Development of Long Term Inventory of Fire Burned Areas and Emissions of North America's Boreal and Temperate Forests

Project Report (April 2001 – March 2002)

By

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Abstract

The primary objective of this research is to test and improve an algorithm capable of detecting fires using all historical AVHRR satellite data in the 80s and 90s and to map burnt areas in North America's temperate forests and to estimate their emissions. During the past year, the project team held two face-to-face meetings at Berkeley and in Washington DC. Research coordination has been maintained through frequent email communication and teleconferencing. Data sharing and algorithm sharing have been smoothly done. In December, the program manager and chief scientist for the NASA land cover land use change program visited the Berkeley group and made a number of constructive comments. The project team are aware of the comments and are considering the suggestions as the project progresses. NOAA AVHRR data acquisition has been effectively coordinated by Ivan Csiszar at NOAA/NESDIS and Zhanqing Li's group at UMD and CCRS. Data transfer from NOAA has no problem in meeting the production needs. Algorithm development has been lead by Zhanqing Li and the CCRS group with participation from Berkeley. Algorithm validation has been carried out by all four groups with CCRS responsible for Canada, Wei Min Hao responsible for the US with the participation of Berkeley for algorithm development and testing for California. A fire emission model is being built by Wei Min Hao's group and fire emission factors compilation and data collection has been progressing well.

The algorithm developed at the CCRS (Li et al. 2000a) was selected to fulfil the task of fire detection, pending successful evaluation. The algorithm was initially designed for application in Canada with NOAA-14 AVHRR data. Its ability to correctly identify fires with other AVHRR sensors over the entire North America is tested. Since the project started last summer, we have tested its performance using NOAA-14 and NOAA-11 in Canada, and NOAA-14 in US. Performance was evaluated with regard to the ability to detect active fire pixels accurately and the frequency of false fires and/or missing actual fires.

Georeferencing capability for the entire US and Canada has been established at Berkeley with over one thousand ground control points densely distributed in the US with a plan to add more points to Canada. Provided cloud is not primarily dominating on an entire scene, georeferencing accuracy can be controlled under 1000 m. The fire seasons of 1999 and 1996 have been processed for both US and Canada at Berkeley. Additional processing power will be added at Berkeley early in Year II of this project.

Keywords (could not link to the keyword page currently with the address given by Dr. Gutman)

1) Research Fields: Fire Mapping
2) Geographic area/biome: North America, Temperate forests
3) Remote sensing: NOAA AVHRR, Landsat TM
4) Methods: Temporal analysis, spatial context analysis

Questions, goals, approaches:

This project addresses the first question of the NASA ESE scientific questions: a) what are the changes in land cover and/or land use (monitoring/mapping activities).

The proportion of Social Science used in this study is 0%

Identify the proportion of the themes: 90% GOFC, 10% Carbon

The goals for 2001-2002 were

1) **to further process the AVHRR data, assess the capabilities of the CCRS fire detection algorithm and ;**
2) **to make modifications at University of Maryland and Berkeley.**
3) **to validate fire detection at the Fire Science Lab in Montana for which a separate report will be supplied by Dr. Wei-Min Hao.**
4) **To develop fire emission algorithms. This is being developed at the Fire Science Lab and a GIS module based on FOFEM was completed at Berkeley. Once the fire maps over the past 10-15 years are completed (anticipated to be December 2002), fire emissions will be estimated.**

The following are some concrete progresses made during this report period.

Transfer 1985-1992 historical data to Berkeley.

The entire data record from 1988 to 1999 has now been transferred to Berkeley. The data for summer 1994, where on-line data were not available, were obtained from CCRS. Data for the 1985-88 period, the other data gap in the SAA online archive, were obtained from NCDC and their transfer to Berkeley is underway.

AVHRR Data Geocoding and Composting

Since the installation of the GeoComp-n that is used for NOAA/AVHRR data geocoding and composting in December, 2000, we have expanded the chip database. Now we have a total of 1042 chips (288 coming with Geocomp, 754 added to it) in the chip database. The additional chips (754) all cover US, made by orthoTM images (TM4, 1000 m resolution). The preliminary tested result by running Geocomp with the expanded chip database indicates that some missing orbits now can be geocoded because the Geocomp collected more chips and the accuracy of geocoding AVHRR data is still less than one pixel (< 1000 m).

