Detecting Tropical Deforestation with ALOS-PalSAR

Shaun Quegan, Martin Whittle
University of Sheffield

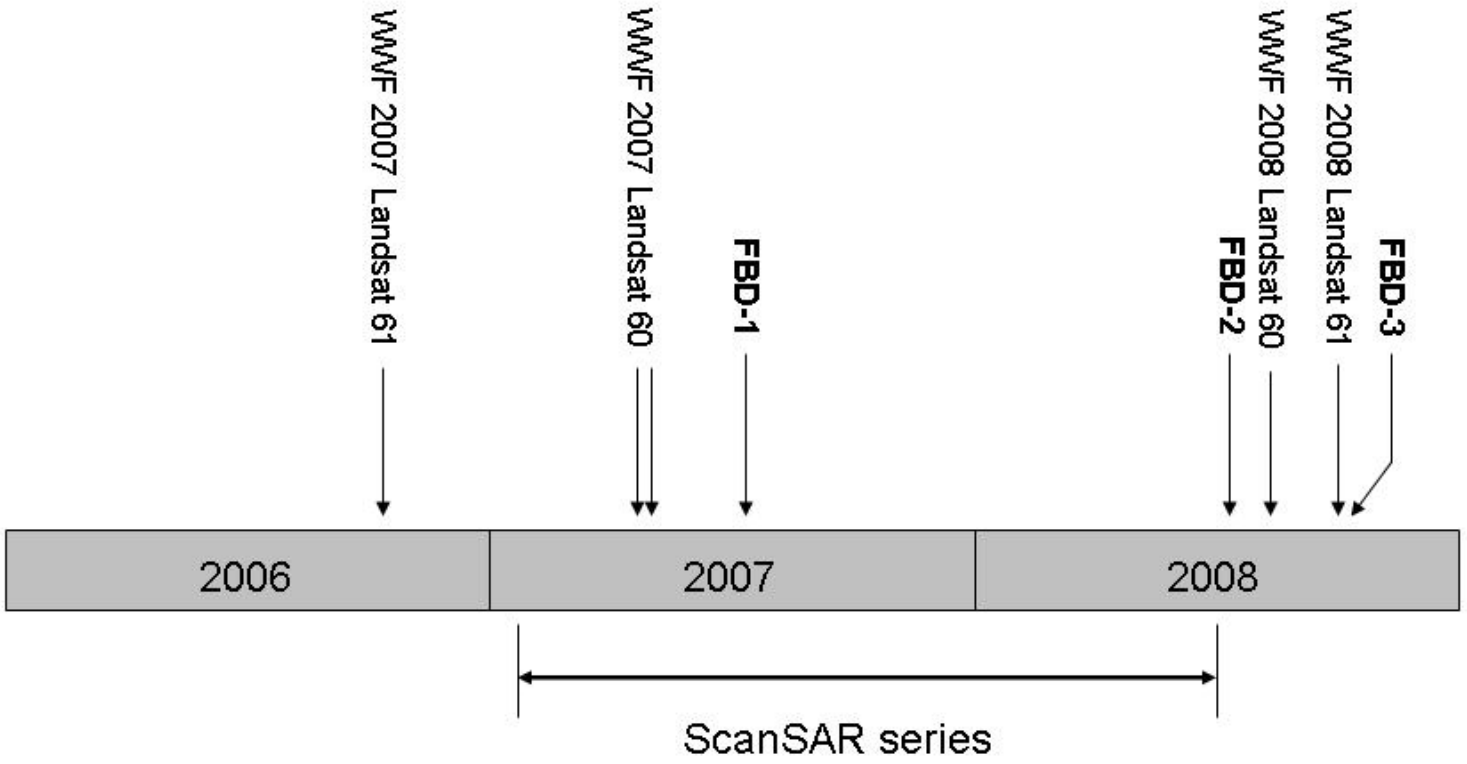
Yumiko Uryu, Michael Stuewe, Koko Yulianto
WWF Indonesia

