

GEO Forest Carbon Tracking (FCT) & Global Forest Observation Initiative (GFOI)

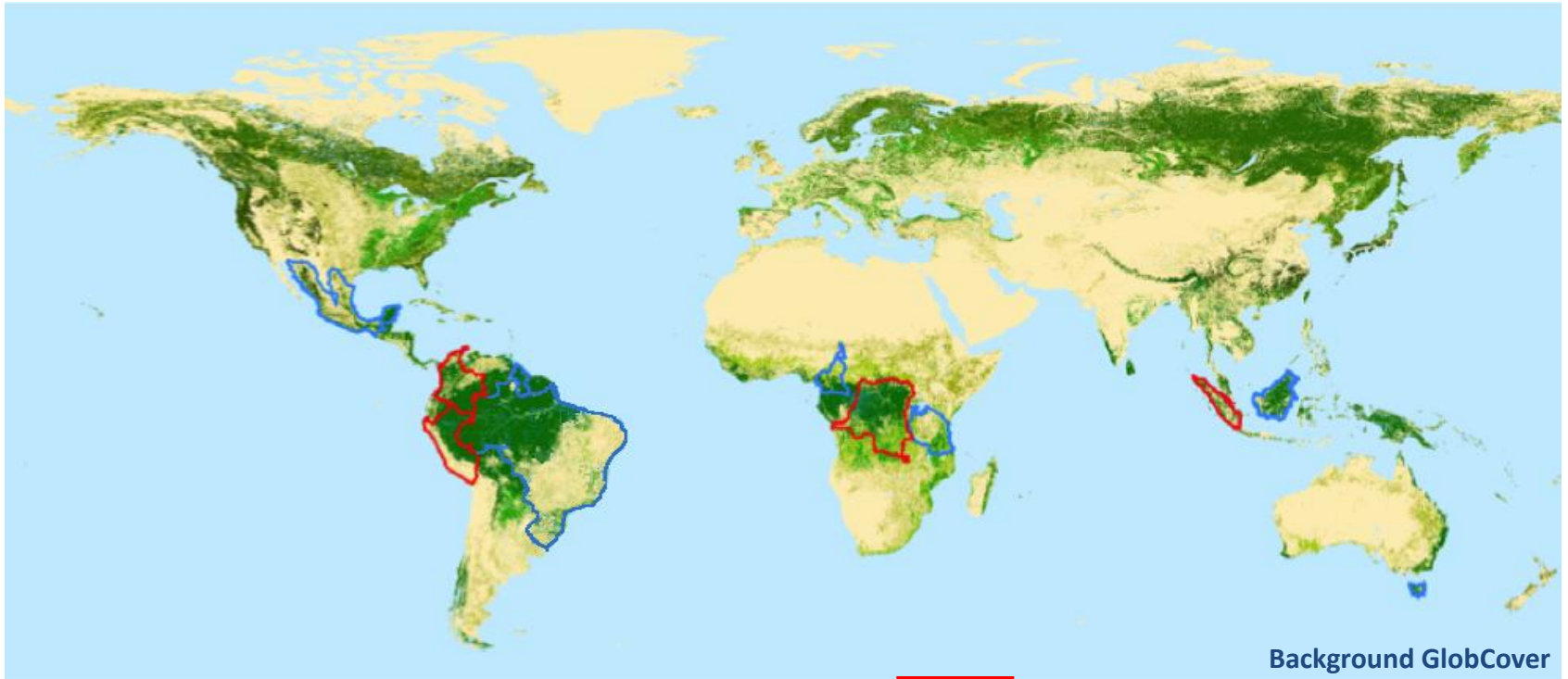
Status September 2011

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Yves Crevier (CSA), Tom Holm (USGS),
and contributing space agencies



Forest Carbon Tracking (FCT)





Background GlobCover

From 2009



- Brazil
- Guyana
- Mexico
- Indonesia (Borneo)
- Australia (Tasmania)
- Cameroon
- Tanzania

From June 2010



- Colombia
- DR Congo
- Peru
- adding Sumatra to Indonesia

From June 2011

- Nepal

From 2011 onwards progressive inclusion of countries from UN-REDD & World Bank FCPF is being planned.

