MONASH University

Engineering

SMAPEx-4 Report and SMAPEx-5 Plan

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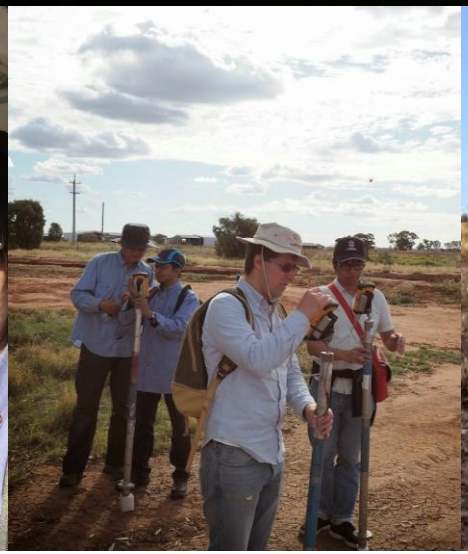
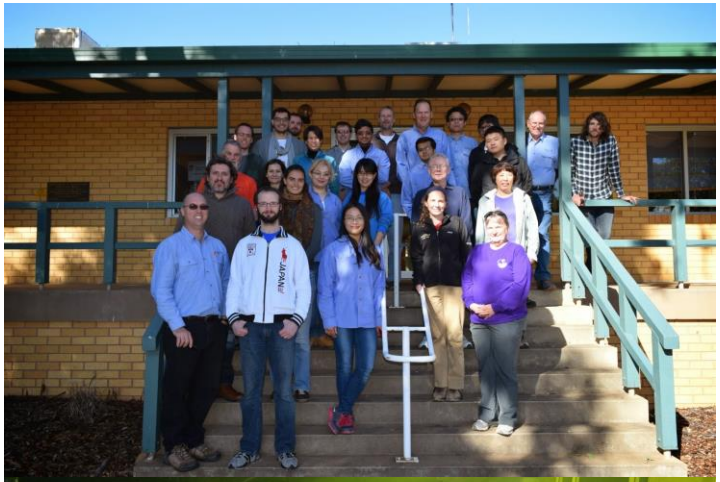


Acknowledgements

Australian Government
Australian Research Council



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- **Monash University:** Ashley Wright, Christoph Rüdiger, Frank Winston, Jon Johansson, Muhsiul Hassan, Nan Ye, Sabah Sabaghy, Shuvashis Dey, Stefania Grimaldi, Xiaoling Wu, Ying Gao, Yuan Li
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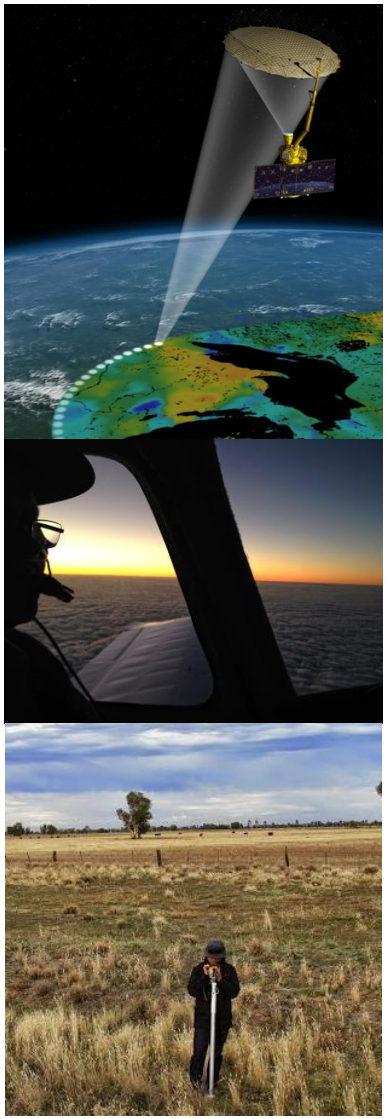
- **USDA:** Alex White, John Prueger, Lynn McKee, Thomas Jackson
- **VUA:** Anouk Gevaert, Richard DeJeu

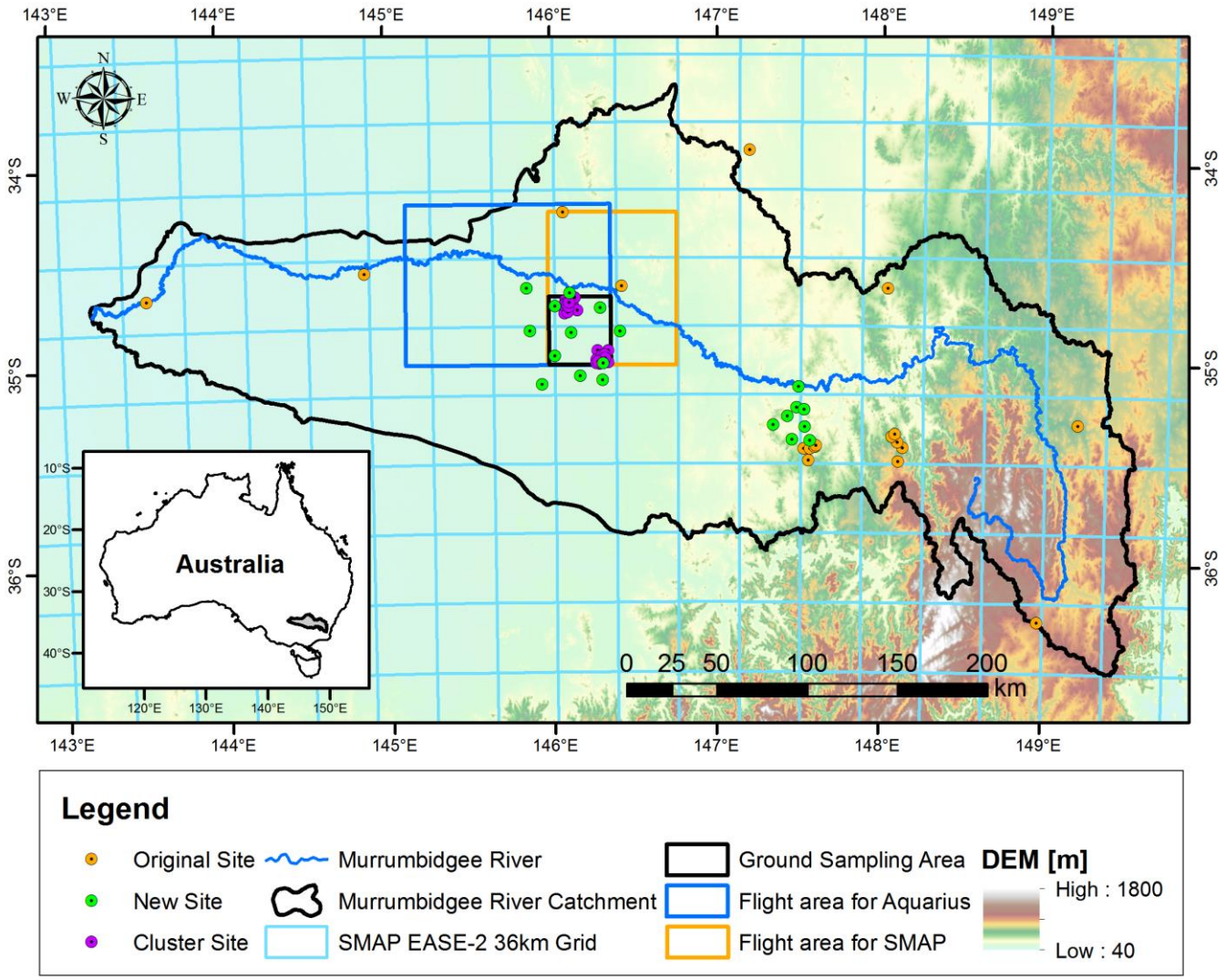
SMAP Experiments (SMAPEx)

- SMAP pre-launch airborne field campaigns were required to:
  - Develop/test SMAP baseline radar algorithm for bare and vegetated soil;
  - Develop/test SMAP radiometer algorithm for vegetated surfaces;
  - **Develop/test SMAP merged active and passive algorithm.**

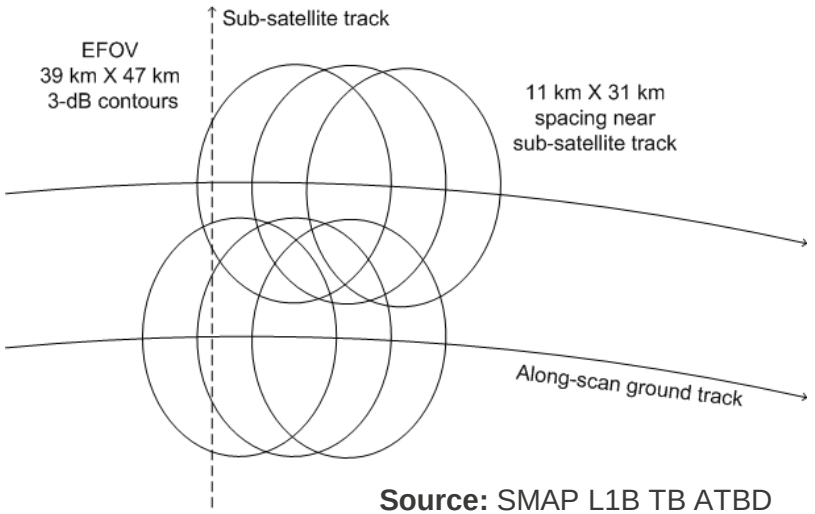
- SMAP post-launch airborne field campaigns are required to:
  - **Evaluate SMAP active-passive downscaled 9km radiometer observations**;
  - Inter-compare between airborne, SMAP, Aquarius, and SMOS radiometer and radar observations;
  - **Validate SMAP SM_P, SM_A, SM_AP retrieval algorithms using airborne soil moisture retrieval results (SMAPEx) and monitoring network (OzNet)**;
  - Further develop radar only soil moisture retrieval algorithms;
  - **Develop/test alternative spatial enhancement algorithms.**



