A CALIBRATION SITE IN THE AUSTRALIAN DESERT FOR SMOS

J. P. Walker, C. Rüdiger
Department of Civil and Environmental Engineering, The University of Melbourne, Australia
Y. H. Kerr
Biospheric Processes, CESBIO, France
E. J. Kim
Hydrospheric and Biospheric Sciences Laboratory, NASA Goddard Space Flight Center, United States
R. Gurney
NERC Environmental Systems Science Center, University of Reading, United Kingdom
D. Barrett
Sustainable Minerals Institute, The University of Queensland, Australia
J. Le Marshall
Bureau of Meteorology Research Center, Bureau of Meteorology, Australia

1. INTRODUCTION

The European Space Agency's Soil Moisture and Ocean Salinity (SMOS) mission, the first dedicated soil moisture satellite mission, was successfully launched on 2 November 2009. This satellite consists of a new type of design based on the radio-astronomy technique of simulating a large antenna from a number of small receivers arranged in a Y-shaped array. Because of this unique design and the fact that it is sensing in a previously unutilized frequency range makes it critical that on-orbit calibration targets be included in the calibration strategy. Consequently, targets such as the Antarctic [1,2], cold oceans [3], tropical forests [4] and deserts [5] are being considered. However, the large footprint size of passive microwave observations requires large scale regions to be identified for calibration purposes. Moreover, these sites must be either stable through time or the temporal variation easily described from point observations. In order to satisfy the calibration accuracy required by SMOS for soil moisture retrieval, such sites should be characterized with a brightness temperature uncertainty of less than 4K.

Field experiments have been undertaken in November 2008 and August 2009 in the Australian Arid Zone to explore the suitability of three such potential on-orbit calibration targets for SMOS. These sites were chosen for their assumed spatial homogeneity in terms of surface conditions (soil moisture and temperature, vegetation, soil type etc.), and consequently their expected homogeneous microwave response. The extent of each site is approximately 50km x 50km, being close to the size of a SMOS footprint. The sites have contrasting surface conditions typical of the Australian Arid Zone and include i) Wirringula Hills, a cattle station to the north-east of

Coober Pedy that is characterized by a dense cover of surface rock with almost no vegetation ; ii) Lake Eyre, a typically dry salt lake characterized by a predominantly moist sandy material under a layer of salt crust; and iii) the Simpson Desert, characterized by typically very dry sand dunes orientated in a north-south direction with low levels of vegetation.

2. STUDY SITES

All three sites reside within the Australia Arid Zone, with only very little annual precipitation and consequently sparse vegetation cover. For each site, two different types of data were collected: i) airborne and ii) in-situ. The airborne data consists of brightness temperatures collected at a resolution of 1km with an L-band radiometer and thermal infrared measurements taken at the same resolution as the brightness temperature data. Those data fully cover all three study areas. In addition, the in-situ data include soil profile temperatures and soil moisture content collected at fixed base stations and also soil moisture data obtained using the Hydraprobe Data Acquisition System (HDAS) developed for collecting point measurements of soil moisture and ancillary data across local scales.

3. RESULTS

The initial hypothesis was that all sites would yield data with a spatial variability close to or even below the 4K SMOS requirement. However, in November 2008, only Wirrangula Hill was found to be within this range (3.5K), while the Simpson Desert (23K) and Lake Eyre (90K) data sets showed significant bi-modality in their brightness temperature responses (Fig. 1). While the bi-modality in the Simpson Desert was due to a significant rain event that passed through the north-eastern part of the site, even the "dry" south-western part exhibited a high variability (9K). Moreover, Lake Eyre was found to exhibit bi-modality in response to geophysical features. Only the low response was expected, reflecting the wet salty conditions of the dry salt lake soils; this very low response was not due to standing open water, as Lake Eyre did not contain any surface water in November 2008. The unexpected high temperature response was found to be a response to slightly higher elevation areas within the lake bed consisting of silty deposits from occasional flood events. Despite the two contrasting emissions, even the spatial variability for the hypothesized "wet" conditions was found to be too large (13K).

To confirm the findings, the campaign was repeated in August 2009 following a period of 3 months without significant precipitation events in the region. The brightness temperature variability across the Wirrangula Hill area was found to be similar to November 2008, underlining the consistent homogeneity of the site. However, this time the Simpson Desert was found to be extremely homogeneous with a variability of 1K.