Forest Carbon Tracking

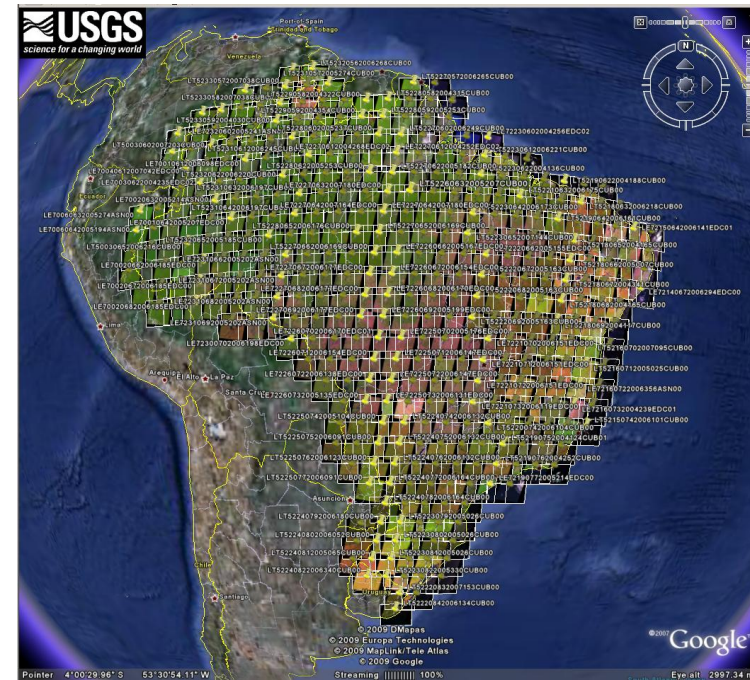


ND	VS	Name	lat	long	Priority	
Mexico	MEX-1	Chiapas-1	N17.00	W93.55	1	
	MEX-2	Chiapas-2	N16.33	W90.65	2	
	MEX-3	Campeche	N18.52	W92.25	2	
Cameroon	ND	VS	Name	lat	long	Priority
		CAM-1	East Region (Ndelele)	N3.92	E14.99	2
		CAM-2	Adamawa Region (Tibati)	N6.52	E12.48	2
		CAM-3	Adamawa Region (Mbakaou)	N6.22	E12.76	1
Colombia	ND	VS	Name	lat	long	Priority
		BOR-1	E-Kalimantan/Sbh	N4.33	E117.01	2
	Indonesia (Borneo)	BOR-2	SW-Kalimantan	S1.82	E111.61	1
		BOR-3	SE-Kalimantan (KFCP REDD)	S2.24	E114.48	1
		BOR-4	C-Kalimantan/Srwk	N2.55	E115.08	2
BOR-5		Berau	N1.91	E116.85	2	
Peru	D.R.	VS	Name	lat	long	Priority
	Indonesia (Sumatra)	SUM-1	Jambi REDD	S2.47	E101.53	1
		SUM-2	Harapan	S2.20	E103.38	1
SUM-3		Riau Pelalawan	N0.0	E102.00	2	
Brazil*	Tasmania	VS	Name	lat	long	Priority
	AU-1	Mathinna	S41.37	E147.76	1	
	AU-2	Takone	S41.19	E145.60	2	
Guyana	Tar	VS	Name	lat	long	Priority
	Nepal	NEP-1	Bharatpur	N27.54	E84.60	1
		NEP-2	Kathmandu/Shivapuri	N27.80	E85.41	1
		NEP-3	Annapurna	N28.33	E84.16	2
		NEP-4	Bhang / Bajura	N29.68	E81.31	2
		NEP-5	Western Terai	N28.82	E80.82	2
		NEP-6	Gulmi / Baglung	N28.09	E83.28	2
NEP-7		Taplejung	N27.29	E87.54	2	

* Xingu in Brazil



- Acquisition preferably close to nadir
- Cloud free observations (< 20% cloud coverage for individual scenes – total cloud removal by multiple scenes)
- All available spectral bands
- Time window – yearly, with preference during dry season
- Level-1 processing



GLS 2005: 423 TM Scenes in USGS Archive



Satellite	Spectral Bands	Geometric Resolution	Swath Width	Repeat Cycle
Landsat 5, 7	VNIR, SWIR, TIR	30 m / 120 m (TIR)	185 km	16 days
IRS: AWiFS	VNIR, SWIR	56 m	740 km	4 days
IRS: LISS-III	VNIR, SWIR	23 m	140 km	24 days
CBERS 2b: CCD*	VNIR	20 m	114 km	26 days
SPOT 4, 5	VNIR, SWIR	20 m / 10 m	60 km	26 days

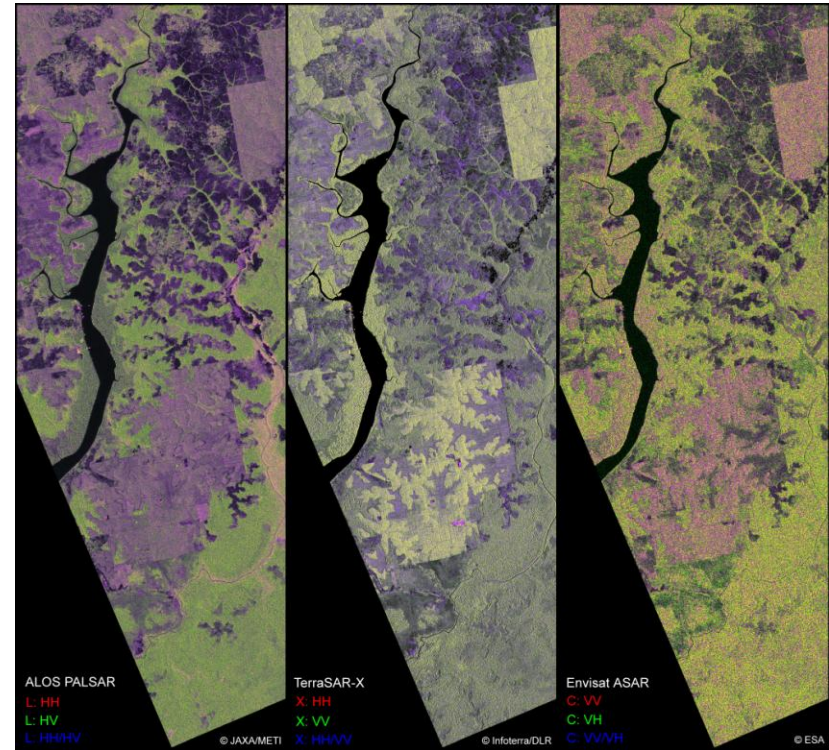
* Mission lost in May 2010



National Demonstrator	Dry Seasons
Brazil	July / August for Xingu, none for overall Amazon basin
Guyana	July - September
Mexico	January - May
Peru	May - September in the Andes, rain (Selva) and cloud forest (Montaña) experiences a hot, humid tropical climate, whereas the coastal zone is dry
Colombia	generally high humidity, but less rainfall during December - March and July / August
Cameroon	November - March and additionally in the South from June - August
Tanzania	December - March and June - October
DR Congo	generally tropical wet climate, with 2 dryer seasons December - February and May- July at the equator and one dry season (May - Sept) in the South
Borneo (Indonesia)	June - September, but strong variations over the island
Sumatra (Indonesia)	generally tropical wet climate, with less precipitation in July - September
Tasmania	February / March (cool temperate climate)



- Spatial and temporal consistency
- Fixed single observation mode
- Time window – twice annual during dry and wet season
- Level-1 processing (calibrated)
 - SLC
 - Multi-look



Polarimetric composites in L-, X- and C-band by ALOS PALSAR, TerraSAR-X and Envisat ASAR



Satellite	Frequency / Polarisation	Geometric Resolution	Swath Width	Repeat Cycle
ALOS PALSAR*	L-band (23.6 cm) / full pol	7 m – 154 m	30 – 360 km	46 days
RADARSAT-1	C-band (5.6 cm) / HH	9 m – 100 m	45 – 500 km	24 days
RADARSAT-2	C-band (5.6 cm) / full pol	3 m – 100 m	20 – 500 km	24 days
ENVISAT ASAR	C-band (5.6 cm) / dual pol	30 m – 150 m	56 – 400 km	35 days
TerraSAR-X	X-band (3.1 cm) / full pol	1 m – 16 m	5 – 100 km	11 days
COSMO-SkyMed	C-band (3.1 cm) / full pol	1 m – 100 m	10 – 100 km	16 days

* Mission lost in April 2011



GEO-FCT – EO Data Coordination

CEOS

Commercial

OPTICAL

LSI Constellation

- USGS (USA)
- CNES (France)
- INPE (Brazil)
- ISRO (India)
- GISTDA (Thailand)
- JAXA (Japan)

SAR

- JAXA (Japan)
- CSA (Canada)
- ESA (Europe)
- ASI (Italy)
- DLR (Germany)

(V)HR

- GeoEye
- Ikonos
- Quickbird
- RapidEye
- DMC
- (Spot)
- (TSX Infoterra)
- (RS-2 MDA)



Coordinate systematic acquisitions to ensure consistent data sets:

