ESA NoR Projects Sponsorship

Project report

“ELECTROMAGNETIC MODELING OF S-3 SRAL WAVEFORMS “

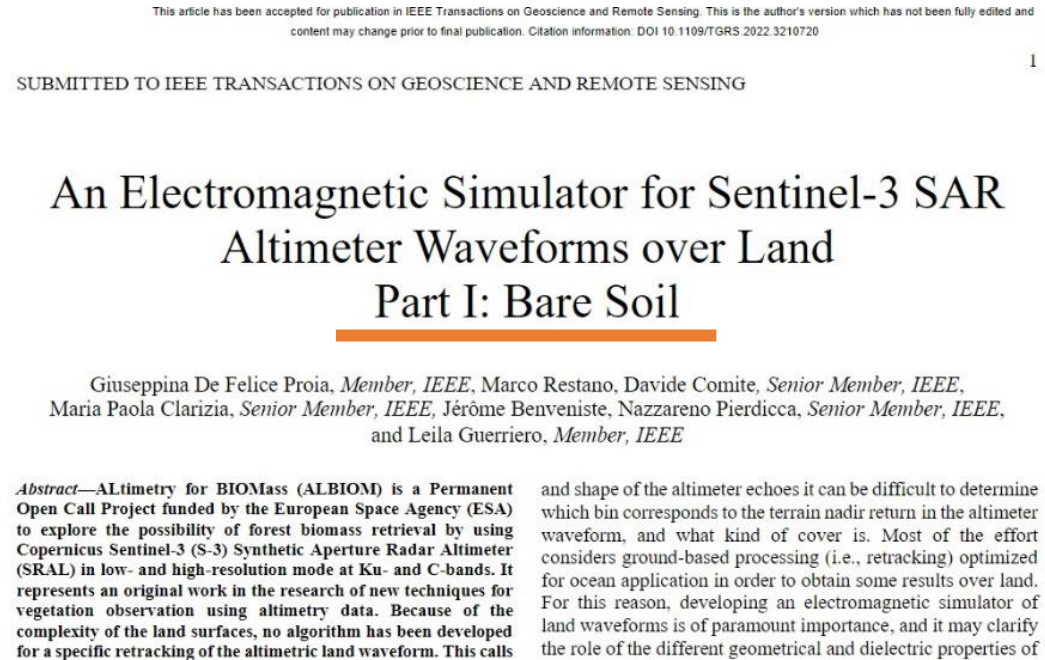
Request ID 1b243a and Service EarthConsole P-PRO

PhD Student: Giuseppina De Felice Proia

University of Rome Tor Vergata

«ELECTROMAGNETIC MODELING OF S-3 SRAL WAVEFORMS» PROJECT

- **This NoR project is a follow-up of the ALBIOM project**
- For further info visit on ALBIOM
  https://eo4society.esa.int/projects/albiom/
- **For further info on the EM MODELING OF S-3 SRAL WAVEFORMS project you could read our two PAPERS accepted for publication in IEEE TGRS (2022)**

