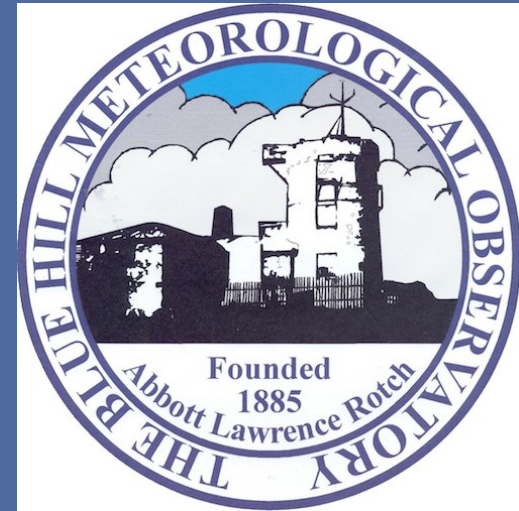
Observatory staff and many volunteers

Southern New England
Weather Conference
20 October 2018



Outline

- Highlights
- Historical Accomplishments
- Educational Programs
- Climate Research



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."

Highlights

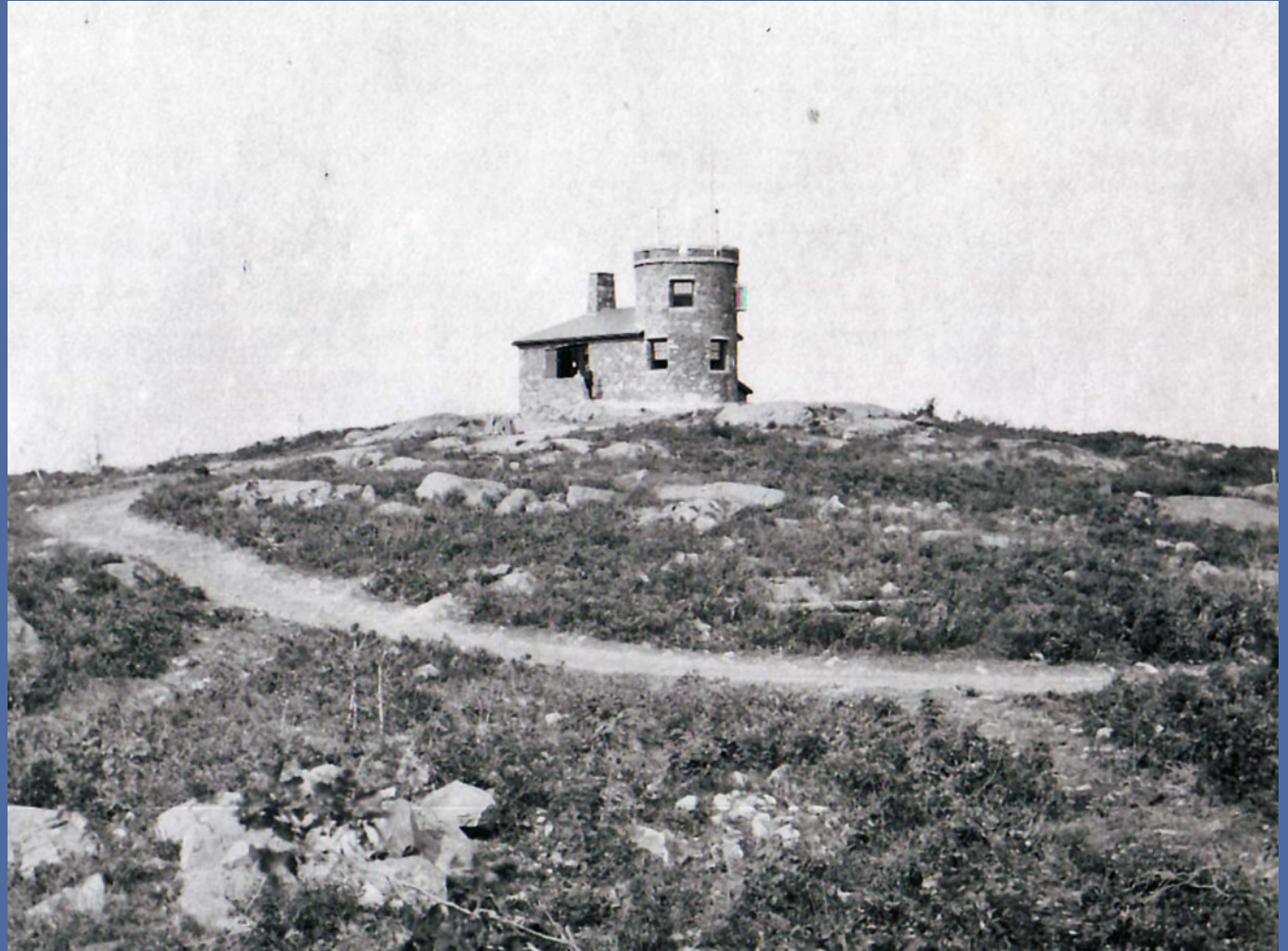
- **Founded by Abbott Lawrence Rotch on February 1, 1885**
- **Accurate, continuous, extensive climate record**
- **Long history of contributions to meteorology**
- **Mission expanded to include science education programs and public outreach**
- **BHO designated a National Historic Landmark in 1989, and a WMO Centennial Observing Station in 2017**
- **BHO data are an irreplaceable resource for climate education and research**

What makes Blue Hill so unique?

- Long duration of record; now more than 133 years
- Very extensive list of weather parameters observed
- High degree of continuity across the decades through the use of traditional instruments and methods
- Little change in site on summit of Great Blue Hill within the Blue Hills Reservation
- Addresses critical need for validation of modern instruments and climate model predictions

