Fires in Eurasia and South America

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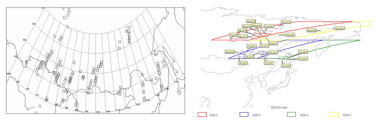
SUMMARY This poster summarizes several research projects dealing with fire monitoring from satellites in study areas of the Northern Eurasia Earth Science Partnership Initiative (NEESPI) and the Large-scale Biosphere-Atmosphere Experiment in the Amazon (LBA). The overarching themes are the evaluation of the satellite-derived fire products, the creation of a long-term consistent data record and the use of the datasets for the analysis of regional fire dynamics.

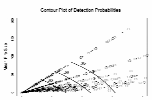
Product validation in Northern Eurasia

Comprehensive biomass burning observations should consist of both active fire data and explicitly mapped burned areas. We carried out rigorous validation of fire products using high resolution imagery. For active fires, we took advantage of the coincident observations by Terra/MODIS and the 15-90m resolution Terra/ASTER (Advanced Spaceborne Thermal Emission and Reflectance) instruments. The reference data for burned area evaluation were primarily Enhanced Thematic Mapper Plus (ETM+) on the Landsat-7 satellite.



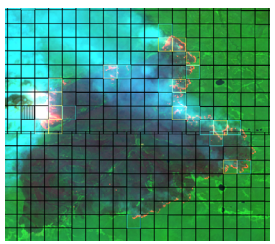
Inventory of ASTER (left) and Landsat/ETM+ (right) imagery from 2001, 2002 and 2003 used for active fire and burned area validation respectively

Active fires



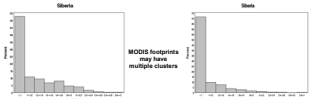
Detection probabilities were derived as a function of the total number of ASTER fire counts and the mean cluster size within the MODIS pixel.

●: MODIS fire ○: MODIS no fire

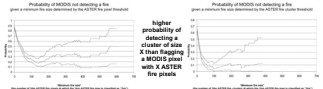


MODIS 1-km grids over an ASTER 8-3-1 red-green-blue image of a large fire complex in Siberia on July 23, 2002. The center of the complex is at 62.57N 125.72E. Yellow and blue MODIS cells correspond to "high" and "nominal" MODIS fire detection confidence respectively

Pixel-based vs. cluster-based validation

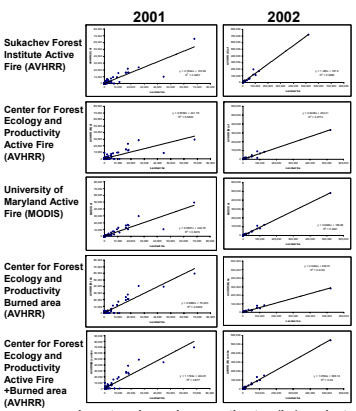


Frequency distributions of the number of ASTER fire pixels within 2x1 km MODIS footprints (left) and of fire cluster sizes expressed by the number of ASTER fire pixels (right)



Pixel-based (left) and cluster-based (right) accuracy assessment curves with the 95% exact confidence intervals.

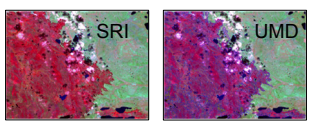
Burned areas



Inventory burned area estimates (ha) against Landsat/ETM+. The combined product (bottom) shows the least interannual change.

Towards a joint burned area validation dataset

- initially merging databases from UMd and SRI
- analysis of overlaps, development of protocol
- distribution in coordination with NERIN and CEOS



ETM+ burned area masks. Path/row 125/15; Sep 6 2001

GOFC-GOLD Global Observation of Forest and Land Cover Dynamics

Regional networks

- Northern Eurasia Regional Information Network (NERIN) http://www.fao.org/GTOS/gofc-gold/net-NERIN.html
- Red Latinoamericana de Teledetección e Incendios Forestales (Redlatif) http://mob.conae.gov.ar/redlatif/

Towards multi-sensor fire products

Northern Eurasia: MODIS and AVHRR

A multi-source database of active-fire detections has been compiled at the Space Research Institute (SRI). The database includes the center location of MODIS and AVHRR pixels flagged as "fire" and auxiliary information. The MODIS data are generated within the MODIS Land Rapid Response System, whereas the AVHRR data are from local receiving stations operated by the Russian collaborators.

