



Agriculture and  
Agri-Food Canada

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Agroalimentaire Canada



# Real-time In-Situ Soil Monitoring for Agriculture (RISMA)

Canada

# RISMA Team (Winnipeg Stations)

## **1. Site Characterization, Sensor Installation and Maintenance**

Lead: Jarrett Powers, Nick Lyon, Tom Hansen

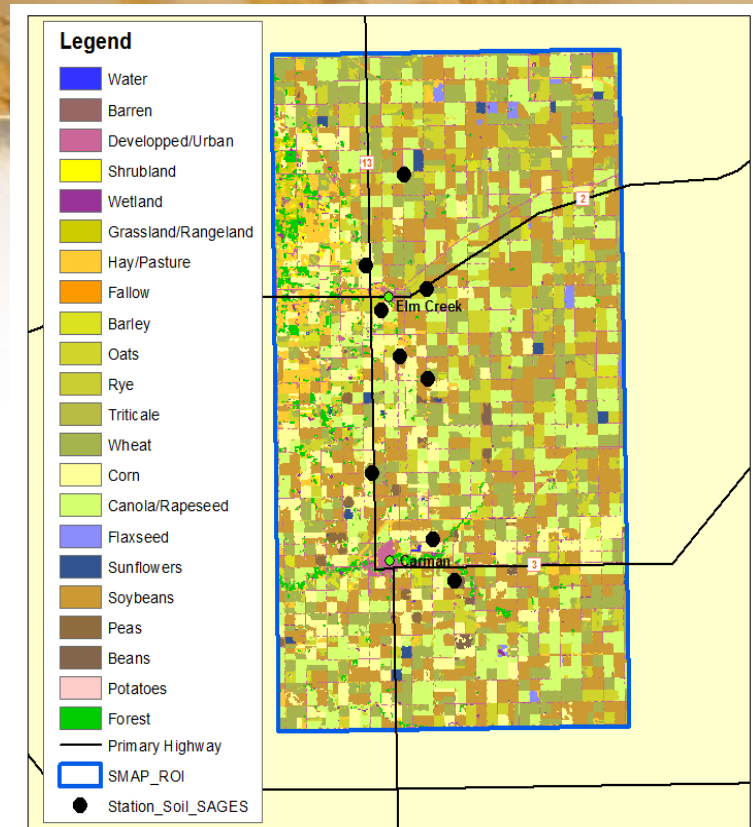
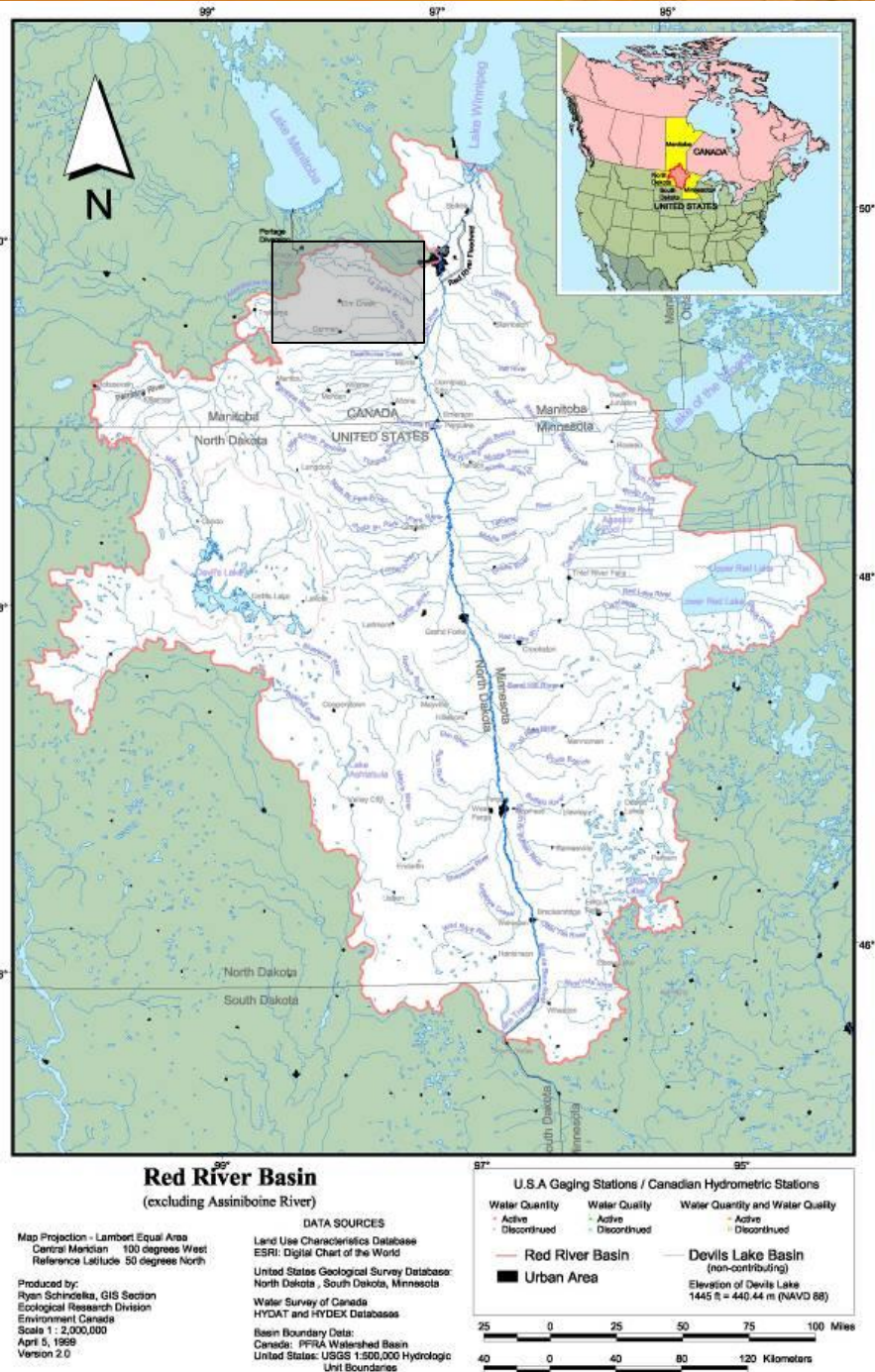
## **2. Sensor Calibration**

