



FORESEE Workshop - Forestry applications of remote sensing technologies
8-10 October 2014 - INRA Champenoux - France

Impact of image resolution on the quality of a photogrammetric DSM

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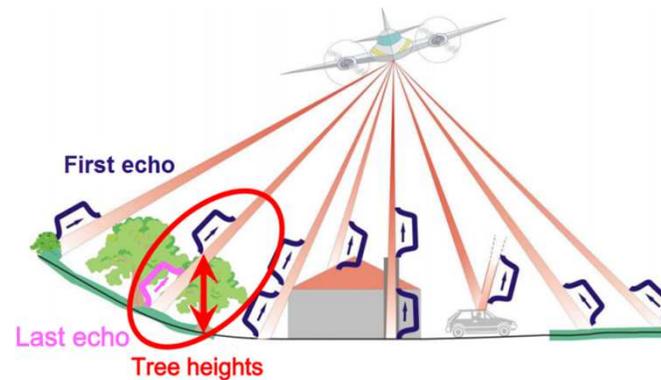
Introduction

- Assessing the accuracy of a photogrammetric DSM for forestry applications
 - Comparing spatial resolutions from different sensors
 - Deriving software parameters for a forest environment
 - Extracting a forest metric : dominant height

Measure of the forest structure

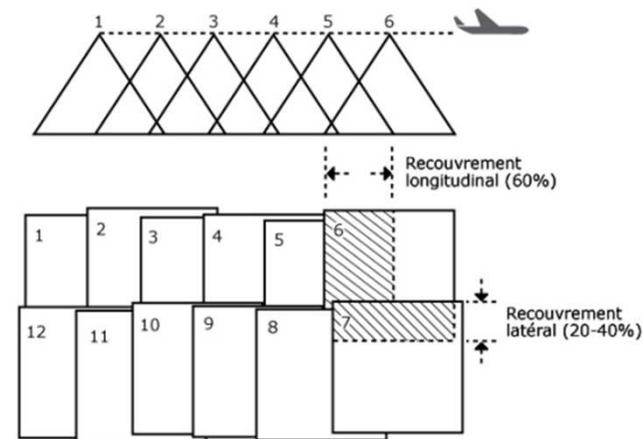
- Airborne Laser Scanning

- 3D point cloud
- DTM
- Cost ++
- End of the 20th century



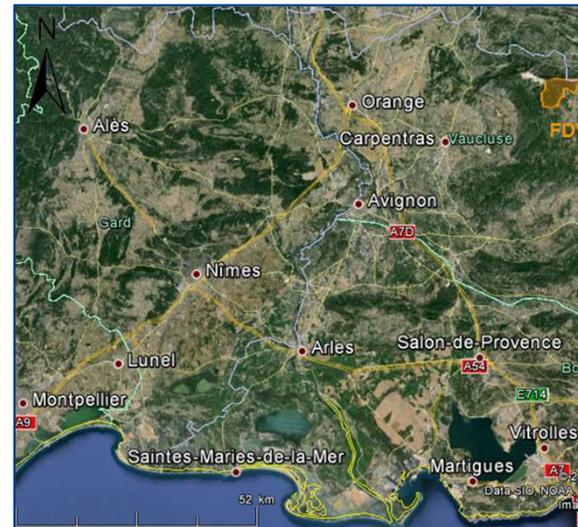
- Photogrammetry

- Passive technology
- 2,5D
- Cost +
- Since 1890's



Area of interest

- Managed state forest of Ventouret (Vaucluse – France)
 - Mixed forest about 2700 ha
 - Middle height mountain (1000 m – 1700 m)

