Estimation of tropical forest biomass with image texture of radar images

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‘Estimation of tropical forest biomass using image texture of radar images’

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PARACOU experimental site in French Guiana

Question :

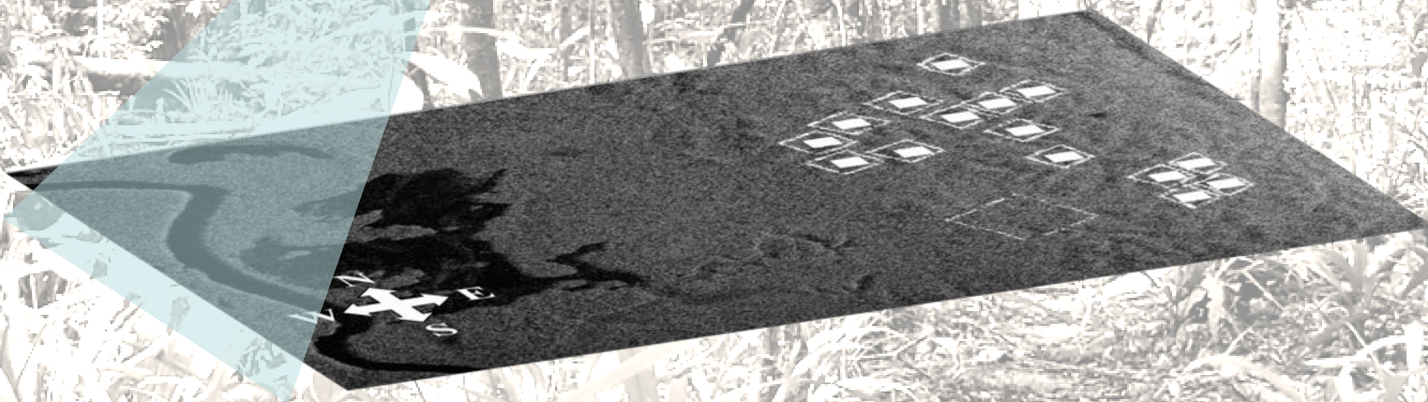
quantifying global carbon fluxes ?

forest biomass retrieving

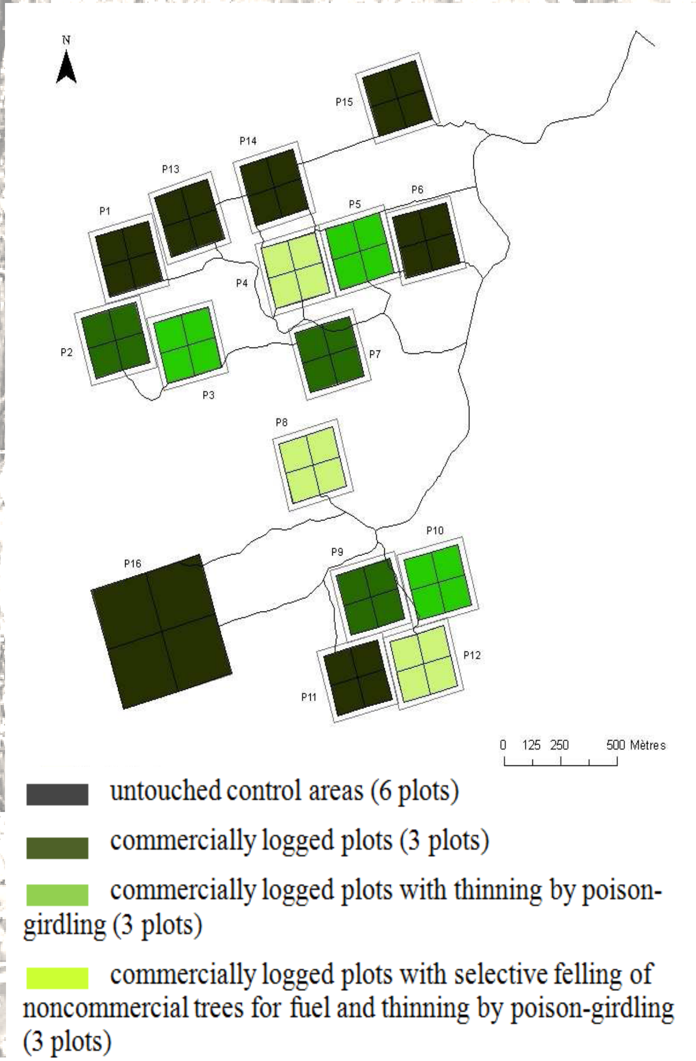
SAR acquisitions with the airborne ONERA SETHI system

fully polarimetric images at X, L, P band

From Dubois-Fernandez et al., 2010



Paracou: 15 measured experimental plots



6 control plots
3 sets of 3 plot each
with various thinning levels

	Plot	Biomass (t.ha^{-1})
Undisturbed forests	P1	389.8
	P6	466.0
	P11	428.5
	P13	436.5
	P14	434.4
	P15	438.3
Logged plots (Treatment 1)	P2	351.3
	P7	409.1
	P9	359.6
Logged plots (Treatment 2)	P3	308.0
	P5	310.7
	P10	318.0
Logged plots (Treatment 3)	P4	297.2
	P8	266.7
	P12	318.2

