

**Introduction**

The most effective tool to detect precipitation is radar. Radar, which stands for **RA**dio **D**etection **A**nd **R**anging, has been utilized to detect precipitation, and especially thunderstorms, since the 1940's. Radar enhancements have enabled NWS forecasters to examine storms with more precision.

The radar used by the National Weather Service is called the WSR-88D, which stands for Weather Surveillance Radar - 1988 Doppler (the prototype radar was built in 1988). As its name suggests, the WSR-88D is a Doppler radar, meaning it can detect motions toward or away from the radar as well as the location of precipitation areas.

This ability to detect motion has greatly improved the meteorologist's ability to peer inside thunderstorms and determine if there is rotation in the cloud, often a precursor to the development of tornadoes.

There are [155 WSR-88D Doppler radar](http://www.srh.weather.gov/ridge/) in the nation, including the U.S. Territory of Guam and the Commonwealth of Puerto Rico, operated by the National Weather Service and the Department of Defense.

**Exactly how does radar work?**

As the radar antenna turns, it emits extremely short bursts of radio waves, called pulses. Each pulse lasts about 0.00000157 seconds (1.57x10-6), with a 0.00099843-second (998.43x10-6) "listening period" in between. The transmitted radio waves move through the atmosphere at about the speed of light.

By recording the direction in which the antenna was pointed, the direction of the target is known as well. Generally, the better the target is at reflecting radio waves (i.e., more raindrops, larger hailstones, etc.), the stronger the reflected radio waves, or echo, will be.

This information is observed within the approximately 0.001-second listening period with the process repeated up to 1,300 times per second. By keeping track of the time it takes the radio waves to leave the antenna, hit the target, and return to the antenna, the radar can calculate the distance to the target.

The WSR-88D's pulses have an average transmitted power of about 450,000 watts. By comparison, a typical home microwave oven will generate about 1000 watts of energy. However, because of the very short period the radar is actually transmitting, when the time of all pulses *each hour* are totaled (the time the radar is actually transmitting), the radar is "on" for a little over 7 seconds each hour. The remaining 59 minutes and 53 seconds are spent listening for any returned signals.

**The Doppler Advantage**

By their design, Doppler radar systems can provide information regarding the *movement* of targets as well their position. When the WSR-88D transmits a pulse of radio waves, the system keeps track of the **phase** (shape, position, and form) of the transmitted radio waves.

By measuring the *shift in phase* between a transmitted pulse and a received echo, the target's radial velocity (the movement of the target directly toward or away from the radar) can be calculated. A positive phase shift implies motion toward the radar and a negative shift suggests motion away from the radar.

The phase shift effect is similar to the "Doppler shift" observed with sound waves. With the "Doppler shift", the sound pitch of an object moving toward your location is *higher* due to compression of sound waves. As an object moves away from your location, sound waves are stretched resulting in a *lower* frequency. You have probably heard this effect from an emergency vehicle or train. As the vehicle or train passes your location, the siren or whistle's pitch lowers as the object passes by.

For the Doppler radar, atmospheric objects moving inbound (toward the radar) produce a positive shift in frequency of the radar signal. Objects moving away from the radar (outbound) produce a negative shift in frequency. It is this change in frequency that allows us to "see" motion in the atmosphere. The larger the phase shift, the greater the target's radial velocity.

**Scanning the horizon**

The WSR-88D employs scanning strategies in which the antenna automatically raises to higher and higher preset angles, or elevation slices, as it rotates. These elevation slices comprise a **volume coverage pattern** or VCP. Once the radar sweeps through all elevation slices a volume scan is complete. In precipitation mode, the WSR-88D completes a volume scan every 4-6 minutes depending upon which VCP is in effect, providing an updated 3-dimensional look at the atmosphere around the radar site.

**NWS Radar on the Web**

The National Weather Service has presents Doppler radar images on the web in two manners; a **Standard version** (an all-in-one image) and an **Enhanced version** by individual interactive layers. Follow are the differences and strengths/weakness of each.

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| **Standard Version** | **Enhanced Version** |
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| In the **Standard** version, each radar image is combined with a legend, highways, and county/state outline overlays into one graphic which is made available via the web. | In the **Enhanced** version, individual radar images are transmitted as well as individual overlay maps for highways, rivers, cities, county boundaries and severe weather warnings. |
| **Advantages:**   * Smallest file size to download for both loop and non-looping images. * Toggle loop on/off just by clicking on image. * No Java/Javascript needed. * Can save any image by right clicking on the image then select "Save As". * Printer friendly "white" background.   **Disadvantage:**   * Each radar image is on a separate webpage that must be downloaded. * Overlays are fixed and always visible. * Unable to stop looping on any image. Stopping the loop always takes you to the most recent image page. | **Advantages:**   * Radar data available for GIS programs. * Individual non-changing overlays, such as topography, can be cached on the local computer eliminating retransmission for each update. * Individual images that change often (radar image itself, watches/warnings, etc.) are much smaller in file size (compared to the standard version image). * Overlays can be toggled on/off and settings are preserved when bookmarked or moving between adjacent radar locations. * Can measure distance and direction between points. * Can determine latitude and longitude of objects.   **Disadvantage:**   * Initial download size of files are much larger (compared with the standard version). * Extensive use of Java/Javascript. |

How can you quickly tell which version of the radar you are viewing? The two obvious differences are in the border color around the radar image and background image. The standard version have a light blue border with a white background. The Enhanced version will have a dark blue border with a map background showing topography. (Samples below)

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| **Standard Version** | **Enhanced Version** |
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In addition, below every radar image, standard or enhanced, are thumbnail images of different sectors of the nation. These thumbnails contain *live* radar information providing, at a glance, a quick overview of where precipitation is occurring from the base reflectivity data.

