CHAPTER 9

Severe Weather: Risks and Mitigation

9.1 Identifying and Profiling Severe Weather Hazards
9.2 Assessment of Local Severe Weather Vulnerability and Potential Losses
9.3 Assessment of State Severe Weather Vulnerability and Potential Losses
9.4 Mitigation Efforts for Severe Weather Hazards

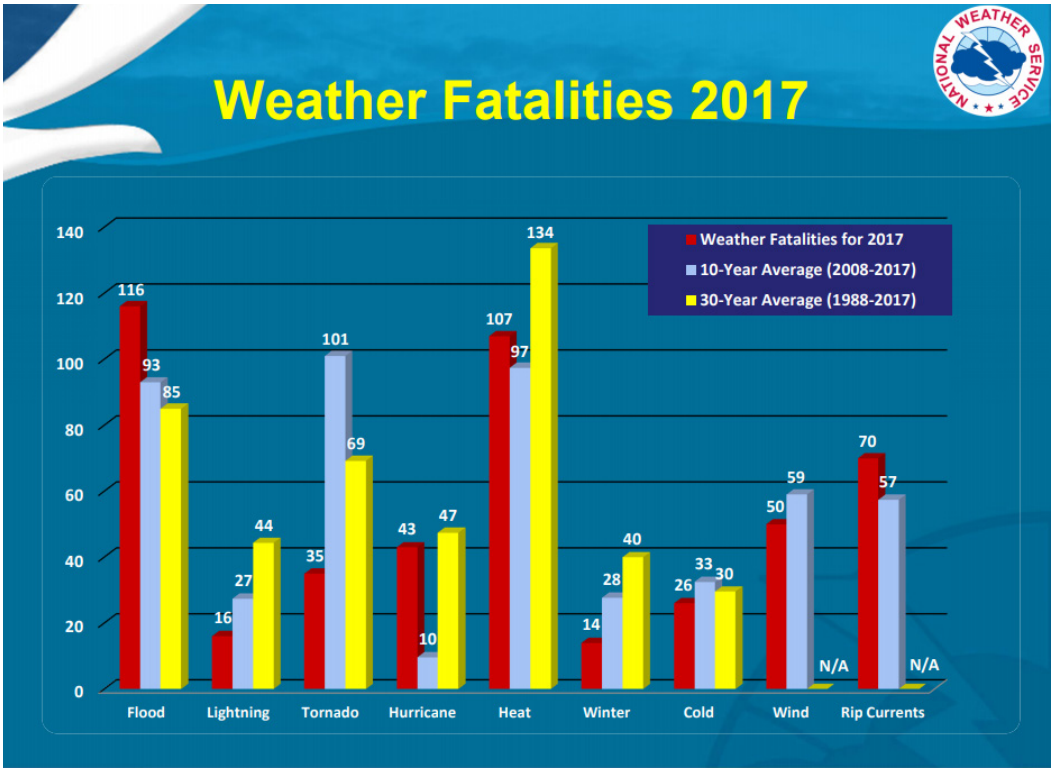
For the purpose of this mitigation plan, the term severe weather is used to represent a broad range of weather phenomena in Utah which include:

- Convective Weather (Lightning, Straight-line Winds, Hail, Tornadoes)
- Winter Storms
- Extreme Cold
- Extreme Heat
- Synoptic Winds (Gradient, Downslope)
- Climate-Related Hazards

9.1 Identifying and Profiling Severe Weather Hazards

The U.S. has sustained 233 weather and climate disasters from 1980 to mid-2018 where overall damages/costs reached or exceeded $1 billion (including CPI adjustment to 2018). The total cost of these 233 events exceeds $1.5 trillion. According to researchers at Cornell, 90% of all presidentially declared disasters are weather-related, costing taxpayers $14 billion in damages.[1] The Congressional Research Service reports tornadoes, severe thunderstorms, and related weather events cause nearly 57 percent of all insured catastrophic losses in the United States for any given year since 1953.[2] In a study conducted by the National Center for Atmospheric Research (NCAR) routine weather events in the U.S., including rain and cooler-than-average temperatures have an annual economic impact of $485 billon on the economy.[3]

Figure 1. 2017 Weather Fatalities



Weather events vary from state to state, but their impact is not just economic. Hazards induced by weather events such as floods, tornadoes, lightning strikes, winter storms and extreme temperatures claim the lives of around 500 Americans annually.4 These risks can be mitigated through weather education and preparedness.

The National Weather Service keeps track of weather related fatalities in the United States. Based on a 30-year average, the weather events with the highest fatality rates are heat, floods, tornadoes, hurricanes, and lightning.

1 http://emergencypreparedness.cce.cornell.edu/disasters/Pages/default.aspx
2 https://fas.org/sgp/crs/misc/R40097.pdf
3 https://www2.ucar.edu/atmosnews/news/4810/economic-cost-weather-may-total-485-billion-us
4 *Source: Lazo, J.K., Lawson, M., Larsen, P.H., and D.M. Waldman. (2011, June). U.S. Economic Sensitivity to Weather Variability. Bulletin of the American Meteorological Society, 92(6).*

In Utah, severe weather has resulted in 225 deaths between 1950 and August 2018.

Table 1. Utah Severe Weather Fatalities and Injuries 1950 – August 2018

County	Deaths	County	Injuries
Salt Lake	8	Salt Lake	44
Summit	7	Summit	17
Garfield	6	Utah	12
San Juan	6	Duchesne	11
Duchesne	5	Tooele	10
Grand	4	Cache	7
Carbon	3	Emery	7
Sanpete	3	Carbon	6
Utah	3	Garfield	6
Cache	2	Weber	5
Daggett	2	Beaver	4
Emery	2	Washington	4
Juab	2	Davis	3
Tooele	2	Grand	3
Uintah	2	San Juan	3
Wasatch	2	Sevier	3
Weber	2	Uintah	3
Davis	1	Wasatch	3
Iron	1	Daggett	2
Morgan	1	Morgan	2
Piute	1	Piute	1
Rich	1	Sanpete	1
Wayne	1	Wayne	1
Beaver	0	Box Elder	0
Box Elder	0	Iron	0
Total	67	Total	158

Data from National Climatic Data Center, NOAA and 2014 SHMP

CONVECTIVE WEATHER – LIGHTNING

Lightning: A visible electrical discharge produced by a thunderstorm. The discharge may occur within or between clouds, between the cloud and the air, or between a cloud and the ground.

Lightning Channel: The irregular path through the air along which a lightning discharge occurs.

Lightning Discharge: The series of electrical processes by which charge is transferred along a channel of high ion density between electrical charge centers of opposite signs.

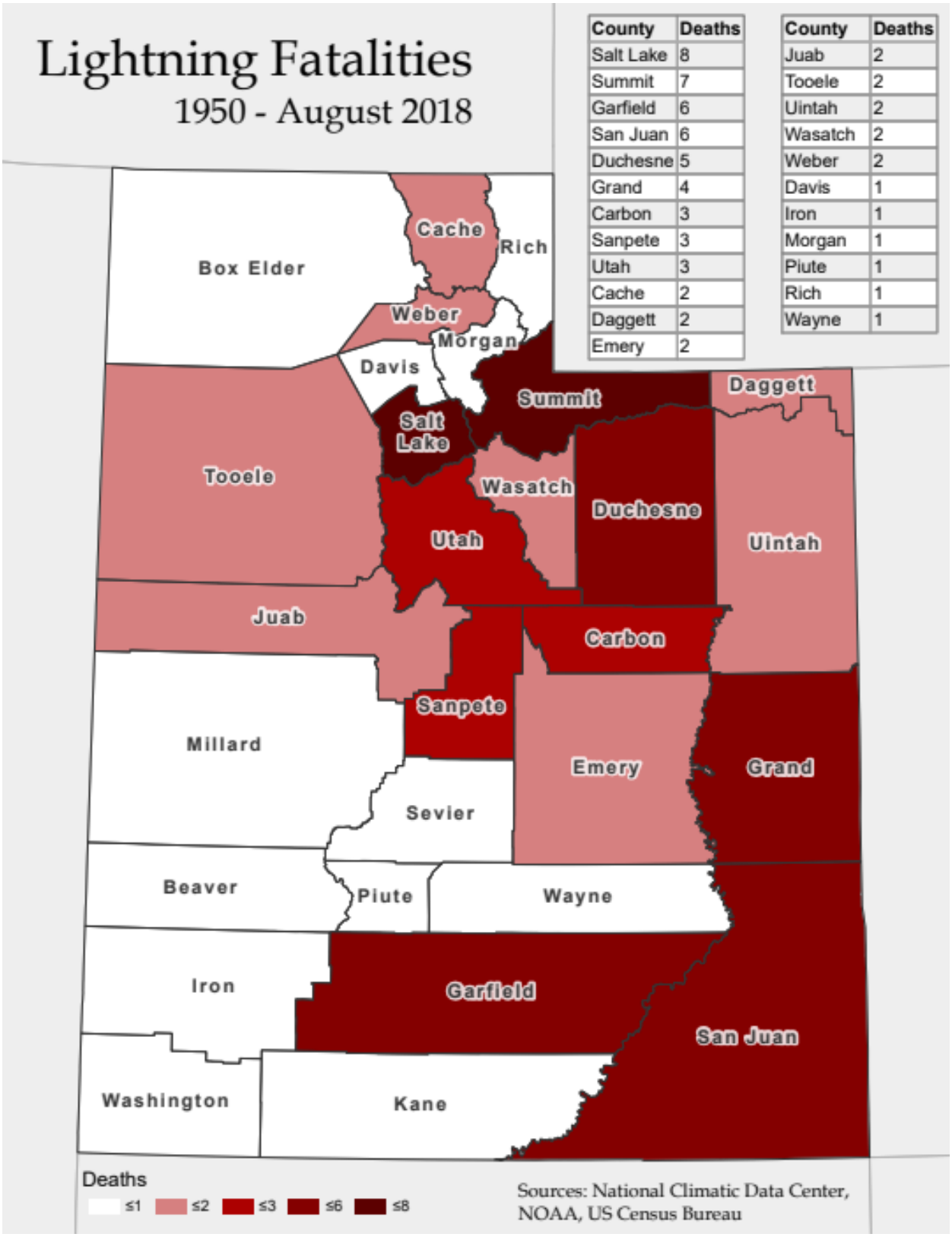
Lightning Stroke: A series of repeated electrical discharges comprising a single lightning discharge.

Thunder: The sound caused by the rapid expansion, then contraction, of air in the lightning channel.

A bolt of lightning can reach up to 10 miles in length, soar to temperatures of approximately 50,000 degrees Fahrenheit, and contain 100 million electrical volts.

There are approximately 25 million recorded lightning strikes in the US and 200,000 cloud-to-ground lightning flashes in Utah annually. Although most lightning occurs in the summer, lightning can strike at any time of year. Lightning kills an average of 47 people in the US each year and hundreds more are severely injured. Additionally, lightning causes billions of dollars in associated losses by igniting fires and disrupting utility, aviation and transportation services.

Map 1. Lightning Fatalities 1950 - 2018

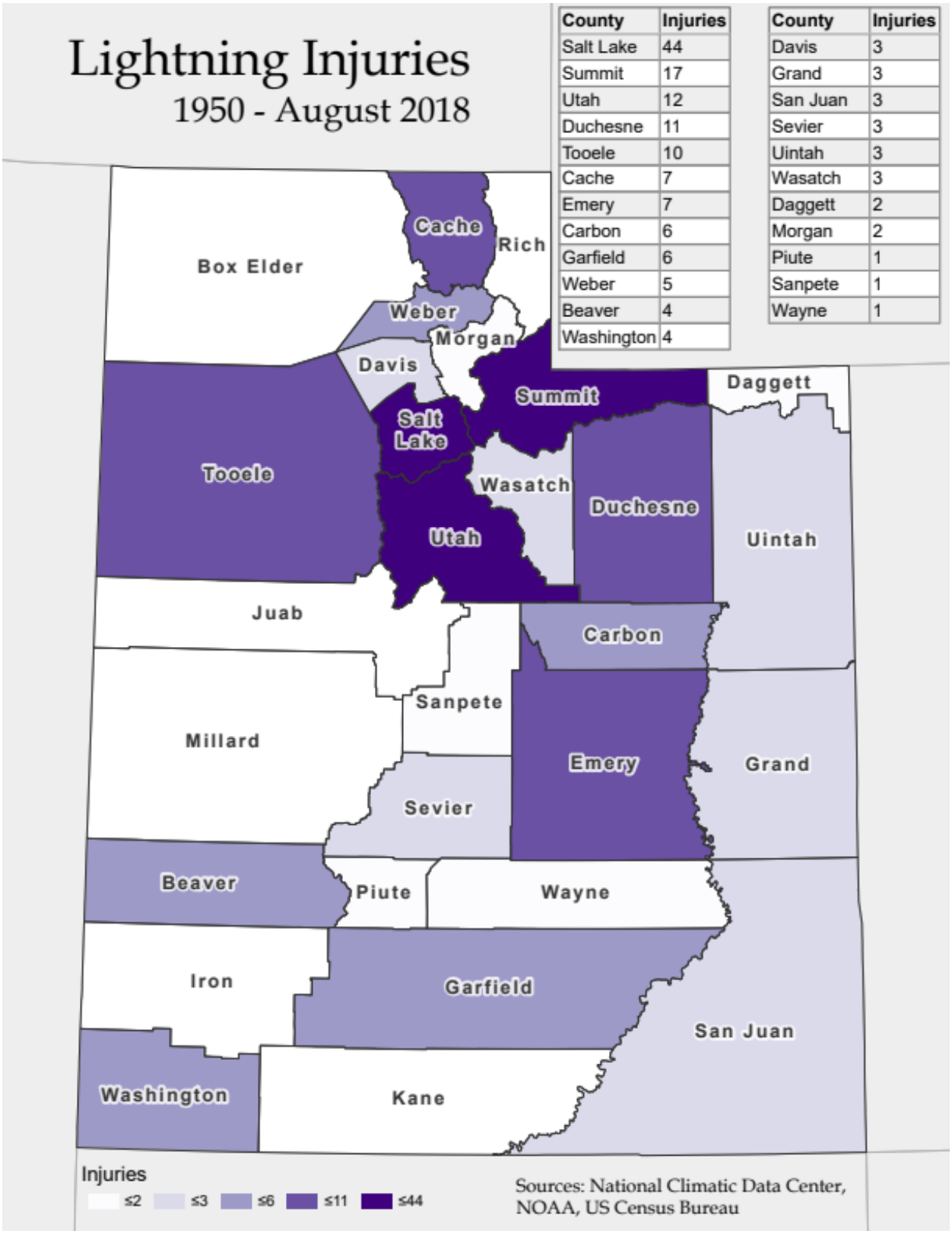


County	Deaths
Salt Lake	8
Summit	7
Garfield	6
San Juan	6
Duchesne	5
Grand	4
Carbon	3
Sanpete	3
Utah	3
Cache	2
Daggett	2
Emery	2

County	Deaths
Juab	2
Tooele	2
Uintah	2
Wasatch	2
Weber	2
Davis	1
Iron	1
Morgan	1
Piute	1
Rich	1
Wayne	1

Since 1950, lightning has claimed the lives of 67 people in Utah, more than any other thunderstorm-related hazard. An additional 161 people suffered lightning-related injuries.