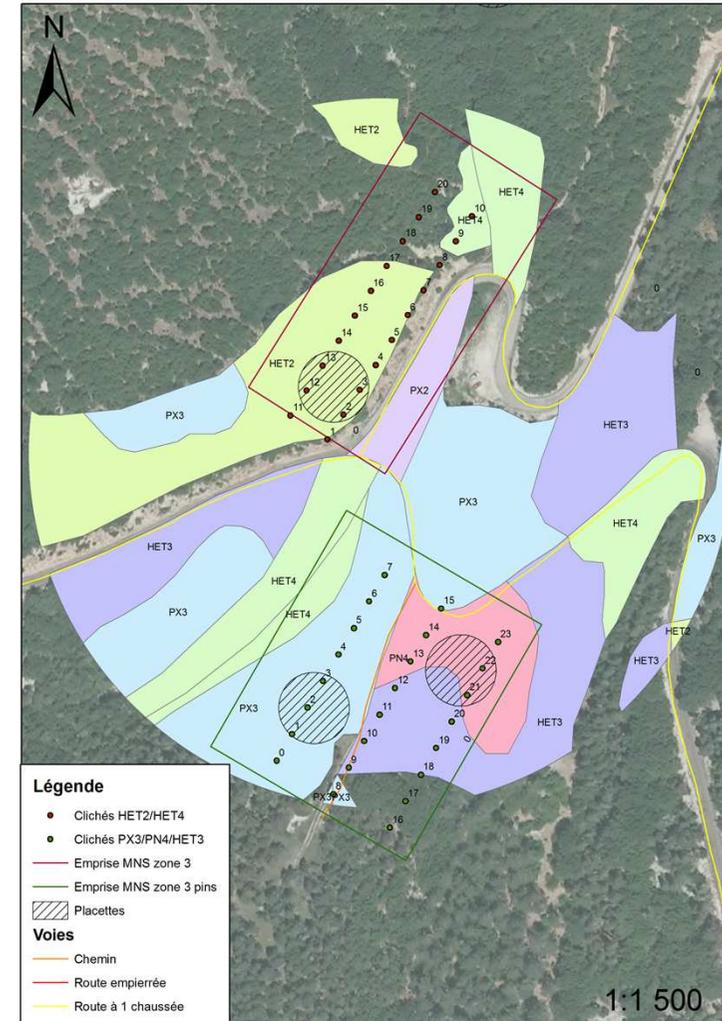


Database

- Airborne Laser Scanning
 - 2 points/m² (©IGN, Spring 2013)
- VHR Aerial photographs
 - SR = 28 cm (©IGN, June 2009)
 - SR = 20 cm (©IGN, May 2012)
- VHR Satellite images
 - Triplet Pléiades (©CNES, August 2013)
 - SR = 50 cm

Acquisition of images with an Unmanned Aerial Vehicle (UAV)

- 4 flights
 - Surface of 1 ha
 - Coverage of circa 80%
 - Flight height of 120 m
 - Spatial resolution of circa 2.5 cm



