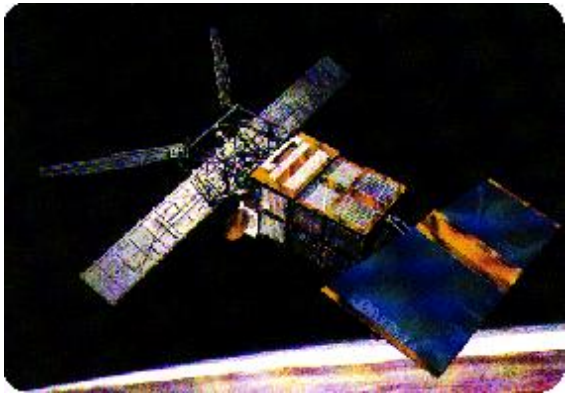


Land applications of SAR remote sensing

Thuy Le Toan

Centre d'Etudes Spatiales de la Biosphère
CNES-CNRS-Université Paul Sabatier- IRD
Toulouse, France

Why observe the land with SAR?

All weather imaging has particular benefits for

- ⇨ Agriculture monitoring
- ⇨ Forest monitoring
- ⇨ Snow and ice studies

Sensitivity to surface roughness

- ⇨ Geological mapping
- ⇨ Topography mapping

Sensitivity to dielectric properties

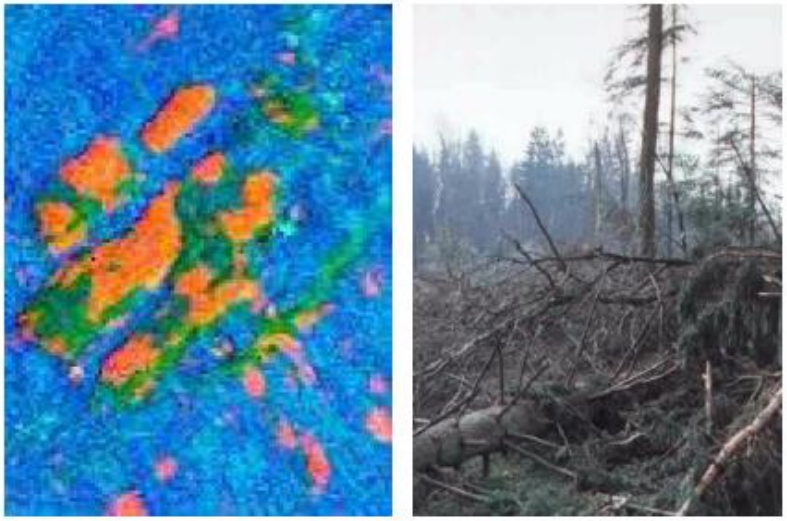
- ⇨ Soil moisture monitoring
- ⇨ Biomass mapping

Mapping land surfaces and monitoring of bio-geophysical parameters for land applications

Hazard mapping

Hazard mapping : forest storm damage

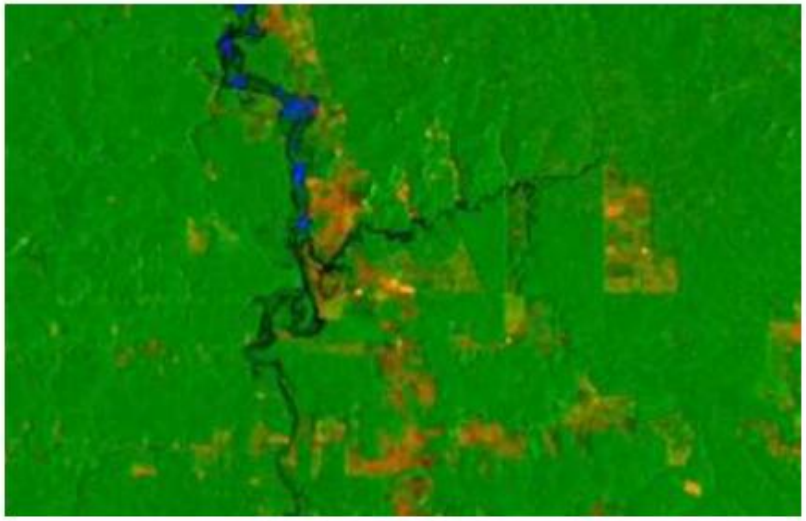
in January 2000, the last acquisition series of ERS tandem



Hazard mapping

Forest damage (orange areas) caused by storm "Lothar" in Dec. 1999, as mapped with multi-temporal ERS SAR interferometry.

Raw data courtesy of ESA. Processing by GAMMA.



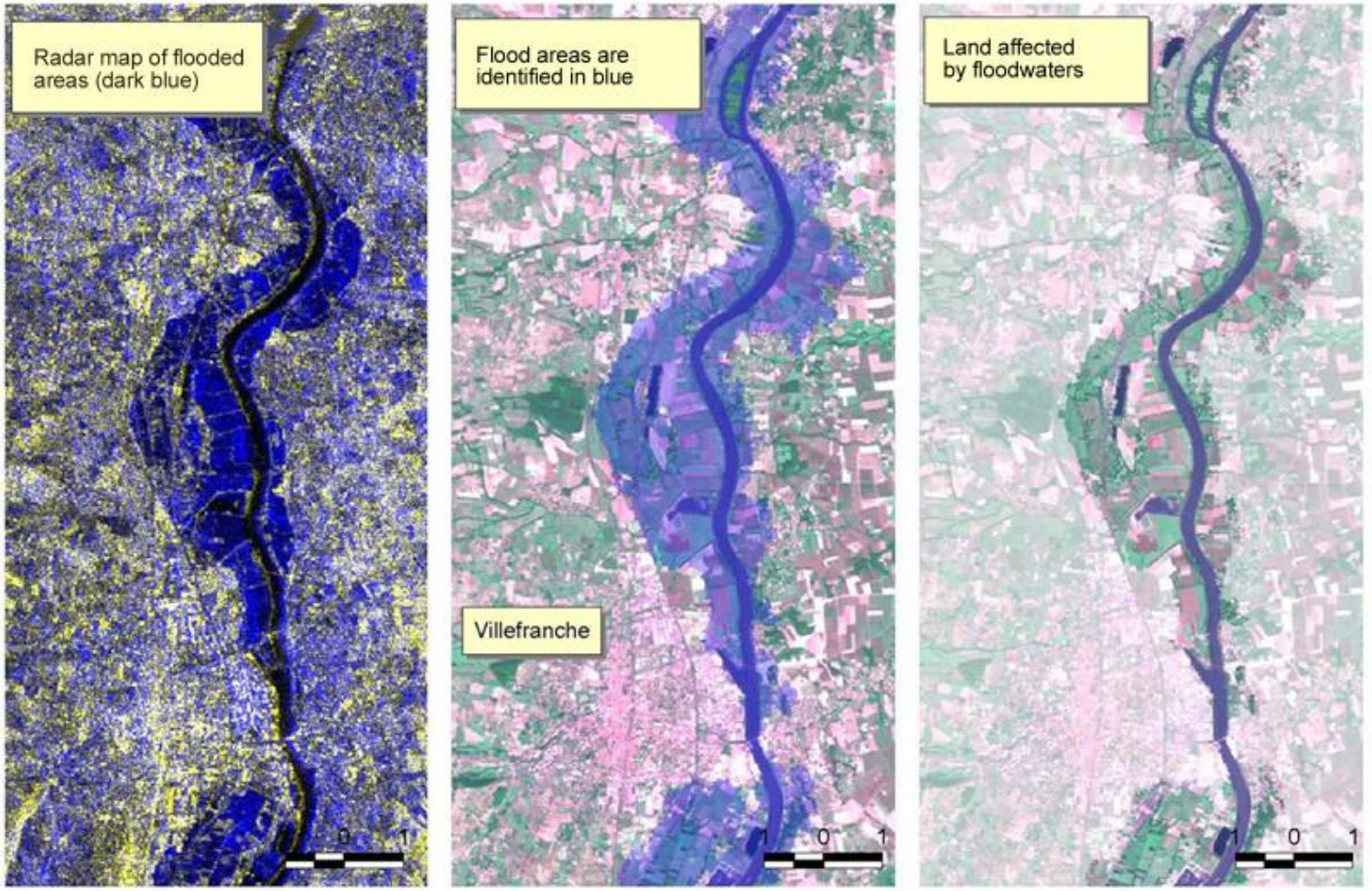
ERS Coherence Product

ERS Tandem coherence (red), backscattering (green), and backscatter change (blue) used to characterize deforestation area.

Raw data courtesy of ESA. Processing by GAMMA.