- Wall-to-wall acquisitions of National Demonstrators
 - **Annual to twice-annual** coverage with 20 – 30 m sensors
 - demonstrate **systematic acquisition capability**
 - develop **historical archive** of consistent time series (GFOI)
 - **anticipating data requirement** in support of UNFCCC post Kyoto agreement like **REDD+** and carbon markets
- Local scale acquisitions over FCT Validation Sites
 - increased **repetition frequency** (about monthly)
 - includes also **VHR sensors** (increase coverage)
 - enable FCT **research** on key science questions and **methodology development** (e.g. dense C-band series)
 - act as **test-bed** for improved national mapping strategy

Campaign	Summer 2009	Spring 2010	Summer 2010	Spring 2011	Total
ALOS PALSAR	6189	7531	13746	15079	42545
RADARSAT-2	595	1278	875	1160	3908
ENVISAT ASAR	684	1419	2785	1389	6277
COSMO - Skymed	not planned	183	N/A	N/A	183
TerraSAR-X	not planned	243	126	170	539
Landsat 5 & 7	6288	5280	11362	11691	34621
SPOT	TPM by ESA, but restrictions related to repatriation		2252	2810	5062
CBERS-2B	3580	N/A	mission lost	mission lost	3580
IRS	not planned	100	13674	6015	19789

more than 116,000 scenes!!!



Summary of EO Data 2011 Acquisitions over NDs and VS

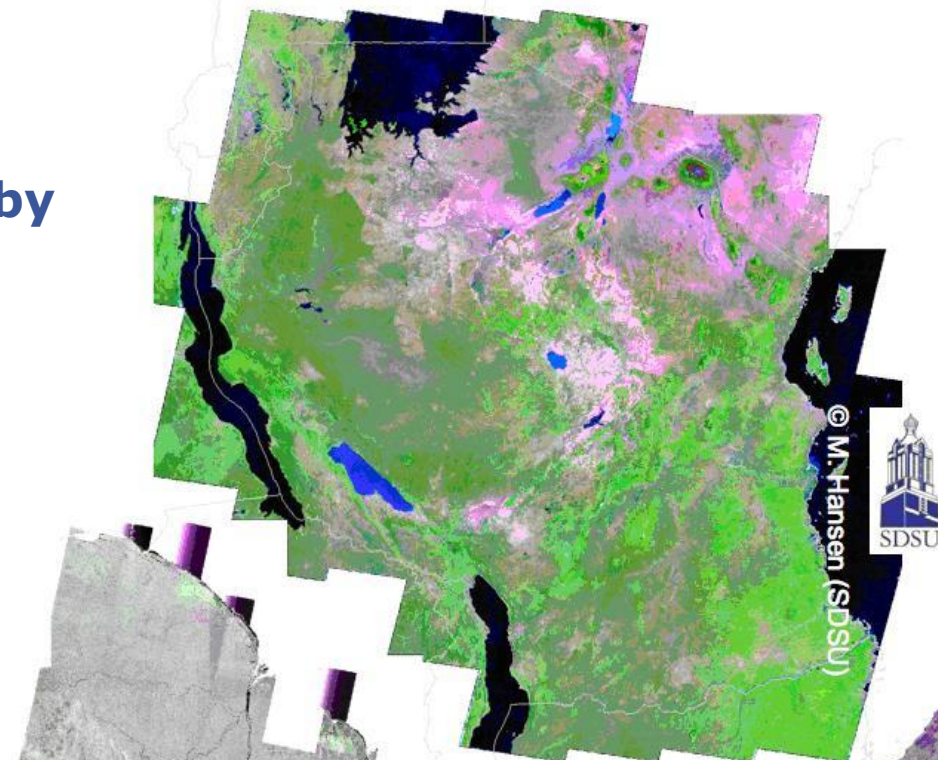
Sensor	Brazil	Guyana	Colombia	Peru	Mexico	Cameroon	DR Congo	Tanzania	Indonesia	Tasmania
ALOS PALSAR*	3457	248	1248	1199	1938	2861		616	3352	160
RADARSAT-2	37	76	251	248	137	35	0	60	263	53
ENVISAT ASAR	174	39	116	29	294	206	32	125	303	71
COSMO - Skymed	under discussion									
TerraSAR-X	24	12	0	0	44	24	0	18	36	12
Landsat 5 & 7	4162	244	1057	714	2765	297	1139	404	721	188
SPOT						2810				
IRS	5715	under discussion								

* mission lost April 2011

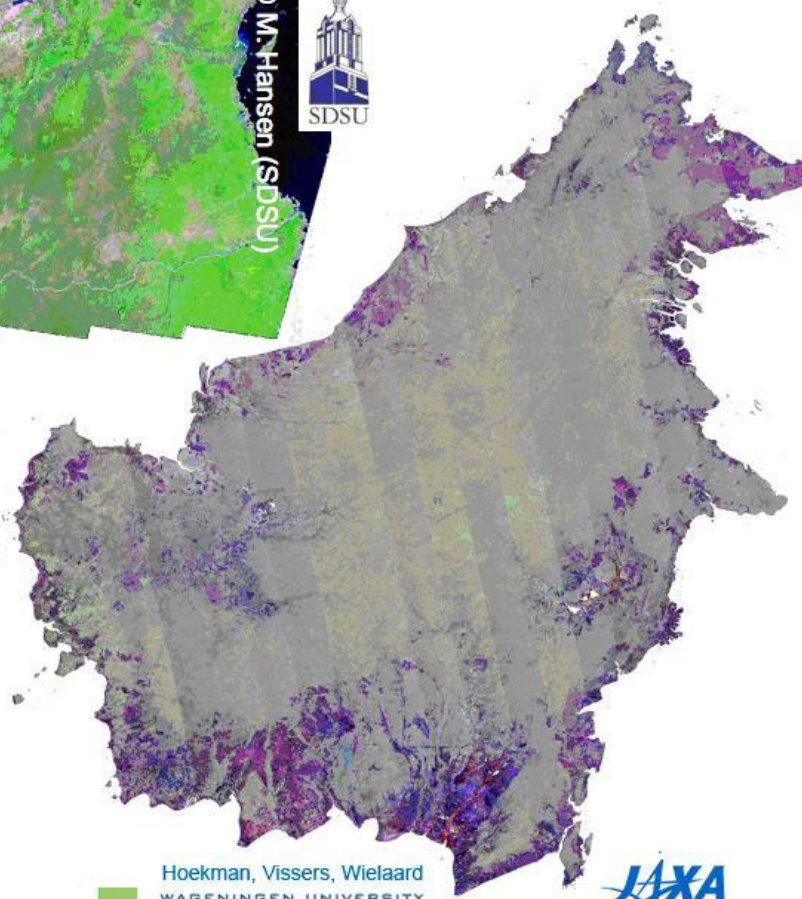
full coverage	not feasible	partially or some restrictions	under discussion
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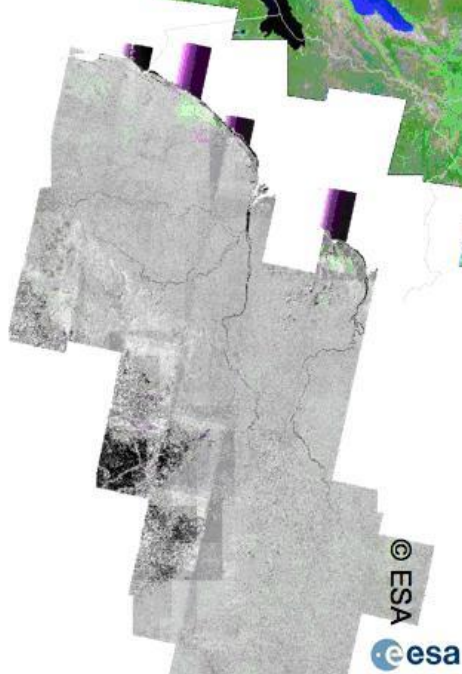
**Tanzania by
Landsat**



