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Calibration and Validation Activities in the Context of the 2023 GABONX Airborne SAR Campaign for Tropical Forest Height and Change Analysis over Gabon

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Tropical forests are of great ecological and climatological importance. Although they only cover about 6% of Earth's surface, they are home to approx. 50% of the world's animal and plant species. Their trees store 50% more carbon than trees outside the tropics. At the same time, they are one of the most endangered ecosystems on Earth: about 6 million of hectares per year are felled for timber or cleared for farming. Compared to the other components of the carbon cycle (i.e. the ocean as a sink and the burning of fossil fuels as a source), the uncertainties in the local land carbon stocks and the carbon fluxes are particularly large. This is especially true for tropical forests: more than 98% of the carbon flux generated by changes in land-use may be due to tropical deforestation, which converts carbon stored as biomass into emissions.

In this context, the AfriSAR 2015/16 campaign, supported by ESA, was carried out over four forest sites in Gabon by ONERA (July 2015) during the dry season and by DLR (February 2016) during the wet season. From the data collected the innovative techniques applied to estimate forest height and biomass could be improved significantly and are summarized in a special issue 'Forest Structure Estimation in Remote Sensing' of IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing.

The motivation of the AfriSAR campaign was to acquire demonstration data for the soon to be launched ESA BIOMASS mission, that was selected as the 7th Earth Explorer mission in May 2013 in order to meet the pressing need for information on tropical carbon sinks and sources by providing estimates of forest height and biomass. AfriSAR focused on African tropical and savannah forest types (with biomass in the 100-300 t/ha range) and complements previous ESA campaigns over Indonesian and Amazonian forest types in 2004 (INDREX-II) and 2009 (TropiSAR).

The present contribution concerns the GABONX campaign, the ESA supported successor to AfriSAR, which took place in May to July 2023. GABONX aims to detect and quantify changes that have occurred since the DLR acquisitions in February 2016. To this end, DLR's F-SAR sensor acquired interferometric stacks of fully polarimetric L- and P-Band data over the same forest sites in the same flight geometry as in 2016. The results presented give an overview of campaign activities with particular emphasis on the calibration of the SAR instrument as well as the validation of forest parameters derived from polarimetric interferometry. The SAR sensor calibration is based on an innovative approach that leverages state-of-the-art EM simulation to accurately characterize the 5m trihedral reference target deployed for the campaign in Gabon. The validation of derived forest parameters uses lidar measurements obtained in the time frame of the GABONX campaign by NASA's LVIS sensor. As an outlook, further collaborative calibration and validation activities will hopefully include the cross-calibration of DLR's F-SAR and NASA's UAVSAR, which is set to acquire L- and P-Band data over the GABONX sites in 2024.