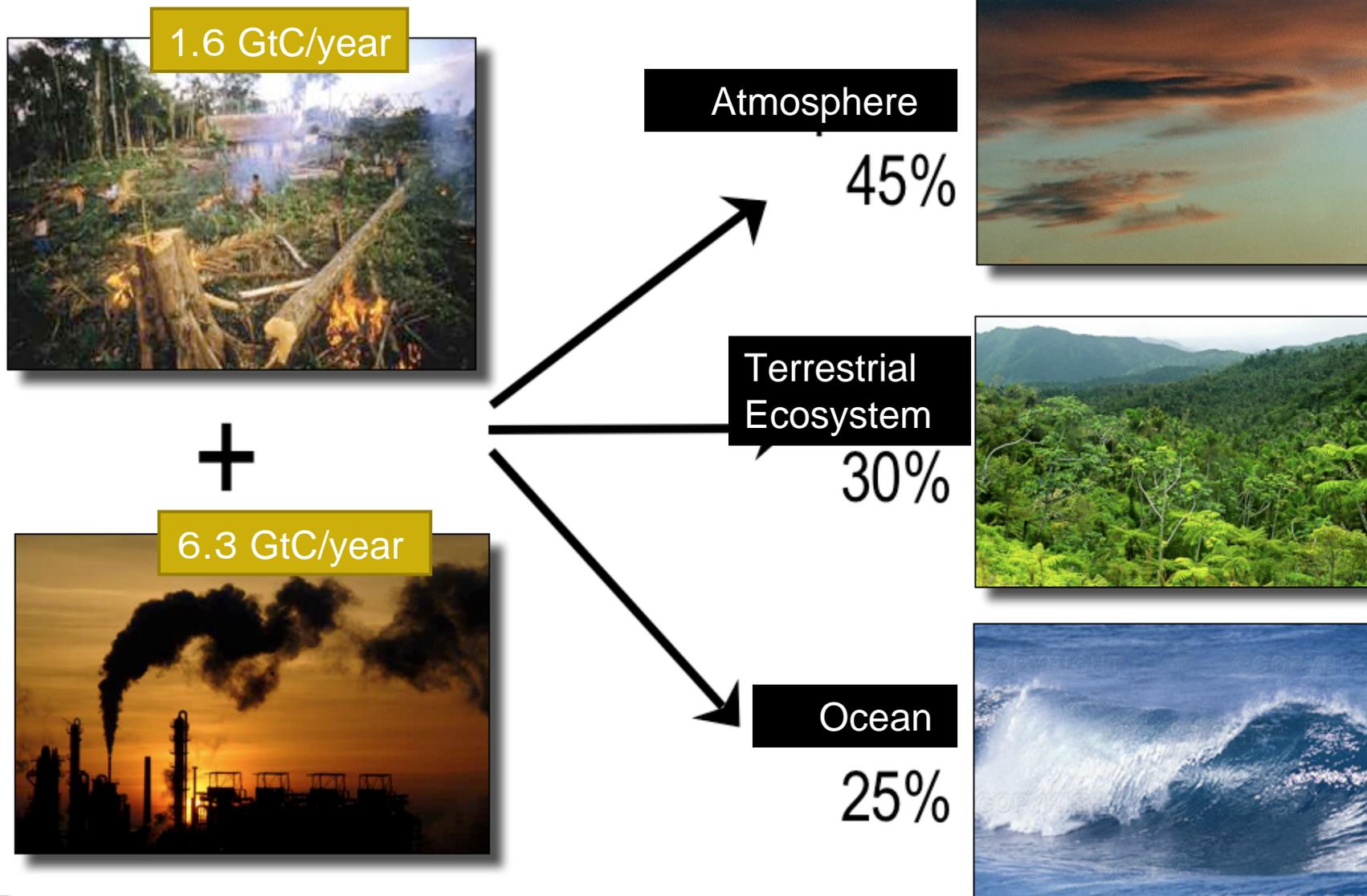


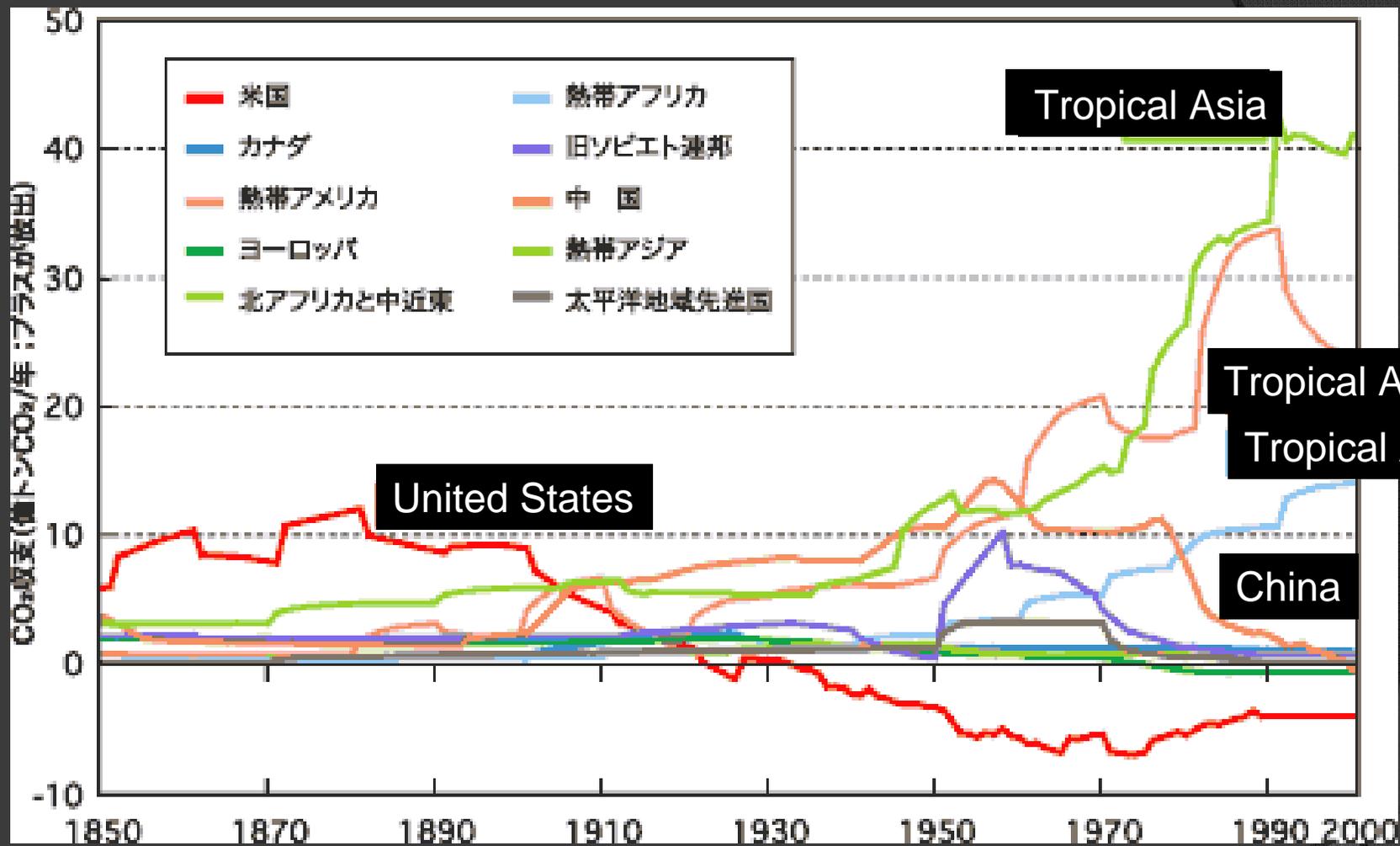
REMOTE SENSING BASED MONITORING SYSTEM FOR LULUCF

National Institute for Environmental Studies

Yoshiki Yamagata

Global Carbon Balance



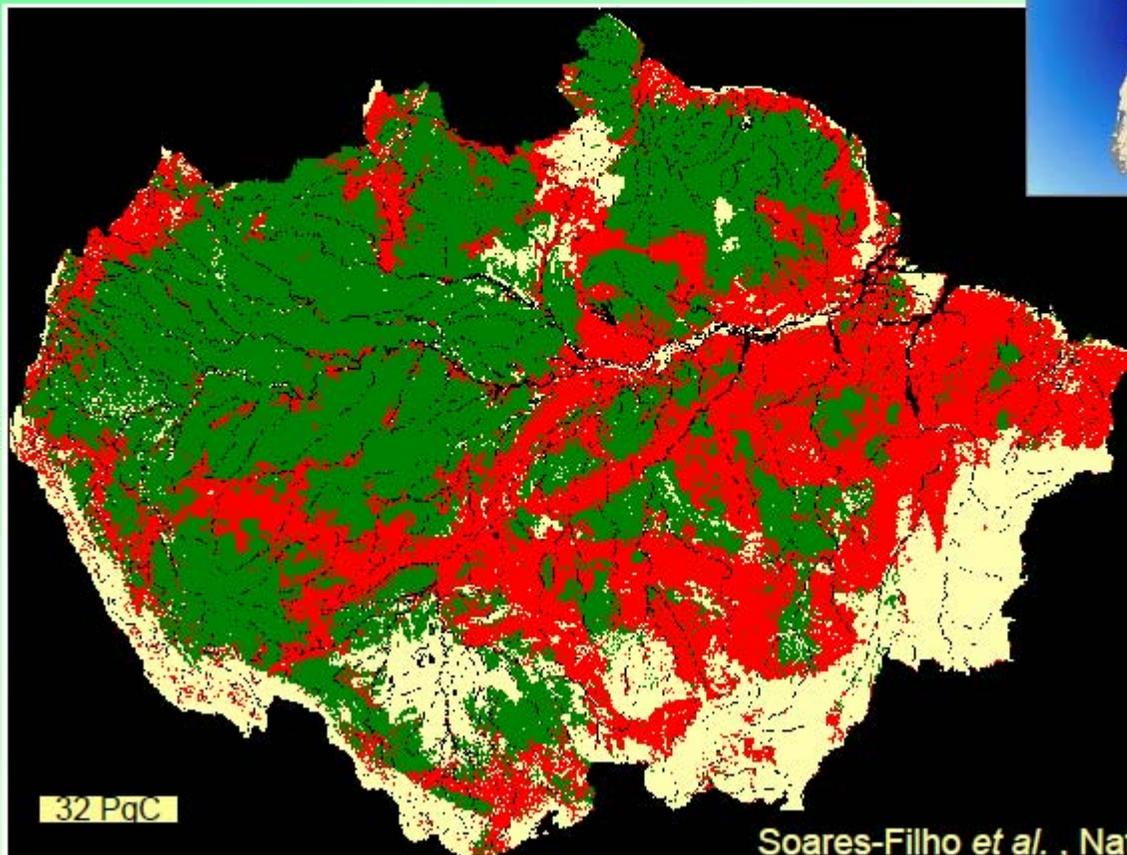


Emission of CO₂ from Deforestation in the past 150 years
(created from Houghton's data)



2050 Business as Usual:

Deforested 2,698,735 km² (32 PgC emitted by 2050)
Forest 3,320,409 km²
Non-forest 1,497,685 km²

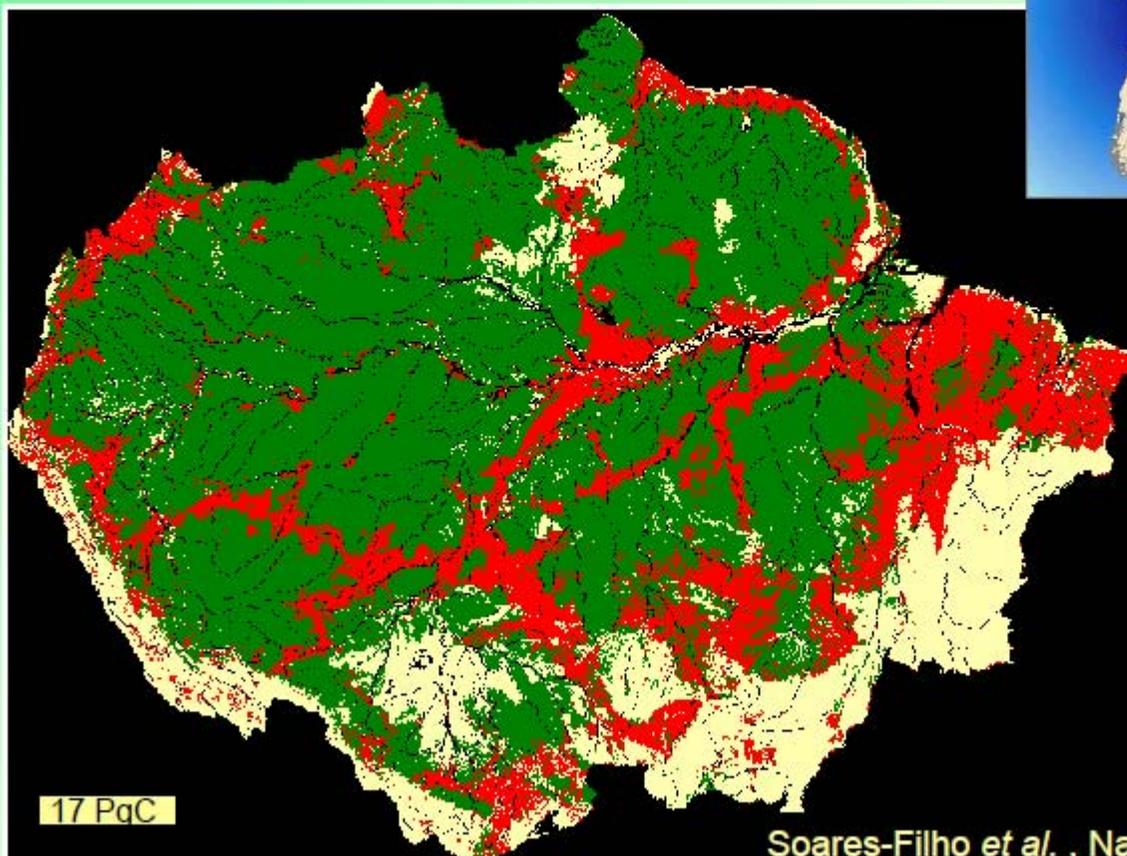


Soares-Filho *et al.*, Nature, 2006



2050 Governance Scenario :

Deforested	1,655,734 km ² (Reduction: 40%)
Forest	4,363,410 km ²
Non-Forest	1,497,685 km ²

