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GOES-R ABI Fire Detection and Monitoring Development Activities

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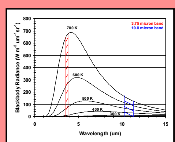
CURRENT STATUS and FIRE DETECTION BASICS:

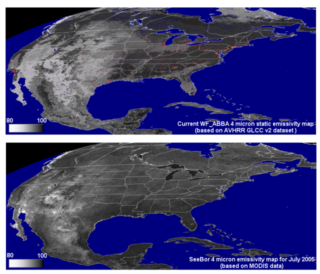
UW-Madison is adapting the current GOES Wildfire Automated Biomass Burning Algorithm (WFABBA) to the GOES-R Advanced Baseline Imager (ABI). Historical and current expertise at CIMSS in fire algorithm development for the global geostationary fire observation network is being leveraged to take advantage 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.



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

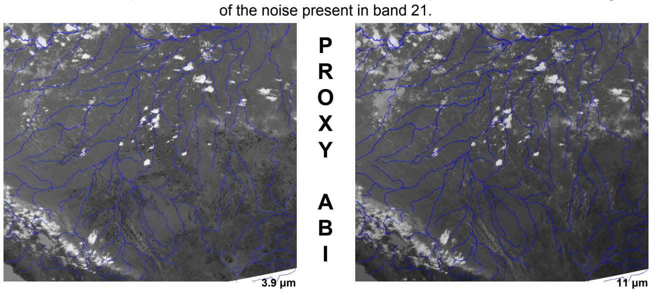
Accurate estimates of surface emissivity are needed for the 4 µm and 11 µm bands. Current WFABBA emissivities are assigned from a look-up table from the AVHRR GLCC dataset. CIMSS is applying the UW Baseline Fit (formerly informally known as SeeBor) dataset which contains monthly estimates of spectral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



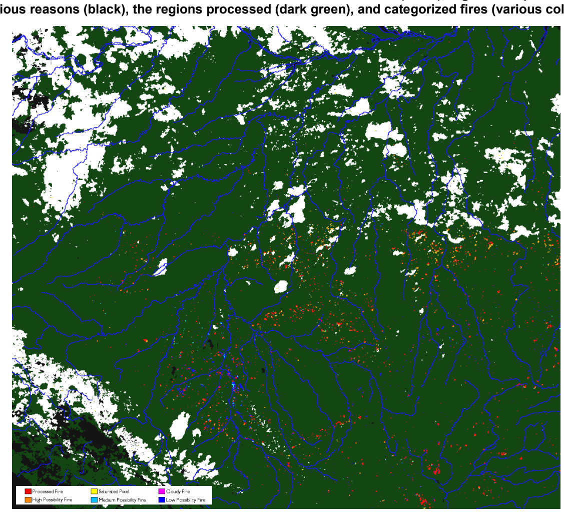
ABI PROXY DATA FROM MODIS

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. See poster P1.35 by Scott Lindstrom for a complete description of this technique. The sample image in this case is the AQUA MODIS image over Brazil on 7 Sept. 2004 at 17:50 UTC.

Remapping takes 1 km MODIS data and outputs 2 km ABI data. MODIS bands 21 and 22 are combined in this process to better match ABI's saturation temperature without introducing all of the noise present in band 21.



The initial iteration of the WFABBA 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 WFABBA.

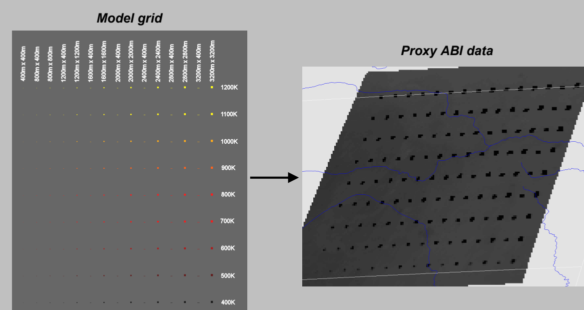
MODEL-GENERATED ABI PROXY DATA

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:

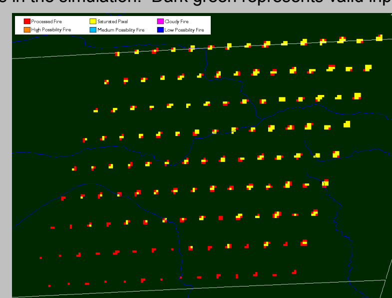
1) **Fire temperatures constant, no clouds**
2) **Fire temperatures constant, with clouds**
3) **Varying fire temperatures, no clouds**

Case #1 is represented below to show the relative performance of the WFABBA. 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.

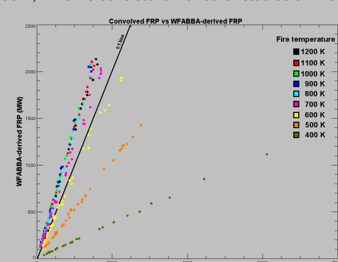
Fires from the no cloud, no time variability case reprojected to ABI resolution and navigation using a Gaussian distribution to approximate the point spread function:



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 WFABBA captures nearly all of the fires, >85% of all pixels and 99% of the clusters. Assessment of the fire characterization is not a simple process given the convolution performed to simulate satellite observation and the number of saturate pixels (saturated pixels cannot be characterized). The proxy team at CIRA applied the same type of convolution to the FRP values from the truth data set, allowing a more direct comparison of fire characteristics. Agreement is best for the warmer fires, though the WFABBA overestimates the FRP relative to the convolved values. However the convolved values are also generally less than the truth values when compared on a cluster-by-cluster basis. The best agreement was for fires above 600 K, which is consistent with other studies on fire characterization.



Since $FRP = \sigma * area * T_{fire}^4$ the convolved FRP can be used to derive the fire size given that T_{fire} is known. The plot to the right codes the fire pixels by whether they were not detected by the WFABBA (black), whether the WFABBA processed fire characteristics (red), and whether they were flagged as saturated fire pixels (yellow). Lines of constant FRP are plotted, as is the estimated minimum detection threshold. While it appears that the WFABBA missed a number of fires, the WFABBA detected >85% of the fire pixels.