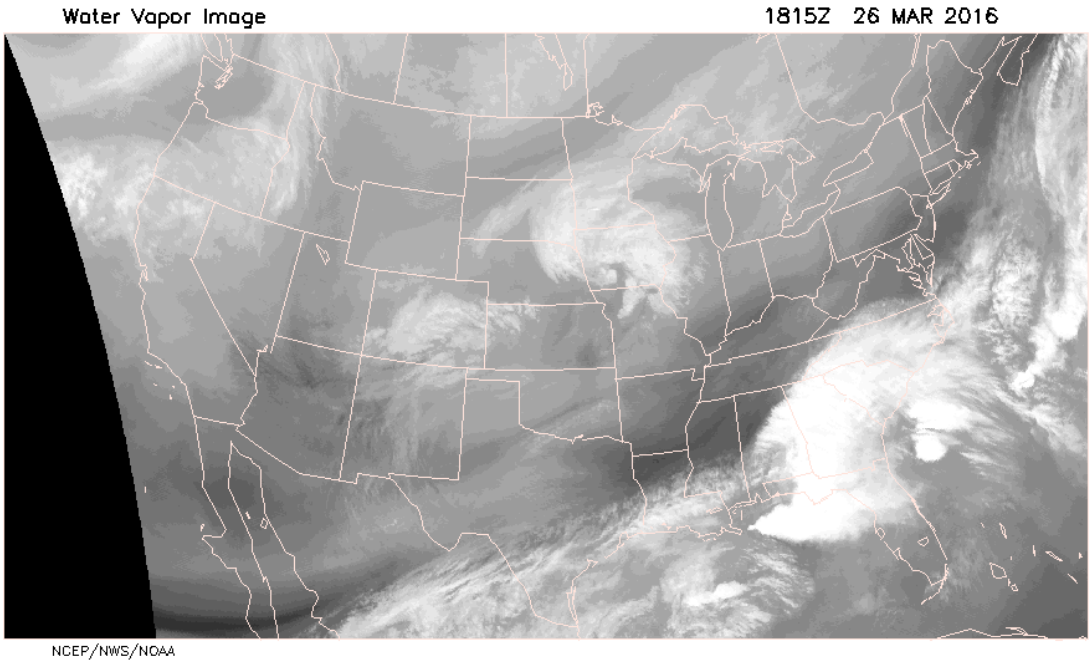
"How Can Flash Floods Be Forecast?" Activity

By their nature, flash floods often develop quickly are affect relatively small areas. So compared with hazardous weather such as hurricanes and wildfires, they are difficult to predict accurately. Even so, National Weather Service meteorologists and other agencies can monitor conditions likely to form flash floods so watches and warnings can be issued in timely fashion to reduce loss of lives.

Part 1 Satellite Imagery

Floods need, of course, a source of water, and at the largest scale, meteorologists can observe where water is flowing through the atmosphere using instruments carried by weather satellites. Geostationary Observational Environmental Satellites (GOES) constantly monitor atmospheric conditions to create images of global weather. Satellite imagery is among the most powerful tools used to know when storms are approaching. (Learn more about satellites and remote sensing.)

Gaseous water vapor is invisible, that is, it is transparent to light energy. But we have learned that water molecules do absorb other energy wavelengths. Instruments aboard the GOES detect differences in the intensity of these wavelengths to detect the amount of water in the atmosphere. Data transmitted from the satellites are then converted by powerful computers into images. Areas with abundant water are shown as bright whites and drier areas as dark region, such as in this image:



At the time of this image, much of the Southeast was experiencing drenching rains, as shown by the brightest white. Storms were also affecting parts of the Midwest and Northwest. The darker

patterns indicate that the Middle Atlantic and New England States were enjoying dry weather.

Meteorologist can learn more about movement of atmospheric moisture when a series of such images are "looped"—put together and shown as if they were a film and run over and over. Here is an example of a loop of water vapor images. Looping helps to track the movement of storms and identify areas that might be affected by flooding.