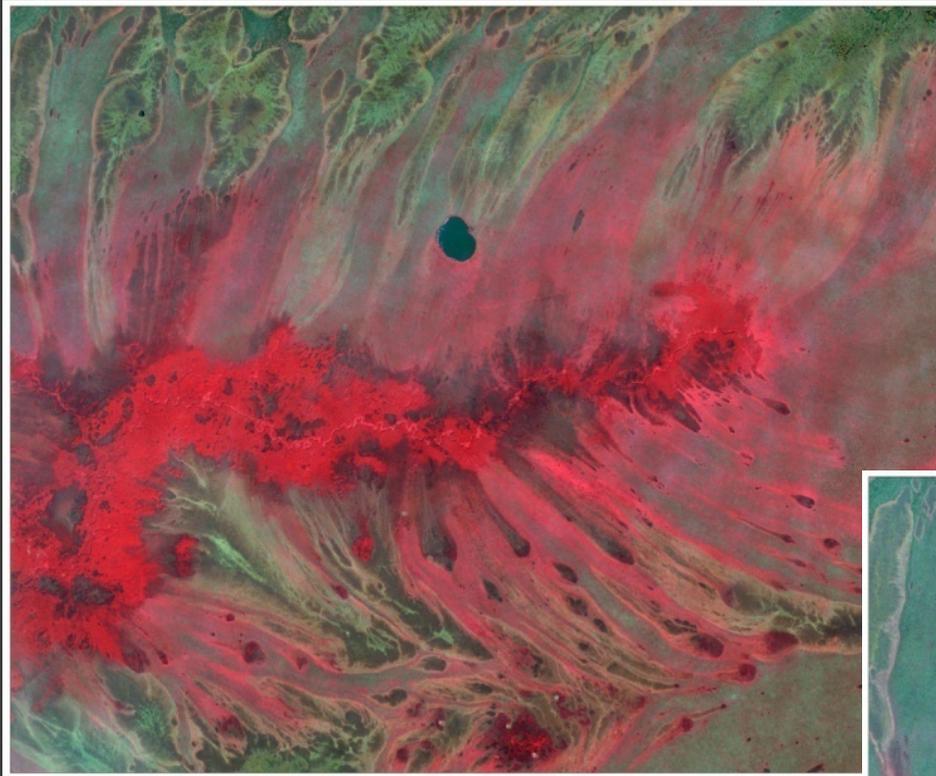


Soares-Filho *et al.* , Nature, 2006 10

Emission reduction and forest conservation

- Carbon stored in above and below ground biomass, and soil. After harvest, decay of biomass occurs in a few years time
- CO₂ emission from deforestation is around 20% of global fossil fuel emission. Deforestation is increasing due to global rapid economic growth
- Consideration for the inclusion of reducing deforestation (REDD) is currently discussed as a new mitigation measures
- Forest conservation is also critically important for preserving Biodiversity (inter-linkage of UNFCCC, CBD, RAMSAR) and as an adaptation measures

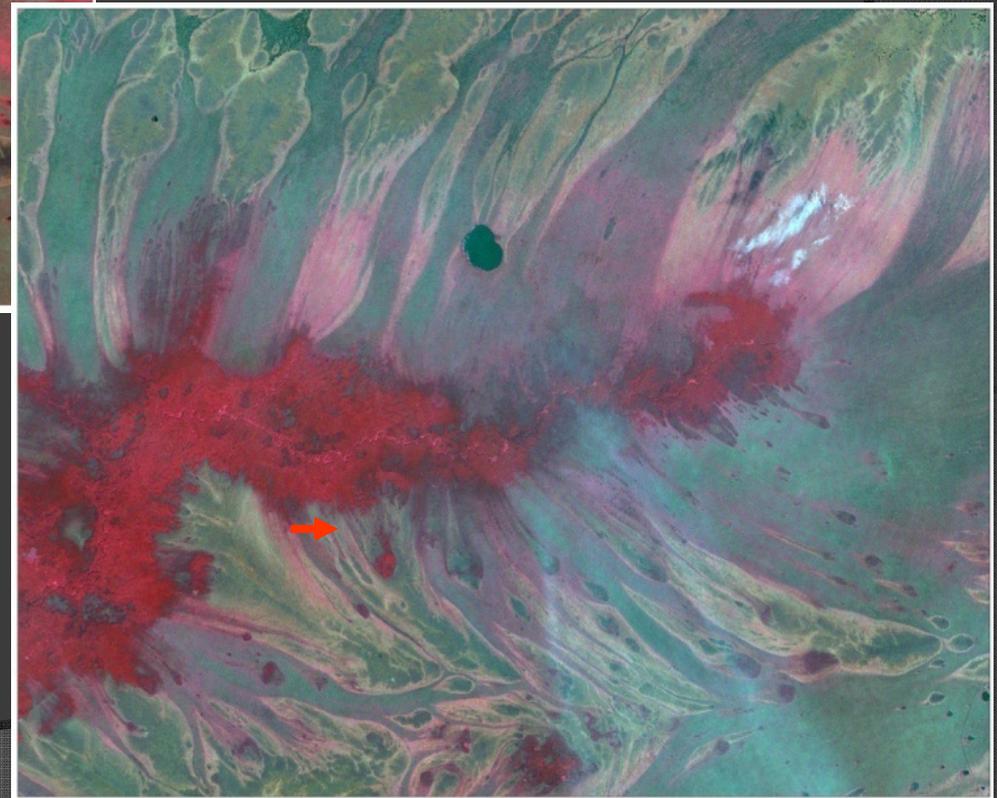
LANDSAT TM, 1989/08/01



Forest-Wetland change (due to climate change?) in western Siberia

From Anna Peregon (NIES)

LANDSAT ETM, 2001/08/02



In 12-years:

Forested peatlands are gradually transformed to open peatlands.

Upland forests are replaced by forested swamps.

IPCC *Good Practice Guidance for LULUCF*: reporting tier options for UNFCCC Annex I country reporting

- **Tier 3** - higher order methods including models and inventory measurement systems tailored to address national circumstances, repeated over time, and driven by high-resolution activity data and disaggregated at sub-national to fine grid scales
 - may be GIS-based combinations of age, class/production data systems with connections to soil modules, integrating several types of monitoring

LULUCF monitoring issues

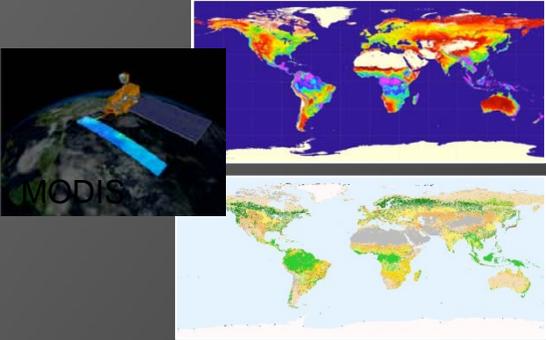
1. How to define Deforestation and Forest degradation (Land use/ Land cover?)
2. Remote sensing can monitor Land Use/Land Cover change?
3. Is the global Forest Carbon Monitoring System for evaluating CO₂ emission/absorption due to Land Use and Land Cover changes is possible?

NEW RESEARCH PROJECT : FOREST CARBON MONITORING SYSTEM

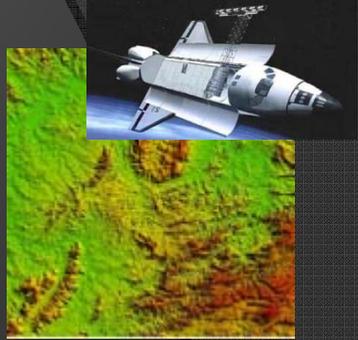
Remote Sensing

- NOAA/AVHRR
- Landsat, SPOT
- TRMM etc.

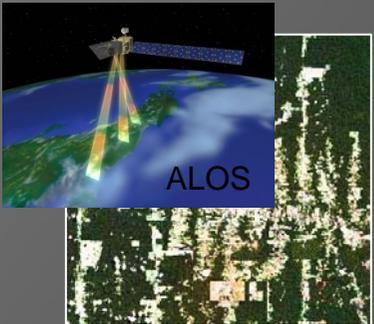
Land Cover



DEM



Forest changes



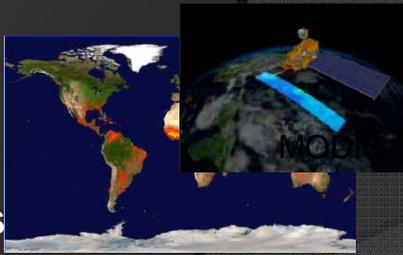
LAI, Canopy, etc.



cf. ASTER

Slopes

Disturbances



GHG concentration



cf. SCIAMACHY, OCO

CO₂

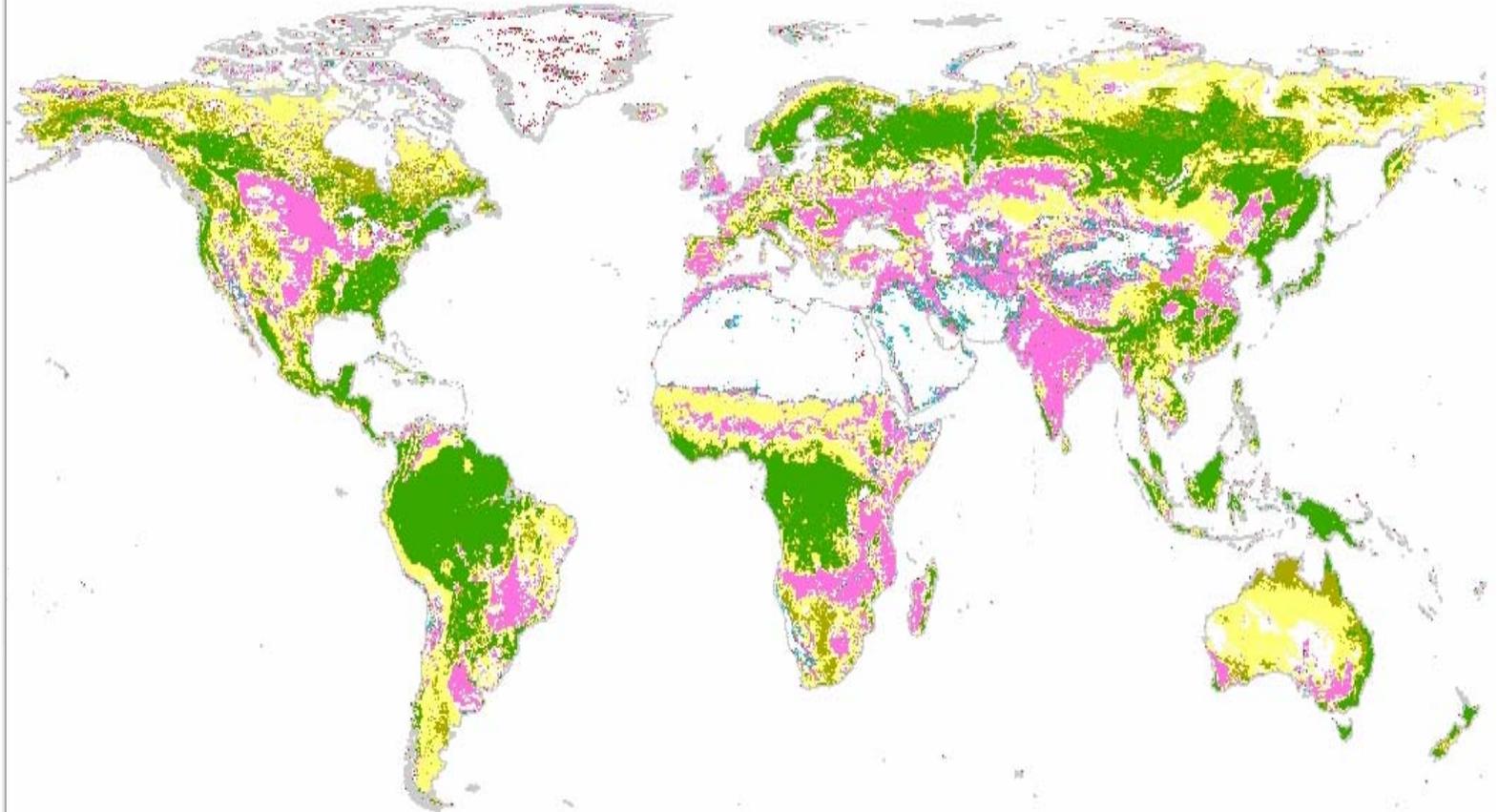
Future sensors

- GCOM etc.

