

Stability of GAMMA-NAUGHT and THE PALSAR based FOREST MRV SYSTEM

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R. Thapa

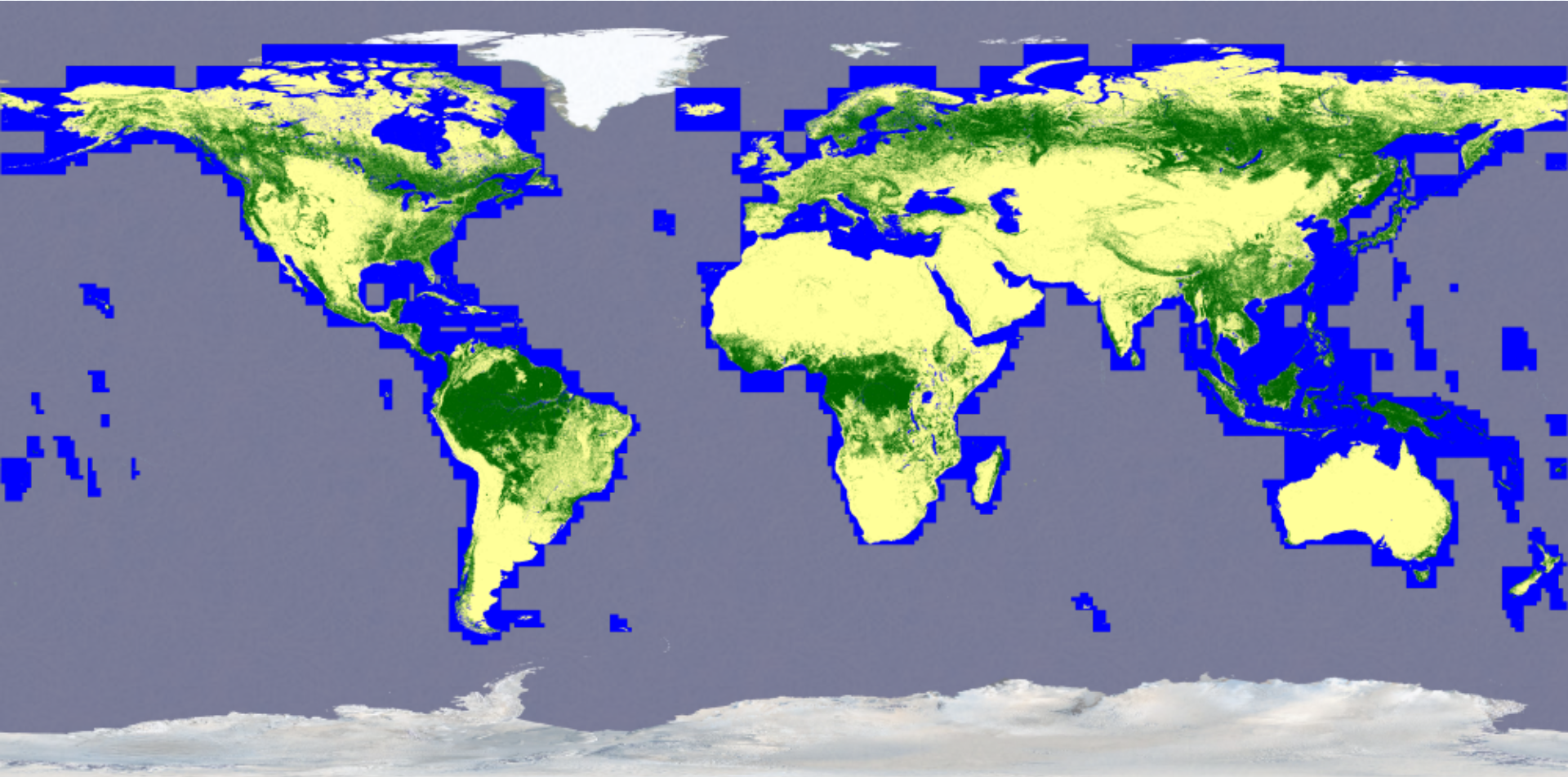
JAXA, EORC

GEOS-AP Forest Session, April 3 2012

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 - Ground Truth Data Collection
 - Global Mangrove Map
5. Conclusion

PALSAR 10m Global Forest/Non-Forest Map 2009



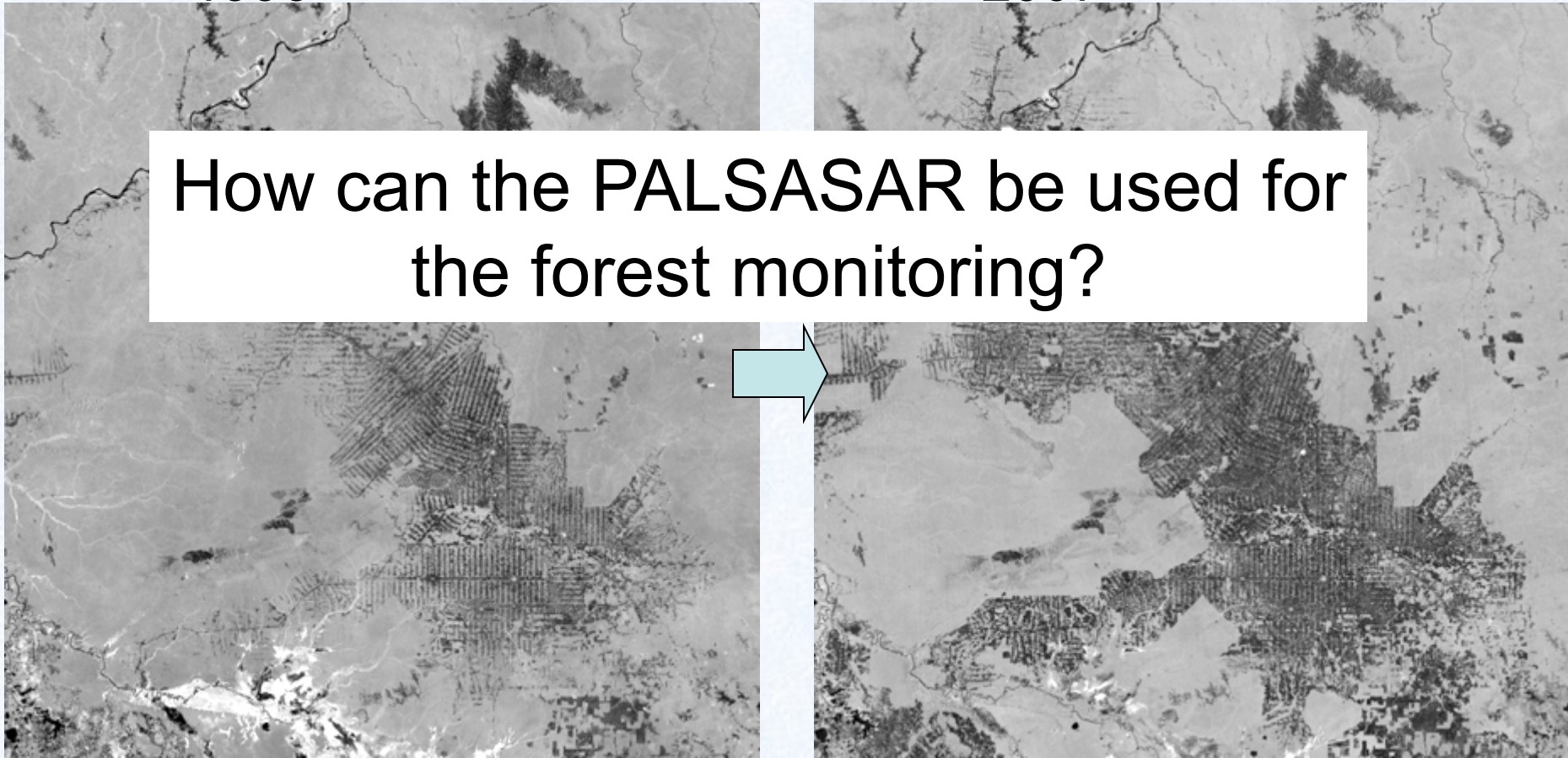
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Deforestation monitoring at Rondonia, Brazil, using JERS-1 SAR and ALOS/PALSAR

JERS-1 SAR
1996

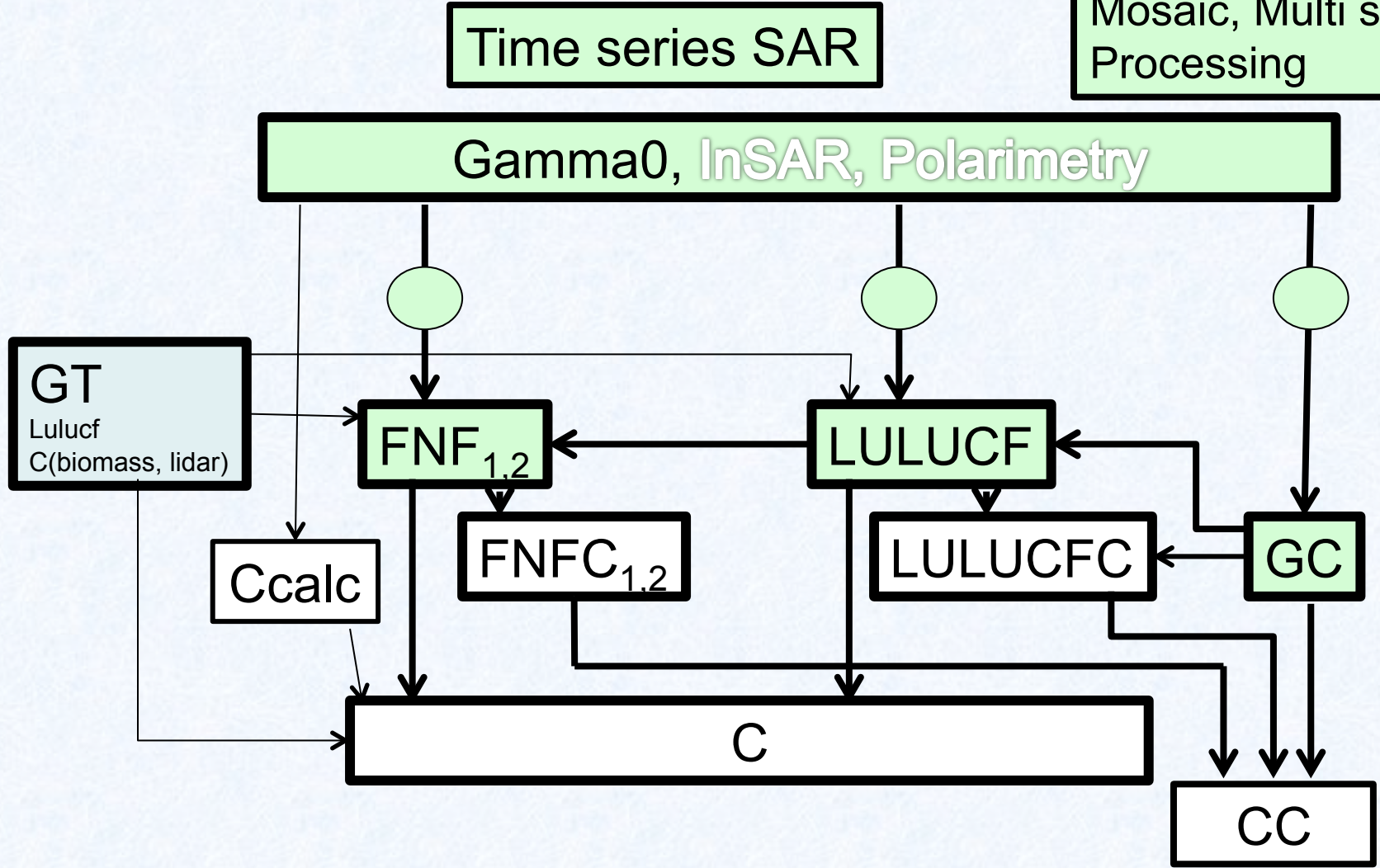
ALOS PALSAR
2007

How can the PALSASAR be used for the forest monitoring?



