Overview of requirements for GEO FCT

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Introduction

GEO FCT has not defined quantitative requirements to meet, for two main reasons:

- UNFCCC negotiations are still on-going on MRV implementation and on “overall performance” for their measurement and monitoring component
- GEO FCT expected results are not of prescriptive nature, but more guidance on implications for different options, characterized by
  - Observations utilized
  - Tools / methodologies from observations to final products
  - Capacity needed and financial resources
  - Accuracy/uncertainty of “final products”

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GEO FCT Objectives

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The need

COP 15 in Copenhagen and COP 16 in Cancun have confirmed that comprehensive, continuous and systematic information on forests is needed to underpin national Measurement, Monitoring, Reporting and Verification (MRV) Systems for REDD+ implementation. The Conference also invited developing countries to move towards implementing these systems, taking into account the need and the opportunity of using all available observations (from satellite Remote Sensing data to ground measurements).

The GEO FCT task has been established in 2008 to address this need and to provide support to Countries in Implementing their national MRV's.

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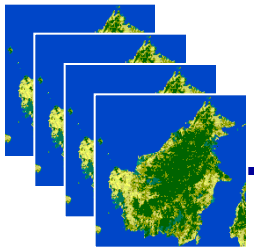
Support to Countries for REDD+ reporting

Support in the construction of consistent time series of observations and of comparable land use/land use conversion products, as well as in improving the determination of emission factors, will enable Countries to build their baselines and to report yearly on land use and carbon stock changes, so to address all REDD+ current objectives.

Reporting on land use changes



Time series

Land Cover / Land Use Changes

Forest Land use changes
Deforestation / Afforestation

Forest remaining forest
Degradation
Conservation
Sustainable management
Enhancement of carbon stocks

Forest Land is the focus of the yearly reporting on land-use conversions.

Reporting on carbon stock changes

Assessment of carbon stock changes is based, according to IPCC guidelines, on land use changes (“activities”) and emission factors.

Emissions estimation / Carbon stock change

=

Activities x *Emission Factor*

Area change

Carbon content

Forest Carbon Tracking

GEO FCT Objective

Demonstrate that coordinated Earth Observations, validated by in situ measurements and properly linked to modeling can provide reliable, accurate, consistent and continuous information, constituting the basis for national systems.

More specifically the overall goal for FCT is to test and compare the use of different observations, models, tools and methodologies in order to provide advice and guidelines to Countries willing to implement national systems.

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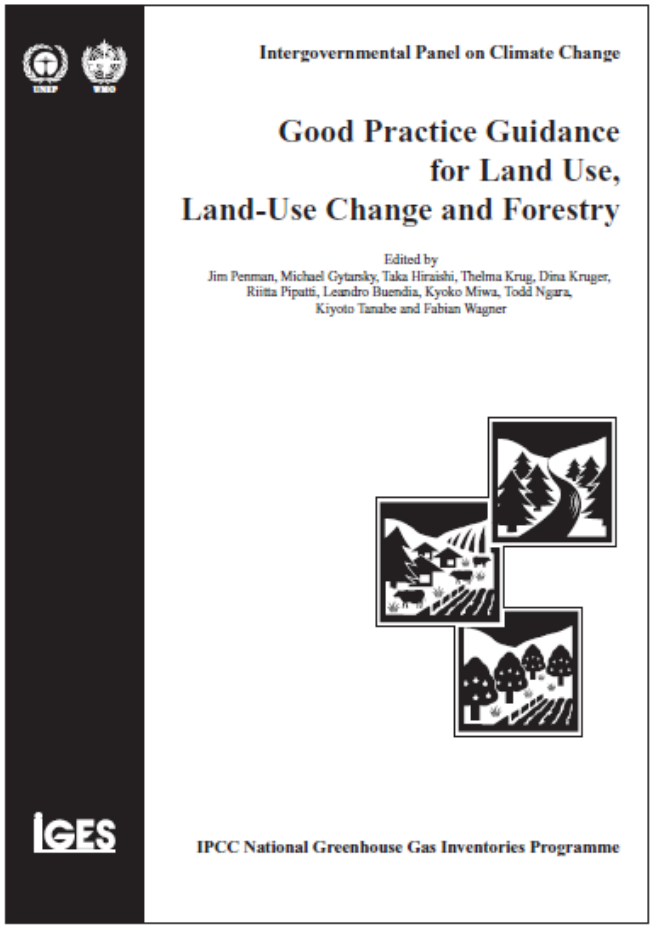
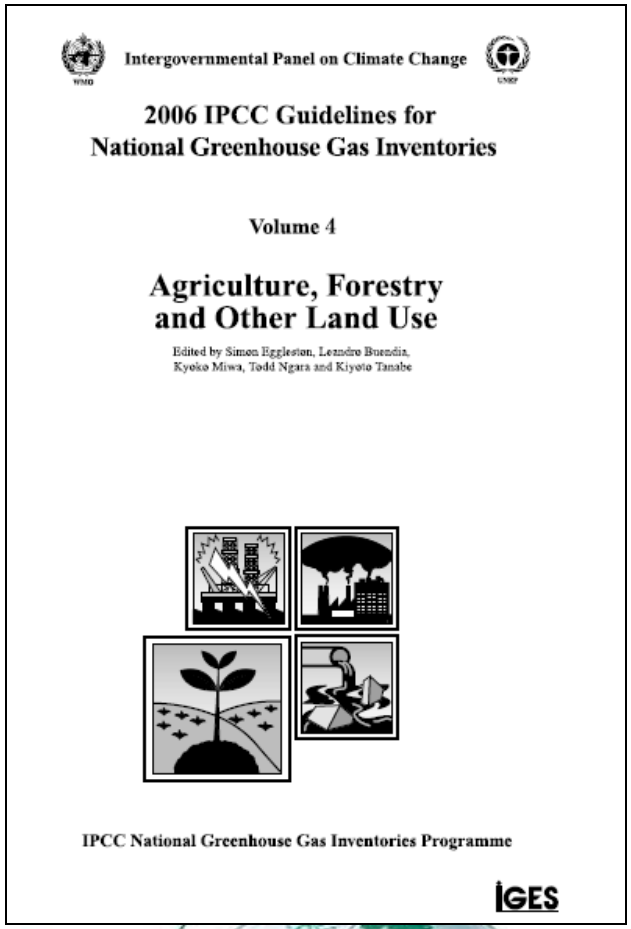
IPCC guidelines for forest representation and carbon accounting

Forest Carbon Tracking

IPCC Reporting Guidance

- 2003 IPCC Good Practice Guidance (LULUCF)
- 2006 Reporting Guidelines (AFOLU)





IPCC Reporting Guidance

- Three reporting tiers – intended to be increasingly accurate, but need for increasingly sophisticated data and analysis tools.
- **Tier 1**: Simplest approach, relies on equations and default parameters from IPCC 2006 GL, requires country-specific activity data but accepts coarse global data products.
- **Tier 2:** Can use same methodological approach as T1, but uses country-specific data. Higher temporal and spatial resolution and more disaggregated activity data.
- **Tier 3:** Uses more sophisticated methods including models and inventories specific to national circumstances, driven by high-resolution activity data, can provide source estimates with interannual variability.

IPCC Reporting Guidance

- Reporting for six land use categories, and associated transition categories
  - Forest, Cropland, Grassland, Wetland, Settlements & Other
  - Land converted from one of these to another
- Describes 3 approaches to identifying land areas:
  - Use of basic (and usually existing) land-use data
  - Survey of land use and land-use change
  - Geographically explicit land-use and LUC mapping
- Assure consistent and complete accounting of all land areas
- Emissions and removals are always reported in the new land-use category – e.g. deforestation to cropland reports emissions in cropland category.

Land-use Change Matrix

- LUC Matrix can be used to summarise land category transitions over specified time period (Source IPCC GPG).

