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Engineering

An Airborne Simulation of the SMAP Data Stream

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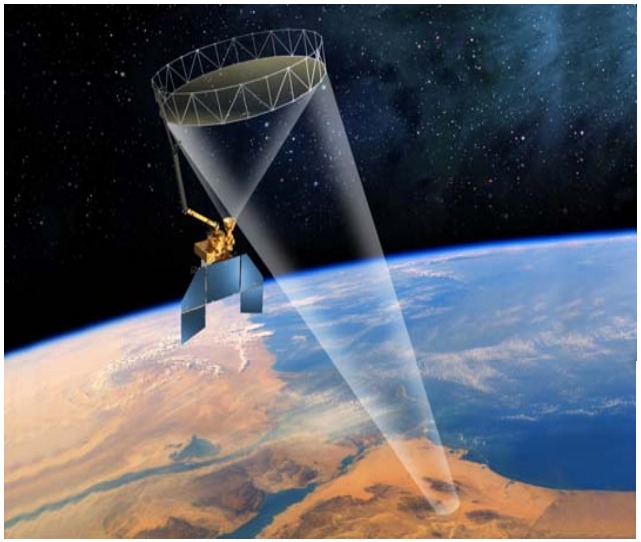
The Soil Moisture Active Passive mission



SMAP Specifications

Launch: NASA, 2014

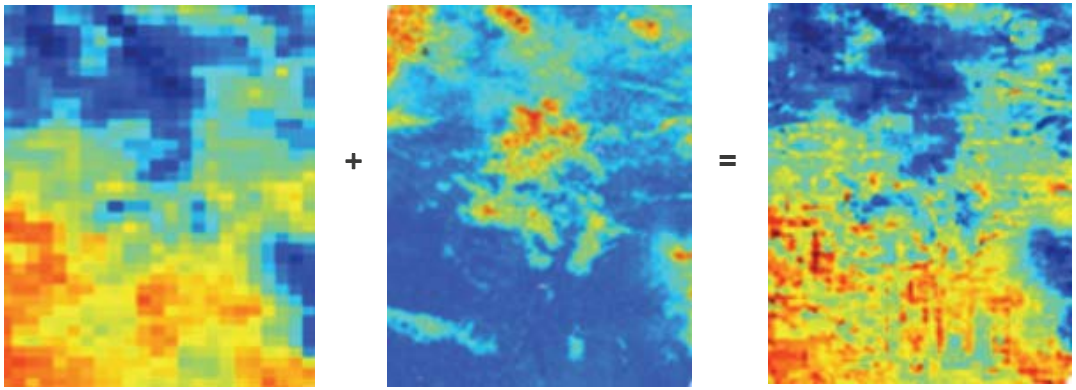
Frequency band: L-band

Incidence angle: 40˚

Azimuth direction: conically-scanning antenna

Resolution: Soil Moisture ~9km -- 36km radiometer + 3km radar

Repeat: 2-3 days



Radiometer observation ~36km + **Radar observation ~3km** = **Downscaled product ~9km**

Algorithms

Active Passive Retrieval and Downscaling

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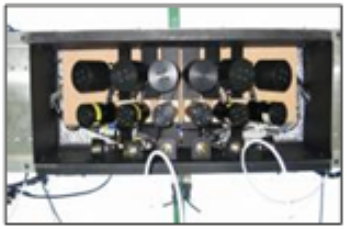
Airborne simulator

L-band radiometer (PLMR)

L-band radar (PLIS)

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: 8 ×8 patch array

PLIS: Polarimetric L-band Imaging SAR

Frequency/bandwidth:1.26GHz/30MHz

Polarisations: VV, VH, HV and HH

Resolution: ~10m

Inc. angles 15º -45º on both sides of aircraft

Antenna type: 2x2 patch array

Motivation

Pre-launch algorithm validation largely based on synthetic studies & few airborne data sets

TEST DATA

Datasets:

T_B at 36km

& σ° at 3km

Downscaled product:

T_B/SM at 9km

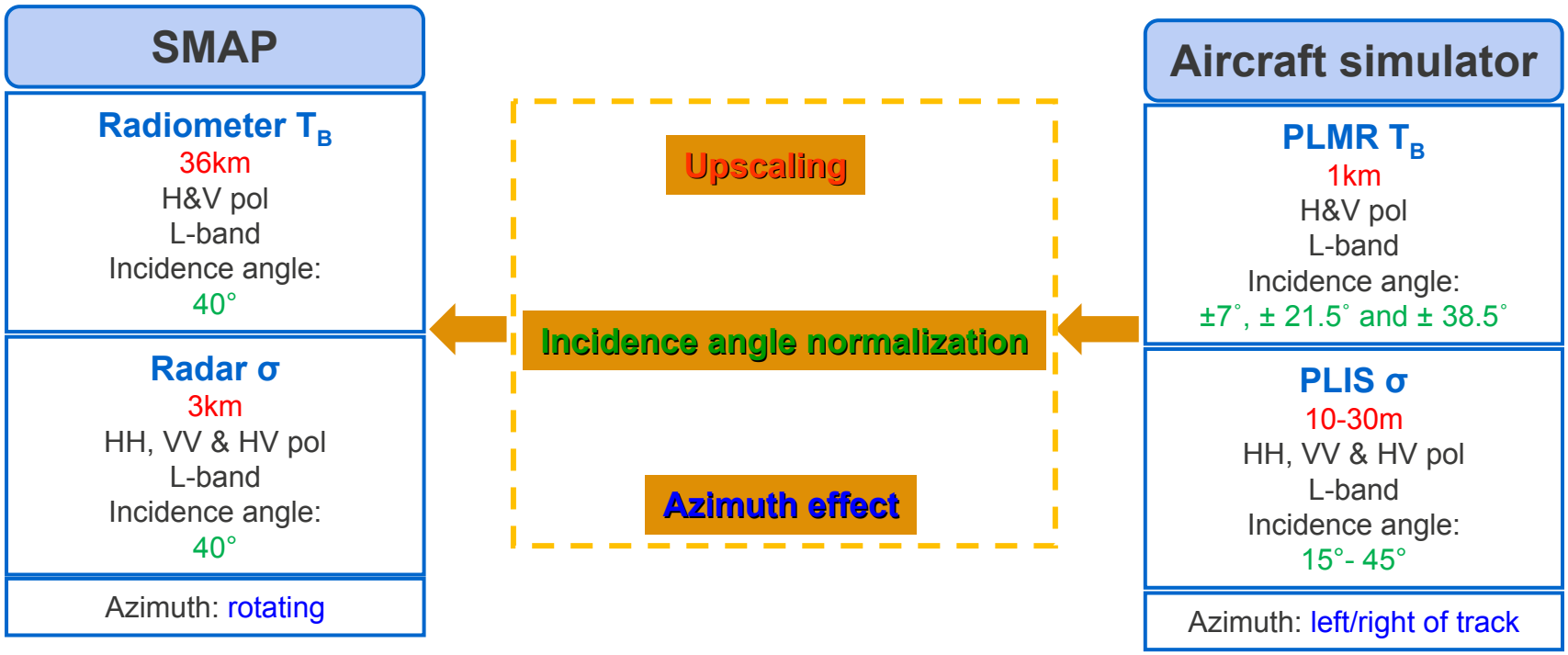
EVALUATION DATA

Reference dataset:

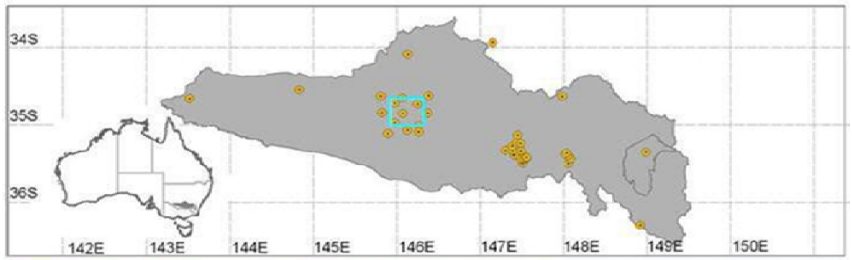
T_B/SM at 1km

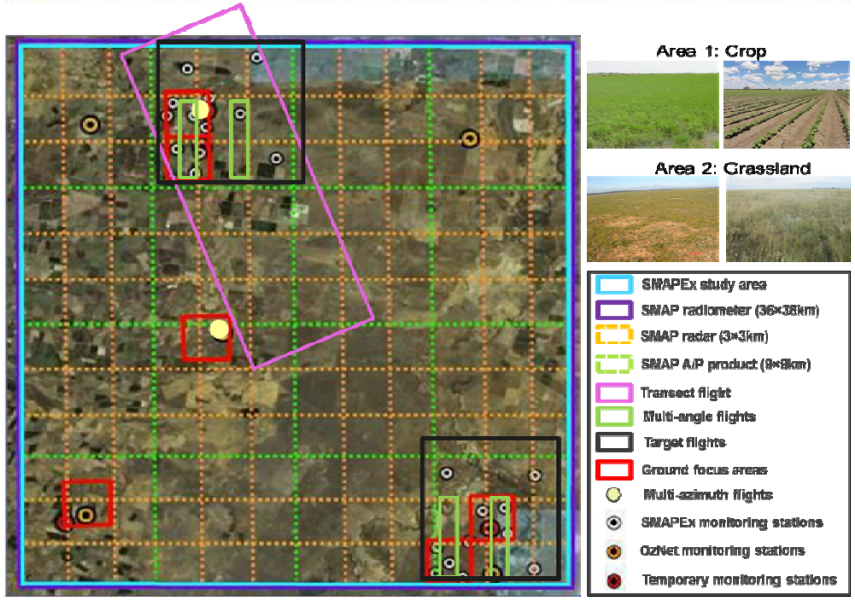
SMAP Data Simulation

Simulation of SMAP data



Study site





Flights

Regional flight, Target flights, Transect flight;

Multi-angle flights and multi-azimuth flights

Soil Moisture Active Passive Experiments (SMAPEx)

Location: Yanco, Murrumbidgee Catchment, NSW;

Field campaigns: SMAPEx-1 (5th-10th July 2010)

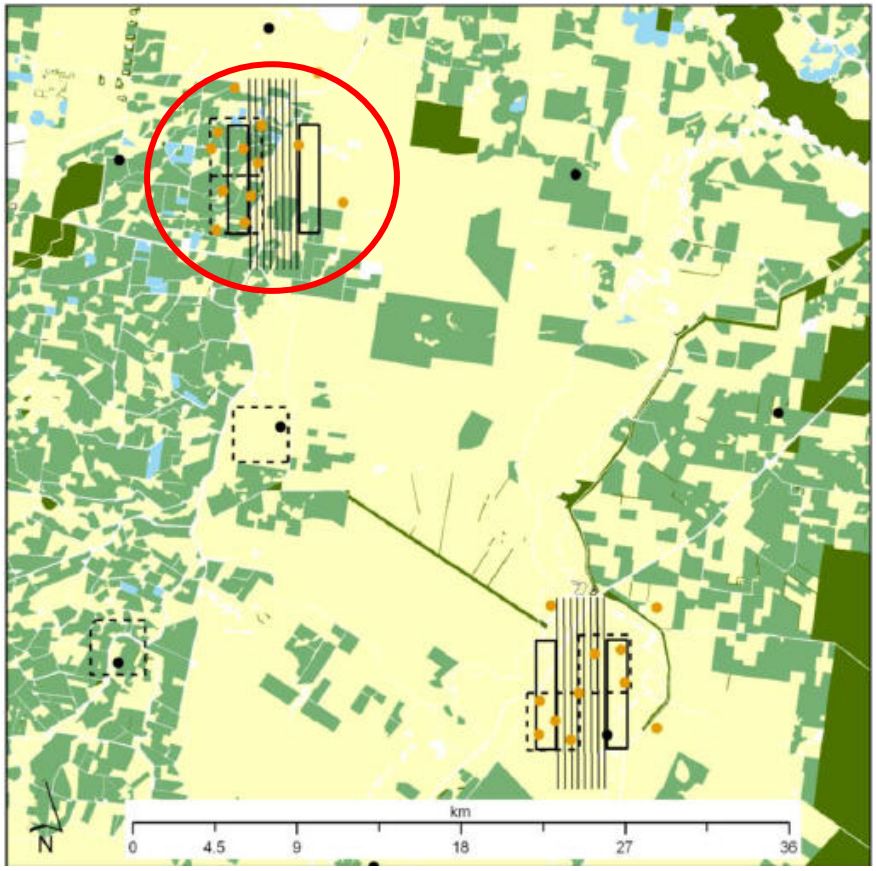
SMAPEx-2 (4th-8th Dec 2010)

SMAPEx-3 (5th-23rd Sept 2011)

