

# Update on the CanEx-SM10 field campaign

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UNIVERSITÉ DE  
**SHERBROOKE**



*Cartel* Centre d'applications et de  
recherches en télédétection

# Introduction

- **Canadian Experiment for Soil Moisture in 2010 (CanEx-SM10)**

Saskatchewan

May 31<sup>st</sup> - June 16<sup>th</sup>, 2010

Joint efforts of Canadian  
and U.S. researchers

# Introduction

## **Financial partners:**

Natural Sciences and Engineering Research Council of  
Canada- Strategic Program Grant (NSERC-SPG)

Environment Canada (EC)

*Canadian* Space Agency (CSA)

Agriculture and Agri-Food *Canada* (AAFC)

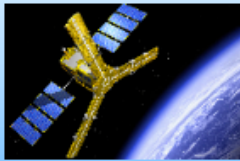
National Aeronautics and Space Administration (NASA)

# Objectives

- Contribute to the **cal/val activities of SMOS data** and the **pre-launch assessment of the proposed SMAP data**.
  - Analysis of L-Band microwave data with field measurements
  - Development of soil moisture retrieval algorithms from passive and active microwave data
  - Scaling methodologies for SMOS coarse resolution data
  - Assimilation of SMOS data in land surface systems to improve land surface initial conditions

# Overview of CanEx-Sm10

## Canadian Experiment for Soil Moisture in 2010 (CanEx-SM10)



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### Overview

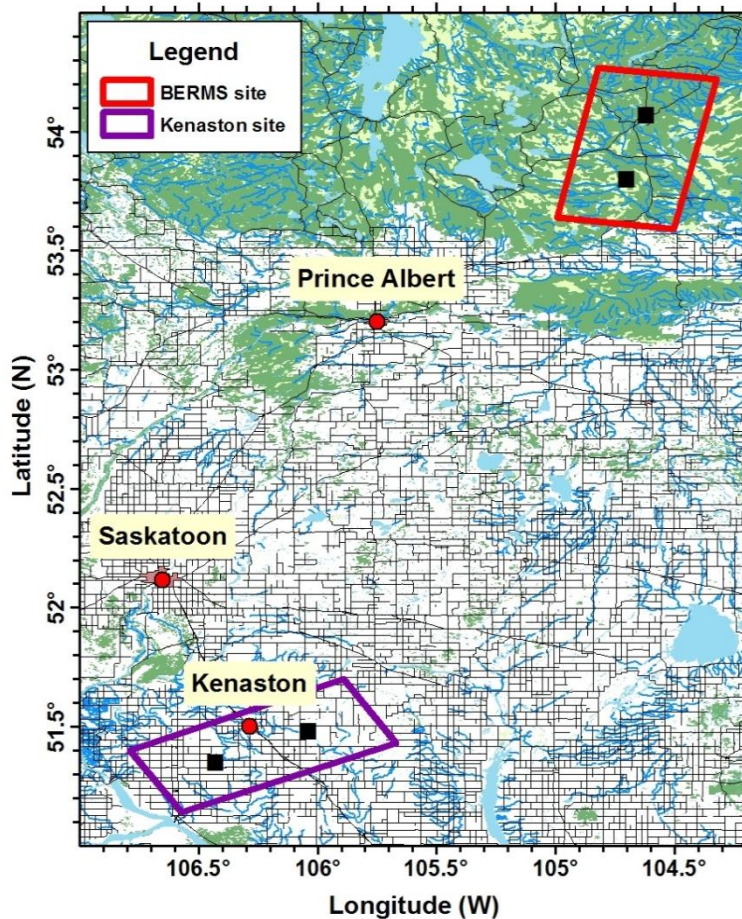
The Canadian Experiment for Soil Moisture in 2010 (CanEx-SM10) is primarily designed to support the ESA's Soil Moisture and Ocean Salinity (SMOS) validation activities over Land and to develop soil moisture retrieval algorithms in Canada. Due to Canada's involvement in the Soil Moisture Active and Passive (SMAP) mission of NASA, scheduled for launch in 2014, CanEx-SM10 is extended to include the pre-launch validation of SMAP.

During CanEx-SM10, scheduled from May 31<sup>st</sup> to June 17<sup>th</sup>, 2010, spaceborne microwave measurements from SMOS, AMSR-E, ASAR-Envisat, RADARSAT-2, and ALOS-PALSAR will be collected along with airborne measurements using passive and active instruments including an L-band radiometer mounted onboard Environment Canada's Twin Otter aircraft and NASA's L-band Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) flown in a Gulfstream III piloted aircraft. In addition, the experiment will provide ground measurements of soil moisture, surface temperature, and others surface characteristics (vegetation, roughness, soil density, etc.) at a time close to satellite and airborne acquisitions.

Over 50 researchers and students will participate to the field campaigns that will take place over an agricultural site located in Kenaston (Saskatoon, Saskatchewan) and a forested site, which is the Boreal Ecosystem Research and Monitoring Sites (BERMS) also located in Saskatchewan. These sites of about 33 km x 71 km, covering about two SMOS pixels, were selected in order to test SMOS and UAVSAR data and soil moisture retrievals algorithms over very different soil and vegetation conditions. Both sites