Lead: Jessika L'Heureux and Rotimi Ojo (University of Manitoba)

## **3. Near Real Time Data Delivery**

Lead: Jessika L'Heureux, Xiaoyuan Geng, Patrick Rollin, Jarrett Powers, Steve Liang (University of Calgary)

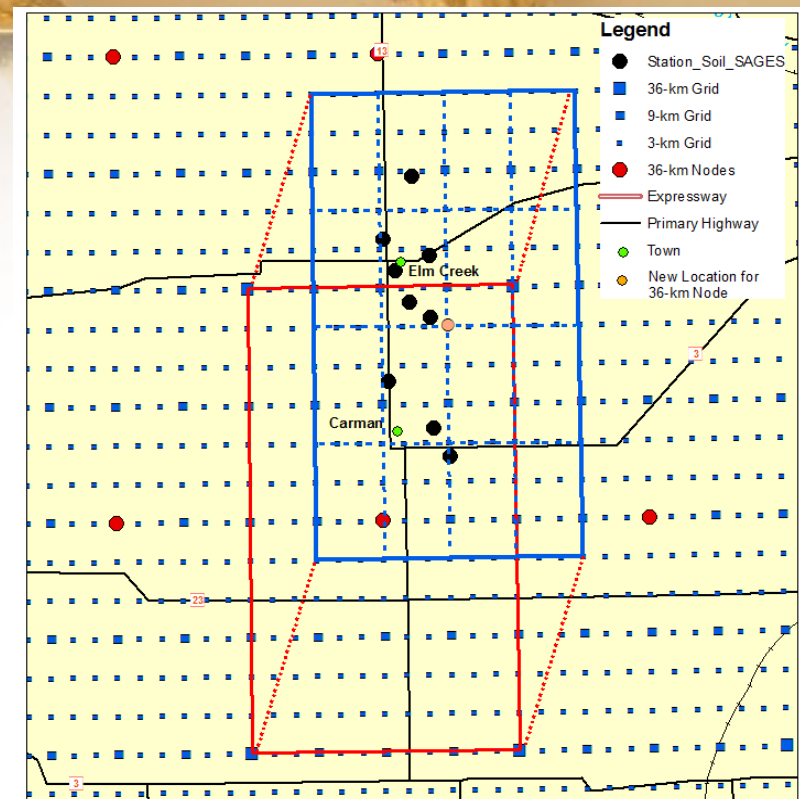
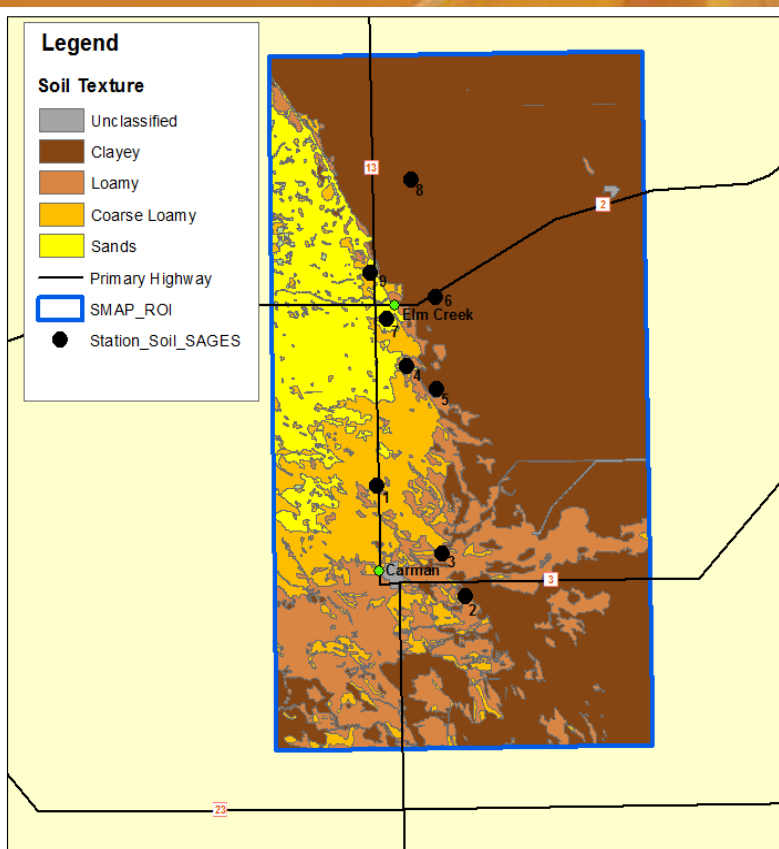
Team: Allan Howard, Heather McNairn, Craig Smith (Environment Canada), Anna Pacheco, Amine Merzouki, Catherine Champagne, Paul Bullock (University of Manitoba), John Fitzmaurice