INTERNATIONAL CHARTER
SPACE AND MAJOR DISASTERS

Situation between Belleville and Villefranche on 27/03/01

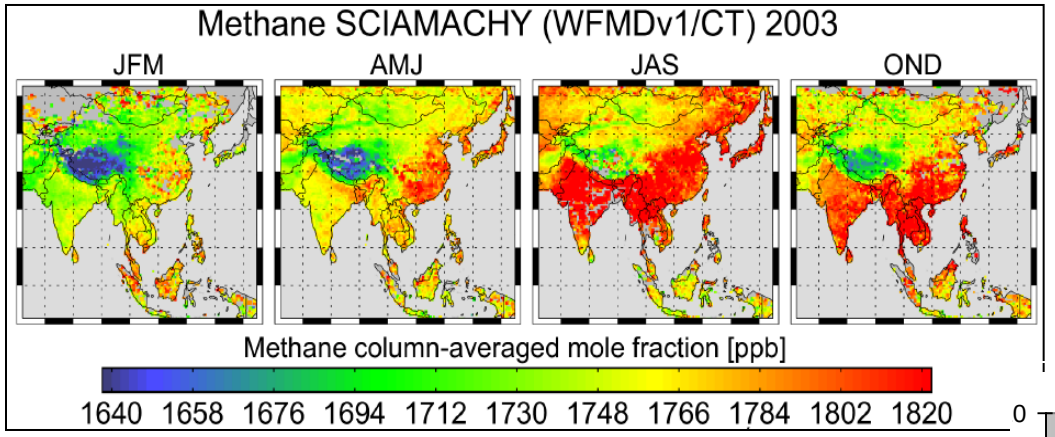


Hervé Yesou, SERTIT

Rice monitoring

Rice: a local interest and a global concern

- Impact of rice on climatic change

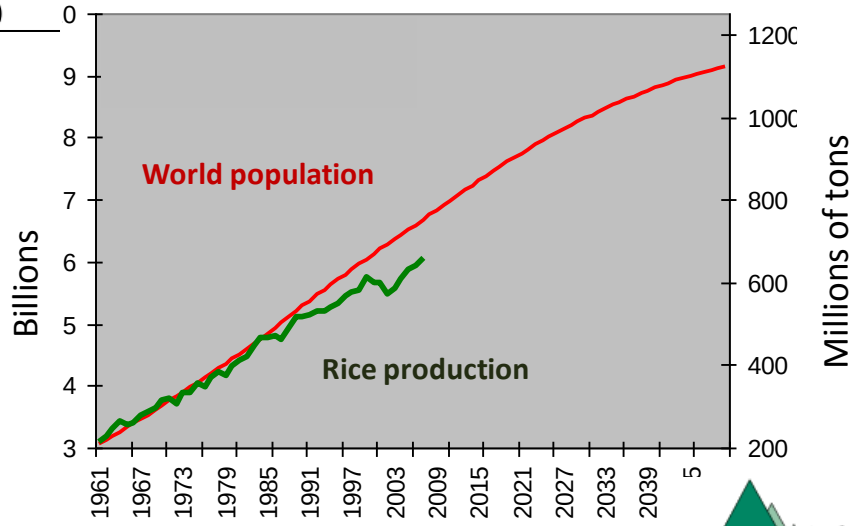


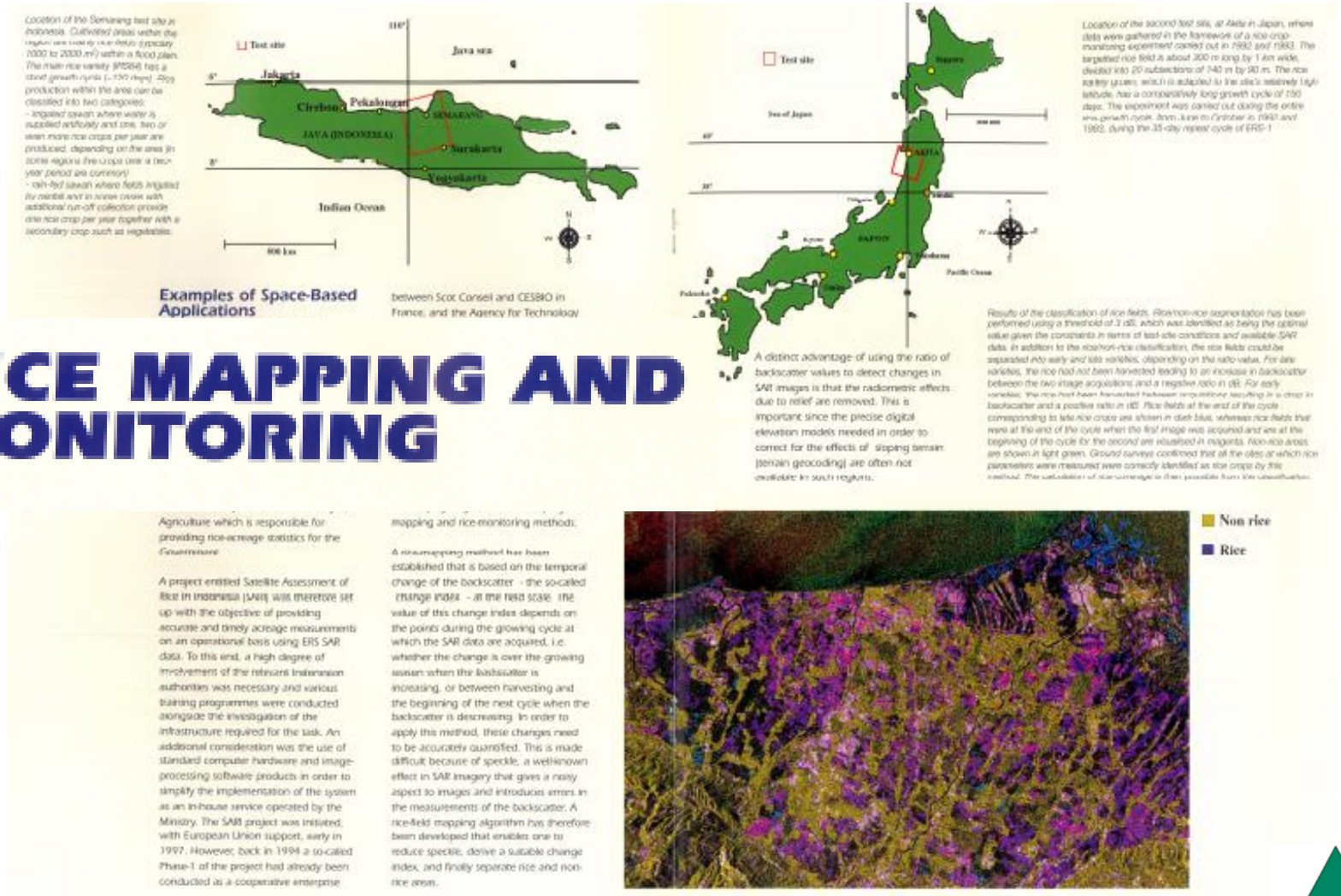
Schneising et al., ACP, 2009

Methane emission from rice (between 7% and 19% of global emission)

- Rice and food security

Food security has become a key global issue due to the Asian region's rapid population growth and extensive conversion of arable lands

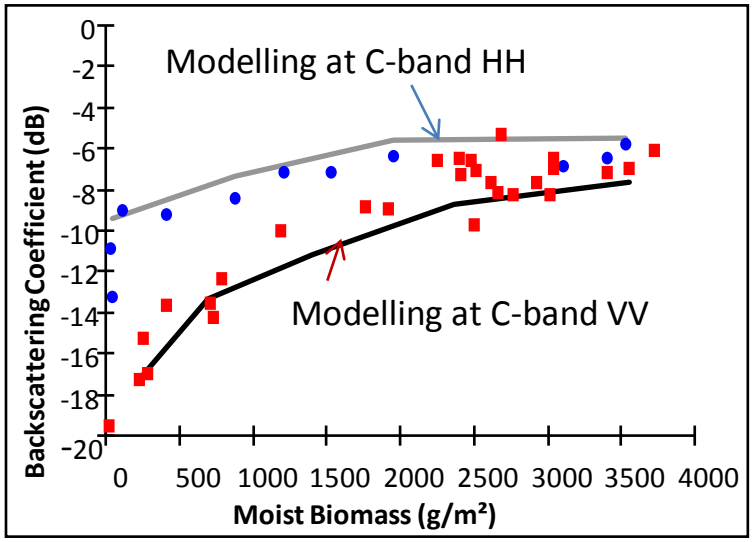




RICE MAPPING AND MONITORING

and in Thailand, Malaysia, India, Vietnam, China …:
Rice mapping and yield estimation at local and regional scales

C-band SAR for rice



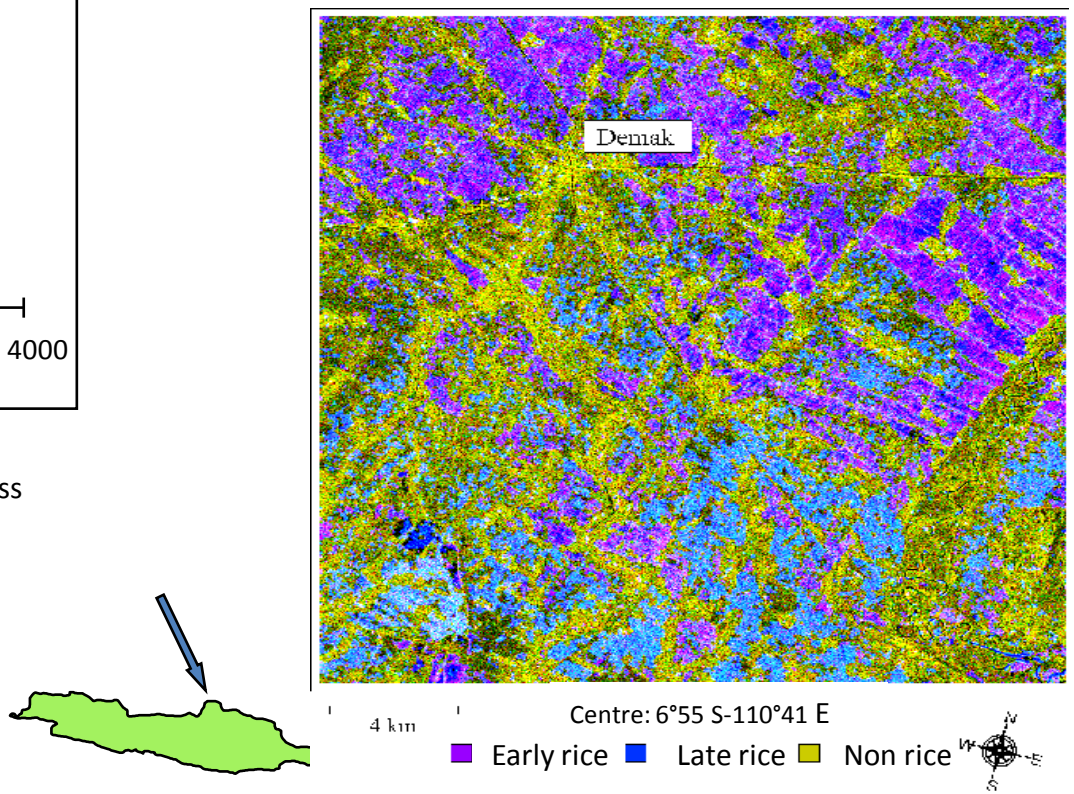
Increase of backscattering coefficient with rice biomass

- Radarsat data
- ERS data

IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, VOL. 35, NO. 1, JANUARY 1997

Rice Crop Mapping and Monitoring Using ERS-1 Data Based on Experiment and Modeling Results

Thuy Le Toan, Florence Ribbes, Li-Fang Wang, Nicolas Floury, Kung-Hau Ding, Jin Au Kong, Masaharu Fujita, *Senior Member, IEEE*, and Takashi Kurosu



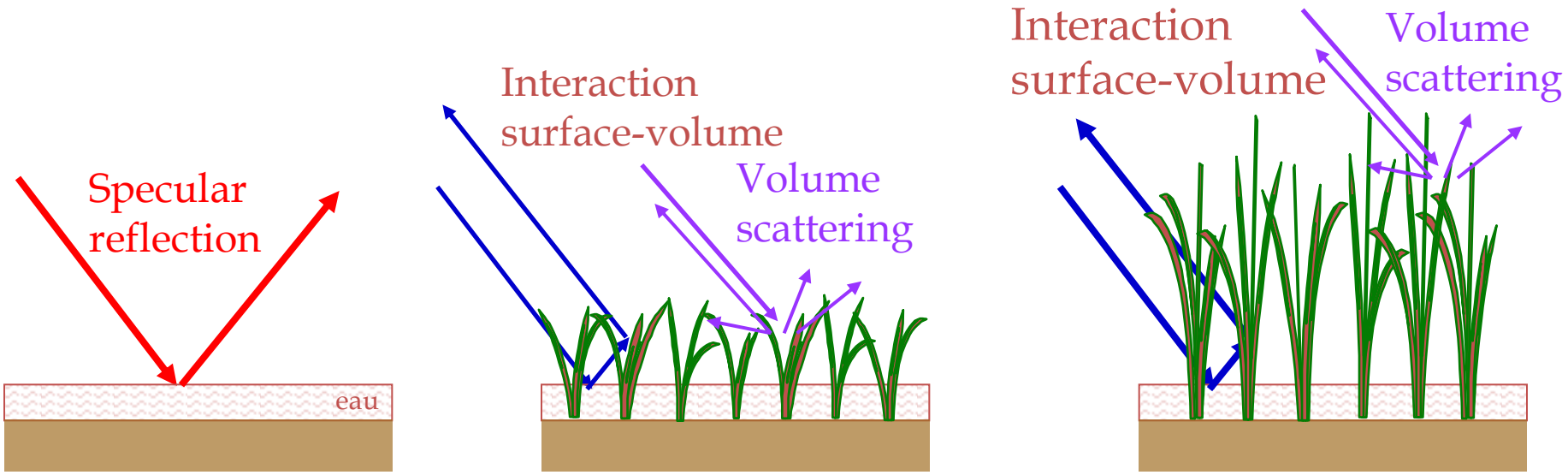
Map of rice fields derived from multitemporal ERS-1 da
Region of Semarang, Java,Indonesia

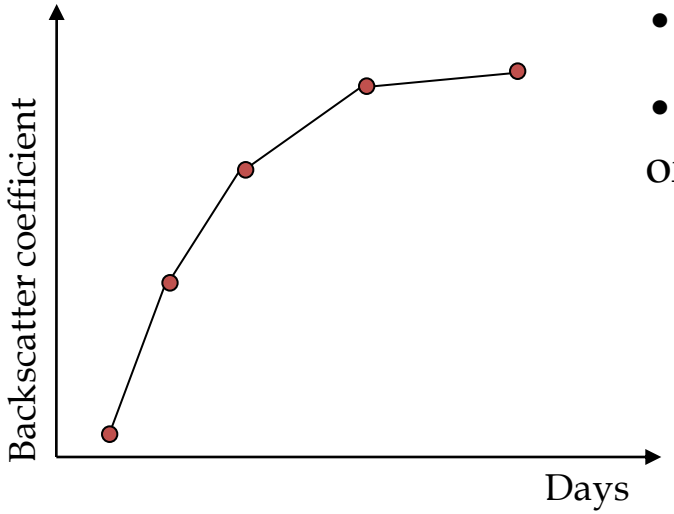
Physical interaction mechanisms

Flooded field

Early growth stage

Fully growth stage

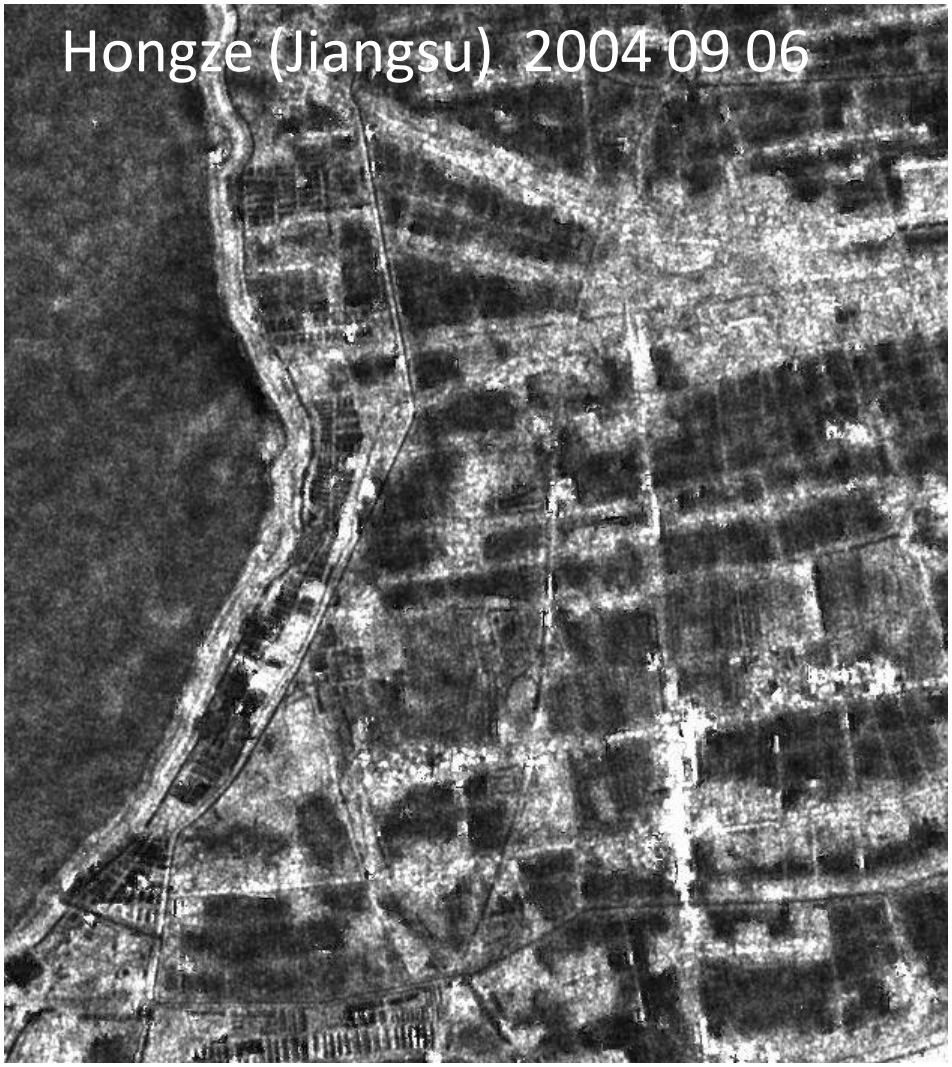




- HH et VV increase with time
- HH/VV increases with the growth of rice because of the attenuation by vertical stems