# Study sites

- Location of the two study sites

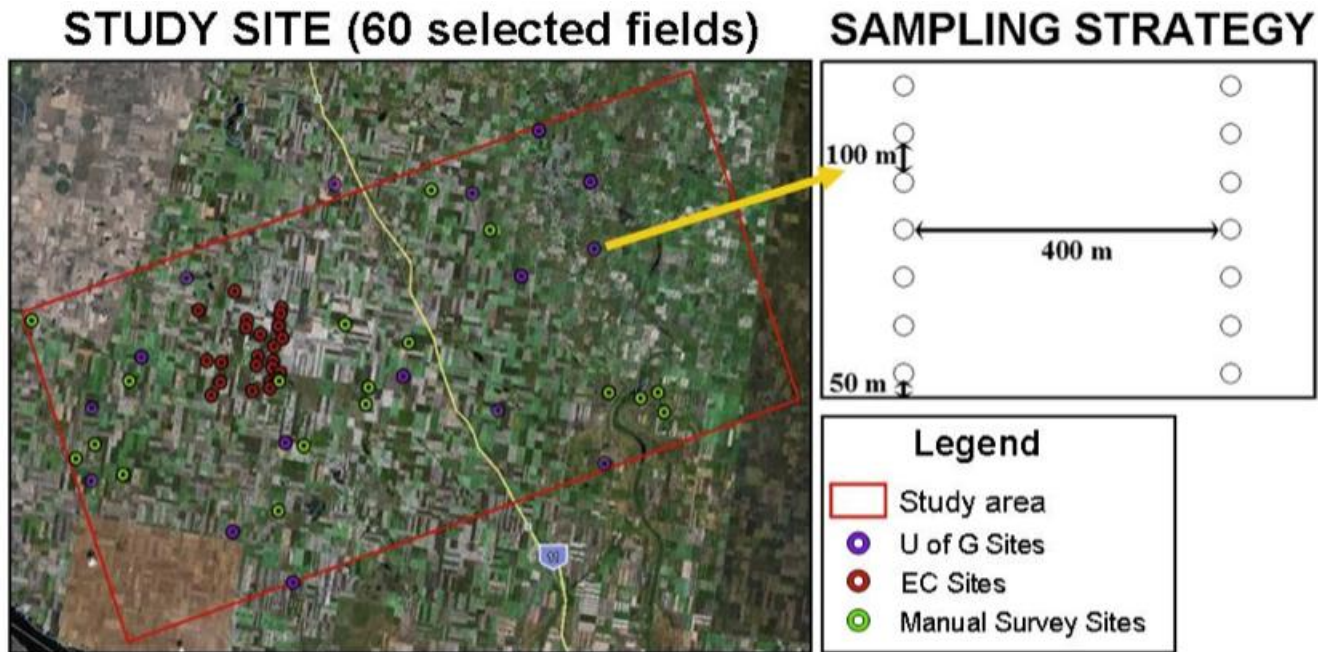


**Boreal Ecosystem Research  
and Monitoring Sites (BERMS)**  
~ 33 x 71 km<sup>2</sup>

**Kenaston agricultural site**  
~ 33 x 71 km<sup>2</sup>

# Kenaston site

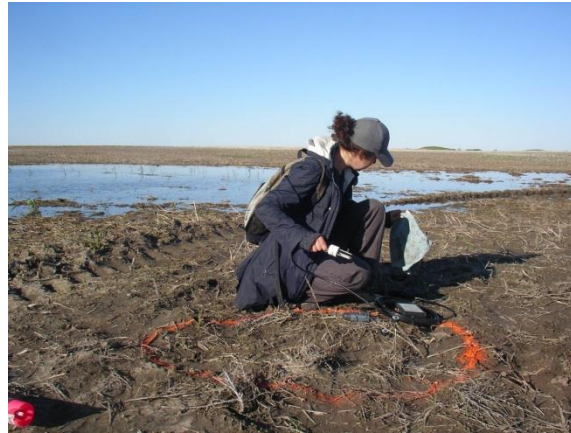
- Soil moisture sampling fields



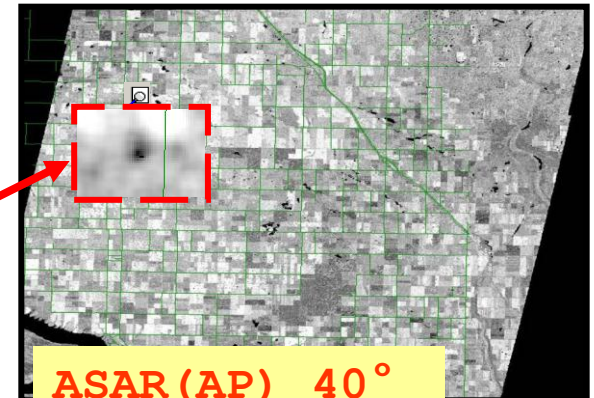
- ▣ Networks
  - 24 EC fields
  - 16 U of Guelph fields
- ▣ 20 manual survey fields

