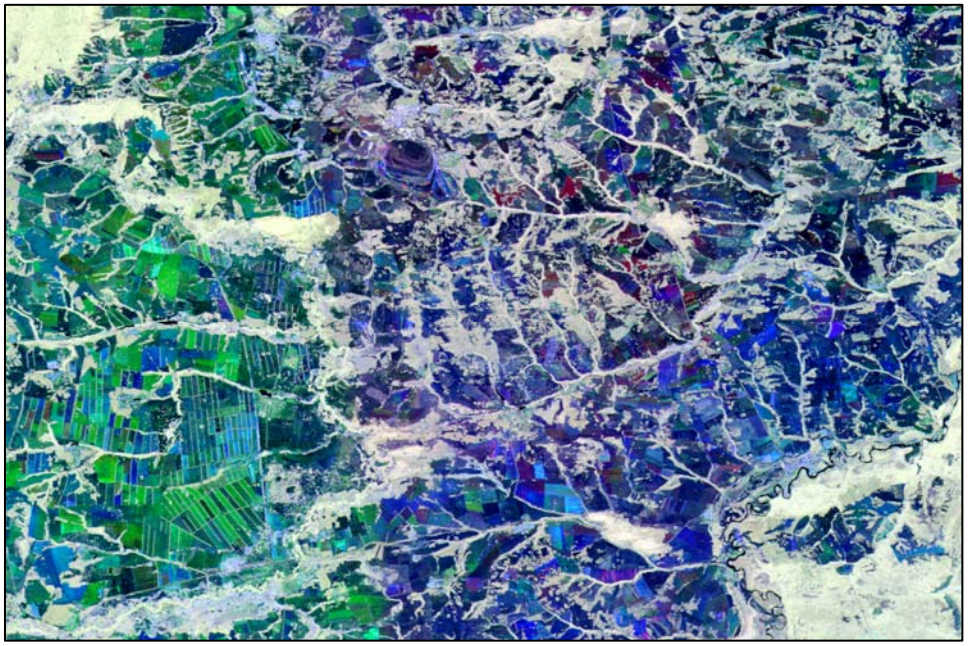
Completion of work from Phase 1

Forestry Theme
Central Siberia



Friedrich-Schiller-University Jena, GAMMA Remote Sensing

seit 1548

GAMMA REMOTE SENSING

Outline

- Subtask 1: (Collecting ground data and deliver to JAXA if requested)
- SAR Data processing and mosaicing
- Subtask 2: (Developing methodology for mapping of forest cover, deforestation and other disturbances)
- Subtask 3: (Developing methodology for product validation and accuracy estimation)
- Subtask 4: (Generating Prototype area maps of: forest and land cover, annual changes in forest cover, maps of deforestation; provide accuracies)

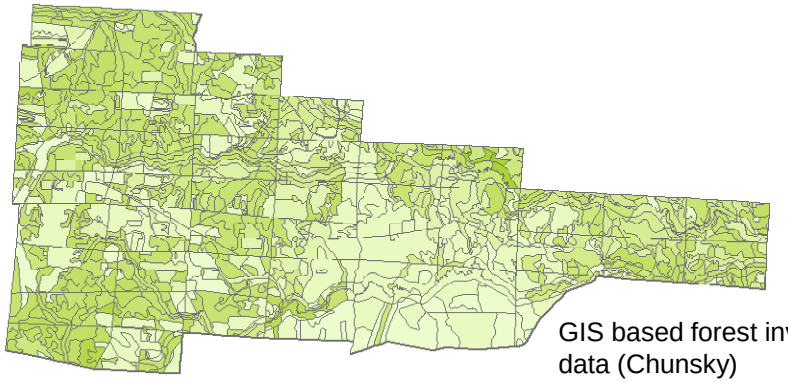
Outline

- "Subtask 1" (Collecting ground data and deliver to JAXA if requested)
- SAR Data processing and mosaicing
- "Subtask 2" (Developing methodology for mapping of forest cover, deforestation and other disturbances)
- "Subtask 4" (Generating Prototype area maps of: forest and land cover, annual changes in forest cover, maps of deforestation; provide accuracies)
- "Subtask 3" (Developing methodology for product validation and accuracy estimation)

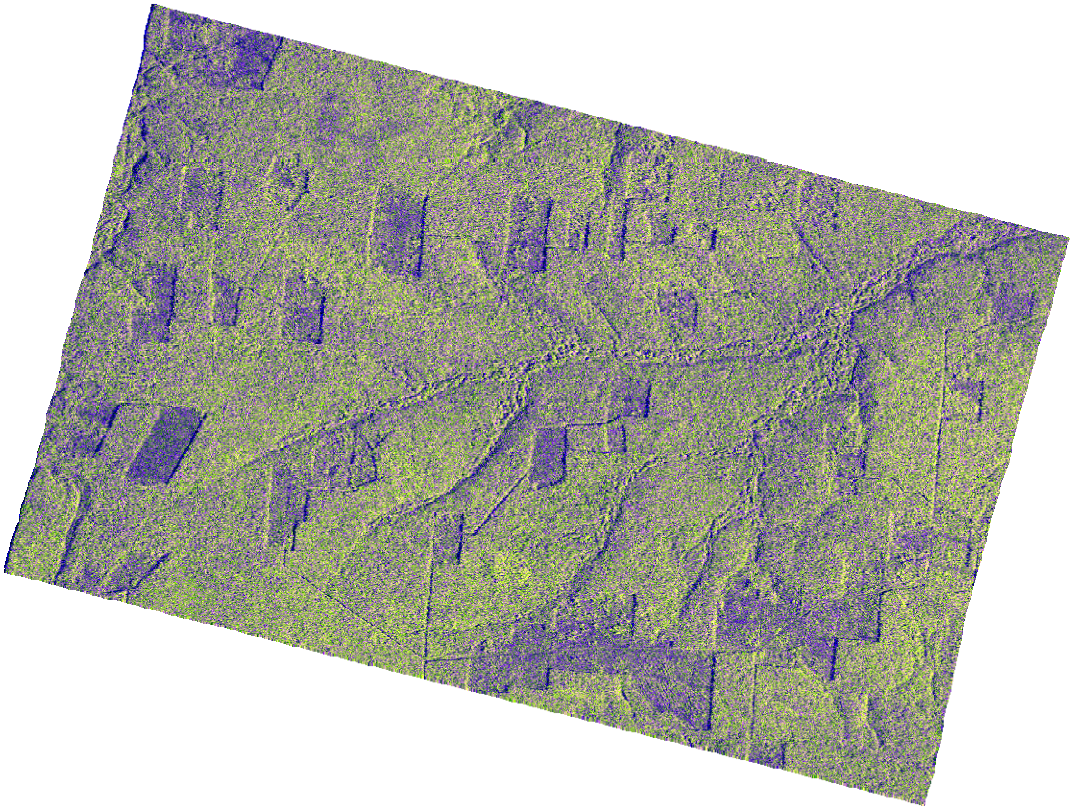
FSU JENA, GAMMA RS

- **Collecting ground data and deliver to JAXA if requested**
  - Present status: completed
  - Deliverables: ground data if requested

Example of HR EO data (QuickBird), taken from Google Earth

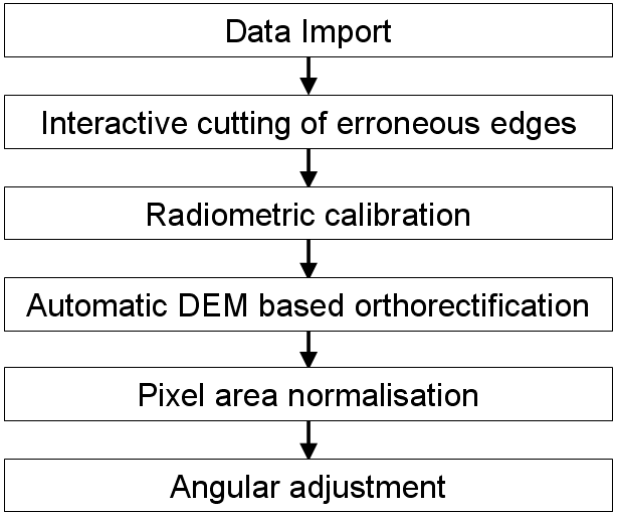


GIS based forest inventory data (Chunsky)

