

# **Impact of the GLS and the USGS open archive policies on the global survey of deforestation in the humid tropics**

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**UNITED  
NATIONS**

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**Framework Convention  
on Climate Change**

Distr.  
GENERAL

FCCC/CP/2009/11/Add.1  
 30 March 2010

Original: ENGLISH

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FCCC/CP/2009/11/Add.1  
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## **Decision 4/CP.15**

**Methodological guidance for activities relating to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries**

# Decision 4/CP.15

FCCC/CP/2009/11/Add.1

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- (d) To establish, according to national circumstances and capabilities, robust and transparent national forest<sup>1</sup> monitoring systems and, if appropriate, sub-national systems as part of national monitoring systems that:
  - (i) Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;
  - (ii) Provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities;
  - (iii) Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties;

# Project Overview

A partnership with the FAO

Supports three key “policy” domains

- 1 Reducing uncertainties in global estimates of forest cover change and related carbon emissions (REDD+)
- 2 The UN CBD
- 3 Development Aid



# TREES focus on humid tropics

Forest cover maps at regional scale

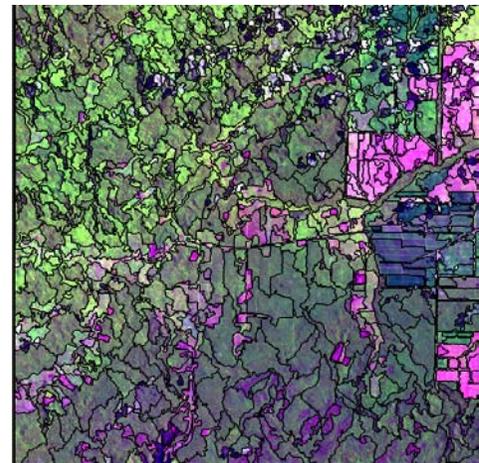
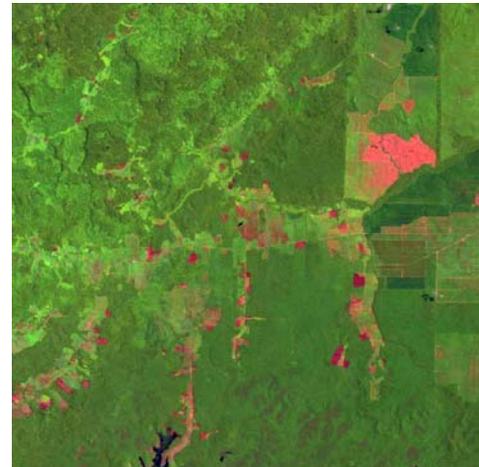
Location of rapidly changing regions -  
hotspots

Forest cover change measurements from  
1990 to 2000 to 2005/2010

Carbon emission estimates from forest cover  
changes

Assessment of deforestation drivers at sub-  
regional levels

Capacity building

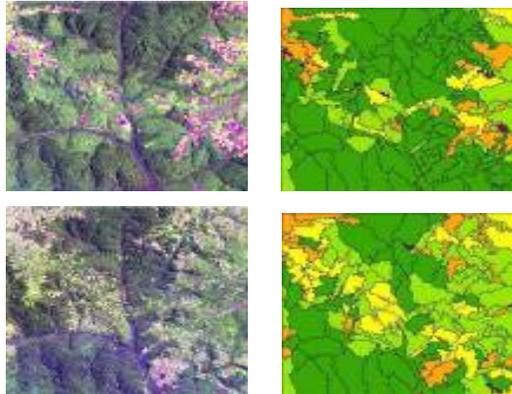
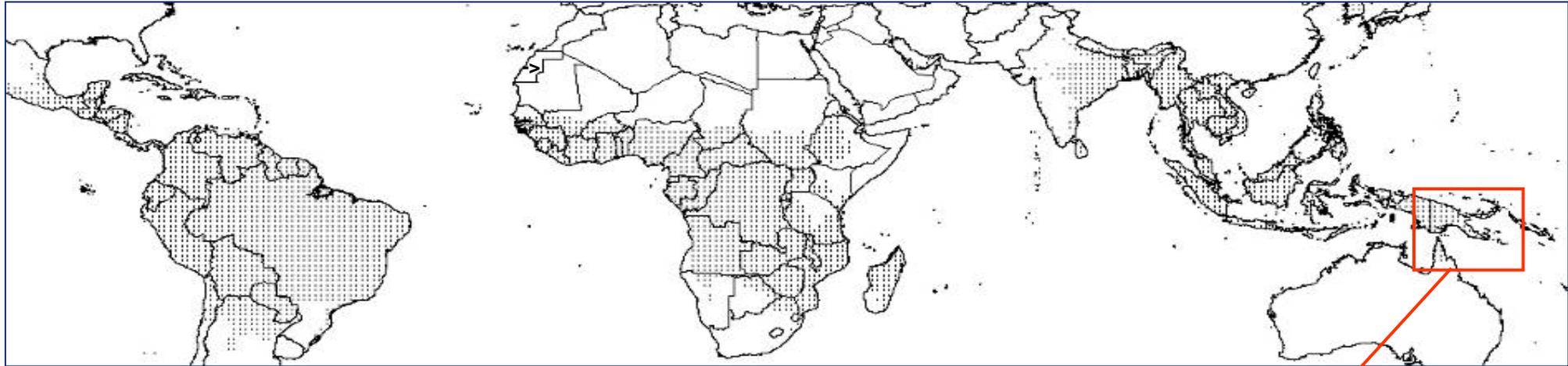


# Systematic sampling - 4016 sample sites

Tropical Latin America & Caribbean (LAC):  
**1230** sample sites

Sub-Saharan Africa  
(AFR):**2045** sample sites

South and Southeast Asia plus PNG  
and the Solomon Islands (SEA):  
**741** sample sites



