



ESA-MOST Dragon Cooperation

中国科技部-欧洲空间局“龙计划”合作

2017 DRAGON 4 SYMPOSIUM

2017年“龙计划”四期学术研讨会

PolTomSAR : Dragon4 id. 31470_2

**3-D Geo-Physical Characterization of Vegetated Areas
using SAR Polarimetry and Tomography (PolSAR, PolTomSAR)**

J. Sun, L. Ferro-Famil, E. Chen, W. Hong, Z. Li, E. Pottier, S. Tebaldini, X. Li



26-30 June 2017 | Copenhagen, Denmark

2017年6月26-30日, 丹麦 哥本哈根



TEAM COMPOSITION



Prof. Laurent FERRO-FAMIL



Prof. Eric POTTIER
IETR - University
of Rennes 1 (F)



Prof. Zengyuan
LI



Prof. Erxue CHEN

Institute of Forest Resources
Information Techniques
Chinese Academy of Forestry



Prof. Stefano
TEBALDINI



Prof. Fabio ROCCA
SAR lab- Politecnico
di Milano (I)



Prof. Wen HONG



Dr.
Qiang
YIN
Institute of Electronics, Chinese
Academy of Science



Prof.
Xinwu
LI



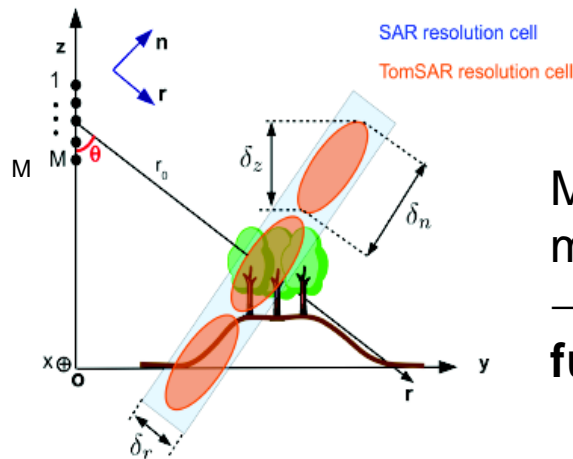
2017年“龙计划”四期
Center for Earth Observation and
Digital Earth
2017年6月26-30日, 丹麦·哥本哈根



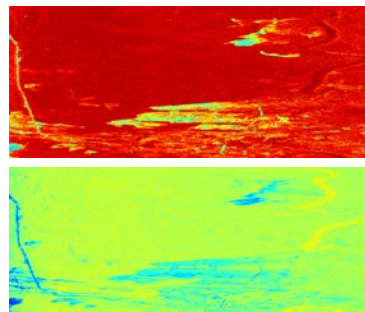
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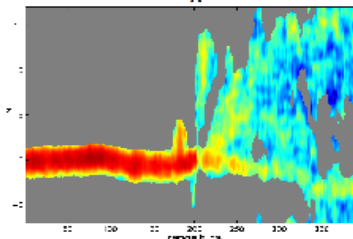
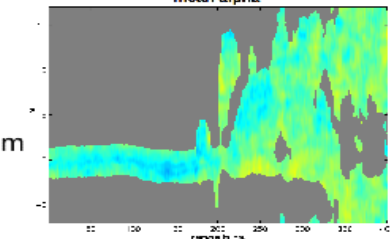
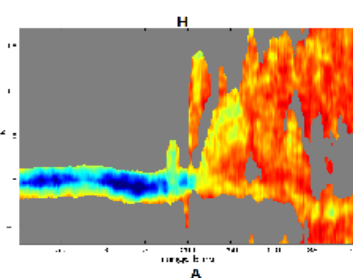
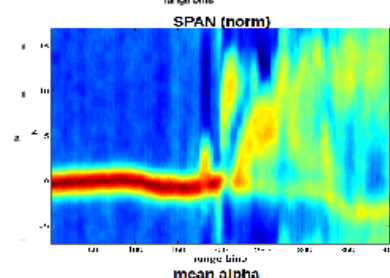
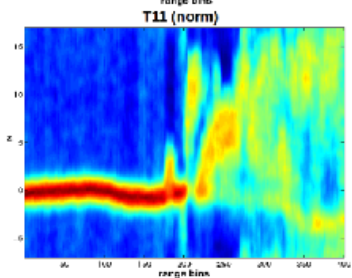
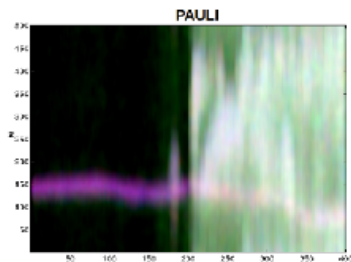
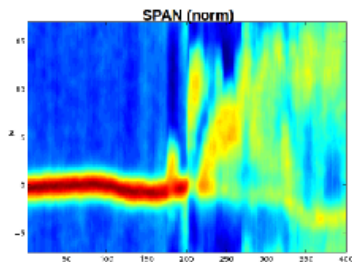
- **TomoSAR processing techniques for Spaceborne SAR missions**
 - preparation of the SAOCOM-CS/PARSIFAL mission projects
- **Biomass estimation over tropical forests at P band**
 - preparation of the BIOMASS mission
- **Achievements and exchanges**



