Addendum to
The Soil Moisture Active Passive Experiments (SMAPEx) Plan

SMAPEx-2, December 4-8, 2010

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Content

1 Overview

This document outlines changes to the SMAPEx baseline experiment plan which took place during the SMAPEx-2 experiment, December 4-8, 2010. Any issue not mentioned in the present document can be assumed unchanged from the original SMAPEx-2 Experiment Plan [1].

A total of 25 hours of scientific flights were conducted between December 4 and 8, with concurrent ground sampling occurring on all days. Intense rainfall was experienced in the study area before and on the last day of SMAPEx-2, with 53mm of rainfall since November 1 to the beginning of sampling (December 4) and 24mm falling during the experiment, meaning that wet soil moisture conditions were experienced (0.25-0.33v/v). Due to warm moist conditions and delayed harvests, vegetation biomass was high, with crops at peak or near-peak biomass (up to 4Kg/m^2) and overgrown native and improved pastures (up to 1.6Kg/m^2).

The intense rainfall prior to the campaign caused extensive flooding in the study area, with access to several of the SMAPEx sampling areas made difficult by standing water throughout the experiment. To accommodate the restricted access and quickly varying conditions, the ground sampling strategy was modified last minute from the SMAPEx baseline approach. The changes are outlined in the following sections. Limited mapping of flooded areas, not described in the SMAPEx-2 experiment plan, was also conducted to provide validation data for radar estimates of standing water. This is described in Section 13.

2 Ground Monitoring

Sampling areas YB5, YB7 and YC presented swampy or flooded conditions throughout the campaign. However, areas YB5 and YC had enough "dry" surface to allow access and sampling. Area YB7 remained inaccessible. The ground monitoring schedule was therefore rearranged as show in Table 2-1.

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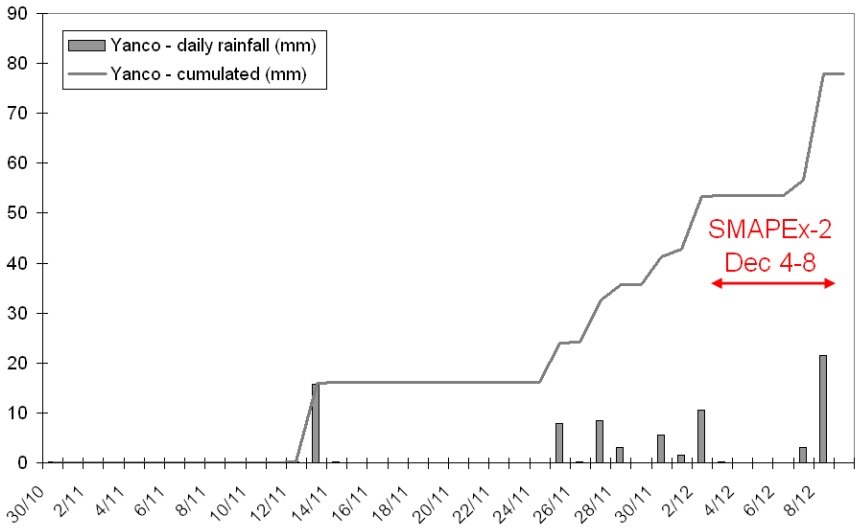


Figure 1-1. Daily and cumulated rainfall at Yanco during November and early December (data source www.eldersweather.com.au)

Table 2-1 Summary of SMAPEx-2 airborne and ground monitoring data. Changes with respect to Table 6-1 of the SMAPEx-2 experiment plan are highlighted in bold blue colour. Prefix [c] indicates mostly cropping area while [g] stands for mostly grazing area. The % indicates the fraction of the planned sampling grids completed by the ground teams.

