FY2017 Progress Report To:

the

Japan Aerospace Exploration Agency

Validation of global water and energy balance monitoring in the Australian Murray-Darling Basin using GCOM-W1 data

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Specification No: JX-PSPC-454882; Contract No: 17RSTK005381

Investigators: Jeffrey Walker (RA1W108), Jason Beringer, Christoph Rüdiger, Edoardo Daly

Contributors: Ying Gao, Mei Sun Yee, Kiri Manson

March 2018

MONASH University
Engineering

Executive Summary

This report presents the research results for the project 'Validation of global water and energy balance monitoring in the Australian Murray-Darling Basin using GCOM-W1 data'. The research seeks to continue operating the JAXA flux tower within the core validation site, and provide spatially distributed soil moisture data from across an AMSR2 sized footprint. Importantly, this project will also make significant independent and collaborative contributions to validation of:

i) the low resolution AMSR2 soil moisture products;

ii) a high resolution downscaled AMSR2 soil moisture product; and

iii) land surface model simulations of soil moisture and latent/sensible heat.

For JFY2017, the research work focused on the above first two targets. Validation results indicated that the AMSR2 L3 soil moisture product match with the JAXA tower and in-situ station measurements relatively well during the dry season (soil moisture higher than 0.1 m^3/m^3). However, during the wet season (soil moisture ranges from 0.1-0.5 m^3/m^3), the AMSR2 product tends to underestimate the condition by around half of the peak soil moisture values. Therefore, it is suggested that the AMSR2 L3 soil moisture algorithm needs to be further improved in the future.

Table of Contents

List of Tables

Chapter 1: Introduction

This report presents a collection of research tasks and outcomes during the FY2017 for the project 'Validation of global water and energy balance monitoring in the Australian Murray-Darling Basin using GCOM-W1 data'. The project seeks to continue operating the JAXA flux tower within the core validation site, and provide spatially distributed soil moisture data from across an AMSR2 sized footprint. Importantly, this project will also make significant independent and collaborative contributions to validation of: i) the low resolution AMSR2 soil moisture products; ii) a high resolution downscaled AMSR2 soil moisture product; and iii) land surface model simulations of soil moisture and latent/sensible heat.

For JFY2017, apart from the maintenance of the JAXA flux tower and data processing, the research work focused on the above first two targets. Other stated objectives will be addressed in the subsequent year.

Chapter 2: Site Description

2.1 The Murrumbidgee Catchment

The Murrumbidgee catchment is located in southern NSW, Australia. It is bordered by the Great Dividing Range to the east, the Lachlan catchment to the north, and the Murray catchment to the south. The Murrumbidgee Catchment exhibits a significant spatial variability in climate, soil, vegetation and land cover because of its distinctive topography (Figure 1). Due to the diversity within this area, the large amount of complementary data from long-term monitoring sites, and past airborne field experiments, this region is an ideal test-bed for the comprehensive validation of satellite soil moisture from missions such as GCOM-W1 and is highly complementary to validation sites in Mongolia and Thailand. Moreover, considering the size of the satellite footprint, there are regions in the catchment that are relatively homogeneous in regard to climate, soil type, vegetation, and consequently radiometric response (Rüdiger et al., 2011) when compared to many other countries.

Temporal climatic variations of the catchment are primarily associated with elevation, varying from semi-arid in the west to temperate in the east. The total average annual rainfall for the entire Murrumbidgee River catchment is about 530 mm, with a mean annual precipitation of 300 mm in the west and about 1,900 mm towards the east in the Snowy Mountains. The actual evapotranspiration is equivalent to precipitation in the west but represents only half of the precipitation in the east. Long term averaged precipitation data for the Murrumbidgee

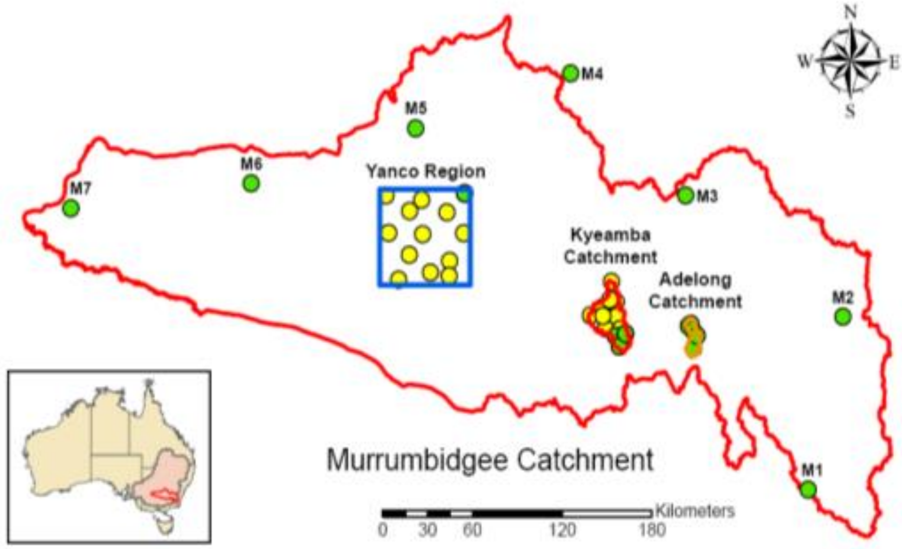

Figure 1: Location of the Yanco core validation site within the Murrumbidgee Catchment. Also shown is the location of the Murrumbidgee Catchment within the Murray-Darling Basin (inset) and the locations of sparse network soil moisture stations.

Catchment shows a relatively constant rate of rainfall across the year, with a slight increase in winter. The Murrumbidgee catchment is characterised by plains in the west with an elevation around 50 m, to steep mountainous regions towards the east with elevations more than 2,100 m in the Snowy Mountains. Soils in the Murrumbidgee Catchment vary from sand to clay, with the western plains being dominated by finer-textured soils and the eastern slopes being dominated by medium-to-coarse textured soils (McKenzie et al., 2000).

Land use in the catchment is predominantly agricultural with the exception of steeper parts, which are dominated by a mixture of native eucalypt forests and exotic forestry plantations. Agricultural land use varies greatly in intensity and includes pastoral, more intensive grazing, broad-acre cropping, and intensive agriculture in irrigation areas along the mid-lower Murrumbidgee. Grazing is predominant in the west and scattered in the east, whereas dryland cropping dominates the mid Murrumbidgee catchment. Irrigation sites are mainly located in western part of the Yanco core validation site. The catchment is comprised of about 52% pasture, followed by about 21% arable and 18% silvicultural land use. The other land use types represent less than 9% of the total catchment area.

2.2 The Yanco site

The Yanco area is a 60 km x 60 km area located in the western plains of the Murrumbidgee Catchment where the topography is flat with very few geological outcroppings (Figure 2). Soil types are predominantly clays, red brown earths, transitional red brown earth, sands over clay, and deep sands. Approximately one-third of the core validation site is irrigated during summer when sufficient water is available. The Coleambally Irrigation Area (CIA) is a flat agricultural area of approximately 95,000 hectares that contains more than 500 farms. The principal summer crops grown in the CIA are rice, corn, and soybeans, while winter crops include wheat, barley, oats, and canola. Rice crops are usually flooded in November by about 30 cm of irrigation water.

A total of 24 surface soil moisture sites were installed in late 2009 to develop a nested soil moisture monitoring configuration for the SMAP mission at scales of approximately 3 km, 9 km and 36 km. These stations continuously monitor the soil moisture over the 0-5 cm layer with a Hydraprobe and soil temperature sensors (Unidata® 6507A/10) at 1, 2.5 and 5cm depths. The 24 sites are concentrated on two 9 km x 9 km focus areas (areas YA and YB), corresponding to two pixels of the SMAP grid at which the active passive soil moisture product (SMAP L3_SM_A/P product) was to be produced. Finally, 10 of the sites within areas YA and YB are concentrated on a further two 3 km x 3 km sub-areas (each) with at least 4 stations

