IBHS Roof Aging Program

2017 Data, Climate, and Roof Condition Summary

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Executive Summary

In 2013, the Insurance Institute for Business & Home Safety (IBHS) began a long-term roof aging program. This 20-year program seeks to understand how the wind, impact, and fire performance of various roof cover materials changes with age and exposure to the natural environment.

This document is the fourth in a series of annual reports on the Roof Aging Farm program and provides:

- A brief description of the program, which currently includes asphalt shingle products at five sites
- Summary tables of maximum and minimum shingle temperatures experienced by roof specimens in 2017
- Summaries of the accumulated time spent above specific temperature thresholds during 2017
- Weather observations in 2017 from the three original operational sites in 2017 and their comparisons to climate averages
- A summary of notable weather events that occurred at the three original operational sites during 2017
- A summary of visual inspections of all specimens

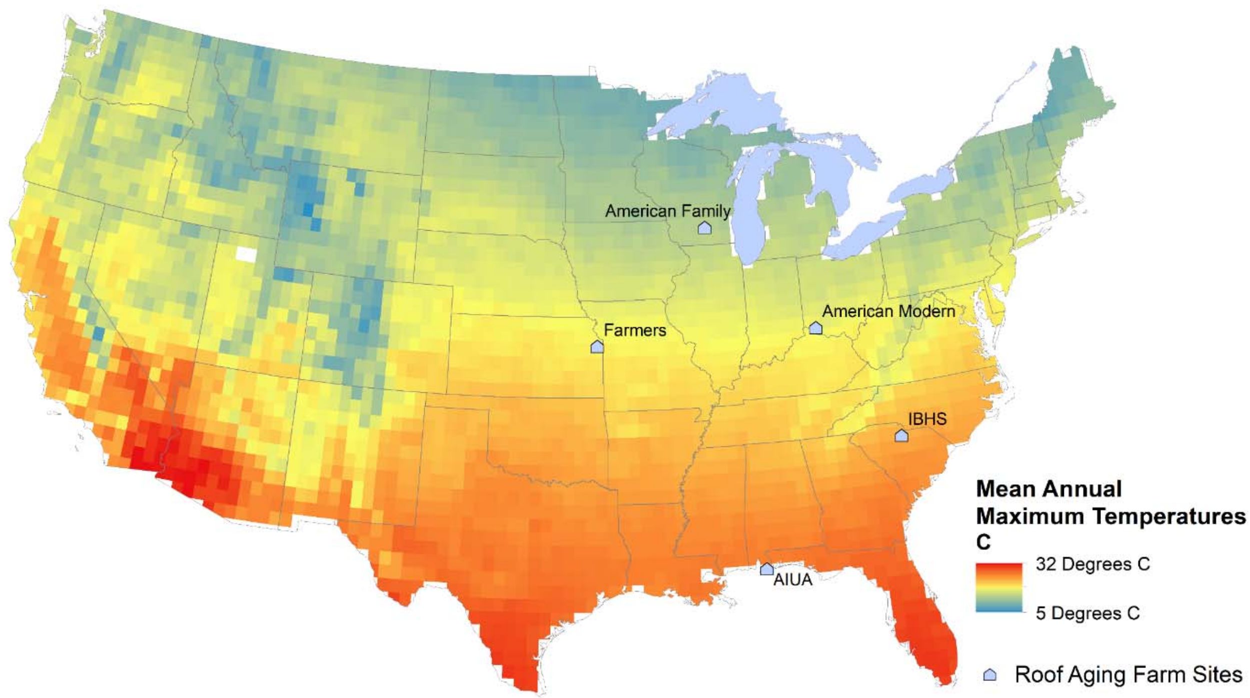

Figure 1: Annual mean temperatures across the continental United States and the locations of the roof aging farm sites. Data source: National Center for Environmental Information.

Program Description

The IBHS roof aging program collects data on the conditions asphalt shingles experience in the natural environment and seeks to relate those data to product performance. The program currently has 84 roofs, at five separate locations, as summarized in Tables 1 and 2. Figure 1 is a map of the five sites and annual mean temperatures across the United States highlighting the different climate zones that are represented in this unique program.

The first set of roofs were installed at the IBHS Research Center in South Carolina in 2013 and additional roofs were installed in 2014 and 2015. The first member company partner installations in Madison, Wisconsin (American Family Insurance), and Amelia, Ohio (American Modern Insurance Group), were completed in 2014.

Additional sites were constructed and instrumented in 2017 in Olathe, Kansas (Farmers Insurance), and in 2018 near Foley, Alabama (Alabama Insurance Underwriting Association). The first annual summary condition reports for these two sites will be released in 2019.

All roofs included in this program feature identical construction, are oriented in the same direction (facing north and south), and are of similar color, so that the research is focused on product type, length of exposure, and climate as the variables. Each of these factors will be examined to understand how they contribute to performance differences.

For additional information on the roof specimen construction and instrumentation, please refer to the *IBHS Roof Aging Farms: 2014 Measurement Summary* and the *IBHS Roof Aging Farms: 2015 Measurement Summary*.

Table 1. Types of products currently deployed on the roof aging farm at the IBHS Research Center in South Carolina.

Specimen Identification	Product Class
2013-IBHS-A	Architectural
2013-IBHS-B	Polymer-Modified Impact-Resistant Architectural
2013-IBHS-C	Architectural
2013-IBHS-D	Architectural
2013-IBHS-E	3-Tab
2013-IBHS-F	3-Tab
2014-IBHS-A	Polymer-Modified Impact-Resistant Architectural
2014-IBHS-B	Traditional Impact-Resistant Architectural
2014-IBHS-C	Traditional Impact-Resistant Architectural
2015-IBHS-A	Architectural
2015-IBHS-B	Architectural
2015-IBHS-C	Traditional Impact-Resistant Architectural
2015-IBHS-D	3-Tab
2015-IBHS-E	Traditional Impact-Resistant Architectural
2015-IBHS-F	Polymer-Modified Impact-Resistant Architectural

Table 2. Types of products currently deployed on the Madison, Wisconsin (AmFam A-C); Amelia, Ohio (AmMod-D); Olathe, Kansas (Farmers-E); and Foley, Alabama (AIUA -F) roof aging farm sites. The matching specimens on the South Carolina aging farm are indicated.

Specimen Identification	IBHS Match	Product Class
2014-AmFam-A	2013-IBHS-A	Architectural
2014-AmFam-B	2013-IBHS-B	Polymer-Modified Impact-Resistant Architectural
2014-AmFam-C	2013-IBHS-C	Architectural
2014-AmMod-D	2013-IBHS-D	Architectural
2018-Farmers-E	*	Polymer-Modified Impact-Resistant Architectural
2018-AIUA-F	2015-IBHS-B	Architectural

* Will be installed at IBHS in 2019

Data Summary

The data collected on the 20-year specimens from each of three roof aging farm sites that were operational throughout 2017 were used to produce summary statistics for:

- Yearly maximum and minimum temperature for each roof face
- Total hours above specified temperature thresholds
- Number of temperature fluctuation events experienced during the year

The maximum and minimum temperatures for all three sites are from data recorded by the shingle thermocouple sensor on the center panel of the north and south roof faces. To show approximately how long the entire roof face was above the specified thresholds, a spatial average over each roof face was calculated for the South Carolina specimens (where there are multiple sensors) for the accumulated hours above different temperature thresholds. In 2017, specimen 2014-IBHS-C-20 suffered a temperature sensor circuit board failure. For this summary report, the 2014-IBHS-C-15 specimen data were used to represent this product.

Maximum and Minimum Shingle Temperatures in 2017

The absolute maximum shingle temperatures during a year are primarily driven by the amount of incoming solar radiation being absorbed by the roof specimens. Differences in peak roof temperatures are also related to the color of individual products and the color's influence on radiative absorption. Roofs at different slopes, different orientations, and with different colors than those in the roof aging farms would vary from the observations presented here.

