The MODIS Vegetation Index Products

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The University of Arizona

MODIS Science Team Meeting
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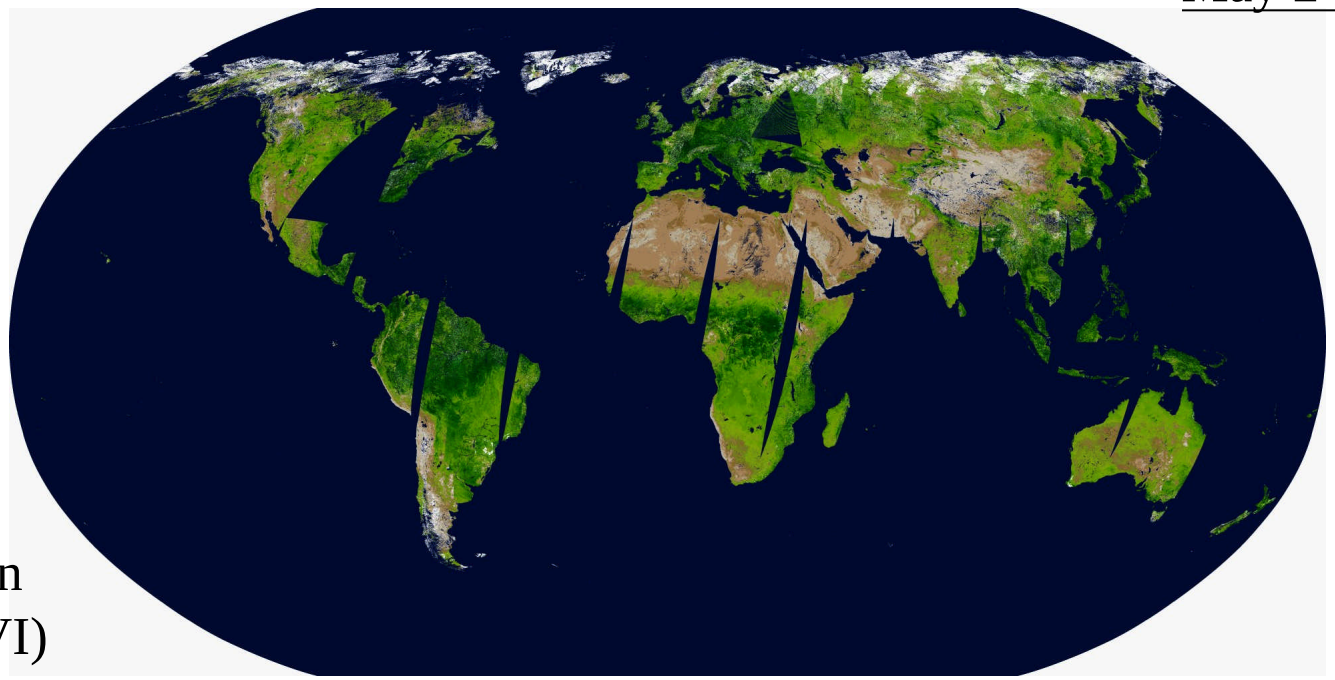
MODIS Standard Vegetation Index Products

- The MODIS Products include 2 Vegetation Indices (NDVI, EVI) and QA produced at 16-day and monthly intervals at 250m/ 500m, 1km, and 25km resolutions
- The narrower ‘red’ MODIS band provides increased chlorophyll sensitivity (band 1),
- The narrower ‘NIR’ MODIS band avoids water vapor absorption (band 2)
- Use of the blue channel in the EVI provides aerosol resistance

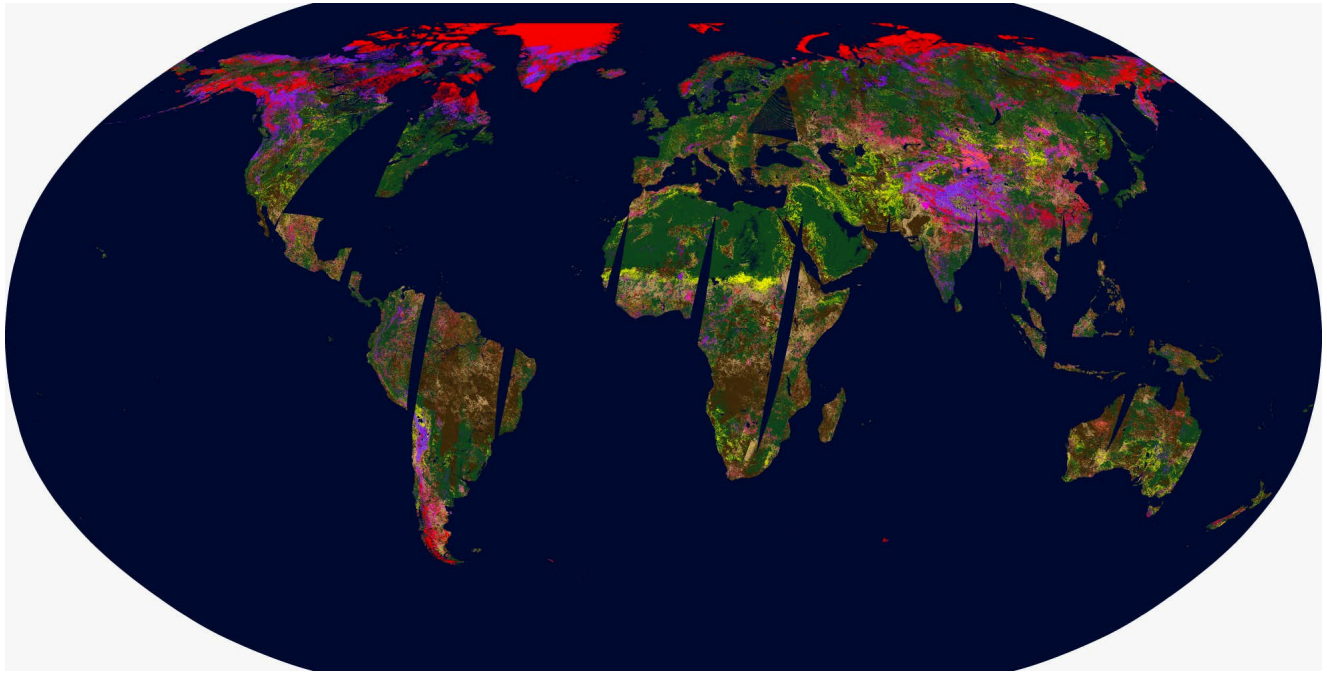
MOD13A2 /1 km 16 days

May 24 – June 8, 2000

Enhanced Vegetation Index (EVI)



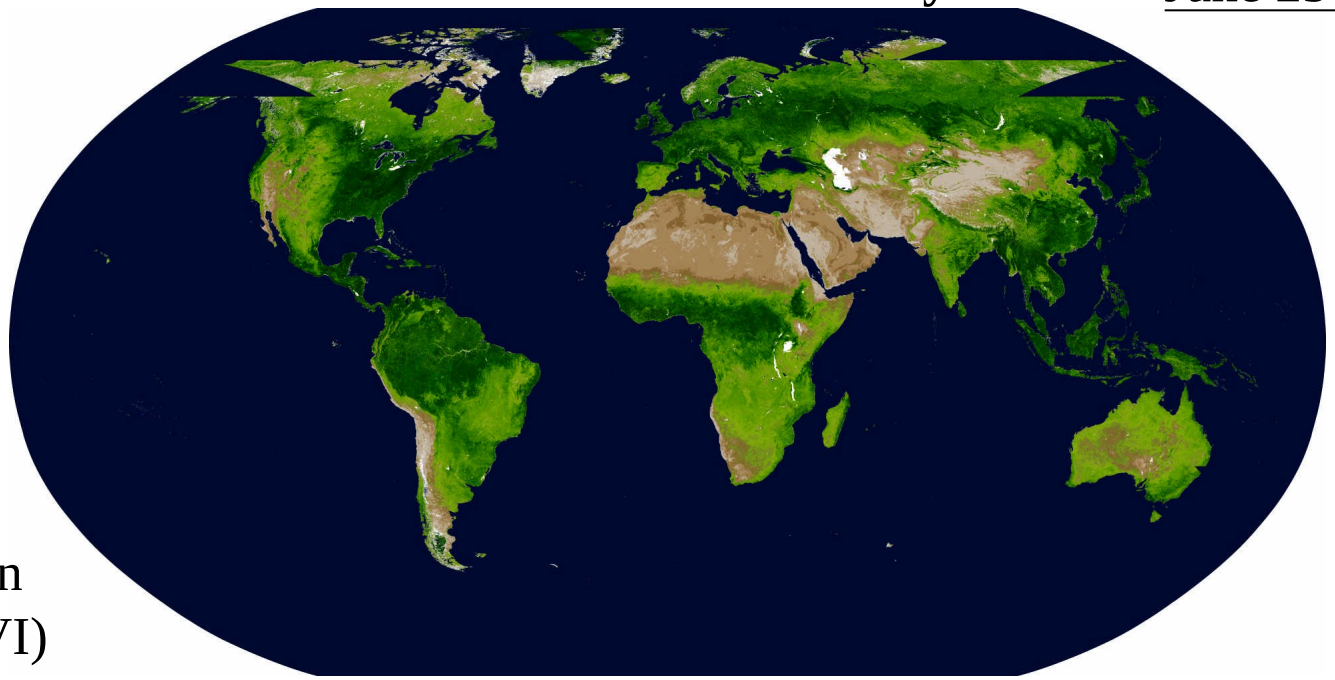
EVI Quality



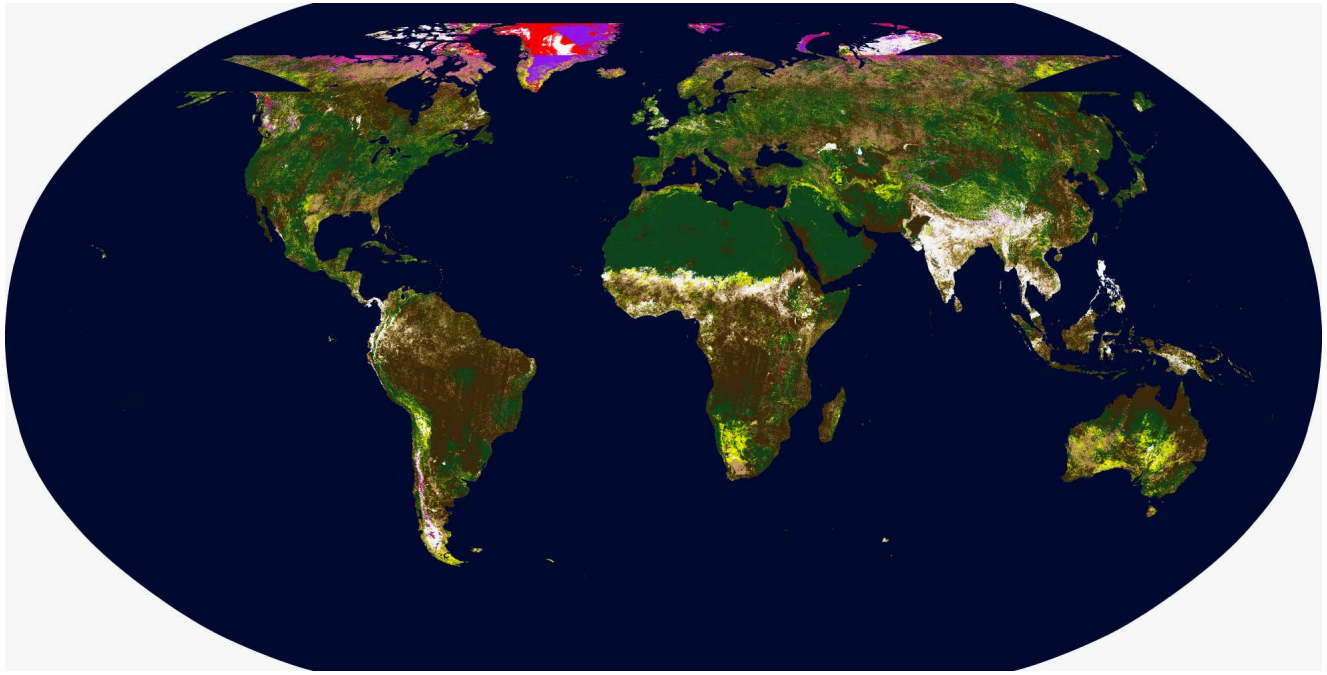
MOD13A2 1 km 16 days

June 25 – July 10, 2000

Enhanced Vegetation Index (EVI)



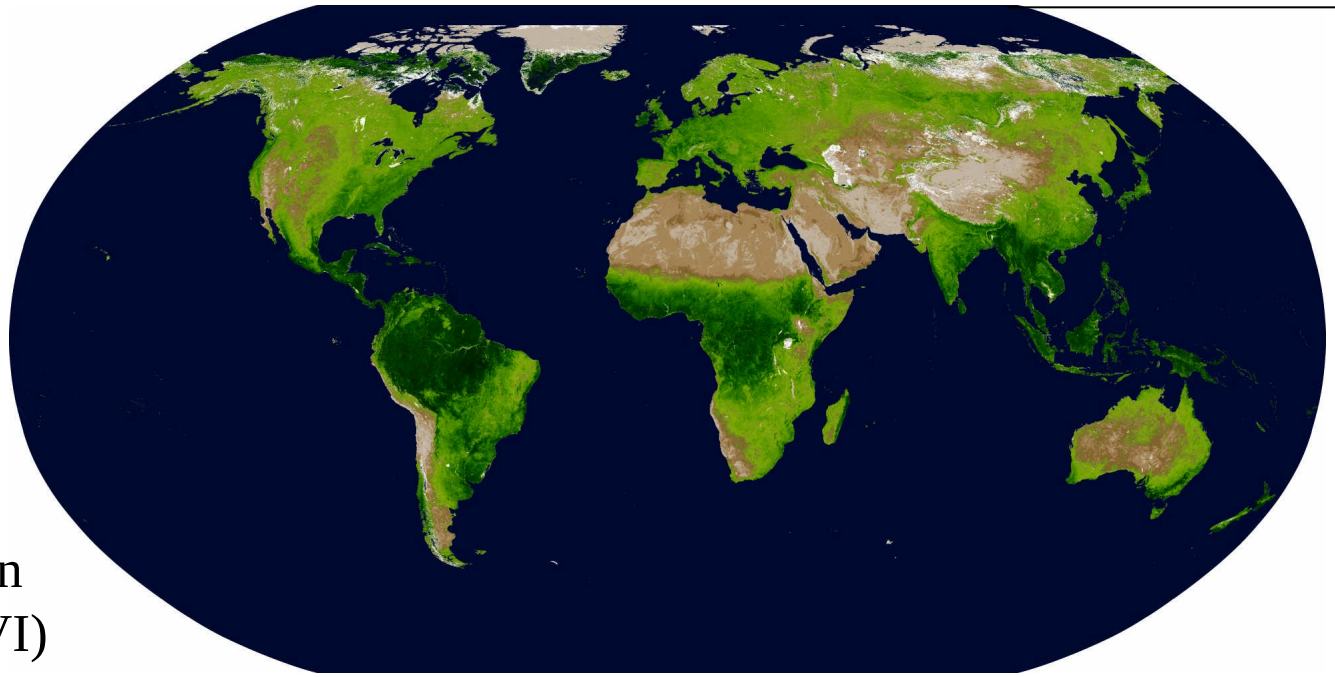
EVI Quality



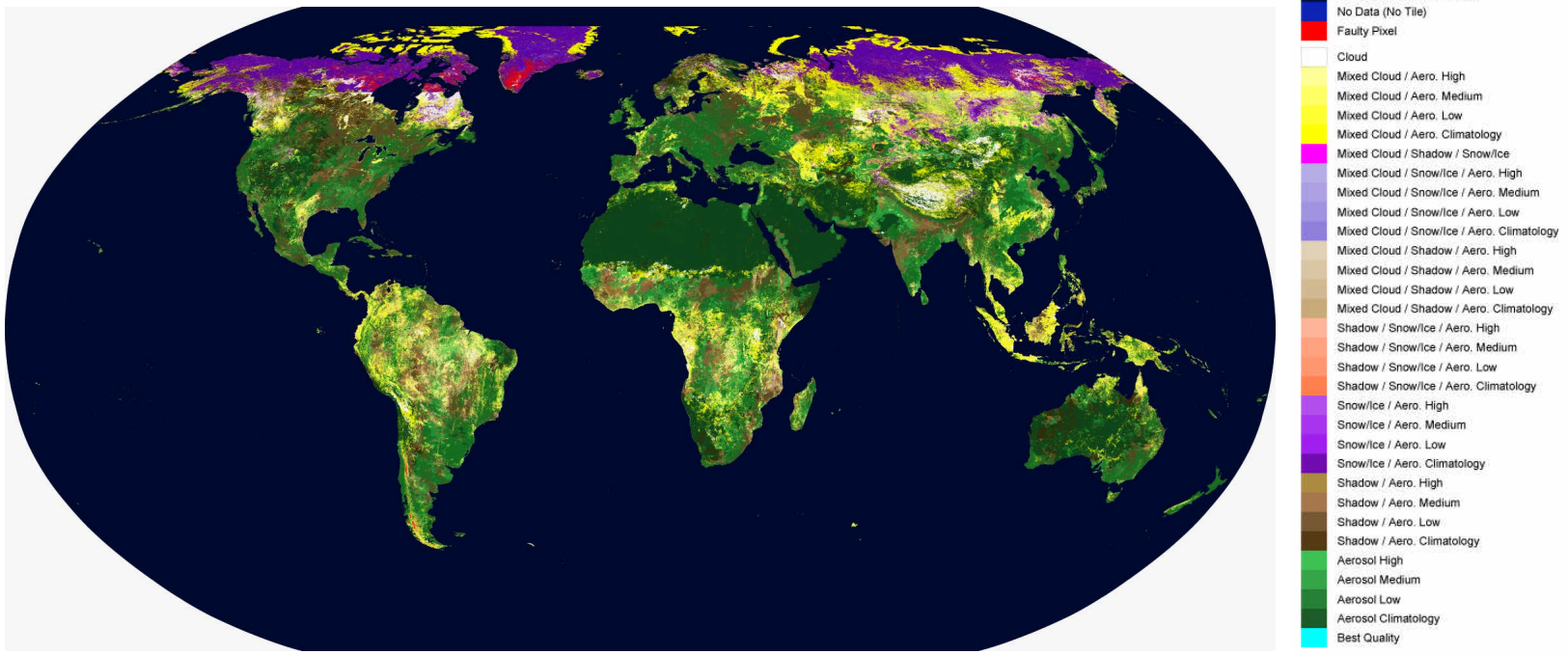
MOD13A2 1 km 16 days

October 15 – October 30, 2000

Enhanced Vegetation Index (EVI)

