Be Prepared!

Montana Hazardous Weather Guide

Foreword by Governor Judy Martz

Montana is a spectacular state and a great place to call home. Diverse in its topography and vast in size, the Treasure State boasts a neighborhood that reaches from border to border. While we marvel at our resources, we are well aware of our hazards.

The events of September 11, 2001 have brought a much greater sense of vigilance to our state regarding our stance on terrorism, yet we continue to address those hazards that have long posed a threat to Montanans: earthquakes, fires and floods. But the most common, the most impacting and even the most costly hazard we routinely face is Montana's weather.

Our weather is among the most extreme in the nation. It has presented us with challenges for as long as people have lived in our great state. While we can prepare for it, preventing it is well beyond our control. Each of our four seasons brings its own challenges, defying us to cope and survive.

Tackling the consequences of weather events can be trying, but existing hazards can become extremely complicated when weather becomes a factor: frigid weather during a catastrophic earthquake can highly impact those affected by the quake; additional precipitation during flooding incidents hampers all response efforts; high winds amidst a chemical spill or forest fire can complicate each and every effort being made to assist.

By itself, weather is a viable hazard. Coupled with an existing event, weather can greatly compound any situation. A powerful force, it deserves our respect and attention.

This publication is filled with information intended to help you better understand the various weather that impacts our state. We have included descriptions and safety tips to deal with powerful winter storms, damaging hail, high winds, flooding, wildfires and tornadoes.

Did you know that an all-hazards radio network exists across Montana? It does! It broadcasts local weather forecasts, conditions and warnings 24 hours a day. You can learn about it right here. There are also various helpful web sites that can help you monitor our ever-changing weather conditions. And, you can discover interesting tidbits about the weather extremes we are known for and advice for dealing with them.

I encourage you to read through this booklet and keep it handy. It is quite informative and could be helpful both during and after an extreme weather event impacts your area. Preparedness and awareness are the cornerstones of safety - what you learn may actually help save your life.

Contact Information

National Weather Service Billings

- (406) 652-0851

http://www.wrh.noaa.gov/Billings

National Weather Service Great Falls

- (406) 453-2081

http://www.wrh.noaa.gov/Greatfalls

National Weather Service Glasgow

- (406) 228-4042

http://www.wrh.noaa.gov/Glasgow

National Weather Service Missoula

- (406) 329-4840

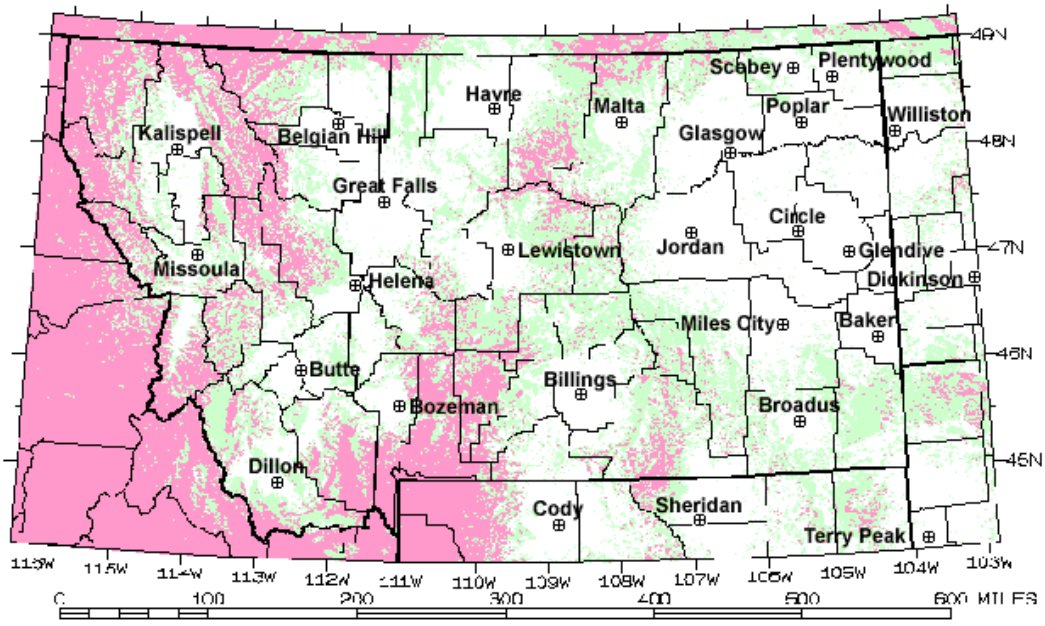
http://www.wrh.noaa.gov/Missoula

NOAA Weather Radio

NOAA Weather Radio (NWR) is a nationwide network of radio stations broadcasting continuous weather information directly from National Weather Service (NWS) offices. NWR broadcasts NWS warnings, watches, forecasts and other hazard information 24 hours a day, 365 days a year.

Working with the Federal Communications Commission's (FCC) Emergency Alert System (EAS), NWR is an "all-hazards" radio network, making it your single source for comprehensive weather and emergency information. NWR also broadcasts warning and post-event information for all types of hazards – both natural (earthquakes, volcanoes, etc.) and environmental (chemical spills, oil spills, etc.).

Known as the "Voice of the National Weather Service," NWR is provided as a public service by the National Oceanic and Atmospheric Administration (NOAA), part of the Department of Commerce. Nationally, there are over 800 transmitters broadcasting across all 50 United States, adjacent coastal waters, Puerto Rico, the U.S. Virgin Islands and the U.S. Pacific Territories. NWR requires a special radio receiver or scanner capable of picking up the signal. Broadcasts are found in the public service band at these seven frequencies (MHz):



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In Montana, there are 22 NOAA Weather Radio transmitters. To see if you are within range of one of these sites, take a look at the map above, visit us on the web at http://www.nws.noaa.gov/nwr, or call your local Montana National Weather Service office for additional information.

Weather Extremes in Montana

One of the reasons Montana can be a dangerous place to live is the extreme climate in which we live. In fact, the Treasure State boasts some of the most extreme weather in the lower 48 states. For example, the lowest temperature ever recorded in the lower 48 United States is 70 degrees below zero near Roger's Pass (just west of Lincoln) on January 20th, 1954. We get hot too! The hottest temperature recorded in Montana is 117 degrees. It happened twice; in Glendive on July 20th, 1893, and in Medicine Lake on July 5th, 1937. That means that our extreme temperature range is 187 degrees, greater than any other state in the Union.