Science Team meeting #15
JAXA TKSC/RESTEC HQ, Tsukuba/Tokyo, January 24-28, 2011

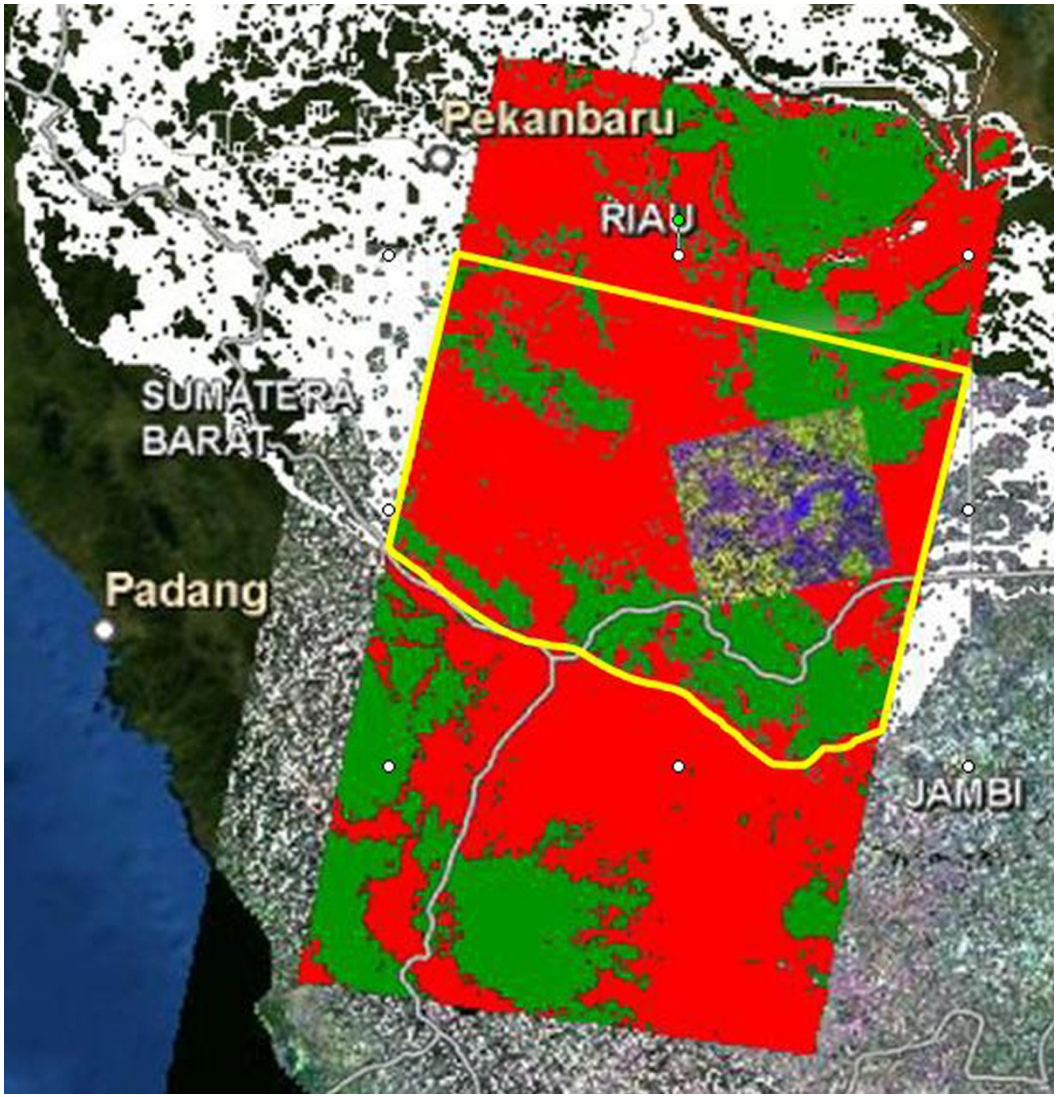
Objectives

1. Deforestation mapping with ScanSAR: can onset of events be detected?
2. Deforestation mapping with FBD: is FBD better then ScanSAR; is HV better than HH?
3. Deforestation mapping with combined ScanSAR & FBD: does combining the data types give better results?

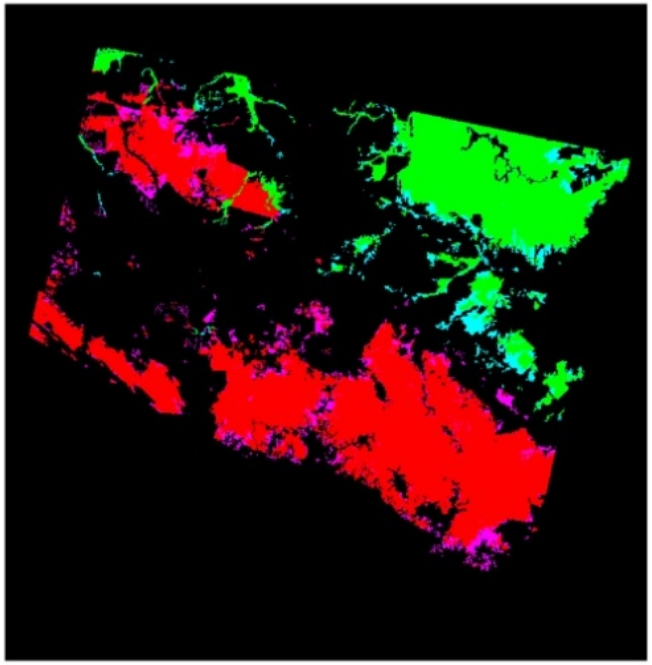
Data Timelines



Data Coverage



WWF databases



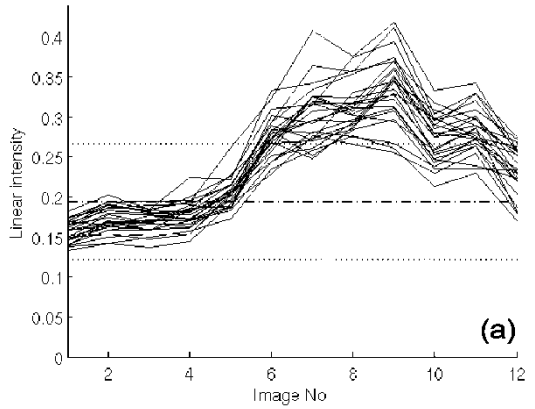
Forest types:
Red = dry, green = swampy.
Deforestation is shown in pink & light blue

