Upper-Air Meteorological Measurements

Weather Balloons

Don Hillger and Garry Toth

As follow-up to three previous articles about weather instruments, this article features weather balloons on postage stamps. The balloons allow direct measurements of the upper atmosphere as opposed to the indirect remote sensing techniques employed by meteorological satellites or ground-based remote sensing instrumentation.

Weather balloons are typically teardrop-shaped rubber enclosures about two meters in diameter filled with sufficient helium to loft an instrument package to very high atmospheric levels. Data on the pressure, temperature, and humidity are collected during the ascent. Winds are calculated from the measured position of the balloon during its ascent. The balloon grows larger as it reaches lower and lower atmospheric pressures until it finally bursts after expanding to six meters or more in diameter. At that point the instrument package falls back to earth, its descent slowed by a parachute. Although expendable, about twenty percent of instrument packages from the 75,000 weather balloons released in the U.S. each year are recovered and returned to be reconditioned and reused.

Denmark issued a stamp (1994/*Scott* 1004) showing Alfred Wegener's weather balloon from the 1906-1908 Danish Greenland expedition. In the days before radio transmitters, it was important that the instrument package be recovered via parachute after the balloon burst so that the data could be collected and analyzed.

Weather balloon ascents to obtain meteorological data are generally made at two standard synoptic times each day, eight and twelve UTC (Coordinated Universal Time). This worldwide coordination allows twice-daily upper-air weather maps to be generated from the data captured simultaneously at many locations around the world. Thus data from some 550 to 600 balloons worldwide are available. The majority of those are launched in the northern hemisphere.

Alfred Wegener's Weather Balloon
Denmark (*Scott* 1004)

Helium Tank Inflates Balloon
South Africa (*Scott* 613)

Radio Transmitters

The instrument package for weather balloons has evolved over time into a smaller unit with better sensors, now typically with a mass of only a few hundred grams depending on the model and features. This package was originally called a radio-meteorograph, but is now referred to as a **radiosonde**: "radio" for the batterypowered transmitter that sends atmospheric data back to earth as the balloon ascends, and "sonde" for the meteorological sounding produced from the transmitted data.

Attaching Radiosonde to Balloon
Australian Antarctic (*Scott* L117)

Launching a Weather Balloon
British Antarctic (*Scott* 21)

Radar Antenna Tracks Balloon
Gilbert and Ellice (*Scott* 220)

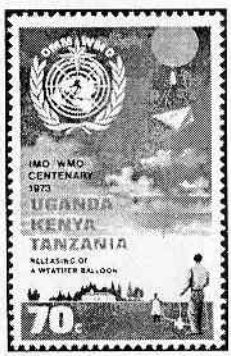
A modern radiosonde is monitored by its radio signals using various types of radio direction-finding equipment. The ascent rate of a weather balloon is approximately constant and is known, so the pressure readings can be related to geometric altitudes. Data transmitted by the radiosonde are recorded by ground equipment and then transmitted around the world so that all nations contribute to an international pool of radiosonde data, and also obtain radiosonde measurements from other countries.

Data from a radiosonde (temperature, humidity, and wind various pressure levels) can be plotted on a thermodynamic diagram as an atmospheric sounding, or on a chart to create a weather map at a given upper level. In addition, radiosonde data are very important in computer models for NWP (Numerical Weather Prediction).

Early weather balloon instrument packages did not have radio transmitters to allow their tracking. Rather, the balloon carried a radar reflector which was actively tracked and located by radar, or by a radio **theodolite**. This kind of weather balloon and instrument packages was called a **rawinsonde** for radar plus wind plus sondes. Upper winds were calculated from the various positions of the balloon recorded by the tracking procedure. A radio transmitter sends back temperature and humidity data.

Balloon Launchings

A balloon ascent can last more than two hours and the balloon can drift as much as 200 km (125 miles). For this reason, the balloons are generally launched about 45 minutes before the time at which their data are considered valid to allow them to rise into the stronger winds of upper levels in the atmosphere. In ideal conditions, weather balloons are capable of reaching altitudes of 30 km (100,000 feet) at pressures typically about 1/100th (10 millibars) of that at the earth surface (1000 millibars), although not all of them make it that high. The temperature sensor is designed to record temperatures as low as minus 90 degrees Centigrade. Upper-air temperatures have always been recorded in degrees Celsius since routine upper-air measurements began. Degrees



Launching a Weather Balloon
Kenya, Uganda, and Tanzania
(1973/*Scott* 260)

Rising Through Electric Storm
Hungary (*Scott* 1664)

Balloon Can Drift 125 Miles
Poland (*Scott* 2976)

Recovering Parachute With Data
Belgium (*Scott* B799)

Fahrenheit are used only for near-surface air temperatures and only by the United States.