→
full rank polarimetry



Full rank polarimetry



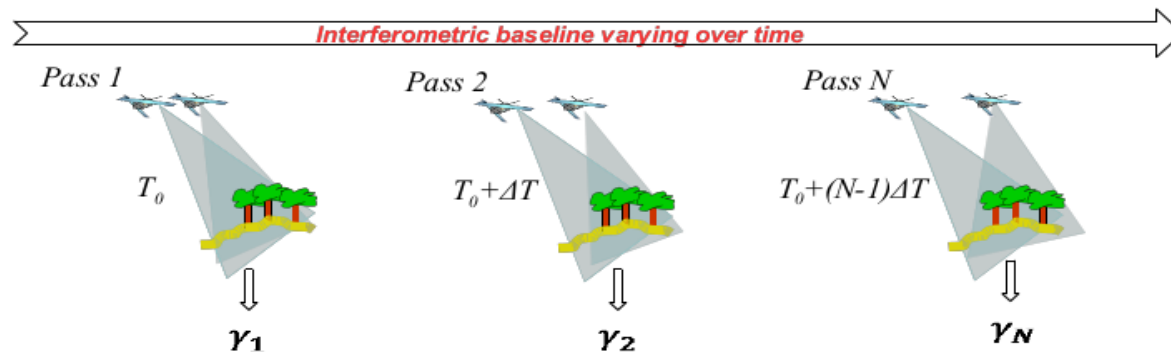
Dornstetten airborne

PolTomSAR data set

- DLR E-SAR
- L-Band
- 21 tracks: average baseline 20m
- Tomographic resolution
 $\delta_z = 2\text{m}$

Single pass systems:

- Cartwheel
- Tandem-X
- Tandem-L
- SAOCOM



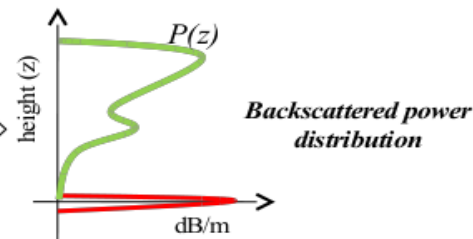
Processing:

Coherence vector
($N \times 1$)

$$\gamma = \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \vdots \\ \gamma_N \end{bmatrix}$$

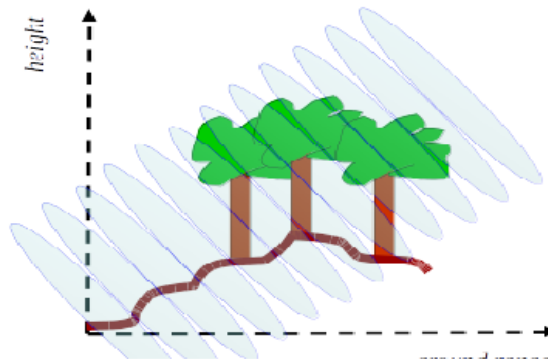
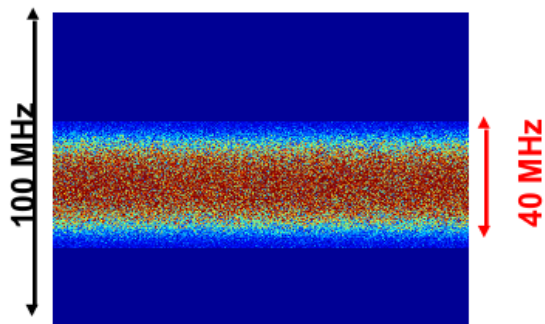


**TomoSAR
processing**

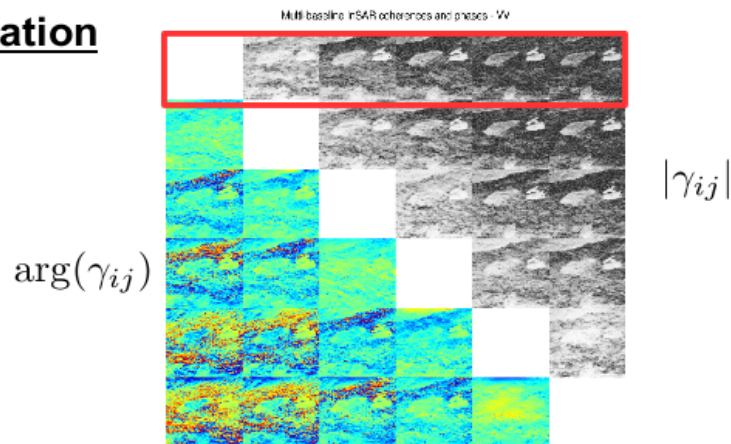


Interferometric pair are acquired nearly simultaneously
→ Intrinsically robust to temporal decorrelation:

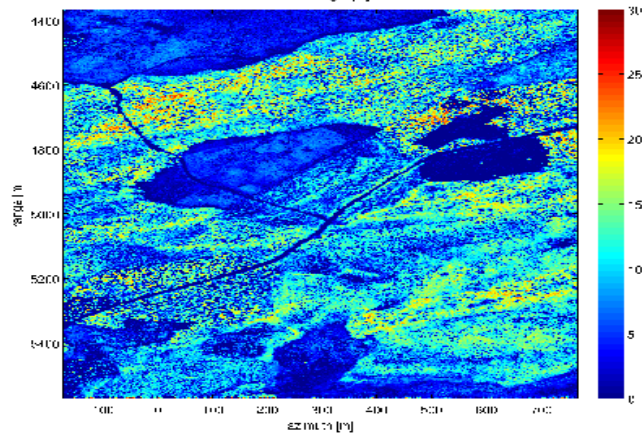
Range resolution reduction



Loss of redundancy & information

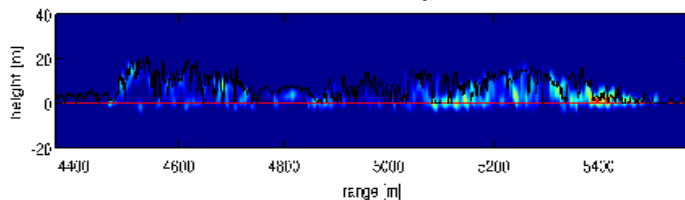


Forest height

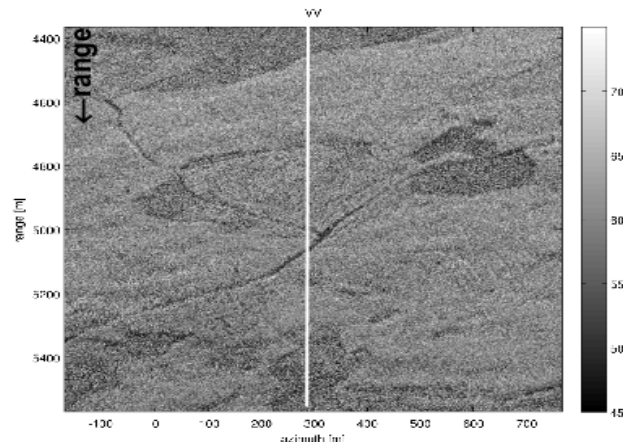


$B_f = 100 \text{ MHz}$

VV SAR Geometry

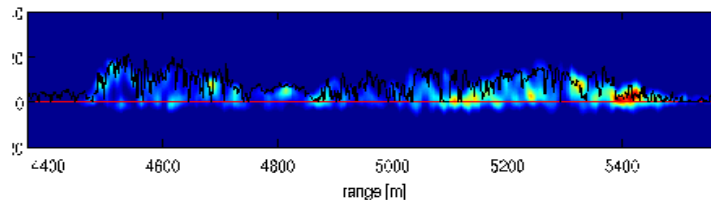


VV intensity

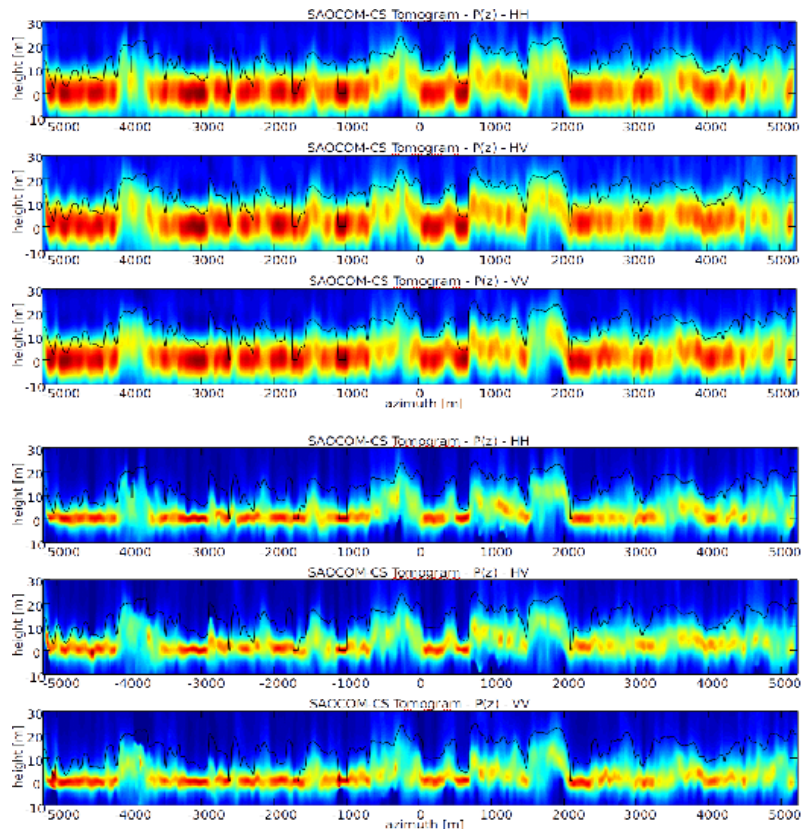


$B_f = 40 \text{ MHz}$

VV SAR Geometry



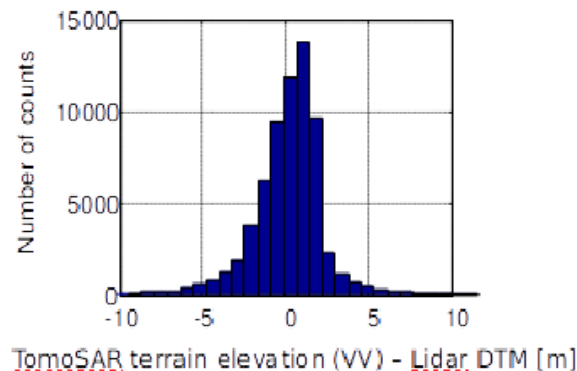
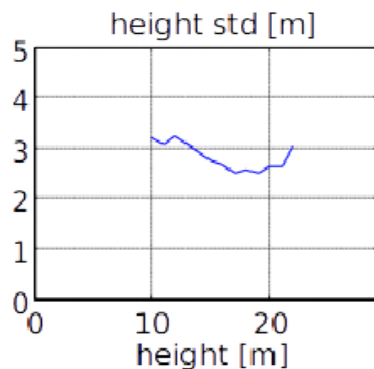
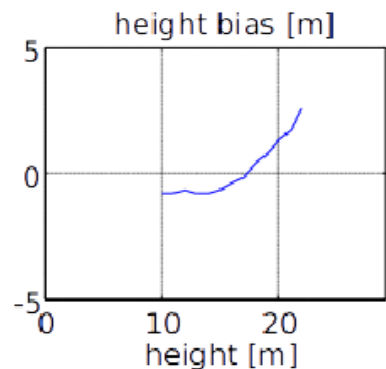
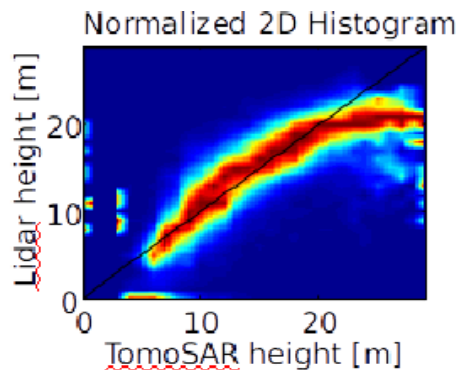
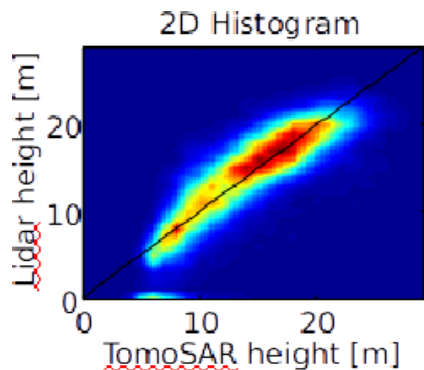
