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WEATHER BUREAU

TIROS

WEATHER OBSERVATION SATELLITE BUILT FOR NASA BY RADIO CORPORATION OF AMERICA

RCA

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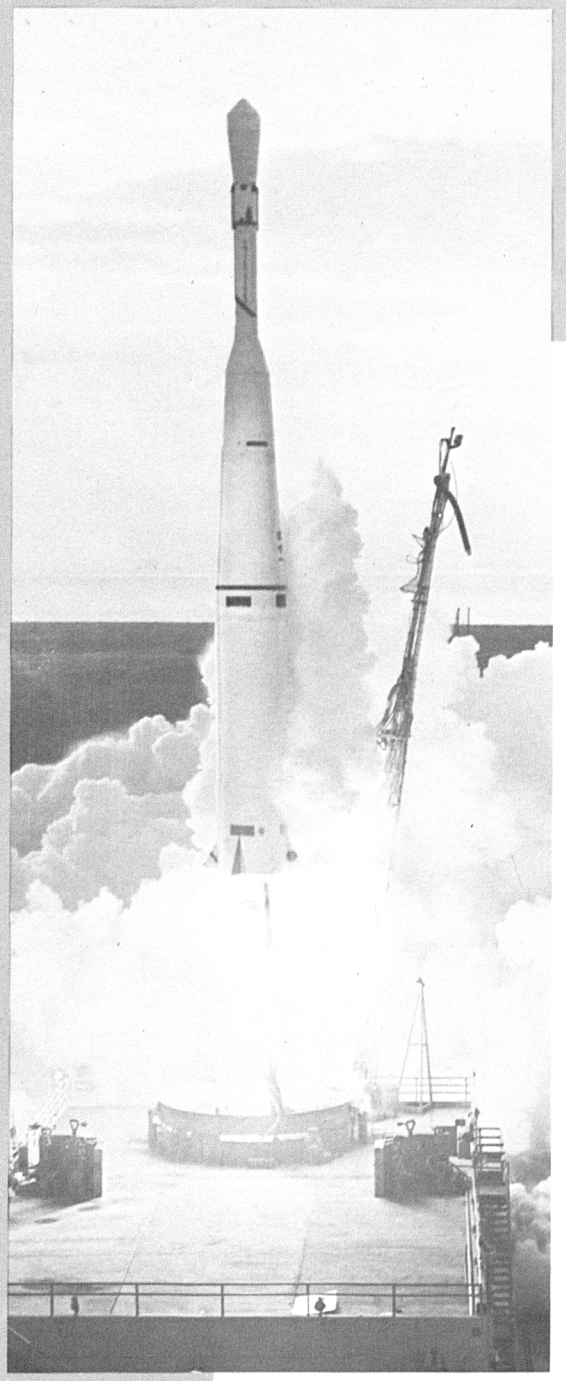
130 436



TIROS

Television **I**nfra-**R**ed
Observation **S**atellite

THE WORLD'S FIRST EXPERIMENTAL AND OPERATIONAL METEOROLOGICAL SATELLITE

A series of meteorological satellites using television cameras for observation of the earth's cloud cover. Built by RCA's Astro-Electronics Division for the National Aeronautics and Space Administration under the technical direction of the Goddard Space Flight Center.

Since April 1960, essentially continuous observation of weather phenomena on a global scale has been possible by successive launches of TIROS satellites in an earth orbit.

TIROS has grown from an experimental project into a program which is providing operational weather data while it continues to serve as a vehicle for research and development.

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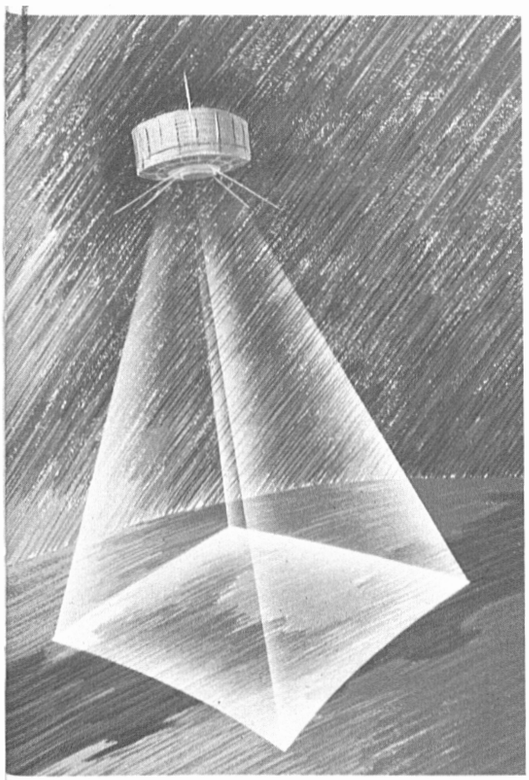
1963

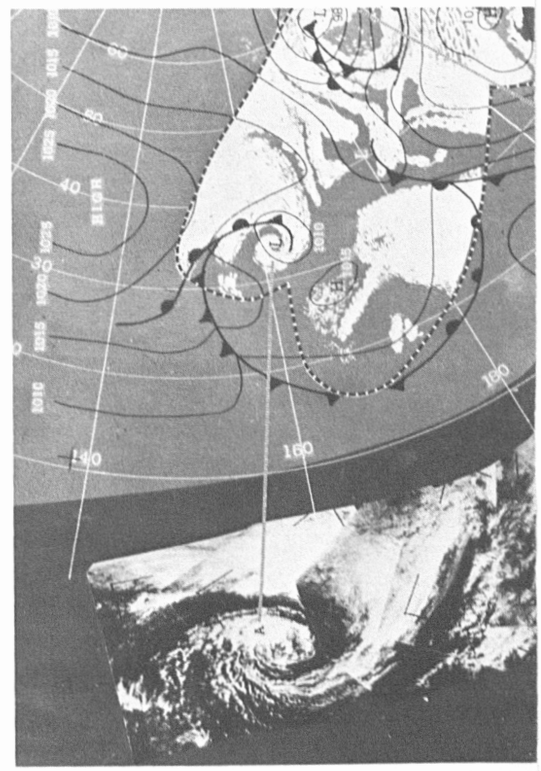
RCA's Astro-Electronics Division, birthplace of the TIROS satellite, has a record of 100% successful space systems. This outstanding performance started in 1958 with Project SCORE, the first active communication satellite. It has since progressed through the series of seven TIROS satellites already launched and the Relay Communications satellite. AED is also working on other scientific spacecraft programs for which future launches are scheduled.

TIROS has been directly responsible for saving lives and millions of dollars in property damage by giving advance warnings of hurricanes, typhoons, and large tropical storms. TIROS satellites have played a major role in the U. S. space program, keeping a watchful eye on weather for Project Mercury launches and recoveries, as well as supporting Ranger, Mariner, and other space probes.

Nephanalyses (the analyses of cloud cover) have been provided on a operational basis by the U. S. Weather Bureau since the inception of TIROS II. This information is disseminated to more than 45 countries through an international facsimile broadcast network. In addition, domestic and international airlines operating from the United States regularly make use of TIROS weather data for overseas and transcontinental flights.

Other special missions successfully undertaken by TIROS include ice surveys in the St. Lawrence River, observations of weather in the Antarctic for the U. S. Navy, and storm advisories for the U. S. Navy and Air Force in the Pacific, Atlantic, and Far East. The spacecraft also has served as a test vehicle for studies by several universities. TIROS is a spin-stabilized spacecraft measuring 42 inches in diameter, 22 inches in height, and weighing from 265 to 300 pounds.