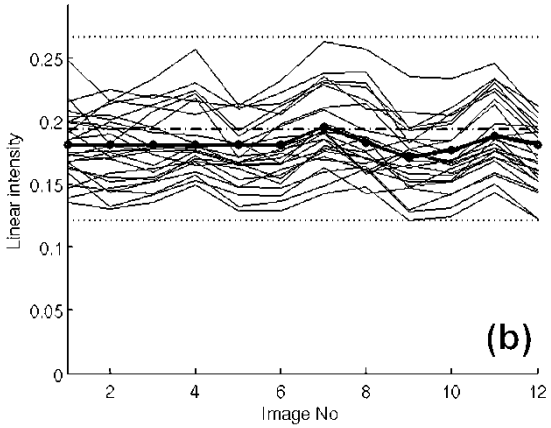
Deforestation Signatures in ScanSAR

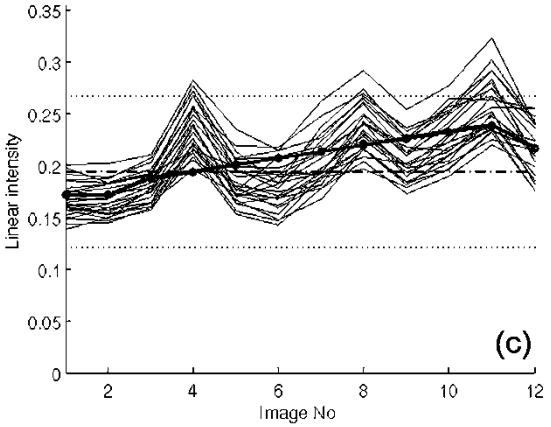
ALOS

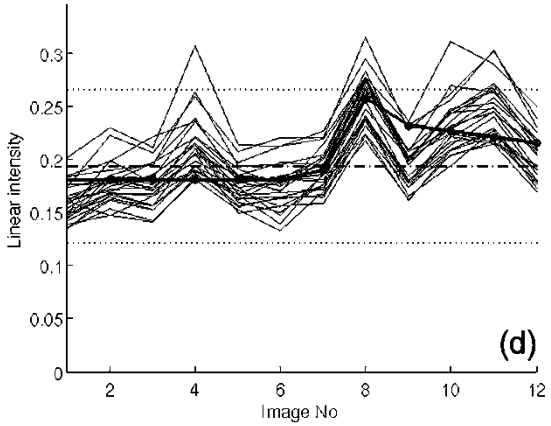
K&C Initiative

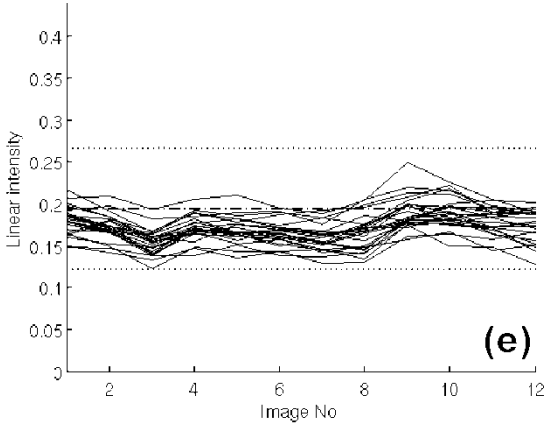
An international science collaboration led by JAXA