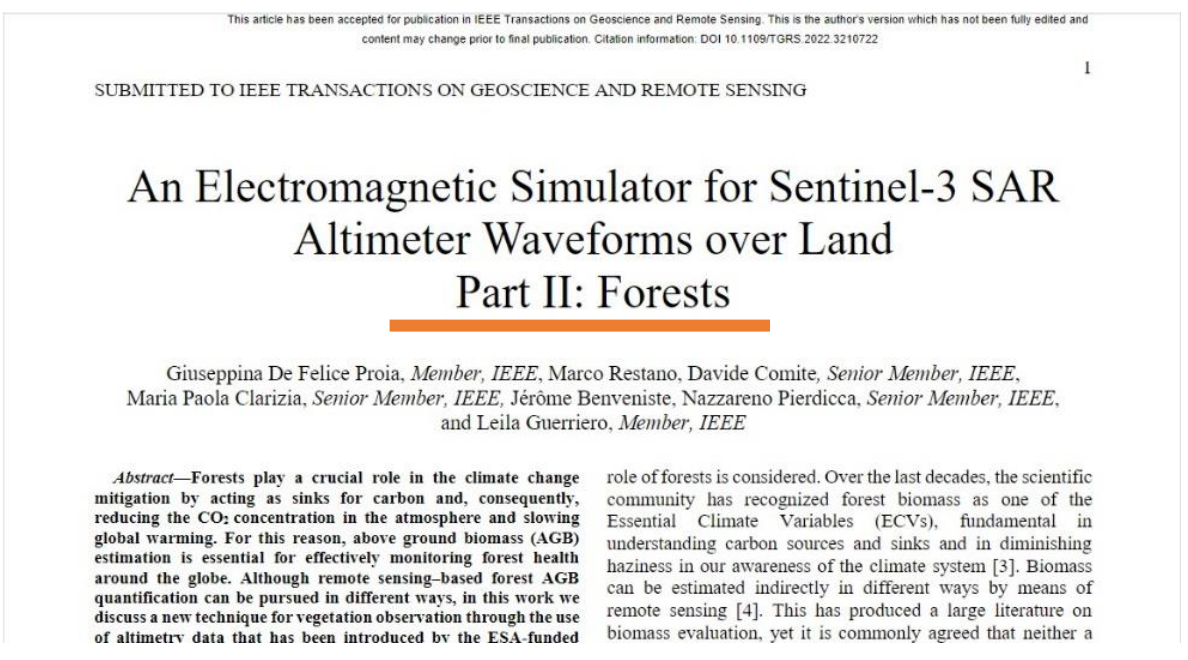


An Electromagnetic Simulator for Sentinel-3 SAR Altimeter Waveforms over Land
Part I: Bare Soil

Giuseppina De Felice Proia, *Member, IEEE*, Marco Restano, Davide Comite, *Senior Member, IEEE*, Maria Paola Clarizia, *Senior Member, IEEE*, Jérôme Benveniste, Nazzareno Pierdicca, *Senior Member, IEEE*, and Leila Guerriero, *Member, IEEE*

***Abstract*—ALtimetry for BIOMass (ALBIOM) is a Permanent Open Call Project funded by the European Space Agency (ESA) to explore the possibility of forest biomass retrieval by using Copernicus Sentinel-3 (S-3) Synthetic Aperture Radar Altimeter (SRAL) in low- and high-resolution mode at Ku- and C-bands. It represents an original work in the research of new techniques for vegetation observation using altimetry data. Because of the complexity of the land surfaces, no algorithm has been developed for a specific retracking of the altimetric land waveform. This calls**

and shape of the altimeter echoes it can be difficult to determine which bin corresponds to the terrain nadir return in the altimeter waveform, and what kind of cover is. Most of the effort considers ground-based processing (i.e., retracking) optimized for ocean application in order to obtain some results over land. For this reason, developing an electromagnetic simulator of land waveforms is of paramount importance, and it may clarify the role of the different geometrical and dielectric properties of



An Electromagnetic Simulator for Sentinel-3 SAR Altimeter Waveforms over Land
Part II: Forests

Giuseppina De Felice Proia, *Member, IEEE*, Marco Restano, Davide Comite, *Senior Member, IEEE*, Maria Paola Clarizia, *Senior Member, IEEE*, Jérôme Benveniste, Nazzareno Pierdicca, *Senior Member, IEEE*, and Leila Guerriero, *Member, IEEE*

***Abstract*—Forests play a crucial role in the climate change mitigation by acting as sinks for carbon and, consequently, reducing the CO_2 concentration in the atmosphere and slowing global warming. For this reason, above ground biomass (AGB) estimation is essential for effectively monitoring forest health around the globe. Although remote sensing–based forest AGB quantification can be pursued in different ways, in this work we discuss a new technique for vegetation observation through the use of altimetry data that has been introduced by the ESA-funded**

role of forests is considered. Over the last decades, the scientific community has recognized forest biomass as one of the Essential Climate Variables (ECVs), fundamental in understanding carbon sources and sinks and in diminishing haziness in our awareness of the climate system [3]. Biomass can be estimated indirectly in different ways by means of remote sensing [4]. This has produced a large literature on biomass evaluation, yet it is commonly agreed that neither a

S-3 SRAL & GEDI LIDAR FOR THE NOR PROJECT

- In order to better characterize the results obtained through the comparison between the simulator and S-3 data we have taken into account data from **NASA lidar Gedi**

