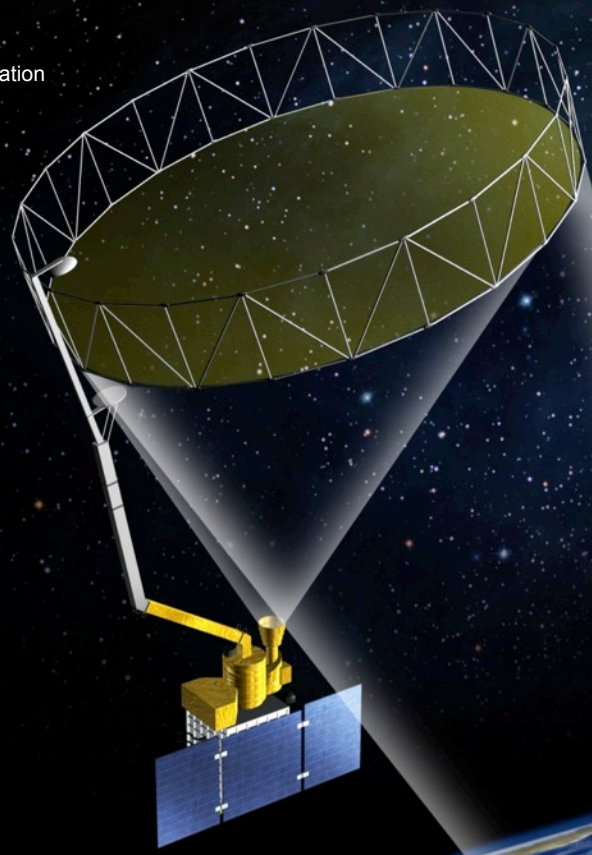
National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology

Soil Moisture
Active Passive
Mission
SMAP



SMAPVEX12: PALS Measurements

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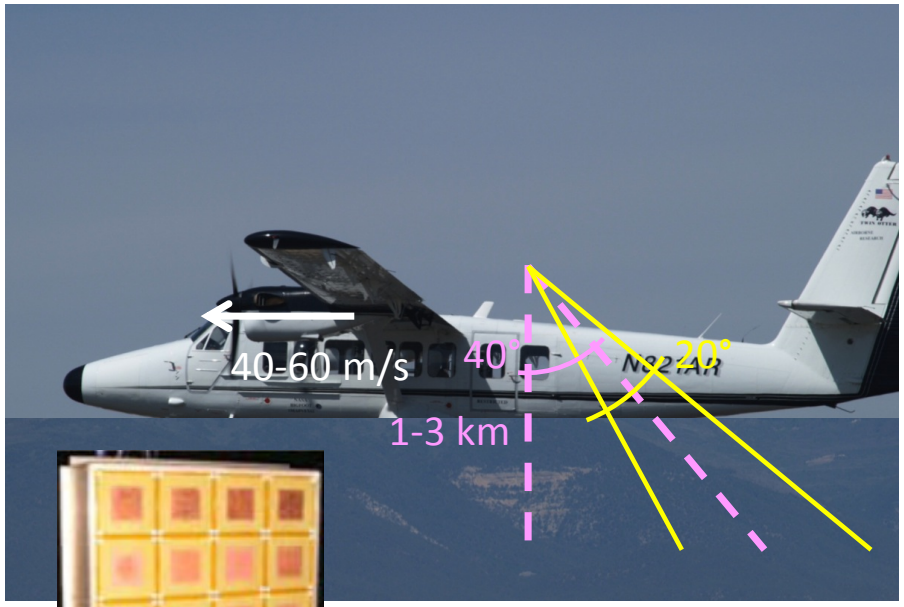
3rd Cal/Val Workshop

Nov. 14-16, 2012

This work was carried out in Jet Propulsion Laboratory, California Institute of Technology under contract with National Aeronautics and Space Administration.