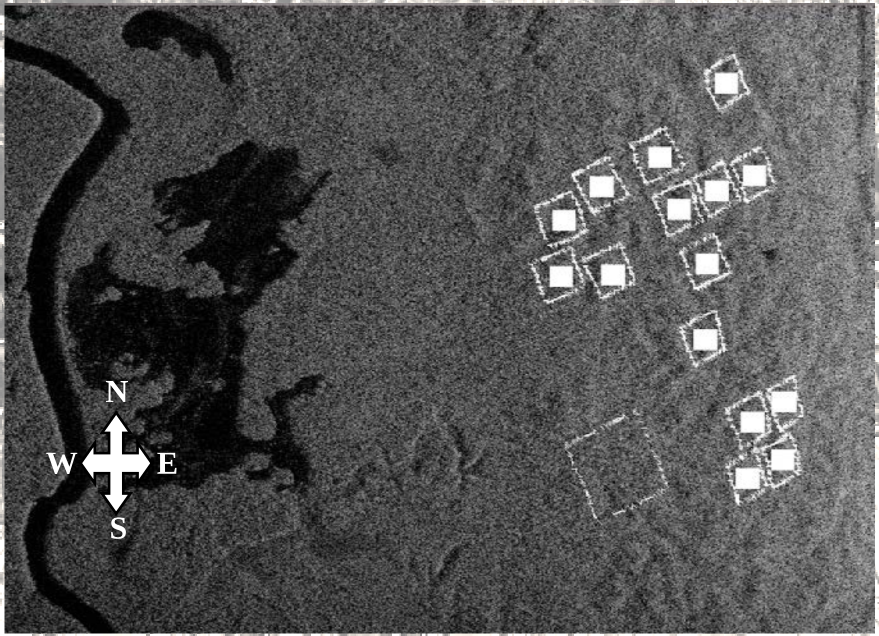
Biomass ranges from 266.7 to 466 t.ha^{-1}

100x100 pixels windows are selected in the SAR image

2 sets of texture features are calculated for each window:

- **features characterizing the basckscattering distribution (variance, skewness, kurtosis, entropy)**

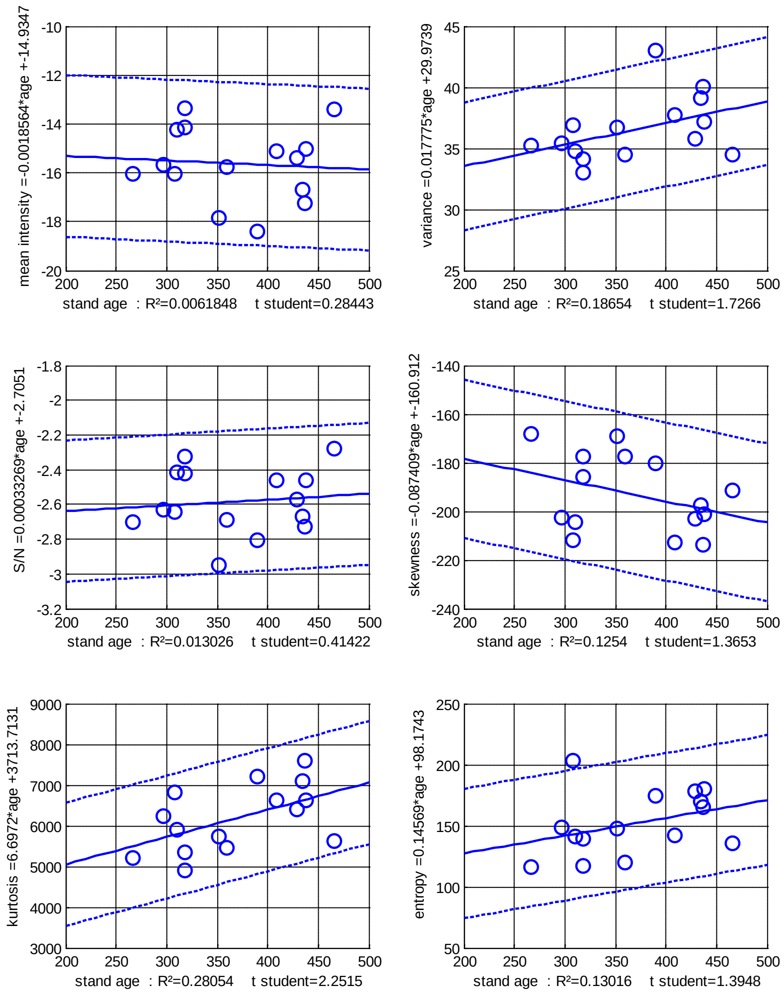
- **features based on the grey level co-occurrence matrix or GLCM (variance, energy, contrast, entropy…) (*Haralick, 1973) (pairs of horizontal joined pixels, 32 levels)***