National Oceanic and Atmospheric Administration
TIROS Satellites and Satellite Meteorology

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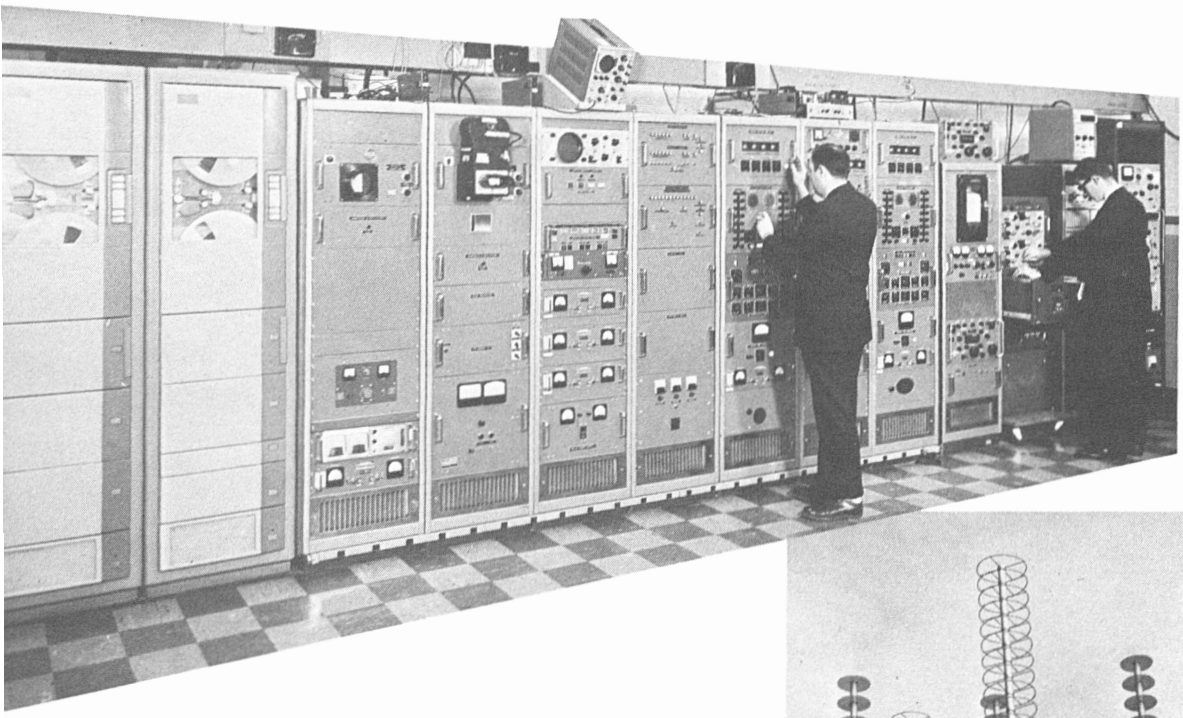
TIROS GROUND STATIONS

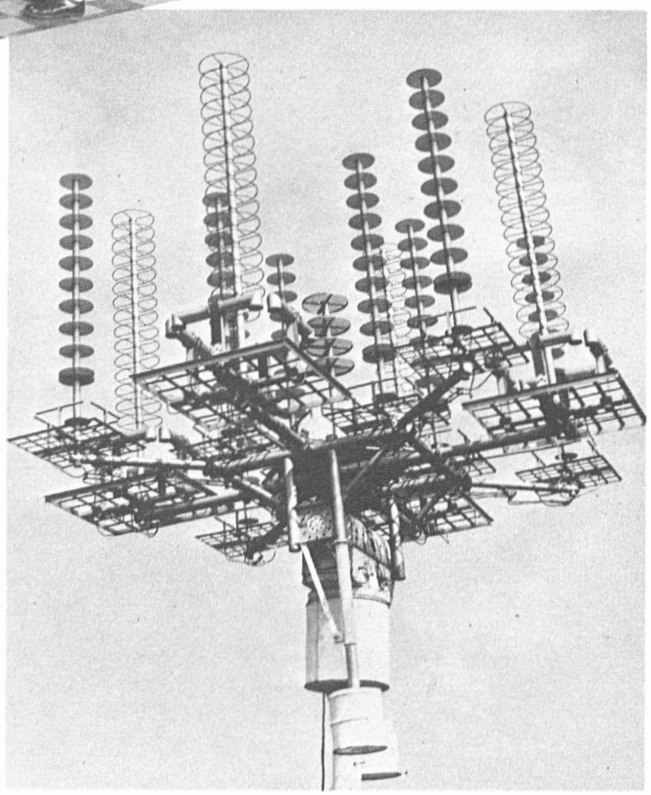
The TIROS system includes three Command and Data Acquisition stations, one at Wallops Island, Virginia; one at Point Mugu, Pacifiic Missile Range, California, and a new station near Fairbanks, Alaska, which began operations in September, 1963. A back-up station is located at the RCA Space Center near Princeton, New Jersey.

These stations have a 1,500-mile range in any direction to command the satellite and acquire data stored in the spacecraft from previous orbits, or receive data directly from observations overhead.



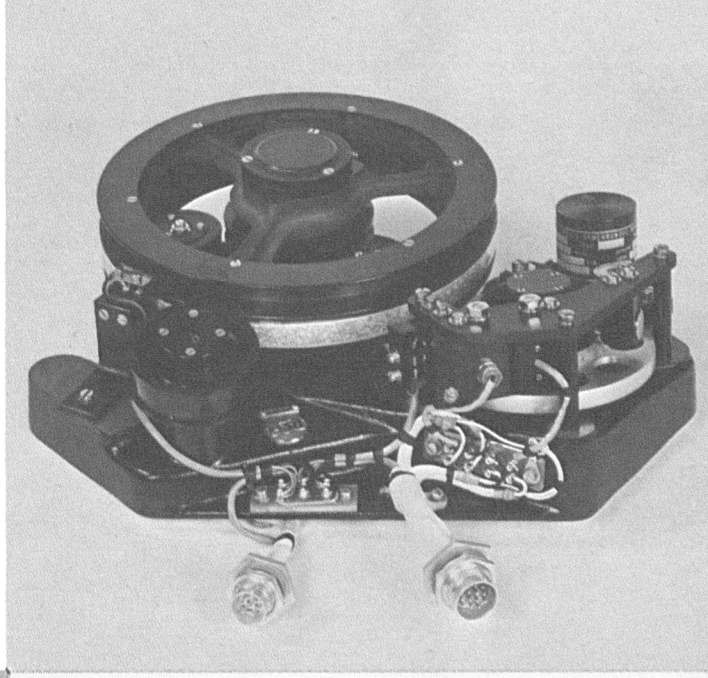
These stations, designed and built by RCA, are operated under NASA direction and program the many functions in the spacecraft.

Control of the over-all TIROS system operations is located at Greenbelt, Maryland, in the TIROS Technical Control Center, Goddard Space Flight Center.

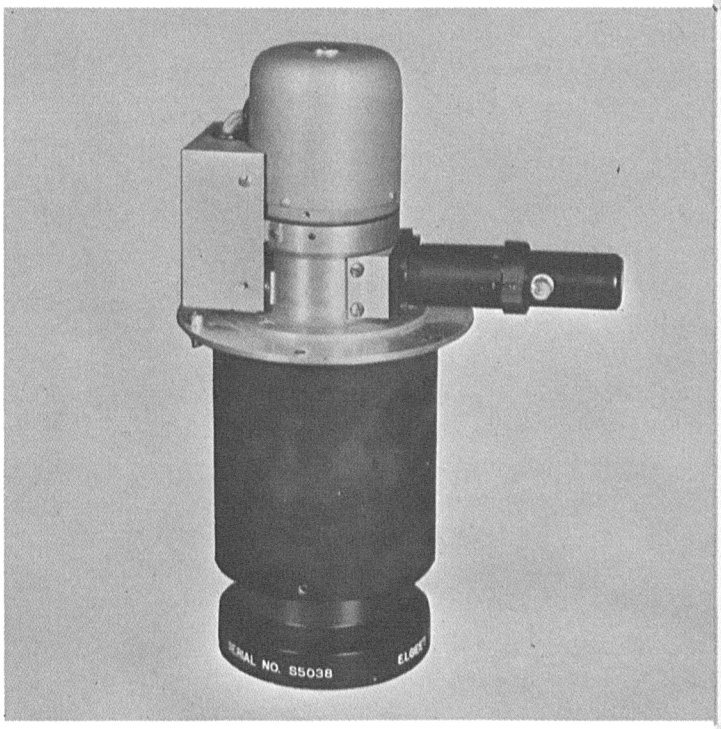


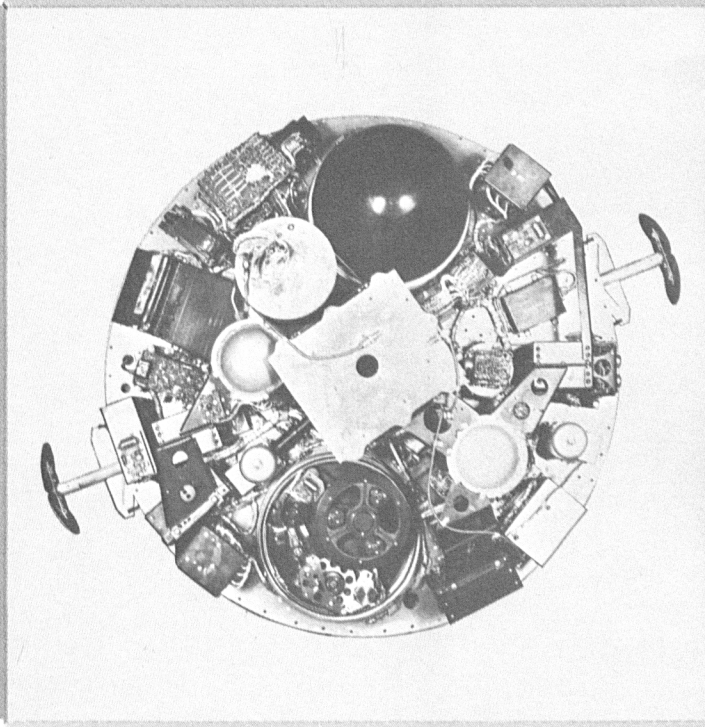
SENSING THE WEATHER

The seven weather spacecraft have similar configurations, each successive model proving the sound engineering and design incorporated in TIROS I.