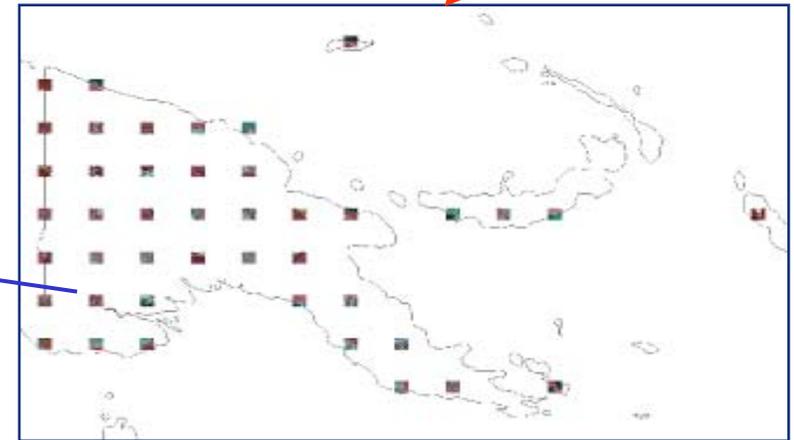
1990



2000

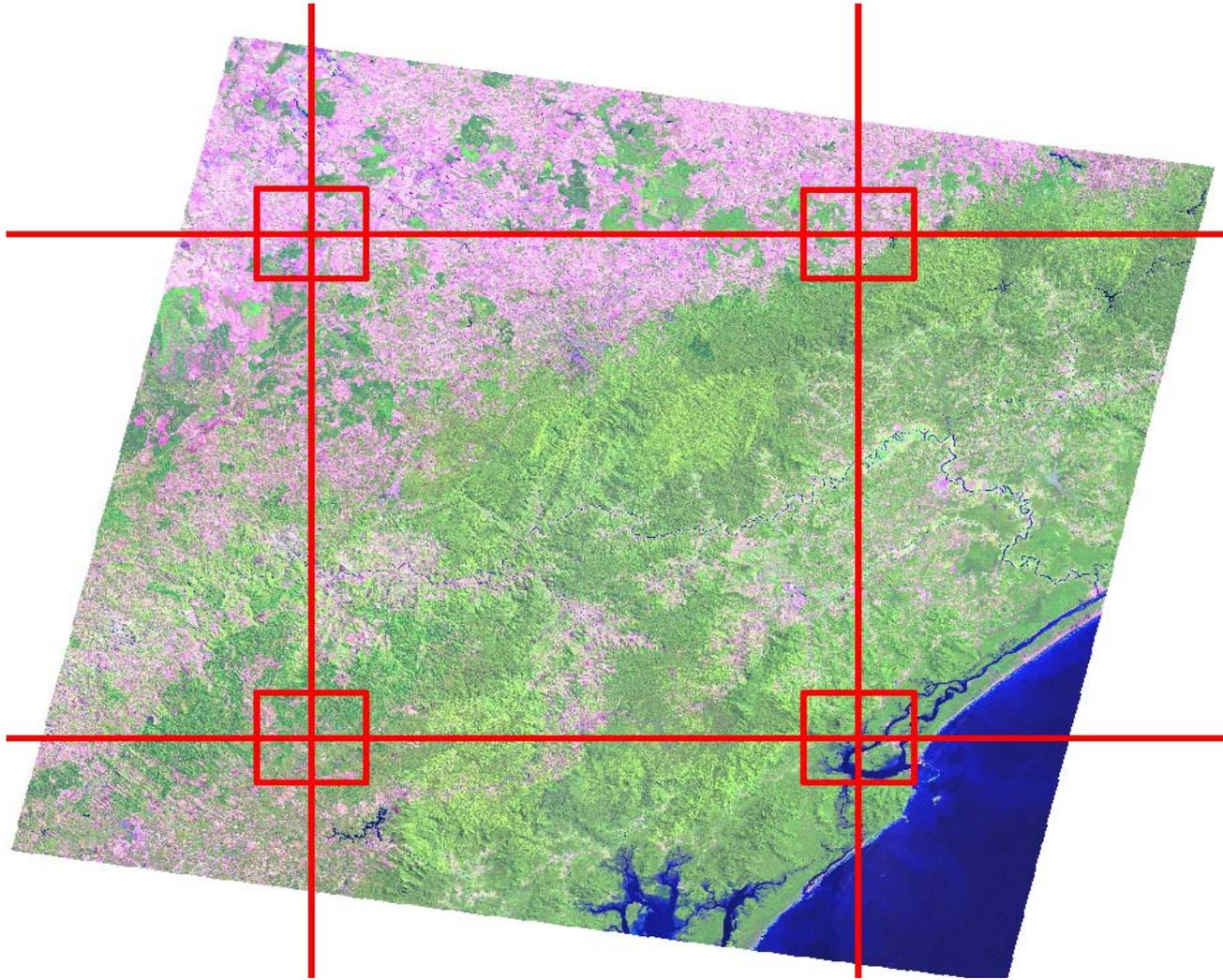


2010



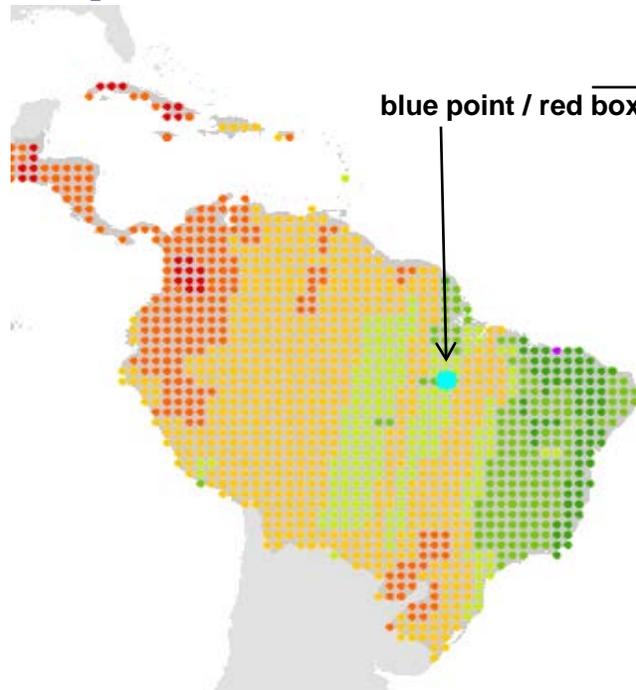
Samples are 20km x 20km size

# One scene = multiple sample sites (boxes)



**Distribution of 20 km X 20 km sample sites for every degree confluence on Landsat scene Path-Row 220-077**

# Depth of the archive

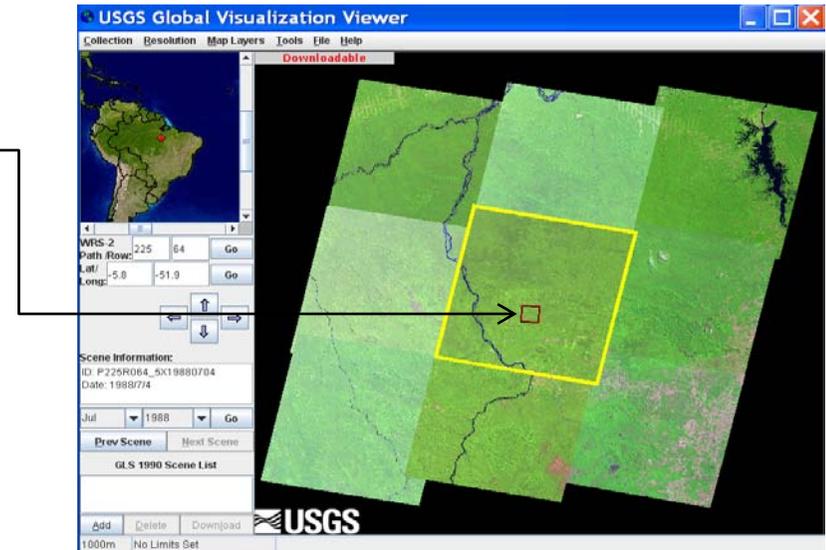


blue point / red box: coordinate S06 \_W052 (Brazil)

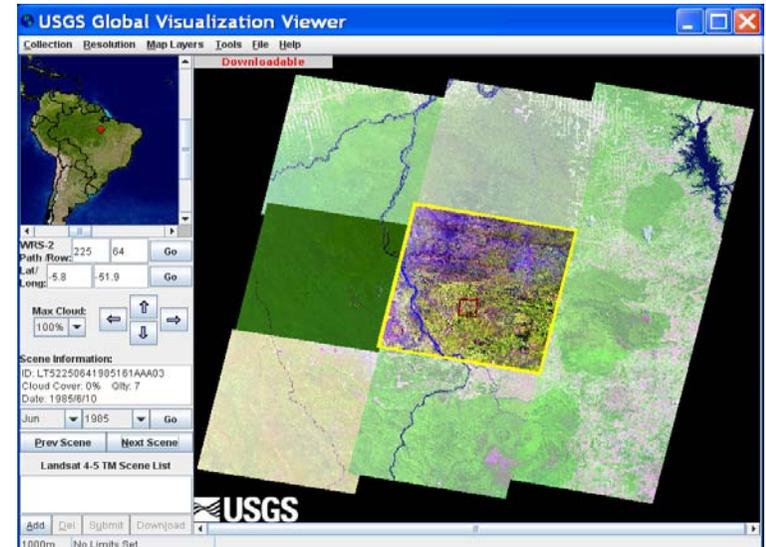
# available scenes (1990)

- 0
- 1 - 5
- 6 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 203

Attributes of E_TM_scenes_per_time_period											
FID	Shape	PR	PATH	ROW	Z0	Z180	UTM_zone	E_TM_84_93	E_TM_99_03	E_TM_04_10	
1376	Point	225066	225	66	-9	-52	22	15	51	11	
1468	Point	225066	225	66	-8	-53	22	15	51	11	
1469	Point	225065	225	65	-8	-52	22	13	56	13	
1470	Point	225066	225	66	-8	-52	22	15	51	11	
1577	Point	225065	225	65	-7	-53	22	13	56	13	
1578	Point	225065	225	65	-7	-52	22	13	56	13	
1666	Point	225064	225	64	-6	-52	22	13	65	13	
1762	Point	225063	225	63	-5	-52	22	12	68	13	
1763	Point	225064	225	64	-5	-52	22	13	65	13	
1765	Point	225063	225	63	-5	-51	22	12	68	13	
1861	Point	225063	225	63	-4	-52	22	12	68	13	
1862	Point	225063	225	63	-4	-51	22	12	68	13	
1947	Point	225062	225	62	-3	-52	22	10	67	13	
1948	Point	225062	225	62	-3	-51	22	10	67	13	