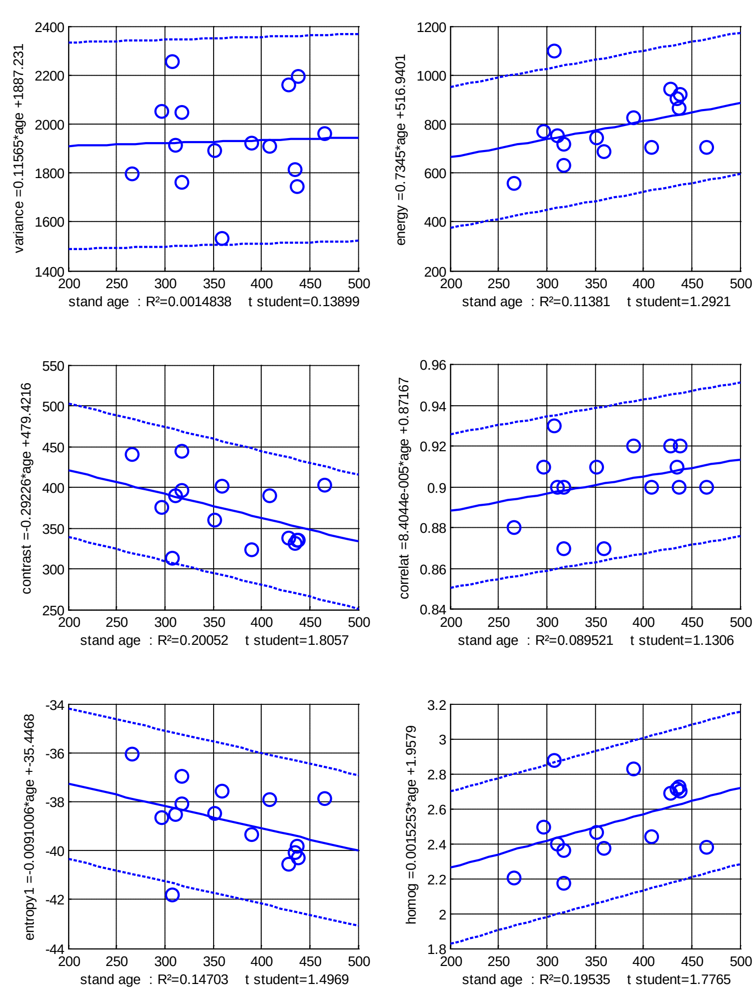
P band, HV SAR image

Texture features *vs* plot biomass regressions

- from σ° distribution

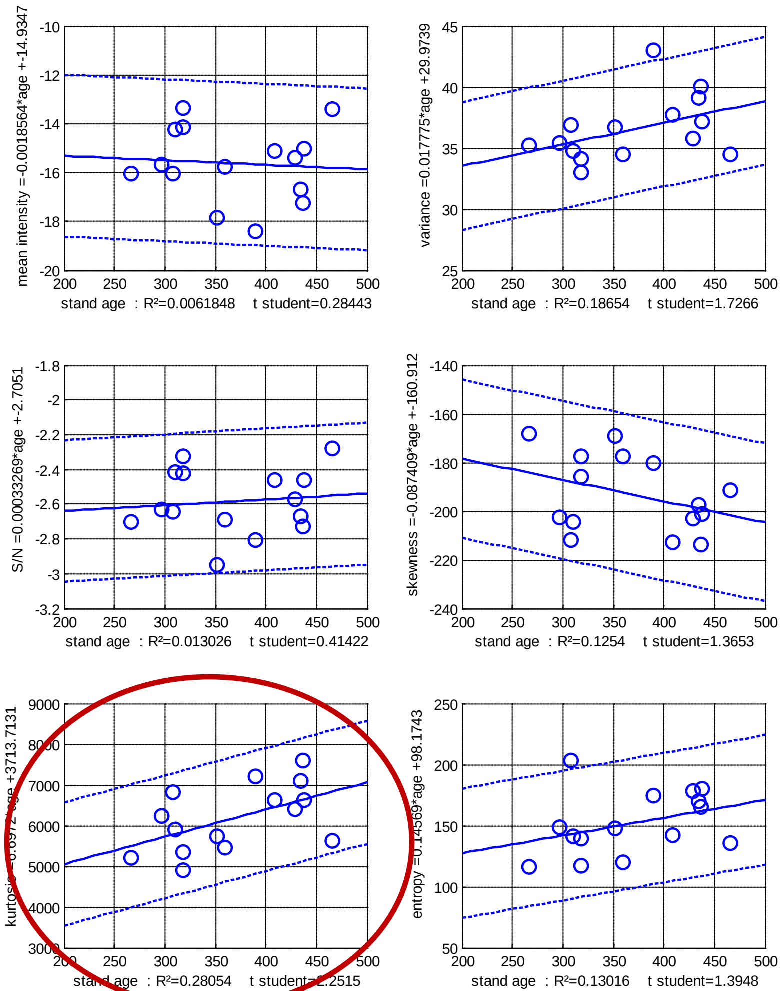


- from GLCM

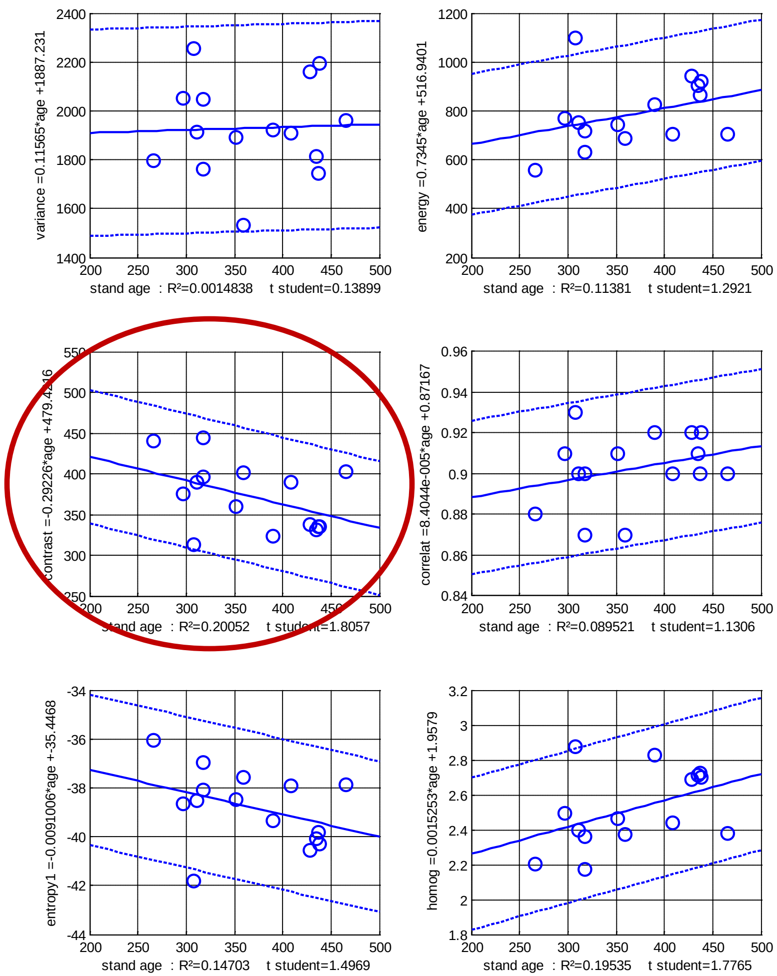


Texture features *vs* plot biomass regressions

