SMOS L1C AND L2 VALIDATION IN AUSTRALIA

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1. INTRODUCTION

Extensive airborne field campaigns (Australian Airborne Cal/val Experiments for SMOS – AACES [1]) were undertaken during the 2010 summer and winter seasons of the southern hemisphere. The purpose of those campaigns was the validation of the Level 1c (brightness temperature) and Level 2 (soil moisture) products of the ESA-led Soil Moisture and Ocean Salinity (SMOS) mission [2]. As SMOS is the first satellite to globally map L-band (1.4GHz) emissions from the Earth's surface, and the first 2-dimensional interferometric microwave radiometer used for Earth observation, large scale and long-term validation campaigns have been conducted world-wide (eg. [3], [4], [5]), of which AACES is the most extensive. AACES combined large scale medium-resolution airborne L-band and spectral observations, along with high-resolution in-situ measurements of soil moisture across a 50,000km^2 area of the Murrumbidgee River catchment, located in south-eastern Australia. This paper presents a qualitative assessment of the SMOS brightness temperature and soil moisture products.

2. STUDY SITE AND INSTRUMENTATION

2.1. Study Site

The Murrumbidgee River catchment is a subcatchment of the larger Murray-Darling River basin, located in southern New South Wales, Australia, and is part of the larger Murray-Darling River basin. It extends from 33-37° southern latitude and 143-150° eastern longitude (Fig. 1), covering a total area of 82,000km^2. The catchment covers a large range of surface and climatic conditions, from flat/semi-arid in its western reaches to mountainous/temperate in the east. The dominant vegetation in the western part is grassland, while the central part includes both dryland and irrigated farming (including the Coleambally Irrigation Area). The eastern parts are again used predominantly for grazing and also contain some extensive forested areas. Due to its large scale homogeneity, the Murrumbidgee River catchment is an ideal region for the validation of coarse scale passive microwave observations. The climate in summer is generally dry and hot particularly in the west. Conversely, the winter periods are wet and in the east can include extended periods of surface frost. The average annual

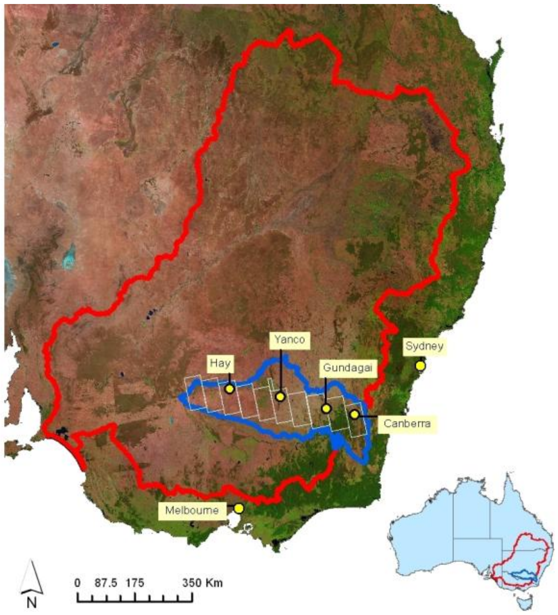

Figure 1. Location of the study catchment within Australia (blue line) along with the flight areas (white lines).

precipitation ranges from ~500mm in the west to 2000mm in the east.

2.2. Instrumentation

The ground-based observations consist of a combination of permanent monitoring stations and high-resolution local measurements of soil moisture and vegetation. The high-resolution information was collected across 10km^2 at 20 different focus locations throughout the catchment. At those locations, soil moisture measurements were taken along six 5km-long transects (300m apart), for a better understanding of the spatial variability of the soil moisture across the field sites. The instrument used for the collection of soil moisture information both for the high-resolution data, as well as the permanent monitoring stations, is the Stevens Hydraprobe, thus sampling the first 5cm of the soil, which corresponds to the approximate observation depth of SMOS.

The airborne measurements were obtained with the Polarimetric L-band Multibeam Radiometer (PLMR, [6]), providing six individual beams at ±7°, ±21.5° and ±38.5° – essentially reproducing the multi-angular capabilities of SMOS –, as well as spectral instruments operating in the visible, infrared and shortwave bands. Each swath obtained from flights at a nominal flying altitude of 3,000m resulted in a six-beam, multi-angle swath of 6km across track. During each flight, a total area of 100km x 50km was covered (Fig. 1), which included four footprints of SMOS.