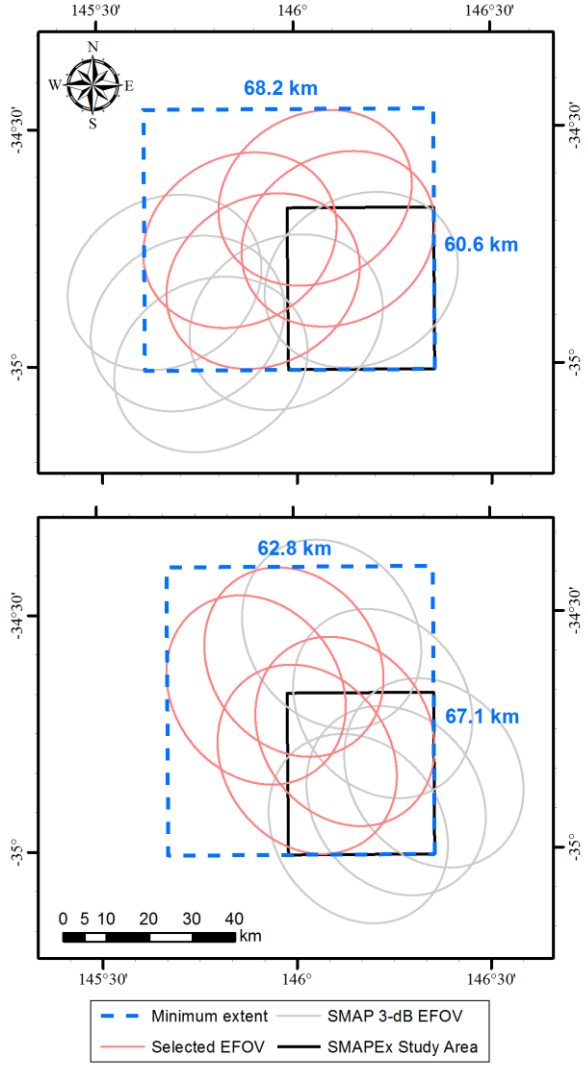
Monitoring station network



SMAP 3-dB effective field-of-view

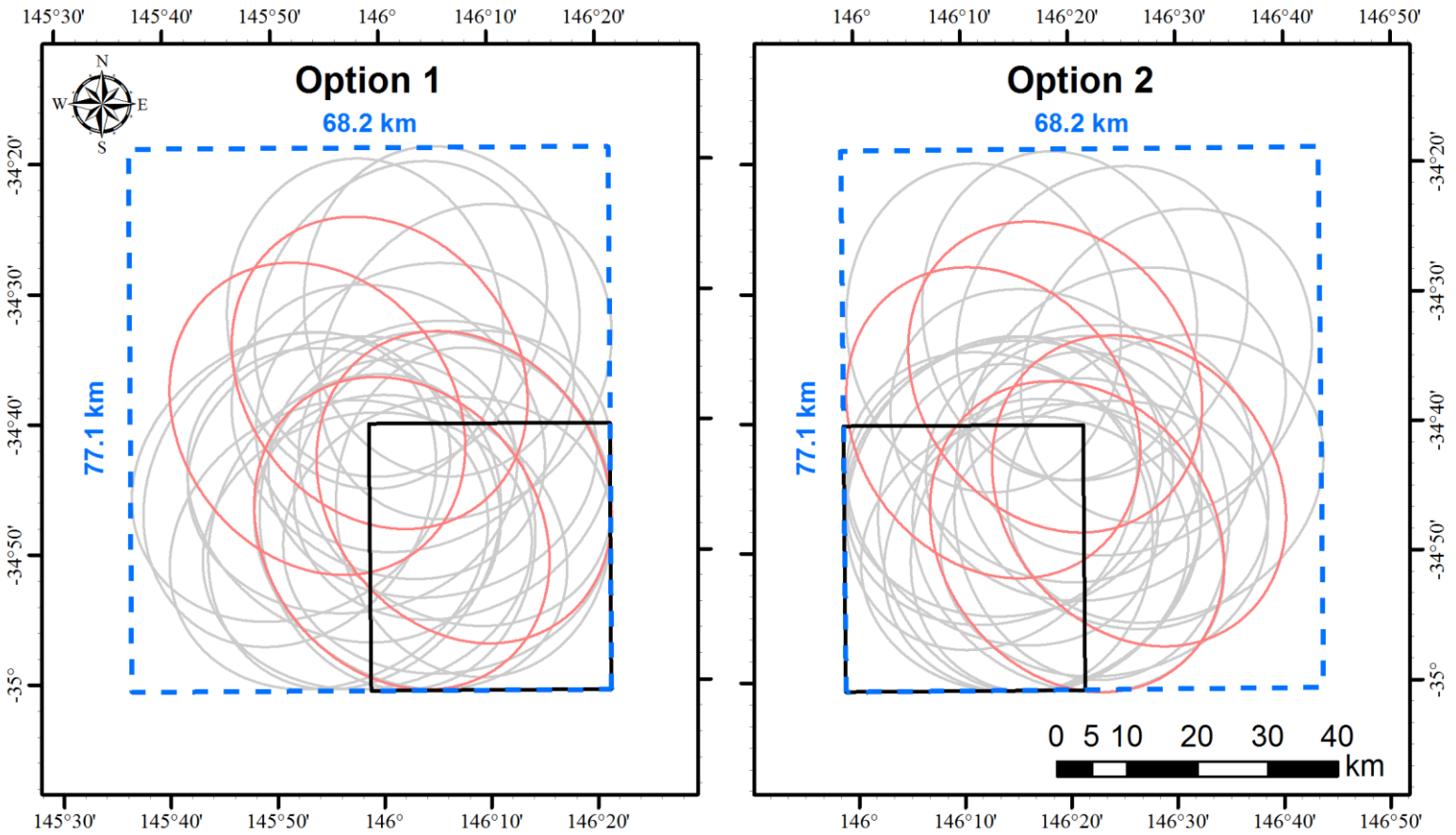


Source: SMAP L1B TB ATBD

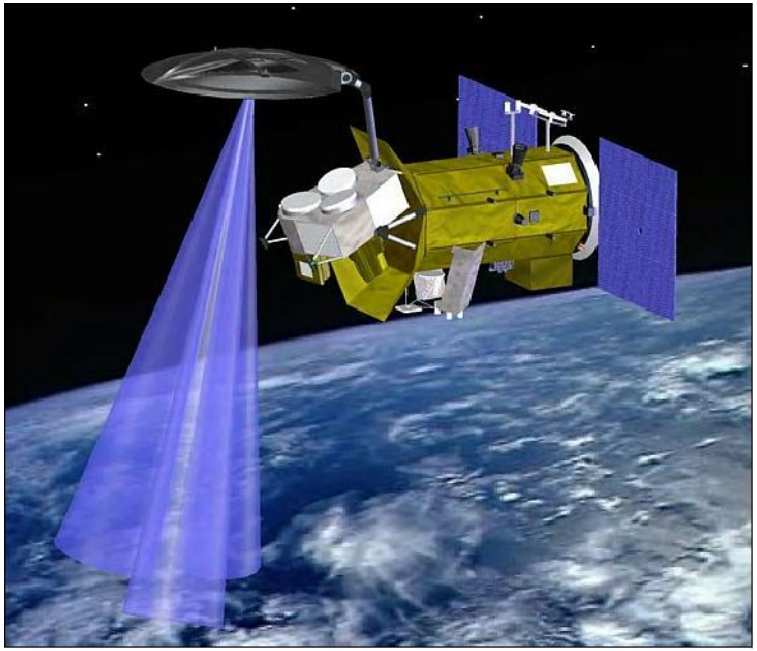


Distance to nadir [km]	Scan angle [°]	Spacing [m]	Azimuth [°]	Looking	Minimum extent	
					width [m]	length [m]
370	48.6	20,175	60.6	F	**68,178**	60,558
			143.6	B	62,817	67,114
-460	66.9	11,578	-54.9	F	60,312	57,472
			-101.1	B	60,207	52,349
-180	21.1	28,857	-9.1	F	54,645	**77,050**
			-146.9	B	66,521	74,945

