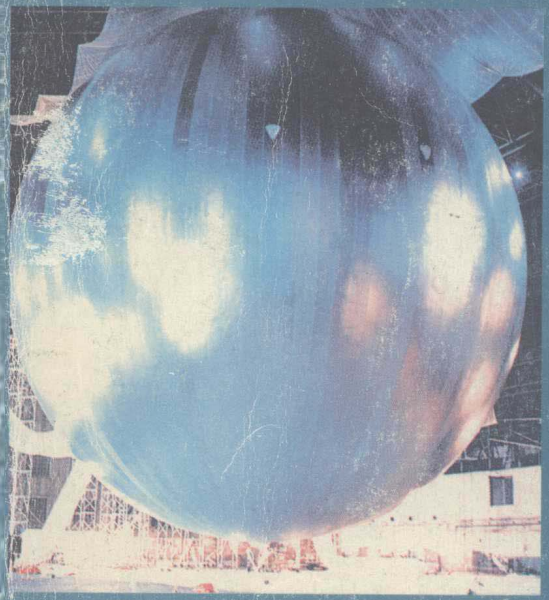
RESEARCH

Exploring Hidden Worlds

人类征服太空的历程 英汉读本



飞向天空的气球

Carole S. Briggs 著
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广西科学技术出版社

BALLOONS

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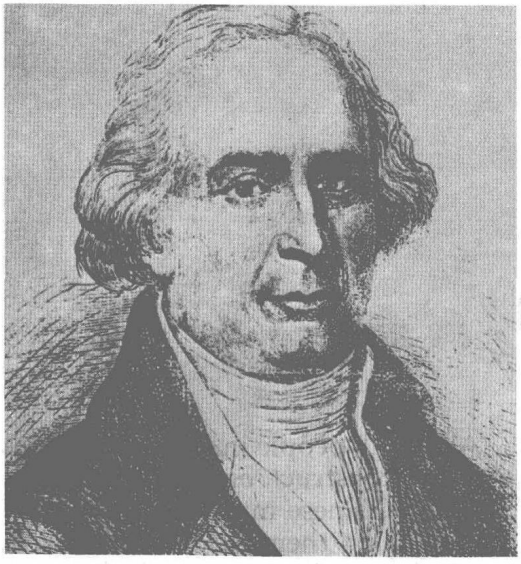
Inventing the Balloon

For centuries, humans have been fascinated with the idea of flying. Some people designed wings to be attached to a person's arms. Others watched smoke rise from fires and thought there must be a way for them to rise with it. These people tried to build balloons.

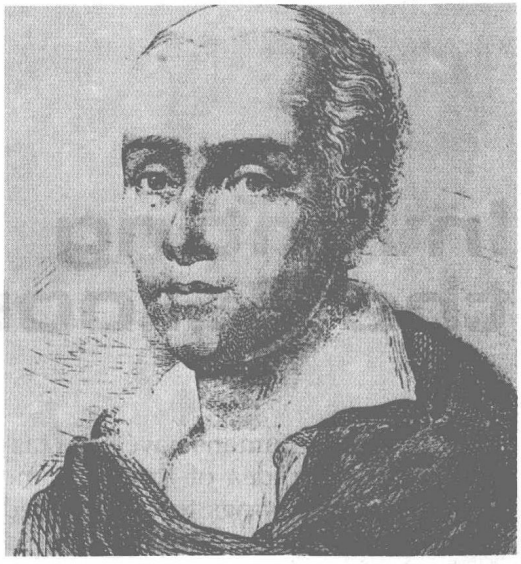
Finally, in 1783, two brothers in France successfully built and launched a balloon. Joseph Montgolfier and his younger brother, Jacques-Etienne, were paper makers in Annonay, France. They often talked about constructing a large, paper globe that would float passengers above the earth. The Montgolfiers thought that smoke was a kind of lighter-than-air gas, so they decided to raise their balloon with smoke from burning rags. Actually, smoke rises because air warmed by fire is lighter than the surrounding cooler air. Therefore, a balloon full of hot air will rise until thinner air at higher altitudes can no longer push up on the balloon or until the balloon's hot air cools enough to make it too heavy to stay aloft.

