Kyoto & Carbon (K&C) Initiative

Forest Theme
Current Status of Project - January 2008

Forest and biomass products using PALSAR

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CESBIO, Toulouse, France

Technical support from
Alexandre Bouvet (CESBIO) and Maurizio Santoro (Gamma)

Overview

- **Product name**

  Algorithms for above ground biomass retrieval

  Regional mapping of forest and forest biomass classes at prototype areas

- **Intended use**: Assessment of carbon budgets in forests (carbon sources and sinks, in particular related to post-disturbance forests)

- **Description:**

  1. Development of biomass mapping using multitemporal PALSAR FBD
  2. Assessment of regional mapping using PALSAR WB1

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- **Prototype areas**
  - 1. Central Siberia: WB1
  - 2. France & N Spain: FBD
  - 3. Vietnam: FBD

- **Data on server**

  WB1: Spring 2006 data over Central Siberia, 18 strips cycle 10, 9 strips cycle 11, available from April to June 07

  FBD: Summer 2006 data over France, 18 strips cycle 12, available November 07

On going work

Scansar data over Siberia: since October 08

FBD data over France: since Jan 08

❑ Deliverables

1. Assessment of forest and biomass classes mapping using multitemporal PALSAR WB1 in Central Siberia

(June 2008)

3. Algorithm (s) for forest and biomass classes using multitemporal PALSAR FBD

(December 2008)

Required collaboration for algorithm synthesis:

R. Lucas, S. Quegan, H. Olson, M.Hallikainen, D. Valeriano, A. Beaudoin

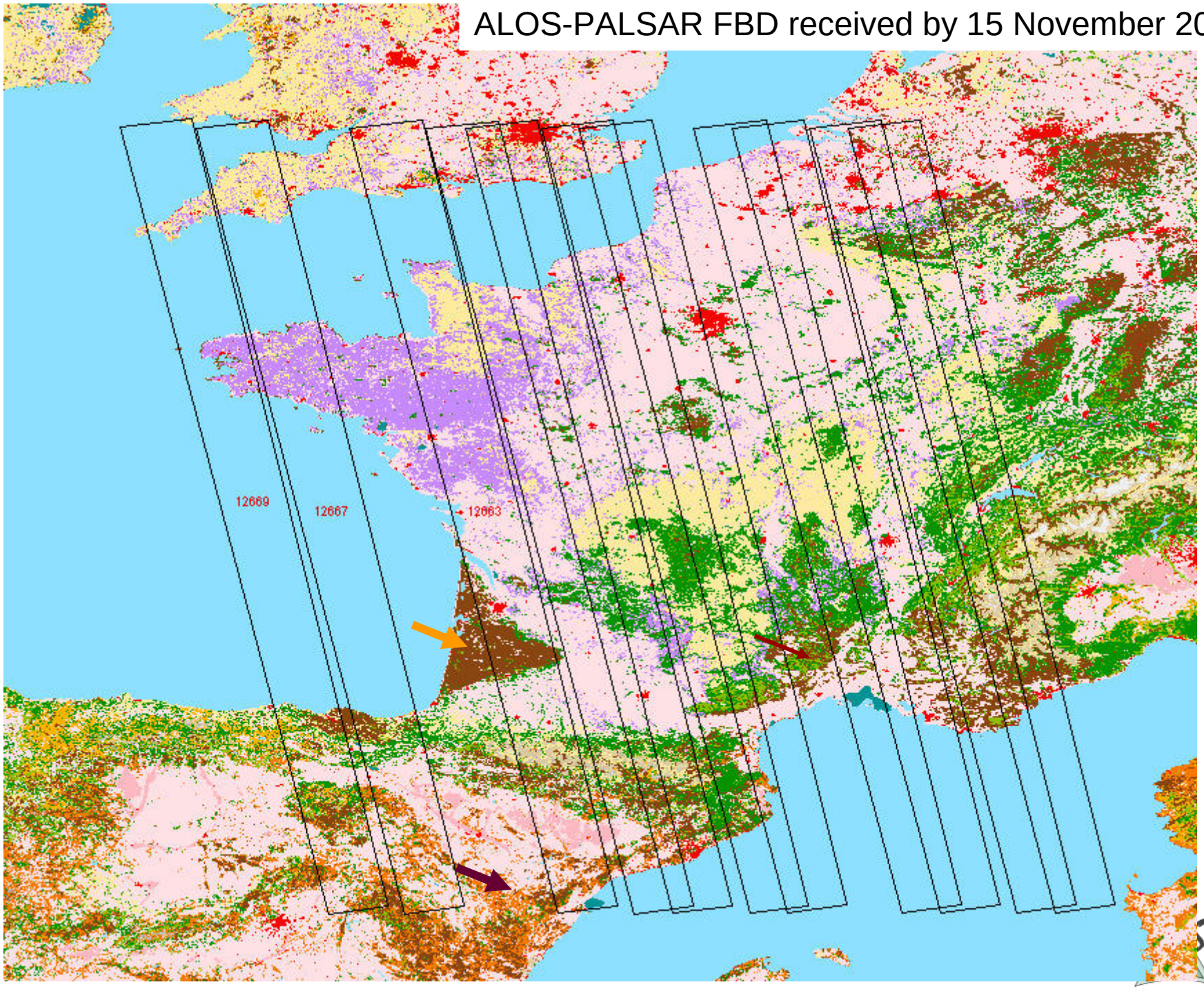
4. Maps of forest and biomass classes in France & N. Spain and Vietnam

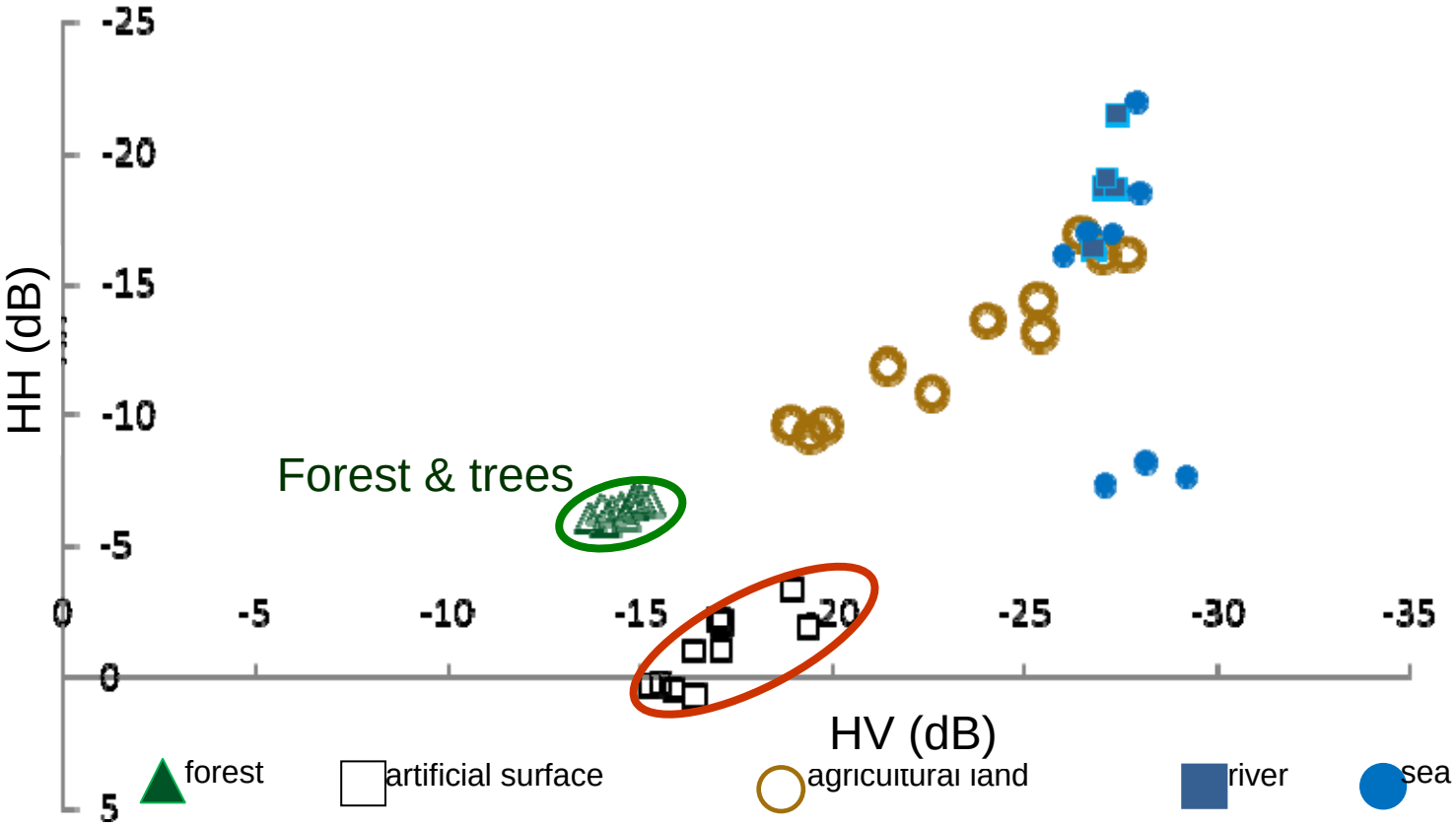
(December 2008)

Depending on data availability

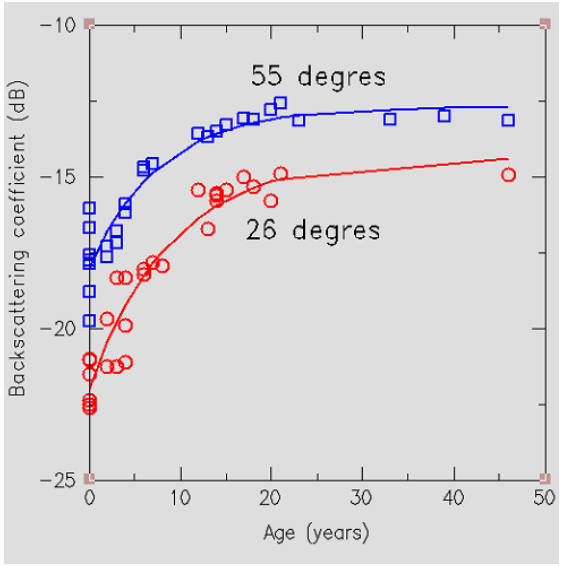
Preliminary analysis of PALSAR FBD over France

ALOS-PALSAR FBD received by 15 November 2007



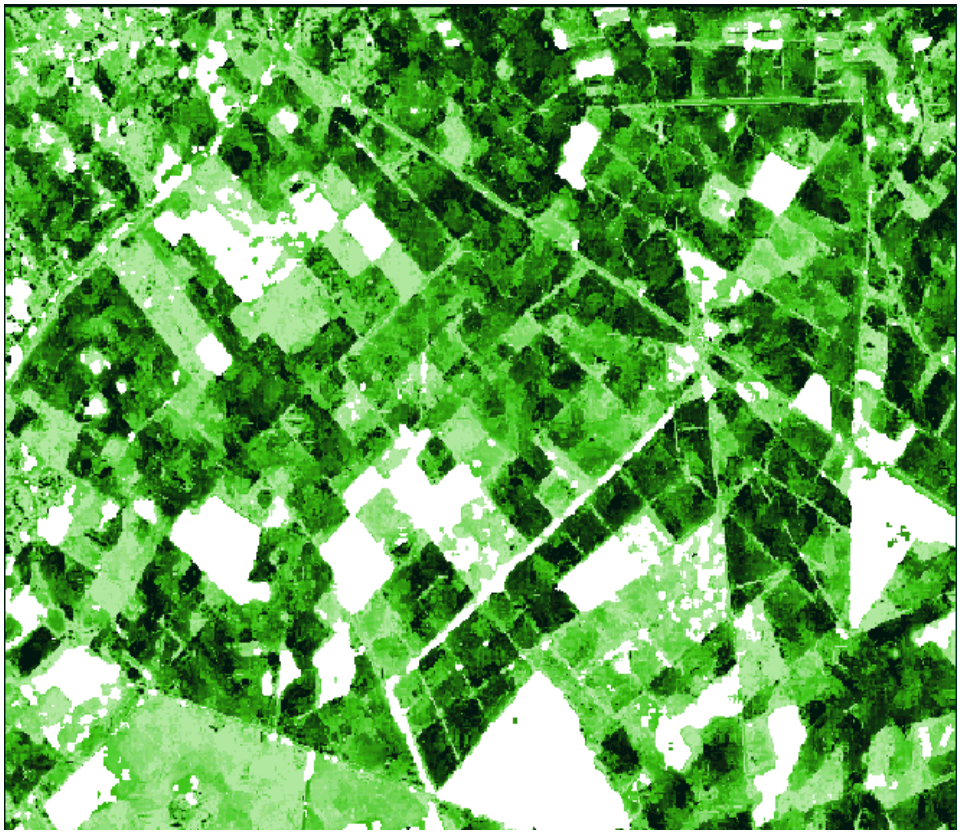

-25
-20
-15
-10
-5
0
5
HH (dB)
0
-5
-10
-15
-20
-25
-30
-35
HV (dB)
Forest & trees
forest
artificial surface
agricultural land
river
sea

L - HV - 26° (SIR-C)



Nézer Site
(Landes Forest)