3. RESULTS

3.1. Brightness Temperatures

Comparing the brightness temperatures observed by SMOS and PLMR respectively for the individual flight days (Fig. 2) revealed a persistent bias. With only a few exceptions (very dry and hot days at the start of the first campaign and very wet and cooler days following significant rain events), the data displays a systematic difference of ~11K. Given systematic nature of the difference, the bias can be removed resulting in a de-biased RMSD of ~6K (both polarizations). As Australia is generally clear of RFI contamination, it can be safely

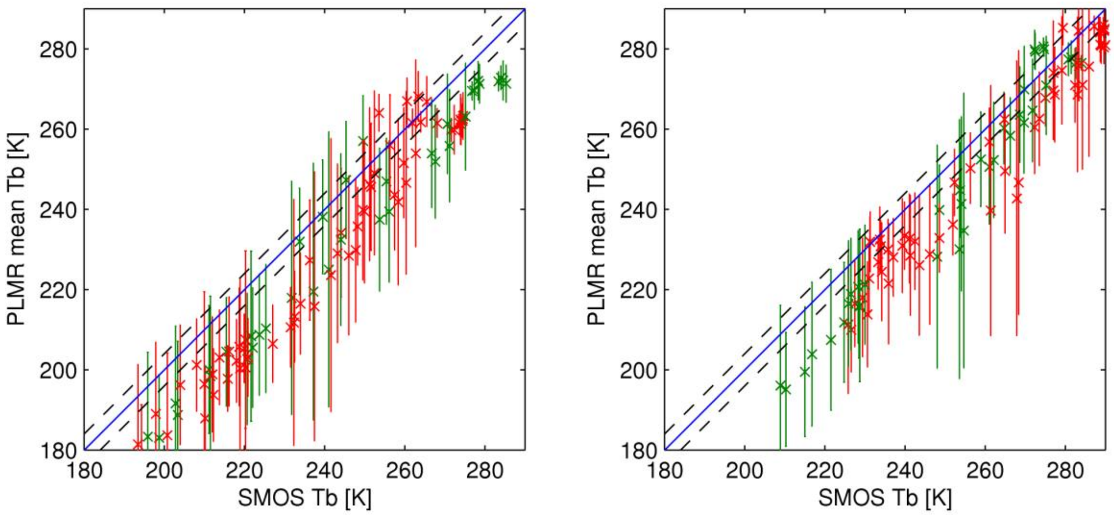

Figure 2. SMOS and PLMR brightness temperatures (horizontal/vertical) for the summer (red) and winter (green) campaigns, along with the standard deviation of the airborne brightness temperatures.

assumed that the bias in the data is not related to RFI. Nevertheless, this analysis shows that this level of error in the SMOS data is close to its target accuracy of 4K.

3.2. Soil Moisture

The Level 2 soil moisture product was compared against both the high-resolution ground-based observationsand those obtained from the permanently installed monitoring stations. The high-resolution data was averaged and compared against the original SMOS data, as well as a disaggregated product [7]. Data collected at the permanent monitoring stations were used for a comparison against the 2010 reprocessed (SMOS L2 v.4.0) data set only (Fig. 3). In all cases the average error was found to be 0.07 m^3m^{-3}. The accuracy was higher for the western sites, particularly in summer, during the very hot and dry period of January/February 2010, whereas significant differences were observed shortly after rainfall events. However, this may be due to the large amount of surface water on the vegetation itself observed during those sampling days.

4. CONCLUSIONS

This study presented results from the Australian validation activities for the ESA-led SMOS mission. It was shown that systematic errors exist both in the Level 1c and Level 2 products. After removal of those errors, the overall absolute errors are found to be ~6K (Level 1c) and 0.07 m^3m^{-3} (soil moisture). The most significant errors were found to occur just after rain events, however, those events are flagged in the SMOS data stream and can therefore be excluded before the data are used [8]. Overall, the errors found are comparable to previous soil moisture products [9] and it can be expected that future releases of reprocessed SMOS data will have improved accuracy.

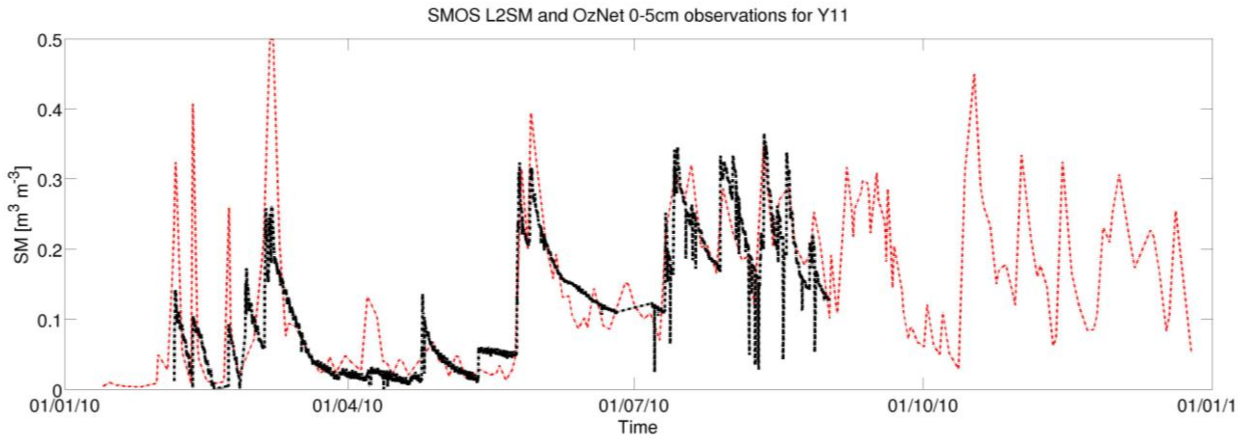

Figure 3. Time series of SMOS (red) and OzNet station data, covering the two AACES campaigns.

6. ACKNOWLEDGEMENTS

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