Rice mapping using:

- HH or VV temporal change and/or
- polarisation ratio HH/VV



HH **VV**

ENVISAT ASAR dual polarisation images

Rice mapping using HH/VV

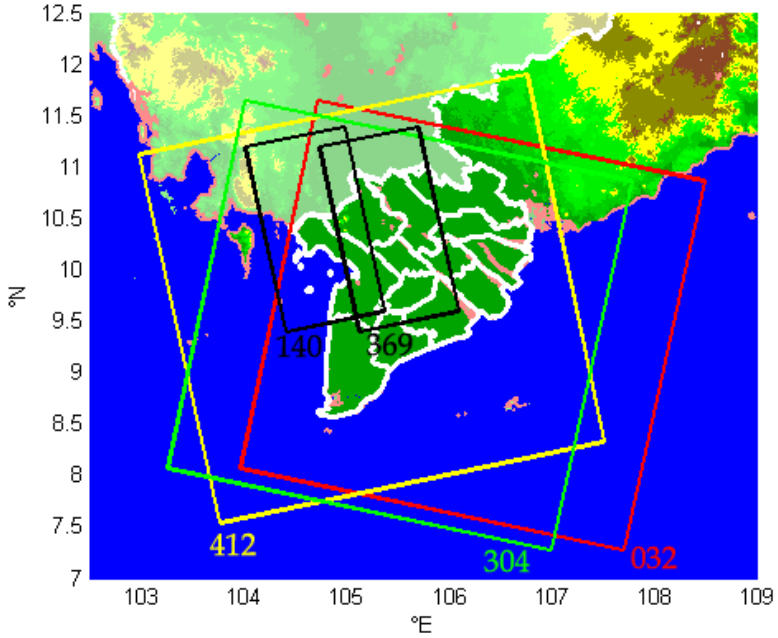
from
ENVISAT ASAR
dual polarisation images

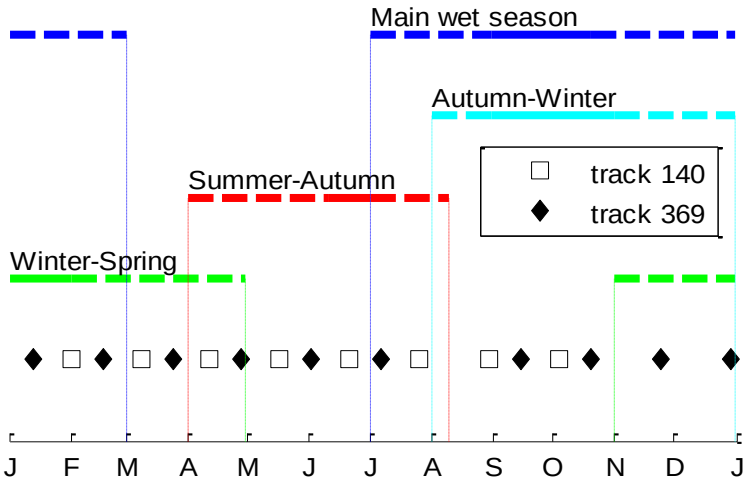
Hongze(Jiangsu)

2004 09 06

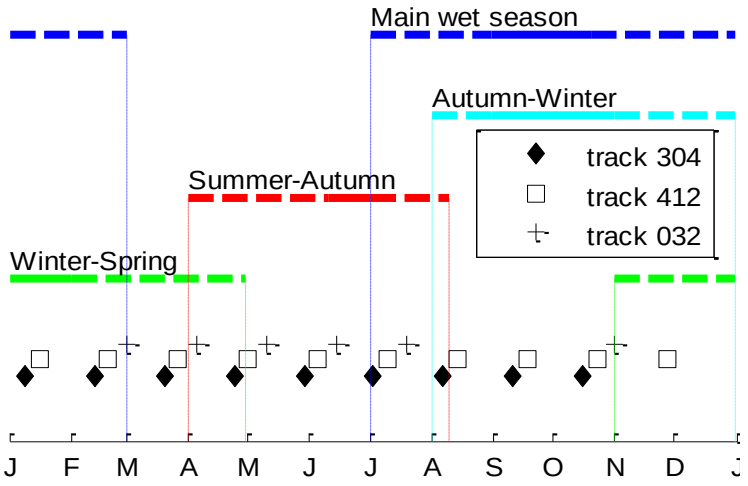
ENVISAT ASAR

	APP	WSM
Polarisations	HH et VV	HH
Pixel size	12,5m	75m
Swathy width	105 km	405 km
incidence angle	19,2°-26,7°	17°-42°
Nomber of looksrange	1	7
Nomber of looks azimuth	2	3



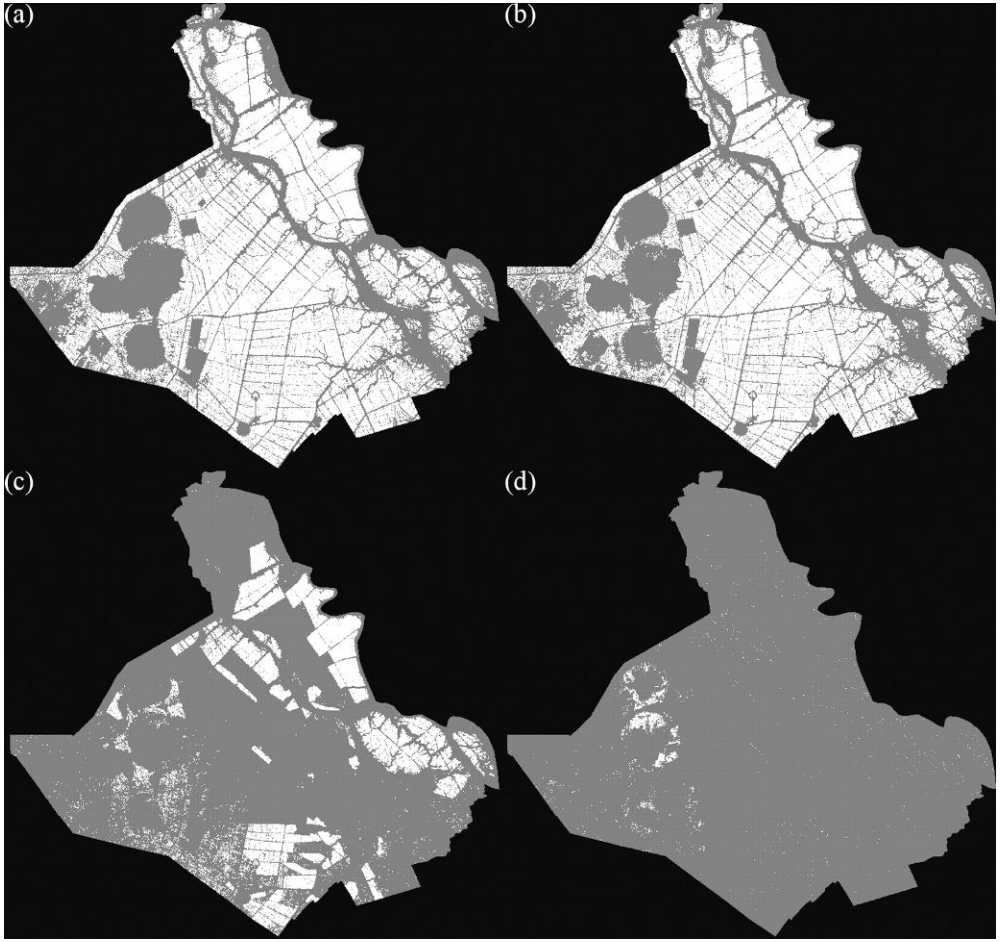


APP- use of polarisation ratio



WSM –use of temporal change

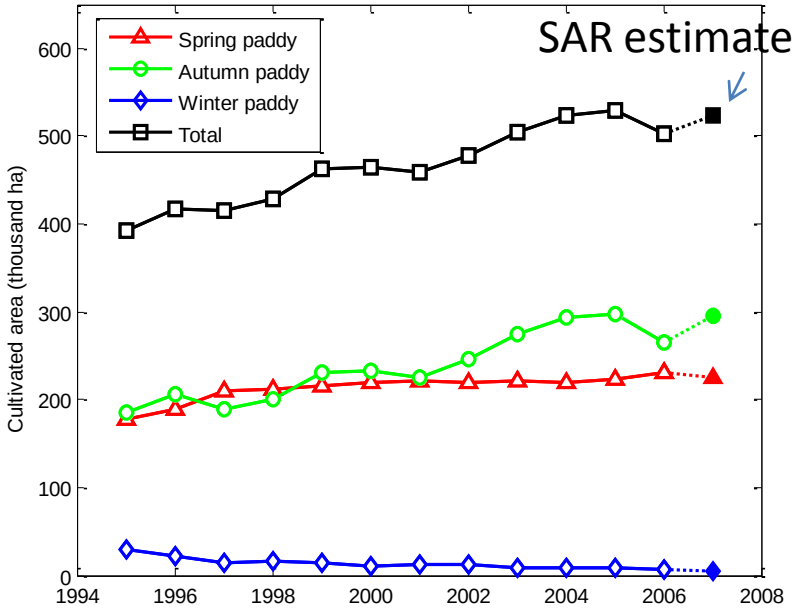
Rice mapping using polarisation ratio from ENVISAT ASAR dual polarisation images



