Forest Structure Estimation by means of TomoSAR at L-band in front of weather and seasonal variability

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Motivation

Radar measurements are sensitive to the morphology (geometry) and the dielectric properties of the scatterers. In consequence, seasonal and environmental effects as the presence or absence of leaves, the daily and seasonal water cycle of the trees, as well as rain, snow but also freeze and drought periods have an effect on the 3D reflectivity retrieved by a TomoSAR system. The strength of the effects strongly depends on the frequency of the SAR system.

The fact that a TomoSAR system is able to reveal such changes / variations relevant for a wide range of ecological questions addressing natural and / or anthropogenic change is on the one hand side an advantage and at the same time a unique feature of SAR remote sensing configurations. On the other hand, the basic structural characterisation of forest should not depend on such non-structural effects. This implies a critical requirement on the algorithms that aim to use 3D reflectivity retrieved by a TomoSAR system to characterize the forest type and / or condition on the basis of structure features – especially in the case where the SAR acquisitions are performed non-simultaneously.

In this poster the proposed forest structure characterisation based on TomoSAR measured 3D reflectivity is investigated with respect to the stability of the classification under the influence of changing environmental (i.e. weather) conditions by using real experimental data.

Temporal variability of TomoSAR reflectivity profiles at L-band

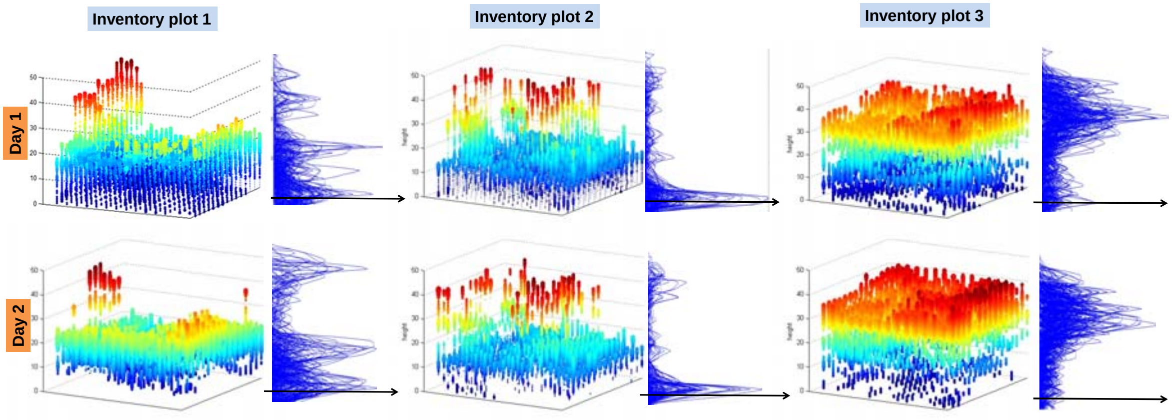
Two TomoSAR data sets acquired over the area of Traunstein (Germany) by DLR's Airborne SAR system operating at L-band on two days with different weather conditions

- Day 1: spring 2008, no rain
- Day 2: spring 2008, rain

are analyzed. A set of derived reflectivity profiles over selected inventory plots (25x25 m) characterized by different forest structure are shown.

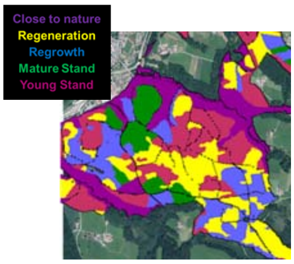
It can be observed that:

- the relative power of the different scatterers changes meaningfully from one day to the other;
- the overall relative position of the peaks in the reflectivity profiles remains stable.



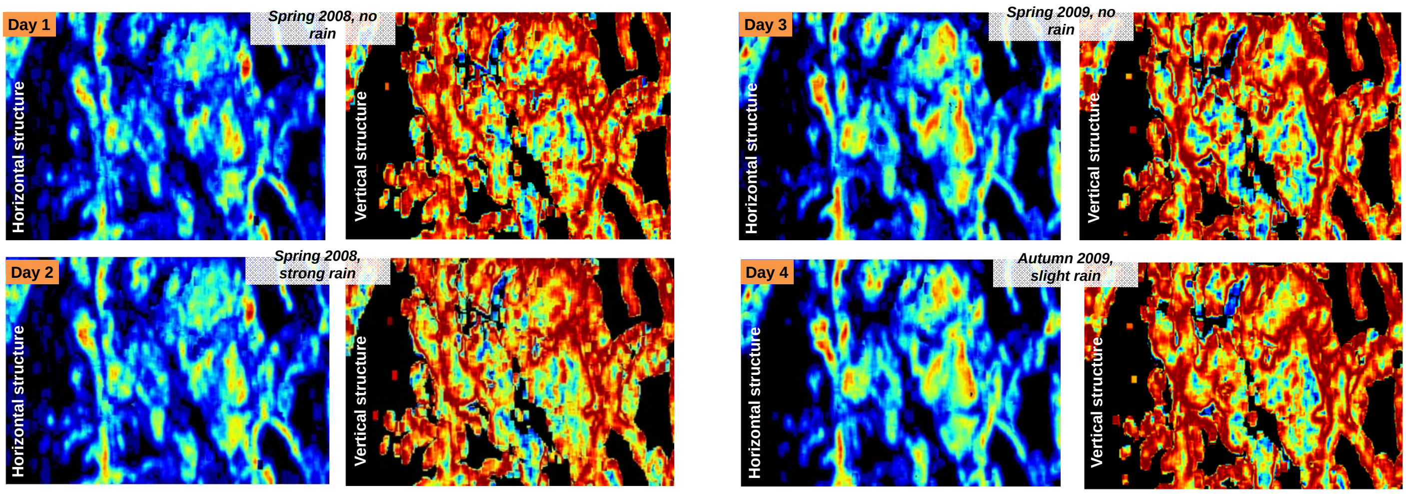
Three different inventory plots (25x25 m) with different forest structure, as seen by a TomoSAR sensor under two different weather conditions (3D representation and vertical reflectivity profiles (2,5x2,5 m) superimposed)

Is it possible to find temporally stable parameters to characterize forest structure from TomoSAR?



After observing that the relative position of the peaks in the reflectivity profiles is a parameter related to structure temporally more stable that the relative power along heights, a measure of forest structure (both horizontal and vertical) is proposed relying on the 3D distribution of peaks of TomoSAR reflectivity. These horizontal and vertical forest structure descriptors from TomoSAR data are estimated over a temporal series of airborne data, covering different weather, wind and seasonal conditions.

Despite slight local differences, globally the same forest structure patterns are preserved. Additionally, it has been verified that these patterns are also consistent with the maps of growth stages established from field data.



Conclusions

Temporal dielectric changes in the soil and the different parts of the trees affect in a non-linear way the amount of energy backscattered to the radar and, as a consequence, the reflectivity profiles. However, it is possible to identify parameters in the TomoSAR data that are less affected by these effects and can then be employed to provide a forest structure estimation, temporally stable. The actual extent of the effect of moisture variations has to be further analyzed on a longer time series, allowing to isolate the different sources of temporal decorrelation: weather, seasonal effect, wind, time of acquisition… with analogous system characteristics.