Montana is a pretty dry state. However, in June 1921, Circle recorded 16.69 inches of rainfall. In 1953, Summit registered 55.51 inches of precipitation for the year. Where is our driest location? Belfry only picked up 2.97 inches of precipitation in 1960. Of course, we are known for snow so you should know that Summit picked up 44 inches of powder in 24 hours on January 29th, 1972. In fact, the five day total from that particular storm amounted to 77.5 inches of snow; the greatest one storm total for the state. And to top things off, Kings Hill measured 426.0 inches of snow during the winter of 1964-1965. That's almost 35 feet!

After a snowstorm in Helena, MT.

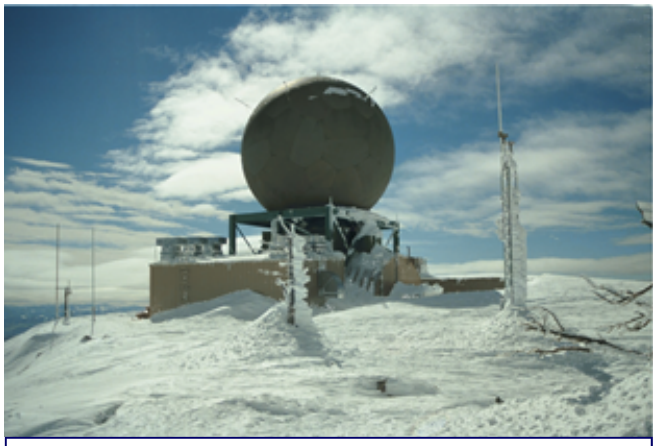
If you are a fan of changeable weather, we have that here too. On January 14th, 1972, Loma (a bit north of Fort Benton) saw their temperature rise from 54 degrees below zero to 49 degrees above zero in 24 hours. That is also a record for the lower 48. Other rapid temperature changes we've recorded include: 63 above to 21 below in 12 hours at Fairfield, and 32 below to 15 above in 7 minutes at Great Falls, which is another national record.

Finally, for those of you familiar with the weather near and just east of the Continental Divide, you know we have to talk about the wind. Places like Choteau, Augusta, Browning, Great Falls and Livingston routinely experience very strong west to southwest winds, especially during the fall and winter. On average, Livingston beats them all. However, in January of 2002, an anemometer (instrument that measures wind speed and direction) at the Miller Colony just north of Choteau registered a gust of 143 mph! That same storm brought a wind gust of 125 mph 25 miles west of Choteau.

So if you are ever visiting another state and you hear someone say, "If you don't like the weather here, just wait a few minutes," you will know that phrase only truly works in Montana.

Winter Weather

Snowfall amounts vary greatly across Montana, largely due to terrain. The southwestern part of the state is very mountainous while the northeastern portion is a lot like the Great Plains. There are some river valleys and groups of hills there, but it is still relatively flat. Elevation ranges from around 1800 feet above sea level where the Kootenai River enters Idaho, to 12,850 feet at Granite Peak near Yellowstone National Park. About half of Montana is above 4000 feet.



Weather Radar site for Missoula, MT in winter.

Annual snowfall varies from quite heavy, 300 inches in some parts of the mountains in the western half of the state, to around 20 inches at some stations east of the Continental Divide in the northern part of the state. Most of the larger cities have annual snowfall within the 30 to 50 inch range. Most snow falls during the November through March period, but heavy snowstorms can occur as early as mid-September or as late as June in the higher southwestern half of the state. In eastern sections of the state, early or late season snows are not as common.

Severe cold snaps cover parts of Montana on the average of 6 to 12 times a winter, and are confined mostly to the northeastern plains of Montana. A few of these cold snaps cover the entire area east of the Continental Divide, and can cover Montana all the way from the Dakotas to Idaho. Any prolonged cold snap is dangerous, but not nearly as much as they were years ago before transportation, roads, communications, and heating plants were developed to their present levels. Cold snaps can be accompanied by strong winds and blowing snow, making them even more inconvenient and dangerous, especially to the careless or inexperienced. Some areas are ideally situated for radiational cooling, the rapid loss of heat at the Earth's surface to space, especially at night. In such spots, low temperatures can fall to -50° F or lower. The coldest ever observed temperature was -70° F at Rogers Pass, 40 miles northwest of Helena, on January 20, 1954. This is the coldest temperature on record for the entire United States, excluding Alaska. In contrast, the low at Helena that same morning was only -36°F.

While usually cold, winters in Montana mean an occasional Chinook to warm things up a bit. These warm, windy winter periods occur almost entirely along the eastern slopes of the Divide. A Chinook wind occurs when wind sinks on the downslope side of a mountain range. As the air sinks, it warms dramatically and eventually erodes the cold air away. In Montana, a Chinook belt extends from the Browning-Shelby area southeastward to the Yellowstone Valley above Billings. Through this belt, Chinook winds frequently reach speeds of 25 to 50 mph or more and can persist with little interruption for several days.

In January, the coldest month, temperature averages range from 11° F for the northeastern portion of Montana, to 22° F for the Upper Yellowstone Valley in the south-central part of the state. In some areas east of the Continental Divide, January or February can average zero or below, but such occurrences range from infrequent to about once in 10 to 15 years in the coldest spots. Most Montana lakes freeze over every winter, but Flathead Lake between Polson and Kalispell freezes over completely only during the coldest winters, or about once in 10 years. All rivers carry floating ice during the late winter or early spring. Few streams freeze solid, and water generally continues to flow beneath the ice.

Climate summary courtesy of Western Region Climate Center

Winter Weather

What is the difference between a Watch, Warning, and Advisory?

A Winter Storm *Watch* is issued when there is the potential for a significant winter weather event within the next 2 days that would threaten life and property.

A Winter Weather *Advisory* is issued when winter weather is imminent or has a very high probability of occurrence, and is expected to cause significant inconveniences. If caution is not exercised, the situation may threaten life and property.

A Winter Storm *Warning* is issued when hazardous winter weather is imminent or has a very high probability of occurrence, and will pose a significant threat to life and property.