- We have considered the values of **rh100 and PAI** and we have computed the **correlation** with some **S-3 SARvatore variables** (such as Sigma0_20Hz, SAR_Echo_Data) **through the Pearson coefficient**

- We present in the following the **preliminary analysis at the early stage over the Afrisar Mabounie site (Gabon)** characterized by the presence of forest

BENEFITS TO SOCIETY

- The project will have an important scientific impact, as it can provide a new global biomass dataset derived from S-3 altimetry, which could be integrated into existing high-resolution biomass products derived from data fusion methods

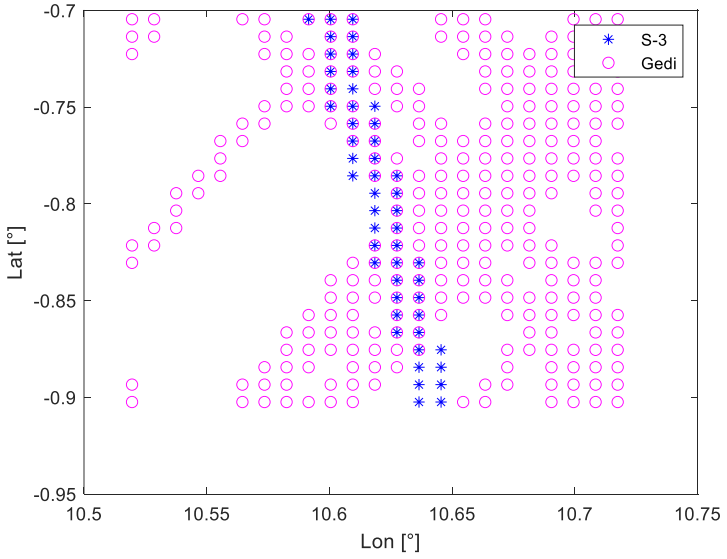
- The project would also open up new perspectives on the use of all the historical data from the past altimetry missions for biomass mapping.

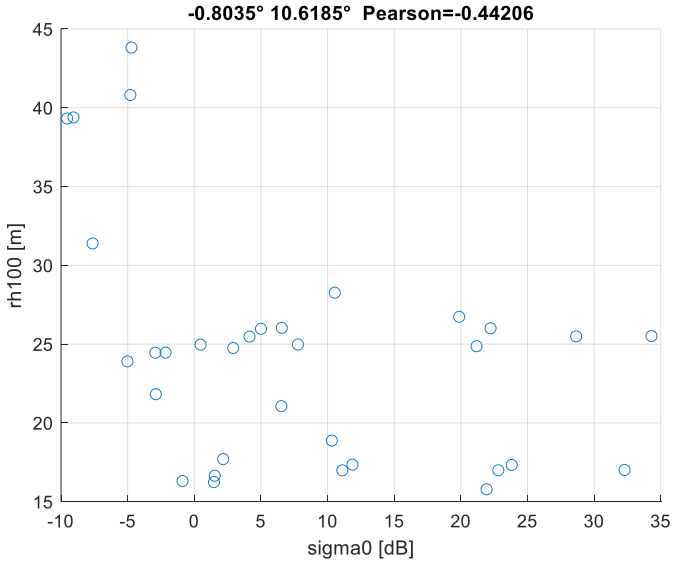
TOOLS AND DATA WITHIN CLOUD ENVIRONMENTS

