

Crops monitoring with radar and optical data

ESA PECS Training

Bratislava, 17th September 2018

Pierre-Louis Frison

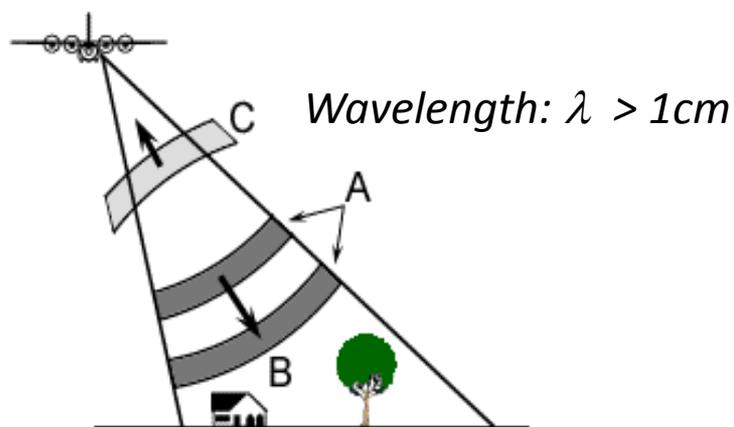
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Vegetation classification with SAR data

Spaceborne Remote Sensing

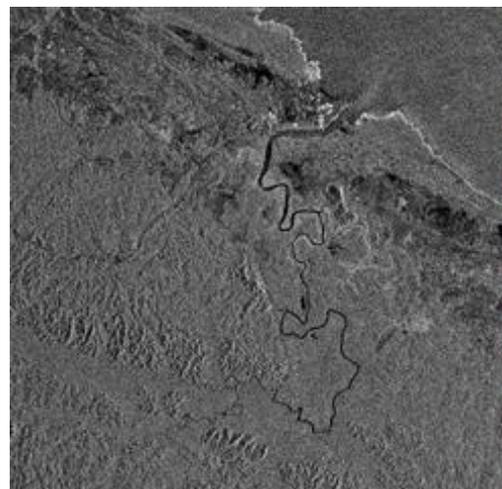
Optical since 70's

Radar since 1991



Source: Centre canadien de télédétection

Radar, ERS

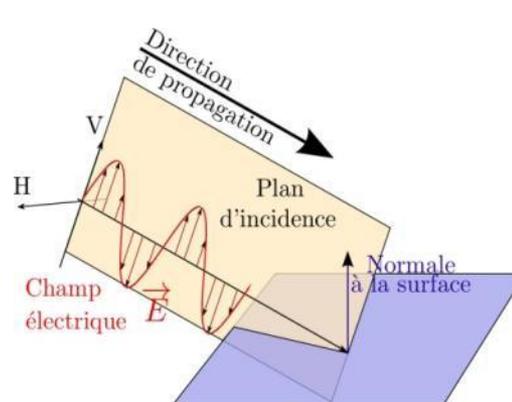


Optical, SPOT

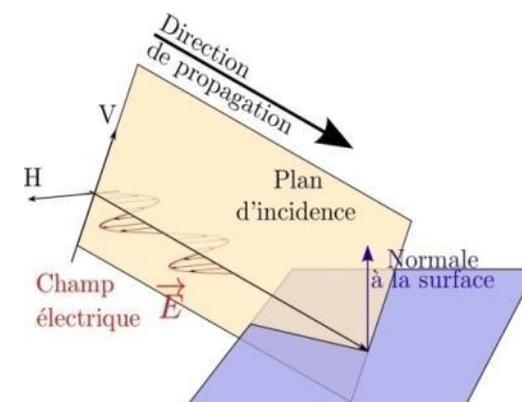


*Insensitive to clouds and atmosphere
day / night acquisitions*

Different polarizations



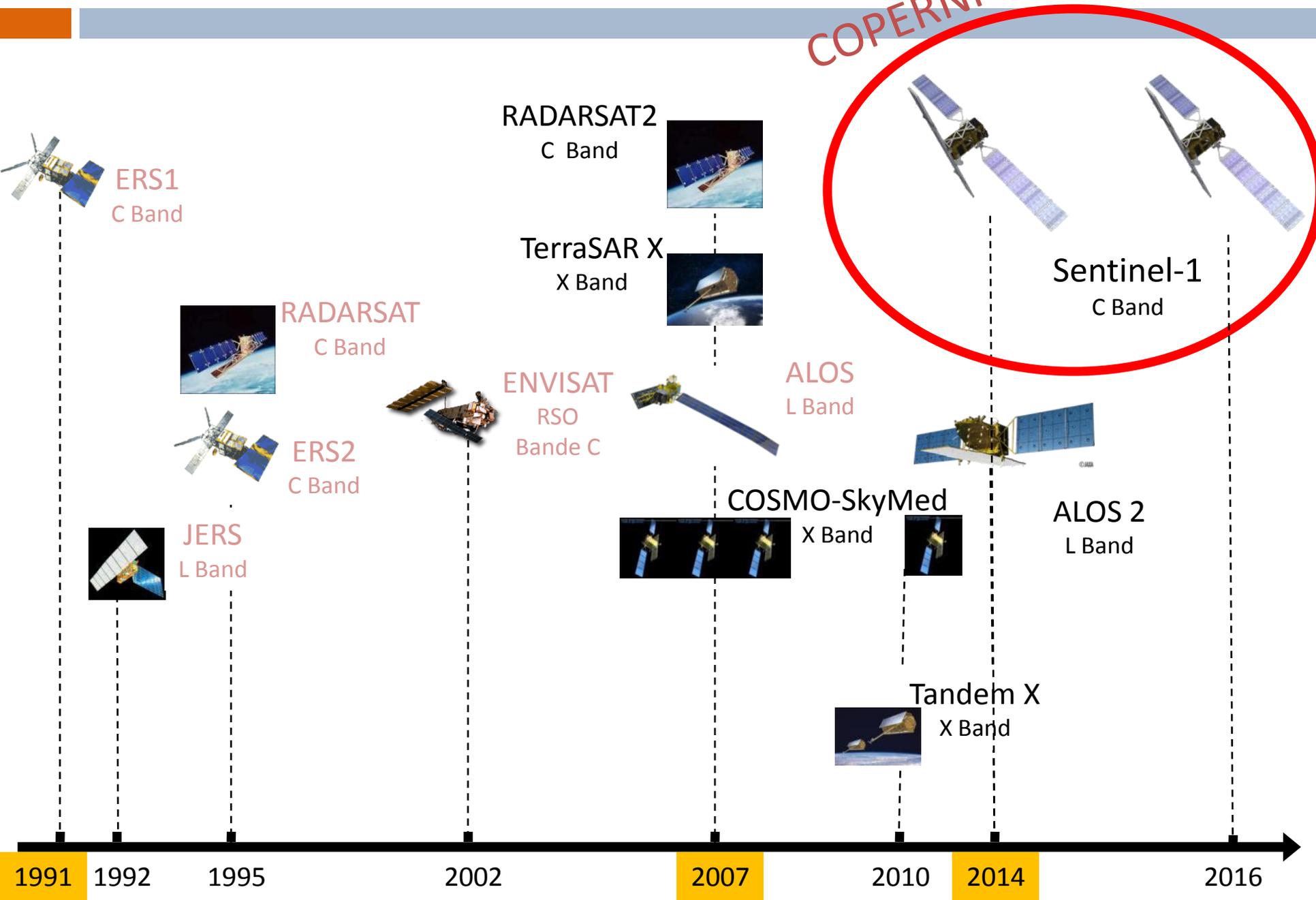
Polarisation V



Polarisation H

SPACEBORNE SAR SENSORS

COPERNICUS



SAR data: summary

<i>Name</i>	<i>Acquisition period</i>	<i>Band Frequency</i>	<i>Polarization mode</i>	<i>Spatial resolution (m)</i>	<i>Revisit time (days)</i>	<i>Scene cover (km)</i>