5. MRV-system development

Basic Information
Ortho, Slope
Mosaic, Multi season
Processing



Simulator, Verification box

MRV Development

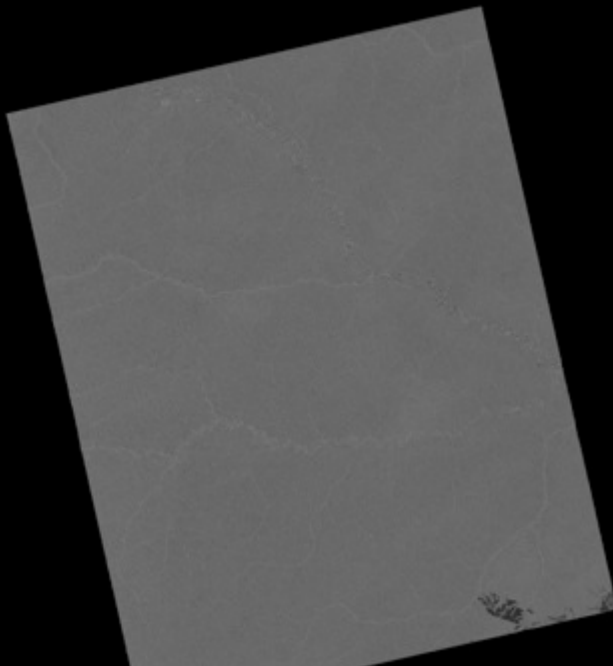
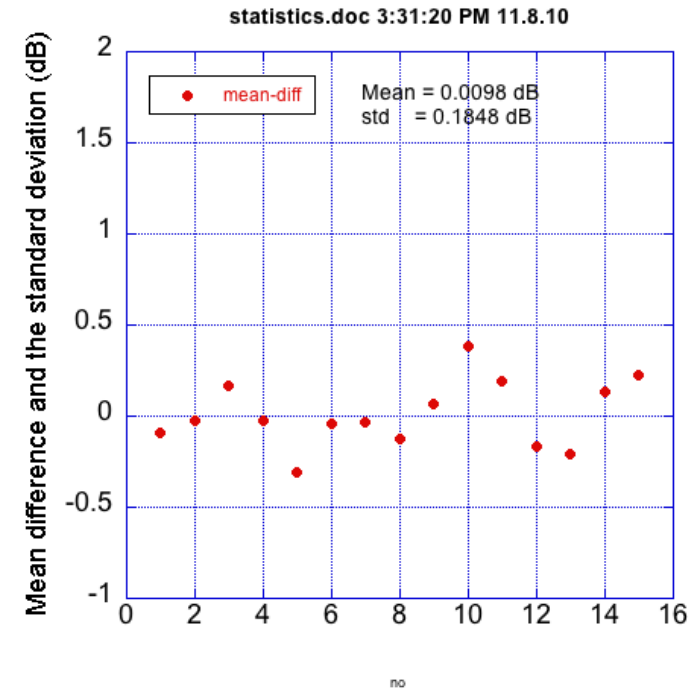
- Generate the Horizon products defined in the GEO-FCT
- Algorithm development as JAXA REDD+ project
- Algorithm development for monitoring the forest (LULUCF, FNF, LULUCF-C, FNF-C)
- Estimate the biomass with accuracy assessment
- Development of the forest area decrease - area estimation
- Validation in JFY2012 (April 2012-March 2013)

4. Stability of PALSAR

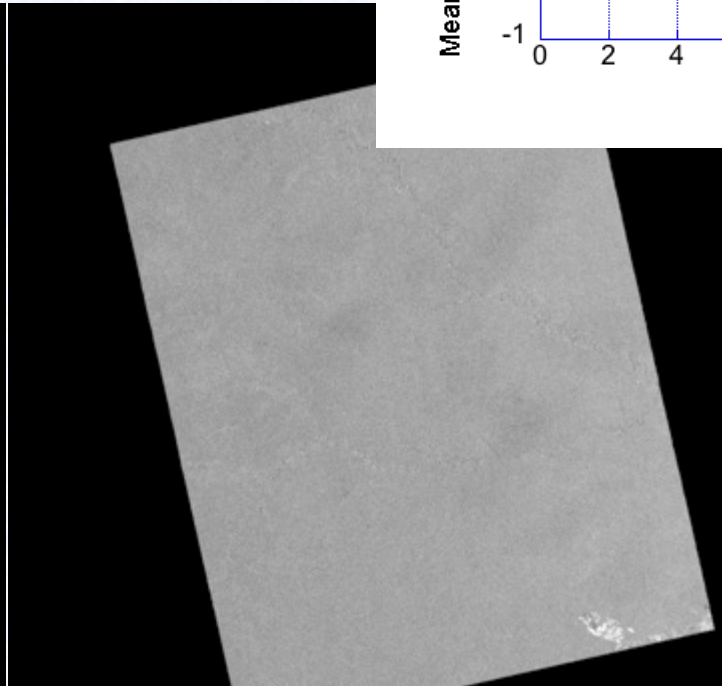
Temporal variation of the SAR data was evaluated. 16 of Amazon PALSAR 4 look data were used.

Ortho, Slope corrected data were evaluated.

Average: **0.01dB**, (**0.185dB**): High stability was confirmed. (similar to JERS-1 SAR)



SAR reference image



SAR differentiation Image

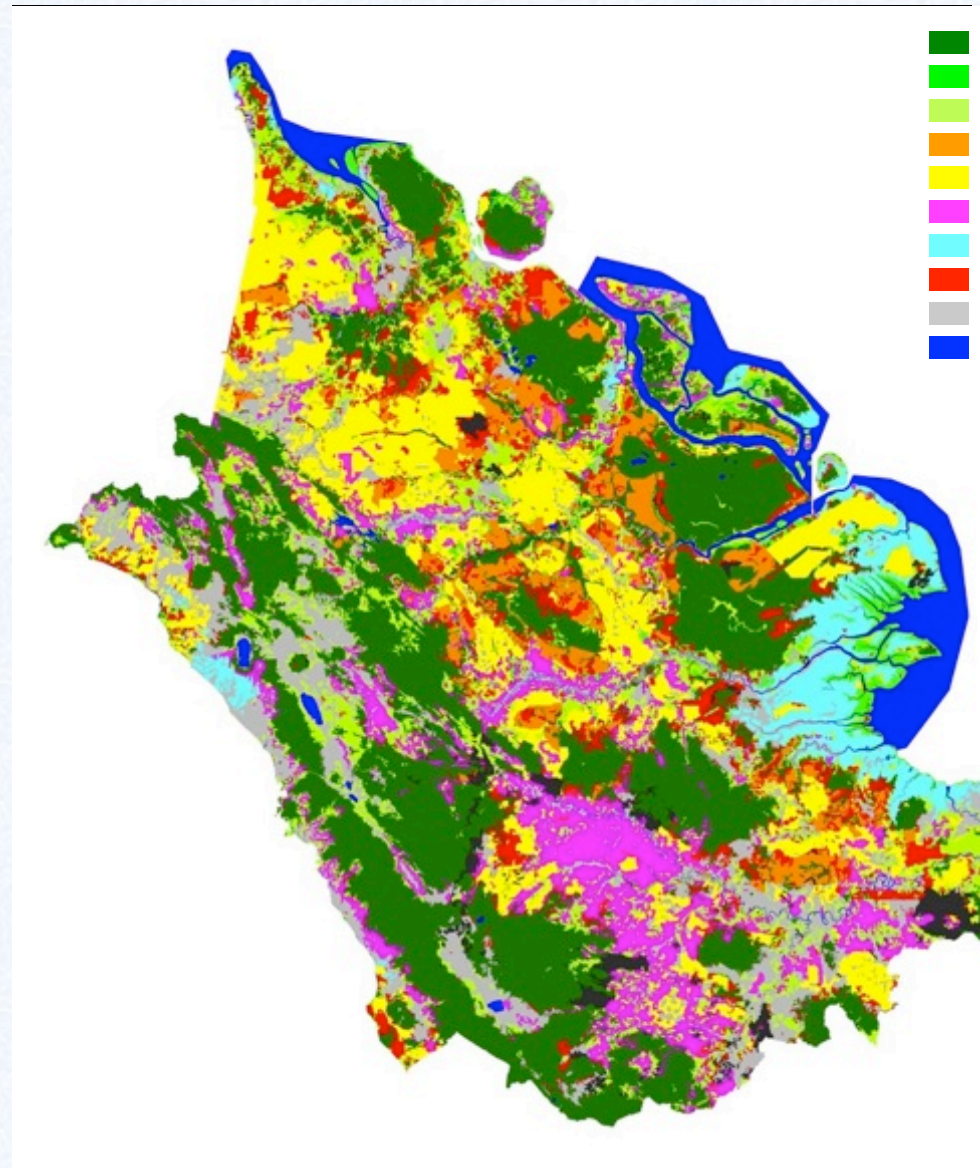
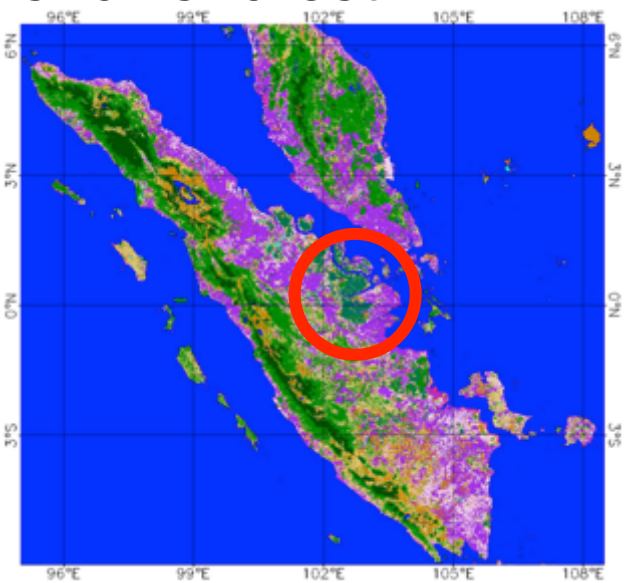
5.1 Change detection using gamma-naught(GC)

- Riau
- 2007–2010 data
- HH, HV
- AVNIR-2 data were used
- WWF data were used.

Temporal change of gamma-naught (2007-2009)

Three colors
Green: No change
Blue: decrease
Red: Increase

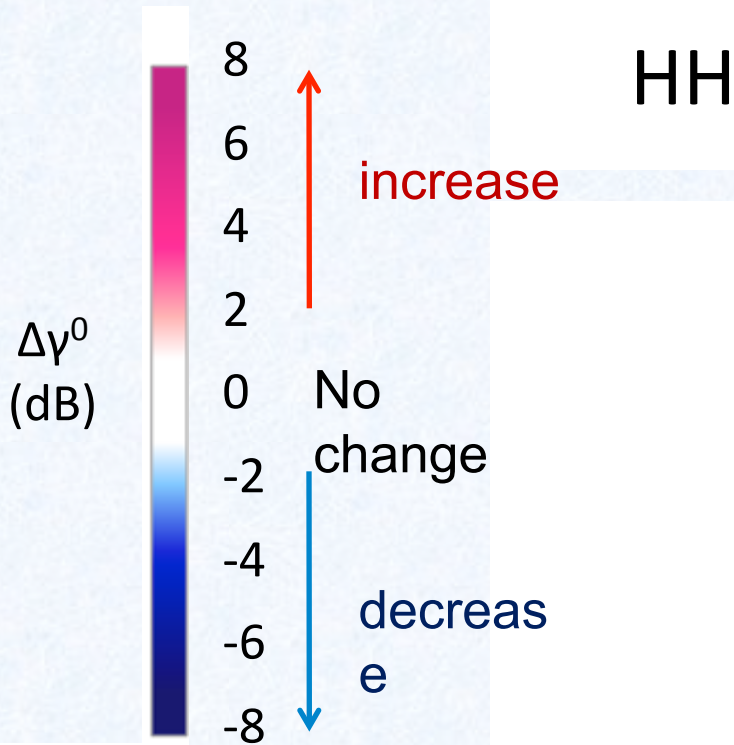
Larger blue color shows forest .



