The ALOS Kyoto & Carbon Initiative - - an overview

A. Rosenqvist

Japan Aerospace Exploration Agency

Earth Observation Research and Applications Center

<ake.rosenqvist@jaxa.jp>

November, 2003

The ALOS Kyoto & Carbon Initiative

Presentation outline

1. Heritage and objectives
2. Project organization
3. Data- and information requirements
4. K&C products
5. The Systematic Observation Strategy
6. Summary
7. References

JAXA
Japan Aerospace Exploration Agency

Heritage and objectives

The Kyoto & Carbon Initiative* is an international collaborative project forming the continuation and extension of the JERS-1 SAR GRFM/GBFM project into the era of the Advanced Land Observing Satellite - ALOS and as far as possible, ADEOS-II GLI.

Aims to support information needs posed by the "3 C's":

- The terrestrial **C**arbon cycle science community (CO2 & CH4 sources and sinks);
- Multinational Environmental **C**onventions and Declarations:
  - UNFCCC Kyoto Protocol (Forest and Land Cover Change);
  - Ramsar Convention (wetland characteristics and disturbances);
  - UN Millenium Declaration & UNCCD (water supply and desertification)
- Environmental **C**onservation

*Support to Multi-national Environmental Conventions and Terrestrial Carbon Cycle Science by ALOS and ADEOS-II – the Kyoto & Carbon Initiative. Proc. IGARSS-2003.

JAXA Japan Aerospace Exploration Agency

K&C Project organization

Project Lead (JAXA EORC)
Ake Rosenqvist

Advisors
Carbon: Shaun Quegan
Conventions: Y. Yamagata; Max Finlayson

Forest & LCC Theme
Theme Coordinators:
Craig Dobson (U-Mich)
Richard Lucas (UW-aber)

Wetlands & CH4 Theme
Theme Coordinator:
Laura Hess (UCSB)

Desert & Water Theme
Theme Coordinator:
Philippe Paillou (OAB)

Mosaic Products Theme
Theme Coordinator:
Bruce Chapman (JPL)

- Product Leader 1
  - Product Team 1
- Product Leader 2
  - Product Team 2
- ...

Theme Coordinators:

– Coordinate, focus and align products within and between the Themes.

– Assure synergy with TCO and convention information needs

– Authors of Theme chapter in the K&C Science Plan.

Product Leaders:

– Responsible for the generation of data- or information products.

Carbon & Convention Advisors:

– Advice Theme Coordinators and Product Leaders on:

– carbon cycle science (TCO) information needs;

– convention information requirements;

– conservation issues.

JAXA
Japan Aerospace Exploration Agency

K&C Project organization

Forest & Land Cover Change Theme

Theme Coordination:

- Craig Dobson - U-Michigan, USA
- Richard Lucas - U-Wales Aberystwyth, U.K.

Advisors:

- UNFCCC Kyoto - Y. Yamagata - IPCC, Japan UNFCCC delegation
- Carbon – Shaun Quegan - GTOS/TCO

Product Leaders:

- Thuy Le Toan - CESBIO, France
- Christiane Schmullius (Leif Eriksson) - U-Jena, Germany
- Shaun Quegan - U-Sheffield, U.K.
- Gianfranco De Grandi - JRC, E.U.
- Hakan Olsson - SLU, Sweden
- Richard Lucas - U-Wales Aberystwyth, U.K.
- Dalton Valeriano & J.R dos Santos - INPE, Brazil
- Dirk Hoekman - Borneo Orangutang Salvation Found., Indonesia
- R. Tateishi - U-Chiba, Japan
- Alberto Moreira (Papahanassoiu & Hajnsek)- DLR, Germany
- Paul Siqueira - JPL, USA

JAXA Japan Aerospace Exploration Agency

K&C Project organization

Wetlands & CH4 Theme

Theme Coordination: Laura Hess - UCSB, USA

Advisors:

- Max Finlayson - Ramsar STRP/Wetlands International
- Shaun Quegan - GTOS/TCO

Product Leaders:

- Laura Hess - UCSB, USA
- Maycira Costa & Kevin Telmer - U-Victoria, Canada
- Tony Milne & Richard Lucas - UNSW, Australia
- Dirk Hoekman - BOSF, Indonesia
- Kyle McDonald - JPL, USA
- Bill Salas - AGS, USA
- Martti Hallikainen - U-Helsinki, Finland
- Doug Taylor (John Lowry) - Wetlands International

JAXA Japan Aerospace Exploration Agency

K&C Project organization

Desert & Water Theme

Theme Coordination: Philippe Paillou - OAB, France

Product Leaders:

- Philippe Paillou - OAB, France
- Francesco Holecz (Paolo Pasquali) - sarmap, Switzerland

Mosaic Products Theme

Theme Coordination: Bruce Chapman - JPL, USA

Product Leaders:

- Bruce Chapman - JPL, USA
- Masanobu Shimada - JAXA EORC, Japan
- Philippe Paillou - OAB, France
- Gianfranco De Grandi - JRC, E.U.
- ACRES, Australia (TBC)

JAXA Japan Aerospace Exploration Agency

K&C Project organization

Product development

Work Approach

1. Methodology development - Year 1-3

• Development of algorithms and methods required to support the specific information requirements identified (e.g. annual biomass change, wetland flooding extents, irrigated rice spatial distribution, etc.);

2. Regional "prototype" demonstration - Year 1-3

• Operational demonstration of the methodology to a "large" geographical region - regional/semi-continental scale. Delivery of prototype product within 3 years of the ALOS launch.

3. Continental/global-scale extrapolation - Year 4+

• Regional/continental-scale application of the methods and work approaches developed to other, or larger, geographical regions *.

*Continental-scale, repetitive & spatio-temporally consistent PALSAR data acquisitions achieved through the Systematic Data Observation Strategy.

JAXA Japan Aerospace Exploration Agency

Data- and information requirements

Forest & Land Cover Change Theme

Support to the Kyoto Protocol*, **
and Terrestrial Carbon Cycle Science***

Data

(1) Development of systematic observation systems and data archives (Kyoto Protocol Art. 5, 10d)

Derived information

(2) Detection and spatial quantification of annual changes in forest- and land cover (Art. 3.3, 3.4, 4, 12)

(3) Incremental changes in [regenerating] above-ground biomass (Art. 3.3, 3.4, 4, 12);

A Review of Remote Sensing Technology in support to the Kyoto Protocol, Environmental Science & Policy, 2003.

**Remote Sensing and the Kyoto Protocol: A Review of Available and Future Technology for Monitoring Treaty Compliance*, ISPRS Report, 1999

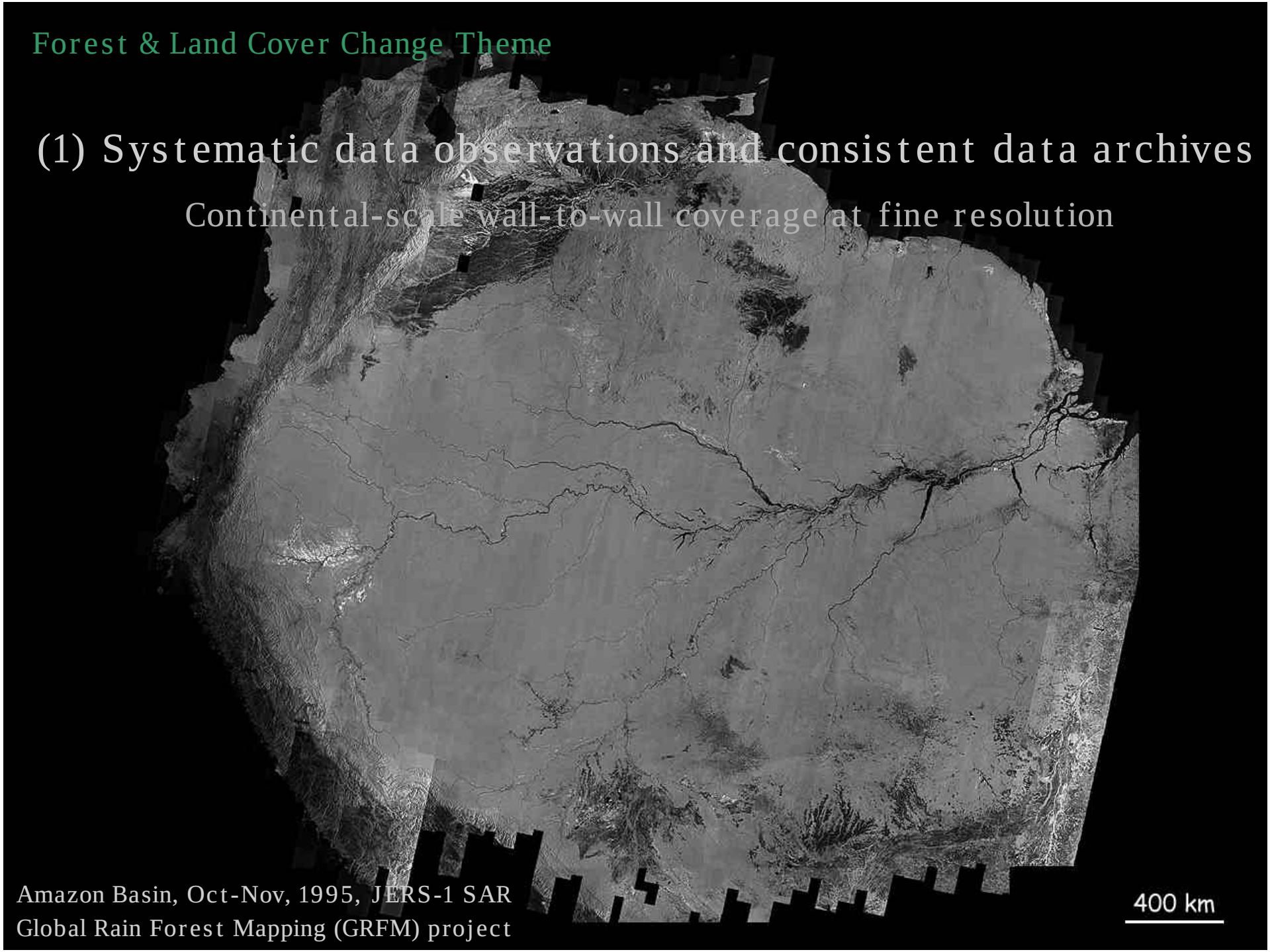
***IGOS-P carbon cycle observations theme: terrestrial and atmospheric components. A report to IGOS-P*; TCO Theme Team, 2001

