GFOI information requirements

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GROUP ON EARTH OBSERVATIONS

SDCG-1
Montréal, Canada
6-8 March 2012

Outline

- *Background*
- *First version FCT/GFOI information requirements*
  - *Interim Guiding Principles for Product Specification*
  - *Current GEO-FCT Forest Information Product Definitions*
- *Comments by UNFCCC and IPCC*
- *Outcomes from the FCT Science & Data Summit*
- *Conclusions*

Confirmation of high level information requirements
Input from IPCC and UNFCCC

- ***Background***

– *We are seeking to understand – from a space data coordination perspective – what the GFOI information requirements entail, and how these can be translated into technical specifications that should guide us in the development of an appropriate set of coordinated satellite data acquisition plans (i.e. the CEOS Data Strategy).*

– *Ultimately, we need to understand the optimal use of each of the available satellite sensors, and for each sensor, the geographical coverage, repeat frequency, and the appropriate observation mode(s).*

First version FCT/GFOI Information Requirements

Interim Guiding Principles for Specification of the GEO-FCT Forest Information Products

(GEO-FCT Guidance Document 004)

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FCT Remote Sensing Monitoring Forest Information Products

GEO FCT aims to define a number of thematic forest information products that can be derived from a combination of satellite and ground measurement data (and other data sources, if available) and that are deemed useful for national forest monitoring and tracking of forest carbon. The products should be compliant with IPCC and UNFCCC information requirements.

It should be noted that not all products may be relavant for a particular country. It is for the countries themselves to determine which of these products to generate.

GEO supports countries' own choices of Monitoring and Reporting against the various IPCC Lands- and Emissions methods

GEO FCT Support

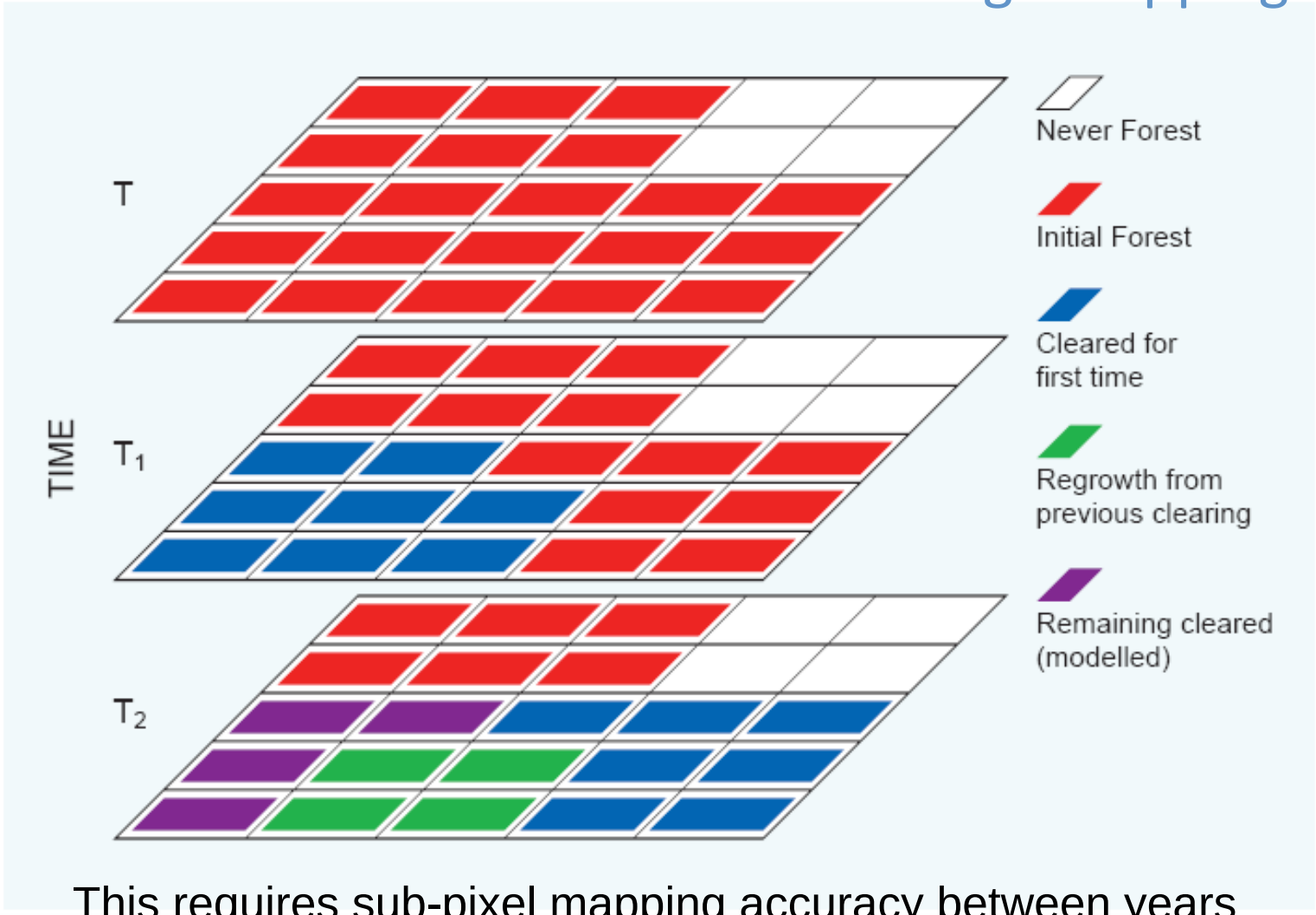
- Land Representation
  - **Approach 1:** areas of different land use at different times (blind to land substitution and transition)
  - **Approach 2:** a land conversion matrix by area to identify land substitution, but not spatially explicit
  - **Approach 3:** spatially explicit (wall-to-wall time-series monitoring of land use change)
- Emissions
  - **Tier 1**: emissions factors using global defaults
  - **Tier 2**: emissions factors using local defaults
  - **Tier 3**: emissions estimated by direct measurement or model