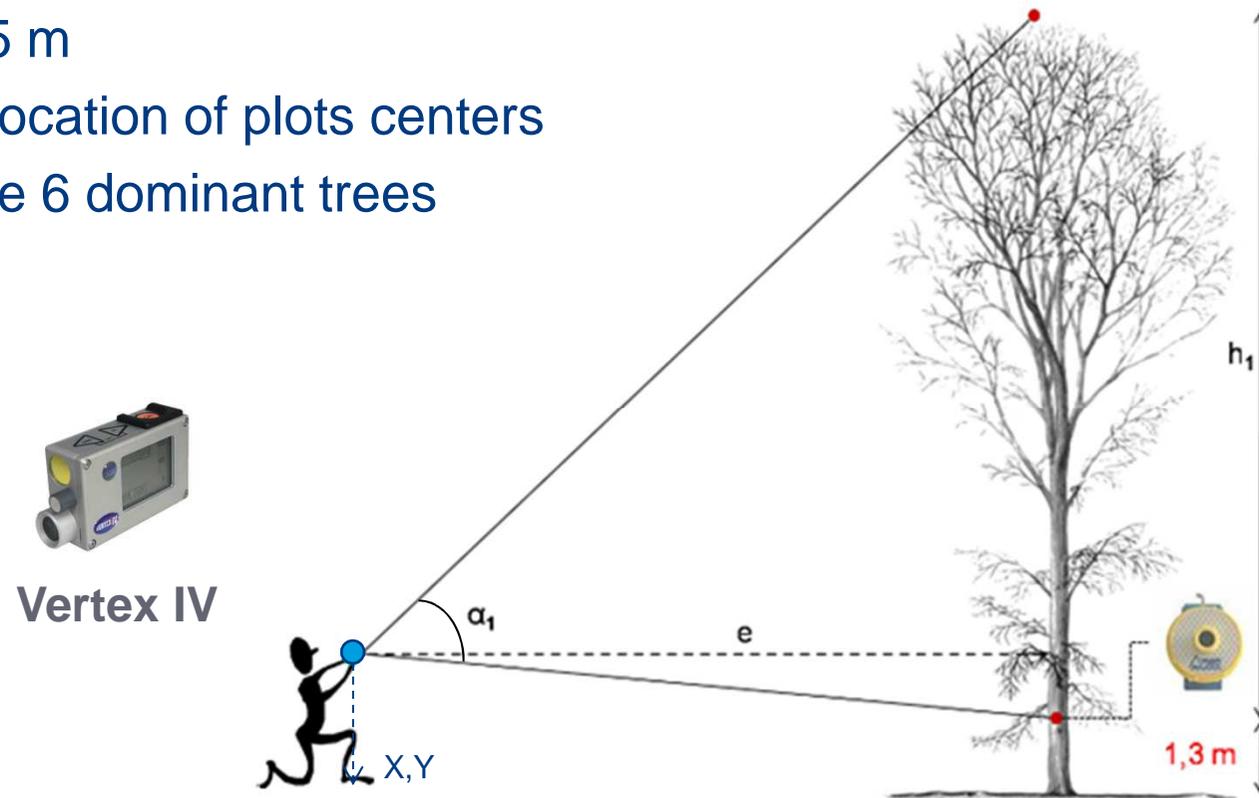
Flight plans

- Accurate geolocation
 - Measure of targets with a DGPS
 - Measure of specific features



Field measurements

- Measuring forest plots
 - Plot radius: 15 m
 - Accurate geolocation of plots centers
 - Measure of the 6 dominant trees