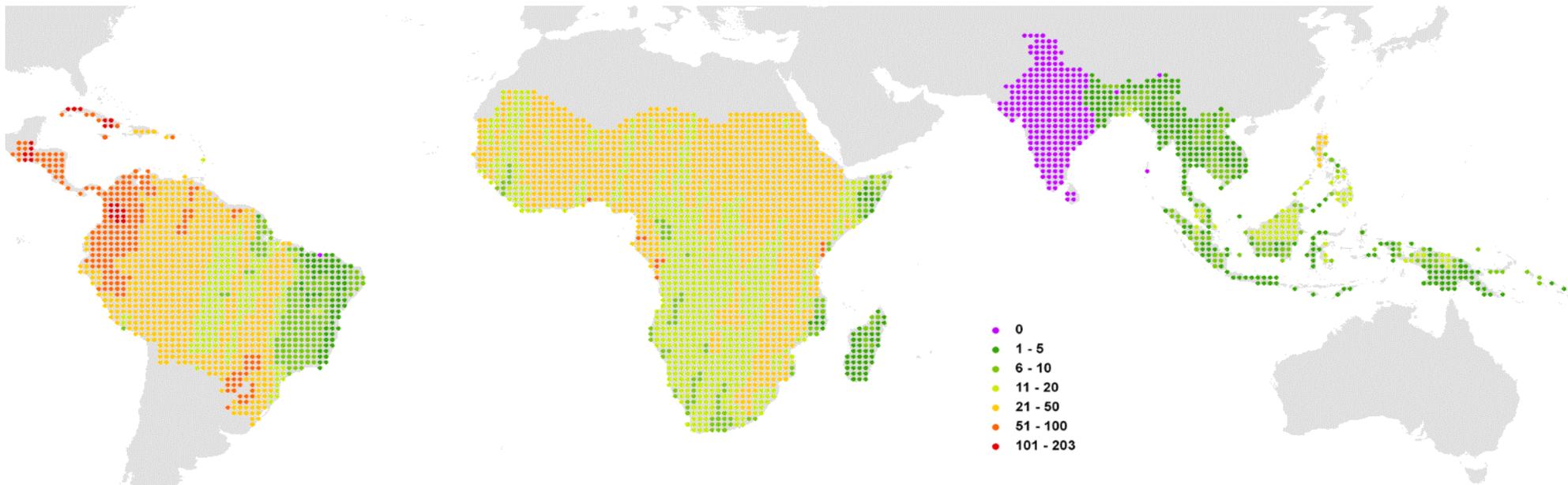


GLS1990 archive for this box: 2 images

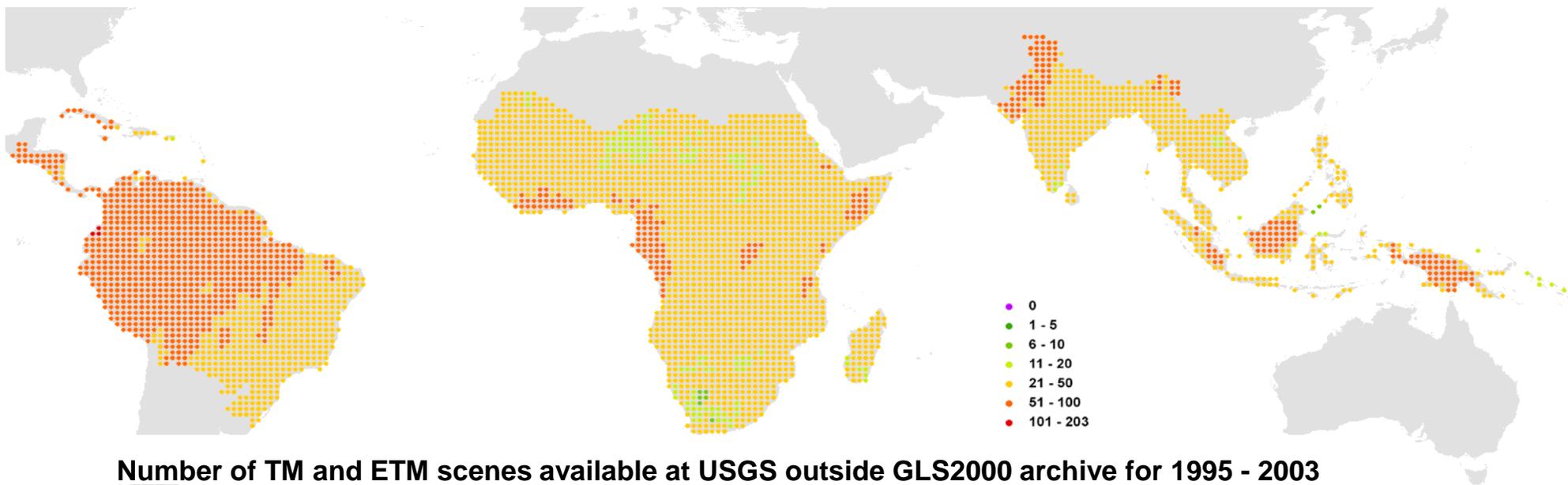


Landsat TM 4-5 archive for this box: 13 images

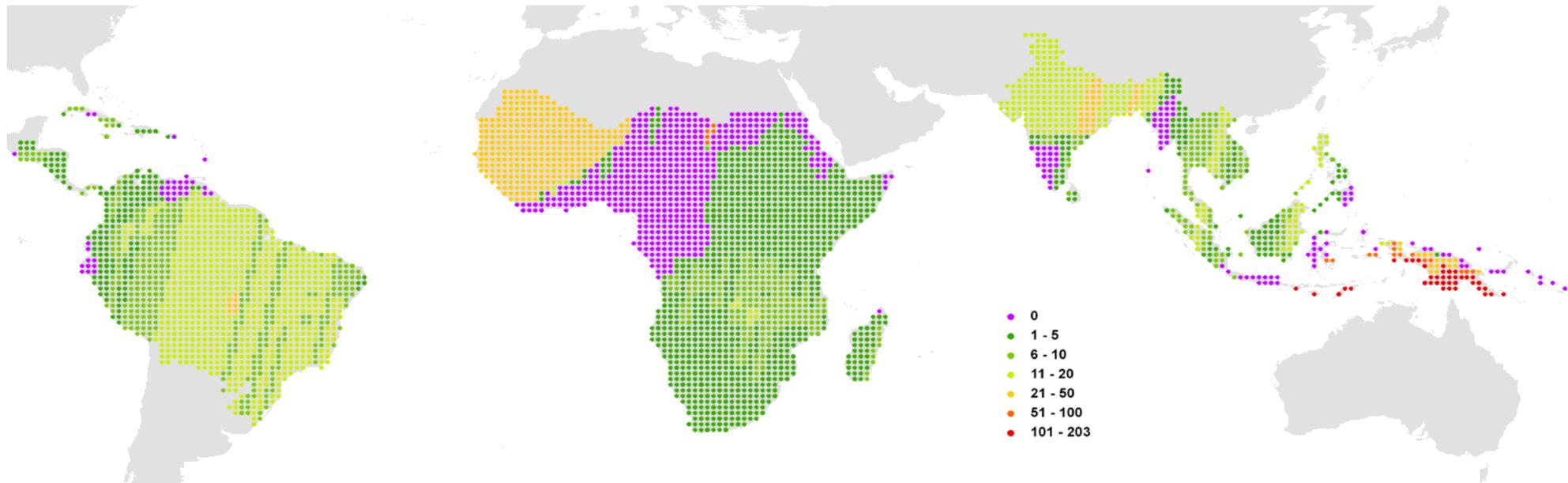
Plus the CEOS Land Surface Imaging constellation and other archives (e.g. INPE)



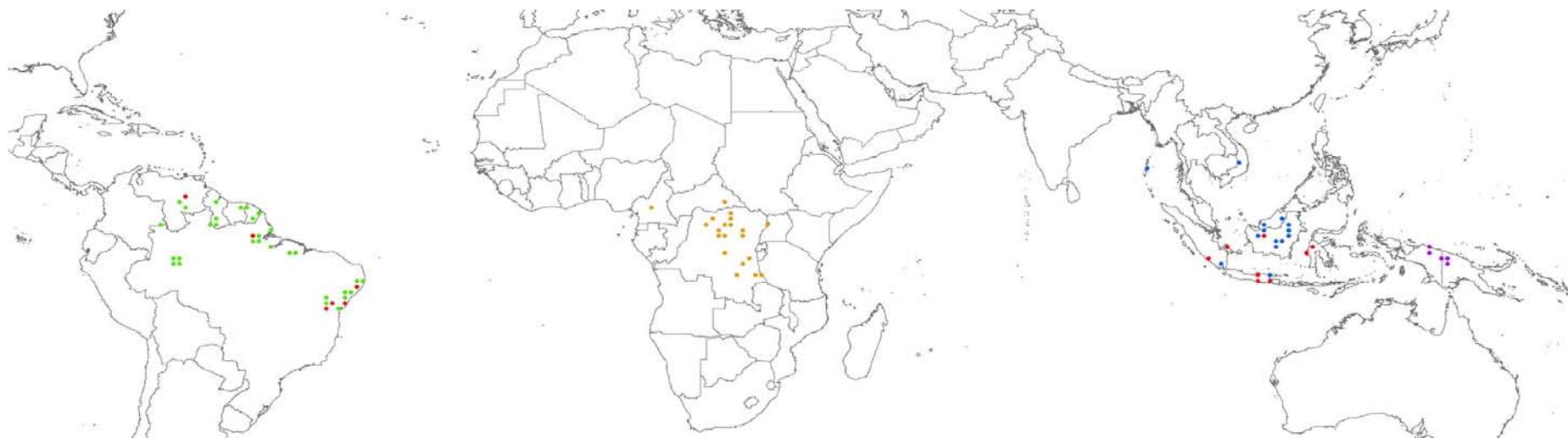
**Number of TM scenes available at USGS outside GLS1990 archive for 1984 - 1994**



**Number of TM and ETM scenes available at USGS outside GLS2000 archive for 1995 - 2003**



**Number of TM scenes available at USGS outside GLS2005 archive for 2004 - 2010**



**Additional data from outside the USGS Landsat archives: Landsat: INPE (green), ACRES (purple), GISTA (blue) - others sensors: SPOT (red), ASTER orange)**

# Each site visually screened for best available image

WORKING ON : Brazil -> Brazil      OUTPUT DIR      Browse      Export

S10\_w063\_tm\_232-067\_08071989.tif      4

R 5      G 4      B 3      Bands 6

Cloud % 0      0 value % 0      Stretch No

20x20 km      10x10 km

dd mm yyyy 08 07 1989

STATUS 1

Usage Quality Priority  
 WHOLE       Good       1  
 MOSAIC       Medium       2  
 REPLACE       Poor       3

EXTRA  Haze       Bias  
 Stripe       Season  
 Topo       Geolocation

CHANGE 90 - 00  
 Yes       No

S10\_w063\_etm\_232-067\_19092001.tif      3

R 5      G 4      B 3      Bands 6

Cloud % 0      0 value % 0      Stretch No

20x20 km      10x10 km

dd mm yyyy 19 09 2001

STATUS 1

Usage Quality Priority  
 WHOLE       Good       1  
 MOSAIC       Medium       2  
 REPLACE       Poor       3

EXTRA  Haze       Bias  
 Stripe       Season  
 Topo       Geolocation

CHANGE 00 - 05  
 Yes       No

S10\_w063\_00000000.tif      0

R 1      G 1      B 1      Bands 0

Cloud %      0 value %      Stretch No

20x20 km      10x10 km

dd mm yyyy

STATUS

Usage Quality Priority  
 WHOLE       Good       1  
 MOSAIC       Medium       2  
 REPLACE       Poor       3

EXTRA  Haze       Bias  
 Stripe       Season  
 Topo       Geolocation

CHANGE 00 - 05  
 Yes       No

GLC2000 classification

AGRI  No       Patch       Large  
FOREST  No       Patch       Large

ZOOM  
Next      Close  
Previous      Save to file  
Reset

Lat lon S 10 W 063

B I N  
F T I (90/00)  
 A       1       GG  
 B       2       MG  
 C       3       GM  
 D       4       MM  
Clear

Add notes  
2      Erase

Global Environment Monitoring Unit  
gem

# GLS *and* archive 98% success for 1990/2000 and 90% for 2005

LAC	Boxes with good data (from 1230)	scenes	box / scene
1990	1219 (99 %)	715	1.70
2000	1219	751	1.62
2005	1112 (90 %)	570	1.94

SEA	Boxes with good data (from 741)	scenes	box / scene
1990	726 (98 %)	451	1.61
2000	726	483	1.50
2005	646 (87 %)	353	1.83

AFR	Boxes with good data (from 2045)	scenes	box / scene
1990	1994 (98 %)	1009	1.98
2000	1994	995	2.00
2005	1854 (91 %)	883	2.10

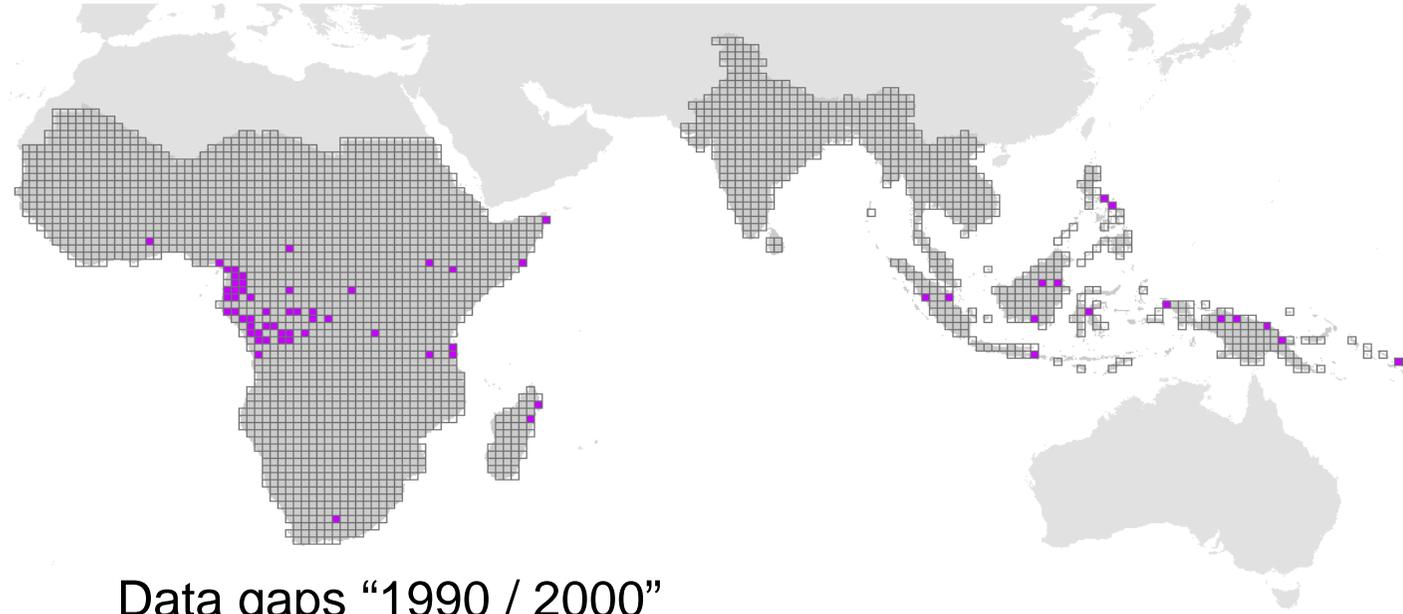
# GLS vs. non-GLS data

<b>Global</b>	<b>Alternative data used</b>	<b>Percent alternative data</b>
<b>1990</b>	<b>559 (from 3939)</b>	<b>14 %</b>
<b>2000</b>	<b>775 (from 3939)</b>	<b>20 %</b>

