Seasonal Variability Studies Across the Amazon Basin with MODIS Vegetation Indices

MOD13

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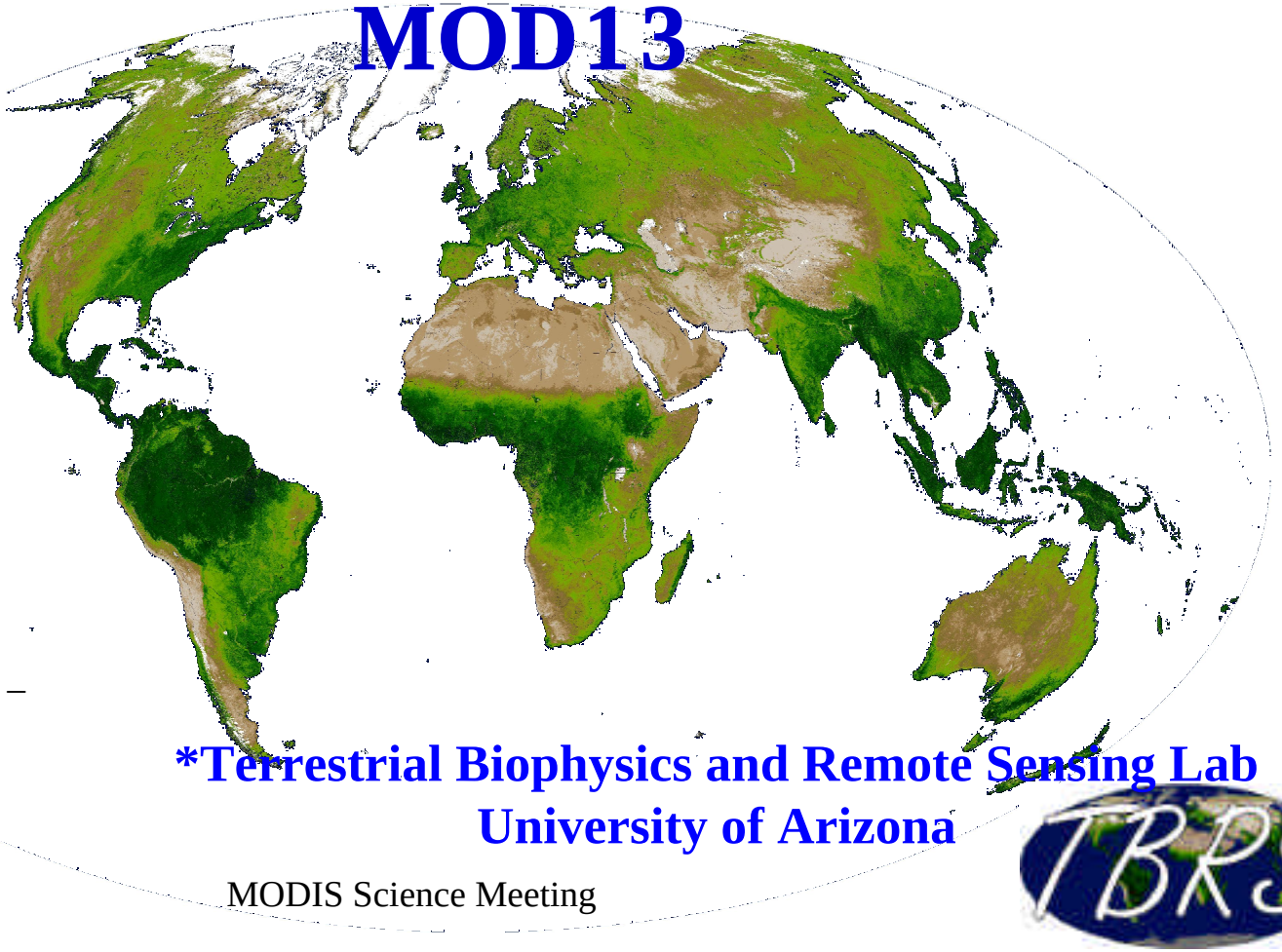


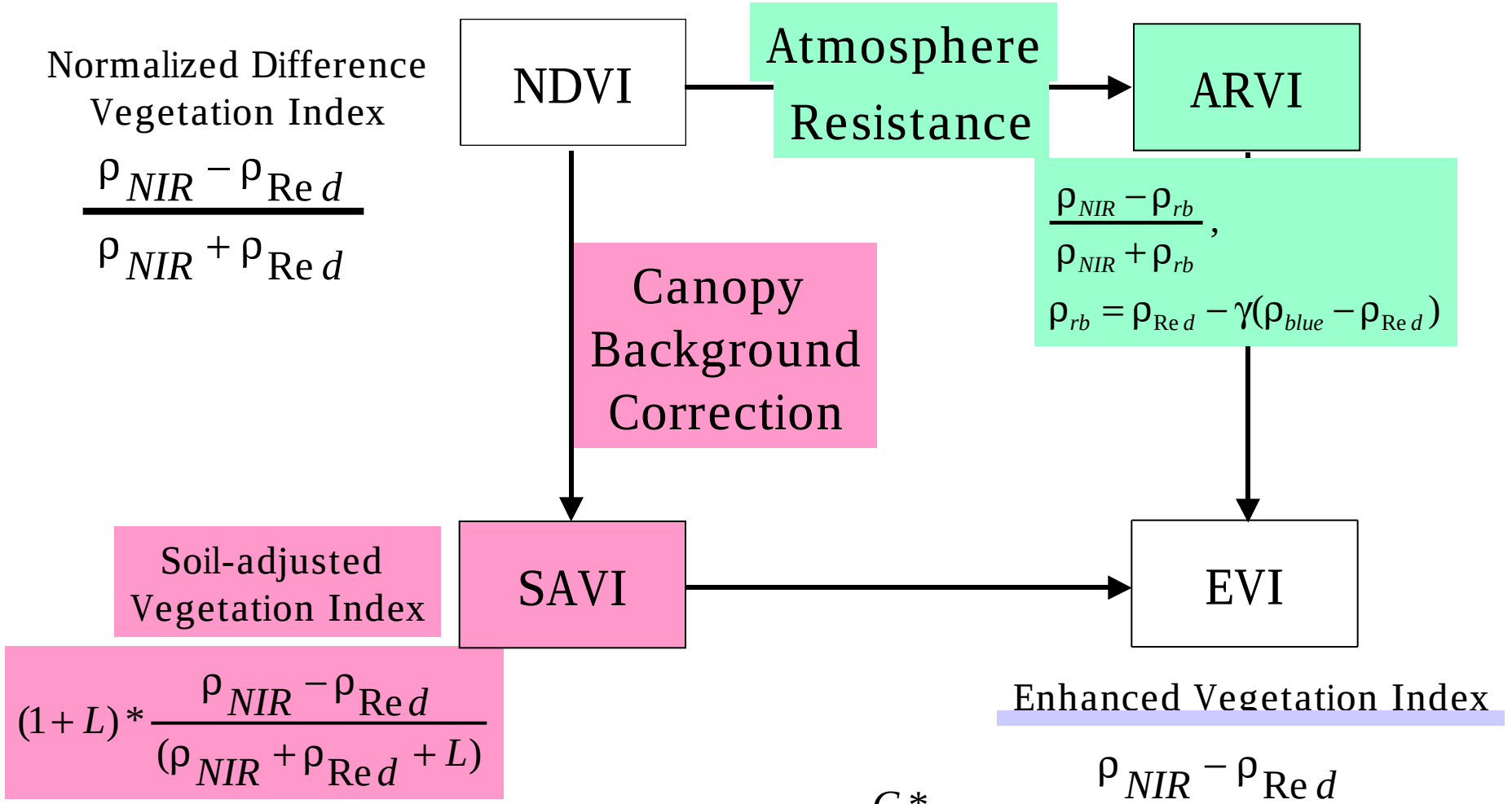
***Terrestrial Biophysics and Remote Sensing Lab**
University of Arizona

Validation

- Validation concerns the outputs or the intended uses of the VI's so as to help the user community understand the reliability, credibility, and limitations of the products.

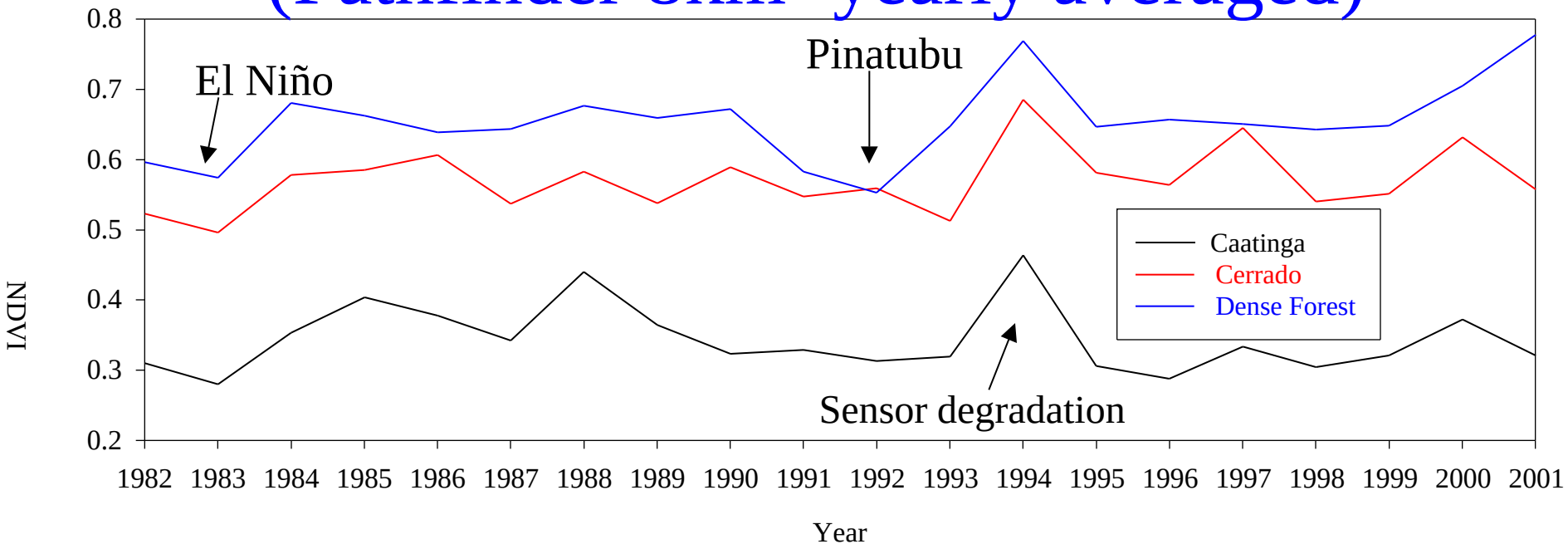
MOD09 (SR)--->

MODIS Vegetation Indices



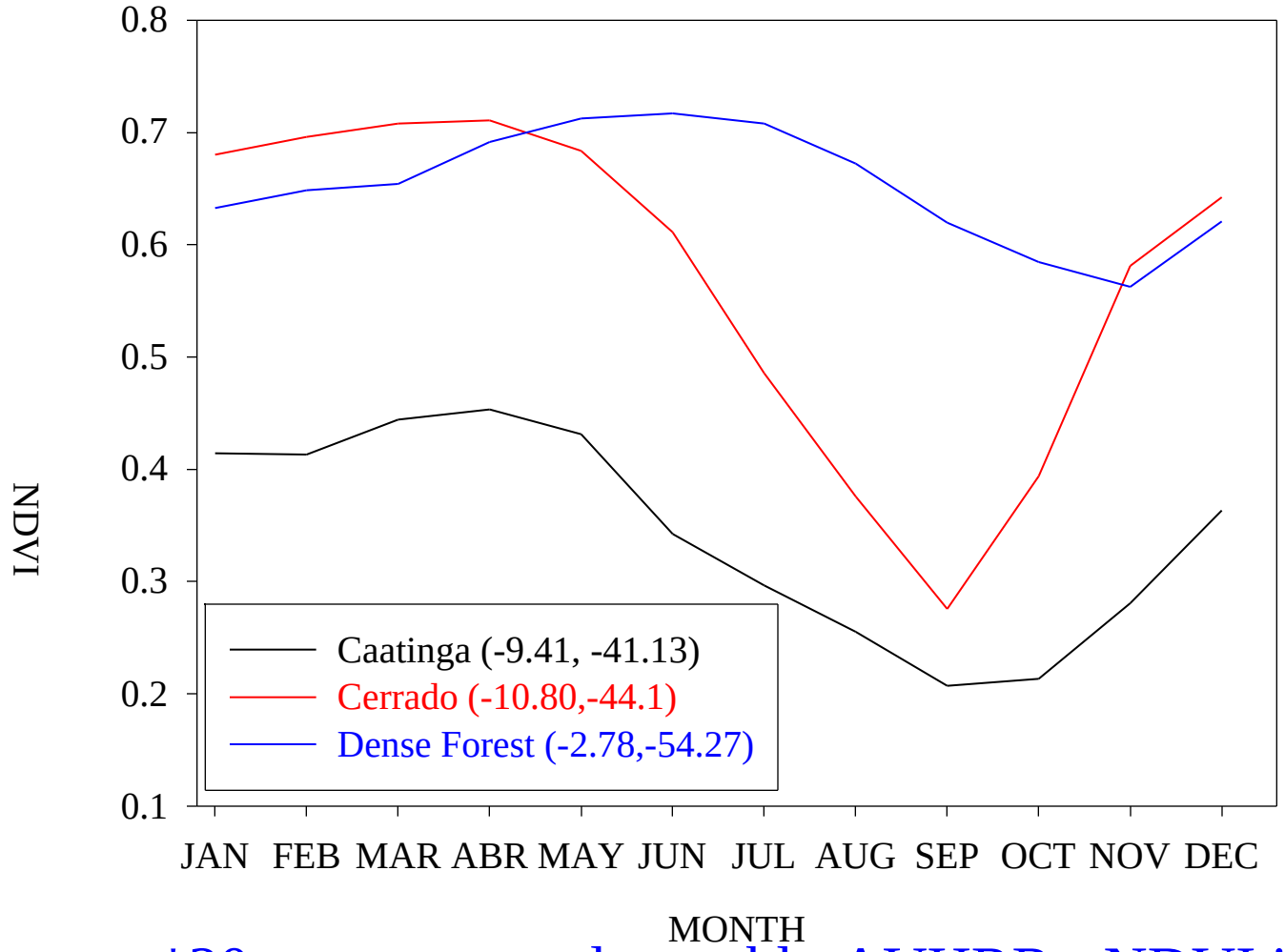
Long term, time series AVHRR-NDVI data

(Pathfinder 8km -yearly averaged)



- Accurate and stable time series data is needed for studies on interannual variation of vegetation in response to climate and for characterization of vegetation anomalies at continental and regional scales.

