Updated July 2015

GOES-R Land Products

Fire Detection and Characterization

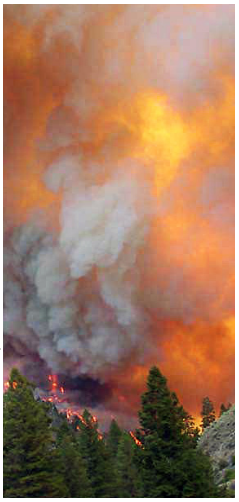


Photo Credit: Kim Soper

What is GOES-R?

The Geostationary Operational Environmental Satellite - R Series (GOES-R) is the next generation of National Oceanic and Atmospheric Administration (NOAA) geostationary Earth-observing systems. Superior spacecraft and instrument technology will support expanded detection of environmental phenomena, resulting in more timely and accurate forecasts and warnings. The Advanced Baseline Imager (ABI), a sixteen channel imager with two visible channels, four near-infrared channels and ten infrared (IR) channels, will provide three times more spectral information, four times the spatial resolution and more than five times faster coverage than the current system. Other advancements over current GOES capabilities include total lightning detection (in-cloud and cloud-to-ground flashes) and mapping from the Geostationary Lightning Mapper (GLM) and increased dynamic range, resolution and sensitivity in monitoring solar X-ray flux with the Solar Ultraviolet Imager (SUVI). The first satellite in the GOES-R series is scheduled for launch in 2016.

Why is satellite-based fire detection and characterization important?

Fires, whether naturally occurring or man-made, have substantial impacts upon society. Wildfires can destroy vast tracts of land, releasing tons of aerosols and gases into the atmosphere, while destroying wildlife habitats and valuable resources. According to the National Interagency Fire Center, wildland fires burned an average of 4,641,405 acres per year in the U.S. from 1985-2008. Recording and monitoring fires from ground-based observations is a labor intensive, expensive process that results in an incomplete record. Satellites allow for detecting and monitoring a range of fires, providing information about the location, duration, size, temperature and power output of those detectable fires that would otherwise be unavailable. This information can be used to track fires in real time, providing input data for air quality modeling and helping to separate the impact of the fires from other sources of pollution.

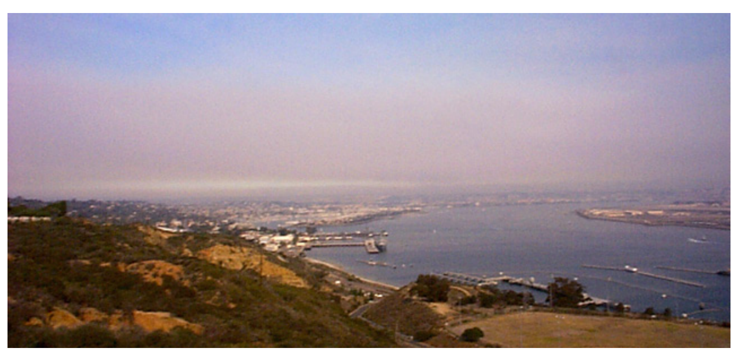
Forest fire over a hill just east of Yellowstone National Park, along US 20, on 10 August 2008.

How will GOES-R detect and characterize fires?

Fires produce a heat signature that is detectable by satellites even when the fires represent a small fraction of the pixel. The GOES-R ABI will be capable of detecting heat signature with improved time and space resolution, including smaller fires, compared to the current GOES imager. GOES-R will represent a step forward in the ability of the hazards and air quality monitoring communities to detect fires and their properties. Fire properties can be measured in three ways: instantaneous fire size, instantaneous fire temperature and fire radiative power (FRP).

How does fire detection and characterization work?

Fires produce a stronger signal in the mid-wave IR bands (around 4 microns) than they do in the long wave IR bands (such as 11 microns). That differential response forms the basis for most **Fire Detection and Characterization (FDC)** algorithms, including the algorithm used for GOES-R. **FDC** was taken into account when creating the specifications of the 3.9 micron band on ABI, allowing GOES-R

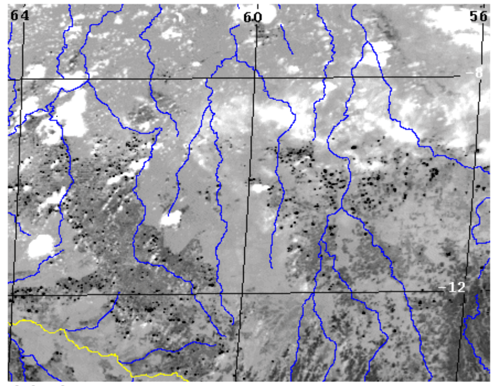


A view of smoke over San Diego on 3 January 2001, as the Viejas Fire raged to the east.

to exceed the **FDC** performance seen with current GOES satellites.