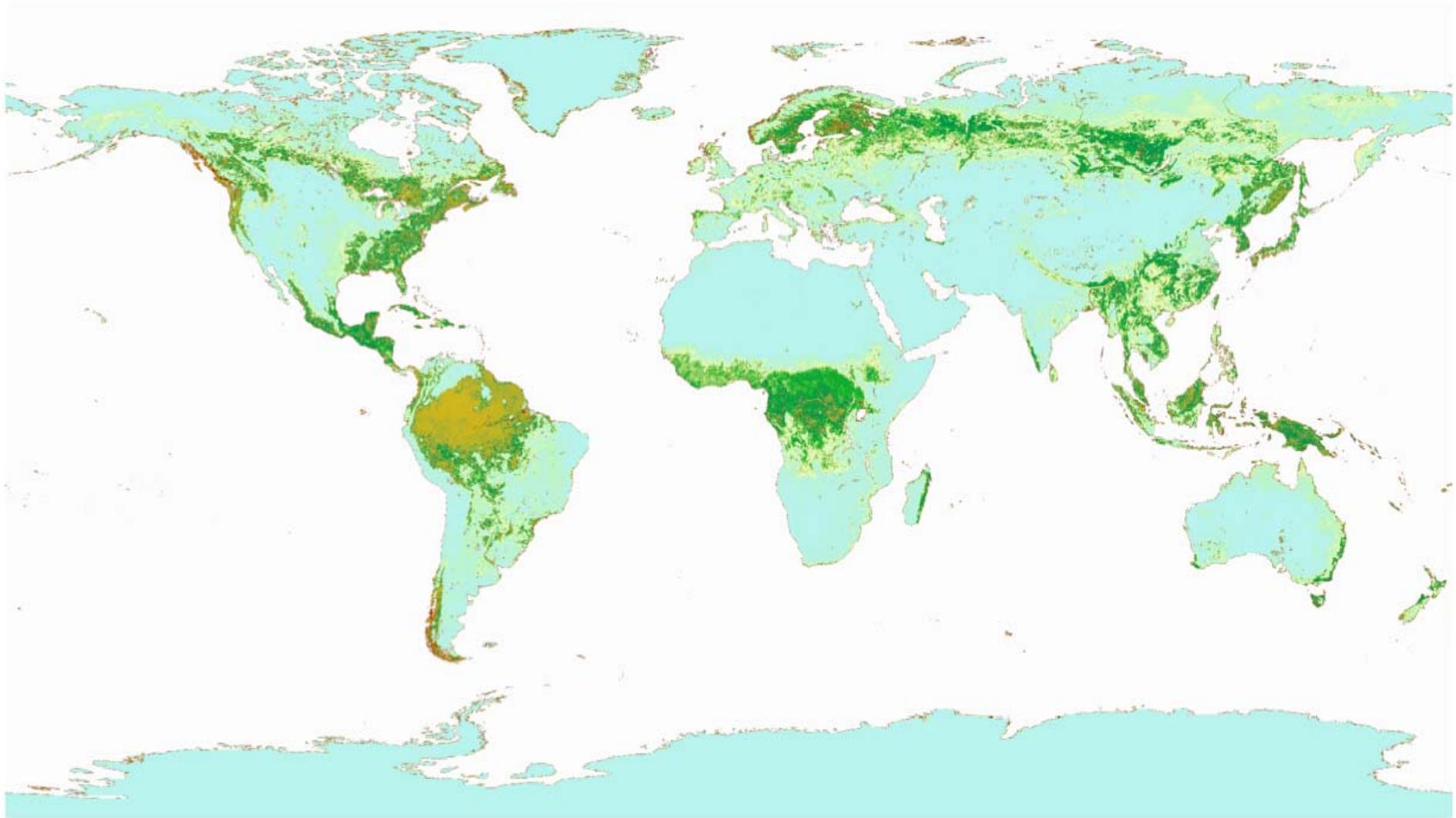
Global Mapping (Land Cover)

全球地图

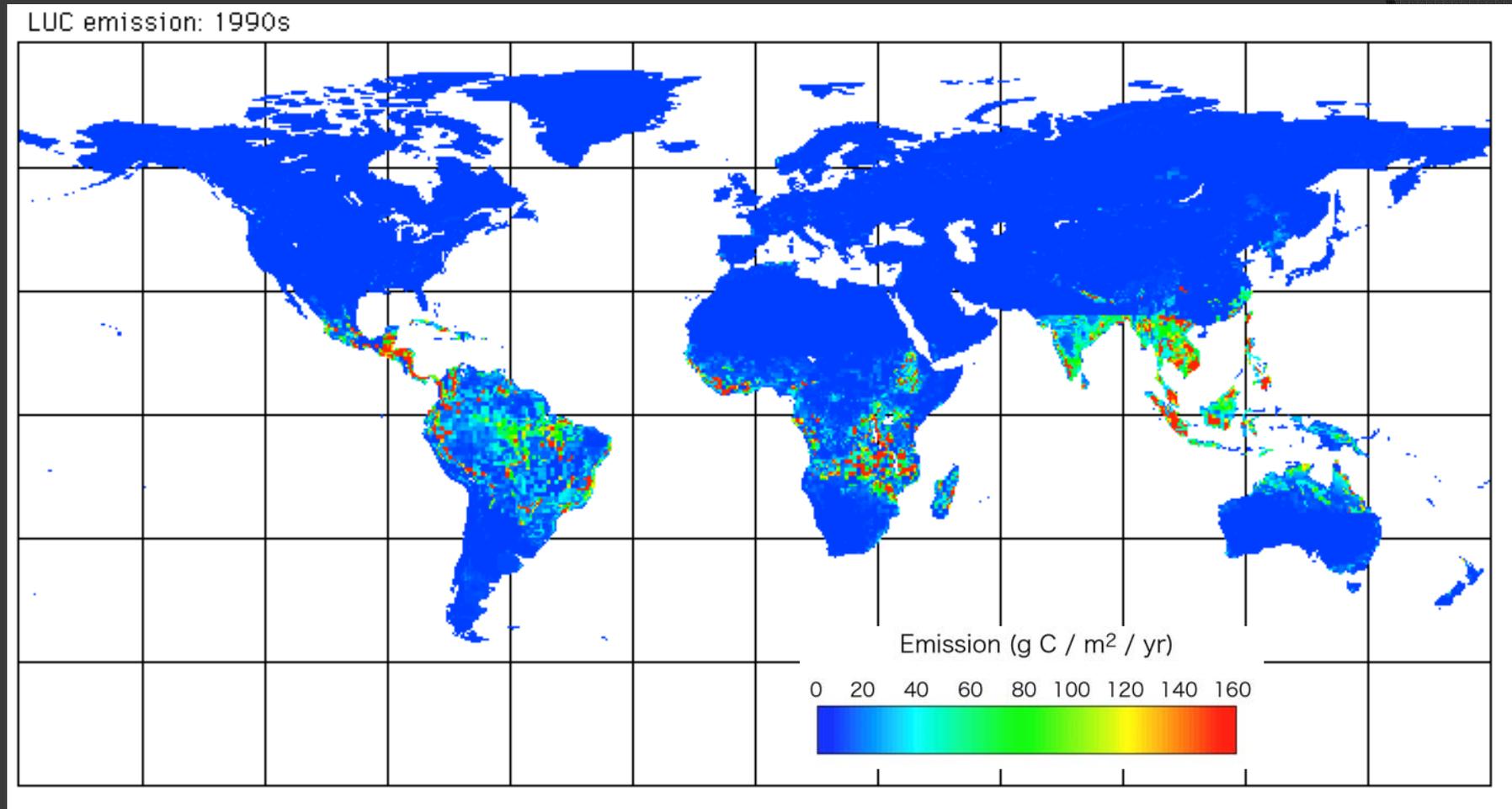
- Broadleaf evergreen
- Broadleaf deciduous
- Needleleaf evergreen
- Needleleaf deciduous
- Mixed forest
- Tree open
- Shrub
- Herbaceous
- Herbaceous with sparse tree
- Sparse vegetation
- Cropland
- Paddy field
- Cropland / other veg mosaic
- Mangrove
- Wetland
- Bare
- Bare area, unconsolidated
- Urban
- Snow / ice
- Water bodies



GLOBAL MAPPING (TREE COVER)



Model estimate: CO₂ emission during 1990s



Needs for an Remote Sensing data for monitoring

- Remote sensing can provide the objective means to observe land use /land cover changes
- Especially for the tropical forests monitoring, cloud-penetrating radar imaging is a key tool
- Coordinated use of latest R/S sensors with in-situ measurements and model will be crucial for LULUCF monitoring

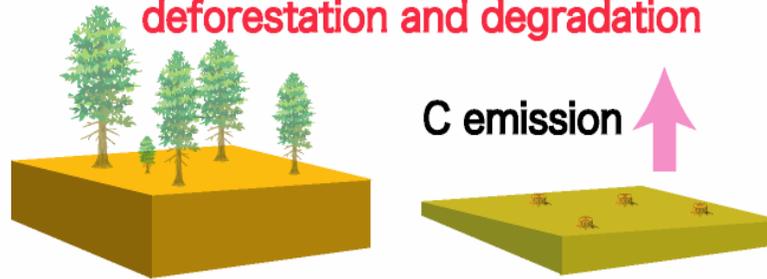
Carbon Accounting Method



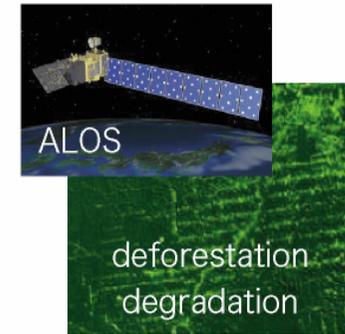
afforestation, growth, succession

deforestation and degradation

C emission



Advanced satellite monitoring system

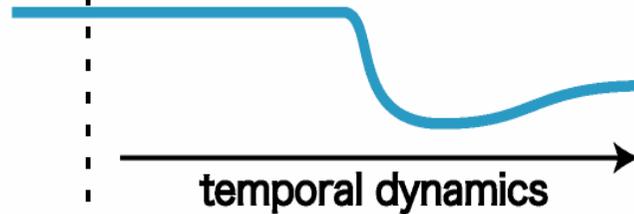


forest monitoring

① Default method

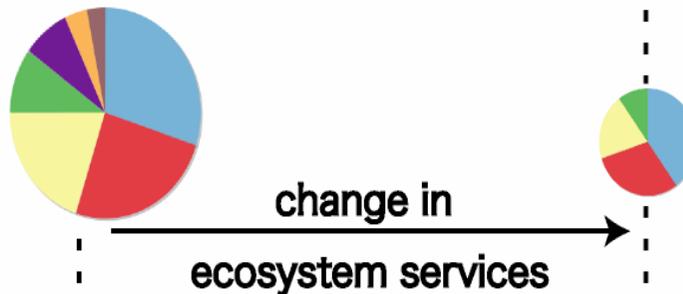


② Ecosystem model

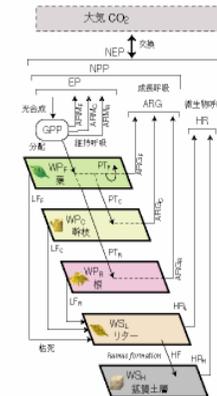


③ Economic evaluation of environmental benefits

- Ecosystem service
- hydrological
 - food, fibre, etc.
 - biodiversity etc.