Seasonality & Phenology Role



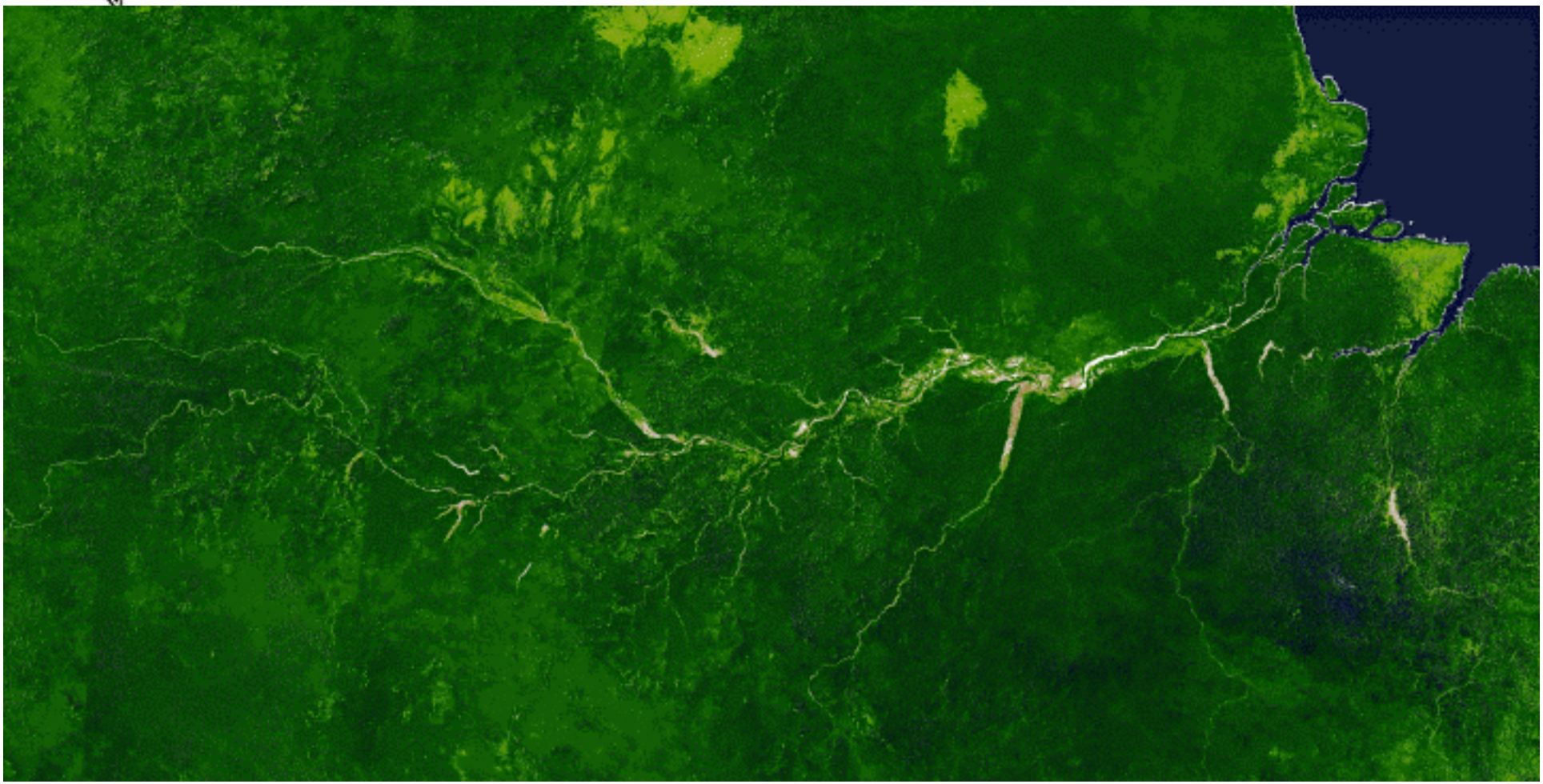
*20 year averaged monthly AVHRR - NDVI in Brazil (Pathfinder 8 km)

Objectives

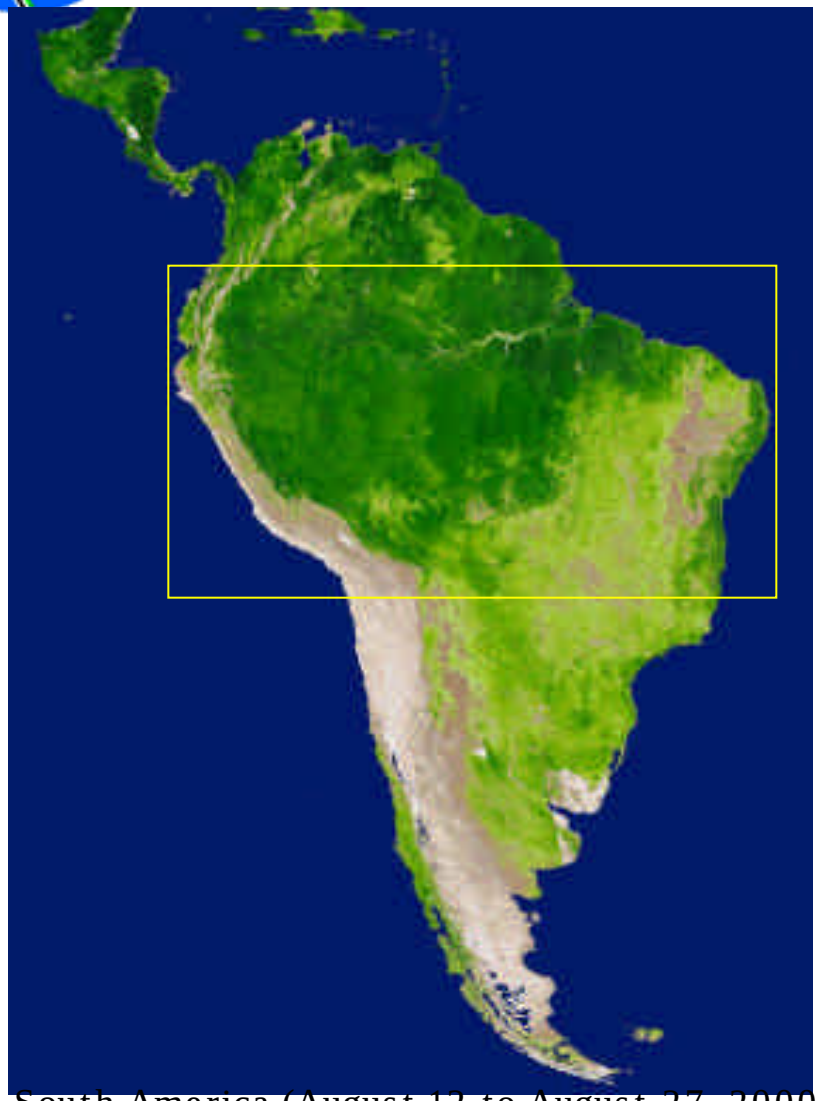
- Evaluate the initial two years of MODIS Vegetation Index (VI) time series data over the Amazon Basin and surrounding regions of Brazil,
- Examine the usefulness of MODIS data in characterizing seasonality along a climate-based ecological transect from the Brazilian cerrado to the seasonal tropical rainforests,
- Examine the usefulness of MODIS data in discriminating land use/conversion patterns and in characterizing the resulting changes in seasonality.

MODIS EVI

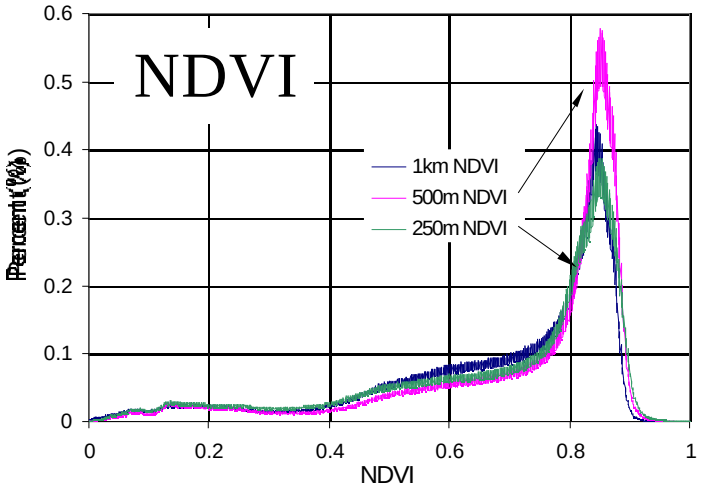
Seasonality (2000-2002)

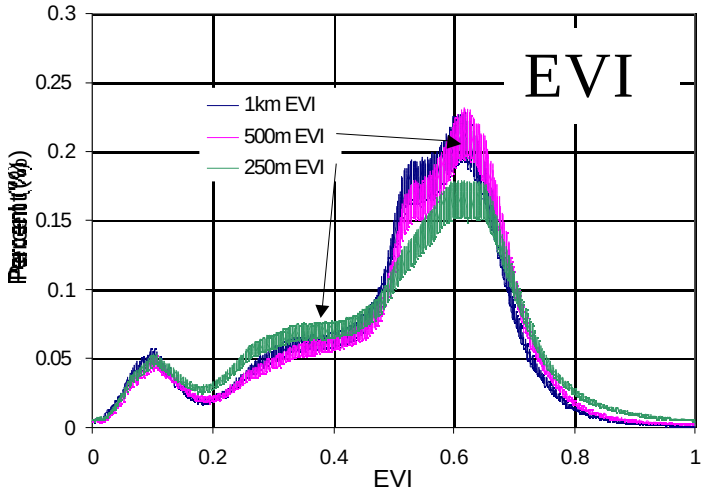


Histograms of VI's at 250 m, 500 m, and 1 km resolutions



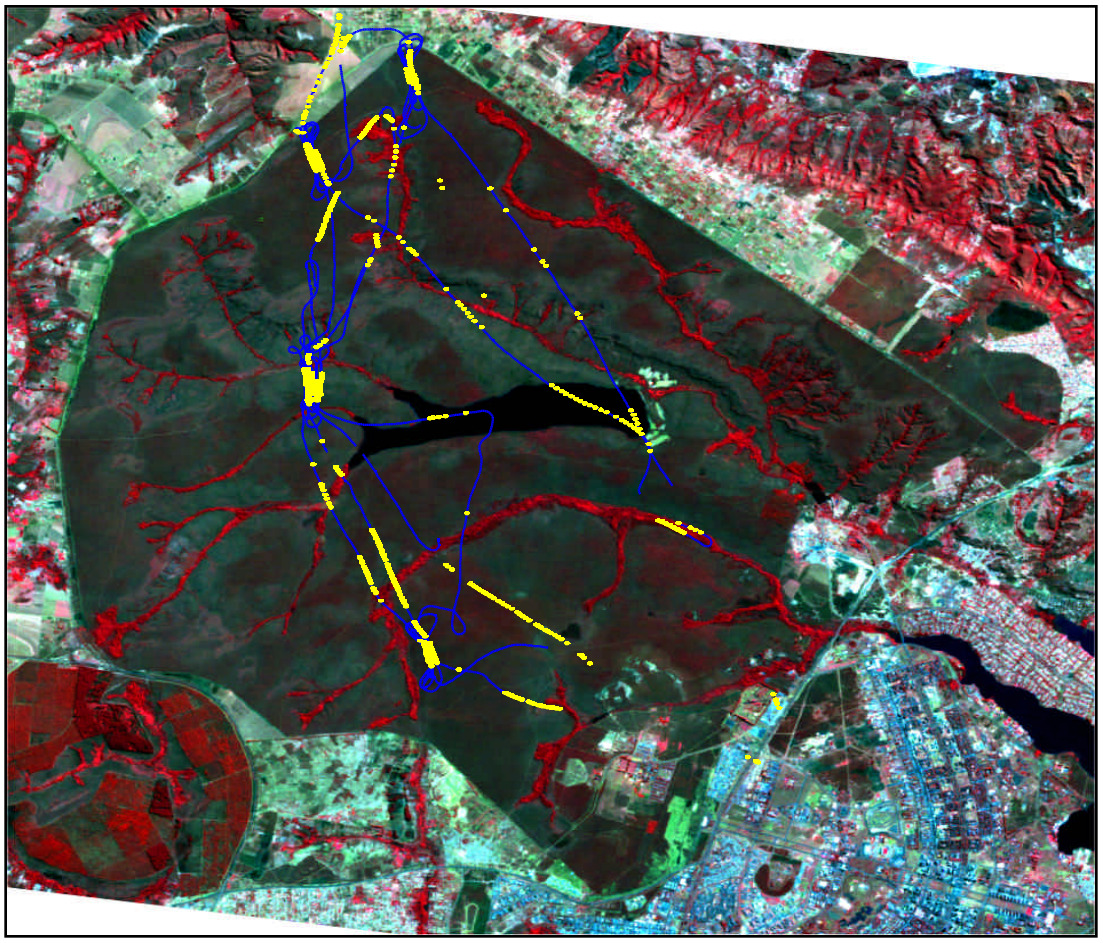
South America (August 12 to August 27, 2000)



