Near Real-Time Automatic Environment and Disaster Monitoring in South and Southeast Asian Regions using MODIS Data

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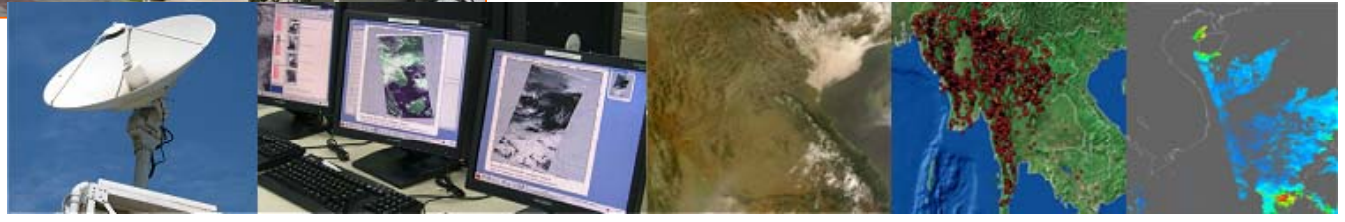

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Bangkok, Thailand

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http://www.geoinfo.ait.ac.th/

Outlines

Lecture:

1. OVERVIEW OF MODIS DATA AND APPLICATIONS

- Near Real Time Global Environment and Disaster Monitoring using MODIS Data

2. UNDERSTAND MODIS DATA FORMAT

- MODIS Band Specifications
- HDF data format
- Scientific Data Sets (SDS)

3. ANALYSIS OF MODIS DATA LEVEL1B & LEVEL2

- MODIS Images Subsets from **Land Atmosphere Near real-time Capability for EOS (LANCE)** at Goddard Space Flight Center, NASA (GSFC/NASA) Greenbelt, Maryland, USA – How to download MODIS Level 1B data
- MODIS Images Subsets from **Level 1 and Atmosphere Archive and Distribution System (LAADS)**, NASA (GSFC/NASA) Greenbelt, Maryland, USA – How to download MODIS Level 1B & Level 2 data
- Geometric Correction of MODIS Level 1b and Level2

Practical Session:

To learn how to work with MODIS data of Level 1B and Level 2 using ENVI 4.x software

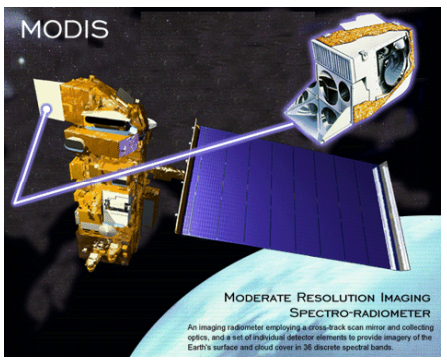
Materials (software, hardware and data) to be used @ practical session:

- Computer with hard disk of at least 10 GB free space.
- Web browser (Firefox, Google Chrome, etc.) and ENVI 4.x software
- Sample MODIS Data are provided
- Good and stable internet connection is necessary.

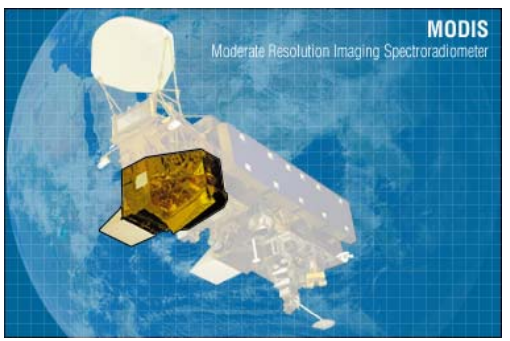
OVERVIEW
OF MODIS DATA & APPLICATIONS

MODIS – Earth Observation System (EOS) Flagship for Global/Regional Environment and Disaster Monitoring since 1999

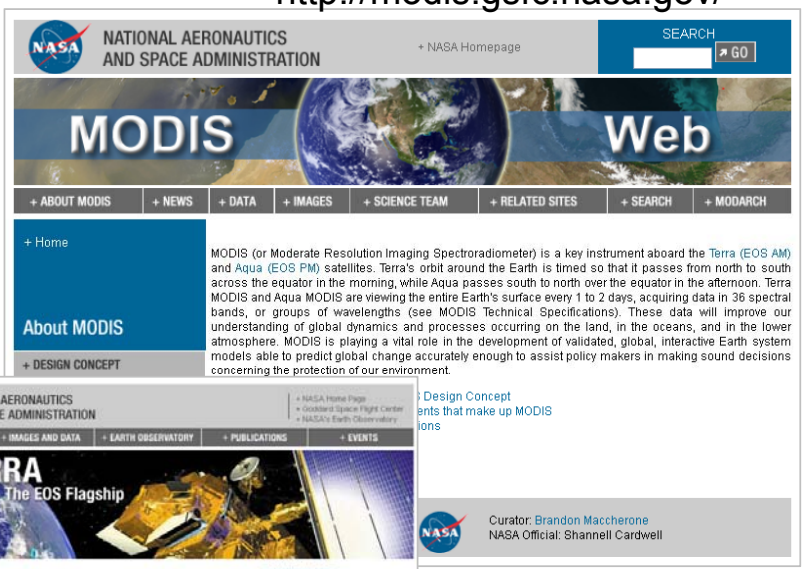
http://modis.gsfc.nasa.gov/

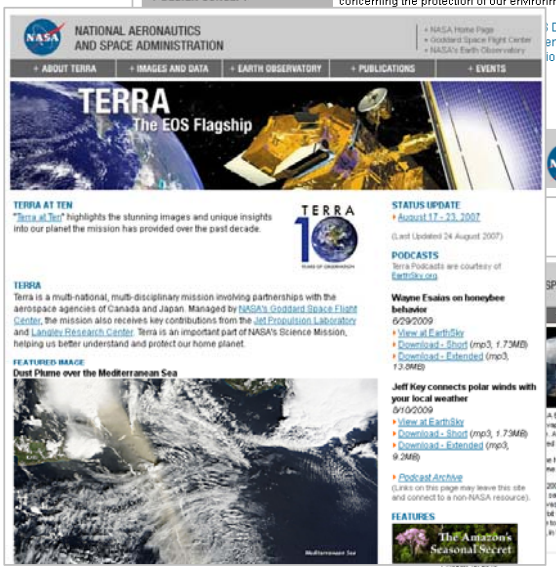


Terra (EOS-AM1) – Dec 1999 until present



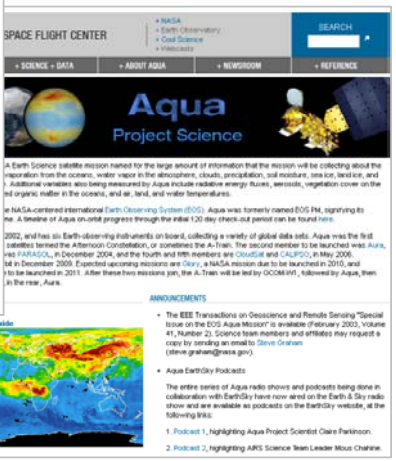
Aqua (EOS-PM1) - May 2002 until present





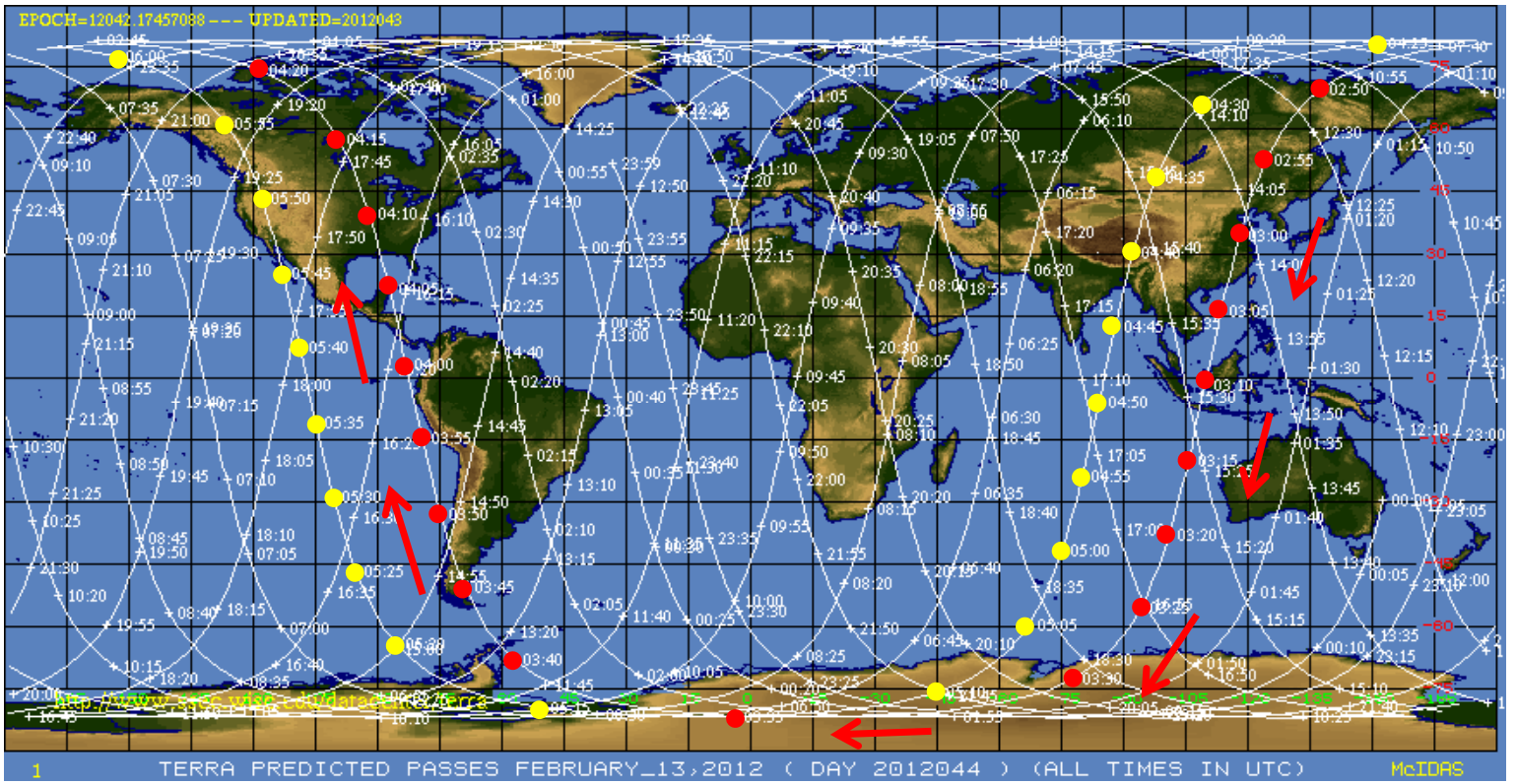
http://terra.nasa.gov/

http://aqua.nasa.gov/



MODIS Rapid Response System

MODIS Image Subsets – Terra Satellite Passes on Feb 13, 2012

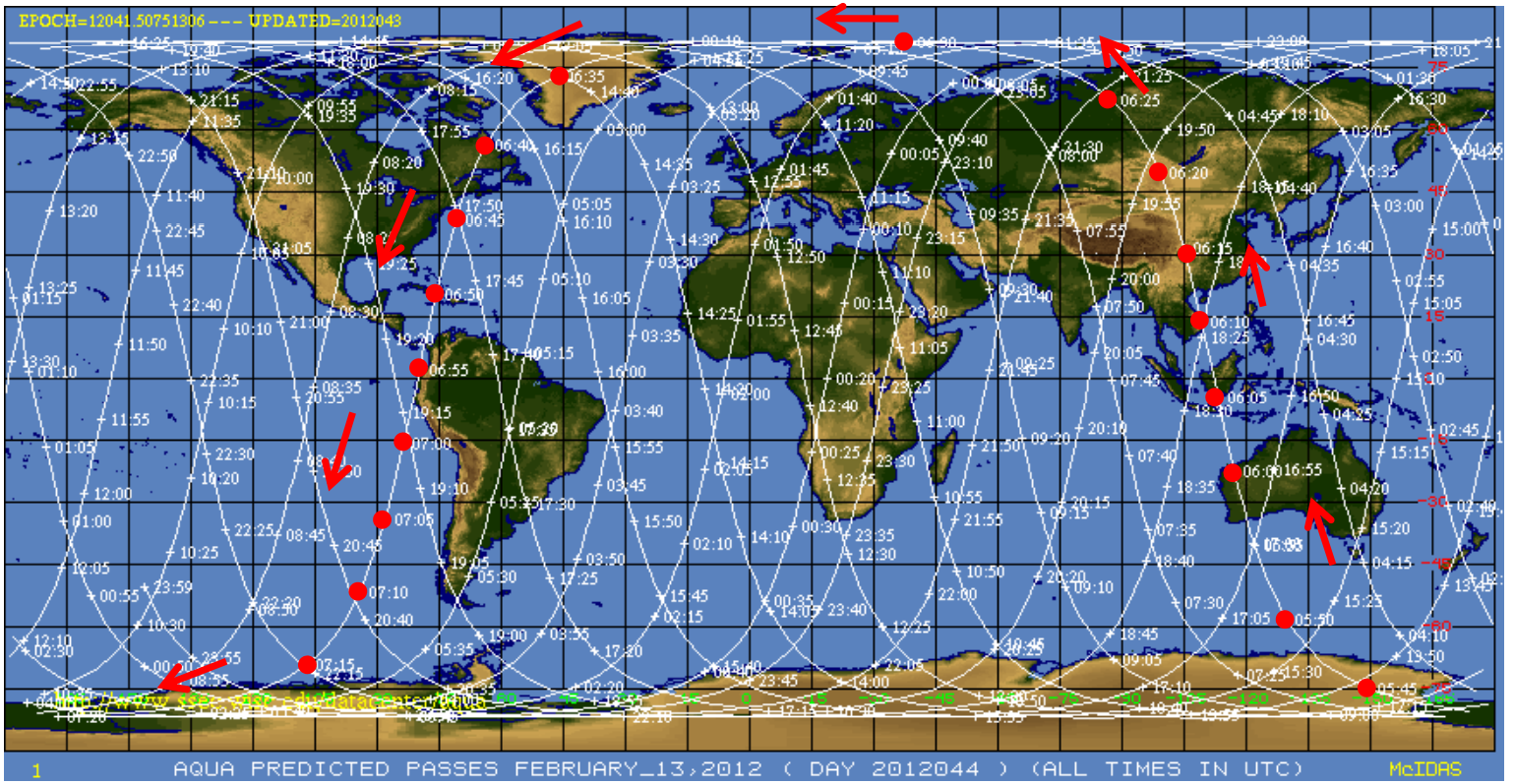


Source: MODIS Rapid Response – LANCE (Feb 23, 2012)

Terra Satellite flight direction is shown by red arrow. The red dots show the overpass time of each 5-min granule. Similarly as the yellow dots.

MODIS Rapid Response System

MODIS Image Subsets – Aqua Satellite Passes on Feb 13, 2012

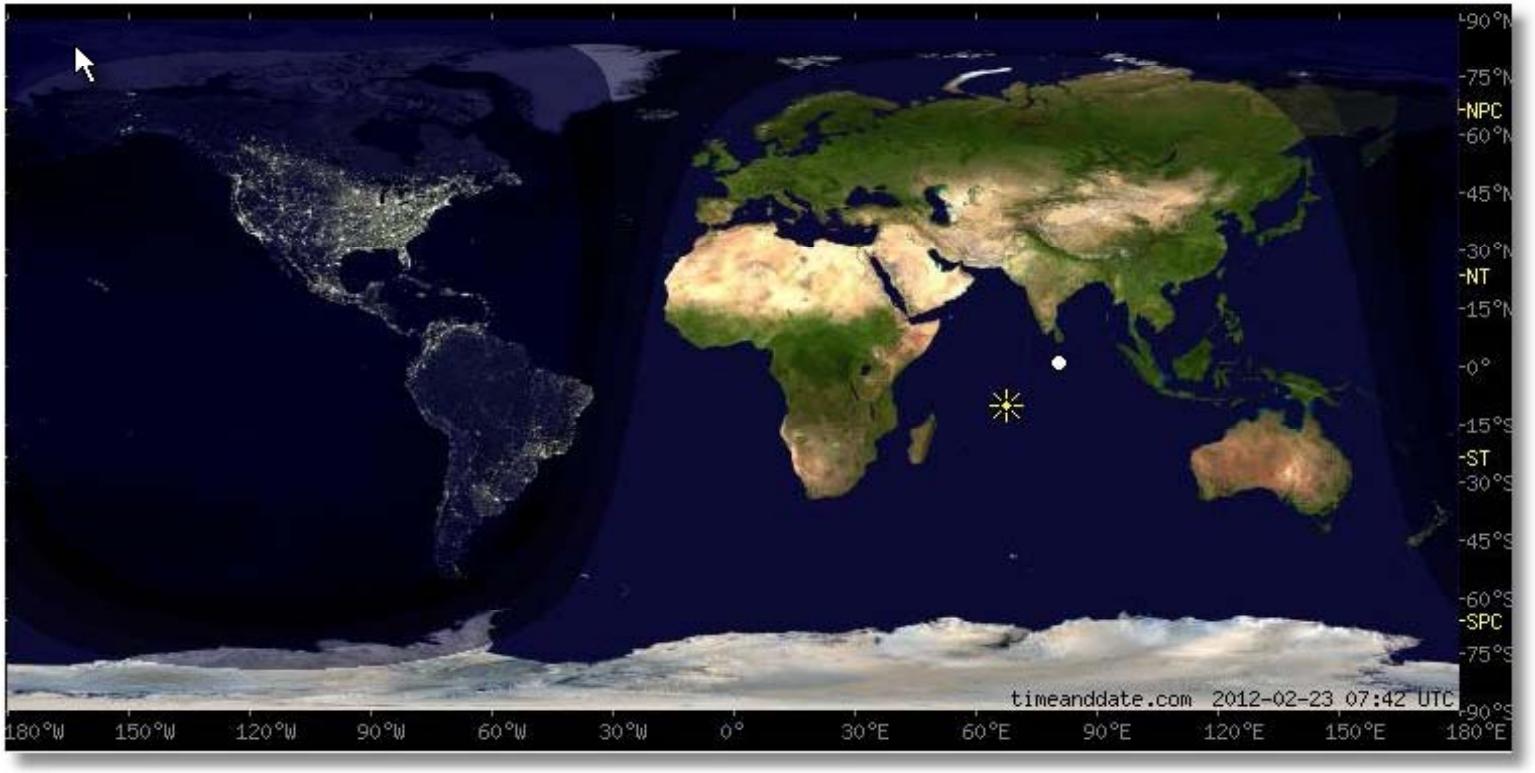


Source: MODIS Rapid Response – LANCE (Feb 23, 2012)

Terra Satellite flight direction is shown by red arrow. The red dots show the overpass time of each 5-min granule. Similarly as the yellow dots.

MODIS Rapid Response System

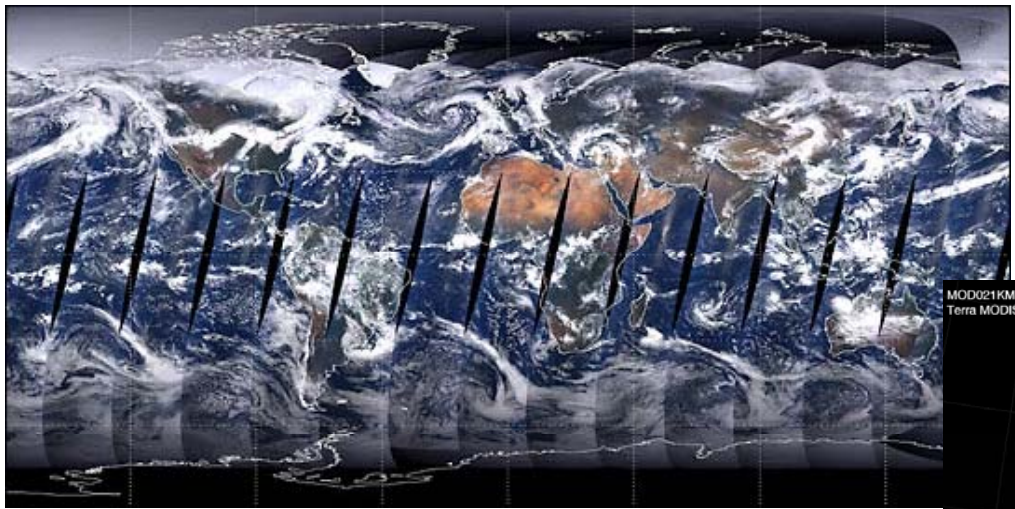
MODIS Image Subsets – Day and Night World Map – Day and night MODIS 5-min granules (subsets)

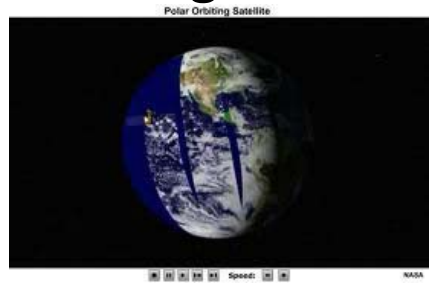


Source: http://www.timeanddate.com/worldclock/sunearth.html (Feb 23, 2012)

MODIS Rapid Response System

Terra Orbit – Terra Passes – Terra MODIS Image Subsets





Terra Orbit

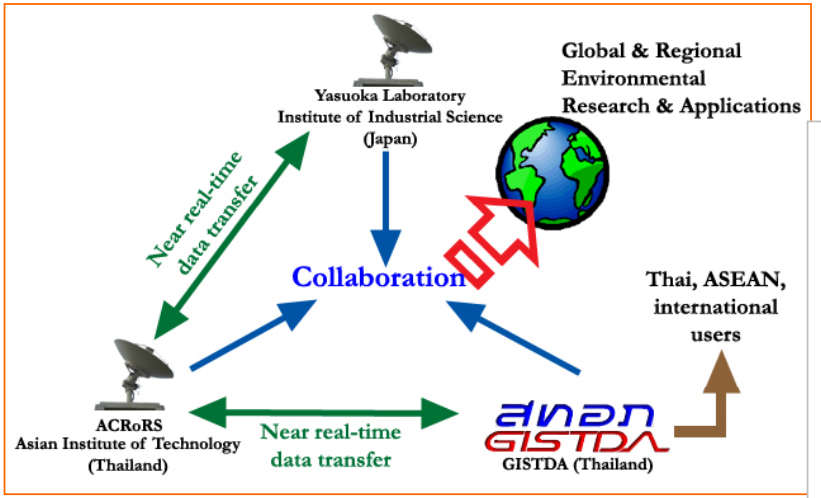
Terra Passes

NASA MODIS 5-min. granules

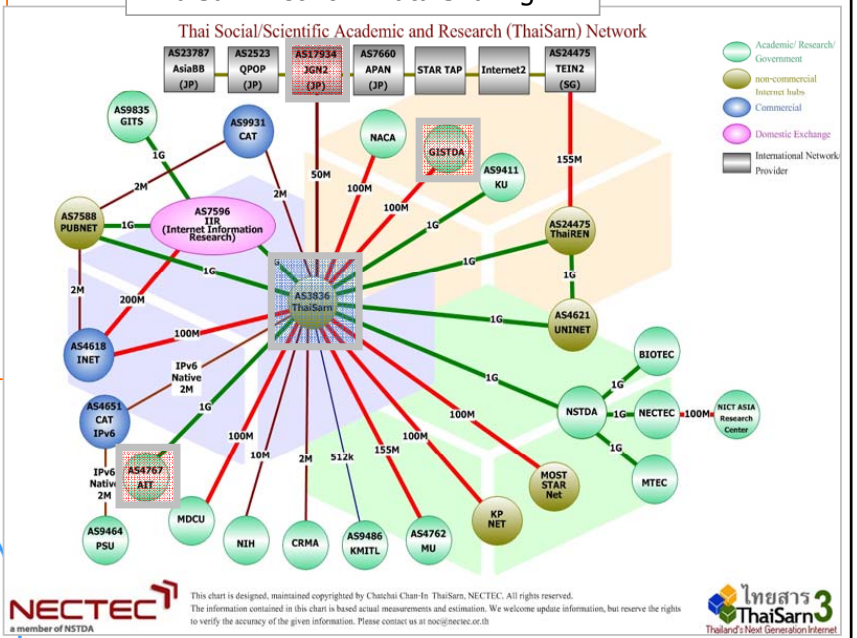
15:15 UTC 15:20 UTC 15:25 UTC

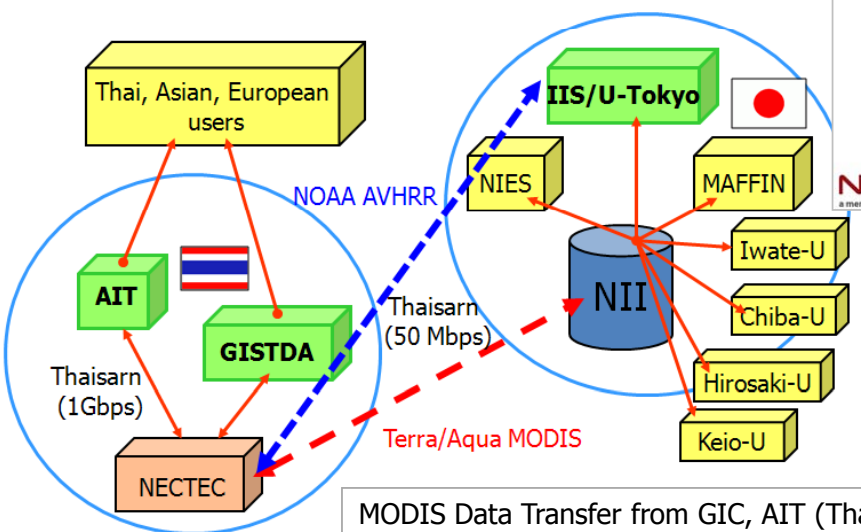
Terra MODIS Sep. 12, 2001
15:20 UTC

MODIS Program in AIT since 2001



ThaiSarn Network Data Sharing





MODIS Data Transfer from GIC, AIT (Thailand) to GISTDA(Thailand) and NII (Japan)

MODIS Program at Geoinformatics Center, AIT since May 2001:

- **Sawada Lab @ University of Tokyo, Japan**
- **GISTDA , Thailand**
- **Geoinformatics Center, AIT, Thailand**

Terra/Aqua MODIS Spectral Bands Specifications

TERRA/MODIS Sensor Characteristics

Primary Use	Band Groups	Band Color	Band	Bandwidth[1]	Spectral Radiance[2]	Required SNR[3]	Purpose (Example)
Land/Cloud/Aerosols Boundaries	①	Yellow - Red	1	620 - 670	21.8	128	Veg. Chlorophyll Absorption
		NIR	2	841 - 876	24.7	201	Cloud and Veg. Land Cover Transformation
Land/Cloud/Aerosols Properties		Blue	3	459 - 479	35.3	243	Soil, Vegetation Differences
		Green	4	545 - 565	29.0	228	Green Vegetation
		NIR	5	1230 - 1250	5.4	74	Leaf/Canopy Differences
		SWIR	6	1628 - 1652	7.3	275	Snow/Cloud Differences
		SWIR	7	2105 - 2155	1.0	110	Land and Cloud Properties
Ocean Color/ Phytoplankton/ Biogeochemistry	②	UV	8	405 - 420	44.9	880	Chlorophyll
		Blue	9	438 - 448	41.9	838	Chlorophyll
		Blue	10	483 - 493	32.1	802	Chlorophyll
		Green	11	526 - 536	27.9	754	Chlorophyll
		Green	12	546 - 556	21.0	750	Sediments
		Yellow	13	662 - 672	9.5	910	Sediments, Atmosphere
		Red	14	673 - 683	8.7	1087	Chlorophyll Fluorescence
		NIR	15	743 - 753	10.2	586	Aerosol Properties
		NIR	16	862 - 877	6.2	516	Aerosol / Atmospheric Properties
Atmospheric Water Vapor	③	NIR	17	890 - 920	10.0	167	Cloud / Atmospheric Properties
		NIR	18	931 - 941	3.6	57	Cloud / Atmospheric Properties
		NIR	19	915 - 965	15.0	250	Cloud / Atmospheric Properties

Note:

①	Land and Cloud Boundaries/Properties Bands
②	Ocean Color Bands
③	Atmosphere / Ocean Bands