Although people in earlier centuries tried to construct balloons—and the Incas or Chinese may have succeeded in launching them—the Montgolfiers are credited with inventing the balloon. They received a good deal of public attention because both they and their rival, Jacques Charles, wanted to be the first to send up a balloon. The Montgolfiers won the race to fly on June 5, 1783, and their balloon's flight —without passengers—was officially witnessed and documented by the Academy of Sciences.

On September 19, 1783, the Montgolfiers flew their invention—later called a *montgolfier* or a hot-air balloon—before King Louis XVI and his court in Versailles. On this second flight, the balloon carried three passengers—a sheep, a duck, and a rooster. The balloon measured 41 feet (12 meters) in diameter and was 86 feet (26 m) high. Floating to a height of 1,450 feet (435 m), the balloon stayed in the air for about 10 minutes. After the balloon's



Joseph Montgolfier



Jacques-Etienne Montgolfier

air cooled, it descended slowly, and the animal passengers landed safely. During both flights, the balloons were *tethered* or tied to the ground with a long cord.

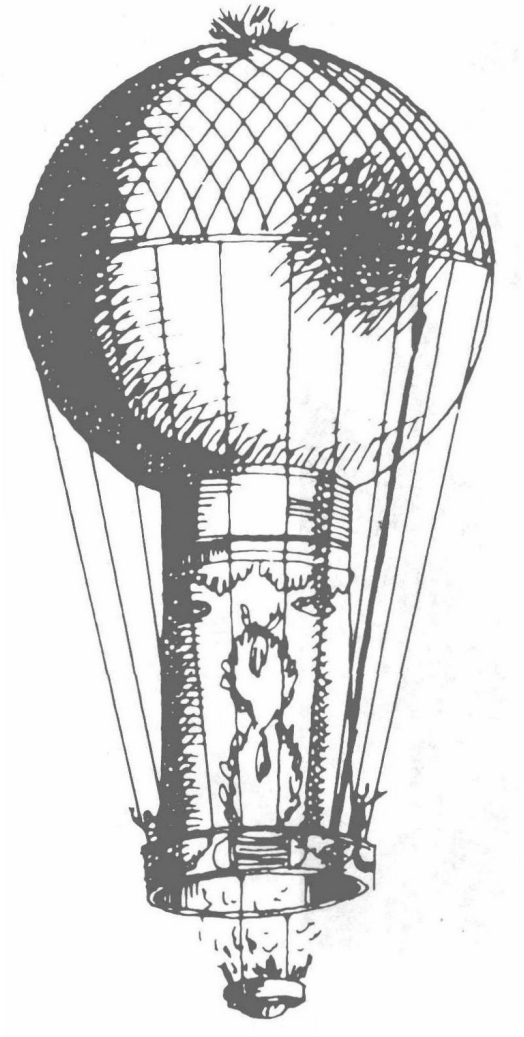
Jacques Charles was not discouraged by the Montgolfiers' success. He continued with his own plans to launch a balloon, but he was not going to use smoke to get his balloon aloft. He had another idea.

Seventeen years earlier, the English scientist Henry Cavendish had discovered a new gas by dropping acid on iron scraps. He filled one animal bladder with air from the atmosphere and another with this new gas. Then he weighed the bladders. The new gas was 11 times lighter! Cavendish named his discovery inflammable air; today it is called hydrogen.

Jacques Charles decided to power his balloon with the new inflammable air. His redesigned *gasbag*, or envelope, was made from silk and lined with an elastic gum, and it was closed at the bottom to keep the gas from escaping.

As a balloon rises higher, the air is thinner, so the gas expands. The air is also colder at higher altitudes, which eventually makes the gas contract, and the balloon descends. These two opposing forces allowed Charles to control his balloon.