An atmospheric level known as the **tropopause** marks the boundary between the **troposphere** (the lower part of the atmosphere in which temperatures normally decrease with height), and the **stratosphere** (the part of the atmosphere above the tropopause in which temperatures remain the same or even increase with height). The coldest temperatures of an ascent are therefore found at the tropopause. Weather balloons generally rise through the tropopause at levels that are quite variable depending on the geographic location and the season. The tropopause is often found at roughly ten km (33,000 feet) altitude.

The first weather balloons for meteorological investigation were used about a century ago while the radiosonde-type of package dates back to 1930. Routine upper-air measurements in the U.S. were started in 1937 when a radiosonde network was established by the Weather Bureau (now the National Weather Service). While the radiosonde was adopted by some European countries at about the same time, the rapid rise in their worldwide use did not occur until just after World War II.

The current U.S. network consists of about 80 sites across the U.S. (including Alaska) where balloons are routinely launched. Approximately 30 additional stations in Canada round out the North American network. Many millions of weather balloons have been launched around the world since upper-air observations were started. There are dense networks in most developed countries and in a few developing countries such as China. However, there are very few launches from Third World countries due to a lack of sufficient infrastructure needed for regular balloon launches.

Weather Balloons on Stamps

A large number of stamps show weather balloons, often with their instrument packages. Those stamps can be categorized by the type of balloon as well as the amount of detail on the balloon and its associated instrumentation.

Weather balloons without enough detail to determine the presence of instrument packages are found on postal items issued by: Angola (1993/*Scott* 860); Belgium (1958/*Scott* C16); British Antarctic Territory (1996/*Scott* 237 and 239); Canada (1968/*Scott* 479); Cuba (1965/*Scott* 962); Finland (1994/*Scott* 938); French Southern and Antarctic Territories (1986/*Scott* C92); Libya (1965/*Scott* 276-278); Russia (1955/*Scott* 1765-1766, 1959/*Scott* 2234, 1970/*Scott* 3700, 2000/*Scott* 6575a); and Thailand (1987/*Scott* 1173).

Finally in this category, a stamp issued by South Africa (1983/*Scott* 613) shows a teardrop-shaped balloon being inflated from a helium tank. This is the only known stamp (shown on page 41) to show this important phase in the launch of a weather balloon.

Weather balloons with radiosonde packages that can be discerned are found on the following items: Afghanistan (1989/*Scott* 1368); Albania (1969/*Scott* 1210); Australian Antarctic Territory (2001/*Scott* L117n); People's Republic of China (1978/*Scott* 1384); Cyprus (2000/*Scott* 960); Finland (1973/*Scott* 531); Libya (1969/*Scott* 359); Namibia (1991/*Scott* 690); New Zealand (1984/*Scott* 794 and 794a); Russia (1958/*Scott* 2091, 1959/*Scott* 2235, 1961/*Scott* 2495,

50 Years of Soviet Radiosondes
Russian 1979 Postal Stationery

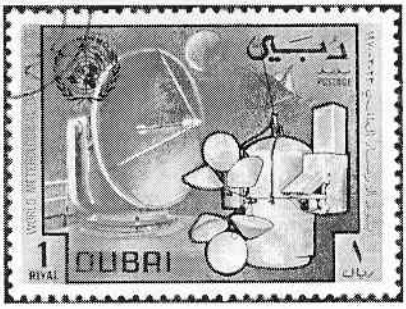
1981/*Scott* 4898); Senegal (2000/*Scott* 1442); Upper Volta (1969/*Scott* C63); and Vanuatu (1992/*Scott* 565).

Weather balloons with radiosonde packages can also be seen on postal stationery of Romania (1984), and Russia (1979, 1981, 1982 and 1984). Of particular interest, the stamped envelope issued by Russia in 1979 commemorates 50 years of Soviet radiosondes indicating that their radiosonde program began in 1929. Also two stamps issued by Syria (1970/*Scott* C452-C453) show a weather balloon in the background being tracked by a set of send-and-receive antennas.