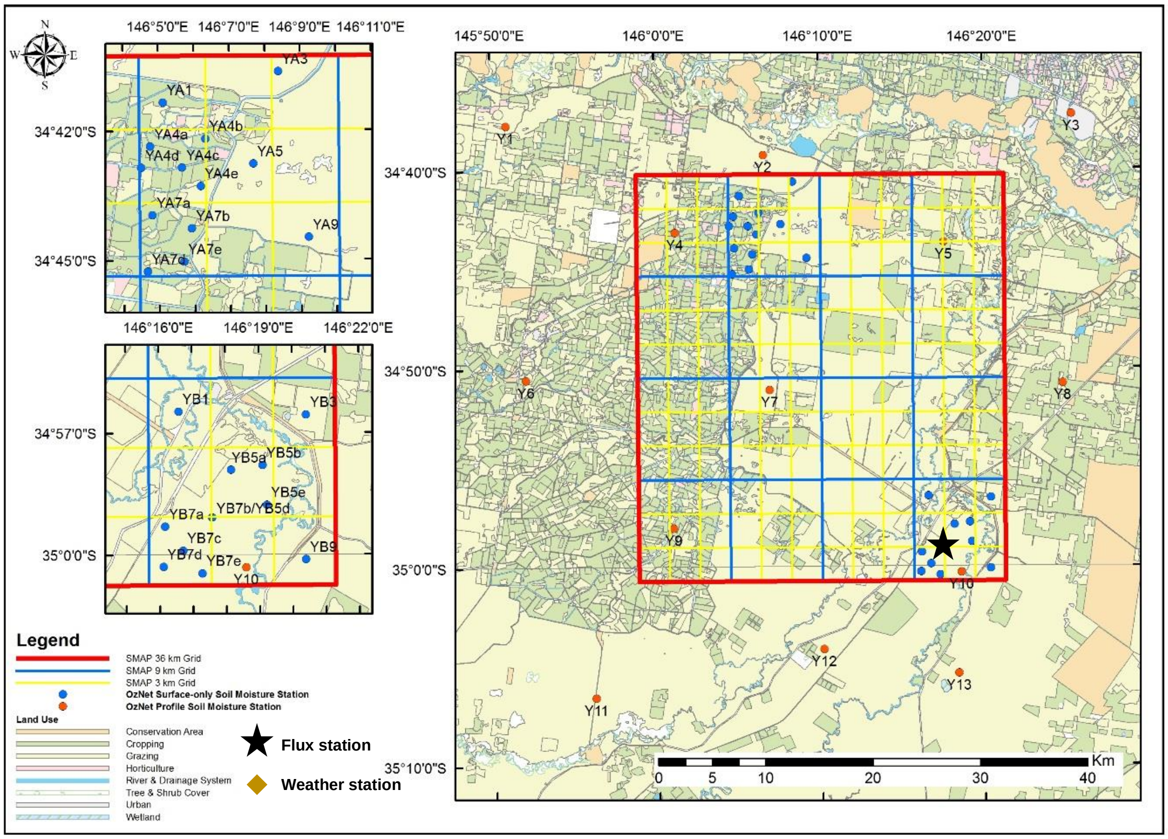

Figure 2: Locations of the JAXA flux station, weather station and soil moisture monitoring stations within the Yanco core validation site. Also shown are the YA and YB focus areas with intensive soil moisture stations, and the locations of intensive ground sampling areas.

measuring the distribution of soil moisture across each, corresponding to a total of four of the SMAP radar pixels (see Figure 2 for details of the YB area). Unfortunately, the SMAP radar failed shortly after commissioning. However, sentinel data are being used to replace the SMAP radar observations for locations such as the Murray Darling Basin.

This intensive network is also an ideal core validation site for AMSR2, as it i) monitors soil moisture across an AMSR2 sized pixel with approximately 30 stations, and ii) can be used to validate AMSR2 downscaling algorithms through the nested sampling design and supplementary intensive ground sampling activities that have been undertaken. Moreover, extensive airborne data sets and supplementary ground data (see www.nafe.unimelb.edu.au; www.moisturemap.monash.edu.aaces; www.smapex. monash.edu) have been used to assess the representativeness of soil moisture sites for each of the 9 km x 9 km focus areas (areas YA and YB), corresponding to two pixels of the SMAP products at 3 km for radar, 9 km for radar-radiometer and 36 km for radiometer pixels (Yee et al. 2016). These stations have also been used to validate AMSR2 soil moisture products based on the JAXA and LPRM algorithm of different versions, and SMOS soil moisture products (Yee et al., 2016), and provide a perfect source of data for the passive-passive downscaling work proposed here.

Chapter 3: Flux Tower Maintenance and Upgrades

Regular site maintenance carried out during 2017 included cleaning of the rain gauge, radiation sensors and solar panels, insect control and regular data downloads.

The Open Path C02/H2O Gas Analyzer (LI-7500A) is due for calibration, which is scheduled to be completed in the next month during a regular site visit.

As reported in 2016, sensors on the ASSH-T Weather Station needed replacement. Upon request, Monash received the following:

Vaisala Weather Transmitter (WXT530)

Vaisala Surge Protector (WSP150)

Humidity and Temperature Probe (HMP 155)

Infrared Radiometer (SI-100)

These instruments were installed on 11th July 2017 and appear to be working well. As reported in 2016, the highest air temperature and humidity sensor (HMP 155A-1) is still removed from the tower as Monash has not received a replacement from JAXA.

Figure 3: Update label on ASSH-T Weather Station sent to Monash by JAXA on 19/09/2017.

Figure 4: Replaced Infrared Radiometer (SI-100)

Figure 5: Replaced Vaisala Surge Protector (WSP150)

Figure 6: Replaced Vaisala Weather Transmitter (WXT530) and Humidity and Temperature Probe (HMP 155) inside.

Chapter 4: Data Description

4.1 JAXA flux tower data

Half-hourly measurements from the JAXA flux tower are uploaded from the JAXA station to a Monash server on a weekly basis. The 10 Hz data are downloaded from the logger during monthly site visits. All raw data are downloadable from oznet.org.au (Figure 7). Simple quality checks have been applied to these data whereby out of range values have been removed.

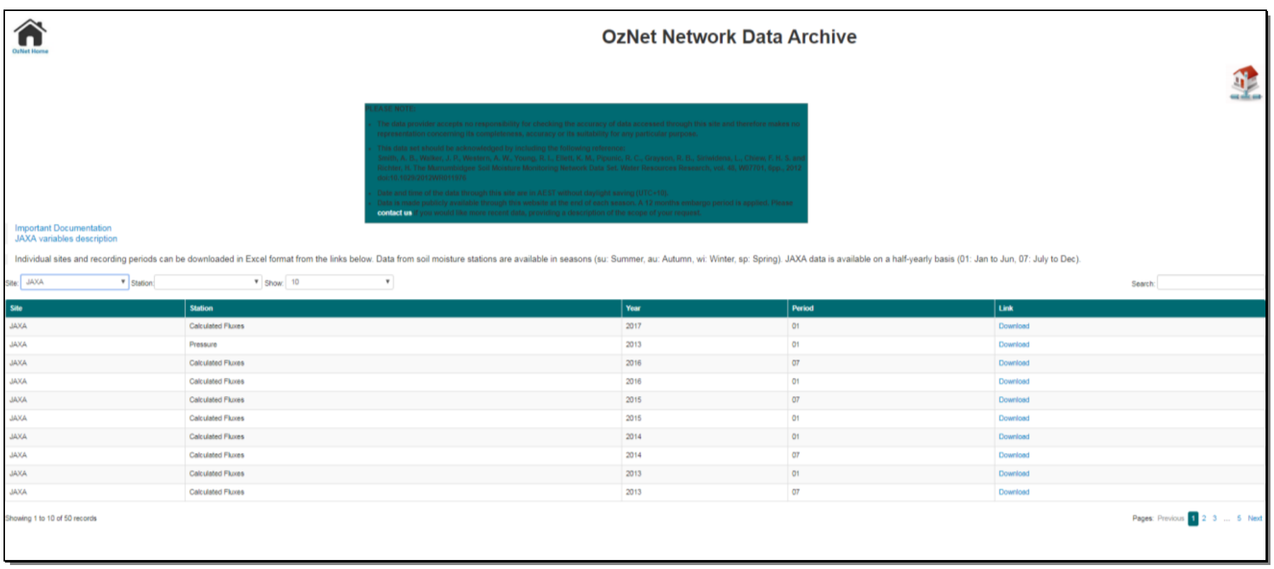

Figure 7: JAXA data download interface on oznet.org.au

The half-hourly measurements are then quality-checked using a Python code developed by the OzFlux Community. Selected outputs are shown in the graphs below (Figure 8 to 11). These original half-hourly and quality checked data can be downloaded from http://data.ozflux.org.au/portal/pub/viewColDetails.jspx?collection.id=1882711&collection.owner.id=304&viewType=anonymous.

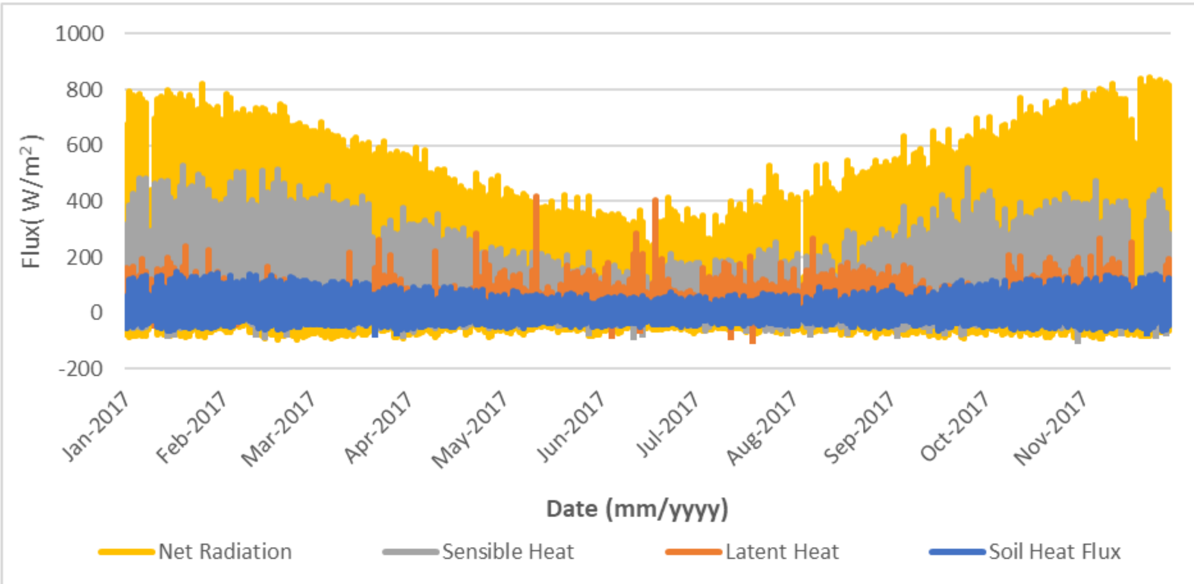

Figure 8: Quality checked heat fluxes measured at JAXA Tower using OzFlux code for 2017.

