Global land cover and forest observations

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www.fao.org/gtos/gofc-gold

www.gofc-gold.uni-jena.de

GTOS

GOFC-GOLD

Global Observations of Forest Cover and Land Dynamics

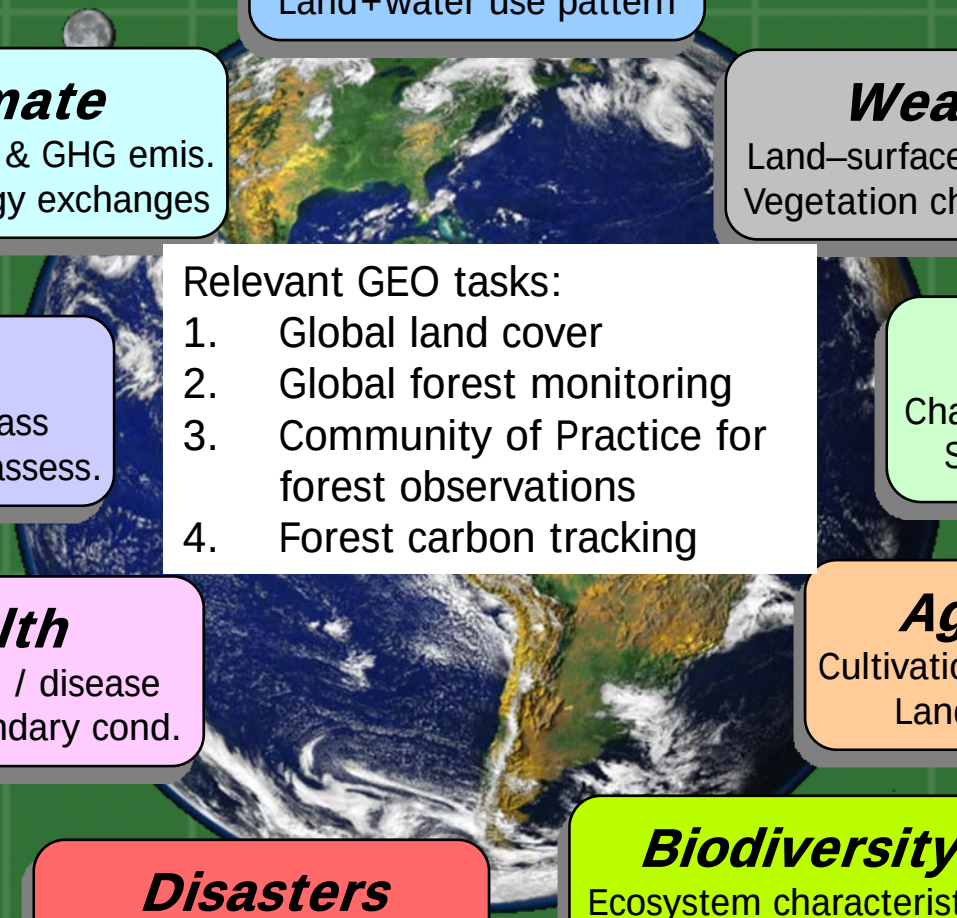
What is GOFC-GOLD?

- GOFC-GOLD is a coordinated international effort:
  - to ensure a continuous program of space-based and on-the-ground forest and land cover observations for global monitoring of terrestrial resources and the study of global change.
- A technical panel of the Global Terrestrial Observing System (GTOS)
- A network of participants implementing coordinated research, demonstration and operational projects
- A vision to share data, information and knowledge, leading to informed action and decision support
- A long term process of building an improved match between Observations, Data Products and User Needs
- GOFC-GOLD operates through:
  - Executive committee, Science and technical board
  - Implementation teams and 3 project office (CA, US, Germany)
  - Dedicated working groups
  - 6 Regional networks

Overview

1. Political initiatives driving observation progress:
   - UNFCCC and Group on Earth Observation (GEO)
2. Global land cover observations and assessments on coarse resolutions:
   - Harmonization, new datasets, validation
   - Integration in global (ecosystem) models
3. Observing fine-scale land cover change – status & activities:
   - Using coarse resolution observations
   - FRA 2010 remote sensing survey
   - National examples
4. Status of observing terrestrial biomass from space

GEO societal benefits and land cover observations



Water
Water resources / quality
Land+water use pattern

Climate
Land change & GHG emis.
Water+energy exchanges

Weather
Land–surface climate int.
Vegetation characteristics

Relevant GEO tasks:
1. Global land cover
2. Global forest monitoring
3. Community of Practice for forest observations
4. Forest carbon tracking

Energy
Bio-energy/biomass
Wind/hydro power assess.

Ecosystems
Change environment cond.
Services + accounting

Health
Land change / disease vectors / boundary cond.

Agriculture
Cultivation pattern+forestry
Land degradations

Biodiversity
Ecosystem characteristics
Habitats + fragmentation

Disasters
Fire monitoring
Land degradation assess.

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UNFCCC and earth observations of land cover

Requirements	**UNFCCC** (Art. 3 / 12) Reporting obligations & sustainable development	**UNFCCC** (Art. 5 / 10) Research & systematic observations	**UNFCCC** (COP13 / Bali plan) Reducing emissions from deforestation in developing countries
Implementation framework	Kyoto Protocol	GCOS Implementation Plan	Post-Kyoto commitments
Implementation guidelines	IPCC Good practice guidance LULUCF / AFOLU	Essential climate variables (ECV) Tasks for land cover observations ECV standards	IPCC Good practice guidance LULUCF / AFOLU GOFC-GOLD REDD Sourcebook
Operation and Application	National LULUCF reporting (Annex I) & CDM A/Reforestation	Evolving global programs and commitments from earth observing agencies	Evolving national carbon monitoring and accounting systems

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Observing Essential Climate Variables (ECV)

Essential Climate Variable	ESA global observation commitments
Snow-cover	GLOBSNOW
Soil Moisture	SMOS*
Glaciers	GLOBICE
Lake levels	*(regional activities)*
Albedo	GLOBALBEDO
FAPAR	GLOBCARBON
Leaf Area Index	GLOBCARBON
Fire disturbance	GLOBCARBON
Land Cover	GLOBCOVER
Biomass	*(regional act., e.g. Siberia/China, BIOMASAR)*

* Future dedicated satellite mission (launch 2008)

Additional terrestrial ECV's include: river discharge, permafrost, water use, ground water, glaciers and ice caps (see GCOS implementation plan)

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REDD and implementation

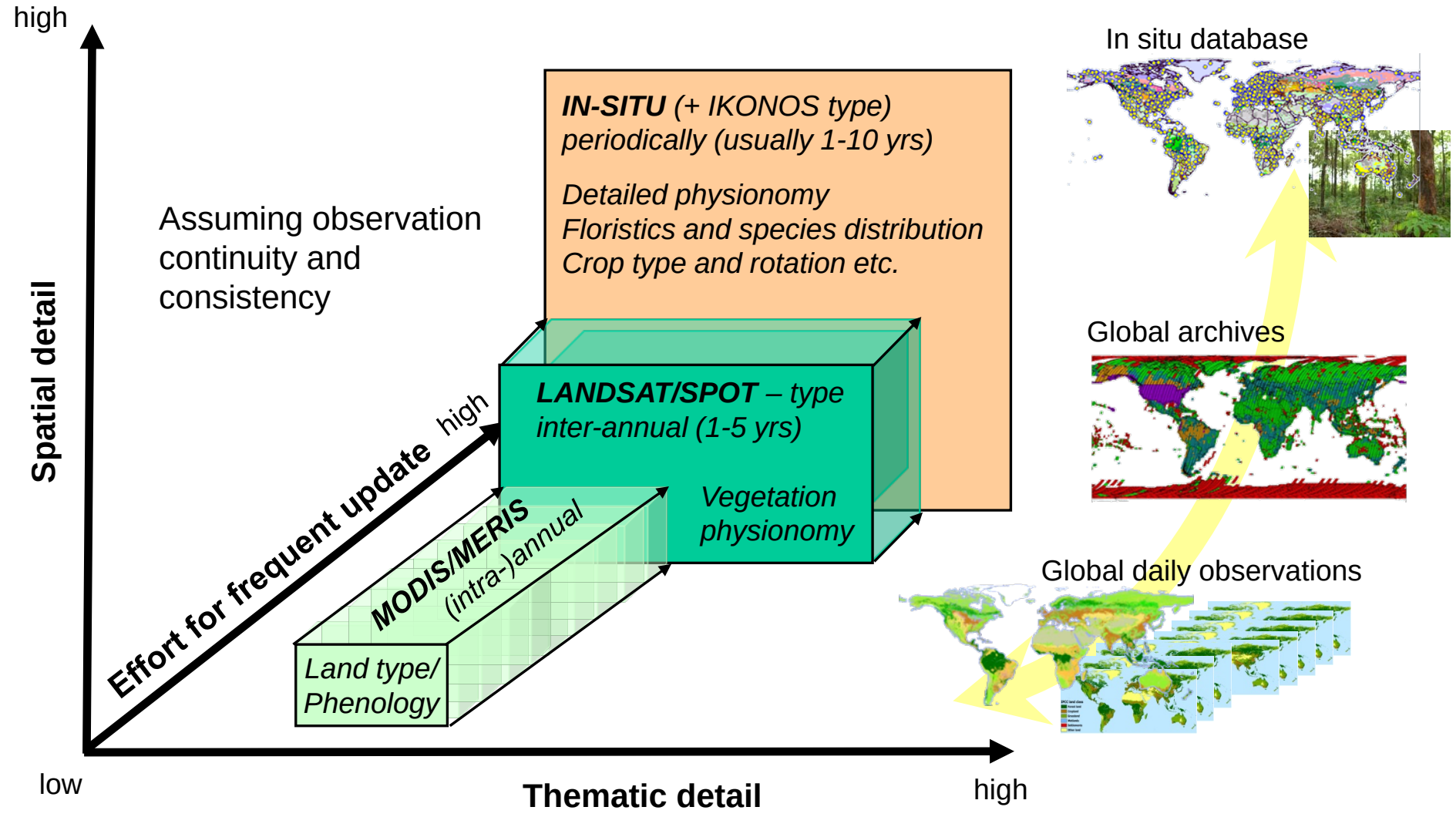
- Incentives to increase climate change mitigation by reducing emissions / stabilizing tropical forest carbon
- Starting REDD implementation:
  - *Establish national carbon accounting capacities*
  - *National REDD implementation strategy and activities*
- 2005: Establishment of GOFC-GOLD REDD working group
  - *Promote satellite monitoring as objective and efficient approach in developing countries*
  - *Forest changes can be monitored with confidence to compare historical and future rates of deforestation*
  - *Building national monitoring systems is process that can start now*
- Tools for estimating, accounting, reporting on REDD:
  - *IPCC Good Practice Guidelines and Guidance*
  - *Dedicated research and case studies*
  - *GOFC-GOLD REDD sourcebook*

Conclusions: International political drivers

1. GEO: provide societal benefits through evolving land cover observations as part of a Global Earth Observation System of Systems (GEOSS)
2. UNFCCC:
   - Experiences (and limitations) of Kyoto land sector reporting
   - 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
3. Effectiveness for global assessments (Clarke et al. 2006):
   - Focus on the process, not the report
   - Focus on salience and legitimacy as well as credibility