Initial / Final	Forest land (Unmanaged)	Forest land (Managed)	Grassland (Rough grazing)	Grassland (Improved)	Cropland	Wetlands	Settlements	Other land	Final area
Forest land (Unmanaged)	5								**5**
Forest land (Managed)		10	1	2	1				**14**
Grassland (Rough grazing)		2	56						**58**
Grassland (Improved)			2	22					**24**
Cropland					29				**29**
Wetlands						0			**0**
Settlements		1	1		1		5		**8**
Other land								2	**2**
Initial area	**5**	**13**	**60**	**24**	**31**	**0**	**5**	**2**	**140**
NET change	0	+1	-2	0	-2	0	+3	0	**0**

Reporting Requirements

- Annual estimates from 1990 onwards of GHG balance
- Stock changes, emissions & removals for 5 C pools:
  - aboveground biomass
  - belowground biomass
  - dead wood,
  - litter
  - soil carbon
- Non-CO_2 GHG emissions CH_4 and N_2O (e.g. forest fires).

Other Requirements

- Estimates of uncertainty must be reported
  - Identify main sources of uncertainty (key category analysis, sensitivity analysis, etc.)
  - Quantify uncertainties
  - Reduce uncertainties "... as far as is practicable"
- Quality Assurance and Quality Control systems
- Documentation and archiving of information required
- Additional requirements as outlined in Chapter 5 of GPG, e.g. time series consistency, etc.

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Monitoring approach, activities and future plans

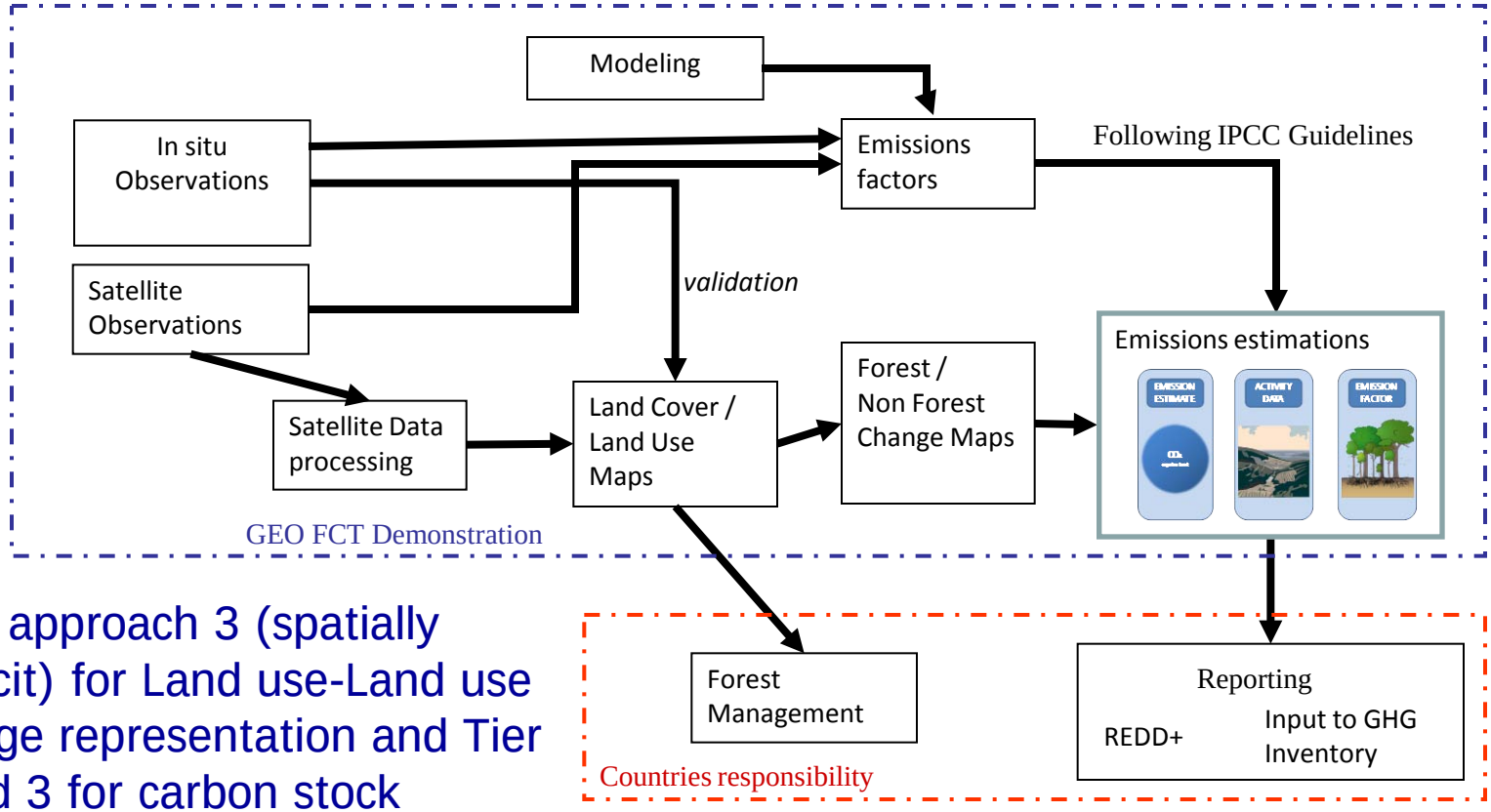
GEO FCT
Monitoring approach

The reference for the definition of the monitoring approach to be substantiated and demonstrated is constituted by the decisions taken within the United Nations Framework Convention on Climate Change (UNFCCC), as consolidated in the IPCC guidelines.

A yearly, wall-to-wall, medium-resolution (25-30 m) monitoring approach has been identified as the best suited to cover a wide range of potential outcomes of the policy-framework negotiations.

Monitoring approach and Information Generation Flow

The information generation flow covers the full process from observations to carbon emissions assessment



IPCC approach 3 (spatially explicit) for Land use-Land use change representation and Tier 2 and 3 for carbon stock changes are addressed.

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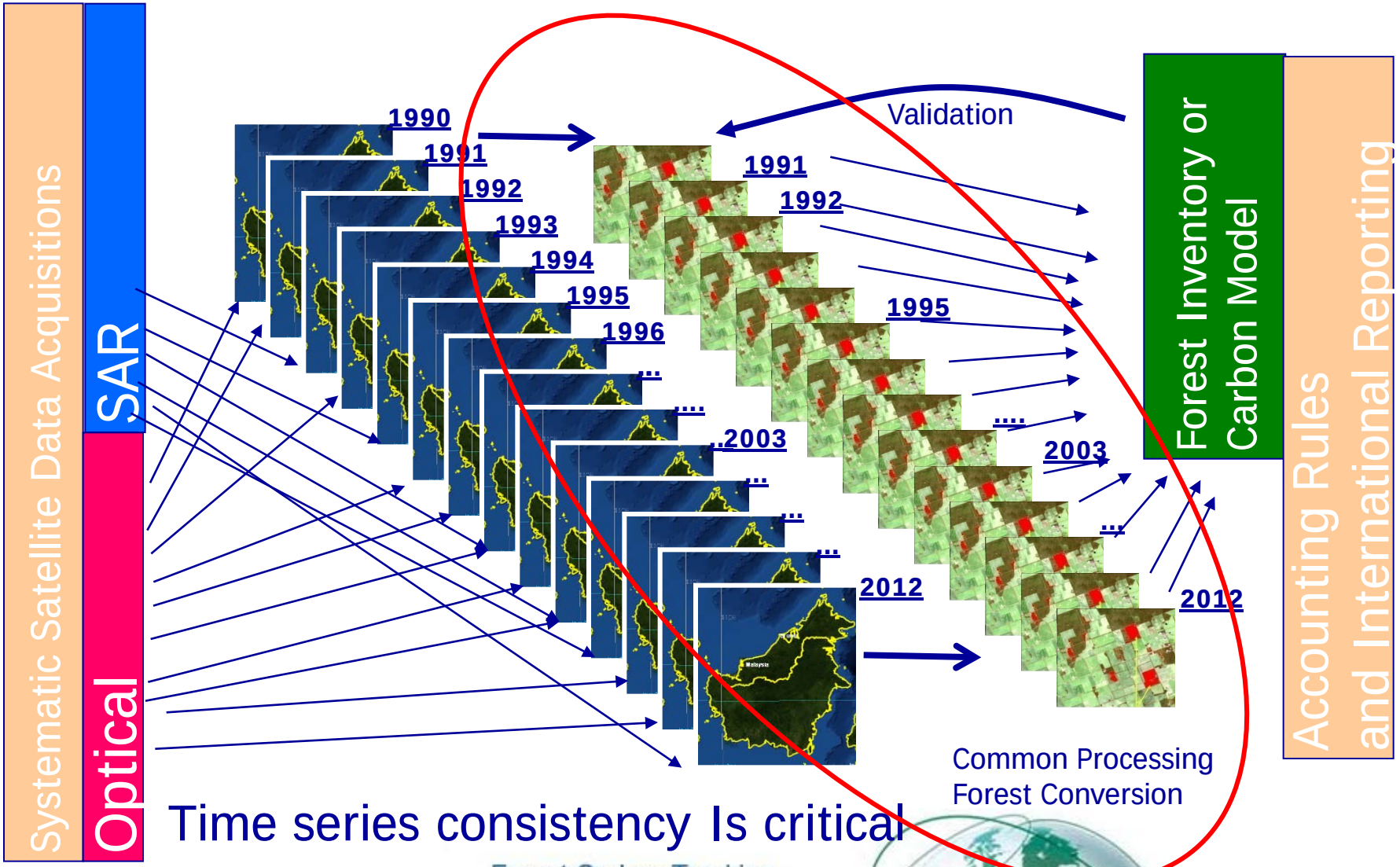
Interoperability and complementarity in RS Data Sources