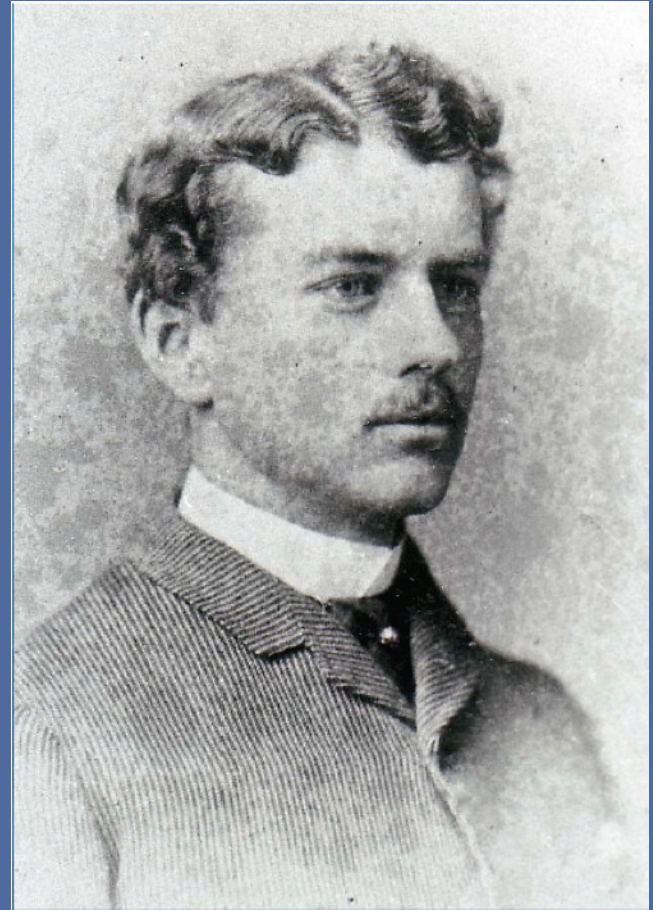
BHO History

Original
Observatory,
Great Blue Hill
c. 1885



Abbott Lawrence Rotch (1861-1912)

- Boston native; MIT graduate
- Later became Professor of Meteorology at Harvard
- Committed to advancement of meteorology and aerology
- Travelled extensively to other observatories
- Corresponded with the Wright brothers



Early Accomplishments

- Consistent weather observing
- Weather forecasting (flag signals)

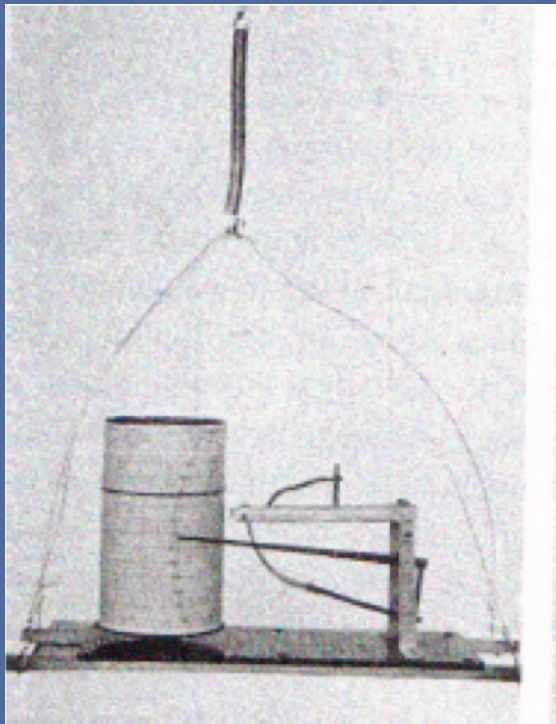


February 1, 1885.

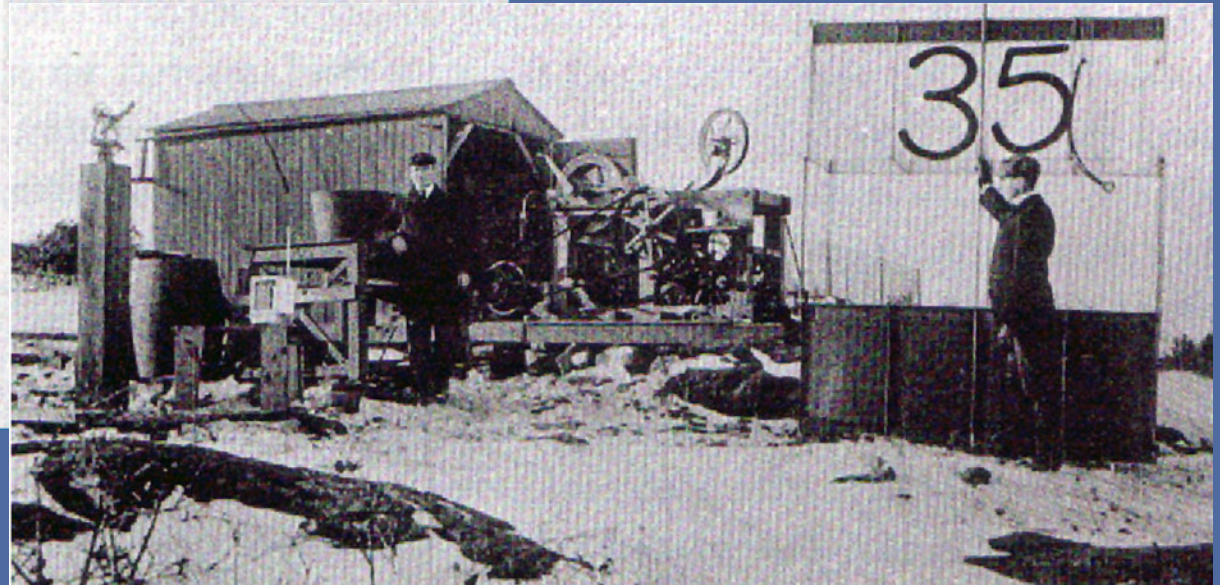
Precipitation.		
Kind		Snow
Time of beginning		AM 10:55
Direction of wind at beginning		S.E.
Time of ending		6:40 P.M.
Direction of wind at ending		W.
Changes in direction of wind.		Veered from S.E. to W.
Amount of rain		
Amount of melted snow by gage		.09 in.
Amount of melted snow by section.		
Estimated depth of snow		1 1/2 in.
Self Registering Thermometers		
7 A.M.	Minimum thermometer	18.1
	Corrected minimum	18.1
	Minimum thermometer	15.7 by Exposed.
	Maximum thermometer	30.4 by Exposed.
	Corrected minimum	15.7
11 P.M.	Corrected maximum	30.4
	Range	14.7
	Minimum after setting	15.0
	Maximum after setting	15.8
Wind		
	Maximum velocity	
	Time of maximum velocity	
	Minimum velocity	
	Time of minimum velocity	
	Changes in direction.	NE veering to W
	Number of miles in 24 hours	4.20
Miscellaneous.		
	Wind Velocity of 36 miles noted at 8 P.M.	
	" " " 42 " " " 8.30	
	" " " 48 " " " 10	

Early Accomplishments

- Sounding of atmosphere with kites (1890-1910)
- Greatest height attained: 4,815 meters MSL (19 July 1900)



(15,797 feet)