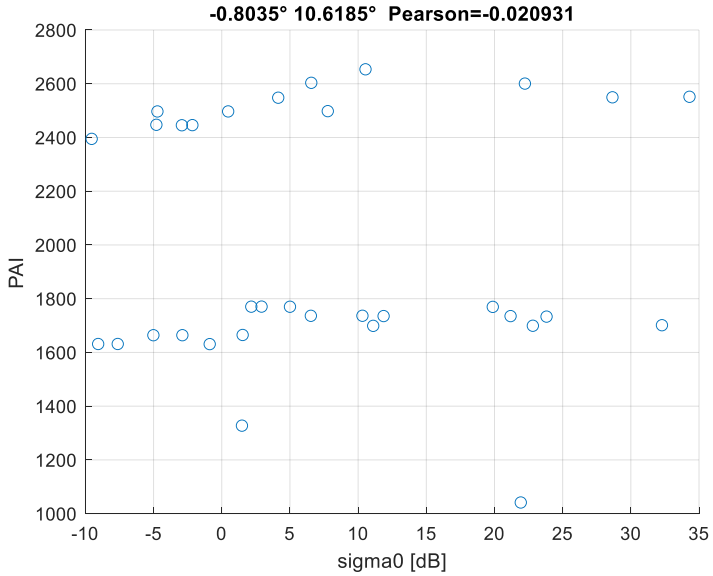
- **We have downloaded G-POD SARvatore for Sentinel-3 Service (now moved to the ESA Altimetry Virtual Lab at EarthConsole) Ku-band waveforms offering 512 bins and true vertical dynamics in dBW**

MABOUNIE SITE: S-3 SRAL & GEDI LIDAR

- We have computed the **projection of Gedi tracks and S3B SARvatore tracks acquired during the period February-July 2019 – 2020 – 2021 and averaged over the EASE grid with resolution 1 km**
  - We have considered the coordinates identified by the superposition of Gedi and SARvatore falling in a square of 20 km x 20 km (i.e. S-3 SRAL footprint) around the coordinate of latitude=0.8035° and longitude=10.6185°
  - We have correlated SARvatore sigma0 in dB with Gedi rh100 in m and PAI, respectively