Table 3 summarizes the observations of peak shingle temperatures. The following observations of peak temperatures came from the data collected in 2017:

North-Facing Roof Slopes

- Maximum shingle temperatures of 170°–185°F continue to be observed each year for the South Carolina site (one specimen reached 189.5°F). Lower maximum temperatures were observed at the Wisconsin and Ohio locations due to their higher latitude.
- Maximum temperatures occurred in June at the South Carolina site and in July at the higher latitude sites in Wisconsin and Ohio (Table 3-A).

South-Facing Roof Slopes

- 2015 remains the only year to date in which a specimen's maximum roof temperature exceeded 200°F.

- Maximum shingle temperatures occurred in June and July for South Carolina specimens and in August for the Wisconsin and Ohio specimens.

General Observations

Daily minimum shingle temperatures converge toward the overnight low environmental temperature, except for impact-rated and polymer-modified products. These products radiatively cool at a slower rate and so are typically warmer at night than non-impact-rated shingles. The added thickness of the impact-rated products or the added polymer (which has a different radiative absorption and emission spectra) could contribute to this.

Minimum temperatures at all sites occurred in January for all specimens.

Table 3. (A) North face and (B) south face maximum and minimum shingle temperatures at the center panel shingle-mounted thermocouple probe for 20-year specimens during 2017.

A.

Specimen	Location	Roof Face Orientation	Maximum Temperature (°F)	Maximum Temperature Month	Minimum Temperature (°F)	Minimum Temperature Month
2013-A-IBHS	Richburg, SC	North	170.7	July	6.2	January
2013-B-IBHS	Richburg, SC	North	162.9	July	5.6	January
2013-C-IBHS	Richburg, SC	North	172.5	July	6.3	January
2013-D-IBHS	Richburg, SC	North	171.9	July	5.9	January
2013-E-IBHS	Richburg, SC	North	188.5	July	23.5	January
2013-F-IBHS	Richburg, SC	North	178.5	July	15.7	January
2014-A-IBHS	Richburg, SC	North	189.5	July	22.3	January
2014-B-IBHS	Richburg, SC	North	186.9	July	21.8	January
2014-C-IBHS	Richburg, SC	North	179.4	July	7.0	NA
2015-A-IBHS	Richburg, SC	North	164.6	July	6.7	January
2015-B-IBHS	Richburg, SC	North	171.5	July	6.4	January
2015-C-IBHS	Richburg, SC	North	168.8	July	4.2	January
2015-D-IBHS	Richburg, SC	North	168.9	July	6.5	January
2015-E-IBHS	Richburg, SC	North	167.7	July	6.5	January
2015-F-IBHS	Richburg, SC	North	164.6	July	6.2	January
2014-A-AmFam	Madison, WI	North	140.1	July	-4.2	January
2014-B-AmFam	Madison, WI	North	136.2	July	-5.3	January
2014-C-AmFam	Madison, WI	North	140.3	July	-4.6	January
2014-D-AmMod	Amelia, OH	North	159.7	July	4.9	January

B.

Specimen	Location	Roof Face Orientation	Maximum Temperature (°F)	Maximum Temperature Month	Minimum Temperature (°F)	Minimum Temperature Month
2013-A-IBHS	Richburg, SC	South	170.7	July	6.1	January
2013-B-IBHS	Richburg, SC	South	162.9	July	5.7	January
2013-C-IBHS	Richburg, SC	South	168.5	June	6.3	January
2013-D-IBHS	Richburg, SC	South	171.9	July	5.8	January
2013-E-IBHS	Richburg, SC	South	188.4	July	23.4	January
2013-F-IBHS	Richburg, SC	South	173.4	June	15.7	January
2014-A-IBHS	Richburg, SC	South	189.4	July	22.3	January
2014-B-IBHS	Richburg, SC	South	186.8	July	21.8	January
2014-C-IBHS	Richburg, SC	South	184.7	July	9.4	January
2015-A-IBHS	Richburg, SC	South	161.4	June	6.7	January
2015-B-IBHS	Richburg, SC	South	171.4	July	6.3	January
2015-C-IBHS	Richburg, SC	South	168.8	July	4.1	January
2015-D-IBHS	Richburg, SC	South	169.0	July	6.6	January
2015-E-IBHS	Richburg, SC	South	165.1	June	6.5	January
2015-F-IBHS	Richburg, SC	South	164.6	July	6.1	January
2014-A-AmFam	Madison, WI	South	184.2	July	-5.0	January
2014-B-AmFam	Madison, WI	South	180.6	July	-5.7	January
2014-C-AmFam	Madison, WI	South	188.0	July	-4.0	January
2014-D-AmMod	Amelia, OH	South	189.9	July	4.3	January

Temperature Thresholds

Shingle temperatures at the three sites were compared to five different thresholds (100°, 120°, 140°, 160°, and 180°F) to examine the accumulated time the roof faces spent above these values. Table 4 shows the accumulated time the north and south faces of each 20-year specimen spent above these values. The following observations were made:

- The South Carolina specimens accumulated more time above each temperature threshold than the higher latitude sites. The differences in incoming solar radiation are responsible for the regional differences, so the new site in Foley, Alabama, is expected to exhibit values higher than that observed at the South Carolina location.
- North-facing roof slopes at Wisconsin and Ohio all exceeded 140°F in 2017. In Wisconsin, temperatures exceeded 140°F for less than 100 hours. The Ohio site approached 200 hours at or above 140°F.
- South-facing roof slopes across all sites exceeded 140°F during much of the year and some exceeded 180°F.

Table 4. (A) North face and (B) south face total hours above the specified temperatures in 2017. For IBHS specimens, duration was determined using a spatial average of temperatures from all thermocouple probes on each roof face. Durations are rounded to the nearest hour.

A.

Specimen	Location	Roof Face Orientation	> 100°F (hours)	> 120°F (hours)	> 140°F (hours)	> 160°F (hours)	> 180°F (hours)
2013-A-IBHS	Richburg, SC	North	2,408	1,965	389	31	0
2013-B-IBHS	Richburg, SC	North	2,007	1,009	357	15	0
2013-C-IBHS	Richburg, SC	North	2,465	1,736	372	38	0
2013-D-IBHS	Richburg, SC	North	2,337	1,863	408	21	0
2013-E-IBHS	Richburg, SC	North	2,207	1,359	511	62	2
2013-F-IBHS	Richburg, SC	North	2,339	1,854	522	87	0
2014-A-IBHS	Richburg, SC	North	2,160	1,403	792	118	5
2014-B-IBHS	Richburg, SC	North	2,212	1,470	759	201	2
2014-C-IBHS	Richburg, SC	North	1,780	1,006	402	63	0
2015-A-IBHS	Richburg, SC	North	1,898	926	389	72	0
2015-B-IBHS	Richburg, SC	North	1,745	1,109	462	71	0
2015-C-IBHS	Richburg, SC	North	1,002	749	174	62	0
2015-D-IBHS	Richburg, SC	North	1,508	1,008	454	60	4
2015-E-IBHS	Richburg, SC	North	1,455	1,000	401	26	0
2015-F-IBHS	Richburg, SC	North	2,036	1,664	855	60	0
2014-A-AmFam	Madison, WI	North	663	110	93	1	0
2014-B-AmFam	Madison, WI	North	601	119	88	0	0
2014-C-AmFam	Madison, WI	North	527	98	84	0	0
2014-D-AmMod	Amelia, OH	North	1,032	864	198	5	0

B.

