A RST-BASED STUDY OF AMSRE C-BAND RADIO FREQUENCY INTERFERENCES

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1. INTRODUCTION

Radio Frequency Interference (RFI) is an increasing severe problem for present and future microwave satellite missions. Transmissions from ground based systems at low microwave frequencies (especially in C- and X-bands) can contaminate with a high level of noise the remote sensed measurements (both from aircraft and satellites) at these wavelengths. Recent experiences with the Advanced Microwave Scanning Radiometer (AMSRE) on Earth Observing System Aqua and the WindSat radiometer on the U.S. Department of Defense Coriolis satellite have further highlighted the negative effect of radio frequency interference on the measured signal at those wavelengths [1] – [4].

Regarding in particular AMSRE, because of this effect, after its launch, data acquired in C-bands, which would have provided reliable measurements of soil moisture, were often discarded, replaced with X-bands data (less RFI affected) in the retrieval algorithms [2], [5] – [10].

In this work, the multi-temporal RST (Robust Satellite Techniques) approach [11] [12] has been applied in order to automatically identify areas systematically affected by RFI contaminating C-band AMSRE radiances. A suitable RFI Exclusion Map for AMSRE C-band has been developed. Such a product may be used to improve AMSRE soil moisture retrieval in C-band discriminating where its use is still possible, and where it is better to avoid it. Moreover, RST approach may allow us to better define where signal variability at C-band is actually related to RFI and not to natural geophysical variability. Preliminary results of such an analysis will be shown in this paper.

2. METHODOLOGY

The Robust Satellite Techniques approach is a general methodology for multi-temporal satellite data analysis already successfully applied to monitor soil wetness variability using NOAA-AMSU (National Oceanic and Atmospheric Administration - Advance Microwave Sounding Unit) data [13] – [18], as well as by AMSRE [19] [20]. It is an automatic change-detection scheme that identifies signal anomalies in the space-time domain as deviations from a normal state that has been preliminarily identified on the basis of satellite observations collected during several years in the past, under similar observational conditions at pixel level. By such an analysis, areas where the analyzed signal shows high variability related to spurious effects such as those related to Radio Interference effect will be easily highlighted.

In order to investigate the amount of C-bands AMSRE RFI, a preliminary RST analysis has been performed studying historical series of AMSRE C-bands data extracted by the AMSRE Level-3 land surface product (AE_Land3) data [21]. In particular, data since 2003 to 2008, stratified in different data-sets depending on the polarization (H or V) and on the orbit (ascending or descending), have been analyzed. In figure 1, results obtained by such a study are shown. In detail, maps of temporal mean and standard deviation of C-bands for the month of January (from 2003 to 2008), computed analyzing the whole datasets, are shown. Looking at figure, and focusing the attention on the standard deviation images, firstly note the presence of cluster of pixels characterized by high values near highly populated urban areas and centers of technical and industrial activity, where RFI may usually occur. Moreover, the analysis of the recorded values allow to infer as no difference seems to be related to the orbit, while measurements achieved in horizontal polarization are higher than measured in vertical ones. This first results have confirmed the potential of RST in investigating RFI effects on AMSRE C-bands by analyzing the single channel. Better results may arise by using a combination of two AMSRE channels.

In absence of any kind of interference, in fact, surface brightness temperatures tend to increase moving from lower to higher microwave frequencies. This natural positive spectral gradient may invert (below 30GHz) only in presence of RFI [1]. To better evaluate C-band AMSRE RFI contamination over North America, an index based on the difference between measurements (brightness temperature - TB) achieved for the same polarization (p =H or V) at 6.9GHz and 10.7GHz has been proposed: RI6.9p= TB6.9p TB10.7p [1]. Positive values of such an index indicate RFI presence. In particular, 5 K<RI6.9p<10 K contains moderate RFI, while RI6.9p>10 K contains strong RFI [1].

Starting from these considerations, we have implemented RST approach globally using this index. Once computed the temporal mean and the standard deviations for of all the months of the year of the RI6.9p, we have built a C-band RFI exclusion map identifying all those pixels characterized by high persistent (for every month of the year) RI6.9p values. Results of such an analysis will be shown and discussed in this work, analyzing also the opportunity of exporting such a methodology also on the future C and X-band passive microwave missions [4] like MIS (Microwave Imager/Sounder) aboard NPOESS (National Polar-orbiting Operational Environmental Satellite System) [22] and AMSR2 aboard GCOM-W1 (Global Change Observation Mission – Water 1) [23] as well as the next L-band microwave missions, like ESA-SMOS (European Space Agency – Soil Moisture and ocean Salinity Mission) [24] (just launched), NASA AQUARIUS [25] and SMAP (Soil Moisture Active & Passive) [26]. Also at these high wavelengths, in fact, potential RFI caused by air-search radars have to be expected [27].