Other Winter Warnings and Advisories:

A *Blizzard Warning* is issued when snow combines with strong winds and reduces visibility. Dangerous wind chills may also occur.

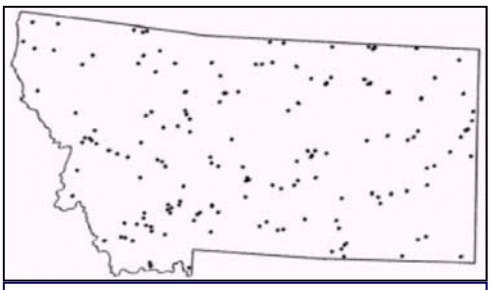
A *Wind Chill Advisory* is issued when dangerous wind chills of 20 to 39 below zero are expected. Frostbite occurs in 15 to 30 minutes.

A *Wind Chill Warning* is issued when extremely dangerous wind chills of 40 below zero or colder are expected. Frostbite occurs in 5 to 10 minutes.

Winter Records in Montana

Consecutive Days Min <= 32 West Yellowstone	251 days	Sep 70-May 71
Record Maximum Winter Snowfall Kings Hill	426.0	1964-65
Record Maximum 1-Day Snowfall Summit	44.0	29 Jan 1972
Highest Average Annual Snowfall Kings Hill	305.5	
Record Lowest Temperature Rogers Pass	-70	20 Jan 1954
Lowest Average Annual Temperature	33.8	Cooke City

Floods

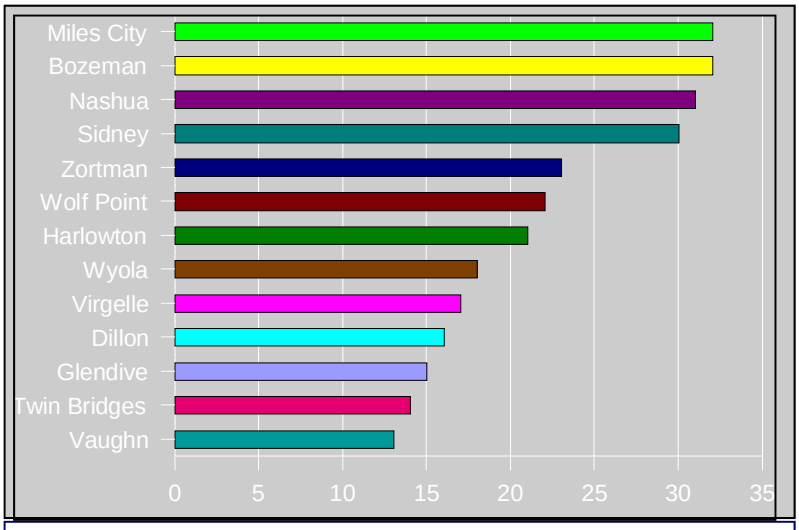


Known Ice Jams in Montana: 1894-1997

Flooding can become a hazard across much of Montana during the late winter and spring. A prolonged cold spell will cause rivers and streams to freeze. If these cold temperatures are followed by a sudden warm spell and accompanied by either heavy rain and/or snow melt, the river ice will begin to break up and move downstream. The blocks of ice can potentially accumulate along river bends, bridges, or other obstructions to cause an ice jam.

An ice jam behaves like a dam. Water will back up behind the jam which will cause flooding upstream. In addition, if the ice jam suddenly breaks, the onrush of water and ice down stream will result in rapid or flash flooding, giving people very little time to react.

The National Weather Service monitors rivers and streams year round. With the help of river gages, rain gages, and volunteer cooperative observers, winter ice jamming and flooding is identified and watched closely. Local community emergency management and law enforcement officials are notified and involved.



Cities with most reported ice jams.

If there is a potential for flooding due to melting snow or heavy rain, a Flood Watch will be issued by the local National Weather Service office. Flood or Flash Flood Warnings will be issued if flooding becomes a certainty or is already occurring.

The aftermath of an ice jam on the Yellowstone River.

If you live or work near a river or a stream, you should always remain alert to the possibility of flooding. One of the best ways to keep informed is to listen to NOAA Weather Radio. Another good way to obtain current weather information is to monitor a local and reliable radio or TV station. Weather can also be monitored at anytime through the National Weather Service website, www.weather.gov.

Flood Safety

- Avoid walking, swimming, or driving in flood waters

- Stay away from high water, storm drains, ditches, ravines, or culverts. If it is moving swiftly, even water six inches deep can knock you off your feet.

- If you come upon flood waters, stop, turn around, and go another way. Climb to higher ground.

- Do not let children play near storm drains.

Winter Safety

Be Prepared and Plan Ahead! Keep ahead of the storm by listening to NOAA Weather Radio, commercial radio and television for the latest winter storm warnings, watches and advisories. At Home and Work: Primary winter weather related concerns pertain to loss of heat, power and telephone service. A shortage of supplies is also possible if storm conditions continue for more than one day. Items to have available:

-Flashlight and extra batteries

-Battery-powered NOAA Weather Radio and portable radio to receive emergency information. These may be your only links to the outside.

-Extra food and water. Keep high energy food, such as dried fruit, nuts and granola bars, and food requiring no cooking or refrigeration in case of power loss.

-Extra medicine and, if applicable, baby items.

-Heating fuel, if applicable.

-Emergency heat source: fireplace, wood stove, space heater. Caution must be used to ensure proper ventilation and prevent a fire.

-Fire extinguisher and smoke alarm.

In Vehicles: Plan winter travel carefully, and check the latest weather reports to avoid a storm. Also, fully check and winterize your vehicle before the winter season begins. Be sure to carry a **WINTER STORM SURVIVAL KIT**:

-Mobile phone, charger, batteries

-Blanket/sleeping bags

-Flashlight with extra batteries

-First-aid kit

-Knife

-High-calorie, non-perishable food

-Extra clothing to keep dry

-Small can and waterproof matches to melt snow for drinking water

-Sack of sand or cat litter for traction

-Shovel

-Windshield scraper and brush

-Tool kit

-Tow rope

-Battery booster cables

-Water container

-Compass and road maps

Winter Safety

Other travel tips:

-Keep your gas tank near full to avoid ice in the tank and fuel lines.

-Avoid traveling alone.