Primary Use		Band	Bandwidth[1]	Spectral Radiance[2]	Required NE[delta]T(K)[4]	
Surface/Cloud Temperature	③	IIR	20	3.660 - 3.840	0.45(300K)	0.05	Sea Surface Temperature
		IIR	21	3.929 - 3.989	2.38(335K)	2.00	Forest Finfraredes/ Volcanoes
		IIR	22	3.929 - 3.989	0.67(300K)	0.07	Cloud/ Surface Temperature
		IIR	23	4.020 - 4.080	0.79(300K)	0.07	Cloud/ Surface Temperature
Atmospheric Temperature		IIR	24	4.433 - 4.498	0.17(250K)	0.25	Trospospheric Temperature/Could Fraction
		IIR	25	4.482 - 4.549	0.59(275K)	0.25	Trospospheric Temperature/Could Fraction
Cirrus Clouds Water Vapor		SWIR	26	1.360 - 1.390	6.00	150(SNR)	Cinfraredrus Cloud Detection
		IR	27	6.535 - 6.895	1.16(240K)	0.25	Mid-Trospospheric Humidity
		IR	28	7.175 - 7.475	2.18(250K)	0.25	Upper-Trospospheric Humidity
Cloud Properties		TIR	29	8.400 - 8.700	9.58(300K)	0.05	Surface Temperature
Ozone		TIR	30	9.580 - 9.880	3.69(250K)	0.25	Total Ozone
Surface/Cloud Temperature		TIR	31	10.780 - 11.280	9.55(300K)	0.05	Cloud/Surface Temperature
		TIR	32	11.770 - 12.270	8.94(300K)	0.05	Cloud Height and Surface Temperature
Cloud Top Altitude		TIR	33	13.185 - 13.485	4.52(260K)	0.25	Cloud Height and Surface Fraction
		TIR	34	13.485 - 13.785	3.76(250K)	0.25	Cloud Height and Surface Fraction
		TIR	35	13.785 - 14.085	3.11(240K)	0.25	Cloud Height and Surface Fraction
		FIR	36	14.085 - 14.385	2.08(220K)	0.35	Cloud Height and Surface Fraction

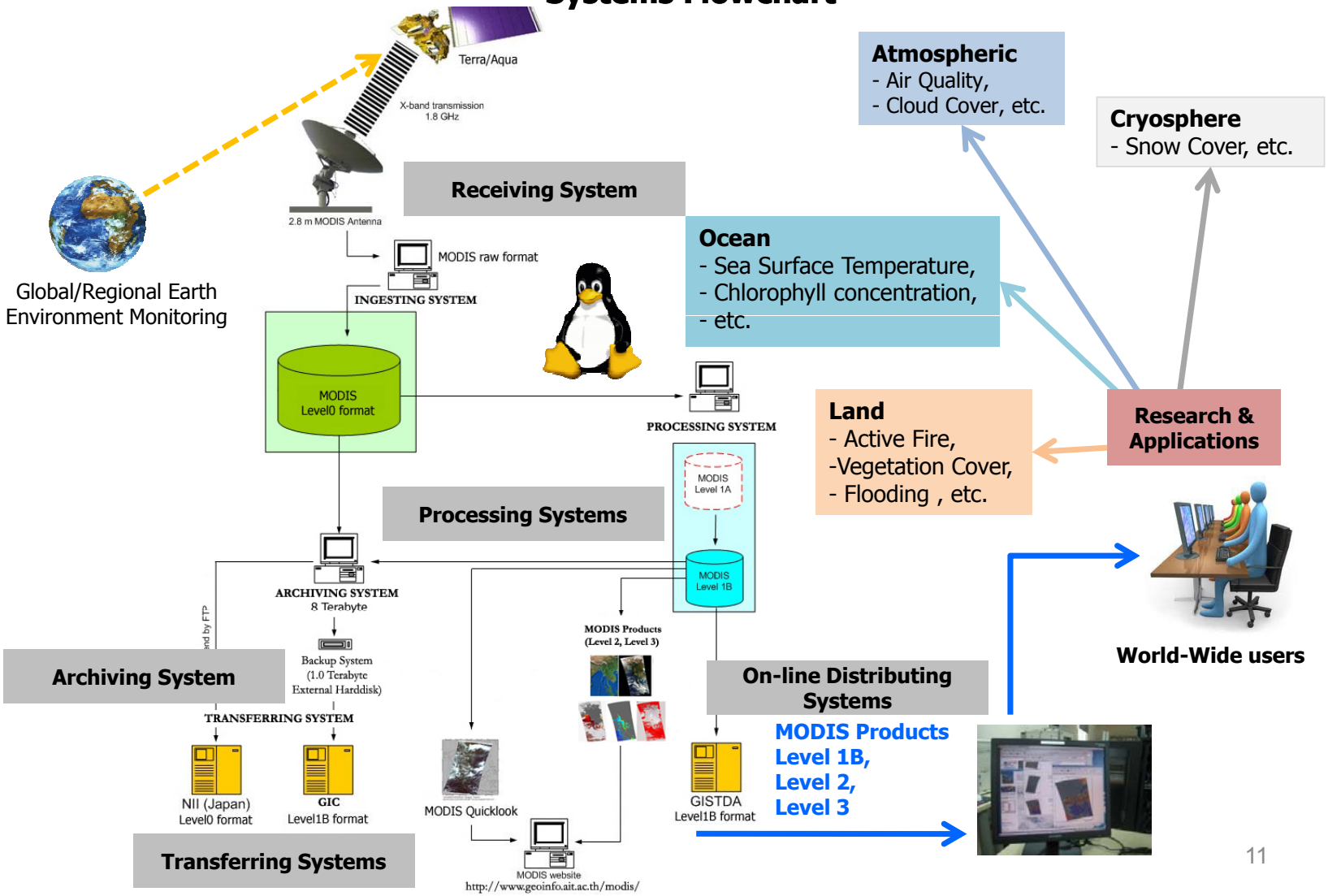
Footnotes:
[1] Bands 1 to 19 are in nm; Bands 20 to 36 are in μm
[2] Spectral Radiance values are (W/m²-μm-sr)
[3] SNR = Signal-to-noise ratio
[4] NE(delta)T = Noise-equivalent temperature difference
Note: Performance goal is 30-40% better than required

Spatial Resolution (in meter)

0.4 – 3.0 μm : Reflective band

3.0 – 15 μm : Emissive Bands (Thermal bands)

GIC/AIT Near Real time Automatic MODIS Receiving, Processing, Archiving, Transferring and Distributing Systems Flowchart

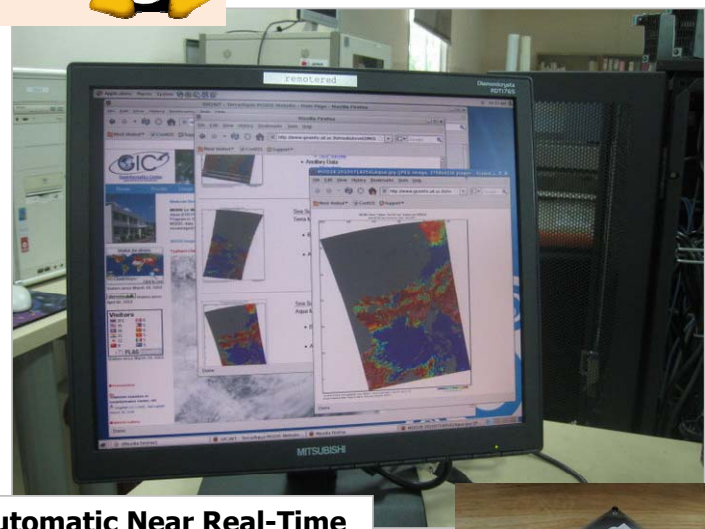


Terra/Aqua MODIS Receiving, Archiving and Processing Systems in Geoinformatics Center (GIC), AIT

- **Operational since May 2001 – present**
- **More than 20,000 Scenes for Terra/Aqua(day and night)**
- **Covering 19 countries (South and Southeast Asia)**
- **Products include:**
  Land, Ocean, Atmosphere and Cryosphere disciplines
- **Most products are Standard NASA Products**
- **Mostly use NASA ATBD** (Algorithm Theoretical Basic Documents) **for data processing**
- **Operating System : Linux** (only!)

Concept of Processing System:
- **Automatic**
- **Near Real-time**
- **Daily (6-8 image scenes/day)**
- **Online Product Access for 24 hours**
- **Easy-to-use Data format Products**

Receiving System



Automatic Near Real-Time Processing Systems

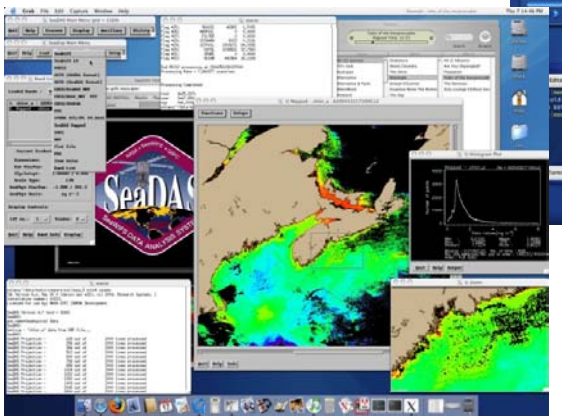
Backup Storage:
- **External USB Hard disks (2.0 TB)**
- **DLT Tapes (40 Gigabytes)**

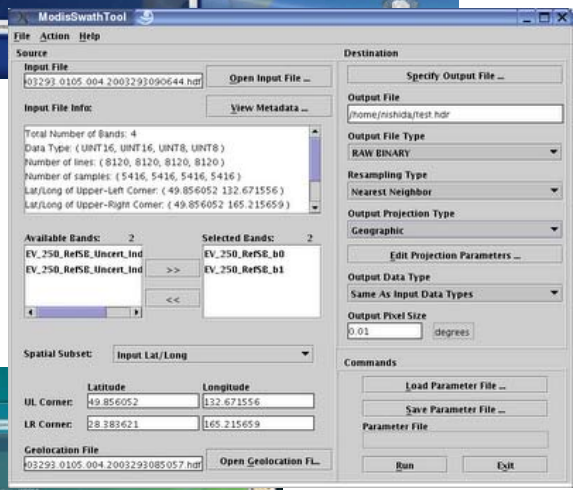
Terra/Aqua MODIS Processing System - Software

http://www.geoinfo.ait.ac.th/modis/modsoftware.php

1. Free Software (Linux-based)

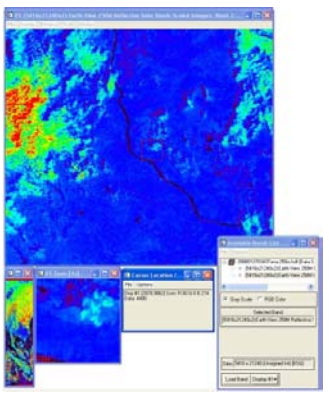
- IMAPP 2.1
- MODISL1DB 1.7
- SIMAP 4.0
- MRTSwath
- HDFLook 8.x
- SeaDAS 5.0
- ScanView
- Hdfview 2.7
- HEG Tools, etc

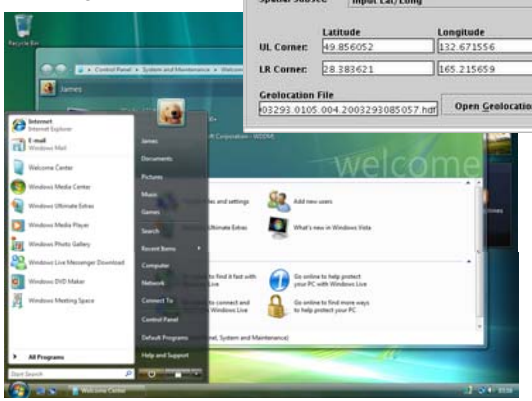




2. Commercial Software (Windows-based)

- ENVI 4.x
- ER-Mapper
- ERDAS, etc.

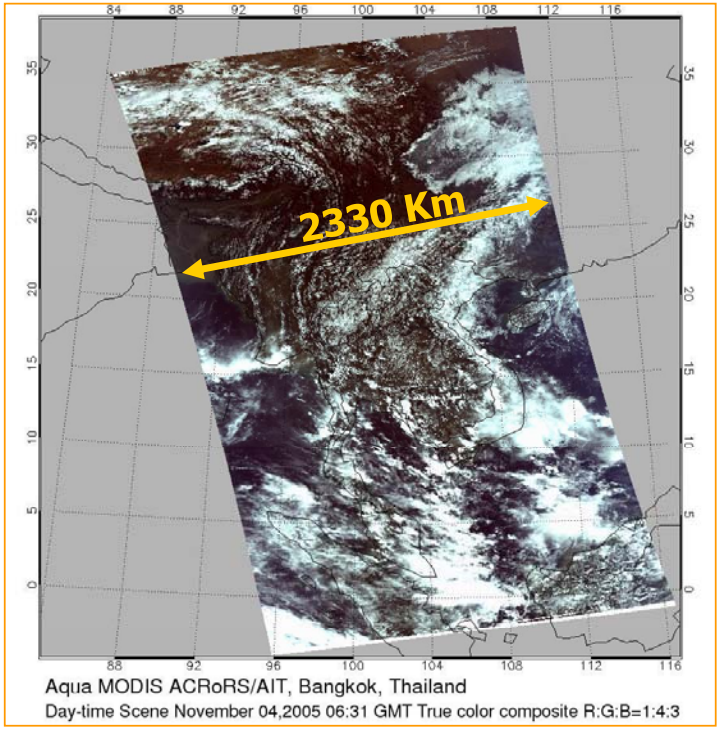




Terra/Aqua MODIS Receiving Coverage in AIT

The Philippines, Taiwan, Indonesia (Kalimantan, Sumatra and Java), Timor Leste, Malaysia (Malaya and Sarawak), Brunei, Singapore, Vietnam, Laos, Thailand, Cambodia, Myanmar, Southern half of China (including Tibet), Easter part of Pakistan, Bangladesh, Nepal, Bhutan, India and Sri Lanka

- Southern China and Andaman Seas
- Gulfs of Tonkin, Thailand and Bengal



Aqua MODIS ACRoRS/AIT, Bangkok, Thailand
Day-time Scene November 04,2005 06:31 GMT True color composite R:G:B=1:4:3

NASA Standard MODIS Products

Calibration

- MOD 01 - Level-1A Radiance Counts
- MOD 02 - Level-1B Calibrated Geolocated Radiances
- MOD 03 - Geolocation Data Set

Atmosphere

- MOD 04 - Aerosol Product
- MOD 05 - Total Precipitable Water (Water Vapor)
- MOD 06 - Cloud Product
- MOD 07 - Atmospheric Profiles
- MOD 08 - Gridded Atmospheric Product
- MOD 35 - Cloud Mask

Land

- MOD 09 - Surface Reflectance
- MOD 11 - Land Surface Temperature & Emissivity
- MOD 12 - Land Cover/Land Cover Change
- MOD 13 - Gridded Vegetation Indices (Max NDVI & Integrated MVI)
- MOD 14 - Thermail Anomalies, Fires & Biomass Burning
- MOD 15 - Leaf Area Index & FPAR
- MOD 16 - Evapotranspiration
- MOD 17 - Net Photosynthesis and Primary Productivity
- MOD 43 - Surface Reflectance
- MOD 44 - Vegetation Cover Conversion

Cryosphere

- MOD 10 - Snow Cover
- MOD 29 - Sea Ice Cover

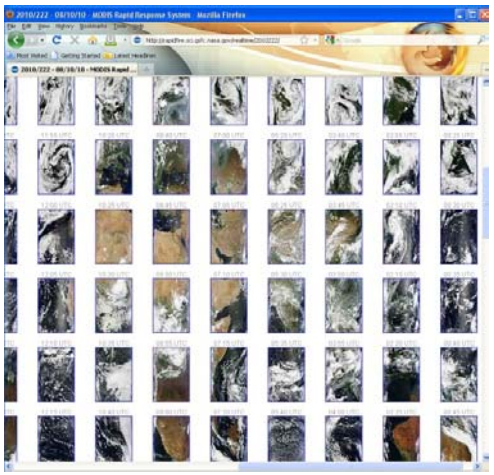
Ocean

- Angstrom Exponent
- Aerosol Optical Thickness
- Chlorophyll a
- Downwelling diffuse attenuation coefficient at 490 nm
- Level 2 Flags
- Photosynthetically Available Radiation
- Particulate Inorganic Carbon
- Particulate Organic Carbon
- Sea Surface Temperature Quality
- Sea Surface Temperature Quality - 4um
- Remote Sensing Reflectance
- Sea Surface Temperature
- Sea Surface Temperature 4um

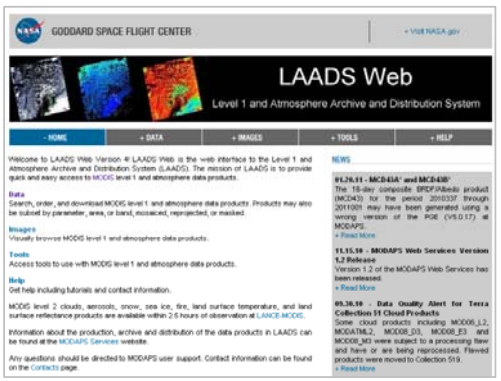
MODIS Science Team

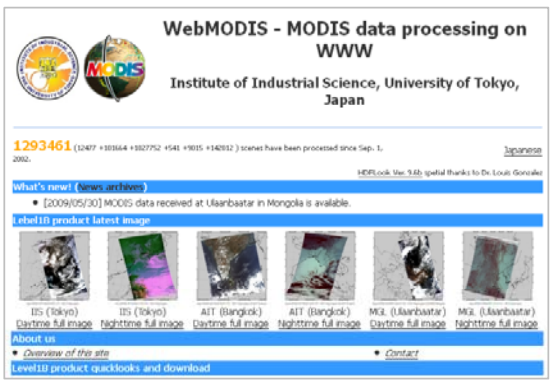
- **Calibration Discipline Group**
  - MODIS Characterization Support Team (MCST)
    - http://www.mcst.ssai.biz/mcstweb/index.html
- **Land Discipline Group** (including Snow/Ice Group)
  - MODLAND
    - http://modis-land.gsfc.nasa.gov/
- **Oceans Discipline Group**
  - Ocean Color
    - http://oceancolor.gsfc.nasa.gov/
- **Atmosphere Discipline Group**
    - http://modis-atmos.gsfc.nasa.gov/

MODIS Data Product on the Internet



- **Geoinformatics Center, AIT**
  - http://www.geoinfo.ait.ac.th/modis/
- **Sawada Laboratory, Institute of Industrial Sciences (IIS), University of Tokyo**
  - http://webmodis.iis.u-tokyo.ac.jp/
- **MODIS Rapid Response System**
  - http://rapidfire.sci.gsfc.nasa.gov/
- **Level 1 and Atmospheric Archive and Distribution System (LAADS) Web**
  - ftp://ladsweb.nascom.nasa.gov/
  - http://ladsweb.nascom.nasa.gov/



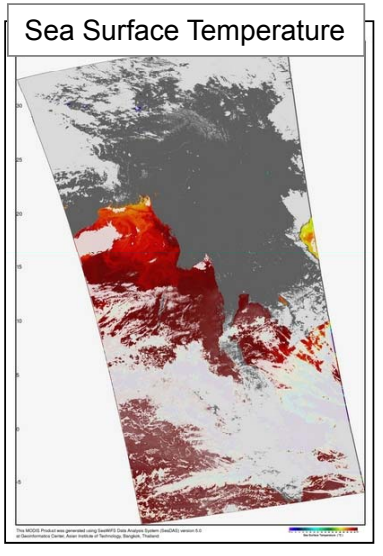


MODIS Products available in Geoinformatics Center, AIT

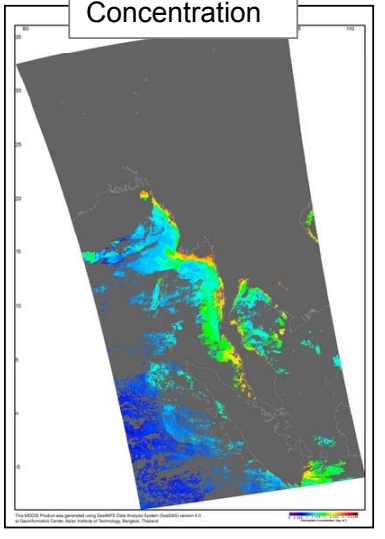
MODIS True Color

Active Fire

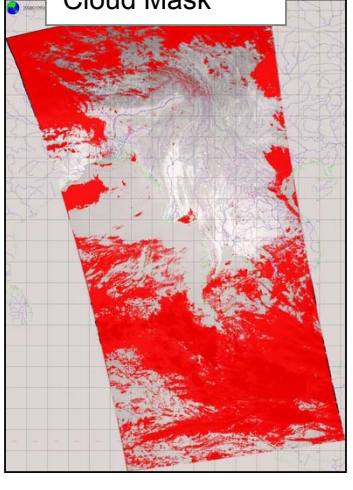
Sea Surface Temperature

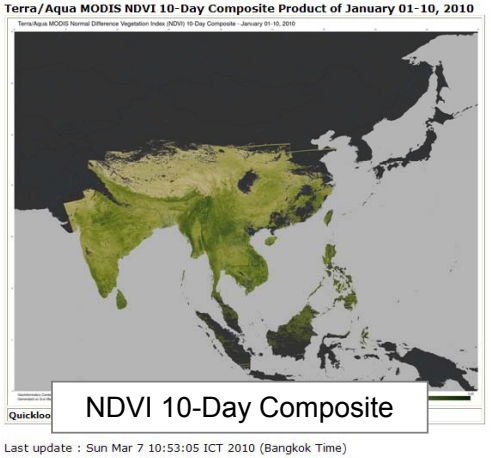


Chlorophyll-a Concentration



Cloud Mask





NDVI 10-Day Composite

Last update : Sun Mar 7 10:53:05 ICT 2010 (Bangkok Time)

1. MODIS True Color 250m resolution

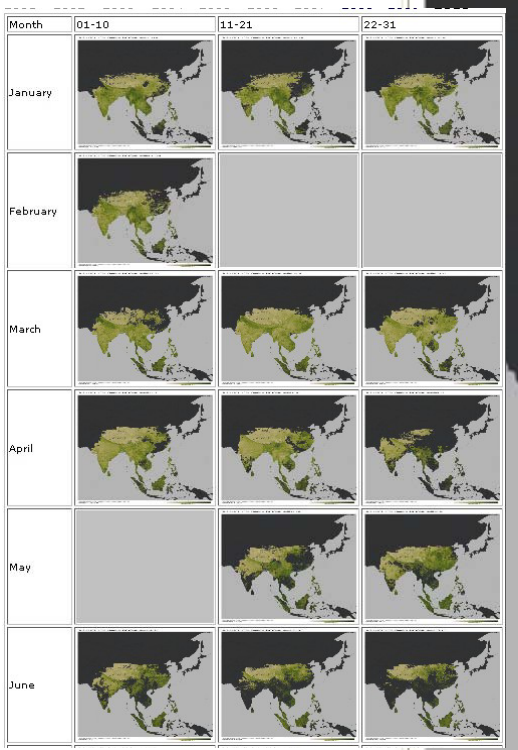
2. Active Fire and Thermal Anomalies (MOD14)

3. Cloud Masking (MOD35)

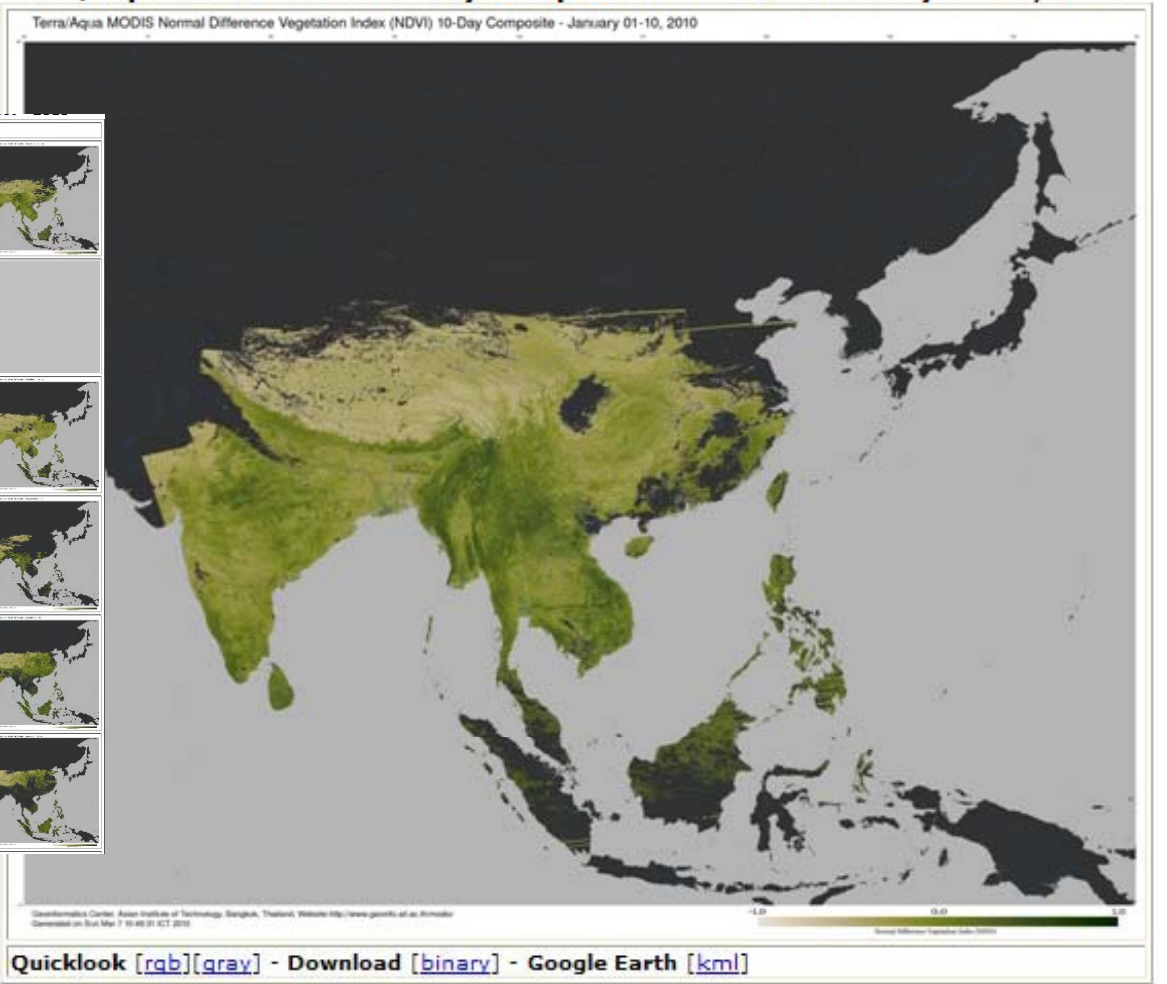
4. Ocean Color Products :
   - 3.1 Sea Surface Temperature (MOD28)
   - 3.2 Chlorophyll-a Concentration (MOD21)

5. NDVI 10-Day Composite

10-Day Composite MODIS Imagery



Terra/Aqua MODIS NDVI 10-Day Composite Product of January 01-10, 2010

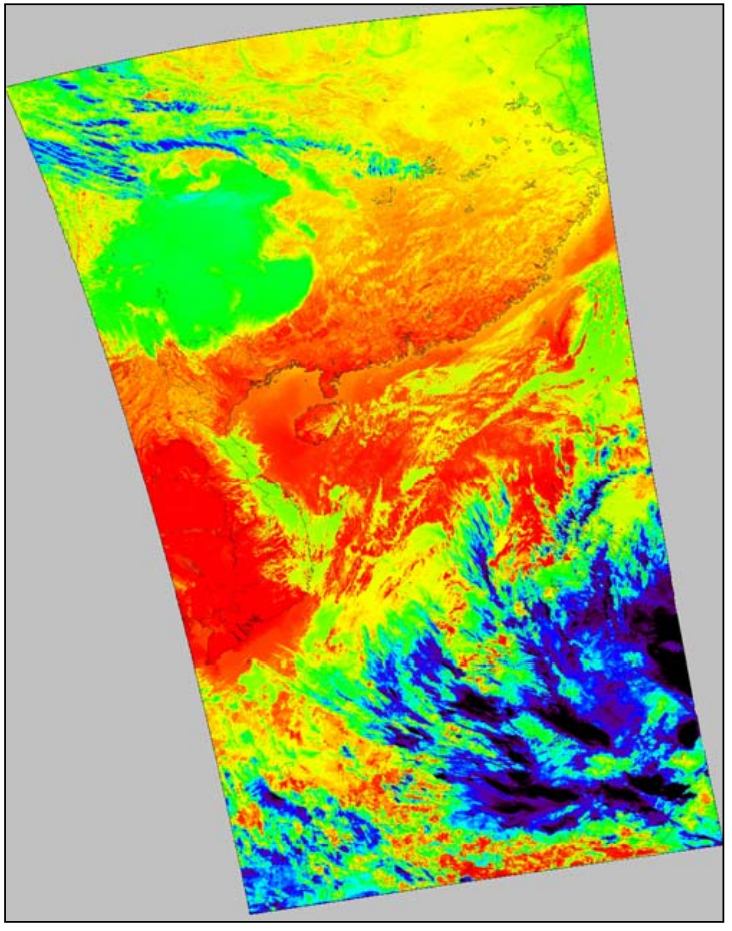


Quicklook [rgb][gray] - **Download** [binary] - **Google Earth** [kml]

