MODIS-Based Techniques for Assessing of Fire Location and Timing in the Alaskan Boreal Forest

Nancy H.F. French[1], Lucas Spaete[1], Elizabeth Hoy[2], Amber J. Soja[3], Eric Kasischke[2], and Richard Powell[1]

[1]Michigan Tech Research Institute,3600 Green Court, Ann Arbor, MI 48105
[2]Department of Geography, University of Maryland, College Park, MD
[3]National Institute of Aerospace, NASA Langley Research Center, Hampton, VA

We have used Moderate Resolution Imaging Spectrometer (MODIS) Rapid Response active fire maps to derive information on fire location and timing in Alaska to improve on information collected by the fire management agency. The MODIS instrument, on-board NASA's TERRA and AQUA satellites, began acquiring images in 2000. The Rapid Response fire product (http://rapidfire.sci.gsfc.nasa.gov) provides twice-daily location of fire hot spots for the world. Our poster presents the results of using MODIS-derived fire location and timing with comparison to previously available data on fire start and stop and fire perimeter. In addition, we demonstrate a method of tracking a fire's progress across the landscape. Currently, the Alaska Interagency Coordination Center (AICC) documents fire start and end dates for fire management purposes. Fire perimeters are also mapped, and fire progression information is sometimes documented, although digital records are not always made. The MODIS-derived products allow for an assessment of fire timing and location that, while available though standard fire fighting activity, is not always fully documented and saved for historic mapping.

MODIS Rapid Response Data

Detects fires using the fire detection algorithm based on algorithms developed for the AVHRR and TRMM VIRS (Giglio et al.,2003). Was developed for the need of the fire community for MODIS fire data shortly after acquisition to aid in fire management

-sun-synchronous orbit
-1 km resolution
-twice daily (terra & aqua) coverage

-basic principles of the Fire Detection Algorithm

4 µm channel > 360K
or
4 µm channel >330K and
4 µm channel - 11µm channel > 25K

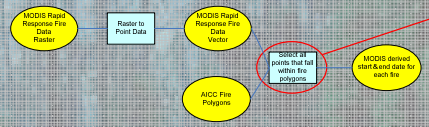
http://rapidfire.sci.gsfc.nasa.gov

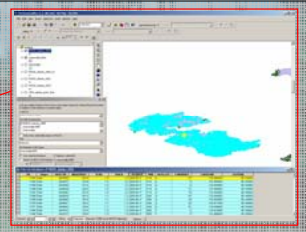
North American MODIS Rapid Response data

Assessment of Alaskan Fire Duration Using MODIS Hotspot Data

Each year the Alaska Interagency Coordination Center (AICC) actively monitors wildland fires throughout Alaska. At the conclusion of each fire year the AICC compiles the yearly data into fire specific information. Historically this information has proven useful to scientists studying the historical effects of fire but has fallen short when it comes to studying seasonal aspects of fire occurrence i.e. start date, end date and duration of fires. Until recently the AICC was the only source where fire occurrence information could be obtained. Moderate Resolution Imaging Spectroradiometer (MODIS) satellites AQUA and Terra pass over the same location several times a day capturing information about the landscape with every pass. This increased temporal resolution can be used to look at seasonal aspects of fire occurrence, information that the AICC data fails to capture.

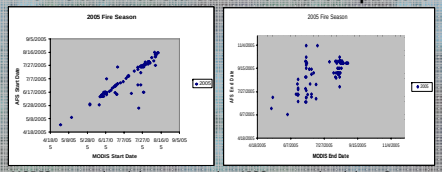
GIS Workflow





MODIS Hot Spot points selected by AICC fire polygons. Earliest fire pixel (highlighted) becomes start date

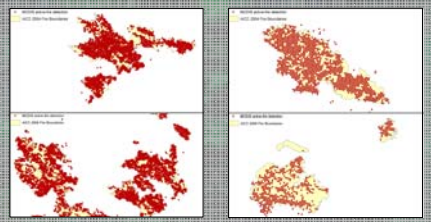
MODIS and AICC Start and End Date Comparisons



MODIS start and end date compared to AICC start and end date. Start date comparisons show similar start dates, while end date comparisons show AICC fires extending longer compared to MODIS derived.