Map 2. Lightning Injuries 1950 - 2018



County	Injuries
Salt Lake	44
Summit	17
Utah	12
Duchesne	11
Tooele	10
Cache	7
Emery	7
Carbon	6
Garfield	6
Weber	5
Beaver	4
Washington	4

County	Injuries
Davis	3
Grand	3
San Juan	3
Sevier	3
Uintah	3
Wasatch	3
Daggett	2
Morgan	2
Piute	1
Sanpete	1
Wayne	1

Table 2. Utah Lightning Fatalities, Injuries, and Property Damage

Utah Lightning Fatalities, Injuries , and Property Damage (1996 - 2018)						
Date	Location	County	Time	Fatalities	Injuries	Property Damage
8/17/1996	Moab	Grand	1730	1	0	
5/20/1997	Bountiful	Davis	1800	0	0	$50000
7/18/1997	Neola	Duchesne	1400	1	2	
8/13/1997	Holladay	Salt Lake	410	0	0	$300000
9/7/1997	Orem	Utah	150	0	0	$10000
10/23/1997	Salt Lake City	Salt Lake	1810	0	0	$26000
6/3/1998	Orem	Utah	2130	0	0	$50000
7/10/1998	Draper	Salt Lake	1430	1	2	
8/26/1998	Holladay	Salt Lake	1500	0	1	$10000
9/1/1998	Santa Clara	Washington	1700	0	0	$10000
10/3/1998	Alpine	Utah	1900	0	1	$100000
4/26/1999	Kaysville	Davis	2321	0	0	$50000
5/2/1999	Midvale	Salt Lake	1500	0	0	$5000
5/4/1999	South Ogden	Weber	1200	0	1	
5/29/1999	Cisco	Grand	830	1	0	
7/14/1999	Crescent Jct	Grand	1700	0	0	
5/24/2000	Midvale	Salt Lake	1400	1	6	
5/24/2000	Midvale	Salt Lake	1405	0	1	
5/25/2000	Orem	Utah	1800	0	0	$1500
5/29/2000	Ballard	Uintah	1300	0	0	$10000
6/9/2000	Myton	Duchesne	1500	0	0	$200000
7/9/2000	Moab	Grand	1745	0	0	$100000
7/10/2000	Layton	Davis	30	0	0	$100000
7/22/2000	Moab	Grand	1702	0	0	$2000
8/16/2000	Bryce Canyon	Garfield	1320	0	1	
8/23/2000	Central Portion	Tooele	1130	2	4	
6/26/2001	Fairview	Sanpete	1700	0	1	
7/25/2002	Countywide	Salt Lake	1800	2	0	
7/19/2003	Central Portion	Summit	1630	2	3	
7/19/2003	La Sal Jct	San Juan	1945	0	0	$1000
8/3/2003	North Ogden	Weber	1415	0	0	$15000
8/14/2003	Central Portion	Summit	1330	1	2	
8/29/2003	Central Portion	Utah	1100	0	1	
10/1/2003	Central Portion	Wasatch	1630	1	0	
6/20/2004	Manila	Daggett	1600	0	0	$2000
8/1/2004	Heber City	Wasatch	1630	0	0	$15000
5/5/2005	Ballard	Uintah	1920	0	0	$3000
5/6/2005	Dutch John	Daggett	1600	0	0	$500
5/17/2005	Dutch John	Daggett	1600	0	0	$500
5/30/2005	Dutch John	Daggett	1600	0	0	$500
6/21/2005	Salina	Sevier	1500	0	1	

6/23/2005	Dutch John	Daggett	1400	0	0	$500
8/2/2005	Mountain Home	Duchesne	2200	1	0	
6/6/2007	Manila	Daggett	2000	0	0	$500
7/21/2007	Manila	Daggett	1600	0	0	$500
10/13/2007	Pineview	Summit	1700	1	2	
6/3/2008	Dutch John	Daggett	2230	0	0	$1000
7/6/2008	Richfield	Sevier	1308	0	1	
5/30/2009	Manila	Daggett	2130	0	0	$500
6/26/2009	Monticello	San Juan	1445	0	0	$100000
8/24/2009	Spring Lake	Utah	1903	0	1	$5000
8/4/2010	Moab	Grand	1900	0	0	$2000
10/5/2010	Santa Clara	Washington	1400	0	2	
4/25/2011	Ellerbeck	Tooele	1651	0	0	$50000
7/11/2011	Cleveland	Emery	1455	1	0	
7/13/2011	Utah Railway Jct	Carbon	930	1	1	
8/18/2011	Bryce Canyon	Garfield	1125	1	0	
8/19/2011	Wilson	Weber	815	0	1	
7/21/2012	Boulder	Garfield	1800	1	0	
7/29/2012	Pineview	Summit	1600	0	1	
5/7/2013	Bennion	Salt Lake	1740	0	0	$200
5/7/2013	Salt Lake City Intl	Salt Lake	1900	0	0	$5000
7/6/2013	Uintah	Weber	1745	0	0	$20000
7/15/2013	Roper	Salt Lake	2130	0	0	$5000
7/15/2013	Altamont	Duchesne	2325	0	0	$80000
5/28/2015	West Pt	Davis	530	0	0	$2000
8/30/2015	Lehi	Utah	1730	1	0	
10/18/2015	Minersville	Iron	1500	0	0	$8000
7/22/2016	Lucerne Valley	Daggett	1100	1	1	
7/29/2017	Beaver	Beaver	930	0	2	
4/7/2018	Santa Clara	Washington	2320	0	0	$400000
Total				21	39	$1,742,200

Source: NOAA National Centers for Environmental Information, Storm Events Database

CONVECTIVE WEATHER – STRAIGHT-LINE WINDS

Straight-Line Winds: All winds produced by a thunderstorm not associated with the rotation of tornadoes. Straight-line winds are responsible for most thunderstorm wind damage, and speeds can exceed 100 mph.

Downburst: A strong downdraft current of air from a cumulonimbus cloud, often associated with intense thunderstorms. Downdrafts may produce damaging winds at the surface. A downburst can cause damage equivalent to a strong tornadoes.

Microburst: A convective downdraft with an affected outflow area of less than 2½ miles wide and peak winds lasting less than five minutes. Microbursts may induce dangerous horizontal and/or vertical wind shears, which can adversely affect aircraft performance and cause property damage.

Dry Microburst: A microburst with little or no precipitation reaching the earth. On the ground, the only visible sign might be a dust plume or a ring of blowing dust beneath an area.

Thunderstorm Wind Gust Hazards	
Risk Level	**Hazard Description**
Low	Chance of a damaging wind gust (>57 mph or 50 kt) is in the 5-15% range. Strong wind gusts expected to be in the 39 to 57 mph (34-49 kt) range.
Moderate	Chance of a damaging wind gust (>57 mph or 50 kt) is in the 15-25% range. Damaging wind gusts expected to be in the 58 to 75 mph (50-64 kt) range.
High	Chance of a damaging wind gust (>57 mph or 50 kt) is greater than 25%. Destructive wind gusts expected to exceed 75 mph (64 kt) range.
Source: National Weather Service: https://www.weather.gov/mhx/ConvectiveWindGust	

Table 3. Thunderstorm Wind Events by Cost $50,000 and Above Jan. 1955 to May 2018

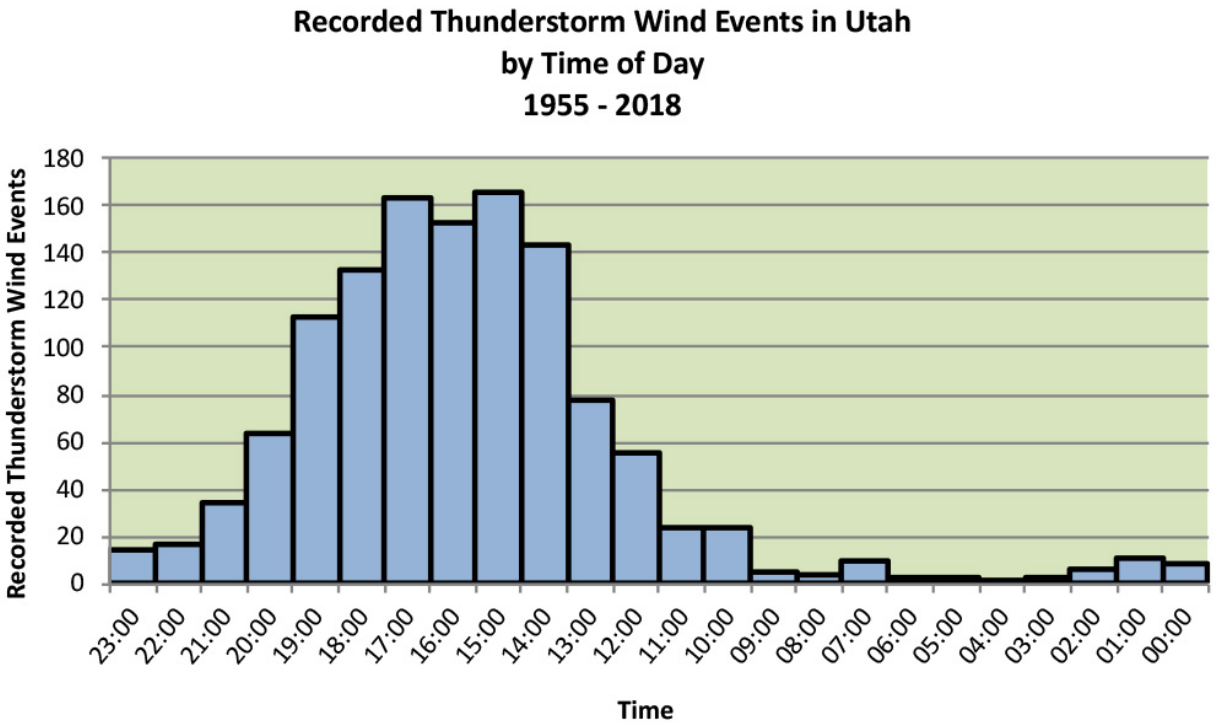
Date	Location	County	Magnitude (1 knot = 1.15 mph)	Injuries	Property Damage Est.	Crop Damage Est.
05/03/93	Farr West	Weber	0 kts.	0	$50,000	$0
05/07/94	Salt Lake City	Salt Lake	0 kts.	0	$50,000	$0
05/31/94	Tooele	Tooele	70 kts.	0	$500,000	$0
05/31/94	Lakeshore	Utah	0 kts.	0	$500,000	$0
05/31/94	Salt Lake City	Salt Lake	54 kts.	0	$500,000	$0
05/31/94	Salt Lake City	Salt Lake	70 kts.	0	$500,000	$0
05/31/94	Provo	Utah	91 kts.	15	$50,000,000	$0
07/05/94	Woods Cross	Davis	70 kts.	0	$50,000	$0
05/29/96	Clearfield	Davis	70 kts.	0	$300,000	$0
07/16/96	Provo	Utah	74 kts.	0	$100,000	$0
07/16/96	Salt Lake City	Salt Lake	56 kts.	1	$100,000	$0
07/05/98	Salt Lake City	Salt Lake	58 kts.	8	$50,000	$800
08/26/98	Kaysville	Davis	61 kts.	0	$400,000	$100,000
08/26/98	Ogden	Weber	52 kts.	0	$100,000	$20,000
05/24/00	Gunnison	Sanpete	52 kts.	0	$50,000	$2,000
04/28/01	Trenton	Cache	70 kts.	0	$100,000	$5,000
06/12/01	Countywide	Salt Lake	64 kts.	1	$500,000	$50,000
06/12/01	Countywide	Utah	65 kts.	0	$250,000	$25,000
06/12/01	Countywide	Tooele	68 kts.	0	$200,000	$25,000
06/12/01	Countywide	Davis	55 kts.	0	$100,000	$10,000
08/21/01	Salt Lake City	Salt Lake	64 kts.	0	$50,000	$5,000
06/21/02	Price	Carbon	50 kts.	0	$300,000	$0
07/26/02	Provo	Utah	62 kts.	0	$50,000	$10,000
08/03/03	South Ogden	Weber	60 kts.	0	$100,000	$20,000
08/22/03	Mendon	Cache	60 kts.	0	$50,000	$0
08/22/03	Countywide	Tooele	63 kts.	0	$100,000	$0
06/07/06	Blanding	San Juan	55 kts.	0	$175,000	$0
07/26/06	Salt Lake City	Salt Lake	50 kts.	2	$50,000	$0

08/01/06	Countywide	Utah	80 kts.	0	$4,000,000	$0
08/01/06	Provo Muni Airport	Utah	92 kts.	0	$3,000,000	$0
08/01/06	Countywide	Salt Lake	75 kts.	0	$2,000,000	$0
07/19/08	Myton	Duchesne	52 kts.	0	$80,000	$0
08/22/10	Salt Lake City	Salt Lake	66 kts.	0	$200,000	$0
08/22/10	Randall	Davis	56 kts.	0	$100,000	$0
04/21/11	Pleasant View	Weber	67 kts.	0	$60,000	$0
07/09/11	Richmond	Cache	52 kts.	0	$55,000	$0
06/12/13	Salt Lake No 2 Arp	Salt Lake	57 kts.	0	$50,000	$0
08/05/13	Dalton	Salt Lake	70 kts.	0	$300,000	$0
09/07/13	Provo Airport	Utah	51 kts.	0	$100,000	$0
08/12/14	Saltair	Salt Lake	51 kts.	0	$50,000	$0
06/01/15	Bothwell	Box Elder	54 kts.	1	$50,000	$0
06/11/16	Francis	Summit	60 kts.	0	$75,000	$0
02/21/17	Amalga	Cache	52 kts.	0	$60,000	$0
05/06/17	Taylor	Weber	61 kts.	0	$60,000	$0
09/14/17	Glen Canyon	Kane	61 kts.	3	$500,000	$0

Storm Data publication of National Centers for Environmental Information, National Oceanic and Atmospheric Administration, https://www.ncdc.noaa.gov/stormevents/

Figure 2 shows the number of recorded thunderstorm wind events in Utah by each hour of the day. The highest number of thunderstorm wind events has occurred between 12:00 and 21:00.

