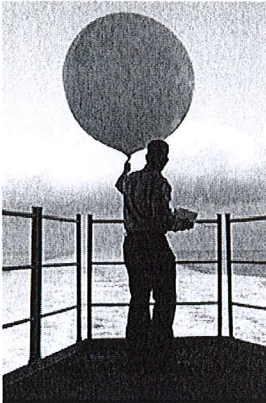


# How Weather Balloons Work

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Weather balloons gather important data from the atmosphere.  
Justin Bane/U.S. Navy/Getty Images

## Introduction to How Weather Balloons Work

At an isolated weather station in the central United States, a technician emerges from a small brick shed grasping a balloon. It's not just any birthday party balloon, mind you, but a massive, white sphere more than 5 feet (1.5 meters) in diameter. Filled with more than 300 cubic feet (8.5 cubic meters) of helium gas, the enormous balloon tugs against the scientist's hand with a force of about four pounds. In the other hand, the scientist grasps a radiosonde, a lightweight cardboard box filled with scientific instruments that's tied to the bottom of the balloon. Striding out into an empty clearing, he gently releases the balloon and radiosonde.

As the balloon hurtles away from the Earth, the radiosonde is already hard at work, beaming atmospheric information back to data centers.

After an hour, the balloon has ascended to almost 100,000 feet (30,480 meters). This is the stratosphere, the second-to-last atmospheric layer before outer space. Below, the Earth's features are obscured by a thick layer of cloud. Above, the blue sky has faded to dark black. It's a beautiful sight, one only seen by a handful of astronauts and test pilots.

For the balloon, these breathtaking views will be its last moments. All throughout its ascent, the balloon has been expanding. It may have started out modestly, but now, at almost 18 miles (29 kilometers) high, the balloon has swelled to the size of a moving truck. Stretched to its limit, the balloon's thin synthetic rubber bursts and sends the tiny radiosonde plummeting back toward Earth. Within seconds, the wind catches a small, orange parachute and slows the device's descent. Hours later -- and hundreds of miles from where it first lifted off -- the weather balloon touches the ground.

Each day, hundreds of weather balloons around the world undertake this dramatic, near-space voyage. More than 70 years after scientists sent up the first experimental weather balloon, they remain the workhorses of modern meteorological forecasts. Whether it's a tornado warning or the weather report on the 6 o'clock news, weather balloons are what keep people on the ground tuned in to the meteorological workings of the upper atmosphere.

What kind of information does a weather balloon collect, and how does it accomplish this feat? Read on to find out.

### BALLOON RIDE

Why let radiosondes have all the fun? In July 1982, truck driver Larry Walters tied 42 weather balloons to a lawn chair with the goal of flying out of Los Angeles, following the wind currents over the desert, and coming to rest safely in the Rocky Mountains. The balloons had more lifting power than Walters bargained for, however, and within minutes, his flying lawn chair had shot up to a chilly 16,000 feet (4,879 meters). Thankfully, Walters had an air gun aboard, and he was able to shoot out a few of the balloons, descending safely into a backyard in Long Beach, Calif.

### Weather Balloon Uses

In 1785, French balloonist Jean-Pierre Blanchard lifted off from Paris on a record-breaking journey across the English Channel. Tagging along for the ride was John Jeffries, an American physician known for dabbling in weather observation. In the skies above Northern Europe, Jeffries hoped to record some of the first-ever measurements of the upper atmosphere. When the balloon came dangerously close to crashing into the English Channel, however, Jeffries was forced to toss his equipment overboard to lighten the load.

Today, weather balloons do most of the work for us, letting the experts stay safely on the ground. In the United States alone, weather balloons are launched twice a day from 92 weather stations. This works out to a total of 67,160 balloons per year. Worldwide, more than 900 weather stations rely on daily weather balloon launches.

It's nearly impossible to predict the weather without knowing the conditions of the upper atmosphere. It may be sunny and quiet at sea level, but at 18,000 feet (5,486 meters), a weak storm system could soon turn into something more dangerous. By sending up regular squadrons of balloons to measure the conditions of the upper atmosphere, meteorologists can keep tabs on brewing storms.

A century ago, scientists could only predict the weather from measurements taken on the ground. With such a limited data set, the best meteorologists can do is predict the weather a few hours into the future. With weather balloons, though, scientists can plot out weather conditions for days in advance.

This information doesn't just keep joggers out of the rain -- it saves lives. High-altitude weather data is critical for predicting oncoming natural disasters like tornadoes, thunderstorms or flash floods. Thanks to weather balloons, officials can scramble supplies and emergency personnel to an affected area hours before a weather disaster strikes.

Like model rockets and remote-controlled airplanes, weather balloons have also entered the hobby market. In 2009, Massachusetts Institute of Technology scientists Oliver Yeh and Justin Lee used a weather balloon, a cooler, a cell phone and a digital camera to take a high altitude photograph of the Earth for less than \$150.

Soon, other hobbyists were cobbling together their own near-space cameras. Of course, Yeh and Lee warn that launching things into the stratosphere can be dangerous [source: Project Icarus]. If it's not equipped with proper parachutes, an amateur weather balloon can become a deadly projectile if it falls in an urban area. The balloons could also provoke a disaster by getting sucked into the jet engines of a passing airliner. If you do start building your own high-altitude science project, make sure you follow all proper precautions.

Specially-designed high-altitude balloons also are used frequently by NASA to perform near-space experiments. During a meteor shower, a high-altitude balloon can collect cosmic dust emitted by the passing space rocks. Beach ball-sized "smart" balloons have been launched to keep tabs on weather conditions around NASA facilities prior to a rocket launch [source: Mullins]. NASA has even toyed with sending high-altitude balloons to probe the atmosphere around Mars.

