RFI Analysis in SMOS Imagery

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The European Space Agency mission SMOS was successfully launched on November 2nd, 2009. Its main objectives are the determination of Soil Moisture over land [1] and Sea Surface Salinity over the oceans [2], with an accuracy of 0.04 m3/m3 every 3 days with a spatial resolution of 50 km [3, R-4.6.1-002 to 004] at level 2, and 0.1 psu every 10 days with a spatial resolution of 200 km [3, G-4.7.2-005] at level 3.
Unfortunately, the first SMOS images [4] using data from the on-ground Image Validation Tests showed a large amount of RFI, specially over land in Europe and Asia, but in some small areas of Africa and Greenland as well (Fig. 1).

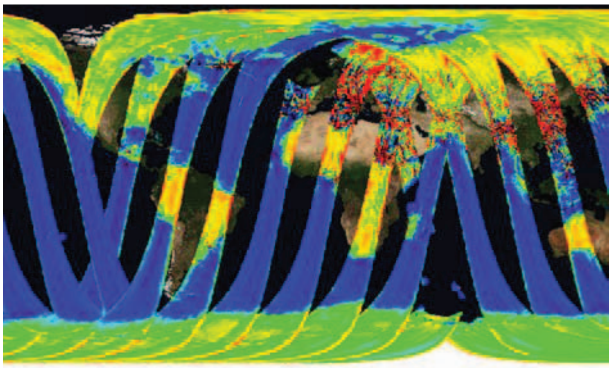

Fig. 1. First data (uncalibrated) sent to Earth by the MIRAS instrument on ESA's SMOS satellite [4].

A refined analysis using on-board calibration data allowed to focus the brightness temperature images [5], but even though the RFI regions are now more localized, the amount of RFI is so large, that it creates ripples (tails of the “impulse response” to a RFI quasi point source) that extend over the whole image, difficulting the retrievals, mainly over land (Figs. 2 and 3).

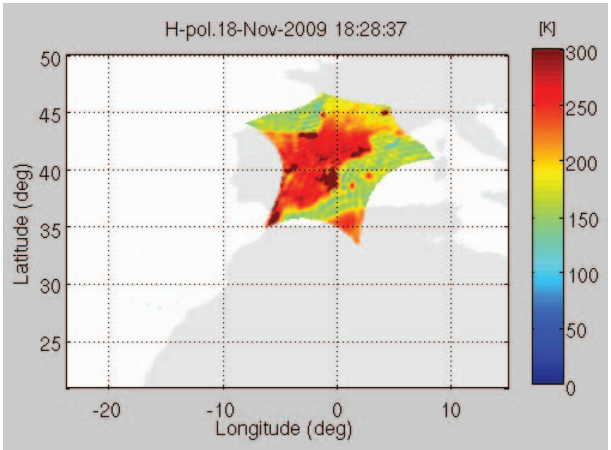

Fig. 2. First image of Catalonia [5]

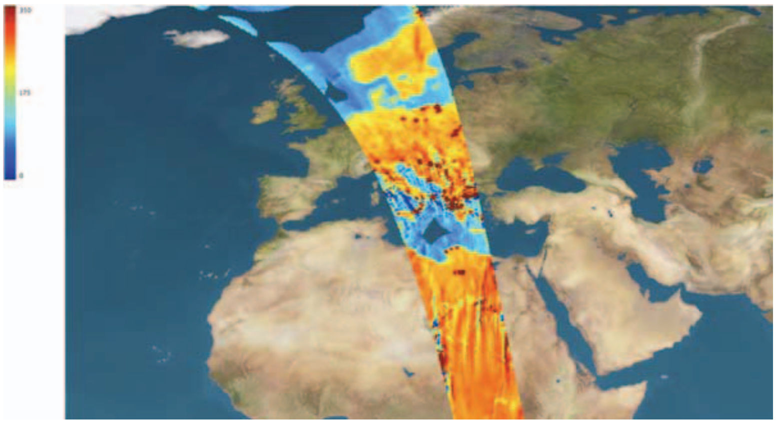

Fig. 3. First image after in-orbit calibration

In [6] an analysis of the potential sources of RFI and their impact was performed, it included: 1) nearby emissions from L-band radars, non-GSO and GSO MSS, 2) harmonics of lower frequency emissions, and 3) possible jamming, which may or may not be deliberately generated. From all the possible interferences, the most important ones were predicted to be those generated by L-band radars due to the high levels of transmitted power, which may interfere in an area of 80 km x 700 km (error 10^{-2} in the normalized cross-correlations) and non-GSO MSS (non Geo-Stationary Orbit Mobile Satellite Services) up-link transmitters (due to the low spurious rejection and to their proximity to the 1400–1427 MHz band), which may interfere in an area of 50 km x 92 km (error 10^{-2} in the normalize cross-correlations).
However, the fact that Europe and North of Asia are the regions most affected by RFI, while Regions 2 and 3 are generally clean, seems to indicate that fixed and mobile services (assigned in this band too, but only in Region 1), may be more important than radio-localization services (assigned in all three Regions) [7, 8] (Fig. 4).

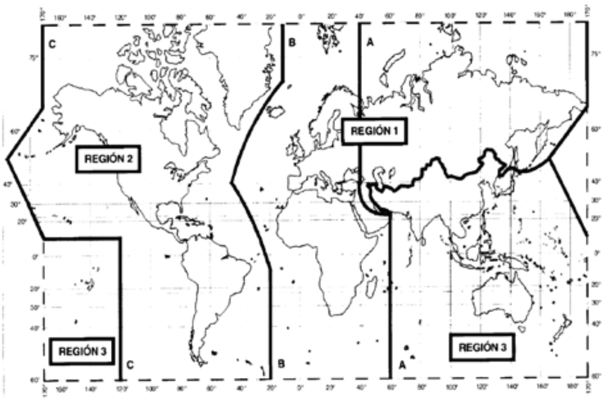

Fig. 4. Definition of Regions for Frequency Allocations [8]

This work will present evidence of different types of RFI encountered in the SMOS mission, their geographical distribution, and –to less extent due to the fixed time of the passage - their temporal distribution

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References:

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[3] SMOS System Requirements Document, doc. SO-RS-ESA-SYS-0555, issue 4.1, date 28-09-2004, http://eopi.esa.int/esa/esa;jsessionid=A294C2ED4515EBEA3949F5202CE564EA?topSelectedNavigationNodeId=AOS&sideNavigationType=AO&type=file&ts=1219832848852&table=aotarget&sideExpandedNavigationBoxId=Aos&cmd=image&id=801

[4] http://www.esa.int/esaLP/SEMOOU49J2G_LPsmos_1.html#subhead1

[5] http://www.smos-bec.icm.csic.es/node/36

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[7] http://www.mityc.es/telecomunicaciones/Espectro/CNAF/4atribuciones.pdf

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