The Foundations of Environmental Satellites:

Providing Data and Imagery for Over 50 Years

Introduction

Today's color satellite imagery and sophisticated measurements are taken for granted. They are received in real-time and promptly available. This is a considerable improvement from the unclear, black and white photographs and simple measurements that were transmitted intermittently over fifty years ago. The following are highlights of significant developments in the history of environmental satellites.

NOAA/U.S. Dept. of Commerce

NASA

Top: The first image from TIROS-1 satellite on April 1, 1960. Bottom: In 1959, University of Wisconsin professors Verner Suomi and Robert Parent pose with their early instrument for measuring the heat balance of the earth.

1940's and 1950's

Following World War II, scientists were experimenting with sounding rockets, also called research measurement rockets, in White Sands, New Mexico. Gun sight aiming point cameras or GSAPs, were placed on the rockets in order to record their rotation and attitude during flight. One day upon developing the film, the scientists noticed a series of pictures of a tropical storm over Brownsville, Texas. Otto Berg assembled these tiny GSAP images into a mosaic. It was the first image of a storm in space. This immediately attracted the attention of the U.S. Weather Bureau, and demonstrated the potential for space–based cameras to monitor the Earth's changing environment.

On May 27, 1955, President Eisenhower approved the International Geophysical Year (IGY)[1] scientific satellite project. It committed the United States to placing an Earth satellite into orbit by 1958 and was headed by the military's Vanguard program. The Department of Defense meteorological satellite program "Janus" was renamed TIROS (Television Infra-Red Observation Satellite) and transferred to the new National Aeronautics and Space Agency[2], NASA, in April 1959. The first successful meteorological satellite experiment flew on Explorer VII on Oct. 13, 1959 with equipment developed by Professors Verner Suomi[3] and Robert Parent at the University of Wisconsin.

A parallel civilian effort was started by U.S. Weather Bureau. The Director of Research Harry Wexler published the first known paper[4] proposing meteorological satellites in 1954. By March 1958, the Chief of the Weather Bureau, Dr. Francis Wilton Reichelderfer, established a special unit, the Meteorological Satellite Research Unit, to prepare for the data generated from the IGY. Dr. Sigmund Fritz as named as head of the Meteorological Satellite Section (MSA). He was joined by David Simonds Johnson, Jay S. Winston, Lester F. Hubert, David Q. Wark and Donald T. Hillary.

1960's

On April 1, 1960, the first weather satellite, TIROS-1, was launched from Cape Canaveral, FL, later renamed the Kennedy Space Center. It weighted 122 kg, carried two TV cameras, two video recorders, and support systems. It had an operating life of 89 days. Seven

[1]International Geophysical Year was from July 15, 1957 through Dec. 31, 1958. It was international in scope, included polar research, and overlapped two calendar years.
[2]Agency later changed to Administration.
[3]Verner E. Suomi (1915-1995). http://library.ssec.wisc.edu/SuomiWebsite/index.html.
[4]Wexler, Harry. *Observing the Weather from a Satellite Vehicle*,Third Symposium on Space Travel, May 4, 1954.

United Launch Alliance/NOAA

NOAA/U.S. Dept. of Commerce

Left: Launch of NOAA-19, NOAA's new polar-orbiting satellite, on February 6, 2009 from Vandenberg Air Force Base, California. Right: TIROS-1, the first weather satellite, was launched on April 1, 1960.

additional TIROS satellites were launched through December 1963. The later versions of TIROS carried experiments to measure the Earth's radiation output, one of today's important measurements of climate change. TIROS-8 was equipped with a wide-angle camera and a new Automatic Picture Transmission (APT) system allowing the first broadcasts from space.

With the launch of TIROS-9 into the new sun-synchronous orbit on July 1, 1965, the first daily coverage of the entire sun-illuminated portion of the earth was available. Also in 1965, the Nimbus-1 satellite carried an infrared (IR) sensor permitting the first nighttime images from space.

In 1965, a new agency, the Environmental Sciences Services Administration (ESSA), the predecessor to NOAA, was given the responsibility for civilian operational weather satellites. The next satellites were in the ESSA series. In the following four years, nine ESSA satellites were orbited and transmitted thousands of images to ground weather stations.

NOAA - 1970 to Present

NOAA was created as a new agency within the Department of Commerce in 1970 and continued its productive relationship with NASA. NOAA is responsible for program funding and on-orbit operations, and NASA procures, develops, and launches the spacecraft.

Following the successful launch of NASA's prototype the improved TIROS Operational System (ITOS-1) on Jan. 23, 1970, the next generation of satellite names, the NOAA series, began. The NOAA series provides day and night viewing using visible and infrared scanning radiometers; direct broadcasts; and data storage. These satellites also began a record of critical measurements for weather forecasting and climate monitoring such as, snow and ice, sea surface temperatures, vertical atmospheric temperatures, and moisture profiles, which continues today. The NOAA series of satellites are now known as Polar Orbiting Environmental Satellites (POES). Currently, NOAA-15 through to NOAA-19 serve as the primary and backup satellites for morning and afternoon global coverage, orbiting the Earth four times a day. Data from current POES satellites also include a broad range of environmental monitoring for weather analysis, climate research, ocean dynamics, volcanic eruptions, forest fires, and search and rescue, among many others.