Figure 2. Utah Wind Events 1955 - 2018



SYNOPTIC WIND EVENTS

High Winds: Speeds created by gradient winds, downslope winds and gap winds can produce catastrophic damage. They also pose a health hazard and can be life threatening.

Gradient High Winds: High winds covering a large area due to synoptic-scale, extra-tropical low pressure systems.

Gap Winds: Strong winds channeled through gaps in mountain ranges.

Downslope Winds: Winds generated as a deep layer of air is forced over a barrier. In these events, winds accelerate down the mountain and form a wave at the base of the terrain, with the strongest winds expected in the wave region.

Damage to Davis County home after 2011 wind storm
Salt Lake Tribune Francisco Kjolseth

In November 2011 winds exceeding 100 mph overturned semis on Interstate 15, bent signs, and toppled trees causing widespread power outages affecting 50,000 homes and businesses in northern Utah. In Davis County the wind damage exceeded $3.5 million prompting a disaster declaration and school cancelations until power could be restored and the shattered windows in 30 school buses could be replaced. Centerville City had more than $8 million in damages.

Table 4. High Winds by Cost $50,000 and Above 2006 to 2017

HAZARD DATE	AREA	INJURIES	FATALITIES	PROPERTY DAMAGE	REMARKS
01/04/2008-01/05/2008	Northern and central Utah	0	0	$500,000	65 kt
03/29/2009	Statewide	0	0	$100,000	63 kt
08/06/2009-08/07/2009	Northern and western Utah	0	0	$80,000	62 kt
04/27/2010-04/28/2010	Statewide	0	0	$310,000	72 kt
05/28/2010	Northwest and central Utah	1	0	$80,000	52 kt
12/01/2011	Northern and central Utah	4	0	$82,250,000	89 kt
12/31/2011	Northern and central Utah	0	0	$50,000	57 kt
04/08/2013-04/09/2013	Northern Utah	0	0	$85,000	65 kt
11/21/2013-11/23/2013	Northern Utah	0	0	$300,000	74 kt
03/17/2014	Northern and central Utah	0	0	$240,000	70 kt
04/22/2014	Statewide	1	0	$900,000	75 kt
11/01/2014	Northern and western Utah	0	0	$75,000	66 kt
12/29/2014-12/30/2014	Northern Utah	0	0	$75,000	68 kt
04/14/2015	Statewide	25	1	$450,000	71 kt
02/17/2016-02/18/2016	Statewide	0	0	$450,000	76 kt
04/30/2016-05/01/2016	Northern Wasatch Front	0	1	$1,000,000	79 kt
03/05/2017	Statewide	10	0	$240,000	67 kt
04/13/2017	Statewide	0	0	$100,000	71 kt
06/11/2017	Statewide	1	0	$50,000	66 kt

Storm Data publication of National Centers for Environmental Information, National Oceanic and Atmospheric Administration

Tornadoes: A violently rotating column of air, usually pendant to a cumulonimbus, with circulation reaching the ground. It nearly always starts as a funnel cloud and may be accompanied by a loud roaring noise. On a local scale, it is the most destructive of all atmospheric phenomena.

Funnel Cloud: A condensation funnel extending from the base of a towering cumulonimbus, associated with a rotating column of air that is not in contact with the ground.

Tornadoes may appear nearly transparent until dust, debris, and/or moisture are picked up. Tornadoes generally move from southwest to northeast, but they can move in any direction and can suddenly change directions. The average forward speed of a tornado is 30 mph, but they can vary from nearly stationary to 70 mph. The strongest tornadoes have rotating winds of more than 300 mph. Tornadoes can occur at any time of day and any day of the year, although in Utah, tornadoes are most likely to occur during late spring, summer and early fall.

Although tornadoes occur in many parts of the world, they are found most frequently in the United States. In an average year, 1,200 tornadoes cause 70 fatalities, 1,500 injuries and $1.1 billion in damage nationwide.

While Utah has some tornadoes every year, these storms represent a relatively low risk for most areas when compared to states in the mid-western and southern U.S. Hurricanes tend to produce similar wind speeds over widespread areas but the maximum winds in tornadoes are usually confined to the funnel.

1999 Salt Lake City tornado damage

Sept 2016 Tornado in Washington Terrace
KSTU Lauren Steinbrecher

Associated Press Chris Detrick

Utah's Strongest Tornadoes

(Category based on old Fujita Scale, see below)
F2 January 22, 1943 Young Ward
F2 June 16, 1955 Sanpete County
F2 June 3, 1963 Bountiful
F2 February 9, 1965 Salt Lake County
F2 November 2, 1967 Emery
F2 August 14, 1968 West Weber
F2 June 10, 1970 Grand County
F2 May 29, 1987 Lewiston
F3 August 11, 1993 Uinta Mountains
F2 August 11, 1999 Salt Lake City
F2 September 8, 2002 Manti

The National Weather Service (NWS) has used the Enhanced Fujita Scale (EF Scale) since 2007. The EF Scale goes from zero to five and relies on wind speed to determine the strength of a tornado while the F-scale is based on the amount of destruction a tornadoes causes on a scale of zero to 12. A set of wind estimates based on damage used to classify tornadoes intensity assigns a category from EF0 through EF5, with higher numbers indicating stronger winds and increased likelihood of property and crop damage, injuries caused by object projectiles and even loss of life.

To determine a tornadoes' EF rating, 28 damage indicators and a corresponding Degree of Damage (DOD) are used. The EF Scale table and supporting information can be found at http://www.spc.noaa.gov/efscale/ef-scale.html.

Table 5. Enhanced Fujita Scale

Category	Wind Speed
EF0	(65-85 mph)
EF1	(86-110 mph)
EF2	(111-135 mph)
EF3	(136-165 mph)
EF4	(166-200 mph)
EF5	(>200 mph)

Table 6. Number of Observed Tornadoes per County by Alphabetical Order

COUNTY	#	COUNTY	#	COUNTY	#
Beaver	6	Iron	4	Sevier	4
Box Elder	11	Juab	1	Summit	0
Cache	4	Kane	0	Tooele	5
Carbon	1	Millard	4	Uintah	6
Daggett	1	Morgan	1	Utah	10
Davis	11	Piute	1	Wasatch	0
Duchesne	4	Rich	3	Washington	2
Emery	8	Salt Lake	15	Wayne	8
Garfield	3	San Juan	0	Weber	7
Grand	5	Sanpete	10	TOTAL	137*

**National Weather Service*

**Storm Data publication of National Centers for Environmental Information, National Oceanic and Atmospheric Administration*

***Three of the above tornadoes were counted twice because they traveled across county borders.*

Table 2G-6 Number of Observed Tornadoes per County by Alphabetical Order

Table 7. Tornadoes by Cost $50,000 and/or with Injuries or Fatalities 1964 to May 31, 2017

HAZARD DATE	COUNTY	EF/F Scale	INJURIES	FATALITIES	PROPERTY DAMAGE	PATH LENGTH/WIDTH
07/06/1884	Summit		2	1		/165 feet
08/14/1968	Weber		1	0	$25,000	1.5 miles/35 yards
04/19/1970	Sevier		1	0	$275	1 mile/13 yards
07/08/1989	Salt Lake	F1	0	0	$2,750	
04/23/1990	Weber	F0	1	0	$27,500	.1 mile/5-15 yards
06/02/1993	Davis	F1	2	0	$2,750	1.0/20 yards
05/3/1993	Tooele	F1	0	0	$275,000	0.1 miles/15 yards
05/29/1996	Weber	F1	1	0	$600,000	1.3 miles/33 yards
08/20/1998	Weber	F1	6	0	$12,000	.1/20 yards
08/11/1999	Salt Lake	F2	80	1	$170,000,000	4.3 miles/150 yards
09/03/1999	Uintah	F1	1	0	$700,000	4 miles/50 yards
09/08/2002	Sanpete	F2	0	0	$2,100,000	2.7 miles/270 yards
09/22/2016	Weber	EF1	5	0	$2,000,000	2.85 miles/50 yards
09/22/2016	Garfield	EF1	0	0	$300,000	.75 miles/25 yards

Storm Data publication of National Centers for Environmental Information, National Oceanic and Atmospheric Administration

Table 8. Utah Tornado History

Utah Tornado History		
Date	Location	Comments
August 1869	American Fork Canyon	The first recorded mention of tornadic activity in Utah, when a "funnel-shaped waterspout" traveled up the canyon and destroyed seven bridges along the way.
July 6, 1884	near Wanship	A tornado damaged trees and caused one fatality.
May 27, 1941	Bountiful	A tornado caused $5,000 in damage to farm buildings and power lines.
Jan. 22, 1943	Young Ward	An F2 tornado touched down.
June 5, 1953	Davis County	An F0 tornado touched down.
July 14, 1953	Kanarraville	A small twister broke tree limbs and tore a metal roof off a garage.
May 25, 1954	Laketown	A tornado damaged an eight-block area. Trees were uprooted and buildings flattened.
June 1, 1955	Uintah County	A tornado was reported.
June 16, 1955	Fayette	Two funnel clouds damaged trees and sheds.
Aug. 7, 1957	Salina	A small tornado blew the roofs off a processing plant and a service station.
May 4, 1961	Emery County	A tornado was reported.
July 9, 1962	Grouse Creek	A tornado tore up ground in an uninhabited area for 15 minutes.
June 3, 1963	Bountiful	A tornado hit Bountiful Elementary School, tore the roof off the school and caused $20,000 in damage. No one was injured. The twister also damaged homes, and one-inch hail afterward broke windows and damaged cars.
Aug. 28, 1964	Gunnison	A tornado damaged a chicken coop, broke windows and tore the roof off a garage.
Feb. 9, 1965	Magna	A small tornado destroyed a three-car garage. No one was hurt and three vehicles parked inside were not damaged.
June 23, 1965	Woodruff	A tornado overturned a trailer and then moved across open fields before lifting into the air.
June 25, 1965	Tooele County	A tornado was reported.
July 9, 1965	Provo Canyon	A tornado in the Vivian Park area damaged trees, vegetation and power lines over a three-mile path.
Aug. 9, 1965	Tooele County	A tornado was reported.
April 17, 1966	Springville	A tornado touched down, breaking large trees and lifting the roof off a house.
May 9, 1966	Emery County	A tornado was reported.
June 16, 1967	Iron County	A tornado was reported.
Nov. 2, 1967	Emery	The Last Chance Hotel was destroyed by an F2 tornado, though no one was injured.
May 22, 1968	Tooele County	A tornado was reported.
Aug. 14, 1968	Box Elder County	A tornado was reported.
Aug. 14, 1968	Salt Lake City	A tornado tore up trees in Pioneer Park and moved toward Temple Square, blowing out windows along the way.
Aug. 14, 1968	West Weber	An F2 tornado unroofed a milking barn and lifted a man and boy off the ground. It also carried a horse over a fence and into another pasture, destroyed a barn and a house and caused $50,000 in damages.

May 31, 1969	Wayne County	Three tornadoes were reported.
April 19, 1970	Annabella	A woman was carried 30 feet by an F1 tornado and then dropped. She received only minor injuries. The twister also damaged two trailers.
June 5, 1970	Box Elder County	A tornado was reported.
June 10, 1970	Davis County	A tornado was reported.
June 10, 1970	Thompson Springs	An F2 tornado damaged trees, leveled two sheds and destroyed a mobile home.
Dec. 2, 1970	Utah County	An F1 tornado was reported.
Sept. 2, 1971	Utah County	An F0 tornado was reported.
May 6, 1981	Cache County	An F1 tornado was reported.
July 24, 1981	Hanksville	An F0 tornado was spotted but caused no damage.
Mar. 29, 1982	Beaver County	An F0 tornado was reported.
May 3, 1982	Beaver County	An F0 tornado was reported.
Sept. 13, 1982	Utah County	An F0 tornado was reported.
Aug. 13, 1984	near Provo	An F0 tornado touched down five miles south of Provo, but produced no damage.
Aug. 15, 1984	Sanpete County	An F0 tornado was reported.
Aug. 16, 1984	Box Elder County	Two F0 tornadoes were reported.
Sept. 11, 1984	near Myton	An F0 tornado overturned a car and truck.
May 30, 1986	Iron County	An F1 tornado was reported.
May 30, 1986	Washington County	An F1 tornado was reported.
Aug. 31, 1986	Wayne County	An F0 tornado was reported.
Sept. 9, 1986	Salt Lake County	An F0 tornado was reported.
May 29, 1987	Cache County	An F1 tornado was reported.
Aug. 25, 1987	Box Elder County	An F0 tornado was reported.
Aug. 25, 1987	Cache County	An F0 tornado was reported.
May 29, 1988	Uintah County	An F0 tornado was reported.
Jan. 10, 1989	Sandy	An F1 tornado damaged one home in the Hidden Valley Estates subdivision.
Mar. 2, 1989	Salt Lake County	An F1 tornado was reported.
May 11, 1989	Davis County	An F0 tornado was reported.
June 7, 1989	Millard County	An F0 tornado was reported.
July 8, 1989	Midvale	An F1 tornado damaged roofs, trees and power lines.
Sept. 17, 1989	Cache County	An F1 tornado was reported.
Mar. 23, 1990	Vernal	An F0 tornado damaged a mobile home and storage sheds.
Apr. 23, 1990	Weber County	An F0 tornado was reported.
July 8, 1990	Duchesne County	An F0 tornado was reported.