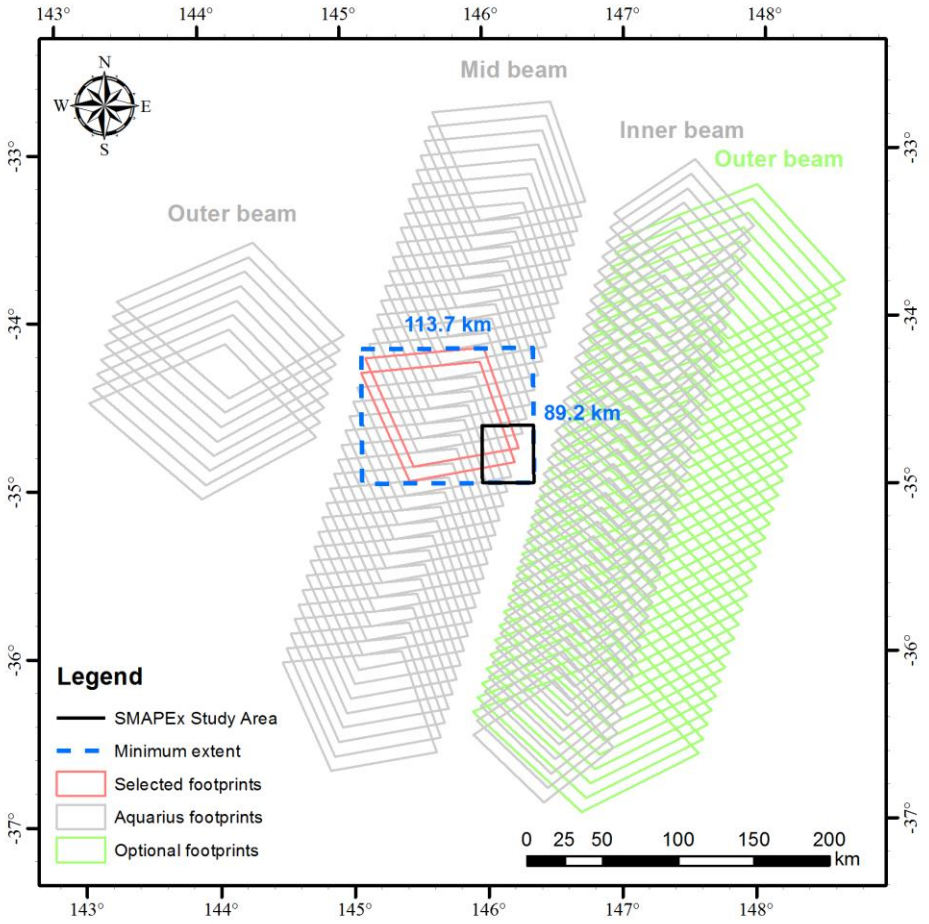
Conservative coverage for SMAP



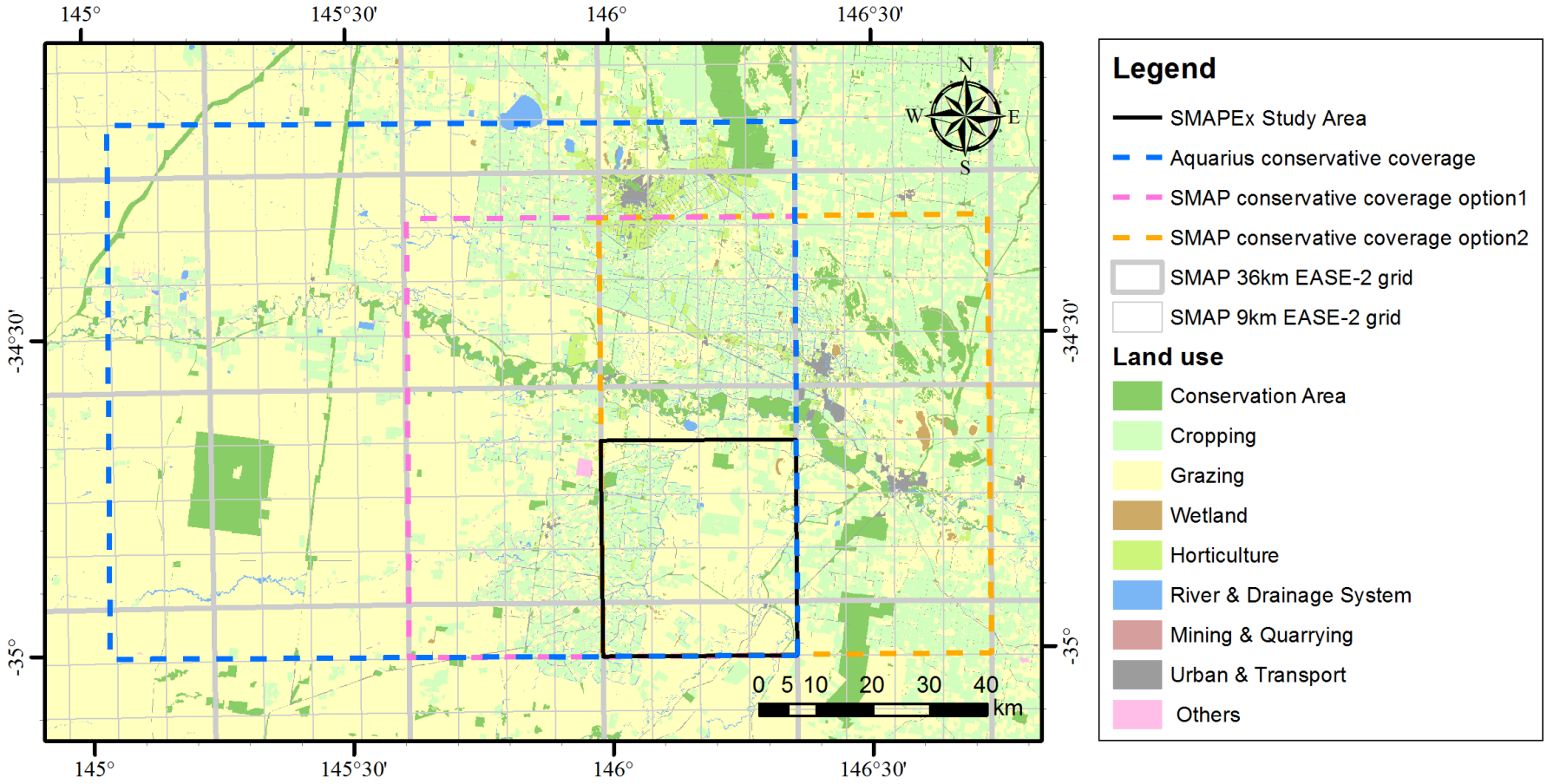
Conservative coverage for Aquarius



Revisit time	Exact 7 days
Beam number	3
Incidence angle [°]	28.7, **37.8**, 45.6
Foot print size [km]	74 × 94, **84 × 120**, 96 × 156
Minimum extent width [km]	113.7
Minimum extent length [km]	89.2

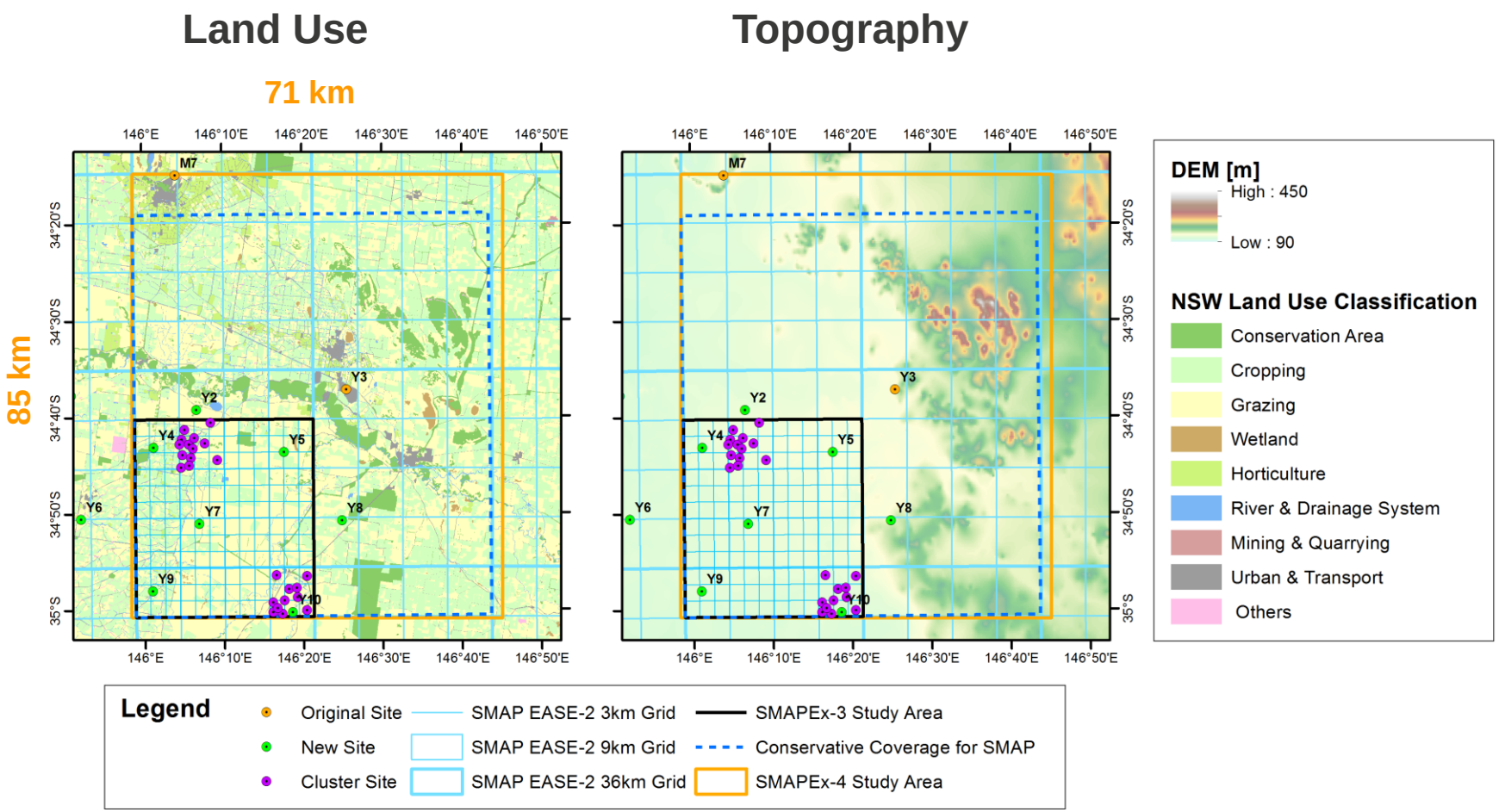


Flight coverage selection

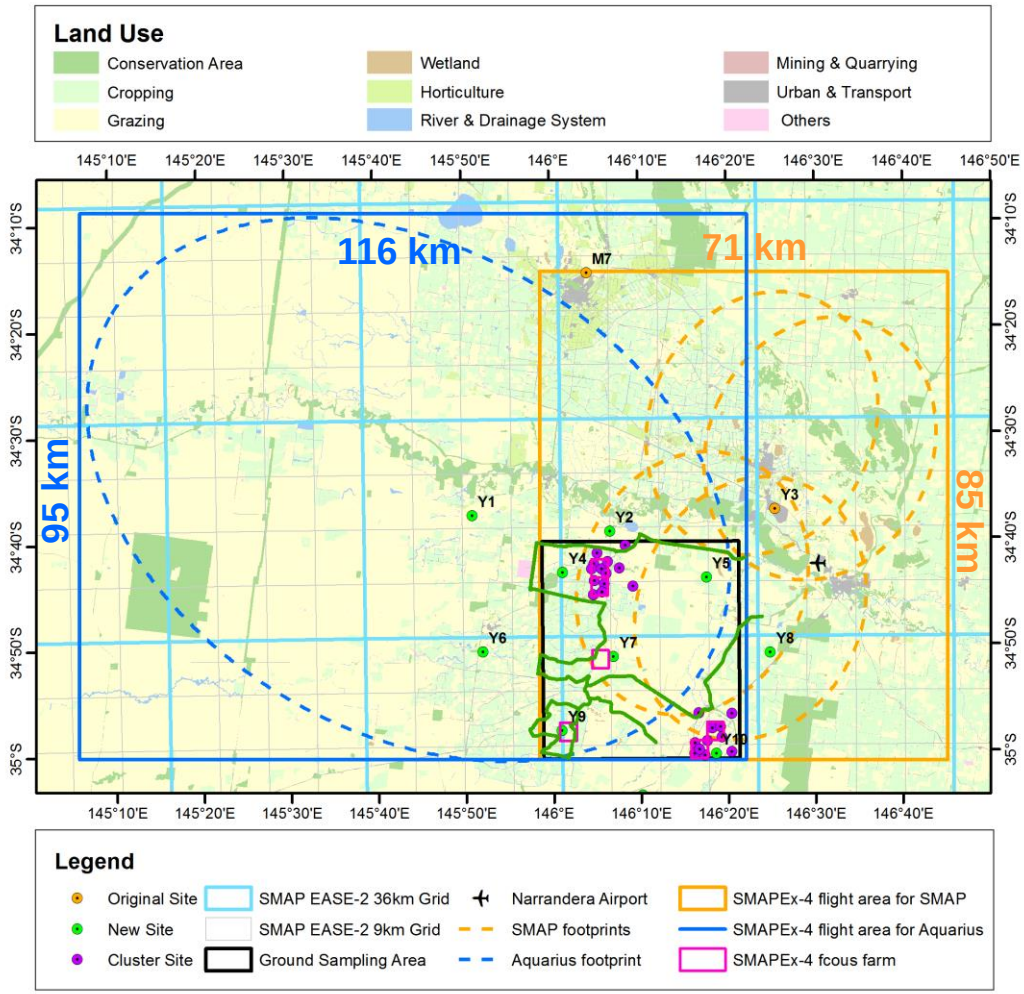


Option 1, option 2, or alternating?

