

A stylized world map in a light grey color, centered on the Atlantic Ocean, set against a dark green background with a faint grid pattern.

# Global land cover observations and assessments: Update on activities for GEO task DA-09-03a

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*[www.fao.org/gtos/gofc-gold](http://www.fao.org/gtos/gofc-gold)  
[www.gofc-gold.uni-jena.de](http://www.gofc-gold.uni-jena.de)*



**GOFC-GOLD**

*Global Observations of Forest Cover and Land Dynamics*

# Overview

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1. Political initiatives driving observation progress and needs for validation
  - UNFCCC and observing land cover as ECV
2. Global land cover observations
  - MODIS and GLOBCOVER
  - Best use of existing reference datasets
3. Coordinated effort to develop LC validation database and “best map”
4. Assessment for fine-scale land cover change and area estimates
  - Post-Kyoto agreement and best practices

# International drivers

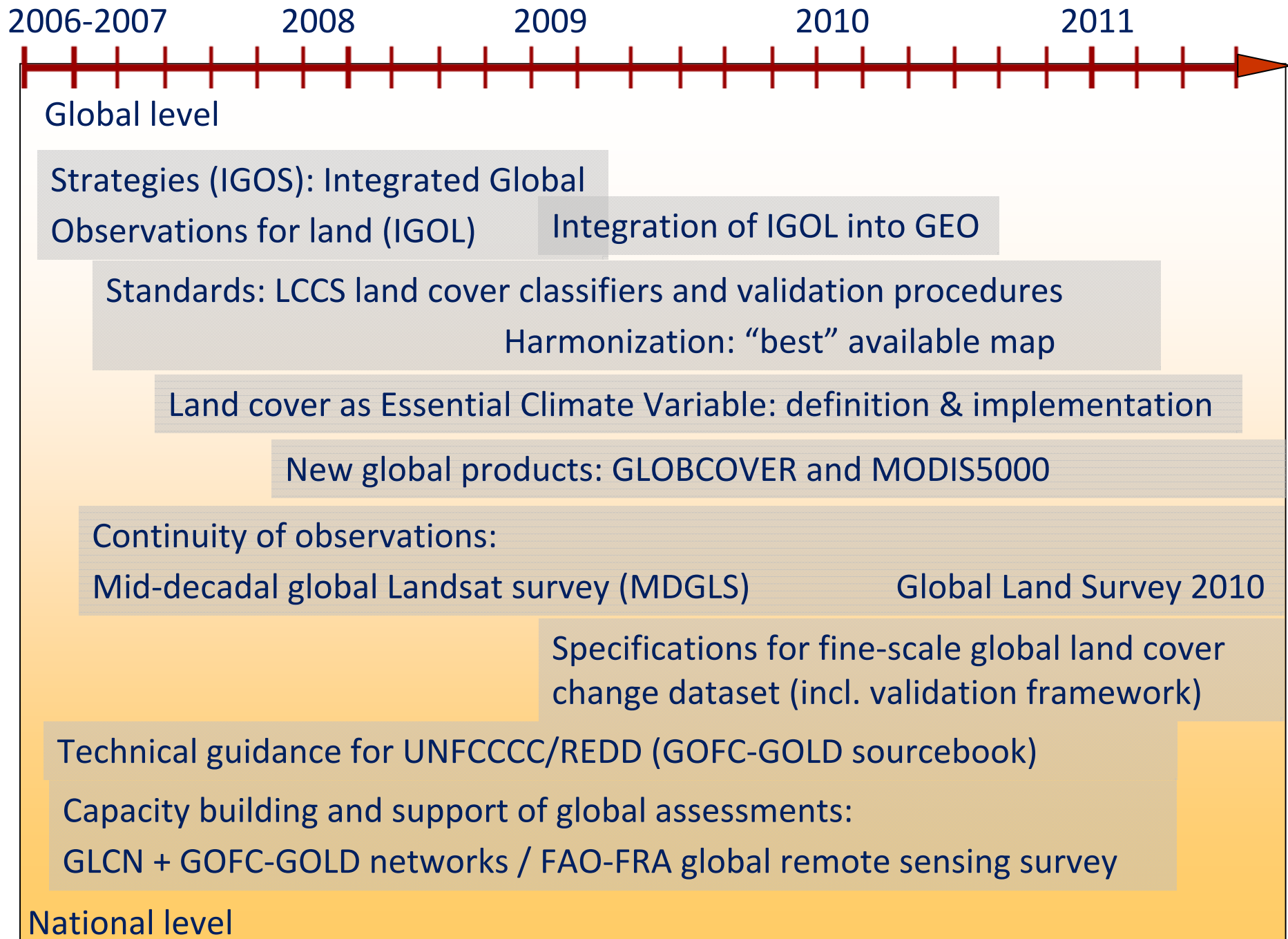
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- 1. United Framework Convention on Climate Change:**
  - Reduce uncertainties in monitoring the global climate system through observing essential climate variables
  - Capacity building needs to address stronger role of developing countries in post-2012 agreement
    - Major REDD readiness funds are currently being allocated
- 2. Group on Earth Observation (GEO) task DA-07-02:**
  - Provide a suite of global land cover datasets, initially based on improved and validated moderate resolution land cover maps and eventually including land-cover change at high resolution (task co-lead by USGS and GOFC-GOLD)
- 3. Global land cover monitoring and assessments:**
  - GLOBCOVER, FAO-Forest Resources Assessm. 2010
  - Operational validation / Efforts for deriving “Best map”

# Details on GEO task DA-09-03a

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1. Advocate existing internationally-agreed approaches to systematic land cover characterization) and (LCCS classifiers validation (CEOS protocols)
2. Utilize and validate moderate resolution time series data and land cover data sets (i.e. GLOBCOVER, MODIS500) and earlier 1-km resolution maps (i.e. GLC2000, IGBP-DIS)
3. Formulate specifications and implement production of a global high-resolution land cover and land change data set and report
4. Set up a centralized web-based access to existing land cover data
5. Identify opportunities for applying land cover data in areas related to key societal benefits.
6. Strengthen national level capacities to produce and use these products especially in developing countries



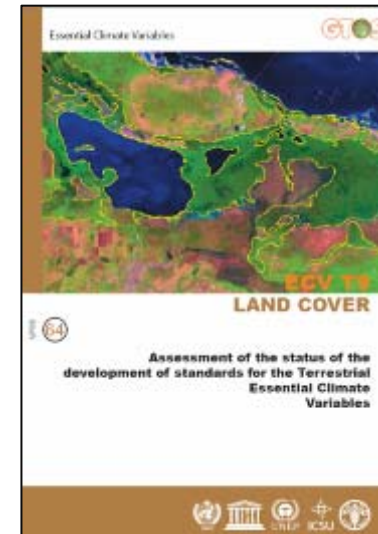
Activities of GEO task DA-09-03a



# Land monitoring and the UNFCCC

## Observing essential climate variables (ECV)

- Reduce uncertainties in monitoring the global climate system
- Land cover as key variable
- Development of standards and prepare implementation programmes

