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SMOS Instrument Performance and Calibration after 3 Years in Orbit

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ESA's Soil Moisture and Ocean Salinity (SMOS) mission has been in orbit for already over 3 years which has allowed the calibration and data processing team consolidating both the calibration strategy and the Level-1 processor which transforms the raw visibility samples into polarimetric brightness temperature images. The payload on board SMOS, MIRAS, is quite unique in that it is the first microwave radiometer in space ever capable to generate wide field of view images at every snapshot measurement. This means that most of the calibration as well as image processing techniques are being developed for the first time with little heritage from any previous space mission. Issues intrinsically attached to its wide field of view such as spatial ripples across the snapshot images are particular to MIRAS and to no other earlier radiometer. Even the fundamental theory behind the instrument was put at test, first on ground inside an electromagnetic compatibility chamber, and now in orbit when imaging the Cosmic Microwave Background Radiation of the cold sky. A groundbreaking effort is being carried out by the SMOS project team to understand and master all calibration and image reconstruction issues of this novel microwave interferometer payload.

MIRAS in-orbit performance is driven by the amplitude of spatial ripples across the image and orbital and seasonal radiometer stability. Spatial ripples are unique to interferometric radiometers and are produced by (a) a limited knowledge of the antenna patterns and, in general, of the model of the instrument, (b) some fundamental limitations related to the inverse problem of image reconstruction in undetermined conditions and (c) subtle data processing inconsistencies which are discovered and corrected. To reduce the spatial ripples sea surface salinity retrievals are performed by first removing the brightness temperature spatial errors using a uniform region of the Pacific Ocean. However soil moisture retrievals cannot benefit of such well known target and suffer from residual undulations in the brightness temperature signatures along incidence angle. In addition, brightness temperatures tend to be negatively bias in the region around nadir, an artifact dependent of the processing technique and which is likely to be corrected in future processor versions.

The 3 year long data set has enabled the computation of the drift of the instrument, at orbital, seasonal and yearly scales. Orbital and seasonal drifts are dominating the stability of the brightness temperature images while the yearly drift is lower but clearly measurable. An important question about these drifts, still under study, is how much of them is coming from the instrument itself and how much is due to other effects influencing the metrics, like the Sun tails or the reflected galaxy. The most recent efforts have therefore focused in the correction of the Sun tails from the images by acquiring the Sun response in orbit through external calibration maneuvers. In parallel new calibration techniques to reduce further any instrumental variation are being investigated as an improved thermal model for the NIR receivers of MIRAS or the so called ALL-LICEF mode.

An overview of the good progress achieved in both calibration and image reconstruction issues in SMOS after these first 3 years in orbit, as described above, shall be presented in this contribution.