ERS-1 / 2	91 - 11	C	VV	20	35	185x185
JERS	92 - 98	L	HH	20	44	75 x 75
Radarsat	95 – 13	C	HH	10-100	24	35 x 500
ASAR	01-13	C	1 or 2 pol. HH/HV/VV	30-1000	few -35	100x500
PALSAR	07-11	L	Polarimetric HH/HV/VV	10-100	few-24	100-500
Radarsat-2	2007 -	C	Polarimetric HH/HV/VV	1-15	5 to 10	NA
TerraSAR-X	2007 -	X	1 or 2 pol. HH/HV/VV	1-20	few-11	5-100
Cosmo-Skymed	2007 -	X	1 or 2 pol HH/HV/VV	1-100	12 h	10-200
SAOCOM	2015	L	Polarimetric HH/HV/VV	7-100	few-16	60-320
Sentinel 1	2015	C	1 or 2 pol HH/HV/VV	5 - 100m	few-12	80-400
ALOS-2	2015	L	Polarimetric HH/HV/VV	3-100	few-14	25-350

Fréquency – Wavelength

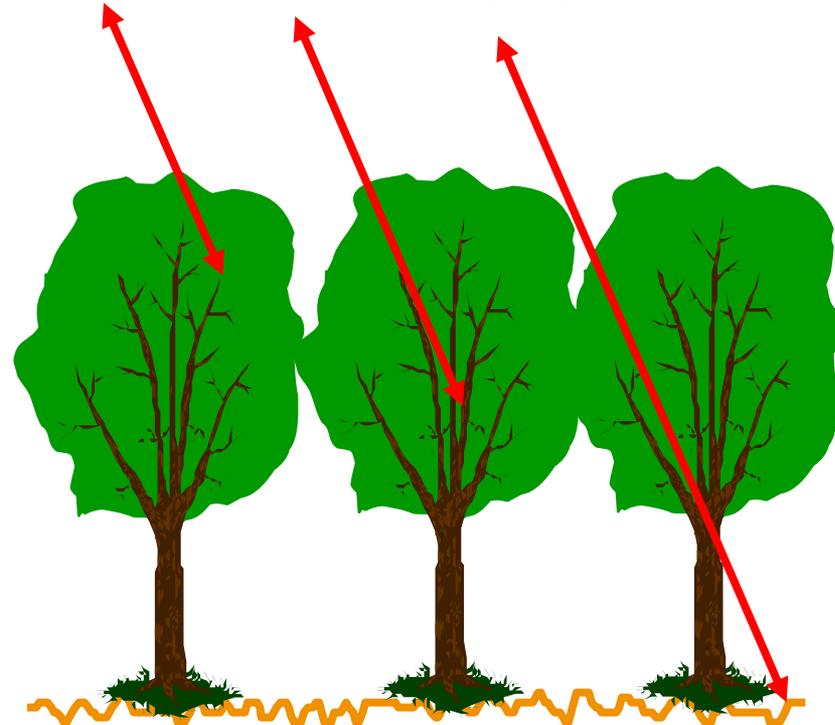
$$f = \frac{c}{\lambda}$$

Bande X	$\lambda \sim 3 \text{ cm}$	f ~ 10 GHz
Bande C	$\lambda \sim 6 \text{ cm}$	f ~ 5 GHz
Bande L	$\lambda \sim 25 \text{ cm}$	f ~ 1,2 GHz
Bande P	$\lambda \sim 70 \text{ cm}$	f ~ 400 MHz

