TITLE: This should match the data set name

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1.0 DATA SET OVERVIEW:

The Murrumbidgee Soil Moisture Monitoring Network (MSMMN) consists of eighteen stations distributed across the Murrumbidgee River Basin, NSW, Australia. Data measured at these sites includes soil moisture (top 90cm, 4 layers), soil temperature, soil suction and rainfall. Meteorological data sets suitable for land surface model inputs have been developed from a combination of the MSMMN and local operational meteorological stations operated by the Australian Bureau of Meteorology.

The data are available from the Austral spring 2001 to 31 May 2004 and will be updated with new measurements periodically. The data are on a 30 minute timestep.

A www site for this and other soil moisture experiments in Australia is http://www.civenv.unimelb.edu.au/~jwalker/data/oznet/.

Table 1 provides coordinates for each station and a summary of meteorological, topographical and landscape characteristics. Landcover at all sites consists of grasses and/or herbaceous cover. Detailed soil characteristics are not available for the sites.

Site	Name	Latitude (WGS84)	Longitude (WGS84)	Elevation (m AHD)	Slope (%)	Aspect (deg)	Annual Precipitation (mm)	Annual areal potential evapo-transpiration (mm)
1	Cooma Airfield	-36.293	148.971	937	~0	-	555	1055
2	Canberra Airport	-35.305	149.201	576	~0	-	643	1114
3	Cootamundra Aerodrome	-34.630	148.037	333	~0	-	668	1202
4	West Wyalong Airfield	-33.938	147.196	257	~0	-	506	1223
5	Balranald-Bolton Park	-34.658	143.549	62	~0	-	333	1149
6	Hay AWS (UNSW Research Station)	-34.547	144.867	89	~0	-	368	1179
7	Griffith Aerodrome	-34.249	146.070	137	~0	-	437	1173
8	Yanco Research Station	-34.621	146.424	144	~0	-	442	1209
9	Kyeamba-Ginninderra (Gentle Slope)	-35.419	147.604	322	9	258	749	1180
10	Adelong-Rochedale	-35.373	148.066	536	22	51	900	1151
11	Kyeamba-Ginninderra (Flats)	-35.427	147.600	295	3	299	732	1180
12	Kyeamba-Waitara	-35.493	147.559	435	12	68	730	1180
13	Kyeamba-Gentle Slope	-35.434	147.569	311	4	271	725	1180
14	Kyeamba-Kyeamba Downs	-35.435	147.530	338	7	143	728	1187
15	Adelong-Weeroona	-35.400	148.101	503	19	26	1329	1137
16	Adelong-Keenan	-35.497	148.106	834	12	106	1360	1137
17	Adelong-Strathvale	-35.428	148.132	567	15	89	1193	1137
18	Adelong-Crawford	-35.360	148.085	375	2	279	936	1151

2.0 INSTRUMENTATION DESCRIPTION:

Field measurements of soil moisture, soil suction, soil temperature and rainfall are measured in the MSMMN. Soil moisture is measured with Campbell Scientific CS615 water content reflectometers. Soil suction in the 60-600kPa range is measure with Measurement Engineering Australia Gypsum Block sensors. Soil temperature is measured with Unidata 6507A sensors. Rainfall is measured with Hydrological Services TB4/0.2mm tipping bucket rain gauges. Table 2 provides a summary of sensor characteristics.

Table 3 provides a summary of sensor installation characteristics at each site. All raingauges are installed at 2.5m and are above the canopy. All other sensors are in-ground sensors.

Table 2: Sensor characteristics.

Sensor	Make and Model	Accuracy	Resolution	Measurement range
Soil moisture	Campbell Scientific CS615 Water content reflectometer	0.024m^3/m^3 rms error	0.001m^3/m^3	
Soil temperature	Unidata 6507A Thermistors		0.1ºC	
Soil suction	Measurement Engineering Australia Gypsum Block		1.5-4% of measured value	60-600kPa
Rainfall	Hydrological Services TB4/0.2mm tipping bucket	±5%	0.2mm	

	raingauge			

Table 3: Sensor installation / measurement depths.

