Tower Site Description (2017-2018)

1.1 Tower experiments

In October 2017, a comprehensive tower-based experiment site was established at Cora Lynn, Melbourne, Australia (Fig. 1), for the specific purpose of undertaking a complete end-to-end evaluation of P-band radiometer soil moisture remote sensing readiness as the next-generation of soil moisture satellite missions. The paddock is divided into four quadrants (numbered as 1-4 from the northwest clockwise) with different soil surface roughness and/or vegetation conditions for comparison. The tower carrying P- and L-band radiometers is located at the center of the paddock (Fig. 1 and Fig. 2a). Five monitoring stations are installed at the four edges of the four quadrants, with stations 136 and 138 installed side by side at the edge between quadrants 1 and 4 (Fig. 1 and Fig. 2b). Temporary station 125 is intended to be used only if paddock work requires removal of the other stations. All stations except 138 have 12 hydra-probes inserted into the soil at 5 cm increments down to 60 cm. Station 138 has 6 hydra-probes installed into the soil at 5 cm increments down to 30 cm. These hydra-probes have been continuously measuring soil temperature, moisture, electrical conductivity and dielectric constant at a 20-minute sampling step.

Other supporting data collected regularly include radiometer calibration data (Fig. 2c), surface soil moisture (~5 cm) over the radiometer footprints using the Hydra-probe Data Acquisition System (HDAS, Fig. 2d), soil surface roughness (Fig. 2e), VWC (Fig. 2f) and the spectral reflectance of vegetation (Fig. 2g). The locations of sampling points are shown in Fig. 1. The purposes of the HDAS measurements are investigating the spatial distribution of soil moisture and correcting the soil moisture measured by the station to the level of that in the footprint. The measurement of both VWC and the spectral reflectance is for the purpose of comparing the vegetation optical depths, respectively, based on the fact that LAI can be retrieved using the optical reflectance.

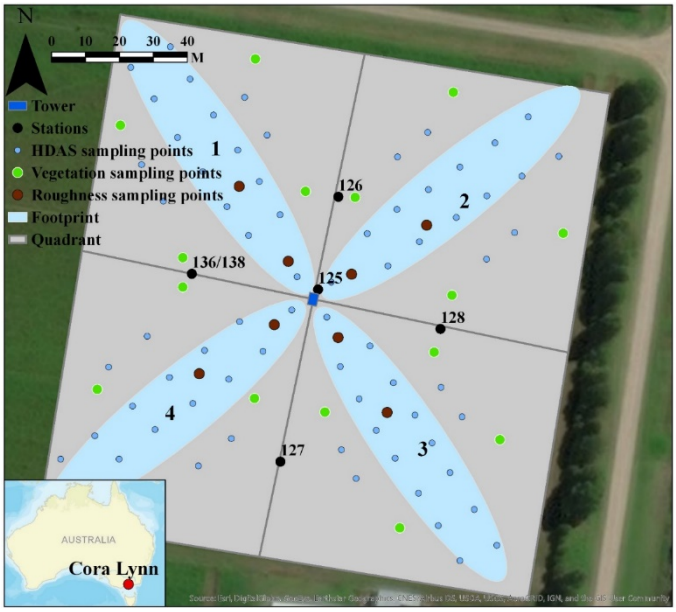

Fig. 1. Map of the tower-based experiment site at Cora Lynn, Melbourne, Australia.

