Remotely Sensed Measurements of Air Quality Emissions in the Contiguous United States

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Introduction and Aim

Crop residue burning is an important land use practice in the U.S. On average 12% of all fires detected by MODIS in the contiguous U.S. are agricultural fires (McCarty *et al*., 2007). These fires are a source of trace gas and particulate emissions and affect local and regional air quality. This research seeks to estimate the seasonal and temporal distribution of emissions released from cropland burning in the contiguous U.S., using satellite and ground based observations. These estimates will support the improvement of the EPA's National Emissions Inventory. MODIS AOT (aerosol optical thickness) and AERONET data will be used to investigate the associated impacts on air quality. Here we present as a case study the Mississippi River Valley region, an area of intense cropland burning.

Methods

1.Satellite data

The following suite of satellite datasets is used in this study:

(a) The MODIS Active Fires and Thermal Anomalies product (MOD14) for both Terra (morning overpass) and Aqua (early afternoon overpass) is used to study seasonal and diurnal patterns of agricultural fire activity. The MOD14 product is generated using the latest and improved MODIS version 4 active fire detection algorithm (Giglio *et al*., 2003).

(b) A burned area for croplands is developed by combining MODIS 8-day difference Normalized Burn Ratio (dNBR) images with the MOD14 Active Fire product. The δNBR algorithms utilize the ~2.2μm MIR band to discriminate burned areas. MOD14 data is compared with the high spatial resolution ASTER data in order to quantify an average burned area associated with the active fire detections.

(c) The experimental 1km MODIS AOT (Aerosol Optical Thickness) product, developed by Dr. Eric Vermote at the University of Maryland, is used to examine whether and how agricultural burning impacts the AOT signal. The 1km MODIS AOT product is produced similar to the operational MODIS Aerosol Product (Levy *et al*., 2007) but at a higher resolution and is calibrated using the QA (Quality Assurance) bits.

2. Field Work

Last year field work was conducted in Arkansas, Idaho and Washington (see pictures below). Several data were collected including: GPS polygons of burned fields, GPS polygons of plowed fields, GPS points of crop type, and regional statistics of residue left on fields after the harvest (equal to fuel load). In collaboration with the Kansas Department of Health and Environment (KDHE) field work is planned in Kansas for the upcoming wheat harvest season in early September.

Picture 1. Wheat residue fire outside of Stuttgart, Arkansas (June 2006).

Picture 2. Co-I Jessica McCarty and Dr. Steve Van Vleet (WSU) investigating an illegal wheat fire in Garfield County, Washington (August 2006).

Results

1. Agricultural Fire Distribution

Application of crop residue burning in this region during the spring is concentrated mainly in Arkansas along the Mississippi river, whereas during the fall harvest, burning also intensifies in the neighboring states along the river (Fig.1) (Korontzi *et al*., in press).

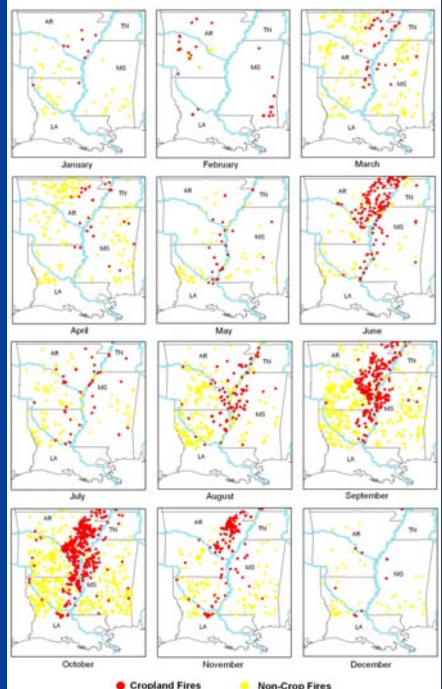

Figure 1. Monthly spatial distribution of cropland and non-cropland fires detected by MODIS Terra and Aqua in the study region in 2003.

Agricultural fire activity showed two seasonal peaks: the first, smaller peak, occurring in June during the spring harvesting of wheat, and the second, bigger peak, in October during the fall harvesting of rice and soy (Fig.2). During the high burning season the majority of agricultural burning occurs during a few days rather than throughout the month (Fig. 3).

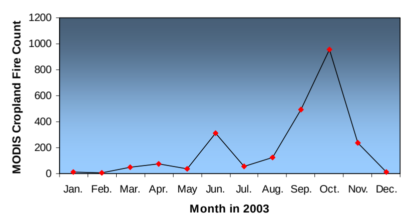

Figure 2. Seasonal distribution of agricultural fires detected by MODIS Terra and Aqua in the study region in 2003.

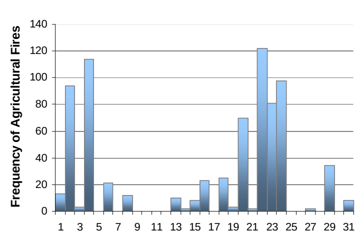

Figure 3. Daily time series of agricultural fires detected by MODIS Aqua in the study region in 2003.

2. Burned Area Mapping

The MODIS δNBR-based area shows a high accuracy with both the ASTER (R^2 = 0.92) and field data (mean accuracy 85%). Additionally, the estimated amounts of burned area compare well with the Arkansas State statistics of crop production in 2003.

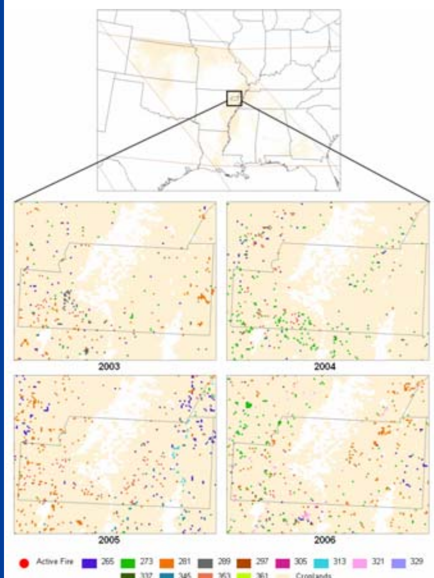

Figure 4. 8-day time series of burned area in croplands in Craighead County, Arkansas for the fall harvesting period (days in Julian dates).

3. Particulate Emissions From Agricultural Burning

A day with significant agricultural fire activity is compared with a day with no burning activity in October 2003 (Figure 3). Pollution originating from these agricultural fires is clearly evident in the MODIS Aqua AOT data.

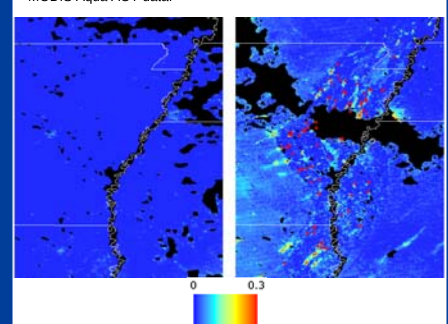

Figure 5. Left: MODIS Aqua 1- km AOT for October 14, 2003 (no agricultural burning), right: MODIS Aqua 1- km data for October 02, 2003 (significant agricultural burning present). Red circles are the MODIS Aqua fire detections that day.

Impacts

This proposed research will provide significant contributions to the goals of the Air Quality program by providing spatially and temporally explicit emission data from cropland burning. This study will improve our understanding of the impacts of agricultural burning on air quality. In addition, this research could be used as a prototype for an operational system to monitor agricultural burning, fire management practices, and associated air quality. The results of this study can be used in support of developing informed legislative measures to mitigate air pollution from agriculture in the United States.

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