Terra D	Aqua A	NOAA-16 A	NOAA-12 A	NOAA-15* A
10:30	13:30	14:15	16:45	18:30

Approximate daytime equator crossing times of the satellites used in this study for the 2004 fire season. D: descending node; A: ascending node. *Used only for cloud adjustment.

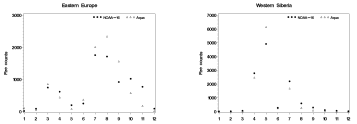
Study areas

- Eastern Europe 40°-50° N; 40°-50° E (agriculture)
- Western Siberia 55°-65° N; 60°-70° E (boreal forest)

Data analyzed

- Monthly total counts of fire pixels from 2004

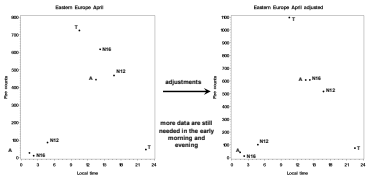
Inter-satellite comparison and adjustment



Monthly total fire counts from daytime Aqua MODIS and NOAA-16 AVHRR over the two study areas in 2004. In general the agreement is good.

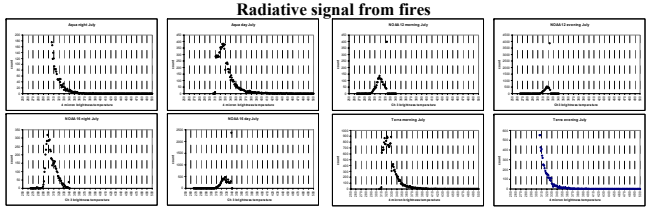
Adjust for differences in

- swath widths of MODIS and AVHRR
- daytime Aqua and NOAA-16 counts
- cloud cover (using AVHRR Pathfinder Atmosphere data)



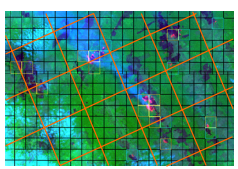
Example of diurnal cycle of fire activity from MODIS and AVHRR

Radiative signal from fires

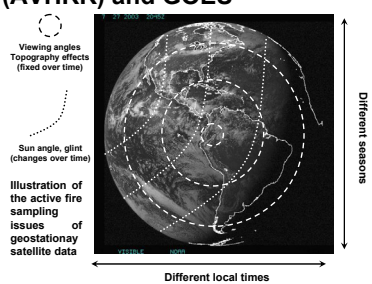


Histograms of MODIS and AVHRR mid-IR brightness temperatures of fire pixels. The 305 K cutoff for MODIS shows the need for a regional algorithm.

South America: MODIS, (AVHRR) and GOES



MODIS 1-km grids over an ASTER 8-3-1 red-green-blue image firesin Acre (Brazil) on August 29, 2003. The center of the image is at 9.79S 67.13W. Yellow and blue MODIS cells correspond to "high" and "nominal" MODIS fire detection confidence respectively. The orange grid represents a hypothetical grid of 4km GOES imager pixels



Publications

Csiszar, I., T. Loboda and J. G. Goldammer, 2004: Contribution of GOFC/GOLD-Fire to fire monitoring in the Russian Federation. New Approaches to Forest Protection and Fire Management at an Ecosystem Level. World Bank and Alex Publishing, Moscow, 138-146.

Csiszar, I., J. Morisette and L. Giglio, Validation of active fire detection from moderate resolution satellite sensors: the MODIS example in Northern Eurasia. IEEE Transactions on Geoscience and Remote Sensing, in press.

Loboda, T. and I. Csiszar, Reconstruction of Fire Spread within Wildland Fire Events in Northern Eurasia from the MODIS Active Fire Product. Global and Planetary Change, in press.

Loupian E.A., et al., 2006: Satellite monitoring of forest fires in Russia at federal and regional levels. Mitigation and Adaptation Strategies for Global Change, 11, 113-145

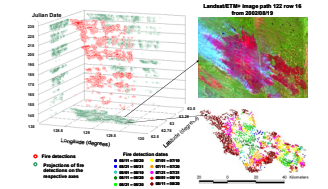
Morisette, J.T., L. Giglio, I. Csiszar, A. Setzer, W. Schroeder, D Morton, C. O. Justice, 2005: Validation of MODIS active fire detection products derived from two algorithms. Earth Interactions, 9, paper no. 9.

