GOES-R ABI Deep-dive Active Fire product Validation

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Introduction&Background

The future GOES-R ABI fire detection and characterization algorithm builds on the Wildfire Automated Biomass Burning Algorithm (WF_ABBA) which originated from GOES VAS data applications. The WF_ABBA product provides routine near real-time detection and characterization of sub-pixel active fires, serving the fire management community as well as the scientific community. Consequently, WF_ABBA must deliver quality data with well characterized sources of errors. Assessment of satellite active fire detection and characterization products requires simultaneous observations in order to reduce the effects of short term variations in fire conditions. Previous studies have used higher spatial resolution satellite data to validate moderate-to-coarse resolution fire products derived from sensors aboard the same orbital platform (e.g., MODIS and ASTER) as well as on separate platforms by limiting the time difference between acquisitions (e.g, GOES and Landsat ETM+). Building upon the validation methods developed for GOES and MODIS fire products, this GOES-R Algorithm Working Group project utilizes higher spatial resolution fire reference data to assess and validate the ABI fire detection and characterization algorithm. We discuss the status of the *deep-dive* fire validation tool and present the preliminary results derived from a 2011 field campaign at Henry Coe State Park/CA, which utilized airborne multi-spectral data to look at fire characterization parameters coincidently derived by WF_ABBA using near-coincident GOES-11 and -13 data.

Fire Detection Data

The GOES-R ABI active fire detection *deep-dive* data validation method has been developed and tested using approximately 300 ASTER reference scenes distributed over North and South America. The approach is based on previous work implemented for the validation of Terra/MODIS and GOES Imager fire data. Active fire reference data are derived from 30 m resolution Landsat-class imagery and used to quantify sub-pixel fire activity observed near-coincidently by GOES-R ABI. Summary fire statistics are derived on a per-pixel basis and used to estimate omission and commission (false alarm) errors.

Fire Characterization Data

The active fire characterization data retrieval methods are based primarily on two techniques that use mid- (4 μm) and thermal-infrared (11 μm) data to derive fire size and temperature, and fire radiative power (FRP).
The Dozier [1981] fire size and temperature retriveal is a bi-spectral method and has the following format:

$$L_4 = pB(\lambda_4, T_f) + (1-p)B(\lambda_4, T_b) + (1-\varepsilon_4)\tau_4 L_{4Solar}$$
$$L_{11} = pB(\lambda_{11}, T_f) + (1-p)B(\lambda_{11}, T_b)$$

Where L_4 and L_{11} are the top-of-atmosphere radiance in the 4 and 11 μm channels, p is the pixel fraction occupied by fire, and B is the planck function in channel i, T is the instanteneous temperature for the fire (f) and background (b) components, ε_4 and τ_4 are the 4 μm emissivity and transmittance values, respectively, and L_{4Solar} is the reflected solar radiance.

The fire radiative power is based on the radiance method of Wooster *et al.* [2003&2005] retrieval as has the form:

$$FRP = C \times (L_{MIR} - L_{MIRb}) \times A$$

Where L_{MIR} and L_{MIRb} are the mid-infrared radiances for the fire pixel and the background, C is a constant dependent on the 4 μm channel spectral response, and A is the pixel area.

Fire Reference Data

The fire characterization reference data are derived using the retrieval methods above applied to fine-resolution fire-dedicated airborne and/or spaceborne data. For development and testing purposes, the reference data described here were derived from the NASA/Ames Airborne Modular Sensor-Wildfire (AMS). The instrument has fire-dedicated bands with high saturation temperatures providing a wide dynamic range for imaging of both small and large fire events. The data processed had a nominal spatial resolution of 10m and were acquired sequentially and coincidently with Landsat TM, MODIS aboard Terra and Aqua, AHVRR aboard NOAA-15, 16, 18, 19 and Metop-A, and GOES Imager East/West.

Future Activities

We will continue to work with the available airborne data to develop and further refine the GOES-R ABI *deep-dive* fire characterization validation tool. The tool will be made generic to allow assimilation of a wide range of candidate future reference data sets.

