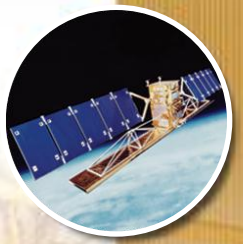
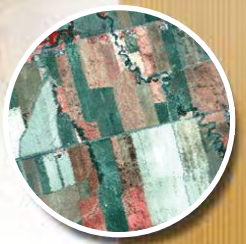
Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada





SMAPVEX12

SMAP Validation Experiment 2012

Canada

SMAPVEX 2012

Objectives (refer to experimental plan):

- To support calibration and validation of SMAP data and products
- To familiarize operational program and policy users with passive and active soil moisture products, to prepare these users for exploitation and assimilation of SMAP products, once available

Location:

- Southern Manitoba (Canada)
- Southwest of capital of Manitoba - Winnipeg

Timing:

- 43 days to capture variable soil and vegetation conditions
- Data collection from June 7 – July 19, 2012

SMAPVEX Participating Agencies

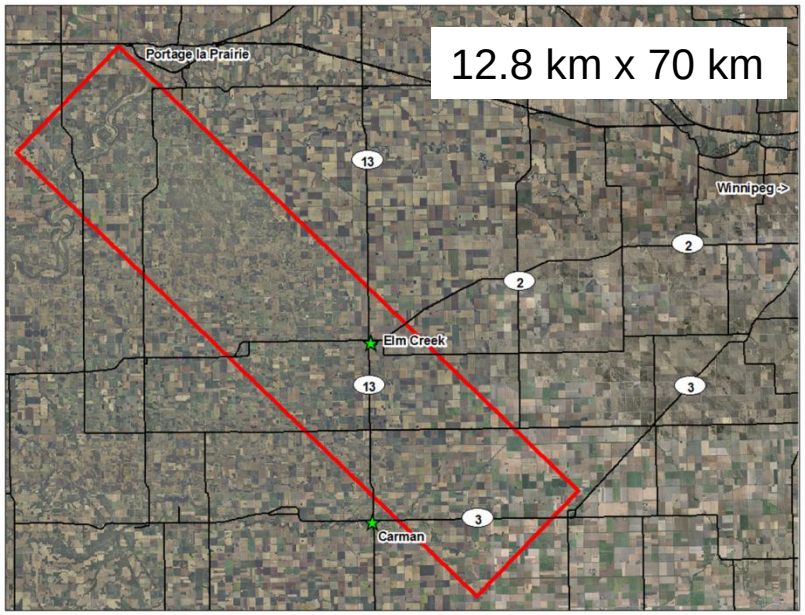
Canada

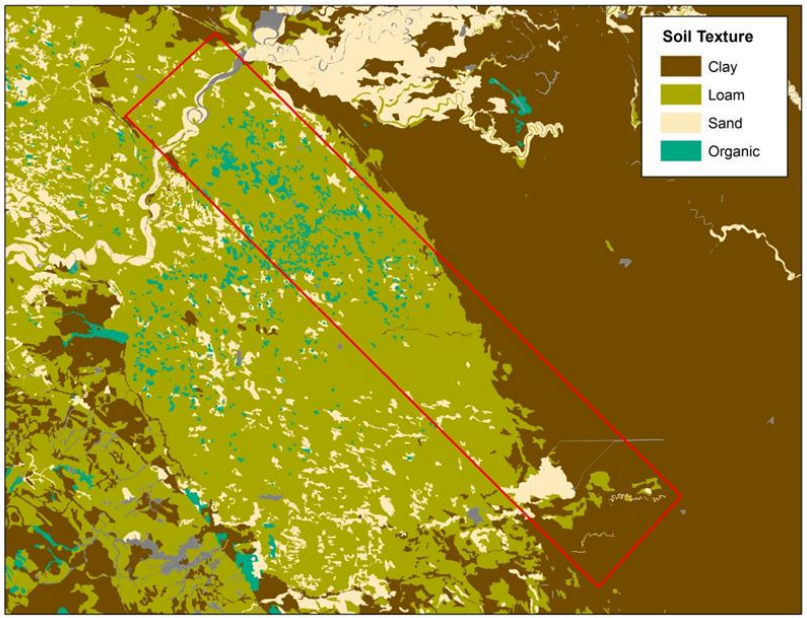
- Agriculture and Agri-Food Canada
- Environment Canada
- University of Guelph
- University of Sherbrooke
- University of Manitoba
- Manitoba Agriculture, Food and Rural Initiatives (MAFRI)
- Canadian Space Agency

