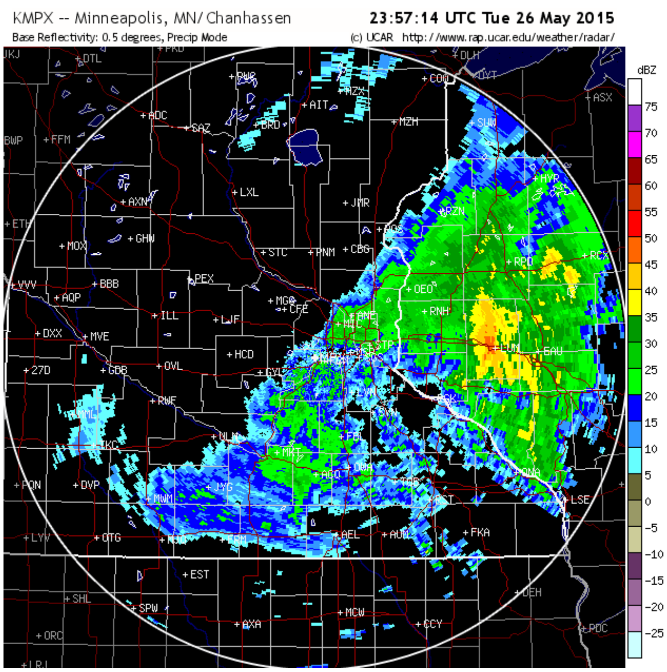
Radar

Radar stands for **RA**dio **D**etection **A**nd **R**anging and is used in meteorology for a variety of purposes. Most commonly, radar is used to find the locations of precipitation and determine where heavy the precipitation is. Radars provide meteorologists with real-time weather data, in order to help them make their forecasts. Radar data can be useful to determine how quickly precipitation is moving through the area, what type of precipitation is falling, and how much precipitation has accumulated. This information allows meteorologists to make forecasts in real-time for flooding, icing, and severe weather.

The display that shows this is called **base reflectivity** and is plotted on a map in dBZ. Below is a sample base reflectivity radar map, where higher values of base reflectivity indicate heavier precipitation and are coded in brighter colors of orange, red, and pink.



In the example above, the highest values of base reflectivity are in Western Wisconsin.

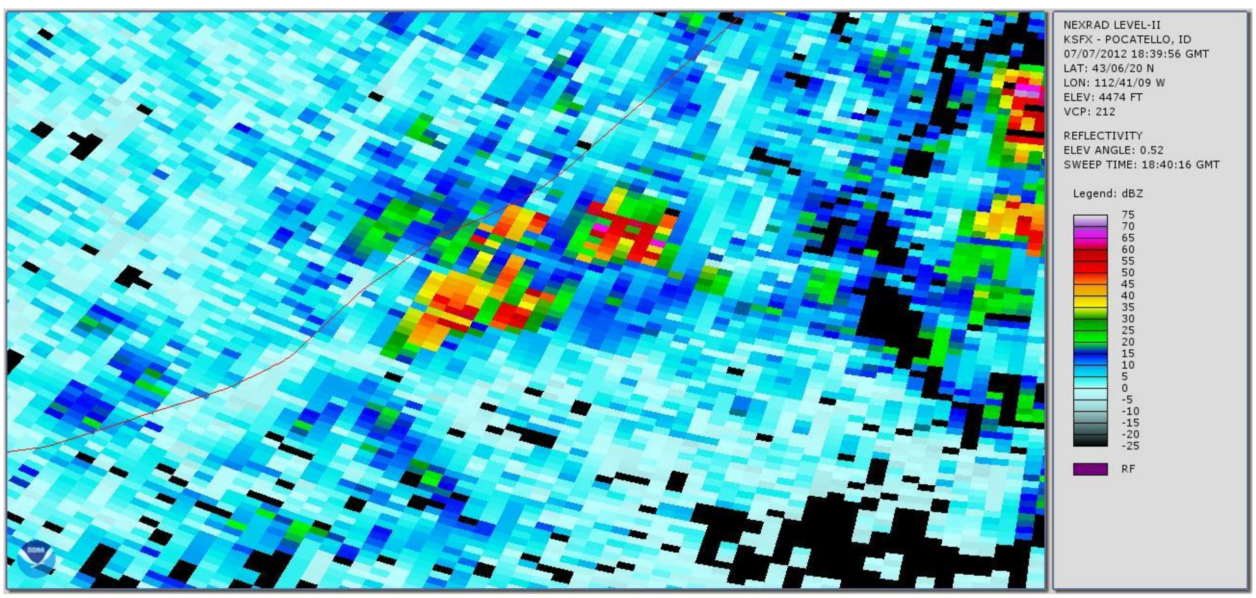
The radar scans the atmosphere with radio wave beam and sweeps in a circle. The radar sweeps at a variety of elevation angles in order to find out what is occurring at different levels in the atmosphere. However, nearly all radar images you will see come from a single elevation angle that covers close to the ground.

