GOFC-GOLD
Global Observation of Forest and Land Cover Dynamics

GOFC-GOLD
Global Observation of Forest Cover and Land Dynamics
Land Cover Project Office

Providing international expertise and coordination for global observation of forest cover and land dynamics

Brice Mora

SCERIN workshop, Prague, June 16-21, 2013

esa

GTOS

WAGENINGEN UNIVERSITEIT
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Need for reliable land cover information has never been stronger

- Scientific requirements (a driver of global change as well as responding to climate change)
  - Climate modelling, carbon cycle,
  - Other biogeochemical cycles
  - Hydrological cycle
  - Understanding of vulnerability of human societies
  - Drivers of land cover change
- Sustainable development (World Summit on Sustainable Development)
- To support international agreements (Convention on Biological diversity, UNFCCC etc.).
- Natural resources management
- Important demand from various user communities

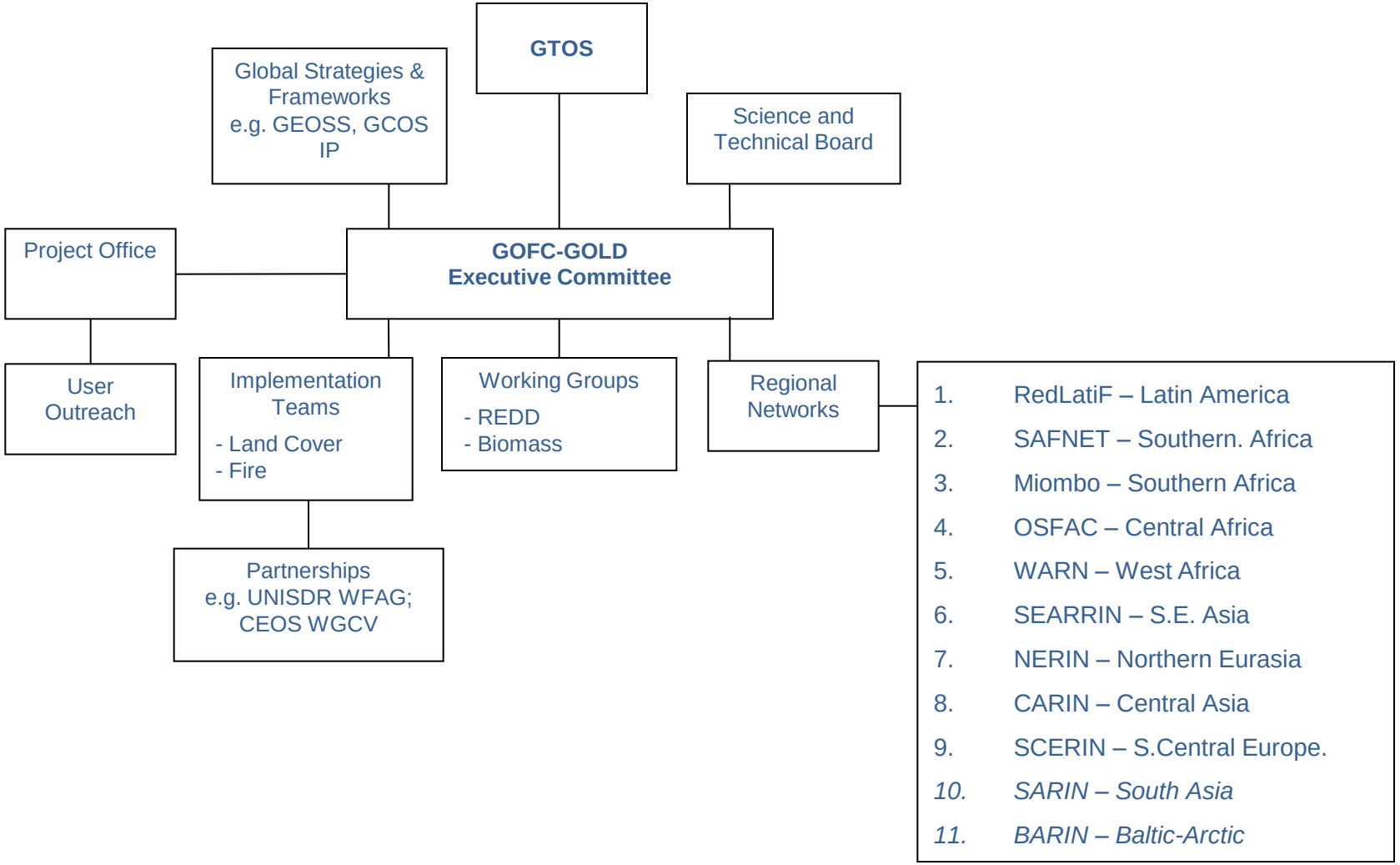
Background to GOFC-GOLD

- Developed in 1997, originally under the Committee on Earth Observation Satellites (CEOS):
  - To test the concept of an Integrated Global Observing System (IGOS)
  - To improve use of Earth Observation data to address major problems of global concern
  - To improve coordination of national programs
  - To improve co-operation between providers and users of Earth Observation data for regional and global applications
- Has become one of the Panels of the Global Terrestrial Observing System GTOS (FAO GTOS Secretariat)
  - Helping to address the Carbon Theme of the IGOS Partners
- Sponsors: FAO, WMO, UNEP, UNESCO, ICSU, EC-JRC, ESA, NASA, USGS, CSA, CFS

What is GOFC-GOLD?