Improved ecosystem model



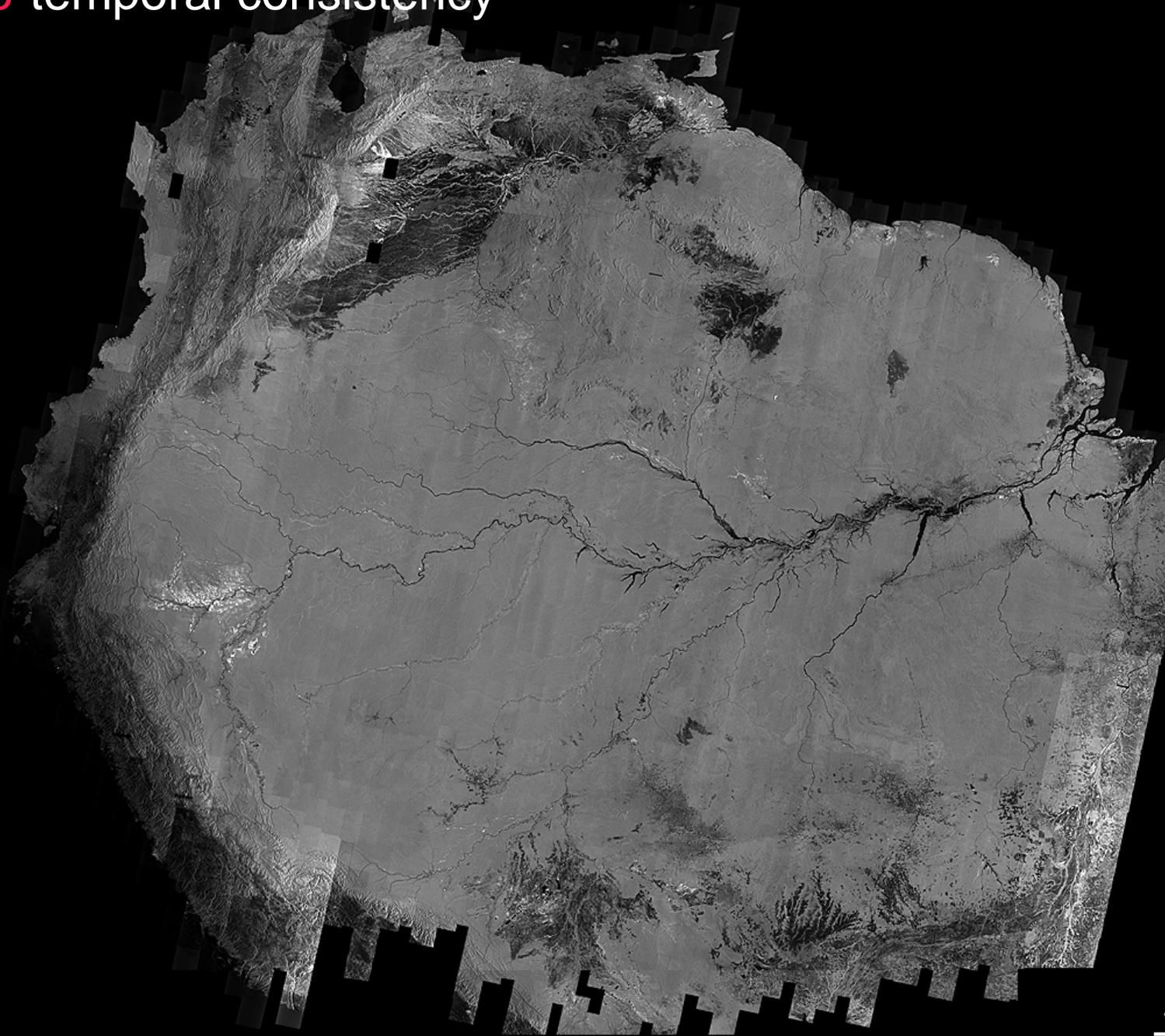
simulation

International Carbon Monitoring System

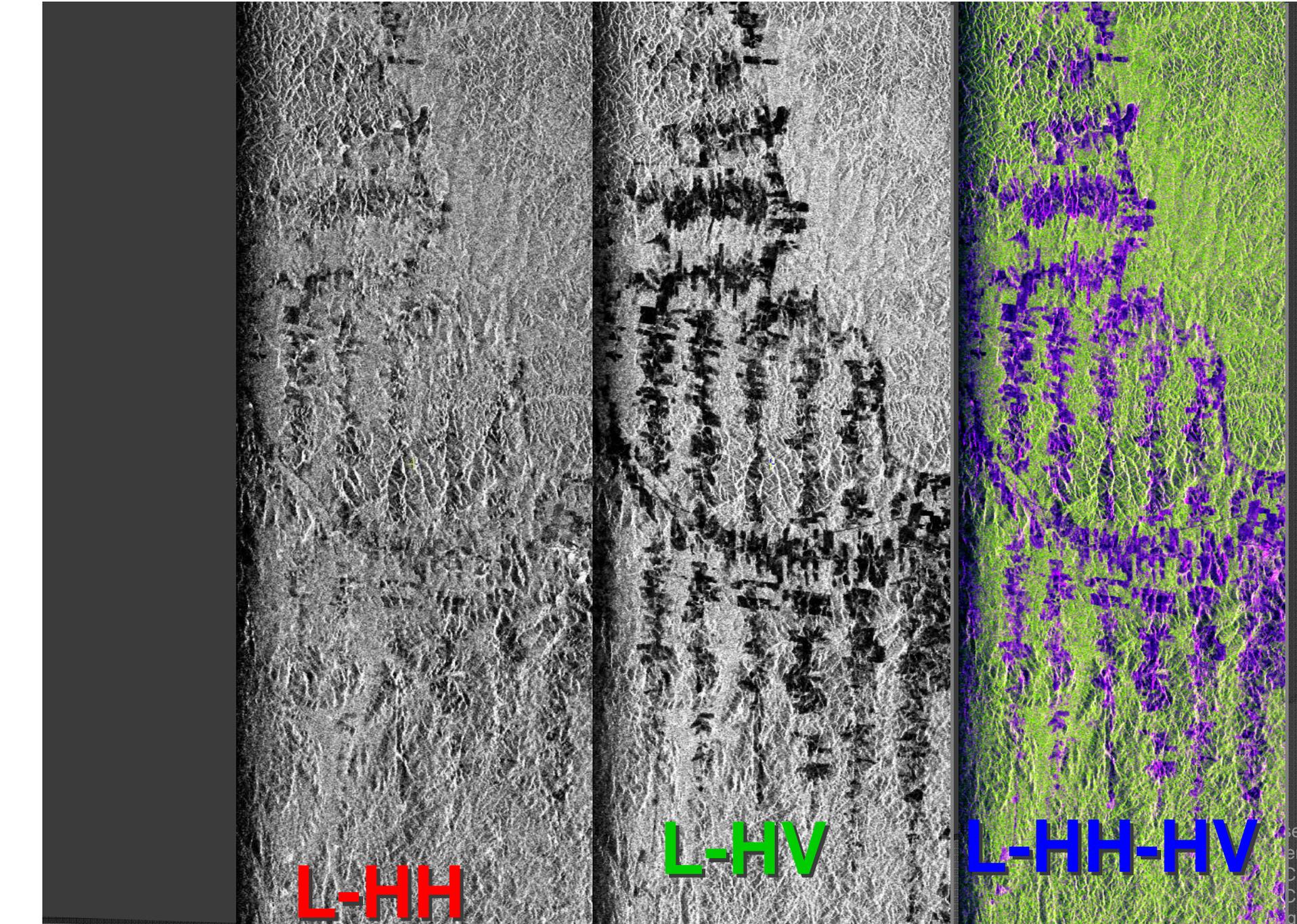


results

Spatio-temporal consistency



400 km



The image consists of three vertical panels of satellite radar imagery. The left panel shows a grayscale image with the text 'L-HH' at the bottom. The middle panel shows a grayscale image with the text 'L-HV' at the bottom. The right panel shows a color image with green and purple areas, with the text 'L-HH-HV' at the bottom. The text is in a bold, sans-serif font.

L-HH

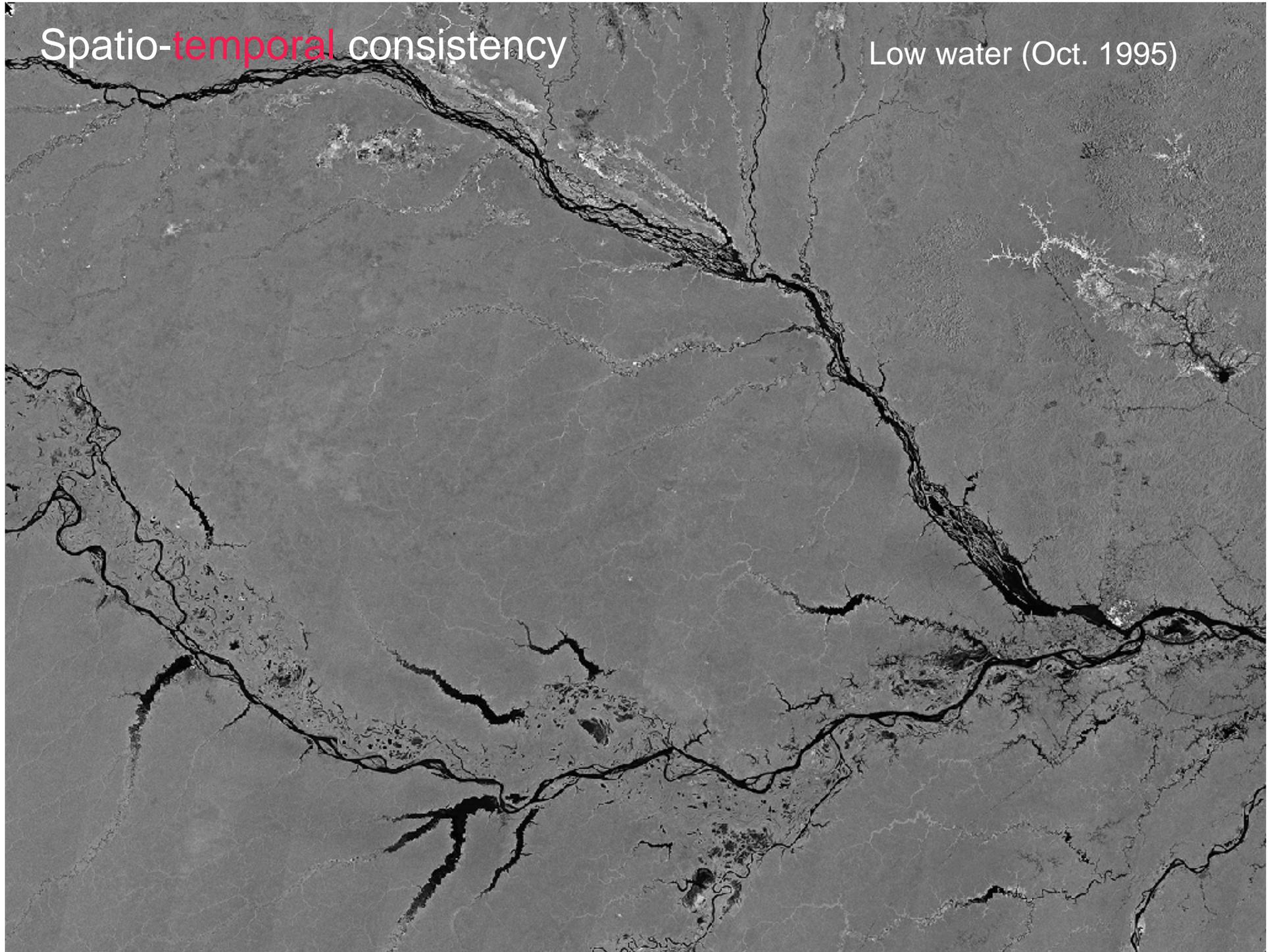
L-HV

L-HH-HV

Ref
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C9
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Tokyo, Jan
2008

