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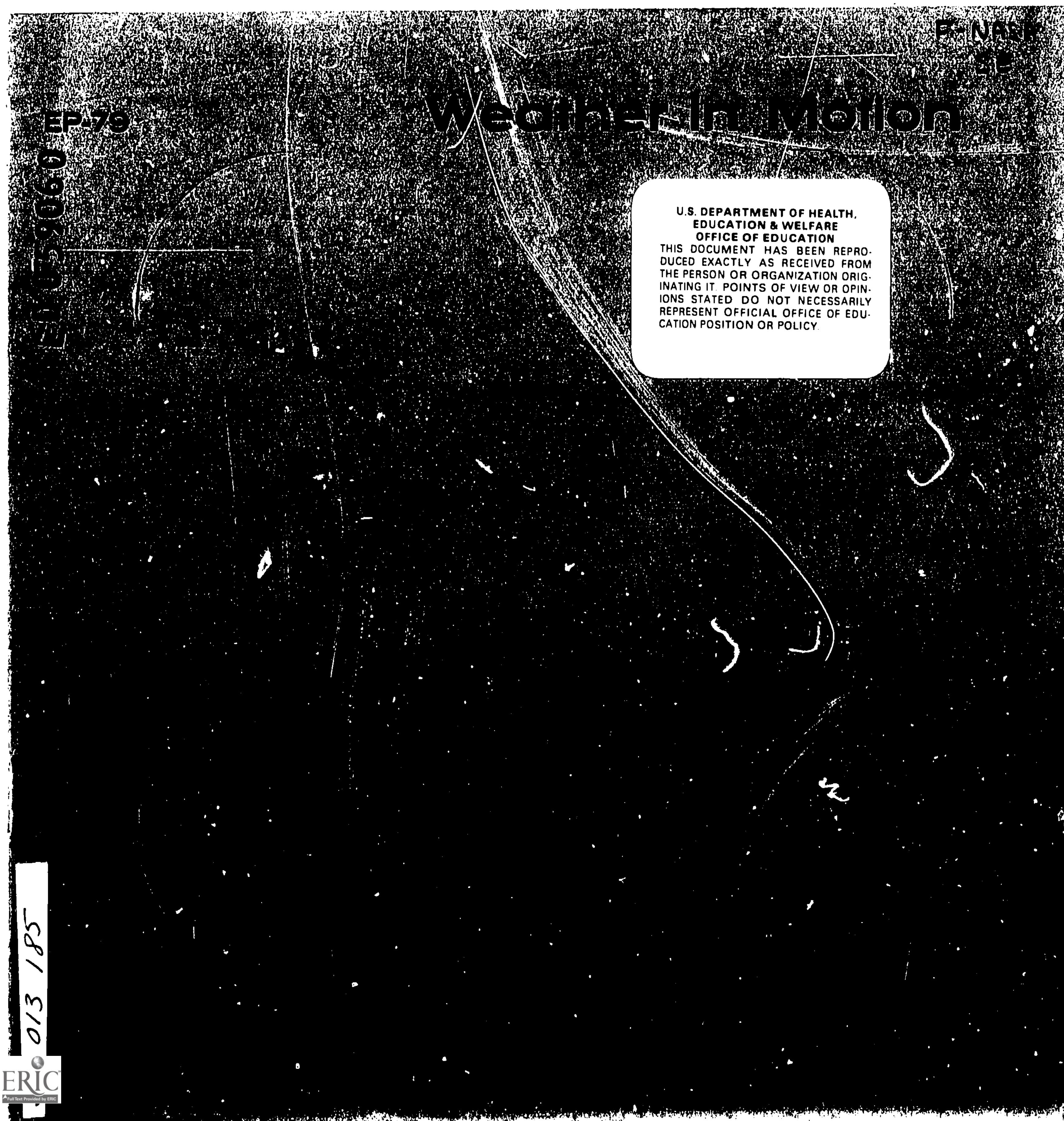
ABSTRACT

The ATS-111 weather satellite, launched on November 18, 1967, in a synchronous earth orbit 22,000 miles above the equator, is described in this folder. The description is divided into these topics: the satellite, the camera, the display, the picture information, and the beneficial use of the satellite. Photographs from the satellite are included. (PR)

EP-79

NASA

Weather in Motion



The cover photograph shows a view of the earth on November 18, 1967 from the NASA ATS-III satellite which was "stationary" 22,000 miles over the equator above South America. This folder describes in detail

the satellite,
the camera,
the display,
the picture information, and
the [illegible] of the satellite.