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| **National Radar Mosaic Sectors** | Alaska | Pac. NW | N. Rockies | Upr. Miss. | Grt. Lakes | Northeast |  |
| Guam | Hawaii | Pac. SW | S. Rockies | S. Plains | Lwr. Miss. | Southeast | Puerto Rico |

Clicking any of these images provides a high resolution sector image. Another click takes you to individual radar images.

These sector views are also divided into standard and enhanced. However, all sector images are non-interactive. The delineation of standard and enhanced allows you to know which version of individual radar you can obtain from each sector.



**Radar Map Projections**

Except for the state of Alaska, the radar images provided by the National Weather Service are in an unprojected latitude/longitude format. This allows geographic information system (GIS) software to ingest NWS radar data for display with other information such as population density, etc.

Because of this unprojected format, the radar images appear "squashed" or oval shaped. The squashing of the radar image increases with increasing distance north (and south) of the equator. The oval ring in the image (right) is the 124 nautical mile range ring, which is the distance "seen" in a "short range" Doppler radar image.

**NWS Radar Images**

Whether looking at the standard or enhanced version of the NWS Doppler radar display the following examples of the different images applies to both varieties. In this section, the enhanced view will be used.

The National Weather Service provides several different images from the [network of Doppler radars](http://www.srh.weather.gov/ridge). These images include reflectivity, velocity and rainfall information.

**Reflectivity Images**

These images are just as they sound as they paint a picture of the weather from the energy *reflected* back to the radar. There are two types available on the web; **Base** (or ½° elevation) reflectivity and **Composite** reflectivity.

**Base Reflectivity** is the default image. Taken from the lowest (½° elevation) slice, it is the primary image used to "see what's out there". There are two versions of Base Reflectivity image; the *short range* version which extends out to 124 nm (about 143 miles) and the *long range* version which extends out to 248 nm (about 286 miles). This image is available upon completion of the ½° elevation scan during each volume scan. [View a sample base reflectivity image.](http://www.srh.noaa.gov/jetstream/doppler/baserefl.htm)

**Composite Reflectivity** images utilize all elevation scans during each volume scan to create the image. It is composed of the greatest echo intensity (reflectivity) from any elevation angle seen from the radar. It is used to reveal the highest reflectivity in all echoes.

Another advantage of **Composite Reflectivity** is in mountainous regions. Often, the Base Reflectivity ½° elevation scan is not high enough to see over mountains. With the addition of higher elevations scans, weather information over mountain peaks can be seen. [View a sample composite reflectivity image.](http://www.srh.noaa.gov/jetstream/doppler/comprefl.htm)

**Velocity Images**

One of the best features on the 88d Doppler radar is its ability to detect motion. However, the only motion it can "see" is either directly *toward* or *away* from the radar. This is called radial velocity as it is the component of the target's motion that is along the direction of the radar beam.

In all velocity images, red colors indicate wind moving away from the radar with green colors representing wind moving toward the radar. It is very important to know where the radar is located as that is your reference point for proper interpolation of the wind's motion.

**Base Velocity** images provides a picture of the basic wind field from the ½° elevation scan. It is useful for determining areas of strong wind from downbursts or detecting the speed of cold fronts. However, since the radar only measures radial velocity, the strength of the wind will always be less than what is actually occurring unless the wind is moving directly toward or away from the radar.

Also, the surface winds are only for areas near the radar. As distance increases from the radar, the reported value will be for increasing heights above the earth's surface.

**Storm Relative Motion** images are very useful images to look for small scale circulations (called mesocyclones) in thunderstorms. Often, these small scale circulations are areas where tornadoes form.

What separates storm relative motion from base velocity is the motion of storms are "subtracted" from the overall flow of the wind. As storms move, their own motion can mask circulations within themselves. This motion is removed to make the view of the wind relative to the storm. In effect, what is seen is the wind's motion as if the storms were stationary.

**Precipitation Images**

There are two precipitation images made available via the web: One-hour Precipitation and Storm Total Precipitation. The maximum range of these two images is 124 nm (about 143 miles) from the radar location. They will not display accumulated precipitation more distant than 124 nm, even though precipitation may be occurring at greater distances. To determine accumulated precipitation at greater distances you should link to an adjacent radar.

**One-hour Precipitation** is an image of estimated one-hour precipitation accumulation. It is used to assess rainfall intensities for flash flood warnings, urban flood statements and special weather statements.

**Storm Total Precipitation** image is of estimated accumulated rainfall, continuously updated, since the last one-hour break in precipitation. This product is used to locate flood potential over urban or rural areas, estimate total basin runoff and provide rainfall accumulations for the duration of the event.

Always check the time frame from which this image is created. There must be one hour without precipitation anywhere on the radar before the accumulation period begins again and, depending upon the weather patterns, that may be up to several days.

**Weather Warnings**

If any portion of a county is affected by severe weather, the NWS issues a weather warning for the *entire* county. However, we actually refine the region affected by drawing the warnings in polygons to indicate the exact region we believe severe weather may occur.

Included with the radar images are graphics of severe weather warnings. (These images can be hidden on the enhanced views of the Doppler radar by toggling off the warnings.) The colors, red, yellow, green and blue represent the four types of warnings that will appear on NWS Doppler radar images.

* **Red** - Tornado Warning. Issued when a tornado is imminent or occurring. A Tornado Warning implies an immediate threat to life and property.
* **Yellow** - Severe Thunderstorm Warning. Issued when a severe thunderstorm is imminent or occurring. A severe thunderstorm is defined as hail 1" or greater and/or a wind speed of 58 mph (50 kts / 93 km/h) or greater.
* **Green** - Flash Flood Warning. Issued with flash flooding is imminent or occurring.
* **Marine** - Special Marine Warning. Issued for hazardous weather conditions (thunderstorms over water, thunderstorms that will move over water, cold air funnels over water, or waterspouts) usually of short duration (2 hours or less) and producing sustained winds or frequent gusts of 34 knots or more that is not covered by existing marine warnings.