Date (EDT)	Airborne Monitoring	Instruments operating	Comments	Ground Soil Moisture Monitoring	Vegetation Monitoring	Comments
4/12/2010	Regional	• L-band radiometer • L-band radar • Multi-spectral (Vis/NIR/SWIR) • TIR radiometers • Digital camera • ~~Thermal imager~~	• Flight delayed until ~2pm due to problems booting the radar. • Right radar antenna recorded only hh-pol data • Digital camera stopped shooting part way through flight • Scattered high cirrus	YA4[c] (90%) **~~YB5[g]~~** **YC[g] (82%)**	YA7[g] (completed) YA4[c] (incomplete)	• YB5 inaccessible (flooded) • YC: Extensive flooded areas
5/12/2010	Target YA	• L-band radiometer • L-band radar • Multi-spectral (Vis/NIR/SWIR) • TIR radiometers • Digital camera • ~~Thermal imager~~	• Right radar antenna recorded only hh-pol data • Photos taken for entire flight • Scattered high cirrus	YA4[c] Transect	YA4[c] (incomplete)	
6/12/2010	Regional	• L-band radiometer • L-band radar • Multi-spectral (Vis/NIR/SWIR) • TIR radiometers • Digital camera • ~~Thermal imager~~	• Right radar antenna recorded only hh-pol data • Photos taken for entire flight • Cumulus build up in flight	YD[c] (100%) **~~YC[g]~~** **YB5[g] (97%)**	YD[c] (completed)	• YC already sampled on 4/12 • YB5: Extensive flooded areas
7/12/2010	Multi-angle Multi-azimuth Transect	• L-band radiometer • L-band radar • Multi-spectral (Vis/NIR/SWIR) • TIR radiometers • ~~Digital camera~~ • ~~Thermal imager~~	• Radar operated normally • Brocken cumulus.	YA4[c] Transect (77%)	YB5[g] (completed)	• 2 members of team A doing standing water mapping in YB5
8/12/2010	Regional	• L-band radiometer • L-band radar • Multi-spectral (Vis/NIR/SWIR) • TIR radiometers • ~~Digital camera~~ • ~~Thermal imager~~	• Radar operated normally • Mostly in/over cloud.	YA7[c] (73%) **~~YB7[g]~~**	YC[g] (completed) YA4[c] (completed)	• YB7 inaccessible (flooded) • Team A and B sampling together YA7 • Sampling interrupted due to rainfall

3 Air Monitoring

Air monitoring was undertaken largely as outlined in the experiment plans, with exception being the few issues indicated in Table 2-1.

Due to an intermittent fault with recording on the PLIS right antenna, radar data for the right antenna is limited to the HH channel for the first three days of flight (4/12-6/12). On the last two days of flight (7/12-8/12) the right antenna operated normally. The left antenna was fully operational on all flights.

4 Spatial Vegetation Monitoring

The vegetation sampling approach was changed from that outlined in the experiment plan to accommodate the limited access to the sampling areas due to the extended floods. Moreover, highly cropped areas YA4 and YD required more time than expected to characterise the variety of vegetation types present. The resulting ground monitoring schedule is shown in Table 2-1. Although the dominant vegetation types for the study area were covered, it was not

Table 4-1. Summary of vegetation and surface roughness sampling during SMAPEx-2; (NC) No CROPSCAN measurements taken and (NL) No LAI taken.

Area	Date	Vegetation type	Nr. measurements	
			Vegetation*	Roughness**
YA7	4/12	Wheat	5	3
YA4	4/12	Maize (short)	5 (steam) +5 (leafes)	1
	7/12	Maize (long)	2 (steam) +2 (leafes)	2
	5/12	Pasture type 1	2	1
	5/12	Pasture type 2	3	1
	8/12	Pasture type 3	3	2
	5/12	Cotton	5	3
	5/12	Barley	5	3
	8/12	Wheat	-	2
YD	6/12	Pasture type 1	4	2
	6/12	Pasture type 2	2	1
	6/12	Rice	2 (NL)	-
	6/12	Oats	4	2
	6/12	Straw	2 (NL)	-
YB5	7/12	Pasture	4 (NC,NL)	3
YC	8/12	Pasture	5	3

* 1x vegetation measurement= x destructive sample + 5x LAI readings+ 25x CROPSCAN readings + canopy height and crop row spacing and direction observations where applicable.