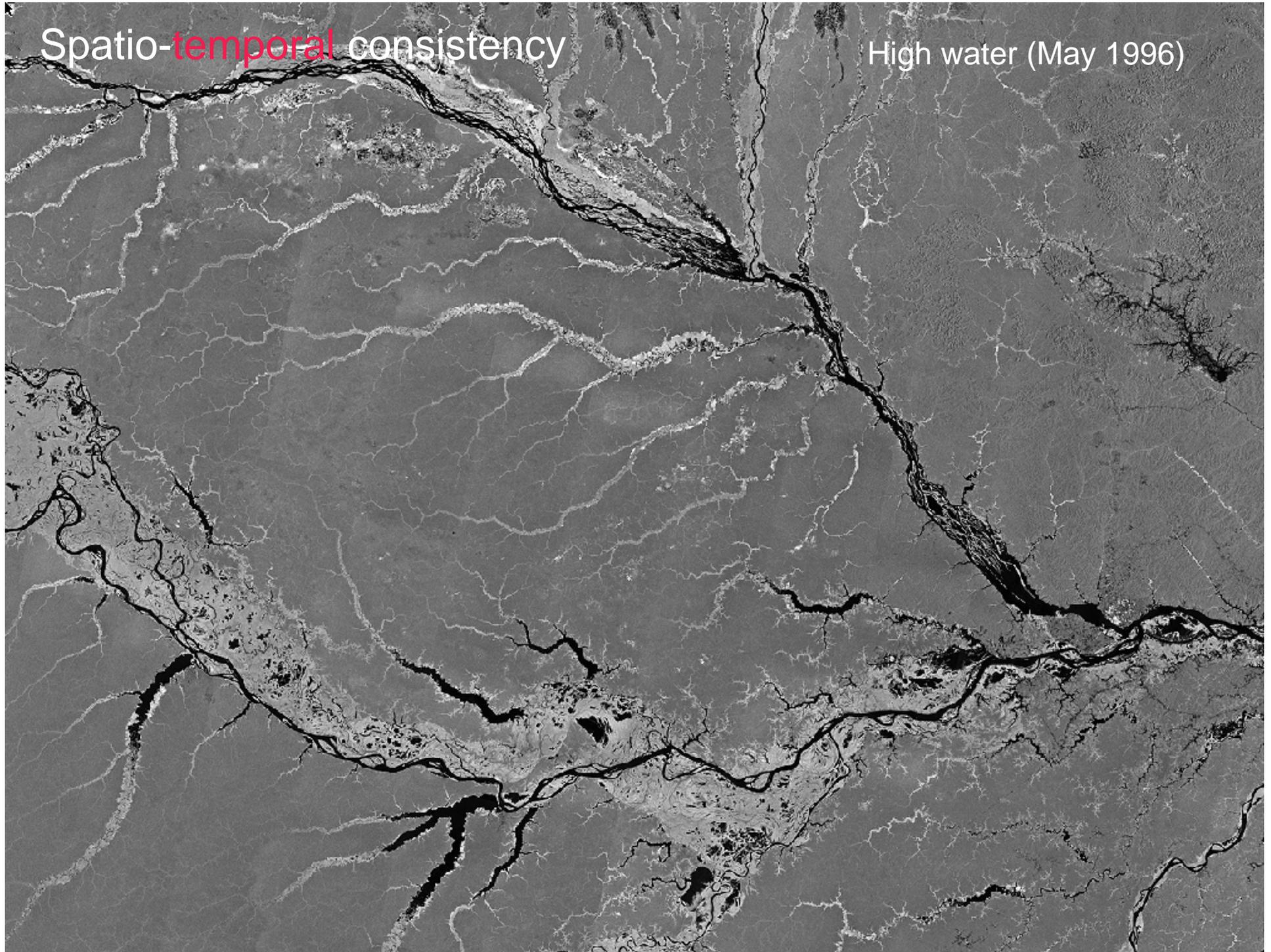
Spatio-temporal consistency

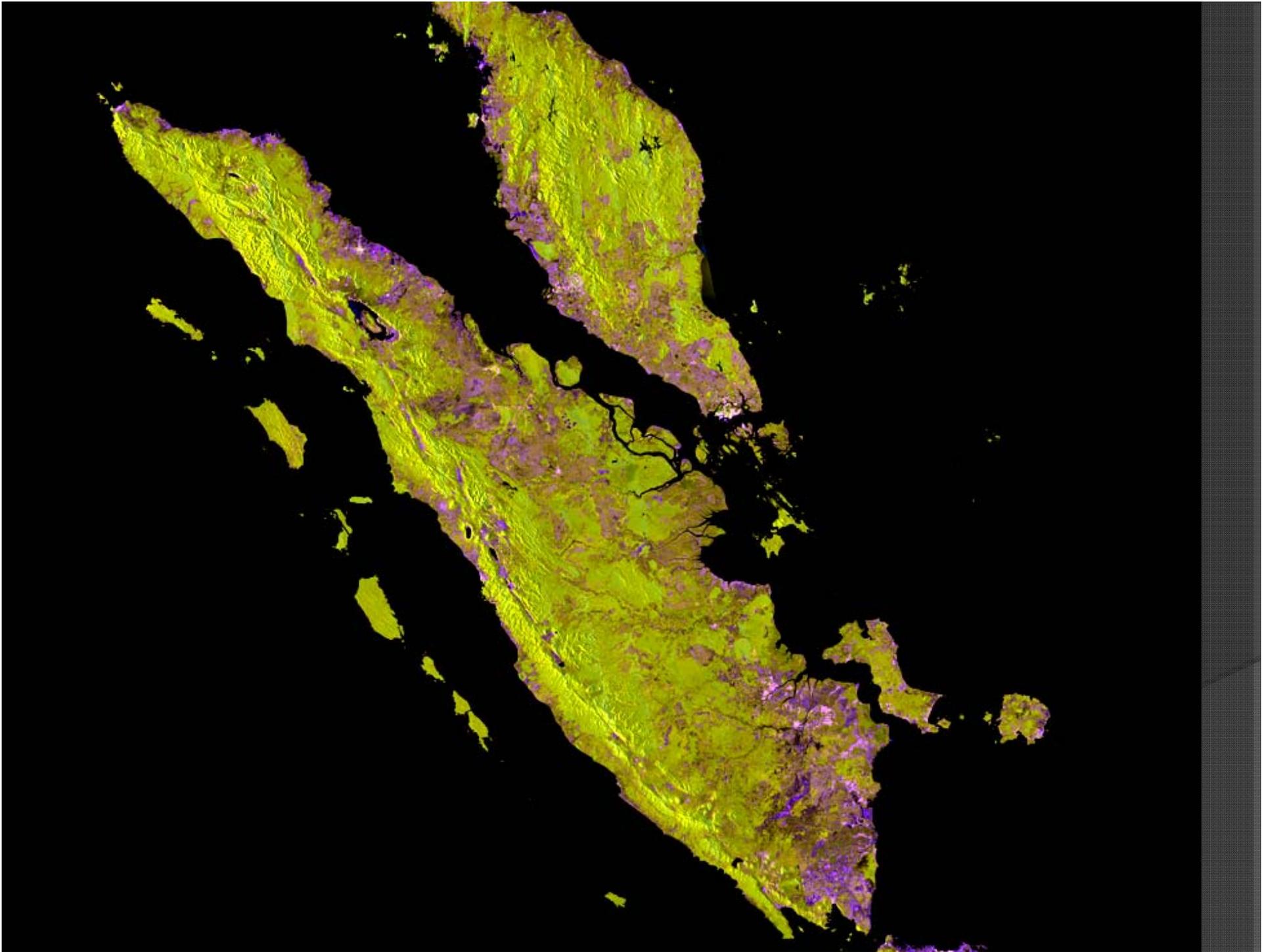
Low water (Oct. 1995)



Spatio-temporal consistency

High water (May 1996)



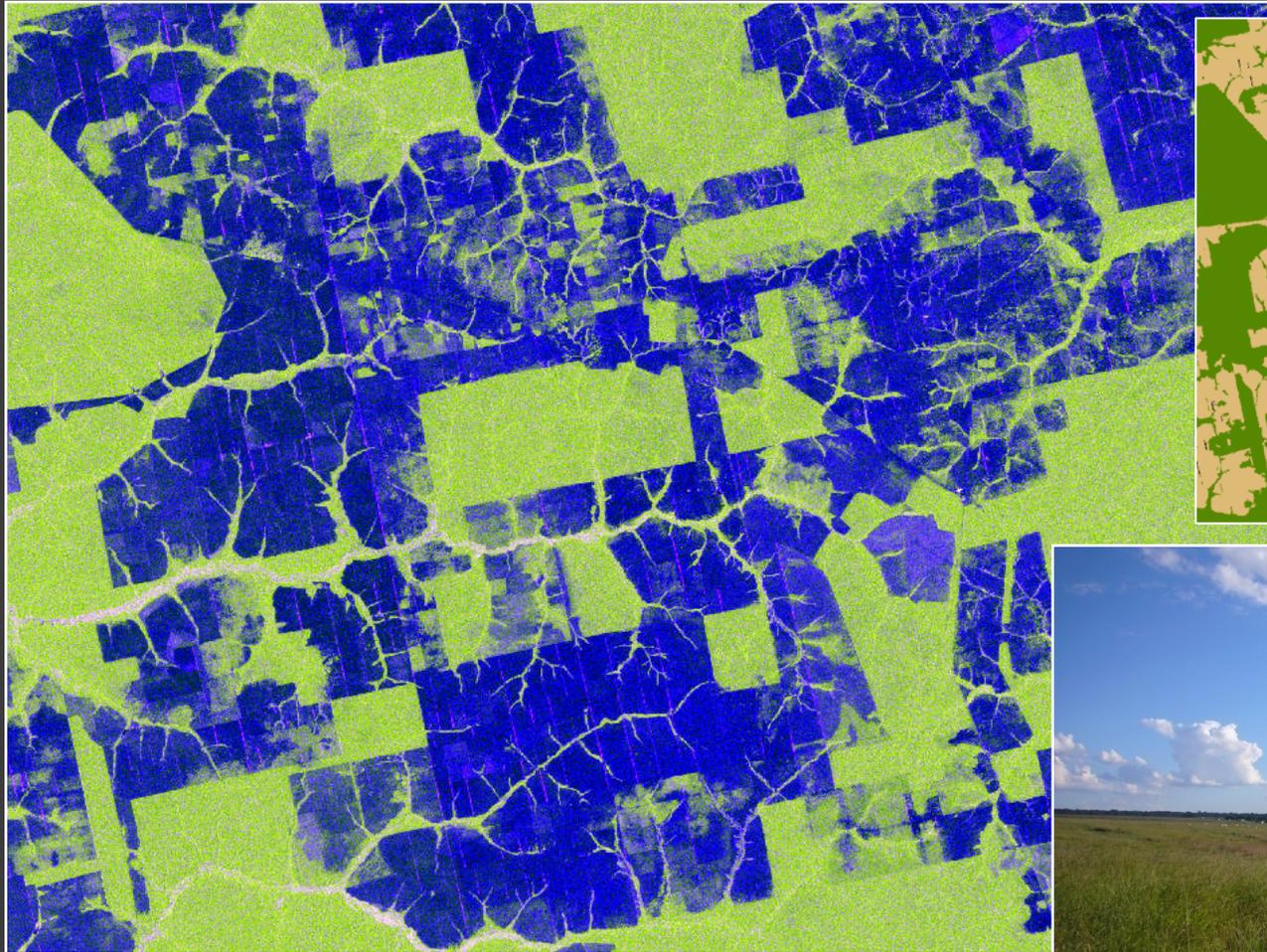




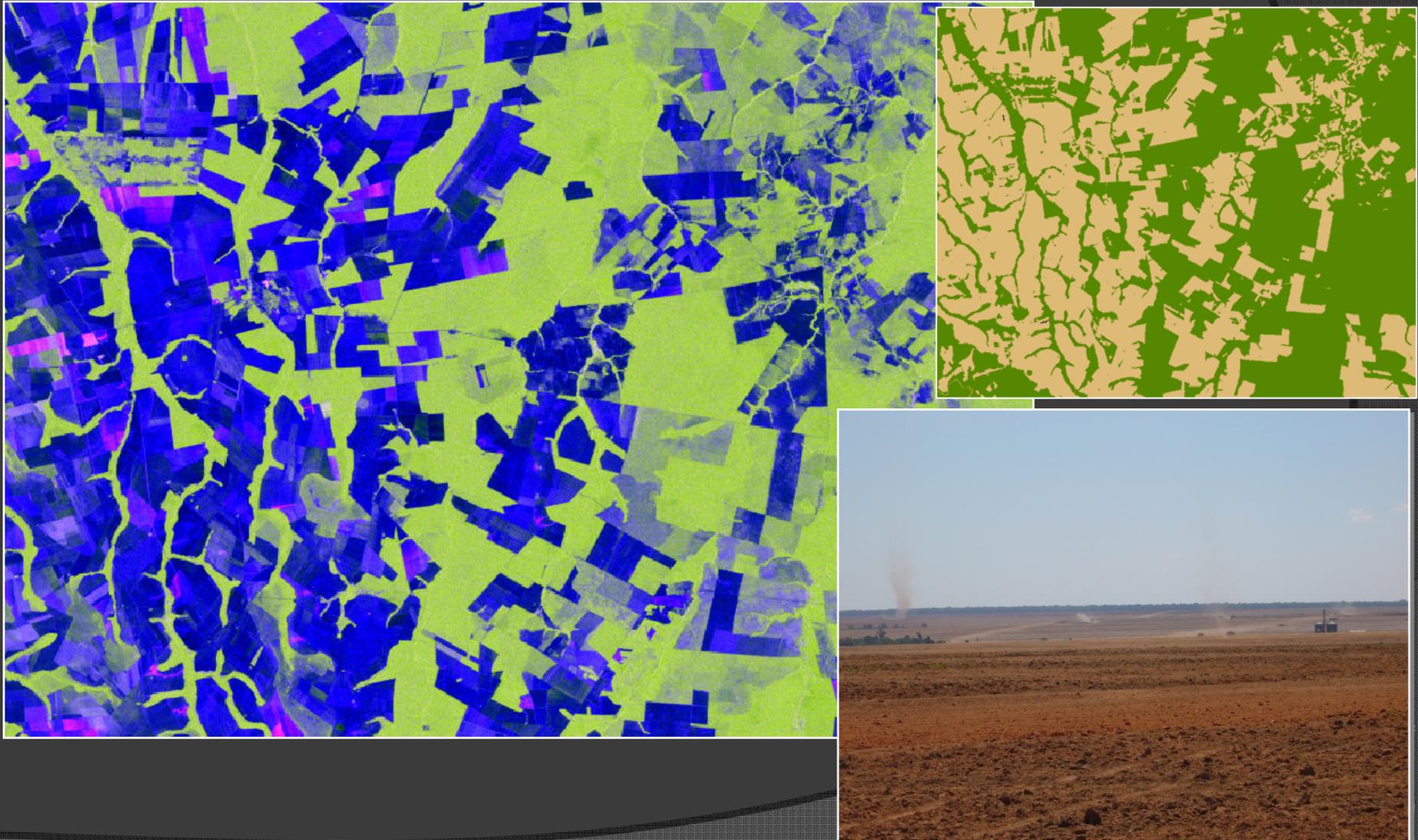
Change Detection ALOS-JERS

- Can Japanese SAR sensors ALOS (2006~) and JERS (1992~1998) historical data be used jointly to establish decadal deforestation rates?
- What types of changes are detected?
What types are not detected?
- Forest, Grassland, Agricultural land, and Wetland