PALS Instrument

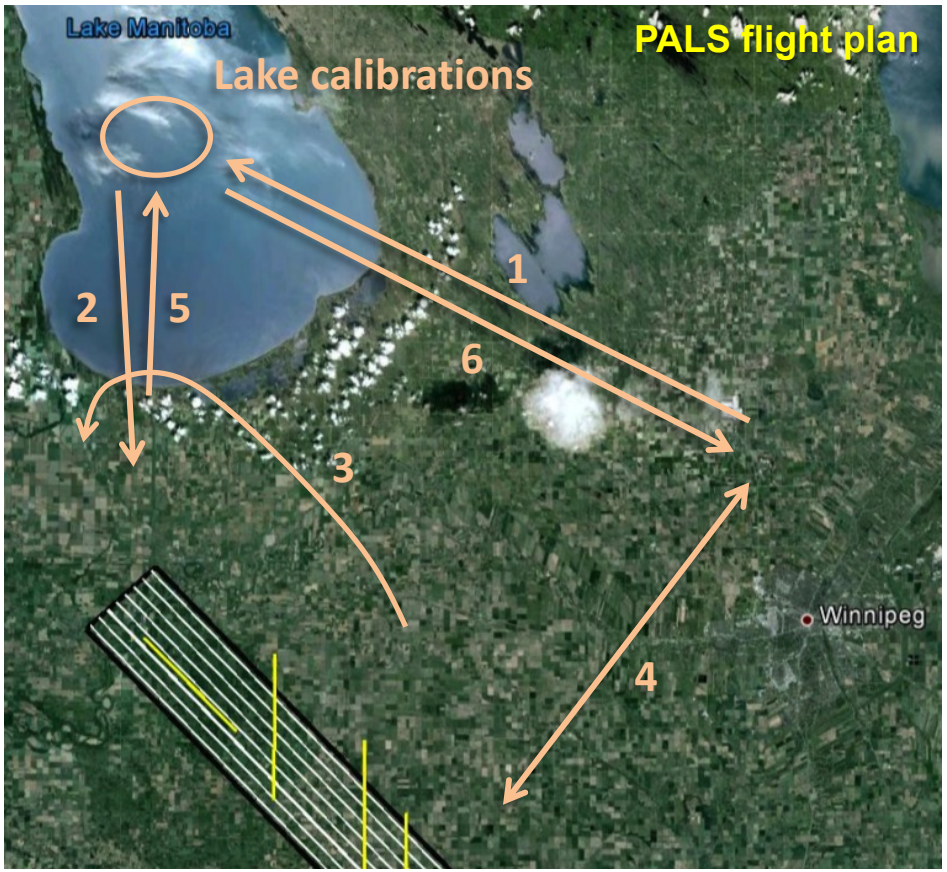
- Passive Active L-band System (PALS) functions as SMAP simulator
- L-band frequency
  - *Radiometer: 1.41 GHz*
  - *Radar: 1.26 GHz*
- View angle: 40°
- Operating altitude: 1-3 km
  - *With 20° beamwidth 600-1500 m footprint*
- Measurement resolution
  - *Radiometer < 0.2 K*
  - *Radar < 0.2 dB*
- Installation included a fast sampling digital backend for RFI studies
- Thermal infrared sensor
  - *Nadir pointing, 2° beamwidth*



