Using Satellite-based Products to Enhance Existing Area Burned Data and the Biomass Emissions Inventory

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Abstract

Although **biomass burning (**wildfire, prescribed burning and agricultural burning) **is a major contributor of particulate matter and other pollutants to the atmosphere**, it is **one of the most poorly documented of all sources**. Biomass burning can be a **significant contributor to the problem of regional haze and a regions inability to achieve the National Ambient Air Quality Standards for PM 2.5 and ozone, particularly on the 20% worst air quality days**. It is also a **significant contributor to the production of greenhouse gases, such as carbon dioxide, carbon monoxide, and methane, which directly contribute to global warming**.

Currently, the United States does not have a standard methodology to track fire occurrence or area burned, which are necessary components to estimating fire emissions. One problem is the ownership and management of the land belongs to multiple organizations and private individuals, so there is not one organization that is responsible for thoroughly monitoring fire, each having different goals and data acquisition methods. Satellite imagery provides the opportunity to remotely sense fire across boundaries.

In this poster, we begin to define the ability of satellite-based fire products to detect active fires in an effort to enhance existing area burned databases and emissions estimates. Two satellite-based fire products are temporally and spatially compared to Florida ground-based fire data from 2002.

If we don't assume the ground-based data are 'ultimate truth', we easily find fires that are not identified in the ground fire database. We show 2 examples from Florida, where satellite-derived data have detected fires that are not recorded in the ground data. We suggest that satellite data could be used to augment existing fire databases and enhance emissions estimates.

Potential Customers for this Satellite-based fire product.

The Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards (OAQPS); the Central Regional Air Planning Association (CENRAP); the Midwest Regional Planning Organization (Midwest RPO); the Mid-Atlantic and Northeast Visibility Union (MANE-VU); the Visibility Improvement State and Tribal Association of the Southeast (VISTAS); the Western Regional Air Partnership (WRAP); the National Park Service; the U.S. Fish and Wildlife Service; and the U.S. Forest Service

Methods

Two satellite based fire products, the Geostationary Operational Environmental Satellite (GOES) Automated Biomass Burning Algorithm (ABBA) and the Moderate Resolution Imaging Spectroradiometer (MODIS) thermal anomaly data, are compared to **Florida** ground fire databases from **May 1, 2002 through August 30, 2002**. Both of these data products have demonstrated their ability to detect biomass burning in numerous ecosystems.

Two satellite products are analyzed to take advantage of the unique temporal resolution of GOES (15 minute data, 16 km^2 nadir resolution) and the unique spatial resolution of MODIS (twice daily, 1 km^2 nadir resolution).

The Florida ground–based fire dataset contains two large databases, one of wildfires and the other, open burns. The wildfire database contains wildfires and prescribed burns that are reported on state and privately held lands. The open burns database contains reported agricultural, land clearing and silvicultural fires, some of which require permits.

First, GOES ABBA estimated location and fire size data are spatially compared to the Florida ground fire data. Then, the fire size is surrounded with an additional 16 km^2 in an effort to realistically estimate the ability of the GOES ABBA product to detect active fire in time and space.

Secondly, overlap between the MODIS point data and the Florida ground data is assessed. Then, in consideration of the MODIS instruments 1 km^2 spatial resolution, the data points are surrounded (buffered) with a 1 km^2 area to evaluate the spatial coincidence between MODIS and ground fire data.

Each of these datasets are converted to GIS shape files for analysis.

Figure 1. The MODIS and GOES data are buffered to represent 1km² and 16 km², respectively, for portions of the analysis. Note the unique sizes (area) of the ground-based data.

Figure 2. Coincidence in Florida ground fire area, GOES area and MODIS point data.

Not much.

Potential problems

Fires are not sensed through thick cloud cover.
MODIS is limited to only 2 overpasses per daylight hours.
Must consider the spatial resolution of the instruments relative to the size and intensity of the fire events.

Many of the ground fires are reported at the county center, not where the fires actually occurred.

Geolocation is a potential problem with each data type.