Site	Name	Soil Moisture (cm)	Soil temperature (cm)	Soil water suction (cm)
1	Cooma Airfield	0-7, 0-30, 30-60, 60-90	4, 15, 45, 75	4, 15, 45, 75
2	Canberra Airport	0-7, 0-30, 30-60, 60-90	4, 15, 45, 75	4, 15, 45, 75
3	Cootamundra Aerodrome	0-7, 0-30, 30-60, 60-90	4, 15, 45, 75	4, 15, 45, 75
4	West Wyalong Airfield	0-7, 0-30, 30-60, 41-71	4, 15, 45, 59	4, 15, 45, 59
5	Balranald- Bolton Park	0-7, 0-30, 30-60, 57-87	4, 15, 45, 62.5	4, 15, 45, 62.5
6	Hay AWS (UNSW Field Station)	0-7, 0-30, 30-60, 56-86	4, 15, 45, 70	4, 15, 45, 66
7	Griffith Aerodrome	0-7, 0-30, 30-60, 60-90	4, 15, 45, 75	4, 15, 45, 75
8	Yanco Research Station	0-7, 0-30, 27-57	4, 15, 42	4, 15, 42
9	Kyeamba-Ginninderra (Gentle Slope)	0-7, 0-30, 30-60, 51-81	4, 15, 45, 66	4, 15, 45, 63.5
10	Adelong-Rochedale	0-7, 0-30, 30-60, 60-90	4, 15, 45, 75	4, 15, 45, 75
11	Kyeamba-Ginninderra (Flats)	0-7, 0-30, 30-60, 60-90	4, 15, 45, 75	4, 15, 45, 75
12	Kyeamba-Waitara	0-7, 0-30, 30-60, 60-90	4, 15, 45, 74	4, 15, 45, 74
13	Kyeamba	0-7, 0-30, 30-60, 43.5-73.5	4, 15, 45, 58.5	4, 15, 45, 56.5
14	Kyeamba-Kyeamba Downs	0-7, 0-30, 30-60, 60-90	4, 15, 45, 75	4, 15, 45, 75
15	Adelong-Weeroona	0-7, 0-30, 30-60, 60-90	4, 15, 45, 75	4, 15, 45, 75
16	Adelong-Keenan	0-7, 0-30, 30-60, 60-90	4, 15, 45, 75	4, 15, 45, 75
17	Adelong-Strathvale	0-7, 0-30, 30-60, 60-90	4, 15, 45, 75	4, 15, 45, 75
18	Adelong-Crawford(Flat)	0-7, 0-30, 30-60, 60-90	4, 15, 45, 75	4, 15, 45, 75

Field calibration of the soil moisture sensors was undertaken at each site and is detailed in Western et al. (2005) and (Western and Seyfried, 2005). The CS615 data were temperature corrected and calibration relationships were established for each sensor. The calibrations were established using a mixture of gravimetric soil samples and TDR (Time Domain Reflectometry) measurements at each site and depth. The calibration relationships suggested an overall root mean squared error of $0.024 m^3/m^3$. It should be noted that some residual temperature effects appear to remain in the data for the 0-7cm and 0-30cm measurements.

3.0 DATA COLLECTION AND PROCESSING:

There are two components to this data set. Component one is the field measured rainfall, soil moisture, soil temperature and soil water suction. Component two is the model forcing data sets developed from operational observations made by the Australian Bureau of Meteorology. These two components are discussed in turn.

All soil moisture, soil temperature, soil suction and site measured rainfall data were recorded using Unidata Starloggers. The soil temperature and rainfall were measured at a six-minute interval but these data are provided here at a 30-minute interval that matches the measurement interval for soil moisture and soil water suction. The soil moisture, soil temperature and soil suction are instantaneous measurements, the rainfall is a 30-minute accumulation. Data loggers were downloaded regularly via cellular phone telemetry systems and stored in a database for subsequent checking.