Ground sampling

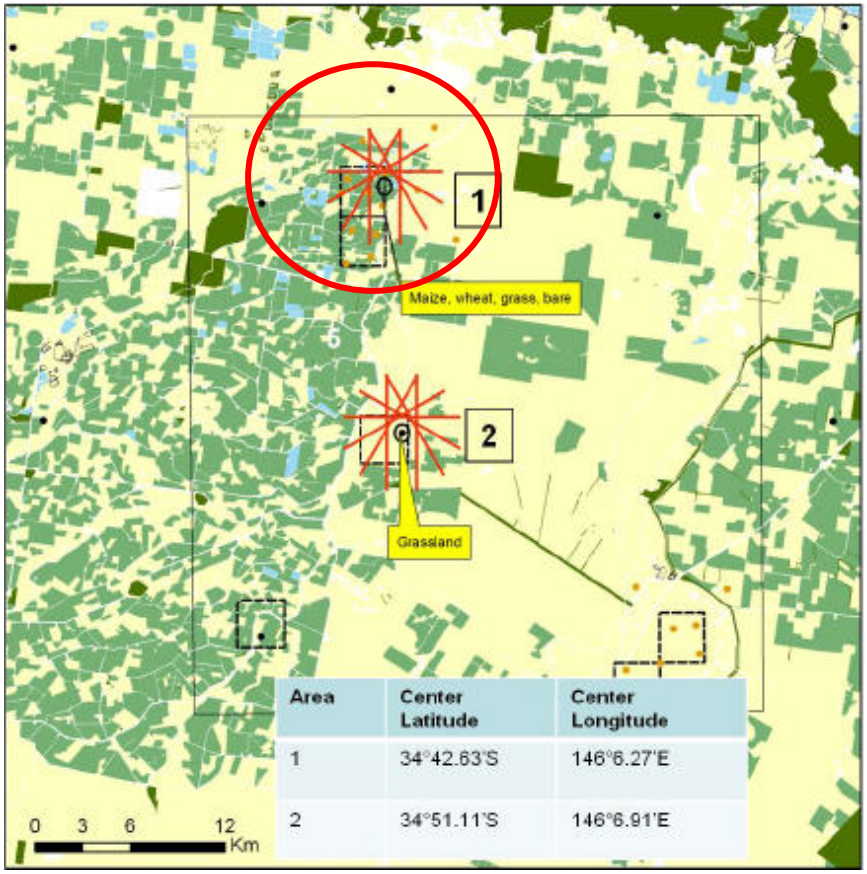
Soil moisture; and vegetation

Target flights



Multi-angle flights

at 3,000m altitude



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

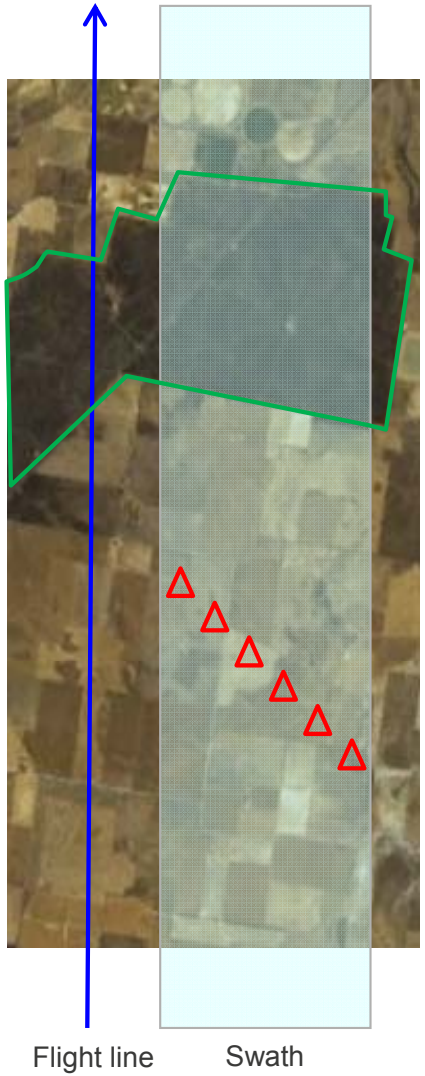
Multi-azimuth and multi-resolution flights

both at 1,500m altitude

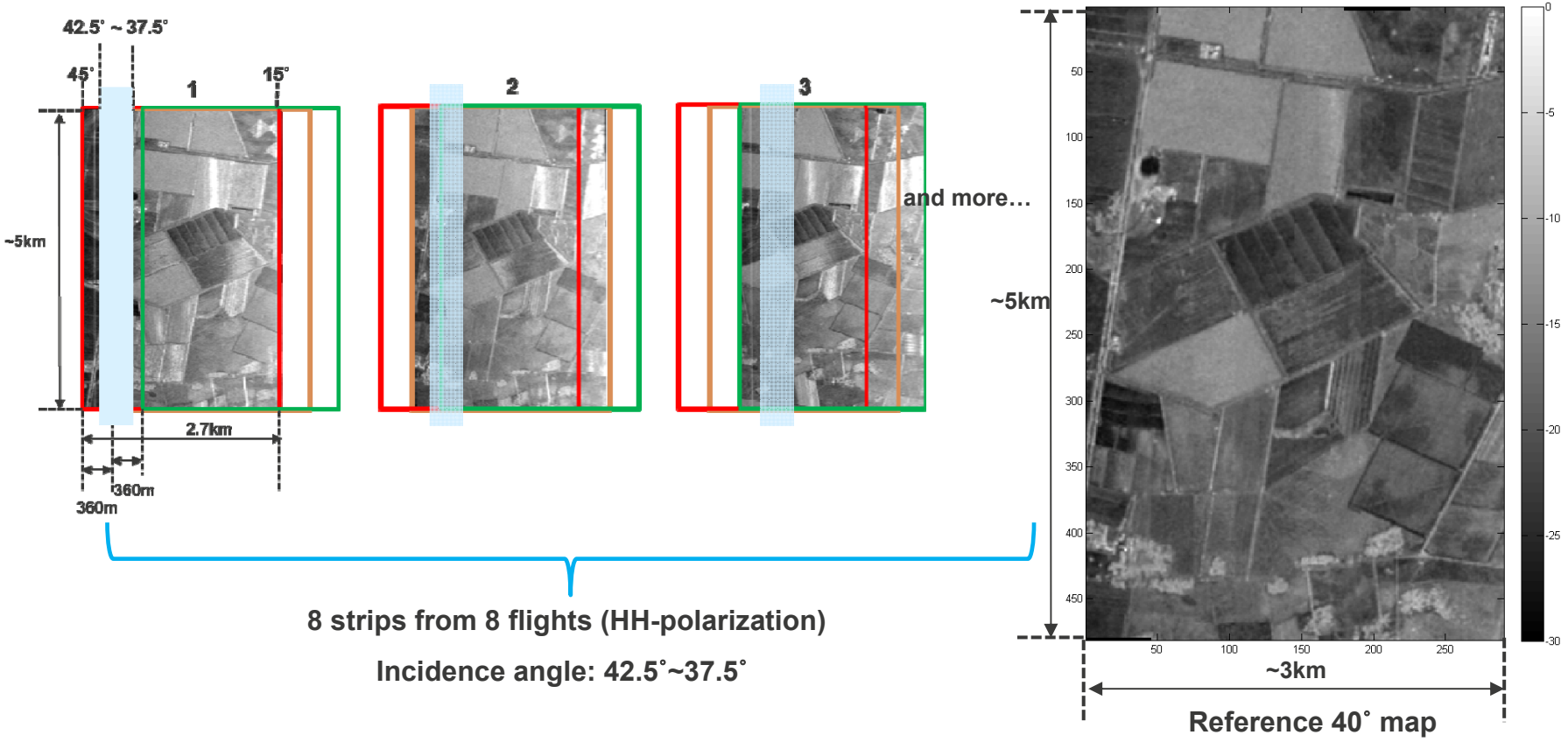
Caveat

- Calibration solutions used here for PLIS are still preliminary
- Absolute calibration accuracy for PLIS based on SMAPEx-3 is ~0.8dB
- Application of a specific SMAPEx-3 calibration to other dates results in ~1.5dB error