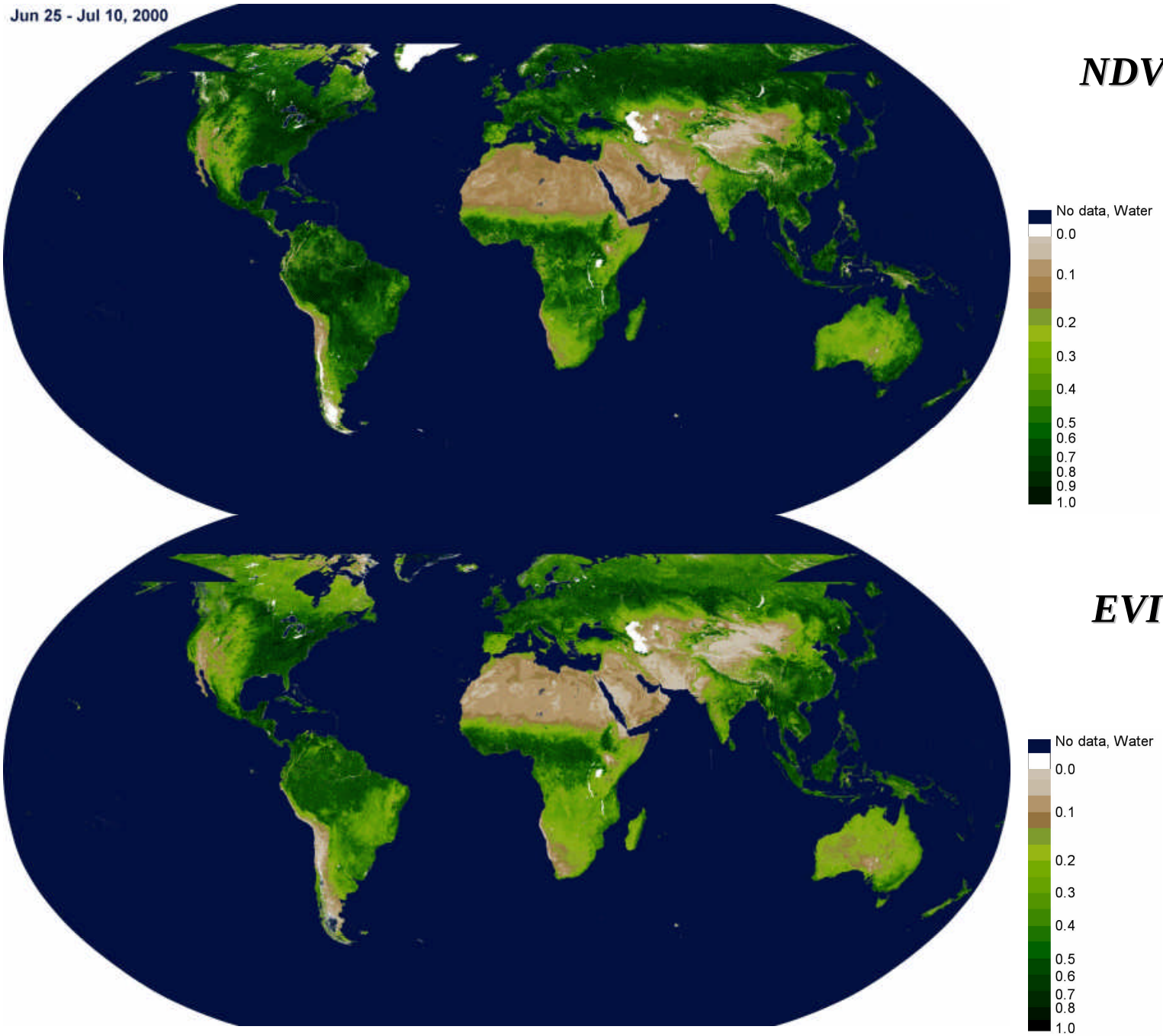


EVI Quality

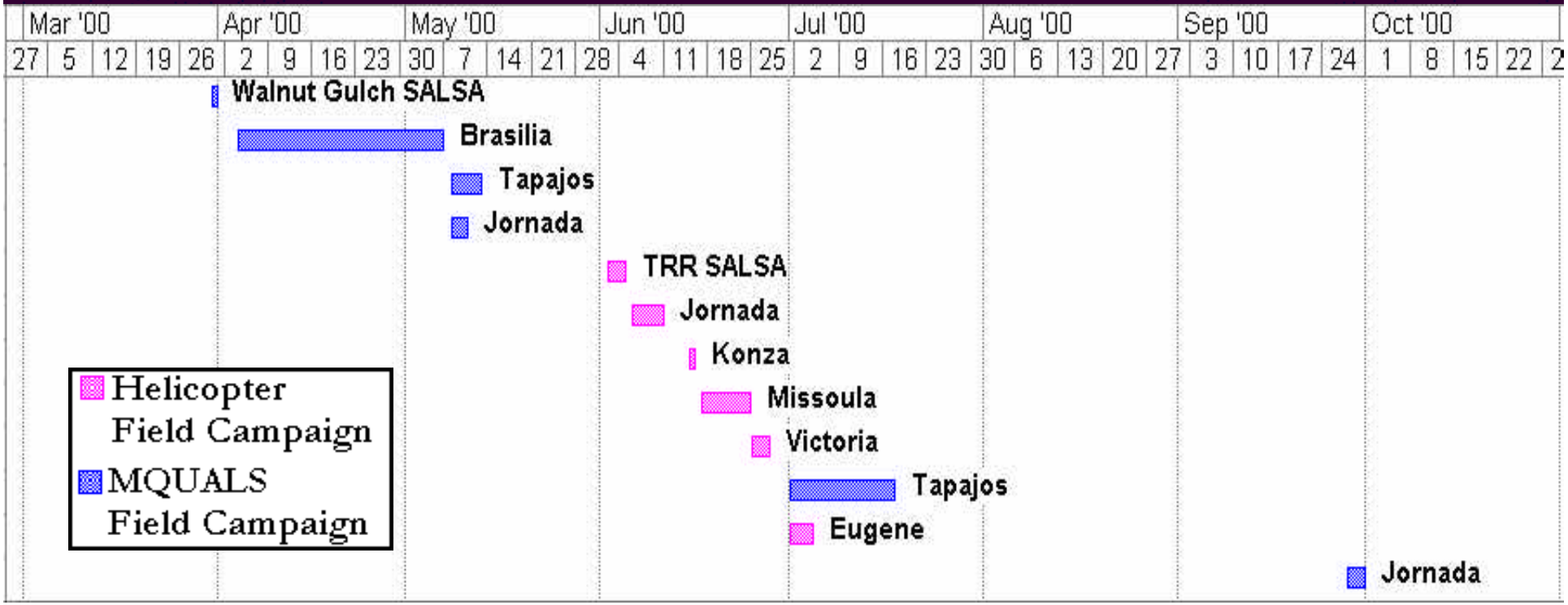


MOD13A1 500 m 16 days

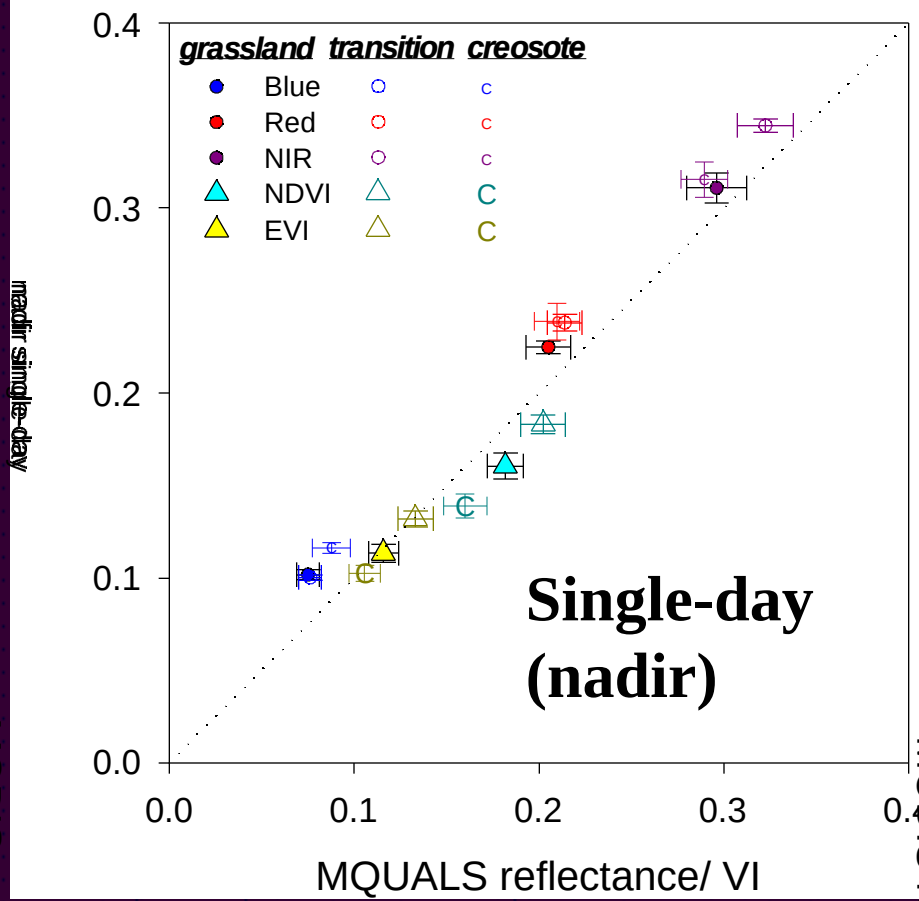
(June 25 – October 14, 2000)

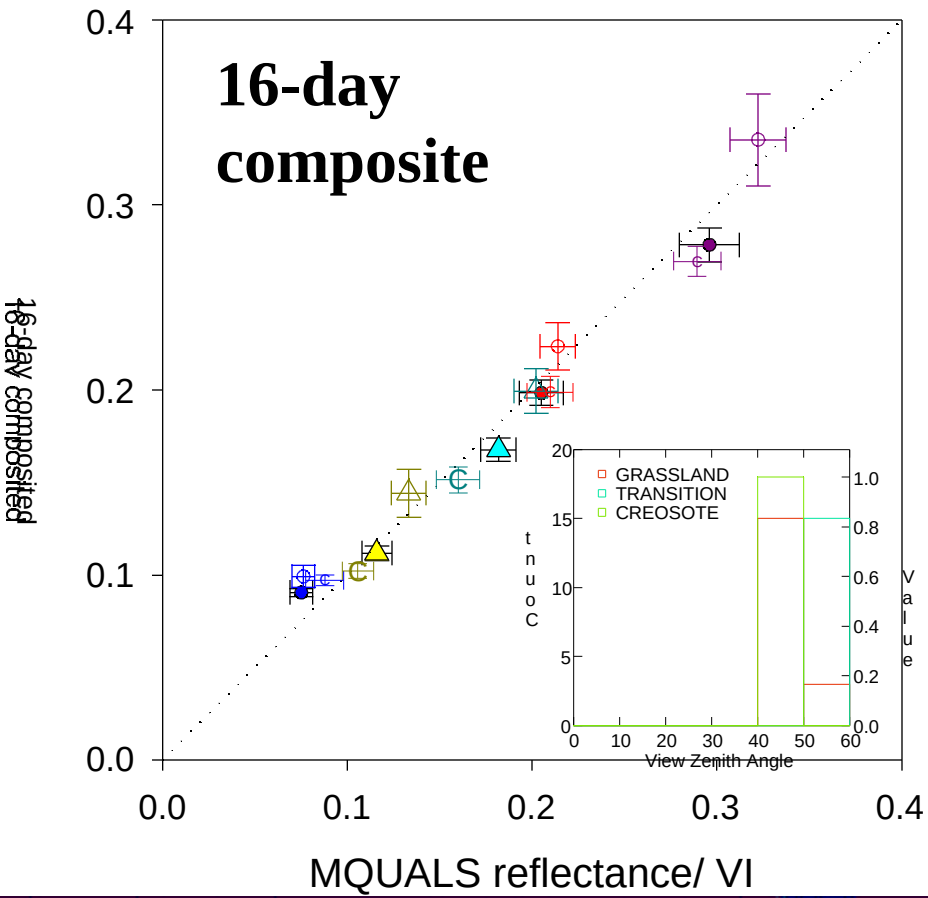


2000 Data Collection

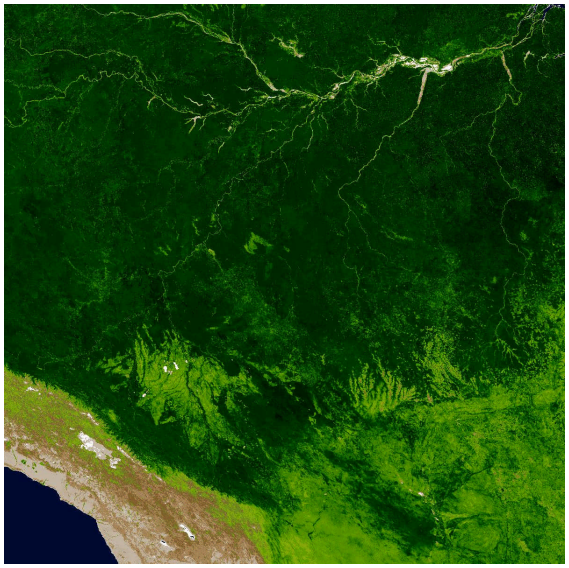


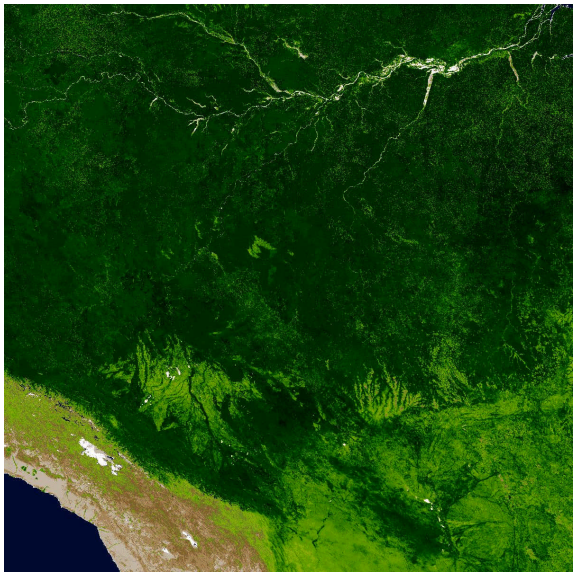
MQUALS vs. MODIS
La Jornada, NM

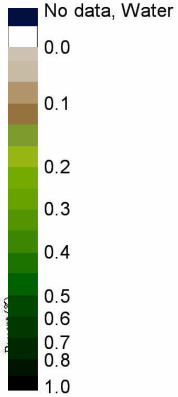




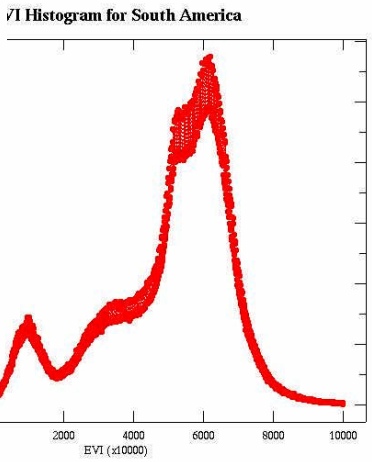
EVI at different resolutions over South America (Forest - Cerrado - Desert)



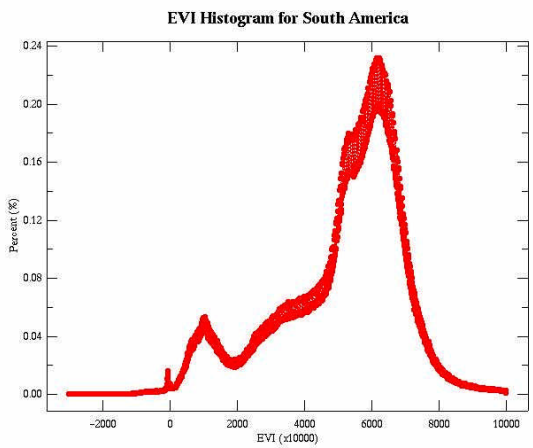




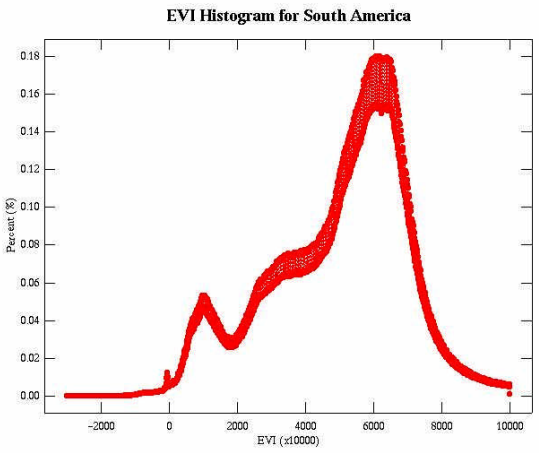
1km



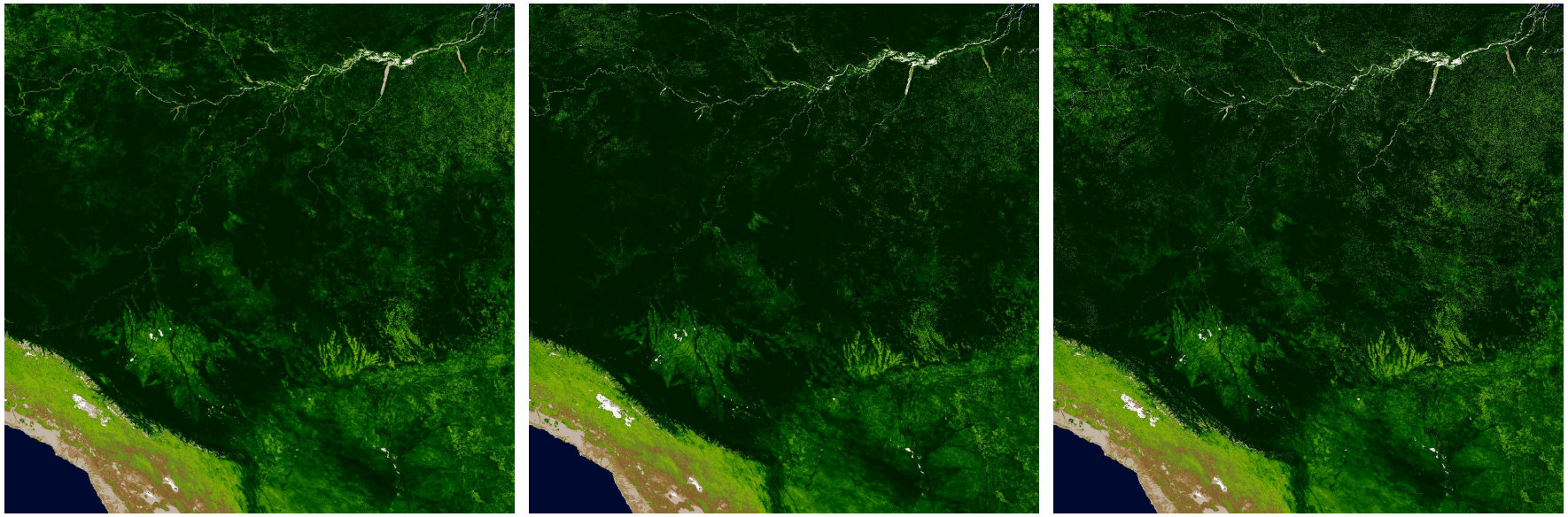
500m

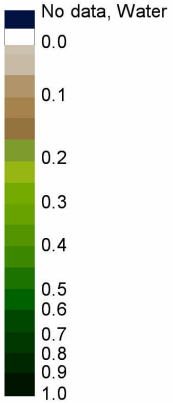


250m



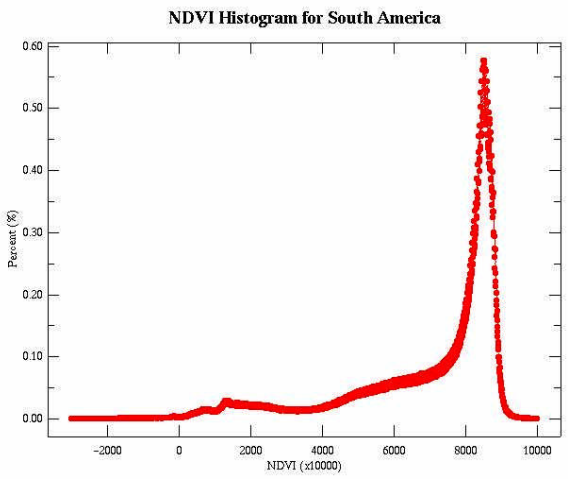
NDVI at different resolutions over South America