Specimen	Location	Roof Face Orientation	> 100°F (hours)	> 120°F (hours)	> 140°F (hours)	> 160°F (hours)	> 180°F (hours)
2013-A-IBHS	Richburg, SC	South	2,486	2,093	593	111	2
2013-B-IBHS	Richburg, SC	South	1,729	1,180	488	65	0
2013-C-IBHS	Richburg, SC	South	2,505	2,110	673	140	0
2013-D-IBHS	Richburg, SC	South	2,470	2,069	591	106	4
2013-E-IBHS	Richburg, SC	South	2,237	1,289	738	294	11
2013-F-IBHS	Richburg, SC	South	2,494	2,083	1,165	157	0
2014-A-IBHS	Richburg, SC	South	2,216	1,631	1,099	494	29
2014-B-IBHS	Richburg, SC	South	2,132	1,560	990	375	31
2014-C-IBHS	Richburg, SC	South	1,617	1,214	532	107	0
2015-A-IBHS	Richburg, SC	South	860	594	402	191	31
2015-B-IBHS	Richburg, SC	South	1,659	1,203	661	194	29
2015-C-IBHS	Richburg, SC	South	849	616	370	159	30
2015-D-IBHS	Richburg, SC	South	1,537	1,135	647	197	41
2015-E-IBHS	Richburg, SC	South	1,486	1,059	536	110	12

Specimen	Location	Roof Face Orientation	> 100°F (hours)	> 120°F (hours)	> 140°F (hours)	> 160°F (hours)	> 180°F (hours)
2015-F-IBHS	Richburg, SC	South	2,328	1,909	821	31	14
2014-A-AmFam	Madison, WI	South	2,006	1,211	388	79	1
2014-B-AmFam	Madison, WI	South	1,475	1,009	299	68	0
2014-C-AmFam	Madison, WI	South	1,398	986	287	62	0
2014-D-AmMod	Amelia, OH	South	2,006	1,621	433	109	5

Temperature Fluctuations

Data collected from this program have been instrumental in diagnosing how shingle material temperatures can rapidly fluctuate. Rapid changes using thresholds of 10°, 25°, 45°, and 60°F temperature decreases were documented. For South Carolina specimens, a spatial average across each roof face was calculated for each five-minute observation. Thus, more localized temperature departures may have exceeded the thresholds used here. Table 5 provides the total number of large fluctuation events observed during 2017 and the results from data showed the following:

- Product-to-product variability was observed again to be most evident in fluctuation events of less than 25°F.
- Large shock events due to thunderstorms and their associated precipitation (> 45°F) affect all product classes nearly equally (i.e., 3-tab versus architectural). Trivial differences between products were found in these extreme cases.
- South-facing roof slopes experience more frequent large shock events, owing to their higher mean temperatures.

Table 5. (A) North face and (B) south face total number of identified temperature fluctuation events in 2017. Events are defined as a temperature decrease of 10°, 25°, 45°, or 60°F between two consecutive five-minute observations. For IBHS specimens, the temperature decrease is determined from the spatial average across each roof face for each five-minute observation.

A.

Specimen	Location	Roof Face Orientation	ΔT > 10°F	ΔT > 25°F	ΔT > 45°F	ΔT > 60°F
2013-A-IBHS	Richburg, SC	North	833	136	8	2
2013-B-IBHS	Richburg, SC	North	519	47	9	1
2013-C-IBHS	Richburg, SC	North	784	111	5	1
2013-D-IBHS	Richburg, SC	North	715	122	5	1
2013-E-IBHS	Richburg, SC	North	1,244	235	7	1
2013-F-IBHS	Richburg, SC	North	823	101	5	2
2014-A-IBHS	Richburg, SC	North	1,141	160	6	0
2014-B-IBHS	Richburg, SC	North	1,213	196	8	4
2014-C-IBHS	Richburg, SC	North	794	117	22	6
2015-A-IBHS	Richburg, SC	North	465	79	12	5

Specimen	Location	Roof Face Orientation	ΔT > 10°F	ΔT > 25°F	ΔT > 45°F	ΔT > 60°F
2015-B-IBHS	Richburg, SC	North	1,190	190	6	2
2015-C-IBHS	Richburg, SC	North	360	47	6	1
2015-D-IBHS	Richburg, SC	North	623	49	6	1
2015-E-IBHS	Richburg, SC	North	724	80	6	0
2015-F-IBHS	Richburg, SC	North	530	39	7	2
2014-A-AmFam	Madison, WI	North	1,334	191	19	0
2014-B-AmFam	Madison, WI	North	1,265	179	16	0
2014-C-AmFam	Madison, WI	North	1,009	186	20	0
2014-D-AmMod	Amelia, OH	North	1,156	202	11	0

B.

Specimen	Location	Roof Face Orientation	ΔT > 10°F	ΔT > 25°F	ΔT > 45°F	ΔT > 60°F
2013-A-IBHS	Richburg, SC	South	931	132	9	2
2013-B-IBHS	Richburg, SC	South	690	74	11	2
2013-C-IBHS	Richburg, SC	South	1,117	206	25	11
2013-D-IBHS	Richburg, SC	South	1,169	233	8	3
2013-E-IBHS	Richburg, SC	South	1,263	427	200	112
2013-F-IBHS	Richburg, SC	South	1,085	161	9	2
2014-A-IBHS	Richburg, SC	South	1,670	293	11	2
2014-B-IBHS	Richburg, SC	South	1,491	249	11	5
2014-C-IBHS	Richburg, SC	South	1,254	244	23	8
2015-A-IBHS	Richburg, SC	South	768	198	19	5
2015-B-IBHS	Richburg, SC	South	1,144	283	9	2
2015-C-IBHS	Richburg, SC	South	614	139	11	3
2015-D-IBHS	Richburg, SC	South	1,032	190	11	0
2015-E-IBHS	Richburg, SC	South	776	82	6	0
2015-F-IBHS	Richburg, SC	South	1,133	623	482	34
2014-A-AmFam	Madison, WI	South	1,446	461	21	0
2014-B-AmFam	Madison, WI	South	1,400	456	28	0
2014-C-AmFam	Madison, WI	South	1,449	487	28	0
2014-D-AmMod	Amelia, OH	South	1,365	245	13	1

2017 Weather and Climate Summary

Instrumentation at each roof aging farm site collects meteorological data. Each site logs temperature, relative humidity, solar radiation, and precipitation. The IBHS Research Center weather observing station also collects wind speed, wind direction, and barometric pressure. In addition to the standard meteorological variables, a hail impact disdrometer was installed at each site in late 2016. Weather observations from 2017 at each site are compared to climatic averages from the closest National Oceanic and Atmospheric Administration (NOAA) long-term observation site. Notable weather events during 2017 are also provided for each site.

Richburg, South Carolina (IBHS Research Center)

Richburg is located in the north-central part of South Carolina, approximately 40 miles south of Charlotte, North Carolina.

Climate Summary

The observations collected at the South Carolina site are compared to the Lancaster, South Carolina (KLKR) climatic record. 2017 was characterized by a warmer than normal winter season with average daily high and low temperatures near or slightly below average during the spring and summer months. Rainfall was generally below average during the year, except for an anomalously wet May.

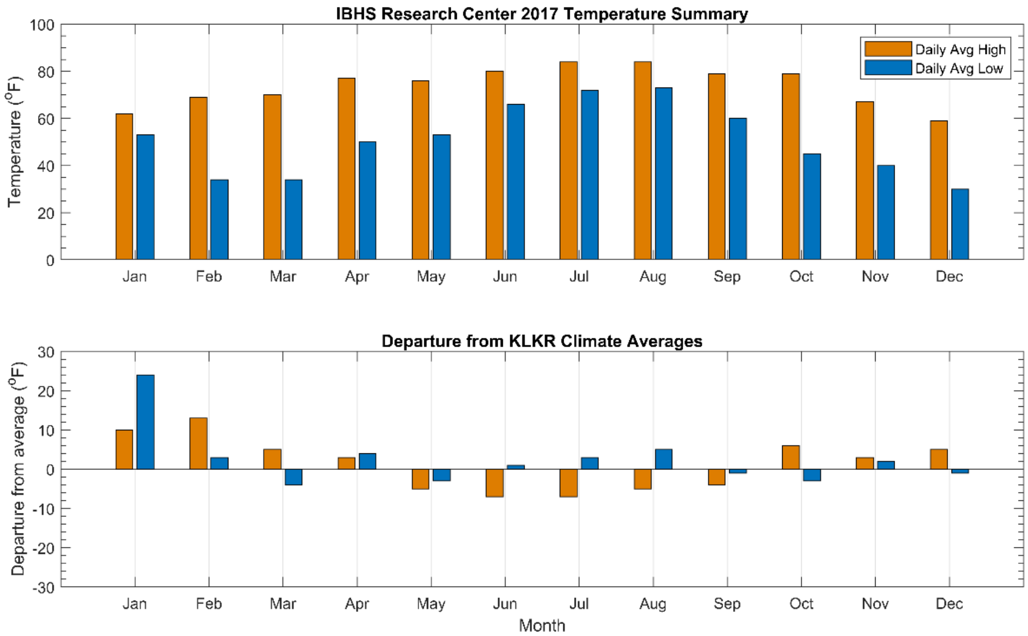

Figure 2. IBHS Research Center (top) average daily maximum and minimum temperatures and (bottom) their departure from KLKR (Lancaster, South Carolina) long-term climate averages for each month.