- 80km southwest of Winnipeg (Manitoba) in the La Salle and Boyne River watershed, in Canada's Prairie/Boreal Plain Ecozone
- distinct soil texture divide between heavy clays/clay loams to the east, and lighter sandy/sandy loam soils to the west
- stations located at the edge of annually cropped agricultural fields (cereals, canola, corn, soybeans)



# SMAP Grid Cell

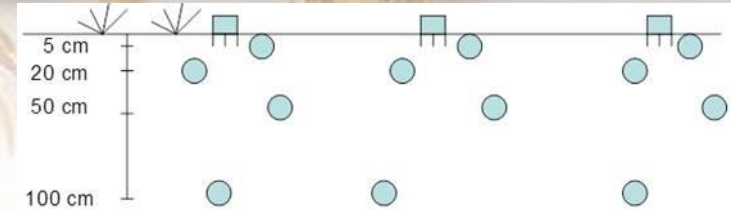


RISMA Network	Soil Texture
Station 1	Coarse Loamy
Station 2	Loamy
Station 3	Loamy
Station 4	Coarse Loamy
Station 5	Clayey
Station 6	Clayey
Station 7	Sands
Station 8	Clayey
Station 9	Sands

- red polygon delineates the original location of the SMAP processing pixel
- blue polygon is shifted processing pixel to maximize coverage of RISMA stations

# Approach to representing the SMAP product

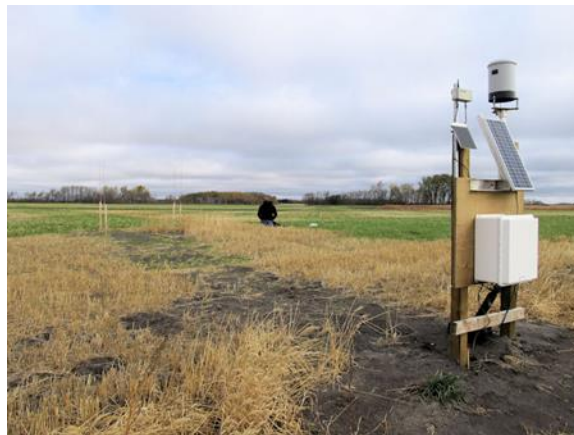
- Measurement Depths: 15 probes per station
- 3 at each depth: 5, 20, 50, 100 cm; 3 vertical measuring 0-5 cm
- 0-5 cm probes will be removed to “till” and re-inserted; regular maintenance to ensure contact with soil