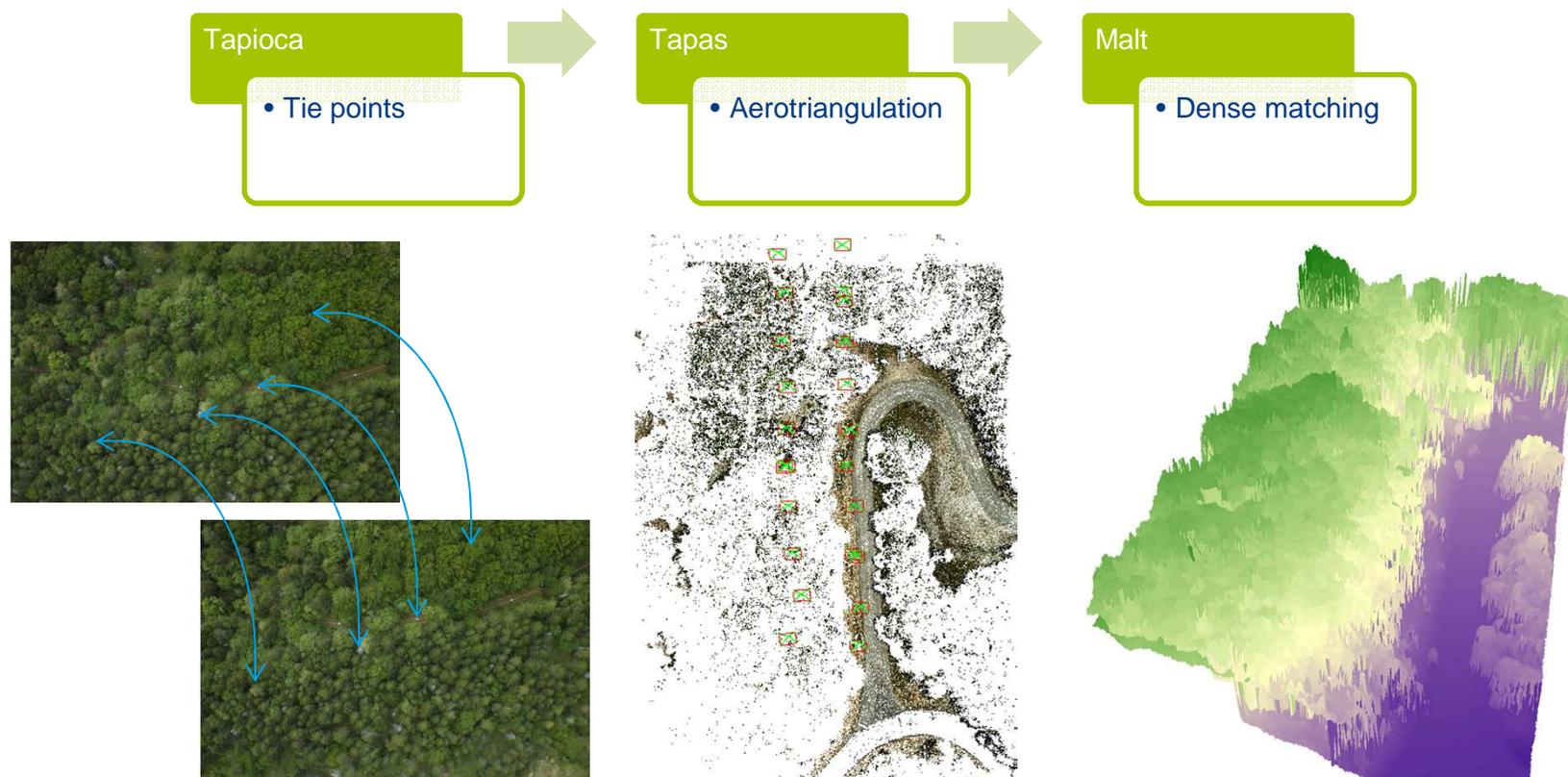


Which data?

- Regarding to (Lucie, 2014), a spatial resolution of 20 cm is the most appropriate for deriving forest parameters from UAV
- Pléiades images are resampled at 50 cm
- Aerial photographs from IGN are not resampled
- Airborne Laser Scanning DSM at 1.0 m

Multi-images matching software

- Open-source software MicMac (IGN)
- Pipeline in 3 steps



Dense matching parameters

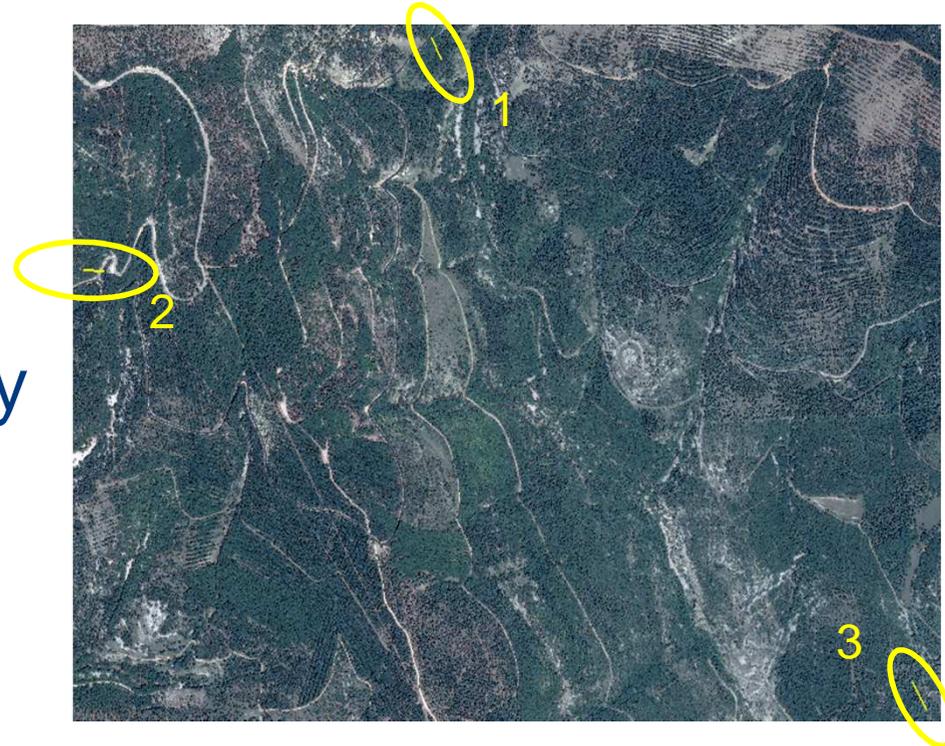
- According to (Vega, 2008) a windows size of 9x9 px² gives the best results in a hardwood forest

Settings	Number of visible images	Window size	Regularization	Resolution	CCC
Default	3	5x5	0.05	2	0.2
Advanced	2	9x9	0.005	1	0.0