Large-Holder Pasture Expansion as seen by ALOS/PALSAR

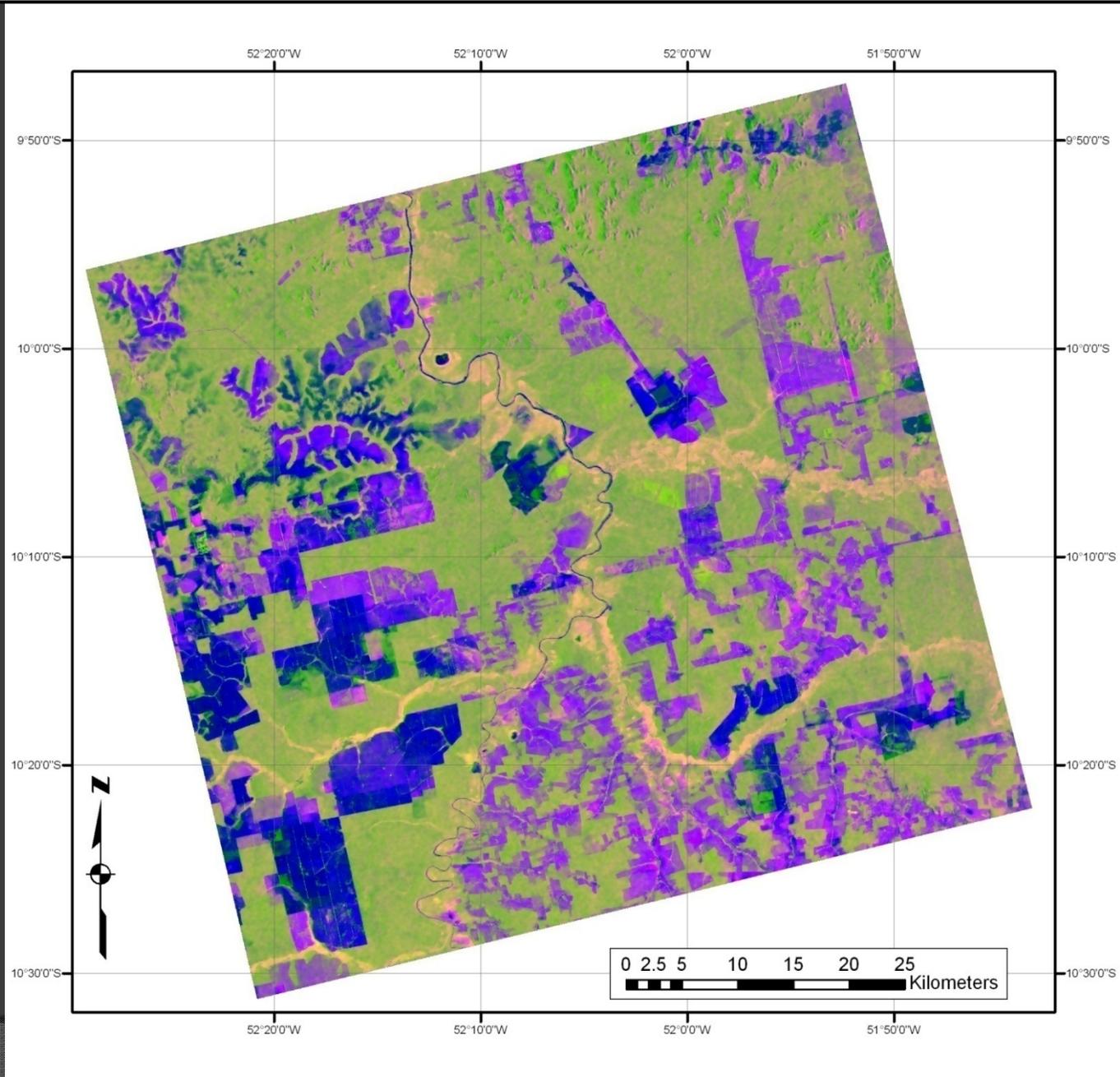


Large-Holder Soy-Field Expansion as seen by ALOS/PALSAR

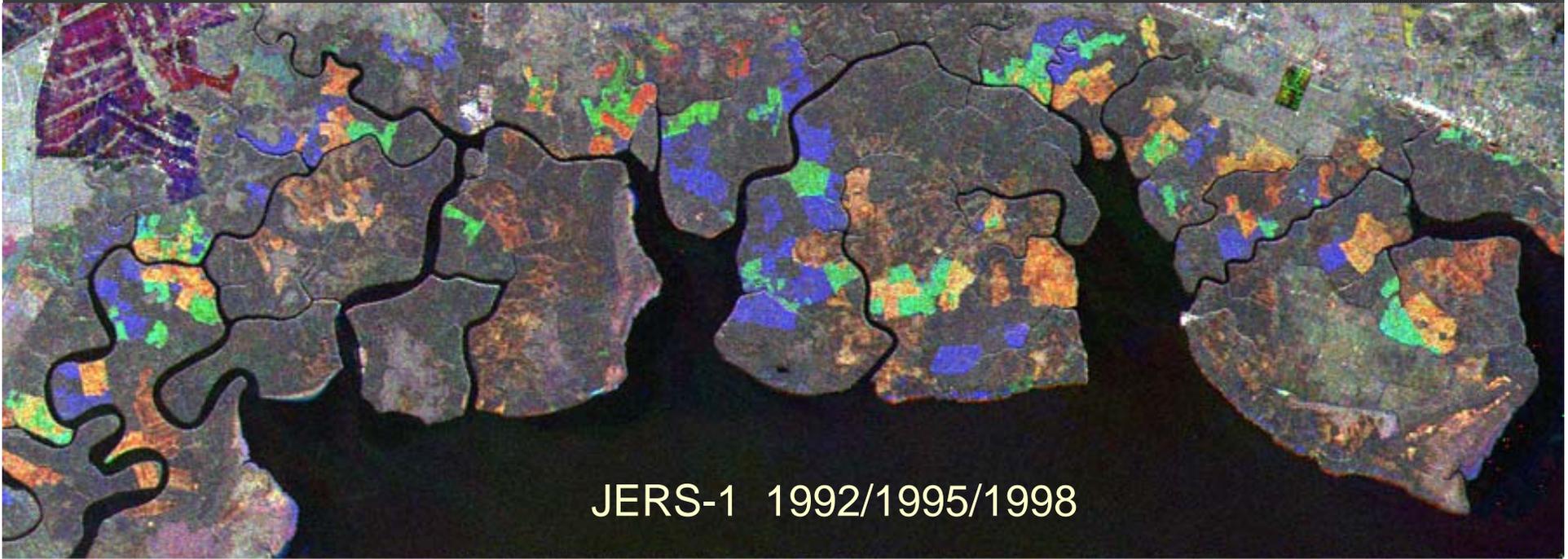


Tokyo, Jan
2008

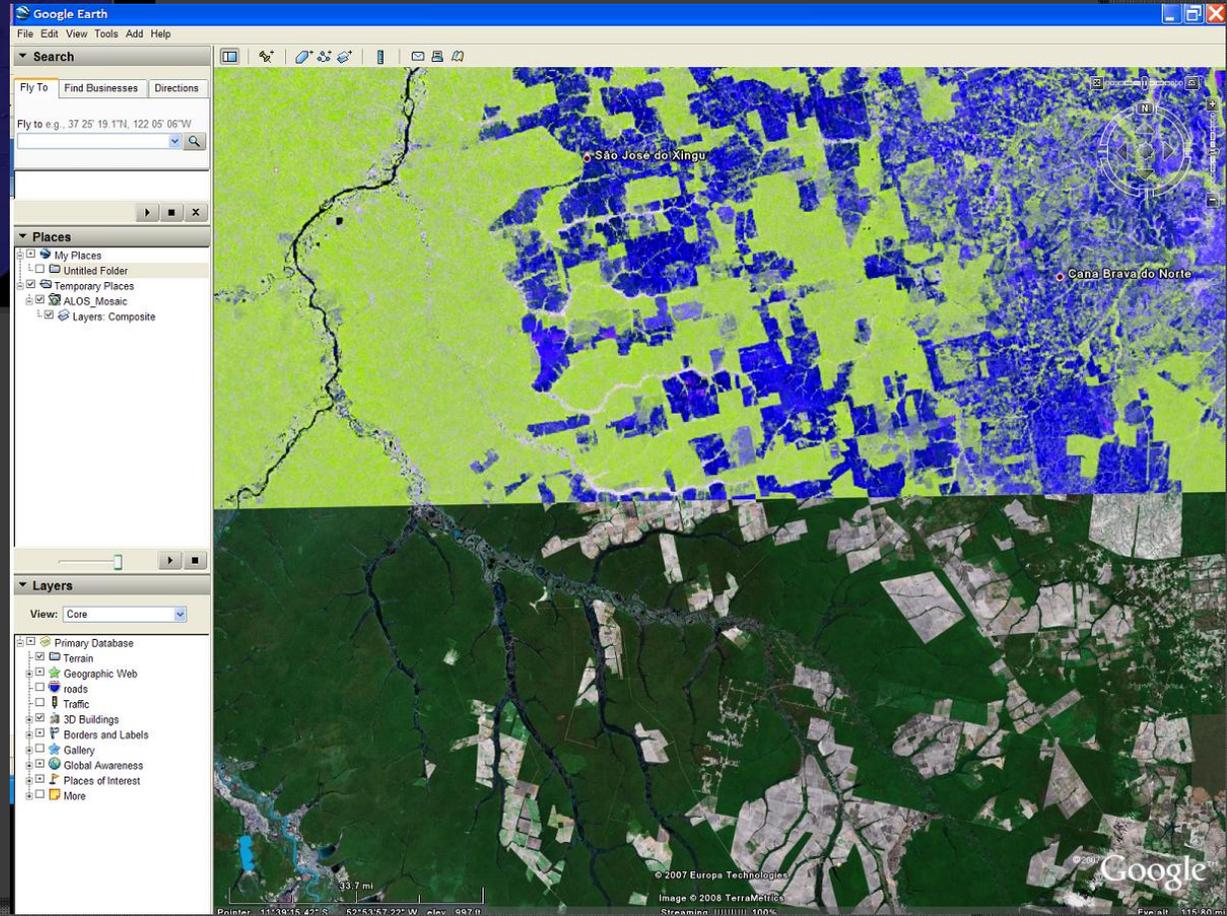
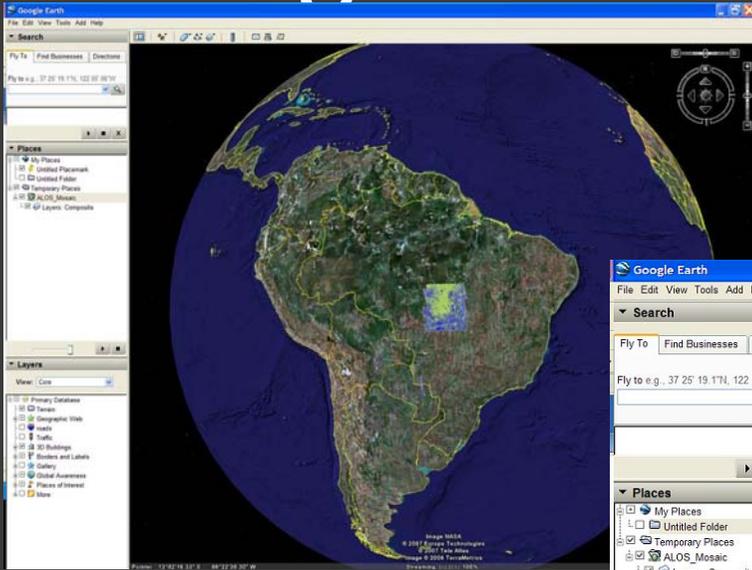
Color Composite Image (R-G-B = JERS-ALOS-Difference)