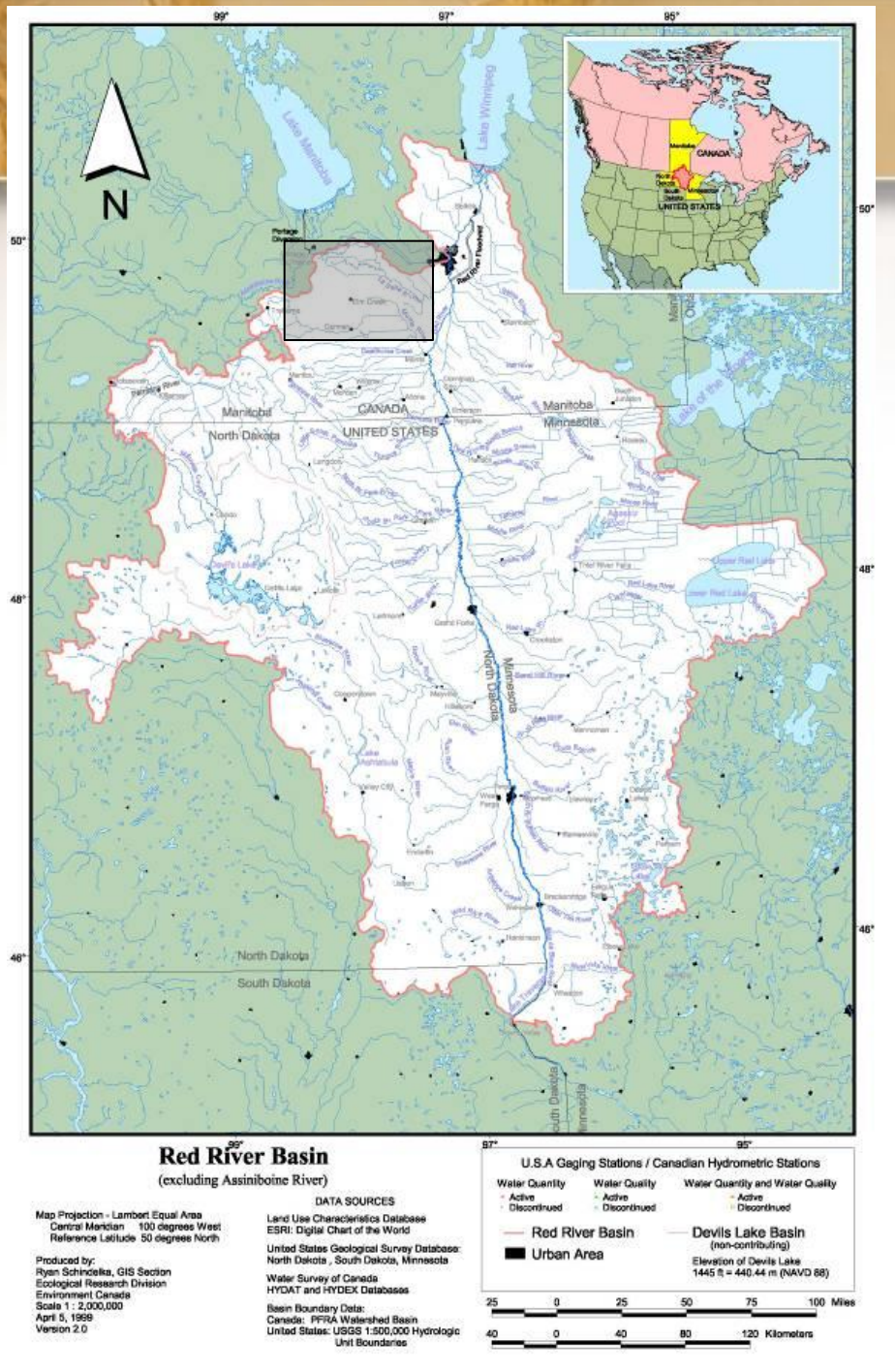
U.S.A.