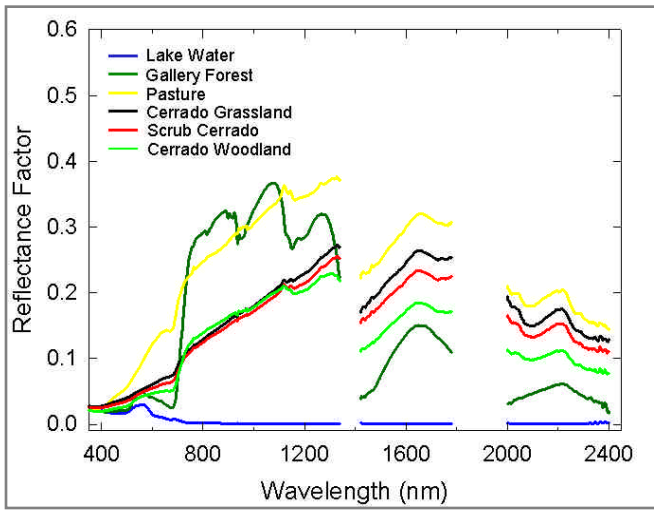



MODIS

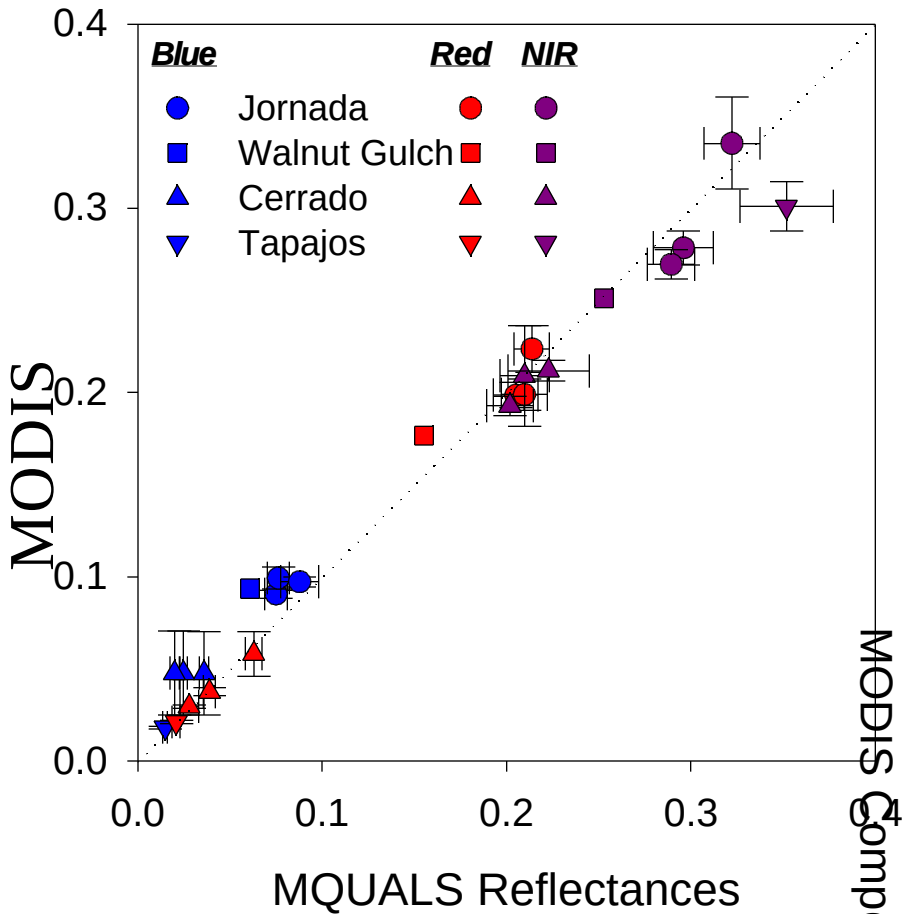
Brasilia National Park

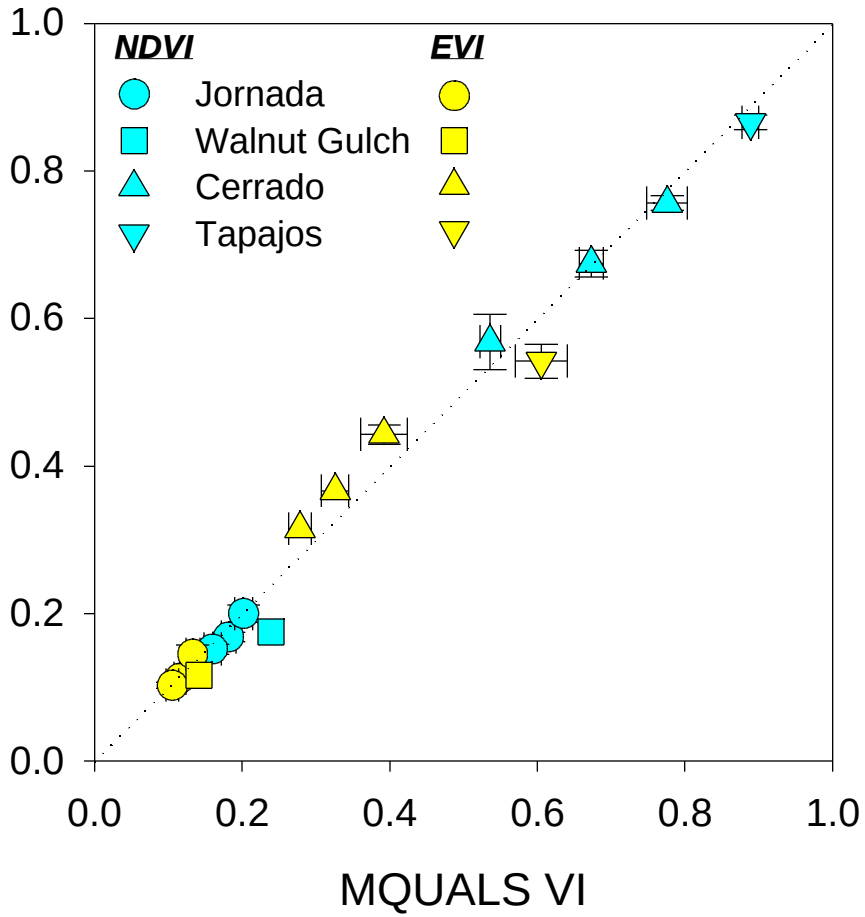


- Blue = ASD
- Yellow = Digital Images

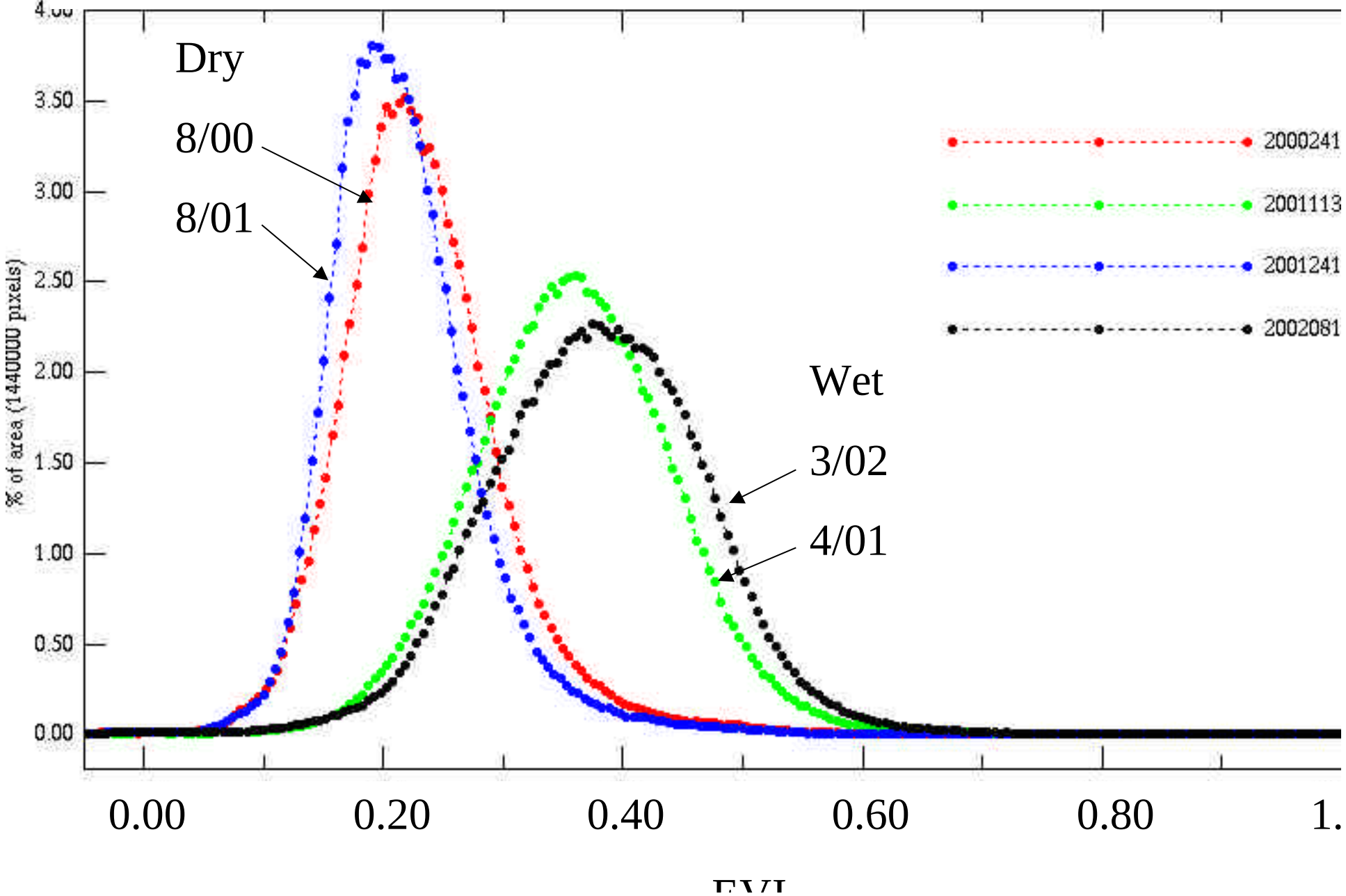


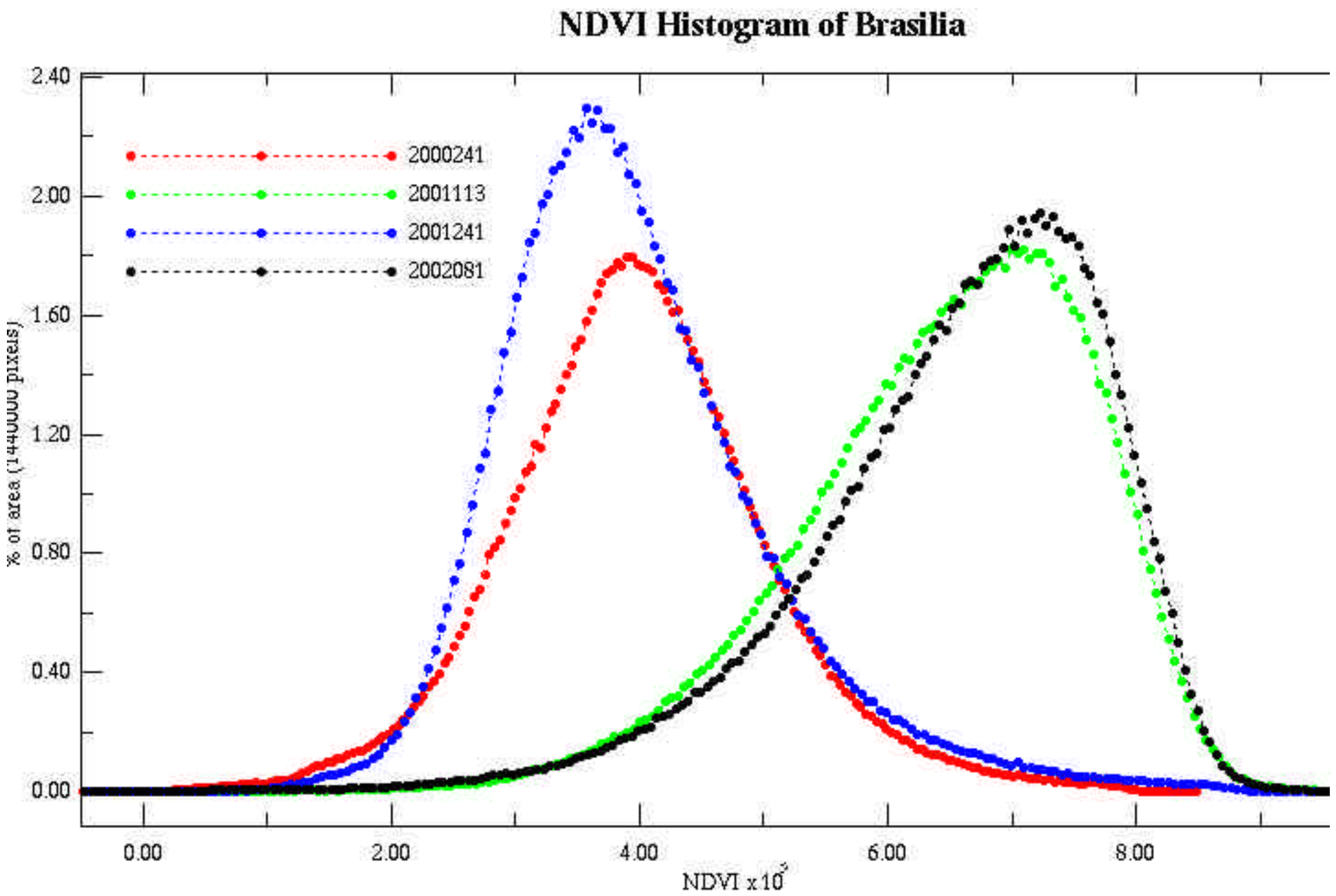
MQUALS and MODIS (Global)

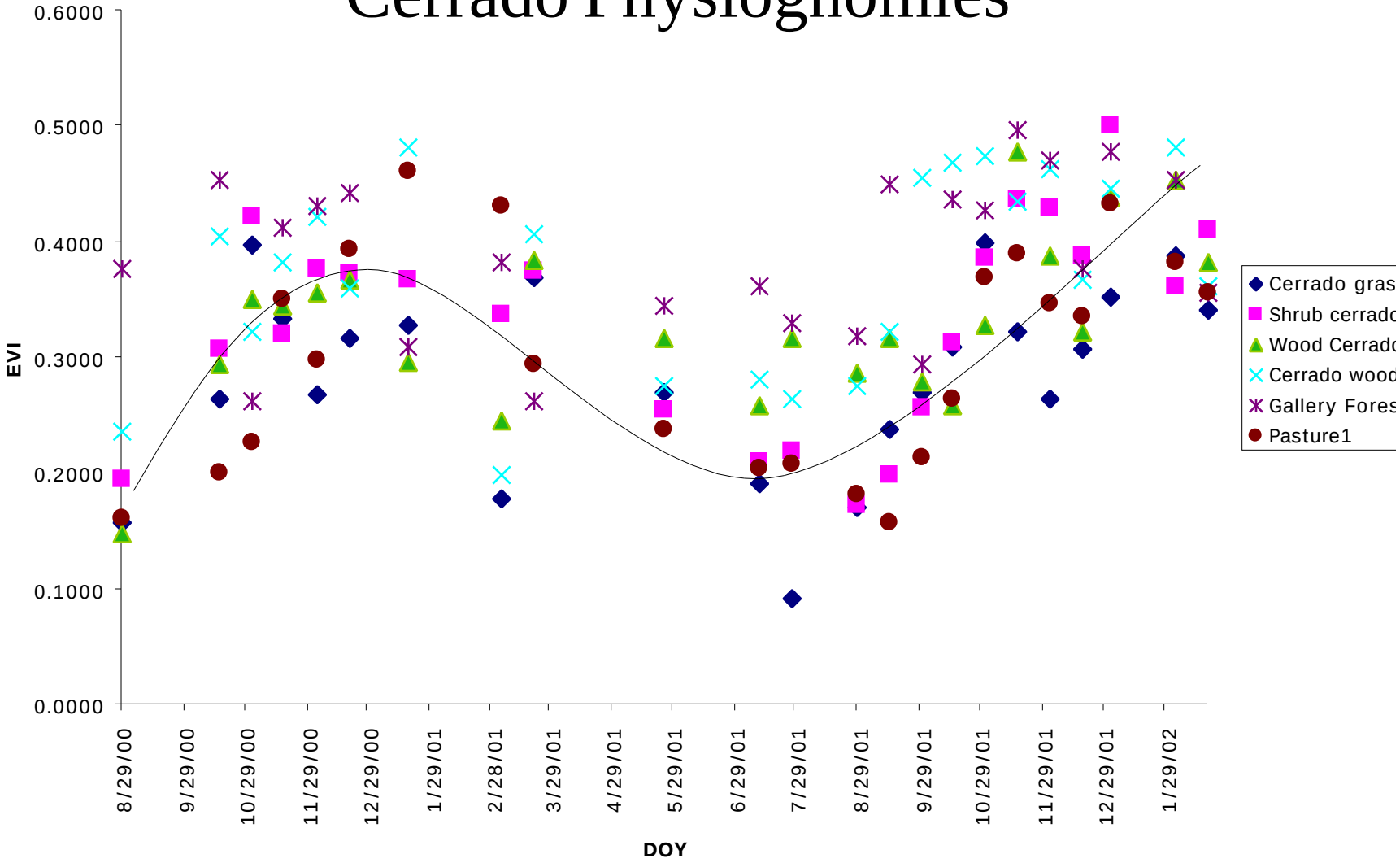




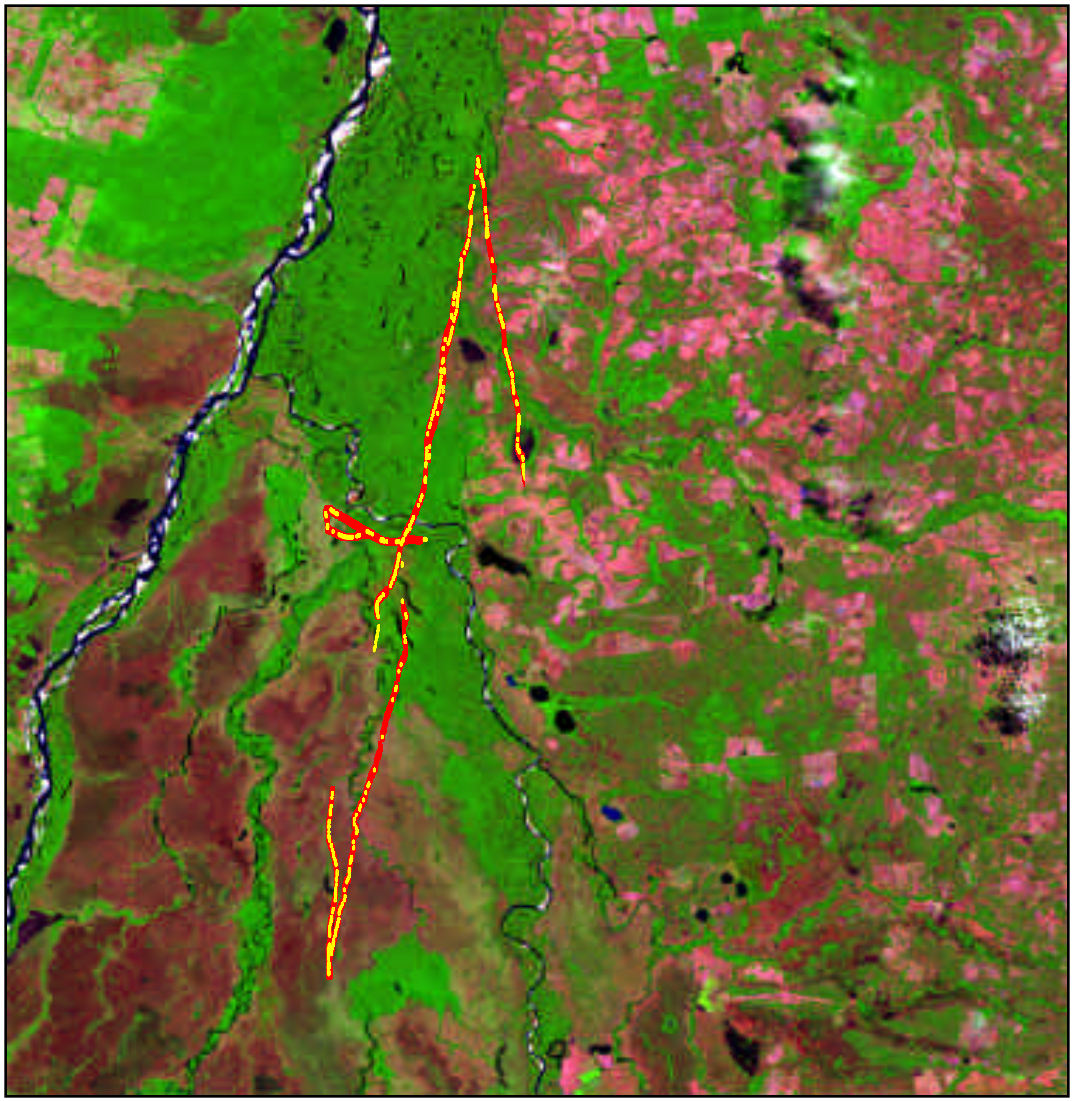
EVI Histogram of Brasilia Tile (Cerrado + conversion