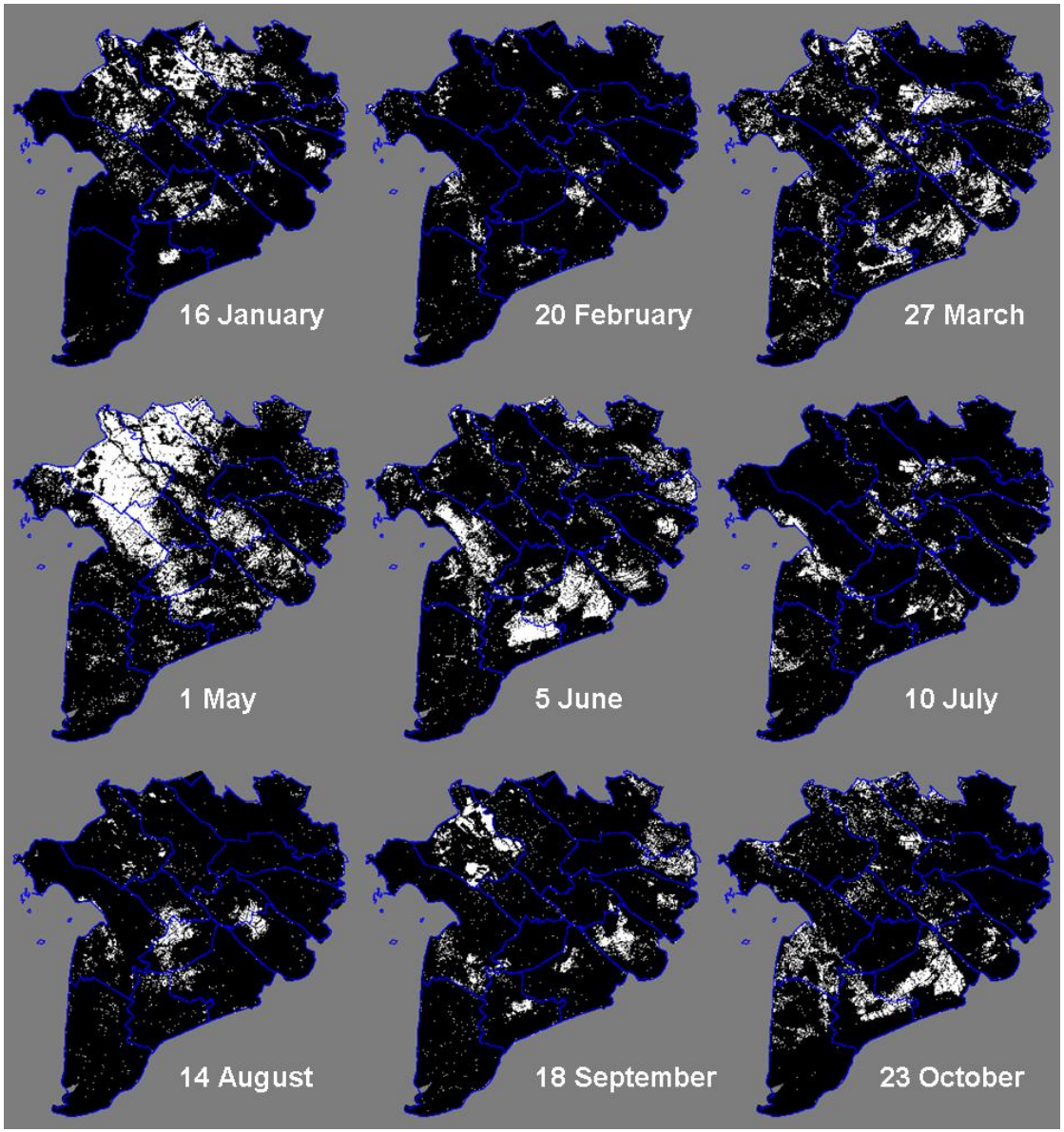
Province of An Giang, Vietnam

Bouvet et al, 2008

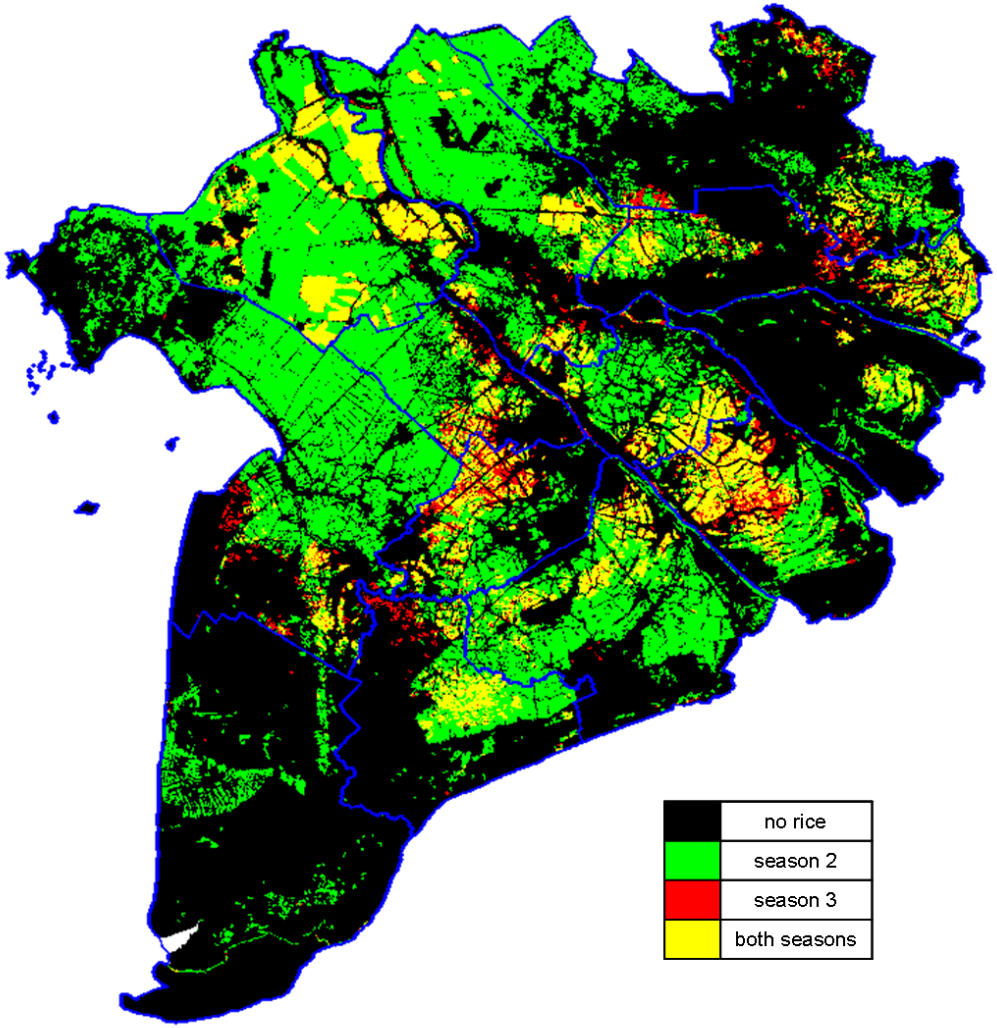
Rice area (1000'ha)	Rice season 1	Rice season 2	Rice season 3
SAR	224,3	294,8	5
VietnamStatistics	230,6	282,7	7,3
Difference	-6,3	12,1	-2,3
Difference in %	-2,7%	4,3%	-31,5%

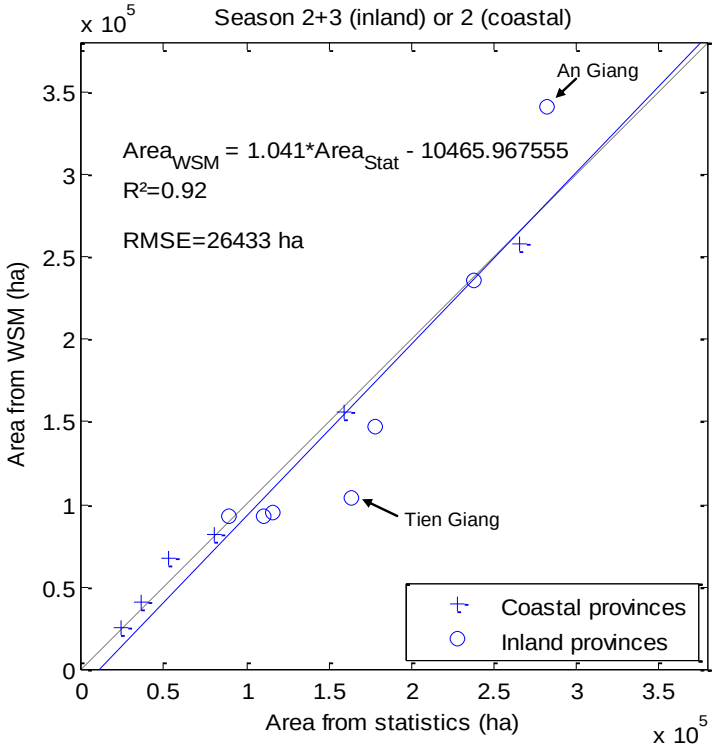


Rice map using ASAR multitemporal WSM data

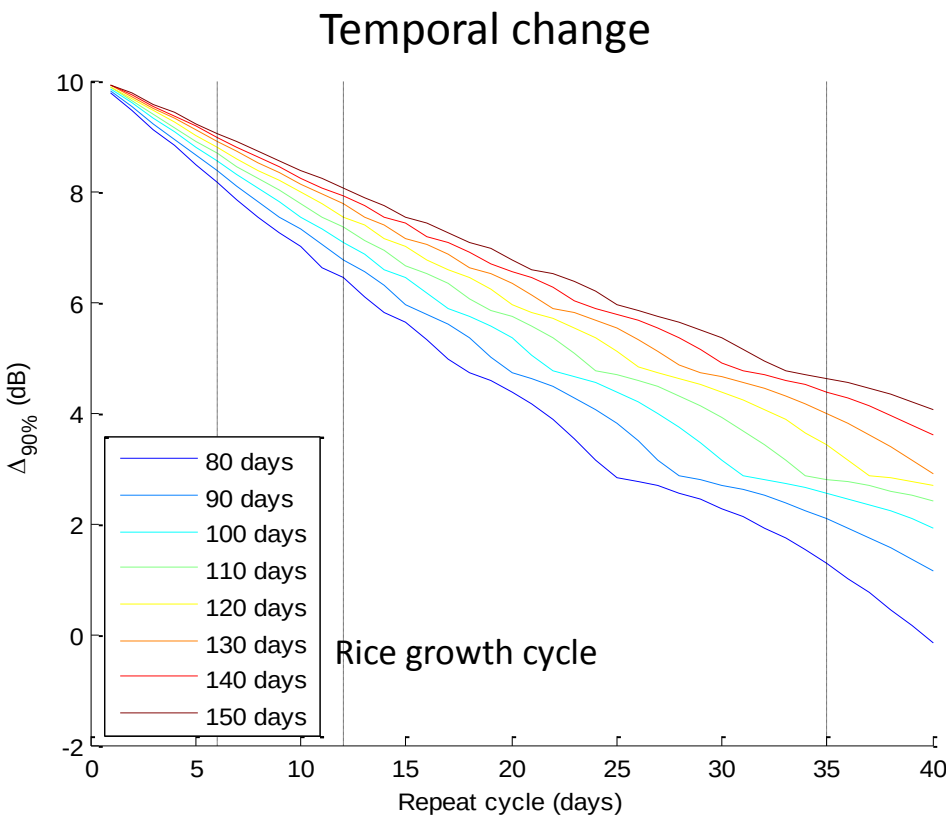


Rice map of South Vietnam

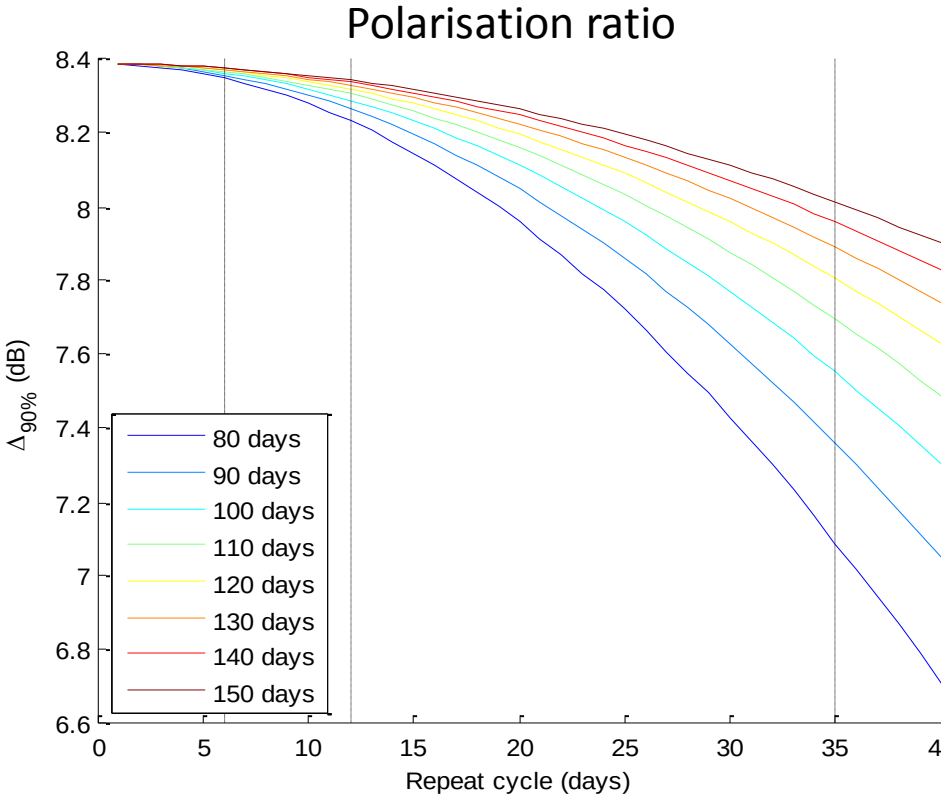




Temporal change and polarisation ratio as a function of rice growth cycle and repeat cycle