Coordinated Fire Management & Data Sampling

Ground Crews


Rx Fire brigade


Drip-torch fire ignition


Aerial fire ignition

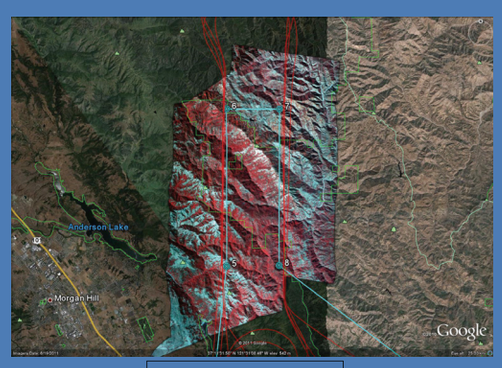
Surface


Fuel Sampling

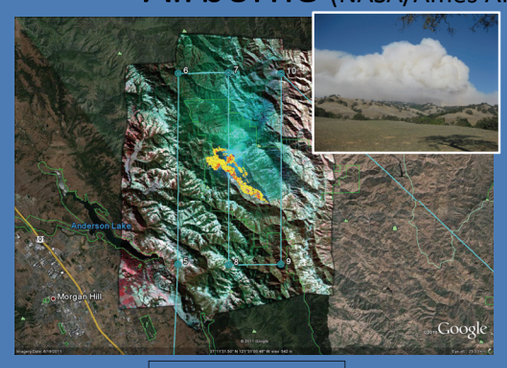

Fire weather


Fire energy

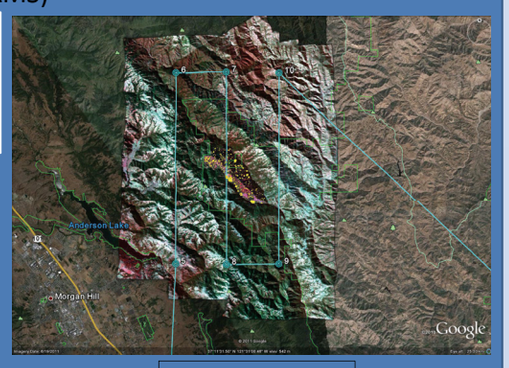
Airborne (NASA/Ames AMS)



Pre-fire



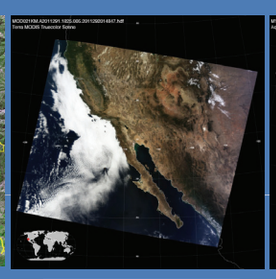
Fire

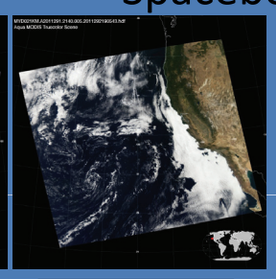


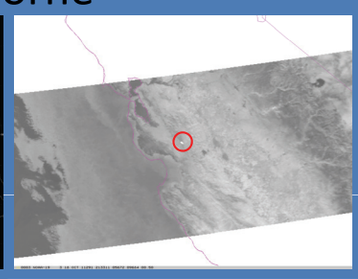
Post-fire

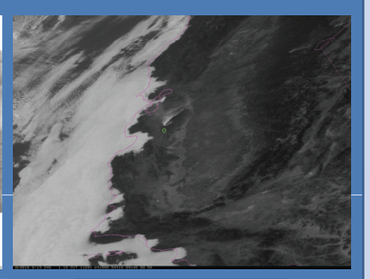
Spaceborne

Landsat TM

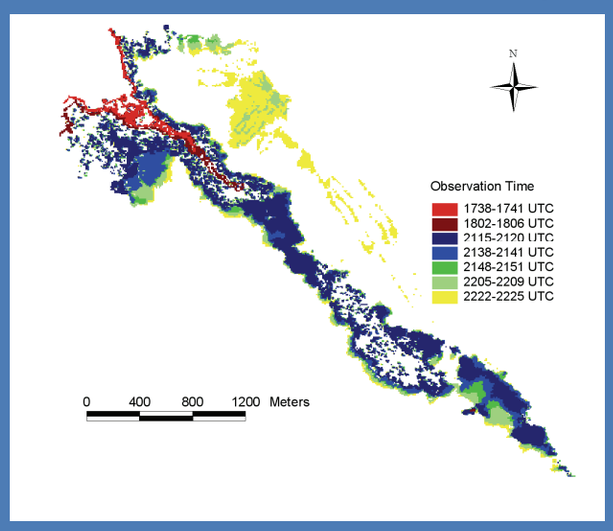

Terra/MODIS

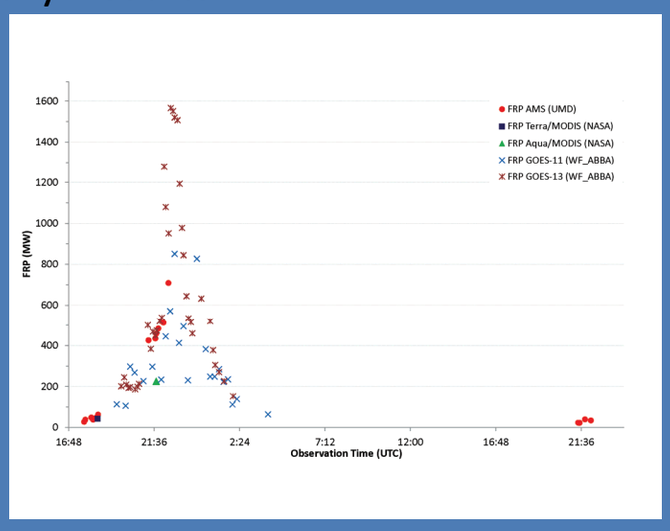

Aqua/MODIS


AVHRR (15-6,18-9, METOP-A


GOES-East/West

Preliminary Results





Fire area (left) and fire radiative power (FRP) progression over time as measured by AMS airborne instrument over the Henry Coe Rx fire in CA, 18 October 2011. Fire area depicts the accumulated active fire (flamming and smoldering components) as fire progressed over terrain and in response to ground/aerial ignition. Satellite FRP retrievals correspond to the total output and may include one or more fire pixels for each observation hour.