The camera experiment on ATS-III was proposed and conceived by investigators at The University of Wisconsin. Santa Barbara Research Center developed the flight model camera. The photographic film animation of "Weather in Motion" was developed by the Walter A. Bohan Company, Park Ridge, Illinois. The entire experiment and display has been supported by the Earth Observations and ATS Programs of the National Aeronautics and Space Administration, Washington, D.C.

Weather in Motion

Space technology for the direct benefit of man in his everyday life has been part of NASA's mission ever since the agency was created in 1958.

The world's first meteorological satellite, TIROS-1, was placed in orbit April 1, 1960, and immediately showed the importance of cloud cover photos from space to weather forecasting. It was followed by more TIROS spacecraft as well as the more advanced Nimbus satellites to continue sensor experimentation for a National Operational Meteorological System.

Early in 1966, the first operational meteorological satellite was placed in orbit for the Weather Bureau bringing mankind a step closer to the time when accurate long range weather forecasts, based on advanced operational satellite-computer technology, will be routine. This goal is expected to be attained in the 1970's.

In late 1966, the ATS-1 spacecraft carrying a cloud cover camera was launched into geo-stationary orbit. Thus, for the first time, man had the opportunity to observe the atmosphere below on a continuous basis. Such observations have proven to be extremely important to the study of severe storms, their formation, and dissipation, through time lapse photography. The cover display is but one example of such photography. The ATS experimental program has demonstrated the usefulness of such techniques and serves as a stepping stone to the operational deployment of a similar system now being developed by NASA for the Environmental Science Services Administration.

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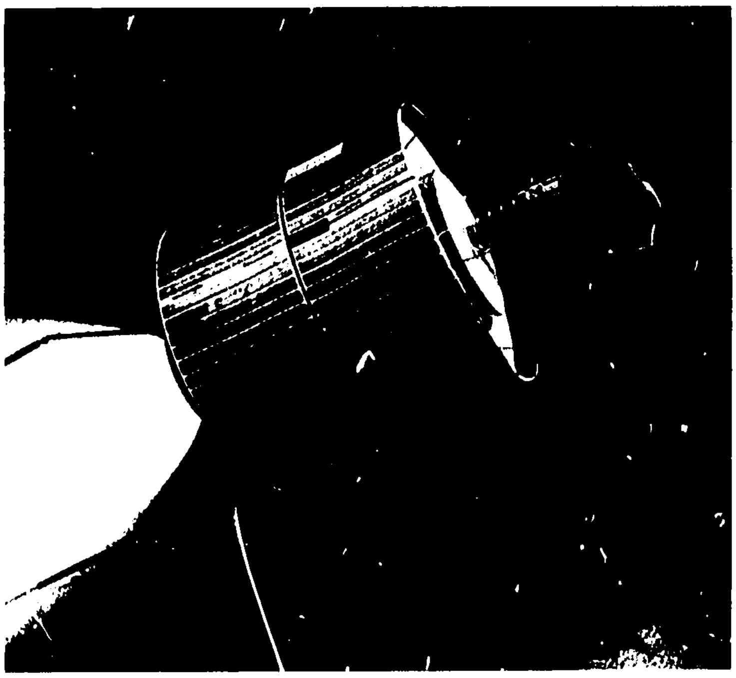
The Satellite

The ATS-III satellite was launched from Cape Kennedy, Florida on November 5, 1967 and is orbiting the earth at an altitude of 22,300 miles above the equator. At this altitude, the spacecraft requires precisely 24 hours to complete one revolution—as does the earth—thus, the satellite is stationary above a single location on the equator. The spacecraft has been over South America during much of its lifetime.