PALS antenna

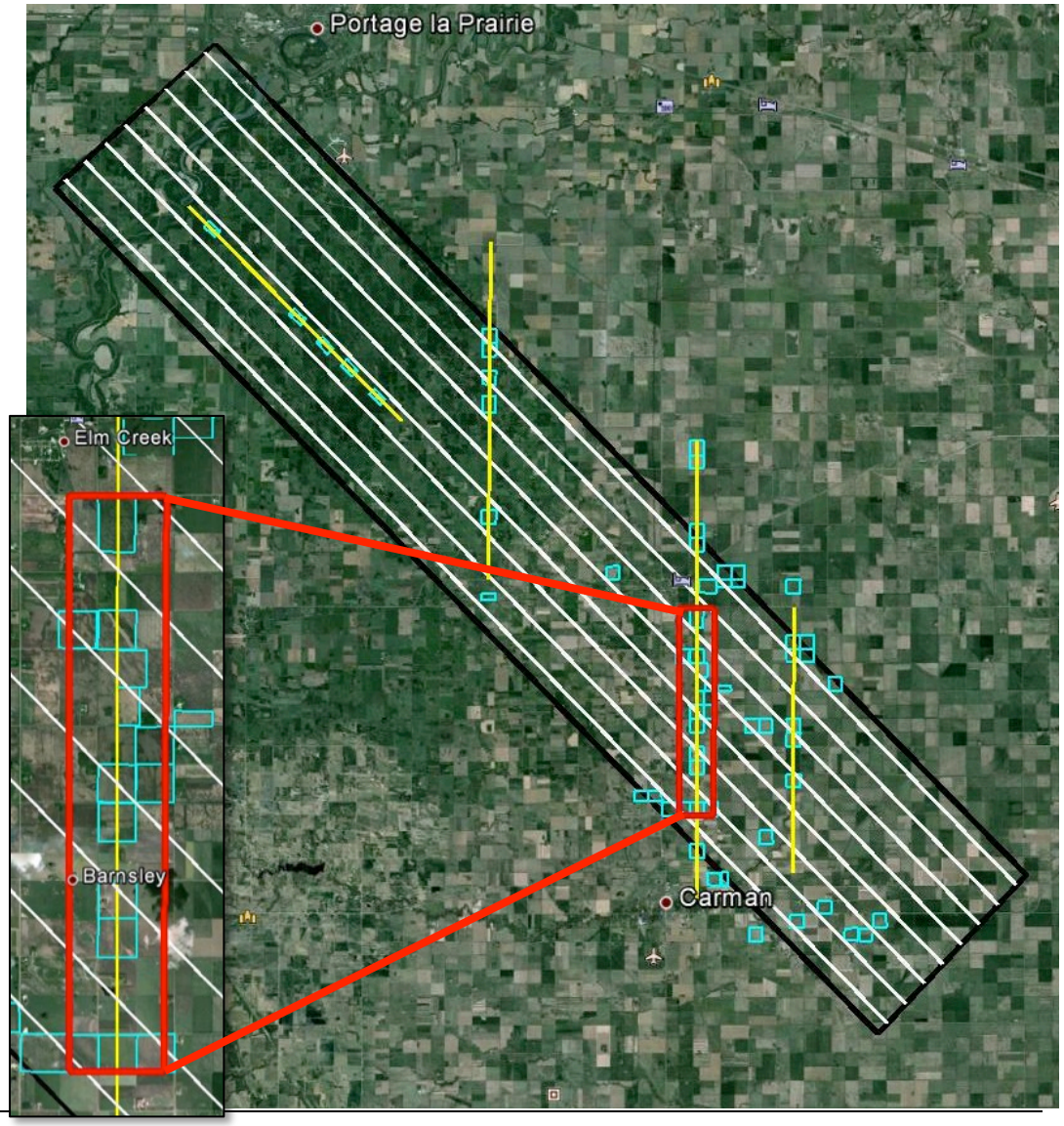
SMAPVEX12 PALS Flight Plan

- PALS flight sequence (6-7 hours)
  - *Take off from Winnipeg*
  - *Lake calibration*
  - *Low-altitude lines*
  - *High-altitude lines partially*
  - *Re-fuel at Winnipeg*
  - *Finish high-altitude lines*
  - *Lake Calibration*
  - *Landing at Winnipeg*
- Operational notes
  - *17 flight days/100+ hours*
  - *10 missed lines (out of total of 12x17=204): mostly due to weather conditions*
  - *Sun glint observed and avoided*
  - *Low RFI levels detected with a digital back-end*

