Elements towards a cal_val strategy for ESA's BIOMASS mission

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Abstract

BIOMASS was approved as the 7th Earth Explorer mission in May 2013 at the Earth Observation Programme Board in Svalbard, Norway. The overall objective of the mission is to reduce the uncertainty in the worldwide spatial distribution and dynamics of forest biomass in order to improve current assessments and future projections of the global carbon cycle. Its payload consists of a fully-polarimetric left-looking P-band SAR in order to reach the main objective to provide consistent global estimates of forest biomass, forest disturbance and re-growth parameters. The BIOMASS mission lasts 5 years, and consists of two phases, i.e. a tomographic and an interferometric phase.

The Preliminary Design Review was completed in 2017 and currently Critical Design Review is foreseen for 2020. The satellite is due for launch in 2022.

The BIOMASS payload is a P-band Synthetic Aperture Radar (SAR), which will operate in Quad-Pol mode, in which the V-polarisation and H-polarisation pulses are transmitted alternatively and both the V- and H- polarisation backscattered signals are received simultaneously. The main mode is similar to a standard stripmap acquisition whereby the subswaths are accessed through a spacecraft roll maneuver. The Biomass payload consists of two elements, i.e.

(1) the main electrical part of the instrument providing all of the functionality up to the Feed Array which transmits/receives the SAR signals as part of the offset fed antenna system; and;

(2) the 12m Large Deployable Reflector (LDR).

BIOMASS will be the first SAR sensor to operate in P-band from space thus facing strong (given the exploited low-frequency) distortions (e.g. polarimetric scattering matrix and geometric distortions) due to the propagation of the radar waveforms through the ionosphere. This calls for an important role of the cal/val activities, especially during the commissioning phase, to be able to properly characterise, calibrate and validate the system despite the presence of ionosphere related distortions in the acquired data.

Due to the changing orbits for each of the distinct mission phases, the calibration methodology in the commissioning phase and routine phases of the mission is different. During the commissioning phase, a four-month period is dedicated to calibration activities

with the first two devoted to the antenna patterns characterisation. During this phase extensive use will be made of the BIOMASS calibration transponder(s) and a specific orbit will be used to ensure the antenna pattern is appropriately sampled in the across-track direction.
Due to the large dimensions of the antenna combined with the large wavelength, the ground-based verification activities will rely on an antenna model that will be based on measurements and simulation data of the primary radiation pattern generated by the feed array (with and without relevant surrounding structural elements) and a full-wave solver for the modeling of the secondary pattern generated by the 12m mesh reflector with the feed array and spacecraft structure. The in-orbit antenna model verification will need to be rigorous due to the circular aperture not allowing a strict separation between azimuth and elevation patterns as well as to mitigate ionospheric effects. As such, the external calibration approach will need to fully accommodate and characterise antenna modelling uncertainties as well as ionosphere related distortions. During the routine phases of the mission – given the infrequent transponder overpasses – alternative external calibration targets will need to be considered.

The presentation will cover these areas in more detail and will include the most recent status thereof.

Keywords - Calibration of future missions