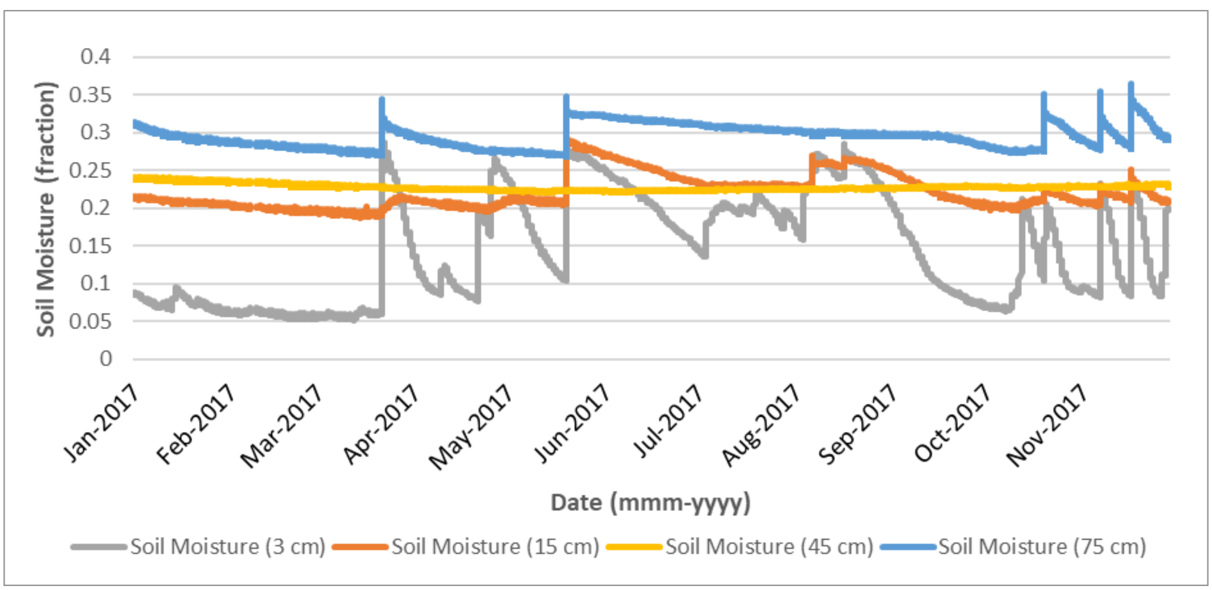

Figure 9: Soil moisture measured at JAXA Tower using OzFlux code for 2017.

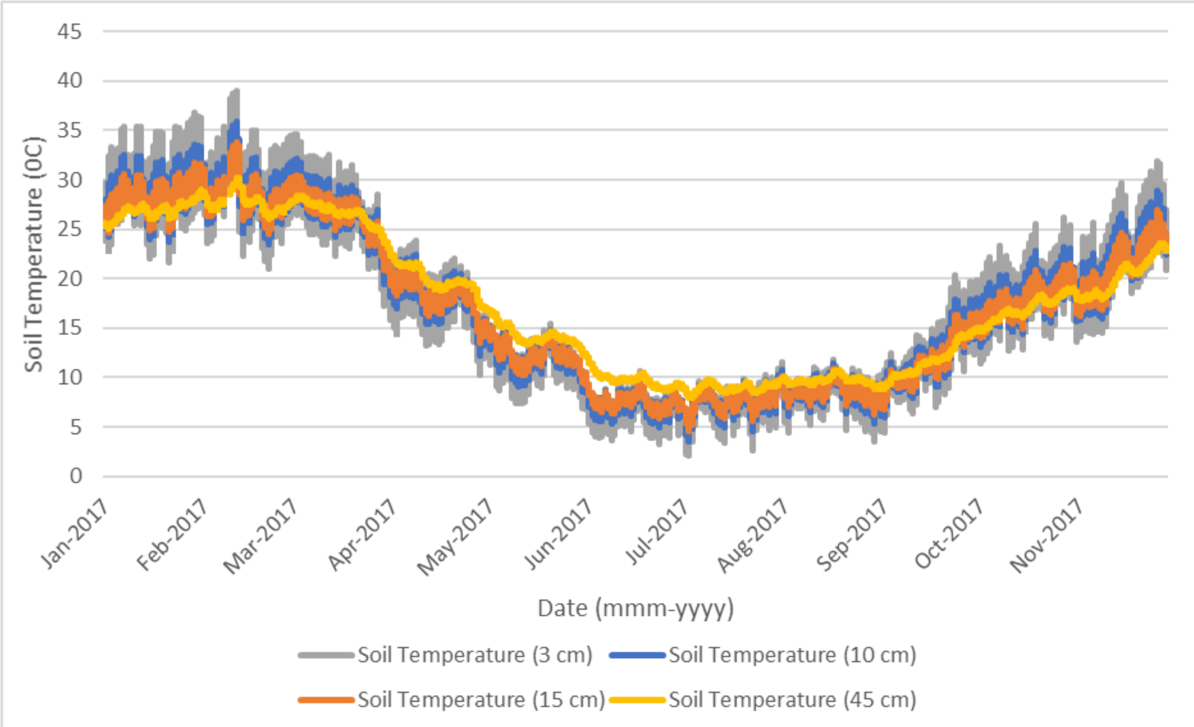

Figure 10: Soil temperature measured at JAXA Tower using OzFlux code for 2017.

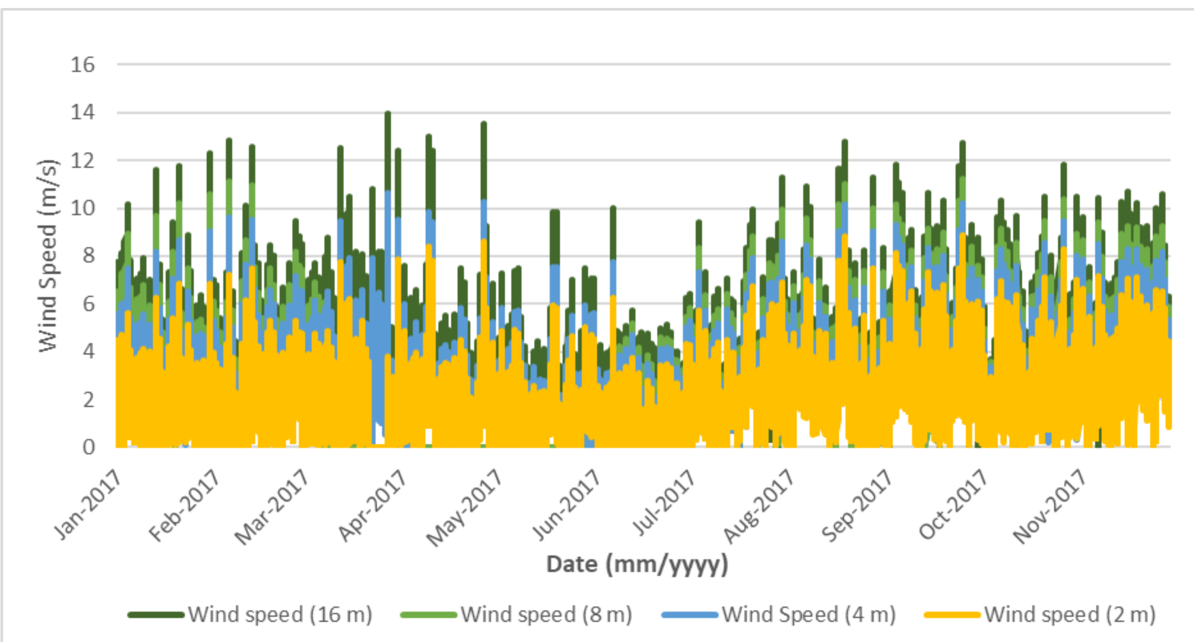

Figure 11: Wind speed at different heights measured at JAXA Tower using OzFlux code for 2017.

4.2 OzNet monitoring station data

20-min interval of measurements of soil moisture and soil temperature from the OzNet monitoring stations are collected from each station. All raw data are downloadable from oznet.org.au. Data were separated and named seasonally, i.e. spring, summer, autumn and winter. Simple quality checks have been applied to these data whereby out of range values have been removed. An example of the data collected from station YA4a from autumn to spring for 2017 are display below.