# Kenaston Site

- Standing water during CanEx-SM10



Field L5: NE 01-29-05



ASAR (AP) 40°  
JUNE 7, 2010

**➡ Issue to consider in data analysis and algorithms development**

# BERMS Study site

- Pictures



OBS



OJP



FEN



H75

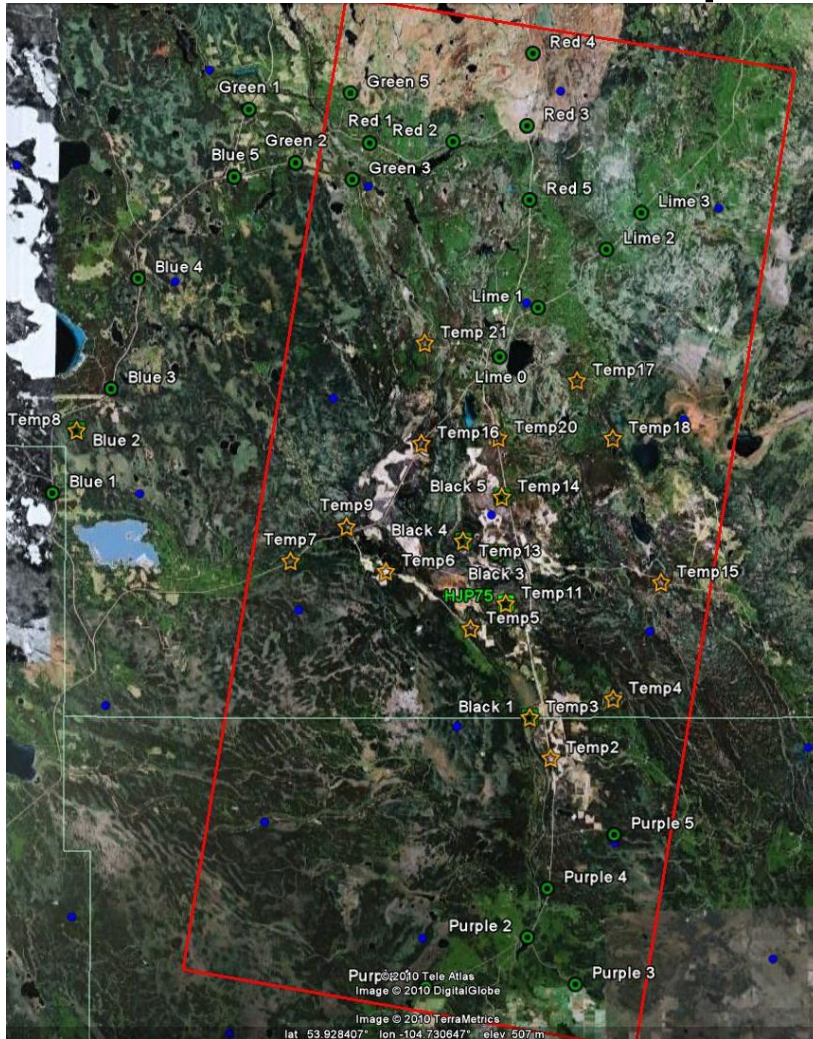


H02



# BERMS site

- Soil moisture sampling sites



## ▣ Networks

BERMS Temporary Network (20)

EC Network (6)

▣ Ground Team Sampling (35)

# Data acquisition

- Calendar of ground, airborne, and satellite measurements

| Measurements           | Sites                 | Kenaston |    |    |   |    |    |    |    |    |    |    |    |    |    | BERMS |
|------------------------|-----------------------|----------|----|----|---|----|----|----|----|----|----|----|----|----|----|-------|
|                        | June 2010             | 1        | 2  | 3  | 4 | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 16    |
| Ground Data Collection |                       | -        | √  | -  | - | √  | √  | √* | -  | √  | -  | -  | -  | √  | √  | √     |
| Satellite              | SMOS                  | √√       | √  | √√ | - | √√ | -  | √  | √√ | -  | √√ | √  | √  | √√ | -  | √√    |
|                        | AMSR-E                | √√       | √√ | √√ | √ | √√ | √√ | √√ | √√ | √√ | √√ | √√ | √√ | √√ | √√ | √√    |
|                        | RADARSAT-2            | √√       | √  | -  | - | √√ | -  | -  | √√ | -  | -  | √  | √  | -  | -  | -     |
|                        | ASAR                  | -        | -  | -  | - | -  | √  | √  | -  | -  | √√ | -  | -  | √  | -  | √     |
|                        | ALOS-PALSAR           | -        | -  | -  | - | -  | √  | √  | -  | √  | -  | -  | -  | -  | √  | -     |
| Airborne               | Twin Otter and UAVSAR | -        | √  | -  | - | √  | √  | √* | -  | √  | -  | -  | -  | √  | √  | √     |

√: one acquisition per day

√√: two acquisitions (ascending and descending) per day

√\*: Partial coverage due to rain event

# Summary of CanEx-SM10 datasets (1)

| Datasets                      | Description                                                                 | Contact                              | Processing |
|-------------------------------|-----------------------------------------------------------------------------|--------------------------------------|------------|
| <b>Satellite acquisitions</b> |                                                                             |                                      |            |
| Passive microwave             | SMOS (L1B, L2)<br>AMSR-E (TB and SM)                                        | Ramata Magagi                        |            |
| Radar                         | RADARSAT-2 (FQ, Std, wide)                                                  | Heather McNairn                      |            |
| Optical                       | SPOT, MODIS                                                                 | Heather McNairn,<br>Tom Jackson      |            |
| <b>Airborne measurements</b>  |                                                                             |                                      |            |
| Twin Otter                    | Radiometer TBH, TBV<br>1.4 GHz at 40° and<br>6.9, 19, 37, and 89 GHz at 55° | Anne Walker<br>Environment<br>Canada | 100 %      |
|                               | Landsat simulator<br>457-521 nm<br>523-595 nm<br>630-687 nm<br>762-897 nm   |                                      |            |
|                               | Infra red Ts                                                                |                                      |            |
|                               |                                                                             |                                      |            |
| UAVSAR*                       | Radar Sigma0<br>1.26 GHz<br>HH, HV, VH, VV<br>25-65°                        | Tom Jackson<br>USDA                  |            |

\*<http://uavsar.jpl.nasa.gov/>

# Summary of CanEx-SM10 datasets (2)

| Datasets                                   | Description                                                                                                                                                | Contact                             | Processing |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|------------|
| <b>Ground Networks - Agricultural site</b> |                                                                                                                                                            |                                     |            |
| Kenaston intensive network (10 km)         | Soil moisture and temperature profiles at 0-6, 5, 25 and 50 cm depths                                                                                      | Brenda Toth,<br>Environment Canada  | 100 %      |
| Kenaston extensive network (40 km)         | Soil moisture and temperature profiles at 0-6, 5, 25 and 50 cm depths                                                                                      | Aaron Berg,<br>University of Guelph | 100 %      |
| <b>Ground Networks - Forested site</b>     |                                                                                                                                                            |                                     |            |
| BERMS permanent network                    | Meteorological data and soil moisture profiles for 2010<br><u>5 sites</u> : 0 – 15, 15 – 30, ... cm depths and<br><u>1 site</u> : 2.5 cm, 7.5 cm ...depths | Anne Walker,<br>Environment Canada  | 100 %      |
| BERMS temporary network                    | Soil moisture at 5 cm depth                                                                                                                                | Mike Cosh,<br>Tom Jackson,<br>USDA  | 100 %      |