- Comparable performance for terrain topography and tree height



BEAMFORMER

VS

**ADAPTED
CAPON METHOD**



M PolSAR images

$$\mathbf{y}_{PS} = \begin{bmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \\ \mathbf{y}_3 \end{bmatrix} \in \mathbb{C}^{3M}$$

$$\mathbf{R}_{PS} = \begin{bmatrix} \mathbf{R}_{11} & \mathbf{R}_{12} & \mathbf{R}_{13} \\ & \mathbf{R}_{22} & \mathbf{R}_{23} \\ & & \mathbf{R}_{33} \end{bmatrix}$$

$$\gamma_{ij}(w_1, w_k)$$

$$\gamma_{ij}(w_2, w_k)$$

$$\gamma_{ij}(w_3, w_k)$$

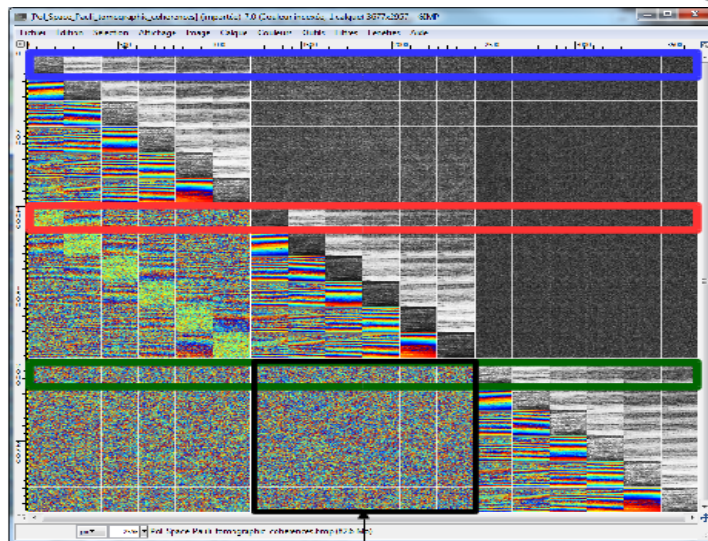
Full rank analysis strategies

- Full-rank P-Capon (LFF et al. 2012)