Interim Guiding Principles for Specification

1. **Address anticipated monitoring and reporting** needs by countries under IPCC GPG, Marrakesh Accord, and SBSTA recommendations*.
2. **Align with UNFCCC** definition of forest and deforestation, adopted for implementation of Kyoto Protocol Article 3.3 and 3.4, includes:
   - A minimum forest mapping area: 0.05 – 1 ha.
   - Potential to reach a min height at maturity in situ of 2 – 5 m
   - Minimum tree crown cover: 10 – 30 %
3. **Robust Data Processing** Algorithm Maturity - for potential Operational Implementation (incl. peer review)
4. **Data Access Readiness**, and long-term continuity assurance by satellite data providers, including backup, interoperable sensors

* see http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

Aim: Pixel-based land cover change mapping



This requires sub-pixel mapping accuracy between years

Interim Guiding Principles for Specification

Referring to UNFCCC :

- National level forest information (wall-to-wall; border-to-border)
  - To avoid 'leakage'
  - Enable reporting at national + sub-national + project levels
- Annual change basis (i.e. time-series ≤ 1 yr)
  - Equal or better than the UN and/or market reporting requirements,
  - Improve accuracy and attribution of changes
- Medium resolution (25-30 m)
  - To report change at sub-hectare basis

GEO-FCT GD-003:
Forest Information Product Specification

Horizon-1 products (mature for operational implementation):

(1a) Forest/Non-Forest Cover (ultimately annually, wall-to-wall national coverage at 25m)

(1b) Forest Cover change (annual, direct/indirect derivative of dual- or multi-year input data)

(1c) Land Use/Land Cover (e.g. national legend or as per the FAO Land Cover Classification System (LCCS))

(1d) Land Use/Land Cover Change (annual land cover category transision map, "activity data")

GEO-FCT GD-003:
Forest Information Product Specification

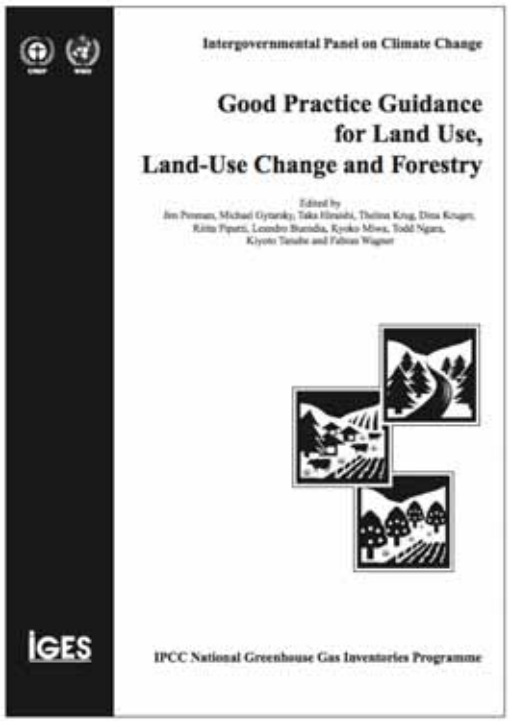
Horizon-2 products: R&D products (non-exhaustive list):

- Forest **degradation** information products:
- **Forest-type** (e.g. softwood, hardwood, native, primary, secondary types etc.)
- **Low-density forest mapping** (e.g. dryland forests, open woodlands and rangelands.
- **Above-ground biomass** maps (NOT for reporting);
- **Near-real time deforestation** detection products;
- Sub-national **hot spot** monitoring by VHR data

Confirmation of high level information requirements

Comments from IPCC and UNFCCC (on GD-003)

Confirmation of high level information requirements
Comments from IPCC and UNFCCC



Jenny Wong, Programme Officer
Maria Sanz-Sanchez, prev. Prog. Officer
UNFCCC Secretariat
Mitigation, Data and Analysis (MDA) Prog.

Jim Penman
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IPCC National GHG Inventories TF
Lead authors of IPCC GPG-LULUCF 2003

Note: The comments provided by the four experts do not constitute any formal review or endorsement, as neither UNFCCC nor IPCC provide that.

Confirmation of high level information requirements
Input from IPCC and UNFCCC

- Several comments on the document background chapter – the perceived role of GFOI and its relationship with UNFCCC and IPCC – which requires improved clarity

Not the focus of the product specification document, but highlights the need for consistent and correct language across all FCT/GFOI documents

- Developing countries are encouraged to follow the 2000 and 2003 IPCC Good Practice Guidance (GPG) on Land Use Land-Use Change and Forestry (LULUCF) [new since Durban COP-17]. Noted that the IPCC guidelines are non-prescriptive, but that they constitute a source of high level technical guidelines also for GFOI.

Confirmation of high level information requirements
Input from IPCC and UNFCCC

– Developing countries span a broad range of technical and instititional rediness for REDD+, many of them still Tier 1, Approach 1. It is emphasised that it is for the countries themselves to decide where to start. It is also possible for countries to use different Tiers/Approaches in different regions within one country.

The aim of GFOI is to *accommodate* Tier 3 / Approach 3 for any country that wishes to use that, in the present or as a goal in the future. The CEOS Data Strategy must be designed accordingly to assure that satellite data does not become the bottleneck for any country's choice.

Confirmation of high level information requirements
Input from IPCC and UNFCCC

The Horizon 1 and 2 definitions received only a few direct comments (IPCC).

- Forest types classification key input to C models(presently H-2 product) as different emission factors apply for different forest types (even Tier 1 requires forest to be divided into forest type and ecosystem)
- Degradation is a priority. Postponement of degradation until Horizon-2 is undesirable given worries about incentives to reduce deforestation inadvertently encouraging degradation
- [SDS comment] Land use transitions ("Horizon 1d") too coarse – needs distinction within "Forest remaining Forest" category to include both enhancements of carbon stocks, as well as various forms of degradation.

Confirmation of high level information requirements
Input from IPCC and UNFCCC

- ***Q: What forest definition is valid?***

The UNFCCC Kyoto Protocol definition of forest :

- Minimum forest mapping area: 0.05 to 1 ha max.
- Potential to reach a minimum height at maturity of 2-5 m
- Minimum tree crown cover, or stocking level: 10 to 20 %

applies only to Annex-1 countries and to CDM (Clean Development Mechanisms) project activities.