Forest Carbon Tracking

GEO FCT
"Activities products"

Two sets of information products were identified to address the "activities*, as defined by the IPCC guidelines

- "Horizon-1" products, which have reached a level of processing 'maturity'; they have the highest-priority during demonstration,

- "Horizon-2" products that constitute a range of more specific demonstration products and will gradually complement Horizon-1, addressing type of forest, sparse woody areas, forest degradation, ...

FCT approach
key scientific and technical issues

- Consolidation of widely agreed information products
- Identification and testing of new products addressing the full range of REDD+ objectives
- Interoperability and complementarity of observations, inclusion of new remote sensing sensors
- Buildup of consistent time series
- Comparable processing to land cover/land use and forest mapping and carbon assessment methodologies
- Products validation /uncertainty assessment

FCT approach
Building a cooperation framework

To meet the objectives and ensure suitable end-to-end demonstration GEO FCT has built a cooperating framework, which is progressively involving and coordinating the three essential components for the success of the initiative:

1. A scientific component, several groups are currently involved
2. A “pre-operational” component, ensured today by CEOS on behalf of its member space agencies
3. A national component, ensuring governments commitment to the activities and involvement of the national technical Institutions in charge.

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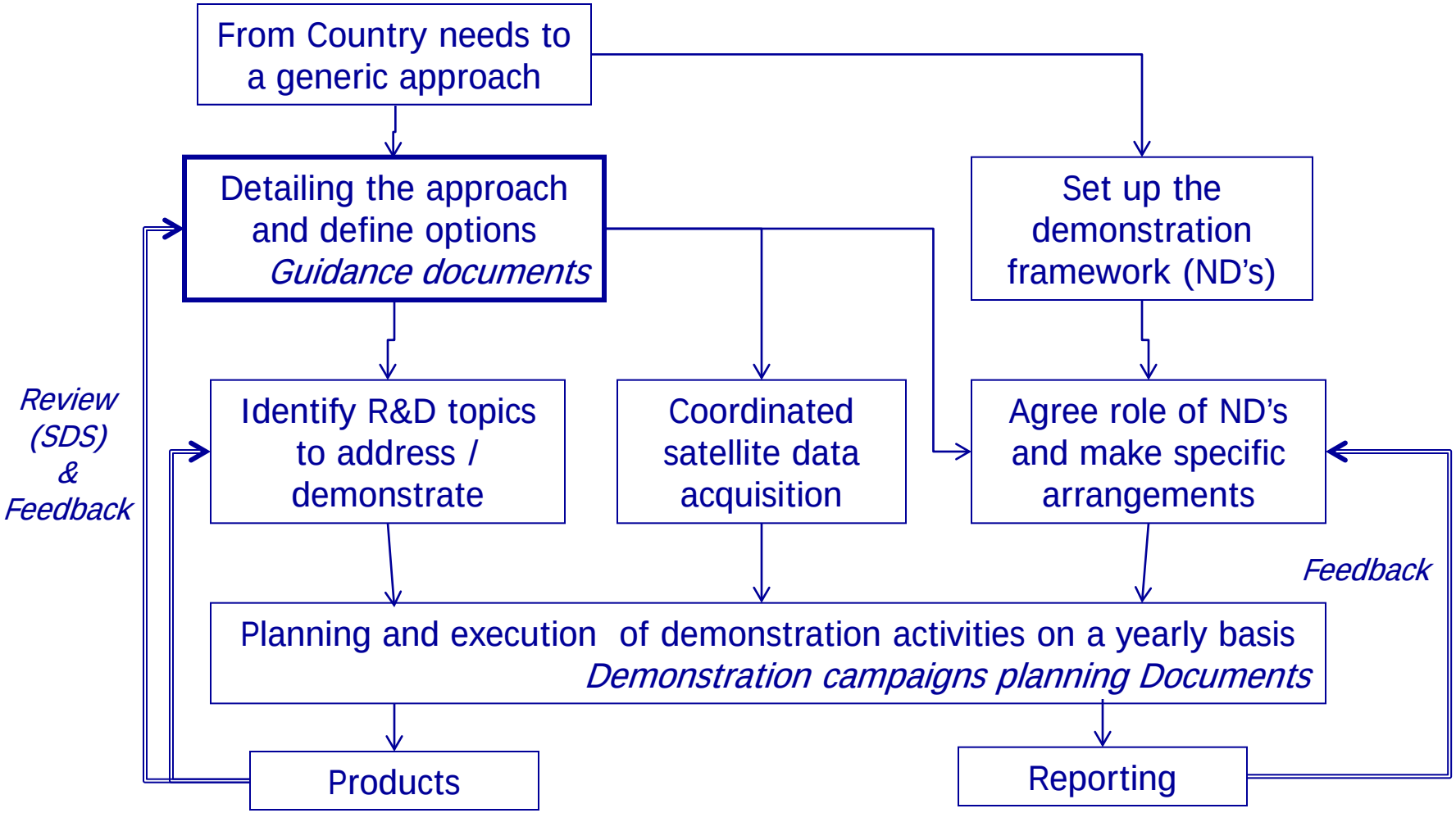
FCT approach – overall planning logic



FCT approach – Guidance Documents

- Guidance documents identify options and implications on how to deal with the key scientific and technical issues; they constitute the drivers for the test and demonstration activities, which, in turn, provide feedback for the refinement and improvement of the documents them self.
- The ultimate objective of these documents, once backed by the evidence coming from the demonstrations, is to provide support and advice to countries willing to implement national systems

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FCT Guidance Documents

- Satellite Forest Information Product Specification
- Satellite Interoperability & Processing Methods
- *In Situ* Forest Measurements Standards and Protocol
- Methods on Validation of Remote Sensing Data Products and Accuracy Metrics
- Linking of In Situ Forest Measurements, Remote Sensing and Carbon Models

FCT approach – Demonstration activities

Demonstration activities should ensure suitable coverage of different type of forest and be fairly representative of how a national system may work, here included the consideration of different national circumstances.

This is why the support of governments is crucial for the success of the GEO FCT activities and this is why the GEO FCT has fostered the involvement of countries since the beginning, through the concept of National Demonstrators.

