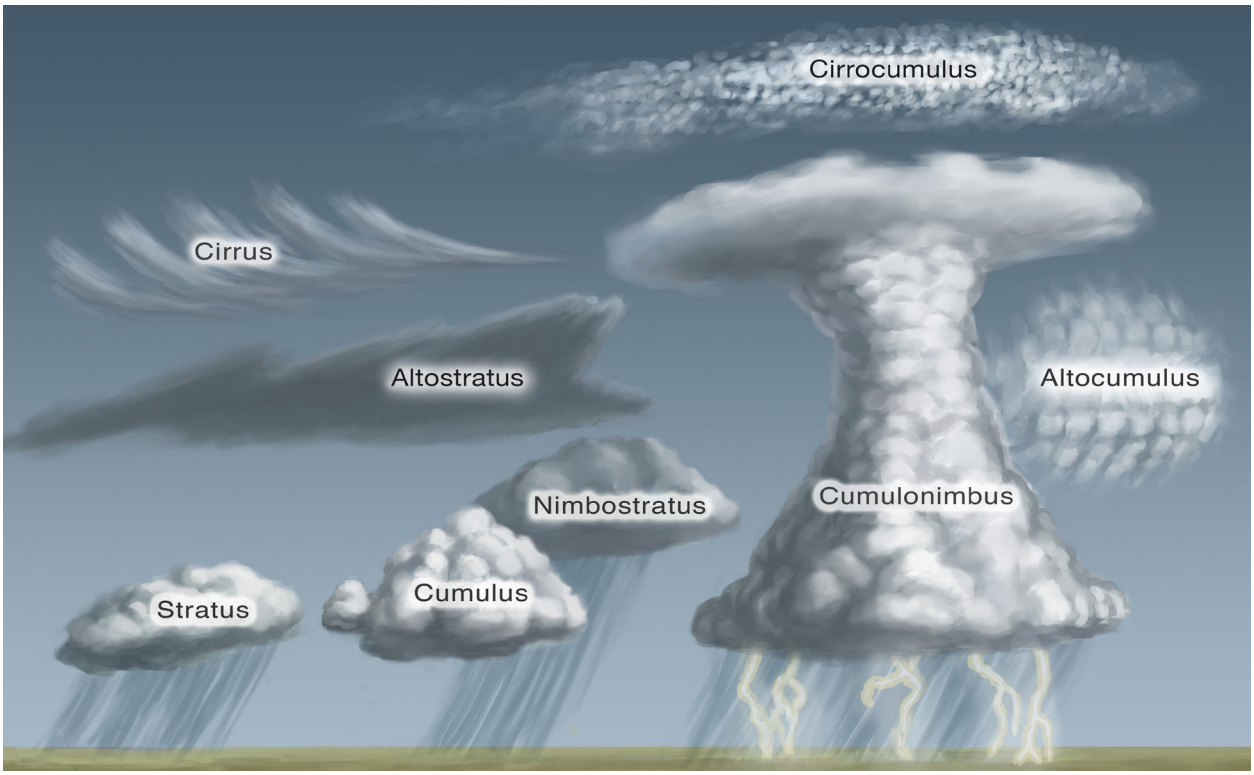


Clouds take different shapes depending on the temperature of the air around them.

What Are Clouds?

Looking Up at the Sky

Dr. Joanne Simpson became fascinated with clouds at an early age. Simpson would grow up to study clouds and become the first woman to earn a PhD in meteorology—but as a child, she simply loved how they looked. When she was a young girl, walking around her town and sailing on the nearby ocean, she noticed all kinds of unusual clouds. She saw clouds that looked like towers looming high, bunches of hanging grapes, and even UFOs! She wondered what they were made of and how they formed so many different amazing shapes.

When Simpson went to college in the 1940s, nobody thought clouds were important for scientists to study. However, Simpson's professors encouraged her to study clouds because she was a woman and they didn't think women could be serious scientists. Clouds seemed to them like a good unimportant subject for a woman to study. Simpson went on to prove her professors wrong about both clouds and female scientists.

Determined to succeed despite sexism, Simpson continued her study of clouds and cloud formation. She collected data as she flew in airplanes high above Earth's surface, taking notes and sketching in her field journal to document the cloud formations she saw. Most interesting of all to Simpson were the gigantic clouds she called hot towers. These cumulonimbus clouds looked like

skyscrapers sticking up above the clouds around them. Simpson wanted to know why hot towers were so unusual, so she set out to study them. She collected data about the temperature, wind conditions, and amount of water vapor in these unusual cloud formations. Eventually, she was able to explain that hot tower clouds form when warm air with lots of water vapor in it rises quickly from Earth's surface into the troposphere, the layer of the atmosphere closest to the Earth, cooling as it goes. Based on her research about hot towers and other kinds of clouds, Simpson is considered one of the most important weather scientists in the history of meteorology.

What All Clouds Share

Research by meteorologists like Simpson shows that all clouds, even the most unusual types, have a lot in common. Meteorologists use a helpful concept, the idea of air parcels, to study all kinds of clouds and track them as they move through the troposphere. An air parcel is an amount of air that moves as a unit.

All clouds form when the water vapor in air parcels comes into contact with colder surrounding air. When it meets the colder air, the water vapor in each air parcel becomes liquid in a process called condensation. In fact, all clouds are made of the same basic ingredient: visible droplets of water floating in the troposphere. If it's cold enough, the water droplets can freeze into tiny ice crystals. How does water vapor get into the troposphere in the first place? It comes from liquid water on Earth's surface. When liquid water gets warm enough, it turns into water vapor through a process called evaporation. The water vapor becomes part of the air and is ready to become part of a cloud when the conditions are right.