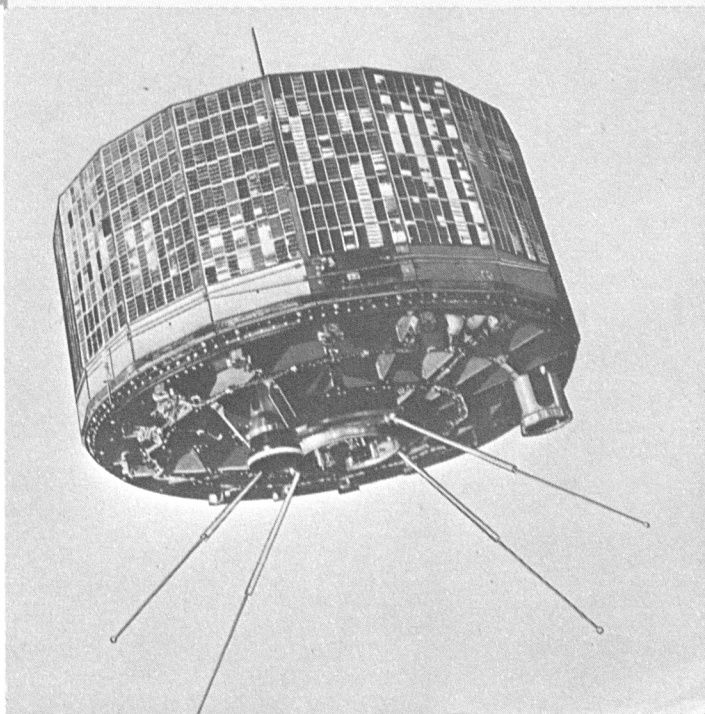


Certainly, advances have been made in RCA tape recorders and cameras. These components have far surpassed the expected design performance.

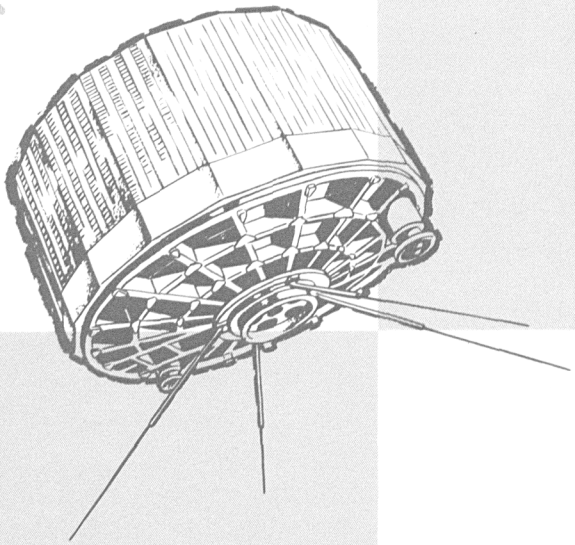




All integral parts of the spacecraft are fastened to a base plate, an airframe-type structure flexible enough to withstand injection into orbit, yet sturdy enough to maintain in space the true alignment of the cameras with the spin axis. The finished product, complete with solar array, is much like an oversized hatbox.



TIROS I



FEASIBILITY DEMONSTRATION

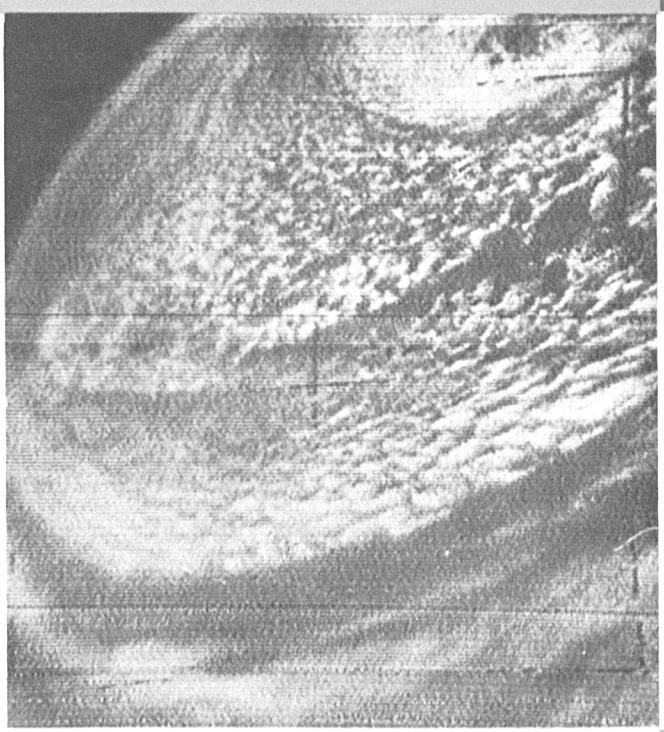
TIROS I, launched April 1, 1960, atop a Thor-Able rocket, demonstrated the feasibility of TV space camera observations and proved system design concepts. The cloud observations made by TIROS confirmed and in some cases brought new light on the large scale organization of clouds, and on the meso-scale phenomena such as tornadoes and jet streams.

Some storms were tracked for as long as four days and demonstrated the feasibility of using satellite data for weather forecasting.

Of the 23,000 cloud-cover photographs transmitted by TIROS I, more than 19,000 were useable for weather analysis. TIROS I, as the pioneer in the meteorological satellite program, opened a new era in weather observation by providing cloud-cover data for vast areas of the earth for both research and day-to-day forecasts. Such data had not previously been available to the meteorologists.

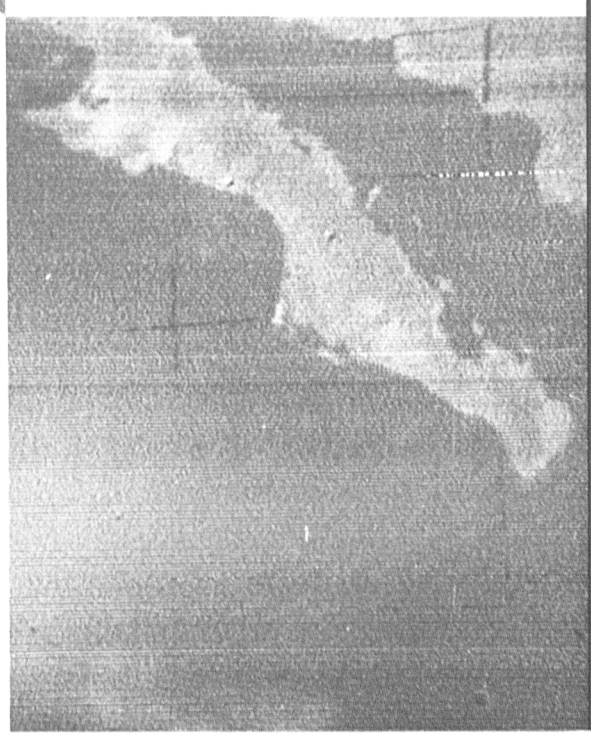
ACTUAL SIZE — HALF-INCH VIDICON IMAGE SENSOR.

Upper Right—Wide-angle view of Saudi Arabia, Iran and Persian Gulf.