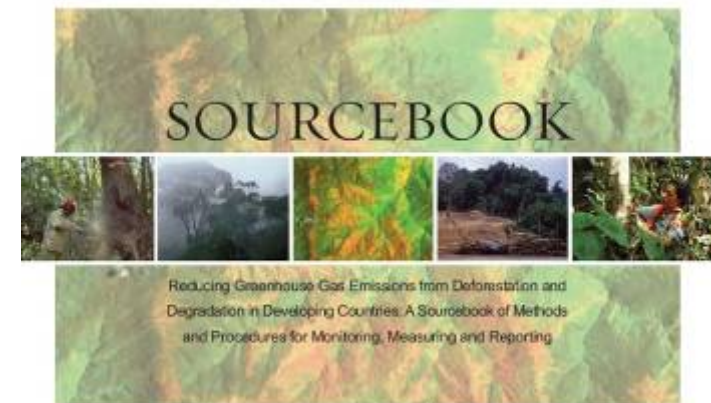


Herold et al.,  
[www.fao.org/gtos/topcECV.html](http://www.fao.org/gtos/topcECV.html)

## Reducing emissions from deforestation and forest degradation (REDD)

- Stronger mitigation role of developing countries in post-2012 agreement
- Remote sensing capabilities to build national forest carbon monitoring systems

**Major investments in land monitoring, estimation and accounting**



Achard, Herold et al.,  
<http://www.gofc-gold.uni-jena.de/redd>

# Observing land cover as ECV

Name	Spatial resolution	Frequency of product update	Maturity
<b>Mapping of land cover</b>			
Land cover maps	250m - 1 km	annual	pre-operational
Fine-scale land cover and land use maps	10-30 m	3-5 years	pre-operational (for land cover)
Global land cover reference sample database	In-situ/1 m	1-5 years	pre-operational (CEOS, GOFC-GOLD)
<b>Monitoring of dynamics and change</b>			
Global land cover dynamics and disturbances	250m - 1 km	intra-annual/ long-time series	pre-operational (for several processes)
Fine-scale land cover and land use change	10-30 m	1-5 years	pre-operational (for land cover)
Monitoring areas of 'Rapid change'	1-30 m	1-2 years or less	pre-operational (for some change processes)

Table 2: Characteristics of land cover mapping and monitoring products useful for observing land cover as an ECV

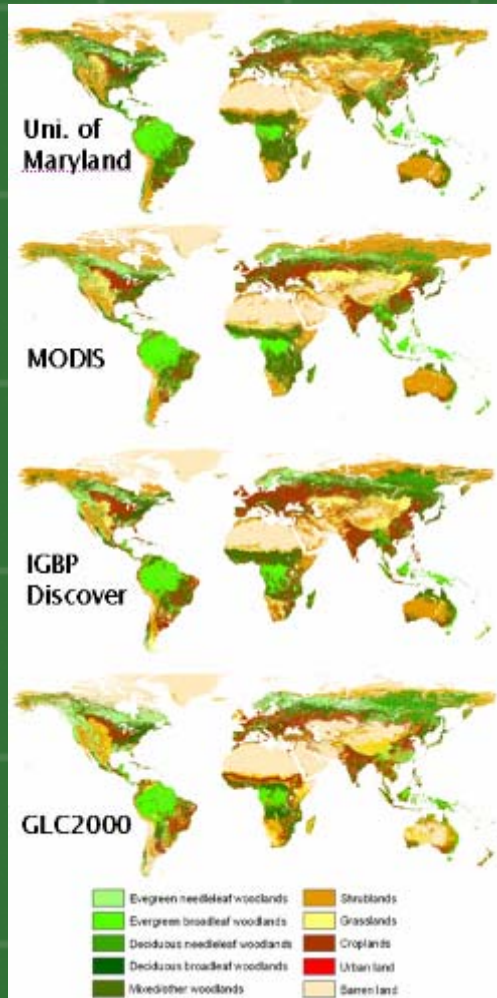
# GCOS implementation plan actions for land cover

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1. Establish international standards (T22)
  - UN Land Cover Classification System (LCCS) classifiers
2. Methods for map accuracy assessment (T23)
  - CEOS WGCV/GOFC-GOLD best practices report
3. Continuity for fine-scale satellite observations (T24)
  - Commitments to operate Landsat 8 (US) and Sentinel 2 (EU)
4. Develop an *in situ* reference network (T25)
  - Global operational validation implementation plan
5. Annual global land-cover products (T26)
  - Release (and continuation) of GLOBCOVER
6. High-resolution global land cover change (T27)
  - FAO/FRA 2010 global sampling & GEO definition of specifications

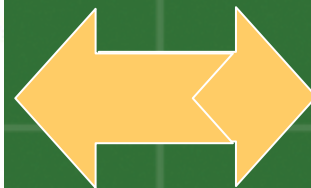
# Harmonized land cover characterization

Existing global land cover datasets

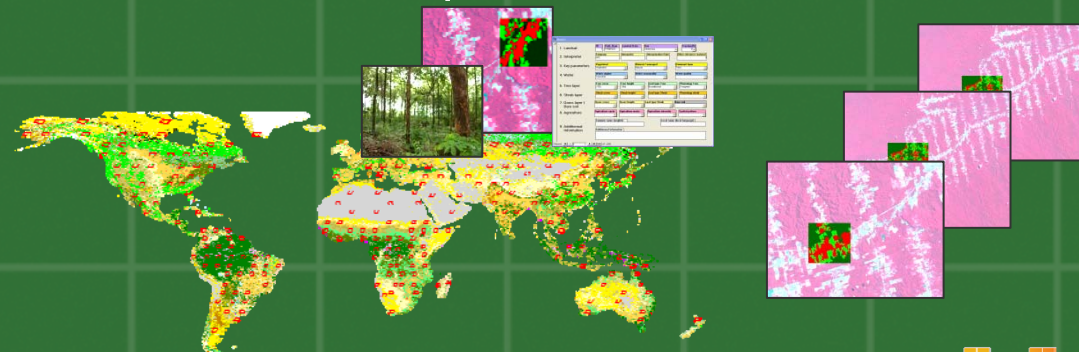


Common land cover classifiers (LCCS)

