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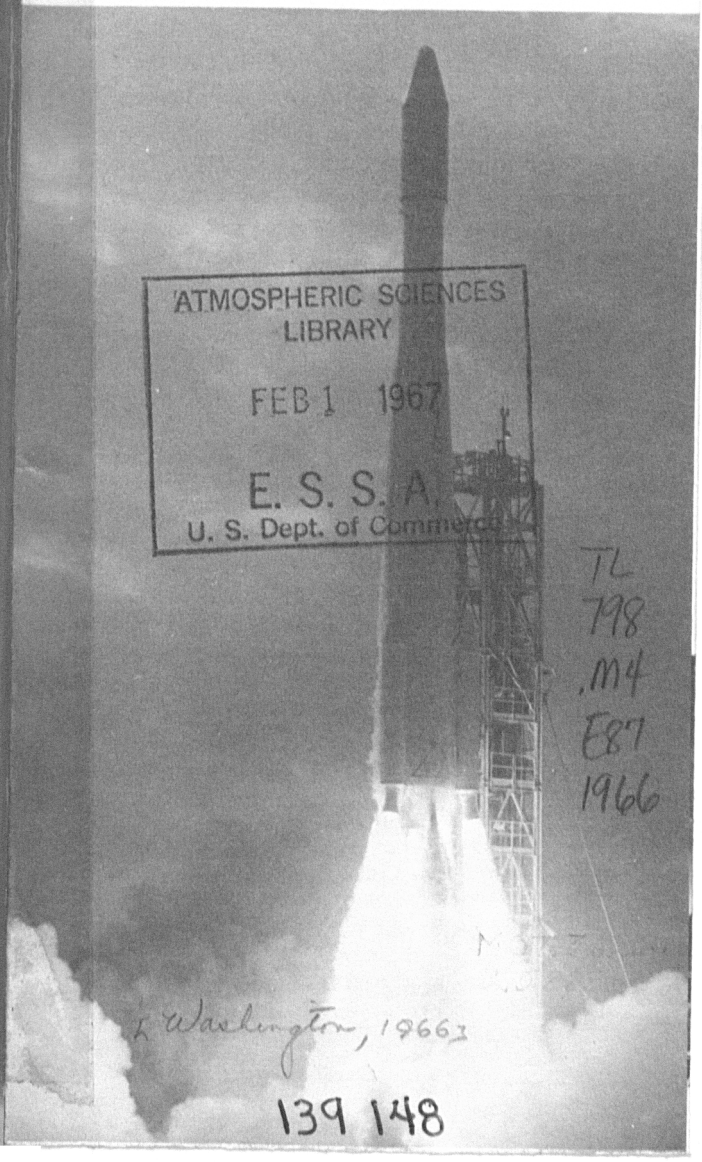
Weather Watch in Space



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National Oceanic and Atmospheric Administration
TIROS Satellites and Satellite Meteorology

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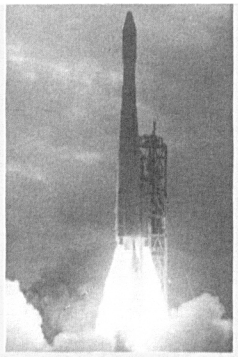
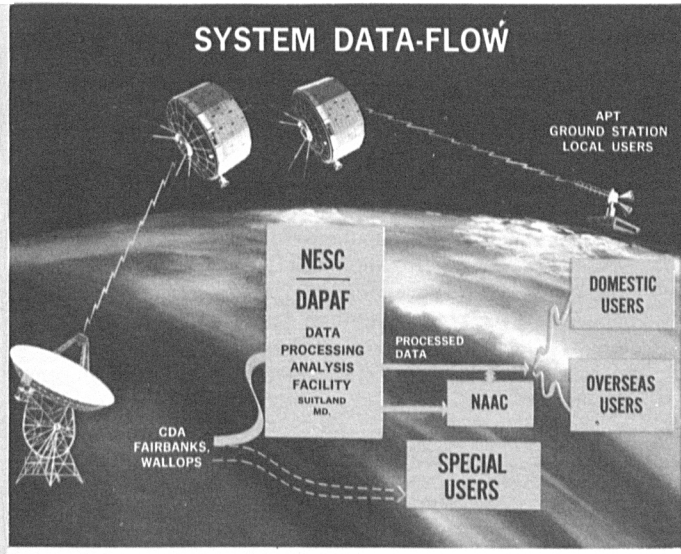


SATELLITE PROGRAMS IN essa

The Environmental Science Services Administration spans environmental science—providing daily coverage of global weather, extending precise geodetic surveys across intercontinental distances, probing the interactions of sun and atmosphere, and relaying environmental data from remote sensors in the air and oceans. As science and technology permit, ESSA is using satellite systems in its quest for an improved understanding of man's physical environment.

The first fully operational weather satellite system was established with the successful launching of ESSA 1 and ESSA 2 spacecraft in February 1966. This TIROS Operational Satellite (TOS) system provides regular and continuous cloud photographs of the entire sunlit portion of the earth at least once each day. The TOS system uses two ESSA (Environmental Survey SAtellite) spacecraft in near-polar, sun-synchronous orbits to provide a mixed photographic capability. The cameras aboard ESSA 1 take and store cloud photographs, and transmit to Command and Data Acquisition (CDA) stations at Gilmore Creek, near Fairbanks, Alaska, and at Wallops Station, Virginia. ESSA 2 is equipped with two Automatic Picture Transmission (APT) cameras, and automatically transmits photographs of regional cloud cover to suitably equipped APT stations near the orbital path of the satellite.