** 1x roughness measurement= 3x 1-m profile (N-S) + 3x 1-m profile (E-W)

always possible to collect 5 vegetation measurements for each dominant vegetation type. Table 4-1 provides a detailed list of the vegetation data collected for each dominant vegetation type.

5 Semi-permanent Network Status

Table 6-1a and b update Table 4-2 of the experiment plan for the 24 soil moisture sites in terms of land cover and vegetation type observed during SMAPEx-2. Data availability for the campaign period is also shown.

Table 5-1a. Land cover conditions and data availability for the SMAPEx semi-permanent monitoring sites during SMAPEx-2. Changes with respect to Table 2-2 of the SMAPEx-1 addendum are highlighted in bold blue colour.

Area ID	Landuse	Vegetation Type	Irrigated	Data availability (UTC time)	Comments (UTC time)
YA1	Fallow	Stubble	No	1cm soil temperature: 06/09 – 10/12 All other sensors: 03/09 – 10/12	1cm soil temperature unreliable from 15/09-29/09 (cause unknown)
YA3	Grazing	Perennial grass	No	1cm and 2.5cm soil temperature: 06/09 – 10/12 All other sensors: 03/09 – 10/12	
YA4a	Cropping	Barley	Recently	1cm soil temperature: 06/09 – 10/12 All other sensors: 03/09 – 10/12	
YA4b	**Cropping**	**Cotton**	Recently	1cm soil temperature: 06/09 – 10/12 All other sensors: 03/09 – 10/12	
YA4c	Cropping	Wheat	Recently	No Data	Logger malfunction
YA4d	**Cropping**	**Maize**	Recently	1cm & 2.5cm soil temperature: 06/09 – 10/12 All other sensors: 03/09 – 10/12	Probes moved into maize paddock on 28/11/12 @ 7.15pm EDT Logger time changed from 5.15pm (EST) to 7.15 am (UTC) on 9/12
YA4e	Grazing	Perennial grass	No	1cm soil temperature: 07/09 – 10/12 All other sensors: 04/09 – 10/12	Logger time in EST Probes buried by sediment till 4/12 Probes unburied and moved 3m on 4/12 between 11am and 13pm (EST)
YA5	Grazing	Perennial grass	No	1cm soil temperature: 08/09 – 10/12 All other sensors: 05/09 – 10/12	
YA7a	**Cropping**	**Rice**	Currently flooded	1 and 2.5cm soil temperature: 04/09 – 09/12 All other sensors: 01/09 – 09/12	~30cm standing water
YA7b	**Cropping**	**Wheat**	Recently	1cm soil temperature: No Data All other sensors: 03/09 – 09/12	
YA7d	Fallow	Stubble	No	All sensors: 29/11 – 9/12	Malfunctioning logger fixed on 28/11/10 Logger time changed from 12.56 pm (EST) to 2.57 am (UTC) on 9/12/10
YA7e	Fallow	Grass	No	All sensors: 3/09 – 9/12	Poor sensitivity of soil temperature sensors
YA9	Grazing	Perennial grass	No	1cm soil temperature: 08/09 – 10/12 All other sensors: 05/09 – 10/12	
YB1	Grazing	Perennial grass	No	All Soil temperatures:12/10/10 – 17/01/11 Soil Moisture: 09/10/10 – 17/01/11	
YB3	unknown	unknown	No	1cm & 2.5cm soil temperature: 18/11/10 – 22/02/11 All other sensors:16/11/10 – 22/02/11	
YB5a	Grazing	Perennial grass	No	1cm soil temperature: 08/09 – 10/12 All other sensors: 04/09 – 10/12	
YB5b	Grazing	Perennial grass	No	1cm soil temperature: 08/09 – 10/12 All other sensors: 04/09 – 10/12	

Table 6-1b. Summary of land cover conditions and data availability for the SMAPEx semi-permanent monitoring sites during SMAPEx-2. Changes with respect to Table 2-2 of the SMAPEx-1 addendum are highlighted in bold blue colour.

