The GOES-R Fire Detection Algorithm from Research to Operations

Jay P. Hoffman*, Christopher C. Schmidt, Elaine M. Prins, Jason C. Brunner
jay.hoffman@ssec.wisc.edu*

Introduction

Real-time satellite fire detection and characterization is possible primarily due to the behavior described by the Planck Function. The 4µm band emission increases faster with increasing temperature (at fire temperatures) than the 11µm band. The GOES-R Fire Algorithm, is a complex contextual algorithm that identifies hotspots by locating pixels with significant differences in the 4µm and 11µm brightness temperature and applying a series of contextual tests.

Global Geostationary Fire Monitoring

The basis of the GOES-R Fire Algorithm is the Global Wildfire Automated Biomass Burning Algorithm (WF_ABBA), developed at CIMSS. WF_ABBA has a longstanding history as an operational satellite fire product that has transitioned to new satellites as they have come on-line.

Current coverage:

- GOES-E/-W/-SA (-13/-15/-12) Imager (75° W / 135° W/ 60° W)
- Met -8/-9 SEVIRI (9.5° E / 0°)
- MTSAT -1R (JAMI) / MTSAT-2 (HRIT) (140° E / 145° E)

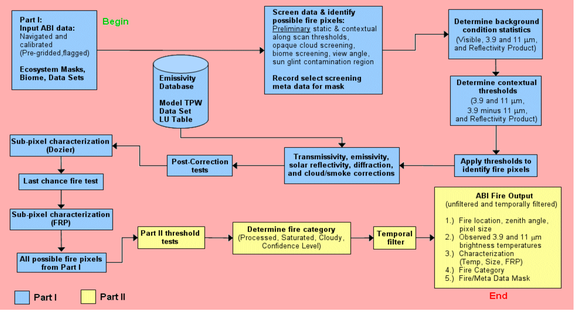
Future coverage

- GOES-14 Imager (on-orbit standby)
- ***GOES-R ABI*** ***(launch est. FY 2015)***
- GOMS Elektro-L N1 /-N2 (76° E / 14.5° E)
- COMS (128° E)

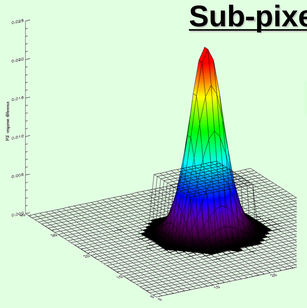
GOES-R ABI Algorithm Development

Development of WF_ABBA for GOES-R ABI is multifaceted:

- Adapt the legacy algorithm for the new satellite system
  - See algorithm flowchart to the right
- Take advantage of the improved spatial, spectral, and temporal resolution
- Address user needs
- Research focused on: surface emissivity, diffraction, atmospheric attenuation, solar contamination, and false alarm reduction



Sub-pixel Fire Detection and Characterization



Observation of fire is sensitive to the characteristics of the sensor. The figure above compares a Gaussian PSF (color filled) with a step function PSF (transparent), both having the same ensquared energy.

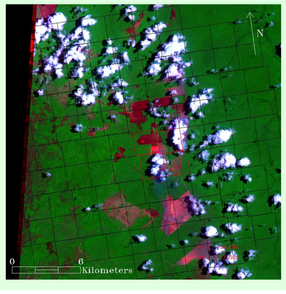
Fire Size and Temperature

To solve fire size and temperature, a system of two equations (4 and 11 micron radiance) with two unknowns (fire temperature and fire size) can be solved numerically.

FRP

Fire radiative power (FRP) is a parameter widely used in emissions modeling as studies have shown a linear relationship between fire emissions and FRP.

The image below shows nominal ABI pixels (grid) overlaid on coincident 30m resolution ASTER image (RGB 8-3-1) acquired on 19 Oct 2002 14:21:59UTC. ABI fire pixels are marked in red (credit: Wilfrid Schroeder). Subpixel hotspot features can appear in multiple full-resolution pixels as an artifact of the shape of the imager response function and relative position of the sub-pixel feature.



More information

- See poster #476 “Western Hemisphere Diurnal Fire Activity 1995-2011:…” by Jason Brunner et al.
- wfabba.ssec.wisc.edu

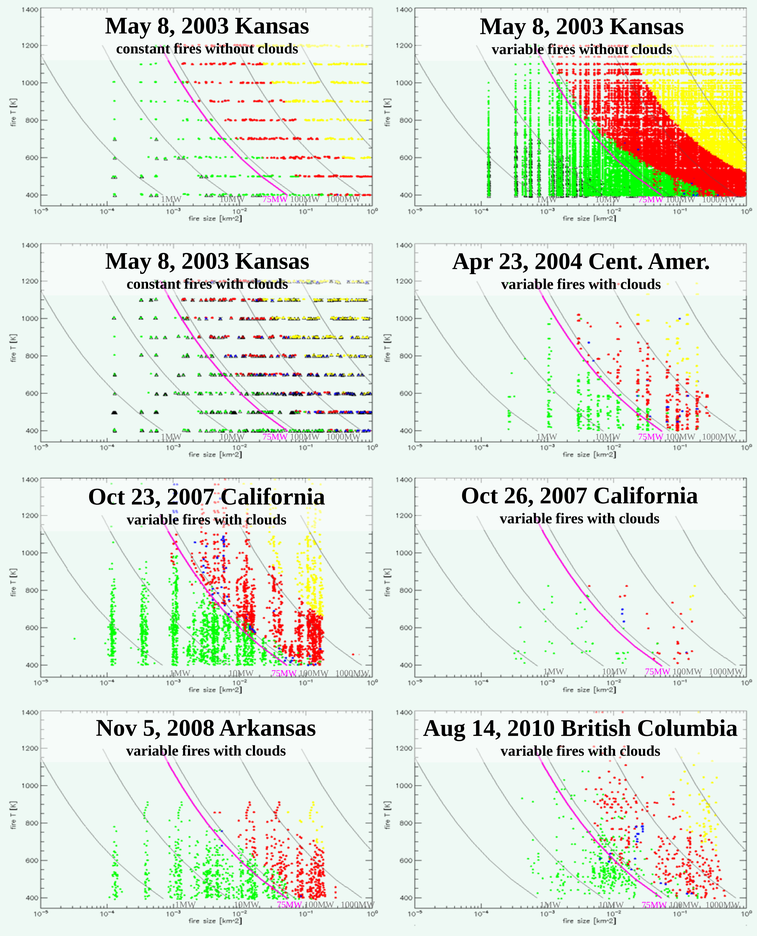
Advanced Baseline Imager (ABI)

