The MODIS Rapid Response Project: A New Suite of Remote Sensing Products
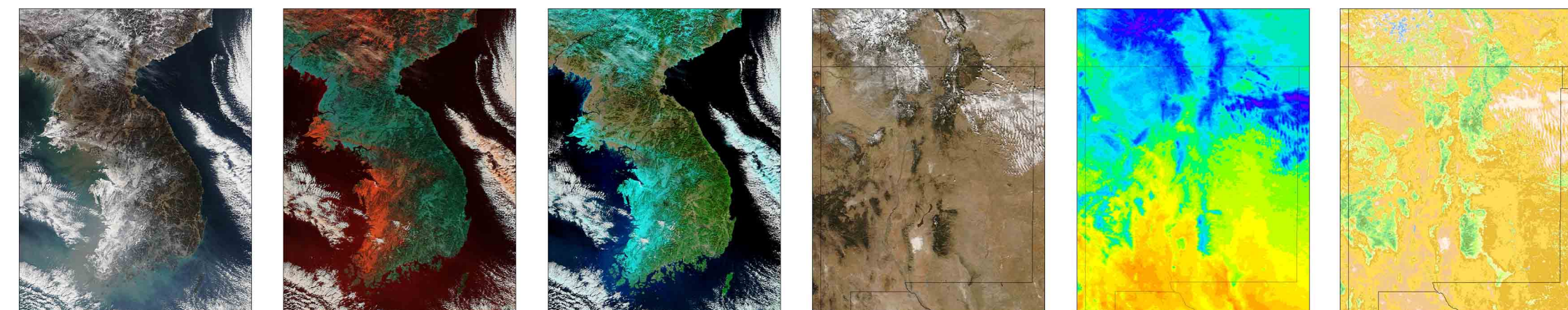## http://rapidfire.sci.gsfc.nasa.gov
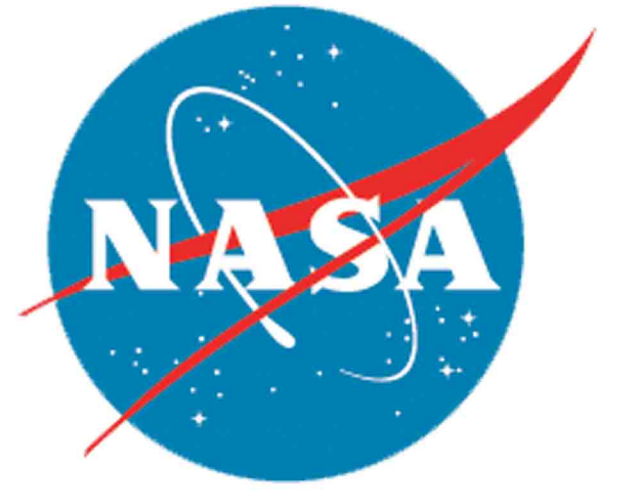
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Abstract

The MODIS Rapid Response System specializes in daily digital satellite imagery and data products, generated and distributed in close to real-time. Our current geographical coverage includes most of the Earth's land surface and a portion of the oceans. From our public web interface, we provide digital images in JPEG format in varying sizes, spatial resolution and band combinations. You c an browse and download our JPEG imagery for free. In addition to our public JPEG distribution, we offer custom image, data processing and distribution services to meet special applications, research, and publication needs. For more information on custom MODIS Rapid Response System products and services, please contact us at contact@rapidfire.sci.gsfc.nasa.gov.

MODIS' high spatial and temporal resolutions make it a valuable tool for tracking rapid change associated with fires, dust storms, floods, smoke transport, severe storms, volcanic eruptions, snow and ice extent, and land cover change. The MODIS Rapid Response System was developed to provide easy access to MODIS imagery within hours of the satellite overpass. It generates image products using a combination of standard MODAPS algorithms adapted to run in the rapid production environment, and custom algorithms and processing needed to generate new products and/or meet specific research and applications needs. The system currently provides unprojected, Level-2 orbit swath images derived from the MODIS Terra and Aqua 5-minute acquisitions for all land areas and much of the oceans. The Level-2 images are not GIS-compatible, but they are useful for locating and previewing MODIS data.. The system also provides daily geocorrected, Level-3 imagery for many land areas. Plans are in place to expand the system's Level-3 production to global land coverage, with Web Mapping Service (WMS) capabilities to allow users to dynamically generate custom image subsets. New products in development, scheduled to begin production in 2006, include multi-day composite vegetation index images and a rapid burn scar product.