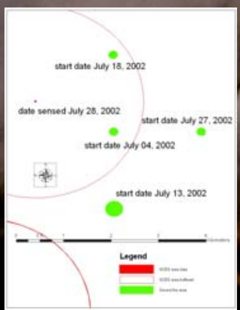

Figure 3. Enlarged view of ground data and GOES instantaneous fire size data demonstrating the proximity of the July 27th and July 28th detections (GOES spatial resolution 16 km²). Even though GOES is most likely detecting this fire event, the data do not coincide.

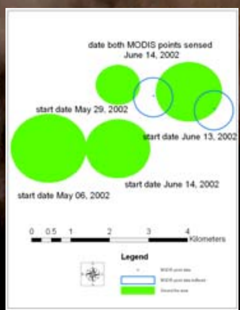

Figure 4. Enlarged view of ground data and MODIS point data demonstrating the proximity of the June 13th and June 14th detections (MODIS spatial resolution 1 km²). Even though MODIS is most likely detecting these fire events, only 1 data point coincides.

Data source	Number of records	Number of intersecting records (satellite to ground)	Reported acres burned (range)	Ground fire area covered after buffering (acres)	Total area of buffer (acres)
GOES ABBA	1596	80	66,491 (0.23 – 187.2)	100,960	5,044,650
MODIS	811	74	none reported	8,637	107,842
Florida ground fires	4342		201,380 (0.1 – 9000)		

Table 1 Comparison of the satellite-based fire data to the Florida ground-based fire data.

The satellite data contains 55% of the total number of records that the ground fire database holds.
9% of the MODIS data points lie on the ground area burned.
5% of the GOES fire records intersect the ground data.

GOES data accounts for 33% of the ground area burned, even though only a momentary calculation is possible (1 per 15 minutes).

After buffering to their respective spatial resolutions, the satellite data coincidence with 54% of the ground fire data.

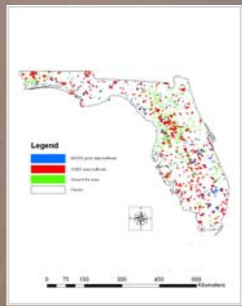

Figure 5. Coincidence in Florida ground fire area and the buffered GOES and MODIS products.

After buffering of the satellite data, there is a much greater coincidence in the data.

Figure 6. The Everglades. Note the numerous satellite detections that are not coincident with ground-based fire data.

July 20, 2002. **August 5, 2002.**

Figure 7. Enhanced Thematic Mapper quick looks sensed near the Everglades. The darker brown portions of these images appear to be burned fields. Several more fields appear burned in the August 5th image, which coincides with MODIS imagery, however these fires are not recorded in the ground fire data.

Figure 8. Okeefenokee. The satellite data are not coincident with the ground data in space and/or time.

May 15, 2002. **May 31, 2002** **June 16, 2002.**

Figure 9. Enhanced Thematic Mapper quick look s sensed near Okefenokee Swamp. The darker brown portion of these images appears to be a large fire scar. The fire scar grows over time, and the location of these scars coincides with GOES imagery, but the fire is not recorded in the ground fire data.

Conclusions

The satellite data are coincident with 14% of the reported ground fires, and 25% of the satellite data are coincident with the ground data. When considering the spatial resolution of the instruments, a coincidence of 54% exists between the satellite and ground-based data. GOES data accounts for 33% of the ground area burned, even though only a momentary calculation is possible (1 per 15 minutes).

In the Florida 2002 open burns database, the largest 5% of the fire events account for 77% of the area burned.
In the wildfire database, the largest 1% of the fire events account for 75% of the area burned.
This is significant because it stresses the importance of accurately quantifying large fire events, which are typically captured with satellite imagery.

Data presented here demonstrates that numerous satellite detections do not coincide with the ground data. From the satellite perspective, 25% of the data coincides with the ground data, however 75% did not. The implication is that we are missing fire events and others are improperly placed.

We suggest that satellite data are capable of identifying active fires that are often missed on the ground and these data would enhance incomplete ground datasets, thus improving biomass emissions estimates.