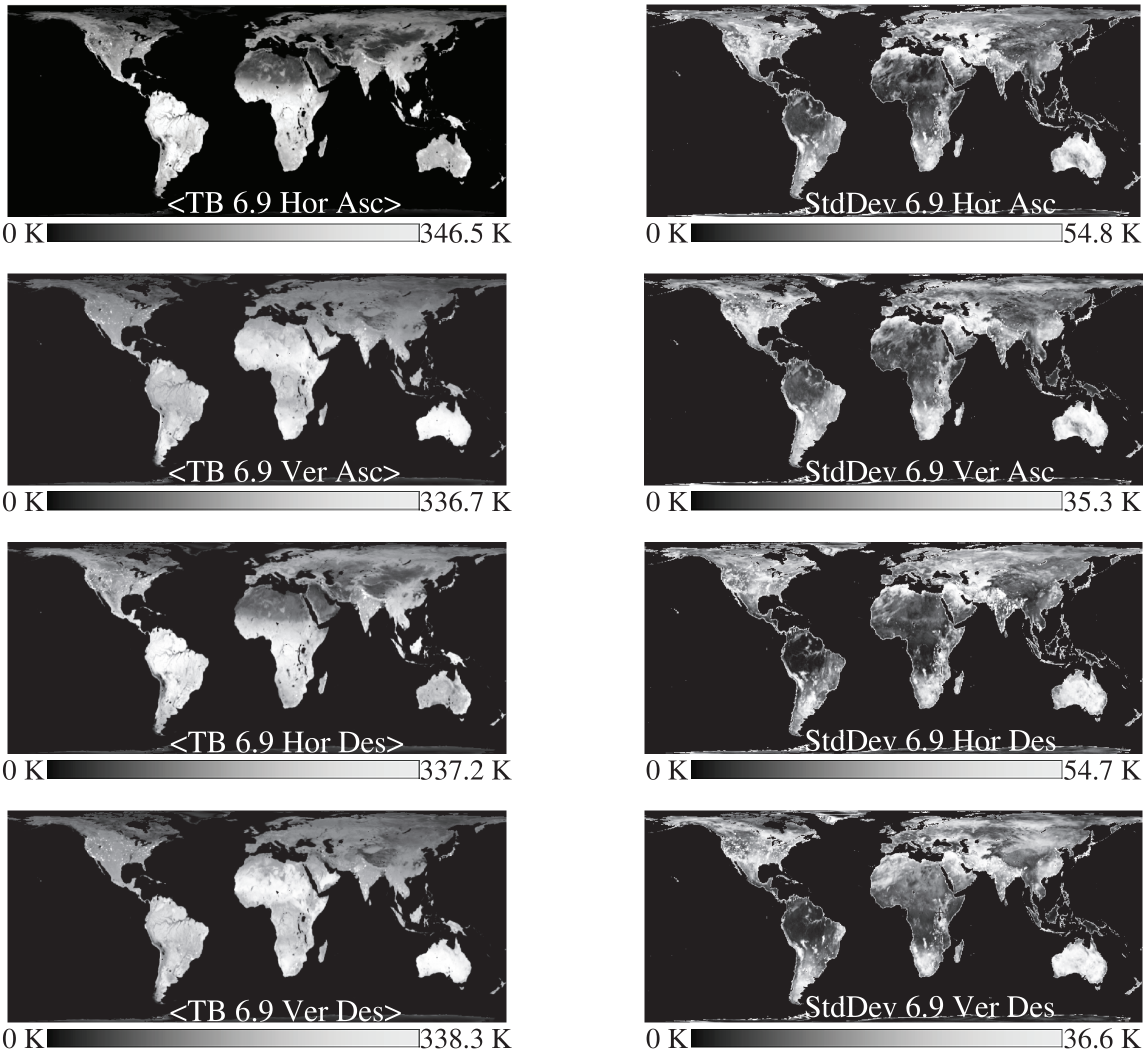

Figure 1: Brightness Temperature temporal mean (left) and standard deviation (right) computed following RST prescriptions for AMSR-E C-band (6.9 GHz) for the month of January. Results obtained for both the polarizations (H or V) and using ascending or descending passes (Asc or Des, respectively) are shown. The grey tones bars show the whole range of fluctuation for each field.

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