Planning for the next generation of polar orbiting satellites has already begun. The new JPSS (Joint Polar Satellite System) advanced satellites will replace the NOAA series. Scheduled for first launch in 2016, it will continue the development of critical earth observing instruments required for long-term environmental observations and climate monitoring.

As of late 2010, there have been forty-three polar-orbiting weather/environmental satellites: ten TIROS (1960-65), nine ESSA (1966-69), eight ITOS (1970-76), and sixteen from the TIROS-N/NOAA series (1978 to present)[5].

[5]There have been three unsuccessful launches.

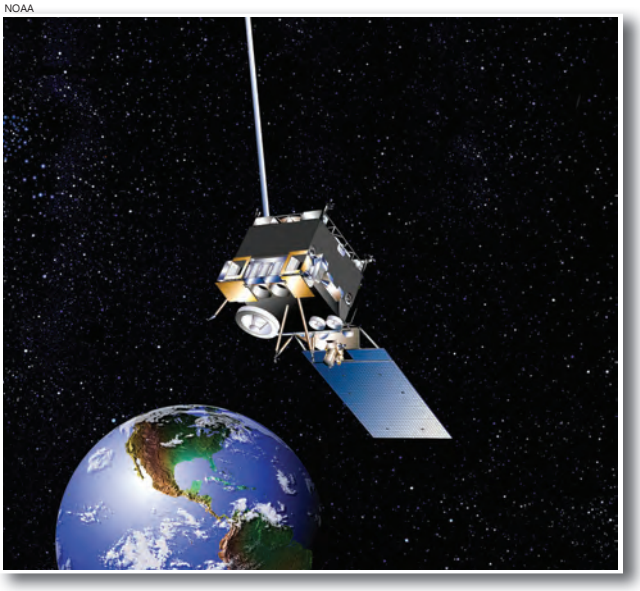
GOES

The value of a geostationary orbit, an equatorial orbit at the same speed as the Earth's rotation which allows the satellite to hover above a fixed location, was successfully demonstrated on Dec. 6, 1966 with the NASA launch of the first Applications Technology Satellite (ATS-1). ATS-1's spin scan camera, also invented by Professors Verner Suomi and Roger Parent, transmitted cloud images in motion every 20 minutes. "Now the clouds move and not the satellite," stated Dr. Suomi.

The era of geostationary meteorological satellites, called the Synchronous Meteorological Satellites (SMS), began on May 4, 1974 with the launch of SMS-1. A second prototype followed in February 1975. After these successful experiments, the Geostationary Operational Environmental Satellites (GOES) program formally began as a joint effort of NOAA and NASA with the GOES-1 launch on October 16, 1975. The GOES series continues to serve the Nation today.

More sophisticated instrumentation built upon the Visible/Infrared Spin Scan Radiometer (VISSR) and the Severe Environmental Storm and Mesocale Experiment (SESAME) project. Other improvements include continuously profiled temperature and water vapor, and upgraded sounders and imagers. Today, GOES-11 is maintaining a constant vigil over the Western United States. GOES-12 monitors South America, and

NOAA



NOAA's GOES-N was launched on May 24, 2006. Now GOES-13, it is operational over the Eastern United States.

NOAA

Artist's conception of GOES-R environmental satellite scheduled for 2015.

GOES-13 watches over the Eastern United States and the Gulf of Mexico. GOES-14 and 15 are in on-orbit storage mode, ready for rapid deployment upon the end of life for either the East or West satellite.

To date there have been eighteen U.S. geostationary weather/environmental satellites: two SMS (1974-75) and sixteen GOES (1975-present, with 1 launch failure).

The Geostationary Operational Environmental Satellite "R" series is the next generation of NOAA Geostationary Satellites. GEOS-R, scheduled for launch in 2015, will fly with improved spacecraft and instrumentation for more timely and accurate weather forecasts. The new instruments include an Advanced Baseline Imager (ABI), a Geostationary Lightning Mapper (GLM), and a Space Environment In-Situ Suite (SEISS). With higher resolution capabilities, GOES-R will improve support for the detection and observations of meteorological events that affect public safety, the protection of property, and economic health.

International Partnerships – Towards a Global Network

In 1972, the first international body, the Coordination Group for Meteorological Satellites (CGMS), met in Washington, DC to informally exchange technical information on satellite compatibility and to cooperate on positioning of their respective satellites. The

first participants were from the United States (NOAA), Japan, and the European Space Agency. Representatives from the Soviet Union (now the Russian Federation), and India soon joined in 1973 and 1978 respectively. CGMS is now organized under the World Meteorological Organization (WMO) and is comprised of 15 national and governmental space agencies. Their scope includes polar orbiting and geostationary meteorological satellite systems, research and development, and operations.

COSPAS-SARSAT is an international satellite-based search and rescue (SAR) alert detection system established by Canada, France, the Russian Federation, and the United States.