Charles' balloon was launched on August 27, 1783. It was the first balloon inflated with hydrogen rather than hot air. Unlike the Montgolfiers'

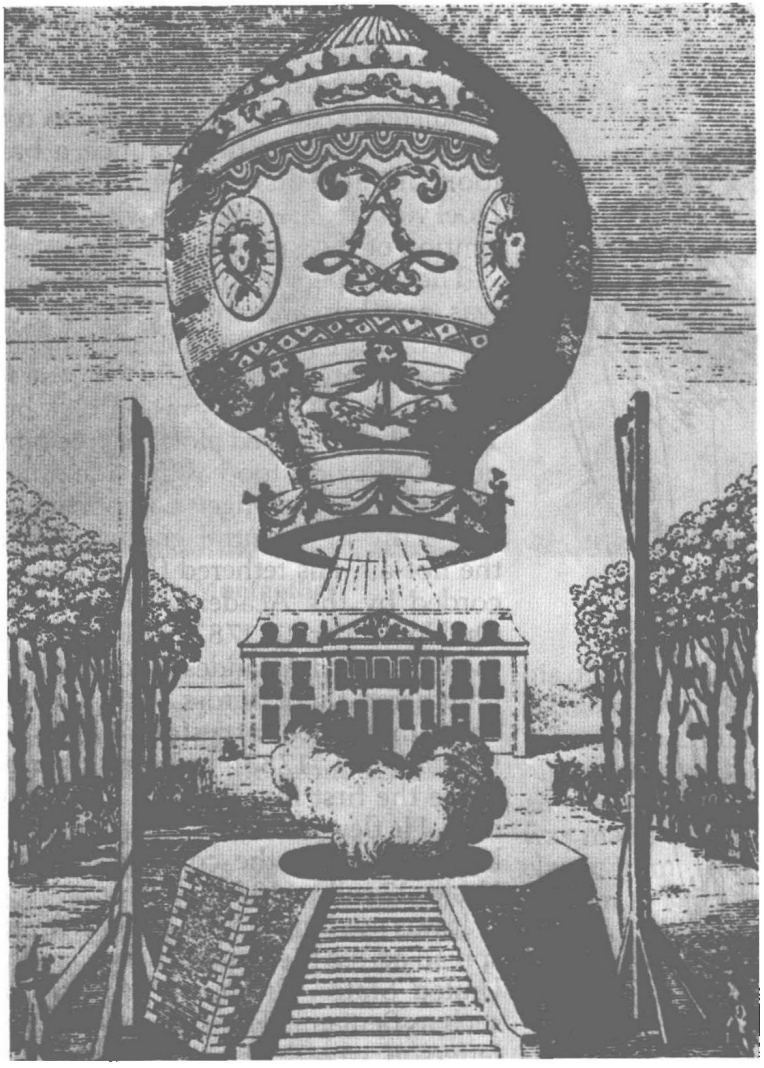


A drawing of an early hot-air balloon. Passengers stand in the gondola that surrounds the fire in the central grate.

balloons, Charles' balloon was not tethered. It ascended 3,000 feet (900 m) and flew a distance of 15 miles (24 kilometers). Although Charles was not the first to successfully launch a balloon, he and his partners, Jean and Noel Robert, are credited with the invention of the gas balloon.

The first person to ride in a balloon was another Frenchman, Pilatre de Rozier. In the hot-air balloon designed by the Montgolfiers, de Rozier rose to a height of 80 feet (24 m) on October 15, 1783, and stayed aloft for five minutes. De Rozier stood at the side of the *gondola*, or passenger compartment, and a fire in a central grate provided the hot air. His tethered flight was recorded by the Academy of Sciences. On November 21, 1783, de Rozier and the Marquis d'Arlandes made the first untethered flight across Paris and the surrounding countryside. Then, on December 1, 1783, Jacques Charles made the first free flight in a gas balloon. He flew over Paris and, two hours later, landed in the country town of Nesle, 27 miles (43 km) away.

It was not long before "balloon fever" spread across the Atlantic Ocean to the United States. Prominent Americans such as Benjamin Franklin and Thomas Jefferson were in France at the time, and they wrote letters home giving enthusiastic reports of the flights they had witnessed. When he returned to the United States, Dr. John Foulke, an American who had studied medicine in France, decided to build his own hot-air balloon. On May 10, 1784, he



The first humans to fly, the Marquis d'Arlandes and Pilatre de Rozier, wave to the crowds at the Bois de Boulogne near Paris. Thirty minutes after taking off, the montgolfier landed in a field.