Cover type/ life form

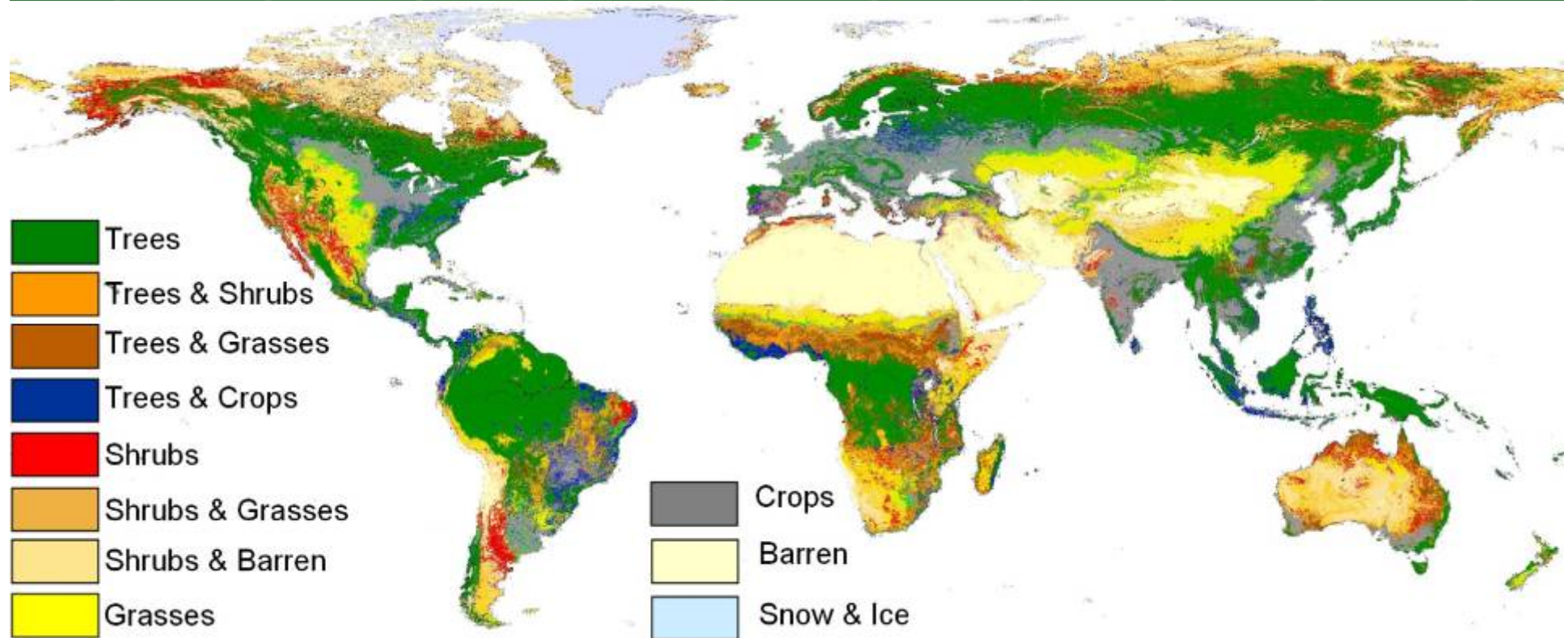


“Living” validation database for comparative assessment



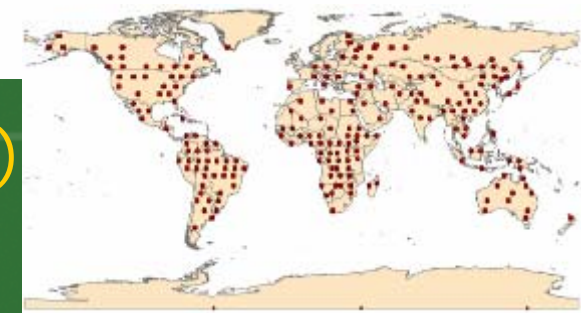
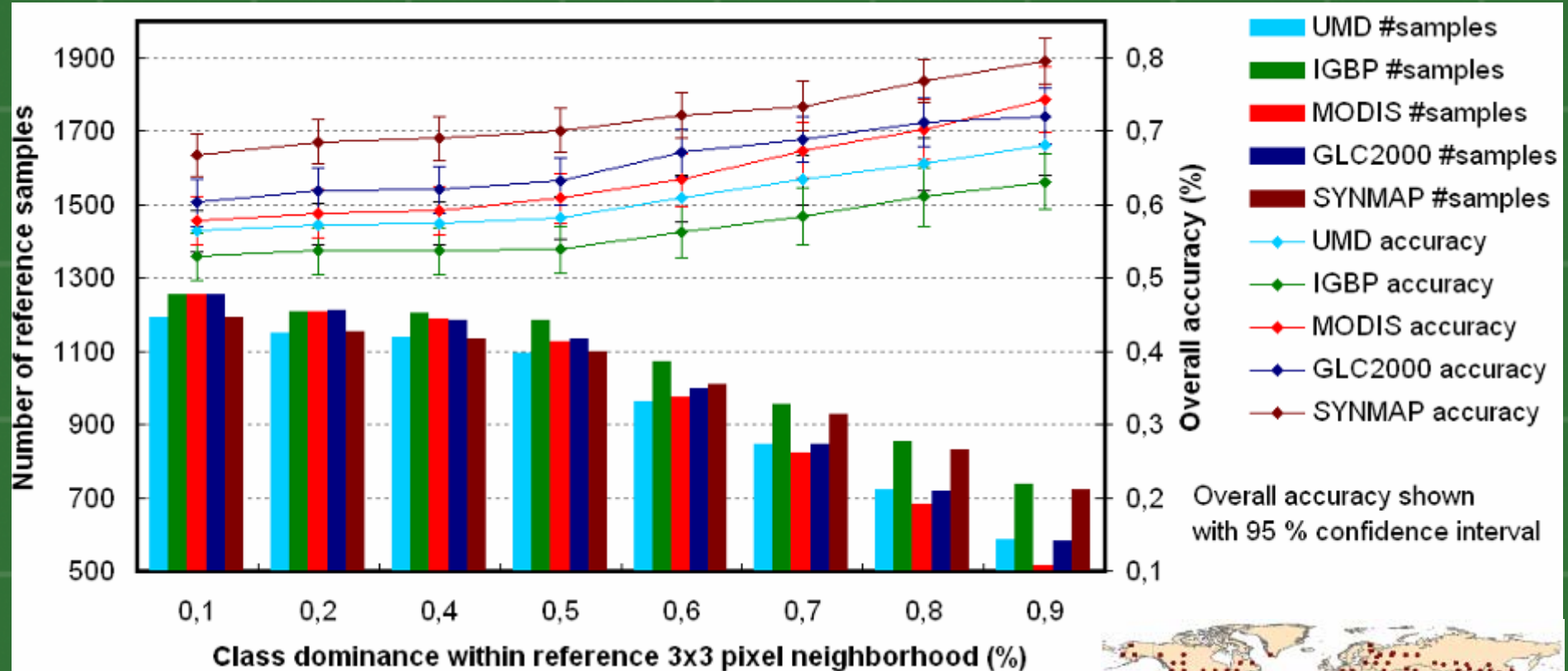
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# SYNMAP – for carbon cycle modeling



SYNMAP – a global synthesis product of existing global land cover maps to provide a targeted and improved land cover map for carbon cycle modelling purposes; here shown as life form assemblages (Source: M. Jung et al. 2006, Remote Sensing of Environment).