JAXA Japan Aerospace Exploration Agency

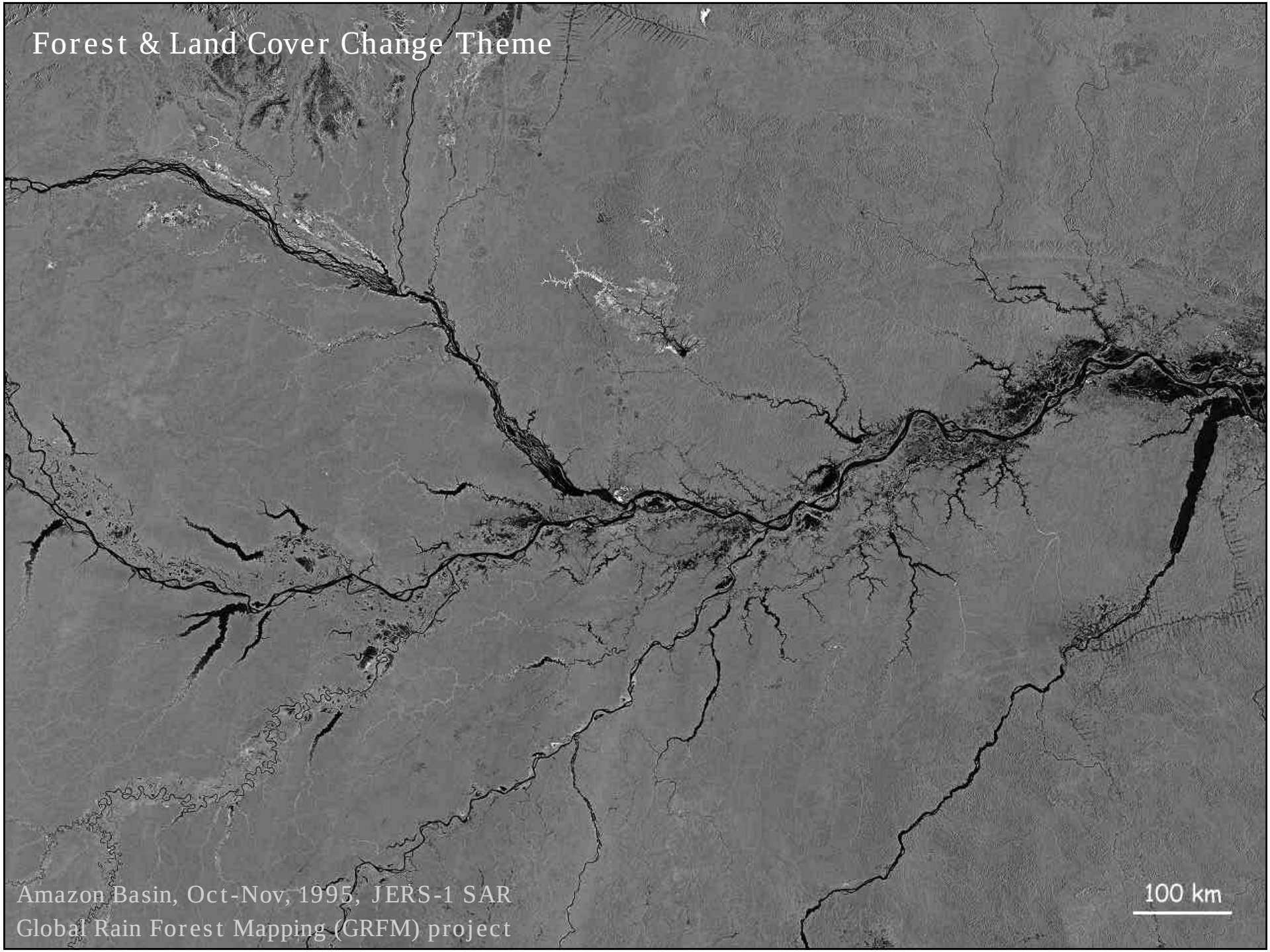
Forest & Land Cover Change Theme

(1) Systematic data observations and consistent data archives

Continental-scale wall-to-wall coverage at fine resolution



Amazon Basin, Oct-Nov, 1995, JERS-1 SAR
Global Rain Forest Mapping (GRFM) project

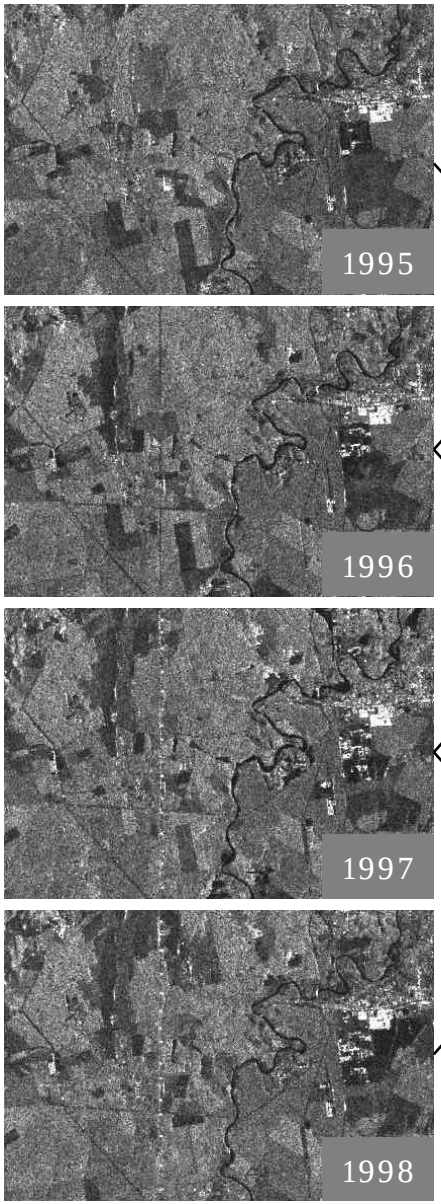

Forest & Land Cover Change Theme
Amazon Basin, Oct-Nov, 1995, JERS-1 SAR
Global Rain Forest Mapping (GRFM) project
100 km


Forest & Land Cover Change Theme
10 km
Amazon Basin, Oct-Nov, 1995, JERS-1 SAR
Global Rain Forest Mapping (GRFM) project

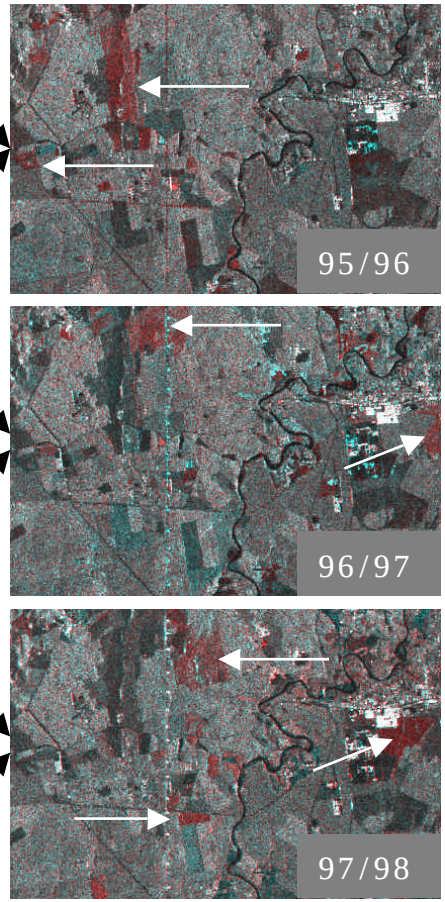

Forest & Land Cover Change Theme
1.25 km
Amazon Basin, Oct.-Nov. 1995, JERS-1 SAR
Global Rain Forest Mapping (GRFM) project

Forest & Land Cover Change Theme

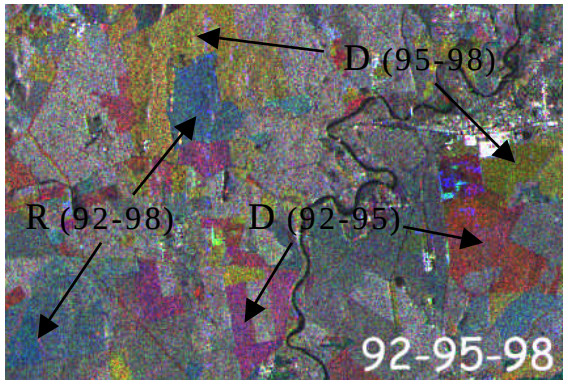
(2, 3) Detection and quantification of changes in land cover and biomass stocks.



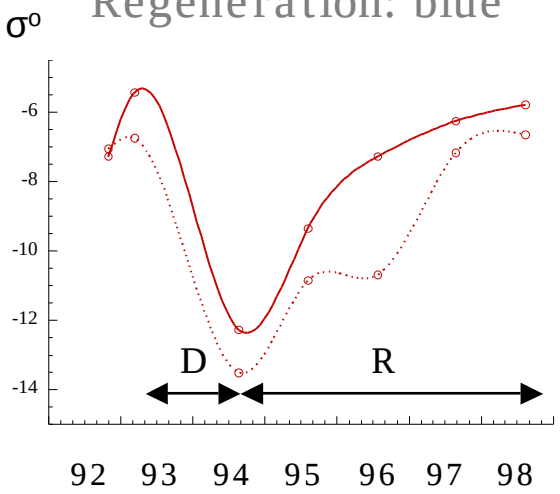
SAR time sequence



Annual forest change
(red areas)



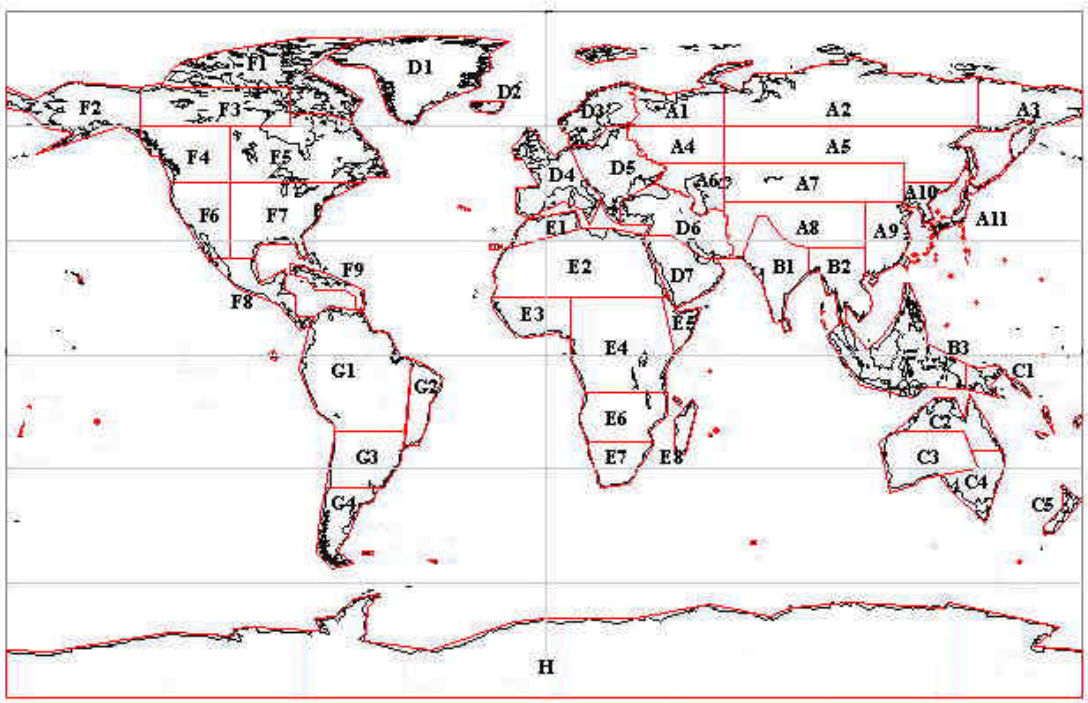
Multi-annual forest change
Clearings: red/yellow/magenta
Regeneration: blue



Incremental biomass change
(< ~100 t/ha)

ALOS PALSAR Observations

- 3 global PALSAR coverages annually
  - Fine-res HH+HV @ 34° (summer/dry season)
  - Fine-res HH+HV @ 43° (winter/wet season)
  - Scansar HH (descending)
- Bi-annual global coverage in InSAR mode (boreal - annual)
- Repetition during ALOS life-time



To minimise seasonal bias in the PALSAR time series, each region is covered the same time (months) every year, witin a 46-day time period.

JAXA Japan Aerospace Exploration Agency

Wetlands & CH4 Theme

Support to the Ramsar Convention on Wetlands* and Terrestrial Carbon Cycle science**

Ramsar information requirements (conservation focus)

(1) Spatial and temporal characteristics of flooding patterns in Ramsar designated (and other) wetland areas

- Spatial extent;
- Temporal cycle (seasonal/annual/decadal...);

(2) Identification of natural- and human-induced disturbances in wetlands;

(3) Support to the Ramsar global wetlands inventory.

