

11A: Thunderstorms

Name _____

Hour _____ Date _____

Outcomes:

A thunderstorm is one of nature's most awesome spectacle; and it is one of nature's mechanisms by which heat is transported from the earth's surface into the atmosphere. It is also responsible for excessive precipitation events that lead to flash floods, dangerous lightning, damaging winds, and even tornadoes. Thunderstorms are the consequence of convection currents that surge to great altitudes within the troposphere (and sometimes into the lower stratosphere). In the mid latitudes, surface heating by the sun can set the stage for thunderstorm development. However, convection forced by converging surface winds or uplift along a frontal; surface or a mountain slope, produces most thunderstorms.

After completing this activity, you should be able to:

- Describe the appearance of thunderstorms on visible satellite imagery.
- Identify probable locations of thunderstorms on infrared satellite imagery.
- List some of the modes of occurrence of thunderstorms.

Investigations:

1. As a general rule of thumb, the greater the altitude of the top of a thunderstorm cloud (cumulonimbus), the more intense is the thunderstorm cell. A relatively high thunderstorm top implies [**weak** / **strong**] convection and a relatively [**weak** / **strong**] updraft.
2. Within a thunderstorm cell, the temperature [**falls** / **rises**] with increasing altitude primarily because of the expansion of rising air within the cloud.
3. An intense thunderstorm thus has a relatively [**cold** / **warm**] cloud top.
4. On a visible satellite image, a large thunderstorm can appear as a bright white blotch, or cluster. The brightness of the blotch indicates that the cloud top has a relatively [**high** / **low**] albedo for visible solar radiation.
5. Figure 1, the visible satellite image for 1815Z (1:15 pm CDT) 12 May 1999, shows a large thunderstorm complex on the Gulf coast at the Texas-Louisiana border. Other areas of thunderstorms occur along one front across Iowa and Missouri and showers north of another front from Lake Michigan to Lake Erie. Thunderstorms are in the Carolinas associated with a coastal low-pressure system. Thunderstorm clouds also outline the coasts of Florida. Finally, convective clouds are dotted along the Appalachians from northern Georgia to central Pennsylvania. All the thunderstorms are located by the [**bright white** / **dark gray**] shading of the cloud tops.
6. Based on the model of the mid latitude wave cyclone, the clouds shown from Iowa to Missouri would be associated with the [**warm** / **cold**] front which those from Lake Michigan to Lake Erie would be associated with the [**warm** / **cold**] front.
7. Figure 2 is an infrared (IR) image for the same time as the visible satellite view in Figure 1. Because IR images are depictions of the temperatures of the radiating surfaces of the land,

oceans, and cloud tops, an IR satellite image can be used to distinguish low clouds from high clouds. High clouds are colder than low clouds so that on an IR image, high clouds show up as light gray to white (on a gray scale) and low clouds appear as dark gray. The IR image indicates that the cloud patch along the Texas-Louisiana border represents relatively [**low / high**] temperature.

A thunderstorm cell progresses through its life cycle (cumulus, mature, dissipating stages) typically in less than an hour. More prolonged periods of thunderstorm weather are associated with multicellular thunderstorms, that is, thunderstorms that are made up of many cells. Each of those cells may be at a different stage of its life cycle with new cells continually forming and old cells dissipating.

A multicellular thunderstorm may form a large nearly circular cluster known as a *mesoscale convective complex (MCC)*. An MCC is typically large enough to cover an area the size of the entire state of Kansas.

Often, a multicellular system forms an elongated (long and narrow) cluster known as a *squall line*. A typical squall line is oriented parallel and just ahead of a well-defined cold front. Severe thunderstorm cells may develop within a squall line. Refer back to Figure 1 of Activity 10A which shows several lines of clouds along the Texas Gulf Coast. These cloud lines to the east of the frontal position, are an indication of such squall line activity.

8. Compare the visible and infrared satellite images of cloud tops associated with the thunderstorm complex along the TX/LA coast. The infrared image shows bright, cold cloud tops are somewhat more extensive than the visible satellite image. This infrared cloud pattern is indicative of the thin cirrus veil from thunderstorm anvils.
9. In addition to the thunderstorm clouds in the upper middle of the U.S. produced by fronts, other formation processes for clouds may be associated with areas noted previously. Convective clouds along the Appalachians were probably caused by [**orographic lifting / sea breeze front**] while the thunderstorms around the Florida coasts were probably caused by a [**orographic lifting / sea breeze front**].