Raingauge calibrations have been checked using a raingauge calibrator that releases the equivalent of 20mm of water into the raingauge in a controlled manner over the period of approximately 13 minutes.

Soil temperature data are required for temperature correcting the CS615 signal. Where soil temperature is missing it has been infilled from nearby sites, as detailed in the soil moisture calibration report. Thus all soil moisture estimates supplied in

the data set have been temperature corrected; however, the infilled temperature data has not been included in the data made publicly available and has instead been flagged as missing data.

Sites were visited every few months as to undertake various maintenance tasks. Data checking procedures are described below.

The model forcing data sets were developed primarily from Australian Bureau of Meteorology operational observations, with the exception of rainfall. Rainfall was observed locally at the site but was supplemented by Bureau observations where there was missing data and for the period from 1 January 2000 to the establishment of each particular site in the observation network. The two clusters each of five soil moisture monitoring sites exist in Kyeamba Creek and Adelong Creek. Only one forcing data set was developed for each of these clusters. Some estimation and translation of observations was required and the methods used to achieve this are described in (Siriwardena et al., 2003). This is particularly the case for Radiation estimates, as there is only a sparse radiation observation network in Australia.

4.0 QUALITY CONTROL PROCEDURES

All data from the soil moisture monitoring stations has been visually inspected to identify errors. This checking included comparisons between soil layers and with rainfall.

In addition to visual inspections, tipping bucket raingauge data has been checked using double mass plots of daily accumulations to identify periods when gauges were not working. For most sites this was done by comparing the recorded data with Bureau of Meteorology data. Raingauge catch rates generally agreed within 5%. For the Kyeamba Creek and Adelong Creek, rainfall measurements from neighbouring soil moisture stations were compared.

Erroneous data were removed from the data base and are flagged as missing data.

5.0 GAP FILLING PROCEDURES

No gap filling of data from the soil moisture monitoring stations has been undertaken.

The methods used to develop the forcing data sets are described in detail in (Siriwardena et al., 2003).

6.0 DATA REMARKS:

These data are generally of high and known quality.

There are two known artefacts in the data set.

1. The 0-7cm and 0-30cm soil moisture data contain a diurnal variation that we believe is unrealistic and due to an uncorrected temperature effect on the CS615 measurements, possibly associated with the varying soil temperature profile.
2. The tipping bucket raingauges are installed at 2.5m above the ground, making them vulnerable to some under-catch due to wind effects. Comparisons with daily data from co-located Bureau of Meteorology gauges installed below 1m indicate some evidence of an undercatch of 0-0.5 mm for this for very daily small (<5 mm) rainfall totals at Balranald, Canberra, Cootamundra and West Wyalong. There is no discernable difference for larger events.

These data (forcing data, soil moisture, soil temperature) have been used in a modelling study by (Richter et al., 2004). No evidence of data problems was found during that study.

7.0 REFERENCE REQUIREMENTS:

Western, A.W., Richter, H., Chiew, F.H.S., Young, R.I., Mills, G., Grayson, R.B., Manton, M. and McMahon, T.A., 2002. Testing the Australian Bureau of Meteorology's land surface simulations using soil moisture observations from the Murrumbidgee Catchment, Hydrology and Water Resources Symposium 2002 [CD-ROM]. IE Aust, Melbourne, Australia, pp. 10.

8.0 REFERENCES:

Richter, H., Western, A.W. and Chiew, F.H.S., 2004. The Effect of Soil and Vegetation Parameters in the ECMWF Land Surface Scheme. Journal of Hydrometeorology, 5(6), 1131-1146.

Siriwardena, L., Chiew, F., Richter, H. and Western, A., 2003. Preparation of a climate data set for the Murrumbidgee River Catchment for land surface modelling experiments. 03/1, Cooperative Research Centre for Catchment Hydrology, Clayton.

Western, A.W. and Seyfried, M.S., 2005. Calibration and Temperature Correction of a reflectometer-based soil moisture sensor. Hydrological Processes, 19, 3785–3793.