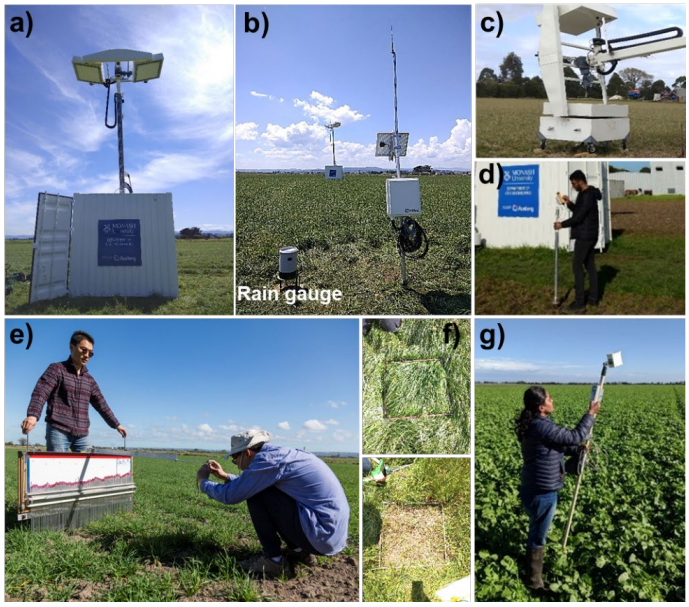

Fig. 2. a) The tower carrying P- and L-band radiometers; b) the monitoring station with rain gauge; c) warm calibration for the radiometer; and regular measurements of d) surface soil moisture using the Hydra-probe Data Acquisition System (HDAS), e) soil surface roughness, f) vegetation water content and g) the spectral reflectance of vegetation.

The two radiometers, namely the Polarimetric P-band Multi-beam Radiometer (PPMR) and the Polarimetric L-band Multi-beam Radiometer (PLMR), operate at 0.742-0.752 GHz and 1.400-1.426 GHz, respectively. PPMR has four antenna beams with 30° beamwidth distributed at angles of ±15° and ±45°, and PLMR has six antenna beams with 15° beamwidth distributed at angles ±7.5°, ±21° and ±38.5° (Fig. 3). Their

approximate footprints have been plotted in Fig. 1. They are mounted on the ten-meter-high rotating tower to alternatively observe the four quadrants of the paddock. A rotation cycle consists of four positions with different azimuth as shown in Fig. 4. Each azimuth position lasts 30 minutes within which the instrument zenith is changed every 10 minutes according to 135°, 142°, and 149°, to produce a range of incidence angles. This four-quadrant paddock has been managed with different roughness and vegetation conditions during different periods for comparison (Fig. 5). The furrows in quadrant 1 and 3 have been made perpendicular to the direction along with the radiometer footprint, while those in quadrant 2 are parallel to the footprint direction (Fig. 5 and Fig. 6). This is designed to compare the roughness effects according to azimuth directions.

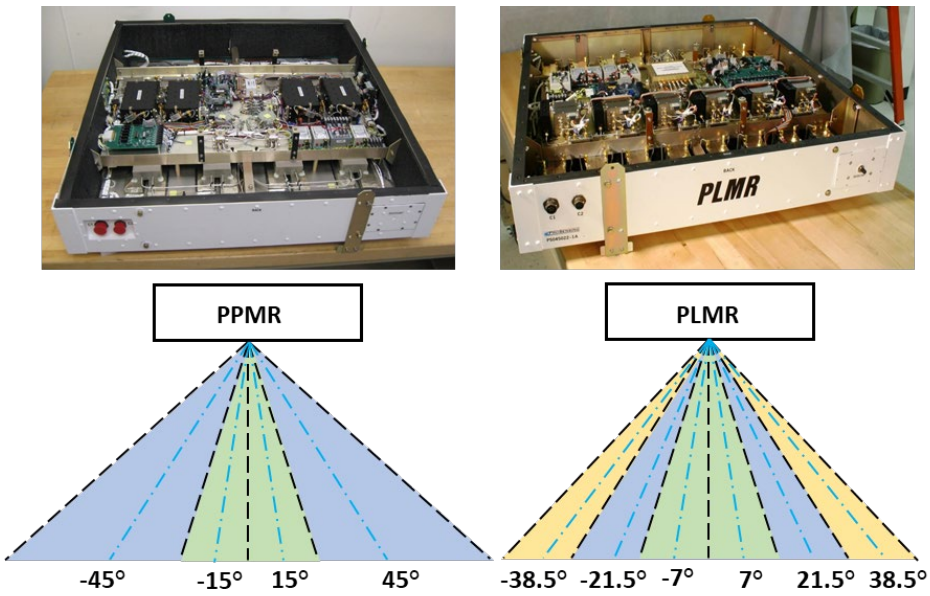

Fig. 3. The two dual-polarized radiometers operating on the tower when pointing at nadir: PPMR (0.742-0.752 GHz) with 4 antenna beams (±15° and ±45°) with 30° beamwidth and PLMR (1.400-1.426 GHz) with 6 antenna beams (±7°, ±21.5°, and ±38.5°) with 15° beamwidth.