Other global cooperative programs include the Initial Joint Polar-Orbiting Operational Satellite System (IJPS) with NOAA and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), the intergovernmental Group on Earth Observations (GEO) the Global Earth Observation System of Systems (GEOSS), World Weather Watch, and many others.

Special Achievements

NOAA's legacy of sixty-one environmental satellites is the culmination of the work of visionary scientists, interagency and international cooperation. Special acknowledgement is made to the leadership and vision of David Simonds Johnson, who, for over the first twenty years led and developed NOAA's satellite service into what it is today. His accomplishments include establishing polar and geostationary satellites, implementing new applications for data collection and processing, forging international cooperation agreements, and lasting collaboration with NASA.

NOAA is the leader in civilian satellite development and operations, and is currently planning for the future with its next generation of more sophisticated satellites.

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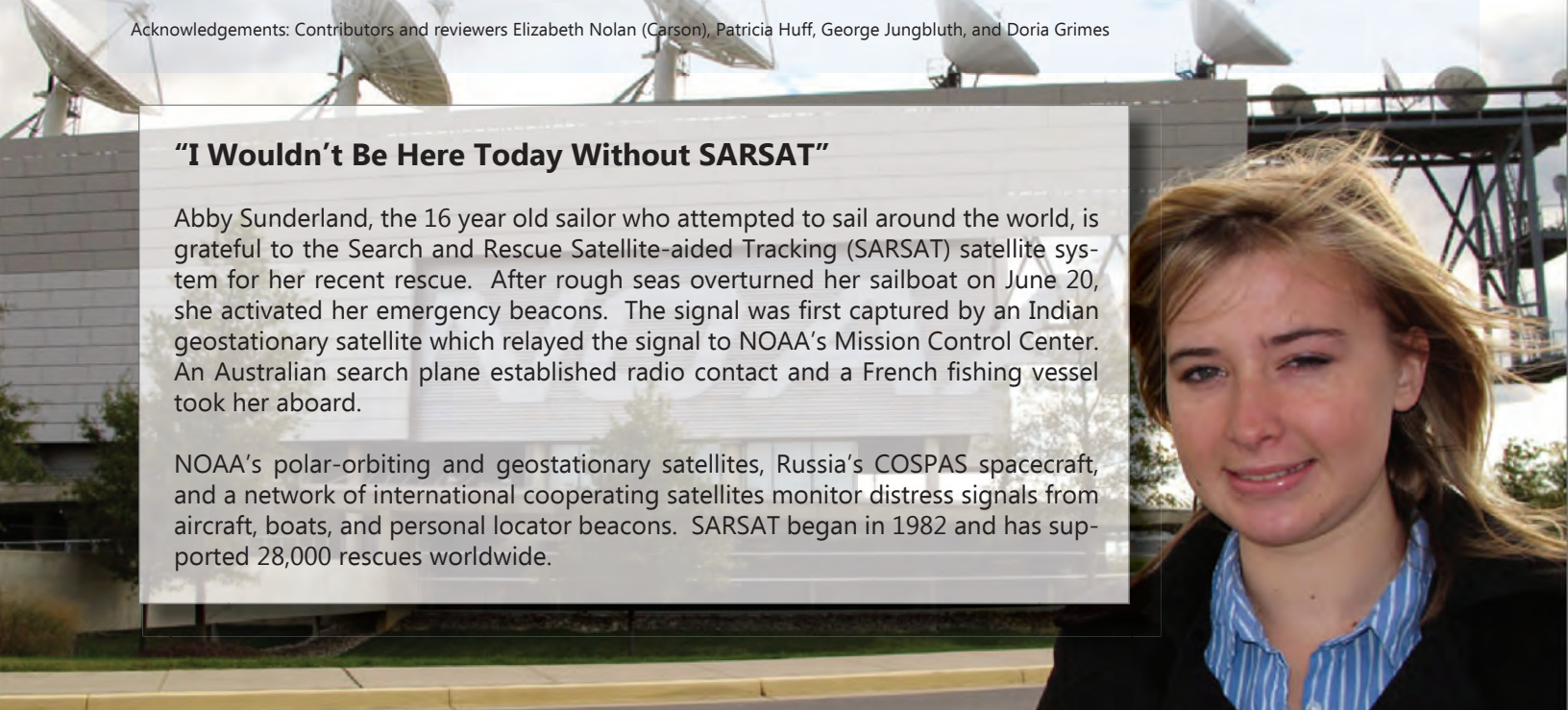

"I Wouldn't Be Here Today Without SARSAT"

Abby Sunderland, the 16 year old sailor who attempted to sail around the world, is grateful to the Search and Rescue Satellite-aided Tracking (SARSAT) satellite system for her recent rescue. After rough seas overturned her sailboat on June 20, she activated her emergency beacons. The signal was first captured by an Indian geostationary satellite which relayed the signal to NOAA's Mission Control Center. An Australian search plane established radio contact and a French fishing vessel took her aboard.

NOAA's polar-orbiting and geostationary satellites, Russia's COSPAS spacecraft, and a network of international cooperating satellites monitor distress signals from aircraft, boats, and personal locator beacons. SARSAT began in 1982 and has supported 28,000 rescues worldwide.