**Borneo by
PALSAR**



**Guyana
by ASAR**



- ASAR IS4 in alternate polarisation has gaps of several kilometres at the Equator!

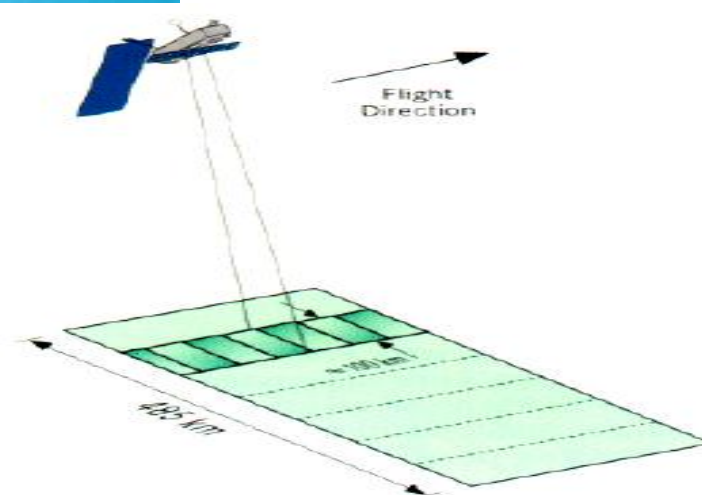
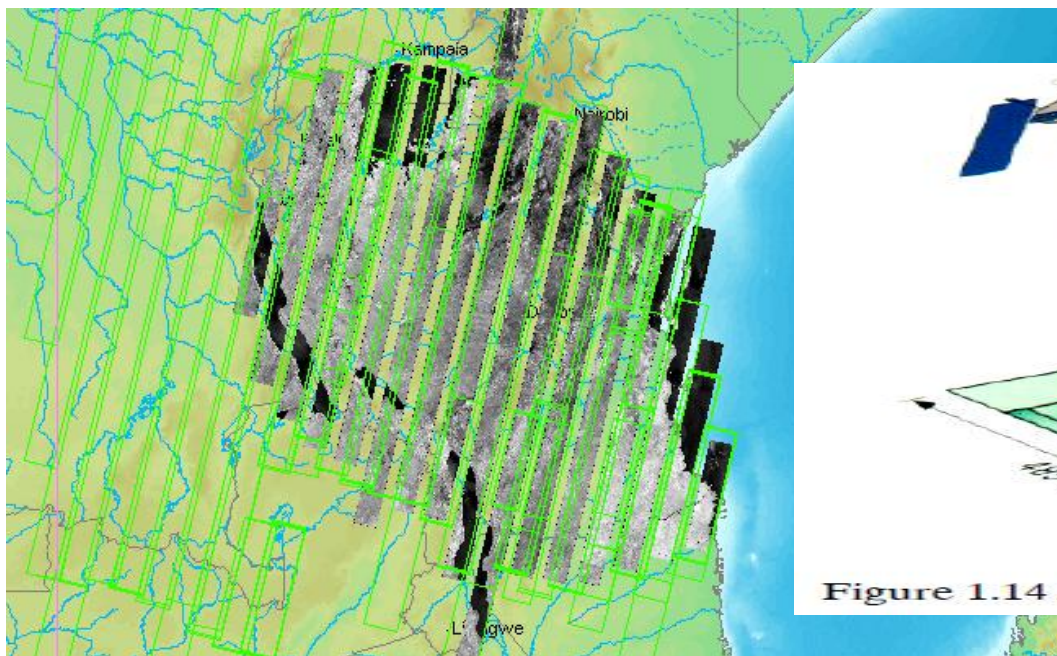


Figure 1.14 Alternating Polarisation Mode

- ➔ Switch to IS1 in AP mode from Oct onwards
- ALOS stopped operating on 22 April 2011**
- ALL current missions are beyond predicted EoL!**



