EARLY CHARACTERIZATION OF THE ACTIVE FIRE DETECTION PRODUCTS DERIVED FROM THE NEXT GENERATION NPOESS/VIIRS AND GOES-R/ABI INSTRUMENTS

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1. INTRODUCTION

The next generation Visible/Infrared Imager/Radiometer Suite (VIIRS) scheduled to fly aboard the National Polar-Orbiting Operational Environmental Satellite System (NPOESS), and the Advanced Baseline Imager (ABI) scheduled to fly aboard the Geostationary Operational Environmental Satellite-R Series (GOES-R) are expected to provide key active fire detection information to the user community. The VIIRS and ABI active fire products build on the fire algorithms developed for the Moderate Resolution Imaging Spectroradiometer (MODIS) and the GOES imager, respectively. Consequently, proper characterization of product performance and capabilities is essential to guarantee data continuity and enhance the contribution of those programs to Earth science applications. Here we present an overview of the ongoing validation effort aimed to characterize the active fire information derived from geostationary and polar orbiting satellite sensors at regional to global scales. We begin with a brief literature review summarizing some of the recent validation work involving the MODIS and GOES imager fire data, and then we discuss the current validation plan being implemented for VIIRS and GOES-R ABI fire products.

2. BACKGROUND

Natural vegetation fires pose major challenges to those aiming to effectively monitor them using satellite remote sensing data. First, due to their high temporal and spatial variability, with temperatures typically spanning several hundred degrees over relatively small scales, vegetation fires can only be partially documented when using sparsely acquired images. Similarly, to properly validate the fire products derived from spaceborne instruments near simultaneous acquisition of reference data is required. Secondly, due to the typical spatial domain of fire fronts, and thanks to their unique radiometric signature which shows a strong peak around the middle infrared part of the spectrum, only a small actively burning fraction of a moderate-to-coarse resolution pixel is required to produce a high confidence detection. Taking those factors into consideration, Morisette *et al*. (2005) used 30-m resolution Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) data to validate sub-pixel fire activity coincidently imaged by MODIS *Thermal Anomalies* product (MOD14) over Southern Africa [1]. That study was followed by others who also took advantage of coincident ASTER imagery to assess the fire detection performance of MOD14 over different geographic areas [2, 3]. In order to evaluate the impact of short-term variations in fire behavior on the validation of moderate-to-coarse spatial resolution satellite data, Csiszar and Schroeder (2008) used Landsat Enhanced Thematic Mapper Plus (ETM+) and ASTER imagery observing the same area 30 minutes apart to assess coincident MOD14 fire data over Amazonia [4]. Using the results from that study, a 15-min tolerance window was applied in two studies aimed to validate GOES Wildfire Automated Biomass Burning (WF_ABBA) algorithm using near-coincident Landsat and ASTER data over North and South America [3, 5]. The above mentioned studies provided several metrics describing the performance of MODIS and GOES fire products, spanning different fire regimes and observation conditions. As a result of the gradual increase in size of the reference data set used to assess the MOD14 fire algorithm, achievement of stage III validation status was possible (see [6] for details about the different validation stages).

3. NPOESS/VIIRS ACTIVE FIRE DETECTION PRODUCT

The active fire detection algorithm being developed for the VIIRS instrument is conceptually similar to the *Thermal Anomalies* product of MODIS. The improved spatial resolution of VIIRS is expected to result in higher probability of detection for relatively small fires compared to MODIS. However, VIIRS sensor characteristics could negatively impact the retrieval of fire information from that instrument. Namely, the lower saturation of the middle infrared band (M13) which will be used for fire detection could impair the characterization of fires currently possible with MODIS. Similarly, the proposed pixel aggregation scheme aimed to minimize along scan image distortion may also negatively impact the performance of the active fire detection algorithm by inadvertently mixing saturated and un-saturated fire pixels.

Because no Landsat-class sensor is expected to fly near coincidently with VIIRS, alternative approaches are being pursued to enable a full characterization of the proposed active fire product. These include the use of coincident airborne remote sensing instruments and data simulation. Collaboration with NASA Ames Research Center and the United State Forest Service has been initiated and airborne data collection is under way. By incorporating specific VIIRS spectral bands, the selected airborne instruments will provide high fidelity data allowing convenient mapping of sub-pixel active fires. Implementation of extensive airborne missions and field campaigns can, however, become cost prohibitive. Consequently, data simulation using ASTER data is being developed in order to add greater flexibility to the validation analyses.

The use of airborne reference data and data simulation should enable achievement of validation stages I and II where major product issues are identified and documented. However, due to the lack of a coincident global reference data set mirroring ASTER/MODIS, achievement of stage III validation status for the VIIRS active fire product is not recognized as a viable option in the foreseeable future.