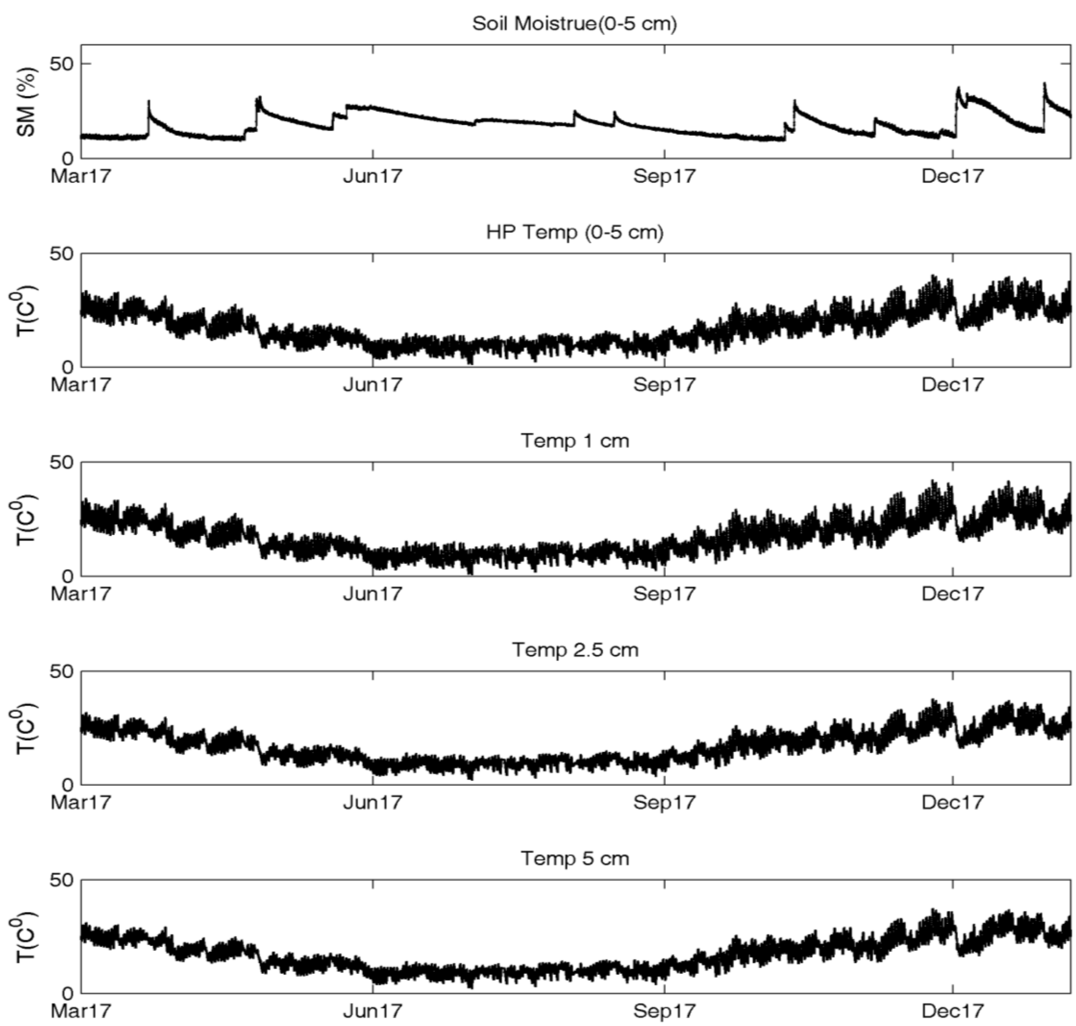

Figure 12: Example of soil moisture and temperature collected from YA4a.

4.3 SMAPEx Campaign data

The fourth and fifth Soil Moisture Active Passive Experiments (SMAPEx-4 & -5) were conducted in the austral autumn, from 1st May to 22nd May 2015, and in the austral spring, from 7th September to 27th September 2015, respectively at the Yanco area. The main objective was to collect airborne active and passive microwave data, ground observations of soil moisture, and ancillary data needed for soil moisture retrievals in coincidence with SMAP coverage, providing microwave observation and soil moisture references for SMAP in-orbit validation. The SMAPEx-5 study area and flight areas are shown in Figure 13.

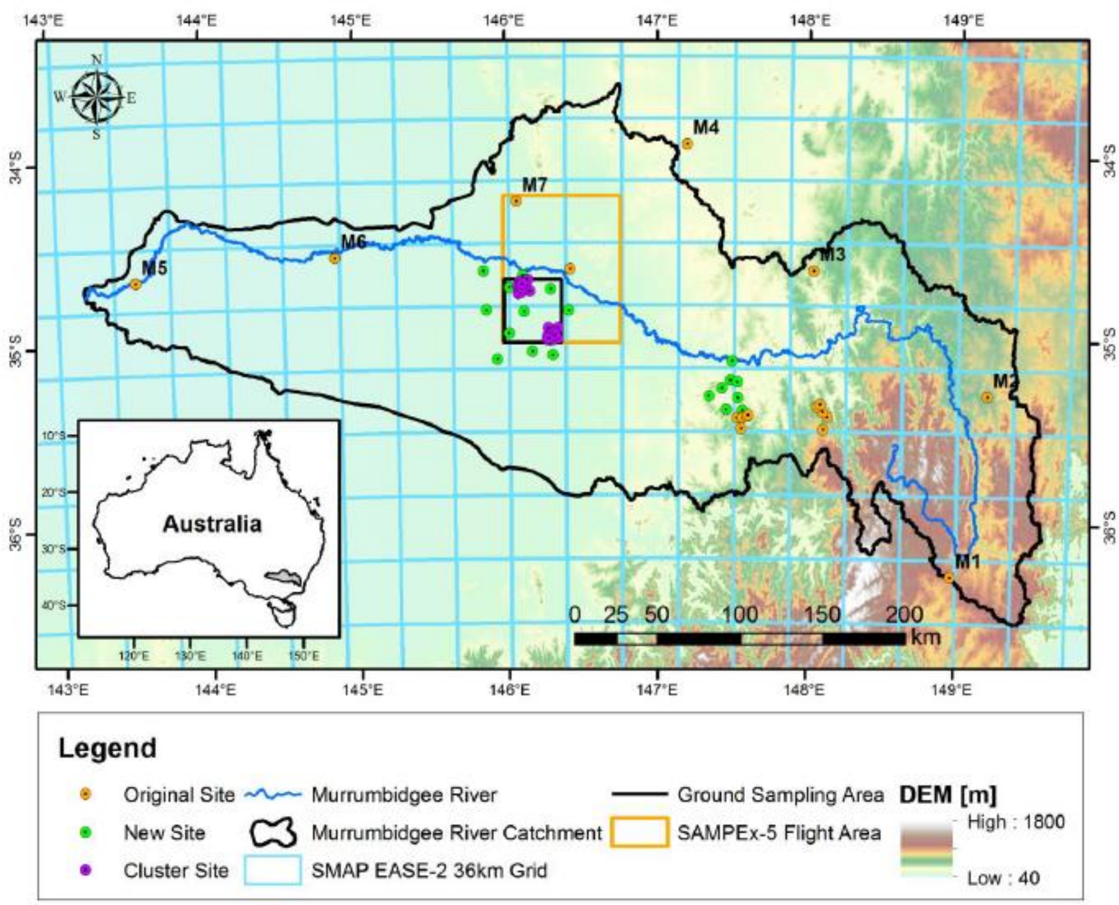

Figure 13: Study area and airborne monitoring are during SMAPEx-5

Soil moisture has been retrieved from both campaigns for the Yanco site from airborne passive microwave observations at 1 km resolution. The passive airborne sensor is called The Polarimetric L-band Multibeam Radiometer (PLMR), which measures brightness temperature at both V and H polarisations using a single receiver with polarisation switch at incidence angles ±7°, ±21.5° and ±38.5° in either across-track or along-track configuration. The soil moisture retrieval at 1-km resolution was performed using the tau-omega model and a sample retrieval result for SMAPEx-5 (flight area shown in Figure 13) is shown in Figure 14.

Ground sampling was undertaken concurrently with the flights and mainly included intensive spatial soil moisture sampling in six focus areas, as well as the regional soil moisture sampling in SMAPEx study area. Other ground activities performed in the study area included the surface roughness sampling, gravimetric soil sampling, intensive vegetation sampling and so on.

