Observing the Forest from Lidar and Radar Remote Sensing

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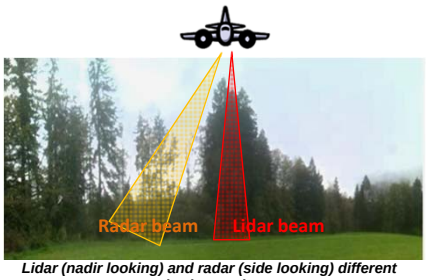
Motivation

Lidar and radar are remote sensing systems that have proven their potential to accurately monitor forest structure characteristics. Both are active systems. They send their own pulses and measure the time elapsed between the transmission of the pulse and its reception after it has been reflected in a scatterer. However, Lidar employs laser light, while radar operates with microwaves, which allows the latter to operate under any weather condition. The viewing geometry is nadir and side looking for the Lidar and the radar respectively, among other differences.

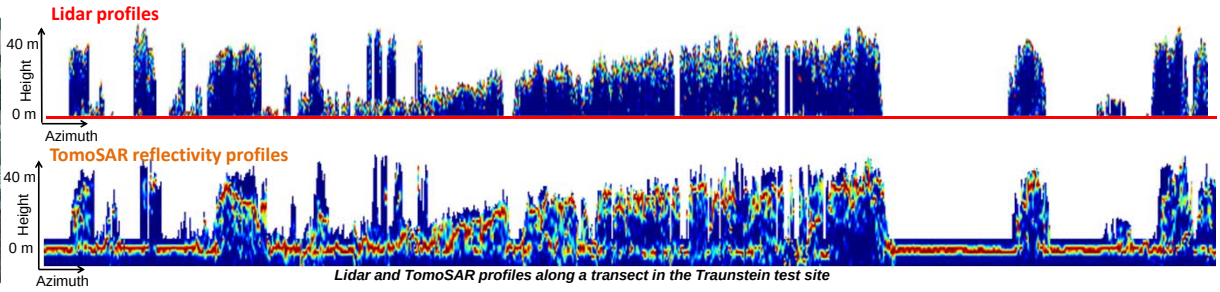
Lidar has been extensively employed by forest scientists and practitioners in the last decade. Thus, the link between Lidar and physical forest structure is better established than with radar. Therefore, Lidar is employed here for validation and better understanding of the information retrieved by the radar system. This is particularly relevant in views of the forthcoming space missions, such as JEDI and Tandem-L.



Lidar (nadir looking) and radar (side looking) different viewing angles

Lidar and Radar 3D forest profiles

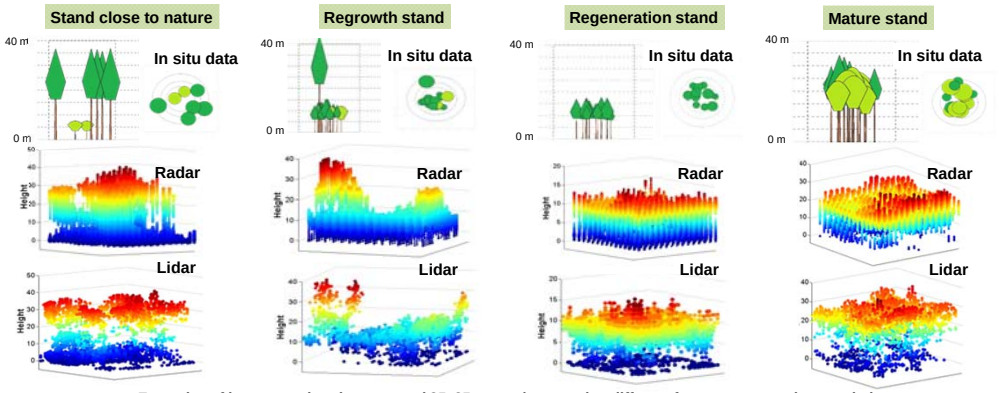
Traunstein test site



Lidar and TomoSAR profiles along a transect in the Traunstein test site

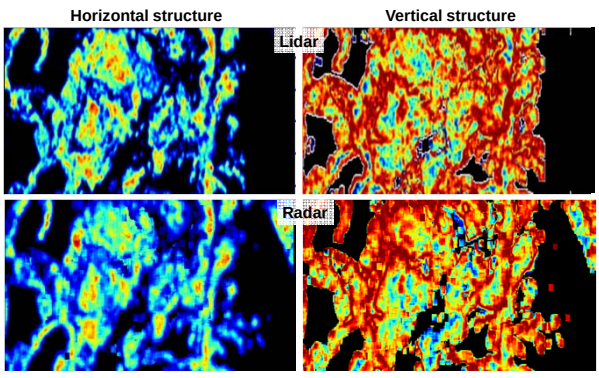
We present data acquired over the area of Traunstein, in the South-East of Germany. The area observed is a highly heterogeneous managed forest in a temperate climate, with pure coniferous, pure deciduous and mixed stands at different growth stages. Lidar as well as TomoSAR data at L-band are acquired. From the profiles representation, it can be observed that:

- Lidar and radar measures are consistent, despite lower resolution of the radar and different viewing geometry ;
- Lidar returns are more concentrated to the top of the canopy; extinction is higher with Lidar than with radar at L-band;
- both Lidar and radar systems are sensitive to structural characteristics of the forest stands.



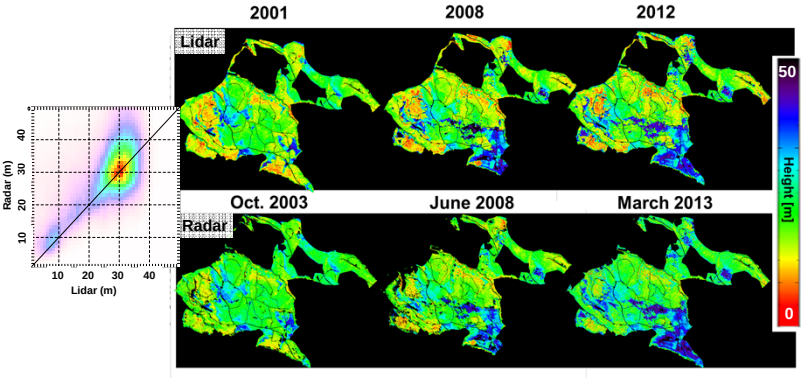
Examples of inventory plots (area around 25x25 meters) presenting different forest structure characteristics.

Forest Structure Estimation



The horizontal and the vertical structures are estimated from the Lidar and the radar data over the test area. Comparable features are retrieved with both sensors. The main differences observed are caused by the lower resolution in the radar. Also in stands, with a high vertical heterogeneity, radar estimates a higher vertical structure than Lidar, probably due to the higher extinction of the Lidar signal.

Forest Height Estimation



Forest height is estimated as well from the Lidar and the radar data in the test site along 10 years.

- Physical product successfully validated over a variety of scenarios;
- Accuracy better than 10%;
- Robustness against weather and seasonality.

Conclusions

Lidar and radar remote sensing systems allow the retrieval of 3D forest structural parameters. With the Lidar, most of the returns measured correspond to the upper parts of the forest canopy, while radar at L-band measures also energy backscattered from lower scatterers in the forest.