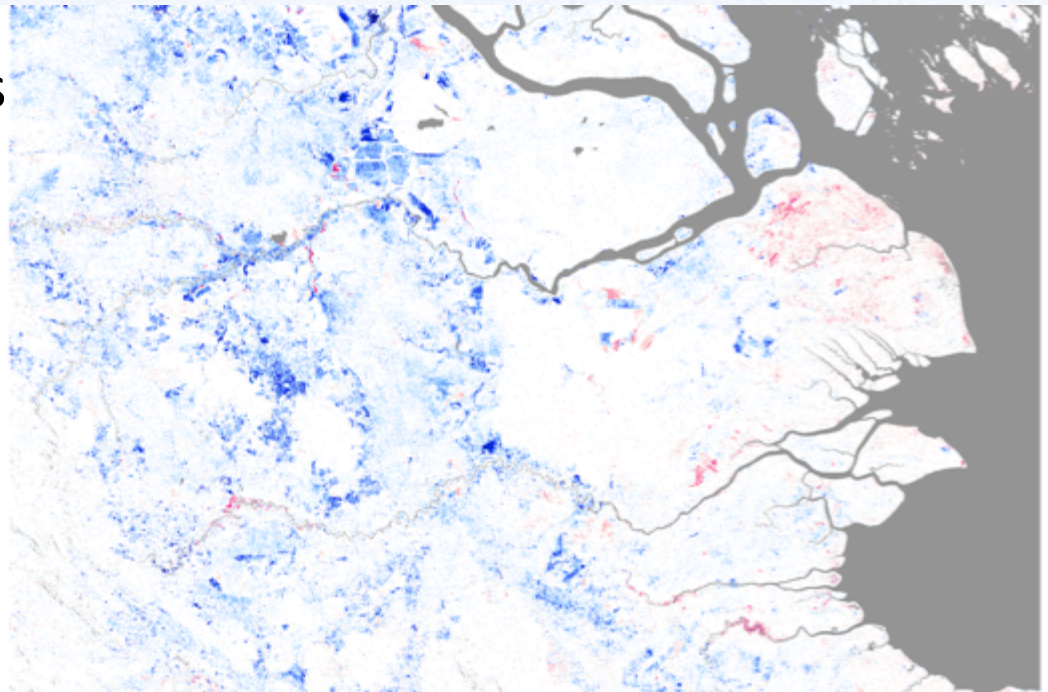
- Natural forest
- Natural mangrove
- Natural re-grow
- Acacia
- Oil Palm
- Rubber
- Coconut
- Open area
- Other
- Water

Using gamma-naught changes for deforestation monitoring

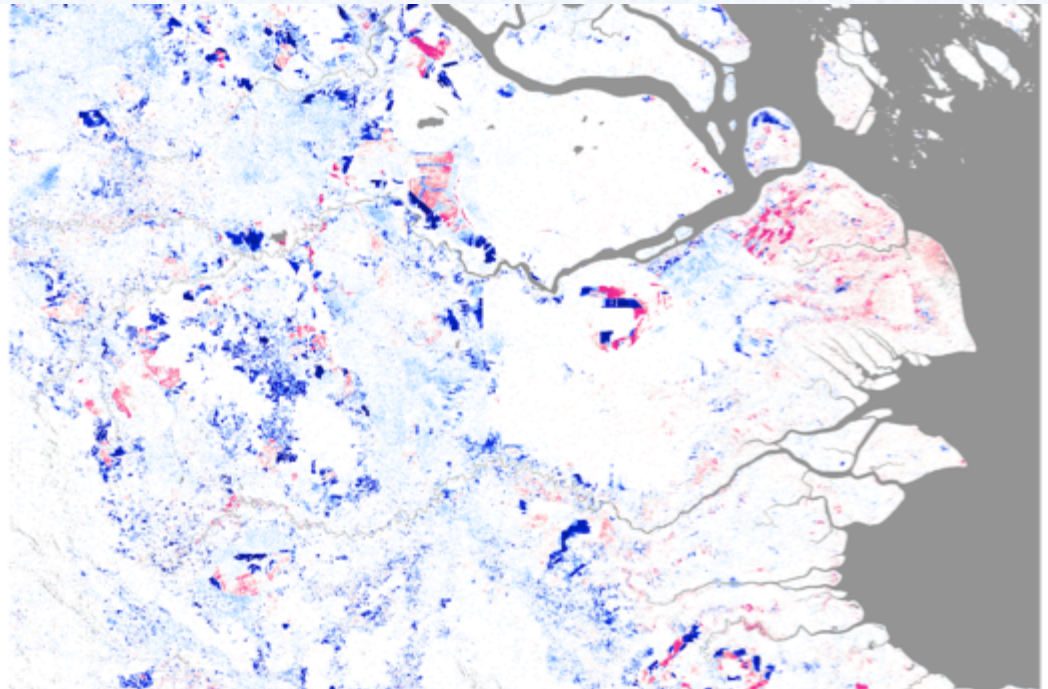
2009 mosaic - 2008 mosaic
Riau province, Indonesia