- NASA and JPL
- U.S. Department of Agriculture
- Massachusetts Institute of Technology
- University of Southern California
- University of South Carolina
- Texas A&M University
- University of Washington
- Ohio State University
- University of Florida
- Florida International University
- University of Montana
- University of Colorado

Site Location







AAFC SAGES Soil Moisture Network

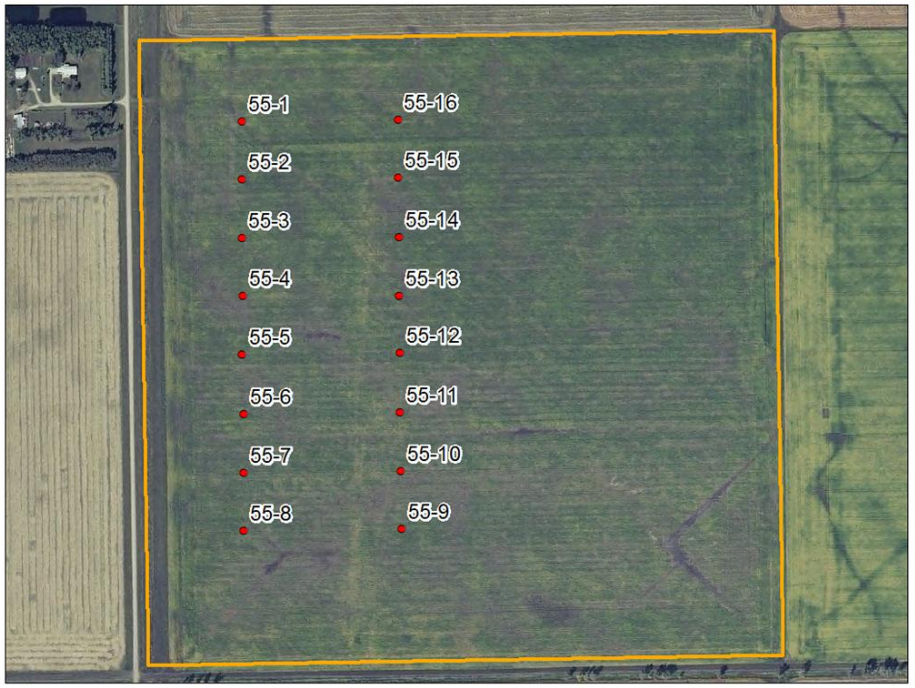
- 9 permanent soil moisture stations installed in 2011
- 6 Stevens hydra probes at surface (vertical and at 5 cm horizontal)
- 3 probes at each depth (20, 50 and 100 cm)
- probes are 50-100 feet from field edge
- tipping bucket rain gauge
- data is transmitted hourly via cell phone to Ottawa
- nearly 400,000 soil moisture\temperature readings during campaign

Temporary Stations

- temporary soil moisture stations were installed: USDA 40, MAFRI 4
- USDA probes at a depth of 5 cm, MAFRI probes at 5, 20, 50, 100 cm
- soil moisture and temperature recorded hourly on data loggers
- installed after seeding, removed before harvest
- over 525,000 readings during SMAPVEX

SMAPVEX Site Characteristics

- 55 SMAPVEX agriculture fields
  - 19 soybeans fields, 16 cereal (13 spring wheat, 1 oat, 2 winter wheat), 8 corn, 7 canola, 4 pasture and 1 forage
- 4 forested sites, varying degrees of tree cover
- Cropland: 16 sample points arranged in two transects running parallel to crop row direction
- in total, 880 cropland sample points



Field Organization

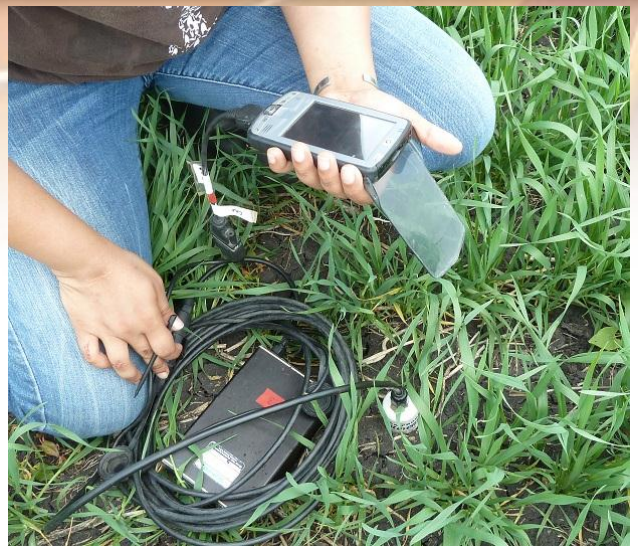
- 5 teams: cropland soil moisture and vegetation; crop structure; forest soil moisture and vegetation; surface roughness; and airborne acquisition.

