

Geostationary satellites delivering continuous, multispectral observations to advance weather forecasting, disaster preparedness, and environmental monitoring.

INTRODUCTION

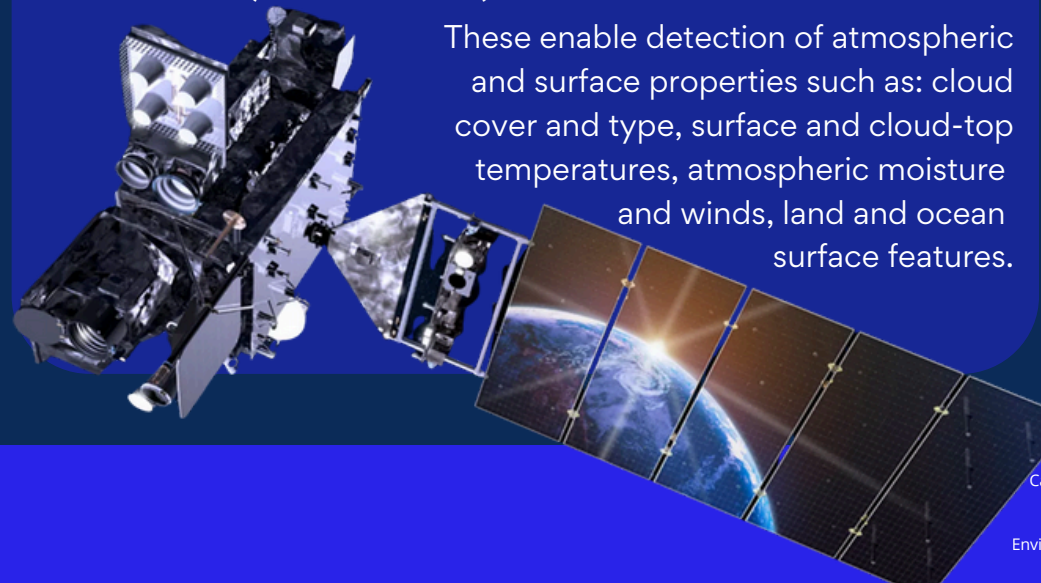
The Geostationary Operational Environmental Satellites (**GOES**) are a cornerstone of U.S. environmental monitoring and weather forecasting. Operated by NOAA, these satellites provide **continuous, real-time observation** of the Western Hemisphere from a fixed position approximately 36,000 km above the equator. Since the launch of the first GOES satellite in 1975, the system has evolved from spin-stabilized platforms with limited viewing capability to the current GOES-R Series, the most advanced fleet of **geostationary** weather satellites to date. They support a wide range of applications including **meteorology, oceanography, climate monitoring, and space weather forecasting** by delivering **high-resolution imagery, atmospheric measurements, and real-time environmental data.**

HOW IT WORKS

GOES satellites maintain a **geosynchronous** orbit, rotating in sync with the Earth to provide continuous observation (as frequently as every **15 minutes**). The current fleet is composed of **5 satellites** (GOES-14, -16, -17, -18, and -19) however GOES 14 is largely dormant and not considered part of the active constellation. The primary instrument aboard the GOES-R Series is the Advanced Baseline Imager (ABI), which captures high-resolution images using **16 spectral bands:**

- 2 visible (including the "red" band at 0.5 km resolution),
- 4 near-infrared (1 km resolution),
- 10 infrared (2 km resolution).

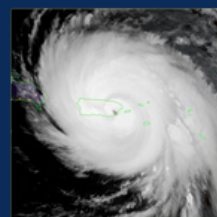
These enable detection of atmospheric and surface properties such as: cloud cover and type, surface and cloud-top temperatures, atmospheric moisture and winds, land and ocean surface features.



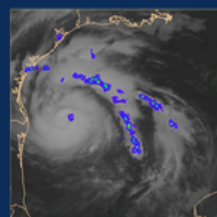
GENERAL APPLICATIONS

As mentioned, the GOES sensors cover many different applications related to forecasting, danger preventions and environmental monitoring. Their applications can be sorted in three different groups ranging from most time-sensitive to longer term studies

- **Natural disasters forecasting**
 - Hurricane track and intensity forecasts
 - Early warning of severe storms and tornadoes
 - Detection of meteors
- **Risk monitoring**
 - Identification of lightning strikes likely to ignite fires
 - Air quality data for alerts
 - Detection of solar activity (coronal holes, flares, CMEs)
- **Research on climate and environment**
 - Monitoring of vegetative health
 - Sea surface temperature for fisheries/marine life
 - Data for long-term climate variability studies



Hurricane Track



Lightning Mapping



Space Weather Monitoring



Solar Imaging

LIMITATIONS

GOES satellites present several limitations compared to other sensors

- **Limited angle** due to the geosynchronicity, limiting their use for higher latitudes, with serious data degradation poleward of 70 degrees latitude
- **High cost**, estimated around 11,7 billion dollars for the development, launching and operating of the GOES-R series
- **Lifespan** of only 10 operational years due to their fuel dependency to function

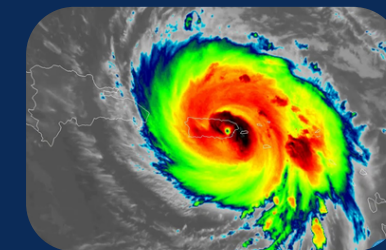
GOES SENSORS FOR ATMOSPHERIC CONDITIONS MONITORING

To be effective at monitoring atmospheric conditions, sensors need to provide continuous data of specific locations. This allows for small shifts in conditions to be distinguished and to identify patterns.

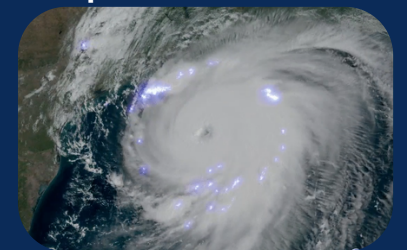
Why are the GOES sensors good for storm tracking?

- Their geostationary position allows for continuous monitoring from the Atlantic, across the Americas and into the Pacific.
- Their **advanced baseline imager (ABI)** allows for the measurement of:
 - cloud patterns in real time
 - storm structure, intensity and lightning
 - characteristics of storms eye's
 - wind speeds

Storm Tracking Examples

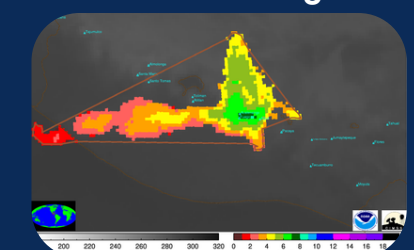


Storm tracking of Hurricane Maria in 2017. Regions of highest storm intensity are shown in red. Recorded using GOES-16. (NOAA's GOES-16 Provides Critical Data on Hurricane Maria, n.d.)



Storm tracking of Hurricane Laura, in 2020 and its lightning intensity. Recorded using GOES-16. (50 Years of Monitoring the Stormy Seas: Hurricane Tracking with NOAA's GOES Satellites, n.d.)

Ash Plume Monitoring Example



Depiction of the plume height and travel direction following the eruption of Volcan de Fuego in 2018. Recorded using GOES-16. (Eruption of Volcán de Fuego in Guatemala, n.d.)