# Summary of CanEx-SM10 datasets (3)

| Datasets                                                   | Description                                                                                                                                        | Contact                                                                        | Processing   |
|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|--------------|
| <b>Ground data collection – Kenaston agricultural site</b> |                                                                                                                                                    |                                                                                |              |
| <b>Soil</b>                                                | <b>Dielectric constant and temperature at 0-6 cm depth</b>                                                                                         | <b>Aaron Berg,<br/>Brenda Toth,<br/>Ramata<br/>Magagi</b>                      | <b>100 %</b> |
|                                                            | <b>Gravimetric measurements for hydra-probe calibration and soil texture and bulk density derivation)</b>                                          |                                                                                | <b>100 %</b> |
|                                                            | <b>Surface and sub-surface temperatures (0, 5 and 10 cm depths)</b>                                                                                |                                                                                | <b>100 %</b> |
|                                                            | <b>Roughness parameters (standard height and correlation length)</b>                                                                               | <b>Ramata<br/>Magagi</b>                                                       | <b>100 %</b> |
| <b>Vegetation</b>                                          | <b>Water content, biomass, LAI, crop structures (height, leaf, stem and stalk sizes, angles, density, etc.), crop reflectance (CROPSCAN), etc.</b> | <b>Aaron Berg,<br/>Brenda Toth,<br/>Heather<br/>Mcnairn,<br/>Peggy O’neill</b> | <b>100 %</b> |

# Summary of CanEx-SM10 datasets (4)

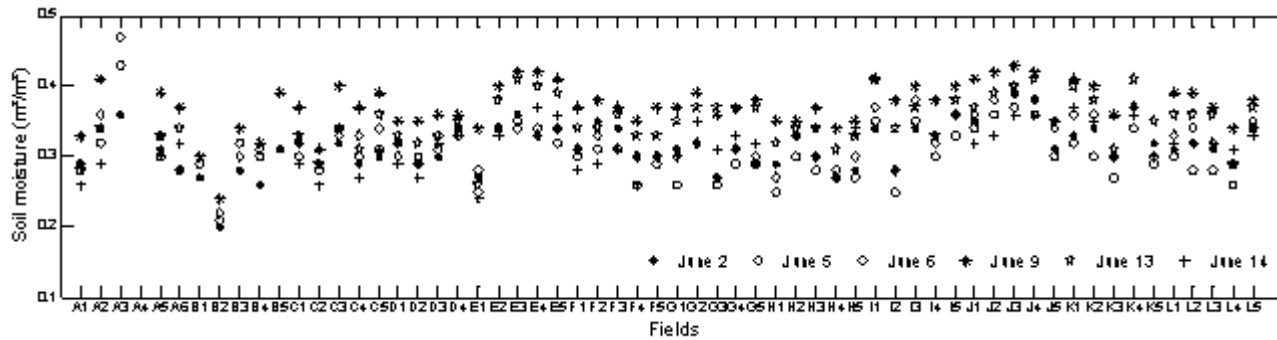
| Datasets                                            | Description                                                                                                                                           | Contact                                                       | Processing   |
|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|--------------|
| <b>Ground data collection – BERMS forested site</b> |                                                                                                                                                       |                                                               |              |
| <b>Soil</b>                                         | Dielectric constant and temperature at 0-6 cm depth                                                                                                   | <b>Aaron Berg,<br/>Brenda Toth<br/>Ramata<br/>Magagi</b>      | <b>100 %</b> |
|                                                     | Gravimetric measurements at the temporary sites                                                                                                       |                                                               | <b>100 %</b> |
|                                                     | Surface and sub-surface temperatures (0, 5 and 10 cm depths)                                                                                          |                                                               | <b>100 %</b> |
| <b>Vegetation</b>                                   | Species identification, tree characteristics (DBH, height, crown fractional cover, stem density, and branch measurements), understory characteristics | <b>Mahta Moghaddam,<br/>University of Southern California</b> | <b>100 %</b> |
|                                                     | Litter depth, Soil and organic weights                                                                                                                | <b>Aaron Berg,<br/>Brenda Toth</b>                            |              |

# Summary of CanEx-SM10 datasets (5)

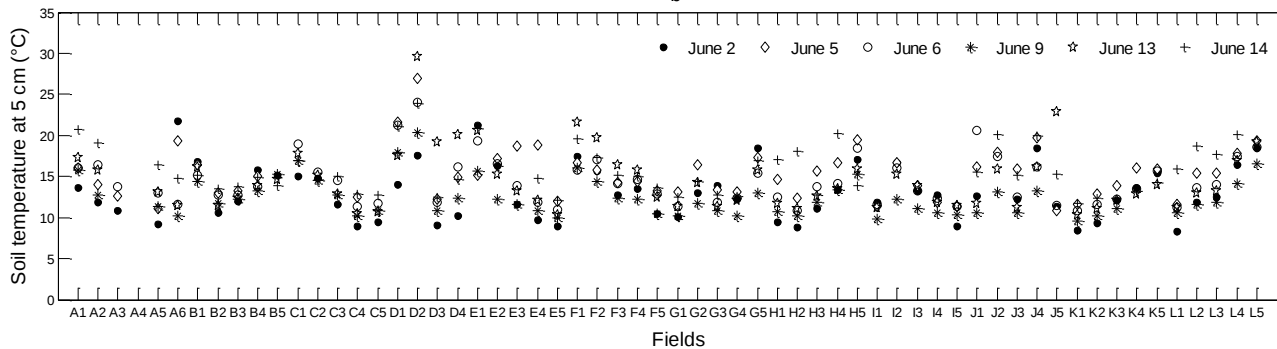
| Datasets              | Description                                              | Contact                          | Processing |
|-----------------------|----------------------------------------------------------|----------------------------------|------------|
| <b>Ancillary data</b> |                                                          |                                  |            |
| Annual crop maps      | NDVI, LAI, Land cover map of the entire Canadian Prairie | Brenda Toth, Environment Canada  | 100 %      |
| Field description     | Tillage, residue, etc.                                   | Aaron Berg, University of Guelph | 100 %      |

