FOREST STRUCTURE CLASSIFICATION EXPLORING THE ANISOTROPY INFORMATION FROM MOMS-2P THREE LINE STEREO SCANNER DATA

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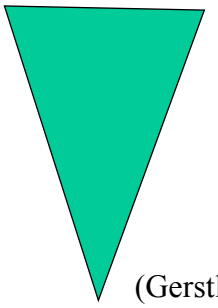
- Introduction and thematic background
- Material und Methods
  - the MOMS-02 System
  - Data set specific issues
  - Classification approach
  - Verification
- Discussion
- Outlook

5 Signature types are known in RS:

- spectral:
  pigment- and water status, cell structure
- angular:
  plant architecture, canopy structure
- textural:
  pattern of similar frequency inside a structure
- polarisation
  not sufficient explored, to low experience
- temporal
  change of signatures between two or more observations



(Gerstl, 1990)

Information content with respect to the status of objects

Structure, an umbrella term!

in RS:

- "micro" to "macro" structures
- used in a 2D but a 3D context as well
- structure is always ***scale*** and ***resolution*** dependent!

Structure forestry:

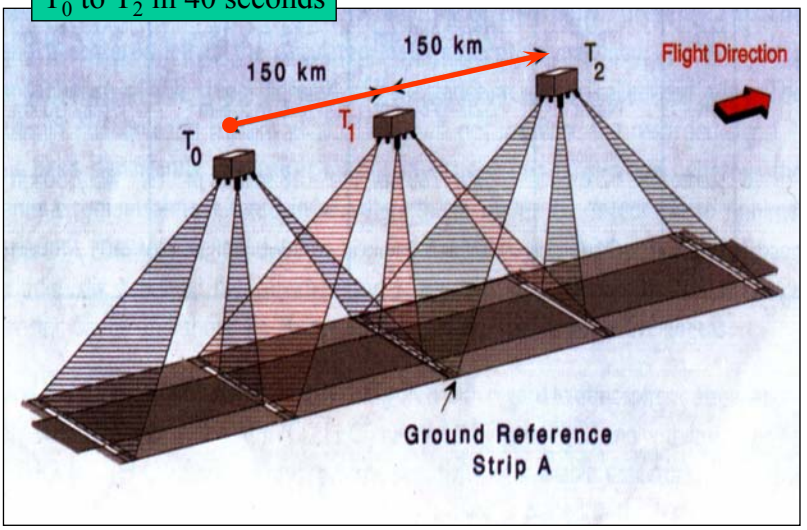
- "horizontal" distribution of tree types, age classes, etc.
- "vertical" features like crown densities, understory features, etc.
- surface features like stand surface roughness, etc.

Structure in the sense of the presented research:

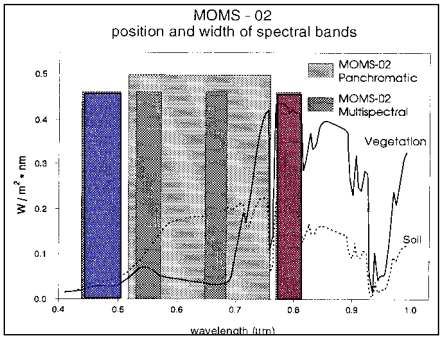
- the horizontal distribution of a feature on segment/ object of interst level (may be addressed as "texture" as well)
- "microstructure" of the microreflectors leaves/needles of the canopy resulting in an ***anisotropic backscatter*** behaviour of the surface as a whole on the scale range of an 18m pixel!

MOMS-02 registration geometry

T_0 to T_2 in 40 seconds

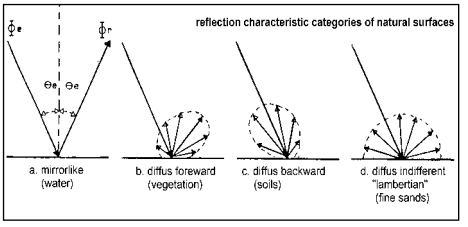


Assessment approaches for MOMS-2P Mode D daten sets



"Multispectral" versus

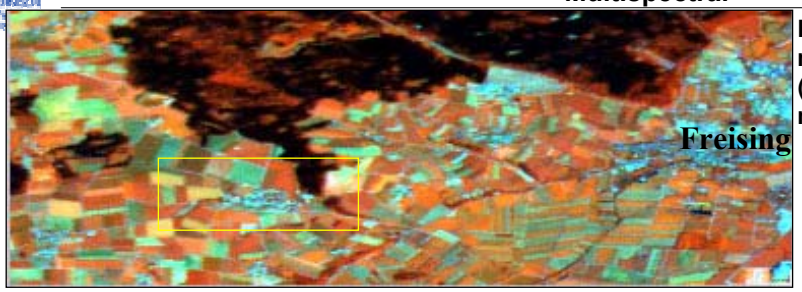
"Anisotropy" approach



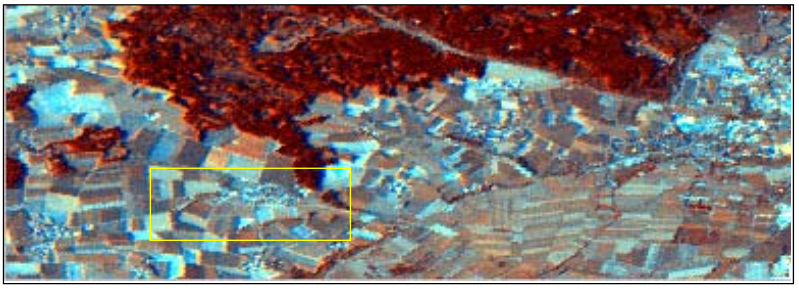
- **based on „spectral" signatures**
- **RGB : ms4, (st6 + st7)/2, ms1**

