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SMOS instrument performance and calibration after six years in orbit

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ABSTRACT

ESA's Soil Moisture and Ocean Salinity (SMOS) mission, launched 2-Nov-2009, has been in orbit for over 6 years, and its Microwave Imaging Radiometer with Aperture Synthesis (MIRAS) in two dimensions keeps working well. The calibration strategy remains overall as established after the commissioning phase, with a few improvements. The data for this whole period has been reprocessed with a new fully polarimetric version of the Level-1 processor which includes a refined calibration schema for the antenna losses. This reprocessing has allowed the assessment of an improved performance benchmark. An overview of the results and the progress achieved in both calibration and image reconstruction is presented in this contribution.

1. Introduction

With an experience of over 6 years of in-orbit operation, much has been learnt on how MIRAS works and how its observations can be improved through better calibration and image reconstruction techniques. The purpose of this paper is to update the reader with the latest results on the payload performance and data processing of the SMOS mission (Mecklenburg et al., 2012). SMOS is currently delivering several products, some of them used by operational systems, others only for scientific research (Mecklenburg et al., 2016). MIRAS is a Microwave Imaging Radiometer with two-dimensional Aperture Synthesis, which remains being the first and so far, the only one of its kind, in space. The main feature of MIRAS is that it obtains two-dimensional images at every snapshot without needing any mechanical scanning of its antenna, a very distinct capability when compared with traditional scanners or push-broom radiometers. A detailed description of the instrumental aspects of MIRAS can be found in (McMullan et al., 2008) while the onboard Calibration System and respective in-flight calibration strategy are described in (Brown, Torres, Corbella, & Colliander, 2008) and (Martín-Neira, Suess, Kainulainen, & Martín-Porqueras, 2008). One year after launch the calibration approach was slightly modified with the initial flight experience, and the first SMOS instrument in-orbit performance was assessed in (Oliva et al., 2013), including the effect of the unexpectedly severe Radio Frequency Interference from ground transmitters (Oliva et al., 2012). The present paper will then follow the same structure as (Oliva et al., 2013), with important additions brought by the accumulated experience of over 6 years: Section 2 provides an overview of the main sources of error and the current mitigation strategies used to overcome them; Section 3 summarizes the current status of calibration activities, including all latest modifications to the initial

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0034-4257/

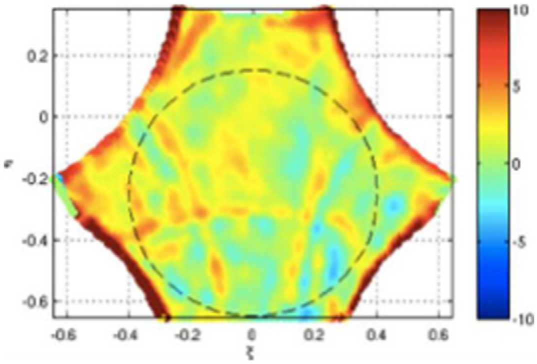

Fig. 1. Example of bias and spatial ripples of SMOS images when compared to a radiative transfer ocean model. The axes are the director cosines and the colour scale is in Kelvin.

calibration plan; Section 4 presents the in-orbit behaviour of the most critical instrument parameters; Section 5 gives the performance obtained with the latest version of the Level-1 processor, through the spatial and temporal analysis of brightness temperature images, and finally, Section 6 includes a view on the current investigations that should lead to the next version of the Level-1 processor with a hint on the expected improvements.

It is worth mentioning that, at the time of the writing of this paper, the running version of the operational SMOS Level-1 data processor is V620, that a new version, V700, has been delivered and is under assessment, and that the entire data record of the SMOS mission (from January 2010 onwards) has been reprocessed with V620 and is available to the whole SMOS user community.