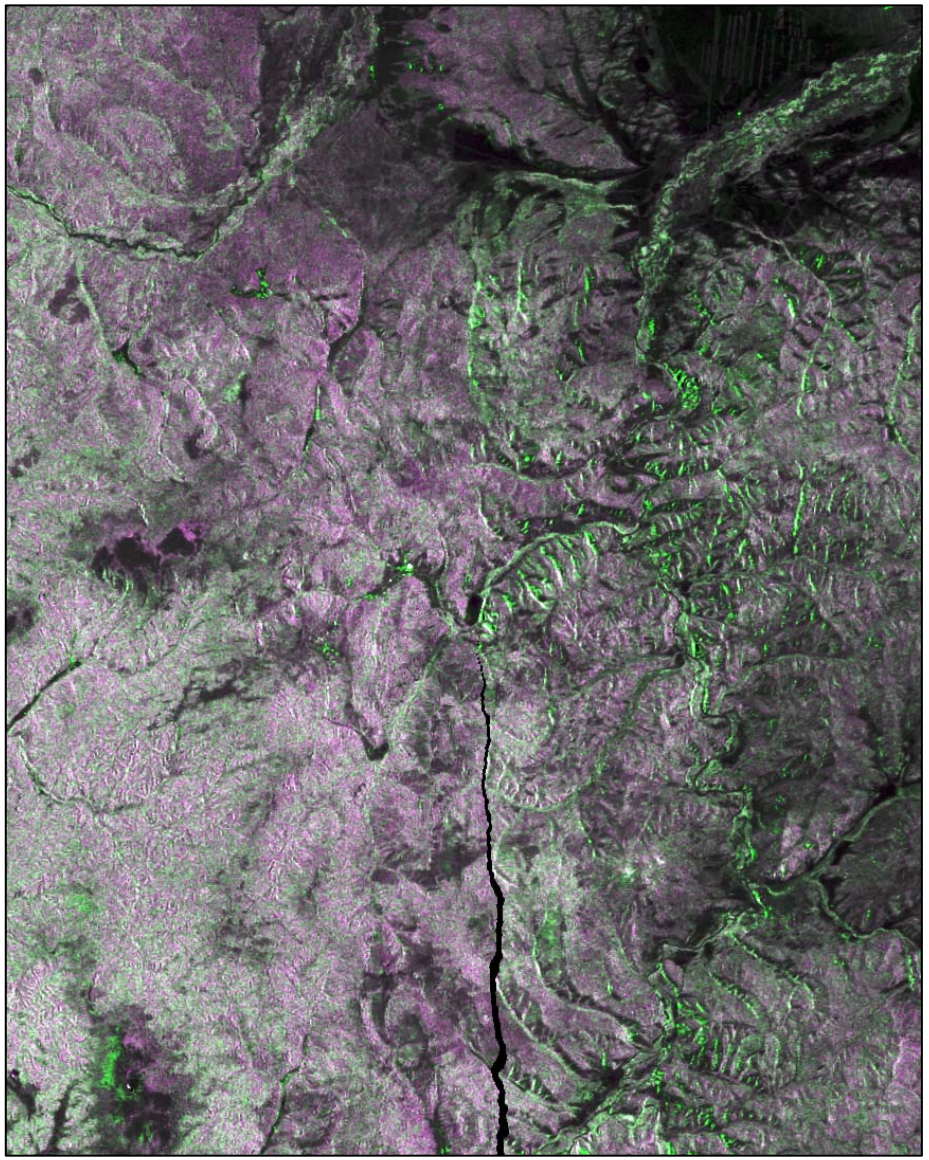


TS-X Scene (HH/VV/Ratio)

- SAR Data processing and mosaicing
  - Present status: completed

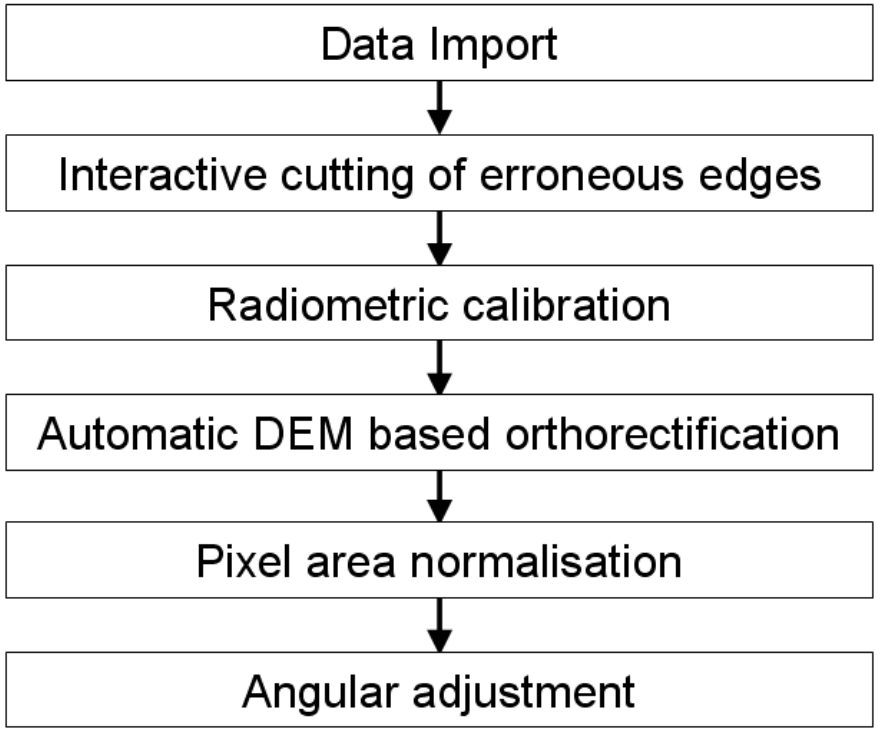


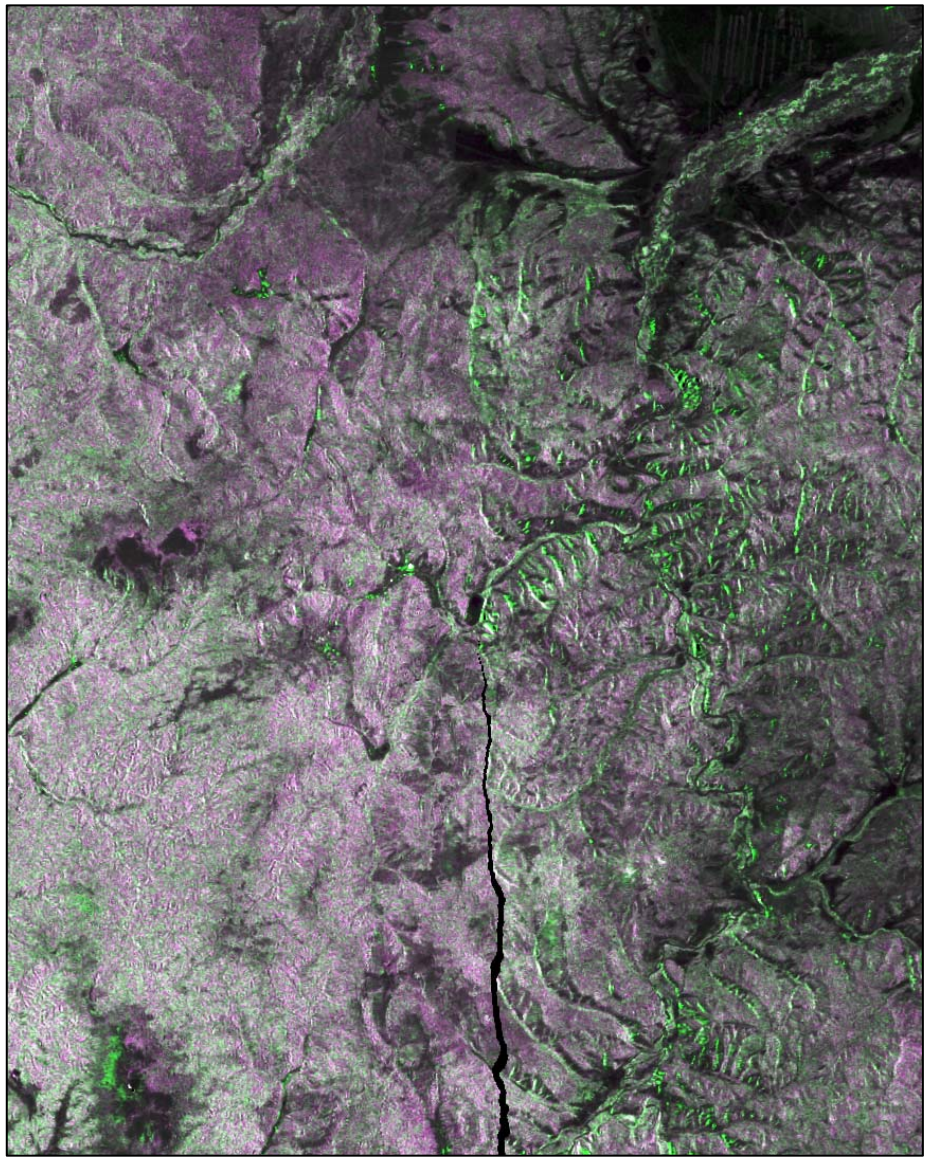
- Unfortunately, still (also at cycle 20) partially erroneous data (intensity ramps) were delivered
- Intensity ramps at the edges of the data stripes could appear at far and near range as well at both azimuth sides
- Magnitude and the width of the erroneous parts were varying. For sustaining as many rows and lines as possible, an interactive approach was chosen instead of a fixed cutting scheme