FCT-Progress to date (1)

Since 2008 significant progress has been achieved, even if some additional effort are needed in the following areas:

Guidance documents definition,

Work on models and methodologies for carbon change assessment

Improve coordination with other global initiative (such as UN-REDD and World Bank FCPF)

Consolidate activities planning in each ND, and work to bring to a comparable level the activities in each ND.

FCT-Progress to date (2)

- FCT Guidance documents identified and being produced
- Work on methods and protocols on going
- GEO FCT data portal online www.geo-fct.org
- 2009-2010-2011 satellite data acquisition performed and data being made available to Countries and Processing Teams (about 64000 scenes acquired in 2010 only)
- In situ measurements at the VS on-going
- Product Development Teams to support National Demonstrators Countries data processing established and working

FCT-Progress to date (3)

- Data processing over ND's started. Initial products available.
- An important review was performed on 8-10 February 2010, where progress in each ND was presented, guidance documents content discussed and key science questions clearly formulated. Presentations are available at http://www.fao.org/forestry/fra/68164/en/ .
- Next review is planned for the 2nd week of February 2012.

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Towards sustained capabilities

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

One additional important step was taken in Beijing in November 2010 GEO VII Plenary approved the planning of the Global Forest Observations Initiative (GFOI) and asked for an implementation plan to be submitted tp GEO VIII.

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GEO FCT and GFOI

- The Global Forest Observation Initiative (GFOI) extends the current GEO Forest Carbon Tracking (FCT) task.
- The FCT focuses on national demonstrators and on developing and testing methods and protocols
- The operationally-focused GFOI will build on the FCT science and demonstration activities and aims at enabling and supporting the worldwide development of national forest information systems.

GFOI objectives

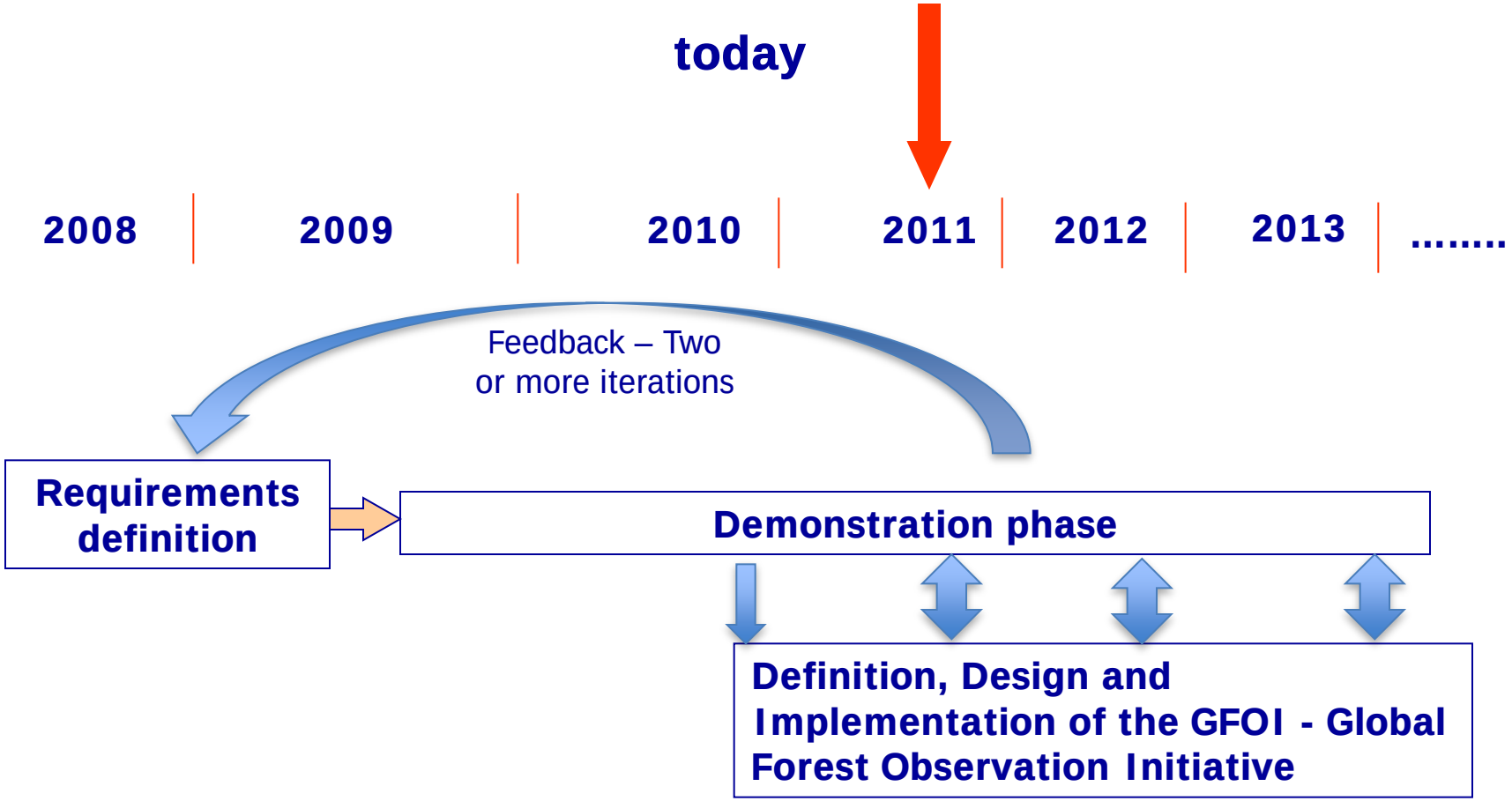
- foster the sustained availability of observations for national forest monitoring systems and assist countries to make the best use these observations;
- support governments that are establishing national systems by providing a platform for coordinating observations, providing assistance and guidance on utilizing observations, developing methods and protocols, and
- promoting ongoing research and development: the GFOI will seek continuous improvements in the use of observations and the uptake of current forest carbon science

What GEO VIII Plenary is expected to do

the forthcoming GEO Plenary, to take place in Istanbul on 16-17 November, is expected to:

- Endorse the *GFOI Implementation Plan*;
- Agree to perform a GFOI Start-up Phase, in 2012 and to accept contributions from Members and Participating Organizations;
- Request to develop proposals for long term GFOI hosting, governance and future budgets for the GEO-IX Plenary, and to facilitate the preparation of an applications development plan and an observations acquisition strategy.

Task Implementation Phases



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Working with the Countries

National Demonstrators

Product Development Teams

Validation Sites

Forest Carbon Tracking

The National Demonstrators

The Task has established a number of reference demonstration areas – “National Demonstrators” for developing and testing approaches and methodologies.

They may cover the whole country or areas within the country that are large enough to demonstrate the wall-to-wall capability; they include several test/validation sites, where the in situ/aerial measurement will take place and higher resolution/higher temporal frequency satellite data will be acquired.

A “Product Development Team” supports each Country in product generation and validation and capacity building activities form an integral part of FCT plans in each ND.