Part 1. Understanding Satellite Imagery

GOES satellites carry instruments that detect wavelength differences which show patterns of Infrared (heat), Visible light, and Water Vapor in the atmosphere. Satellite images—like many other computer images—consist of thousands of tiny boxes ('pixels') that are assigned a particular level of color or white-gray-black, depending on the strength of those wavelengths. What you see as the image results from computer programs that create an overall pattern of the pixel shadings. We then can interpret these images to understand weather patterns, and in this case, look for places which might experience flash flooding.

Go to http://www.goes.noaa.gov/index.html.

Look at the thumbnail images and find one that includes your State. Example the "Visible" image (MPEG) first—this is a black-and-white version of what you would see with your eyes if you were on the satellite. It is made by measuring the amount of sunlight reflected from the surface to the satellite. Clouds block such reflected light. So the whiter the pixel, the thicker the clouds. Of course, using visible images is limited because they are dark at night when no light is reflected.

1. Describe what you see in this visible GOES image that includes your State.

2. Now look at the accompanying Loop. What additional information do you notice?

Now examine the "Infrared" image that accompanies the visible image you chose. This is created by measuring the amount of infrared (heat) energy that is radiated from Earth's surface and detected in each pixel. Because Earth always emits such wavelengths, infrared images can be made day or night. Clouds absorb these waves, so again the whiter the pixel, the thicker the clouds.

3. Compare and contrast the infrared image (MPEG) with the visible image you examined earlier.

4. Now look at the accompanying Loop. What additional information can you learn?

Next, examine the Water Vapor MPEG and Loop imagery. These are created by monitoring the amount of energy at wavelengths absorbed by water molecules that reach each pixel. The less energy received—that is, the more water vapor in the atmosphere-- the brighter the pixel.

5. Compare and contrast these with the visible and infrared images.

6. Example some of the other satellite imagery and describe what they represent.

7. Using the images for this time, identify areas that might be having flash floods (if any.)

8. Write a brief explanation of what you now understand about how satellite imagery can help meteorologists forecast the possibility of flooding.

Part 2 Radar Imagery

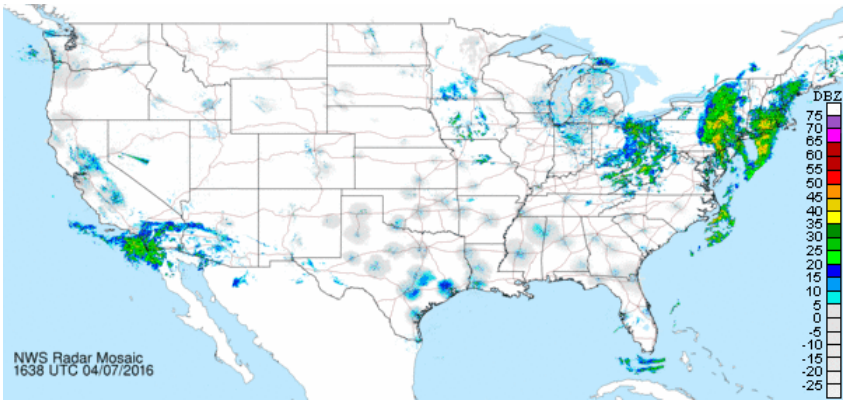
Satellites provide the largest-scale view of what is happening in the atmosphere. Radars can provide a "regional" picture covering about 400 km (240 mi) around the radar location. Each emits radio-frequency energy waves that may are reflected back from clouds, precipitation, and other objects in the atmosphere. (Read more about weather radar.) The NWS operates more than 150 Doppler radar stations which allows coverage of almost all of the country.

Go to http://www.weather.gov/ and type in your zip code or location in the upper-left search box. This will bring you to the current forecast page for your home area. Scroll down to the "Additional Resources" on the right-hand side and click on "Radar."

9. This image uses color-coding to represent weather in the sector of the country that includes your home. Greens usually indicate rain, but other colors ranging from blues through oranges and reds indicate showers or severe storms. Describe what you see in the image for the current time period.

10. Click on "Go to loop of this image" to view a series of radar images from the past hour or so. Like the satellite imagery looping, this computer-based tool allows meteorologists to watch the progress of storms. Describe what you learn from looking at the current loop.

11. The NWS radars and computer are also programmed to create a guide to where severe weather is occurring across the country. Click on http://www.weather.gov/Radar to view a "mosaic" (combination) of all Doppler radars. Here is one example.