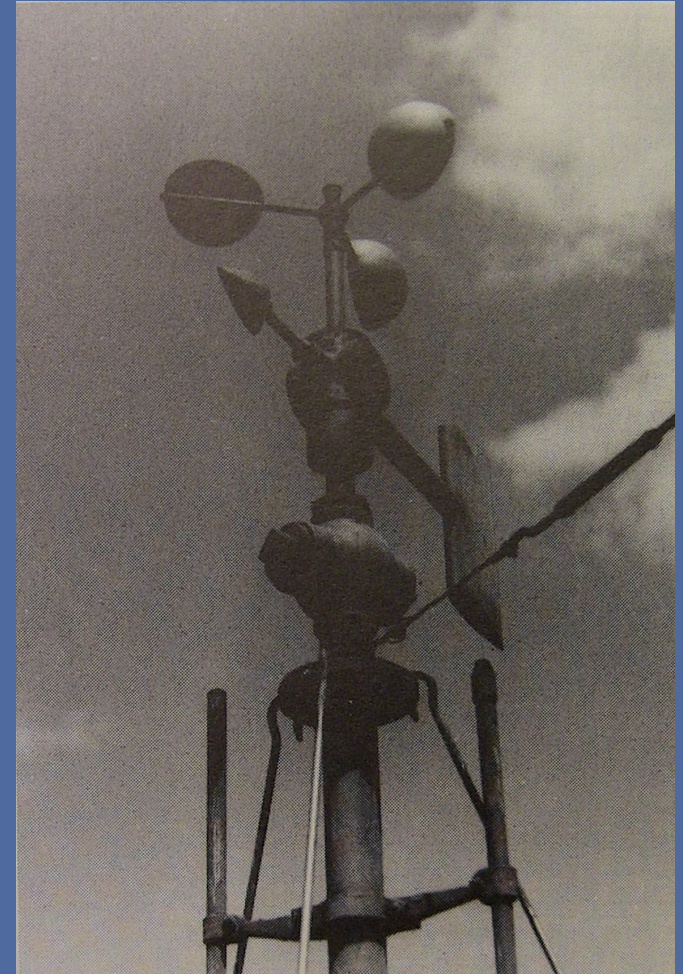
Early Accomplishments

- Pioneered use of radio to transmit weather data in 1930s (precursor to current weather balloon sounding)
- First successful radio-meteorograph transmission from a free balloon was made at BHO in 1935



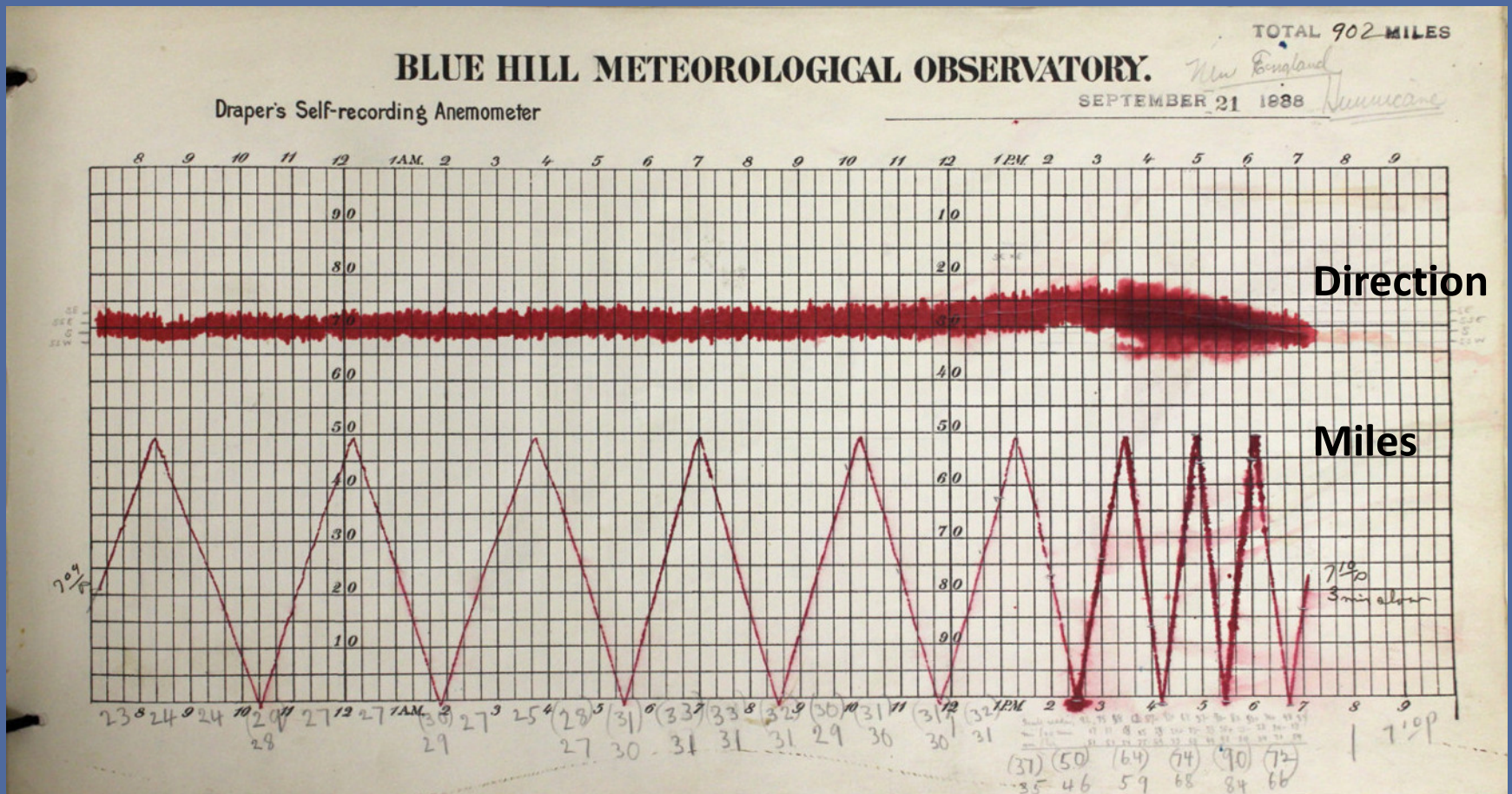
Early Accomplishments

- Survived Great New England Hurricane on September 21, 1938
- Highest 5-minute average speed: **121 mph, S** (6:11-6:16 PM; Draper anemometer and recorder)
- Highest wind gust: **186 mph, S** (calculated from 5-min avg. with error of +/- 30-40 mph)
- Lowest pressure: 29.01" (5:17 PM)
- Precipitation: 0.13"!