Integrated land cover observations

Completed and endorsed by IGOS partnership and GEO in 2007



From Herold et al 2008, IEEE Systems

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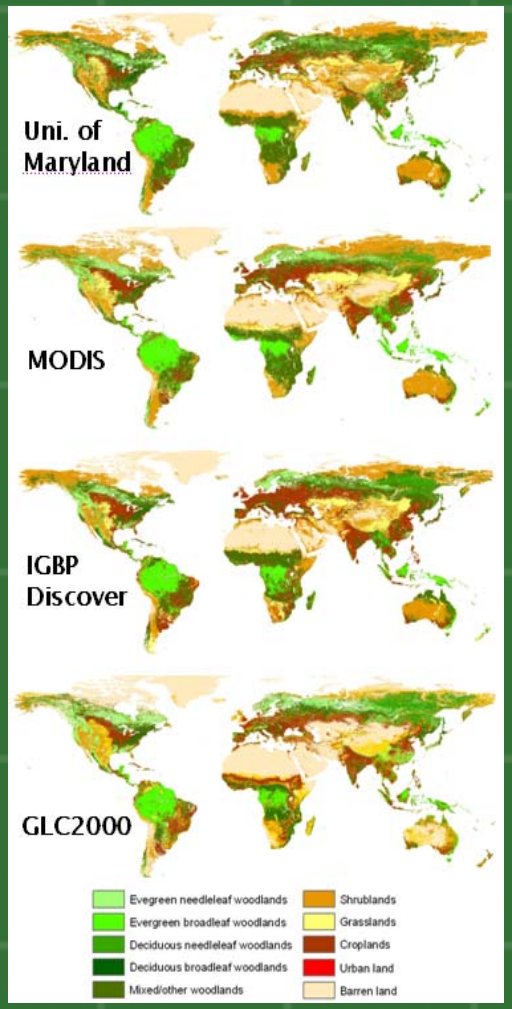
UN land cover classification system (LCCS)

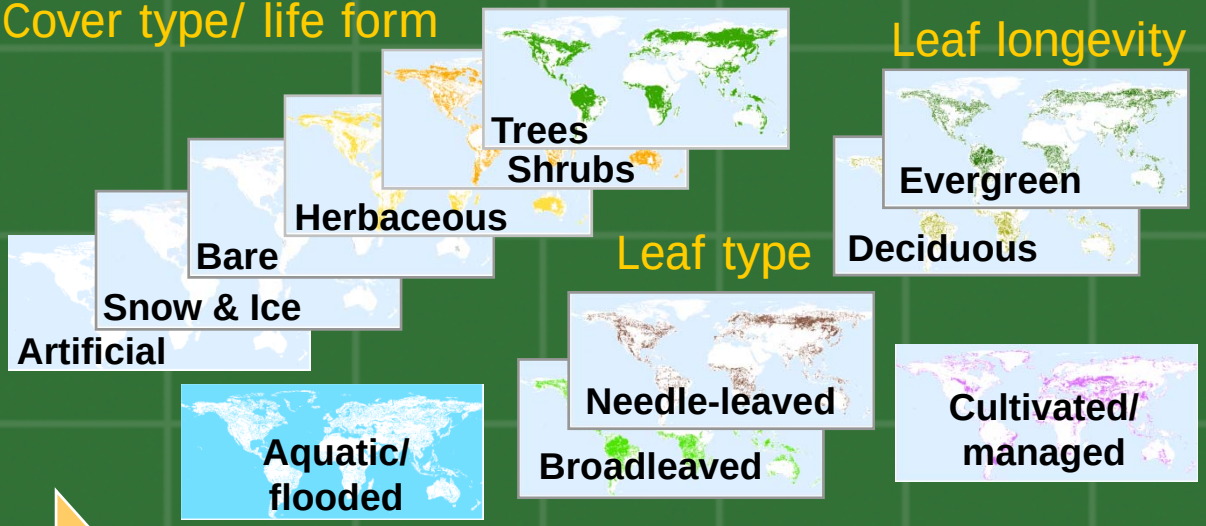
- Too much standardization reduces application relevance (i.e. single lc/lu legend)
- Standardizing terminology rather than categories
  - *Consensus on criteria and thresholds*
  - *Separation of land cover and use*
  - *LCCS as common language*
- LCCS: classification system to describe land cover features worldwide at any scale or level of detail
- Harmonization exercises for existing datasets:
  - *Advocate LCCS resources and classifier concept*
  - *Legend translations, assess comparability and synergy*
- Towards more standardized land cover characterization:
  - *Set of common classifiers and generic classes*
  - *Impact on operational land mapping activities*

Harmonized land cover characterization

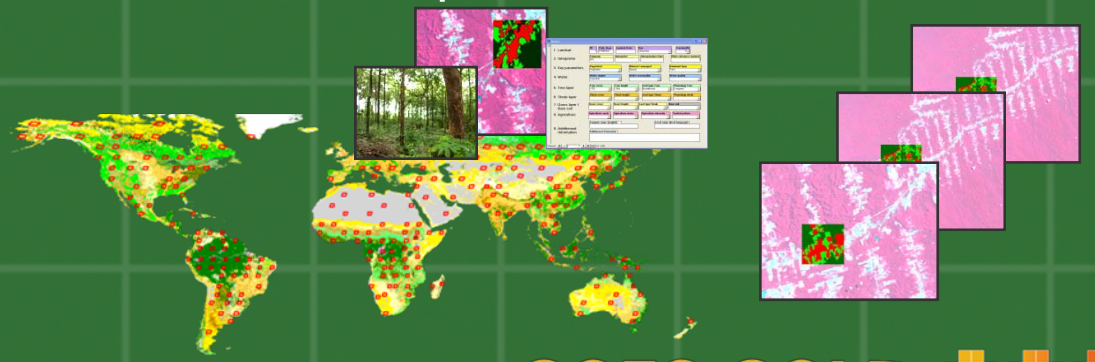
Existing global land cover datasets



Common land cover classifiers (LCCS)



"Living" validation database for comparative assessment



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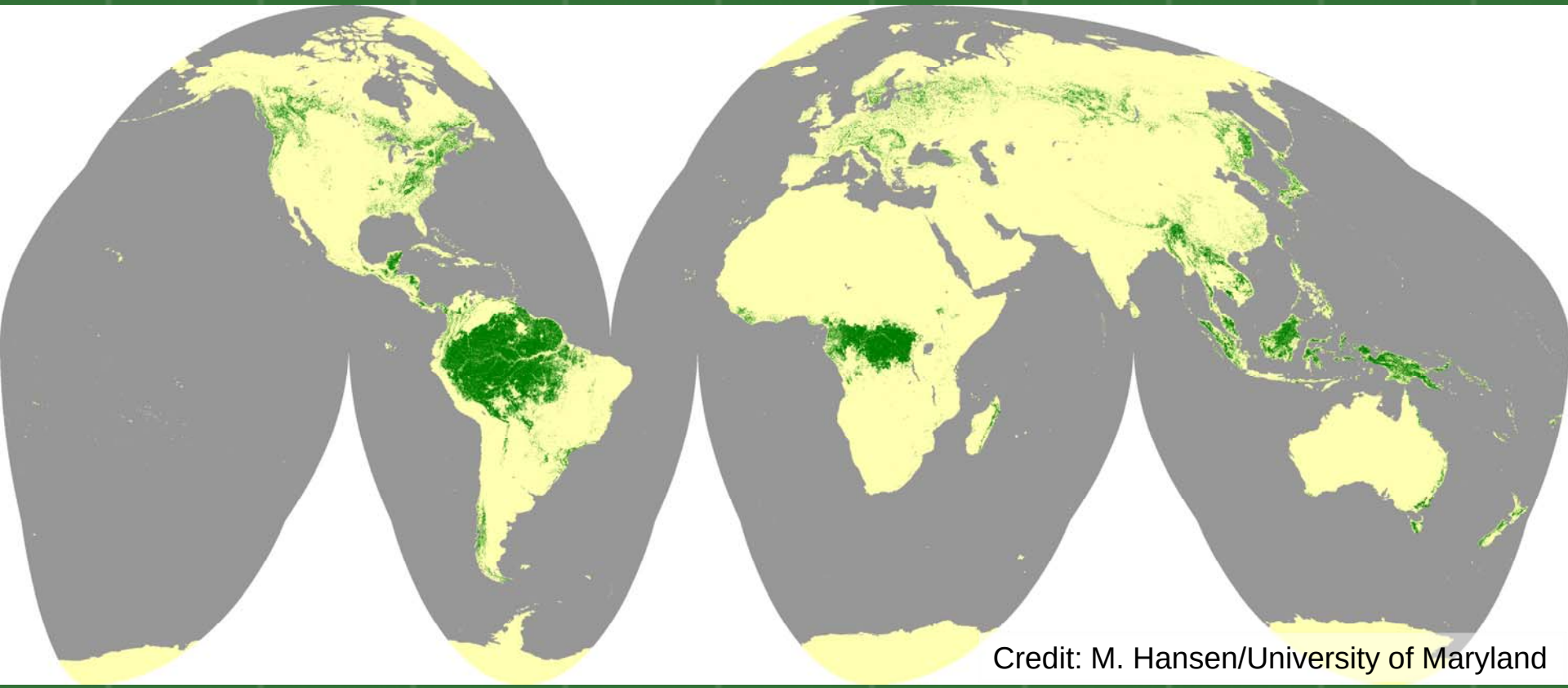
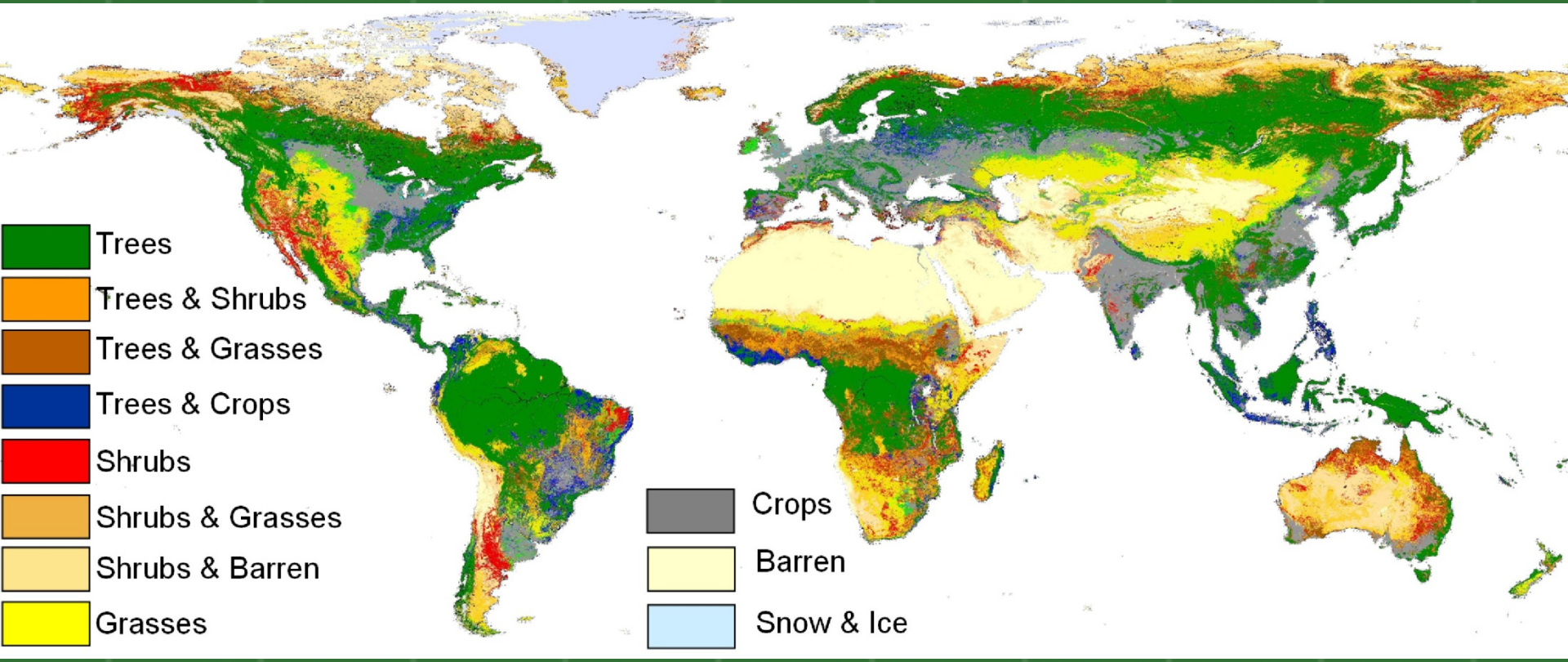
Continuous tree cover observations from satellite data



