VALIDATION OF SMOS L1C AND L2 PRODUCTS WITH AIRBORNE AND IN-SITU OBSERVATIONS ACROSS SOUTH-EASTERN AUSTRALIA

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1. INTRODUCTION

The Soil Moisture and Ocean Salinity (SMOS) mission was launched in November 2009 as the first L-band satellite with the specific purpose of global soil moisture mapping [1]. Moreover, it has used a novel aperture synthesis technique to simulate the antenna size required to provide observations at a resolution of less than 50km. Consequently the brightness temperatures and derived soil moisture products need to be thoroughly validated through ground- and airborne experiments. As SMOS provides observations with an average footprint size of ~43km, it was necessary that large areas be monitored with relevant airborne and ground-based instrumentation.

In January/February and September 2010, two extensive field campaigns were undertaken in south-eastern Australia (the Australian Airborne Cal/val Experiment for SMOS (AACES [2]) for the validation of the L1c (brightness temperature) and L2 (surface soil moisture) products of the SMOS mission. The field site chosen for these campaigns was the 82,000km^2 Murrumbidgee River catchment, located between 33-37°S and 144-151°E. The diversity in environmental conditions across the catchment and the existing soil moisture monitoring infrastructure made it an exceptionally well suited catchment for such satellite validation activities. Specifically, it ranges from semi-arid plains in the west, to irrigated cultivated areas in the central part, and temperate subalpine conditions in the east.

2. INSTRUMENT AND DATA DESCRIPTION

The primary instrument deployed during these campaigns was the Polarimetric L-band Multi-beam Radiometer (PLMR) on a small aircraft. During the summer campaign (January/February 2010), a total area of 50,000km^2 was covered, requiring 10 flight days and including 40 full SMOS footprints, with each flight day covering an area of approximately 100km x 50km at 1km resolution. Each flight day