- A coordinated international effort to ensure a systematic and continuous program of space-based and on-the-ground forest and land cover observations
- 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

What is GOFC-GOLD?



GOFC-GOLD on-going work & achievements

- Land Cover IT
  - Extensive use of historical archives, global products, emphasis on validation, LCCS classification scheme

GEO Global Land-cover and Land-cover Change Task

GROUP ON EARTH OBSERVATIONS

Coordination *Prof. Martin Herold (Wageningen U., The Netherlands),*
Dr. Brice Mora (GOFC-GOLD Land Cover Office)

Structure

- C1: Global Land Cover Datasets and Service
  Coordinator: Prof. Jun Chen (National Geomatics Center of China)
- C2: Global Land Cover Validation and User Engagement
  Coordinators: Dr. Christian Steenmans, Dr. Tobias Langanke (European Environment Agency)
- C3: Global Land Cover Methodology and Capacity Building/Outreach
  Coordinators: Prof. Martin Herold, Dr. Brice Mora

GEO Global Land-cover and Land-cover Change Task

GROUP ON EARTH OBSERVATIONS

Task SB-02-C1

Recent Progress and Key Outputs for 2013

- Release of global land cover products (Tsinghua U., China), ESA/Louvain-la-Neuve, Belgium)
- Global land cover information portal (NGCC, China)
- Land Cover Classification System (LCCS) standard
- Mechanism among ESA and USGS for joint operations for new satellite data

GEO Global Land-cover and Land-cover Change Task

GROUP ON EARTH OBSERVATIONS

Task SB-02-C2

Recent Progress and Key Outputs for 2013

- Develop harmonized products, translation rules (legend)
- Initiate collaboration for GEO portal connecting all major GLC websites (portals: NGCC, GOFC-GOLD LC, EEA: Eye on Earth platform)
- NGCC to release 30m water product for verification
- GOFC-GOLD LC / Boston U. VHSR reference dataset
- GLC reference data portal by GOFC-GOLD Land Cover Office
- Crowd sourcing: how to benefit from these initiatives (Geo-wiki, Oklahoma photo library, etc.)?

GEO Global Land-cover and Land-cover Change Task

GROUP ON EARTH OBSERVATIONS

Task SB-02-C3

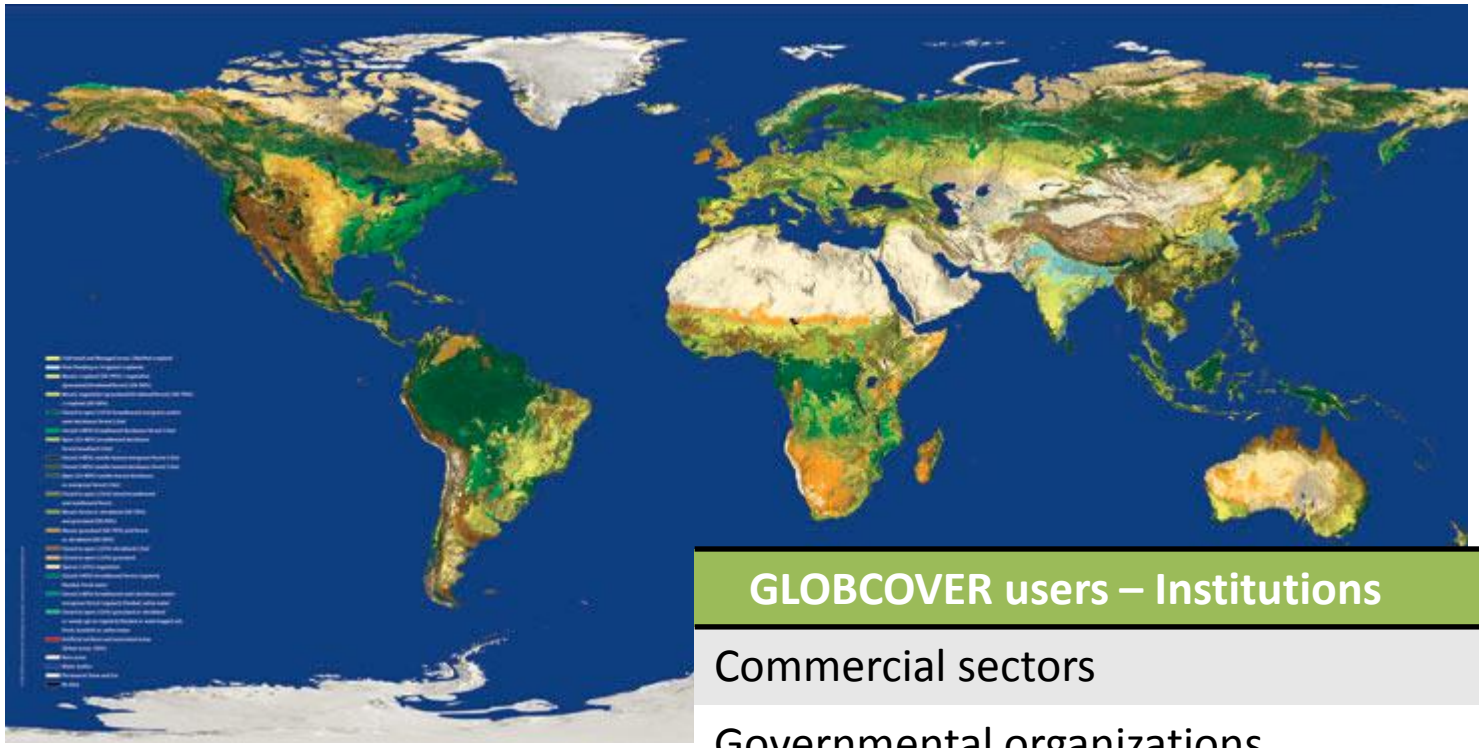
Recent Progress and Key Outputs for 2013