PALSAR HV/HH/HV composite for demonstration of high geolocation precision

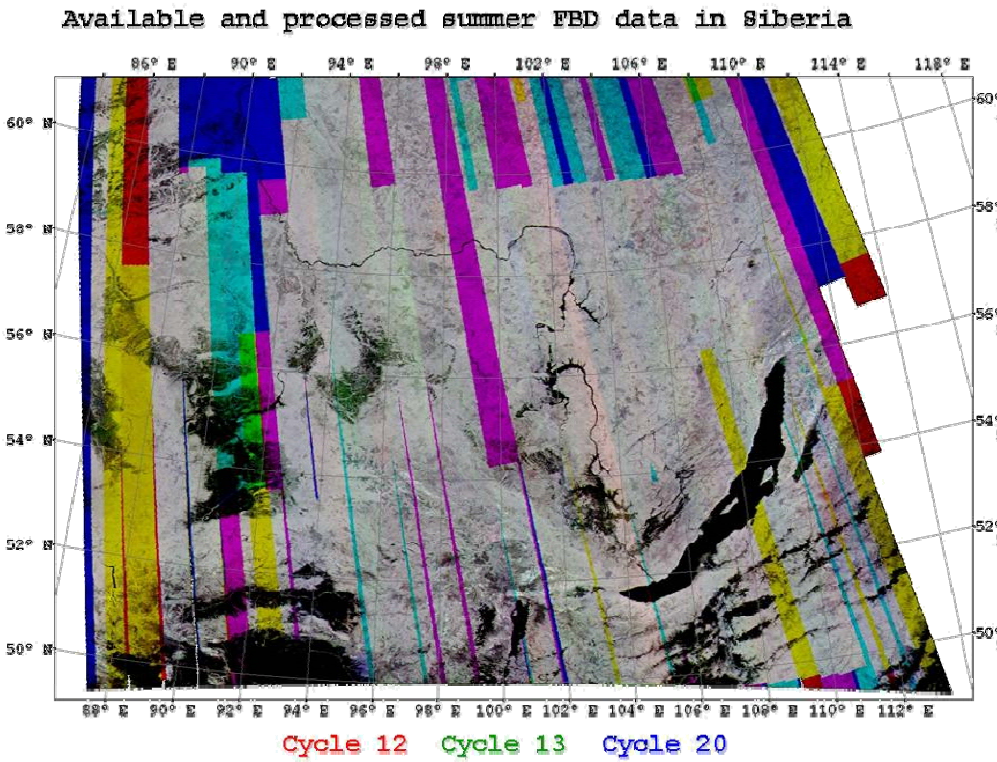
- SAR Data processing and mosaicing
  - Present status: completed

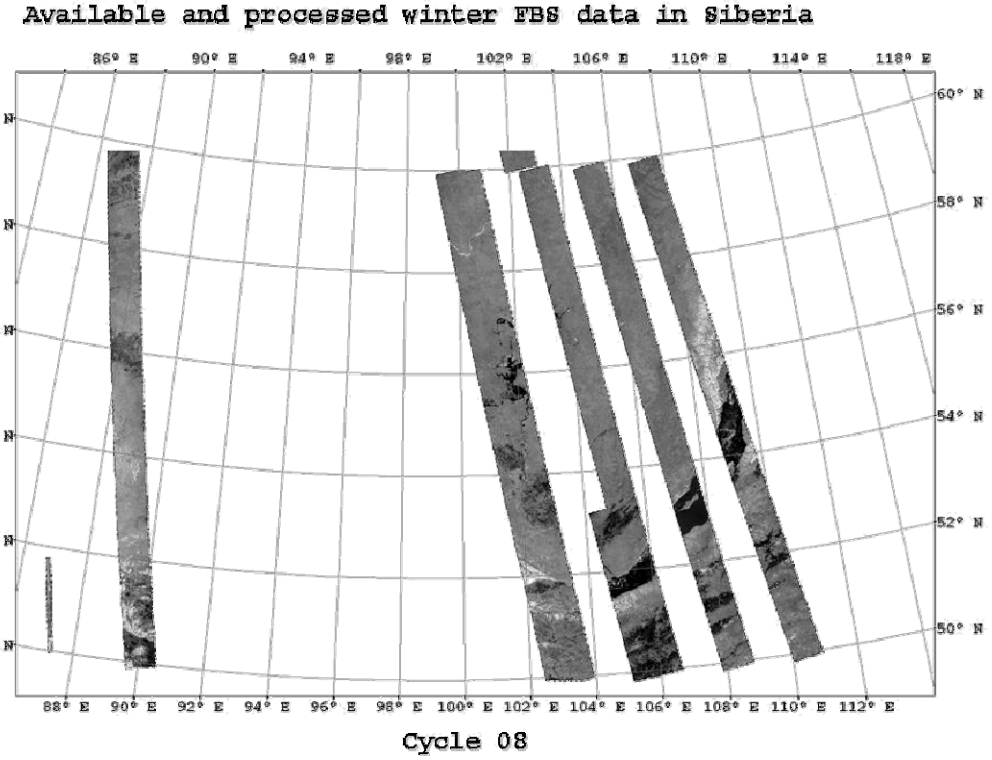




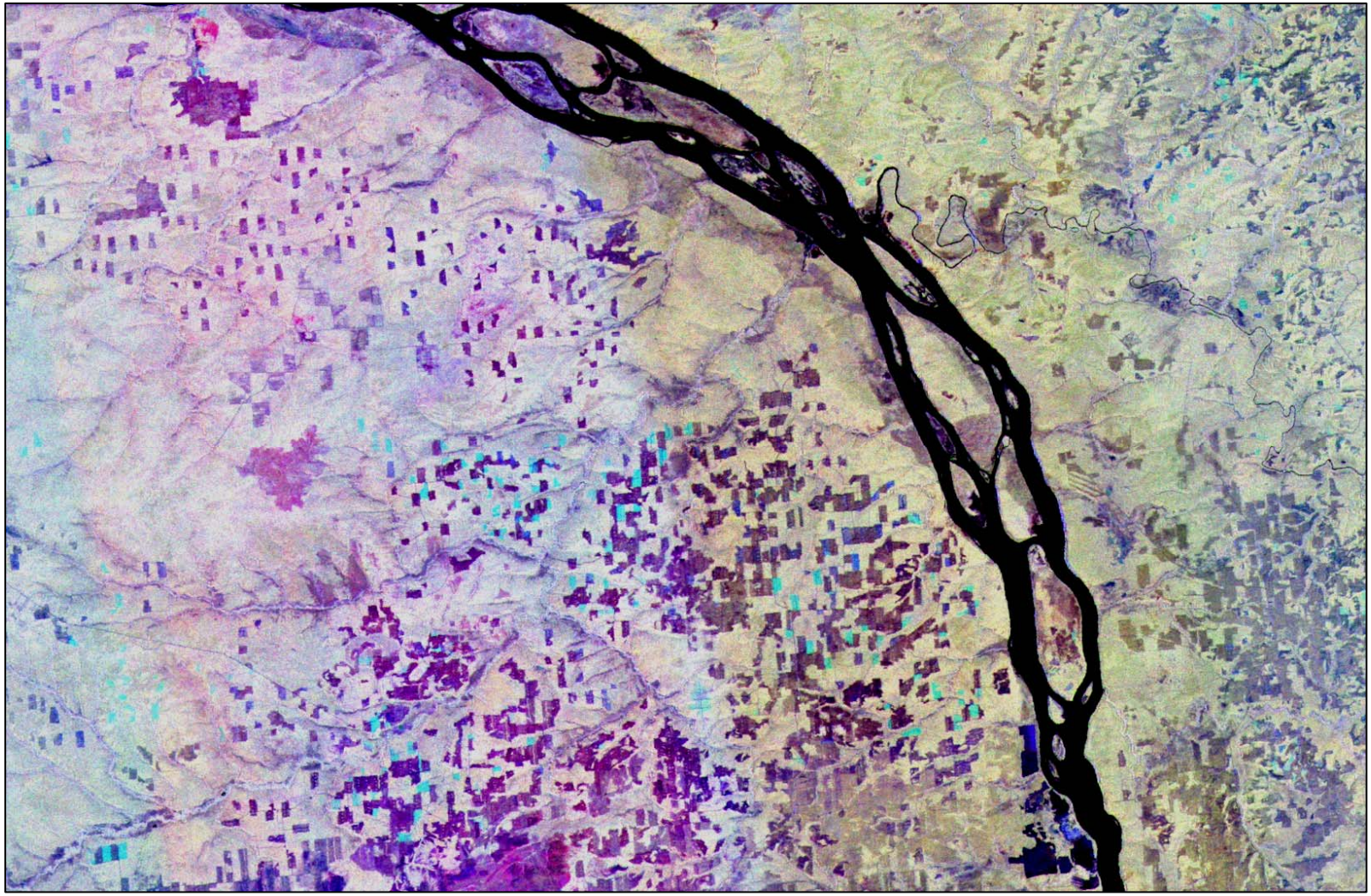
PALSAR HV/HH/HV composite for demonstration of high geolocation precision

- SAR Data processing and mosaicing
  - Present status: completed





- SAR Data processing and mosaicing



Cycles 20-13-12 HV

- Subtask 2: (Developing methodology for mapping of forest cover, deforestation and other disturbances)
- Subtask 4: (Generating Prototype area maps of: forest and land cover, annual changes in forest cover, maps of deforestation; provide accuracies)