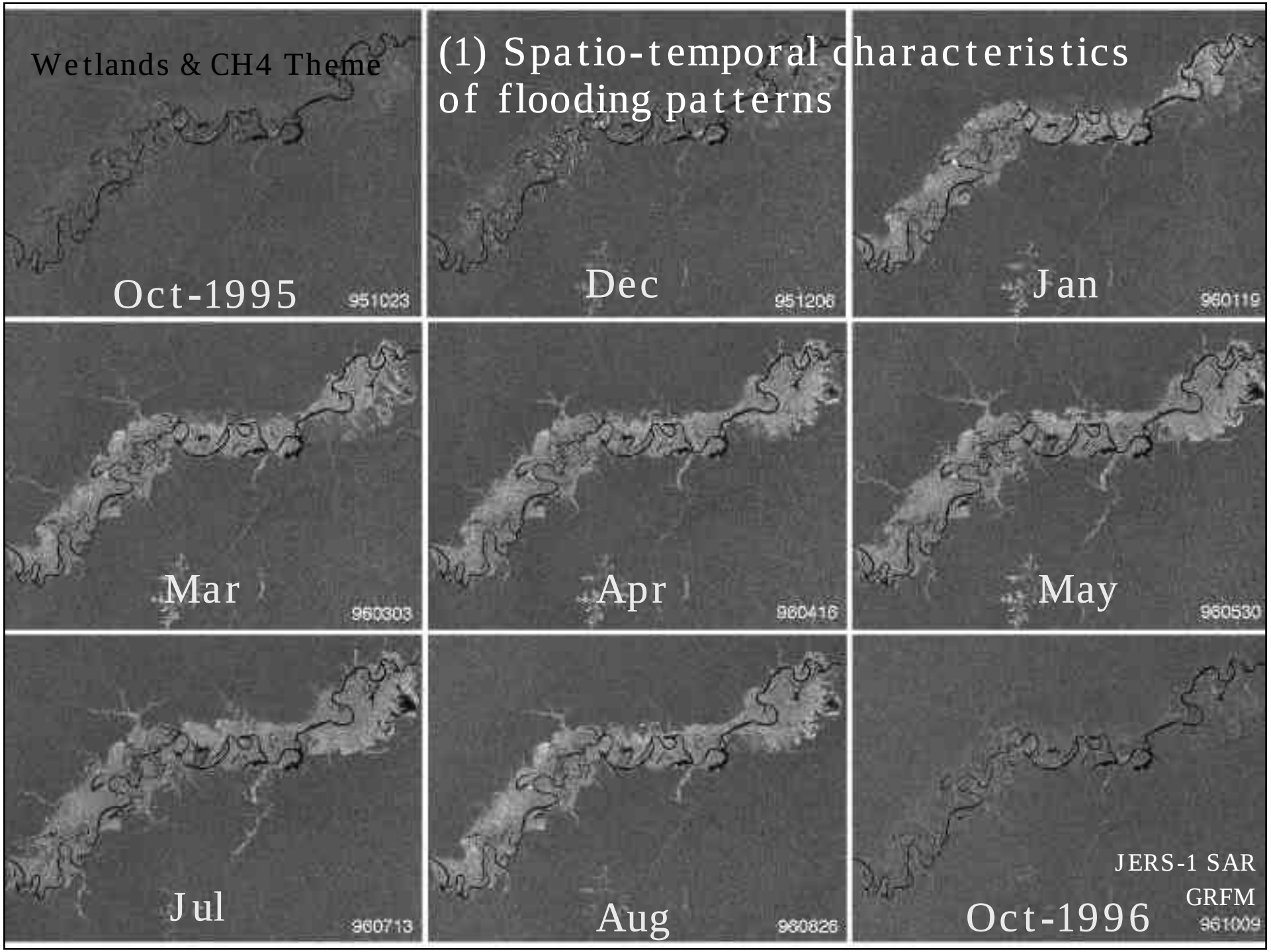
Relevance to TCO (Wetlands as sources of CH4)

(4) Monitoring of anthropogenic and natural sources of CH4:

* Ramsar Bureau, Personal communication, Oct., 2002.

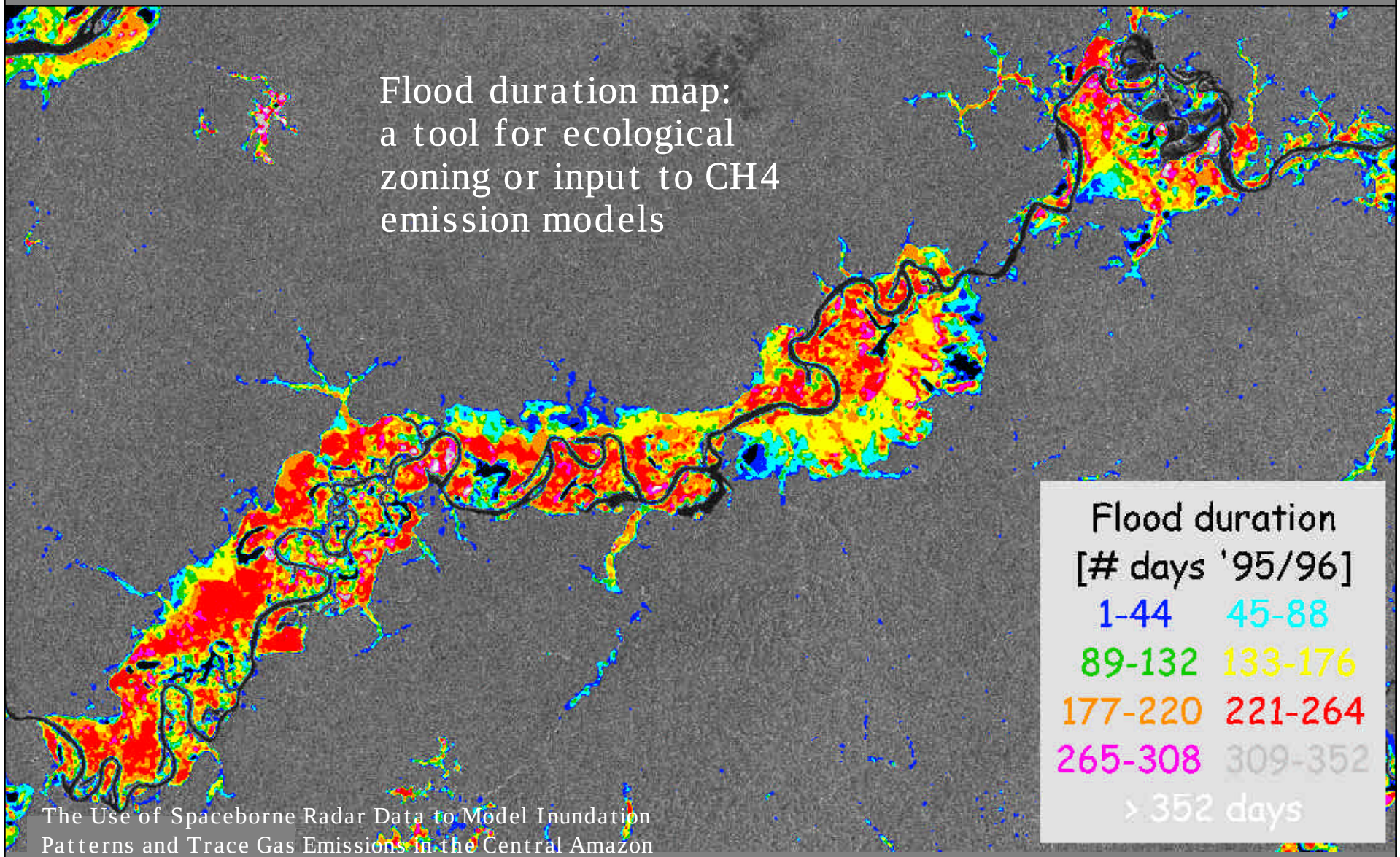
** IGOS-P carbon cycle observations theme: terrestrial and atmospheric components. A report to IGOS-P; TCO Theme Team, 2001

JAXA Japan Aerospace Exploration Agency


Wetlands & CH4 Theme
(1) Spatio-temporal characteristics of flooding patterns
Oct-1995
951023
Dec
951206
Jan
960119
Mar
960303
Apr
960416
May
960530
Jul
960713
Aug
960826
JERS-1 SAR
GRFM
Oct-1996
961009

Wetlands & CH4 Theme

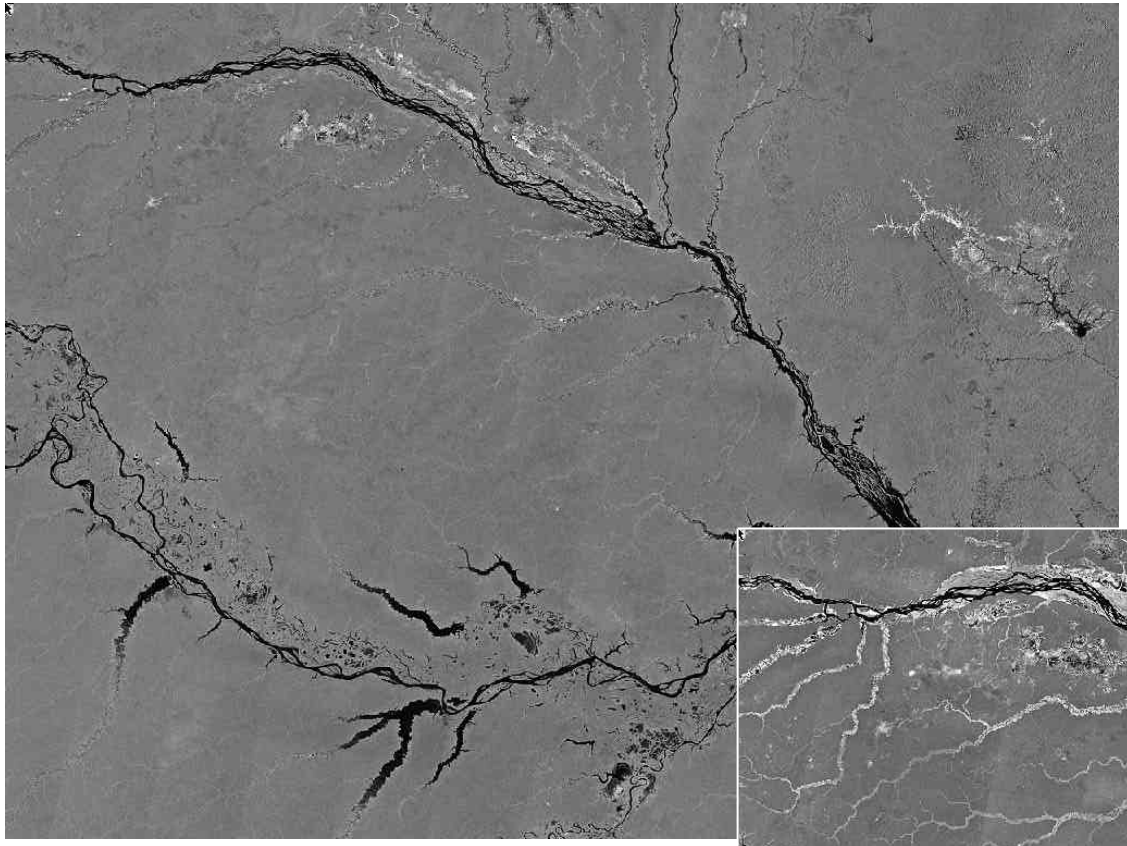
(1) Spatio-temporal characteristics of flooding patterns



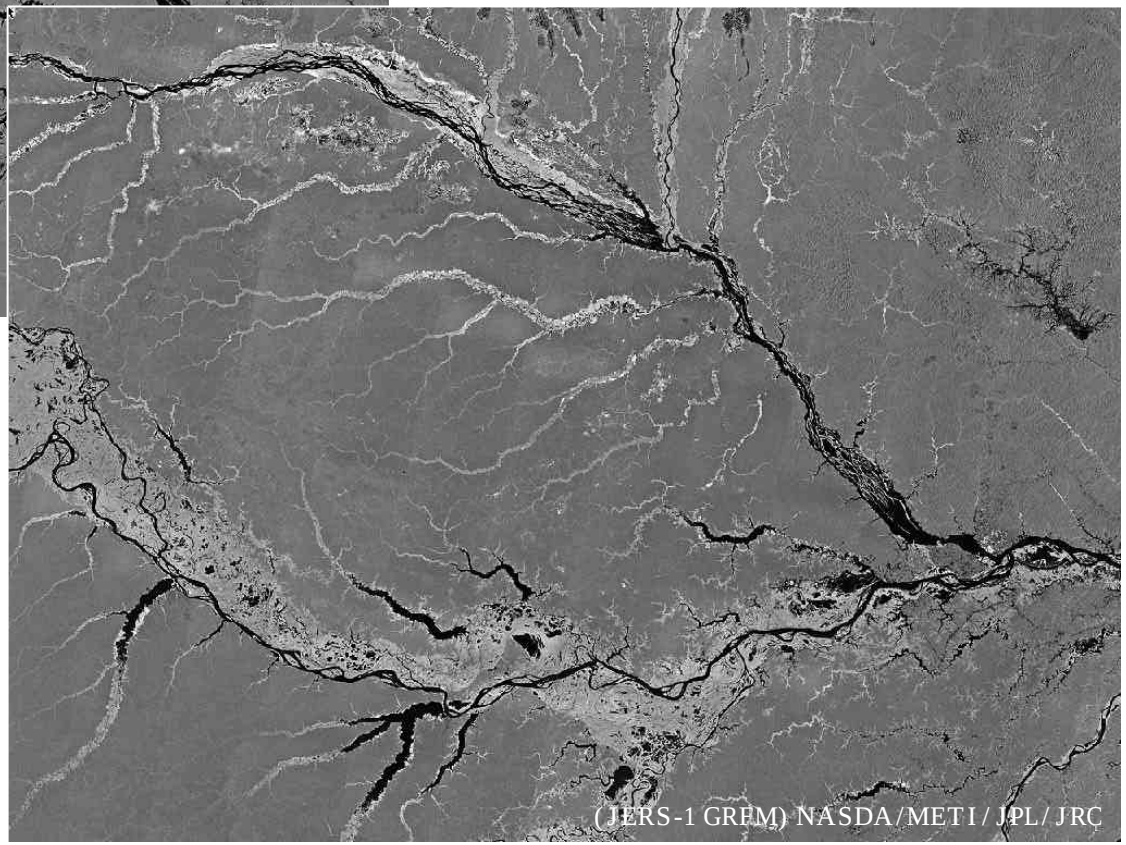
The Use of Spaceborne Radar Data to Model Inundation Patterns and Trace Gas Emissions in the Central Amazon Floodplain. International Journal of Remote Sensing, 2002.