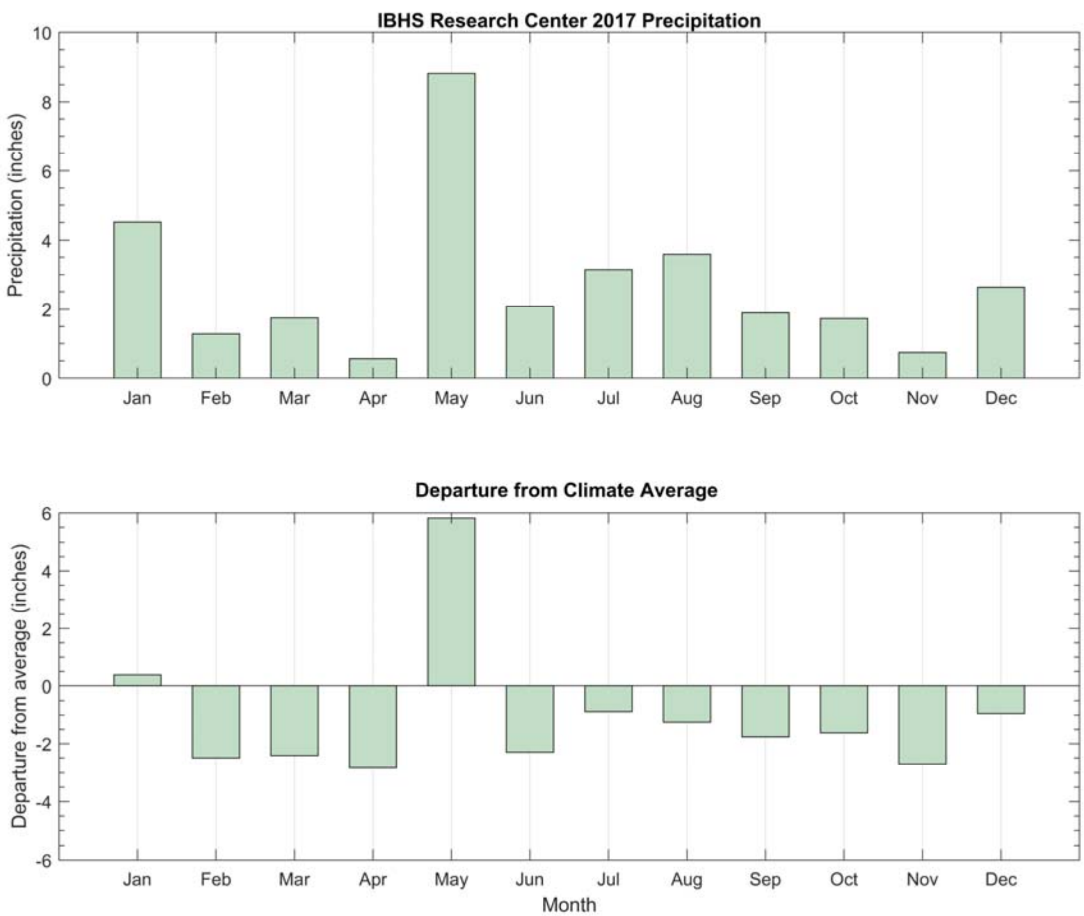

Figure 3. IBHS Research Center (top) monthly total precipitation and (bottom) departure from KLKR (Lancaster, South Carolina) long-term climate average.

Notable Weather Events

March 1, 2017 Severe Thunderstorms

A strong front made its way through the Piedmont region of North and South Carolina during the evening on March 1. The cold front helped trigger a line of strong to severe thunderstorms that moved across the area. The largest hail size reported in Chester County was approximately 0.75 inches with several wind reports of tree damage. The hail disdrometer at the IBHS lab recorded some small hail impacts, less than 0.5 inches in maximum size with only six total impacts on the IBHS hail disdrometer. There was no visible damage to any roof specimen.

August 21, 2017 Great American Eclipse

The Great American Eclipse in 2017 offered a unique opportunity to observe asphalt shingle temperature changes as solar radiation was steadily reduced. The IBHS Research Center fell just outside of the swath of totality, reaching 99.6%. Throughout the day, there were periods of cloud cover in the morning to early afternoon hours. There were clear skies in Chester County during the period that the eclipse occurred, and the peak in coverage occurred near 2:30 PM EDT, which caused the weather observing station temperature to drop from 91° to 84°F between 2:15 p.m. and 3:15 p.m. Figure 4 shows a series of photographs taken at the IBHS Research Center. Roof temperatures were near their daily peak just prior to the start of the eclipse. As incoming solar radiation reached a minimum, roof temperatures fell nearly 50°F. Figure 5 shows the temperature time history for several of the 2013 specimens.

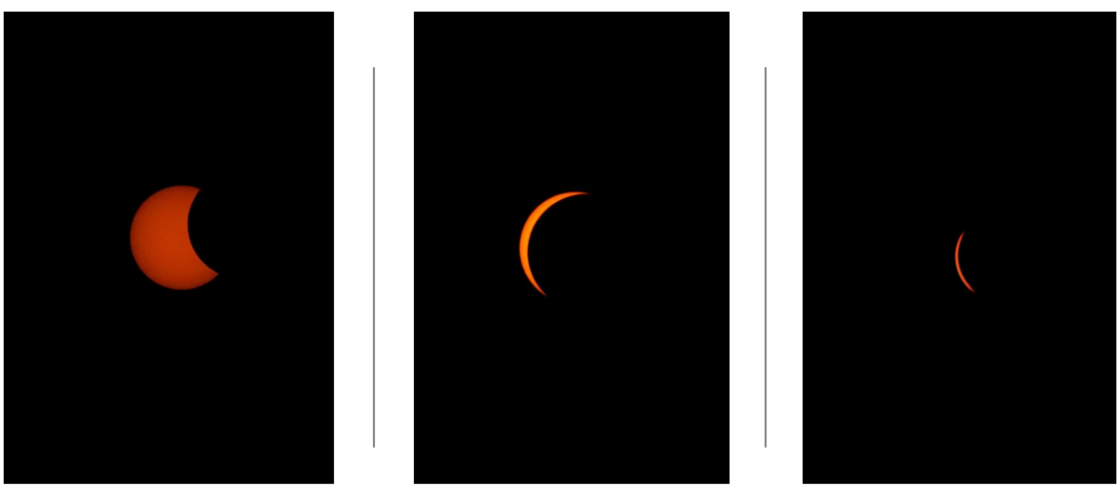

Figure 4. Photographs showing the progression of the eclipse at the IBHS Research Center. The photograph on the far right shows the eclipse nearing its peak of 99.6% of totality. Photographs by Ian Giammanco.