# Assessing accuracy of global datasets



Based on GLC2000 reference database (2000) with 1253 secondary samples world wide interpreted with Landsat data. All global land cover products have been translated and aggregated according to the generalized

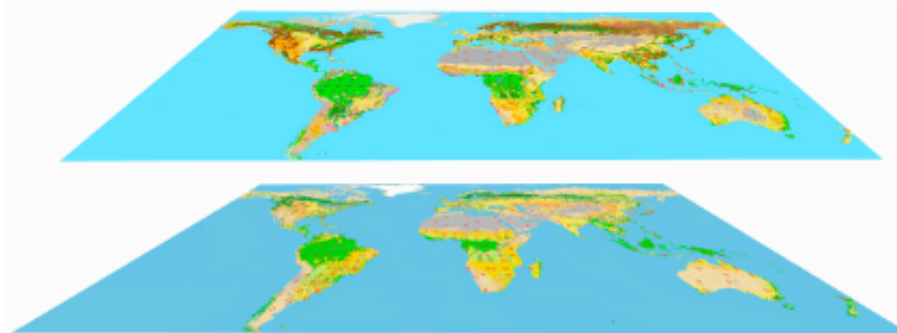


# International consensus on technical issues

## “Best Practices Document”

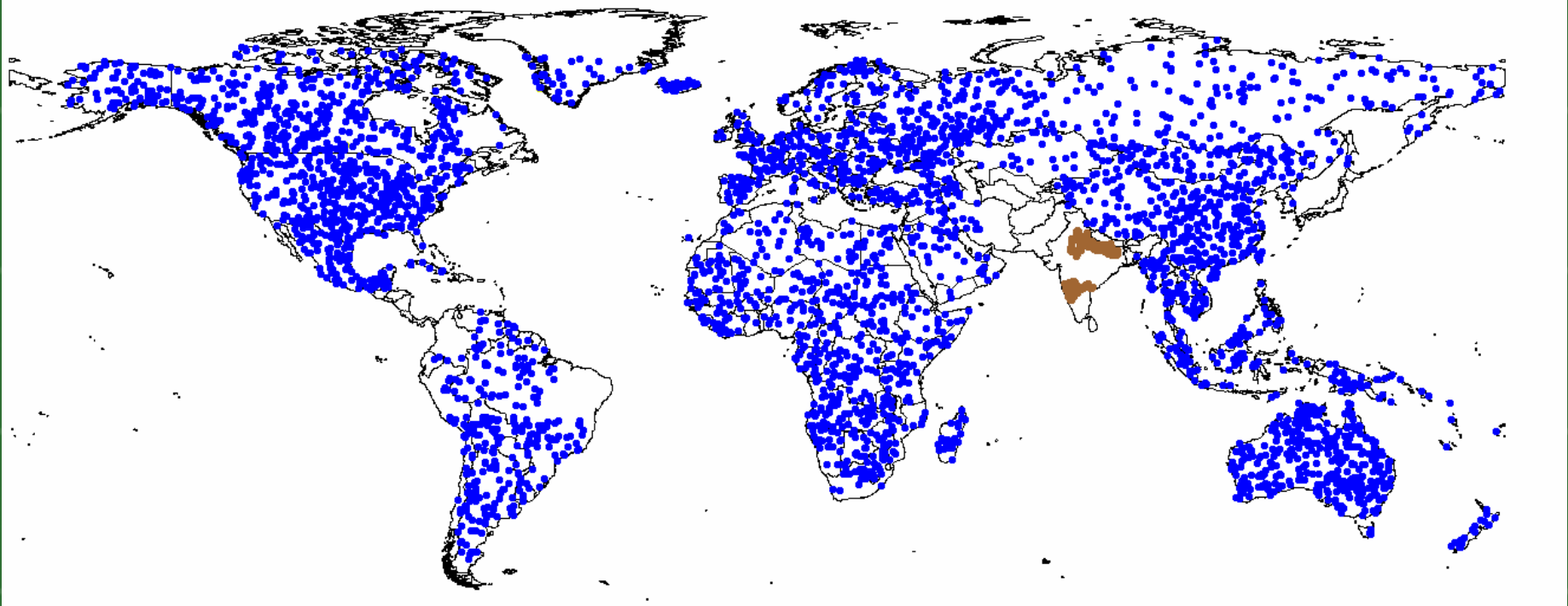
Strahler et al., 2006

**GLOBAL LAND COVER VALIDATION:  
RECOMMENDATIONS FOR EVALUATION AND  
ACCURACY ASSESSMENT OF  
GLOBAL LAND COVER MAPS**



# GLOBCOVER validation

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More than 4300 validation points interpreted by int. experts

