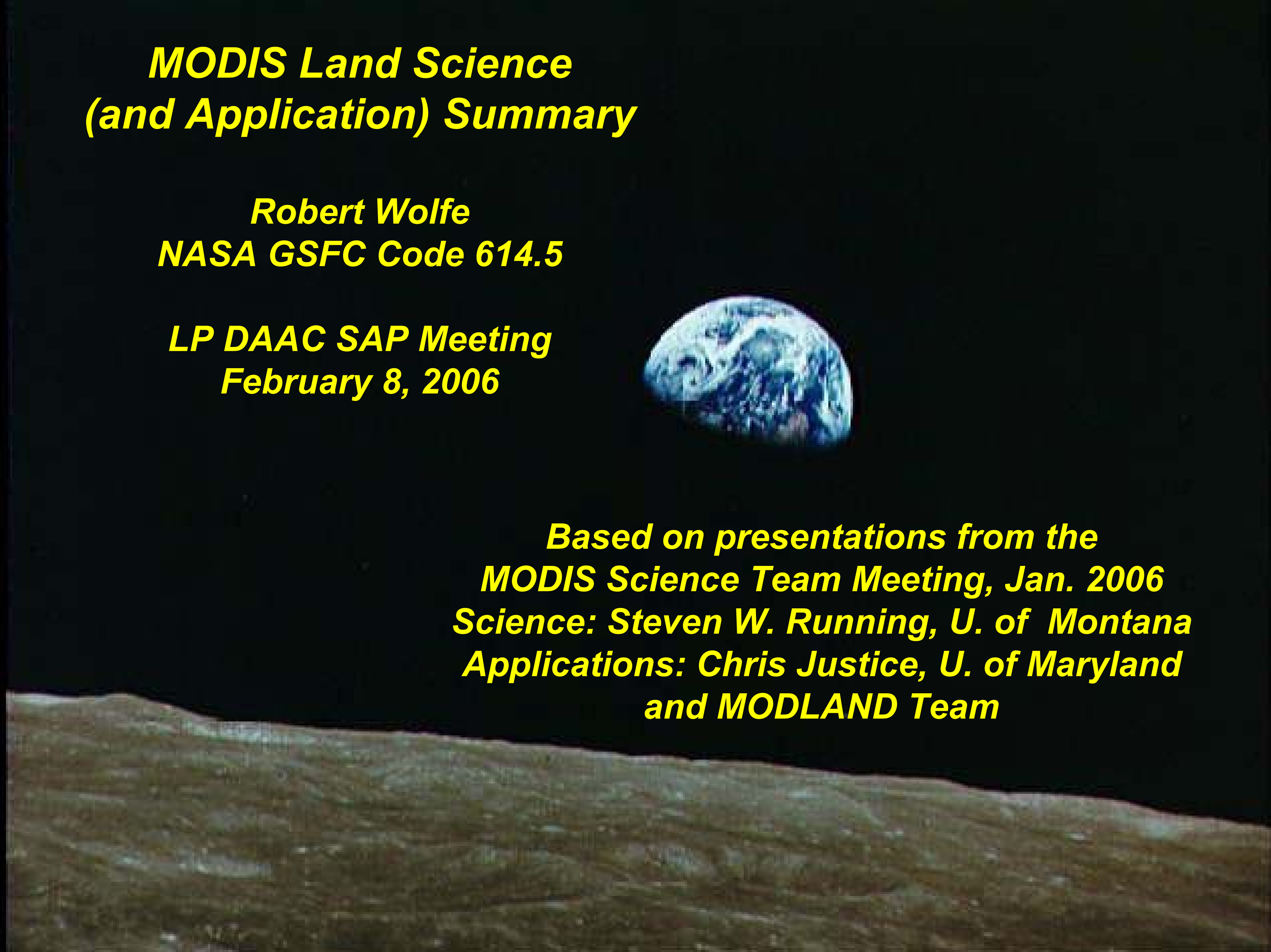


MODIS Land Science (and Application) Summary

Robert Wolfe
NASA GSFC Code 614.5

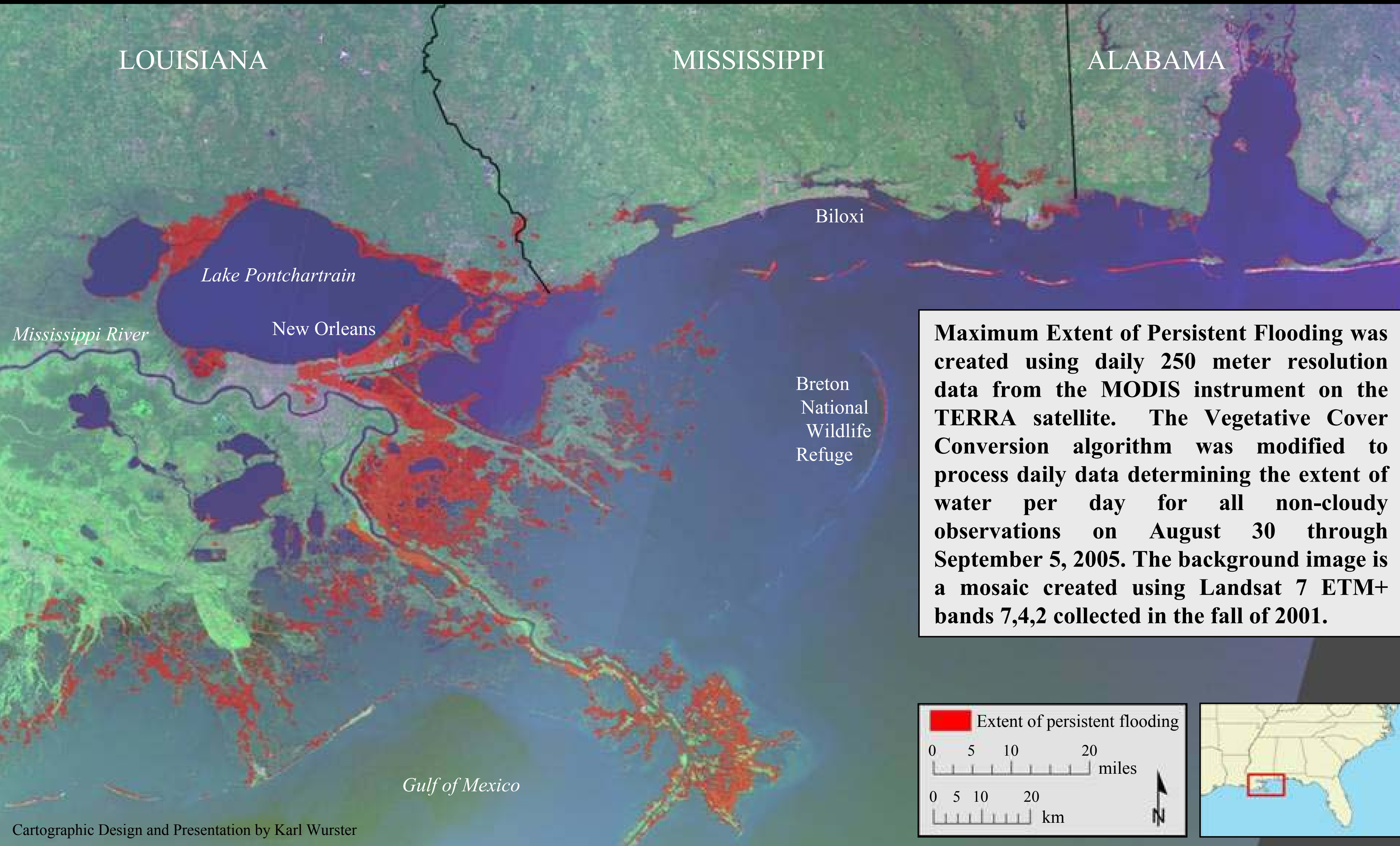
LP DAAC SAP Meeting
February 8, 2006

Based on presentations from the
MODIS Science Team Meeting, Jan. 2006
Science: Steven W. Running, U. of Montana
Applications: Chris Justice, U. of Maryland
and MODLAND Team

Science

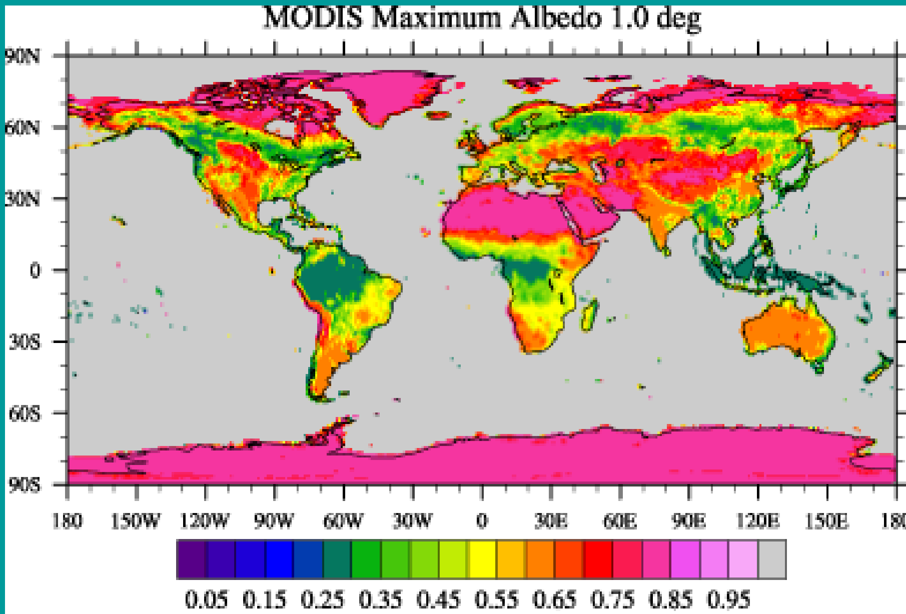
Maximum Extent of Persistent Flooding Caused by Hurricane Katrina

Mark Carroll, Charlene DiMiceli, Robert Sohlberg, John Townshend
Department of Geography, University of Maryland

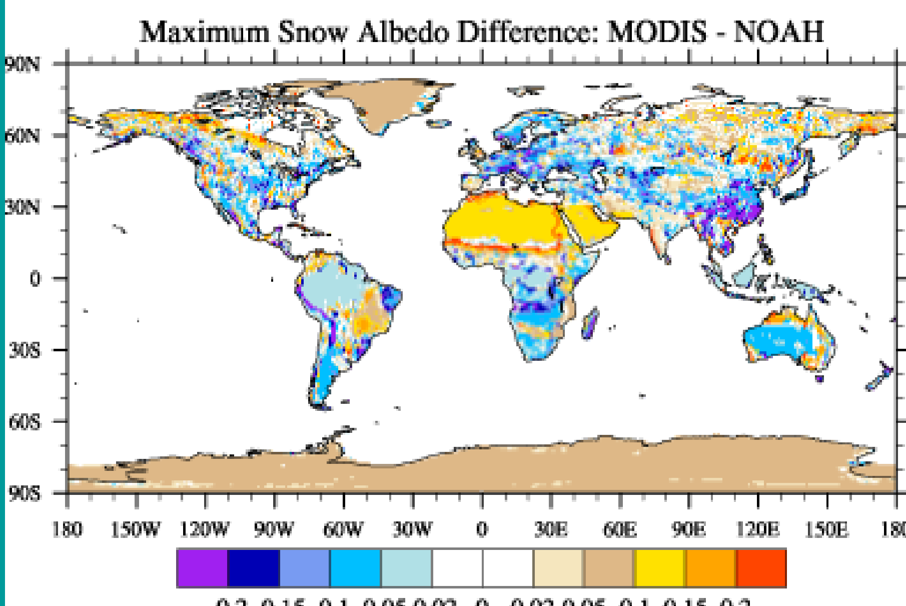


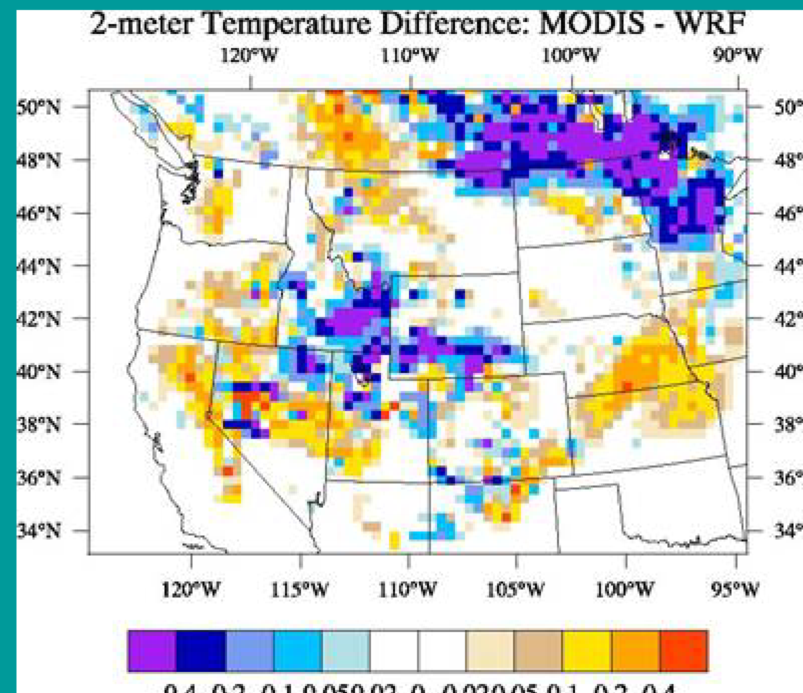
Maximum Extent of Persistent Flooding was created using daily 250 meter resolution data from the MODIS instrument on the TERRA satellite. The Vegetative Cover Conversion algorithm was modified to process daily data determining the extent of water per day for all non-cloudy observations on August 30 through September 5, 2005. The background image is a mosaic created using Landsat 7 ETM+ bands 7,4,2 collected in the fall of 2001.

Cartographic Design and Presentation by Karl Wurster



Global maximum snow albedo data are derived using multiple MODIS land data (<u>PI: Xubin Zeng</u>; Barlage et al. 2005, GRL) They differ from those in NCEP/Noah land model These differences affect 2-m air temp in 24-hour WRF forecasting





MODIS Fire & Albedo Product

Application Example

Jin, Y.[1] and Roy, D.P.[2]

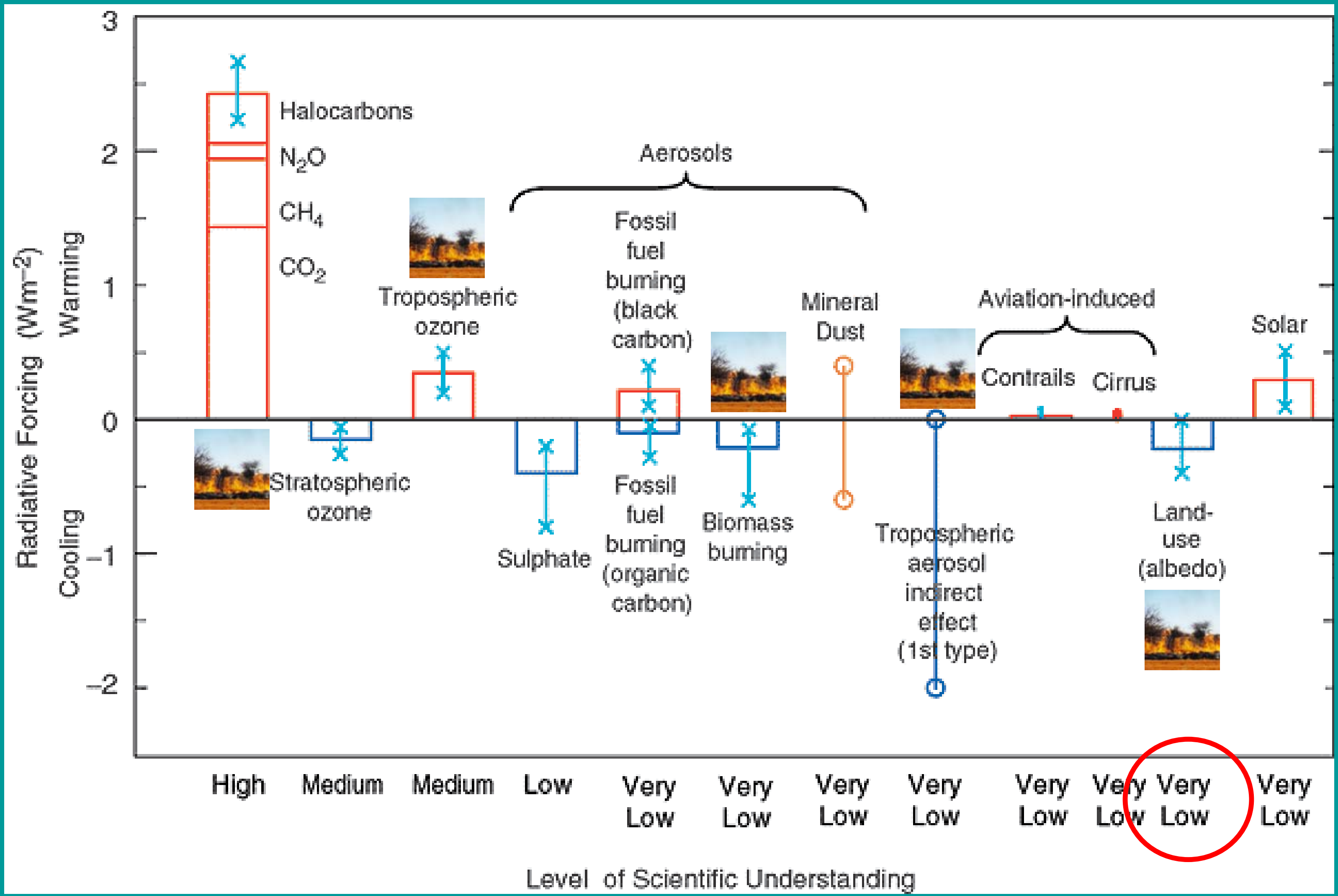
Fire-induced albedo change and its radiative forcing at the surface in northern Australia

***Geophys. Res. Lett.*, 2005, *32*, L13401, doi:10.1029/2005GL022822**

[1] Department of Earth System Science,
University of California, Irvine, CA

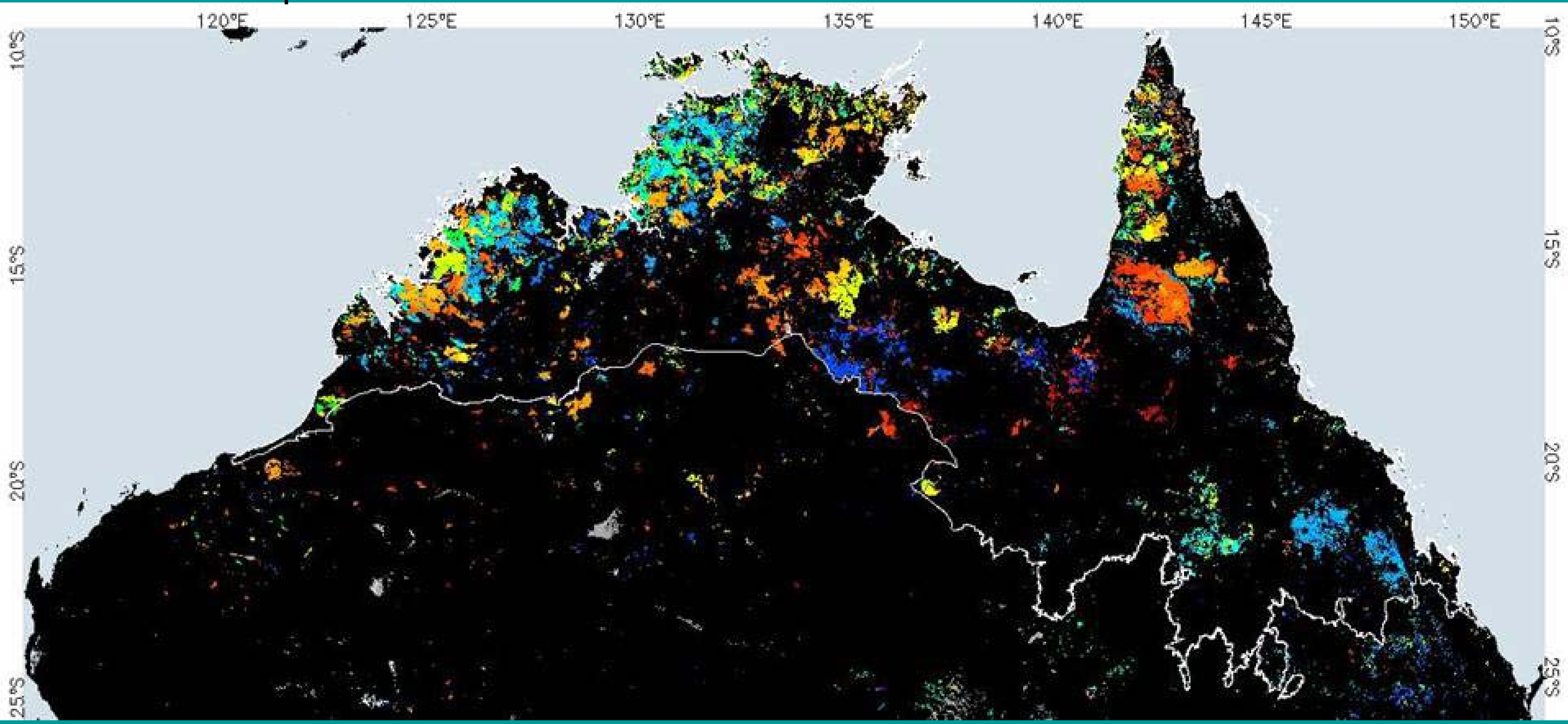
[2] Geographic Information Science Center of Excellence,
South Dakota State University, Brookings, SD

Global, annual-mean radiative forcings (Wm^{-2}) due to a number of agents for the period pre-industrial (1750) to present, Intergovernmental Panel on Climate Change 2001



Burned area 2003 dry season (March – November)