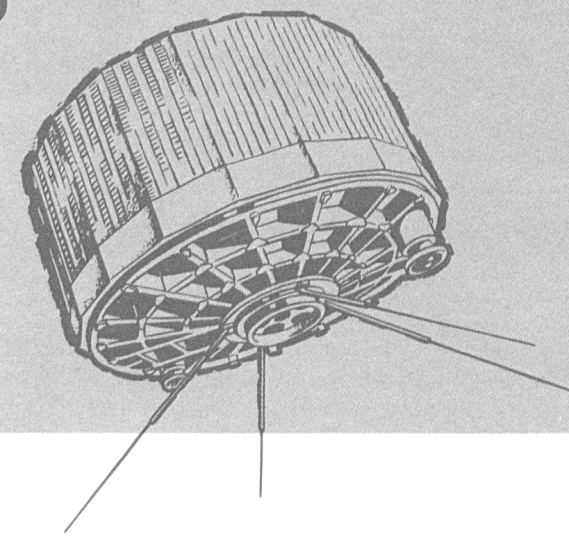
Above—Early picture showing vast organization of clouds. Storm center is seen at top right.

Lower Right—Baja California on cloudless day.



TIROS I 4/1/60 89 DAYS 23,000 TV PICTURES

TIROS II



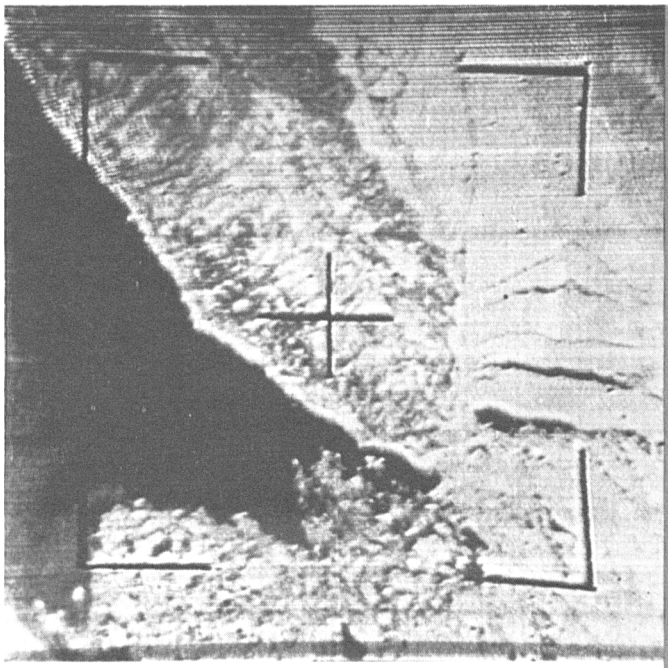
LONGEVITY IN SPACE

TIROS II was placed in orbit by a Thor-Delta booster on November 23, 1960, and it provided more than 37,000 photographs of cloud cover. Its use far exceeded the expected life of 1300 orbits or 90 days by performing for 5600 orbits in 12 months and clearly demonstrating satellite longevity in space. The spacecraft demonstrated the first use of magnetic attitude control for orienting satellites and, in addition, carried a NASA infrared experiment for thermal mapping of Earth.

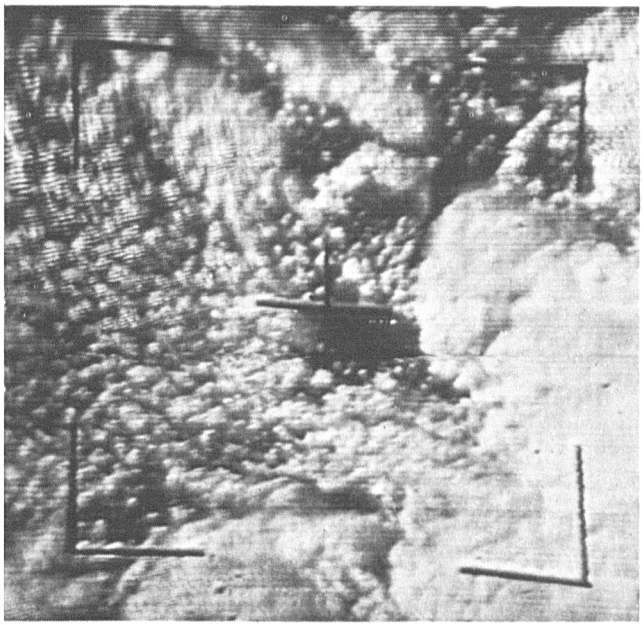
Photographs of ice pack conditions in the St. Lawrence proved that weather satellites could locate ice boundaries in relation to open seas. Of meteorological significance was the TIROS data which forecast the break of a 45-day heat wave in Australia.

Data supplied by TIROS II was used by forecasters in selecting proper weather conditions for the suborbital flight of Alan B. Shepard Jr. in May 1961, and the launching of Ranger 1 two months later.

After the Ranger I launch, TIROS II continued to provide limited data through May 1962, 17 months after launch. At that time, the second of the "Weather Eyes" was formally turned off.

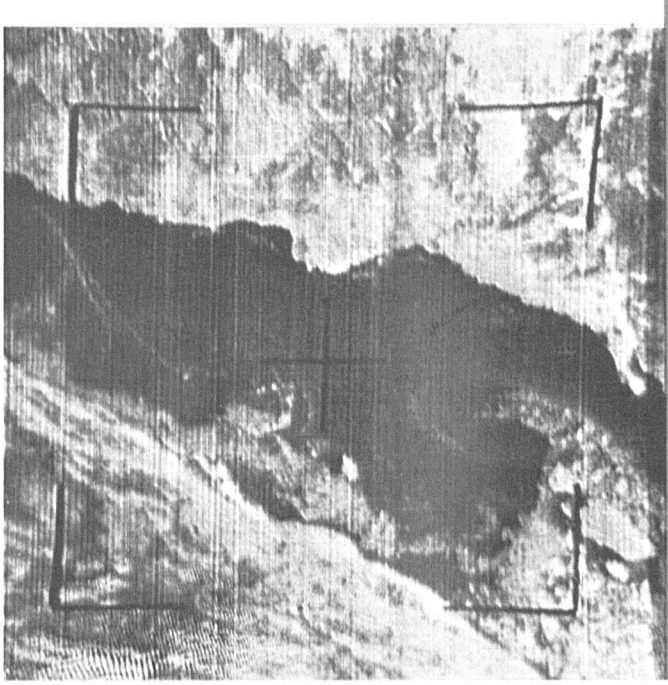


Ice floes breaking up off Anticostia Island in the Gulf of St. Lawrence.



Left — Post-frontal cumulus over the Atlantic Ocean.

Below — Ice in the St. Lawrence River.



TIROS III

HURRICANE WATCH

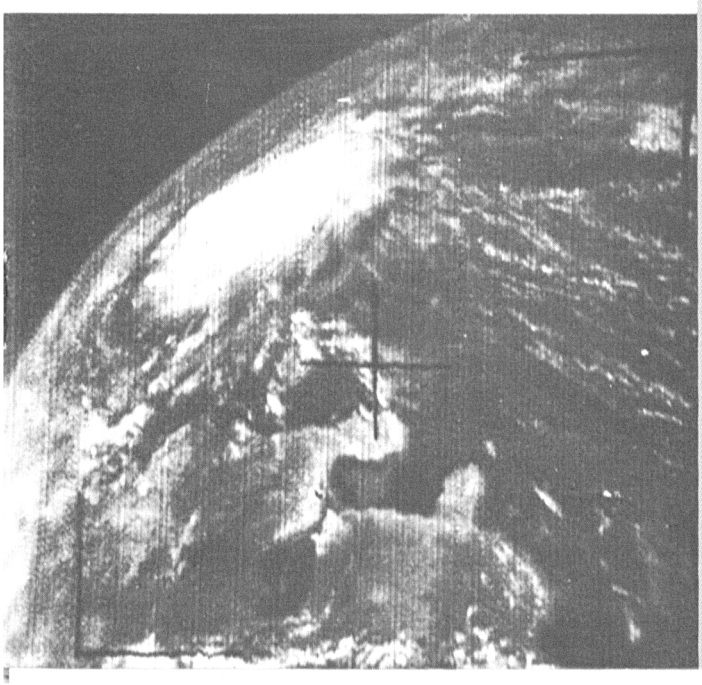
Further accomplishments to the TIROS record were added when the third spacecraft was placed into orbital operation July 12, 1961, particularly in the detection of tropical storms. All six of the major hurricanes of the 1961 season were observed by TIROS III. Hurricane Esther was detected by the satellite two days before it was observed by conventional methods.