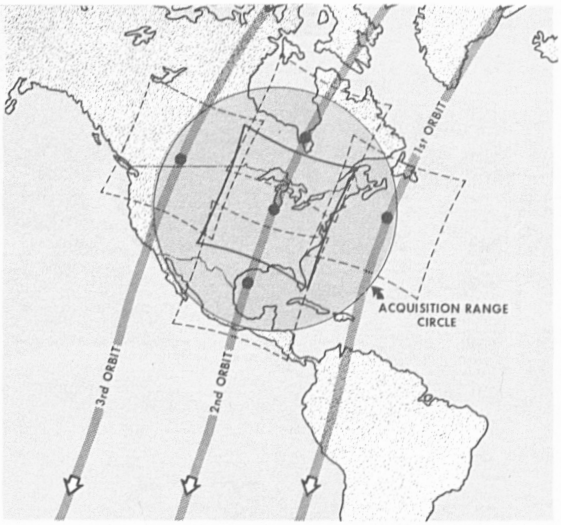
When the initial ESSA spacecraft cease to be useful for meteorological purposes, they will be replaced with advanced models in the ESSA series, to ensure a continuous flow of data.

The National Environmental Satellite Center (NESC) manages and operates the TOS system; it also processes satellite data and furnishes it to ESSA's Weather Bureau, other Federal agencies, and foreign governments. Stored pictures are received from ESSA spacecraft at the Command and Data Acquisition (CDA) stations at Gilmore Creek, Alaska, and Wallops Station, Virginia, where meteorological data are recorded on magnetic tape and immediately retransmitted to the NESC at Suitland, Maryland. At NESC, picture signals are projected on special television screens and photographed by 35-mm cameras. Geographical information—coast lines and latitude and longitude grids—prepared by computer are electronically combined with the picture signal to provide location information. Meteorologists use the gridded photographs to produce cloud-cover maps, called nephanalyses. The Weather Bureau's National Meteorological Center then integrates cloud maps with worldwide data obtained by conventional weather-observing methods for use in daily weather analysis and forecasting. The satellite analyses are also relayed to field stations in the United States and to other countries throughout the world.

The ESSA (Environmental Survey Satellite) spacecraft used in the TOS system evolved from the experimental TIROS series of satellites developed initially by the National Aeronautics and Space Administration (NASA). The first eight TIROS satellites were spin-stabilized and their orbits inclined less than 60 degrees to the Equator; although their experimental value was great, their operational usefulness was limited.

TIROS IX, launched in January 1965, resembled earlier TIROS satellites but was redesigned to a "cartwheel" configuration, a design retained in the present ESSA spacecraft. After injection into orbit, a cartwheel satellite is turned so that its spin axis is perpendicular to the orbital plane. In this position, the satellite rolls along in orbit on its side like a wheel. The cameras point outward from the rim of the satellite, and take pictures only when facing the earth.

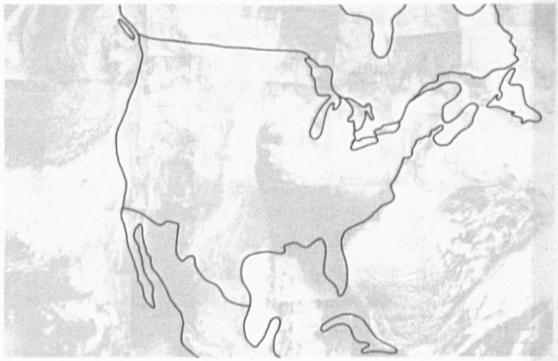
The orbit of ESSA 1 has an apogee (high point) of 521 statute miles and a perigee (low point) of 432 statute miles. ESSA 2 orbits at an average height of about 865 statute miles, has an orbital period of 113 minutes, and makes 12.75 orbits per day. Future ESSA spacecraft will occupy orbits similar to that of ESSA 2, and will be equipped with improved cameras and with infrared sensors. Ultimately, ESSA craft in the TOS and other environmental satellite systems will carry a full range of environmental sensors into space.



Properly equipped ground stations can receive pictures when the satellite is within 2,100 statute miles, and can acquire two or three pictures per orbit on each of one to three orbits. Each APT picture has 800 scan lines and covers an area on the earth about 2,000 statute miles on a side. Picture resolution is about 2 statute miles per scan line directly below the camera, and about 5.2 statute miles at the picture edge.

The number of daily orbits on which the satellite comes within receiving range depends on the latitude of the station, being greater near the poles and lower near the Equator. NESC sends alerting messages to stations all over the world to advise them of times when the satellite will be within range of their receivers.

The camera subsystems aboard ESSA 2 are identical 1-inch Automatic Picture Transmission (APT) cameras, which take cloud photographs and transmit them immediately to simple receiving stations on the ground. The cameras have a wide-angle (90-degree) lens, are mounted 180 degrees apart on the rim of the spacecraft, and point directly downward once per revolution (every 5.5 seconds). An APT camera automatically takes and transmits a picture every 352 seconds while the satellite is in daylight.



The photomosaic printed above shows a heavy rain-producing storm along the Pacific coast, ice in Lake Erie, snow cover over northeastern United States, and clouds in cold air flow off Atlantic coast. The mosaic was constructed from about 45 ESSA 1 photographs. Distortion is caused by oblique view of ESSA 1 cameras and by the curvature of the earth.

U.S. DEPARTMENT OF COMMERCE
Environmental Science Services Administration

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