- The calibration procedure for PLMR is mature and is accurate to ~2K



Normalization to 40˚ for PLIS

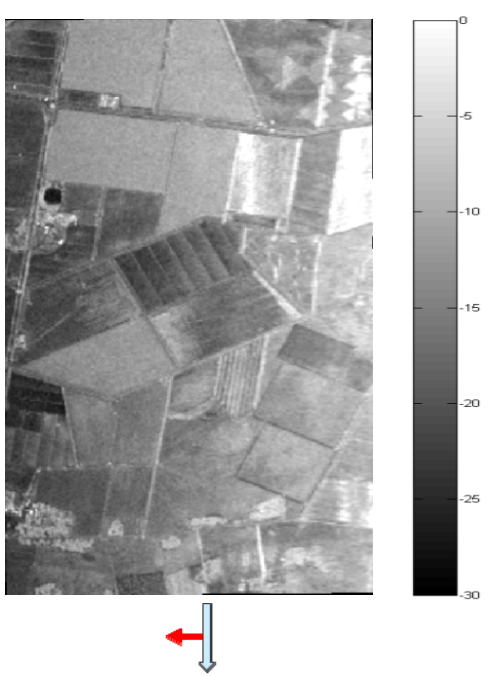


8 strips from 8 flights (HH-polarization)

Incidence angle: 42.5˚~37.5˚

Normalization to 40˚ for PLIS

Original flight (HH-pol)



Normalized flight (HH-pol) CDF method

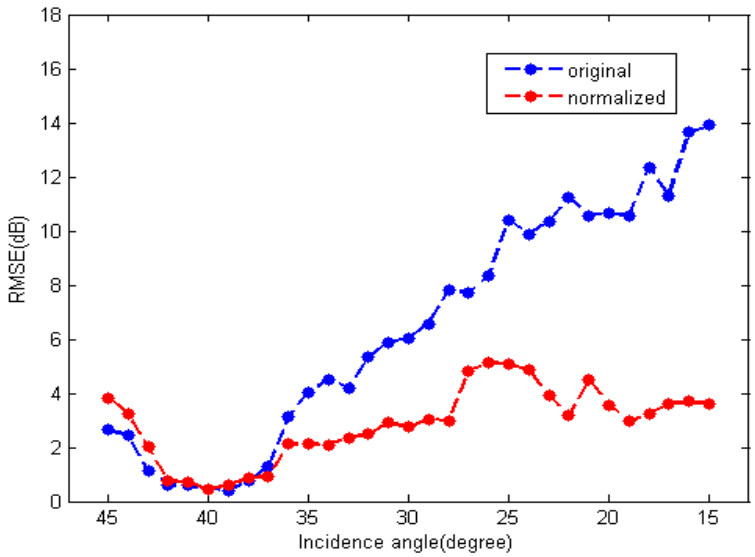
Reference (HH-pol)

See poster: WEP. P. 5, Wednesday 25th July 17:20-19:00

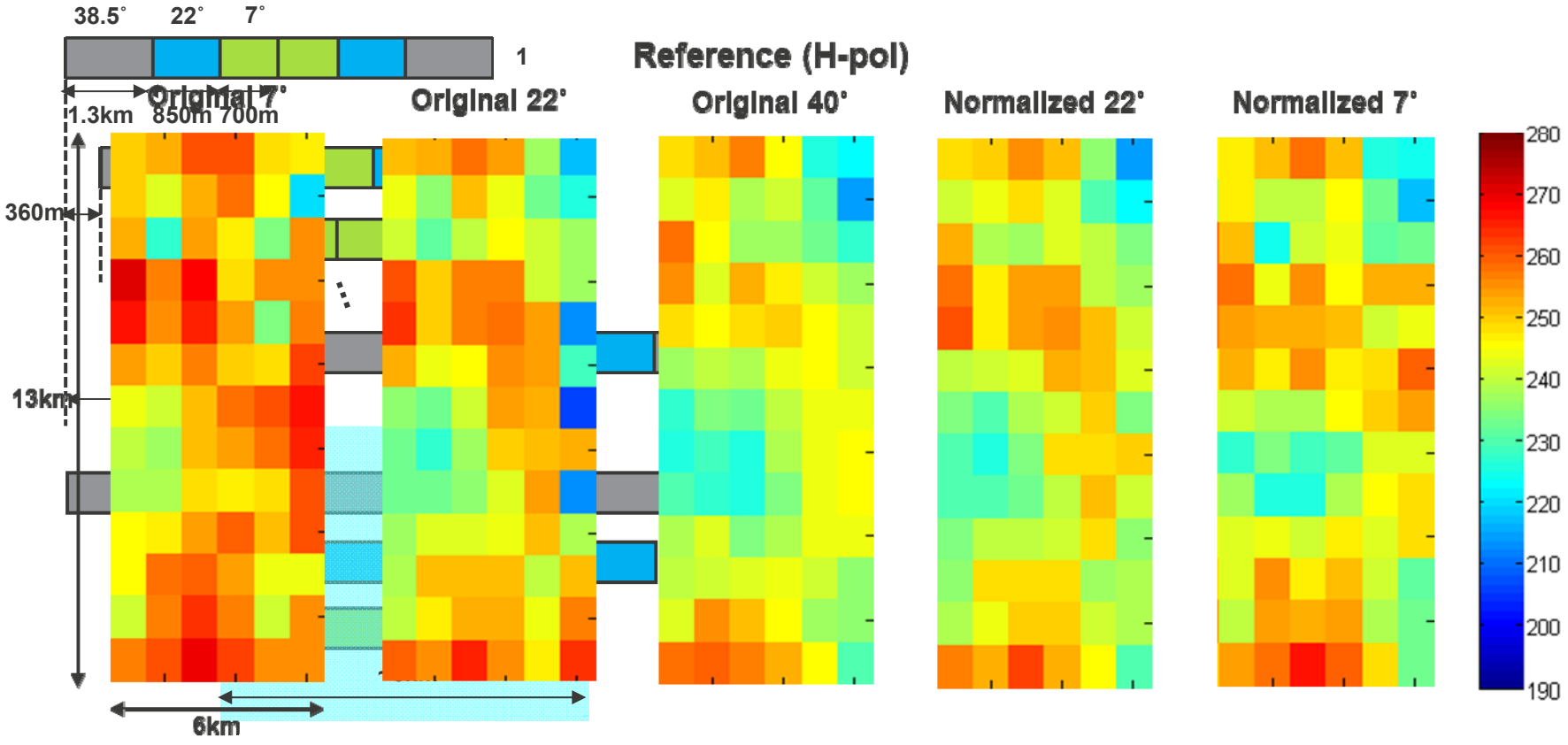
"A cumulative distribution function based method for normalising …"