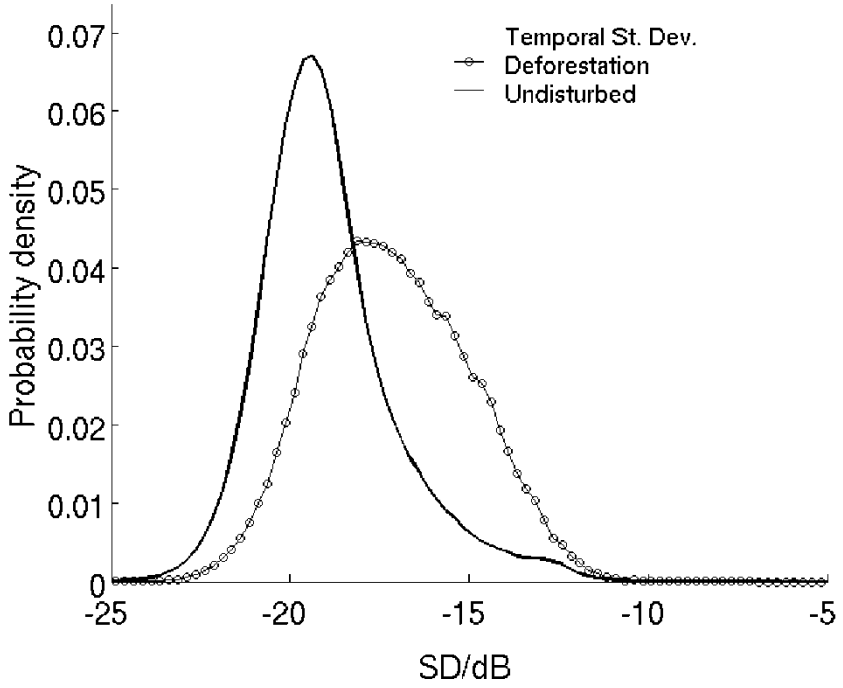


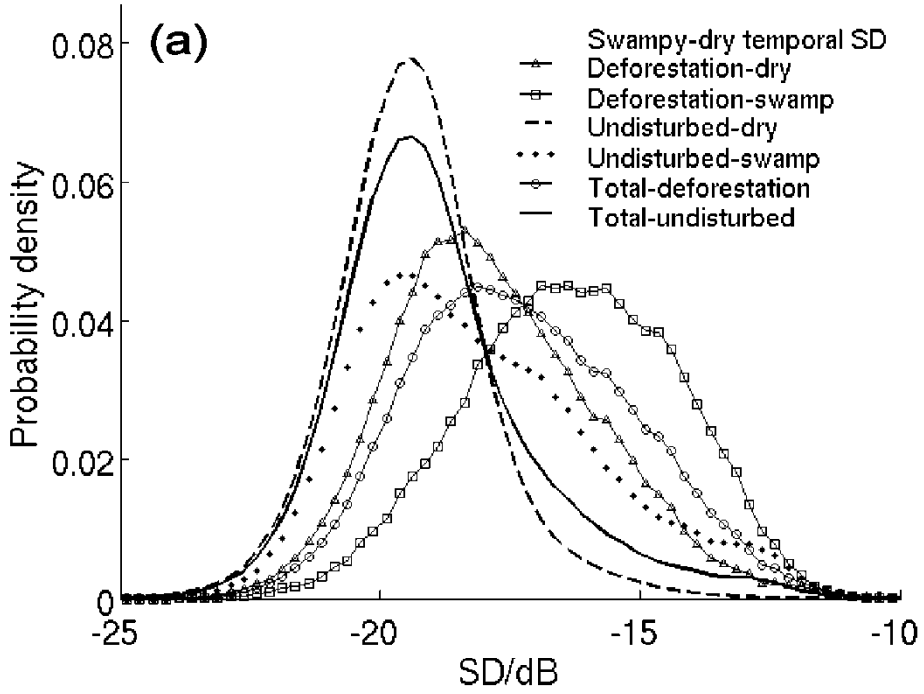




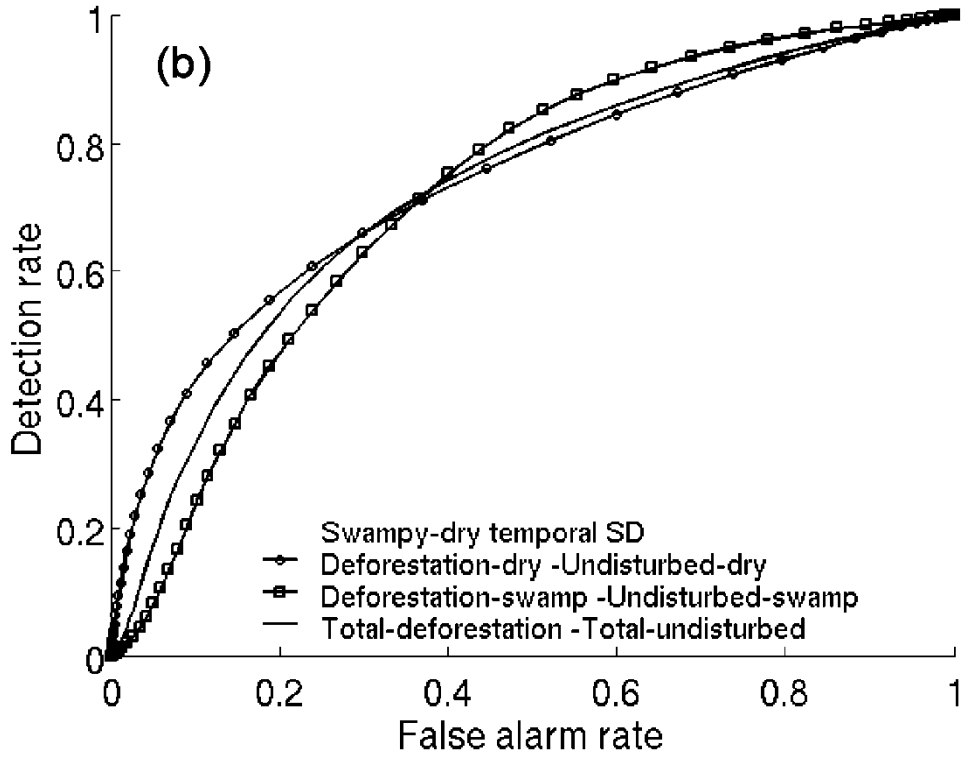


Detection and False Alarm in ScanSAR



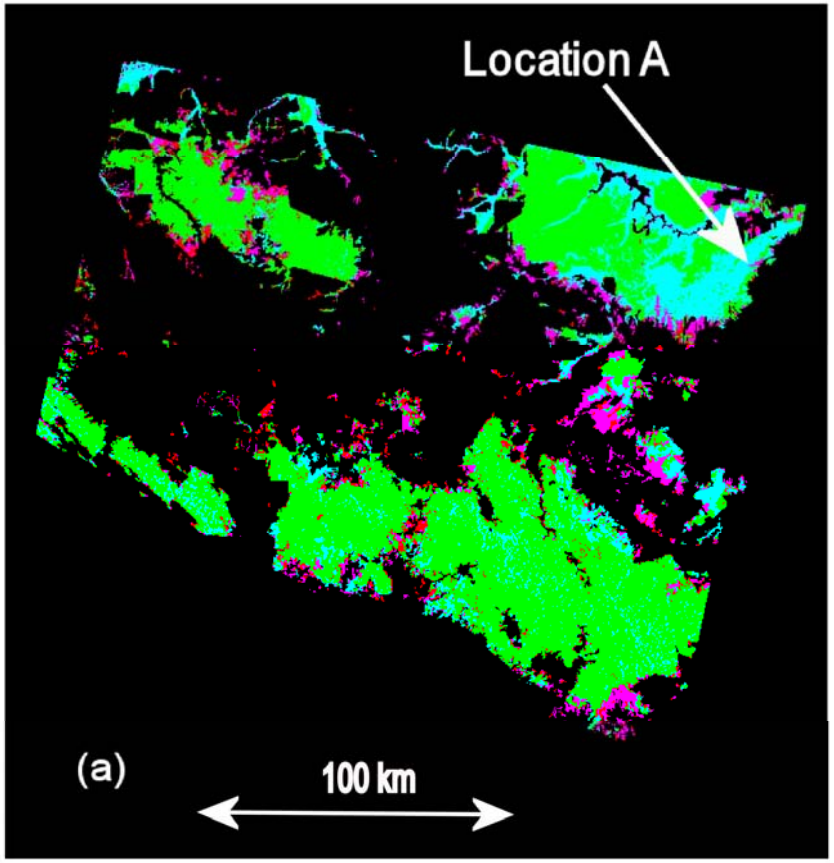


ScanSAR ROC Curves

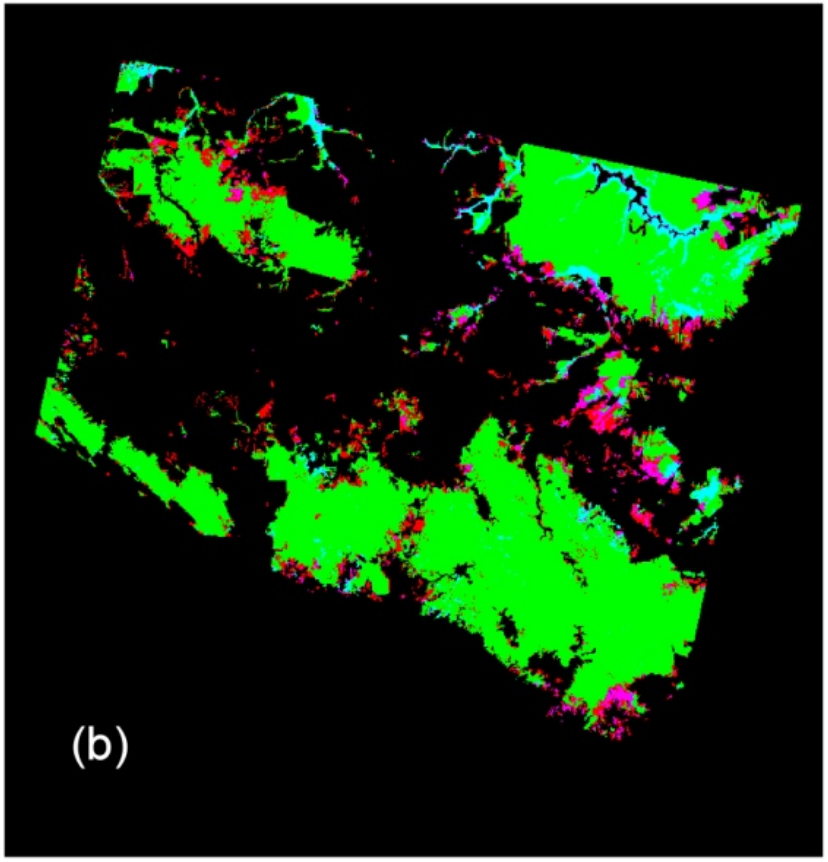


Detection is poorer in swamp forest than in dry forest, for a given false alarm rate

Detection and False Alarm in ScanSAR



False alarm rate = 24%



False alarm rate = 7%

Detection of deforestation in FBD data measures change by taking image ratios, i.e.,

$$R(\mathbf{x}) = I_1(\mathbf{x}) / I_2(\mathbf{x})$$

for images at times t = 1 and t =2 (equivalent to differences if expressed in dB).
This is directional change: increase (R < 1) or decrease (R > 1).