The science behind radars is very complex. How a radio senses weather targets and non-weather targets is described by a complicated equation called "The Radar Equation" which is found by using difficult algebraic and physics concepts. Therefore, it is not explained here.

Radars are also only helpful for a certain distance around the radar. In an ideal situation, the best radars have large distance ranges and are able to measure the highest wind speeds. Both of these properties are very important to meteorologists. But, that is a caveat. You cannot have both without lowering the wavelength of the radar, which limits the radar's overall effectiveness. This is called the Doppler dilemma, and it is a major hindrance to radar usage.

In addition to base reflectivity described previously, there are additional radar products. Other radar products tell us about how fast the **hydrometeors** (i.e. precipitation) are moving (base velocity), how much their size is changing (Differential Reflectivity-ZDR), how tall and wide they are (Correlation Coefficient) and a variety of other products. However, many of these are only used by trained meteorologists and are not available on most radar websites.

Radars also pick up more than just hydrometeors. Frequently radars will show the presence from a variety of non-weather targets, such as wind farms, birds, aircraft, and buildings. This false data often poses difficulties for meteorologists and computer programs alike, as they affect precipitation estimates and other signatures for different types of severe and hazardous weather. Such as the image below (Courtesy of NOAA NEXRAD Data Archive and NOAA Weather and Climate toolkit):



The above image shows a wind farm in eastern Idaho from July 7, 2012. While it looks like precipitation is falling, on this day Pocatello reported no precipitation and clear skies. Turns out, there are a number of wind farms across eastern Idaho! While on sunny days this poses minimal issues, wind farms can pose an issue in identifying regions of light precipitation and sometimes moderate to heavy precipitation!

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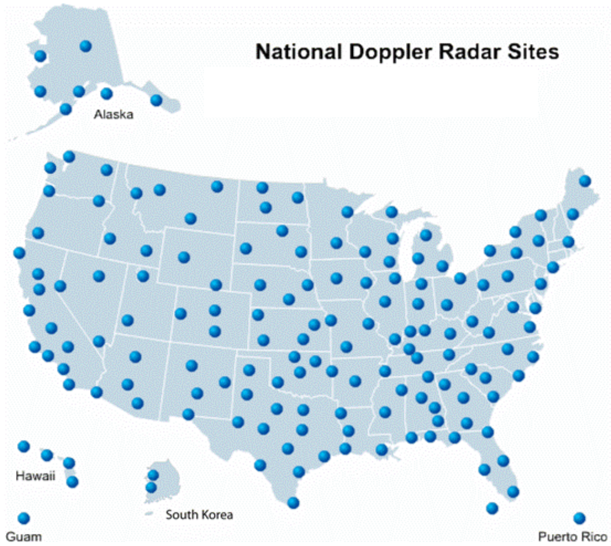
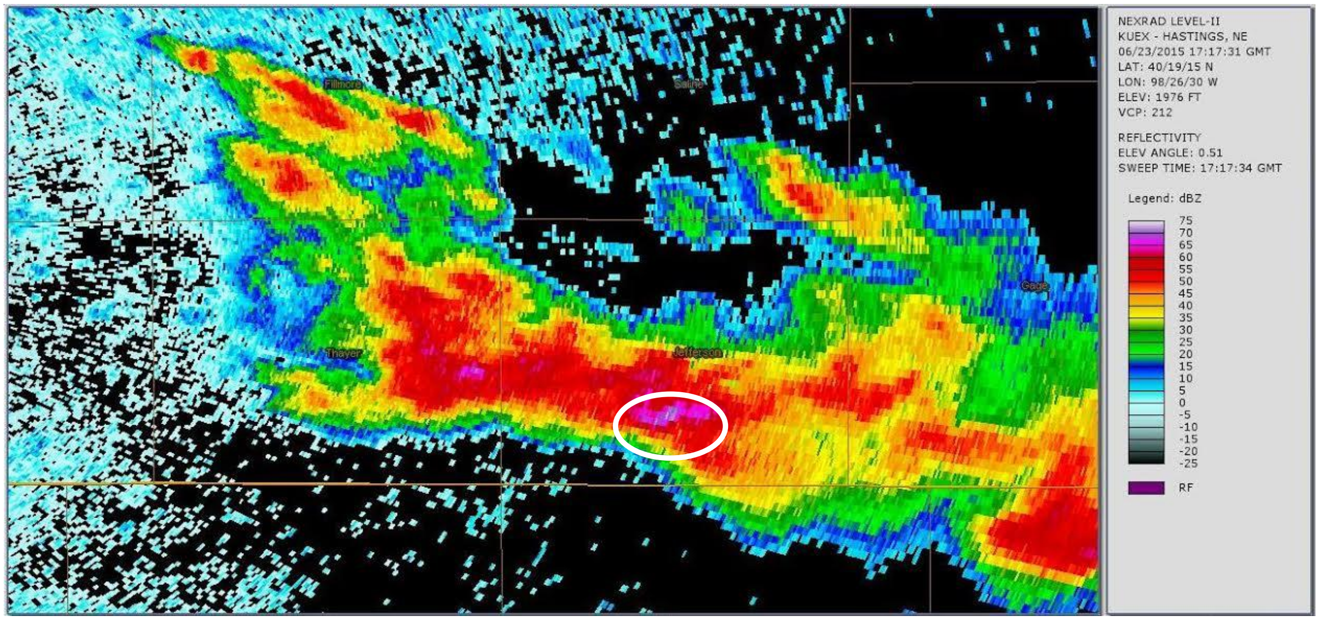
Radars are typically located at or near airports, military bases, and National Weather Service offices. There are over 100 radar sites that are part of the National Weather Service network of radars. Below is map showing all of the locations of these Radars. As this map shows, there is NOT a NWS radar in every state, as Connecticut, Maryland, New Hampshire, and Rhode Island do not have a radar, but all four states are amply covered by radars from surrounding states.