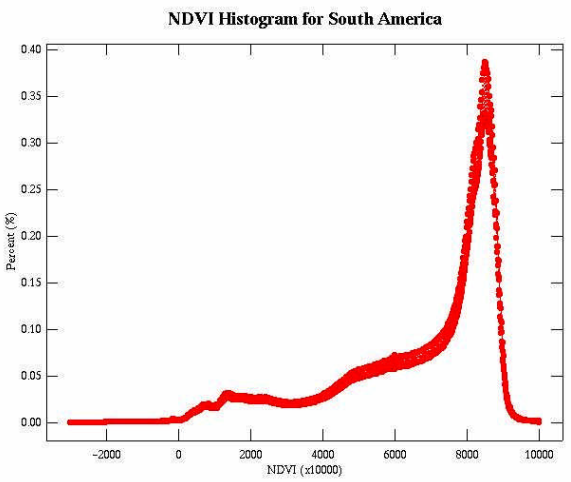


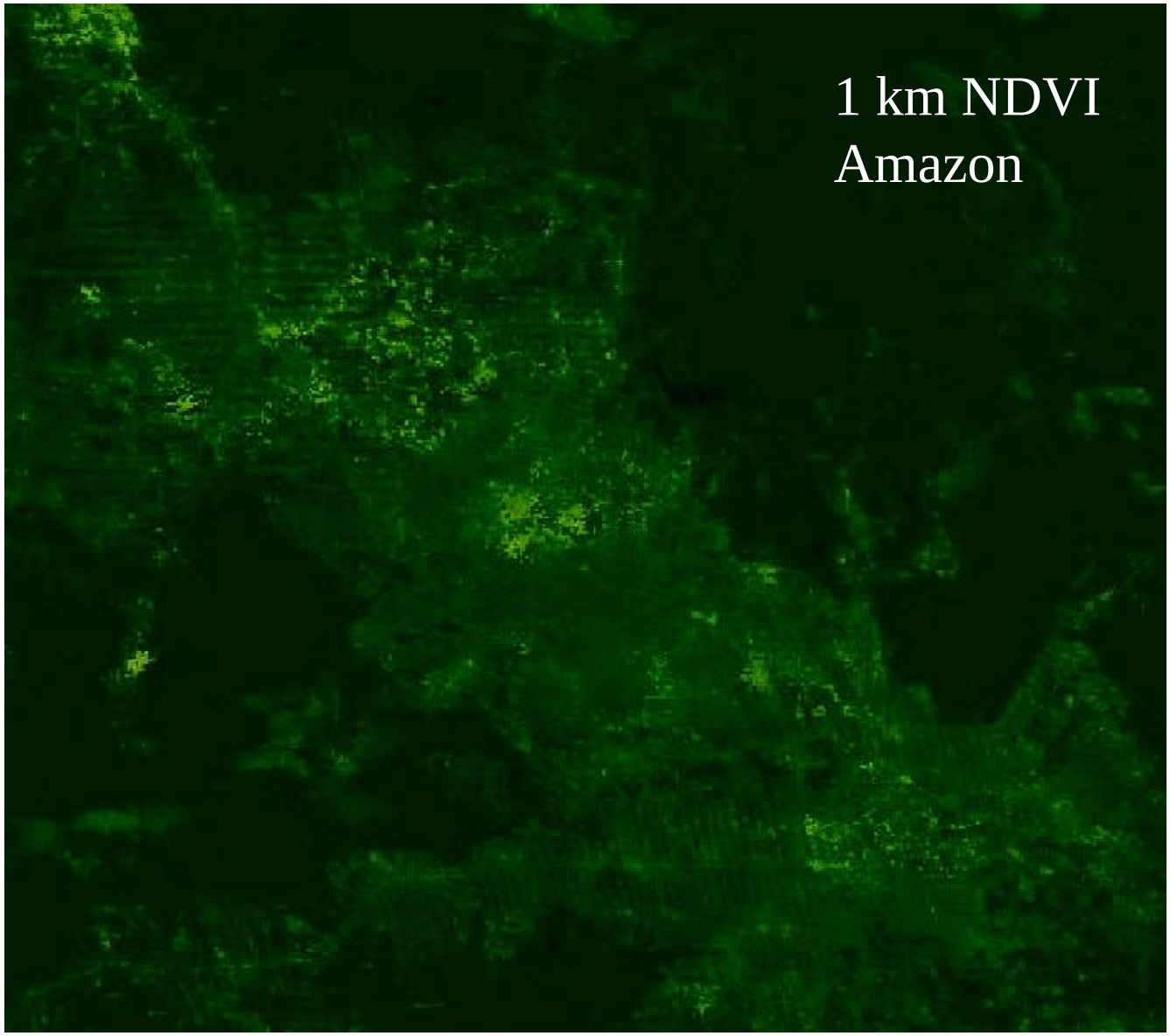
1km

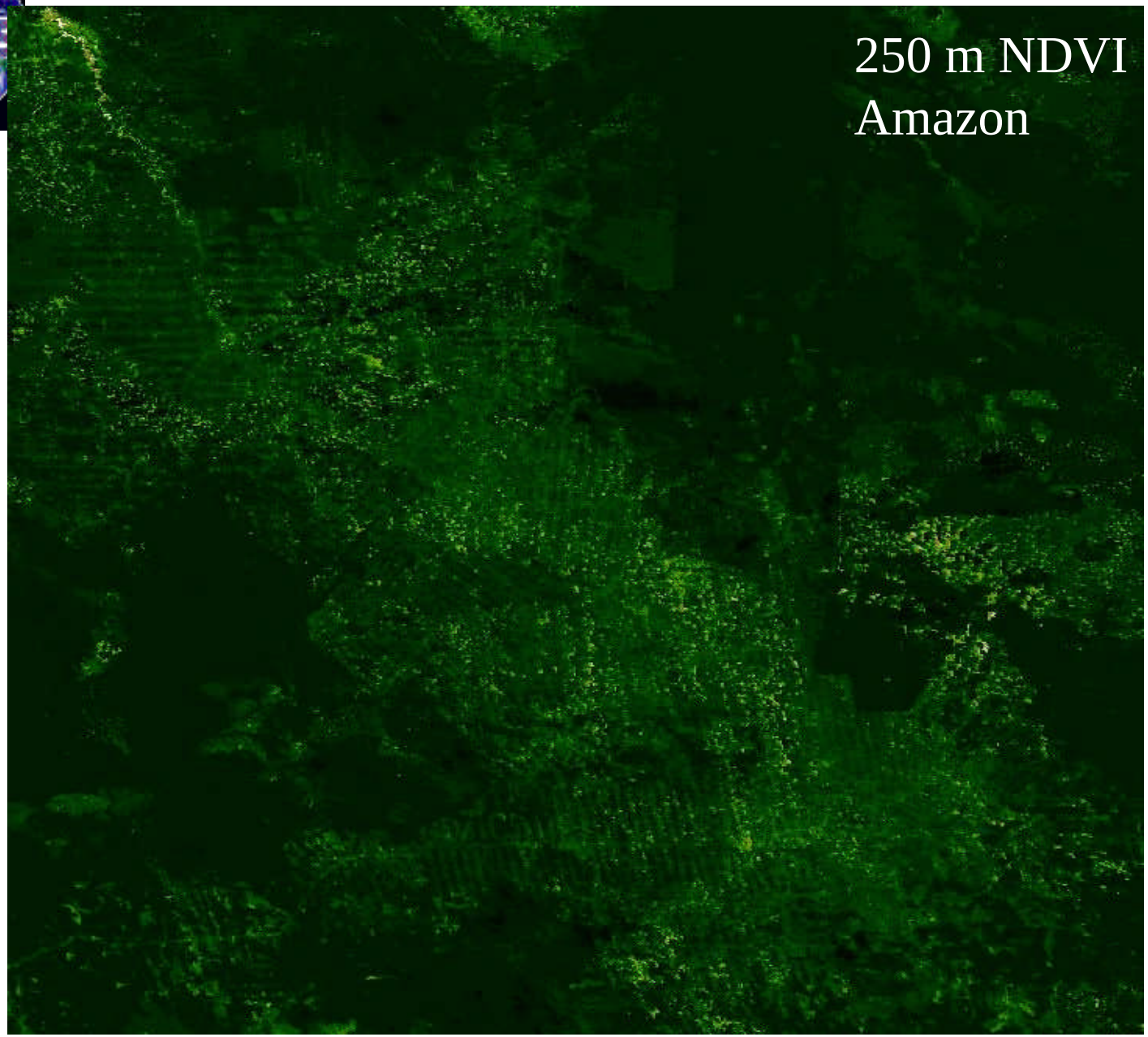
500m

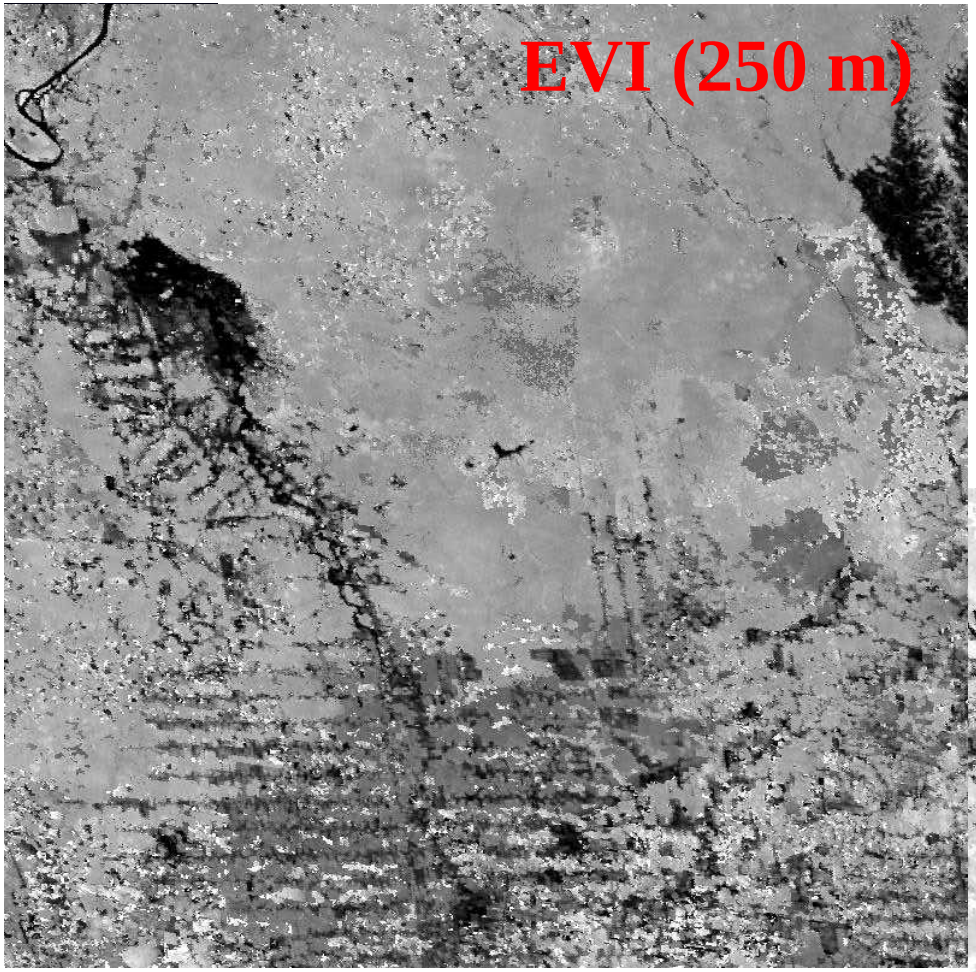


250m

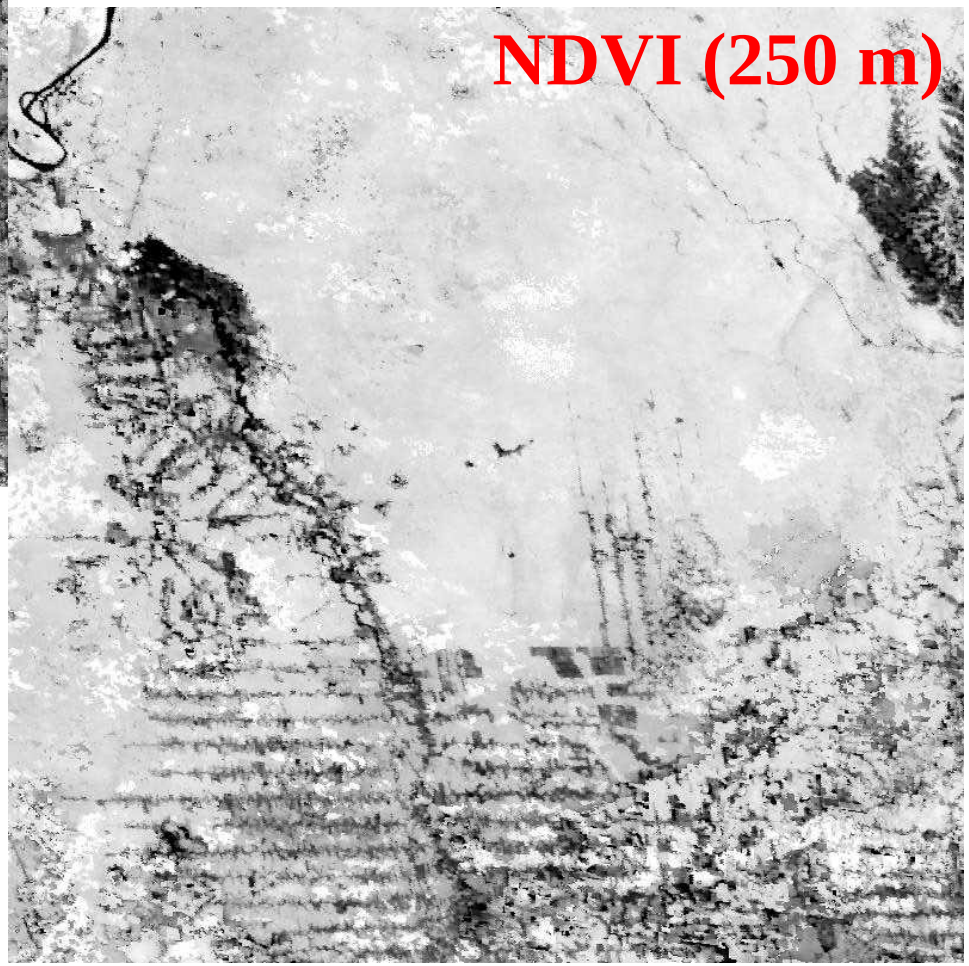



1 km NDVI
Amazon


250 m NDVI
Amazon



Land-Use Discrimination in the Amazon

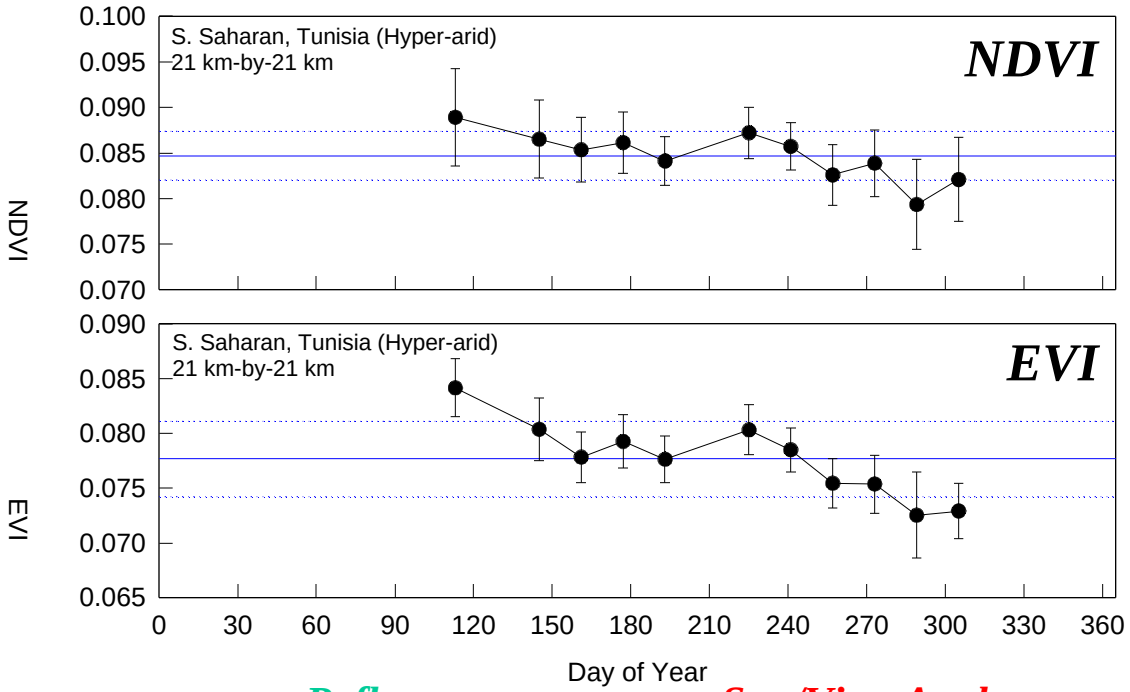


- **What are the consequences of land cover and land use change for the sustainability of ecosystems and economic productivity?**

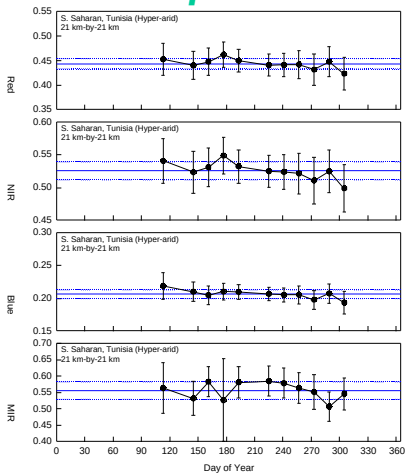
QA: Long Term Stability (Baseline) Monitoring

South Saharan Site, Tunisia

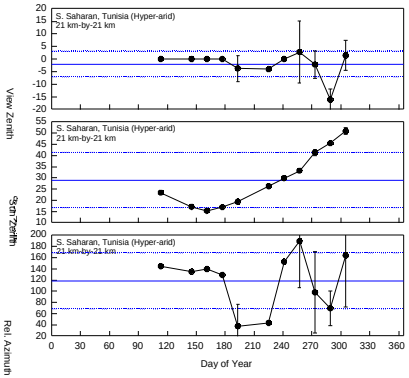
1 km 16 days EVI
Aug 28 – Sep. 12, 2000



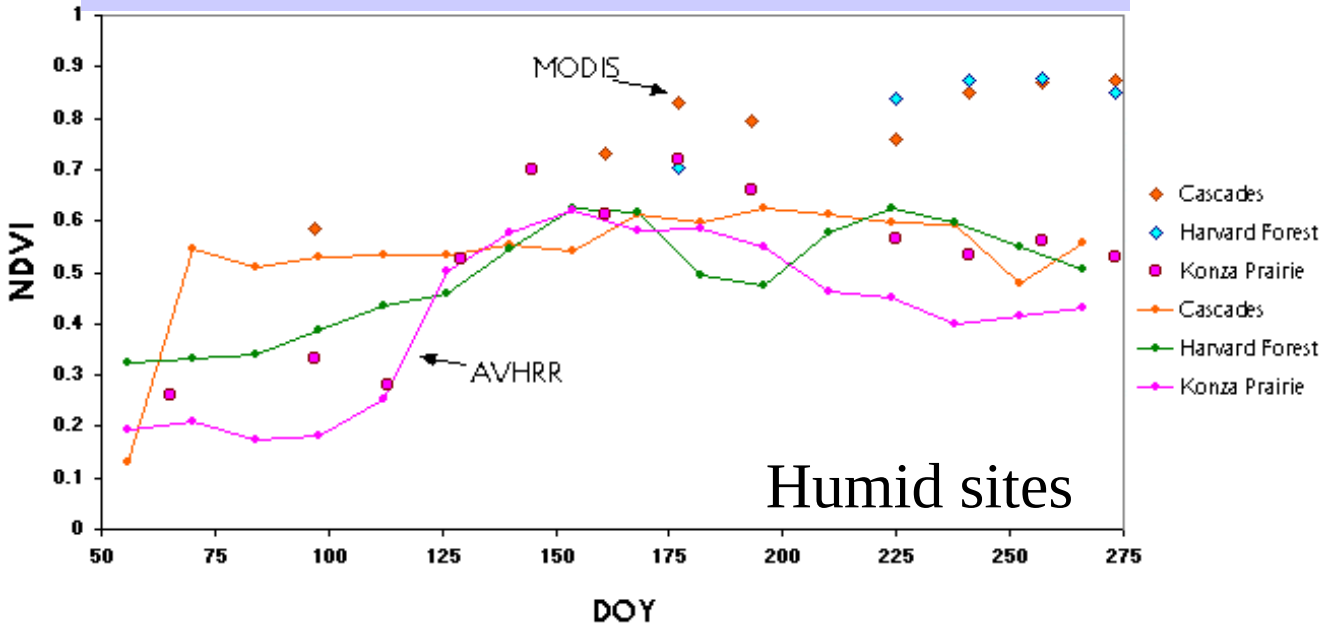
Reflectance

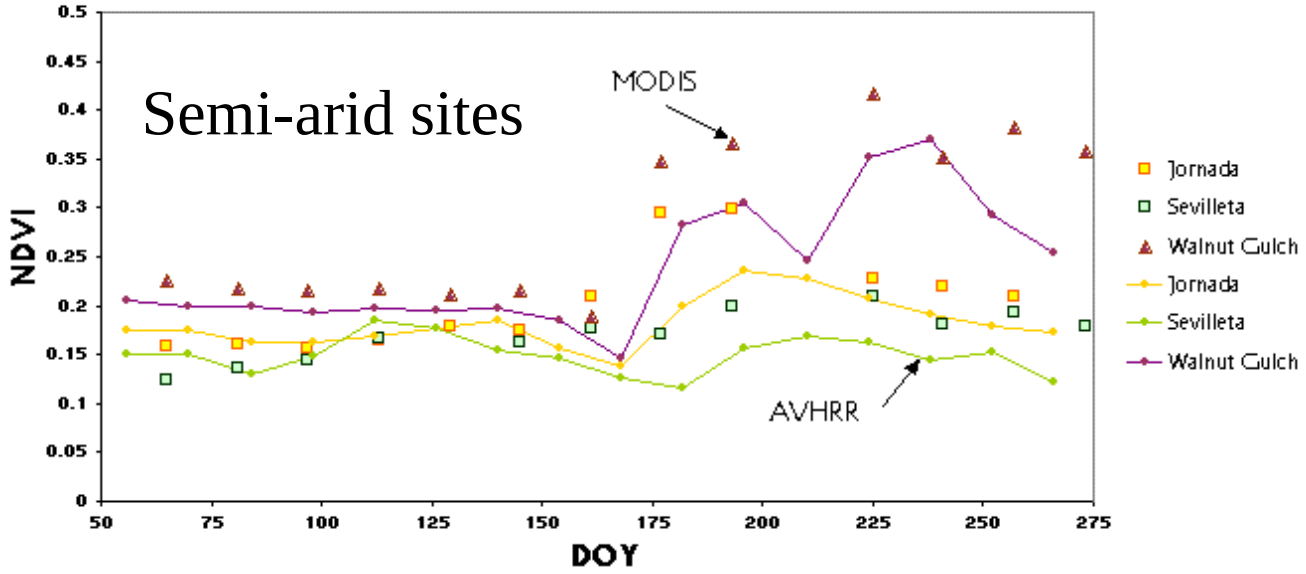


Sun/View Angles



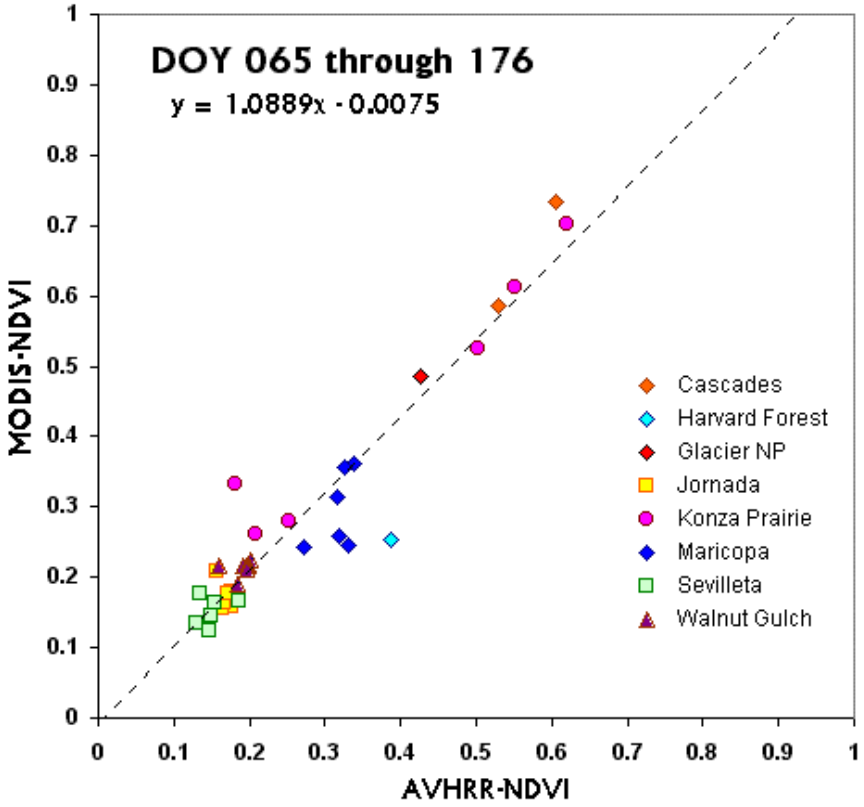
Issue: AVHRR time series continuity

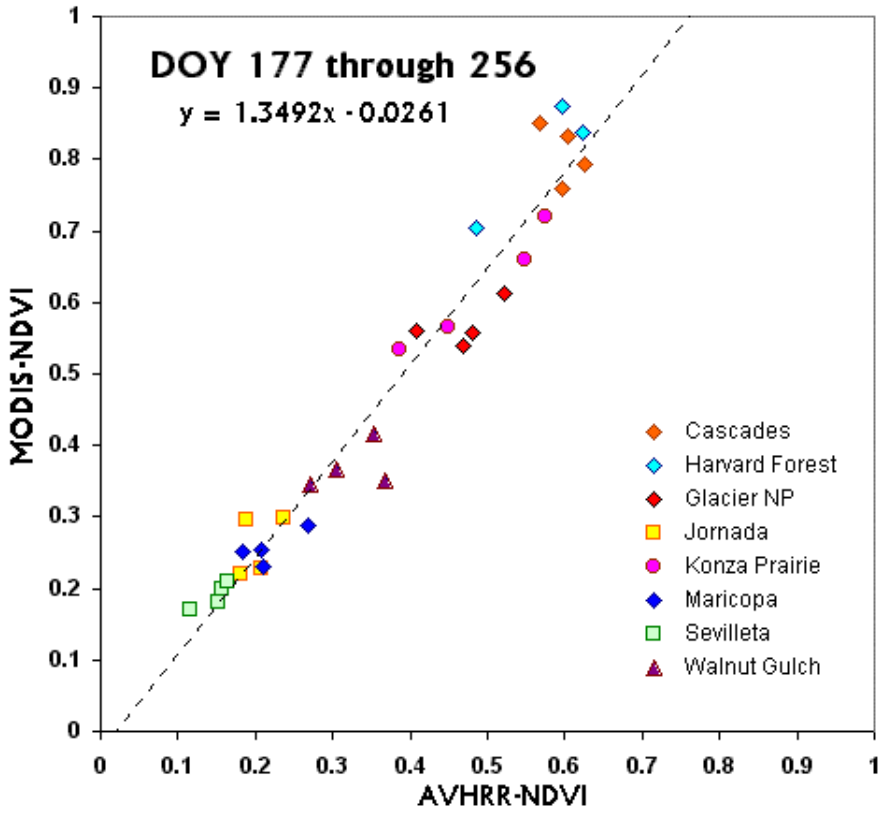




MODIS vs. AVHRR NDVI

- MODIS exhibits greater sensitivity.
- Slope is steeper in the wet season due to water vapor contamination in the AVHRR