Image Products

True Color (Bands 143) | SWIR (Bands 367) | Near Infrared & SWIR (Bands 721) | True Color (Bands 143) | Land Surface Temp. | NDVI

The MODIS Rapid Response System receives Level-0 MODIS data from NOAA through a "bent pipe" data feed within one to two hours of data acquisition. Level-2 images and data products for all land areas and much of the ocean are automatically generated from the conversion of raw satellite data observations into derived geophysical parameters. However, the spatial representation of the parameters is not changed in the Level-2 processing. The resulting images and data products remain in their native satellite orbit swath location. As of December 2005, our near-real-time Level-2 image production included several 3-band (R:G:B) corrected reflectance combinations, normalized difference vegetation index (NDVI), and land surface temperature (LST) in 4-km, 2-km, 1-km, 500-m, and 250-m spatial resolution.

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Near Real Time > USA 7
USA 7
Search for date (mm/dd/yyyy)
Browse   Prev 09/24   Next 09/26
Return to near real time map
Date: 2005/268 - 09/25

Terra MODIS
True color | 721 | NDVI
Pixel size: 2km | 1km | 500m | 250m

Aqua MODIS
True color | 721 | NDVI
Pixel size: 2km | 1km | 500m | 250m

Geocorrected (GIS compatible) images are freely available online within hours of data acquisition.

Daily Level-3 geocorrected, images that are mapped on uniform space-time grid scales, are generated from Level-2 products for many land areas in a variety of band combinations. The daily Level-3 images are normally provided in the Platte Carree map projection, but the Rapid Response System can generate Level-3 (geocorrected) images and data products in a variety of other map projections, including but not limited to Lambert Azimuthal and Sinusoidal. Some Level-3 images in GeoTIFF format are also available online on a limited basis, but additional GeoTIFF images may be provided upon request.

Current GIS-compatible Level-3 images cover select areas of the globe, but plans are in place to expand coverage to all land surfaces in 2006. When global Level-3 production begins, the images will be tiled to make mosaicking easy. For select areas where tiled images are already being produced (United States, Europe, North Africa, and Australia), users can generate and view regional mosaic images dynamically created from Level-3 images. This function will be extended to other regions as coverage expands in 2006.

Mosaic of the United States acquired by Terra MODIS on August 29, 2005, when Hurricane Katrina came ashore.

New Data Products

In collaboration with research and applications users, the MODIS Rapid Response System project develops new rapid data and image products. In 2005, new product development included: Level-2 and daily Level-3 land surface temperature (LST), 10-day global fire maps, multi-day vegetation index composites, and a rapid burn scar detection product.