**Enhanced RIDGE Radar View**

The enhanced view of NWS Doppler radar images allows interactivity with the display providing you with the ability to customize the way you "look" at weather. Called **RIDGE** (**R**adar **I**ntegrated **D**isplay with **G**eospatial **E**lements), the radar image can be layered with geospatial elements such as topography maps, highways, state/county boundaries and weather warnings.

While the radar image itself is the same as in the standard version, the geospatial ability in the enhanced version allows for the use of several features to aid the viewer. Both "looping" images and "current image" have unique tools to help provide more information than what is available in the standard version of the NWS Doppler display. The following table shows which features are available.

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|  | [**Toggle overlays on/off**](http://www.srh.noaa.gov/jetstream/doppler/ridge.htm) | [**MouseOver image swap**](http://www.srh.noaa.gov/jetstream/doppler/ridge.htm) | [**Range Bearing finder**](http://www.srh.noaa.gov/jetstream/doppler/ridge.htm) | [**Determine Distance to/from object**](http://www.srh.noaa.gov/jetstream/doppler/ridge.htm) | [**Determine Lat/Long**](http://www.srh.noaa.gov/jetstream/doppler/ridge.htm) | [**Zoom and pan**](http://www.srh.noaa.gov/jetstream/doppler/ridge.htm) | [**Automatic Update**](http://www.srh.noaa.gov/jetstream/doppler/ridge.htm) |
| **Current image** | **YES** | **YES** | **YES** | **YES** | **YES** | **No** | **No** |
| **Looping images** | **YES** | **No** | **No** | **No** | **No** | **YES** | **YES** |

**Overlay toggles**

Availability: **Current Image** -  **Yes** , **Looping images** -  **Yes**   
Common to both the loop and non-looping images the overlay toggles area one of the best features of the enhanced view. Located below the main radar image, using these toggles, you have the ability to turn the various overlays graphics on and off.

* **Topo** - The topography for the region covered by the radar. This "jpeg" image is usually the largest file downloaded. The size of the files depends directly upon how much the terrain varies across the range of the radar. Large variation in terrain means this topo map file size will be large. Radars along coasts with relatively flat terrain usually have the smallest file size images. A basic black background is visible when the topo overlay is turned off. It will give you the appearance of the original style radar image.
* **Radar** - This is the actual radar image. We currently offer base reflectivity (124 km and 248 km range), base velocity, storm relative velocity, one hour precipitation and storm total precipitation. **Counties** - Counties are indicated by a green outline. White outlines indicate state boundaries.
* **Rivers** - Shows and hides major rivers and lakes.
* **Highways** - View Interstates and major U.S. Highways
* **Cities** - Turn on/off the names of major population areas.
* **Warnings** - This on/off toggle shows you the actual shape of the polygon so you can know the portion of the county that is actually under the threat of severe weather.
* **Legend** - The date/time at the top and bottom of the radar image as well as the key to the colors in the lower right.

**Preserving Your Toggle Settings.** Except for the "Rivers" image, all overlays are set to display when the page is initially loaded. However, you can control which overlays display each time a page is loaded as the RIDGE enhanced version can "remember" your preferences. One method is simply that the toggle switches are preserved as you move from radar to radar using the "Adjacent Radars" arrows.

A second method to preserve your preferences is to change the default settings manually in the radar's URL, located at the top of your browser. In the URL you will see a section of the address that looks like this...

overlay=11101111

These ones and zero signify which overlay is visible and and which is not. There is a value, 1 or 0, for each overlay toggle where the number "1" indicates an overlay is *visible* and the "0" indicated the overlay is *hidden*. The ones and zero are in the same order as the toggle boxes. By default, we set the "Rivers" overlay to be "0" meaning that it is hidden when the page initially loads.

To preserve your toggle settings, change the ones and zeros to your preference, then *bookmark that page*. That will save the URL with your preferences. Those preferences will also be preserved when you move from radar to radar using the "Adjacent Radars" arrows.

Note: All overlays will load each time a RIDGE page is loaded. The toggle functions only hides or un-hides each overlay.

**MouseOver Image Swap**



Availability: **Current Image** -  **Yes** , **Looping images** -  **No**   
When the current image is loaded, all images in addition to the overlays are loaded as well. These include: **Base Reflectivity**, **Composite Reflectivity**, **Base Velocity**, **Storm Relative Motion**, **One-Hour Precipitation** and **Storm Total Precipitation**. You can view each image by clicking on its link.

But for a faster comparison between images, there is a MouseOver switch that will change each image just by moving the mouse over the link. By default, the switch is off. To enable the feature select the "MouseOver On" option from the drop-down menu located about midway down to the left of the radar image.

Why do this? No one radar image provides the whole "picture" of what is occurring, especially during severe weather. Often meteorologist want to compare **Base Reflectivity** with **Storm Relative Motion** images to determine locations of wind flow relative to intense rainfall. This MouseOver feature allows for quicker comparison between the two images without taking eyes off of the images themselves.

**Range and Bearing, Distance and Latitude/Longitude**

Availability: **Current Image** -  **Yes** , **Looping images** -  **No**   
Located below the overlay toggles, range and bearing information provides you with an *interactive* tool to determine the distance and direction to an object. It is basically divided into two halves; "distance from radar" and "distance from selected location".



* **Distance from Radar** - When the page first loads, the reference point for the "distance from radar" information will be located at the radar itself as indicated by the "0 mi North". The reference point's latitude and longitude are also indicated (negative degrees indicates WEST longitude).  
    
