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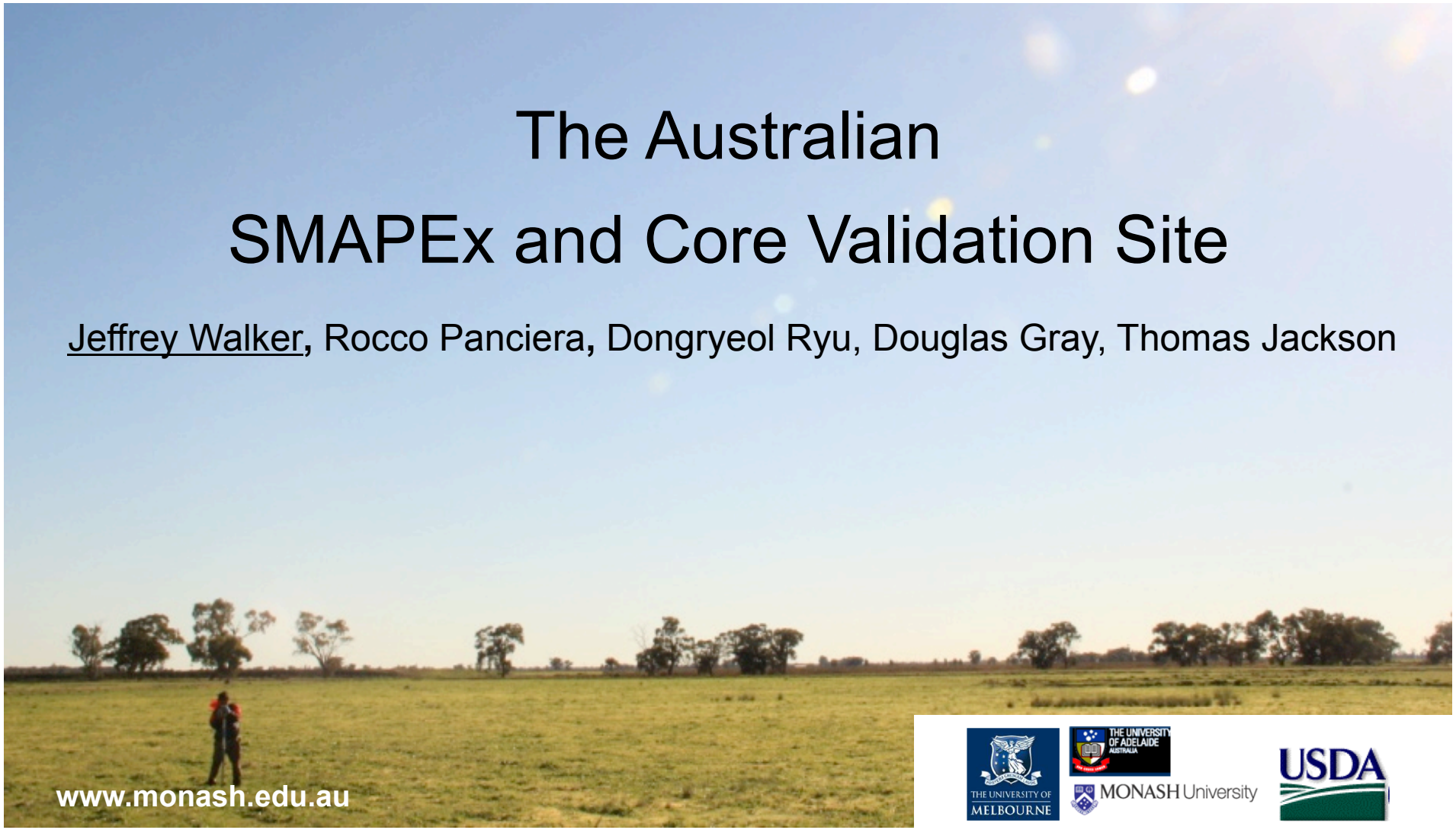

The Australian SMAPEx and Core Validation Site

Jeffrey Walker, Rocco Panciera, Dongryeol Ryu, Douglas Gray, Thomas Jackson

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MONASH University
USDA

Objectives

1. Radar-only soil moisture retrieval (3km)

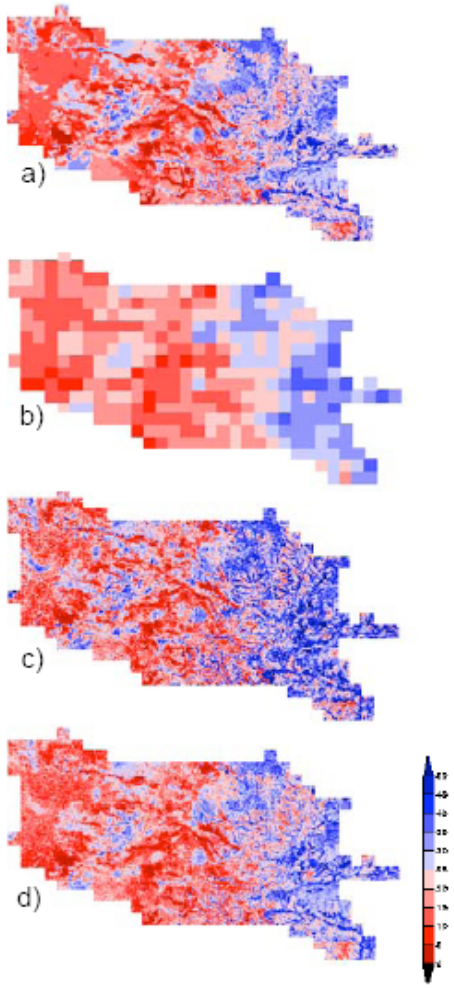
   Verify baseline algorithms proposed for SMAP

2. Radiometer-only soil moisture retrieval (40km)

   Use the SMAP radar information on surface roughness and vegetation structure (3km) to aid the soil moisture retrieval from the SMAP radiometer (40km)

3. Active Passive soil moisture product (10km)

   Use the high resolution (3km) but noisy SMAP radar observations to downscale the accurate but low resolution (40km) radiometer footprint

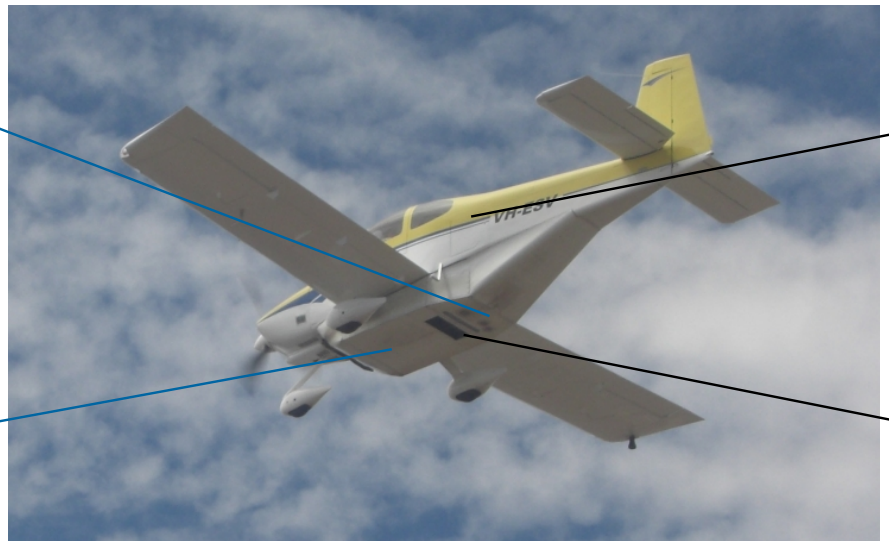


Simulated fields of a) 3km truth soil moisture and retrieved soil moisture for b) 40km passive microwave observations, c) 3km radar observations and d) 3km merged passive microwave and radar observations (Zhan et al., 2006).

The airborne SMAP simulator

L-band Radar

L-band Radiometer)



6 x Vis/NIR/SWIR/TIR

PLMR:
Polarimetric L-band Multibeam Radiometer

Frequency/bandwidth: 1.413GHz/24MHz

Polarisations: V and H

Resolution: ~1km at 10,000ft flying height,

Incidence angles: +/- 7°, +/-21.5°, +/- 38.5° across track

Antenna type: 8x8 patch array

PLIS:
Polarimetric L-band Imaging SAR:

Frequency/bandwidth:1.26GHz/30MHz

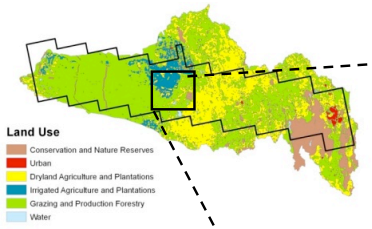
Polarisations: VV, VH, HV and HH

Resolution: ~10m

Incidence angles 15º -45º on both sides of aircraft

Antenna type: 2x2 patch array

The SMAP test-bed (core validation site)