THE MODIS LAI/FPAR PRODUCT: STATUS

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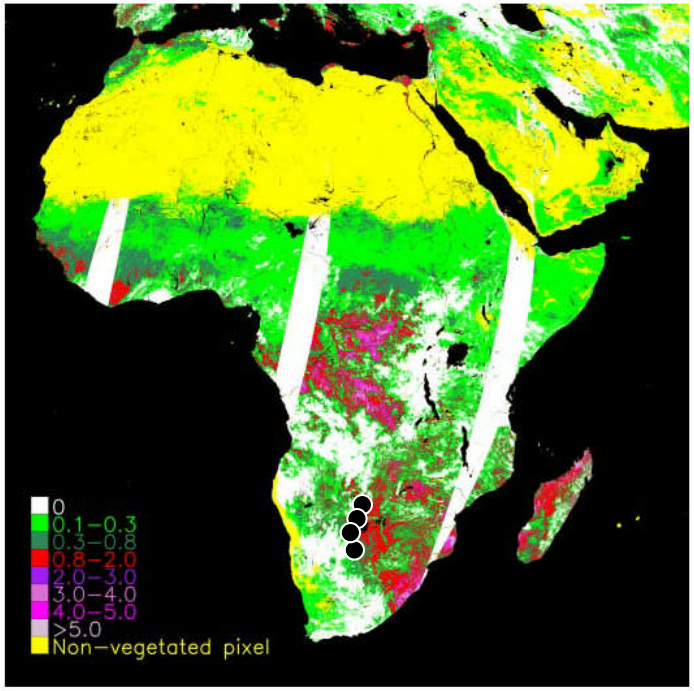
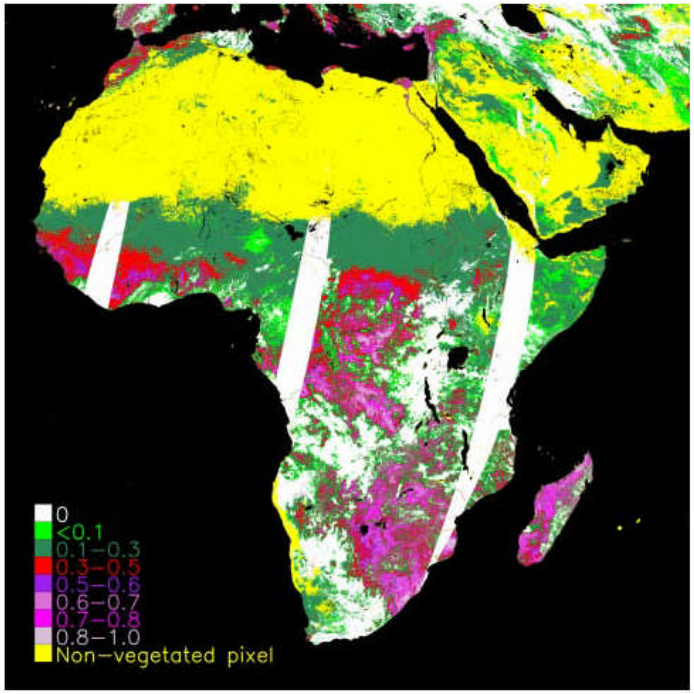
MODIS Science Team Meeting

January 24-26, 2001

MODIS LAI and FPAR maps for March-25-2000

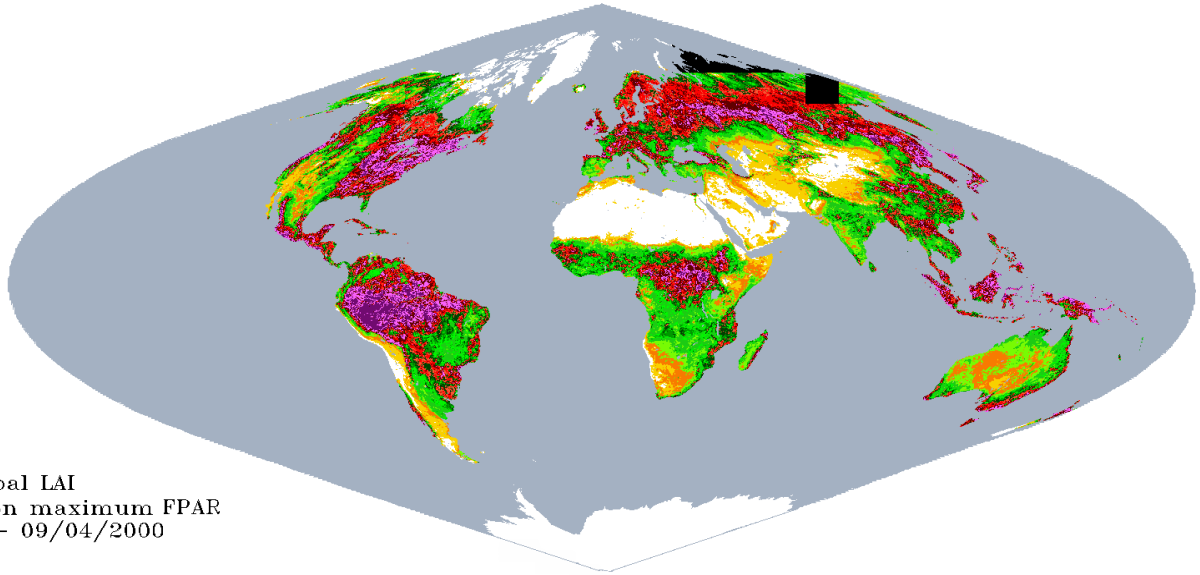




MOD15A1 LAI (left panel) and FPAR (right panel) maps of March-25-2000. Black dots on the left panel indicate the locations of the SAFARI 2000 Wet Season Field Campaign Sites: Pandamatenga (top dot), Maun, Okwa and Tshane (lower dot).

LAI

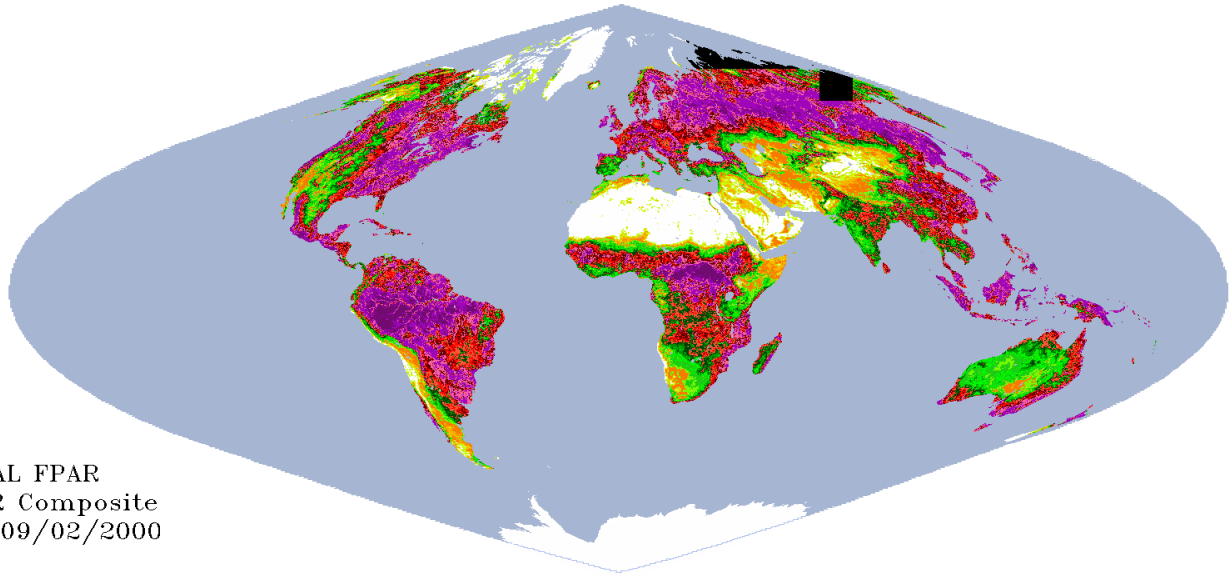
- NO DATA
- 0.0
- 0.1 – 0.2
- 0.3 – 0.4
- 0.5 – 0.7
- 0.8 – 1.1
- 1.2 – 1.5
- 1.6 – 2.0
- 2.1 – 2.7
- 2.8 – 3.3
- 3.4 – 4.3
- 4.4 – 5.3
- 5.4 – 6.0
- 6.1 – 6.6



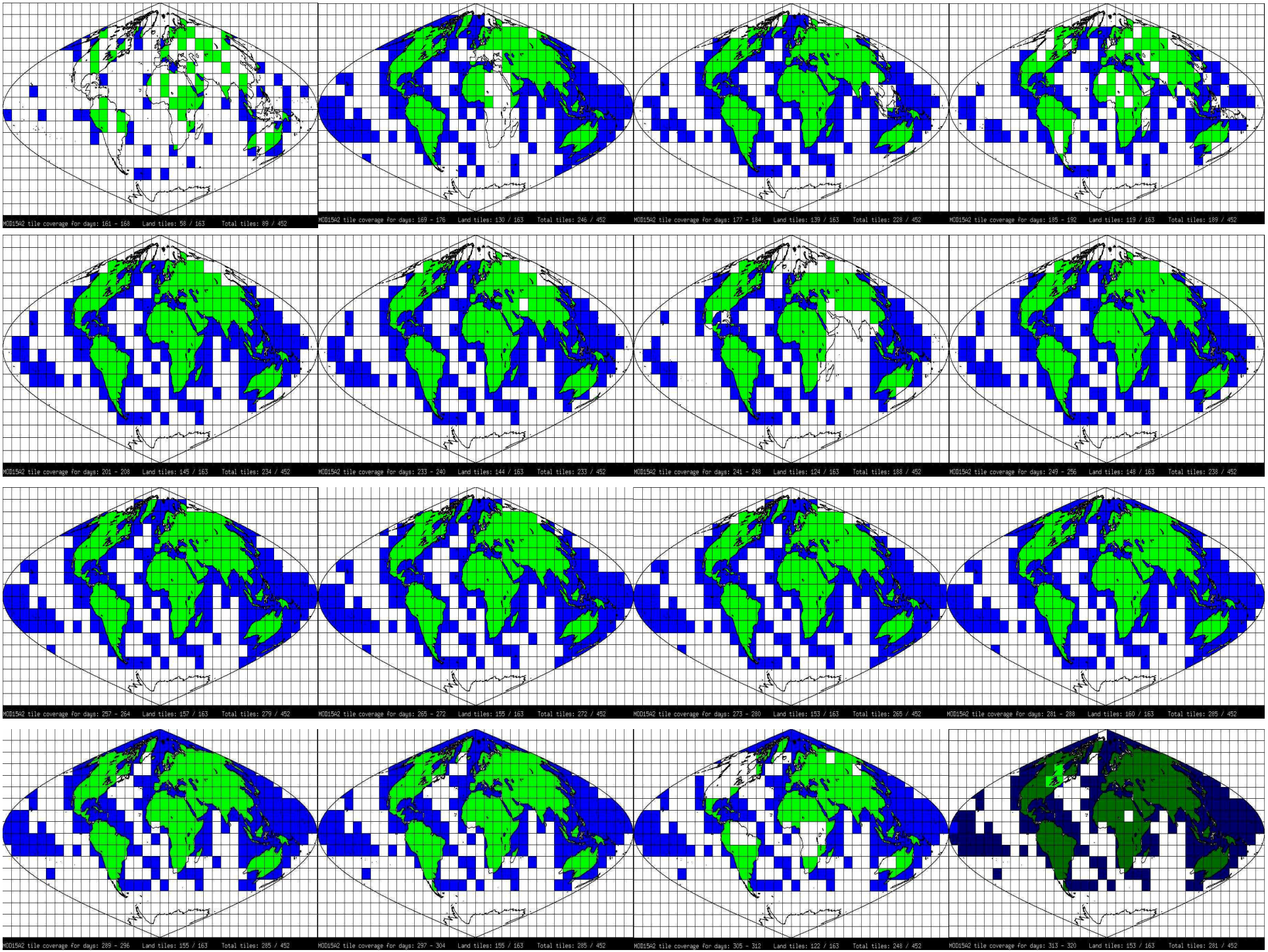
MOD15A2 Global LAI
Composited on maximum FPAR
06/08/2000 – 09/04/2000

FPAR

- NO DATA
- 0.00
- 0.01 – 0.07
- 0.08 – 0.14
- 0.15 – 0.21
- 0.22 – 0.28
- 0.29 – 0.35
- 0.36 – 0.42
- 0.43 – 0.49
- 0.50 – 0.56
- 0.57 – 0.63
- 0.64 – 0.70
- 0.71 – 0.77
- 0.78 – 0.84
- 0.85 – 0.91
- 0.92 – 0.96

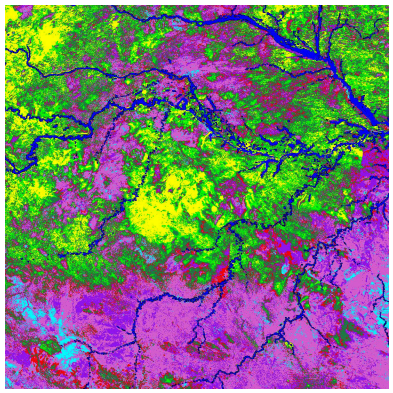


MOD15A2 GLOBAL FPAR
Maximum FPAR Composite
06/08/2000 – 09/02/2000


MOD15A2 tile coverage for days: 161 - 168 Land tiles: 58 / 163 Total tiles: 89 / 452
MOD15A2 tile coverage for days: 169 - 176 Land tiles: 130 / 163 Total tiles: 246 / 452
MOD15A2 tile coverage for days: 177 - 184 Land tiles: 139 / 163 Total tiles: 228 / 452
MOD15A2 tile coverage for days: 185 - 192 Land tiles: 119 / 163 Total tiles: 189 / 452
MOD15A2 tile coverage for days: 201 - 208 Land tiles: 145 / 163 Total tiles: 234 / 452
MOD15A2 tile coverage for days: 233 - 240 Land tiles: 144 / 163 Total tiles: 233 / 452
MOD15A2 tile coverage for days: 241 - 248 Land tiles: 124 / 163 Total tiles: 188 / 452
MOD15A2 tile coverage for days: 249 - 256 Land tiles: 148 / 163 Total tiles: 238 / 452
MOD15A2 tile coverage for days: 257 - 264 Land tiles: 157 / 163 Total tiles: 279 / 452
MOD15A2 tile coverage for days: 265 - 272 Land tiles: 155 / 163 Total tiles: 272 / 452
MOD15A2 tile coverage for days: 273 - 280 Land tiles: 153 / 163 Total tiles: 265 / 452
MOD15A2 tile coverage for days: 281 - 288 Land tiles: 160 / 163 Total tiles: 285 / 452
MOD15A2 tile coverage for days: 289 - 296 Land tiles: 155 / 163 Total tiles: 285 / 452
MOD15A2 tile coverage for days: 297 - 304 Land tiles: 155 / 163 Total tiles: 285 / 452
MOD15A2 tile coverage for days: 305 - 312 Land tiles: 122 / 163 Total tiles: 248 / 452
MOD15A2 tile coverage for days: 313 - 320 Land tiles: 153 / 163 Total tiles: 281 / 452

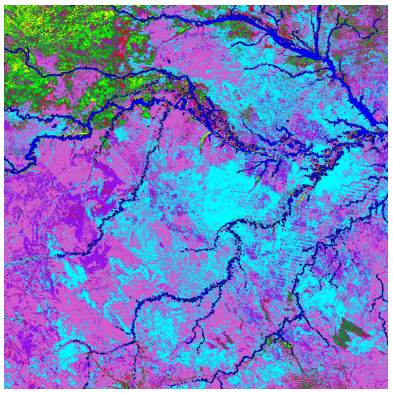
LAI, TILE:H11V09

DATE: July 3, 2000 – July 10, 2000



LAI, TILE:H11V09

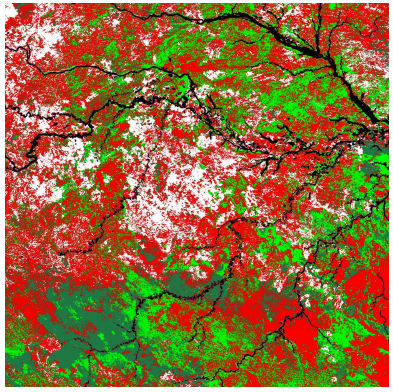
DATE: July 19, 2000 – July 26, 2000



0-0.5 **0.5-1.0** **1.0-2.5** **2.5-4.0** **4.0-5.0** **5.0-6.0** **6.0-7.0** **non-vegetated** **water** **fill value**

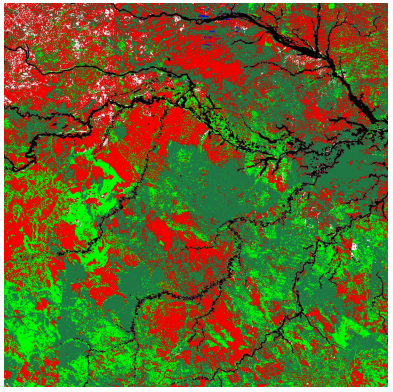
QA, TILE:H11V09

DATE: July 3, 2000 – July 10, 2000



QA, TILE:H11V09

DATE: July 19, 2000 – July 26, 2000



cloud

main algorithm (clear)

saturation (clear)

backup algorithm (clear)