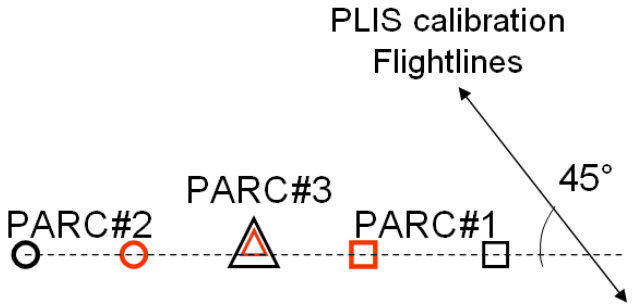
Area ID	Landuse	Vegetation Type	Irrigated	Data availability (All times in UTC)	Comments (All times in UTC)
YB7b/YB5d	Grazing	Perennial grass	No	1cm soil temperature: 07/09 – 11/12 All other sensors: 04/09 – 11/12	
YB5e	Grazing	Perennial grass	No	1cm soil temperature: 01/12 – 11/12 All other sensors: 25/08 – 11/12	
YB7a	Grazing	Perennial grass	No	1cm soil temperature: No Data All other sensors: 04/09 – 11/12	Unreliable soil temperature data between 04/09-27/10 (output voltage too low)
YB7c	Grazing	Perennial grass	No	1cm soil temperature: 07/09 – 11/12 All other sensors: 04/09 – 11/12	
YB7d	Grazing	Perennial grass	No	1cm soil temperature: 07/09 – 11/12 All other sensors: 04/09 – 11/12	Hydraprobe sensor data unreliable (sensor ripped off the ground by cows)
YB7e	Grazing	Perennial grass	No	1cm soil temperature: 07/09 – 12/12 All other sensors: 04/09 – 12/12	Unreliable 5cm soil temperature data between 22/09-12/12 (output voltage too high)
YB9	Grazing	Perennial grass	No	1cm soil temperature: 15/10/10 – 17/01/11 All other sensors: 12/10/10 – 17/01/11	Hydraprobe sensor data unreliable (dielectric constant too low)

6 PLMR Calibration

The water temperature and salinity buoy at Lake Wyangan was positioned at 409854.3087E, 6212921.148N (WGS 1984, UTM Zone 55S).

7 Polarimetric Active Radar Calibrators (PARCs)

During SMAPEx-2 the PARCs were located inside the Narrandera airport. Actual configuration and locations of these are listed in Figure 7-1.



Calibration Configuration	PARC#1	PARC#2	PARC#3
Regional	146.5171	146.5109	146.5140
	-34.6978	-34.6975	-34.6977
Target	146.5156	146.5125	146.5140
	-34.6977	-34.6976	-34.6977

Figure 7-1. Schematic of PARCs locations at the Narrandera airport during SMAPEx-2 (Black symbols indicate regional configuration, red symbols target configuration). The table lists the geographic coordinates of the PARCs for each configuration.

8 Passive Radar Calibrators (PRCs)

Coordinates and photos of the PRCs are listed in Table 8-1 and Figure 8-1 respectively.

Table 8-1. Coordinates and characteristics of the PRCs locations during SMAPEx-2.

PRC#	Latitude	Longitude	Orientation	Land use	Comments
TR1	-34.9763	146.3082	East	Grazing land, perennial grass	- old rusty fence ~1m in front of reflector
TR2	-34.7142	146.0831	East	Wheat, Flood irrigated	- Large tree 200m away slightly north-west - Road and power-line running east-west, 80m south of reflector
TR3	-34.9723	146.0017	East	Maize, Flood irrigated	- Irrigation canal and farm track 50m ahead (east) - Irrigation canal running east-west, 30m south of reflector