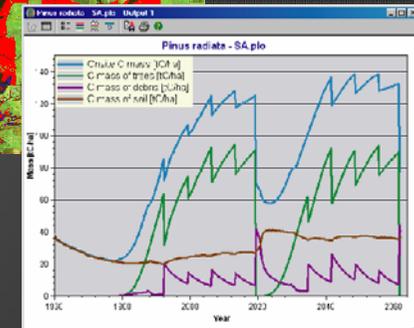
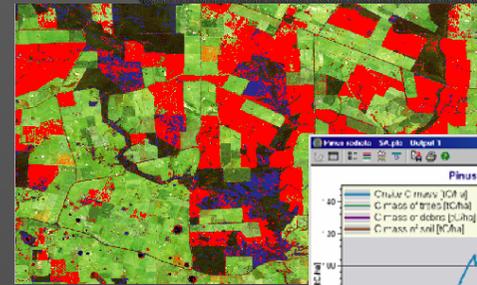
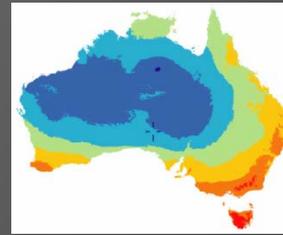
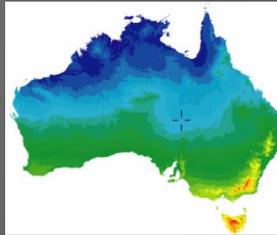
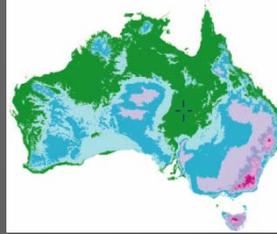
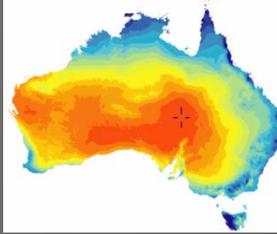
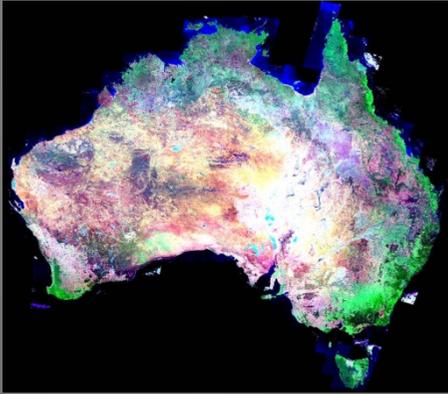


Josef
Kellendorfer,
WHRC,
K&C9
Meeting,
Tokyo, Jan
2008



Google Earth will

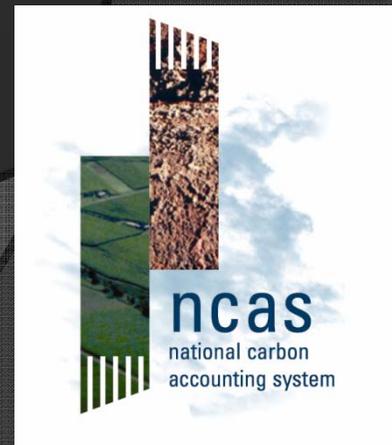




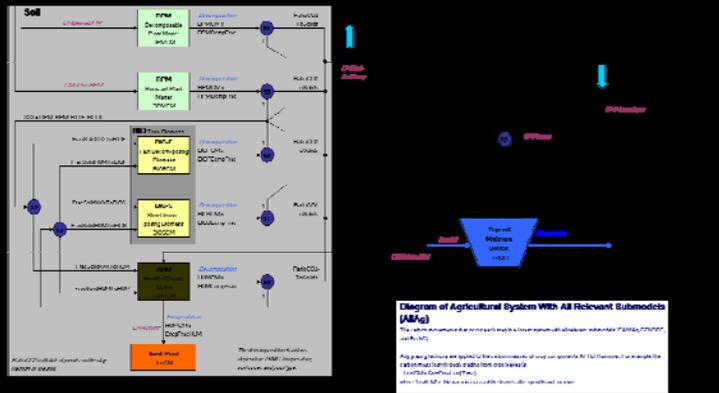
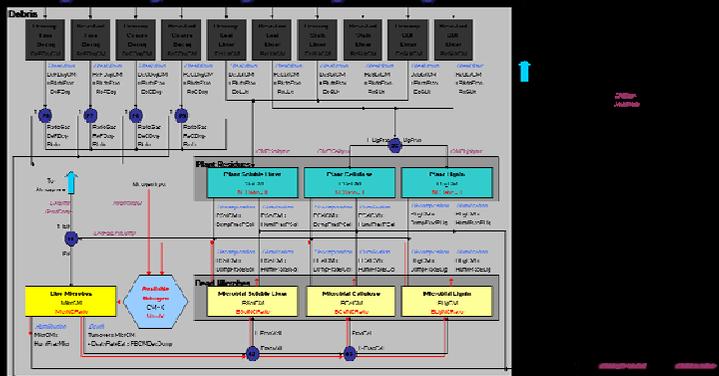
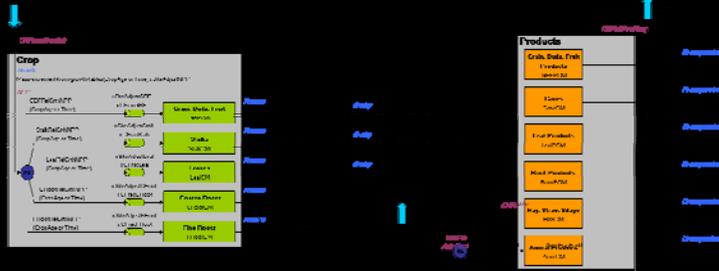
AUSTRALIA'S NATIONAL CARBON ACCOUNTING SYSTEM



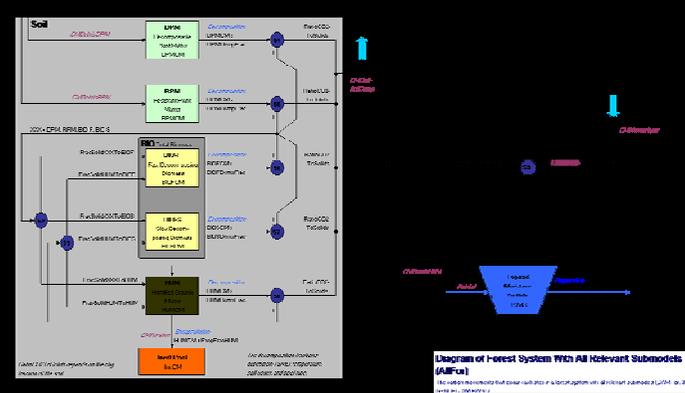
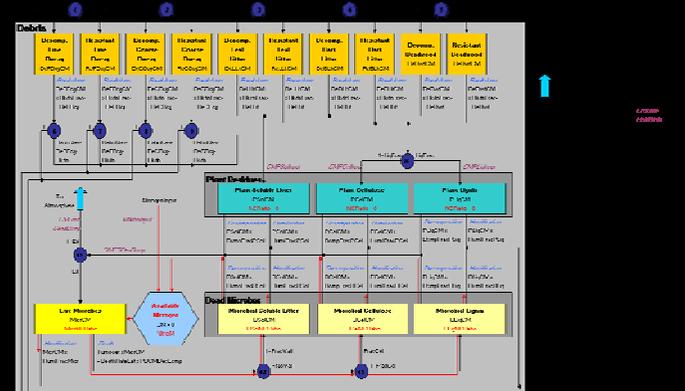
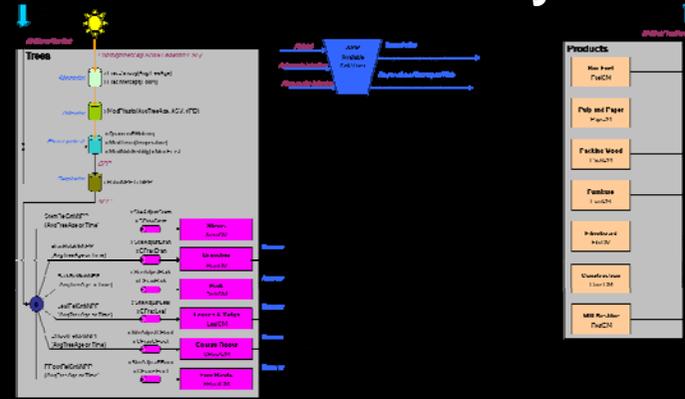
Australian Government
Department of the Environment and Water Resources



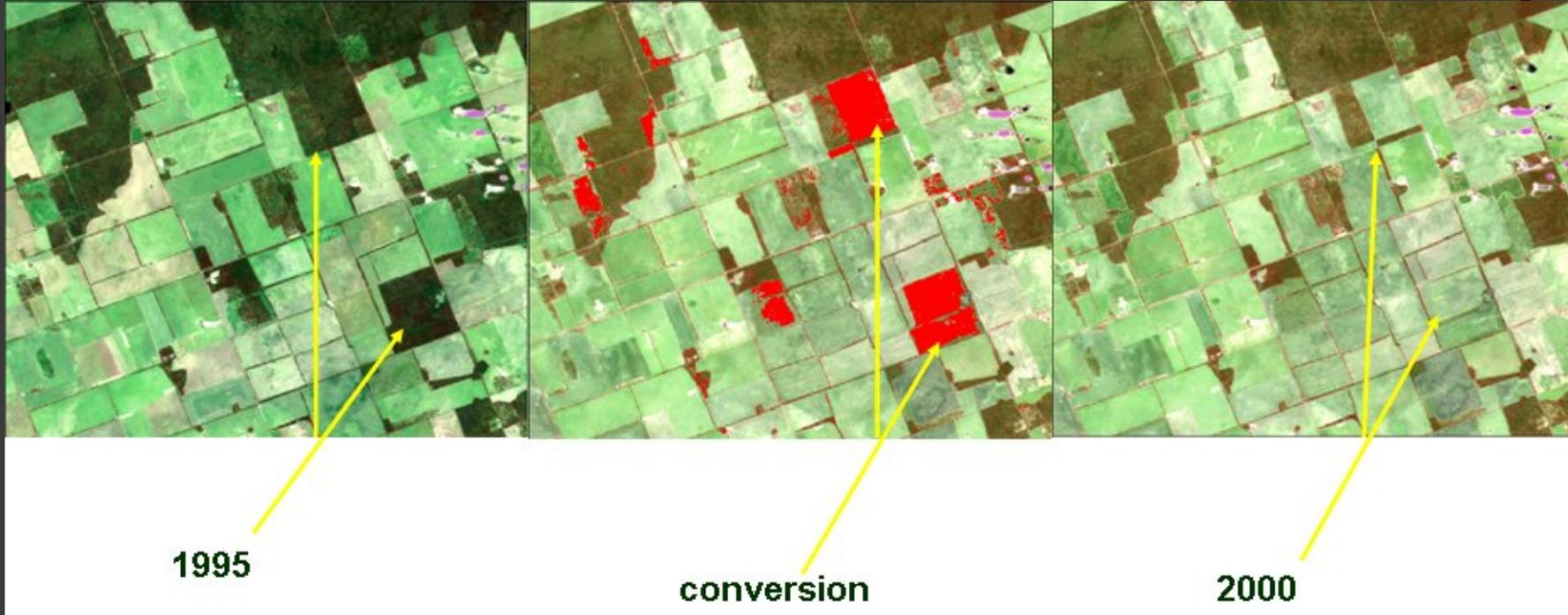
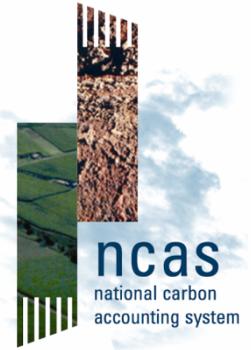
Agriculture



Forestry



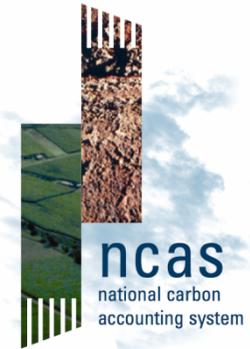
Deforestation



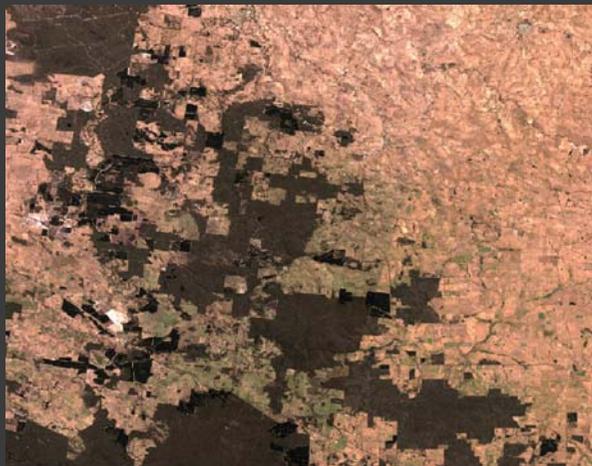
Annual national updates –
most recent 2005