$$\mathbf{R}_{PS} \longrightarrow \sigma(z)\mathbf{T}(z)$$

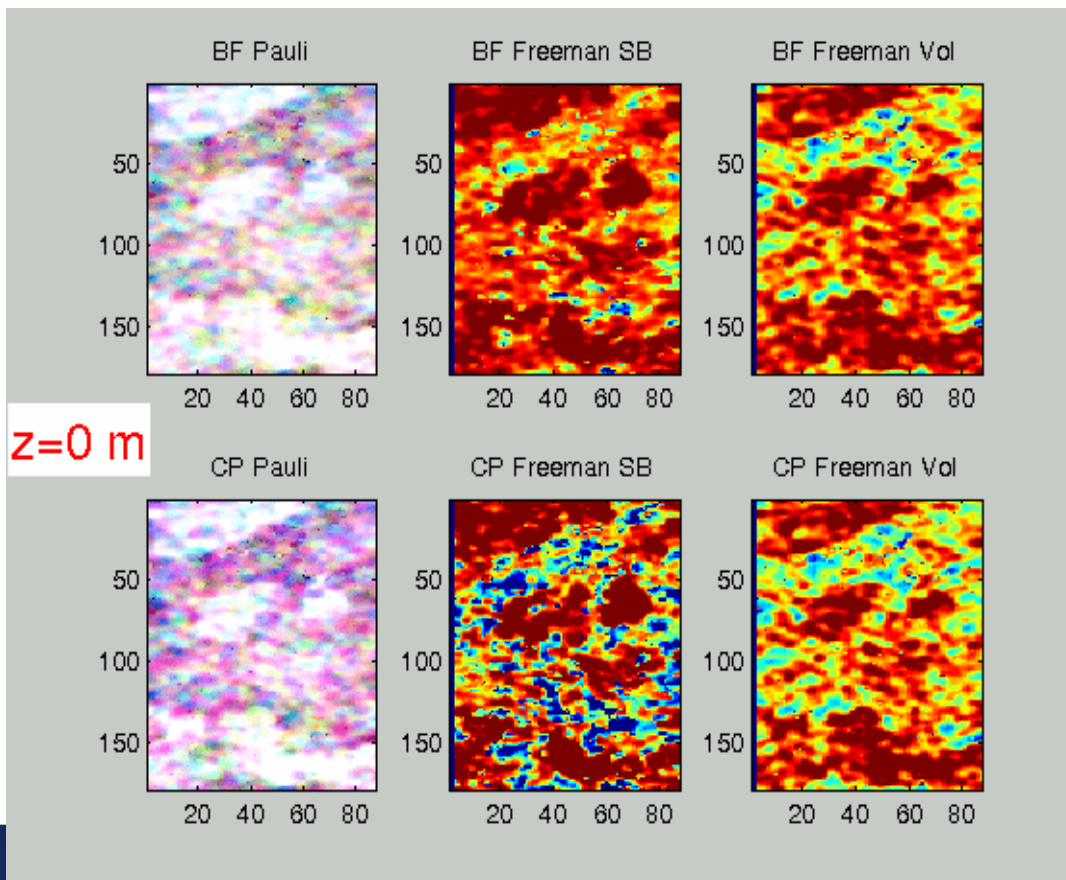
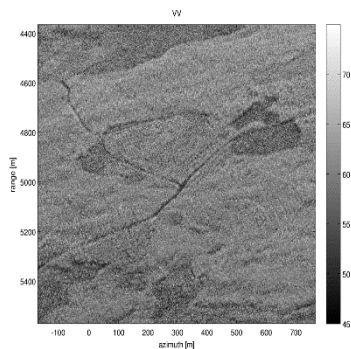
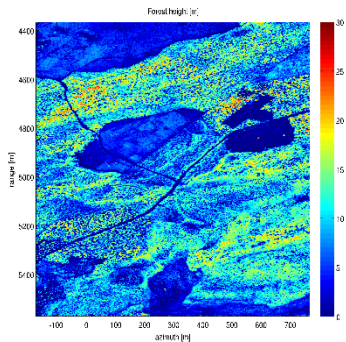
- SKP decomposition (Tebaldini 2009)

$$\mathbf{R}_{PS} = \sum_i \mathbf{T}_{P_i} \otimes \mathbf{R}_{S_i} \longrightarrow \sum_i \sigma_i(z) \mathbf{T}_{P_i}$$