Credit: M. Hansen/University of Maryland

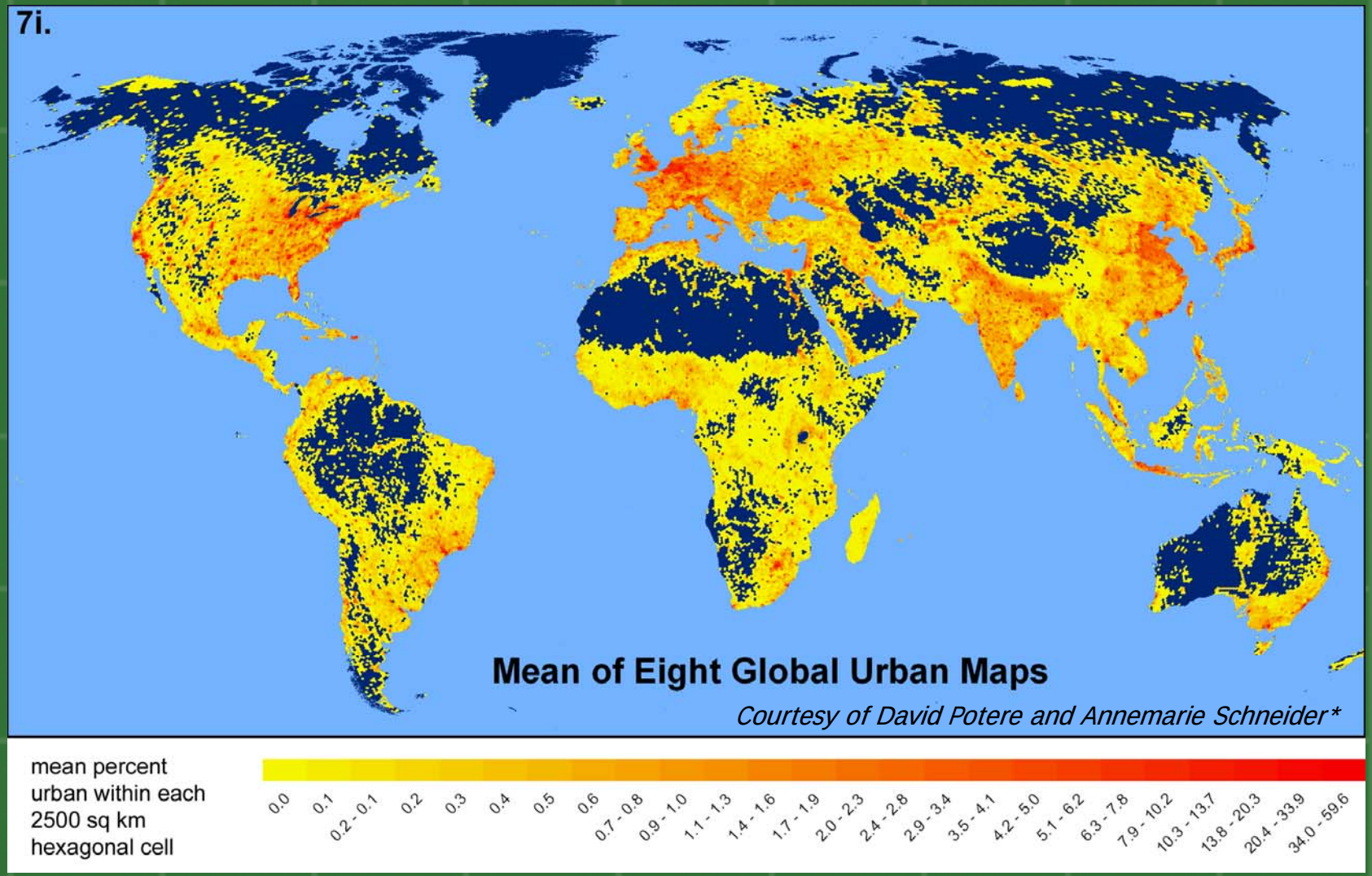
0% **tree cover threshold** 100%

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).

Global urban mapping – a synthesis



Amount of urban area for each grid cell averaged across all eight maps (VMAP0, GLC00, GLOBC, HYDE3, IMPSA, MOD500, MOD1K, and GRUMP). The total extent of this mean urban map is approximately 864,000 sq. km.

**Chapter in upcoming book: Global Mapping of Human Settlements(2009)*

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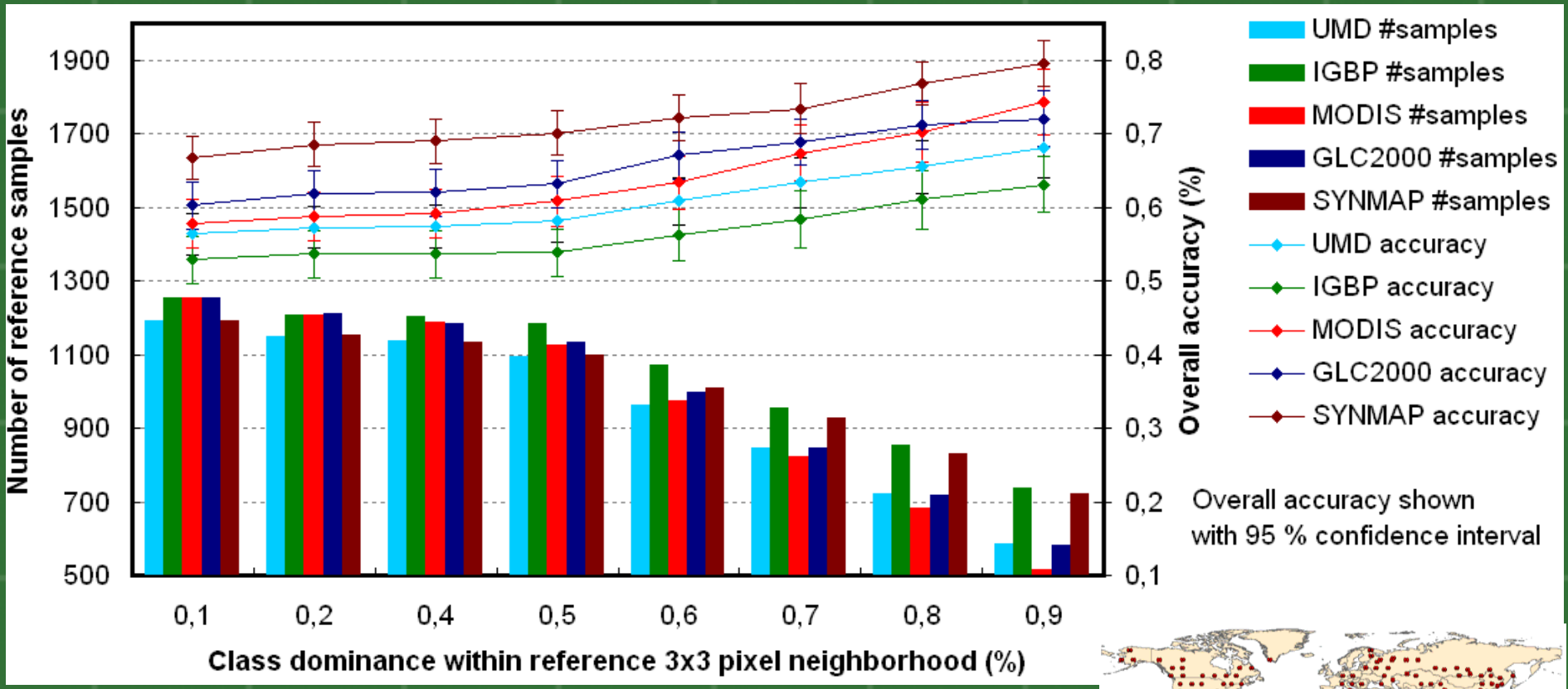
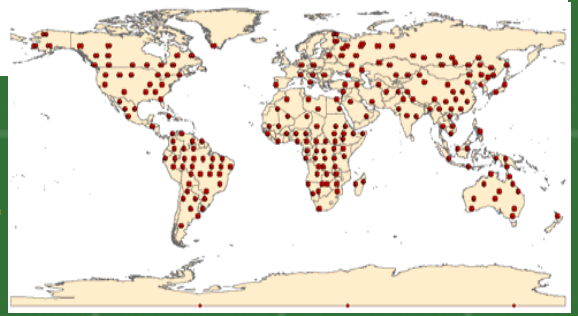
Assessing accuracy of global datasets





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 legend for 11 classes.

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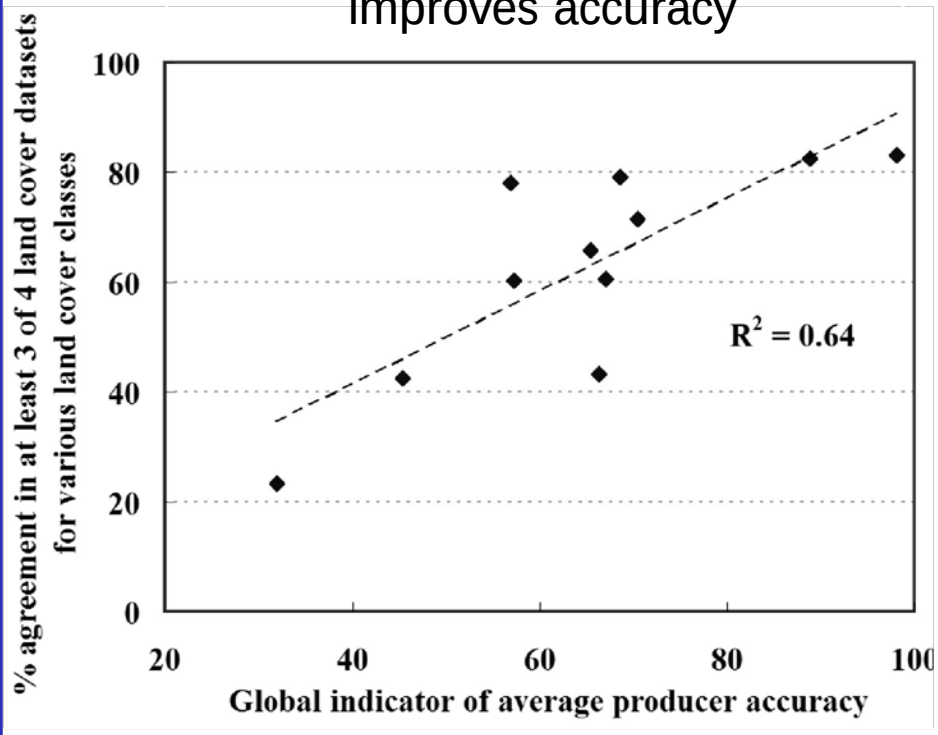
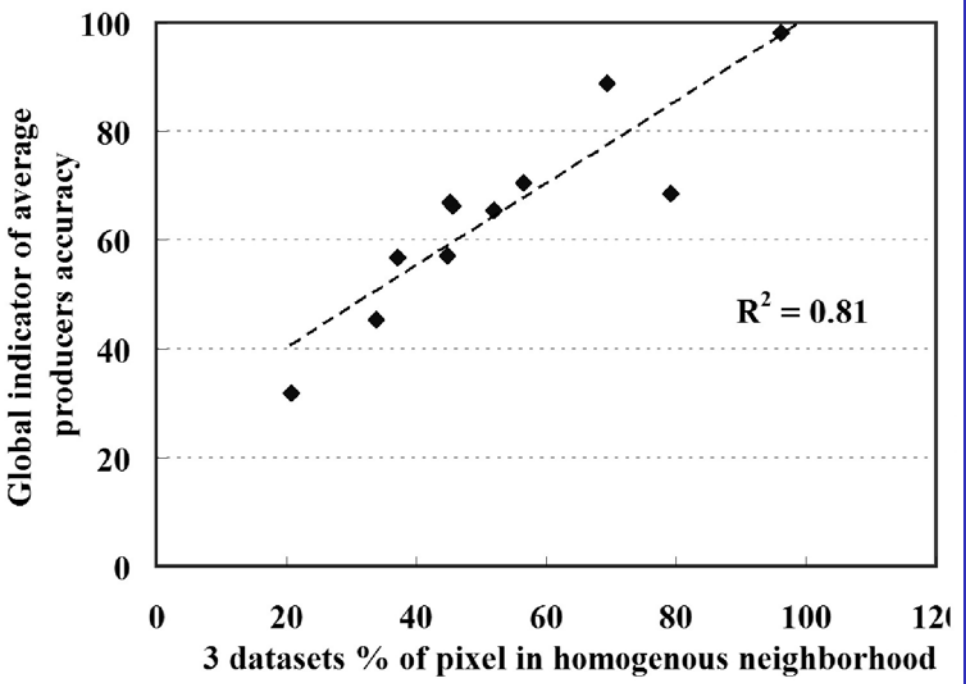
Understanding uncertainties