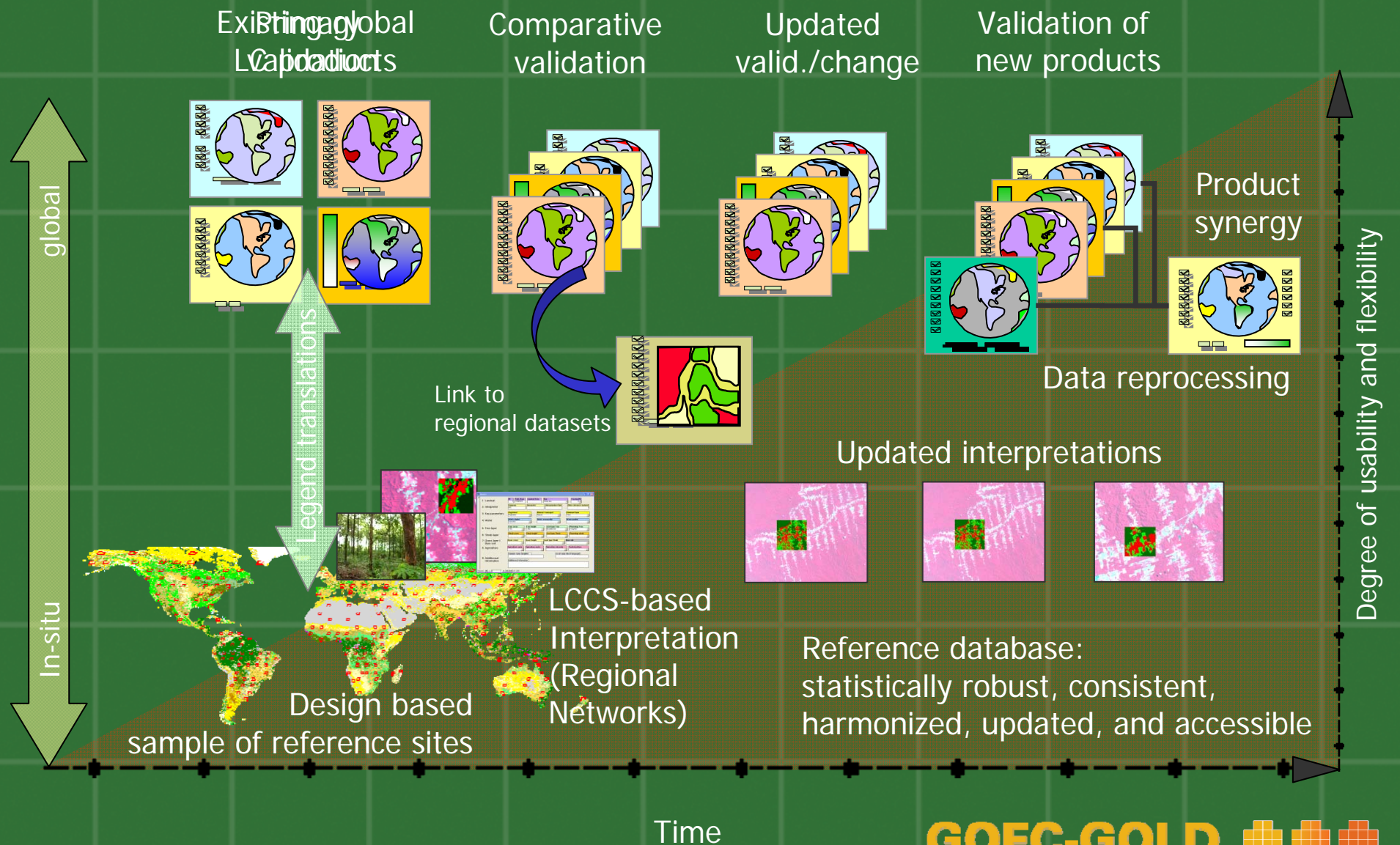
Blue points: Globcover project (3835 points) + Gond's set (n~80)  
*(including 225 double interpretation by 2 experts)*

Brown points: IMWI data (403 points)

Global area weighted accuracy: ~73 % based on 3167 reference points

Validation report available ~ 15. October 2008

# Operational IC validation framework



# Operational lc validation framework

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- Effort serves purpose for estimating:
  - Individual map accuracy / best available map
  - Area of land-cover classes or land-cover change
- Sampling design:
  - 10 km by 10 km block (Landsat – MODIS)
  - Flexible to increase sample size to provide precise country or region specific estimates
  - Stratification by geographic reporting regions, areas where maps differ, important rare land-cover classes
- Response design:
  - Reference data (i.e. SPOT) interpreted by regional experts (i.e. GOFC-GOLD networks) using LCCS classifiers
- Analysis design:
  - Error matrix for each map and region
  - Estimates of class area
  - Supplementary accuracy information on land-cover composition and landscape pattern

# Fine-scale land cover change

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- Suite of national / regional experiences:
  - National/regional monitoring programs
  - UNFCCC Kyoto reporting on LULUCF/AFOLU
- UNFCCC process on reducing emissions from deforestation in developing countries:
  - case studies, readiness activities, post 2012
- Projects with global/large scale focus:
  - EU/JRC: TREES 3 (sampling approach)
  - UMD/SDSU: combined MODIS/Landsat approach
- FAO-Forest Resources Assessment 2010
- Accuracy assessment of area changes?

# Current availability of fine-scale satellite data sources and capacities for global land cover change observations

	Satellite observation system/program	Technical observation challenges solved	Access to information on quality of archived data worldwide	Continuous observation program for global coverage	Pre-processed global image datasets generated & accessible	Image data available in mapping agencies for land change analysis	Capacities to sustainably produce/use map products in developing countries
OPTICAL	LANDSAT TM/ETM	Dark Gray	Dark Gray	Dark Gray	Dark Gray	Dark Gray	Light Gray
	ASTER	Dark Gray	Dark Gray	Light Gray	On demand	Light Gray	White
	SPOT HRV (1-5)	Dark Gray	Dark Gray	Dark Gray	Commercially	Light Gray	Light Gray
	CBERS 1-3	Dark Gray	Light Gray	Light Gray	Regionally	White	White
	IRS / Indian program	Dark Gray	Light Gray	Light Gray	Regionally	White	White
	DMC program	Dark Gray	Light Gray	Light Gray	Probably	Commercially	White
SAR	ALOS/PALSAR + JERS	Dark Gray	Dark Gray	Dark Gray	Regionally	White	White
	ENVISAT ASAR, ERS 1/2	Dark Gray	Dark Gray	Dark Gray	Regionally	White	White
	TERRARSAR-X	Dark Gray	Light Gray	White	Commercially	White	White
	IKONOS, GEOEye	Dark Gray	Dark Gray	Probably	Commercially	White	White
	ICESAT/GLAS (LIDAR)	Light Gray	Dark Gray	White	White	White	White

(Note: dark gray=common or fully applicable, light gray=partially applicable/several examples, white=rare or no applications or examples)

# GOFC-GOLD Regional Network Data Initiative

- **Goals**

- Disseminate US earth observation data in regions where available distribution methods are not effective
- Compile regional and in country data sets relevant to land cover and fire observations and make them freely available to the international community
- Engage regional expertise in global data set development, evaluation and validation

- **Opportunity**

- USGS to complete the orthorectified GLS 2005 data set and provide free access to Landsat 4–7 archive
- New LC and LCC products using GLS data and use of Landsat data for validating global science results
- Growing MODIS record and availability of MODIS-based fire and LC/change products