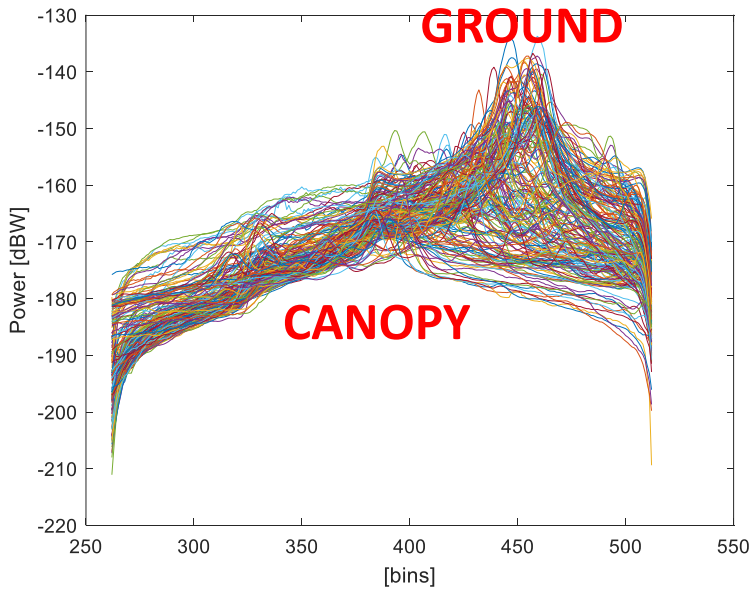


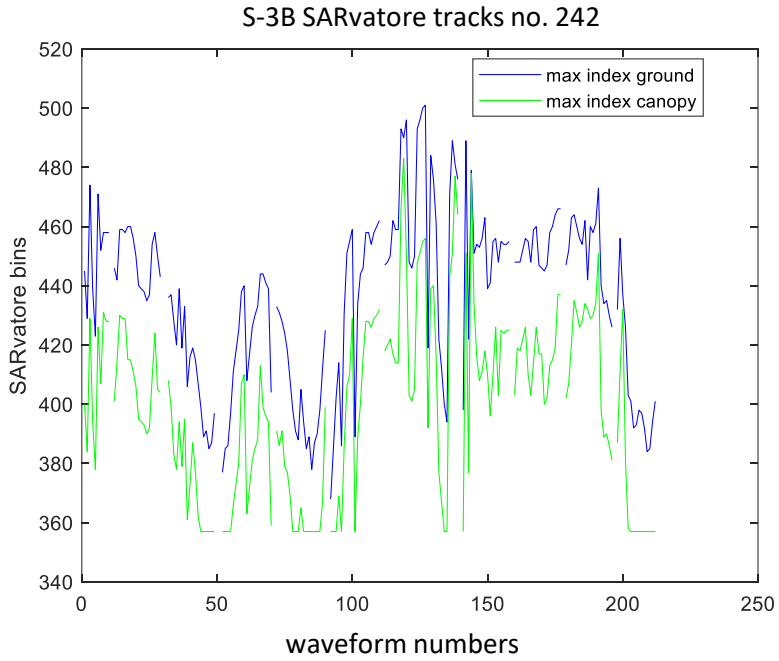




MABOUNIE SITE: S-3 SRAL & GEDI LIDAR

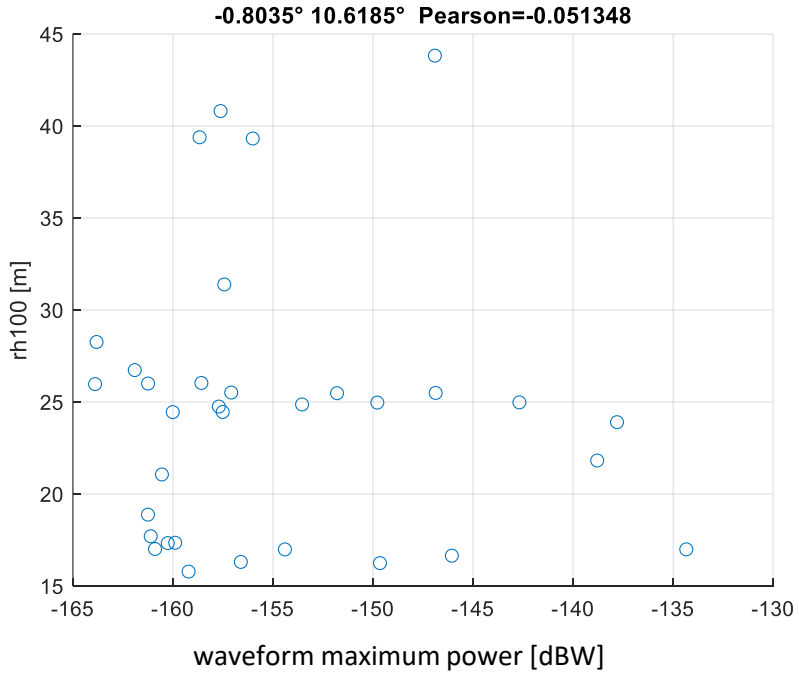
- We have also considered SARvatore waveforms in the same area, distinguishing the **absolute maxima due to the signal coming from the ground and the maxima in the previuos 20m – 40m corresponding to the signal coming from the tree canopy (i.e. 45 – 87 bins before the bins of the absolute maxima)**