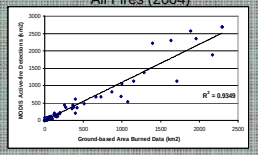
Quantifying Area Burned Using MODIS Hotspot Data

Currently, the United States does not have a standard methodology to track fire occurrence or area burned, which are essential components to estimating fire emissions. MODIS satellite data provides the opportunity to consistently sense fire across boundaries. The goal of the NASA Langley/National Institute of Aerospace investigation is to define the ability of satellite-based fire products to detect active fire and quantify area burned in an effort to enhance existing area burned databases and emissions estimates. The fire detection product used in this investigation was the National Oceanographic and Atmospheric Administration (NOAA) Hazard Mapping System (HMS) fire maps, which use the MODIS Rapid Response product

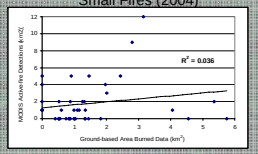


MODIS thermal anomaly data are overlaid on a fire perimeter database showing the spatial coincidence in the MODIS data and the fire scars over time. In most cases, the MODIS data fall within the fire perimeters demonstrating the ability of MODIS data to outline the spatial movement of fire over time.

All Fires (2004)



Small Fires (2004)



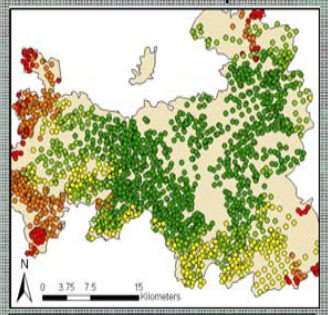
Comparison of area burned during the extreme 2004 fire season in Alaska. MODIS data are taken from June, July and August 2004 when the fires are most active and the fire scars sizes are reported for the entire fire season. The linear relationship shows that MODIS data are able to accurately estimate the amount of area burned, particularly for large fires. Small fires area estimates are less accurate. Large fires are responsible for 97%-98% of area burned in boreal regions.

MODIS satellite data could significantly improve biomass burning emission estimates by: (1) improving the temporal availability of emissions; (2) enhancing and improving estimates during times when detailed ground inventories are not available; and (3) enhancing and improving estimates in regions where temporal and/or spatial ground-based data is imprecise. Our ultimate goal is to work towards establishing a national, automated Remote Sensing-based near-real-time biomass burning emissions inventory system that contains accurate error assessments for forecasting emission impacts for hazard reduction and health.

Fire Progression Using MODIS Hotspot Data

Fire events occurring late in the summer season may burn deeper into the organic layer, leading more severe environmental impacts than early season fires. However, it can be difficult to determine the date a site burned using AICC reports. To better determine burn seasonality, MODIS Hotspot data from the 2004 fire season in Alaska, in point format, was analyzed using ArcGIS. A universal kriging interpolation map was created to map the spread of fire by date over the landscape. This interpolation map was then used to determine the day in year (DIY) that study plots burned.

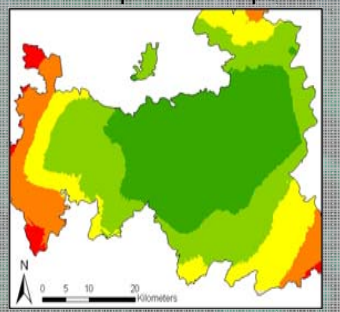
MODIS Hotspots



MODIS Hotspot data for the summer of 2004, in point format, for the Porcupine burn in Alaska. The points are colored to represent the day of year of the fire.

Porcupine Burn: Alaska 2004

Interpolation Map



Interpolation map for the 2004 Porcupine burn in Alaska showing the progression of the fire through the summer months. RMSE = 6.732.