Our Earth as a Satellite Sees It

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The scientist who directed the development and launching of Tiros I, *NASA's historic weather satellite, tells of its exciting discoveries and its successors' promising future*

THE WORLD has had its picture taken. For the first time in the millions of centuries that our planet has been whirling around the sun, we can see our home as it looks from a tiny companion in space. A man-made satellite, circling some 450 miles overhead, has photographed us not once but thousands of times.

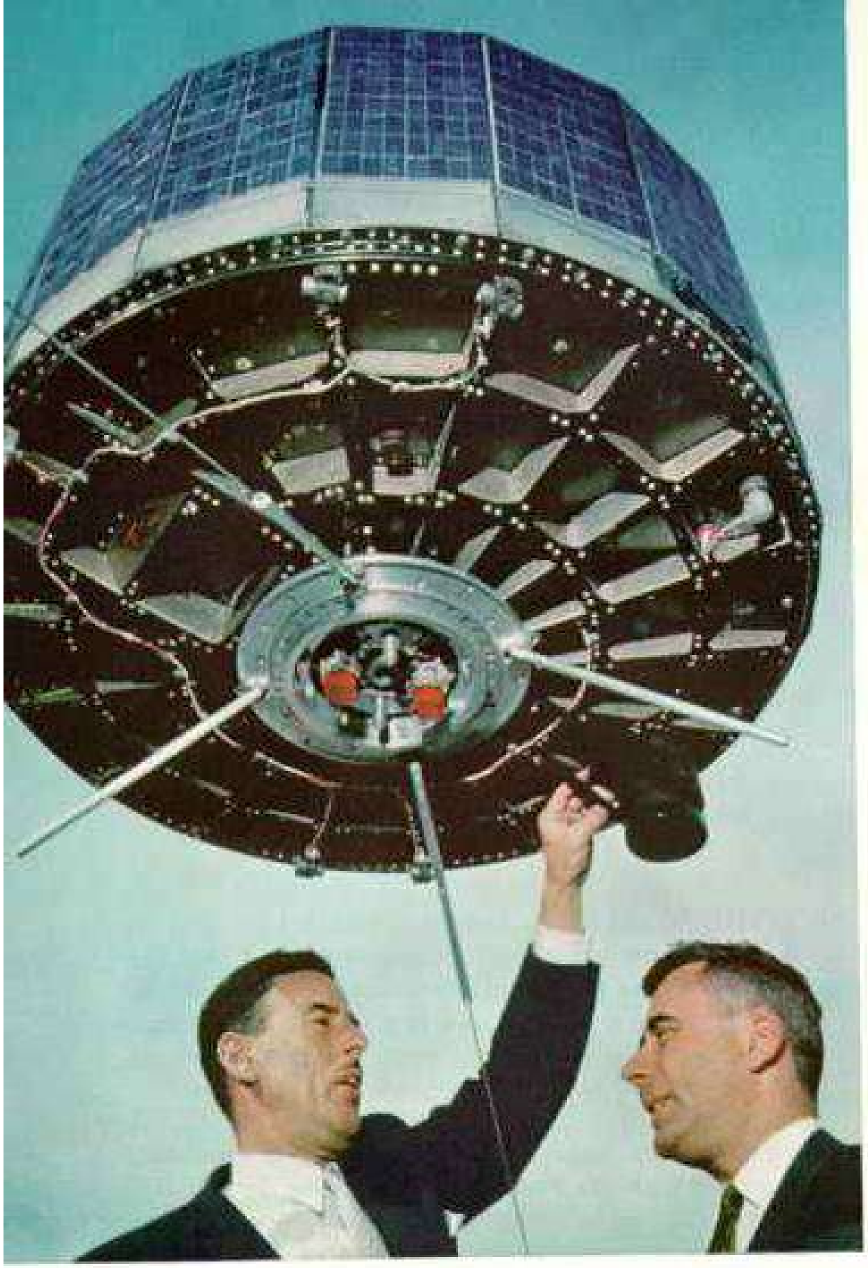
Such spectacular panoramas as the view of Florida on the opposite page show our planet—its continents and seas, its clouds and storms—as never before seen by man except in his imagination.