  - 1.) Multi-temporal Classification (6 data layers – 3 acquisitions)
  - 2.) Mono-temporal Classification (2 data layers – 3 acquisitions)
  - 3.) Classification of Changes (4 data layers – 2 acquisitions)
  - 4.) Classification using Intensity and Coherence (3 data layers – 3 acquisitions)

  - Present status: completed
  - Deliverables: Methods

• 1.) Multitemporal classification

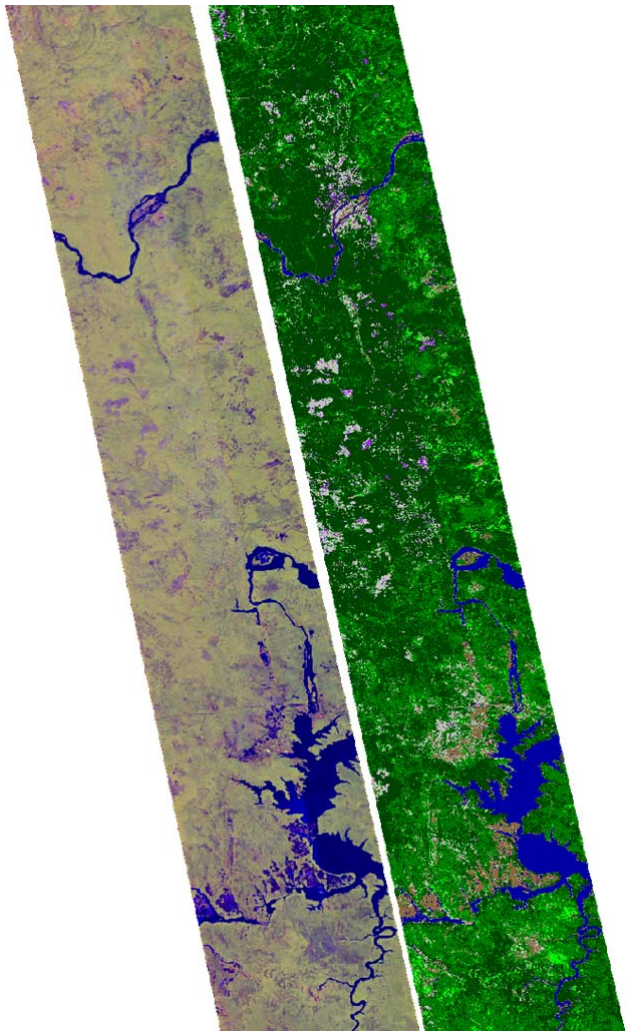
PALSAR Data	Multitemporal Metrics
FBD HH/HV Cycle 12 (early summer 2007)	Minimum
FBD HH/HV Cycle 13 (late summer 2007)	Mean
FBD HH/HV Cycle 20 (early summer 2008)	Maximum
	Standard Deviation (averaged by 5x5 matrix)

	HH Min	HH Mean	HH Max	HH Std.	HV Min	HV Mean	HV Max	HV Std.
Water	--	-	0	-	--	--	-	0
Agriculture	--	--	0	++	--	-	0	0
Forest 1 (dense, high biomass)	+	+	+	--	++	++	++	--
Forest 2 (low biomass)	0	0	0	--	0	0	0	--
Forest 3 (very low biomass)	-	-	-	-	-	-	-	-
Clear-cuts & burnt areas	--	-	-	-	--	--	-	-
Settlement	++	++	++	+	0	+	+	+
New clear-cuts and fire scars	--	0	+	++	--	0	++	++

	HH Min	HH Mean	HH Max	HH Std.	HV Min	HV Mean	HV Max	HV Std.
Water (Def. 1)	< -19 dB					< -26 dB		
Water (Def. 2)	< -16 dB			< 1.0		< -26 dB		
Water (Def. 3)	< -19 dB				< -30 dB			
Forest 1 (dense, high biomass)		< -2 dB					> -14 dB	< 1.2
Forest 2 (low biomass)		< -2 dB					> -17 dB	< 1.0
Forest 3 (very low biomass)		< -2 dB					> -20 dB	< 0.8
Settlement (Def. 1)		> -1 dB	> 0 dB	> 1.0				
Settlement (Def. 2)		> -3 dB	> -2 dB	> 2.0				
New clear-cuts and fire scars		< -4 dB				> -18 dB	> -14 dB	> 1.2
Clear-cuts & burnt areas		> -9 dB		< 2.0				
Agriculture		< -9 dB		> 2.0				

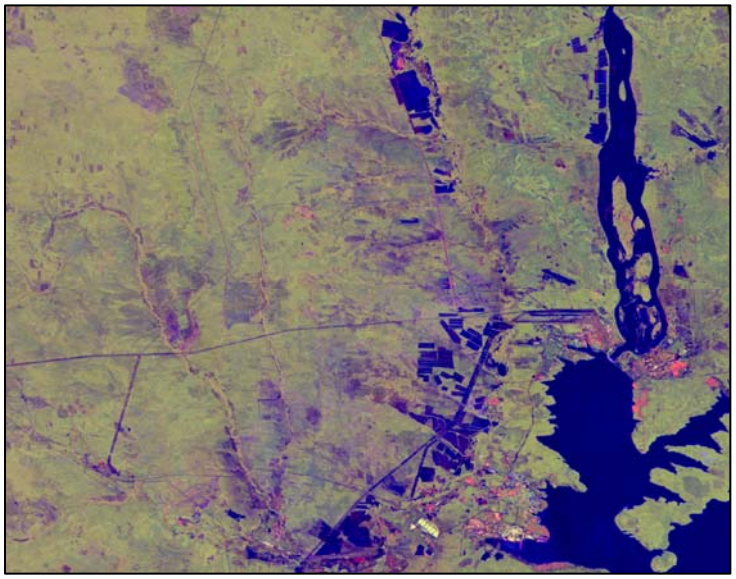
- The multitemporal classification makes use of the characteristic temporal backscattering variations of the considered classes
- Simple multitemporal metrics have been computed
- Aim of the multitemporal classification was to separate as many land cover types as possible
- Collection of typical relative values for the available data layers from very high (++) to very low (--), 0 means medium values
- These ratings are basing on fundamental knowledge and the examination of the available data
- Suited and robust metrics have been selected and thresholds for the considered classes have been defined
- One aim of the class definition was to apply as few thresholds as possible, to keep the classification approach transparent and simple

- 1.) Multitemporal classification

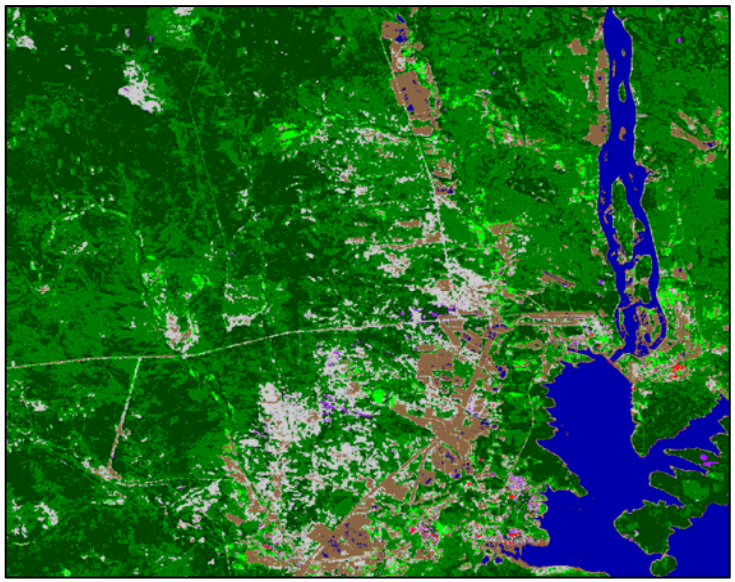


SAR data (left) and classification result (right) for the whole subset (Tracks 467 and 468, 54° N-60° N)

HH mean
HV mean
HV std. dev



water (blue)
forest dense (dark green)
forest low biomass (green)
forest very low biomass (light green)
settlement (red)
agriculture (brown)
clear-cuts & burnt areas (grey)
new clear-cuts and fire scars (purple)