Settings	UAV-ALS correlation (%)
Default	61.0
Advanced	70.1

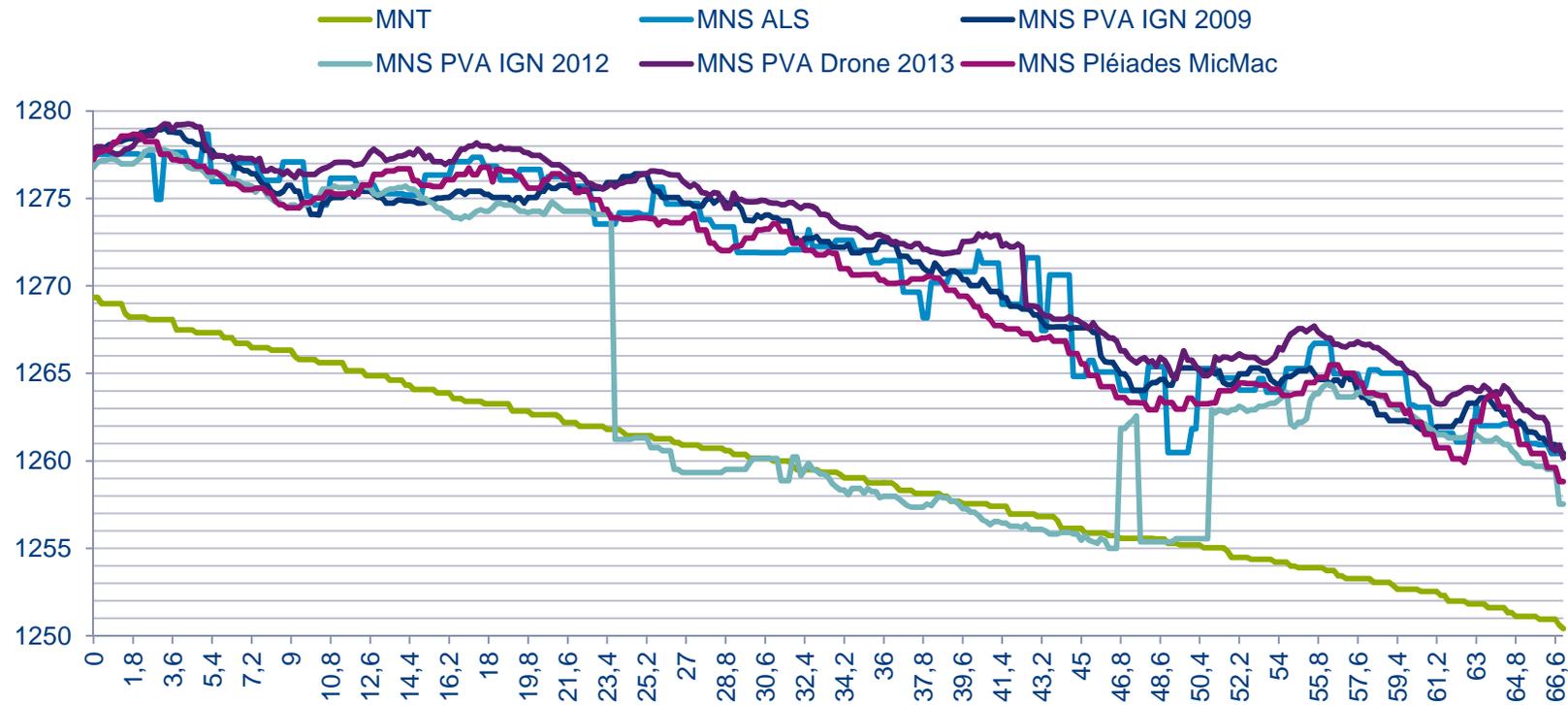
Assessing the MNS accuracy

- 3 transects
 - All data sources
 - Mixed species