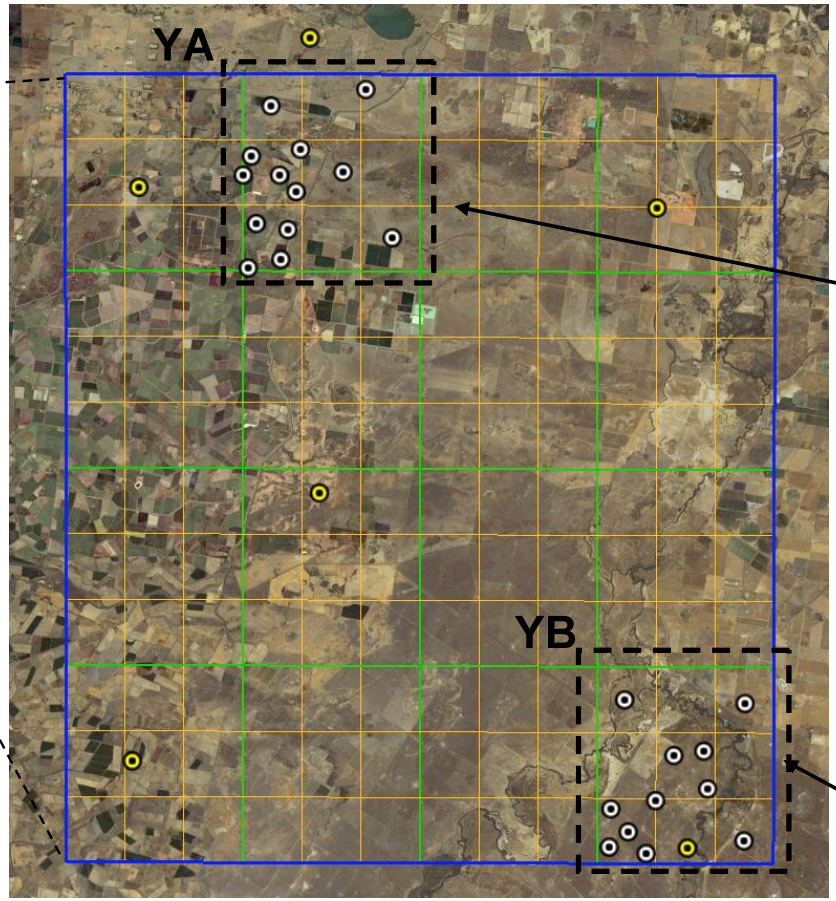


SM sites

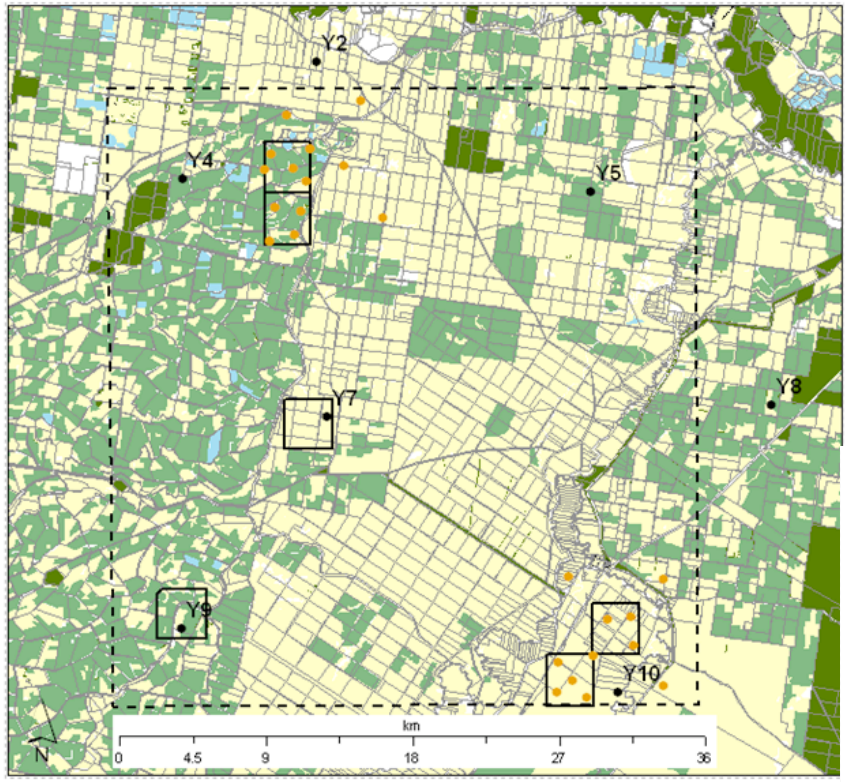
- 0-5cm
- 0-90cm only

SMAP grids

- L3_SM_40km
- L3_HiRes
- L3_AP_SM



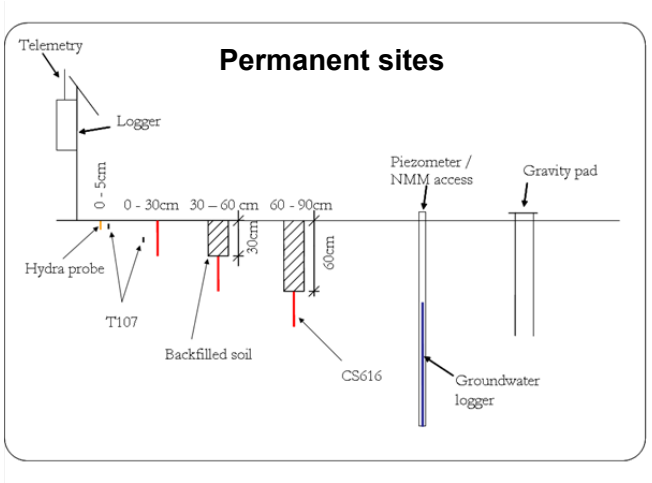
Monitoring network



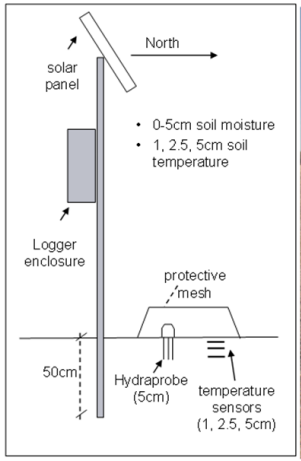
Permanent station
Semi-Permanent station
Ground sampling area
Airborne mapping area
Lot boundaries

Land Use

Conservation Area
Cropping Area
Dry Land
Horticulture



Semi-Permanent sites



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SMAPEx: The concept

Study Area:

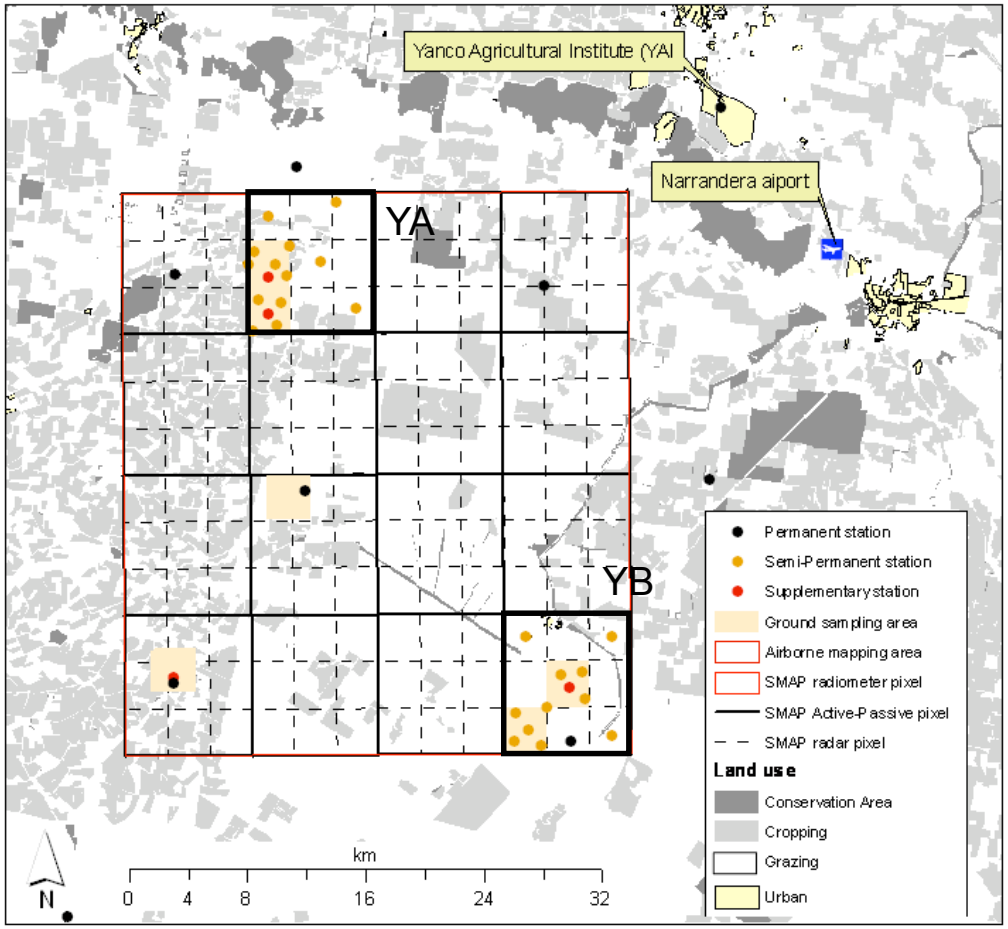
One SMAP radiometer pixel (34km x 38km) with 29 monitoring sites

Focus areas YA & YB:

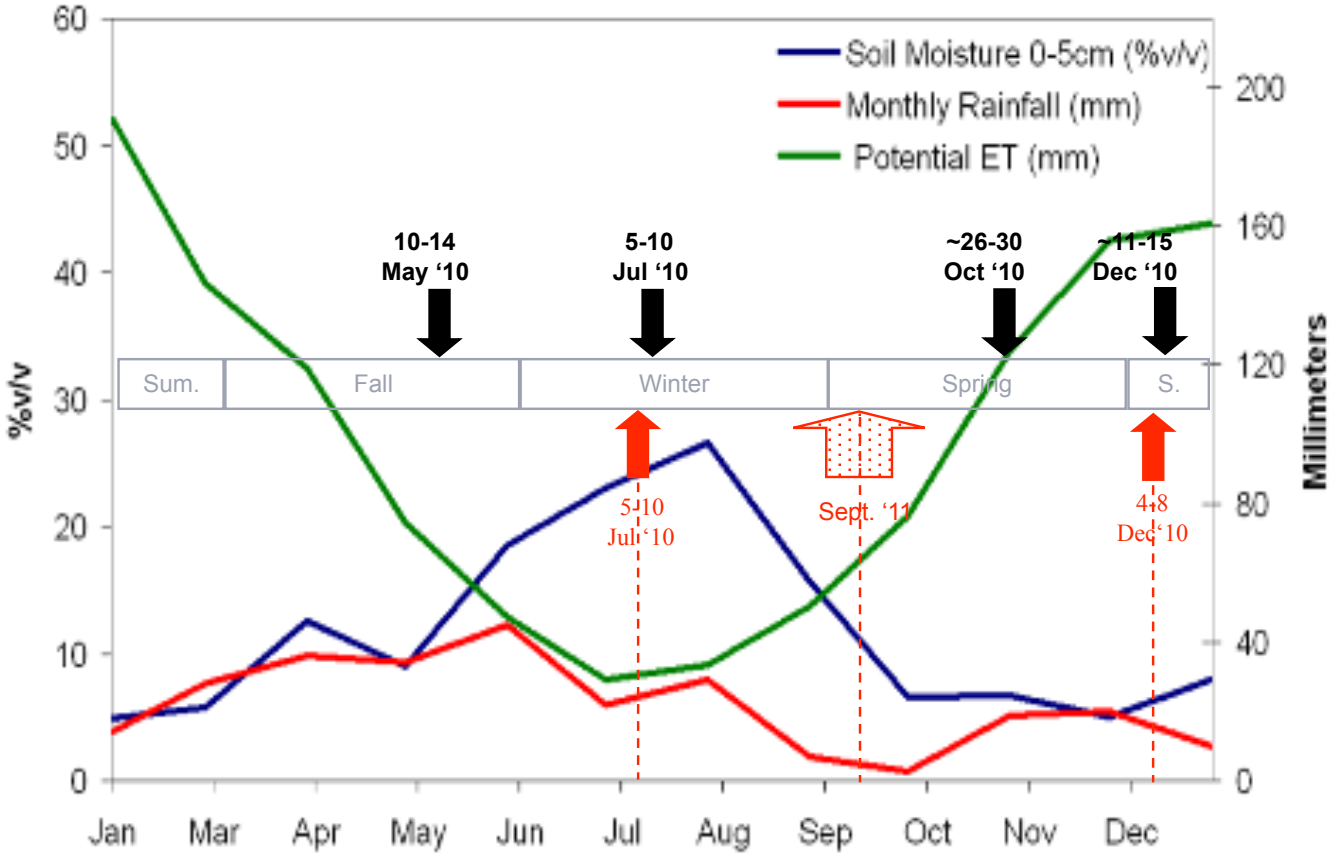
Two SMAP active passive product pixels (~9km x 9km) with 13 monitoring sites ea.

Ground Sampling:

Six SMAP radar pixels (~3km x 3km)



Campaign strategy



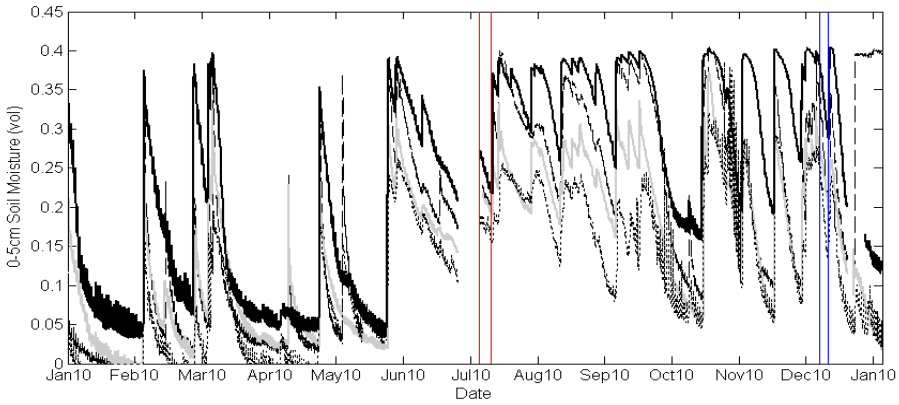
SM: 0.2-0.3 m^3/m^3
Early stage of crop growth

SM: 0.3-0.5 m^3/m^3
Mature crops

Seasonal cycle

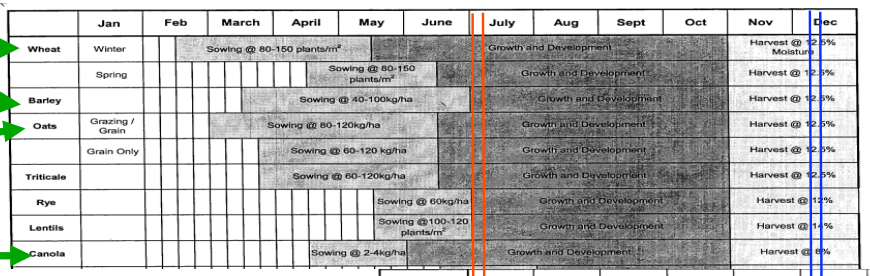
Soil Moisture

SMAPEx-1: July 5-10
SMAPEx-2: December 4-8

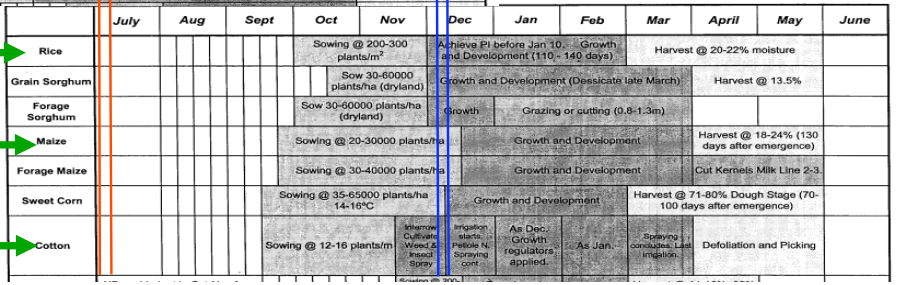


Crop growth stage

wheat
barley
oats
canola



rice
maize
cotton



SMAPEx monitoring strategy

Flight Description

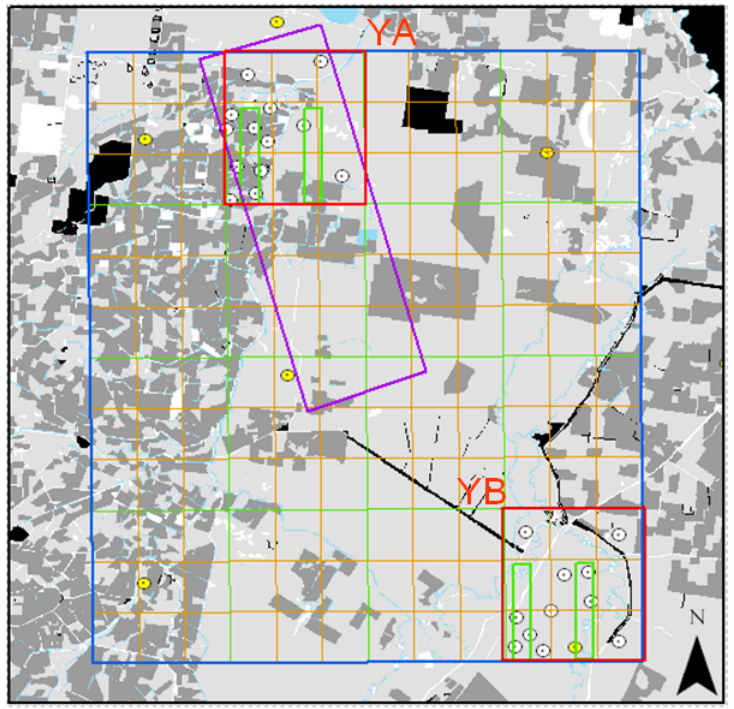
Flight Type	Aim	Altitude (AGL)	Coverage	Ground Resolution
Regional	Active/Passive retrieval	10,000ft	36km x 38km	1km (P)/10m (A)
Multiangle	Effect of incidence and azimuth angle on radar	10,000ft	1km x 6km (2 strips)	1km (P)/10m (A)
PALSAR Transect	Comparison PLIS vs PALSAR	10,000ft	8km x 22km	1km (P)/10m (A)
Target	Radar algorithm development	1000ft	9km x 9km	100m (P)/10m (A)

Weekly Flight Schedule

Flight Type	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Regional		7.30-10.20+		7.30-10.20+		7.30-10.20+
Multi-angle		10.20-13.30		10.20-13.30		10.20-13.30
Transect*	21.40-23.20					
Target			AREA YB 7.30-11.10+		AREA YA 7.30-11.10 +	

**PALSAR overpass at 10:30pm of Monday (Exact day of PALSAR transect flight will change for each campaign accordingly to PALSAR overpass*