NDVI Histogram of Brasilia
2000241
2001113
2001241
2002081
% of area (1440000 pixels)
2.40
2.00
1.60
1.20
0.80
0.40
0.00
0.00
2.00
4.00
6.00
8.00
NDVI x10


Cerrado physiognomies
Cerrado Physiognomies
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
EVI
8/29/00
9/29/00
10/29/00
11/29/00
12/29/00
1/29/01
2/28/01
3/29/01
4/29/01
5/29/01
6/29/01
7/29/01
8/29/01
9/29/01
10/29/01
11/29/01
12/29/01
1/29/02
DOY
Cerrado gras
Shrub cerrado
Wood Cerrado
Cerrado wood
Gallery Fores
Pasture1

Cangaçu & Santana do Araguaia



- Red = ASD
- Yellow = Digital Images

MODIS VI Seasonal Profiles of Land Converted Areas

Primary Forest ("***High***")

biomass:
147.16 to 205.29 t / ha
LAI: **5.61 to 7.06**

Pasture site

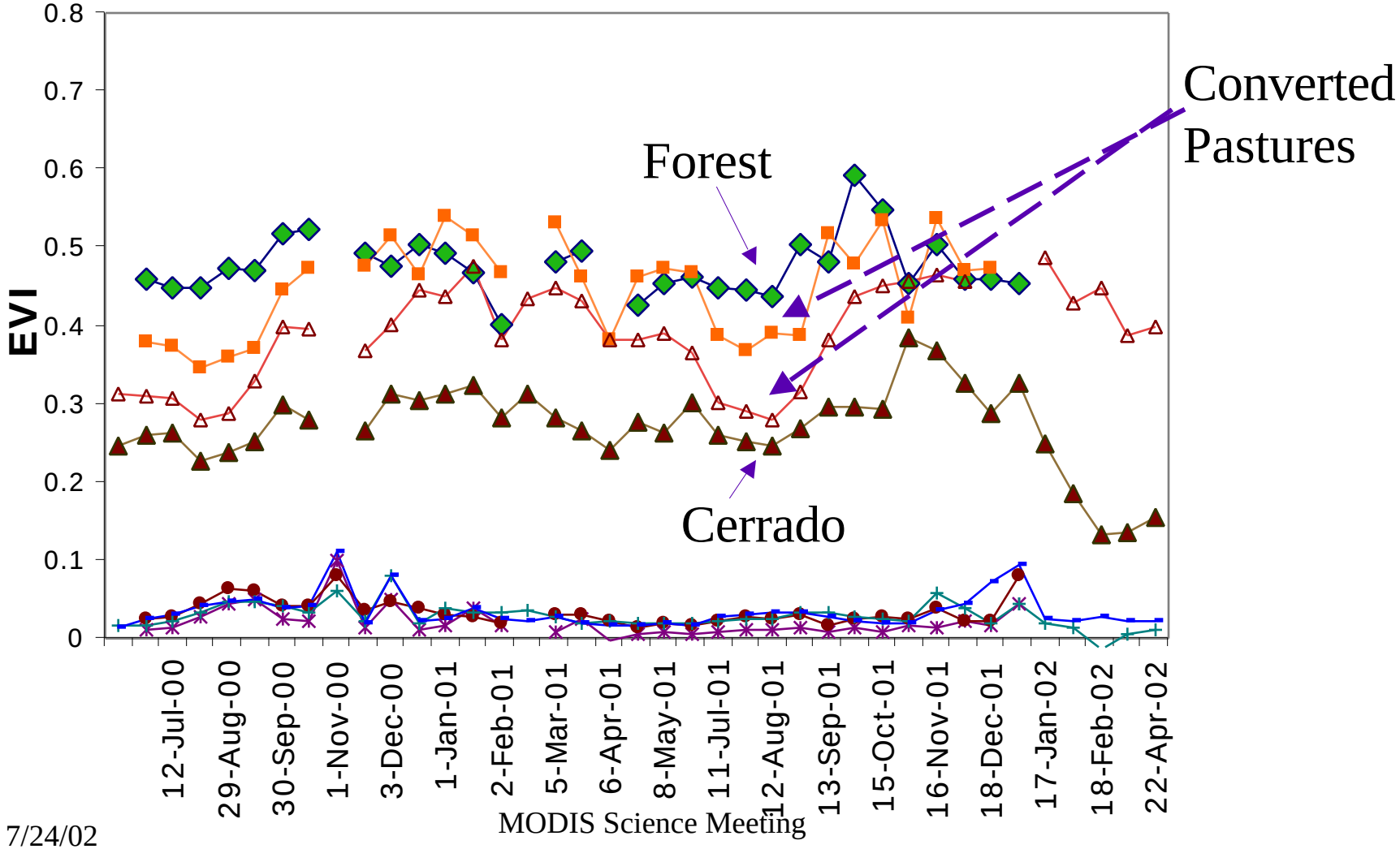
biomass:
~1.3 t / ha
LAI: **~2.82**

Regeneration site

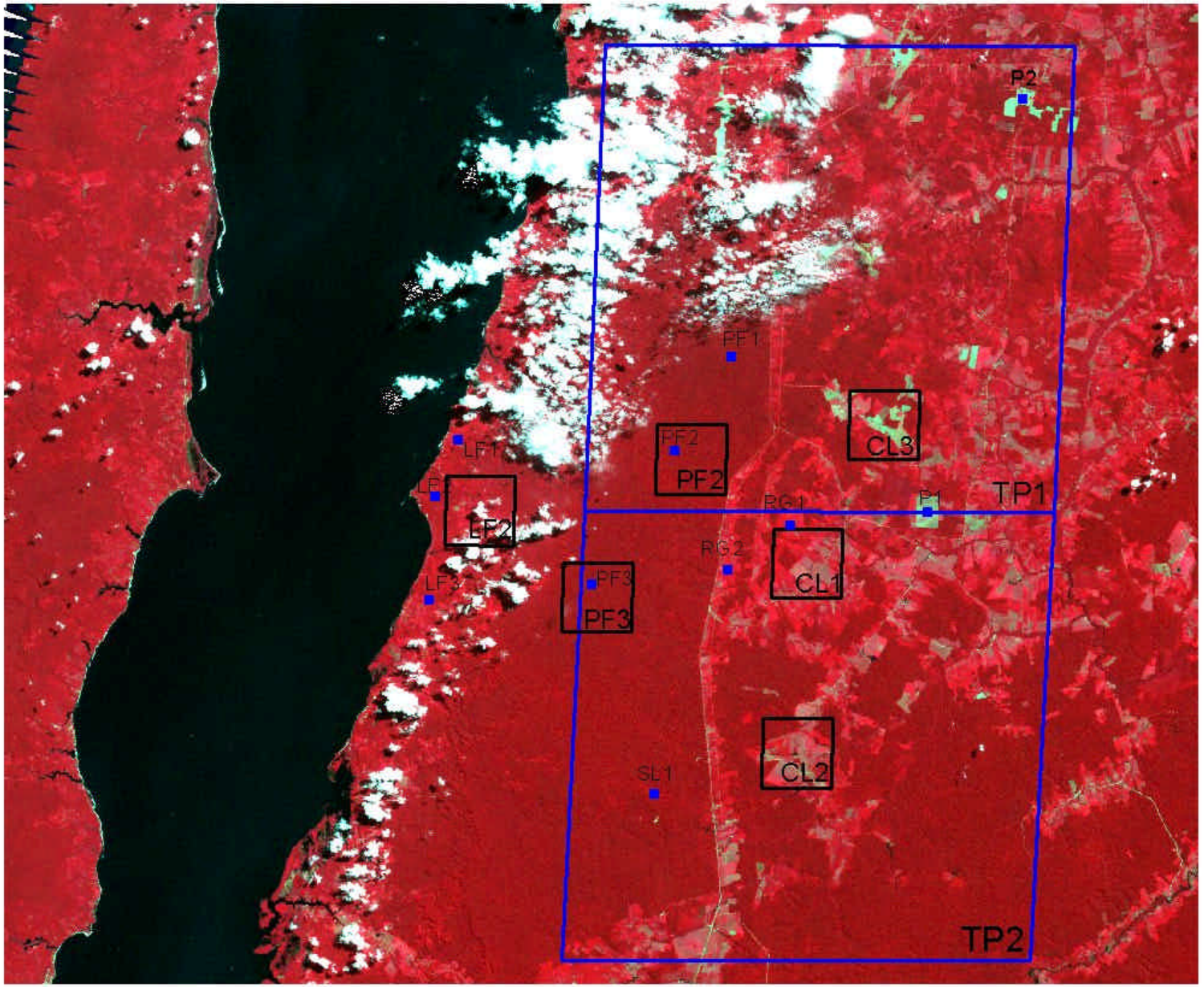
biomass:
6.85 to 134.94 t / ha
LAI: **4.11 to 6.27**

MODIS 250m EVI

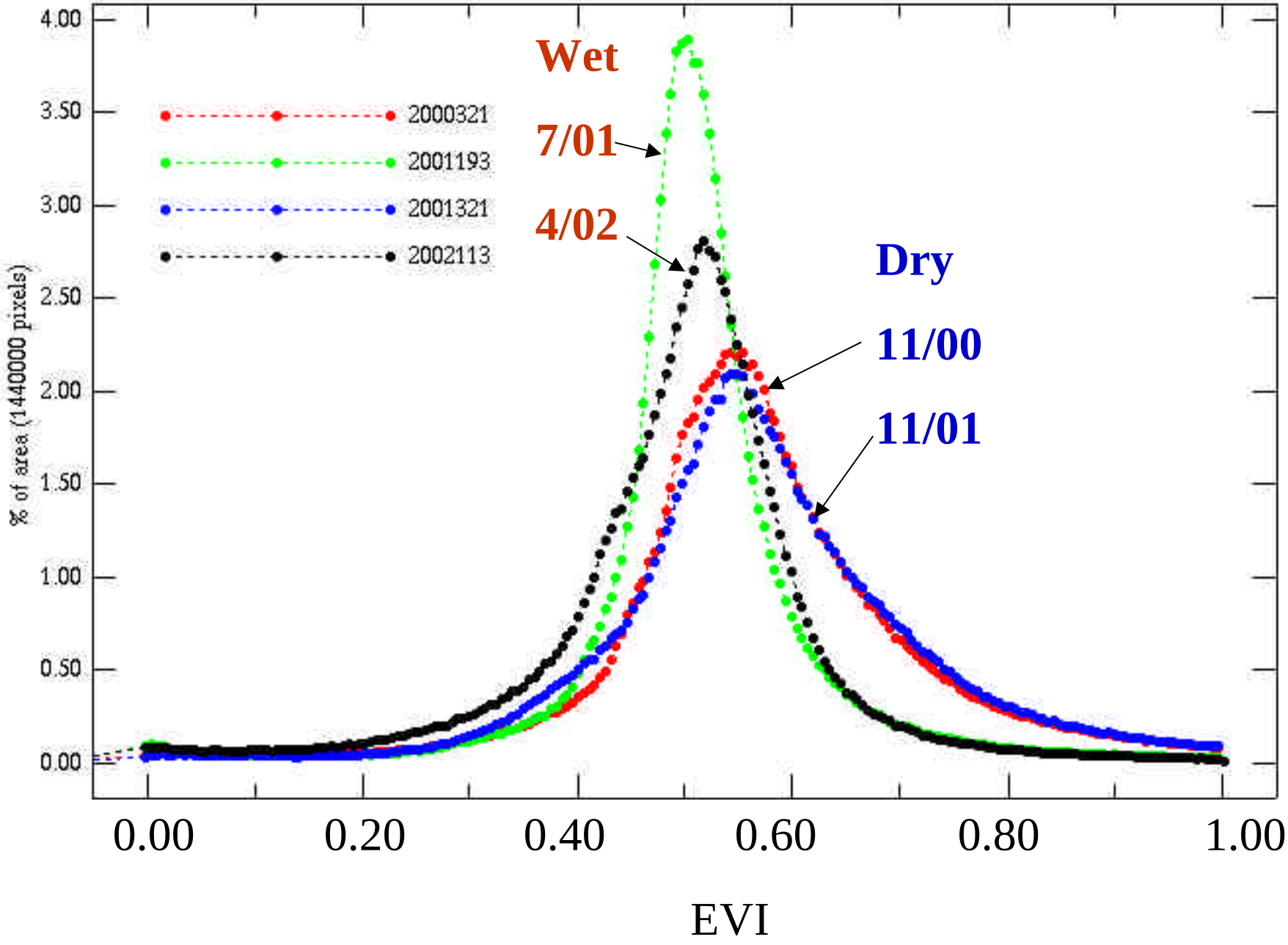
Land Conversion at Santana do Araguaia & Cangaçu (Forest - Cerrado Transition)

