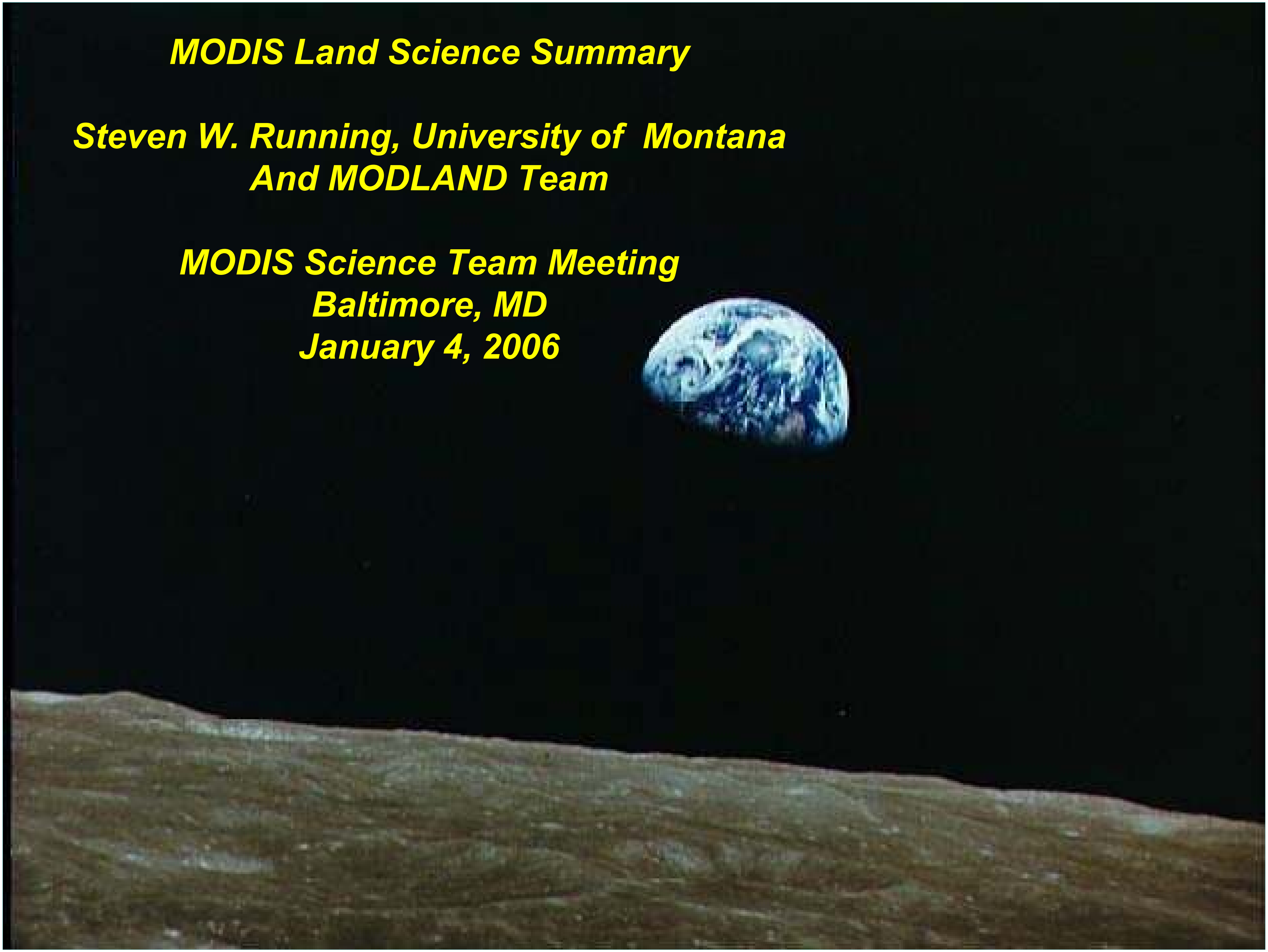
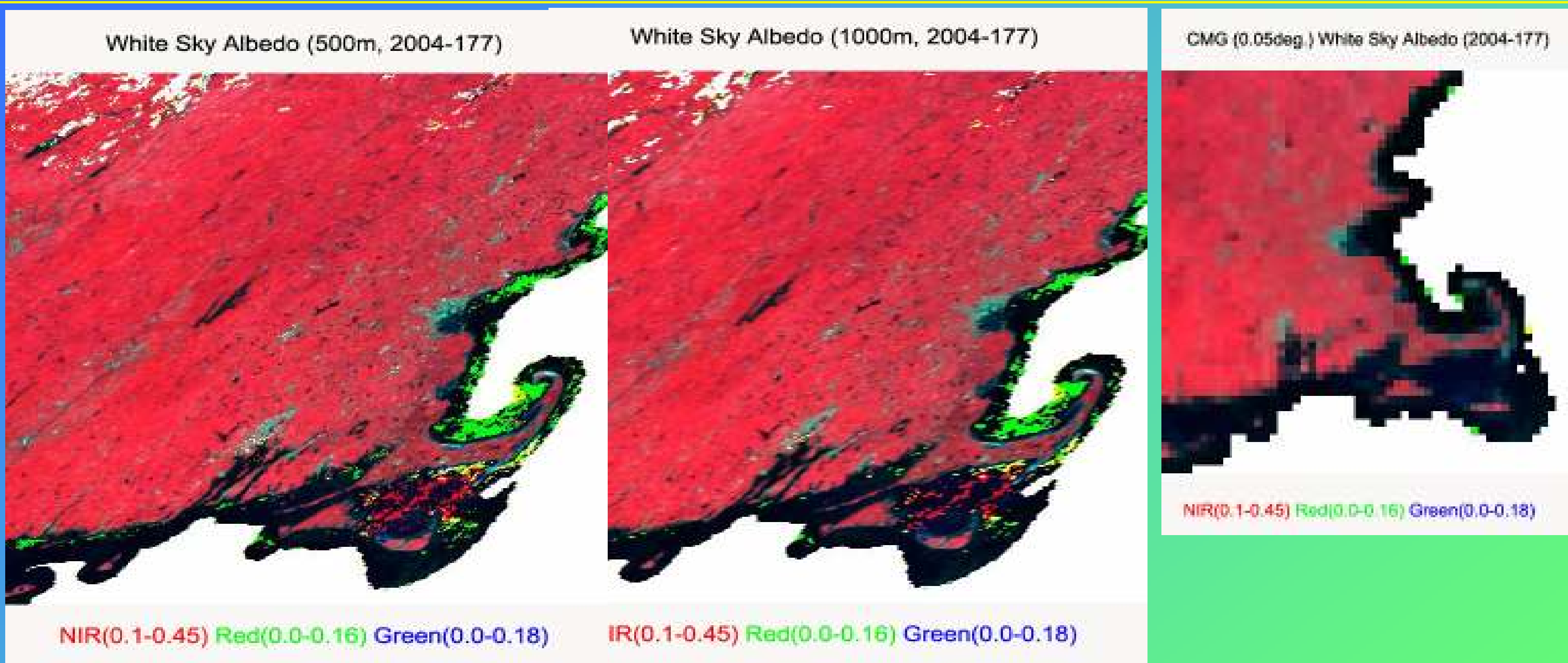

MODIS Land Science Summary
Steven W. Running, University of Montana
And MODLAND Team
MODIS Science Team Meeting
Baltimore, MD
January 4, 2006

MODIS BRDF/Albedo Products

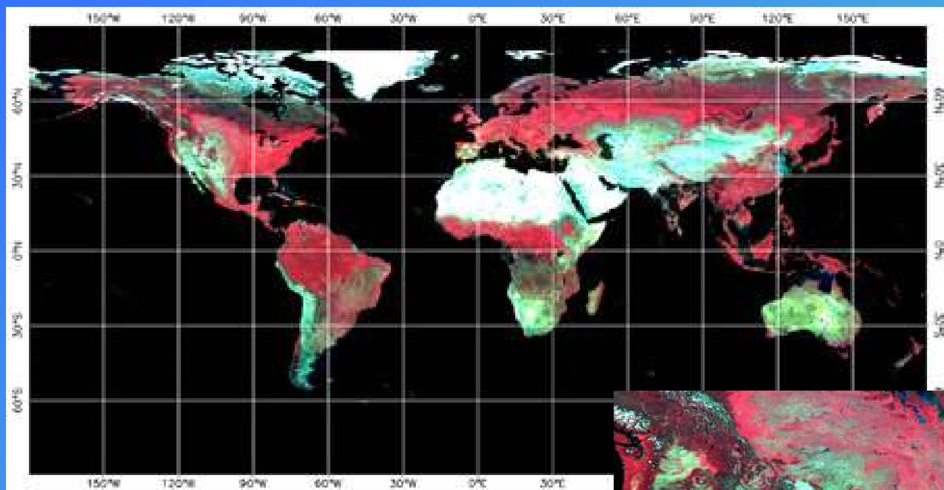
- Combined Terra and Aqua MODIS surface reflectances are used to retrieve highest quality products
- Product provider measures of surface albedo and anisotropy
  - Intrinsic surface albedos
  - BRDF models
  - Nadir BRDF-Adjusted Reflectances (NBAR)
- V005 reprocessed products provided at three resolutions
  - 500m (for mesoscale applications)
  - 1km (for regional applications)
  - 0.05deg (for global applications)
- 500m products provide better spatial detail and will allow global land cover at 500m spatial resolution

MODIS BRDF/Albedo Products



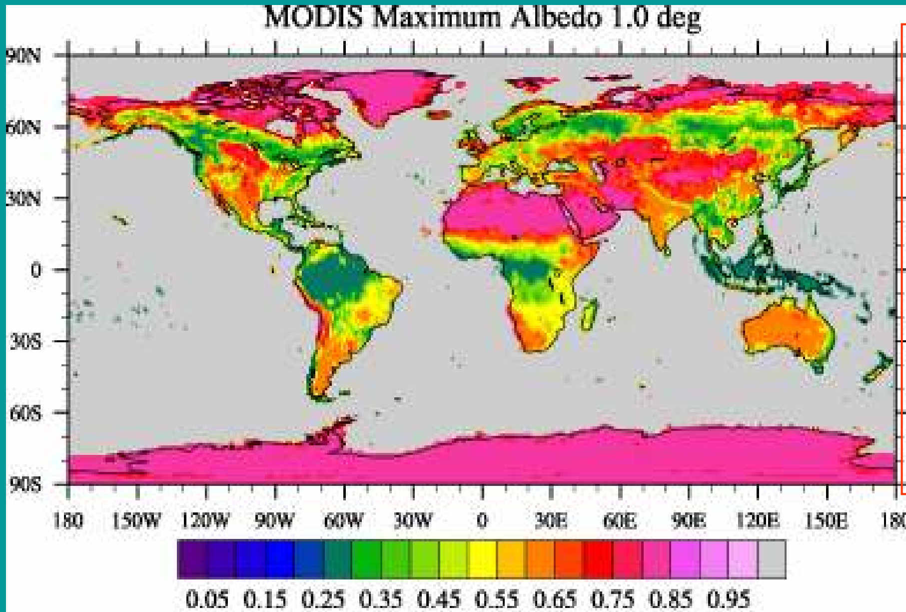
Version 5 White Sky Albedo products in New England area with 3 different resolutions (500m, 1km, and 0.05 degrees)

CMG products

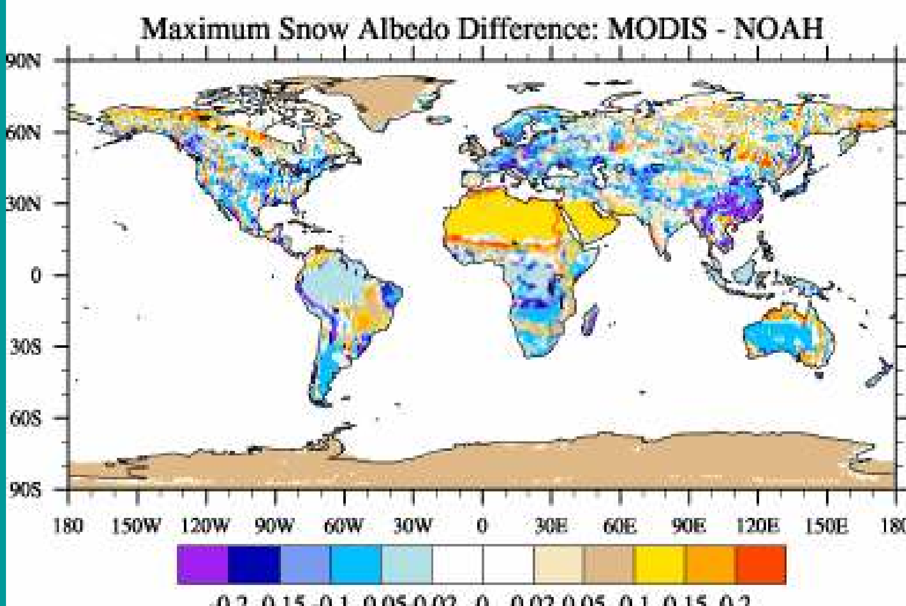


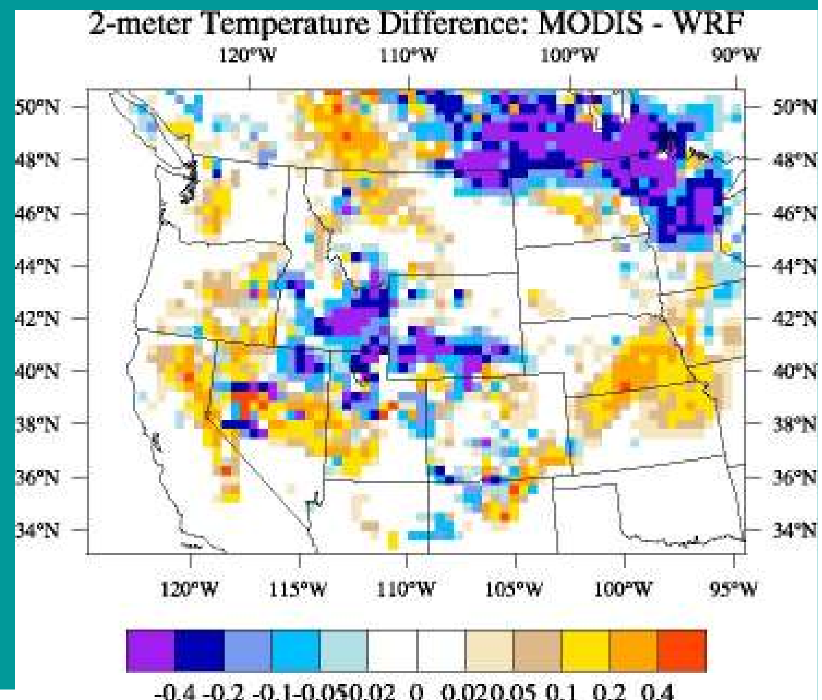
False color composite of White Sky Albedo

CMG products can be used in global, regional and local applications



Global maximum snow albedo data are derived using multiple MODIS land data (PI: Xubin Zeng; 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]

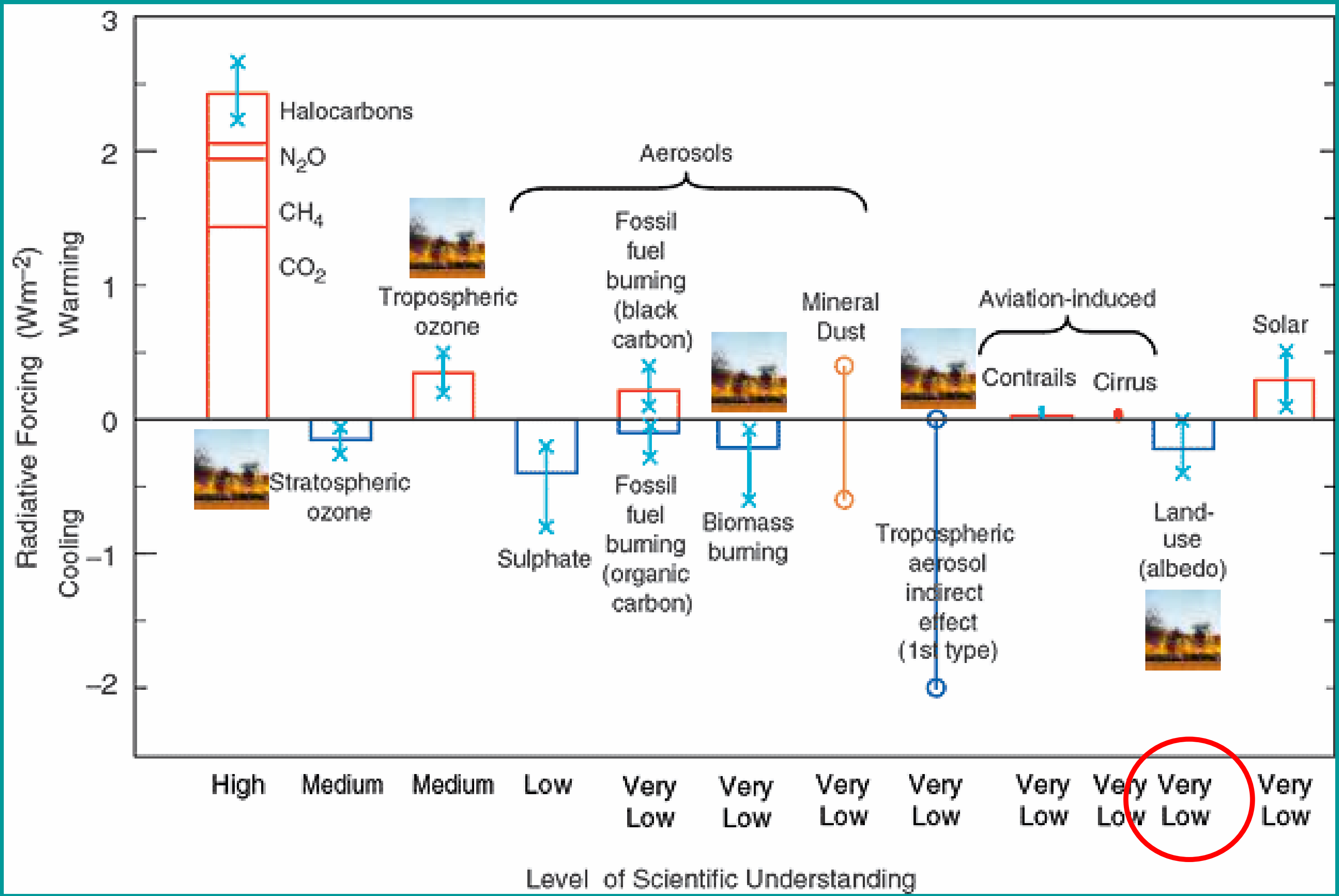
Fire-induced albedo change and its radiative forcing at the surface in northern Australia