Also important is the non-directional change measure:

$$R_1(\mathbf{x}) = \max\left[\frac{I_1(\mathbf{x})}{I_2(\mathbf{x})}, \frac{I_2(\mathbf{x})}{I_1(\mathbf{x})}\right] - 1$$

ALOS

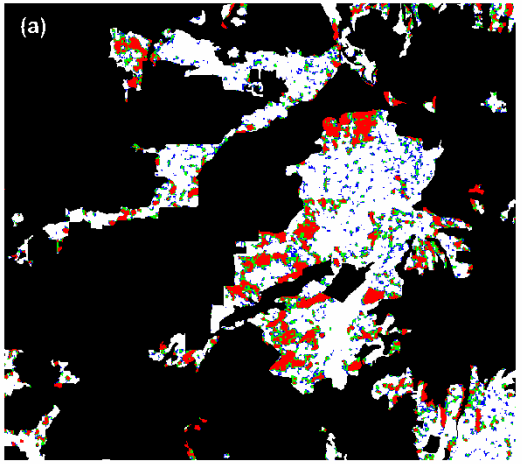
HH & HV change detection

K&C Initiative
An international science collaboration led by JAXA

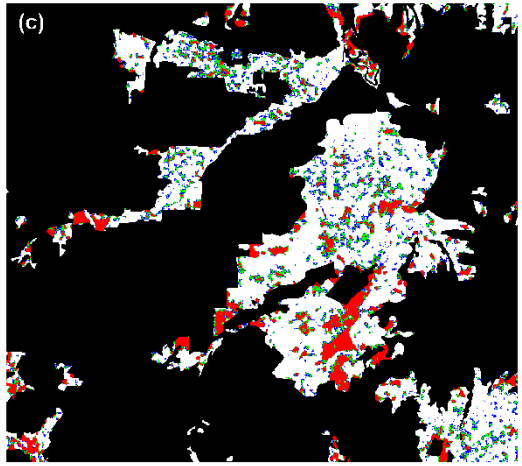
Increases

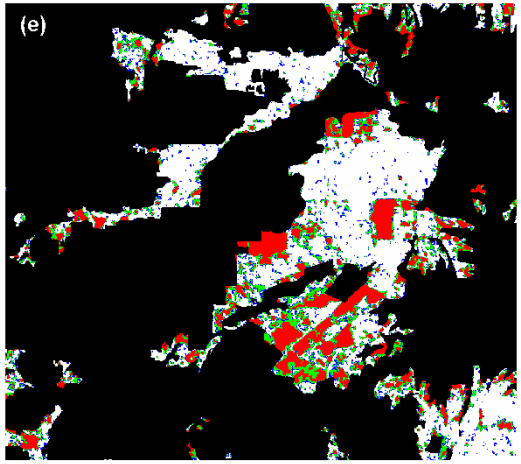
Decreases

Fusion

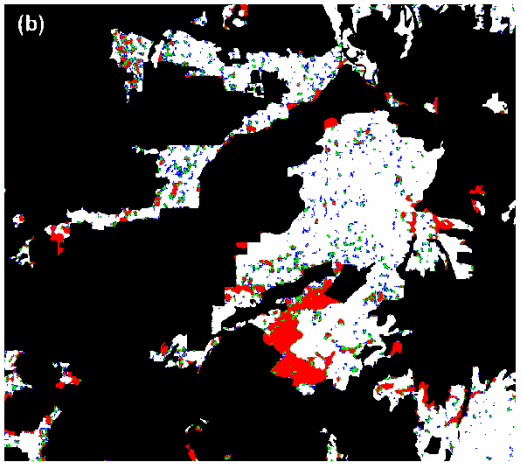


HH

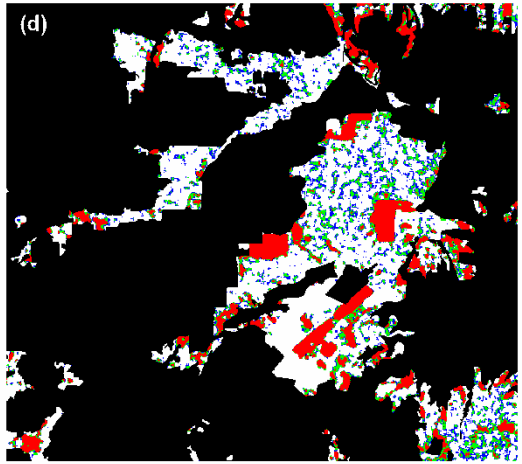