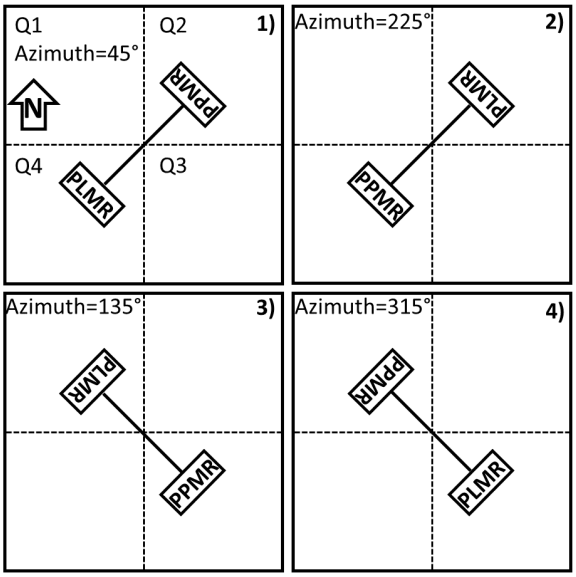

Fig. 4. A two-hour-long tower rotation cycle consists of positions 1) to 4) in order.

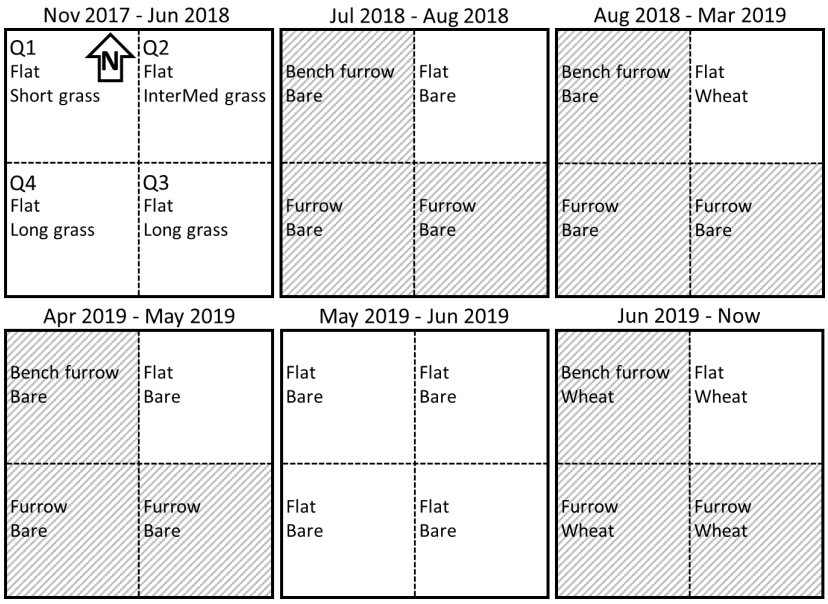

Fig. 5. Timeline of paddock conditions.

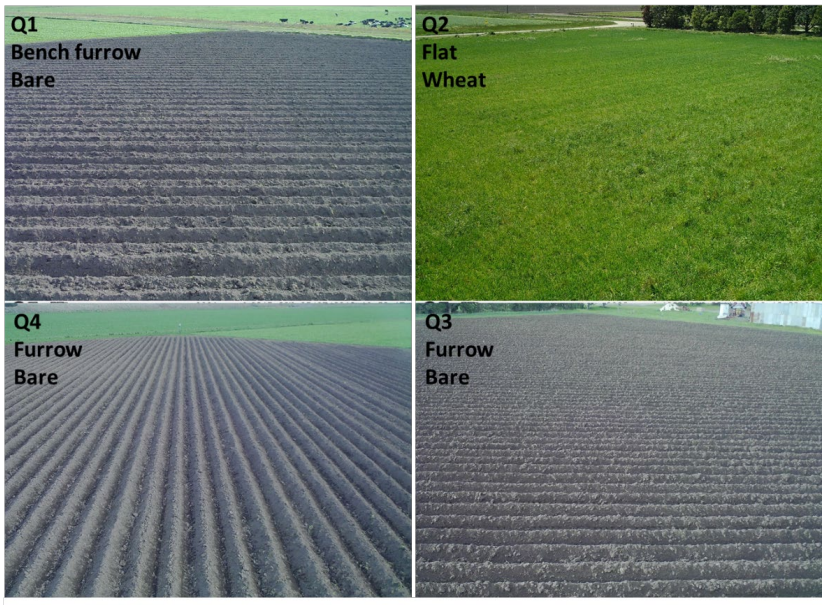

Fig. 6. Photos for different conditions of the four quadrants, taken in Oct. 2018.