The **FDC** algorithm is a contextual algorithm that looks for hot spots, attempts to determine the background temperature without fire present, corrects for solar contamination and water vapor attenuation and in cases where confidence is high, provides fire characteristics for the detected fires. The algorithm screens out surfaces that are not usable, such as water, tundra, deserts and sparsely vegetated mountains. Such surfaces either do not see fires or are prone to false alarms due to extreme daytime heating. Regions where solar reflection is an issue are screened out based on the viewing geometry. The algorithm also screens out clouds that are opaque for ~4 micron radiation. This is different than a typical cloud mask since fires are often detected through thin clouds such as cirrus or stratus decks.

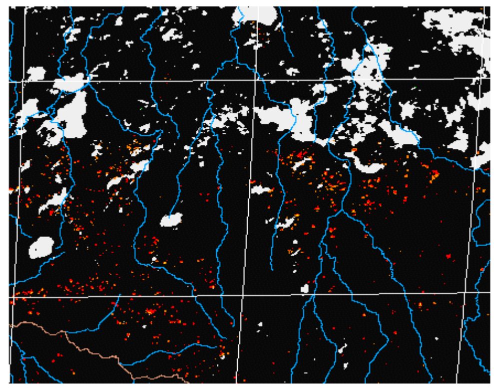
Once a fire has been detected and corrections applied to the radiances, the instantaneous fire size and temperature can be estimated. FRP is also calculated for the fire. FRP is directly related to fire size and temperature, but the different characteristics can be used in various applications.



ABI proxy data created from MODIS data.

Date: 7-Sep-2004
Time: 17:50 UTC

GOES-R ABI 3.9 μm data



Experimental WF_ABBA Fire Legend
- Processed Fire
- Saturated Pixel
- Cloudy Fire
- High Possibility
- Medium Possibility Fire

- **No Fire**
- **Opaque Cloud**

CIMSS GOES-R ABI Wildfire Automated Biomass Burning Algorithm (WF_ABBA) fire mask product.

ABI Proxy data created from Moderate Resolution Imaging Spectroradiometer (MODIS) data for 7 September 2004 at 17:51 UTC over the Amazon Basin in Brazil. The top image shows the ABI proxy data and the bottom image contains the ***FDC*** *product output showing detected fires and areas flagged as opaque clouds. Most fires are "processed," having associated fire size, temperature and radiative power, though other categories occur as well.*

What are the benefits?

The aerosols released by fires and the degraded air quality caused by them represent tremendous costs to society, so reliable information on fire locations and characteristics is important to a wide variety of users. Hazards monitors such as the Hazards Mapping System at NOAA/NESDIS use the fire detection data from current GOES, along with those from other satellites, to create maps of fire locations. Air quality modelers take fire data as inputs to their models to improve estimates and tracking of smoke plumes and regulated quantities of fine particle pollution (PM2.5). Land use change monitors look to records of detected fires to aid in mapping the impact of anthropogenic changes to the landscape. Additionally, as higher temporal resolution becomes available, real-time monitoring of active wildfires becomes increasingly useful for various federal, state and local agencies. Timely and reliable monitoring of fires can lead to increased protection of life and property and also to better air quality predictions.

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- Cooperative Institute for Meteorological Satellite Studies (CIMSS)
- NOAA National Environmental Satellite, Data and Information Service, Center for Satellite Applications and Research (NESDIS/STAR)
- NOAA/NESDIS Office of Satellite Data, Processing, and Distribution (OSDPD)
- Naval Research Laboratory (NRL), Monterey, CA

On the Web

http://www.ssd.noaa.gov/PS/FIRE/Layers/ABBA/abba.html
http://cimss.ssec.wisc.edu/goes/burn/wfabba.html

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