- Benefit from sub-tasks C1, C2
  - GLC maps and validation data portals
  - standardized procedures
  - validation tools
- Workshops and symposiums, reports, special issues
- Capacity development workshops
  - China
  - GOFC-GOLD Regional networks (11)
  - Boston/USGS workshops

Existing Global LC datasets

Dataset	Sensor	Spatial resolution	Time of data collection
IGBP DISCover	AVHRR	1 km	1992-93
UMD LC	AVHRR	1 km	1992-93
MODIS LC	MODIS	1 km	Jan-Dec 2001
MODIS LC	MODIS	500 m	2001-2008
GLC2000	SPOT 4 VEGETATTION	1 km	Nov 1999-Dec 2000
GLCNMO	MODIS	1 km	2003
GlobCover	MERIS	300 m	2005-2006
Globcover 2	MERIS	300 m	2009
FROM-GLC	Landsat	30 m	2010

ESA GlobCover 2005, 2009 products

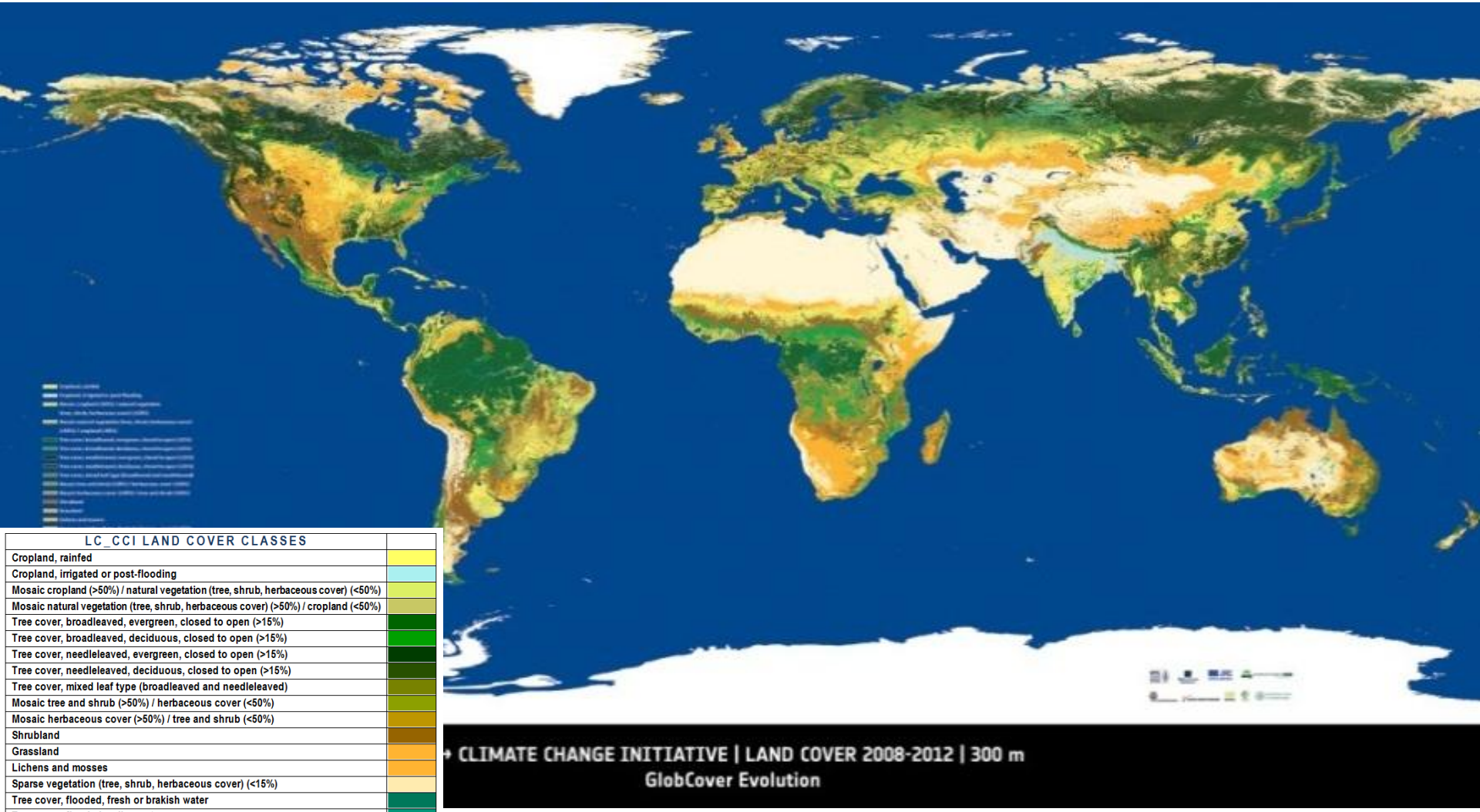


> 50,000 downloads since 2010

GLOBCOVER users – Institutions	Proportion (%)
Commercial sectors	21
Governmental organizations	14
Non-governmental organizations	17
University/ research institutions	48
Total	**100**

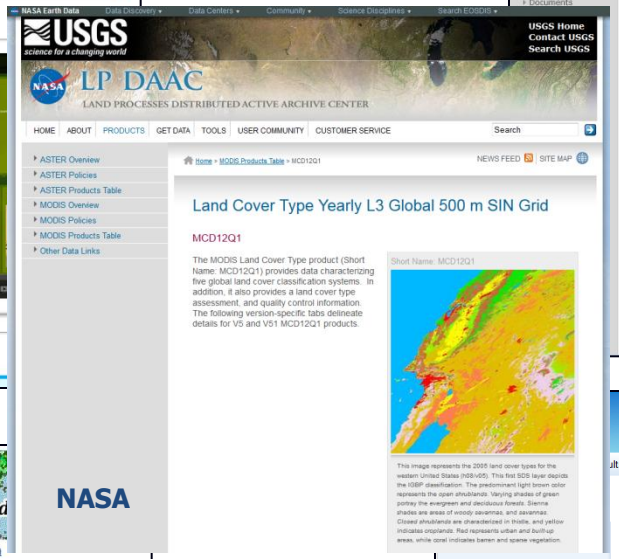
Source: ESA/WU Globcover user survey 2010 (N=372)