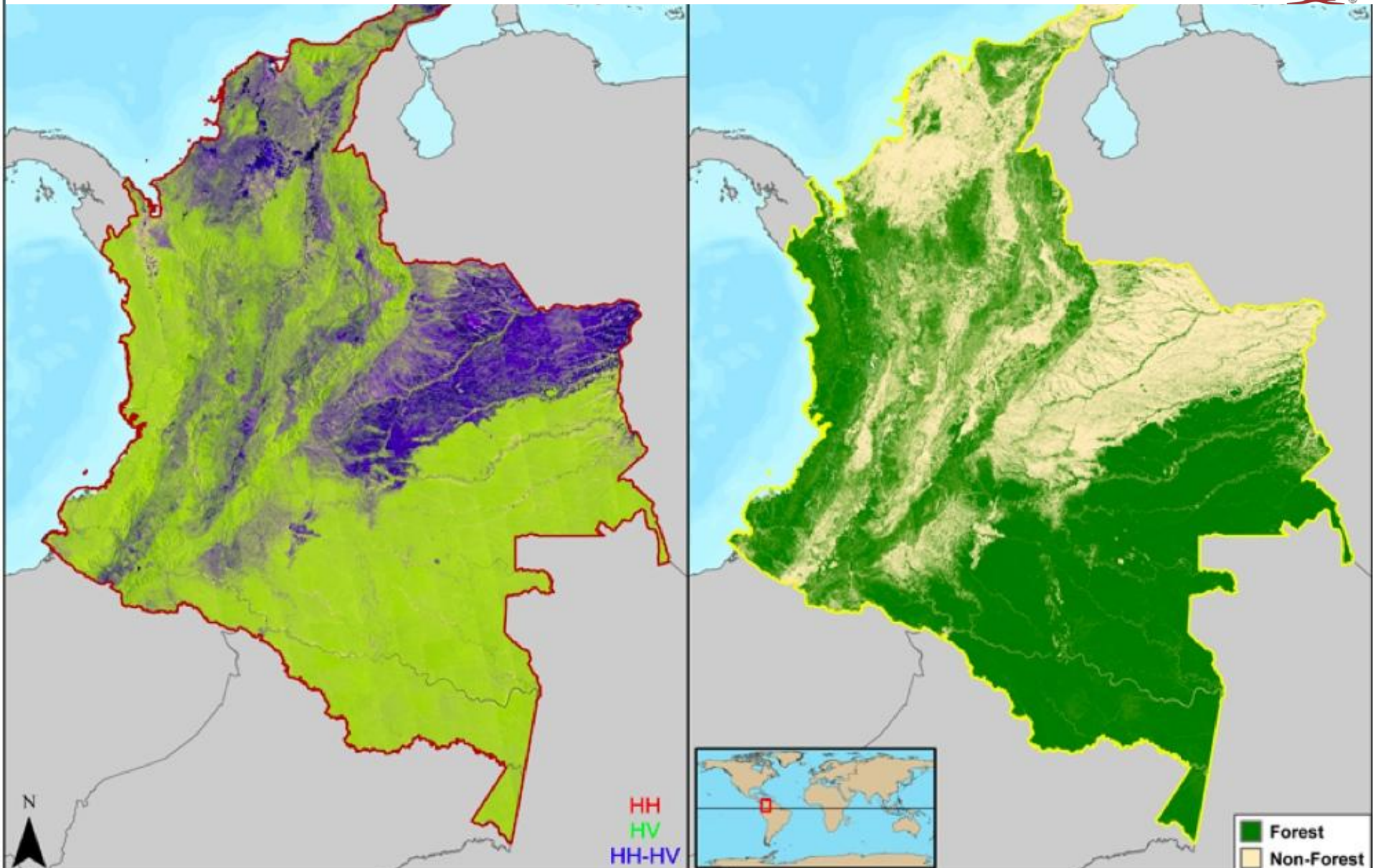
- **Coordinated acquisition** of satellite data over FCT National Demonstrators and Verification Sites: **more than 116,000 scenes** acquired until April 2011
 - **Distribution of EO data:** all required 2009 data delivered to PD teams, 2010 and 2011 on-going
 - **Expansion** of demonstration area: **> 10 Msqkm**
- ➔ **Only possible with excellent international cooperation!!!**