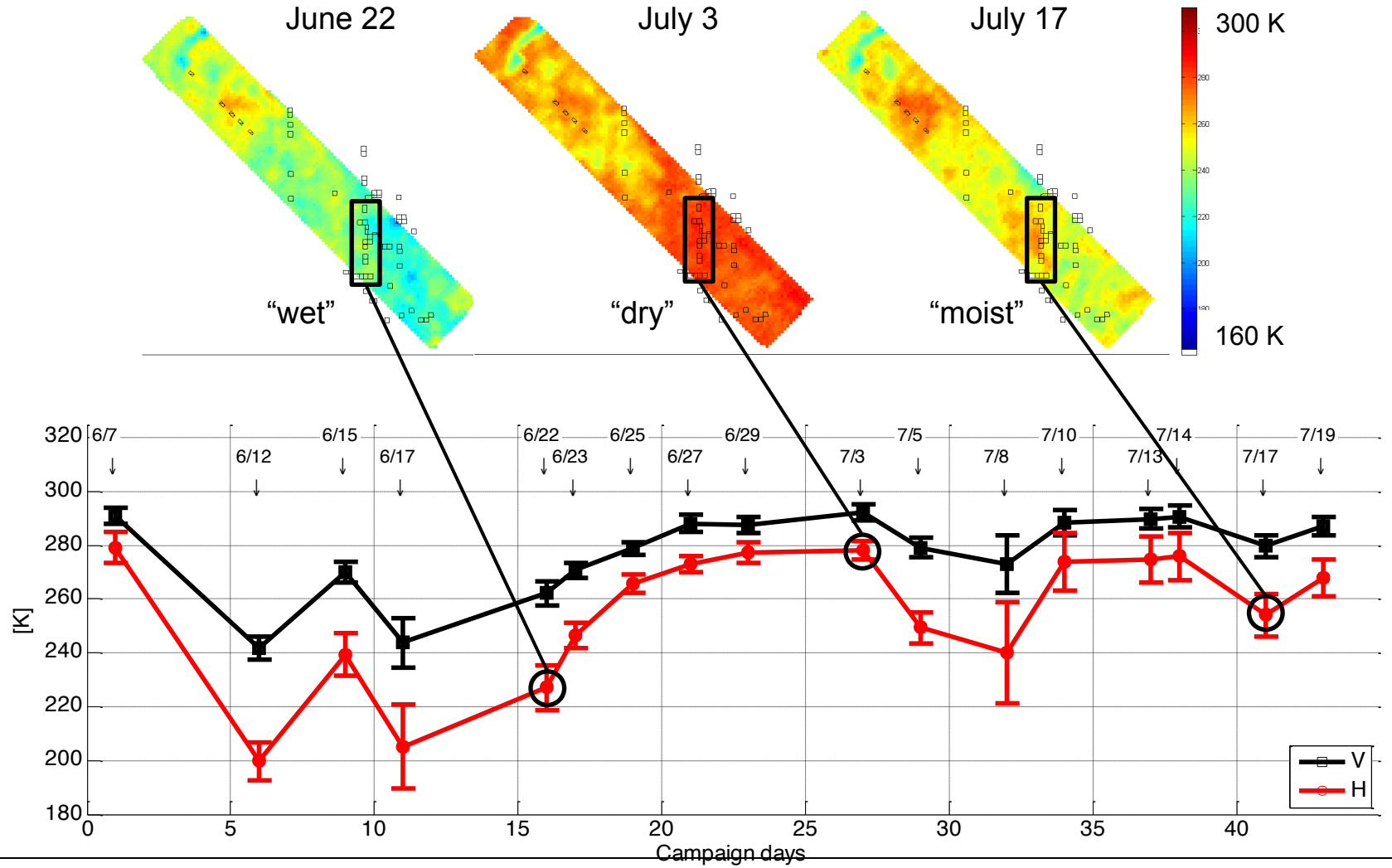


PALS results

- PALS acquisitions were validated using a test area over a set of fields in the agriculture region
- Reference for low- and high-altitude measurements
- Soil moisture changes estimated from uncalibrated (at this point in time) in situ sensor readings



PALS radiometer results (1/3)



PALS radiometer results (2/3)

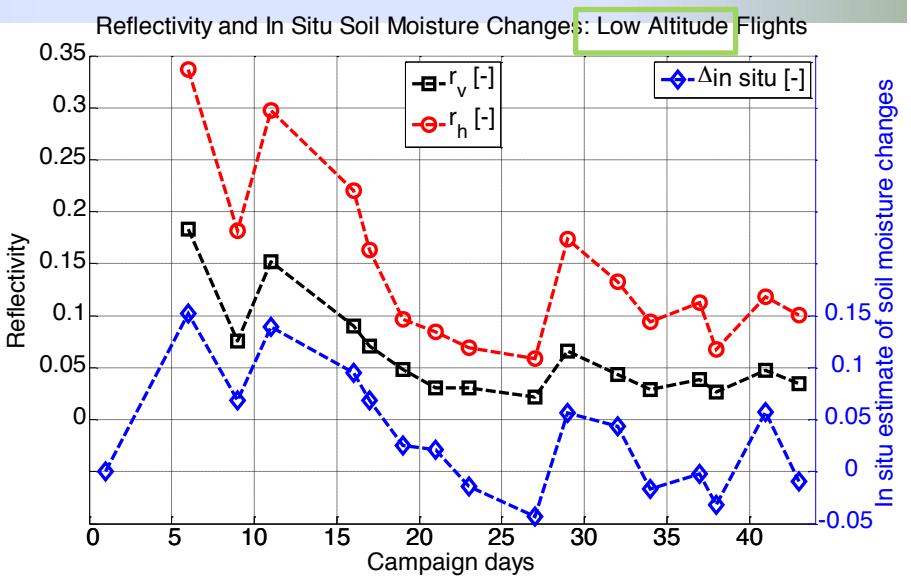
- Retrieve emissivity using the thermal infrared measurements
- Convert to reflectivity for straightforward comparison with soil moisture
- Time-series of airborne and in situ measurements matches well