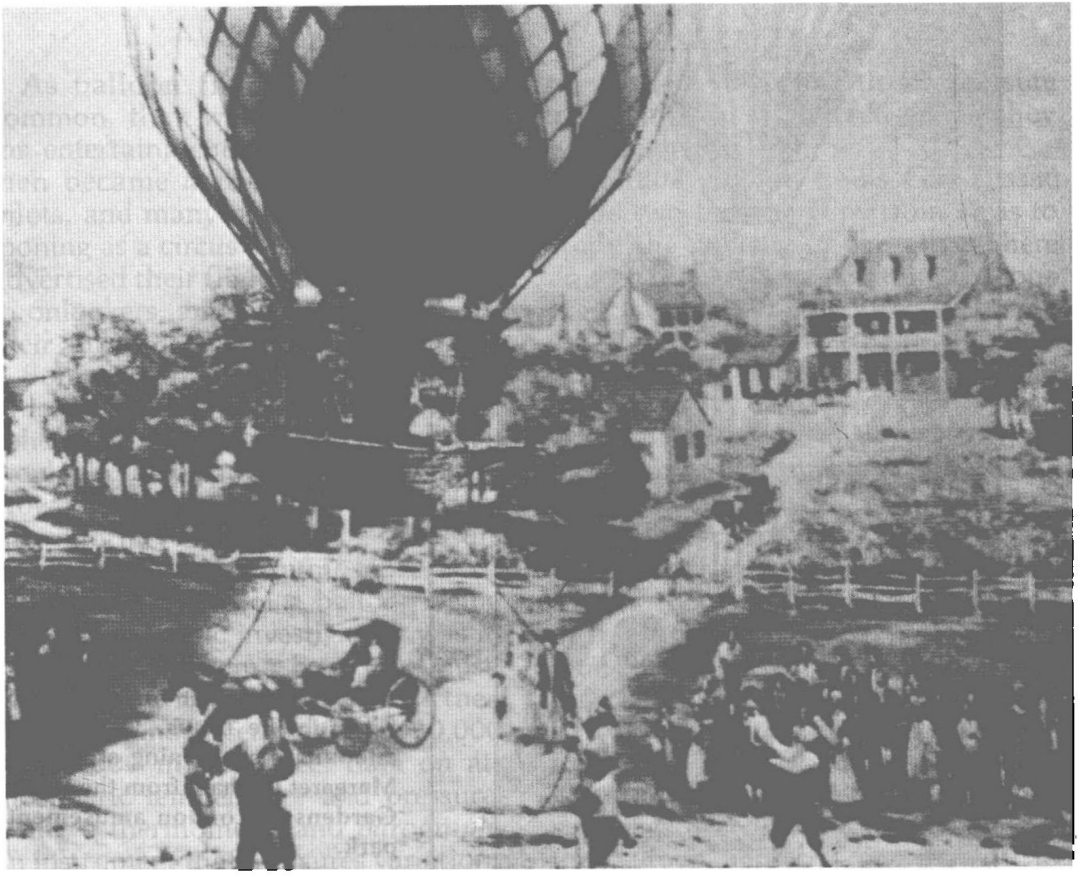
sent his first free-floating balloon aloft over Philadelphia.

Like the race in France between Charles and the Montgolfiers, a contest to send up a piloted balloon began in the United States. Dr. Foulke and some of his colleagues decided to make a silk balloon that could carry people. A lawyer named Peter Carnes decided to do the same.