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

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

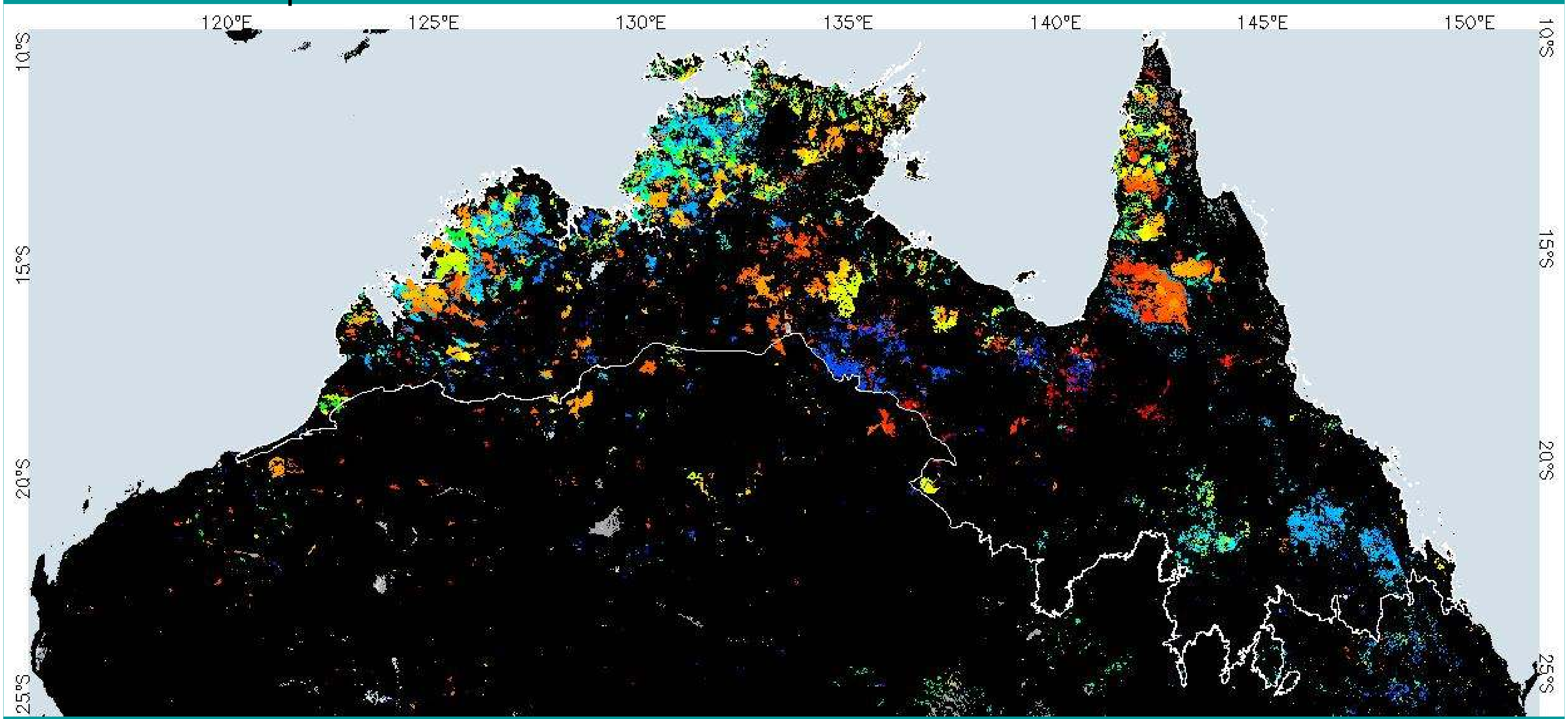
[2] Geographic Information Science Center of Excellence,
South Dakota State University, Brookings, SD

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)

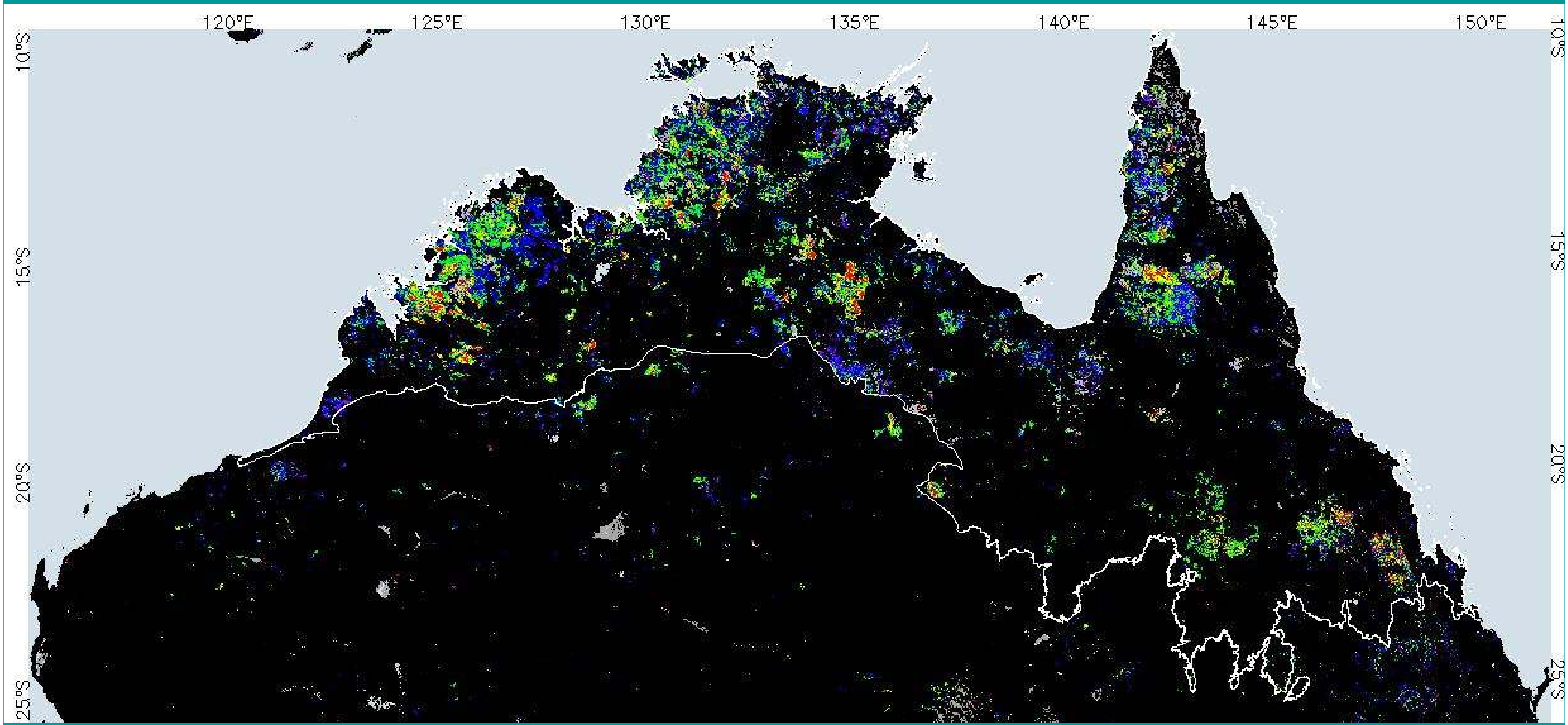
derived from Aqua + Terra MODIS data



March April May June July August September October November

Australia north of 26.5°S

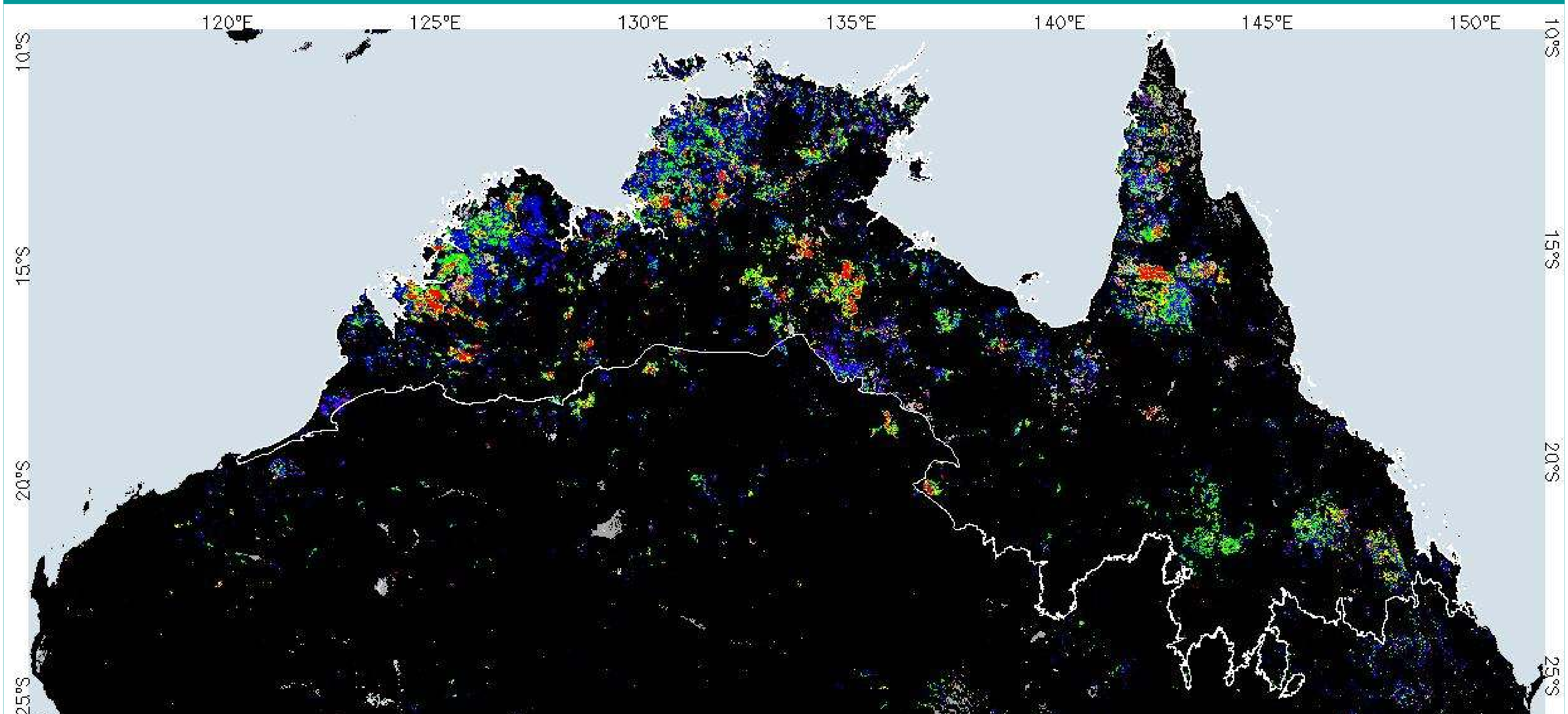
Shortwave "instantaneous" Δ albedo due to fire



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) Validation

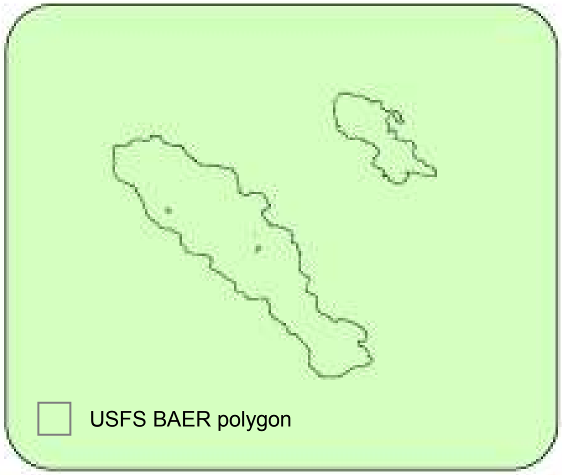


Figure 1a - USFS BAER Mineral Primm fire polygons.

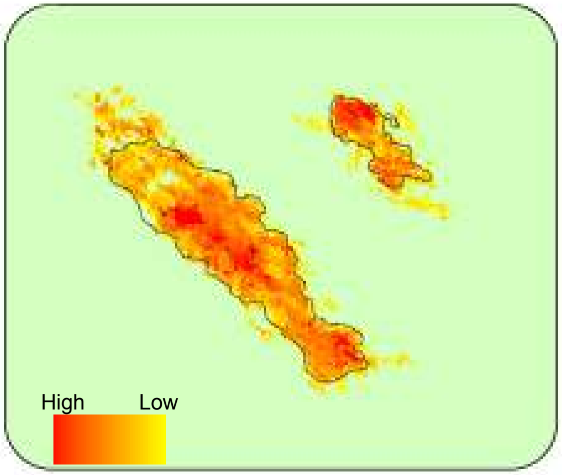


Figure 2a - MODIS VCC-CDB fire intensity (yellow = low while red = high), with USFS BAER Mineral Primm fire polygons.

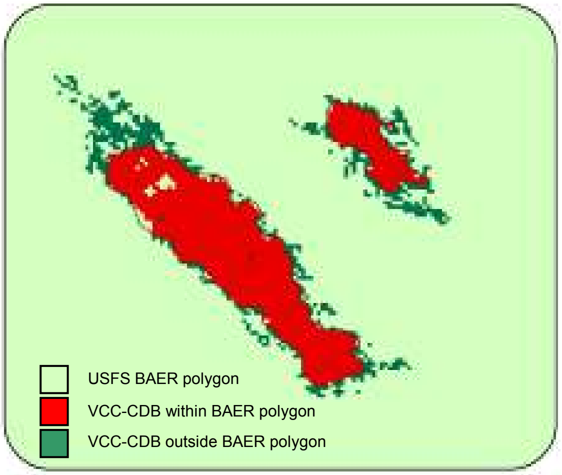
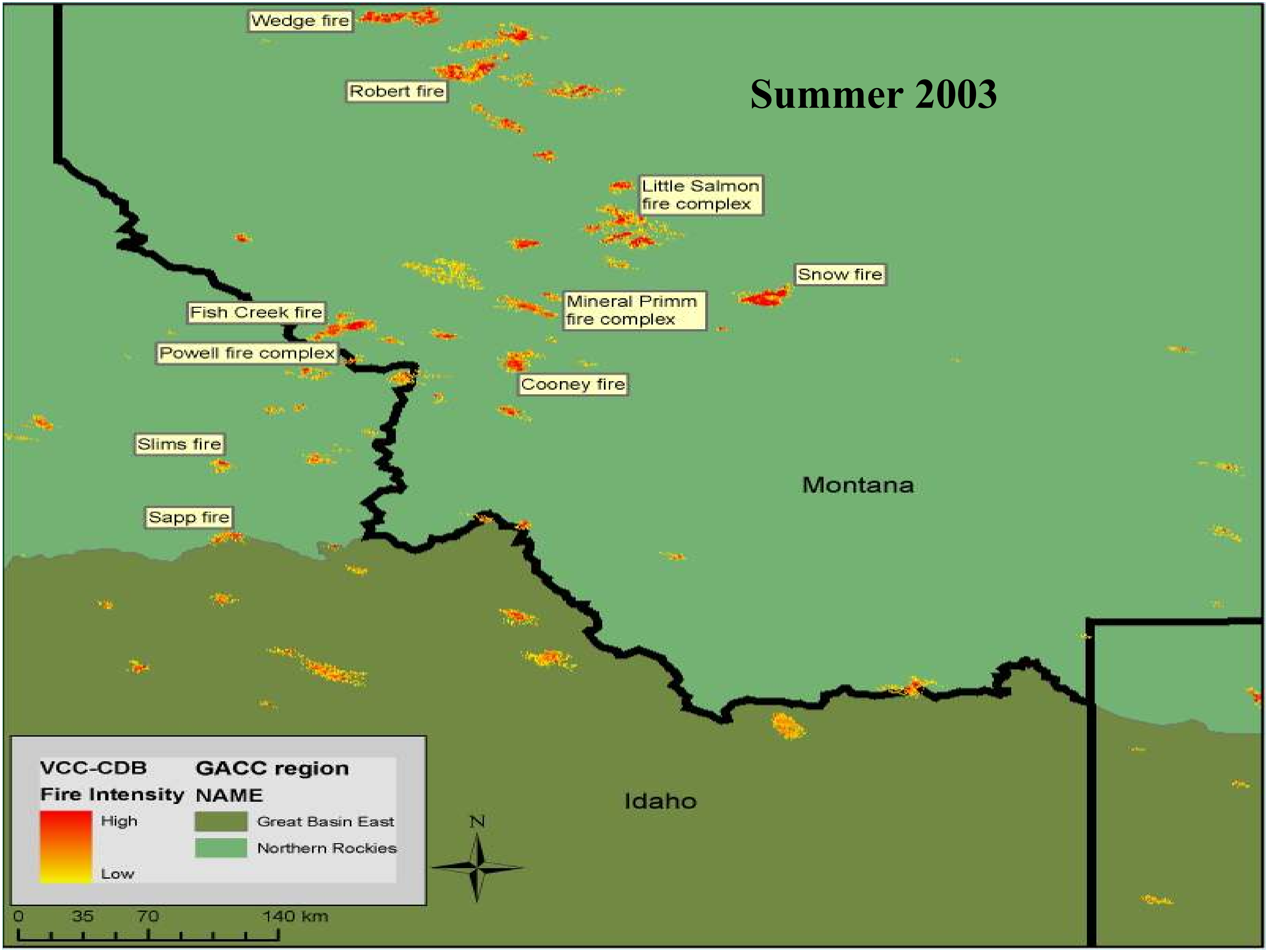
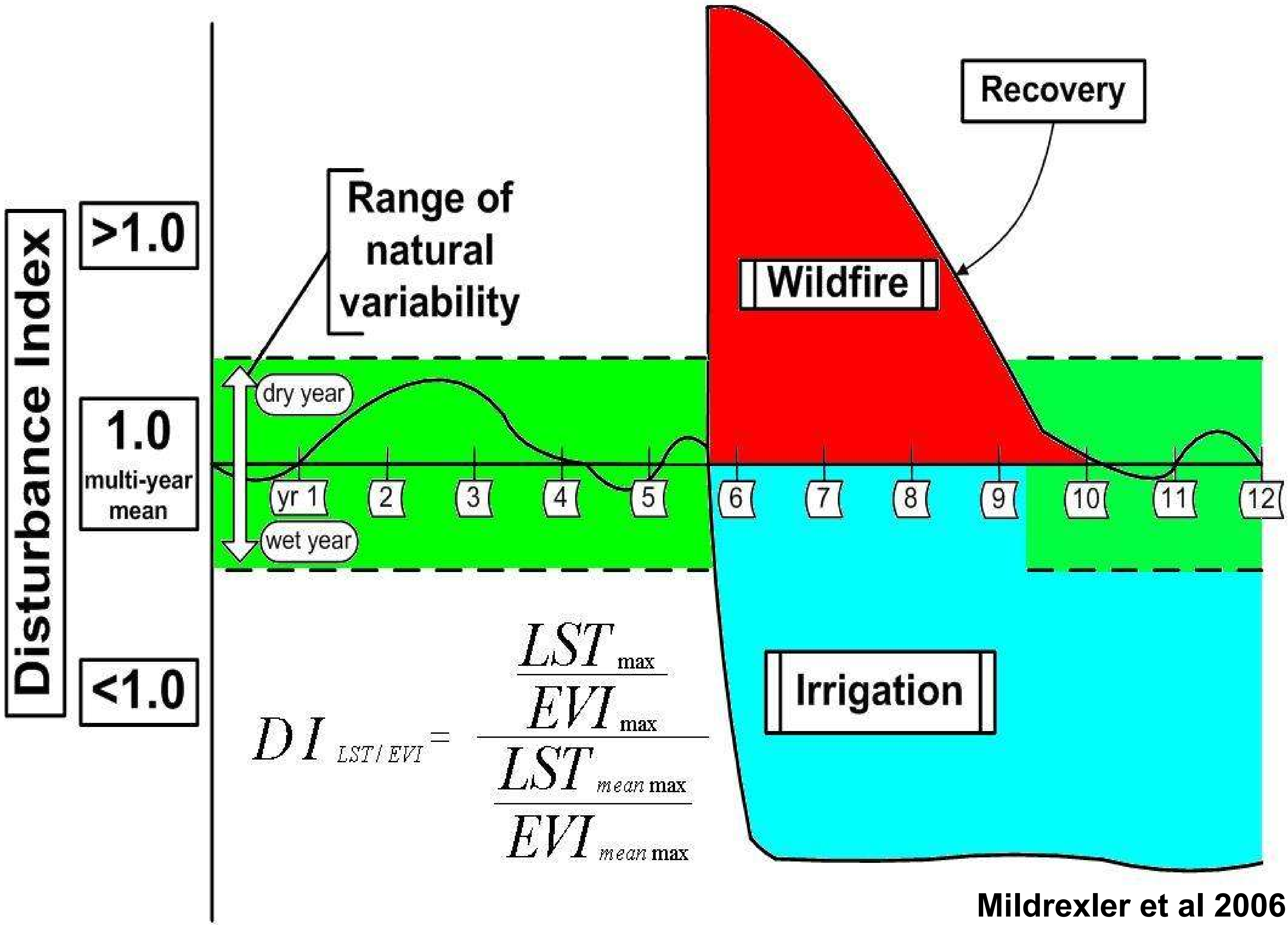