ESA Land Cover CCI products

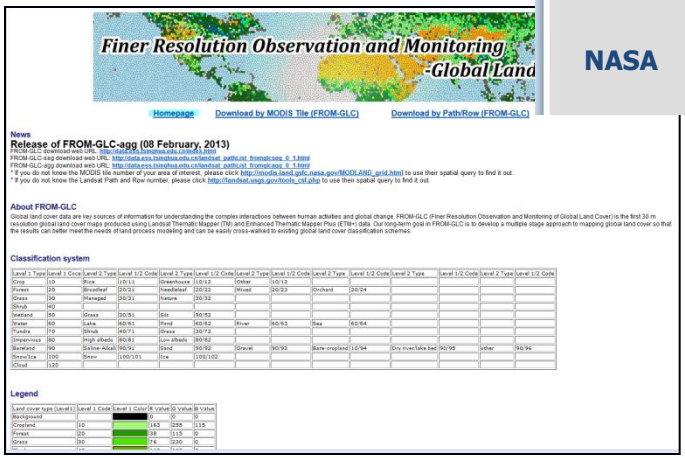


GLC data web portals

EEA



NASA



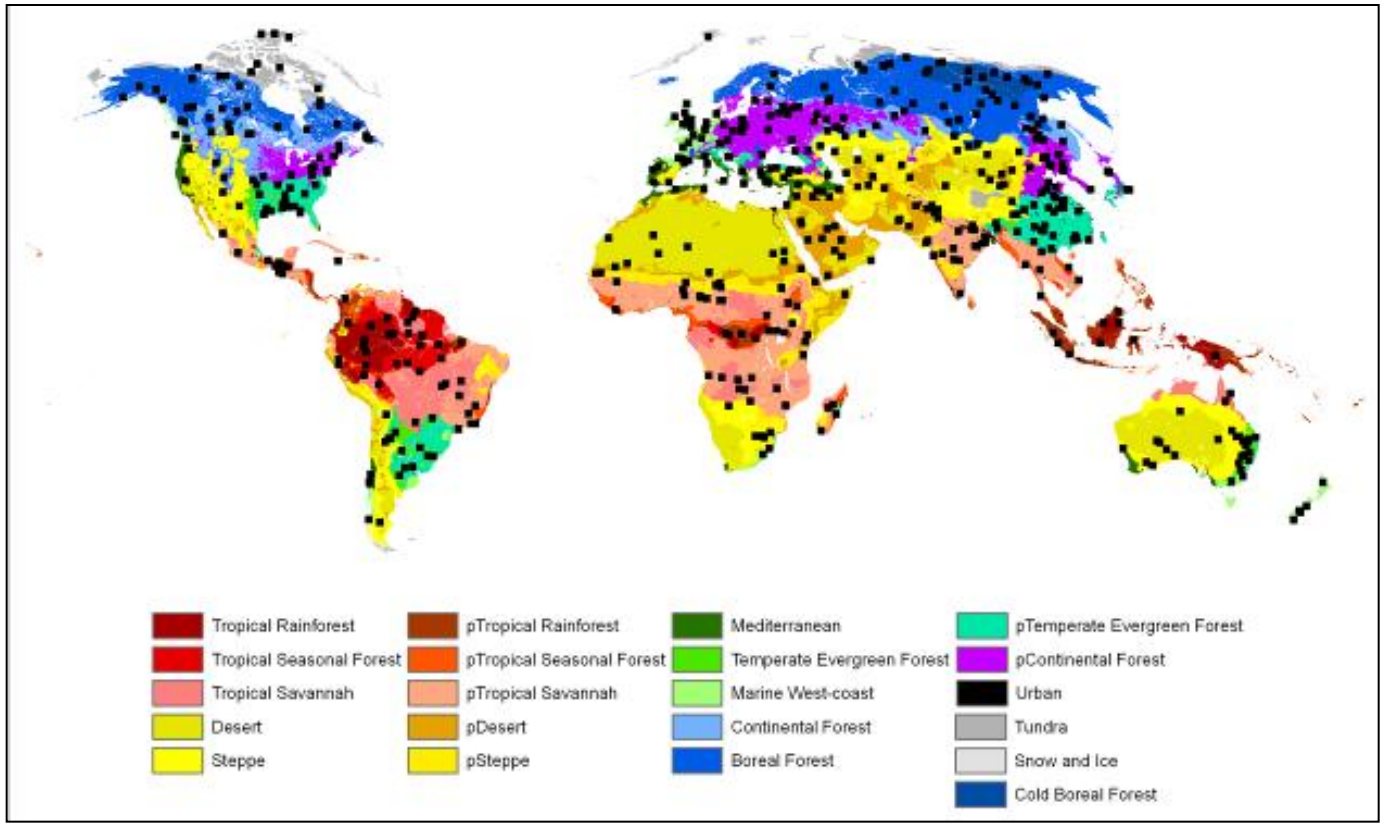
NGCC

GOFC-GOLD reference data web portal

Spatial distribution of the datasets available on the portal

Global reference validation database for accuracy assessment of land Cover

GOFC-GOLD / Boston U. VHSR dataset (500 samples)



Land Cover Classification system

- Developed by FAO and UNEP as comprehensive and standardized classification system for mapping purposes.
- Independent from mapping scale
- Allows dynamic creation of classes using combination of LC diagnostic attributes called *classifiers*.
- Last version of the LCCS: LC Metadata Language (LCML – LCCS v.3) proposed as standard by the International Organization for Standardization (ISO): ISO 19144-1.
- Complementary specifications under development (reference WI 19144-2).
- Herold, M., Hubald, R., & Di Gregorio, A. (2008). *Translating and evaluating the land cover legends using the UN Land Cover Classification System (LCCS)*. *Network* (p. 189). Jena, Germany. http://nofc.cfs.nrcan.gc.ca/gofc-gold/Report%20Series/GOLD_43.pdf

GMES Sentinel Missions

Sentinel 1 – SAR imaging
All weather, day/night applications, interferometry

2013 (A), 2014+ (B)

Sentinel 2 – Multispectral imaging
Land applications: urban, forest, agriculture,..
Continuity of Landsat, SPOT

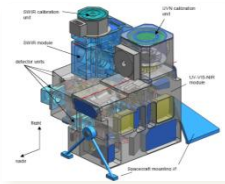
2014 (A), 2015+ (B)

Sentinel 3 – Ocean and global land monitoring
Wide-swath ocean colour, vegetation, sea/land surface temperature, altimetry

2014 (A), 2015+ (B)

Sentinel 4 – Geostationary atmospheric
Atmospheric composition monitoring, trans-boundary pollution

2018



Sentinel 5 and Precursor – Low-orbit atmospheric
Atmospheric composition monitoring