REDD+ allows developing countries to use their own definition of forest.

Confirmation of high level information requirements
Input from IPCC and UNFCCC

- ***Q: Spatial resolution / minimum mapping area***

The UNFCCC Kyoto Protocol definition of minimum forest mapping area: (0.05 – 1 ha) applies only to Annex 1 countries and CDM projects.

There is no agreement of a required spatial resolution by UNFCCC or IPCC for REDD+.

Minimum mapping area/spatial resolution is for developing countries to decide, but is likely to be driven by thematic issues (e.g. degradation) and by carbon markets' requirements for accuracy. Requirements for spatial resolution (observations) can differ in different regions within a given country.

Confirmation of high level information requirements
Input from IPCC and UNFCCC

- **Q: Reporting frequency**
  - Developing countries report to the UNFCCC every two years [since Durban COP-17] *"This does not necessarily define the desirable frequency for remote sensing data acquisition (the Brazilian DETER system, used to identify where deforestation is occurring, has I understand a period of two weeks). But I think annual or semi-annual is not unreasonable place to start, since the information gives some redundancy for biennial inventory reporting" [JP] .*
  - IPCC has advice on uncertainty estimation. Consistent time series data are particularly important for trend estimation, given the size of absolute uncertainties likely to be encountered.

Status of scientific development

Outcomes from the GEO-FCT Science & Data Summit

GROUP ON EARTH OBSERVATIONS

SDCG-1
Montréal, Canada
6-8 March 2012

Key RS Science Questions discussed at SDS

1. Sensor Interoperability

"Obtaining the same thematic results from different sensors"

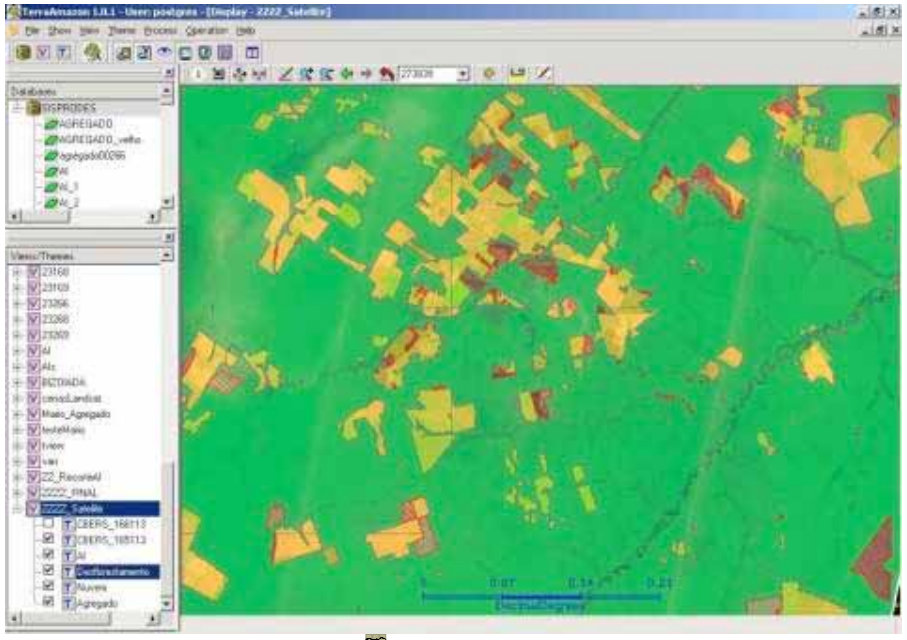
2. Sensor Complementarity

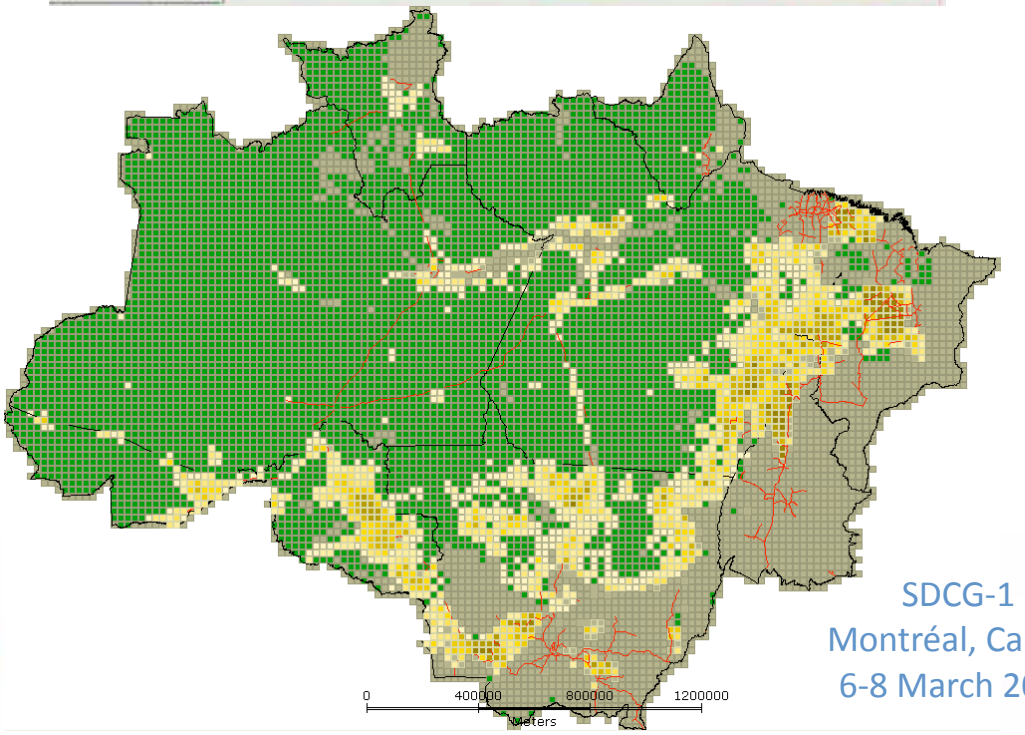
"Obtaining additional thematic information through the (synergetic) use of two or more different sensors"