 - Steep topography



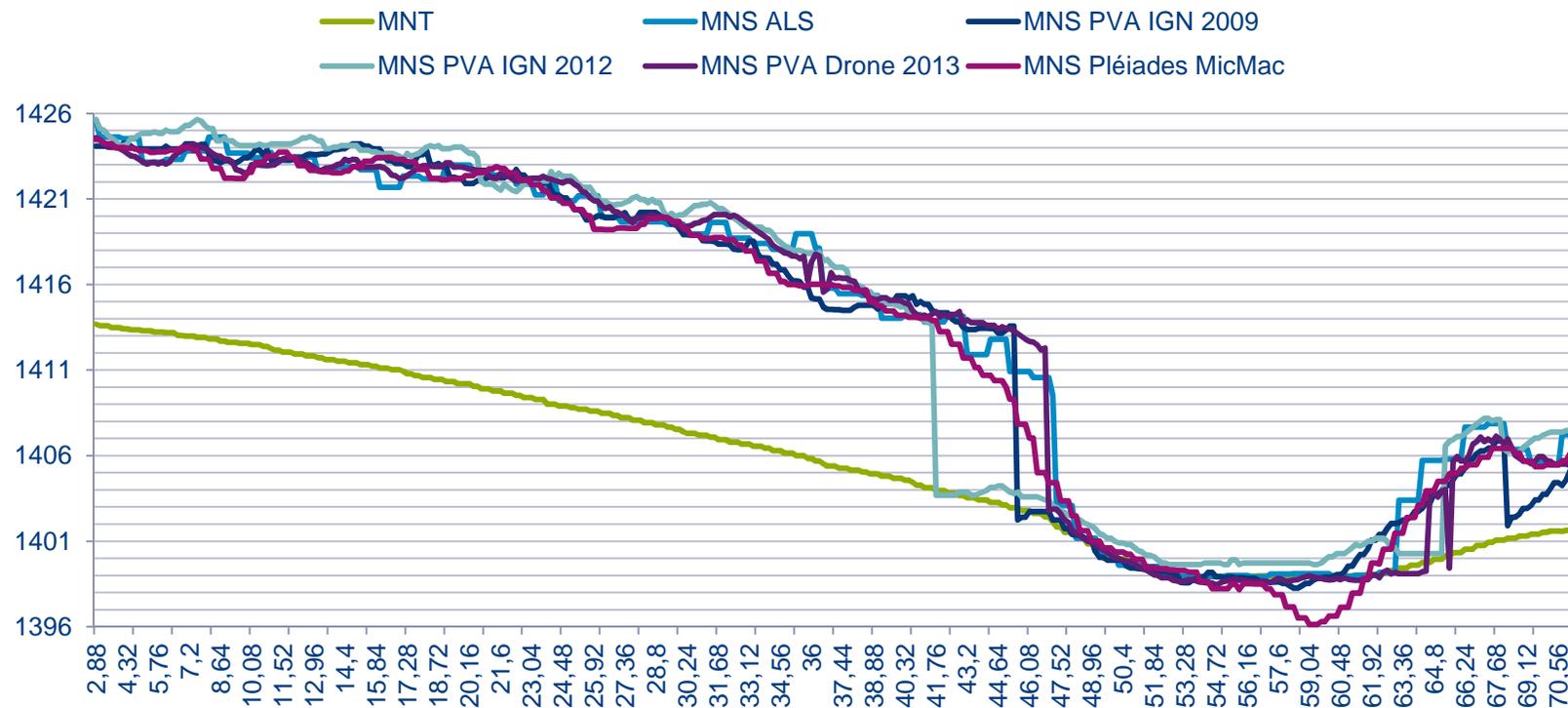
Transect n°1

- NW → SE (Beech – Pine)



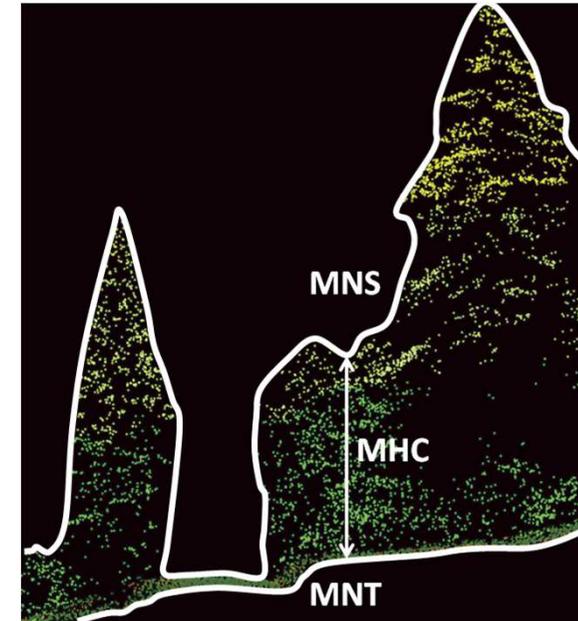
Transect n°2

- W → E (Beech – Pine)