Streaking around the earth at almost five miles a second, the American experimental weather satellite *Tiros I* (Television and Infra-Red Observation Satellite) has sent us an enormous number of pictures since its launching on April 1; its two television cameras have snapped them as rapidly as one every 30 seconds. The 264-pound "hatbox" satellite has also reported continuously on its position, internal temperatures, angle to the sun, and even the condition of its instruments.

Spinning lazily on its axis, *Tiros* circles the globe once

Photographed from 450 miles in the sky, Florida takes shape on the globe. Shoals fringe the Gulf coast and the Bahamas (lower right). Cape Canaveral, launching site of *Tiros I*, juts into the Atlantic. Clouds to the north bathe the Great Smokies. The 35-mm. original at right, shown actual size, was received by a station that ordered the satellite to turn on its signal, then automatically recorded frame number, orbit, sun angle, and the camera used (page 297).

NASA



Tiros, Perched on the Nose of Its Rocket, Roars Off for the Heavens

Here, seconds after blast-off, the 90-foot, three-stage Thor-Able lifts majestically from its pad at Cape Canaveral. The umbilical tower, last link with earth, topples amid fire and vapor. Plastic shroud at the rocket's tip protects the satellite during the ascent, then falls away to expose the solar cells at left.

Cells that convert solar energy into battery power glisten from the sides of the 264-pound satellite. Its four antennas have flashed thousands of television images since *Tiros* took off.

Adjusting the lens of the satellite's wide-angle camera is Herbert Butler of the United States Army Signal Research and Development Laboratory, Fort Monmouth, New Jersey, where many of *Tiros*'s television pictures have been received. Sidney Sternberg (right) represents RCA, which designed the satellite for the National Aeronautics and Space Administration.

KODACHROME (LEFT) BY NATIONAL GEOGRAPHIC PHOTOGRAPHER W. D. VAUGHN; EKTACHROME BY NASA © N.G.S.

every 100 minutes. Thanks largely to a rocket guidance system developed by Bell Telephone Laboratories, its orbit varies only slightly from a perfect circle—as of its launching date the most precise achieved by any satellite.

Thus *Tiros I*, the United States' eighteenth satellite in orbit around the earth, became man's first weather eye in the sky. The brains controlling the eye acted through two data acquisition sites—one at Fort Monmouth, New Jersey, the other at Kaena Point, Hawaii.

Pictures Stored by Tape Recorder

When the satellite flashed within range of one of these stations to begin another photo-taking orbit, an engineer gave it a spate of prearranged orders. Via radio, he could tell *Tiros* when to start its next sequence of 32 pictures—perhaps as it whizzed over Africa 15 minutes later—and which of its television cameras to use. Its orders memorized electronically, the satellite spun on its way.

Precisely at the 15-minute mark, over Africa, its camera began snapping; but *Tiros* was then too far from either data site to transmit pictures directly—as it did when photographing within range of a station. Instead, a tape recorder automatically stored the views as they were snapped at 30-second intervals. On its return passage the engineer issued another order, and the satellite dutifully beamed the photographs to the station.

Of *Tiros*'s two TV cameras, one—fitted with a wide-angle lens—focused upon a vast area three times as large as France; the other scanned in greater detail a square 100 miles by 100 miles. Each camera, about the size of a water glass and weighing only two pounds, peered at the earth through a picture tube narrower than a man's finger.

Whenever I was in a data station during *Tiros*'s 10-minute passage, excitement among

Kuril Islands dot the foreground; Hokkaido lies at lower left as *Tiros* sweeps across the Pacific, taking pictures to be stored in its memory for broadcast later. Dense clouds swathe eastern Siberia.