In addition to a radiosonde package, a parachute can be seen between the balloon and the radiosonde on some postal items. This parachute is usually held open to some degree so that when the balloon bursts the parachute will open fully in the updraft of free fall. In some cases the parachute is held open by being attached to a ring that is perpendicular to the cord connecting the balloon and the radiosonde, and which flares the connecting cord into several strands.

Parachutes and Rawinsondes

Parachutes and/or their associated rings are found on the following items: Brazil (1988/*Scott* 2127); Burma (1980/*Scott* 275); China Republic (1962/*Scott* 1337 and 1339); Cuba (1967/*Scott* 1221 and 1971/*Scott* 1592); Ivory Coast (1964/*Scott* 213); Jamaica (1991/*Scott* 746-747); Kuwait (1990/*Scott*



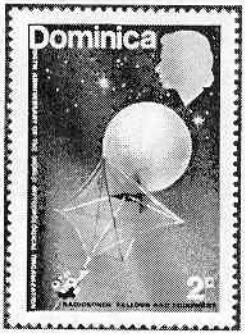
Radiosonde With Six Cup Sequencer
Dubai (*Scott* 122)

1132-1134); Mali (1963/*Scott* 45-47); Poland (1990/*Scott* 2976); Portugal (1971/*Scott* 1114); Thailand (1992/*Scott* 1472); United Nations (1957/*Scott* 49-50); South Viet Nam (1964/*Scott* 235-238); and a 1999 Spain aerogramme.

Weather balloons with discernable radar reflectors (i.e. **rawinsondes**) are found on the following items: Chad (1970/*Scott* 227); Dubai (1970/*Scott* 121); Hungary (1965/*Scott* 1664); Kuwait (1965/*Scott* 272-274); St. Pierre and Miquelon (1974/*Scott* 431); and Saudi Arabia (1975/*Scott* 670). All but the last of these items contain parachutes as well as radar reflectors.

In addition, stamps issued by British Antarctic Territory (1969/*Scott* 21 and 1987/*Scott* 144); the People's Republic of China stamp mentioned above; and a stamp issued by Kenya, Uganda, and Tanzania (1973/*Scott* 260) nicely demonstrate the two-person operation typically required to launch a weather balloon with a radiosonde package. Finally in this category, a stamp issued by Gilbert and Ellice Islands (1973/*Scott* 220) shows the actual radar tracking antenna (the "windfinding radar") in the foreground with the weather balloon and rawinsonde in the background, shown on page 42.

Anemometerlike devices are sometimes associated with radiosondes. The cups on those devices are not used to measure the wind, but as a windmill to mechanically turn or sequence the measurements of pressure, temperature, and humidity. Typically the cups are vertically-mounted and the turning of the cups is forced by the downward relative wind



A Vertical-Mounted Sequencer
Dominica (*Scott* 356)

caused by the balloon's ascent. Modern radiosondes do not use such wind-driven sequencers; instead, they use the atmospheric pressure drop to sequence the measurements.

Sequencers and Paddles

Vertically-mounted sequencers are found on the following items: Algeria (1966/*Scott* 351); Dominica (1973/*Scott* 356); Dubai (1970/*Scott* 122); Ghana (1973/*Scott* 503); Grenada (1973/*Scott* 493); Qatar (1973/*Scott* 348); and Senegal (1978/*Scott* C62). Of particular note is the Dubai stamp which shows a radiosonde with a sixcup sequencer, more cups than shown on any other stamp with such sequencers. The radiosonde pictured on that stamp shown on page 44 is similar to the Mark 2B developed for the British Meteorological Office and used in many parts of the world.

Another set of postal items shows similar sequencers, but horizontally-mounted: China (1958/*Scott* 368 and 1960/*Scott* 484); Iraq (1972/*Scott* 644-645); and Saudi Arabia (1967/*Scott* 456-460). The two stamps from China appear to show cups on the arms of the horizontally-mounted sequencer. It is improbable that horizontally mounted sequencers with cups would work since the weather balloon floats with the horizontal wind; therefore no relative wind would be present to turn the cups. In order to catch the downdraft of the wind upon ascent, angled paddles rather than cups on the arms are necessary to turn the sequencer. Such paddles appear to be shown on the Iraq stamps but the images are too small to know for sure.