- **based on „angular" signatures**
- **RGB st6 /st7, st6, st7**

“Multispectral”



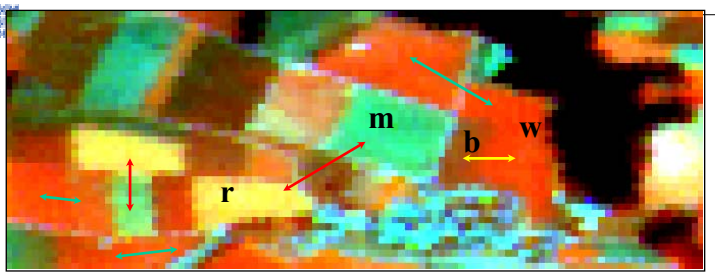
RGB =
ms 4
(st6+st7)/2
ms 1



RGB =
st 6 / st 7
st 6
st 7

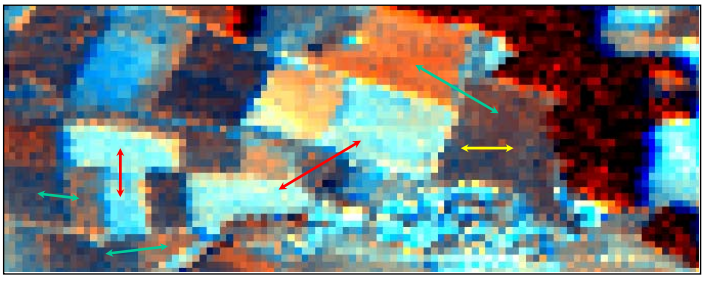
“Anisotropy”

FCC Dürnast

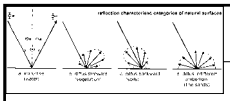


“Multispectral approach”

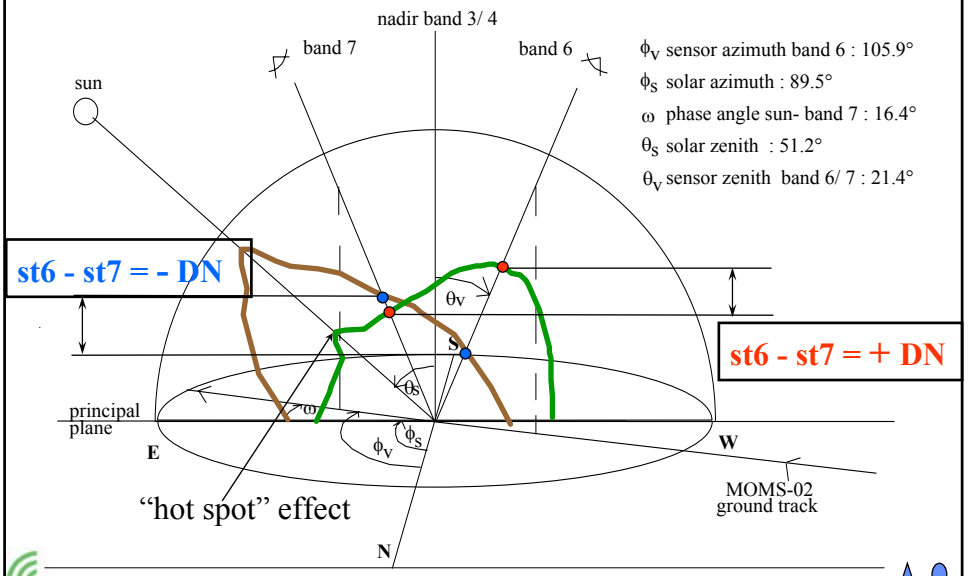
r = rape, m = maize, b = barley, w = wheat



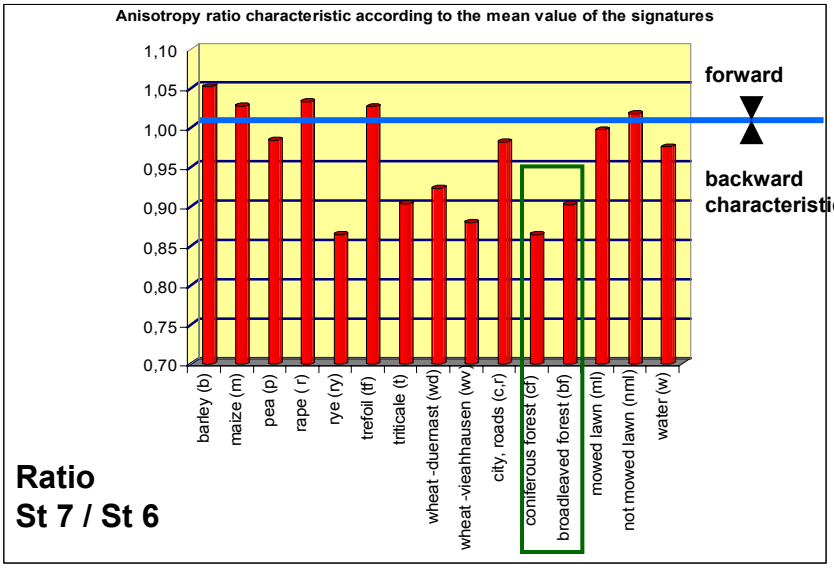
“Anisotropy approach”



