

In this issue:

Why So Many Tornadoes in the United States?	2-4
Major Repairs to KPUX	5
Support Provided by NWS Pueblo for Our Partners	6
South Central and Southeast Colorado 2017 Summer and Early Fall climate Summary	7-8
Upslope? Downslope? Why Does it Matter?	9
Incident Meteorologist Makoto Moore Supports Wildfires on Site	10
Welcome Everett!	11
Hazard Simplification: A Step Forward	
What Does it Mean?	12

Why So Many Tornadoes in the United States?

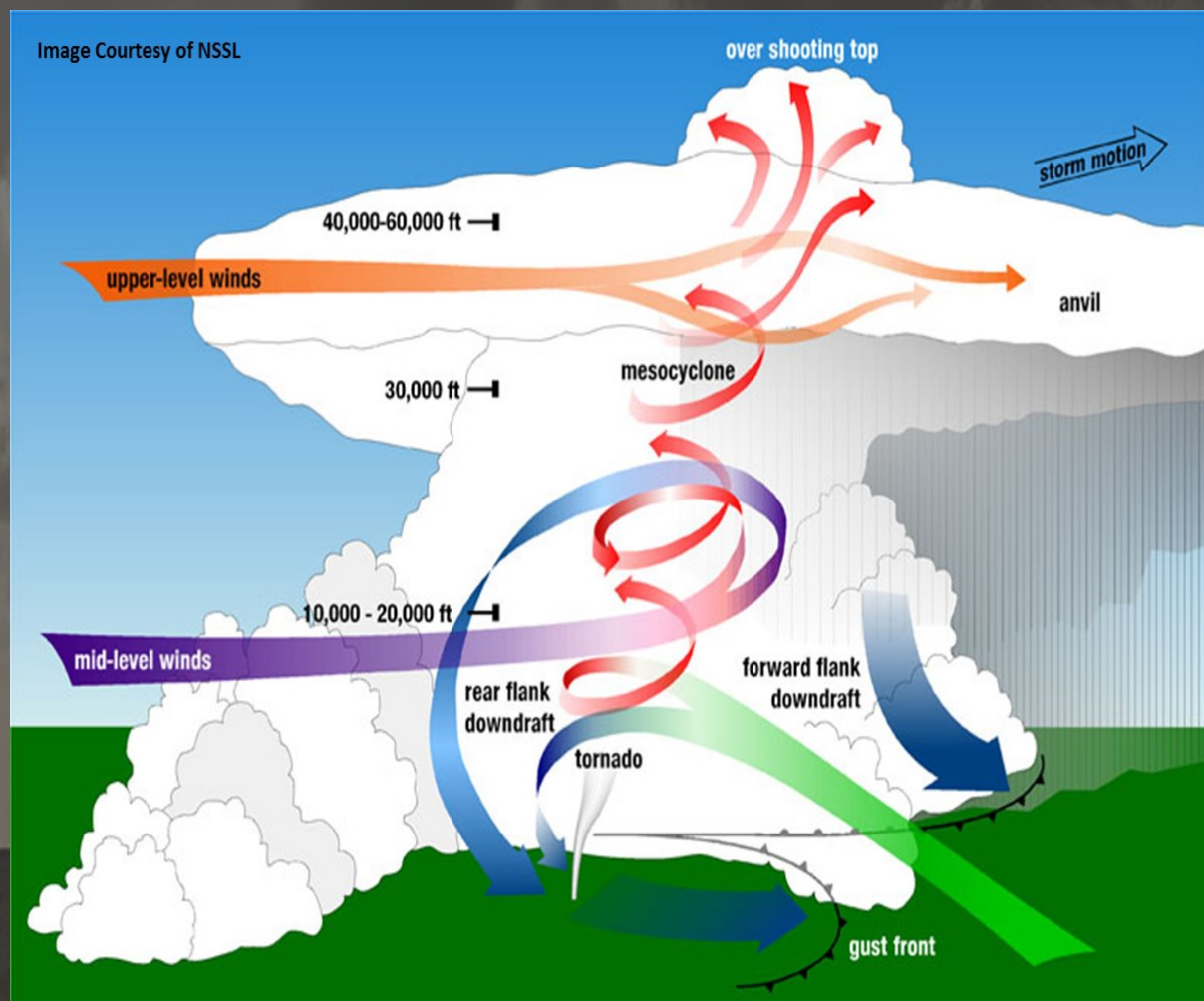
By Steve Hodanish and Kyle Mozley

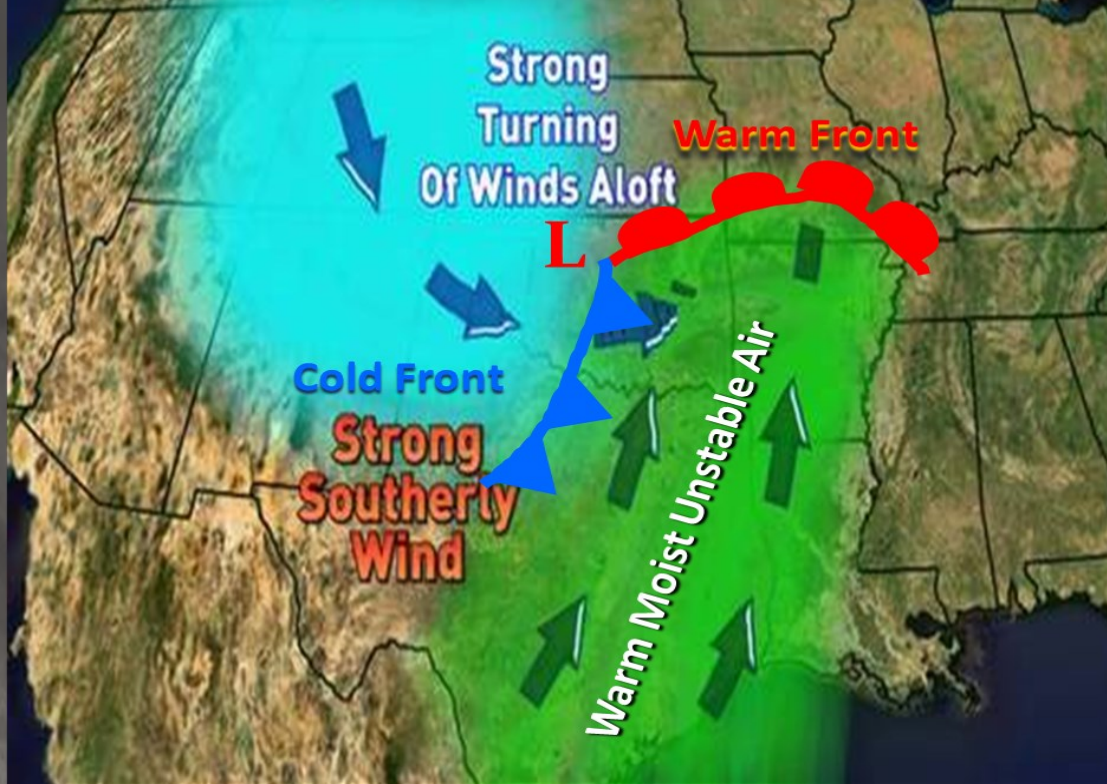
One of our readers posed the questions: Why does the United States have so many tornadoes, and why do we not hear about tornadoes in other parts of the world? Both are great questions and we will explain why the United States has so many tornadoes, and what other areas of the world experience tornadoes.

Since all tornadoes are produced by thunderstorms, we must first understand what it takes to produce a thunderstorm. The three basic ingredients needed for thunderstorms are: moisture, rising unstable air and a lifting mechanism (such as weather fronts or mountain ranges). In a typical year, there are about 100,000 thunderstorms in the United States.

Most thunderstorms only produce periods of heavy rain, gusty winds and lightning. However, a small percentage of thunderstorms produce dangerous severe weather. A thunderstorm is defined as severe if it produces hail 1 inch or greater, a wind gust of 58 mph or stronger or a tornado. About 1 out of every 10 thunderstorms produces severe weather. Most of the thunderstorms that produce significant severe weather (very large hail, very damaging winds or strong tornadoes) are called Supercell Thunderstorms.

Of the 10,000 severe thunderstorms that occur every year, 1 out of 10 (or roughly 1200) produce tornadoes. In order for a tornado to form in a thunderstorm, proper wind shear must be in place and the atmosphere must be quite unstable. The shear and instability allow the storm to rotate counterclockwise and keeps the storm "organized".





