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| **Drone-based SAR imaging of forest** |
| **Introduction/Aim**: The synthetic aperture radar (SAR) has long been used from satellites for forest monitoring at global level. The boreal forests in Sweden are well described wall-to-wall from airborne laser scanning and airborne photography, causing SAR as sensor type to provide only limited added value, due to the lower resolution compared to other sensors, despite its all-weather acquisition capabilities. Yet, by accounting for various interfering effects that currently degrade the useful information in SAR images, it can be extremely valuable for both vegetation mapping and belowground mapping (e.g., soil conditions). In the current work, we present the configuration of a drone-based SAR experiment that allows us to image the forest in very high spatial resolution.  **Methods**: The drone-borne multi-band interferometric SAR system acquires data in the P-, Land C-bands. Using a helical flight trajectory enables an accurate tomographic reconstruction in 3D, both above and partly below ground. The spatial resolution is ~20 cm in the P-band, ~6 cm in the L-band, and ~2 cm in the C-band. The drone acquisitions cover forest from mineral soil, a peatland area, and a gravel road, hence providing different soil conditions. The various soil moisture conditions are quantified in-situ using soil moisture sensors and simulations of the ground water table. The trees were scanned using terrestrial, mobile, and airborne laser scanning during 2023 and 2024, and sap flow sensors will be installed during the spring 2024 to enable modelling of the evapotranspiration in the trees. Additionally, ground-penetrating radar will be used for ground measurements in 2024. The reconstruction of both singletree properties above ground as well as soil characteristics are currently analysed.  **Results**: We expect the accurate height and density information provided from the SAR acquisitions to enable accurate estimates of the tree biomass and tree shape. Furthermore, we explore the penetration into the soil by putting the tomographic focus below ground, which would allow us to derive information potentially related to the trees’ root structures.  **Conclusion**: Utilizing the newly developed drone-based SAR system facilitates in-depth exploration of complex forest structures. Through this research endeavour, our objectives encompass enhancing comprehension of evapotranspiration in trees, reconstructing forest characteristics, evaluating the influence of weather factors, and investigating SAR's reflectivity and penetration capability through the canopy and soil in a boreal forest setting. |