Look at your current image and describe what you learn from this national view that was not seen in the regional views.

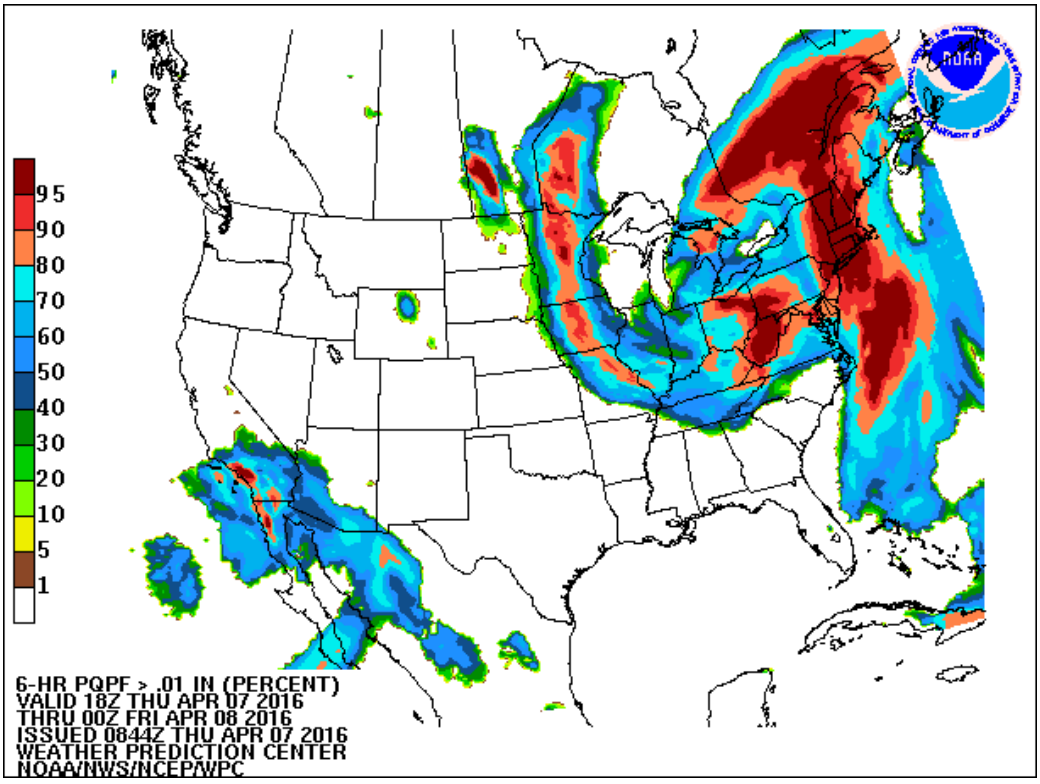
Are there any locations that might be experiencing flooding?

Part 3. Creating Our "NWS Weather-Ready Nation"

The National Weather Service has set as its vision creation of "A Weather-Ready Nation: Society Is Prepared for and Responds to Weather-Dependent Events." One strategy used to achieve this are alerts or advisories, watches, and warnings on their home page, www.weather.gov. It indicates by county locations that might or are experiencing a variety of types of hazardous weather. The color-coded index below the map presents some of the many types of alerts, watches, and warnings that could be issued by the NWS. These are also relayed to the areas affected by local TV and radio stations, as well as emergency systems through sirens and other technologies.

12. Click on the "Flood watch" and "Flood Warning" boxes. This will bring you to current announcements issued for the NWS Offices across the country. Select one and discuss the information provided in a warning.

Weather forecasting will never be 100% accurate, but ground-based monitoring systems, radars, satellites, and other technologies have made predictions better than ever. The NWS has created many products used by their meteorologists and forecasters you see or listen to on your local tv or radio stations that can help identify where flash floods or other hazardous weather may occur. One of these are the "probability maps" created by the Weather Prediction Center. These charts are created using powerful computers that utilize data from surface, radars, and satellites to run sets of mathematical models, such as the one below.