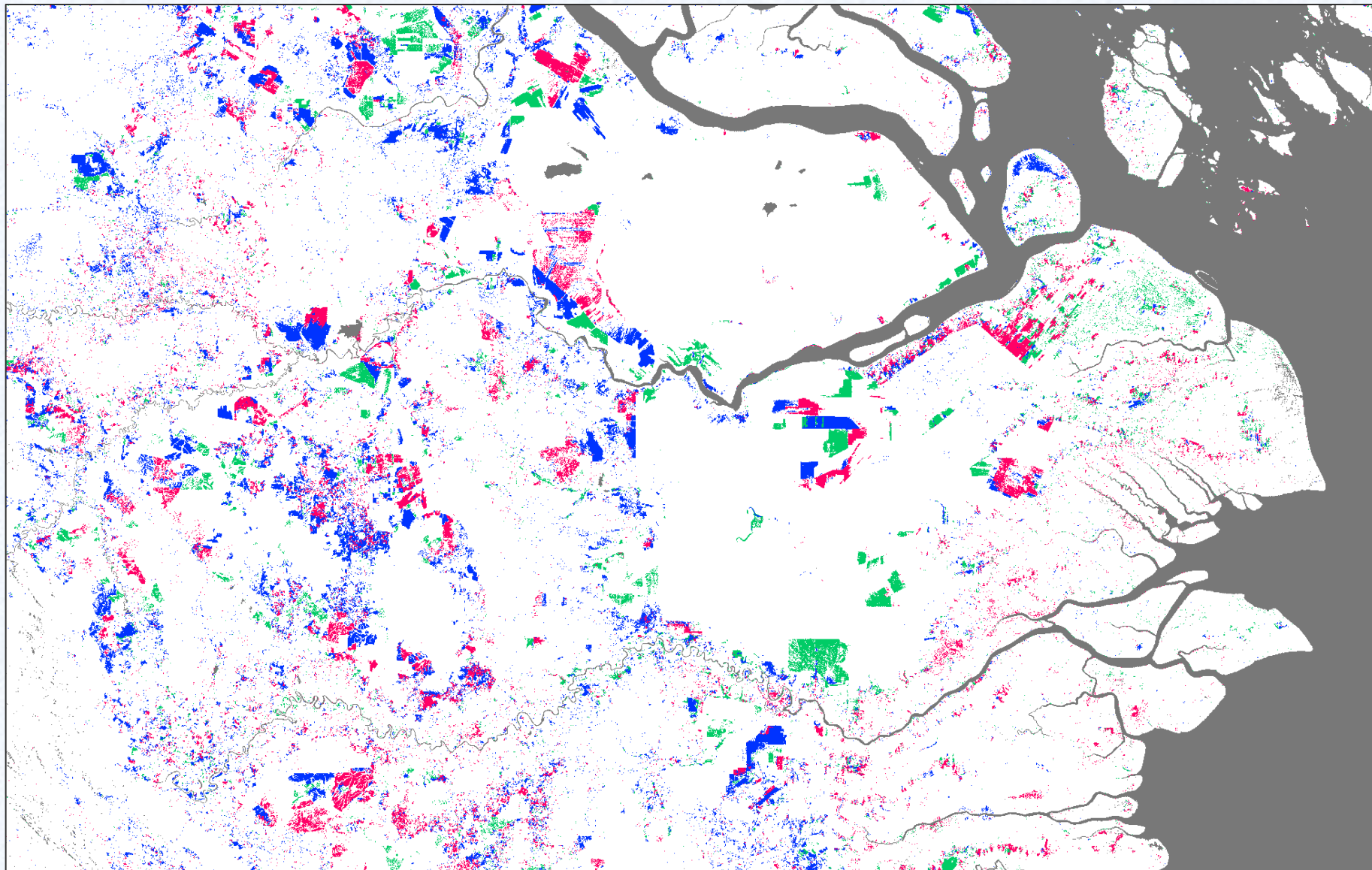
HH



HV



Annual decrease of gamma naught HV ... $\Delta\gamma^0 < -2$ dB



2007-2008

2008-2009

2009-2010

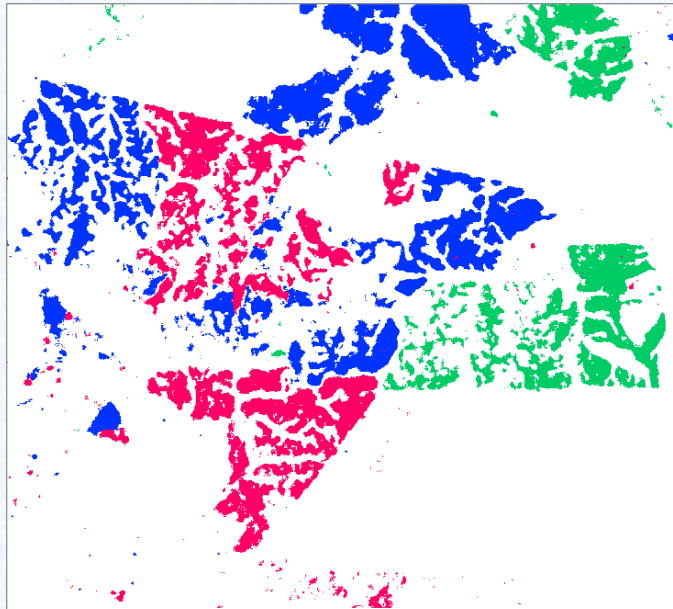
Example-1)
Acacia
concession

2007-2008

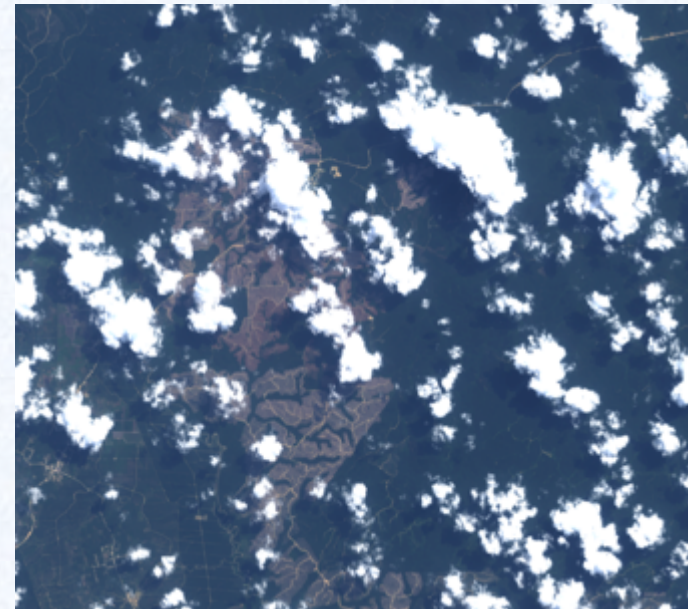
2008-2009

2009-2010

PALSAR 2007-2010



AVNIR-2 2008/07/05



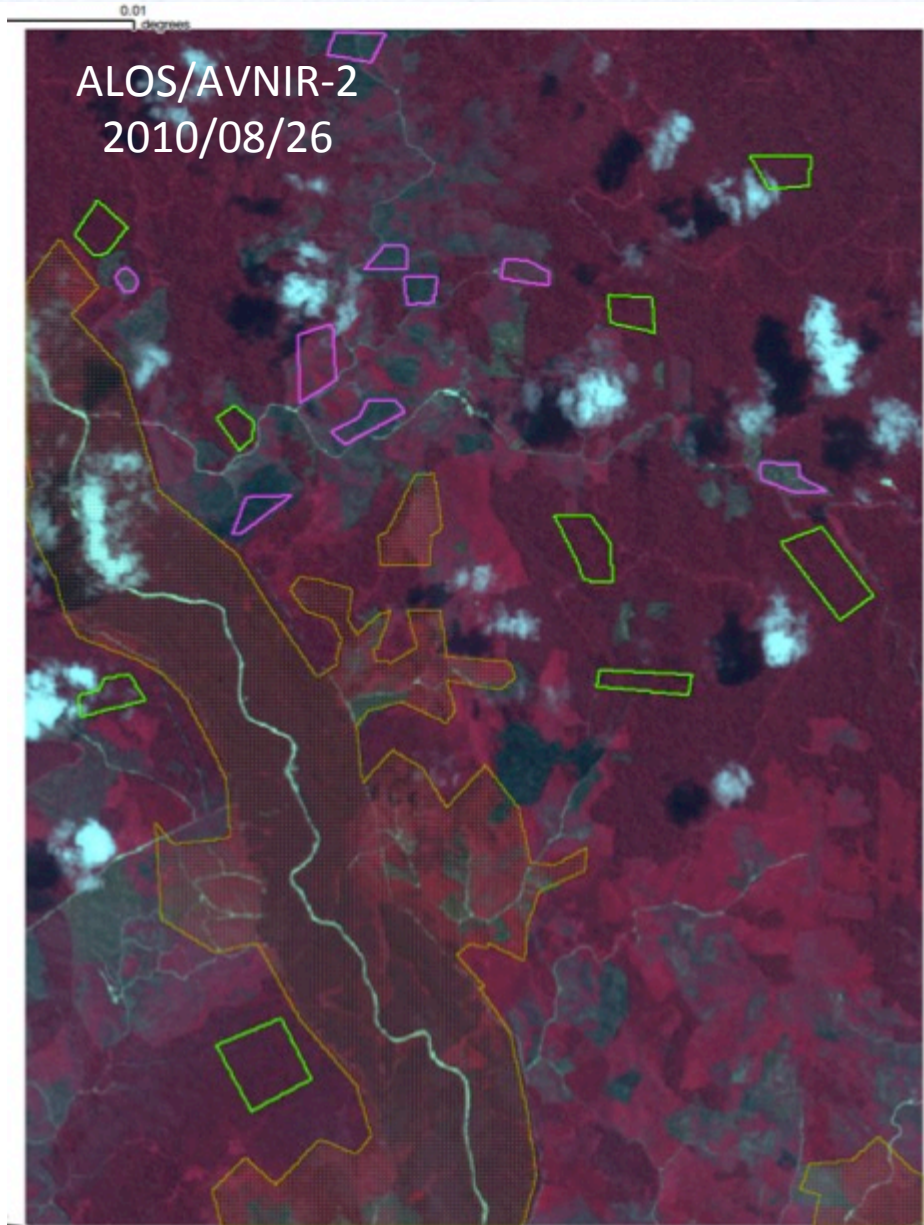
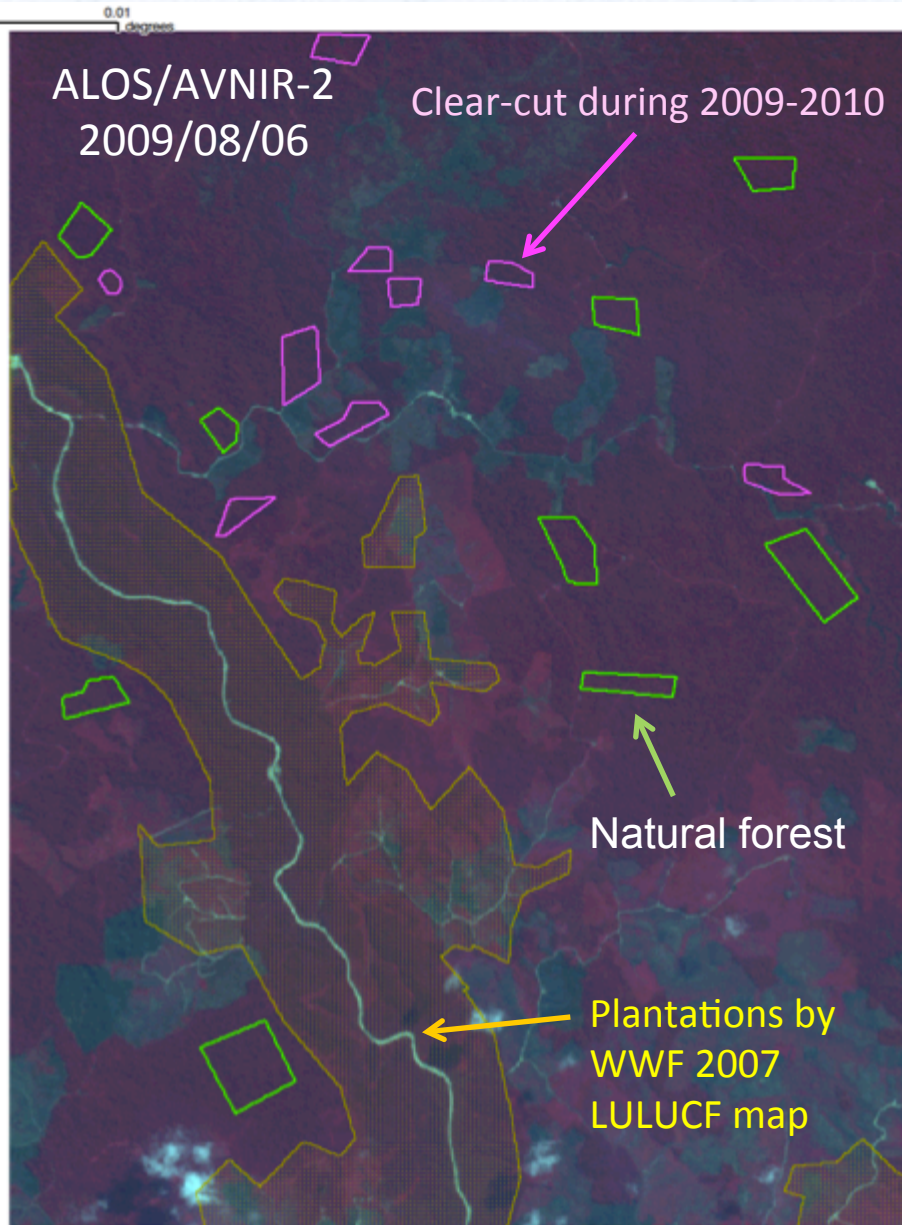
AVNIR-2 2009/10/08



AVNIR-2 2010/10/11

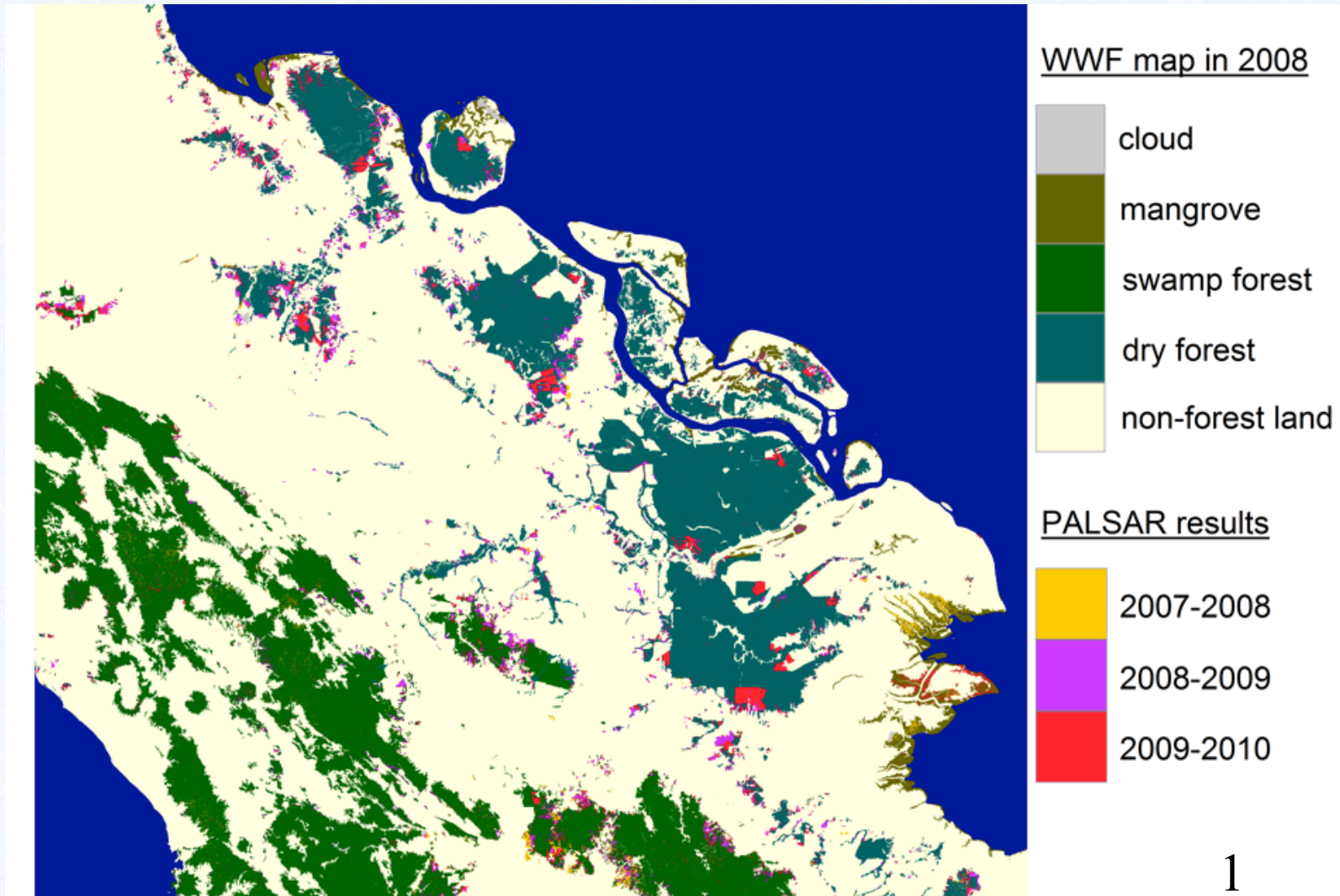


Example-2) Tesso Niro natural forest, Riau, Indonesia



Deforestation map of central Sumatra derived by PALSAR 25-m mosaics

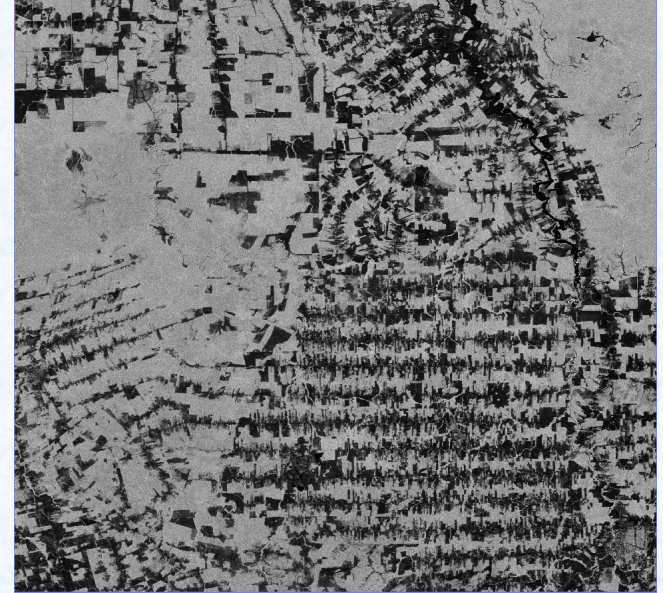
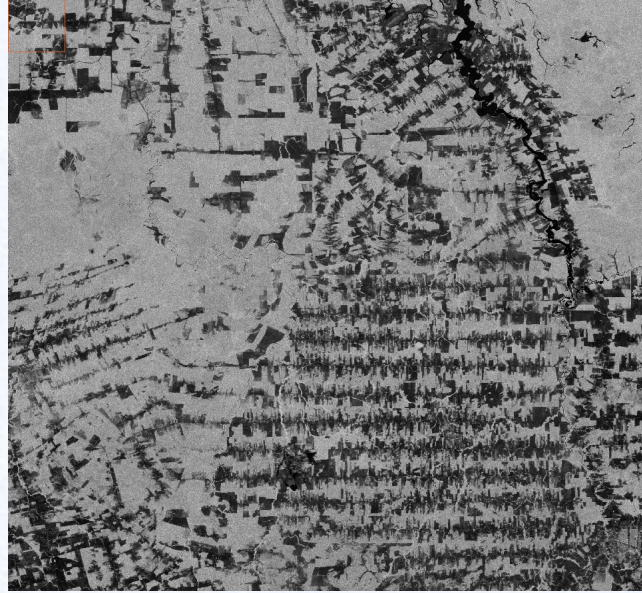
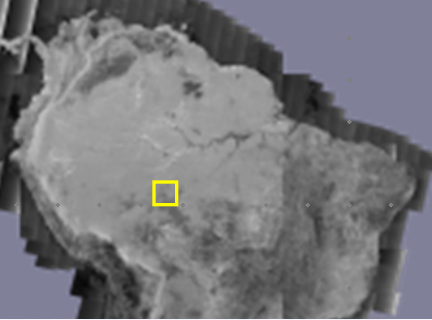
Gamma-naught change : allows the deforestation monitoring and forest changes at the known classes