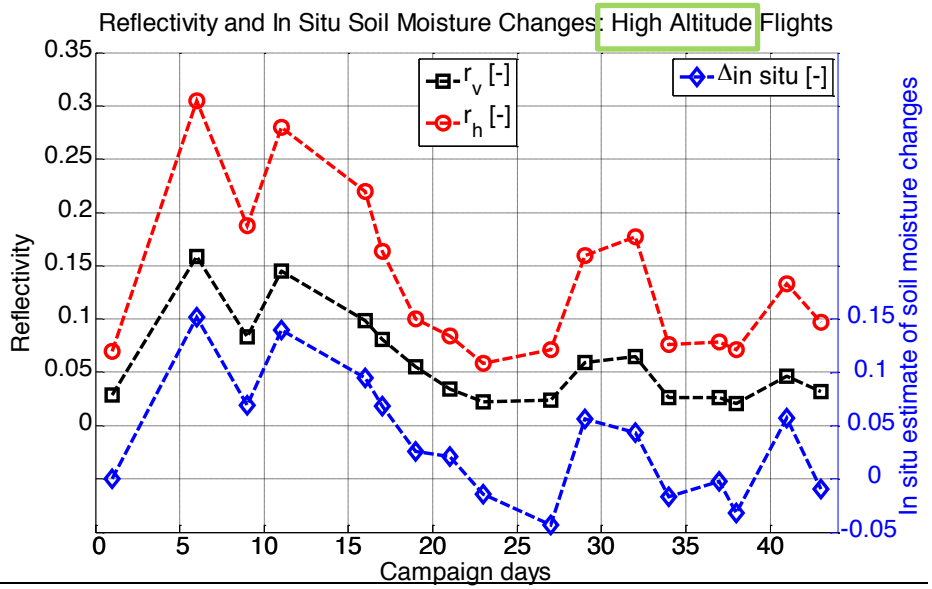
Emissivity

$$e\downarrow p\ (\theta)=T\downarrow B,p\ (\theta)/T\downarrow phys$$

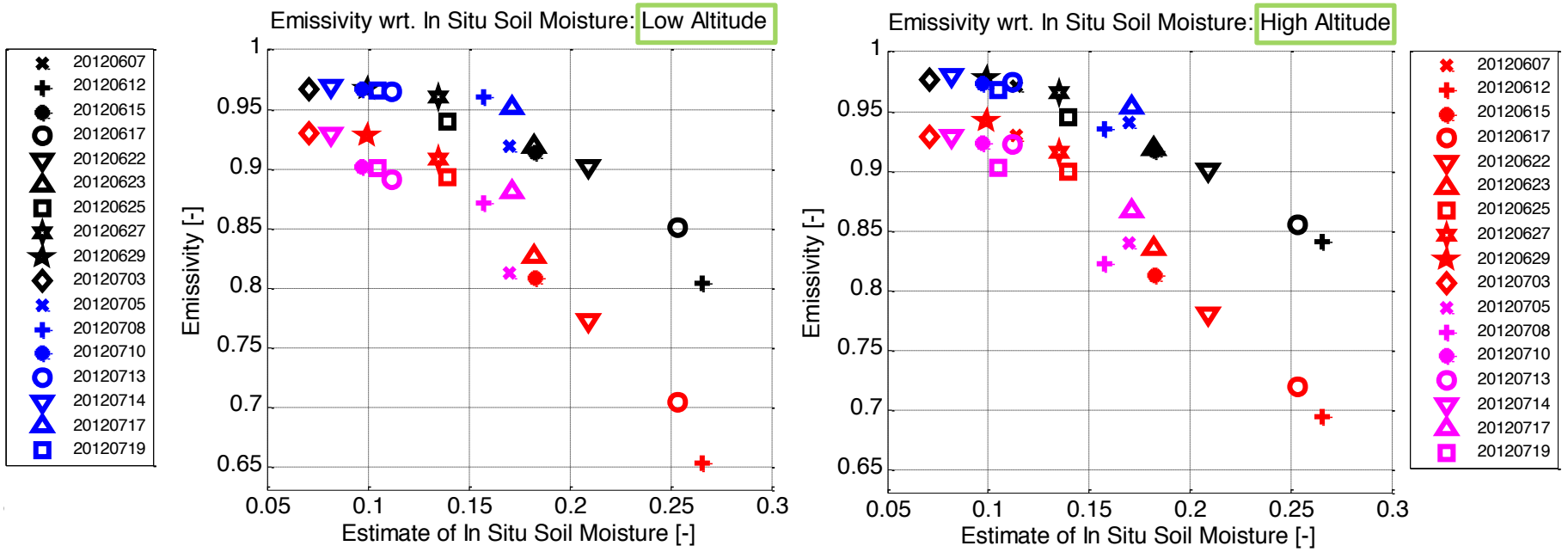
Reflectivity

$$r\downarrow p\ (\theta)=1-e\downarrow p\ (\theta)$$