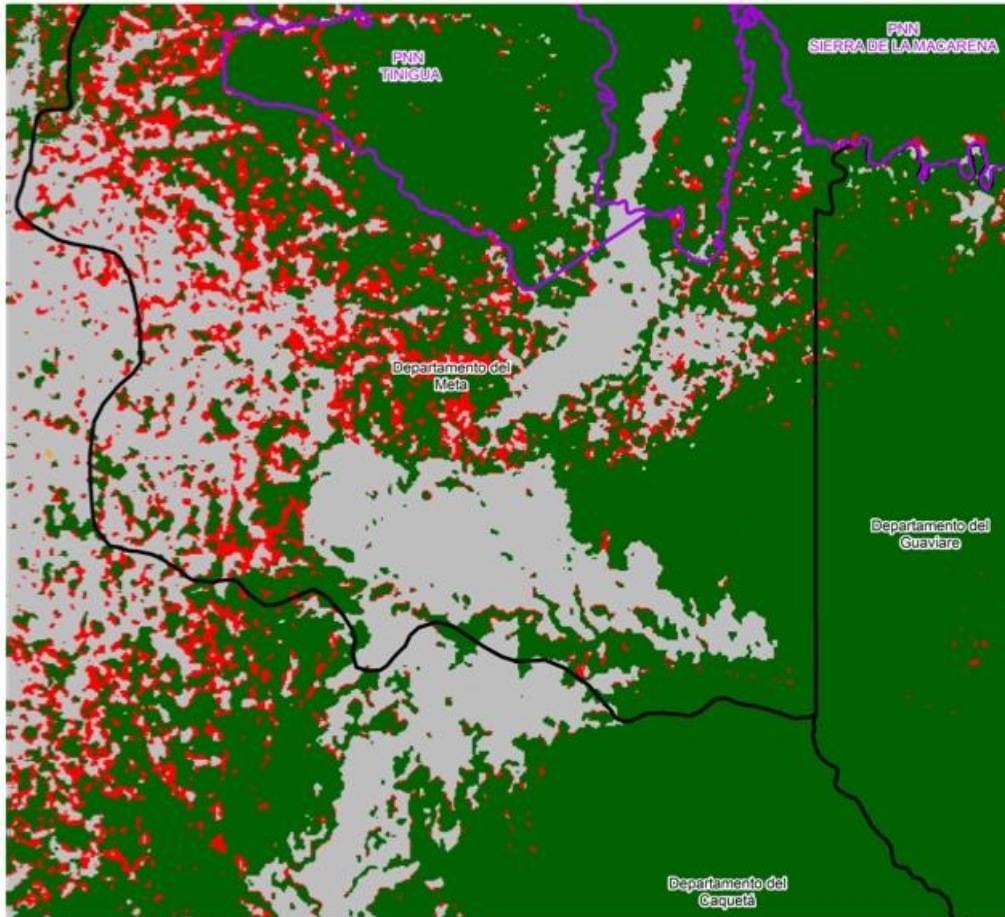


GEO FCT Products



Colombia: Forest/Non-Forest





Forest / Non Forest
2000

Forest / Non Forest
2007

Change
Forest / Non Forest
2000-2007

Forest Change 2000-2007

Change Map

Testsite CAM-3

Location Diagram



Change 1986-2009

- Non-Forest -> Forest
- Forest -> Non-Forest

Administrative Information

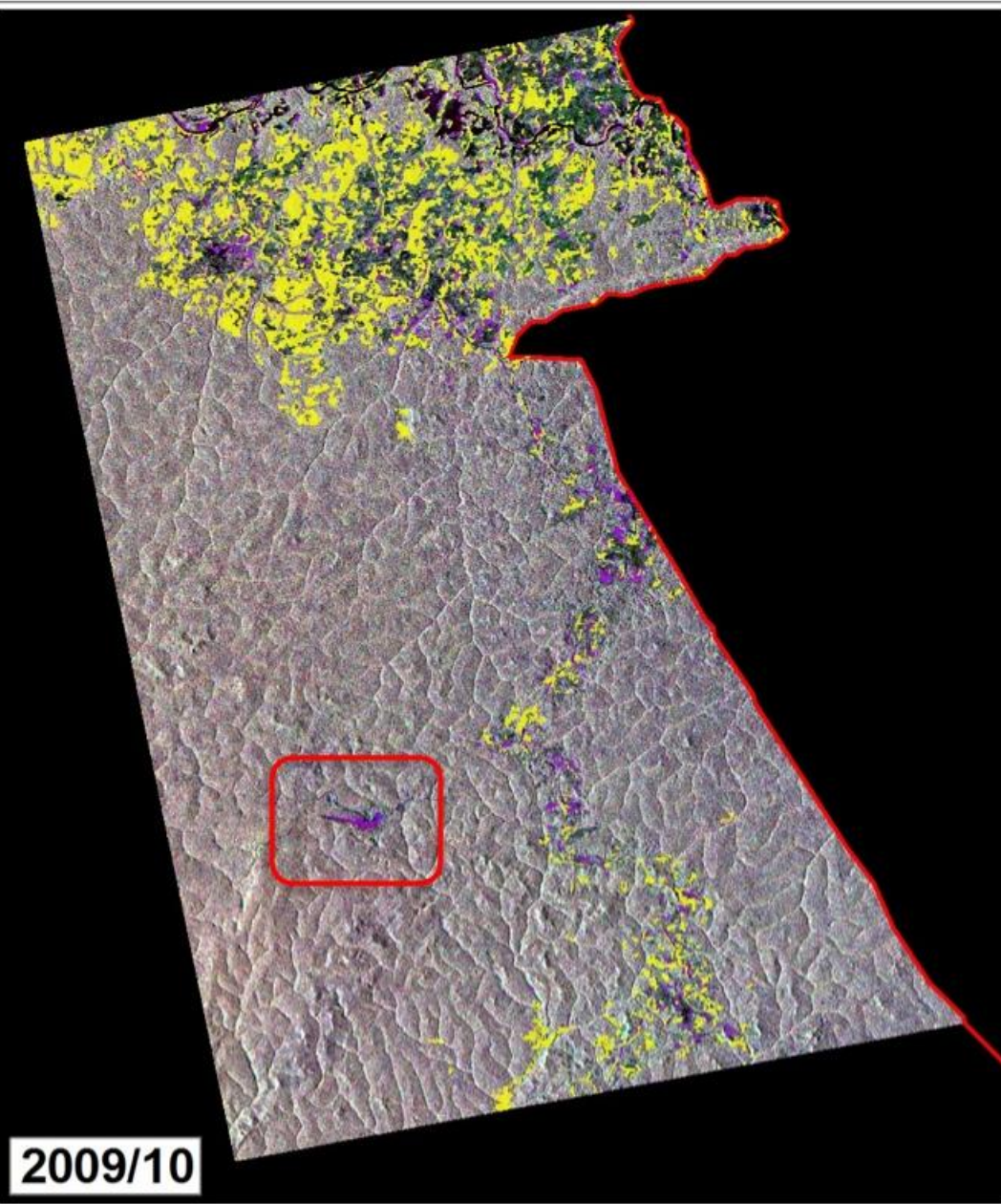
- National Boundary of Cameroon

Description

Classification 1986 derived from Landsat 5 TM; Classification 2009 derived from ALOS Palsar

ALOS Palsar

Band 1: Jul HV, 2009
Band 2: Oct HV, 2009
Band 3: Jan HH, 2010



2009/10



GAF, 2010

Borneo: Land Cover/Land Use

GEO-FCT Horizon 1c

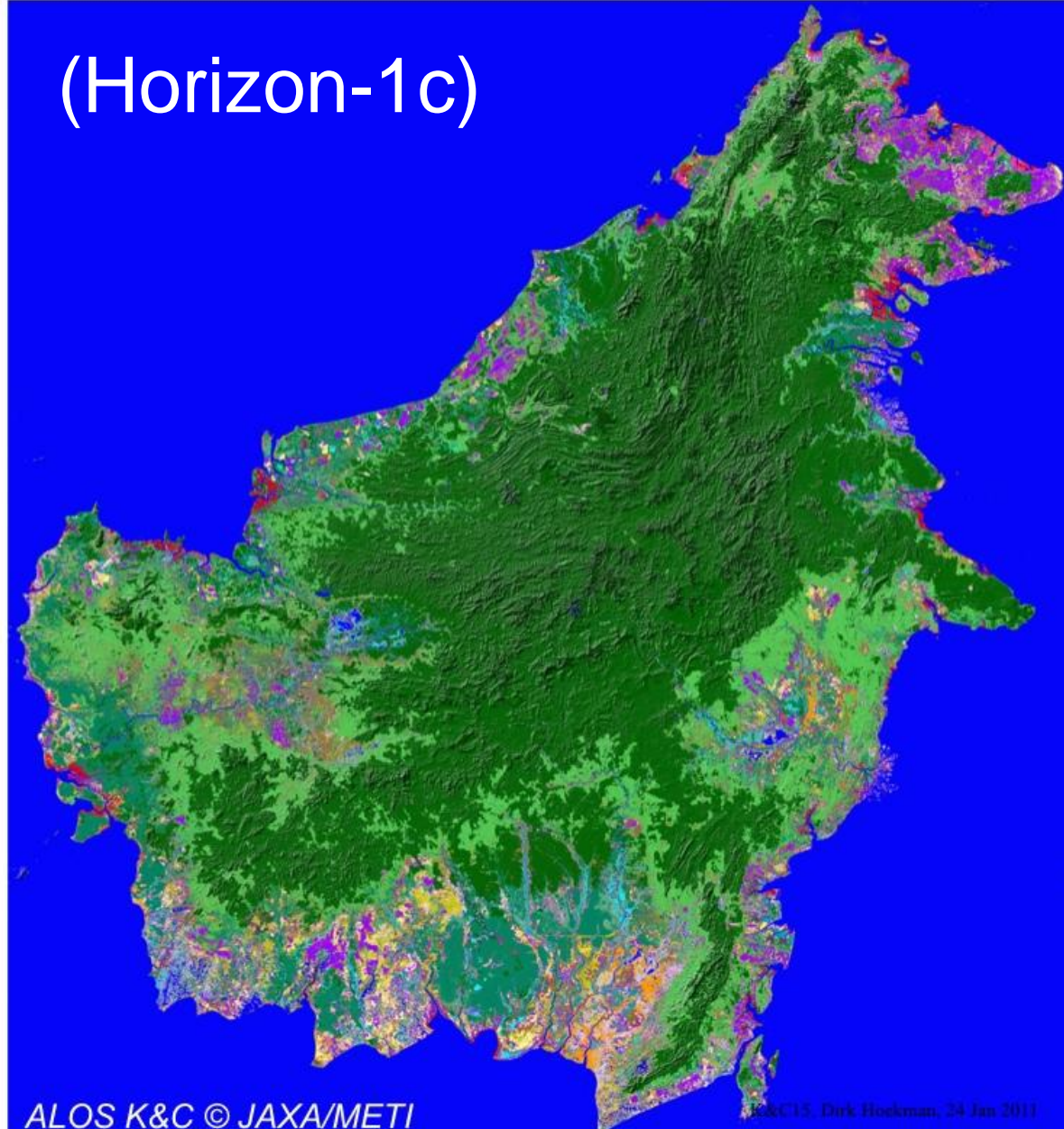
LULC classification

Borneo 2007

(shaded relief version)