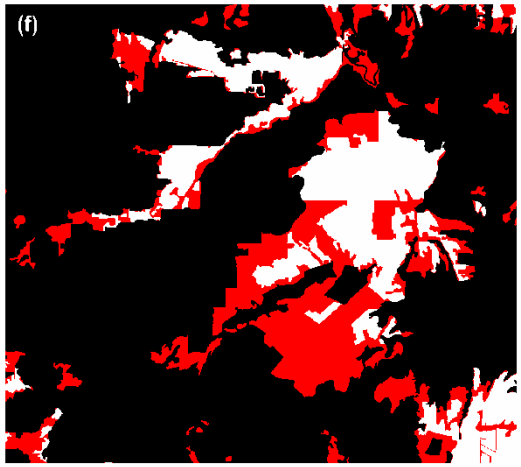


WWF databases



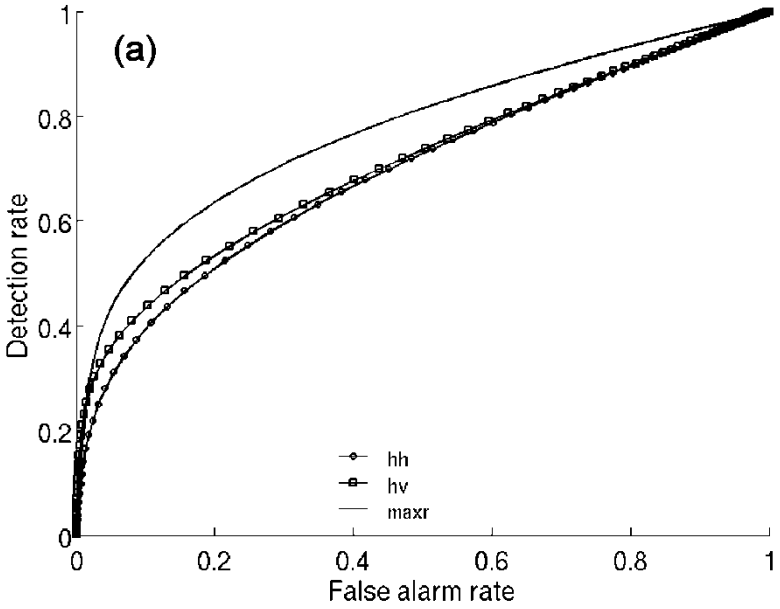
HV



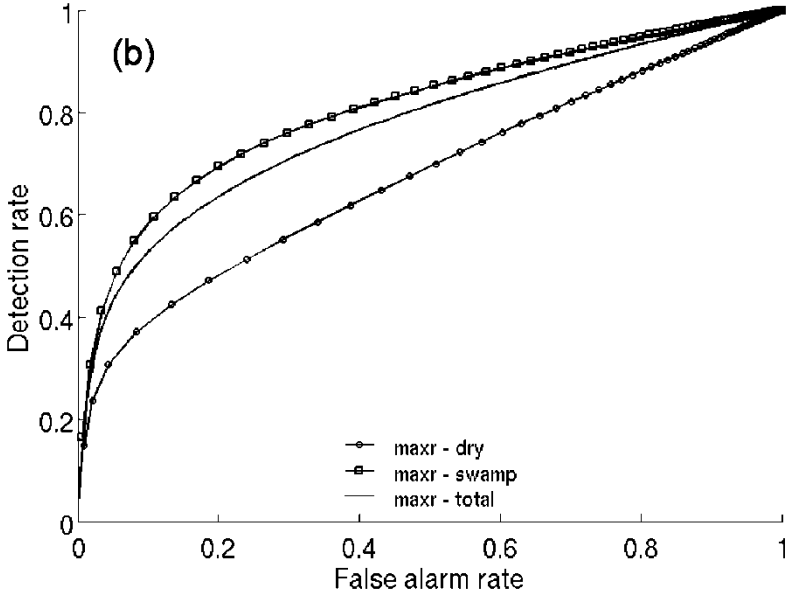


HH, HV & Fused ROC curves

HH, HV & Fused

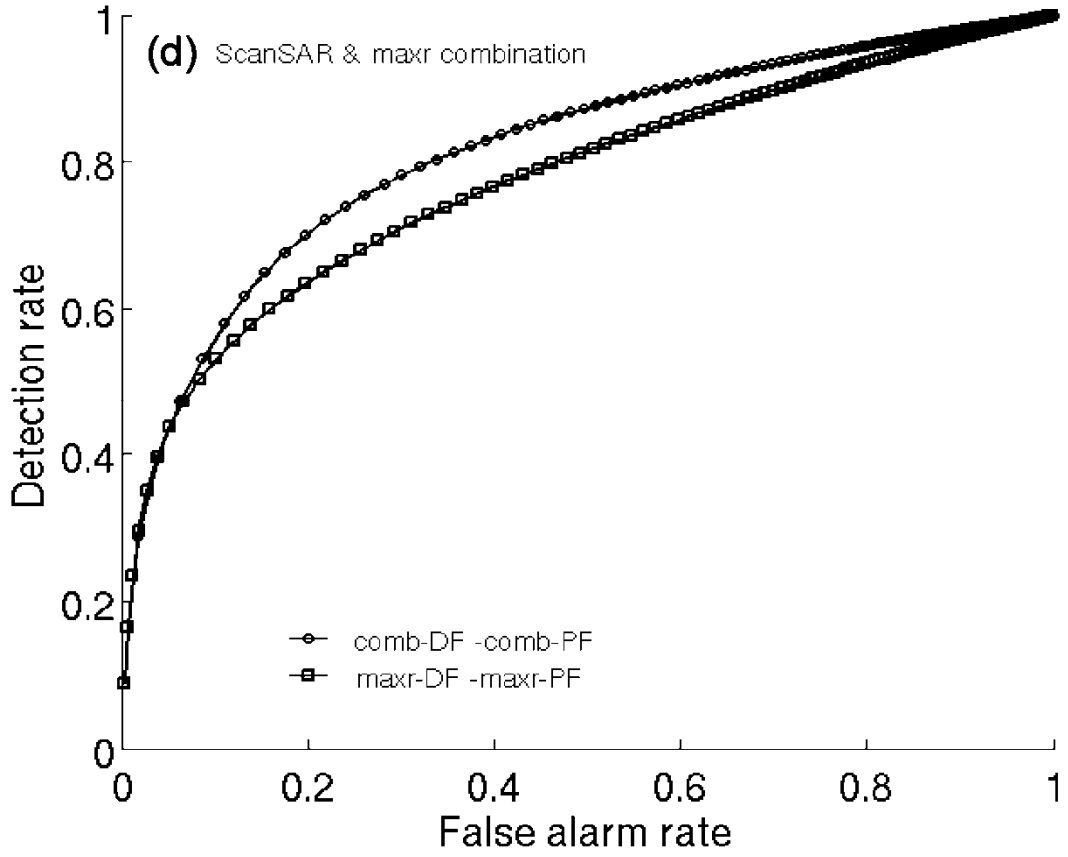


Fused, Wet & Dry



- HH and HV give almost the same detection rate for a given FA rate.
- At 20% FA rate, single channel FBD is comparable to ScanSAR.
- Combining HH & HV increases detection by over 10%.
- Detection is poorer in dry forest than in swamp forest for a given false alarm rate: opposite of ScanSAR.