SMAPEx-4 flight area for SMAP



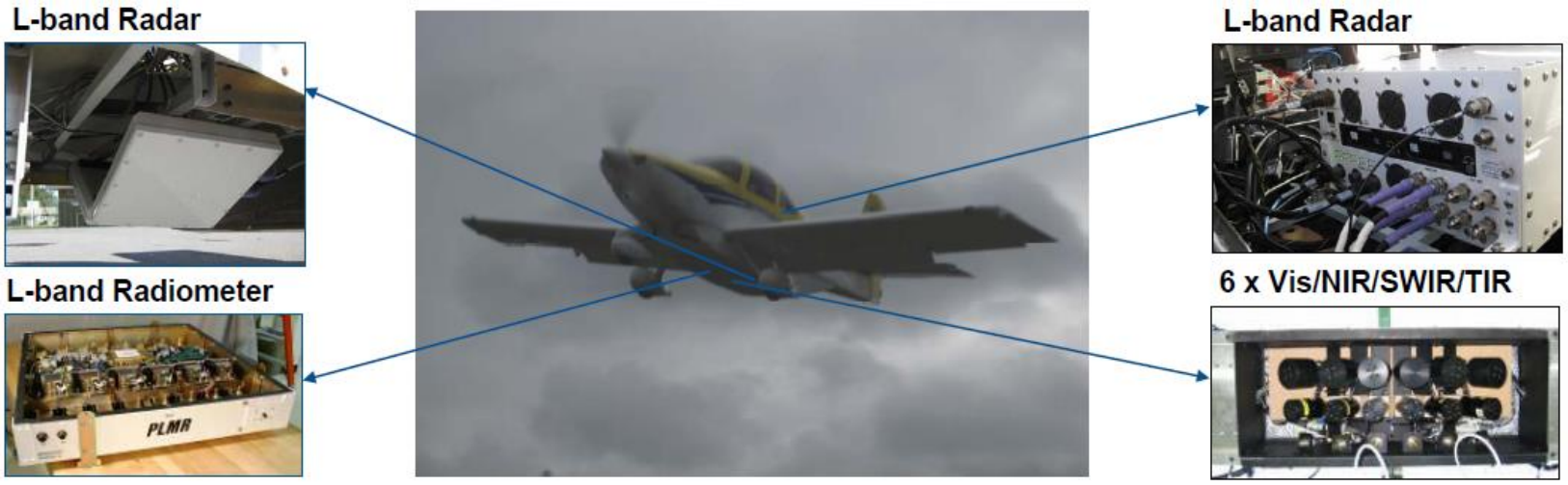
SMAPEx-4 study area and schedule



Red=lost data Blue=gained data
Green=regional sampling route

UTC date	Flight	Ground	SMAP
05-02	Flight 1	Intensive	A + P
05-03	Flight 2	Intensive	A + P
05-04		Regional	
05-05	Flight 3	Intensive	A + P
05-06		Regional	
05-07		Regional	
05-08			A + P
05-09			
05-10	Flight 4	Intensive	A + P
05-11	Flight 5 (AQ)	Intensive	A + P
05-12		Regional	
05-13	Flight 6	Intensive	A + P
05-14		Regional	
05-15		Regional	
05-16			A + P
05-17			
05-18	Flight 7	Intensive	A + P
05-19	Flight 8	Intensive	A + P
05-20		Regional	
05-21	Flight 9	Intensive	A + P

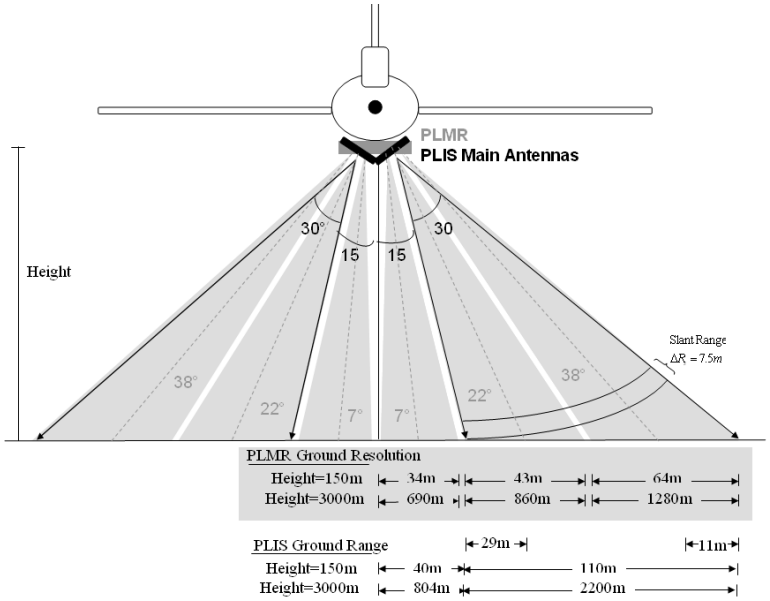
Airborne sampling

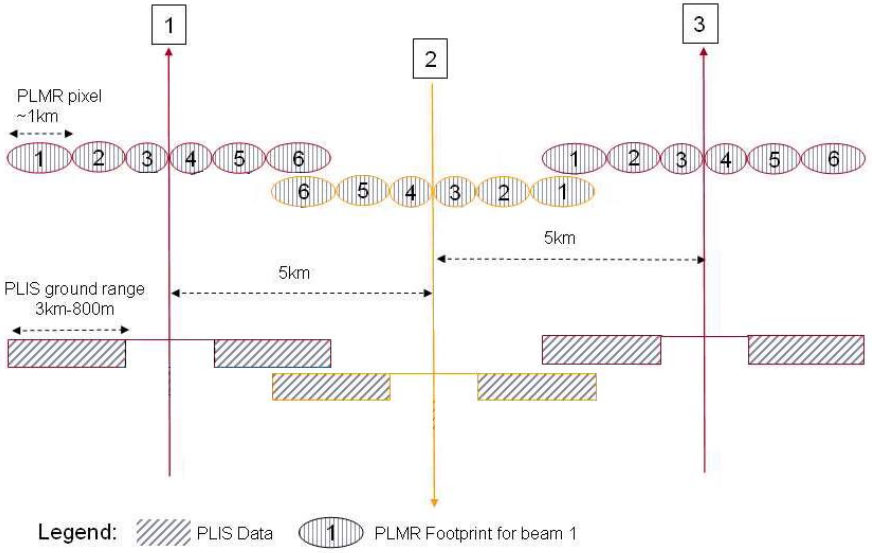


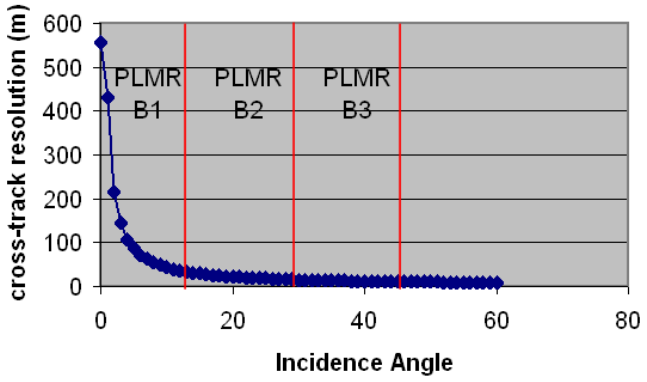
PLMR:
Polarimetric L-band Multibeam Radiometer
Frequency/bandwidth: 1.413GHz/24MHz
Polarisations: V and H
Resolution: ~1km at 10,000ft flying height,
Incidence angles: ±7º, ±21.5º, ±38.5º across track
Antenna type: 8x8 patch array

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

Airborne sampling stragety







- **Altitude:**

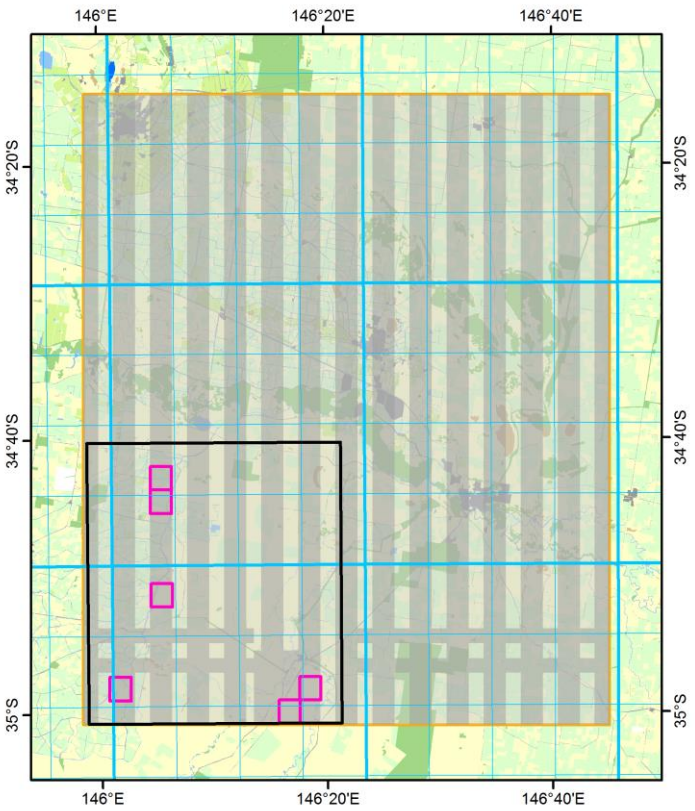
  10,000ft (AGL)

- **Ground resolution:**

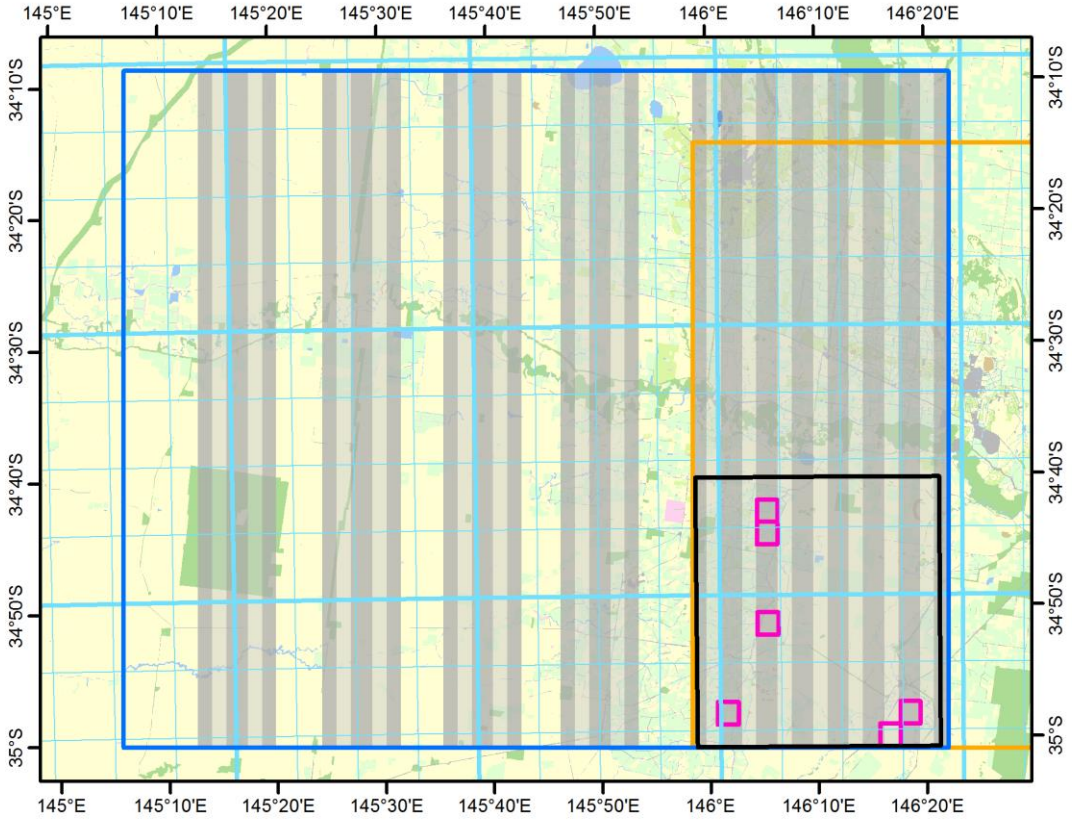
  1km (PLMR)