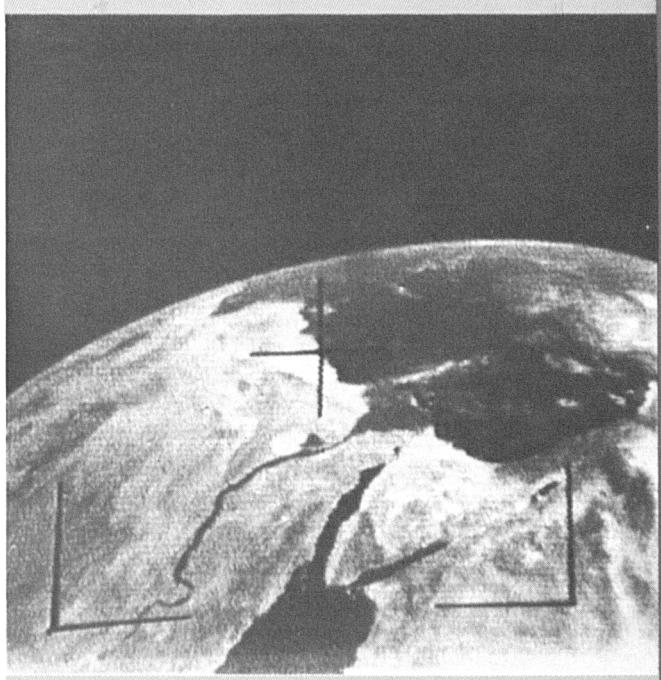
Information which resulted in 70 storm advisories were sent to weathermen throughout the world, particularly in the United States. In addition, TIROS III data led to adjustments in 76 analyses made by the National Weather Satellite Center.

TIROS III television photographs were used in the support of launches involving Project Mercury, Ranger, the Air Force's Discoverer series, the Navy's 1961 Antarctic resupply mission, and the firing of Long Tom meteorological rockets in Australia. During the spacecraft's 230-day lifetime, more than 24,000 useable cloud cover photographs were received and evaluated out of a total of 36,000 pictures transmitted.

Above—Hurricane Anna, the first hurricane observed from space, tracked July 20 to 22. The storm vortex, upper left, is moving northwestward across the Caribbean.

Below—The vortex of Hurricane Anna is heading for Central America on July 22, northwest of Venezuela. Lake Maracaibo is visible. This photo was transmitted during Orbit 147.

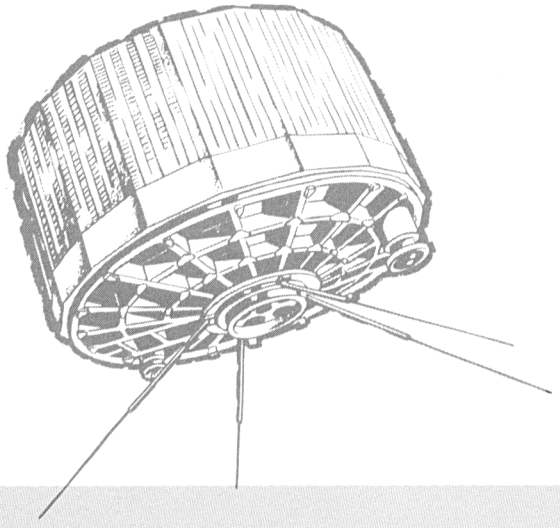




Above—Sunny day in the Near East. Visible are Libya, the Nile River and its delta, Suez, Sinai Peninsula, Red Sea, Israel, Dead Sea, Arabia, the Mediterranean and Cyprus.

TIROS III 7/12/61 230 DAYS 36,000 TV PICTURES

TIROS IV



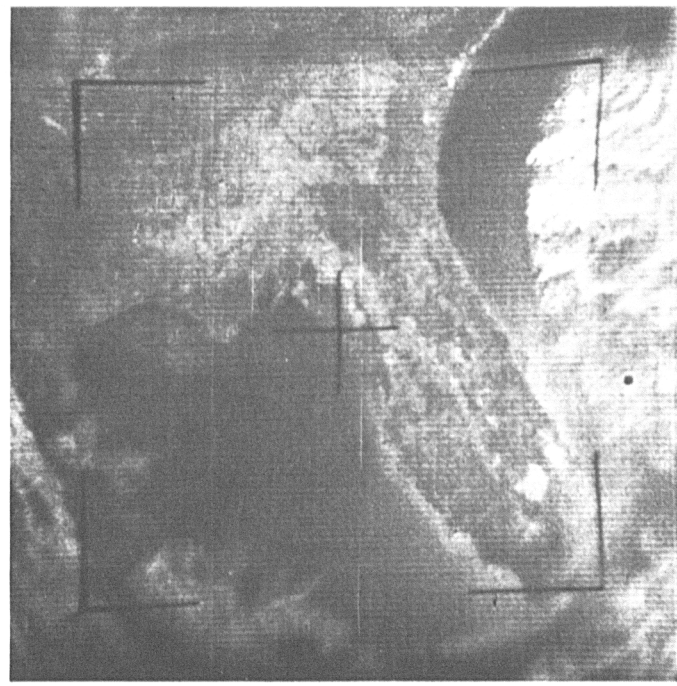
ICE RECONNAISSANCE

The fourth in the satellite series took place February 8, 1962, primarily to continue earth cloud cover photography and to confirm TIROS' capability as an ice reconnaissance vehicle. Under Project TIREC—Tiros Ice Reconnaissance—a joint NASA-U. S. Weather Bureau-U. S. Navy-Canadian government project, aircraft took photographs while flying the predicted path covered by TIROS. These pictures were compared with those taken by TIROS IV, with the conclusion that photographs provided by TIROS were a better means of ice study over large areas than by aircraft reconnaissance.

TIROS IV photos were also used in Project Bright Cloud, a joint NASA-USAF venture to develop a cloud identification system based on the shape and brightness of cloud cover.

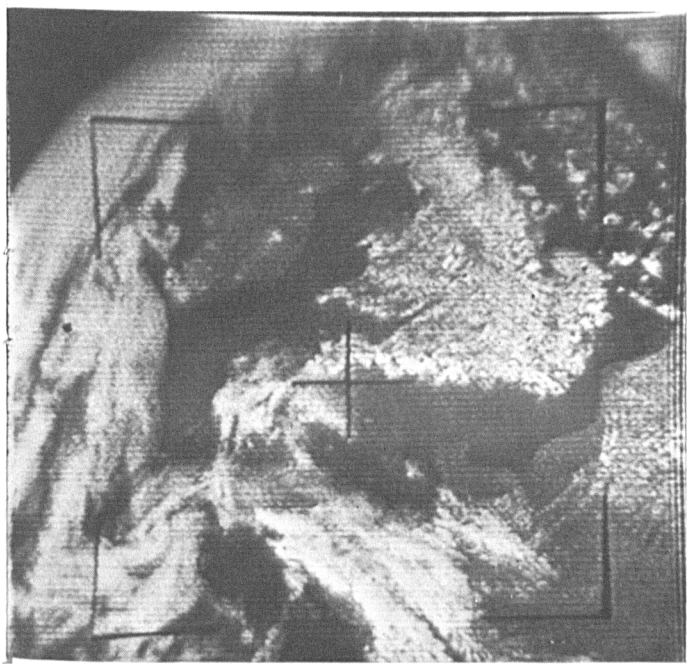
During its operational life of 141 days, TIROS IV transmitted 23,300 useable photographs out of a total of 32,500 which resulted in the issuing of 102 storm advisories and furnishing the basis for 79 adjustments in National Weather Satellite Center analyses. The fourth TIROS supported the launch of Col. John Glenn, Ranger 4, and initiated routine international use of its weather data.

Gulf of St. Lawrence and Canada's Gaspé Peninsula. Sea ice surrounds Prince Edward Island.

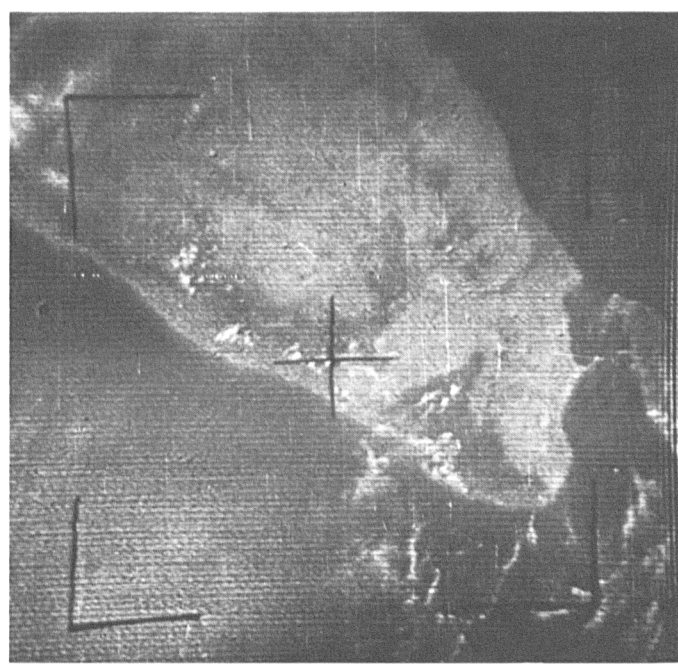


South Carolina, Georgia and Florida with the sun reflecting off Lake Okeechobee. Clouds off-shore in the Atlantic mark the edge of the Gulf Stream.