The entire satellite spins at 100 rpm—much like a gyroscope—so that it does not tumble in space. This rotation is extremely precise, as if the satellite were on perfect bearings. The spin axis of the satellite is very nearly parallel to the earth's axis of rotation.

More than 24,000 solar cells cover the outside of the drum shaped spacecraft and provide 175 watts of electrical power for the various experiments and for radio communication with the earth.

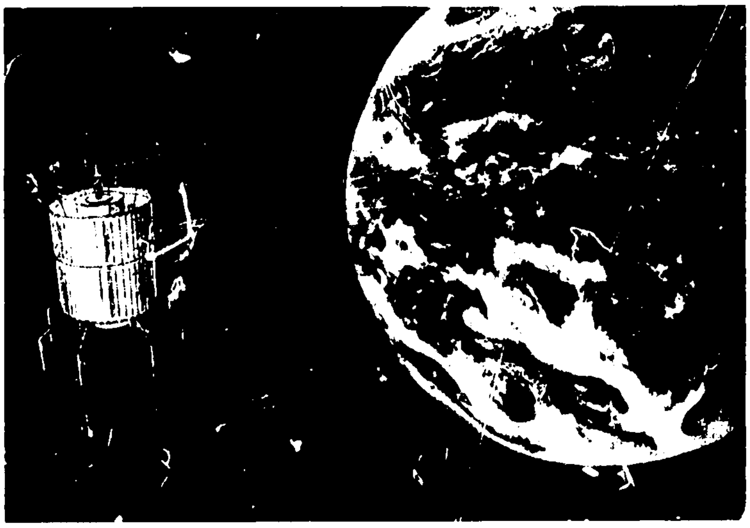
ATS-III carried eleven experiments into orbit; these concern communication, navigation, and meteorology. The Multicolor Spin-Scan Cloud Camera, discussed in this folder, is one of the experiments.



ATS-III Spacecraft

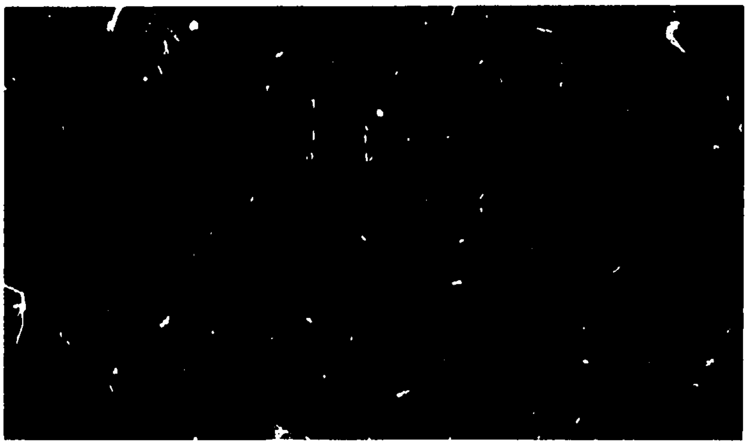
The Camera

The "camera" is really a telescope which scans across the earth from west to east with each rotation of the satellite. A rectangular picture is produced by tilting the camera a small amount so that each new scan line is obtained adjacent to the previous line. The complete picture is made up of 2400 scan lines which are acquired in 24 minutes, because the rotation rate of the satellite is 100 revolutions per minute.