- flight days (soil moisture sampling)
  - crews arrived at fields around 7:30 AM and completed sampling around noon
  - each crew of 2 sampled 4-5 cropland fields
  - 17 soil moisture days
  - some dropped fields due to road access or crop dusting

- non-flight days (vegetation sampling)
  - goal was to measure vegetation on each field once per week
  - cropland crew measured height, stem diameter, LAI, crop reflectance and took biomass samples
  - forest crews took spatial or destructive samples
  - 12 vegetation days

- crop structure team (2) worked independent of fly/no fly days

Soil Moisture



- hand held Stevens Hydra probes used to collect data coincident in time with flight overpasses
- cropland sites: 3 replicate readings at each site (total of 48 measurements per field)
- over 44,000 moisture readings during SMAPVEX

- one 5 cm soil core collected at one of 16 sites (in 55 fields) during each flight overpass
- cores were oven dried to provide volumetric soil moisture and for particle size distribution
- over 850 soil cores collected

- these bulk density samples used to develop field specific calibration equations for Hydra Probe measurements

Soil and Vegetation Temperature

- subsurface soil temperature (at 5 cm & 10 cm) and surface soil and vegetation temperature (shaded and sunlit) recorded for 4 sites per field during every flight overpass (points 1, 8, 9 and 16)
- over 5000 soil and crop temperature readings collected

Crop Characterization

- each field visited about once per week (875 samples collected)
  - 3 vegetation sample sites per field (sites 2, 11, 14)
  - biomass: wheat/pasture/forage using 0.5 x 0.5m quadrat; all other crops collected 10 plants over 2 rows
  - crop height and stem diameter: 10 plants/site
  - plant phenology: BBCH scale
  - LAI: hemispherical photos (7 photos along two transects (14 in total))
  - CropScan (440-1700 nm) reflectance: collected at one site per field (14 measurements per site)
- site 2 samples separated for plant organs before weighing and drying
- samples placed in drying room
- sub-sample placed in drying oven to determine drying correction factor

Soil and Vegetation Structure

Wheat: Field #71 – June 11

Canola: Field #124 – June 16

- surface roughness measured parallel to look direction for aircraft and satellites using pin board
- once after seeding with 2 measurements per field (3 metre profile)
- photos post-processed for rms and correlation length

- 17 fields visited 5-6 times to measure crop structure attributes (2 sites per field)
- plant height, stem width, stalk height, stalk angle, number of leaves, leaf length, leaf width, leaf thickness, leaf angle, number of plants per square meter, row orientation and row width

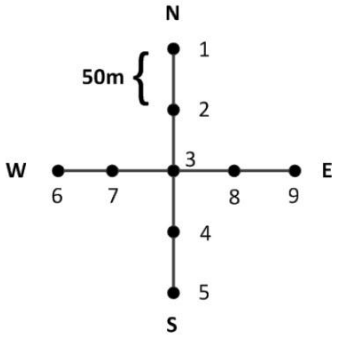
Forest Sampling

- observation area within each site consisted of two orthogonal transects within a circle of 100 m radius

- temporary soil moisture station at F1 and F2

- nine soil moisture sampling points within each observation area

- parameters measured during flight days:
  - soil moisture and dielectric constant (Steven's Hydra probes)
  - soil organic depth
  - soil temperature at 0 cm, 5 cm and 10 cm depths.
  - soil bulk density samples for soil texture



Forest Vegetation Measurements

Vegetation sampling (non-flight days)

(1) spatial sampling

(2) destructive sampling & dielectric measurements

Spatial sampling (June 7 to June 28)

- measured every tree within +/- 1 meter of the transect line for DBH, height and species
- at every 10 meters along the transect:
  - trunk height (hypsometer or a yard stick)
  - number of primary branches (visual)
  - angle of primary branches (visual)
  - fractional ground cover in percent (quadrat and visual estimate)
  - understory height (yard stick)