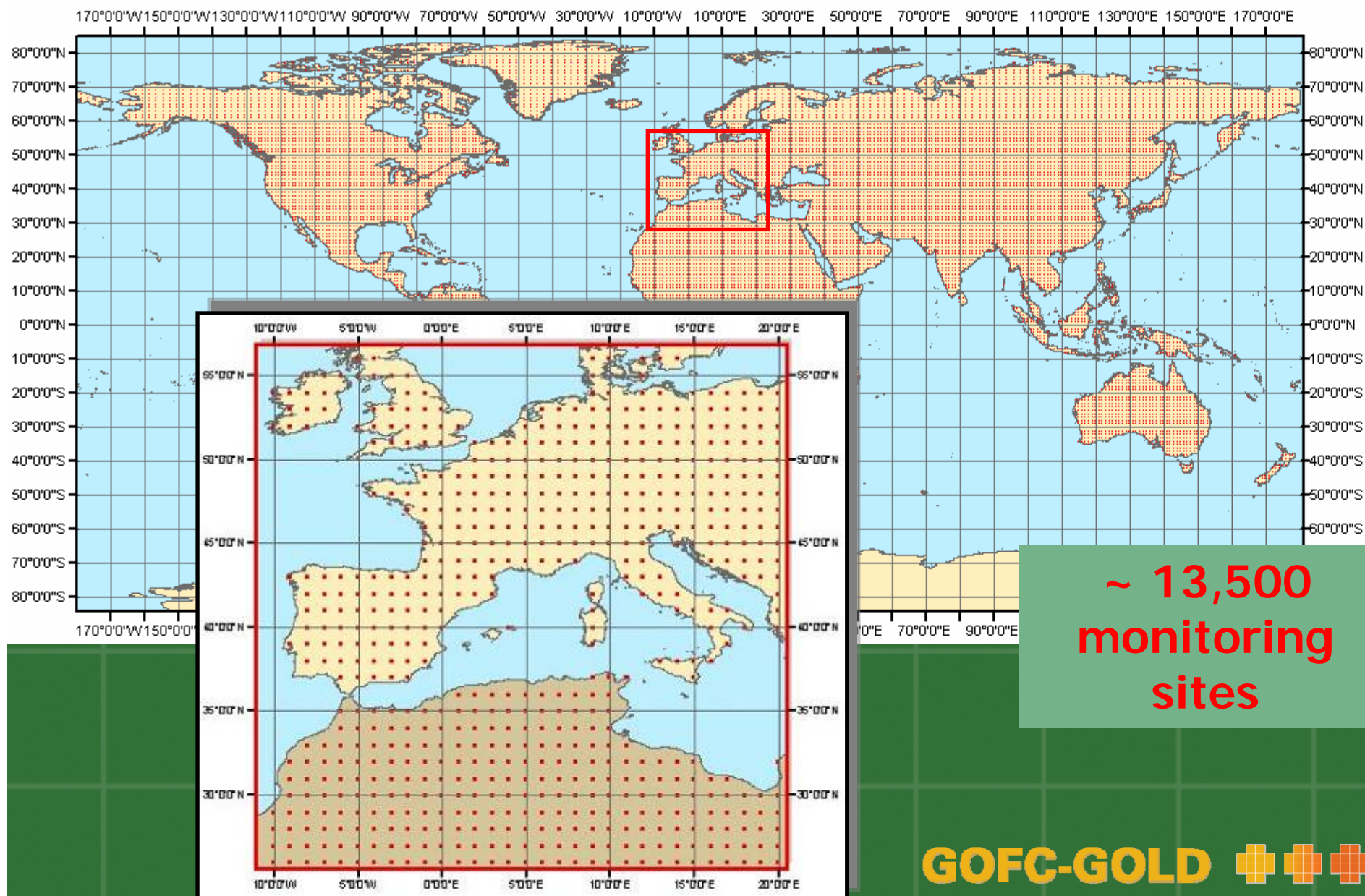
- **Approach** -- GOFC-GOLD regional network structure will be used to establish regional nodes within the networks to:

- disseminate data on media (DVD, Disk)
- encourage regional products to be developed using the data
- collect and document information on regional data sets and their availability within GOFC-GOLD thematic domain