● from σ° distribution



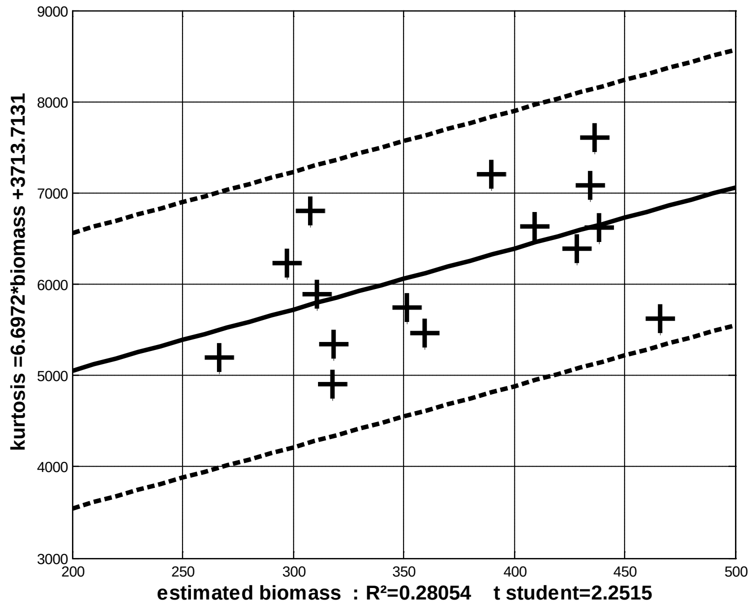
● from GLCM

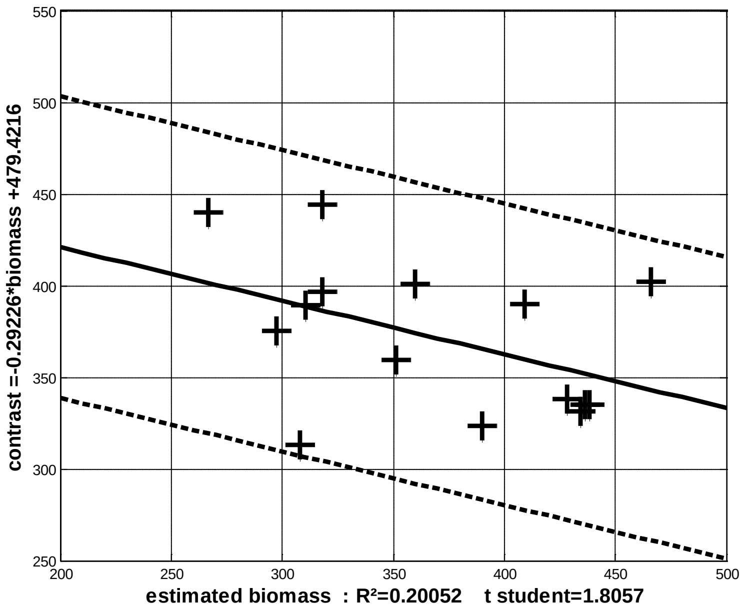


Texture features:

1) from σ° distribution kurtosis R^2=0.28

2) From GLCM contrast R^2=0.20





Correlation is poor: dispersion is large with respect to biomass range !