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Guidelines for ND establishment

The key criteria considered to identify countries acting as ND's can be summarized as follows:

- The choice of NDs is based on central governments firm plans to implement national forest carbon monitoring, verification and reporting.
- External donor countries and/or donor organisations have been identified for long-term involvement and support of capacity building, field measurement and satellite/airborne data acquisition and analysis, and monitoring system implementation.
- National government ensure commitment of government institutions in charge and local expert capabilities and assist in providing access to field data

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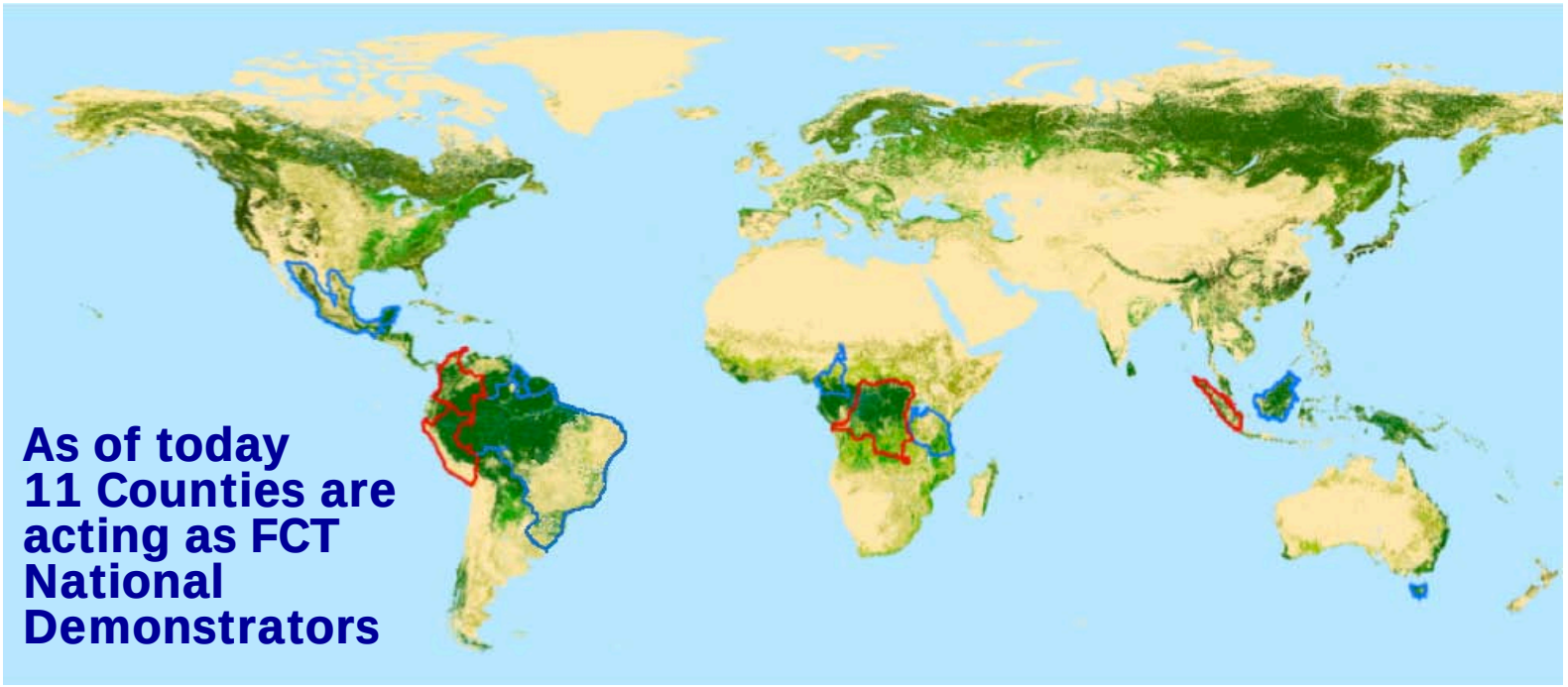
FCT Network of "National Demonstrators"



From 2009
- Brazil
- Guyana
- Mexico
- Indonesia (Borneo)
- Australia (Tasmania)
- Cameroon
- Tanzania

From June 2010
- Colombia
- DR Congo
- Peru, and
- adding Sumatra to Indonesia

From June 2011
- Nepal

From 2012 onwards Progressive inclusion of countries from UN-REDD & World Bank FCPF is being planned.

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Product Development Team organisation

Product Development (PD) Teams have been established – as in interim solution while building in-country capacity - to support ND authorities with the technical/scientific development of the forest information products that subsequently are to serve as information layers to the MRV.

Note: Responsibility for the release of forest- and carbon products lies with the national authorities of each of the National Demonstrator (ND) countries.

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GEO-FCT Product Development Teams Contributing organisations

ND	ND authority	PD team contributing organisations
Brazil	INPE	INPE
Guyana	GFC	WU, CI, NSC
Mexico	SEMARNAT	CONAFOR, CONABIO, INEGI, SAGARPA, CONANP, PMC, WHRC, USGS, CSA, FSU-Jena, DLR-DFD Germany, NRCan
Colombia	Ministerio del Medio Ambiente	IDEAM, WHRC
Peru	Ministerio de Ambiente	SIGMINAM, WHRC
D.R. Congo	Ministry of Environment, Nat. Conserv. and Tourism	TBC
Cameroon	MINEF	ESA, GAF with GSE Forest Monitoring consortium
Tanzania	MNRT	NSC, KSAT
Indonesia	LAPAN	LAPAN, WU, CSIRO, CRC-SI, JAXA/NIES
Tasmania	DCC	CSIRO, CRC-SI

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GEO-FCT Product Development Teams
PD team leaders (technical)

ND	ND Product Development team lead	Organisation
Brazil	Julio Dalge	INPE
Guyana	Dirk Hoekman	Wageningen Univ.
Mexico	Michael Schmidt / Sergio Ojeda / Fernando Paz	CONABIO / INEGI / COLPOS
Colombia	Josef Kellndorfer	WHRC
Peru	Josef Kellndorfer	WHRC
D.R. Congo	TBC	TBC
Cameroon	Thomas Häusler	GAF
Tanzania	Jan Petter Pedersen	KSAT
Indonesia (BOR/SUM)	Dirk Hoekman	Wageningen Univ.
Tasmania	Anthony Milne	UNSW/CRC-SI
Xingu - FCT method site	Josef Kellndorfer	WHRC

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GEO-FCT Product Development Teams
Terms of reference (key points)

- Actively seek contact and collaborate with the ND autority and organisations listed as PD team participating organisations in Table 1, to assure the necessary in-country involvement and authorisation;
- Place satellite data processing orders at desired processing levels, and subsequently, download the data from the data providers;
- Share the satellite data with the ND autority and organisations listed as PD team participating organisations in Table 1, when required;
- Undertake/oversee data post-processing, sensor synthesis and prototype (Horizon-1) product generation;
- Undertake/oversee product validation (by in situ, hi-res RS etc.)
- Undertake scientific analysis of the satellite data with respect to a number of pre-defined topics that are to be investigated by all FCT PD teams;

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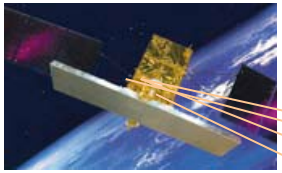
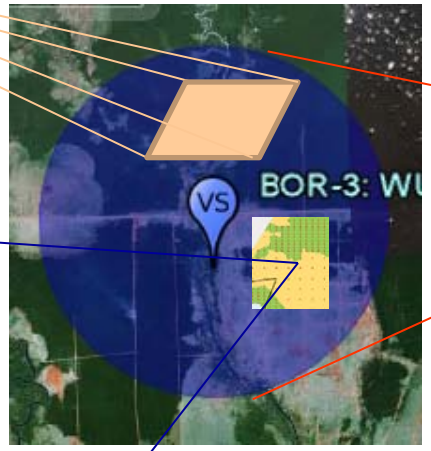
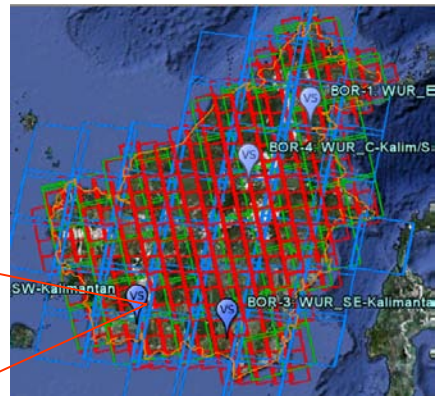
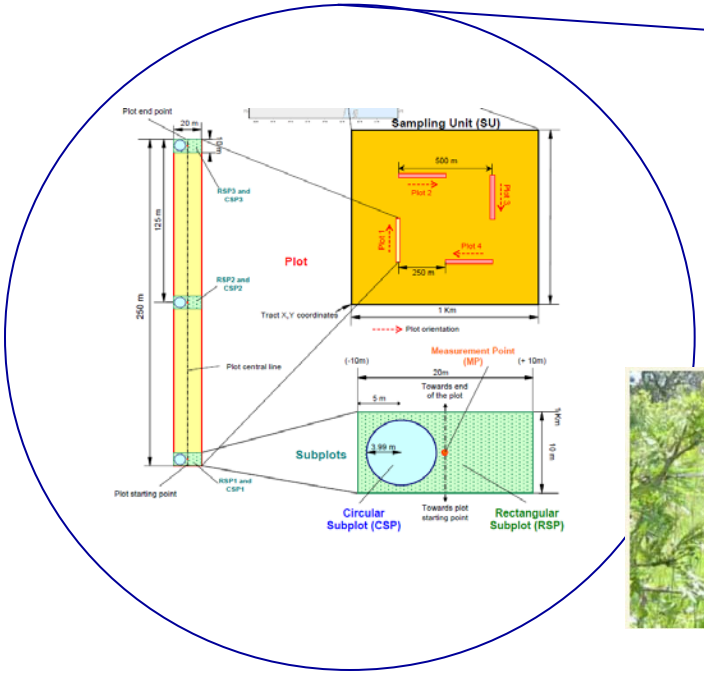
Validation Sites