Computation of a Canopy Height Model (CHM)

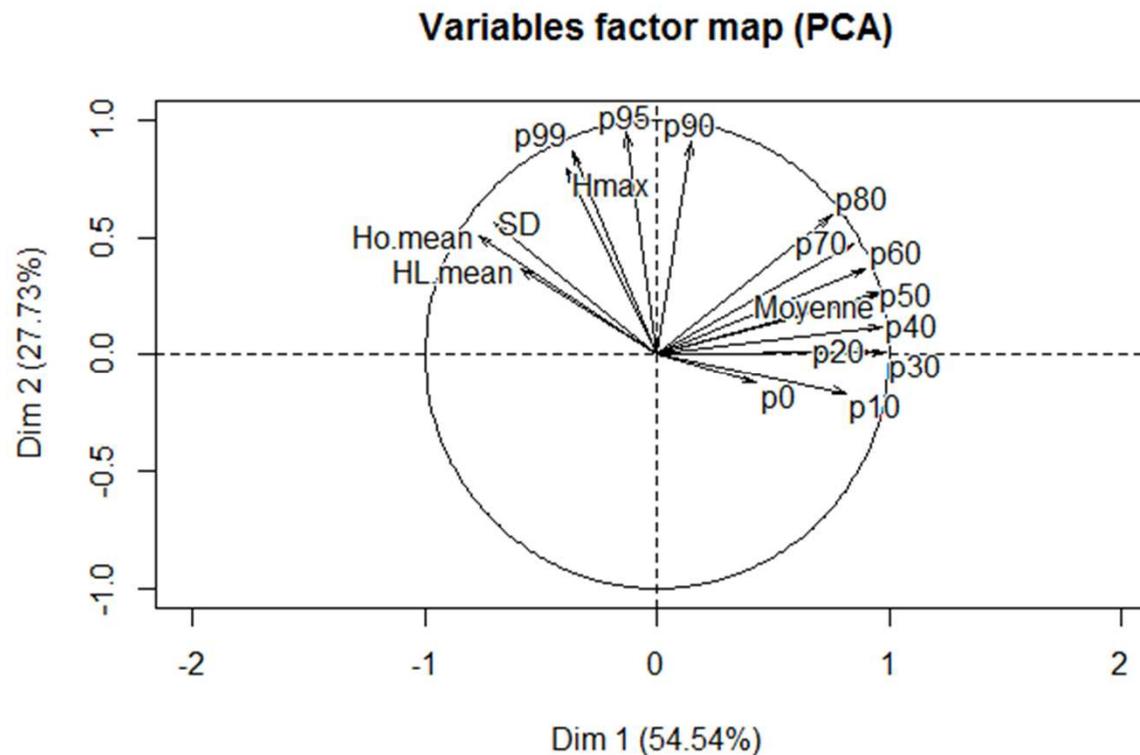
- $CHM = DSM_{photo} - DTM_{LiDAR}$
- Assessment of dominant height (H_0)
- Percentiles of height distribution
 - $p_0, p_{10}, \dots, p_{100}$
- 5 plots utilized for the test



Forest structure
(coloured point cloud)

Choice of a height indicator

- Principal Component Analysis (PCA)
 - The 2 first dimensions represent 82% of the information
 - H_{max} is the best indicator to explain the dominant height



Prediction of the dominant height

- Affine regression model
 - $H_0 = a + b \cdot H_{max} + \varepsilon$
 - Results by data source

Source	a (m)	b (m)	R ²	ε (m)
PVA UAV 2013	-4,25	1,15	0,69	2,16
ALS 2013	0,51	0,91	0,80	1,53
PVA IGN 2009	-6,98	1,32	0,62	2,42
PVA IGN 2012*	0,50	1,08	0,30	3,27
Pleiades 2013	-25,76	2,88	0,68	2,22

**Data excluded due to the time of acquisition*

Conclusion

- DSM computed from UAV images and ALS DSM seem very closed in despite of the difference of resolution
- DSM computed from 2012 aerial images is not accurate due to the time of acquisition (off-leaf season)
- DSM computed from 2009 aerial images and Pléiades images under assess the altitude
- Photogrammetric DSMs have a smoother texture than ALS DSM
- For deriving the dominant height, ALS remains the best sensor followed by the VHR sensor onboard the UAV

Thank you for your attention !



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