# Soil characteristics

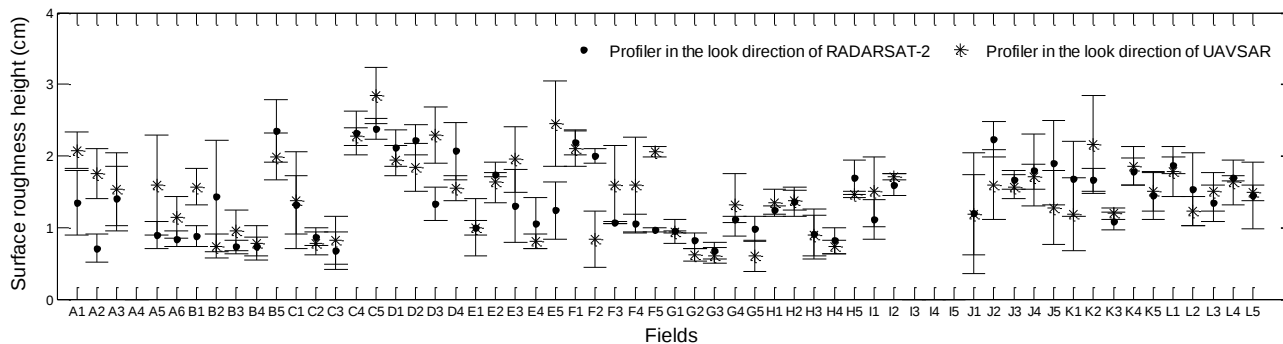
- Kenaston



6-cm Soil moisture



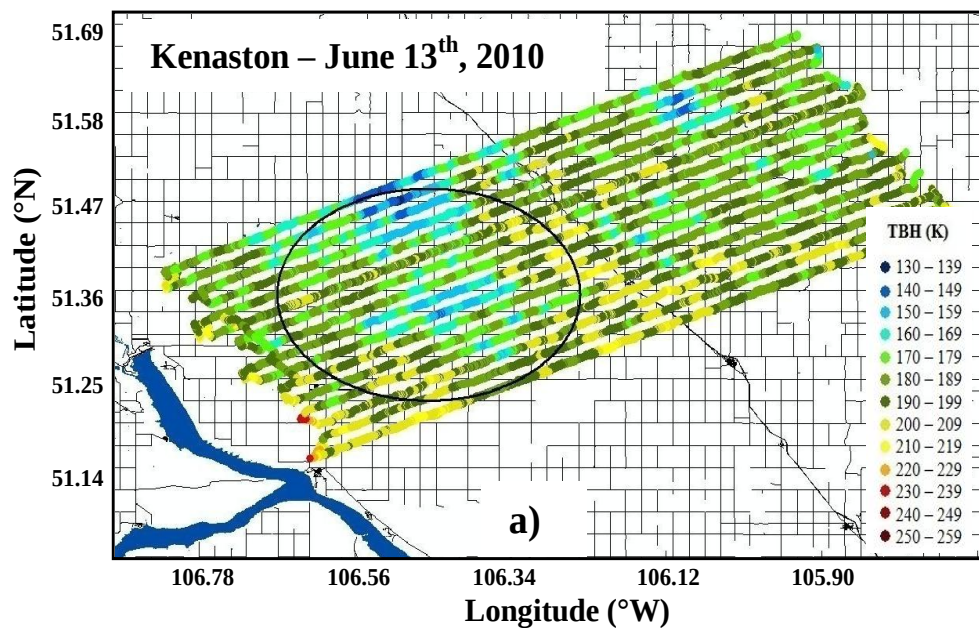
5-cm soil temperature



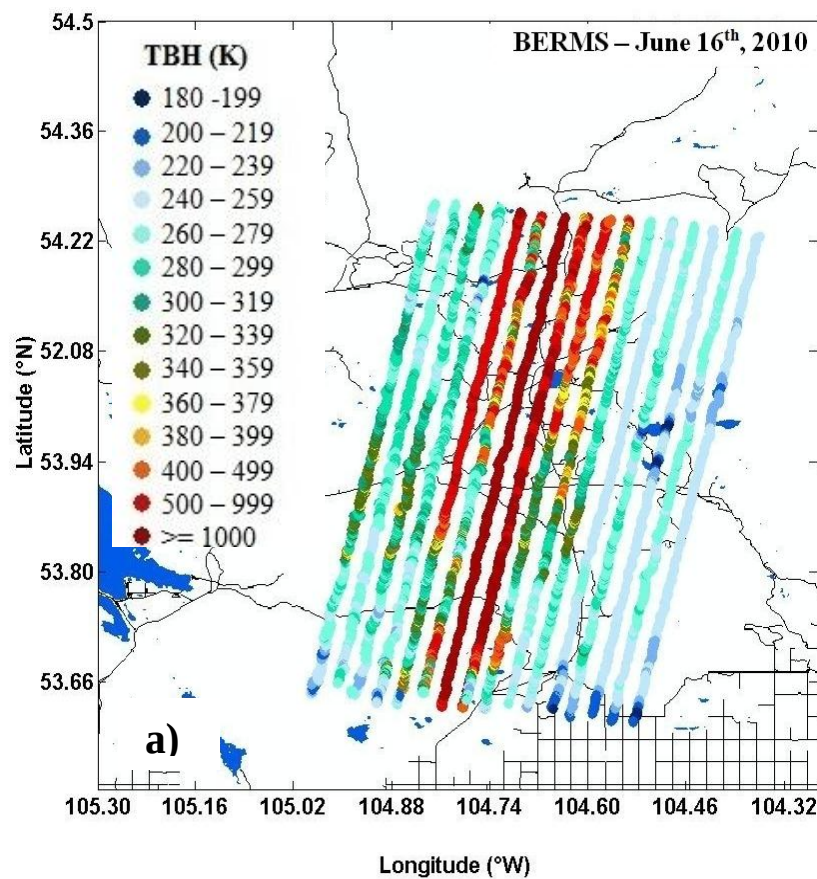