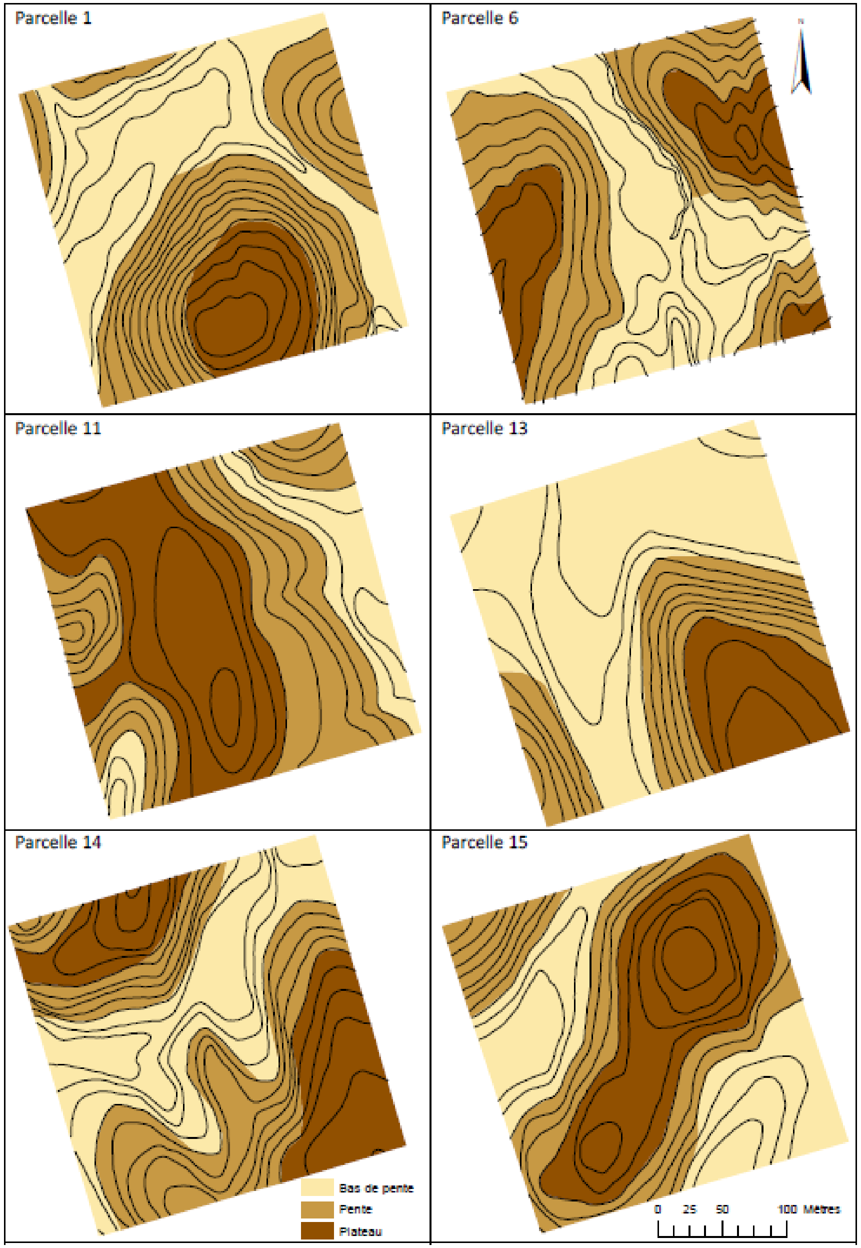
Structural characteristics of plots

Plots are settled in a hilly landscape

Topographical classes for the 6 control plots
P1, P6, P11, P13, P14, P15

Bottomlands
Hillsides
Hilltops

From F. Morneau, 2007



Edaphic constraints influence floristic composition and stand structure

Plots were characterized by their trunk dbh class distributions

> • as far as the global structures of the stands are concerned, the grouping resulted in more contrasted situations: block 1 (P1 to P3 and P8), the most heterogeneous, groups very different plots, characterised either by a lot of small trees (P1), a lot of trees in intermediate classes (P2) or a lot of big trees (P3 and P8). Block 2 (P6, P7, P10 and P12) groups plots differing