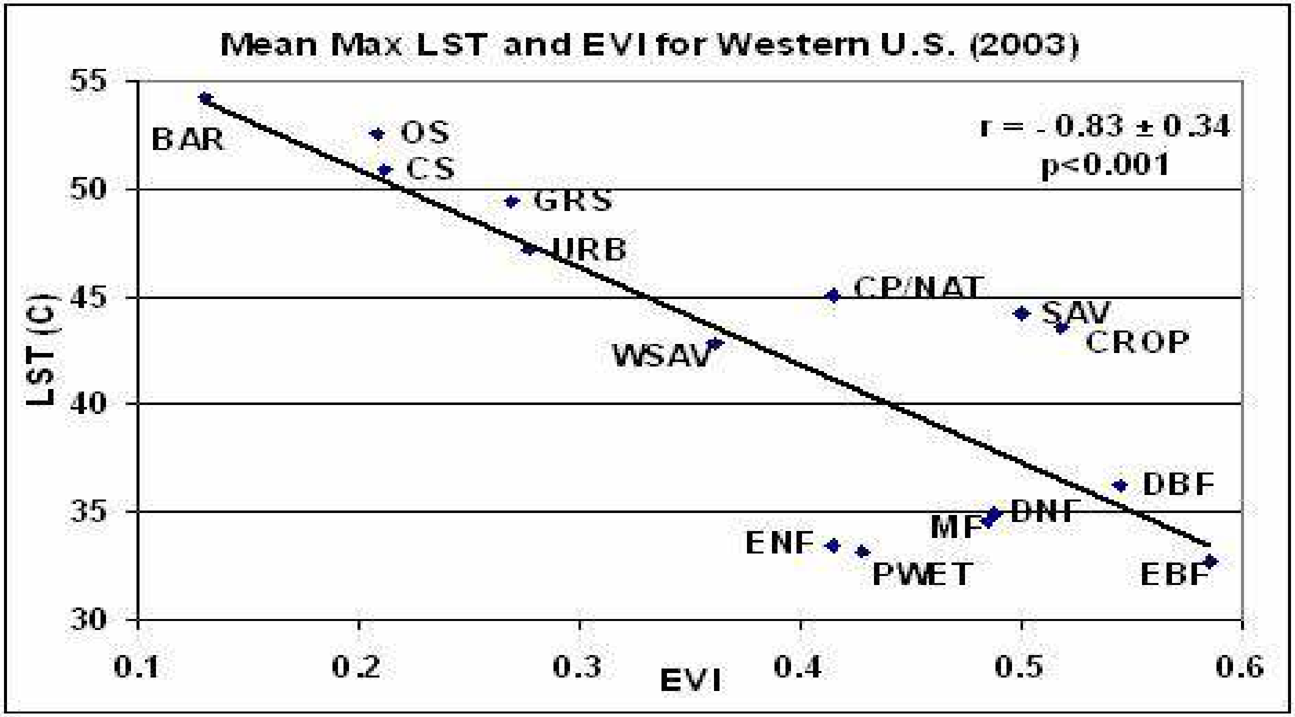
Figure 3a - Aggregated MODIS VCC-CDB polygon. Area in red represents VCC-CDB within the BAER polygon while the area in dark green is outside the BAER Mineral Primm fire polygon.

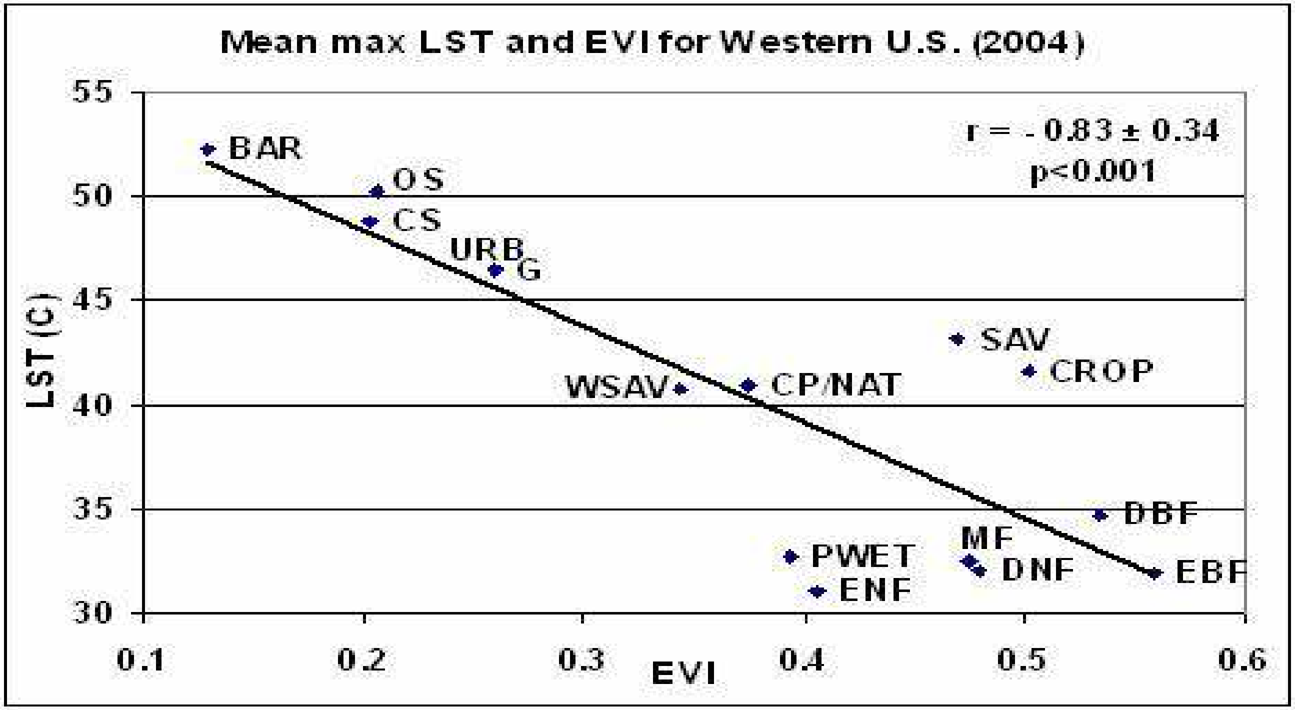
Fire Name	Total Area VCC	total BAER Acres	VCC Acres within BAER Polygon	VCC Acres outside BAER Polygon	% of BAER Polygon Area Covered by VCC Polygon
Mineral Primm Fire Complex	34023	23830	22753	11271	95.48%

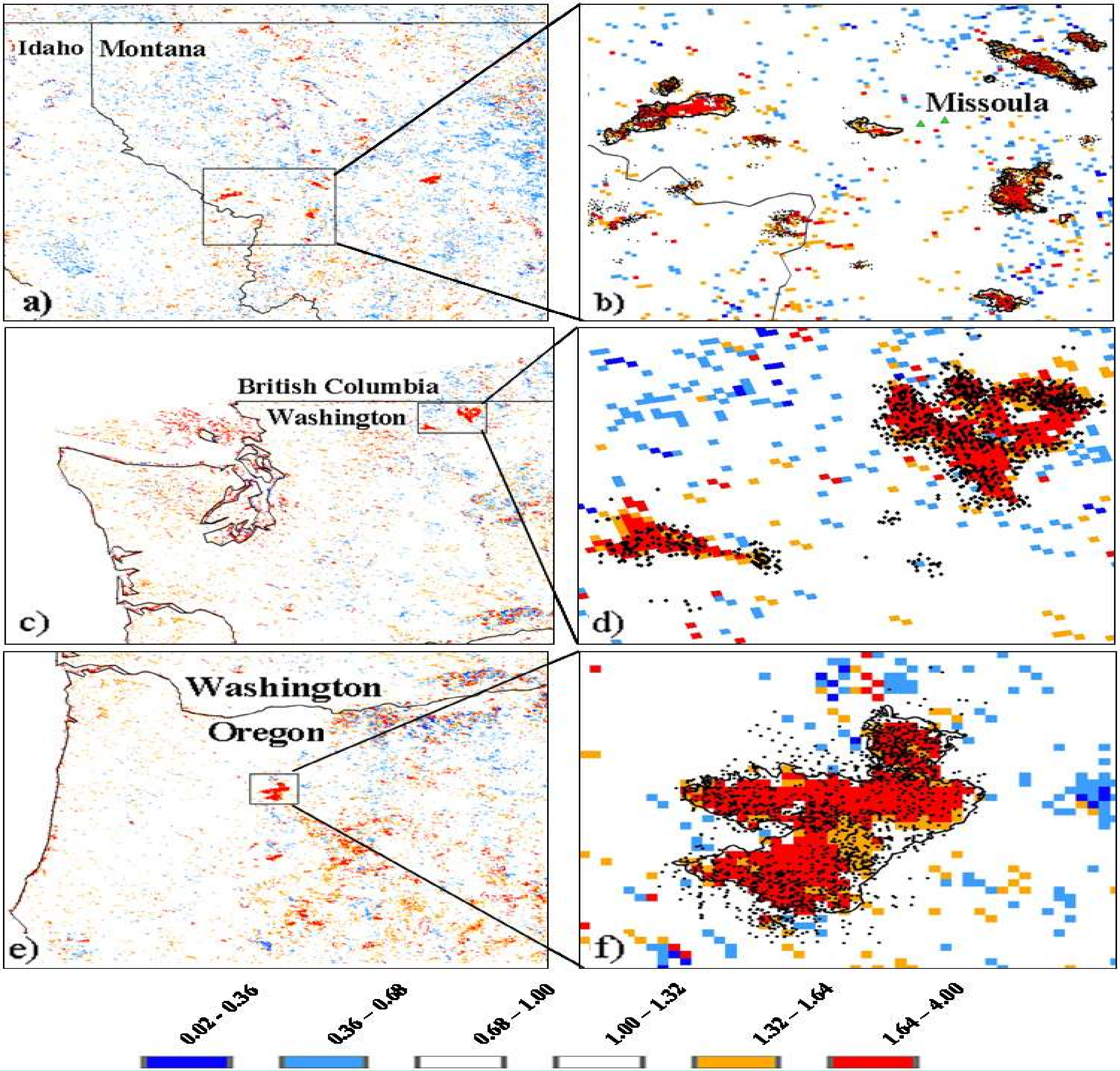

Summer 2003
Wedge fire
Robert fire
Little Salmon fire complex
Snow fire
Mineral Primm fire complex
Fish Creek fire
Powell fire complex
Cooney fire
Slims fire
Sapp fire
Montana
Idaho
VCC-CDB Fire Intensity
High
Low
GACC region NAME
Great Basin East
Northern Rockies
N
0 35 70 140 km



Mildrexler et al 2006


Mean Max LST and EVI for Western U.S. (2003)
r = - 0.83 ± 0.34
p<0.001
LST (C)
EVI
55
50
45
40
35
30
0.1
0.2
0.3
0.4
0.5
0.6
BAR
OS
CS
GRS
URB
CP/NAT
SAV
CROP
WSAV
DBF
DNF
MF
ENF
PWET
EBF

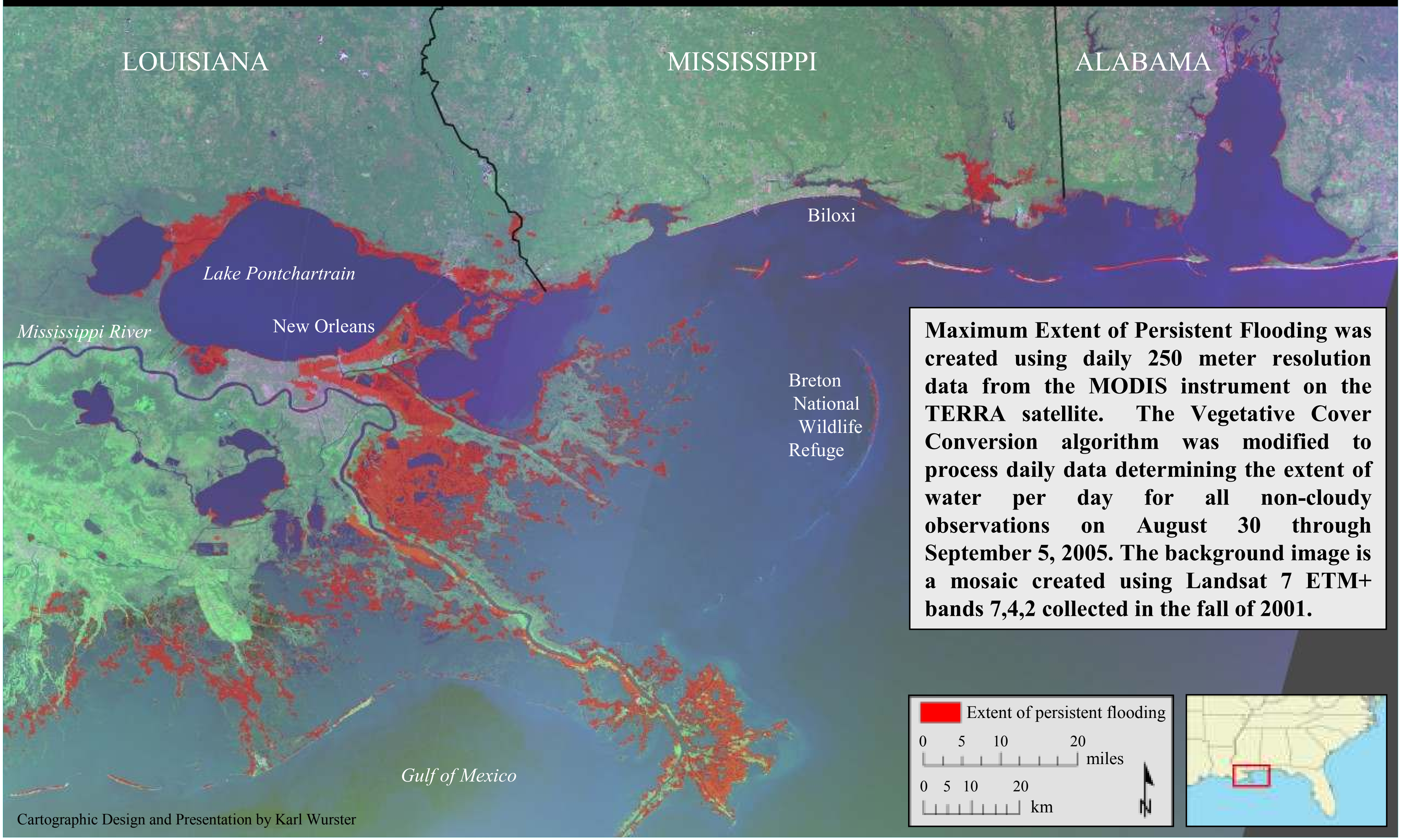

Mean max LST and EVI for Western U.S. (2004)
r = - 0.83 ± 0.34
p<0.001
LST (C)
EVI
55
50
45
40
35
30
0.1
0.2
0.3
0.4
0.5
0.6
BAR
OS
CS
URB
G
SAV
CROP
WSAV
CP/NAT
DBF
MF
PWET
DNF
EBF
ENF