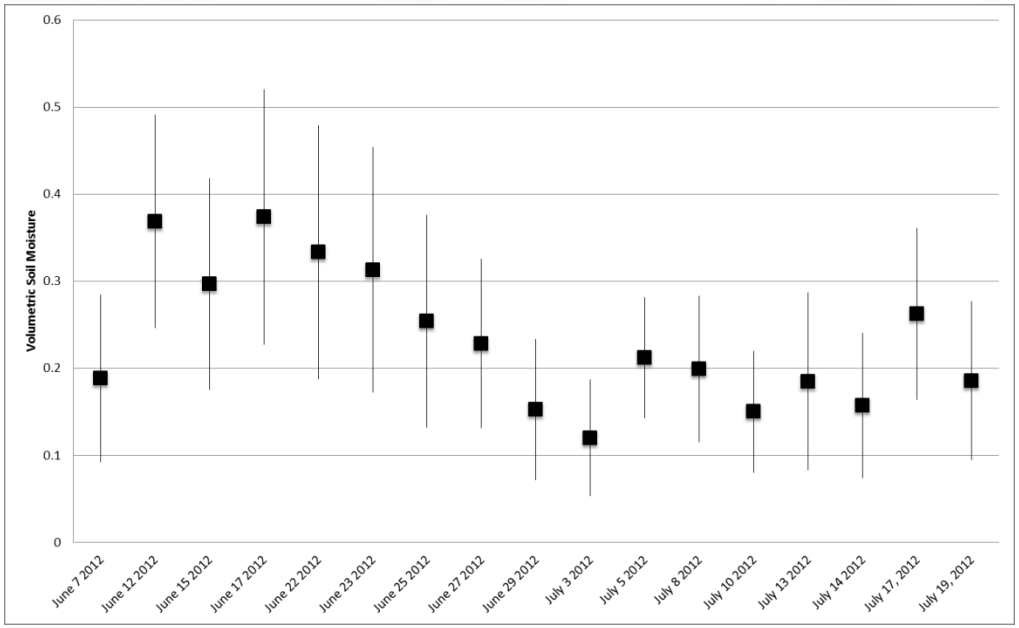
Forest Vegetation Measurements

Destructive measurements (June 29 to July 17) consisted of harvesting/felling an “average” tree

- trunk diameter at each 30 cm interval
- wafer of ~ 3 cm thickness for gravimetric measurements at each 30 cm interval
- primary branch angles
- number of branches (primary, secondary) and leaf count
- all branch lengths, diameters, and when possible, dielectric constant
- 3-4 samples of branches for gravimetric measurements
- note on leaf clumping

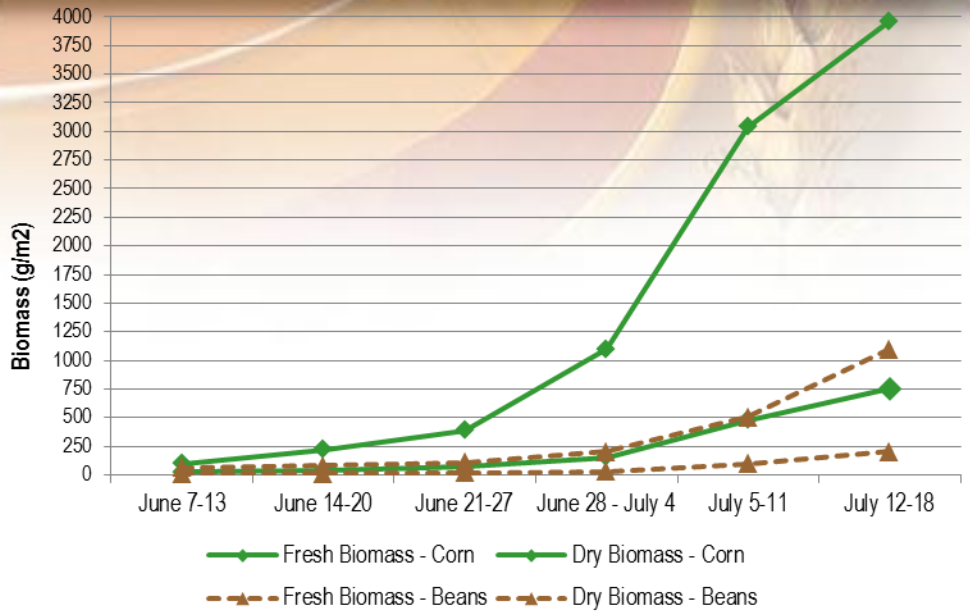
Dielectric measurement using an Agilent field portable network analyzer (FieldFox N9923A)