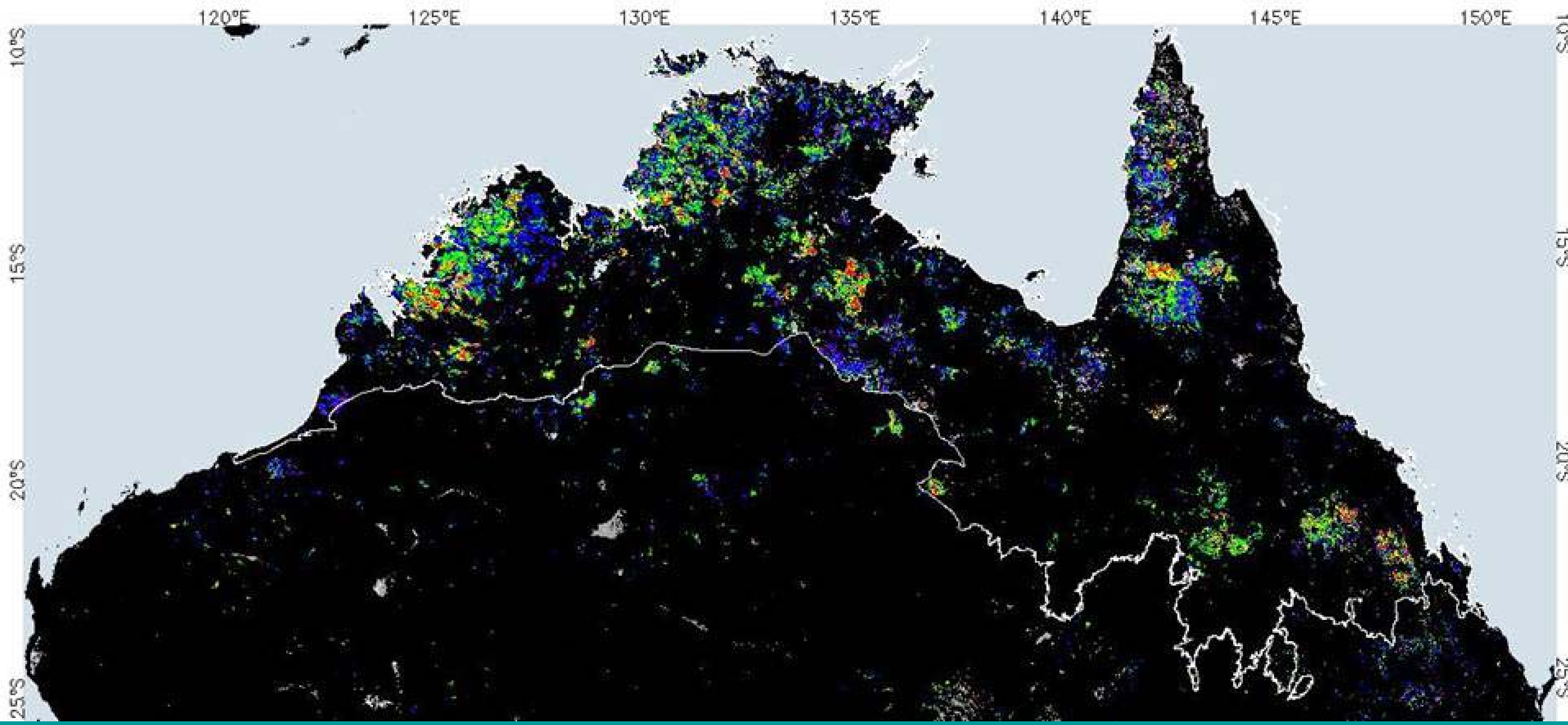
derived from Aqua + Terra MODIS data



March April May June July August September October November

Australia north of 26.5° S

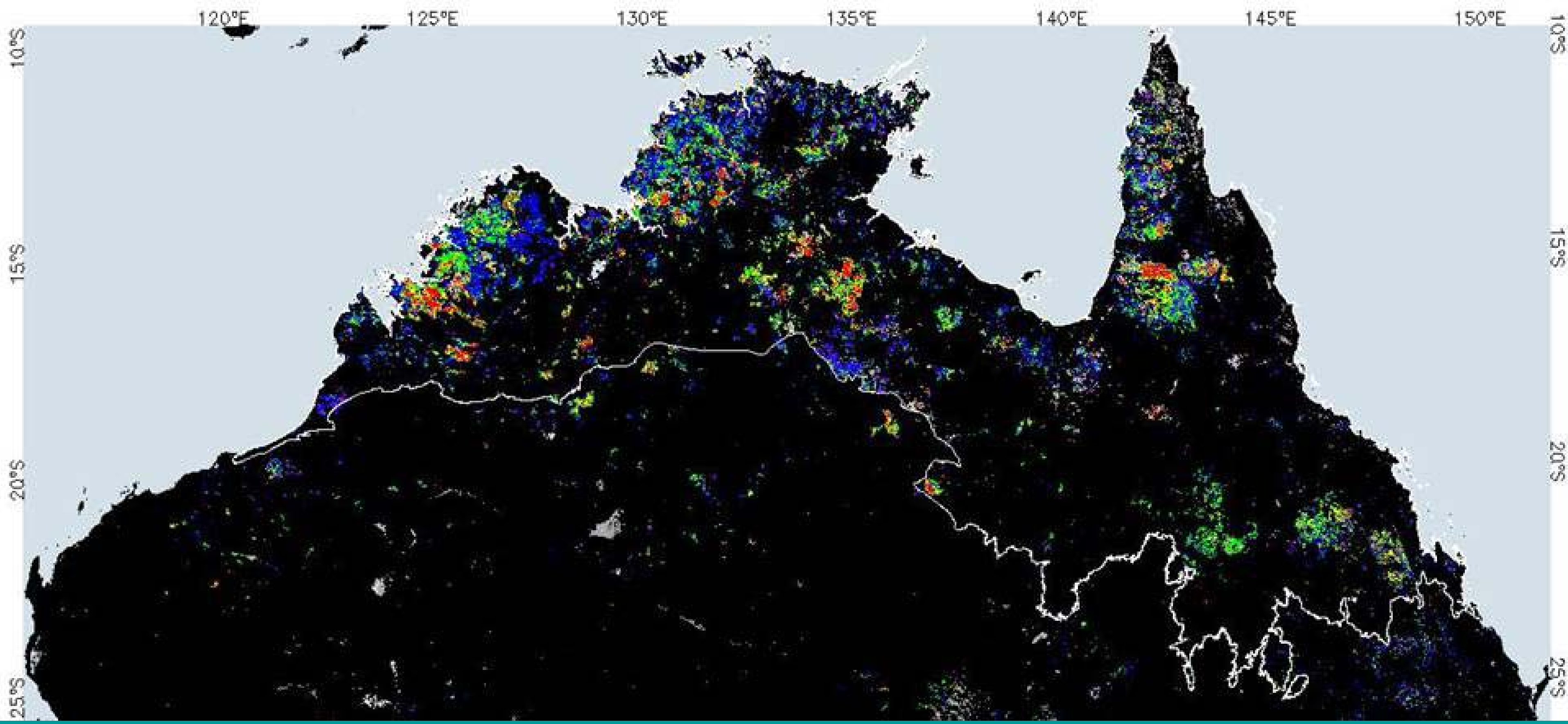
Shortwave "instantaneous" Δ albedo due to fire



Sienna	Blue	Green	Yellow	Red
>0.0	0.0 to -0.02	-0.02 to -0.04	-0.04 to -0.06	<-0.06

Increase **Decrease** →

"Instantaneous" radiative forcing (Wm^{-2})



Sienna	Blue	Green	Yellow	Red
<0.0	0.0 to 5.0	5.0 to 10.0	10.0 to 15.0	>15

Cooling **Warming** →

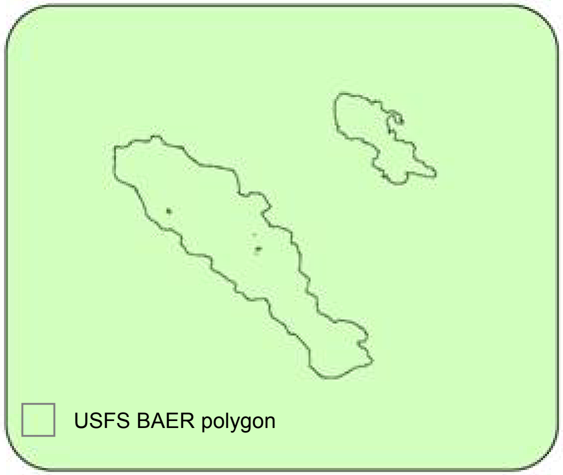
Mapping Wildfire Effects for Rehabilitation and Inventory Applications

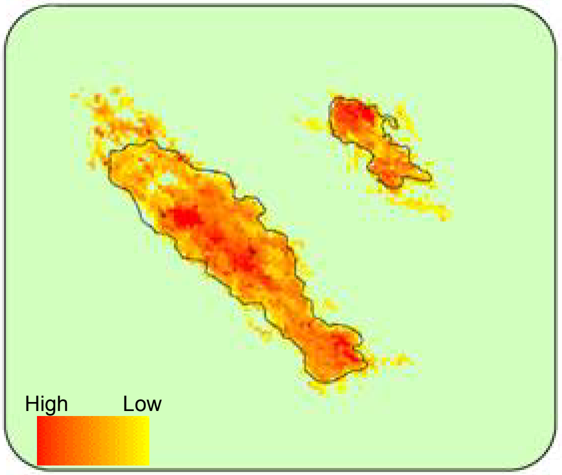
From Rob Sohlberg, Univ. of Maryland

Vegetative Cover Conversion – Change Due to Burning (VCC-CDB)

The Vegetative Cover Conversion product (VCC) is designed to be a global alarm product for rapid land cover change. VCC intends to locate change caused by deforestation, fire, and floods. VCC-Change Due to Burning (VCC-CDB) is generated at 250m resolution using data from the MODIS instrument and the Normalized Burn Ratio (NBR) calculated from 16-day composites.

Vegetative Cover Conversion – Change Due to Burning (VCC-CDB)





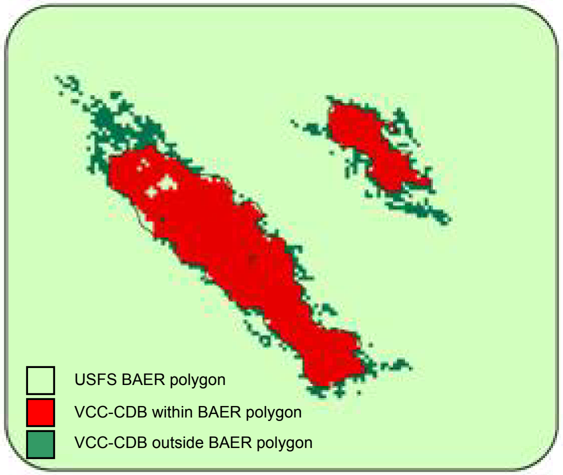
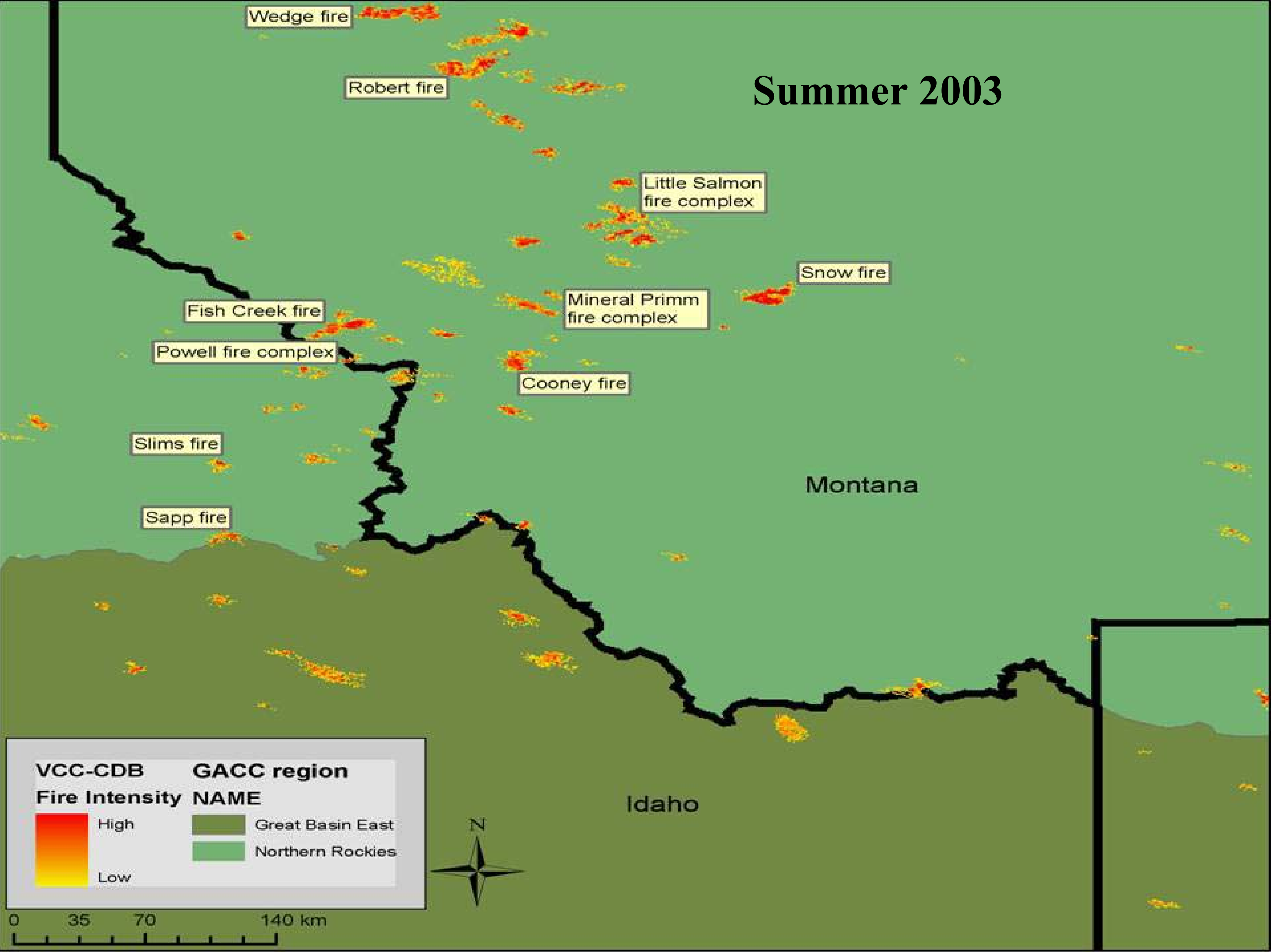


Figure 1a - USFS BAER Mineral Primm fire polygons.

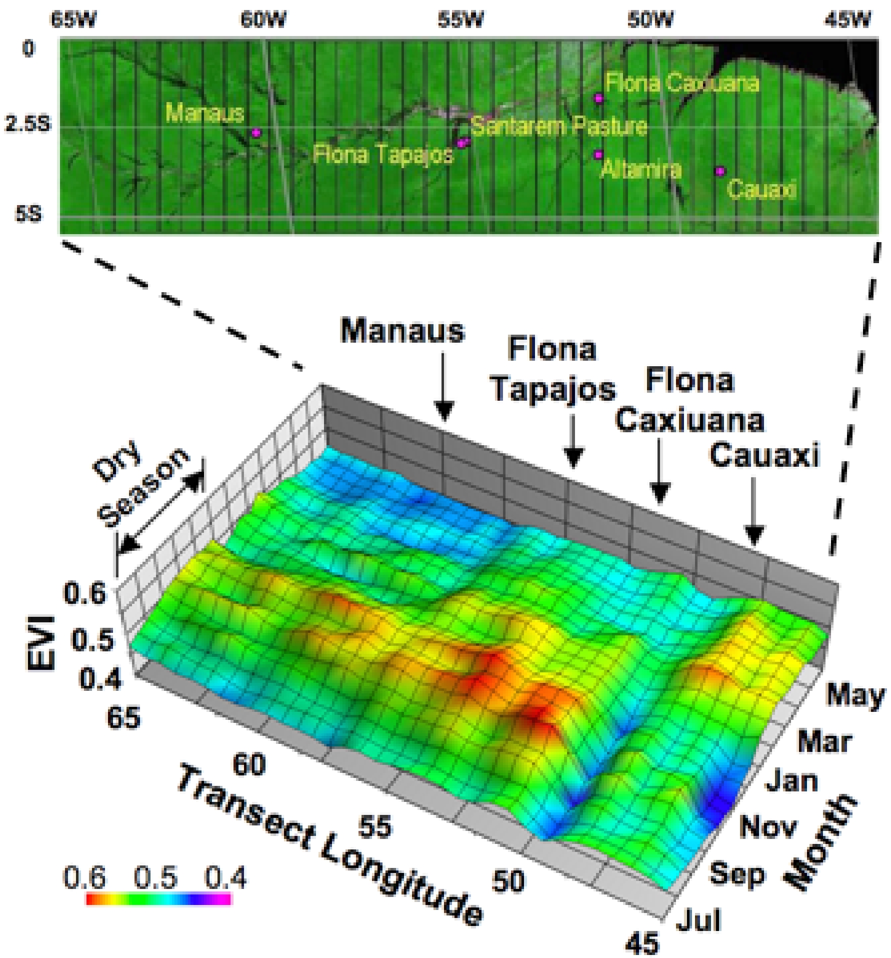
Figure 2a - MODIS VCC-CDB fire intensity (yellow = low while red = high), with USFS BAER Mineral Primm fire polygons.

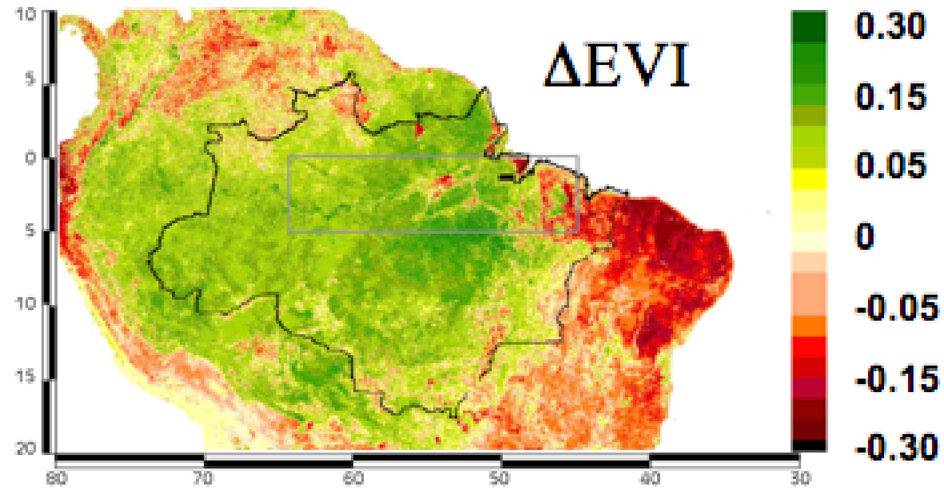
Figure 3a - Aggregated MODIS VCC-CDB polygon. Area in red represents VCC-CDB within the BAER polygon while the area in dark green is outside the BAER Mineral Primm fire polygon.

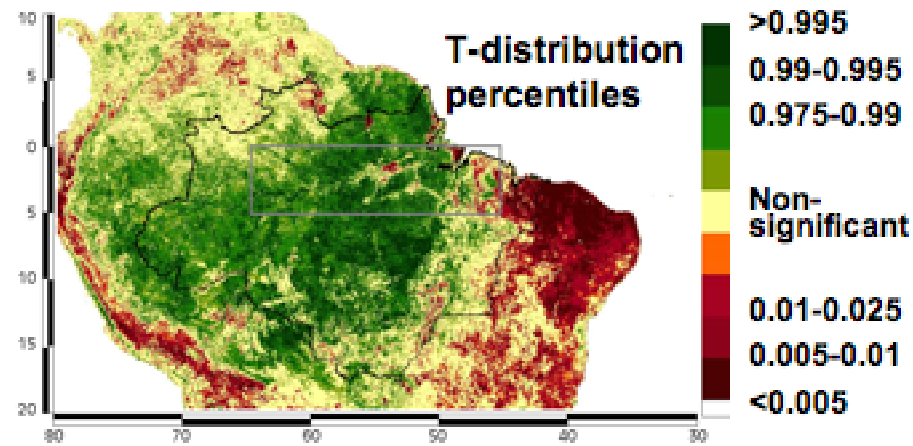
Fire Name	Total Area VCC	total BAER Acres	VCC Acres within BAER Polygon	VCC Acres outside BAER Polygon	% of BAER Polygon Area Covered by VCC Polygon
Mineral Primm Fire Complex	34023	23830	22753	11271	95.48%


Summer 2003
Wedge fire
Robert fire
Little Salmon
fire complex
Snow fire
Mineral Primm
fire complex
Fish Creek fire
Powell fire complex
Cooney fire
Slims fire
Sapp fire
Montana
Idaho
VCC-CDB
Fire Intensity
High
Low
GACC region
NAME
Great Basin East
Northern Rockies
N
0
35
70
140 km

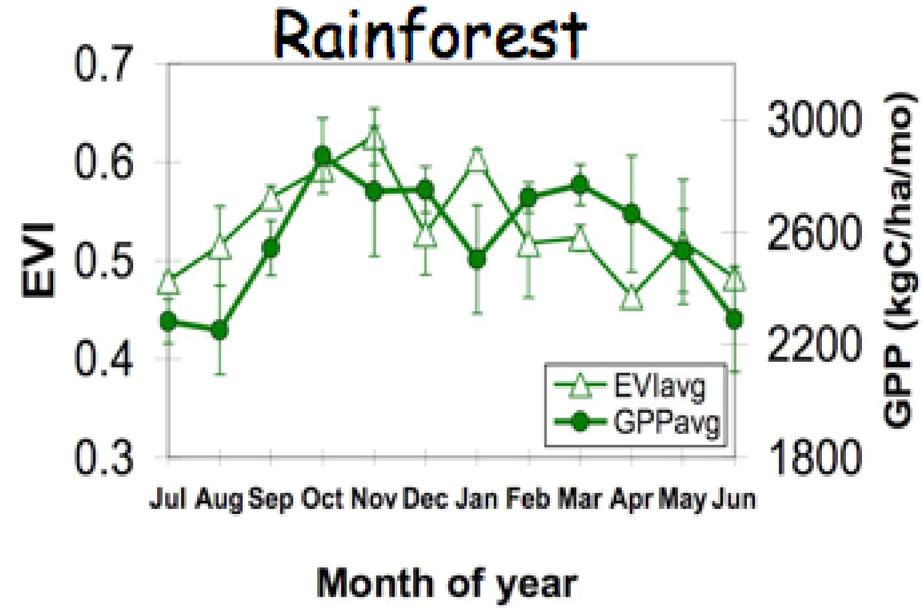
Amazon Rainforests Green-up with Sunlight in Dry Season