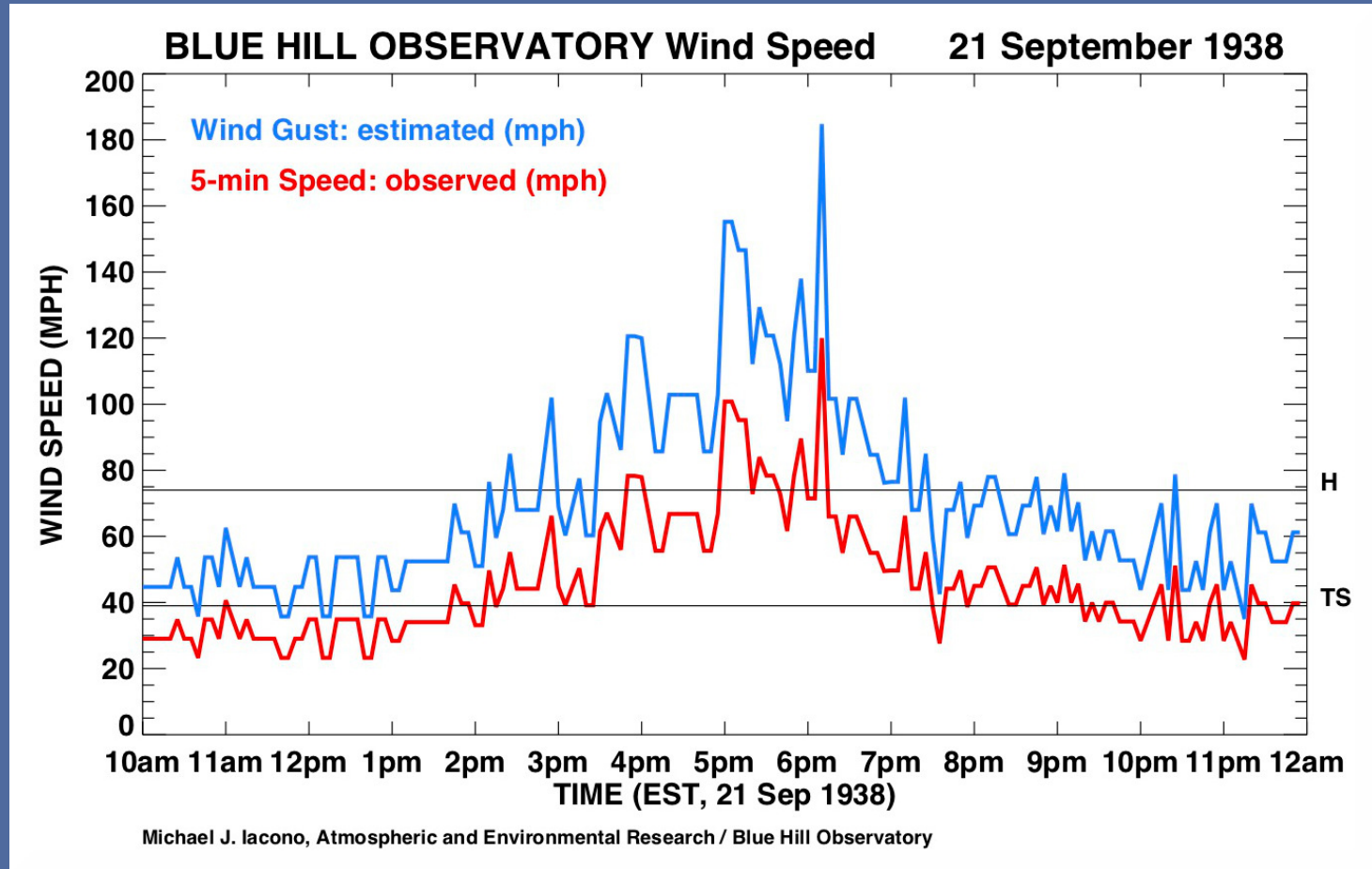
Early Accomplishments

- Great New England Hurricane original wind chart



Early Accomplishments

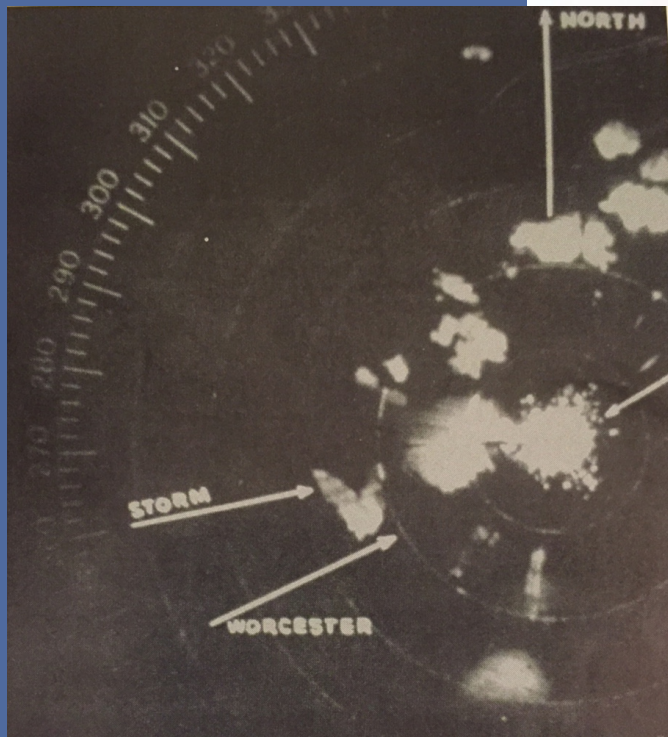
- Great New England Hurricane analyzed wind speeds



Eye Location: LI CT MA VT

Early Accomplishments

- Site of early weather radar experiments in 1950s by MIT/AFRL
- Radar image of the Worcester tornado, June 9, 1953



BHO Educational Programs and Public Outreach



Kite Building
and Flying
Workshops

BHO Science Center Educational Programs

Southern New England Weather Conference

- Annual meeting of local scientists, weather professionals, teachers, students and general public

Observatory Activities

- Programs include *Weather Watching, Observatory Exploration, Weather Forecasting, Kite Making Workshops*, in-depth tours, guided hikes, etc.
- School groups, public tours; sponsor student interns

Women in Natural Science (WINS) Program

- Seeks to inspire girls to learn about science and math

BHO Science Center Public Outreach

Online and Social Media

- Observatory web site (bluehill.org), Facebook and Twitter

Public Presentations

- Civic organizations, schools, libraries, museums, etc.
- AMS and AGU Conference posters

Media Support

- Newspapers, TV and radio stations

Climate Data Requests

- Support for outside research and climate assessments

BHO Science

Sun pillar
February 7, 2009



How Does BHO Preserve the Weather?

- Where possible, traditional observing methods and instruments are used to ensure long-term **consistency**
- Hazen temperature shelter on same spot since 1905
- Oldest instrument in use: Mercury barometer (1887)
- Mean temperature reflects 24 hours instead of average of maximum and minimum (NWS)
- Adjustments applied to wind speed for consistency with prior instruments
- Complete daily database for entire period of record is under development

How Does BHO Preserve the Weather?

Extensive observations

- 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.