according to the weight of intermediate and large diameter classes. Block 3 (P4, P5, P9 and P11) is the most homogeneous, grouping mainly plots where small diameter classes are highly represented.

Block 1 **small P1,**
intermediate P2,
big: P3, P8

Block 2 intermediate and big
P6, P7, P10, P12

Block 3 small P4, P5, P9, P11

From Gourlet-Fleury et al., 2004

Edaphic constraints influences canopy structure of plots

Plots are characterized by their trunk dbh distribution

Block 1 small P1,
intermediate P2,
big: P3, P8

Block 2 intermediate and big
P6, P7, P10, P12

Block 3 small P4, P5, P9, P11

S small, I intermediate, B big, IB intermediate and big

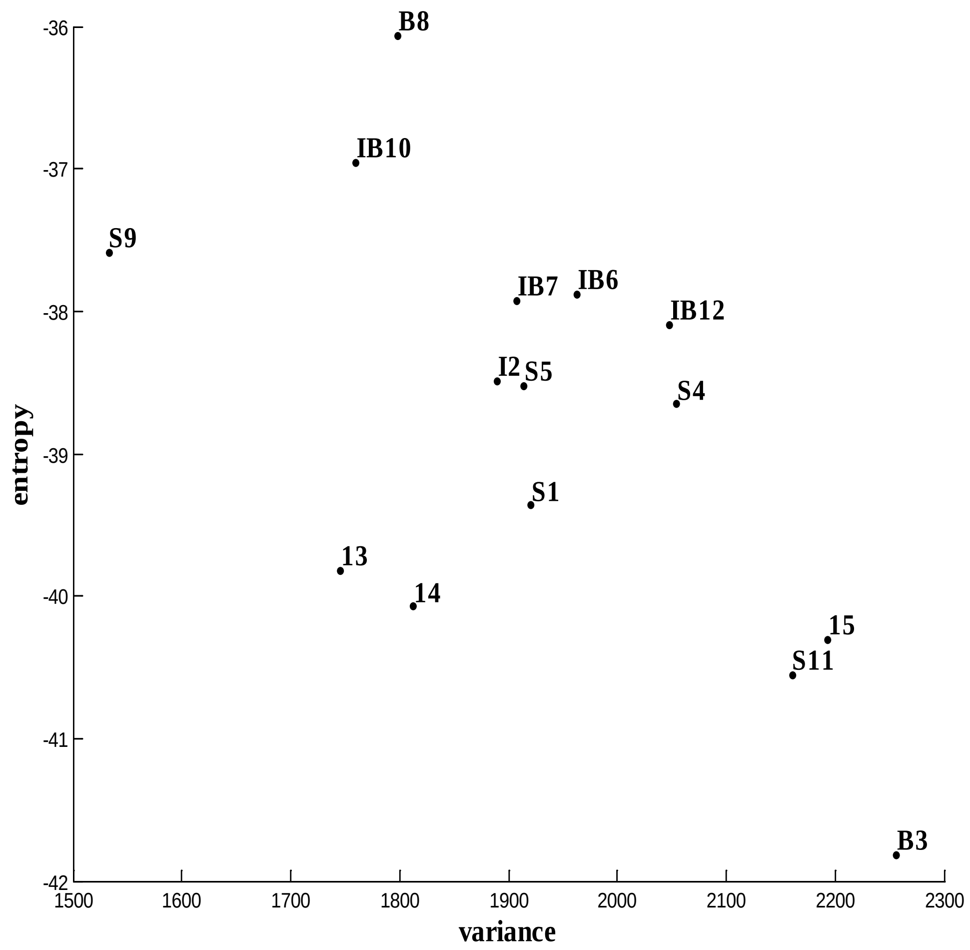
S1, I2, B3, S5, IB6, IB7, B8, S9, IB10, S11, IB12
and unknown
13, 14, 15