Soil Moisture Conditions During SMAPVEX

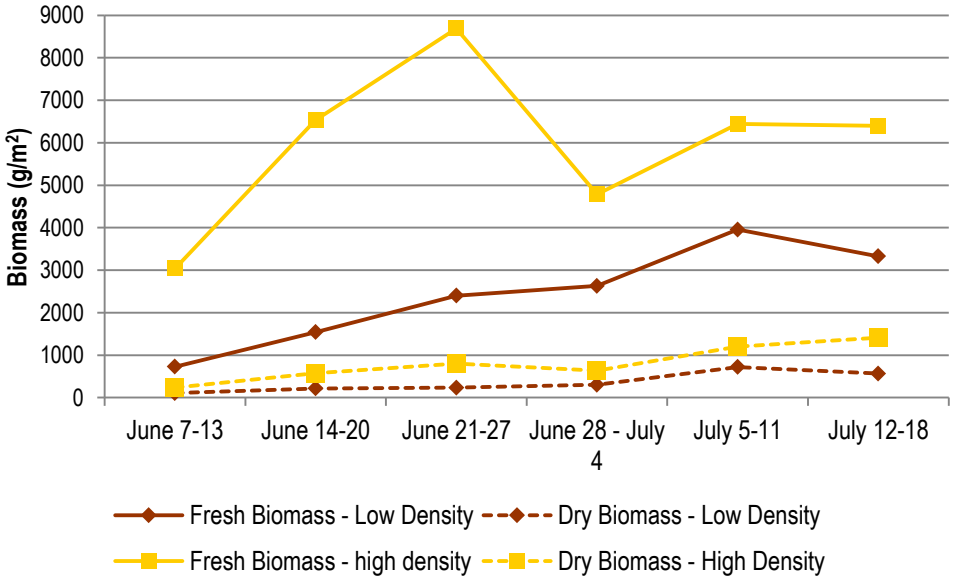


- large variation in soil moisture conditions (> 50% VWC to <10%)
- temporally, wetter conditions early in SMAPVEX followed by dry down and generally drier conditions in latter half with smaller wetting and drying events
- spatially, very large variations in any given day due differences in soil textures among 55 fields