Band Number	Bandwidth (µm)	Range Limit	Spatial Resolution	in Fire Code
2	0.59 – 0.69	515 W/m²/sr/µm	0.5 km	optional
7	3.8 – 4.0	400 K	2 km	✓
14	10.8 – 11.6	330 K	2 km	✓
15	11.8 – 12.8	330 K	2 km	optional

- 5 min CONUS
- 15 FD coverage

ABI Fire Algorithm Performance

The charts below depict the GOES-R Fire Detection Algorithm fire detection and classification as a function of the model simulated (developed at CIRA) ABI fire size and fire temperature. Notice that WF_ABBA is quite successful detecting fires with FRP > 75 MW.

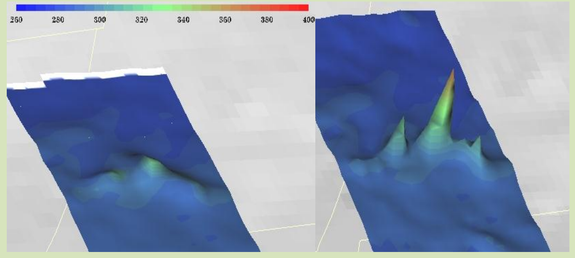


Not Detected
Processed Fire Pixel
High Probability Fire Pixel
Not Detected Due to Block-out zone
Saturated Fire Pixel
Medium Probability Fire Pixel
Cloudy Fire Pixel

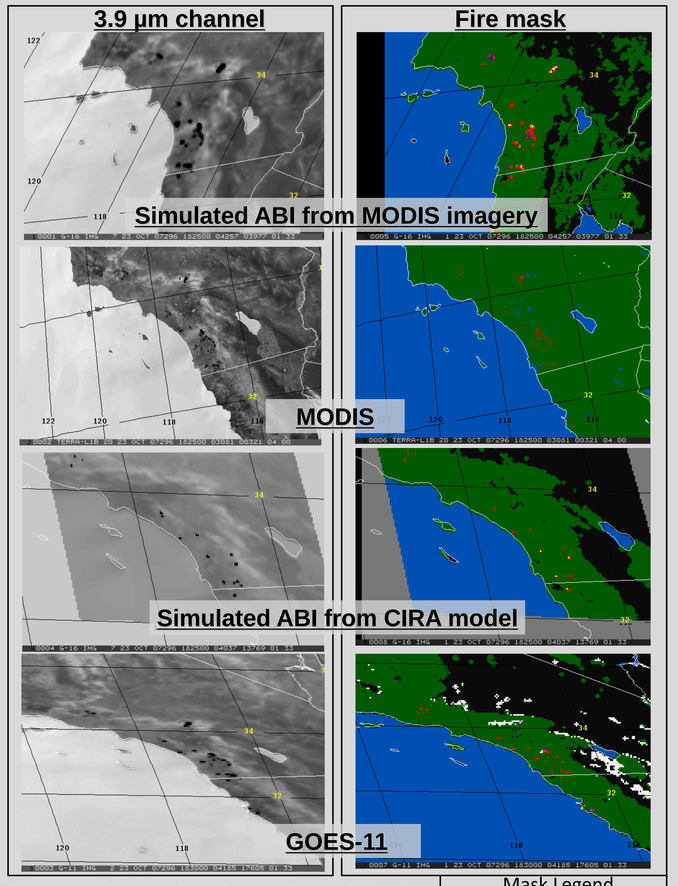
Improved ABI Resolution

Fire detection and characterization will benefit from the improved spatial, spectral, and temporal resolution provided by GOES-R ABI. Spatial resolution of the 3.9 micron brightness temperature is illustrated below. On the left, 4km GOES-12 data from Oct 27, 2003 is shown, and, on the right, the corresponding 2km simulated ABI 3.9 micron brightness temperature data.

Greater contrast between fire and background is achieved due to improved spatial resolution.



Proxy Data



The examples to the above show the 2007 Oct. Southern California fire outbreak. Simulated ABI and MODIS source data are presented in the top two image sets. A numerically based simulated ABI model data from CIRA is also shown with the corresponding GOES-11 data in the bottom two image sets.

The images below and right show a case study from Sep 7, 2004. ABI data (left) is simulated from MODIS (lower right). WF_ABBA is run using the simulated ABI data and the results are shown run on the right. In red the ABI fire detections are plotted while the MODIS fire product detections are shown in blue.