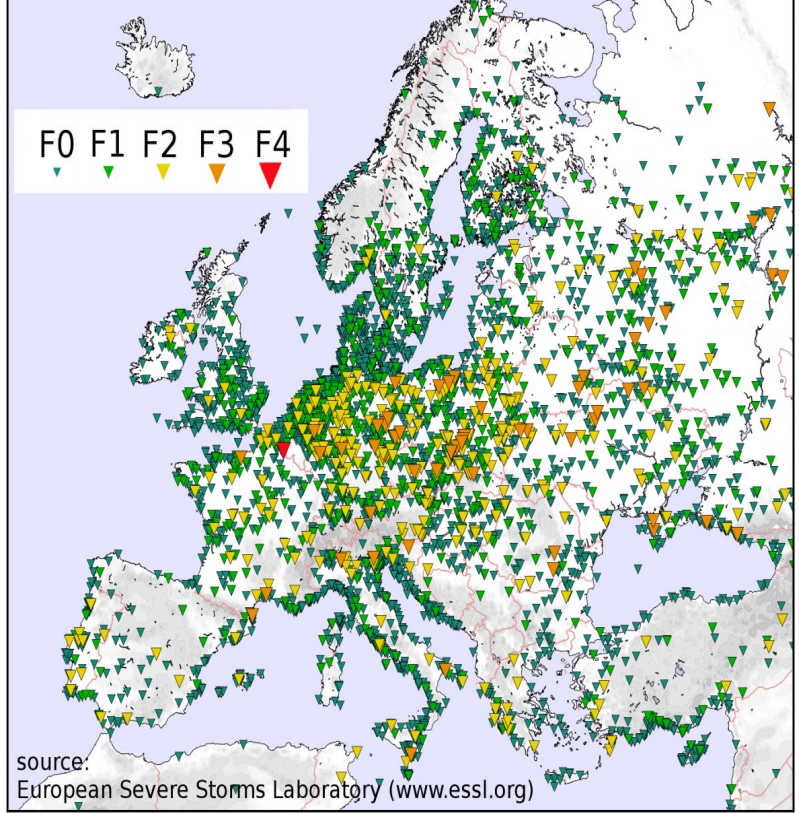
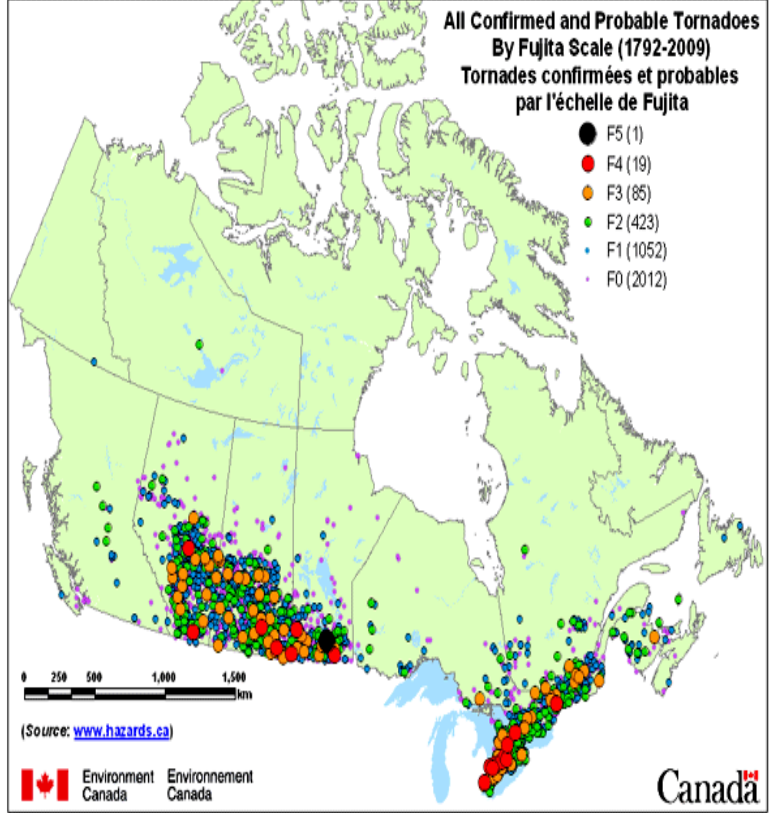
So, getting back to one of our original questions: Why are there so many tornadoes in the United States? The answer is: The Rocky Mountains and the Gulf of Mexico. Weather systems in the United States typically move from west to east. In advance of a typical weather system (a trough of low pressure), winds in the low levels are from a southerly direction, while at mid-levels, the winds are from

the southwest to west. A weather system moving across the western United States will produce southerly low level winds across the Plains which will bring abundant low level moisture northward out of the Gulf of Mexico, while the westerly winds aloft bring dry and cool air in from the Rocky Mountains and the desert southwest.

It is this combination of the dry/cool air in the mid-levels of the atmosphere coming out of the mountains and the moist and unstable air at the low levels coming out of the Gulf of Mexico, along with a favorable wind shear pattern (winds increasing and turning with height) that allow for so many tornadoes to occur across the United States. Nowhere else in the world do these two favorable ingredients come into play so often to produce tornadoes.

That does not mean tornadoes do not occur elsewhere around the world. The United States accounts for about 75% of the world's tornadoes, so where do the rest occur? While many people think of Canada being cold and snowy, the late spring and summer are quite similar to our weather here in the United States. The cool/dry air off the Rockies and moisture carried from the Gulf of Mexico, clear into Central Canada leads to roughly 5% of the world's total tornado count. That is second behind the United States.

