A REAL-TIME BURN SCAR MAPPING TECHNIQUE UTILIZING MODIS DIRECT-BROADCAST DATA: A VALIDATION ACROSS UNITED STATES FUEL TYPES

J. Meghan Salmon, Wei Min Hao, and Bryce Nordgren
USDA Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory

The fire chemistry project at the Missoula Fire Sciences Laboratory manages a Direct-Broadcast (db) system to receive data from the MODerate resolution Imaging Spectroradiometer (MODIS) sensors onboard NASA's Terra and Aqua satellites. This data is used to monitor actively burning fires throughout western North America. Work is in progress to automate the prediction of these fires' effect on air quality. An important element of this work is the quantification and spatial mapping of burned area. Here, we present our technique combining active fire location information with a spectral test in the near infrared. We also include results from our validation work performed on this method for fires spanning a variety of Eastern and Western United States Fuel Types.

1. INTRODUCTION

The role of wildland fires in forcing climate can be understood only once the emissions from such fires have been quantified. With this goal, we are developing a near real-time smoke and air quality forecasting system at the Missoula Fire Sciences Laboratory. This system relies primarily upon MODIS fire occurrence observations, Farsite fire growth predictions, and WRF-Chem air quality forecasts.

The wildland fire emissions are estimated from MODIS observations and Farsite fire growth model predictions. Current burned area is mapped from the MODIS data, and used to calibrate the Farsite model to the current fire perimeter. Then, running the Farsite model yields predictions of fuel consumed hourly. This is combined with our in-house emission factor database, compiled from many field campaigns, to produce total emission estimates, separated by major constituents.

2. BACKGROUND

Many burn scar detection algorithms rely upon temporal change metrics. Because the Terra and Aqua satellites have a sixteen-day repeat cycle, applying these methods to MODIS data is likely to result in either delayed or less spatially precise observations. We began our investigation into mapping burned areas in real-time using single-scene metrics by utilizing the active fire (MOD14 Thermal Anomalies) product. Although active fire pixel centers correspond highly with perimeter growth, the information yielded concerns only the active fire location at the moment of satellite observation. This results in unmapped burned areas when the fire moves quickly between satellite overpasses.

3. METHODS

Li et al (2004) developed a burn scar mapping algorithm tailored to meet the requirements outlined above (real-time for db stations, and responding to the unique spectral signature associated with recently burned vegetation). This algorithm utilizes the near- and mid-infrared bands, and thus the burn scar can be mapped at 500m resolution. The main component of the algorithm is a ratio between the reflectances in the 1.2 mm and 2.1 mm bands, as illustrated in Equation One below.

$$\frac{(\rho_{1.2\,\mu\mathrm{m}}\ ?\ 0.05)}{\rho_{2.1\,\mu\mathrm{m}}} \le [0.8, 1.0]$$

In the preliminary validation, focusing on fires in the U. S., Canada, and Australia, the threshold was found to be effective at discriminating burn from non-burn when set anywhere within the range [0.8, 1.0]. This allows those implementing the algorithm to choose either a high or low threshold, based upon the relative costs of false alarms versus errors of omission for their application. For our purposes, we selected the conservative threshold of 0.8. The algorithm also includes several additional spectral tests designed to remove false alarms from sun glint, clouds, and cloud shadows.

We found, however, that the algorithm described above produces a relatively high incidence of false alarms when run operationally on all the MODIS data retrieved with the db station. Therefore, we added a filtering component based on the Land/Sea Mask in the Geolocation Fields product, mimicking the Thermal Anomalies algorithm. We also added a spatial test that verifies polygons of agglomerated detection pixels from above by checking for spatial and temporal nearness with an active fire detection. The agglomeration is done using a non-convex hull algorithm known as alpha shapes.

We have validated our modified version of the burn scar mapping algorithm on several major fires in the U. S. and Canada. The ground truth data used were Forest Service (USDA and Canadian) and Bureau of Land Management perimeters, usually mapped by a combination nighttime aerial infrared imaging and daytime foot patrol. The results demonstrate the algorithm's effectiveness for accurate real-time burn scar mapping based on MODIS db data.

4. REFERENCES

Li, R.-R., Y. J. Kaufman, W. M. Hao, J. M. Salmon, and B. C. Gao, 2004: A Technique for Detecting Burn Scars Using MODIS Data. IEEE Transactions on Geoscience and Remote Sensing, **42**, **6**, 1300-1308.

5. AUTHOR BIOGRAPHY

Meghan has a B. S. in Imaging Science from Rochester Institute of Technology and a Master's degree in Geography from the University of Maryland, College Park. She now lives in Missoula, MT and works with the Fire Chemistry project at the Fire Sciences Laboratory. Her work there focuses on computer programming and didgital image processing to support the automated smoke forecasting system.