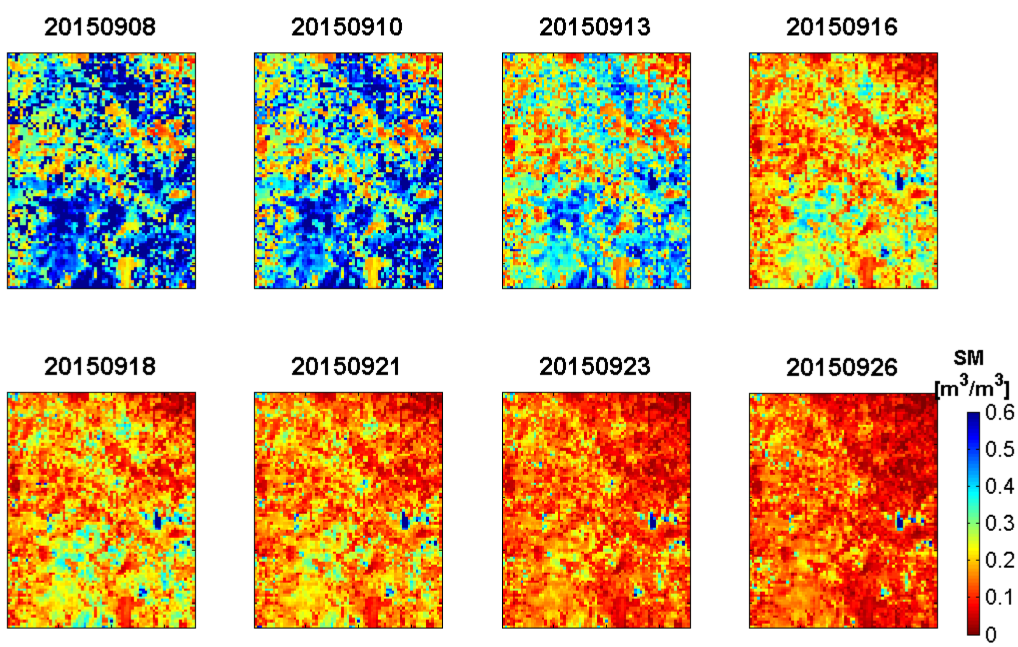

Figure 14: Airborne passive soil moisture retrieval from SMAPEx-5 for Yanco area. Title of each subplot indicates flight date with the format of YYYYMMDD.

4.4 AMSR2 Level 3 soil moisture product

The AMSR2 L3 soil moisture product was downloaded from the GCOM-W1 Data providing Service (gcom-w1.jaxa.jp/index.html). To cover the whole period in which AMSR2 data is available, the analysis covered a time series from July 2012 to December 2017. Both the high resolution 10-km product and the low resolution 25-km product were considered in the analysis. The identifier for the two types of products are GW1AM2_YYYYMMDD_01D_EQMD_L3SGSMCHF3300300 and GW1AM2_20120706_01D_EQMD_L3SGSMCLF3300300, respectively.

The AMSR2 pixel in which JAXA tower (-34.99S, 146.29E) is located was extracted. The pixel location of the L3 SM data scene is Row 1250, Column 1463 for the 10-km product, and Row 500, Column 586 for the 25-km product. The pixel boundaries

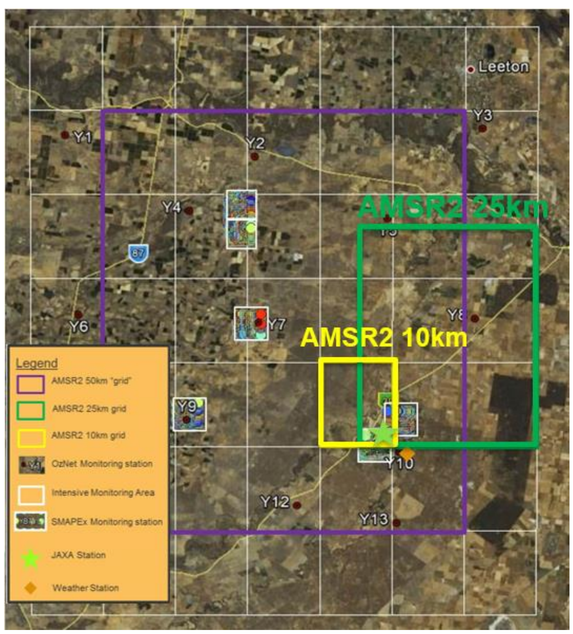

Figure 15: Location of the 10-km and 25-km AMSR2 L3 SMC pixel with respect to the flux tower location.

with respect to the flux town location is shown in Figure 15.

The time series of the AMSR2 L3 SMC 10-km and 25-km products are shown in Figure 16. It can be seen the high-resolution soil moisture almost coincide with the low-resolution data, especially during the dry season for each year (October to March). During the wet season (May to August), however, the low-resolution soil moisture has a relatively larger dynamic range. This could be due the reason that 25-km pixel contains a larger area and thus include mixed land cover types such as

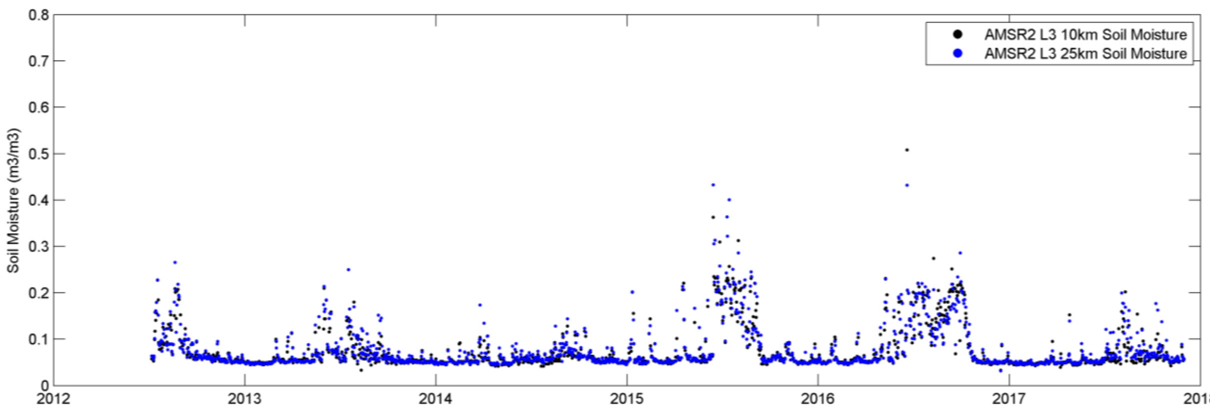

Figure 16: Time series of the AMSR2 L3 10-km and 25-km soil mositure in the Yanco site.

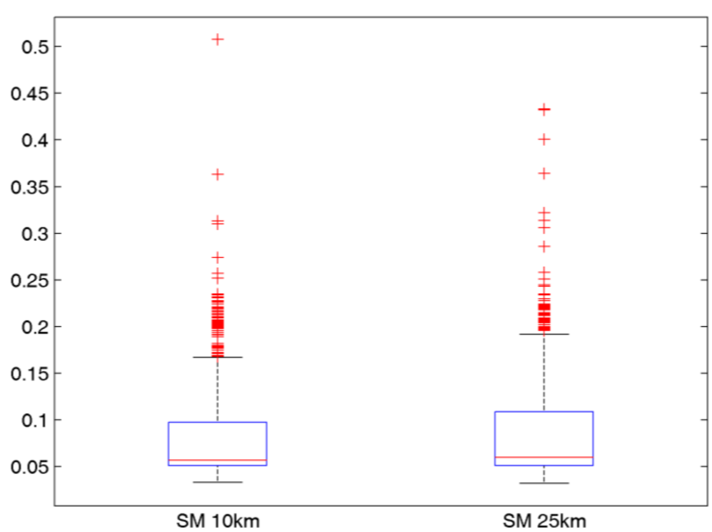

Figure 17: Box plot of the AMSR2 L3 10-km and 25-km soil moisture in the Yanco site.

pasture, crops and forest, which the 10-km pixel is almost pasture. Over the 5 years since AMSR2 was launched, it can be seen that year 2013, 2014 and 2017 are relatively dry in Yanco region, while 2015 and 2016 experienced more rainfall compare with other years.

From Figure 17 which show the box plots of the AMSR2 L3 low- and high-resolution soil moisture, it is seen that most of data fall in the range of 0.05 m^3/m^3 to 0.1 m^3/m^3 and the average is only slightly above 0.05 m^3/m^3. Very few data exceed 0.2 m^3/m^3 which mostly happened in the winter season of 2015 and 2016, with the highest reaching 0.5 m^3/m^3.