Texture features (GLCM)

: entropy *vs* variance

S small,
I intermediate,
IG, intermediate and big,
B big

No structural information
P13, P14, P15



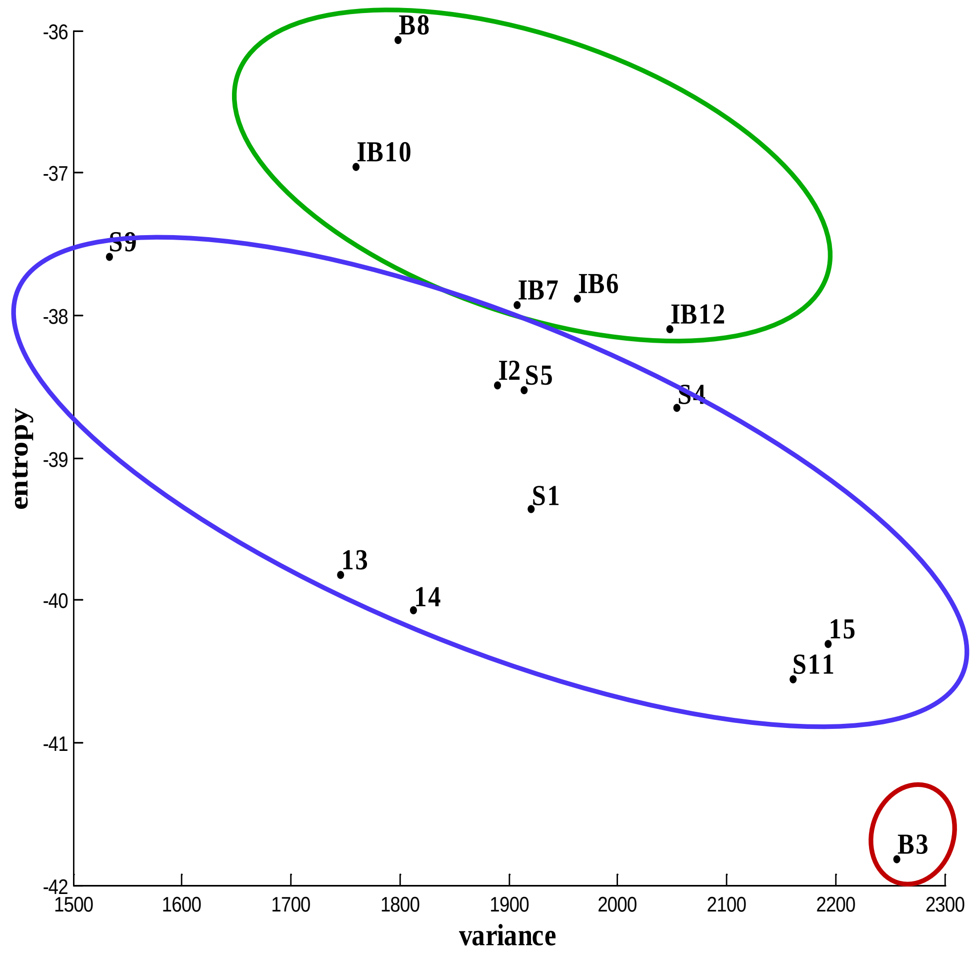
Texture features (GLCM): entropy *vs* variance