Aug. 16, 1990	Salt Lake County	An F0 tornado was reported.
July 25, 1991	Tooele County	An F1 tornado was reported.
July 26, 1991	Emery County	Two F0 tornadoes were reported.
Sept. 7, 1991	Beaver County	An F0 tornado was reported.
Sept. 10, 1991	Brigham City	An F0 tornado severed power lines, uprooted trees and damaged buildings.
May 21, 1992	Beaver County	An F0 tornado was reported.
Aug. 30, 1992	near Kennecott mine	An F0 tornado was observed but no damage.
Aug. 31, 1992	Washington County	An F0 tornado was reported.
Sept. 23, 1992	Davis County	An F1 tornado was reported.
April 4, 1993	Caineville	An F1 tornado damaged a restaurant and motor home.
May 3, 1993	Erda	An F1 tornado destroyed a Tooele County drive-in.
May 5, 1993	Leota	An F0 tornado touched down.
Aug. 11, 1993	Uinta Mountains	An F3 strong tornado damaged 1,000 acres of trees, four cars and a truck.
Nov. 5, 1993	Emigration Canyon	An F0 tornado was reported.
July 29, 1995	Centerville	An F0 tornado was reported.
Dec. 5, 1995	Pleasant View	An F0 tornado was reported.
May 28, 1996	Delta	An F0 tornado was reported.
May 29, 1996	Syracuse	An F0 tornado was reported.
May 29, 1996	North Ogden	An F1 tornado was reported.
April 5, 1997	Cedar Valley	An F0 tornado was reported.
May 8, 1998	Magna	An F0 tornado was reported.
May 21, 1998	West Point	An F0 tornado was reported.
May 21, 1998	Roy	An F0 tornado was reported.
Sept. 12, 1998	Emigration Canyon	An F0 tornado was reported.
Aug. 11, 1999	Salt Lake City	A strong tornado (F2), with winds up to 157 mph, whipped through downtown, killing one man, injuring 80 people and damaging or destroying 500 trees. Total damage was about $170 million in a 4 1/4-mile path of damage.
Sept. 3, 1999	Vernal/Naples	An F1 tornado caused minor damage.
May 24, 2000	near Gunnison	A small tornado (F0) touched down but caused no damage.
May 25, 2000	Holladay	An F0 tornado damaged cars, a roof and uprooted trees.
Sept. 8, 2000	Panguitch	An F0 tornado was spotted near Panguitch on Highway 20 which goes from US-89 to I-15. The tornado stayed over open country for about 5 minutes before lifting. No damage was reported.
Sept. 8, 2000	Moab	A weak tornado (F0) was observed. The thunderstorm which produced this tornado had a dark green appearance.
July 25, 2001	Price	An F0 tornado was spotted over open country about 10 miles southwest of Price.
Aug. 8, 2001	Fairview	An F0 tornado touched down and lasted about 10 minutes and remained over open country.

Aug. 21, 2001	Dutch John	A narrow and long, rope-like F0 tornado was observed in Flaming Gorge National Recreation Area. The tornado picked up brush, branches, and tree limbs along its path through the forested land. Some of the debris was deposited on the roads.
Aug. 21, 2001	Sugar House	An F0 tornado briefly touched down in the Sugarhouse area of Salt Lake City. Other reports of the storm indicated a funnel cloud and strong thunderstorm winds. No damage or injuries were reported.
Sept. 4, 2001	Milford	A thunderstorm spawned a F0 tornado which touched down 6 miles southwest of Milford, then lifted up and touched down again in the foothills east of Milford. It finally moved to about 10 miles northeast of town before dissipating. The entire event lasted about 15 minutes over open country.
Sept. 8, 2002	Centerfield	An F0 tornado was spotted on the ground for a short time over open country 5 miles NNE of Centerfield.
Sept. 8, 2002	Manti	An F2 tornado with winds as high as 157 mph damaged a pioneer building, lumber business, trailers, and a residential area before dissipating. The distance traveled was 2.75 miles, and the width was 800 feet. Time on the ground was approximately 15 minutes. Estimated damage is around $2,000,000.
Sept. 12, 2002	Ephraim	A small tornado (F0) was observed and moved slowly to the northeast over open country before dissipating. This tornado remained on the ground for only a few seconds, but the funnel cloud was visible for about 10 minutes.
Sept. 12, 2002	Hanksville	A small tornado (F0) was observed 20 miles southeast of Hanksville. It was on the ground over open country for a short time, and debris from the ground was observed rising before the funnel dissipated.
June 9, 2003	Payson	A small tornado (F0) touched down and damaged about 100 feet of vinyl fence and lifted a small aluminum boat off of its trailer. The path of the tornado was about 100 yards.
Aug. 22, 2003	Levan	An F0 tornado touched down near State Route 28 between Levan and Yuba Lake in Juab County. The tornado stayed on the ground for one minute, picking up rocks and shrubs before dissipating.
May 30, 2005	Lehi	A brief F0 tornado touchdown along Utah Lake shore.
June 23, 2005	Duchesne	A brief F0 tornado touchdown along HWY 40 near Duchesne.
June 25, 2005	Mt Pleasant	Brief F0 tornado touchdown flipped over a motor home and blew the roof off a shed.
Aug. 2, 2005	Bountiful	An F0 tornado touched down on the northern part of Antelope Island.
June 8, 2006	Green River	A ropelike F0 tornado observed a few miles west of Green River. No damage was observed and the tornado was short lived.
Sept. 22, 2006	Moab	An F0 traveled across open country and ripped branches off of juniper and pinyon pine trees.
July 25, 2007	Plymouth	An EF0 tornado was reported along I-15 in Plymouth. The tornado moved through a field and did not impact any structures.
May 3, 2009	Willard	An EF0 tornado touched down in Willard. The tornado path was one mile. The damage from the tornado included damaged siding, several uprooted trees, a couple of snapped trees, and a tossed empty snowmobile trailer.
May 24, 2009	Milford	An EF0 tornado touched down 5 miles west of Milford in an uninhabited area and did no damage.

Aug. 6, 2009	Leota	AEF0 tornado traveled across Pelican Lake and the on the east shore of the lake, the tornado tore up some trees and flipped over a trailer.
Aug. 6, 2009	Vernal	An EF0 tornado tracked through a small section of Vernal, mostly staying between houses. A number of trees had large limbs broken off and some minor damage occurred to sheds. The tornado was seen by many area residents and photographed by at least three persons.
July 26, 2010	Carbon County Airport	An EF0 tornado touched down near Wellington, with multiple members of the public seeing the tornado and taking pictures. The tornado damaged a trailer, rolling it over onto its side, and uprooted a few large trees.
Oct. 6, 2010	Hanksville	An EF0 tornado touched down west of Canyonlands National Park, at the south end of Robbers Roost Flat. Approximately 30 juniper trees were either snapped or uprooted by the tornado. No monetary damage occurred as the tornado occurred in a rural area and no trees fell on the nearby dirt road, so no cleanup was necessary.
Aug. 24, 2011	Hurricane Airport	An EF0 tornado touched down west of Apple Valley, Utah. The weak tornado was short-lived and caused no damage.
Aug. 21, 2012	Newhouse	An EF0 tornado was reported along the Utah/Nevada border.
Sept. 7, 2013	American Fork	An EF0 small tornado was spotted and removed a metal roof from a barn, and did minor damage to trees and other outbuildings in the area.
June 6, 2015	Mexican Hat	An EF0 tornado initially touched down near Comb Ridge and traveled northeast near to Montezuma Creek before dissipating.
June 16, 2015	Dry Fork	An EF0 tornado touched down for about 9 minutes on the ground.
Aug. 26, 2016	Panguitch	An EF0 tornado briefly touched down near the town of Panguitch, but no damage was reported or found.
Sept. 22, 2016	Panguitch	A tornado touched down in Panguitch, producing an intermittent damage path, which included EF1 damage to a business in town and EF0 damage to several homes and numerous trees. The most significant damage occurred to a business where the tornado took off the roof of a building. The tornado also caused significant damage to numerous vehicles in the area and knocked down multiple power lines, leaving much of the community without power. No injuries were reported across the area.
Sept. 22, 2016	Roy	An EF1 tornado touched down in Riverdale in Weber County. The tornado moved rapidly to the northeast, but was not consistently on the ground. It skipped on several occasions in Riverdale, producing primarily EF0 damage to trees and a several homes. The tornado then produced a more continuous swath of damage through Washington Terrace producing EF1 damage to numerous homes, structures, as well as many trees. Finally, the tornado skipped briefly into South Ogden producing EF0 damage before dissipating. One person suffered a head injury and took private transportation to a hospital. A few others were cut by flying glass, but were not hospitalized. The many downed trees across the area caused widespread power outages, with over 37,000 customers impacted. Approximately 12 homes in Washington Terrace were so damaged that they were deemed uninhabitable until repaired, and a total of about 30 homes were damaged across Weber County.
July 8, 2017	Hurricane Airport	An EFU tornado touched down east of St. George. No damage was reported or found.
July 10, 2017	Natch	An EFU tornado touched down east of Panguitch Lake. No damage was reported or found.
May 28, 2018	Snowville	A brief tornado touchdown was observed and photographed near Snowville. No damage was reported.
May 28, 2018	Wallsburg	A brief, weak tornado touchdown was reported and photographed by multiple individuals at Strawberry Reservoir. No damage was observed.

Source: NOAA, National Centers for Environmental Information; Natural History Museum of Utah, About Tornadoes

CONVECTIVE WEATHER – HAIL

Hail: Showery precipitation in the form of irregular pellets or balls of ice, more than 5 mm in diameter, falling from a cumulonimbus cloud.

Hail is created when strong, rising currents of air within a storm called updrafts carry water droplets to a height where they freeze. As ice particles grow in size, they become too heavy to be supported by the updraft, and fall to the ground. Hail causes more than $1 billion in crop and property damage each year.

Brigham City Hail Storm June 12, 2016

Table 9. Utah Recorded Hail Damage 1993 – 2017

Utah Recorded Hail Damage 1993 -2017						
Date	Location	County	Time	Size (inches)	Property Damage (estimate)	Crop Damage (estimate)
8/8/1993	Murray	Salt Lake	1347	1.5	$5000	$500
8/8/1993	Herriman	Salt Lake	1235	1.25	$500	$500
8/8/1993	Midvale	Salt Lake	1301	0.75	$500	$50
8/8/1993	Sandy	Salt Lake	1302	1	$500	$50
8/8/1993	Holladay	Salt Lake	1308	0.75	$500	$50
8/8/1993	Midvale	Salt Lake	1330	1.5	$500	$50
8/8/1993	Millcreek	Salt Lake	1330	0.75	$500	$50
8/8/1993	Willowcreek	Salt Lake	1340	0.75	$500	$50
8/8/1993	Sandy	Salt Lake	1425	1.5	$500	$50
8/8/1993	Sandy	Salt Lake	1440	1.25	$500	$50
8/8/1993	Murray	Salt Lake	1445	1	$500	$50
10/5/1994	Cottonwood Heights	Salt Lake	638	1	$5000000	
10/5/1994	Salt Lake City	Salt Lake	444	0.75	$500000	
7/26/1996	(Cdc)Cedar City Airport	Iron	1705	1	$50000	
6/10/1997	Caineville	Wayne	1100	2	$15000	
6/10/1997	Salt Lake City	Salt Lake	1310	1	$15000	
6/10/1997	Harrisville	Weber	1730	1	$5000	
6/10/1997	Salt Lake City	Salt Lake	1240	1	$2000	
6/10/1997	Grantsville	Tooele	1500	0.75	$2000	
6/18/1997	Pleasant Grove	Utah	1732	0.75	$2000	
7/10/1997	Yost	Box Elder	1422	1.75	$30000	$30000
8/17/1997	South Jordan	Salt Lake	1310	1	$10000	
9/6/1997	Paradise	Cache	2140	1	$10000	
9/7/1997	American Fork	Utah	140	1.5	$25000	
9/8/1997	Hatch	Garfield	1245	0.75	$10000	
9/11/1997	Riverside	Box Elder	1330	0.75	$5000	
9/14/1997	Escalante	Garfield	1500	1	$7000	
8/26/1998	American Fork	Utah	1527	1.25	$300000	$100000
8/30/1998	Zion National Park	Washington	1520	0.75	$1000	$3000
9/3/1999	Naples	Uintah	1520	1.75	$40000	
9/21/2000	Cisco	Grand	1415	1	$10000	

7/14/2001	Soldier Summit	Utah	1500	1.25	$2000	
6/21/2004	Brigham City	Box Elder	1400	0.01	$24000	
7/15/2004	Manila	Daggett	1315	1.25	$30000	
9/29/2004	Kanab	Kane	1550	0.01	$20000	
9/9/2005	Green River	Emery	1345	1.5	$4000	
9/21/2005	Crescent Jct	Grand	1508	0.75	$5000	
6/21/2009	Jensen	Uintah	1430	1.75	$20000	
8/6/2009	(Vel)Vernal Arpt	Uintah	1522	1.75	$100000	$40000
8/6/2009	Dutch John	Daggett	1545	1.75	$80000	
8/6/2009	Manila	Daggett	2032	1.25	$20000	
8/3/2010	Loa	Wayne	1520	1	$20000	
9/14/2013	Harrisburg Jct	Washington	1814	1	$1000	
9/17/2013	Maeser	Uintah	1755	1.75	$30000	
9/17/2013	Blanding	San Juan	1545	1.75	$20000	
9/17/2013	(4BI)Blanding Municipal Airport	San Juan	1545	1.75	$20000	
9/17/2013	Vernal	Uintah	1755	1.5	$20000	
9/22/2013	Montezuma Creek	San Juan	1251	1.5	$20000	
5/16/2014	Maeser	Uintah	1700	1.5	$20000	
9/21/2014	Cannonville	Garfield	1600	1.75	$1000	
4/28/2016	Beaver	Beaver	1230	0.25	$25000	
5/15/2016	Champlin Siding	Juab	1802	1.25	$2000	
Total					$6,533,000	$174,450

Source: NOAA, Storm Data publication of National Centers for Environmental Information
Storm Data publication of National Centers for Environmental Information, National Oceanic and Atmospheric Administration. Table 2G-8 Hail Storms by Cost $50,000 and Above

WINTER STORMS AND EXTREME COLD

Blizzard: Sustained wind or frequent gusts of 35 miles an hour or greater and considerable falling and/or blowing snow, reducing visibility to less than ¼ mile and prevailing for a period of 3 hours or longer.