Using the Geocomp-n with the expanded chip database, by April 30, 2002, we have processed NOAA/AVHRR (geocoded and composited) daily products, covering the North America (NA) as follows:
1999, May-Oct
1998, May-Oct;
1997, May-Oct;
1996, Jan-Dec;

1995, May-Oct;
1994, May-Sep 13 (CEOS format);
1993, May-Oct;
1992, May-Oct;
1991, May-Oct;
1990, May-Oct;
1989, May-Oct;
1988, Aug-Sep

Those Geocomp products have been backed up on the DLT tapes for daily hotspot detection and burned scar mapping later on. Based on the current processing rate on one machine, if uniform data sources (NOAA/AVHRR) are available, we can process approximately 7 - 8 months daily data per month.

Running Hotspot Detection and Burned Scar Mapping Algorithms

To produce the final fire products, we need to generate daily fire masks first. We have gotten and tested a new version of hotspot detection algorithm and HANDS algorithm of burned scar mapping from CCRS for daily hotspot detection and monthly and yearly burned scar mapping, respectively. We have produced daily hotspot masks 1990-1999 10 year period for NA as follows:

1999, May-Oct
1998, May-Oct;
1997, May-Oct;
1996, Jan-Dec;
1995, May-Oct;
1994, May-Sep 13;
1993, May-Oct;
1992, May-Oct;
1991, May-Oct;
1990, May-Oct;

and obtained monthly and yearly hotspot composites with those daily hotspot masks. We have also done May through Oct, 1996 monthly and a 6-month burned scar mapping for that year. The results of hotspot detection and burned scar mapping of 1996 are being validated by the fire science lab.

Problems

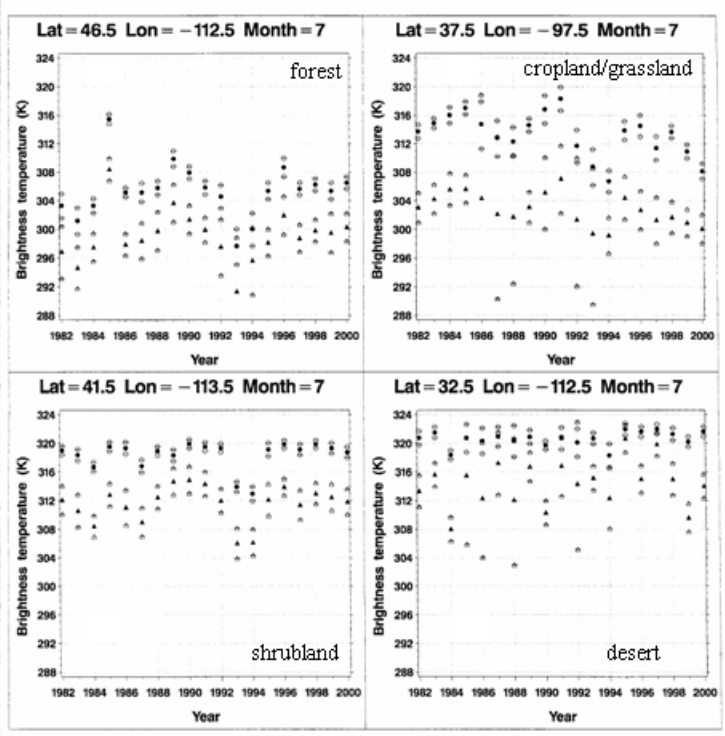
During the processing of daily AVHRR data of NA with Geocomp, we found that most of the winter and spring AVHRR data of NA could not be geocoded because of weather (too much cloud). We found almost no single-day data have been geocoded and composited covering the entire North America in the winter of 1996. For the entire US only a few daily data can be geocoded because of cloud, but almost no winter data can be geocoded for Canada (almost every day is cloudy). So it seems problematic for us to use winter and early spring data to do hotspot detection and burn scar mapping, even for

southern US as in Florida. For NOAA-9/AVHRR data before 1989, we found that even though the data were acquired in the summer, the daily geo-composited results seem to have incomplete data as most daily composites are not covering the entire NA. This may be caused by two reasons: One is the quality of the images due to the problem of radiance calibration; second, we suspect that the orbit parameters cannot be handled well by Geocomp.

Cooperate with CCRS and Forest Service in algorithm development and validation NOAA-9, -8 and -6 satellites.

Data from the early period of the AVHRR record were analyzed, with special respect to the separability of fire and false hotspot signal over non-forested areas of North America. Time series of monthly mean mid- and thermal infrared AVHRR brightness temperatures were processed over target areas of various biomes (Fig 1). Favorable/unfavorable conditions as a function of surface type, the sampling time of the diurnal temperature cycle as well as meteorological effects were analyzed. Changing sun-glint conditions with satellite orbital drift were also identified as potential sources of error in log-term time series.