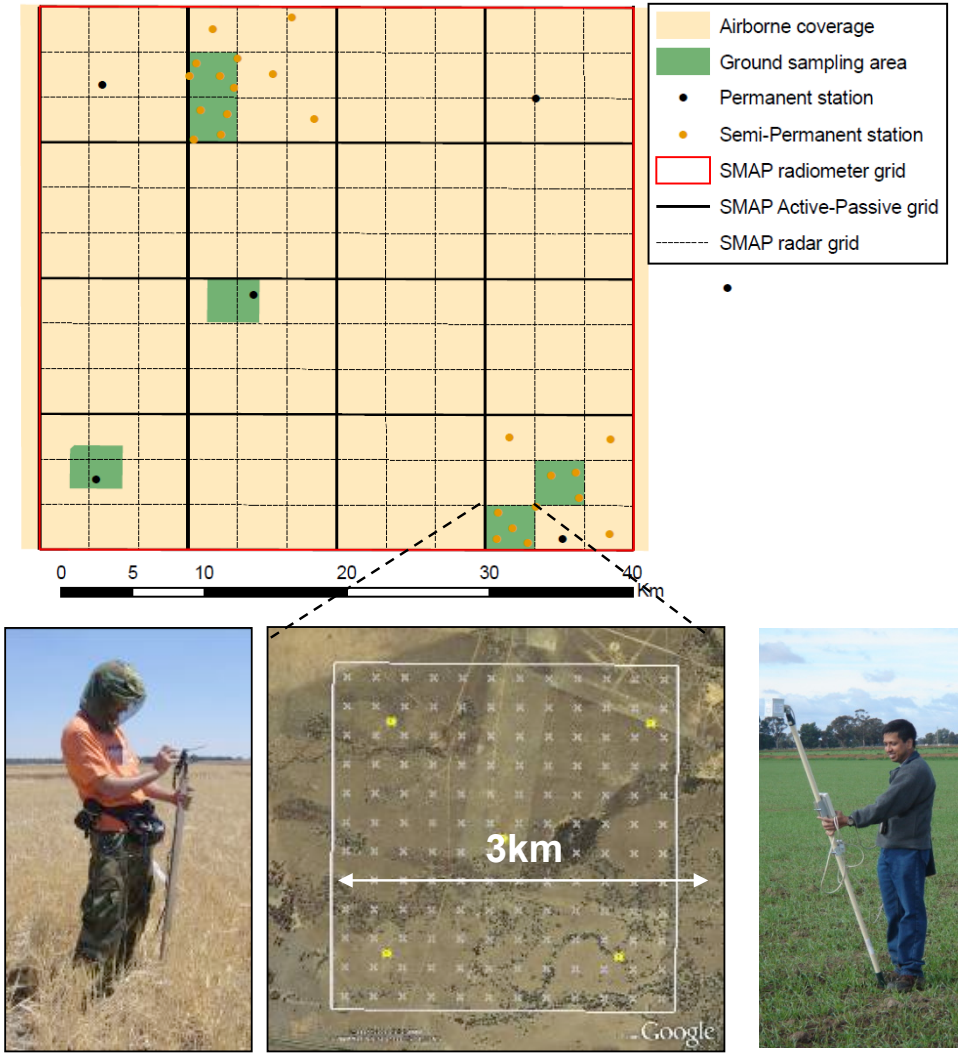
+ Sunrise at 7.24am (EDT), start mapping at 8:15am (i.e., 45min after sunrise for Skye data reliability)



SMAPEx monitoring strategy

Ground validation data

- Continuous soil moisture at 29 sites
- Continuous TIR/soil temperature at 4 sites
- Six 3km x 3km focus areas
  - > Soil moisture @ 250m spacing (Regional days)
  - > Soil moisture @ 50m spacing (Target days)
  - > Vegetation biomass, water content, LAI, reflectance @ 5 sites per dominant vegetation type
  - > Surface roughness @ 3 sites per dominant vegetation type



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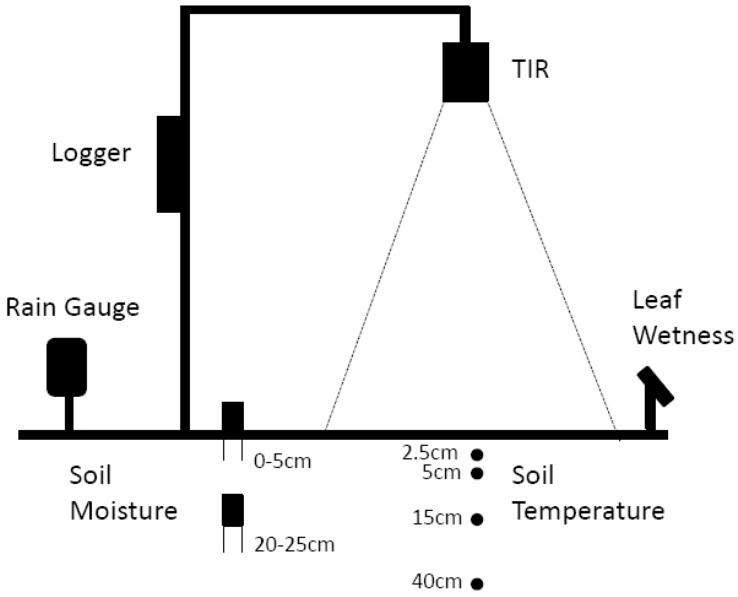
Supplementary data



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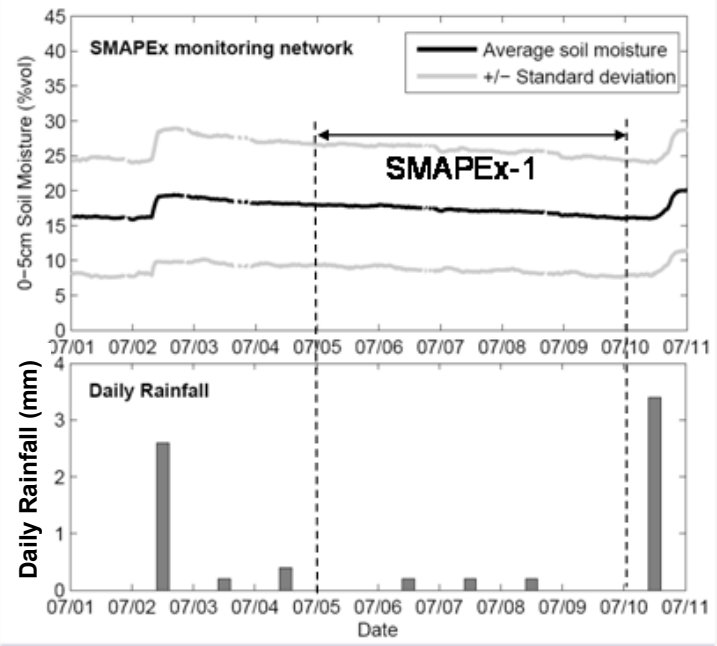
Ground validation data

HDAS
- soil moisture
- vegetation type
- vegetation height
- dew amount

Vegetation
- water content
- biomass
- type
- LAI
- spectral
- crop row spacing/orientation

SMAPEx-1

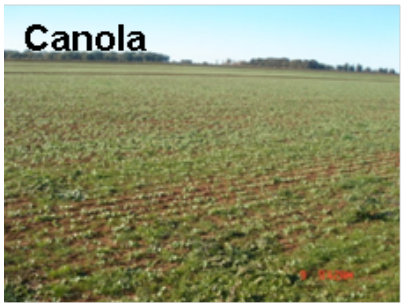

SMAPEx monitoring network
Average soil moisture
+/− Standard deviation
SMAPEx-1
0−5cm Soil Moisture (%vol)
Daily Rainfall
Daily Rainfall (mm)
07/01 07/02 07/03 07/04 07/05 07/06 07/07 07/08 07/09 07/10 07/11
Date