1. Gamma-naught variation and the forest decrease

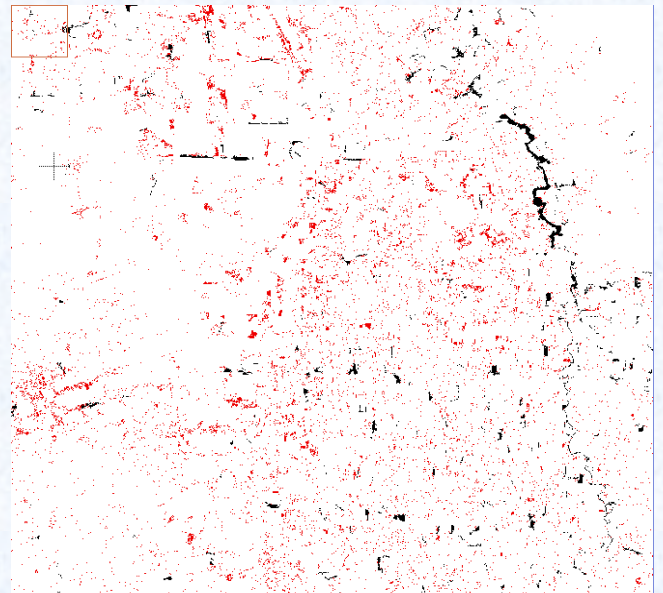
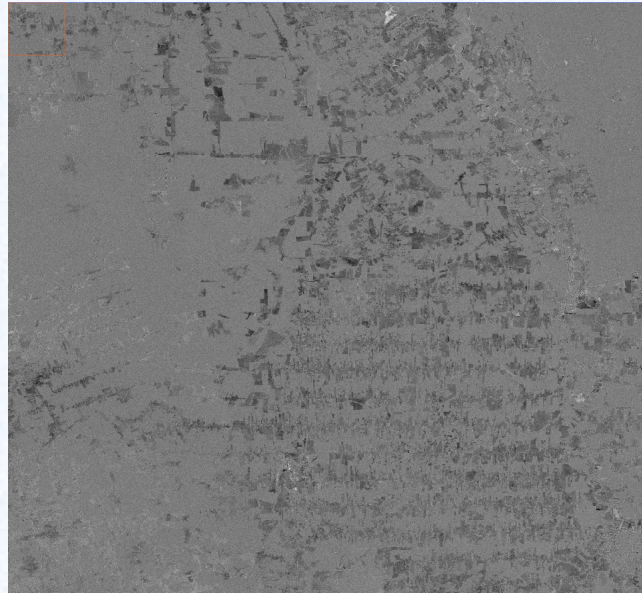
2009年モザイク

2010年モザイク



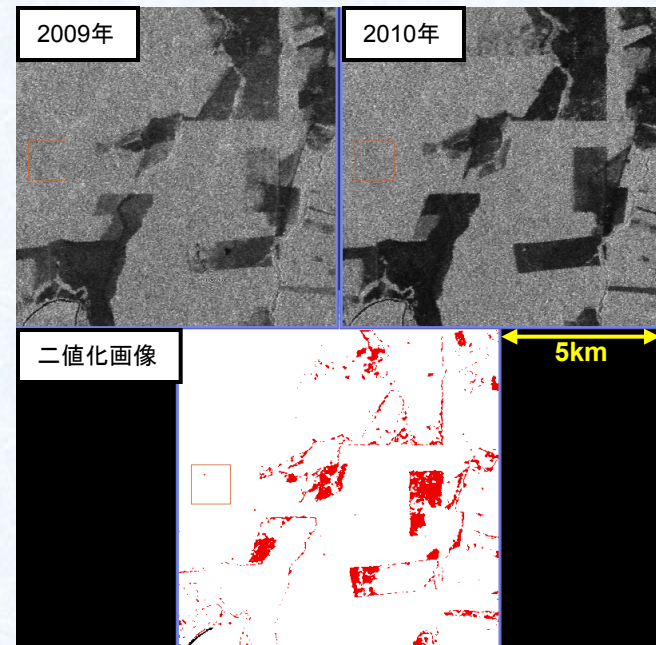
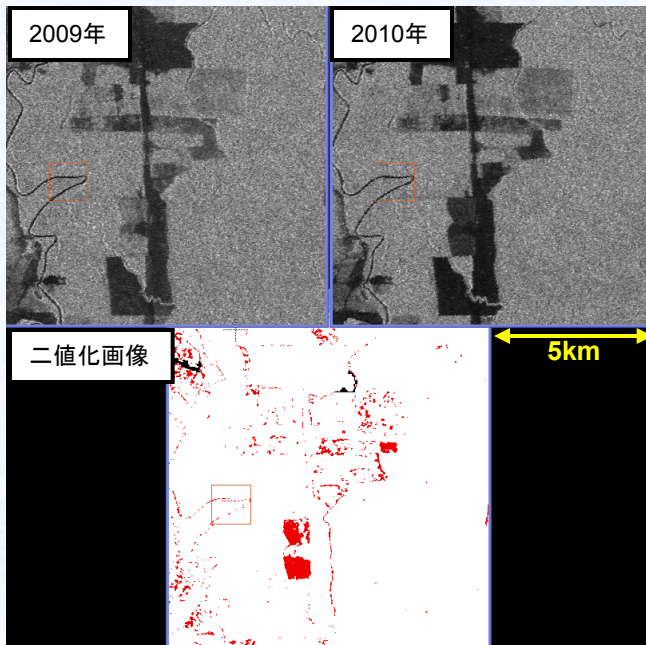
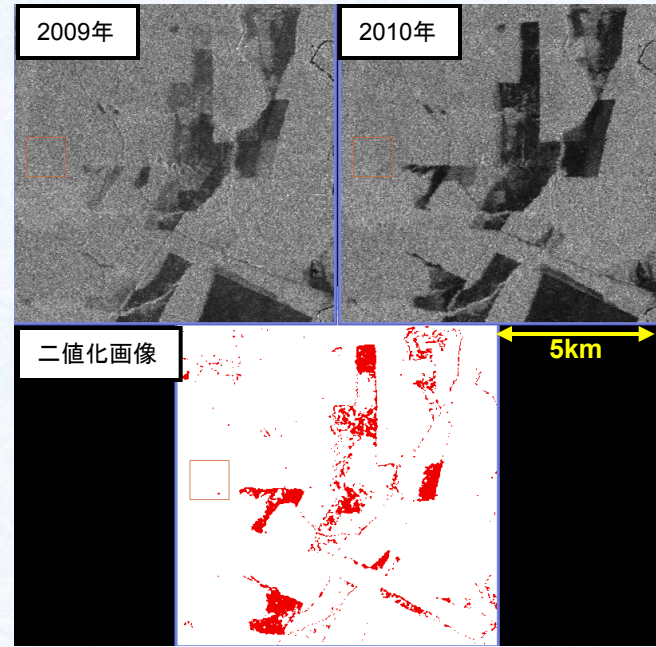
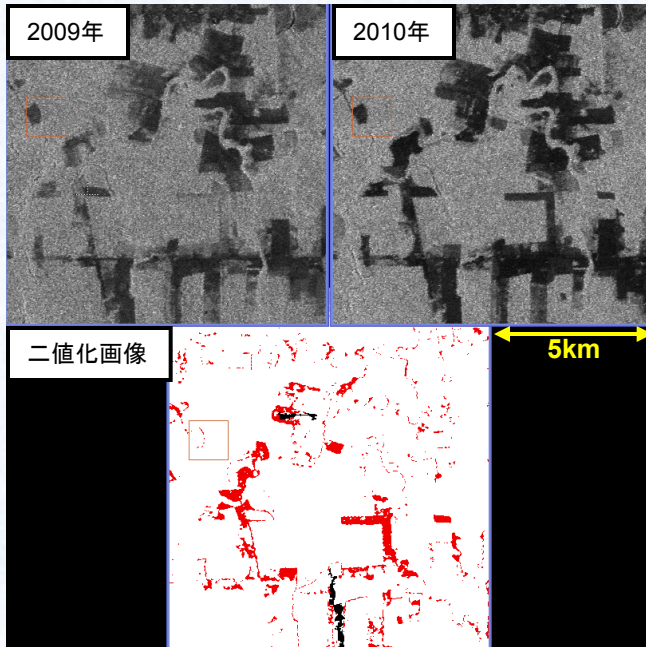
差分画像(2010年-2009年)

二値化画像



30km

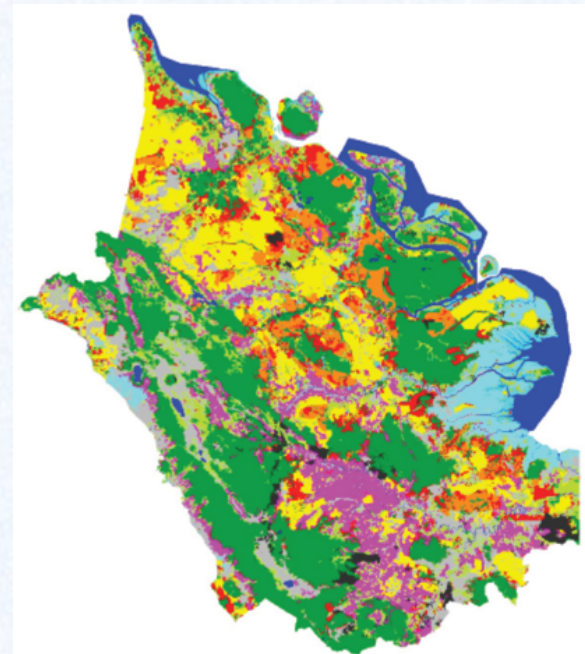
2. Gamma-naught variation and the forest decrease



Comparison study for: LULUCF

- Area : Riau
 - Method : Subspace (SS), Decision Tree (DT), Nearest Neighbor (NN), Support Vector Machine(SVM)
 - Output, LULUCF & FNF
 - Accuracy:SS>DT>NN>SVM at FNF,SS showed the best of 88%.
-
- Accuracy Comparison:- Stratified random sampling approach

Land cover class	%Landscape	CI ±3
Natural forest	30.19	322
Natural mangrove forest	1.79	19
Natural re-growth	12.17	130
Acacia	5.09	54
Oil Palm	13.53	144
Rubber	9.53	102
Coconut	3.95	42
Open area	6.94	74
Other	10.98	117
Water	5.83	62
Total	100.00	1067



Ground truth WWF¹⁷ Map (20

LULUCF algorithm comparison (Number is accuracy in %, LULUCF in 9 classes, FNF in 2 classes Blue points correct, red points in incorrect (≠))