  Clicking anywhere on the radar image resets the reference point to the location selected. That new reference point's distance and direction are now given relative to the radar. Clicking **RESET** returns the reference point to the radar's location at the center of the image.
* **Distance from Selected Location** - Using the mouse pointer, this is the distance (in miles) and direction (in whole degrees) from the selected reference point. As you move the mouse this information constantly updates. By default, the selected location is at the radar in the center of the image.

To determine your distance from a storm, you can either click on the storm and move your mouse over your location or select your location and move the mouse over the storm. The latitude and longitude are also indicated (negative degrees indicates WEST longitude).

**Zooming and Panning**

Availability: **Current Image** -  **No** , **Looping images** -  **Yes**  Only available for looping images, the RIDGE display features the ability to "zoom in" and "pan around" the image. The instructions are located at the bottom of the controls on the looping images.

To **Zoom**, select the looping image you desire, then just click on the image at the point you want to zoom. The more you click, the more you zoom. Right click to reverse the zoom. Middle click (the wheel on some mice) to reset to the original image.

The resolution of the radar images is 0.54 x 0.54 nautical miles (1x1 kilometer). This is the same resolution seen by the meteorologists at your local [Forecast Office](http://www.srh.noaa.gov/jetstream/nws/wfo_map.htm). As a result, you will notice the image becoming increasingly "blocky" as you zoom.

To **Pan** select the looping image you desire then click on the image where you want to zoom and zoom at least one time. Then "Click and hold" the mouse button down to drag the inside of the applet window.

**Omitting Bad Images**

Availability: **Current Image** -  **No** , **Looping images** -  **Yes**   
Occasionally bad or mis-dated images will be included in loops. To omit the image(s), click the little blue square (located just below the toggles) that is associated with the wrong image. That square will turn red and will not be included in the loop.

**AutoUpdate**

Availability: **Current Image** -  **No** , **Looping images** -  **Yes**   
Also only a part of the looping feature, to refresh the loop automatically, click the "AutoUpdate is Off" button. The text will change to "AutoUpdate is On" and the loop will update every five minutes. However, depending upon the radar's [volume coverage pattern](http://www.srh.noaa.gov/jetstream/doppler/vcp_max.htm) the looping images may not update with each refresh.

**Downloading RIDGE Radar Images**

Unlike the old radar display, "right clicking" on a RIDGE radar image will only allow you to copy or "save to the clipboard" the very top layer, based upon the selected overlays. In the toggle overlay section, just below the radar image, the *right most* selected overlay is the top image.



In the example above, the "Legend" graphic is the top image selected. Trying to save the RIDGE image will only save the legend graphic. In the toggle overlay example (below), the "Cities" overlay is the top graphic and the only one that can be saved by selecting the image.



A typical RIDGE radar view is comprised of seven individual images layered on top of each other through the use of style sheets. Except for the topography, these images are a "gif" format with a white background that has been made transparent. (The topography image is a compressed jpeg image.) To reproduce the RIDGE radar image, each layer needs to be captured and stacked on top of each other.

But it is not as bad as it sounds as fortunately, for any one radar site, once a copy of the overlays are obtained, only the radar image and the "Warnings" and "Legend" overlays change. The "Highways", "Topo", "Counties", "Rivers", and "Cities" overlays only needed to be downloaded once.

At present, there are three ways to obtain images from the RIDGE radar.

* **Grunt method**. Use the overlay toggles and "right click" on each layer to save it to the local computer. Remember, this only saves the *right-most* image as indicated by the toggle bar.
* **Screen Capture**. Use the toggle overlays to configure the image then use a screen capture utility to save the image to the local computer. This saves the steps needed to stack the images onto of each other in a graphics program and is also how all the RIDGE images used in this section were obtained.
* **Download the individual files**. All RIDGE radar images are downloadable and all that is needed is the URL. The table (below) provides the paths to each image. For the radar image, legend, or warnings images, the most recent graphic available ends in "\_0.gif". For example, the most recent radar image for the Fort Worth Doppler radar is...

<http://radar.weather.gov/ridge/RadarImg/N0R/FWS_N0R_0.gif>

To view and retrieve the 20 most recent radar images then the URL is...

<http://radar.weather.gov/ridge/RadarImg/N0R/FWS/>

The filename format for these recent images is: xxx\_YYYYMMDD\_hhmm\_N??.gif, where  
xxx - [Radar site ID](http://www.srh.noaa.gov/jetstream/doppler/ridge_download.htm)  
YYYY - year  
MM - month  
DD - day  
hh - hour  
mm - minutes  
N?? - image ID (N0R, N0S, etc)

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| The paths to the RIDGE overlays are [**http://radar.weather.gov/ridge**](http://radar.weather.gov/ridge) (then) | | | |
| **Directory** | **Overlay Directory** | **Directory (for short range) or Directory (for long range)** | **Filename** |
| /Overlays | /Topo | /Short | /xxx\_Topo\_Short.jpg |
| /Long | /xxx\_Topo\_Long.jpg |
| /County | /Short | /xxx\_County\_Short.gif |
| /Long | /xxx\_County\_Long.gif |
| /Rivers | /Short | /xxx\_Rivers\_Short.gif |
| /Highways | /Short | /xxx\_Highways\_Short.gif |
| /Long | /xxx\_Highways\_Long.gif |
| /Cities | /Short | /xxx\_City\_Short.gif |
| /Long | /xxx\_City\_Long.gif |

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| The paths to the NWS severe weather warnings overlays are [**http://radar.weather.gov/ridge**](http://radar.weather.gov/ridge) (then) | | | |
| **Directory** | **Directory** | **Directory (for past images) or Filename (for current image)** | **Legend** |
| /Warnings | /Short | /xxx | **xxx**: [Radar site ID](http://www.srh.noaa.gov/jetstream/doppler/ridge_download.htm)  The file name format for past images is as follows:  xxx\_YYYYMMDD\_hhmm\_N??\_Warnings.gif  YYYY - year MM - month DD - day hh - hour mm - minutes N?? - image ID (N0R, N0S, etc) |
| /xxx\_Warnings\_0.gif |
| /Long | /xxx |
| /xxx\_Warnings\_0.gif |