Europe also sees tornadoes. The European Continent typically has around 300 tornado reports a year. The contrasting air masses from the Gobi Desert and Himalayan Mountains lead to the greatest tornado counts across Russia. The European "Tornado Alley" runs from northeast France, toward Poland. Locations along the Mediterranean Sea where wa-



terspouts (tornadoes over water), move onshore. This is especially prevalent in Italy!

Many people would not think of Bangladesh being a tornado hot spot, but it comes in third place behind the United States and Canada for most tornadoes each year. Bangladesh is one of the most populous countries in the world, but is also one of the poorest countries. Both factors lead to high fatality rates. Bangladesh holds the record for a single deadliest tornado on April 26, 1989 when over 1300 people perished. Tornadoes in Bangladesh are a result of the clash of air masses from the Bay of Bengal and the Tibetan Plateau.

Tornadoes also happen in the Southern Hemisphere. Australia has tornado activity caused by land falling tropical cyclones. In South America, Argentina is known for its strong tornadoes. In fact, the ratio of strong tornadoes to weak ones is higher than anywhere else in the world, except for the United States. South Africa has a few tornadoes every year during their spring and summer months.

Overall, we hear a lot about tornadoes here in the United States, but as you can see, they do happen around the world where conditions are met. Thanks for the questions: if you have a weather question you would like answered, let us know!

Sources: National Severe Storms Lab, European Severe Storms Lab, Environment Canada, www.USTornadoes.com, bangladeshtornadoes.org

MAJOR REPAIRS TO KPUX RADAR

BY KATHY TORGERSON

Major repairs of the National Weather Service Pueblo Doppler radar took place this past September with the replacement of the bull gear and gear box. The bull gear is responsible for the rotation of the radar, which gave out after nearly 23 years of 24/7 use. This was a complex operation as the antenna assembly (around 4000 pounds of weight) had to be lifted to gain access to the bull gear. The pictures above show the extent of these repairs as well as some of the parts, old and new, that went into the operation. A special crew from the Radar Operations Center in Norman, OK was deployed to perform the repairs, along with assistance from our local technicians. Although the repairs were anticipated to take 10 days from start to finish, they were completed in only six!

Meteorologists at NWS Pueblo had full access to adjacent radars in Denver, Goodland, Dodge City, Amarillo, Albuquerque, and Grand Junction to help with thunderstorm interrogation and warnings across south central and southeast Colorado during the outage period, which spanned a two week window as parts and equipment were being rounded up prior to the teams' arrival. Forecasters also had use of the new higher resolution GOES16 satellite data to aid in storm assessment. However, our weather spotters, a valuable part of the warning process, became an even greater resource as lower scans from these more distant radars weren't always in an ideal position to view some of these storms. While we always appreciate the volunteer time our weather spotters provide, a big thanks goes out to those who supplemented the warning process with their observations during that critical period. A special thanks goes to the Colorado Springs Skywarn group who provided valuable rainfall observations the evening of September 23rd when the Denver radar also experienced a hardware failure!



Support Provided by NWS Pueblo for our Partners

By Eric Petersen

In southern Colorado, summer is filled with numerous outdoor activities and events, many of which need specific and accurate weather information to ensure the safety of organizers and participants. A major duty of meteorologists at the NWS in Pueblo is to provide weather support to emergency personnel and public safety officials for these events and to ensure decision-makers have the most accurate, reliable and trustworthy weather, water and climate information. The NWS calls this support Impact-based Decision Support Services, abbreviated as IDSS, with all NWS offices in the U.S. providing IDSS for a wide variety of events year round. During the summer, IDSS at WFO Pueblo often consists of closely monitoring radar, satellite and lightning data for thunderstorm development and movement,

then coordinating with local public safety officials to provide advance notice of any hazardous weather potentially impacting events with large numbers of people outdoors.



During the summer of 2017, NWS Pueblo performed IDSS for numerous events, including the Colorado High School Rodeo Finals in Lamar, the Pueblo County Fair and Colorado State Fair in Pueblo, the Labor Day Liftoff Hot Air Balloon Event in Colorado Springs, and several mountain bike and trail run events in the central mountains around Leadville. In August, WFO Pueblo provided IDSS to the Colorado Classic Bike Race in Colorado Springs, giving race officials minute by minute updates on thunderstorms and lightning which moved across the race course during the event. The NWS also worked closely with El Paso

County Search and Rescue to support the Pikes Peak Ascent and Marathon, advising organizers of expected timing of thunderstorm development and the potential for lightning across the upper reaches of Pikes Peak above timberline. WFO Pueblo also worked with the Colorado Department of Transportation (CDOT) before, during and after the solar eclipse in August to aide in traffic flow management across the state.