On the outside, Radars look like large white balls in the air on top of a metal structure, such as the radar for the Twin Cities, located in in Chanhassen, MN below:

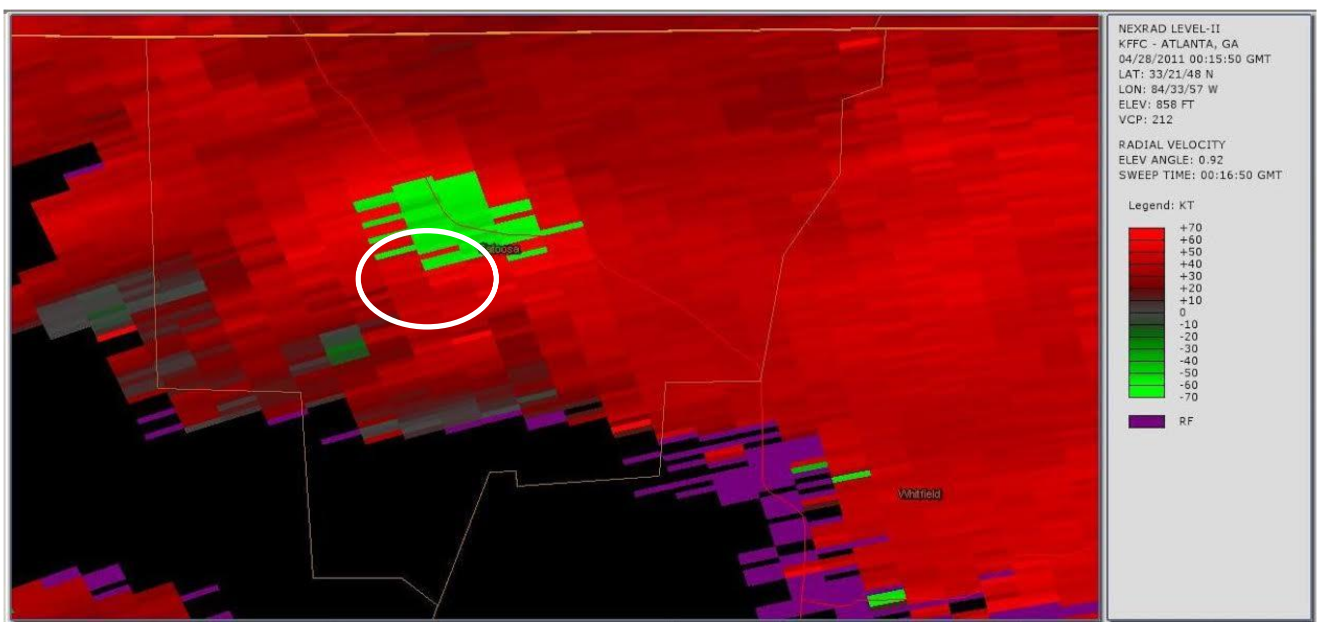
Below are some examples of different radar images of different types of weather events. Images obtained via NOAA NEXRAD Data Archive and NOAA Weather and Climate toolkit.

Example #1:



The above radar image comes from the Hastings, Nebraska radar on June 23, 2015. It is showing base reflectivity values. At the time of this radar sweep, very large hail (diameter of over two inches) was reported to the National Weather Service in the region circled in white. In that region, base reflectivity values go up to around 75 dBZ! Usually, base reflectivity values over 65 dBZ are indicative of large hail falling.