Normalization to 40˚ for PLIS

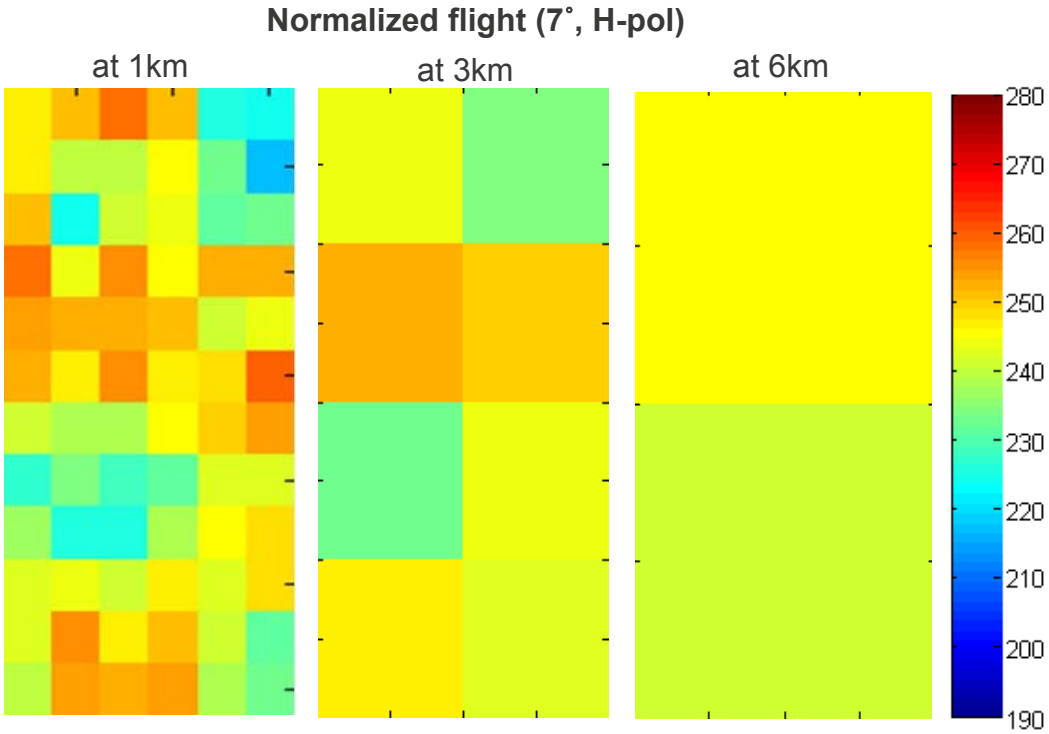
(1˚ / ~90m)