Idaho
Montana
a)
Missoula
b)
British Columbia
Washington
c)
d)
Washington
Oregon
e)
f)
0.02 - 0.36
0.36 – 0.68
0.68 – 1.00
1.00 – 1.32
1.32 – 1.64
1.64 – 4.00

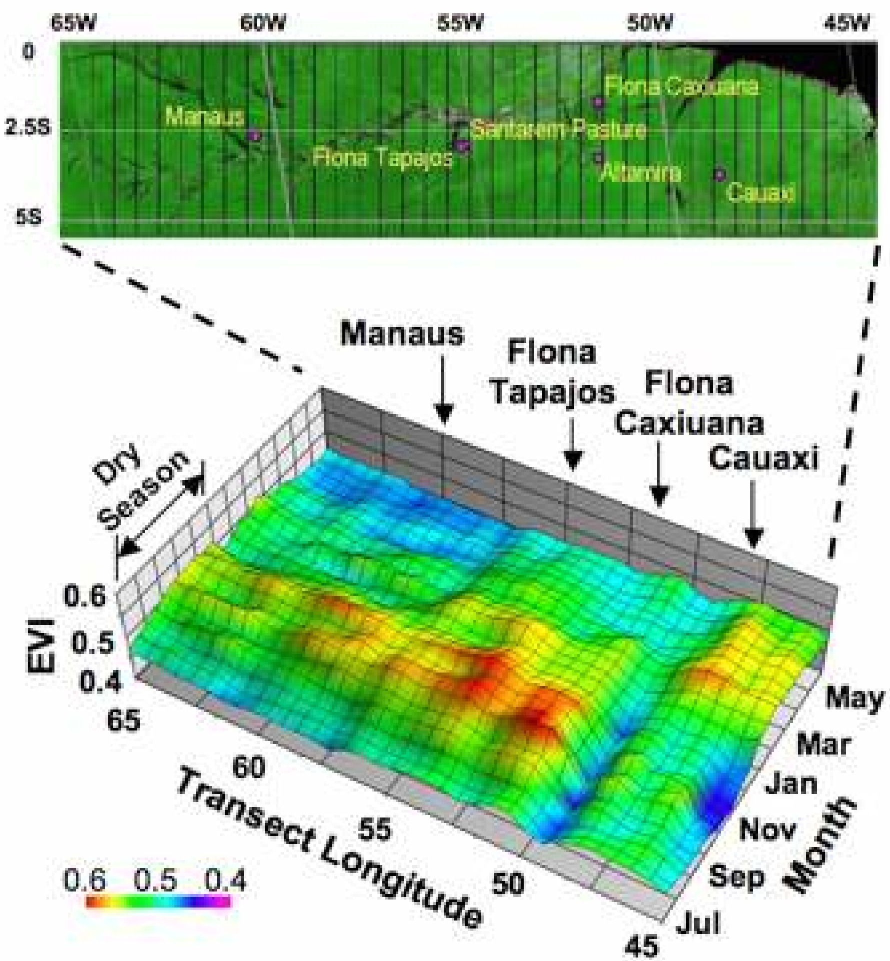
Maximum Extent of Persistent Flooding Caused by Hurricane Katrina

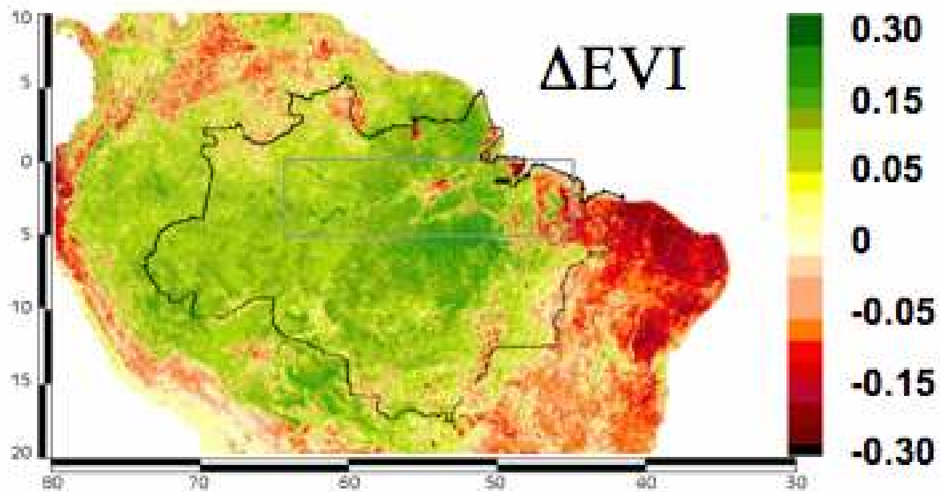
Mark Carroll, Charlene DiMiceli, Robert Sohlberg, John Townshend
Department of Geography, University of Maryland

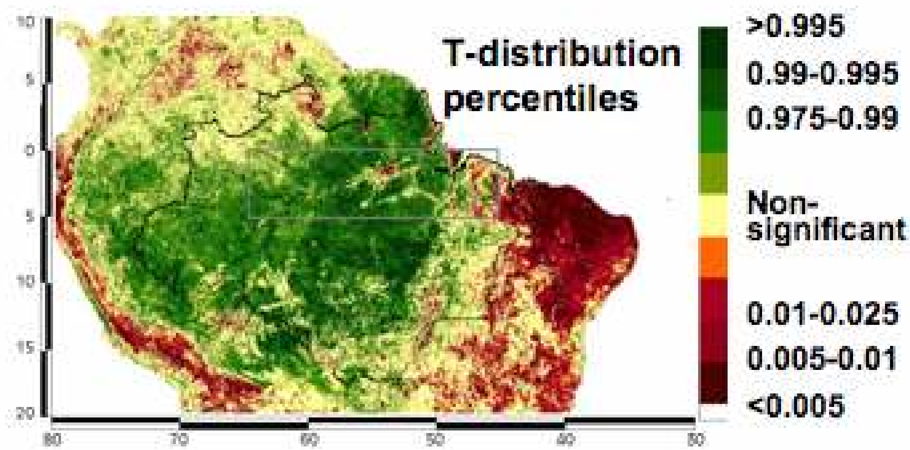


Maximum Extent of Persistent Flooding was created using daily 250 meter resolution data from the MODIS instrument on the TERRA satellite. The Vegetative Cover Conversion algorithm was modified to process daily data determining the extent of water per day for all non-cloudy observations on August 30 through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

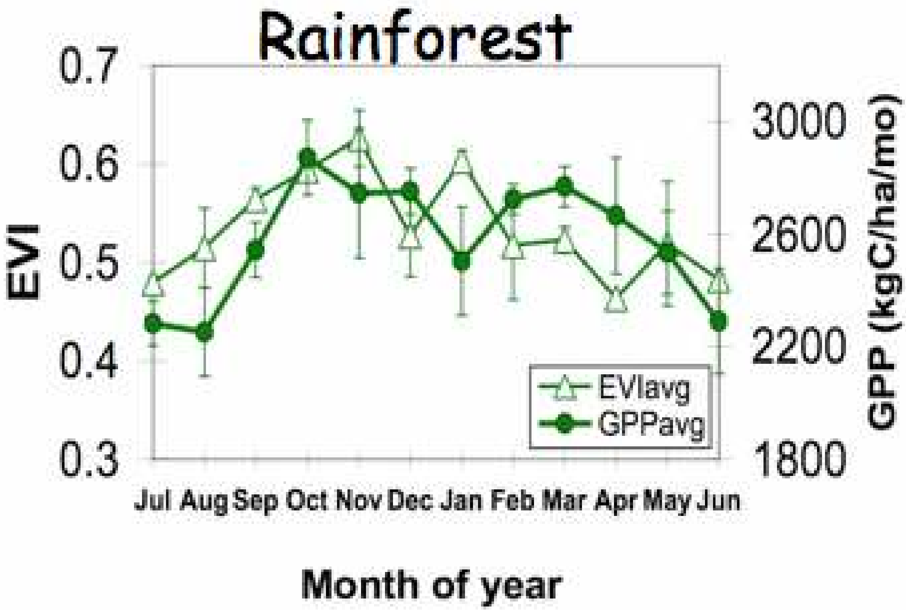
Amazon Rainforests Green-up with Sunlight in Dry Season

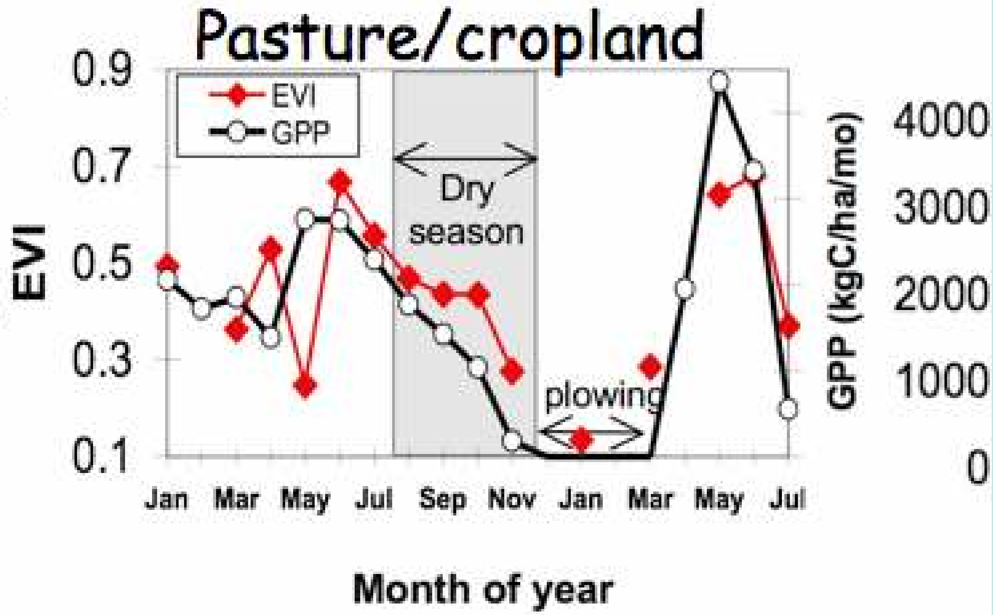






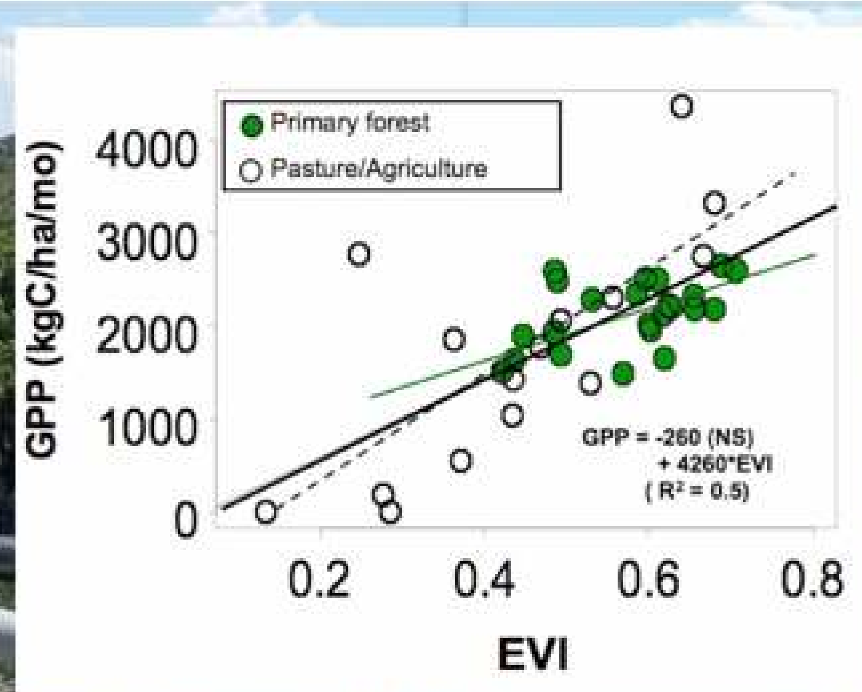
Huete et al. (in review)



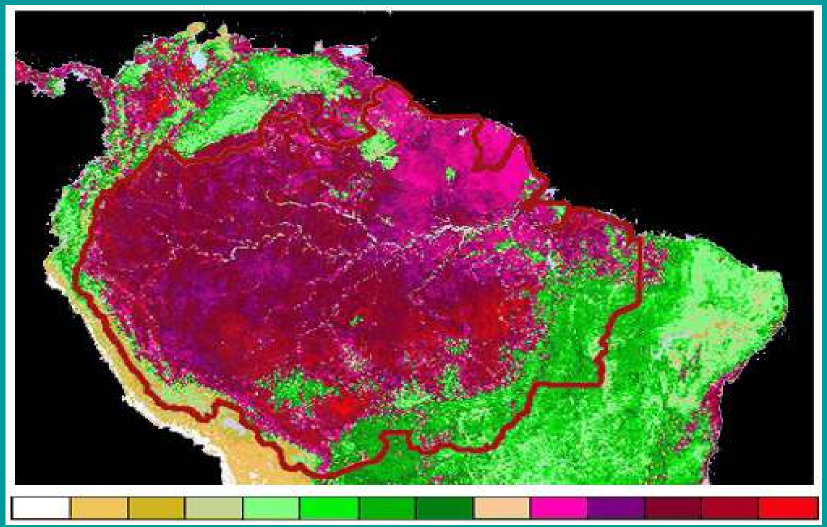


Validation @ plot level (flux tower sites)

- 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.