data error

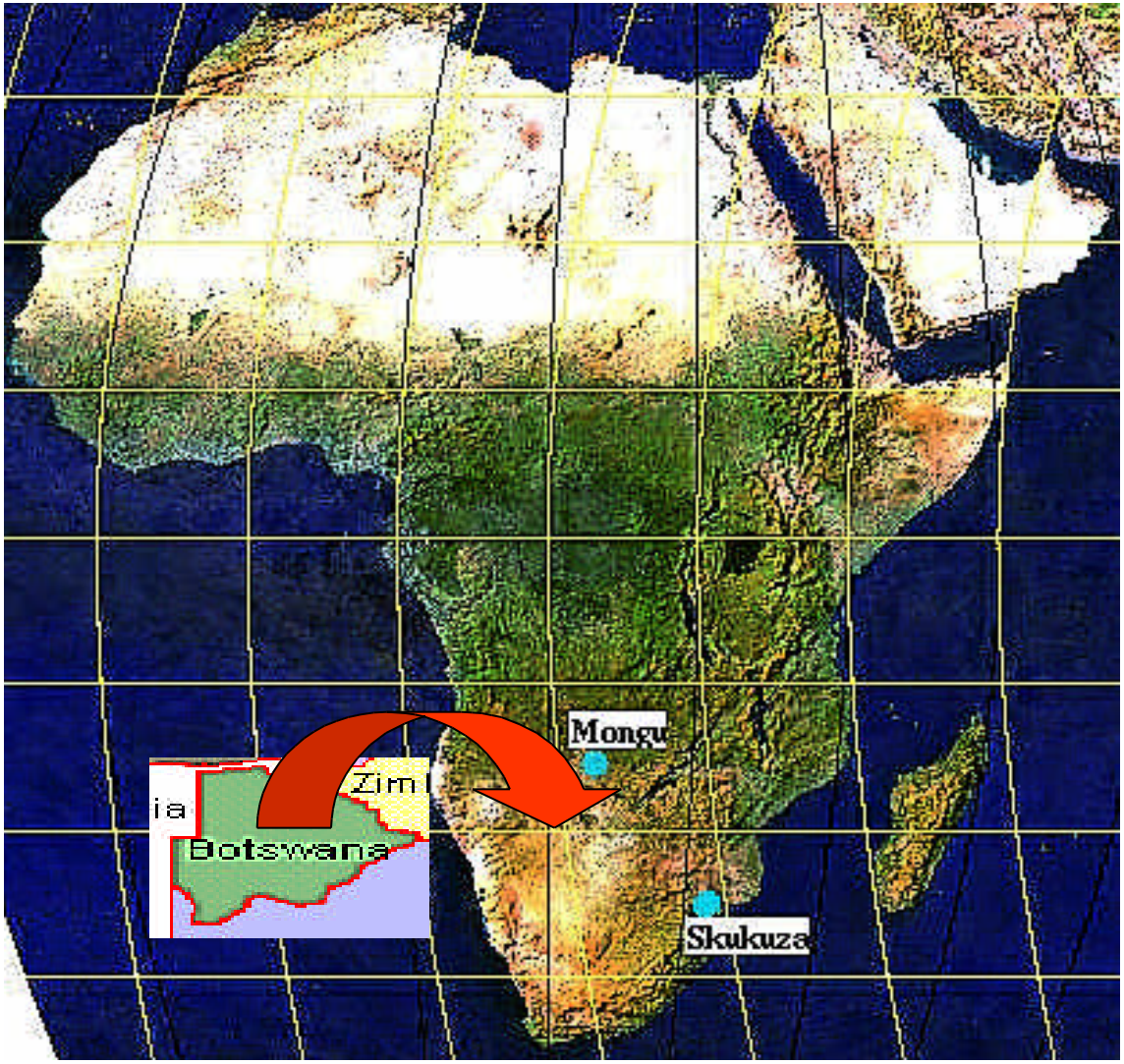
water

fill value

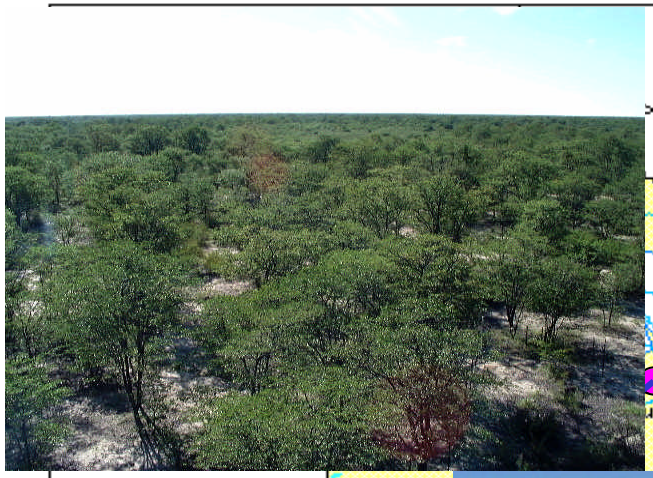
SAFARI 2000 Wet Season Campaign

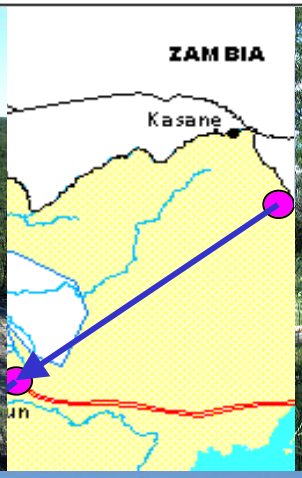
March 3 – 18, 2000

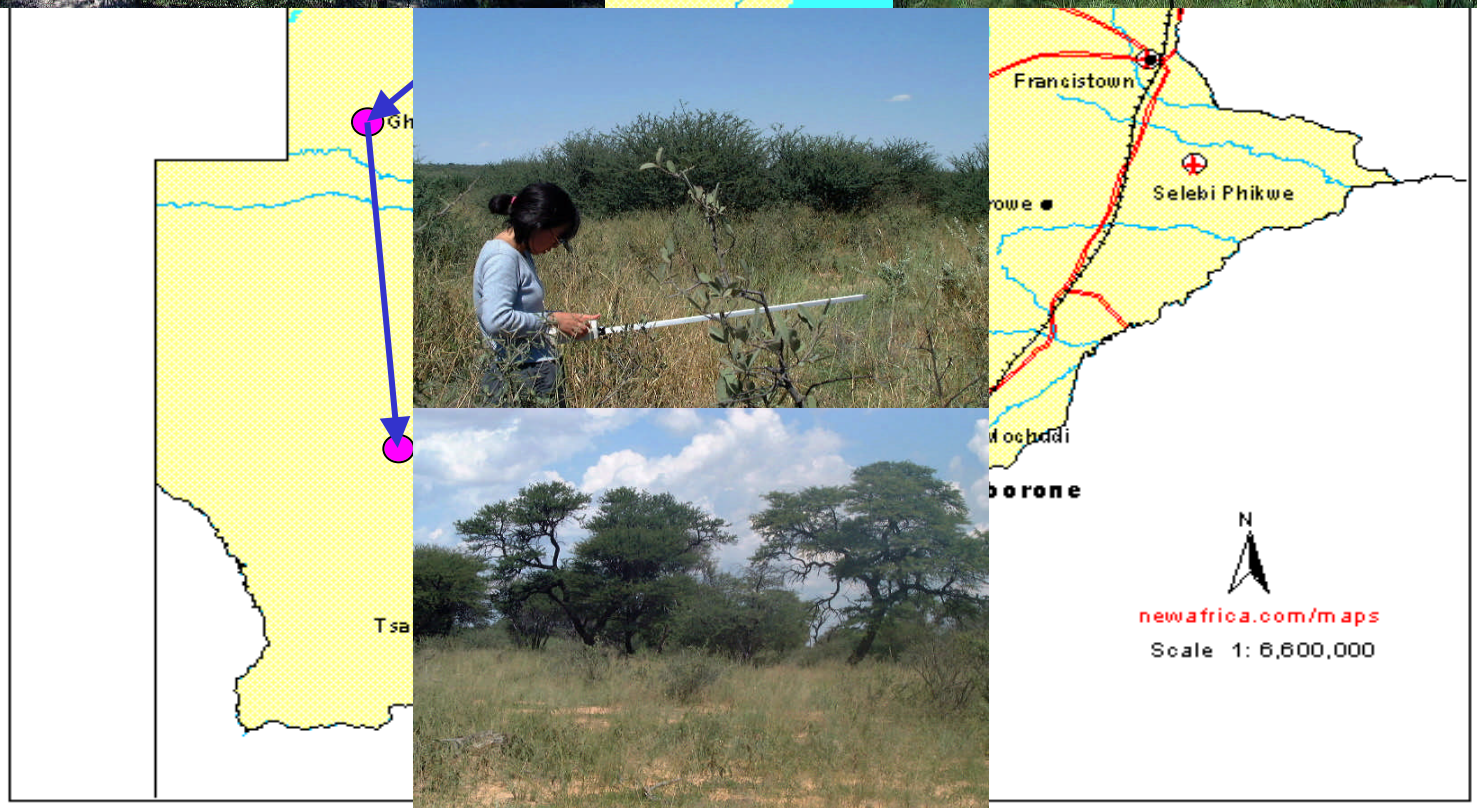
Yuhong Tian,Yujie Wang,Yu Zhang, Karyn Tabor



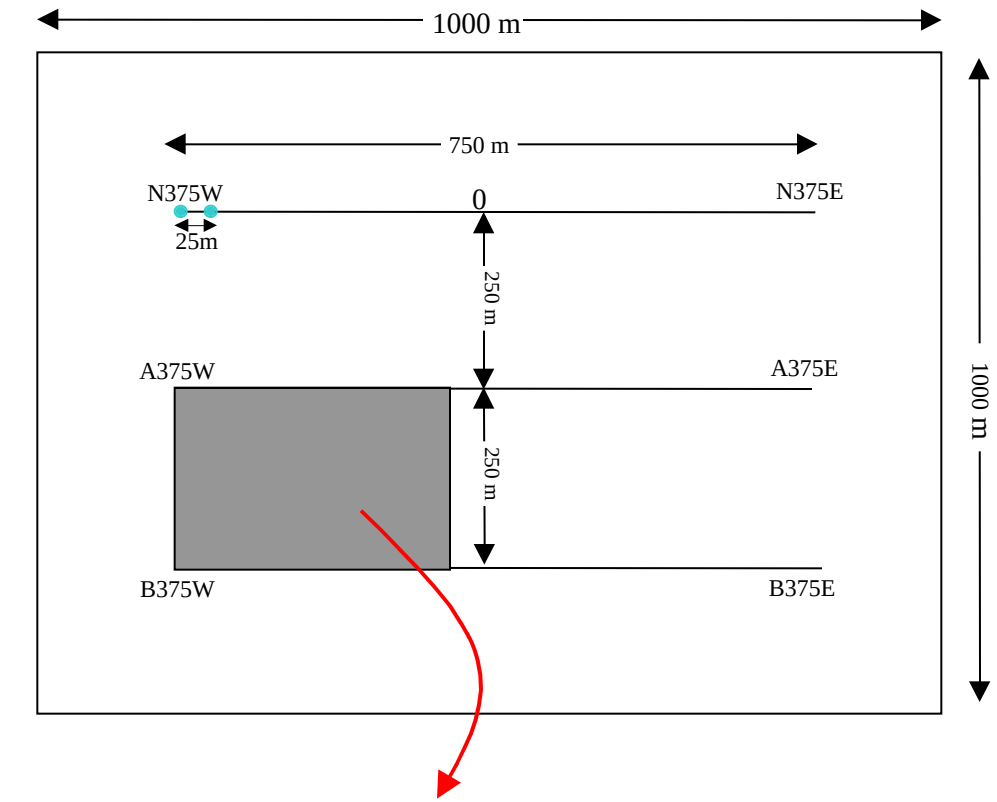
BOTSWANA OVERVIEW MAP

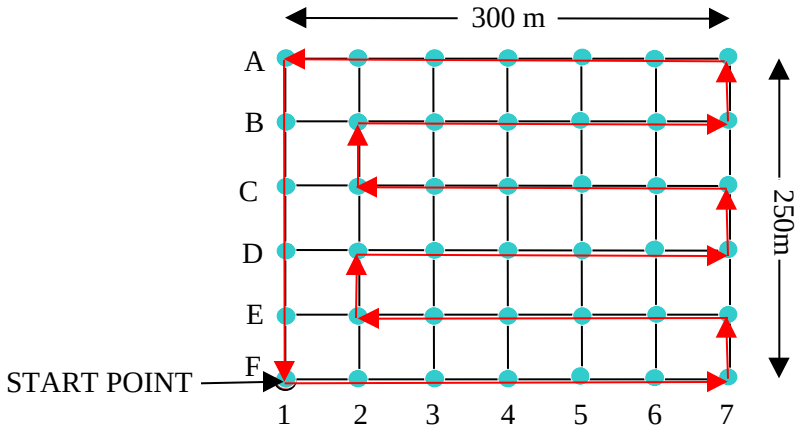






Experimental Design



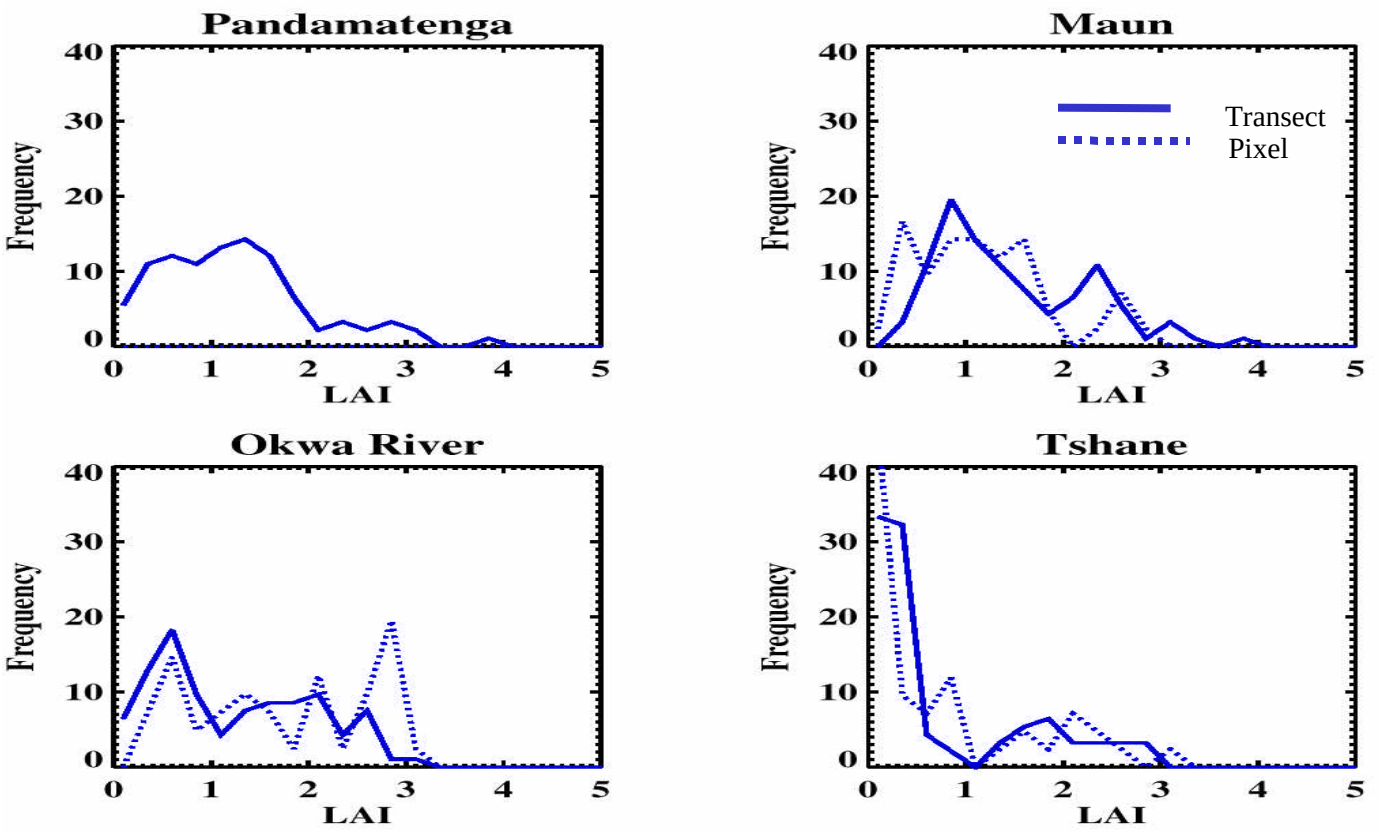


Measurements Taken During the SAFARI 2000 Campaign

Site / Measurement	Pandamatenga		Maun		Okwa		Tshane	
	Transect Scale	Grid Scale	Transect Scale	Grid Scale	Transect Scale	Grid Scale	Transect Scale	Grid Scale
LAI-2000	+	+	+	+	+	+	+	+
AccuPAR								
Incident Flux	+	+	+	+	+	-	+	-
Transmitted Flux	+	+	+	+	+	-	+	-
Reflected Flux	-	-	-	-	-	-	-	-
Reflected Flux From 40m Tower	-	-	+	+	-	-	-	-
LI-1800								
Leaf Spectral Reflectance, Transmittance	+	+	+	+	+	+	+	+
Incident Flux	+	-	+	-	+	-	+	-
ASD								
Canopy Transmittance	+	-	+	-	+	-	+	-
Background HDRF (nadir)	+	+	+	+	+	+	+	+
Top of canopy HDRF	-	-	+	+	-	-	-	-
Top of individual canopy HDRF (nadir)	-	-	-	-	+	+	-	-

+ : There are measurements on the site. - : No measurements on the site.

Statistical Analysis of Measured LAI from Four SAFARI Sites

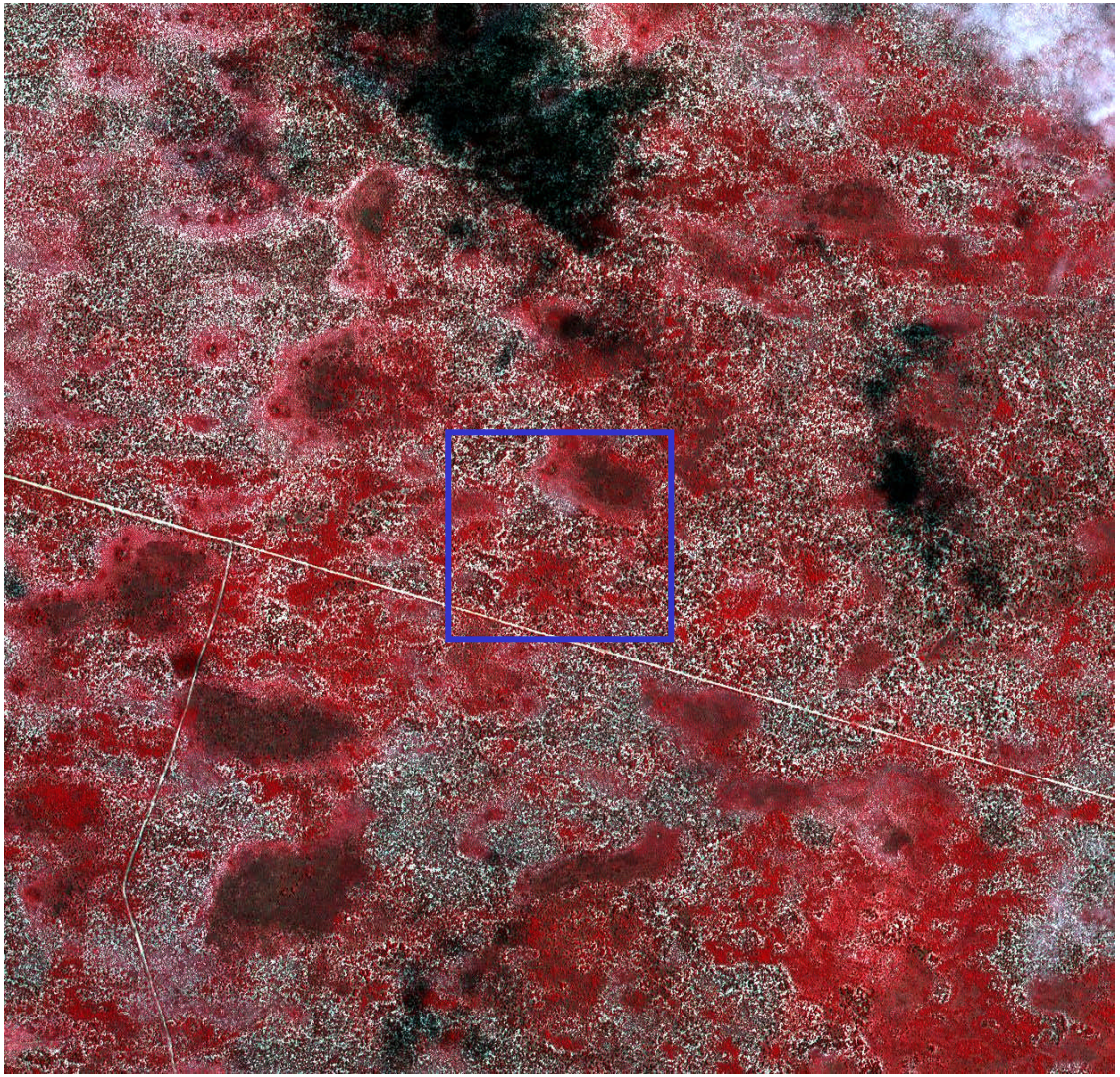


Mean LAI and standard deviation

Site Name	Mean LAI		Standard Deviation	
	Transect Scale	Grid Scale	Transect Scale	Grid Scale
Pandamatenga	1.25956	-	0.783491	-
Maun	1.503913	1.207143	0.774568	0.680704
Okwa	1.276129	1.752195	0.802867	0.894132
Tshane	0.776667	0.777619	0.858399	0.900463

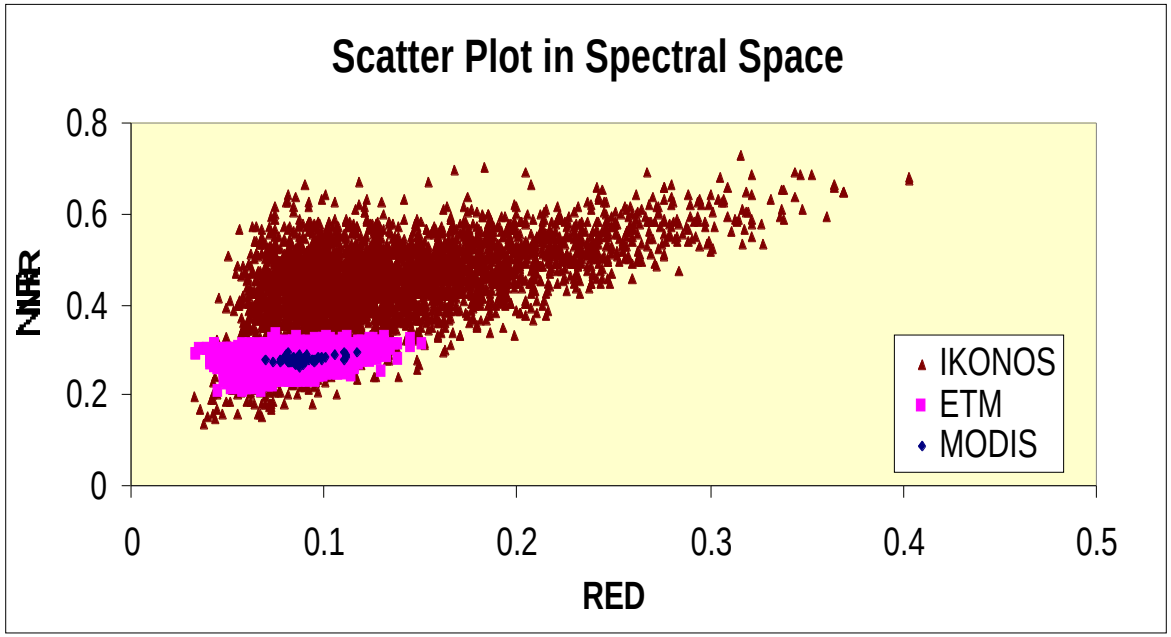
Intensive Analysis over Maun in 5 km Area

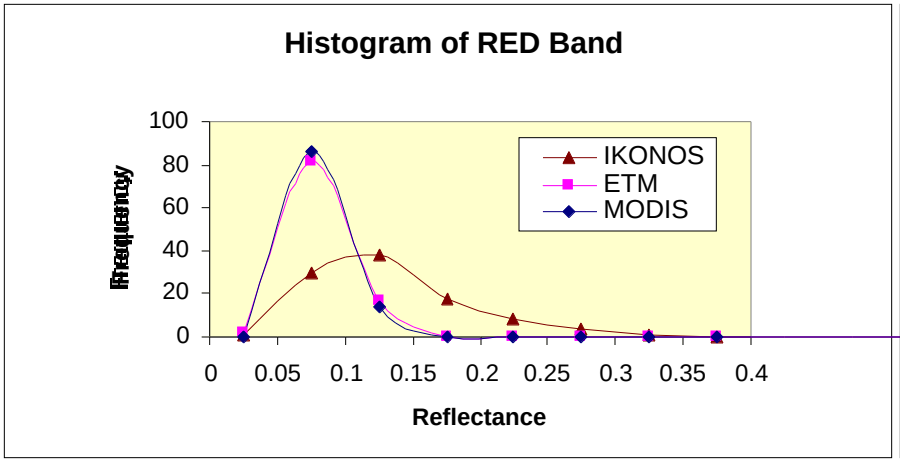
IKONOS Image of Maun

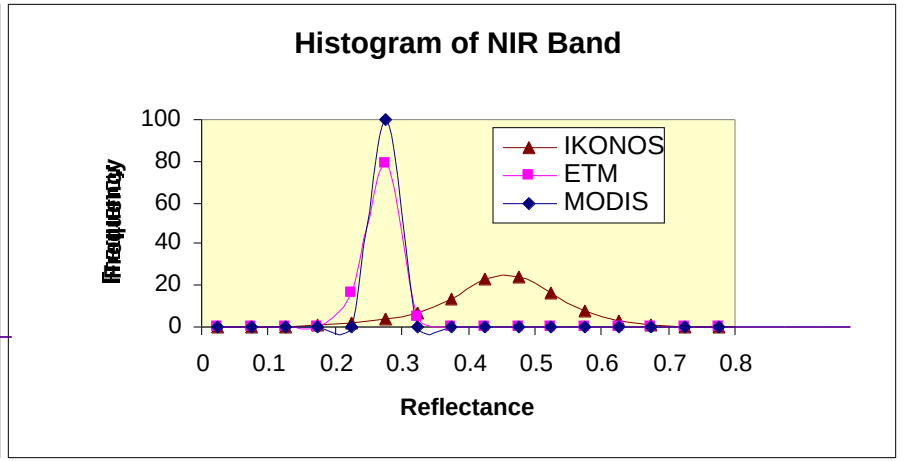


Color composite image produced by displaying NIR, RED, and GREEN band as red, green and blue. The blue square is the 1km area where we took measurements.