Joanne Simpson photographed and collected observations and evidence about all kinds of clouds.

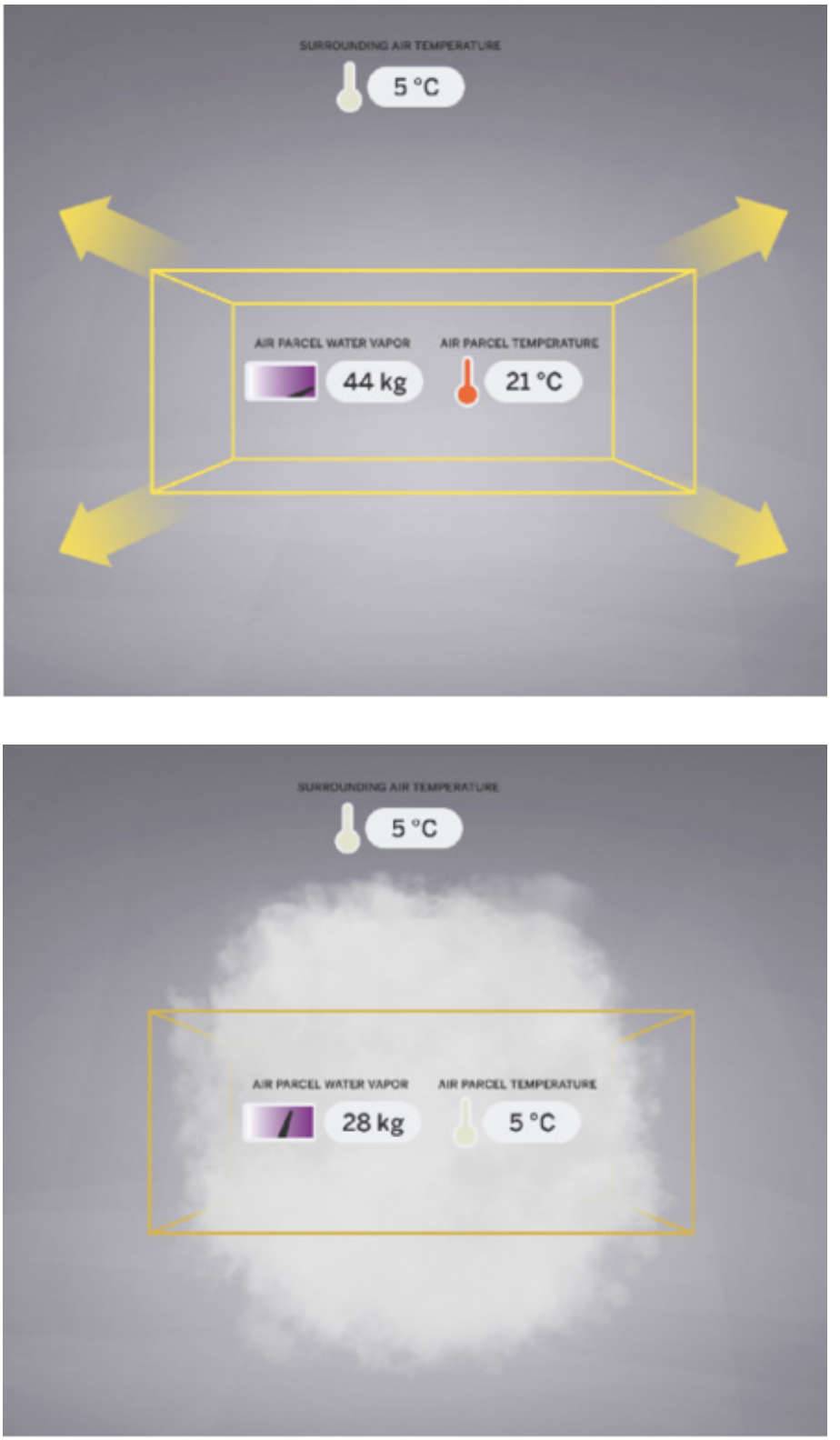
The hot tower clouds that Simpson identified are a type of cumulonimbus cloud.

Cloud Formation and Energy

Cooling is an important cause of rainfall—cooling air parcels can cause clouds to form and rain to fall. What causes an air parcel to cool? The process is driven by energy. When a warm air parcel is surrounded by colder air, the energy from the warm air parcel is transferred to the colder air until the temperature of all the air is equal. While an air parcel is losing energy, the temperature of the air parcel decreases. The energy transfer that causes the warm air parcel to cool can also cause the water vapor in the parcel to condense into liquid water. This liquid water is what forms a cloud. The more energy the air parcel loses, the more it cools and the more liquid water it forms, making more rainfall possible. When the droplets of liquid water in the clouds become big enough, they fall to the ground as rain.

Joanne Simpson's Legacy

Joanne Simpson started her career focused on the beautiful shapes she saw in the sky, wondering how and why the amazing clouds that she saw might form. Simpson's curiosity as a child led her to a pioneering career in the field of meteorology. Her work helped us understand how energy, evaporation, and condensation form the clouds that we see in the sky. Meteorologists today still make use of Simpson's work as they study the weather.



This diagram shows how energy is transferred during cloud formation. As energy is transferred out of an air parcel, its temperature drops. When the air parcel has lost enough energy and become cold enough, water vapor in the parcel condenses, forming a cloud.