$$\mathbf{R}_{ij} \in \mathbb{C}^{M \times M}$$

Interpolation techniques:
see paper at IGARSS 2017



TropiSAR campaign

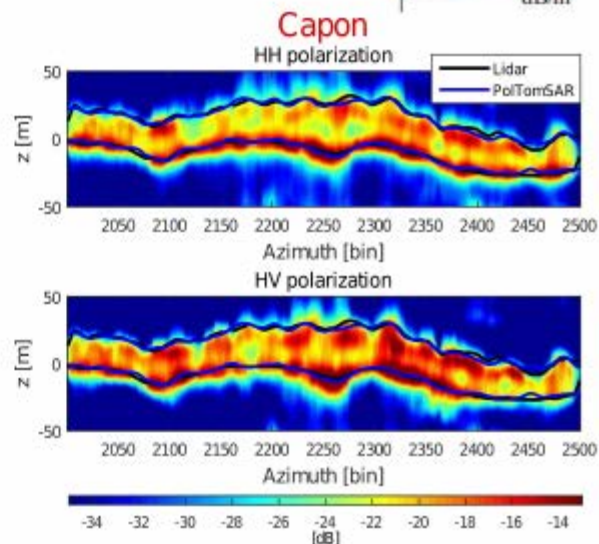
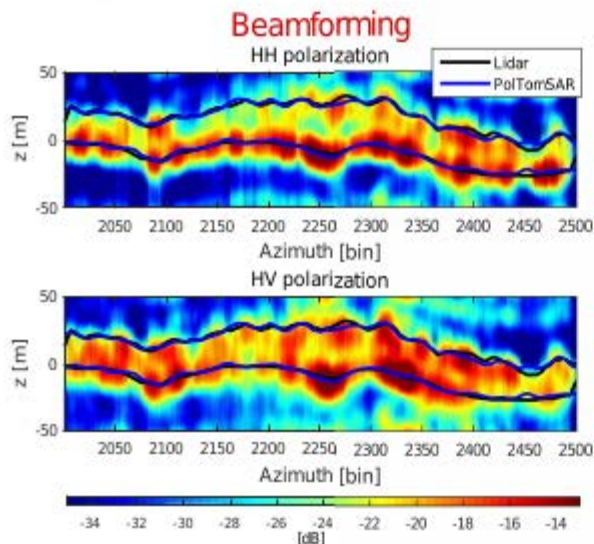
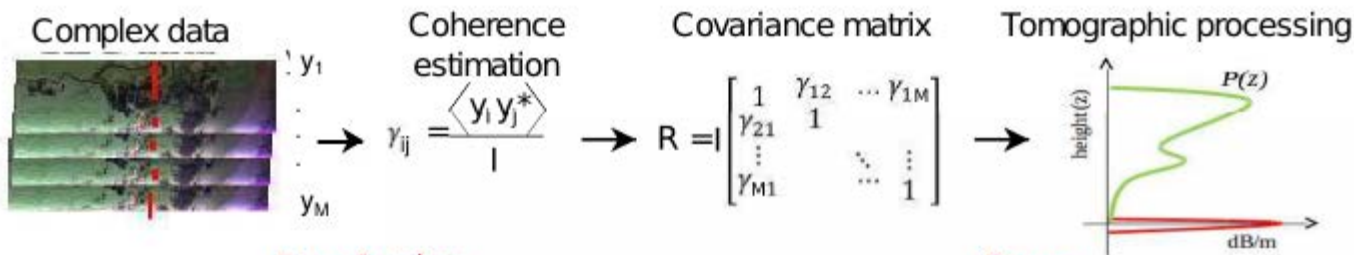


- The ECOFOG Sites
- Nouragues
 - Paracou
 - Arboceel
- The Calibration site
- Rochambeau
- Other site
- Marais de Kaw