Large Seasonal Swings in Leaf Area of Amazon Rainforests

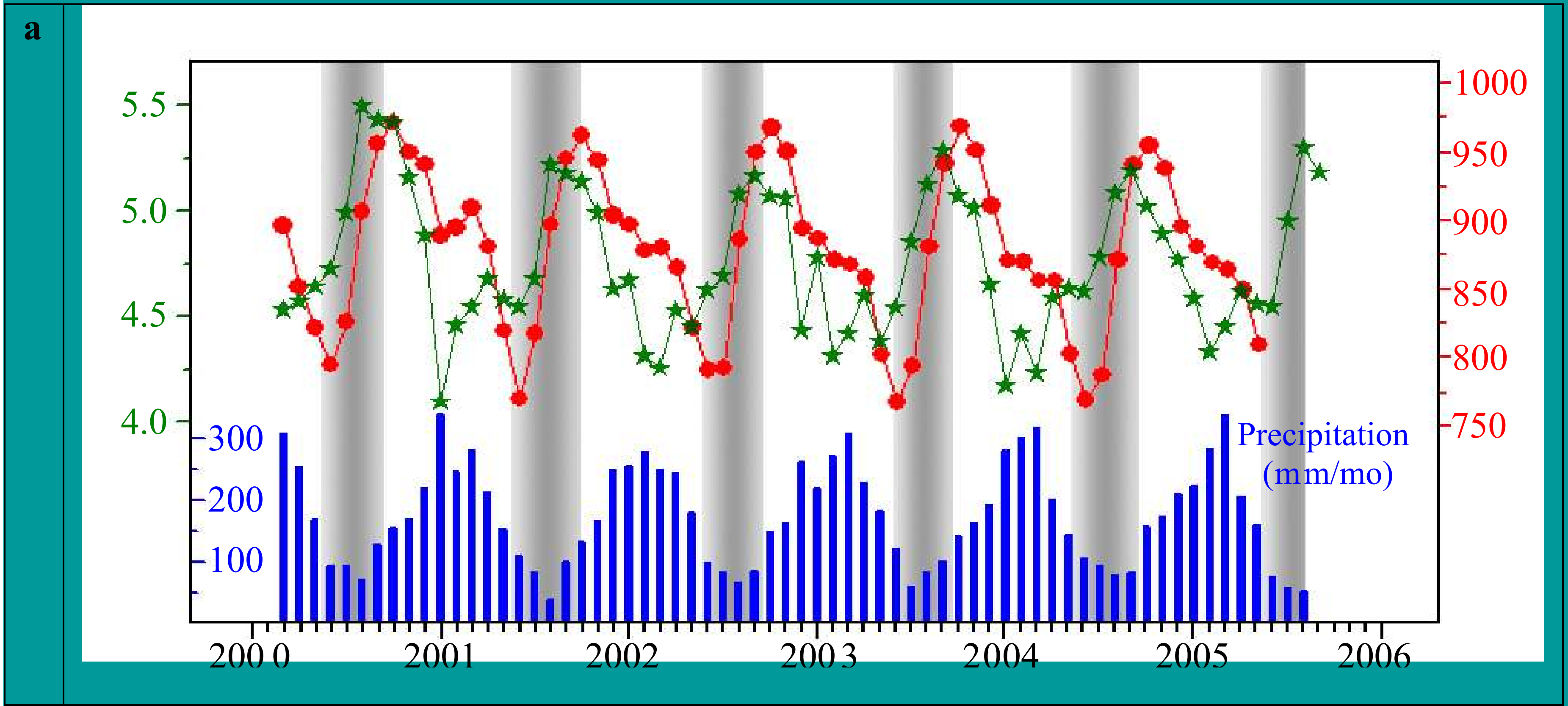


0.0 0.3 0.8 1.6 2.8 4.2 5.0 7.0

Annual Average Leaf Area Index

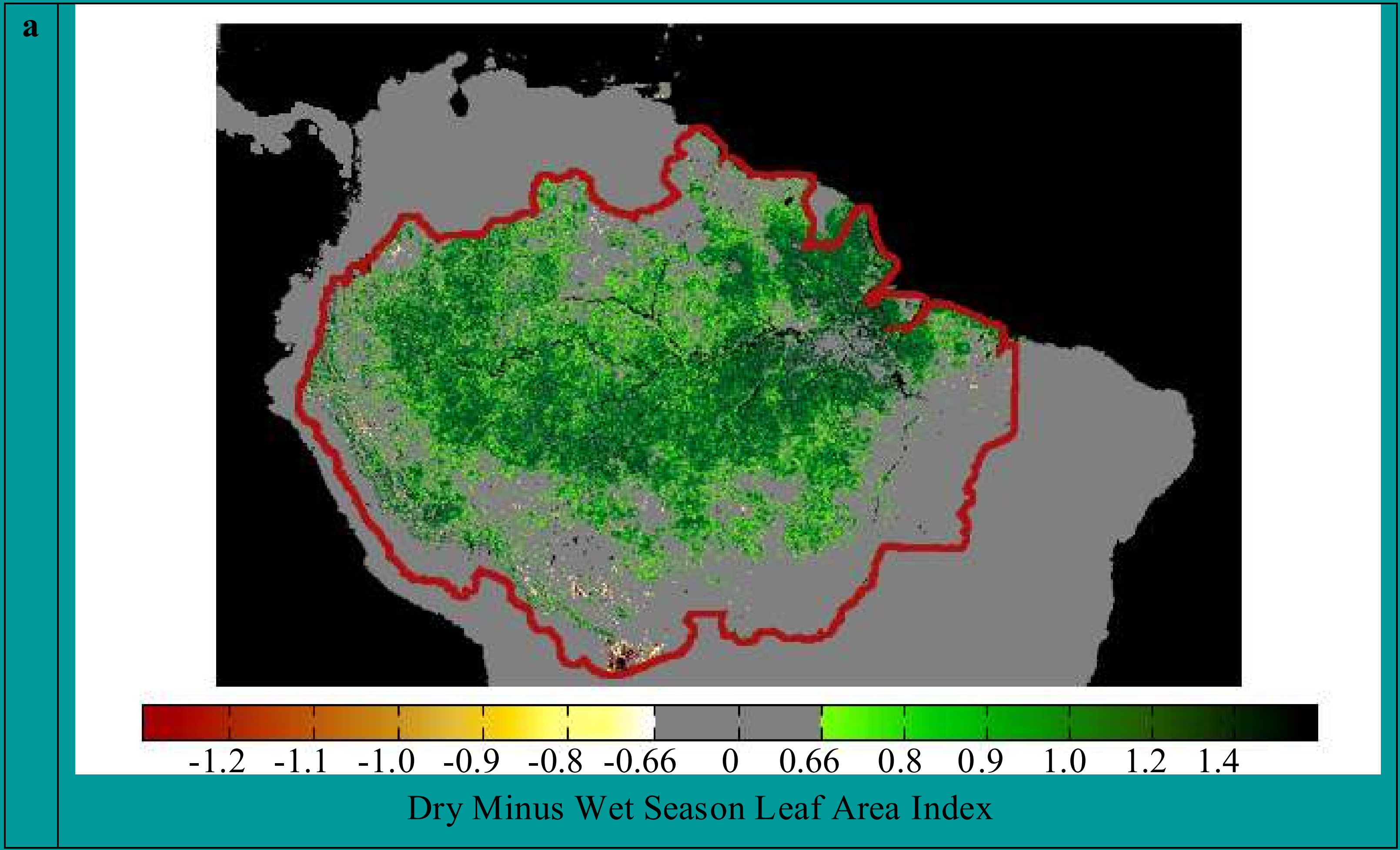
Myneni et al. (unpublished)

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



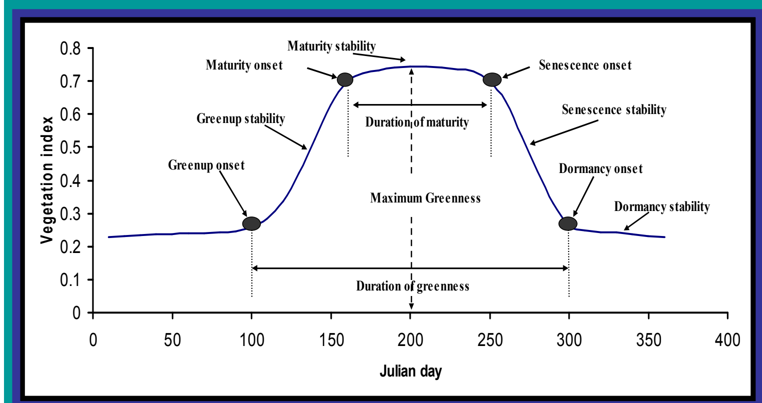
The derived spatial pattern of seasonal LAI amplitude reveals a heretofore unknown picture of phenology over a broad contiguous swath of land, anchored to the Amazon river, from its mouth in the east to its western-most reaches in Peru, in the heart of the basin.

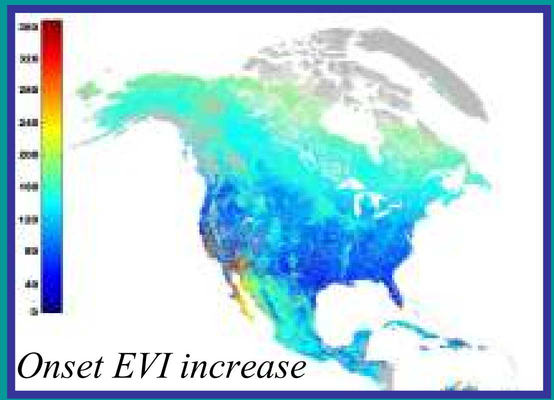
MOD12Q2: Global Vegetation Phenology

From Mark Friedl, Boston Univ.

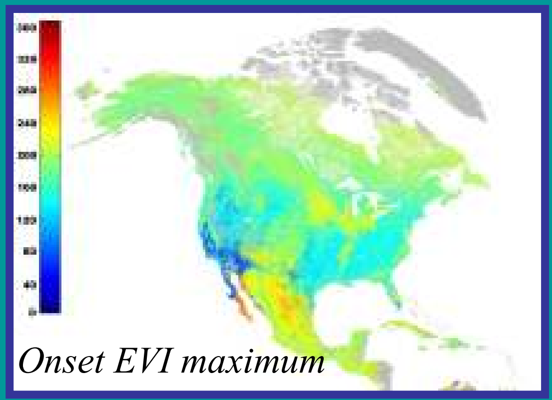
First global products for vegetation phenology based on MODIS EVI data released for 2001-2004

- Identifies key transition dates in growing season

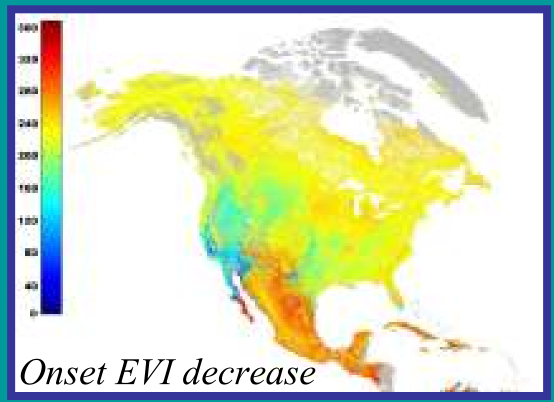




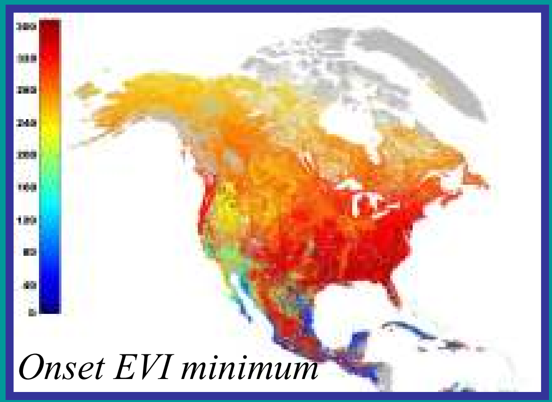
Onset EVI increase



Onset EVI maximum



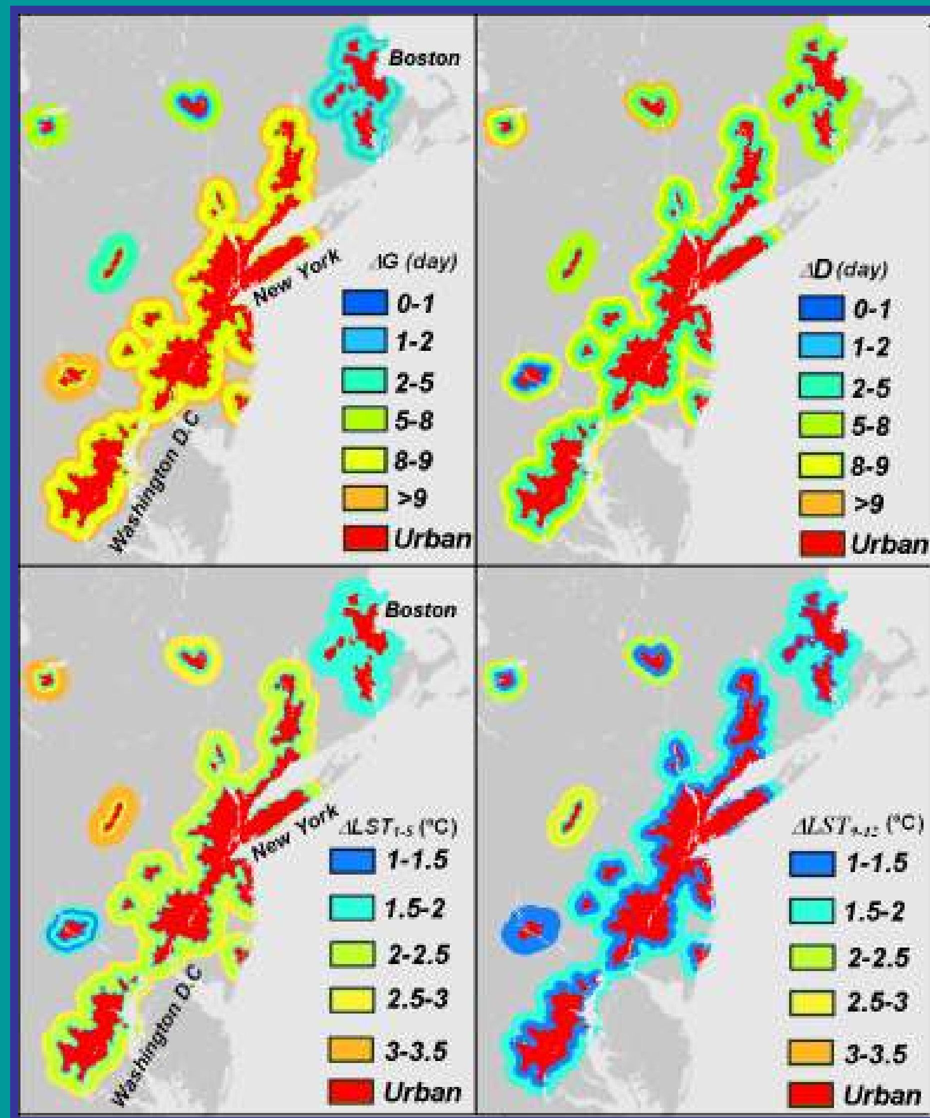
Onset EVI decrease



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

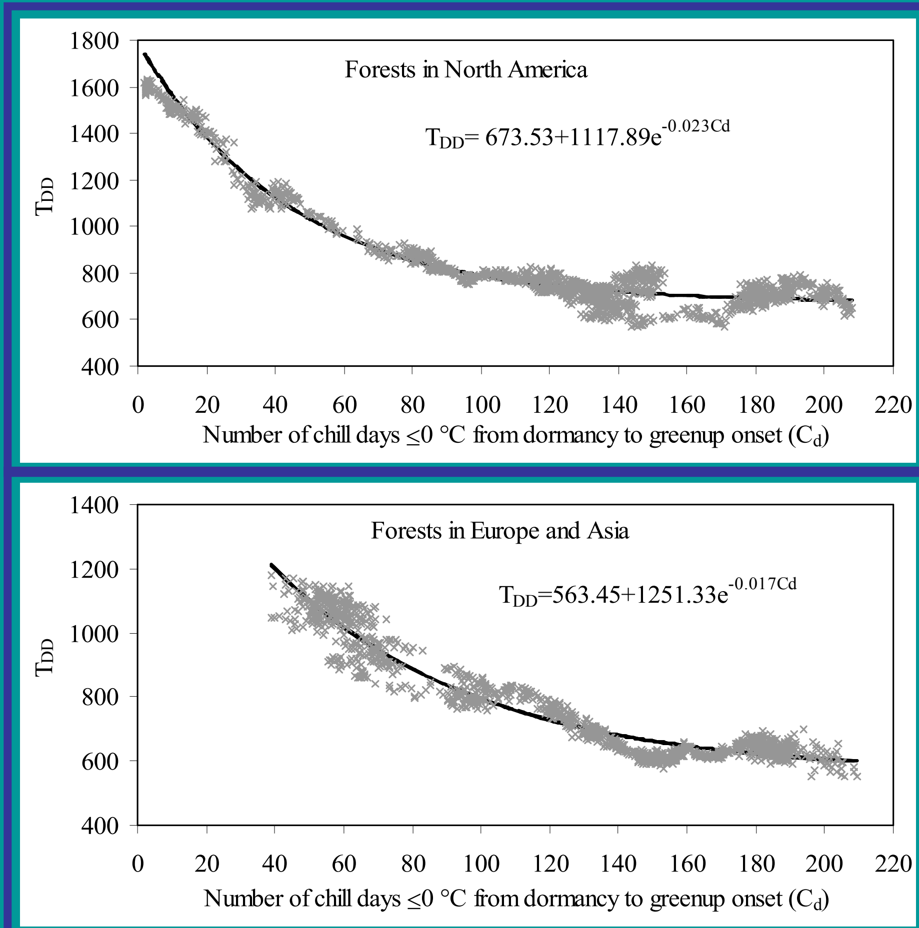
- Thermal "Time Chilling" Model for Forest Greenup:

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

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

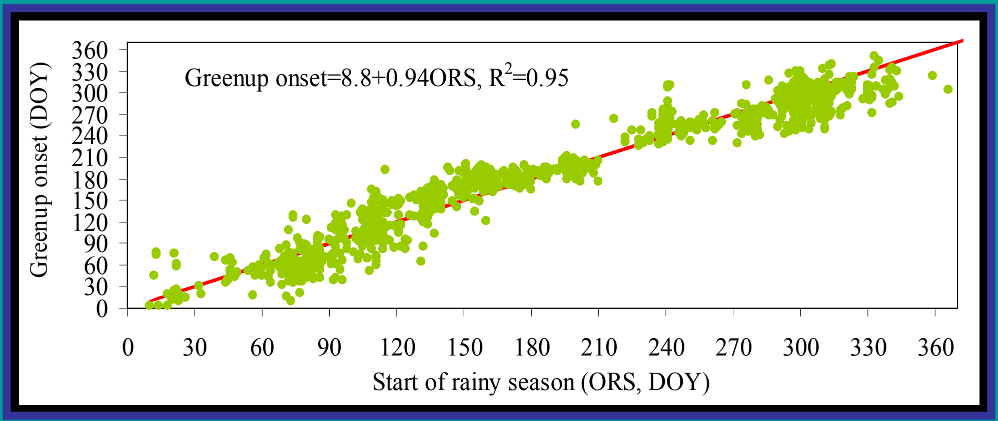
  – Explains ~ 83-95% of variance in T_{DD}

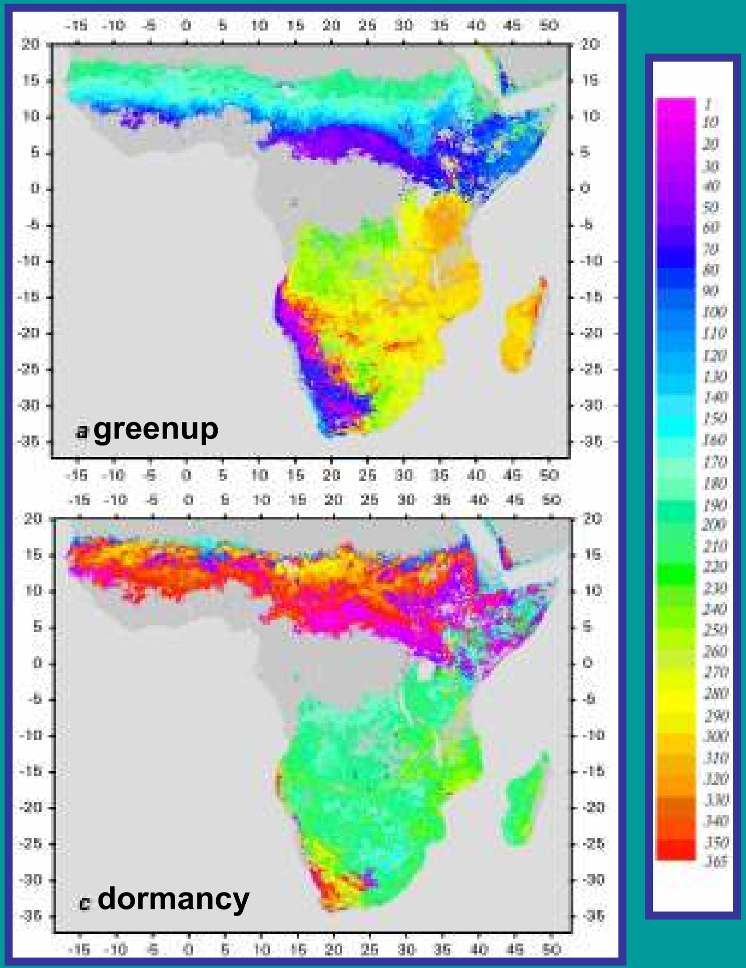
- Implication:
  – High latitude warming may have small effect on forests
  – Lower latitudes may have delayed delayed greenup!