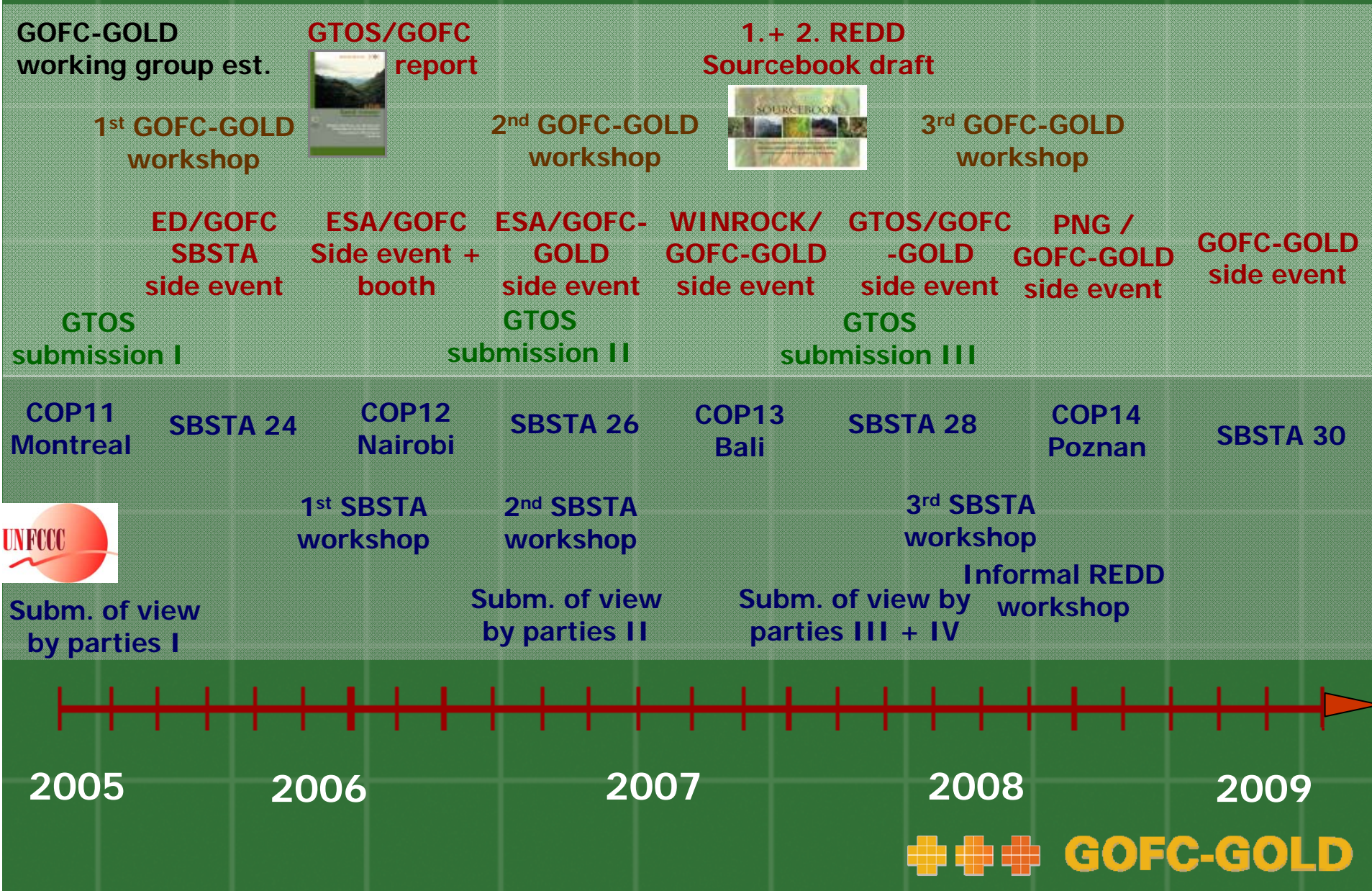
- **Pilot for Africa**

- Involves 5 regional networks
- Network representatives to receive data and training over 3 weeks at USGS EDC and South Dakota State University (SDSU) in 2009
- Support provided by START; partnership development with USGS, UNEP, SDSU

# FAO FRA 2010 –remote sensing survey



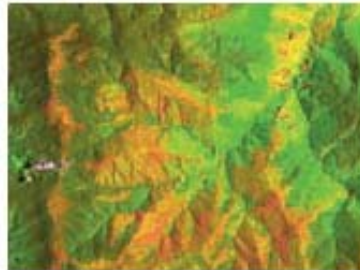
# Earth observation contribution to UNFCCC-REDD



# Sourcebook cover

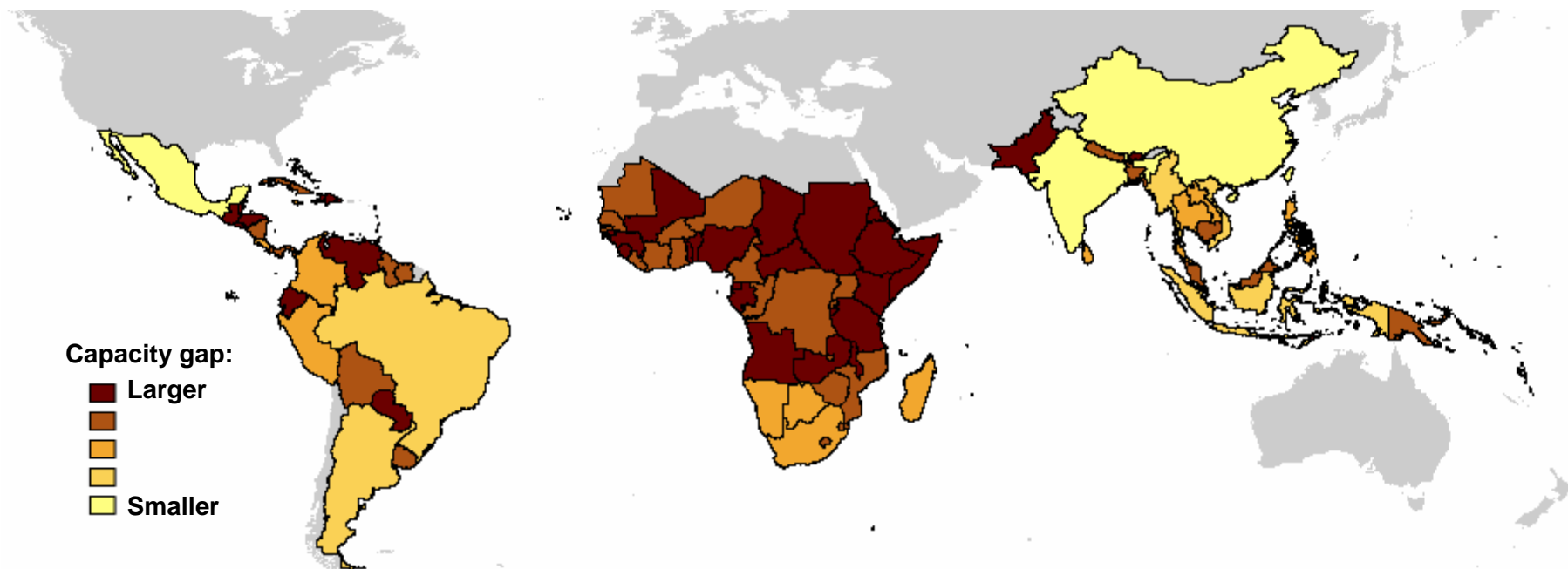


## SOURCEBOOK



Reducing Greenhouse Gas Emissions from Deforestation and Degradation in Developing Countries: A Sourcebook of Methods and Procedures for Monitoring, Measuring and Reporting

# Variability in capacities for REDD monitoring

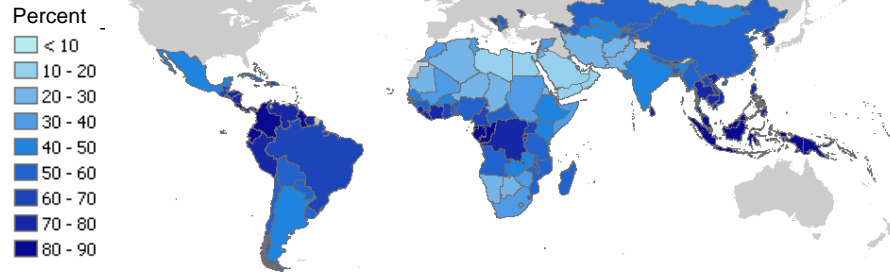


Consideration of factors:

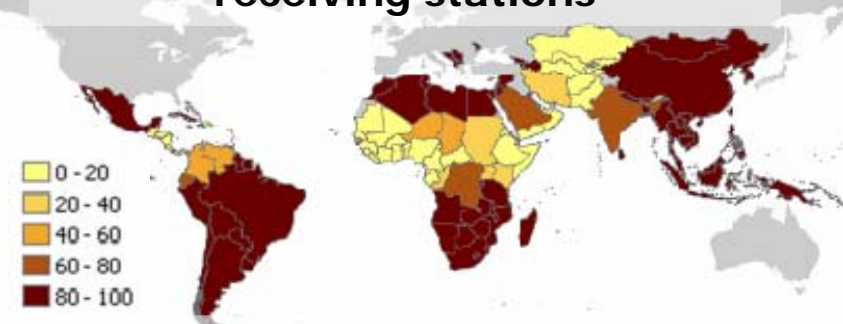
1. Requirements for monitoring forest carbon on national level (IPCC GPG)
2. Existing national capacities for national forest monitoring
3. Progress in national GHG inventory and engagement in REDD
4. REDD particular characteristics: importance of forest fires, soil carbon, deforestation rate etc.
5. Specific technical challenges (remote sensing): cloud cover, seasonality, topography, remote sensing data availability and access procedures