Till now, extensive data have been collected as plotted in Fig. 7. Soil texture analysis has also been carried out for different locations and depths (Fig. 8). The average soil texture is 18.3% clay, 13.7% sand, and 68% silt, indicating a silt loam soil. These tower-based data will be used for research questions 1-3.

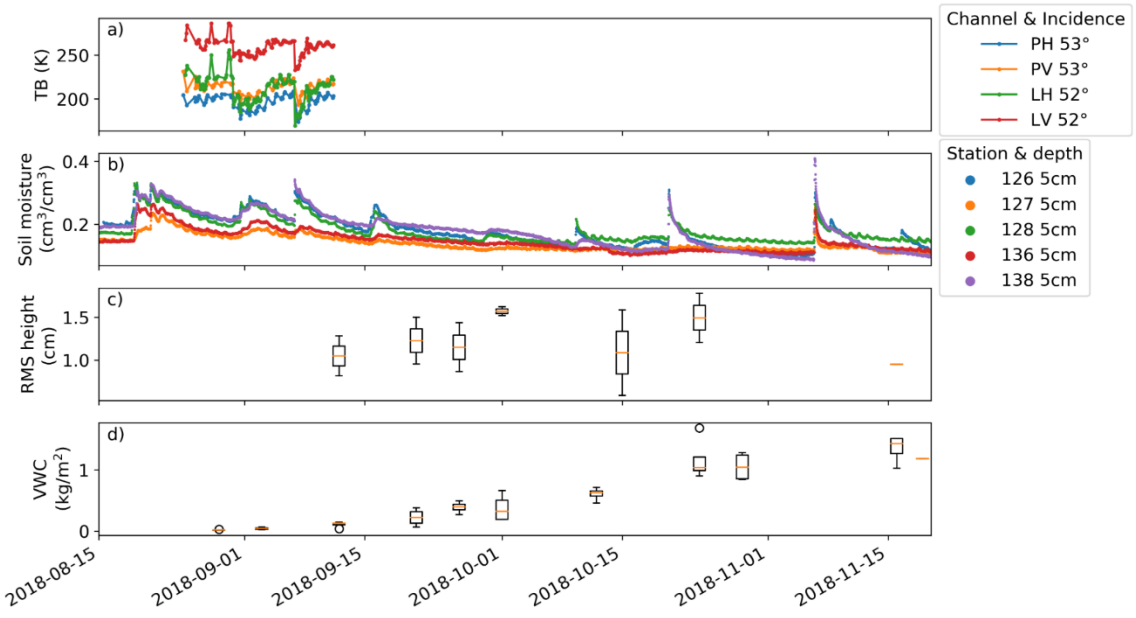

Fig. 7. Data collected in quadrant 2 as an example (TB data are still under processing and will be updated), including a) TB observations, b) soil moisture measurements, c) RMS height and d) VWC of wheat.

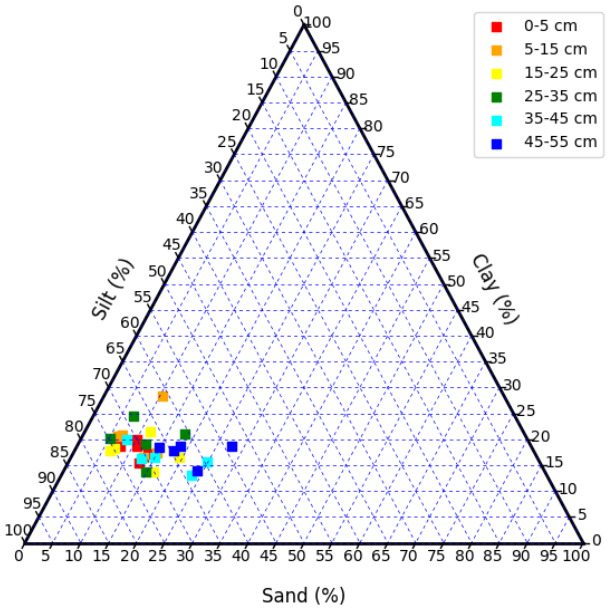

Fig. 8. Soil texture at different depths.