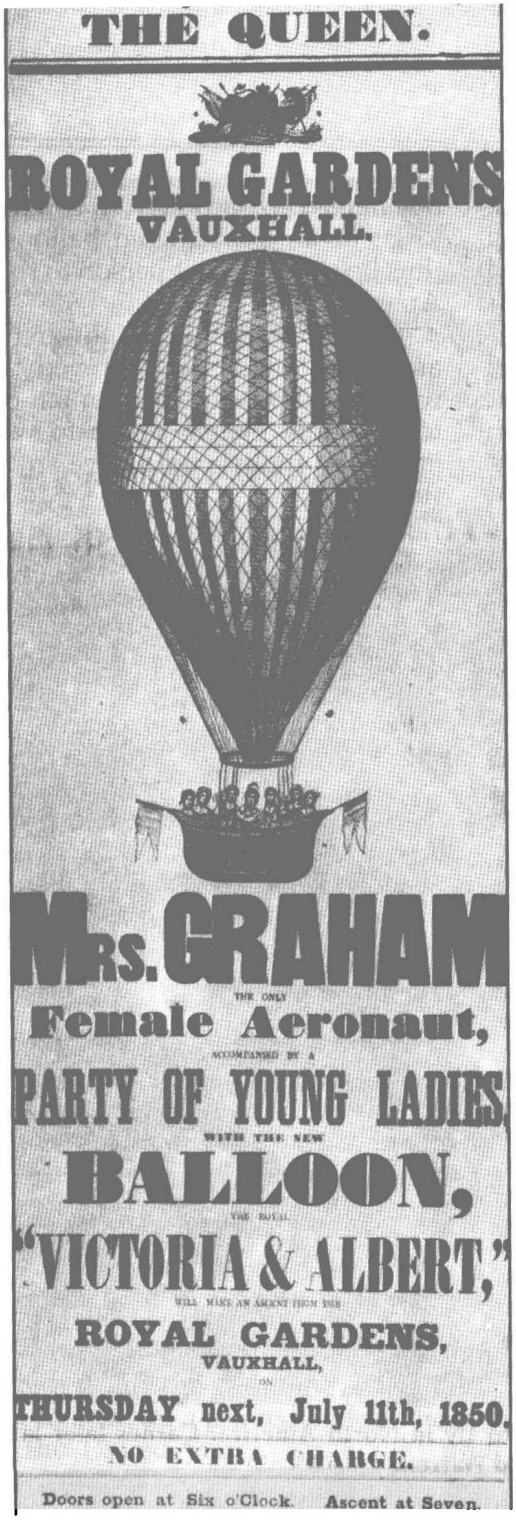
On June 24, 1784, in Baltimore, Maryland, Carnes flew his balloon

several times in front of a large crowd. His flights, however, were unpiloted and tethered. The onlookers shouted for Carnes to get into the gondola, but Carnes weighed 234 pounds (105 kilograms), and he had already discovered in several earlier private attempts that the balloon would not go very high with him on board. As the crowd became more demanding, a 13-year-old boy named Edward Warren volunteered to go up in the tethered balloon and thus became the first person to fly over American soil.

These early balloon flights in France and the United States proved that it was indeed possible for human beings to fly. Now people began to wonder if balloon flights could have any practical uses.



Peter Carnes launches the first balloon to fly in North America. Carnes later launched his balloon with its first passenger, Edward Warren.



An advertisement for a balloon flight in the 1800s. This poster announces an evening ascent by Margaret Graham from the Royal Gardens, a London amusement park.

2

Exploring the Lower Atmosphere

As balloon flights became more common, they were most often used for entertainment. Both women and men became *aeronauts*, or balloon pilots, and many of them treated ballooning as a circus performance. They advertised their flights and sold tickets to onlookers, amazing audiences with their ability to fly.

Some aeronauts, however, wanted to learn more about the earth's atmosphere. If one flew higher, how much would the temperature of the air change? How did the direction and speed of the wind vary? How would air pressure change high up in the atmosphere?

The first record of a balloon being used for scientific investigation was in August 1784 when a French chemist, Guyton de Moreau, and his partner, Abbe Bertrand, ascended to over 10,000 feet (3,000 m) to collect data on atmospheric temperature and pressure. Using a thermometer and *barograph*, an instrument that measures variations of air pressure in relation to altitude, they observed that both air pressure and temperature decreased as they went higher.

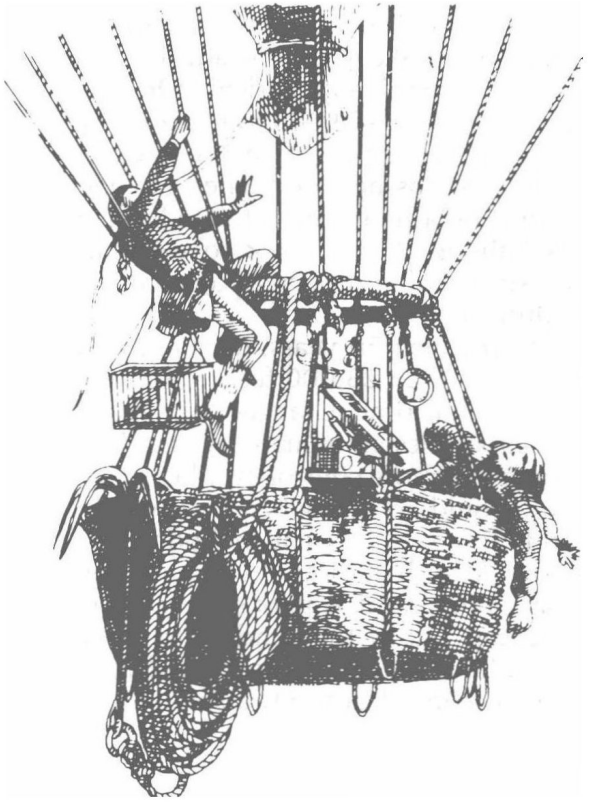
In 1804, Joseph Louis Gay-Lussac made two balloon trips from Paris to study the makeup of the atmosphere and the earth's magnetism. On one flight, soaring to 23,000 feet (6,900 m), Gay-Lussac felt his heartbeat grow more rapid as he rose higher. He had trouble breathing and he fainted. Then his balloon drifted back to earth as the surrounding upper air cooled the hydrogen.