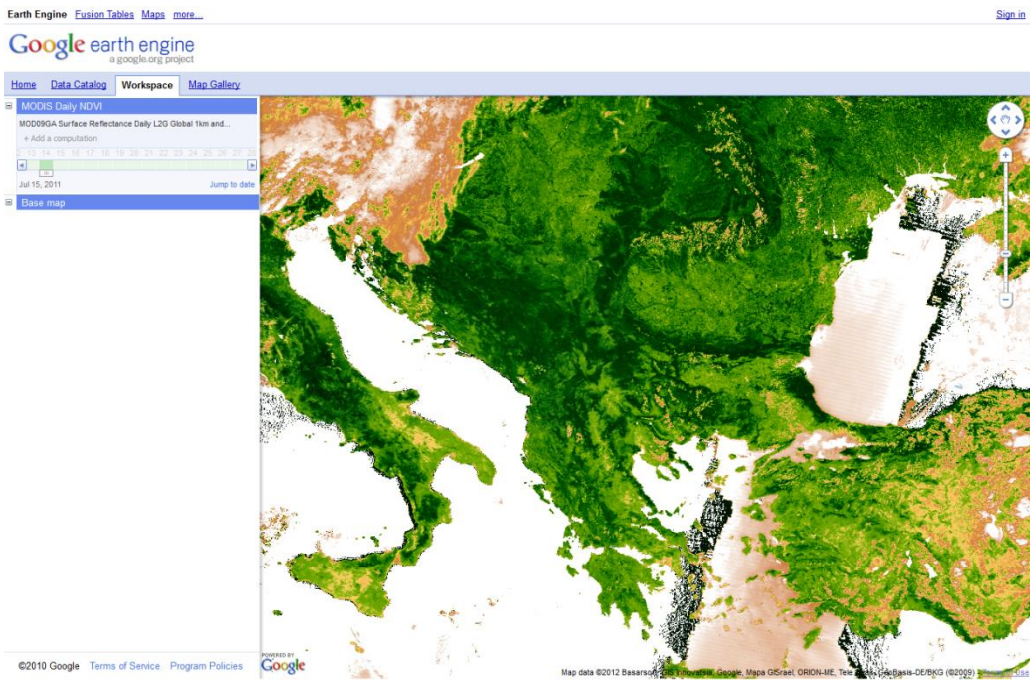
2014 (5P), 2019

Free and open data policy!

GMES
We care for a safer world

Cloud-computing and web-based approaches to support forest monitoring

- "Cloud-based" databases and data processing platform Google Earth Engine
- Landsat-based products available
- In discussion to support regional networks and validation
  test site network



MODIS daily NDVI for July 15, 2011

Samples of GOFC-GOLD achievements

- Land Cover IT
  - Extensive use of historical archives, global products, emphasis on validation, LCCS classification scheme
- Fire IT
  - Global fire risk using satellite data, global and regional fire assessments

GOFC-GOLD Fire-IT activities

GOFC-GOLD Fire-IT activities

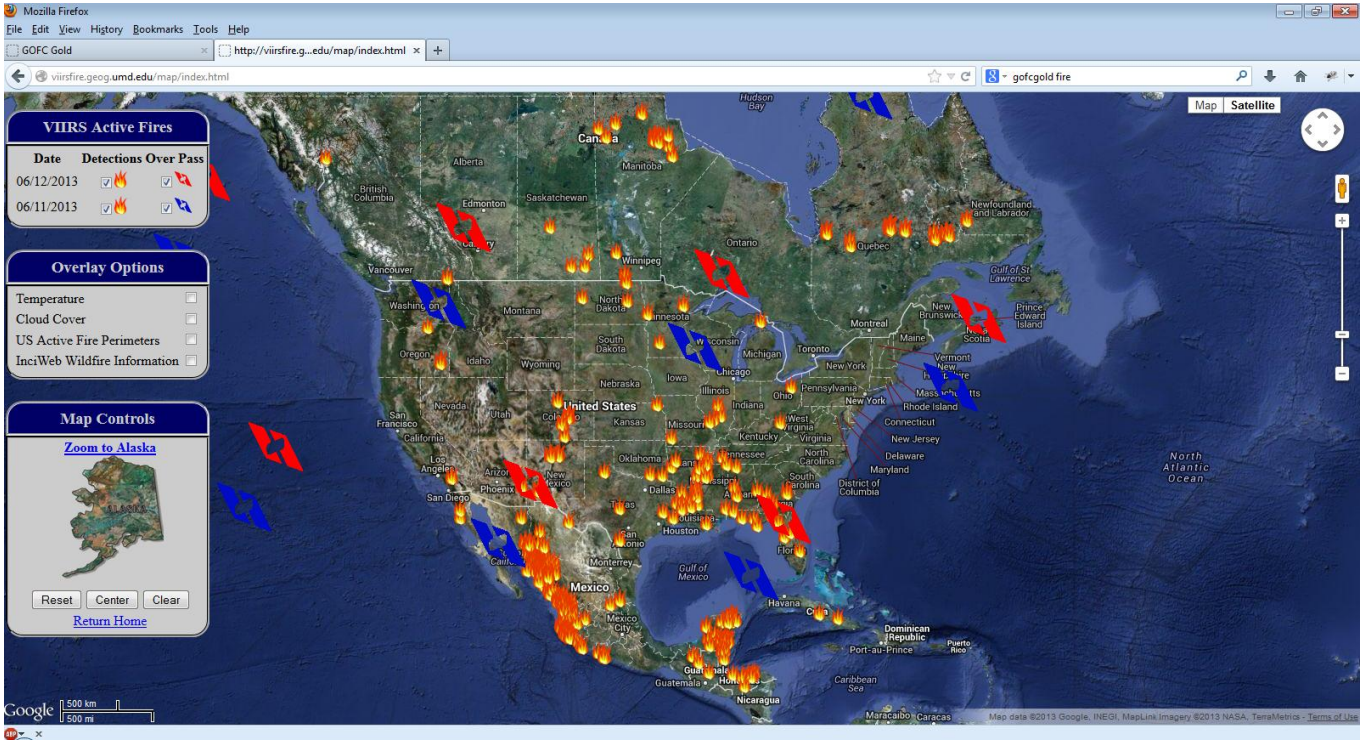
VIIRS: Visible Infrared Imager Radiometer Suite