Bare soil


Fallow


Maize


Wheat


Canola

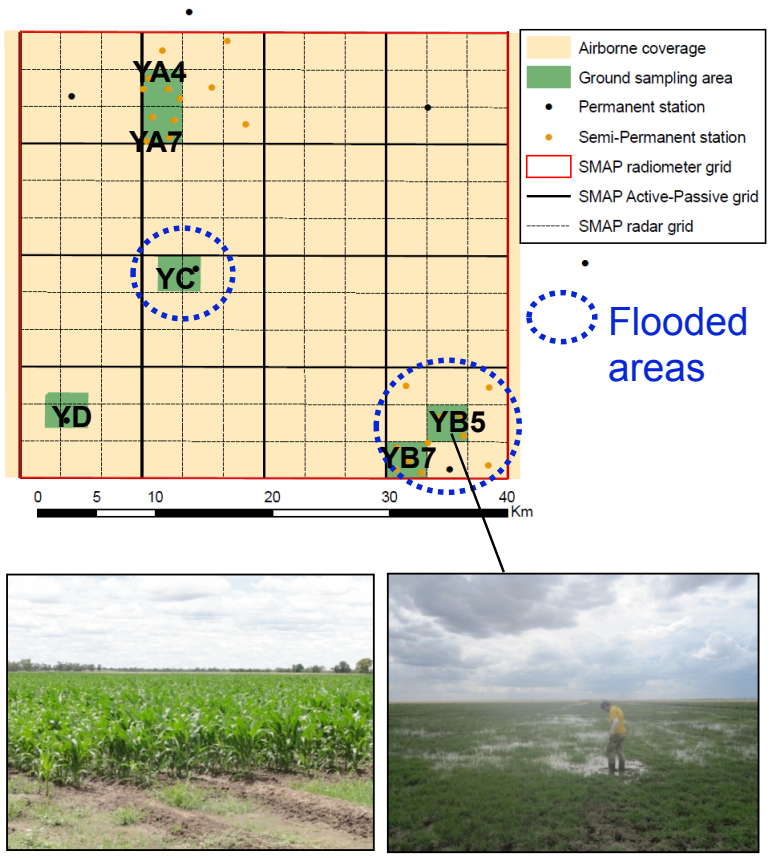

Lucerne

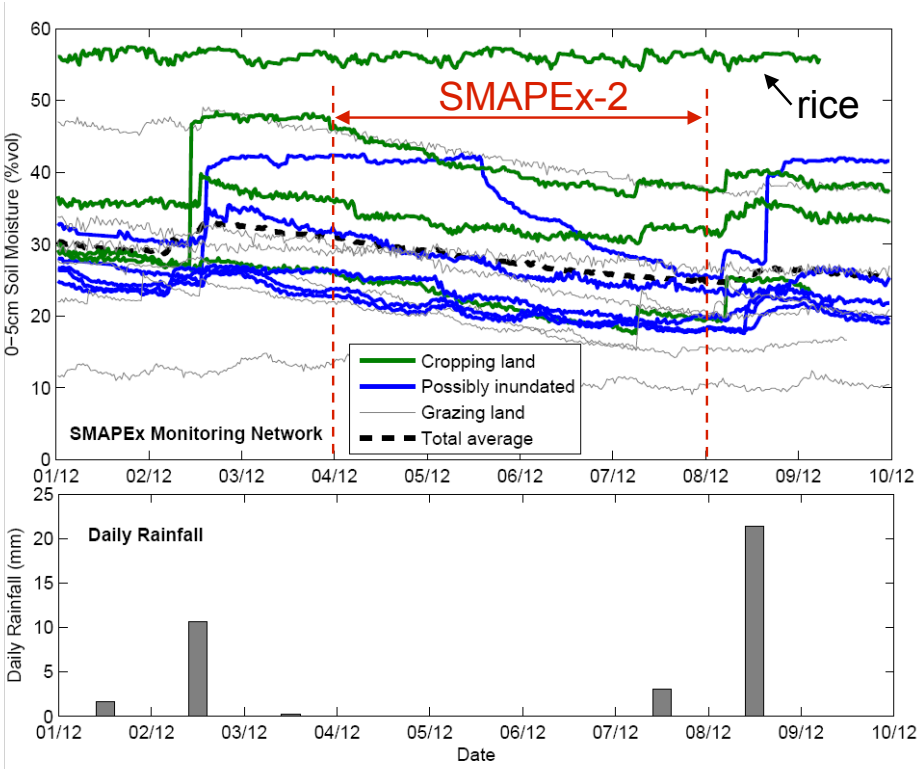

Native pasture


Improved pasture

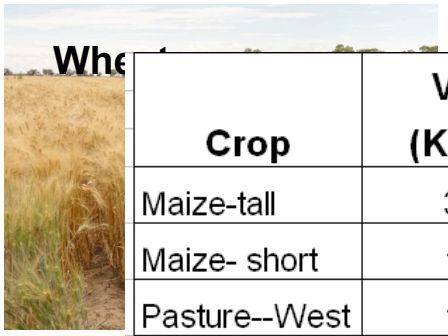
SMAPEx-2

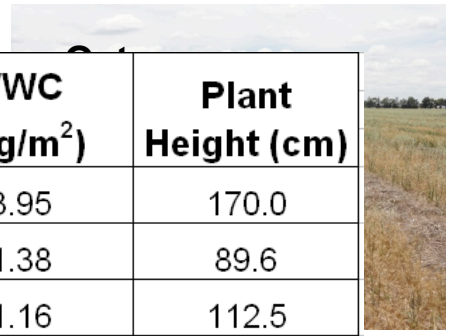
Extensive flooding

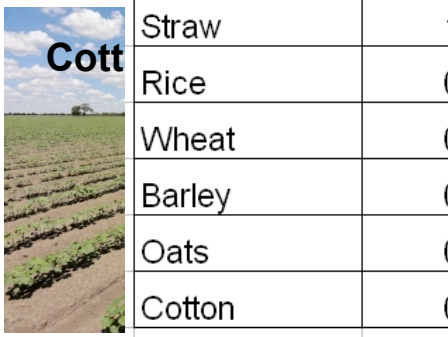


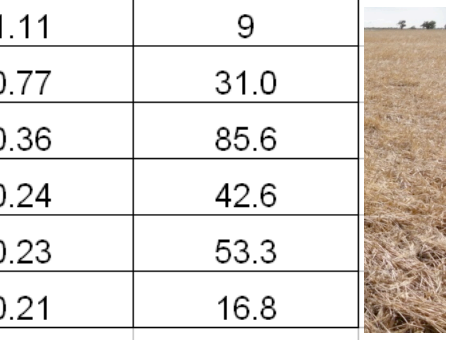


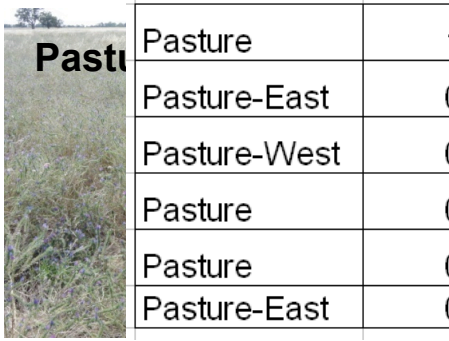
SMAPEx-2: vegetation sampling

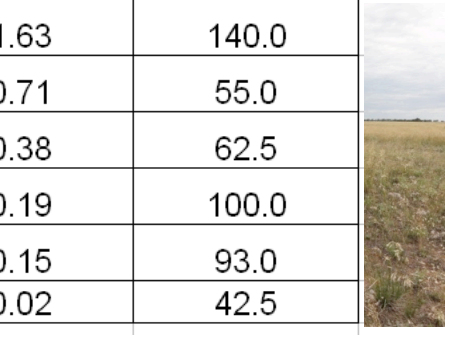








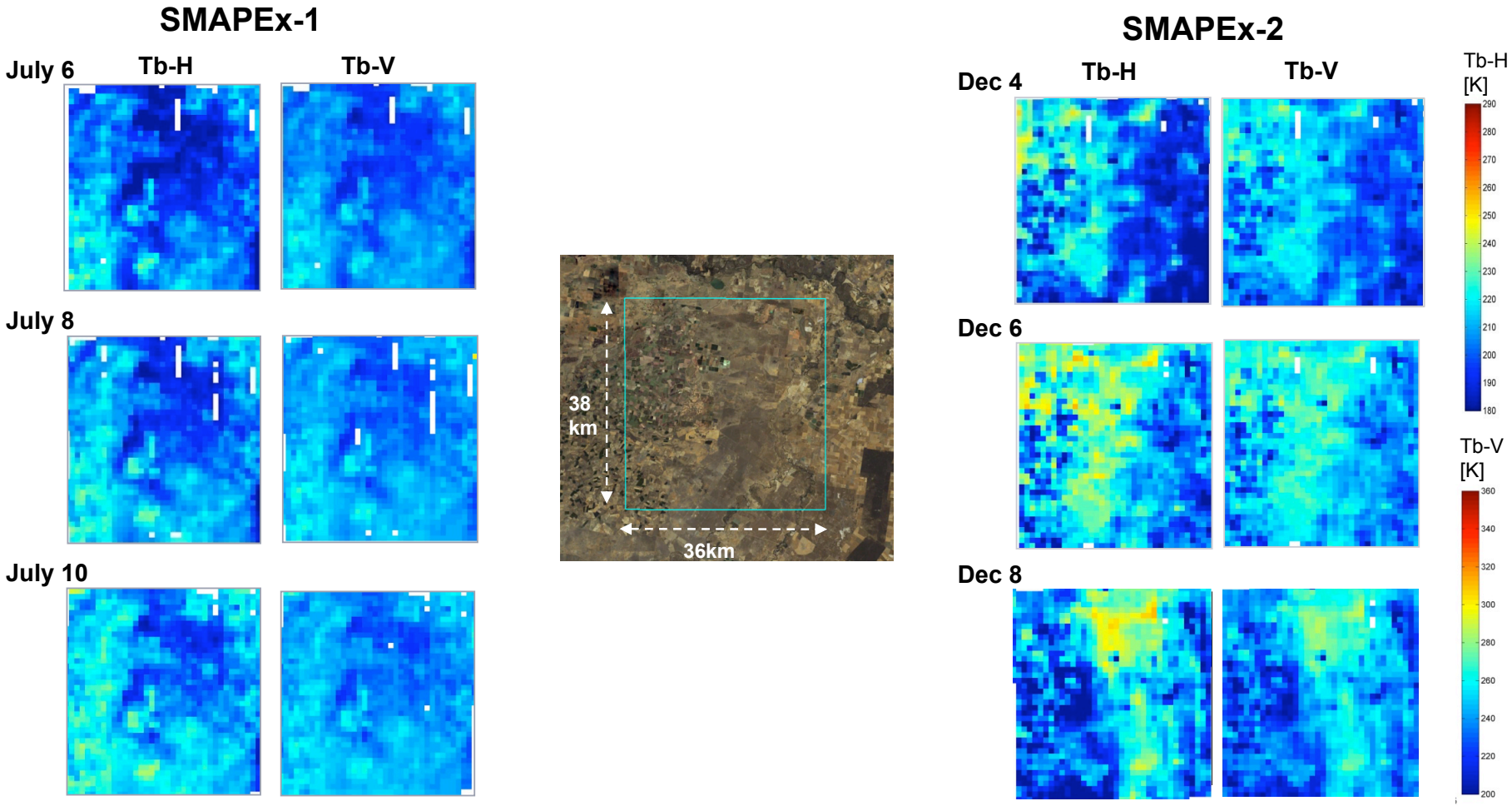




Crop	VWC (Kg/m^2)	Plant Height (cm)
Maize-tall	3.95	170.0
Maize- short	1.38	89.6
Pasture--West	1.16	112.5
Straw	1.11	9
Rice	0.77	31.0
Wheat	0.36	85.6
Barley	0.24	42.6
Oats	0.23	53.3
Cotton	0.21	16.8
Pasture	1.63	140.0
Pasture-East	0.71	55.0
Pasture-West	0.38	62.5
Pasture	0.19	100.0
Pasture	0.15	93.0
Pasture-East	0.02	42.5

