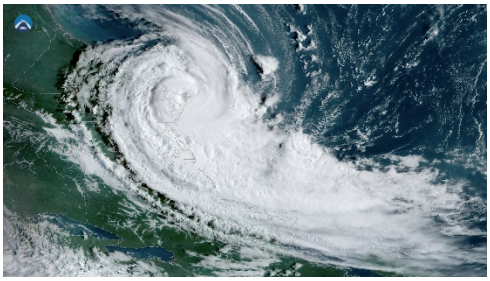
Applications of Earth Observation Data

Introduction

The United States was impacted by 14 natural disasters that each caused over a billion dollars in damage in 2019 alone.[1] Fortunately, scientists are using a multitude of resources to learn more about severe weather, including remote sensing satellites that monitor the Earth from space.[2] Information from these satellites becomes especially important during hurricane season when wind, rain, and the potential for flooding endanger life and property.[3] Last year, satellite imagery taken before and after Hurricane Dorian made landfall allowed the Federal Emergency Management Agency (FEMA) to identify the areas most affected by the storm and to coordinate a rapid response with state and local officials. Evacuation orders were issued for counties across the southeast.[4] Assistance-based organizations like the Red Cross assembled close to 200 emergency shelters for residents in those areas to wait out the storm in safety.[5] Florida's governor, Ron DeSantis, mobilized 4,500 members of the National Guard as meteorologists predicted the storm would be particularly destructive in that state.[6] The remote sensing satellite programs that aided these responsive actions are often collaborative efforts between government agencies and even countries.[7] These instruments collect a range of data that help scientists evaluate our home planet's weather systems and prepare for natural disasters in real time.[8]



Hurricane Dorian seen from the GOES East satellite
Image Source: NOAA

Earth Observation at NASA

The National Aeronautics and Space Administration's (NASA) Earth Observing System (EOS) is made up of a series of remote sensing satellites that have been monitoring Earth's environmental systems for decades.[9] As part of the Earth Science Division of NASA's Science Mission Directorate, EOS gathers information on different aspects of our planet's weather and climate systems. Multiple current and completed satellite missions have collected data on precipitation, water vapor, clouds, radiation, the oceans, and more.

Global Precipitation Measurement
One program that monitors the Earth's weather systems is the Global Precipitation Measurement (GPM) mission. This is a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA) that launched in 2014.[10] The GPM program encompasses a constellation of satellites led by the GPM Core Observatory, which obtains information on the state, distribution, and movement of water throughout the Earth's atmosphere.[11] According to Dr. Dalia Kirschbaum, GPM's Deputy Project Scientist for Applications and Disaster Coordinator, the information gathered from these satellites provide an unprecedented measure of global rain and snowfall.[12]

These measurements can be used for weather forecasting and prediction and the analysis of natural disasters. Satellites offer a considerable advantage over Earth-based equipment as they can provide more frequent and reliable measurements that cover more of the planet's surface area.[13] Ground-based methods are limited and have a difficult time obtaining information from bodies of water. The GPM mission, however, is able to remotely gather data on the type and amount of precipitation, the movement of weather systems, and can even generate three-dimensional structures of storms.[14] Information collected on precipitation and wind structure, ocean surface temperature, and land surface moisture can be assimilated into models to improve forecasting. Results generated from these models help community leaders and emergency management coordinators make decisions on evacuation orders and resource mobilization before a storm even makes landfall.[15] In fact, environmental data can be acquired and sent to weather forecasters in as little as 15 minutes.[16]

While the number of applications for Earth observation data is growing, there are potential issues regarding usage. Managing large amounts of data and obtaining results from models can be difficult due to the use of different formats.[17] This process can be time consuming, costly, and often requires special training.[11] However, Dr. Kirschbaum indicated that

NASA has made an effort to expand the use of its observational data in several ways.[18] Much of this information is considered to be open source data and is available to the public at no charge. The agency also offers training programs on data usage, such as Applied Remote Sensing Training (ARSET). This program instructs participants on how to acquire and use remote sensing data for decision making.[19]

GPM Core Observatory
Image Source: NASA

Future Applications
The increased use of environmental data shows the importance and benefits of Earth observation science. The potential for future applications in this field seems almost limitless. Dr. Kirschbaum and others at NASA are currently working on an upcoming remote sensing program called Aerosol and Cloud, Convection and Precipitation (ACCP).[20] These next generation satellites will measure climate variability and change as well as weather and air quality.[21] Information gathered will be added to the long-running record of Earth observation data and will be used to further improve forecasting and environmental modeling.

Earth Observation at NOAA

Monitoring our home planet is also important to the National Oceanic and Atmospheric Administration (NOAA) as the agency seeks to understand and predict changes in the Earth's systems and to share that knowledge with others.[22] NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) gathers data on environmental systems from satellites and other resources.[23] That information is used to analyze weather systems all around the world and evaluate the scale of natural disasters after they occur.

National Weather Service
The National Weather Service (NWS) operates as part of NOAA[24] and uses satellite information to directly deliver data on environmental systems to the public and community decision makers and to issue forecasts and warnings about severe weather.[25] Dr. Jordan Gerth, a meteorologist at the NWS Office of Observations, specified that this information from remote sensing satellites improves the accuracy of weather prediction worldwide.[26] Measurements from NOAA satellite imagery offer insights into land and sea conditions, cloud distribution, moisture levels, temperature, and wind and speed direction. This data can be entered into models and used to evaluate the development, movement, and even the intensity of storms.

The greatest strength of these satellite observations, according to Dr. Gerth, is that they provide widespread coverage of the planet's systems, which allows for frequent imaging.[27] While it is difficult to take measurements of oceans and remote lands from Earth, satellites are able to deliver important information on changes in conditions from across the globe. These images, which are taken frequently over the course of 24 hours, improve weather forecasting and predictions. In fact, some geostationary satellites, which continuously monitor the same section of the planet, are capable of taking images of storms every 30 seconds. Geostationary Operational Environmental Satellites (GOES) are part of a joint program between NOAA and NASA that continually monitors the Western Hemisphere.[28] This group of satellites is responsible for monitoring and tracking storms in order to give more lead time for preparations prior to landfall.

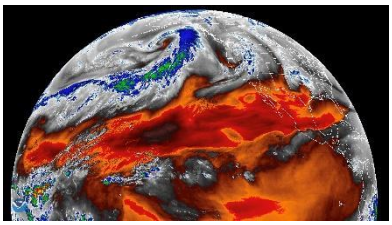


Image from the GOES West satellite
Image Source: NOAA

Future Applications

While the latest series of geostationary satellites, GOES-R, is operational through the year 2036,[29] Dr. Gerth and others at NOAA are currently evaluating options for future satellites that will allow them to continue their observations for the next 20 years.[30] Not only are they assessing new instruments, but they are also considering the use of smaller constellation satellites. This presents a possible opportunity to obtain weather data from commercial satellite partners. As part of this evaluation, NOAA is also connecting with people on the front lines. The agency is researching and discovering ways to improve the acquisition and use of satellite imagery to deliver the information needed by meteorologists, emergency responders, and industry officials.

Conclusion

While many people may never consider the source of their local weather forecast, data obtained from remote sensing satellites provide vital information used to track and analyze Earth's environmental systems. The importance and value of Earth observation data prove that activities in space are not only about exploring other worlds. They also help us to safeguard life on our home planet.

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