3. Optimising information extraction from C-band SAR

4. Applications and optimal use of X-band SAR

5. Others (e.g. biomass estimations, woodlands, etc)





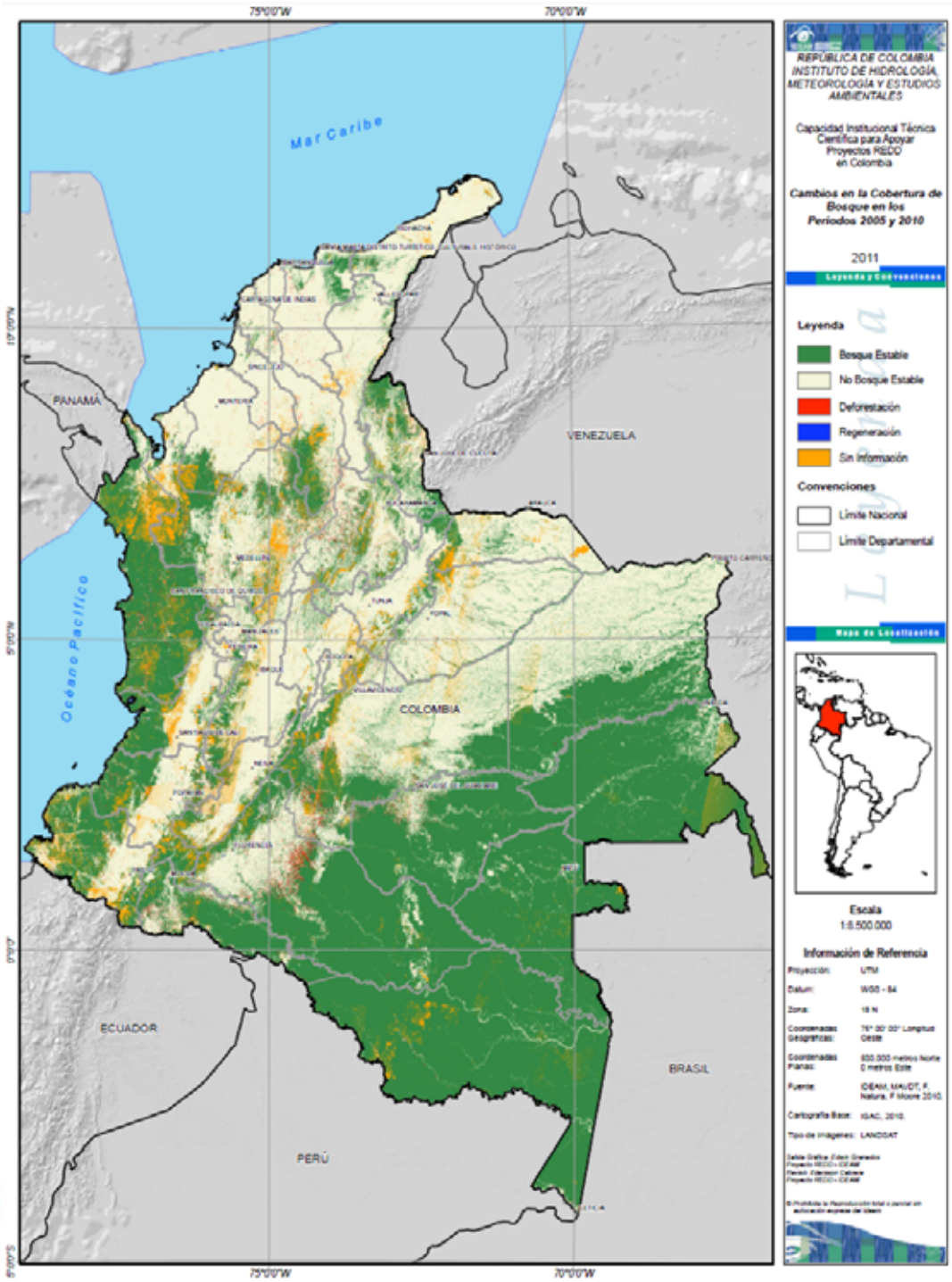
Brazil

Horizon 1a & 1b

Forest cover & forest cover change

PRODES – Brazilian Amazon (w2w) annual forest change. Operational system since 1988. Minimum mapping unit 6.25 ha.

A range of different optical sensors have been used (Landsat 5, 7, CBERS, DMC, IRS)

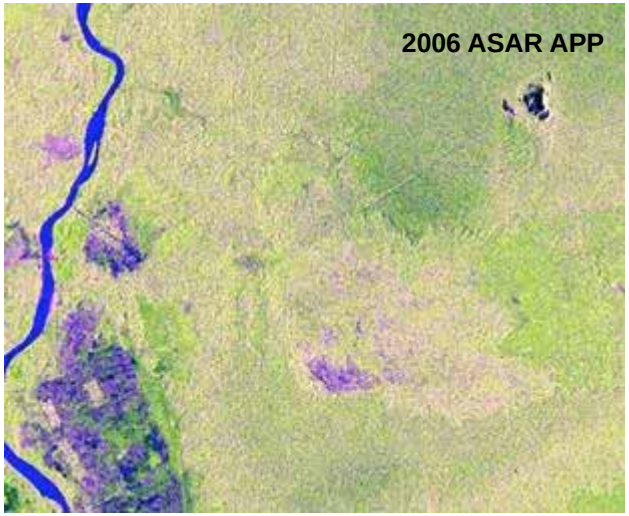


Colombia
Horizon 1a & 1b
Forest cover & forest cover change

National-scale (w2w)Horizon 1a and 1b product - (combined) forest cover and change - derived from Landsat data.