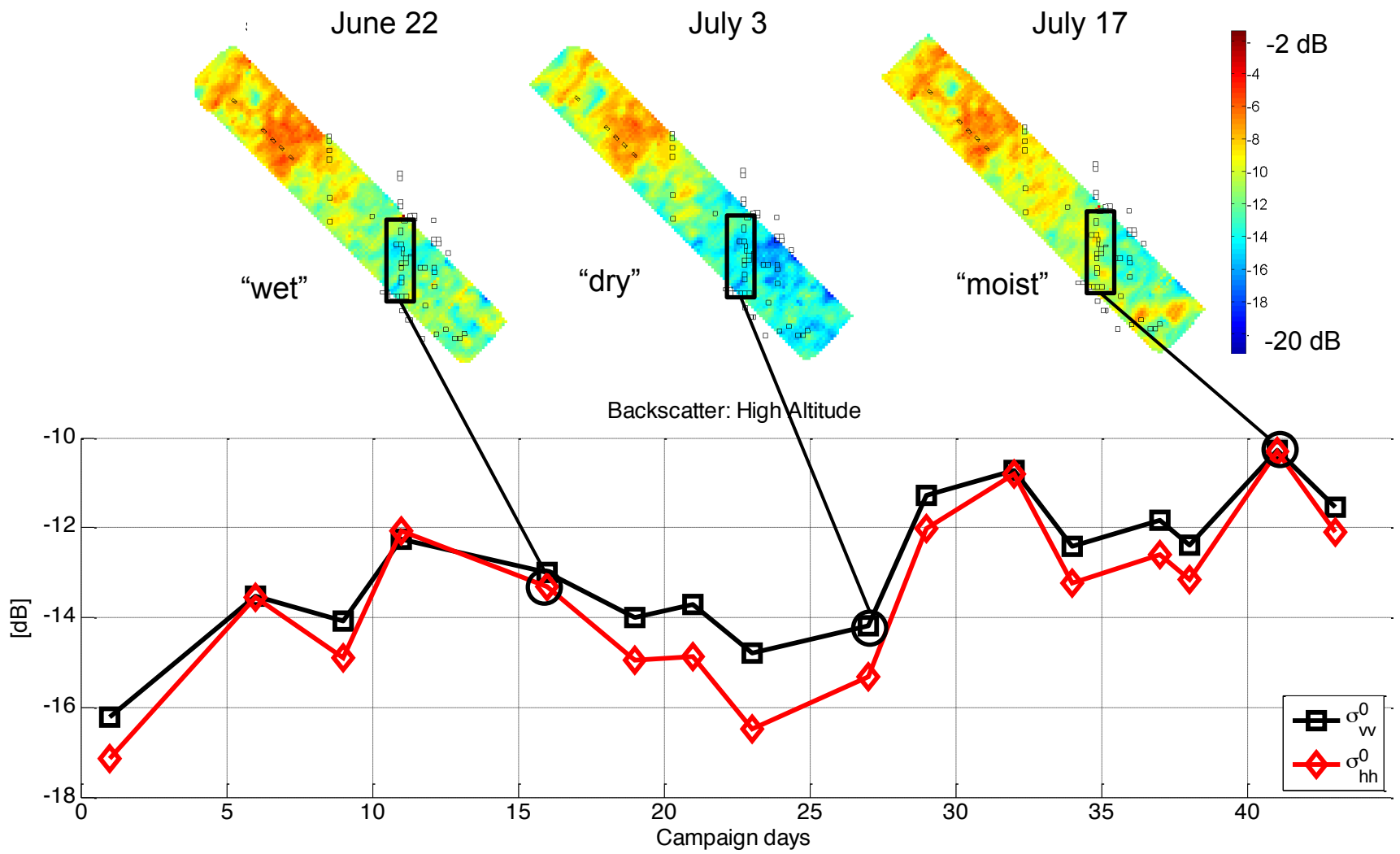


PALS radiometer results (3/3)

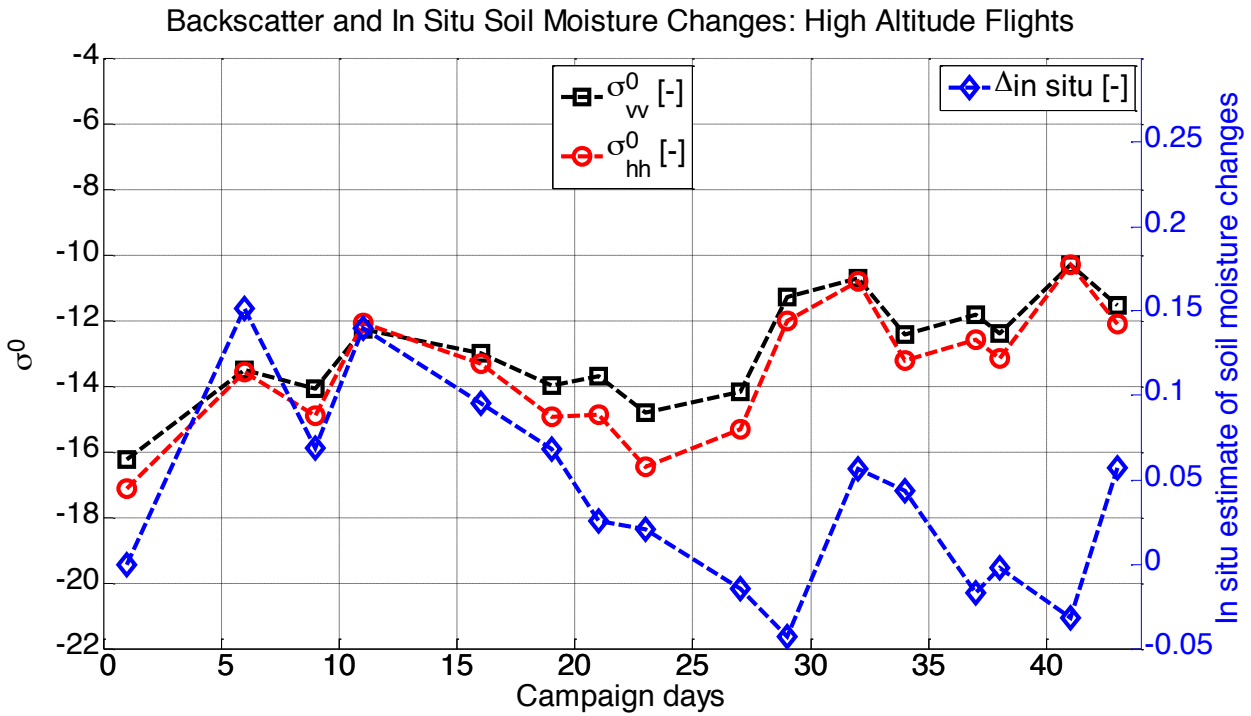


- Emissivity vs. (uncalibrated) soil moisture over the test area
- Correlation between airborne and in situ measurements as expected