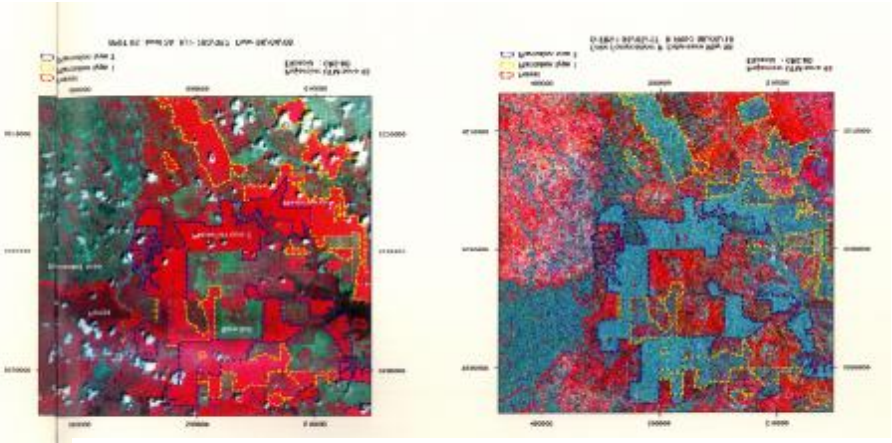
Sentinel



ASAR

Forest monitoring

Multitemporal SAR methods for deforestation monitoring



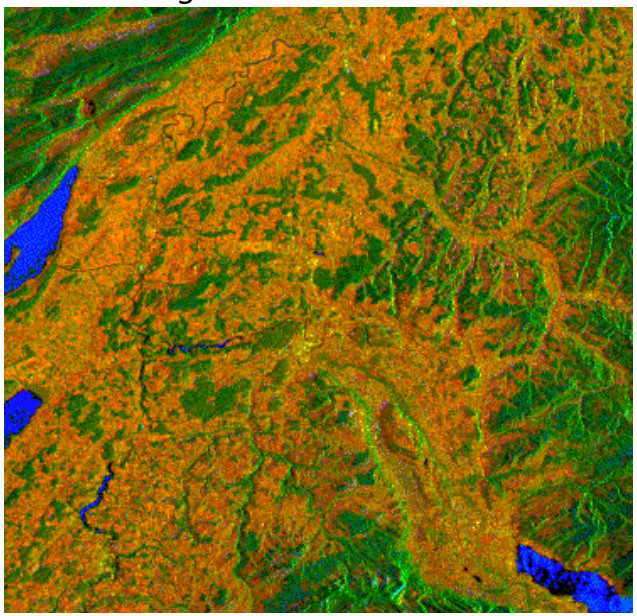
CESBIO, and also the JRC TREES projects

TROPICAL FOREST MONITORING

Interferometry for forest mapping and parameter retrieval

Forest mapping

Wegmueller et al 1996



Bern (CH), ERS-1, 24/27 Nov. 1991:
RGB composite of interferometric correlation (red), backscatter intensity (green), and backscatter change (blue).

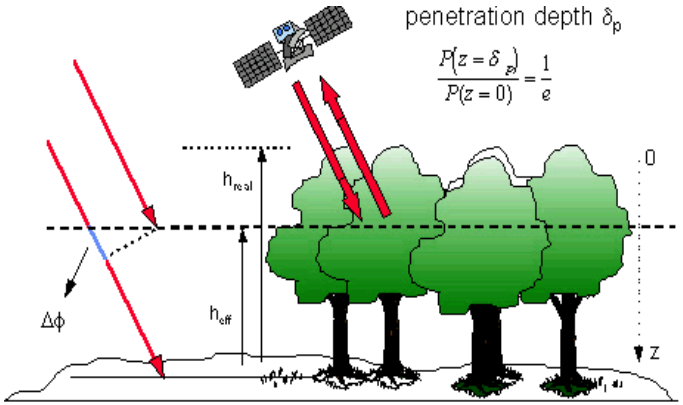
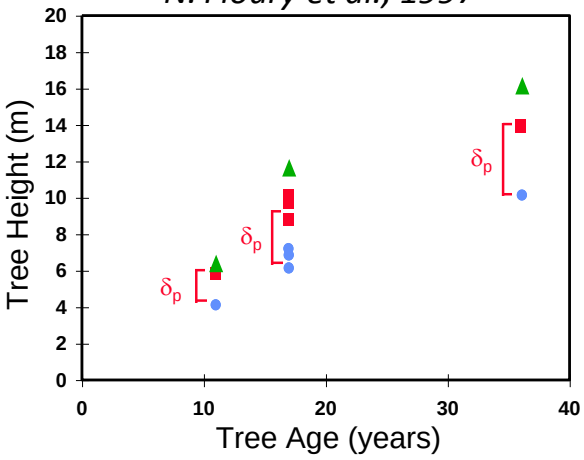


Figure 8: Determination of canopy height from interferometry

Height in temperate forest

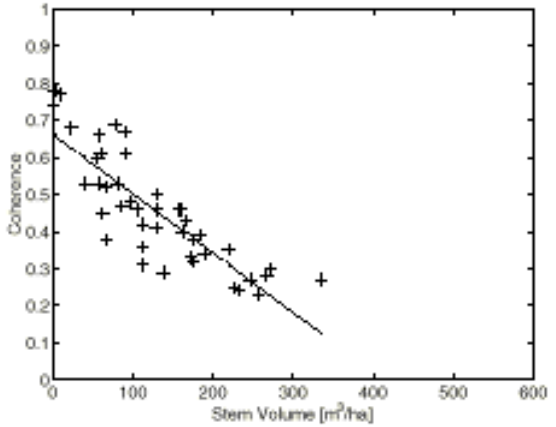
N. Floury et al., 1997



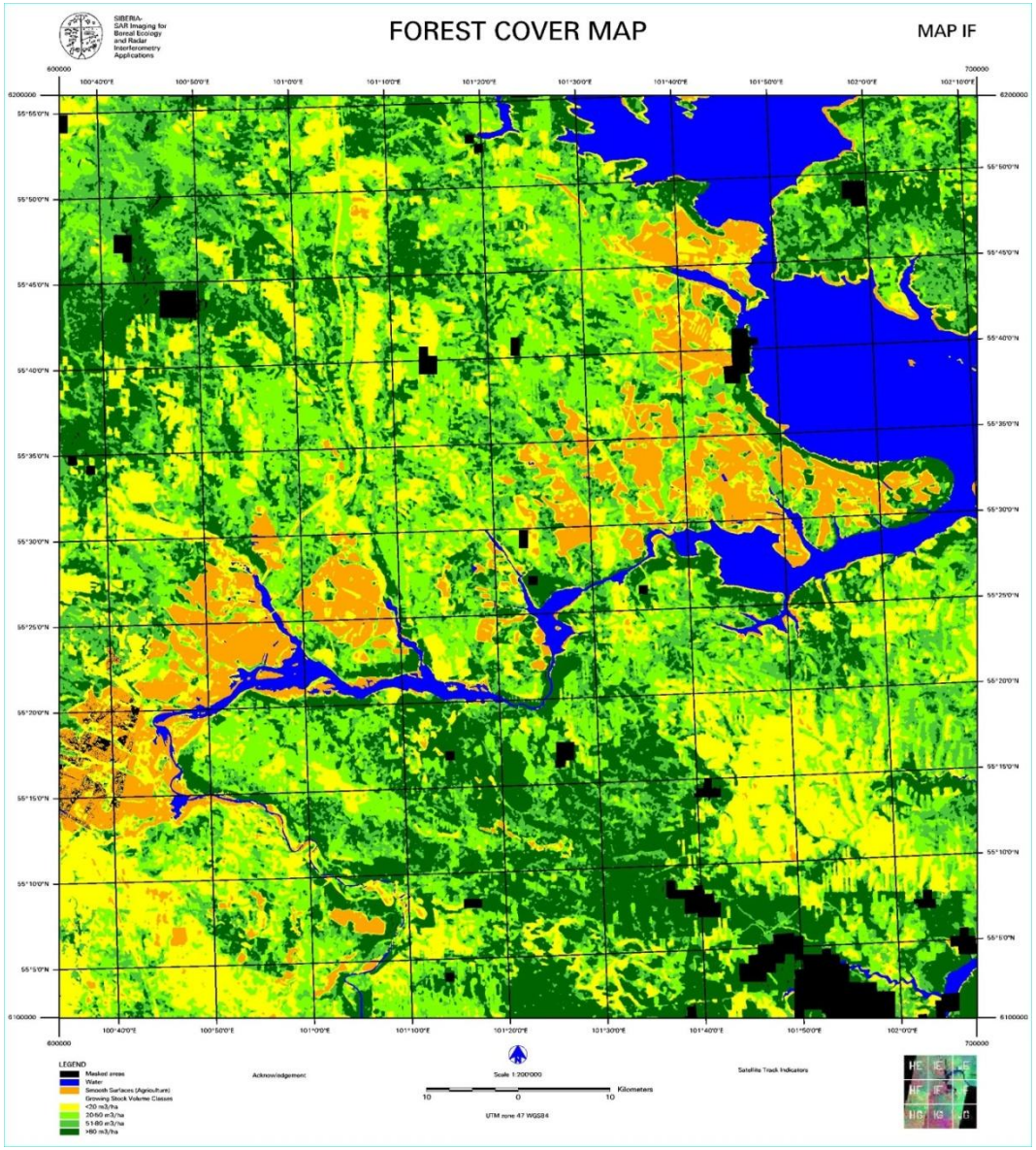
- Estimated Height from Interferometry
- Estimated Height from Interferometry + Simulated Penetration Depth (δ_p)
- Actual Height

Stem volume in boreal forest

Askne et al., 1998



ERS coherence versus stem volume for Kättböle test-site. Image pair 17th/18th March 1996.



SIBERIA (SAR Imaging for Boreal Ecology and Radar Interferometry Applications), EU/CEO project no ENV4-CT97-0743.

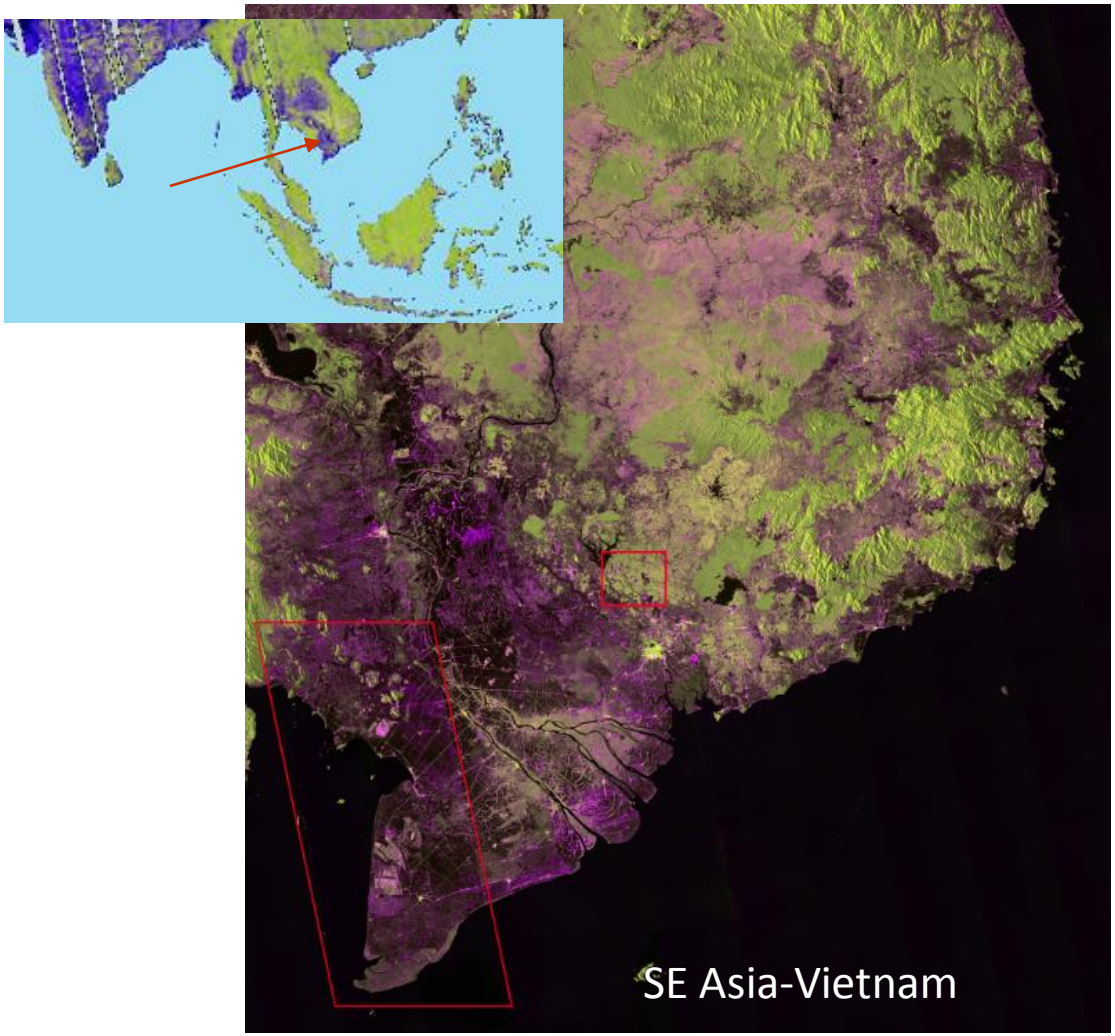
ACHIEVEMENT: Generation of a forest map of central Siberia from
ERS-1/ERS-2 Tandem coverage 1997
JERS coverage 1998

RESULTS: 96 forest cover maps (100 km X 100 km) covering 650000 km2. An example of map is shown on the left.