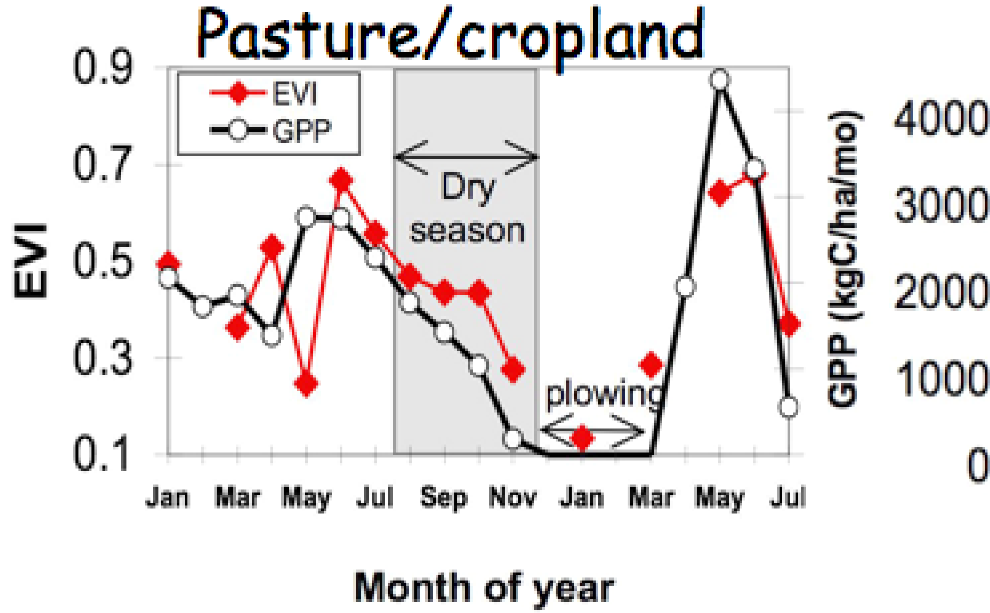






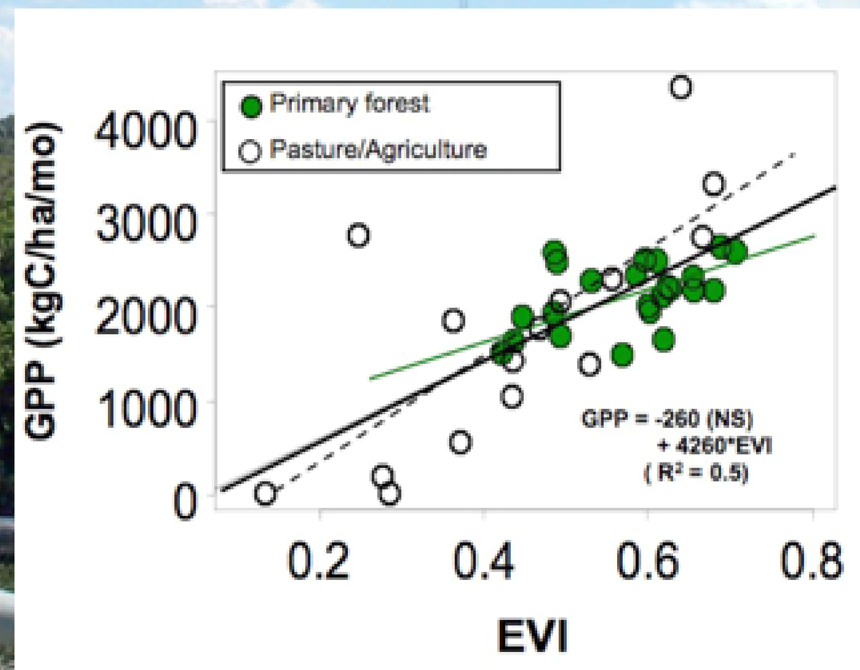
Huete et al. (in review)





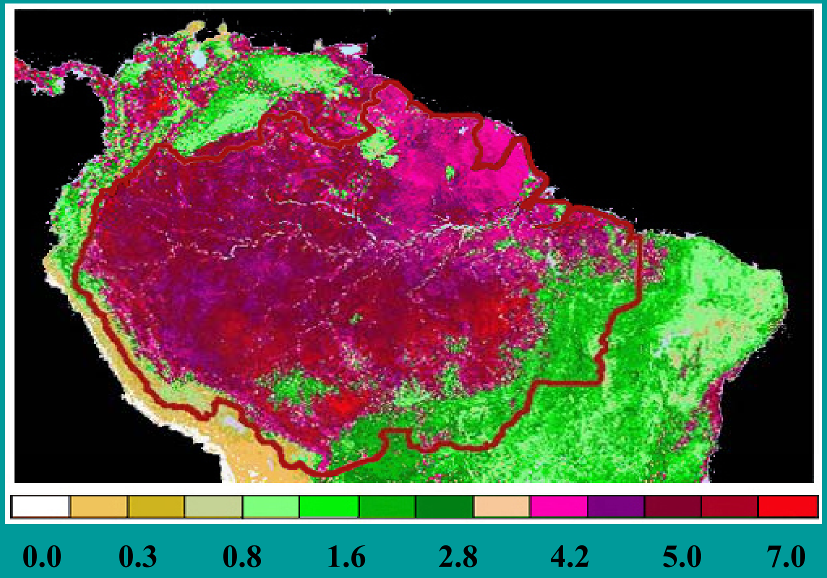
Validation @ plot level (flux tower sites)

- Both flux tower data and EVI show 'greening' in forests and 'browning' in pasture during the dry season,
- EVI scales the same in both forest and pasture biome types and suggests that basin-wide carbon fluxes can be constrained by integrating remote sensing and local flux measurements.



7. 4. 2000

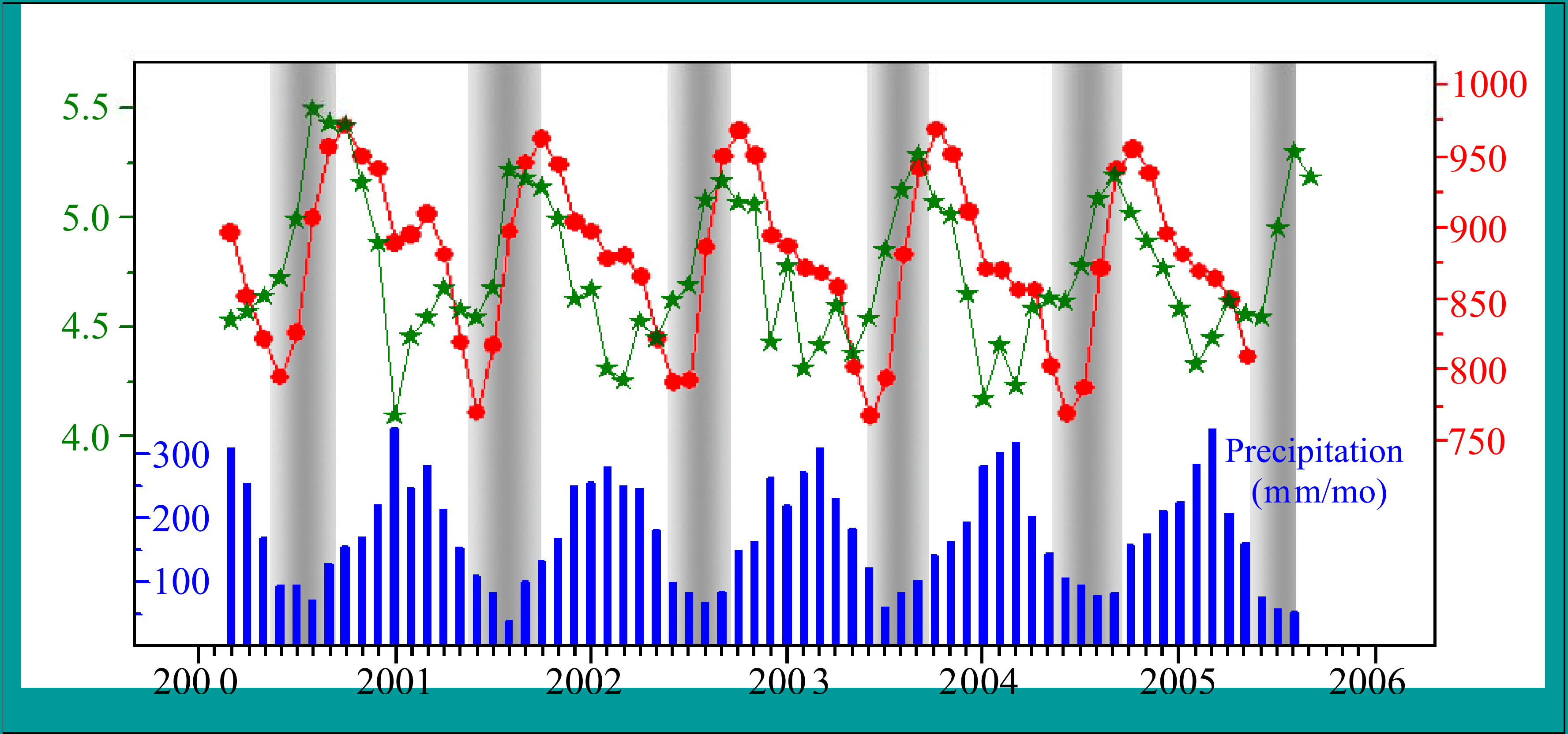
Large Seasonal Swings in Leaf Area of Amazon Rainforests



Annual Average Leaf Area Index

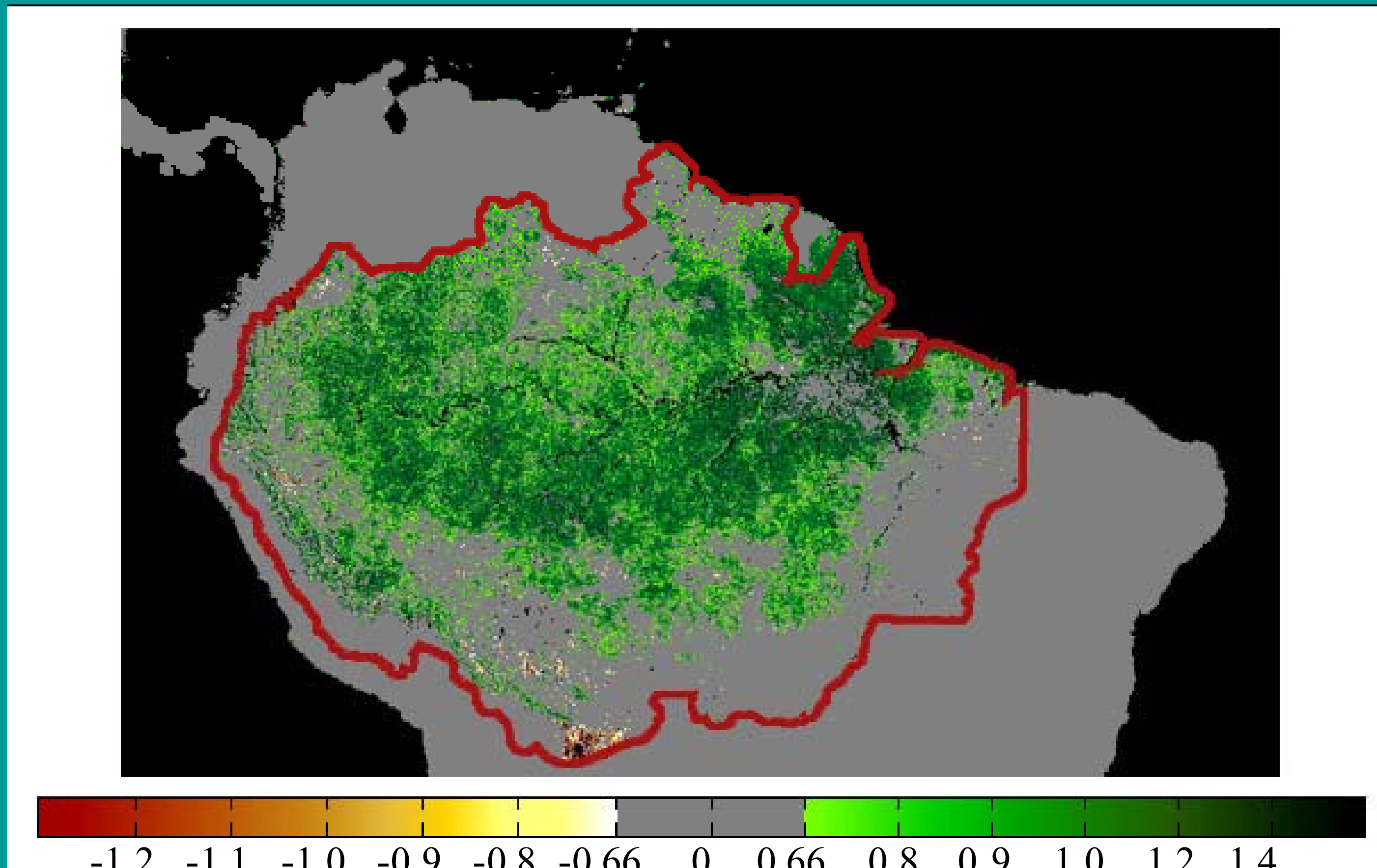
Myneni et al. (unpublished)

Spatially Averaged Behavior: LAI Amplitude



Leaf area data of the Amazon rainforests exhibit *notable seasonality*, with an amplitude (peak to trough difference) that is about 25% of the average annual LAI of 4.7, over the entire course of the data record.

Spatially Explicit Behavior: Pattern



Dry Minus Wet Season Leaf Area Index

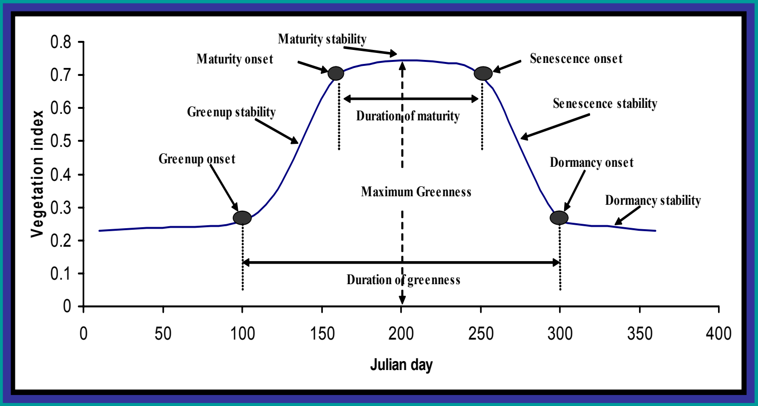
The derived spatial pattern of seasonal LAI amplitude reveals a heretofore unknown picture of phenology over a broad contiguous swath of land, anchored to the Amazon river, from its mouth in the east to its western-most reaches in Peru, in the heart of the basin.

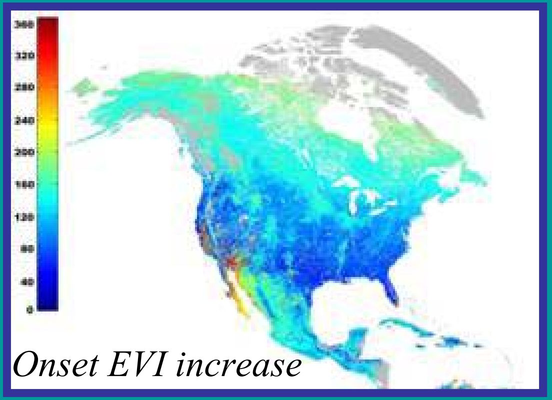
MOD12Q2: Global Vegetation Phenology

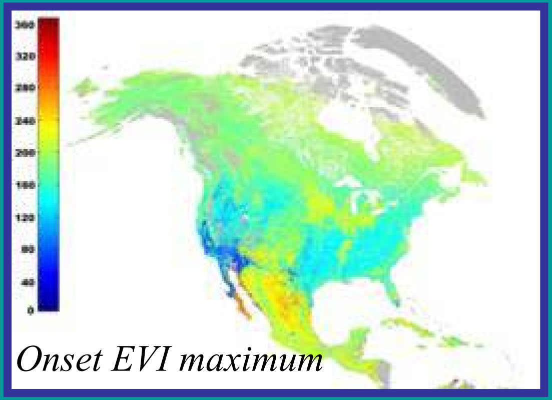
From Mark Friedl, Boston Univ.

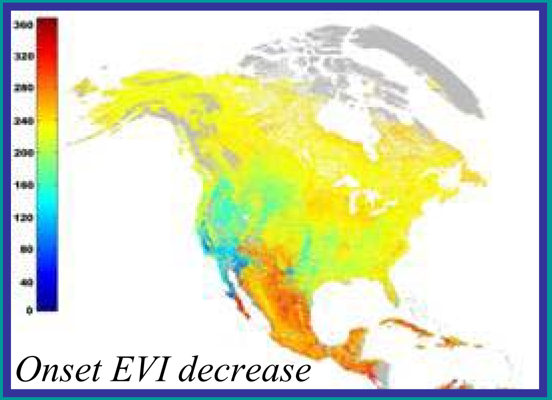
First global products for vegetation phenology based on MODIS EVI data released for 2001-2004

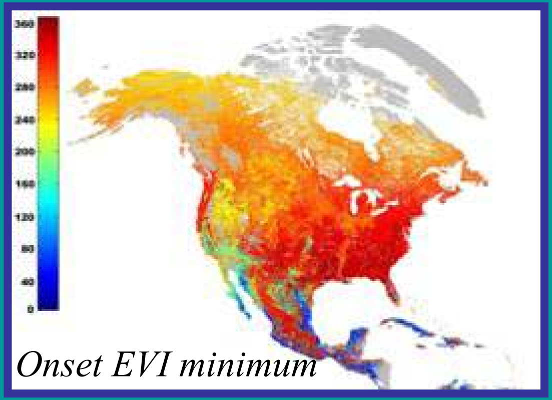
- Identifies key transition dates in growing season




Onset EVI increase

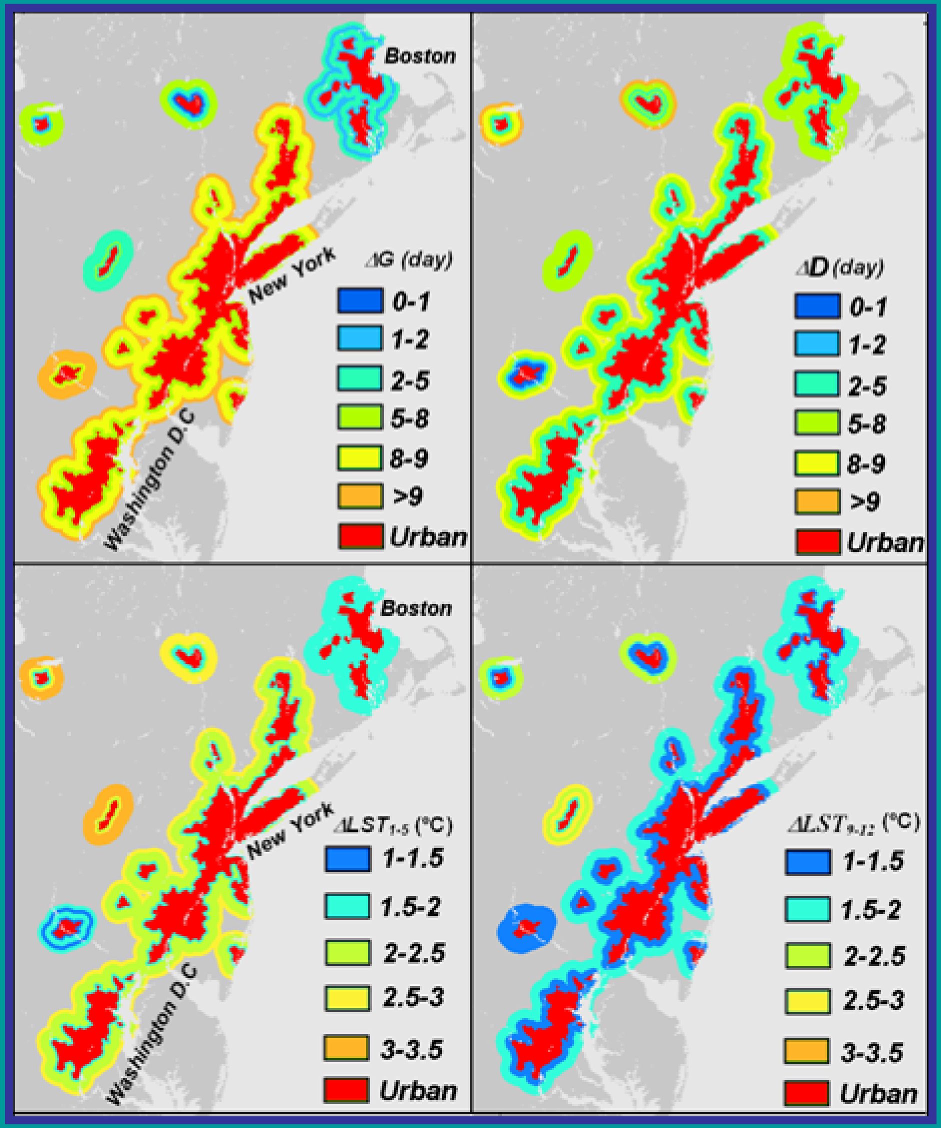

Onset EVI maximum


Onset EVI decrease


Onset EVI minimum

Footprint of Urban Climates on Phenology

- Results:
  - Phenological signature extends well beyond urban periphery
    - Exponential decay
  - Footprint
    - 2.4 x urban area
    - Longer growing season



Temperature-Driven Phenology in Northern Hemisphere

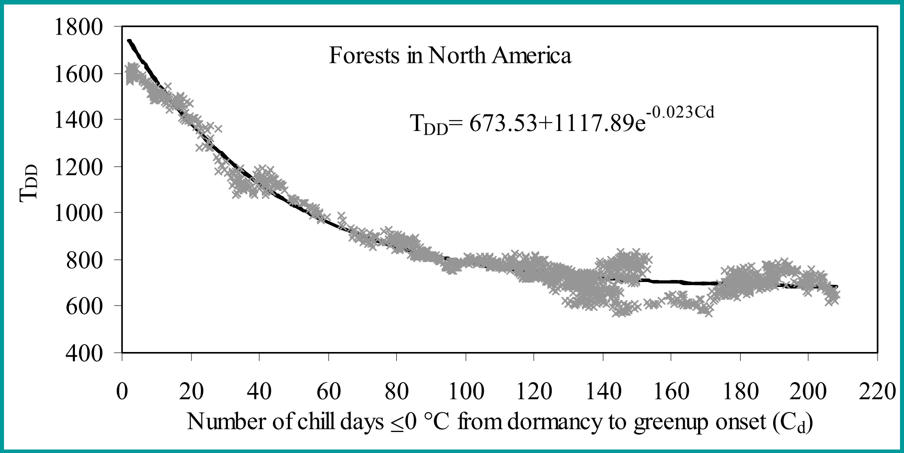
- Thermal "Time Chilling" Model for Forest Greenup:

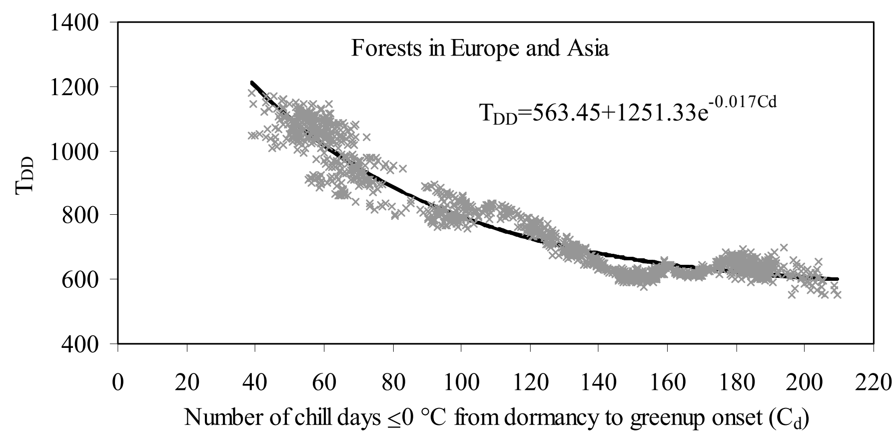
  $$T_{DD}=a + be^{gC_d}$$

  – T_{DD} is degree days and C_d is the # of days below threshold.