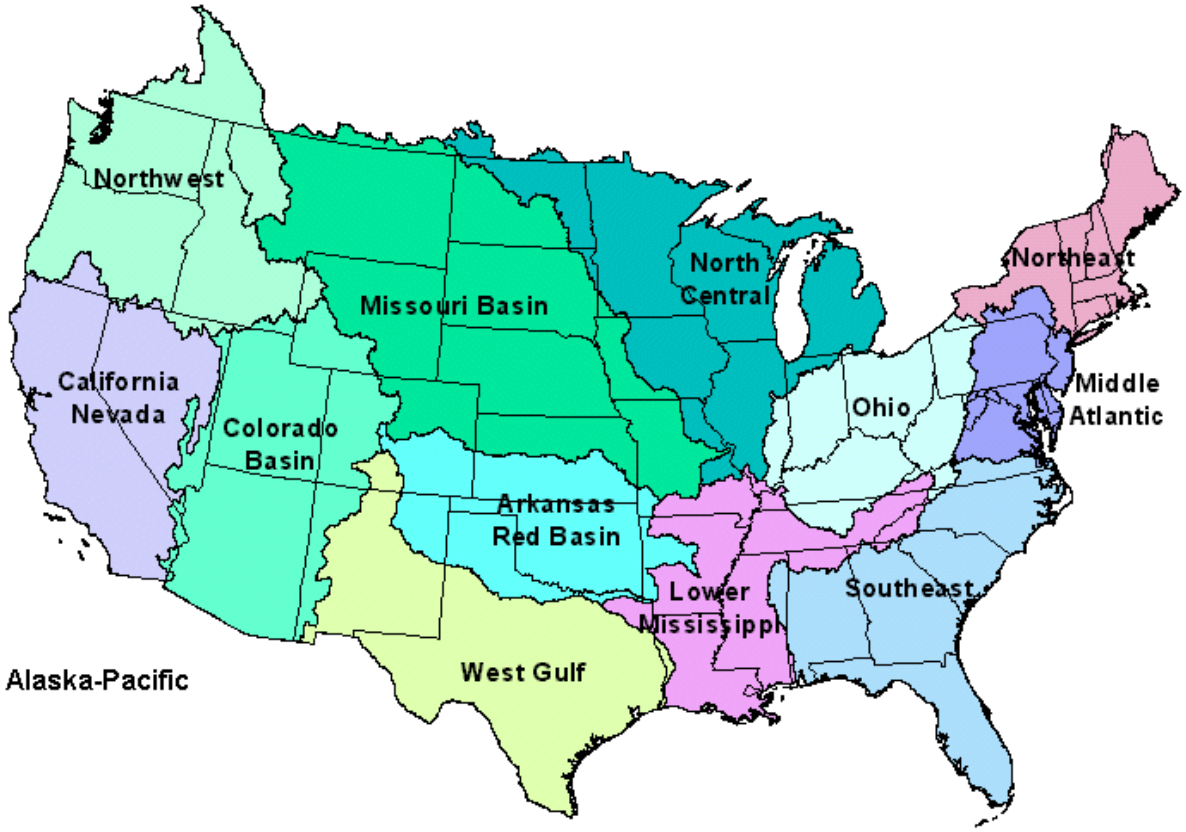
The color-coded bars on the left side indicate the probability of precipitation of the selected amount (in this case, more than 0.01 inch) during the selected time period (in this case, the next 6 hours).

13. Go to the current WPC Precipitation Guidance. Spend a few minutes examining the current map. Then use the tabs at the top to look at other time periods over the next three days. Describe what you see and have learned from this activity.