Balloons For Measuring Ozone
British Antarctic (*Scott* 176)

Paddles are more clearly seen on some of the postal covers not specifically mentioned in this article. They can be seen on the authors' Website mentioned at the end of the article. Interestingly, the stamps from Saudi Arabia over-emphasize the horizontal sequencer to the point that the radiosonde package is not even shown.

Stratospheric balloons are also seen on many postal items. These are larger scientific balloons designed to ascend well into the stratosphere where their measurements are made. In this article a distinction is made between manned and unmanned stratospheric balloons with only the unmanned balloons being featured. Manned balloons are found on the following postal items: French Southern and Antarctic Territories (1963/*Scott* 24) and 1983/*Scott* C81); Mongolia (1965/*Scott* 372); Mozambique (1985/*Scott* 946); German Democratic Republic (1958/*Scott* 371); and Sweden (1991/*Scott* 1892). The stratospheric balloon used by August Piccard can be seen on stamps of Belgium (1932/*Scott* 251-253) and Monaco (1984/*Scott* 1433).

Specialized stratospheric balloons intended for ozone monitoring are featured on a limited number of postal items. A stamp issued by British Antarctic Territory (1991/*Scott* 176) shows an **ozonesonde**, while a stamp issued the same year by French Southern and Antarctic Territories (1991/*Scott* C115) shows a stratospheric balloon for ozone study.

Another particular type of balloon was part of the Eole program which was active in the late 1960s and early 1970s. In this program a large number of helium-filled balloons floating in the upper atmosphere were tracked by dedicated satellites. The

Eole balloon system was a series of instrumented earth-circling constant-density meteorological balloons. The Eole spacecraft served primarily as communications satellites to relay data collected by the Eole balloons on upper-atmospheric altitude, pressure, temperature, moisture, and winds. As many as 500 Eole program balloons were launched at the rate of three per day from three sites in Argentina. The balloon system was intended to monitor the atmosphere at pressure altitudes of about 200 millibars (approximately 12,000 meters), particularly between 30 and 60 degrees south latitude where observations from conventional upper-air weather balloons are particularly sparse. The number of Eole balloons gradually decreased during the program's lifetime which ended in 1973 when the last balloons were intentionally destroyed.

Only three stamps are known to specifically show Eole program balloons. Those stamps were issued when the Eole program was still in effect. They include Argentina (1972/*Scott* 977); Central Africa Republic (1973/*Scott* (C115); and Mali (1972/*Scott* 174).

Pilot Balloons

Pilot balloons are another category of atmospheric sounding balloons. They are typically smaller (about one meter in diameter), and carry no meteorological

Manned Stratospheric Balloons Not Included In This Article
Monaco (*Scott* 1433)

instrumentation. They do not ascend as high or travel as far as weather balloons. Also called **pibals** (short for pilot balloons), they are typically round compared to teardrop-shaped weather balloons and are tracked by an optical tracking **theodolite**, an instrument used to determine their position as a function of time as they rise through the lower layers of the atmosphere. The optical theodolite is similar to a surveyor's transit, but has a tilted optical axis so that the telescope can be tilted up to track the balloon as it rises while the user continues to look horizontally into the device through the eyepiece mounted on its side.

This style of theodolite was developed in the earliest years of the 20th century by Alfred de Quervain (1879-1927), a Swiss polar explorer, meteorologist, and aeronaut. In 1905 he designed the first theodolite suitable for tracking pilot balloons. It incorporated a right-angled telescope that allowed the axis of the eyepiece to remain horizontal no matter what the angle of elevation of the telescope. This basic design is still used today.

A stamp issued by Australian Antarctic Territory (1966/*Scott* L14) shows both a pilot balloon and an optical tracking theodolite. Similarly, Belgium issued a

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Weather Balloons
continued from page 46

stamp (1966/*Scott* B799) showing a sounding balloon and a tracking theodolite used during the 1963-1965 Belgian Antarctic expedition. A set of three stamps issued by French Southern and Antarctic Territories (1957/*Scott* 8-10) shows a pilot balloon tracking theodolite being used. Romania issued a stamp and souvenir sheet (1948/*Scott* B415 and B416a) showing a balloon tracking theodolite and a pilot balloon. One has to look carefully at this stamp to identify these items since the principal feature of the stamp is a *DC-3* aircraft. Similarly, Romania also issued a postal card in 1998 with a theodolite and no balloon. This item was issued for the 100th anniversary of the 1898-1899 Belgica Antarctic expedition, and the cachet shows an expedition member, Georges Lecointe, "making a meteorological measurement" with what is probably a tracking theodolite.