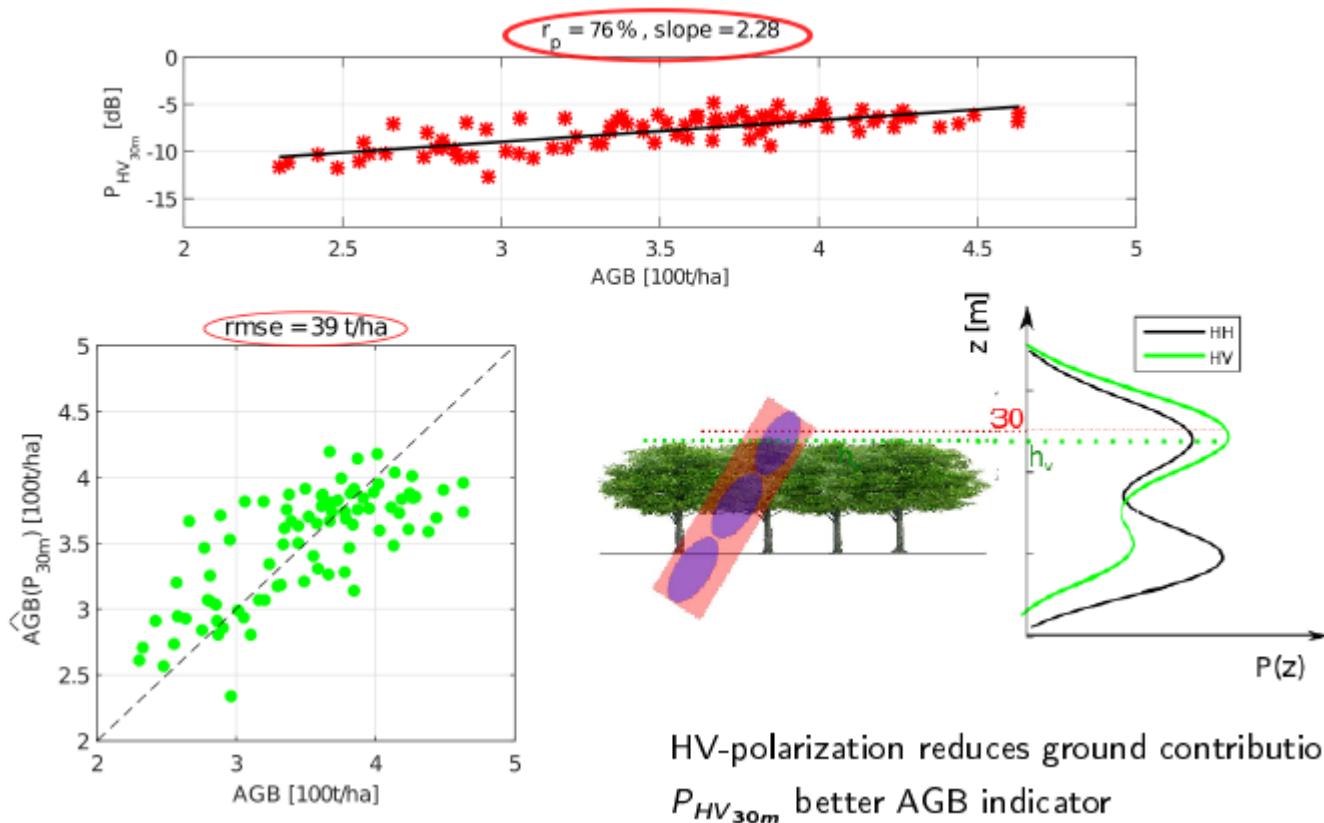
Paracou test site



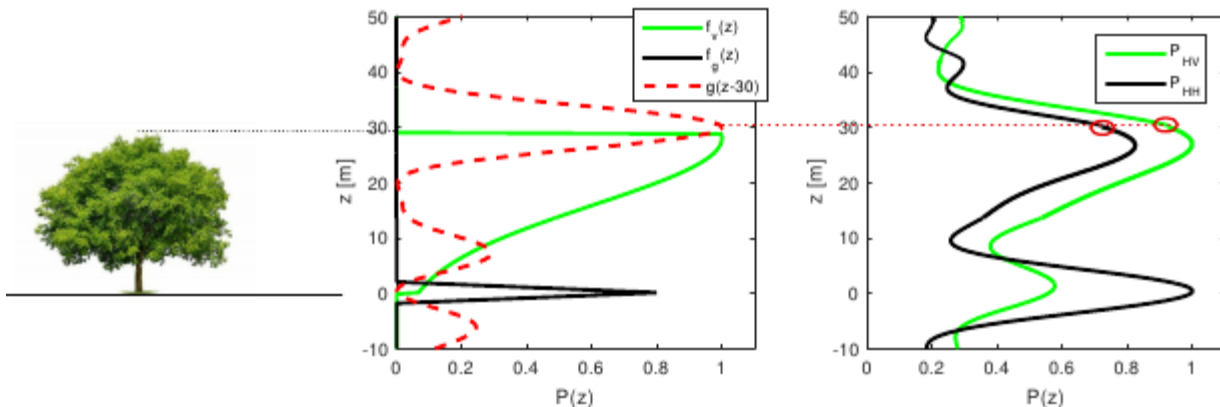
- TropiSAR campaign, 2009
- ONERA SETHI
- P-Band
- Resolutions:
 - Azimuth: $\delta_a = 1.245m$
 - Range: $\delta_r = 1m$
 - vertical: $\delta_z = 20m$
- 6 tracks



$$\widehat{AGB} = \alpha_1 P_{HV_{30m}} + \alpha_2$$



$$P_{30m} \propto \int f(z)g(30-z)dz$$



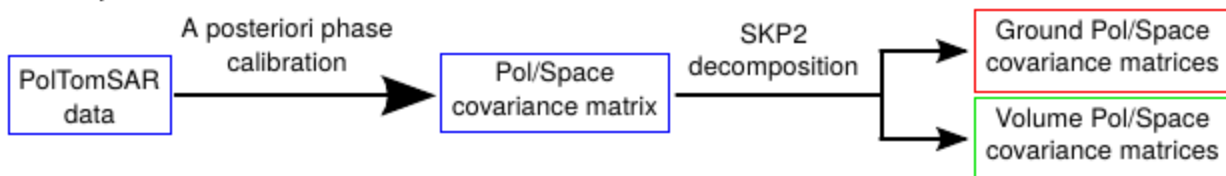
✦ Advantages:

- HV polarization → low ground-to-volume ratio
- 30-meters layer → get canopy information (for high enough trees)

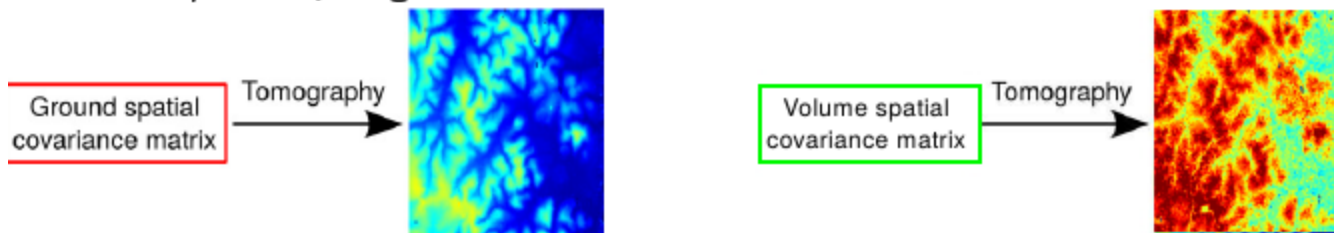
✦ Biomass estimation improvement:

- Space-pol separation of ground and volume responses (SKP2-decomposition)
- Adaptive height selection