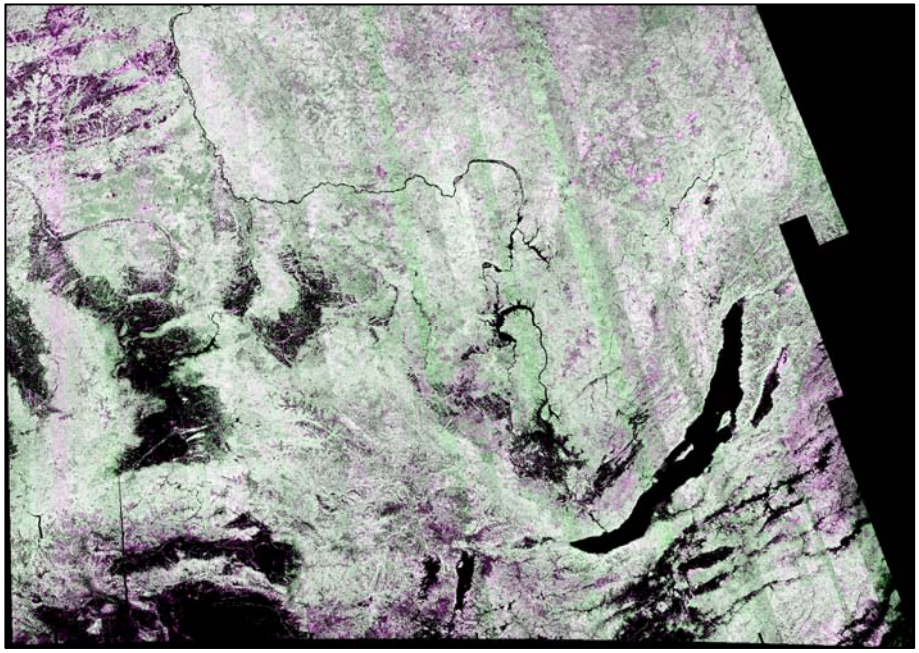


- 2.) Mono-temporal classification of basic landcover for whole prototype area

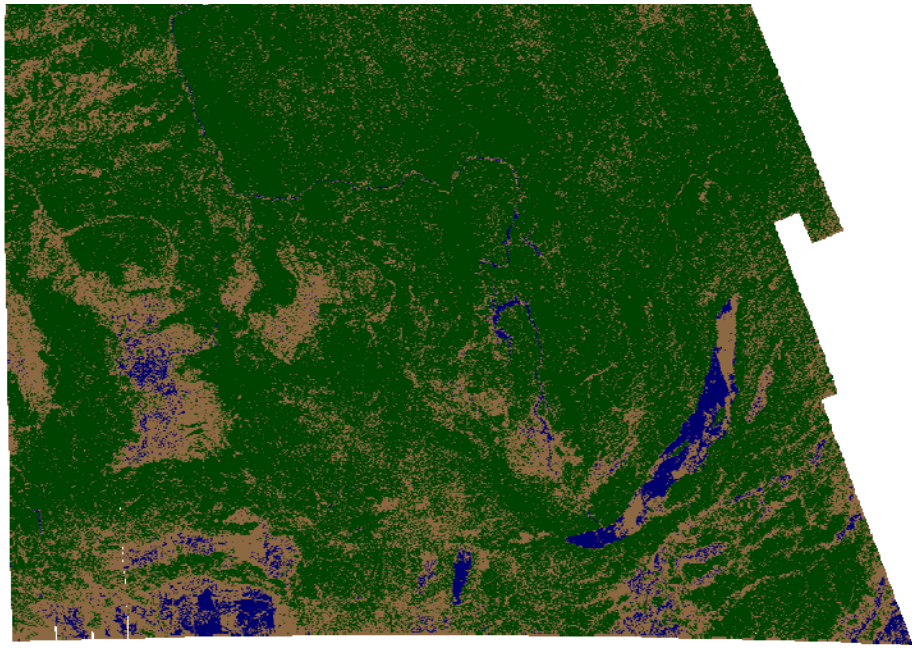
	HH	HV
Water	--	--
Forest/Settlements	+	++
Very low biomass	-	-

	HH	HV
Water	< -19 dB	< -26 dB
Forest/Settlements	> -8 dB	> -20 dB
Very low biomass	Remaining values	Remaining values

- Approach can provide a map with the most complete coverage of the prototype area but with the lowest accuracy



HH/HV/HH of multitemporal mosaic



Map (green: forest, blue: water, brown: other non-forest)

3.) Classification of Changes

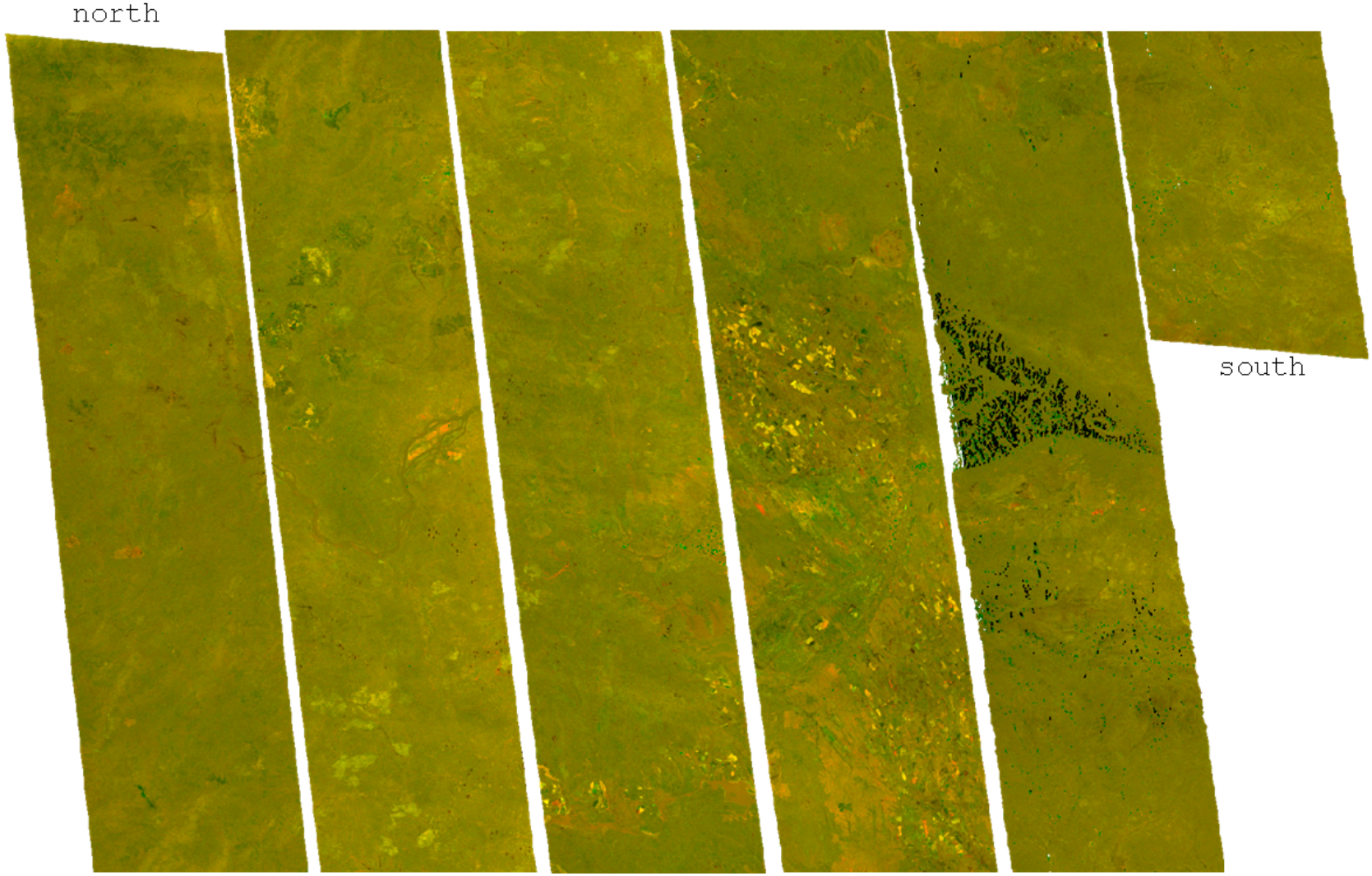
- Change detection (basing on backscatter change)
- Normalised backscatter difference: achieve easier comparability between the different tracks
- Due to radiometric deviations between the stripes (moisture etc.), the changes have to be detected stripe-wise
  Alternative: Histogram matching/manipulation strategies

$$NBDI_{XX} = \left\langle \frac{\sigma^0{}_{XX\,f_{t1}} - \sigma^0{}_{XX\,f_{t2}}}{\sigma^0{}_{XX\,f_{t1}} + \sigma^0{}_{XX\,f_{t2}}} \right\rangle$$