Using agreement among dataset improves accuracy



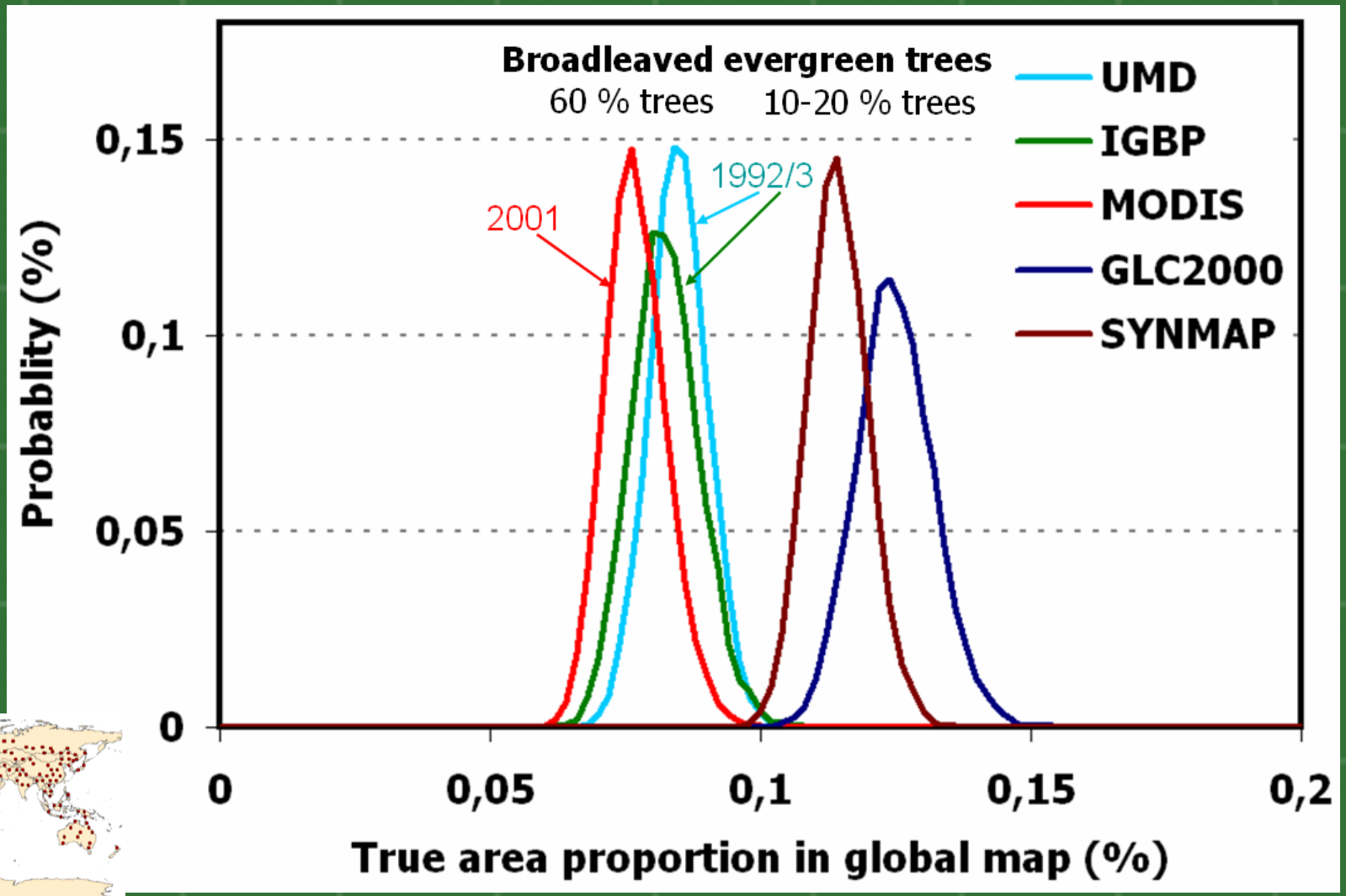
Spatially heterogeneous classes are most uncertain

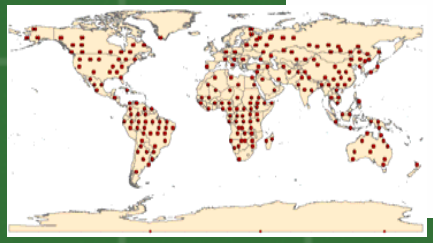


Results from analyzing three global datasets (IGBP-DIS, MODIS, GLC2000)

From Herold et al., 2008

Improving global estimates





Based on GLC2000 reference database (2000) with 1253 secondary samples world wide interpreted with Landsat data

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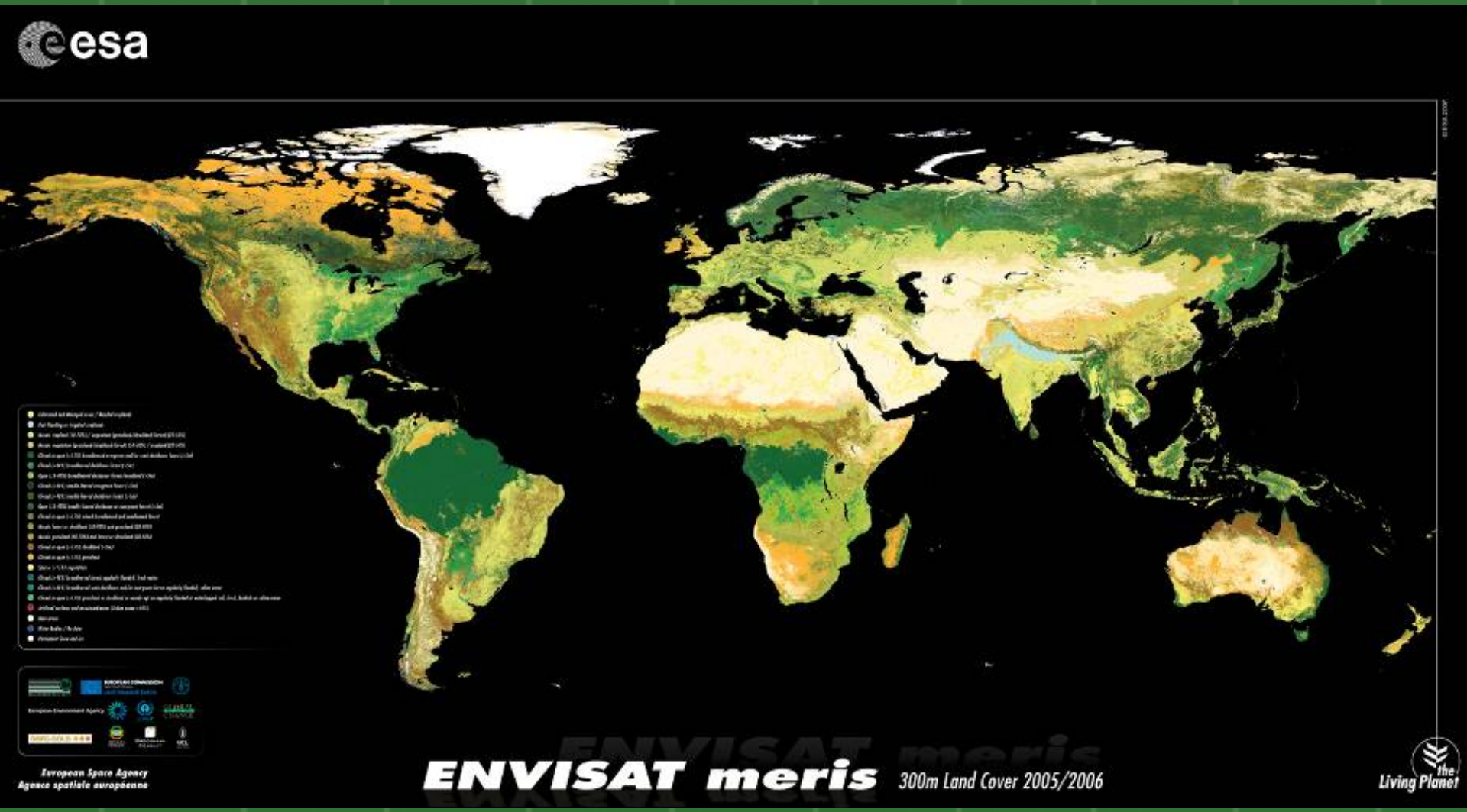
GLOBCOVER (2005/6)



Beta version in review by GEO task team

Dataset release: September 2008

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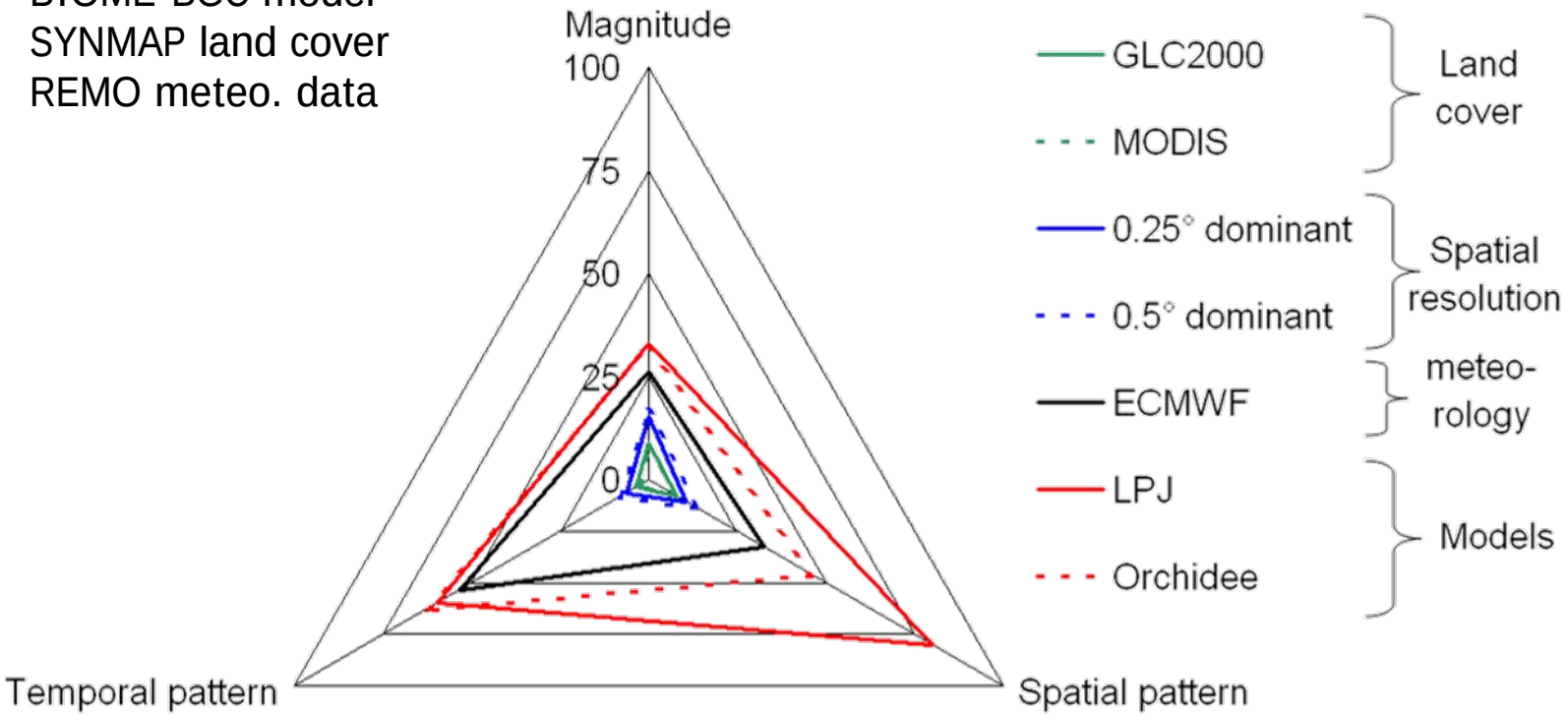
Conclusions: Global land cover mapping

