SMAPEX-4 Report and SMAPEX-5 Plan

Jeffrey Walker, Nan Ye, Xiaoling Wu, Christoph Rüdiger, Thomas Jackson, Dara Entekhabi, Richard DeJeu, Olivier Merlin, Edward Kim, Luigi Renzullo
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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

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<th>Looking</th>
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Conservative coverage for SMAP

Option 1
68.2 km

Option 2
68.2 km

77.1 km
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

Land Use

Topography

Legend
- Original Site
- New Site
- Cluster Site
- SMAP EASE-2 3km Grid
- SMAP EASE-2 9km Grid
- SMAP EASE-2 36km Grid
- SMAPEx-3 Study Area
- SMAPEx-4 Study Area
- Conservative Coverage for SMAP

71 km

85 km

DEM [m]
- High: 450
- Low: 90

NSW Land Use Classification
- Conservation Area
- Cropping
- Grazing
- Wetland
- Horticulture
- River & Drainage System
- Mining & Quarrying
- Urban & Transport
- Others
SMAPEx-4 study area and schedule

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

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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: $\pm 7^\circ$, $\pm 21.5^\circ$, $\pm 38.5^\circ$ 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: $15^\circ$ - $45^\circ$ on both sides of aircraft
- Antenna type: 2x2 patch array
Airborne sampling strategy

- **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
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
SMAPEX-4 1km TB

Topography

2015-05-02

2015-05-03

2015-05-05

2015-05-10

TBh [K]

260

160

85 km

71 km

Land Use
- Conservation Area
- Cropping
- Grazing
- Wetland
- Horticulture
- River & Drainage System
- Mining & Quarrying
- Urban & Transport
- Others

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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

05-02  05-05  05-10  05-11  05-19  05-21  TBh [K]

SMAP 9km TBh

PLMR 9km TBh

H-pol  V-pol  R  H-pol  V-pol  RMSE  Topography

Land Use:
- Conservation Area
- Cropping
- Grazing
- Mining & Quarrying
- Urban & Transport
- Wetland
- Horticulture
- River & Drainage System
- Others

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SMAP TB vs SMAPEX-4 TB @ 9km

**H-pol**

- SMAPEX-4 1km TB averaged at 9km [K]
- SMA downsampled 9km TB V199 [K]
- R=0.858 RMSE=10.9

**V-pol**

- SMAPEX-4 1km TB averaged at 9km [K]
- SMA downsampled 9km TB V199 [K]
- R=0.857 RMSE=7.9

UTC date

- 0521
- 0519
- 0511
- 0510
- 0505
- 0502
SMAP SM vs Station SM @ 3km (Crop)
SMAP SM vs Station SM @ 3km (Grass)

SMAP SM vs Station SM @ 3km (Grass)

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SMAP SM vs Station SM @ 3km (Grass)
SMAP SM vs SMAPEX-4 SM @3km

**Graph:**
- **Legend:**
  - Cropland: R=0.26, RMSE=0.073
  - Pasture: R=0.95, RMSE=0.176

**Y-axis:** SMAPEx-4 250m SM averaged to 3km [m^3/m^3]

**X-axis:** SMAP L2 3km A SM V199 [m^3/m^3]
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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Follow us at [smapex4.blogspot.com](http://smapex4.blogspot.com) [smapex5.blogspot.com](http://smapex5.blogspot.com)
### SMAPEX-5 plan

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#### Legend
- **Original Site**
- **SMAP EASE-2 36km Grid**
- **SMAP EASE-2 9km Grid**
- **SMAP Ex-5 Flight Area**
- **Ground Sampling Area**
- **SMAPEx-5 Focus Farm**
- **Narrandera Airport**

#### Symbols
- ●: Fully cover
- ○: Partly cover
- N: Night overpass
- F: Full polarization
- ◼: Close to swath edge

#### Maps
- Flight sampling
- Travel
- Day off

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**SMAPEX-4 Report and SMAPEX-5 Plan**

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