Indonesia Horizon 1b & Horizon 2

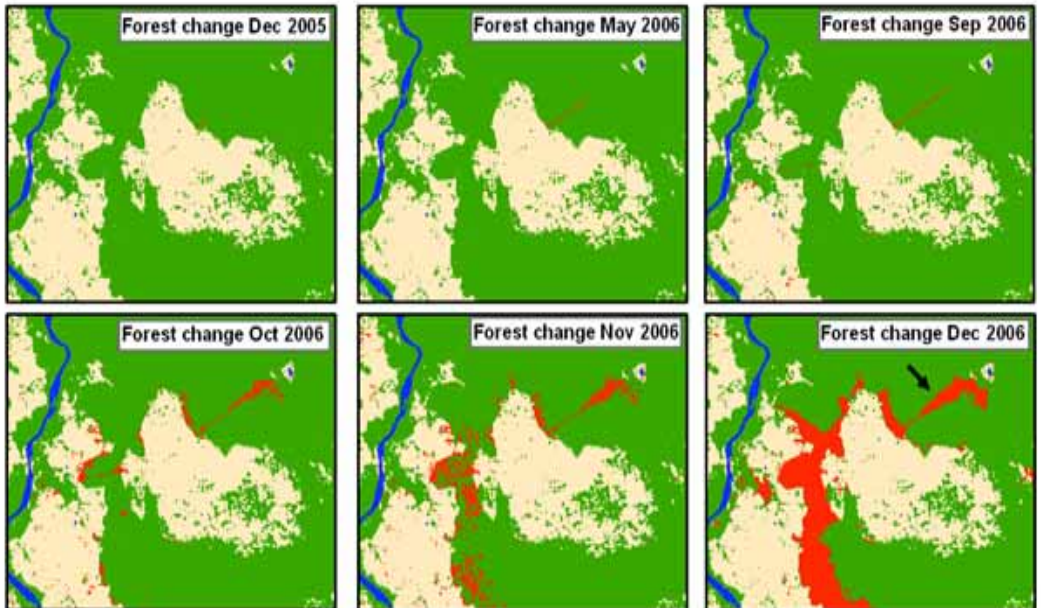
Forest cover change & Deforestation detection



Satellite data courtesy ESA, processed by SarVision

ENVISAT ASAR APP has been demonstrated in Borneo as a fast and reliable tool for operational deforestation monitoring

Feasible to use optical (or L-band SAR) to generate forest/non-forest mask and monthly/bi-monthly time-series of C-band SAR to monitor tropical deforestation



Optimising information extraction from C-band SAR

WETLANDS INTERNATIONAL

WAGENINGEN UNIVERSITY ENVIRONMENTAL SCIENCES

SarVision

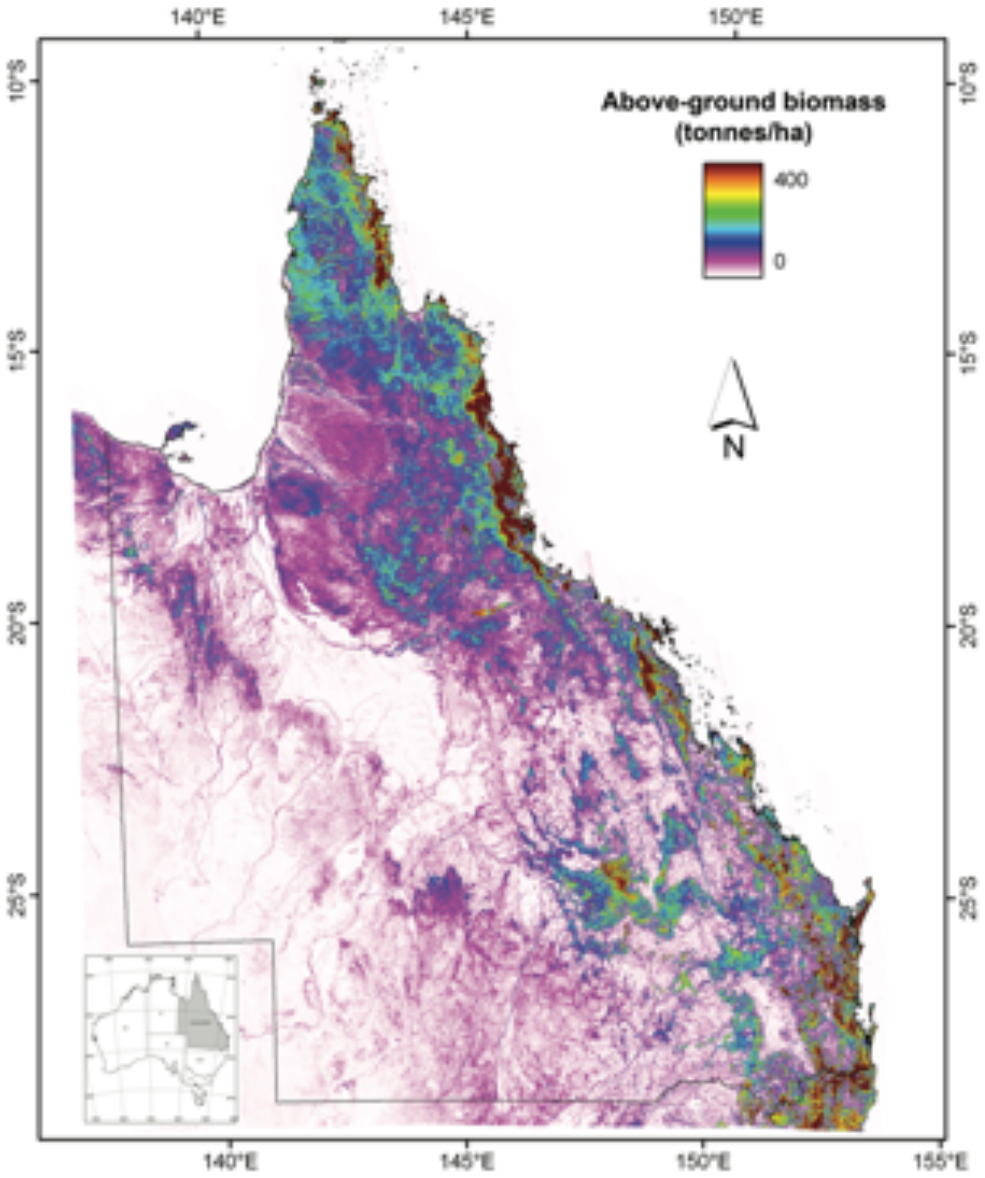
Borneo

Horizon 1c

Land cover

Subnational-scale (w2w)Horizon 1c product derived from dual-season ALOS (L-band) data.