1. Strategies for harmonization (LCCS), dataset comparison and comparative validation to improve synergy, usability and flexibility
2. New global land cover products:
   - More detailed spatial resolution (GLOBCOVER 2005 with 300x300m or MODIS 500)
   - Thematic detail (LCCS classifiers) and targeted synergy products for specific applications
3. Quantification and treatment of error
   - Operational global accuracy assessment system
   - Problems in characterizing heterogeneous areas
4. Integration into ESM

Role of land cover products in dynamic vegetation models

Modeling gross primary productivity over Europe

Center:
BIOME-BGC model
SYNMAP land cover
REMO meteo. data



Different model runs and effects on the magnitude, spatial, and temporal patterns on GPP (kgC/m^2/yr) simulations over Europe 1981-2000
(Jung, et al., GCB 2007).

Remarks: Use of land cover data in models

1. Global land cover datasets are based on continuous and consistent measurements
2. Issues for role of including in ecosystem models:
   - Spatial detail and heterogeneity versus modeling scale
   - Conceptualization/parameterization of land cover:
     - Common land cover categories or LCCS classifiers
     - Regionalization of processes through, i.e. PFT concepts
     - Biophysical variables (LAI, FAPAR, carbon stocks etc.)
3. Treatment of error in models
   - Land cover products will come with better accuracy information, i.e. overall/class accuracies, pixel-based accuracy estimates, adjusted area estimates
4. Capabilities to deal with land change information

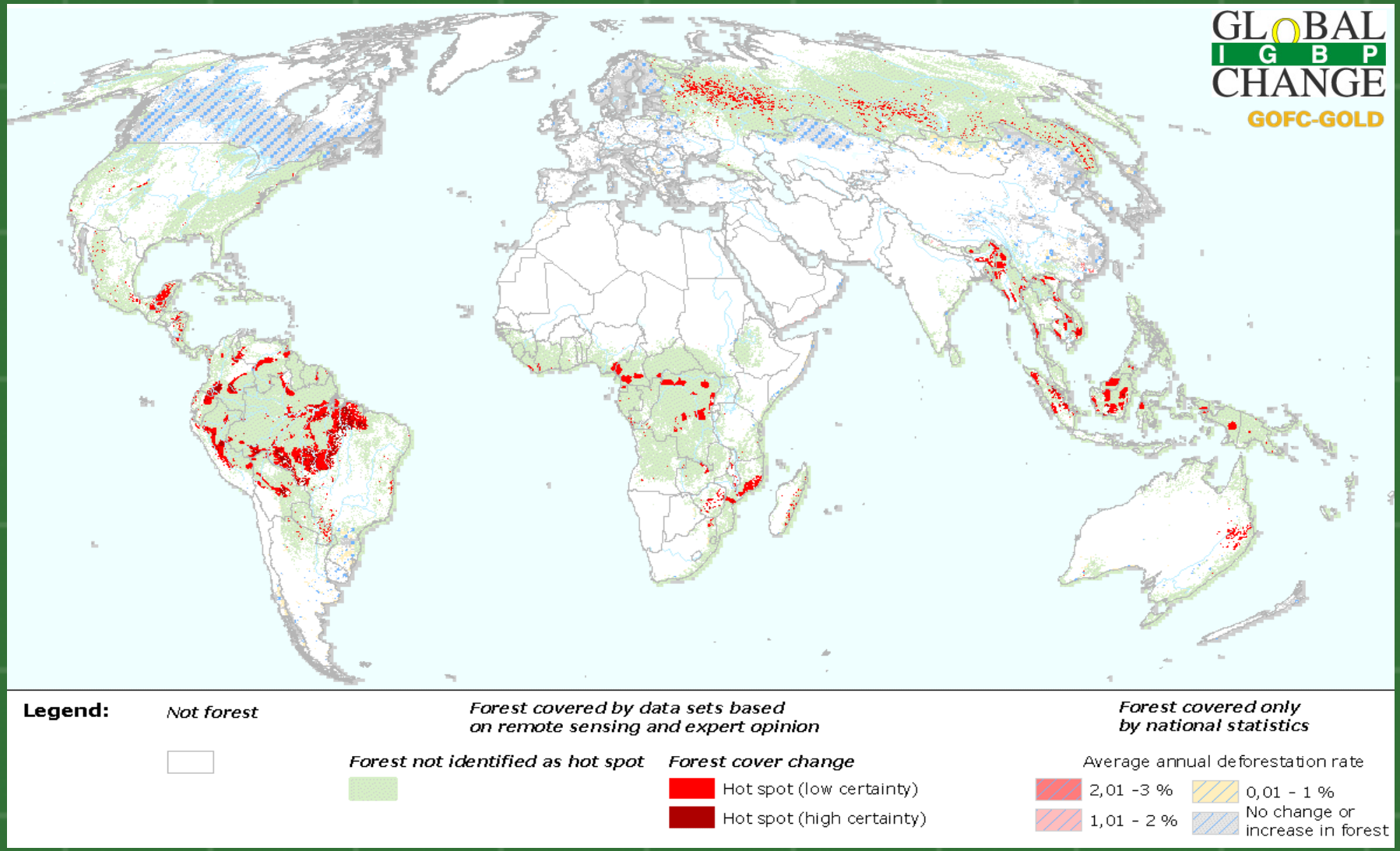
Observing change using coarse resolution data

1. Synergy of existing map products + ancillary data
   - Challenging but some regional examples
2. Vegetation continuous change (VCC)
   - Tree canopy cover/deforestation (20x20 km blocks)
3. Observation of active fire and burned areas
   - Several operational products
4. Observing long-term trends
   - AVHRR/NDVI times series data since 1981
   - Night-time lights
5. Near-real time observations (i.e. deforestation/DETER)

Usefulness:

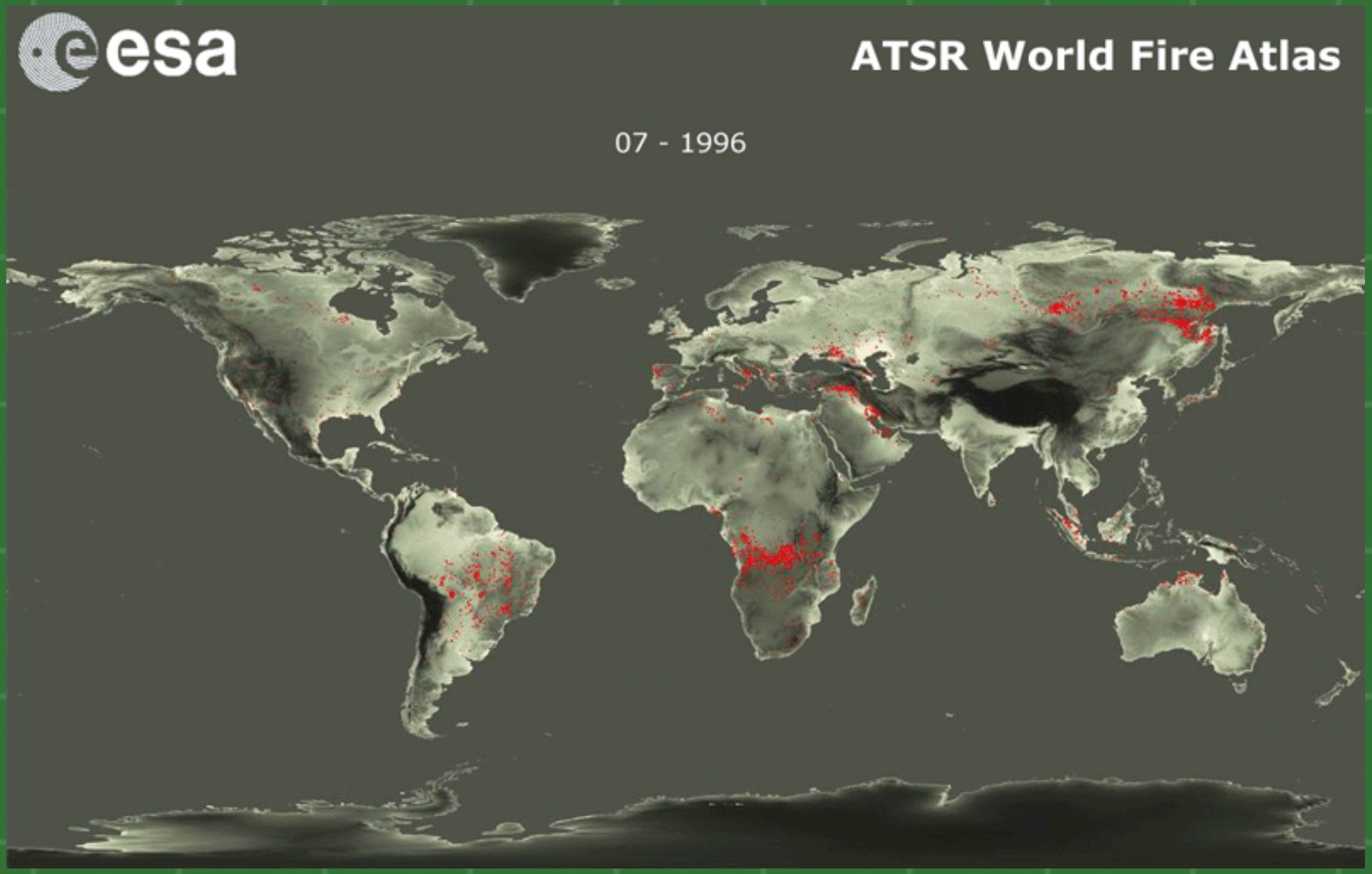
- Indicators and hot spots of change
- Guide more detailed analysis and true area estimations
- Understand inter-annual versus intra-annual dynamics