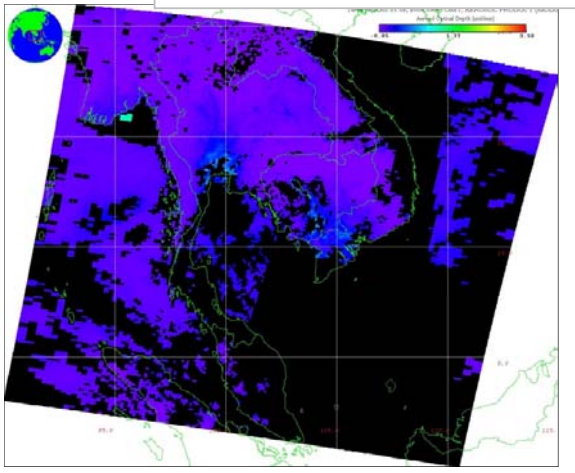
Last update : Sun Mar 7 10:53:05 ICT 2010 (Bangkok Time)

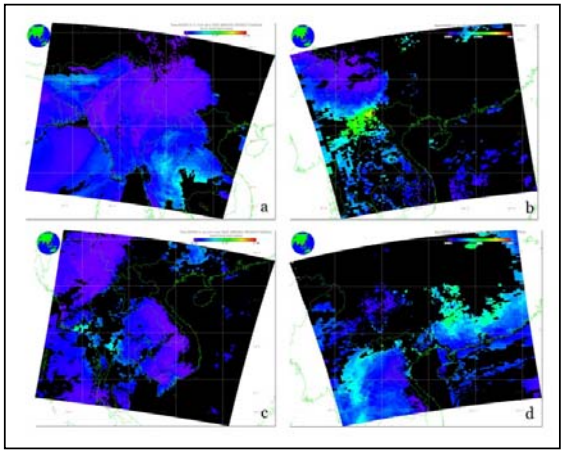
MODIS Products under development in Geoinformatics Center, AIT

1. Land Surface Temperature (MOD11)
2. Surface Reflectance (MOD09)
3. Aerosol Optical Thickness (MOD04)
4. Burning Area



Land Surface Temperature (MOD11)



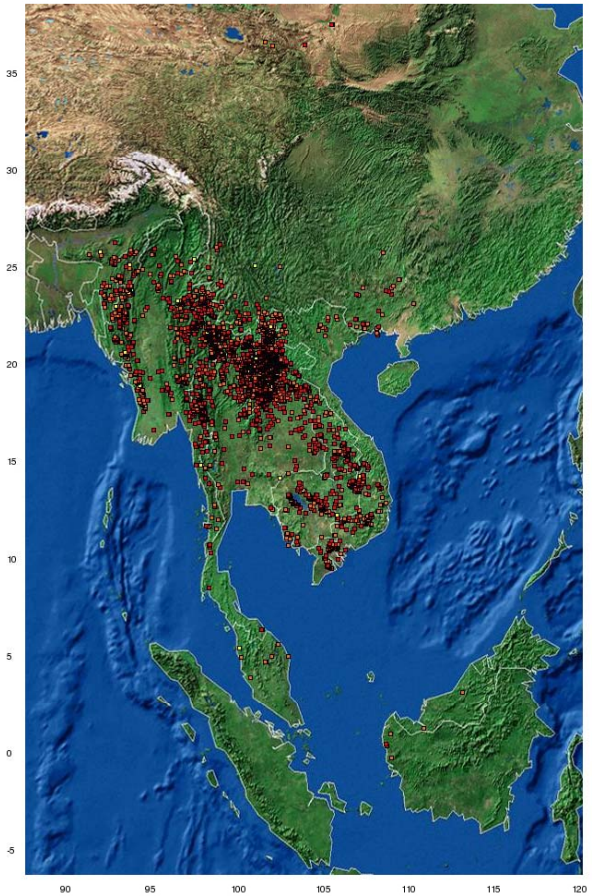


Aerosol Optical Thickness (MOD04)

Application of MODIS Active Fires and Aerosol Products for Biomass Burning and Air Quality Monitoring in SE Asia

MODIS Fire Product(MOD14)

Aqua MODIS Day-time Scene March 25,2010 06:24GMT

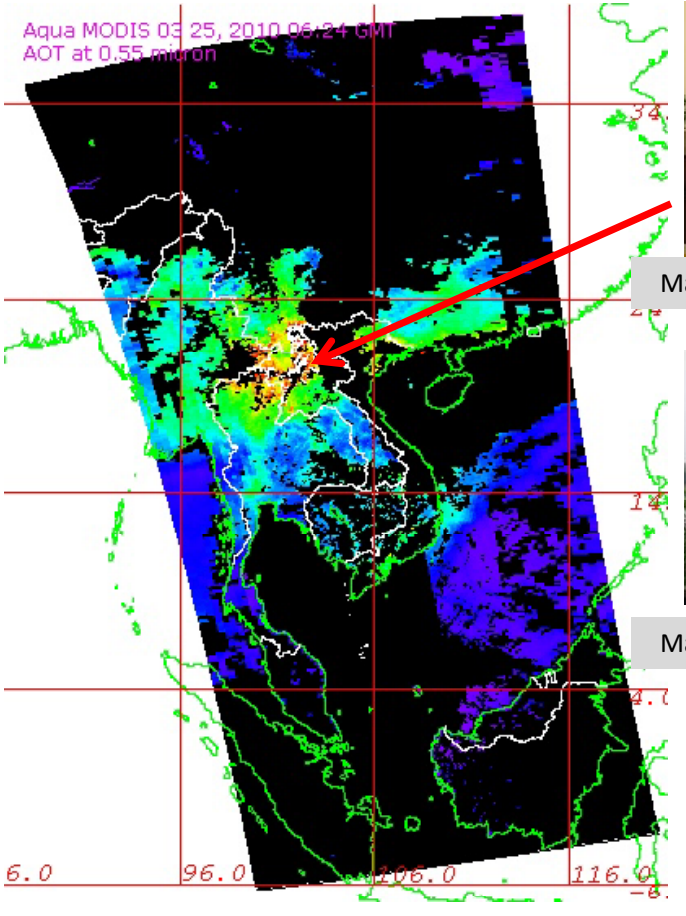


Total Hotspot: 5160

Fire Confidence Classes: Low(yellow): 93 Nominal(orange): 1320 High(red): 3747

The product was generated using MODIS Active Fire Product (MOD14) Production Code, Version 4.3.2 at Geoinformatics Center, Asian Institute of Technology, Bangkok, Thailand

Aerosol Optical Thickness (MOD04)

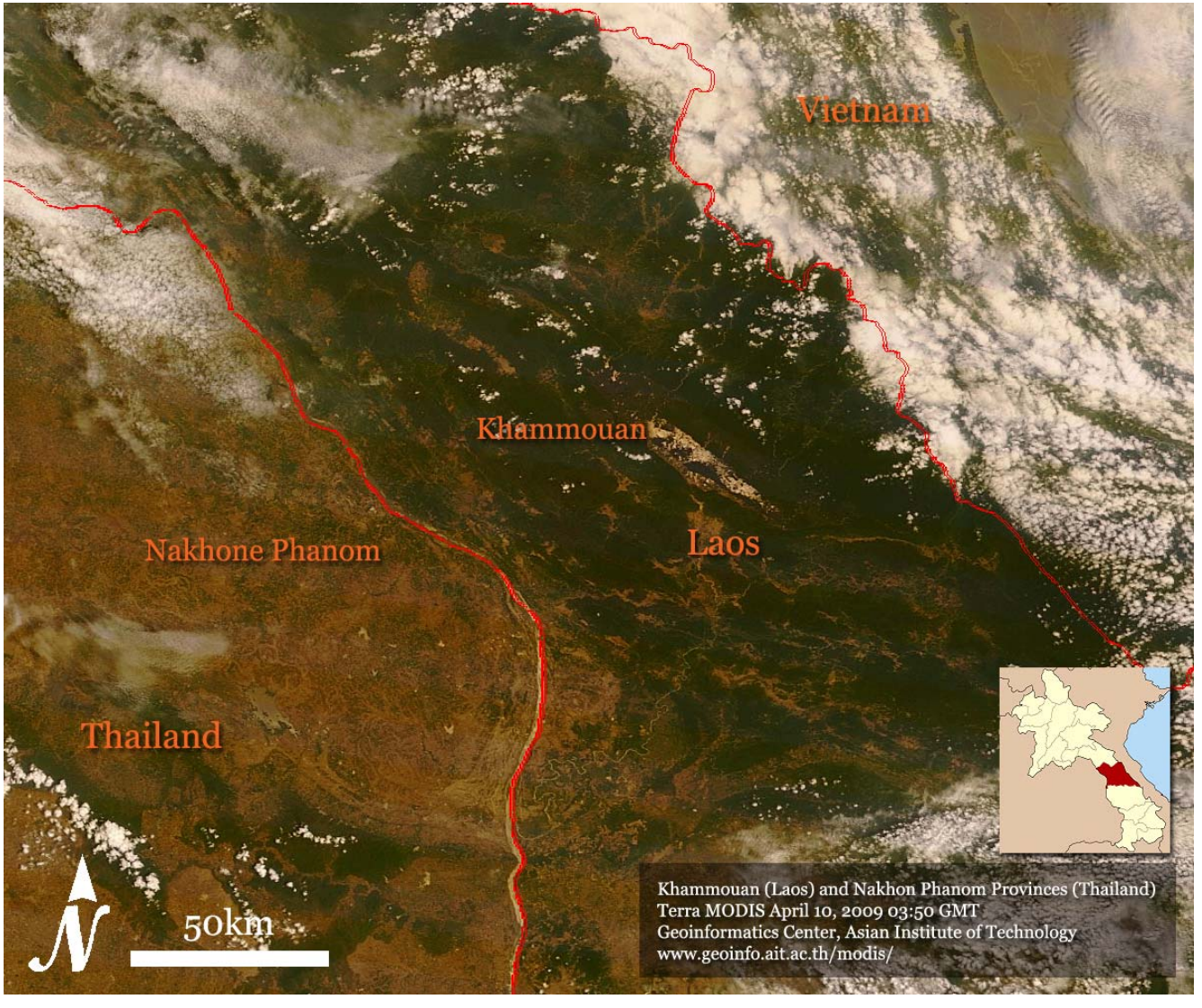


Aqua MODIS March 25, 2010 06:24 GMT

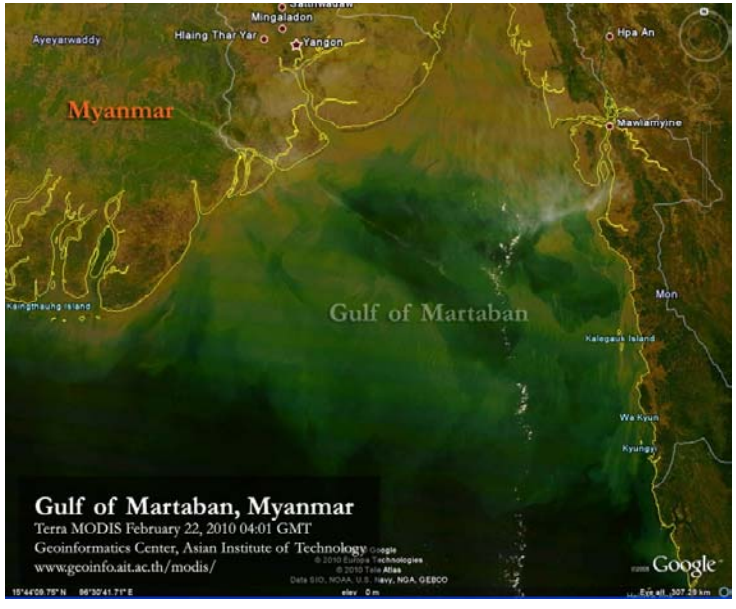
March 25, 2010, Luang Prabang

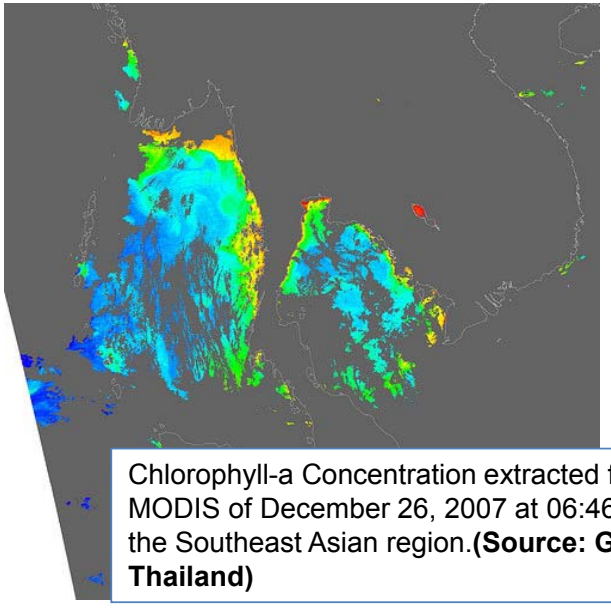
March 26, 2010, Luang Prabang

Monitoring of Land Cover using MODIS imagery

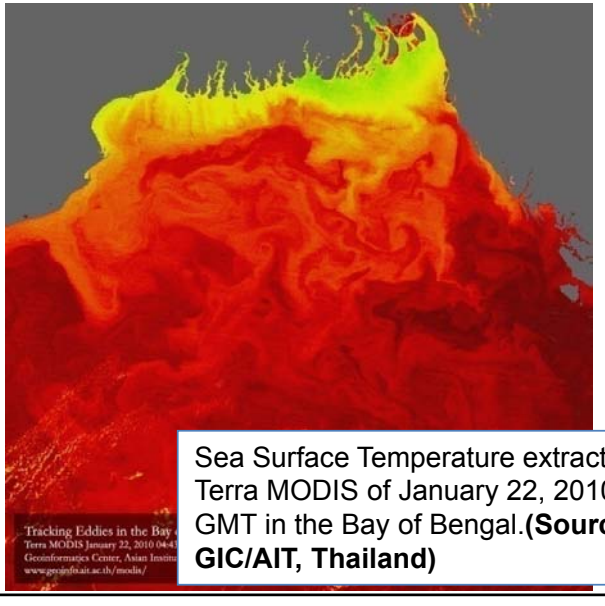


Monitoring of Ocean Color using MODIS imagery





Chlorophyll-a Concentration extracted from Aqua MODIS of December 26, 2007 at 06:46 GMT in the Southeast Asian region.**(Source: GIC/AIT, Thailand)**

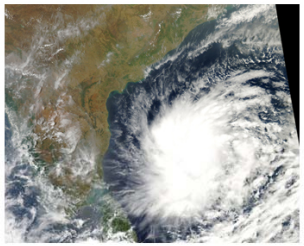


Sea Surface Temperature extracted from Terra MODIS of January 22, 2010 at 04:43 GMT in the Bay of Bengal.**(Source: GIC/AIT, Thailand)**

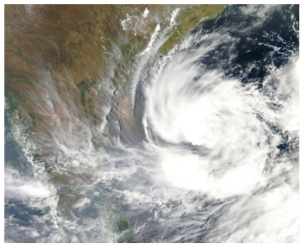
Typhoon/Tropical Cyclone Monitoring using MODIS

TROPICAL CYCLONE NARGIS

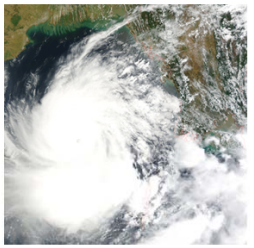
Terra/Aqua MODIS Time-Serie (April 27- May 03, 2008)



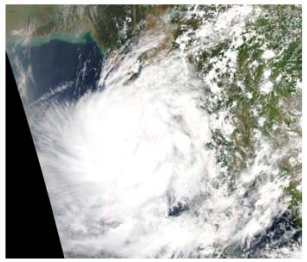
Aqua MODIS April 27, 2008, 08:06 GMT



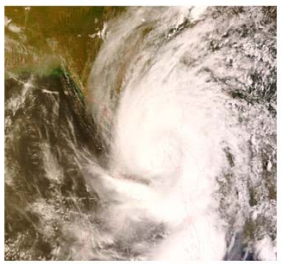
Aqua MODIS April 29, 2008 07:54 GMT



Terra MODIS May 01, 2008 04:35 GMT

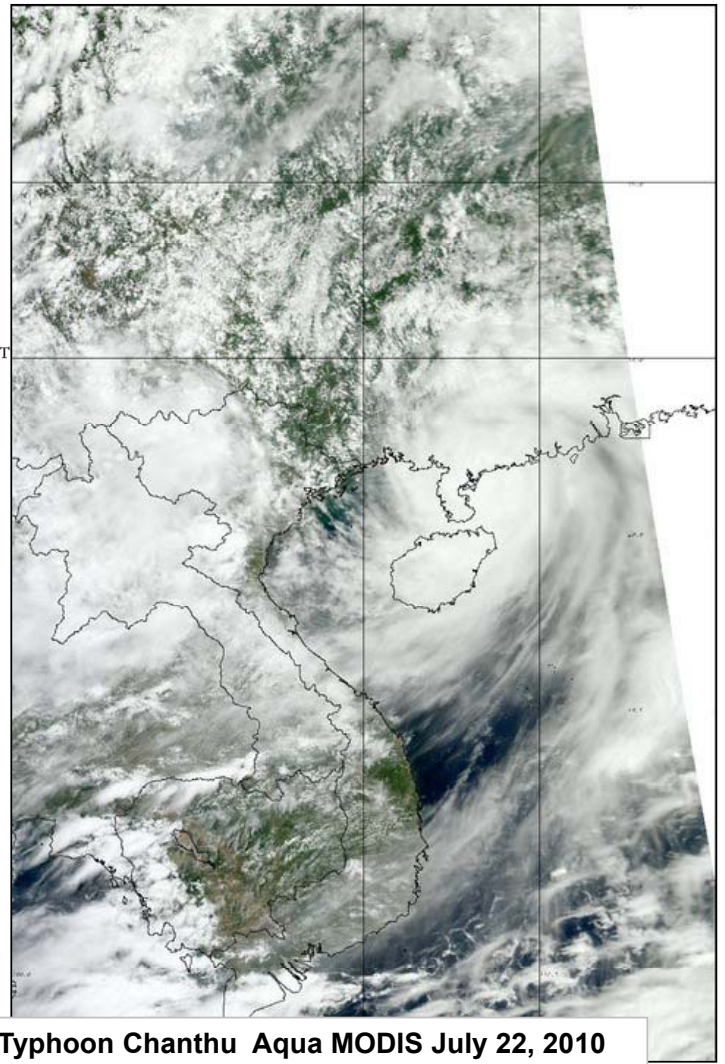


Aqua MODIS May 02, 2008 06:46 GMT



Terra MODIS May 03, 2008 04:25 GMT

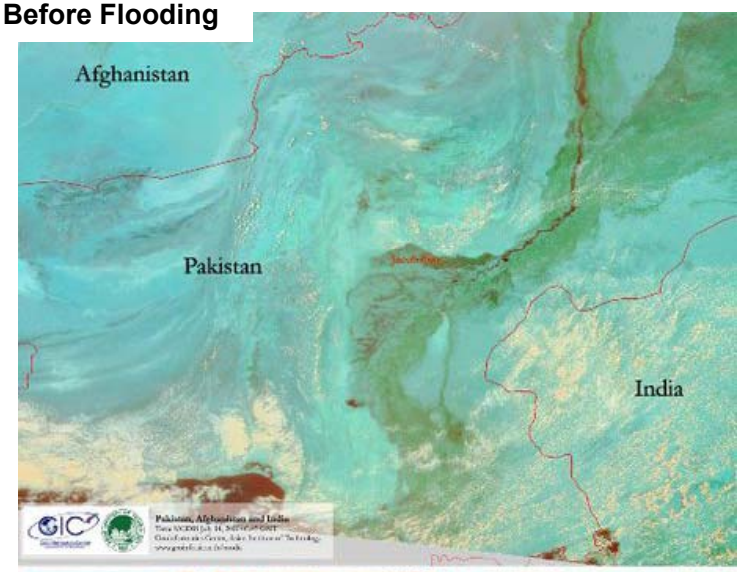
AIT ASIAN INSTITUTE OF TECHNOLOGY GIC Geoinformatics Center, Asian Institute of Technology, Bangkok, Thailand



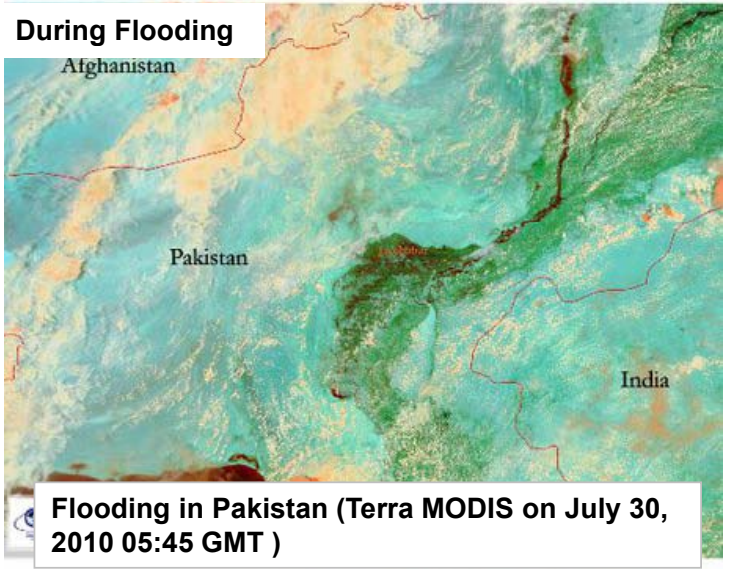
Typhoon Chanthu Aqua MODIS July 22, 2010 06:29 GMT (Source: GIC/AIT, Thailand)

Regional Flood Monitoring using MODIS

Before Flooding

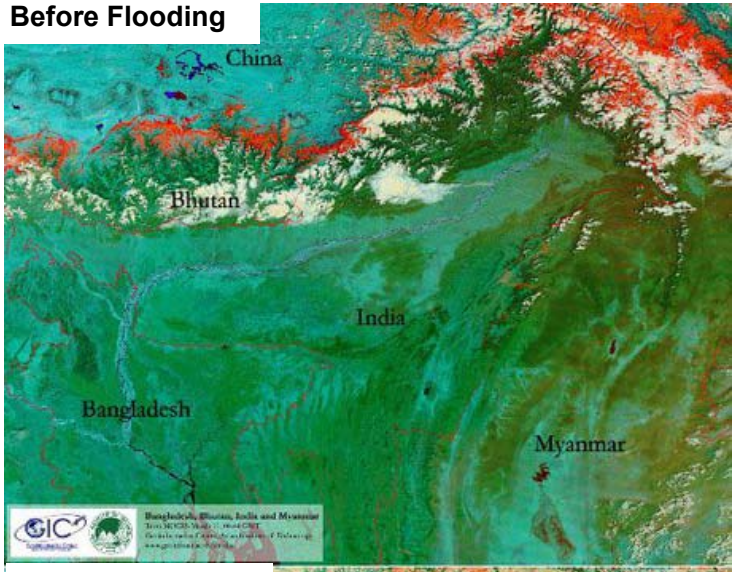


During Flooding

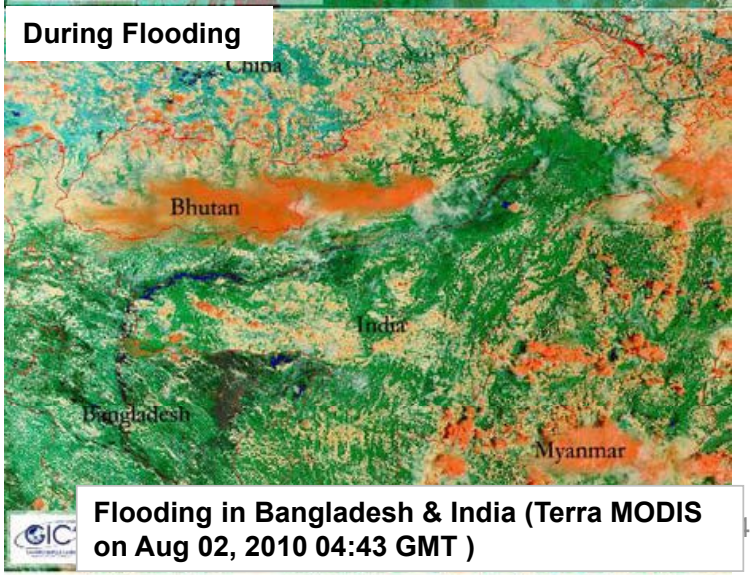


Flooding in Pakistan (Terra MODIS on July 30, 2010 05:45 GMT)

Before Flooding



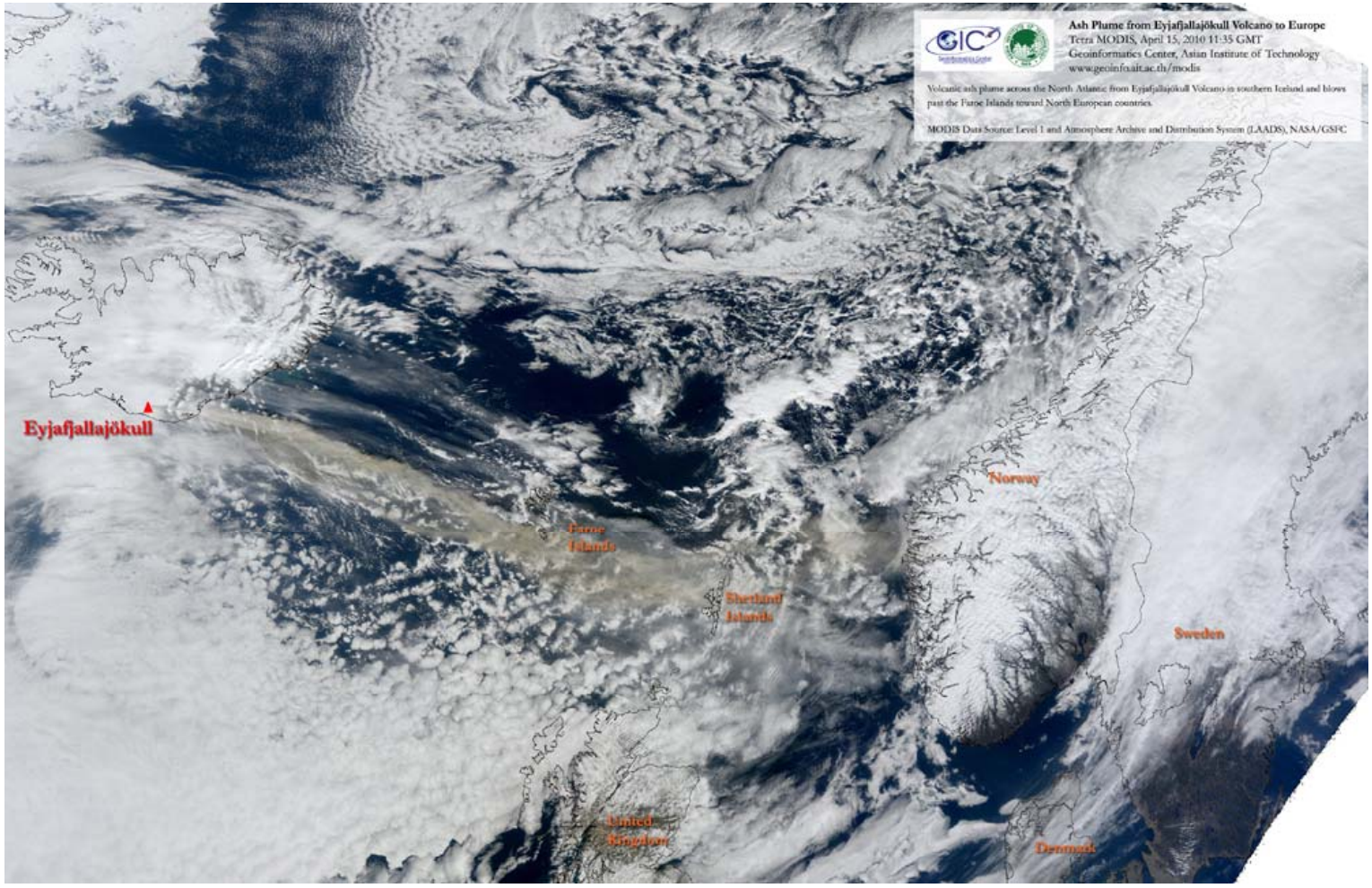
During Flooding



Flooding in Bangladesh & India (Terra MODIS on Aug 02, 2010 04:43 GMT)