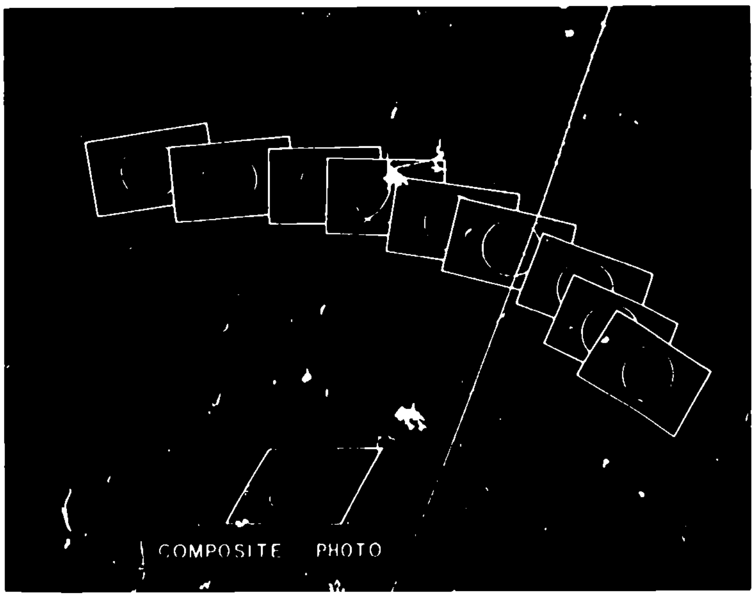
The extremely uniform rotation of the satellite in space allows the "camera" to obtain high precision pictures of the earth. Although the satellite is 22,300 miles above the earth, the camera can be used to measure the distance between land features to within a few miles.

At the focus of the camera are 3 tiny pinhole aperatures which allow the formation of separate blue, green, and red images. Color photos are generated at the ground station by combining these three-color images



The Display

The display is a composite of 9 individual pictures taken on November 18, 1967 at approximately 60 minute intervals by the NASA Multicolor Spin-Scan Cloud Camera on the Applications Technology Satellite, ATS-III. The total time interval presented in the display is about an 8-hour period.

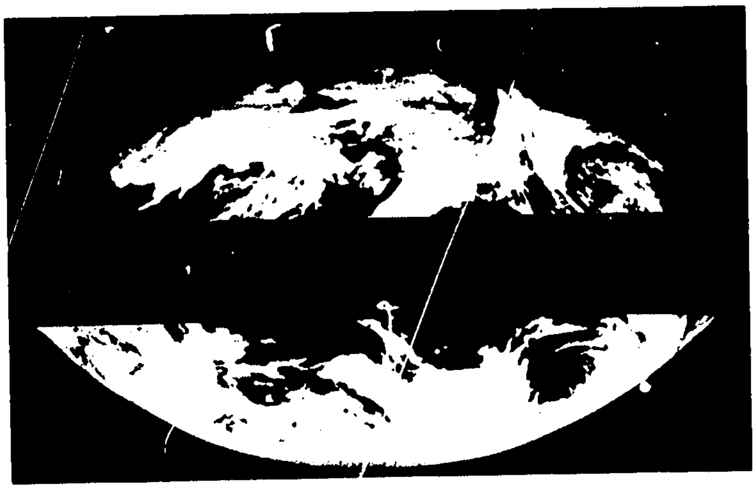


This photograph which provides the sensation of three-dimensional viewing is called a panoramic parallax stereogram. A horizontal screen is used to alternately place lines of the nine individual pictures on the final image. A lenticular screen is placed over the final print so that parallax allows viewing of alternate images, as the picture is tilted back and forth.

The Picture Information

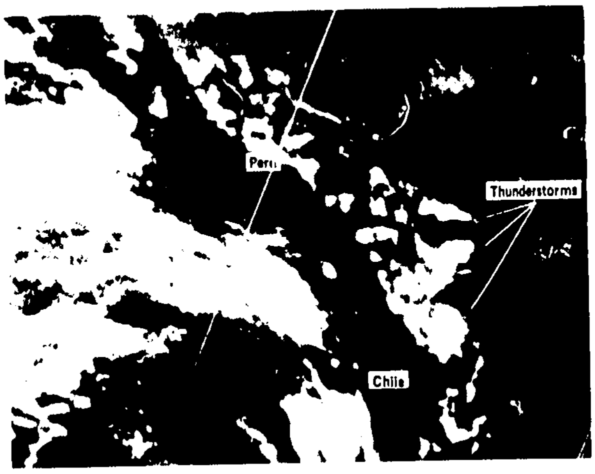
Earth Shadow

The South Polar region has continuous daylight at this time (November 18), but the North Polar region receives much less sunlight and the extreme northern region is continuously shaded from the sun's rays.