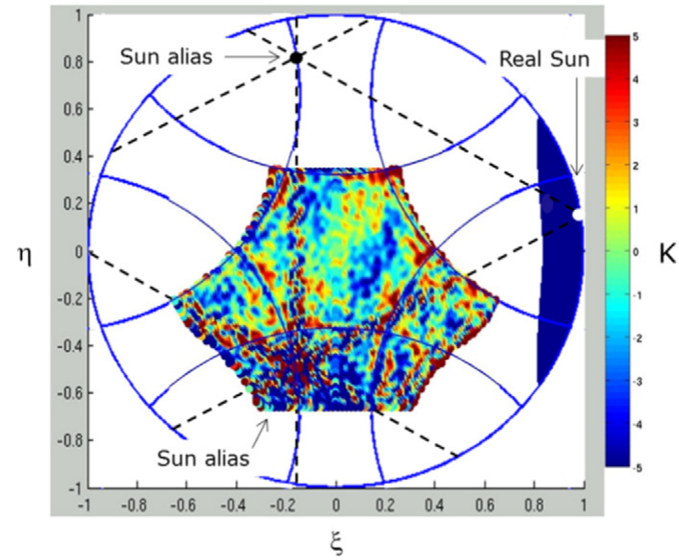

Fig. 3. Sun tails and alias affecting an ocean image.

2. Error sources and mitigation techniques

2.1. Error sources

Different error sources cause different effects on the SMOS brightness temperature images. Therefore in this section the error sources will be presented according to the effect they produce in the images.

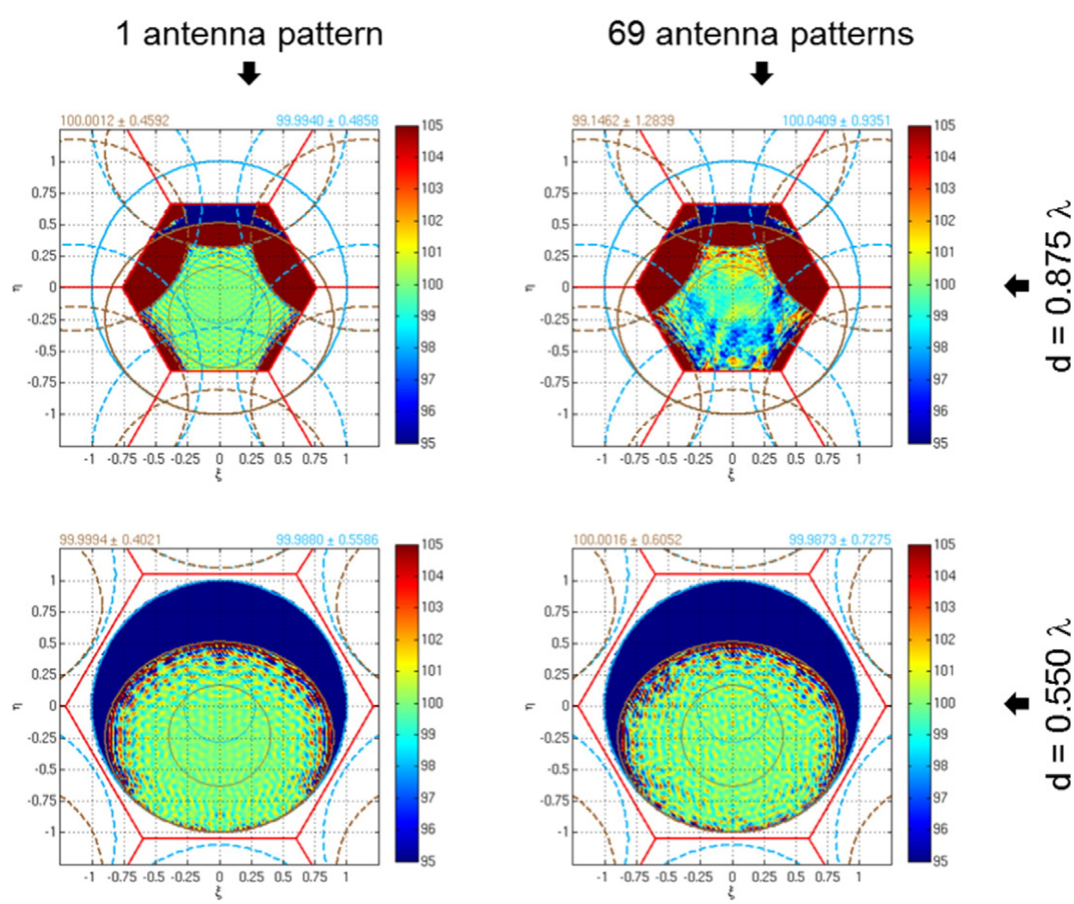

Fig. 2. Illustration that the spatial ripple results from the combination of different antenna patterns and alias condition. The image shows the Earth and the sky at a spatially uniform but different brightness temperature, viewed with the nominal SMOS geometry. The axes are the director cosines and the colour bar represents the retrieved brightness temperature in Kelvin.