Sub Space

Decision Tree

Nearest Neighbor

Support Vector
Machine

55.4

56.0

46.8

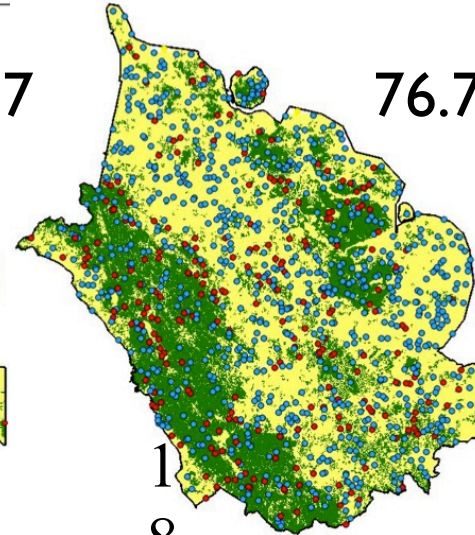
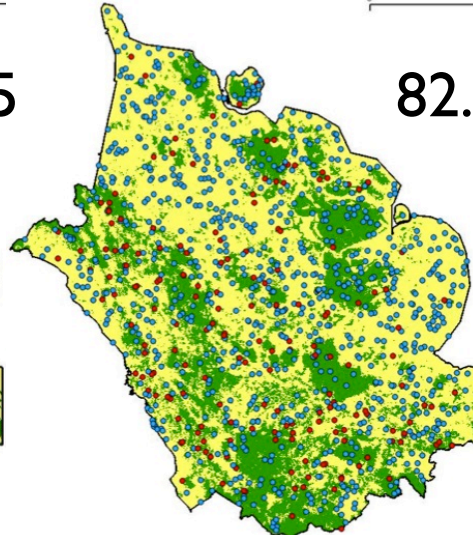
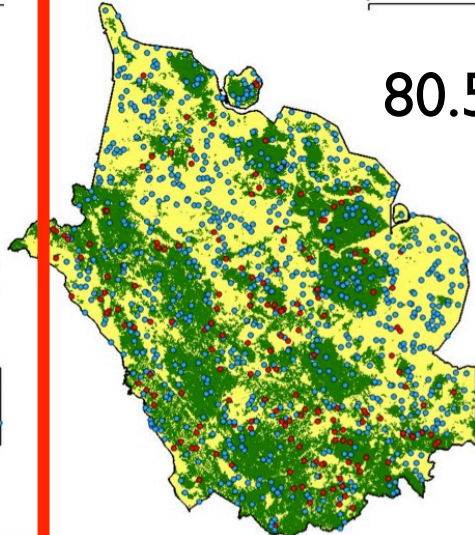
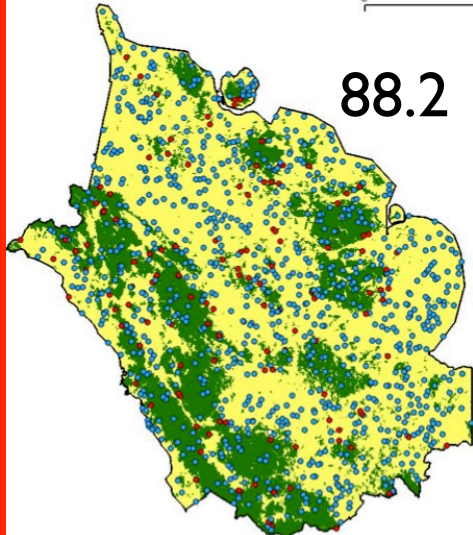
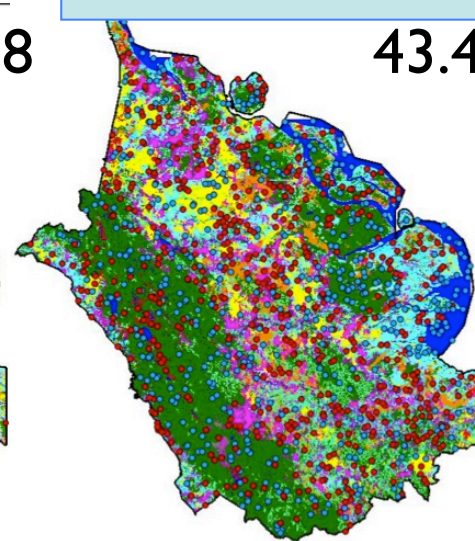
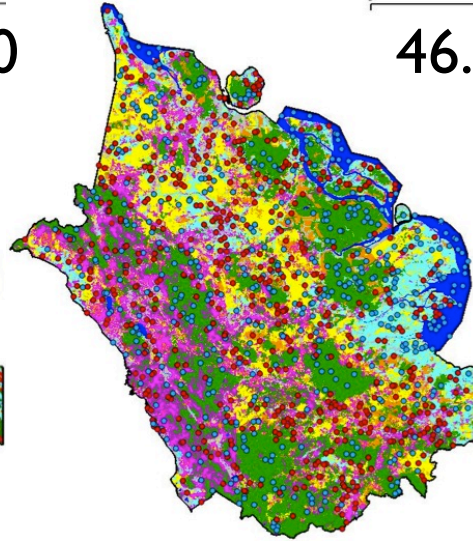
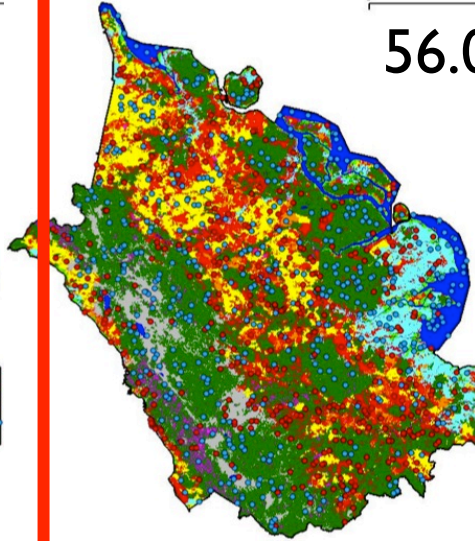
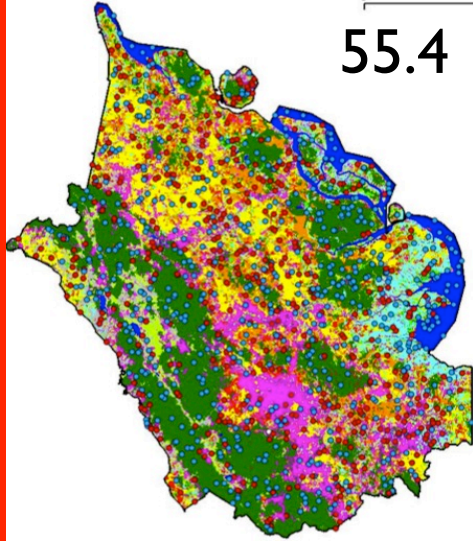
43.4

88.2

80.5

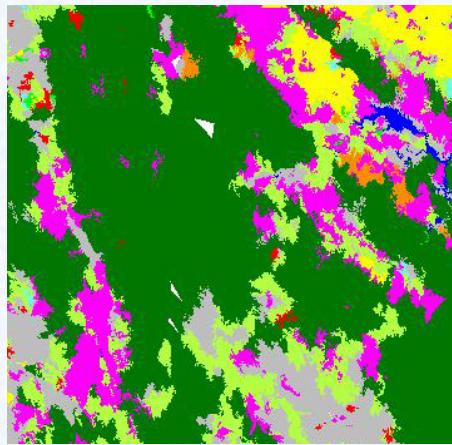
82.7

76.7

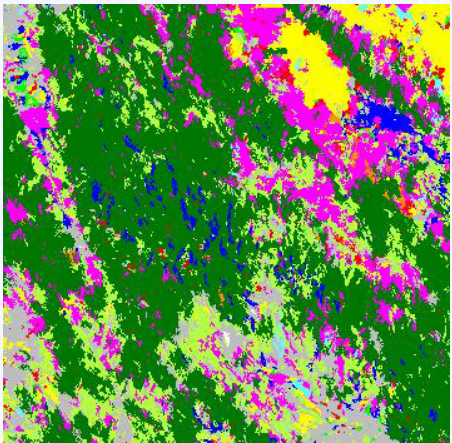


Slope correct effect and advantage of Gamma-naught Visualization

- LULUCF(FNF)
- FNF



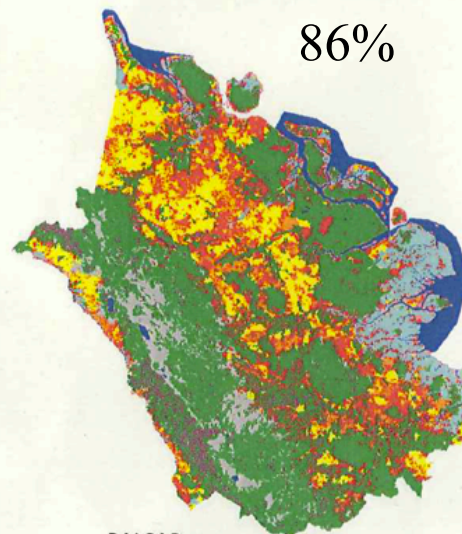
勾配補正有り



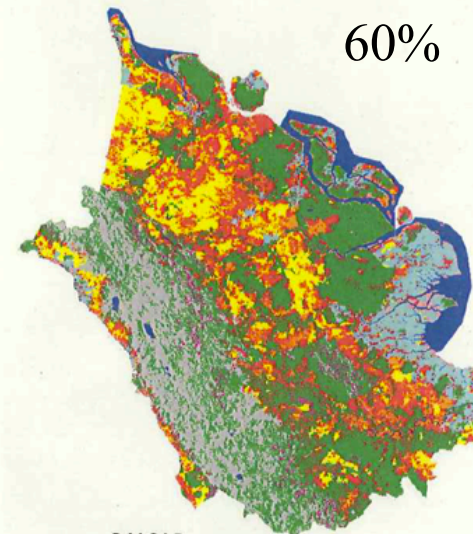
勾配補正なし

Slope correction

Without slope correction



86%



60%

PALSAR
(HH + HV, Slope Correctionあり)

PALSAR
(HH + HV, Slope Correctionなし)

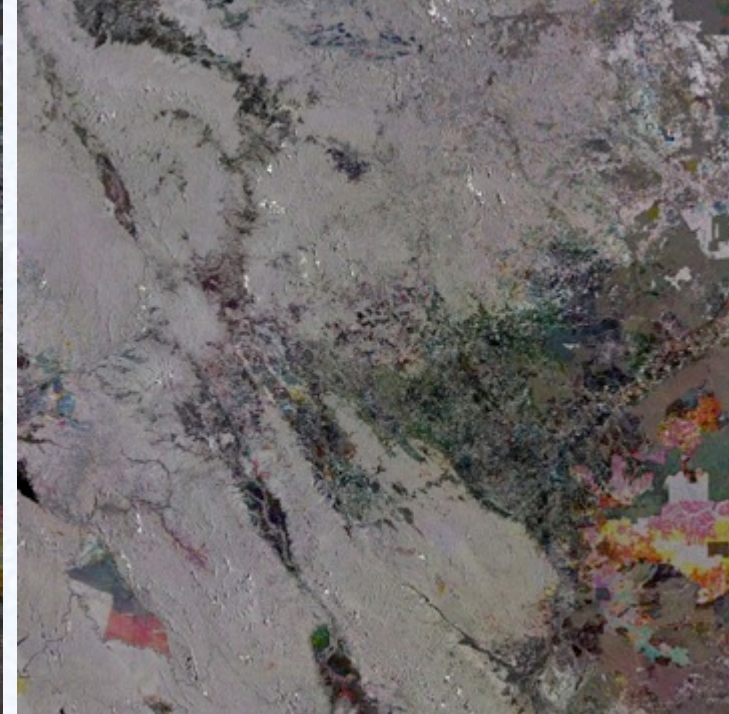
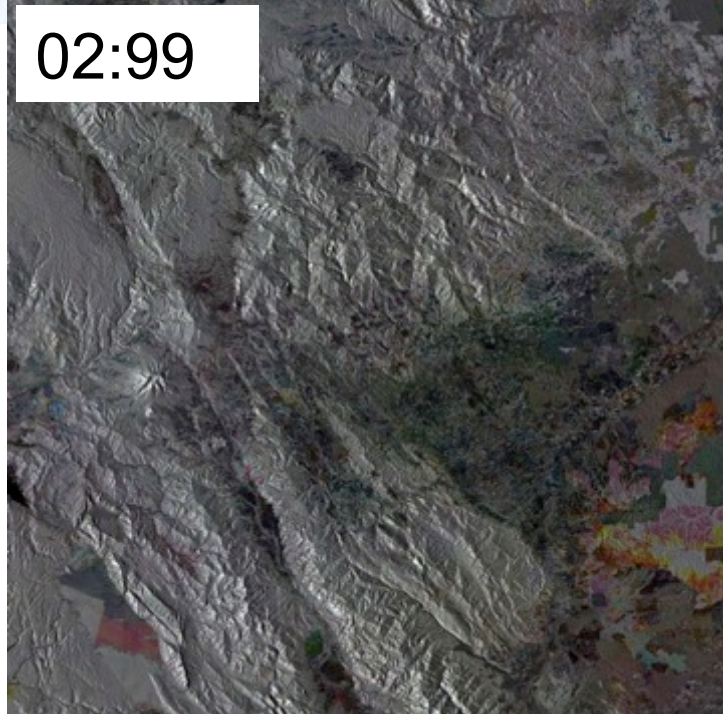
		Forest	Mangrove	ReGrowth	Acacia	Oil Palm	Rubber	Coconut	OpenArea	Others
Slope Correction	Producer'S Accuracy [%]	64.03%	33.57%	0.00%	26.66%	55.39%	20.75%	43.17%	17.03%	29.78%
	User'S Accuracy [%]	86.43%	31.81%	0.00%	12.84%	56.92%	4.03%	69.62%	45.61%	19.52%
Slope Correction	Producer'S Accuracy [%]	51.49%	27.24%	0.00%	20.14%	52.22%	14.67%	35.97%	14.89%	14.19%
	User'S Accuracy [%]	60.99%	28.00%	0.00%	13.29%	54.49%	2.18%	73.51%	48.03%	23.20%