Surface roughness height

# L-Band airborne radiometer data

- Kenaston



## BERMS

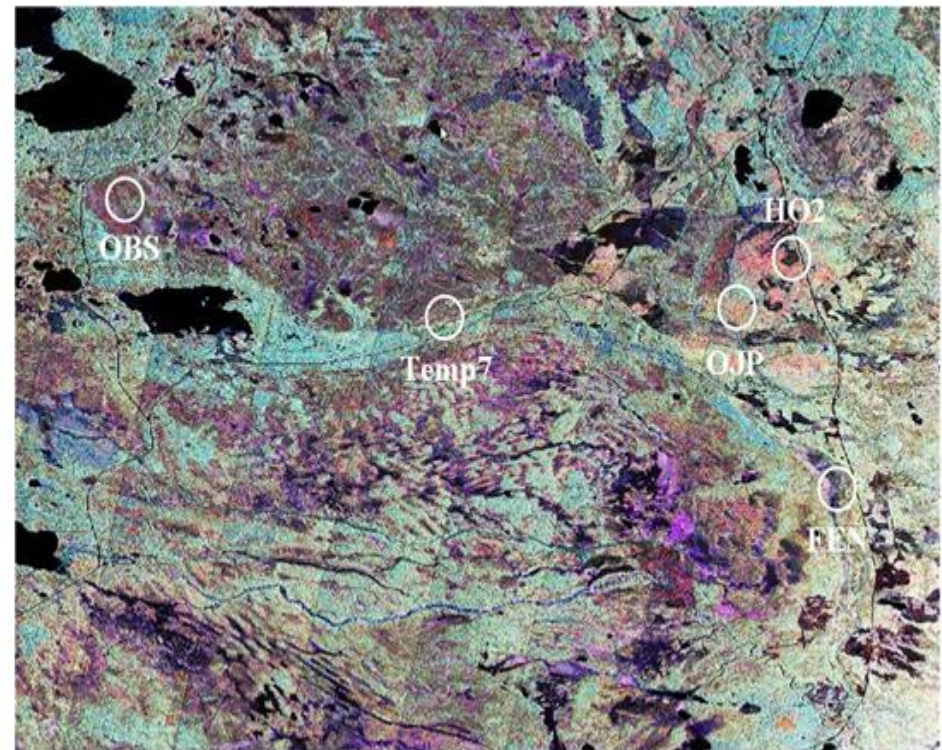
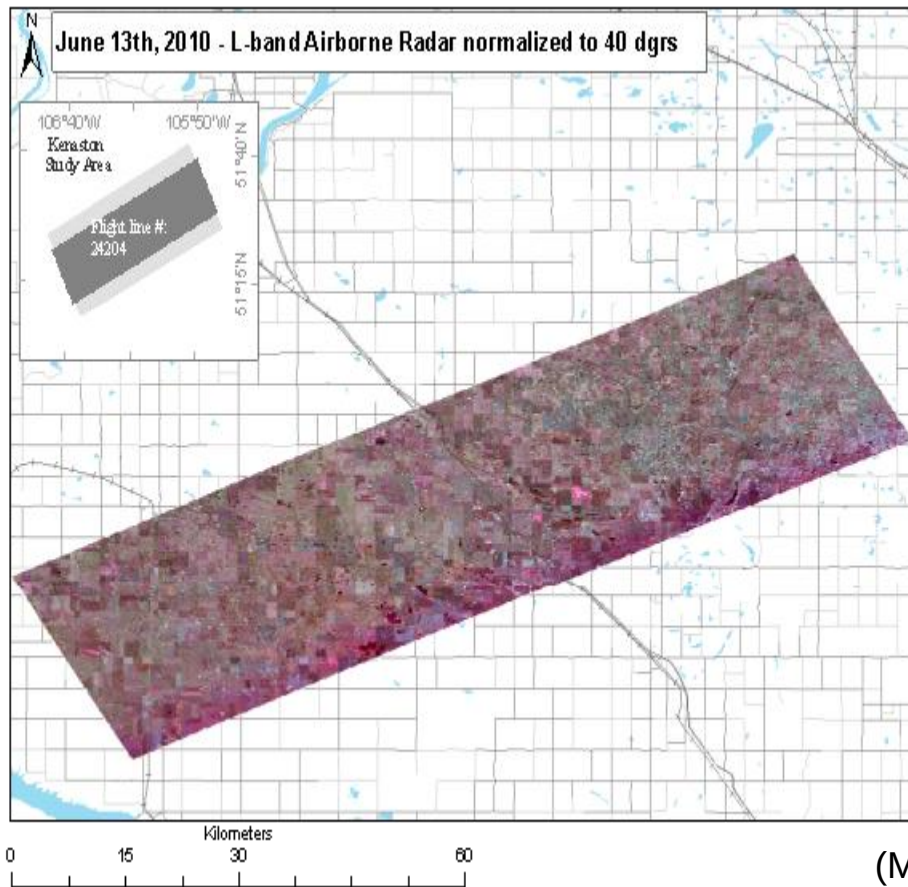