If you must travel, let someone know your timetable as well as primary and alternate routes.

Dress for the Season!

Wear loose, lightweight, warm clothes in layers. Trapped air insulates the body. Remove layers to avoid perspiration and subsequent chill. Outer garments should be tightly woven, water repellent, and hooded. Wear a hat. Most of your body heat loss is from your head. Cover your mouth to protect your lungs from extreme cold. Mittens, snug at the wrist, are better than gloves. Try to stay dry.

WIND CHILL CHART

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98
FROSTBITE OCCURS IN:								30 minutes		10 minutes		5 minutes							

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

T = Air Temperature (°F) V = Wind Speed (mph)

What to Do When Caught in a Winter Storm

Outside:

-Find shelter. Try to stay dry, and cover all exposed body parts.

-If no shelter is available, build a lean-to, windbreak or snow cave for protection from the wind. Build a fire for heat and to attract attention. Place rocks around the fire to absorb and reflect heat.

Melt snow for drinking water. Eating snow will lower your body temperature more than drinking melted snow.

In a Vehicle:

-Stay in your vehicle! You become quickly disoriented in wind-driven snow and cold. Run the motor about 10 minutes each hour for heat. Open the window a little for fresh air to avoid carbon monoxide poisoning. Make sure the exhaust pipe is not blocked.

-Be visible to rescuers. Turn on the dome light at night when running the engine. Tie a colored cloth, preferable red, to your antenna or door. After the snow stops falling, raise the hood to indicate you need help.

Exercise. From time to time, move arms, legs, fingers and toes vigorously to keep blood circulating and to keep warm.

Inside:

-Stay inside! When using alternate heat, use fire safeguards and properly ventilate.

If there is no heat available, close off unneeded rooms. Stuff towels or rags in crack under doors. Cover windows at night. Eat and drink since food provides the body with energy for producing its own heat. Keep the body replenished with fluids to prevent dehydration. Also, wear layers of loose-fitting, lightweight and warm clothes.

Avoid Overexertion, such as shoveling heavy snow, pushing a car, or walking in deep snow. The strain from the cold and the hard labor may cause a heart attack. Sweating could lead to a chill and hypothermia.

El Niño and La Niña: Unmasked

We hear about El Niño and La Niña more and more these days. Why? Because these conditions play an important role in long term weather patterns not only across Montana, but also across the United States and the world. Let's begin with defining these two weather makers.

An El Niño occurs when average surface water temperatures along the equatorial Pacific Ocean (between 5° N and 5° S and 120° W and 170° W) warm to 0.5° C higher than normal. Simply put, El Niños occur when a large portion of the tropical Pacific warms more than normal. La Niñas occur when those same waters cool to 0.5° C lower than normal. Occasionally, the warming or cooling of the oceans' surface temperature can be more drastic than others. The El Niño or La Niña is considered to be moderate or strong depending on the water temperature difference from normal.

Now that we know what El Niño and La Niña are, we can explain their effect on weather. Changes in the ocean surface temperature affect tropical rainfall patterns and atmospheric winds over the Pacific Ocean, which in turn impacts ocean temperatures and currents. The El Niño and La Niña related patterns of tropical rainfall cause changes in the weather patterns around the globe. During an El Niño or La Niña, the changes in Pacific Ocean temperatures affect the patterns of tropical rainfall from Indonesia to the west coast of South America, a distance covering approximately half the world. These changes in tropical rainfall affect weather patterns throughout the world.

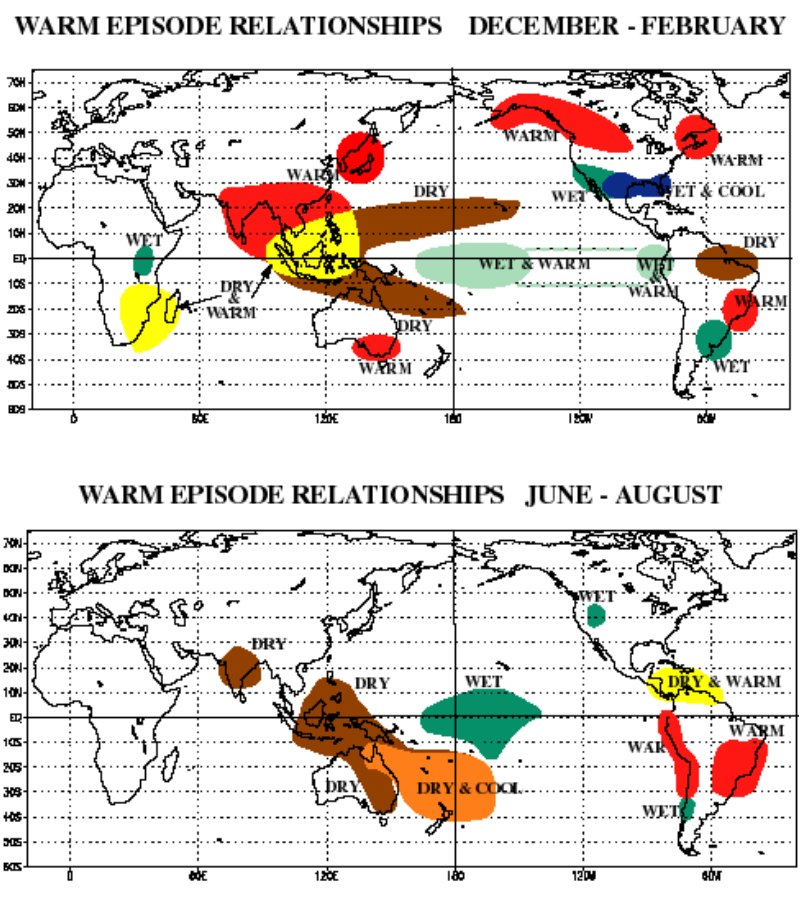


Figure 1: Warm episode graphics

During an El Niño, thunderstorm activity increases over the eastern Pacific Ocean, while thunderstorm activity decreases over the western Pacific Ocean, Indonesia and northern Australia. Furthermore, low level easterly winds decrease over the eastern Pacific while winds become westerly along the western Pacific's equatorial regions. These subtle changes impact weather across the globe. Typical results from an El Niño are shown in the graphics at the left (Figure 1).