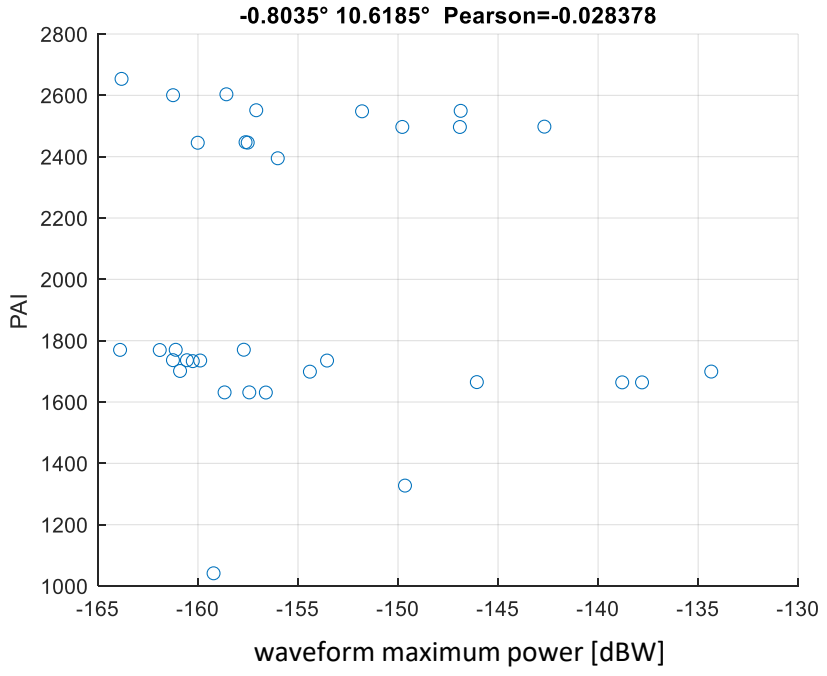




MABOUNIE SITE: S-3 SRAL & GEDI LIDAR

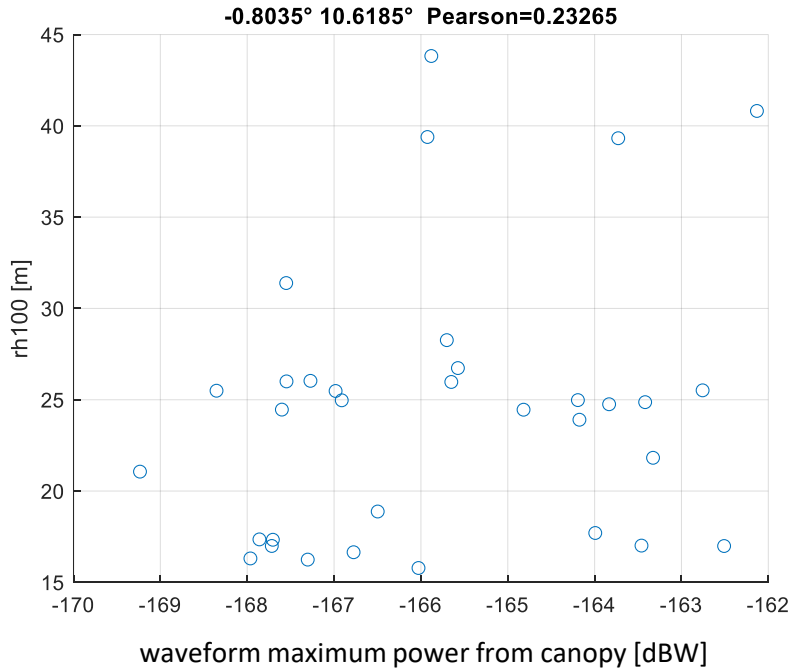
- We have correlated the values of the absolute maxima in SARvatore SAR_Echo_Data in dBW with Gedi rh100 and PAI, respectively