Blowing Snow: Wind-driven snow that reduces surface visibility. Blowing snow can be falling snow, or snow that has already accumulated and is picked up and redistributed by strong winds. Blowing snow is usually accompanied by drifting snow.

Freeze: A period of at least four hours of air temperatures below 25 degrees F leading to ice formation in standing water and hard ground, cold enough to kill seasonal vegetation.

Ice Storm: An ice storm is used to describe occasions when damaging accumulations of ice are observed or expected during freezing rain situations.

Lake Effect Snow: Snow showers that are created when cold air passes over a large, warmer lake and picks up moisture and heat.

Frostbite: Human tissue damage caused by exposure to intense cold. Frostbite causes a loss of feeling and a white or pale appearance in extremities, such as fingers, toes, ear lobes or the tip of the nose.

Hypothermia: A rapid, progressive mental and physical collapse that accompanies the lowering of body temperature. The warning signs of hypothermia include low body temperature, uncontrollable shivering, memory loss, disorientation, incoherence, slurred speech, drowsiness and apparent exhaustion.

Commuters on I-215 Deseret News Jeffrey D. Allred

In an average year, winter weather is directly or indirectly involved in 400,000 vehicular accidents in the United States leading to 1,300 fatalities and additional loss of life caused by avalanches and exposure to cold. Annual economic losses total in the billions resulting from snow removal, road closures contributing to lost retail, wages and tax revenue, flight cancellations and delays, damage to utilities, flooding from snowmelt, and agriculture and timber damage.

The total economic impact in Utah for a 24 hour statewide winter storm is $66.36 million, including $42.81 million in lost wages and salaries and overtime, $18.26 million in lost retail sales, $3.32 million in federal taxes, and $1.98 million for state and local taxes.[5]

Ice storms can bring down trees, topple utility poles and towers and disrupt communications and power for days while utility companies work to repair the damage. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze and become slick before other surfaces.

In January 2005 a Southwest flow ahead of a Pacific storm system brought mid-level moisture from the subtropics into northern Utah. Clouds cleared out long enough on the evening of the 26th to allow for sufficient radiational cooling to take place. Several areas along the northern and central Wasatch front observed freezing rain. The ice accumulated to about one-half of an inch along the Ogden and Salt Lake Valley areas. The Ogden Bench, Sandy, and West Haven all reported ice

On January 24, 2013 a rare freezing rain event occurred in Utah. Very cold air was trapped in valley locations due to a persistent inversion when a weather disturbance brought precipitation to the area causing freezing rain and widespread travel difficulties.

Table 10. Ice Storms 1996 - 2018

Hazard Date	County	Injuries	Fatalities	Remarks
01/26/2005	Box Elder, Weber, Davis	0	0	Ice Storm
01/27/2005	Salt Lake, Tooele	0	0	Ice Storm
01/24/2013	Salt Lake, Tooele	300	0	Ice Storm
01/24/2013	Utah	73	1	Ice Storm
01/24/2013	Cache	100	0	Ice Storm

Winter storms are considered deceptive killers because most deaths are indirectly related to the storm. Fatalities occur to individuals involved in traffic accidents caused by icy roads, heart attacks brought on by the exertion of shoveling snow and hypothermia due to prolonged exposure to the cold. Of all fatalities related to ice and snow, about 70% occur in automobiles and 25% are a result of people caught out in the elements. The majority of winter storm fatalities occur in males over age 40. Fifty-percent of all exposure-related deaths are people over age 60 and more than 75% of victims are male. About 20% of winter fatalities occur inside the home, primarily when people leave space heaters on that catch fire or die of carbon monoxide poisoning from furnaces that aren't properly ventilated.[6]

Winters with above average rainfall can trigger more intense landslide debris flows.

5 https://www.ncdc.noaa.gov/billions/events/UT/1980-2018

6 https://www.nssl.noaa.gov/education/svrwx101/winter/

Freeze hazards occur when temperatures are below freezing for a sustained period of time causing harm to Utah's vulnerable agriculture, like fruit trees. Below freezing temperatures does serve a purpose in killing off some infestations, pests and pathogens during the winter months but sustained periods of freezing temperatures occurring during spring growing seasons can cause extensive crop damage. Secondary impacts of freezes include major economic impacts on farmers, farm workers, packers and shippers of agricultural products leading to increases in food prices for consumers or shortages.

No known current assessment of state vulnerability or potential losses is available at this time. Assessment of Local Vulnerability and Potential Losses Information related to community vulnerability and loss assessments may be found in Local Hazard Mitigation Plans.

Table 11. Heavy Storms by Cost Above $50,000 1962 - 2018

Hazard Date	County	Injuries	Fatalities	Property Damage	Remarks	Crop Damage
02/08/1962	Millard, Sanpete	0	0	$500,000	Rain and snow melt	
03/29/1967	Statewide	0	0	$500,000	Wind and snow	
03/21/1973	Box Elder, Weber	0	0	$500,000	Heavy wet snow	
03/25/1975	Statewide	0	0	$517,857	Heavy snowstorms	
10/18/1984	Salt Lake	20	0	$500,000	Snow	
12/18/1990	Statewide	45	7	$500,000	Heavy snow	
12/21/1990	Statewide	5	1	$5,000,000	Extreme cold	
12/29/1990	Statewide	0	0	$500,000	Extreme cold	
01/06/1993	Davis, Juab, Salt Lake, Tooele, Utah, Weber	18	1	$5,000,000	Heavy snow	
10/24/1996	Statewide	20	0	$1,000,000	Winter storm	
11/28/1996	Salt Lake & Tooele	8	0	$100,000	Heavy snow	
12/01/1996	Salt Lake	0	0	$1,000,000	Winter storm	
12/05/1996	Cache	20	0	$300,000	Heavy snow	
12/20/1996	Wasatch	3	0	$50,000	Heavy snow	
01/11/1997	Statewide	50	3	$40,000,000	Blizzard	
01/25/1997	Salt Lake, Rich	20	1	$300,000	Winter storm	
01/25/1997	Wasatch	0	0	$300,000	Winter storm	
02/02/1997	Wasatch, Hunstville, Park City	5	0	$50,000	Heavy snow	
02/05/1997	Salt Lake & Tooele	10	0	$200,000	Heavy snow	
02/17/1997	Salt Lake & Tooele	4	0	$80,000	Heavy snow	
02/26/1997	Statewide	20	0	$500,000	Heavy snow	
03/02/1997	Statewide	30	0	$500,000	Heavy snow	
03/31/1997	Statewide	60	3	$2,000,000	Winter storm	
04/04/1997	Salt Lake & Tooele	2	0	$50,000	Heavy snow	
12/07/1997	Box Elder, Weber, Davis	0	1	$200,000	Winter storm	
12/23/1997	Utah	0	0	$80,000	Winter storm	
01/11/1998	Salt Lake, Rich	0	4	$140,000	Winter storm	$20,000
01/11/1998	Box Elder	0	0	$140,000	Winter storm	
01/19/1998	Cache	0	0	$30,000	Winter storm	$5,000
02/07/1998	Cache	20	0	$80,000	Heavy snow	$20,000
02/21/1998	Statewide	40	0	$900,000	Winter storm	$200,000
02/21/1998	Cache	0	0	$500,000	Winter storm	
03/05/1998	Cache	0	0	$95,000	Winter storm	$5,000

03/17/1998	Washington	0	0	$15,000	Winter storm	$5,000
03/27/1998	Box Elder, Weber, Davis	5	0	$80,000	Heavy snow	$6,000
04/12/1998	Cache	0	0	$30,000	Winter storm	$3,000
05/08/1998	Roy	0	0	$80,000	Heavy rain	$2,000
06/07/1998	Orem	0	0	$260,000	Heavy rain	$10,000
06/09/1998	West Jordan	0	0	$1,500,000	Heavy rain	$10,000
10/15/1998	Iron	0	0	$100,000	Winter storm	
07/24/1998	Kimball Junction	0	0	$100,000	Heavy rain	$30,000
11/08/1998	Statewide	10	0	$500,000	Winter storm	
11/08/1998	Beaver	0	0	$500,000	Winter storm	
12/04/1998	Box Elder, Weber, Davis	0	0	$50,000	Winter storm	
12/19/1998	Washington	0	0	$100,000	Winter storm	
01/26/1999	Box Elder, Weber, Davis	0	0	$50,000	Winter storm	
04/01/1999	Weber, Morgan, Summit	0	0	$50,000	Winter storm	
04/01/1999	Salt Lake, Tooele	0	0	$100,000	Winter storm	
12/02/1999	Utah, Juab	2	0	$200,000	Heavy snow	
11/14/2000	Box Elder, Weber, Davis	6	0	$50,000	Heavy snow	
12/15/2000	Box Elder, Weber, Davis	1	1	$20,000	Winter storm	
04/07/2001	Salt Lake, Tooele	10	1	$100,000	Heavy Snow	
11/22/2001	Statewide	0	0	$560,000	Winter storm	
11/22/2001	Salt Lake	0	0	$300,000	Winter storm	
11/24/2001	Statewide	1	0	$600,000	Winter storm	$50,000
11/24/2001	Salt Lake	0	0	$200,000	Winter storm	
11/24/2001	Box Elder, Weber, Davis	0	0	$100,000	Winter storm	
11/24/2001	Rich, Cache, Weber, Morgan	0	0	$100,000	Winter storm	
11/24/2001	Weber, Morgan, Summit	0	0	$100,000	Winter storm	
11/24/01	Utah, Juab	0	0	$100,000	Winter storm	
11/29/2001	Juab	1	2	$20,000	Winter storm	
11/29/2001	Millard	1	12	$50,000	Winter storm	
12/02/01	Salt Lake	0	0	$50,000	Winter storm	$10,000
01/27/2002	Statewide	40	0	$720,000	Winter storm	
01/27/2002	Salt Lake	0	0	$500,000	Winter storm	
01/27/2002	Box Elder, Weber	0	0	$100,000	Winter storm	
03/07/2002	Salt Lake, Tooele	35	2	$140,000	Winter storm	
12/29/2002	Salt Lake, Tooele	0	0	$100,000	Winter storm	
11/21/2003	Statewide	0	0	$550,000	Winter storm	
11/21/2003	Salt Lake	0	0	$200,000	Winter storm	
11/21/2003	Box Elder	0	0	$150,000	Winter storm	
11/21/2003	Utah	0	0	$150,000	Winter storm	
12/25/2003	Statewide	0	0	$1,500,000	Winter storm	
12/25/2003	Box Elder	0	0	$500,000	Winter storm	
12/25/2003	Salt Lake	0	0	$400,000	Winter storm	
12/25/2003	Utah	0	0	$300,000	Winter storm	
12/25/2003	Cache	0	0	$100,000	Winter storm	
12/28/2003	Box Elder, Weber	0	0	$100,000	Winter storm	
12/28/2003	Salt Lake Tooele	0	0	$100,000	Winter storm	

11/27/2004	Rich, Cache, Weber, Morgan	6	0	$250,000	Heavy snow	
03/24/2005	Box Elder	7	1	Unknown	Winter storm	
03/24/2005	Millard	1	1	Unknown	Winter storm	
11/09/2012	Salt Lake, Tooele, Washington	0	0	$100,0000	Winter storm	
11/09/2012	Utah	0	0	$70,000	Winter storm	
11/09/12-11/11/12	Statewide	0	0	$170,000	Heavy snow	
05/10/2014	Cache	0	0	$100,000	Winter storm	

"Hazards & Vulnerability Research Institute (2011). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

**Data reflects Hazard Events until 2009.*

"Storm Data publication of National Centers for Environmental Information, National Oceanic and Atmospheric Administration