# L-Band airborne radar data

- Kenaston

BERMS

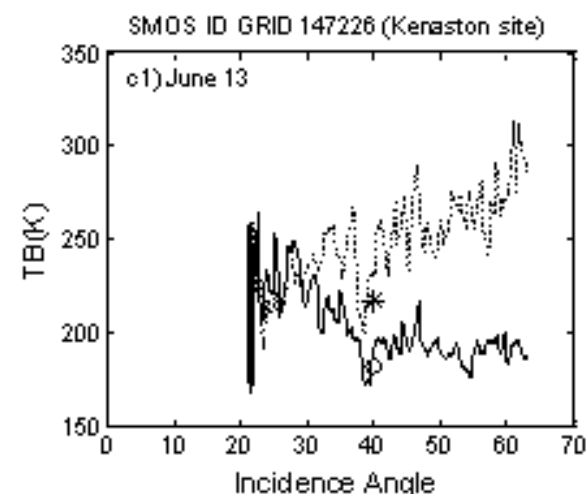
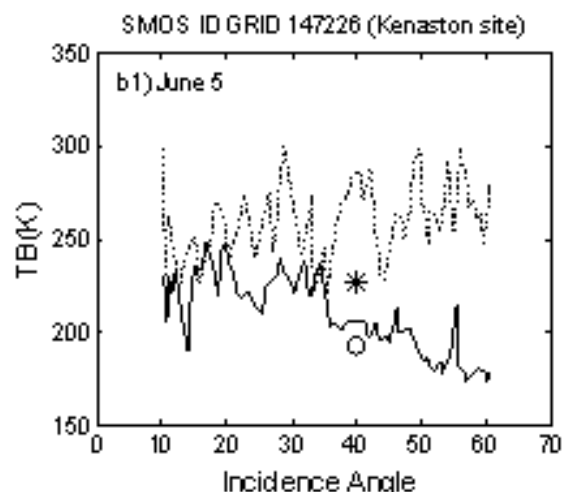
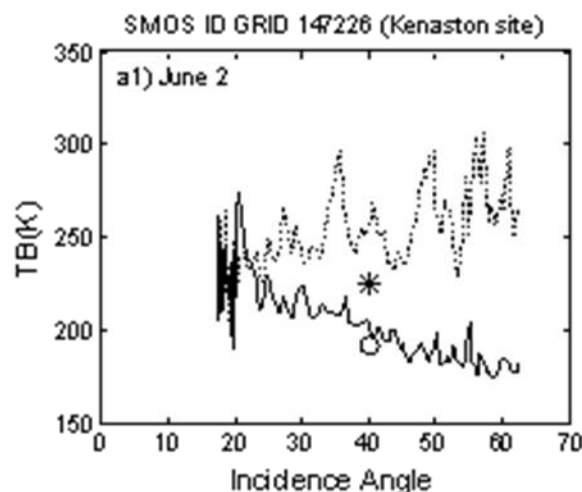
HH-HV-VV



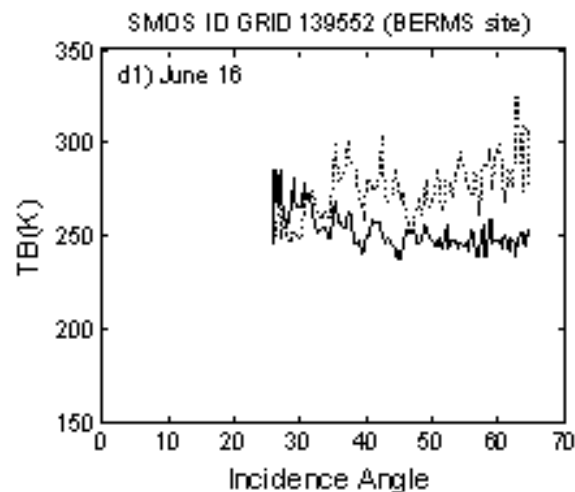
(Magagi et al., 2013)