For the next 50 years, no one dared go higher than 23,000 feet (6,900 m). During that time, changes were made in balloon design, which gave gas balloon pilots more control over how high they would go and when they would land. To control ascent, balloons carried *ballast*. Ballast could be anything heavy, often sand. A pilot simply threw sandbags out of the gondola to make the balloon lighter. This caused it to rise. To control descent, a small valve

was installed at the top of a balloon. Pilots would pull a cord that opened the valve to let gas escape. This made the balloon less buoyant, and it would slowly descend. *Valving* is still used in all piloted balloons and in some radio-controlled balloons as well.

Finally, in 1862, aeronaut Henry Coxwell and scientist James Glaisher could not resist attempting an altitude record. While flying their gas balloon to nearly 30,000 feet (9,000 m) above the English Midlands, Glaisher fainted from lack of oxygen. Coxwell, however, managed to pull the valve line with his teeth and release enough hydrogen to bring the balloon down.

James Glaisher and Henry Coxwell's first balloon flight.



Undaunted, Coxwell and Glaisher made 26 more flights to learn about the lower atmosphere. On some flights, they used a *hygrometer* to measure the amount of water vapor at different altitudes. On others, they used a thermometer to measure air temperature at different altitudes. They learned that the colder the air, the less moisture it holds, and that when the air is full of as much moisture as it can hold, clouds form. They discovered that clouds usually form at 1,000 to 50,000 feet (300-15,000 m) where air is colder than at sea level. Coxwell and Glaisher also classified clouds according to their appearance and height.

In 1875, scientists Theodore Sivel and Joseph Croce-Spinelli attempted to better Glaisher and Coxwell's high-altitude record. Ascending from Paris, France, they used oxygen-filled bladders with mouthpieces for breathing but, unfortunately, did not carry enough oxygen. When their balloon, the *Zenith*, rose to 28,000 feet (8,400 m), Sivel, Croce-Spinelli, and aeronaut Gaston Tissandier, all fainted. As the balloon descended into a more oxygen-rich atmosphere, Tissandier woke up and discovered that his two companions were dead.

This tragedy all but stopped high-altitude ballooning, but it did not diminish scientific curiosity. Continuing as leaders in developing technology,

Sivel (left) cuts the ballast loose while Tissandier (center) observes the barometers and Croce-Spinelli takes a breath of oxygen.

the French began using large, mechanized, *meteorological balloons* to study the atmosphere in 1892.

Meteorological balloons carried instruments to record temperature and altitude. These balloons often rose to an altitude of 8 to 10 miles (13-16 km). Because there was little air pressure on the balloon's surface at that height, the hydrogen would expand to fill the gasbag. Then the gas automatically would begin to *vent*, or escape, out the bottom of the bag. Because the hydrogen leaked out so slowly, balloons often drifted up to 700 miles (1,120 km) away from their launch sites before landing. Therefore, recovering the recording instruments was not always easy.

To solve this problem, German aeronaut-meteorologist William F. Assmann designed *expandable balloons* made of rubber. Closed at the bottom, each balloon carried instruments sealed in a wicker box suspended in a hoop. When the gas expanded beyond the gasbag's capacity, the balloon would burst and a parachute would open and float the instruments back to earth. Parachutes descend more quickly than balloons, so the instruments from an expandable balloon would land closer to the launch site.

