



120 Years of Daily Sunshine Observations from the Blue Hill Meteorological Observatory



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Abstract

A nearly continuous record of daily bright sunshine from 1889 through 2011 has been collected and digitized at the Blue Hill Observatory in Milton, MA. The Blue Hill Observatory is singular among North American weather stations for maintaining the longest continuous record of meteorological observations in the United States. Moreover, many of the measurements continue to be collected using traditional observing methods and instruments, and in a few cases the same instruments have been in use for much of the time since the observatory's founding in 1885. This provides an unprecedented degree of continuity within the records.

Existing digital datasets of temperature, precipitation and wind have now been expanded to include a new record of daily bright sunshine collected with a Campbell-Stokes sunshine recorder. The original sunshine recorder remained in use for over a century from 1886 until its replacement with a modern equivalent in the 1990s. The Campbell-Stokes instrument measures the duration of bright sunshine in hours per day. Daily bright sunshine is determined from the length of a burn on a calibrated paper card caused by unobscured direct sunlight being focused by a glass sphere into a small point on the card throughout the day. The total burn length is manually translated into minutes, and subsequently hours, of bright sunshine at a precision of 0.1 hours. During a short period of time after sunrise and before sunset, insolation is too weak to burn the card. Hence, the total possible bright sunshine duration measured by the instrument on a clear day will be slightly less than the time between sunrise and sunset. While a simple correction can account for the non-burning time, the data presented are uncorrected.

There are wide-ranging research applications of the sunshine dataset. We have already begun to explore a variety of discernable features such as global dimming and the 11-year solar cycle. It is likely that many other signals of both natural and anthropogenic phenomena exist within a sunshine record of this length. Ongoing digitization of other historical weather records at Blue Hill will provide additional research opportunities to utilize the sunshine data.

Blue Hill Observatory

• Founded in 1885 by Abbott Lawrence Rotch on the summit of Great Blue Hill (*El.* 635 ft.), 10 miles SSW of Boston, MA

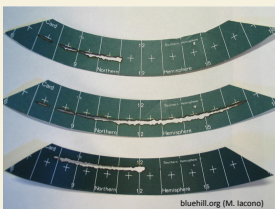
• Operated by Rotch, Harvard University, NOAA (NWS) and currently by non-profit Blue Hill Observatory foundation

• Longest continuous weather record in North America (1885 to present)



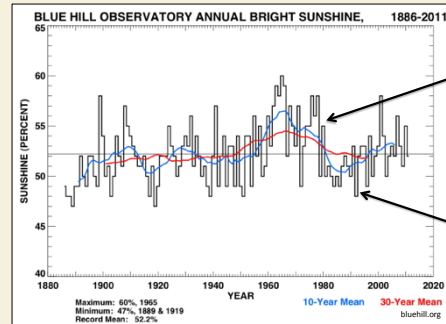
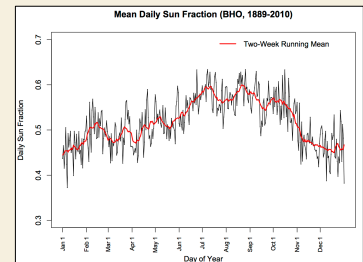
Campbell-Stokes Solar Observations

- Focuses sunlight through glass sphere onto calibrated paper card
- Card burns when insolation exceeds $\sim 120 \text{ Wm}^{-2}$
- Length of burn corresponds to daily duration of "bright sunshine" measured in 6-minute increments



Daily Sunshine Dataset

- 40,328 valid daily data points spanning 1889-2011
- Missing daily data for 1893-95, 1899, 1916-18, 1921, 1927, 1929
- Daily bright sun duration not corrected for non-burning time just after sunrise and before sunset (insolation $< 120 \text{ Wm}^{-2}$)

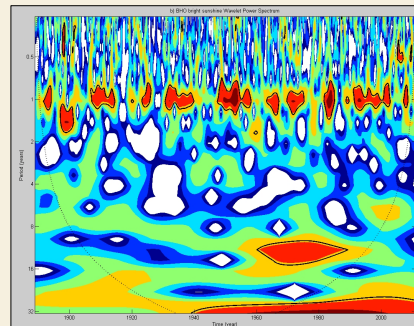


“Global dimming”

Pinatubo eruption

Preliminary Findings

- Signals of increased aerosol loading during industrial era, and Mt. Pinatubo eruption (June 15, 1991)
- Potential global dimming signal (Stanhill and Cohen, 2001)
- Solar cycles revealed in wavelet analysis of daily sun fraction



Note: Warmer colors represent dominant modes in time-frequency space (i.e. wavelet functions with largest amplitudes)

Annual cycle

11-year solar cycle

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Reference: Stanhill, G. and S. Cohen (2001). "Global dimming: a review of the evidence for a widespread and significant reduction in global radiation with discussion of its probable causes and possible agricultural consequences." *Agricultural and Forest Meteorology* 107 (4): 255-278.