Normalised Backscatter Difference Index

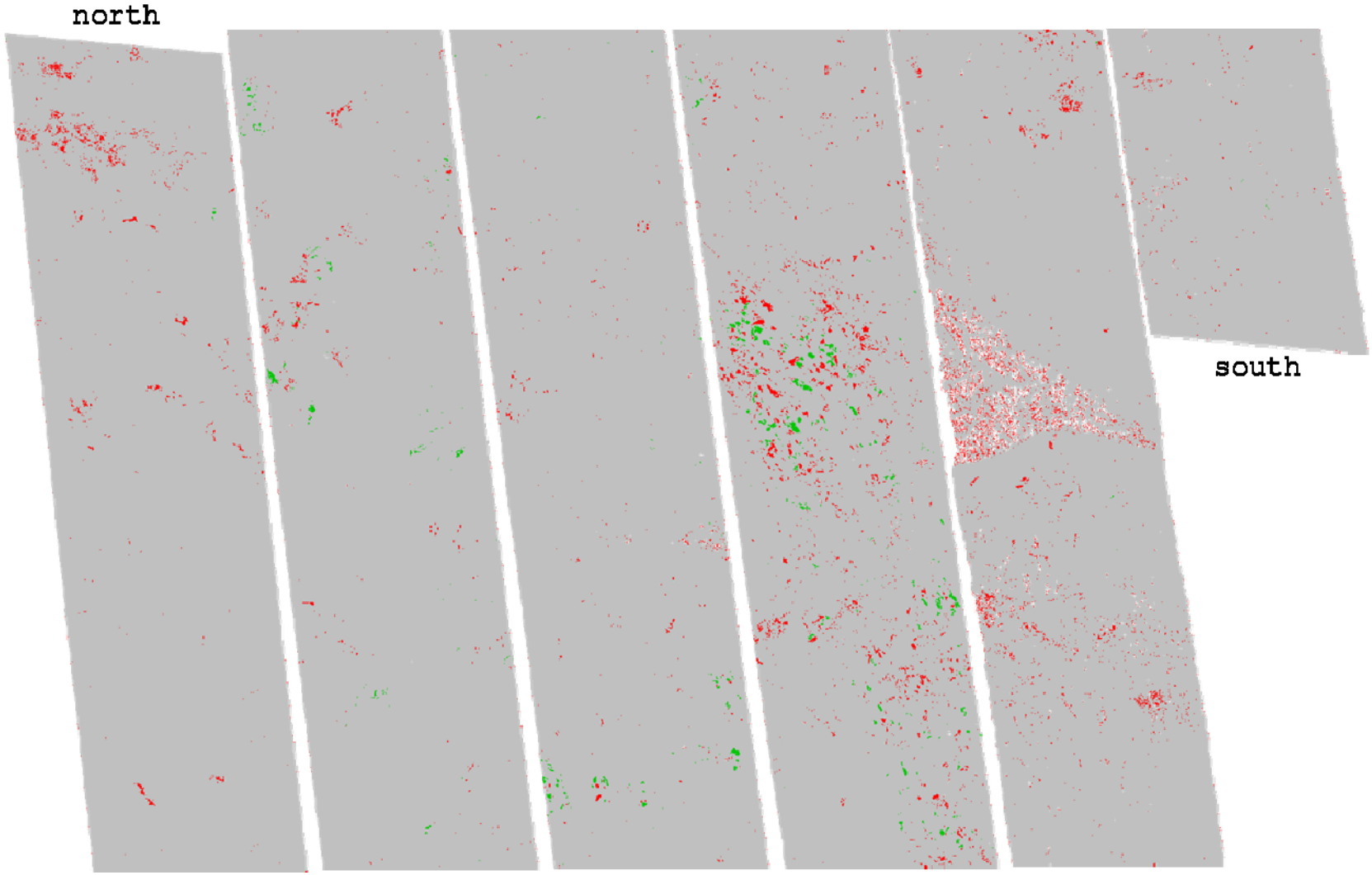
	$NBDI_{HH}$	$NBDI_{HV}$
Significant increase of backscatter	0.25	0.10
Significant decrease of backscatter	-0.04	-0.02
Significant decrease of backscatter	-0.15	

- 3.) Classification of Changes



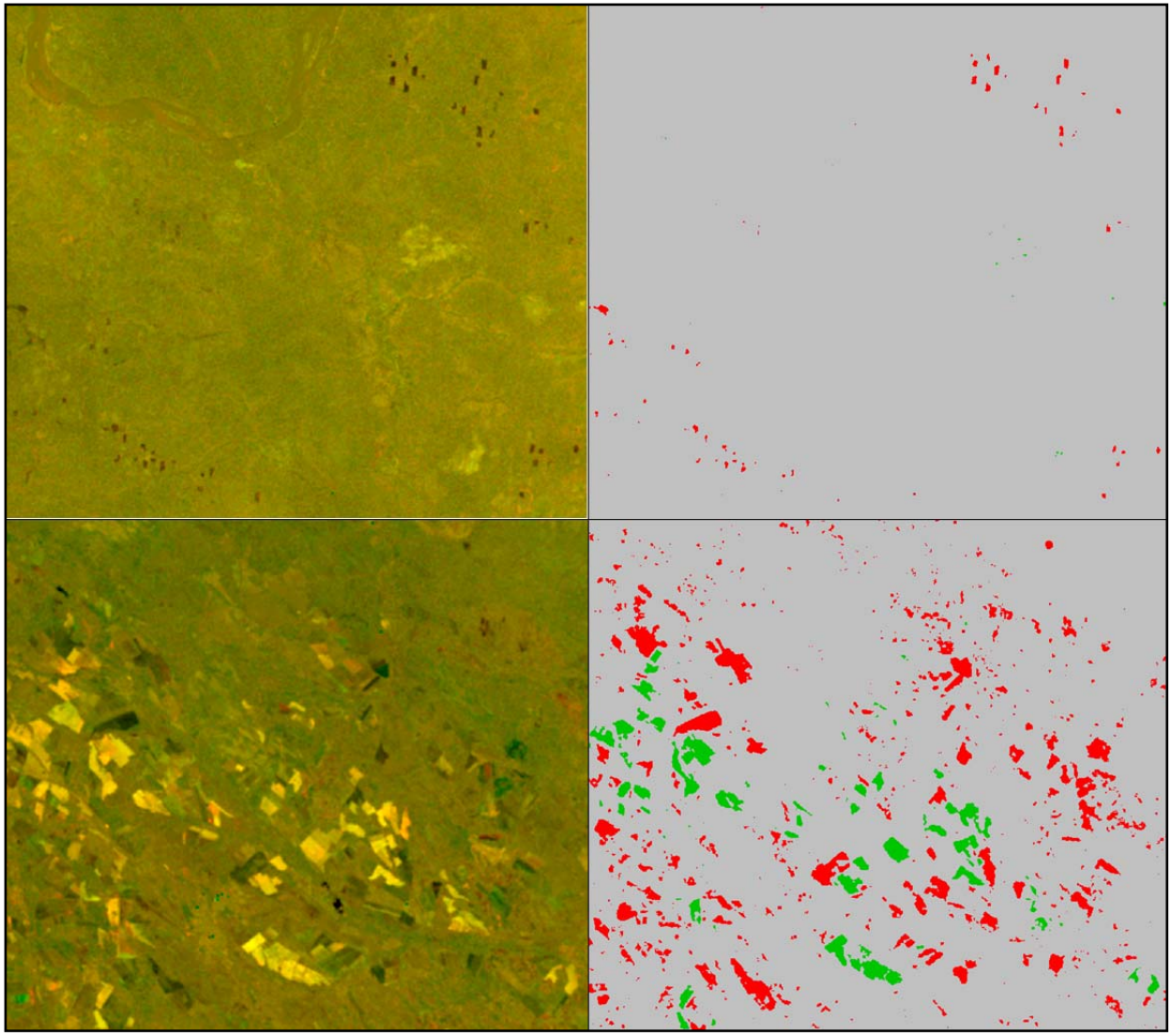
NBDI of cycles 12 and 20 (RG composite: HH NBDI /HV NBDI)

- 3.) Classification of Changes



Change map: grey: no change, white: no data, red: decrease of backscatter, green: increase of backscatter