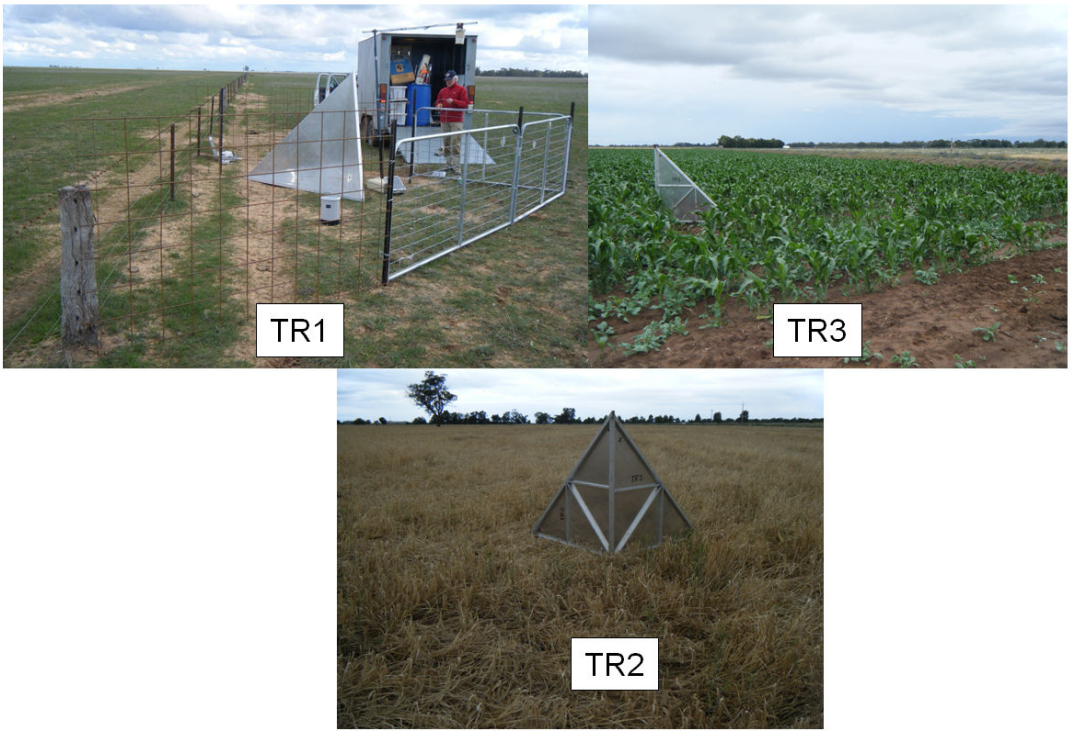


Figure 8-1. Photos of the PRCs location during SMAPEx-2

9 Supplementary Monitoring Stations

Four supplementary monitoring stations were deployed during SMAPEx-2. The only deviation from the experiment plan was for station YS3, where only data from the Thetaprobe at 5cm are available, due to a malfunction of the 20-25cm Thetaprobe. The coordinates and land cover conditions are listed in Table 9-1. Table 9-2 provides a summary of the sensors installed at each station and the data available. Photos of the sites are shown in Figure 0-1. NOTE: all loggers were set to Eastern Daylight Time (EDT) instead of UTC.

Table 9-1. Coordinates and land cover conditions of the supplementary monitoring stations during SMAPEx-2

Station ID	Latitude	Longitude	Comments
YS1	34° 42’38.430”S,	146° 06’14.130”E	• Vegetation type: Improved pasture • TIR sensor height (lens): 168cm • Veg height: 125cm
YS2	34° 58’20.422”S,	146° 0’ 03.874”E	• Vegetation type: Maize • TIR sensor height (lens): 199cm • Veg height: 74cm
YS3	34° 58’34.752”S,	146° 18’ 29.786”E	• Vegetation type: Perennial grass • TIR sensor height (lens): 192cm • Veg height: 20cm
YS4	34° 44’ 01.704”S	146° 06’ 01.074”E	• Vegetation type: Wheat • TIR sensor height (lens): 190cm • Veg height: 80cm

Table 9-2. Instruments and data availability of the supplementary monitoring stations during SMAPEx-2. Changes to the experiment plan are highlighted in bold blue colour.