Table 12. Dense Fog Events 1996 - 2018

Dense Fog Events in Utah 1996 - 2018					
Date	Location	Time	Fatalities	Injuries	Property Damage
1/4/2002	Grand Flat And Arches	2100	0	0	
2/3/2002	Box Elder, Tooele, Salt Lake, Utah	2300	3	3	$500000
12/1/2002	Eastern Uinta Basin	2300	0	0	
12/2/2002	Eastern Uinta Basin	2000	0	0	
12/3/2002	Eastern Uinta Basin	1800	0	0	
12/4/2002	Eastern Uinta Basin	2130	0	0	
12/30/2002	Grand Flat And Arches	400	0	0	
12/30/2002	Eastern Uinta Basin	2100	0	0	
1/1/2003	Grand Flat And Arches	N/A	0	0	
1/1/2003	Eastern Uinta Basin	N/A	0	0	
1/1/2003	Eastern Uinta Basin	1900	0	0	
1/2/2003	Grand Flat And Arches	400	0	0	
1/5/2003	Eastern Uinta Basin	2000	0	0	
1/6/2003	Eastern Uinta Basin	1700	0	0	
1/7/2003	Eastern Uinta Basin	2300	0	0	
1/8/2003	Salt Lake, Tooele	500	0	14	$500000
1/9/2003	Eastern Uinta Basin	N/A	0	0	
1/10/2003	Salt Lake, Tooele	2100	2	1	$200000
1/16/2003	Eastern Uinta Basin	N/A	0	0	
1/29/2003	Eastern Uinta Basin	2230	0	0	
11/27/2003	Utah, Juab	800	1	2	$20000
12/31/2003	Grand Flat And Arches	N/A	0	0	
1/1/2004	Grand Flat And Arches	N/A	0	0	
1/8/2004	Grand Flat And Arches	700	0	0	
1/9/2004	Grand Flat And Arches	N/A	0	0	
1/11/2004	Eastern Uinta Basin	1800	0	0	

1/15/2004	Southeast Utah	2300	0	0	
11/23/2004	Grand Flat And Arches	N/A	0	0	
12/13/2004	Southeast Utah	2330	0	0	
12/14/2004	Southeast Utah	1930	0	0	
12/29/2004	Eastern Uinta Basin	1900	0	0	
1/21/2005	Eastern Uinta Basin	1500	0	0	
1/28/2005	Eastern Uinta Basin	N/A	0	0	
2/12/2005	Box Elde, Weber, Davis	400	0	12	$32000
2/12/2005	Salt Lake, Tooele	400	0	0	
2/13/2005	Eastern Uinta Basin	200	0	0	
2/12/2007	Eastern Uinta Basin	2040	0	0	
12/15/2007	Eastern Uinta Basin	N/A	0	0	
1/18/2009	Eastern Uinta Basin	N/A	0	0	
1/19/2009	Eastern Uinta Basin	N/A	0	0	
1/20/2009	Eastern Uinta Basin	N/A	0	0	
1/24/2009	Eastern Uinta Basin	N/A	0	0	
1/25/2009	Eastern Uinta Basin	N/A	0	0	
2/8/2009	Eastern Uinta Basin	200	0	0	
2/24/2009	Grand Flat And Arches	400	0	0	
12/13/2009	Grand Flat And Arches	2000	0	0	
12/18/2009	Grand Flat And Arches	1800	0	0	
12/19/2009	Eastern Uinta Basin	200	0	0	
12/23/2009	Grand Flat And Arches	500	0	0	
12/31/2009	Eastern Uinta Basin	1700	0	0	
1/1/2010	Eastern Uinta Basin	N/A	0	0	
1/19/2010	Eastern Uinta Basin	1700	0	0	
1/28/2010	Grand Flat And Arches	1530	0	0	
1/28/2010	Southeast Utah	1900	0	0	
1/28/2010	Eastern Uinta Basin	2330	0	0	
1/29/2010	Grand Flat And Arches	1700	0	0	
2/2/2010	Grand Flat And Arches	2000	0	0	
2/3/2010	Eastern Uinta Basin	100	0	0	
2/3/2010	Grand Flat And Arches	2000	0	0	
2/4/2010	Eastern Uinta Basin	630	0	0	
2/4/2010	Grand Flat And Arches	700	0	0	
2/4/2010	Eastern Uinta Basin	2200	0	0	
2/8/2010	Grand Flat And Arches	100	0	0	
2/16/2010	Grand Flat And Arches	230	0	0	
2/16/2010	Grand Flat And Arches	2100	0	0	
2/16/2010	Eastern Uinta Basin	2300	0	0	
2/19/2010	Southeast Utah	700	0	0	
3/14/2010	Southeast Utah	1700	0	0	
3/14/2010	Canyonlands / Natural Bridges	1930	0	0	
3/14/2010	Tavaputs Plateau	2200	0	0	

3/15/2010	Grand Flat And Arches	300	0	0	
12/23/2010	Eastern Uinta Basin	2000	0	0	
2/4/2013	Eastern Uinta Basin	530	0	0	
2/7/2013	Eastern Uinta Basin	1700	0	0	
11/24/2013	Grand Flat And Arches	N/A	0	0	
11/30/2013	Southeast Utah	N/A	0	0	
12/19/2013	Eastern Uinta Basin	N/A	0	0	
12/20/2013	Canyonlands / Natural Bridges	N/A	0	0	
12/21/2013	Eastern Uinta Basin	1700	0	0	
12/4/2014	Southeast Utah	2330	0	0	
1/1/2015	Southeast Utah	N/A	0	0	
1/11/2015	Southeast Utah	700	0	0	
1/14/2015	Eastern Uinta Basin	245	0	0	
1/14/2015	Canyonlands / Natural Bridges	330	0	0	
1/16/2015	Southeast Utah	2300	0	0	
1/17/2015	Eastern Uinta Basin	2030	0	0	
1/19/2015	Eastern Uinta Basin	200	0	0	
1/20/2015	Eastern Uinta Basin	1800	0	0	
1/30/2015	Eastern Uinta Basin	2330	0	0	
1/31/2015	Southeast Utah	1900	0	0	
2/1/2015	Southeast Utah	N/A	0	0	
12/22/2015	Eastern Uinta Basin	N/A	0	0	
12/31/2015	Eastern Uinta Basin	730	0	0	
1/7/2016	Grand Flat And Arches	430	0	0	
1/7/2016	Eastern Uinta Basin	2000	0	0	
1/8/2016	Grand Flat And Arches	900	0	0	
1/13/2016	Southeast Utah	300	0	0	
1/25/2016	Eastern Uinta Basin	500	0	0	
1/25/2016	Eastern Uinta Basin	1930	0	0	
1/27/2016	Eastern Uinta Basin	300	0	0	
2/4/2016	Grand Flat And Arches	2100	0	0	
12/23/2016	Southeast Utah	700	0	0	
12/23/2016	Grand Flat And Arches	830	0	0	
12/23/2016	Canyonlands / Natural Bridges	900	0	0	
1/1/2017	Southeast Utah	100	0	0	
1/13/2017	Eastern Uinta Basin	1900	0	0	
2/3/2017	Eastern Uinta Basin	700	0	0	
1/7/2018	Canyonlands / Natural Bridges	2230	0	0	
1/10/2018	Eastern Uinta Basin	330	0	0	
Total			6	32	$1,250,000

Source: NOAA, Storm Data publication of National Centers for Environmental Information

Table 13. Utah Major Wind Chill Events 1996 - 2018

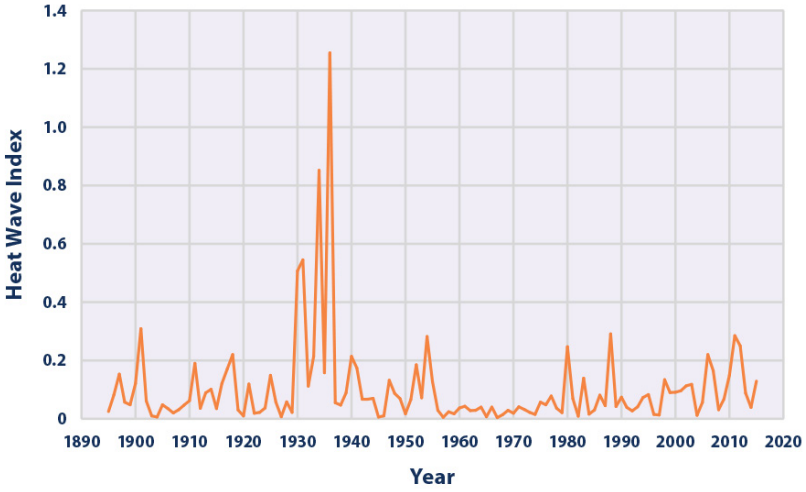
Utah Major Wind Chill Events 1996 - 2018				
Date	Location	Property Damage	Crop Damage	Comments
12/21/1998	Statewide	$20,000		Bitterly cold arctic air swept over the state, bringing sub-zero readings to most areas. The coldest readings recorded during the arctic blast were -40 at Greenville, -34 at Roosevelt, -30 in Milford, -29 at Woodruff, -27 at Manti, -26 at Randolph, -25 in Joseph and Delta, -24 in Richfield and -23 at Duchesne.
4/1/1999	Utah'S Dixie and Zion National Park		$100,000	
11/30/2004	Beaver, Iron, Salt Lake, Tooele			Clear skies and fresh snow cover combined to produce record breaking cold temperatures in portions of southwest and north central Utah. The following cities and towns reported record cold for the morning of November 30th: Cedar City -6 F, Milford -4 F, Ferron -2 F, Fillmore 3 F, and Spanish Fork 2 F.
3/26/2005	Statewide			Very cold air behind a departing winter storm allowed temperatures to plunge to record levels. Cedar City broke a 34 year record for the date with a low of 15 degrees. Randolph in northern Utah dropped to a daily record of 10 degrees.
12/4/2005	Eastern Utah			Arctic Air spilled down mainly into the lower elevations of eastern Utah in early December and remained trapped for about two weeks. Some of the coldest temperatures recorded in eastern Utah during this time period included minus 21 degrees at the Flaming Gorge dam, minus 17 degrees at Manila, minus 6 degrees at Vernal, and minus 1 degree just east of Monticello.
12/9/2013	Northern Wasatch Front (Zone)	$40,000		Following a deep winter storm, very cold temperatures settled into Utah. Some property damage was reported due to these temperatures, primarily across the northern Wasatch Front.

Source: NOAA, Storm Data publication of National Centers for Environmental Information

EXTREME HEAT

Heat waves do not cause damage or elicit the immediate response that floods, fires, earthquakes and other disasters do but they can be more deadly than other severe weather. Heat is the leading weather-related killer in the United States, responsible for, on average, 131 fatalities each year in the US. In extreme heat and high humidity evaporation is slowed and the body must work overtime to maintain a normal temperature and avoid heat-related illnesses and death.

Figure 3. Heat Wave Index 1895 - 2015



US Annual Heat Wave Index 1895 – 2015[7]

7 https://www.epa.gov/climate-indicators/climate-change-indicators-high-and-low-temperatures

Figure 4. Changes in Unusually hot temperatures in the US 1948 - 2015[8]

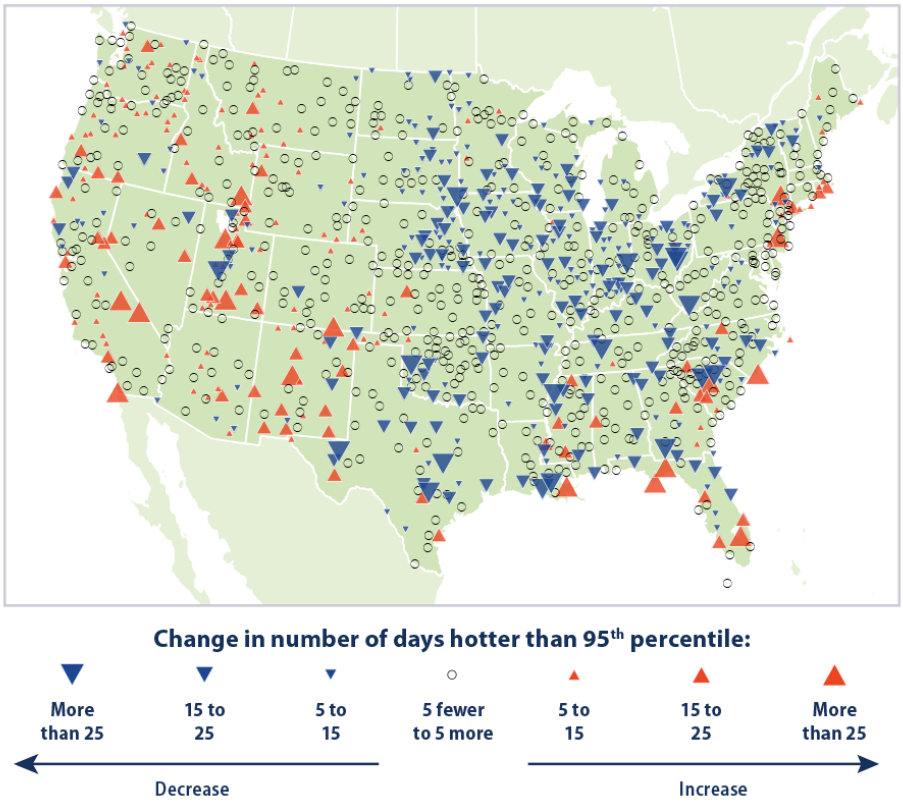
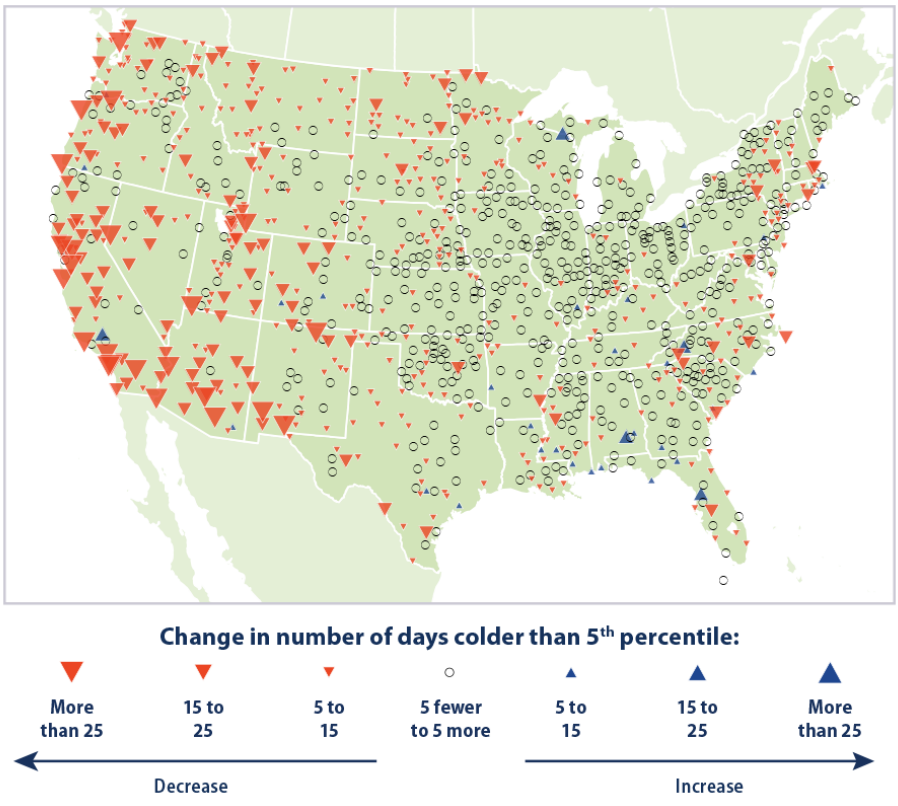


