

## The Necessary Ingredients for Thunderstorms



All thunderstorms require three ingredients for their formation:

- Moisture,
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- Instability, and
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- A lifting mechanism.

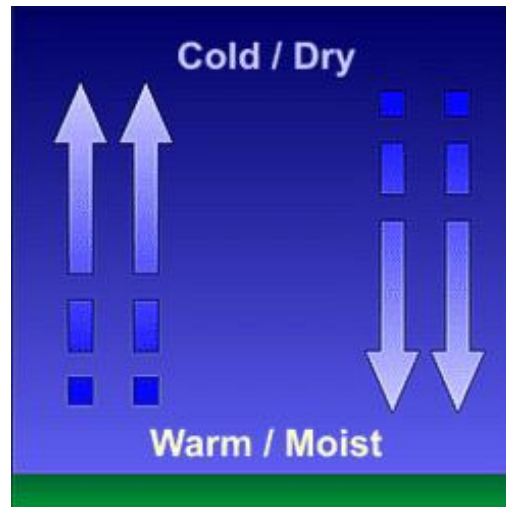
## Sources of moisture

Typical sources of moisture are large bodies of water such as the Atlantic and Pacific oceans as well as the Gulf of Mexico.

Water temperature plays a large role in how much moisture is in the atmosphere. Recall from the Ocean Section that warm ocean currents occur along east coasts of continents and cool ocean currents occur along west coasts. The amount of ocean water evaporation into the atmosphere is higher in warm ocean currents and therefore put more moisture into the atmosphere than with cold ocean currents at the same latitude.

The southeastern U.S. has access to two moisture sources in the Atlantic ocean and the Gulf of Mexico which helps explain why there are so much rain in that region.

## Instability



Air is considered unstable if it continues to rise when given a nudge upward (or continues to sink if given a nudge downward). An unstable air mass is characterized by warm moist air near the surface and cold dry air aloft. In these situations, if a bubble or parcel of air is forced upward it will continue to rise on its own. As it rises it cools and some of the water vapor will condense, forming the familiar tall cumulonimbus cloud that is the thunderstorm.

Characteristics of an unstable air mass with warm moist air near the surface with colder and drier air aloft. Air that is forced upward will continue to rise, and air that is forced downward will continue to sink.

## Sources of Lift (upward)

Typically, for a thunderstorm to develop, there needs to be a mechanism which initiates the upward motion, something that will give the air a nudge upward. This is done by several methods.

### Differential Heating

This heating of the ground and lower atmosphere is not uniform. For example, a grassy field will heat at a slower rate than a paved street. The warmest air, called thermals, tends to rise. In the image (right) a wildfire provided the differential heating for a cumulus cloud to form over the smoke plume.

### Fronts, Drylines and Outflow Boundaries



Fronts are the boundary between two air masses of different temperatures.

Fronts lift warm moist air. Cold fronts lift air the most abruptly. If the air is moist and unstable thunderstorms will form along the cold front.

Drylines are the boundary between two air masses of different moisture content and separate warm moist air from hot dry air.

While the temperature may be different across the dryline, the main difference is the rapid decrease in moisture behind the dryline.

It is the lack of moisture which allows the temperatures to occasionally be higher than ahead of the dryline.

However, the result is the same as the warm moist air is lifted along the dryline forming thunderstorms. This is common over the plains in the spring and early summer.

Outflow boundaries are a result of the rush of cold air as a thunderstorm moves overhead.

The rain-cooled air acts as a "mini cold front", called an outflow boundary. Like fronts, this boundary lifts warm moist air and can cause new thunderstorms to form.

#### Terrain

As air encounters a mountain it is forced up the slope of the terrain. Upslope thunderstorms are common in the Rocky Mountain west during the summer