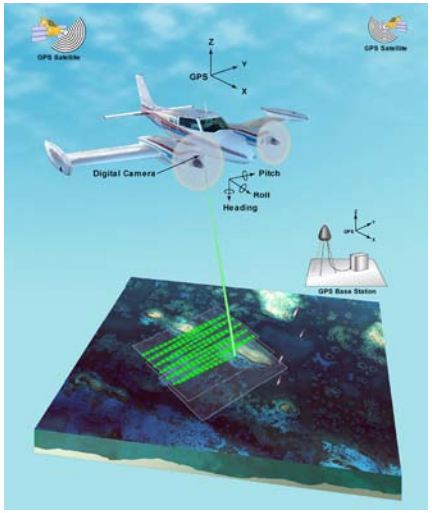
Very High resolution satellite imagery







In situ measurements



Aerial campaigns

Forest Carbon Tracking

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Validation Sites (1)

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
	MEX-4	Oaxaca	N17.58	W96.46	2
	MEX-5	Hidalgo	N20.62	W98.62	1
	MEX-6	Nuevo León	N25.43	W98.52	2
	MEX-7	Michoacán	N19.57	W101.18	2
Colombia	COL-1	Andes-Huila	N1.74	W76.18	1
	COL-2	Choco-Cajambre	N3.40	W77.18	1
	COL-3	Pacifico-Bajo_Mira	N1.65	W78.76	2
	COL-4	Amazonia-Tinigua	N2.17	W74.15	1
	COL-5	Andes-Antioquia	N7.83	W76.45	2
Peru	PER-1	Bosques de Pomac	S6.48	W79.77	1
	PER-2	Alpahuayo Mishana	S3.93	W73.54	1
	PER-3	Manglares de Tumbes	S3.55	W80.32	2
	PER-4	San Matias San Carlos	S10.77	W74.93	2
	PER-5	Cordillera Azul	S6.97	W76.11	2
	PER-6	Cuenca baja del VRAE	S11.68	W73.84	2
	PER-7	Ambito de Barranquita	S6.12	W76.17	2
Brazil*	BRAX-1	Xingu-1	S11.91	W52.58	1
	BRAX-2	Xingu-2	S13.06	W52.38	1
Guyana	GUY-1	GFC-1	N6.00	W60.00	1
	GUY-2	GFC-2	N7.00	W59.00	1
	GUY-3	GFC-3	N3.00	W59.00	2
	GUY-4	Fairview	N4.65	W58.69	2
	GUY-5	Crashwater-N. Rupununi	N3.86	W59.05	2
	GUY-6	Apoteri	N4.04	W58.59	2

*** Xingu in Brazil is a methodology development site**

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Validation Sites (2)

ND	VS	Name	lat	long	Priority
Cameroon	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
	CAM-4	Pallisco Concession Area	N3.21	E13.74	1
	CAM-5	Direct Biomass Assessment 2	TBD in July 2011		2
	CAM-6	Direct Biomass Assessment 3	TBD in July 2011		2
D.R. Congo	DRC-1	Luki Reserve	S5.67	E13.17	2
	DRC-2	Bikoro	S0.25	E18.67	2
	DRC-3	Lisala Bumba	N2.83	E21.83	1
	DRC-4	Kisangani Sud	N0.17	E25.83	2
	DRC-5	Basankusu	N0.83	E20.17	2
	DRC-6	Mambasa Sud	N1.17	E29.67	1
	DRC-7	Oshwe	S4.17	E20.33	2
	DRC-8	Lubumbashi	S11.0	E27.33	2
Tanzania	TNZ-1	FAO_FRA-1	S4.00	E32.00	2
	TNZ-2	FAO_FRA-2	S10.00	E36.00	2
	TNZ-3	FAO_FRA-3	S10.00	E38.00	2
	TNZ-4	Nilo Forest Reserve	S4.92	E38.66	2
	TNZ-5	Amani	S5.13	E38.63	1
	TNZ-6	Liwale	S9.30	E38.00	1

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Validation Sites (3)

ND	VS	Name	lat	long	Priority
Indonesia (Borneo)	BOR-1	E-Kalimantan/Sbh	N4.33	E117.01	2
	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
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
Tasmania	AU-1	Mathinna	S41.37	E147.76	1
	AU-2	Takone	S41.19	E145.60	2
	AU-3	Warra	S43.11	E146.90	2
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

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Satellite data acquisition strategy

Satellite data acquisition coordination

- The Committee on Earth Observation Satellites (CEOS) has committed in 2009 to ensure coordination of data acquisition from satellites operated by its member agencies and access to the Product Development Teams supporting each ND.
- The FCT task Team has also involved commercial satellite data providers for limited data availability over the validation sites.

EO Data Coordination

GEO-FCT – EO Data Coordination

CEOS

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)

Commercial

(V)HR

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

Current FCT Data Strategy

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

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FCT Acquisition Summary

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	241	6	49	**539**
Landsat 5 & 7	7288	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!!!

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Requirements for optical Satellites

- 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

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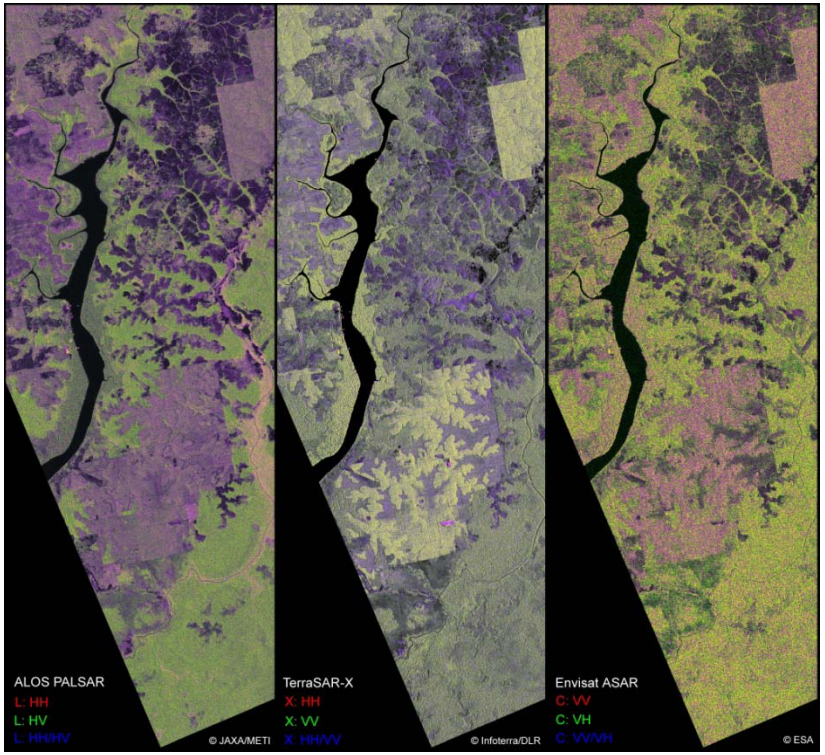
Dry Seasons