C. Schmullius

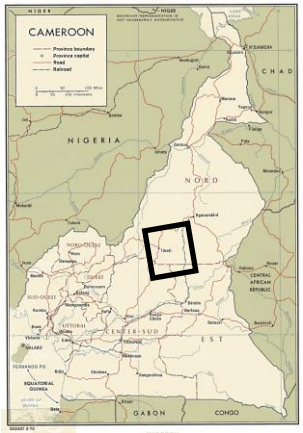
- Water
- Agriculture, bogs, grass
- Open forest, cut, fire
- Forest 10-30 t/ha
- Forest 30-50 t/ha
- Forest> 50 t/ha

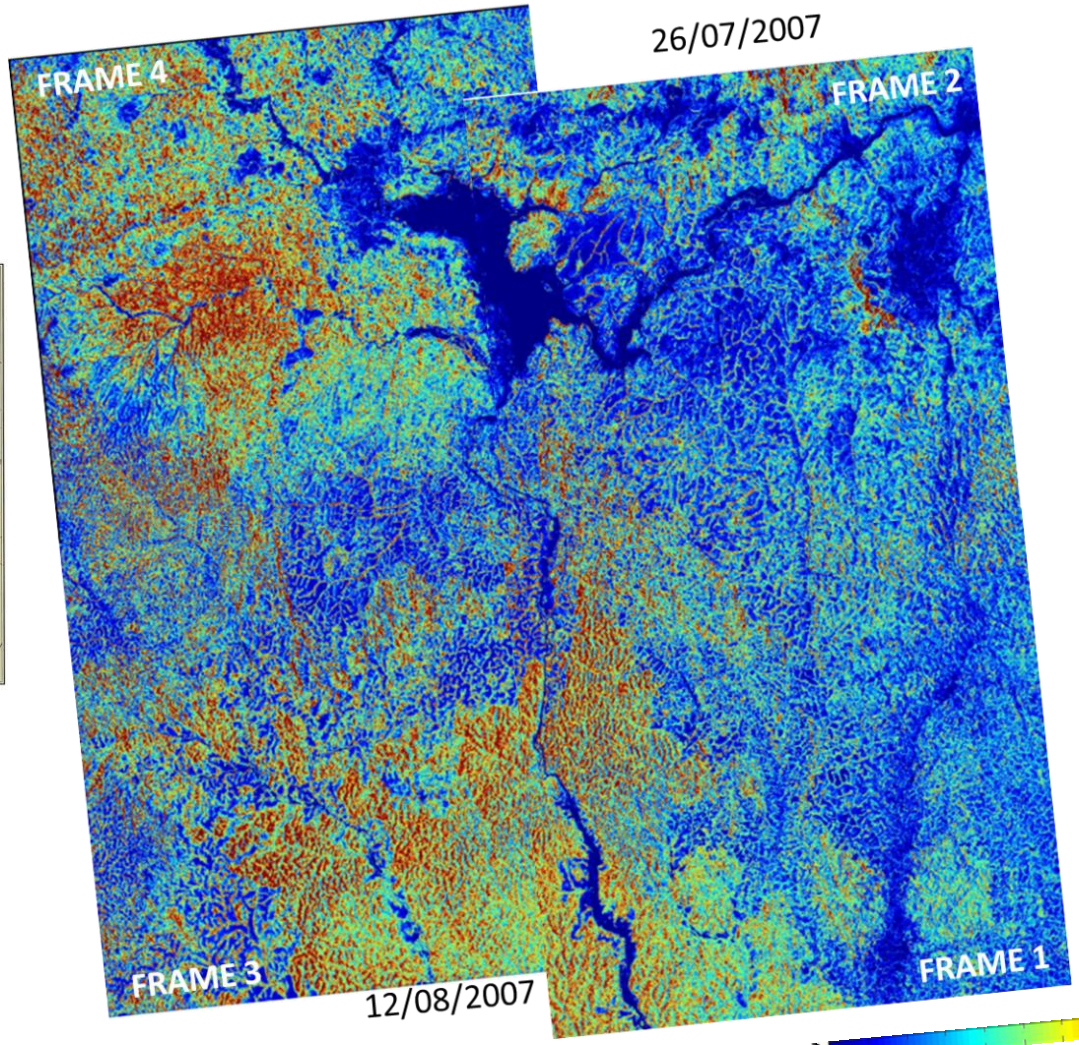
Biomass map from PALSAR: illustration



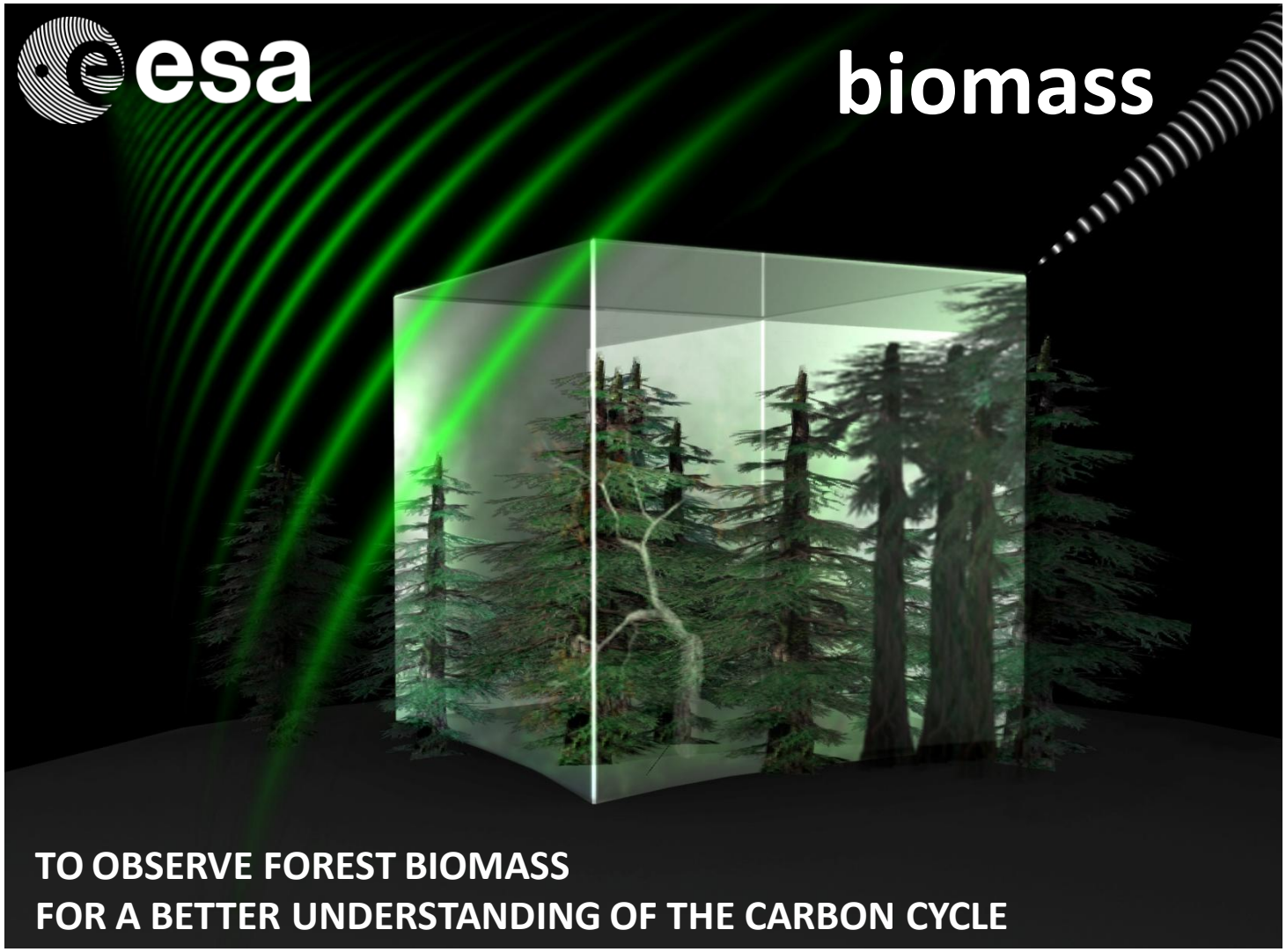
Le Toan et al., K&C Jan 2009

Forest-Savannah biomass using PALSAR





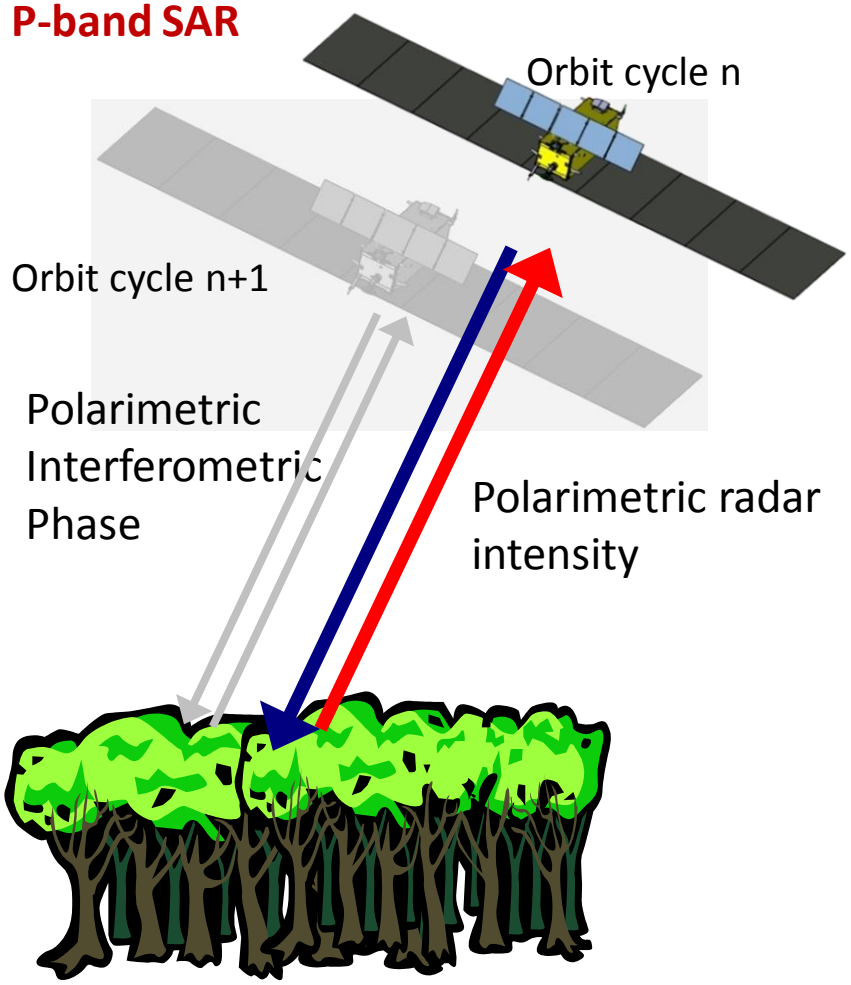
~120 km x 120 km


esa
biomass
TO OBSERVE FOREST BIOMASS
FOR A BETTER UNDERSTANDING OF THE CARBON CYCLE

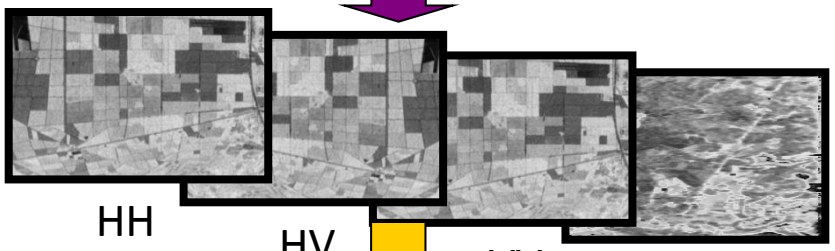
CESBIO

BIOMASS observation concept

P-band SAR



Calibration, Ionospheric correction



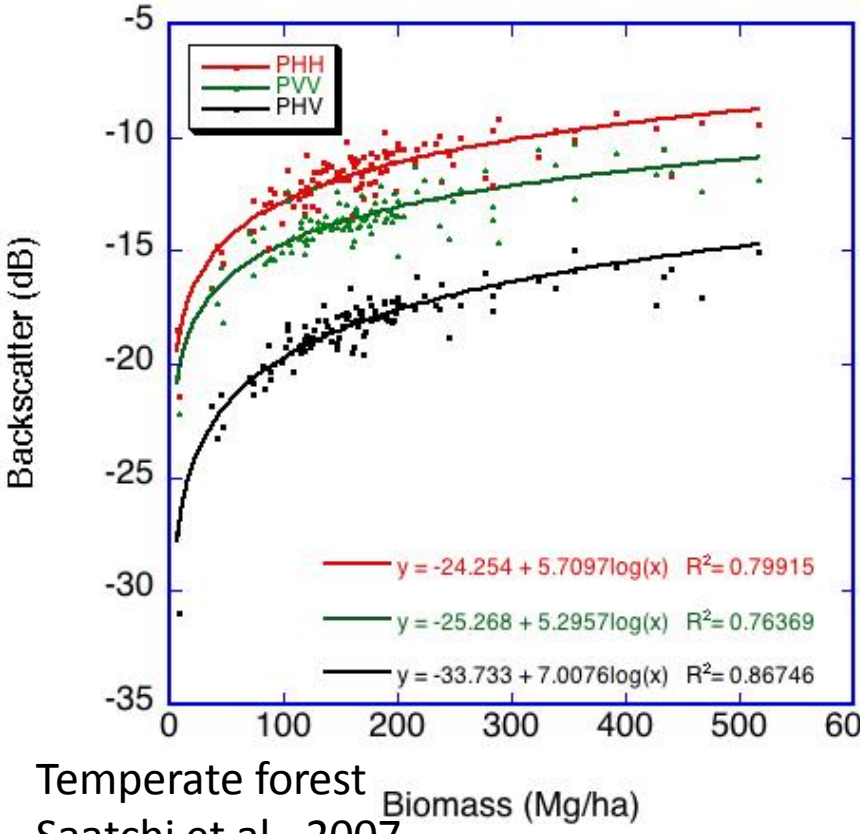
Retrieval algorithm

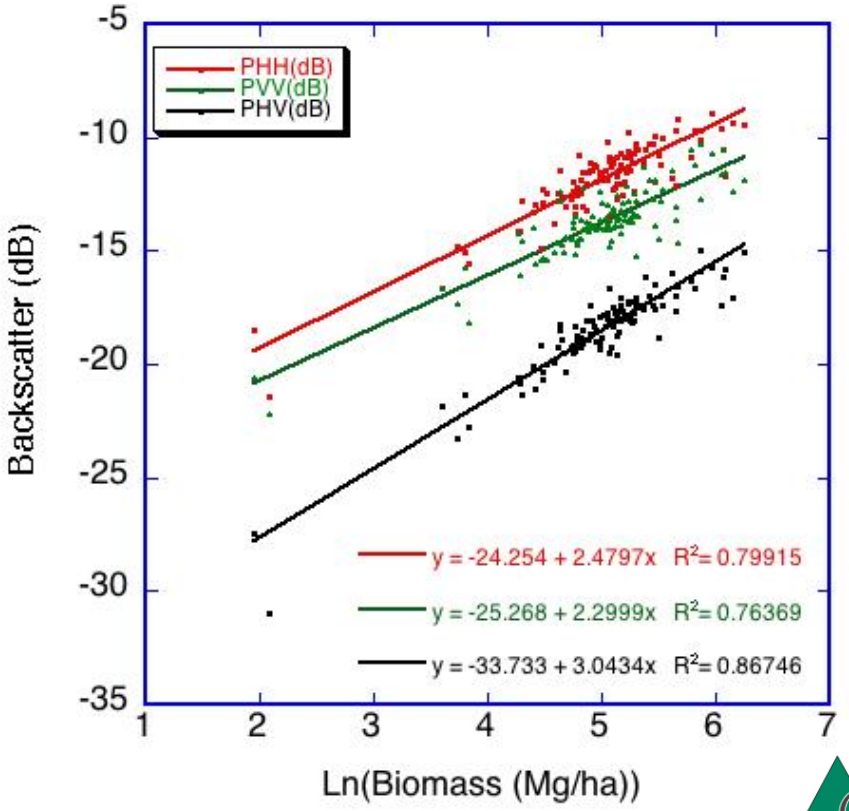
- Forest biomass