Schroeder, W., J. Morisette, I. Csiszar, L. Giglio, D. Morton, C.O. Justice, 2005: Characterizing Vegetation Fire Dynamics in Brazil Through Multi-Satellite Data: Common Trends and Practical Issues. Earth Interactions, 9, paper no. 13.Sukhinin, A.I., et al., 2004: Satellite-based mapping of fires in Eastern Russia: new products for fire Management and carbon cycle studies. Remote Sensing of Environment, 93, 546-564.

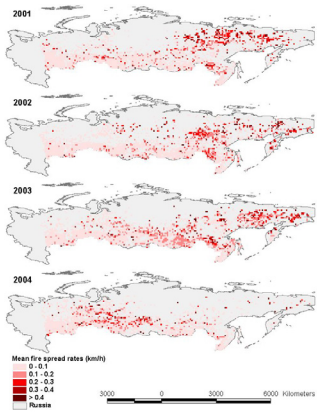
Fire dynamics

Northern Eurasia: fire spread

We developed an approach to reconstruct the development of fire events from MODIS active fire detections. Individual fire detections are clustered within a GIS environment based on a set of rules determining proximity between fire observations in space and time. FSR determines the number of fire events, their approximate size, duration, and fire spread rate and allows for the analysis of fire occurrence and spread as a function of vegetation, fire season, fire weather and other parameters.

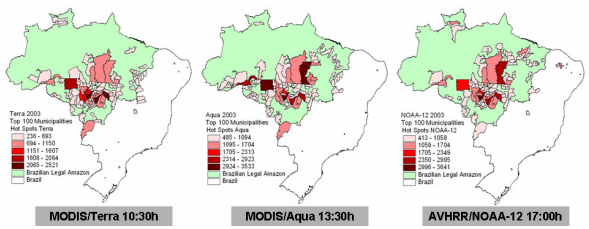


Distribution of MODIS fire points from fire season of 2002 within a large fire scar in Yakutia in space and time. Active fire detections are color coded to represent temporal progression of fire in 10-11 day intervals.

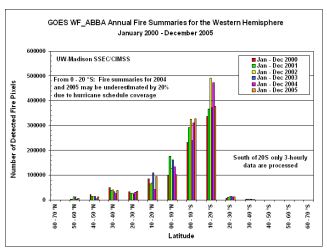


Average fire spread rates in 2001 – 2004 by 0.5° grid cells

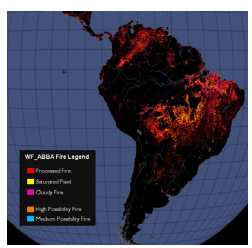
South America: large-scale, long-term analysis



Top 100 Brazilian municipalities in terms of fire occurrence during 2003 as depicted by MODIS/Terra, MODIS/Aqua and AVHRR/NOAA-12 daytime detection.



Number of fire pixels detected with the GOES-12 WF_ABBA over the past 6 years in 10 degree latitude bins. The values for 0-20 degrees South for 2004 and 2005 are underestimates due to less complete GOES coverage in South America during the peak of the fire seasons.



GOES-12 WF_ABBA fire product annual summary for January through December 2004, based on half-hourly fire detects for the entire year.

Projects and acknowledgment

Intercalibration of fire products from AVHRR and MODIS in Northern Eurasia. NASA New Investigator in Earth Science, Jan 2003 – Jan 2006, NAG512667.

Development of an Integrated System of Ground-, Air- and Space-based Observations of Biomass Burning in Northern Eurasia. NASA LCLUC Feb 2004- Jan 2006, NNG04GC82G.

Quantifying the accuracy of MODIS fire products and establishing their relationship with land cover dynamics. NASA LBA-ECO Phase II. Sep 2003- Aug 2006, NAG 513617.

Analysis of long-term fire dynamics and impacts in the Amazon using integrated multi-source fire observations. NASA LBA-ECO Phase III, Mar 2006 – Feb 2009, NAG06GE21A.

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