Land Surface Temperature
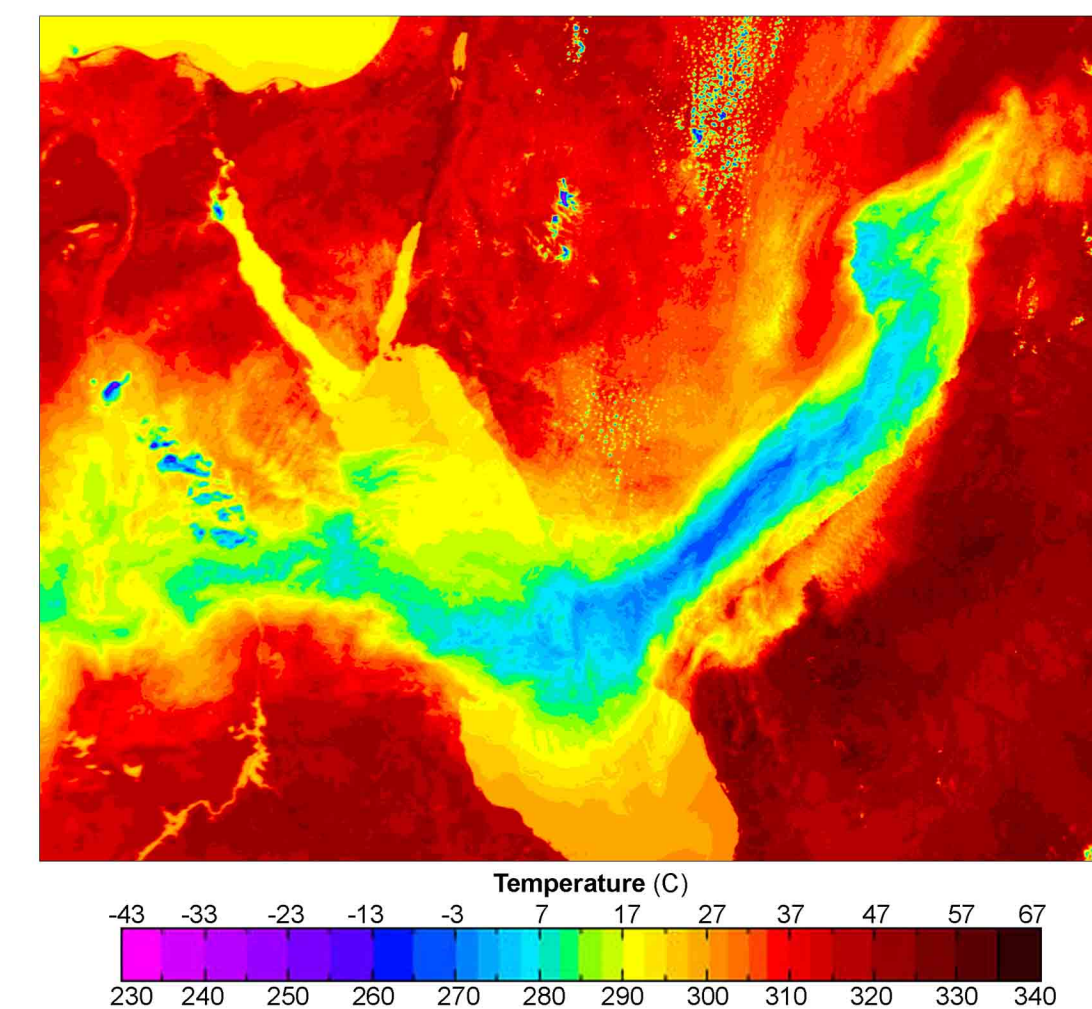
The Rapid Response MODIS Land Surface Temperature (LST) product is based on the split-window algorithm developed by Wan et al. (1996) for the standard Land Surface Temperature product (MOD11_L2; MYD11_L2). The algorithm was streamlined to be used in a near real-time production environment so that land surface temperature images are generated for every Level-2 MODIS granule processed by the MODIS Rapid Response System and for selected Level-3 geocorrected subset areas.

Following implementation of the LST prototype in our near-real-time Level-2 production and selected Level-3 subsets, scientists in the GSFC Hydrological Sciences Branch (Code 614.3) and analysts from the USDA FAS began to evaluate the product. Pinheiro et al (2005) compared MOD11_L2 and Rapid Response System LST products from both day and night overpasses of the EOS Aqua satellite and report that the differences between these products, on a global basis, are less than 0.1 K.

Right, a land surface temperature image of a dust storm over the Red Sea, taken on May 13, 2005, by Aqua MODIS.