Biomass Map

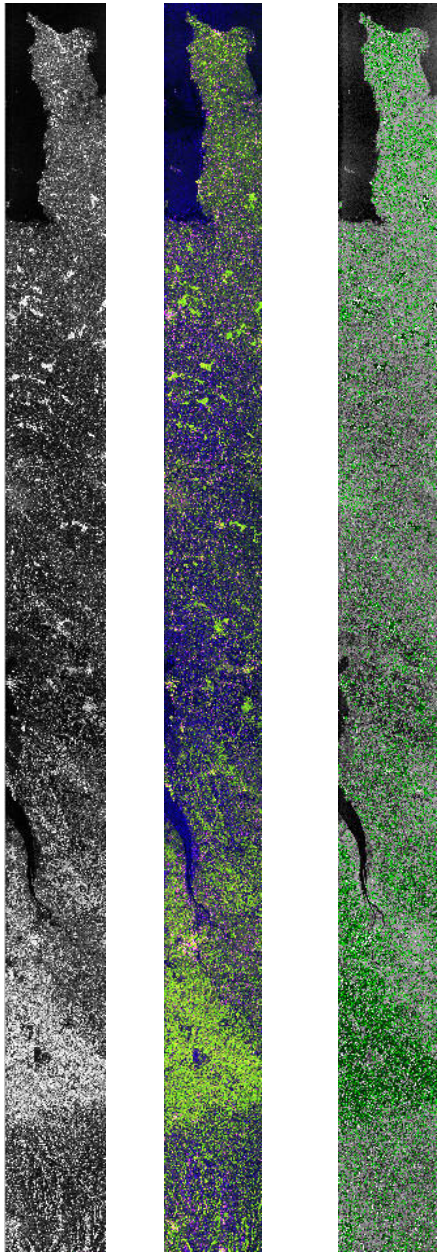


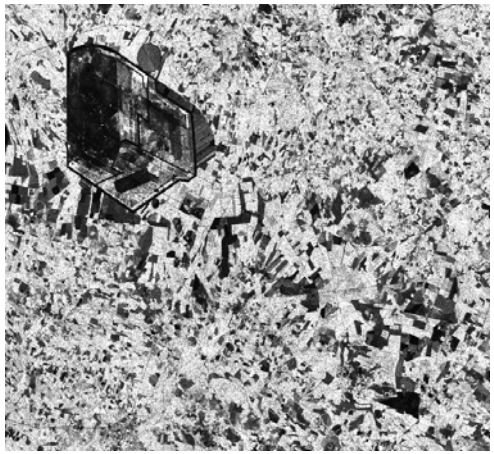
Clear cut 25 t/ha 50t/ha 75 t/ha

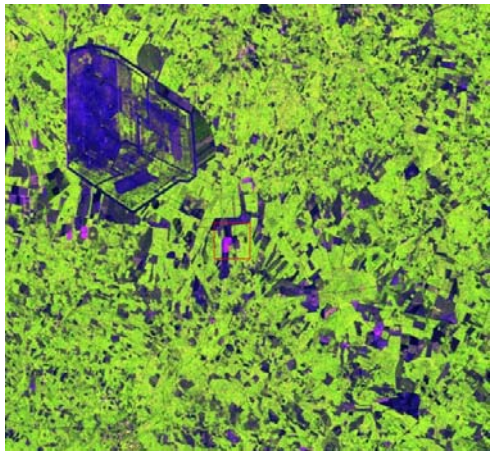
HV

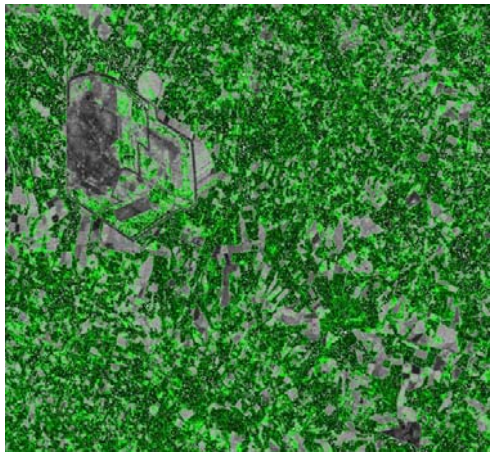
R: HH,
G: HV,
B: HV/HH

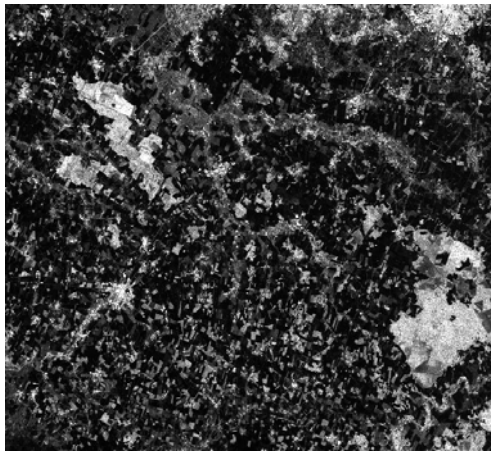
3 classes
of biomass

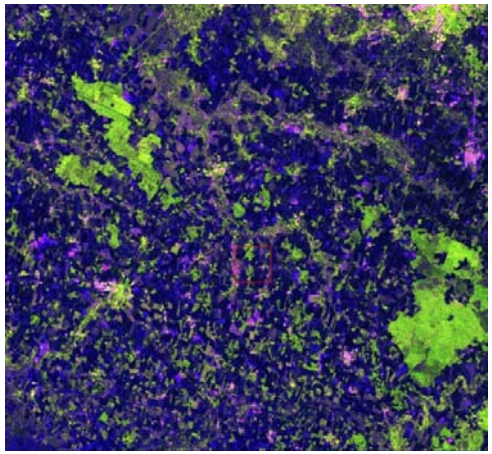


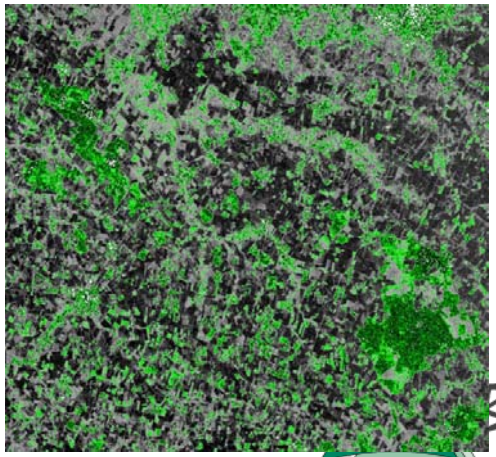




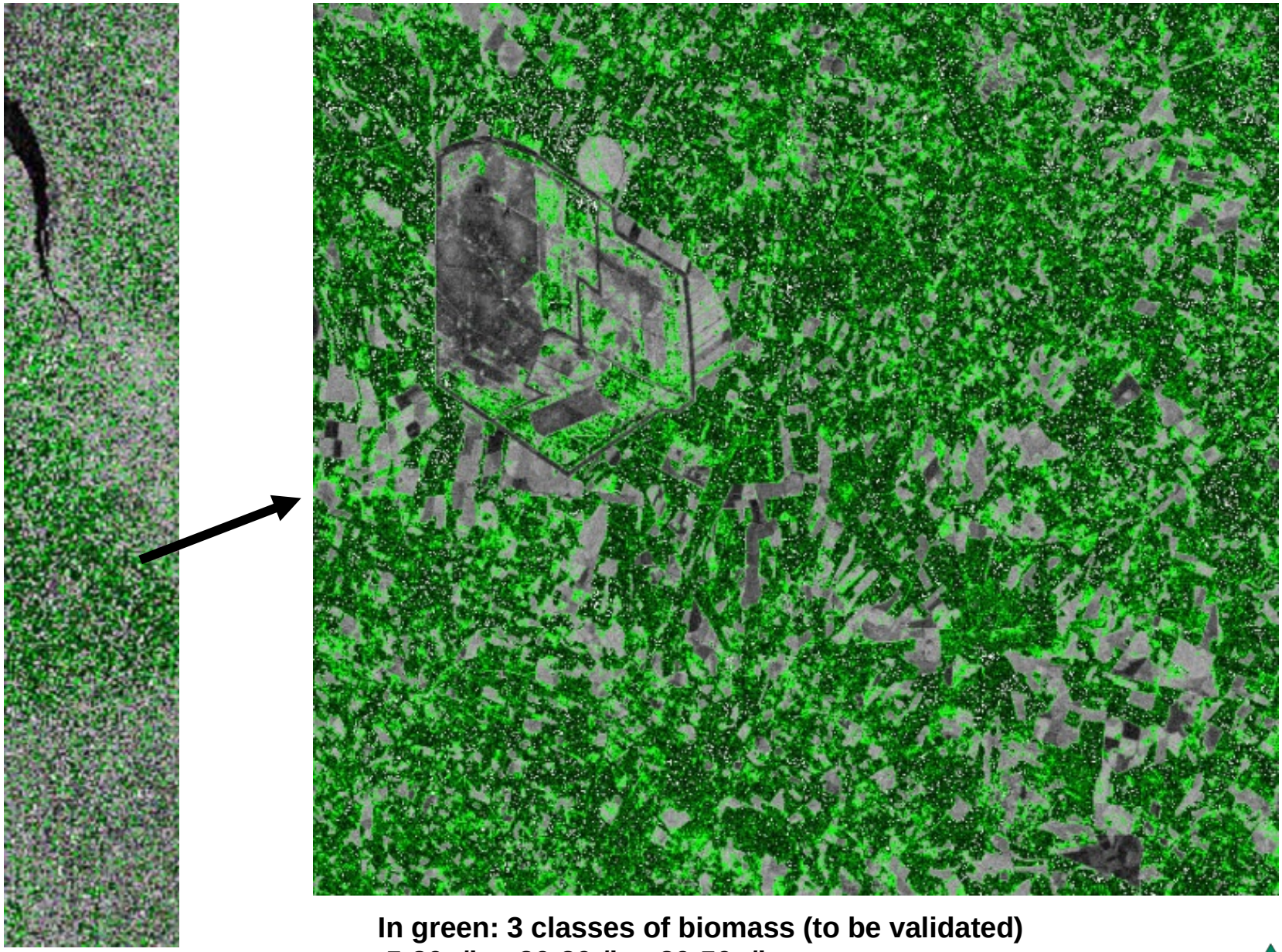




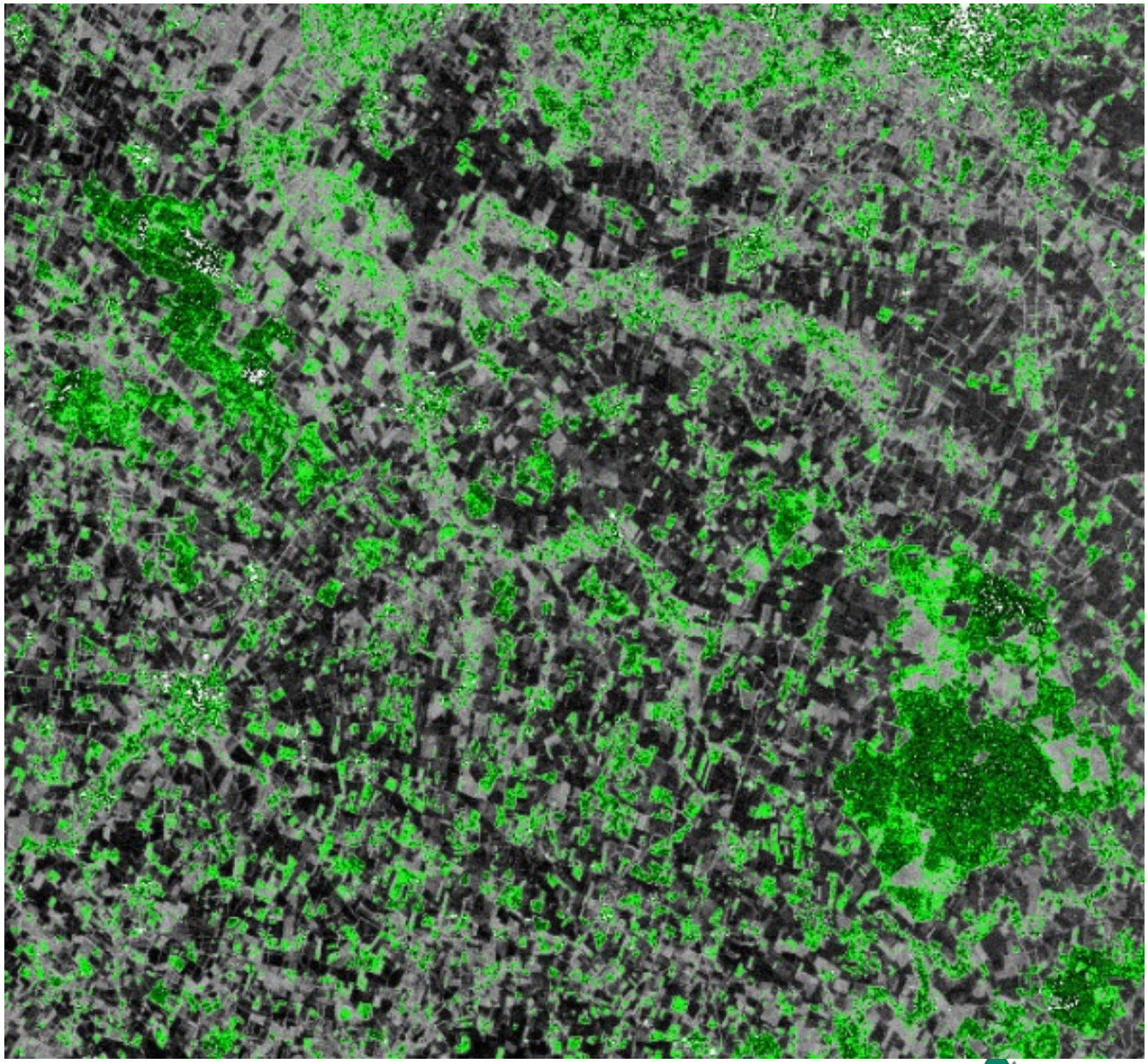




BIO

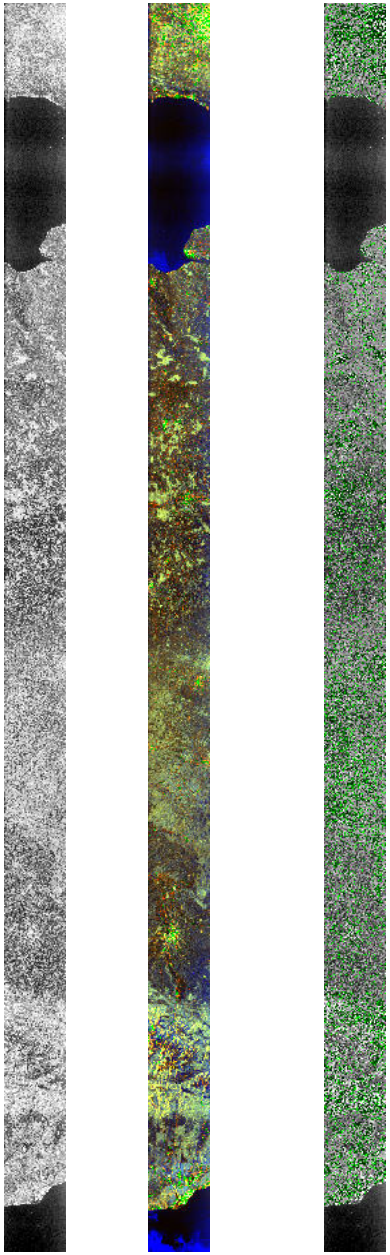


In green: 3 classes of biomass (to be validated)
5-20 t/ha, 20-30t/ha, 30-50 t/ha

