SMOS L1 ALGORITHMS

Antonio Gutiérrez[(1)], José Barbosa[(1)], Nuno Catarino[(1)], Rita Castro[(1)], Sofia Freitas[(1)], Bruno Lucas[(1)], Henrique Candeias[(1)], José Freitas[(2)], Marco Ventura[(2)], Michele Zundo[(3)]

Author Affiliation(s)

(1) Ground Segment Systems, Deimos Engenharia, S.A.; Lisboa, Portugal
(2) Command and Control, Critical Software S.A.; Lisboa, Portugal
(3) European Space Agency; Noordwijk, The Netherlands

ABSTRACT

L1 Processing of SMOS data transform MIRAS instrument raw outputs into geolocated Brightness Temperatures, providing observation angles and additional parameters for the L2 Processor.

Prior to SMOS launch in in November 2009 the Level 1 Prototype Processor (L1PP) lead the way for specifying product types and contents, as well as define, implement and validate all processing algorithms. The best ones were used as baseline in the operational processing chain.
During the six months of Commissioning Activities, L1PP continued to be the testing environment for all new algorithms and proposed modifications to the L1 products. Particular emphasis should be given to L1PP's capability to produce the first image from SMOS. Within less than three hours after the data acquisition at ESAC, L1PP generated images. L1PP has also been tuned to identify unforeseen hardware problems that have been spotted only with the satellite in-orbit.

This paper is divided in 3 sections: I) a high level description of the L1 processing strategy and functional blocks of the processor (called processing units); II) important results obtained during the Commissioning Phase, namely for calibration optimization, image reconstruction improvement, geolocation assessment and the impact on scientific results, in particular, to insure optimal input to Level 2 Soil Moisture and Ocean Salinity retrieval; and III) conclusions from the Commissioning Phase and future work for other interferometeric missions.

Keywords - SMOS; L1 processing; software; algorithms; commissioning

I) Prototype Architecture and Product Types

The Level 1 Prototype Processor (L1PP) is divided into three major units:

- L1a – this module is responsible for transforming raw data coming from the instrument into calibration products and use them to obtain calibrated visibilities;
- L1b – the core of L1PP is the Image Reconstruction module where the L1a calibrated visibilities are transformed to brightness temperatures, after being corrected from the influence of Foreign Sources. In addition, it is at this level of processing that the G and J^+ Matrices are generated, as well as the Flat Target Response Auxiliary Data File (ADF);
- L1c – the final model of the processor is responsible for geolocating the brightness temperatures in Earth's surface.