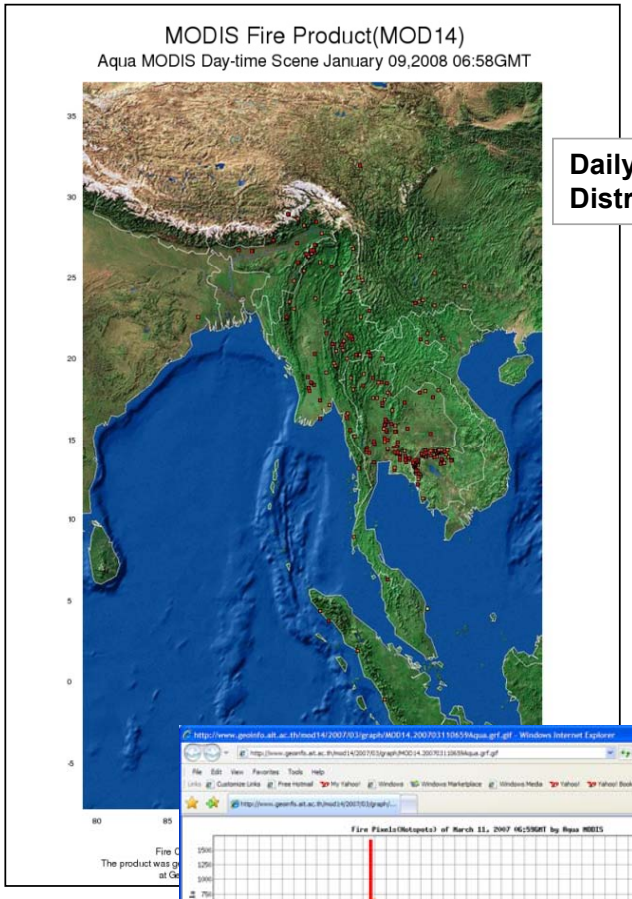
Monitoring of Volcano Eruption using MODIS imagery

Ash Plume from Eyjafjallajökull Volcano to Europe

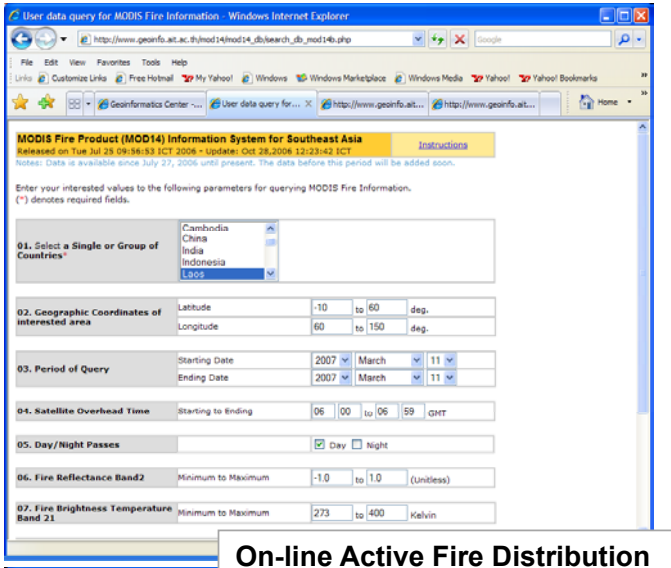


Eyjafjallajökull Volcano seen by Terra MODIS April 15, 2010 11:35 GMT (Source: GIC/AIT, Thailand)

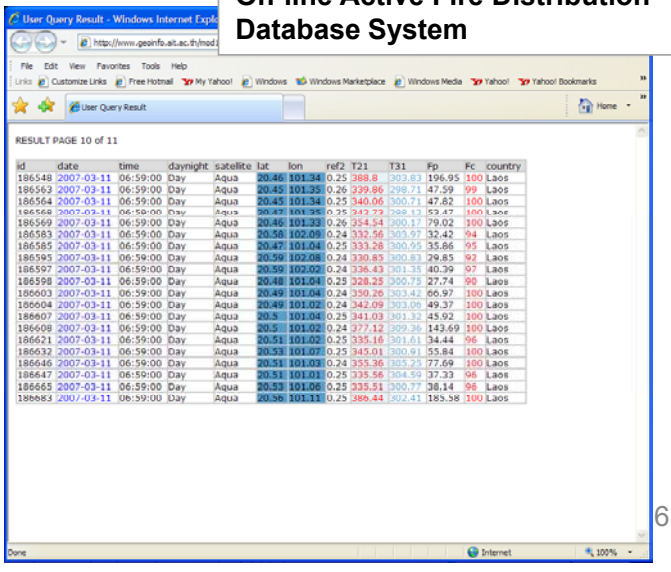
MODIS Active Fire Monitoring System in Regional Level – South and Southeast Asia

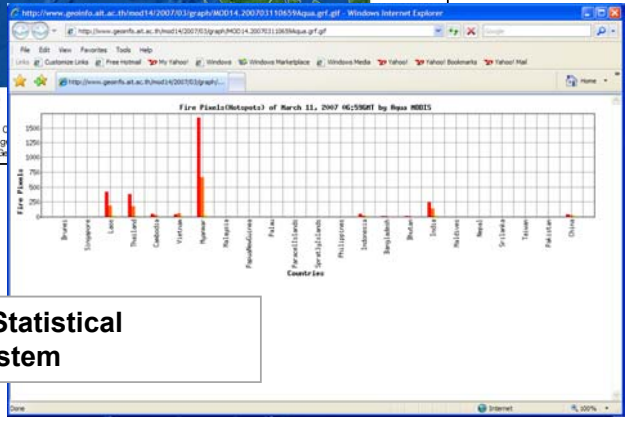


Daily Active Fire Distribution Maps



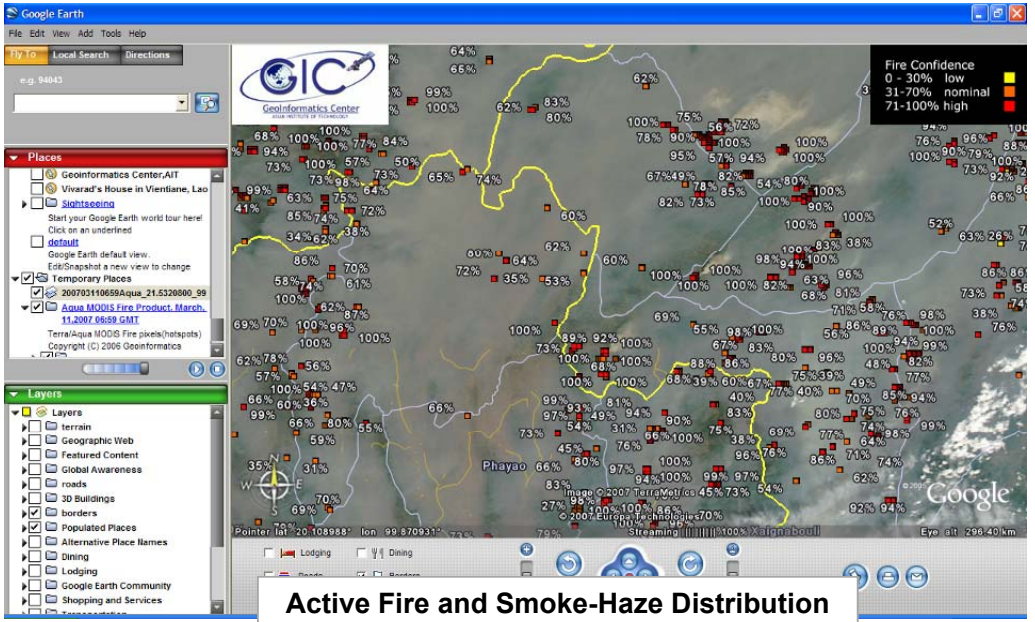
On-line Active Fire Distribution Database System





Active Fire Statistical Analysis System

MODIS Active Fire Monitoring & Visualization System in Regional Level South and Southeast Asia



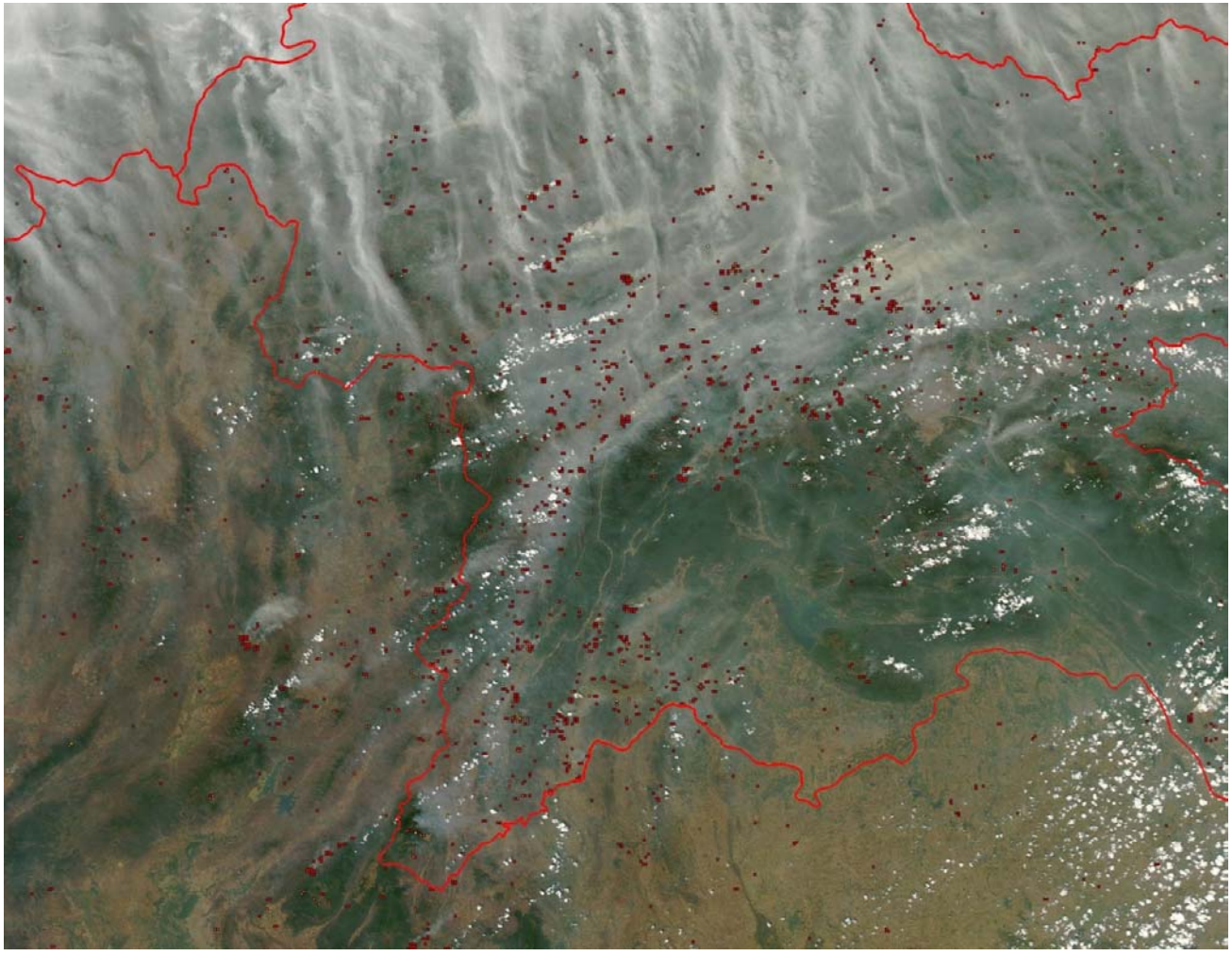
Active Fire and Smoke-Haze Distribution Visualization Systems

Active Fire Distribution Visualization

Smoke-Haze Distribution Visualization

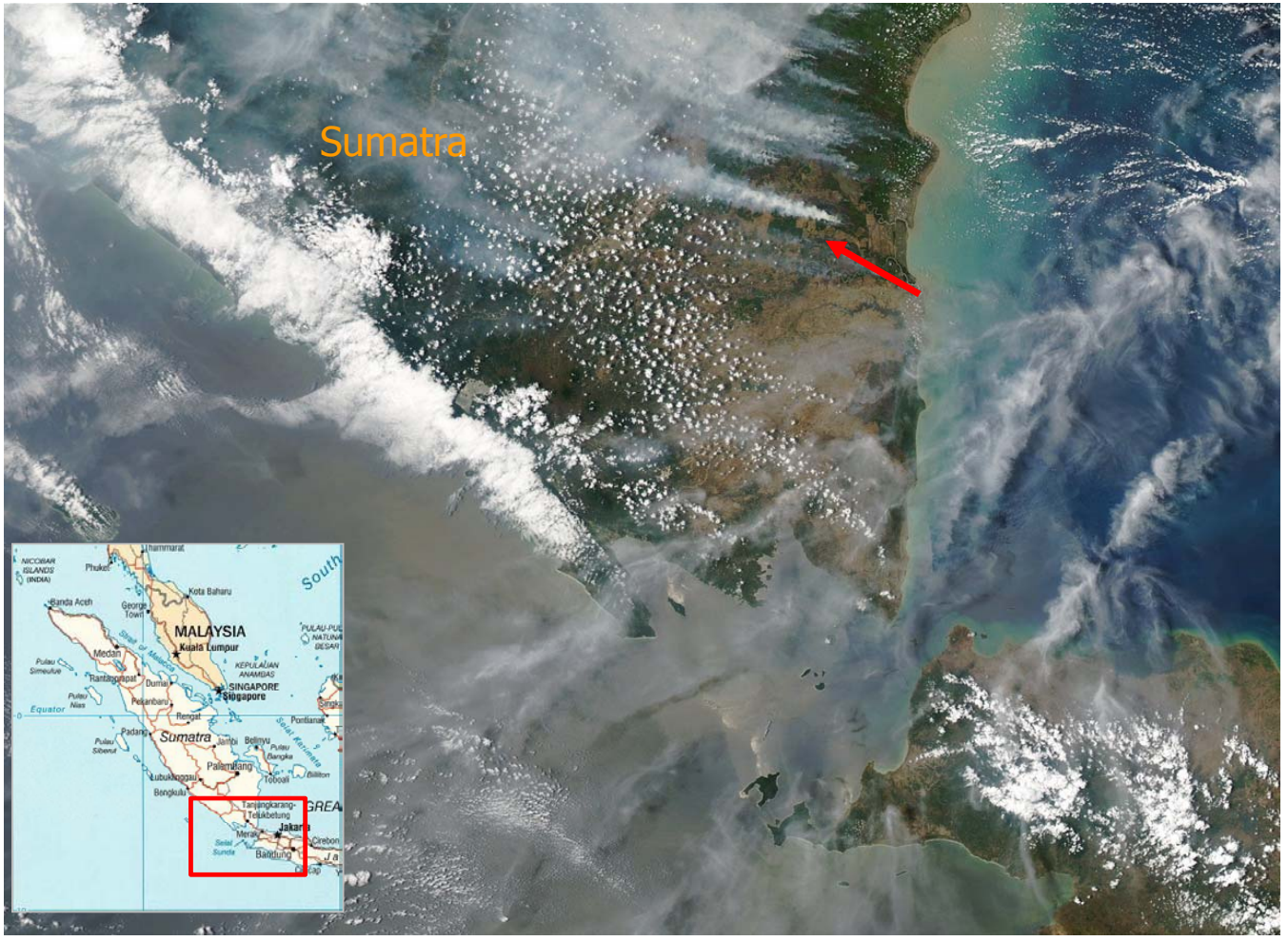
MODIS Active Fire Monitoring System in Regional Level – South and Southeast Asia

Laos & Thailand - Aqua MODIS March 14, 2009 06:43 GMT



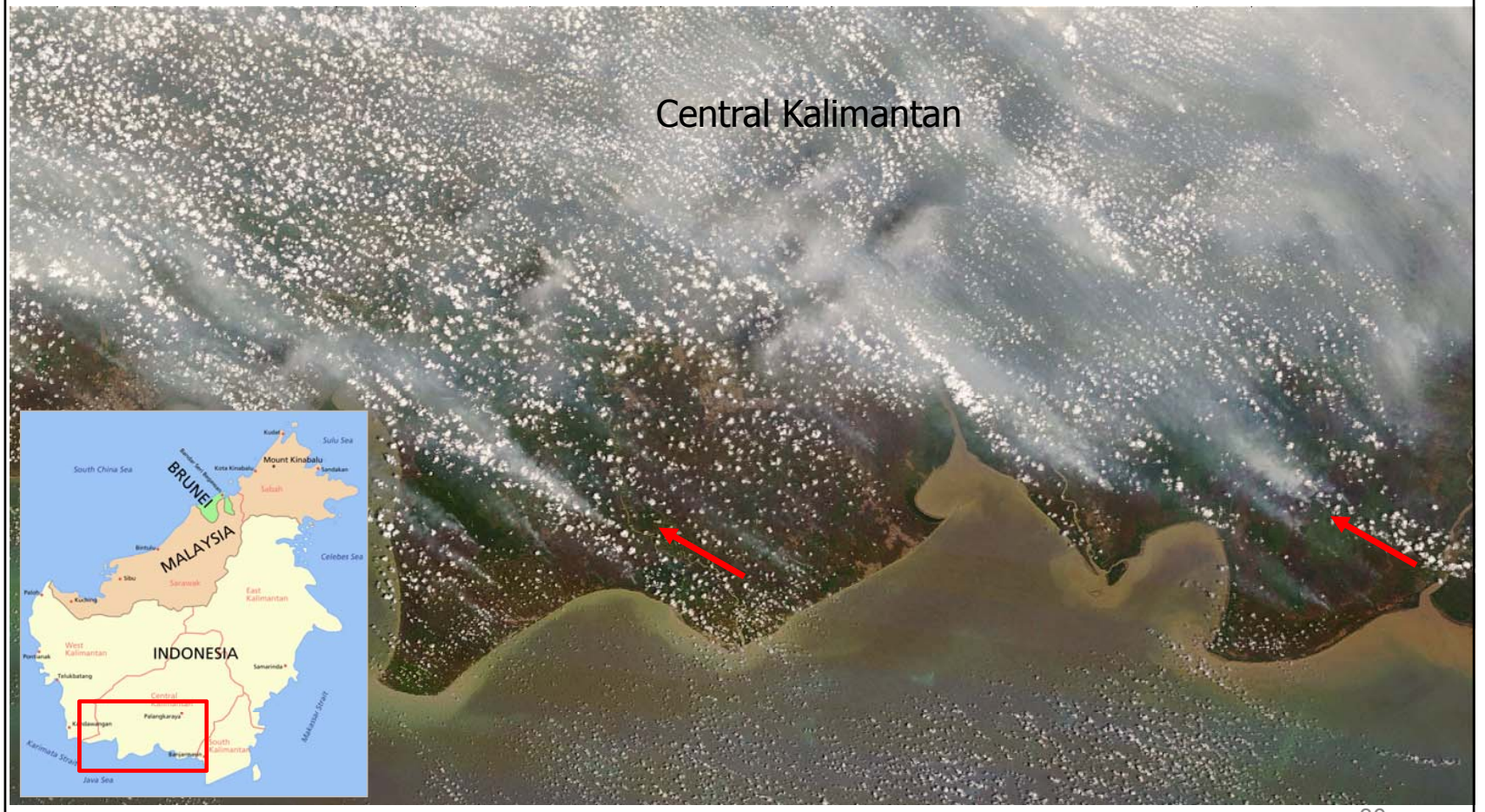
MODIS Active Fire Monitoring System in Regional Level – South and Southeast Asia

Sumatra (Indonesia) Aqua MODIS Oct. 06, 2006 06:34 GMT
Strong smoke from the wild fire location (shown by red arrow) are clearly visible



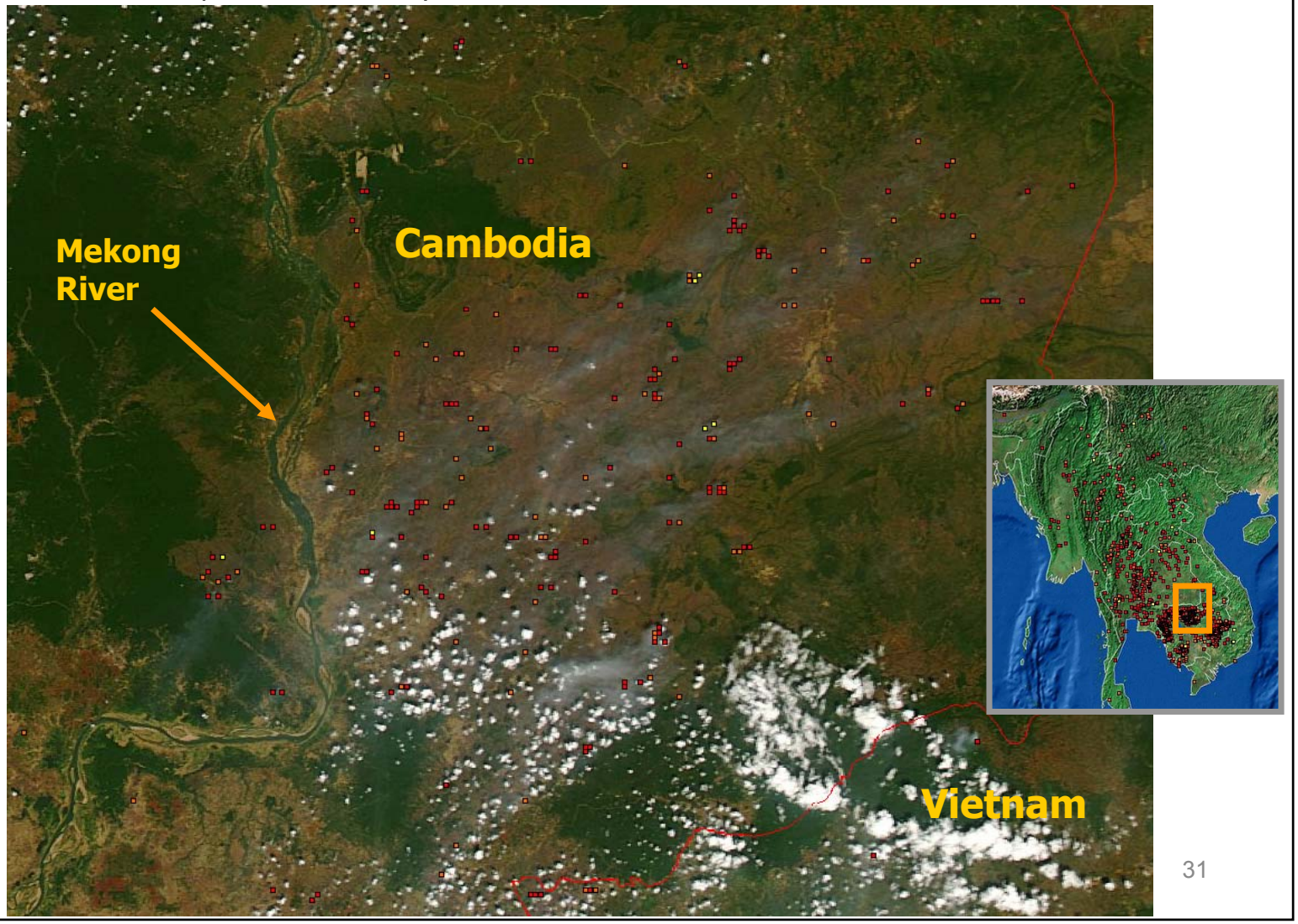
MODIS Active Fire Monitoring System in Regional Level – South and Southeast Asia

Kalimantan (Indonesia) Terra MODIS Nov. 04, 2006 02:59



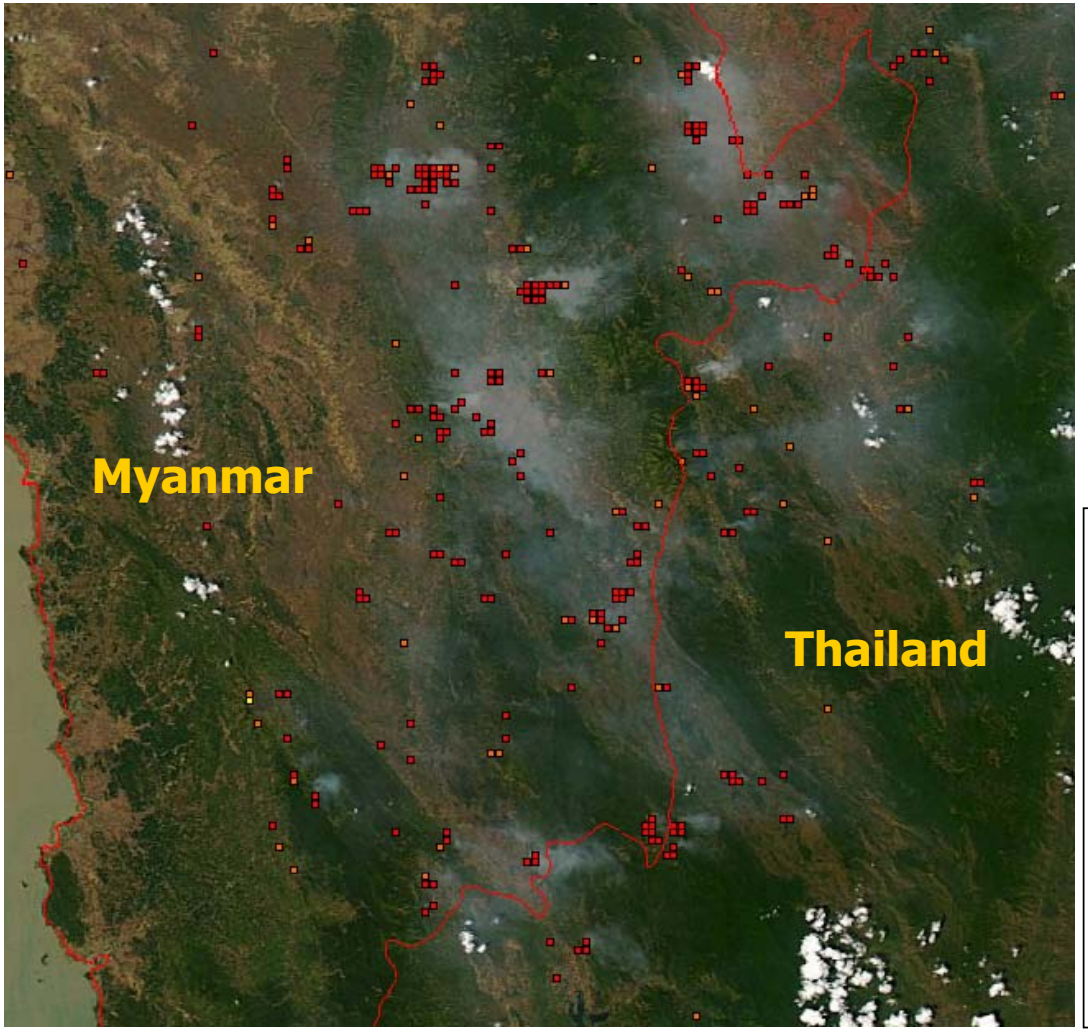
MODIS Active Fire Monitoring System in Regional Level – South and Southeast Asia

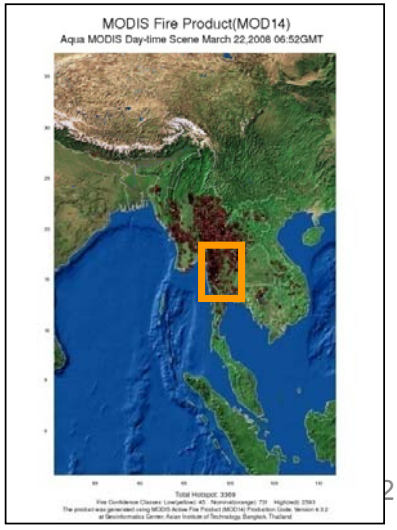
Cambodia - Aqua MODIS January 20, 2008 06:40 GMT



MODIS Active Fire Monitoring System in Regional Level – South and Southeast Asia

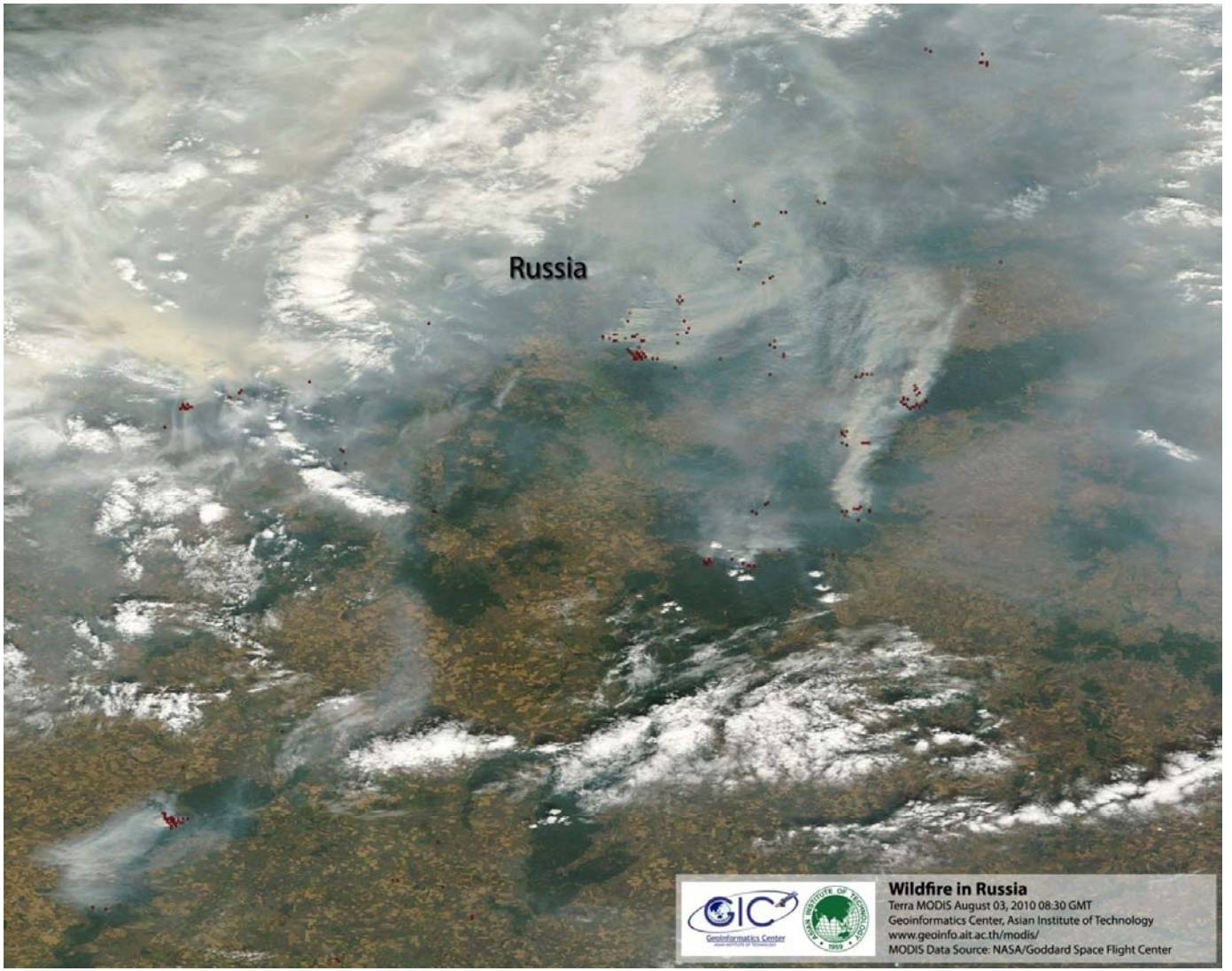
Myanmar & Thailand – Aqua MODIS March 22, 2008 06:52 GMT