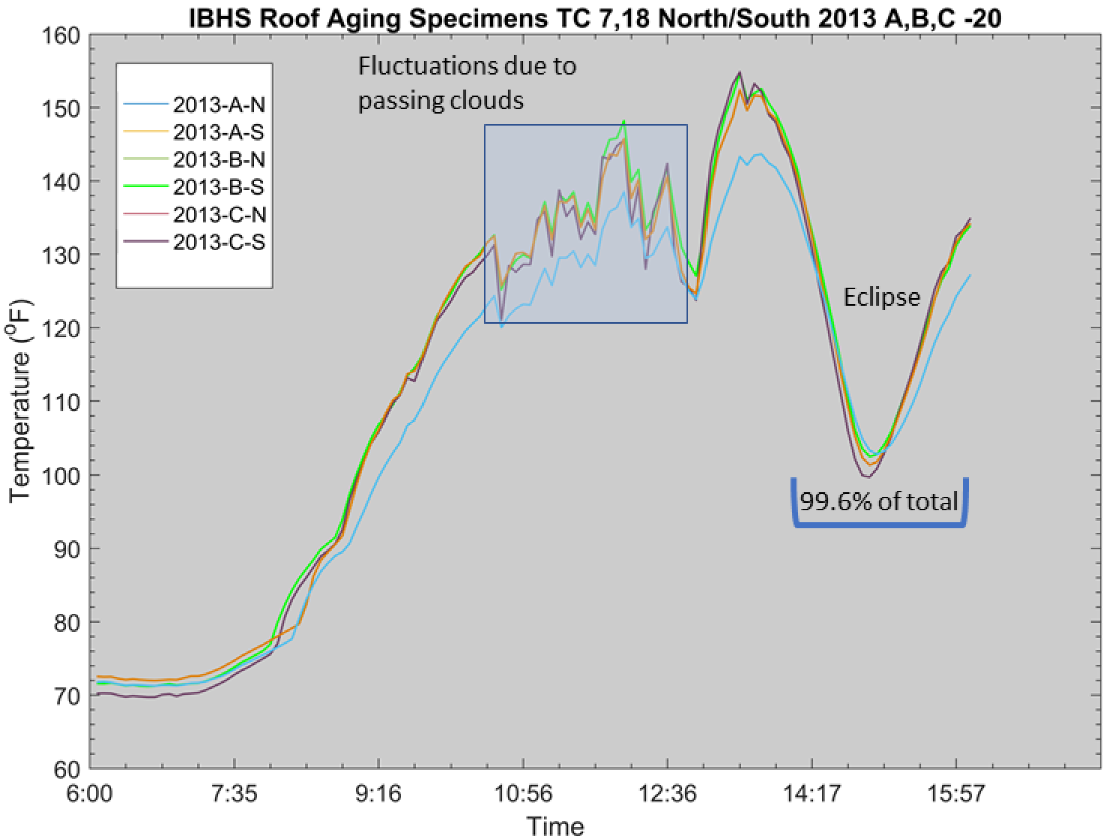

Figure 5. Roof temperatures for IBHS specimens 2013-A, -B and -C for both north- and south-facing roof slopes during the 2017 Great American Eclipse. These are five-minute mean shingle temperatures measured at the center of each roof face. Differences are due to shingle composition and north- and south-facing roof slopes (6/12 pitch). Also note the fluctuations due to passing clouds before the eclipse began.

July 23, 2017 Severe Thunderstorms and High Winds

There was a significant outbreak of severe weather extending from eastern Alabama all the way through the Piedmont region of the Carolinas. In Chester County, there was a round of severe thunderstorms with straight-line winds that affected the IBHS Research Center and surrounding area during the late afternoon hours. There were several severe wind reports throughout the area, with most damage being confined to downed trees. The National Weather Service (NWS) Automated Surface Observing Station (ASOS) at Chester, SC measured a peak wind gust of 65 mph. The weather observing station at IBHS recorded a peak three-second wind gust of 39 mph and 0.98 inches of rain as the thunderstorms passed the site.

Madison, Wisconsin

Madison is located in the southern part of Wisconsin, approximately 75 miles west of Milwaukee and Lake Michigan.

Climate Summary

Observations collected at the Madison, Wisconsin roof aging farm site are compared to long-term records collected at the Dane County Regional Airport (KMSN). Snowfall measurements were measured at KMSN. The average daily high temperatures observed for the cold season (January–March, and December) were well above average (Figure 6). However, daily low temperatures fell below average during the cold season months. The coldest temperature observed in 2017 occurred on January 6 with a minimum of -5.4°F at the roof aging farm site (KMSN minimum was -5.0°F). This was also the coldest day of the year with a high temperature of only 4.4°F.

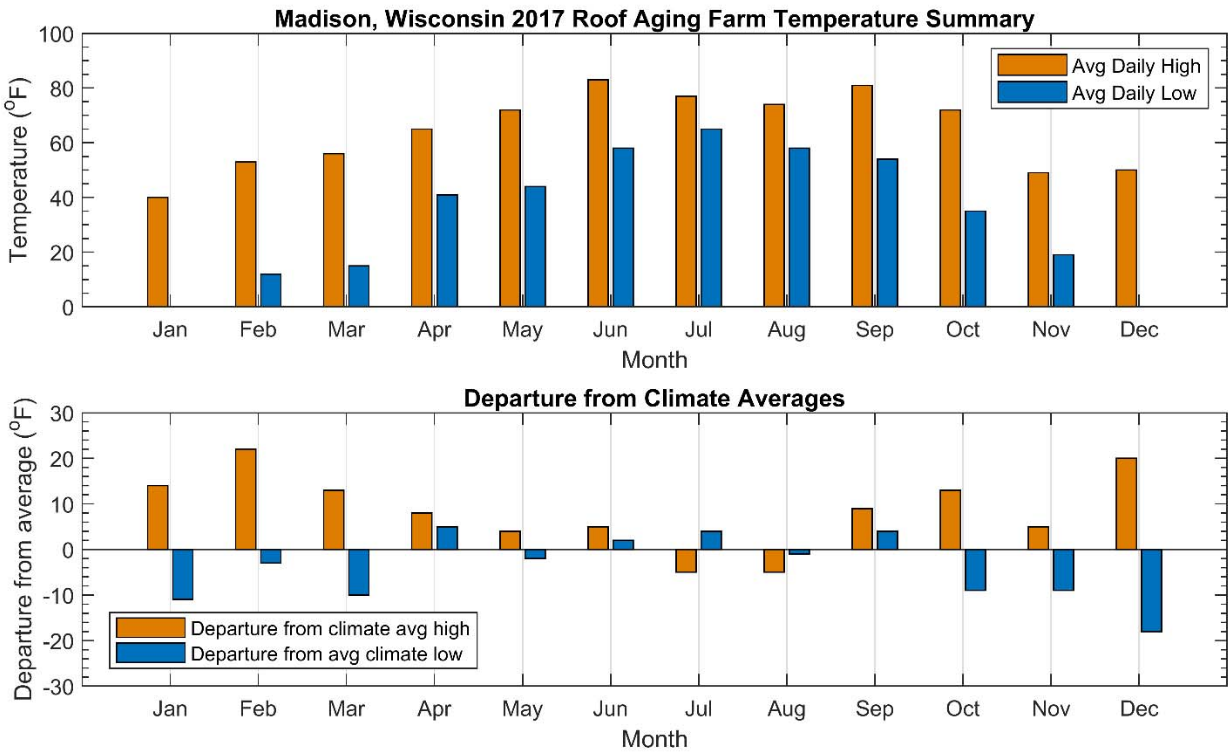

Figure 6. Madison, Wisconsin roof aging farm site (top) average daily maximum and minimum temperatures and (bottom) their departure from KMSN (Dane County Regional Airport) long-term climate averages for each month.

During the summer months average daily high and low temperatures were only slightly different from the long-term climate averages. July and August were the only months in which daily average high temperatures fell below their long-term means. The warmest days of the year were June 11–12. The daily high temperatures on these two days reached 91.4°F and 91.6°F, respectively. These were the only days of the year above 90°F observed at this site.

The first half of 2017 was wetter than normal, with every month except May having above average precipitation (Figure 7). After the mid-point in the year, precipitation was low. From August–December, only October saw higher than normal rainfall. Only 13 inches of snow fell in 2017 in Madison. While the 2016–2017 winter season was snowy, it was driven by 22.7 inches of snow in December.