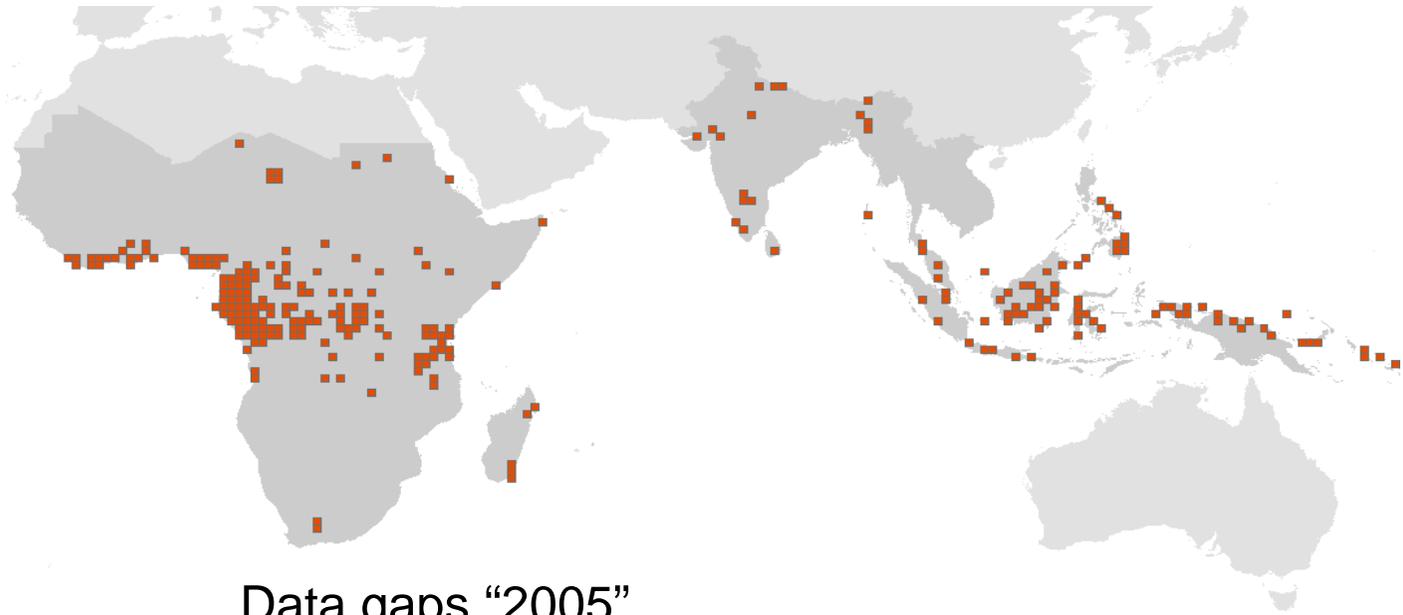
<b>LAC</b>	<b>Alternative data used</b>	<b>Percent alternative data</b>
<b>1990</b>	<b>288 (from 1219)</b>	<b>24 %</b>
<b>2000</b>	<b>440 (from 1219)</b>	<b>36 %</b>

<b>SEA</b>	<b>Alternative data used</b>	<b>Percent alternative data</b>
<b>1990</b>	<b>102 (from 726)</b>	<b>14 %</b>
<b>2000</b>	<b>225 (from 726)</b>	<b>31 %</b>

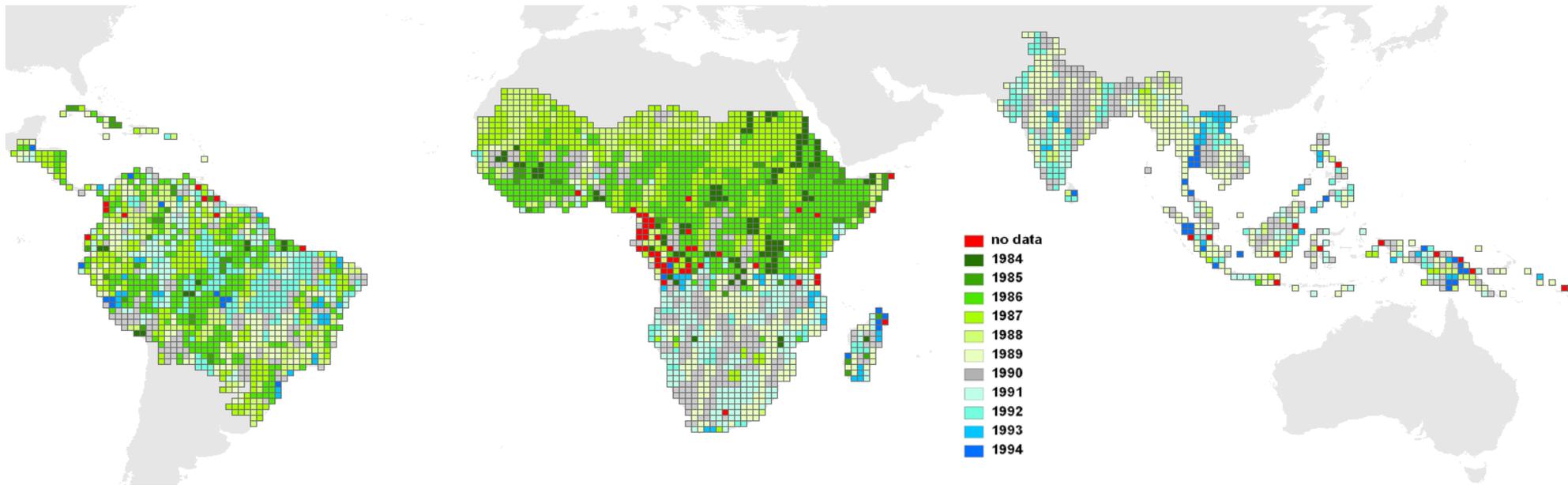
<b>AFR</b>	<b>Alternative data used</b>	<b>Percent alternative data</b>
<b>1990</b>	<b>178 (from 1994)</b>	<b>9 %</b>
<b>2000</b>	<b>118 (from 1994)</b>	<b>6 %</b>



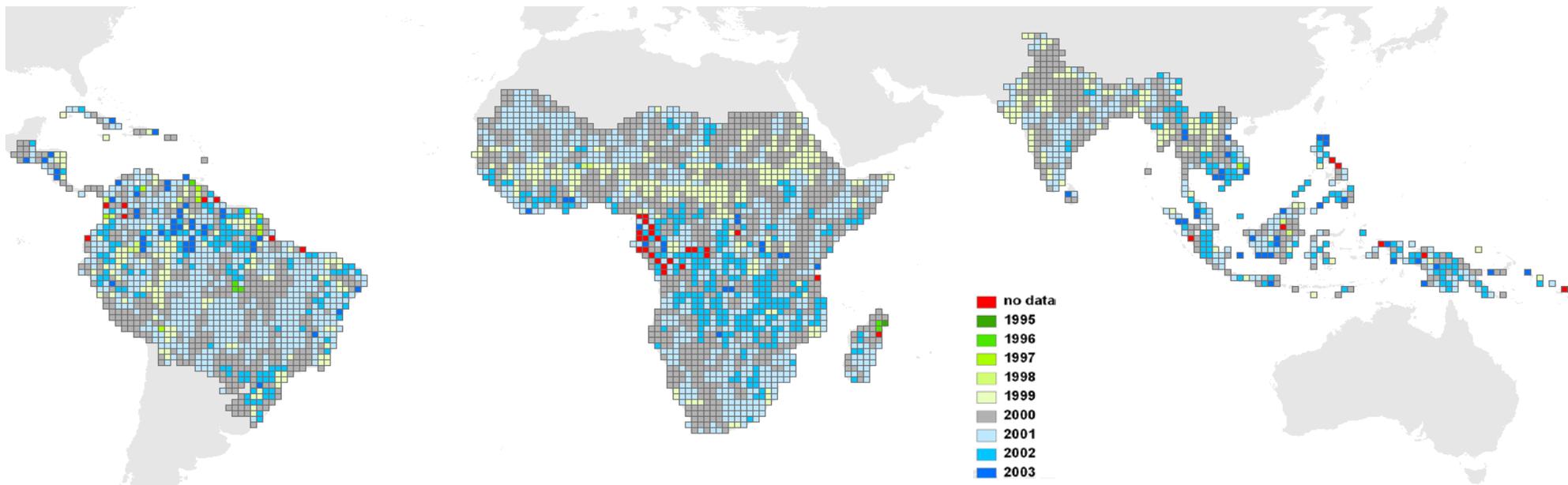
Data gaps "1990 / 2000"