  10m (PLIS)

Airborne sampling coverage



~7hr
100% PLMR coverage
61% PLIS coverage

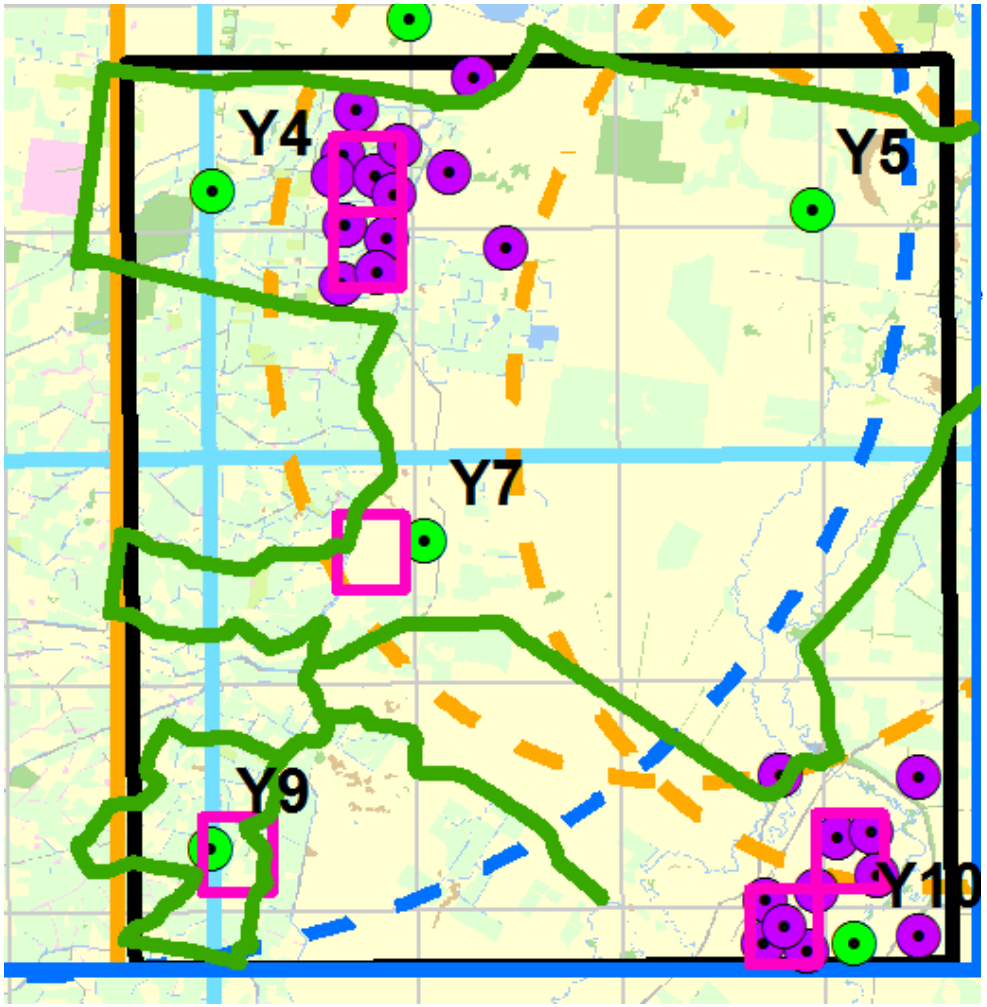


~7.5hr
72% PLMR coverage
47% PLIS coverage

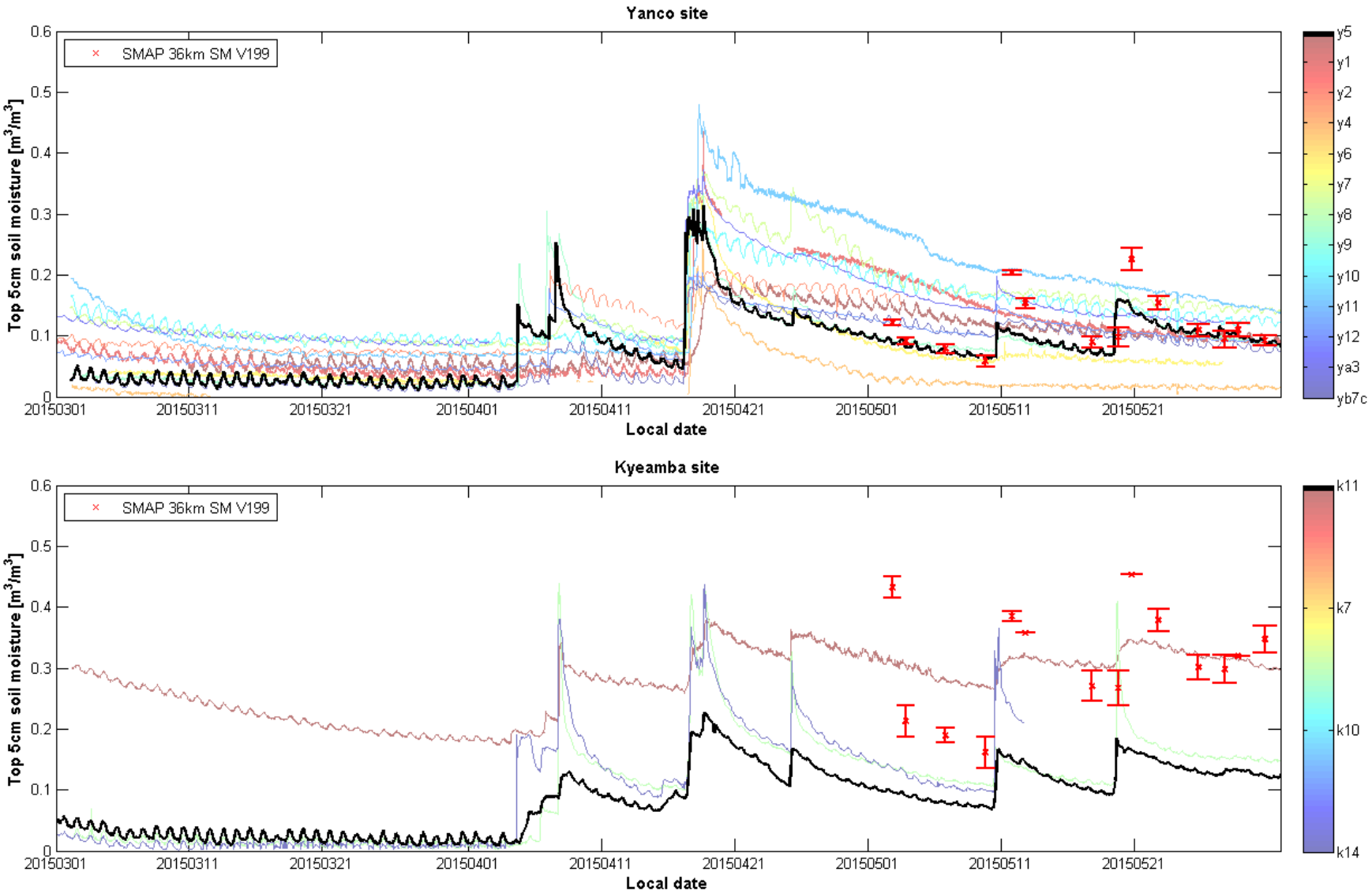
PLIS coverage
PLMR coverage

Ground sampling

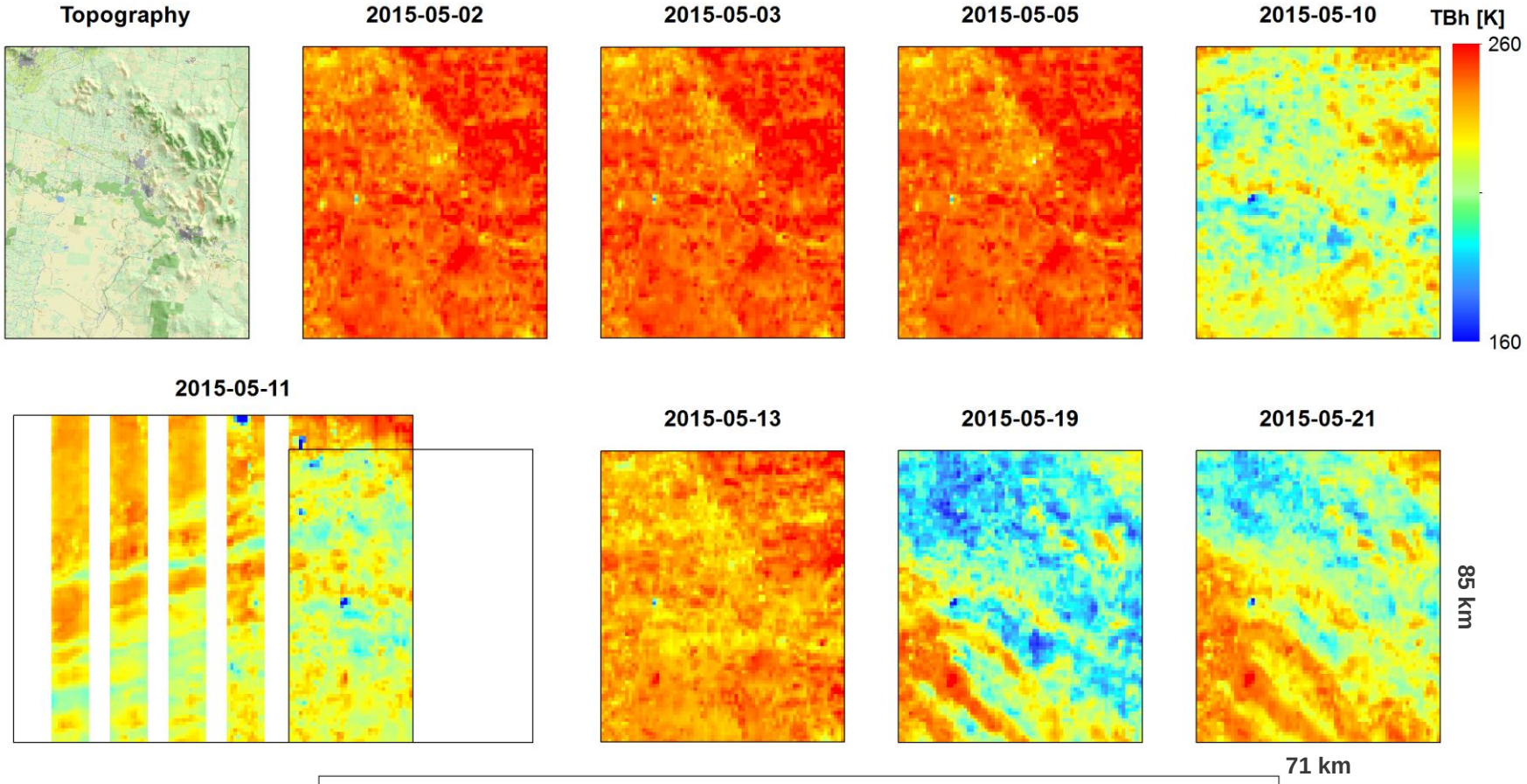
- **Ground validation data**
  - Continuous soil moisture at 29 sites
  - Continuous TIR/soil temperature, soil moisture, leaf wetness at six temporary sites
  - Six 3km x 3km focus areas
    - Soil moisture @ 250m spacing
    - Regional soil moisture sampling