Chapter 5: Validation of AMSR-2 Level 3 soil moisture products

5.1 Validation against Flux Tower

The AMSR2 L3 low- and high-resolution soil moisture products are first compared with the in-situ soil moisture measurements from the JAXA flux tower. The soil moisture sensor was installed at 3 cm depth below ground. A time series plot of the comparison is shown in Figure 18. It is seen that the AMSR2 product is underestimating the soil moisture generally. The correlation is relatively higher during the dry period of year 2013, 2014 and 2015. However, the satellite product

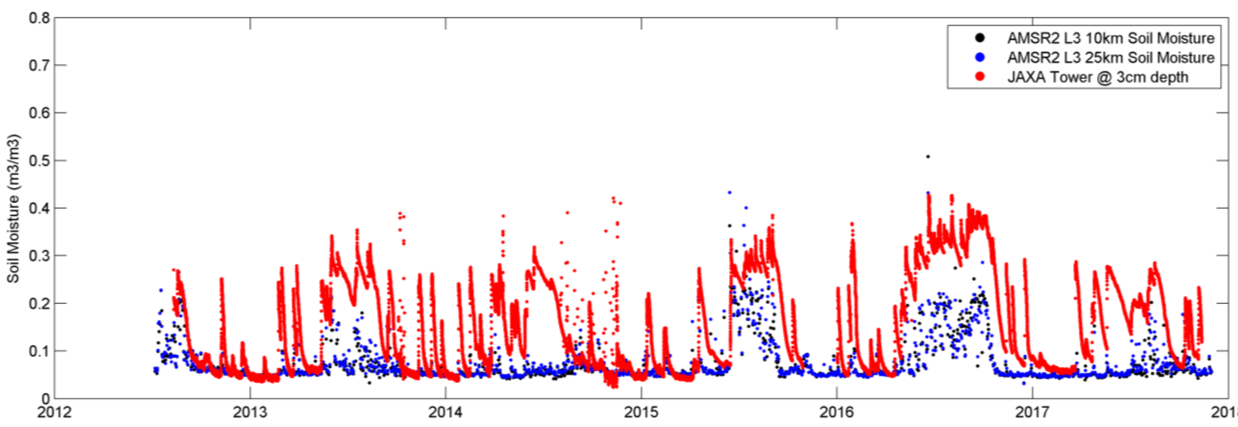

Figure 18: Time series plot of AMSR2 L3 10- and 25-km soil moisture product against JAXA flux tower soil moisture measured at 3-cm depth.

and in-situ measurement have a large offset during the wet season, with difference ranging from approximately 0.1 to 0.2 m^3/m^3. In winter of 2015 and 2016, the satellite observation managed to capture the part of the soil moisture increase and the variation pattern, however, the magnitude is only about half of the 'truth'. Winter of 2014, however, is a special case which different from other years. The satellite product did not reflect the soil moisture increase at all and stayed around 0.05 m^3/m^3, while the tower measurement rocketed to almost 0.3 m^3/m^3.

There are two main reasons which might lead to the discrepancies:

i) Flux tower measurement is only a 'point' measurement which only reflect the situation at or immediately around the station, while the satellite product corresponds to a larger area;

ii) The soil moisture retrieval algorithm of the AMSR2 L3 product is based on the brightness temperature (TB) observation at 10 GHz (V, H) and 36 GHz (V) . The microwave signal at such frequencies was emitted from the very top of the ground surface (less than 1 cm depth) and was relatively more sensitive to the overlaying vegetation compared with lower frequencies, while the tower moisture sensor was measuring the soil moisture at a deeper layer of 3 cm.

5.2 Validation against OzNet stations

The comparison of the AMSR2 products against the OzNet stations shows similar results as above. Two stations within the network, YA5 and YB7a, which were previously demonstrated to be the most representative of the entire Yanco area (Yee et al., 2016), were chosen for the validation. From the time series of the satellite and station soil moisture plotted in Figure 19, it is seen that the AMSR2 product is

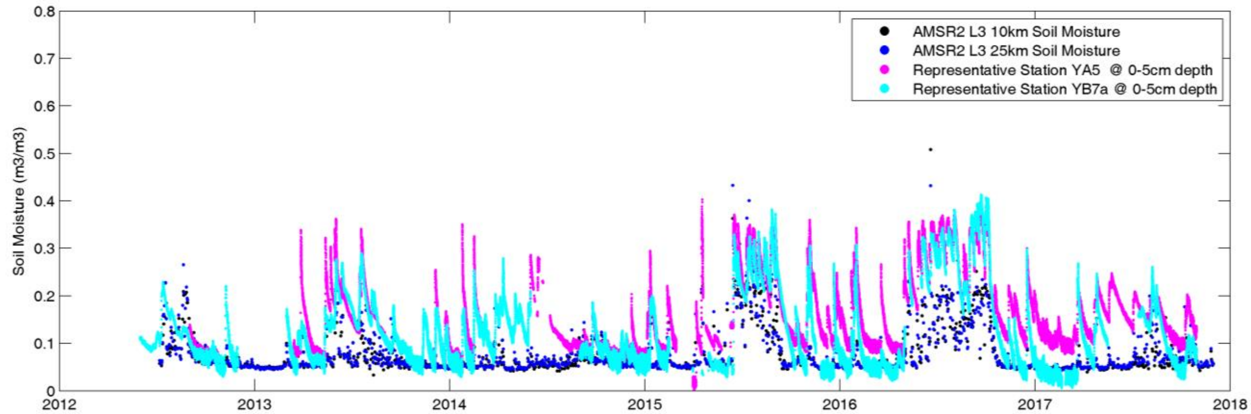

Figure 19: Time series plot of AMSR2 L3 10-km and 25-km soil moisture product against two representative stations YA5 and YB7a within the OzNet monitoring network.

again underestimating the soil moisture 'truth' measured by the in-situ sensor. The two main reasons of the discrepancy summarized in the previous section applied here as well, except that the OzNet station measurements represent an average value of the surface soil profile from 0 to 5 cm.

5.3 Validation against SMAPEx campaign data sets

The AMSR2 L3 products are also validated against the soil moisture retrieved from the airborne measurement and ground sampling from SMAPEx-4 and -5 campaigns. Since the high-resolution product almost coincide with the low-resolution one, only the 10-km product were included for the validation. Airborne-retrieved and ground-sampled soil moisture which falls in the AMSR2 10-km pixel area was extracted for comparison. Validation was only done for the days in which both satellite data and airborne/ground sampling data are available for a more accurate match in time.

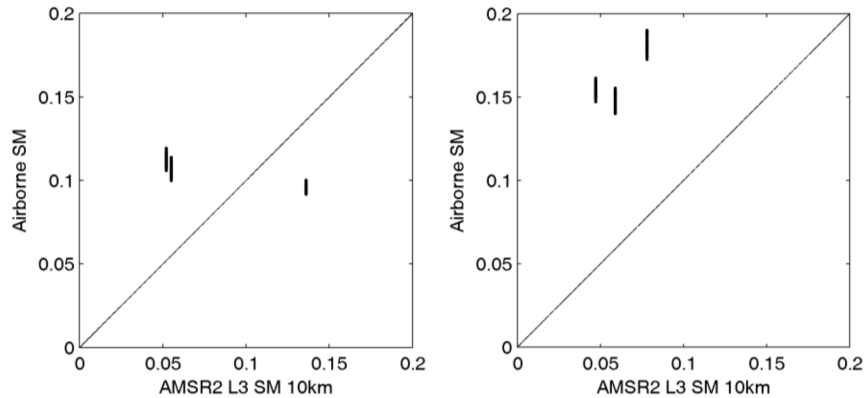

Figure 20: Scatter plots of AMSR2 L3 SM product against SMAPEx airborne soil moisture retrievals for SMAPEx-4 (left) and SMAPEx-5 (right).

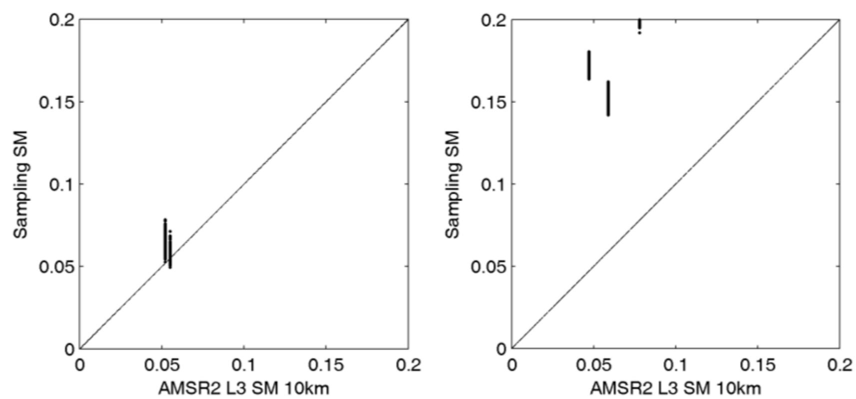

Figure 21: Scatter plots of AMSR2 L3 SM product against SMAPEx ground samplings of soil moisture for SMAPEx-4 (left) and SMAPEx-5 (right).

As can be see in Figure 20 and 21, the number of days in which concurrent measurements of both AMSR2 and airborne/ground sampling are available is very limited. However, it is still obvious that AMSR2 SM product is underestimating both airborne observed SM and ground sampled SM, especially during SMAPEx-5 in September which correspond to the wet season. In May however, the AMSR2 product is more correlated to the campaign data, especially against ground sampling of SM (Figure 21, left).