Wetlands & CH4 Theme

(1) Spatial and temporal characteristics of flooding patterns



Central Amazon basin
Low flood (Oct. 1995)



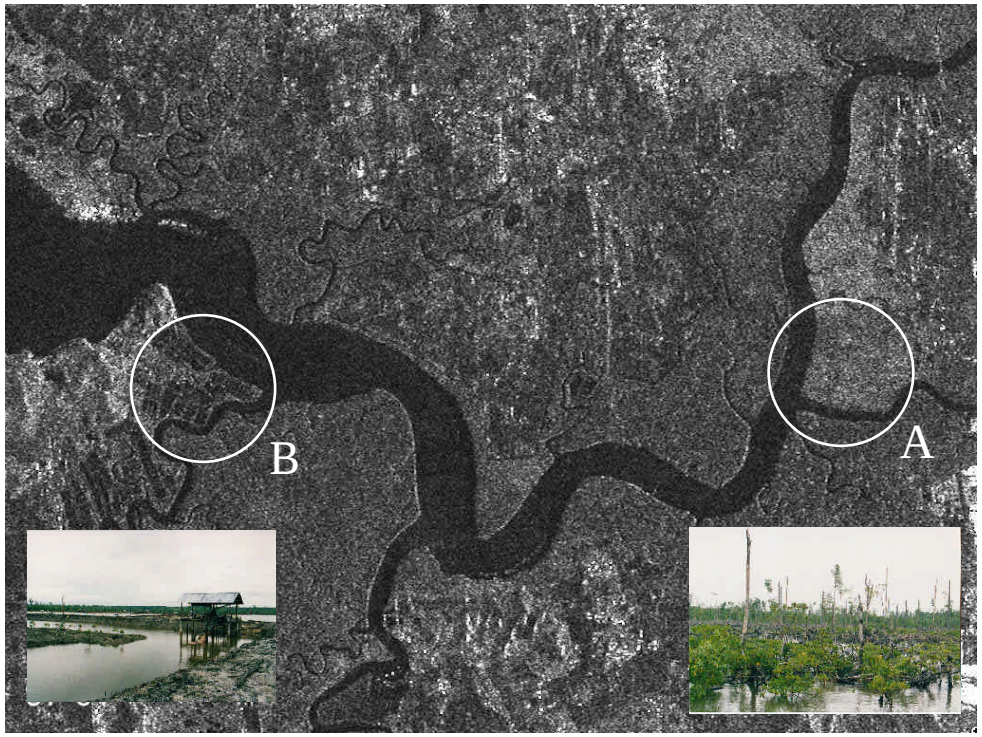
High flood (May 1996)

(JERS-1 GRFM) NASDA/METI / JPL / JRC

Flood monitoring over regional scales

JAXA
Japan Aerospace Exploration Agency

(2) Identification of wetland disturbances



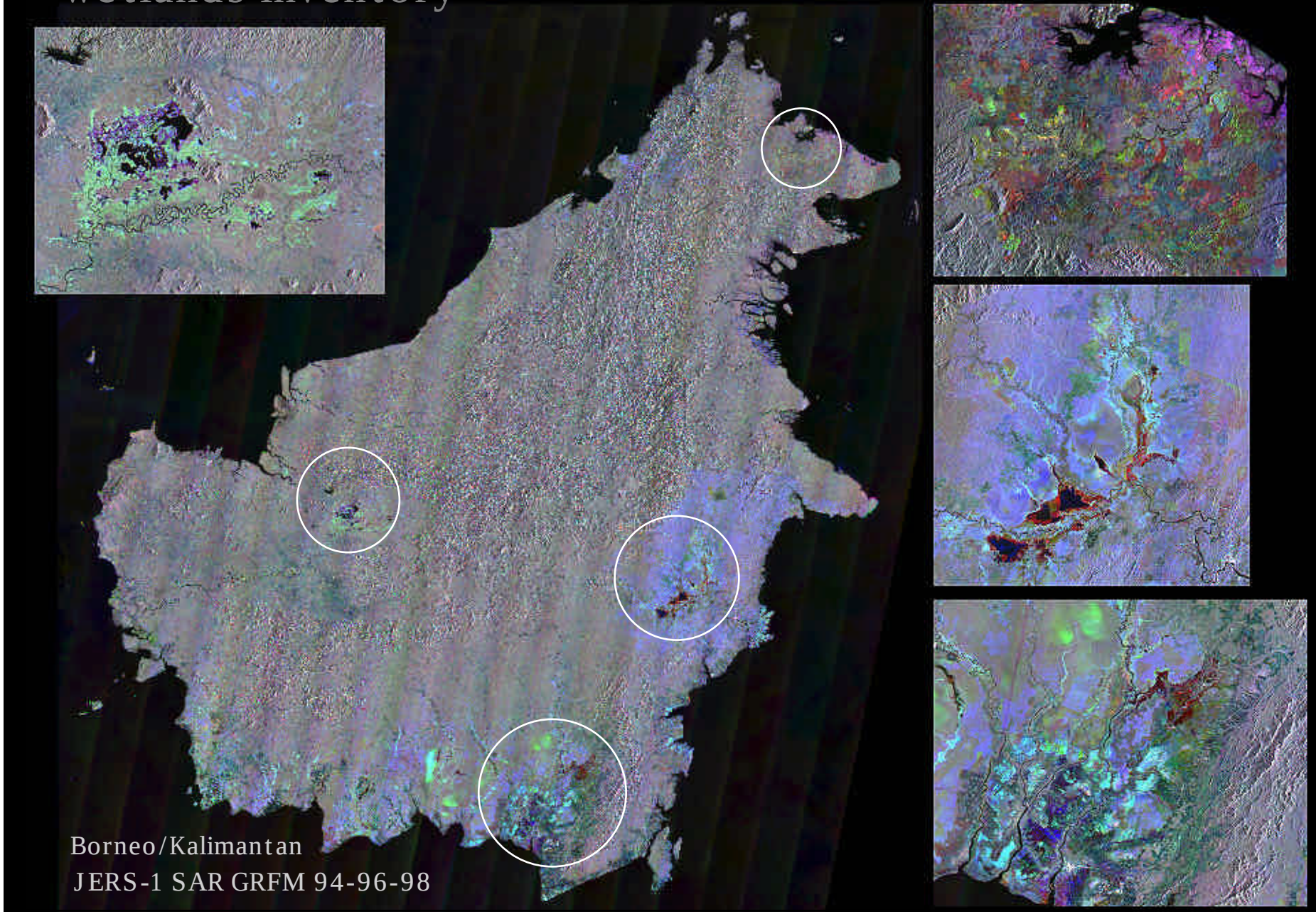
Mangrove clearing (A)
and conversion to aquaculture (B)
(Kedah, Malaysia)

Peat swamp conversion to rice cultivation
(Banjarmasin, Indonesia)