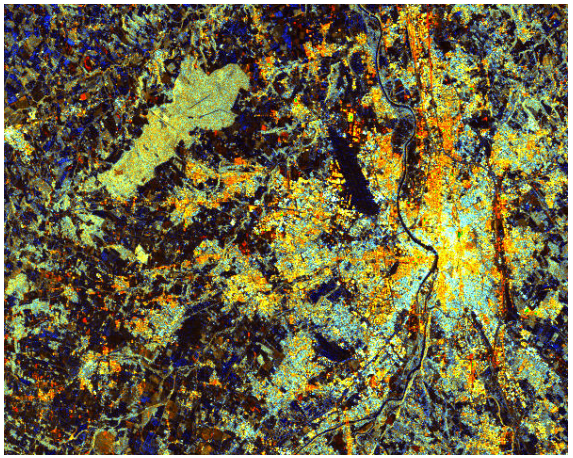


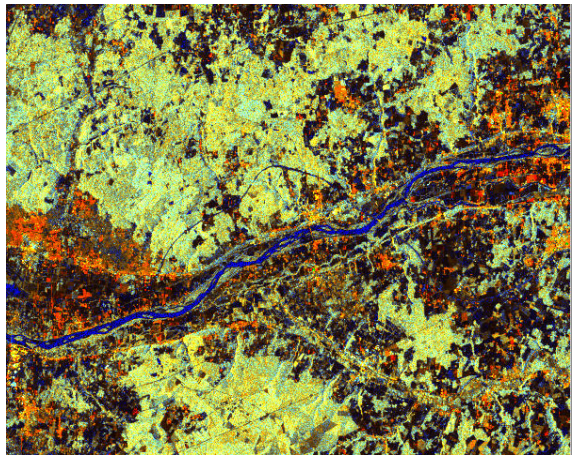
HV

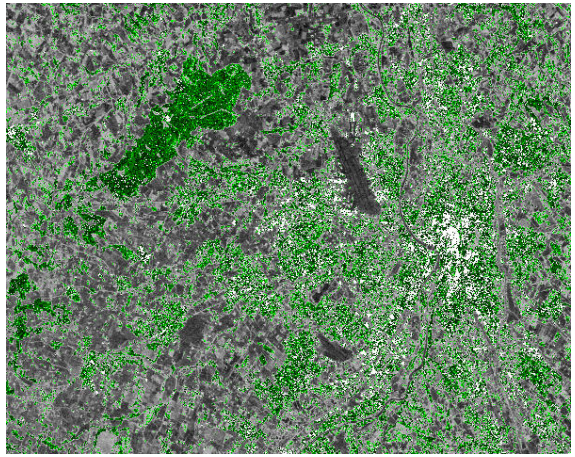
R: HH,
G: HV,
B: HV/HH

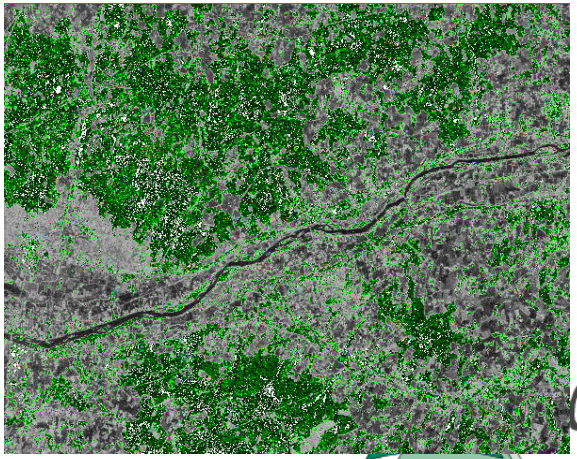


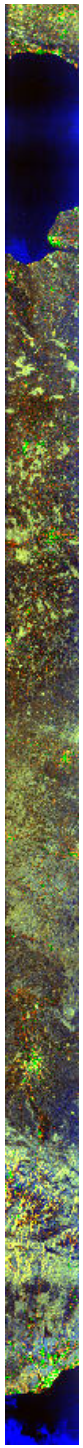
Biomass





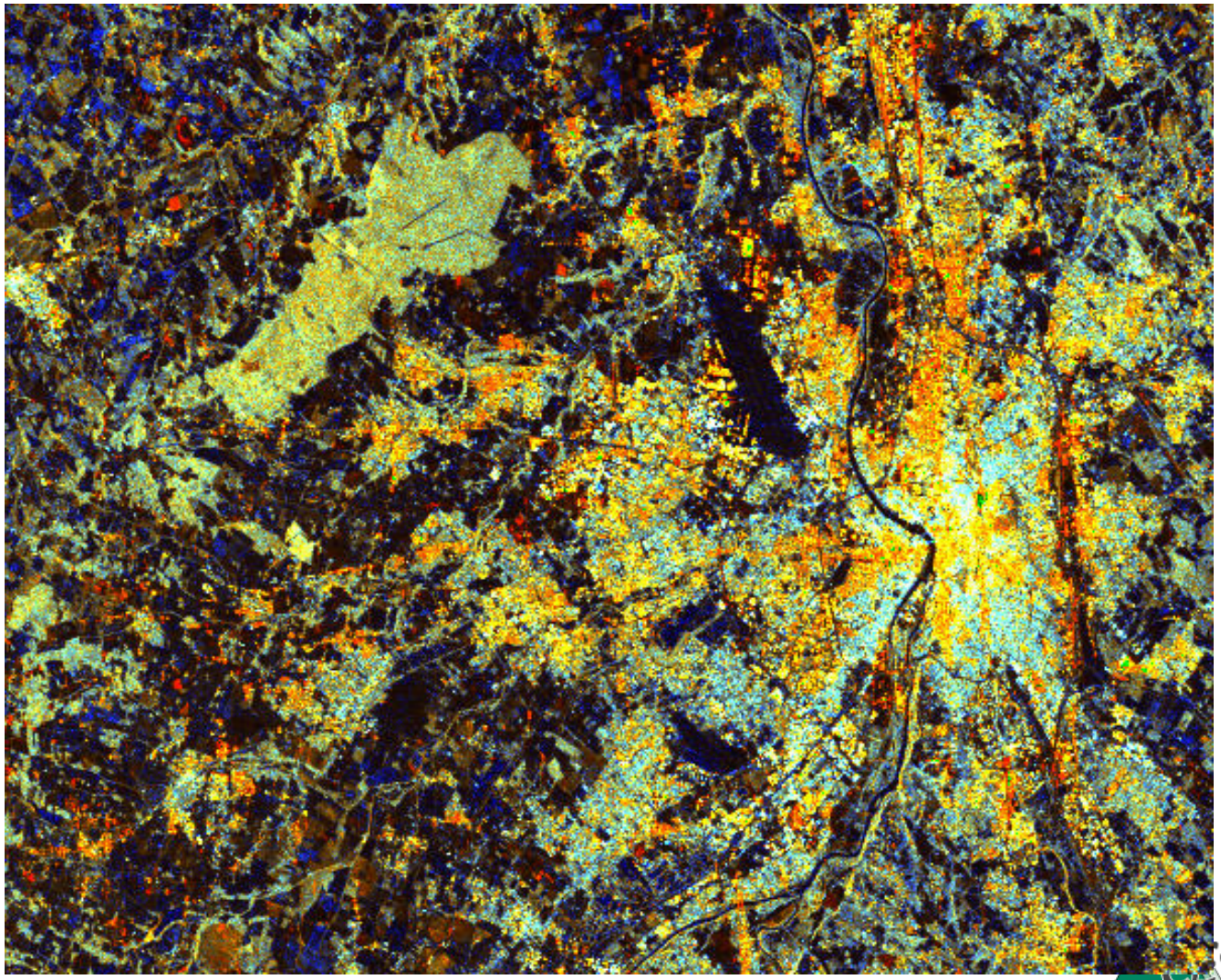


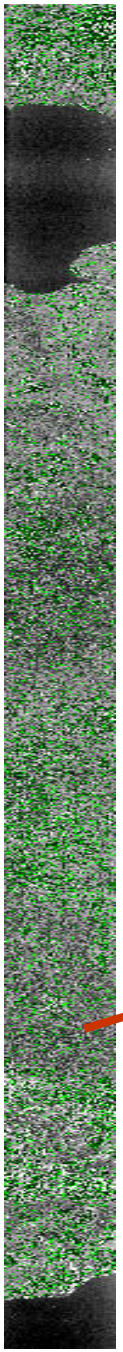




R: HH,
G: HV,
B: HV/HH

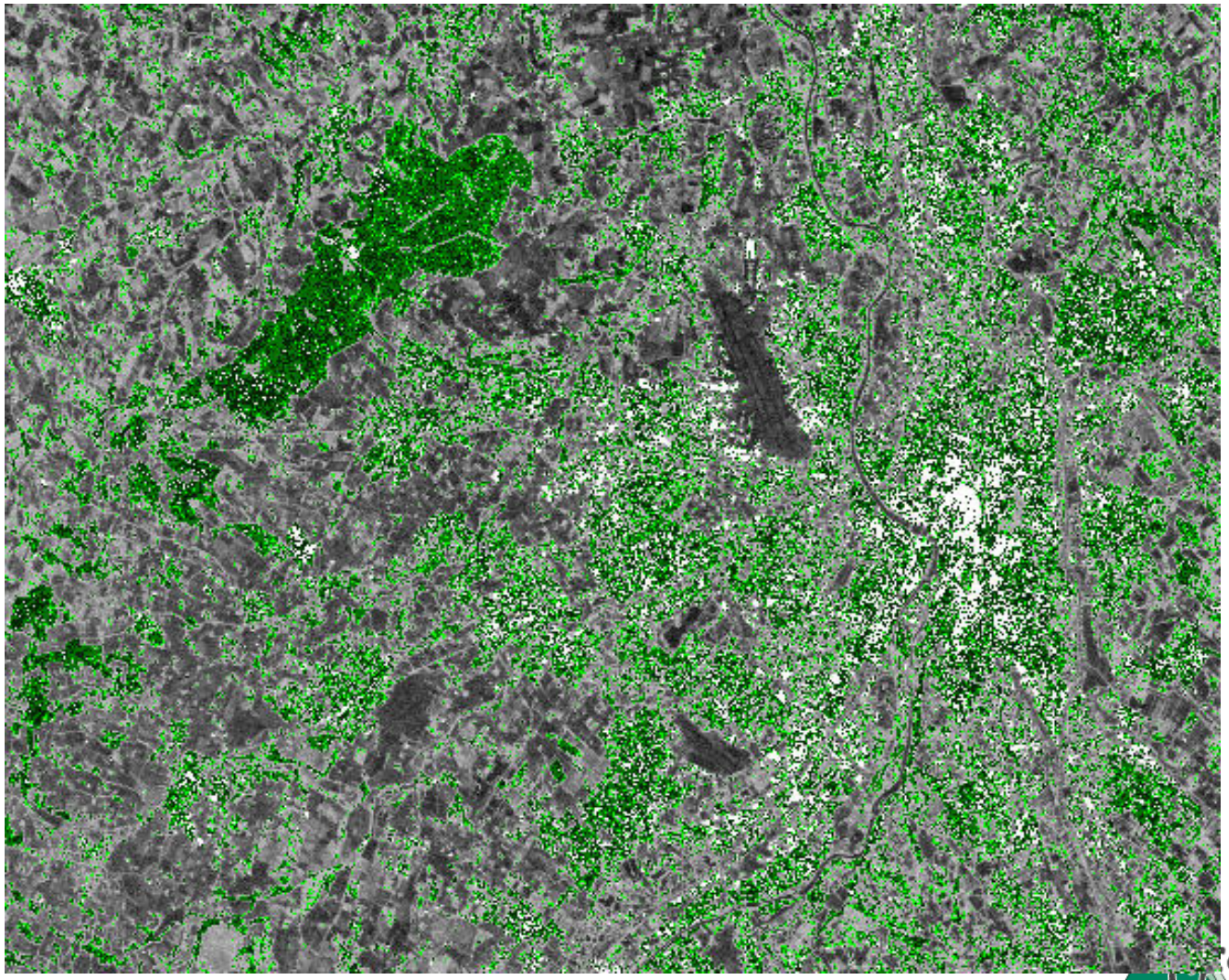
Toulouse





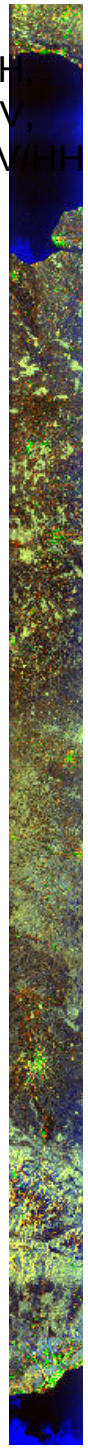
3 classes of biomass

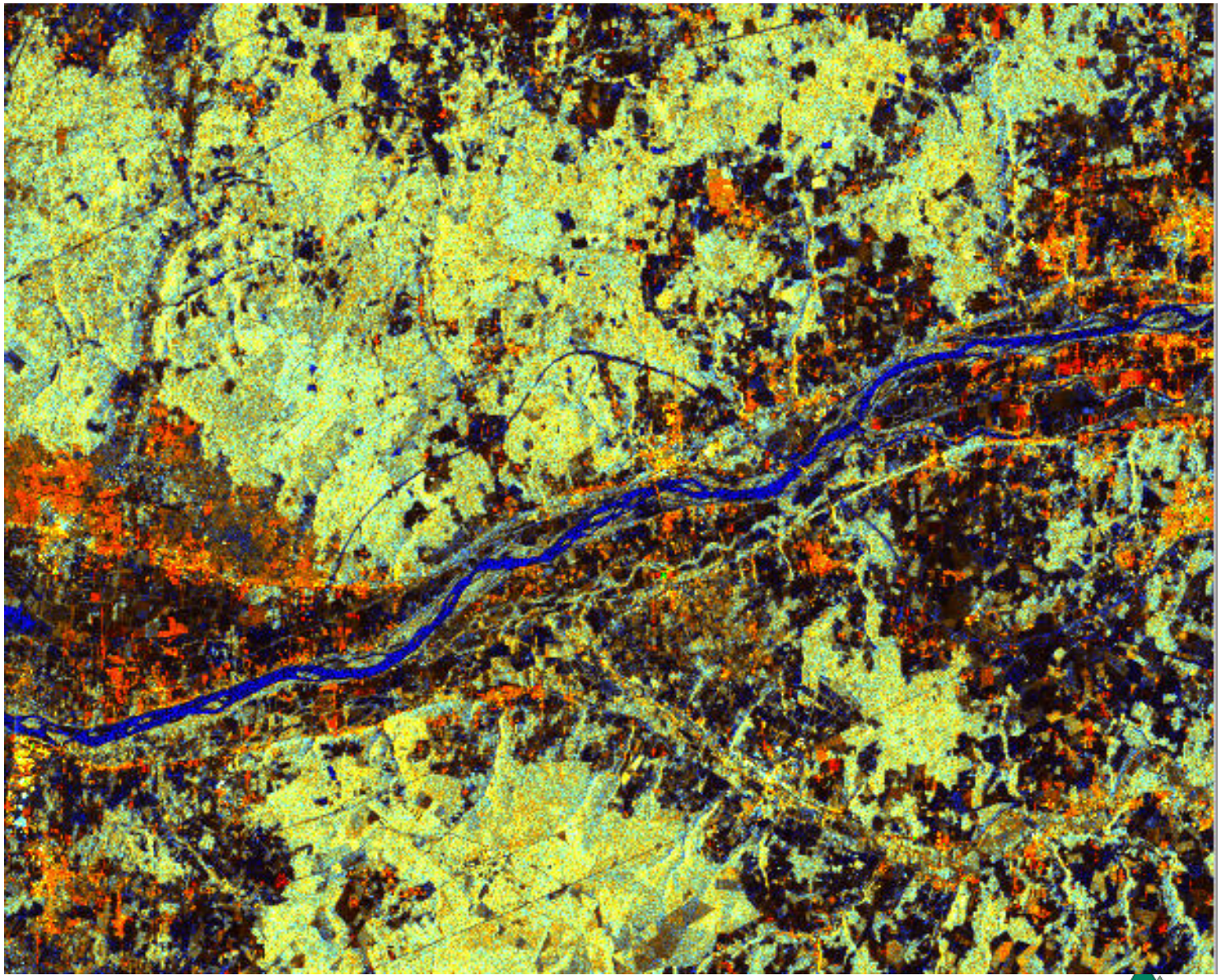
Toulouse

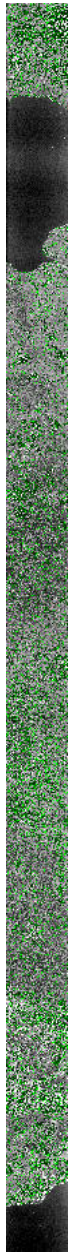


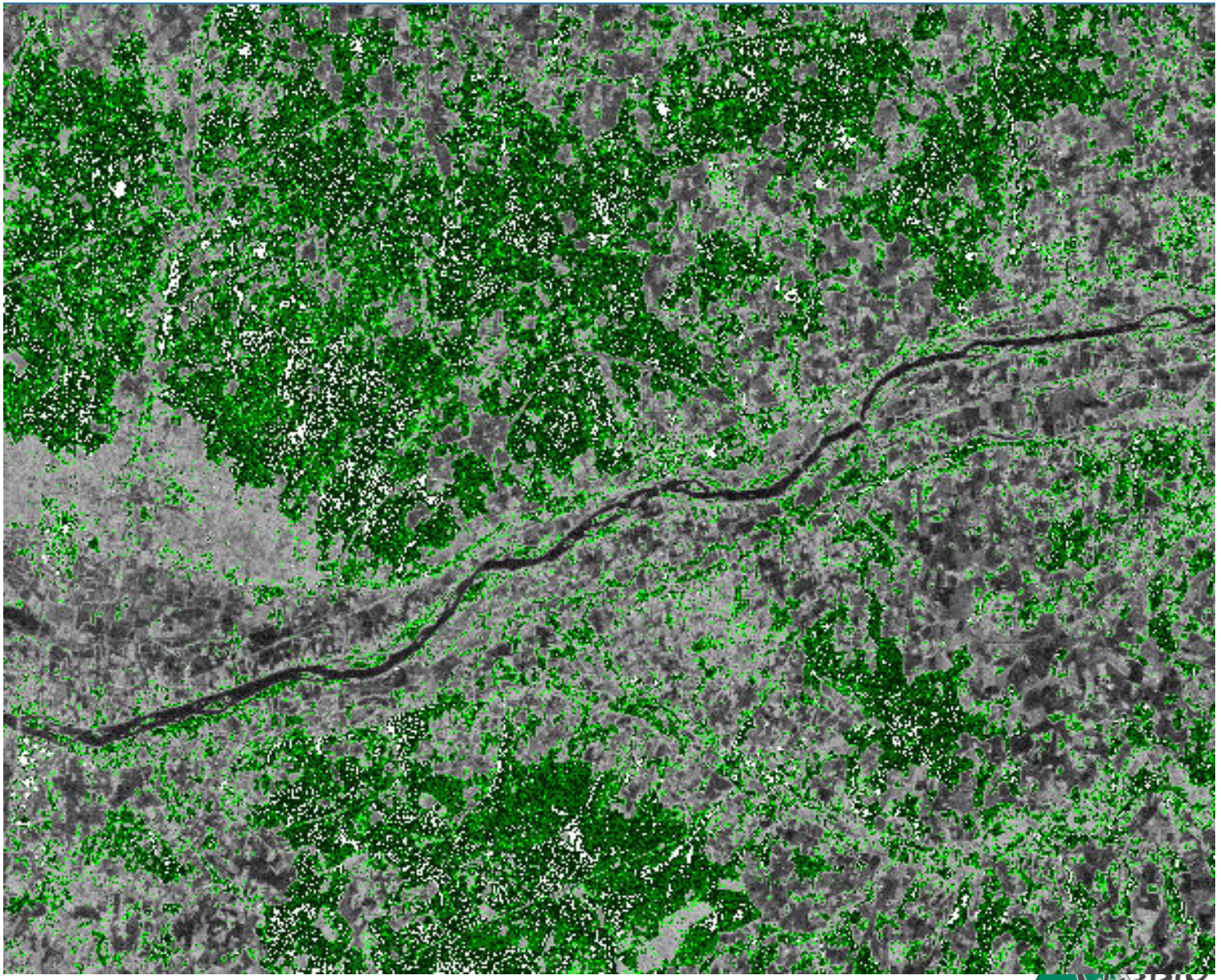
R: HH,
G: HV,
B: HV/HH

HV









Inversion using Bayesian approach

General formulation (Bayes theorem):

$$P(B \mid \sigma_0) = \frac{P(\sigma_0 \mid B)P(B)}{P(\sigma_0)}$$

Posterior PDF **P(B|σ0)** obtained by calculating marginal PDF w.r.t *« nuisance »* parameters

$$P(B \mid \sigma_0) \propto \left[\int_{B1}^{B2} P(\sigma_0 \mid B) \right] P(B)$$

The shape of the Posterior PDF **P(B|σ0)** will generally depend on the prior information about biomass

Different ways of expressing limits depending on information available:

1) **Hard boundaries** determined using in-situ measurements or validity regions of models used (express ignorance about details of PDF)

2) **PDF-model** on *a priori* information available for the inversion task at hand:

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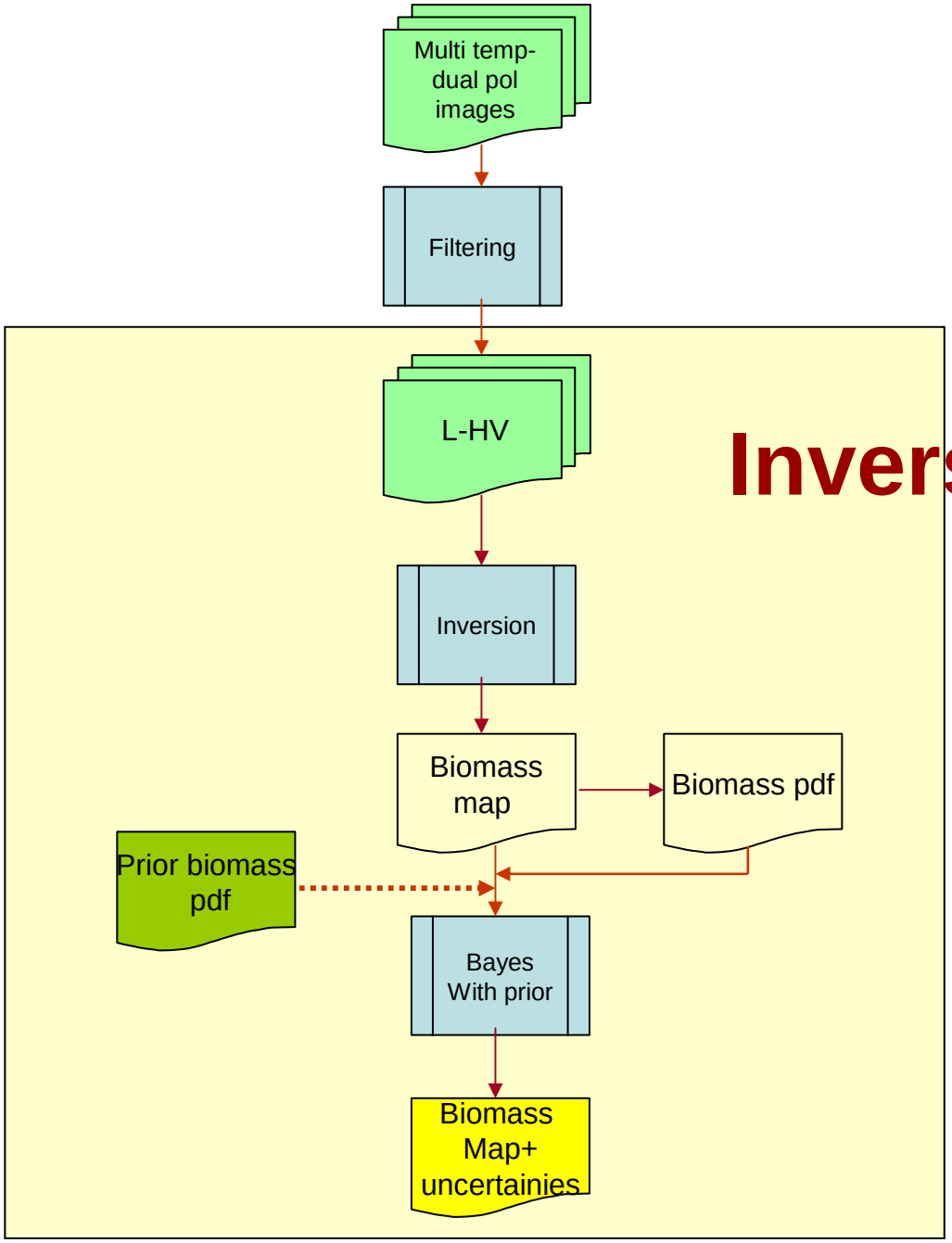
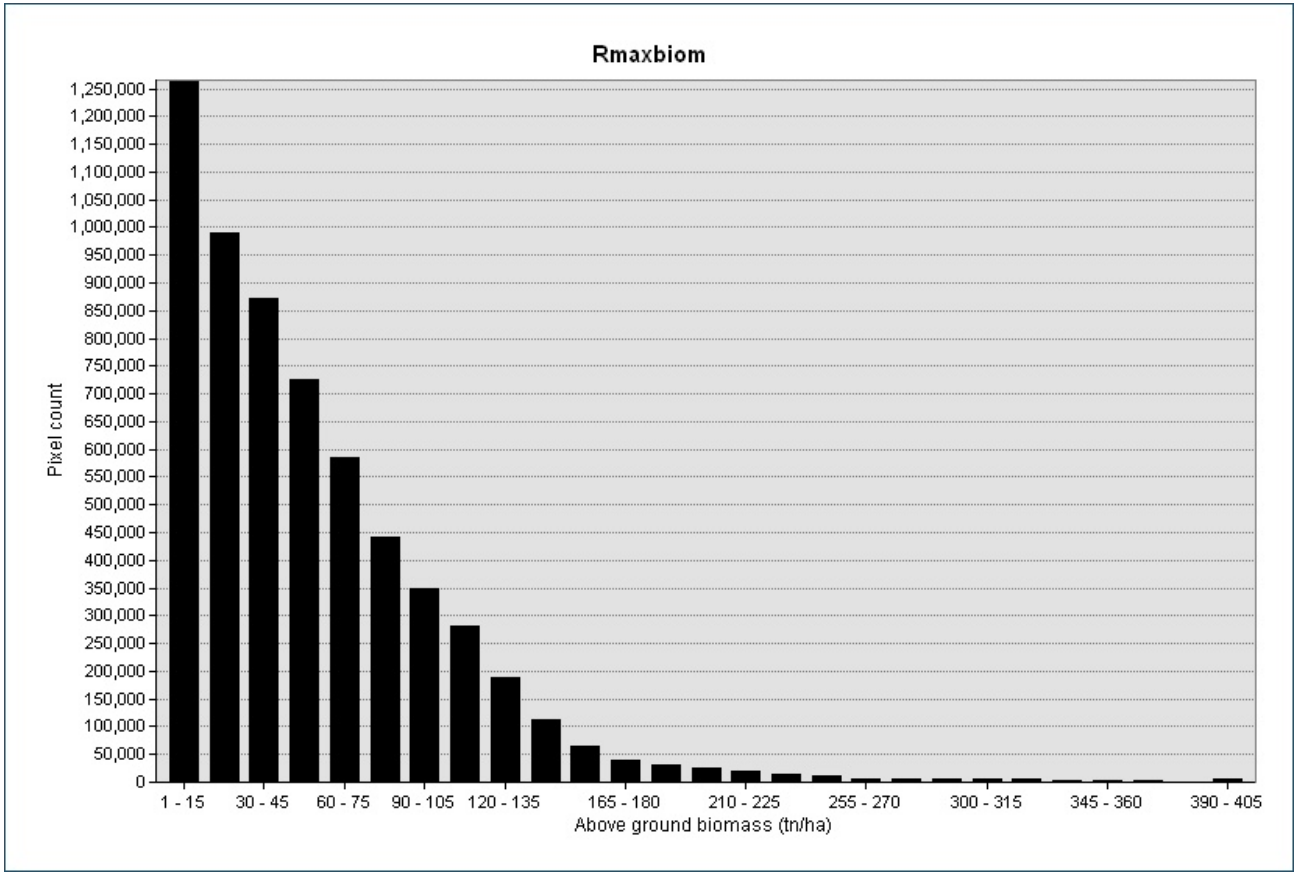
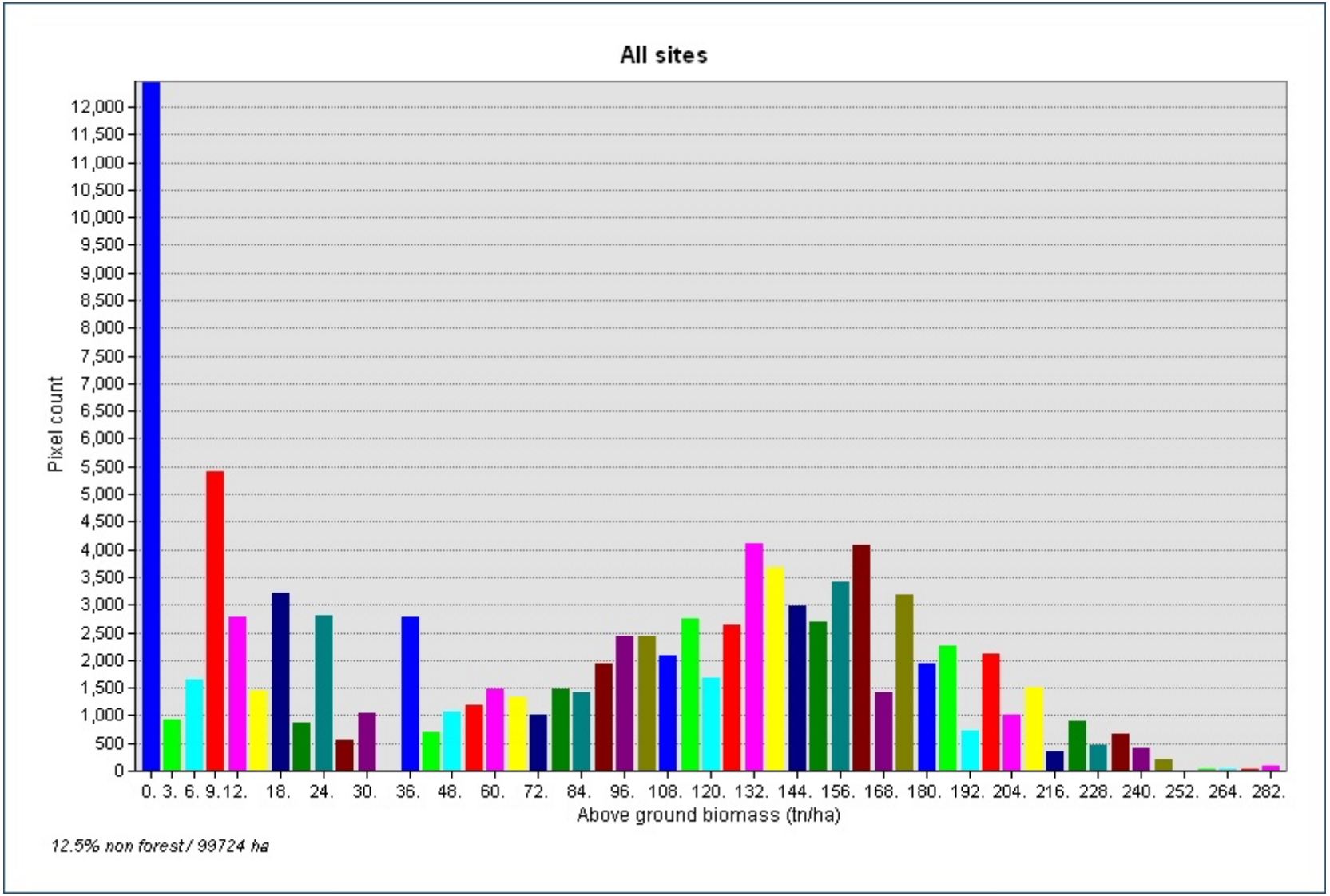
Inversion L-HV



Prior information on biomass pdf



Biomass distribution from Siberia databases



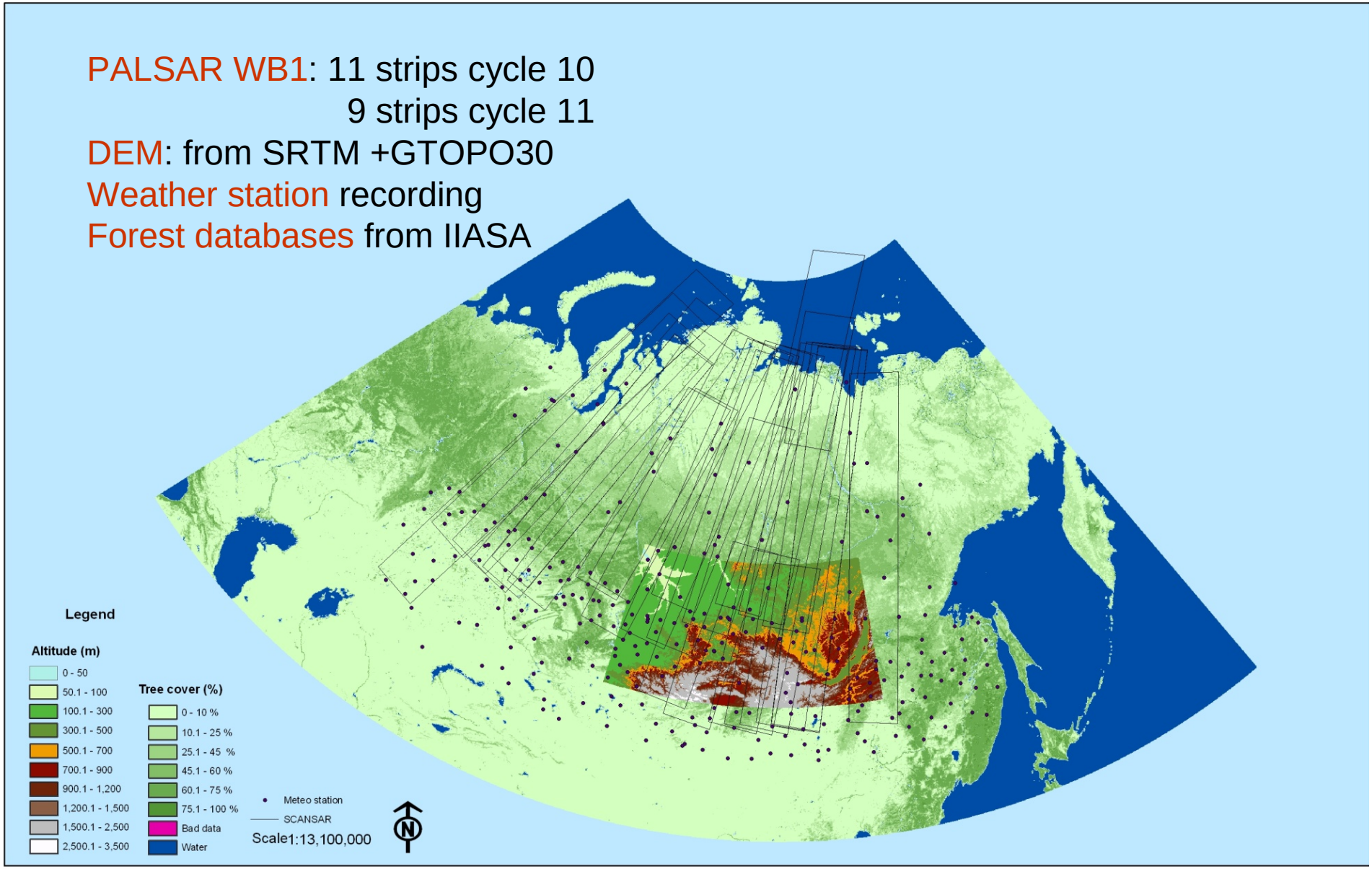
Analysis of PALSAR WB1 over Central Siberia

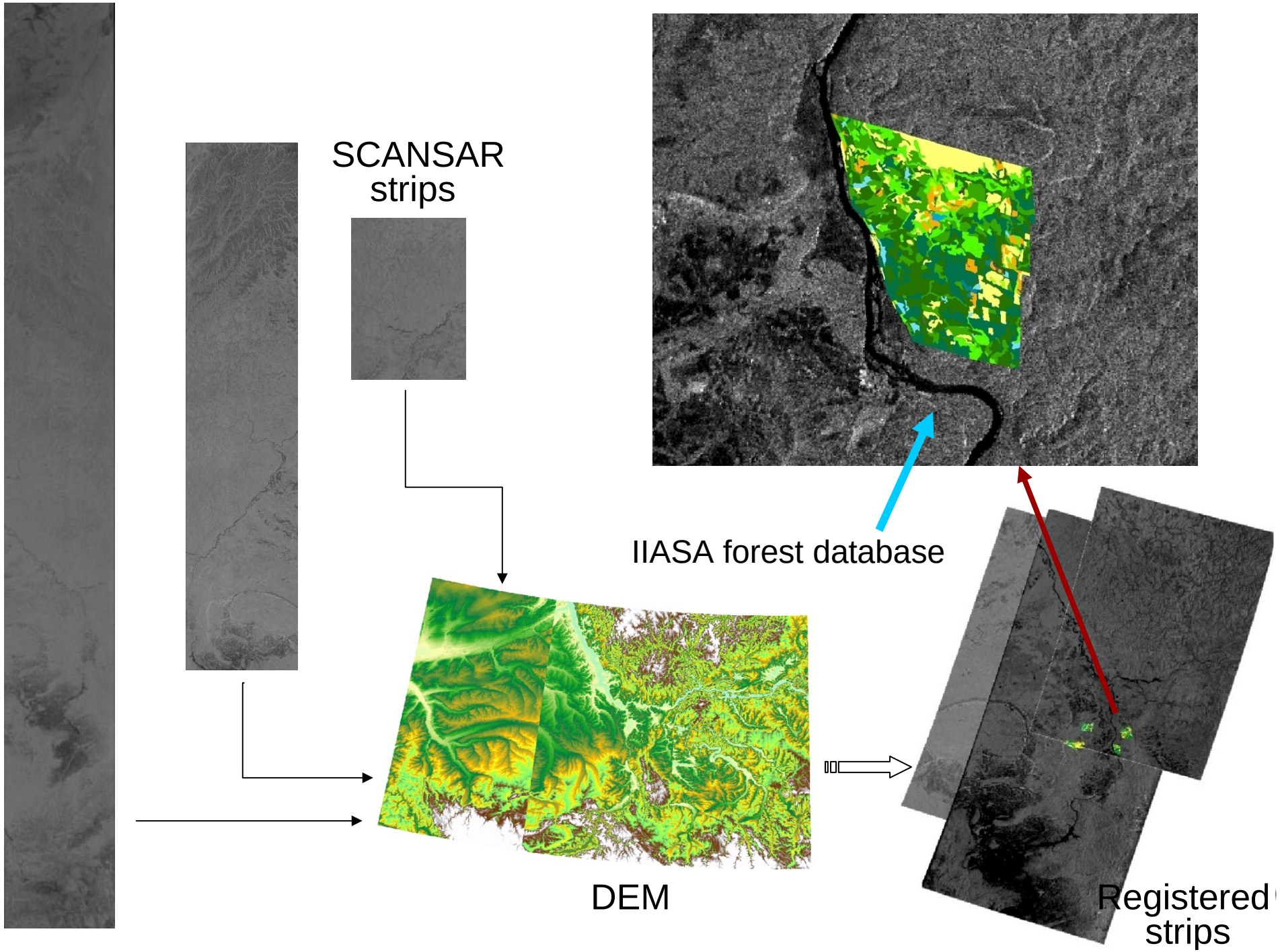
Q. Is it possible to have large scale forest and biomass map using ScanSAR L-HH?