5.4 Validation against SMAP soil moisture products

The AMSR2 L3 products are finally compared against the Soil Moisture Active Passive (SMAP) L3 product which was retrieved from L-band (1.4 GHz) brightness temperature observations. SMAP has a larger footprint of 36 km compared with AMSR2. Figure 22 shows the location of the SMAP pixel which falls on the Yanco study site, in comparison with the location of AMSR2 pixels. The time series of the two satellite products, together with the JAXA tower measurement are plotted in Figure 23. It is seen while SMAP product is also significantly higher than AMSR2 during the wet season, it has a better correlation with the in-situ measurement from the JAXA tower. Since it has also been widely demonstrated in the past that low frequency (such as L-band) has higher sensitivity to the moisture content variation and more capable to retrieve accurate surface soil moisture, it is suggested

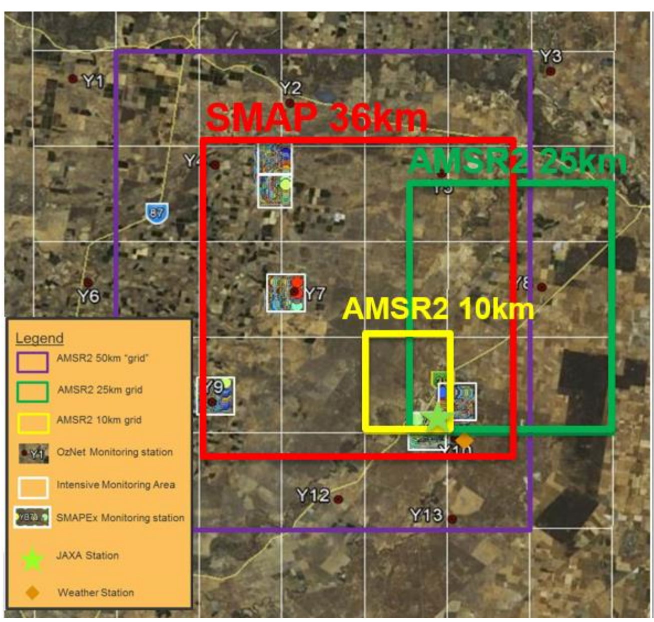

Figure 22: Location of the 10-km and 25-km AMSR2 L3 SMC pixel with respect to the flux tower location.

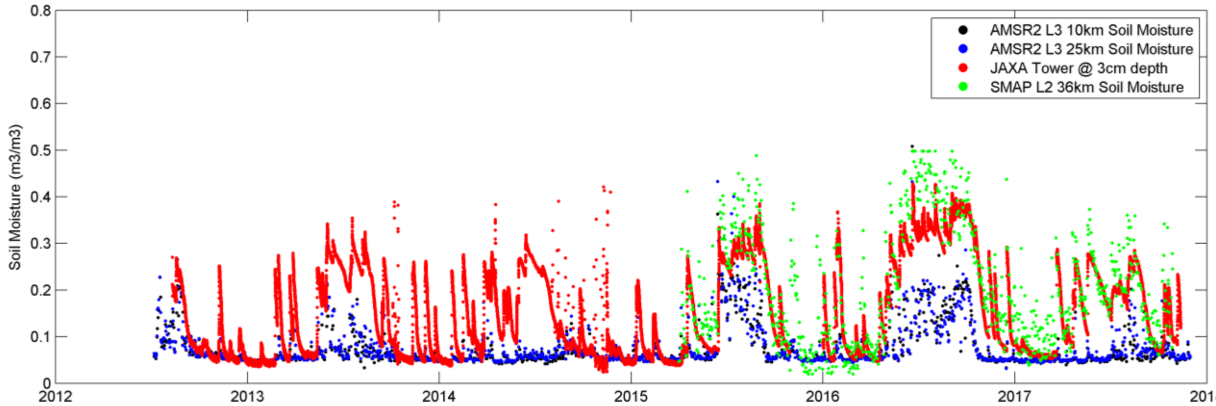

Figure 23: Time series plot of AMSR2 L3 10-km and 25-km soil moisture product against two representative stations YA5 and YB7a within the OzNet monitoring network.

that the SMAP product should be closer to the 'truth', and the AMSR2 retrieval algorithm might need further improvement.

One possible way for a straight-forward enhancement for the AMSR2 soil moisture product is through applying a simple regression of itself against in-situ measurement based on the historical data profile. This regression could be set to apply to the original product once soil moisture exceeds certain level, e.g. 0.1 m^3/m^3, beyond which the product/in-situ discrepancy starts to become more pronounced. Relevant research is currently underway and could be further verified with more data coming in the future.

Chapter 6: Downscaling of Brightness Temperature and Soil Moisture Retrieval from AMSR2 Level 1 Products

6.1 Downscaling methodology

Soil moisture products at spatial resolutions finer than the AMSR2 footprint are important for many hydro-meteorologic applications. Consequently, we propose to use higher resolution Ka-band brightness temperature (TB) data from AMSR2 to downscale its low-resolution C-band TB data using passive-passive downscaling techniques. The smoothing filter-based modulation (SFIM) technique (Liu, 2000) has been chosen to be the primary option for downscaling. The advantage of this technique is that all observations are made from the same platform, thereby avoiding issues regarding differences in observation times. It was suggested by Santi (2010) for soil moisture downscaling and has also been applied by Jeu et al., (2014), Parinussa et al., (2014) and Gevaert et al., (2015). Furthermore, we propose to validate the downscaled results against in-situ station data, as well as intensive soil moisture sampling data and airborne soil moisture product from the SMAPEx campaign.

In this downscaling technique, the Ka-band TB observations are aggregated to the resolution of the C-band using a low pass filter. Subsequently, the ratio between the high- and low-resolution Ka-band TB is used to modulate the low-resolution C-band TB of both polarizations by the following equation:

$$TB_{C\text{-}high} = TB_{Ka-high} / TB_{Ka-low} \times TB_{C-low} \qquad \text{Eq. 1}$$

where the subscripts in Eq. 1 refer to the frequency bands and resolutions, respectively. This technique assumes that the variability within a C-band footprint is linked to the variability in the Ka-band.

Since the higher frequency of Ka-band signal is more sensitive to attenuation by vegetation and thus less sensitive to soil moisture than longer wavelengths such as the C-band, the Ka-band TB, therefore, is not used in the later soil moisture retrievals. Even so, this enhanced sensitivity to vegetation could potentially impact

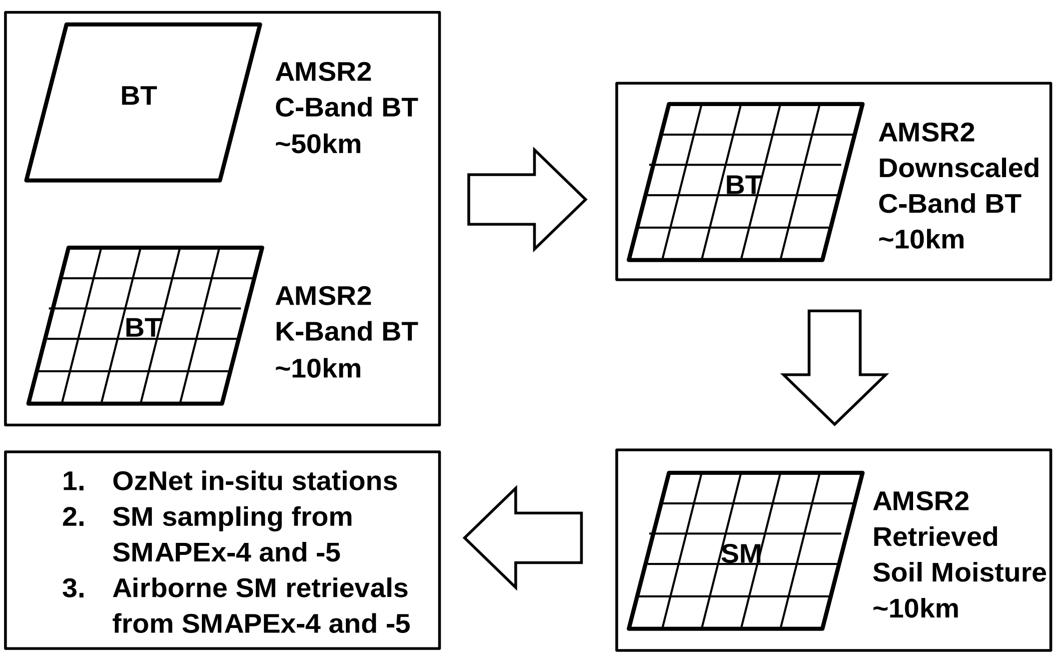

Figure 24: A schematic plan for AMSR2 soil moisture downscaling and validation procedures.

the quality of sharpened soil moisture products over densely vegetated areas. More details about this technique can be found in Santi (2010), Jeu et al., (2014), Parinussa et al., (2014) and Gevaert et al., (2015). A schematic plot of the downscaling and validation processes is shown in Figure 24.

6.2 AMSE-2 Level 1 TB products

The AMSR2 L1R brightness temperature product was downloaded from the GCOM-W1 ftp server. The product identifier is GW1AM2_YYYYMMDDHHMM_XXXD _2220220. The 6 GHz – V and – H (C-band) and 36 GHz – V and – H (Ka-band) TB data were extracted from the original product. The study period was initially focused on May and September 2015, for better comparison and validation with the SMAPEx field campaign. We chose the non-gridded original swath data because it is the actual values derived from AMSR2 observations and thus avoiding the averaging affect happened during the gridding process. Swath data is provided at a resolution of ~10km, which means there were significant over-sampling at low resolution (i.e. C-band) but are nearly independent at high resolution (Ka-band in this case).

Since the processing volume is relatively high for the non-gridded swath data of L1 product, at current stage the downscaling process and analysis are still underway and about to conclude. More results will be discussed in the journal publication scheduled in JFY2018 and the progress report for the coming year.