Note that with an El Niño during the winter in the northern hemisphere, the southern U.S. experiences above normal precipitation, while the Pacific Northwest (including Montana) experiences warmer than normal temperatures. El Niños occurring during the northern hemisphere's summer months produce above normal precipitation across the northern Rockies. In either case, Indonesia and northern Australia experience drier and warmer than normal conditions.

Climate Prediction Center
NCEP

El Niño and La Niña: Unmasked

La Niña generally produces the opposite effects of El Niño. That is, thunderstorm activity in the eastern Pacific is suppressed while the western Pacific sees an increase in thunderstorm activity. Also, the easterly winds along the equator are enhanced across the entire Pacific Ocean. As you might imagine, global weather impacts are quite different as well (see Figure 2).

Note the wetter than normal impact over the western Pacific during winter and summer. Little impact is noted over the U.S. during the summer months, but cooler and wetter than normal weather is experienced along the coast of the Pacific Northwest. Montana will typically see cooler than normal temperatures during the winter months of a La Niña.

El Niño and La Niña episodes typically occur every 3 to 5 years. However, throughout historical record this interval has varied from 2 to 7 years. El Niño typically lasts 9 to 12 months, while La Niña typically lasts 1 to 3 years. They both tend to develop during the spring, reach peak intensity during the winter, and then weaken during early summer. However, prolonged El Niño episodes have lasted 2 years and even as long as 3 to 4 years.

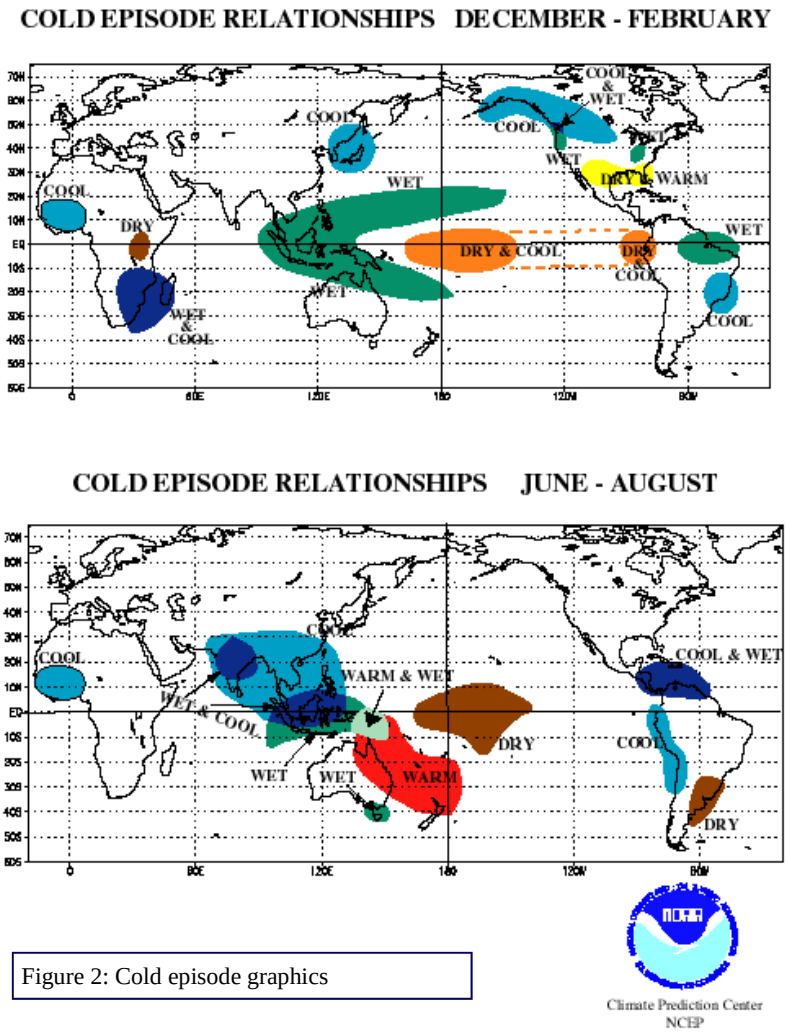


Figure 2: Cold episode graphics

Improved prediction of the potential for extreme climate episodes like floods and droughts could save the United States billions of dollars in damage. Predicting the life cycle and strength of a Pacific warm or cold episode is critical in helping farmers. It also helps water, energy, and transportation managers plan for, avoid or mitigate potential losses. Advances and improvements in long-term climate prediction will also result in significantly enhanced economic opportunities, particularly for the national agriculture, fishing, forestry and energy sectors, as well as social benefits.

So, during an El Niño, if it rains at my house, can I "blame it on El Niño?" It is inaccurate to label individual storms or events as a La Niña or El Niño event. Rather, these climate extremes affect the position and intensity of the global jet streams and the normal regions of high and low pressure. This in turn affects the average intensity and track of storms. Individual storms are not necessarily caused by El Niño or La Niña, but the overall storm pattern is more closely related to the El Niño or La Niña.

For more information about climate, visit NOAA's Climate Prediction Center on the web at www.cpc.ncep.noaa.gov.

Thunderstorms

Thunderstorms can occur at any time of the year across Montana, and can be associated with rain, freezing rain, sleet, or snow. Severe thunderstorms typically occur during the late spring and summer months, but can occur any time between March and November. A severe thunderstorm is defined as having hail ¾ of an inch in diameter or larger and/or wind of at least 58 mph. Not only do severe thunderstorms produce damage and injury from large hail and straight-line wind, but tornadoes can and do develop from these thunderstorms. By preparing for severe weather and by taking warnings seriously, we can help lessen their impact.

Straight-line thunderstorm winds (sometimes called a microbursts) reach severe levels an average of 80 times a year across Montana. Damaging thunderstorm winds are 5 to 10 times more likely than tornadoes in Montana, and they can be just as devastating. Thunderstorm winds can exceed 100 mph, a wind speed equal to that of a weak tornado, doing damage to buildings, trees, and crops. Like a tornado, the most danger is not from the wind itself but from flying debris picked up by the wind. Even small objects become dangerous in strong thunderstorm winds. Since 1950, six people have been injured by thunderstorm winds in Montana with no fatalities reported.