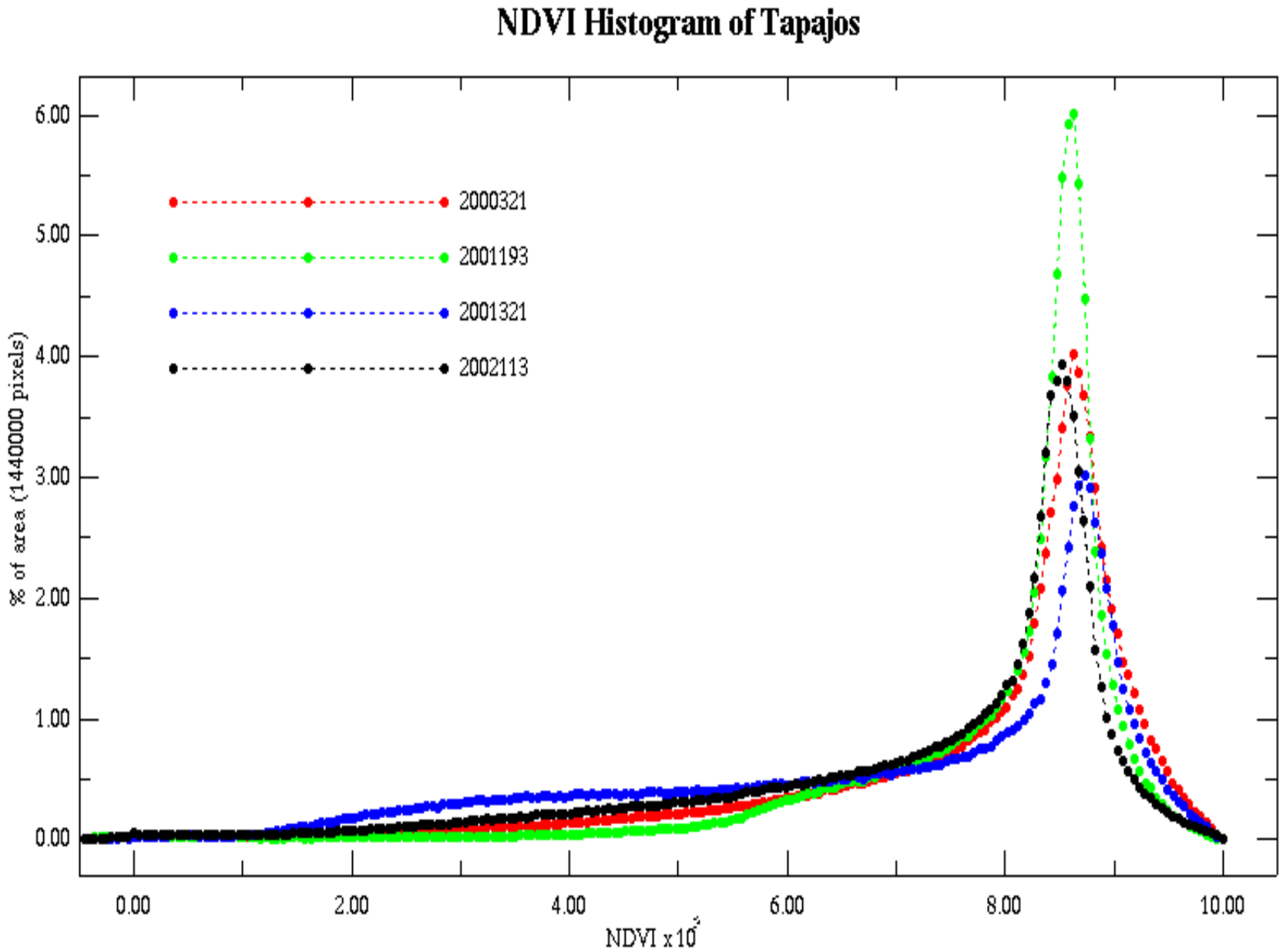


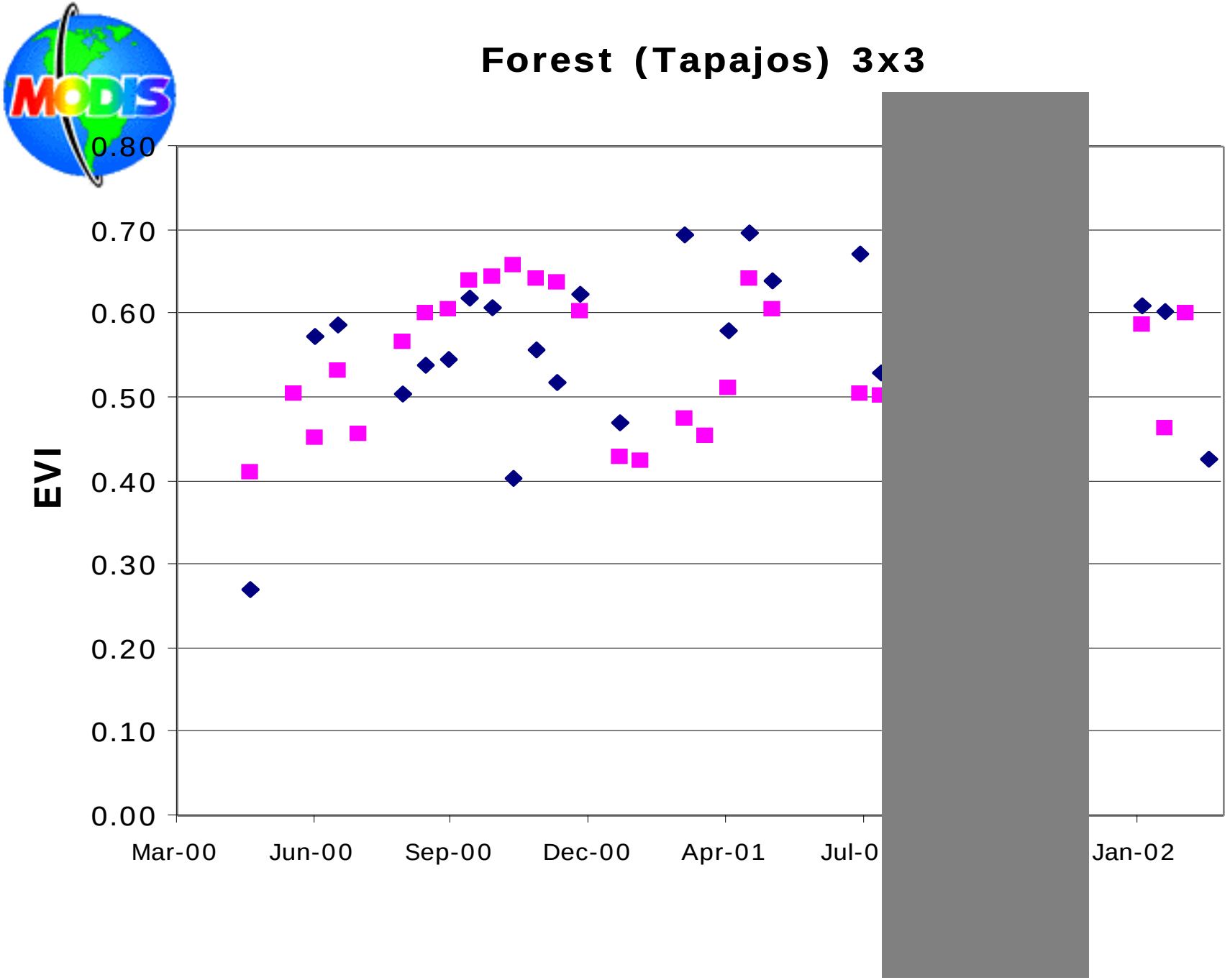
Tapajos Extraction Sites



EVI Histogram of Tapajos Tile (Seasonal Forest)

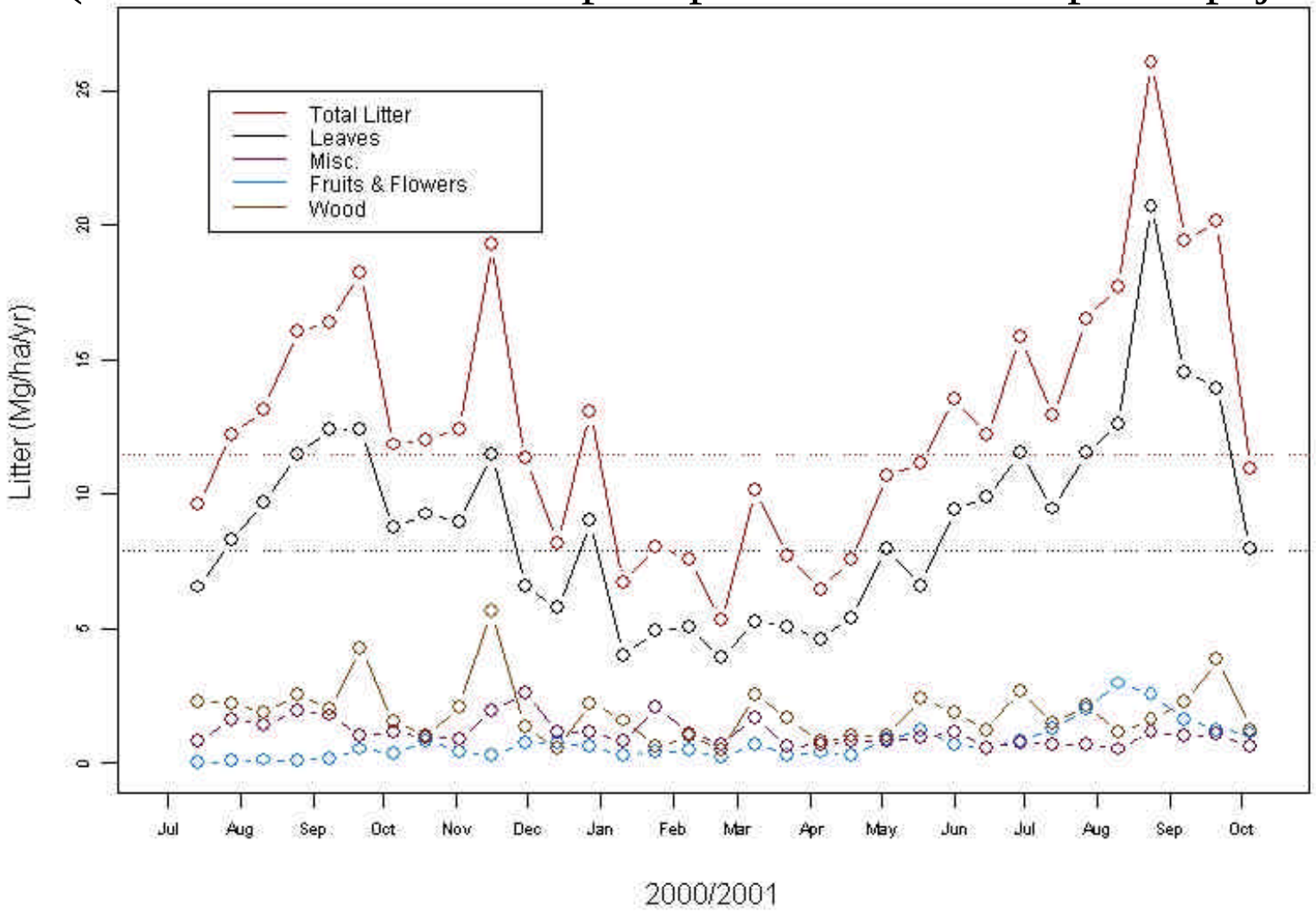


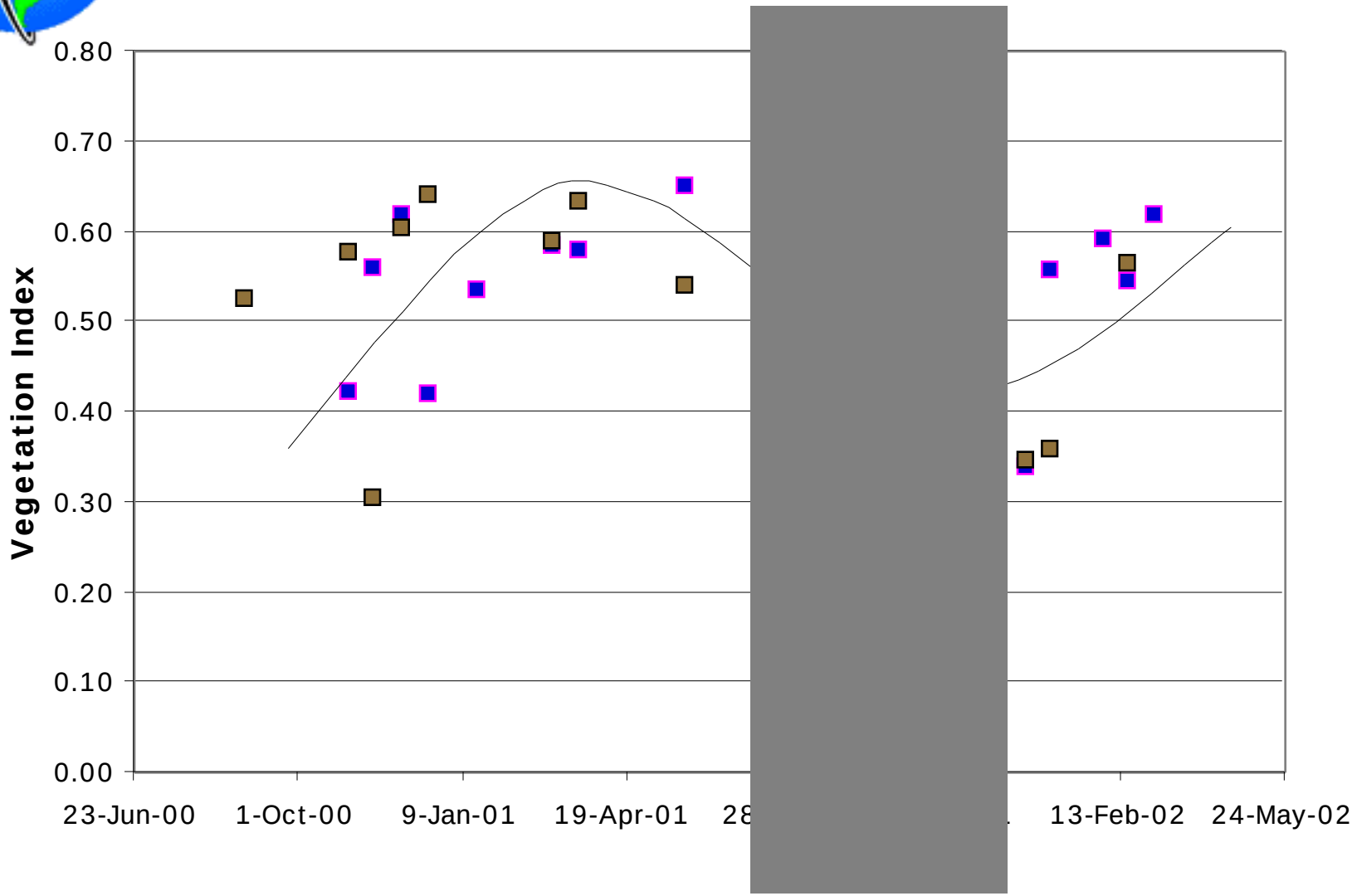

NDVI Histogram of Tapajos
2000321
2001193
2001321
2002113
% of area (1440000 pixels)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
2.00
4.00
6.00
8.00
10.00
NDVI x 10

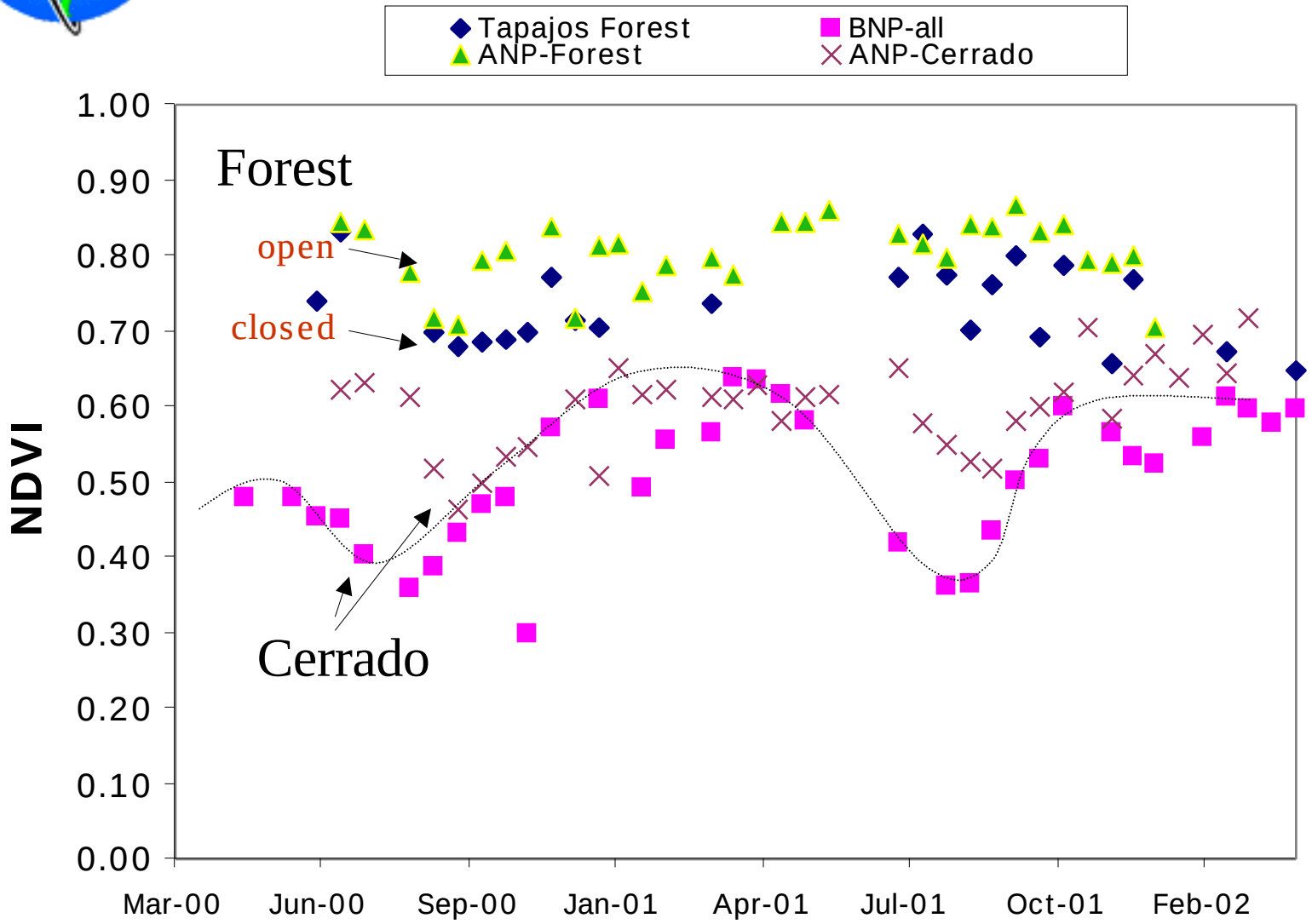

Forest (Tapajos) 3x3
EVI
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Mar-00
Jun-00
Sep-00
Dec-00
Apr-01
Jul-0
Jan-02