- on-board of the Suomi National Polar-orbiting Partnership (NPP) satellite
- launched in 2011
- light shortwave data
- first fire detections in 2012
- continuation of high quality active fire monitoring capabilities started with the Moderate Resolution Imaging Spectro-radiometer (MODIS)
- significant improvement vs. Advanced Very High Resolution Radiometer (AVHRR) on operational polar satellites.

GOFC-GOLD Fire-IT activities

VIIRS Fire Detection Map

- Online tool
- Products available for download



Samples of GOFC-GOLD achievements

- Land Cover IT
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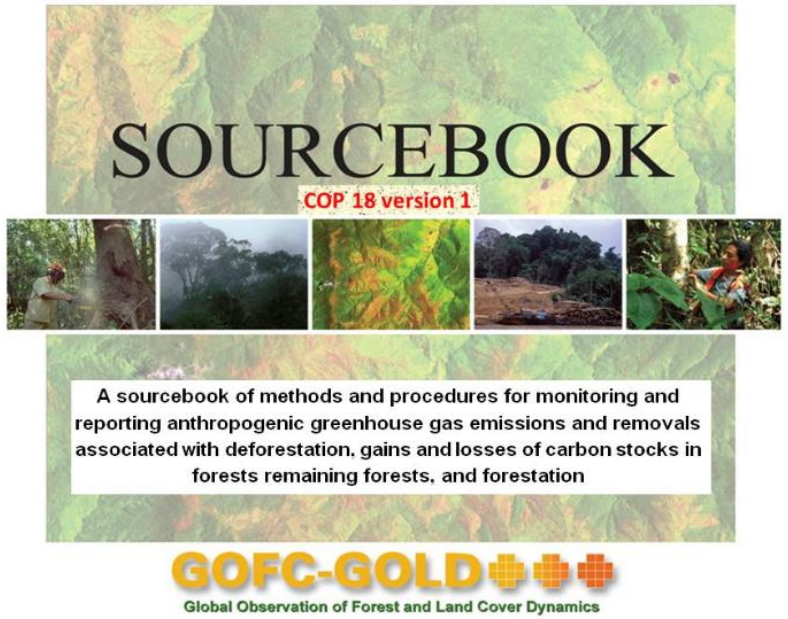
- REDD working group
  - Several activities around the Sourcebook and beyond

Reducing Emissions from Deforestation and Forest Degradation

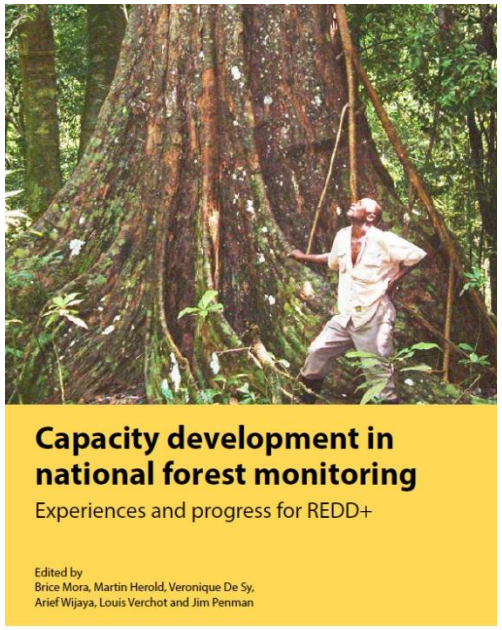
- GOFC-GOLD REDD working group formed in 2006 to address key technical issues (i.e. degradation, accuracy assessment).
- "Sourcebook" on technical capabilities for monitoring deforestation and its emissions

- 7th version for UNFCCC COP 18
- Includes role of land cover and fire analysis in REDD
- Updated for REDD+ (Deforestation, Gains and Losses of Carbon Stocks in Forests Remaining Forests, and Forestation)
- Future updates: evolving technologies (Radar, Lidar), degradation, RLs/RELs

http://www.gofcgold.wur.nl/redd



Reducing Emissions from Deforestation and Forest Degradation



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Current Opinion in Environmental Sustainability

Synergies of multiple remote sensing data sources for REDD+ monitoring

Veronique De Sy[1], Martin Herold[1], Frédéric Achard[2], Gregory P Asner[3], Alex Held[4], Josef Kellndorfer[5] and Jan Verbesselt[1]

http://www.norway.org.et/PageFiles/628168/De%20Sy%20et%20al,%202012%20-%20Synergies%20of%20multiple%20remote%20sensing%20data%20sources%20for%20REDD%20monitoring.pdf

Available online at www.sciencedirect.com

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journal homepage: www.elsevier.com/locate/envsci

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Environmental Science & Policy