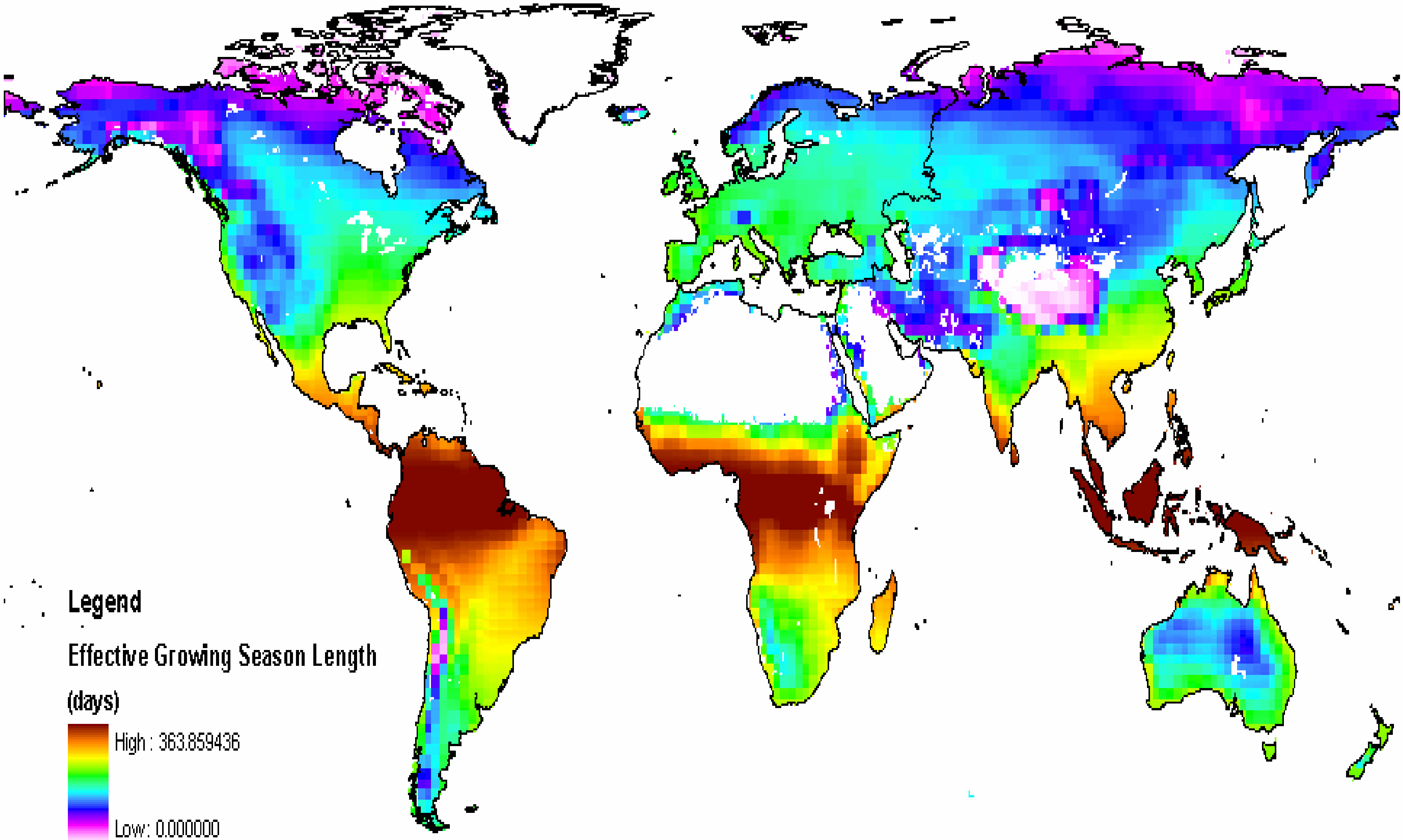
Precipitation-Driven Phenology in Africa

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



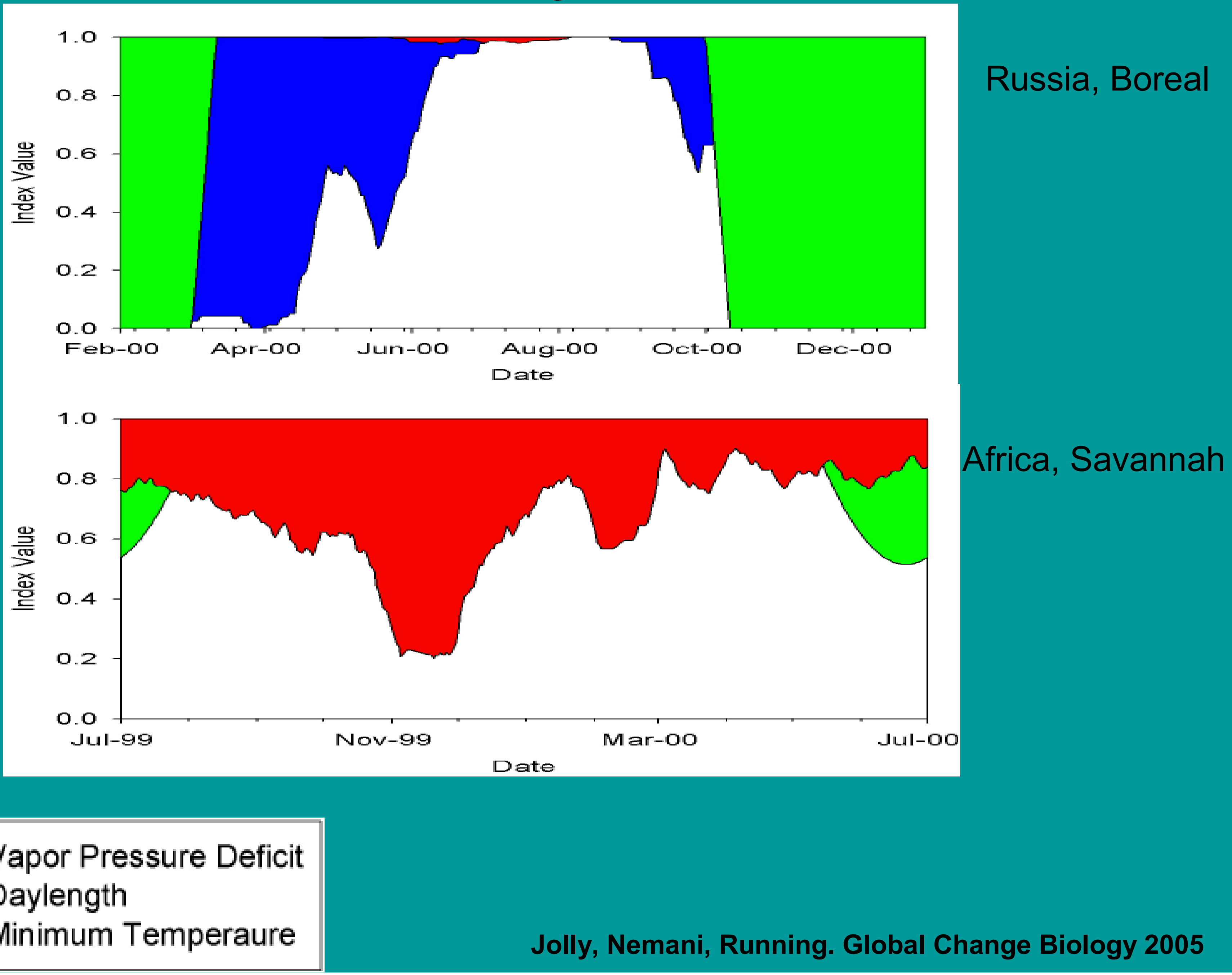


Global Effective Growing Season Length



Jolly, Nemani, Running. Global Change Biology 2005

Seasonal Growing Season Constraints



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*”

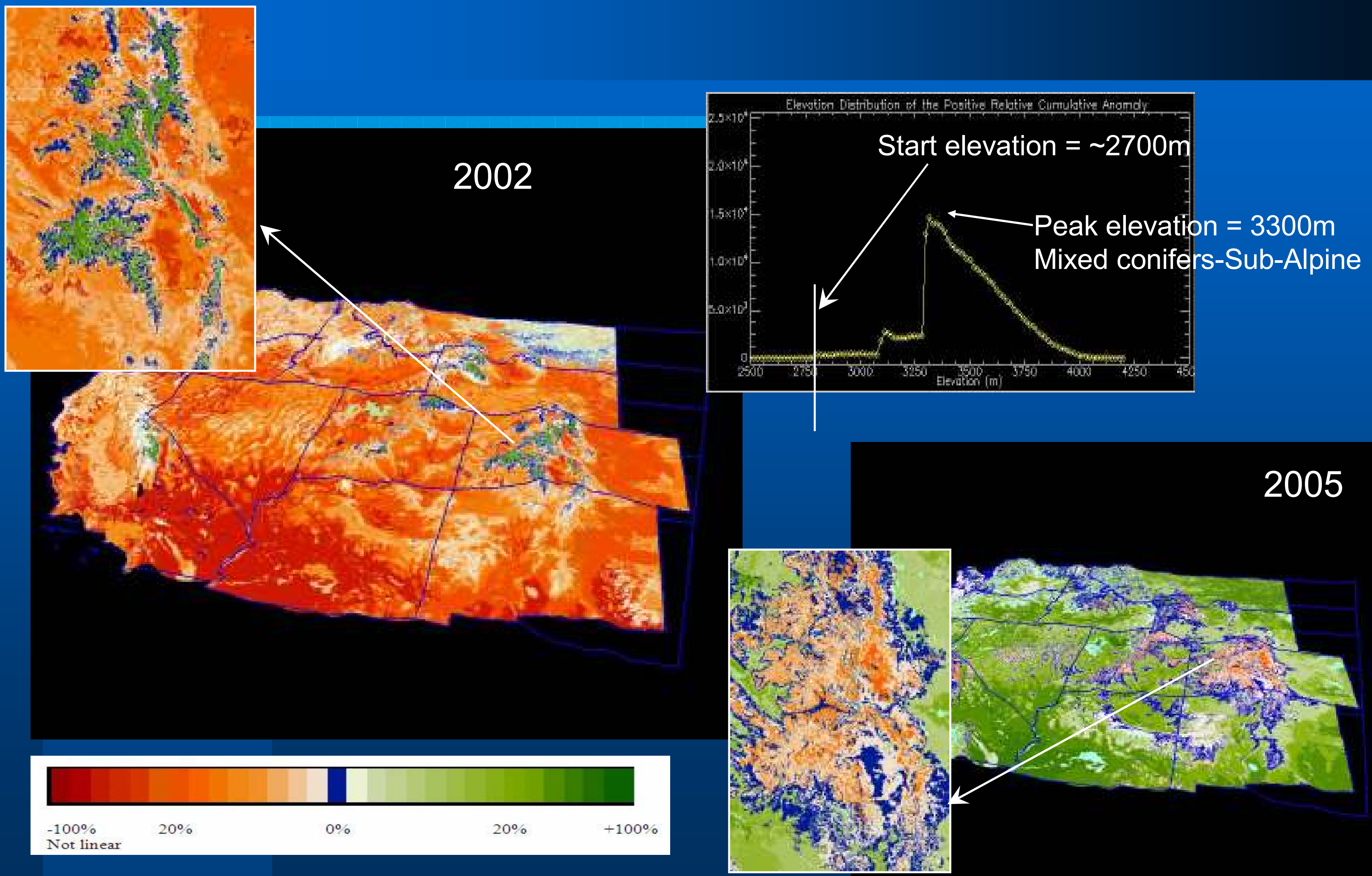
Kamel Didan, Alfredo Huete

TBRS Lab., SWES Dept.

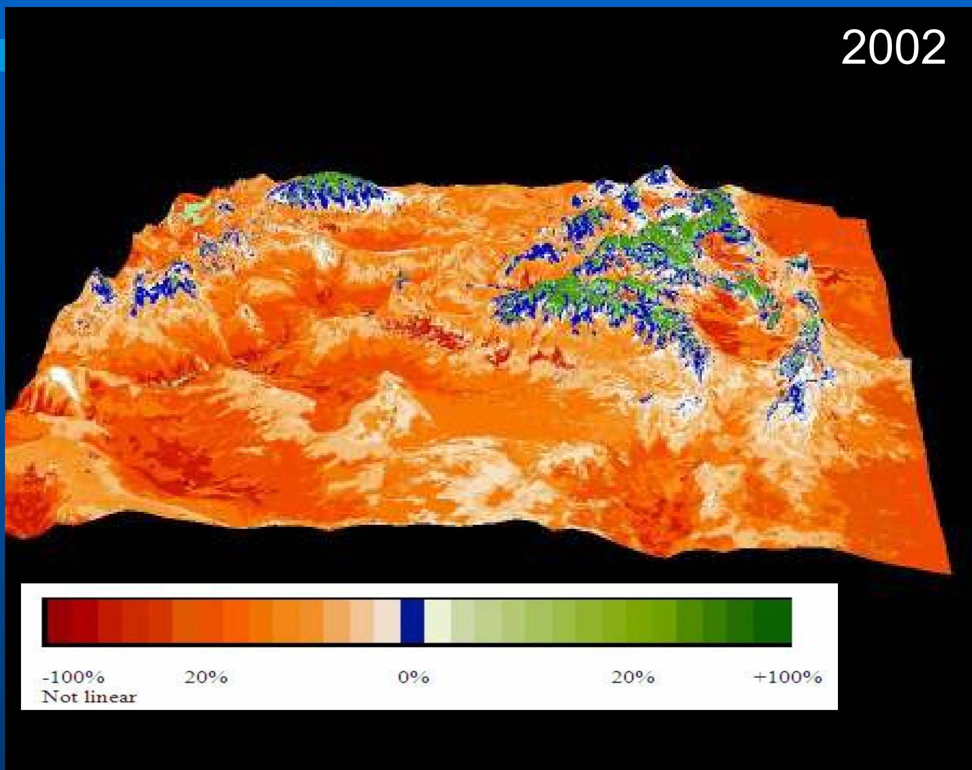
The University of Arizona

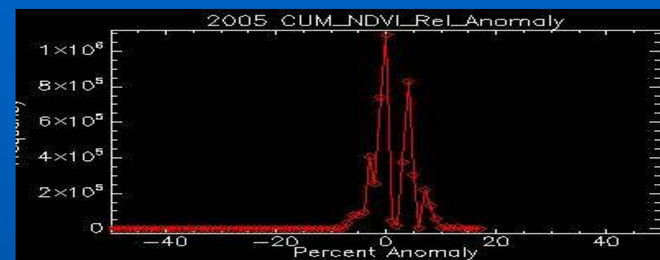
AGU Fall Meeting, 2005
San Francisco, CA

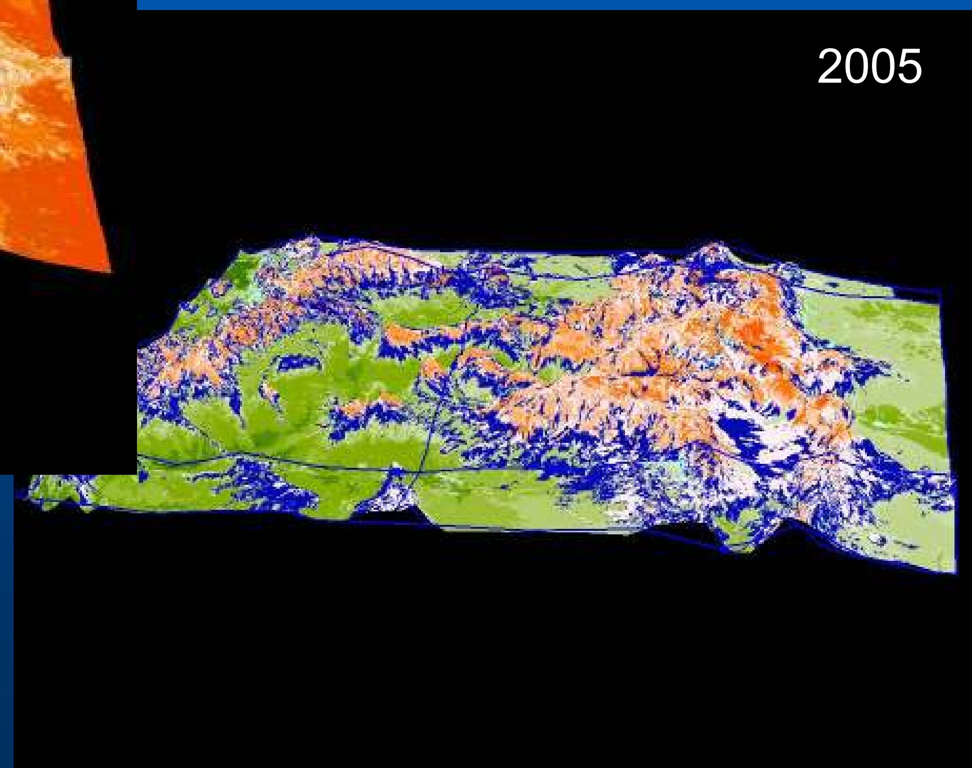
Cumulative VI anomaly



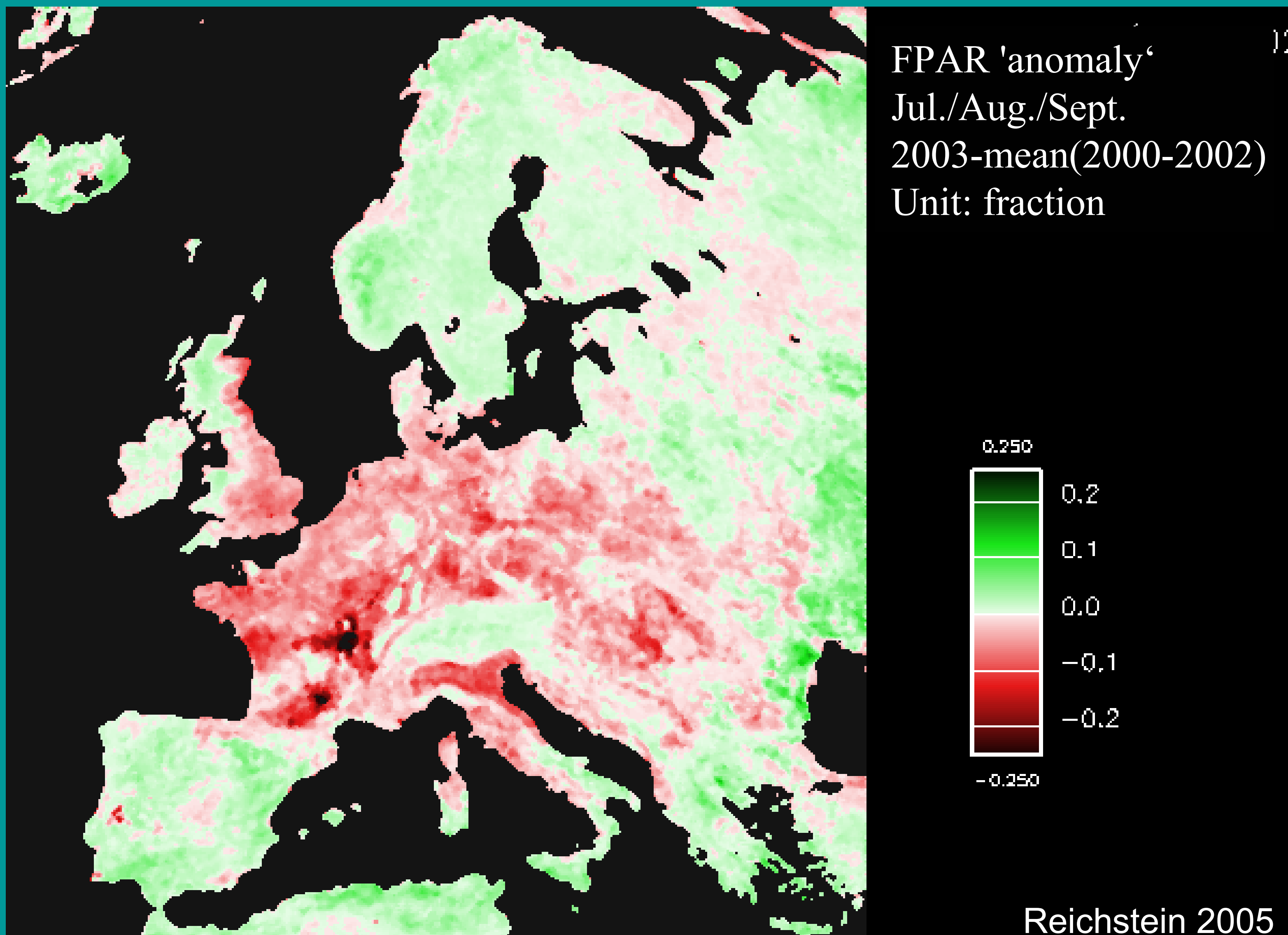
Cumulative VI anomaly (the Rockies)