# Some technical challenges for remote sensing

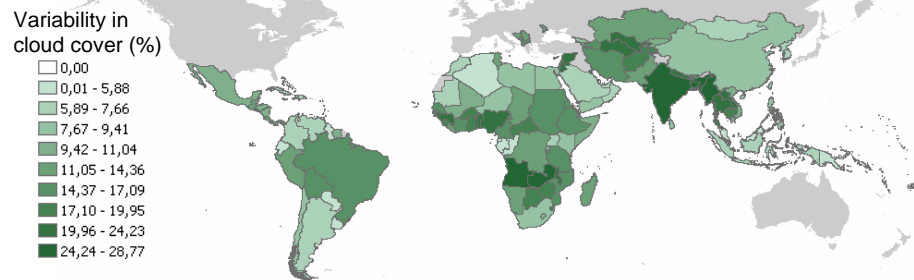
## Mean annual cloud cover



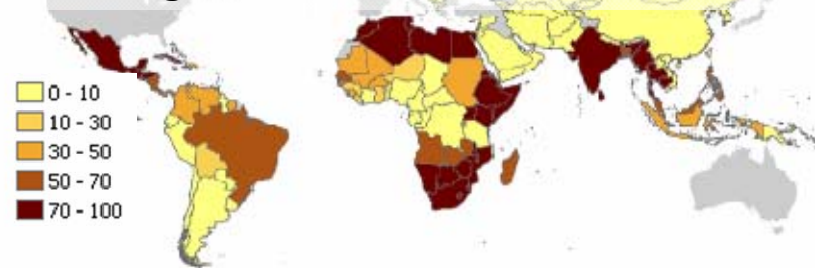
## Country coverage of Landsat 5 receiving stations



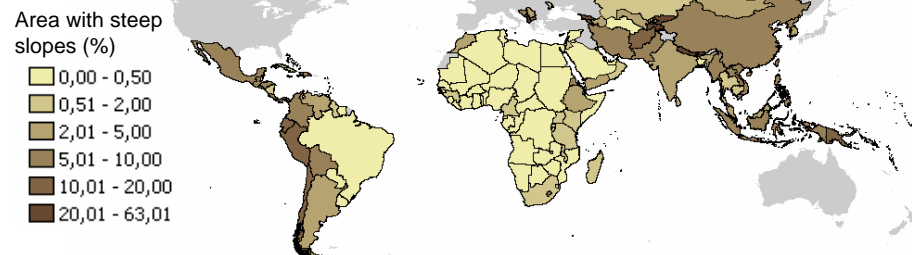
## Seasonality



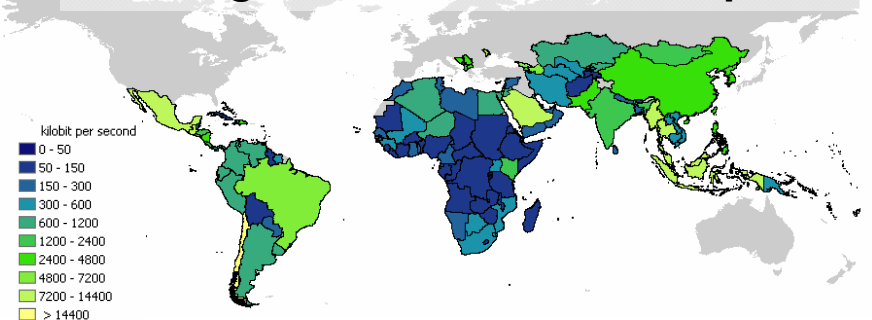
## Mean annual cloud free country coverage with SPOT data 2006-08



## Topography



## Average internet download speed



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# Remote sensing support for carbon estimation

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➤ Direct biomass mapping from space remains a challenge

➤ Existing capabilities:

➤ Satellite observation may help to map some specific forest types (i.e. mangroves, plantations etc.)

➤ Targeted remote surveys to support carbon monitoring:

- *Very high resolution satellite or airborne data of air-photo quality to assist field surveys*

- *Sensitivity of LIDAR and long-wave RADAR observations (few regional examples)*

- *Integration of in-situ and satellite data for large scale biomass mapping*

- *Direct estimation of emissions from fire radiative power*

➤ Technologies are not operational globally but evolving



A light grey world map is centered on the slide, showing the continents. The text 'GOFC-GOLD biomass working group' is overlaid on the map in a bold, yellow, sans-serif font.

# GOFC-GOLD biomass working group

Summary of 1. GOFC-GOLD biomass WG meeting,  
Missoula, Montana, June 15, 2009

[www.fao.org/gtos/gofc-gold](http://www.fao.org/gtos/gofc-gold)  
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**GOFC-GOLD**

*Global Observations of Forest Cover and Land Dynamics*

# Initial set of goals and objectives

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1. Establish a platform for coordination and cooperation for biomass monitoring
2. Develop a community-consens framework for monitoring biomass globally
3. Dedicated contributions to key international activities:
  - Consensus framework on how to observe biomass as ECV and support of evolving programs
  - GOFC-GOLD contribution to GEO tasks
  - GOFC-GOLD technical REDD sourcebook
  - Support of space agencies and plans for dedicated missions (BIOMASS, Desdiny etc.)
  - Integrate activities with other ECV observation products (land cover and fire)
4. Foster comparison and synergy among existing datasets

# DA-09-03a summary

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- Development and implementation of IGOL
- Evolve community consensus input to global land monitoring
- Improved, validated, harmonized and up-to-date global moderate resolution land cover datasets
- Specifications and implementation plan for production of global high-resolution land-cover and land cover change data products
- Support to UNFCCC:
  - Specific land cover tasks in GCOS implementation plan
  - REDD: sourcebook and technical guidance for post 2012 climate agreement
- Ongoing cooperation with other tasks:
  - FAO-FRA 2010 remote sensing survey
  - Engage further user communities
  - Foster provision of baseline satellite data
  - Forest Carbon Tracking

# Web resources

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- **GOFC-GOLD:**
  - <http://www.fao.org/gtos/gofc-gold/>
- **GOFC-GOLD land cover project office:**
  - <http://www.gofc-gold.uni-jena.de/>
- **GOFC-GOLD REDD sourcebook:**
  - <http://www.gofc-gold.uni-jena.de/redd>
- **IPCC background paper on use of remote sensing in LULUCF sector (GOFC-GOLD 33):**
  - <http://www.fao.org/gtos/gofc-gold/series.html>
- **UNFCCC/SBSTA technical paper on costs of monitoring for REDD**
  - <http://unfccc.int/resource/docs/2009/tp/01.pdf>