JAXA
Japan Aerospace Exploration Agency

(3) Support to the Ramsar global wetlands inventory

Wetlands & CH4 Theme

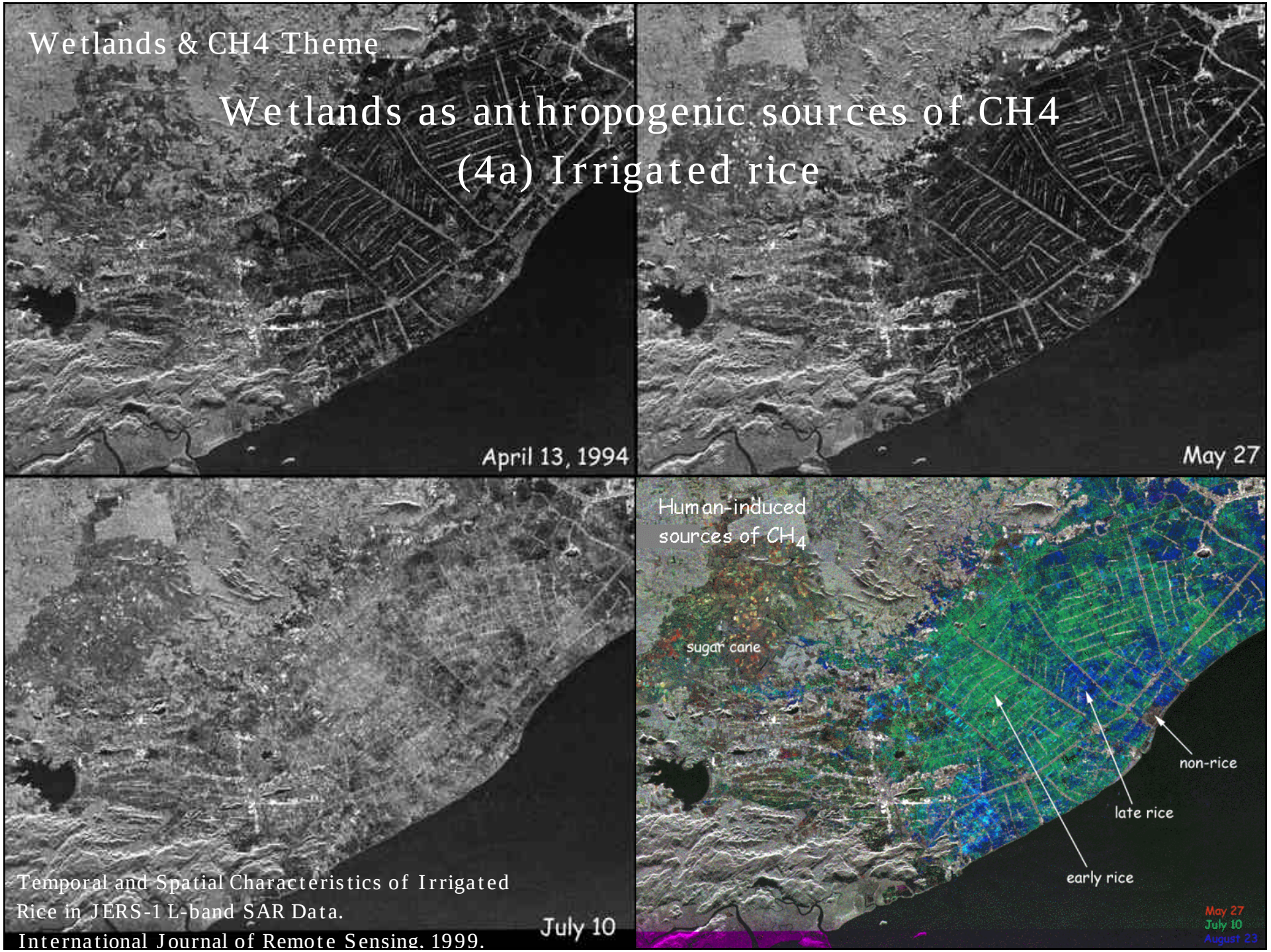


Borneo/Kalimantan
JERS-1 SAR GRFM 94-96-98

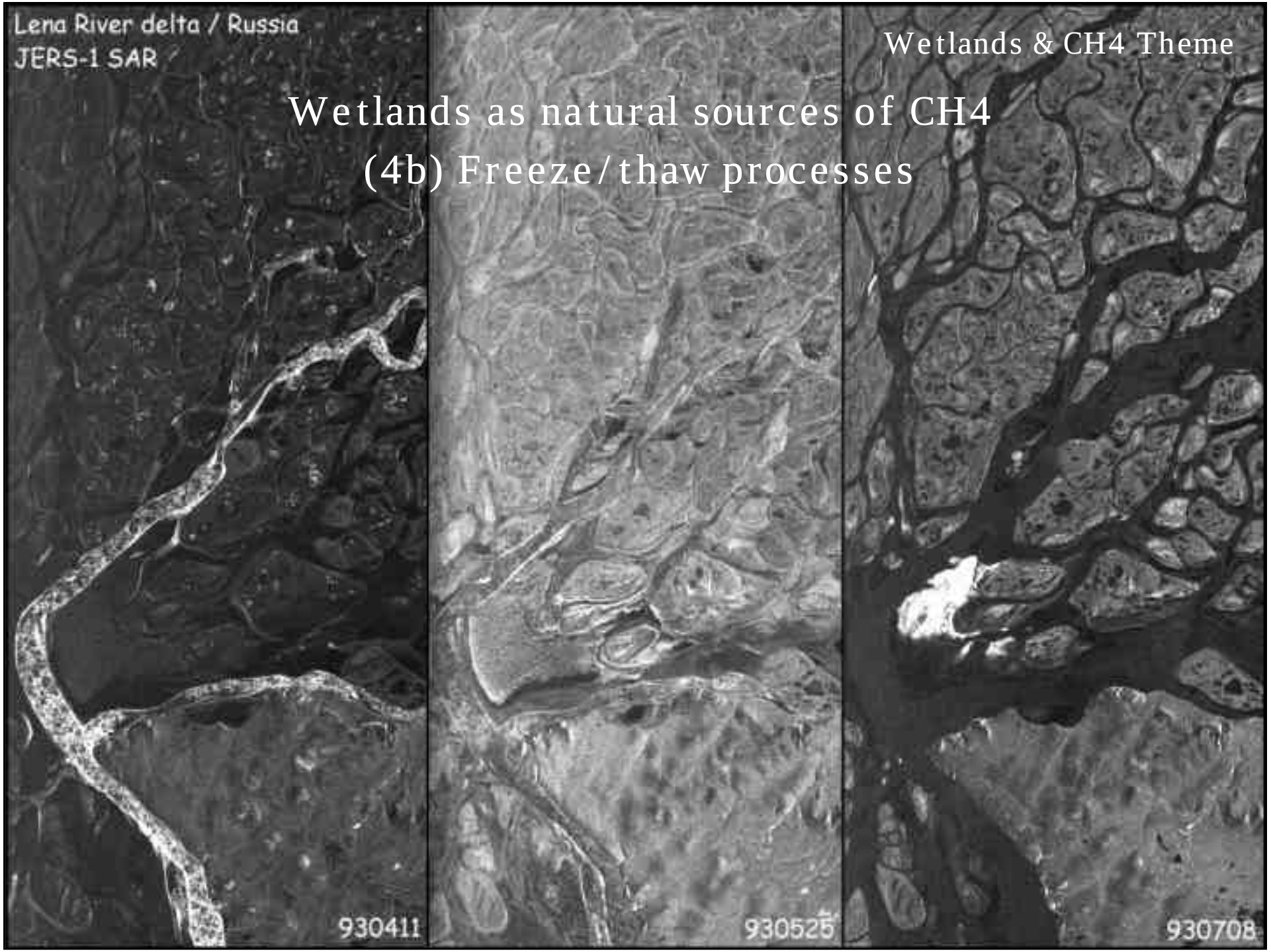
Wetlands & CH4 Theme

Wetlands as anthropogenic sources of CH4

(4a) Irrigated rice



Temporal and Spatial Characteristics of Irrigated Rice in JERS-1 L-band SAR Data.
International Journal of Remote Sensing, 1999.