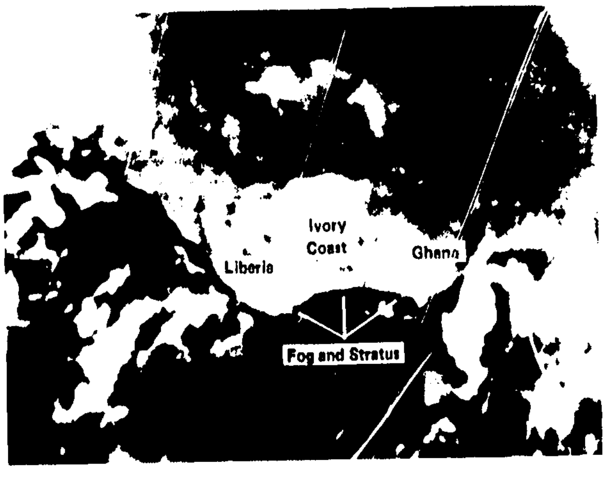
Cloud Formation

Thunderstorms which usually form during the daytime can be seen forming over the Andes Mountains of South America and over the extensive Amazon Basin.

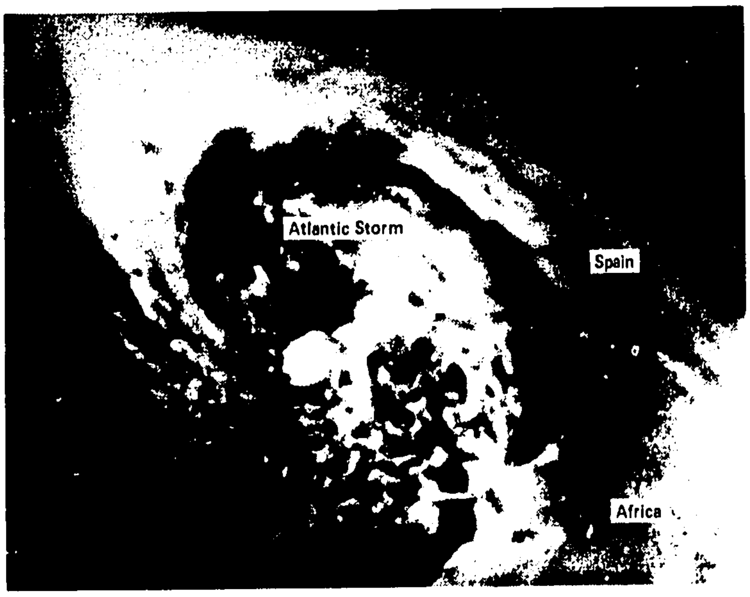


Cloud Decay

Fog along the coast of Chile, associated with cold Pacific Ocean water, disappears during the day. Similarly, fog and low stratus clouds along the African coasts of Liberia, Ivory Coast and Ghana dissipate during the daytime because of intense warming of air in the tropics. High clouds disappear over the equatorial Atlantic because of the descending and warming motion of the air near the equator.



Cloud Motion
Storm clouds move with circular motion in mid-latitudes of both hemispheres. An active storm can be seen in the northwest portion of the picture over New York State and a dissipating storm can be seen in the northeast portion of the picture just off the coast of Spain. Note that these storms rotate in opposite directions to the storm near the southern tip of Chile and to the young storm south of the bulge of Brazil. Meteorologist are learning from these time series pictures that clouds are tied to these *large* scale motions of the atmosphere.