Radar images interpretation rules

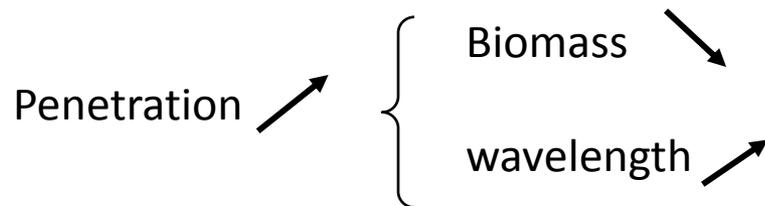
Volume scattering

C band L band P-band



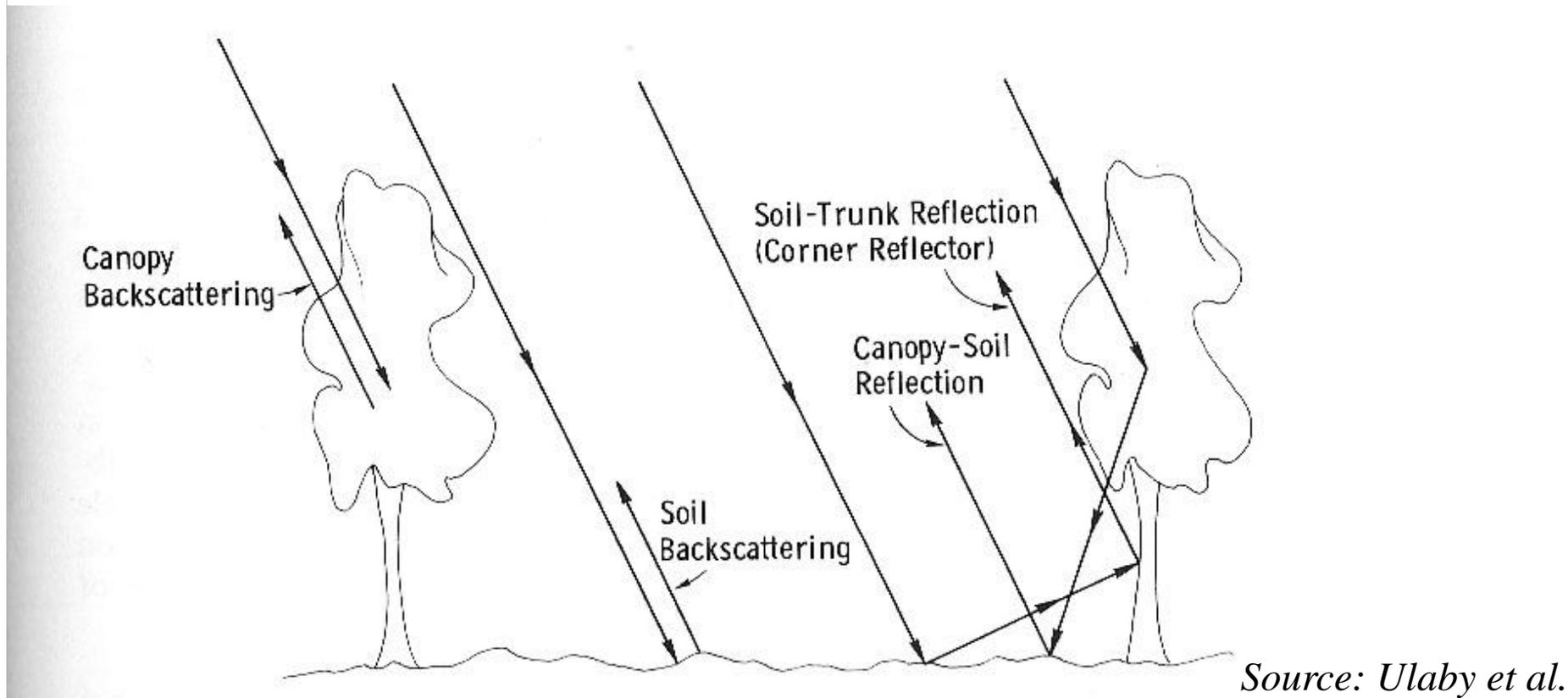
Penetration Depth:

$$\delta = \frac{\lambda}{4\pi \operatorname{Im}(\sqrt{\epsilon})}$$



Radar response sensitivity

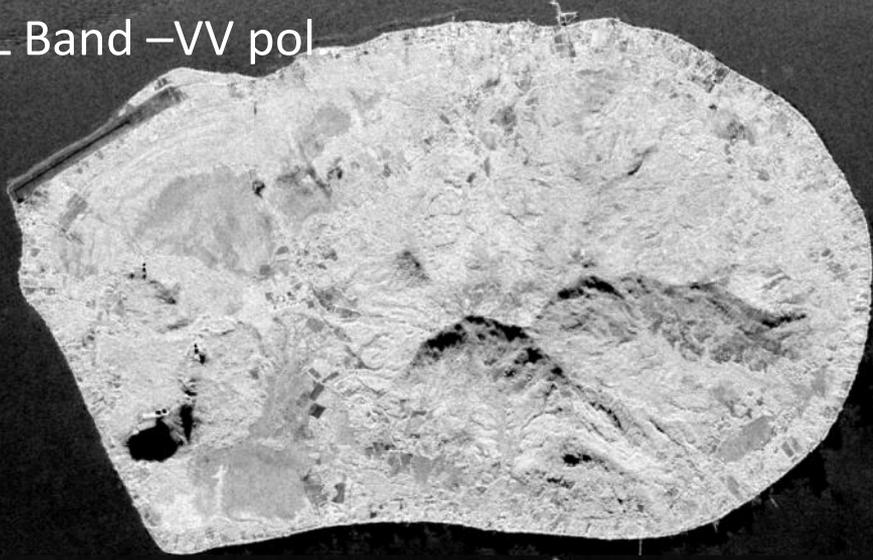
Backscattering mechanism on vegetation



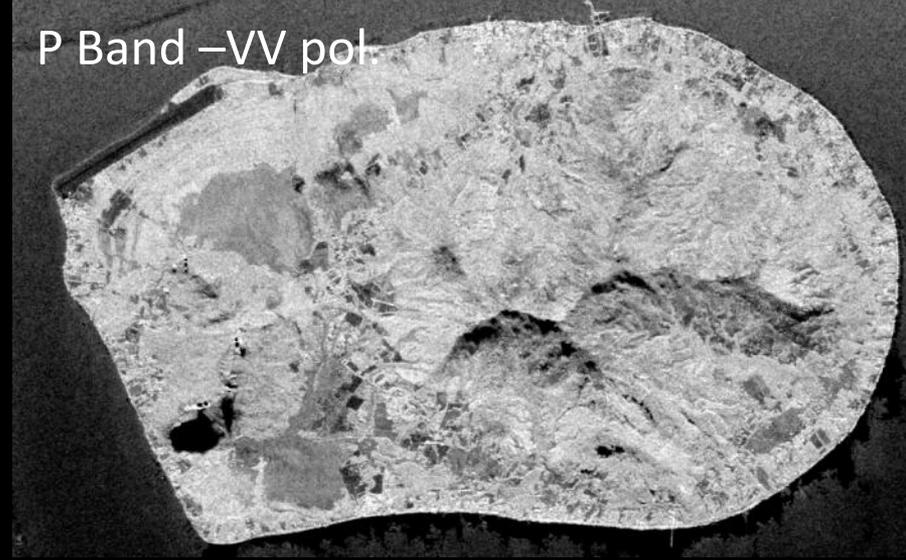
Frequency diversity – Wavelength

Tubuai Island, French Polynesia