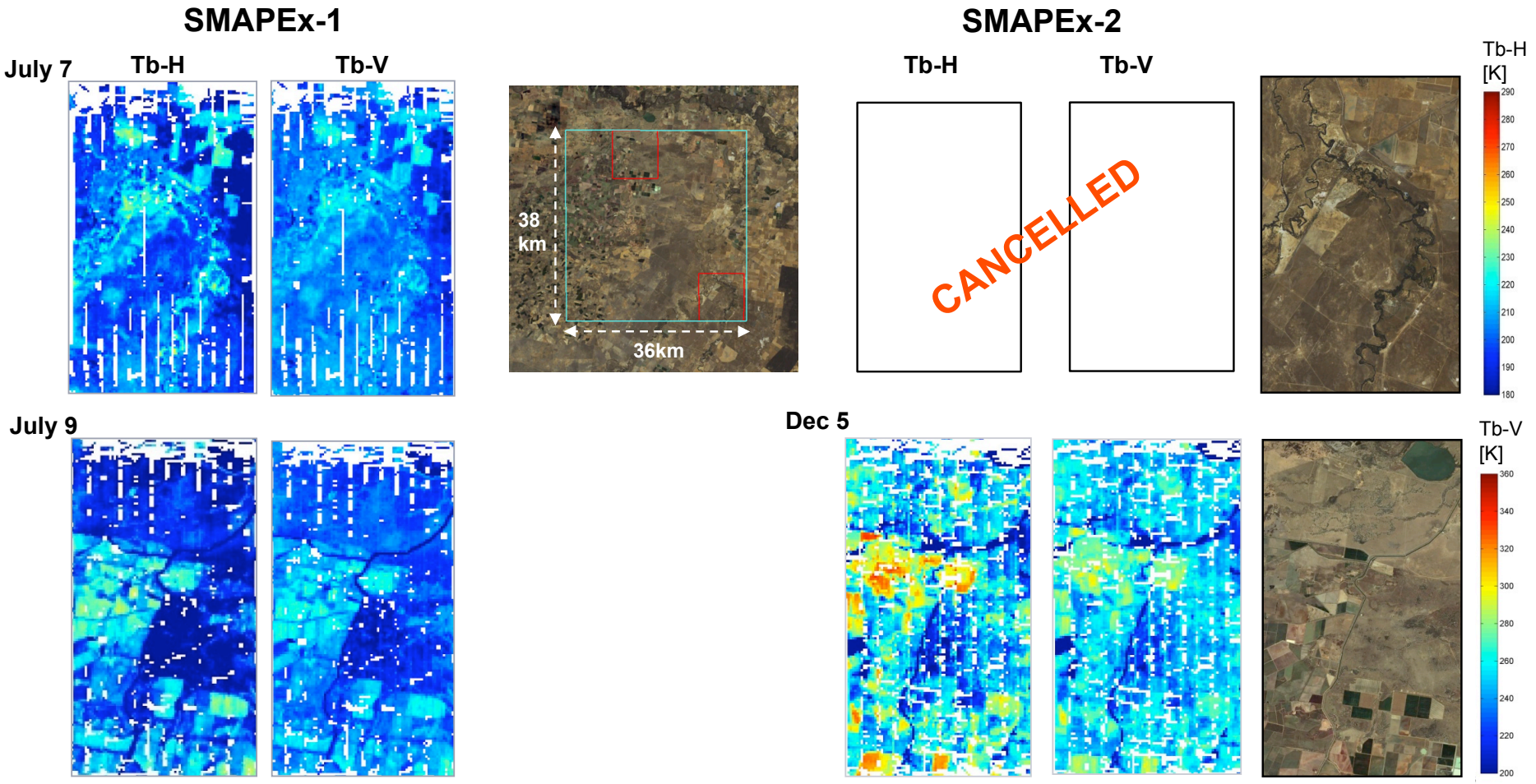
Regional flights

PLMR



Target flights

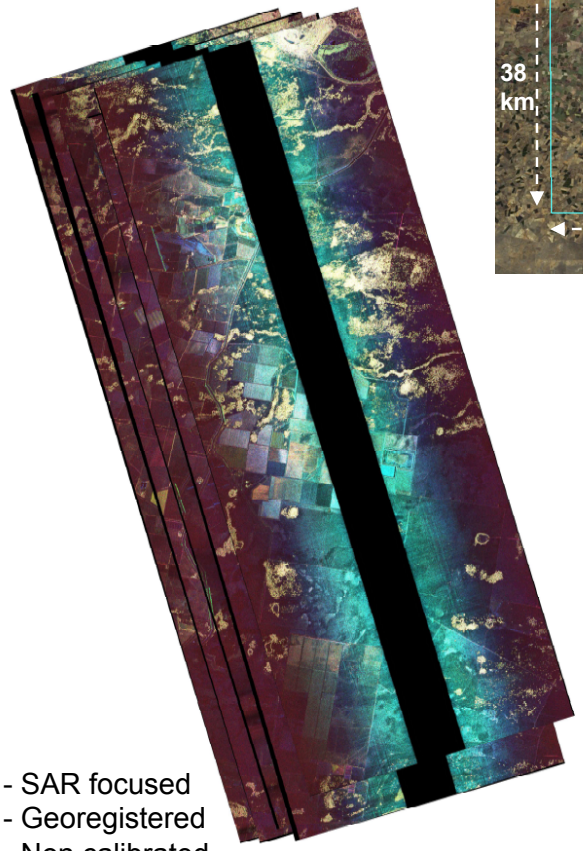
PLMR

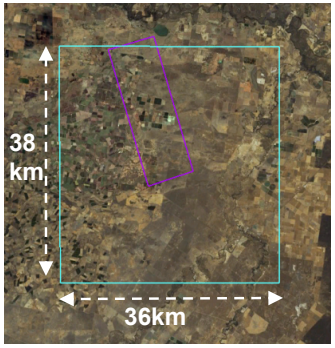


Other airborne data

PLIS, SMAPEx-1,July 5

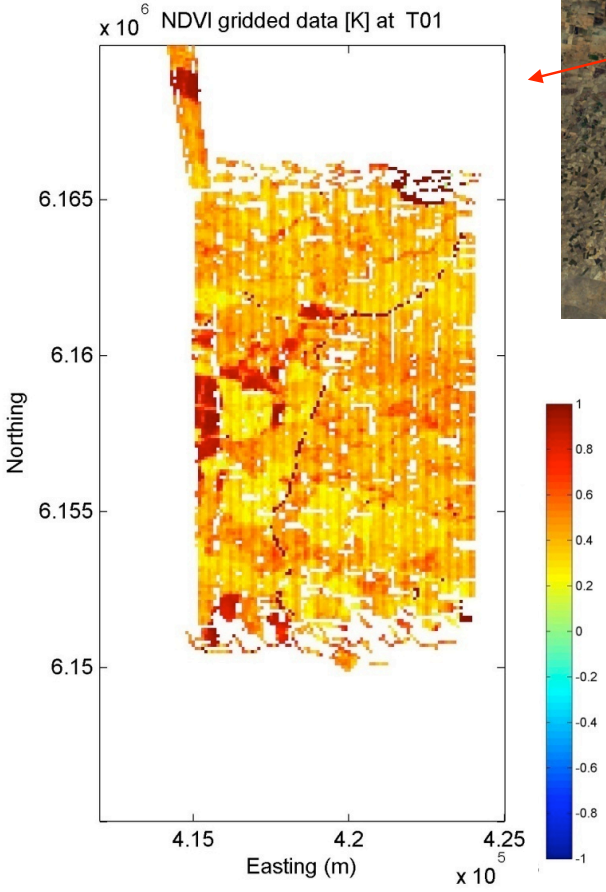
PALSAR Transect

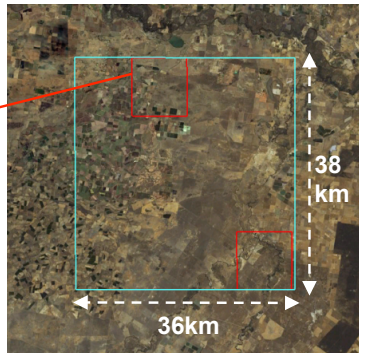




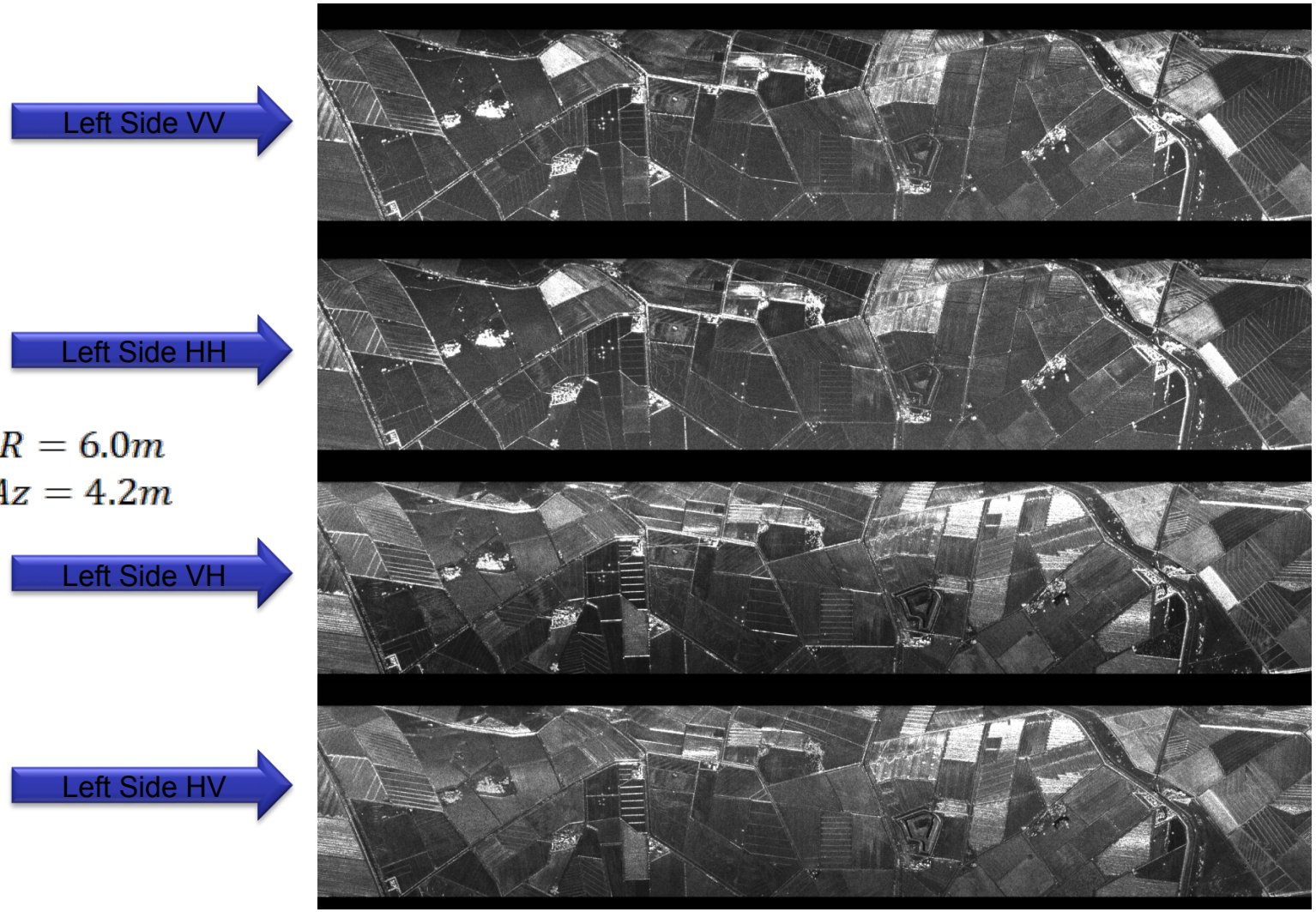
- SAR focused
- Georegistered
- Non calibrated
- Different polarisation combinations for RGB bands