We'll take a closer look at the components of a weather balloon on the next page.

Use for astronomer

**CLOSE ENCOUNTERS**

With so many thousands of weather balloons crowding the skies, it's inevitable that some are mistaken for alien spacecraft. The most high-profile case was in July 1947, when military officials in Roswell, N.M., stunned the world with reports that they had recovered the remains of a "flying disk." Later, however, government reports showed that the debris was from a top secret experimental balloon used to monitor Soviet nuclear tests.

**Components of a Weather Balloon**

Occasionally, an American homeowner wakes up to find a spent weather balloon in his or her backyard. It's a strange sight: tattered strips of neoprene, tangled cords, a crumpled parachute and a small cardboard box. It's no surprise that weather balloons are often mistaken for extra-terrestrial spacecraft.

The core component of the whole assembly is the **radiosonde**, a shoebox-sized cardboard box packed with three basic atmospheric instruments:

- **Thermistor.** A ceramic-covered metal rod that acts as a rudimentary thermometer.
- **Hygristor.** A small slide that acts as a humidity sensor. The slide is coated with film of lithium chloride (LiCl), the electrical resistance of which changes based on the surrounding humidity.
- **Aneroid barometer.** A small metal canister filled with air that measures air pressure. As the air pressure around it decreases at higher altitudes, the canister expands, triggering a sensor.

The radiosonde also has a low-powered radio transmitter to relay data from all three instruments back to receivers on the ground. A small battery provides power to the radiosonde.

The advantage of a radiosonde is that scientists don't need to retrieve the device to obtain weather data. In the 1920s and '30s, when meteorologists used kites or aircraft to measure upper-atmosphere weather data, specialists would have to wait until the aircraft touched down or the kite was reeled in before they could start making weather calculations.

Holding the whole assembly aloft is a large balloon made of neoprene, a synthetic rubber. The balloons are filled either with helium or hydrogen depending on the preferences of the individual launch station. Hydrogen is cheaper, has better lifting capacity, and can be easily extracted from water. However, hydrogen is also very flammable -- a fact that has prompted many explosion-shy weather stations to adopt helium instead.

Altogether, a complete weather balloon assembly costs about a few hundred dollars. A high-altitude rocket, on the other hand, can cost several hundred thousand dollars for just a single flight. Even a high-altitude aircraft flight can cost up thousands of dollars per hour. The relative cheapness of weather balloons is what has kept them the go-to device for recording weather data for more than six decades.

**KILLER BALLOONS**

In the waning days of World War II, the Japanese military strapped bombs to the bottom of weather balloons and sent them floating toward Canada and the United States. The Japanese figured the balloons would kick off a wave of forest fires and deadly explosions, slowing the American advance across the Pacific. Japanese propaganda reported that the balloons had killed 10,000 Americans, but in reality, the only mayhem caused was the death of six people.

**Weather Balloon Launches**

In an isolated field in the middle of Australia, NASA officials slowly inflated a massive helium balloon that would carry a \$2 million gamma ray telescope into the upper atmosphere. The location was perfect for a balloon launch: flat, dry and clear. Before the balloon was fully inflated, however, a sudden gust of wind caught the balloon and sent it hurtling across the countryside. Crew members ran for their lives as the telescope smashed into a nearby SUV and ripped through a fence before crumpling into a heap more than 492 feet (150 meters) away.

Of the many things that can go wrong during a balloon launch, leaving a trail of destruction is obviously one of the worst. Most weather balloons, on the other hand, are launched without a hitch. In the United States, weather stations will typically have an onsite shed built especially for the purpose of balloon inflation. To prepare a balloon for launch, a technician will first secure the balloon to a nozzle and begin filling it with helium or hydrogen. As it fills, he tests the radiosonde's battery, tunes the radio equipment and attaches the whole assembly together with a length of nylon cord.

Once the balloon has inflated to about the size of a yoga ball, the technician ties it off and ushers it outside. Walking the balloon a short distance clear of trees, power lines and other obstacles, he'll simply give it a gentle push upward.

As soon as the balloon begins to float, the radiosonde gets to work, beaming data to weather computers on the ground. In real time, these computers plot the data into three-dimensional weather models and send them to weather stations across the country. Ground technicians, meanwhile, track the rising balloon with radar equipment. By noting the sideways movement of the ascending balloon, they can calculate wind speed and direction at different altitudes.

There's a reason weather balloons don't just float into space. As the balloon moves farther away from Earth, there's less air to push against the outside of the balloon. With less air pressure to rein it in, the gas inside the balloon expands as its altitude rises. The balloon can only expand so much, however, and it will typically burst at altitudes above 15 miles (24.1 kilometers) -- about three times higher than Mount Everest.

If the radiosonde was simply allowed to plummet to earth, it could wreak deadly havoc on human settlements below. That's why each weather balloon has a small parachute connected to the cord joining the radiosonde to the balloon. As the balloon ascends, the parachute remains folded by the downward rush of air. When the assembly starts to descend, however, the parachute is blown open, slowing the balloon to a manageable 22 miles per hour (9.8 meters per second).

Much of the time, weather balloons simply become litter after a trip into near-space. If balloons catch a particularly strong gust of wind, they can travel several hundred miles -- touching down anywhere from a marshy bog to the snowy peaks of the Rocky Mountains. Sending helicopters to pick up almost 200 weather balloons launched in the United States each day simply isn't in the budget.

However, inside each radiosonde is a large postage-paid envelope. If you ever come across an old weather balloon, simply place it inside the envelope and pop it into a mailbox, and days later it'll be returned to the National Weather Service to fly again.

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