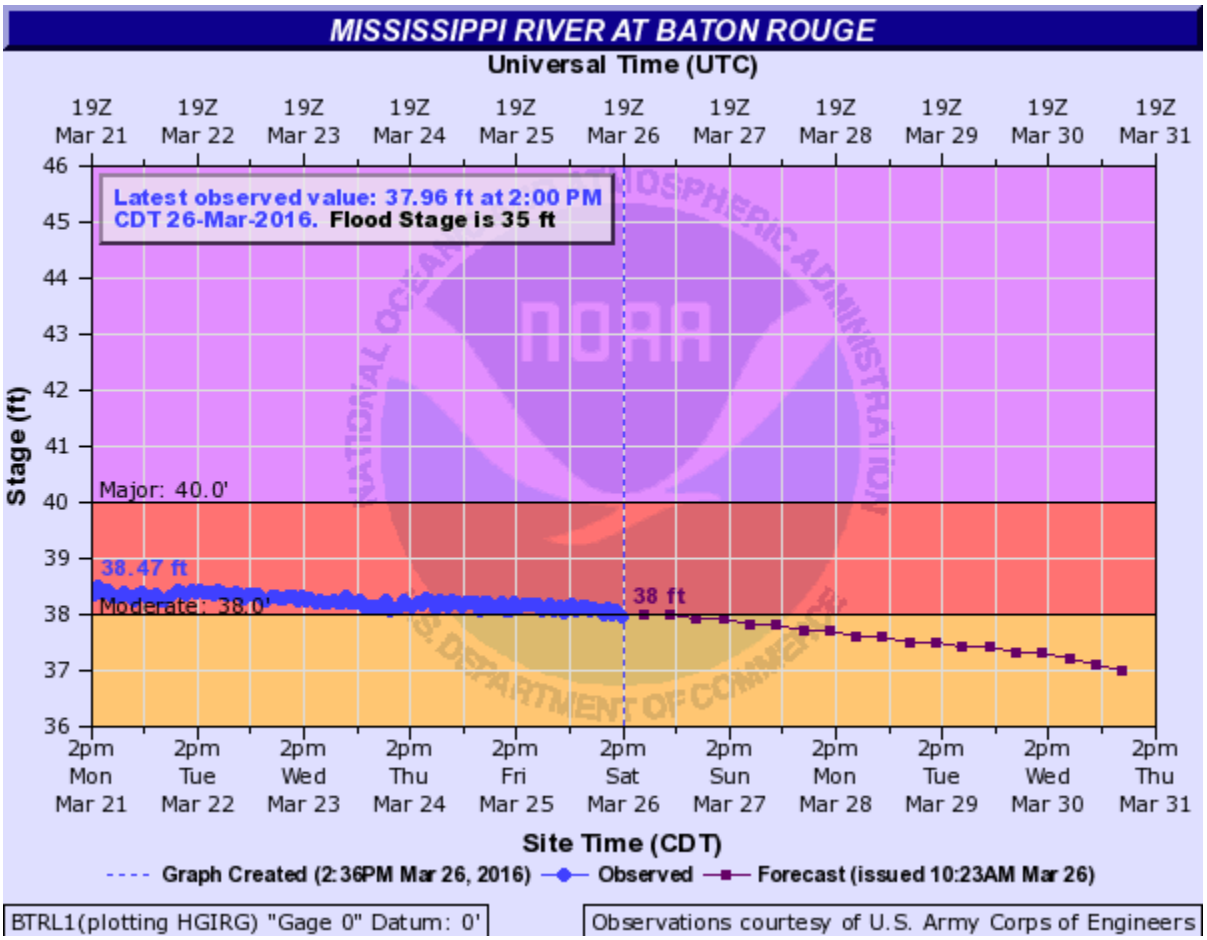
Part 4. Interagency Cooperation in the Creation of Weather Forecasts

The National Weather Service does not rely only on its own resources to collect data and prepare forecasts. The NWS collaborates with federal agencies, as well as state and local emergency managers across the country. This Advanced Hydrologic Prediction Service helps avoid duplication of efforts. Among the partners cooperating with the NWS are the US Geological Survey, US Bureau of Reclamation, US Army Corps of Engineers, Natural Resource Conservation Service, National Park Service, and other agencies. You can read more about the AHPS here.

Much of this cooperation takes place in the River Forecast Centers located across the country.



14. Open the interactive map and click on your home region. Color-coded circles and squares indicate currents conditions at measuring stations. Here is one example of what you may find:

15. 

At the time this chart was made, the Mississippi River was experiencing moderate flooding.

14. Examine conditions for locations near your home and describe what you learn.

As a final activity, examine the AHPS "Experimental Long Range River Flood Risk" webpage. This is an ongoing research project to try to expand our ability to identify the probability of flooding over a three-month period.

15. Examine this chart and click on some of the categories (for example, "Gauges with > 50% Moderate Long-range Flood Risk." Describe what you learn here. Is your home in any danger?