Temperature (C)
-43 -33 -23 -13 -3 7 17 27 37 47 57 67
Temperature (K)
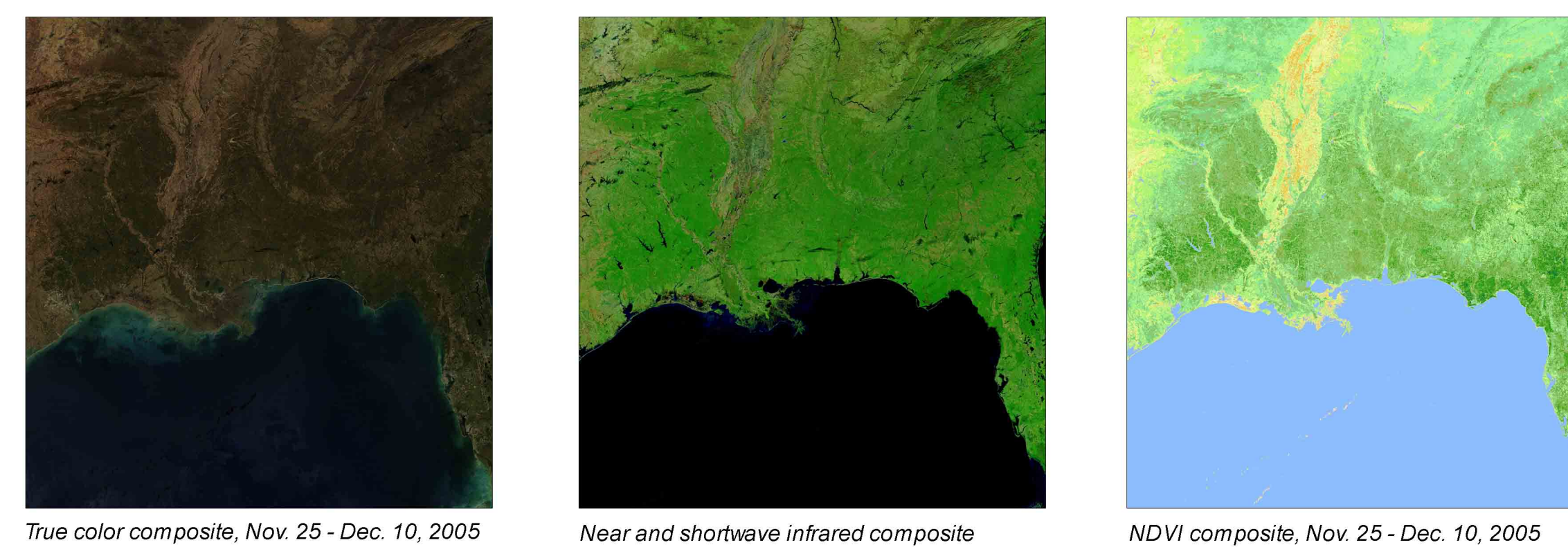230 240 250 260 270 280 290 300 310 320 330 340