  – Explains ~ 83-95% of variance in T_{DD}

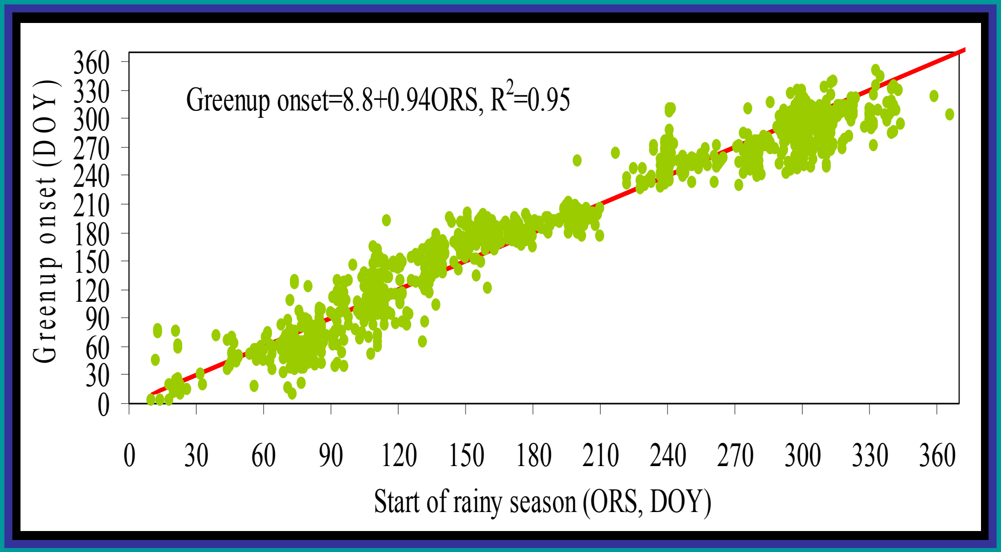
- Implication:
  – High latitude warming may have small effect on forests
  – Lower latitudes may have delayed delayed greenup!

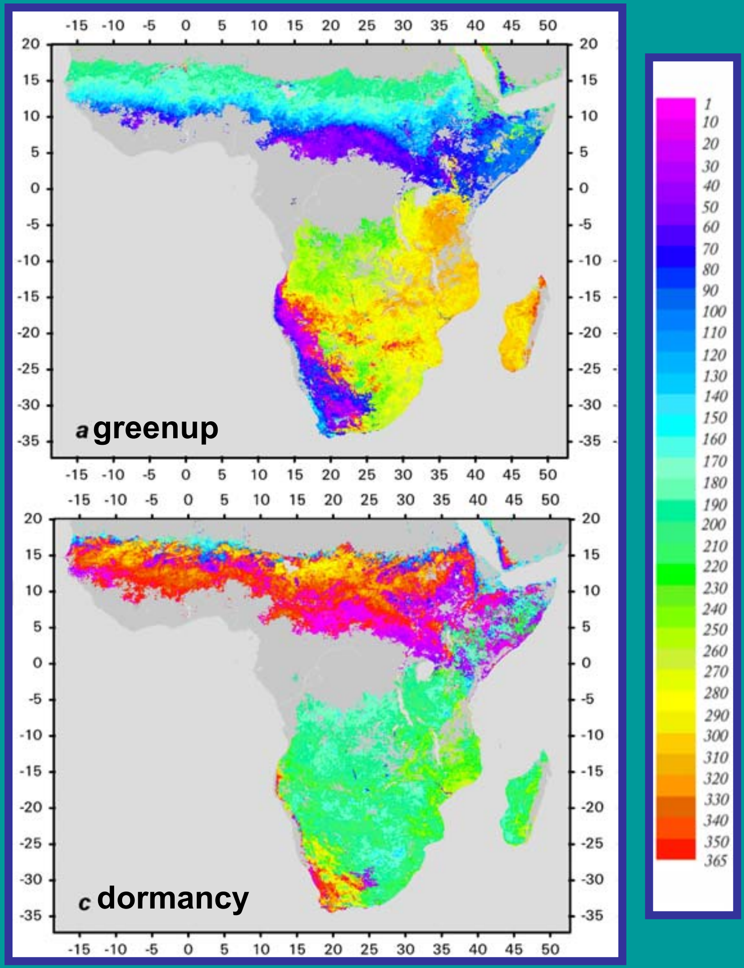




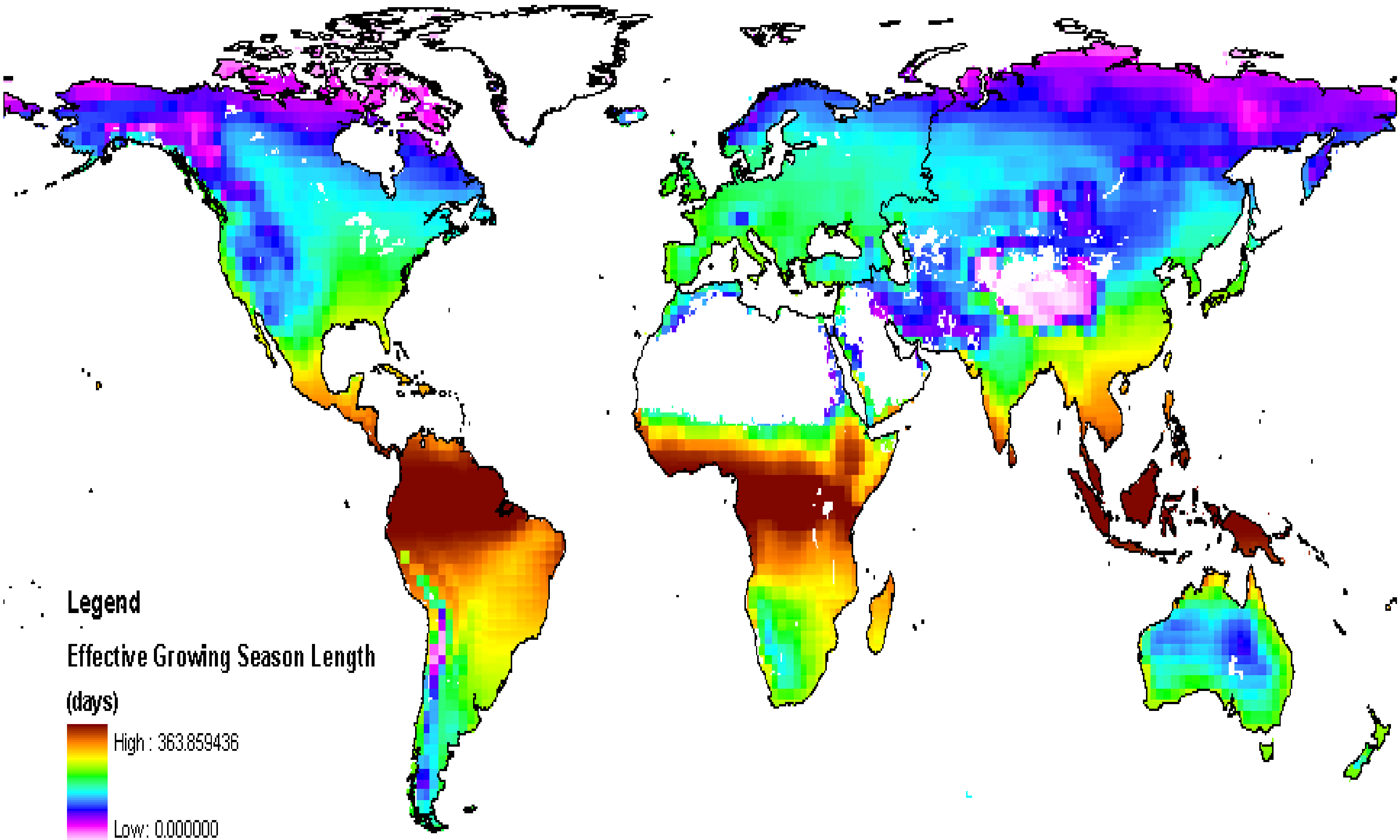
Precipitation-Driven Phenology in Africa

- Compare Onset of rainy season (TRMM) onset of greenup (MODIS)
  - Linear model explains 93-95% of variance in timing of greenup onset



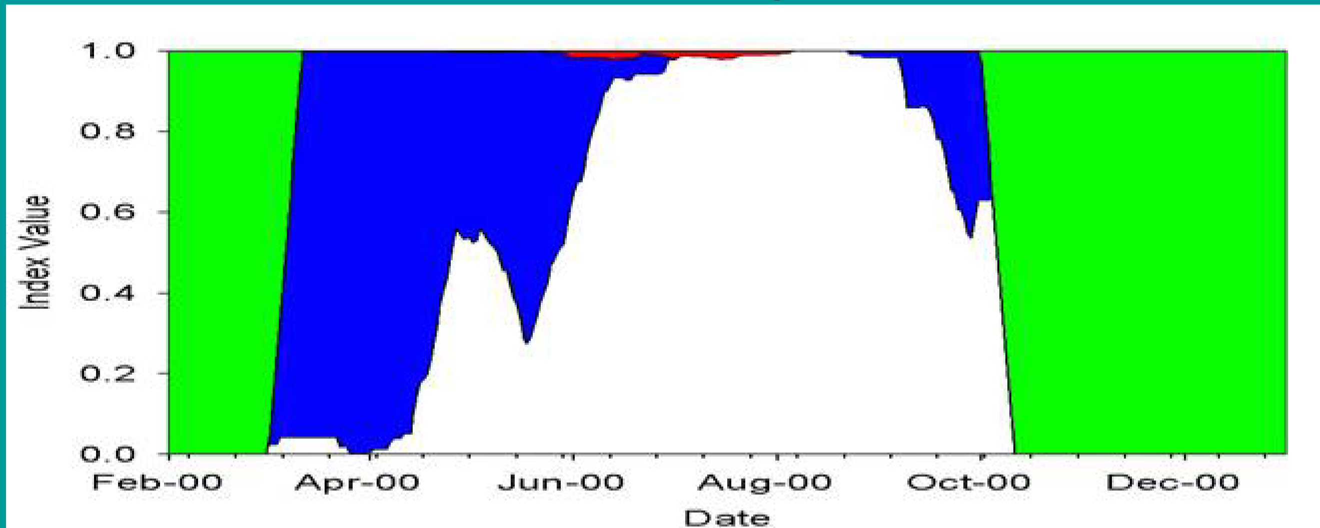


Global Effective Growing Season Length

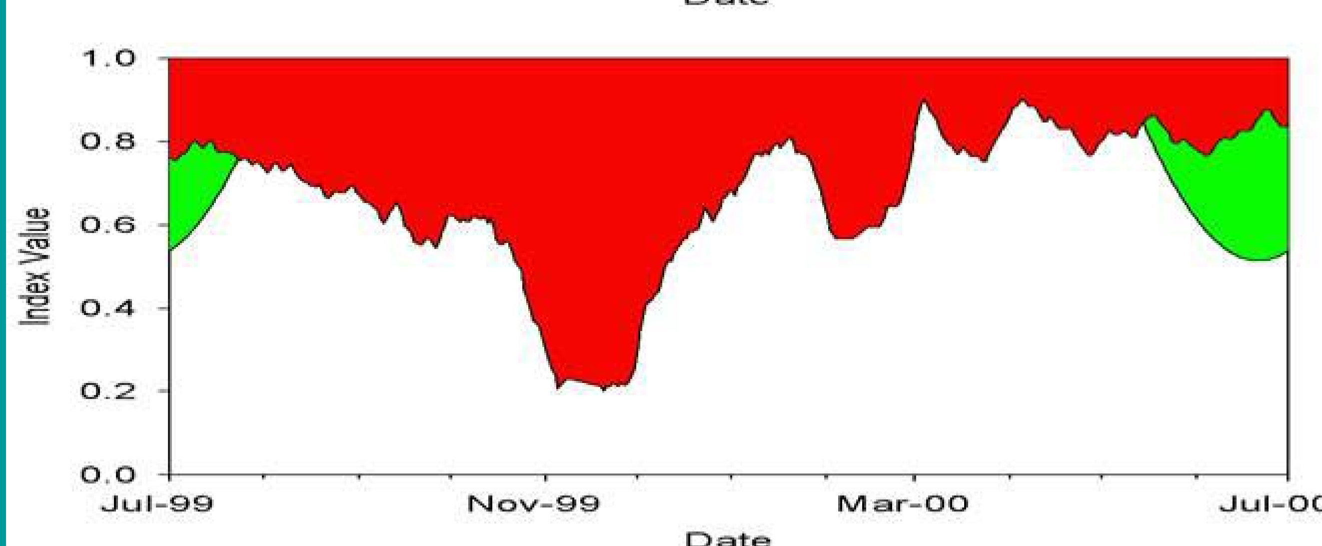


Jolly, Nemani, Running. Global Change Biology 2005

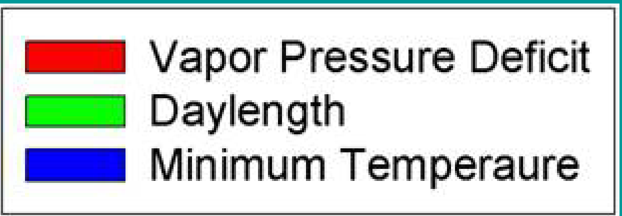
Seasonal Growing Season Constraints



Russia, Boreal



Africa, Savannah



Jolly, Nemani, Running. Global Change Biology 2005

US West Montane zone vegetation dynamics change in response to a global warming-like temperature increase induced by a severe drought: *"Plants green up and ecosystem becomes vulnerable to invasive species"*

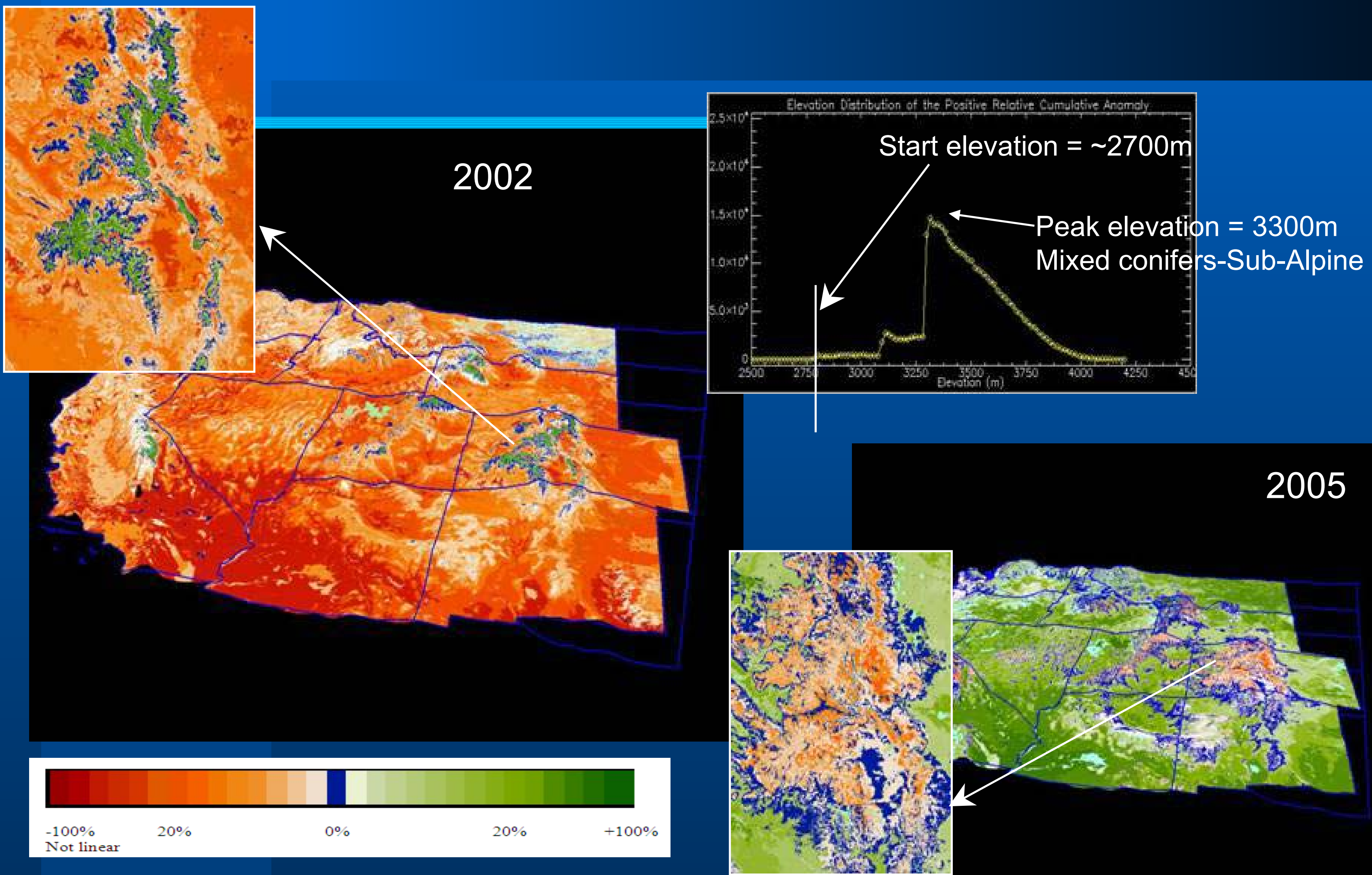
Kamel Didan, Alfredo Huete

TBRS Lab., SWES Dept.

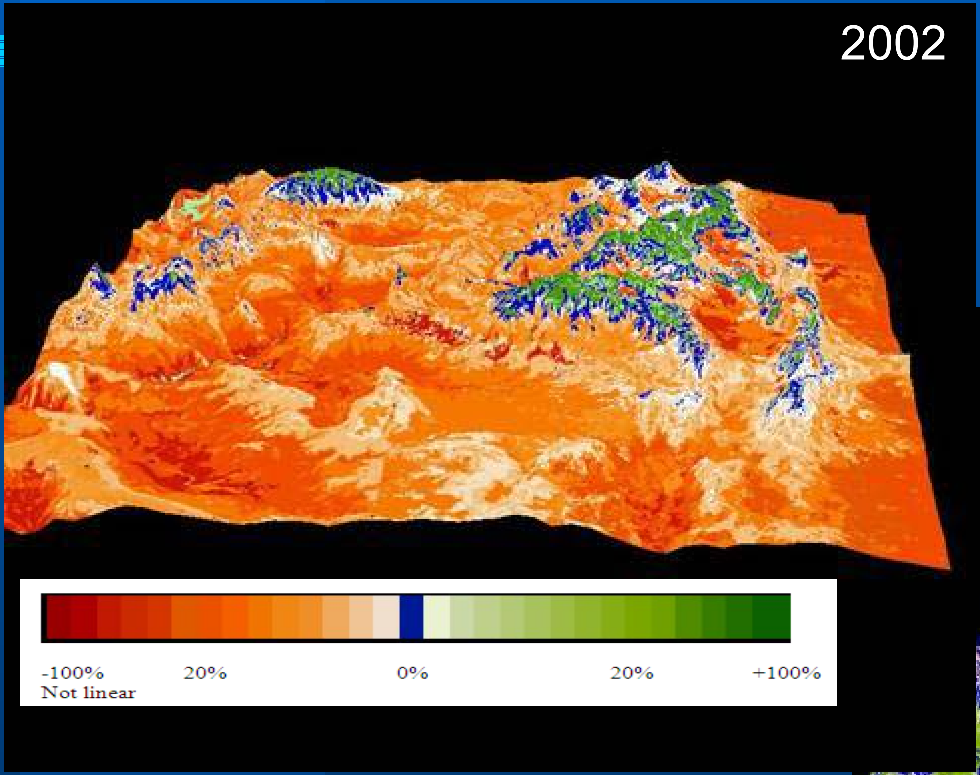
The University of Arizona

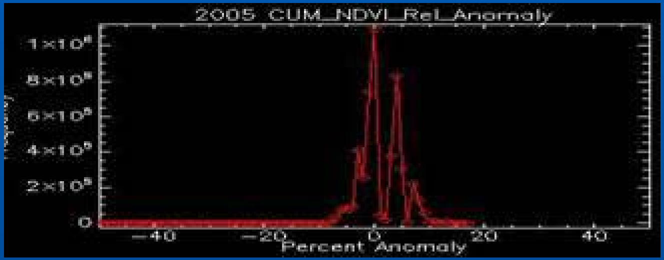
AGU Fall Meeting, 2005
San Francisco, CA

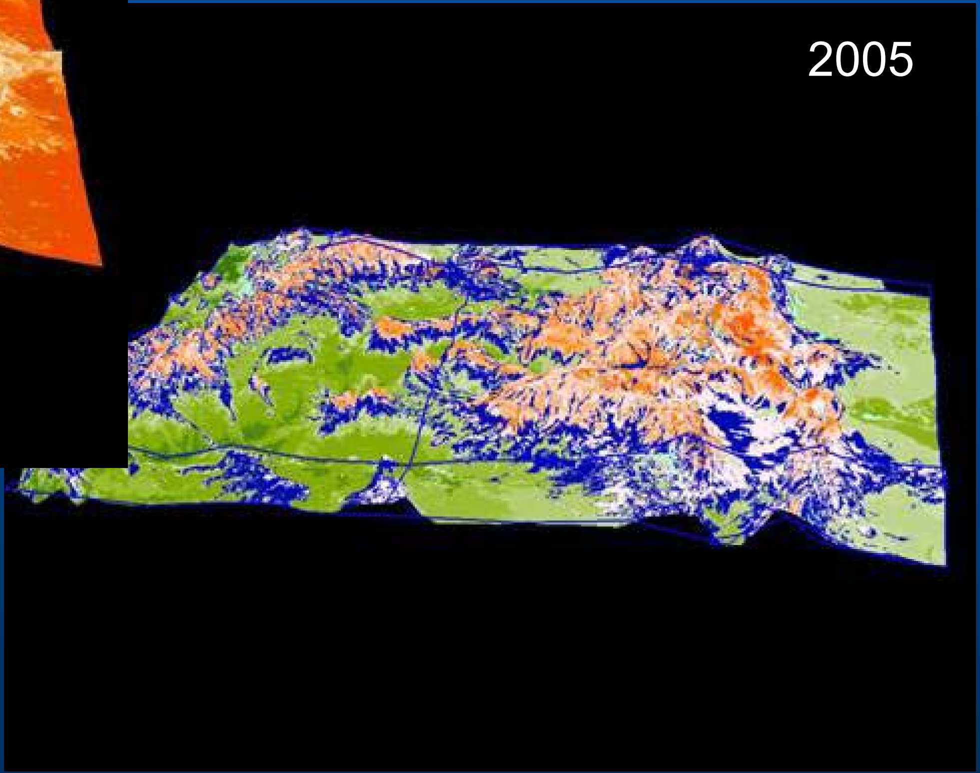
Cumulative VI anomaly

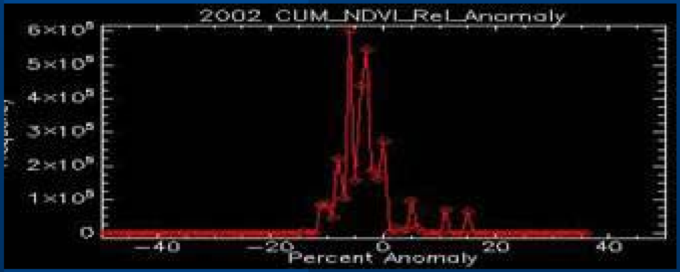


Cumulative VI anomaly (the Rockies)