Normalization to 40˚ for PLMR



Normalization to 40˚ for PLMR



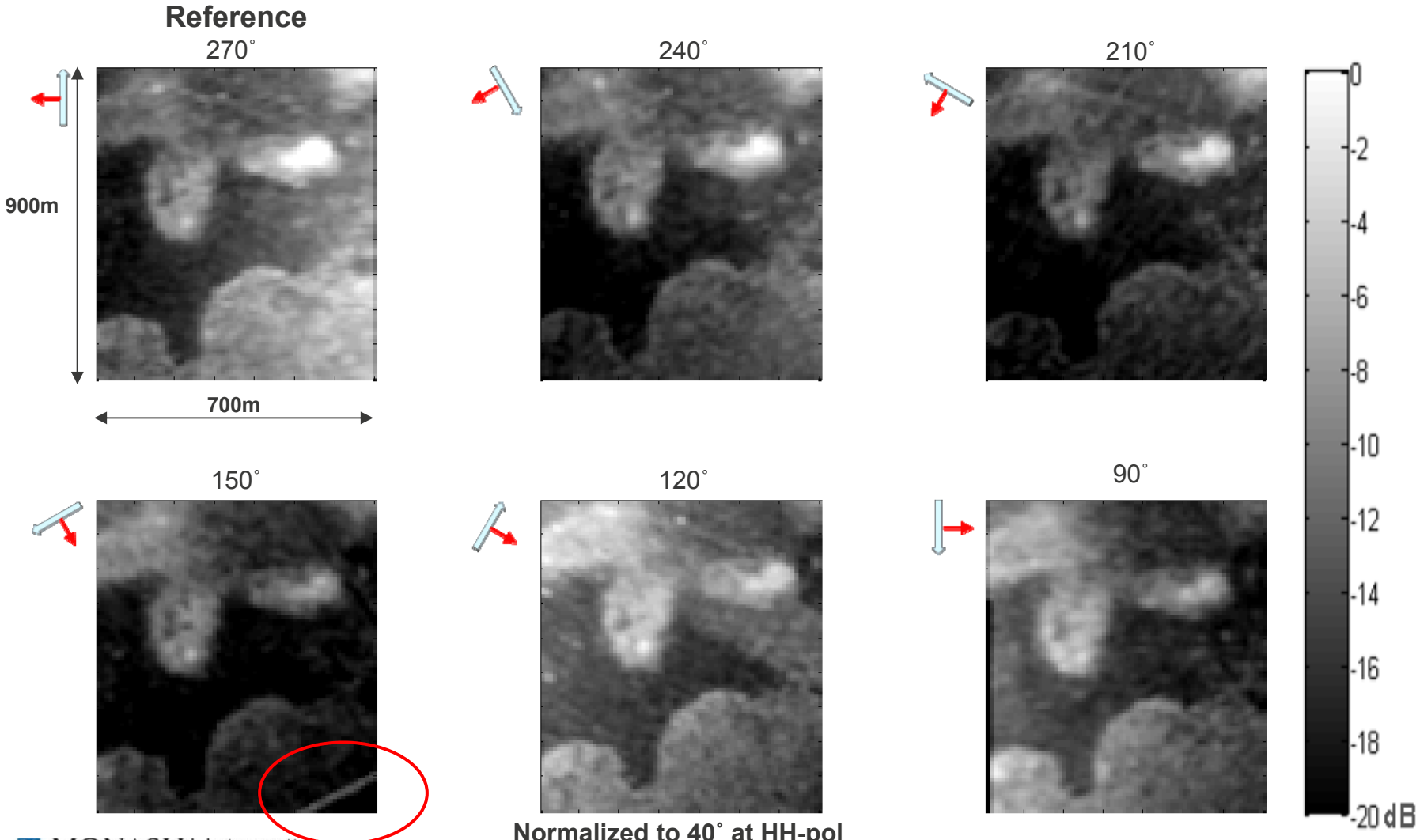
Normalized flight -- 7˚

RMSE(K)	1km	3km	6km
Original	13.7	12.6	11.2
Normalized	7.4	5.7	3.0

Normalized flight -- 22˚

RMSE (K)	1km	3km	6km
Original	11.6	7.2	6.6
