# SMAPEX: SOIL MOISTURE ACTIVE PASSIVE REMOTE SENSING EXPERIMENT FOR SMAP ALGORITHM DEVELOPMENT

*J. P. Walker, R. Panciera, D. Ryu*
Department of Civil and Environmental Engineering, The University of Melbourne, Australia
*D. Gray*
Department of Electrical and Electronic Engineering, The University of Adelaide, Australia
*T. J. Jackson*
United States Department of Agriculture, United States

## 1. INTRODUCTION

NASA's Soil Moisture Active Passive (SMAP) mission, scheduled for launch in 2015, will carry an innovative L-band microwave radar and radiometer system with the objective of mapping soil moisture in the near-surface layer (top 5 cm) at global scale, near-daily temporal resolution, and unprecedented spatial resolution [1]. The scientific rationale behind SMAP, inherited from the earlier HYDROS [2] mission proposal, is an improved accuracy and resolution of soil moisture estimates as compared to those currently possible from the ESA Soil Moisture and Ocean Salinity (SMOS) mission, through the fusion of high resolution (3 km) but noisy soil moisture information provided by the radar with the more accurate yet lower resolution (40 km) soil moisture information from the radiometer, in order to obtain a 9 km active passive soil moisture product [2]. In order to achieve these objectives, algorithms suitable to take advantages of the synergy between radar (active microwave) and radiometer (passive microwave) observations need to be developed and tested using field data. The Soil Moisture Active Passive Experiments (SMAPEx) described in this study aim at contributing to the development and validation of such algorithms before the SMAP launch, by means of prototype SMAP observations collected by a unique active and passive airborne facility over a heavily monitored study area. This paper outlines the airborne and ground sampling rationale of the SMAPEx experiments.

## 2. STUDY AREA

The field work required by this project will be undertaken in the Yanco intensive study area, located in the Murrumbidgee catchment in south-eastern Australia (see Fig. 1). The Yanco study area was the focus of the National Airborne Field Experiment in 2006 (NAFE'06) [3] and therefore constitutes a very suitable study site in terms of background knowledge and data sets, scientific requirements, and logistics. A semi-arid region consisting of mostly dryland and irrigation farming practices, the Yanco study area has been monitored for a series of remote sensing campaigns since 2004 with a network of soil moisture and soil temperature monitoring