Example #2:



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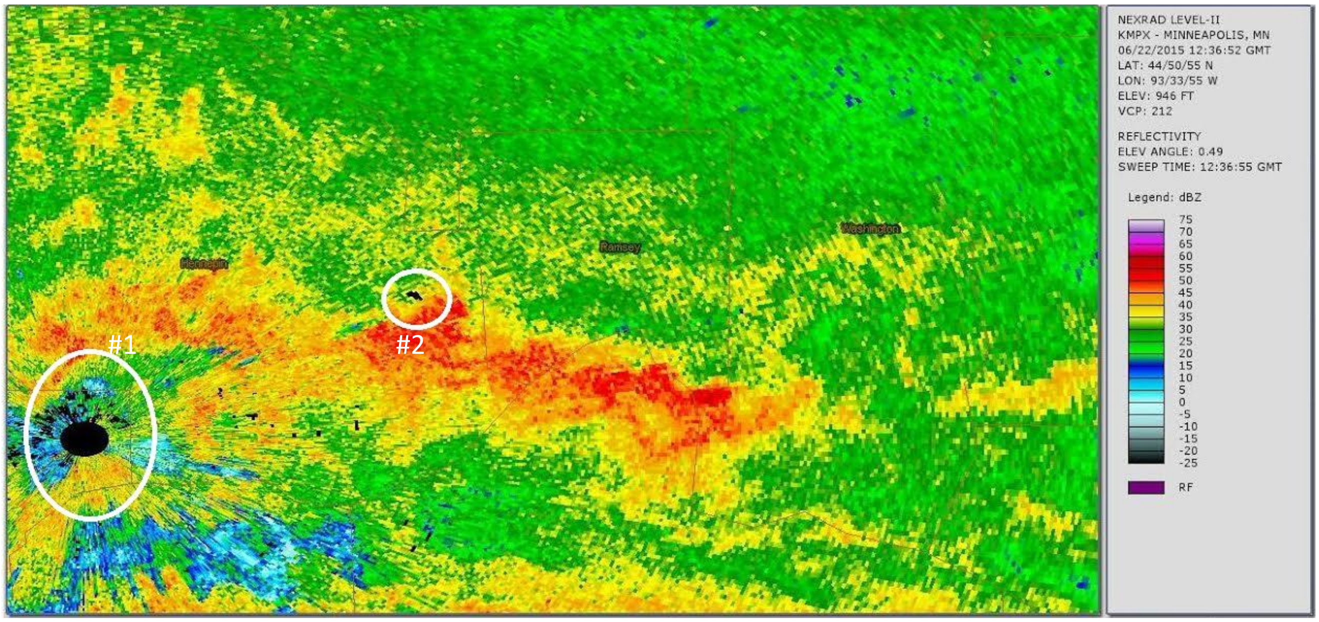
The prior radar image comes from the Atlanta, Georgia radar on April 27, 2011.It is showing radial velocity, which shows radial (or circular) parts of wind. The image is showing very strong winds moving in opposing directions (as seen in the circled region). This is showing a tornado in Catoosa County, GA; in fact this tornado was an EF-4 tornado, part of the historic April 27, 2011 tornado outbreak across the southeast.

Example #3:



The image above from the Minneapolis radar on June 22, 2015 is showing lots of rain of varying strength over the metro area. But, you can see two issues with radar that meteorologists have. Circle #1 encircles where the radar is in Carver County. There is no data in the region. This is called the **Cone of Silence**. Regions too close to the radar are unable to be seen by the radar, therefore it is shown on radar images as a circle of no radar returns. Circle #2 is showing a region of no radar returns, despite it being surrounded by radar returns. This small region is Downtown Minneapolis! The radar beam is hitting the buildings downtown!

In a hazardous weather situations, such as a tornado or heavy rain, having access to radar data allows decision makers, such as your school principal and superintendent, to make decisions about your fellow students', teachers', and your safety. Radar gives us a real-time picture about the conditions outside and if it safe for you buses to run, or in a tornado situation, if it's safe to leave your shelter.

The following activity will allow you to look at a variety of different methods for decision makers to look up radar data.

Research the methods of acquiring radar data you teacher provides you. After researching and thinking about the different methods to get radar data, answer the following questions:

1. Which method do you think was the easiest to use? Why?

2. Which method do you think provided the best information? (e.g. which method was simpler to understand, gave more information, etc.)

3. Which method do you think was the easiest to access?

4. Which method would work best in a hazardous weather situation? (Hint: Consider if you didn't have power or if the internet went down)

5. For your school to be a StormReady Supporter there needs to be a way for decision-makers to access radar data. Which method(s) do you think your school should utilize? Why?

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