MODIS Active Fire Monitoring System in Global Region

Fire in Russia – Terra MODIS August 03, 2010 08:30 GMT



MODIS Active Fire Monitoring System in National Level - Laos

Flowchart of the Development

[Objective 2]
2. DEVELOPMENT

Spatial Data Processing System

Country filtering = Laos

Admin. filtering = {District , Province}

Land use filtering = {landuse type}

Find the closest village to the given fire pixel

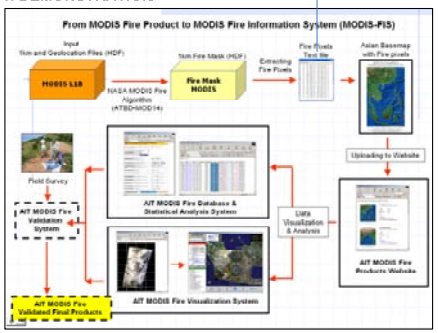
Database

Web Server (WEBGIS)

Geographical location of fire pixels

System for Monitoring in Regional Level

[Objective 1]
1. DEMONSTRATION



Existing MODIS Fire Information System

☑

☑ Developed & opened to public

☑ Under development

System for Monitoring in Country Level

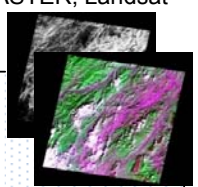
☑

Extended System for Laos

Geographical Location of fire pixels with administration location

[Objective 3]
3. APPLICATIONS

ASTER, Landsat



High Resolution Satellite Images

Secondary data (Burn area records)

Estimation of Burn Area

Burn Area Mapping

Burning Area Estimation

☑

MODIS RGB 721

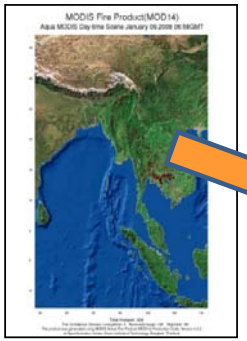
Burn Area Estimation
(using fire geographical location from MODIS and High-Resolution Sat. images)

Terra ASTER specifications

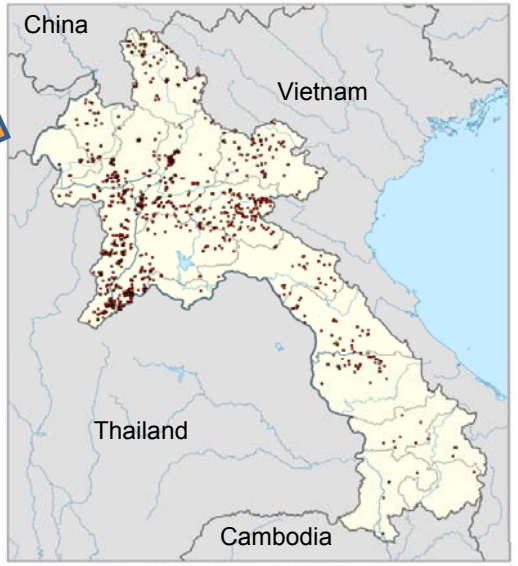
Instrument	VNIR	SWIR	TIR
Bands	1-3	4-9	10-14
Spatial Resolution	15m	30m	90m
Swath Width	60km	60km	60km
Cross Track Pointing	± 318km (± 24 deg)	± 116km (± 8.55 deg)	± 116km (± 8.55 deg)
Quantisation (bits)	8	8	12

MODIS Active Fire Monitoring System in National Level - Laos

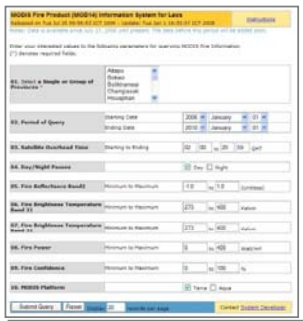
Regional level



National level



high	nom	low	dist	prov
0	1	0	Sanxai	Attapu
0	0	0	Samakhixai	Attapu
0	0	0	Xaisettha	Attapu
0	0	0	Phouvong	Attapu
0	0	0	Sanamxai	Attapu
2	0	0	Houayxay	Bokeo
0	0	0	Meung	Bokeo
0	0	0	Tonpheung	Bokeo
2	0	0	Paktha	Bokeo
9	3	0	Pha-Oudom	Bokeo
27	20	1	Bolikhamxai	Bolikhamxai
12	14	1	Viengthong	Bolikhamxai
1	0	0	Thaphabat	Bolikhamxai
0	0	0	Pakxan	Bolikhamxai
6	1	0	Pakkading	Bolikhamxai
8	5	0	Khamkheut	Bolikhamxai
0	0	0	Xanasomboun	Champasak
0	0	0	BachiengCh	Champasak
1	0	0	Pakxong	Champasak
0	0	0	Phonethong	Champasak
0	0	0	Pakxe	Champasak
4	1	0	Champasak	Champasak
2	1	0	Pathoumphone	Champasak
0	0	0	Soukhouma	Champasak
0	0	0	Mounlapamok	Champasak
1	0	0	Khong	Champasak
13	4	0	Et	Houaphan
1	3	0	Xiengkho	Houaphan
2	0	0	Sopbao	Houaphan
12	14	1	Viengthong	Bolikhamxai
9	10	0	Xamnua	Houaphan
4	1	0	Viengxai	Houaphan
12	3	0	Houamuang	Houaphan

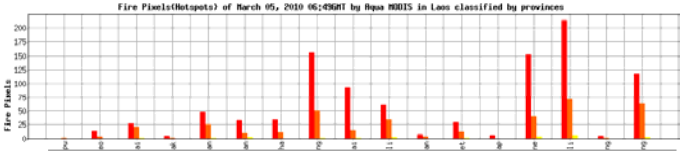


RESULT PAGE 792 of 826

id	date	time	daynight	satellite	lat	lon	ref2	T21	T31	Fp	Fc	district	province	country
23589	2010-03-07	06:37:00	Day	Aqua	20.24	104.28	0.27	327.34	299.05	25.38	89	Xamnua	Houaphan	Laos
23590	2010-03-07	06:37:00	Day	Aqua	20.18	103.81	0.27	356.11	303.24	77.4	100	Houamuang	Houaphan	Laos
23591	2010-03-07	06:37:00	Day	Aqua	20.19	103.81	0.27	345.81	301.1	54.2	100	Houamuang	Houaphan	Laos
23592	2010-03-07	06:37:00	Day	Aqua	20.19	103.8	0.27	365.02	305.19	102.14	100	Houamuang	Houaphan	Laos
23593	2010-03-07	06:37:00	Day	Aqua	20.19	103.79	0.29	350.17	305.34	64.01	100	Houamuang	Houaphan	Laos
23594	2010-03-07	06:37:00	Day	Aqua	20.15	103.46	0.25	316.36	303.33	10.57	71	Viengthong	Bolikhamxai	Laos
23595	2010-03-07	06:37:00	Day	Aqua	20.03	102.58	0.24	320.18	301.68	14.68	80	Pakxeng	Louangphabang	Laos
23596	2010-03-07	06:37:00	Day	Aqua	19.87	101.48	0.23	319.36	305.05	13.5	79	Houn	Oudomxai	Laos
23597	2010-03-07	06:37:00	Day	Aqua	19.76	100.73	0.21	314.01	302.67	5.16	27	Xianghon	Xaignabouli	Laos
23598	2010-03-07	06:37:00	Day	Aqua	20.27	104.34	0.24	313.8	296.69	11.16	66	Viengxai	Houaphan	Laos
23599	2010-03-07	06:37:00	Day	Aqua	20.22	103.92	0.26	312.2	300.49	7.21	52	Houamuang	Houaphan	Laos
23600	2010-03-07	06:37:00	Day	Aqua	20.22	103.91	0.27	310.77	299.52	6.27	33	Houamuang	Houaphan	Laos
23601	2010-03-07	06:37:00	Day	Aqua	20.07	102.86	0.26	334.89	300.75	36.42	96	Pakxeng	Louangphabang	Laos
23602	2010-03-07	06:37:00	Day	Aqua	20.07	102.85	0.26	332.08	300.91	32.24	94	Pakxeng	Louangphabang	Laos
23603	2010-03-07	06:37:00	Day	Aqua	19.77	100.73	0.18	322.01	303.85	14.23	83	Xianghon	Xaignabouli	Laos
23604	2010-03-07	06:37:00	Day	Aqua	20.04	102.53	0.2	328.69	300.78	25.43	90	Pakxeng	Louangphabang	Laos
23605	2010-03-07	06:37:00	Day	Aqua	20.04	102.52	0.21	327.61	304.13	145.67	100	Pakxeng	Louangphabang	Laos
23606	2010-03													Laos
23607	2010-03													Laos
23608	2010-03													Laos

On-line Active Fire Distribution Database System by Provinces and Districts

Active Fire Distribution and Statistical Analysis System

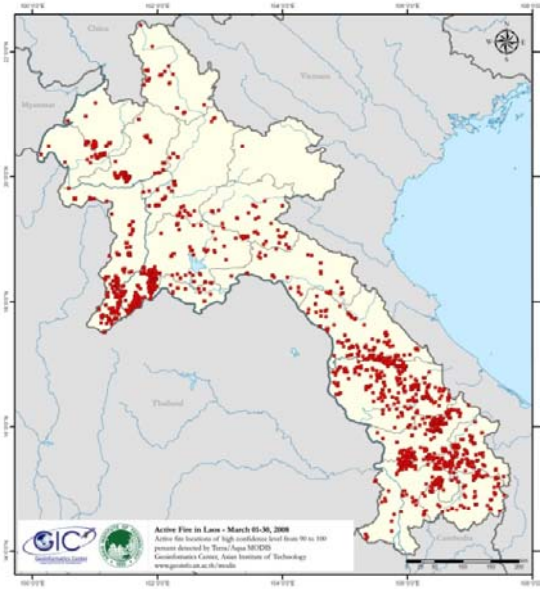


Statistical Distribution of Active Fire by Provinces

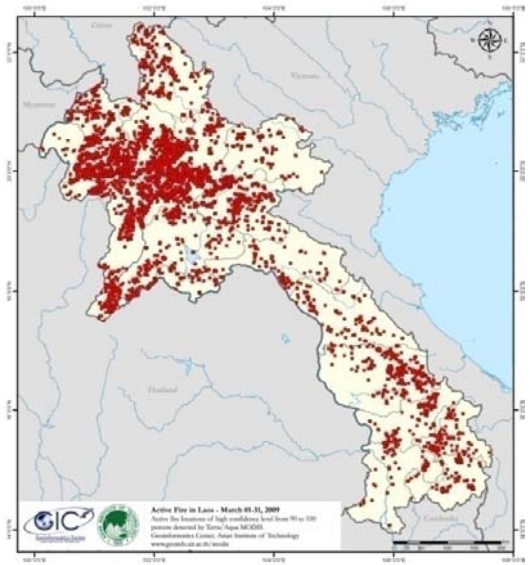
Annual Distributions of Detected Active Fire in Laos

for March 2008, 2009 and 2010

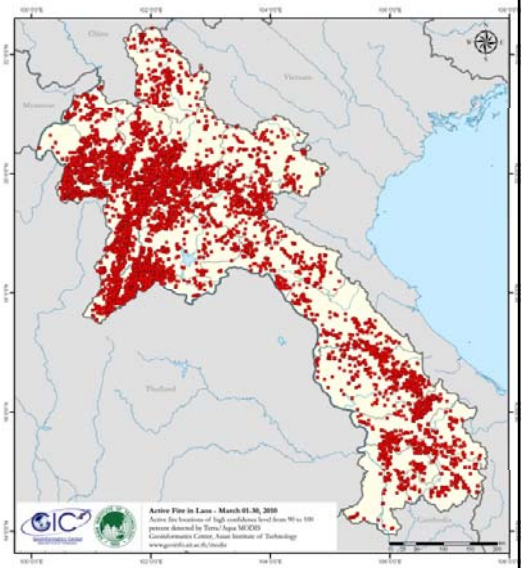
(based on selected fire confidence of 90-100%)



March 01-31, 2008

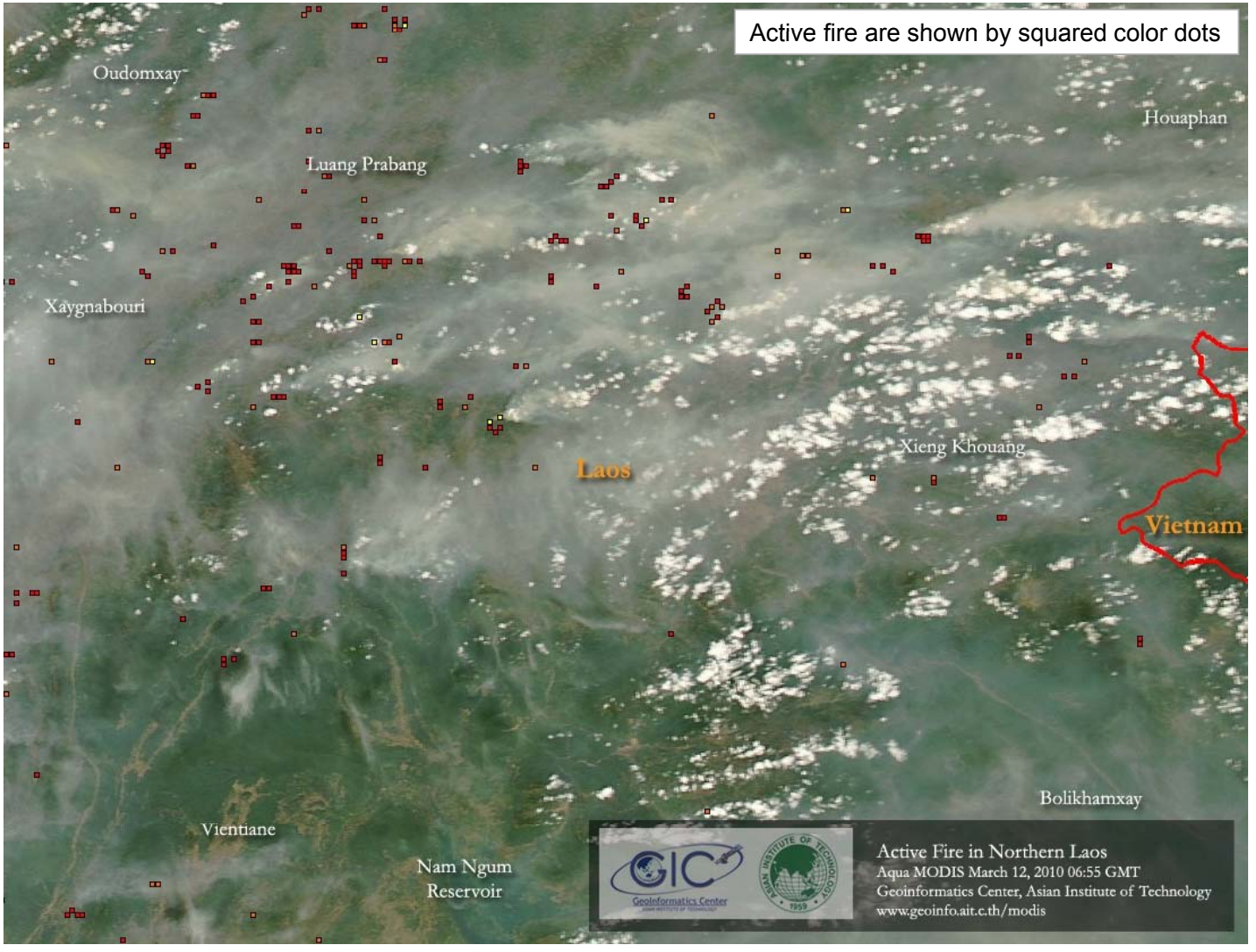


March 01-31, 2009

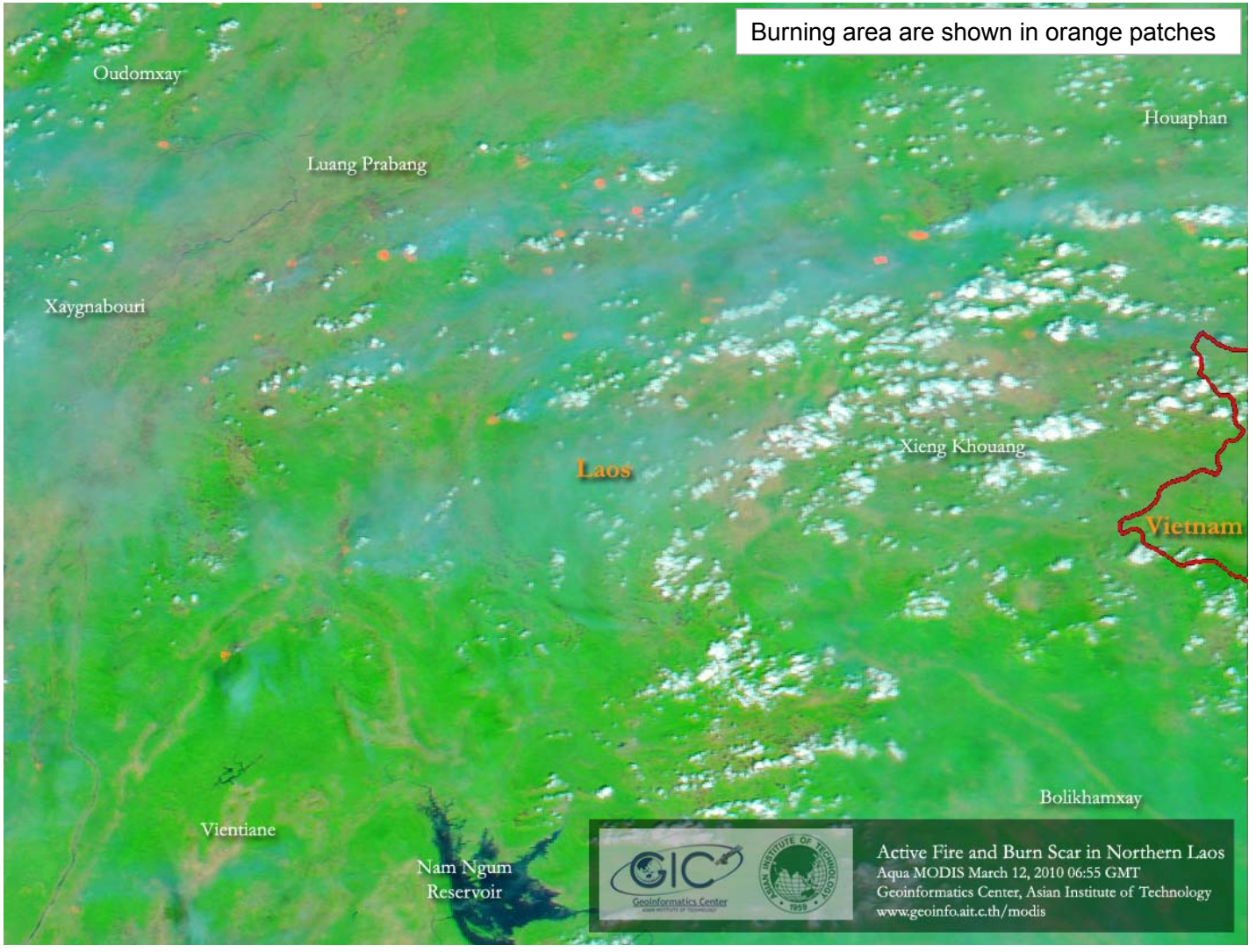


March 01-31, 2010

MODIS Burning Area Monitoring System in Regional Level
South and Southeast Asia



MODIS Burning Area Monitoring System in Regional Level
South and Southeast Asia



UNDERSTAND
MODIS DATA FORMAT

MODIS Data Level, Format and Structure

- **MODIS Data Level**
  - **Raw Data** – Data in original packets as received from observer.
  - **Level 0 -** a sequence of CCSDS packets in standard Production Data Set or PDS format
  - **Level 1B Calibrated Radiance (1km, 500m and 250m)**
  - – processed to sensor unit, radiometrically calibrated data stored with sub-sampled geolocation data
  - -- Calibration of earth view raw MODIS digital counts into radiance values
  - **Level 1B Geolocation -** geolocation product that contains useful ancillary products (geolocation parameters) such as position, sensor and solar angles for each 1km pixel.
  - **Level 2** – Derived Geophysical parameters in the location and resolution of source data.
  - **Level 3 (Grided vs. Tiled)** – Variables mapped on uniformed space- time grid scales, usually with some completeness and consistency**.**
- **MODIS Data Format**
  - **Hierarchical Data Format** (HDF)
  - **MODIS EOS-HDF** vs. NCSA-HDF
- **Example of MODIS data in EOS-HDF format**
- **MODIS Scientific Data Sets (SDS)**
- **MODIS file name format (AIT, NASA)**

Hierarchical Data Format

1. HDF is common data and multi-object file format, developed by NCSA and HDF Group to assist users, scientists and programmers to assist users in the storing, sharing, transferring, distribution and manipulation of scientific data across diverse operating systems and computer platforms, using FORTRAN and C calling interfaces and utilities.
2. HDF is the standard data format for all NASA Earth Observing System (EOS) data products.
3. Some important features of HDF are:
   - 3.1 **Self-describing**: For each data object in an HDF file, there is also information (or metadata) about the data type, size, dimensions and location found within the file itself.
   - 3.2 **Extensibility**: HDF is designed to accommodate future (new) data types and data models.
   - 3.3 **Versatility**: Currently, HDF supports different data types and provides software and applications to read and write these data types in HDF, e.g: Scientific Data sets which are Multi-dimensional integer or floating point arrays.
   - 3.4 **Flexibility**: HDF lets the user group, store, and read/write different data types in the same file or in more than one file.
   - 3.5 **Portability**: HDF software is mainly platform independent and can be shared across most computer platforms.
   - 3.6 **Standardization**: HDF standardizes the formats and descriptions of many types of commonly- used data types (i.e., arrays, images, etc.).
   - 3.7 HDF is available in the public domain.

From HDF to HDF-EOS

Each **data object** in an HDF data file - predefined tags identify the type, amount, and dimensions of the data; and the file location of various objects. It also can accommodate different data types, such as symbolic, numerical, and graphical data

Self-describing capability of HDF helps users to fully understand the **file's structure and contents** from the information stored in the file itself. A program interprets and identifies **tag types** in an HDF file and processes the corresponding data.

However, raster images and multidimensional arrays are often **not geolocated**. Because many earth science data structures **need to be geolocated**, The HDF Group developed the **HDF-EOS** (**Hierarchical Data Format Earth Observation System**) format with additional conventions and data types for HDF files.

HDF-EOS supports **three geospatial data types**: **grid**, **point**, and **swath**, providing uniform access to diverse data types in a geospatial context. The HDF-EOS software library allows a user to query or subset the contents of a file by **earth coordinates** and **time** if there is a spatial dimension in the data. Tools that process standard HDF files also read HDF-EOS files; however, standard HDF library calls cannot access **geolocation data**, **time data**, and **product metadata** as easily as with HDF-EOS library calls.

From HDF to HDF-EOS

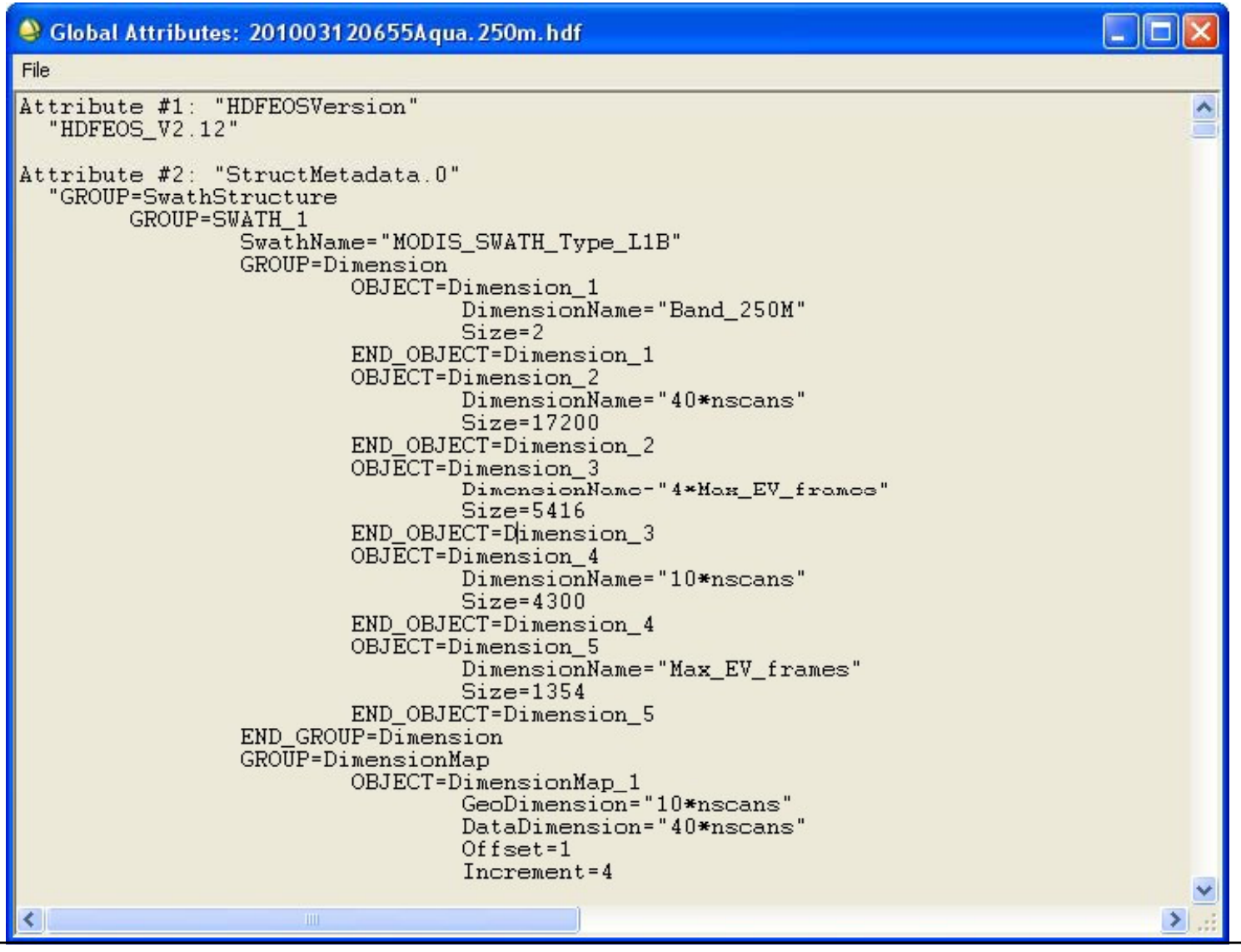
HDF-EOS supports three types of **geolocation** data types:

1.Point Data Types - Data, such as ship observation reports, that is irregularly spaced in time and/or space.