Land white as snow, sea dark as ink: a view of the Middle East. Just as on a map, the Omani peninsula all but pinches off the Persian Gulf from the nearer Gulf of Oman. Clouds veil Iran (right center); sunlight brightens the Arabian Peninsula.

NATIONAL GEOGRAPHIC PHOTOGRAPHER W. O. FOSTER

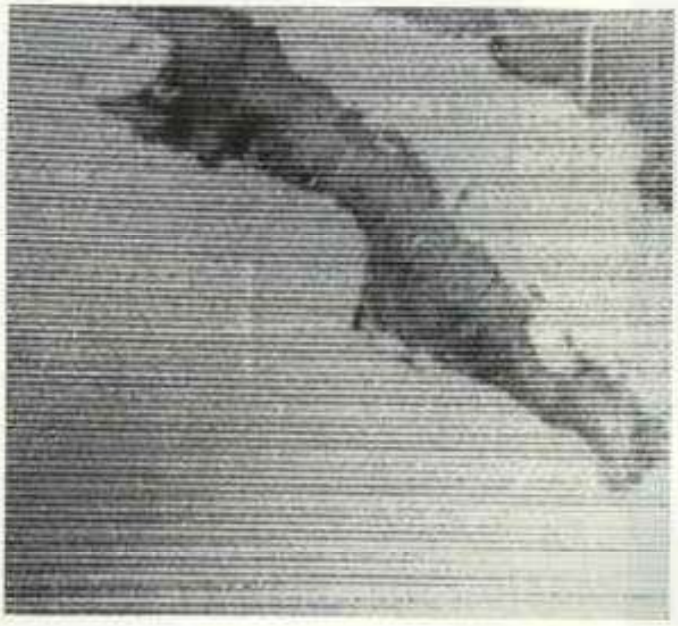
Tension Grows as *Tiros I* Approaches Fort Monmouth With a New Cargo of Pictures

Within the control room of the New Jersey read-out station, the console operator gives instructions to the mammoth antenna that will pick up signals from the satellite on its swift passage from horizon to horizon. Technician at rear clasps his earphones, listening for the first beep-beep-beep from space.

String of cirrus clouds drifting across Sudan indicates the presence of a paralleling jet stream farther north (page 302). Speeds up to 175 knots have been recorded for these elusive high-altitude winds.

Winding north across Egypt, the Nile empties into the black Mediterranean. The Red Sea forks into the Gulfs of Suez and Aqaba; a faint line knifing between Africa and the Sinai Peninsula marks the Suez Canal.

Coded data show that camera 2 (wide angle) took frame 5 (1 plus 4), stored it on tape, and, on *Tiros*'s 44th orbit, beamed it to "M," or Fort Monmouth.



Bathed in April sunshine, Lower California poses for the eye in the sky. Two random clouds drift across its southern tip. Gulf of California, winter playground of fishermen and yachtsmen, separates the 800-mile-long peninsula from mainland Mexico.

NASA

Hook of land identifies Cap Blanc, a western tip of Africa. Here the Spanish Sahara borders French Mauritania some 150 miles south of the Tropic of Cancer. Clouds form white patches above the Atlantic.

the engineers mounted steadily as "the bird" approached. A giant 60-foot antenna shaped like a dish locked in on the satellite and tracked it across the sky. A babble of signals flowed in, the ground equipment unscrambled them, and—in the familiar manner of a home TV set—"wrote" the pictures on the face of a screen, where a 35-mm. camera automatically photographed them.

In these pictures the maps we studied in our school days seem to come alive. The continents assume their familiar shapes; on page 299 the whole of Italy sprawls before us, the toe of its famous boot apparently poised to kick a cloud-shrouded Sicily into North Africa. The valley of the Nile, where ancient wonders sleep, twists like a dark snake beneath the modern wonder of *Tiros I*'s wide-angle stare (left).

Though the satellite was amazingly versatile, it could not change its line of vision, as you can by moving your head or eyes. Spin-stabilized like a gyroscope, its axis—and its cameras—pointed always in a single direction. As *Tiros I* orbited, there were times when the lenses looked out into space.

