GOES-R ABI fire detection and monitoring with the WildFire ABBA

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CURRENT STATUS OF ONGOING WORK:

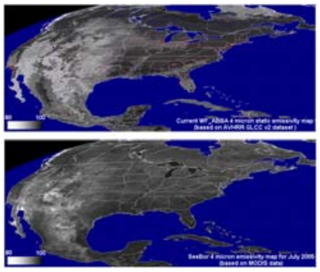
UW-Madison is adapting the current GOES Wildfire Automated Biomass Burning Algorithm (WF_ABBA) to the GOES-R Advanced Baseline Imager (ABI). Historical and current expertise at CIMSS in fire algorithm development for the global geostationary fire observation network is being leveraged to take advantage of the improved temporal and spatial resolution of the ABI. Proxy data is key to the effort, and two primary sources are being used: data derived from MODIS and model-generated fire data. The team at CIMSS has developed a technique to carefully re-project MODIS data to an ABI projection, and teams at the Cooperative Institute for Research Applications (CIRA) and CIMSS are creating model-derived proxy ABI datasets containing fires. Early results are encouraging, with progress being made with both proxy datasets.

FIRE DETECTION BASICS

Satellite-based fire detection schemes rely on heat signatures detectable in the short to mid range IR, such as the 4 μm band. Longer wavelengths such as 11 μm are less sensitive fire signatures and provide the basis for separating fires from land features. Additional information is used to refine detection and make characterization of fire properties (such as instantaneous size, temperature, and radiated power) possible, including but not limited to atmospheric total precipitable water, surface emissivity, and surface type.

ALGORITHM IMPROVEMENT: EMISSIVITY

Accurate estimates of surface emissivity are needed for the 4 μm and 11 μm bands. Current WF_ABBA emissivities are assigned from a look-up table from the AVHRR GLCC dataset. CIMSS is applying the UW Baseline Fit (formerly informally known as SeeBor) dataset which contains monthly estimates of spectral band emissivities derived from MODIS data.



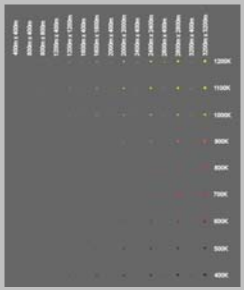
MODEL-GENERATED ABI PROXY DATA

The proxy data team at CIRA has assembled three variations of their test case. In each case the fires are laid out in a regular grid with size and shape varying in the horizontal and temperature varying in the vertical. The starting grid has a cell size of 400m on a side, a resolution that balanced computational time against the highest resolution possible. This technique allows for a very well defined truth dataset that was applied to three conditions within their mesoscale weather model:

1) **Fire temperatures constant, no clouds**
2) **Fire temperatures constant, with clouds**
3) **Varying fire temperatures, no clouds**

Cases #1 and #3 are represented below to show the relative performance of the WF_ABBA at relative extremes. It should be noted that the large fires in this simulation are emitting an extreme amount of power, well above that normally detected by satellites.

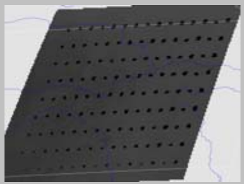
Time invariant fires with no clouds



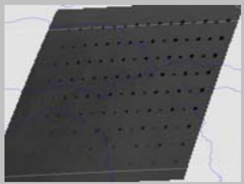
"TRUTH"

Time varying fires with no clouds (18th time step)

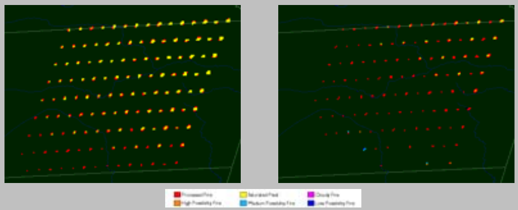
Fires are reprojected to ABI resolution and navigation using a Gaussian distribution to approximate the point spread function:



PROXY ABI



The WF_ABBA was run on the ABI proxy data, producing the output below. The high proportion of saturated pixels reflects the large size and high temperatures of the fires in the simulation. Dark green represents valid input data:

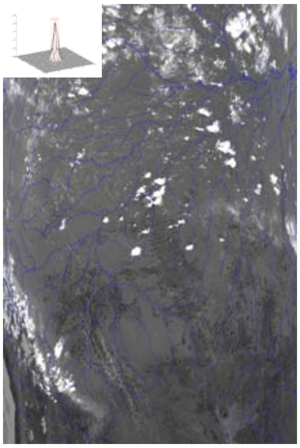


Overall the WF_ABBA captures nearly all of the fires distinguishable by the human eye and does not fail for the extremely hot cases. Validation efforts are underway to determine how well the WF_ABBA performed its characterization of instantaneous fire size, temperature and radiated power.

ABI PROXY DATA FROM MODIS

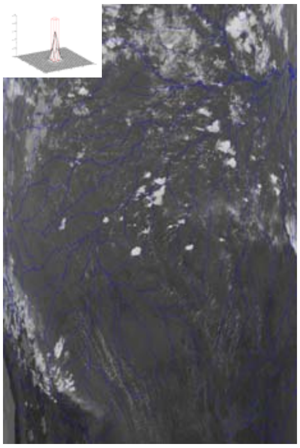
Creating proxy data for a new instrument from current instruments, while providing a level of detail beyond current models, must address radiometric and viewing geometry issues. In order to address the latter simulated point spread functions (PSFs) were applied to MODIS data in a way that simulates a scan by ABI. This approach was chosen over the typical interpolation, spline, and averaging methods as it provides a clean solution that accounts for viewing geometry. The radiometric differences between ABI and MODIS have yet to be directly addressed, but the WF_ABBA produces good output regardless. The AQUA MODIS image is over Brazil on 7 Sept. 2004 at 17:50 UTC.

MODIS (original) 3.9 μm (band 22) with PSF

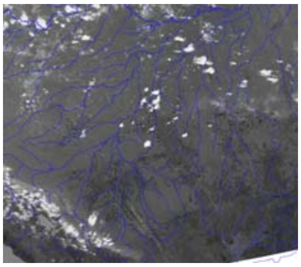


AQUA MODIS

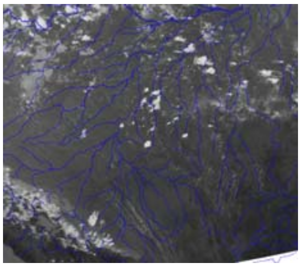
MODIS (original) 11 μm (band 31) with PSF



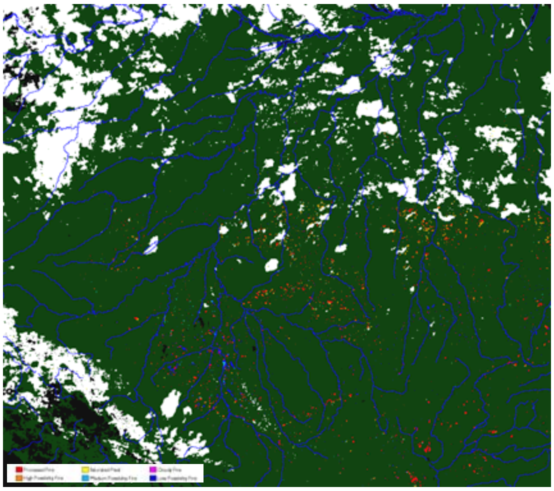
Remapping takes 1 km MODIS data and outputs 2 km ABI data. Note that the "bowtie" is all but gone. MODIS bands 21 and 22 are combined in this process (band 21 not shown) to better match ABI's saturation temperature without introducing all of the noise present in band 21.



PROXY ABI



The initial iteration of the WF_ABBA for ABI takes the 3.9 μm and 11 μm bands to perform its detection and characterization. The fire mask below contains cloud information (white), regions not processed for various reasons (black), the regions processed (dark green), and categorized fires (various colors):



Performance is good despite the fact that the MODIS spectral response function produces a different range of 3.9 μm and 11 μm radiances than what the ABI is expected to provide (ABI calibration was used in this case). Future work will address this issue. Validation will consist of comparisons with other fire products such as the MODIS fire product and the current GOES WF_ABBA.