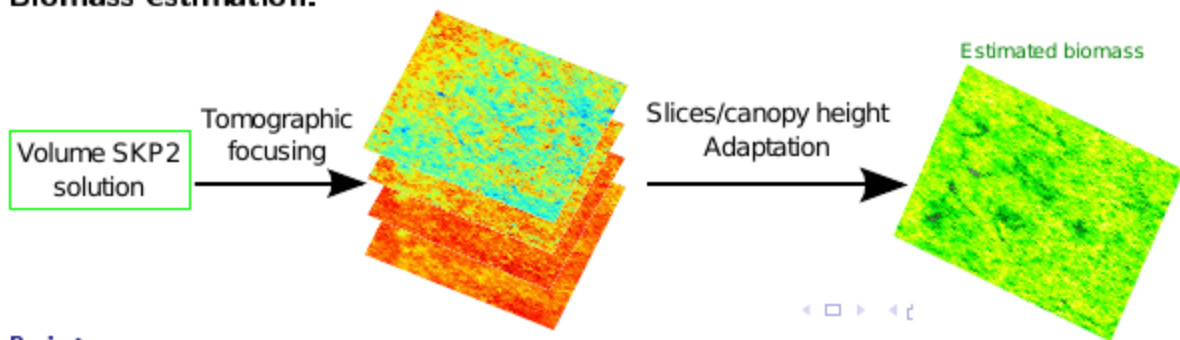
✦ Ground/Volume separation:

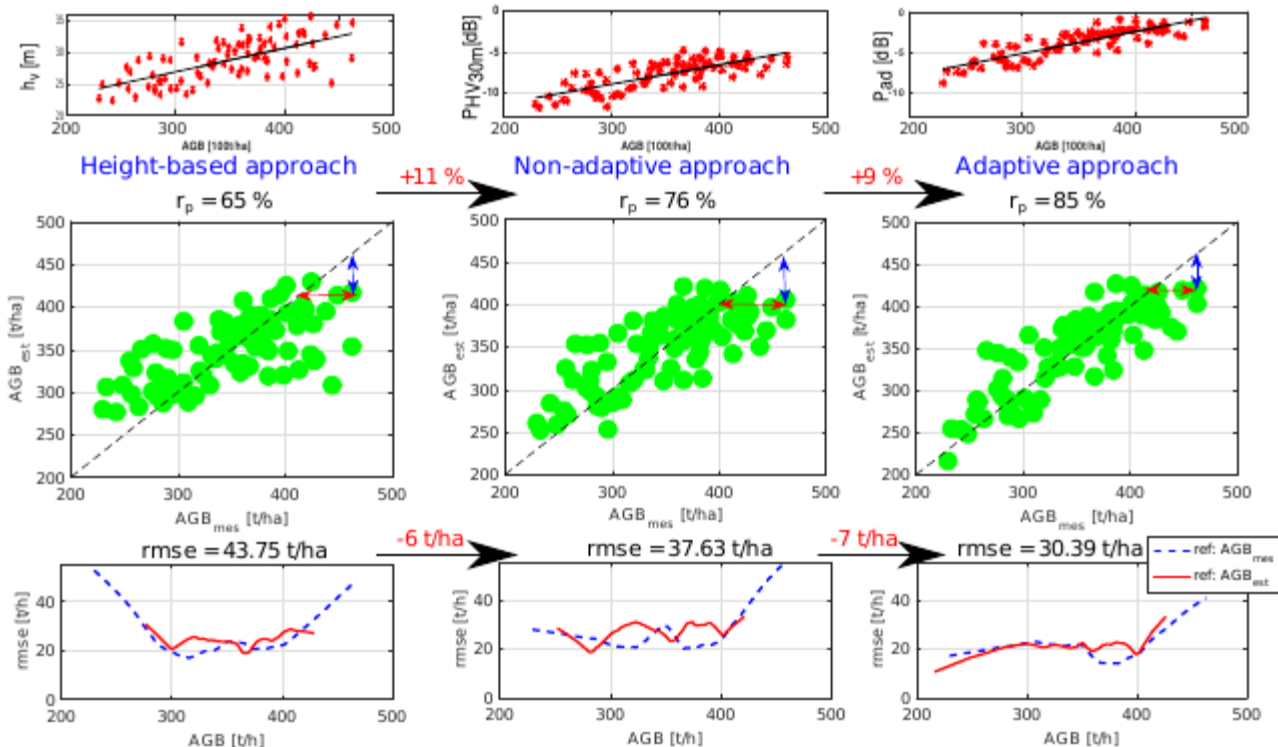


✦ Ground/tree top heights estimation:



✦ Biomass estimation:





- 2 visitors at the IETR working on polTomSAR and PolinSAR



-SUN Jili, IECAS, Beijing, China



- SUN Sheng, GuangDong University of Technology, China

- 1-week ESA training course in 2017, Frascati, Italy



- joint publications

Tebaldini, F. Rocca, M. Mariotti d'Alessandro, and L Ferro-Famil. Phase Calibration of Airborne Tomographic SAR Data via Phase Center Double Localization. IEEE Transactions on Geoscience and Remote Sensing, 54(3):1775–1792, March 2016.

Laurent Ferro-Famil, Yue Huang, and Eric Pottier. Principles and Applications of Polarimetric SAR Tomography for the Characterization of Complex Environments. International Association of Geodesy Symposia. F. Sanso Ed., Springer-Verlag, 142(1-13):243–255, 2016.

W. Wu, X. Li, H. Guo, L. Ferro-Famil, and L. Zhang. Noncircularity Parameters and Their Potential Applications in UHR MMW SAR Data Sets. IEEE Geoscience and Remote Sensing Letters, 13:1547–1551, 2016.

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