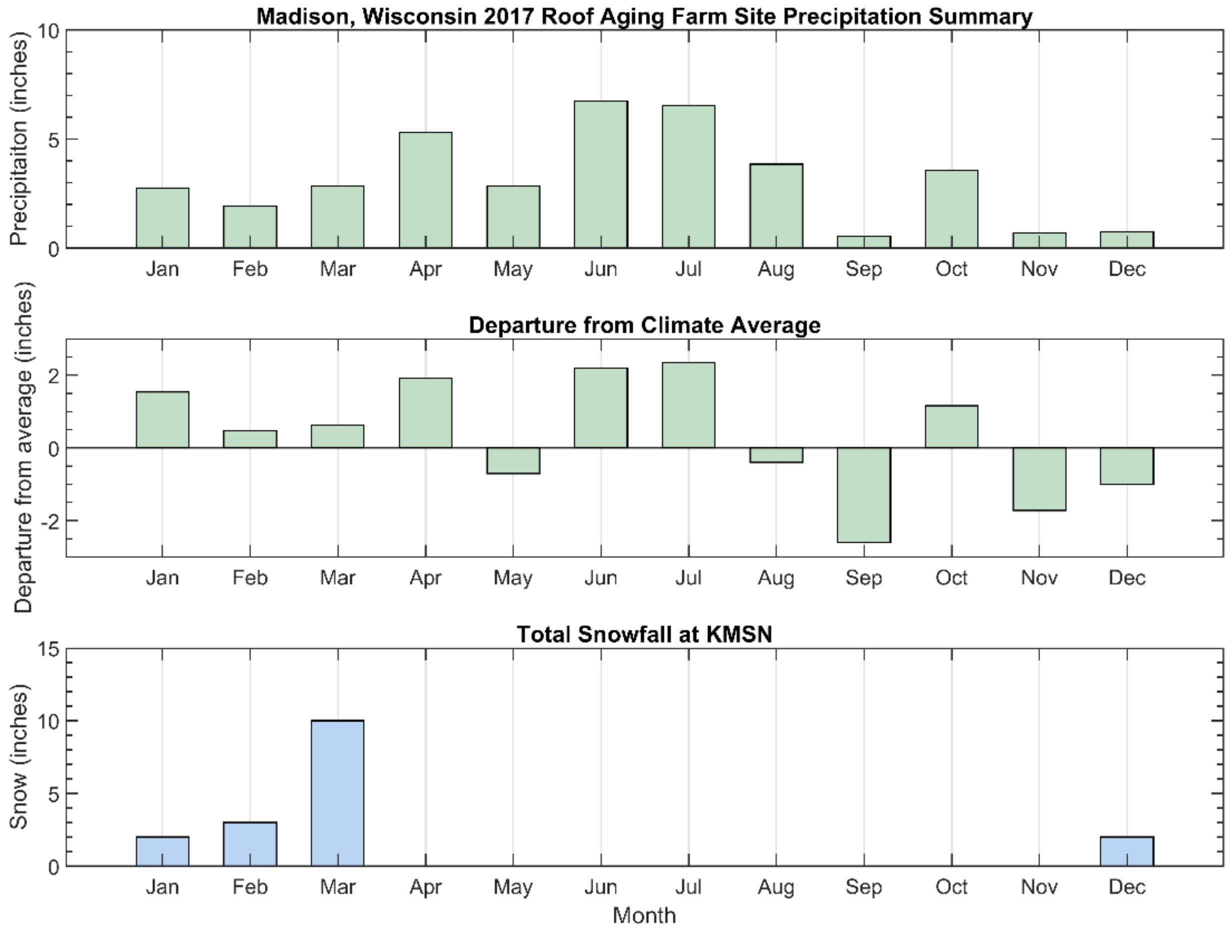

Figure 7. Madison, Wisconsin roof aging farm (top) monthly total liquid precipitation, (middle) departure from KMSN (Dane County Regional Airport) long-term climate average, and (bottom) monthly total measured snowfall at KMSN.

Notable Weather Events

January 24–25, 2017 Winter Storm

A band of heavy snow that extended from the Minnesota-Iowa border towards southern Wisconsin began the evening of January 24. The event lasted throughout the night and all day on January 25. Locations across Dane County received 4–6 inches of snowfall from this event and it was the highest recorded snowfall event of 2017.

May 15, 2017 Severe Thunderstorms with Large Hail

Two rounds of severe weather affected southern Wisconsin. The first storms occurred in the late afternoon and produced up to 1.75-inch hail in northern Dane County. Then a rapidly moving line of thunderstorms came through during the late evening hours causing tree damage, bringing down power lines, and producing hail up to 2 inches in diameter in southeastern Dane County. The roof aging farm site narrowly avoid this significant severe weather event. No hail was reported in the immediate area and the hail impact disdrometer did not record any strikes. Wind gusts reached 80 mph during both rounds of severe storms. The event also produced 1.87 inches of rain at the site. Rain totals over 2 inches were common across the area.

August 21, 2017 Great American Eclipse

The Wisconsin roof aging farm site experienced approximately 87% of totality during the 2017 eclipse. This produced a 2°F weather observing station temperature decrease, with roof temperatures falling 10°–15°F. However, cloud cover moderated the impact of the eclipse on the roof data.

December 16–18, 2017 Late Season Severe Thunderstorms

In the late afternoon hours, a frontal boundary enhanced development of severe storms that moved northeast through southern Wisconsin. A moist atmosphere at the lower levels and strong wind shear created high instability and rotation bringing a tornado threat to the area. An EF-0 tornado briefly touched down on the east side of Dane County from 4:59 p.m. to 5:15 p.m. local time. There were several reports of fallen trees. Some trees fell on homes across the eastern side of Dane County. There were no reports of damage near the roof aging site.

Amelia, Ohio

Amelia is located in Clermont County, Ohio, approximately 16 miles southeast of Cincinnati, Ohio.

Climate Summary

Temperature data collected at the Amelia, Ohio roof aging farm are compared to long-term records collected at the Cincinnati-Northern Kentucky International Airport (KCVG). The Ohio roof aging farm exhibited a similar pattern to that observed at the roof aging farm in Wisconsin. The year began with above normal daily high temperatures, but in general average daily low temperatures were below average. The coldest days of the year were January 6–7. Both days had the coldest daily high temperatures (14.3°F and 14.6°F, respectively). The low temperature of 4°F on January 7 was the coldest of the year. By the late spring into summer, temperatures were near average. 2017 concluded with only nine days at or above 90°F observed at the site. The warmest day of the year was June 12, which had an observed daily maximum temperature of 91.8°F. However, the onset of fall brought above normal daily high temperatures, but daily low temperatures were below the long-term climate averages (Figure 8).