Global Fire Maps

The MODIS Rapid Response System provides global fire maps in 10-day composite periods from February 2000 to the present. Each fire map accumulates the locations of the fires detected by MODIS on board the Terra and Aqua satellites over a 10-day period. Each colored dot indicates a location where MODIS detected at least one fire during the compositing period. Color ranges from red where the fire count is low to yellow where the number of fires is large. The compositing periods are referenced by their start and end dates (julian day). Compositing periods are reset every year to make year-to-year comparisons straightforward. The first compositing period of each year starts on January 1. The last compositing period of each year includes a few days from the next year.
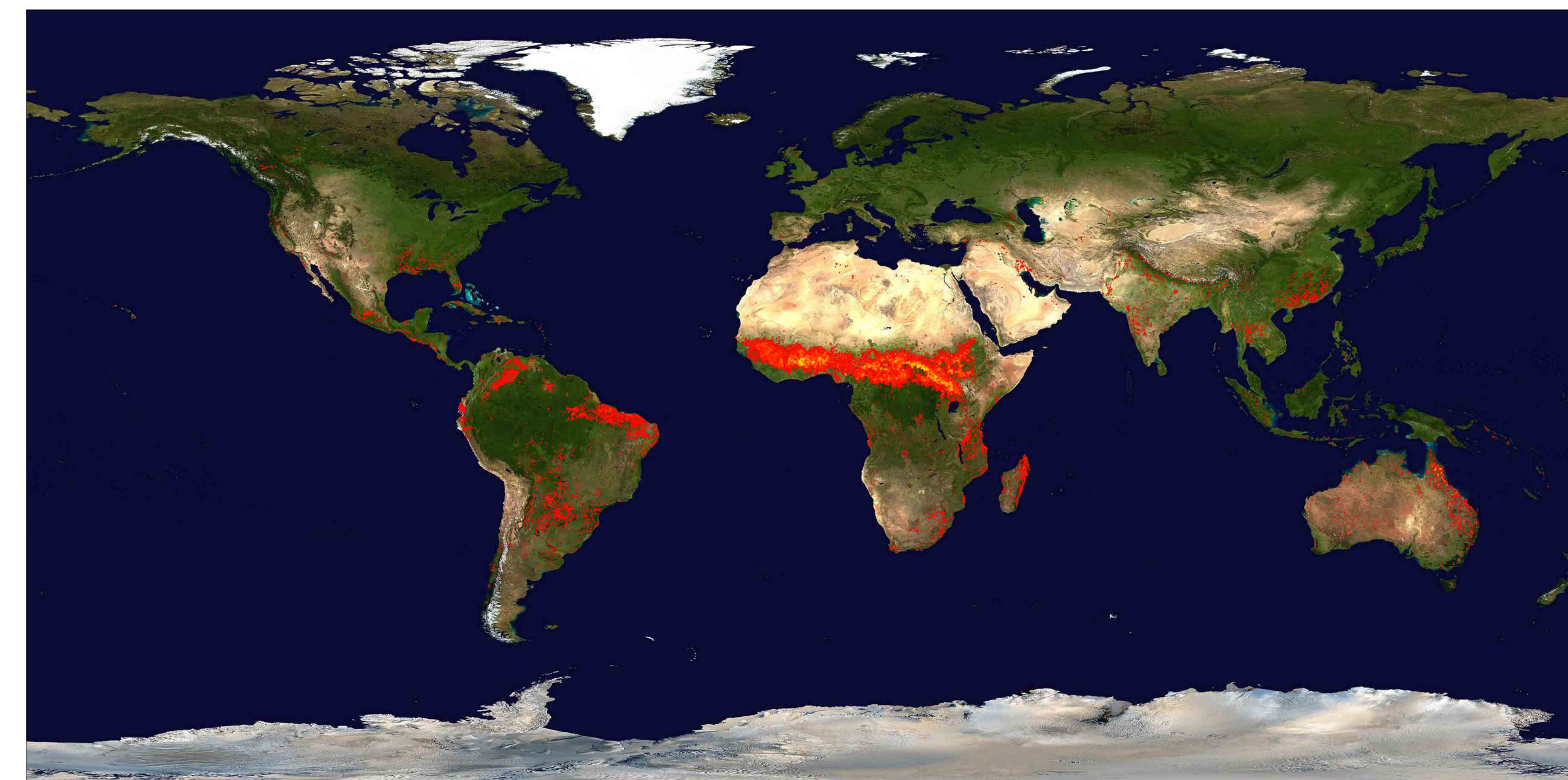
A global fire map generated from fire detections observed between December 7 and December 16, 2005.

Vegetation Index Composite

True color composite, Nov. 25 - Dec. 10, 2005 | *Near and shortwave infrared composite* | *NDVI composite, Nov. 25 - Dec. 10, 2005*

The MODIS Rapid Response Team is developing a vegetation index composite product in partnership with the USDA Foreign Agricultural Service. Similar to the MODIS Level-3 VI product generated by MODAPS (MOD13Q1), the Rapid Response System's VI composite aggregates VI measurements over 16-day periods. However, in order to meet the needs of time-critical applications, the start date for the compositing period of the Rapid Response System VI composite is incremented every 4 days to provide a "rolling" temporal composite. In addition, the VI products implemented in the Rapid Response System are derived from our own corrected reflectance band products that do not include aerosol corrections used in the surface reflectance products generated by MODAPS. The product is currently being generated for selected regions to support product evaluation.