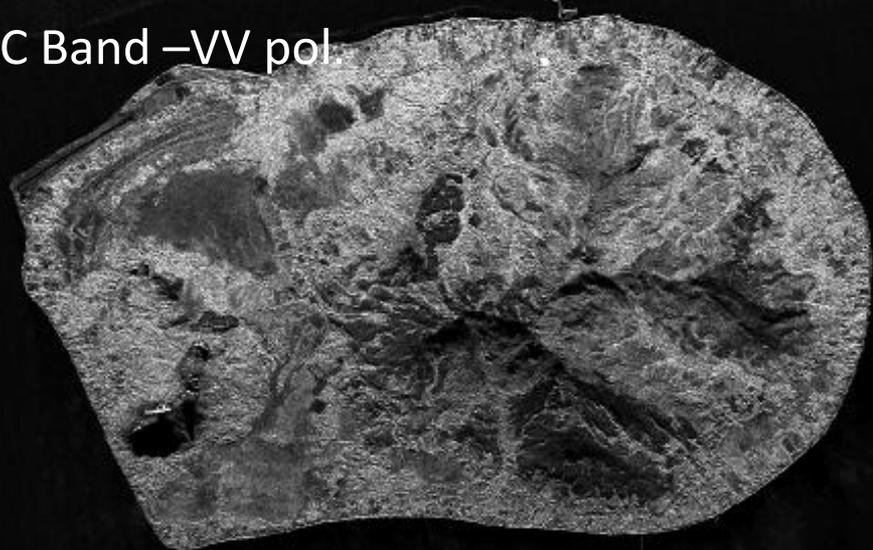
L Band –VV pol



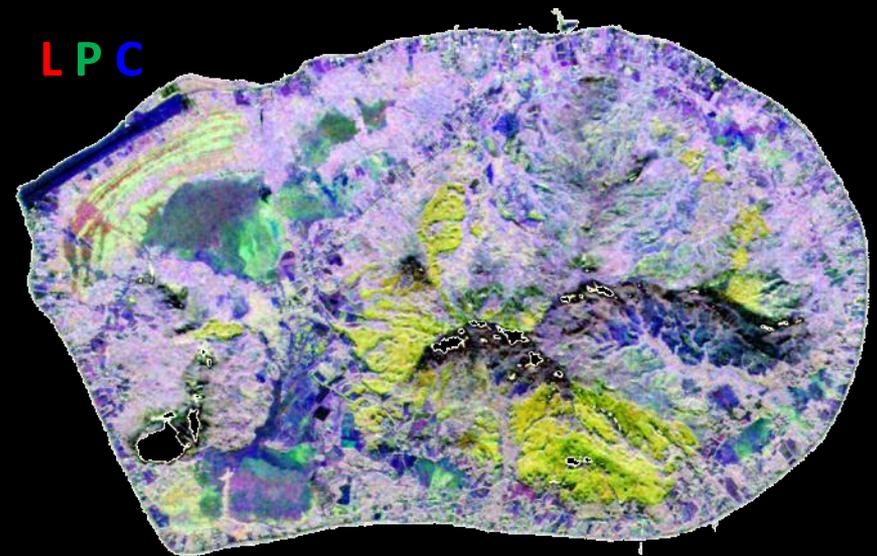
P Band –VV pol



C Band –VV pol



LPC



Polarisation Diversity

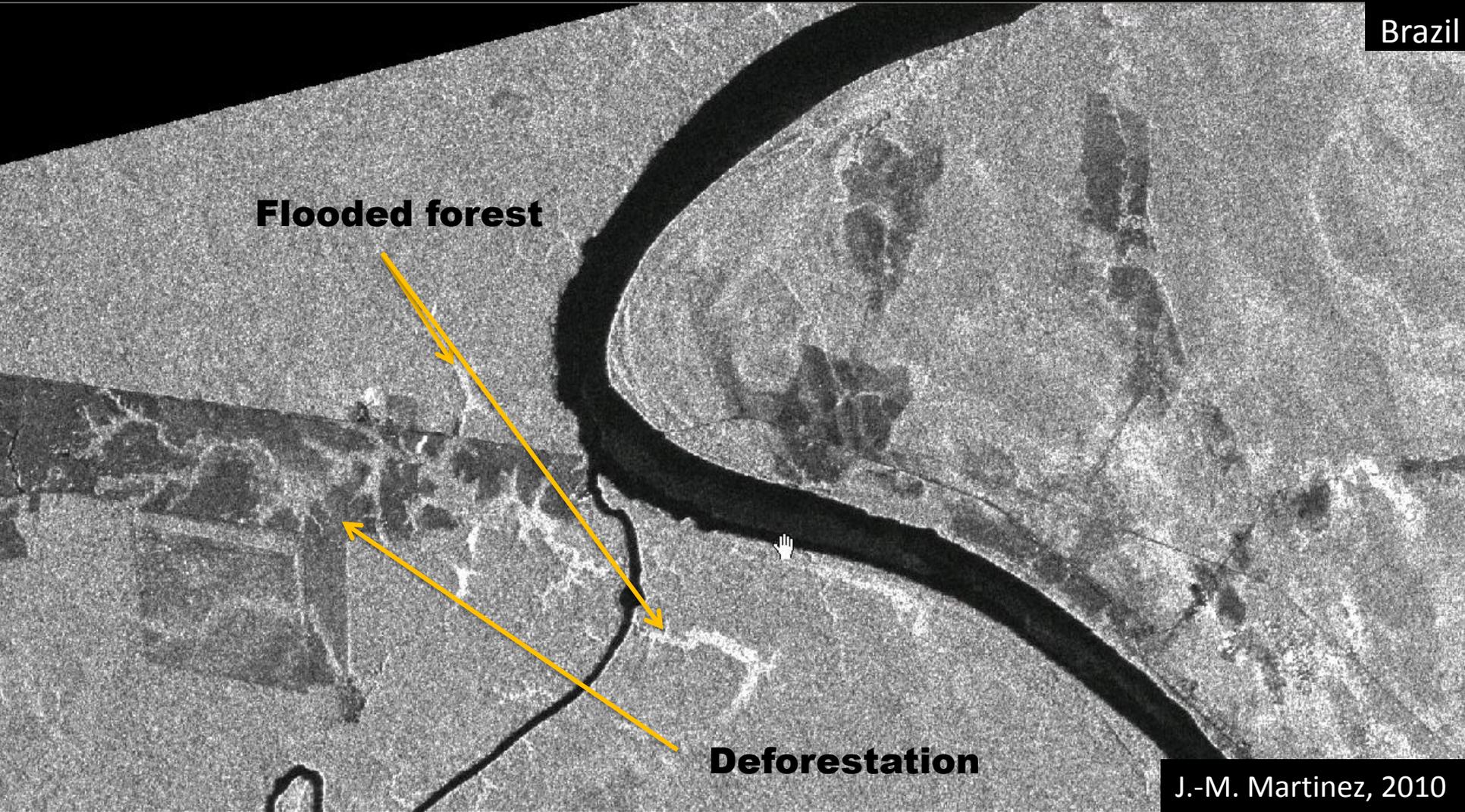
Brazil

Flooded forest

Deforestation

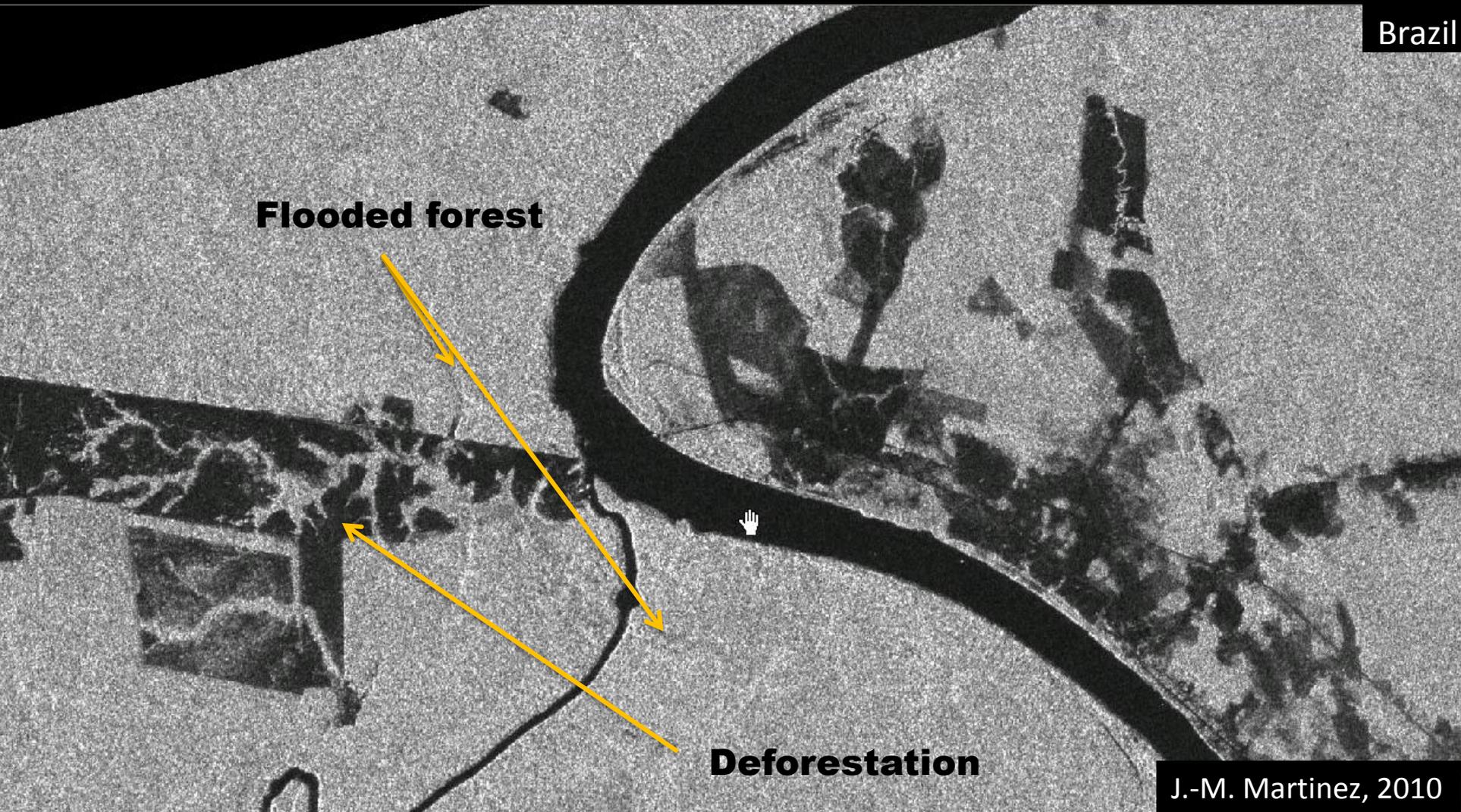
J.-M. Martinez, 2010

ALOS acquisition ($\lambda = 24$ cm)- Polarization **HH**



Polarisation Diversity

Brazil



ALOS acquisition ($\lambda = 24$ cm)- Polarization *HV*

radar polarimetry for forest cartography

Tubuai Island, French Polynesia

7 different classes:

- bare soils
- swamps
- fern lands

4 forest species

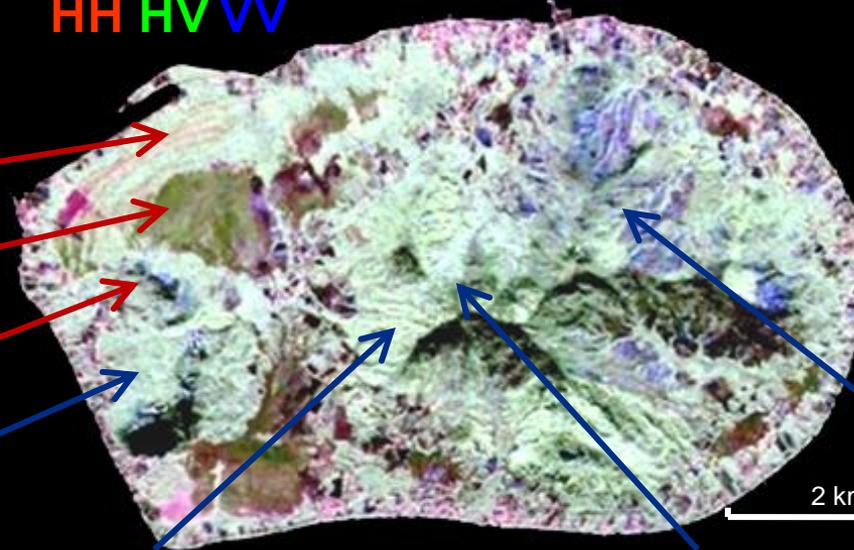
• Purau

• Pine

• Falcata

• Guava

HH HV VV



AIRSAR data
L Band ($\lambda = 24$ cm)
Aug. 2000

2 km

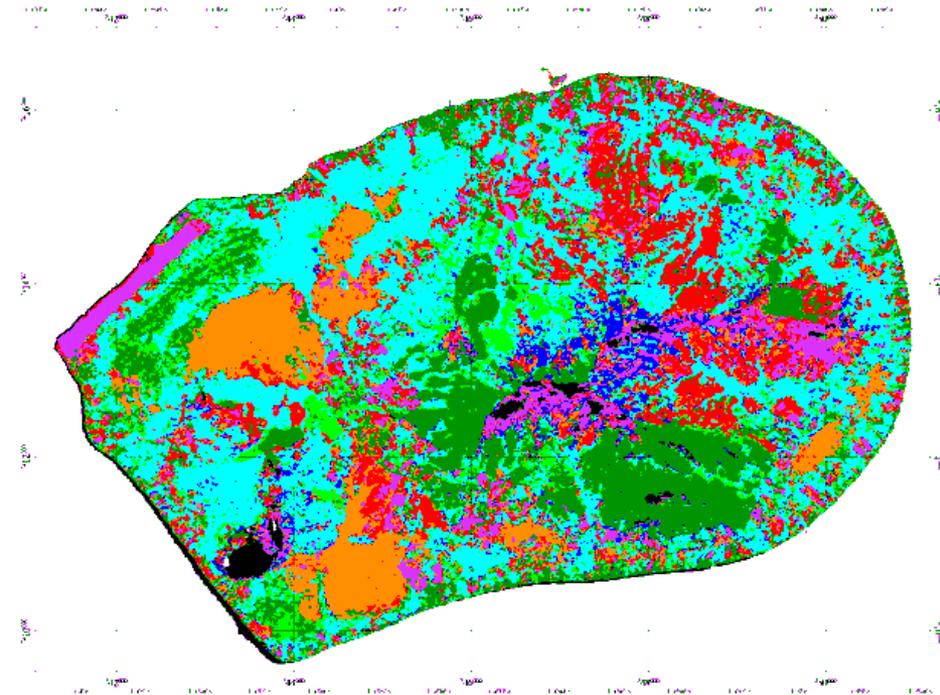
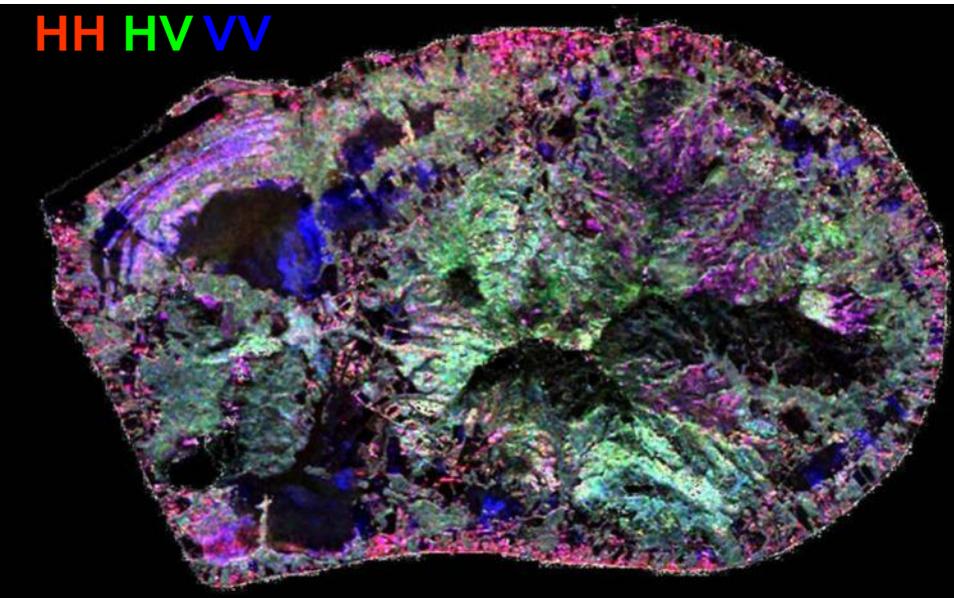


Vegetation classification with radar polarimetry

Tubuai Island (French Polynesia)

*AIRSAR data
August 2000*

Classification



(4 Forest types)

Vegetation classification with SAR data

Session Program:

Remote Sensing data:

Sentinel-1 (C Band)
ALOS-PALSAR (L Band)
Sentinel-2

FREELY AVAILABLE!

Study site:
Hradek Kralove
(Czech Republic)

Processing softwares:

SNAP or kit QGIS: S1 Processing
QGIS: ROI definition
QGIS - OTB: Classification

OPENSOURCE!

Map of vegetation types

Sentinel-1 data (C band) processing:

1) Download GRD products from ESA Scientific Data Hub

IW mode Dual Polarization VV - VH

2) Calibration and Georeferencement over a sub-area of interest

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Calibration:

Image DN

==>

Radar Backscat. Coef. σ^0

(~ radar reflectance)

Vegetation monitoring

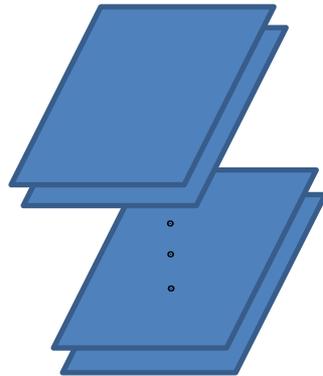
Sentinel-1 data (C band) processing :

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IW mode Dual Polarization VV - VH

2) Calibration and Georeferencement over a sub-area of interest

3) Stacking all the acquisitions



One file with $2*N$ bands

N: number of acquisition dates

2: VV and VH polarization

Vegetation monitoring

Sentinel-1 data (C band) processing:

1) Download GRD products from ESA Scientific Data Hub

IW mode Dual Polarization VV - VH

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Generation of 2 products

Creation of a **temporal average image**
($VV - VH - VH/VV$)