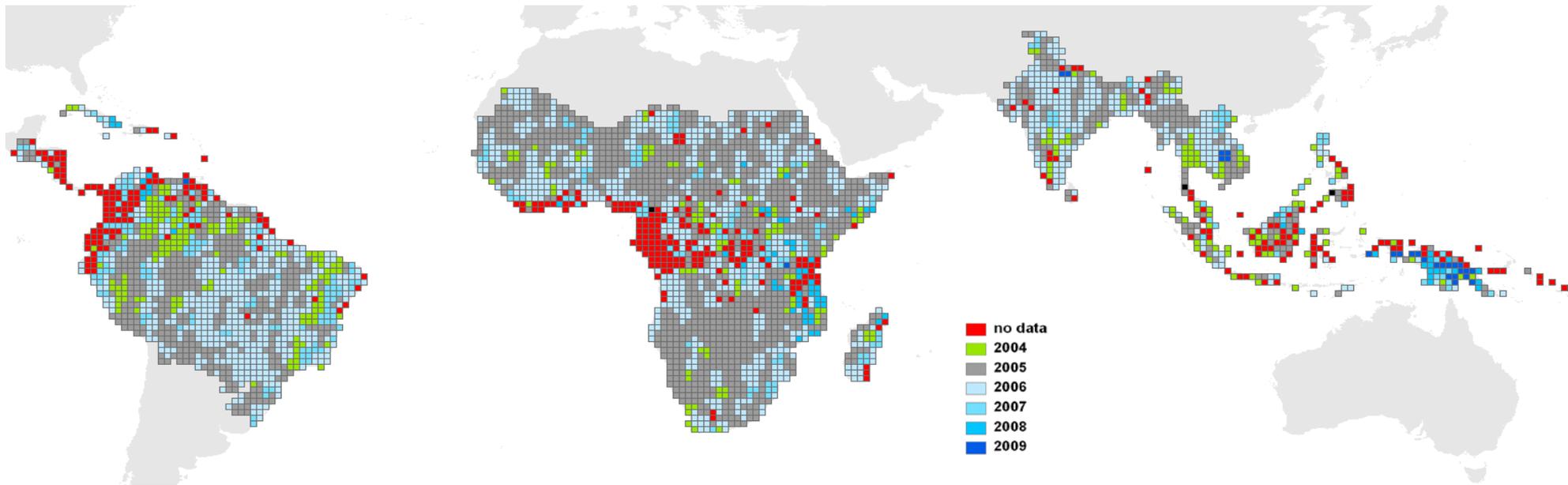
Data gaps "2005"



Acquisition dates for satellite imagery used for the “year 1990 period”



Acquisition dates for satellite imagery used for the “year 2000 period”



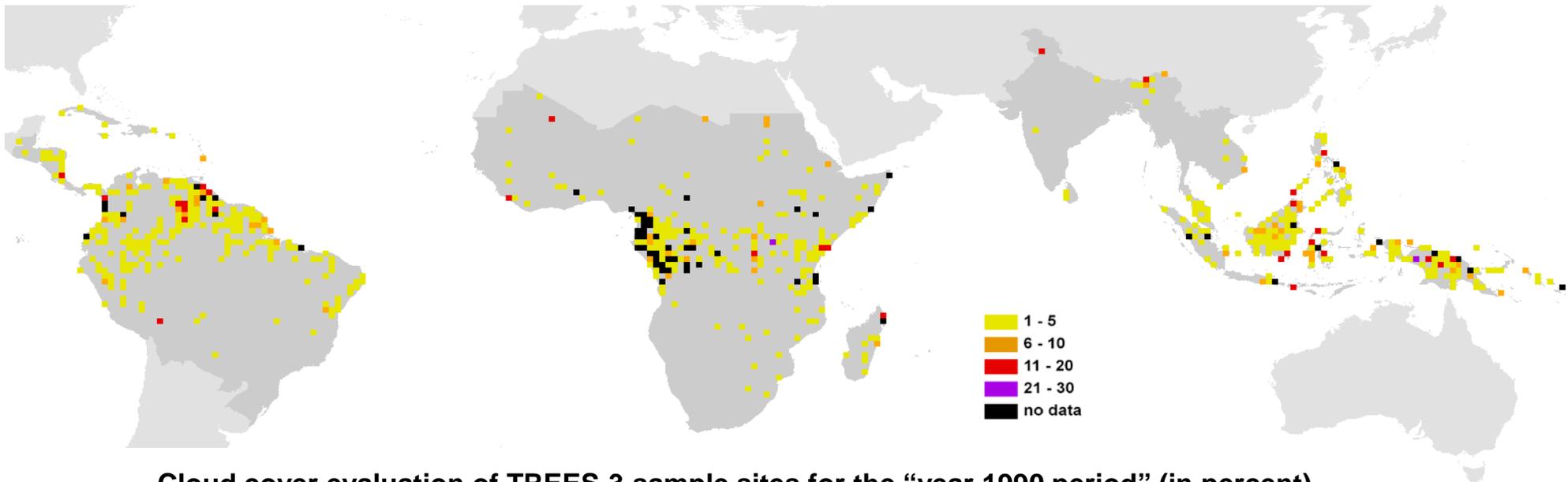
Acquisition dates for satellite imagery used for the “year 2005 period”

# Geolocation

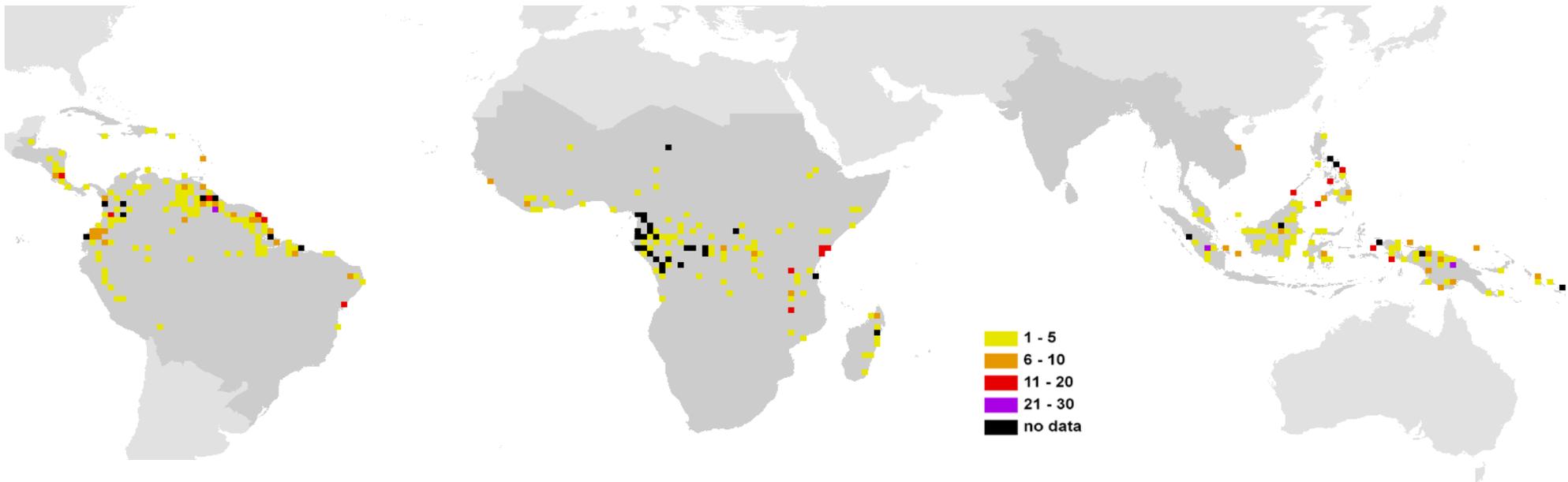
<b>LAC</b>	<b>Data with good fit</b>	<b>Simple shift</b>	<b>Transform</b>
<b>1990</b>	<b>88%</b>	<b>126</b>	<b>22</b>
<b>2000</b>	<b>95%</b>	<b>37</b>	<b>22</b>
<b>2005</b>	<b>95%</b>	<b>37</b>	<b>22</b>
<b>SEA</b>			
<b>1990</b>	<b>86%</b>	<b>98</b>	<b>6</b>
<b>2000</b>	<b>98%</b>	<b>13</b>	<b>6</b>
<b>2005</b>	<b>94%</b>	<b>31</b>	<b>6</b>
<b>AFR</b>			
<b>1990</b>	<b>91%</b>	<b>139</b>	<b>13</b>
<b>2000</b>	<b>96%</b>	<b>34</b>	<b>13</b>
<b>2005</b>	<b>92%</b>	<b>113</b>	<b>13</b>

# Clouds

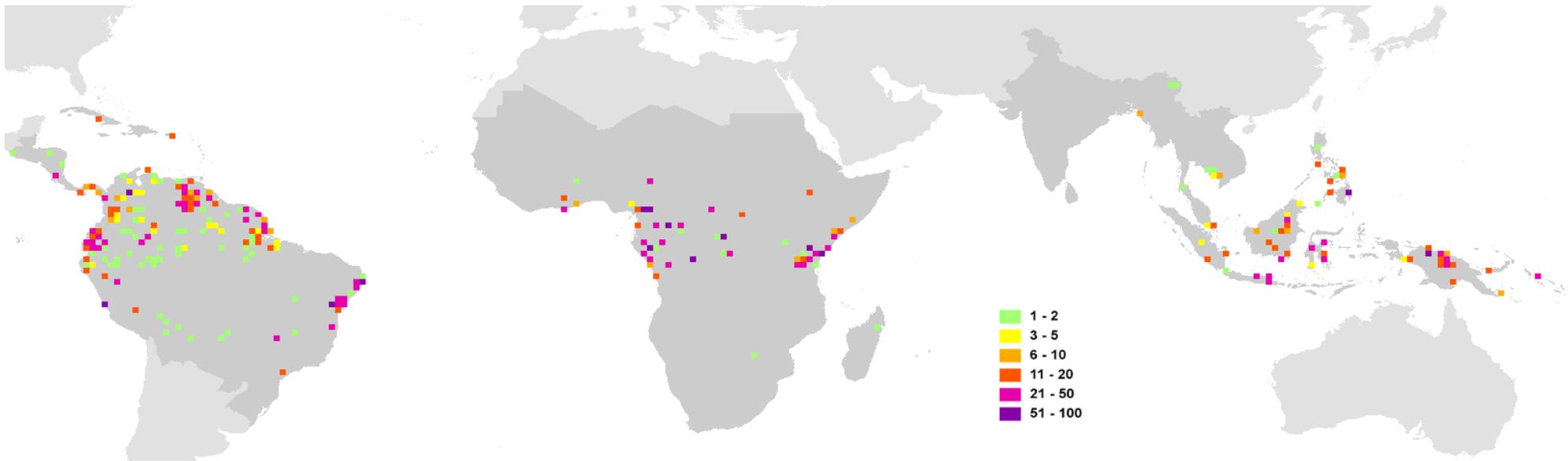
<b>LAC</b>	<b>Boxes with clouds</b>	<b>Percent cloudy boxes</b>
<b>1990</b>	<b>225 (from 1219)</b>	<b>18 %</b>
<b>2000</b>	<b>268 (from 1219)</b>	<b>22 %</b>
<b>2005</b>	<b>228 (from 1112)</b>	<b>24 %</b>
<b>SEA</b>	<b>Boxes with clouds</b>	<b>Percent cloudy boxes</b>
<b>1990</b>	<b>184 (from 726)</b>	<b>25 %</b>
<b>2000</b>	<b>170 (from 726)</b>	<b>23 %</b>
<b>2005</b>	<b>135 (from 646)</b>	<b>21 %</b>
<b>AFR</b>	<b>Boxes with clouds</b>	<b>Percent cloudy boxes</b>
<b>1990</b>	<b>185 (from 1994)</b>	<b>9 %</b>
<b>2000</b>	<b>140 (from 1994)</b>	<b>7 %</b>
<b>2005</b>	<b>??</b>	<b>??</b>