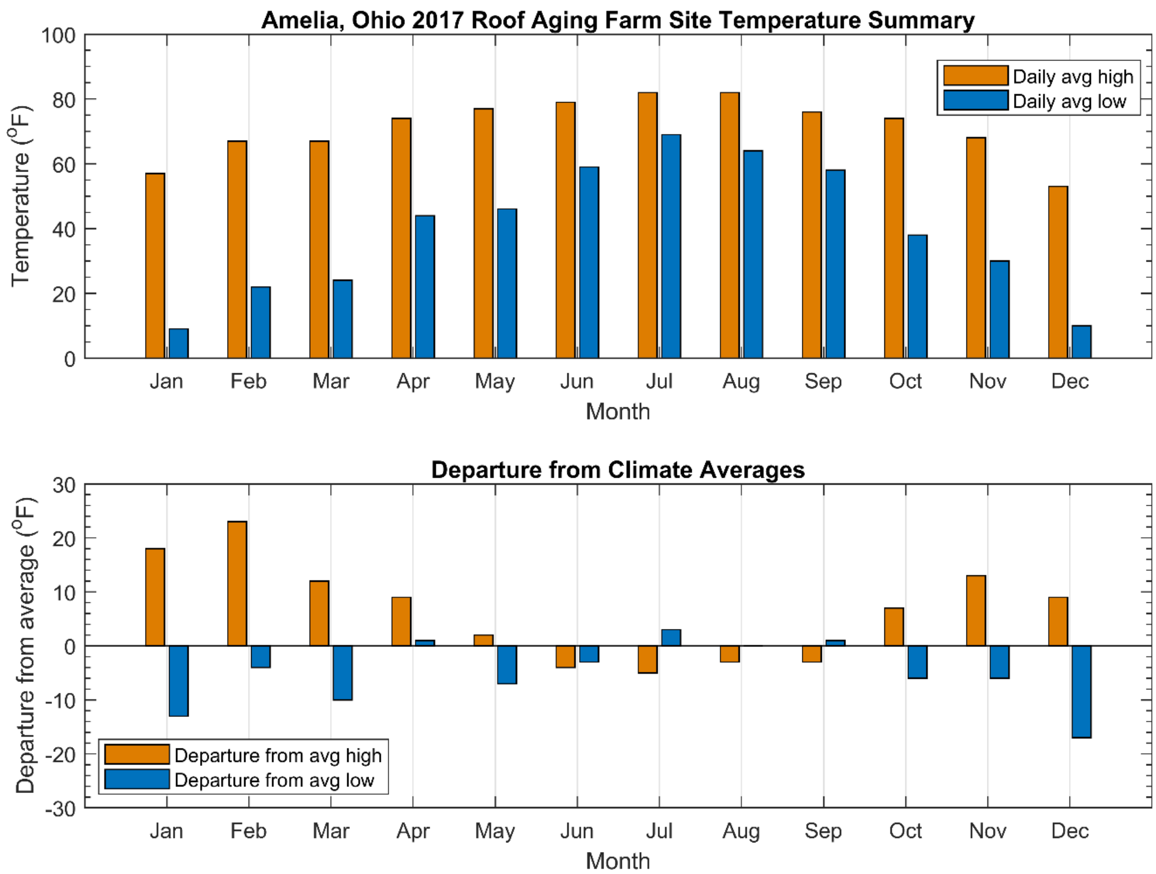

Figure 8. Amelia, Ohio roof aging farm site (top) average daily maximum and minimum temperatures and (bottom) their departure from KCVG (Cincinnati-Northern Kentucky International Airport) long-term climate averages for each month.

Unlike 2016, which had a cyclic precipitation pattern alternating between above and below normal, the first half of 2017 was notably drier than average. By June and July rainfall crept slightly above average but the area returned to a dry pattern in the fall, with only October being wetter than normal. Snowfall in 2017 (13.5 inches) fell well below the average of 22 inches. December was the snowiest month during 2017 with 8.2 inches total reported at the closest NWS observation site (KCVG, Cincinnati-Northern Kentucky Regional Airport). The snowfall, though, was spread over several events, with the largest (2.2 inches) occurring during the winter weather event of December 29–30.

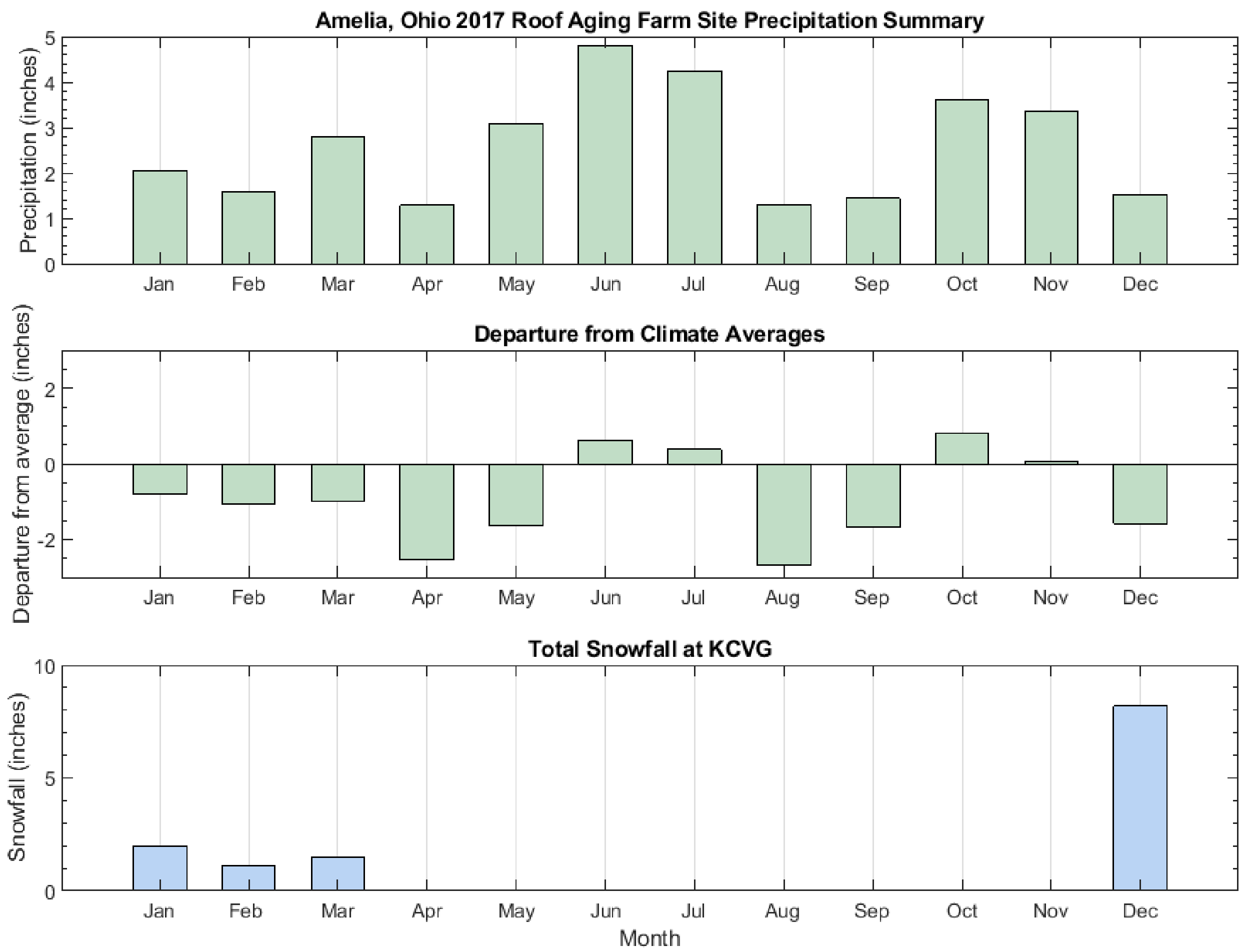

Figure 9. American Modern Insurance Group roof aging farm (top) monthly total liquid precipitation, (middle) departure from KCVG (Cincinnati-Northern Kentucky International Airport) long-term climate average, and (bottom) monthly total measured snowfall at KCVG.

Notable Weather Events

March 1, 2017 Severe Weather Outbreak

A strong low-pressure system brought on a significant outbreak of severe weather from eastern Ohio extending southwestward towards eastern Oklahoma. There were tornado reports for Clermont County, Ohio, during the early morning hours, with a confirmed EF-1 tornado (peak winds estimated around 110 mph). The damage in Clermont County consisted of several trees down, roof damage from fallen trees, and a roof that completely lifted off one home.

March 27, 2017 Isolated Tornado

A brief tornado was confirmed in Clermont County, Ohio, in the early afternoon, and was classified as an EF-1 after the damage assessment by the National Weather Service. This tornado traveled 0.3 miles and caused a significant amount of damage during its brief time on the ground. In addition to the brief tornado, straight-line winds caused significant tree damage around the area.

August 21, 2017 Great American Eclipse

While the IBHS site saw nearly a total solar eclipse, the Ohio site experienced approximately 90% of total. This produced a surface temperature drop of 3°F at the weather observing station, and roof temperatures fell approximately 20°F on both the north and south faces.

December 29, 2017 Winter Weather

Throughout Clermont County, Ohio, snowfall totals estimated around 1–2 inches. This winter weather event occurred during the evening hours on December 29. Despite small amounts of precipitation, temperatures did not reach above 20°F for the duration of the event.