Station ID	Sensors	Data availability (EST time)	Comments
YS1	1 x Thermal infrared (Thermalert old)	30/11-08/12	
	2 x Thetaprobes (0-5, 20-25cm)	30/11-08/12	
	4 x Soil temperatures (2.5, 15, 40cm):	30/11-08/12	
	1 x Raingauge	30/11-08/12	
	1 x Leaf Wetness	30/11-08/12	
YS2	1 x Thermal infrared (Apogee)	29/11-08/12	
	2 x Thetaprobes (0-5, 20-25cm)	29/11-08/12	
	4 x Soil temperatures (2.5, 15, 40cm):	29/11-08/12	
	1 x Raingauge	29/11-08/12	
	1 x Leaf wetness	29/11-08/12	
YS3	1 x Thermal infrared (Apogee)	1/12-12/12	
	1 x Thetaprobe (0-5cm)	1/12-12/12	The second thetaprobe mulfunctioned and was not installed
	4 x Soil temperatures (2.5, 15, 40cm):	1/12-12/12	
	1 x Raingauge	1/12-12/12	
	1 x Leaf wetness	1/12-12/12	
YS4	1 x Thermal infrared (Apogee)	29/11-08/12	
	2 x Thetaprobes (0-5, 20-25cm)	29/11-08/12	
	4 x Soil temperatures (2.5, 5, 15, 40cm):	29/11-08/12	
	1 x Raingauge	29/11-08/12	
	1 x Leaf wetness	29/11-08/12	