In this article the emphasis has been on stamps, souvenir sheets, and postal stationery. However, weather balloons and radiosondes are also seen on many other types of philatelic items such as cancels and cachets on FDCs and other types of covers. A checklist and images of all the postal items mentioned, along with many additional postal items that are not discussed here, can be found on the authors' Website:
<http://www.cira.colostate.edu/ramm/hillger/wxballoon.htm>

If readers know of other postal items showing weather balloons and radiosondes, the authors would greatly appreciate learning about them.•

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Rain Gauge Correction

There was an error in the ancient rain gauge depicted in Hiller and Toth's article appearing on page 25 of the November-December 2005 issue of *Topical Time*.

This stamp was incorrectly identified as "Ancient Rain Gauge / South Korea (*Scott* 1459). It is instead a 1959 issue of the Peoples Republic of China (*Scott* 460) which shows a girl standing beside an Alter-type wind screen.

This 1987 South Korea stamp (*Scott* 1459) should have been used that depicts a stone foundation rain gauge that dates from the Sejong period of the Chosun Dynasty, circa 1450 A.D.

Military Vehicle Typos

Thank you for publishing my article "U.S. Military Vehicles" in the May-June issue of *Topical Time*. However, there were two typos in the article. Most readers will be able to figure out that "Fisher Boyd" in the third paragraph on page 38 should be "Fisher Body." Also on page 39 under "Trucks," the manufacturer is given as "GMA" rather than "GMC." I am sure that most readers will recognize GMC as a well-known automobile manufacturer. I would advocate a correction notice for these two misprints.

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Is It Two Rivers?

In Ian Paton's fine article "U.S.A. Becomes a World Power, Part II" in the May-June 2006 issue of *Topical Time*, I believe there is a spelling error. Near the bottom of column two on page 19, Ian writes: "He was killed in a battle at Dios Rios." I am nearly 100 percent certain that this should be "Dos Rios" which in English means "Two Rivers." "Dios Rios" does not make any sense in Spanish.

Dymetro Bykovetz, Jr.
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Weather Balloon Corrections

The "Weather Balloons article in the May-June 2006 issue of *Topical Time* looks good, but contains some errors that should be noted. The Australian Antarctic Territory stamp on page 41 as *Scott* L14 should have been identified as "Preparing a Pilot Balloon for Launching." The Belgium stamp (*Scott* B799) on page 43 actually shows a "Sounding Balloon and Tracking Theodolite." The Russian stamp on page 44 is *Scott* 5163 and not a postal entire as stated. These stamps are all depicted on the Hillger/Toth webpage at: *<http://www.cira.colostate.edu/ramm/hilger/wx-balloon.htm>*.

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Famous Librarians

Topical Time readers may be interested in knowing that retired New York librarian Vladimir Wertsman has published an article describing famous librarians who have appeared on stamps. The article appears in the Spring 2006 issue of the *Multicultural Review*, a publication that is published in cooperation with the American Library Association. Among the noted librarians identified by Wertsman are Chinese chairman Mao Zedong (1893-1976) who worked in the periodical section of the Beijing University Library; Benjamin Franklin (1706-1790) who started the first U.S. subscription library; and Russian dissident Alexander Solzhenitsyn who served as a prison librarian after he was confined by the Soviets in 1947. Other notables who served as librarians include Pope Nicholas V (1398-1455); Pope Marcellus II (1501-1555); university founder John Harvard (1607-1638); Thomas Jefferson (1743-1826); Johann Wolfgang Goethe (1749-1832); industrialist Andrew Carnegie (1835-1919); and poets Henry Wadsworth Longfellow (1807-1882) and Ogden Nash (1902-1971).

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Editor's Note: Mark Winnegrad's source for this information was an article that appeared in the January 23, 2006, issue of the *New York Daily News*. However, the editor has not been able to obtain a copy of the full article even though he has found that the *Multicultural Review* is published by the Goldsman Group in Tampa, Florida, and not by the American Library Association. If any reader can obtain a copy, would they share it with your editor?

Make "Topical Postline" your forum. We want to hear from you. Remember, however, that concise letters will be more appreciated by other readers. Therefore your letter may be edited for reasons of clarity and available space. Letters should be sent to George Griffenhagen, Editor, *Topical Time*, 2501 Drexel Street, Vienna, VA 22180, U.S.A.