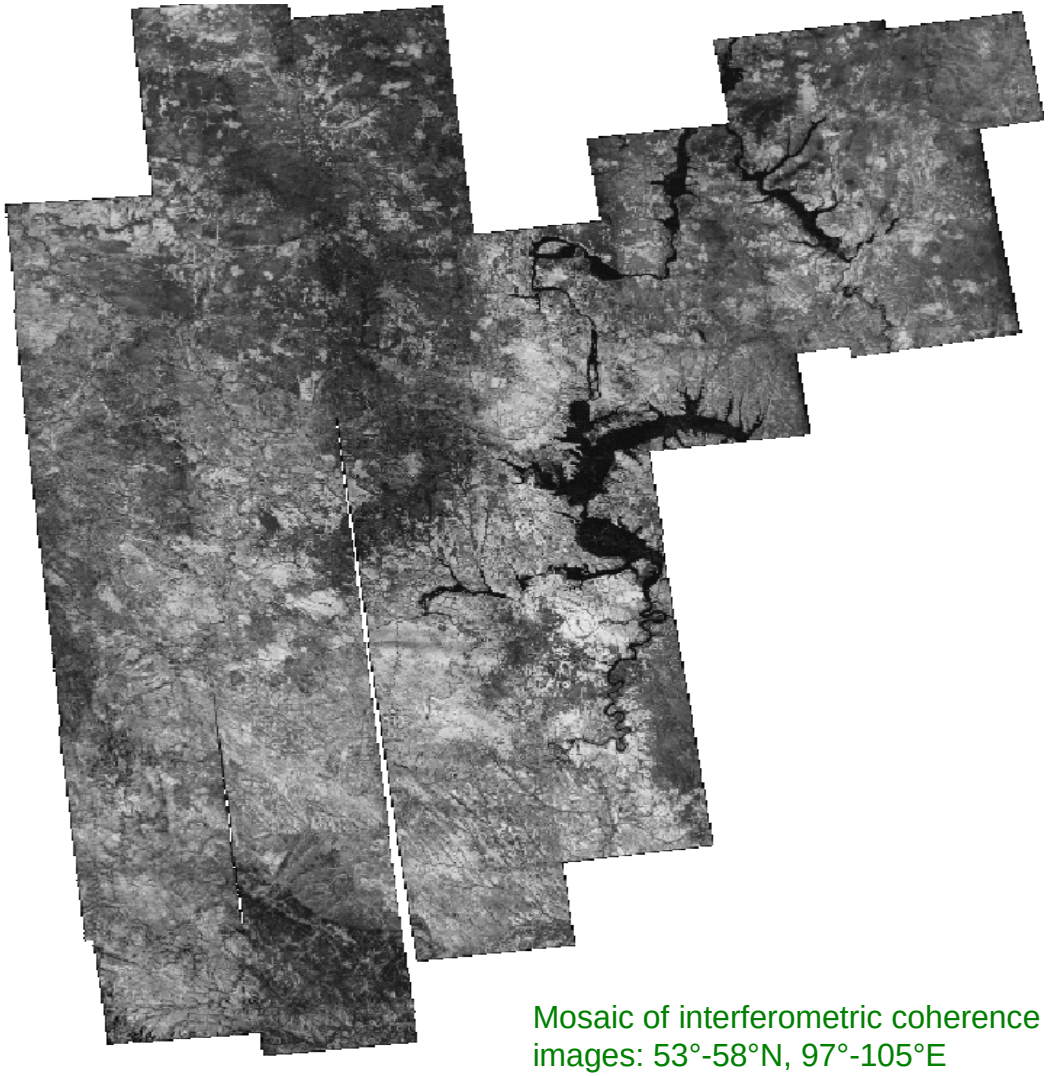
- 3.) Classification of Changes



Top: forest dominated area
Bottom: agriculture dominated area

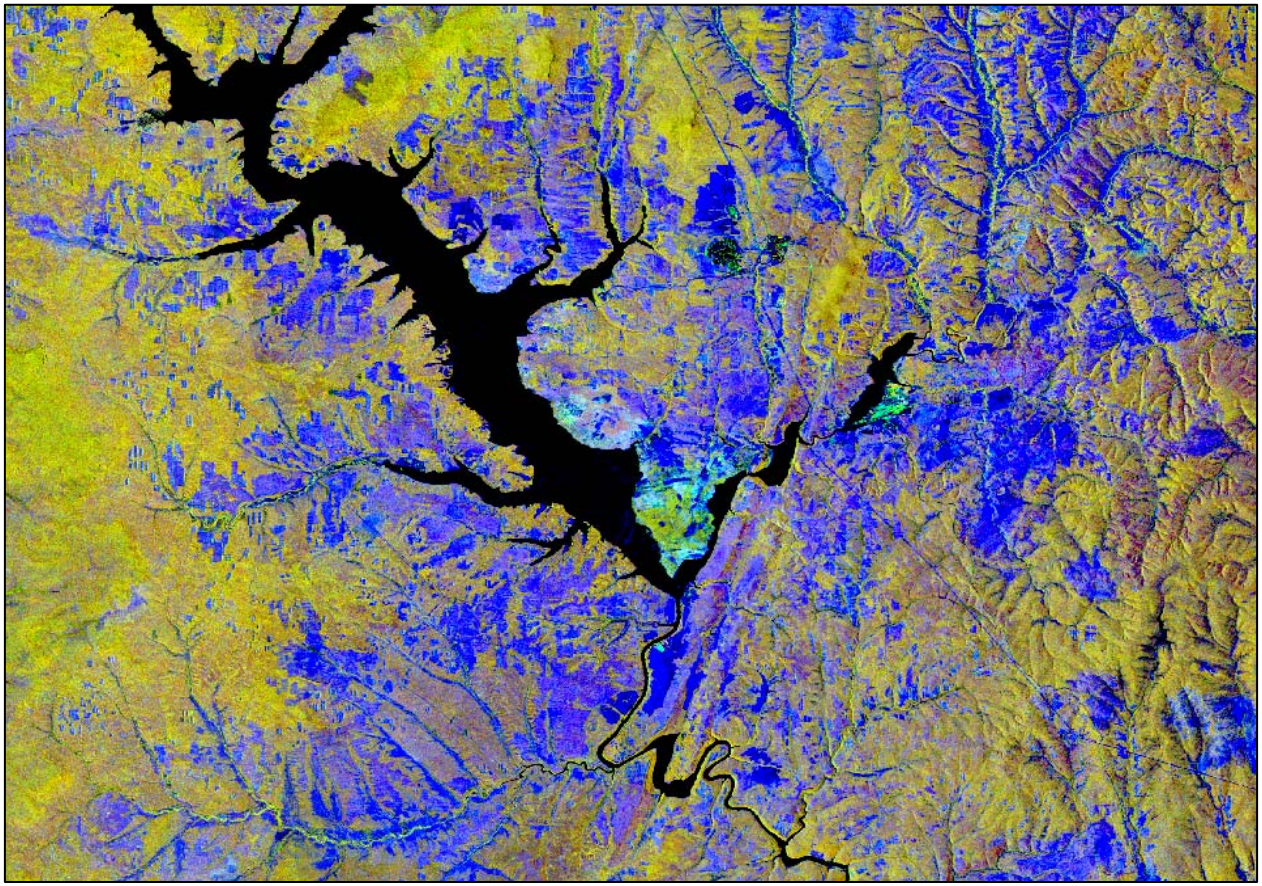
4.) Forest Cover Mapping Using Intensity and Coherence

- This initial investigation was carried out in the framework of GSE Forest Monitoring
- Summer intensity and winter coherence images are used
- Intensities (FBD HH/HV) have been acquired during summer 2007 (K&C intensity stripes)
- For coherence estimation standard level 1.1 FBS scenes were applied
- 43 pairs have been acquired during winters 2006/2007 (cycles 8 & 9) and 2007/2008 (cycles 16 & 17)
- Each pair stems from consecutive cycles (46 days temporal baseline)
- During both winters suited weather conditions have been reported



Mosaic of interferometric coherence images: 53°-58°N, 97°-105°E

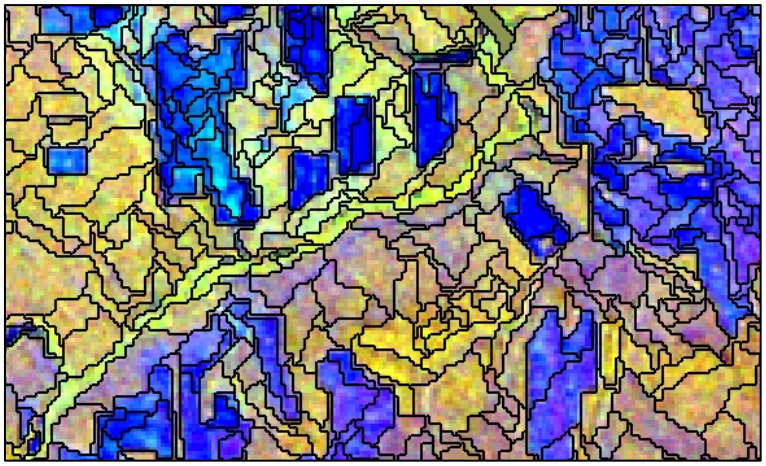
- 4.) Forest Cover Mapping Using Intensity and Coherence



Composite of HV & HH backscatter and winter coherence for a subset of the monitoring area (taken from north-eastern section)

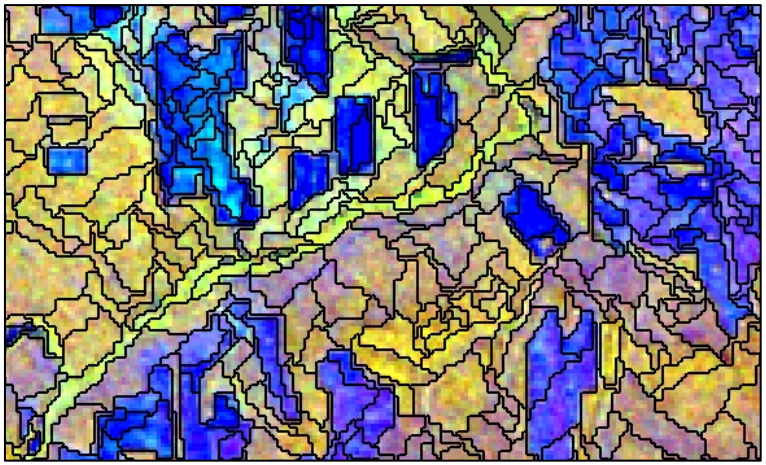
Test area (light green patch, right image) in the centre of the prototype area

- 4.) Forest Cover Mapping Using Intensity and Coherence
  - Classification is based on image segments (multiresolution segmentation algorithm)
  - Nearest Neighbor algorithm was used
  - Defined target classes: forest, very low biomass forest and non-forest
  - For each class 20 samples have been selected