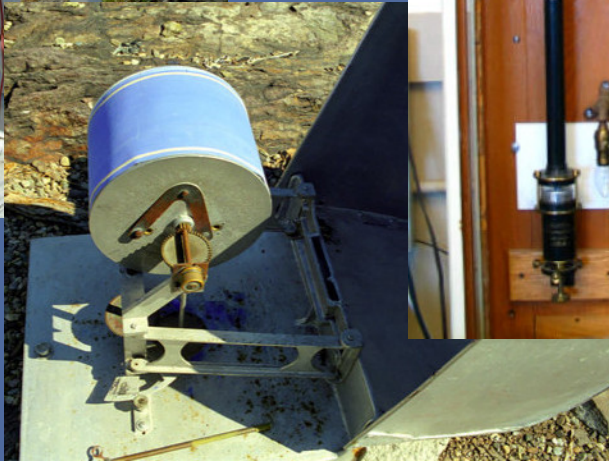
Outdoor instrument enclosure at BHO

How Does BHO Preserve the Weather?

Traditional instruments



Hazen
temperature
shelter



Ombroscope



Mercury
barometers



Sunshine recorder

How Does BHO Preserve the Weather?

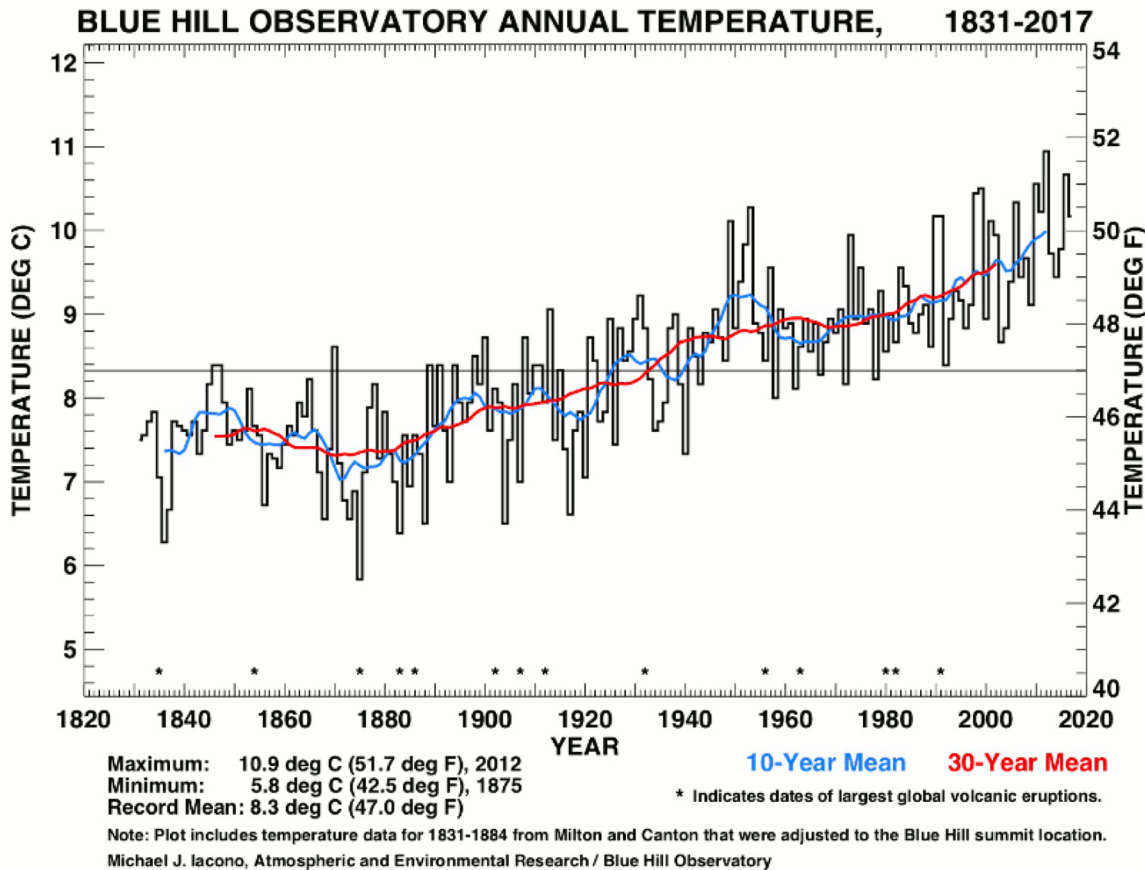
Ensuring continuity



Temporary wind tower installed to continue wind speed record during Observatory renovations in 2019



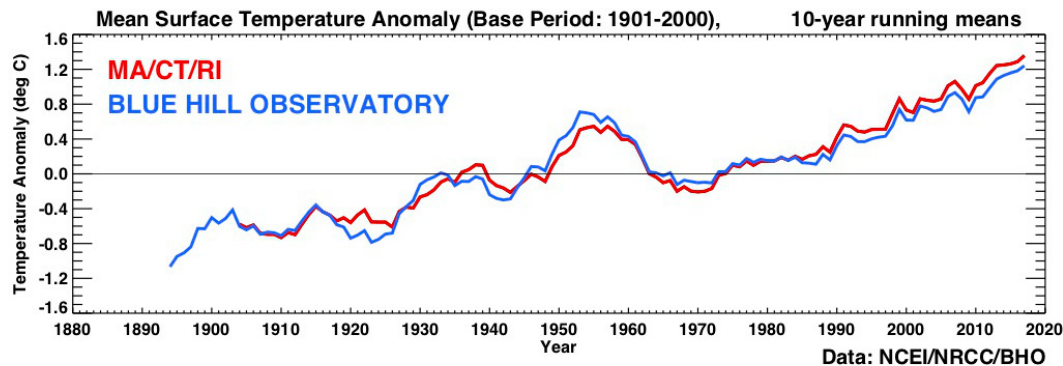
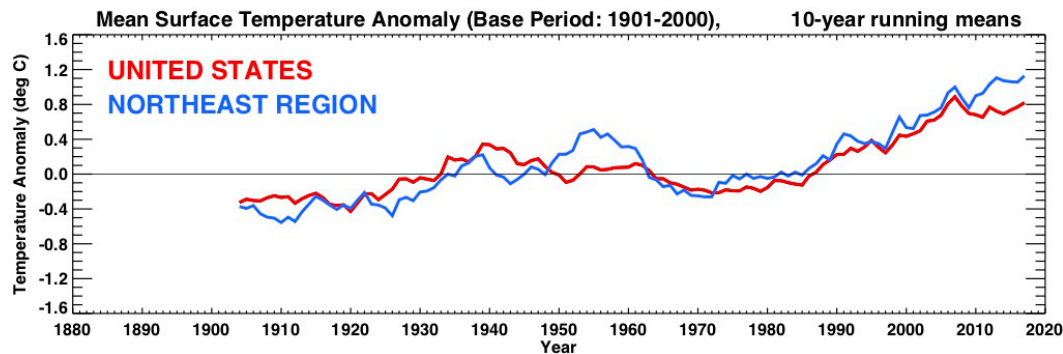
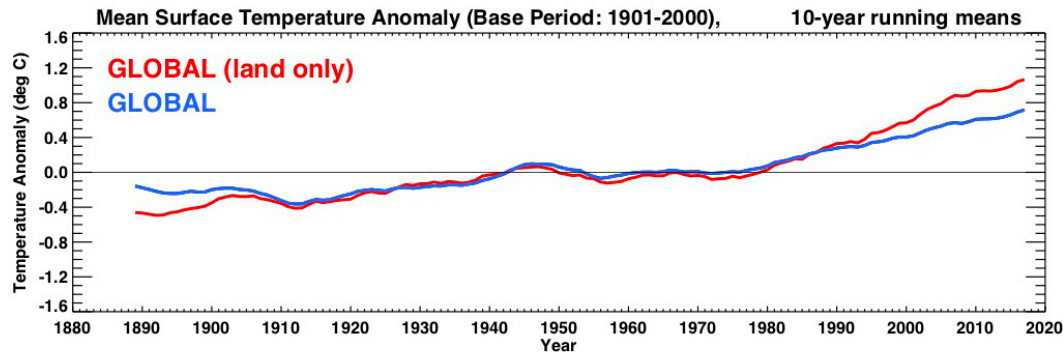
Temperature: Annual Mean