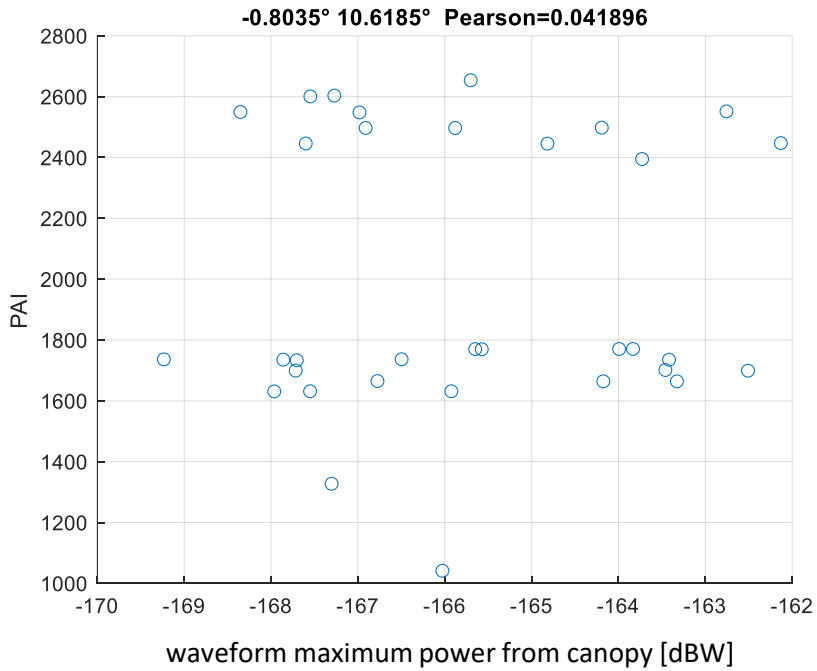




MABOUNIE SITE: S-3 SRAL & GEDI LIDAR

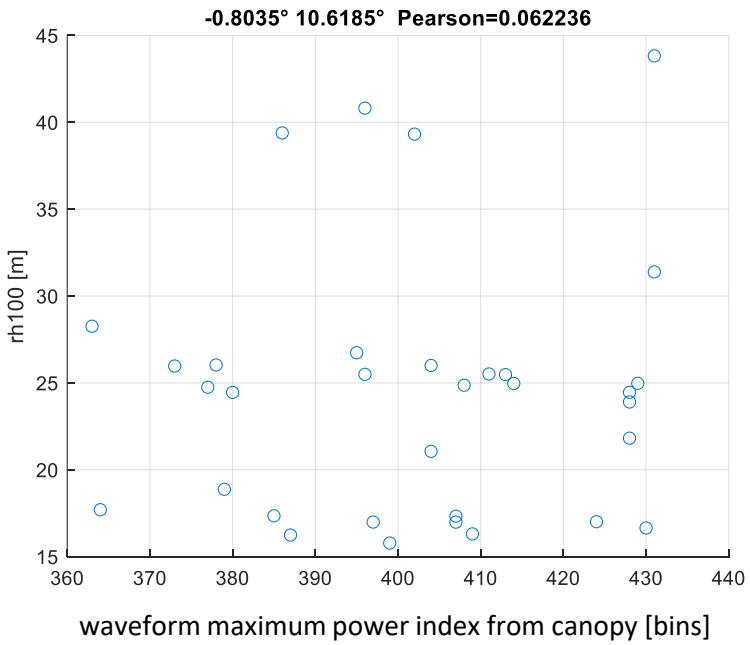
- We have correlated the values of **the signal coming from the tree canopy (i.e. 45 – 87 bins before the bins of the absolute maxima)** in SARvatore SAR_Echo_Data in dBW with Gedi rh100 and PAI, respectively

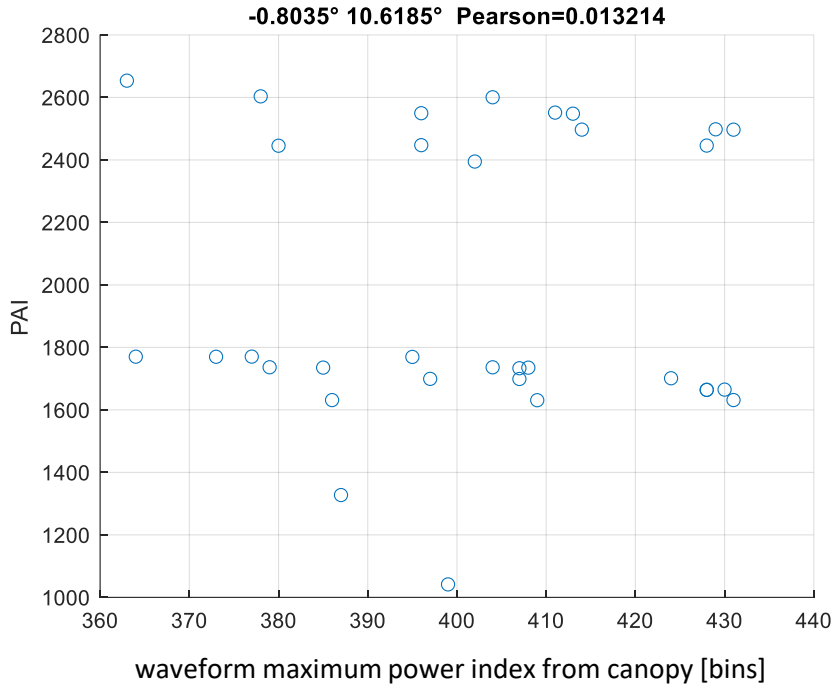




MABOUNIE SITE: S-3 SRAL & GEDI LIDAR

- We have correlated the values of **the bin corresponding to the signal coming from the tree canopy (i.e. 45 – 87 bins before the bins of the absolute maxima)** in SARvatore SAR_Echo_Data with Gedi rh100 and PAI, respectively





CONCLUSIONS

- At the present stage the preliminary analysis of the correlation shows low values
- We are investigating the use of a different filtering strategy able to avoid points representing outliers or a system of weights able to discriminate among the points in the considered area