VIS/NIR/SWIR, SMAPEx-2, Dec 5

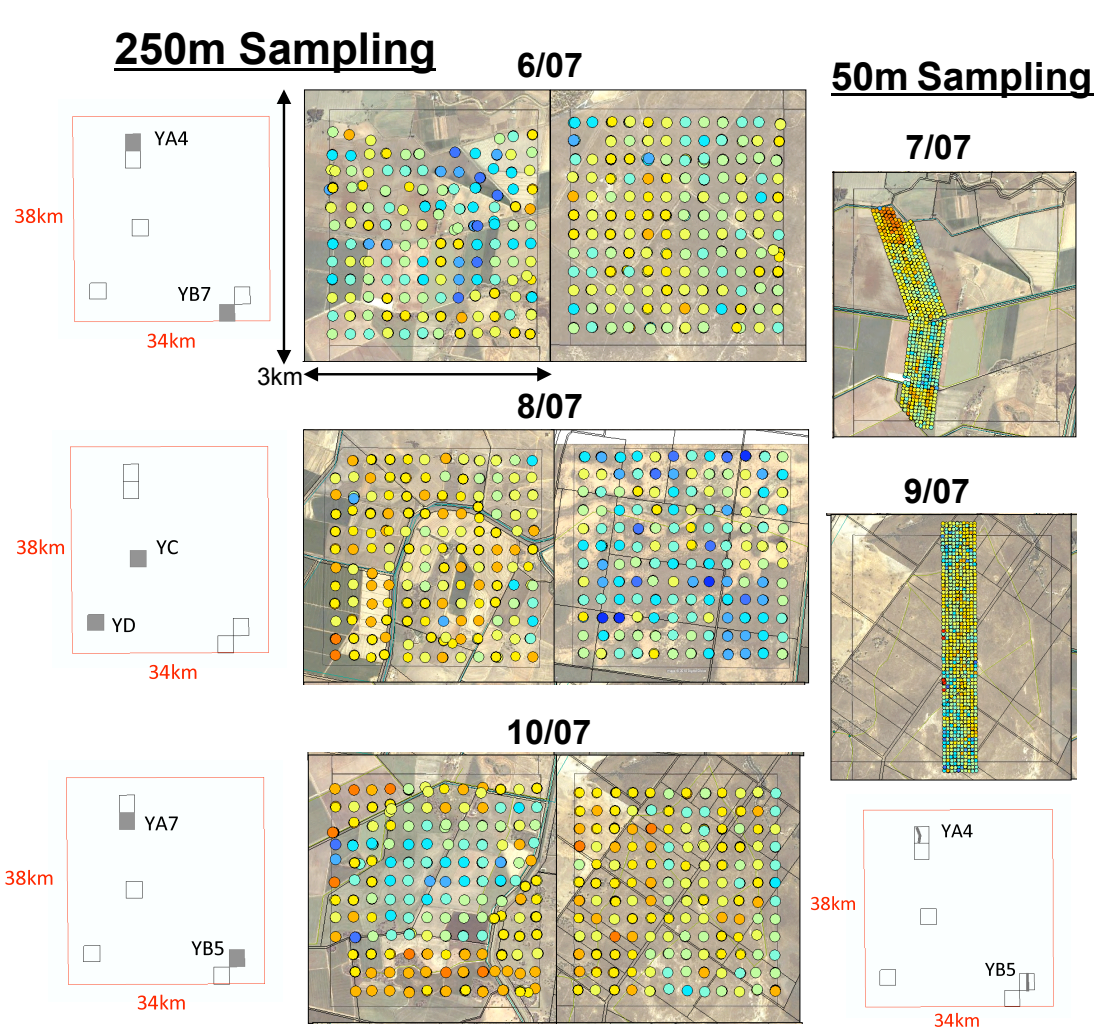


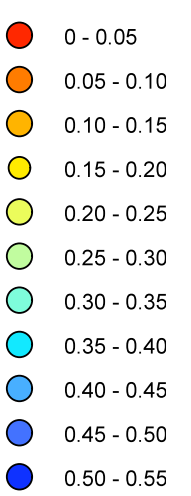


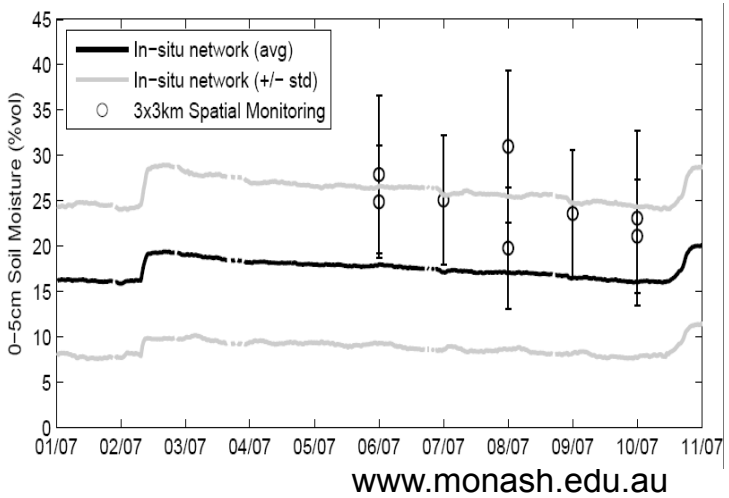
Example PLIS data: SMAPEx-1



SMAPEx-1: soil moisture data







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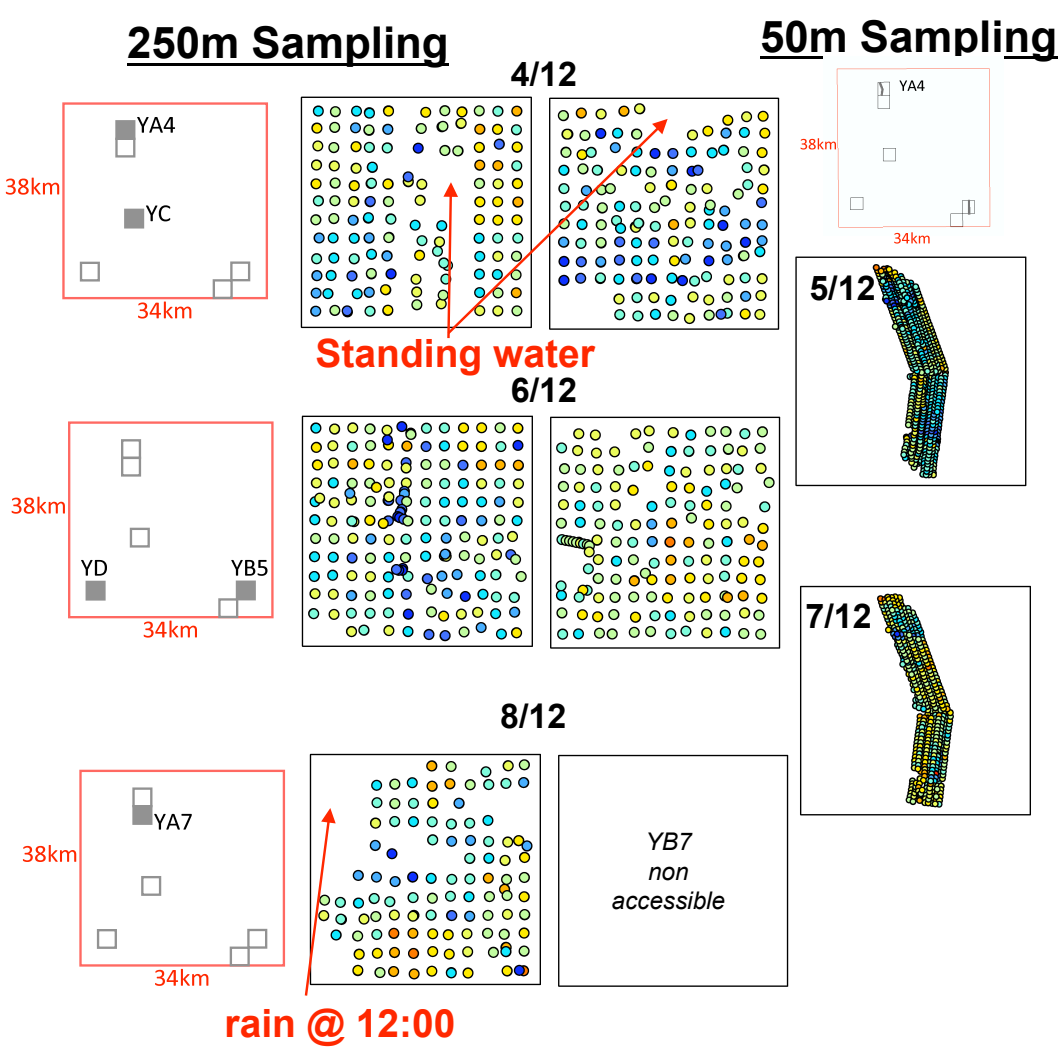
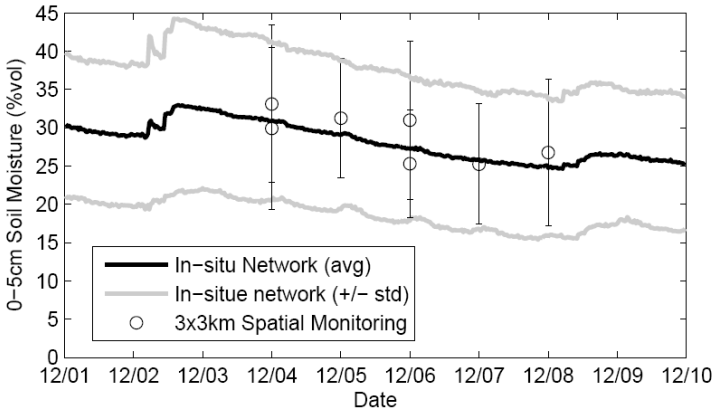
SMAPEx-2: soil moisture data





