NEAR-REAL TIME ACTIVE FIRE MAPPING OVER ASIA USING AQUA/TERRA MODIS

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ABSTRACT

This research focuses on the near-real time network based active fire mapping and alert system over Asia using MODIS onboard Aqua and Terra satellite. Firstly, the algorithm used for fire mapping is described that is basically improved on the heritage of AVHRR using 4- and 11-μ m thermal channels. Secondly, our fire product is described that is mainly composed of fire mask along with latitude and longitude tables. Thirdly, our current status of fire product production is presented and the way to obtain them through FTP or HTTP is described. Finally, some caveats to bear in mind when using our fire product and our future works are described for the refinement of our algorithm.

1 INTRODUCTION

1.1 Needs for better information

According to WRI, frontier forests are forests that are relatively undisturbed and big enough to maintain all of their biodiversity, including viable populations of the wide-ranging species associated with each forest type (WRI, 2005). In Asian forests, wildfire is a natural and fundamental disturbance regime essential in controlling many ecosystem processes, helping to shape landscape structure, improve the availability of soil nutrients, and initiate natural cycles of plant succession. The number of human-caused fires, however, greatly exceeds naturally occurring fires (UNDP, 2001).

Since a lot of forest fires take place in hardly accessible areas, remote sensing seems to be the most appropriate tool to monitor forests. Several techniques have been developed to detect and map fire growth by using multi-spectral analysis of remote sensing data. High spatial resolution data such as Landsat TM, SPOT HRV and Terra ASTER have been used to get the surface information of fire damaged area by using principal component analysis, change vector analysis and NDVI classification (Garcia-Haro *et al.*, 2001). However, they may not cover an target area frequently because of their narrow swath width. Another objection to monitoring the fire with high resolution data is cost and logistics of handling the data volume. Monitoring the growth mapping would require to use wide coverage data, such as from NOAA AVHRR or Terra MODIS.

1.2 Objective of this research

This research focuses on the near-real time network based active fire mapping and alert system over Asia using MODIS onboard Aqua and Terra satellite. Firstly, the algorithm used for fire mapping is described. Secondly, our fire product is described. Thirdly, our current status of fire product production is presented and the way to obtain them through FTP or HTTP is described. Finally, some caveats to bear in mind when using our fire product and our future works are described for the refinement of our algorithm.

2 METHODOLOGY

Our active fire mapping algorithm basically followed the approach proposed by (Giglio *et al.*, 2003) and is the improved detection algorithm developed for AVHRR (Kaufman *et al.*, 1997). Our fire product is denoted as MOD14 following the NASA/MODLAND teams product naming. It uses brightness temperatures derived from the MODIS 4-and 11-μ m channels, denoted by T22 and T31, respectively. The MODIS instrument has two 4-μ m channels, numbered 21 and 22, both of which are used by the detection algorithm. Channel 21 saturates at nearly 500 K; channel 22 saturates at 331 K. Since the low-saturation channel (22) is less noisy and has a smaller quantization error, T22 is derived from this channel whenever possible. However, when channel 22 saturates or has missing data, it is replaced with the high saturation channel to derive T22. T31 is computed from the 11-μm channel (channel 31), which saturates at approximately 400 K for the Terra MODIS and 340 K for the Aqua MODIS. The 12-μ m channel (channel 32) is used for cloud masking; brightness temperatures for this channel are denoted by T12.

3 RESULTS

3.1 Fire product description

The fire mask is the principle component of the Level 2 MODIS fire product, and is stored as an 8bit unsigned integer Scientific Data Set (SDS) named 'Fire _Map' in 1 km resolution along with latitude and longitude grid tables in 5 km resolution. In it, individual 1-km pixels are assigned one of nine classes. The meaning of each class is listed in Table 1.

Table 1. Legend and id used in MODIS fire map product

id	legend
3	water
4	cloud
5	non-fire clear land
7	low-confidence fire (0-30%)
8	nominal-confidence fire (30-70%)
9	high-confidence fire (70-100%)

We have stored many of the product-specific metadata fields of each fire pixel in simple ascii text file; Latitude, Longitude, R2 reflectance, T22 (K), T31 (K) and confidence value. A detection confidence intended to help users gauge the quality of individual fire pixels. This confidence estimate, which ranges between 0% and 100%, is used to assign one of the three fire classes (low-confidence fire, nominal-confidence fire, or highconfidence fire) to all fire pixels within the fire mask. An example of a metadata is shown below;

20050705.FIRE.txt

```
 # LAT(deg.)  LON(deg.)  REF2(%) T22(K) T31(K) CONFIDENCE(%)
31.979397 117.255943 0.265969 320.278168 295.943878 57
31.939053 117.259239 0.270117 322.583588 293.936523 73
31.936943 117.271469 0.271943 328.083862 296.270966 90
31.835857 117.318924 0.251624 321.923523 294.569916 27
31.476776 118.412544 0.270130 313.733917 294.438507 55
29.819904 112.897804 0.246956 315.107361 293.052795 26
...
```