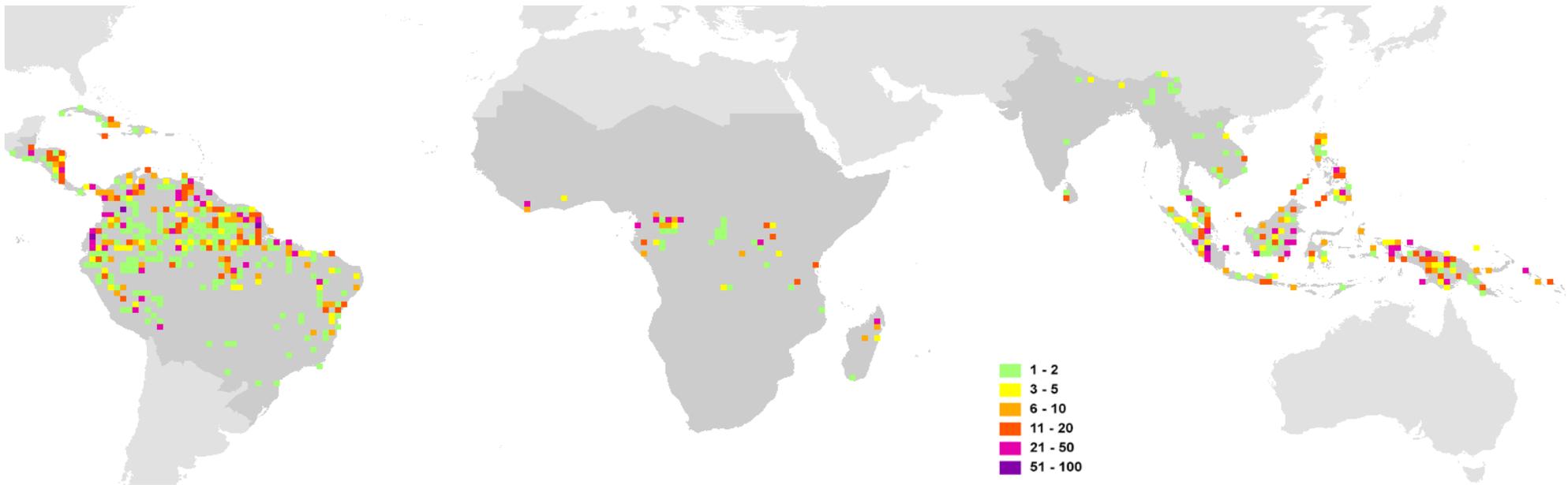
**Cloud cover evaluation of TREES-3 sample sites for the “year 1990 period” (in percent)**



**Cloud cover evaluation of TREES-3 sample sites for the “year 2000 period” (in percent)**

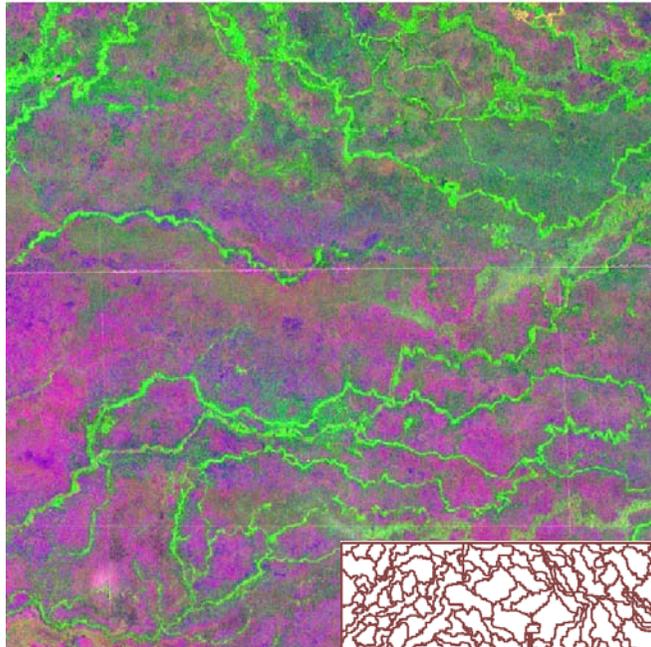


**Reduction (delta) of cloud cover of TREES-3 sample sites by using alternative data to GLS1990 (in percent)**

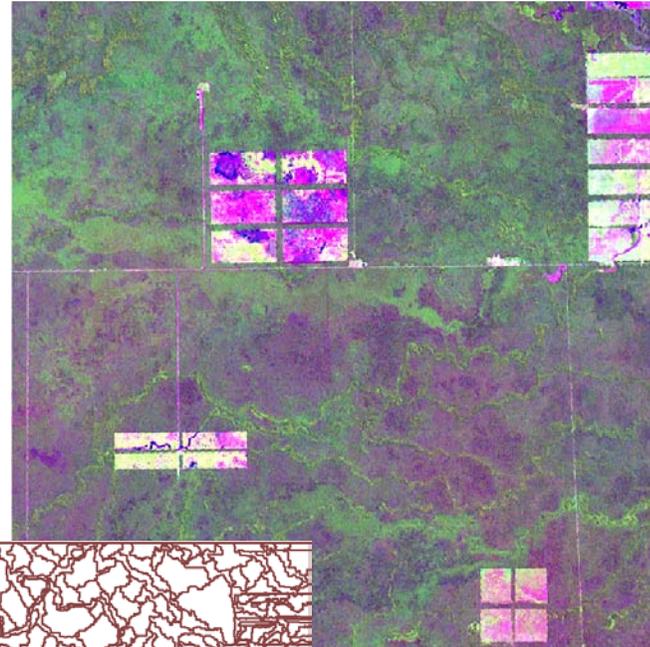


**Reduction (delta) of cloud cover of TREES-3 sample sites by using alternative data to GLS2000 (in percent)**

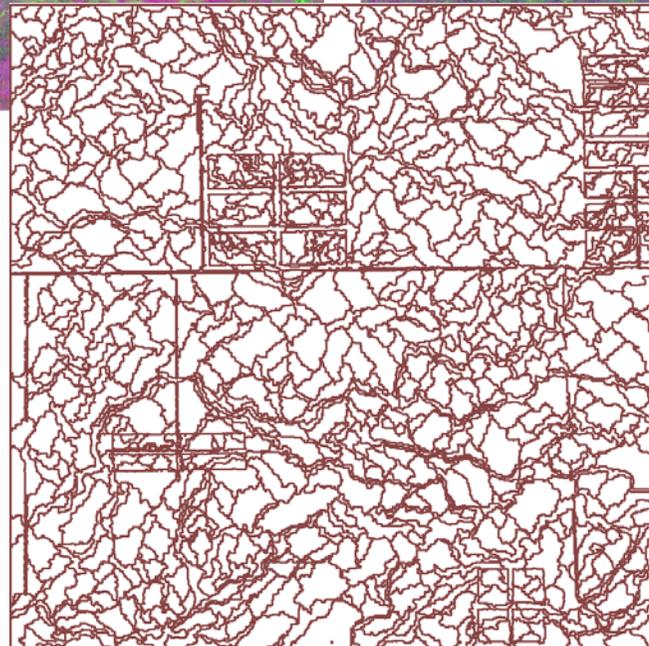
# Segmentation



Historical

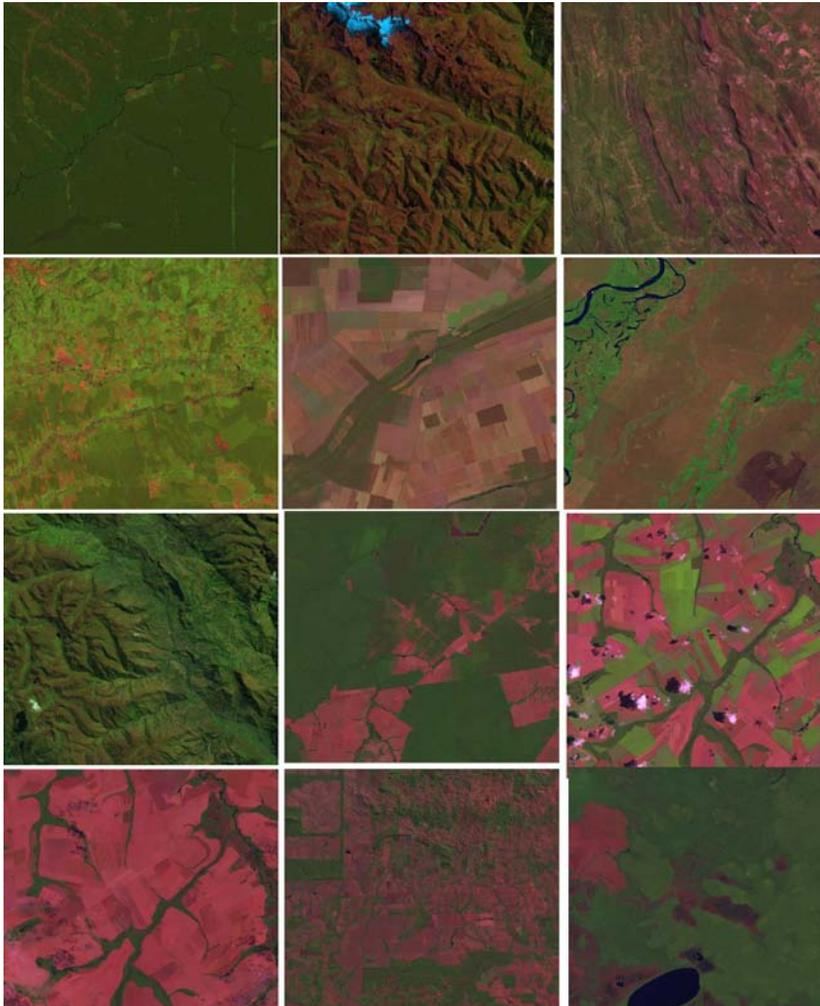


Recent

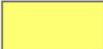
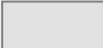


# Classification

A regional subset is used to collect spectral signatures



## Legend

-  TREE COVER
-  TREE MOSAIC - HIGH%
-  TREE MOSAIC - LOW%
-  SHRUB COVER
-  SHRUB COVER - REGROWTH
-  OTHER VEGETATION COVER
-  BARE OR ARTIFICIAL
-  BURNT
-  WATER
-  NON-TREE MOSAIC
-  CLOUD OR SHADOW
-  NO DATA

IDL 1990

UNKNOWN

VEGETATION  Evergreen  Dec

Vegetation with forest

Dense  Open  D

Regrowth  Plantation

Mosaic Forest / Other  Rural

Mosaic Other / Forest

Other vegetation

Shrubs  Grasslands

Trees plant.  Shrubs plant.