- Forest height
- Forest biomass temporal change
- Forest disturbance

CESBIO

Past results on P-band intensity

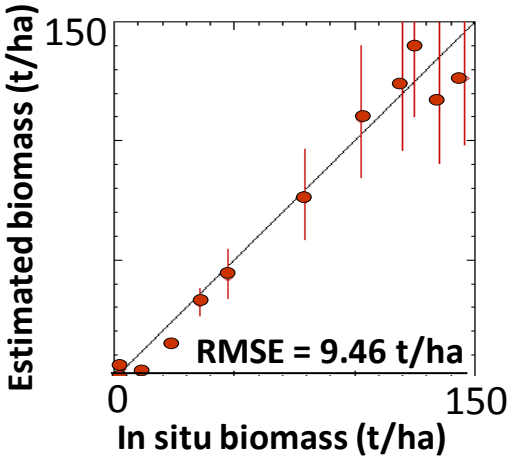
Experimental relationship between P-band Backscatter and Aboveground Biomass

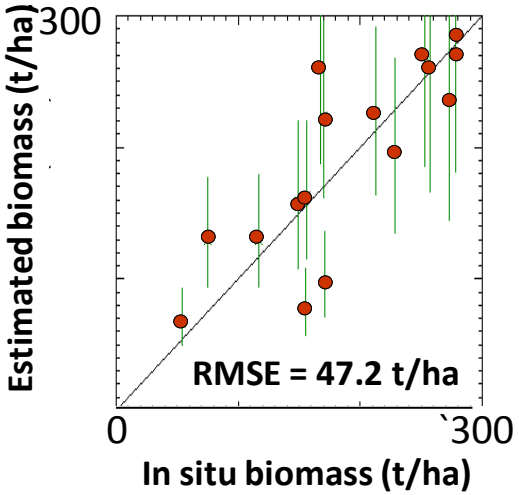


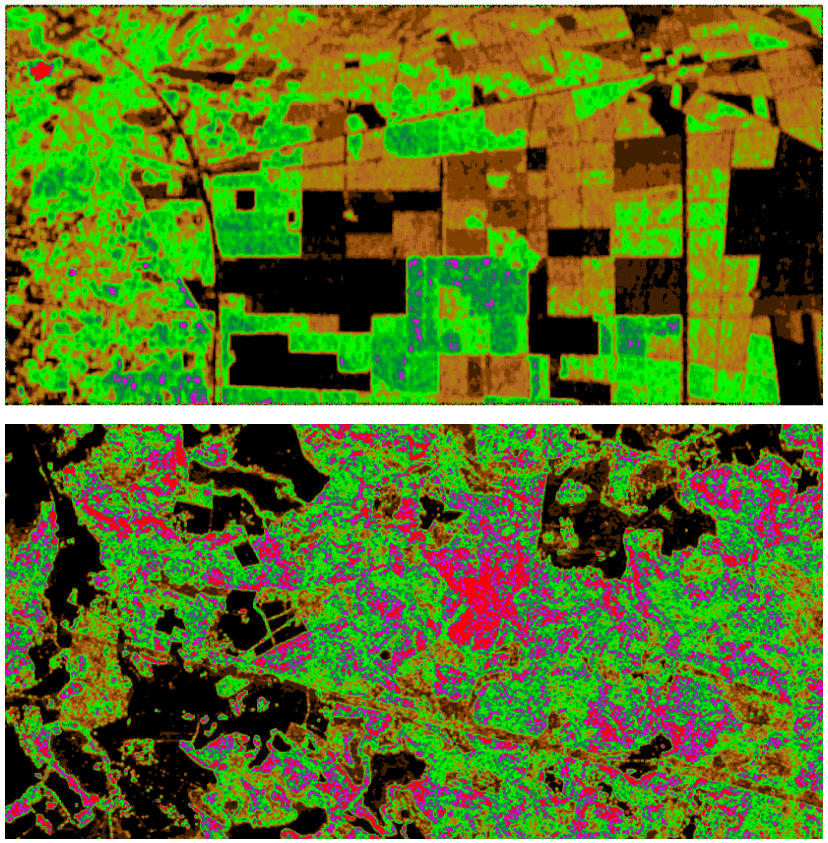


Temperate forest
Saatchi et al., 2007

Forest biomass mapping using P-band HV intensity



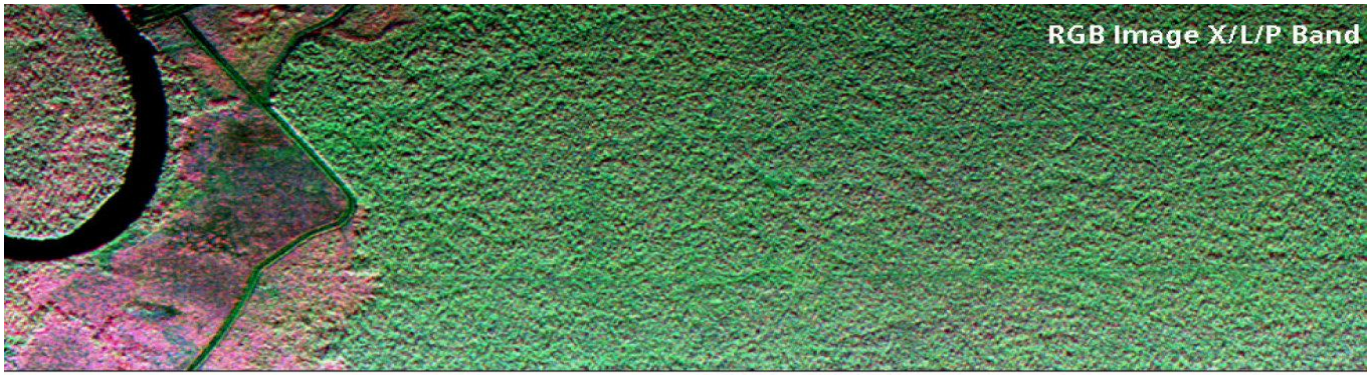


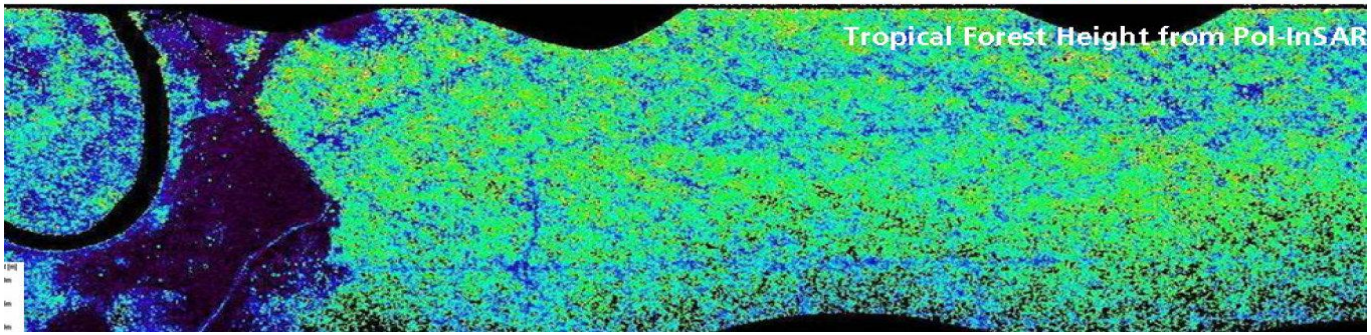


Pol-InSAR

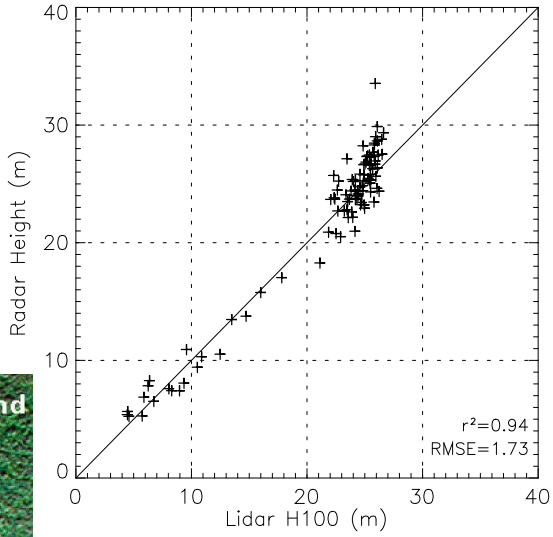
Tree height inversion

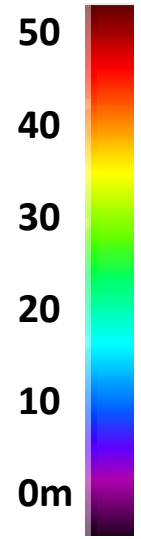
Hajnsek et al., 2009





Peat Swamp forest, Mawas, Kalimantan

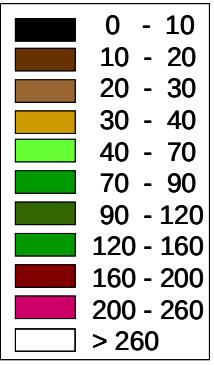




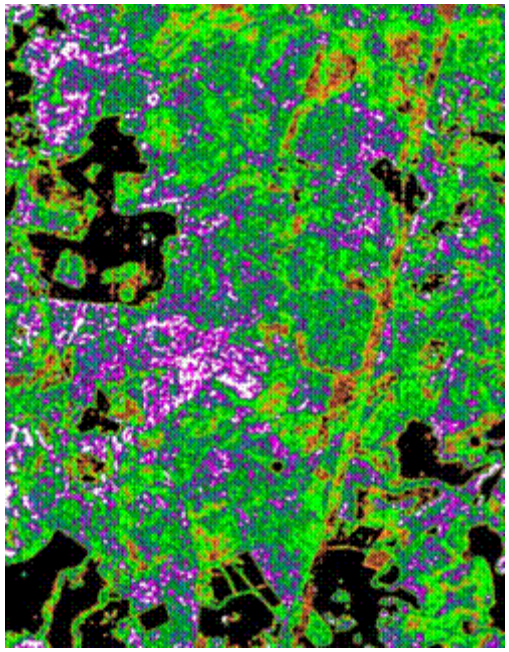
Height (m)