    - Vegetation biomass, water content, LAI, reflectance @ 5 sites per dominant vegetation type
    - Surface roughness @ 3 sites per dominant vegetation type
    - Supplementary data from vehicle-based L-band radiometer, etc.



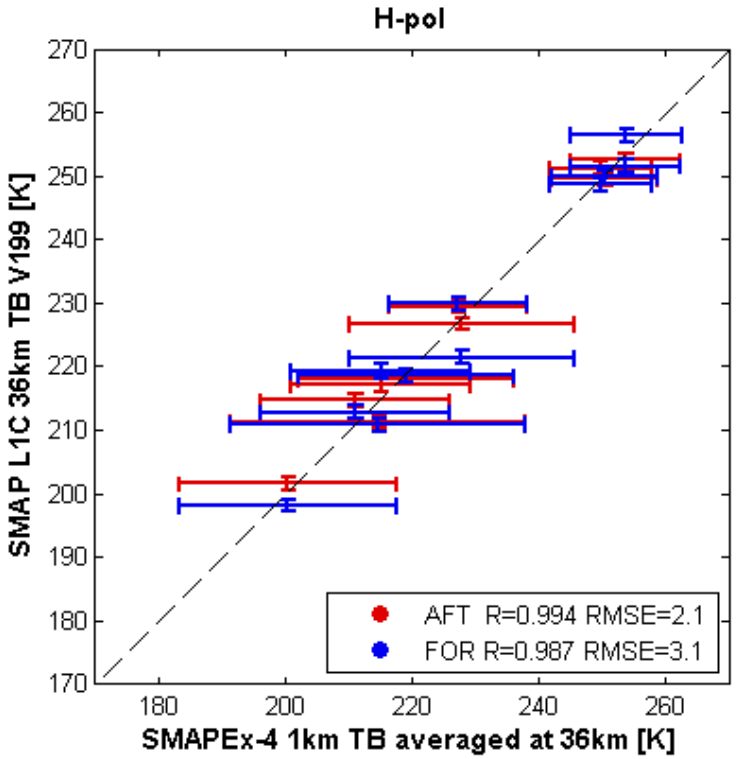
OzNet data

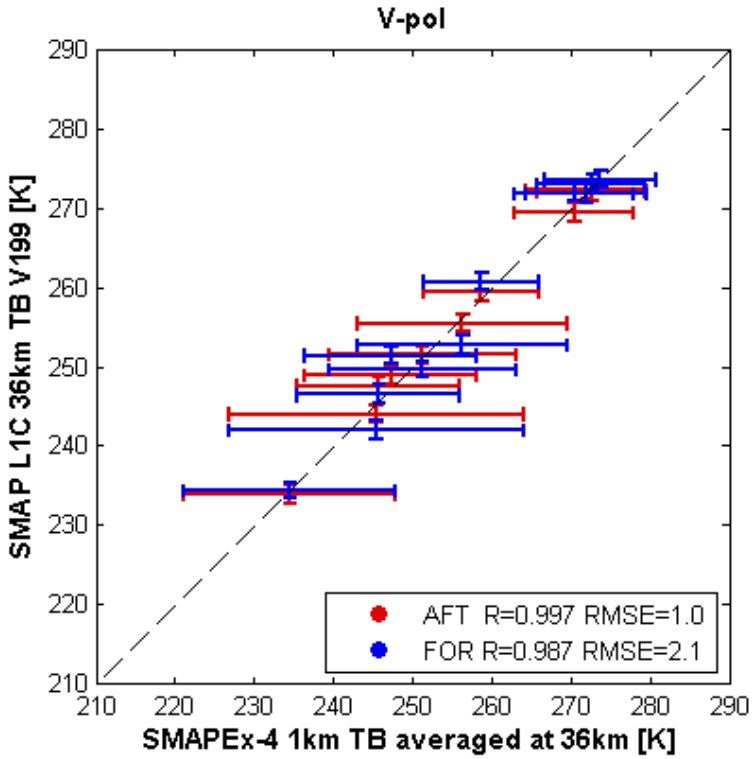

Yanco site
SMAP 36km SM V199
Top 5cm soil moisture [m3/m3]
Local date
0
0.1
0.2
0.3
0.4
0.5
0.6
20150301
20150311
20150321
20150401
20150411
20150421
20150501
20150511
20150521
y5
y1
y2
y4
y6
y7
y8
y9
y10
y11
y12
ya3
yb7c
Kyeamba site
SMAP 36km SM V199
Top 5cm soil moisture [m3/m3]
Local date
k11
k7
k10
k14