Solar cells—9,300 of them—spangled the satellite's sides and top. Converting the sun's rays into electrical energy, the cells furnished the lifeblood of *Tiros*'s instruments. But the career of an instrumented satellite on the

(*Continued on page 302*)

As the satellite spins through space, rotating 10 times a minute, the earth appears to turn dizzily beneath it. Arcing southward above the Red Sea, *Tiros* caught this dramatic sequence in five minutes. Clicking automatically every 30 seconds, and covering 140 miles between pictures, the camera registered a two-thirds overlap between photographs, allowing meteorologists to trace shifts in cloud patterns. This sequence, selected from a series of 32 televised images, shows (from top to bottom) the first, fifth, seventh, and eleventh exposures.

Top picture shows the triangular Sinai Peninsula linking the cloud-shrouded Mediterranean and the dark oblong of the Red Sea. In the bottom frame *Tiros* has streaked 1,500 miles and looks at the southern edge of Arabia and the protruding headland of East Africa.

Italy's toe aims a kick at Sicily. Orbiting above the Mediterranean, *Tiros* caught this dramatic scene that ranges from Africa on the left to the Greek island of Corfu (lower right).

This view of the globe precisely matches *Tiros*'s altitude, position, and camera coverage when it made the extraordinary picture above. To simulate the satellite's 450-mile-high look at our 8,000-mile-diameter planet, National Geographic cartographers placed a pinhole camera 2¼ inches above the 40-inch globe—an exact ratio.

NATIONAL GEOGRAPHIC PHOTOGRAPHER HARRY C. BISHOP (ABOVE) AND NASA

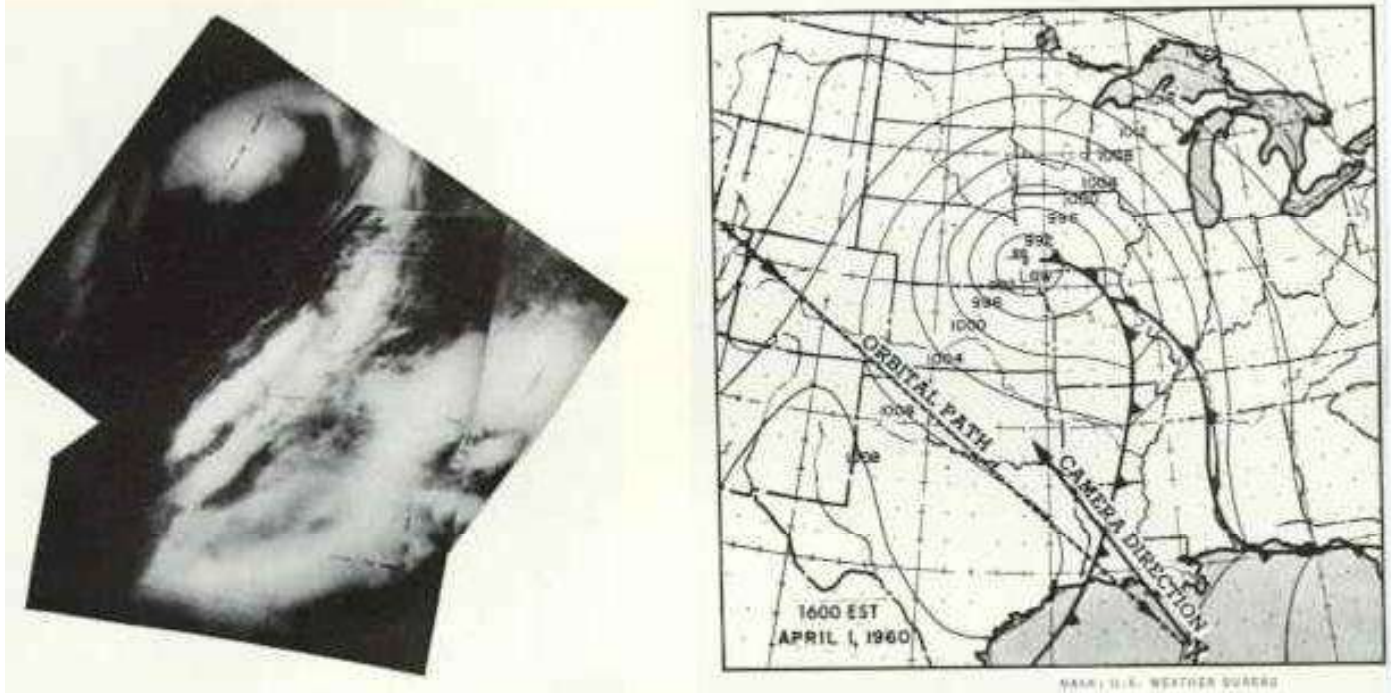
Overlapping photographs show continuous 4,000-mile strips of the globe as seen by *Tiros*. Each series, representing 32 consecutive views, stretches from northwest Spain to central Africa.