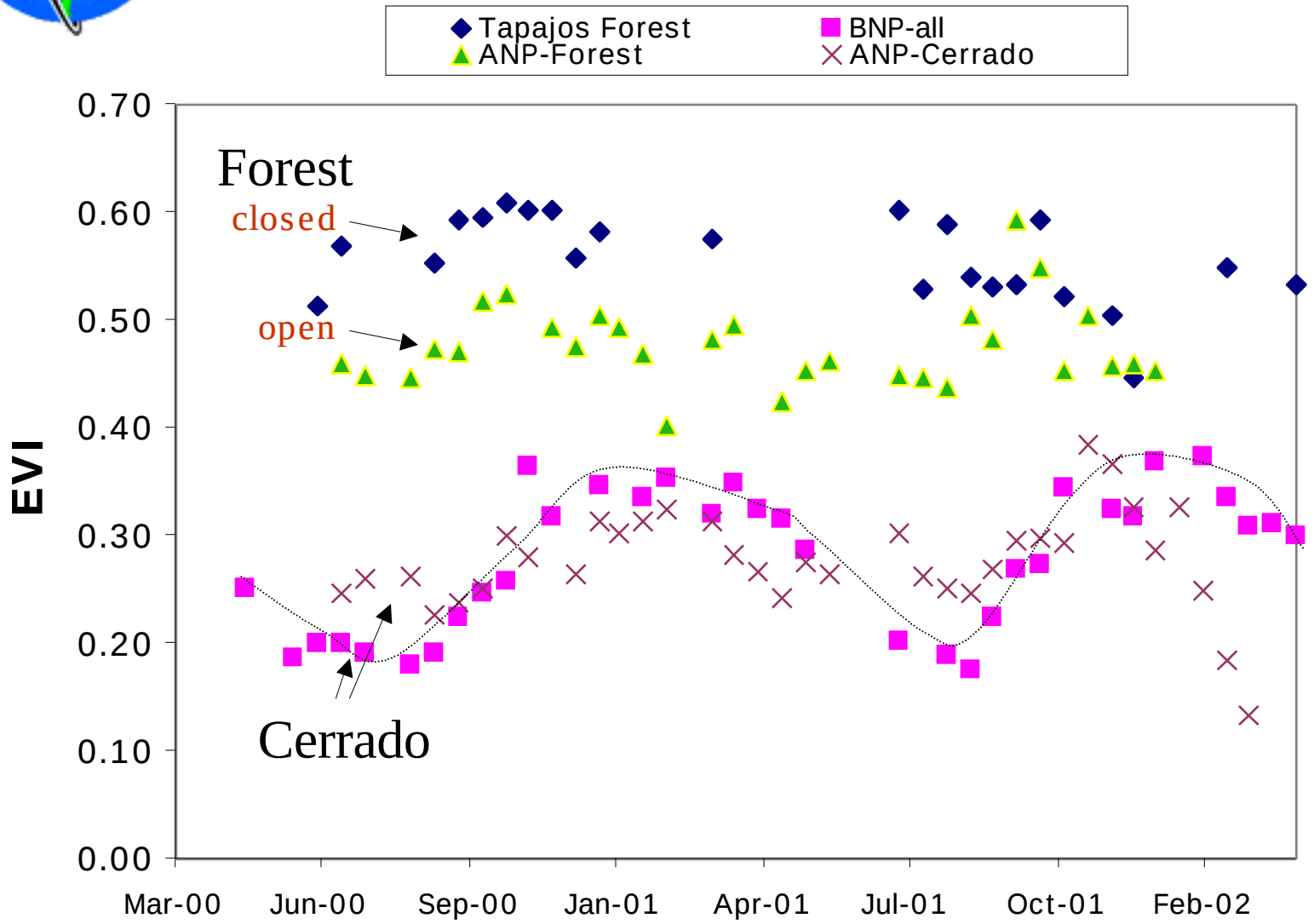
Litterfall Seasonal Dynamics (Tapajos)

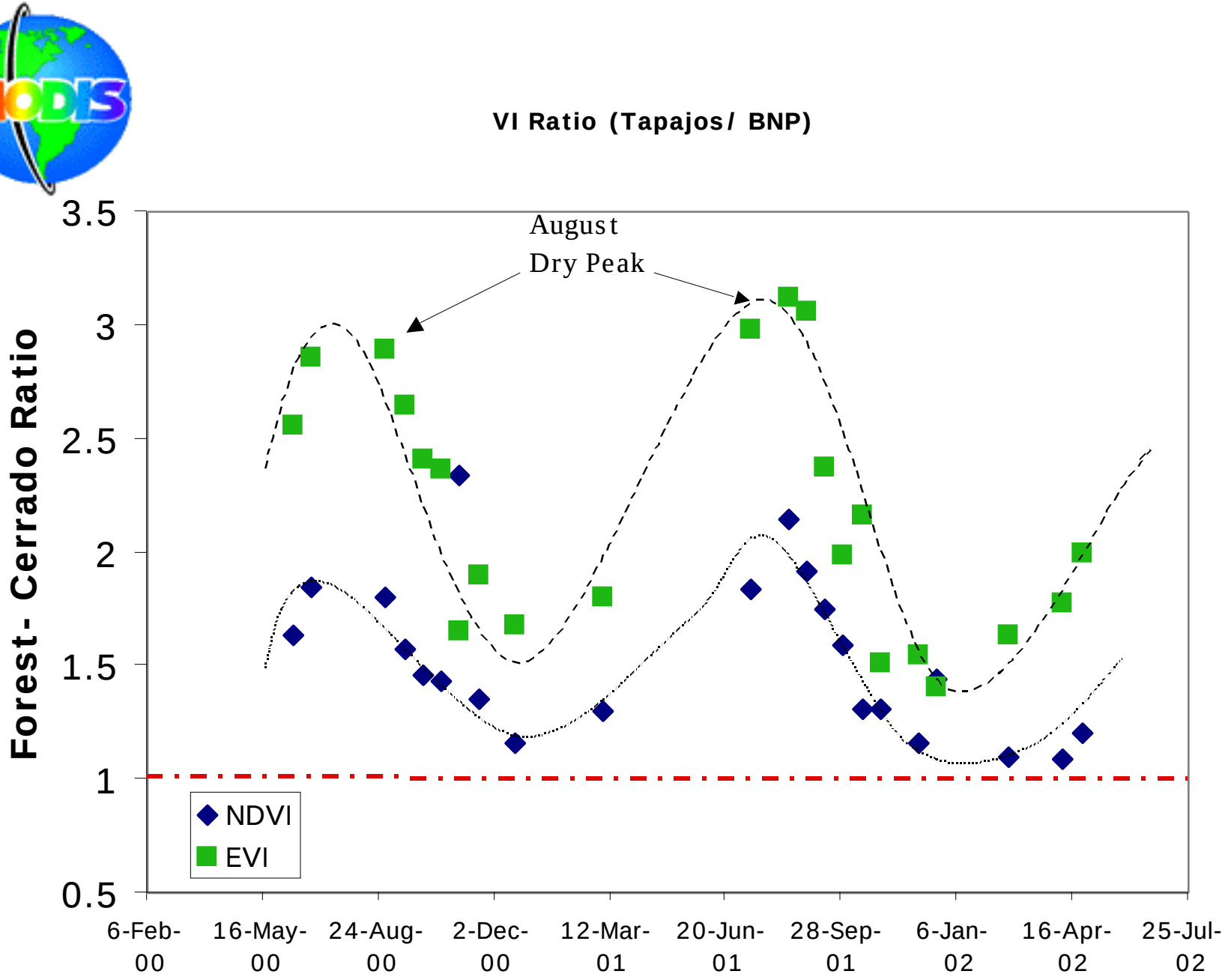
(Woods Hall/ LBA/ <ftp://ftp.as.harvard.edu/pub/tapajos/>)




Pasture sites near Tapajos
Vegetation Index
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
23-Jun-00
1-Oct-00
9-Jan-01
19-Apr-01
13-Feb-02
24-May-02

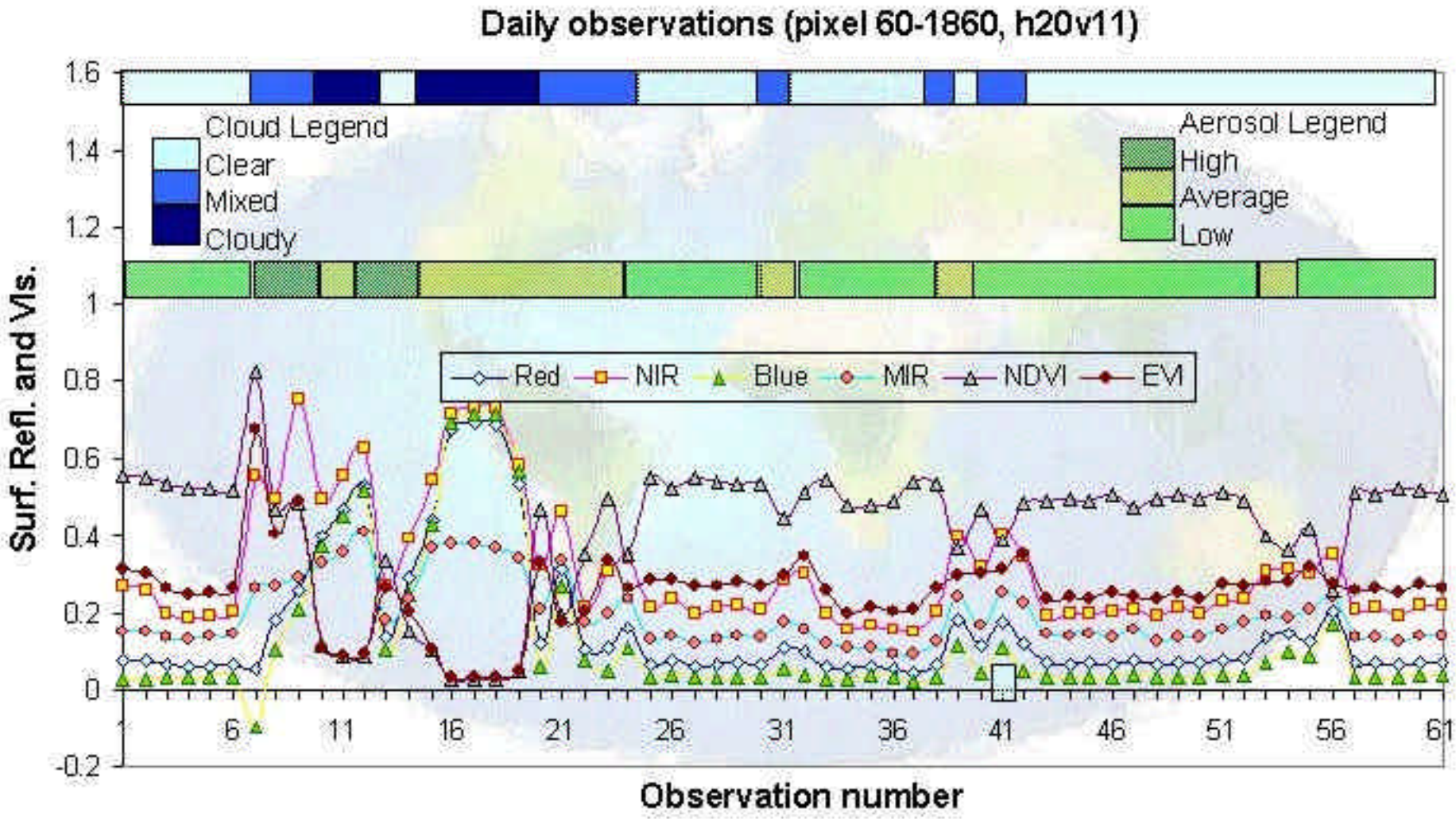

Tapajos Forest
BNP-all
ANP-Forest
ANP-Cerrado
Forest
open
closed
Cerrado
NDVI
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Mar-00
Jun-00
Sep-00
Jan-01
Apr-01
Jul-01
Oct-01
Feb-02


Tapajos Forest
BNP-all
ANP-Forest
ANP-Cerrado
Forest
closed
open
Cerrado
EVI
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Mar-00
Jun-00
Sep-00
Jan-01
Apr-01
Jul-01
Oct-01
Feb-02

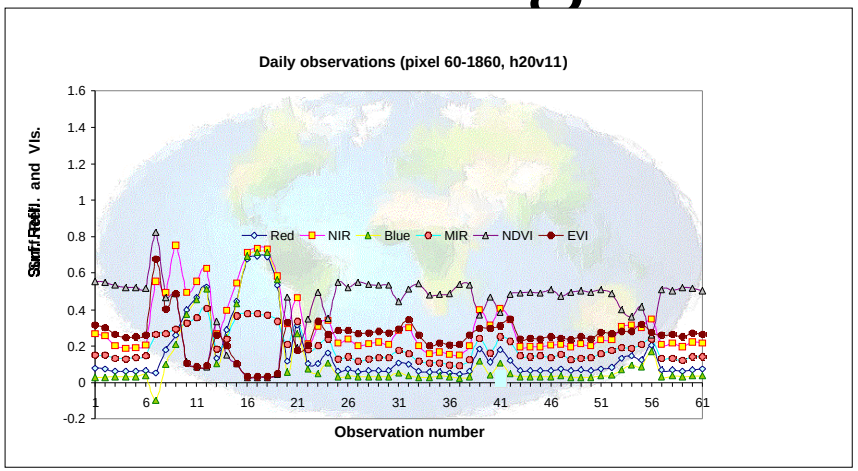

VI Ratio (Tapajos/ BNP)
Forest- Cerrado Ratio
3.5
3
2.5
2
1.5
1
0.5
August
Dry Peak
NDVI
EVI
6-Feb-00
16-May-00
24-Aug-00
2-Dec-00
12-Mar-01
20-Jun-01
28-Sep-01
6-Jan-02
16-Apr-02
25-Jul-02

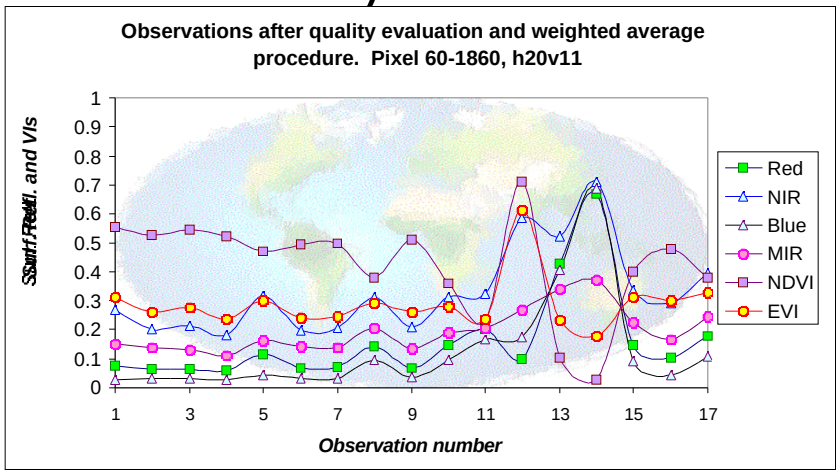
Conclusions (Brazil)

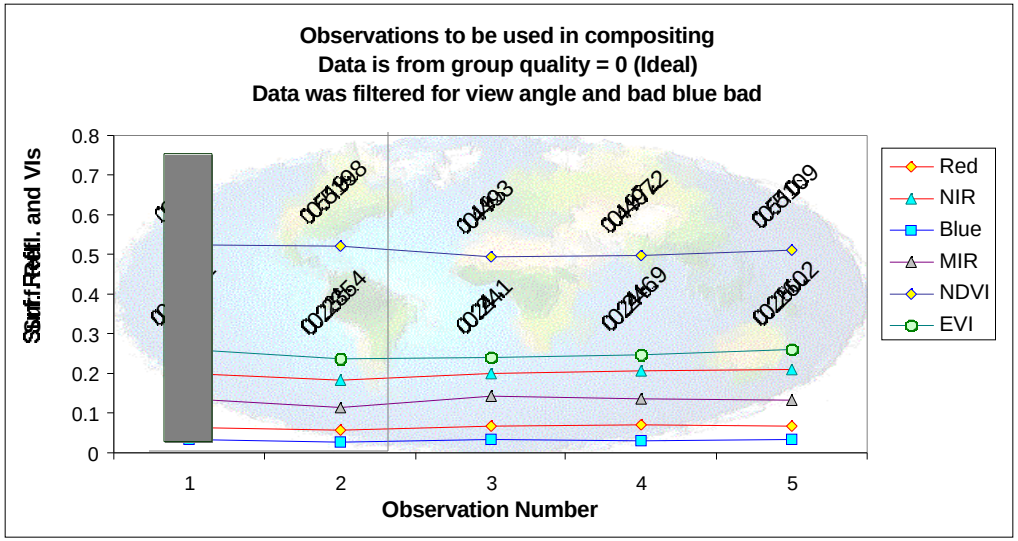
- We found MODIS to be useful in characterizing the spatial and temporal dynamics of the Amazon Basin,
- Multitemporal profiles of the MODIS data revealed well-defined seasonal patterns in the cerrado region with decreasing dry-wet seasonal patterns in the transitional areas near Santana do Araguaia,
- Seasonality was observed to a small and uncertain extent at the Tapajos National Forest site, however, it was unclear whether this was associated with seasonal changes in forest leaf area or temporal changes in understory vegetation,
- We further found MODIS VI seasonal patterns to significantly vary in land converted areas.