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| The paths to the RIDGE legend overlays are [**http://radar.weather.gov/ridge**](http://radar.weather.gov/ridge) then | | | |
| **Directory** | **Image ID** | **Directory (for past images) or Filename (for current image)** | **Legend** |
| /Legend | /N0R | /xxx | Short Range images (views out to 124 nmi) **N0R**: Base Reflectivity **N0S**: Storm Relative Motion **N0V**: Base Velocity **N1P**: One-Hour Precipitation **NCR**: Composite Reflectivity **NTP**: Storm Total Precipitation  Long Range image (view out to 248 nmi) **N0Z**: Base Reflectivity  **xxx**: [Radar site ID](http://www.srh.noaa.gov/jetstream/doppler/ridge_download.htm)  The file name format for past images is as follows:  xxx\_YYYYMMDD\_hhmm\_N??\_Legend.gif  YYYY - year MM - month DD - day hh - hour mm - minutes N?? - image ID (N0R, N0S, etc) |
| /xxx\_N0R\_Legend\_0.gif |
| /N0S | /xxx |
| /xxx\_N0S\_Legend\_0.gif |
| /N0V | /xxx |
| /xxx\_N0V\_Legend\_0.gif |
| /N0Z | /xxx |
| /xxx\_N0Z\_Legend\_0.gif |
| /N1P | /xxx |
| /xxx\_N1P\_Legend\_0.gif |
| /NCR | /xxx |
| /xxx\_NCR\_Legend\_0.gif |
| /NTP | /xxx |
| /xxx\_NTP\_Legend\_0.gif |

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| **Radars ID's by Site** | **Radars ID's by State** |

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**tRadar Images for GIS Software**

The best feature about the RIDGE enhanced views of NWS Dopper radar images is that each image can be incorporated into GIS software. Each RIDGE radar image is created separately without backgrounds on the image and in a standard geographic projection referenced to **North American Datum 1983** (NAD83). With GIS software (free or off-shelf) you can import the image and add any overlaying dataset without the distraction of unwanted layers.

Each of the RIDGE radar image has a "world file" associated with it. A world file is an ASCII text file associated with an image and contains the following lines:  
Line 1: x-dimension of a pixel in map units  
Line 2: rotation parameter  
Line 3: rotation parameter  
Line 4: NEGATIVE of y-dimension of a pixel in map units  
Line 5: x-coordinate of center of upper left pixel  
Line 6: y-coordinate of center of upper left pixel  
  
If the image file name has a 3-character extension (image1.gif), the world file has the same name followed by an extension containing the first and last letters of the image's extension and ending with a 'w' (image1.gfw).

**Loading Images into GIS Software**

**Individual Radars**

* Go to the directory where the radar images reside: <http://radar.weather.gov/ridge/RadarImg/>
* Select an image directory:
* N0R = Reflectivity
* N1P = 1 Hour Precipitation
* NTP = Storm Total Precipitation
* NOV = Velocity
* N0S = Storm Relative Motion
* N0Z = Long Range Reflectivity
* Save both the image of the radar (file ending in ".gif") and the **world file** (ending in ".gfw") that goes with it to a computer in the same directory. (The "\_0" in the file name indicates that this is the latest image.)
* Load the image into a GIS as any other layer.

This process can be repeated for the warning polygons (<http://radar.weather.gov/ridge/Warnings/Short/>) and all other layers on the RIDGE pages (<http://radar.weather.gov/ridge/Overlays/>)

**National or Regional Mosaics:**

* Go to the directory where the images reside: <http://radar.weather.gov/ridge/Conus/RadarImg/>
* Select an image:
* National Mosaic = latest\_radaronly.gif (3400x1600)
* Pacific Northwest Sector = pacnorthwest\_radaronly.gif (840x800)
* Northern Rockies Sector = northrockies\_radaronly.gif (840x800)
* Upper Mississippi Valley Sector = uppermissvly\_radaronly.gif (840x800)
* Central Great Lakes Sector = centgrtlakes\_radaronly.gif (840x800)
* Northeast Sector = northeast\_radaronly.gif (840x800)
* Southeast Sector = southeast\_radaronly.gif (840x800)
* South Mississippi Valley Sector = southmissvly\_radaronly.gif (840x800)
* Southern Plains Sector = southplains\_radaronly.gif (840x800)
* Southern Rockies Sector = southrockies\_radaronly.gif (840x800)
* Pacific Southwest Sector = pacsouthwest\_radaronly.gif (840x800)
* Save both the image and radar (file ending in ".gif" and the **world file** (ending in ".gfw") that goes with it to a computer in the same directory.
* Load the image into a GIS as any other layer.

**Frequently Asked Questions**

**Why does it take so long to load?**  
The enhanced version initially takes longer to load due to added functionality such as the toggle on/off ability of graphics, calculating the distance from a storm to your approximate location and lat/lon info for hurricane tracking.

However, many of the overlays are static in that they do not require to be retransmitted to update the page. Since these images are "cached" on your computer, subsequent visits to your favorite radar site do not require retransmission of most graphics leading to a much reduced download file size.

For most folks, the topography image is the largest file the needs to be transferred. The file size of the topo overlay is smallest for radar located near the ocean or Great Lakes. The largest topo files are for radars in the Rocky Mountain regions due to large differences in terrain.