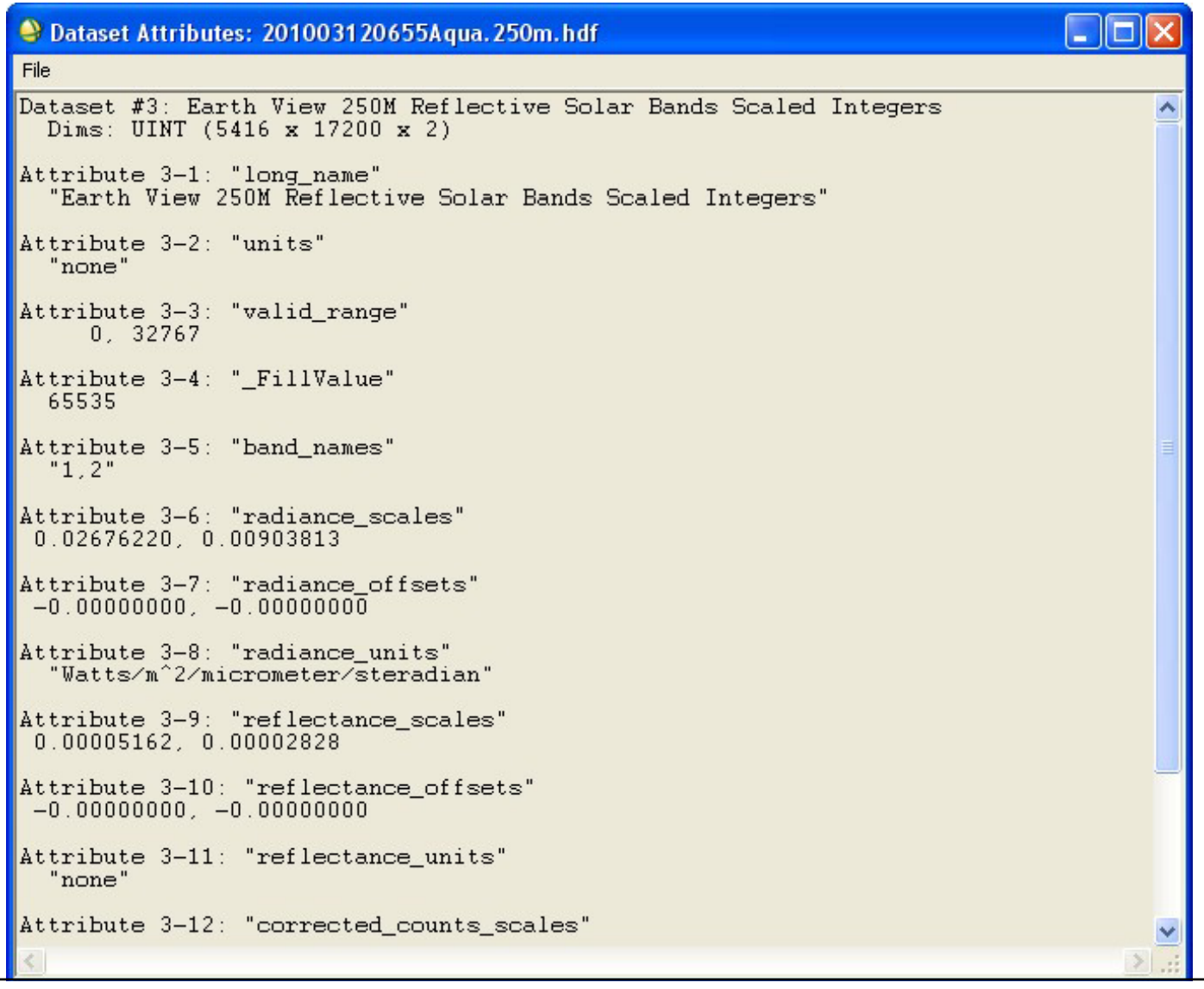
2.Swath Data Types - Time-ordered satellite data which represents time sequences of scan lines, profiles, or other array data.

3. **Grid Data Types** - Data that has been stored or can be represented on a regular grid and is based on certain set earth/map projection (i.e., Mercator, Lambert Conformal, etc..).

From HDF to HDF-EOS

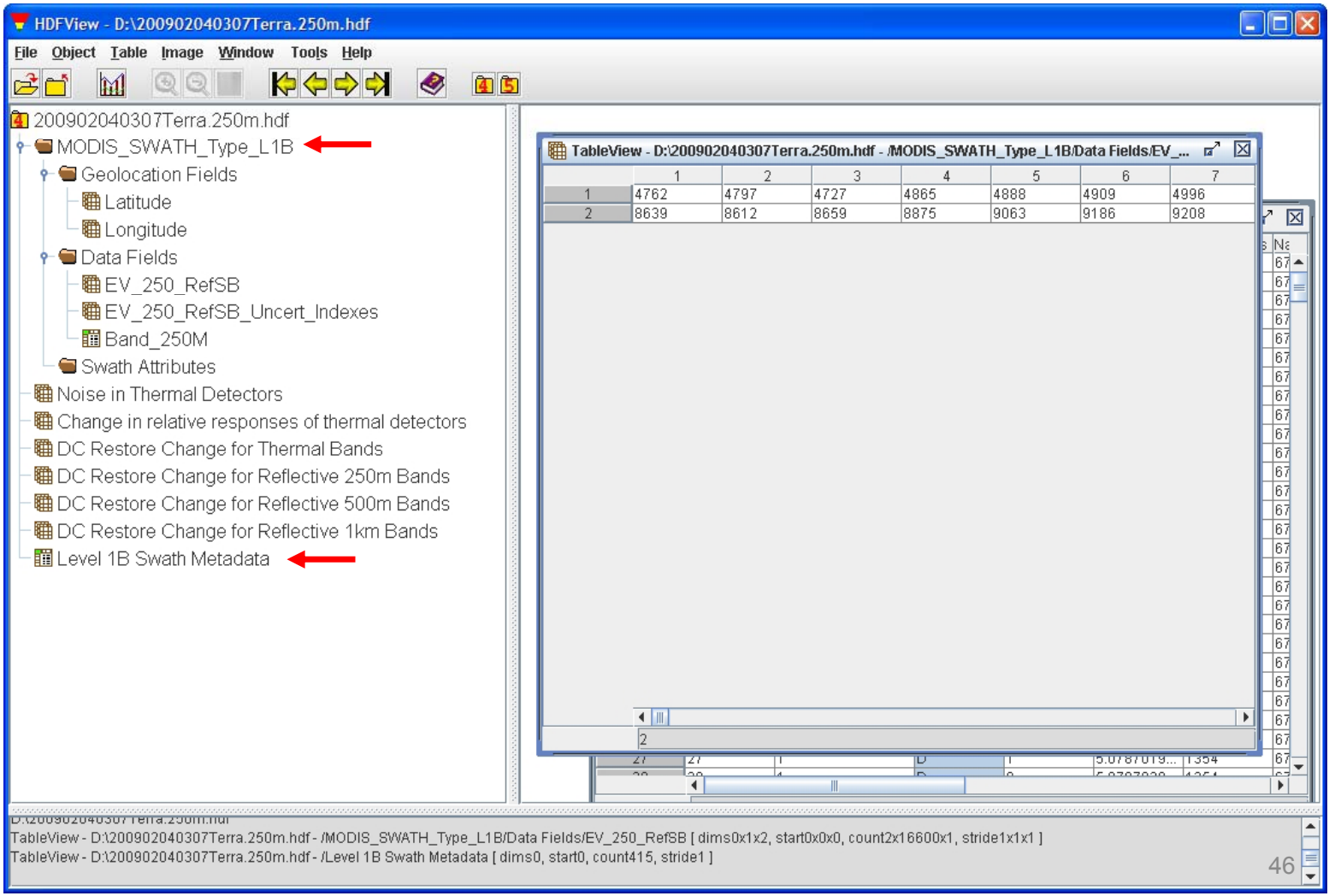


From HDF to HDF-EOS



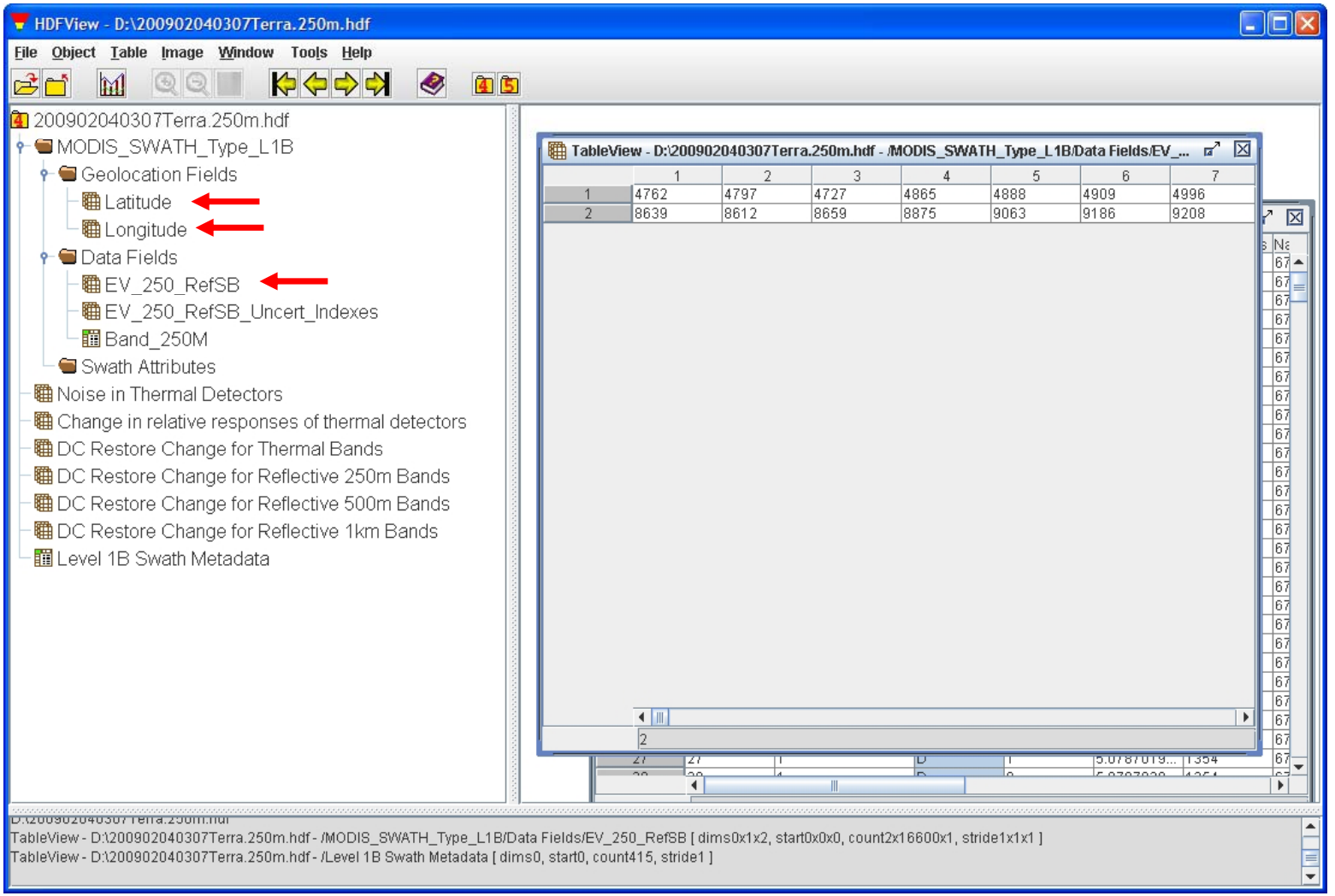
MODIS Data Level, Format and Structure

Viewing MODIS Data format – Hierarchical Data Format (HDF) using HDF Viewer



MODIS Data Level, Format and Structure

Viewing of MODIS Scientific Data Set (SDS) using HDF Viewer



MODIS Data Level, Format and Structure

- **MODIS Scientific Data Set (SDS) for 250m, 500m and 1000m spatial resolutions**

QKM			HKM			1KM		
Index	Band	SDS name	Index	Band	SDS name	Index	Band	SDS name
1	**1**	EV_250_RefSB	1	**1**	EV_250__Aggr500_RefSB	1	**1**	EV_250_Aggr_1KM_RefSB
2	**2**	EV_250_RefSB	2	**2**	EV_250__Aggr500_RefSB	2	**2**	EV_250_Aggr_1KM_RefSB
			1	**3**	EV_500_RefSB	1	**3**	EV_500_Aggr_1KM_RefSB
			2	**4**	EV_500_RefSB	2	**4**	EV_500_Aggr_1KM_RefSB
			3	**5**	EV_500_RefSB	3	**5**	EV_500_Aggr_1KM_RefSB
			4	**6**	EV_500_RefSB	4	**6**	EV_500_Aggr_1KM_RefSB
			5	**7**	EV_500_RefSB	5	**7**	EV_500_Aggr_1KM_RefSB
						1	**8**	EV_1KM_RefSB
						2	**9**	EV_1KM_RefSB
						3	**10**	EV_1KM_RefSB
						4	**11**	EV_1KM_RefSB
						5	**12**	EV_1KM_RefSB
						6	**13 L**	EV_1KM_RefSB
						7	**13 H**	EV_1KM_RefSB
						8	**14 L**	EV_1KM_RefSB
						9	**14 H**	EV_1KM_RefSB
						10	**15**	EV_1KM_RefSB
						11	**16**	EV_1KM_RefSB
						12	**17**	EV_1KM_RefSB
						13	**18**	EV_1KM_RefSB
						14	**19**	EV_1KM_RefSB
						15	**26**	EV_1KM_RefSB
						1	**20**	EV_1KM_Emissive
						2	**21**	EV_1KM_Emissive
						3	**22**	EV_1KM_Emissive
						4	**23**	EV_1KM_Emissive
						5	**24**	EV_1KM_Emissive
						6	**25**	EV_1KM_Emissive
						7	**27**	EV_1KM_Emissive
						8	**28**	EV_1KM_Emissive
						9	**29**	EV_1KM_Emissive
						10	**30**	EV_1KM_Emissive
						11	**31**	EV_1KM_Emissive
						12	**32**	EV_1KM_Emissive
						13	**33**	EV_1KM_Emissive
						14	**34**	EV_1KM_Emissive
						15	**35**	EV_1KM_Emissive
						16	**36**	EV_1KM_Emissive

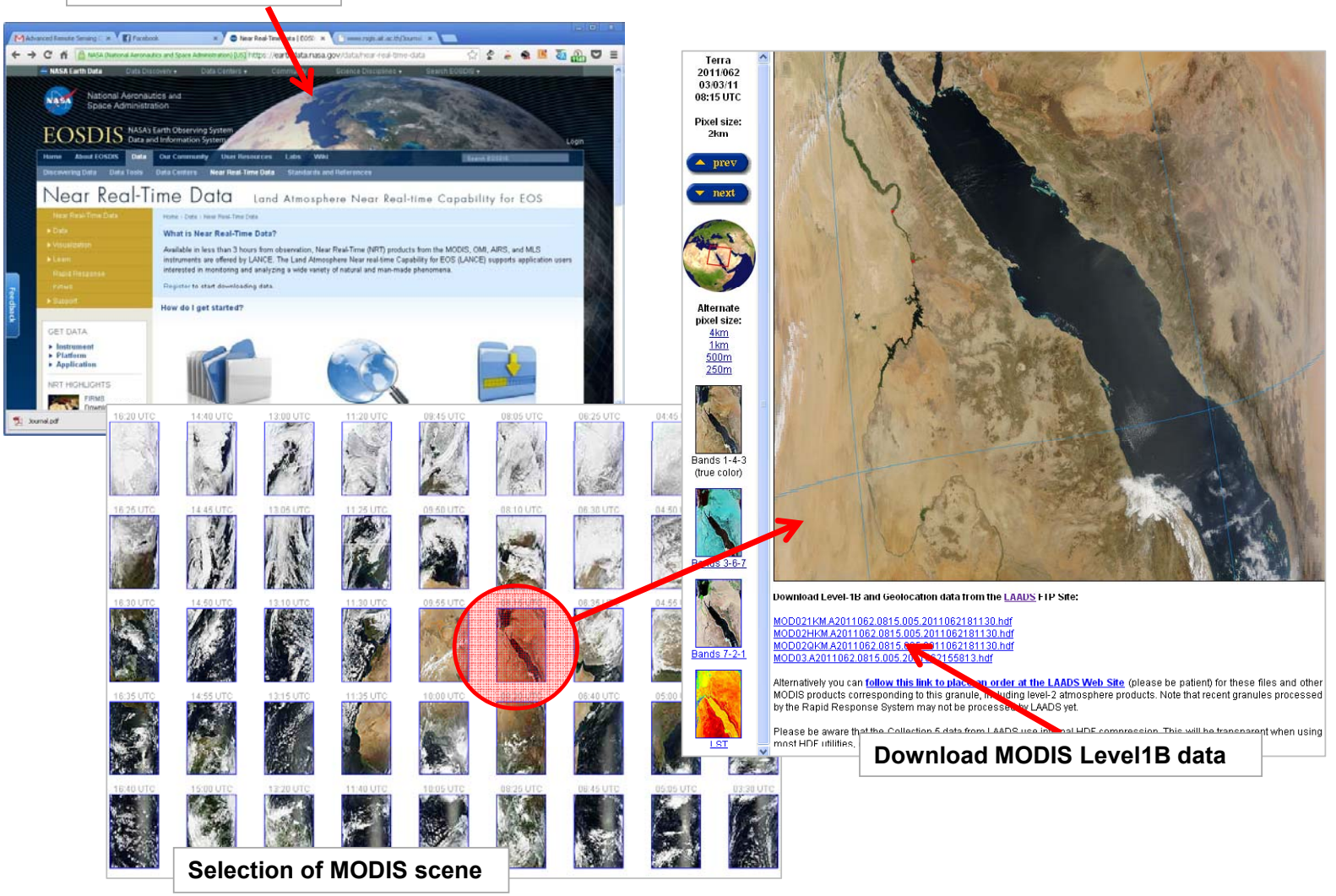
MODIS Data Level, Format and Structure

- **MODIS file name format**
  - **GIC/AIT:** Terra MODIS of Feb 23, 2009 03:37 GMT
    - **200902230337Terra.1000m.hdf**
    - **200902230337Terra.500m.hdf**
    - **200902230337Terra.250m.hdf**
    - **200902230337Terra.geo.hdf**
  - **NASA:** Terra MODIS of Feb 20, 2009 03:00 GMT → NRT
    - **MOD021KM.A2009051.0300.005.2009051133350.hdf**
    - **MOD02HKM.A2009051.0300.005.2009051133350.hdf**
    - **MOD02QKM.A2009051.0300.005.2009051133350.hdf**
    - **MOD03.A2009051.0300.005.2009051115557.hdf**

ANALYSIS OF
MODIS DATA LEVEL1B & LEVEL2

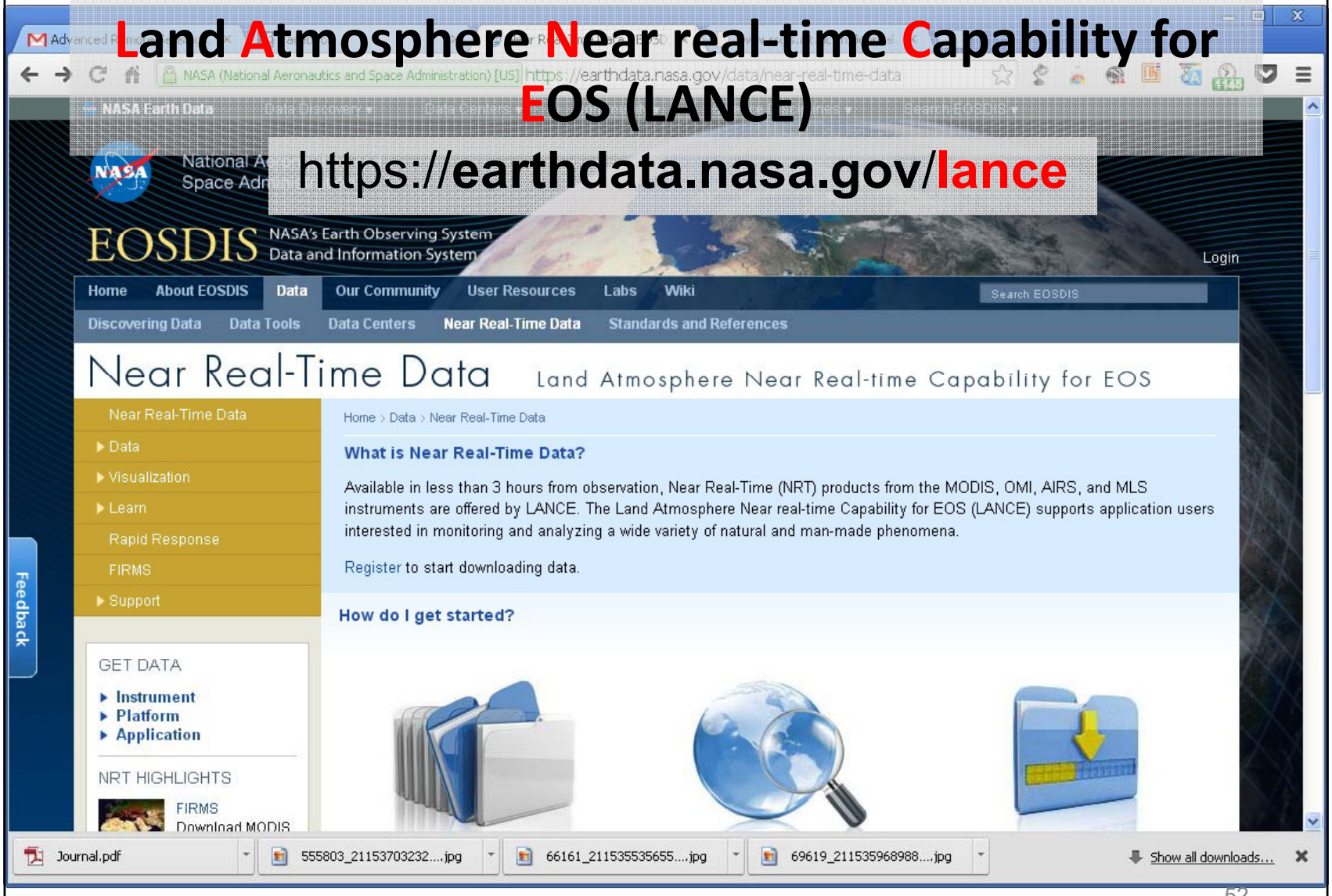
MODIS Rapid Response System @ NASA/GSFC

https://earthdata.nasa.gov/data/near-real-time-data



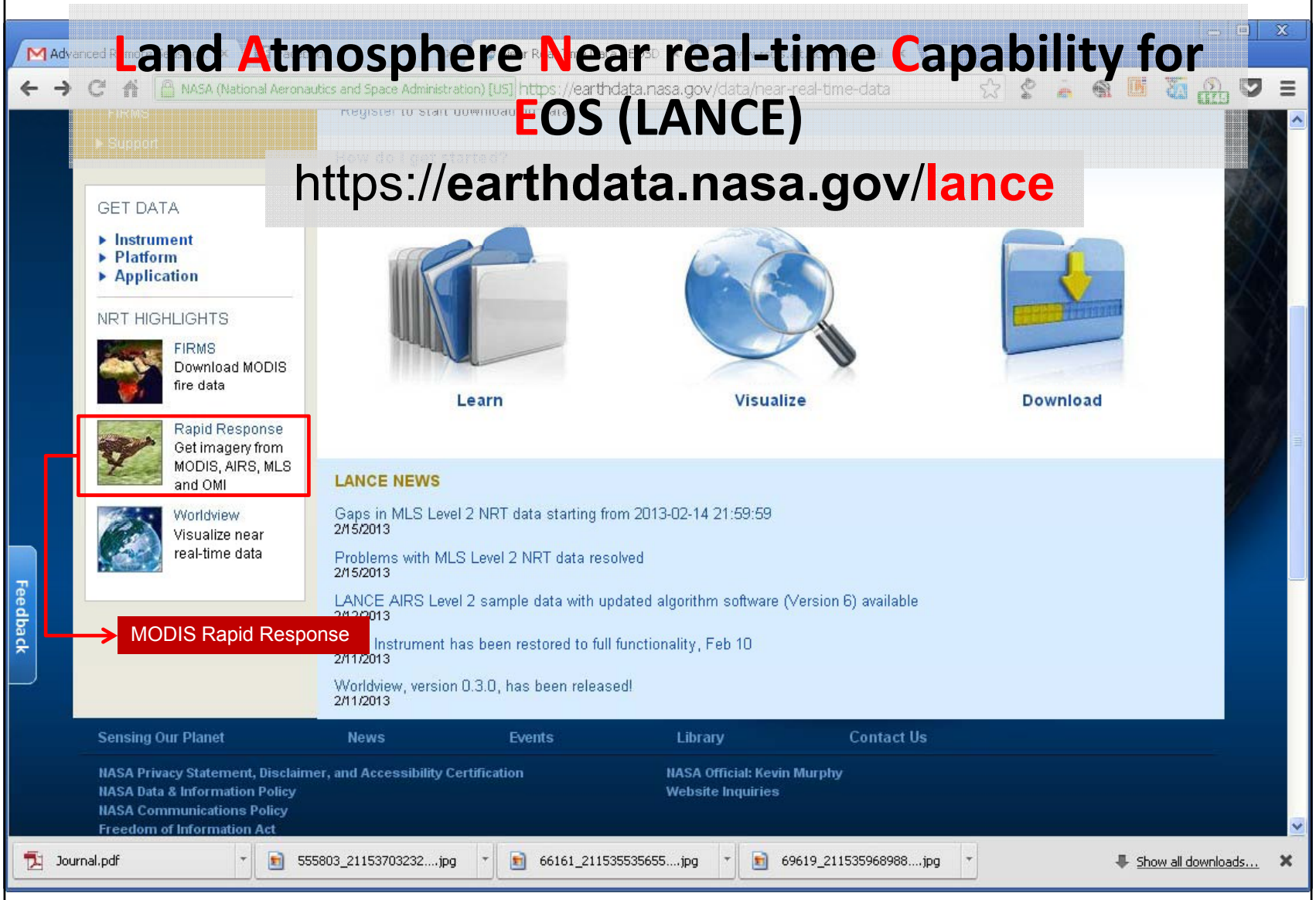
Land Atmosphere Near real-time Capability for EOS (LANCE)

https://earthdata.nasa.gov/lance



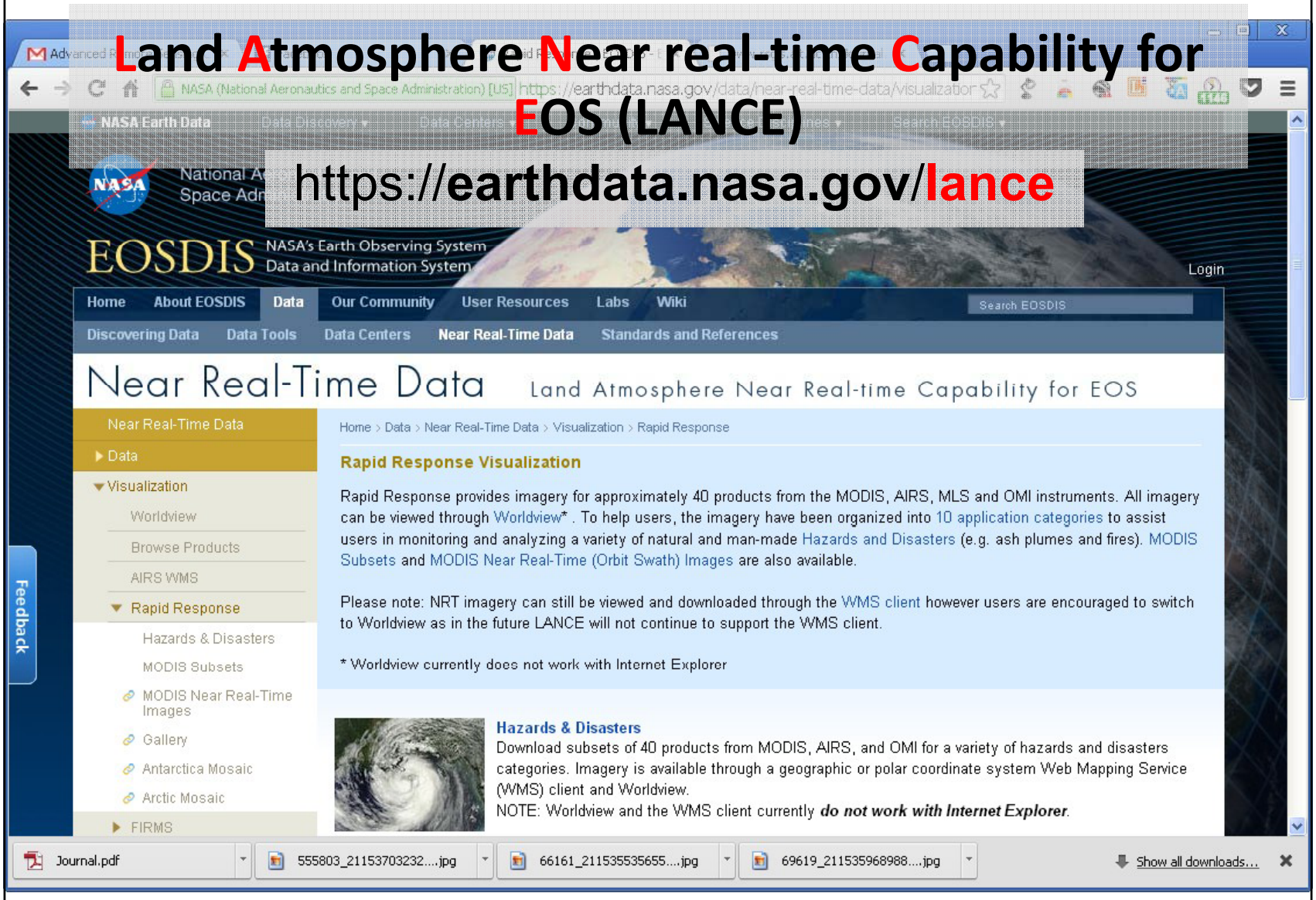
Land Atmosphere Near real-time Capability for EOS (LANCE)