Combining FBD and ScanSAR



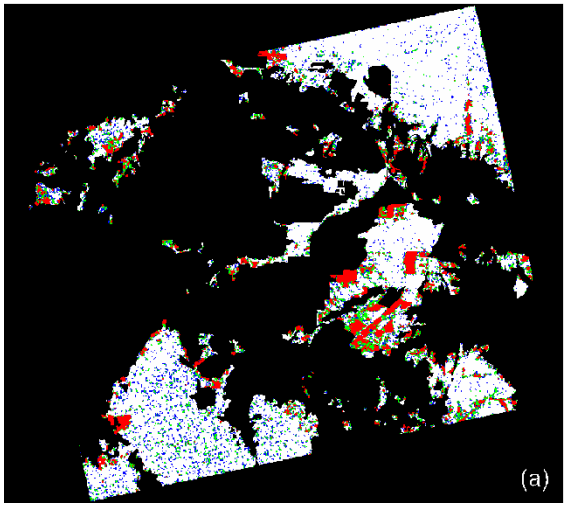
FBD & ScanSAR Deforestation Maps

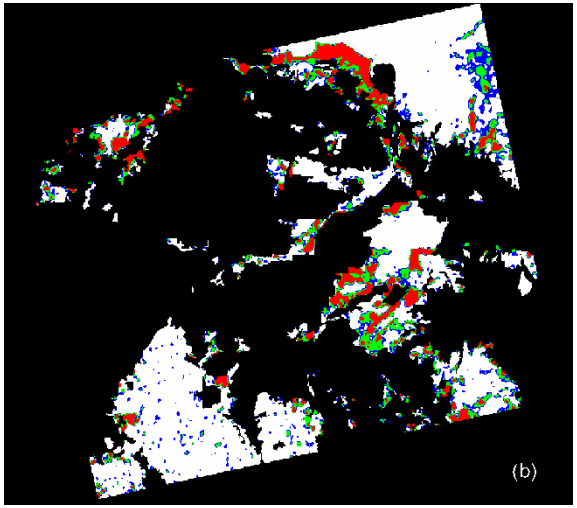
ALOS

K&C Initiative

An international science collaboration led by JAXA

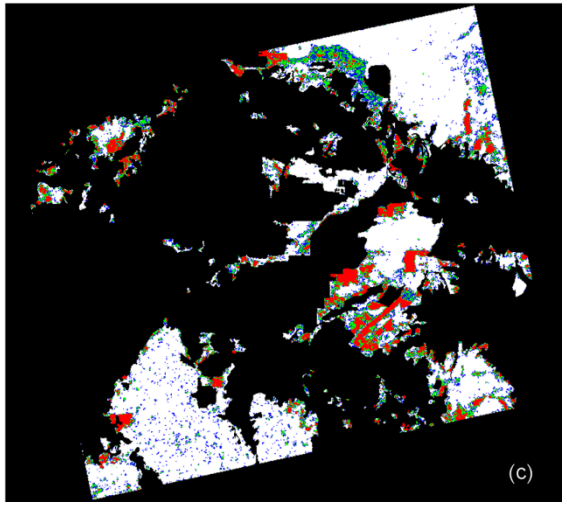
FBD

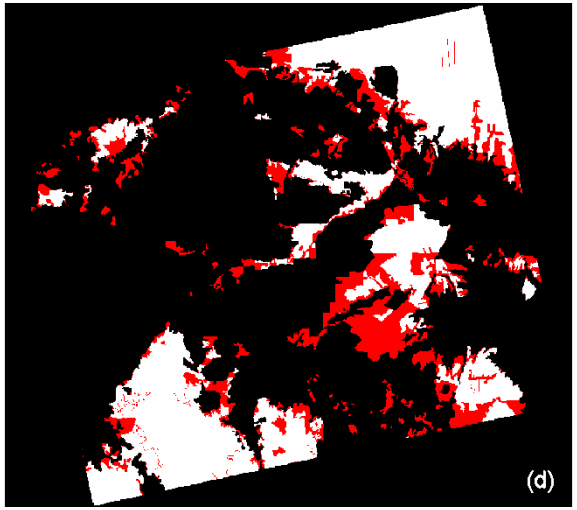




ScanSAR

Fused





WWF Databases

Summary 1

1. Deforestation does not leave a distinctive signature in ScanSAR data. Simple change measures yield detection rates of 38% and 56% for false alarm rates of 10% and 20% respectively.
2. Detection of deforestation in FBD data exploits both increases and decreases in HH and HV intensity; all four types of change carry **different** relevant information.
3. The detection performance with HH alone is only slightly worse than with HV alone, but significantly better results are obtained by combining them.

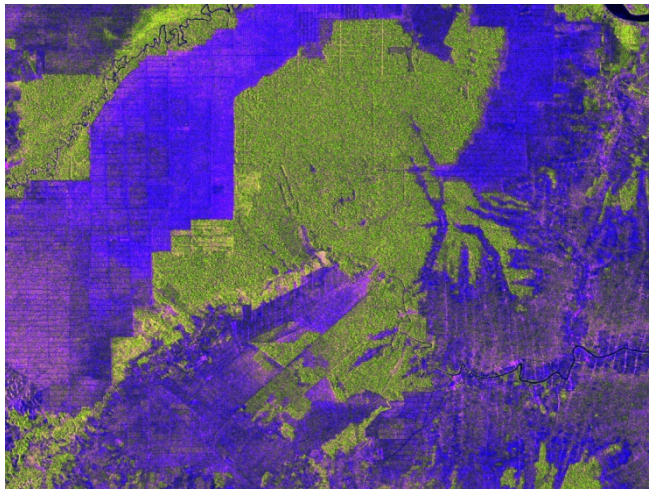
Summary 2

1. Detection rates for HH, HV and HH & HV were
   39%, 43% and 53% for FA = 10% and
   51%, 54% and 64% for FA = 20%.
2. The best detection performance is obtained by combining ScanSAR and FBD. This yields detection rates of 56% for FA = 10% and 70% for FA = 20%; the corresponding detection rates using only FBD are 53% and 64% respectively.