Dr. Sigmund Fritz (left), Lester F. Hubert, and other scientists of the U.S. Weather Bureau's satellite section prepared for the *Tiros* project by intensive study of rocket-made photographs of small areas of the earth.

A Dying Storm Slowly Pinwheels Across the Pacific

Tiros revealed to meteorologists that temperate-zone storms, like their tropical kin, often whirl in spirals. This cyclone swirls across 1,000 miles of the Pacific. Its blustery center, the white patch at the upper right, lies between Hawaii and the west coast of the United States.

The storm is in its dying phase. Clear areas of the earth's surface show as black spaces between the spiraling clouds.



Clouds Over the Central United States Match Their Weather-map Portrait

Like a swan, the cloud formation swims in the sky with its head above Nebraska and body over the Mississippi Valley. Cold, dry Canadian air forms the black wedge knifing in from the left. On the map, the low-pressure area corresponds to the swan's head; the heavy black lines of a cold front simulate the bird's body.

hostile edge of space is pitifully short. Lengthy, unremitting exposure to the blazing sunlight could quite literally cook it, a key component could break down and silence it, or the annual orbit of the earth around the sun could throw it into prolonged shadow, causing its storage batteries to run down.

Future weather explorers, however, will be largely free of these disabilities. Some will boast infrared scanners capable of taking pictures in the dark; others will eye the earth constantly, turning very slowly to adjust their viewing axis. Once orbited over the poles, such satellites could keep weather developments in all parts of the world under surveillance. And, from an orbit 22,000 miles above the Equator, a single camera could continuously view one-third of the earth.

New World Opens for Weathermen

Meanwhile, for meteorologists, *Tiros I* is uncovering a spectacular new facet of their science. Cloud formations are the chief quarry of its cameras, and these show up on film with remarkable clarity. On an early pass a thin trail of clouds scudding across Sudan and the Red Sea (page 297) suggested a jet stream farther north. A check of conventional weather measurements for the same day verified the presence of the elusive high-altitude wind current.

Time after time, in frame after frame, all sizes and complexities of storm areas appeared: A typhoon took shape off New Zealand, a cyclone in the Indian Ocean. Highly organized cloud patterns spiraled turbulently across 1,000 miles of the Pacific. Spiral formations, in fact, march through the pictures like a recurrent theme; ultimately they may provide us with a key to the life cycles of storms.

Scientists are still strangers in this curious, unmapped world of the topside of the sky. Extensive study and analysis, however, will enable meteorologists to relate these new observations to our present understanding of the earth's weather. And someday the knowledge gleaned from satellites such as *Tiros I* will permit man to live at greater ease with the elements.

"The weatherman," says Dr. Morris Tepper, Chief of NASA's Meteorological Satellite Programs, "has been like the proverbial blind man who tries to describe an elephant by feeling its trunk. Now, for the first time, his eyes are being opened to a view of the entire animal."