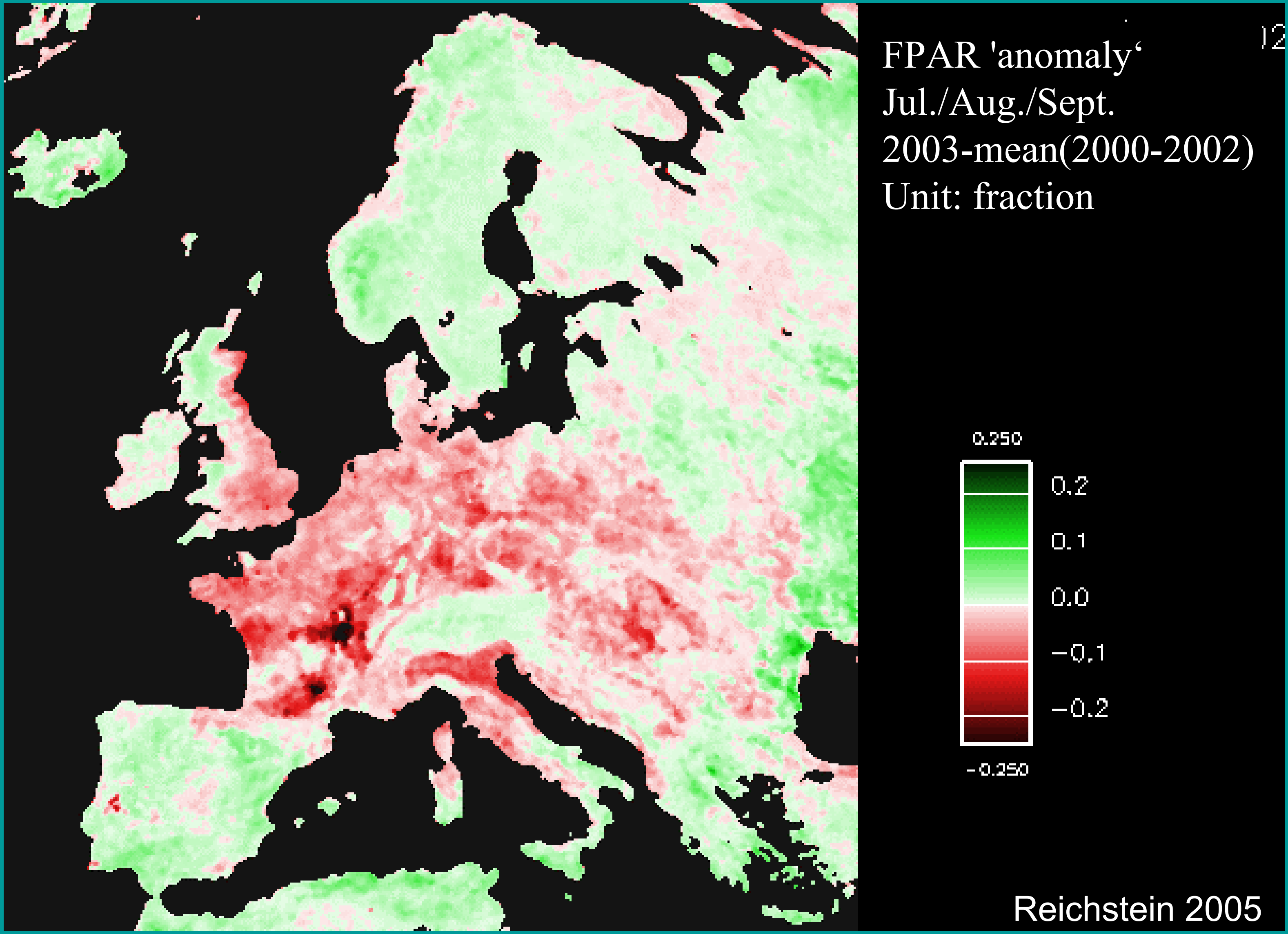




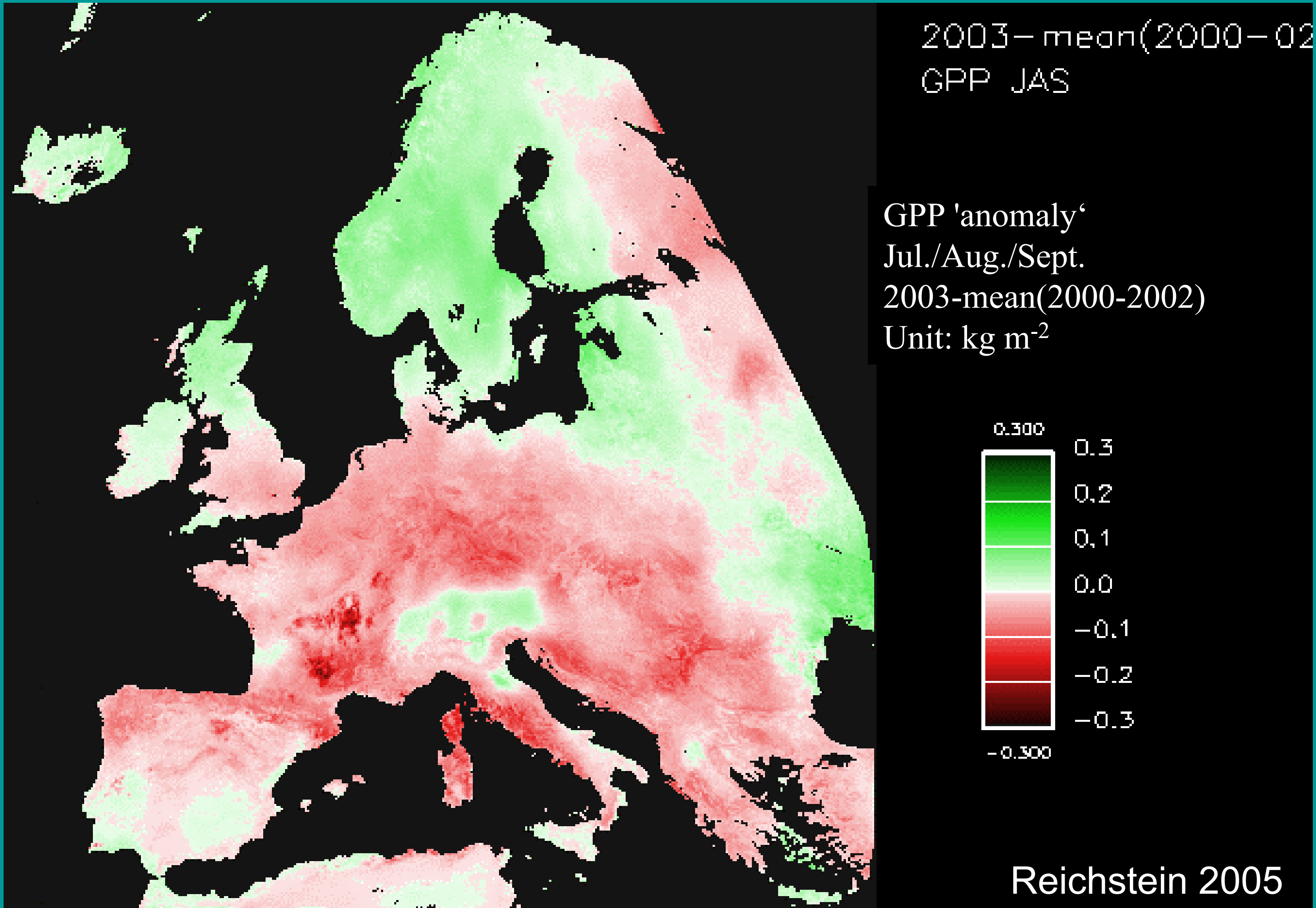




Summer 2003 fPAR 'anomaly' acc. to MOD15+

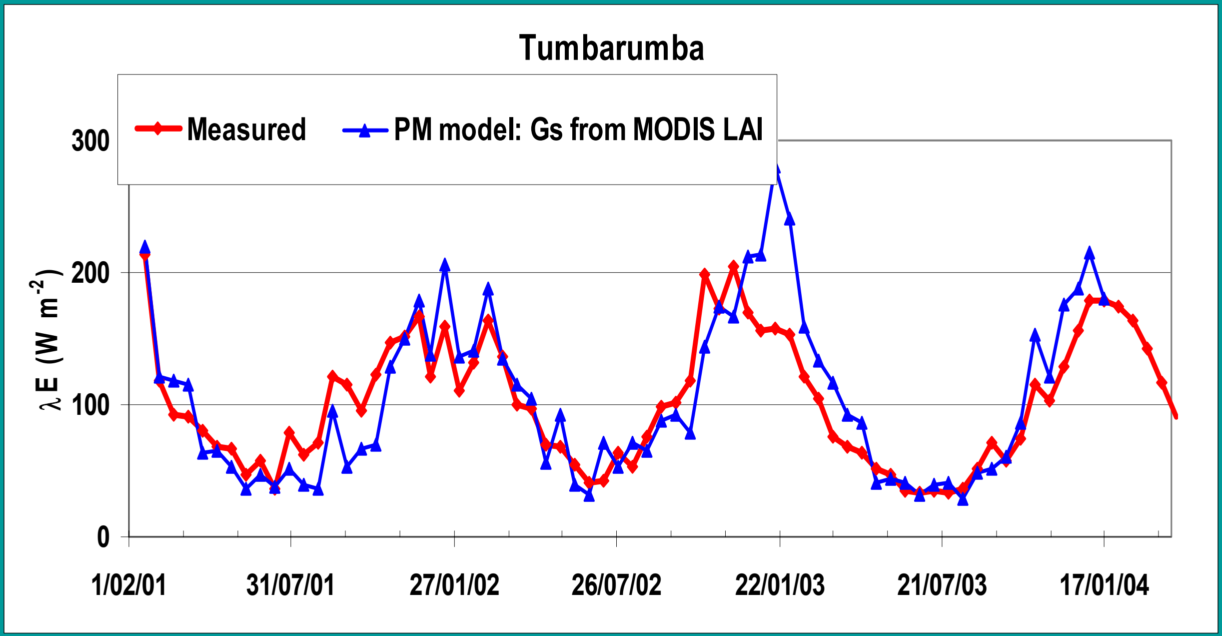


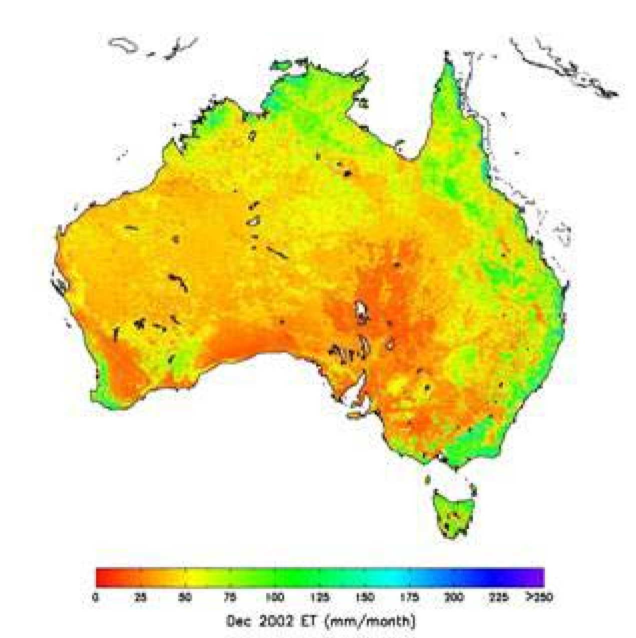
Summer 2003 GPP 'anomaly' acc. to MOD17+

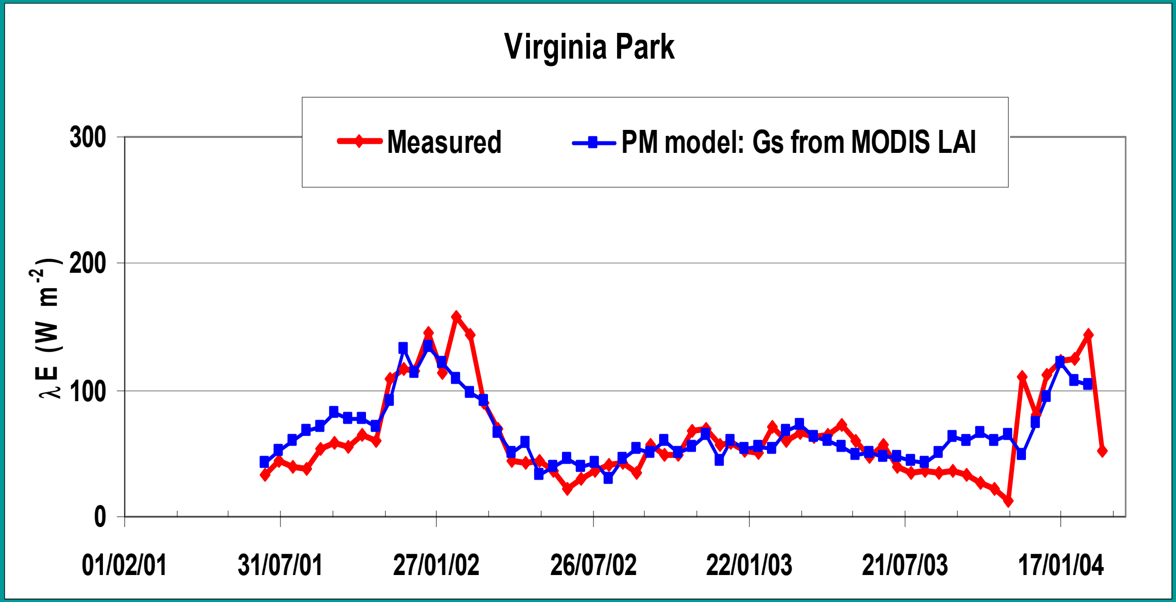


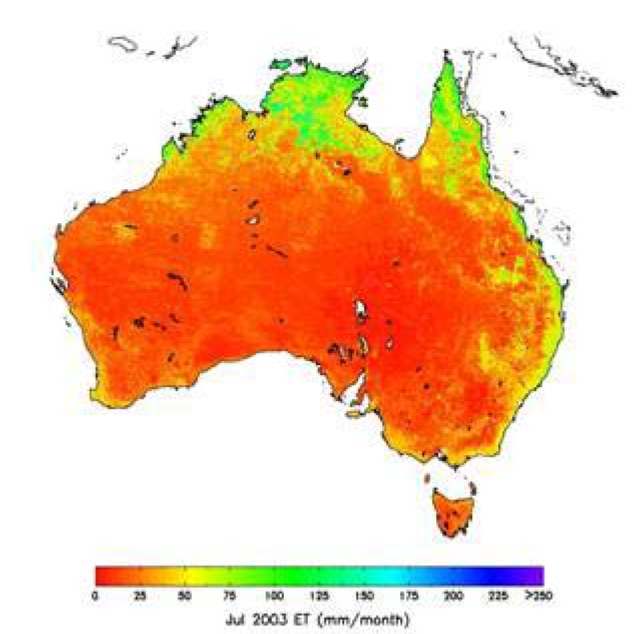
Reichstein 2005

TEST OF NEW MOD 16 DAILY EVAPOTRANSPIRATION





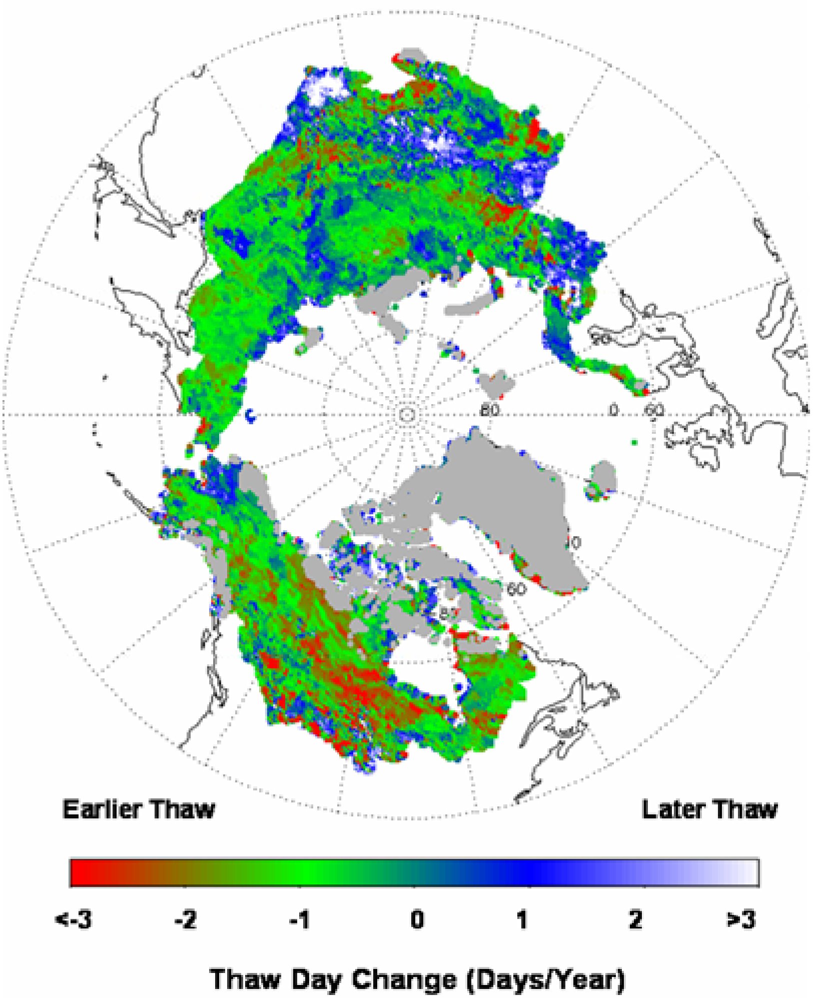




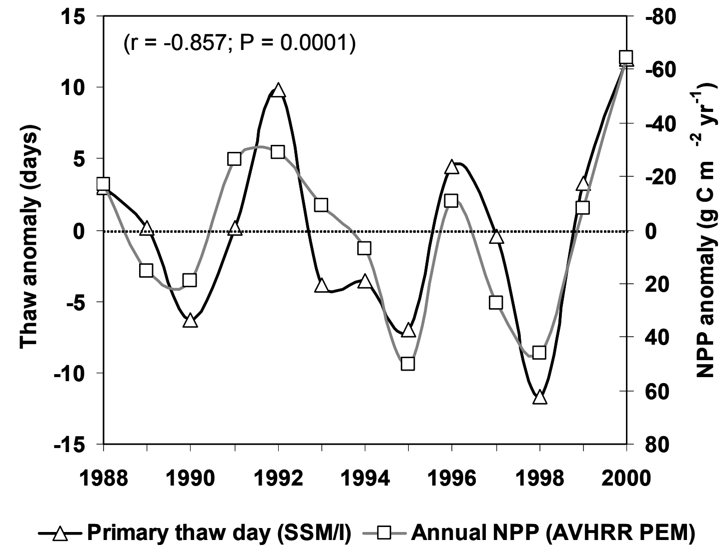
Cleugh et al 2006

Spring Thaw Impacts to Boreal-Arctic NPP

Spring Thaw Trend (SSM/I, 1988-2001)



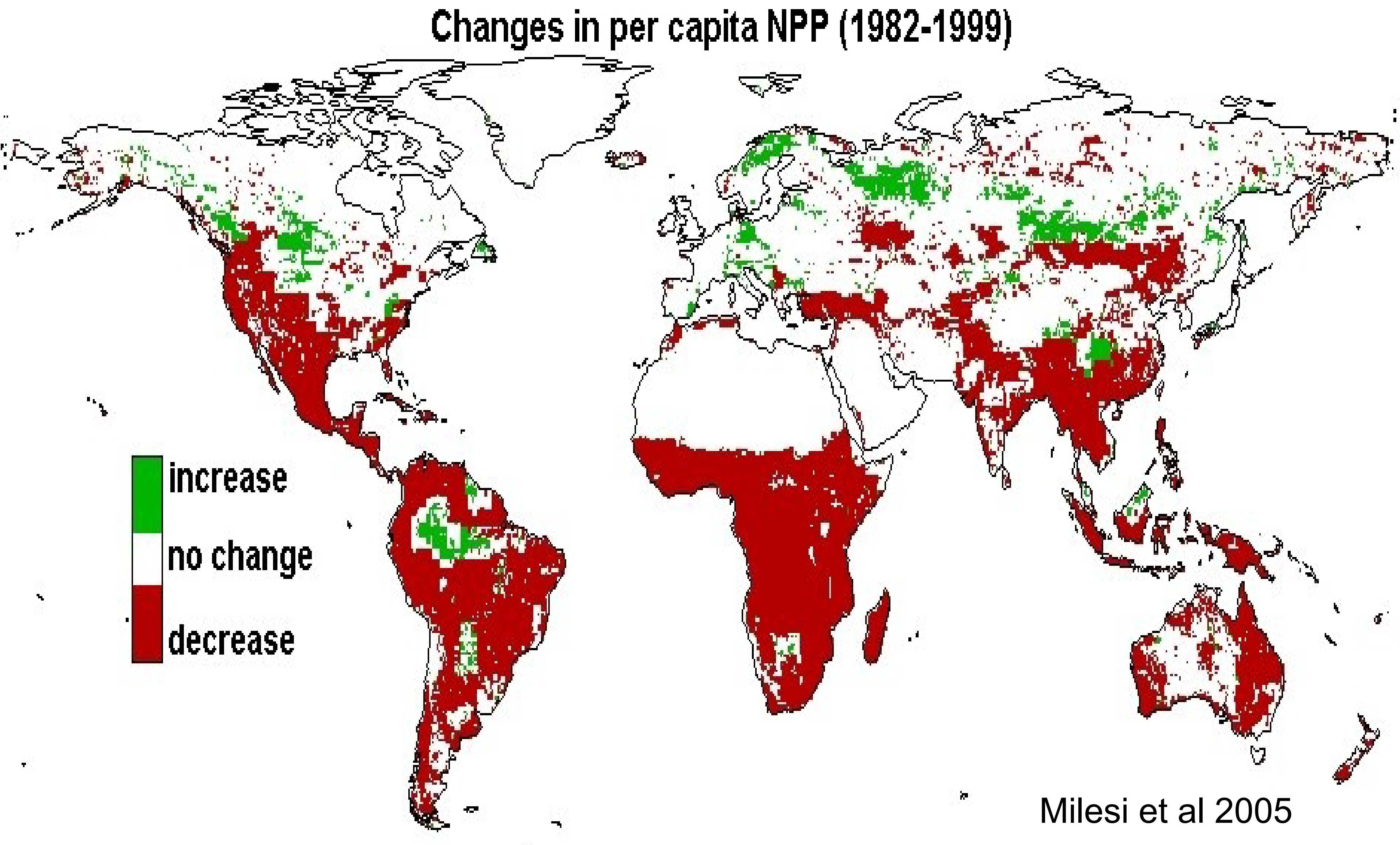
Sping thaw vs NPP (MOD17A2)



Map (**at left**) of the SSM/I derived trend in the timing of spring thaw for the pan-Arctic basin and Alaska, excluding non-vegetated areas (in grey). The SSM/I thaw signal coincides with the seasonal relaxation of low temperature constraints to photosynthesis and the onset of the growing season at high latitudes. The timing of thaw corresponds closely with regional anomalies in annual NPP derived from the MOD17A2 production efficiency model and the AVHRR Pathfinder record over Alaska and Northwest Canada (**above**). Negative anomalies relative to the long-term (1988-2001) satellite record denote both earlier thaws and greater productivity while positive values denote the opposite response. **Mean annual variability in springtime thaw is on the order of ±7 days, with corresponding impacts to annual productivity of approximately 1% per day.** Satellite based observations of an advancing spring thaw trend may be a physical mechanism driving positive vegetation productivity trends and an advancing CO_2 cycle for northern latitudes.