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Supplementary data

Vegetation destructive sample, LAI, reflectances

Vegetation type	Nr. of Samples	
	SMAPEx-1	SMAPEx-2
Barley	3	5
Wheat	1	5
Oats	4	4
Pasture	10	23
Maize	3	510(st)+7(leaf)
Canola	3	
Lucerne	4	
Cotton		5
Rice		2
Straw	-	2
Cereal grain	4	-
Bare Soil	3	-
Fallow	3	-
Mix wheat/fallow	1	-

Surface roughness

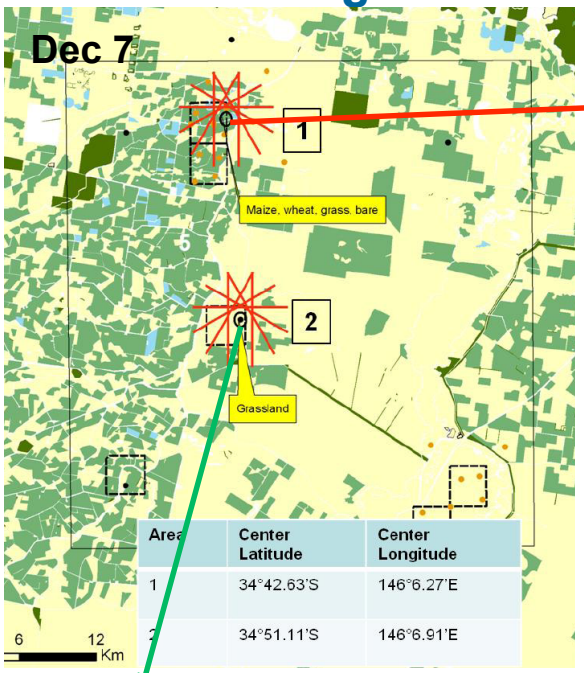
Vegetation type	Nr. of Samples	
	SMAPEx-1	SMAPEx-2
Barley	3	3
Wheat	1	5
Oats	4	2
Pasture	10	13
Maize	1	3
Canola	3	
Lucerne	3	
Cotton		3
Cereal grain	1	-
lucerne/grass	1	-
Bare Soil	1	-
Fallow	3	-
Mix wheat/fallow	1	-

1x vegetation = 1x destructive sample + 5x LAI + 25x reflectance

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

SMAPEx-2: additional data

Multi-azimuth flights



Area	Center Latitude	Center Longitude
1	34°42.63'S	146°6.27'E
2	34°51.11'S	146°6.91'E

- **Radar scaling overpasses**
  - Effect of resolution on radar obs.
  - Multi-resolution radar images (5m, 50m, 150m)
- **Ground mapping of standing water**
  - Retrieval of standing water in satellite footprints
  - 9 inundated areas boundaries mapped using GPS tracking
  - Extension: $10m^2$– $0.2km^2$

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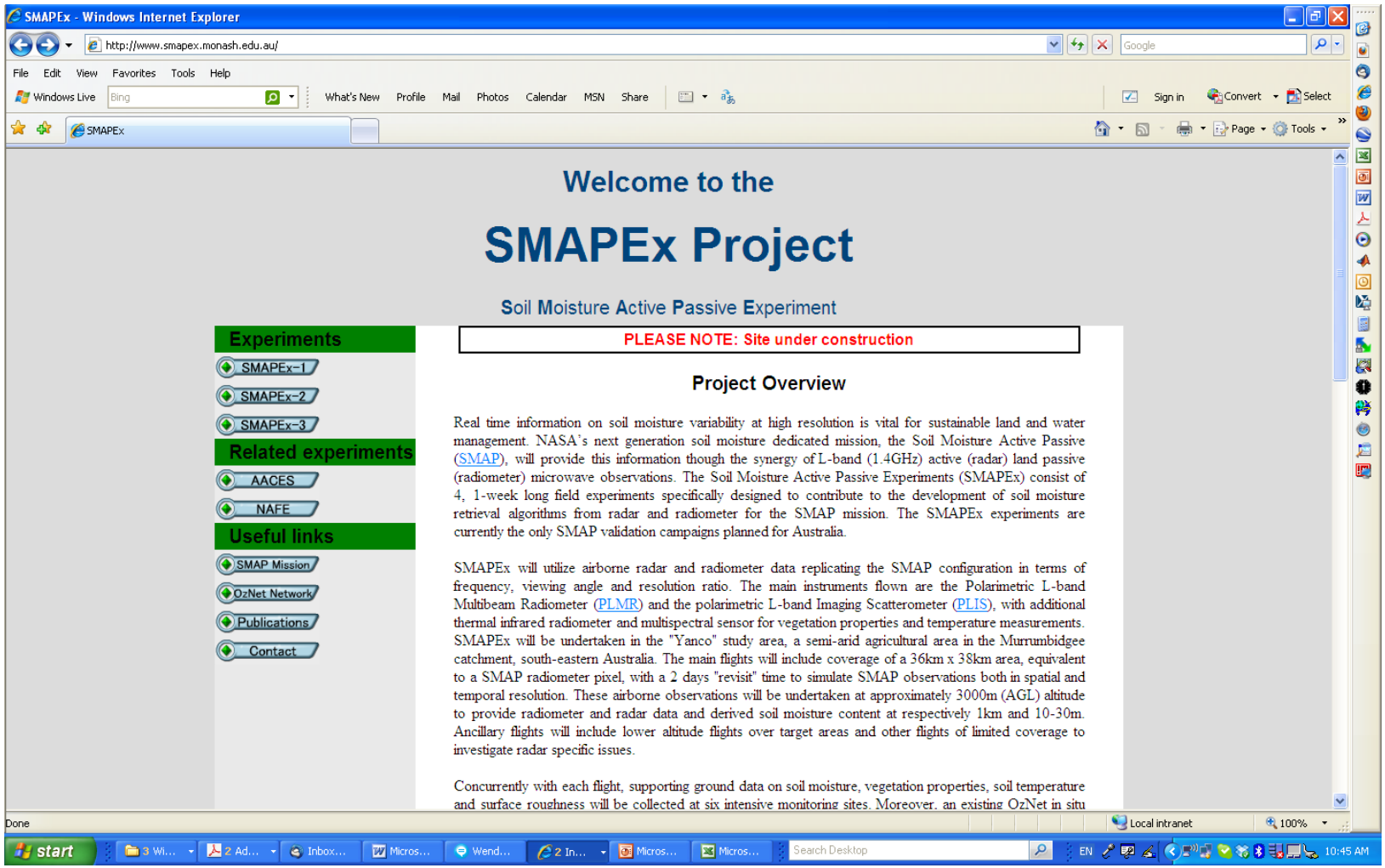
SMAPEx archive: www.smapex.monash.edu.au

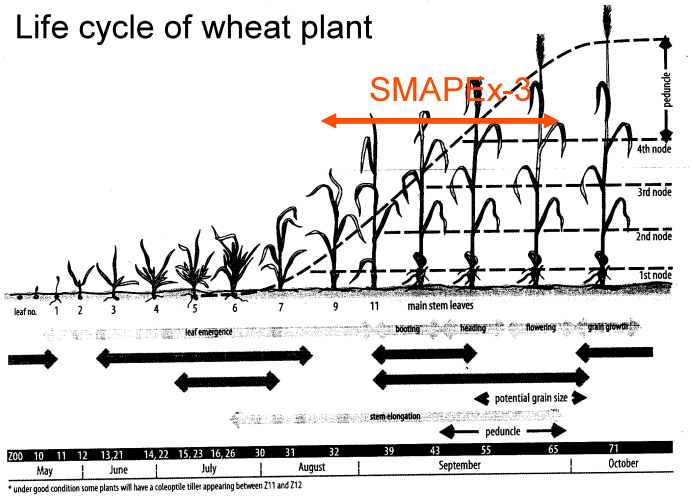


SMAPEx-3

- Focus on change detection techniques

  3-weeks campaign to capture crop growth phase

  regional monitoring with 2-3 days “revisit”



Radar soil moisture retrieval (Superscience)

detailed vegetation structure sampling

additional soil moisture sampling

monitoring of forest (airborne soil moisture & vegetation)

airborne LIDAR and hyperspectral for validation of radar retrieval of vegetation parameters

- Tentative dates: 2-26 Sept 11----- volunteers welcome !

Participants: SMAPEX-1

AIR CREW
Jeff Walker (Monash Uni)
Jon Johannson
Heath Yardley (Adelaide Uni)

VEGETATION SAMPLING
Peggy O'Neill (GSFC)
Alicia Joseph (GSFC)
Rajat Blindlish (USDA)
Susie Chai

SOIL MOISTURE SAMPLING
Dongryeol Ryu (Melbourne Uni)
Rocco Panciera (Melbourne Uni)
James Yates (Monash Uni)
Kung Khin loh (Monash Uni)
Wenshen Wong (Monash Uni)
Anna Balenzano (CNR, Italy)
Mohan Yellishetty (Monash Uni)
Wen Ooi (Monash Uni)
Sheen Chua (Monash Uni)
Chin Cheong (Monash Uni)
Rodger Young (Melbourne Uni)
Andreas Colliander (JPL)

Participants: SMAPEx-2

AIR CREW
Jeff Walker (Monash Uni)
Jon Johannson
Heath Yardley (Adelaide Uni)

VEGETATION SAMPLING
Lynn McKee (USDA)
John Prueger (USDA)
Seungbum Kim (JPL)
Mehmet Kurum (GSFC)

SOIL MOISTURE SAMPLING
Dongryeol Ryu (Melbourne Uni)
Lucheng Huang (Monash Uni)
Giuseppe Satalino (CNR,Italy)
Perrine Hamel (Monash Uni)
Rocco Panciera (Melbourne Uni)
Maria Piles (Melbourne Uni)
Chris Rudiger (Monash Uni)
Fedra Mendez
Muzaffar Ahmad (Melbourne Uni)
Rodger Young (Melbourne Uni)