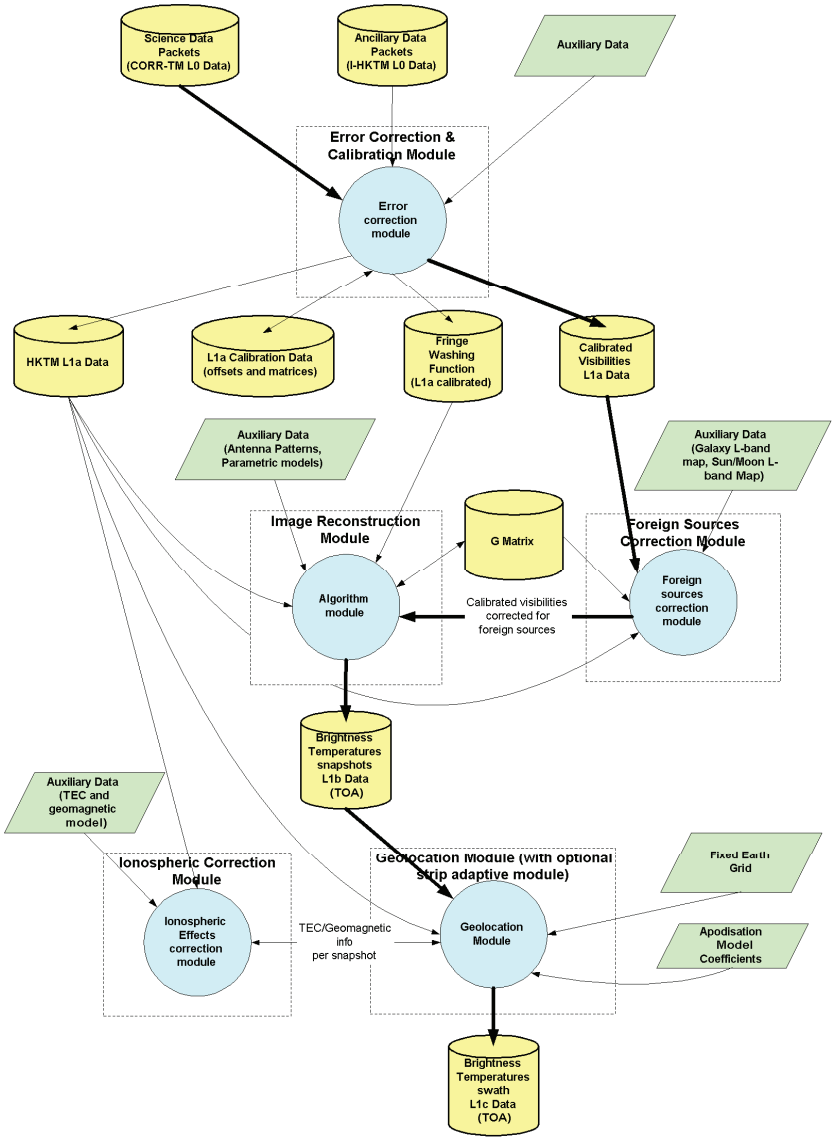

Figure 1: Processing data flow diagram

II. COMMISSIONING ACTIVITIES

Using calibration data obtained in the Image Validation Tests (Noordwijk, 2007) the first image from SMOS was processed buy L1PP, as shown in Figure 2.

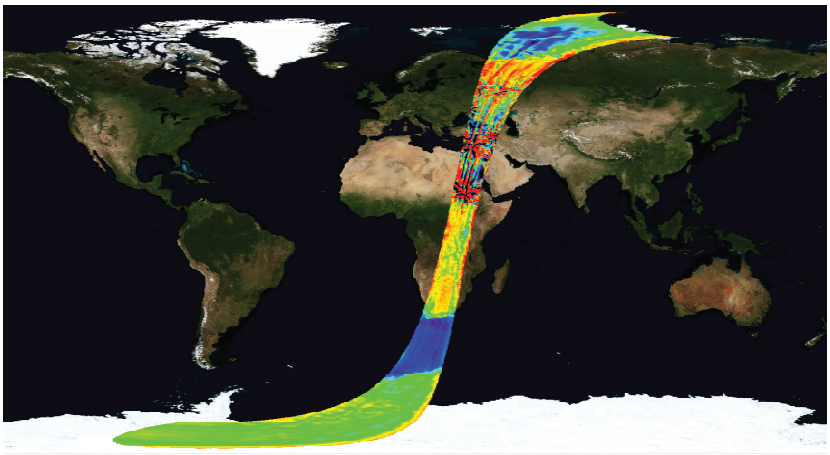

Figure 2: First on-ground calibrated image from SMOS processed with L1PP (H-polarisation)

As it can be seen, the swath is contaminated with radio frequency interference (RFI) in the swath on Jerusalem and in the Middle East area. During the commissioning phase algorithms to mitigate this feature have been developed and tested.
The correct usage of in-orbit calibration data is also a key factor in reconstructing good images. For example, Figure 3 shows two snapshots acquired in November, on a descending pass on Australia, processed with different calibration data.

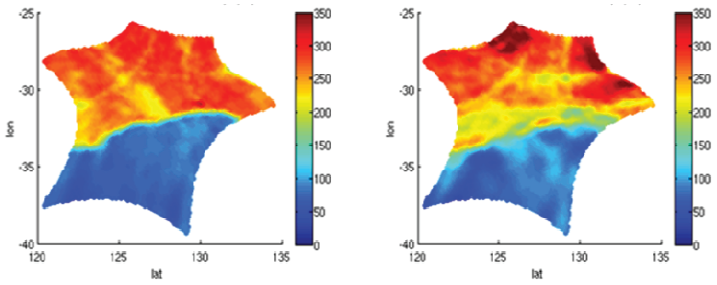

Figure 3: Effects of in-orbit calibration data (left) and on-ground calibration (right) on a snapshot aquired over Australia (H-polarisation)

During commissioning all the calibration routines have been checked and new algorithms have been tested for the first time (PMS calibration using the Cold Sky as a reference target).