Satellite Reflectance Comparisons

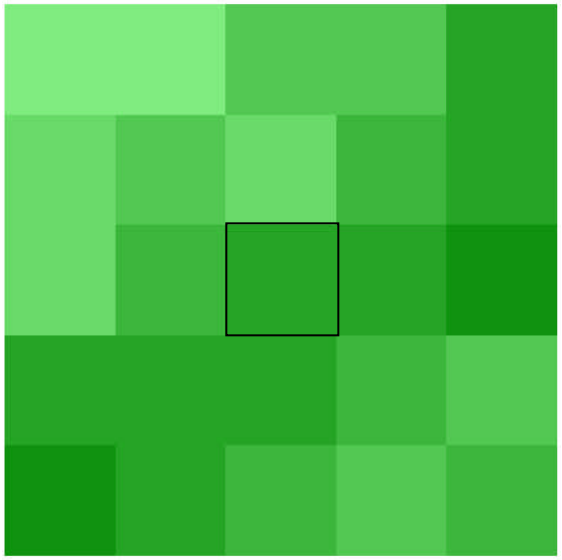




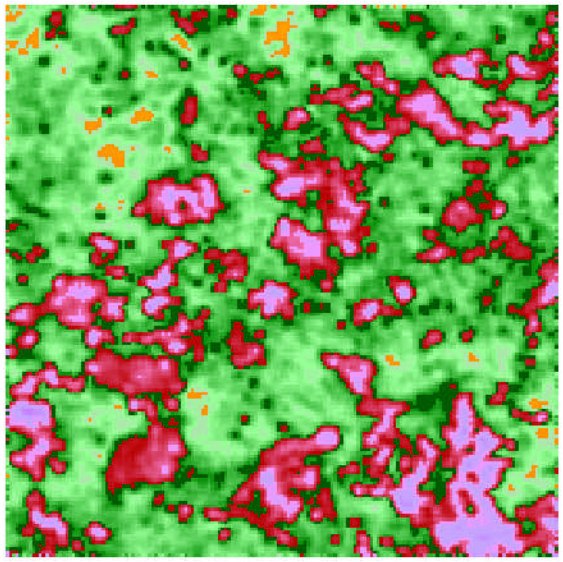


LAI Map of a 5 KM Area

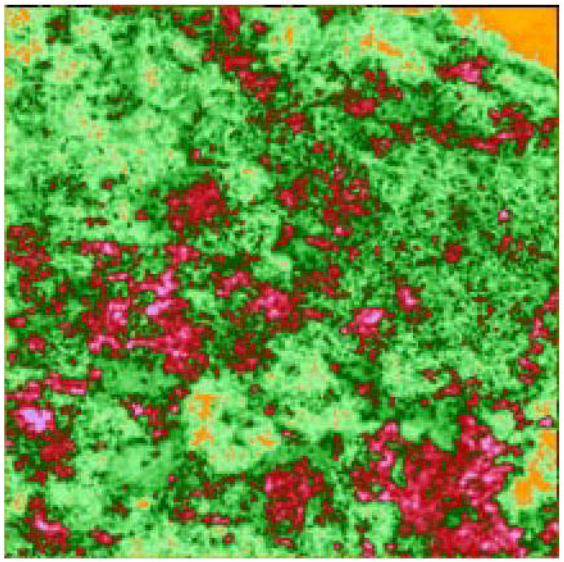
MODIS Retrievals, Apr. 3, 2000

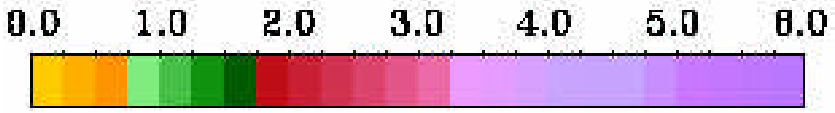


ETM Retrievals, Apr.3, 2000

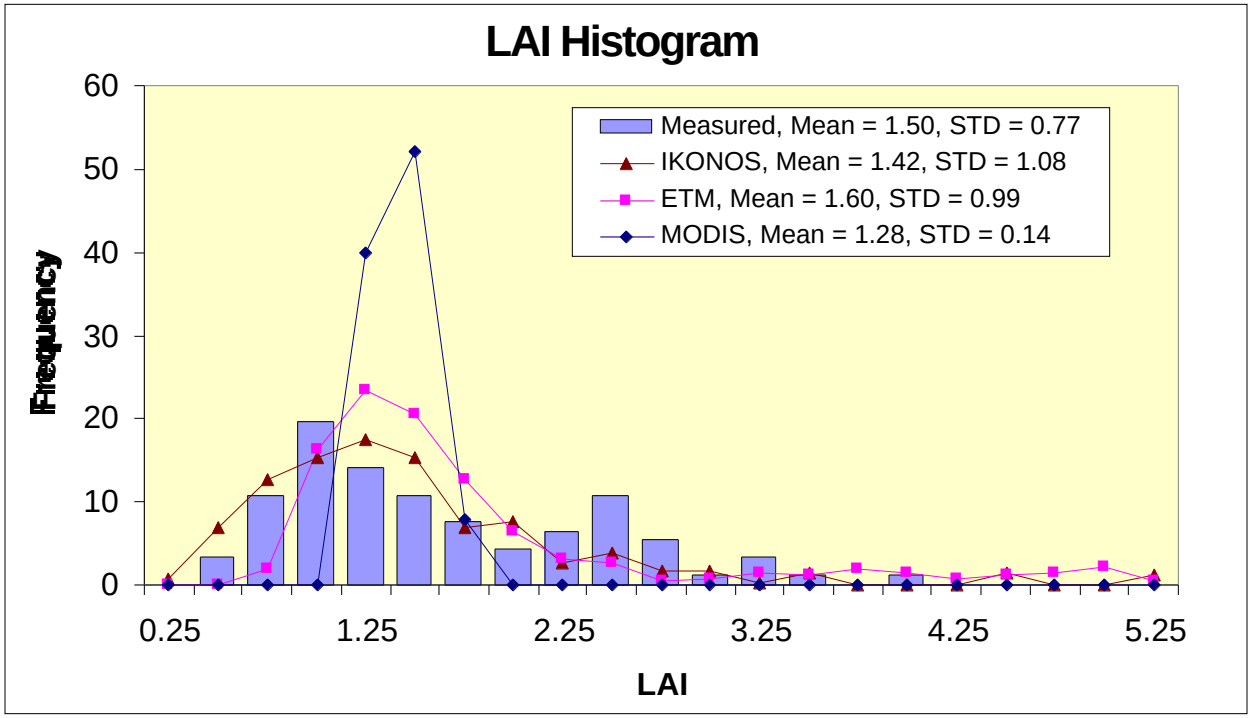


IKONOS Retrievals, Mar. 30,2000





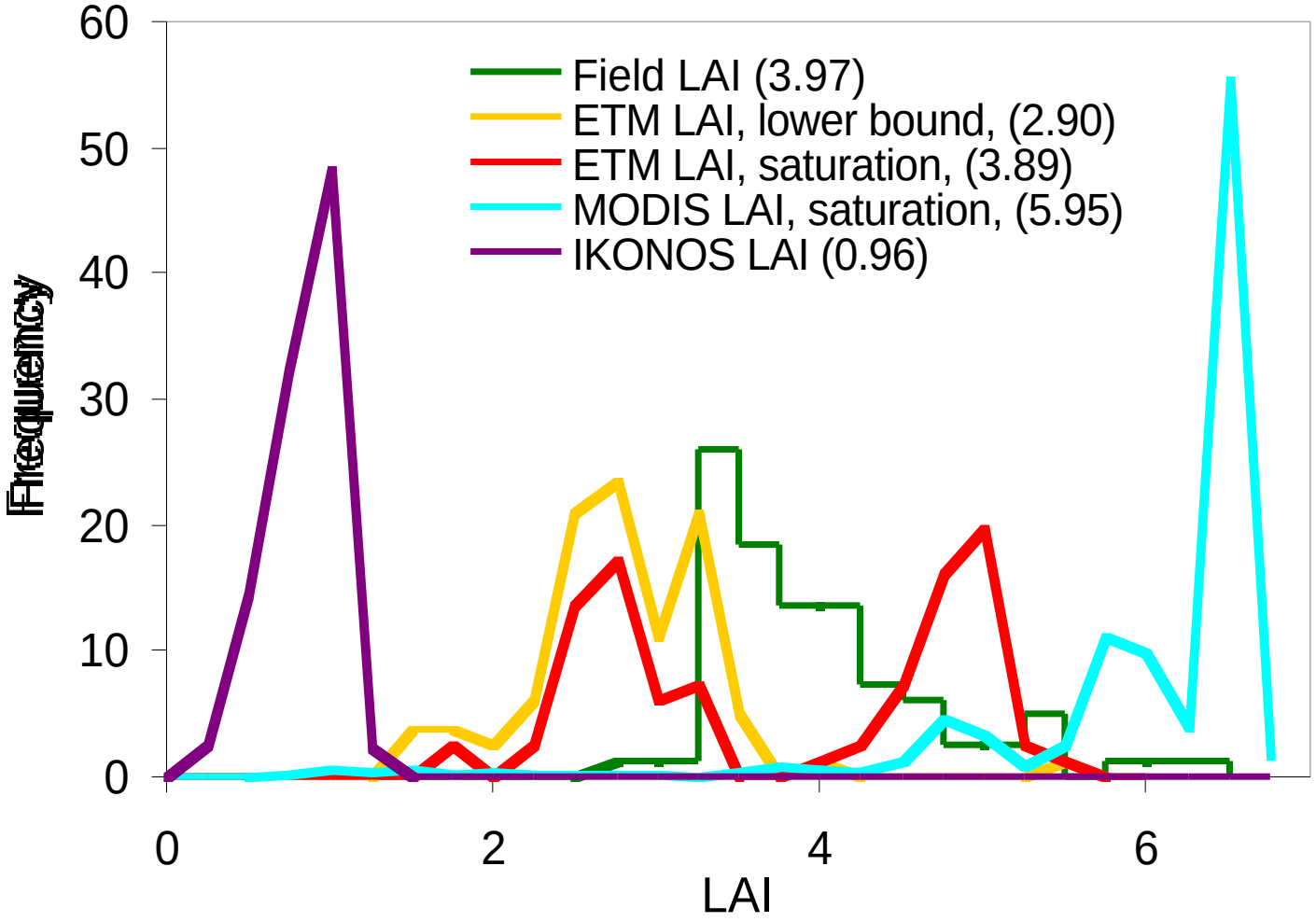
Histogram of Retrieved LAI



Harvard Forest, Massachusetts, July 21-25, 2000

**Nikolay Shabanov, Jiarui Dong, Seth Hoffman, Grace Smith,
Yuhong Tian, Liming Zhou, Yujie Wang,Yu Zhang,
Wolfgang Buermann, Juri Knyazikhin and Ranga B. Myneni**

LAI Intercomparison of ETM and Field Data

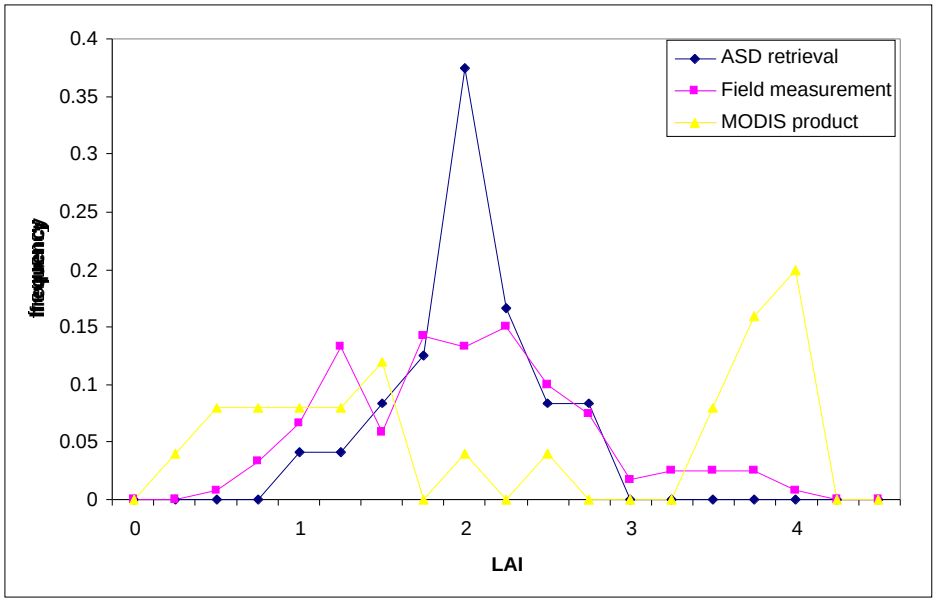


Ruokolahti Field Campaign 2000

Jun. 14—Jun. 21, 2000

Yujie Wang, Wolfgang Buermann, Pauline Stenberg,
Pekka Voipio, Heikki Smolander, Tuomas Hame

LAI distribution for algorithm retrieval and field measurements

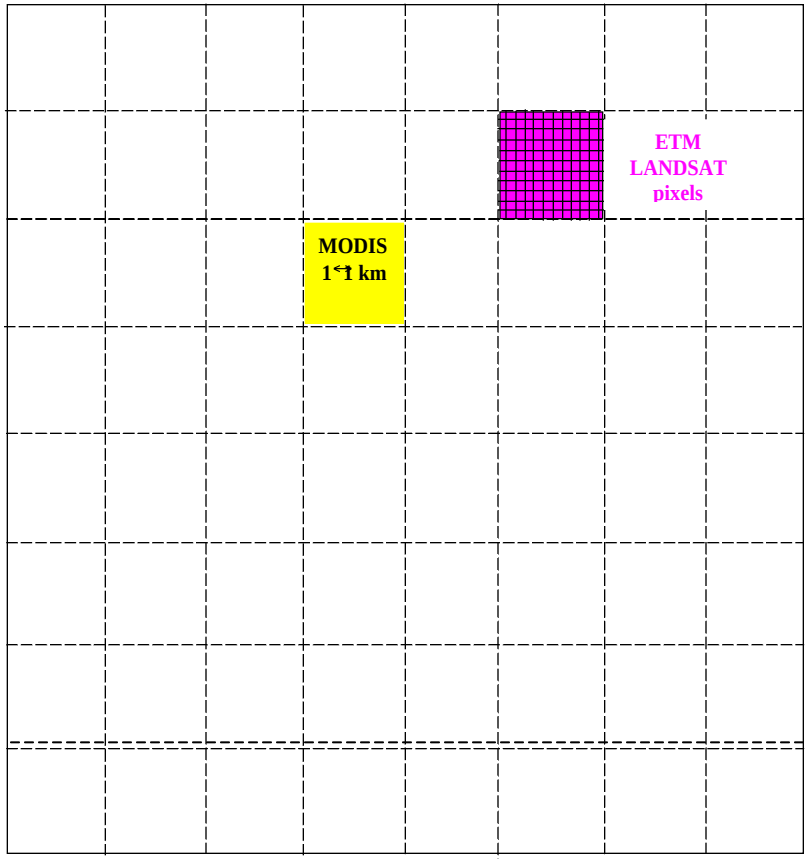


	Mean	Stdev
ASD retrieval	1.87	0.12
Field measurement	1.89	0.73
MODIS product	2.2	1.40

Scaling: Definition

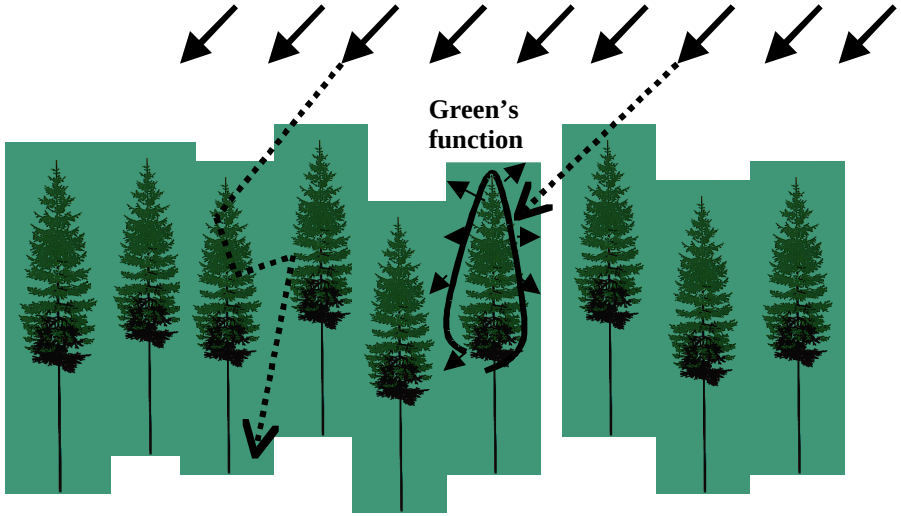
$$LAI\_SeaWiFS = \frac{1}{64}\sum_{p=1}^{64} LAI\_MODIS_p + \delta$$

SeaWiFS pixel, 8×8 km



$$LAI\_MODIS = \frac{1}{1111}\sum_{p=1}^{1111} LAI\_ETM\_LANDSAT_p + \varepsilon$$

ENERGY CONSERVATION LAW AS A TOOL TO SCALE LAI AND FPAR FIELDS



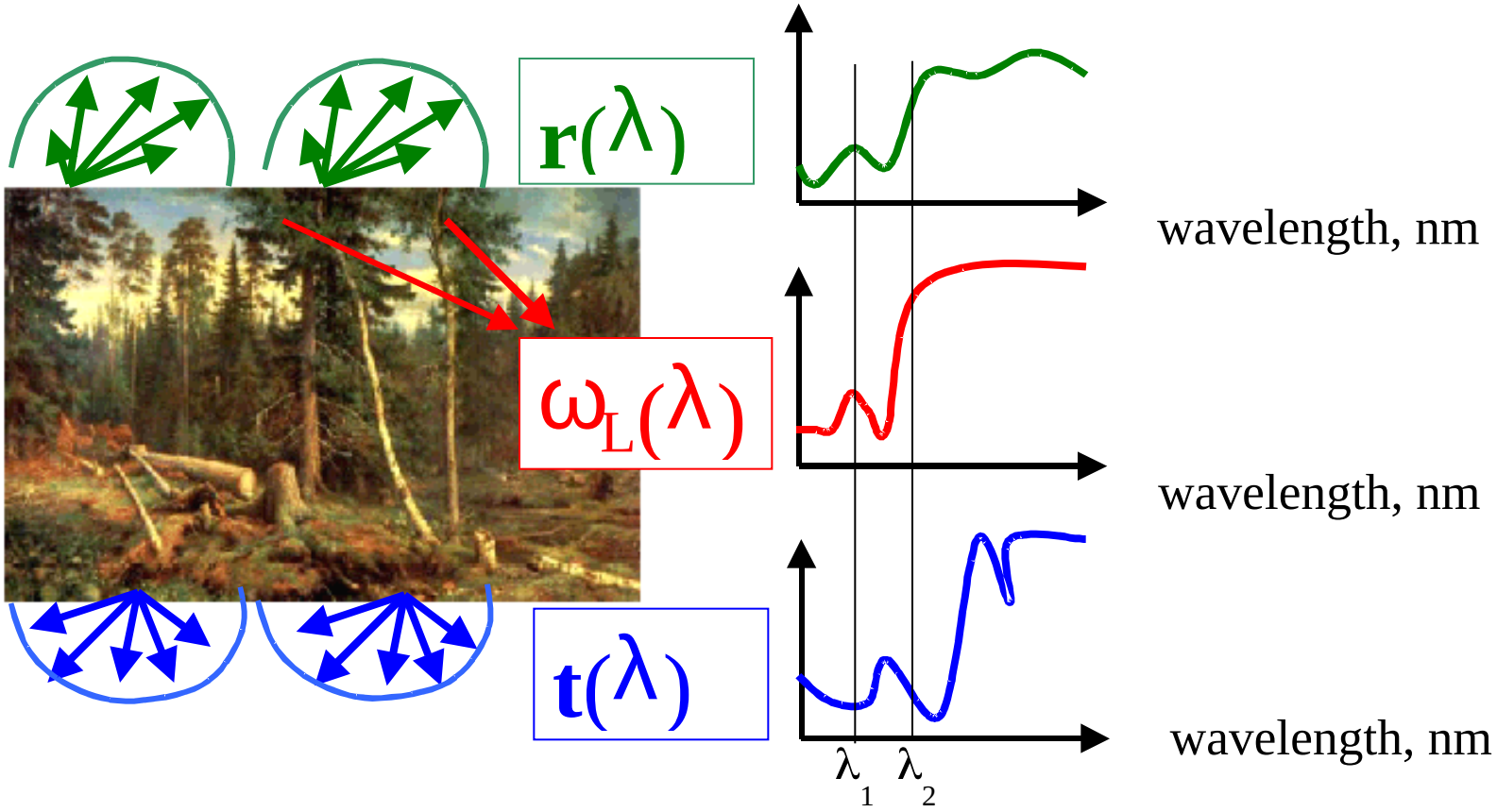
ABSORPTION = F(LEAF, TREE, CANOPY) = Φ(CROWN, CANOPY)