Principle of anisotropy signature evaluation from stereo band data



Anisotropy behaviour of different surface categories



"on-track" stereo data image the anisotropic behaviour of surfaces !!

expectations:

- derivation of angular signatures
- information on the structure of surface elements
- complement information from spectral signatures

experience:

- anisotropie-signal is controlled by diverse external factors!!
- ***very promising results on agricultural sites!!!***

Potential in the forest domain???

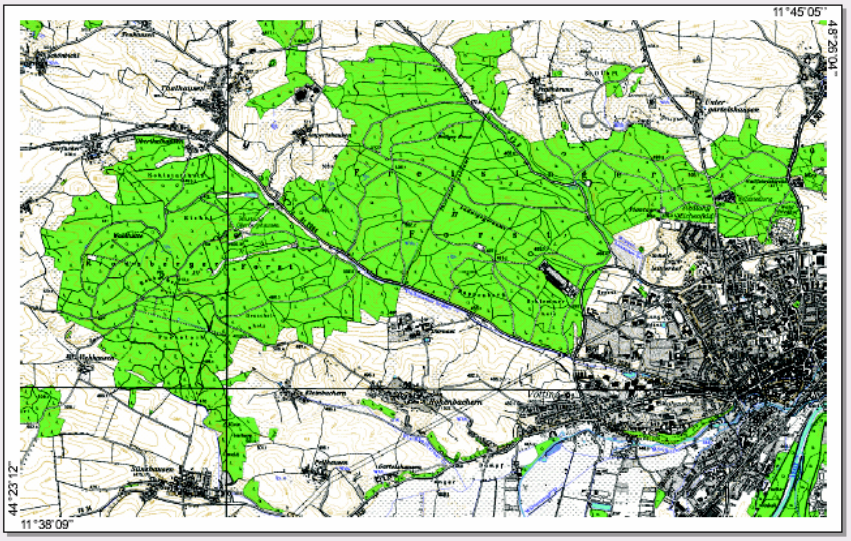
Hypothesis:

• *spectral*, resp. *angular signatures* from MOMS-2P mode D data are appropriate to assess forest parameter

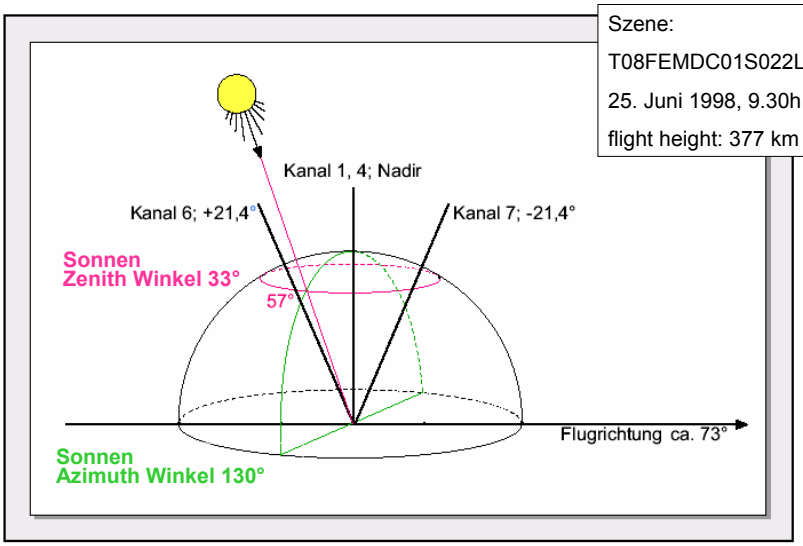
Test site:

• Thalhauser Forst, Freisinger Forst und Kranzberger Forst, (Bayern, Deutschland)

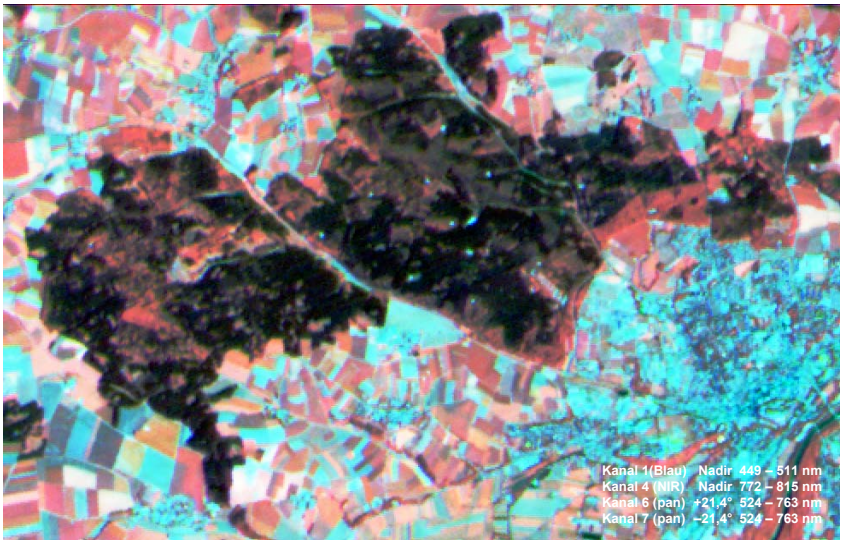
Test site as displayed in the digital map TK25 of the Bayerisches Landesvermessungsamt