This winter, WFO Pueblo will continue to work closely with CDOT to coordinate snow plowing efforts during winter storms, and will provide detailed snowfall and wind chill information to area school districts in support of school closing decisions. The NWS will also give up to the minute data and forecasts for snowfall and freezing pavement potential to the Colorado Springs and Pueblo airports to facilitate runway plowing and other operational requirements. During dry and windy weather, WFO Pueblo will coordinate with local land management agencies to provide advance notification of critical fire weather conditions, and will provide spot specific weather forecasts for any fires which occur to local firefighters and first responders.

South Central and Southeast Colorado 2017 Summer and Early Fall Climate Summary

By Mark Wankowski

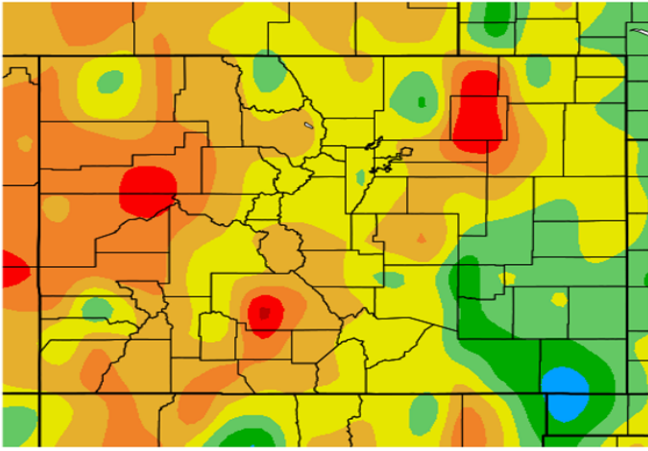
After a wet Spring of 2017, the first month of "Meteorological Summer" warmed up and dried out across south central and southeast Colorado. While some portions of Eastern Colorado saw spotty amounts of above normal precipitation through the month of June, along with bouts of severe weather, most of south central and southeast Colorado saw above normal temperatures and below normal precipitation for the month as a whole.

July started where June left off, mainly hot and dry across south central and southeast Colorado. The summer monsoon started to bring in some moisture into western Colorado after the first week of the month, with the monsoon increasing into the middle of the month and remaining in full swing across south central and southeast through the end of the month. For the month as a whole, above to well above normal precipitation and generally above normal temperatures, were experienced across much of south central and southeast Colorado.

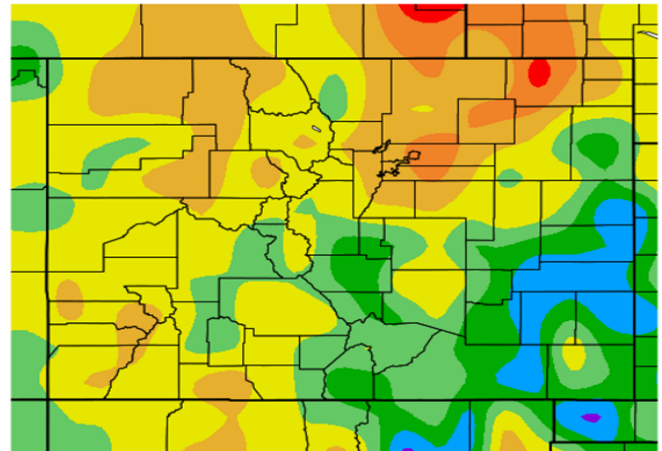
August started off where July left, with ample "monsoonal moisture" in place across the region, leading to daily showers and thunderstorms spreading across south central and southeast Colorado. However, the monsoonal moisture tap started to dry out into the middle of the month, which led to much more isolated storms across the area, with this drier weather pattern then persisting through the end of the month. For the month as a whole, generally below normal temperatures and precipitation were experienced across south central and southeast Colorado, save for localized areas of above normal precipitation across the far southeastern Colorado Plains.

For the Summer Season as a whole, generally around normal to slightly above normal temperatures were experienced across South Central Colorado through the I-25 Corridor, with below to well below normal temperatures experienced across the southeast Colorado Plains. Near normal to slightly above normal precipitation was experienced across most of south central and southeast Colorado through the Summer of 2017, with well above normal precipitation experienced across portions of the San Luis Valley and the southeast Colorado Plains. The following graphics depict seasonal temperature and precipitation departures from normal across the area for the Summer of 2017 (June, July, and August).