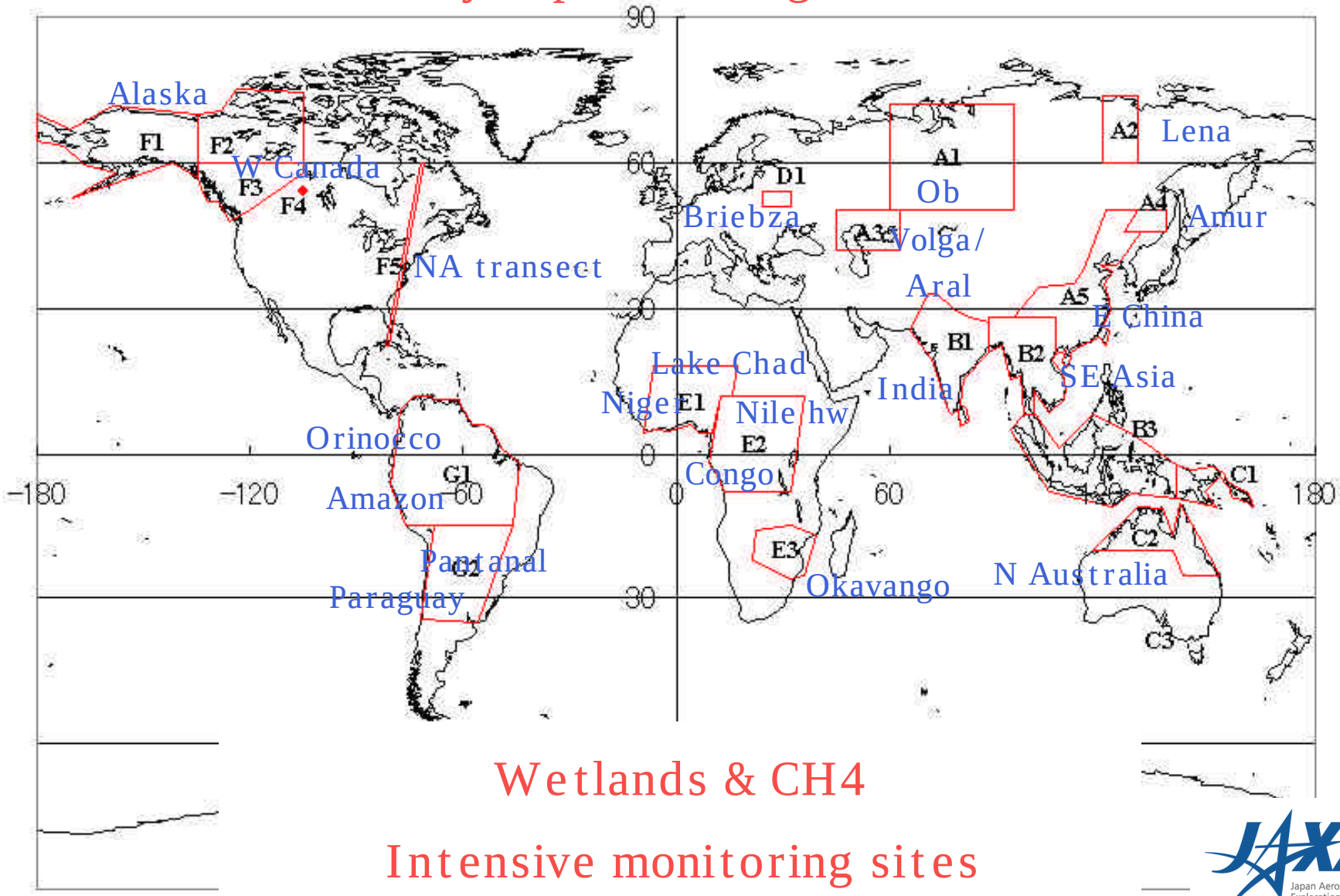


Wetlands as natural sources of CH4

(4b) Freeze/thaw processes

Wetlands & CH4 Theme

PALSAR ScanSAR
46-day repeat during 13 months



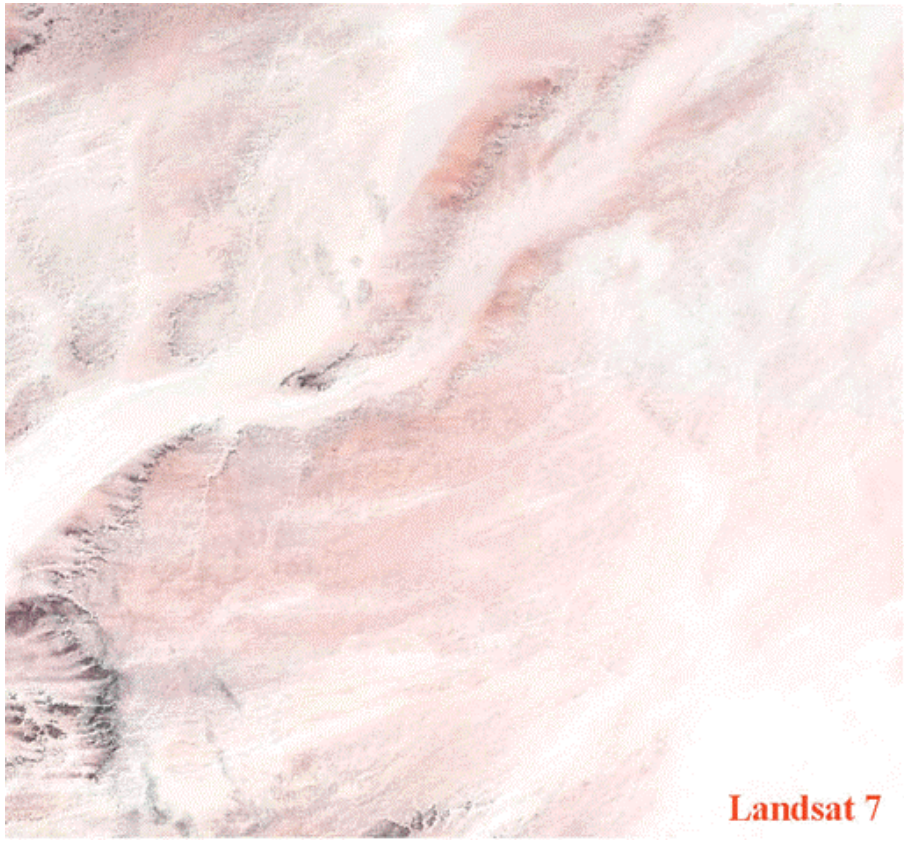
Wetlands & CH4

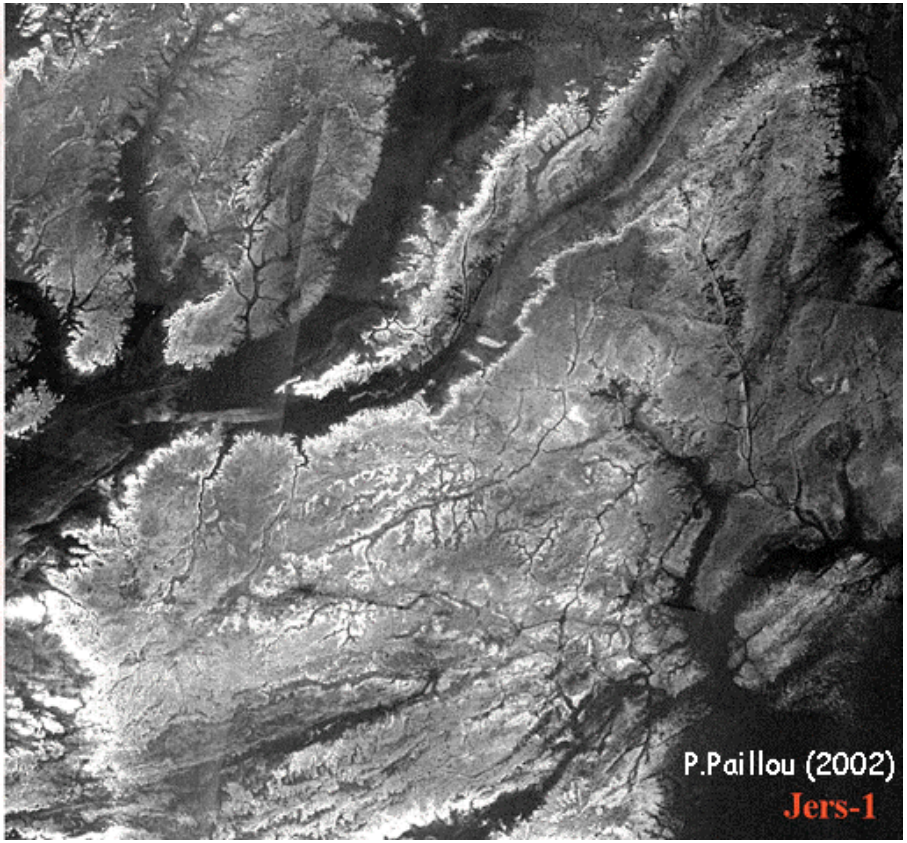
Intensive monitoring sites

JAXA
Japan Aerospace Exploration Agency

Desert & Water Theme

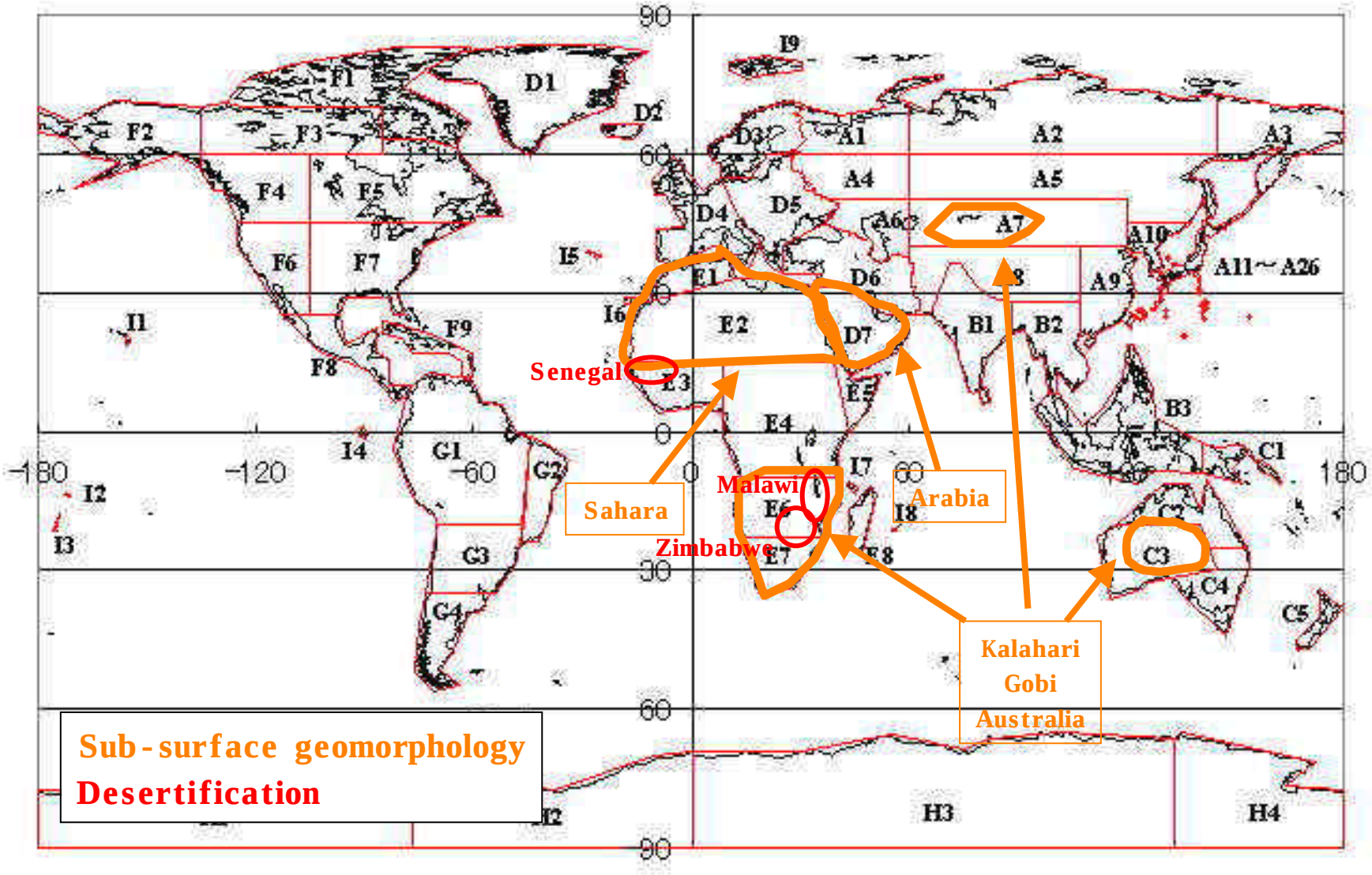
- Mapping of sub-surface geomorphology in hyper-arid areas for water prospecting (JERS-1 SAR SAHARASAR* continuation)
- Short term (conjunctural) desertification vulnerability mapping



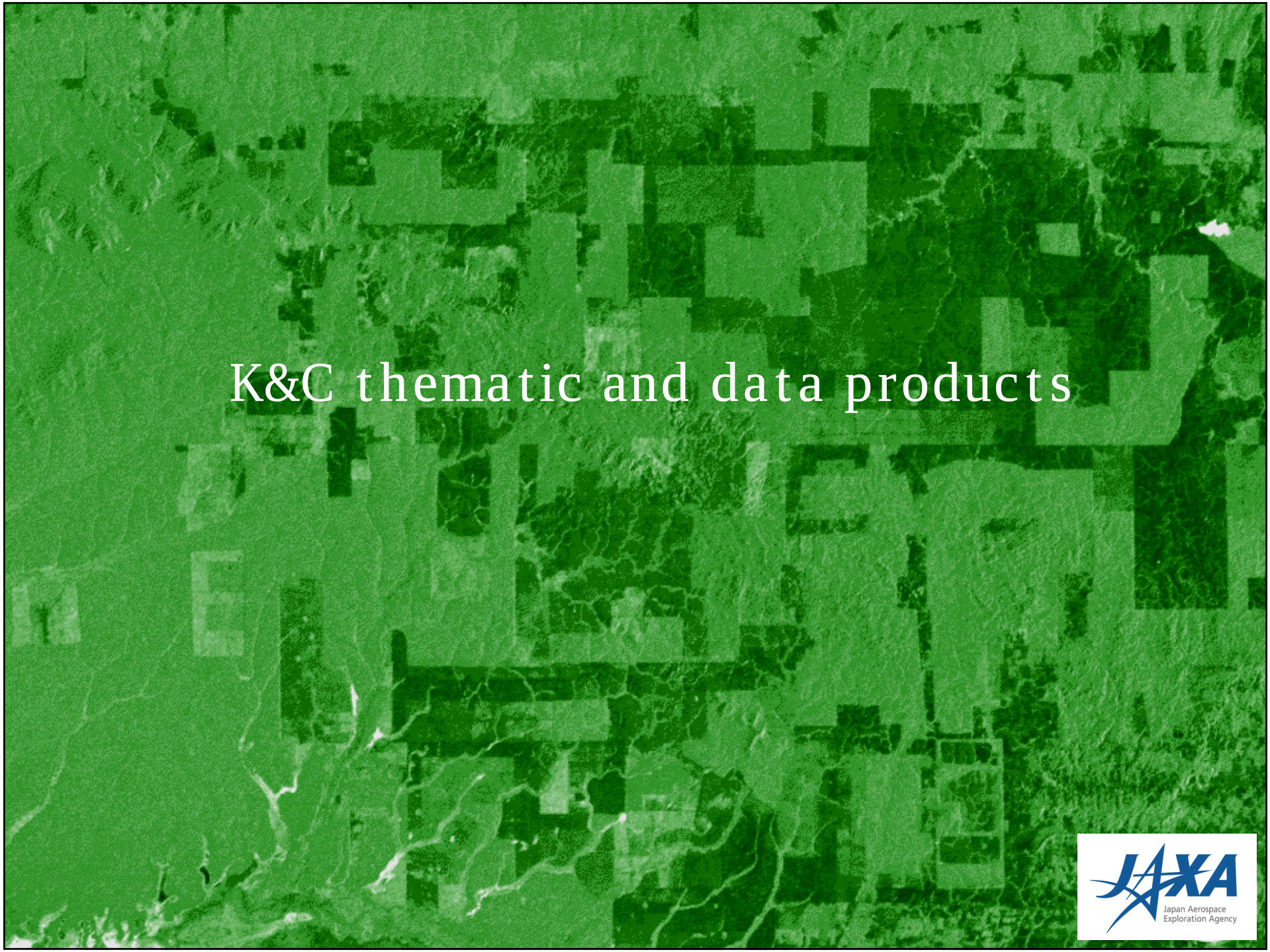


*** The SAHARASAR project: Potential support to water prospecting in arid Africa by SAR.**
Proc. IGARSS-2003.

Desert & Water - Focus sites



PALSAR Dual-pol (HH+HV)


K&C thematic and data products
JAXA
Japan Aerospace
Exploration Agency

K&C Thematic Products - all public domain
(as of Nov. 21, 2003)

Theme	Group	Product	Area
Forests	Biomass and structure	Biomass Map	Queensland
Forests	Biomass and structure	Biomass	Siberia
Forests	Biomass and structure	Biomass	Boreal forests, Sweden
Forests	Biomass and structure	Biomass map	Boreal forests, Finland
Forests	Forest change mapping	Biomass map	Temperate
Forests	Biomass and Structure	Forest Height	Global
Forests	Forest change mapping	Map of managed deforestation	Boreal, temperate, tropical
Forest	Forest change monitoring	Forest change map	Brazil
Forest	Forest change monitoring	Forest change map	Insular SE Asia and PNG
Forest	Forest change monitoring	Disturbance maps	Boreal forests
Forest	Forest change monitoring	Forest change map	Boreal forests
Forests	Forest change monitoring	Deforestation reporting in a sampling	Boreal forests, Sweden
Forest	Land cover (forest) classification	Land cover classification	Boreal forests
Forests	Land cover (forest) classification	Land cover map	Asia
Forests	Land cover (forest) mapping	Forest map	Transition zone, Congo Basin
Forests	Land cover (forest) mapping	Map of forest	Boreal, temperate, tropical
Forests	Land cover (forest) mapping	Land cover (forest) map	Siberia
Forests	Land Cover Map	Forest Cover Map	Eurasia Boreal
Wetlands	Global Wetlands and Properties	Tropical Wetland extent	Southeast Asia, Mekong River
Wetlands	Global wetlands extent and	Tropical wetlands inundation and	southern South American basins
Wetlands	Global wetlands extent and	Tropical wetland extent	southern South American basins
Wetlands	Map and monitor major wetlands	Lake Census	Global lakes spatial analysis
Wetlands	Mapping and Monitoring of functional	Rice paddy extent	Pan Asia
Wetlands	Mapping and Monitoring of functional	Rice cropping systems	Pan Asia
Wetlands	Mapping and Monitoring of functional	Rice inundation period	Pan Asia
Wetlands	Mapping and Monitoring of functional	Ricebiophysical characteristics	Pan Asia
Wetlands	Mapping and Monitoring of functional	Intermittent drainage	China
Wetlands	Product Dissemination	Wetlands data warehouse	Global
Wetlands	Seasonal monitoring of major wetland	Seasonal monitoring of wetlands	Pantanal, South America
Wetlands	Wetland Mapping	Tropical peat forests	Insular SE Asia and PNG
Desert and Water	Water Resources	Subsurface geology	Sahara, Arabia
Desert and Water	Water Resources	Volume scattering map	Sahara, Arabia
Desert and Water	Water Resources	2 year subsurface change map	Sahara, Arabia
Arid lands	Desertification	Vulnerability map	Senegal, Zimbabwe and Malawi
Arid lands	Desertification	land cover map	Senegal, Zimbabwe and Malawi
Arid lands	Desertification	land cover change map	Senegal, Zimbabwe and Malawi

PALSAR Mosaic Products

- Global dual-polarisation (HH+HV) mosaics @ 50 m
- ScanSAR mosaic time series (~90 m) over wetlands