森林・非森林
86%
↓
60%

Slope Correctionされていないデータでは、特に地形の起伏が多い山岳地帯における森林分類の精度が大きく低下した。

Comparison of
slope-
correction and
without slope
correction :

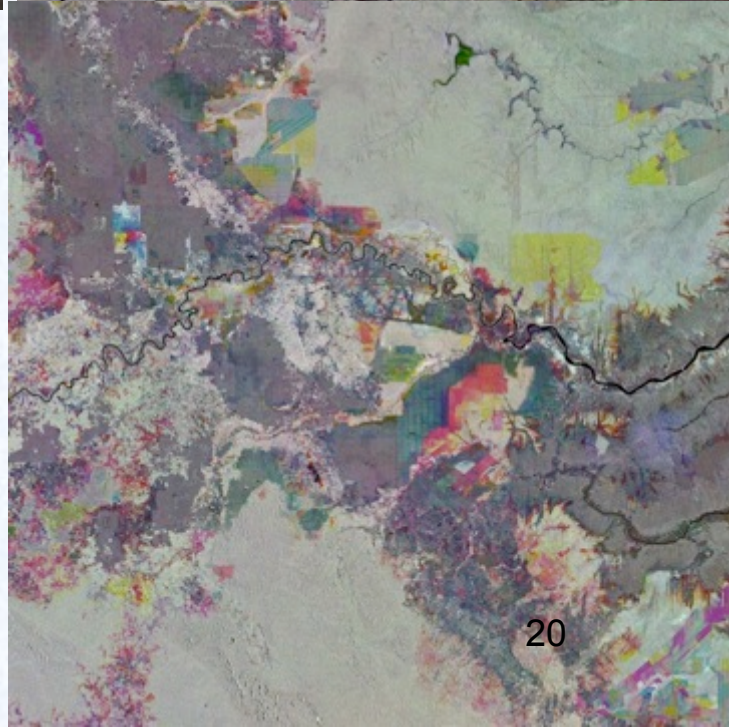
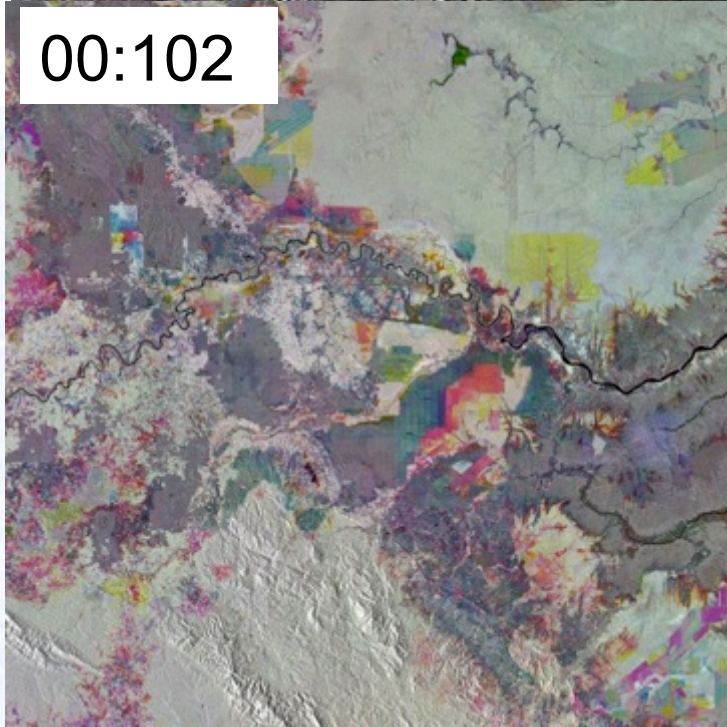
02:99



Riau

R:2007, G:
2009:B:2010

00:102



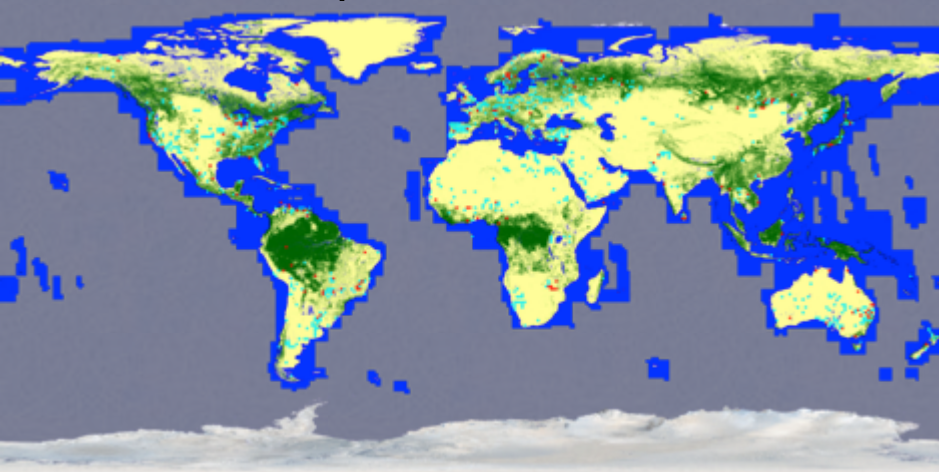
5.3 FNF

- Target area : Riau
- Method : Thresholding using eCOG (-11.5 dB for g^0_{HV})
- Output, FNF

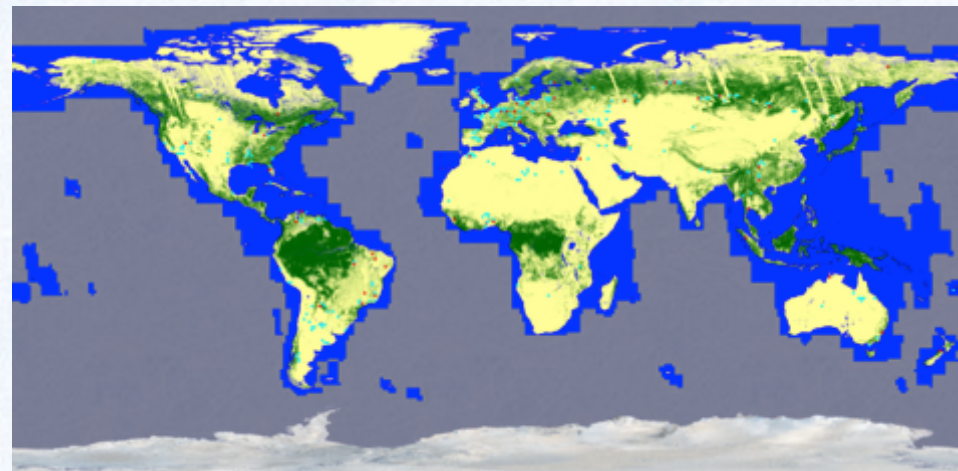
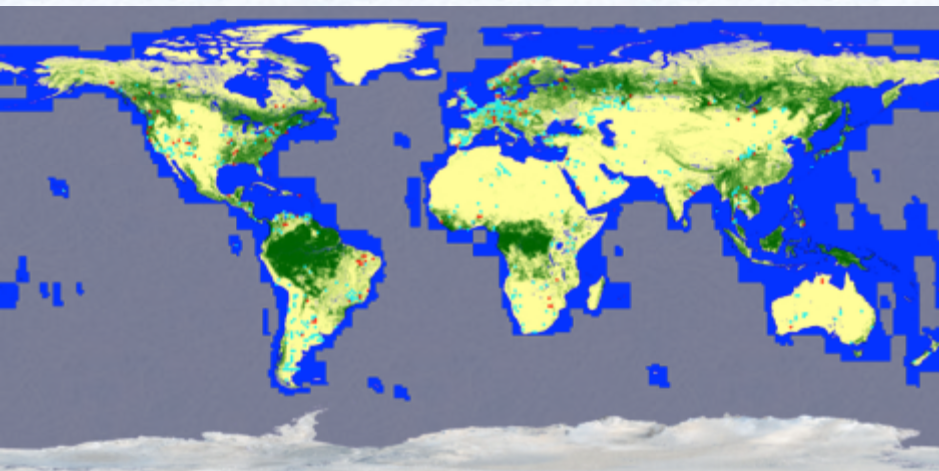
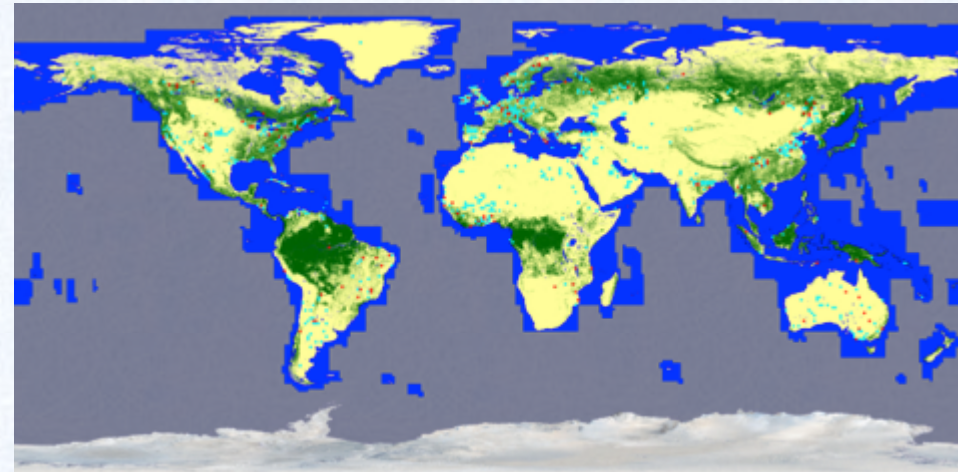
- Other: Global FNF
- Comparison with DCP

Accuracy evaluation of FNF2007-2009 using

PALSAR FNF 2007
84.54%, 925points



PALSAR FNF 2008
83.02%, 736points



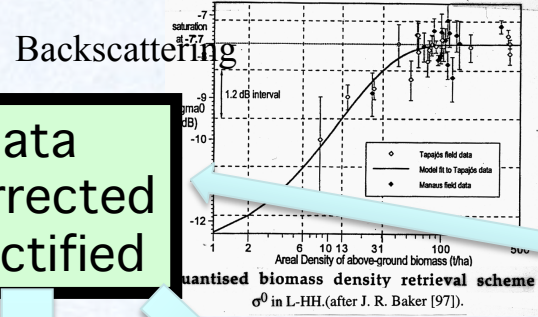
PALSAR FNF 2009
82.68%, 635points

● : Forest, ● : Non-Forest, ● : Water
● : Correct, ● : Incorrect

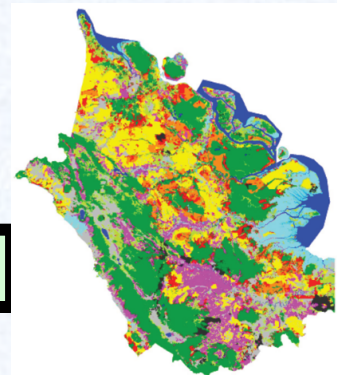
PALSAR FNF 2010
83.93%, 280points

biomass estimation (accuracy) (Tier-2~3)

SAR data
Slope corrected
Ortho-rectified



LULUCF
FNF



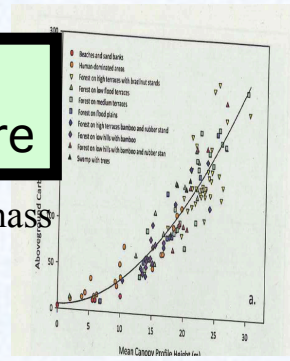
biomass(accuracy)

$$B = \sum_i b_i A_i$$

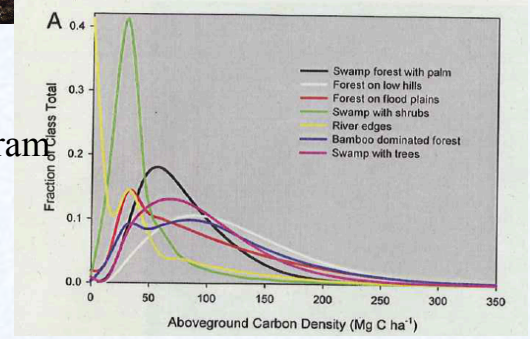
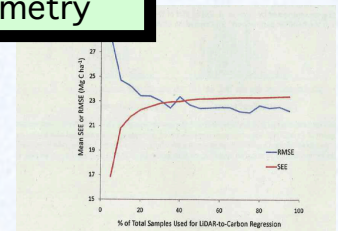
$$\Delta B = \sqrt{\sum_i (\Delta b_i A_i)^2}$$

Estimate the forest biomass and its accuracy

Lidar data
Height measure



Ground truth data
Brest-height-diameter
Tree height, Alometry



biomass

MRV Status

Two methods are being developed for the operations, SS for LULUCF, and Gamma-naught change detection estimating the forest area change in Indonesia and Brazil.