Departure from Normal Temperature (F)
6/1/2017 - 8/31/2017



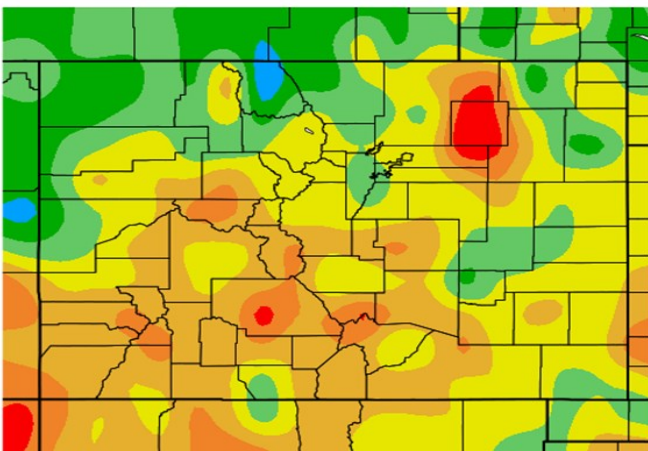
Departure from Normal Precipitation (in)
6/1/2017 - 8/31/2017



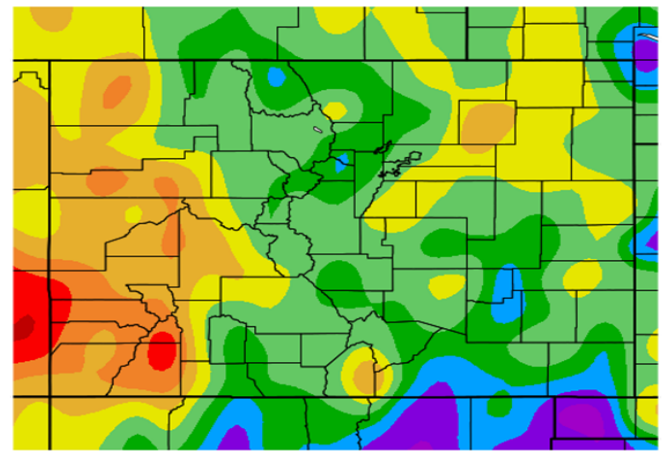
September, the start of "Meteorological Fall," started where August left off, mainly warm and dry across south central and southeast Colorado. This warm and dry pattern persisted through the middle of the month before a substantial pattern change brought cool and wet weather to south central and southeast Colorado through the end of the month. This pattern change also brought nearly a week straight of cloudy conditions to much of southeastern Colorado, with more than a couple consecutive days of cloudy conditions highly anomalous any time of the year across eastern Colorado. For the month as a whole, generally above normal temperatures and precipitation were experienced across south central and southeast Colorado, with areas of well above normal precipitation across portions of southern Colorado.

October was a generally warm and dry month across south central and southeast Colorado, with several weather systems and associated cold fronts moving across the region throughout the month. These weather systems brought big temperature swings and some light rain and snow across the region. For the month as a whole, generally above normal temperatures and below normal precipitation were experienced across south central and southeast Colorado, save for at or above normal precipitation across portions of the central mountains. The following graphics depict temperature and precipitation departures from normal across the state for the first two months of the 2017 Fall Season.

Departure from Normal Temperature (F)
9/2/2017 - 10/31/2017



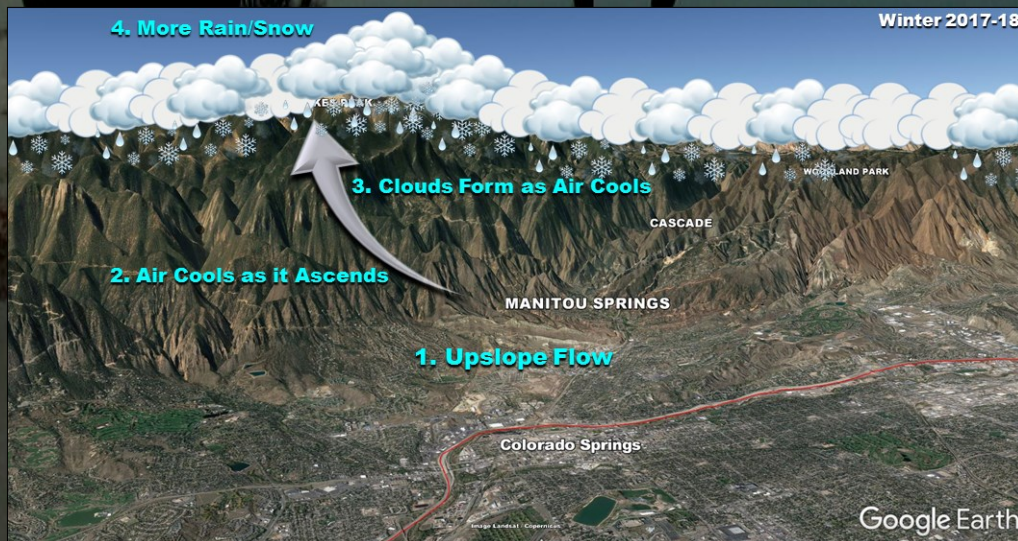
Departure from Normal Precipitation (in)
9/2/2017 - 10/31/2017



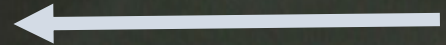
Upslope? Downslope? Why Does it Matter?