Hot spots of forest cover change 1980-2000



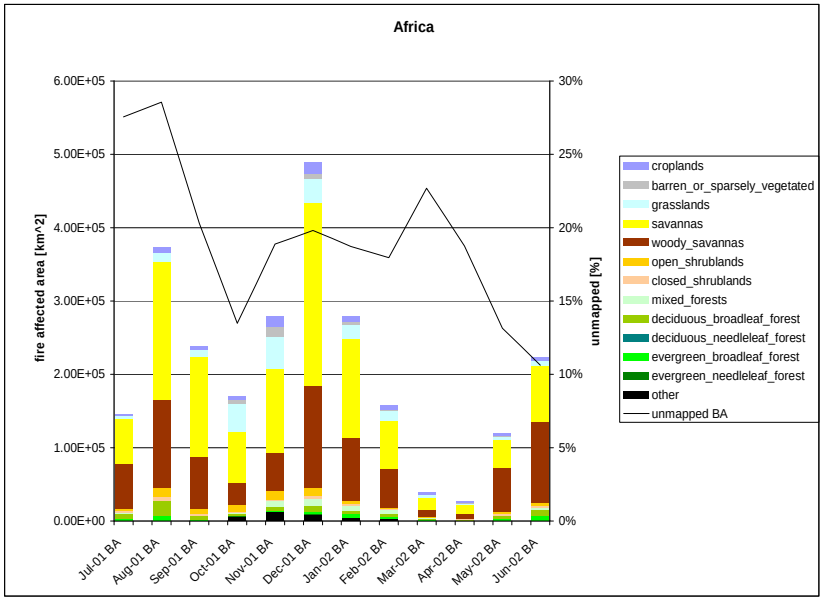
Lepers et al., (2005). A synthesis of information on rapid land-cover change for the period 1981-2000. BioScience, 55 (2), 115-124

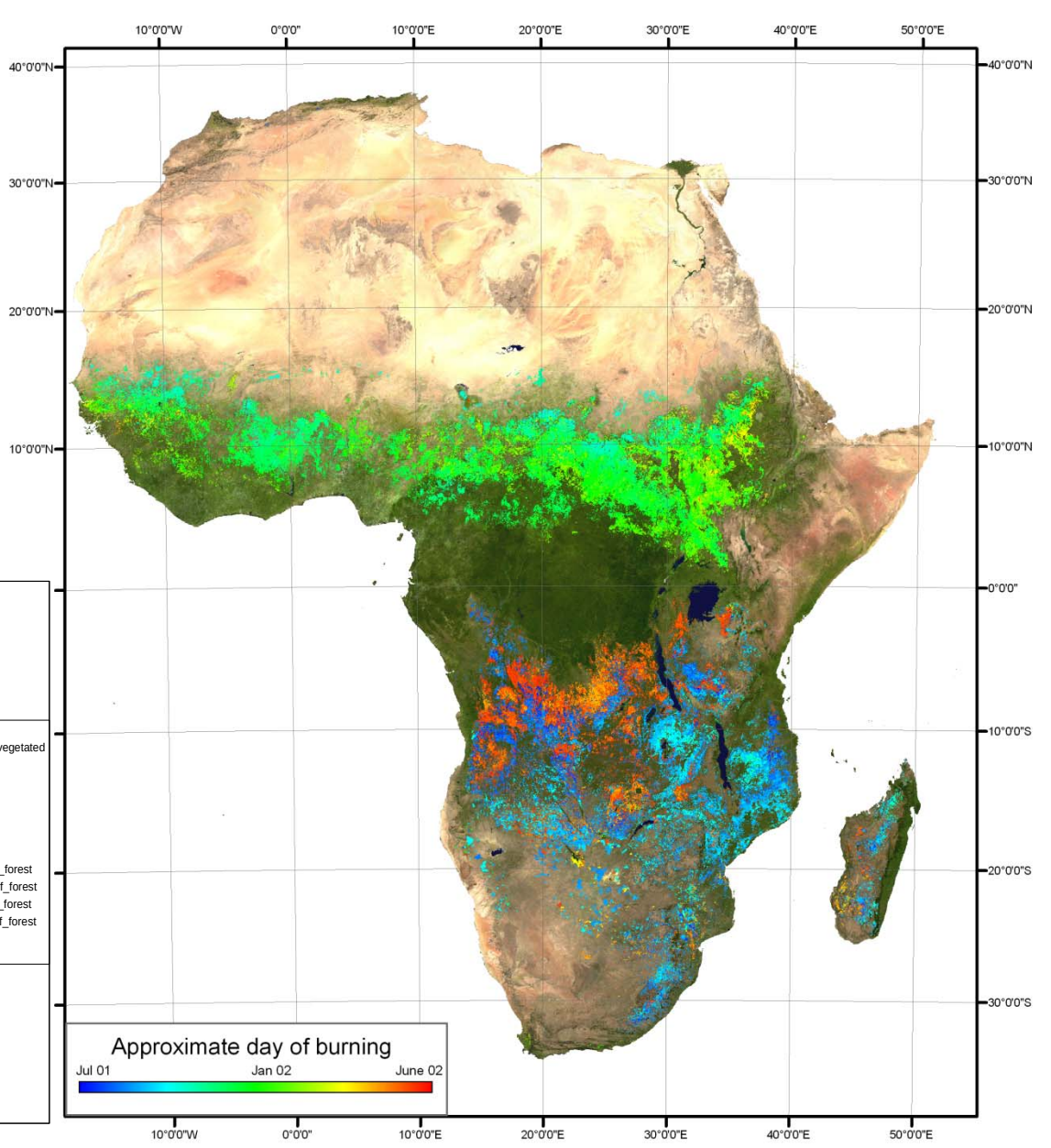
Global active fire observations



EXAMPLE APPLICATIONS

- 1 year of composite of MODIS burned areas, superimposed on surface reflectance to provide geographic context.