PALSAR basic processing: done.

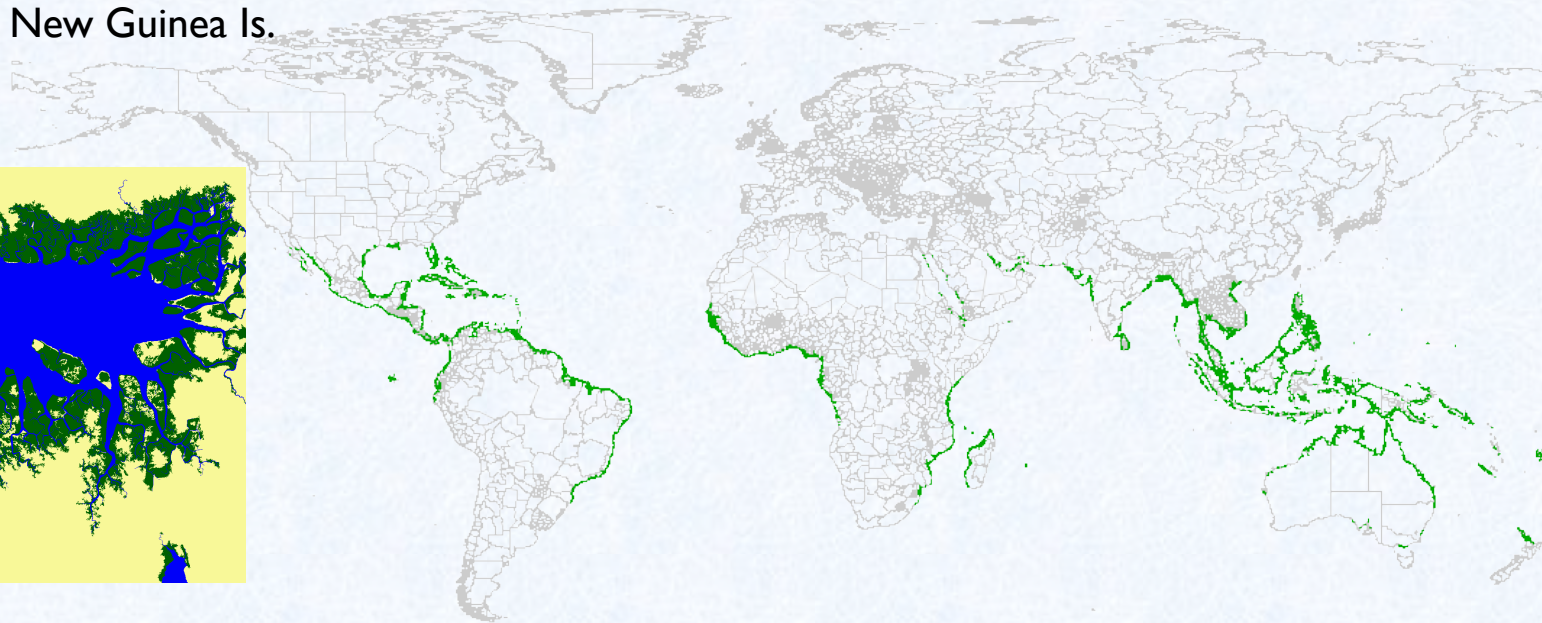
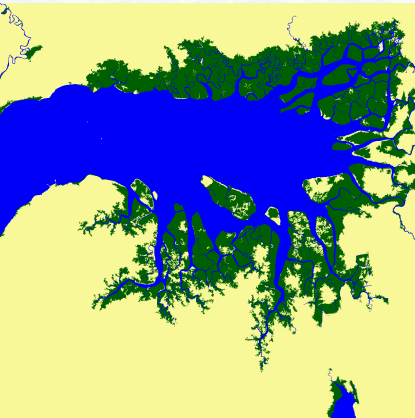
Ground plotting 48 points in Riau

Lidar data in Riau



Global Mangrove Map

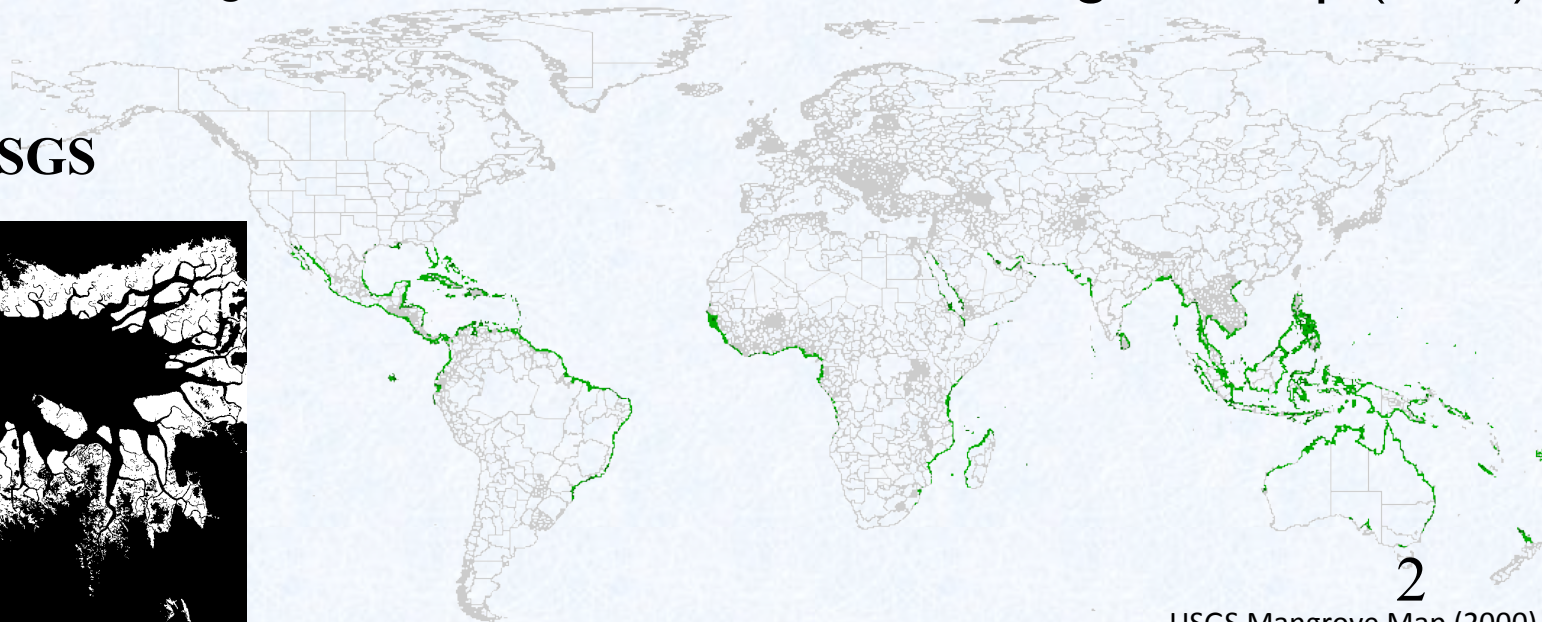
S02E133 New Guinea Is.



PALSAR 25 Mangrove

PALSAR Mangrove Map (2010)

USGS

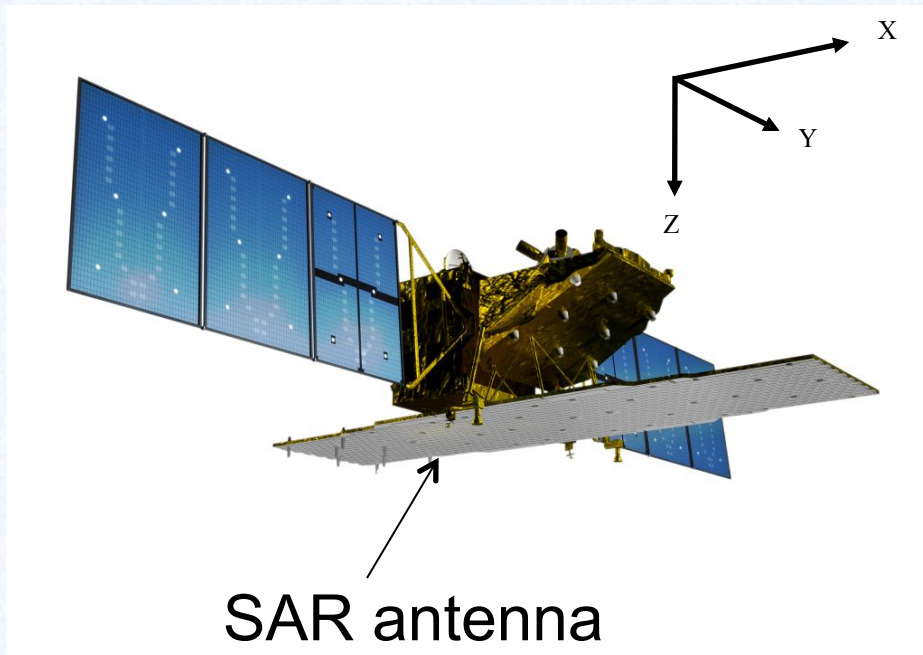


2
USGS Mangrove Map (2000)
5

The overview of ALOS-2

ALOS-2 satellite parameters

- Orbit type : Sun-synchronous
- Launch : 2013
- Altitude : 628km +/- 500m(for reference orbit)
- Revisit time : 14days
- LSDN : 12:00 +/- 15min



PALSAR-2 (Mission Sensor)

- L-band Synthetic Aperture Radar
- Active Phased Array Antenna type
 - two dimensions scan (range and azimuth)
- Antenna size : 3m(EI) x 10m(Az)
- Bandwidth : 14 to 84MHz
- Peak transmit Power : 5100W
- Observation swath : 25km to 490km
- Resolution : Range 3m to 100m
Azimuth 1m to 100m

7. Summary

- Slope corrected gamma-naught of PALSAR and JERS-1 SAR are effective parameter to express the deforestation status. Time series of the gamma-naught change will be the useful method for detecting the forest decrease.
- Development of the LULUCF is underway and aggregated FNF using the subspace method reaches to 88%.
- We will continue to develop the biomass quantity (and carbon) change combining the ground truth data and lidar data.

Acknowledgements

- Great Thanks to RESTEC researchers
- T. Yamanokuchi, T. Itoh, O. Isoguchi, and H. Okumura

5.2 LULUCF Classification development

- Area : Riau
- Method : Several
- SVM, eCOG MDM, eCOG Bayesian, Sub-Space(SS)
- Output, LULUCF & FNF
- SS>SVM>eCOG at FNF, SS showed the best accuracy of 88%.