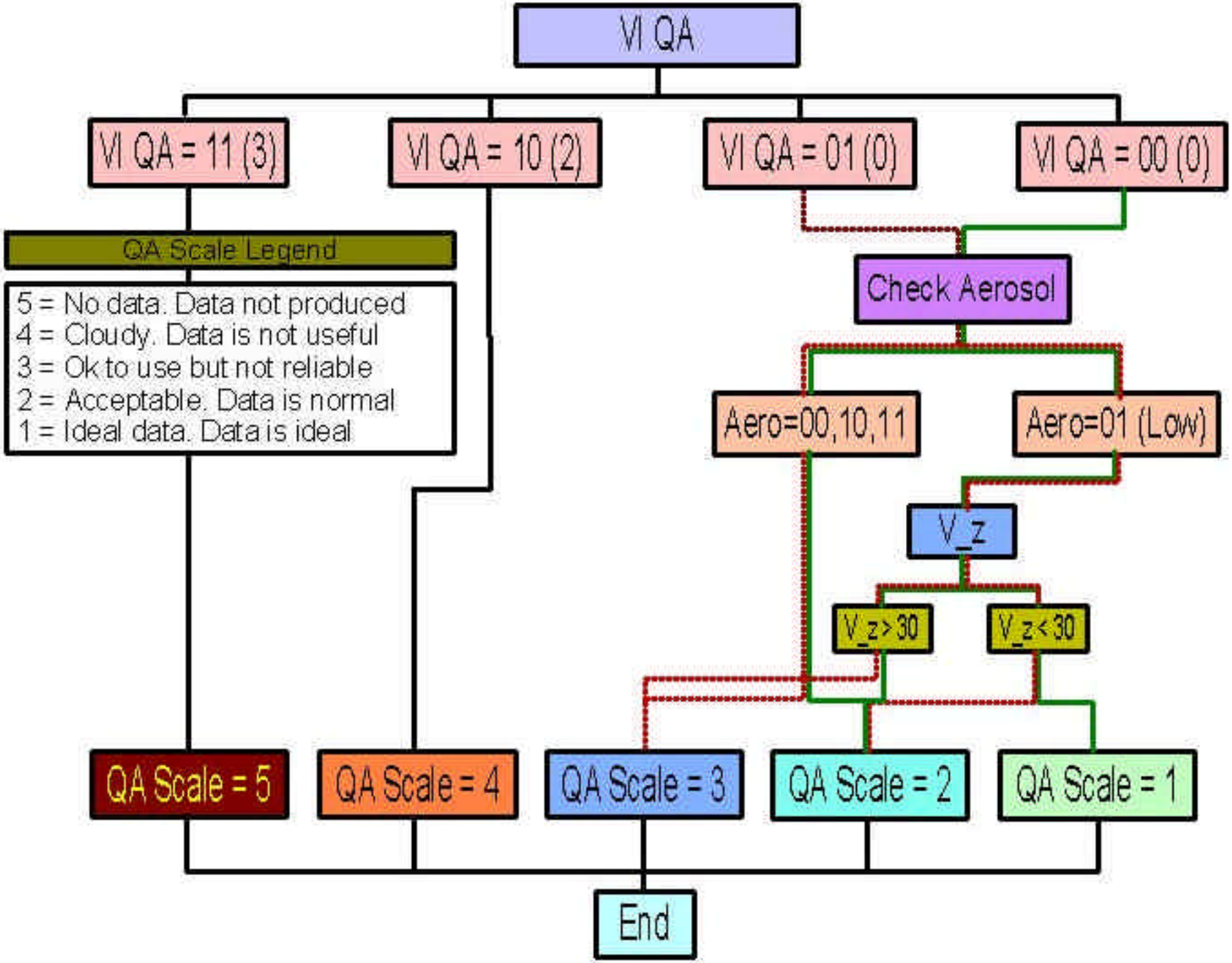

Daily observations (pixel 60-1860, h20v11)
Cloud Legend
Clear
Mixed
Cloudy
Aerosol Legend
High
Average
Low
Red
NIR
Blue
MIR
NDVI
EVI
Surf. Refl. and VIs.
Observation number
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
1
6
11
16
21
26
31
36
41
46
51
56
61

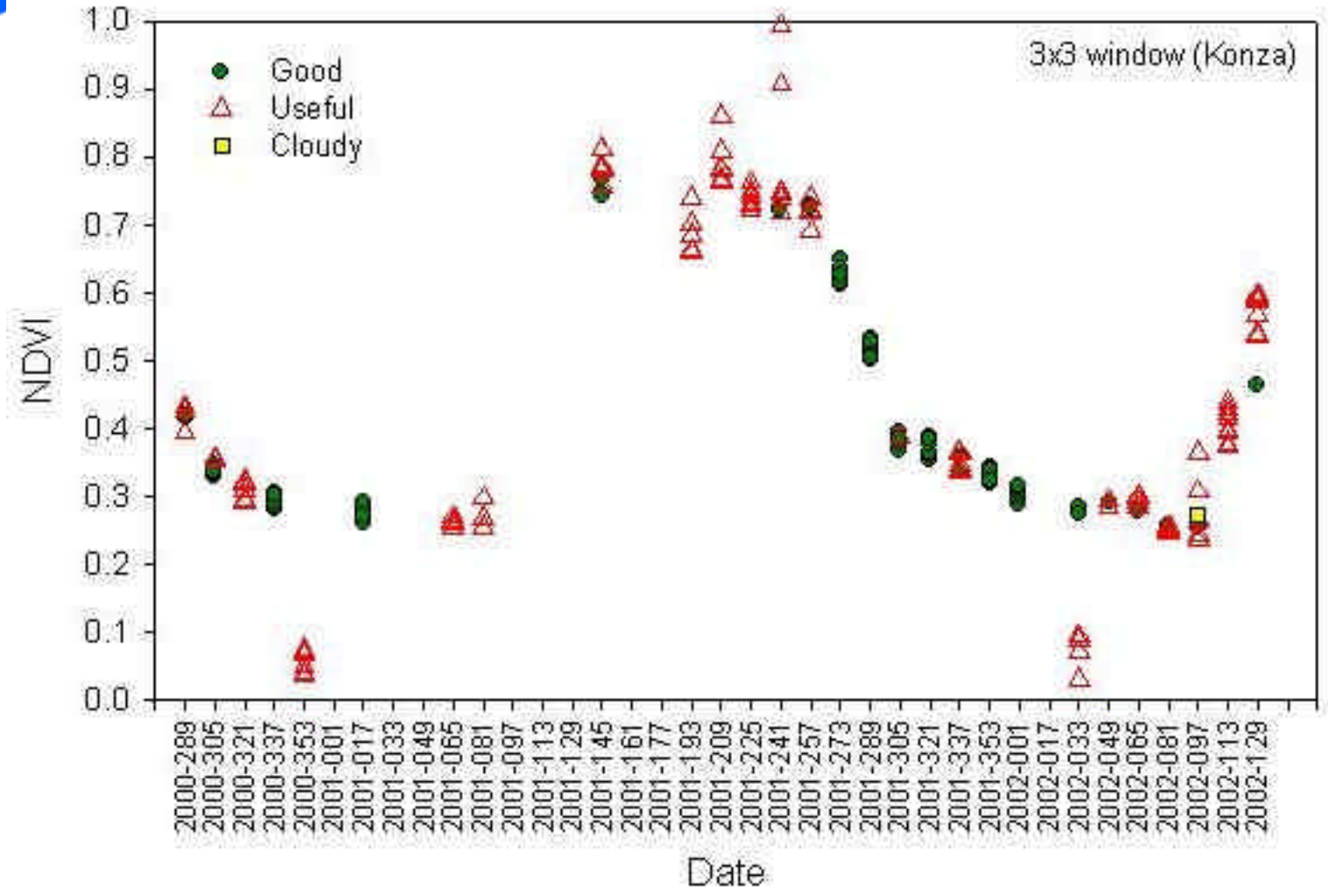
Algorithm summary

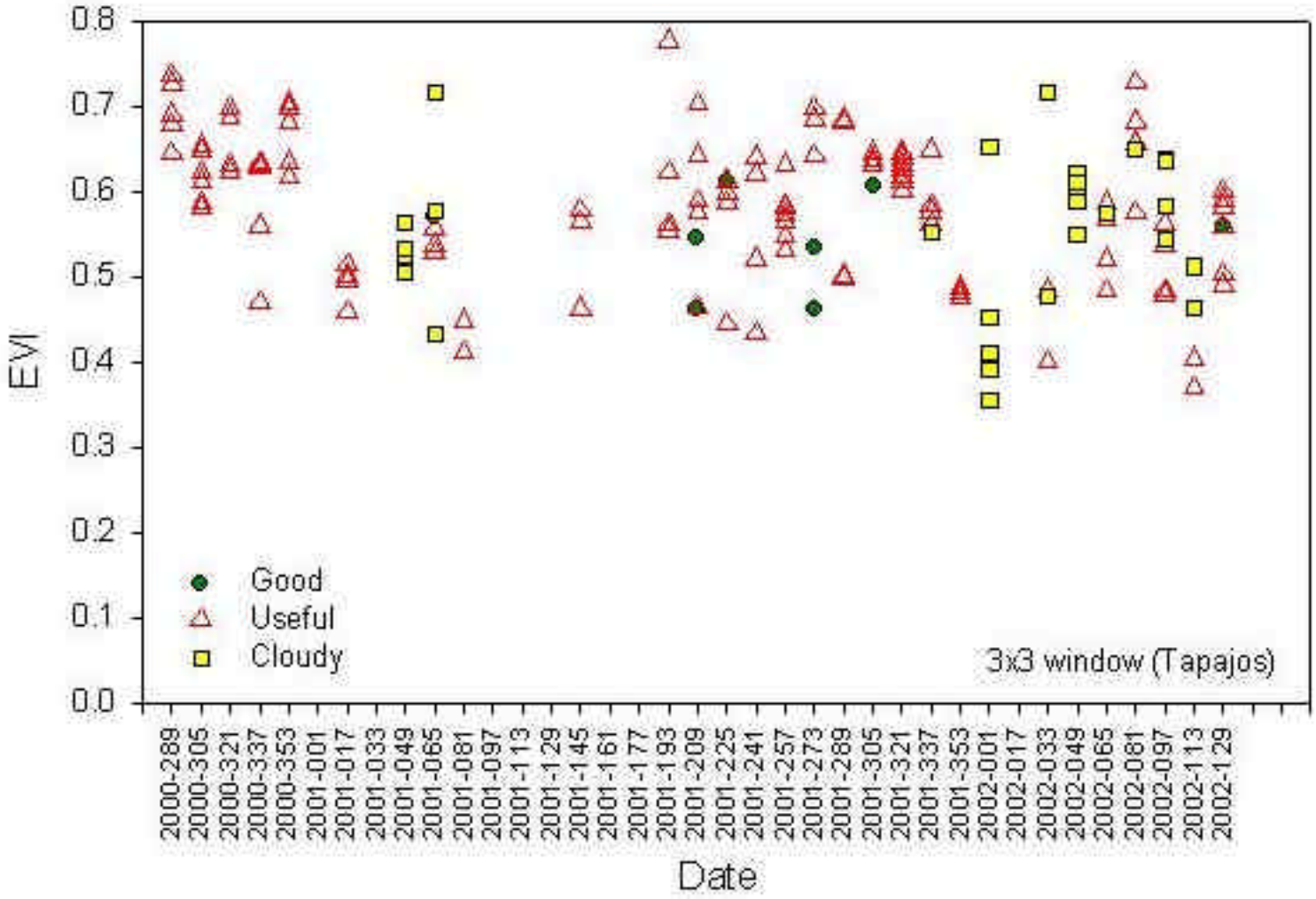







VI QA
VI QA = 11 (3)
VI QA = 10 (2)
VI QA = 01 (0)
VI QA = 00 (0)
QA Scale Legend
5 = No data. Data not produced
4 = Cloudy. Data is not useful
3 = Ok to use but not reliable
2 = Acceptable. Data is normal
1 = Ideal data. Data is ideal
Check Aerosol
Aero=00,10,11
Aero=01 (Low)
V_z
V_z>30
V_z<30
QA Scale = 5
QA Scale = 4
QA Scale = 3
QA Scale = 2
QA Scale = 1
End

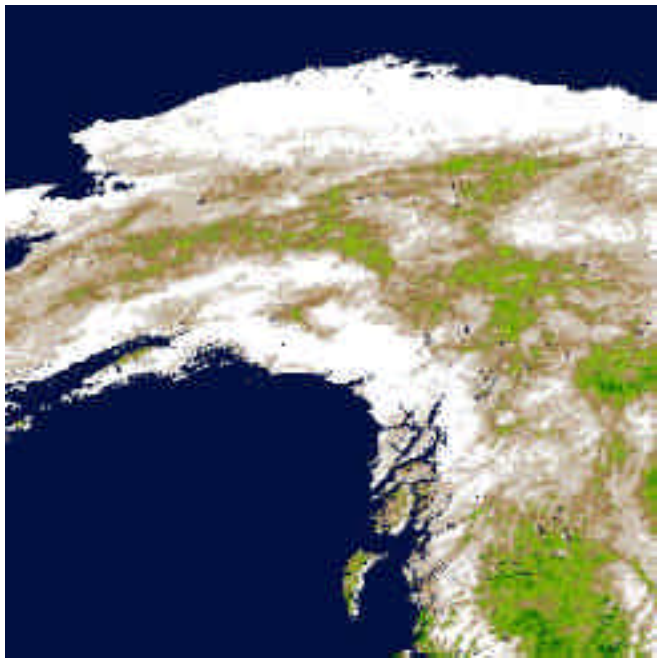

3x3 window (Konza)
Good
Useful
Cloudy
NDVI
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2000-289
2000-305
2000-321
2000-337
2000-353
2001-001
2001-017
2001-033
2001-049
2001-065
2001-081
2001-097
2001-113
2001-129
2001-145
2001-161
2001-177
2001-193
2001-209
2001-225
2001-241
2001-257
2001-273
2001-289
2001-305
2001-321
2001-337
2001-353
2002-001
2002-017
2002-033
2002-049
2002-065
2002-081
2002-097
2002-113
2002-129
Date



Clouds, cloud shadow, and BRDF induce the largest uncertainties.