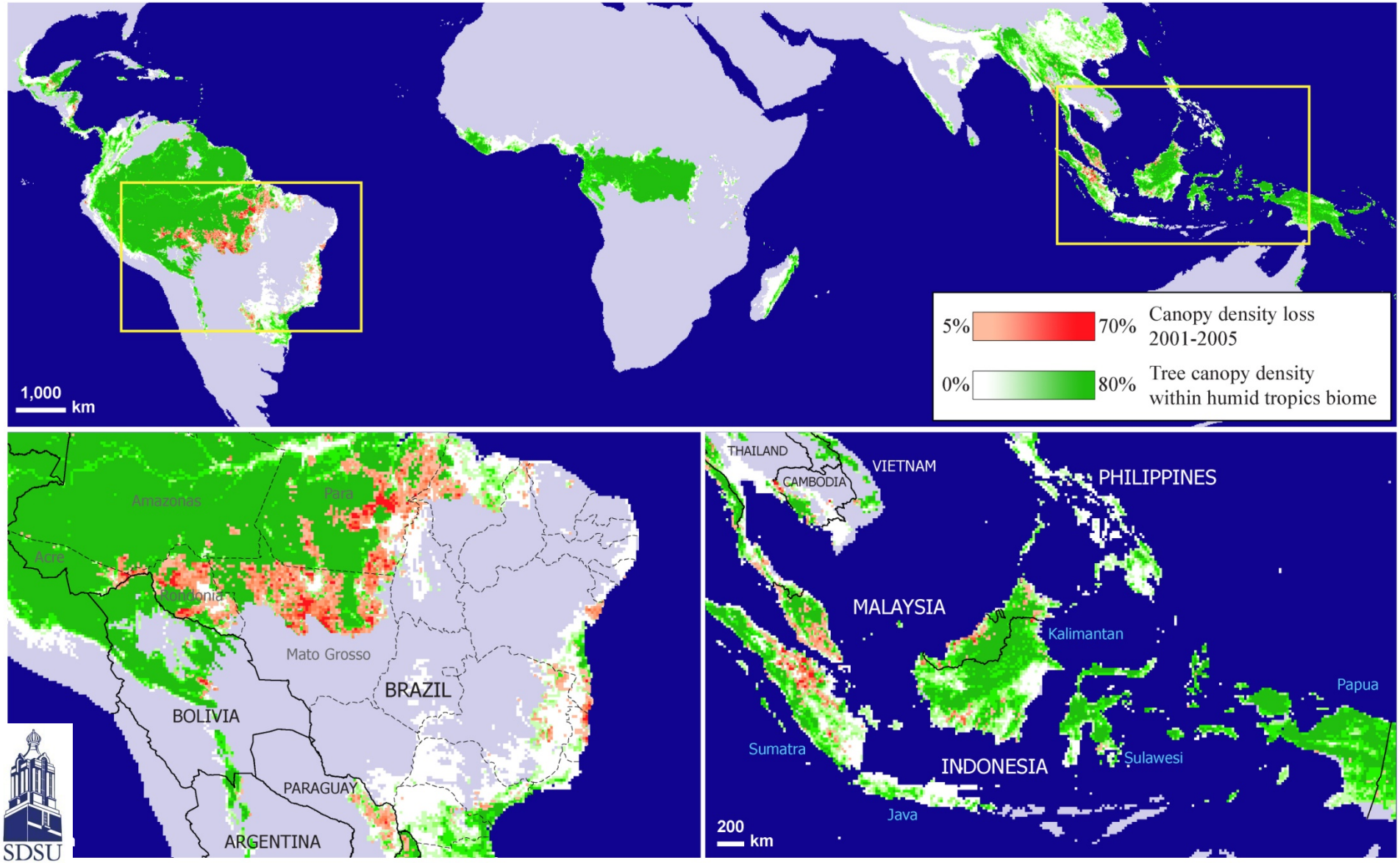


http://modis-fire.umd.edu/MCD45A1.asp

Contact: Luigi Boschetti <luigi@hermes.geog.umd.edu>

Pan-humid tropics forest clearing, 2000-2005

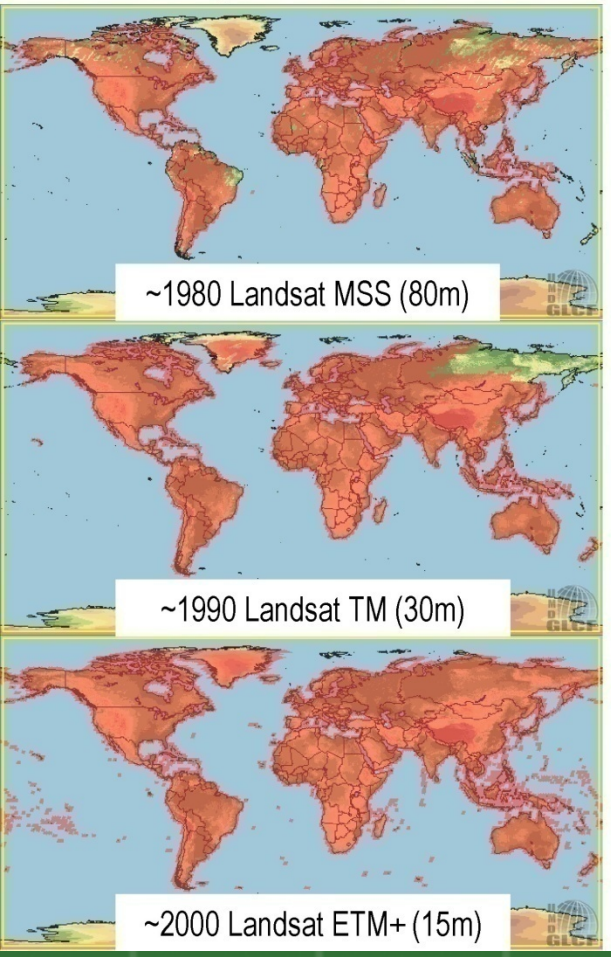
Courtesy of M.Hansen, SDSU



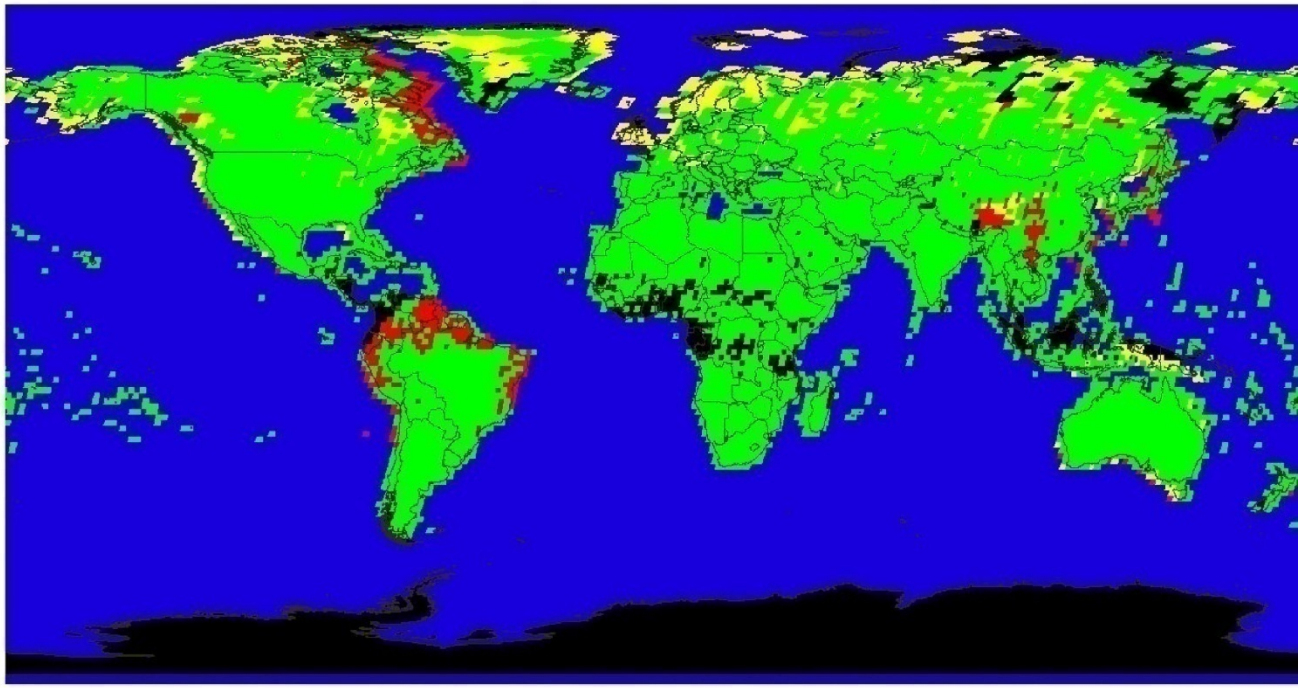
Fine-scale land cover change

- Synthesizing experiences:
  - National/regional monitoring programs
  - Global technical community (guidance, networks)
  - UNFCCC Kyoto reporting on LULUCF/AFOLU
- GEO to formulate specifications
- REDD case studies and readiness activities
- Projects with global/large scale focus:
  - EU/JRC: TREES 3 (sampling approach)
  - UMD/SDSU: combined MODIS/Landsat approach
- FAO-Forest Resources Assessment 2010

Historical global Landsat data



Mid-decadal global Landsat survey 2005

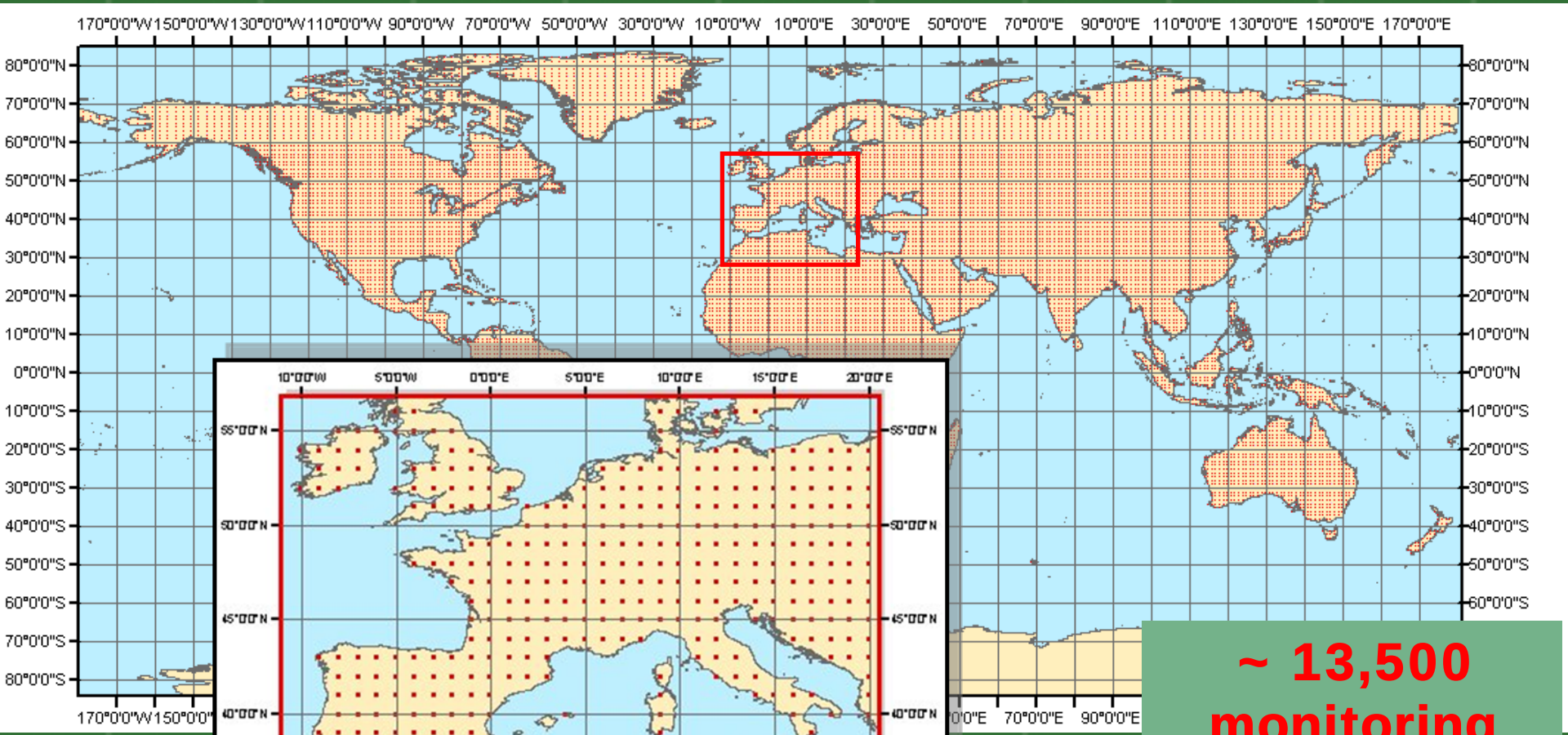


Blue: Water
Green: Landsat ETM Base image < 5/10% cloud cover
Yellow: Landsat TM archived data < 10 % cloud cover
Red: Landsat TM archived data unknown cloud cover
Black: No suitable Landsat imagery, Fill with alternate
Http://mdgls.umd.edu

USGS NASA

Availability of historical Landsat data as key source of fine-scale global land cover change observations (left, areas covered shown in red). NASA and USGS are currently compiling the next global mosaic for 2005 known as the mid-decadal global Landsat survey – a truly global effort integrating different satellite images from different Landsat sources and other sensors where needed (Source: NASA).

FAO FRA 2010 –remote sensing survey



~ 13,500 monitoring sites

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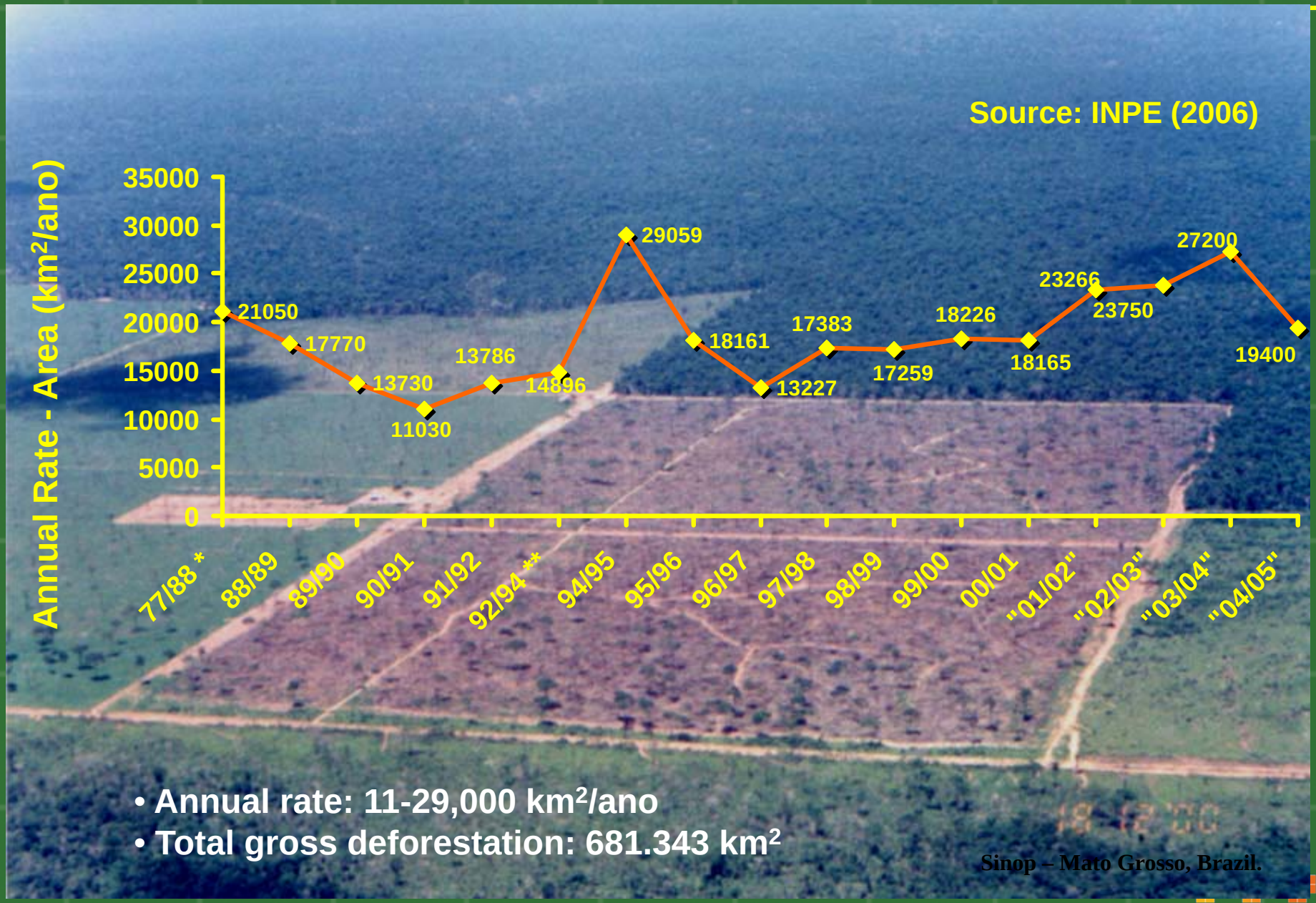
FAO FRA 2010 –remote sensing survey

- Covers the whole land surface of the Earth
- Systematic grid based sampling: a monitoring site at each latitude and longitude degree (20x20 km blocks)
- Historical forest change 1990-2000-(2005) using Landsat data
- Independent monitoring system to provide estimates on forest change at global, biome and regional level
- Complementary to national country reports
- Increased in-country capacity, in particular for developing nations (i.e. densify sampling, REDD readiness)
- Potential for spin off activities