Illumination and registration geometry of the MOMS-2P mode D Szene



multispectral image of the test site Kranzberger Forst



Classification strategy

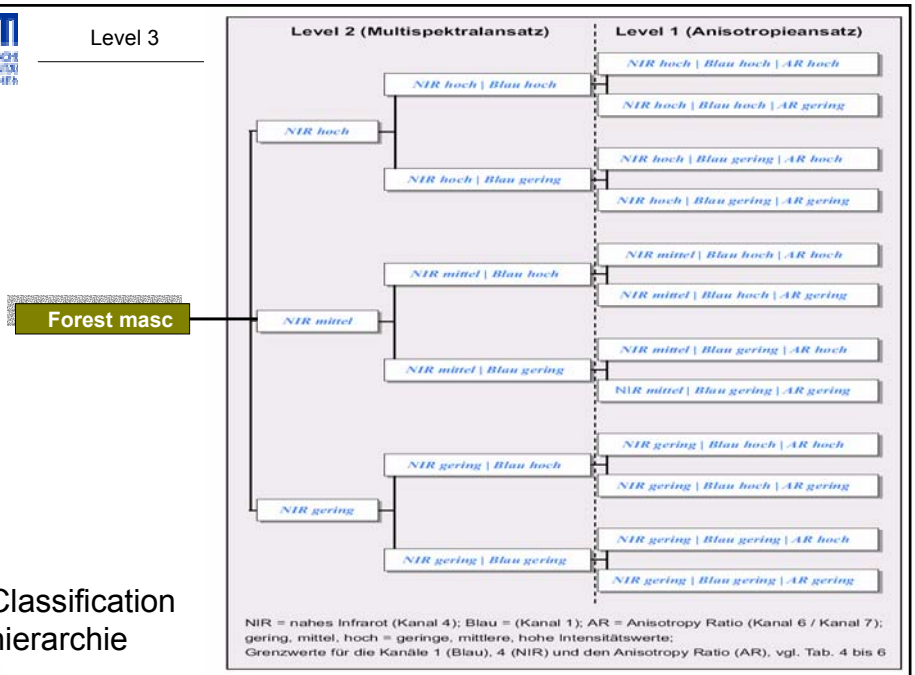
- Assumptions and presuppositions:
  - At 18 m pixel size we have to assume a mixed signal from more than one tree
  - At segment borders which coincide with height differences the anisotropy ratio is corrupted!
  - Position error of about 20m (one pixel)
- Methods:
  - eCognition “object oriented”, hierarchical analysis method
  - Verification is performed by comparing against inventory point data

- Top down approach !!

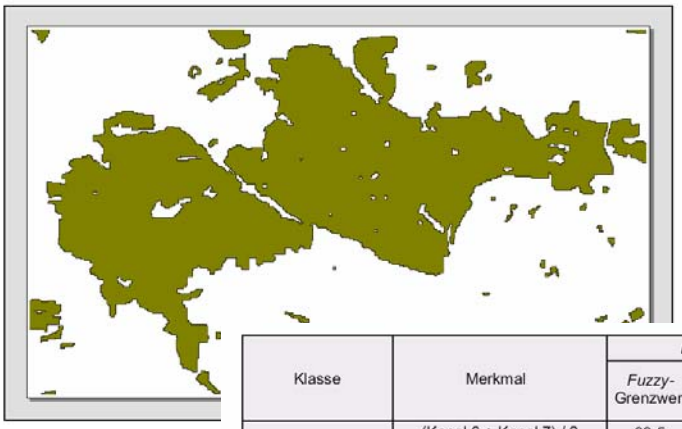
level	aim of processing step	scale parameter	weight factors applied					
			K1 Blue	K4 NIR	st6 pan	st7 pan	color/ shape	smoothness / compactness
level 3	forest masc	10	3	1	1	1	0,9 / 0,1	0,6 / 0,4
	fusion of objects assigned to the same class							
level 2	multispectral approach	10	1	1	0	0	0,9 / 0,1	0,6 / 0,4
	fusion of objects assigned to the same class							
level 1	Anisotropy approach	10	0	0	1	1	0,9 / 0,1	0,6 / 0,4

From principle an unsupervised classification!