Biomass Conditions During SMAPVEX12



Canola



Corn and Beans

Satellite Acquisitions

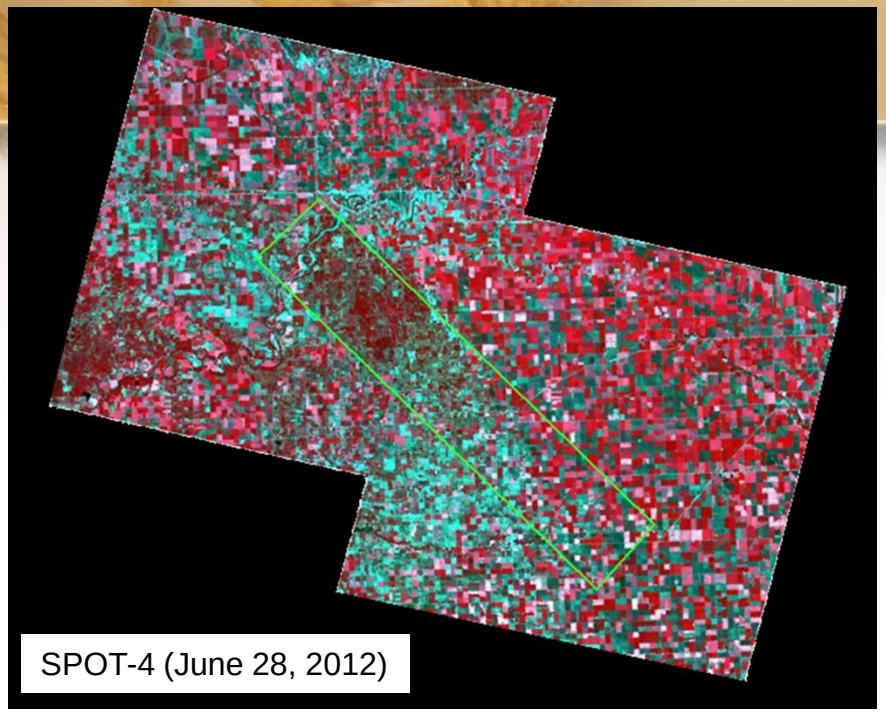
- Optical and SAR satellites programmed

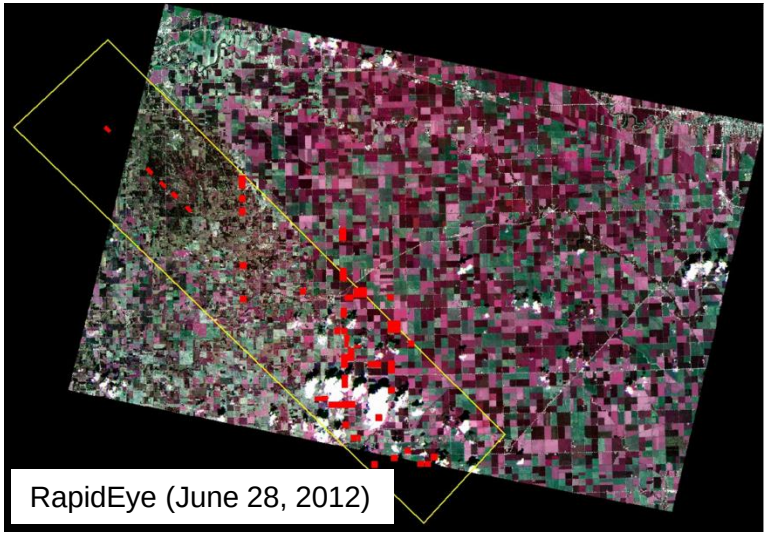
- RapidEye
  - 20 dates from May 14th to September 26th
  - 5 m resolution (B,G,R,RE,NIR)

- SPOT-4/5 images
  - 4 dates (3 complete coverages)
  - Re-sampled to 20 m (B,G,R,NIR)

- SAR Satellites (May to September)
  - 58 Fine Wide Quad-Pol RADARSAT-2 (2-3 frames per date) (partial coverage)
  - 7 Standard Mode RADARAST-2 (dual polarization) (complete coverage)
  - 13 Dsc and 9 Asc TerraSAR-X StripMap (VV, VH) (partial coverage)

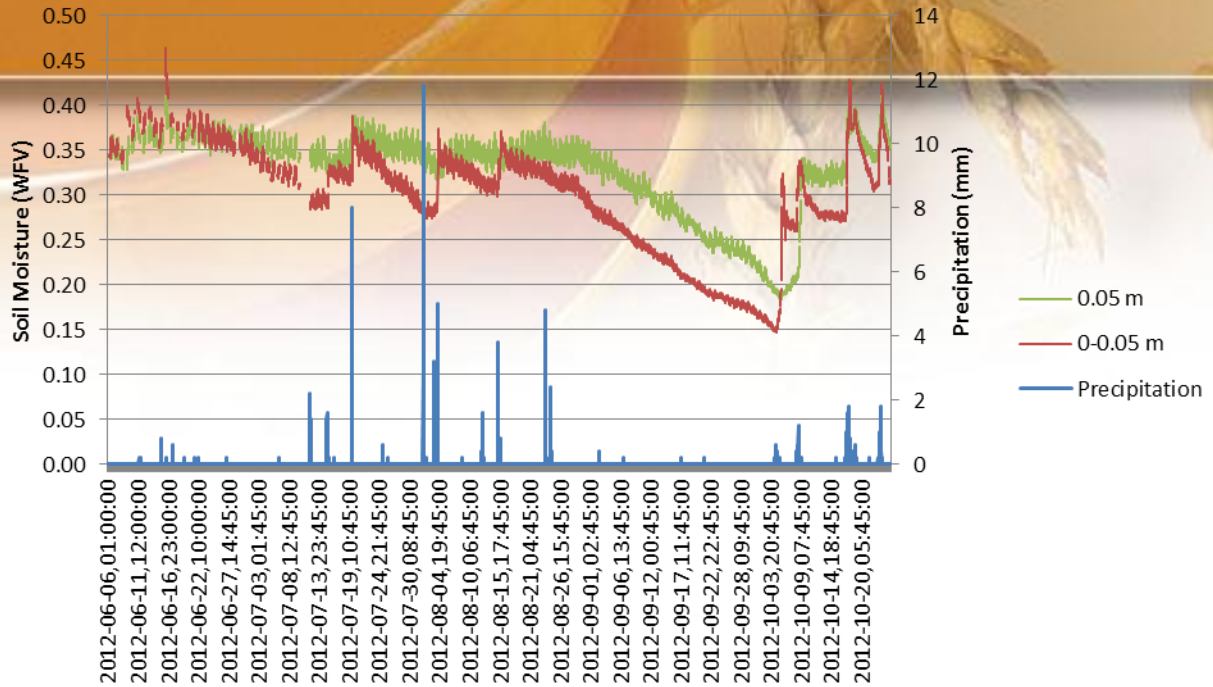
- Restrictions on access due to data licensing


SPOT-4 (June 28, 2012)