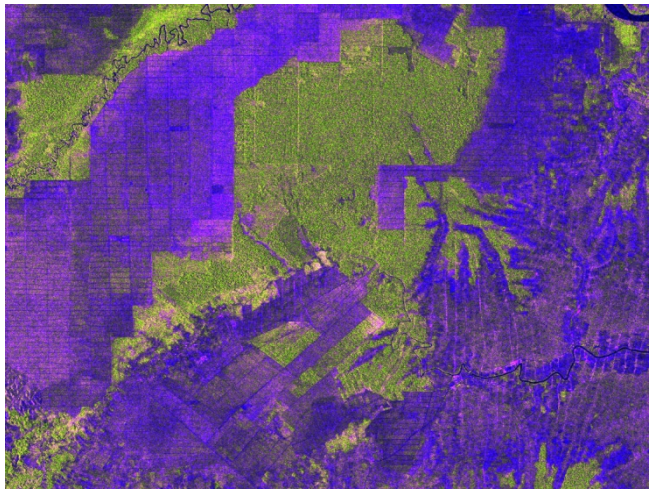
Accuracy of WWF databases

ALOS

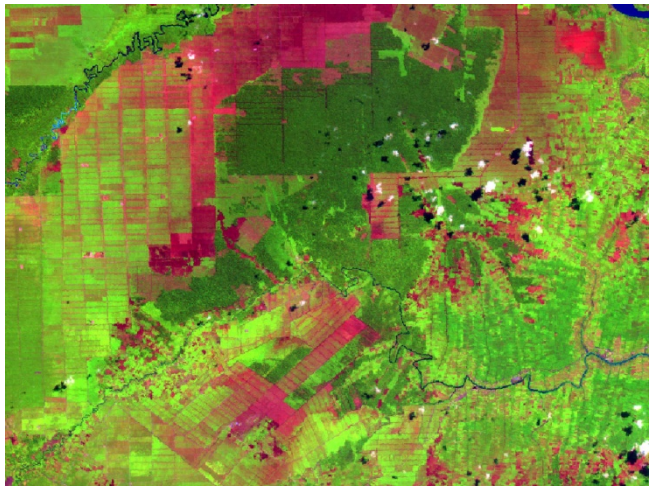
K&C Initiative
An international science collaboration led by JAXA



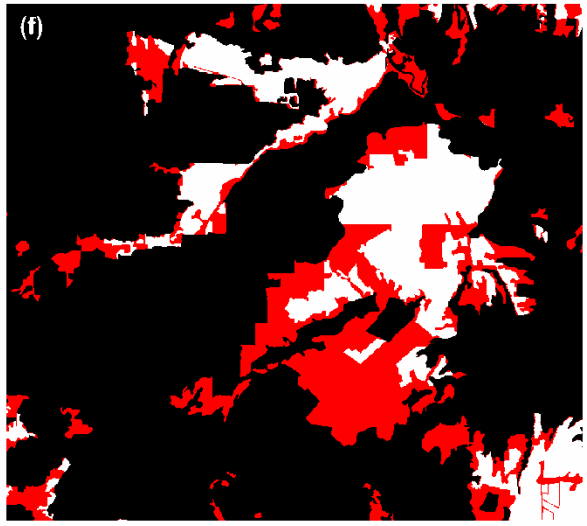
29/06/07



30/06/08

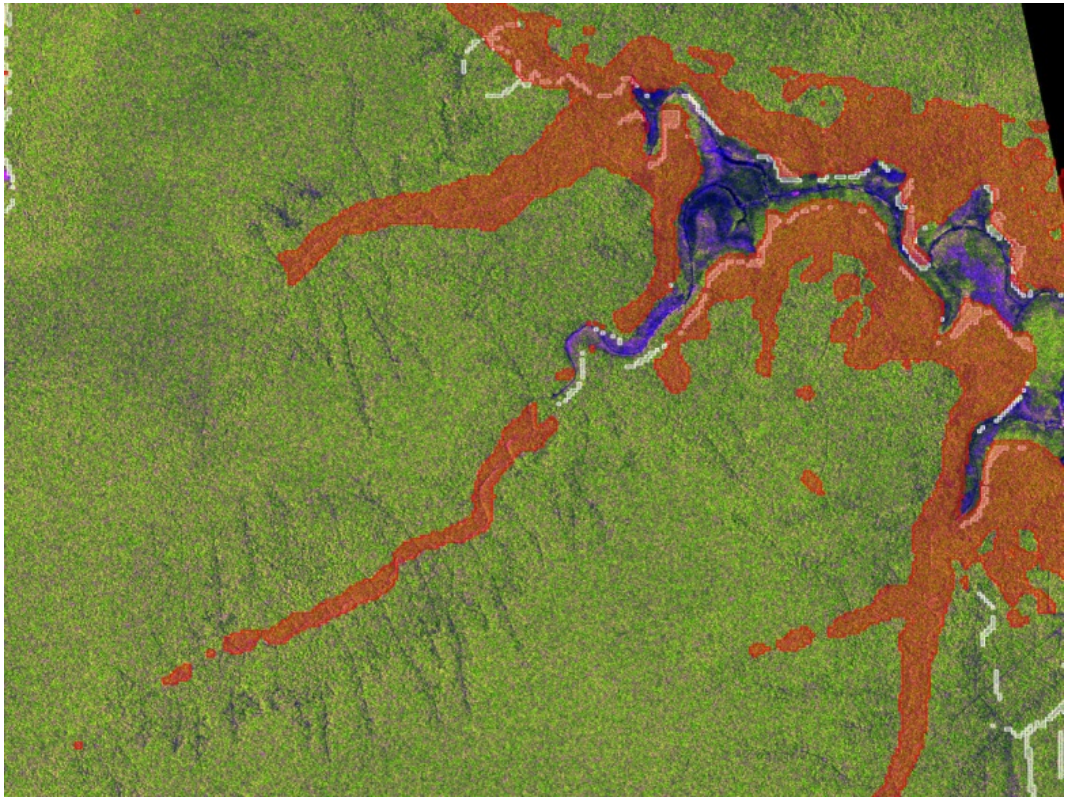


20/06/08



WWF Databases

Systematic errors in ScanSAR



FBD image with ScanSAR detections shown in red

K&C deliverables

Papers and Reports

1. Published (please provide PDF file)

- K&C Phase-1 report
- K&C Phase-2 report

2. Ready to be Submitted

Detection of tropical deforestation by using ALOS-PalSAR, Whittle, Quegan, Uryu, Stuewe, Yulianto (Remote Sensing of Environment; Special Issue or independently??)

Data Timelines