Large hail is reported across Montana about 200 times per year on average. Although ¾ inch hail is the threshold for severe weather, the largest hailstones can reach the size of softballs or grapefruits. On average, there are one or two reports of hail 3 inches or larger per year across Montana. Each year, large hail does serious damage to crops, buildings, and livestock across the state. Although only one injury has occurred due to hail since 1950 in Montana, a good size hail stone can fall at speeds over 100 mph and can cause serious injury.

Tornadoes

Tornadoes are violently rotating columns of air that descend from thunderstorms to come in contact with the ground. Tornadoes typically develop when wind variation with height (called wind shear) supports rotation in a thunderstorm's updraft. Tornadoes have wind speeds that vary from as low as 65 mph to as high as 300 mph. Tornadoes move with the thunderstorms that produce them at forward motions ranging from nearly stationary to over 70 miles per hour. Severe thunderstorms and tornadoes develop when three key ingredients are present: Moisture, instability, and lift. When these conditions are present during the spring and summer, severe thunderstorms and tornadoes are possible across all of Montana.

Tornadoes across Montana: On average, there are around 12 reported tornadoes across the state of Montana per year. Severe thunderstorms and tornadoes occur most often during the summer months of June, July, and August. Since 1950, no tornadoes have been reported in Montana during November, December, January, and February. Most tornadoes occur during the afternoon and evening between the hours of 2:00 PM and 8:00 PM, when thunderstorms are typically most powerful across the state. They are least likely between 3:00 AM and 9:00 AM. However, tornadoes can and do occur across Montana during all hours of the day and night.

Powerful, long lived tornadoes are rare across Montana, but can and do occur. Tornadoes are typically of a weak variety across the state (winds less than 115 mph), but are still extremely dangerous and can be deadly. There have been two reported tornado-related deaths across the state since 1950: 7/19/52 in Wibaux County (one killed), and 7/9/83 in McCone County (one killed)

There have also been 20 reported tornado-related injuries across Montana since 1950. The costliest tornado in Montana history occurred in Lewistown on August 14, 1999, with the damage amount totaling about 4 million dollars.

Tornado Safety

Tornadoes develop very rapidly and can move very quickly. Planning and preparation is necessary before a tornado strikes so immediate action can be taken to protect ourselves. Some questions you can ask yourself to find out if you are prepared for a tornado are:

-Do you know the basic safety rules?

-What is the best shelter available to you?

-Do your children know what to do if they are home alone?

-Is there a plan for moving disabled or elderly persons to the nearest shelter?

-What is the best source to obtain warning information?

Knowing the answers to these questions are the first step to planning ahead. Basic severe weather preparedness plans must include:

-A strong knowledge of safety rules

-Selection and designation of the best available shelter

-A reliable source for warning information

-Instructions for every person in proper procedures to follow when a watch or warning is issued, or if threatening weather should develop without warning.

-Holding drills and practice the plan.

The National Weather Service can help you with your planning. Brochures and additional information about severe weather and tornadoes are available upon request.

Before you can know what to do, you must understand the terms used in a tornado situation. **Tornado Watch** – Issued by the Storm Prediction Center for a large area across portions of one or more states when atmospheric conditions are favorable for tornado development. A watch is intended to give you time to prepare and review safety rules. Watch for threatening weather as severe thunderstorms and tornadoes can develop quickly. Stay informed by listening to NOAA Weather Radio or your favorite media outlet, and be prepared to move to safety quickly. **Tornado Warning** – Issued by local National Weather Service offices when a tornado has been detected by radar or reported by spotters. A warning is typically issued for one or two counties. If there is a tornado warning for your area, you should seek shelter immediately. Remember, tornadoes can form quickly. You may only have a few seconds to react and seek shelter. When a tornado threatens, immediate action can save your life. Once you reach your shelter, get as low as you can. A basement below ground or at least the lowest floor of a building offers the greatest protection. Put as many walls between you and the outside as possible.

-Homes or small buildings – Go to the basement or to a small interior room such as a closet or bathroom or an interior hall on the lowest level. If available, get under something sturdy like a heavy table. Protect yourself from flying debris with pillows, heavy coats, blankets, or quilts.

-Schools, nursing homes, hospitals, factories, and shopping centers – Go to a pre-designated shelter area. Basements are the best, but interior hallways on the lowest floor usually offer protection. Close all doors to the hallway for the greatest protection.

-Mobile Homes or Vehicles – Leave them and go to a strong building. If there is no shelter nearby, get into the nearest ditch and lie flat with your hands shielding your head.

Remember, **stay away from windows!** Don't worry about opening or closing them as it won't help to protect the structure. You will just waste time and put yourself and others at greater risk. **Avoid underpasses for shelter!** Tornado winds can speed up through an underpass, making tornado debris even more dangerous.

Lightning and Lightning Safety

The Threat

Lightning is the second deadliest weather phenomena in the United States, killing on average more than hurricanes and tornadoes. However, the real story of lightning isn't the deaths, it's the injuries. About 90% of all people struck by lightning survive, but many suffer from long term injury or disability. These injuries are primarily neurological with a wide range of symptoms, and they are sometimes difficult to diagnose. Lightning also causes about $5 billion of economic loss each year in the U.S.

The Solution

Public education is the key! The vast majority of lightning casualties can be easily avoided if the proper rules are followed. People need increased awareness of the hazards of lightning and knowledge of lightning safety.

Lightning--The Underrated Killer

Lightning has been rightfully called "the underrated killer" since it does not usually receive much front page attention. Nationally, lightning causes on average around 80 deaths and 500 injuries per year. Every thunderstorm has the potential to produce deadly cloud to ground lightning strikes. Whether it is a powerful severe thunderstorm or a more common "garden variety" thunderstorm, the electrical charge can reach 100 million volts with a temperature of 30,000 degrees Fahrenheit. The charge is always present and searching for the path of least resistance to complete the circuit. This path may include a tree, an object out in the open, or you! Keep in mind that you do not have to be standing directly beneath a cloud to be hit.

Take time to learn or refresh your memory on lightning safety rules. That quick dash out in the open when a thunderstorm is in the area may unnecessarily expose you to the possibility of being struck. Is it worth the risk?

No place outside is safe near thunderstorms!

If you are planning to be outside, watch the weather forecast beforehand. Know your local weather patterns. Make plans to avoid the potential hazard of lightning.