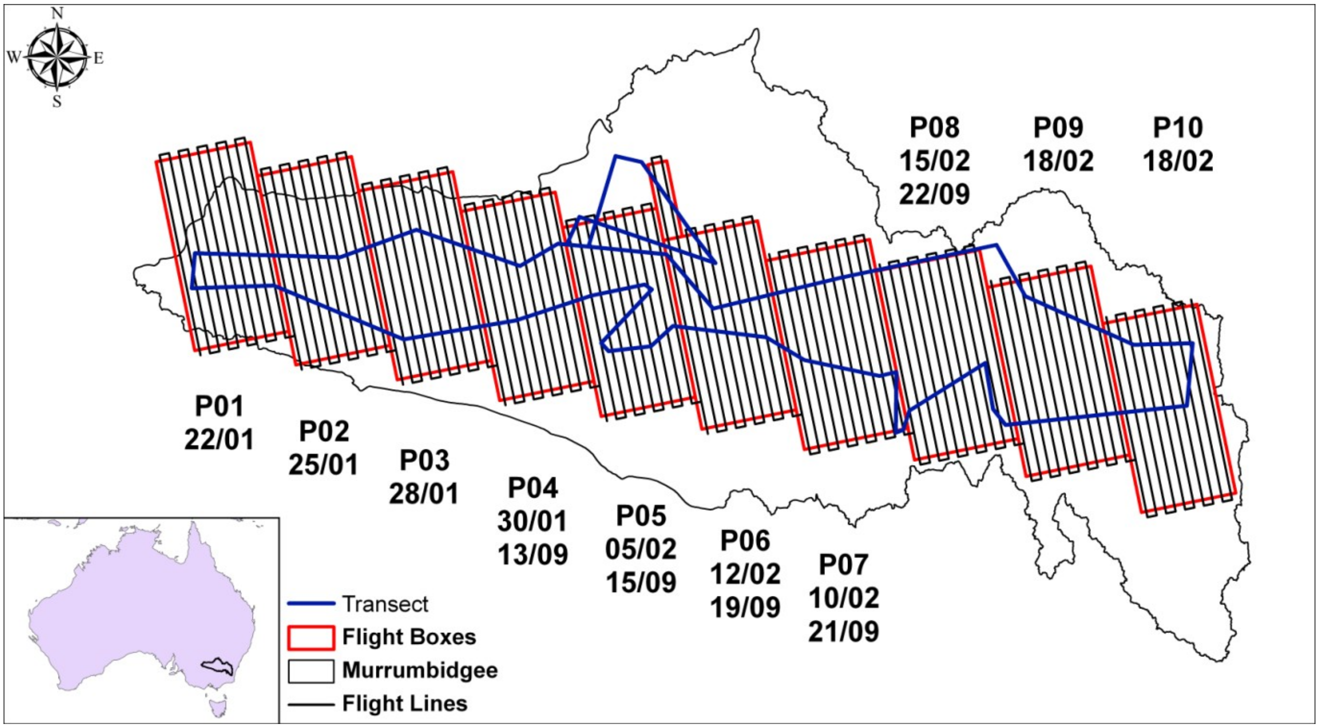

Fig 1. Outline of the Murrumbidgee River catchment (insert: location of the catchment within Australia). The flight boxes for the 10 focus areas are shown along with the corresponding flight lines. The transect flight was flown at the start, middle and end of the campaigns. The dates represent are those of the flight days (Jan/Feb – summer campaign; Sep – winter campaign).

coincided with a SMOS ascending overpass. The winter campaign covered a smaller are of 25,000 km^2, including 20 SMOS footprints (Fig. 1).

In addition to the airborne data collection, ground measurements were taken across focus farms, including soil moisture and temperature, leaf area index (LAI), hyperspectral measurements of the vegetation, destructive samples of vegetation for Vegetation water content and drybiomass, and thermogravimetric samples for calibration and soil property analysis. These ground measurements were obtained through in-situ measurements across two focus farms in each 100km x 50km area, with an extent of 5km x 2km each. While the soil moisture and temperature measurements were taken along 6 parallel transects every 50m, the vegetation measurements were collected within smaller (representative) vegetation sampling areas.

3. DISCUSSION

The brightness temperatures observed with PLMR were used to calculate the soil moisture across the Murrumbidgee River catchment using the L-band Microwave Emission of the Biosphere Model (LMEB;

[3])., and retrievals validated with ground measurements. Both airborne derived soil moisture during the campaigns and long-term soil moisture data from the monitoring network were then compared to the official L2 soil moisture data products. The airborne brightness temperatures were also used directly to validate the L1c brightness temperatures. It was found that a persistent over- (brightness temperature) and underestimation (soil moisture) exists within the SMOS data throughout the measurements (for the data sets released operationally during the campaigns). This bias was found across all vegetation and climate conditions and may therefore not be related to the surface conditions.

This experimental data was also used to study the spatial coverage requirements for airborne validation campaigns. Using this extensive data set, it was found that the minimum fraction of a satellite footprint to be covered so as to achieve an uncertainty in the average of airborne data (due to incomplete sampling) not greater than the 4K design accuracy of SMOS was determined. It was found that the coverage requirements are dependent on the underlying subpixel variability of the actual footprint, but typically 50% of the footprint needs to be covered by the airborne measurements to achieve this goal.

The campaign data are available from www.moisturemap.monash.edu/aaces.

4. REFERENCES

[1] Y.H. Kerr, P. Waldteufel, J.-P. Wigneron, S. Delwart, F. Cabot, J. Boutin, M.-J. Escorihuela, J. Font, N. Reul, C. Gruhier, S.E. Juglea, M.R. Drinkwater, A. Hahne, M. Martín-Neira, and S. Mecklenburg, "The SMOS Mission: New tool for monitoring key elements of the global water cycle," Proc. IEEE, vol. 98, no. 5, pp. 666-687, 2010, doi:10.1109/JPROC.2010.2043032.

[2] S. Peischl, J.P. Walker, C. Rüdiger, Y.H. Kerr, D. Ryu, and N. Ye, "The AACES Field Experiments for SMOS validation," submitted to IEEE Trans. Geosci. Remote Sens.

[3] J. P. Wigneron, Y. Kerr, P. Waldteufel et al., "L-band Microwave Emission of the Biosphere (L-MEB) Model: Description and calibration against experimental data sets over crop fields," Remote Sens. Environ., vol. 107, no. 4, pp. 639-655, Apr, 2007.