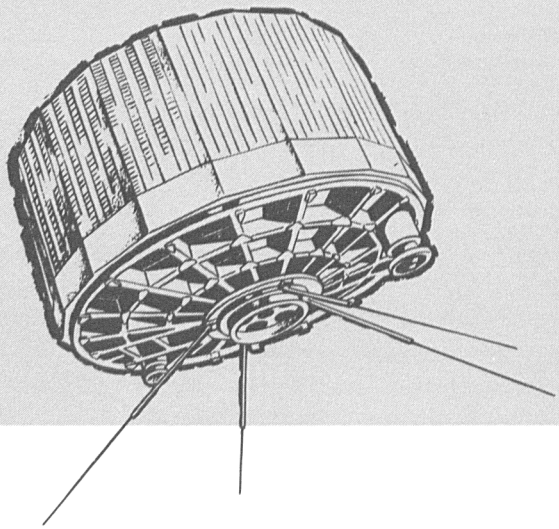
Foggy day in London town. Clouds completely outline England and Scotland while the Emerald Isle basks in the sun. Northern France is partially cloudy. A frontal system approaches from the Atlantic.



The lower half of India on a cloudless day. Note the sun glint in the Indian Ocean in the lower left corner.



TIROS V



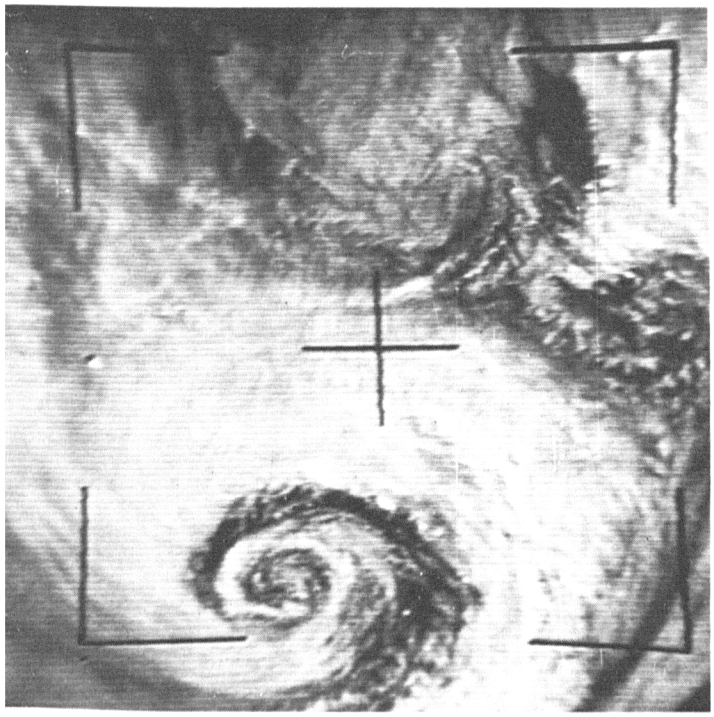
SUPPORT OF PROJECT MERCURY

TIROS V was considered virtually operational when placed into orbit June 19, 1962, in conjunction with the year's hurricane season. The Delta booster was programmed for a double dog-leg patch, carrying the spacecraft up the east coast, turning slightly east to miss the Cape Hatteras area, then turning east again to place the spacecraft into an orbit of 60 degrees inclination in respect to the equator.

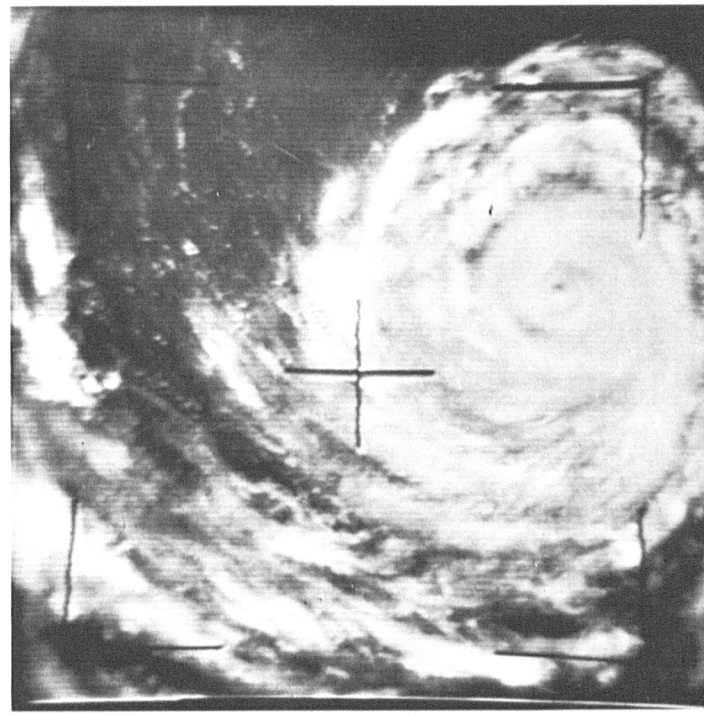
With this increased global coverage, the satellite observed all tropical storms, hurricanes and typhoons occurring in the Atlantic and South Pacific. TIROS V gave first warning on most of the world's serious storms in August.

Supporting the Mariner lunar launch as well as furnishing 1200 photos in direct aid to Cdr. Walter Schirra's earth orbit, TIROS V continued its international role of weather observation, transmitting television pictures of "good to excellent quality"—more than 58,000 photographs in nearly 11 months of operations.

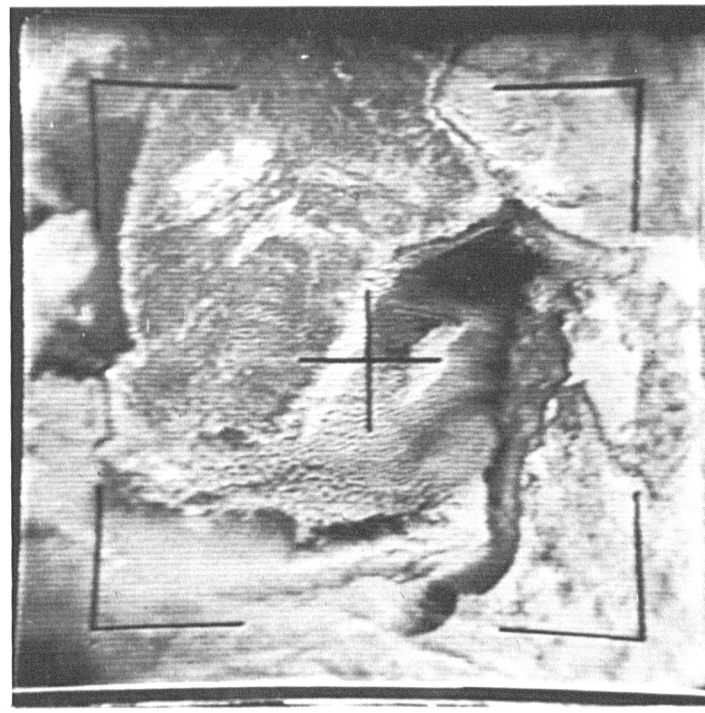
Classic picture of a large vortex off Greenland, taken on Orbit 3473, February 16, 1963. The photo covers from 500,000 square miles.



Typhoon Ruth near Japan, more than 500 miles in diameter. The eye of the storm is clearly visible.

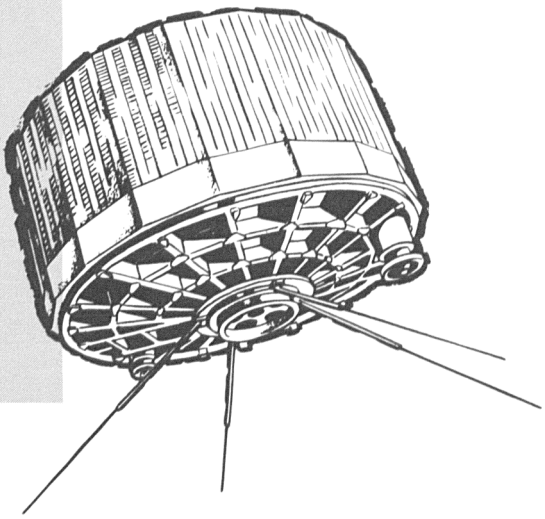


Lower third of Sweden with the Gulf of Riga frozen and sea ice on the Baltic on February 19, 1963, when TIROS V logged its eighth month.