4. GOES-R/ABI ACTIVE FIRE DETECTION PRODUCT

The future GOES-R ABI fire detection and characterization algorithm builds on the GOES WF_ABBA fire product. That algorithm has achieved operational status at NOAA/NESDIS generating routine fire information from the GOES imager data for the western hemisphere. Recent revitalization of the WF_ABBA algorithm (version 6.5) included a much improved metadata file and a new fire characterization parameter (fire radiative power). Although running operationally for several years, the WF_ABBA algorithm has been the topic of a limited number of validation studies. Thanks to the high observation frequency and continental coverage of geostationary satellites, the opportunities for coincident acquisition of reference data sets are greatly improved. However, the unstable image navigation of the GOES imager data represents a major obstacle as a result of the high costs associated with labor-intensive image registration. With improved spatial and temporal resolution and reduced navigation errors, the GOES-R ABI fire data should provide great opportunities for comprehensive validation studies. The validation methodology being proposed for ABI's fire product builds on the approach designed for the GOES imager and utilizes higher resolution near-simultaneous spaceborne remote sensing data. Pre-launch assessment of the simulated ABI fire product is under development using ASTER reference data to characterize algorithm performance (Figure 1).

5. FINAL REMARKS

The protocols for validation of the active fire detection products to be derived from the VIIRS and ABI instruments are currently being developed. Reference data sets to characterize those two products will be derived primarily from near-coincident higher spatial resolution airborne and spaceborne data mirroring the methods developed to validate the MODIS *Thermal Anomalies* and the GOES imager WF_ABBA products. This pre-launch period is being dedicated to the analyses of the new fire products using proxy data that simulates sensor characteristics. Investigation of critical data characteristics such as pixel saturation levels and spatial resolution suggest that while the size of minimum detectable fire may be reduced, fire characterization may be impaired for a relatively larger percentage of fire pixels compared to current instruments.

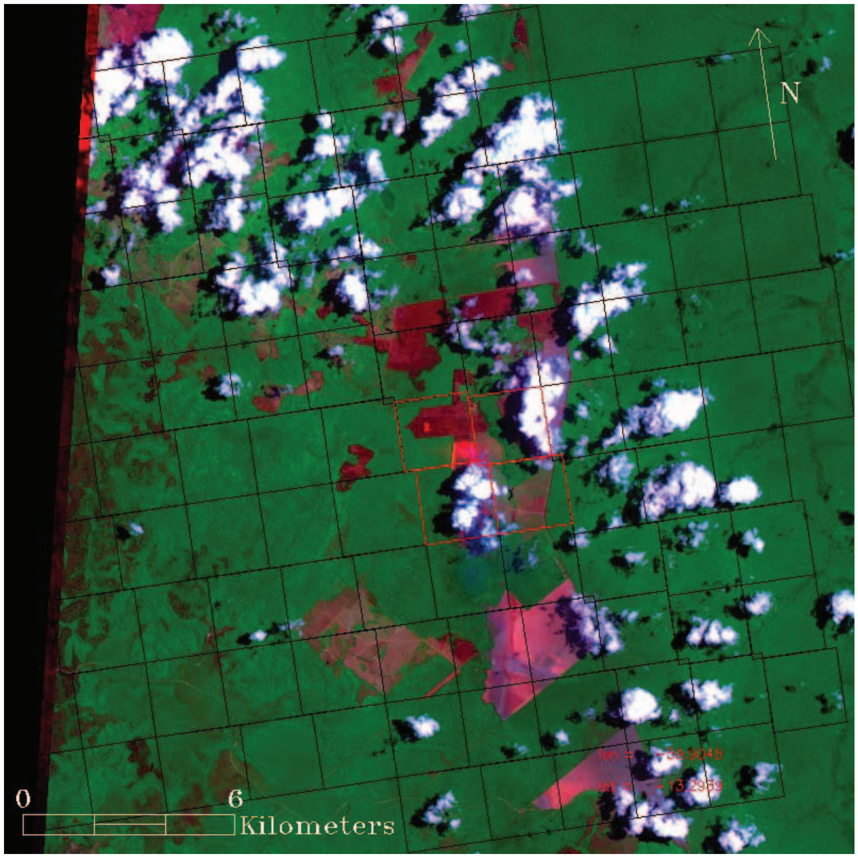

Figure 1: GOES-R ABI active fire detection simulation data overlaid on ASTER RGB composite (bands 8-3-1). The ABI fire product was generated using proxy data derived from MODIS L1B radiance data acquired coincidently with the ASTER scene on 19 October 2002 at 14:21:29 UTC. The grid shown depicts the ABI pixels nominal pixels. Active fire line appears in bright red tone in the ASTER scene; green is vegetation, white is clouds. ABI fire pixels are marked in red. The "x" indicates the image center point for which the latitude/longitude values are shown.

6. REFERENCES

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