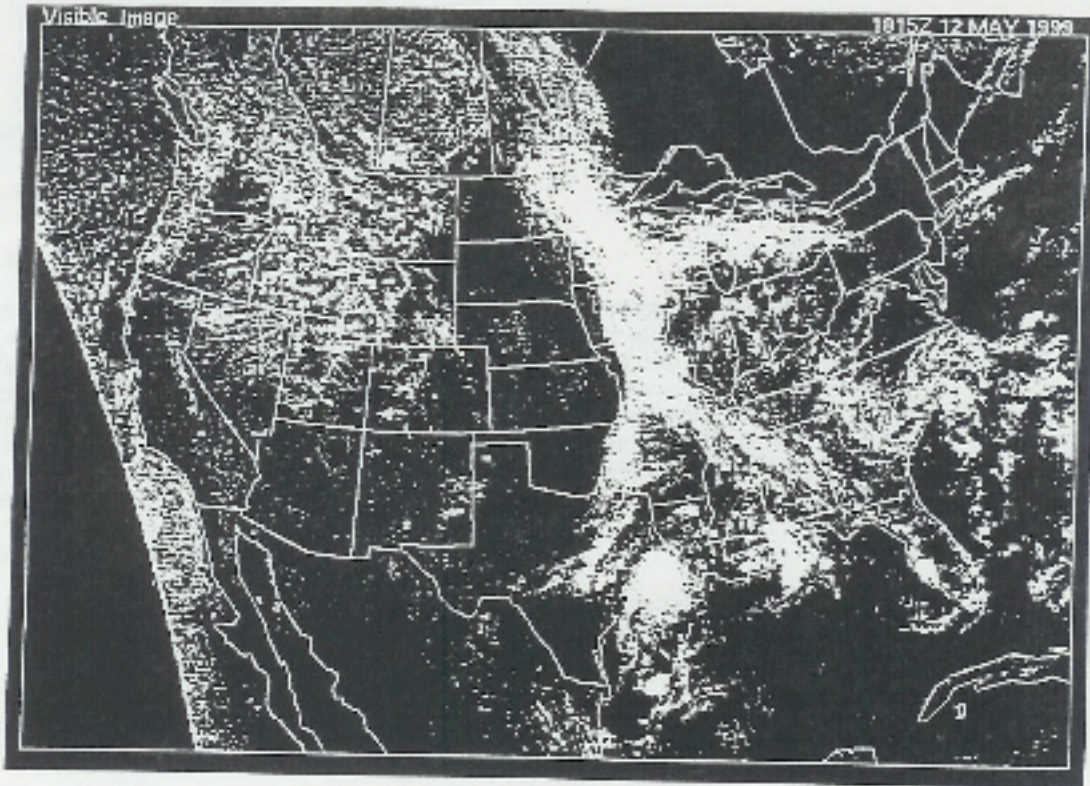


Figure 1: Visible Satellite Image

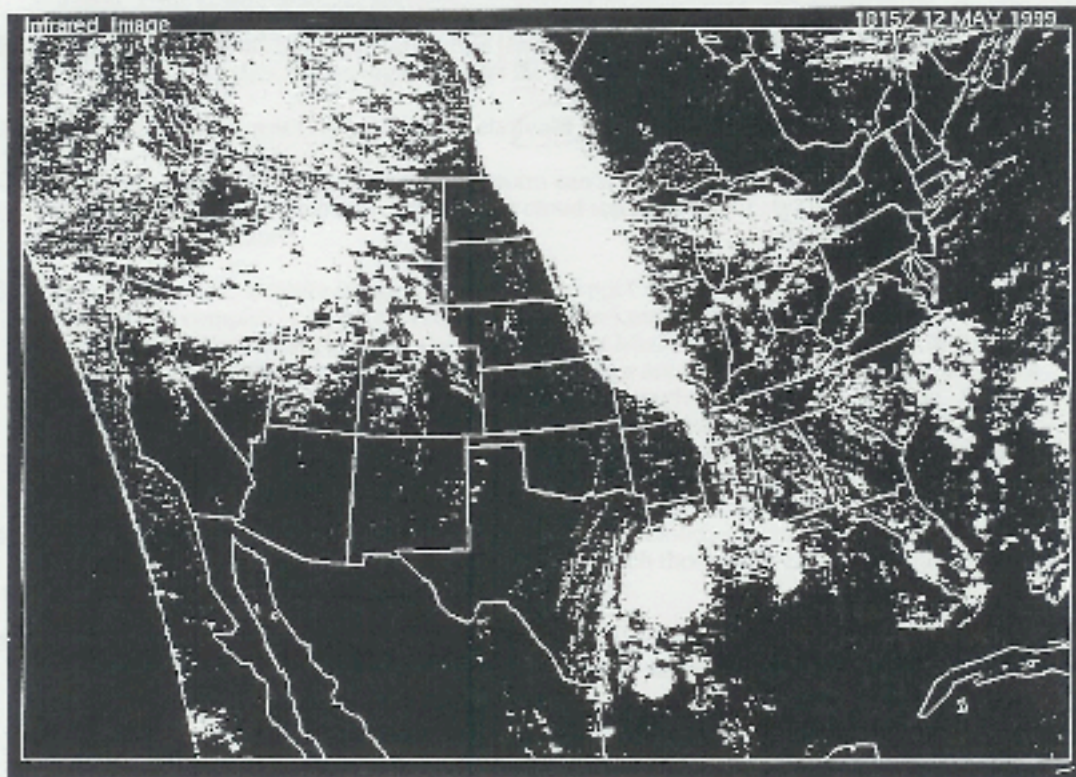


Figure 2 : Infrared Satellite Image