**Why can't I loop radar images in the standard version with my broadband connection?**  
The looping images in the "[Standard Version](http://www.srh.noaa.gov/ridge/index_lite.htm)" radar display are animated gifs. Some third-party browser utilities include "pop-up blockers" which include a feature to disable *animated ads*. Set your preference to allow animated ads and the radar loop should load properly.

**Why can't I loop radar images in the standard version with my dial-up connection?**  
The looping images in the "[Standard Version](http://www.srh.noaa.gov/ridge/index_lite.htm)" radar display are animated gifs. Web accelerator services that are designed to decrease your download times do so by many methods, one of which is to compress graphics.

When an accelerator service compresses the radar loop, it essentially keeps the oldest image (first in the loop) and deletes the remaining images. To view the loop in the "Standard Version" you need to disable the accelerator service to prevent this compression of the radar image.

Yes, the files are large and it will be slow on dial-up but the overall file size, including the webpage and all graphics is typically much smaller than the old original looping version (about 25% smaller).

**Why is the image squashed? What projection is this?**  
The images appear elongated because of the Geographic Coordinate System (GCS) way of displaying the information. In order for GIS-based programs to ingest the Doppler radar data, the information is displayed in an UN-projected format. This means the display of information, intended for a spherical earth, becomes distorted when the image is viewed on a flat surface.

**Why doesn't the loop fully load?**  
The looping feature requires Adobe Flash Player to operate. Please visit [get.adobe.com/flashplayer](http://get.adobe.com/flashplayer/) for more information on Adobe Flash Player or download the most recent version.

**Where is the old "black background" version?**  
In the "[Standard Version](http://www.srh.noaa.gov/ridge/index_lite.htm)" of the radar display, the background color was changed from black to white for accessibility reasons. The black background was less friendly to those with colorblindness. In fact the black background with green and red data (highways and county lines) is impossible for the 1 in 20 males to use. The white background complies with Section 508 accessibility requirements - which cannot be said for the black background.

**How can I set the way I want the overlays to display?**  
See "[Preserving Your Toggle Settings](http://www.srh.noaa.gov/jetstream/doppler/ridge.htm)"

**How can I zoom and pan on a storm or feature?**  
The zoom feature is based on a Java applet and that is *only seen on the looping mode* of the radar. Select the looping image you desire then select the "zoom-pan" button ([located just below the main radar image](http://www.srh.noaa.gov/jetstream/doppler/ridge.htm)). Your pointer should change to a finger.

To ZOOM: Click on the image where you want to zoom. The more you click the image the more you zoom.

To PAN: If you "click and hold" the mouse button down you can then drag the image around inside of the applet window.

**How often does the radar display refresh with AutoUpdate turned on?**  
Every five minutes. [Read more about the AutoUpdate feature.](http://www.srh.noaa.gov/jetstream/doppler/ridge.htm)

**The radar stopped working - what have you done?**  
There may several reasons why a radar is not in operation but primarily will be due to either a part that has failed or it is just routine maintain. Check the [Status reports](http://www.weather.gov/view/validProds.php?prod=FTM) page of the Doppler radar. These are messages describing the anticipated time the radar is to be out of service.

**Radar Images**

**Are there any other radar images available besides the current six?**  
The National Weather Service has a central collection of WSR-88D radar products in process. While we currently only display six of those products (Base Reflectivity, Composite Reflectivity, Base Velocity, Storm Relative Motion, One-Hour Precipitation, and Storm Total Precipitation) through these local radar pages, you can receive all products through a "multicast" flow or via standard anonymous FTP from the Gateway file servers. Information on the other products and the type of computer equipment you need to receive the products can be found at the [Radar Product Central Collection/Distribution Service](http://www.nws.noaa.gov/tg/rpccds.html) webpage.

**What are the different types of radar images?**  
There are six different types of images currently available for the RIDGE radar display: Base Reflectivity, Composite Reflectivity, Base Velocity, Storm Relative Motion, One-hour Precipitation and Storm Total Precipitation.

**Base Reflectivity**

This is a display of echo intensity (reflectivity) measured in **dBZ** (decibels of Z, where Z represents the energy reflected back to the radar). "Reflectivity" is the amount of transmitted power returned to the radar receiver. Base Reflectivity images are available at several different elevation angles (tilts) of the antenna and are used to detect precipitation, evaluate storm structure, locate atmospheric boundaries and determine hail potential.  
  
The base reflectivity image is from the lowest "tilt" angle (0.5°). This means the radar's antenna is tilted 0.5° above the horizon.

**Composite Reflectivity**

This display is of maximum echo intensity (reflectivity) from any elevation angle at every range from the radar. This product is used to reveal the highest reflectivity in all echoes. When compared with Base Reflectivity, the Composite Reflectivity can reveal important storm structure features and intensity trends of storms.

**Base Velocity**

This display of [radial velocity](http://www.srh.noaa.gov/jetstream/doppler/radialvel_max.htm) represents the overall wind field. Green colors indicate wind moving *toward* the radar with red colors indicating wind moving *away* from the radar. The maximum range of this product is 124 nm (about 143 miles) from the radar location

**Storm Relative Motion**

This display is of [radial velocity](http://www.srh.noaa.gov/jetstream/doppler/radialvel_max.htm) of the wind relative to the storm's motion. The result is a picture of the wind as if the storms were stationary. This often unmasks storms that rotate (supercells) which can be a precursor to the formation of tornadoes. Green colors indicate wind moving toward the radar with red colors indicating wind moving away from the radar. The maximum range of this product is 124 nm (about 143 miles) from the radar location

**One-hour Precipitation**

This is an image of estimated one-hour precipitation accumulation. This product is used to assess rainfall intensities for flash flood warnings, urban flood statements and special weather statements. The maximum range of this product is 124 nm (about 143 miles) from the radar location. This image will not display accumulated precipitation more distant than 124 nm, even though precipitation may be occurring at greater distances. To determine accumulated precipitation at greater distances you should link to an adjacent radar.