- Data set is first classified
- Results are labelled on behalf of reference data

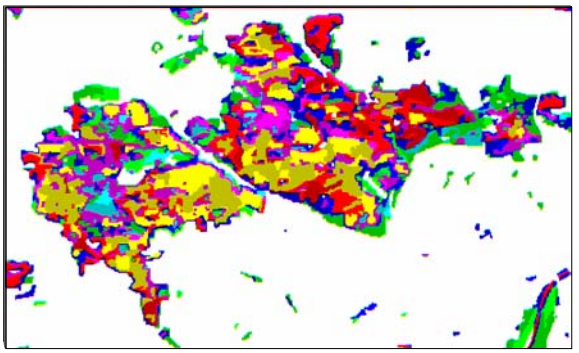


Classification hierarchie



Klasse	Merkmal	*Fuzzy*-Bereich			Grenz-wert
		Fuzzy-Grenzwert	Zugehörigkeits Funktion	*Fuzzy*-Grenzwert	
Wald	(Kanal 6 + Kanal 7) / 2	33,5		34,5	34
	Mean diff. to scene Kanal 6	-7		-6	-6,5
	Mean diff. to scene Kanal 7	-4,5		-3,5	-4
	Mean Kanal 1	52		53	52,5
	Mean Kanal 6	38		39	38,5
	Mean Kanal 7	28,5		29,5	29
nicht Wald	*Classified as Wald*	0 (nein)		1 (ja)	

Classification strategy



- NIR hoch | Blau hoch | AR hoch
- NIR hoch | Blau hoch | AR gering
- NIR hoch | Blau gering | AR hoch
- NIR hoch | Blau gering | AR gering
- NIR mittel | Blau hoch | AR hoch
- NIR mittel | Blau hoch | AR gering
- NIR mittel | Blau gering | AR hoch
- NIR mittel | Blau gering | AR gering
- NIR gering | Blau hoch | AR hoch
- NIR gering | Blau hoch | AR gering
- NIR gering | Blau gering | AR hoch
- NIR gering | Blau gering | AR gering

Classification level 2:

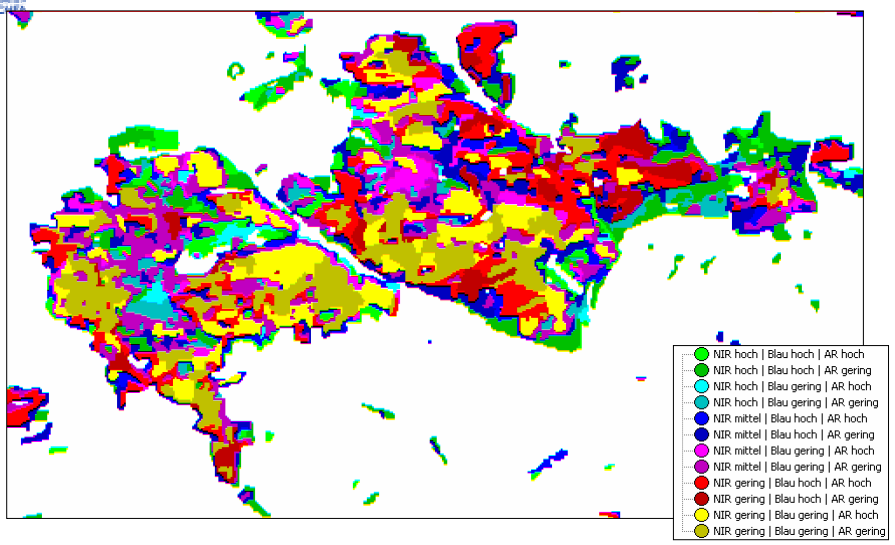
a) Based on NIR band 4: three visuall distinguished classes

b) Based on band 1 (blue): the three classes from step 2a are further divided in two new classes each. No visual detectable differences due to striping, that fore creation of two equally large groups!

Classification level 1:

c) Based on the anisotropy ratio (st-band 6 / st-band 7): Subdivision of each class from step 2b into two new classes. Again two equally large classes should be created

Classification results



A nice colorful image, but whats behind???

Evaluation of classification results

Method:

- Classified object groups are verified on the basis of inventory point data !

Reference data

▪ subset of the inventory data base:

- tree type proportion
- stem number
- stand age
- dbh
- mean height

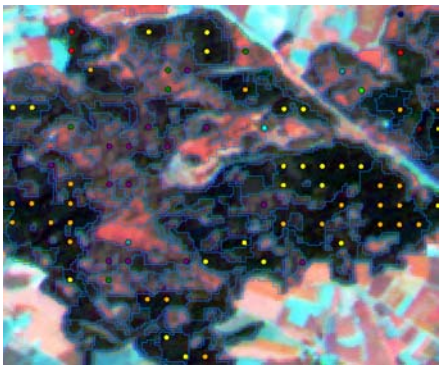
Preparation of the inventory data:

▪ solely upper stand layer information used

▪ merge of tree types in tree type groups:

- coniferous trees
- broadleaved trees
- larch

Inventory point reference data



Matching the classification results with inventory point information:

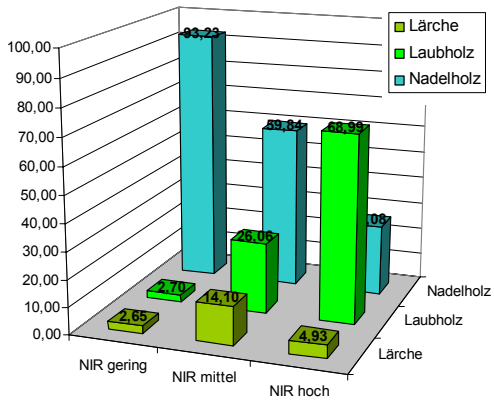
1. Import of inventory points to GIS

2. Import of the classification results in GIS

3. Removal of unappropriated inventory points by buffering (20m buffer)

4. Statistics based comparison of inventory points and classification results

Evaluation of classification results



- classification based on NIR band 4:

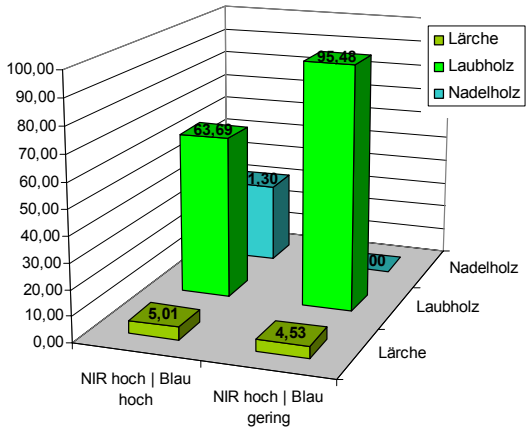
*Significant differences with regard to **tree type composition**!*

low intensity (NIR):
- *nearaly poor coniferous*

medium intensity (NIR):
- *mixed class with high proportion of coniferous trees*
- *high proportion of larch*

high intensity (NIR):
- *high proportion of broadleaved trees*

Evaluation of classification results

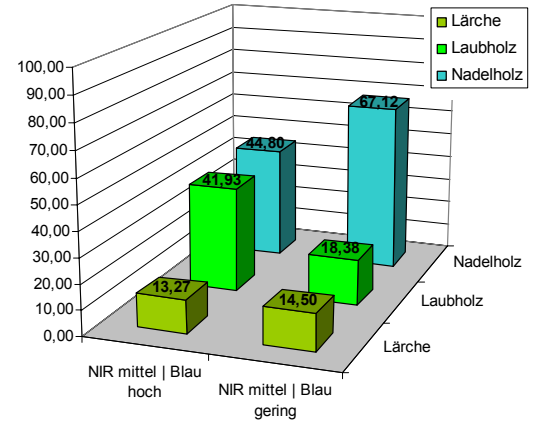


- classification based on band 4 (NIR) **„high“** and band 1 (blue): *Significant differences with regard to **tree type composition**!*

NIR ***high*** / blue ***high*** intensity
- *dominated by broadleaved, high proportion of coniferous*

NIR ***high*** / blue ***low*** intensity:
- *nearly pure broadleaved*

Evaluation of classification results

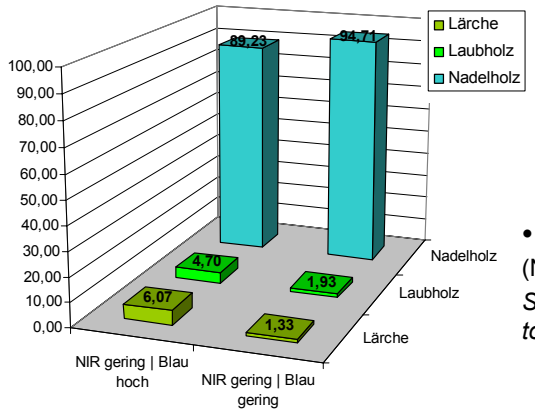


- classification based on band 4 (NIR) **„medium“** and band 1 (blue): *Significant differences with regard to **tree type composition**!*

NIR ***medium*** / blue ***high*** intensity
- *balanced distribution of coniferous and broadleaved trees with relatively high larch contribution*

NIR ***medium*** / blue ***high*** intensity
- *coniferous dominated at balanced larch/ broadleved proportion*

Evaluation of classification results

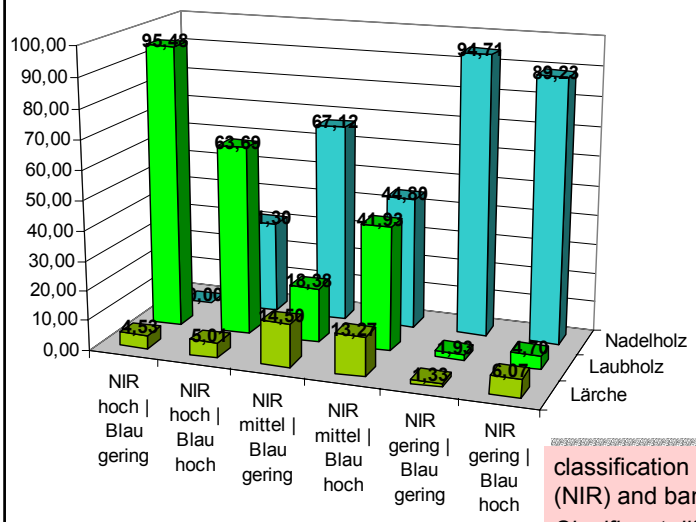


- classification based on band 4 (NIR) **„low“** and band 1 (blue):
  *Significant differences with regard to **tree type composition**!*