RapidEye (June 28, 2012)

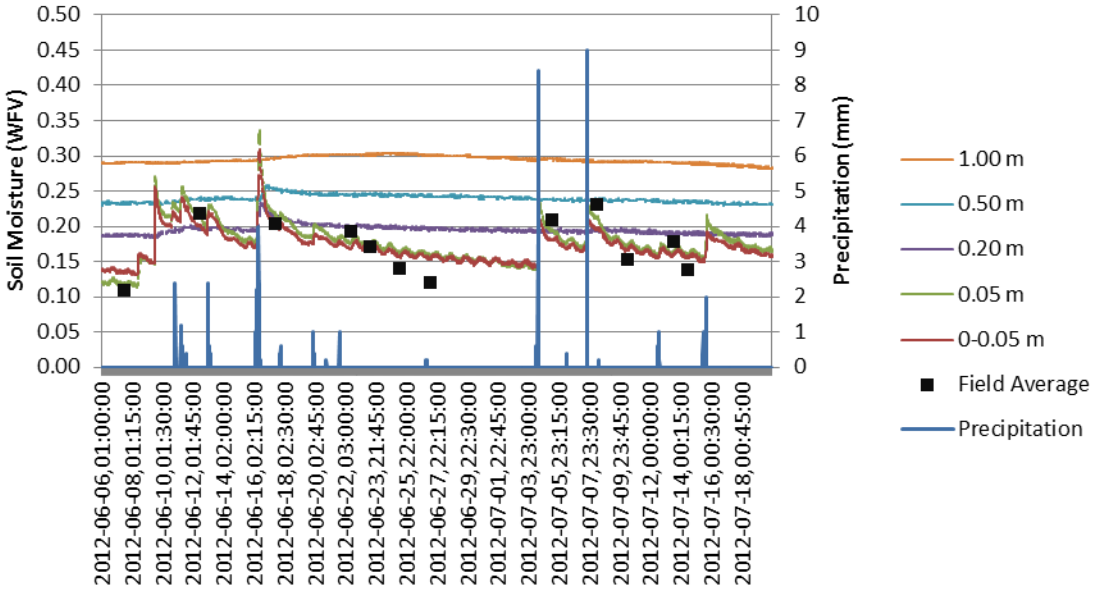
Data Status

- Ground data and PALS data:
  - University of Sherbrooke is hosting SMAPVEX web site http://pages.usherbrooke.ca/smapvex12/
  - Wider distribution August 2013
- UAVSAR data: http://uavsar.jpl.nasa.gov/cgi-bin/data.pl
- Satellite data: licensing restrictions (contact AAFC)
- reports: experimental plan, data collection report, soil moisture calibration report and VWC correction report provided on Sherbrooke web site
- Two outstanding items:
  - Calibration of corn PWC and dry biomass (lab work completed; need to apply correction)
  - SAGES in situ: Resolving problems discovered with some probes - in particular performance in heavy clays at depth and communication gaps



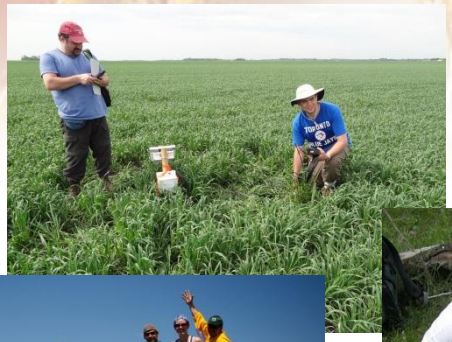
Station 6
Crop: Wheat
Owner: Rempel
Gleyed Humic Vertisol
Texture: Heavy clay (>70%)

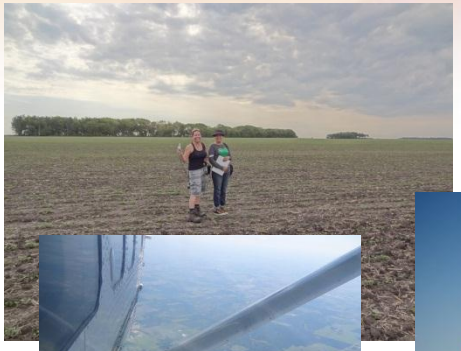
Station 1
Crop: Wheat
Owner: Park
Gleyed Black Chernozem
Texture: Sandy Loam



Acknowledgements

- Thanks to entire SMAPVEX12 team for their hard work and dedication





- We look forward to a successful SMAPVEX15 campaign