TIROS V * 6/19/62 * 321 DAYS * 58,200 TV PICTURES

TIROS VI



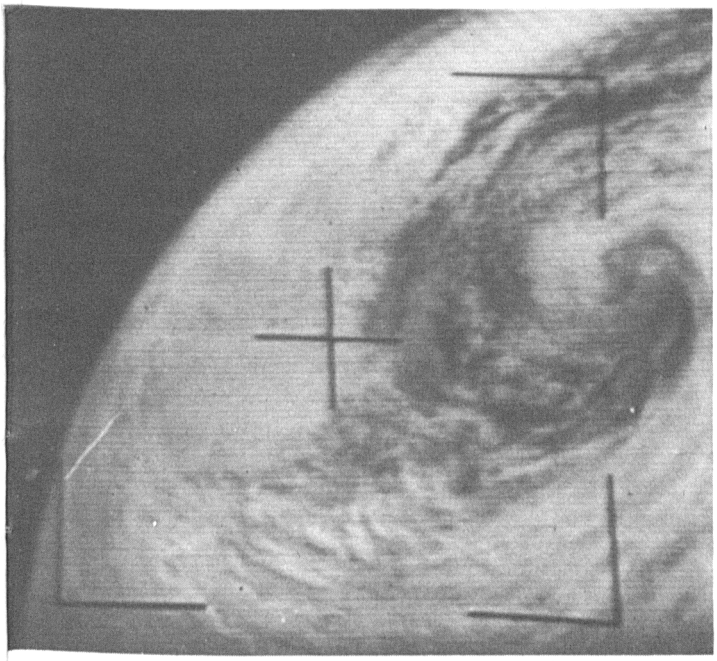
OPERATIONAL DATA

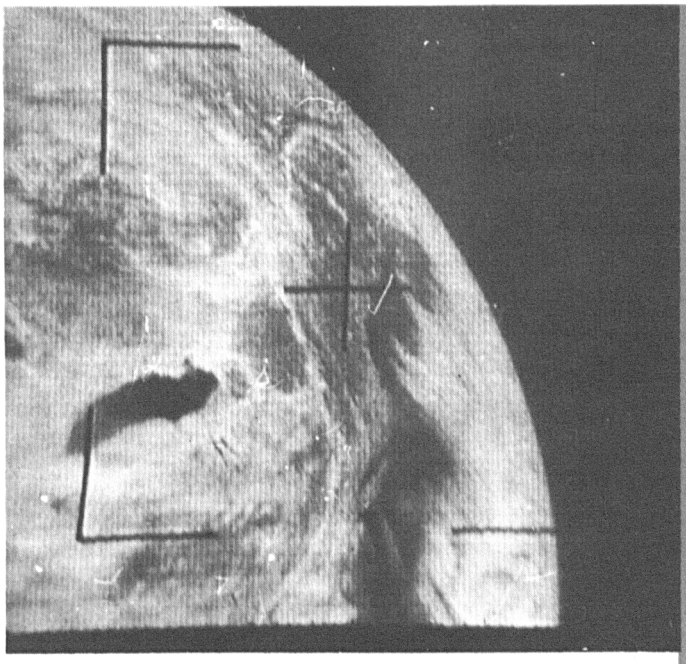
Augmenting TIROS V's hurricane watch, TIROS VI was launched September 18, 1962, establishing an outstanding record of six straight orbital successes in as many tries—a high mark in the U. S. Space program to date.

Having TIROS V and VI orbiting simultaneously, scientists were offered the unique opportunity of having similar photos from both spacecraft to compare and evaluate as well as utilizing the extended coverage.

Like TIROS V, the sixth spacecraft not only offered broader global coverage but also supported international facsimile broadcast of cloud cover and furnished data for the Schirra flight. More than 4700 television photos were transmitted by the two satellites for his mission.

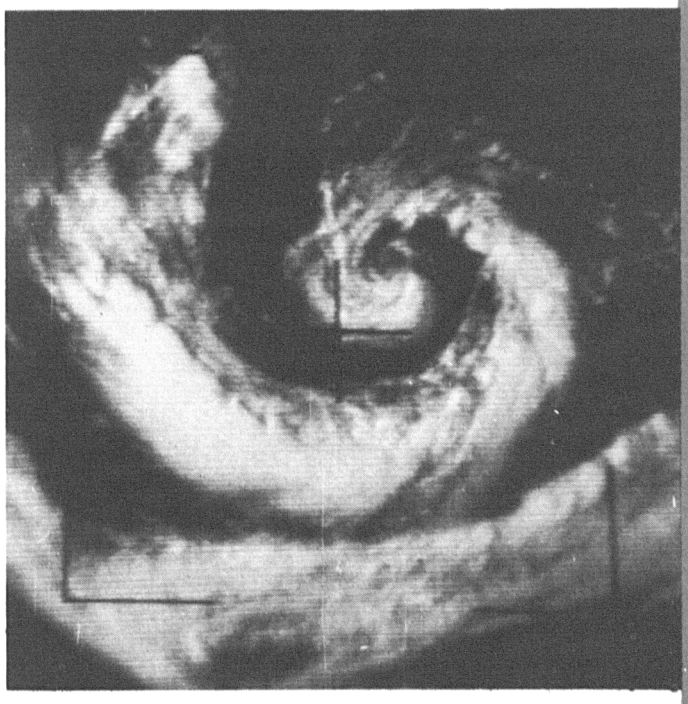
TIROS VI ceased operation after orbit 5664, or 389 days in space. During its nearly 13 months of operation, more than 66,500 television pictures were transmitted. Picture utilization, which was nearly 90 percent of all received, was the highest on record. Like TIROS VII, it too hunted and tracked tropical storms, hurricanes, and typhoons during the 1963 season.

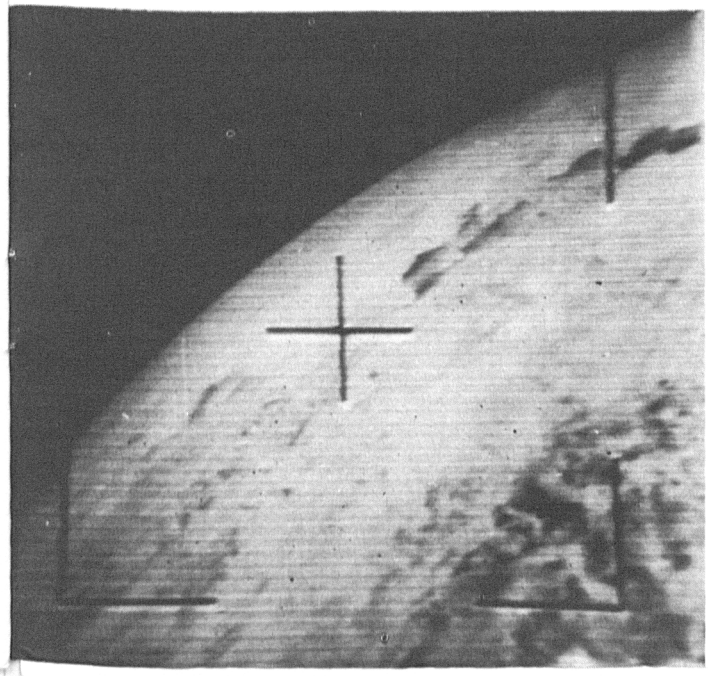




Upper Left—Large vortex taken during orbit 5581 after 12½ months of operation.

Upper Right—Northeast coast of the United States and Quebec Province. Snow rims Lake Ontario. Visible are two Finger Lakes and Long Island.



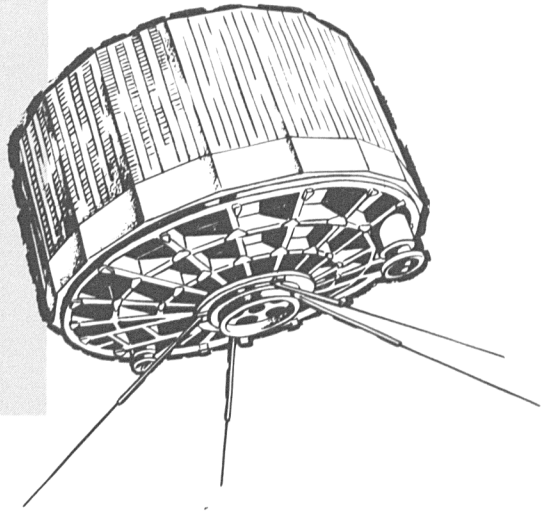


Above—Massive vortex of a storm in the North Atlantic taken during Orbit 835.