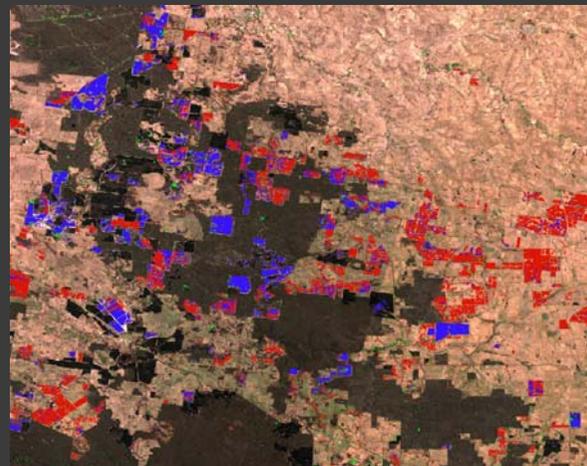
Reforestation



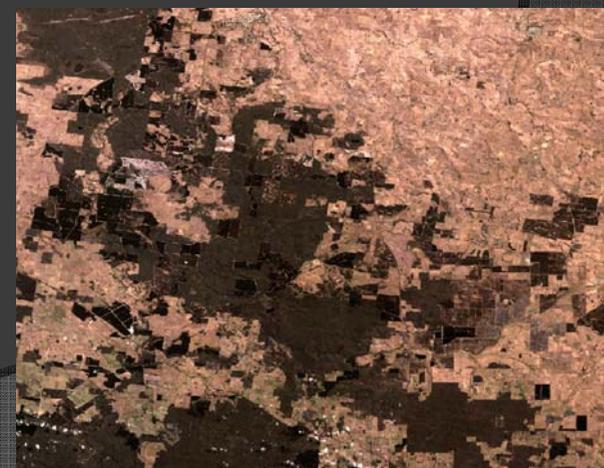
1989



Establishment



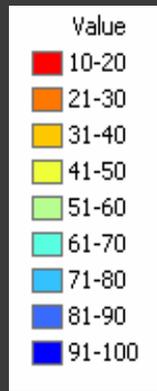
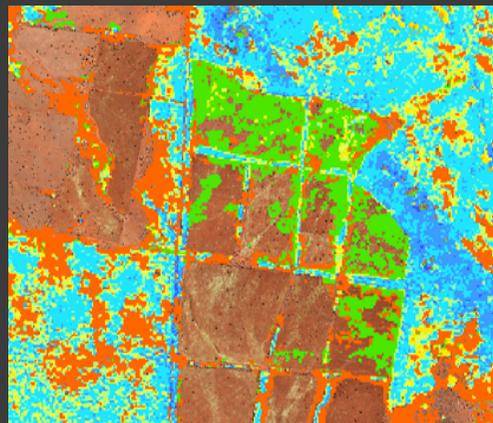
2004



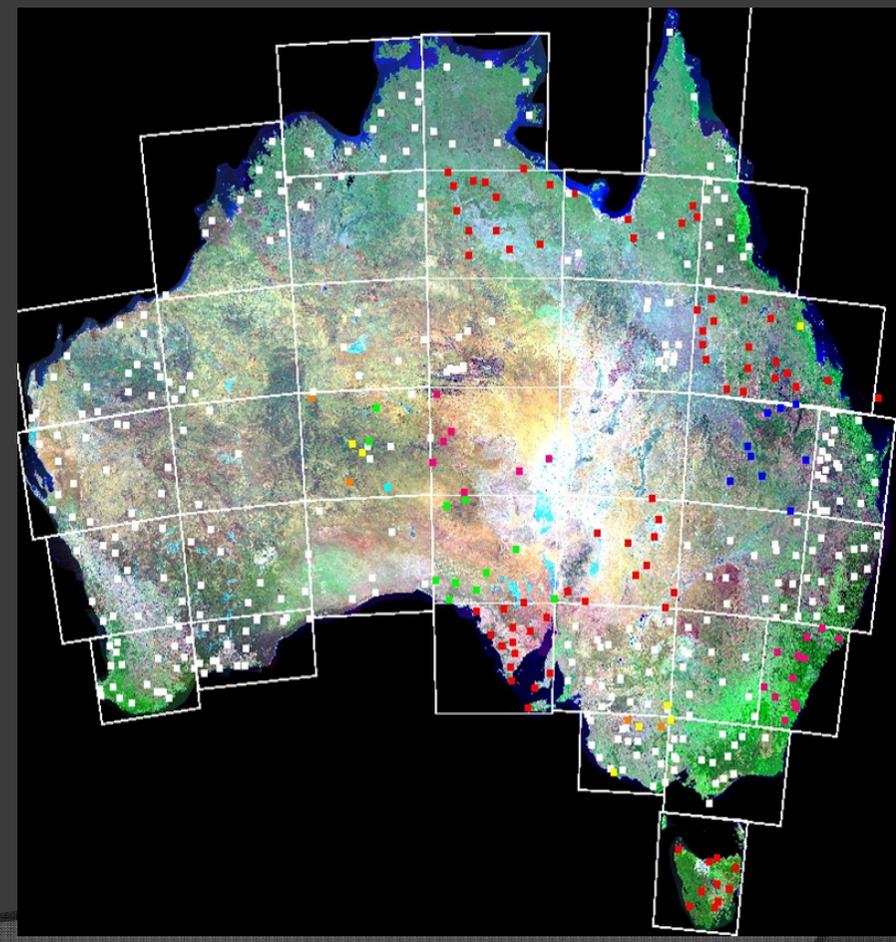
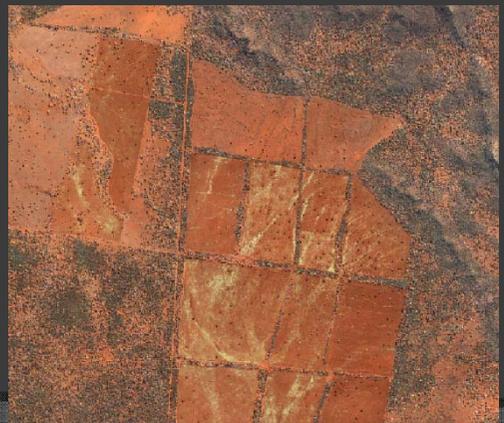
3 forest types;
conifer, hardwood,
other 'native'



Remote Sensing - Verification

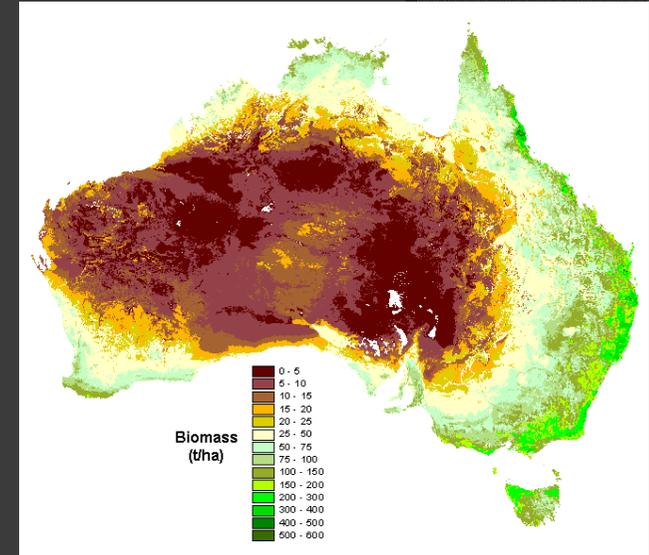
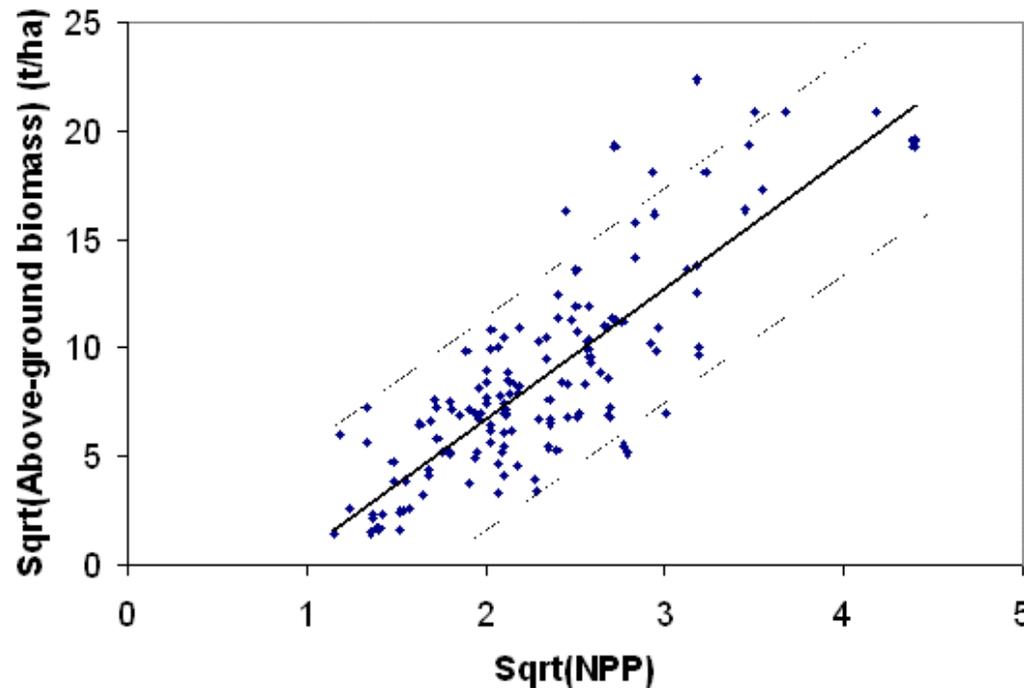


 Recent clearing



NCAS - biomass

- Allows estimates of total biomass with relatively few ground plot samples
- Spatial regression techniques enable the estimation of the point value and probable range of likely biomass on any specific pixel.



Australian Government
Department of the Environment and Heritage
Australian Greenhouse Office

the national carbon accounting toolbox and data viewer

These products showcase technological advances, allowing you to search and use data sets, technical reports, carbon accounting methods, detailed guidelines and more. These freely accessible tools are here to help you with your present or planned planning. Developed by the Australian Greenhouse Office in collaboration with the CSIRO, the Australian National University and Queensland Australia.

national carbon accounting toolbox

Providing tools to enhance sustainable land management

The National Carbon Accounting Toolbox assists in estimating and predicting greenhouse gas emissions and carbon stock changes from land use and management. It contains the FULICAM modelling software and a complete set of supporting technical documentation.

Use the toolbox to:

- Browse or search our complete set of technical reports covering all aspects of carbon accounting
- Run the FULICAM model to estimate greenhouse gas emissions and predict carbon stock changes

Please check our web site for periodic updates:
<http://www.greenhouse.gov.au/ncaas>
 Email enquiries to: ncaas@greenhouse.gov.au

The National Carbon Accounting Toolbox is derived from Australia's National Carbon Accounting System, with assistance from CSIRO and the Australian National University. No responsibility is accepted for the completeness, accuracy, currency or suitability of the toolbox.
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National Carbon Accounting System Data Viewer

national carbon accounting system data viewer

Version 2.1
Records of Australia's landscape, vegetation & climate

This data viewer provides a unique satellite record of landscape and vegetation change, and climate patterns in Australia since 1972.

Assess changes in tree cover, options for re-vegetation, and effects of drought, fire, or climate variability.

Please check <http://www.greenhouse.gov.au/ncaas> for periodic updates. Email enquiries to: ncaas@greenhouse.gov.au.

The Commonwealth accepts no liability for any loss, damages, expenses and costs incurred by any person as a result of reliance on or use of this system. The Australian National University developed the data viewer. ANU/CSIRO and Sustainable Australia. ANU is supported by IRADA. © Copyright 2005 Commonwealth of Australia

Australian Government
Department of the Environment and Heritage
Australian Greenhouse Office

CSIRO

national carbon accounting system

fulICAM

Version
Predicting carbon flows in forest and agricultural systems

FULICAM estimates and predicts carbon flows associated with all biomass, litter and soil carbon pools in forest and agricultural systems.

Dr Gary Richards
Director & Principal Scientist
National Carbon Accounting System

Dr David Evans
Modeller & Lead Programmer

Please check <http://www.greenhouse.gov.au/ncaas> for periodic updates. Email enquiries to: ncaas@greenhouse.gov.au

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Australian Government
Department of the Environment and Heritage
Australian Greenhouse Office

CSIRO

ANU
THE AUSTRALIAN NATIONAL UNIVERSITY

national carbon accounting system

technical report no. 5a
Review of Alluvial Habitats for Woody Biomes in the Northern West of WA

technical report no. 5b
Review of Alluvial Habitats for Woody Biomes in the Northern West of WA

technical report no. 17
Synthesis of Alluvial Habitats for Woody Biomes in the Northern West of WA

technical report no. 25
Review of Unpublished Biomass-Related Information: Western Australia, South Australia, New South Wales and Queensland