Normalized	6.7	4.0	2.9

Azimuth effect for PLIS



Normalized to 40˚ at HH-pol

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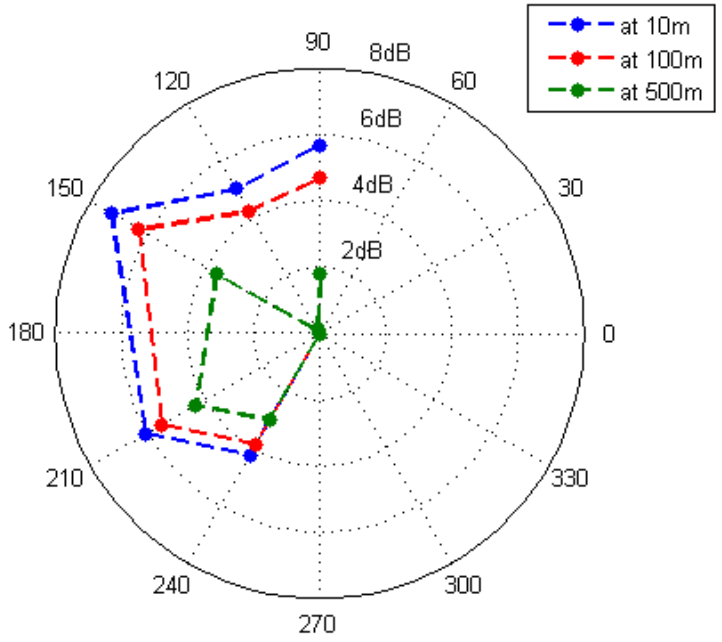
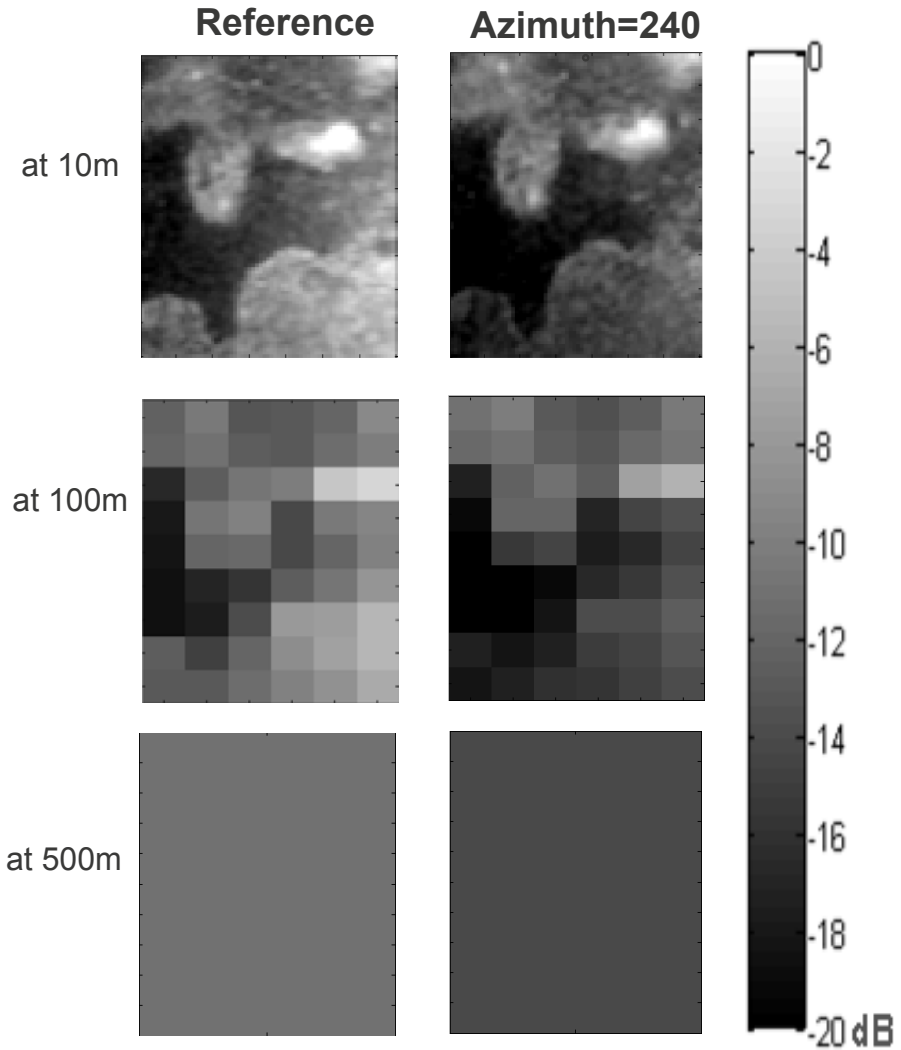
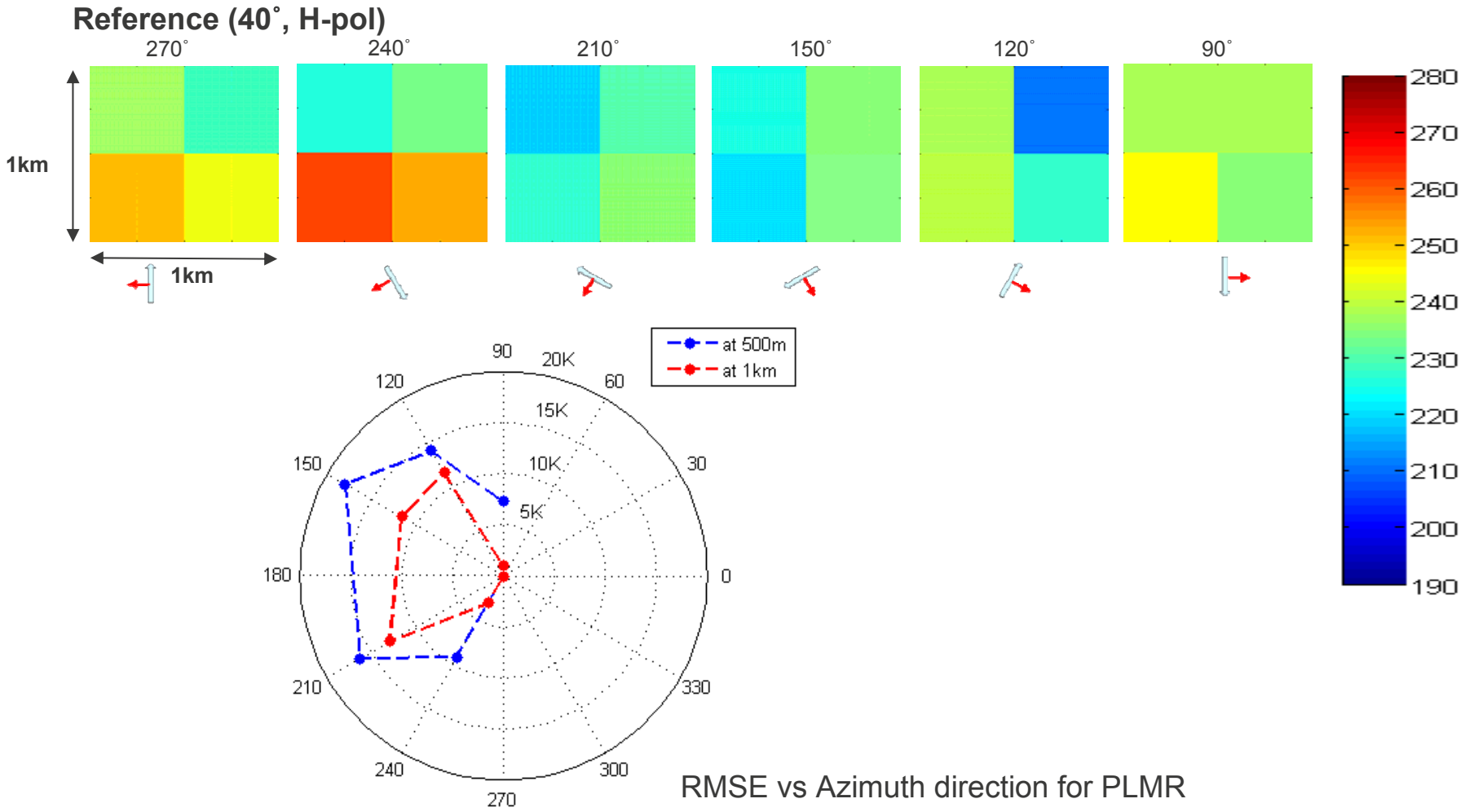
Azimuth effect for PLIS