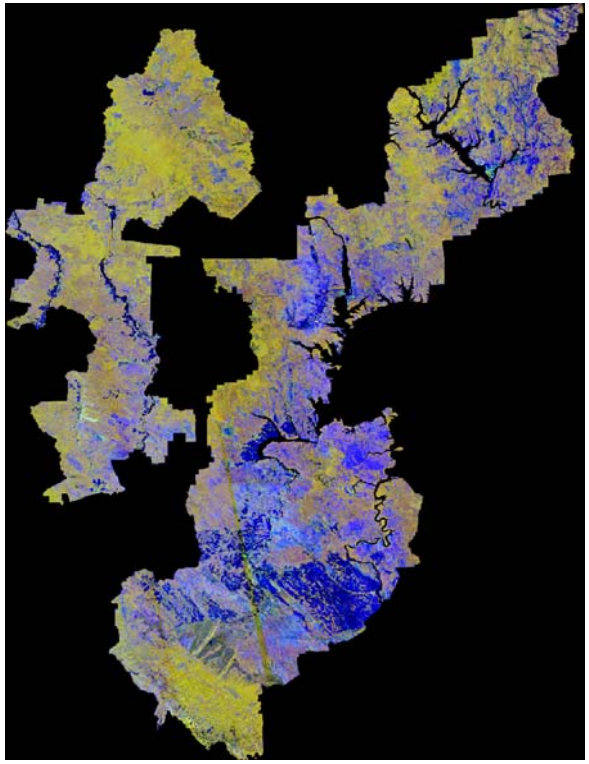


Example of segmented dataset

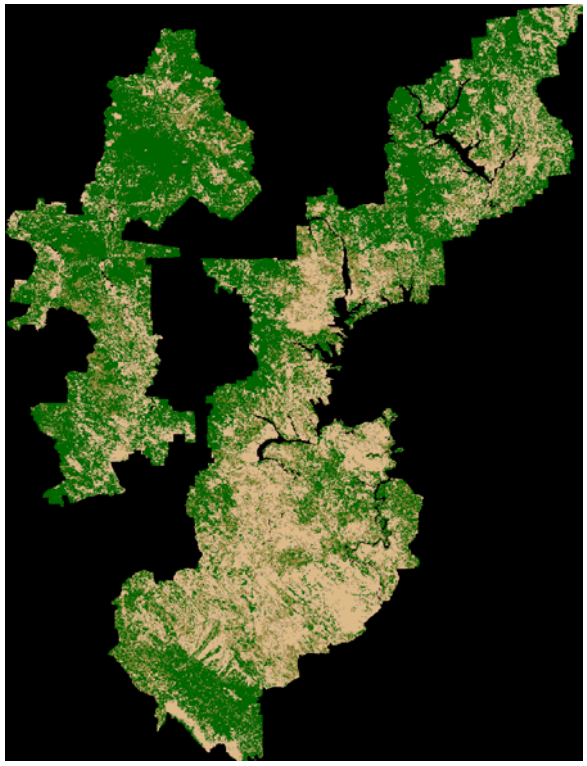
- 4.) Forest Cover Mapping Using Intensity and Coherence
  - Classification is based on image segments (multiresolution segmentation algorithm)
  - Nearest Neighbor algorithm was used
  - Defined target classes: forest, very low biomass forest and non-forest
  - For each class 20 samples have been selected



Example of segmented dataset

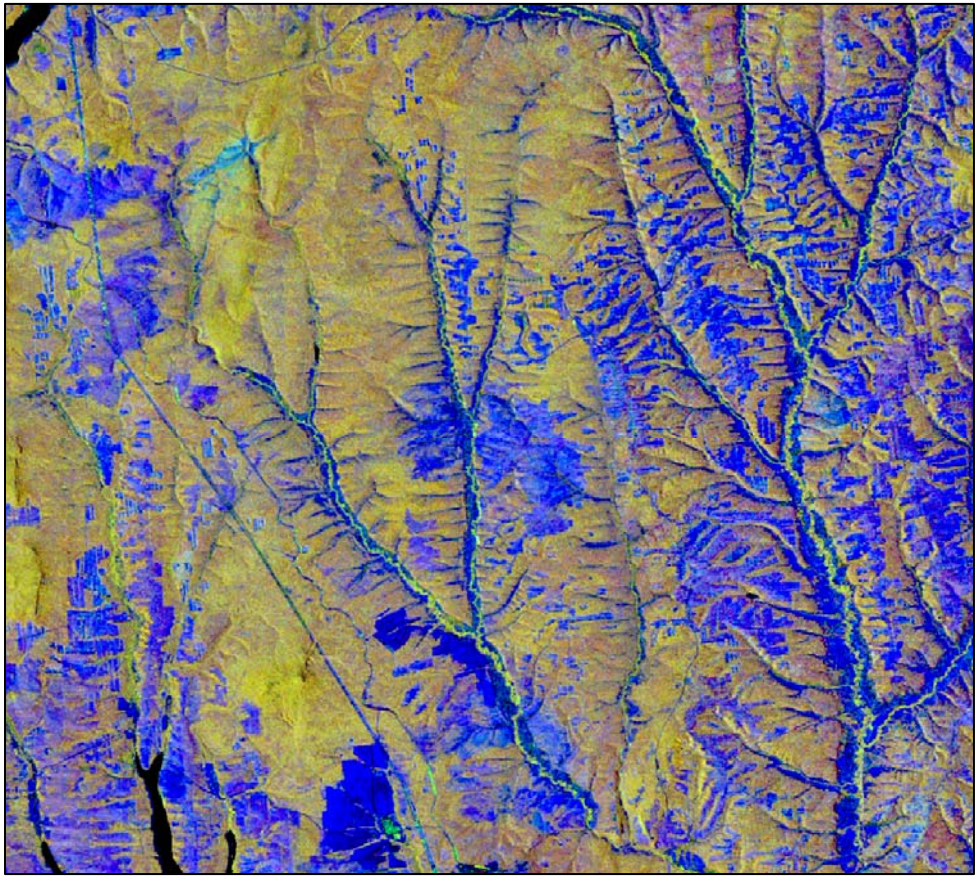


SAR data (HV/HH/Coherence)

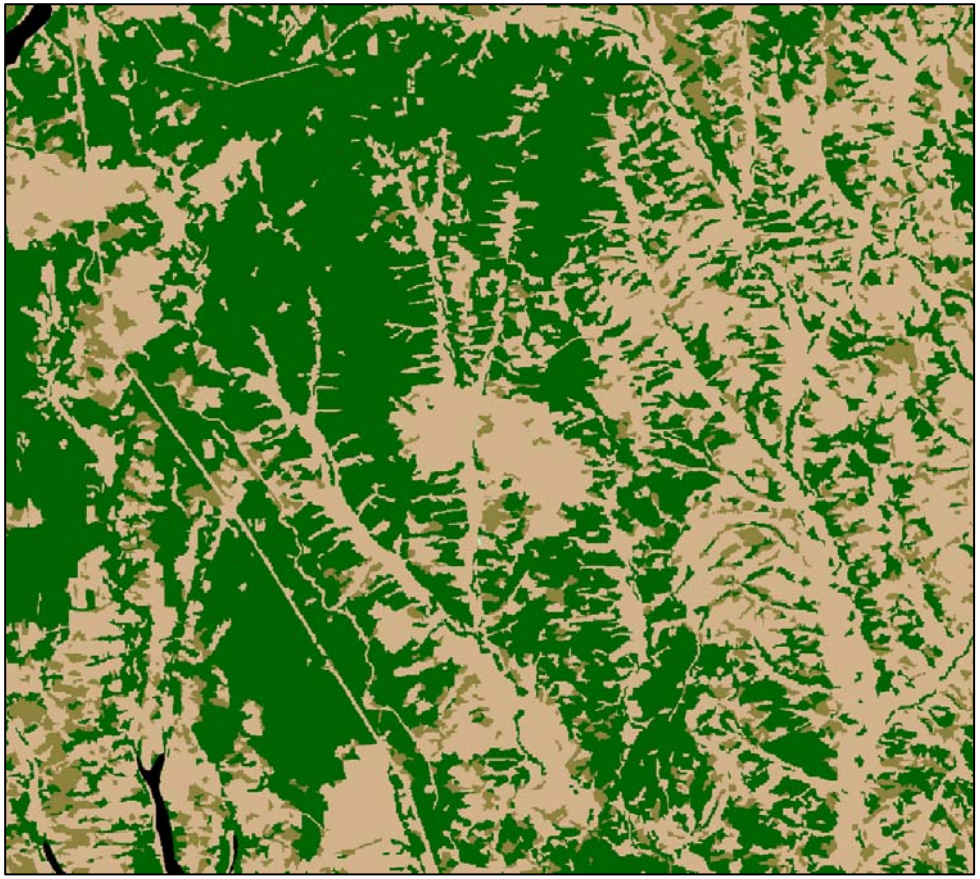


Map (forest: green, very low biomass forest: brownish green, non-forest: light brown)

- 4.) Forest Cover Mapping Using Intensity and Coherence
  - The accuracy assessment for the whole monitoring area is basing on 1,000 point samples
  - The random sampling was stratified by class proportion
  - Overall accuracy: 90.87%.



SAR data (HV/HH/Coherence)



Map (forest: green, very low biomass forest: brownish green, non-forest: light brown)

- Thank you