(Horizon-1c)



Tasmania: Forest/Non-Forest

Multi-source forest/non-forest maps

Tasmania
(NCAS TM 2007)

Tasmania
(Radar 2007)

TASVEG

CRC-IS, 2010
(Milne/Mitchell)



Legend



Legend

VALUE



FCT Cooperation

- **UN-REDD** with 9 pilot countries
 - UN-REDD/GEO Symposium in Mexico
 - 1st ND Summit and 2nd SDS at FAO in Rome
 - Challenge to increase acquisition area over **UN-REDD pilot countries** until end 2012

- World bank's **Forest Carbon Partnership Facility (FCPF)** with 37 REDD country participants
 - Future expansion countries
 - Challenge to start to cover them from end 2011 onwards ...



Global Forest Observation Initiative (GFOI)



Towards sustained global capability

- Significant progress in 2009, 2010 & 2011 for FCT
- ... but need to move from preliminary tasks to more **comprehensive, consistent and continuous forest observations** setting up permanent solutions to issues like data policies, satellite availability, transition from demonstration to operations, ...



- **GEO Global Forest Observations Initiative (GFOI)** from 2012 onwards
 - GEO VII Plenary approved the planning of the GFOI and asked for an **implementation plan (GFOI IP)** to be submitted to GEO VIII (Nov. 2011)

- **Support to national governments:** to help governments build individually developed yet comparable national forest monitoring systems
- **Observations and measurement:** systematic observations and measurements are essential for effective reporting. Continuity and interoperability of data supply needed
- **Methods and protocols for data collection, processing and integration:** promote and encourage development of methods and protocols for data collection, processing and integration.
- **Continuing research and development:** promote coordinated research and development needed for continuous improvement of national forest information systems.
- **National capacity building:** to help governments develop national forest information systems, GFOI will work in collaboration with other providers such as the FAO.

- GFOI provides support **in response to governmental request to aid national activities** – in support of national forest information systems and reporting commitments via UNFCCC and FAO
- **GFOI isn't an independent production or validation body but rather a framework for coordination**
- **Resources incl. data provided through existing multilateral and bilateral channels:**
 - GFOI coordination platform improving links between the needs for data and the supply of observations. Should reduce costs, improve efficiency and ensure sustainability.

- **Consistent with GEO Data Sharing principles**
- **GFOI Methods and Protocols developed through a formal GEO document process including GEO government endorsement.**
 - A key task will be to interface this GFOI work with the IPCC inventory methods.
- **Extends the science and test-bed efforts within FCT** and will maintain strong links with scientific community



The GFOI Task Force currently includes representatives from:

Australia

Brazil

China

Norway

Tanzania

UK

USA

CEOS

FAO

GTOS/GOFC-GOLD

UNFCCC Secretariat

World Bank

and the **GEO Secretariat**



- GFOI will keep **strong links to the science community**, both within and beyond the GEO FCT.
- FCT should continue **parallel R&D activity in support to the GFOI** to cover:
 - the satellite data observations and ...
 - their use, integration with ground data and carbon modeling.
- FCT will expand its collaboration beyond the present expertise and establish **stronger interfaces with organizations such as FAO, IPCC and leading experts in carbon modeling.**



- **"Key Remote Sensing Science Questions"** as specific R&D topics to the FCT such as:
 - Optimizing forest information extraction from C-band SAR.
 - Clarifying the optimal role for X-band SAR.
 - Multi-sensor interoperability and complementarity.
- **The current 11 NDs would continue to be supported by the FCT PD teams** and serve as test-beds for the approaches and methods developed and described in the Guidance Documents.
- **2 GFOI IP tasks (out of 20) deal with FCT:**
 - ADM.6: GEO Forest Carbon Tracking task transition plan and interface
 - RD.3: FCT technical & scientific studies

Demonstration phase extended until 2012/2013

- Continue to ensure **wall to wall** coverage (ideally semi-annual) of the **11 National Demonstrators**
- Full satellite coverage of the 13 UN-REDD pilot countries and Congo basin countries by end 2012



- Continue optical and SAR data acquisitions at monthly/bi-monthly repetition over the **Validation Sites** for **methodology development** and research on **key FCT science questions**
- Increase cooperation with ND organisations e.g. capacity building
- Work with **Global Forest Observations Initiative (GFOI) Team** to define:
 - o Coordinated GFOI-FCT strategy
 - o GEO FCT R&D activities in support to GFOI

Satellite Data Acquisitions at Risk

- **Short to mid term acquisitions are getting more and more difficult!!!**
- **Long term data continuity is vital !!!**
 - o CBERS-3/4, Landsat LDCM, Sentinel-2, ... (optical)
 - o ALOS-2/3, RCM, Sentinel-1, TerraSAR-2, ... (SAR)
- **Need for a CEOS Strategy in support to both FCT and GFOI**





CEOS Strategy in support to FCT & GFOI: *Objectives* (1/2)



Draft **CEOS Strategy** document:

- Covers both sustained **global observations** in support of GFOI and the technical support activities on going within the FCT
- **Baseline:** coordinated global data acquisition strategy involving a small number of **core data streams** (free of charge) in response to national needs assessments during GFOI implementation



- and **encourages non-core data streams** to contribute to the long-term building of consistent wall-to-wall time series archives on scales from national to global – even if an explicit commitment to free-of-charge data provision cannot be guaranteed
- **Data supply in support of FCT activities:** science studies in support to the GEO-branded methods and protocol documents for GFOI; interoperability studies; and validation activities

Key criteria to be satisfied by **Core Data Streams**:

- **Core data streams must be available on a public good basis**, in support of any country's information requirements;
- **Core data stream systems should have a capacity in coverage, processing and distribution** which is consistent with the large (global) scale data requirements of the GFOI.