Problems foreseen:
-L-HH affected by ground condition (weather, roughness)
-forest backscatter dynamic range can be reduced (<3 dB)
-Problems inherent to ScanSAR

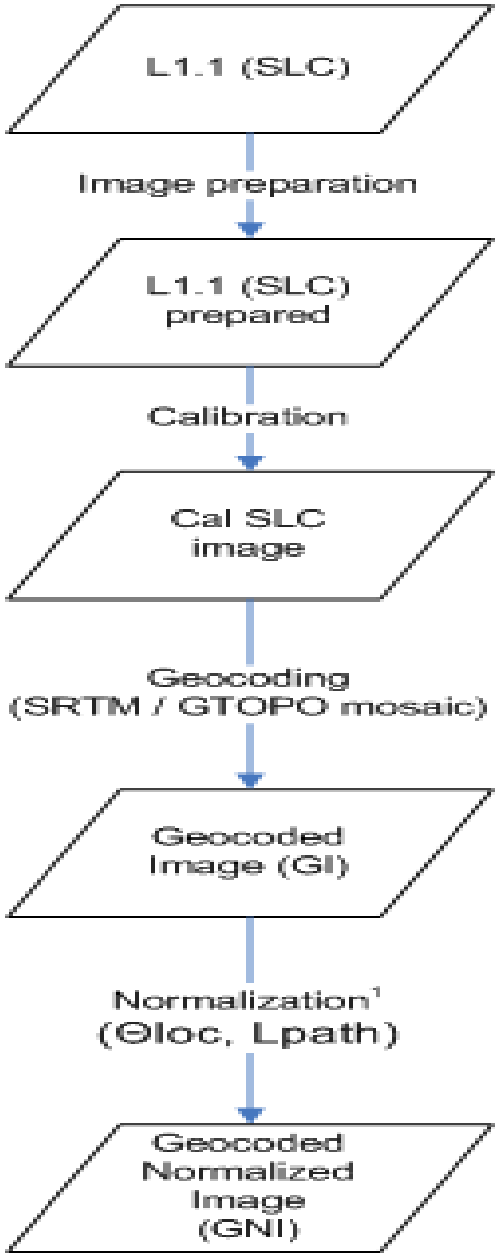
Siberia data sets

PALSAR WB1: 11 strips cycle 10
9 strips cycle 11
DEM: from SRTM +GTOPO30
Weather station recording
Forest databases from IIASA




SCANSAR
strips
IIASA forest database
DEM
Registered
strips

Data preparation



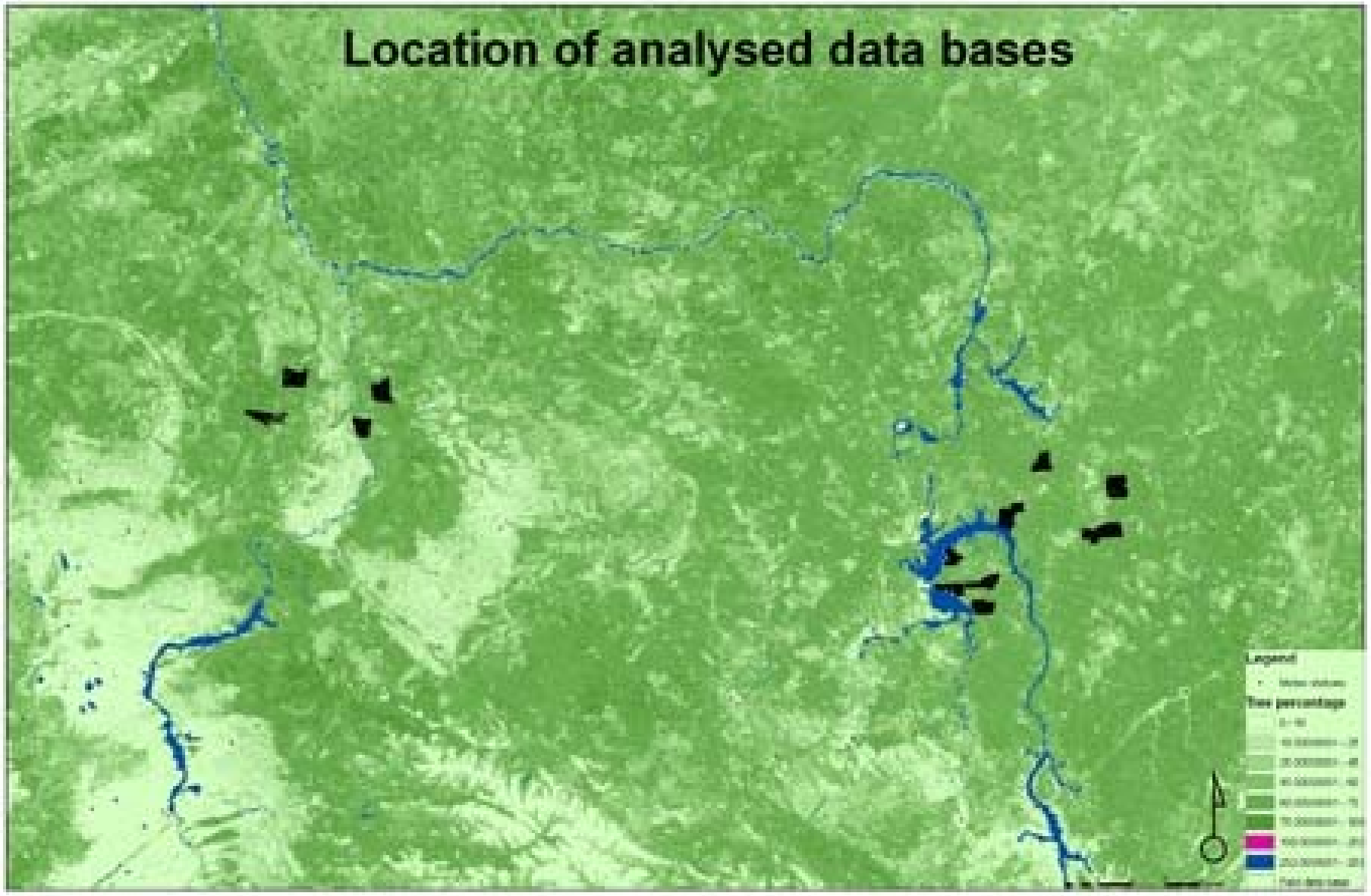
1 **Local incidence angle**

$Y_{loc} = GI * pix * [\cos(\Theta i) / \cos(\Theta loc)]$

Angular decrease correction

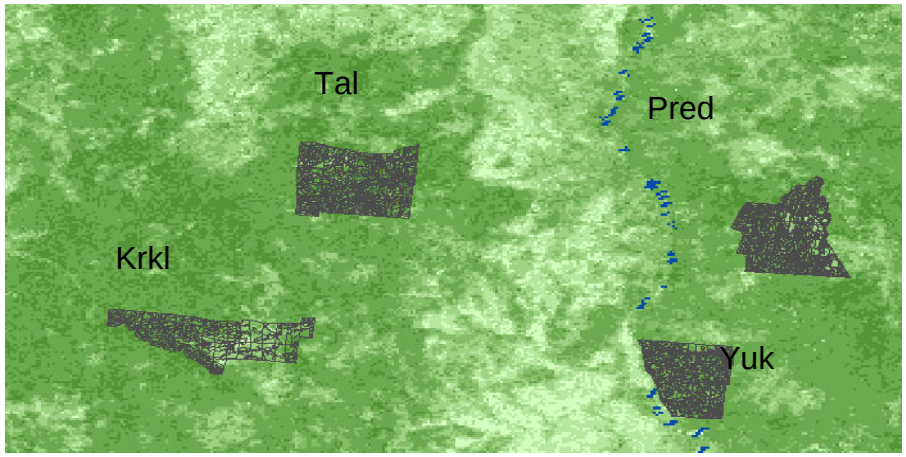
$Yi = Y_{loc} * [\cos(\Theta loc)/\cos(\Theta i)]^{n}$

Data analysis vs forest databases

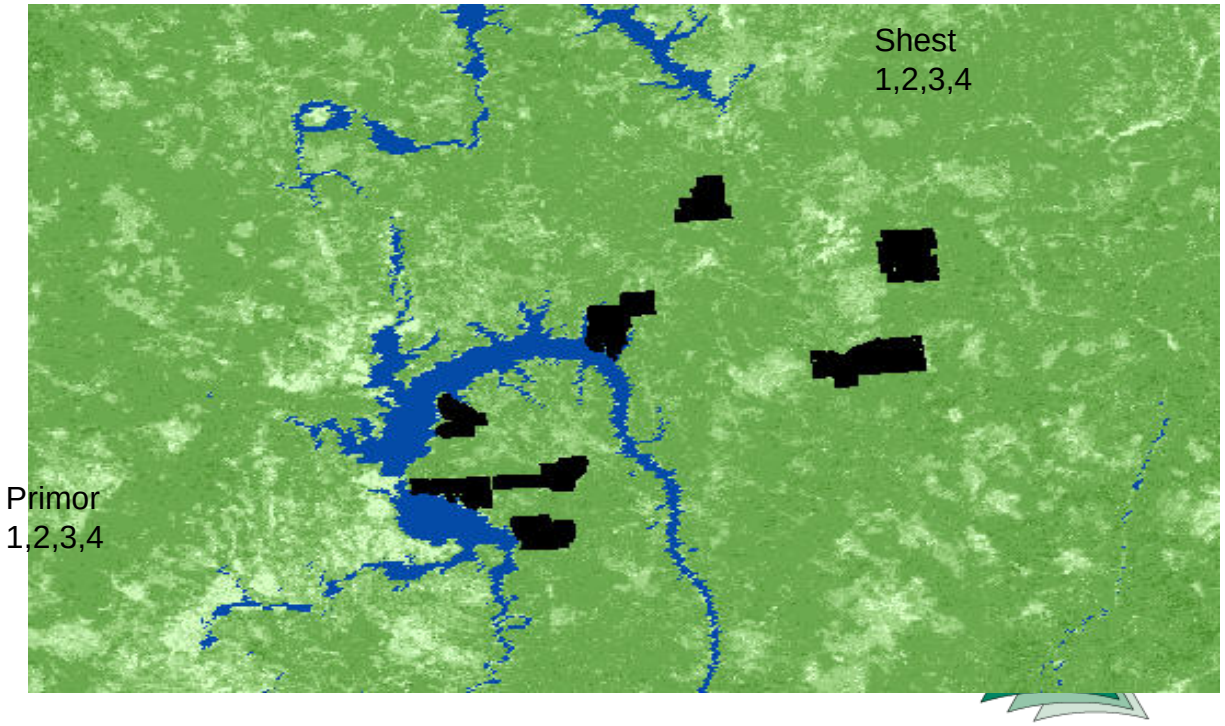


Data analysis vs forest databases

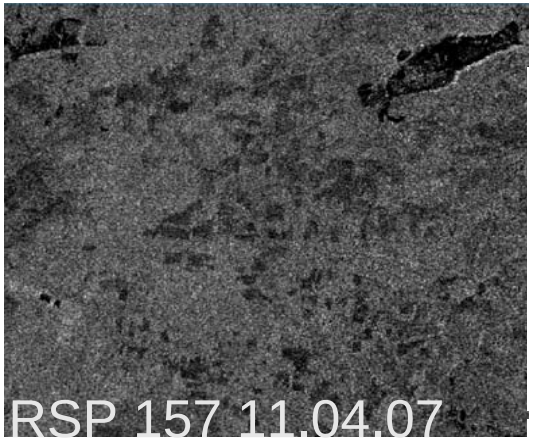
Bolshe Murtinski

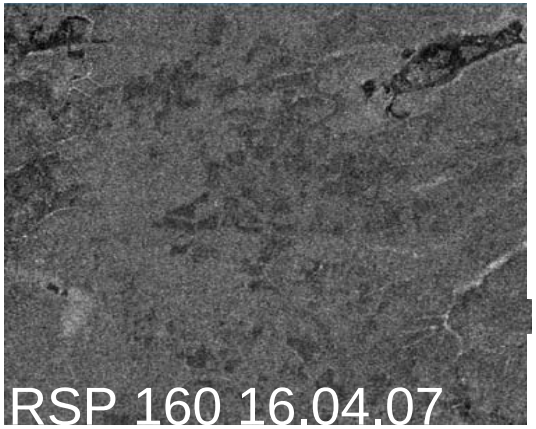


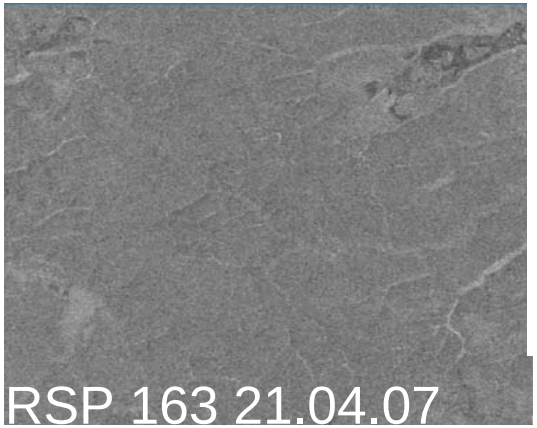
Shestak Primorski

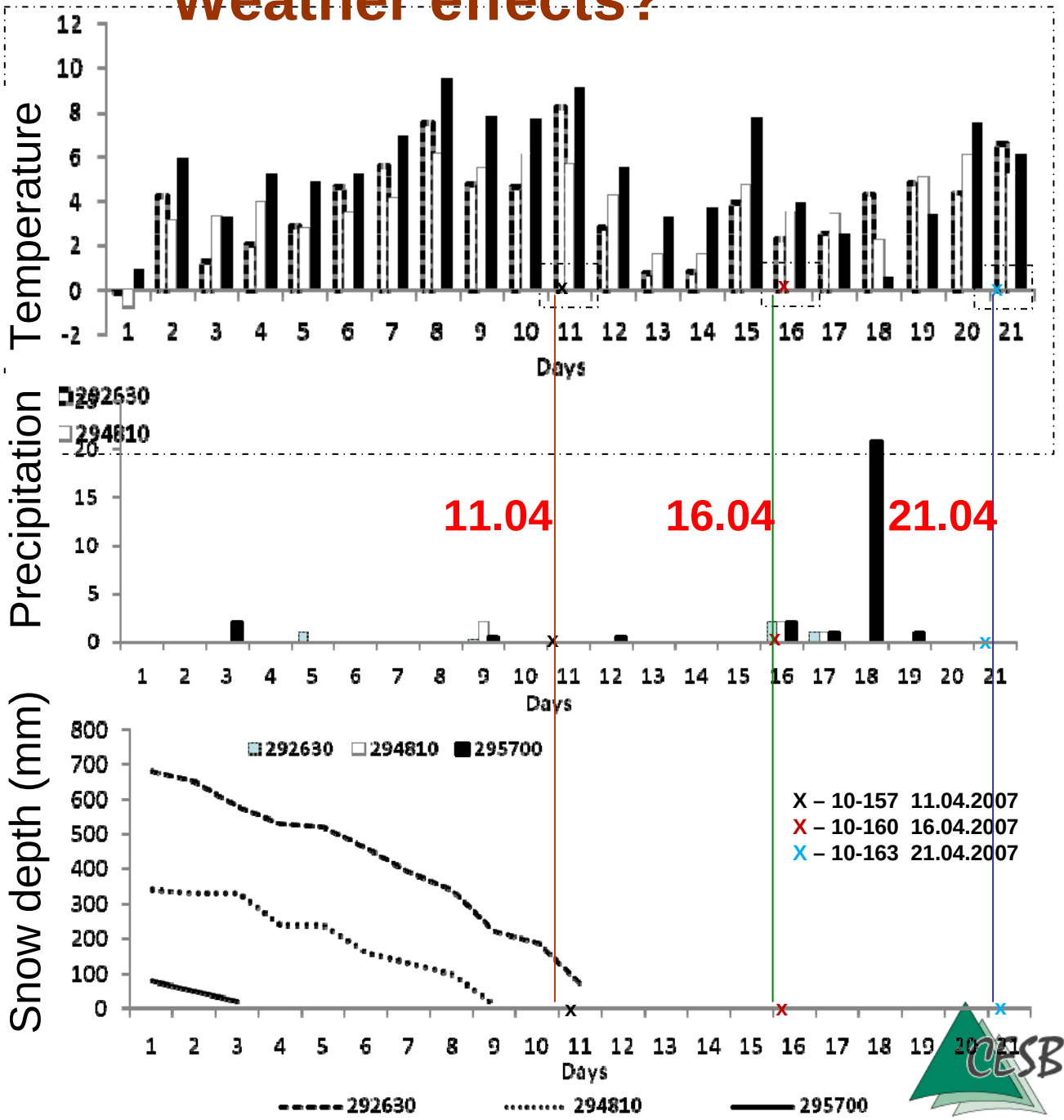


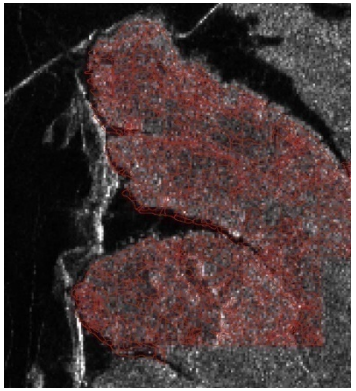
Weather effects?