https://earthdata.nasa.gov/lance



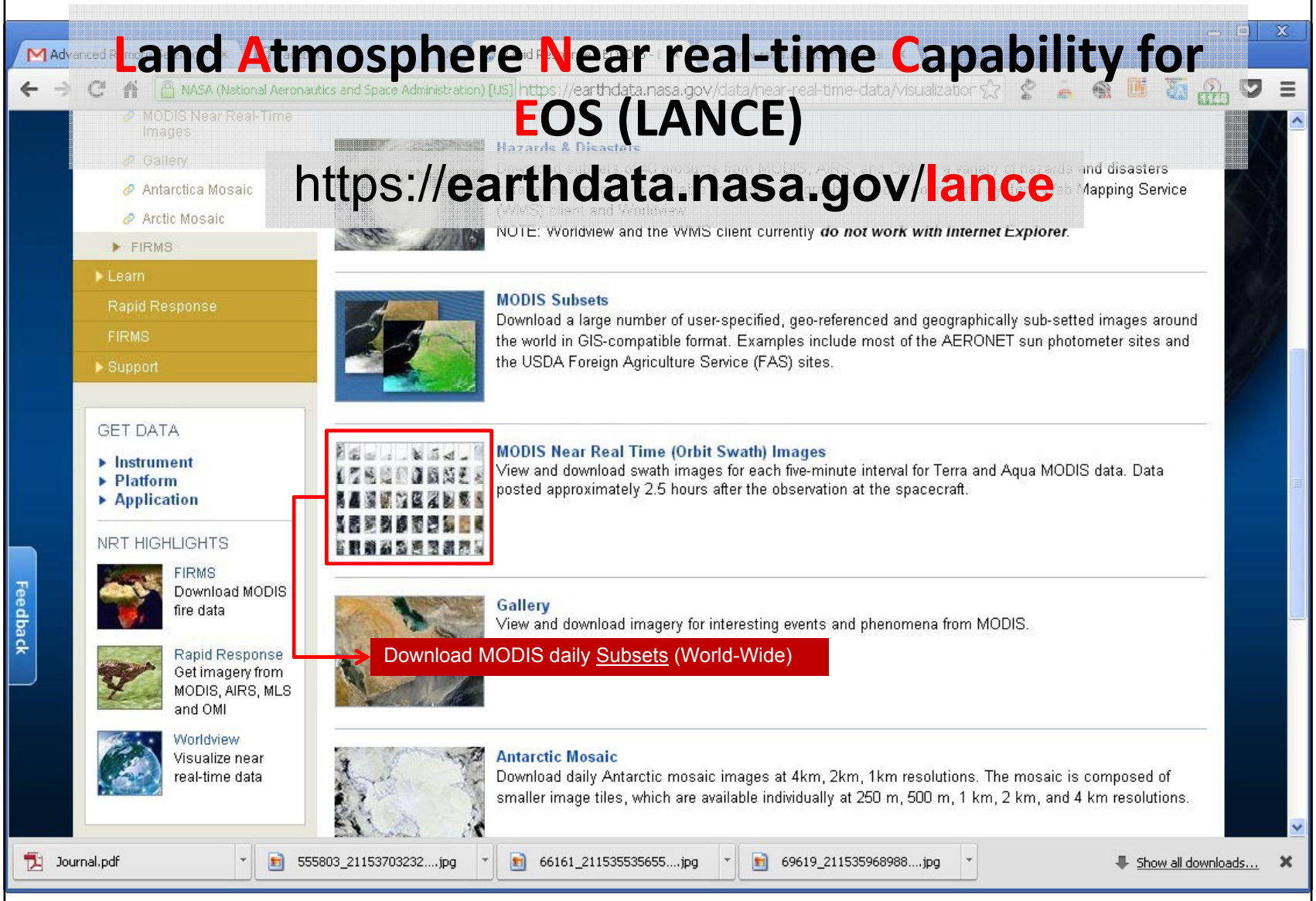
Land Atmosphere Near real-time Capability for EOS (LANCE)

https://earthdata.nasa.gov/lance



Land Atmosphere Near real-time Capability for EOS (LANCE)

https://earthdata.nasa.gov/lance



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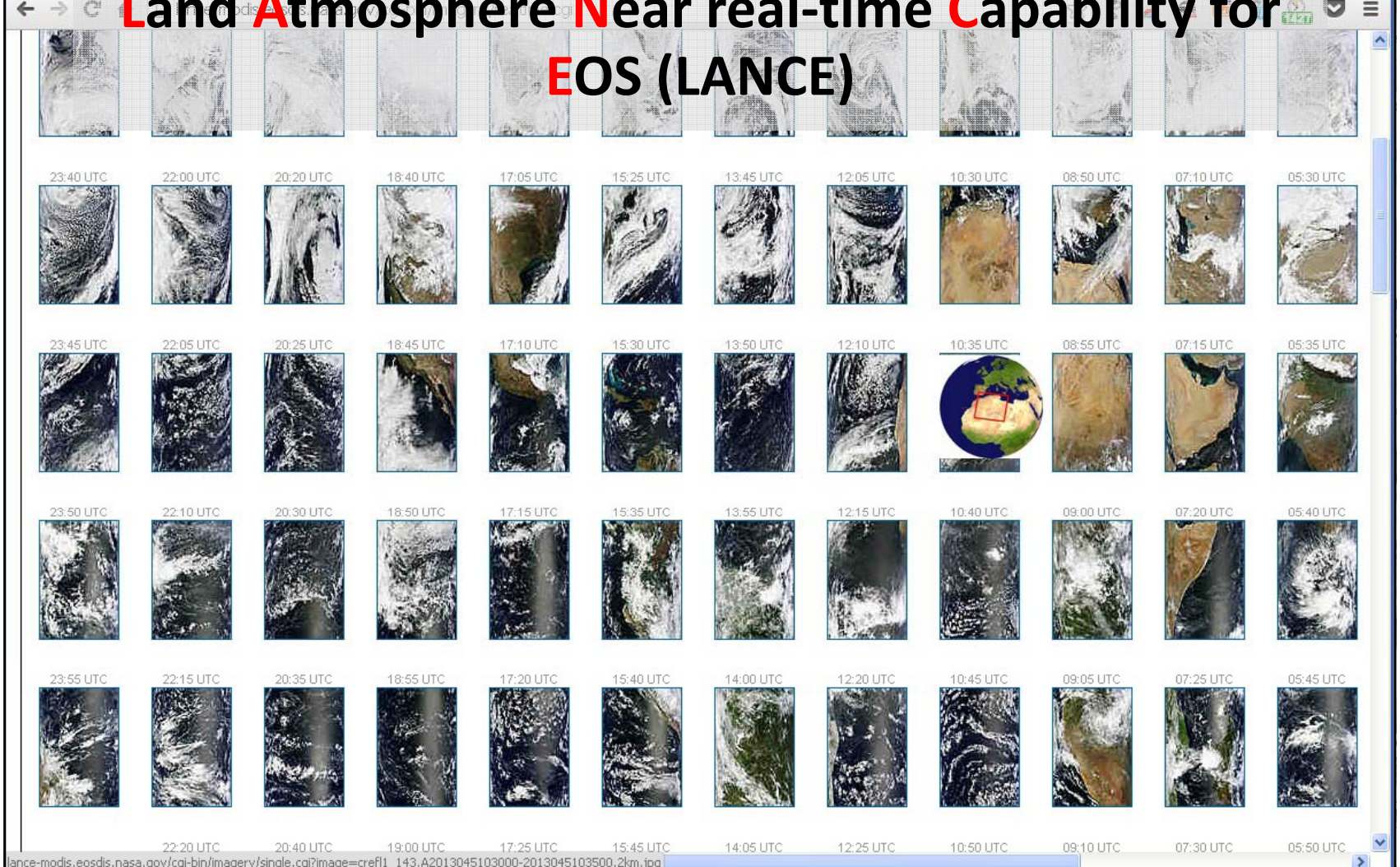
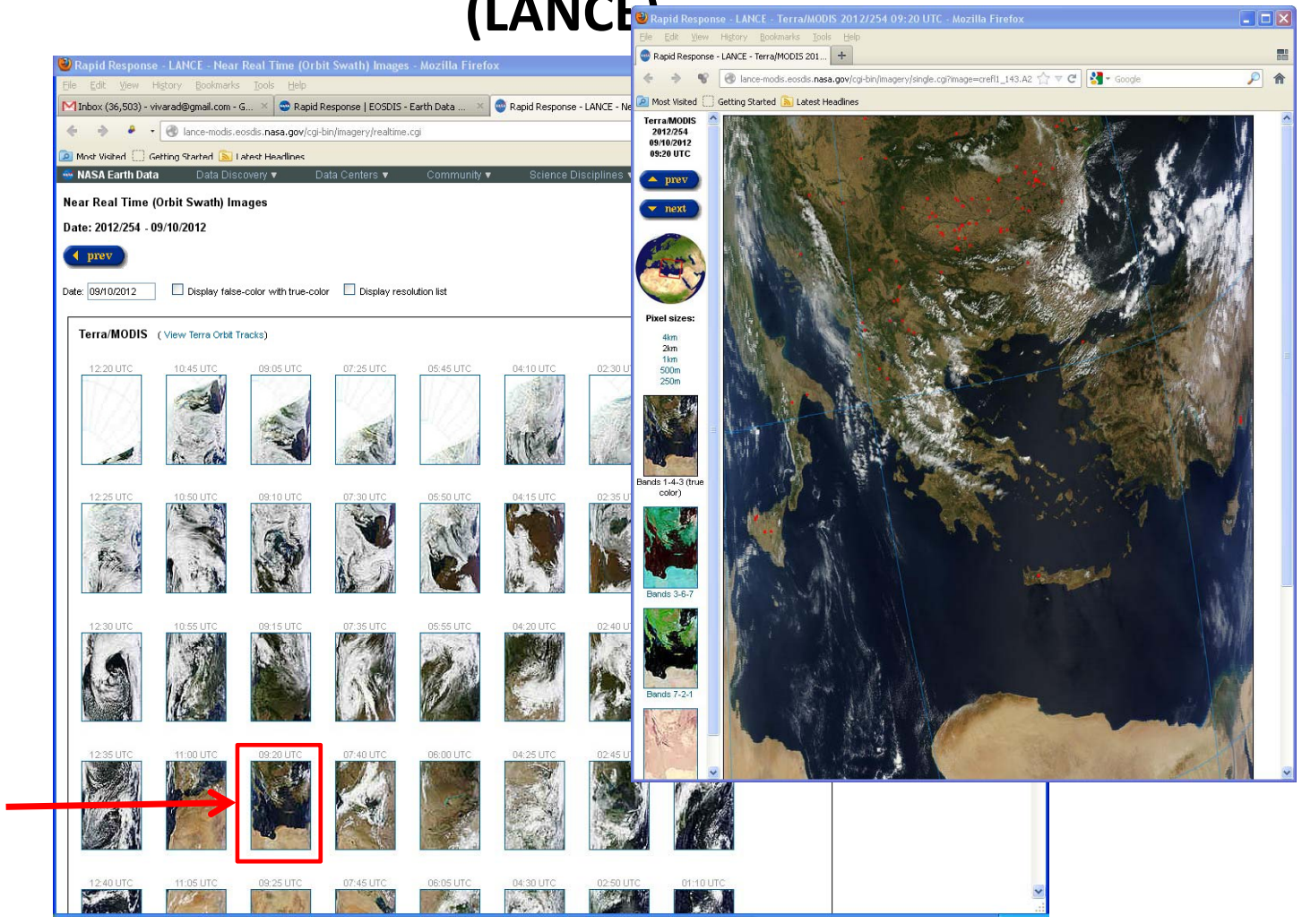


Land Atmosphere Near real-time Capability for EOS (LANCE)



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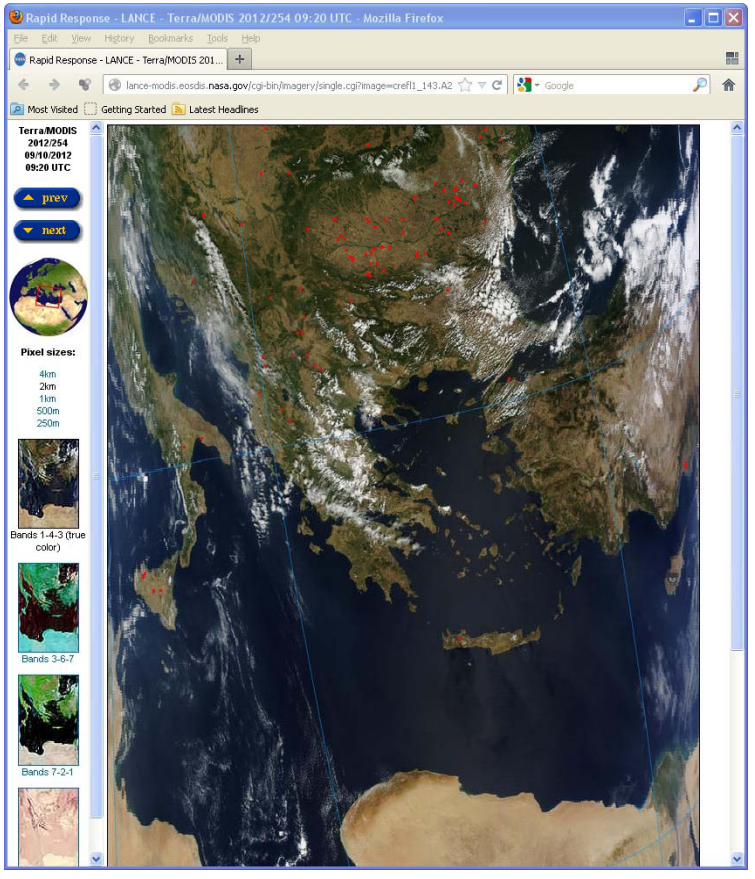
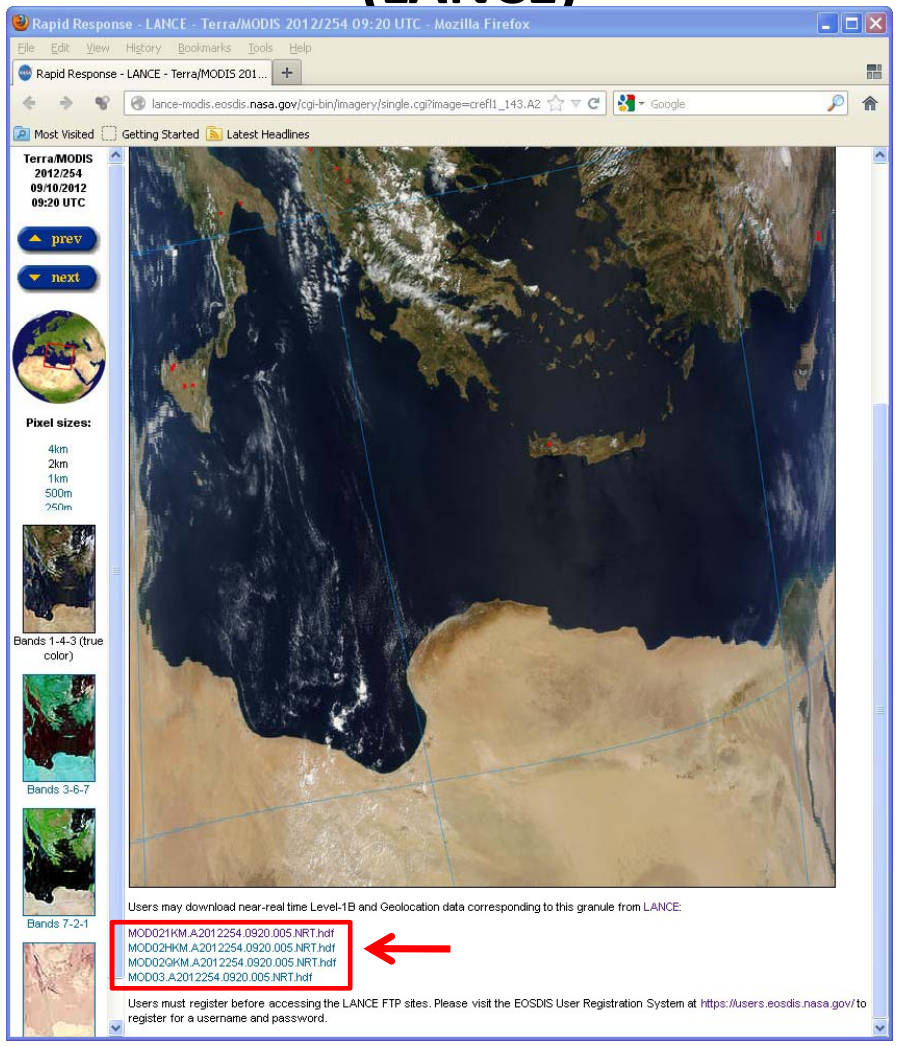
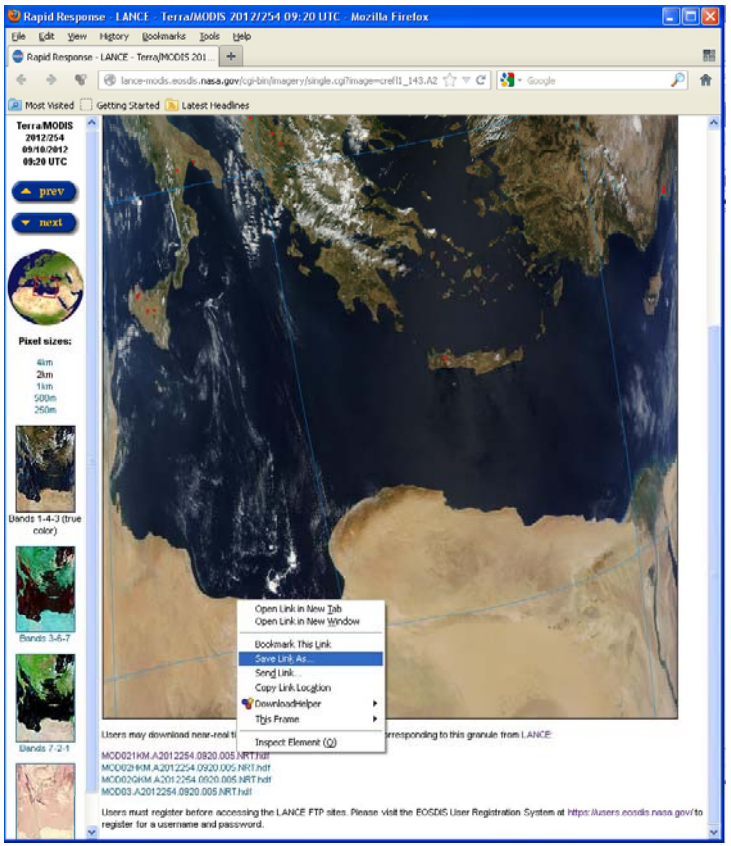
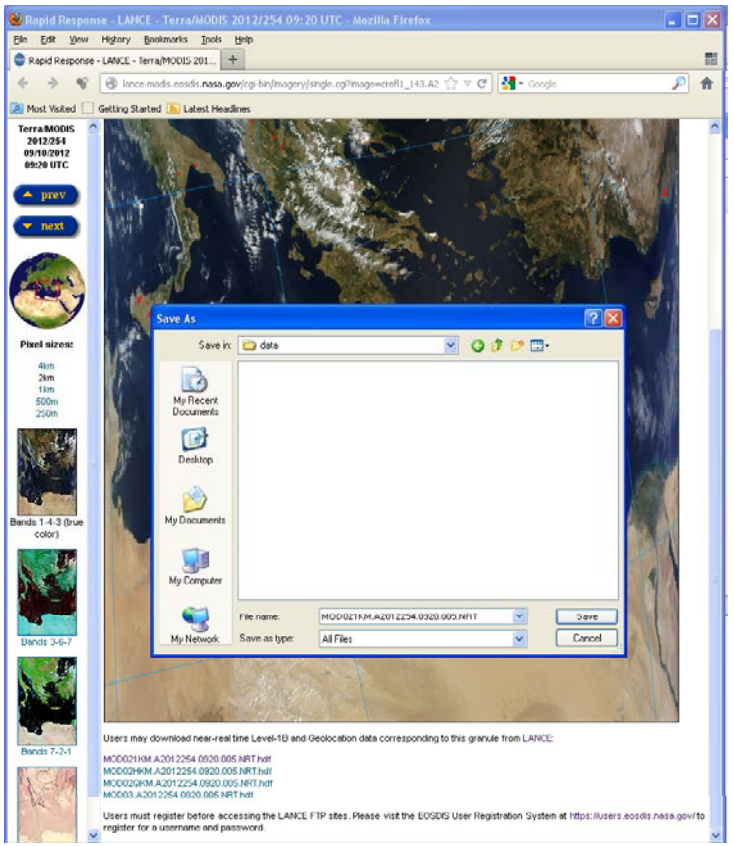


Land Atmosphere Near real-time Capability for EOS (LANCE)

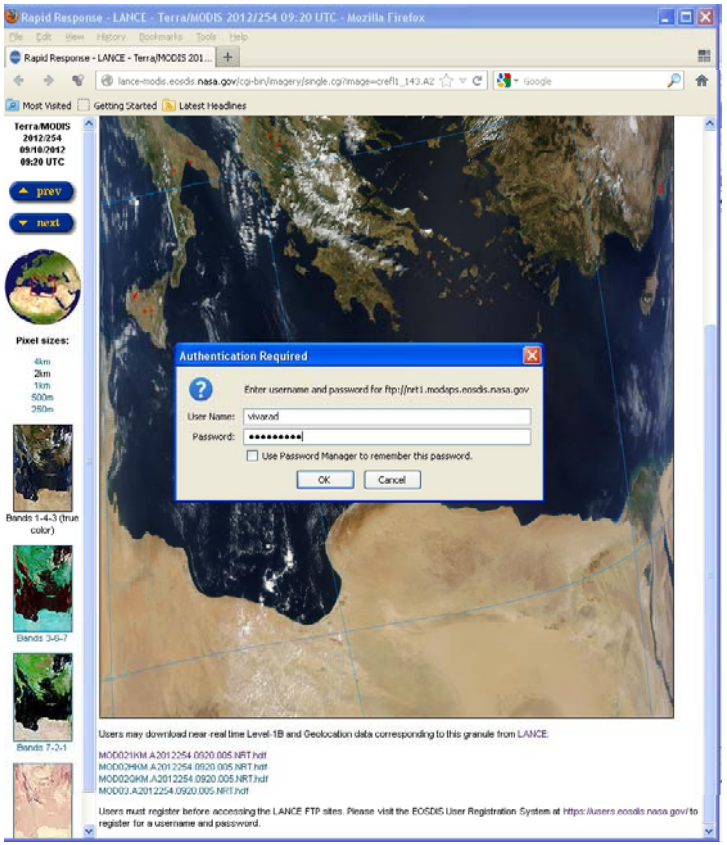


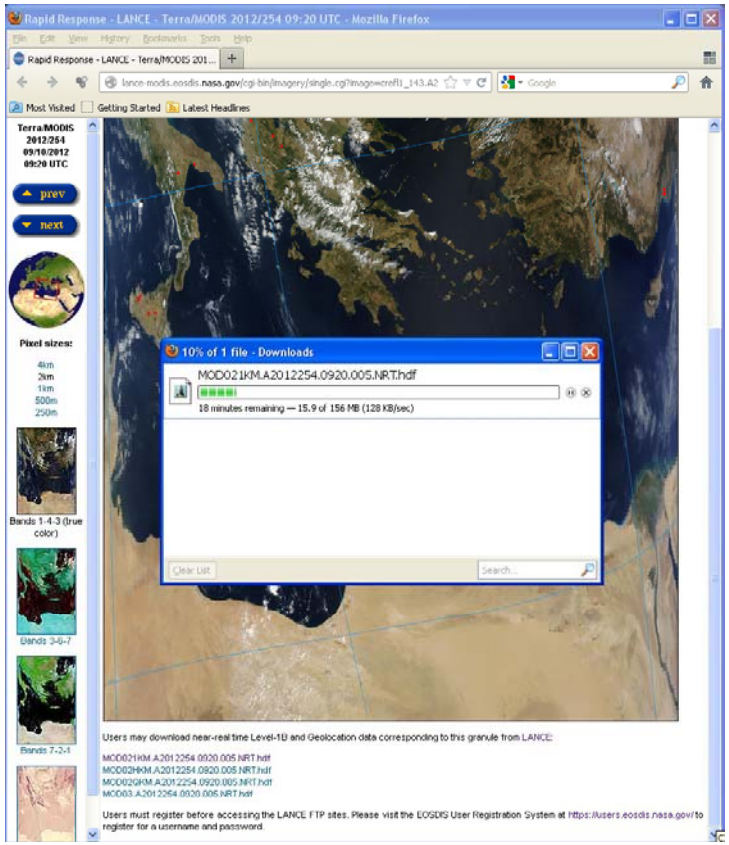
Land Atmosphere Near real-time Capability for EOS (LANCE)





Land Atmosphere Near real-time Capability for EOS (LANCE)





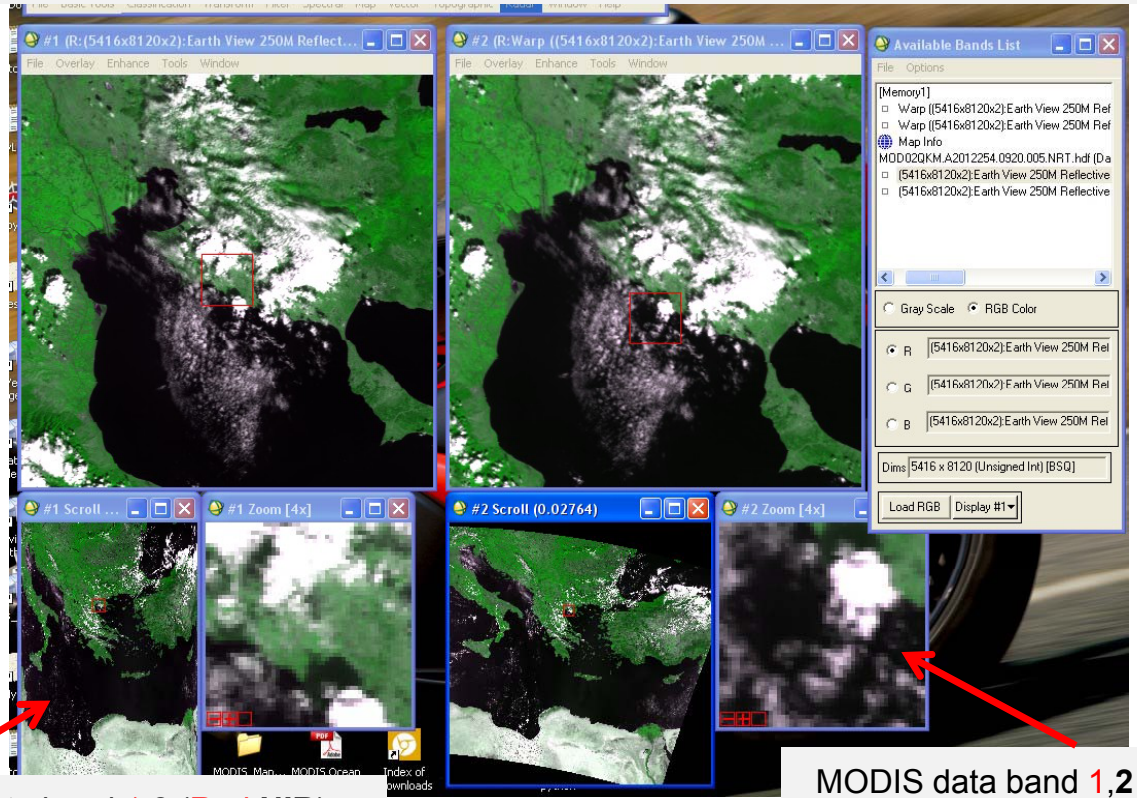
Land Atmosphere Near real-time Capability for EOS (LANCE)

Downloaded MODIS level 1b data

Name	Size	Type	Date Modified
MOD02HKM.A2012254.0920.005.NRT	147,653 KB	NCSA HDF Files	10/9/2555 22:37
MOD02QKM.A2012254.0920.005.NRT	159,645 KB	NCSA HDF Files	10/9/2555 22:39
MOD03.A2012254.0920.005.NRT	30,470 KB	NCSA HDF Files	10/9/2555 22:20
MOD021KM.A2012254.0920.005.NRT	160,210 KB	NCSA HDF Files	10/9/2555 22:16