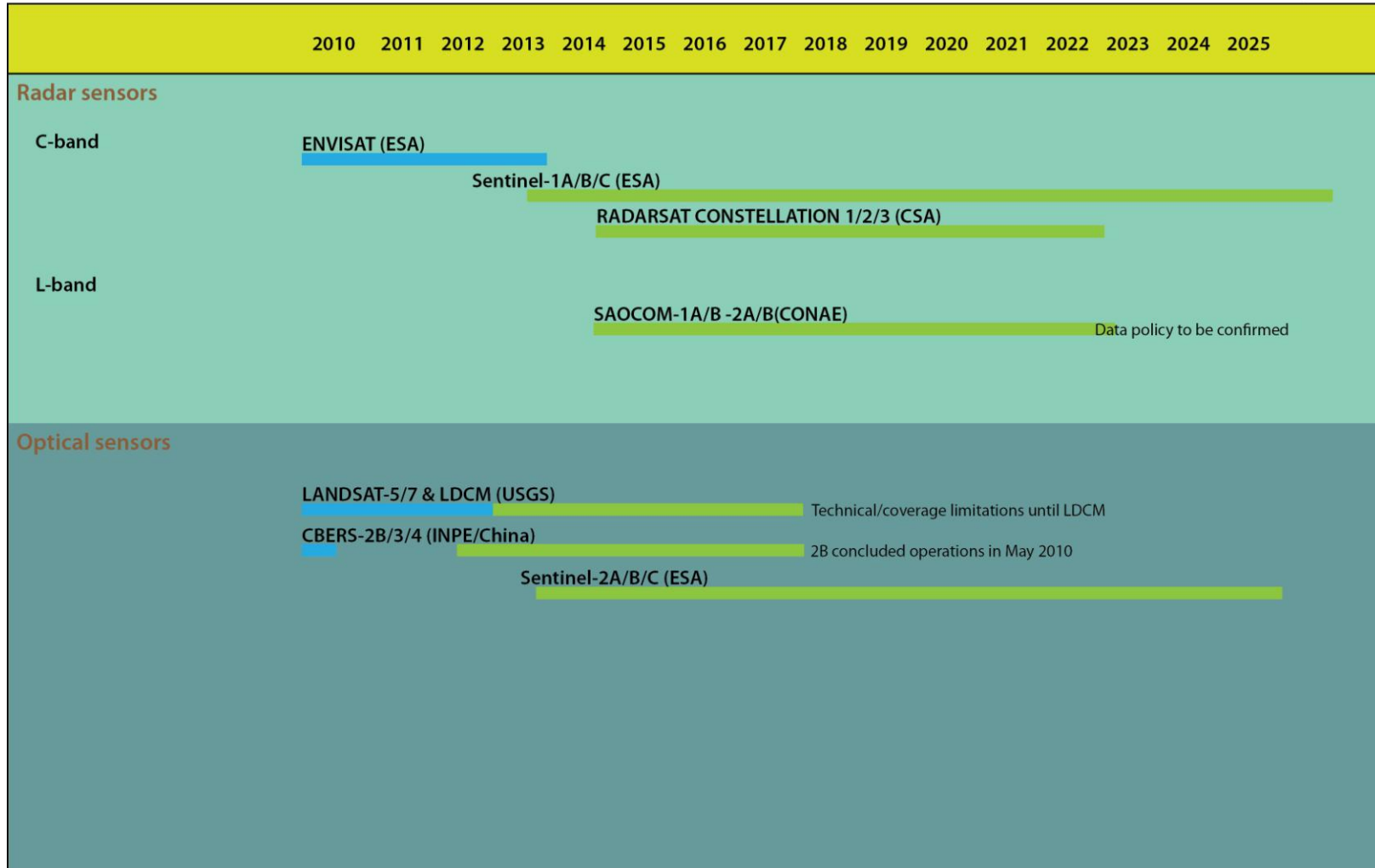


- Currently in the **CEOS strategy document** (v0.6):
 - **Landsat-5/7/8** (optical) – **USGS**;
 - **ENVISAT** (C-band SAR) – **ESA**;
 - **Sentinel-1 series** (C-band SAR) – **ESA**;
 - **Sentinel-2 series** (optical) – **ESA**;
 - **CBERS-3 & -4** (optical) – **INPE/China**;
 - **Radarsat Constellation Mission** (C-band SAR) – **CSA**.
- **SAOCOM series of satellites (CONAE)** are a candidate core data stream, pending confirmation of their satisfying the key criteria.



Sub 30m public good satellite data streams for continuous, annual, global coverage

Sep 2011



2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025

Radar sensors

C-band

RADARSAT 2 (CSA)
Commercial system

L-band

ALOS & ALOS-2 (JAXA)
Data policy to be confirmed

X-band

TERRASAR-X & TANDEM-X & TERRASAR-X-2 (DLR)
Commercial system, German Govt considering bulk purchase

COSMO-SkyMed Constellation & 2nd generation (ASI)
Commercial system

There are also numerous one-off C- and X-band missions in planning by several countries

Optical sensors

SPOT-4/5 (CNES) Commercial system, but Congo Basin coverage offered by French Govt (via AFD) for FCT purposes until 2015.

SPOT-6/7 (SpotImage/Infoterra)

DMC-2 Constellation (UK)
Commercial system

Deimos-1 (Spain) Commercial system
Ingenio (Spain) Data policy to be determined

RapidEye (Germany)
Commercial system

IRS-1c/d & RESOURCESAT series (India)
Commercial system

There are also numerous missions in planning by several countries that may be of value - including many high resolution missions of interest for validation. Few datastreams will have the capacity to provide routine global coverage. But many more will be able to contribute to national and regional coverages.



- **“CEOS Strategy for Space Data Coverage and Continuity in Support of the GFOI and FCT Task”** document (draft, v0.7)
 - will be updated and circulated ahead of CEOS Plenary
 - Seek for CEOS endorsement and support from key data providers
- **Space Data Coordination Group** on the global data acquisition strategy will be formalised after CEOS Plenary
 - will build on existing effort towards Sentinel-1/RadarsatCM and Sentinel-2/Landsat-8 cooperation
- **CEOS support will be sought at GEO plenary,** along with that of FAO and key REDD+ stakeholder countries and donors...



- **CEOS Plenary**, 7-9 Nov, Lucca (Italy)
- **GEO Plenary**, 16-17 Nov, Istanbul, Turkey
- **UNFCCC COP-17**, 28 Nov – 9 Dec, Durban (SA)
- **2nd FCT Science and Data Summit**, Feb 2012
- **Establishment of a GFOI Project Office**, 2012
- **GFOI Linkages Forum**, May 2012
- **Review and assess Nationals' needs**, Jun 2012
 - main potential **GFOI data suppliers** and **CEOS Space Data Coordination Group for GFOI** to be involved



Thank you ...

Questions ??