Arable  Irrigated

Pasture  Agri - mosaic

UNVEGETATED

Water Open

Water - flooded vegetation

Urban  Infrastructure

Rocks  Black

Bare soil +  White

Snow/ice

Other  Cloud  Cloud shadow

Observation condition

OK  Shadow  Burnt

Haze  Sun facing slope  Floded

Image season

Dry  Wet  Undetermined

Pure spectral class in the box  Yes  No

Comment on specific ecosystem

SNOW/ICE

Other  Cloud  Cloud shadow

Observation condition

OK  Shadow  Burnt

Haze  Sun facing slope  Floded

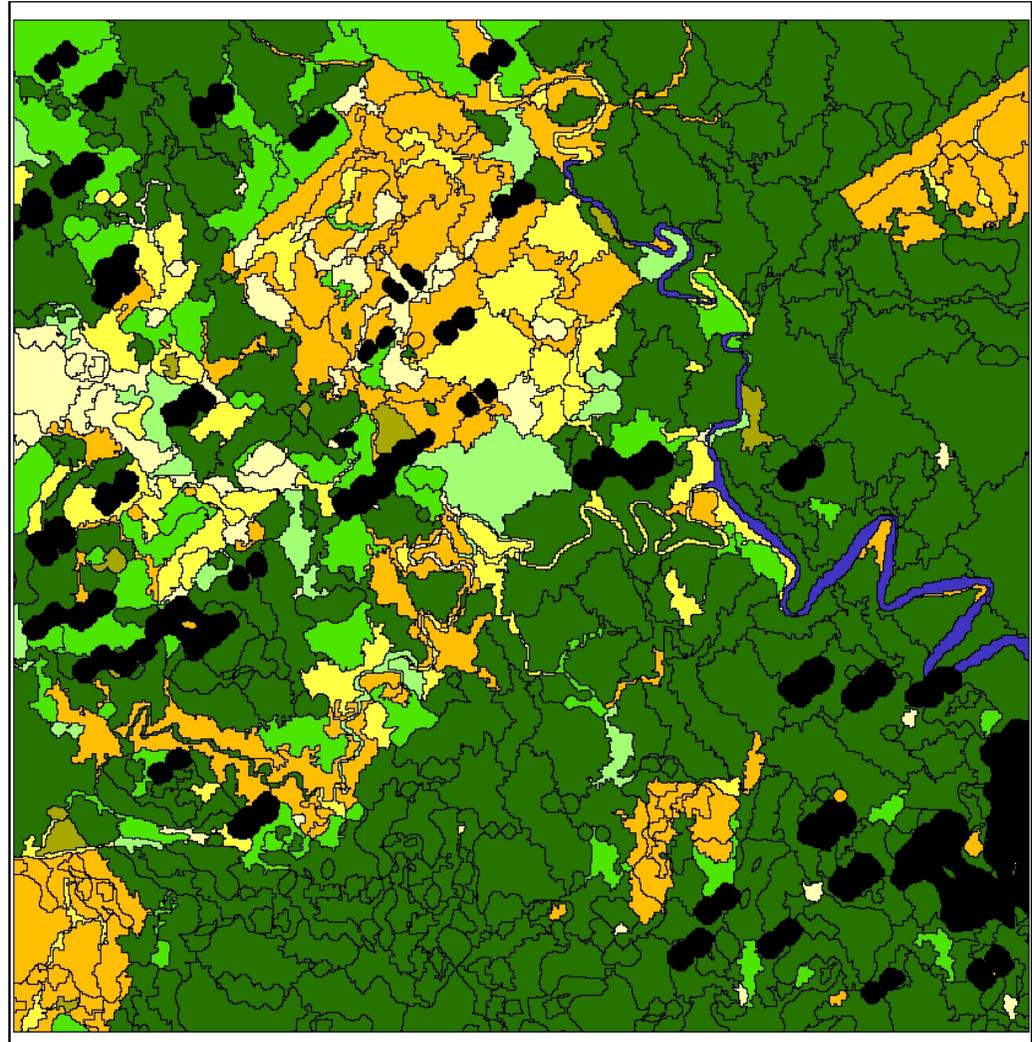
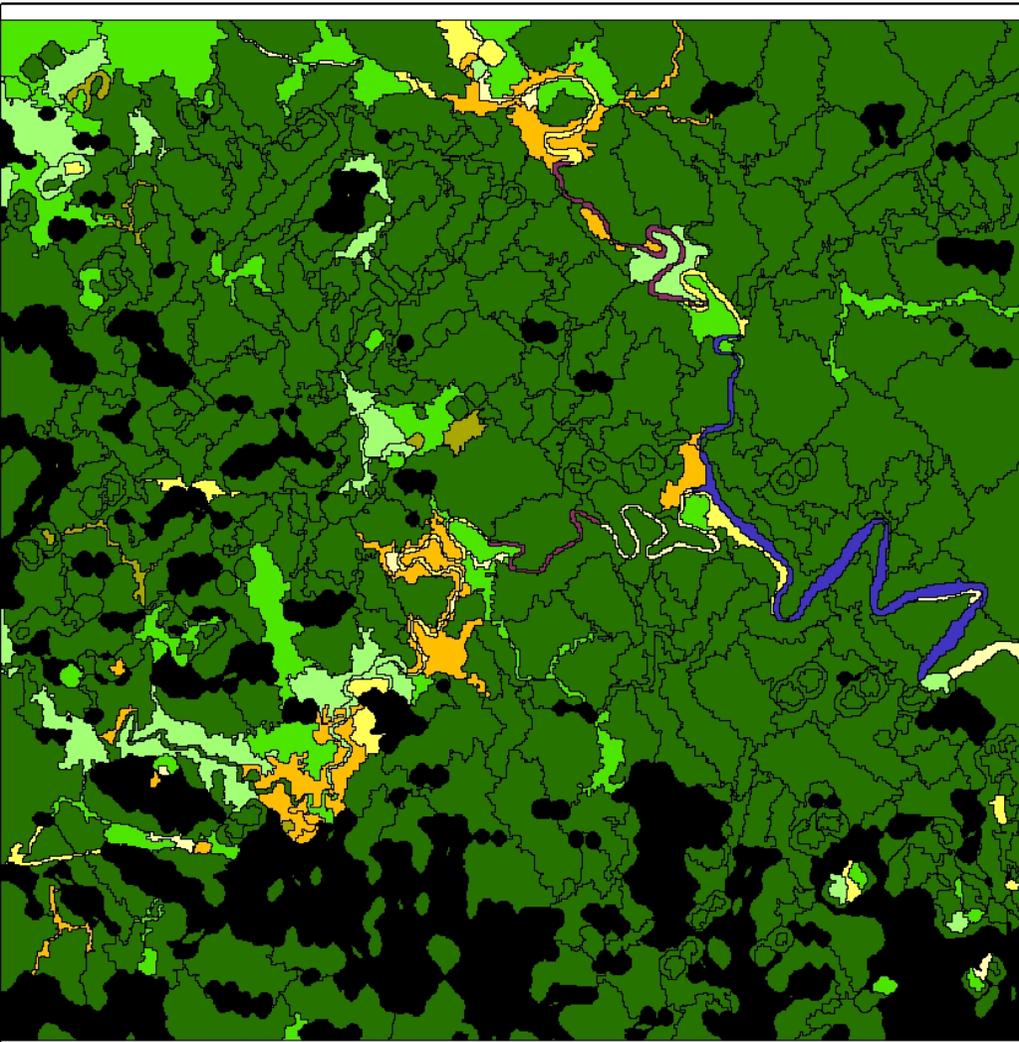
Image season

Dry  Wet  Undetermined

Pure spectral class in the box  Yes  No

Comment on specific ecosystem

N4 E117 Borneo / E-Kalimantan-North



N4 E117 Borneo / E-Kalimantan-North (Mentarang): Inland Swamp Forests / Oil Palm

# Web based validation tool (and workshops)

European Commission  
**gem** Global Environment Monitoring

European Commission > JRC > IES > GEM > Data & Products > TREES-3 > Access to dataset

Subarea:

Country:

Latitude	Longitude	Sensor	Path	Row	Date	Sensor	Path	Row	Date
-10	-55	tm	226	067	09 07 1987	etm	226	067	18 06 2000

S18\_W042 S05\_W045  
S26\_W052 S09\_W039  
S04\_W047 S05\_W064  
S01\_W048 S10\_W048  
S11\_W063 S06\_W039  
S16\_W049 S07\_W051  
S05\_W047 S04\_W050  
S20\_W049 S15\_W049  
S16\_W048 S11\_W048  
S11\_W044 S16\_W042  
S20\_W041 S04\_W041  
S17\_W040 S04\_W040  
S26\_W051 N00\_W056  
S16\_W045 N01\_W060  
N00\_W060 S13\_W061  
S10\_W068 S08\_W051  
S30\_W055 S10\_W055  
S18\_W054 S01\_W053  
S10\_W051 S10\_W063

Map data ©2009 Google Technologies - Terms of Use

Class\_Names

- Outside USA
- Dry and Cropland and Pasture
- Impervious Cropland and Pasture
- Mixed Dryland/Irrigated Cropland
- Grassland/Cropland and Mixed
- Woodland/Cropland Mixed
- Grassland
- Desert Shrubland
- Mixed Shrubland/Grassland
- Chaparral
- Savanna