If you are going to be outside anyway, stay near proper shelter and use the 30-30 Rule to know when to seek the proper shelter.

Lightning and Lightning Safety

Lightning safety involves several easy steps that can be taken by anyone. While following lightning safety rules can sometimes be inconvenient, consider how inconvenient the alternative could be! Adults are ALWAYS responsible for the safety of children under their care, and this includes lightning safety.

The 30-30 Rule: When you see lightning, count the time until you hear thunder. If this time is 30 seconds or less, seek proper shelter. If you can't see the lightning, just hearing the thunder is a good back-up rule. Wait 30 minutes or more after hearing the last thunder before leaving shelter.

The best shelter commonly available against lightning is a large fully enclosed and substantially constructed building. Substantially constructed means it has wiring and plumbing in the walls. Once inside, stay away from any conducting path to the outside. Stay off the corded telephone except for emergencies. Stay away from electrical appliances, lighting, and electrical sockets. Stay away from plumbing. Don't watch lightning from windows or doorways. Instead, seek shelter in an interior room.

If you can't get to a substantial building, a vehicle with a solid metal roof and metal sides is a reasonable second option. As with a building, avoid contact with conducting paths going outside: close the windows, lean away from the door, put your hands in your lap, don't touch the steering wheel, ignition, gear shifter, or radio. Convertibles, cars with fiberglass or plastic shells, and open framed vehicles are not good lightning shelters.

If you can't get to a proper lightning shelter, avoid the most dangerous locations such as higher elevations and trees. Do not stand beneath a tall isolated tree, or in an open area. Other tips:

-DO NOT GO UNDER TREES TO KEEP DRY DURING THUNDERSTORMS!

-Avoid tall isolated objects like trees, poles, and light posts.

-Avoid projecting above the surrounding landscape as on a hilltop in an open field, on a beach, or fishing from a boat.

-Avoid swimming (includes indoor pools)

-Move away from open water or from tractors or other farm equipment.

-Get off and away from motorcycles, scooters, golf carts, riding lawn mowers, and bicycles. Put down golf clubs.

-Stay away from wire fences, clotheslines, metal pipes, rails, or other metallic paths which could carry lightning to you from some distance away.

-Avoid standing in small isolated sheds or other small structures in open areas like picnic pavilions, rain shelters, and bus stops.

-Avoid metal fences and metal bleachers.

-In a forest, seek shelter in a low area under a thick growth of small trees. In open areas, go to a low place such as a ravine or valley. Be alert for flash floods.

-If you feel your hair stand on end, this indicates that lightning is about to strike. D r o p to your knees and bend forward putting your hands over your ears. Do not lie flat on the ground.

-Remember, there is no truth to the old myth that "lightning never strikes twice."

Become a Spotter!

Technology has increased the warning system in the past 20 years, from the application of Doppler radar systems in the detection of severe weather to the Emergency Alert System (EAS) in the quest to distribute critical weather information to save lives. But with all of the technology, there is an important human element in the warning system – the storm spotter.

Storm spotters come from all walks of life – ranchers, farmers, doctors, lawyers, carpenters, plumbers, bakery workers, just about any profession you care to name. And their interest stems from two areas – an interest in weather and an interest in serving their communities. Spotters are organized loosely around SKYWARN, a volunteer program developed many years ago by the National Weather Service to train and organize spotters. Spotters are more formally organized around local emergency management agencies or other local organizations such as amateur radio clubs who work directly with the spotters in their local communities. Public service personnel from fire departments, rescue squads, and law enforcement agencies are also active in severe storm spotting activities. In Montana alone, there are nearly 3500 weather spotters.

With all of the technology, why are spotters important? Spotters are critical to the warning process because they provide timely information on the weather that is happening on the ground, often referred to as ground truth. High tech satellite imagery and Doppler radar provide National Weather Service meteorologists with large amounts of information about the storm and its structure, information critical to decisions to issue warnings ahead of severe weather events. But the high tech equipment does not tell meteorologists the specifics about the weather that is actually occurring at the ground – that's where spotters become the eyes and ears for the whole community. For example, the National Weather Service Doppler radar system can estimate hail size within a thunderstorm, but those values are for hail occurring inside the thunderstorm – not values for size of hail reaching the ground.

Storm spotters go through vigorous training provided by the National Weather Service to gain an understanding of storm structure. The training includes discussion of the climatology of severe weather in Montana, details on the structure of the most severe thunderstorms known as supercells, exposure to visual clues that are often present prior to and during tornado and severe storm events, and information on tornado, lightning, and reporting procedure. Storm spotters also in Montana are trained to report on winter conditions such as

Spotters typically work in small groups organized around a county, or in some cases, around a grouping of several counties. Amateur radio operators compose an important group of spotters because of their ability to communicate using their radios even when power and conventional communication methods are knocked out. National Weather Service offices have excellent working relationships with the amateur community. Working with permanent radio equipment, hams can talk with amateur radio storm spotters throughout the county warning areas in Montana. This communication network often provides rapid reports of severe weather as it occurs. And it can provide essential communication with emergency management agencies and others when severe weather does happen.

The warning system is a complex interaction of various systems working to enhance the safety of people. Volunteer storm spotters are one of the most valuable assets we have in improving public safety.

Additional information on storm spotter activities can be found on the Internet http://www.skywarn.org.

All—Hazards Response—The IMET

Natural disasters such as wildfires threaten lives and property. The primary mission of the National Weather Service (NWS) is to protect lives and property. Incident Meteorologists (IMET) are forecasters in the NWS who are specially trained to provide weather support at the site of these natural disasters. This support includes natural hazards such as wildfires, chemical spills, flash floods, earthquakes and volcanic eruptions. Wildfire support contributes to over 95% of the IMET's work.

To help suppress large wildfires, National Incident Management Teams (IMT) are sent in to manage the operations and support firefighters on the line. If a wildfire becomes complex, the IMT will call for an IMET. Micro-scale mountain meteorology is one of the specialties the IMET is trained in.