B big
IB, intermediate and big,

differ from

S small and I intermediate,
with P13, P14, P15

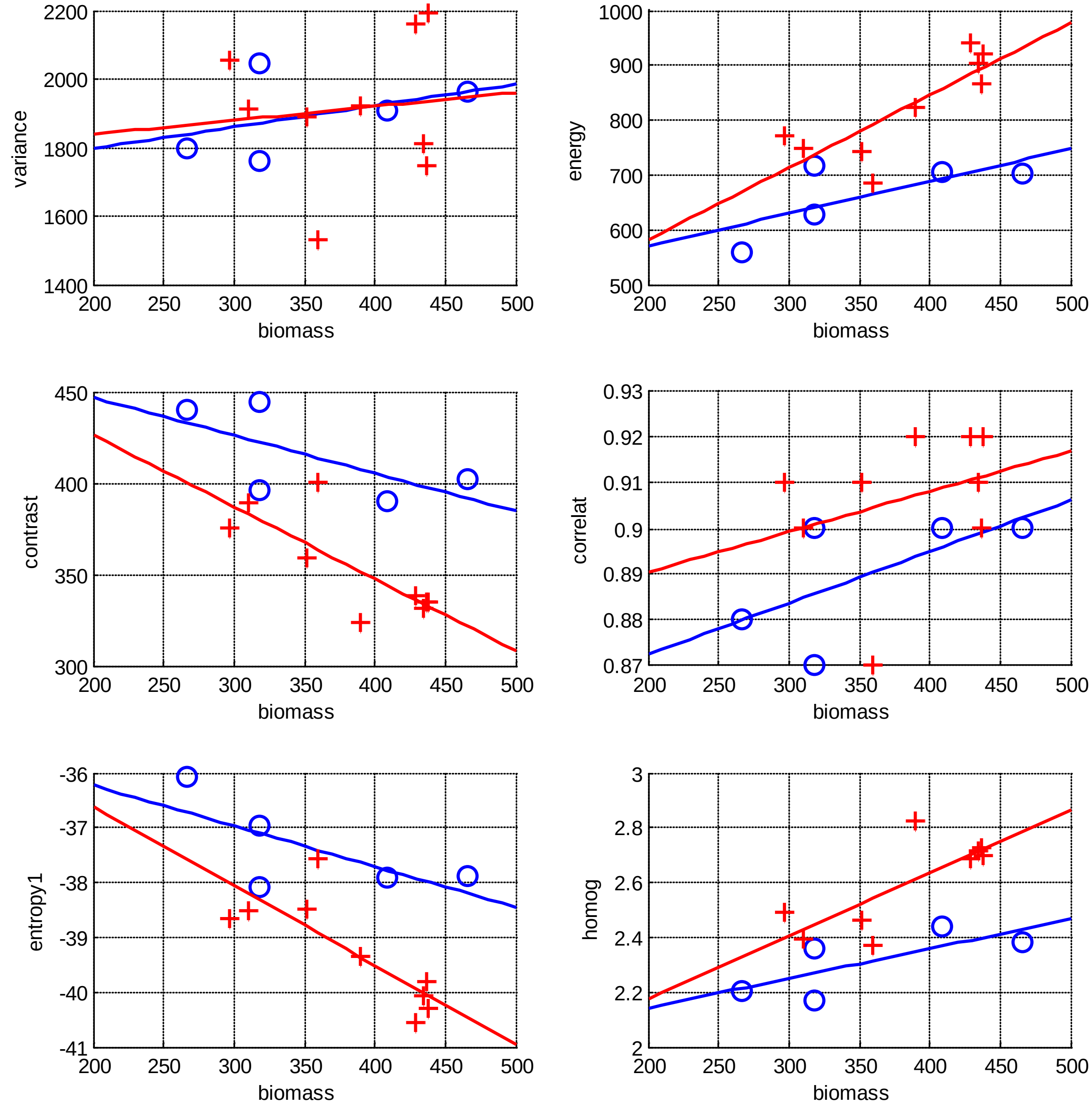
Apart P3…



Texture indicator: GLCM-based statistics with two structural classes

O : Big trees

+ : Small trees



Retrieving biomass accounting for structural classes

		Group "big", NdF=4		Group "small", NdF=8	
		R^2	t-student	R^2	t-student
Local statistics	variance	0.10	0.75	0.26	1.55
	skewness	0.54	2.40*	0.06	0.67
	kurtosis	0.37	1.72	0.43	2.31**
	entropy	0.44	1.98	0.51	2.72**
Texture from the GLCM	energy	0.50	2.21*	0.66	3.69***
	contrast	0.43	1.93	0.61	3.31**
	entropy	0.48	2.13*	0.64	3.53***
	homog	0.54	2.42*	0.60	3.23**

- ***discrimination of structural classes ?***
- ***variation with topography and soil ?***