By Larry Walrod

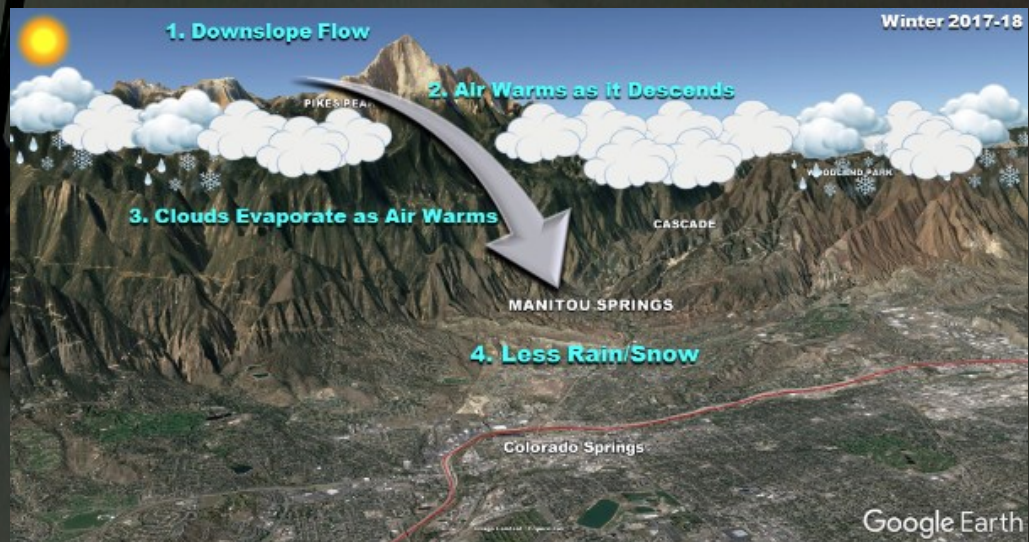
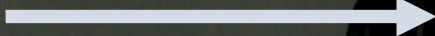
As winter returns to southern Colorado, you will more than likely hear the terms “upslope flow” and “downslope flow” used with increasing frequency by southern Colorado meteorologists. Why do these terms keep coming up? Because they have everything to do with whether or not it rains or snows. Upslope flow occurs when winds blow up the terrain. Because air expands and cools as it is forced upward, this reduces the air’s capacity to hold moisture in the gaseous state. Consequently, the moisture condenses out of the air, forming clouds and precipitation. This increases the odds that it will rain or snow. As you might imagine, “downslope flow” occurs when winds blow down the terrain. Because air compresses and heats as it is forced downward, this increases the air’s capacity to hold moisture in the gaseous state. Consequently, downslope flow tends to evaporate clouds and precipitation, decreasing the chances for rain or snow. So, the next time rain or snow is expected, see if you can determine whether or not the flow will be upslope or downslope at your location. You may be able to improve upon your local forecast.



Upslope Flow Increases Rain and Snow



Downslope Flow Decreases Rain and Snow



Incident Meteorologist Makoto Moore Supports

Wildfires on Site

By Makoto Moore

Makoto Moore, Incident Meteorologist (IMET) for the Pueblo weather office, was dispatched twice to Montana this past year to provide on-site weather support for teams working the numerous wildfires across the state. A very wet spring helped fields of cheat grass to grow rapidly. When drought conditions set in during the summer, these fields cured and became 18 to 30 inch “fuses” for fire to reach stands of timber. By the end of September 2017, nearly 1.3 million acres of Montana had burned.



Makoto was dispatched July 26th to Broadus in southeast Montana to help with the Buffalo Fire. There he worked with a Type 1 Alaska Incident Management Team (IMT). This team was also tasked to manage the Bruner Mountain Fire near Roundup in south central Montana, which threatened a subdivision and a mining operation. Makoto

transferred to that fire on July 30th and stayed there through August 3rd. The Alaska IMT was a great team to work with, being on the leading edge of firefighting technology with their extensive use of drones to scout fire activity and safety zones.

