A Review of Solar Eclipses and their Effects at the Blue Hill Observatory

Jonathan O'Brien
Blue Hill Meteorological Observatory

Across the country, attention is turning to the upcoming "Great American Eclipse of 2017". A solar eclipse is a partial or total obstruction of the solar disk by the Moon, as viewed from Earth, as the Moon passes between the Sun and the Earth. Across the entire United States, a solar eclipse will take place during the afternoon (UTC) of August 21st. A narrow northwest-to-southeast path from Oregon to South Carolina will experience totality, with the Moon entirely blocking the Sun for a couple of minutes. As the Moon's shadow passes over the Earth, other locations will see some form of partial eclipse, with the amount of Sun blocked decreasing farther from the path of totality. The Moon will cover approximately 63% of the Sun during the peak of the upcoming eclipse at the location of the Blue Hill Observatory. This is the first time since June 8, 1918 that a solar eclipse will be viewable across the entire US.

Thirty-seven known solar eclipses have been visible from the Blue Hill Observatory since its founding in February of 1885. Weather records from these days have been studied to formulate an "eclipse climatology" for Blue Hill. Routine observations as well as any special notes on past eclipses have been examined. Particular emphasis was given to two main factors. First were the viewing conditions on the day of the eclipse. An effort was made to determine whether or not the eclipse would be visible based on weather conditions. Second, work was done to determine what effect, if any, the eclipse had on weather, especially temperature, as it occurred. Data have been reviewed for 36 of the eclipses.

Viewing conditions were divided into three categories. Good viewing condition days were those with mostly clear to partly cloudy skies during the eclipse and/or had notes describing the eclipse. Poor viewing condition days were those in which the sky was overcast or nearly so based on routine sky observations and any firsthand notes. A few eclipse days were considered to have marginal viewing conditions, with skies mostly cloudy (80-90% cloud coverage). Sixteen events fell into the good category, with seventeen poor and three marginal cases. Thus, the historic odds of actually seeing the eclipse are no better than flipping a coin and are in line with the Observatory's mean long term cloud cover near 50 percent.

Table 1: Eclipses that have measurably affected the temperature at Blue Hill Observatory.

Date	Summary
5/28/1900	Despite poor viewing conditions with only one glimpse of the Sun observed, detailed observations were made during this event, and a temperature drop of 1.5 degrees was attributed to the eclipse. Many detailed meteorological observations were made during this eclipse of near 90% coverage at Blue Hill.
3/7/1970	A near total eclipse (97% coverage) occurred in the mid-afternoon, peaking around 2-3PM local time. Viewing conditions were good. The temperature fell from 43° to at least 41° during the peak of the eclipse, before rebounding back to 43° afterwards.
7/10/1972	An eclipse of 86% coverage occurred with similar timing to 3/7/1970 as well as good viewing conditions. The temperature fell from 77 at 2PM to 70 at 4PM, likely due at least in part to the eclipse.
5/10/1994	An eclipse with 88% coverage peaking from 1-2PM caused the temperature to fall eight degrees at peak, the largest drop found which could be attributed to an eclipse.
12/25/2000	Another early afternoon eclipse occurred on this day, with coverage near 60%. The temperature fell from 18° to 17° during the peak of the event despite clear skies. This may have been partly due to the eclipse, but a correlation from this event is harder to make due to the weakness of the Sun in late December.

Only one total eclipse has occurred at Blue Hill since its founding. This was a "sunrise" total eclipse on October 2, 1959, with the path of totality beginning right over the Boston area. However, viewing of this eclipse was impossible due to rain. An eclipse on January 24, 1925 was very nearly a total eclipse, with around 99% coverage, and this one was visible although no specific notes about it have been found. Other eclipses with coverage around 90% or better occurred on May 28, 1900, August 31, 1932, July 20, 1963, March 7, 1970, May 30, 1984, and May 10, 1994. Good viewing conditions existed for three of these six, with the others poor.

It was noted that eclipses have historically occurred on cool days, even in the summer. The warmest day at Blue Hill to feature a solar eclipse was July 9, 1945, which had a high of 83° after a morning partial eclipse of around 60% coverage. The coldest eclipse was the near total eclipse of January 24, 1925, which had a morning low of -5°, with the eclipse occurring during the mid-morning while the temperature was still near zero. A few eclipse days with other noteworthy weather events were found, all of which fell into the poor viewing category. A partial eclipse with only about 25% coverage on July 29, 1897 was obscured on a day which set a still standing record low maximum temperature for the date of 62°. A partial eclipse with around 40% coverage on February 3, 1916 was blocked by the tail end of a two-day snowstorm

that brought 12.2" of snow to the summit. And another February eclipse, this one with about 70% coverage on February 26, 1979, was obscured in the midst of a severe multi-day ice storm. A few cases were found in which it is certain or very likely that the eclipse impacted temperature at Blue Hill as it occurred, and Table 1 provides a summary of these events.

Based on these data from Blue Hill and previous observations elsewhere, a solar eclipse can impact weather at least in a local and temporary sense, especially when coverage of the solar disk exceeds 50%. It has been shown in prior cases, particularly in areas near totality, that an eclipse can also have lesser impacts on other atmospheric quantities like wind and cloud cover. For example, since atmospheric mixing induced by solar heating increases wind speed, the wind may temporarily decrease for locations experiencing totality as heating momentarily stops.

The August 2017 solar eclipse has the potential to be a watershed moment for how such events are observed in the age of modern technology at Blue Hill and across the United States. Detailed observations by official surface observing sites like Blue Hill as well as citizen scientists have the potential to improve our understanding of how such events can temporarily impact our weather.