SMAPEx-4 1km TB



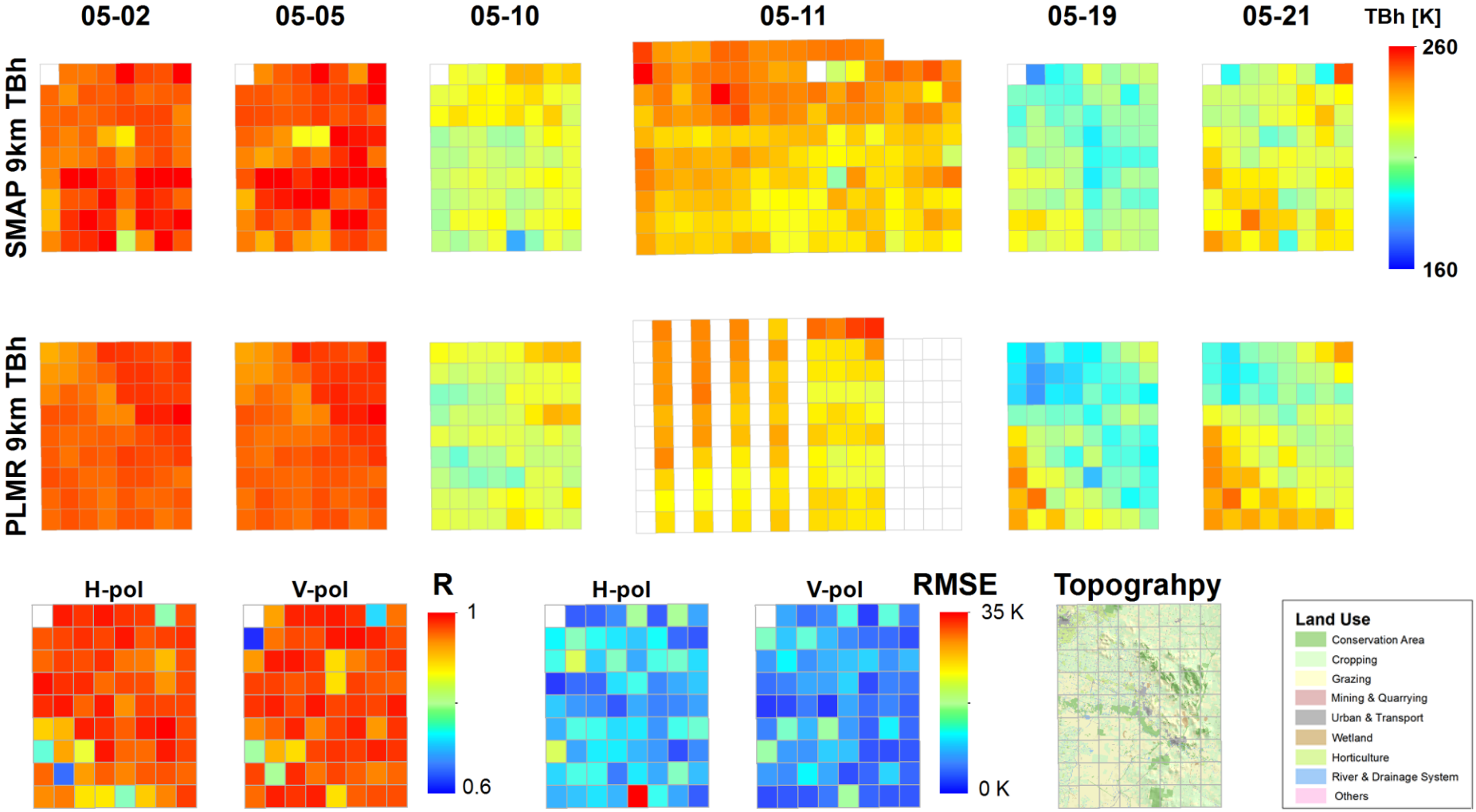
SMAP TB vs SMAPEx-4 TB @ 36km



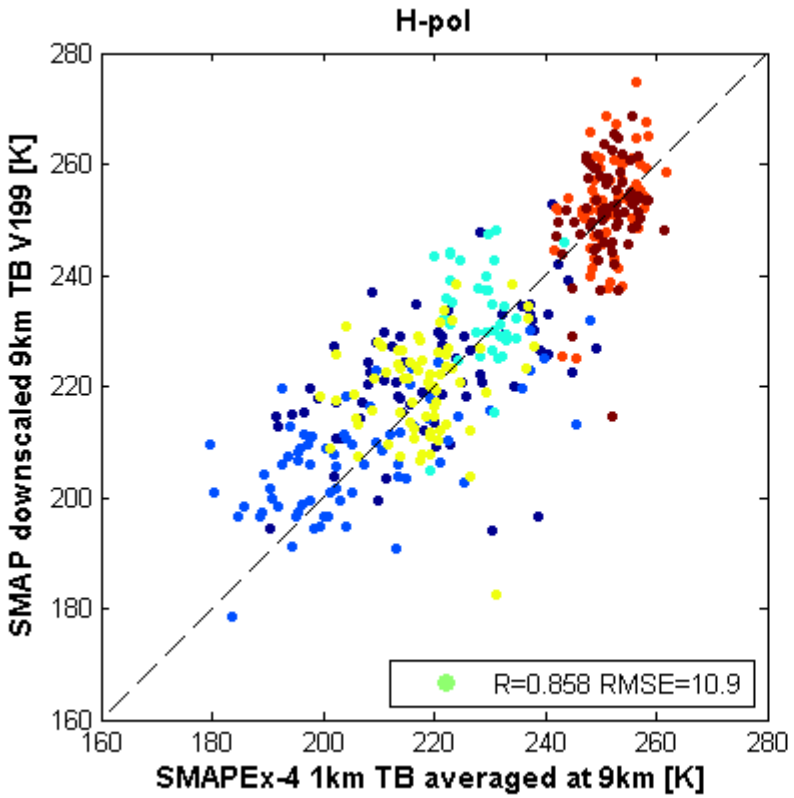


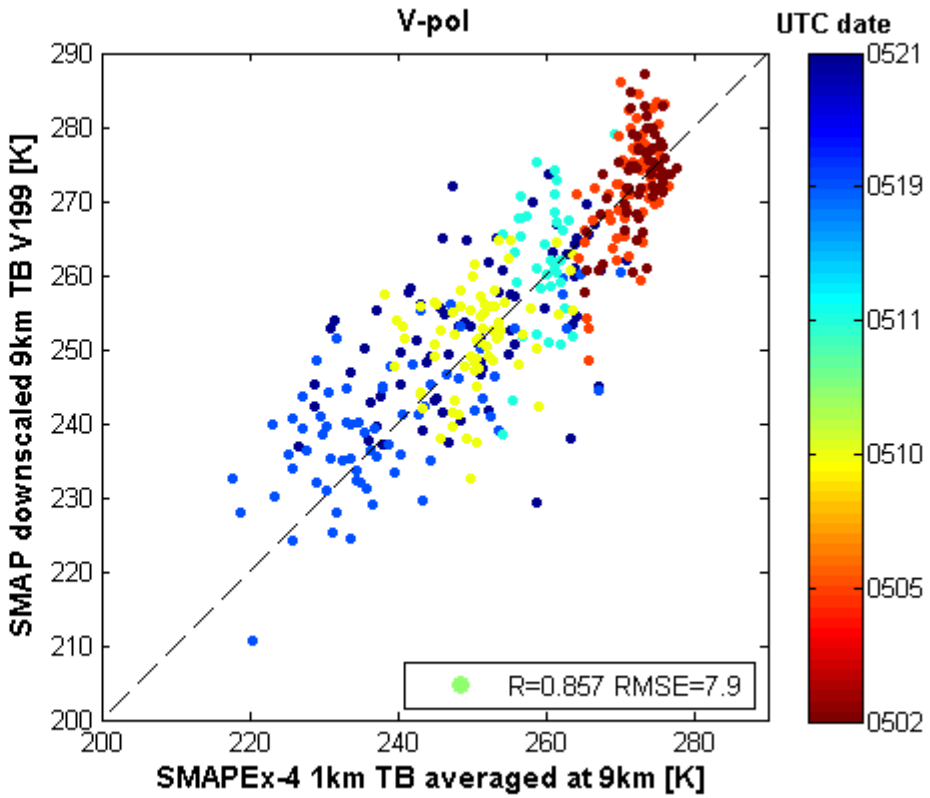
Note: a single linear adjustment was applied in order to remove any offset between SMAP and PLMR

SMAPEx-4 and SMAP 9km TB

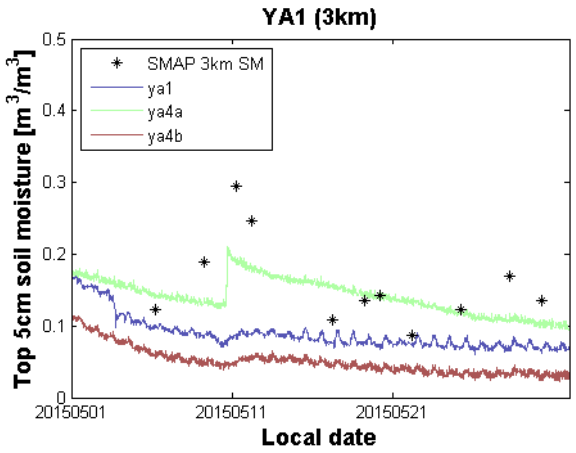


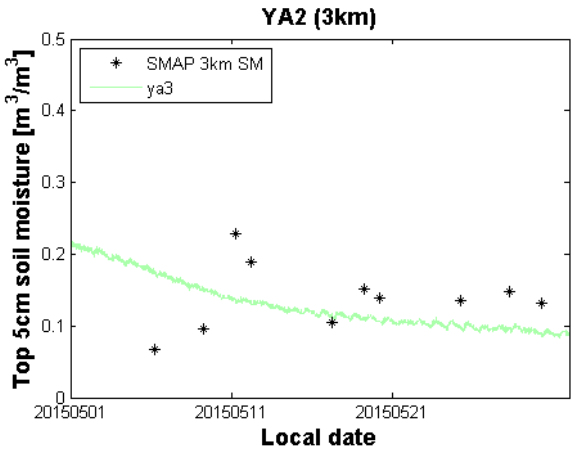
SMAP TB vs SMAPEx-4 TB @ 9km

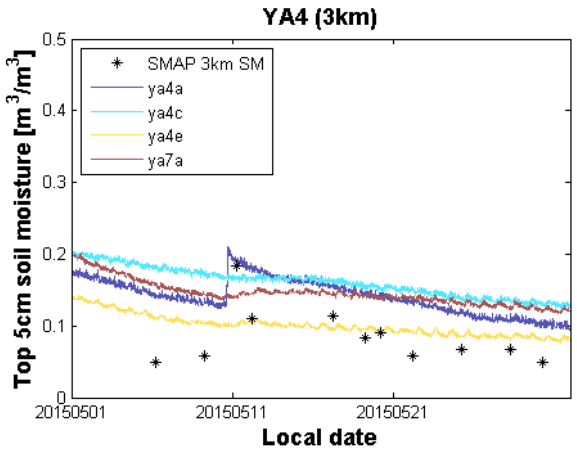


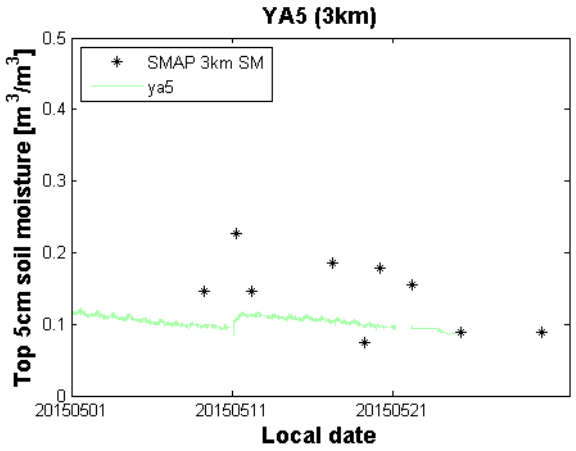


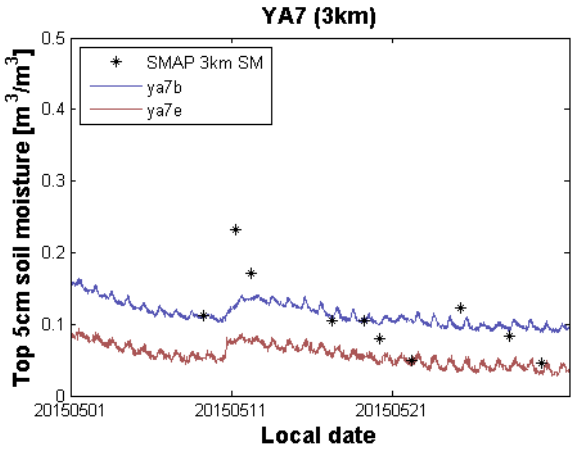
SMAP SM vs Station SM @ 3km (Crop)