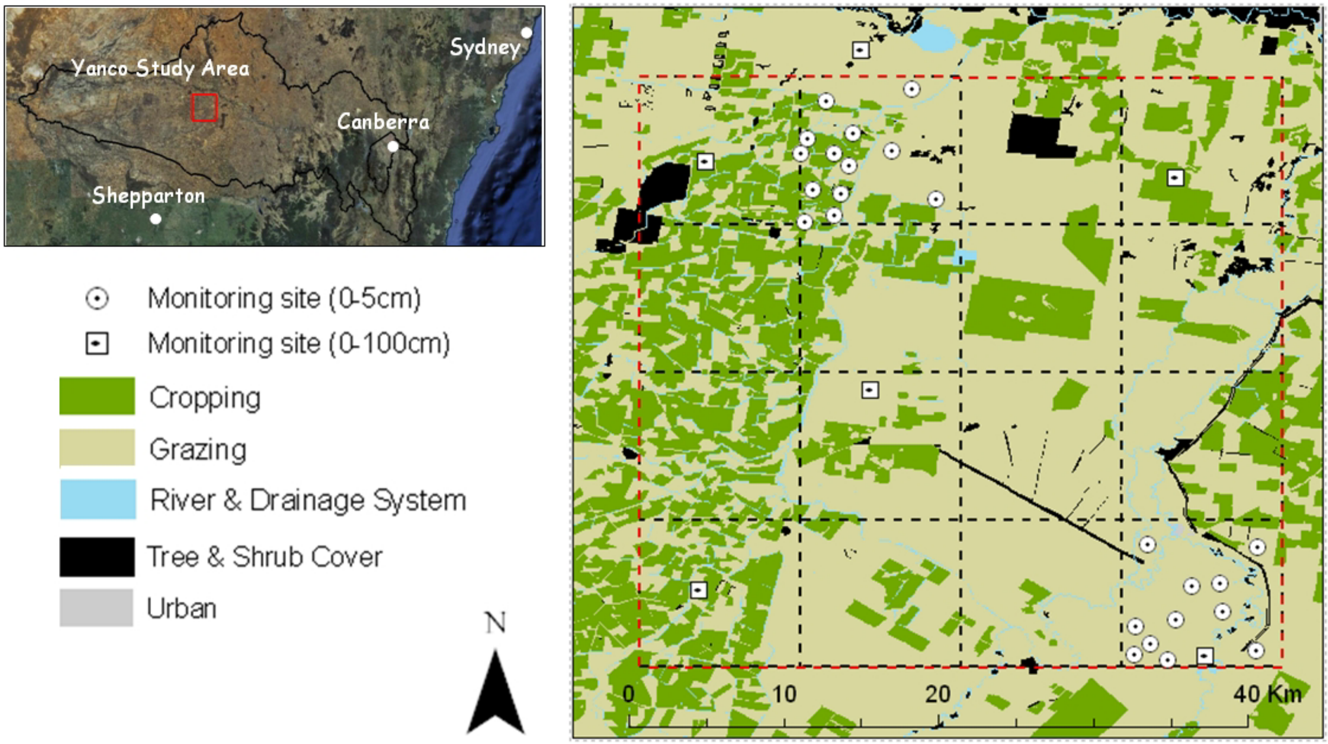


**Fig. 1: Location and land use conditions in the SMAPEx Yanco study area, corresponding to the SMAP 36km x 36km grid (red rectangle), and the ground sampling focus areas corresponding to the SMAP 9km x 9km grid (black rectangles). Locations of the continuous monitoring stations are indicated with white circles and squares.**

sites, and upgraded with 24 additional near-surface (0-5 cm) sites in 2009. The additional monitoring sites were installed with the SMAP mission particularly in mind, with locations based on the SMAP global grids, corresponding to approximately 3km, 9km and 36km nested sampling.

The area receives approximately 300–500 mm of rainfall annually, which is nearly entirely lost through evapotranspiration. The Coleambally Irrigation Area (CIA), an agricultural area of approximately 95,000 ha, occupies approximately one-third of the Yanco study area. The principal summer crops grown in CIA are rice, maize, and soybeans, while woodlands and grazing dry lands with occasional winter crops (wheat, barley, oats, and canola) and wetlands occupy the rest of the study area. The profile soil moisture monitoring sites in the Yanco area (shown in Fig. 1 as white squares) cover a range of soils and landcover types typical of the region, and evenly divided between the 3 main land uses in the region: irrigated cropping, dry-land cropping and grazing. The 24 additional near-surface sites are concentrated in two focus areas, one characterised by irrigated cropping (north) and the other by dryland grazing (south), to be the focus of extensive ground and airborne monitoring.

## 3. AIRBORNE SMAP SIMULATOR

SMAP will consist of a combined radar and radiometer system operating at 1.26 GHz (with VV, HH, and HV polarisations) and 1.41 GHz (H, V and U polarisations), respectively. The radar and radiometer will share the aperture of a single feedhorn and reflector, which rotate conically about the nadir axis to form a constant incidence angle of 39.3º. Radar acquisition will be at 1 km resolution (and averaged to 3 km) with coincident 40 km radiometer measurements across a 1000 km wide swath. Due to the peculiarities of radar measurement, no high resolution radar data will be obtained within the 300 km band of the swath centred on the nadir track.

This configuration will be replicated by our SMAP simulator using the Polarimetric L-band Multibeam Radiometer (PLMR; 1.41GHz, H and V polarisations) and the Polarimetric L-band Imaging Synthetic aperture radar (PLIS; 1.26 GHz, VV, HH, and HV polarisations). Both instruments will be mounted under the fuselage of the same aircraft so that they take concurrent observations of the same ground area. The ground resolutions will be 1 km for the radiometer and approximately 10 m for the radar observations at the flight altitude of 3 km. As for SMAP, no high-resolution data will be available from the airborne SMAP simulator within the approximately 1.5 km band of the swath centred on the nadir track for a 3 km flying height. Consequently the flight lines will be designed so that the 15º - 45º field of view of the radar will provide full coverage of the radiometer swath. This airborne configuration will therefore allow collection of data which are a scaled replicate of SMAP acquisition in terms of incidence angles, swath coverage and resolution ratio between active and passive data.

## 4. THE SMAPEX FIELD CAMPAIGNS

SMAPEx will be comprised of four airborne campaigns throughout 2010 and 2011, undertaken in different seasons to allow the collection of SMAP prototype data over different soil moisture and vegetation growth conditions. Ground sampling of soil moisture and vegetation will be undertaken by ground teams in two focus areas, one dryland grazing and one irrigated cropping, corresponding to two 9 km x 9 km nested grids of the SMAP downscaled soil moisture product (see Fig. 1). In these areas, near-surface soil moisture will be continuously monitored throughout the season at 29 locations, while additional intensive measurements of near-surface soil moisture spatial distribution, vegetation water content and surface roughness will be undertaken concurrently with flights.

## 5. ALGORITHM DEVELOPMENT

Data from the SMAPEx experiments will be used to develop and validate algorithms for the SMAP soil moisture retrieval. In particular, it will be used to (i) investigate the effect of soil moisture, vegetation and surface roughness on the active microwave observations, (ii) downscale the coarse radiometer observations using the high resolution radar observations, and (iii) use radar and radiometer data synergistically to increase the accuracy of the retrieved soil moisture as compared to using either data source alone.

## 6. REFERENCES


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