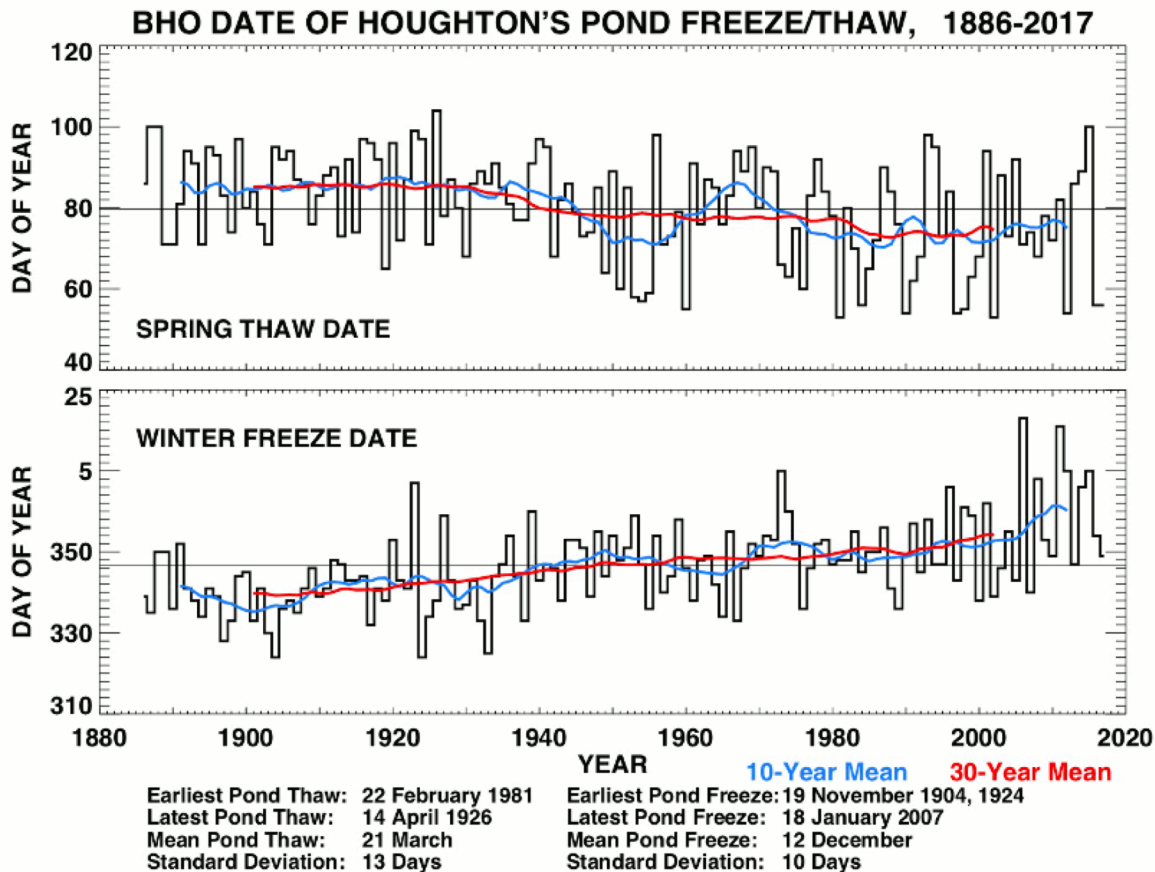
- Upward Trend:
+0.31 deg. F/decade,
+4.0 deg. F since 1885
- Trend statistically significant to 99.9% due to:
 - Long duration
 - Size of trend relative to annual variations

Temperature: Comparison with larger scales

- Global trend:
+0.17 deg. F/decade
+2.2 deg. F since 1880
- Southern New England trend
adjusted by NCEI;
now similar to BHO