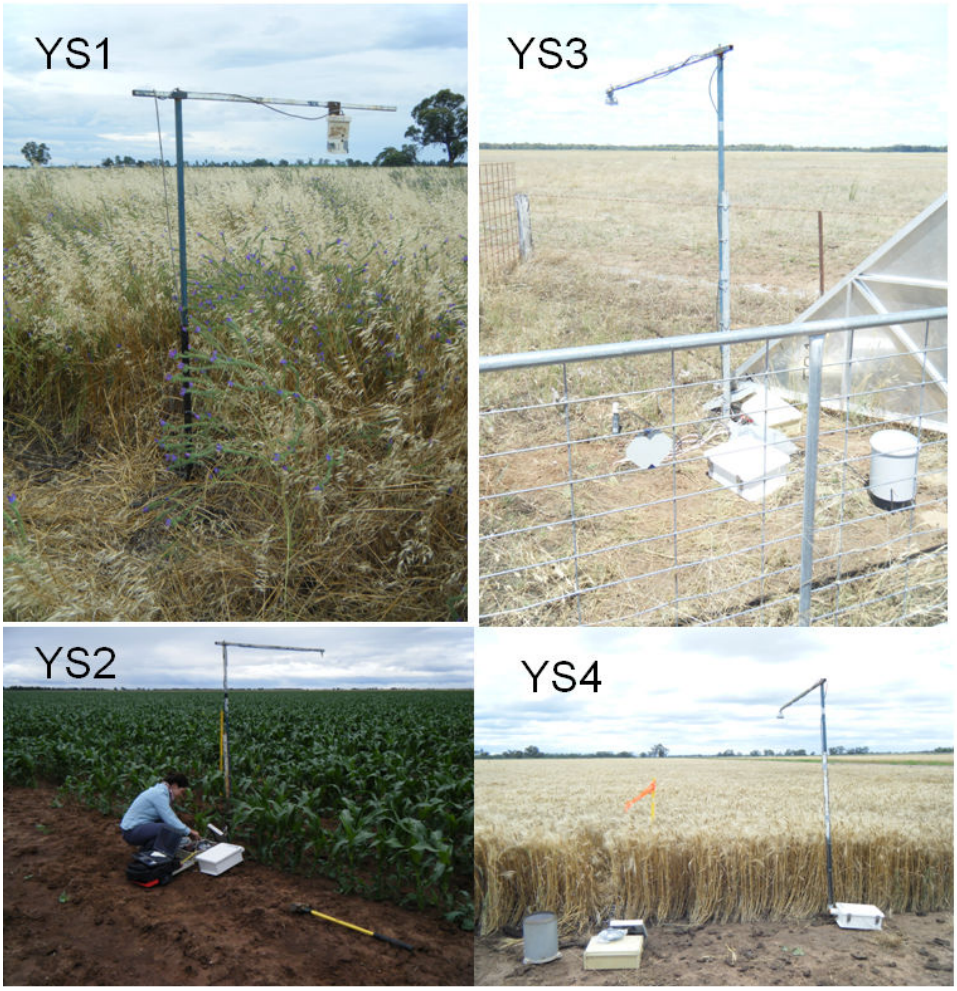


Figure 0-1. Photos of the supplementary monitoring stations

10 Surface Roughness Sampling

Surface roughness sampling followed, with few exceptions, the vegetation sampling schedule and approach, as both were performed by the vegetation team. A summary of the surface roughness measurements available is provided in Table 4-1.

11 Gravimetric Soil Samples

Very few gravimetric soil samples for sensor calibration purposes were collected during SMAPEx-2, since many samples had been already collected in the same areas during SMAPEx-1 with similar wetness conditions. A total of 11 samples were collected in areas YB5 and YA4.

12 UTC/EDT Time Reference

Not all data were recorded in UTC time during SMAPEx-2. It was in fact opted to keep some datasets in local time (Eastern Daylight Time, EDT, being UTC+11 hours) for consistency with daily activities, while the permanent monitoring stations run on Eastern Standard Time all year round (EST, being UTC+10 hours). Table 13-1 lists the time reference used for each SMAPEx-2 dataset.

13 Additional Monitoring: Standing Water Mapping

A limited mapping of flooded areas was performed by a team of two people from team A on Tuesday, December 7 in the target YB area, around 146°18.625'E and approximately between 34°57.917'S and 35°0.584'S . The boundaries of 9 areas presenting surface water and ranging in size from $10m^2$– $0.2km^2$ were mapped using GPS.

Table 13-1. Time reference used for different SMAPEx-2 datasets. UTC=Coordinated Universal Time; EST=Easter Standard Time (UTC+10 hours), EDT=Easter Standard Time (UTC+11 hours).

Dataset	Time reference
Airborne data	UTC
HDAS systems	UTC
SMAPEx Semi-permanent network	UTC
SMAPEx additional network	EST
OzNet Permanent Network	EST
Soil gravimetric samples	EDT
Vegetation samples, LAI and reflectances	EDT
Surface roughness measurements	EDT

Table 12-1. Summary of the standing water mapping during SMAPEx-2

Area name	Surface Area (approx.)	Vegetation type	Water depth (cm)	Canopy height (cm)	Vegetation fraction cover (%)
Roma	$400m^2$	native grass	5	30	10
Berlin	$220m^2$	native grass	3	20	5
Dolphin	$10m^2$	native grass	5	15	5
Andorra	$3m^2$	native grass	5	20	10
Pamplona	$10m^2$	native grass	7	40	20
Valencia	$100m^2$	native grass	5-7	35	40
Venezia	0.1ha	native grass	15-20	40	40
Pez	0.5ha	native grass	5-10	50	40
Russia	14ha	short green grass	unknown	10	20

For each area, the GPS coordinates of the boundaries was recorded, together with ancillary observations on the above water vegetation type, height and fraction cover and water depth. Vegetation height and water depth were estimated by random sampling at several locations using a metered stick. Vegetation cover fraction was estimated visually. It should be noted that these measurements should be treated as rough estimates. Table 12-1 provides details on the areas mapped.

14 References

[1] Rocco Panciera, Jeffrey Walker, Dongryeol Ryu,Douglas Gray and Thomas Jackson, "The Soil Moisture Active Passive Experimen 2 (SMAPEx-2), Dec 4-8, 2011", Experiment Plan, November 2010.