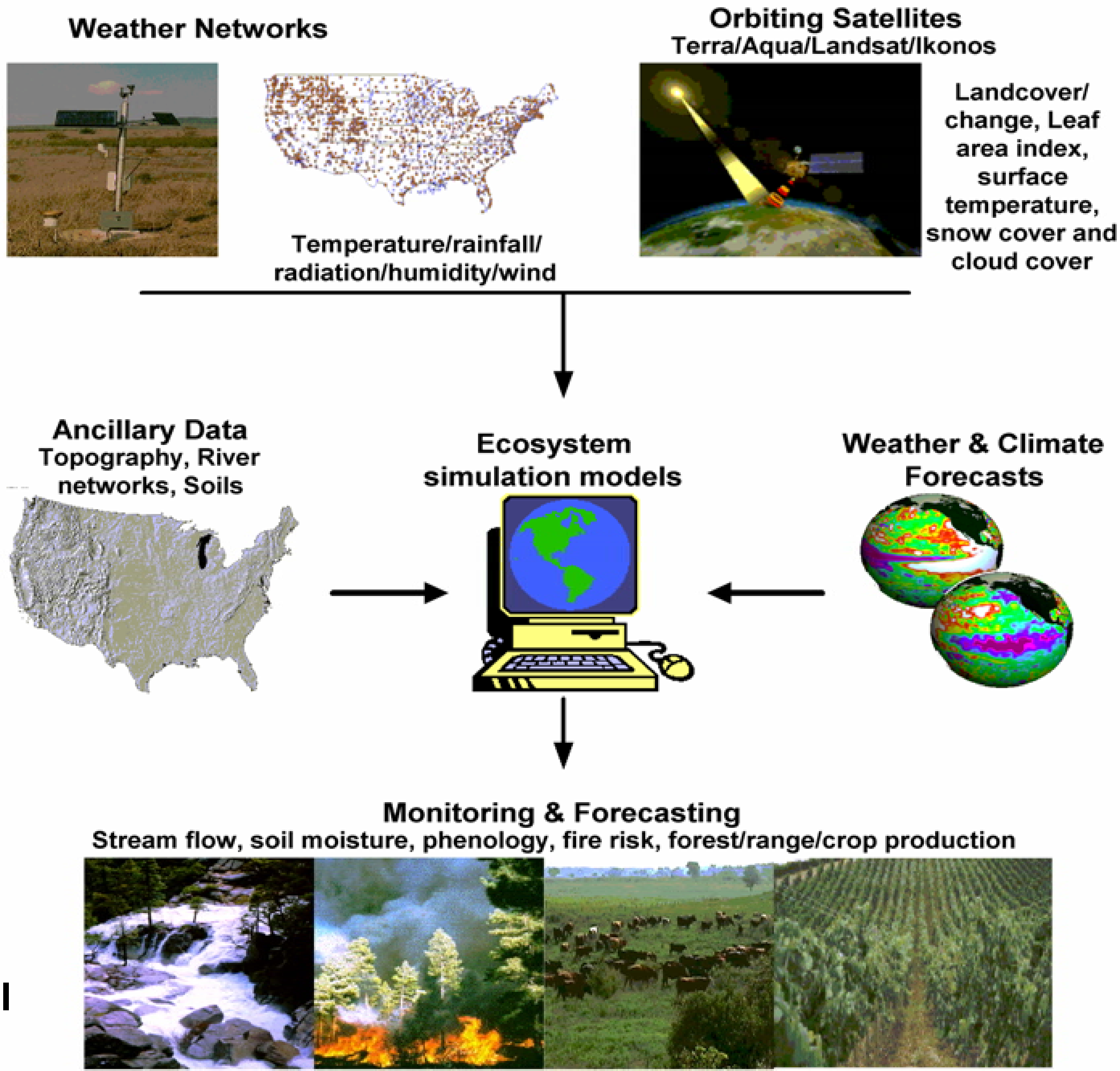
Source: Kimball, J.S., K.C. McDonald and M. Zhao, 2005. *Earth Interactions* (In-review)

The increase in NPP is very modest compared to population growth



Over 80% of the populated land areas NPP per capita declined

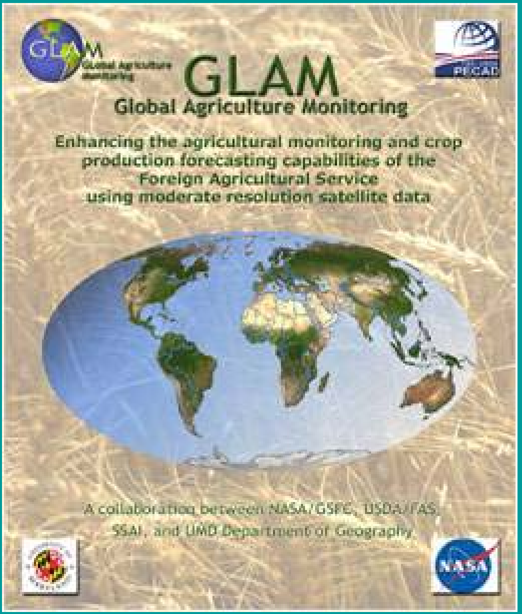
Terrestrial Observation and Prediction System



Nemani et al 2005

Applications

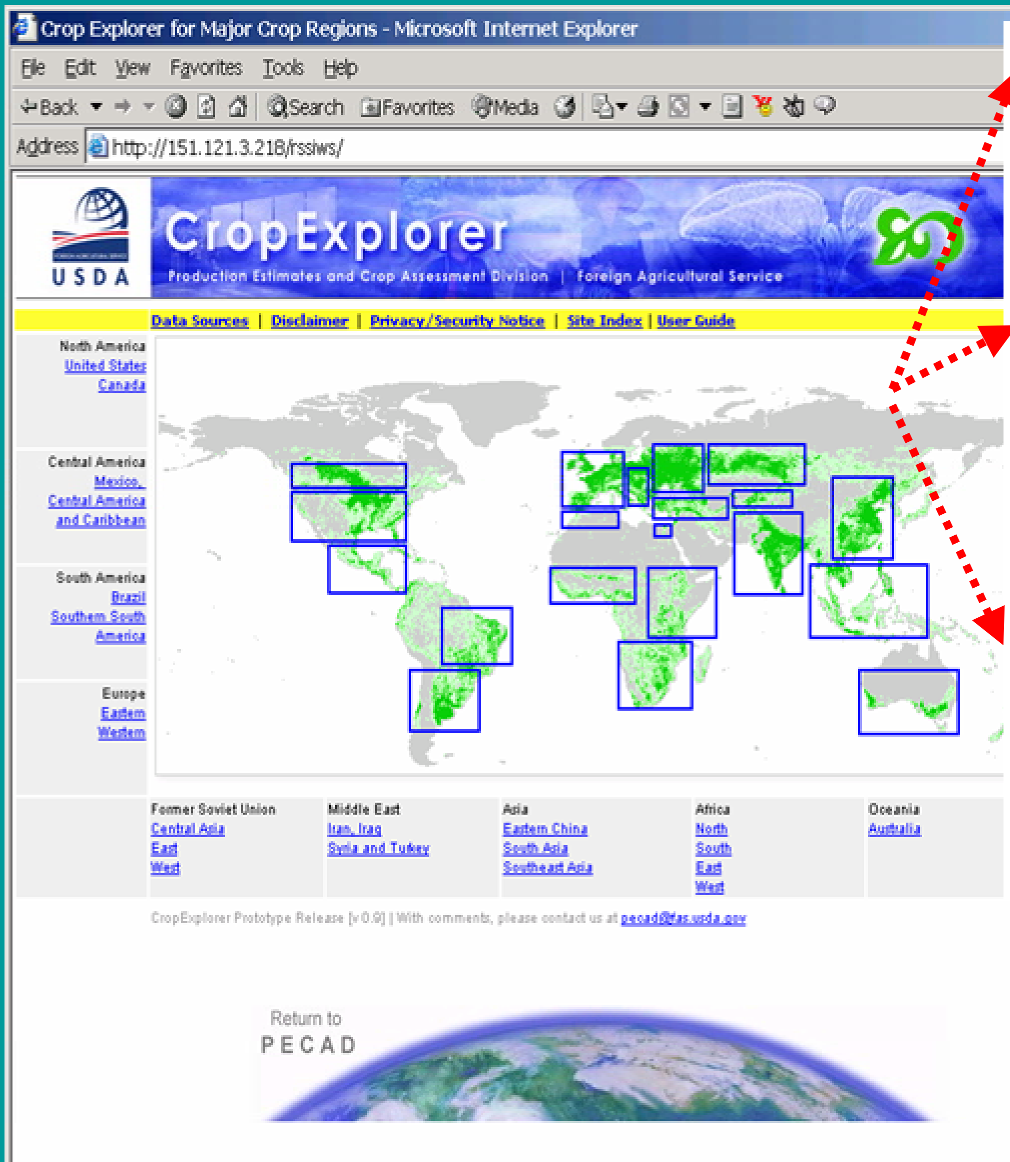
GLobal Agricultural Monitoring (GLAM)



- **Upgrade from AVHRR 8km to MODIS**
  - **Establish Data Continuity**
- **NRT MODIS Rapid Response Data**
  - **Customized products**
- **MODIS Crop Mask / Type Mapping**
- **MODIS/AVHRR Time-series Data Base**
- **Improved GUI for Information Extraction**
- **Develop an Operational FAS Prototype based at GSFC**
- **Prepare for use of NPP VIIRS**

Project website: http://tripwire.geog.umd.edu/usda/index.asp

Crop Explorer = Automated Weather, Crop Models, & Vegetation Analysis Over Major Crop Regions



Weather Data

- Current precipitation & temperature compared to climate normals
- Source: AFWA & WMO

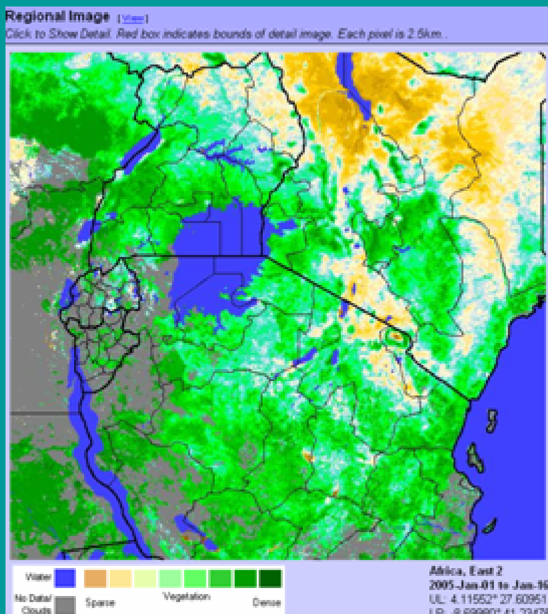
Crop Models

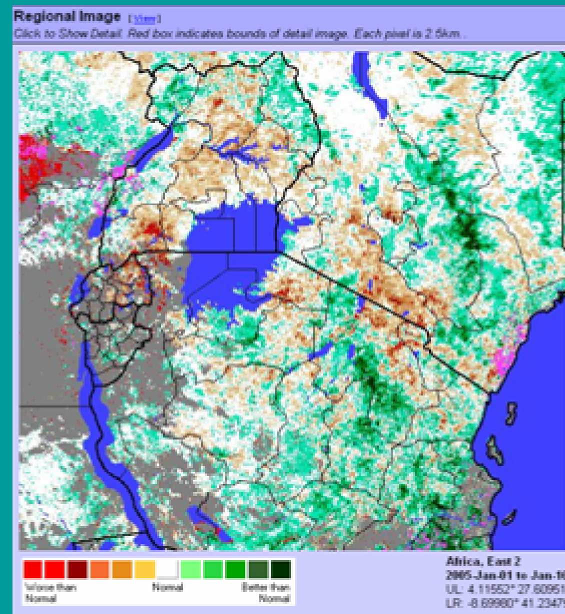
- Soil moisture (two-layer)
- Crop calendars (or stage) for spring wheat, winter wheat, & corn
- Source: Models originally developed by ARS AGRISTARS project (1980s)

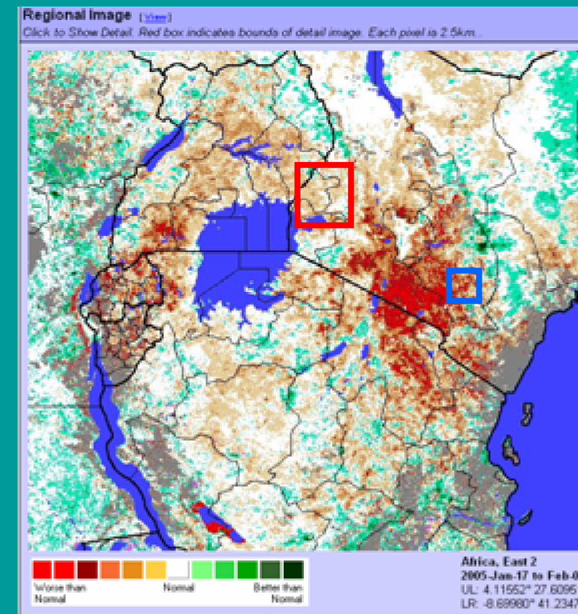
Vegetation Indices

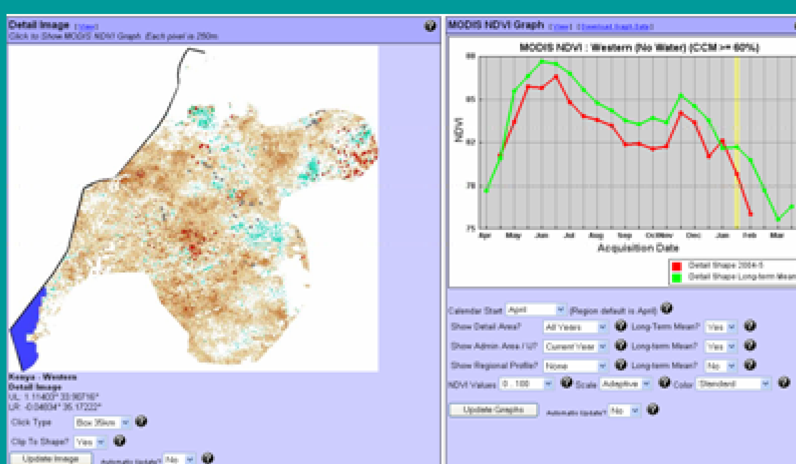
- GAC (8-km) and LAC (1-km) from AVHRR-NOAA
- SPOT-VEG (1-km)
- MODIS RR and Time Series

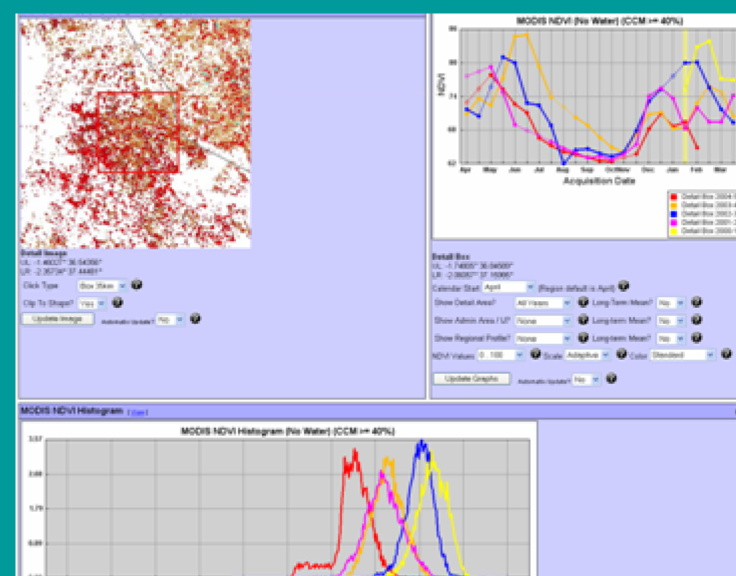
Kenyan Drought depicted by Database GUI











The cereal deficit this season has grown to 300,000 metric tons, which means that up to 2.7 million people will need food aid this season in Kenya

Developing a fire early warning system for South Africa

- In South Africa wildfires often make headline news.
- Following a tragic incident in 2001 the Department of Agriculture installed a MODIS Direct Broadcast system at the Satellite Applications Center (SAC) in Pretoria
- SAC asked UMD and NASA to help demonstrate the utility of a fire early warning system to the National Disaster Management Center and Eskom – South African power company

Why Eskom?

ESKOM produces 95% of South Africa's electricity

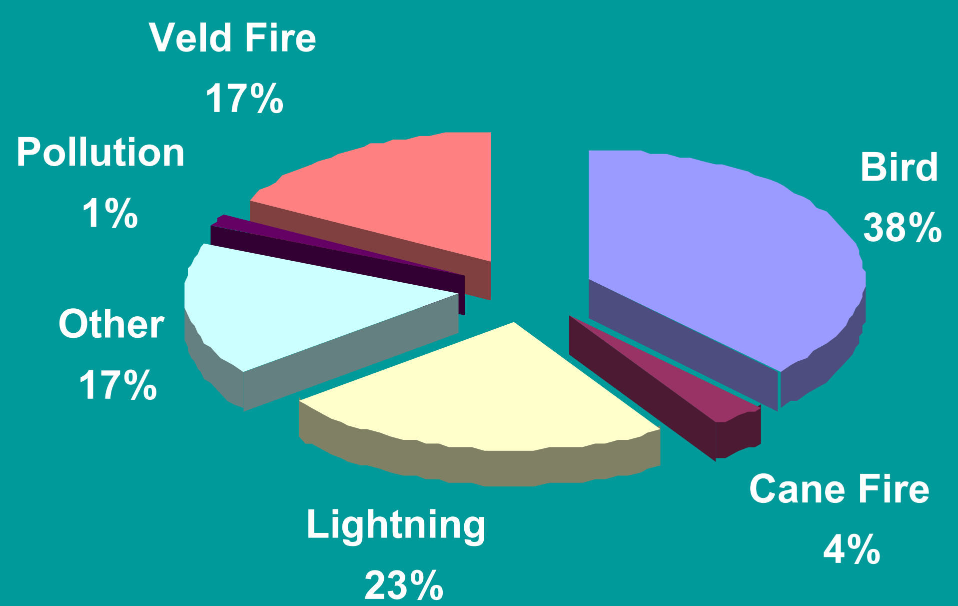
ESKOM transmission network in South Africa

Why ESKOM?

- Each year ESKOM experiences a substantial amount down time on its transmission lines due to ‘flashovers’ triggered by hot air plasma from intense fires that causes an electrical short

Photo courtesy of R.Evert, Eskom

Integrating Active Fire data into ESKOM's decision support system



Source: ESKOM

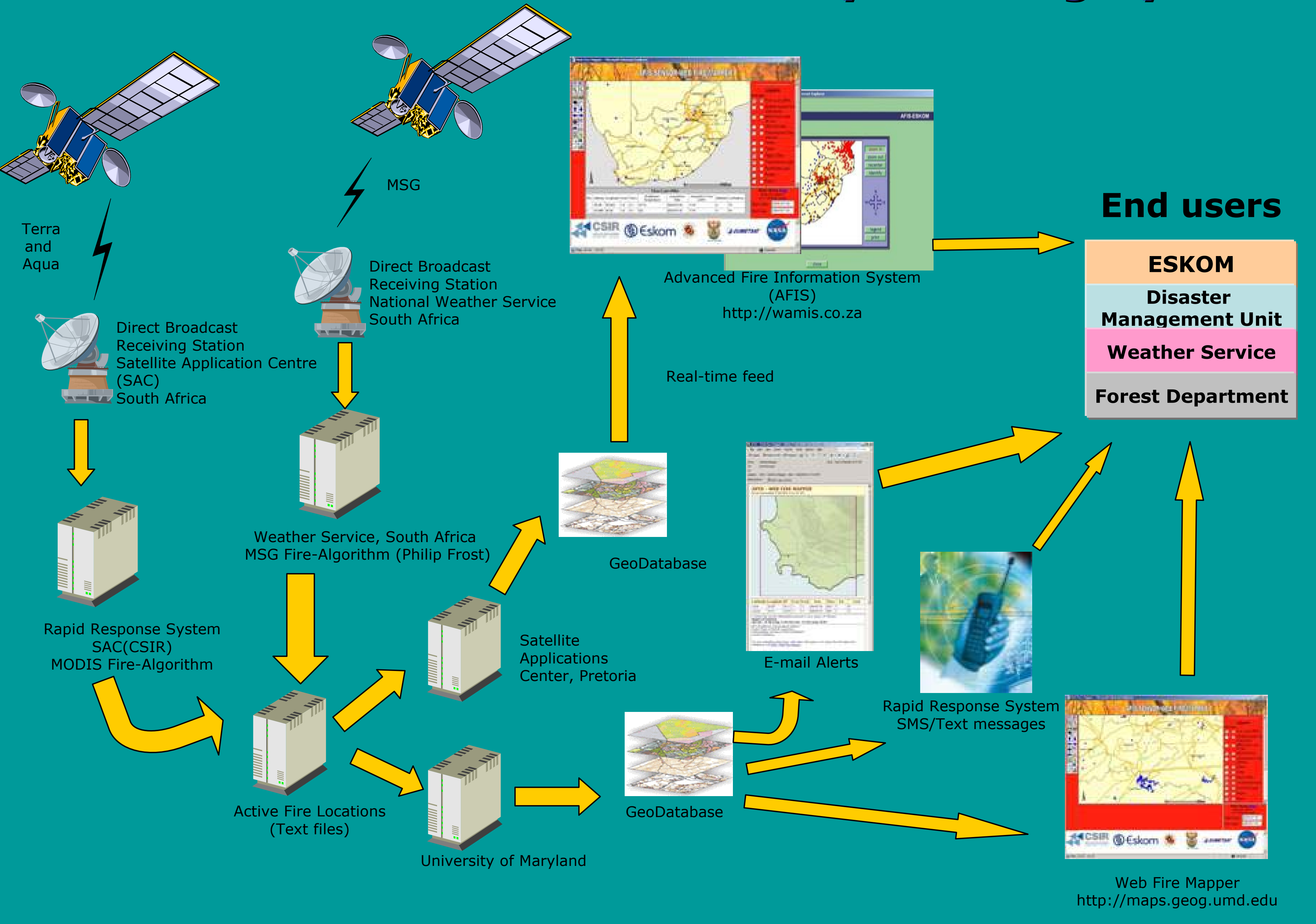
If ESKOM knows when an active fire is approaching the transmission line staff can be deployed to assess the situation

- suppress the fire
- affected lines can be switched out and electricity supply re-routed through the grid

Establishing the Advanced Fire Information System (AFIS)