**Storm Total Precipitation**

This image is of estimated accumulated rainfall, continuously updated, since the last one-hour break in precipitation. This image is used to locate flood potential over urban or rural areas, estimate total basin runoff and provide rainfall accumulations for the duration of the event.  
  
The maximum range of this product is 124 nm (about 143 miles) from the radar location. This product will not display accumulated precipitation more distant than 124 nm, even though precipitation may be occurring at greater distances. To determine accumulated precipitation at greater distances link to an adjacent radar.

**What is Range Folding (RF)? What does the purple color mean?**  
Range Folding is basically when the radar is unable to determine the wind's velocity. This is due to the speed at which the radar transmits signals, called the pulse repetition frequency (PRF). The faster the pulses are sent by the radar the less time it has to listen for any returned signals. It occurs when the return from a prior pulse is detected during the listening period for the current pulse. Both reflectivity and velocity data are affected by this.  
  
The occurrence of range folding can usually be detected by radar software and reflectivity data can be "unfolded" using special programs. However, velocity data cannot be accurately unfolded and therefore the effective range with which Doppler radars can detect velocity data is limited by the frequency of the radar pulses; the higher the pulse rate, the shorter the range within which the velocity field can be determined.  
  
When the radar is unable to "unfold" the information, we paint the region purple as an indicator of the problem. There are some ways to minimize range folding and we have recently implemented a program which will sample the atmosphere with different PRF to do just that.

**What do the colors mean in the reflectivity images?**  
The colors are the different values of energy that are reflected back toward the radar. Called echoes, the reflected intensities are measured in dBZ (decibels of z). As the strength of the signal returned to the radar increases the dBZ values increases. The Doppler radar does not determine where rain is located, only areas of returned energy.

The "dB" in the dBz scale is logarithmic and has no numerical value, but is used only to express a ratio. The "z" is the ratio of the density of water drops (measured in millimeters, raised to the 6th power) in each cubic meter (mm^6/m^3). Mathematically:

**dBz= 10 \* log (z/z0)** Where z = reflectivity factor and Z0 is defined to be 1 mm^6/m^3

When the "z" is large (many drops in a cubic meter), the reflected power is large. A small "z" means little returned energy. In fact, "z" can be less than 1 mm^6/m^3 and since it is logarithmic, dBz values will become negative, as often in the case when the radar is in clear air mode and indicated by earthtone colors.

The scale of dBZ values is also related to the intensity of rainfall. Typically, light rain is occurring when the dBZ value reaches 20. The higher the dBZ, the stronger the rainrate.

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**What do the colors mean in the velocity images?**  
The colors are the different [radial velocities](http://www.srh.noaa.gov/jetstream/doppler/radialvel_max.htm) measured by the radar. In velocity images, red colors indicated wind moving away from the radar with green colors indicating motion toward the radar. The transition zone between incoming and outgoing winds are indicated the gray-ish colors between the two.

Each velocity image includes one of two velocity scales regardless of the radar's operation mode. One scale (far left) represents radial velocities in the base velocity image. The other scale (near left) represents the "storm relative motion" radial velocities. *Note: As in the case of reflectivity images, the* ***color*** *on each scale* ***remains the same*** *in both velocity images,* ***only*** *the* ***values change****.* The velocity of the wind is measured in knots (1 knot = 1.15 mph).

Since these colors represent values relative to the radar, to interpret these images correctly, it is most important to know where the radar is located each velocity image. For example, a region with outbound wind in one radar will be represented by red colors. That same region's wind could be inbound on an adjacent radar image and represented by green colors.

**General questions**

**How does the radar work?**  
**NEXRAD** (**Nex**t Generation **Rad**ar) obtains weather information (precipitation and wind) based upon returned energy. The radar emits a burst of energy (green). If the energy strikes an object (rain drop, bug, bird, etc), the energy is scattered in all directions (blue). A small fraction of that scattered energy is directed back toward the radar.

This reflected signal is then received by the radar during its listening period. Computers analyze the strength of the returned pulse, time it took to travel to the object and back, and phase shift of the pulse. This process of emitting a signal, listening for any returned signal, then emitting the next signal, takes place very fast, up to around 1300 times each second.

**Is everything I see on the images an accurate picture of my weather?**  
Weather surveillance radars such as the WSR-88D can detect most precipitation within approximately 80 nautical miles (nm) of the radar, and intense rain or snow within approximately 140 nm. However, light rain, light snow, or drizzle from shallow cloud weather systems are not necessarily detected.

Echoes from surface targets appear in almost all radar reflectivity images. In the immediate area of the radar, "ground clutter" generally appears within a radius of 20 nm. This appears as a roughly circular region with echoes that show little spatial continuity. It results from radio energy reflected back to the radar from outside the central radar beam, from the earth's surface or buildings.

Under highly stable atmospheric conditions (typically on calm, clear nights), the radar beam can be refracted almost directly into the ground at some distance from the radar, resulting in an area of intense-looking echoes. This "anomalous propagation" phenomenon (commonly known as AP) is much less common than ground clutter. Certain sites situated at low elevations on coastlines regularly detect "sea return", a phenomenon similar to ground clutter except that the echoes come from ocean waves.

Returns from aerial targets are also rather common. Echoes from migrating birds regularly appear during nighttime hours between late February and late May, and again from August through early November. Return from insects is sometimes apparent during July and August. The apparent intensity and areal coverage of these features is partly dependent on radio propagation conditions, but they usually appear within 30 nm of the radar and produce reflectivities of <30 dBZ (decibels of Z).

However, during the peaks of the bird migration seasons, in April and early September, extensive areas of the south-central U.S. may be covered by such echoes. Finally, aircraft often appear as "point targets" far from the radar, particularly in composite reflectivity images.