Changes in background conditions



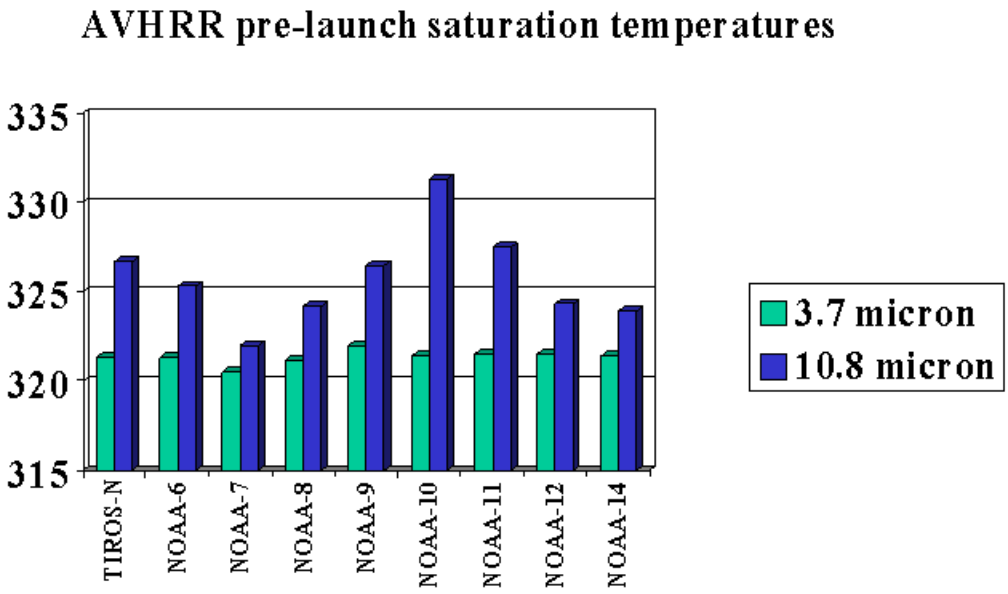
From Pathfinder Atmosphere 1°x 1° clear-sky radiances (AVHRR/GAC)

●: T3 ± std.
△: T4 ± std.

Csiszar, I. et al., Interannual changes of active fire detectability from long-term records of the Advanced Very High Resolution Radiometer. JGR, accepted.

The radiometric characteristics of the mid-infrared AVHRR channels on various NOAA satellites were also analyzed. Pre-launch saturation temperatures were re-calculated from laboratory calibration data (Fig. 2) and were compared to empirical post-launch data. The results indicate that the inter-satellite variability, as well as the degradation of sensor

sensitivity, remains in a small enough range to be ignored in inter-satellite fire detection algorithm tuning.



Csiszar, I. and J. Sullivan, On the saturation temperatures of the 3.7 μm sensors of the Advanced Very High Resolution Radiometer (AVHRR) on board the TIROS-N to NOAA–14 satellites. Submitted to Remote Sensing Letters.

Participate in writing publications.

Conference presentation:

Csiszar. I., A. A. Abuelgasim, R. Fraser, Z. Li, J. Jin, W.-M. Hao, P. Gong, R. Pu Algorithm Issues Related to the Development of a Long-Term Inventory of Active Fires Over North America From NOAA/AVHRR Data. **American Geophysical Union Spring Meeting**, Boston, MA (poster).

Papers accepted for publication:

Csiszar, I., A. Abdelgadir, Z. Li, J. Jin, R. Fraser and W.-M. Hao, Interannual changes of active fire detectability in North America from long-term records of the Advanced Very High Resolution Radiometer. **Journal of Geophysical Research**, accepted.

Li, Z., R. Fraser, J. Jin, A.A. Abuelgasim, I. Csiszar, P. Gong and W.-M. Hao, Evaluation of satellite-based algorithms for fire detection and mapping within North America. **Journal of Geophysical Research,** accepted.

Paper under review:

Csiszar, I. and J. Sullivan, Recalculated pre-launch saturation temperatures of the AVHRR 3.7 μm sensors on board the TIROS-N to NOAA–14 satellites. Submitted to **Remote Sensing Letters.**

Gong, P., R. Pu, Z.Q. Li, An integrated approach to burned area mapping in California with NOAA AVHRR data, submitted to *International Journal of Remote Sensing*.

Pu, R., P. Gong, Z.Q. Li, J. Scarborough, A dynamic algorithm for wild land burned scar detection using NOAA AVHRR data, submitted to *International Journal of Wildland Fire*.

Pu, R., P. Gong, Z.Q. Li, **Prediction of Burned Scars Using Logistic Regression and Neural Network Techniques from a Single Post-Fire Landsat-7 TM Imagery, ready for submission**