Figure 5. Change in Unusually Cold Temperatures in the US 1948 – 2015



8 https://www.epa.gov/climate-indicators/climate-change-indicators-high-and-low-temperatures

Figure 6. Mean Temperature Departures from Average Jan – May 2017

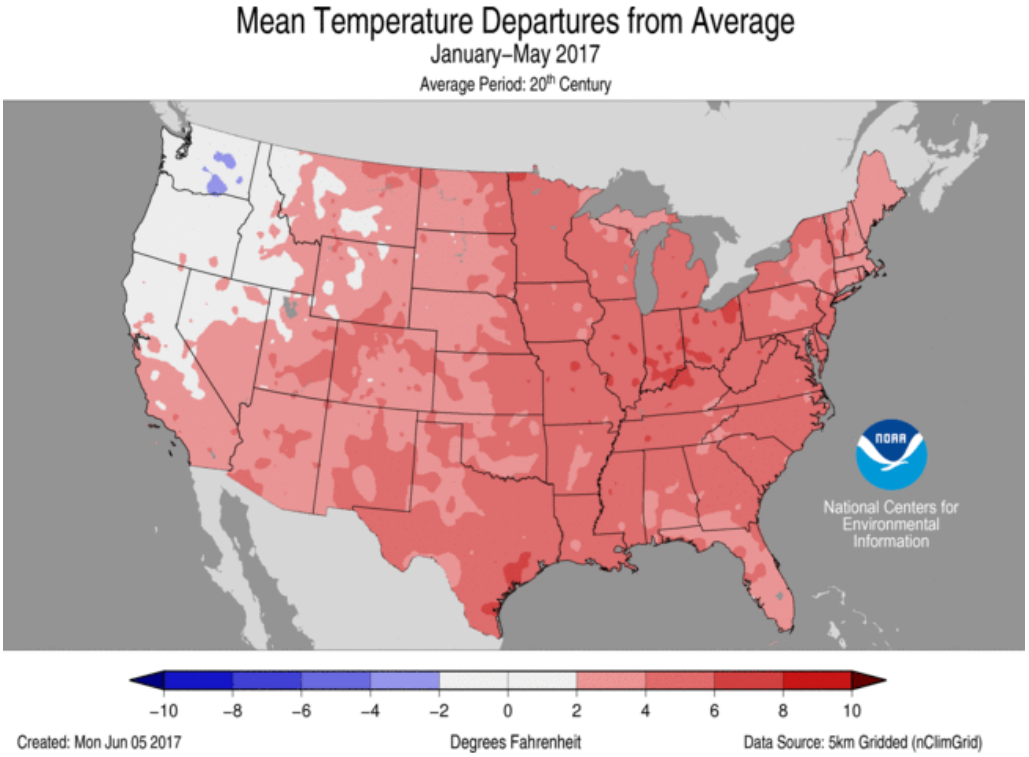
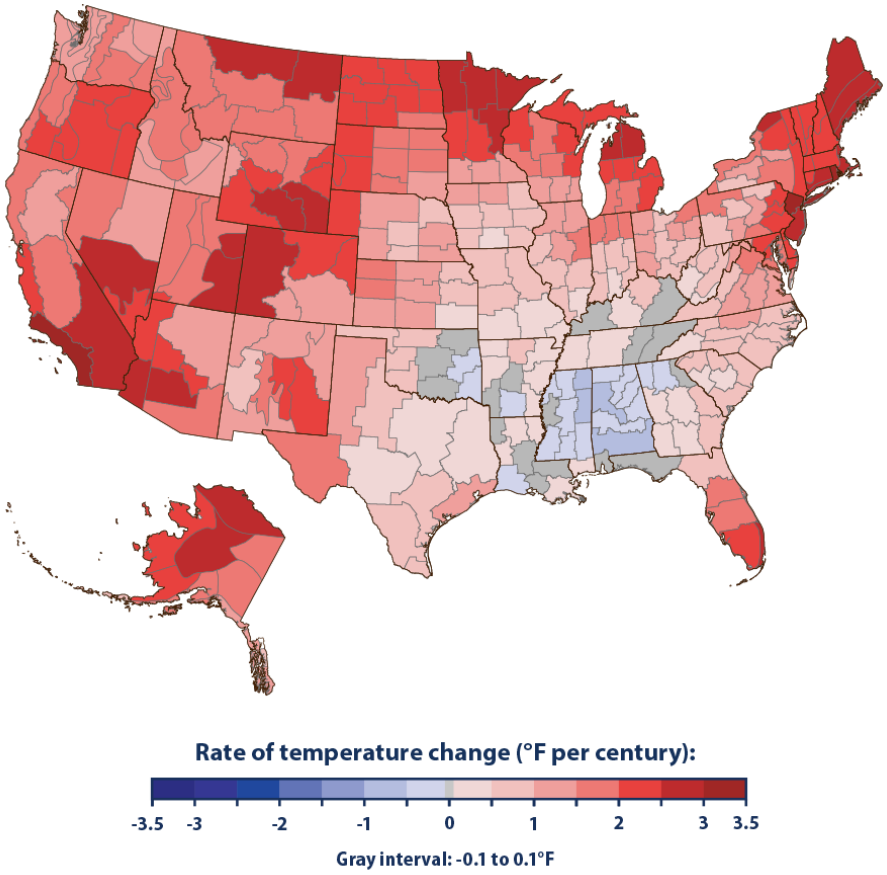


Figure 7. Rate of Temperature Change in the US 1901 – 2015[9]



9 https://www.epa.gov/climate-indicators/climate-change-indicators-us-and-global-temperature

Groups typically identified as “heat sensitive” or “heat vulnerable” include the elderly and children, people on certain medications and/or with preexisting conditions which make them sensitive to heat, outdoor workers and those exercising or doing strenuous activities, people without a reliable source of cooling and/or water and people not acclimated to the high temperatures. Additionally, some economic sectors are also affected by increasing high temperatures such as individuals employed in the energy and transportation industries.

Figure 8. Statewide Average Temperature Ranks Jan – May 2017

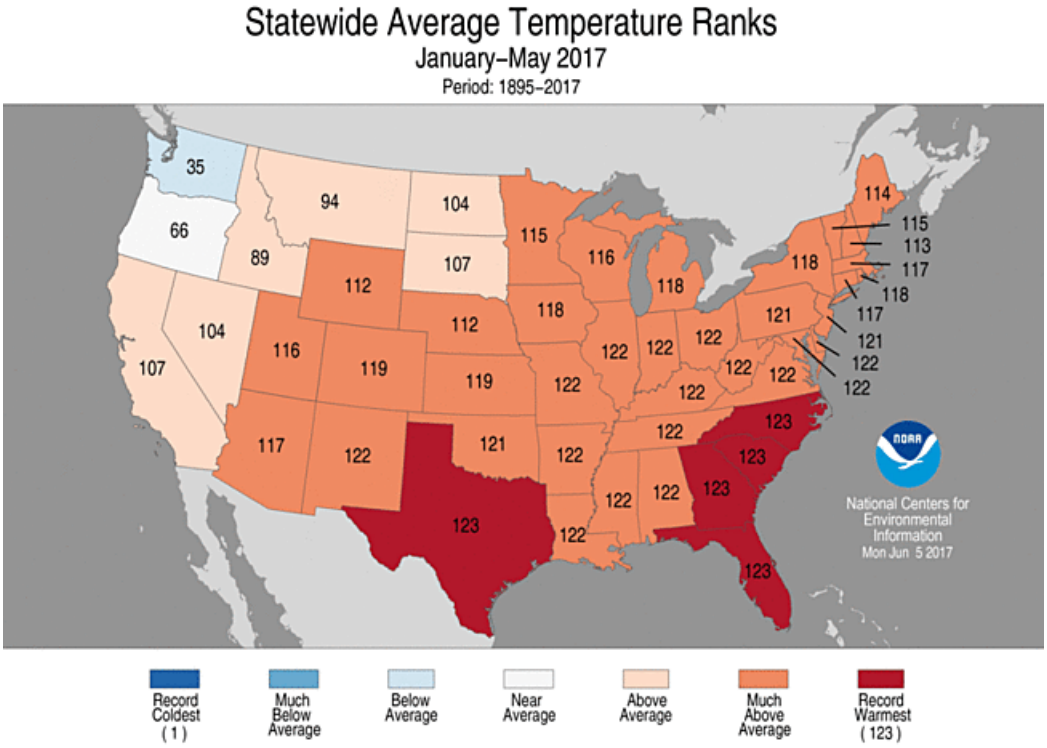
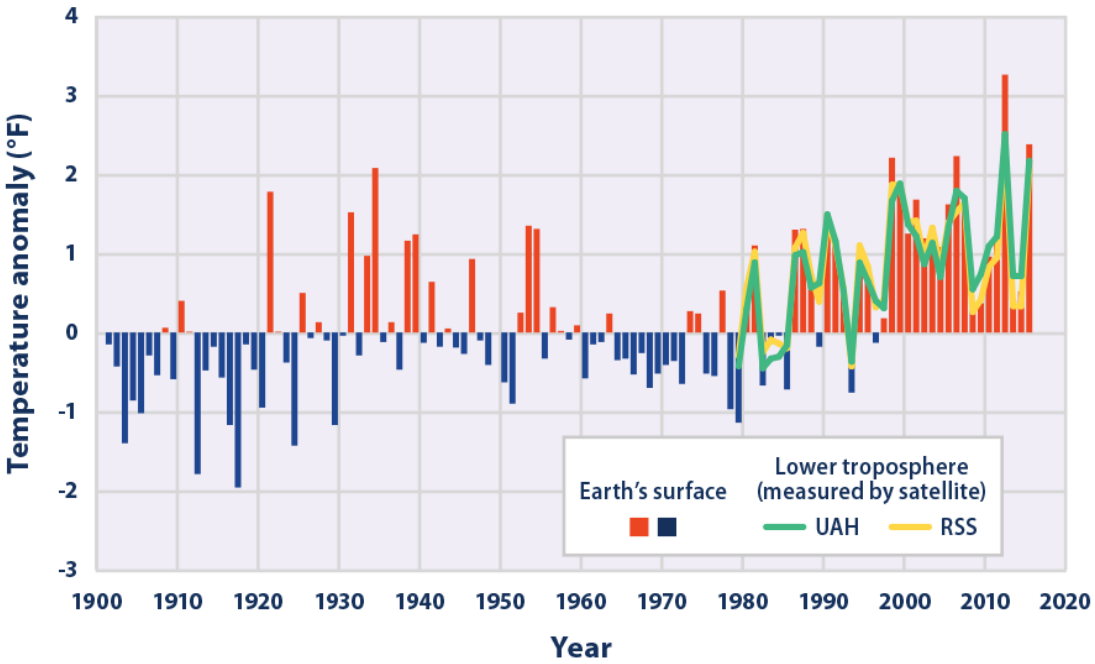


Figure 9. Temperature Anomalies



[10]*NOAA 2016*

10 https://www.epa.gov/climate-indicators/climate-change-indicators-us-and-global-temperature

Several factors influence the impacts of a heat event including how significantly above normal high temperatures are, the time of year and the duration of the unusual heat. When the Heat Index is 90°F, heat exhaustion is possible with prolonged exposure and/or physical activity. Heat exhaustion occurs when the body is dehydrated resulting in an imbalance of electrolytes. Symptoms include headache, nausea, dizziness, cool and clammy skin, flushed face, cramps, weakness, rapid pulse and profuse perspiration. First aid to treat heat exhaustion involves moving to a cooler spot, wrapping the individual in a cool, wet sheet, calling for medical assistance and giving the patient drinking water with a small amount of salt added (one teaspoon per quart). Without intervention, heat exhaustion can lead to collapse and heatstroke if perspiration is impeded as the body overheats causing confusion, coma and death.

Heat events do not get emergency disaster declaration status, although they can be deadly for human populations and devastating for agriculture.

Any mitigation efforts aimed at reducing heat wave losses should focus on reducing social isolation, cooling built environments and avoiding power outages caused by the increased use of air conditioners. Upgrading water and power infrastructure is one strategy for extreme heat mitigation. Outreach to vulnerable populations to ensure they have access to resources is also an effective strategy.

People with developmental or intellectual disabilities including cerebral palsy, epilepsy, and autism. Those with vision or hearing impediments, mobility limitations, chronic health conditions like diabetes, arthritis, dialysis and asthma, adults with age-related limitations and children are all more susceptible to heat events. Animals including domestic pets, livestock and poultry are also susceptible to extreme heat and can have economic implications for Utah's agricultural economy. As temperatures rise, Utahans will face greater risk of death from dehydration, heat stroke/exhaustion, heart attack, stroke and respiratory distress caused by extreme heat. By mid-century, extreme heat events in urban centers could cause two to three times more heat-related deaths than occur today. By 2100, hotter temperatures are expected throughout the state, with an increase of 3 to 5.5°F if the state adopts lower emissions standards and 8 to 10.5°F with current emission standards.