Multi-seasonal (2 obs/yr wet/dry) image pairs improve distinction between certain classes compared to only one acquisition per year.



Australia (QL)

Horizon 2

Above-ground biomass

Subnational-scale (w2w)ABG map derived from a combination of Landsat and ALOS (L-band) data.

Status of scientific development

- **Degradation**

– Due to logging, fire, pests/insects. Degradation also early indicator of fortcoming large-scale deforestation

– A big challenge for GFOI.

  - High or Very High spatial resolution required to detect subtle changes in the forest canopy
  - High temporal revisit required

Sensors of use:

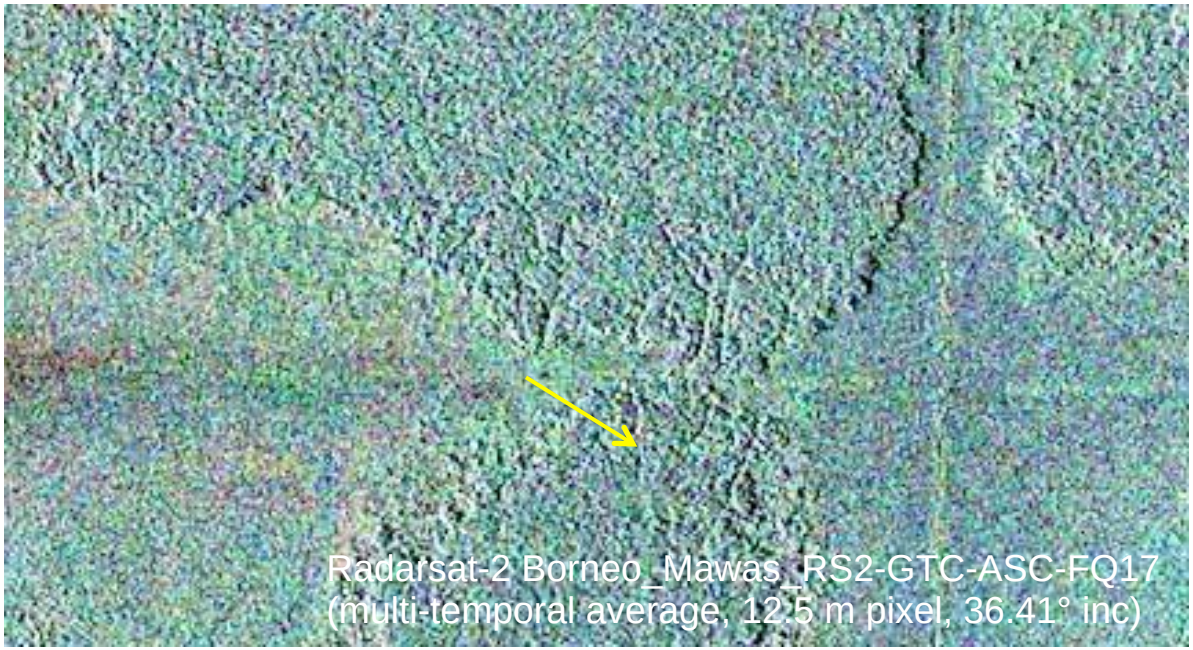
– VHR optical systems

– SAR

  - Dense time series (monthly/bi-monthly)

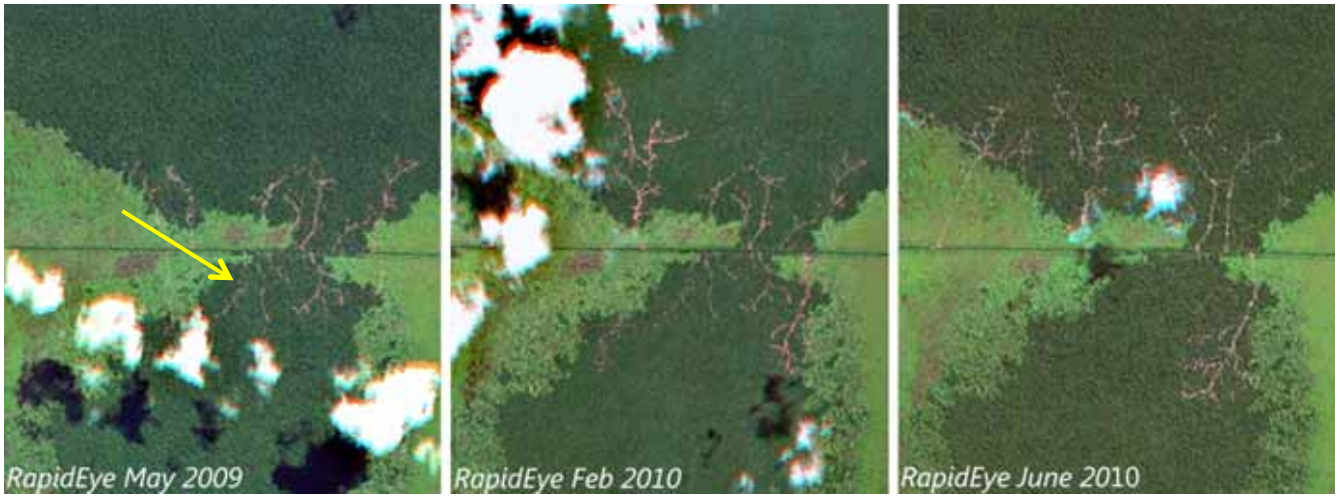
Indonesia Horizon 2a

Degradation (detection of logging roads)



Dense time series (monthly/bi-monthly) of Radarsat-2 (C-band)