NIR ***low*** / blue ***high*** intensity
- *nearly pure coniferous with broadleaved trees and larch contribution*

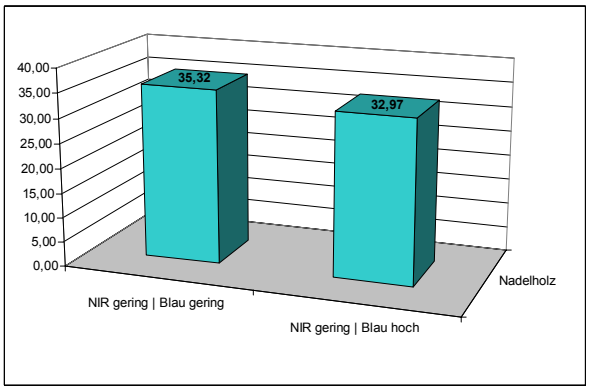
NIR ***low*** / blue ***low*** intensity
- *nearly pure coniferous*

Evaluation of classification results



classification based on band 4 (NIR) and band 1 (blue):
*Significant differences with regard to **tree type composition**!*

Evaluation of classification results



classification based on band 4 (NIR) **„low“** and band 1 (blue):

•*Significant differences with regard to* ***tree type composition*** **and**

- ***tree age***
- ***mean tree height***
- ***dbh***

Evaluation of classification results

Level 1:
Classification based on band 4 (NIR), band 1 (blue) and **Anisotropy Ratio**:

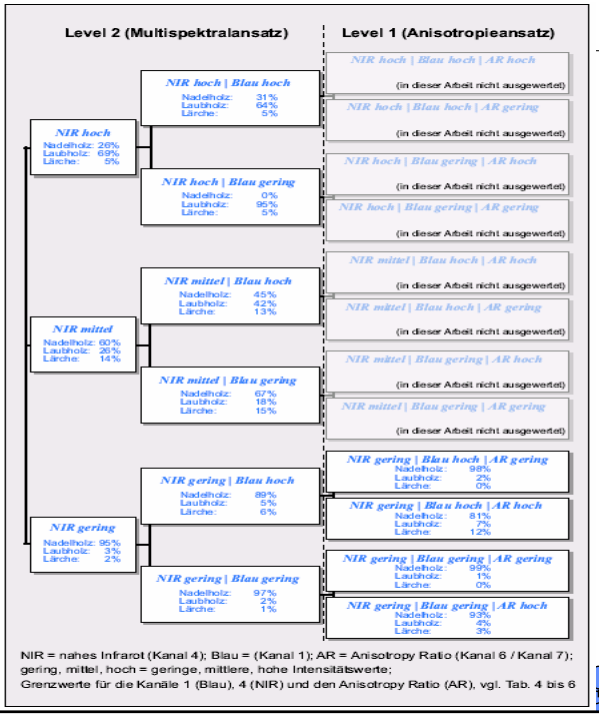
- 3 classes * 2 classes * 2 classes = 12 classes

Problem:

For some of the 12 new classes there are not enough inventory points available matching the selection criteria (20m buffer)!! Consequence:

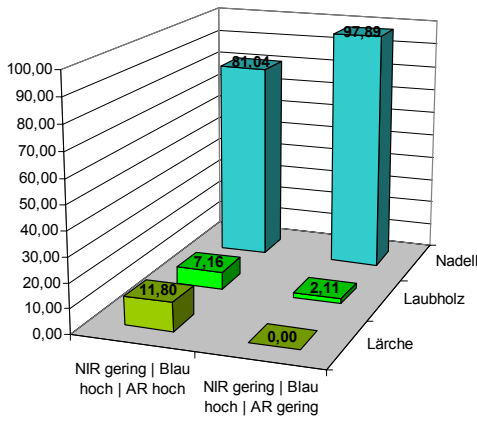
• the verification was restricted on classes represented by sufficient inventory points which are solely the homogeneoud coniferous stands!

Cold comfort:
- Homogeneous surfaces are more appropriated to firstly investigate a firstly investigated phenomenon like the „anisotropy effect“ as displayed in on track stereo data.



NIR = nahes Infrarot (Kanal 4); Blau = (Kanal 1); AR = Anisotropy Ratio (Kanal 6 / Kanal 7); gering, mittel, hoch = geringe, mittlere, hohe Intensitätswerte;
Grenzwerte für die Kanäle 1 (Blau), 4 (NIR) und den Anisotropy Ratio (AR), vgl. Tab. 4 bis 6

Evaluation of classification results

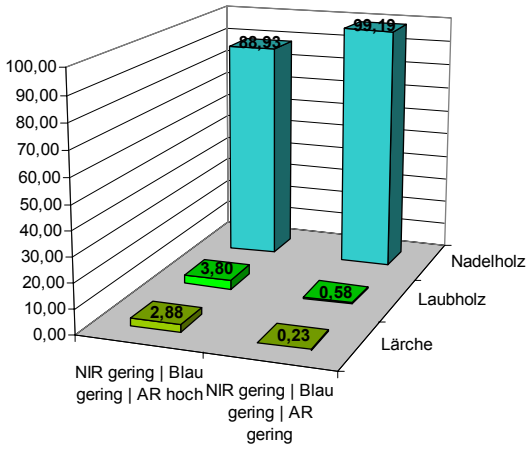


- subdivision of the classification based on band 4 (NIR) **„low“** and band 1 (blue) **„high“** according to the anisotropy ratio:

  *Significant differences with regard to **tree type composition**!*

Anisotropy property seems to be sensitive to tree type composition!!