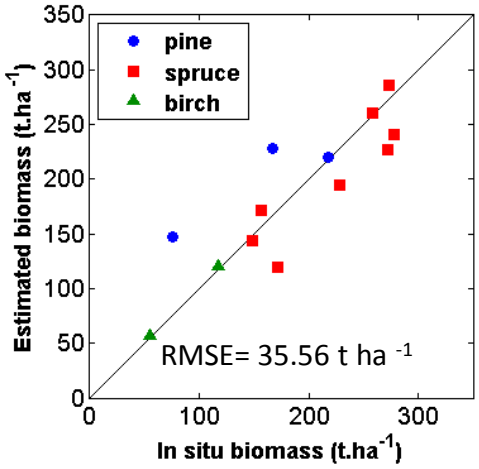
Biomass inversion combines intensity and height

Biomass from Intensity



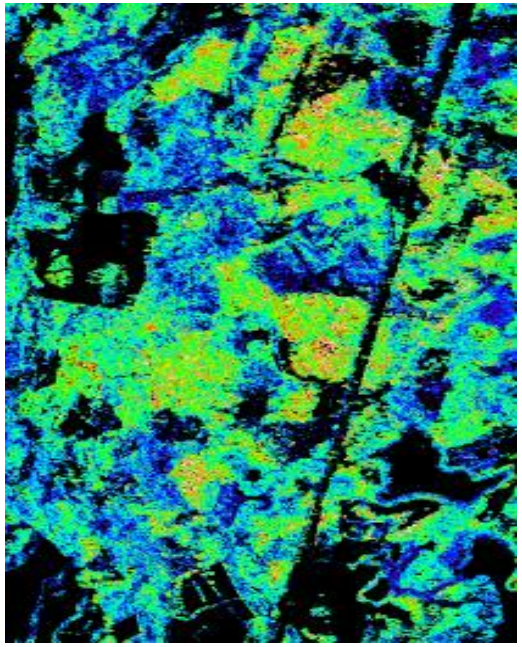
Biomass (ton/ha)



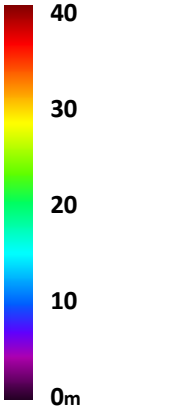


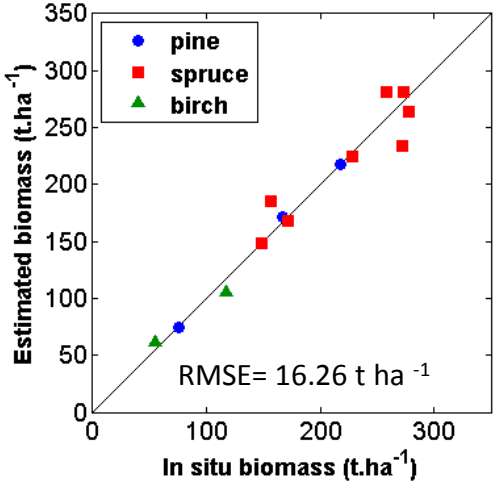
Intensity + Pol-InSAR

Pol-InSAR height



Height (m)

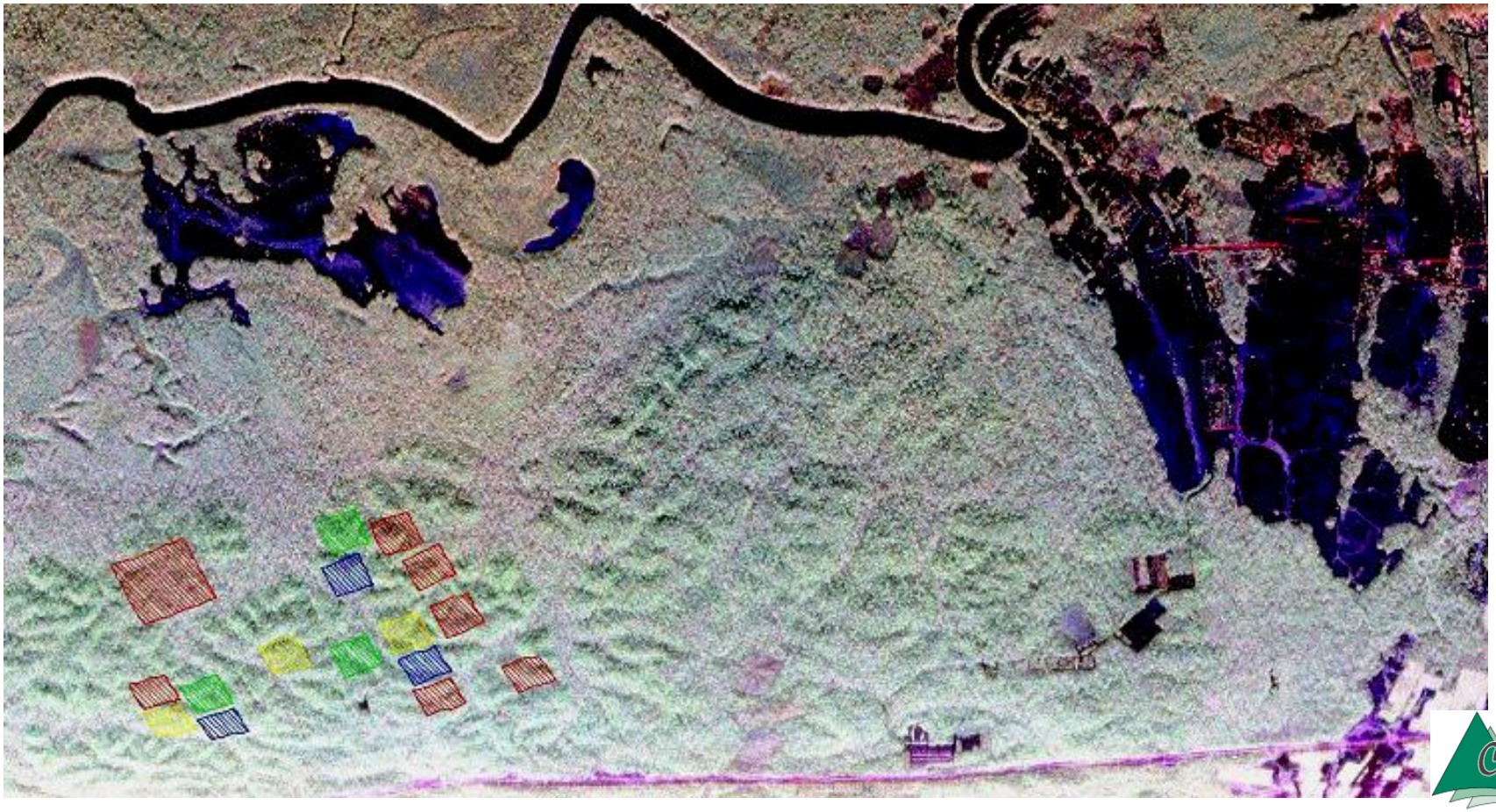


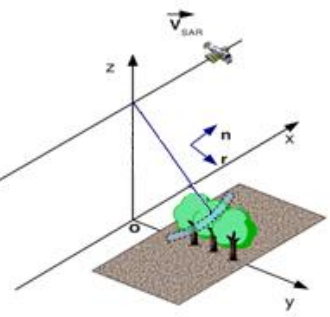


Challenging issue: to retrieve biomass > 300 ton/ha

HH, VV, HV

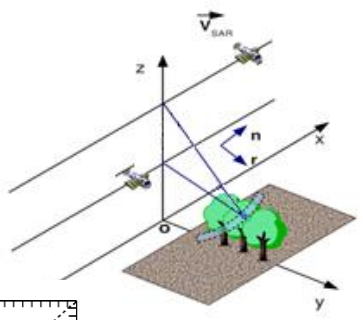
TropiSAR P-band image, Paracou, French Guiana

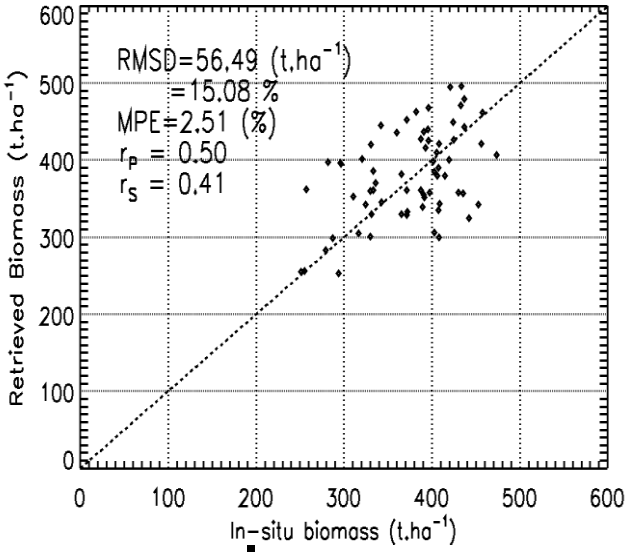


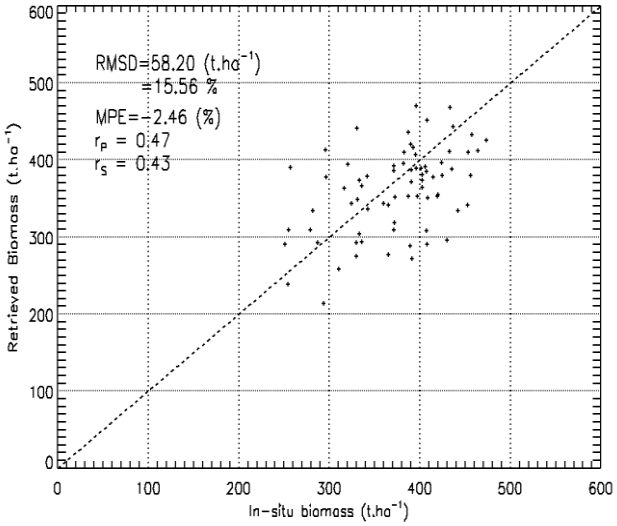


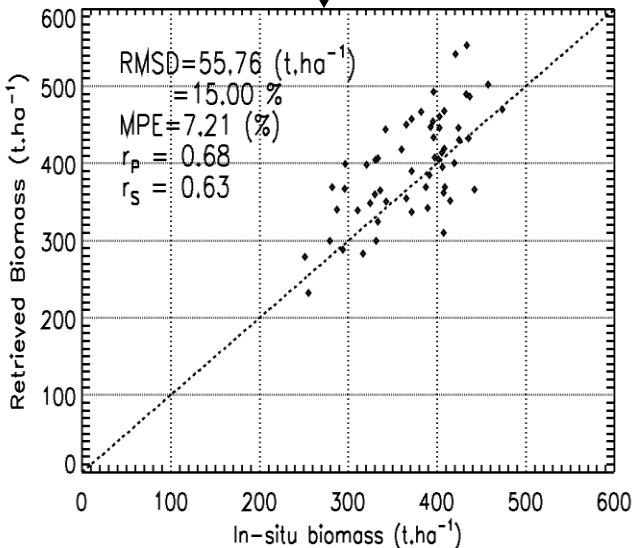
Intensity hv

PolInSAR









Inversion relying on a combination of intensity and PolInSAR