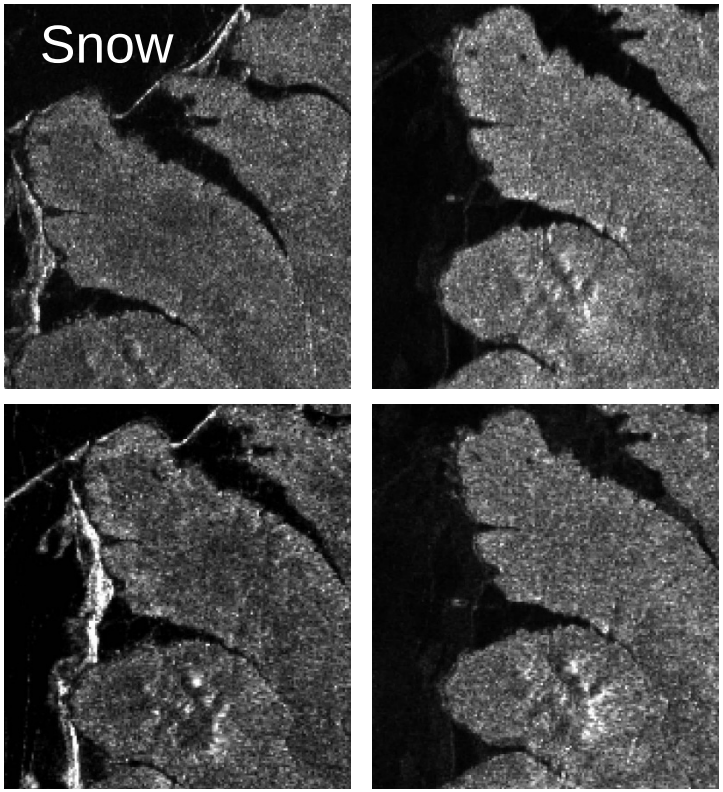


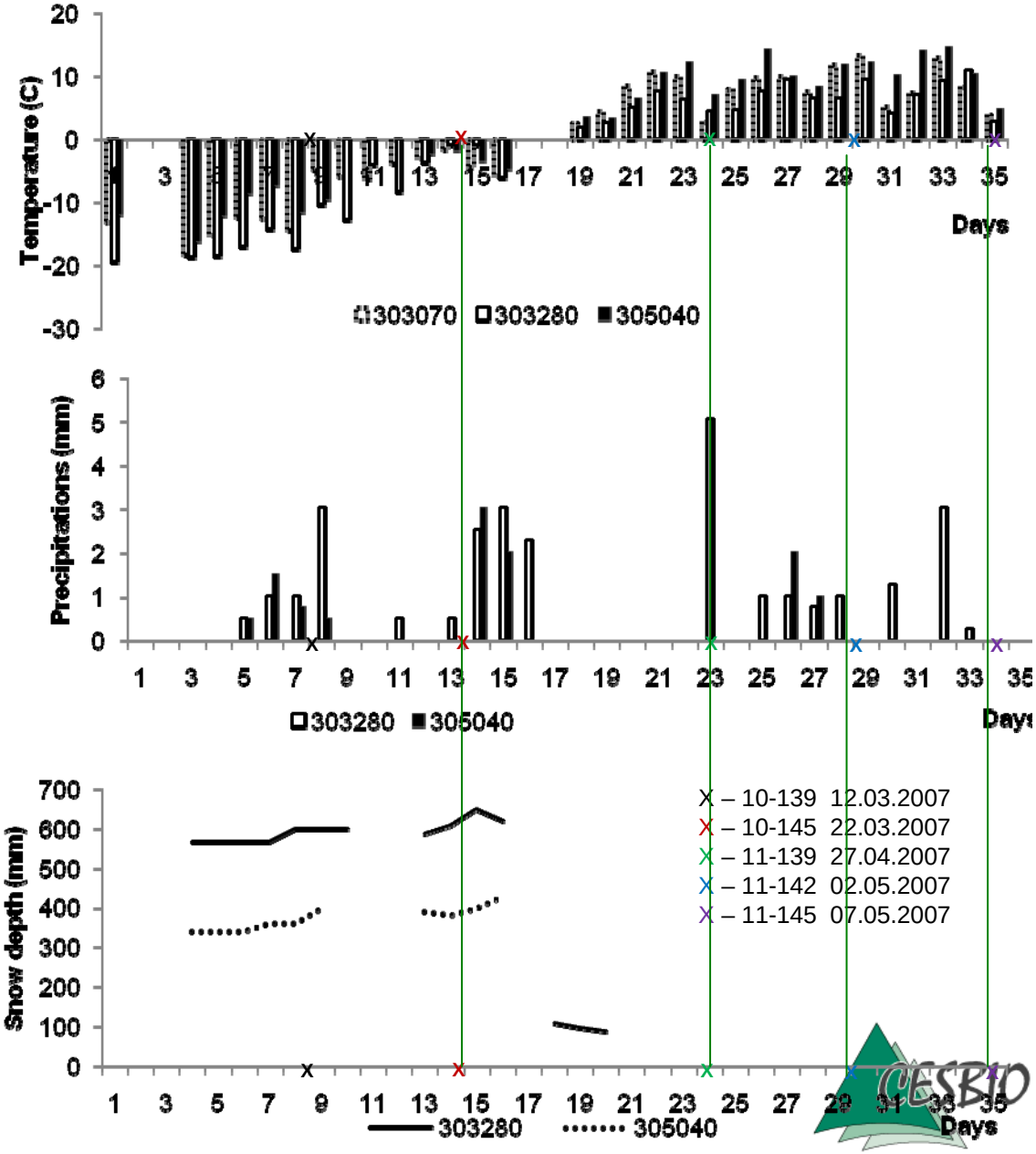




Rain

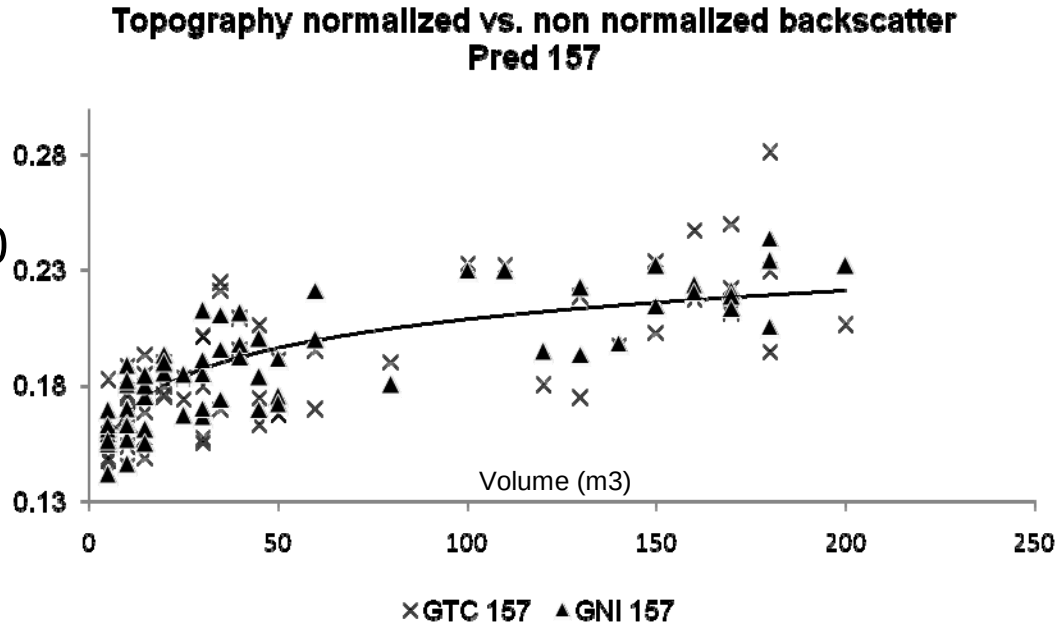
Snow

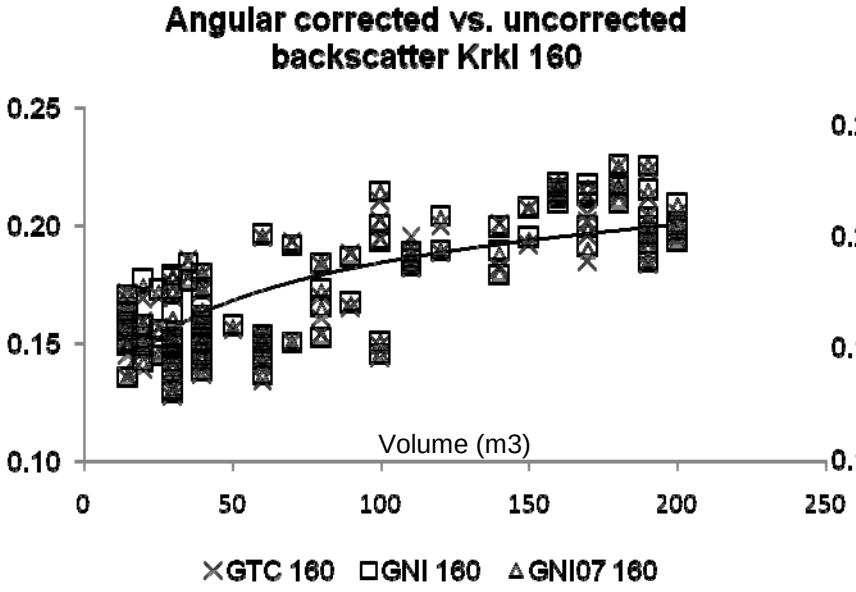


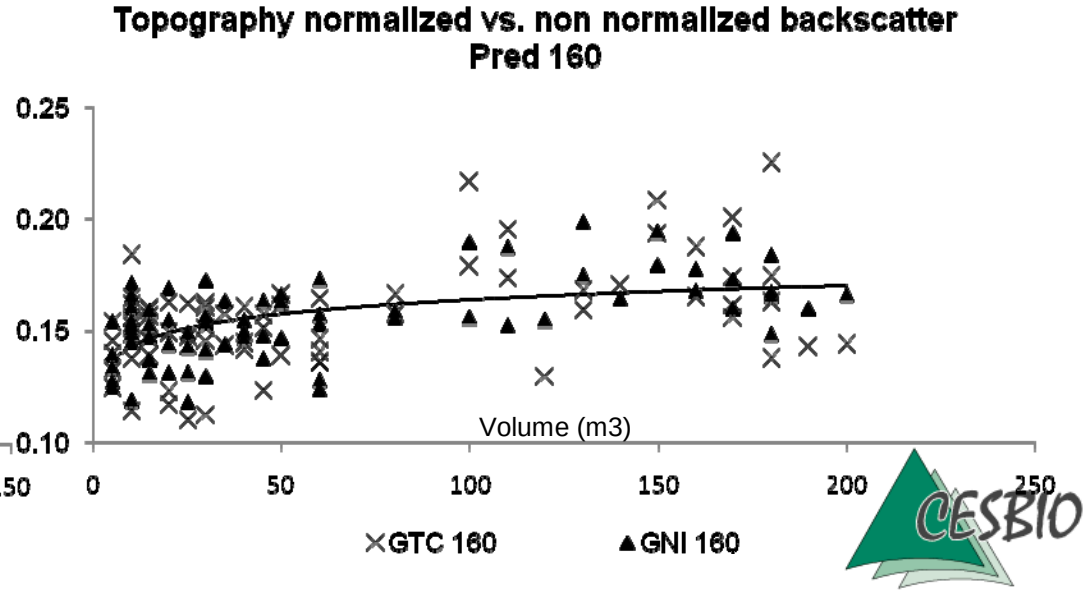

Temperature (C)
Days
303070 303280 305040
Precipitations (mm)
303280 305040
Snow depth (mm)
X – 10-139 12.03.2007
X – 10-145 22.03.2007
X – 11-139 27.04.2007
X – 11-142 02.05.2007
X – 11-145 07.05.2007
303280 305040
Days

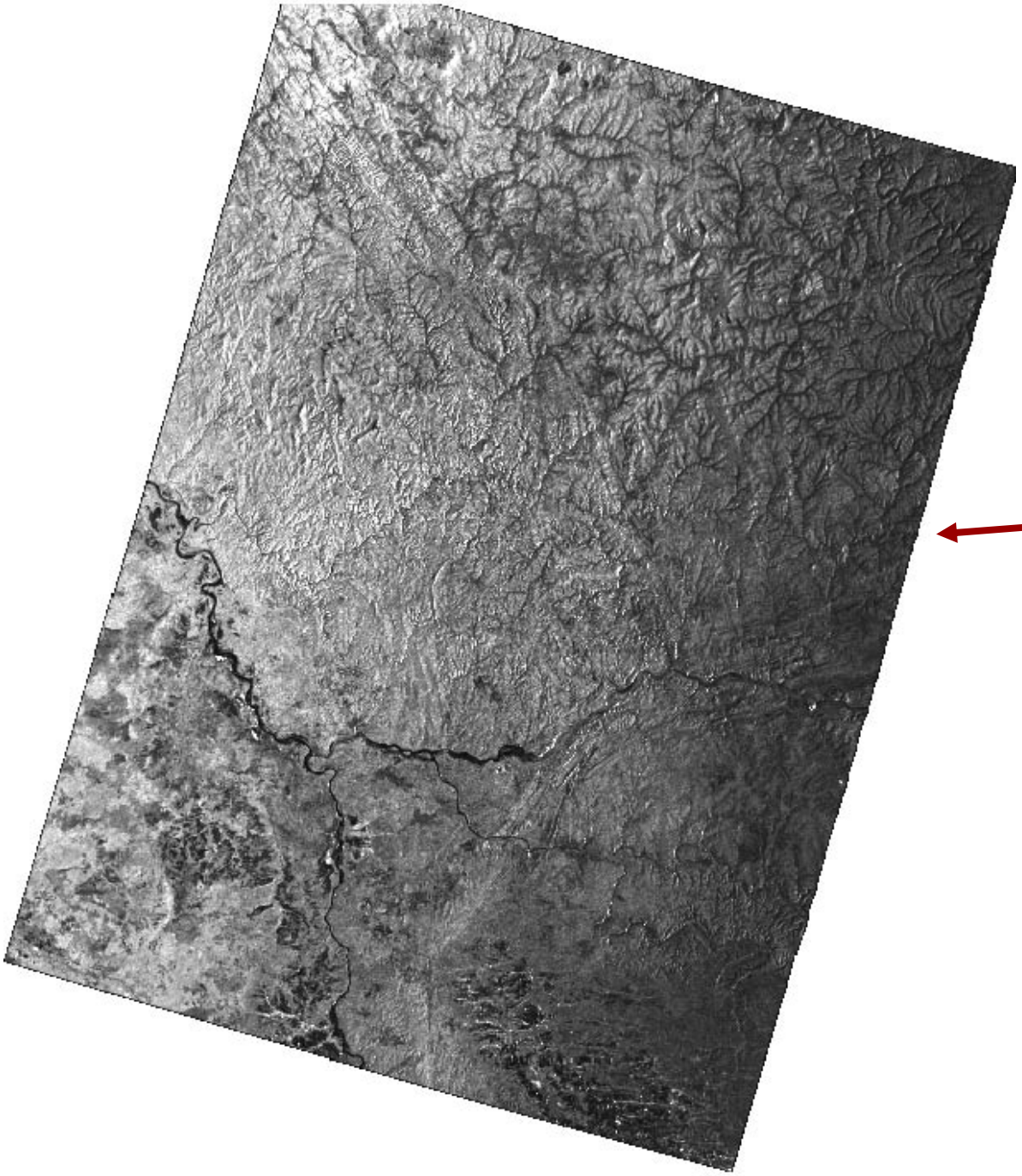
Angular effect normalisation

- Forest stands over 35 ha
- Volumes between 10 and 200 m3
- Eight images
- Two regions
- Eleven databases