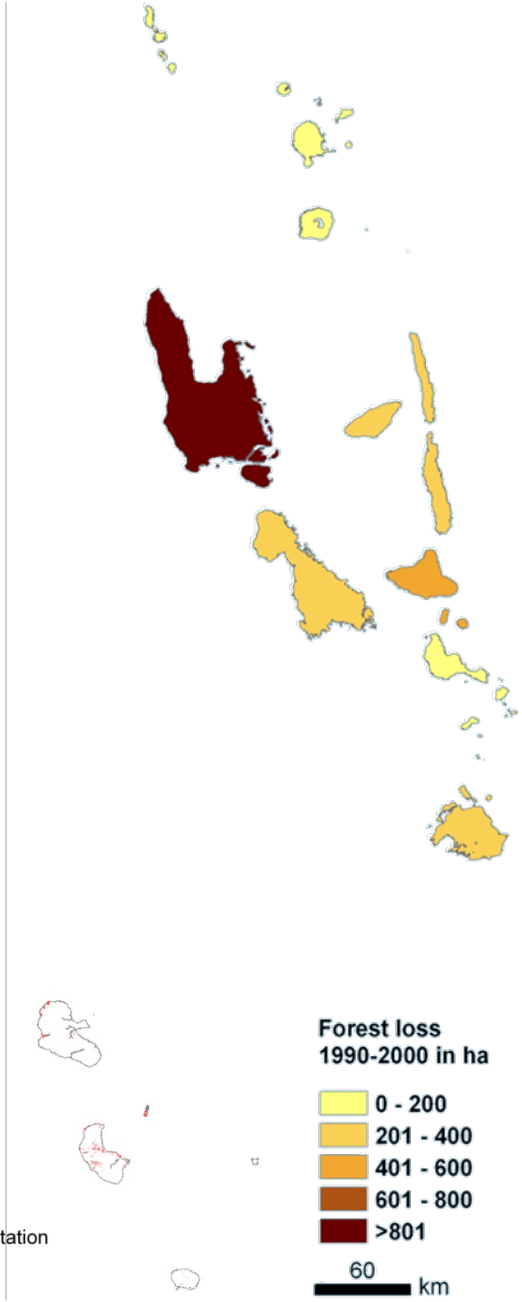
Annual Gross Deforestation (Brazil)



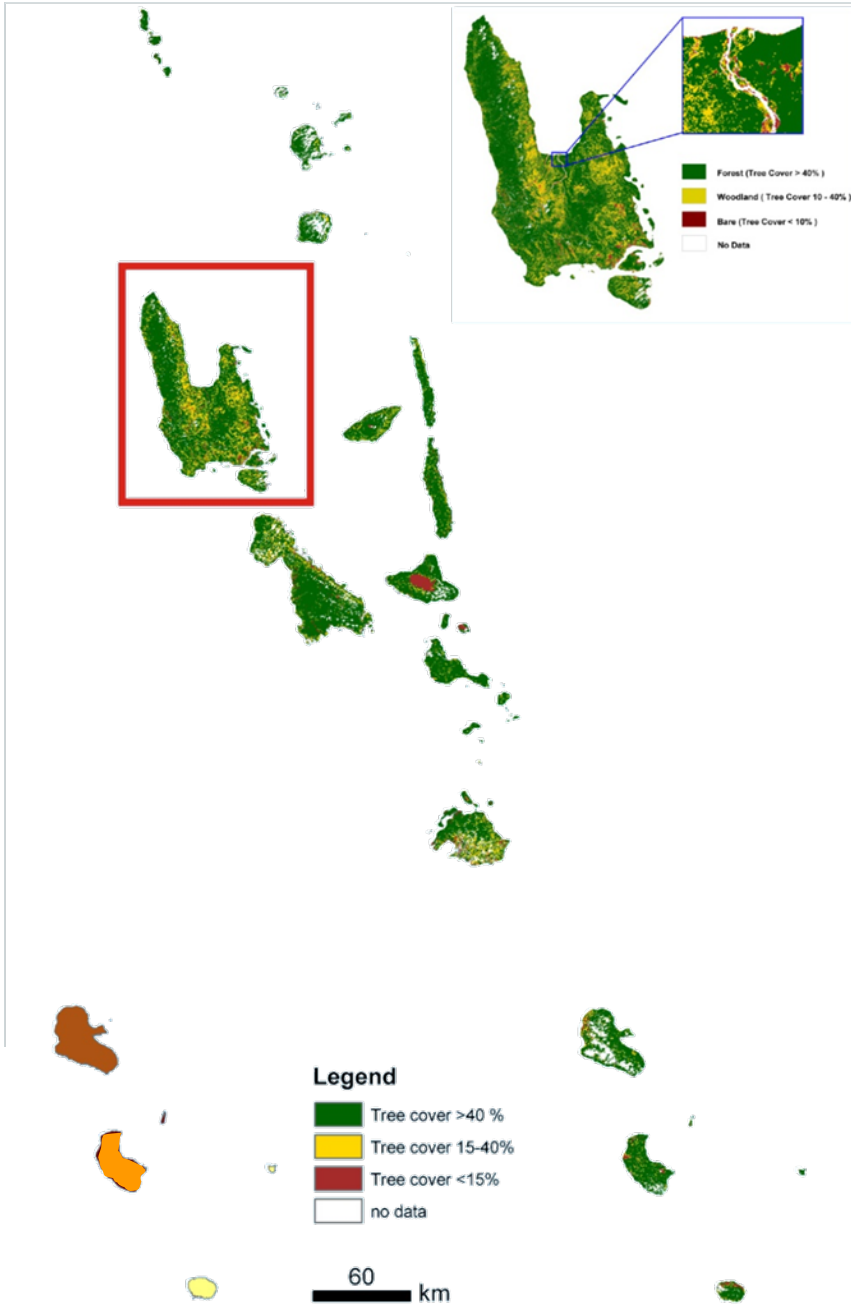
Assessing gross deforestation in Vanuatu

Hot spots

Forest loss [ha]



Tree canopy cover [%]



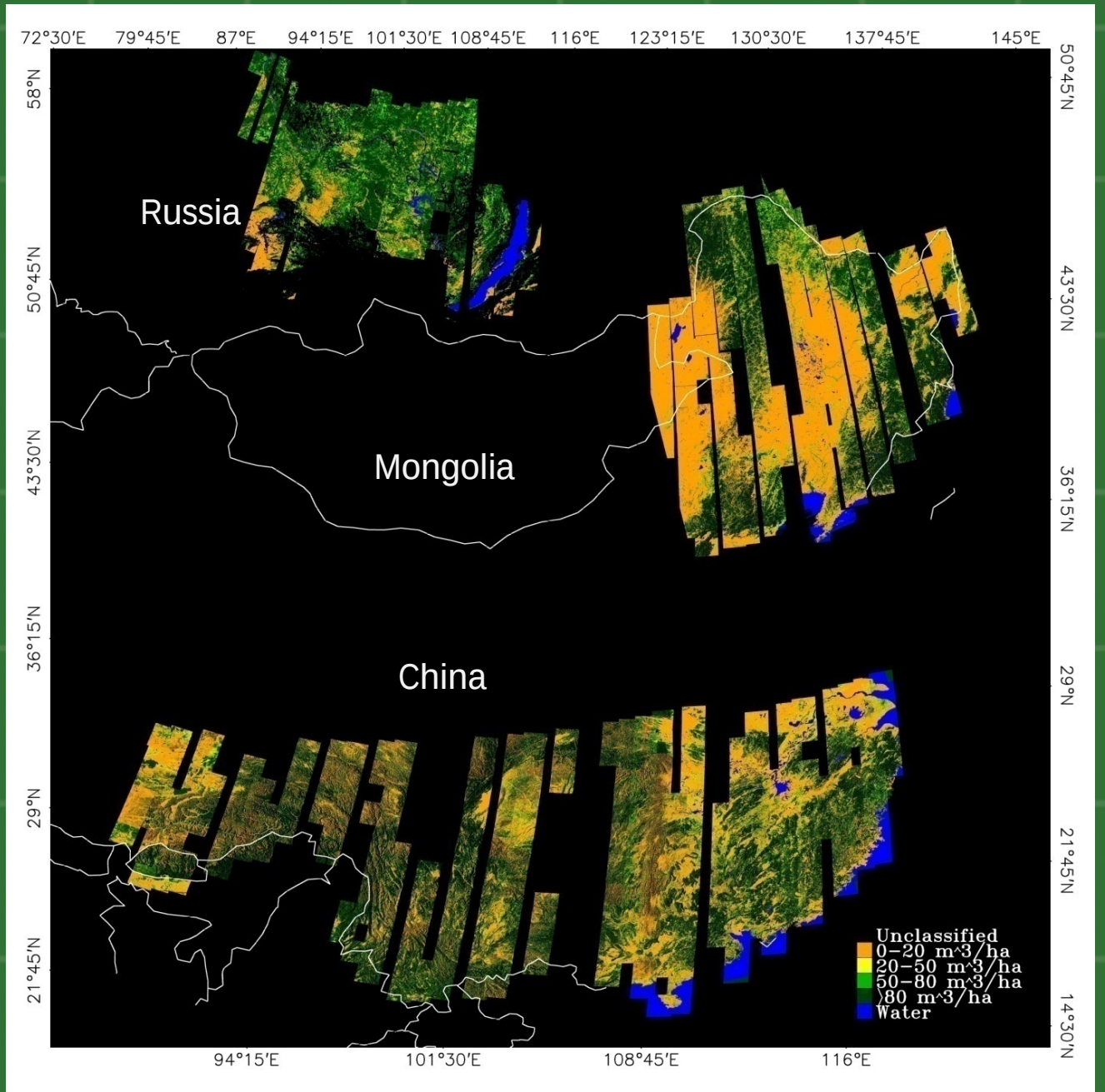
Remarks: Observing land cover change

1. Availability of baseline observation datasets
2. Coarse resolution observation provide consistent global measurements today but widely limited to provide change indications
3. Fine-scale (i.e. Landsat) data essential to observe and assess land cover (and land use) change
4. Technical understanding and baseline observation datasets are (almost) available 1990-2005
5. Implementing global fine-scale land change (deforestation/land use) assessment requires country involvement
6. Data and knowledge on historical deforestation is expected to increase significantly by 2010/11

Remote sensing support for carbon estimation

- Direct biomass mapping from space remains a challenge
- Existing capabilities:
  - Satellite observation may help to map some specific forest types / stratification of carbon density classes
  - 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 (i.e. using Landsat or MODIS data)*
    - *Direct estimation of emissions from fire radiative power*

Mapping forest biomass from SAR interferometry



ESA Dragon Program

Remarks: RS support for carbon estimation

- Technologies are not operational globally but evolving
- Limited access to national forest information and in situ reference biomass/carbon data
- Efficient coarse-scale monitoring efforts will require a synergistic approach of different data sources:
  - Understanding of potentials and limitations of individual technologies
- Satellite missions in preparation (2014/15):
  - ESA biomass (P-band SAR)
  - NASA Desdyni (combined SAR and LIDAR)

Final remarks

- Deforestation and land change prominent on the political agenda and drive observation progress:
  - National level capacities
  - Reducing uncertainties in observing the global climate system
- Understanding on the capabilities and limitations of remote sensing approaches for operational purposes
- Integrated analysis approach of coarse resolution and fine scale satellite data would allow suitable estimates of historical deforestation at least 1990-2005
- Further capabilities are evolving

United Nations Forum on Forests - Mozilla Firefox

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http://www.un.org/esa/forests/2011/2011.html

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For the sake of current and future generations,
we need to raise awareness and promote global action
to sustainably manage, conserve and protect our world's forests.

UN Resolution || Resolution Sponsors || Press Release || UNFF Secretariat

The United Nations Forum on Forests Secretariat
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Fax: +1-917-367-3186
E-mail: Contact Us

Next GOFC-GOLD symposium

3rd GOFC-GOLD Land Cover Symposium , 13-17. Oct. 2008, Jena, Germany

Agenda overview

Day	Morning	Afternoon	
Monday, 13 October	Workshop on Monitoring Tropical Deforestation and Degradation (REDD)	Workshop on Monitoring Boreal Forests	
Tuesday, 14 October	GOFC-GOLD/CEOS Workshop on Land Cover Change Accuracy Assessment	GOFC-GOLD Strategic Meeting - Review	
Wednesday, 15 October	Land Cover Symposium		
Thursday, 16 October	Land Cover Symposium - Break out group discussions	Land Cover Implementation Team Meeting (internal)	GOFC-GOLD Strategic Meeting - Conclusion
Friday, 17 October	LCCS and harmonization workshop & Regional Network Meeting		

More info: www.gofc-gold.uni-jena.de/

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