3.2 Obtaining fire products

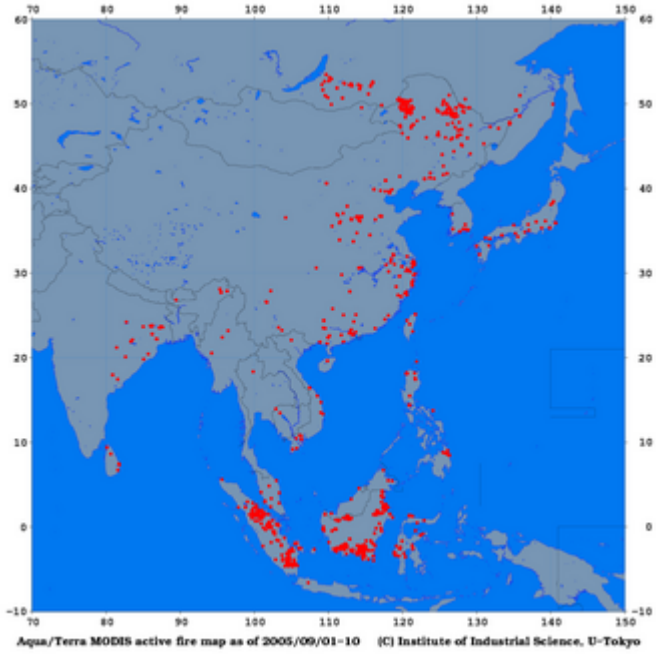
The are are mainly two ways to obtain our MODIS fire products; Anonymous FTP at WebMODIS [1] or SORST/IIS website [2]. Currently fire product in hdf format is available at WebMODIS FTP site during 2003 Jan - 2004 Dec over AIT coverage (4514 scenes). The data volume one scene is approximately 6 MB including fire map in 1 km, latitude and longitude tables in 5 km. Daily based fire pixels metadata fields in the above mentioned ascii format, fire maps in png format, quicklooks in reflective channels and thermal anomalies in jpeg format are available at SORST/IIS website as shown in Figure 1 during 2005 May - 2005 Jul.

4 DISCUSSIONS AND CONCLUSIONS

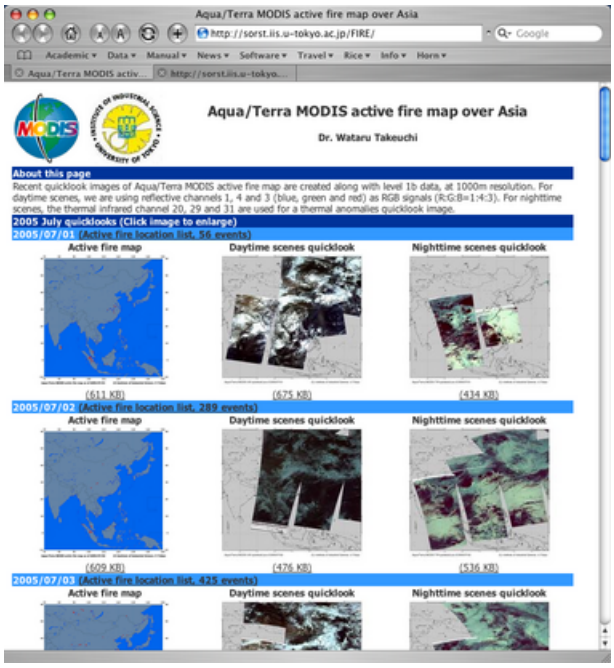
In this research the near-real time online active fire over Asia have been setup using MODIS data. There are some caveats to bear in mind when using the above mentioned MODIS fire products;

- The active fires observed with the MODIS instrument are generally very much smaller than the individual 1 km MODIS pixels; it is usually incorrect to assume that the instantaneous fire area is that of the entire pixel.
- Only fires actively burning at the time of the satellite overpass can be detected.
- Algorithm performance depends upon many variables including fire size and temperature, viewing geometry, biome, season, time of day, and properties of accompanying smoke.
- Gas glares and active volcanoes are routinely detected as thermal anomalies in addition to vegetation fires.

[1] Anonumous FTP at `ftp://webmodis.iis.u-tokyo.ac.jp/{AIT,IIS}/FIRE/`
[2] SORST/IIS website at `http://sorst.iis.u-tokyo.ac.jp/FIRE/`



(a) 2005 September 1st - 10th active fire map



(b) SORST/IIS website

Figure 1. Daily based fire pixels metadata fields in ascii format, fire maps in png format, quicklooks in reflective channels and thermal anomalies in jpeg format available at `http://sorst.iis.u-tokyo.ac.jp/FIRE/`.

The assessment of thematic accuracy of fire map products and data sets derived from processing of remote sensing data has a long way to go because of it few scientific consensus. In order to overcome that problem, the validation efforts should represents a difficult logistics challenge. Since the derived fire map created in this study distributes over large area, a considerable number of scientist or their information on the local land use will be indispensable to get the better scientific consensus. Only through discussion between the intimately familiar with operational organizational needs and those with considerable background in land cover characterization strategies and capabilities, can acceptable levels of accuracy of results be achieved. All of this leads to the conclusion that we still have much to do in this study. We must continue to study hard toward and the routine or operational development of wildfire maping over Asia and there are still many lessons to be learned and problems to be solved.

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