# Comparing SMOS and airborne data

- Over Kenaston



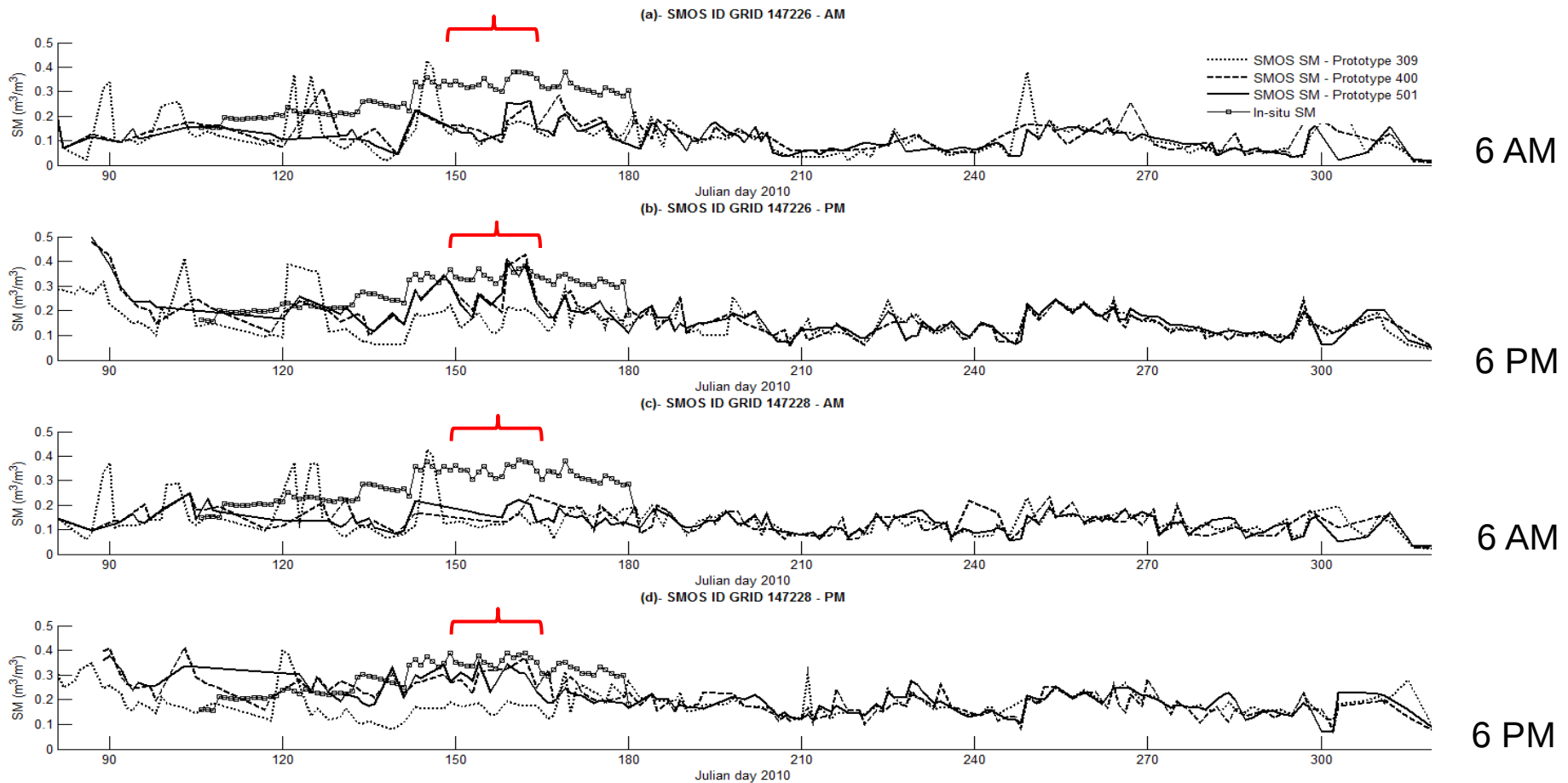
- Over BERMS



# Comparing SMOS L2 products and ground data (networks and sampling)

- Kenaston

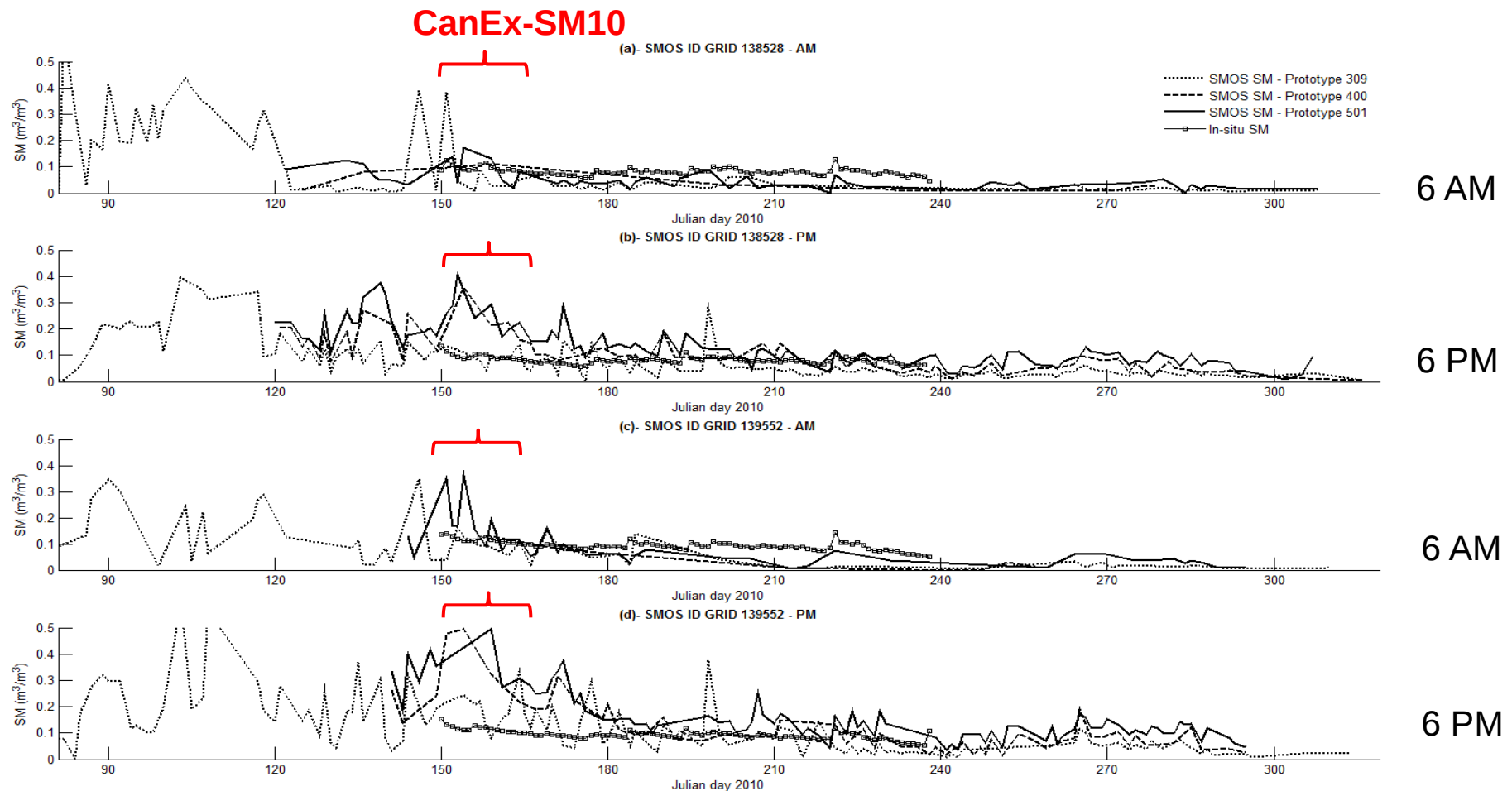
CanEx-SM10



(Djamaï et al., submitted)

# Comparing SMOS L2 products and ground data (temporary network)

- BERMS



(Djamaï et al., submitted)

# Conclusion

- Data sets available on <http://pages.usherbrooke.ca/canexsm10/intranet.php> and released to public in the summer of 2012
- Connexion with International soil moisture network (ISMN)
- Datasets used conjointly with those of SMAPVEX12 (<http://pages.usherbrooke.ca/smapvex12/>) for research and the training of HQP.

# Thanks!

- **Financial partners (NSERC, EC, CSA, AAFC, NASA, USDA, ....)**
- **All the participants to CanEx-SM10**
- **ESA and CESBIO for providing us SMOS data**

**.....**