<http://bioval.jrc.ec.europa.eu/TREES/>

# Regional validation workshops



**Dakar** (08-13 March 2010)

**West Africa**

15 Experts from 14 countries  
3 JRC support staff



**Nairobi** (28 Sept- 2 Oct 2009)

**East Africa**

12 Experts from 10 countries  
4 support staff including 3 JRC



**Kinshasa** (28 Sept- 9 Oct 2009)

**Central Africa**

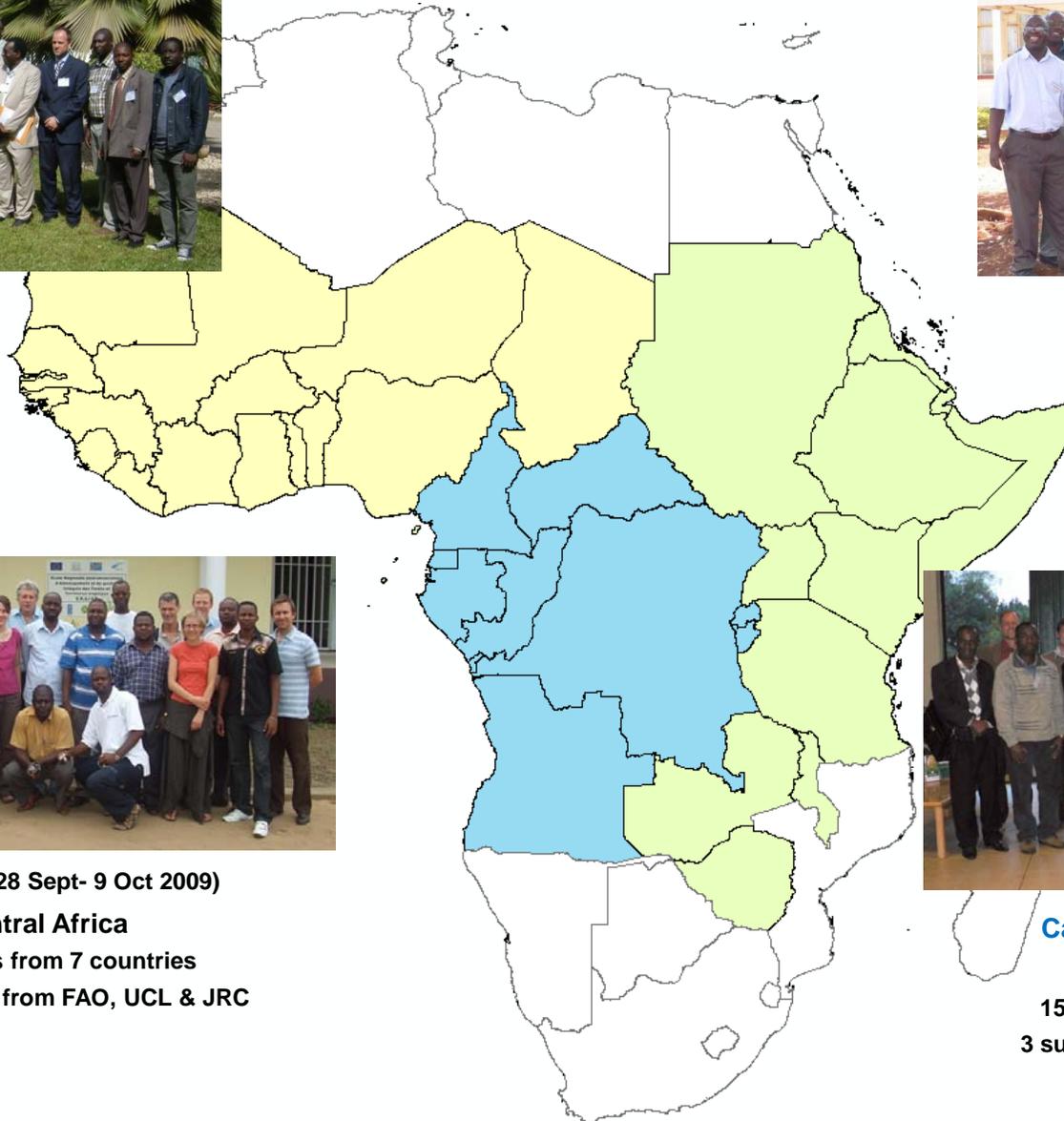
15 Experts from 7 countries  
6 support staff from FAO, UCL & JRC



**Cape Town** (3-7 May 2010)

**Southern Africa**

15 Experts from 8 countries  
3 support staff including 2 JRC



# Validation and ownership

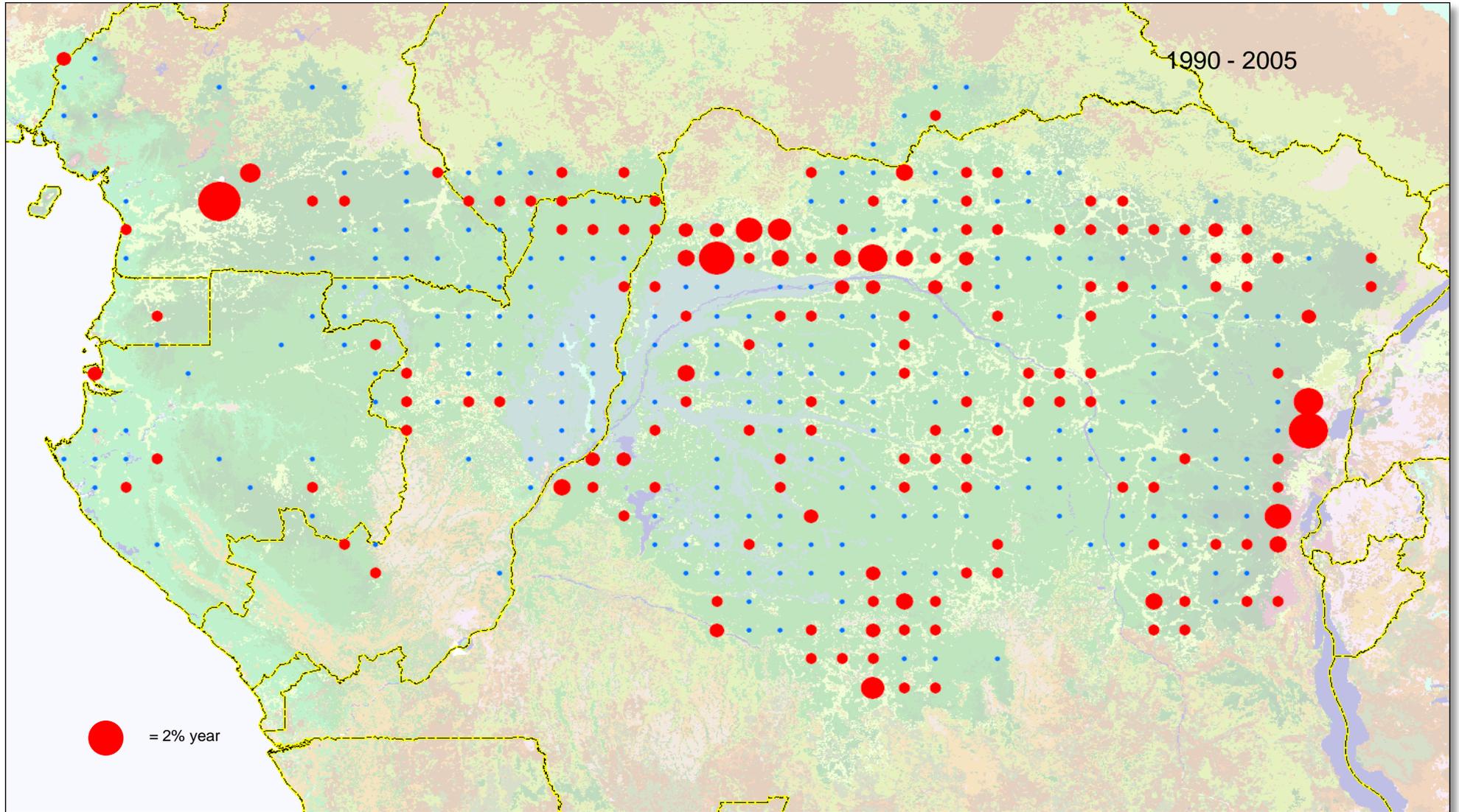
1. Campinas, Brazil; June 2009
  2. Kinshasa, D.R.Congo: September 2009
  3. La Molina, Peru: October 2009
  4. Santa Cruz, Bolivia: October 2009
  5. Nairobi, Kenya: October 2009
  6. Campinas, Brazil: November 2009
  7. Brazzaville, Congo: February 2010
  8. Pathumthani, Thailand: February 2010
  9. Dakar, Senegal: March 2010
  10. Dhera Dun, India: April 2010
  11. Cape Town, South Africa: May 2010
- 
1. Panama City, Panama: July 2010
  2. Himalayan States: August 2010
  3. Cayenne, French Guyana: October 2010

Plus 12 sessions at Ispra, Italy

Angola	Ethiopia	Nicaragua
Bangladesh	French Guyana	Niger
Belize	Gabon	Nigeria
Benin	Ghana	Peru
Bolivia	Guatemala	Philippines
Botswana	Guinée-Conakry	PNG
Brazil	Guyana	Rwanda
Burkina Faso	India	Senegal
Burundi	Indonesia	Sierra Leone
Cambodia	Kenya	Somalia
Cameroon	Laos PDR	South Africa
CAR	Lesotho	Surinam
Chad	Liberia	Swaziland
Colombia	Madagascar	Tanzania
Congo	Malaysia	Thailand
Costa Rica	Mali	Togo
Côte d'Ivoire	Mauritania	Uganda
DR Congo	Mozambique	Venezuela
Ecuador	Myanmar	Viêtnam
Eq. Guinea	Namibia	Zambia

**137 regional experts from 60 countries**

# Results; Central Africa 0.16% / yr



# Regional monitoring centre Kinshasa

Under the guidance of COMIFAC  
Commission des Forêts d'Afrique Centrale

Provides a research-base  
Deforestation, logging, biodiversity  
Reference in REDD and FLEGT

Helps establish take up of methods  
Legal and political framework  
Building local ownership

Helps transfer know-how  
Local production of information  
Integration in decision-making process  
Capacity building



# Conclusions

The Landsat programme *is the only* viable means of measuring deforestation throughout the humid tropics from the 1990 baseline 'till present

Local interest and commitment is very real

The GLS and L1T have proven robust, reliable and immensely valuable

The CEOS LSI constellation has had positive impact

The depth of archive offers significant improvements to the quality (and completeness) of the sample

Problem areas do exist – for 1990s, 2005, 2010

No data and/or persistent cloud cover