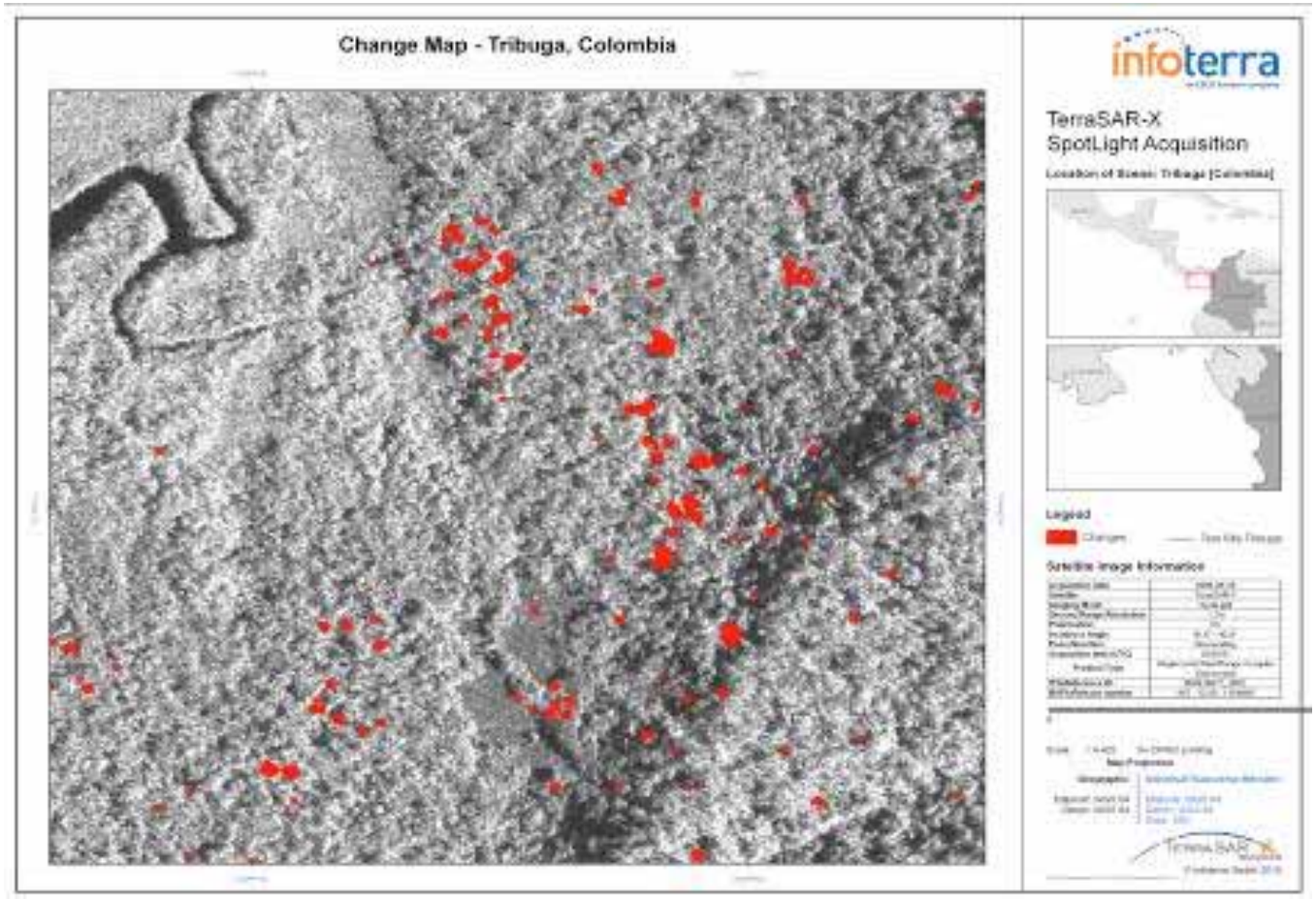
Multi-temporal filtering improves radiometric quality (speckle reduction) while maintaining spatial resolution



Logging roads remain visible longer in Radarsat-2 than in RapidEye

Colombia Horizon 2a

Degradation (selective logging)



Local scale
Detection of the removal of individual trees detected in TerraSAR-X (spotlight mode)