Burn Scar Product

To further support fire applications, we are currently adapting a post-fire burned area detection algorithm developed by Louis Giglio to generate near-real-time burn scar products in the Rapid Response System. The algorithm looks for abrupt changes in a time-series of observations assembled from daily, corrected reflectance imagery to identify burned pixels. It has been prototyped over several hundred MODIS tiles with very good results in a wide range of environments.

The new burn scar product will be generated daily or every few days to provide a "rolling" composite product that can be used in applications such as fire management that require information that is updated in close to real time. In addition to identifying burned pixels and providing the date that the burn occurred, post-fire vegetation index (VI), VI change difference (pre-fire minus post-fire), and quality assurance flags will be provided.

The burn scar product shows area burned in a fire in western Australia between October 1 and October 21, 2003, with a true-color image acquired on October 21 in the background. The first image on the left shows the total area burned in orange. The second image outlines the area burned during the 20-day period. The true-color image, without the burn-product overlay is shown center right. Here, as in all of the images, pixels in which MODIS detected active fires on October 21 are outlined in red. The final image shows the corresponding false-color image (bands 721), which highlights charred land in brick red.

Interfaces and Distribution Services

The Rapid Response System is being expanded to provide a number of new capabilities based on the Open GIS Consortium (OGC) Web Mapping Service (WMS) standard. WMS is a protocol that specifies how client applications and servers should communicate to allow users to access geospatial data sets and on-demand visualization and mapping services that are hosted on remote systems. With its new WMS interface, the Rapid Response System will provide web mapping tool developers and users with a means to dynamically create customized maps and image products from Rapid Response System daily Level-3 subsets and gallery images. In addition to expanding our usefulness to the science and education communities, the WMS implementation will help to increase utilization of Rapid Response System products in geographical information systems (GIS) used in decision support by federal, state, local, and tribal agencies and private organizations.
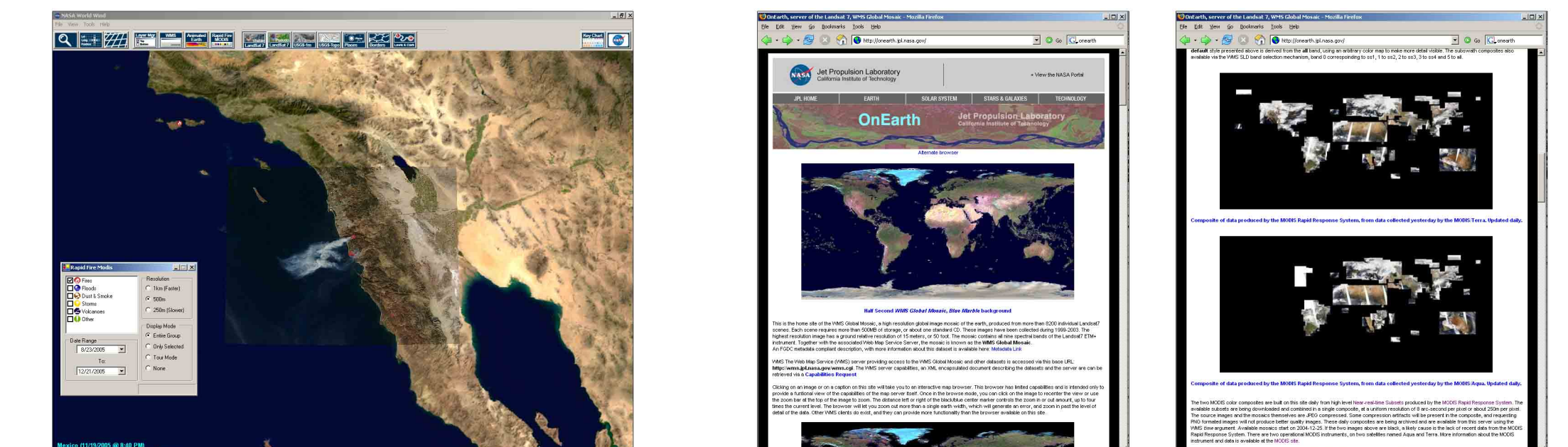
A Rapid Response image in the WorldWind WMS interface | *Rapid Response mosaics in the OnEarth WMS produced at NASA JPL.*