RMSE vs Azimuth direction for PLIS

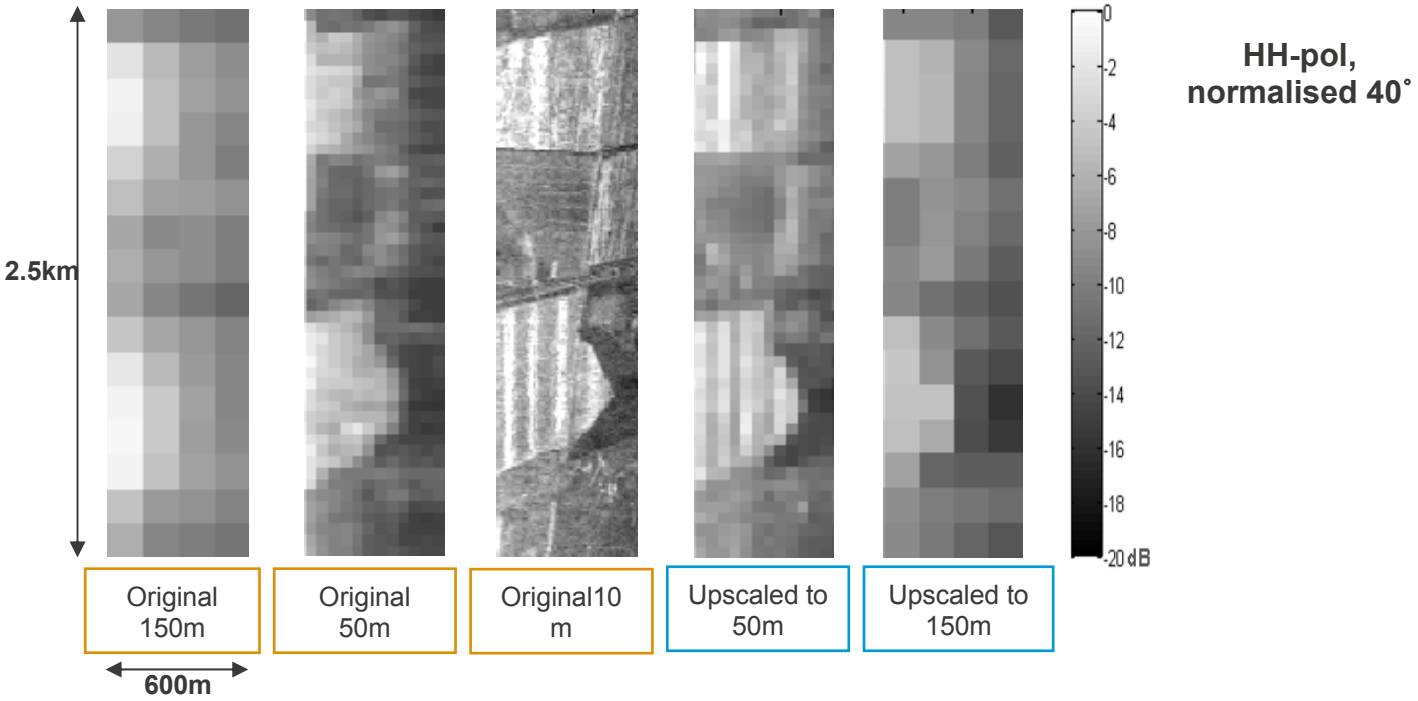


Azimuth effect for PLMR



RMSE vs Azimuth direction for PLMR

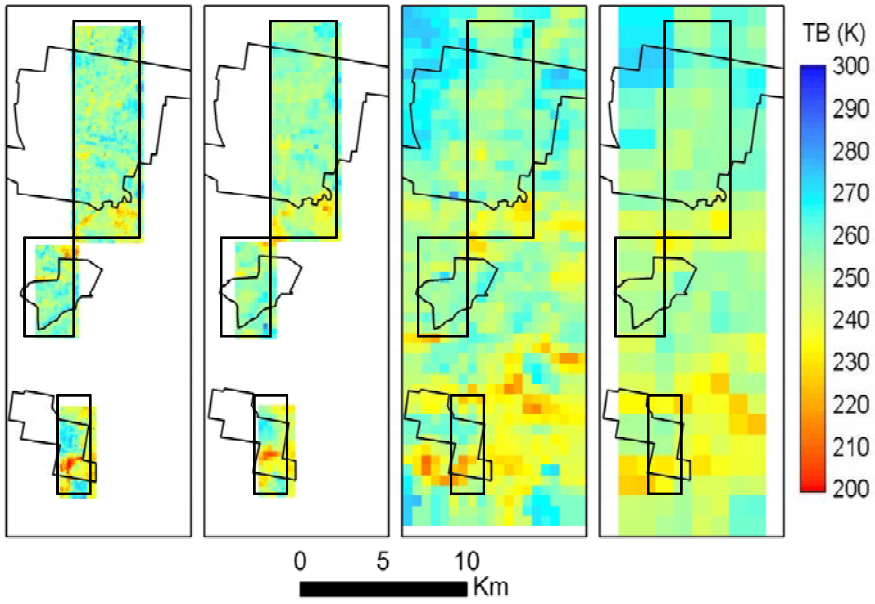
Upscaling for PLIS

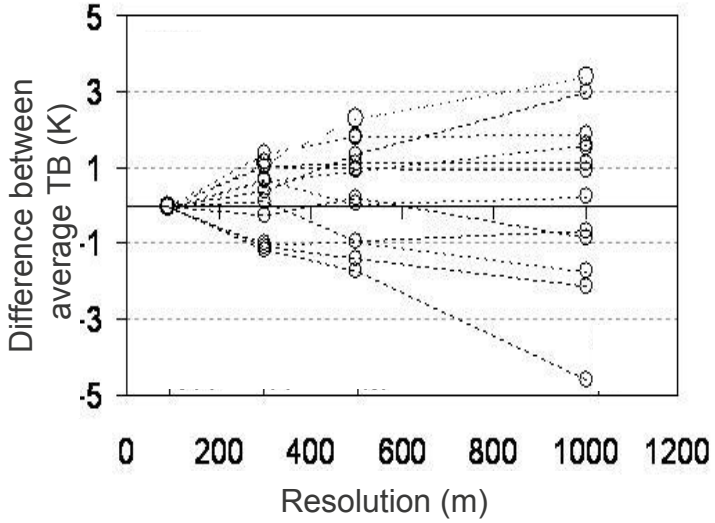


	50m	150m
RMSE (dB) of upscaling	5.1	3.3

	10m	100m	500m
RMSE (dB) of normalisation	4.7	2.3	2.9

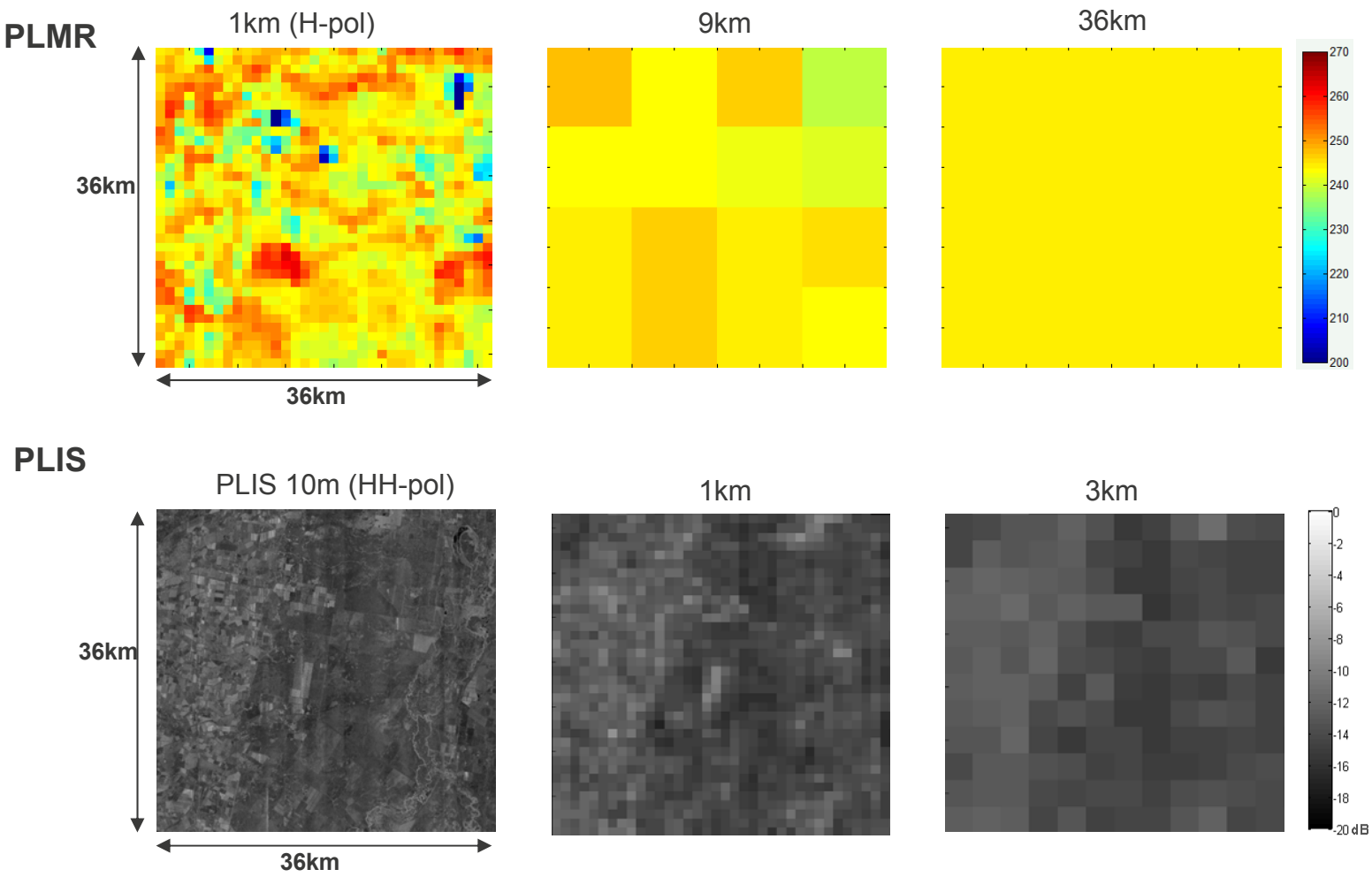
Upscaling for PLMR





Panciera, Walker et al. (2009), RSE

Example of simulated data



(Data collected on 23rd Sept. 2011)

Future work

- Refine the PLIS calibration and repeat the analysis
- Try and eliminate any angle normalisation contributions to the azimuth and scaling results and assess georegistration contributions
- Produce a time sequence of simulated SMAP data
- Undertake soil moisture retrievals from 1km PLMR (passive only), validated with higher resolution PLMR data and ground observations, for:
  - Evaluation of SMAP downscaling algorithms based on simulated SMAP data from airborne simulator, and
  - Evaluation of proposed active-passive retrieval algorithms using 1km and 36km radar/radiometer data

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