Roof Condition Inspections

Visual inspections of each roof at the South Carolina site were conducted in August and September in 2017. The Ohio and Wisconsin sites were inspected in August. All faces of all roofs were visually examined, and locations of unsealing, nail pops or exposed fasteners, granule loss, blistering, foot traffic scuffs, uneven substrates, and other types of vulnerabilities were documented and will be monitored each year. These conditions may have been widespread across entire roof faces or limited to small areas on an individual roof face. New areas of interest will be added to the database each year as they appear, and trends will be monitored. Some general patterns observed on the South Carolina site, by product, are listed in Table 6. General patterns, by product, as observed in Wisconsin and Ohio are listed in Table 7.

Table 6. Roof condition visual evaluation patterns from surveys at the South Carolina site by IBHS personnel in 2017. Color codes identify observation modes to allow for quick comparisons between products. These represent common patterns observed on each roof set, but other conditions may be present on individual roof faces.

Roof Set	Condition Description	North Faces Affected	South Faces Affected
2013-A-IBHS	Loss of granules generally around edges of shingles	4/4	3/4
	Loss of granules exposing mat	4/4	2/4
	Loss of granules due to blistering	4/4	2/4
2013-B-IBHS	Loss of granules generally around edges of shingles	3/4	2/4
	Loss of granules due to blistering	4/4	4/4
	Lumps and unevenness of shingles	2/4	0/4
2013-C-IBHS	Loss of granules not exposing mat	3/4	3/4
	Loss of granules generally around edges of shingles	3/4	3/4
	Loss of granules exposing mat	1/4	2/4
	Lumps and unevenness of substrate	0/4	2/4

Roof Set	Condition Description	North Faces Affected	South Faces Affected
2013-D-IBHS	Loss of granules generally around edges of shingles	3/4	4/4
	Loss of granules due to blistering	3/4	2/4
	Lumps and unevenness of substrate	1/4	2/4
2013-E-IBHS	Loss of granules not exposing mat	3/4	4/4
	Loss of granules generally around edges of shingles	2/4	3/4
	Loss of granules due to blistering	3/4	2/4
	Lumps and unevenness of shingles	1/4	2/4
2013-F-IBHS	Loss of granules generally around edges of shingles	1/4	4/4
	Loss of granules due to blistering	4/4	4/4
	Lumps and unevenness of substrate	2/4	1/4
	Holes in shingles that do not extend to underlayment	2/4	0/4
	Fasteners beginning to back out	1/4	3/4
2014-A-IBHS	Loss of granules not exposing mat	3/4	3/4
	Loss of granules generally around edges of shingles	4/4	3/4
	Loss of granules due to blistering	3/4	2/4
	Lumps and unevenness of substrate	3/4	2/4
2014-B-IBHS	Loss of granules not exposing mat	4/4	2/4
	Loss of granules generally around edges of shingles	4/4	4/4
	Loss of granules exposing mat	4/4	3/4
	Loss of granules due to blistering	3/4	3/4
	Lumps and unevenness of substrate	3/4	1/4
2014-C-IBHS	Loss of granules not exposing mat	3/4	4/4
	Loss of granules generally around edges of shingles	4/4	4/4
	Loss of granules due to blistering	2/4	4/4
	Lumps and unevenness of shingles	2/4	2/4
	Lumps and unevenness of substrate	3/4	2/4
2015-A-IBHS	Loss of granules not exposing mat	3/4	3/4
	Loss of granules generally around edges of shingles	2/4	2/4
	Loss of granules due to blistering	2/4	1/4
	Holes in shingles that do not extend to underlayment	0/4	2/4
	Lumps and unevenness of shingles	1/4	3/4
	Lumps and unevenness of substrate	2/4	1/4

Roof Set	Condition Description	North Faces Affected	South Faces Affected
2015-B-IBHS	Loss of granules generally around edges of shingles	3/4	4/4
	Scuff marks	3/4	
	Loss of granules due to blistering	3/4	3/4
	Lumps and unevenness of substrate	3/4	
2015-C-IBHS	Loss of granules not exposing mat	2/4	1/4
	Loss of granules generally around edges of shingles	4/4	4/4
	Scuff marks	1/4	2/4
	Loss of granules due to blistering	4/4	3/4
	Holes in shingles that do not extend to underlayment	3/4	4/4
	Lumps and unevenness of shingles	3/4	1/4
	Fasteners beginning to back out	1/4	2/4
2015-D-IBHS	Loss of granules not exposing mat	2/4	3/4
	Loss of granules generally around edges of shingles	2/4	1/4
	Loss of granules due to blistering	2/4	0/4
	Lumps and unevenness of shingles	2/4	1/4
	Fasteners beginning to back out		3/4
2015-E-IBHS	Loss of granules not exposing mat	2/4	1/4
	Loss of granules generally around edges of shingles	4/4	3/4
	Loss of granules due to blistering	3/4	3/4
	Lumps and unevenness of substrate	1/4	3/4
	Fasteners beginning to back out	2/4	1/4
2015-F-IBHS	Loss of granules generally around edges of shingles	1/4	3/4
	Loss of granules due to blistering	1/4	2/4
	Holes in shingles that do not extend to underlayment	3/4	1/4
	Lumps and unevenness of shingles	2/4	2/4

Table 7. Roof condition visual evaluation patterns at the Wisconsin and Ohio roof aging farms by IBHS personnel in 2017. Observation modes are identified by color codes to allow for quick comparisons between products. These represent common patterns and other conditions may be present on individual roof faces.

Roof Set	Condition Description	North Faces Affected	South Faces Affected
2014-A-AmFam	Loss of granules not exposing mat	3/4	4/4
	Loss of granules generally around edges of shingles	4/4	4/4
	Loss of granules due to blistering	2/4	2/4
	Loss of granules exposing mat	2/4	1/4
	Lumps and unevenness of shingles	2/4	4/4
2014-B-AmFam	Loss of granules not exposing mat	4/4	4/4
	Loss of granules generally around edges of shingles	4/4	3/4
	Loss of granules due to blistering	3/4	3/4
	Lumps and unevenness of shingles	2/4	2/4
	Holes in shingles that do not extend to underlayment	4/4	3/4
2014-C AmFam	Loss of granules not exposing mat	3/4	4/4
	Loss of granules generally around edges of shingles	4/4	4/4
	Loss of granules due to blistering	2/4	1/4
	Lumps and unevenness of shingles	4/4	4/4
2014-D-AmMod	Loss of granules generally around edges of shingles	2/4	2/4
	Loss of granules due to blistering	1/4	2/4
	Fasteners beginning to back out	3/4	2/4

Loss of granules, in various zones and of various severities, was the most common condition observed. This condition was more frequent, with additional loss modes present, and in some cases were more severe losses, compared to the observations made in 2016. Lumps and unevenness, and fasteners beginning to back out were seen across multiple roof sets but occurred less frequently than granule loss. Based on these observations, granule loss patterns will be important to monitor over the long-term life of the project to determine if shingle manufacturer, color, location, and/or roof direction play a larger role. Granule loss due to natural weathering and exposure can be mistaken for hail damage, particularly for high severity and large coverage instances, but these annual inspections clearly show that granule loss can be problematic even without a hail event, because the roof aging farm weather data show that no substantial hail has occurred at any of the sites. Some initial trends indicate that some shingle brands may have more widespread granule loss and increased likelihood of lumps and unevenness in the shingles.

Summary

On-site instrumentation installed on specimens at the roof aging sites has enabled a detailed examination of the conditions experienced by the asphalt shingles. Roof condition inspections are also conducted annually. This information has guided IBHS research initiatives simulating these conditions in a laboratory environment. Climate data and roof condition summaries will continue to be compiled each year and provide an overview of the conditions experienced by the roof specimens. Annual reports for the two new roof aging farms in Olathe, Kansas, and Foley, Alabama, will start with 2018 data, which will be published in 2019. A more detailed analysis study will be conducted when the first group of specimens are ready for testing in 2019. This analysis will examine the annual variability in the conditions experienced over the previous exposure period. The data and visual inspection information will be compared to performance test results to identify trends.