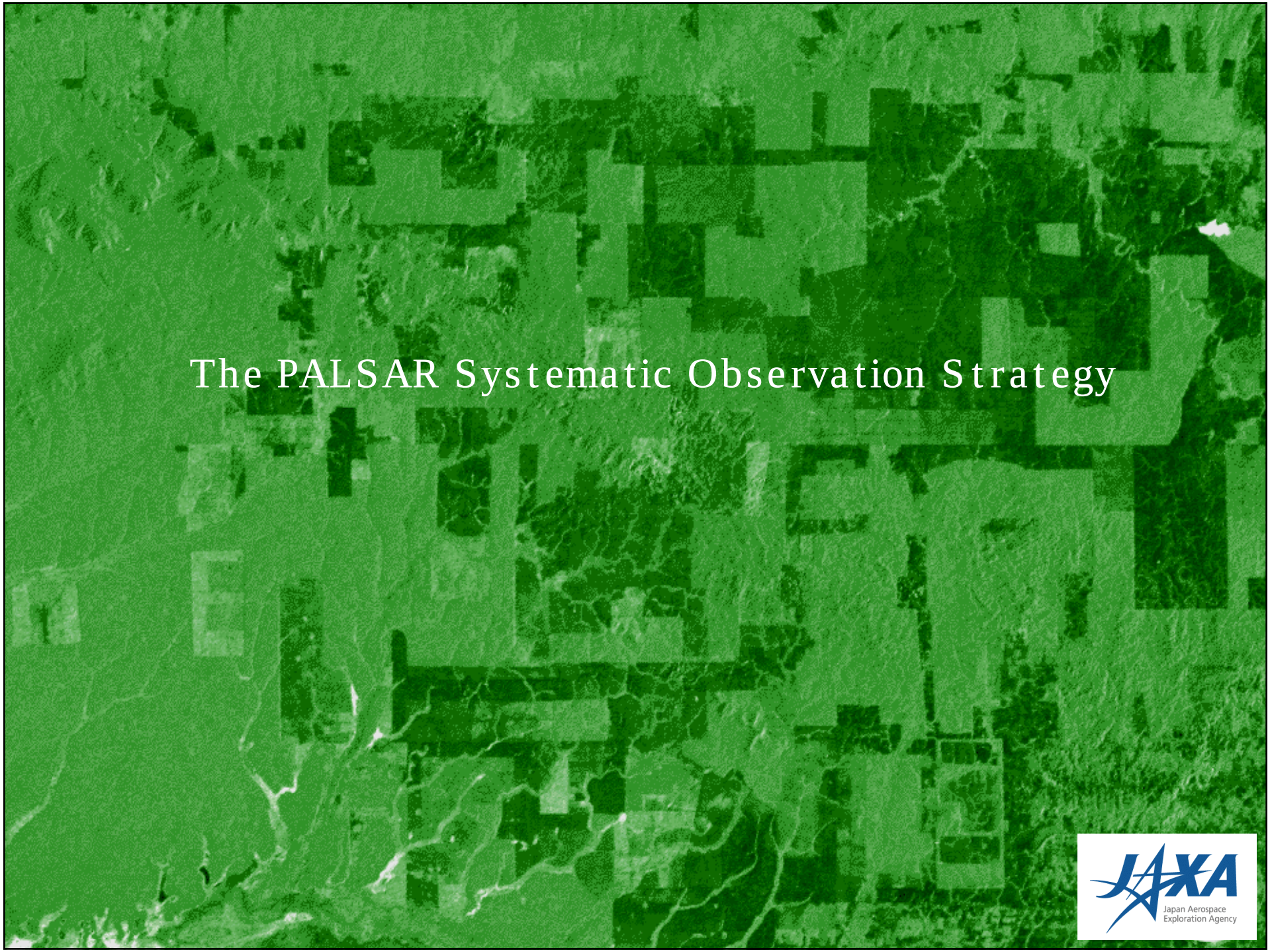
  Terrain corrected by DEM (SRTM when available)
- Low resolution (500 m) quick-look browse mosaics of all K&C data acquired

The PALSAR mosaics will be used as:

- Intermediate products by K&C Science Team in thematic product development;
- End products - to be made available in public domain

Mainland SE-Asia 97-98, JERS-1 SAR
Global Rain Forest Mapping project

The PALSAR Systematic Observation Strategy



Objectives of the Observation Strategy

- Support the science objectives of the ALOS Kyoto & Carbon Initiative
- Direct response to Art. 10d of the Kyoto Protocol, which calls on Parties to *"promote the maintenance and development of systematic observation systems and development of data archives to reduce uncertainties related to the climate system, and the adverse impacts of climate change..."*.
  - → Creation of a systematic archive of L-band SAR data, in which a consistent time series of data can be found for any arbitrary point, or region, on the Earth.
- Initial poor simulation results prompted a need to minimise conflicts between the many ALOS user groups:
  - JAXA (K&C, solid Earth, sea ice...)
  - METI/ERSDAC (geology, resource exploration)
  - Japanese Gov't Agencies (M-Environment, M-Forestry & Agriculture, Coast Guard, Geographical Survey Inst. ...)
  - ALOS PI programme

JAXA
Japan Aerospace Exploration Agency

The Systematic Observation Strategy - Factors considered*

1. Spatio-temporal consistency over regional scales
   - Semi-continental wall-to-wall coverage
   - Acquisitions within a short time window (46-day cycle)
2. "Adequate" temporal repetition;
   - Plan individually adapted to the Forest, Wetlands and Desert themes
3. Accurate timing;
   - Regional seasonality a major driver
4. Consistent sensor configuration;
   - Limitation of the PALSAR operational modes
5. Long-term continuity
   - Repetition to EOL the target.

***Systematic Data Acquisitions - A Pre-requisite for Meaningful Biophysical Parameter Retrieval?** Communications, IEEE Transactions on Geoscience and Remote Sensing, 2003.

JAXA Japan Aerospace Exploration Agency

The key - minimising conflicts

Step 1: Reducing the number of operational modes (132➞5) *

Step 2: Designating each 46-day cycle to a specific sensor mode.

Step 3: Separating conflicting requests into ascending and descending operations.

- Ascending passes:
- Dedicated to global-scale, semi-annual monitoring
- Fine-res, HH @ 34. 3° (Solid Earth)
- Fine-res, HH+HV @ 34.3° (Forest & Land Cover)
- Fine-res, HH+HV @ 43.4° (Geology, Forest & Land Cover)
- Quad-pol @ 21.5° (Pol-InSAR R/D)

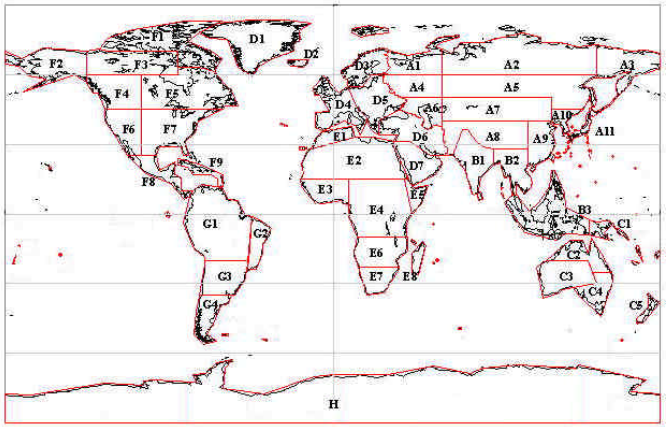
- Descending passes:
- Dedicated to regional-scale, every-cycle repeat monitoring
- ScanSAR HH 5-beam (Wetlands & CH4)

* Best trade-off sensor modes selected on a scientific basis, identified by the ALOS K&C Science Advisory Panel.