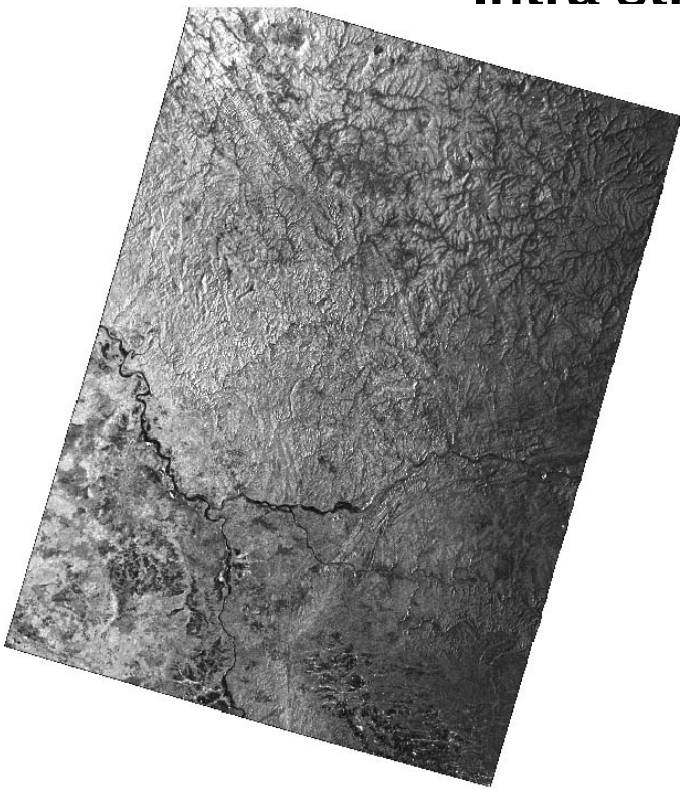




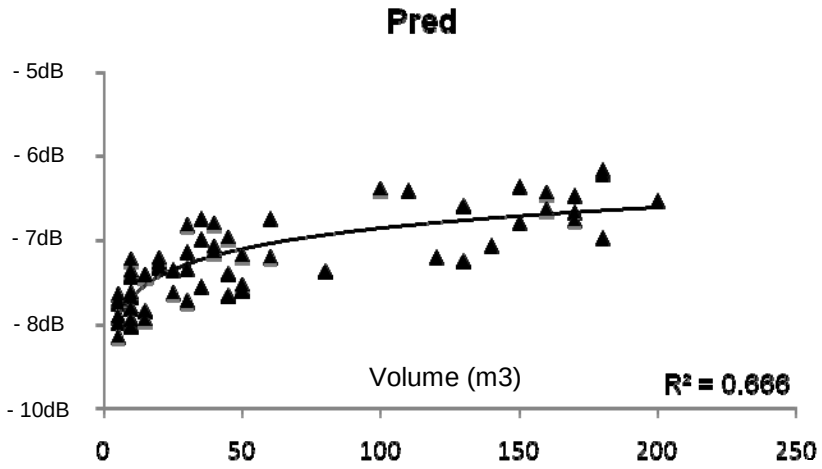
RSP 10-157

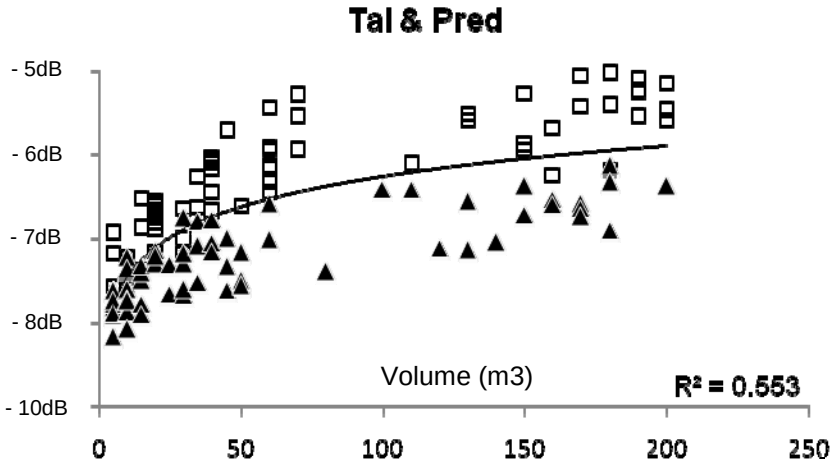
Near range

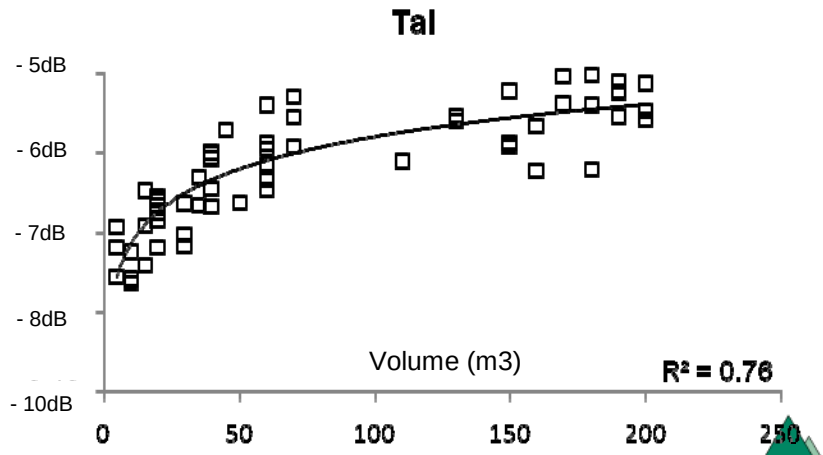
Intra strip variability



RSP 10-157

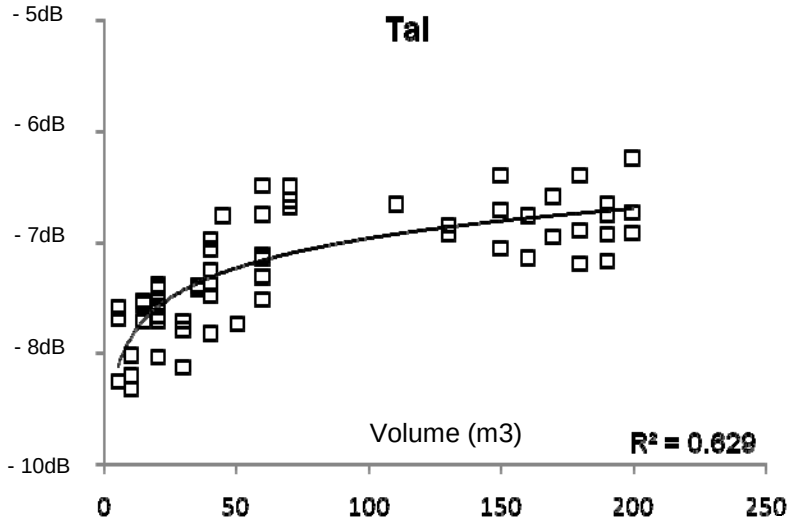


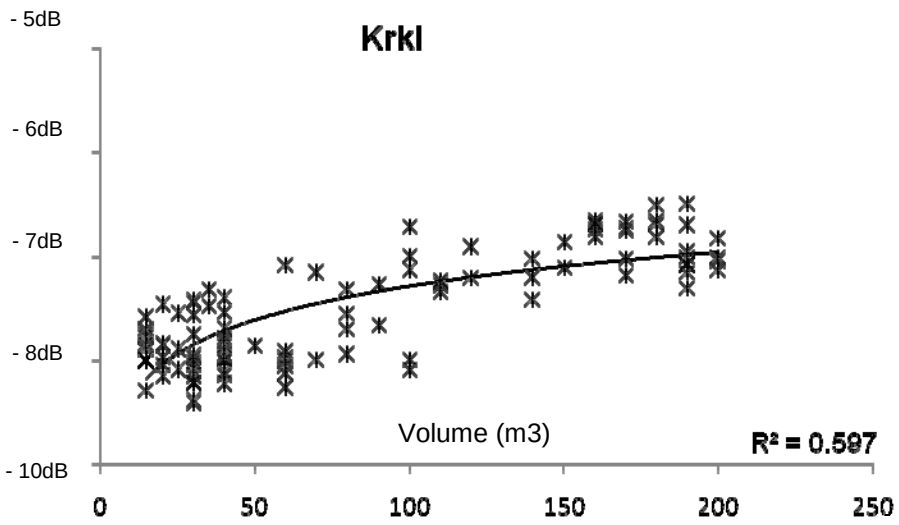


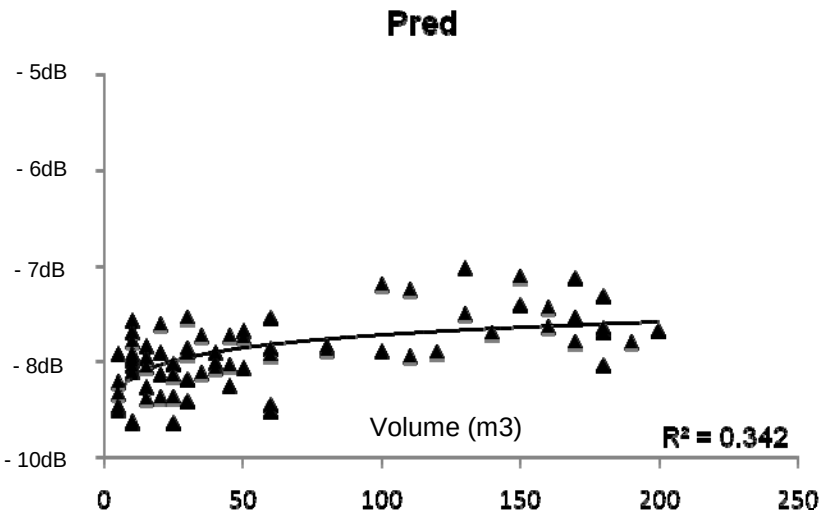


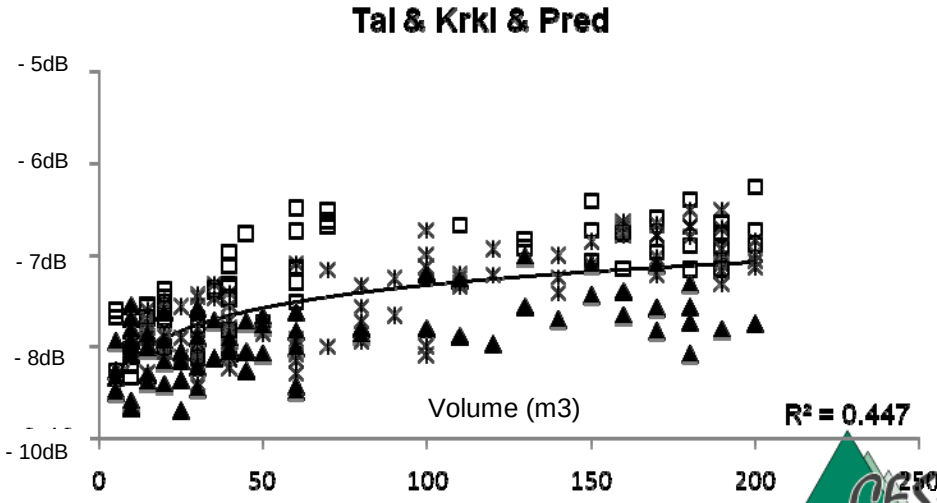
Intra strip variability

RSP 10-160

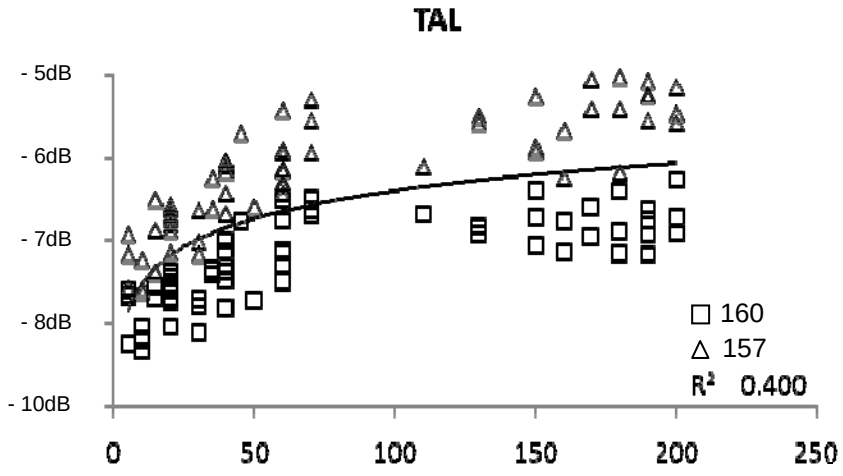


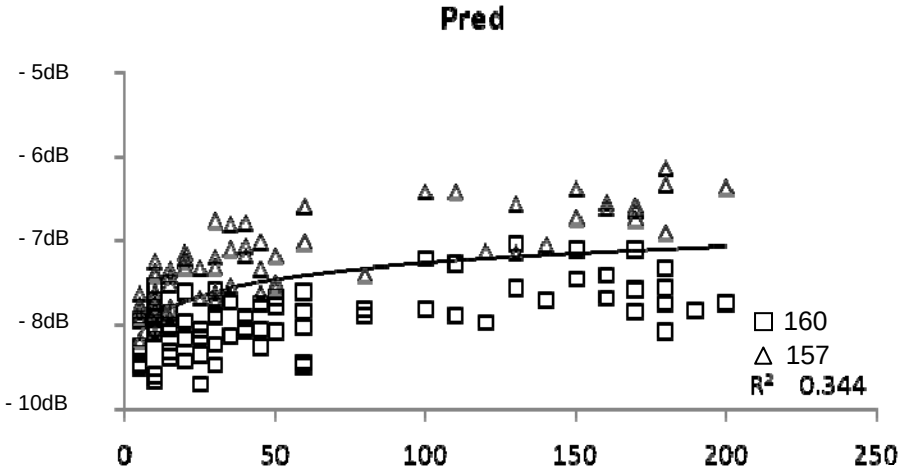


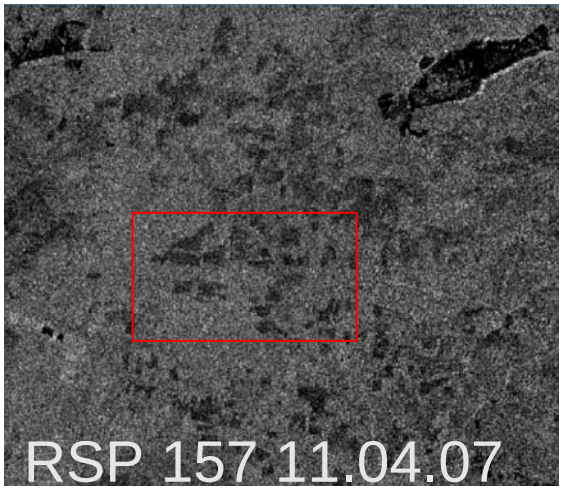


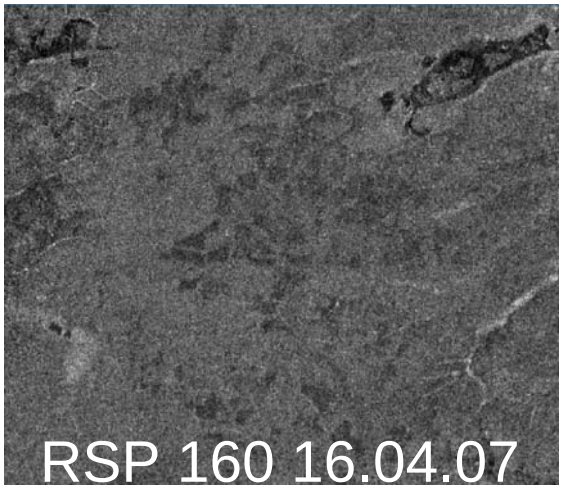


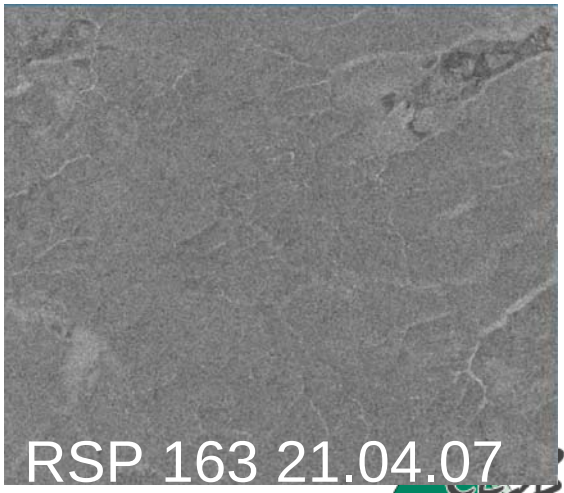
Inter-images variability



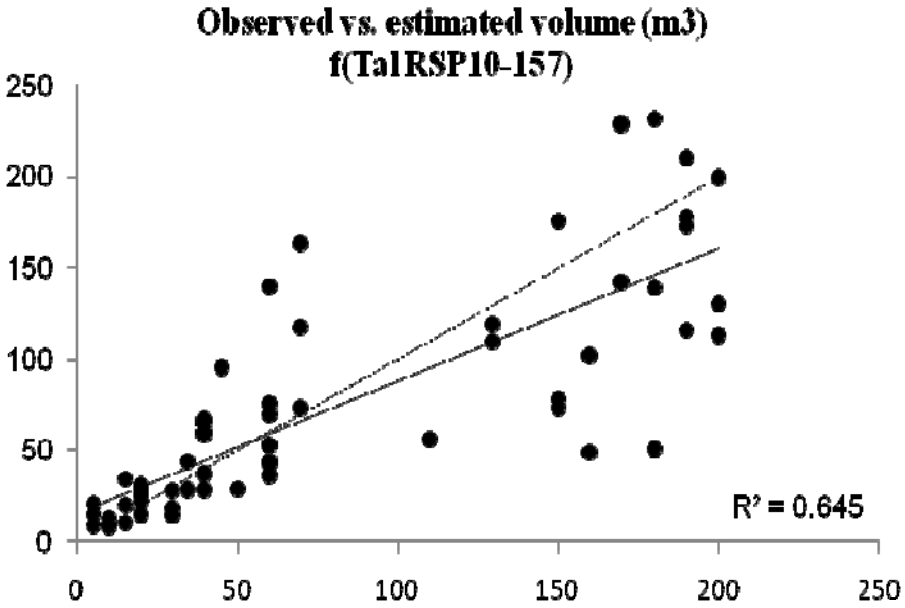


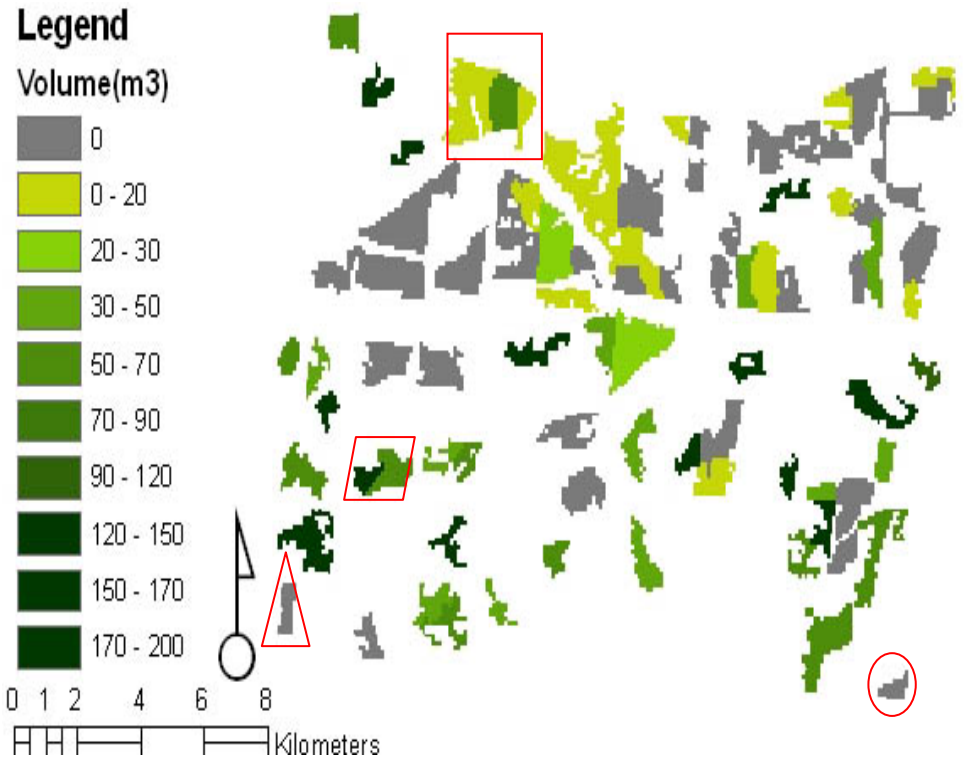




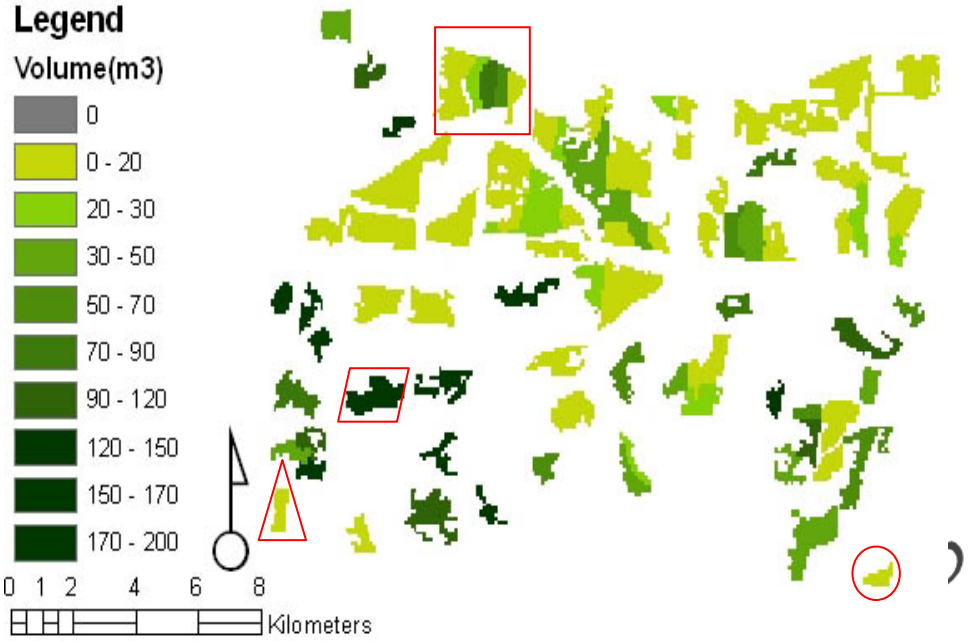


Forest GIS database



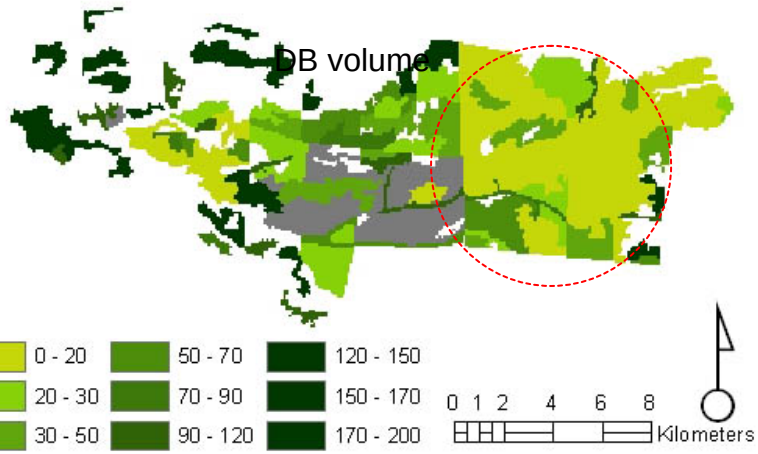


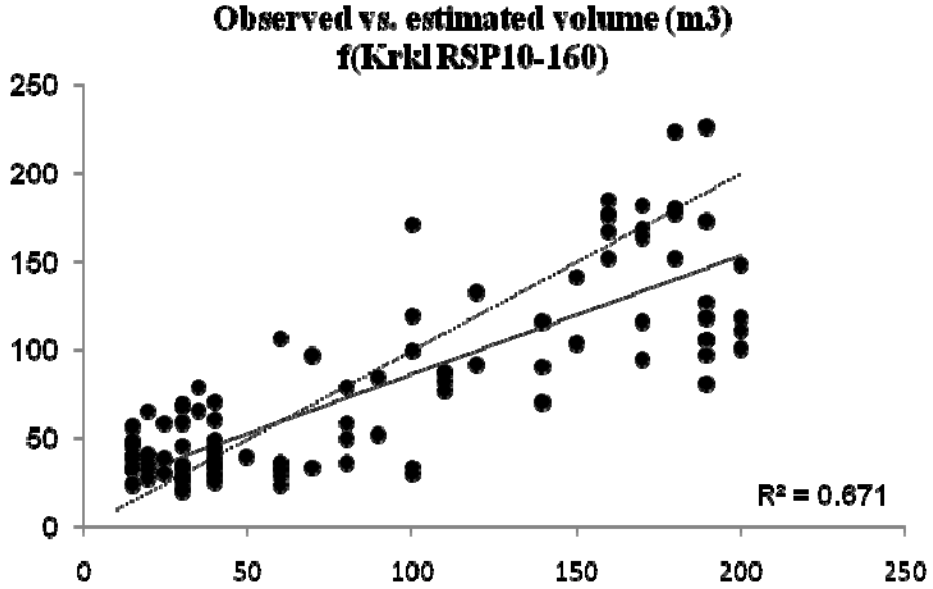
Palsar inversion



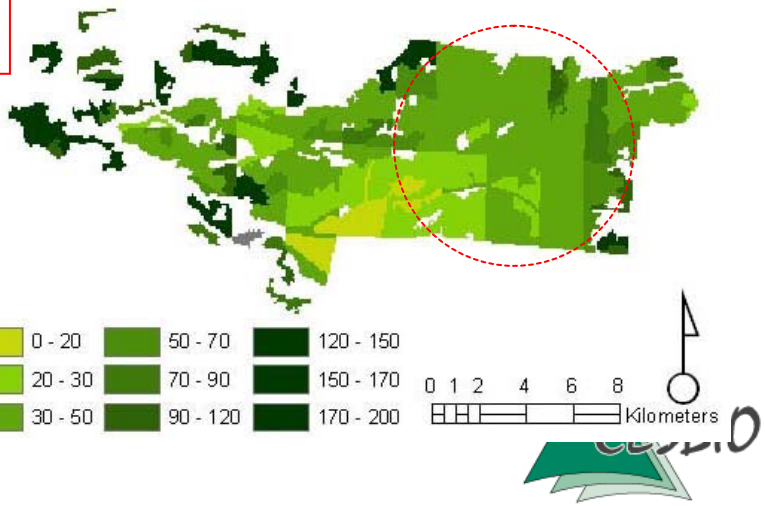
Estimated volume f(Tal 10-157) ,157

Forest GIS database





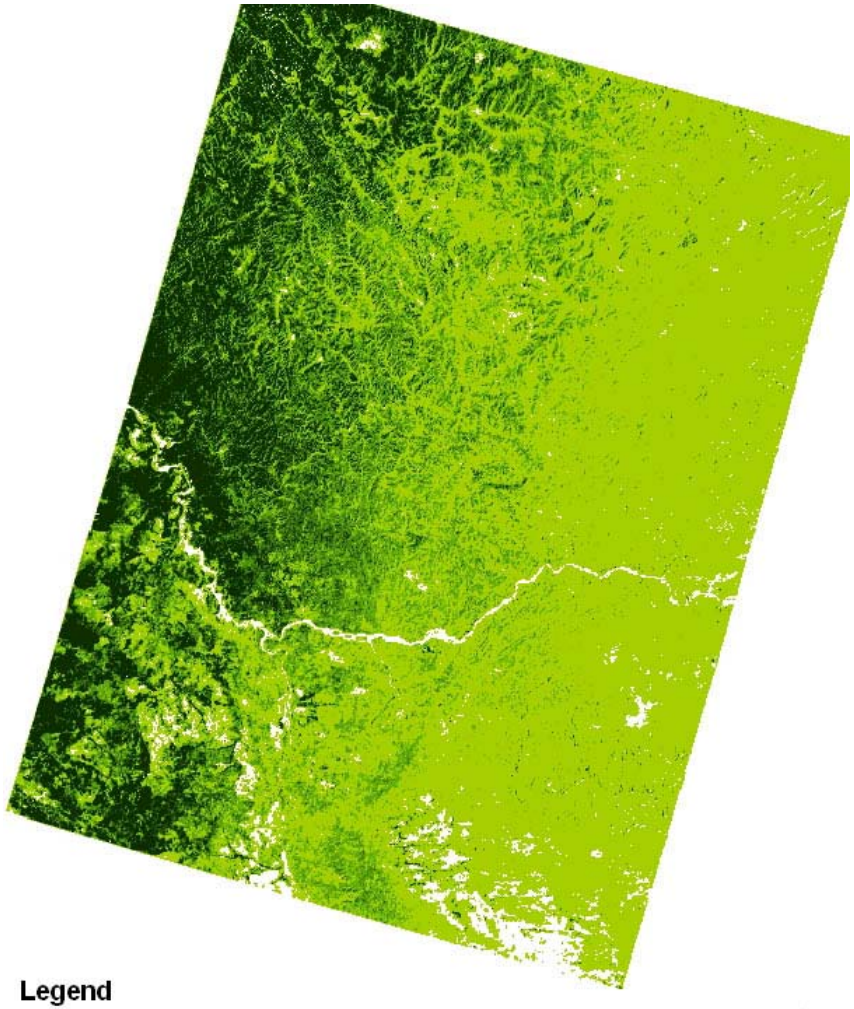
Estimated volume – f(Krkl 10-160) , 160

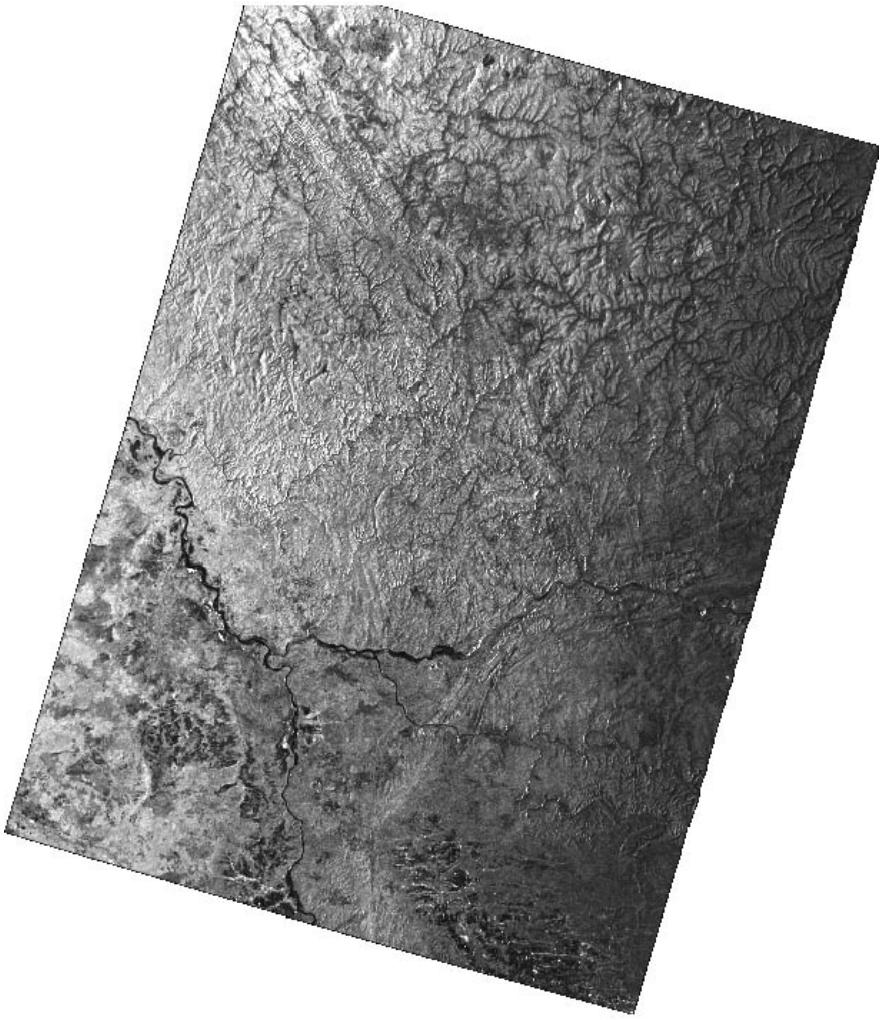


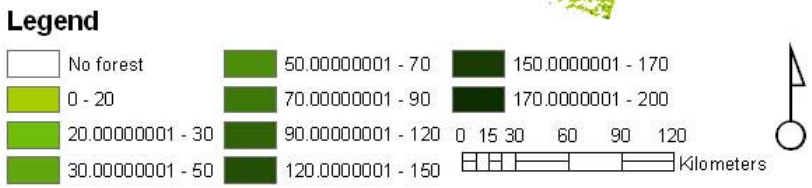
PALSAR WB1 inversion