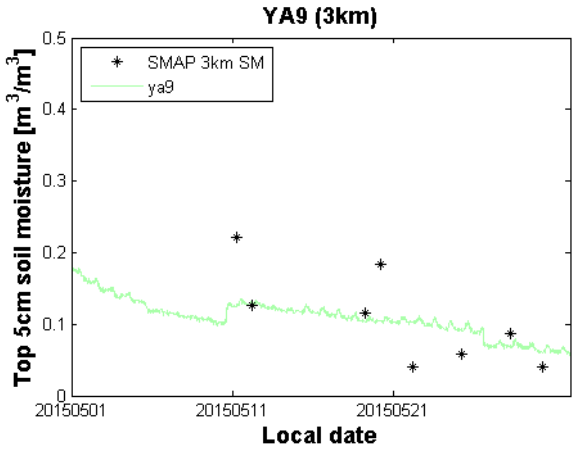




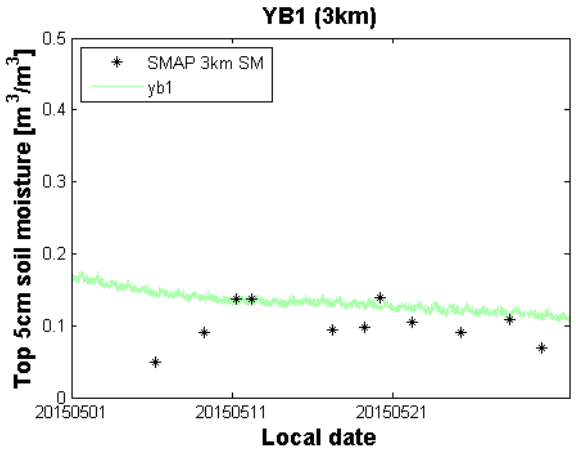


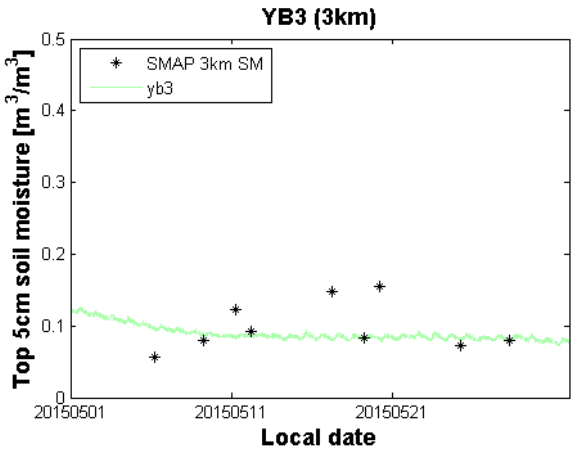


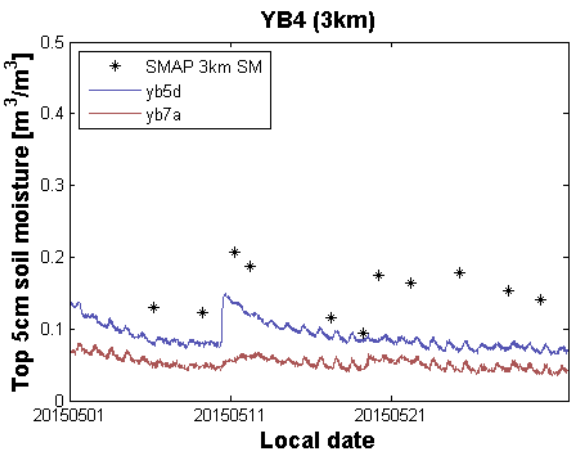


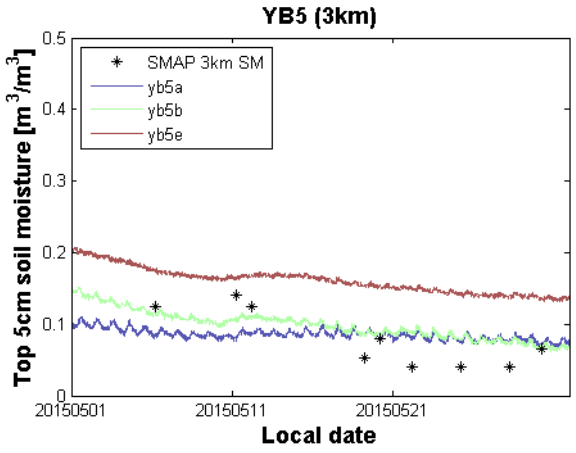


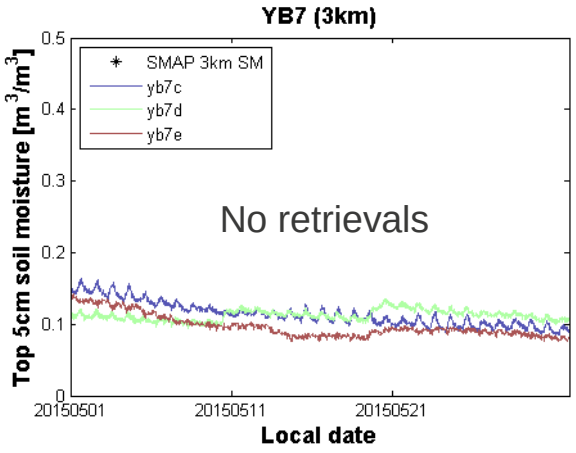
SMAP SM vs Station SM @ 3km (Grass)

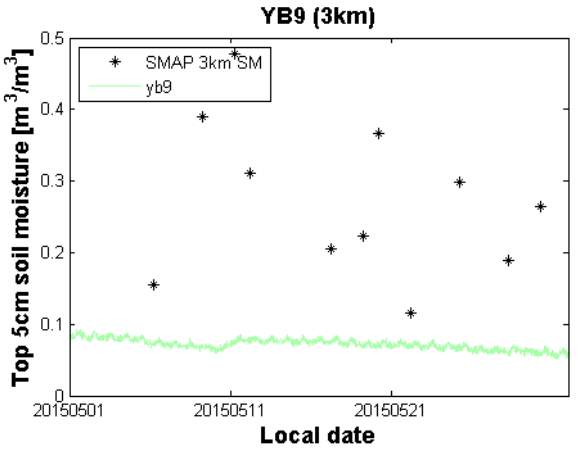




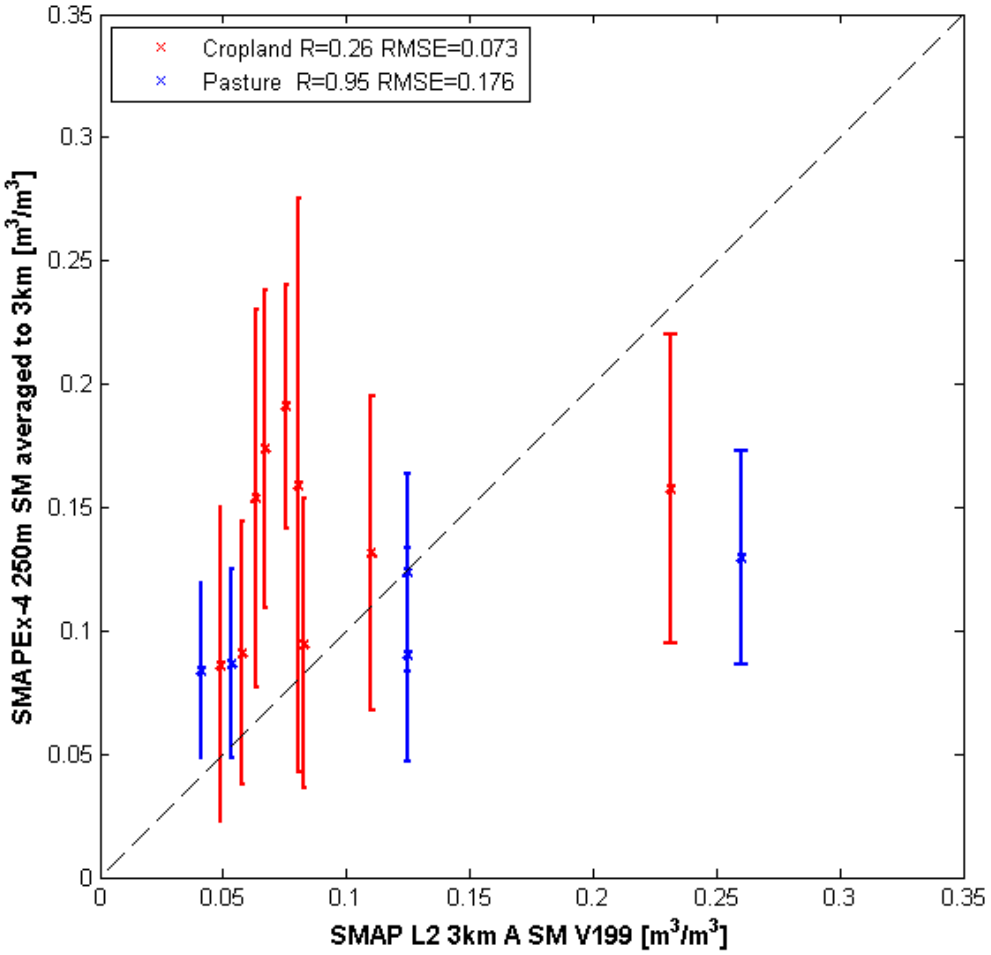








SMAP SM vs SMAPEx-4 SM @3km



Conclusion

- Results are still preliminary, but:
  - SMAP 36km passive SM has a good temporal agreement with the most representative station at Yanco; the agreement at Kyeamba is not so good;
  - A similar spatial pattern was captured by SMAP 9km downscaled TB and SMAPEx-4 TB averaged at 9km, but the RMSE is ~8-10K;
  - SMAP 3km active SM has higher correlation over pasture than cropland

- SMAPEx-5 is scheduled for 6-28 September 2015

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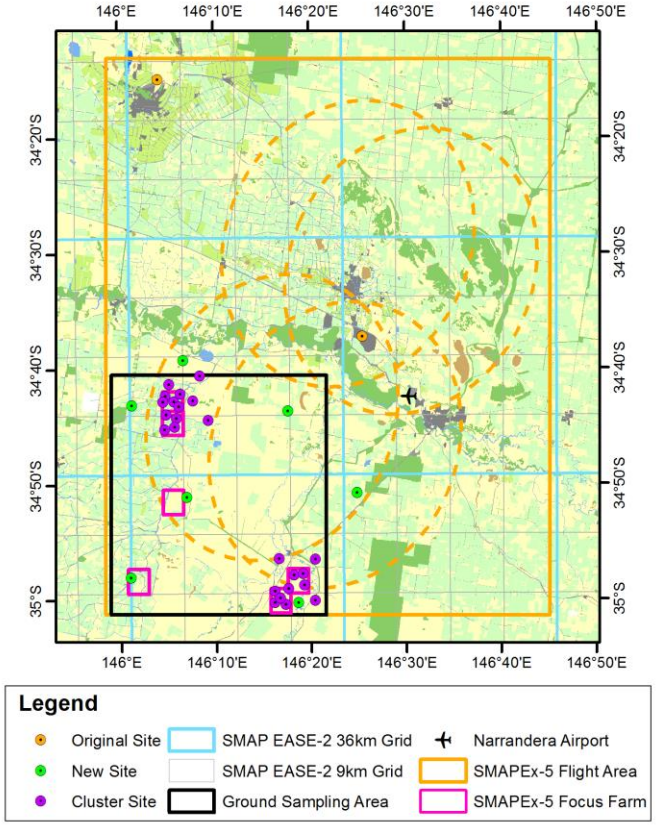
SMAPEx-5 plan



Local Date	Day	SMAP	SMOS	PALSAR -2	Sentinel -1A	RadarSat -2	Landsat -7	Landsat -8	Sentinel -2A	Flight
6/09	Sun	●					●		●	
7/09	Mon		○	○						
8/09	Tues	●								GNSS-R
9/09	Wed	●	●						○	Flight 1
10/09	Thurs				○	●				
11/09	Fri	●	○	●		○F				Flight 2
12/09	Sat		●							
13/09	Sun					●	○			
14/09	Mon	●	●			○F		●		Flight 3
15/09	Tues				●					
16/09	Wed	●							●	
17/09	Thurs	●	●							Flight 4
18/09	Fri									
19/09	Sat	●	●						○	Flight 5
20/09	Sun					●				
21/09	Mon					●N		○		
22/09	Tues	●	●		○		●			Flight 6
23/09	Wed									
24/09	Thurs	●	●	○N						Flight 7
25/09	Fri	●	○							
26/09	Sat								●	
27/09	Sun	●	●		●	○F				Flight 8
28/09	Mon									

Flight sampling
Close to swath edge
Travel
Partly cover
Day off
N Night overpass
● Fully cover
F Full polarization