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)

Requirements for SAR Satellites

- 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

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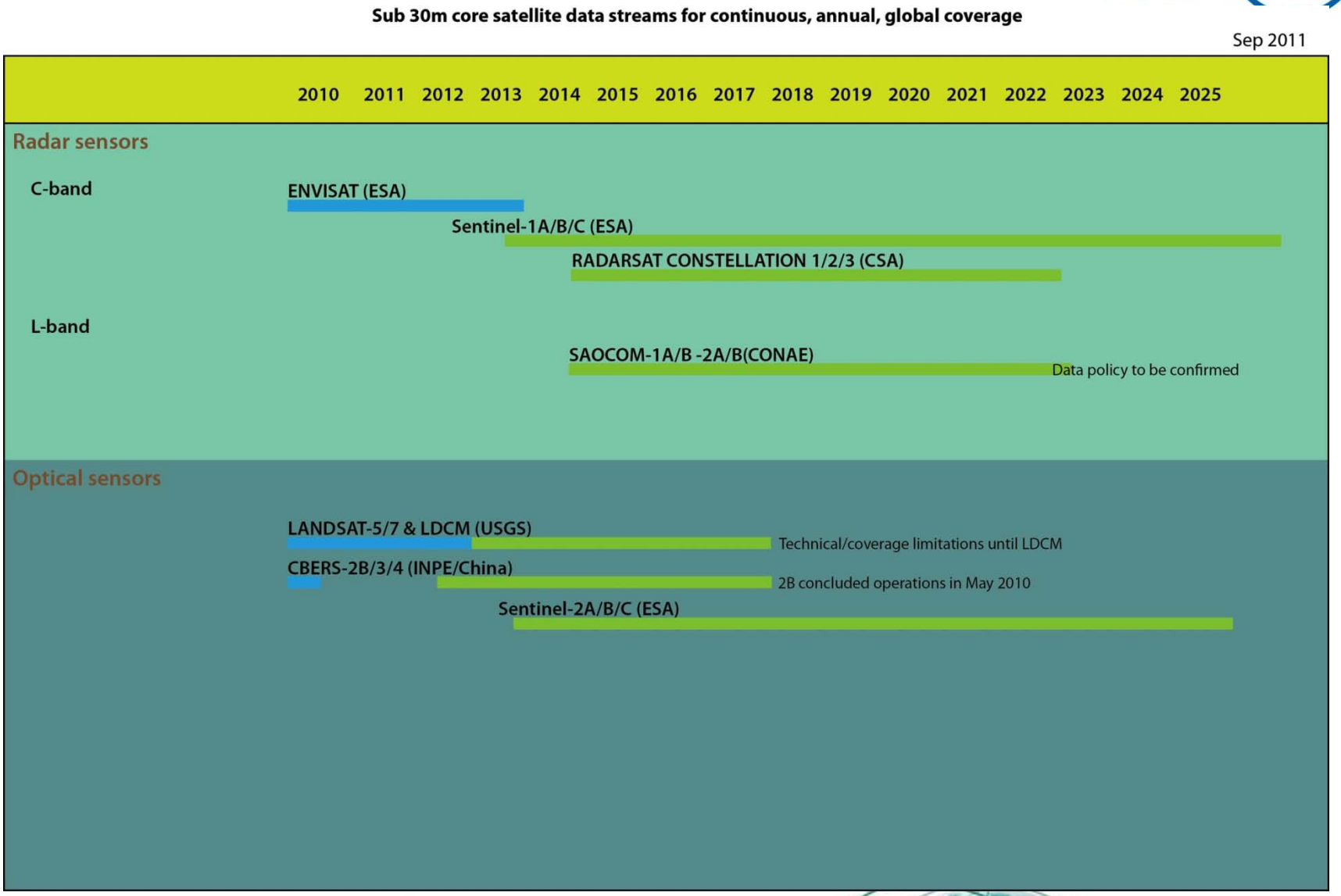
Future GFOI-FCT Strategy

Covers both sustained global observations in support of GFOI and the technical support activities on-going within the FCT, including the NDs and science questions

1. A baseline, coordinated global data acquisition strategy involving a number of ‘core data streams’ that can be used free-of-charge for GFOI-FCT puroposes.
2. A coordinated national data acquisition strategy in response to national needs assessments undertaken in the course of GFOI implementation
3. Data supply in support of FCT activities, including the science and interoperability studies and validation activities.

Core Data Stream Candidates



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Data integration and carbon models

Approaches to Developing Forest Carbon Budgets

- Choice of methods depends on national circumstances and intended use of the system
  - Difference between two inventories (e.g. USA)
  - One inventory plus change information (e.g. Canada)
  - No Inventory – process modeling (e.g. Australia)
  - Simple implementation of IPCC guidelines
  - Mixed approaches (?)
- Convergence and comparison of methods can be expected

Methods / Approaches

- Calculate the stock differences between two forest inventories
  - Likely most accurate method for total change
  - Integrates all factors (disturbances, management, LUC, climate)
  - Must cover start and end year of reporting period (or extrapolate)
  - More difficult to implement if inventory is based on annual measurements of a subset of plots
  - No estimates of interannual variation within observation period
  - Additional data required to estimate non-CO_2 emissions
  - Additional data (LUC) required to report LUC impacts
  - Not suitable for future projections

Methods / Approaches

- One inventory plus change information
  - Requires at least one inventory and models to integrate data on change, disturbances, and LUC
  - Requires activity data (LUC, FM, disturbances) for reporting period
  - Inventory need not be at start of observation period, but change data must cover entire period.
  - Potential to combine with two inventory approach for accuracy and uncertainty assessment.
  - Future projection possible if model is supplied with scenarios of activity data.

Methods / Approaches

- No inventory - process modelling
  - Requires remote sensing information on land cover, soil and climate attributes
  - Requires activity data (LUC, FM, disturbances) for reporting period
  - Careful calibration of process models needed
  - Limited experience; successfully implemented in Australia

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Science issues and preliminary results

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GEO-FCT Forest Information Products

Horizon 1a: Forest/Non-Forest
Horizon 1b: Forest Cover Change
Horizon 1c: Land Cover/Land Use
Horizon 1d: LULC Change

Horizon 2 (experimental & TBD):

- Forest type; Degradation products; Sparse woody perennial cover; Forest cover density trends; Rapid deforestation products; etc.

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Key RS Science Questions for SDS#2

1. Sensor Interoperability

"Obtaining the same thematic results from different sensors"

(Full / partial interoperability)

2. Sensor Complementarity

"Obtaining additional thematic information through the (synergetic) use of two or more different sensors"

3. Optimising information extraction from C-band SAR

4. Applications and optimal use of X-band SAR

Forest Carbon Tracking

Sensor Interoperability

”Obtaining the same thematic results from different sensors”

To which extent can one sensor can be used in place of one an other? – e.g. to increase data acquisition opportunities, replacement in case of data contingency.

Optical/optical

Landsat / CBERS / DMC / IRS-LISS

Optical/SAR

Optical / ALOS PALSAR (L-band) / ASAR/R-2 (C-band)

SAR/SAR

ENVISAT ASAR / RADARSAT-2 (C-band / C-band)

Sensor Complementarity

”Obtaining additional thematic information through the (synergetic) use of two or more different sensors”

*Obtain **quantitative figures** on the performance of the different sensors, their **relative importance** to the product generation, and the effect on the classification results in case one or more data sources become unavailable.*

Optimising information extraction from C-band SAR

For various reasons, C-band SAR has not been used to larger extents for forestry applications in the past. However, (present plans for) near-future public open data streams include optical (Landsat, CBERS) and C-band SAR (Sentinels, RCM)

What can be done to enhance information extraction from C-band data (e.g can information contents be enhanced by using more dense time-series?)