PALS radar results (1/2)



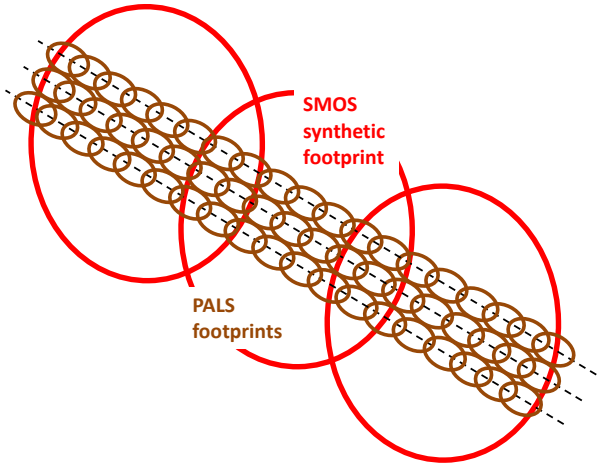
PALS radar results (2/2)

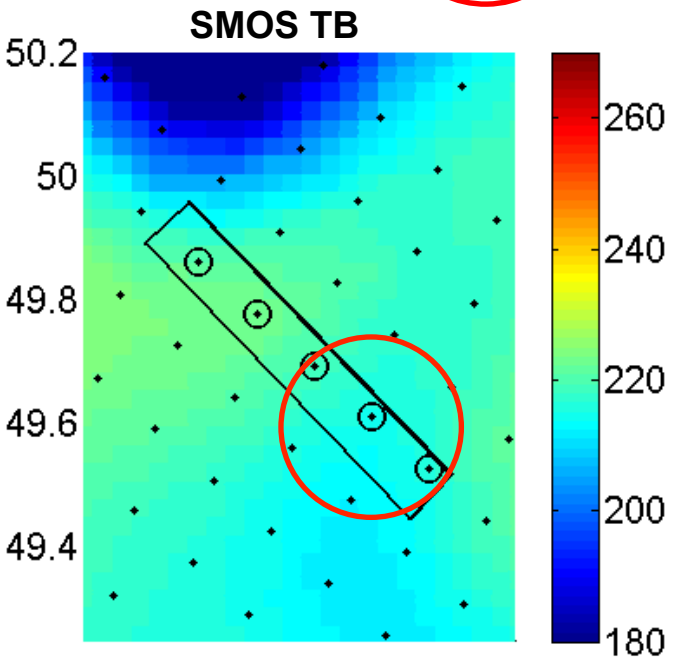


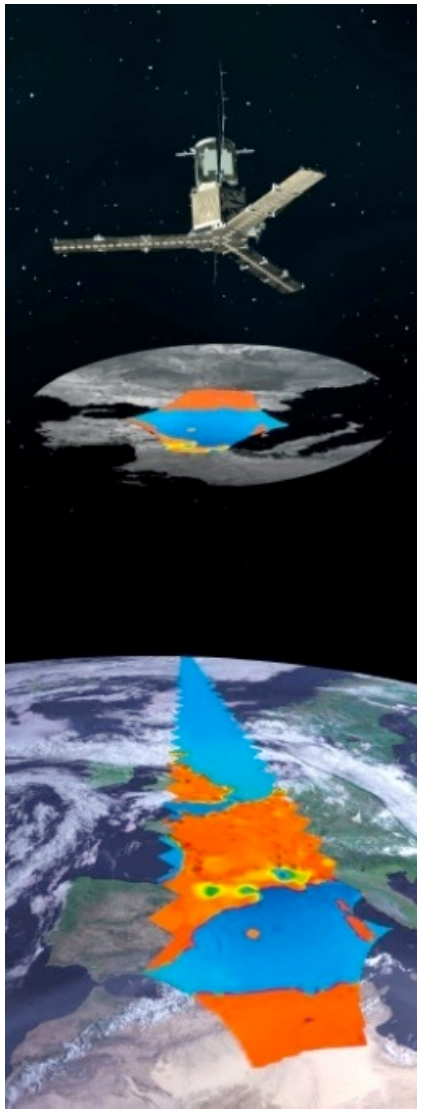
- Changes in backscatter match mostly the changes in soil moisture
- The effect of increasing vegetation can be seen as overall increasing trend in backscatter with respect to the soil moisture

PALS comparison to SMOS (1/2)

- Geophysical parameter retrieval algorithm development pre- and post-launch benefits from consistent airborne and spaceborne data sets
- Measurements did not cover full SMOS pixels (not the objective of the campaign)
- One SMOS footprint selected: centered mostly over the agriculture area
- Respective area of high-altitude PALS measurements analyzed