Pixel based inversion

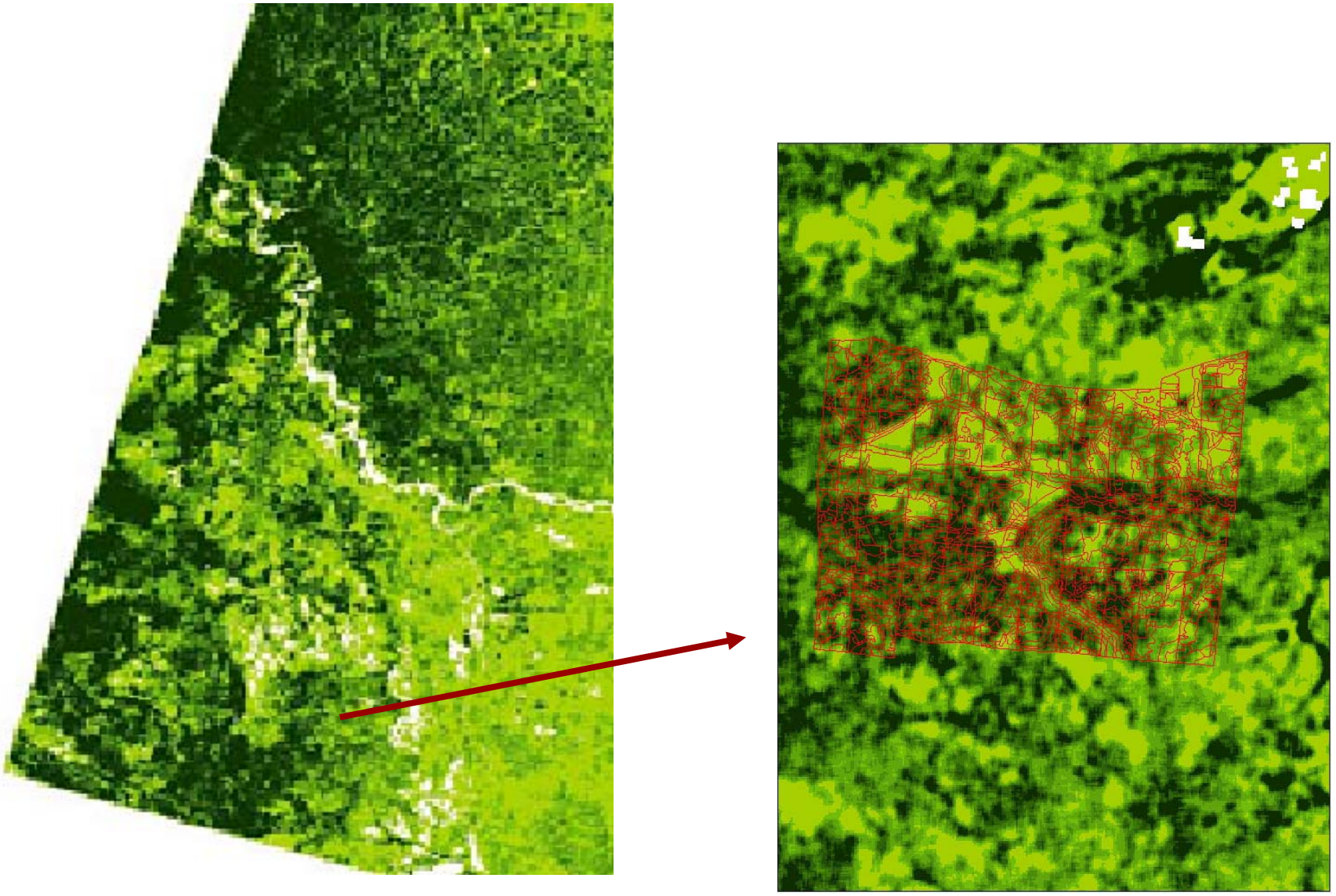
Inversion of RSP10-157







CESBIO



Legend

Volume(m3)

0	0 - 20	50 - 70	120 - 150
	20 - 30	70 - 90	150 - 170
	30 - 50	90 - 120	170 - 200

CESBIO

Remarks on Scansar data (1)

Image quality:

- Errors of up to 10 pixels in near range while geocoding Scansar strips,
- Near range lower radiometry: reprocessing ?
- Large temporal variation: Winter acquisition promising. Waiting for Summer data from cycles 12,13,14

Processing:

- Radiometric distortions due to slope effect reduced using SRTM data (> 60° no forest database)

Remarks (2)

Biomass analysis

- **Sources of error**:
  - coregistration databases and GIS
  - errors of databases (need to be updated)
  - errors in radiometry (e.g. near range)
- **Analysis results**
  - effect of weather, inter and intra strips (need multi-temporal, summer passes)
  - increase of L-HH with biomass: at least few classes of biomass could be mapped
- **Inversion**
  - Depending on the direct relations used: need strategy for
    - adapting relationships to strip data
    - dealing with intra strip weather conditions. Chose best data? Cutting in tiles?
  - Pixel based inversion: multi-temporal data filtering will improve