Left —Sea ice off Antarctica in November, 1962.

TIROS VI 9/18/62 389 DAYS * 66,500 TV PICTURES

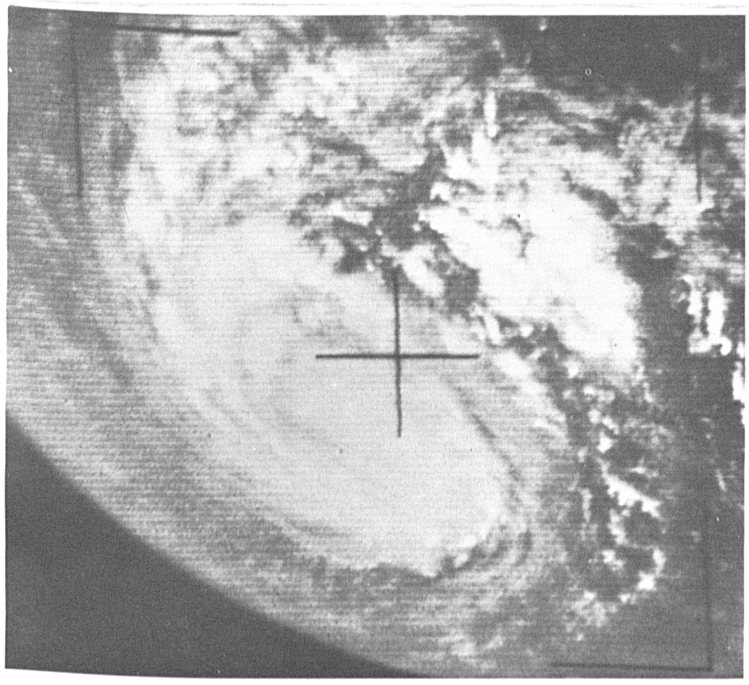
TIROS VII

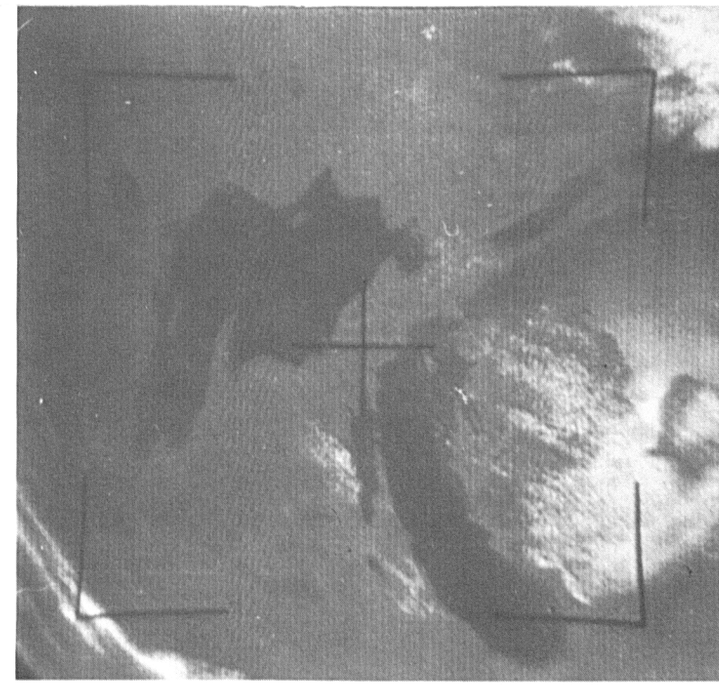


TIROS VII was successfully launched on June 19, 1963 (the first-year anniversary of TIROS V), to provide television coverage for the 1963 hurricane season, between July and October. It was the seventh orbital success in seven launch operations, a launching record of unique achievement. The launch was timed so that TIROS VII operates in the opposite hemisphere with respect to TIROS VI. In addition, TIROS VII cameras face the Northern Hemisphere during the peak of the hurricane season.

This satellite is the heaviest of the seven, weighing approximately 300 pounds. The payload consists of the NASA scanning Infra-Red experiment, similar to TIROS II, III, and VI; the University of Wisconsin omnidirectional IR system; and the University of Michigan electron temperature probe. Like TIROS III, it utilizes two wide-angle television cameras.

TIROS VII achieved its main objective of locating and tracking major tropical storms, typhoons, and hurricanes. Hurricane Arlene was first spotted by TIROS VII and was tracked by its TV cameras from August 2 to 9, 1963. Movements of Typhoon Bess were followed from August 9 to 18, and Typhoon Carmen was observed during the same period. Hurricane Beulah was spotted on August 21, 1963 as a tropical storm and was tracked until August 27, 1963. Tropical storms Della, Elaine, Faye, and Ginny were also detected over the Pacific. All systems are operational November 1, 1963, 135 days in orbit.

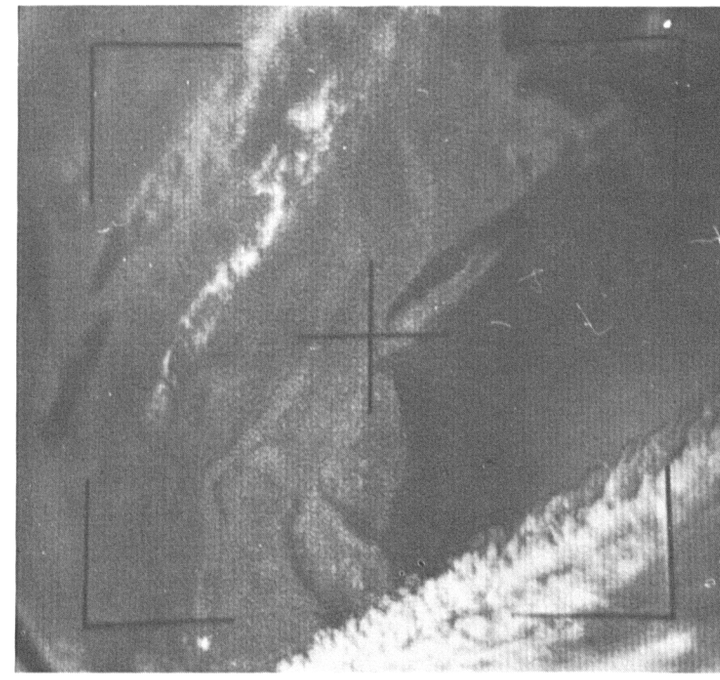


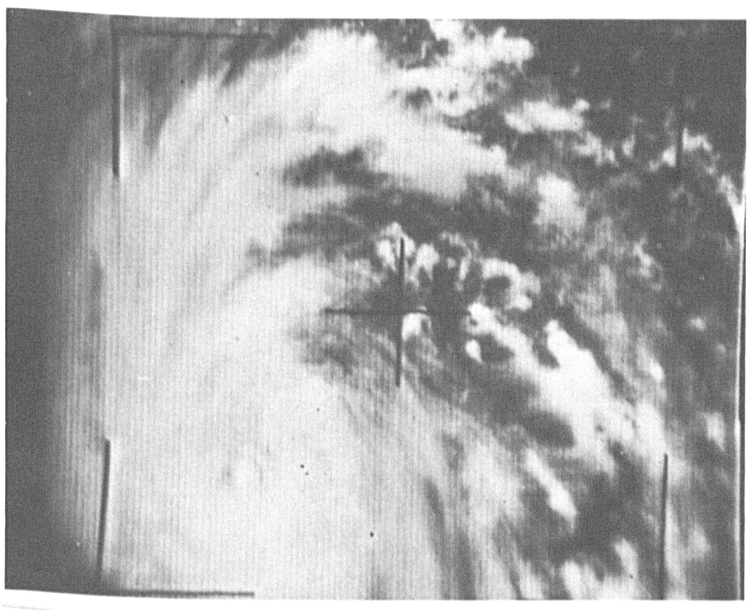


Upper Left—Hurricane Beulah photographed in August 1963, during orbit 948.

Upper Right—Lake Michigan and Lake Superior.

Below—Typhoon Carmen photographed in the Pacific by TIROS VII, during orbit 779.





Above—New Jersey, Long Island, and Cape Cod.

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