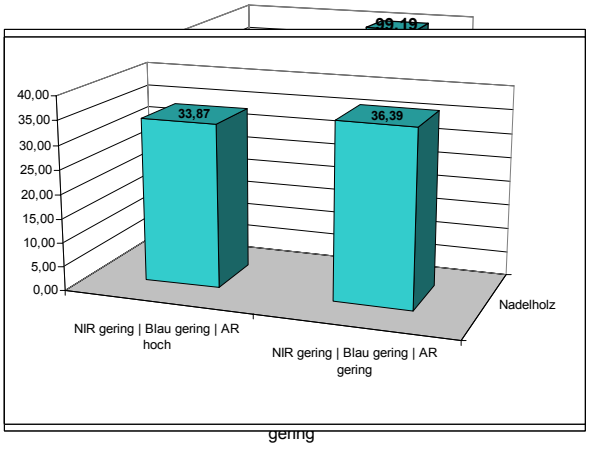
Evaluation of classification results



- subdivision of the classification based on band 4 (NIR) **„low“** and band 1 (blue) **„low“** according to the anisotropy ratio**:**

*differences with regard to **tree type composition low due to pure stands**!*

Evaluation of classification results



- subdivision of the classification based on band 4 (NIR) **„low“** and band 1 (blue) **„low“** according to the anisotropy ratio**:**

*Significant differences with regard to **tree type composition**!*

and:

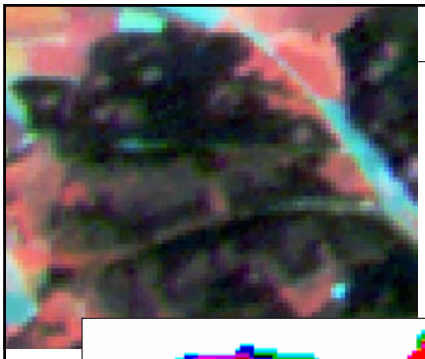
- tree age
- mean height
- mean dbh

Klasse	Merkmal	Fuzzy-Bereich			Grenzwert
		Fuzzy-Grenzwert	Zugehörigkeits Funktion	Fuzzy-Grenzwert	
NIR hoch	*Existence of Wald super-objects*	0 (nein)		1 (ja)	
	Mean Kanal 4	93		117	105
NIR mittel	*Existence of Wald super-objects*	0 (nein)		1 (ja)	
	Mean Kanal 4	93		117	105
	Mean Kanal 4	69		93	81
NIR gering	*Existence of Wald super-objects*	0 (nein)		1 (ja)	
	Mean Kanal 4	69		93	81

Level 2 class specification multispectral approach, MOMS-2P band 4 (NIR)

Klasse	Merkmal	Fuzzy-Bereich			Grenzwert
		Fuzzy-Grenzwert	Zugehörigkeits Funktion	Fuzzy-Grenzwert	
NIR hoch | Blau hoch	*Mean* Kanal 1	50,6		51,2	50,9
NIR hoch | Blau gering	*Mean* Kanal 1	50,6		51,2	50,9
NIR mittel | Blau hoch	*Mean* Kanal 1	50,4		51,0	50,7
NIR mittel | Blau gering	*Mean* Kanal 1	50,4		51,0	50,7
NIR gering | Blau hoch	*Mean* Kanal 1	49,7		50,3	50,0
NIR gering | Blau gering	*Mean* Kanal 1	49,7		50,3	50,0

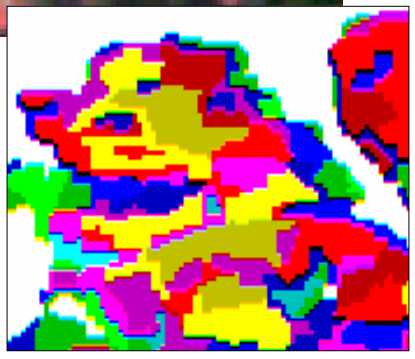
Level 2 class specification multispectral approach, MOMS-2P band 1 (blue)

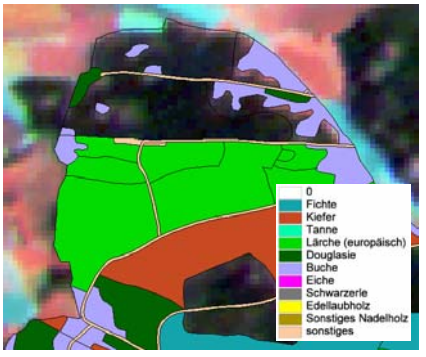


Erfassung von Bestandesgrößen

Probleme bei der Evaluierung mit Einzelbestandes-Weise erhobenen Begangsdaten

(Forst-Betriebs-Karten)





Final cartographic presentation of the evaluation:

NIR gering / blau gering / AR gering und NIR gering / Blau gering / AR hoch