MODIS Rapid Response images are currently being incorporated into two WMS systems developed by NASA: World Wind and OnEarth. World Wind is an open source 3D interactive world viewer created by NASA's Learning Technologies project (http://worldwind.arc.nasa.gov/) at Ames Research Center uses a prototype WMS interface to dynamically access the Rapid Response System's gallery images and provide place marks and MODIS images captured for significant events. OnEarth is an image archive and WMS system (http://onearth.jpl.nasa.gov/) at NASA's Jet Propulsion Laboratory that provides online global mosaics created from high-resolution images collected by Landsat, SRTM, MODIS, and other instruments. The mosaics are displayed in an interactive map browser.

In addition to providing a WMS interface, the Rapid Response System plans to begin publication and distribution of Google Earth metadata (KML documents) for the images available from our web site. Google Earth (http://earth.google.com) is a desktop mapping application that is freely distributed by Google and has been gaining a lot of popularity because, like NASA's World Wind product, it provides a convenient, albeit simple, way to combine and visualize satellite imagery with other geographic information.
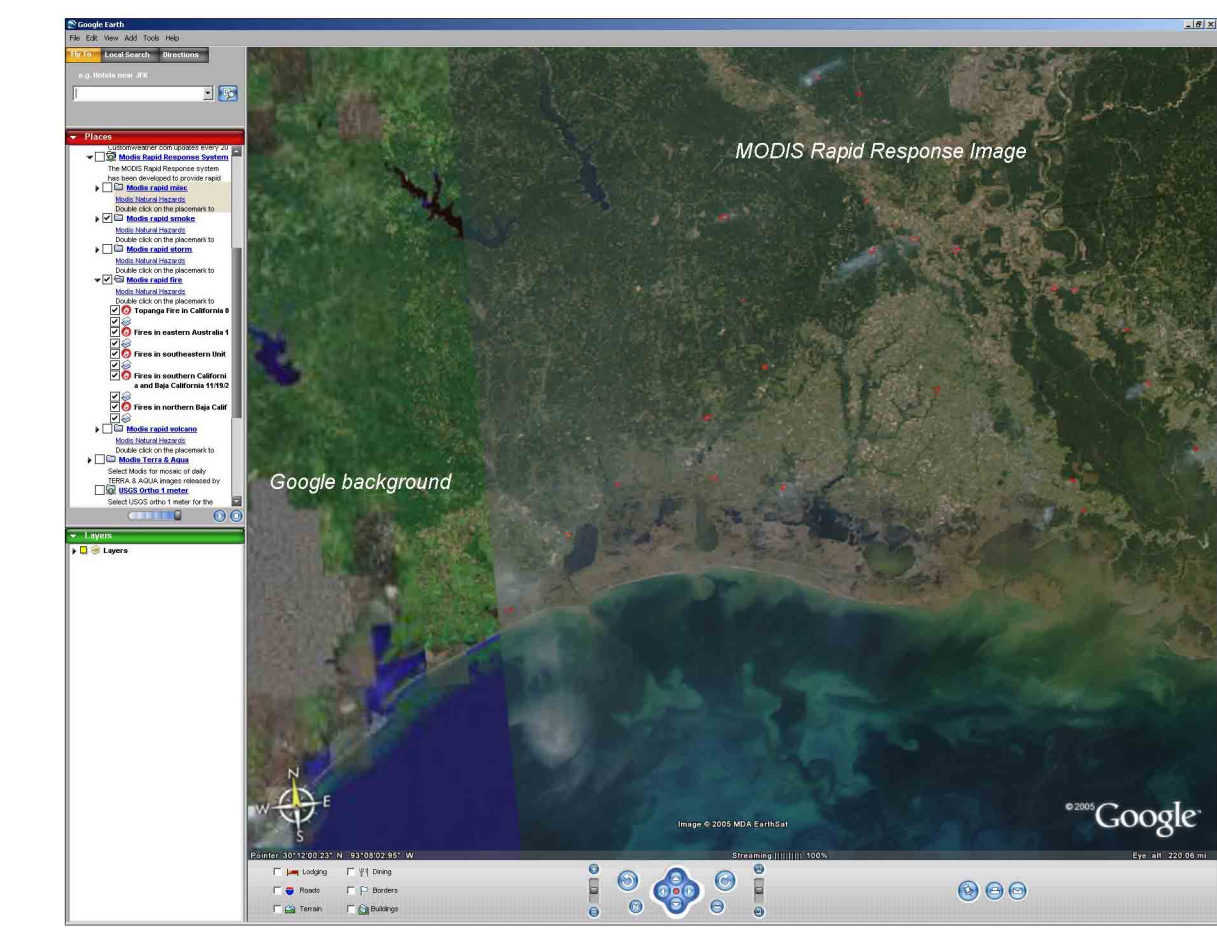
A Rapid Response image incorporated into Google Earth.