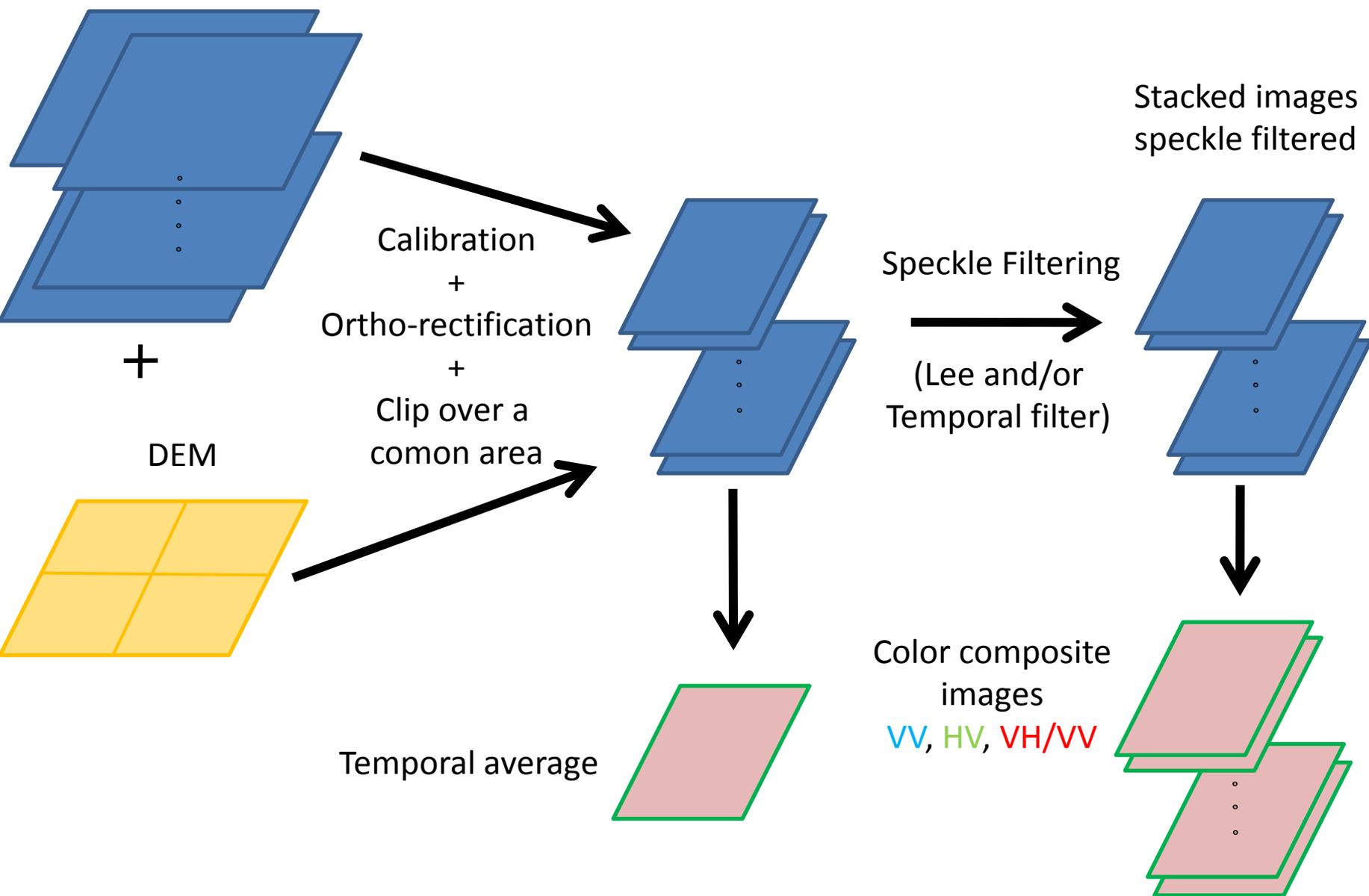
- Radar image with (*almost*) no speckle!
- Comfortable for visual interpretation
- Well suited for the delineation of training and validation data sets

Spatio-temporal filtering of the image
($VV ; VH ; VH/VV * \# \text{ acquisitions date}$)

Necessary for classification processing

Sentinel-1 Processing

Uncompressed downloaded
Sentinel-1 images
at GRD format



Vegetation monitoring

ALOS- pALSAR data processing :

1) Download HH-HV 25 m mosaic

Already calibrated, and ortho-rectified

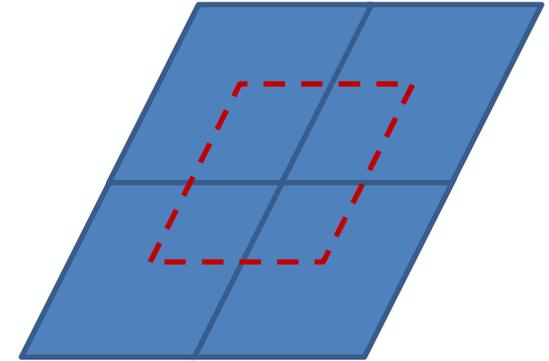
2) Agregate and crop the tiles over the study-area

3) . Calibrate

. speckle filtering

. Creation of HH/HV

==> 3 bands: HH, HV, HH/HV



Vegetation monitoring

Sentinel-2 data processing :

1) Download (tiles) L1C products (without clouds)

Already calibrated, and ortho-rectified

2) 4 bands : resolution 10 m

6 bands : resolution 20 m

==> Pan sharpening ==> 10 bands: resolution 10 m

