SAOCOM-1A Internal Calibration Results

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Abstract

A calibration strategy based on external calibration combined with internal calibration and an antenna model has been adopted for the SAOCOM 1A Commissioning. The internal calibration effort will be discussed and results will be presented.

The SAOCOM mission consists of two identical L-band satellites with advanced space borne Synthetic Aperture Radar instruments designed, produced, tested and operated in Argentina, under the initiative of CONAE within the framework of the National Space Plan and with disaster monitoring and soil moisture derived applications as main driver. The SAR payload operates at a frequency of 1275 MHz (L band) and it is able to produce full polarimetric images (HH, HV, VH and VV polarizations). Thanks to its 3.5m by 10m active phase array antenna it is capable of performing beam forming in range and azimuth, being able of operating in a variety of modes. Combining the different polarimetric modes (Single HH, Single VV, Dual VH/VV, Dual HV/HH, Quad-pol and Compact-pol Right and Left) and swaths (19 stripmap and 6 TOPSAR), 64 Stripmap plus 17 TOPSAR modes are defined.

SAOCOM-1A spacecraft launch has been successfully carried out on October 7th, 2018 from Vandenberg Air Force Base, reaching its´ nominal orbit height on December 16th. Its CALVAL commissioning phase has now been finished with very good results. SAOCOM-1B production and pre-launch tests have been finished, and its launch date is planned in February/March 2020.

Demanding requirements from the soil moisture application, particularly on the absolute and polarimetric accuracy, impose a high demand on the mission radiometric calibration and validation. An overview of the SAOCOM CALVAL phases, activities, results and way forward will be discussed, taking into account both pre and post launch measurements. Specific SAOCOM-1A commissioning activities and results will be summarized in relation to onboard radiofrequency components tuning and monitoring supported by internal calibration, pointing calibration based on notch modes and doppler, geolocation and IRF validation over point targets, azimuth antenna pattern validation with ground receivers, relative calibration supported by antenna model and rain forest datatakes, and polarimetric plus absolute radiometric calibration based on corner reflectors and polarimetric active radar transponder datatakes.

Having the SAR sensors capability of observation in Stripmap, TOPSAR narrow and TOPSAR wide swath modes in single, dual, quad and compact polarization, resulting in more than 60

different acquisition modalities, a calibration strategy based on external calibration combined with internal calibration and an antenna model has been adopted to reach 0.5dB 1-sigma absolute radiometric accuracy requirement in a 6 months commissioning phase. The SAR Instrument main subsystems are defined as the SAR active phased array antenna and SAR Central electronics. Extensive tests and characterizations at different integration levels have been performed to populate databases of the internal calibration software running in the ground segment and validate its algorithms. In the case of the SAR Central Electronics, this included the arbitrary waveform generator, central transmitter, central receiver and down-converter, analog to digital converters, and isolators. In the case of the SAR active phased array antenna, this included 140 Transmit-receive modules with their independent H and V channels, many power splitter and combiners and cables building up the antenna RF distribution network, and finally the Radiating Modules assemblies. Everything was measured at different operative temperatures, and over frequency at different test facilities in Argentina. In addition to this, the radiation patterns of seven 1.4m by 3.5m panels building up the SAR antenna were measured over temperature with the planar near field scanner at CONAE facilities in Cordoba. The full 10m by 3.5m antenna pattern was also measured at ambient temperature.

During CALVAL pre-launch phase activities, the characterization data and internal calibration algorithms were validated. Reference constants were obtained at different pre-launch test campaigns over time, and this has been continued in-flight to monitor the SAR Instrument subsystems stability.

Keywords - Calibration methodology and techniques