6.3 Soil moisture retrieval algorithm

Single Channel Algorithm was used for soil moisture retrieval of the downscaled brightness temperature. In this algorithm, soil moisture is retrieved using the tau-omega model. The model parameters are calibrated based on the soil moisture and surface temperature measurements from in-situ stations. Two most sensitive parameters: vegetation parameter *b* and roughness parameter *h*, will be calibrated simultaneously at both horizontal and vertical polarizations. The optical depth *tau* is estimated from *b* and vegetation water content (VWC), which can be calculated from MODIS NDVI product. The calibration is performed while compromising between two criteria: 1) minimization of the Root Mean Squared Difference (RMSD) of simulated and observed TB, and 2) maintaining the dynamic range of the time series as close as to the satellite signals. The calibrated *b* and *h* are then applied for

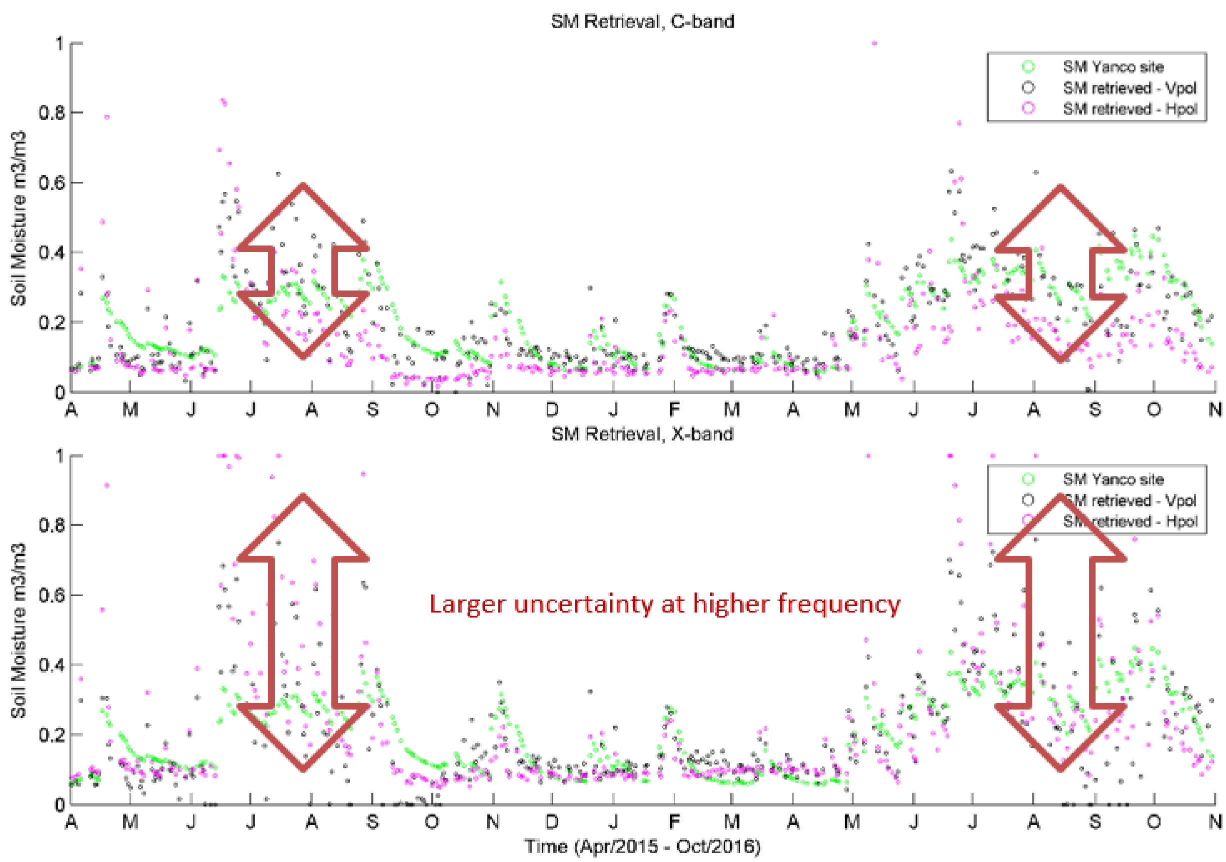

Figure 25: Soil moisture retrieval from AMSR2 C- and X-band brightness temperature.

soil moisture retrieval using the downscaled AMSR2 C-band observations.

Preliminary soil moisture was performed to the AMSR2 C- and X-band TB which was simply resampled to the Yanco study site for the period of 2015 to 2016. The soil moisture retrieval result is shown in Figure 25. It can be seen that during the dry season (October to March), the retrieval matches relatively well with the in-situ measurements. However there exist uncertainty for the retrieval during wet season (June to August). And the uncertainty becomes larger for higher frequency. This is because the vegetation is denser in the wet season compared with dry season, thus the vegetation water content is higher, which results in more pronounced emission

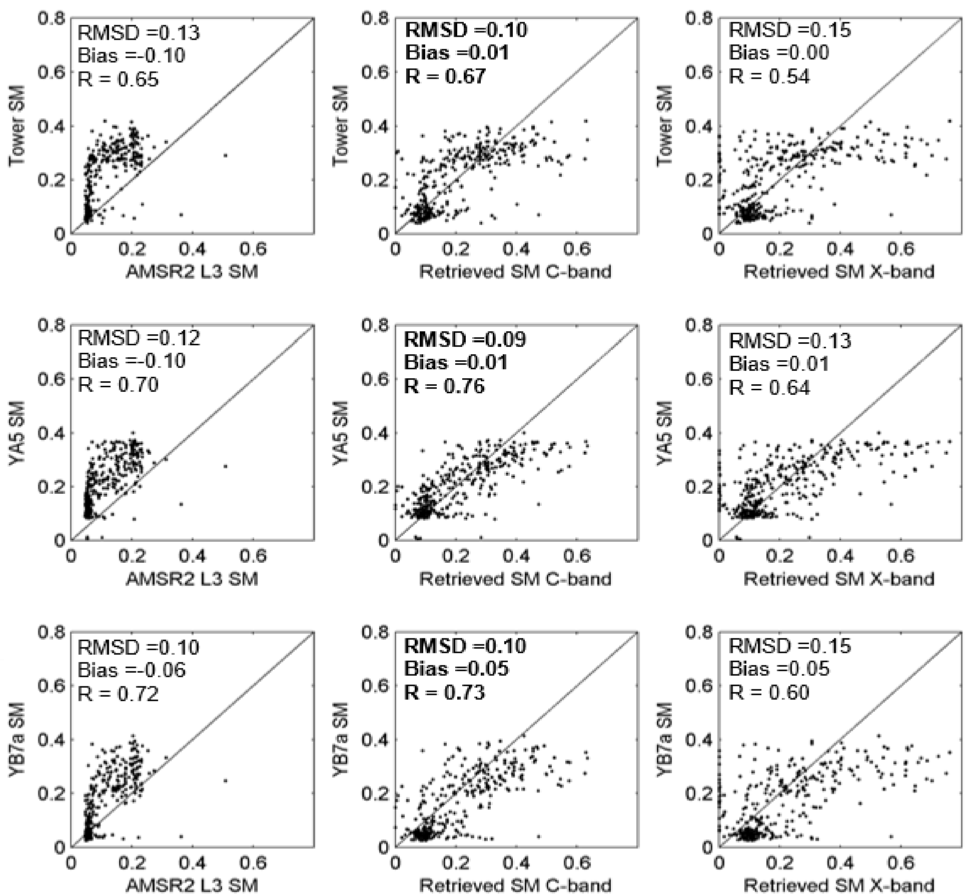

Figure 26: Soil moisture retrieval in comparison with in-situ station.

at higher frequency.

A comparison of the retrieved soil moisture with JAXA tower, OzNet station YA5 and YB7a, as well as their corresponding statistics are shown in Figure 26. It is seen that the C-band retrieval has higher accuracy (RMSD around 0.1 m^3/m^3 for all stations) compared with X-band (RMSD ranges from 0.13-0.15 m^3/m^3) statistically.

Chapter 7: Summary and Conclusion

This report presents the research results for the project 'Validation of global water and energy balance monitoring in the Australian Murray-Darling Basin using GCOM-W1 data'. During JFY2017, this project focused on: i) validation of the low resolution AMSR2 soil moisture products and ii) a high resolution downscaled AMSR2 soil moisture product. Results indicated that the AMSR2 L3 soil moisture product match with the JAXA tower and in-situ station measurements relatively well during the dry season (soil moisture higher than 0.1 m^3/m^3). However, during the wet season (soil moisture ranges from 0.1-0.5 m^3/m^3), the AMSR2 product tends to underestimate the condition by around half of the peak soil moisture values. Therefore, it is suggested that the AMSR2 L3 soil moisture algorithm needs to be improved in the future. The downscaling schemes and the soil moisture retrieval algorithms were also presented in this report. Results show the soil moisture retrieved from the C-band brightness temperature outperforms the X-band data. More research on downscaling of C-band data from Ka-band is currently underway and are about to conclude. The results will be included in the journal paper scheduled later this year as well as in future progress report.

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