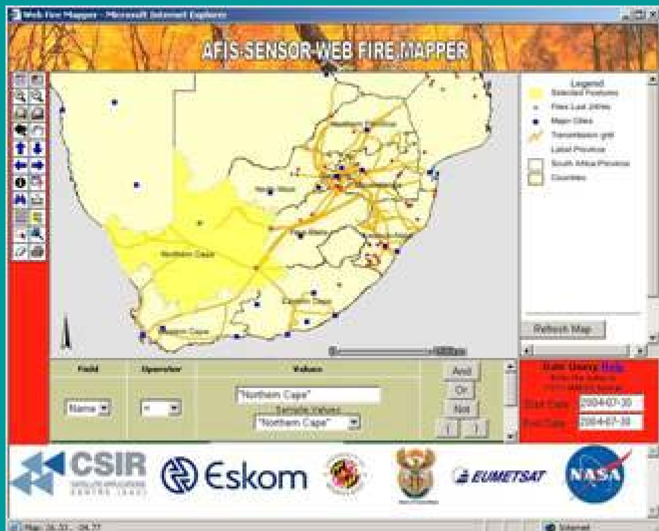
1. Replicate the MODIS Rapid Response system to enable automated processing of near real-time (40 mins) active fire data and production of MODIS imagery
2. Customize Web Fire Mapper internet mapping tool to allow users to view and query the full database of active fire detections.
3. Develop an SMS / text messaging and email alert system to warn managers of fires within a 2.5km buffer around transmission lines

Overview South Africa's Fire Early Warning System



Advanced Fire Information System (AFIS):

Web mapping tool that allows users to view and query active information



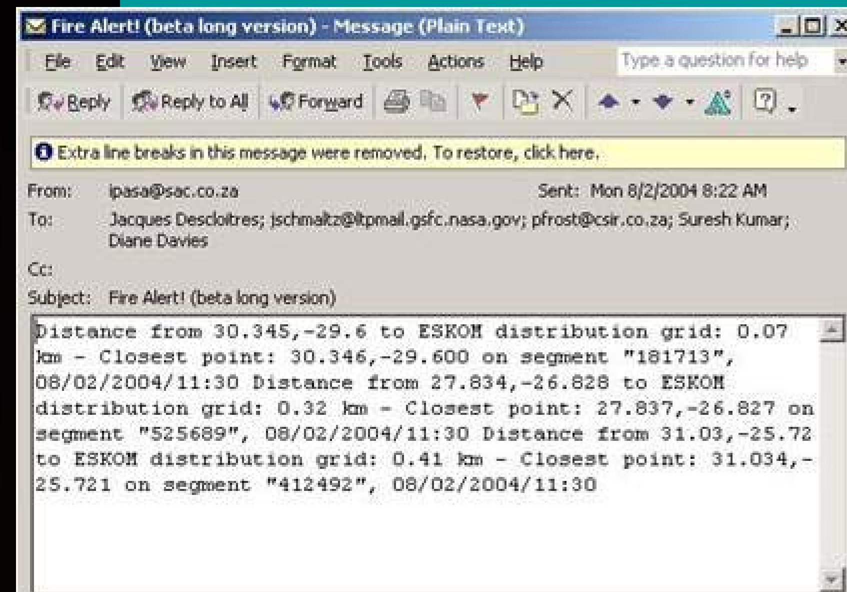
Query

Buffer

Find

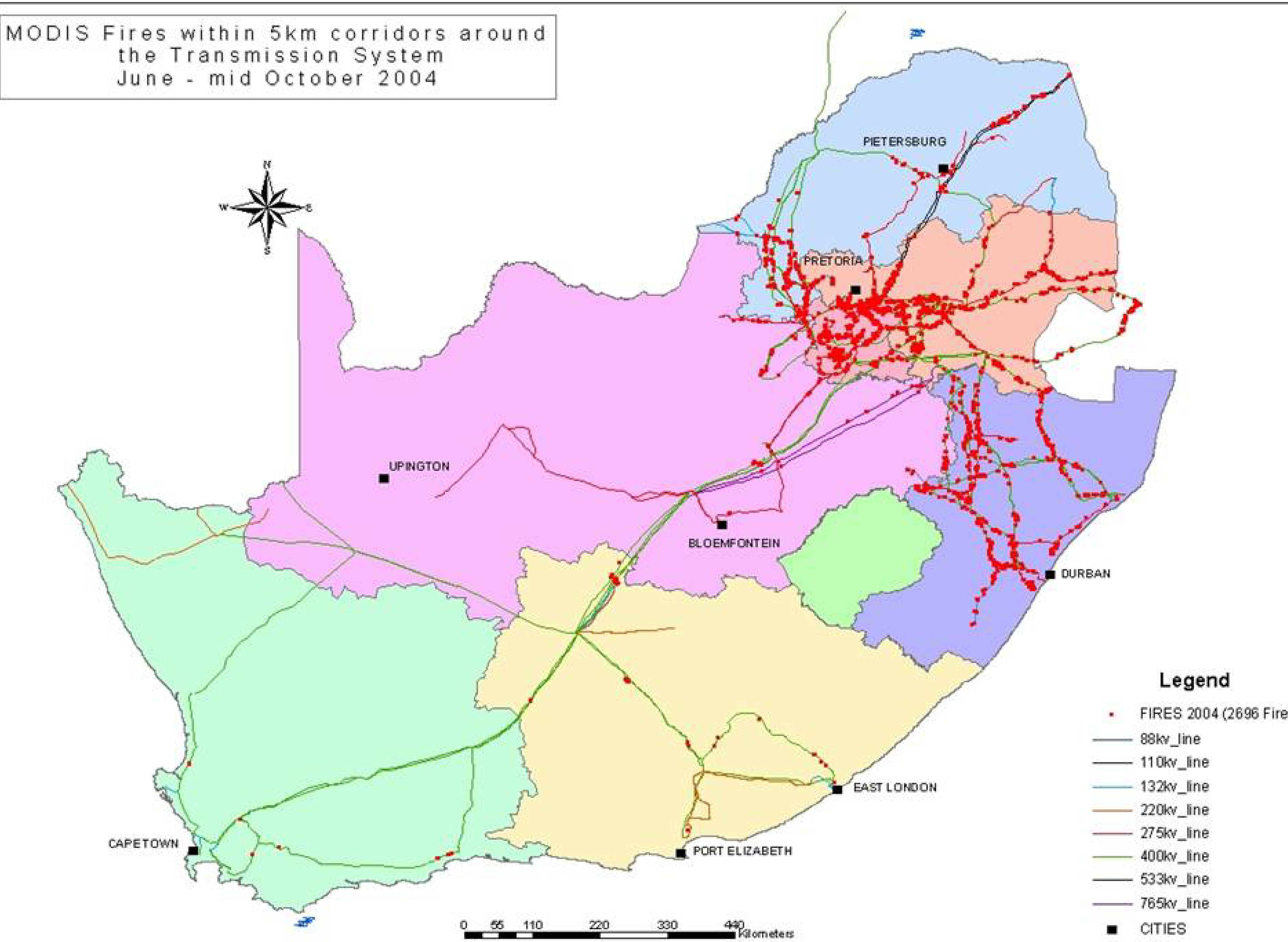
- MODIS Image
- Fire Archive
- Distance Calculator
- Identify layer attributes
- Print maps
- Scale
- Pan and Zoom
- Overview Maps
- Slimed down version for dialup users

Text message service



- Capable of handling both SMS/Text messages and E-mail messages
- Can be sent in near real-time

Davies et al. UMD


MODIS Fires within 5km corridors around the Transmission System June - mid October 2004
N
W
E
S
PIETERSBURG
PRETORIA
UPINGTON
BLOEMFONTEIN
DURBAN
EAST LONDON
PORT ELIZABETH
CAPETOWN
Legend
FIRES 2004 (2696 Fires)
88kv_line
110kv_line
132kv_line
220kv_line
275kv_line
400kv_line
533kv_line
765kv_line
CITIES
0 55 110 220 330 440 Kilometers

Results from the 2004 fire season

- ESKOM statistics show a 30% drop in line faults since the introduction of AFIS
- The system was successful in raising awareness and better enabled ESKOM to manage fire events
- The economic benefits to ESKOM will lead to them continuing to fund AFIS - and make the data freely available to other users in the region

Operational Deforestation Detection in Brazilian Legal Amazon with MODIS

(**DETER** - **DE**tecção em **TE**mpo **R**eal do Desmatamento na Amazônia Legal)

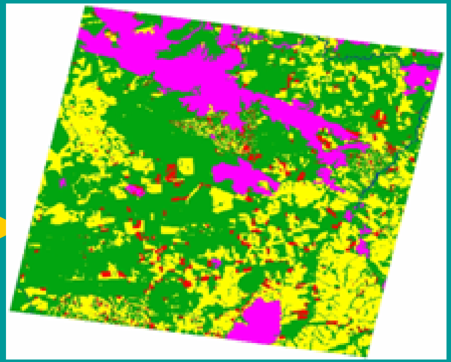
www.obt.inpe.br/deter

Reference: deforestation map available from the Landsat derived deforestation product (PRODES) for the previous year

- **Monthly detection of changes in forested areas without cloud cover**
- **Rapid production and dissemination of the results using the internet**
- **Daily acquisitions and free availability key for operational real-time monitoring**
- **Not a substitute for higher resolution, Landsat-like observations but allows rapid assessment**

DETER

PRODES Project



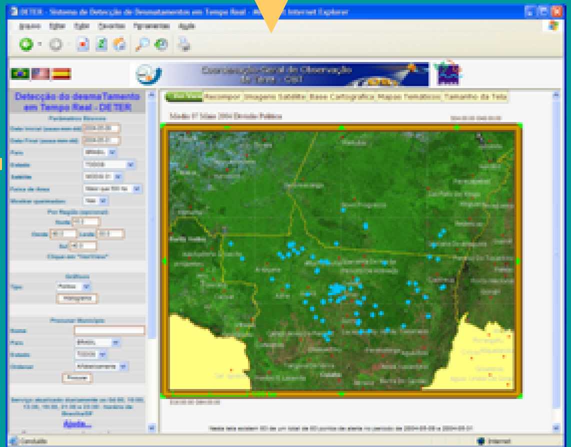
Deforestation Database for the previous years

MODIS image from NASA

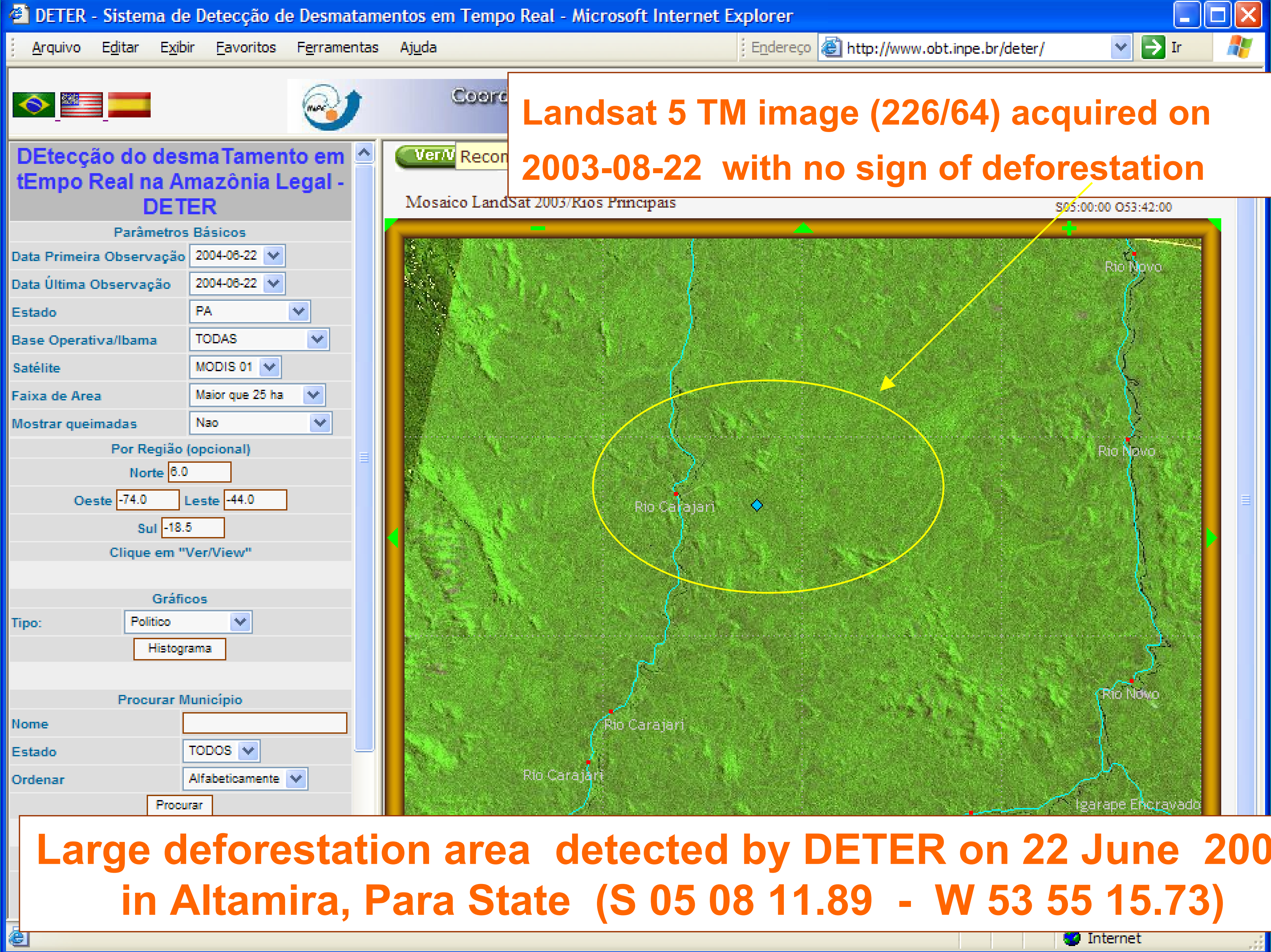
Ground Station Cuiabá / MT (In the future)

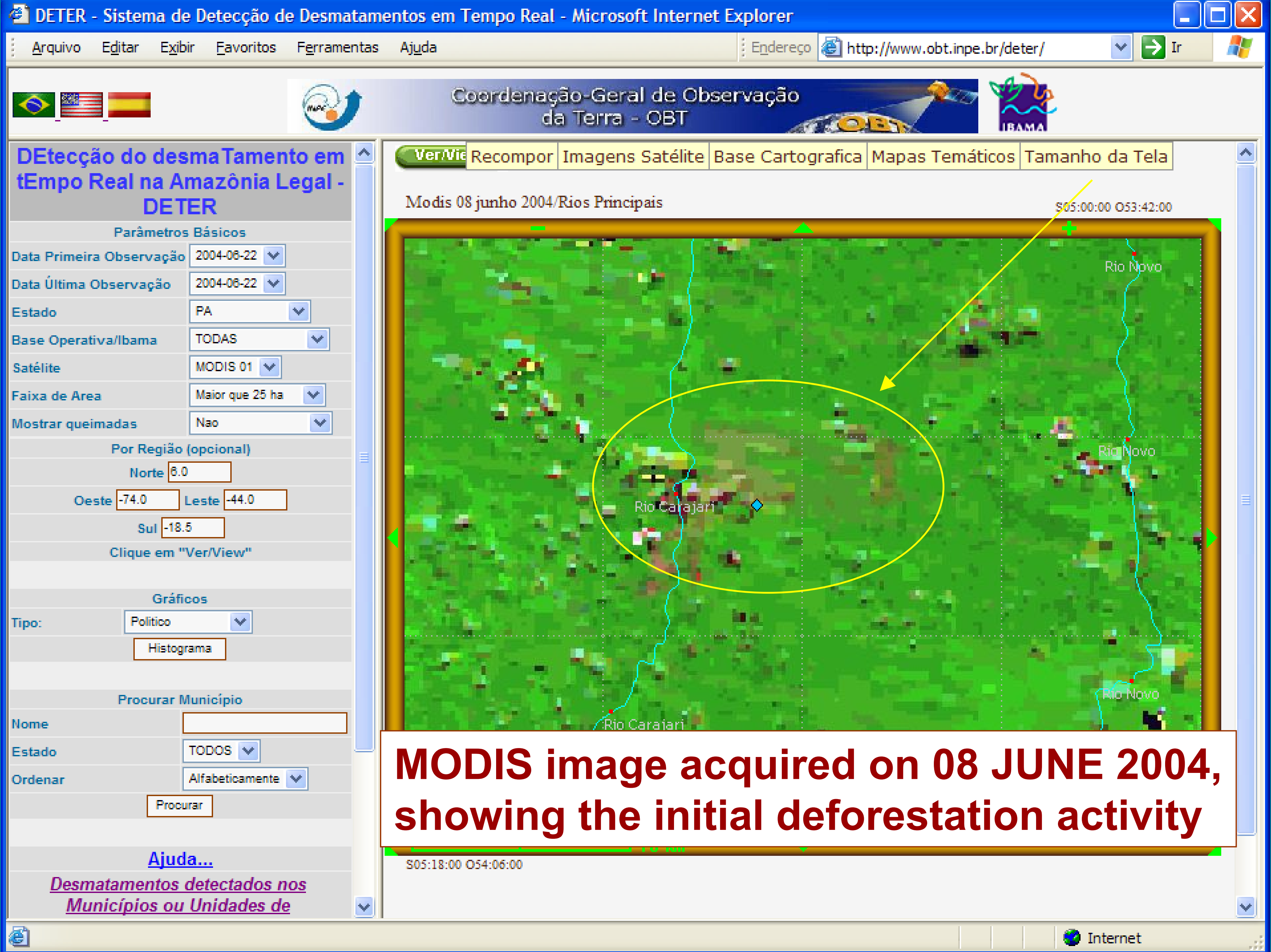
Processing data in S.J. Campos: SPRING – detection of new deforestation areas

Products in the Internet

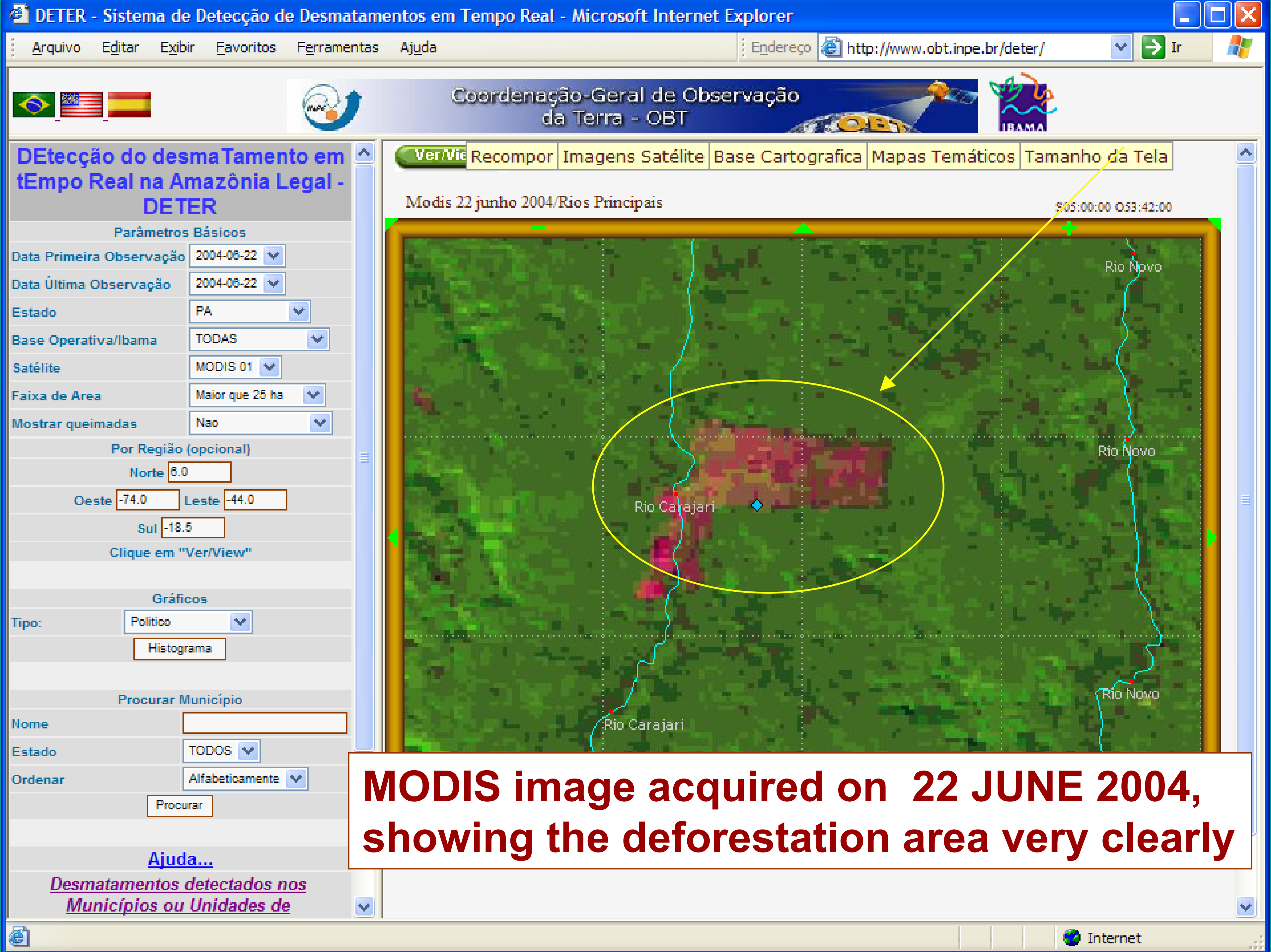


Fiscalization: IBAMA and other Institutions

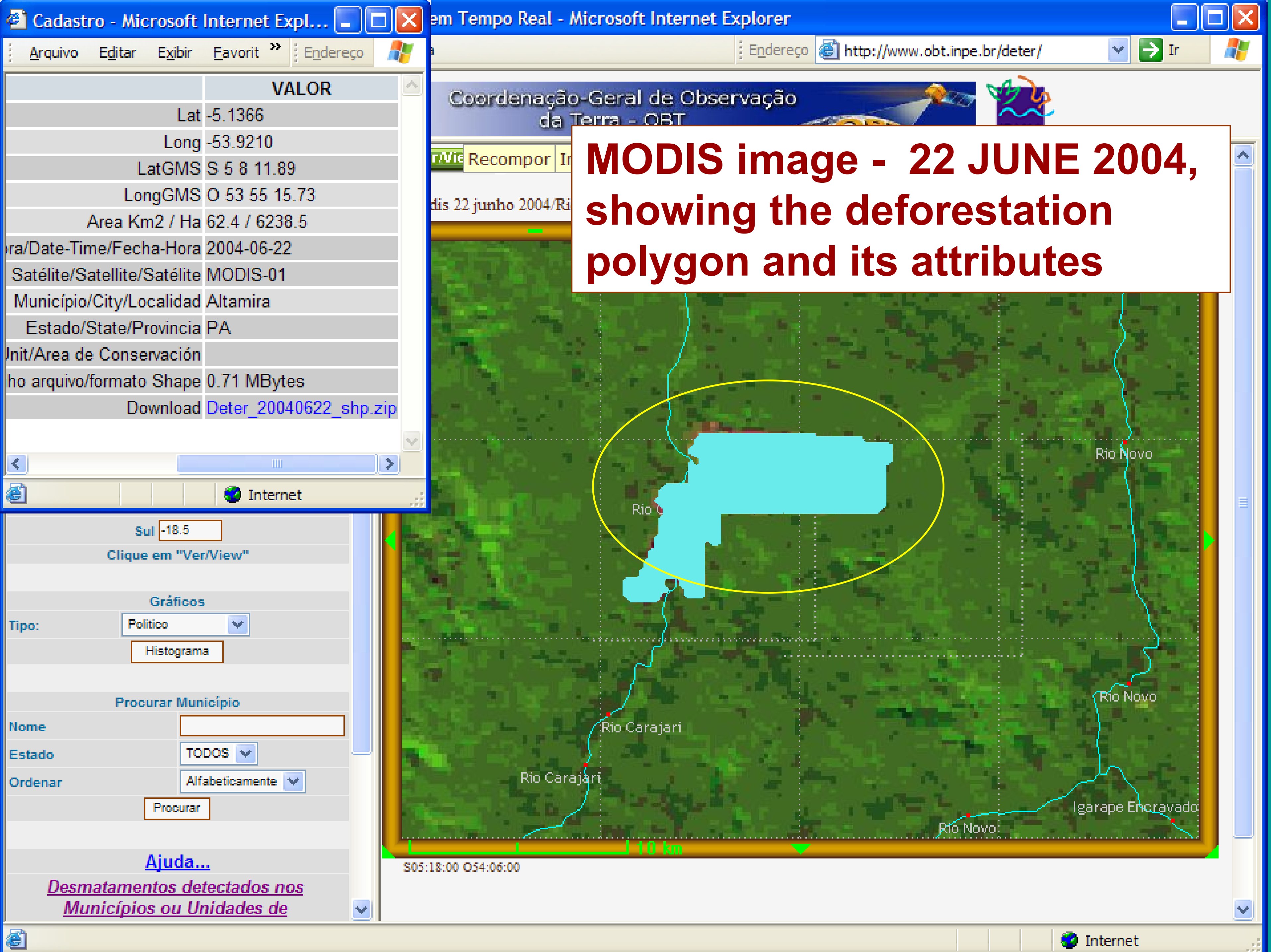

DETER - Sistema de Detecção de Desmatamentos em Tempo Real - Microsoft Internet Explorer
Arquivo
Editar
Exibir
Favoritos
Ferramentas
Ajuda
Endereço
http://www.obt.inpe.br/deter/
Ir
Landsat 5 TM image (226/64) acquired on 2003-08-22 with no sign of deforestation
DEtecção do desmaTamento em tEmpo Real na Amazônia Legal - DETER
Parâmetros Básicos
Data Primeira Observação
2004-06-22
Data Última Observação
2004-06-22
Estado
PA
Base Operativa/Ibama
TODAS
Satélite
MODIS 01
Faixa de Area
Maior que 25 ha
Mostrar queimadas
Nao
Por Região (opcional)
Norte
6.0
Oeste
-74.0
Leste
-44.0
Sul
-18.5
Clique em "Ver/View"
Gráficos
Tipo:
Politico
Histograma
Procurar Município
Nome
Estado
TODOS
Ordenar
Alfabeticamente
Procurar
Mosaico LandSat 2003/Rios Principais
S05:00:00 O53:42:00
Rio Novo
Rio Novo
Rio Novo
Rio Carajari
Rio Carajari
Rio Carajari
Igarape Encravado
Large deforestation area detected by DETER on 22 June 200
in Altamira, Para State (S 05 08 11.89 - W 53 55 15.73)
Internet