JAXA Japan Aerospace Exploration Agency

ALOS Acquisition Strategy

Observation plan concept

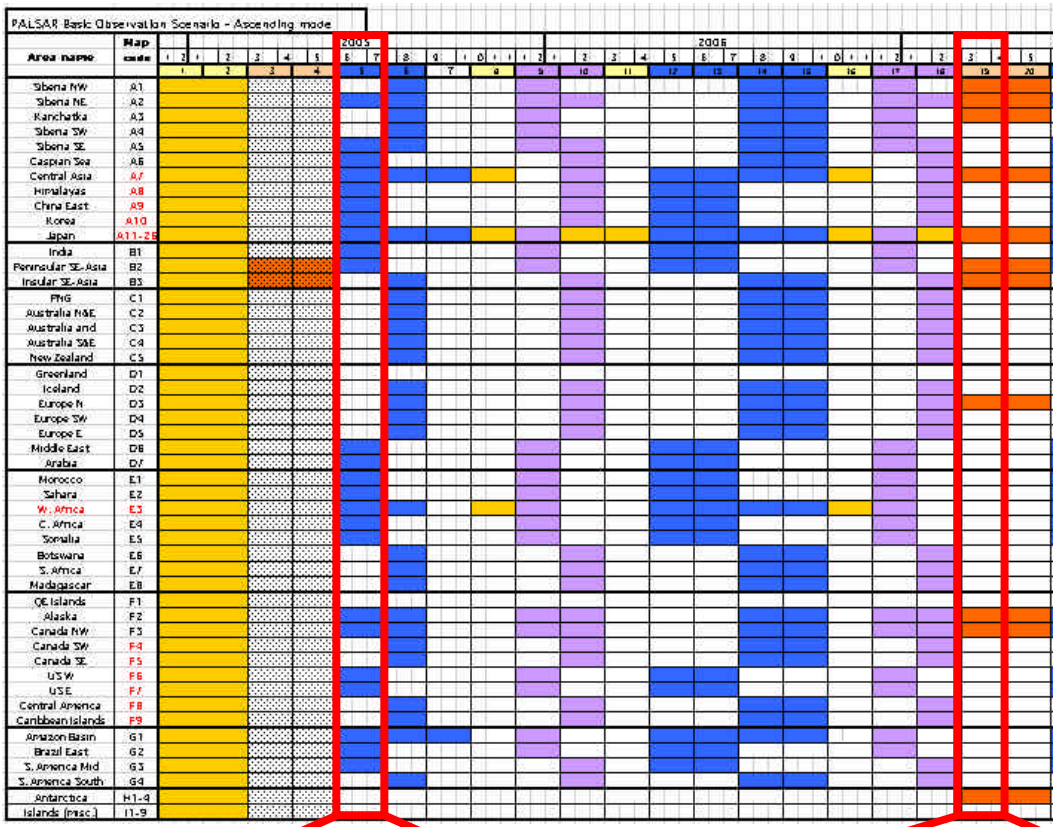


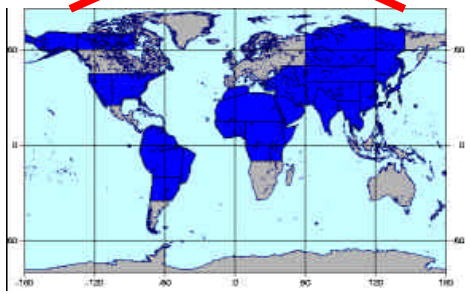
HH+HV 34.3°

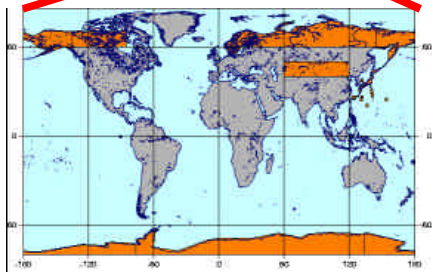
HH+HV 43.4°

HH 34.3°

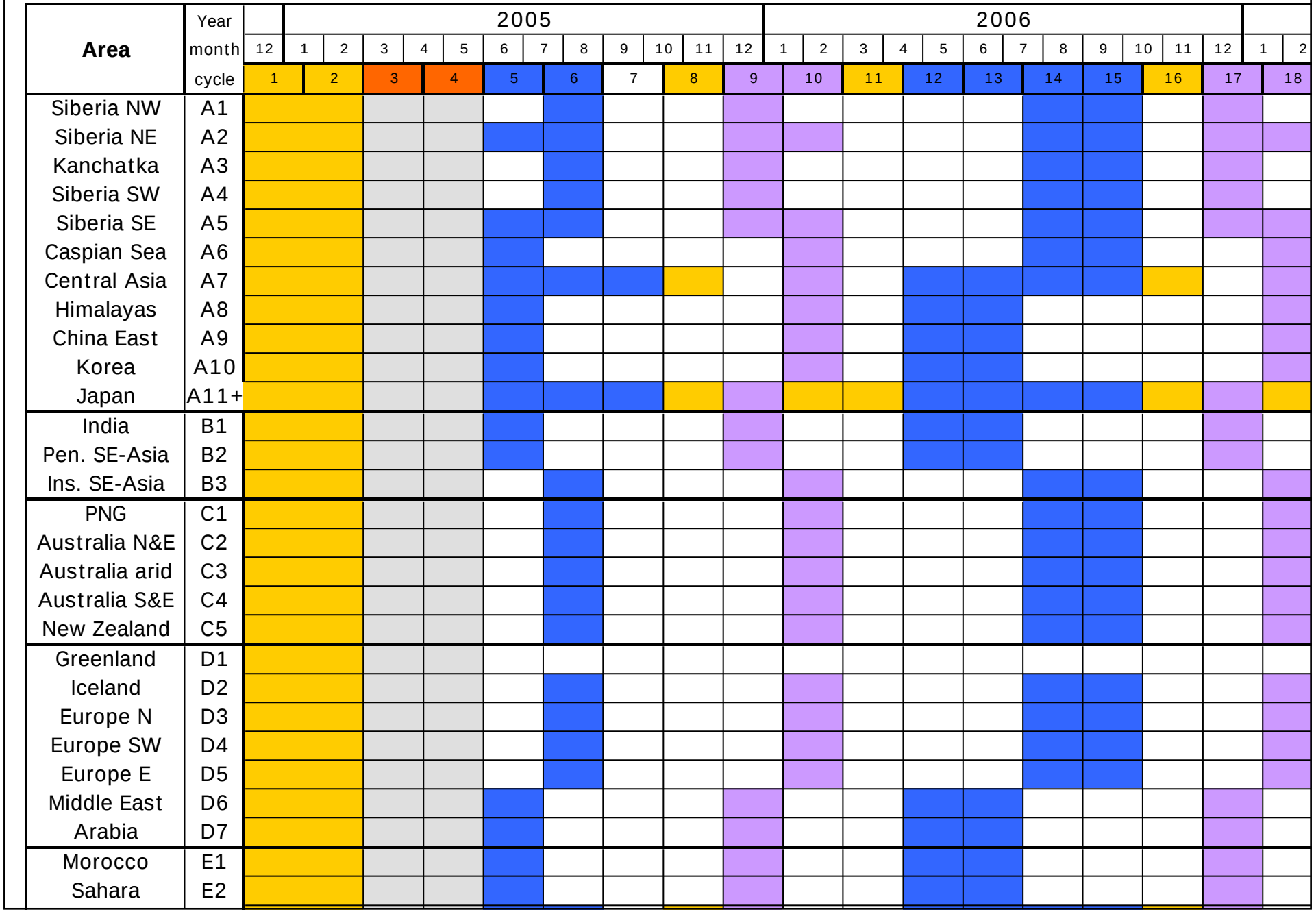
Quad-pol 21.5°



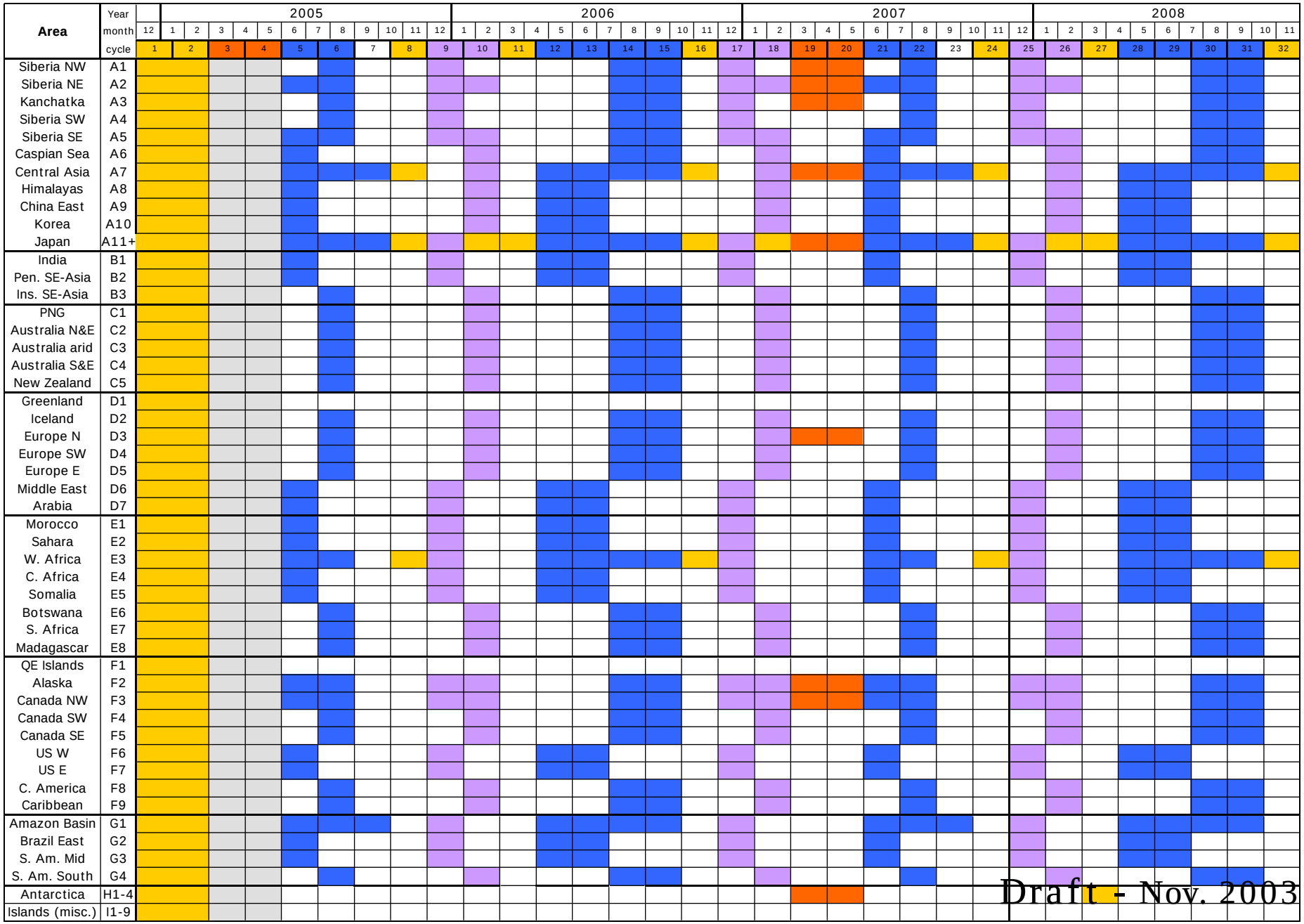




ALOS Acquisition Strategy PALSAR Ascending (draft scenario)



ALOS Acquisition Strategy Ascending (~10 pm) passes (~237,000 scenes/year)



ALOS Acquisition Strategy

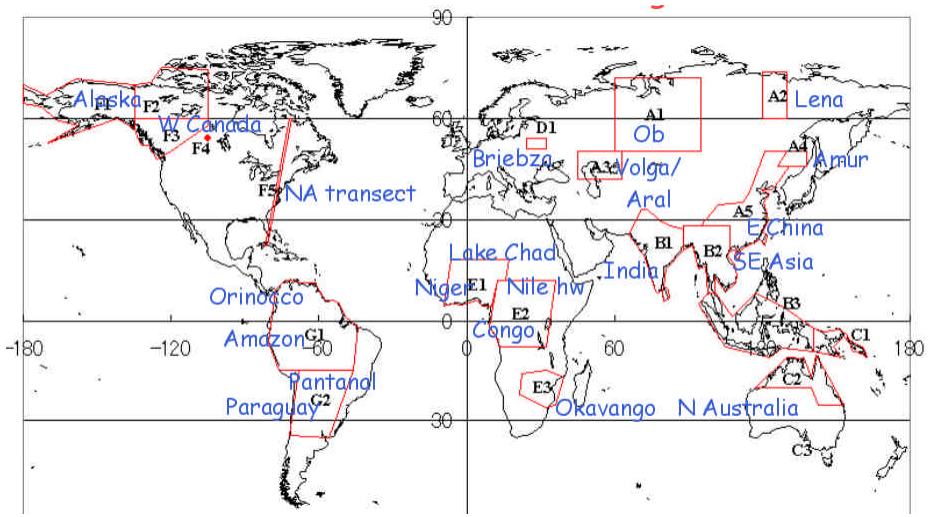
Descending (~10 am) acquisitions

Priority to PRISM & AVNIR-2

PALSAR limited to ScanSAR (5-beam mode, HH)

Focus on wetland & CH4 intensive monitoring

~13,000 scenes/year



ScanSAR Wetlands Descending	2005					2006								2007								2008								
	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33			
West Siberia						■	■	■	■	■	■	■	■																			
Lena Delta																						■	■	■	■	■	■	■	■			
Volga Delta																						■	■	■	■	■	■	■	■			
Amur																						■	■	■	■	■	■	■	■			
East Asia paddy				■	■	■	■	■	■	■	■																					
India paddy												■	■	■	■	■	■	■	■													
Mainland SE-Asia				■	■	■	■	■	■	■	■																					
Insular SE-Asia										■	■	■	■	■	■	■	■															
PNG										■	■	■	■	■	■	■	■															
North Australia				■	■	■	■	■	■	■	■																					
Pripet-Biebrza						■	■	■	■	■	■	■	■																			
Niber Basin																						■	■	■	■	■	■	■	■			
Congo Basin									■	■	■	■	■	■	■	■	■															
Okavango-Mozambique											■	■	■	■	■	■	■	■														
ASF mask						■	■	■	■	■	■	■	■																			
BOREAS SSA														■	■	■	■	■	■	■	■											
Quebec-Everglades													■	■	■	■	■	■	■	■												
Amazon Basin	■	■	■	■	■	■	■	■	■	■	■						■	■	■					■	■	■	■					
Pantanal	■	■	■	■	■	■	■	■	■																							

Draft - Nov. 2003

Observation Strategy - Summary

PALSAR (ascending)

- Default mode: Dual-pol (HH+HV, 20m)
- 2 Global coverages annually
  - Summer/dry season (34°);
  - Winter/rainy season (43°)
- Global InSAR coverage (34°) every 2 yrs
- 2 Pol-InSAR campaigns during first 3 yrs
- ~ 237,000 scenes/year

PALSAR (descending)

- Default mode: ScanSAR (5-beam HH)
- 1 Global ScanSAR coverage annually
- Intensive wetlands & CH4 monitoring
  - 46-day repeat during a full annual cycle (13 months)
- ~ 13,000 ScanSAR scenes/year

- Observation simulation results have improved from below 50% to above 80% (ascending) after implementation of the joint observation plan.

- The plan is ultimately a compromise between many different user needs.

JAXA
Japan Aerospace Exploration Agency

K&C Summary

- The Kyoto & Carbon Initiative is a JAXA-led international collaborative project;
- K&C science team from 15+ countries
- Aims to support the "3 C's":
  - Conventions
  - Carbon
  - Conservation
- Generation of data sets and validated derived information
- Global Observation Strategy implemented for ALOS PALSAR

JAXA
Japan Aerospace Exploration Agency

References

Systematic Data Acquisitions - A Pre-requisite for Meaningful Biophysical Parameter Retrieval? Rosenqvist, A., Milne A.K. and Zimmermann, R., 2003. Communications, IEEE Transactions on Geoscience and Remote Sensing, Vol. 41, No. 7, pp. 1709-1711, July, 2003.

Initiating the ALOS Kyoto & Carbon Initiative. Rosenqvist, A., Ogawa T., Shimada M. and Igarashi T. Proc. IGARSS'01, Sydney, Australia. July 9-13, 2001.

Support to Multi-national Environmental Conventions and Terrestrial Carbon Cycle Science by ALOS and ADEOS-II – the Kyoto & Carbon Initiative. Rosenqvist A., M. Shimada, T. Igarashi, M. Watanabe, T. Tadono and H. Yamamoto. Proc. IGARSS'03, Toulouse, France. July 21-25, 2003.

IGOS-P Carbon Cycle Observation Theme: Terrestrial and atmospheric components. Cihlar J., et al. (Eds.). Report to IGOS-P by the Terrestrial Carbon Theme Team, IGOS-P, 2001.

Remote Sensing and the Kyoto Protocol: A Review of Available and Future Technology for Monitoring Treaty Compliance. Rosenqvist, A., Imhoff, M., Milne A.K. and Dobson C. (Eds.). ISPRS Workshop Report (159 pp.). Ann Arbor, MI, USA, Oct. 20-22, 1999.

A review of remote sensing technology in support of the Kyoto Protocol. Rosenqvist, A., Milne A.K., Lucas R., Imhoff, M. and Dobson C , Environmental Science & Policy, Vol. 6, No. 5, pp 441-455, Oct. 2003.

The SAHARASAR project: Potential support to water prospecting in arid Africa by SAR. Paillou P., and Rosenqvist A. Proc. IGARSS'03, Toulouse, France. July 21-25, 2003.

The Use of Spaceborne Radar Data to Model Inundation Patterns and Trace Gas Emissions in the Central Amazon Floodplain. Rosenqvist, A., Forsberg, B, Pimentel, T., Rauste Y. and Richey J., International Journal of Remote Sensing, Vol. 23, No. 7, pp. 1303-1328, 2002.

Temporal and Spatial Characteristics of Irrigated Rice in JERS-1 L-band SAR Data. Rosenqvist A., International Journal of Remote Sensing, Vol. 20, No. 8, pp. 1567-1587, 1999.

ALOS Kyoto & Carbon Initiative homepage:
http://www.eorc.jaxa.jp/ALOS/kyoto/kyoto_index.htm

JAXA
Japan Aerospace Exploration Agency