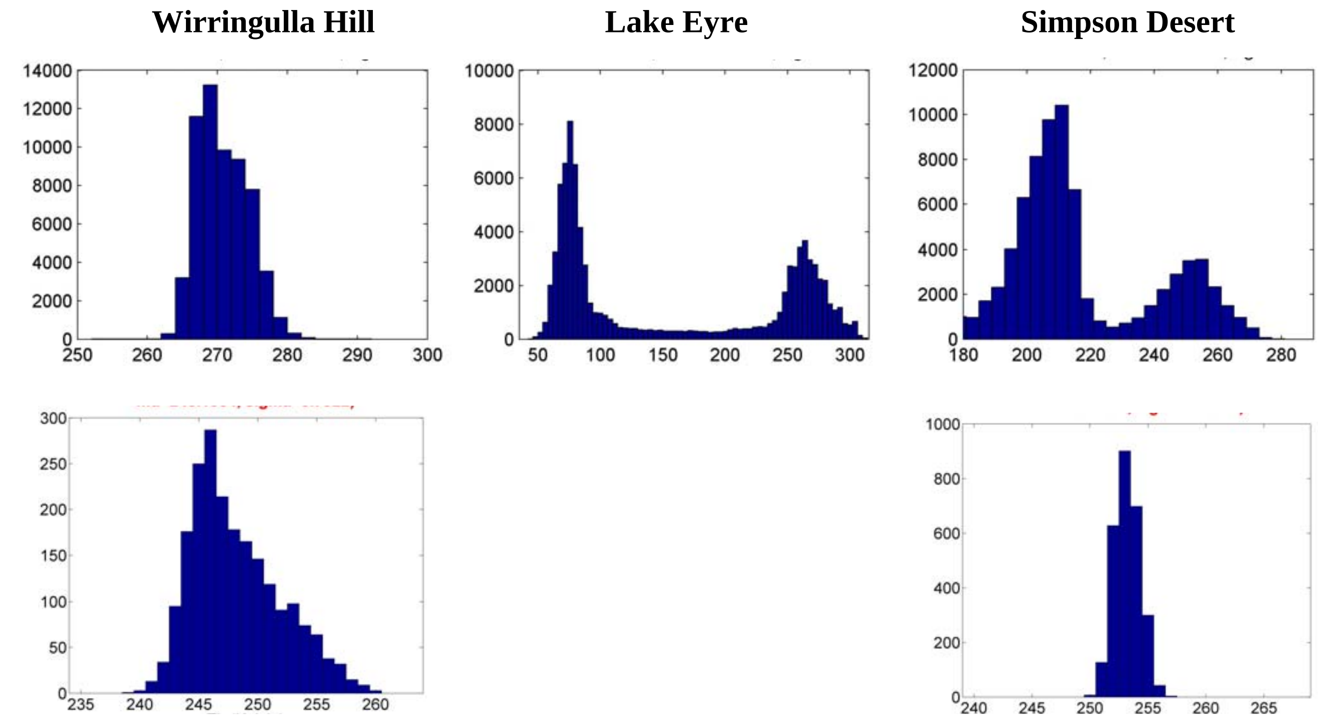

Figure 1. Histograms of the horizontally polarized brightness temperature responses across Wirrangula Hill, Lake Eyre and Simpson Desert in November 2008 (top row) and August 2009 (bottom row).

4. CONCLUSIONS

Airborne field campaigns were undertaken to identify potential vicarious microwave satellite calibration sites within the Australian Arid Zone. It was found that two sites may be considered for such purposes (Wirrangula Hill and Simpson Desert), as their temporal and spatial variability is within the 4K target accuracy for SMOS. However, monitoring of precipitation events will be necessary, as they significantly influence the brightness temperature response of these generally dry sites. Lake Eyre was found to be an unsuitable target.

5. REFERENCES

[1] Macelloni, G., M. Brogioni, P. Pampaloni, M. Drinkwater, and A. Cagnati (2006), DOMEX 2004: An experimental campaign at Dome-C Antarctica for the calibration of space-borne low-frequency microwave radiometers. *IEEE Transactions on Geoscience and Remote Sensing*, 44(10), 2642–2653.

[2] Macelloni, G., M. Brogioni, P. Pampaloni, and A. Cagnati (2007), Multifrequency microwave emission from the Dome-C area on the East Antarctic Plateau: Temporal and Spatial Variability. *IEEE Transactions on Geoscience and Remote Sensing*, 45(7), 2029–2039.

[3] Burrage, D., J. Wesson, and J. Miller (2008), Deriving sea surface salinity and density variations from satellite and aircraft microwave radiometer measurements. *IEEE Transactions on Geoscience and Remote Sensing*, 46(3), 765–785.

[4] Ferrazzoli, P., L. Guerriero, and J.-P. Wigneron (2002), Simulating L-band emission of forests in view of future satellite applications. *IEEE Transactions on Geoscience and Remote Sensing*, 40(12), 2700–2708.

[5] Delwart, S., C. Bouzinac, P. Wursteisen, M. Berger, M. Drinkwater, M. Martin-Neira, and Y.H. Kerr (2008), SMOS validation and the COSMOS campaigns. *IEEE Transactions on Geoscience and Remote Sensing*, 46(3), 695–704.