Snow Problem in VI's

NDVI



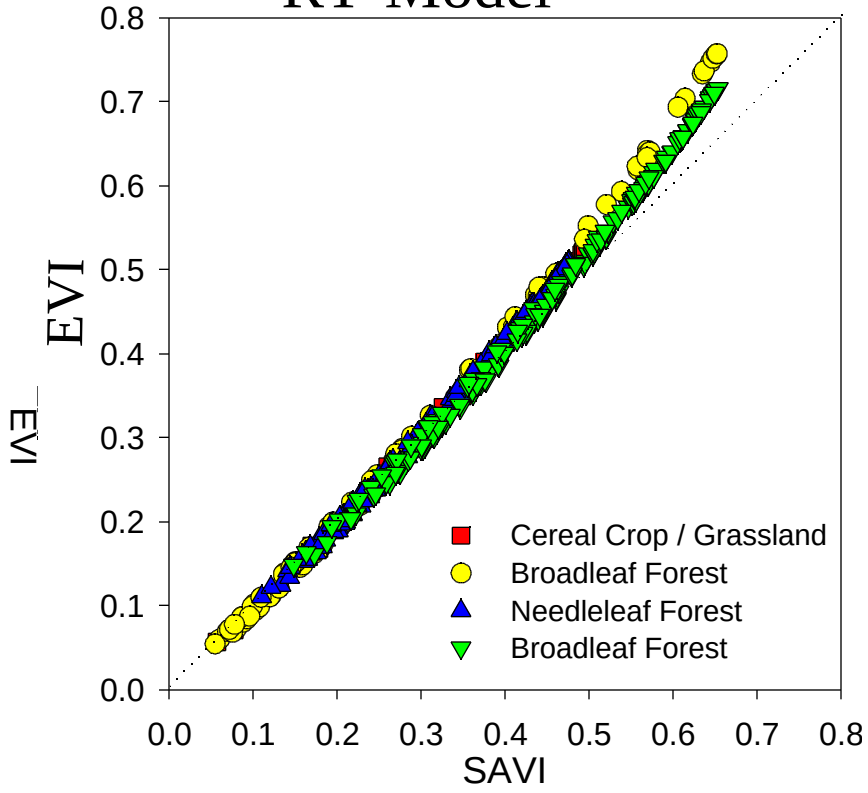
EVI

Snow effects:

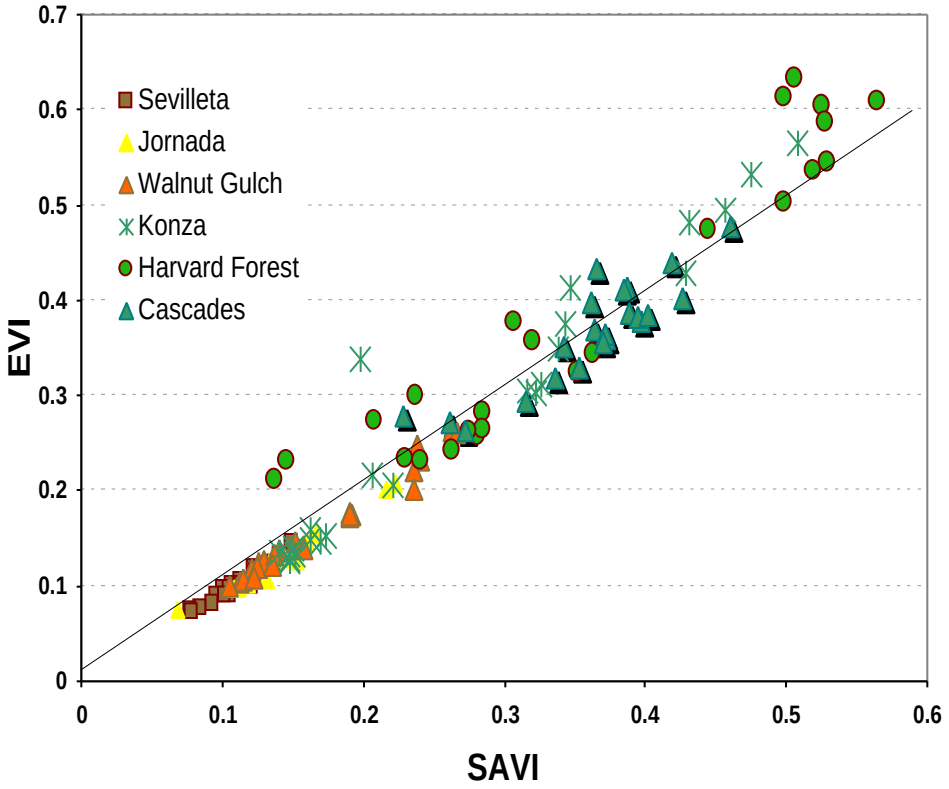
- Blue > Red > NIR
- NDVI gives false negative signal
- EVI gives false positive signal

EVI & SAVI Relationships for Snow

RT-Model

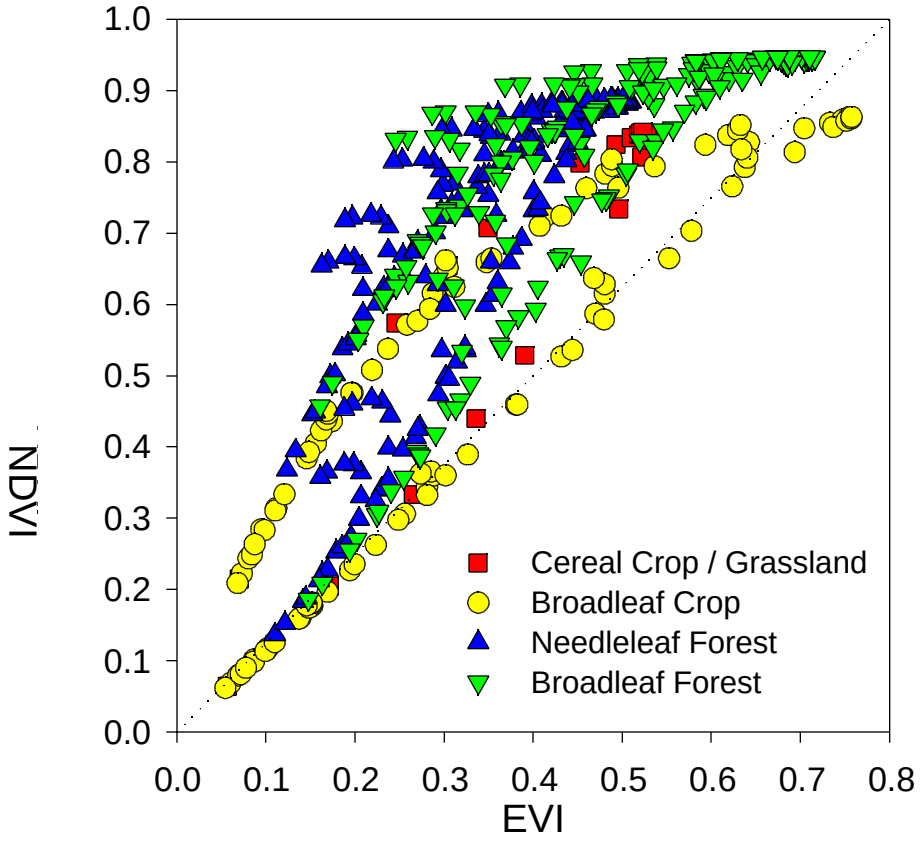


MODIS Data (2000-2001)

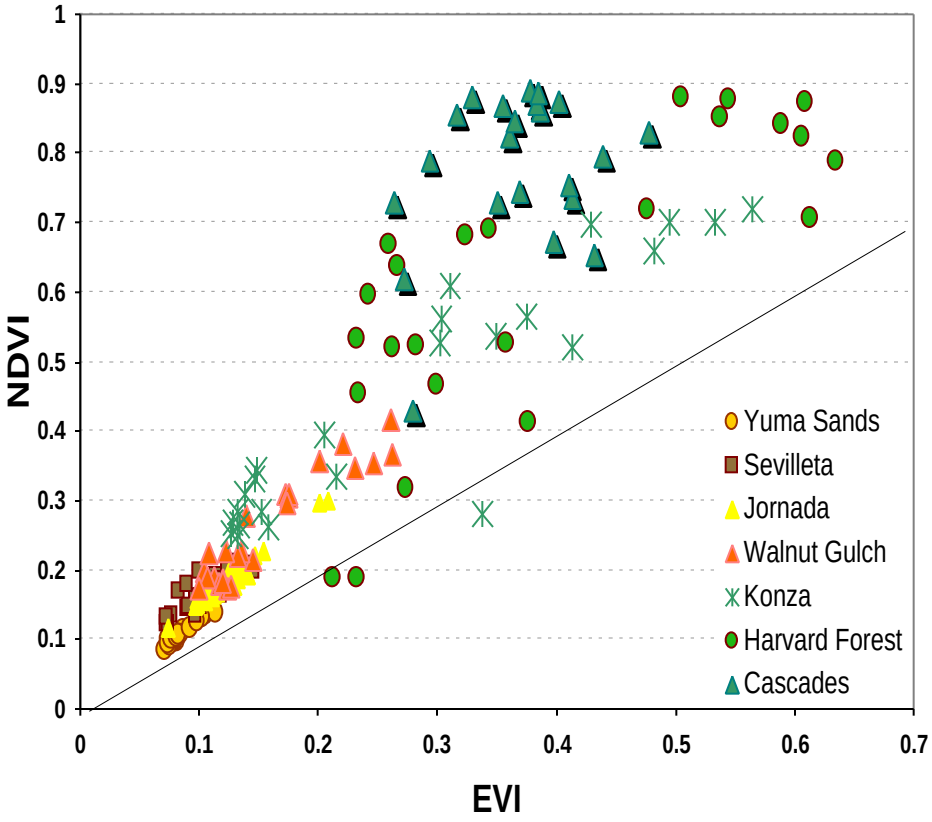


NDVI & EVI Relationships

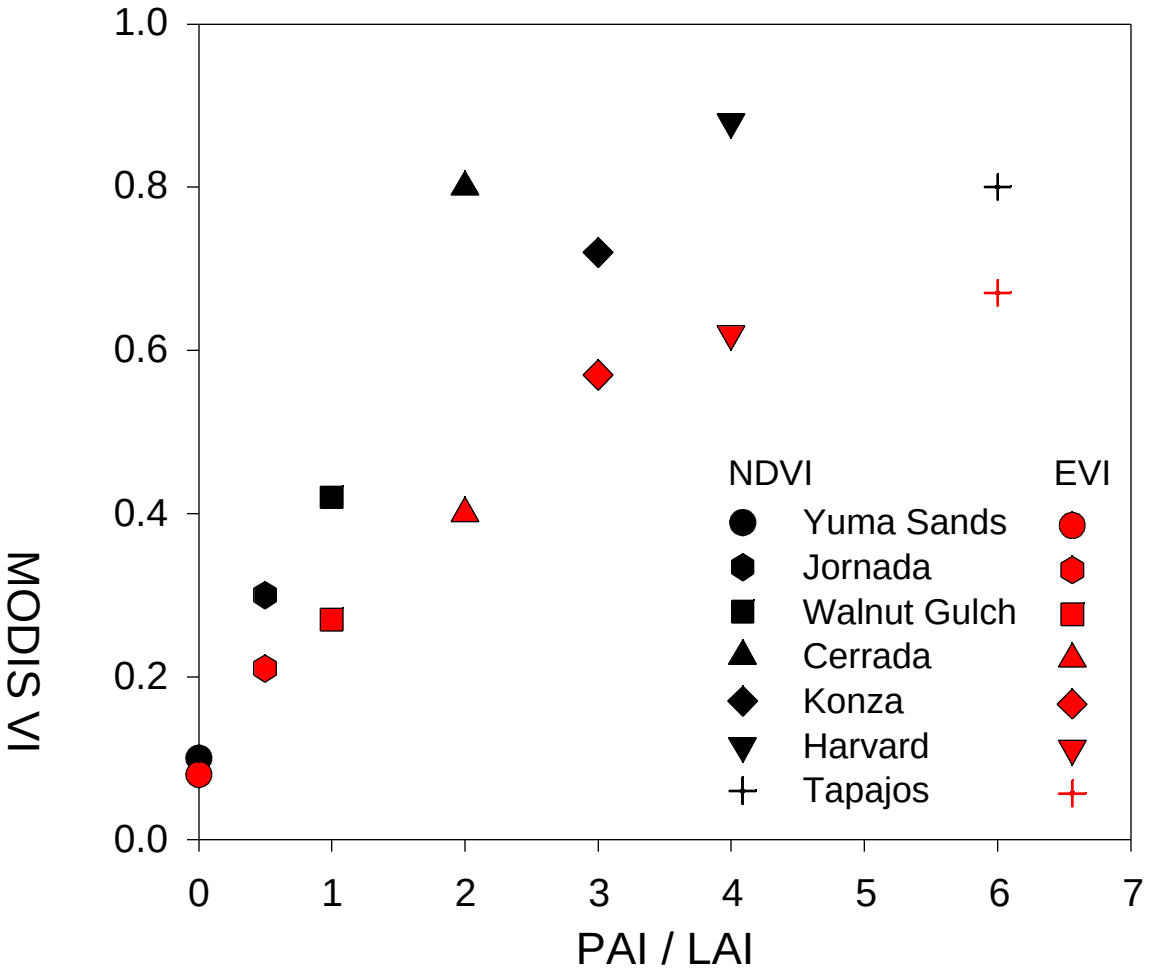
RT-Model

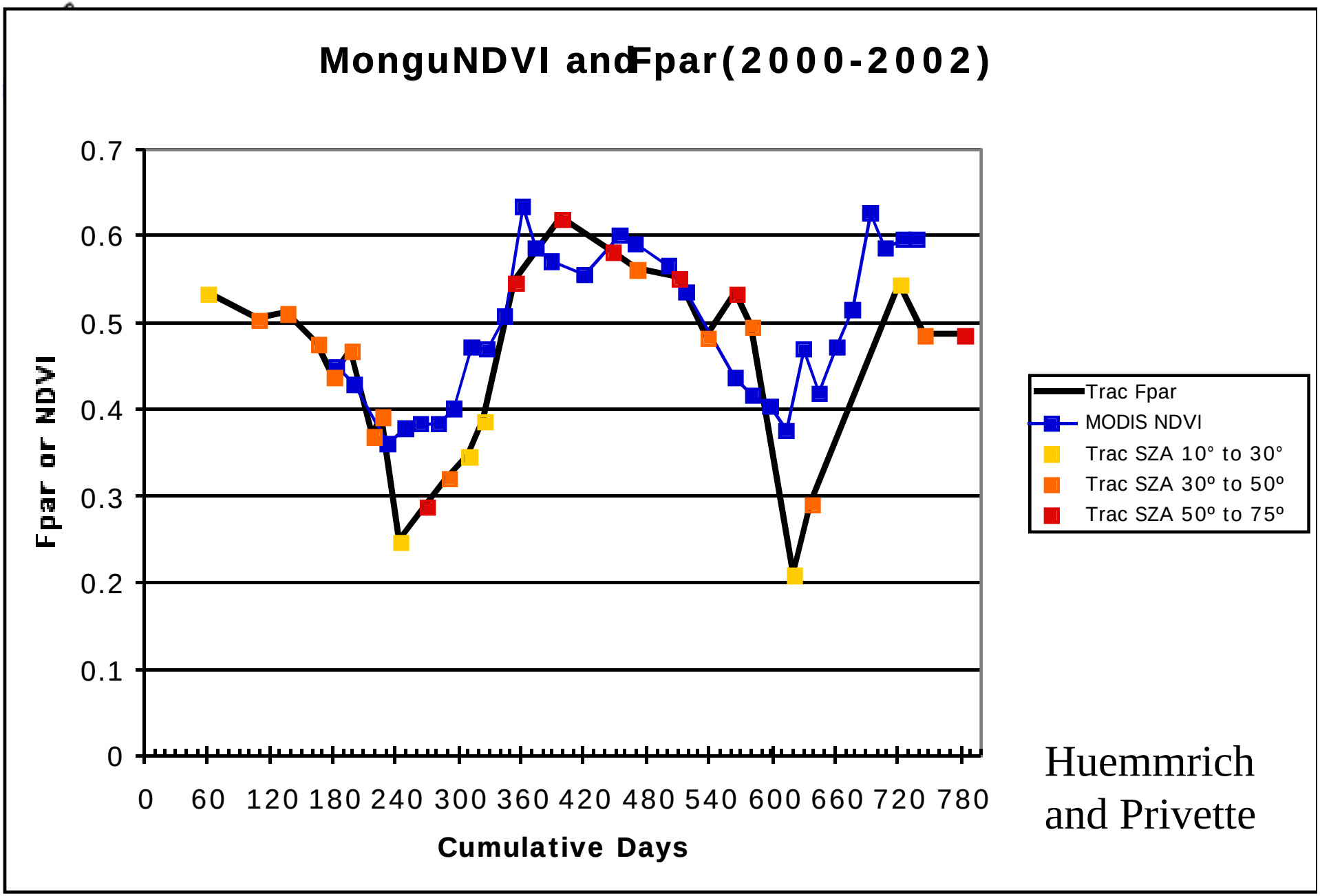


MODIS Data (2000-2001)



Biophysical Validation




MonguNDVI and Fpar (2000-2002)
Fpar or NDVI
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 60 120 180 240 300 360 420 480 540 600 660 720 780
Cumulative Days
Trac Fpar
MODIS NDVI
Trac SZA 10° to 30°
Trac SZA 30º to 50º
Trac SZA 50º to 75º
Huemmrich and Privette

Conclusions

- VI products are provisionally validated from radiometric, seasonal, interannual and biophysical perspectives,
  - product accuracy has been assessed by a number of independent measurements, at a number of locations or times representative of conditions portrayed by the product.
- Residual cloud, cloud shadow, BRDF, topography, and snow induce the largest uncertainties in the VI's,
  - Assessment of feasibility of using snow product and BRDF products.
- VI product accuracy varies with QA.