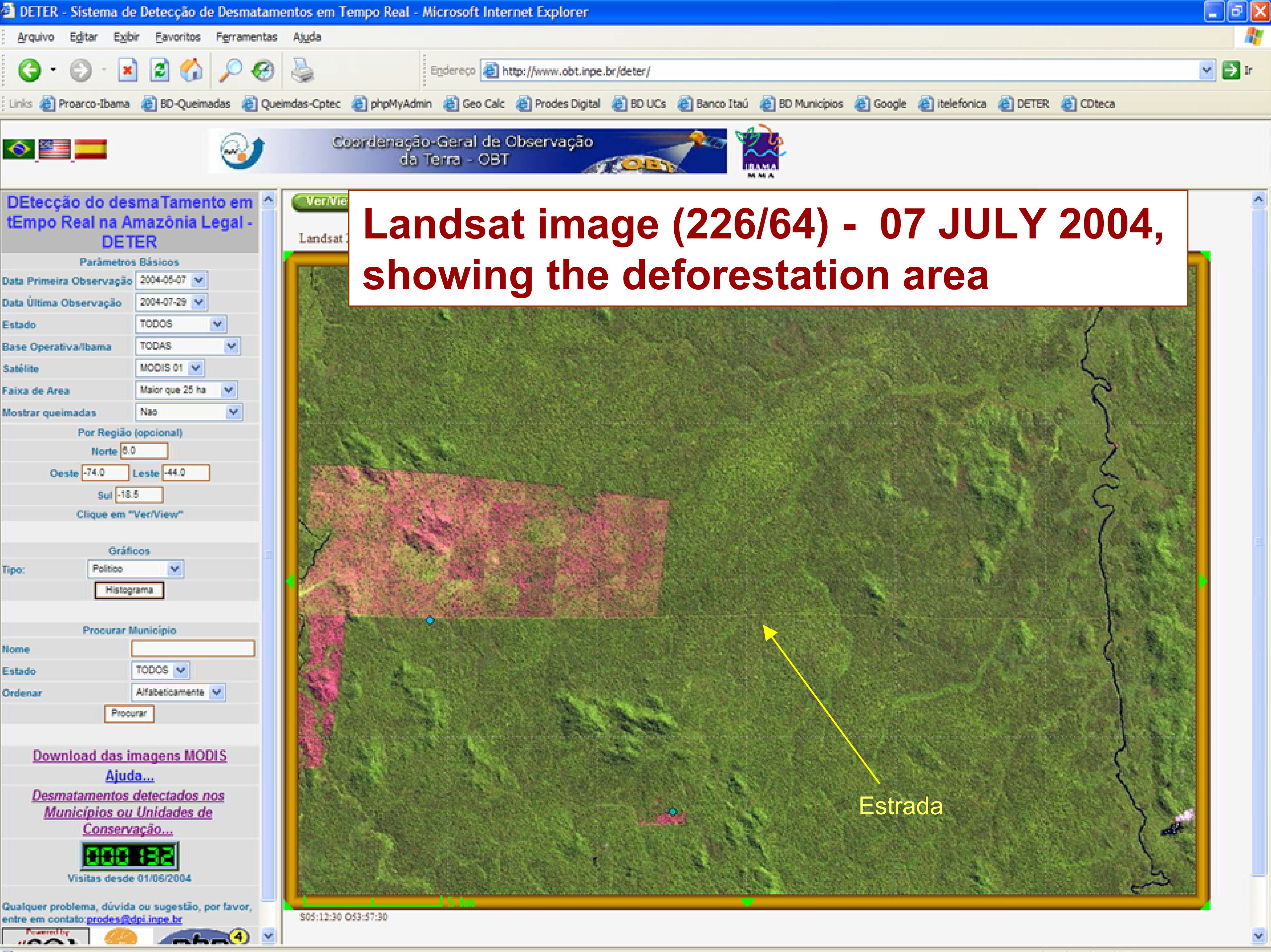
MODIS image acquired on 08 JUNE 2004, showing the initial deforestation activity



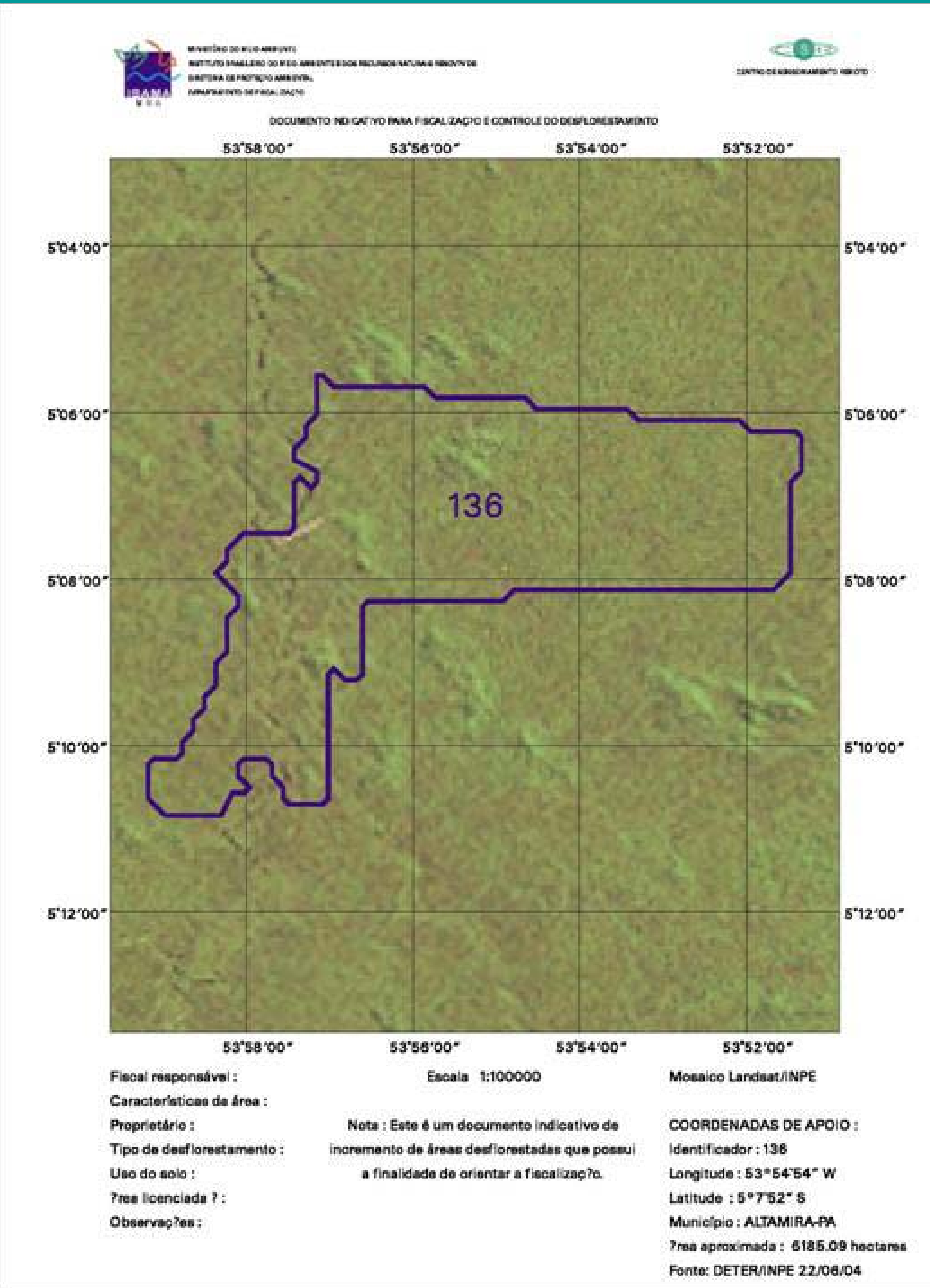
MODIS image acquired on 22 JUNE 2004, showing the deforestation area very clearly



MODIS image - 22 JUNE 2004, showing the deforestation polygon and its attributes



DETER - Sistema de Detecção de Desmatamentos em Tempo Real - Microsoft Internet Explorer
Arquivo Editar Exibir Favoritos Ferramentas Ajuda
Endereço http://www.obt.inpe.br/deter/
Links Proarco-Ibama BD-Queimadas Queimdas-Cptec phpMyAdmin Geo Calc Prodes Digital BD UCs Banco Itaú BD Municípios Google itelefonica DETER CDteca
Coordenação-Geral de Observação da Terra - OBT
IBAMA MMA
Landsat image (226/64) - 07 JULY 2004, showing the deforestation area
DEtecção do desmaTamento em tEmpo Real na Amazônia Legal - DETER
Parâmetros Básicos
Data Primeira Observação 2004-05-07
Data Última Observação 2004-07-29
Estado TODOS
Base Operativa/Ibama TODAS
Satélite MODIS 01
Faixa de Area Maior que 25 ha
Mostrar queimadas Nao
Por Região (opcional)
Norte 6.0
Oeste -74.0 Leste -44.0
Sul -18.5
Clique em "Ver/View"
Gráficos
Tipo: Politico
Histograma
Procurar Município
Nome
Estado TODOS
Ordenar Alfabeticamente
Procurar
Download das imagens MODIS
Ajuda...
Desmatamentos detectados nos Municípios ou Unidades de Conservação...
000132
Visitas desde 01/06/2004
Qualquer problema, dúvida ou sugestão, por favor, entre em contato: prodes@dpi.inpe.br
Estrada



"Document Indicative for Fiscalization and Control of Deforestation", written by IBAMA/MMA based on DETER information


16 17:48

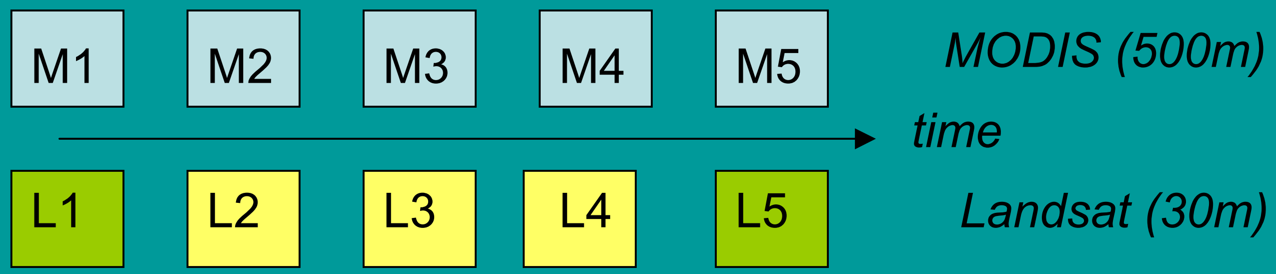

16 17:49

DATA BLENDER PROJECT

“Daily” Landsat Surface Reflectance

- Objectives:

  blend high-frequency temporal information from MODIS and high spatial resolution information from Landsat to produce “daily” Landsat-like surface reflectance



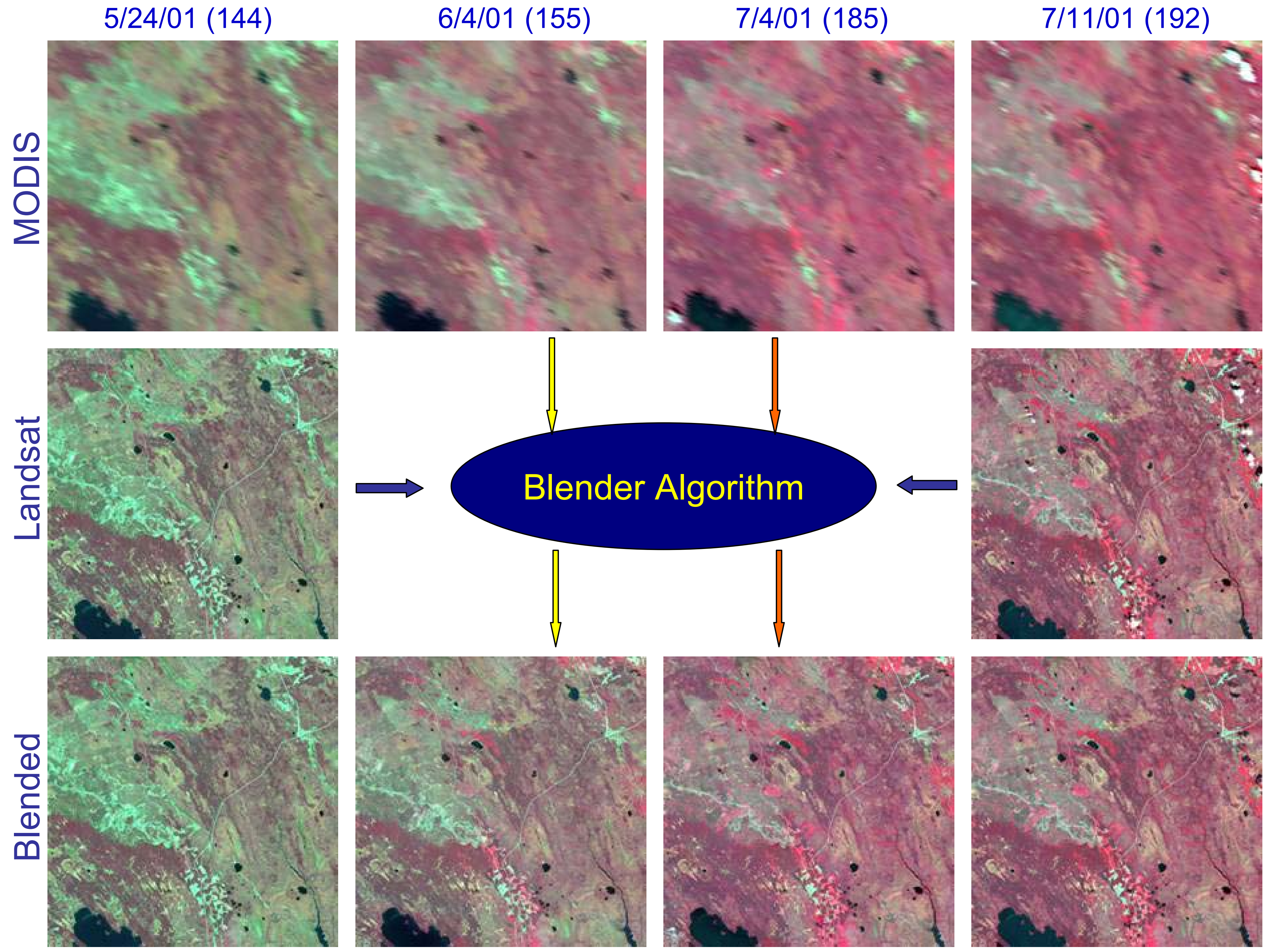
- Input:

  MODIS surface reflectance $M(x_i,y_j,t_k)$ at t_k
  Landsat surface reflectance $L(x_i,y_j,t_k)$ at t_k
  MODIS surface reflectance $M(x_i,y_j,t_0)$ at t_0

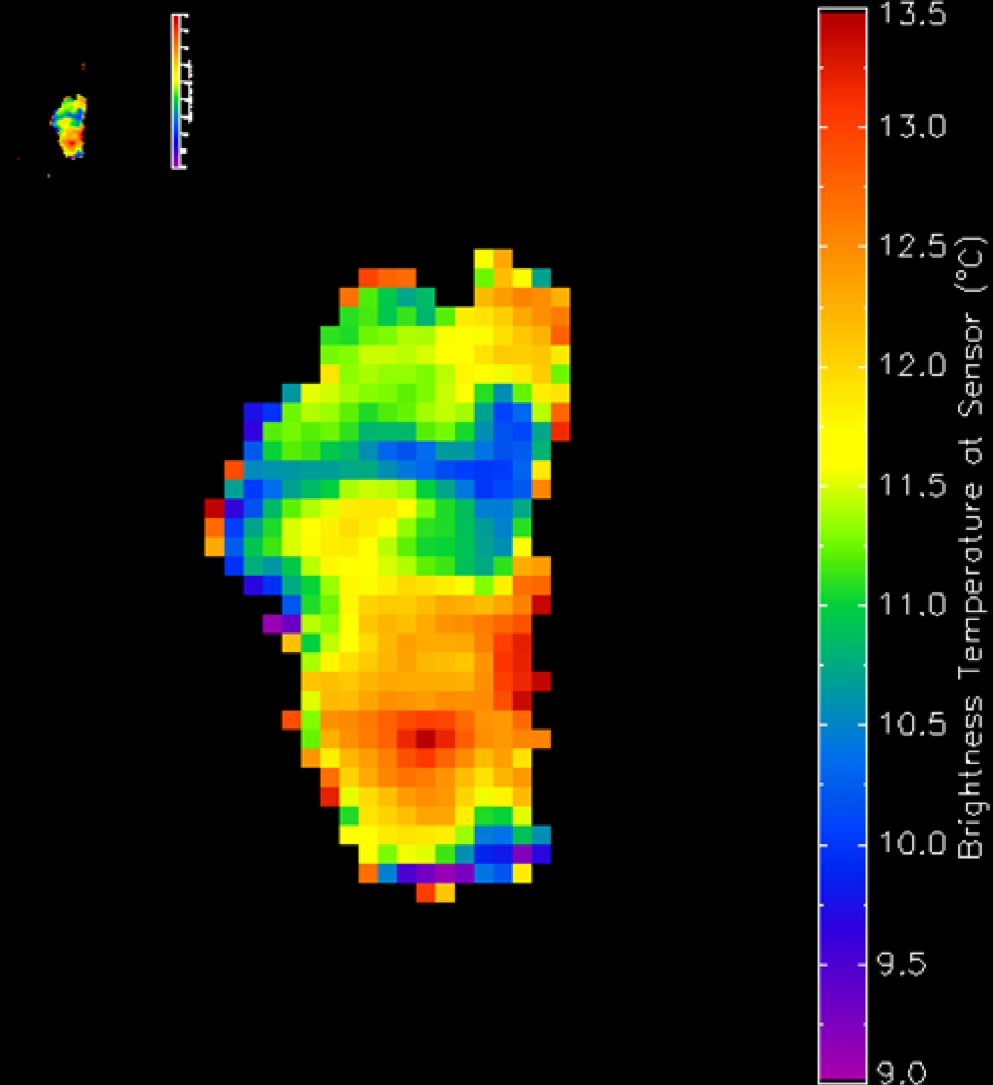
- Predict:

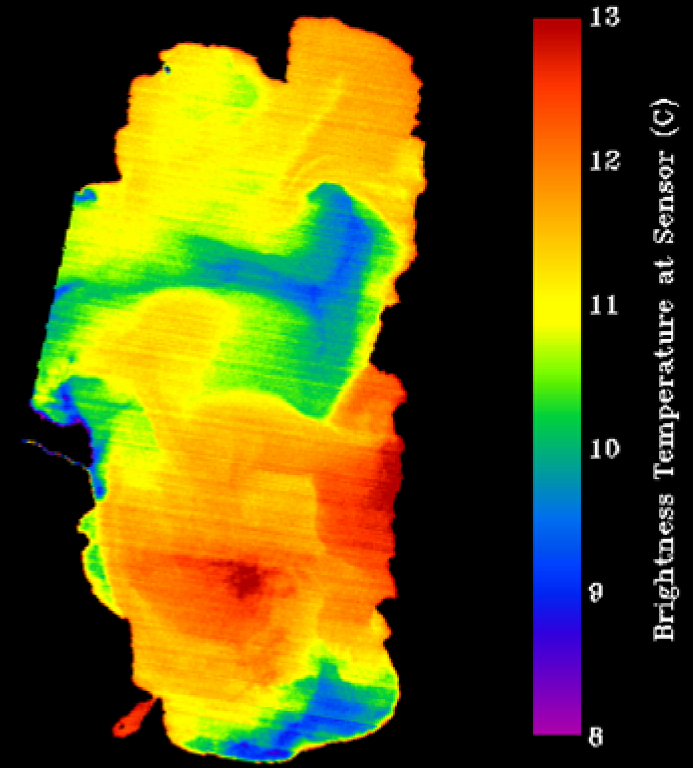
  Landsat surface reflectance $L(x_i,y_j,t_0)$ at t_0

Masek et al. GSFC


5/24/01 (144)
6/4/01 (155)
7/4/01 (185)
7/11/01 (192)
MODIS
Landsat
Blended
Blender Algorithm

Detecting upwellings (cold water plumes) with MODIS and ASTER





MODIS 6/03/2001

ASTER 6/03/2001