F: $$\Omega \quad \varphi_L + \sigma_L \varphi_L = \omega_L \int_{4\pi} \Gamma(\Omega' \blacklozenge \Omega) \varphi_L \, d\Omega'$$

Φ: $$\Omega \quad \varphi_C + \sigma_C \varphi_C = \omega_C \int_{4\pi} G(\Omega' \blacklozenge \Omega) \varphi_C \, d\Omega'$$

$$\frac{1-\omega_C(\lambda)}{1-\omega_C(\lambda_0)} = \frac{1-\omega_L(\lambda)}{1-p\omega_L(\lambda)} \leftrightarrow \frac{1-\omega_L(\lambda_0)}{1-p\omega_L(\lambda_0)}^{-1}$$

SCALING PARAMETER: FIELD MEASUREMENTS



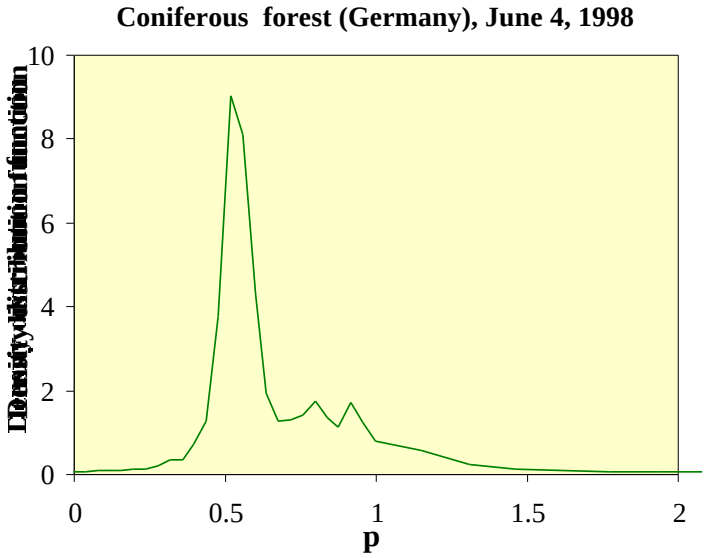
$$p = \frac{\mathbf{i}(\lambda_2) - \mathbf{i}(\lambda_1)}{\omega_L(\lambda_2)\mathbf{i}(\lambda_2) - \omega_L(\lambda_1)\mathbf{i}(\lambda_1)}$$

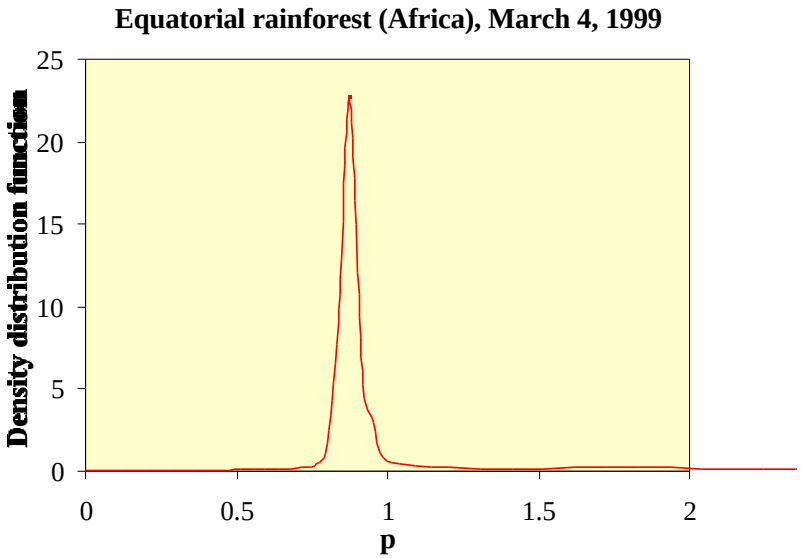
$$\mathbf{i}(\lambda) = \frac{1 - \mathbf{t}(\lambda) - \mathbf{r}(\lambda)}{1 - \omega_L(\lambda)}$$

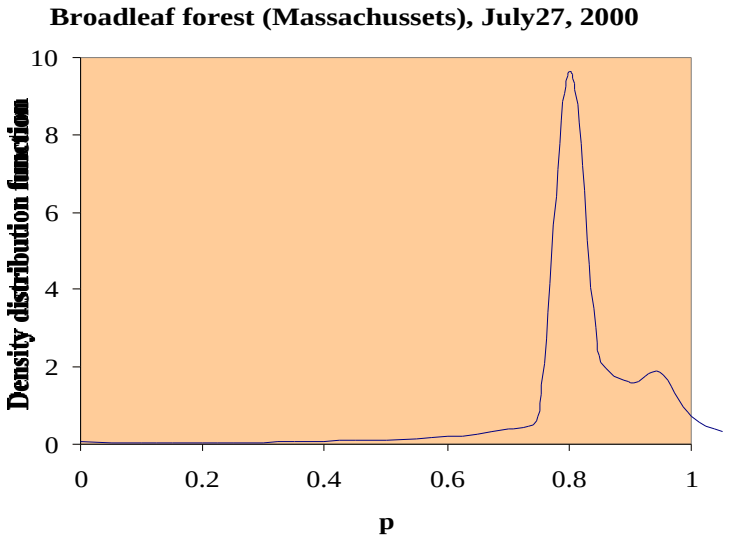
SCALING PARAMETER: FIELD MEASUREMENTS

$$p = \frac{\mathbf{i}(\lambda_0) - \mathbf{i}(\lambda_1)}{\omega_L(\lambda_0)\mathbf{i}(\lambda_0) - \omega_L(\lambda_1)\mathbf{i}(\lambda_1)}$$

$$\mathbf{i}(\lambda) = \frac{1 - \mathbf{t}(\lambda) - \mathbf{r}(\lambda)}{1 - \omega_L(\lambda)}$$







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Knyazikhin, Y., J.V., Martonchik, R.B. Myneni, D.J. Diner, and S.W. Running, Synergistic algorithm for estimating vegetation canopy leaf area index and fraction of absorbed photosynthetically active radiation from MODIS and MISR data, *J. Geophys. Res*., *103*, 32257-32275, 1998.

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Panferov, O., Y. Knyazikhin, R. B. Myneni, J. Szarzynski, S. Engwald, K. G. Schnitzler, and G. Gravenhorst,The role of canopy structure in the spectral variation of transmission and absorption of solar radiation in vegetation canopies, *IEEE Trans. Geosci. Remote Sens*., vol. 39, 2001 (in print).

Wang, Y., Y. Tian, Y. Zhang, Y., N. El-Saleous, Y. Knyazikhin, E. Vermote, and R.B. Myneni, Investigation of Product Accuracy as a Function of Input and Model Uncertainties: Case Study with SEAWIFS and MODIS LAI/FPAR Algorithm, *Remote Sems.Environ*, 2001 (accepted for publication).

CONCLUSIONS

- THE LAI/FPAR ALGORITHM BEHAVES AS EXPECTED

- TWO SPECTRAL BANDS, RED AND NIR, ARE CURRENTLY USED TO PRODUCE THE GLOBAL LAI AND FPAR FIELDS

- THE LAI/FPAR PRODUCT FOLLOWS REGULARITIES EXPECTED FROM PHYSICS

- COMPARISON OF MODIS LAI FIELD WITH FIELD MEASUREMENTS HAS BEEN CARRIED OUT

CURRENT STATUS OF MODIS

8-DAY PHOTOSYNTHESIS and

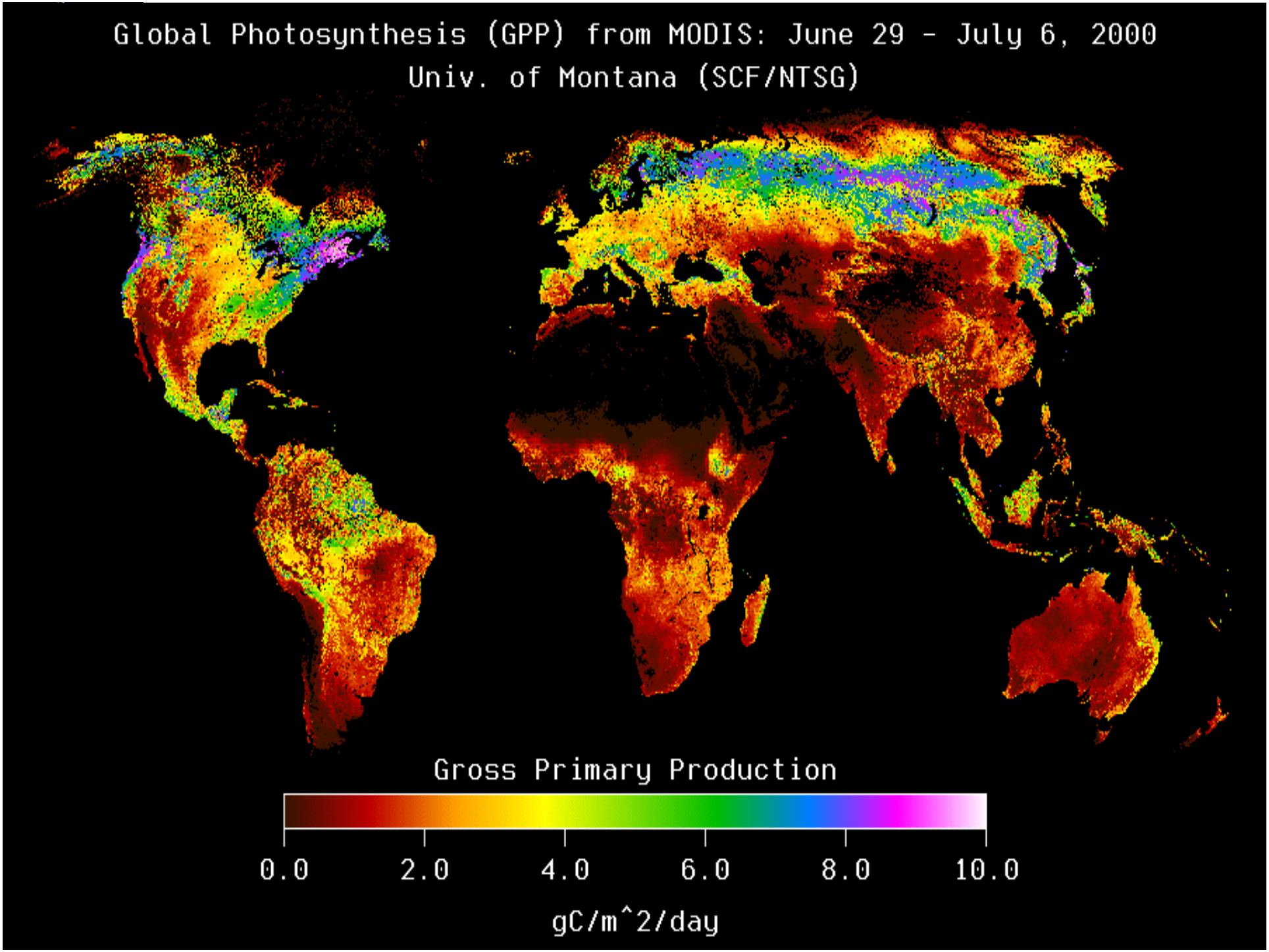
ANNUAL PRIMARY PRODUCTION

S. W. Running, R. Nemani, J. Glassy, P. Thornton, P. Votava

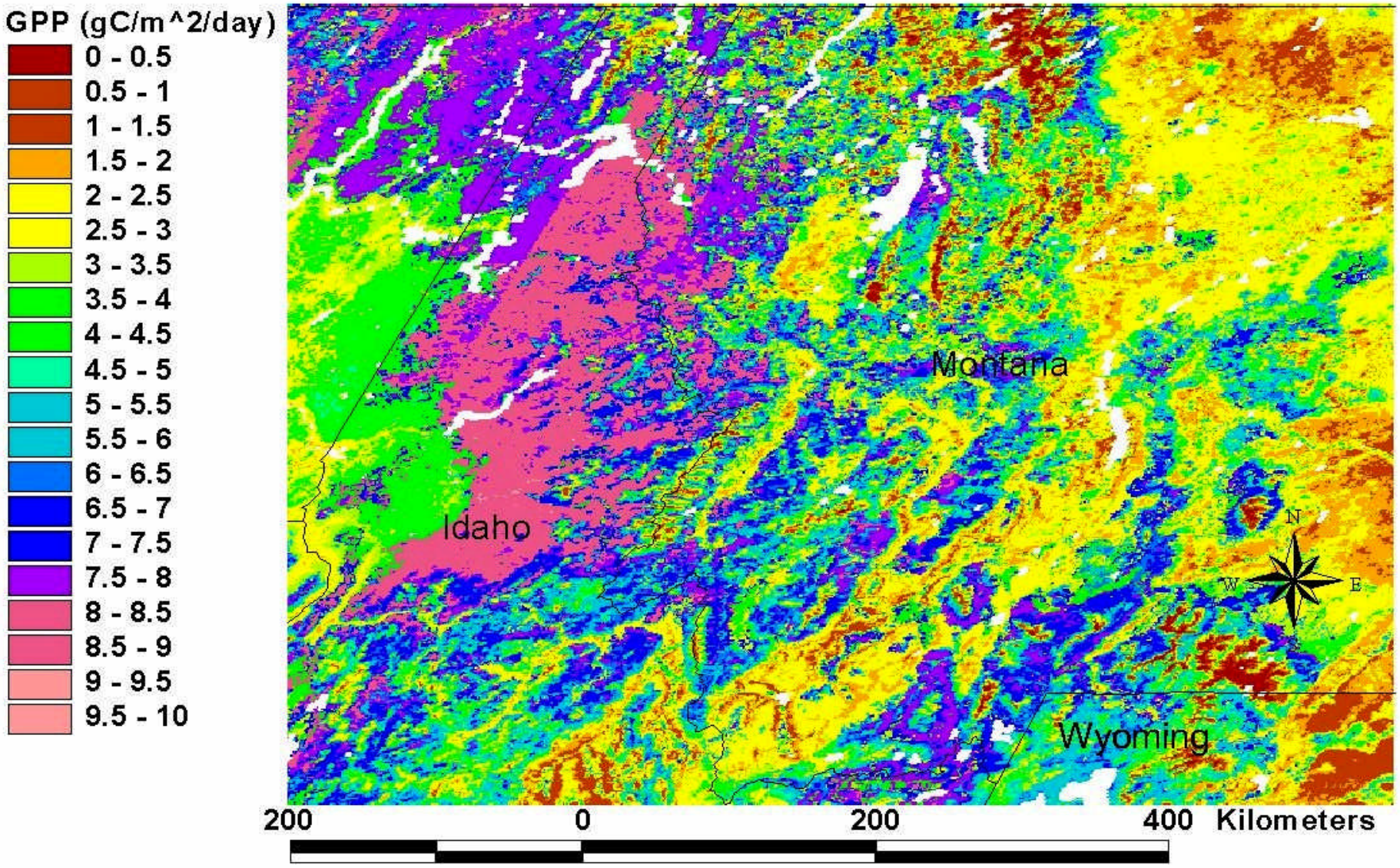
NTSG, Univ. of Montana

MODIS SCIENCE TEAM MEETING

18 January 2001

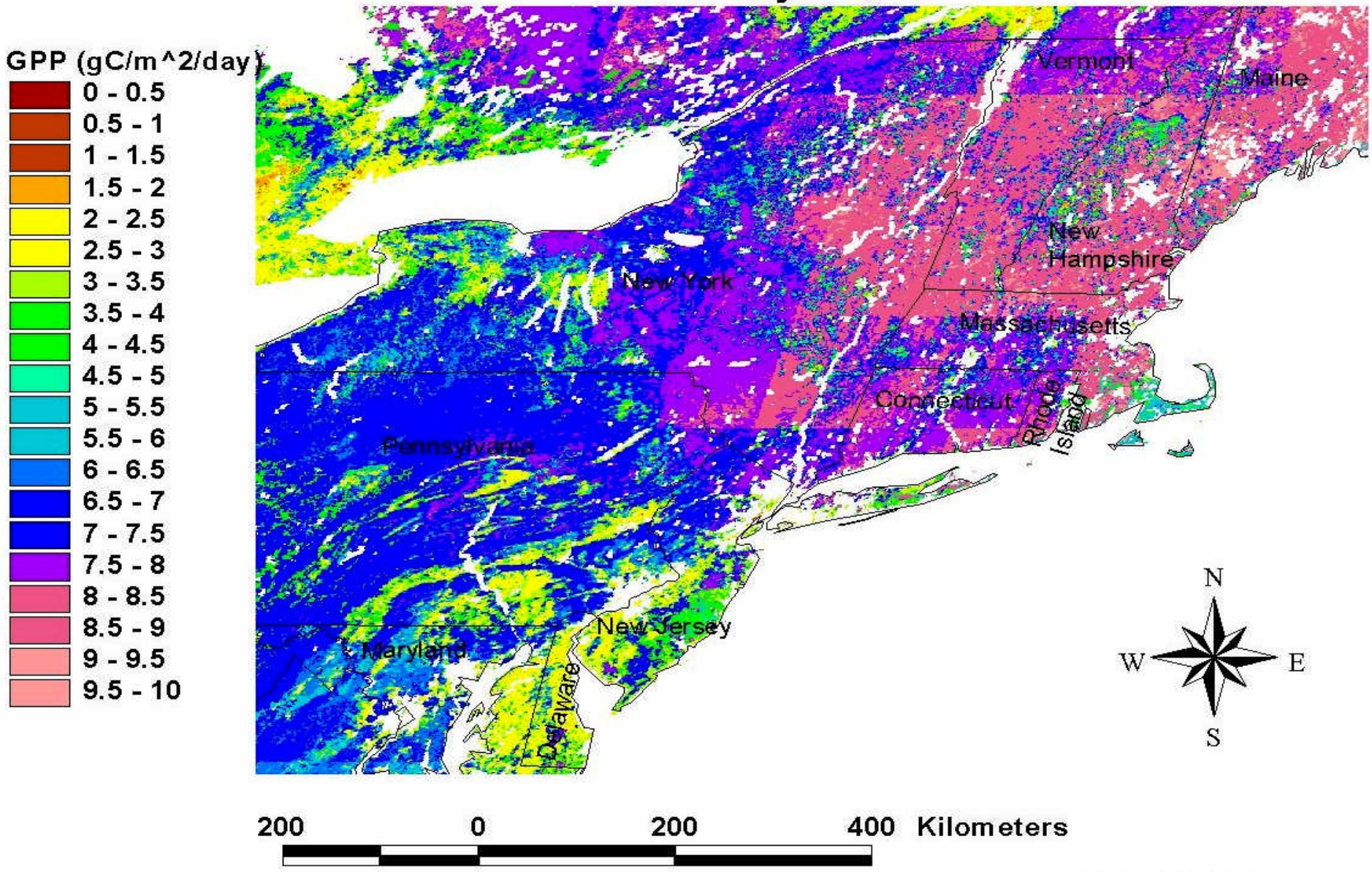

Global Photosynthesis (GPP) from MODIS: June 29 - July 6, 2000
Univ. of Montana (SCF/NTSG)
Gross Primary Production
0.0
2.0
4.0
6.0
8.0
10.0
gC/m^2/day

MODIS Gross Primary Production (GPP)
June 29 - July 6, 2000



NTSG / U. Montana

MODIS Gross Primary Production (GPP)
June 29 - July 6, 2000



NTSG / U. Montana

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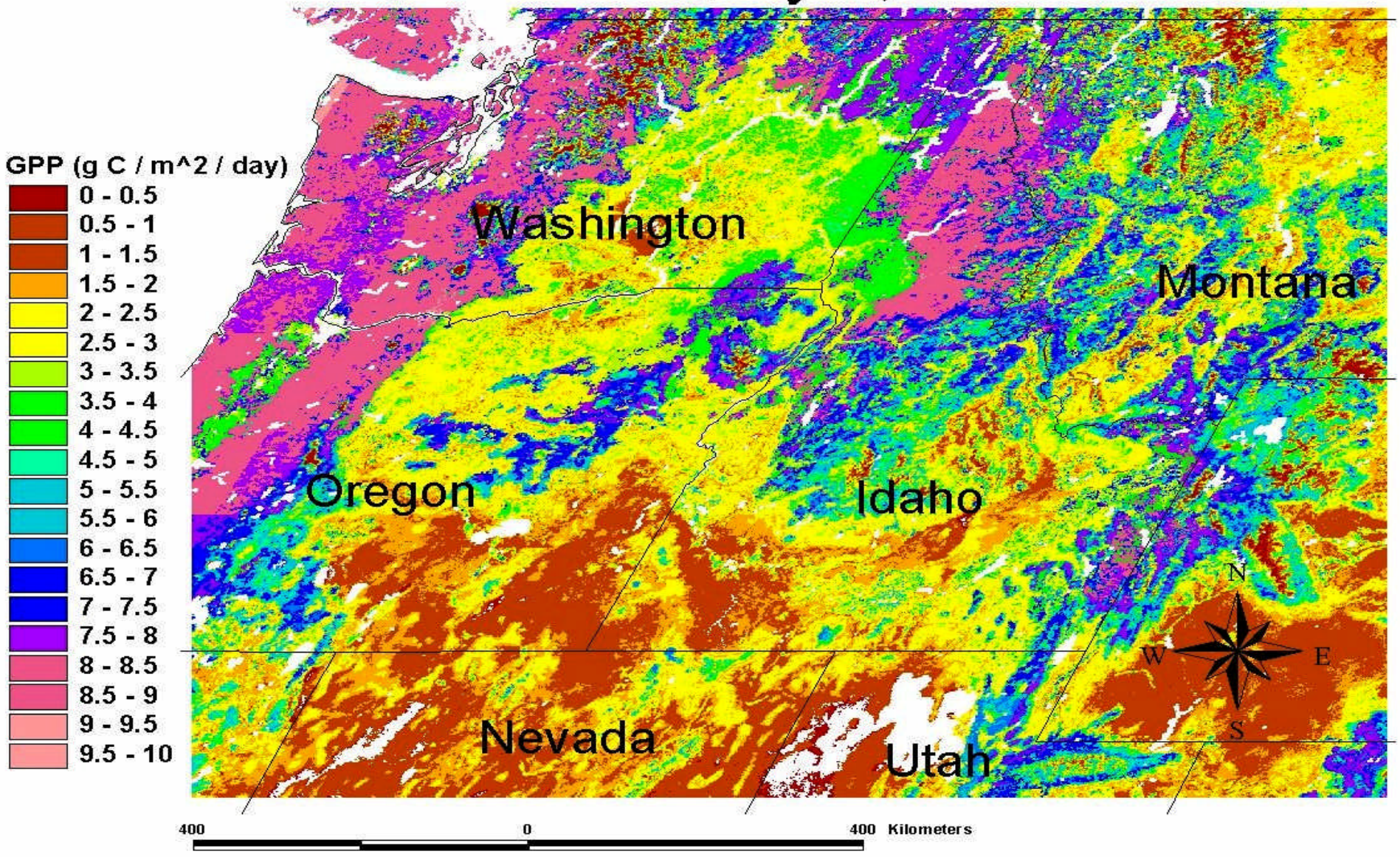