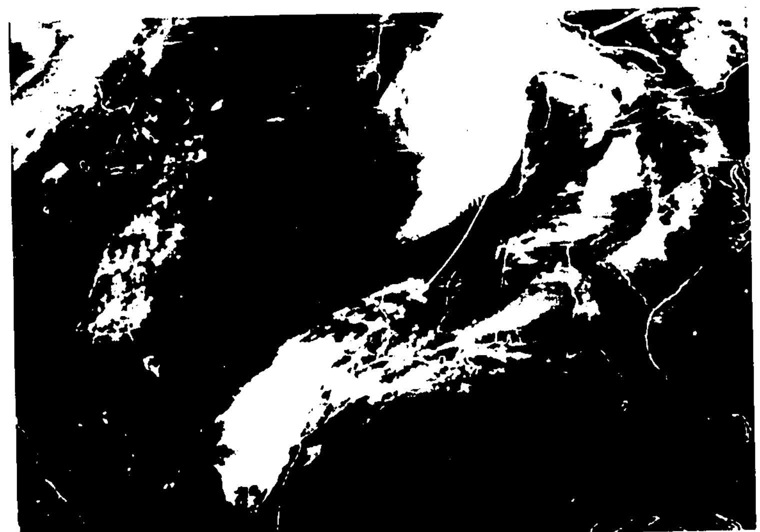
The low, cumuliform clouds which move westward in the tropics are drifting with the easterly "trade winds." Some high cirrus clouds are above the "trade wind" region and are carried north-eastward in "jet streams" over the coast of West Africa. Large quantities of heat and moisture are carried poleward from the tropics by these "jet streams."

Sun Glitter
The bright area which approaches the coast of Brazil is caused by mirror like reflections of the sun's image from the ocean surface. The size of the area can be used to measure the wind speed over the ocean surface.

The Benefits

Severe Storm Detection

The use of earth synchronous satellites gives meteorologist a valuable capability for pinpointing and tracking both hurricanes and severe storms which form tornadoes. A dramatic illustration of this capability is shown by the cloud structure over Kentucky and Tennessee. These cellular clouds are the actual blow-off anvil tops of severe thunderstorms which generated many tornadoes in those two States at that time. Thus, pictures such as this give meteorologist a valuable tool for "nowcasting" as well as forecasting.



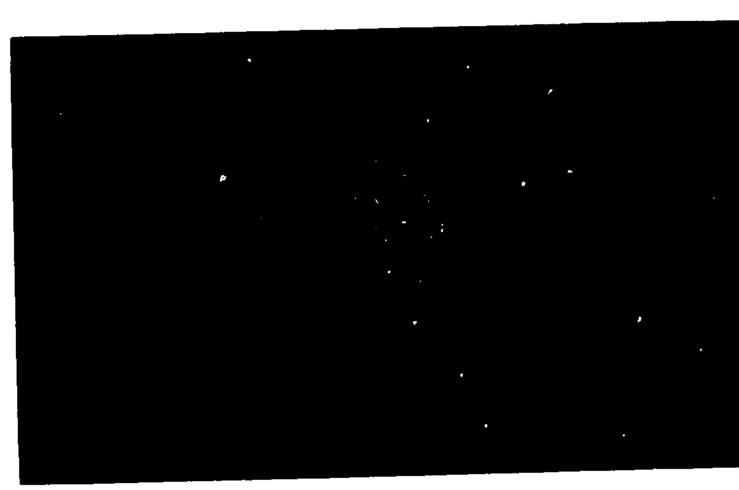
ATS-III photo of cloud systems over the United States

Remote Sensing of Atmospheric Winds

The motion of the clouds is clearly visible by tilting the picture to obtain a time sequence of the pictures. By using display techniques with greater resolution it is possible to measure cloud displacements with sufficient precision to infer atmospheric winds from the displacements. One series of pictures, such as these, can provide winds over 1/3 of the earth's surface—which is a fantastic increase over the present capability of determining winds by balloon.

Global Measurements

With four synchronous satellites properly spaced around the earth, it is possible to monitor nearly all of the earth's cloud cover all of the time. Only small areas in the polar regions are not in view of the satellites. This unique observing capability will be implemented in the mid-1970's to serve as an important component of an international program to make detailed, global observations of the atmosphere.



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