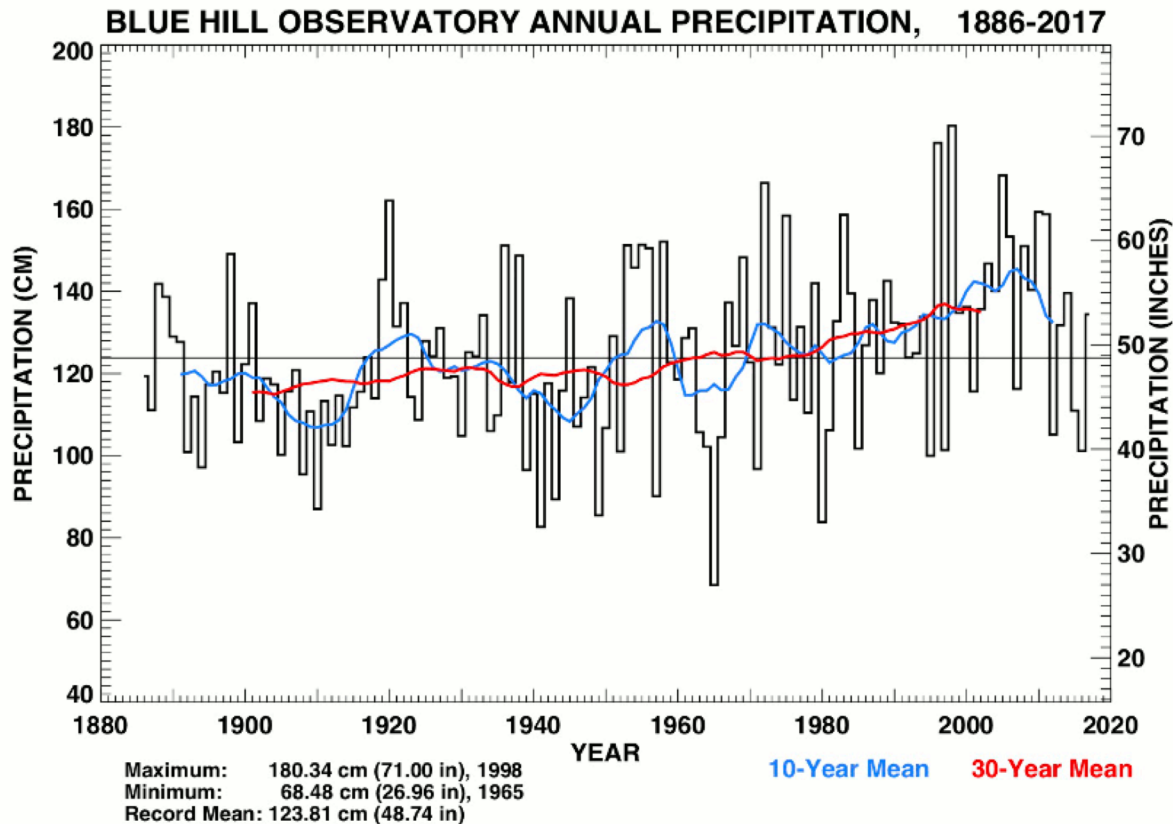
Temperature: Pond Freeze/Thaw Dates



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

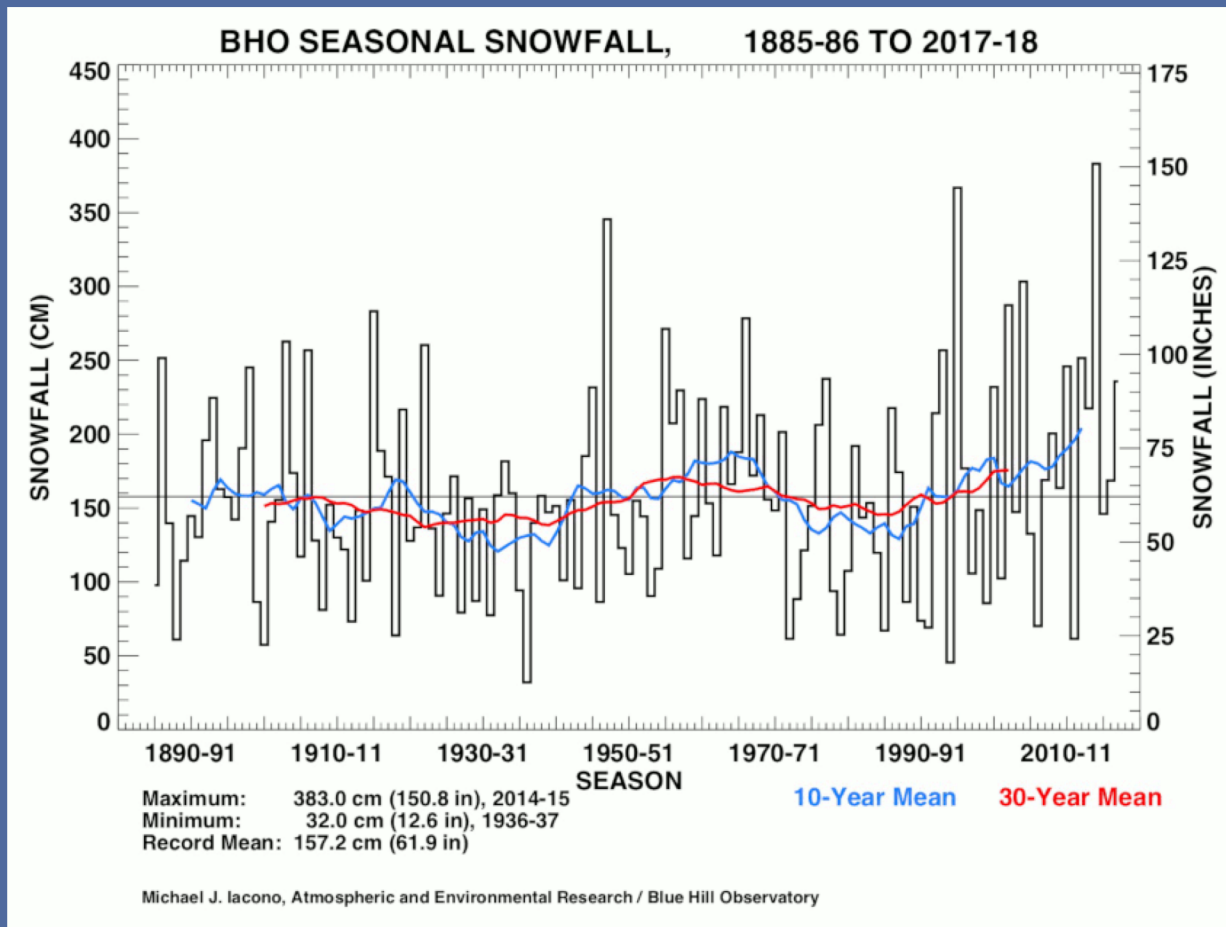
Precipitation: Annual Total



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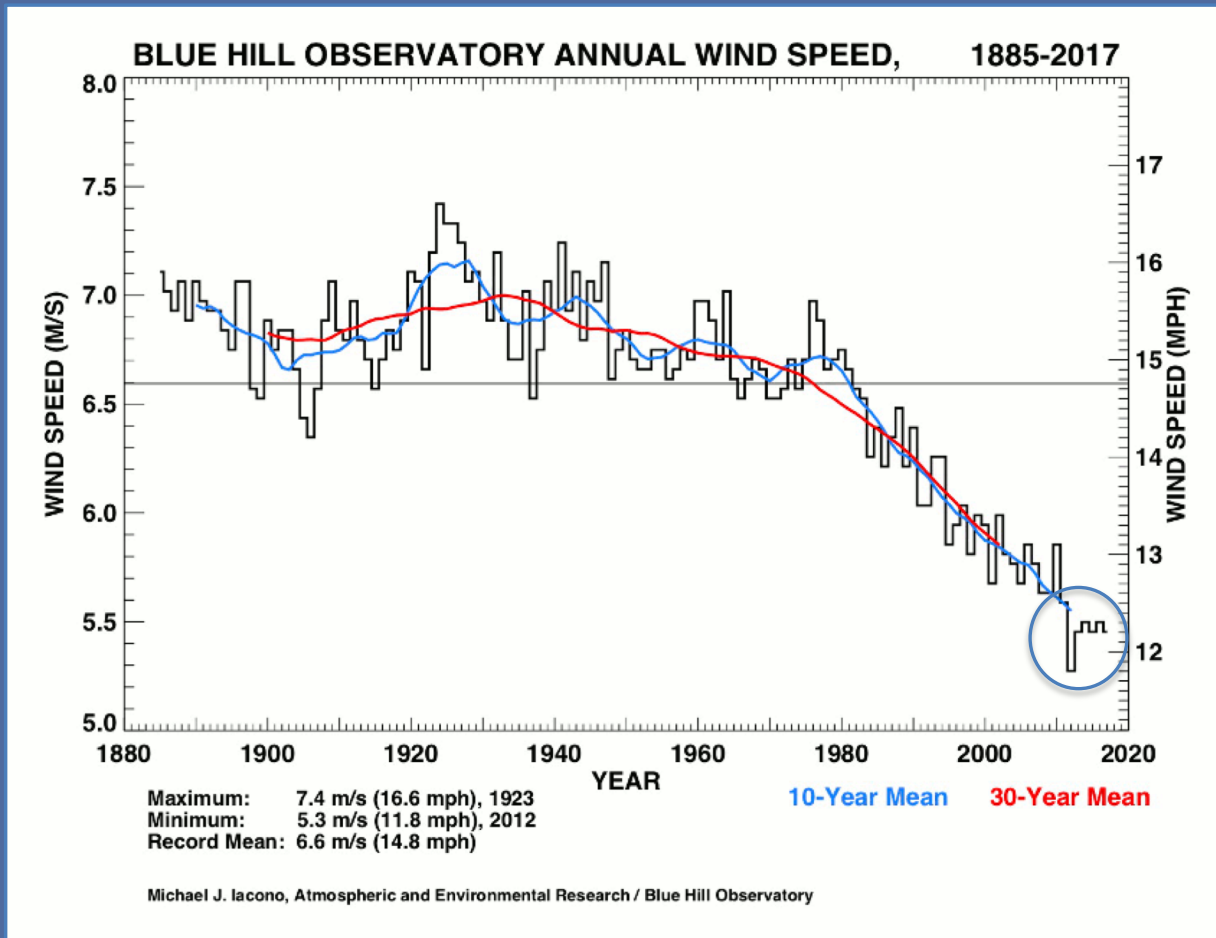
- Total precipitation (rain plus melted snow) is increasing +0.60 in/decade
- High variability from year to year, upward trend is statistically significant

Snowfall: Seasonal Total



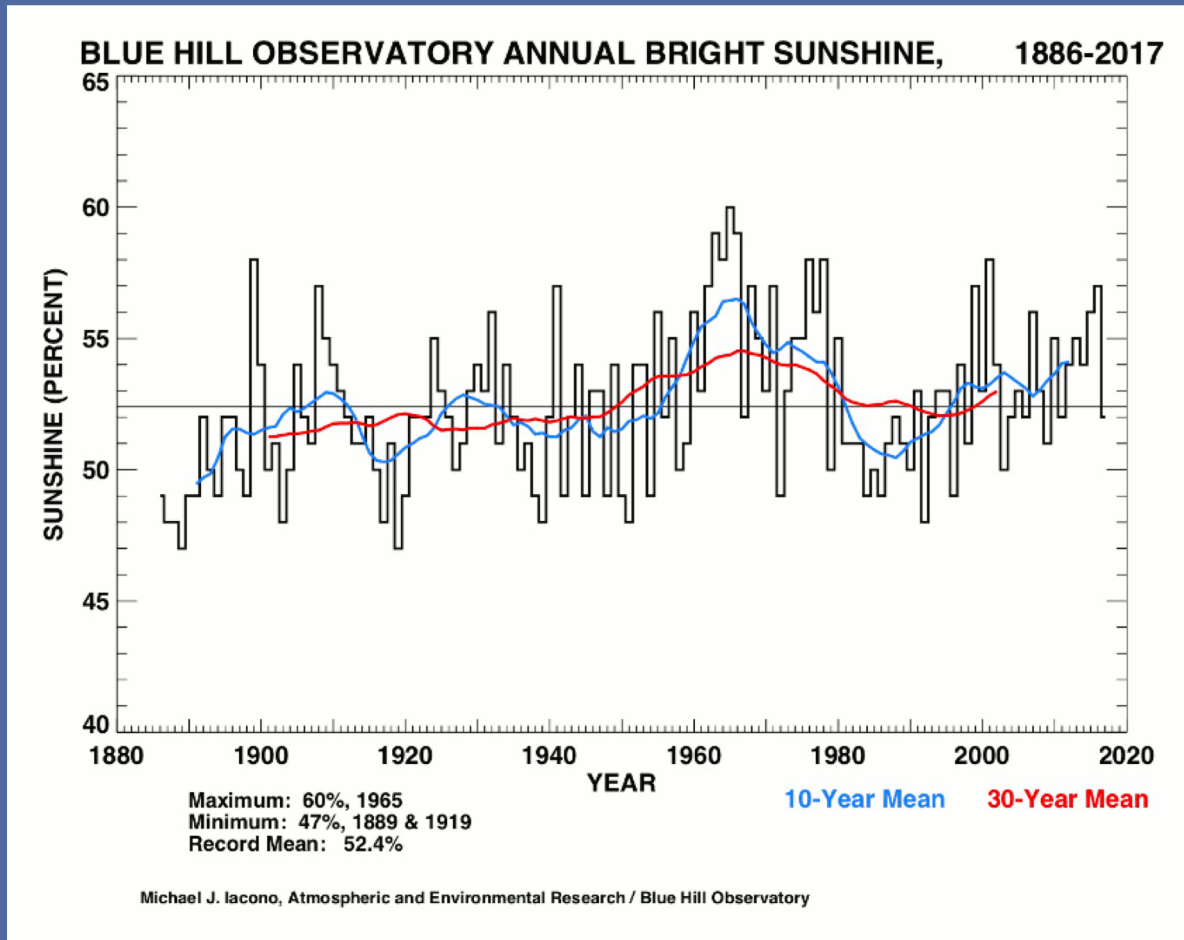
- Seasonal snowfall shows no significant trend
- Very high variation from year to year
- Decadal variability

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

Future Objectives

- **Sustain tradition of high-quality observing program critical to validating and understanding climate change**
- **Increase BHO role in climate education**
 - build upon existing, successful BHO programs
 - expand classroom space to reach more young people
- **Increase accessibility of BHO climate data**
 - support local climate research
- **Develop new science and educational activities to:**
 - promote a better informed citizenry
 - continue to inspire future scientists



Thank You!