The accuracy of the instrument has also been assessed during the commissioning period. This activity is performed when observing a flat unpolarised image, i.e., the Sky. Preliminary results obtained in December indicate that the instrument is within the expected sensitivity of ~2 to ~3 K.

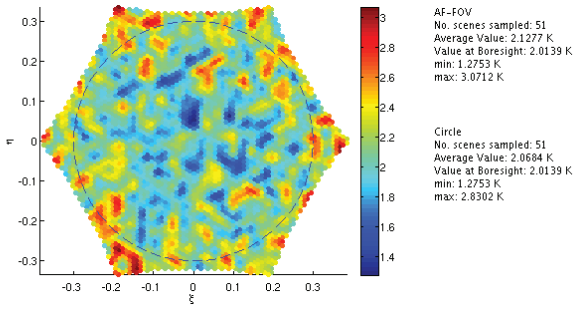

Figure 4: Preliminary assessment of Radiometric Sensitivity (H-polarisation)

It is known that some baselines induced large errors in the Image Reconstruction process. A solution has been devised to mitigate them and it has been shown that the best way to do it is with the aid through the use of a weighting matrix for the visibilities, as well as a weighted J^+ Matrix [1].
A similar analysis as the one performed in [1] has been repeated with in-orbit data acquired by MIRAS when is pointing to the Sky. The analysis of these this data allows us to estimate a new weighting matrix and, using L1PP, the corresponding System Response Function has been obtained and geolocated products generated.

III. CONCLUSIONS

L1PP was able to process data from SMOS even with on ground calibration data (cf. Figure 2) and with in-orbit calibration the images obtained were substantially improved (cf. Figure 5). Further studies on the best calibration options will be made available during the commissioning phase.

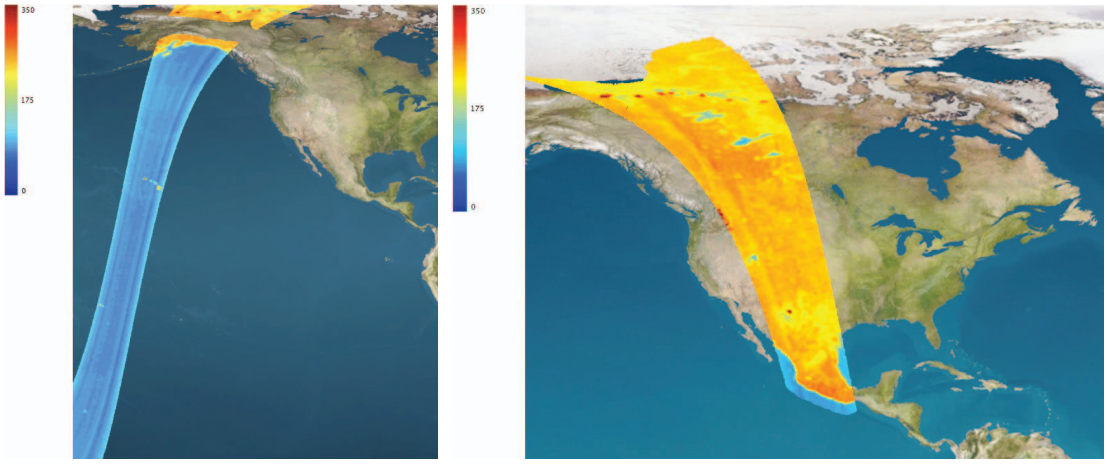

Figure 5: Swaths over North America and the Pacific (H-polarisation)

REFERENCES

[1] E.Anterrieu, H.Carfantan, M.Martin-Neira, J.Barbosa, and R.Castro, "Estimating and accounting for the covariance matrix of the MIRAS instrument onboard SMOS", *Accepted for oral presentation at the 11th Specialist Meeting on Microwave Radiometry & Remote Sensing Applications (μRAD'10)*, Washington (District of Columbia), 1-4 March 2010.