The Rapid Response System provides its data and image products and services to a variety of external systems through customized interfaces. Some examples of our custom distribution services and interfaces include:

USDA Crop Explorer | *USDA Forest Service* | *Chesapeake Bay System*

Crop Explorer
The U.S. Department of Agriculture Foreign Agricultural Service (USDA FAS) dynamically integrates near-real-time MODIS true color, false color, and vegetation index images for global agricultural regions received from the Rapid Response System in multiple spatial resolutions and file formats into their Crop Explorer system (http://www.pecad.fas.usda.gov/cropexplorer/). Crop Explorer provides USDA FAS analysts and customers "with timely and accurate crop condition information on a global scale unavailable from any other source."

USDA Forest Service
The USDA Forest Service Remote Sensing Applications Center receives fire location data and MODIS image products as they are generated in near-real-time by the Rapid Response System, and automatically integrates them into their web-based MODIS Active Fire Maps tools (e.g. http://activefiremaps.fs.fed.us/conus/viewer.htm) to allow users to dynamically create custom fire maps for the Conterminous U.S., Alaska, and Canada.

Chesapeake Bay System
The Maryland Department of Natural Resources (DNR) obtains daily MODIS imagery from the Rapid Response System for use in its Chesapeake Bay monitoring program. The DNR Eyes in the Sky web page (http://mddnr.chesapeakebay.net/NASAimagery/EyesInTheSky.cfm) provides visitors with near-real-time true color images as well as derived temperature, chlorophyll, turbidity maps.

Iraqi Marshlands Observation System | *SERVIR* | *Web Fire Mapper*

Iraqi Marshlands Observation System (IMOS)
The United Nations Environment Program (UNEP) Post Conflict Assessment Unit receives historical and near-real-time 250-meter MODIS data files containing corrected surface reflectance bands and a fire mask for regions in Iraq as they are generated by the Rapid Response System and integrates them into their Iraqi Marshlands Observation System (IMOS) (http://imos.grid.unep.ch/). IMOS is being used to assess ecosystem restoration efforts in Iraq, assist marshland management with timely scientific information, and help build a broad baseline of environmental data.

SERVIR
The Mesoamerican Visualization and Monitoring System (SERVIR) (http://servir.nsstc.nasa.gov) obtains MODIS images with active fire pixels overlaid twice daily from the Rapid Response System and integrates these multi-resolution products into its online archive of GIS-compatible imagery for Costa Rica, Guatemala, Honduras, Mexico, Nicaragua, and Panama.

Web Fire Mapper
The University of Maryland receives fire location data products as they are generated in near-real-time by the Rapid Response System, and automatically integrates them into their Web Fire Mapper system (http://maps.geog.umd.edu/) to allow users to dynamically create custom fire maps for any region of interest in the world.