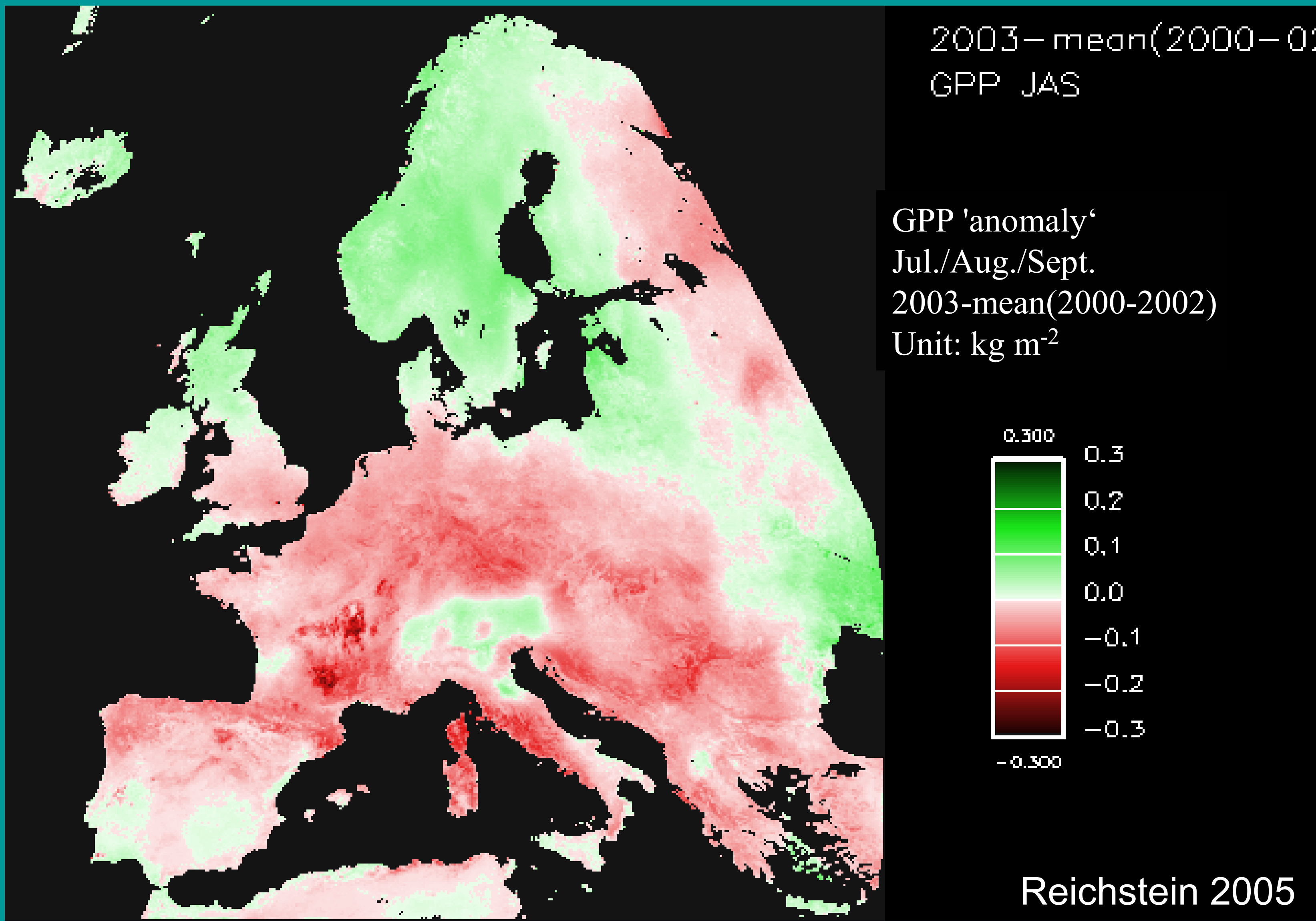




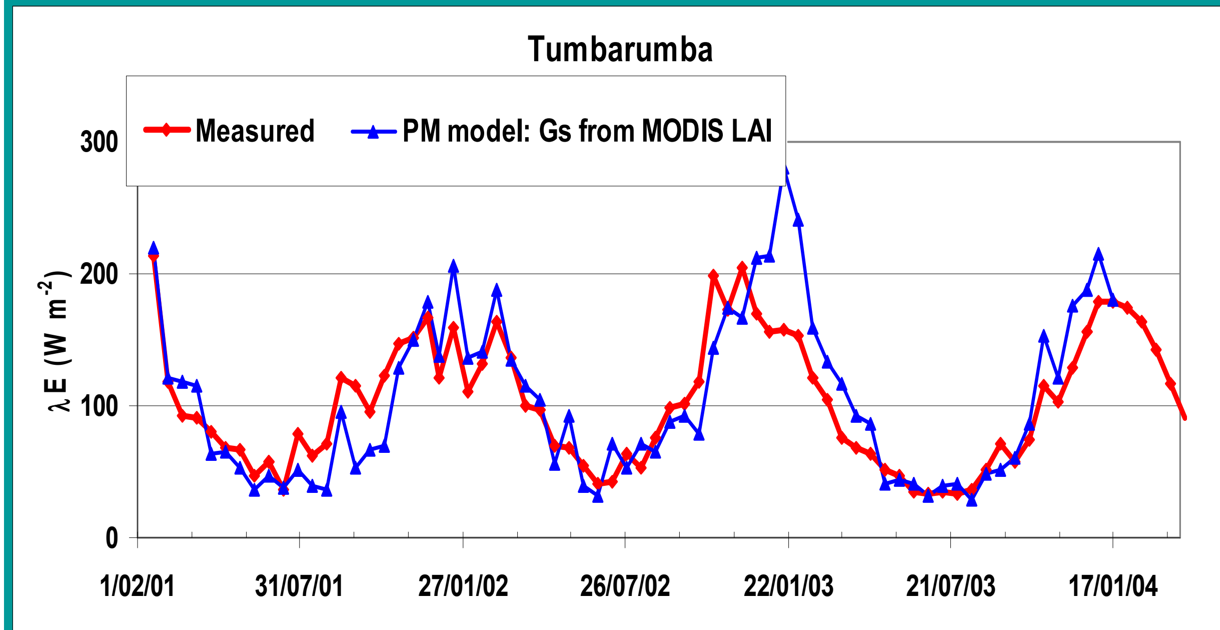
Summer 2003 fPAR 'anomaly' acc. to MOD15+

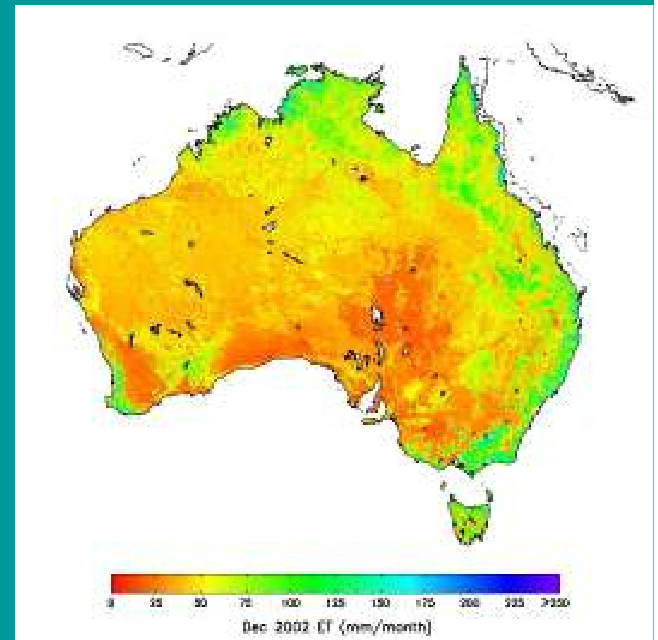


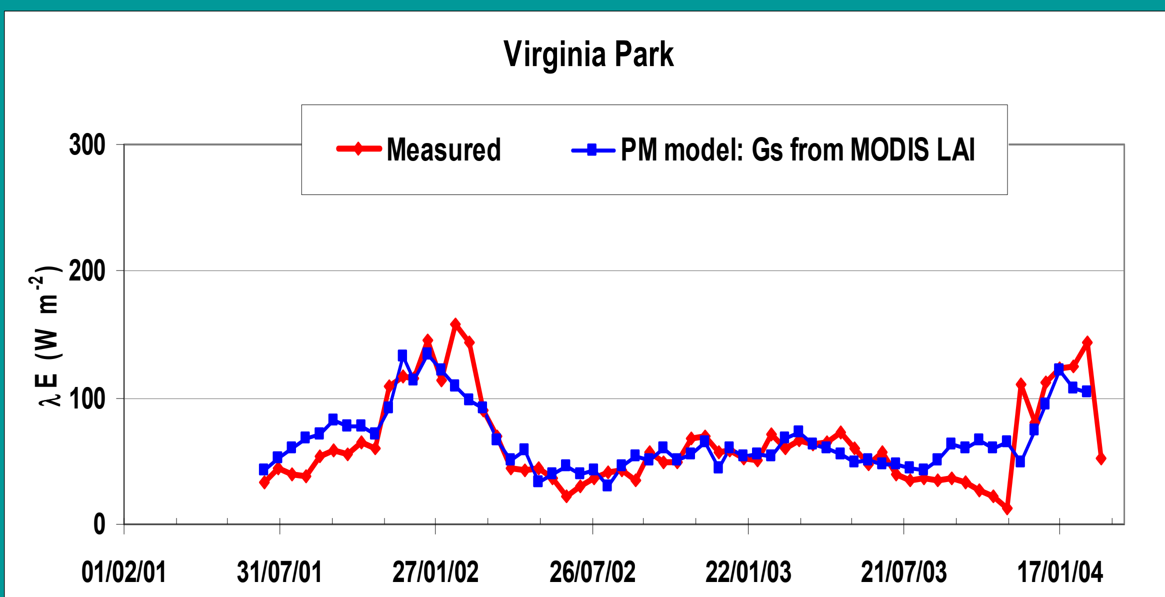
Summer 2003 GPP 'anomaly‘ acc. to MOD17+

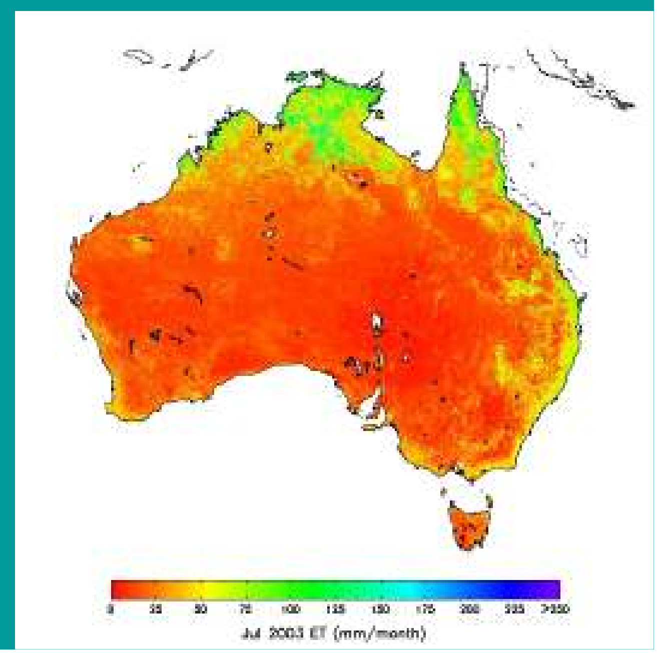


TEST OF NEW MOD 16 DAILY EVAPOTRANSPIRATION



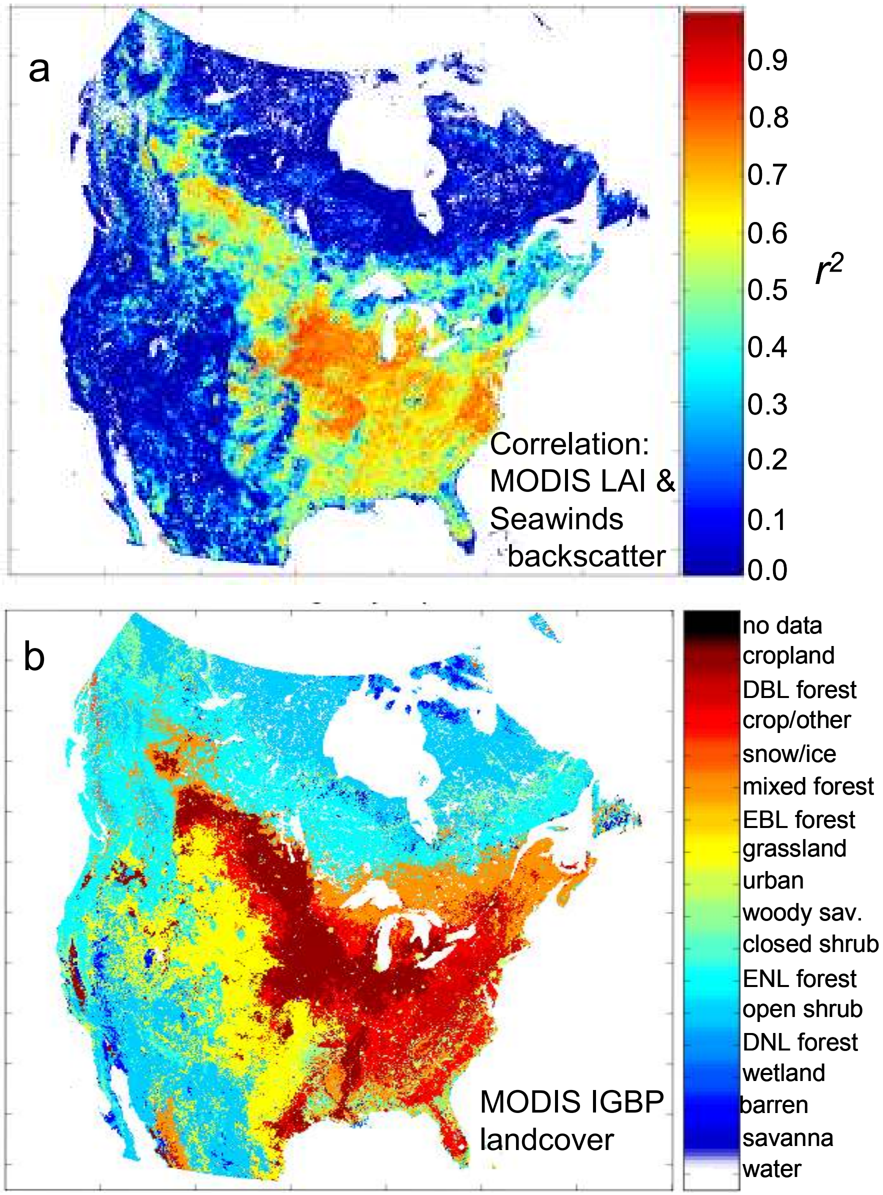






Cleugh et al 2006

Developing an Integrated MODIS-SeaWinds Phenology Measure

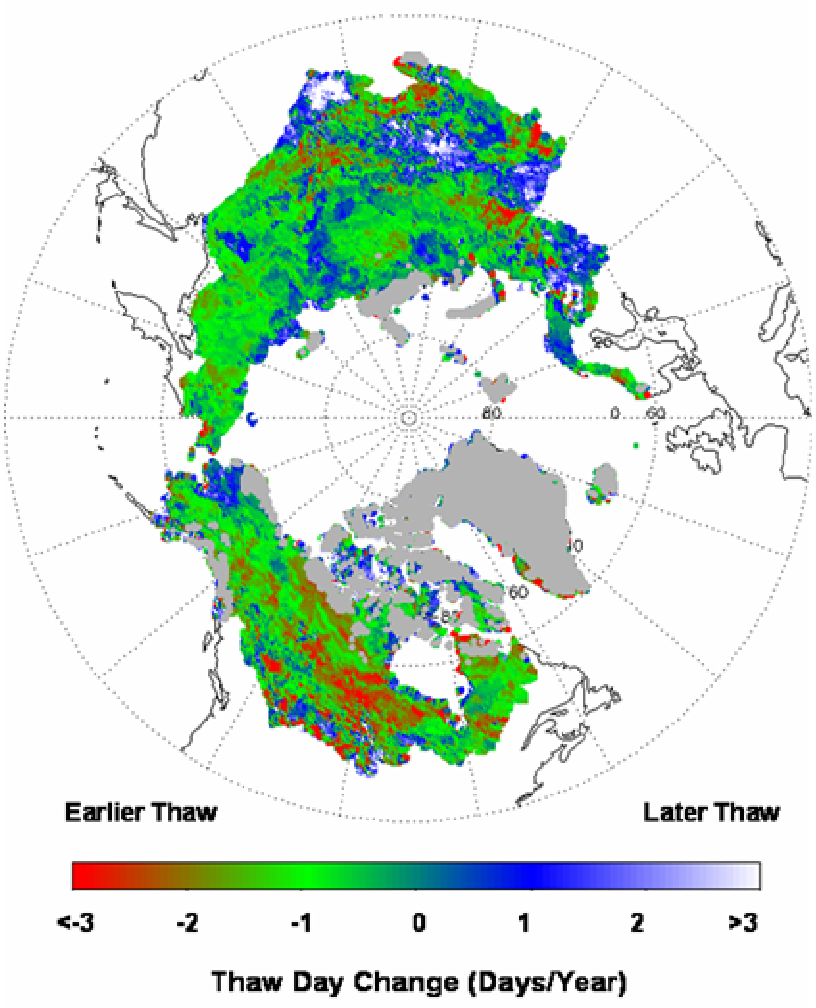


Map (a) of the statistical correspondence (r^2) between growing season 8-day composite MODIS LAI (MOD15A2) and SeaWinds Ku band backscatter for January 2000 through August 2002 for North America. The MODIS land cover product is also shown (b). Temporal variability in the SeaWinds Ku-band backscatter signal corresponds closely with seasonal variations in MODIS derived LAI for grassland and broadleaf deciduous forest biomes of North America. Statistical correspondence is lower where LAI seasonal variability is small (e.g., evergreen forests) and where biomass is low (arid and semiarid shrublands). **The combined information from MODIS and SeaWinds may provide an improved measure of vegetation phenology that is less constrained by atmospheric aerosol contamination (e.g., clouds, smoke) and solar illumination effects.**