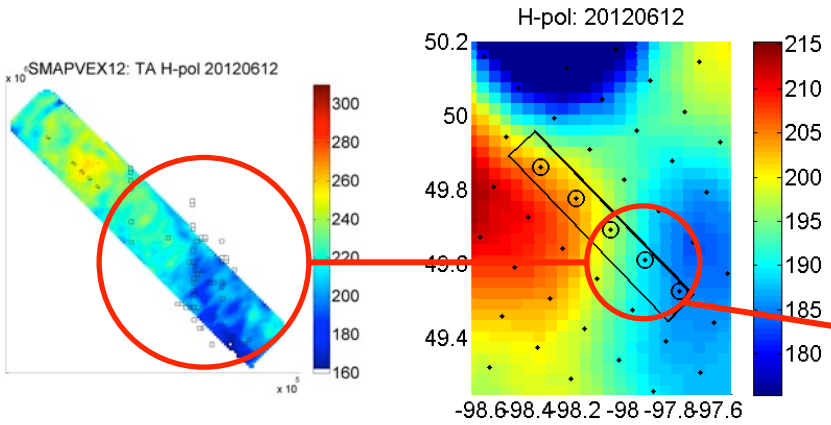


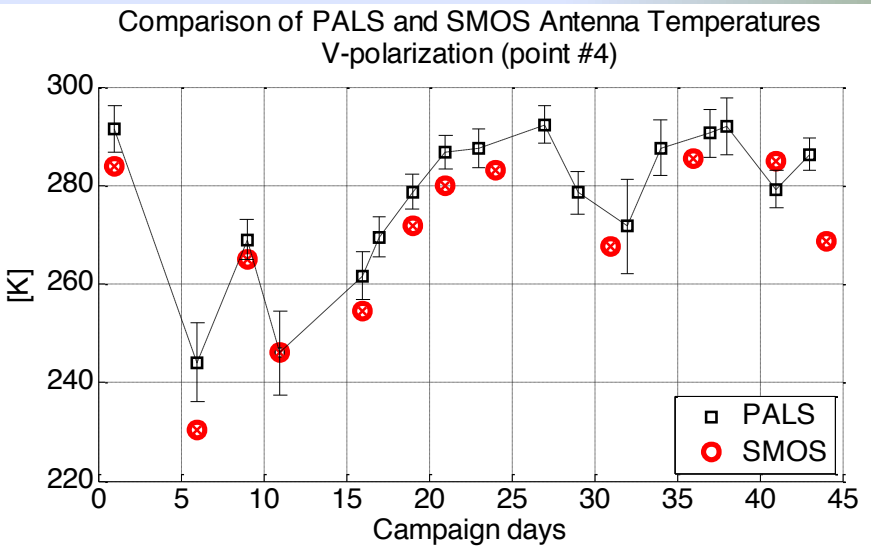


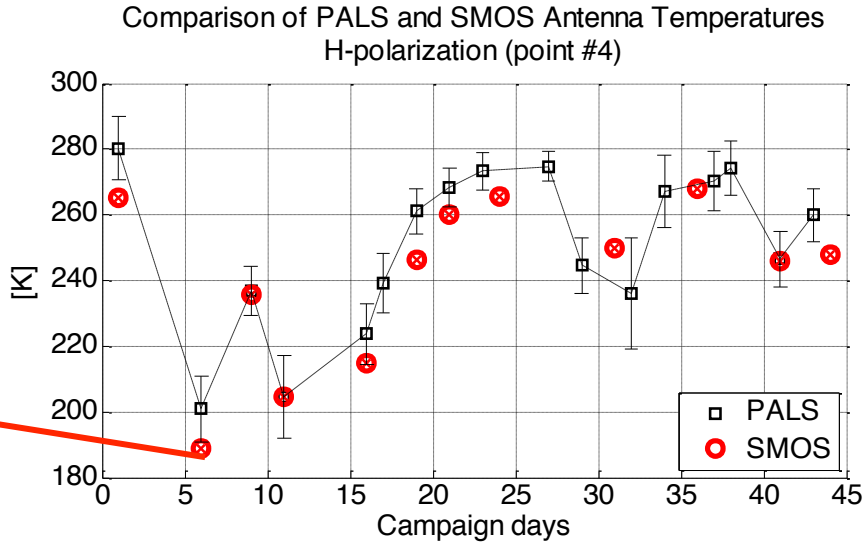


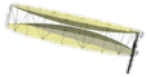
PALS comparison to SMOS (2/2)

- Generally a very good agreement between the trends in the two measurements
- A few Kelvins bias between the measurements may be caused by different support areas of the measurements
- Values seen in the airborne measurements are representative to those seen from the orbit









Conclusions

- Initial comparisons of PALS acquisitions with in situ measurements and SMOS measurements show a good match indicating that the objective of the campaign was met and the PALS data can be used for SMAP soil moisture algorithm development, testing and validation