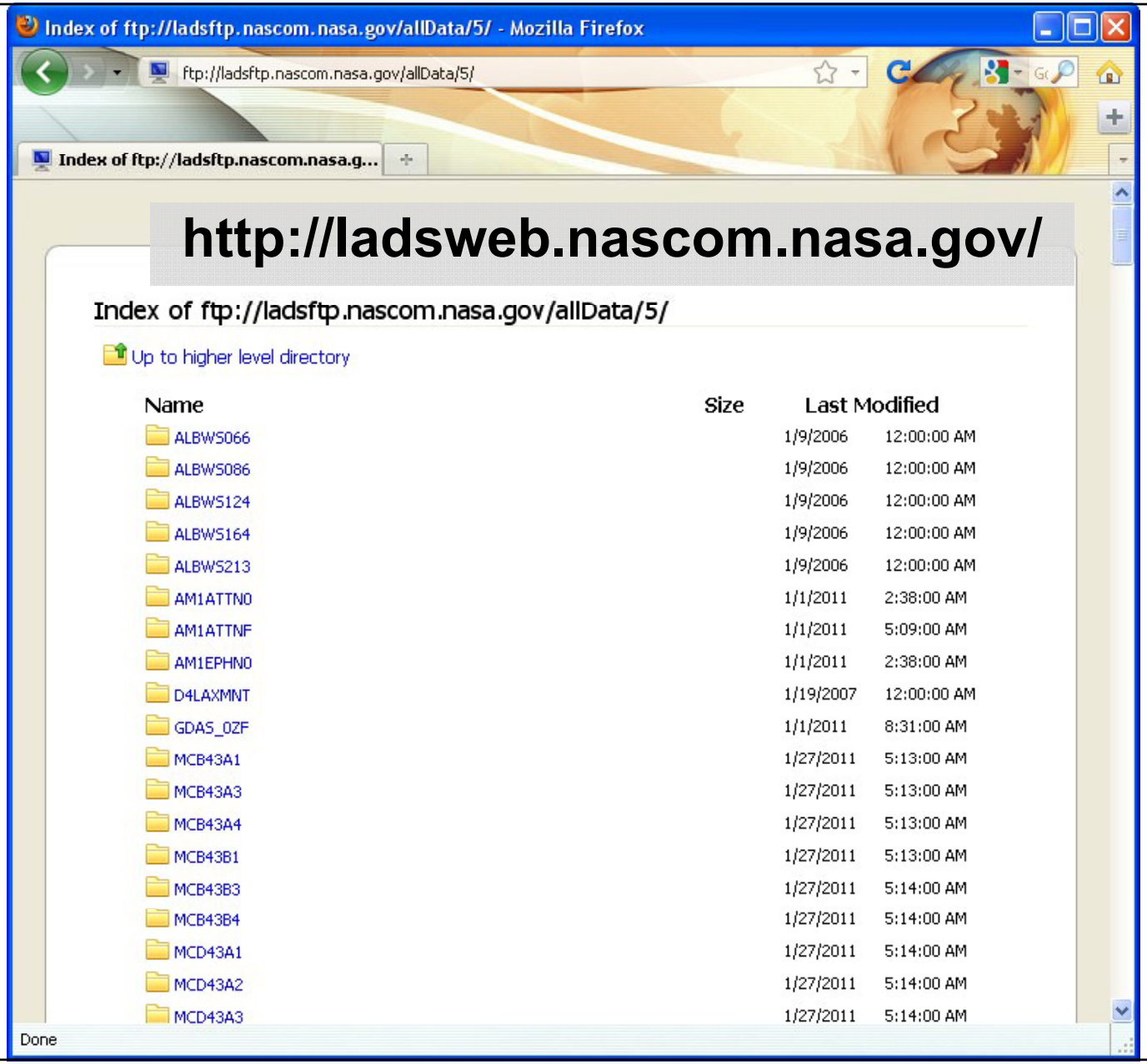
Land Atmosphere Near real-time Capability for EOS (LANCE)

Geometric Correction of MODIS Level1B image using ENVI



MODIS data band 1,**2** (Red,**NIR**) - Before Geometric Correction

MODIS data band 1,**2** (Red, **NIR**) - After Geometric Correction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Up to higher level directory
Name
Size
Last Modified
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ALBWS213 1/9/2006 12:00:00 AM
AM1ATTN0 1/1/2011 2:38:00 AM
AM1ATTNF 1/1/2011 5:09:00 AM
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GDAS_0ZF 1/1/2011 8:31:00 AM
MCB43A1 1/27/2011 5:13:00 AM
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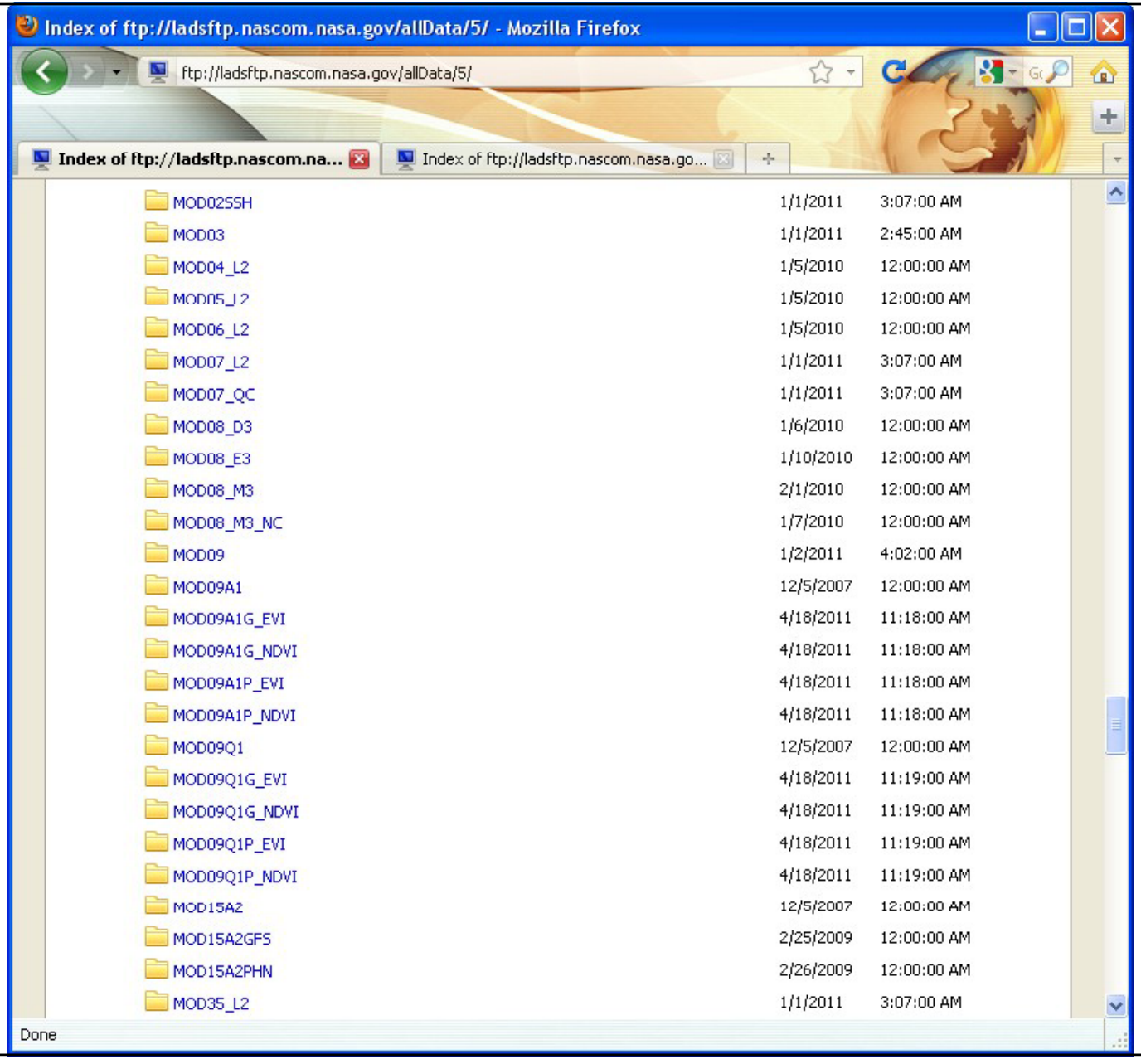
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MOD02SSH 1/1/2011 3:07:00 AM
MOD03 1/1/2011 2:45:00 AM
MOD04_L2 1/5/2010 12:00:00 AM
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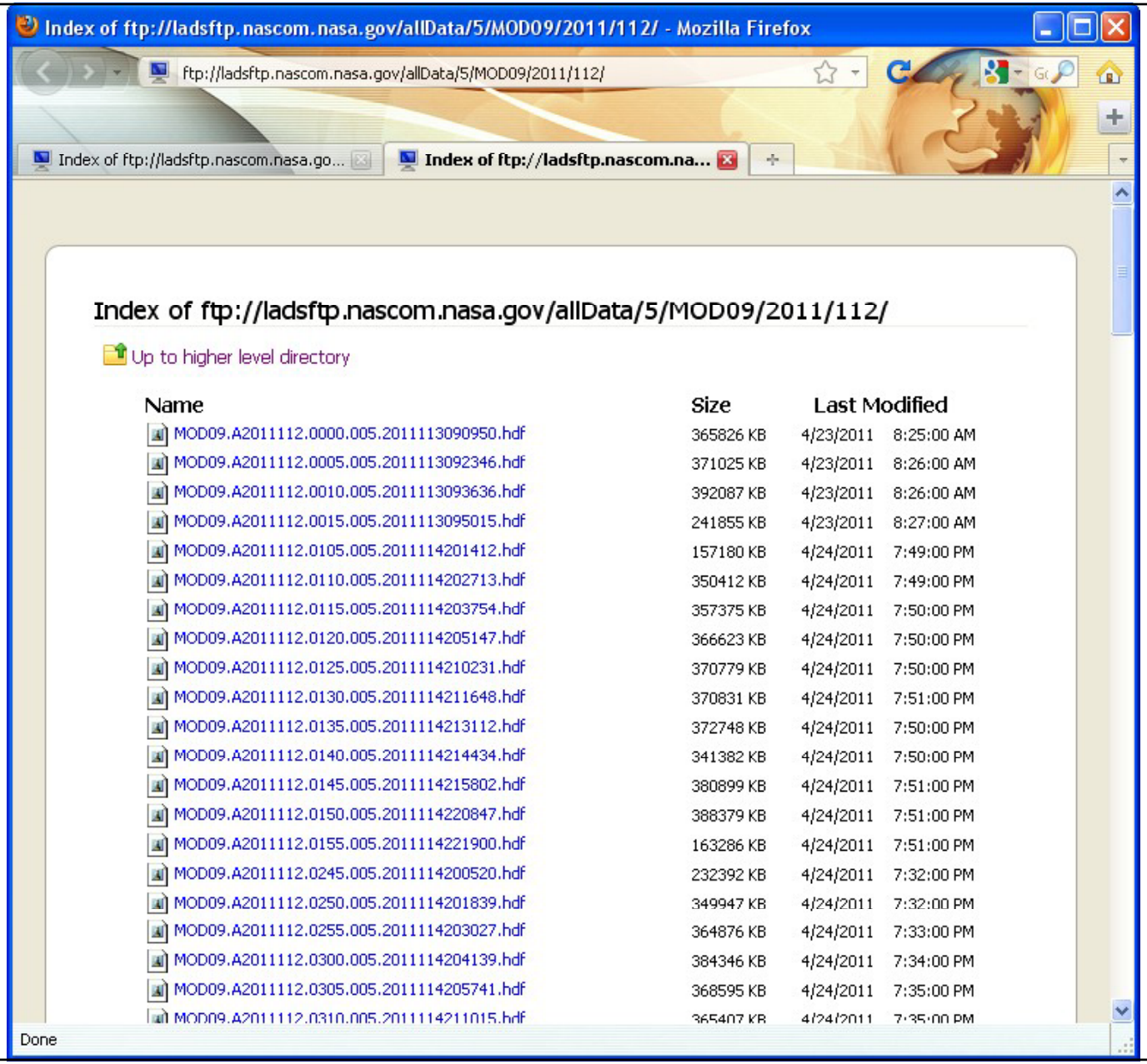
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Up to higher level directory
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Size
Last Modified
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MOD09.A2011112.0115.005.2011114203754.hdf 357375 KB 4/24/2011 7:50:00 PM
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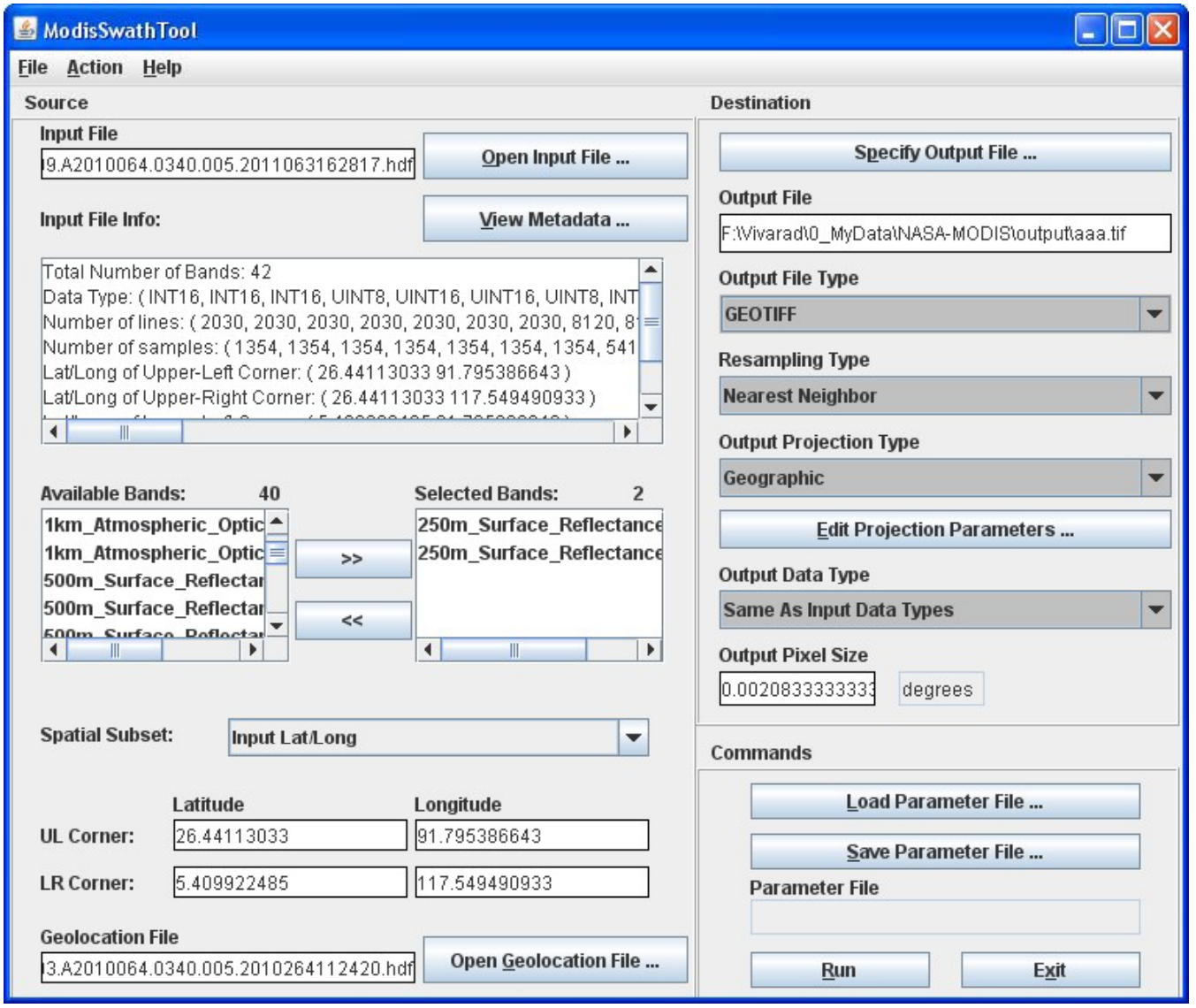
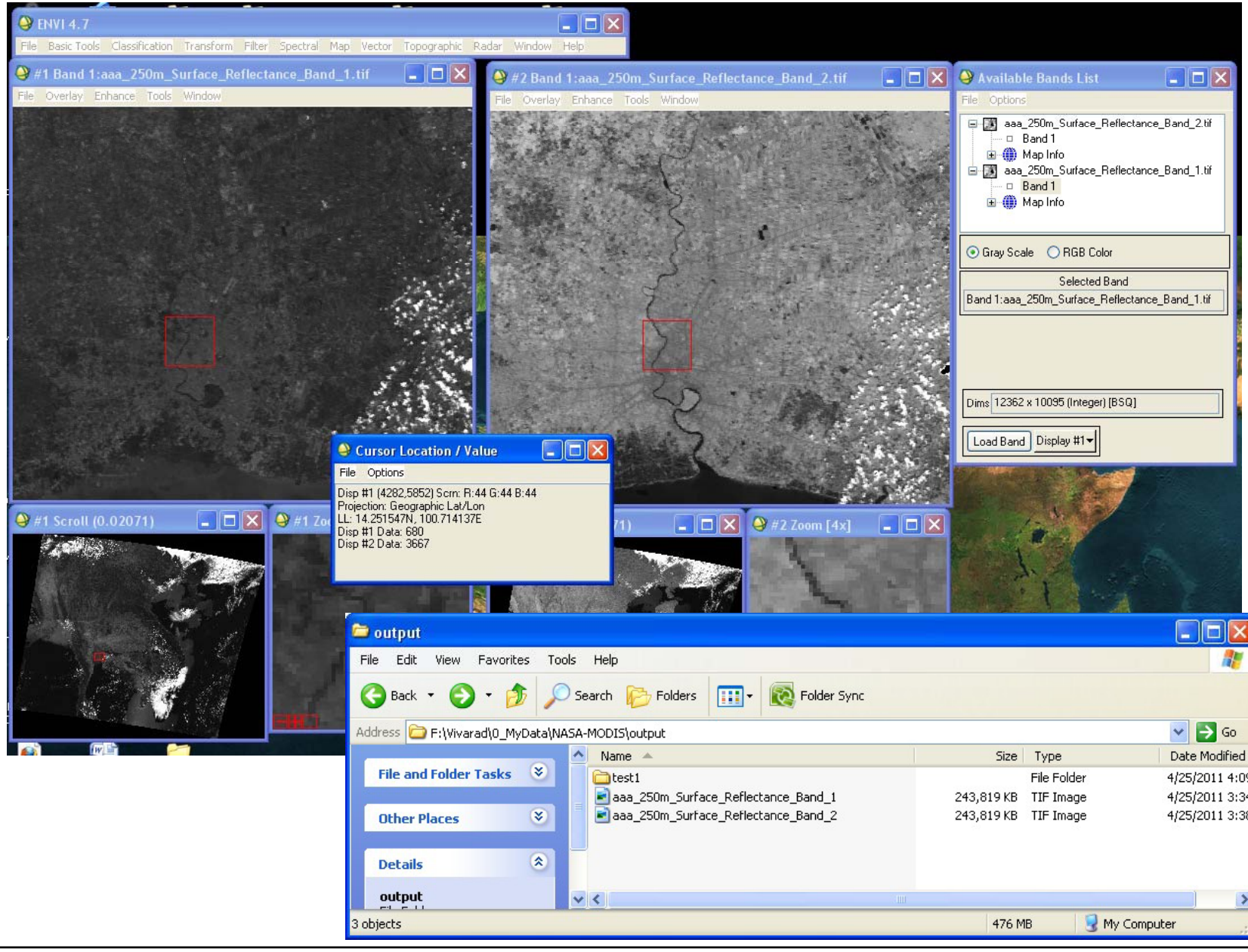
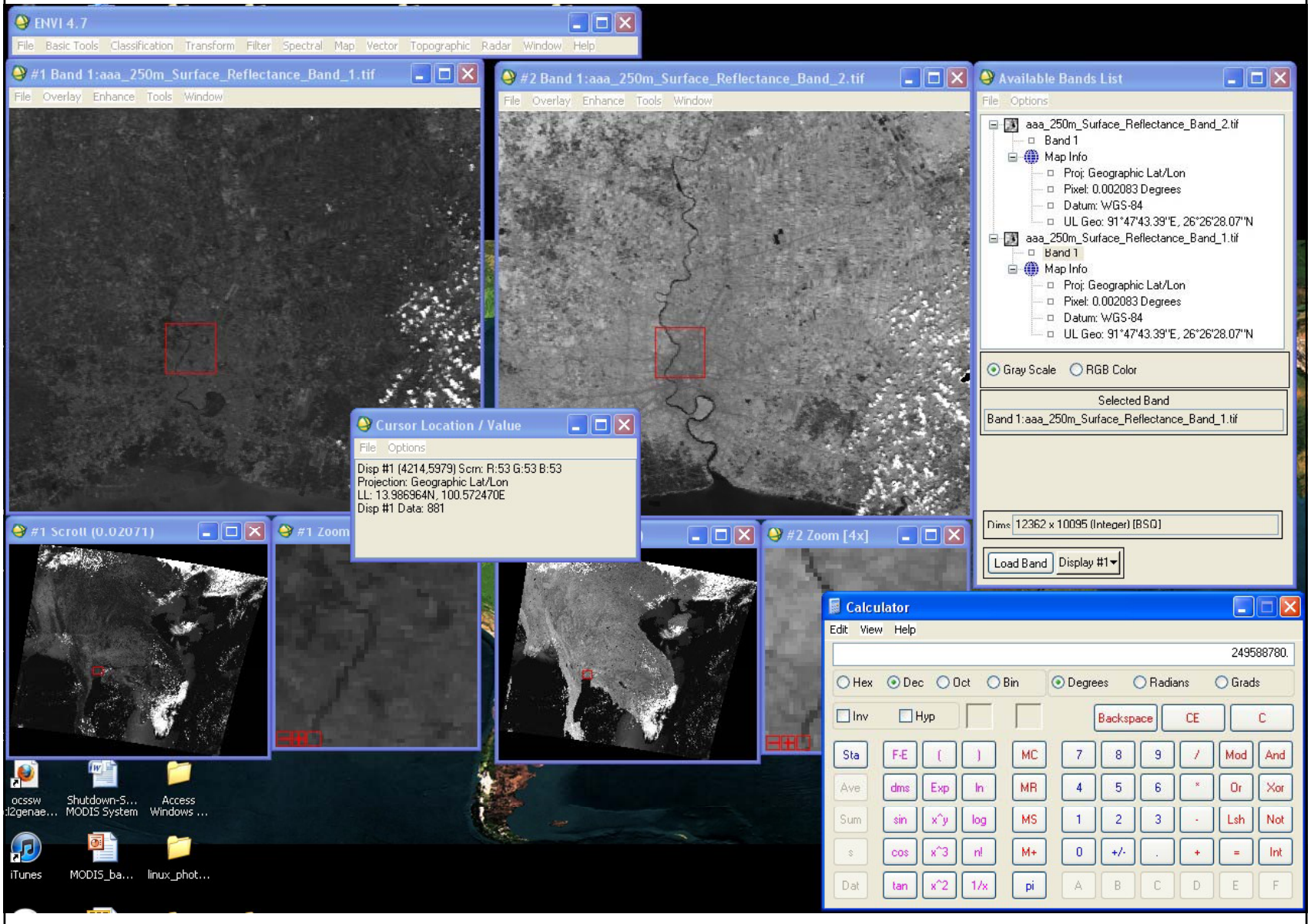
MOD09.A2011112.0310.005.2011114211015.hdf 365407 KB 4/24/2011 7:35:00 PM
Done

https://lpdaac.usgs.gov/lpdaac/products/modis_products_table

https://lpdaac.usgs.gov/lpdaac/tools/modis_reprojection_tool_swath


ModisSwathTool
File Action Help
Source
Input File
9.A2010064.0340.005.2011063162817.hdf
Open Input File ...
Input File Info:
View Metadata ...
Total Number of Bands: 42
Data Type: (INT16, INT16, INT16, UINT8, UINT16, UINT16, UINT8, INT
Number of lines: (2030, 2030, 2030, 2030, 2030, 2030, 2030, 8120, 8
Number of samples: (1354, 1354, 1354, 1354, 1354, 1354, 1354, 541
Lat/Long of Upper-Left Corner: (26.44113033 91.795386643)
Lat/Long of Upper-Right Corner: (26.44113033 117.549490933)
Available Bands: 40
1km_Atmospheric_Optic
1km_Atmospheric_Optic
500m_Surface_Reflectar
500m_Surface_Reflectar
>>
<<
Selected Bands: 2
250m_Surface_Reflectance
250m_Surface_Reflectance
Spatial Subset:
Input Lat/Long
Latitude
Longitude
UL Corner:
26.44113033
91.795386643
LR Corner:
5.409922485
117.549490933
Geolocation File
3.A2010064.0340.005.2010264112420.hdf
Open Geolocation File ...
Destination
Specify Output File ...
Output File
F:\Vivarad\0_MyData\NASA-MODIS\output\aaa.tif
Output File Type
GEOTIFF
Resampling Type
Nearest Neighbor
Output Projection Type
Geographic
Edit Projection Parameters ...
Output Data Type
Same As Input Data Types
Output Pixel Size
0.0020833333333
degrees
Commands
Load Parameter File ...
Save Parameter File ...
Parameter File
Run
Exit


ENVI 4.7
File Basic Tools Classification Transform Filter Spectral Map Vector Topographic Radar Window Help
#1 Band 1:aaa_250m_Surface_Reflectance_Band_1.tif
File Overlay Enhance Tools Window
#2 Band 1:aaa_250m_Surface_Reflectance_Band_2.tif
File Overlay Enhance Tools Window
Available Bands List
File Options
aaa_250m_Surface_Reflectance_Band_2.tif
Band 1
Map Info
aaa_250m_Surface_Reflectance_Band_1.tif
Band 1
Map Info
Gray Scale
RGB Color
Selected Band
Band 1:aaa_250m_Surface_Reflectance_Band_1.tif
Dims 12362 x 10095 (Integer) [BSQ]
Load Band
Display #1
Cursor Location / Value
File Options
Disp #1 (4282,5852) Scrn: R:44 G:44 B:44
Projection: Geographic Lat/Lon
LL: 14.251547N, 100.714137E
Disp #1 Data: 680
Disp #2 Data: 3667
#1 Scroll (0.02071)
#2 Zoom [4x]
output
File Edit View Favorites Tools Help
Back
Search
Folders
Folder Sync
Address F:\Vivarad\0_MyData\NASA-MODIS\output
Go
File and Folder Tasks
Other Places
Details
output
Name
Size
Type
Date Modified
test1
File Folder
4/25/2011 4:09
aaa_250m_Surface_Reflectance_Band_1
243,819 KB
TIF Image
4/25/2011 3:34
aaa_250m_Surface_Reflectance_Band_2
243,819 KB
TIF Image
4/25/2011 3:38
3 objects
476 MB
My Computer


ENVI 4.7
File Basic Tools Classification Transform Filter Spectral Map Vector Topographic Radar Window Help
#1 Band 1:aaa_250m_Surface_Reflectance_Band_1.tif
File Overlay Enhance Tools Window
#2 Band 1:aaa_250m_Surface_Reflectance_Band_2.tif
File Overlay Enhance Tools Window
Available Bands List
File Options
aaa_250m_Surface_Reflectance_Band_2.tif
Band 1
Map Info
Proj: Geographic Lat/Lon
Pixel: 0.002083 Degrees
Datum: WGS-84
UL Geo: 91°47'43.39"E, 26°26'28.07"N
aaa_250m_Surface_Reflectance_Band_1.tif
Band 1
Map Info
Proj: Geographic Lat/Lon
Pixel: 0.002083 Degrees
Datum: WGS-84
UL Geo: 91°47'43.39"E, 26°26'28.07"N
Gray Scale
RGB Color
Selected Band
Band 1:aaa_250m_Surface_Reflectance_Band_1.tif
Dims 12362 x 10095 (Integer) [BSQ]
Load Band
Display #1
Cursor Location / Value
File Options
Disp #1 (4214,5979) Scrn: R:53 G:53 B:53
Projection: Geographic Lat/Lon
LL: 13.986964N, 100.572470E
Disp #1 Data: 881
#1 Scroll (0.02071)
#1 Zoom
#2 Zoom [4x]
Calculator
Edit View Help
249588780.
Hex Dec Oct Bin
Degrees Radians Grads
Inv Hyp
Backspace CE C
Sta F-E ( ) MC 7 8 9 / Mod And
Ave dms Exp ln MR 4 5 6 * Or Xor
Sum sin x^y log MS 1 2 3 - Lsh Not
s cos x^3 n! M+ 0 +/- . + = Int
Dat tan x^2 1/x pi A B C D E F
ocssw
Shutdown-S... MODIS System
Access Windows ...
iTunes
MODIS_ba...
linux_phot...

END OF PRESENTATION

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