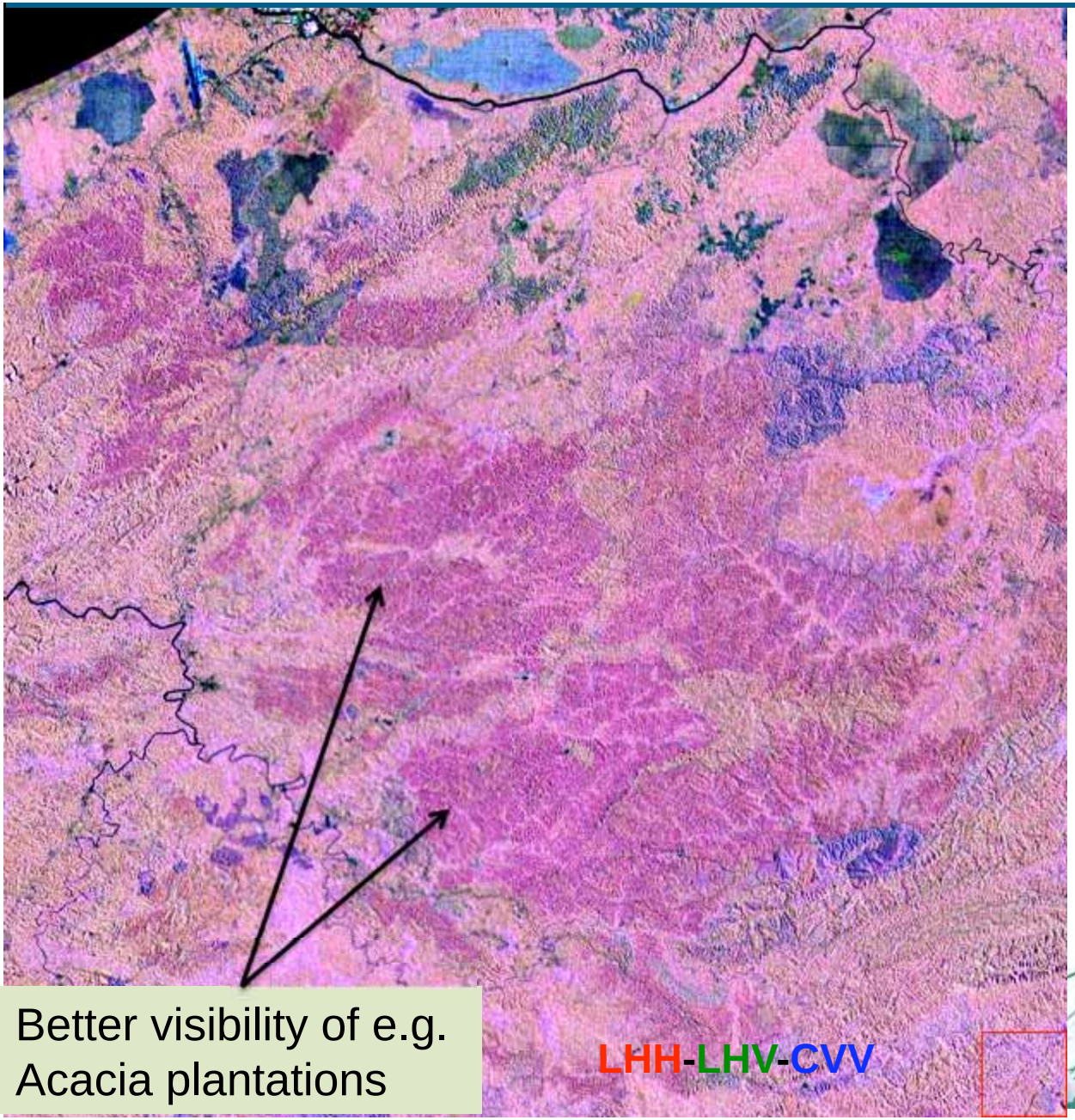
Status of scientific development

- **Forest type classification**
  - Correlation with both forest spectral signature and with forest structural parameters and above ground biomass

Sensors of use:

- Optical systems (SWIR bands particularly useful)
- SAR
  - Multi-season observations improve class distinction
  - Consistent obervations over several years provide “retroactive improvement” of classification results
  - Combined use of different sensors (“complementarity”) can improve class distinction

Improved distinction of Forest types



Better visibility of e.g. Acacia plantations

LHH-LHV-CVV

L-band/C-band complementarity

Radarsat-2 WB C-band
PALSAR FB L-band
LHH-LHV-CVV

Sarawak, Malaysia

L-band/C-band combination improves contrast between forest and Acacia plantations and between (medium biomass level) forest types and within forest (biomass) variation

WAGENINGEN UNIVERSITY
ENVIRONMENTAL SCIENCES

Forest monitoring systems for Indonesia: a three-tier approach

A. Consistent annual wall-to-wall land cover classification based on **PALSAR-2** and other data such as Radarsat-2, Sentinel-1, Landsat, Sentinel-2 *(25 m; every year; within 1 month*)

B. Frequent and fast update of deforestation based on **Sentinel-1**(*25 m; every 6-12 days; within 1 day*)

C. Frequent and fast high-resolution update of deforestation and degradation based on **(equatorial) SAR** and other data such as TS-X, Cosmo-SkyMed, RS-2 Ultra-fine, and RapidEye (*3-6 m; every 7-14 days; within 1 day*)

SDS conclusions

- ***It was demonstrated that:***

– National and sub-national scale Horizon 1 products could be generated

– All sensor types have some unique characteristics that render them useful for some specific applications

– Combined use of different sensor types can render new information that is not evident in any one data on its own

– The GEO-FCT “ad-hoc” coordinated acquisitions since 2009 have resulted in a range of new applications having been discovered

– The importance of a consistent archive cannot be under-estimated.

SDS conclusions

Optical sensors

- *The optical core missions (Landsat, Sentinel-2, CBERS-3) are the anticipated work-horses for GFOI. At least one cloud-free coverage desired per year*
- *Cloud coverage is the most serious limitation. What can be done to improve utlilisation?*
  - *investigate interoperability between the core missions – as well as other relevant optical missions (SPOT, DMC, RapidEye etc.). Investigate to what extent can these sensors can be used to replace each other.*
  - *Enhanced pixel mining/cloud-free compositing – making use of all data acquired. (WELD pres.)*

SDS conclusions

C-band SAR

– *Sentinel-1 and RCM the anticipated SAR work-horses. Several approaches to enhance information extraction from C-band SAR were demonstrated. Possible acquisition scenario:*

- *National-scale w2w coverages 2 times/year (dual-season) (or every 2 years) for baseline mapping in combimation with other sensors*
- *Dense time series mapping over deforestation hotspot regions (stratified w2w) under forest mask*
  - *Monthly – no less than bi-monthly – acquisitions required in order not to lose the signal*

SDS conclusions

L-band SAR

- *Demonstrated utility for forest applications with an established science and user community*
- *ALOS PALSAR is presently PPP and not one of the core missions, but nevertheless one of the most utilised sensors – on par with Landsat – within GEO-FCT.*
- *The global acquisition strategy for PALSAR – global w2w coverage two times/year – adequate for GFOI.*
- *L/C-band complementarity demonstrated*
- *The evolution of CONAE's SAOCOM-1 L-band SAR of great interest for GFOI*

SDS conclusions

X-band SAR

– *Several approaches to enhance information extraction from X-band SAR were demonstrated. X-band is the key sensor to address the degradation requirement*

- *VHR resolution acquisitions very demanding on system resources*
- *No "default" acquisition strategy can be anticipated. Has to be tailored individually for each country that requests it (data provision through bilateral agreements foreseen for TS-X/TD-X)*

Conclustions (final)

Outset:

– *We are seeking to understand – from a space data coordination perspective – what the GFOI information requirements entail, and how these can be translated into technical specifications that should guide us in the development of an appropriate set of coordinated satellite data acquisition plans (i.e. the CEOS Data Strategy).*

I believe that we have obtained sufficient input and background information from UNFCCC, IPCC and the GEO-FCT science teams to allow the CEOS Space Data Coordination Group to get started .