The IMET's purpose on a wildfire is twofold. First, they provide forecasts for a Fire Behavior Analyst (FBA). The FBA inputs this information into formulas which predict how fast the fire might move, flame lengths, and what kind of behavior the fire might have. The IMET is also onsite to mitigate lack of communication. The weather is very critical to the safety of firefighters. Firefighters have been killed on incidents where the weather suddenly changed with little advanced warning. Some of this weather cannot be predicted with pinpoint precision from miles away at a forecast office. For example, a sudden shift of the wind, break of the inversion, approaching dry thunderstorms with high winds can all dramatically affect fire behavior and put lives and property in danger.

An IMET sets up a theodolite to track a small weather balloon to obtain wind information.

The IMET obtains his/her information through an advanced communications system called FX-Net. FX-Net is a system composed of a satellite dish and laptop computer. This satellite dish can transmit and receive data. The most important data the IMET receives consists of computerized weather maps and forecast models in an exact replica of what they use in the office. This technology was first used at the 2002 Salt Lake Olympics. Data such as up to the minute radar, satellite, local observations, lightning and computer model data out to 240 hours is used to help the IMET make decisions for the local burn area.

Another means of obtaining data on a fire is by sending up pibal balloons. Pibal balloons are sent up daily and tracked by an instrument called a theodolite. This process gives a profile of the atmosphere's wind speed and direction above the fire. This is very useful for predicting when an inversion will break and what kind of winds are above the inversion. The time at which an inversion breaks is when fire behavior suddenly increases and can become critical to firefighters.

Lastly, decisions by the IMT on how to fight the fire are made every day. Many of these decisions are weather dependent and end up directly or indirectly affecting the cost of the fire. Long range forecasts are given on fires so the IMT can make plans to fight the fire and mitigate costs.

An IMET gives a weather briefing at the Boles Meadow fire in the summer of 2003, near Missoula, MT.

Weather on the Web

A wealth of weather information is available via the internet! Each National Weather service office in Montana has their own website for local weather information. Please see map below for phone numbers and web addresses. Many national websites also exist. The following are just a few additional links that may be of interest:

National Oceanic and Atmospheric Administration (NOAA): www.noaa.gov

National Weather Service (NWS): www.weather.gov

National Climatic Data Center (NCDC): www.lwf.ncdc.noaa.gov/oa/ncdc.html

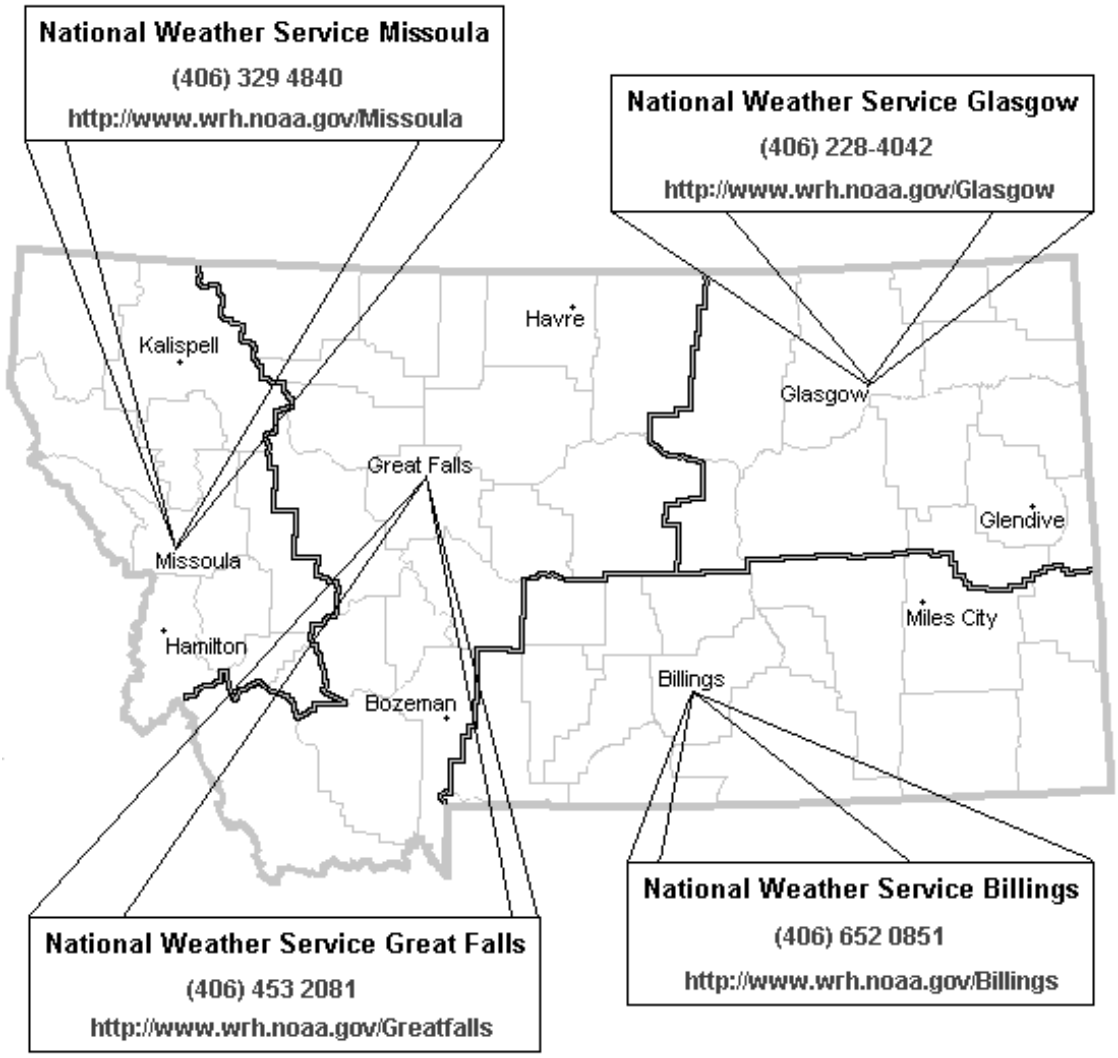
Storm Prediction Center (SPC): www.spc.noaa.gov

National Severe Storms Laboratory (NSSL): www.nssl.noaa.gov

Children's weather safety: www.crh.noaa.gov/mkx/owlie/owlie.htm

Climate Diagnostics Center (CDC): www.cdc.noaa.gov

National Center for Environmental Prediction (NCEP): wwwt.ncep.noaa.gov



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