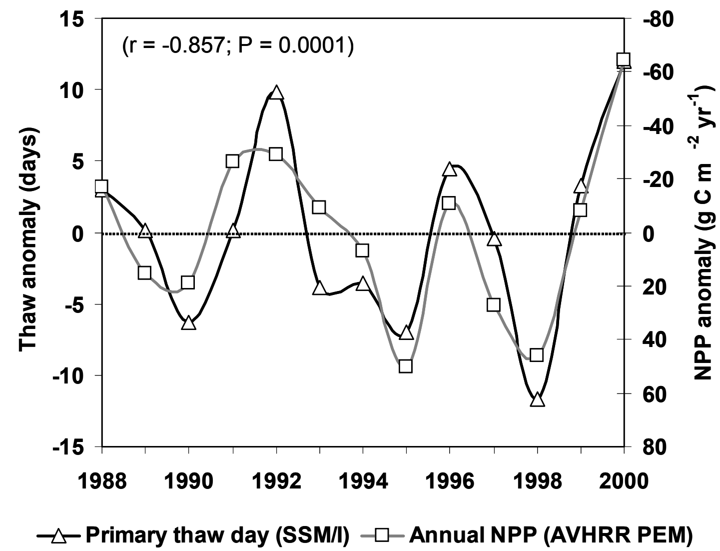
Source: Frolking, S., T. Milliman, K.C. McDonald, J. Kimball, M. Zhao, and M. Fahnestock, 2006. *J. Geophys. Res.* (In press)

Spring Thaw Impacts to Boreal-Arctic NPP

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



Sping thaw vs NPP (MOD17A2)

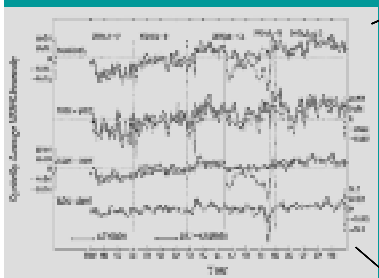


Map (**at left**) of the SSM/I derived trend in the timing of spring thaw for the pan-Arctic basin and Alaska, excluding non-vegetated areas (in grey). The SSM/I thaw signal coincides with the seasonal relaxation of low temperature constraints to photosynthesis and the onset of the growing season at 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.

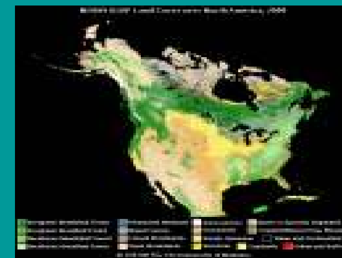
Source: Kimball, J.S., K.C. McDonald and M. Zhao, 2005. *Earth Interactions* (In-review)

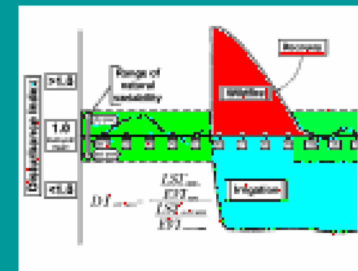
Terrestrial Carbon Monitor

SATELLITE DATA

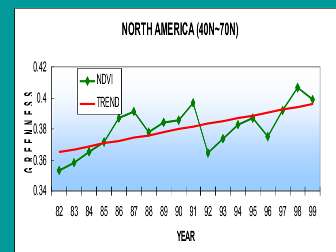


LANDCOVER

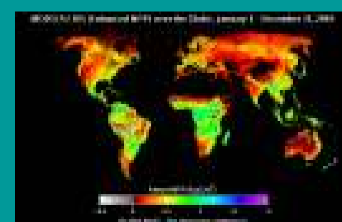




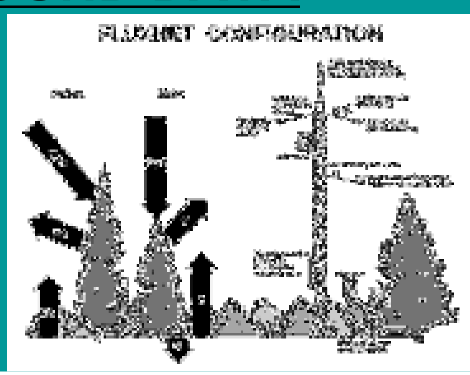
GROWING SEASON

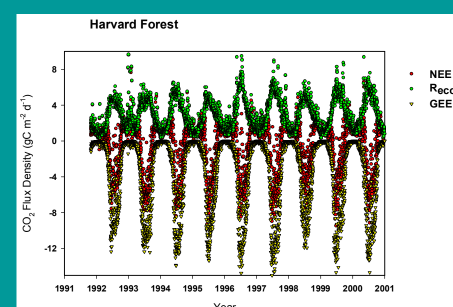


PRIMARY PRODUCTION

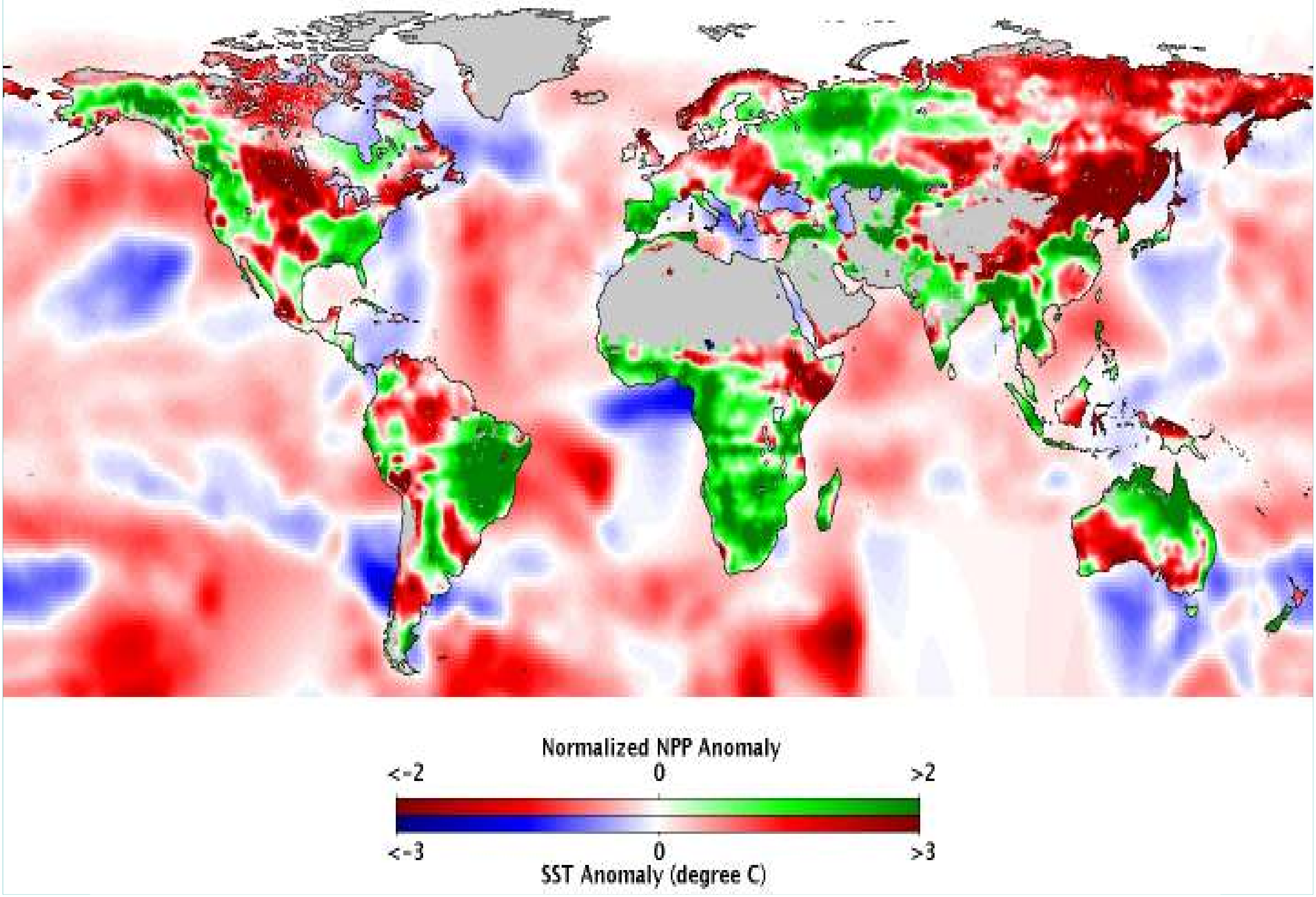


GROUND DATA

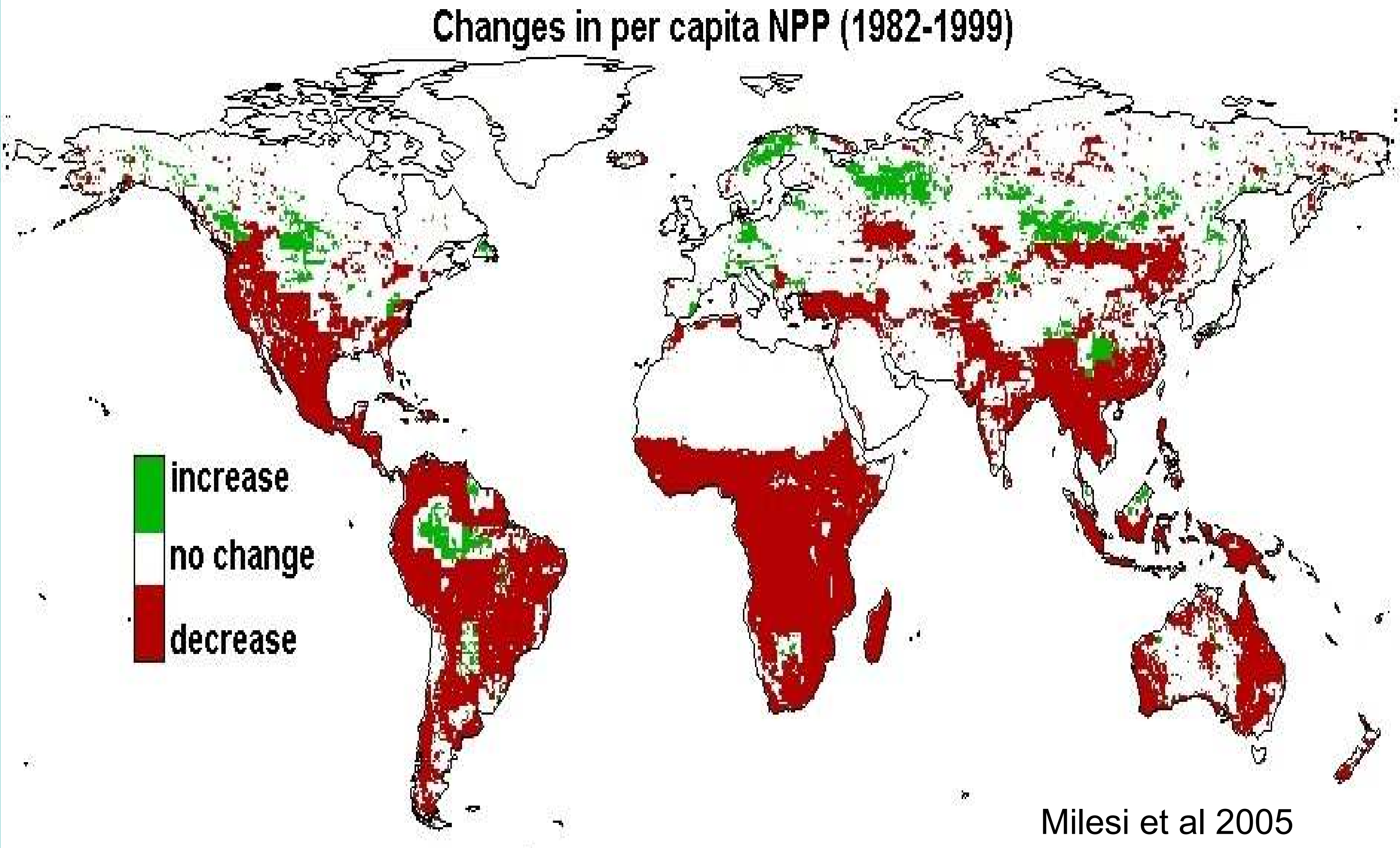




JUNE 2004 MONTHLY NPP ANOMALY



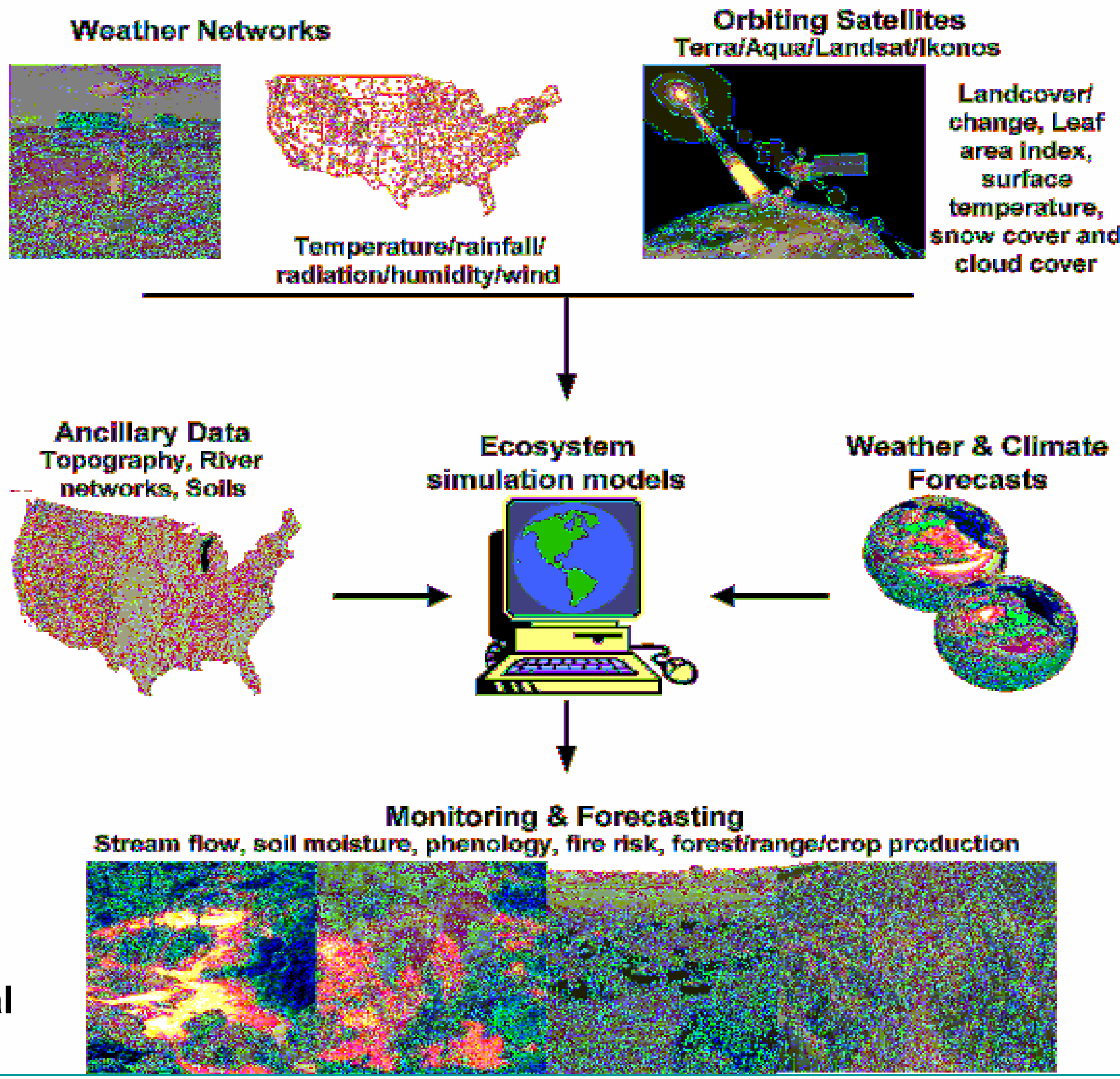
The increase in NPP is very modest compared to population growth



Milesi et al 2005

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

Terrestrial Observation and Prediction System



Nemani et al 2005