NTSG / U. Montana

MODIS Gross Primary Production (GPP)
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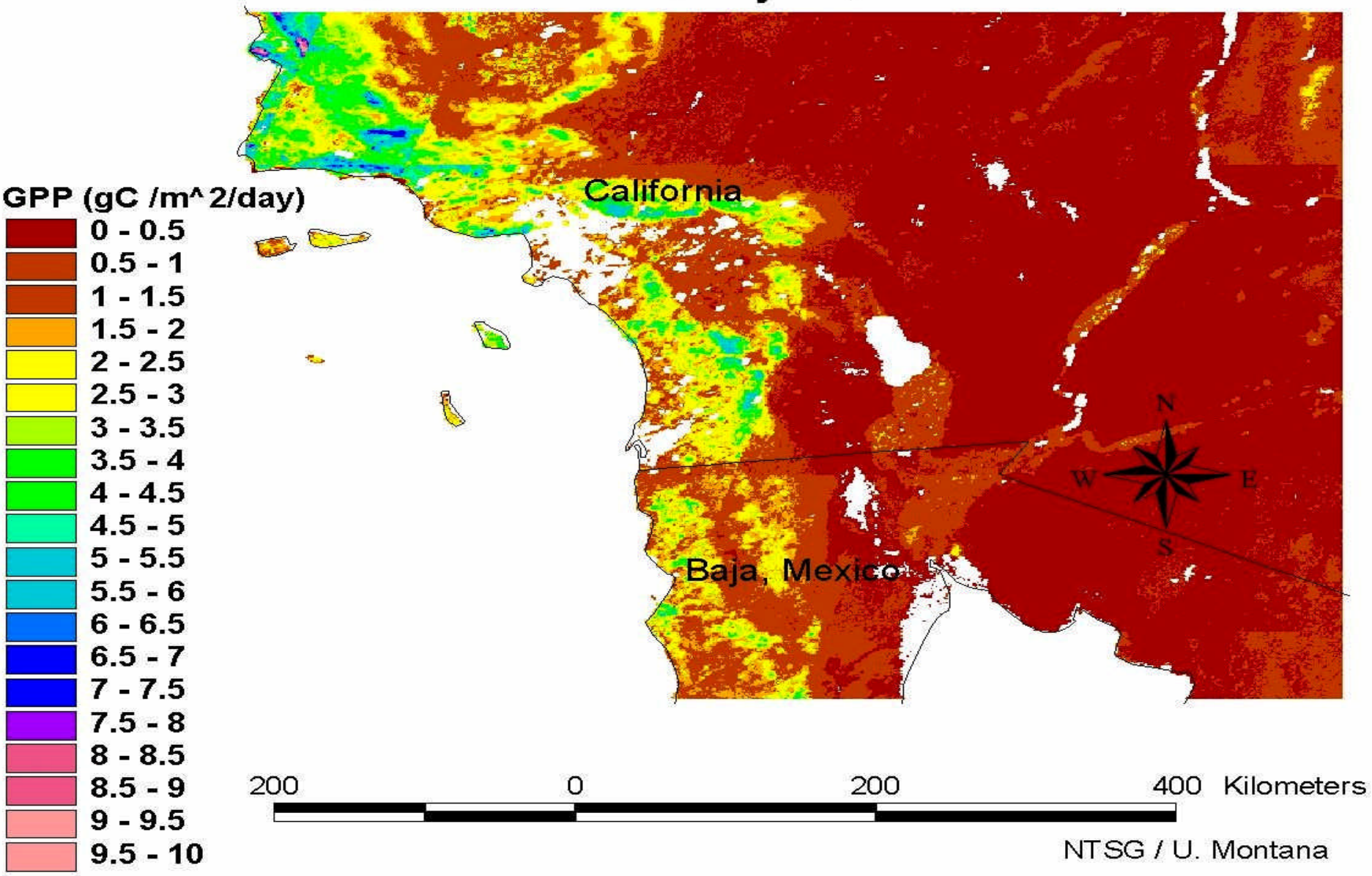
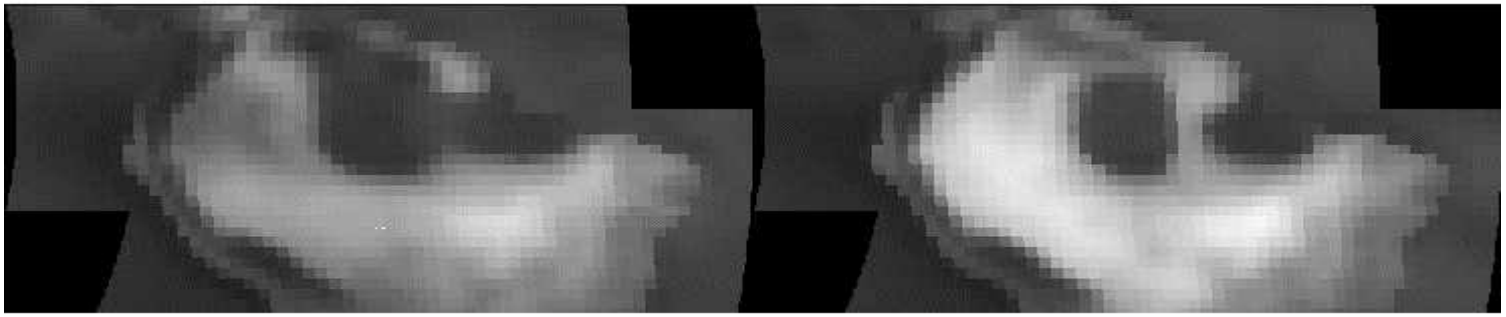
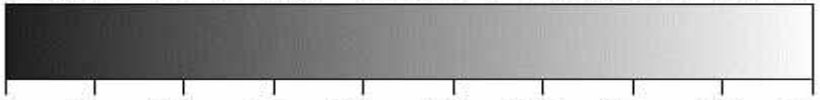


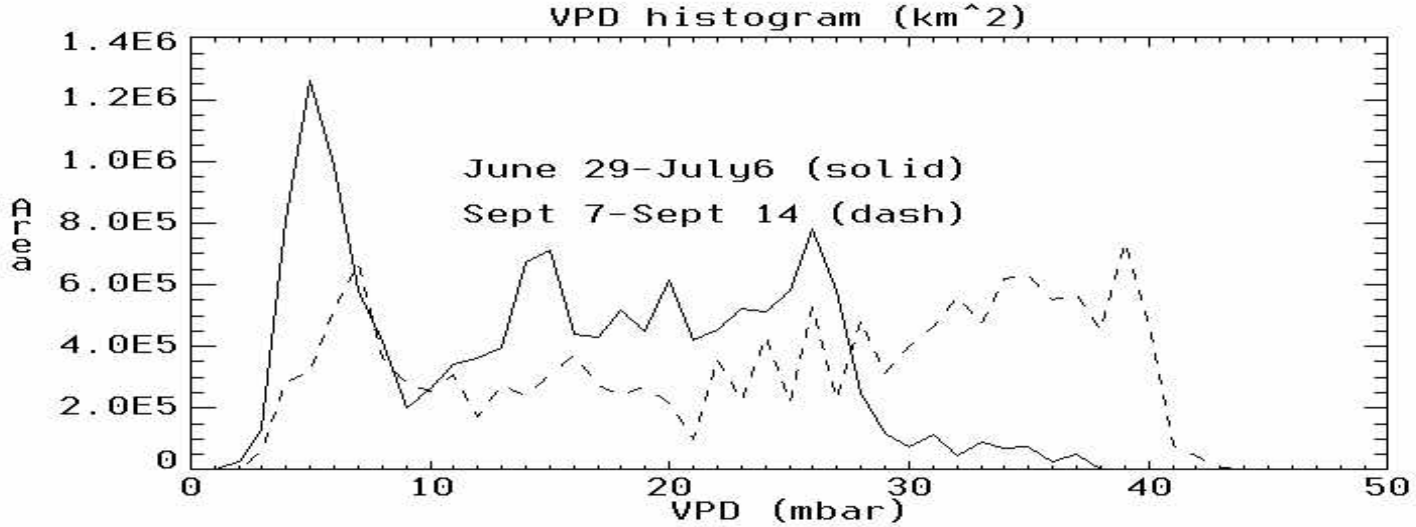
June 29 - July 6

Sept 7 - Sept 14



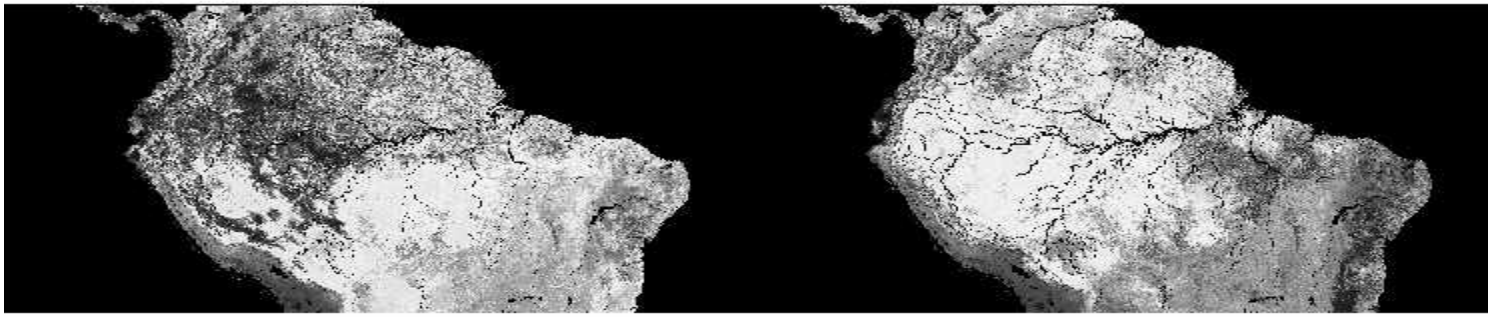
Daylight Average Vapor Pressure Deficit

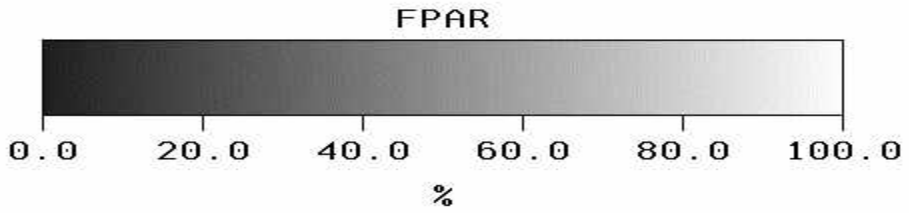


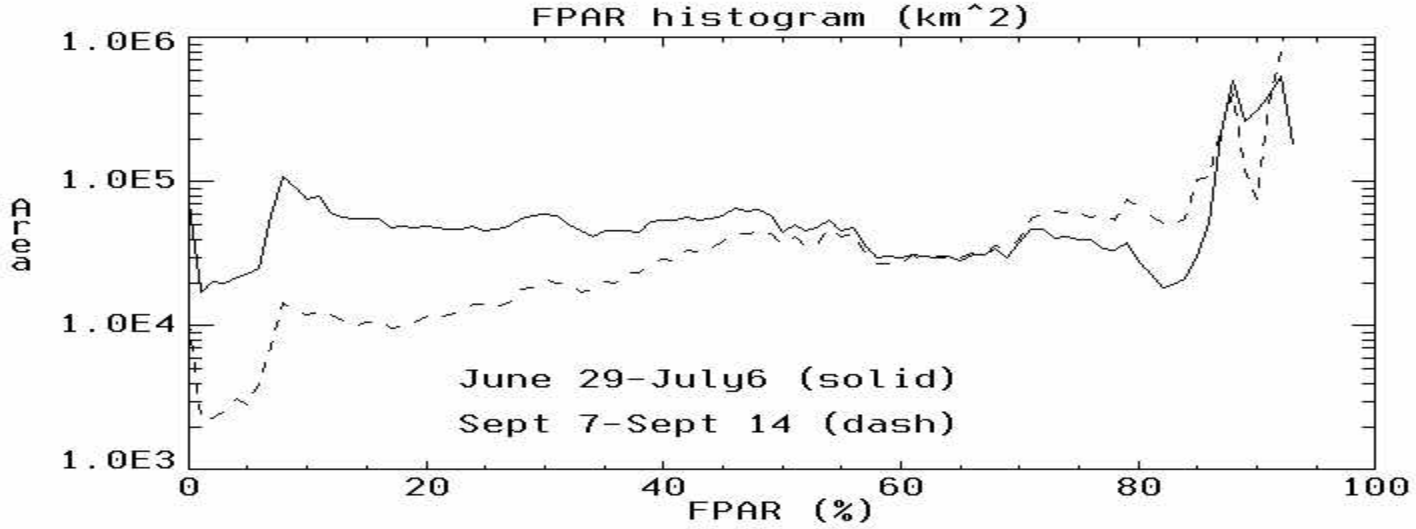


June 29 - July 6

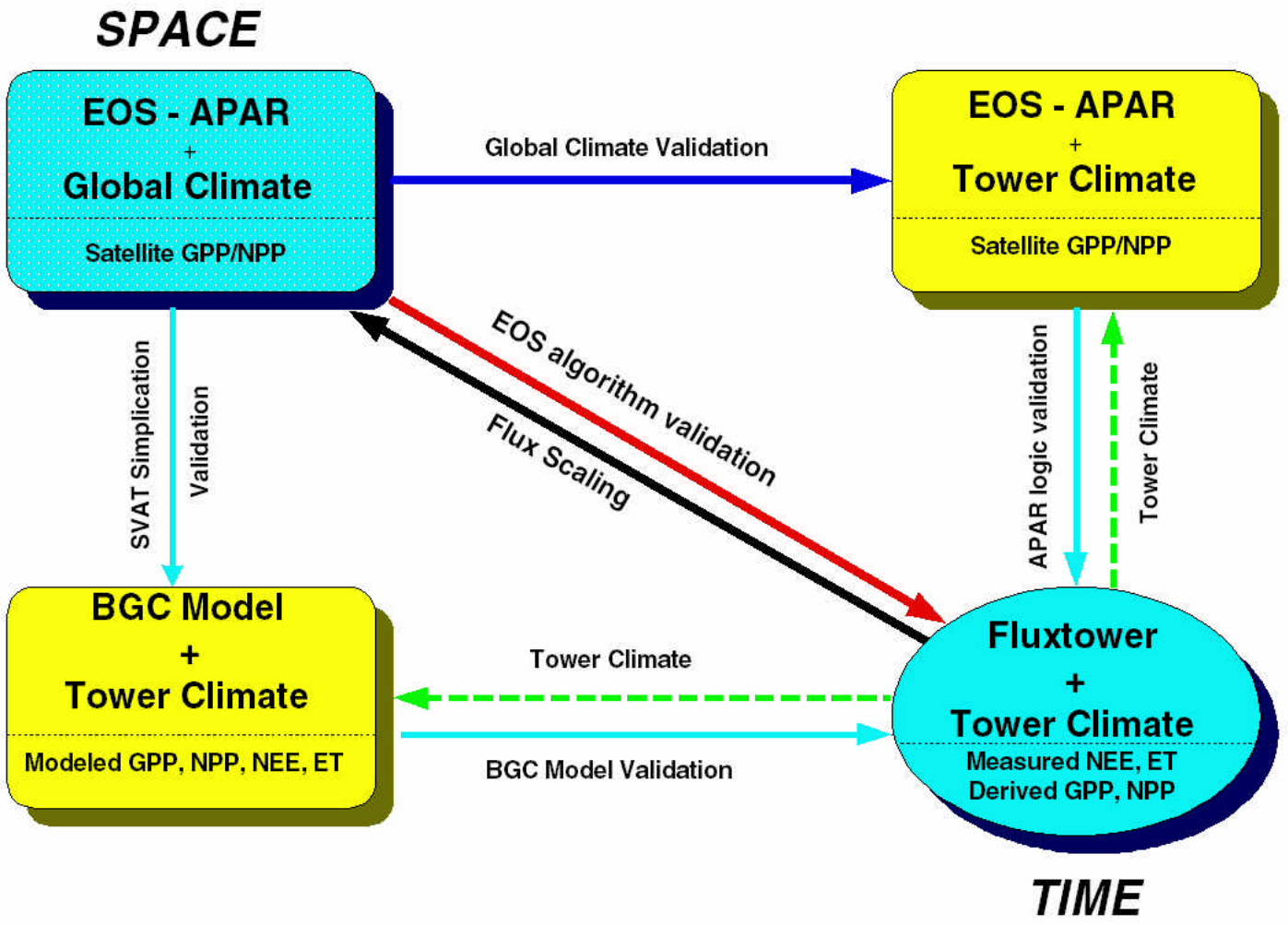
Sept 7 - Sept 14



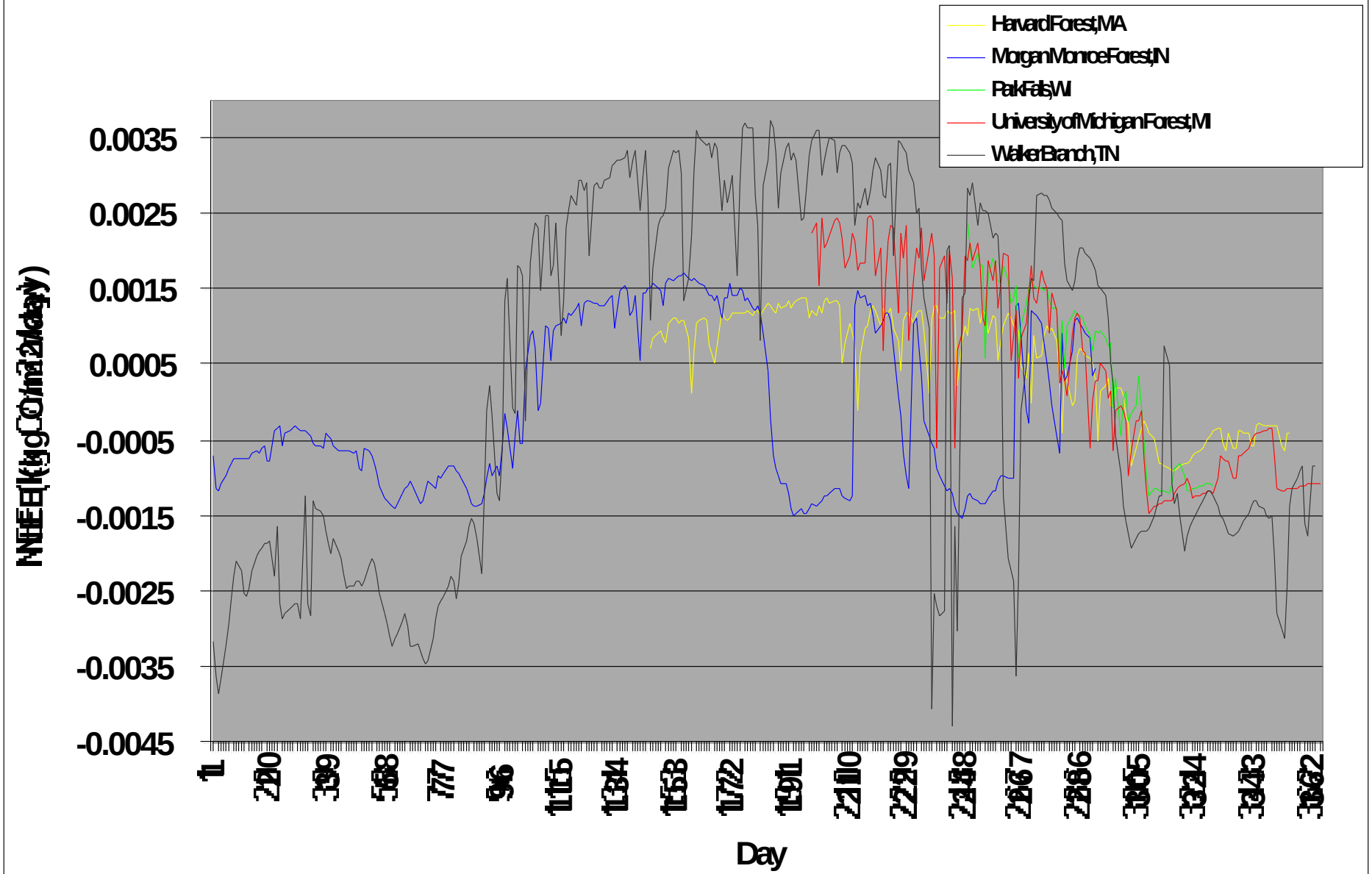




FLUX TOWER BASED VALIDATION FOR MODIS GPP/NPP



Deciduous Broadleaf Sites



SUMMARY

3 PROBLEMS IDENTIFIED AND SOLVED THIS YEAR

(1) Algorithm problem - Aug 2000
(2) Goddard DAO misdefined units - Aug 2000
(3) Goddard DAO surface rainfall problem - Nov. 2000

As of now we have not seen any MOD 17 data with the corrected DAO meteorology so we are unable to analyze or show what we consider publicly ready products.