Assessing capacities of non-Annex I countries for national forest monitoring in the context of REDD+

Erika Romijn[a,*], *Martin Herold*[a], *Lammert Kooistra*[a], *Daniel Murdiyarso*[b], *Louis Verchot*[b]

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[b] *Center for International Forestry Research, Jl. CIFOR, Situgede, Bogor 16115, Indonesia*

http://www.sciencedirect.com/science/article/pii/S1462901112000202

Samples of GOFC-GOLD achievements

- Land Cover
  - Extensive use of historical archives, global products, emphasis on validation, LCCS classification scheme
- Fire
  - Global fire risk using satellite data, global and regional fire assessments
- REDD
  - Several activities around the Sourcebook and beyond
- Networks
  - Bringing regional expertise to bear in many parts of the world
- Biomass
  - Galvanizing the scientific community to pursue new opportunities

Continued Strategic Thrusts

- Advocacy for free and open access to data
- Continuity of observations and coordination of observing programs
- Importance of validation of products
- Moving towards higher-level products
- Building capacity in regional networks
- Engaging regional experts with important processes and activities

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GOFC-GOLD / UNFCCC web resources

- GOFC-GOLD:
  http://www.fao.org/gtos/gofc-gold/
- GOFC-GOLD land cover project office:
  http://www.gofcgold.wur.nl/
- GOFC-GOLD fire project office:
  http://gofc-fire.umd.edu
- GOFC-GOLD REDD sourcebook:
  http://www.gofcgold.wur.nl/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

Earth Observation sensors

Visit EO Sensor table on

http://www.gofcgold.wur.nl/

Available GLC map products

Dataset name	Spatial resolution	Sensor name	Time of data collection	Input data	Classification method	Classification scheme	Validation	Absolute positional accuracy (RMSE)	Area weighted thematic overall accuracy	Reference
IGBP DISCover	1km	AVHRR	1992-1993	Monthly NDVI from 10 day composites	Unsupervised clustering	IGBP 17 class	Independent validation datasets	~1 km	67%	(Loveland et al., 2000, Husak et al., 1999, Scepan et al., 1999)
UMD land cover product				Monthly NDVI and 5 bands from 10 day composites	Supervised classification tree	Simplified IGBP 14 class	Evaluated using other dataset			(Hansen et al., 2000)
MODIS land cover	1 km	MODIS	Jan-DEC 2001	16 day composites of 7 bands and EVI	Supervised decision tree	IGBP, UMD and other	Cross validated	1-1.5km	71.6% ±2.5%	(Friedl et al., 2002, Friedl et al., 2010, Strahler et al., 2003, Strahler et al., 1999)
MODIS land cover 5	500 m		2001-2008	Monthly EVI, LST and 7 bands from 8 day composites	Supervised decision tree boosting	5 different LC Classification system			74.8% ±1.3%	
GLC 2000	1 km	SPOT 4 VEGETA-TION	Nov 1999-Dec 2000	Monthly to 3 monthly NDVI composites	Optimal classification methods	LCCS 22 class	Independent validation datasets	300m ~1/3 pixel	68.6% ±5%	(Bartholomé and Belward, 2005, Mayaux et al., 2006)
GLCNMO	1 km	MODIS	2003	16 day composites of NDVI and 7 bands	Supervised classification	Modified LCCS 20 class	Independent validation datasets	141-277m	81.2%	(Tateishi et al., 2011)
Glob Cover	300 m	MERIS	2005-2006	Bi-monthly from 10 day composites	(Un)supervised spatio-temporal clustering	LCCS 22 class	Independent validation datasets	77m	73.1%	(Bicheron et al., 2008, Bontemps et al., 2011, Defourny et al., 2011)
Glob Cover v2			2009						67.5%	
FROM-GLC	30 m	Landsat TM/ETM+, MODIS	Circa 2010 (3/4), circa 2000 (1/4)	Landsat, 16-day MODIS time series, bioclimatic products	Supervised classification methods	8 land cover classes	Independent validation datasets	30 m	66%	(Gong et al., 2013)

GLC Data portals

- National Geomatics Center of China GLC data web portal (water, settlements, cropland, etc.)

  http://www.globallandcover.com/glc/index2_en.html

- 30m GLC map product (Tsinghua University)

  http://data.ess.tsinghua.edu.cn/index.html

- GOFC-GOLD Land Cover Office GLC Reference data portal:

  http://www.gofcgold.wur.nl/sites/gofcgold_refdataportal.php

- GOFC-GOLD Regional Networks

  http://www.fao.org/gtos/gofc-gold/networks.html

- USGS MODIS Land Cover products

  https://lpdaac.usgs.gov/products/modis_products_table/mcd12q1

Literature

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- GOFC-GOLD. (2012). A sourcebook of methods and procedures for monitoring and reporting anthropogenic greenhouse gas emissions and removals associated with deforestation, gains and losses of carbon stocks in forests remaining forests, and forestation - Version COP18-1 (p. 225). Wageningen, The Netherlands. http://www.gofcgold.wur.nl/redd/index.php