The radar is also limited close in by its inability to scan directly overhead. Therefore, close to the radar, data are not available due to the radar's maximum tilt elevation of 19.5°. This area is commonly referred to as the radar's "Cone of Silence".

Though surface echoes appear in the base and composite reflectivity images, special automated error checking generally removes their effects from precipitation accumulation products. The national reflectivity mosaic product is also automatically edited to detect and remove most non-precipitation features. Even with limited experience, users of unedited products can differentiate precipitation from other echoes, if they are aware of the general meteorological situation.

**What is UTC Time?**

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| U. S. Standard Time vs. Universal Time Coordinated (Z-time) | | | | | | | | | | | | | | | | | | | | | | | | | |
| **UTC Time** | **off- set** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** |
| **AST** | -4 | 8p\* | 9p\* | 10p\* | 11p\* | 12M | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12N | 1p | 2p | 3p | 4p | 5p | 6p | 7p |
| **EST** | -5 | 7p\* | 8p\* | 9p\* | 10p\* | 11p\* | 12M | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12N | 1p | 2p | 3p | 4p | 5p | 6p |
| **CST** | -6 | 6p\* | 7p\* | 8p\* | 9p\* | 10p\* | 11p\* | 12M | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12N | 1p | 2p | 3p | 4p | 5p |
| **MST** | -7 | 5p\* | 6p\* | 7p\* | 8p\* | 9p\* | 10p\* | 11p\* | 12M | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12N | 1p | 2p | 3p | 4p |
| **PST** | -8 | 4p\* | 5p\* | 6p\* | 7p\* | 8p\* | 9p\* | 10p\* | 11p\* | 12M | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12N | 1p | 2p | 3p |
| **AK** | -9 | 3p\* | 4p\* | 5p\* | 6p\* | 7p\* | 8p\* | 9p\* | 10p\* | 11p\* | 12M | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12N | 1p | 2p |
| **Hi** | -10 | 2p | 3p\* | 4p\* | 5p\* | 6p\* | 7p\* | 8p\* | 9p\* | 10p\* | 11p\* | 12M | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12N | 1p |
| **Guam** | +10 | 10a | 11a | 12N | 1p | 2p | 3p | 4p | 5p | 6p | 7p | 8p | 9p | 10p | 11p | 12M% | 1a% | 2a% | 3a% | 4a% | 5a% | 6a% | 7a% | 8a% | 9a% |
| Note: AST - Atlantic   AK - Alaska time   HI - Hawaii time   \*The previous day   %The next day | | | | | | | | | | | | | | | | | | | | | | | | |  |

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| Daylight Saving Time vs. Universal Time Coordinated (Z-time) | | | | | | | | | | | | | | | | | | | | | | | | | |
| **UTC Time** | **off- set** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** |
| **EDT** | -4 | 8p\* | 9p\* | 10p\* | 11p\* | 12M | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12N | 1p | 2p | 3p | 4p | 5p | 6p | 7p |
| **CDT** | -5 | 7p\* | 8p\* | 9p\* | 10p\* | 11p\* | 12M | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12N | 1p | 2p | 3p | 4p | 5p | 6p |
| **MDT** | -6 | 6p\* | 7p\* | 8p\* | 9p\* | 10p\* | 11p\* | 12M | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12N | 1p | 2p | 3p | 4p | 5p |
| **PDT** | -7 | 5p\* | 6p\* | 7p\* | 8p\* | 9p\* | 10p\* | 11p\* | 12M | 1a | 2a | 3a | 4a | 5a | 6a | 7a | 8a | 9a | 10a | 11a | 12N | 1p | 2p | 3p | 4p |

Weather observations around the world (including radar observations) are always taken with respect to a standard time. By convention, the world's weather communities use a twenty four hour clock, similar to "military" time based on the 0° longitude meridian, also known as the Greenwich meridian.

To obtain your local time here in the United States, you need to subtract a certain number of hours from UTC depending on how many time zones you are away from Greenwich (England). The table (right) shows the standard difference from UTC time to local time.

The switch to daylight saving time does not affect UTC. It refers to time on the zero or Greenwich meridian, which is not adjusted to reflect changes either to or from Daylight Saving Time.

However, you need to know what happens during daylight saving time in the United States. In short, the **local time is advanced one hour** during daylight saving time. As an example, the Eastern Time zone difference from UTC is a -4 hours during daylight saving time rather than -5 hours as it is during standard time.

**Where is the sweeping line showing where the radar is pointing?**  
Prior to Doppler radars, the old analog type of radar continually transmitted a signal and its return would be projected on a screen as a line sweeping around the scope. As the radar made its sweep, the updated information would overwrite the older info. Also these older weather radars required an operator to manually tilt the antenna up and down whenever a vertical cross section of a storm was desired, or when the upper parts of a storm needed to be investigated.

Doppler radars store information like all digitized systems; in 1's and 0's. Because of this, all Doppler radars wait until the radar makes one complete 360° rotation before any information is transmitted to the user. Gone is the old sweeping line. It no longer applies to Doppler's digital data.

Old habits are hard to die however. You may occasionally notice a sweeping line (with data being updated as it makes its sweep) during the weather report of some television stations. This is special effect and is not real. Special software had to be written to make it **appear** the information is being updated as the beam moves. The National Weather Service does not use this effect, which is why you do not see any sweeping lines.

**How often are the images updated?**  
Image updates are based upon the operation mode of the radar at the time the image is generated. The WSR-88D Doppler radar is operated in one of two modes -- **clear air mode** or **precipitation mode**. In clear air mode, images are updated every 10 minutes. In precipitation mode, images are updated every four to six minutes. The collection of radar data, repeated at regular time intervals, is referred to as a volume scan.