Makoto was called out again September 2nd to help with the East Fork Fire near Box Elder in north central Montana. He worked with the Great Basin Team 2 IMT, a Type 1 team based out of Salt Lake City, UT. The fire had started on tribal land, but quickly spread to private land and threatened ranches as well as thousands of head of cattle. The fire was declared contained September 8th, so he then traveled to western Montana to work on the Lolo Peak Fire near Florence with a Type 1 Northern Rockies IMT. The Lolo Peak Fire was a 54,000 acre fire on the Lolo National Forest and burned for over 2 months, having started July 15th due to a lightning strike, and was responsible for the death of one firefighter. Fall finally arrived in western Montana by mid-September and fire activity came to a standstill, so Makoto finished out his 14 day assignment and traveled home September 17th.

The image to the right is a view of the Lolo Peak Fire, on a rare day when the inversion lifted and fire activity could actually be seen.



Welcome Everett Briggs to NWS Pueblo!

I started my Federal Service in the US Navy as a Fire Controlman. I was assigned to Naval Air Search Radar 3D phased array, serving from June 1988 to Jan 1994. I spent the next 20 years working in the civilian sector of telecommunications (Motorola/Qualcomm/Google/Intel).

I have been doing Electronic Technologies work for the National Weather Service since November 2014, starting in Brownsville, Texas. Everett has been with NWS Pueblo since October! He is looking forward to hiking and flying his drone when he can. Welcome Everett!



Hazard Simplification: A Step Forward!

By Thomas Magnuson

Hazard Simplification, or HazSimp for short, is a term the National Weather Service uses to explain the simplification of current watch/warning/advisory products. Winter products are the first to be simplified, followed by hydrologic products during the next calendar year.

HazSimp actually started this past October 2nd.

In addition to consolidating certain highlights/products, the format changed to a "What", "Where", "When", "Additional Details", and "Precautionary/Preparedness Actions" approach in the text. This allows you to quickly find all the information you need to know about the risks regarding the hazardous weather episode. The information conveyed will essentially be the same, just in a simpler package.

What does this mean for Colorado winter highlights/products? In the past, NWS Pueblo had the option of issuing a Freezing Rain Advisory, which included risks from both freezing rain (rare in Colorado) and freezing drizzle (much more common). Now, the freezing precipitation risks will fall under the umbrella of the Winter Weather Advisory, with a specific mention of freezing precipitation in the product. Also, if there is a possibility of blizzard conditions, that will be consolidated into the Winter Storm Watch product, with the potential for blizzard conditions specifically mentioned in the product. When the risk for a blizzard is very certain, a Blizzard Warning will still be issued, as in the past.

So, the new bullet format of the winter weather products should make it easier for you to see the important information and risks from upcoming winter storms.

Enjoy this winter in Colorado, and always make wise decisions when it comes to travel and recreation!

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...WINTER WEATHER ADVISORY REMAINS IN EFFECT FROM 2 AM TO 11 AM  
MST TUESDAY...
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* WHAT...Freezing drizzle expected. The ice will result in  
difficult travel conditions, including during the morning  
commute on Tuesday. Total ice accumulations of up to one tenth  
of an inch are expected.
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* WHERE...Northern El Paso County and Kiowa County.
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* WHEN...From 2 AM to 11 AM MST Tuesday.
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* ADDITIONAL DETAILS...Be prepared for black ice conditions on  
roadways, especially bridges and overpasses.
```

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/NWSPueblo



@NWSPueblo



Watch....Warning....Advisory

WHAT'S THE DIFFERENCE???

How many times have you seen the TV crawler with “National Weather Service has issued a Watch/Warning/Advisory” and wondered

“ What’s the difference? ”

The difference determines the risk to life and property of the citizens of the United States, and more specifically, those folks that are in the hazard area that is defined.

The National Weather Service issues a variety of products to keep our customers in-formed of unusual, inconvenient and hazardous weather conditions. A multi-tier concept is employed to accomplish this task with Outlooks, Watches, Warnings and Advisories to point out specific conditions.

Definitions:

Outlook: Used to give considerable lead time that a hazardous event may develop.

Watch: Issued when the risk of a hazardous weather or hydrologic event has increased significantly, but its occurrence, location, and/or timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so.

Warning: Issued when a hazardous event is occurring or has a very high probability of occurrence. Warnings advise of a **threat to life or property.**

Advisory: Issued when a hazardous event is occurring or has a very high probability of occurrence. Advisories describe events that **cause significant inconvenience.**

Here at NWS Pueblo.. we tweet and we post, using Twitter and Facebook as additional sources to reach the citizens that rely on us.

You can follow us either way, to stay in touch and stay informed, as the seasons, and weather, change.

Stay safe, Stay dry and Stay informed.

Stay up to date with your winter weather at:

WEATHER.GOV/PUB