No current assessment of state vulnerability or potential extreme heat hazard losses is available at this time.

Table 14. Heat Fatality Events 2005 – 2018

Date	Area	Fatalities	Narrative
7/12/2005	GLEN CANYON/ LAKE POWELL	1	Excessive heat likely led to the death of a hiker in Glen Canyon. Temperatures reached 110 degrees during the afternoon.
7/1/2013 - 7/4/2013	SOUTH CENTRAL UTAH	3	Hot temperatures contributed to the deaths of three hikers in southern Utah. On July 3, an elderly couple from California received permits to hike The Wave, a popular destination in far southern Utah. Both victims were found on the morning of July 4, and it is believed that they died during the afternoon of the 3rd, when temperatures were close to 100 degrees. The third victim, a 35-year-old female from Denver, passed away on the 4th of July. She was hiking with a friend near Spooky Gulch in the Grand Staircase-Escalante National Monument. The two women became lost for a couple hours, before other hikers found them and helped them back toward the trailhead. The victim was struggling in the heat and ran out of water near the trailhead, so her friend ran to find help. When she returned, the victim had no pulse, and all efforts to revive her were unsuccessful.
7/22/2013	SOUTH CENTRAL UTAH	1	A 27-year-old Arizona woman was hiking The Wave with her husband on July 22, when they got lost and spent several hours trying to find their way back to their vehicle. Around 2 p.m., the woman collapsed, and her husband left to get help. When help arrived, she was already in cardiac arrest, and she passed away that afternoon, as emergency responders were unable to revive her.
8/15/2013	SAN RAFAEL SWELL	1	A 56-year-old woman and her husband were hiking the Brimhall Double Bridge Trail in Capitol Reef National Park on August 15, when the woman became ill. The man went to get help, but she had passed away by the time medical personnel arrived. The cause of death was heat exhaustion, with temperatures exceeding 90 degrees. The time listed is approximate.
7/31/2018	SOUTH CENTRAL UTAH	1	A 49-year old man from Belgium was hiking The Wave with his son when he became disoriented. His son went toward the trailhead to find help. When rescuers found the victim, he was already deceased. Temperatures were in the 90s.

"Storm Data publication of National Centers for Environmental Information, National Oceanic and Atmospheric Administration

CLIMATE-RELATED HAZARDS

Weather: the state of the atmosphere at a given place and time.

Climate: the weather conditions prevailing in an area or region over a long period of time.

Often the terms "global warming" and "climate change" are used interchangeably. Global warming refers to the warming of Earth's temperatures due to an increase in greenhouse gas concentrations. Increasing temperatures are a direct consequence of increasing greenhouse gas concentrations. However, warming temperatures can cause disruptions to Earth's weather patterns. "Climate change" is the disruption of Earth's weather patterns because of warming temperatures. Warming temperatures are important to global climate, but a warmer Earth causes a series of complex changes to weather patterns.

Severe weather events will increase with climate change. Future increases in severe weather events will be due to changes in weather patterns and changes in extreme precipitation. Extreme precipitation events are projected to increase because a warmer atmosphere holds more water and the increase in water vapor in the atmosphere will cause more intense rainfall events. While projections of changes in the North American monsoon, which affects southern and eastern Utah are unclear, more water vapor in the atmosphere will certainly cause more intense rainfall events. Changing weather patterns in the Pacific Ocean may alter how winter storms impact Utah. One such impact is a change in winter storm cycles that impact Utah; atmospheric rivers- or "pineapple express"- type storms have the potential to create significant changes in winter precipitation patterns.

AIR POLLUTION

The Utah Department of Environmental Quality tracks Utah's air quality for all counties and issues daily reports on the air quality index for particulate matter and ozone. There are six classifications good, moderate, unhealthy for sensitive groups, unhealthy, very unhealthy and hazardous and three forecasts unrestricted, voluntary and mandatory action. DEQ works with UDOT to use freeway message boards to encourage commuters to TravelWise on voluntary and mandatory action days by utilizing public transit, consolidating trips and issuing red burn day restrictions. According to Utah Clean Air vehicles are the primary source of pollutants accounting for 48% of emissions, homes and buildings contribute 39% and industry 13%.[11] DAQ has created a pollution reduction State Implementation Plan (SIP) for Utah proposing rules to reduce emissions. In 1998 the EPA implemented federal standards to reduce emissions from consumer products.

Air pollution is much more hazardous to the health of Utahns than other threats, especially in Utah's counties with the highest populations.

ENERGY SHORTAGE HAZARDS

Rocky Mountain Power reports there have been no major severe weather related blackouts in Utah since 1981. Rolling blackouts are a last-resort measure by an electric utility company to avoid a total blackout of the power system when the demand for electricity exceeds the power supply capability of the network. Heat waves and rolling blackouts are becoming increasingly common in neighboring states like California. In July 2006 a heat storm event affected most Western states, producing record energy demand levels in California, Arizona and Utah. Secondary impacts of energy shortages most often affect vulnerable populations including individuals who rely on electric powered life-saving medical equipment. During periods of extreme heat emergencies the elderly and the very young are also more vulnerable to the loss of cooling systems requiring power sources. With climate warming, higher costs from increased demand for cooling homes and businesses in the summer are expected to outweigh the decreases in heating costs in the cooler seasons. Educating the public about power usage and pleas for energy conservation can mitigate rolling black-outs and help prevent traffic, flight and public transportation disruptions.

The goal of Utah's Energy Commission should be to assist local governments in creating plans to become more energy resilient by upgrading aging energy infrastructure, incentivizing home and business owners to implement energy efficiency measures and addressing energy interdependency and resiliency. This can be done through building codes, zoning ordinances, climate action plans, energy assurance plans and growth and development projections. Encouraging energy efficient green building techniques and the use of renewable resources will reduce energy consumption during the construction process and throughout the life of a

11 https://www.ucair.org/sources-of-emissions/

structure. The Million Solar Roofs Initiative Small Grant Program for State and Local Partnerships sponsored by the U.S. Department of Energy (DOE) in 2004 is one example of incentives at the national level. The DOE initiative provided grant opportunities of up to $50,000 to state and local partnerships to reduce market Barriers to the use of solar energy systems. In 2016 Utah was ranked sixth in the nation for total solar capacity installed.[12]

Municipal codes with mandatory compliance of building codes ensure that construction in a community meets minimum standards required for public health and safety and for quality workmanship by requiring facilities to be adequately prepared for power disruptions. Local governments can use zoning change requests, permit applications and economic development plans to identify modification of a building's use which could significantly affect electrical service requirements. Zoning plays a role in determining the location of a site for electric power facilities, including power plants, transmission lines, and substations. All electric power companies develop projections of long-term demand as a starting point for planning the expansion of electric power generation, transmission, and distribution facilities.

9.2 Assessment of Local Severe Weather Vulnerability and Potential Losses

An assessment of LHMPs was conducted which examined how each jurisdiction ranked the frequency and severity of severe weather hazards. A map was created that combines the frequency and severity ranking for every county in Utah. This map shows each county's perceived vulnerability of severe weather based on the reporting in the LHMPs, but it does not show actual vulnerability to severe weather.

It is very difficult to estimate potential losses by jurisdiction for severe weather. Several factors limit researcher's ability to determine potential losses including:

- Lack of location research
- Most hazards are tied to weather and cannot be predicted by location
- Limited GIS data is available for severe weather in Utah.

Severe weather hazards can do extensive damage to property and crops and occur at random times in all areas of the state, with the exception of avalanches.

When considering dollar losses in the calculation of jurisdictional vulnerability, a key variable is the value of the human built environment and population. For that reason, the more populous counties along the Wasatch Front including Salt Lake, Davis, Weber, Tooele, and Utah County experience greater vulnerability.

Map 3. Severe Weather Hazard Rankings from LHMPs

12 https://www.ksl.com/?sid=43583920&nid=1012

9.3 Assessment of State Severe Weather Vulnerability and Potential Losses

With the exception of avalanches and tornadoes, weather-related hazards typically cause very little damage to state owned facilities. The August 1999 tornadoes in Salt Lake City tracked just east of the state capitol breaking windows, downing trees and doing extensive damage to several state buildings in the capitol complex. All of the facilities in the tornadoes' path shared an equal risk of being damaged by the severe winds. Updated hazard building codes that incorporated advances in science and engineering protected newer buildings that proved to be more resistant to the forces of severe weather.

1999 Salt Lake Tornadoes damage

Table 15. Total Number of State-Owned Facilities and Insured Value

County	Count Facilities	Insured Value of Facilities
Beaver	35	$41,032,093
Box Elder	200	$298,041,925
Cache	613	$3,340,693,369
Carbon	113	$162,484,250
Daggett	20	$3,415,881
Davis	278	$1,393,256,017
Duchesne	72	$37,934,210
Emery	108	$41,071,459
Garfield	59	$20,808,298
Grand	81	$62,763,853
Iron	224	$490,154,483
Juab	41	$13,469,125
Kane	51	$15,679,404
Millard	78	$94,808,959
Morgan	48	$25,152,828
Piute	23	$4,841,000
Rich	84	$11,160,077
Salt Lake	1,463	$7,274,528,270
San Juan	111	$111,325,088
Sanpete	204	$437,926,899
Sevier	135	$209,506,871
Summit	128	$158,297,671
Tooele	89	$296,471,019
Uintah	117	$262,341,461
Utah	577	$2,272,452,584
Wasatch	178	$104,105,879
Washington	215	$620,545,353
Wayne	33	$4,730,187
Weber	317	$1,267,926,750
Total	5,695	$19,076,925,263

Source: Utah Automated Geographic Reference Center (state facility data)

Utah's vulnerability to severe weather and hazards places state assets and resources at risk and threatens Utah's economy because millions of people rely on state facilities and their continuity. To some extent, all of these facilities are vulnerable to severe weather. The level of risk is dependent on location, construction type, height and age.

Table 15 shows all of the state-owned facilities in each county and their total insured values which exceed $24 billion. Counties at highest risk of loss from severe weather include Salt Lake, Cache, Utah, Davis, and Weber counties.

Severe weather can strike anywhere in Utah, at any time and any place. More data on severe weather hazards is needed to gain a better understanding of the state's severe weather vulnerability. Counties that are better prepared will be less vulnerable when faced with a severe weather event.

9.4 Mitigation Efforts for Severe Weather Hazards

Tornadoes are monitored by NOAA and the National Weather Service that issue warning announcements to local emergency management agencies and to the media through the Federal Emergency Management Agency's Integrated Public Alert and Warning System.

Tornadoes mitigation is achieved through the enforcement of wind engineering design, building codes and construction standards. If windstorms increase in number and intensity in the future there will be a substantial impact on future building codes provisions, landscape design and maintenance and power line and pole design. At this time there are no additional strategies identified to prevent or mitigate tornado hazards.

The state also has the capacity to send alerts to televisions, cell phones, freeway message boards, social media, sirens and weather radios to warn the public about severe weather.

Since 2006 Utah's Be Ready outreach campaign has helped numerous families, businesses, schools and communities take action to increase their emergency preparedness and become better prepared to respond to and recover from disasters. The bereadyutah.gov website has tips on creating emergency plans, 72 hour kits, preparedness information and free trainings available to the public. Utah's Be Ready team also provides free preparedness presentations to groups and organizations across the state, participates in numerous fairs and conferences, hosts the Utah Prepare Expo and organizes an annual statewide earthquake drill with over one million participants and a Prep on the Hill day for state legislators.

Creating a Best Practices Hazard Mitigation Strategy aligning local mitigation actions with Utah's hazard mitigation strategies is an ongoing process. Whenever possible, state and federal agencies should combine efforts and respond to severe weather related disasters in a Joint Hazard Mitigation Branch office, following the protocol established by California during their 2017 severe winter storm episode. Joint branch teams can work together to develop a strategy to enhance and expand hazard mitigation technical assistance to local jurisdictions.

The strategy has four principal elements and defined actions to be taken by each element. The following is a list of each element and some of the actions that should be taken by each branch to support local capabilities:

- Hazard Mitigation Grants and Planning: Coordinate with Public Assistance (PA) and determine immediate needs projects which would be first priority for HMGP funding received under this disaster. The group should work together to solicit immediate needs projects during applicant briefings and conducted outreach in declared counties to determine if any additional prior local hazard mitigation project requests could be funded. They should also provide prioritized technical assistance and training outreach efforts to counties with declared disasters, focusing on the counties without approved LHMPs.

- Hazards Performance and Analysis: Execute an advanced losses avoided analysis to conduct a comprehensive study of the mitigation effectiveness of projects within declared counties, as well as an analysis of the compounding effects of economic and climatologic changes over time. This effort is intended to support the declared counties with conducting mitigation project performance assessments.

- Flood Management and Insurance: Serve as point of coordination and resource on local floodplain management regulations and enforcement and all hazards insurance; promote community participation in the National Flood Insurance Program (NFIP); and ensure compliance with NFIP regulations in disaster recovery.

- Community Education and Outreach: Efforts by this element will be coordinated between FEMA and DEM, as needed.

For additional severe winter weather mitigation ideas FEMA has published "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards" on their website *http://www.fema.gov/library/viewRecord.do?id=6938*.

OPPORTUNITIES FOR ENHANCED ENERGY SHORTAGE HAZARD MITIGATION

Energy strategies could include (1) an increase in energy efficiency efforts in climate vulnerable areas, (2) assessment of environmental impacts from changes in climate to siting and relicensing of new energy facilities (3) better assessment and management of changing weather conditions variability (4) creation of statewide renewable energy goals.

Changes in weather conditions and a desire to decrease national dependence on foreign oil supply could be addressed with the development of low-cost non-fossil biodiesel fuels and efficient alternative energy sources like solar and wind power. State and local decision makers could create policies and offer incentives to encourage energy conservation efforts.

Predicted increases in heat waves and increasingly severe winter storms will put greater strain on Utah's electricity infrastructure.