Blue Hill Observatory

In 1885, Abbot Lawrence Rotch founded the Blue Hill Observatory. Located about 10 miles (16 km) south of Boston, Massachusetts, on the top of the Great Blue Hill, the observatory would use kites and meteorological balloons to provide weather information. The observatory consisted of a round brick tower attached to a low, square building that looked like an old castle.

At first, Rotch and his three colleagues —Henry Helm Clayton, Sterling P. Fergusson, and Willard P. Gerrish— observed cloud appearances and heights and the weather that accompanied

each kind of cloud formation from the ground. Then, in 1894, they sent aloft a kite that carried a *thermograph*, a device designed to record air temperature at different altitudes. These scientists launched more than 80 box kites during 1896 and, in 1900, they sent a kite to a record altitude of 16,050 feet (4,815 m).

Aware that the French were using gas balloons for atmospheric studies, Rotch longed to do the same. Balloons launched from Blue Hill Observatory, however, could easily drift over the Atlantic Ocean, losing their cargo, or *payloads*, in the sea. Rotch decided to launch his balloon from a safer location and sent his colleague, Sterling P. Fergusson, to the Louisiana Purchase Exposition in St. Louis, Missouri. Fergusson launched the first U.S. weather balloon on September 15, 1905. The expandable balloon burst at an altitude of 56,815 feet (17,045 m), and its payload landed 50 miles (80 km) from the launch site. The instruments had recorded temperature, air pressure, and altitude and showed that air temperature stops falling at an altitude of 8 to 10 miles (13-16 km) above sea level.

Between 1905 and 1908, over 80 balloon flights supervised by the Blue Hill Observatory team were launched from St. Louis and later from Pittsfield, Massachusetts, a city farther inland than Boston. Most flights lasted from two to three hours, and the balloons usually rose 8 to 10 miles (13-16 km). Very few balloons were lost, and few instruments were damaged.

After Rotch's death in 1912, the observatory was donated to Harvard University. Routine measurements, or *soundings*, of atmospheric conditions at various heights were made by balloon flights at Blue Hill until the beginning of World War I, when all available money was channeled into the war effort.

Meteorological Balloons

During the 1930s, balloon-borne meteorological instruments were put back in use. Old instruments were improved, and new ones were designed. One new device was the *radiosonde*. As a balloon rose, a radiosonde would send out a series of coded electrical impulses that indicated changes in temperature, air pressure, and relative humidity. The radiosonde in use today is similar, but it also has an automatic tracking antenna, a *theodolite*, which allows meteorologists to compute the altitude of the radiosonde and the upper air wind speed and direction.

Meteorological balloons in use today are made of high-quality neoprene rubber. Like Assmann's expandable balloon, they are closed at the bottom so, when they reach the desired altitude, the ever-expanding gas will fill the gasbag, causing it to burst.

Weather balloons are usually inflated inside special buildings that have been designed to shield balloons from the wind. First, a launch specialist inserts the empty balloon into a fiberglass cylinder, and then a member of

In 1936, the U.S. Navy used this radiosonde to measure changes in air temperature, pressure, and humidity.

the launch crew turns on the pump switch connected to tanks of helium. Slowly the balloon fills with helium and emerges from the top of the cylinder, as if someone chewing gum were blowing an enormous bubble. When the balloon is properly inflated, it rises enough to pull on the line attached to the pump switch, shutting it off. As it leaves the cylinder, the balloon begins to rise through an opening in the roof. A payload of instruments is attached, and the balloon drifts quickly upward, becoming a tiny dot against the sky.

Most balloons carrying radiosondes measure 5 feet (1.5 m) in diameter at launching. Often they stretch to 20 feet (6 m) before bursting, sending their payloads back to earth by parachute. The exact design of a radiosonde can vary. Some mechanically code data for transmission to the ground, while others produce direct electrical impulses. All types of radiosondes, however, provide valuable information on temperature, pressure, humidity, and wind speeds at various altitudes up to 100,000 feet (30,000 m).

Twice each day, hundreds of balloons carrying radiosondes are launched by meteorological stations throughout the world. This is part of the upper-air program of the World Meteorological Organization. Using the information provided by radiosondes, local meteorologists track world weather patterns and make accurate weather forecasts. Unlike satellites, balloons can record readings at several different altitudes during a flight.