Initial outcomes of the Science Question

• Key question to be answered: are all the satellite sensor data presently being aquired with FCT useful? Results indicate that it is the case:

- Optical data most commonly used and with most rich infomramtion content. weak points in cloudy areas and capacity to obtain targeted w2w acquisitions within short time windows.

- L-band most commonly used SAR sensor due to wavelength and global systematic acquisition strategy already implemented

- C-band has been demonstrated to provide useful additional information – in some cases even better differentiation between certain forest types (low biomass vegetation) than L-band.

-- Initial X-band SAR results indicate potential, especially for identification of degradation and selective logging,

-- VHR little used so far, but highly desired, e.g. for product validation

Initial outcomes of the Science Question

. Utility of time-series of data emphasised – for all sensor types - both for change monitoring, as well as to improve classification accuracy (the longer time series - the better accuracy, corrections for regional/seasonal biases)

• Utllisation of time-series of C-band SAR an important way to improve the utility of the data. Great hope was laced on the near-future operational C-band SAR systems.

• 2011 research task for the PD teams – analysis of simulated ”Sentinel/RCM” time seris data sets over some of the ND Verification Sites (dense time series of ASAR and R-2)

Initial outcomes of the Science Question

Recommendations to space agencies/CEOS for mid-2011 GEO-FCT acquisition campaign

- Continue with annual, dual-eason w2w coverages over the NDs with optical, L-band and C-band
- VHR (optical and X-band) data highly desired
- Dense ASAR/R-2 time series over certain VS to simulate new-generation C-band satellite datasets

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Conclusions

Issues requiring QA4EO involvement (1)

- Implementation of QA/QC provisions into FCT "processing flow"
- Accuracy/uncertainty assessment of "activities" products (maps and change matrices), including sensitivity analysis as a function of type and availability of observations
- Sensors interoperability and complementarity
  - Multiband SAR
  - Optical/SAR
  - Buildup of "mixed" time series"

Issues requiring QA4EO involvement (2)

- Type and frequency of observations at VS (for QA/QC purposes)
- Suitable data acquisition windows for different world regions
- Use of VHR satellite data for thematic products validation (partial replacement of ground measurements)
- Integration of Remote Sensing Fire products into LULUC products
- Development of FCT “interoperability standards” ?

Practical actions - QA4EO involvement

- appointment of a focal point for FCT-related issues
- contribution to Guidance documents writing and periodic review
- contribution to demonstration campaigns requirements and planning
- participation in FCT products development and/or their assessment
- participation to FCT reviews

Thank you

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www.geo-fct.org

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BACK-UP SLIDES

FCT Task Team

Co-leads

- Norway (NSC)
- Japan (JAXA)
- Australia (Department of Climate Change & CSIRO)
- Canada (CFS-CSA)
- USA (USGS)
- FAO
- CEOS (ESA)

Additional partners contributing space and forest research data and expertise are Brazil, France, the Netherlands, United Kingdom, European Commission and GOFC-GOLD.
The GEO Secretariat supports activities coordination and facilitate their execution.

Including the 11 National Demonstrators, Organizations from more than 30 Countries are contributing to the GEO task.

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REDD+ at COP-16

- *Encourages developing country Parties to contribute to mitigation actions in the forest sector by undertaking the following activities…*
  - (a) Reducing emissions from deforestation;
  - (b) Reducing emissions from forest degradation;
  - (c) Conservation of forest carbon stocks;
  - (d) Sustainable management of forest;
  - (e) Enhancement of forest carbon stocks.

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REDD+ at COP-16

- *Requests* developing country Parties aiming to undertake activities *...* to develop the following elements:
  - (a) A national strategy or action plan;
  - (b) A national forest reference emission level and/or forest reference level
  - (c) A robust and transparent national forest monitoring system for the monitoring and reporting of the REDD+
  - (d) A system for providing information on how the safeguards are being addressed and respected

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Optical Satellites

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

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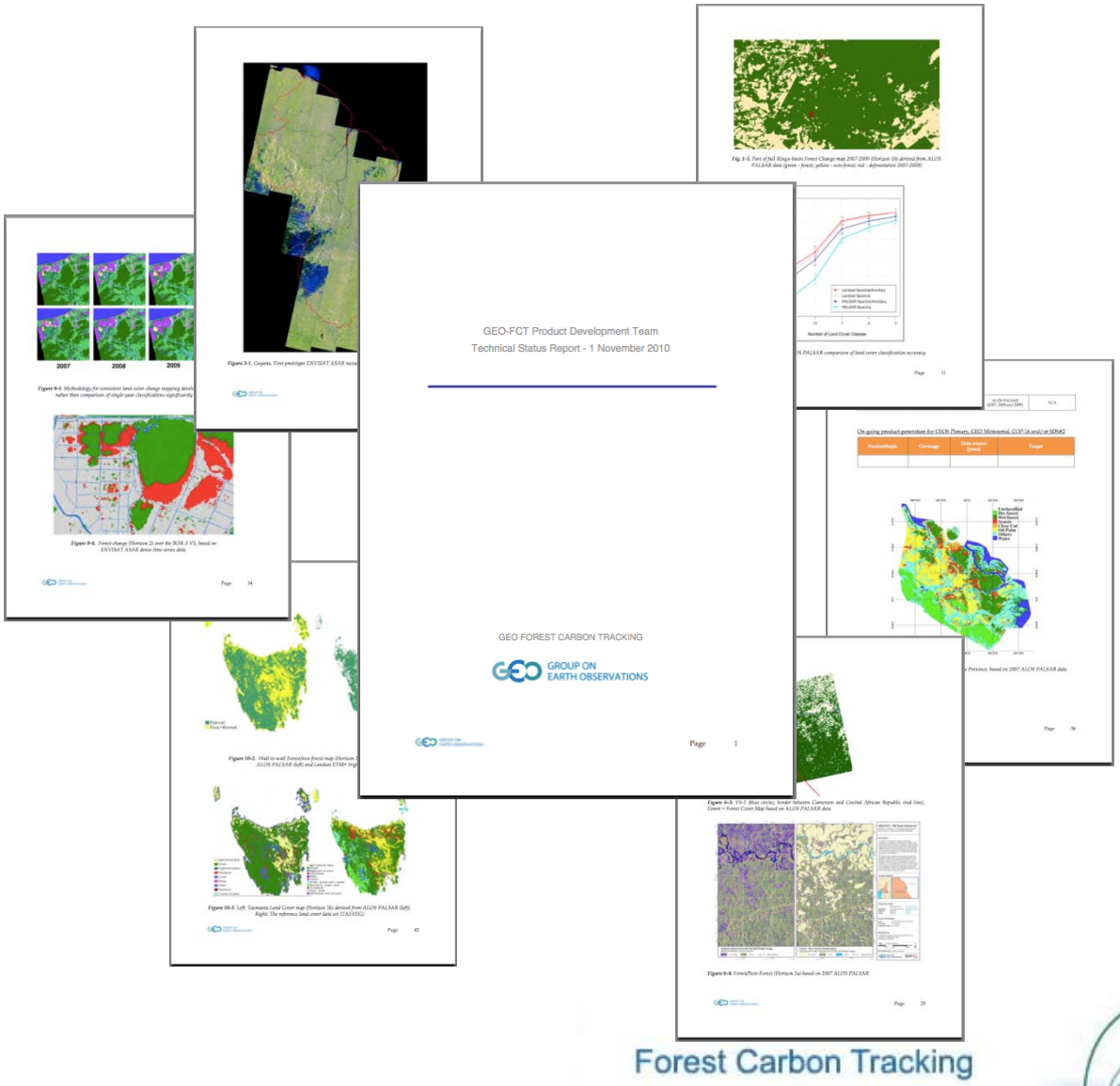
SAR Satellites

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 Product Development Technical Reporting



Technical Progress Report for 2010 with contributions from all PD teams.

Available for download at the GEO-FCT Portal
http://www.geo-fct.org/

Forests play a key role in many Societal Benefit Areas