- Stations are at edge of field, but probes cabled 10-30m into field
- Site is hand-seeded as per crop planted in field
- Regular maintenance/spraying
- Hand harvested coincident with field harvest
- If not managed this way, not representative of field (as per station 8 (farmer is certified seed grower and did not want another variety of soybeans planted around the probes))



# Landscape and photos



# Approach to Calibration

- At time of installation, soil cores collected for all depths in order to develop site specific calibration and for particle size analysis
- In 2012-2013, evaluated multiple approaches
  - Bellingham (“factory” calibration using texture classes)
  - Site specific lab calibration: calibration curves developed during lab dry down experiments with cores collected at installation
  - Regional calibration (Rotimi Ojo)
    - field-derived calibrations from 13 permanent sites located within or close to RISMA site
    - sites installed in 2009 and 2010 with a total of 326 calibration points divided into coarse (< 20% clay), medium (20 – 40% clay) and fine soils (> 40% clay)
    - linear model of hydra probe versus field measured (surface only)
  - Based on consensus from calibration team, first order calibration applies station-site specific (lab) curves to clays and regional (Ojo) model to lighter sandy and loam soils
- 2013, U of Manitoba and AAFC collected additional soil cores at all sites (2-3 samples at 5, 20 and 50 cm 9 times over the season). Take undisturbed cores near stations and insert hydroprobe into the core to get RDC reading.

# Approach to Up-scaling

Approach is a simple weighted average based on area representation of soil texture

In-situ Mv (SMAP pixel) =

$$(C_{imv} \times 47.55) + (L_{imv} \times 32.32) + (CL_{imv} \times 8.93) + (S_{imv} \times 11.20) ,$$

where  $C_{imv}$ ,  $L_{imv}$ ,  $CL_{imv}$ , and  $S_{imv}$  are the averages of the in-situ soil moisture for the clayey, loamey, coarse loamey, and sandy in-situ stations, respectively.

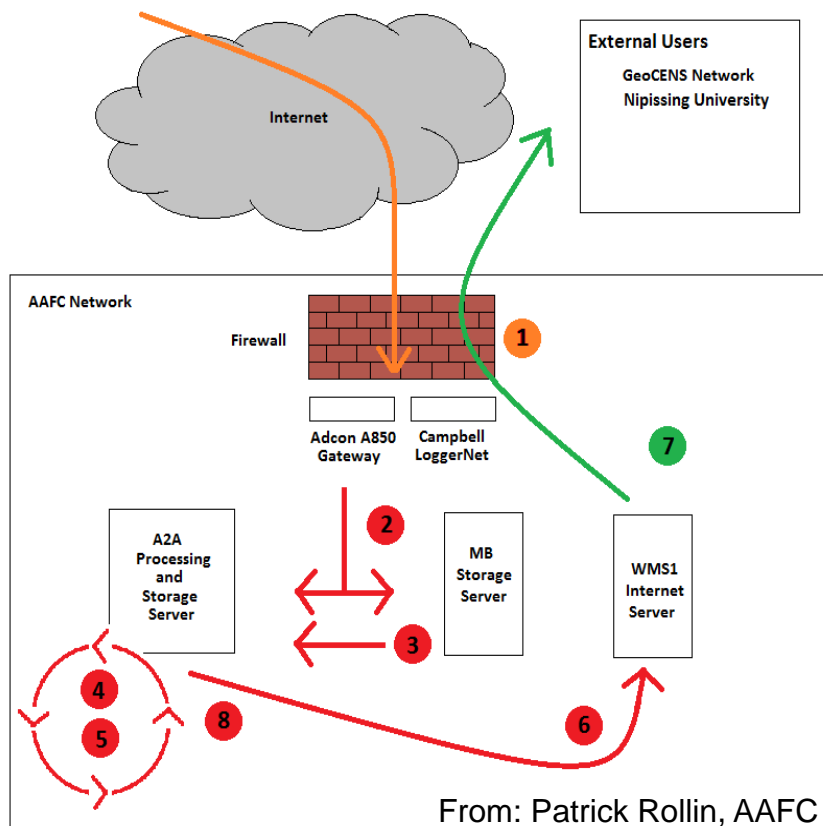
Soil Texture Type	Soil Moisture Average Equation Symbol	In-situ Stations	Percent Area Equation Symbol	Re-calibrated Percent Area
Unclassified				
Rock				
Clayey	$C_{imv}$	5-6-8	$C_a$	47.55
Loamy	$L_{imv}$	2-3	$L_a$	32.32
Coarse Loamy	$CL_{imv}$	1-4	$CL_a$	8.93
Sands	$S_{imv}$	7-9	$S_a$	11.20
Organic				



# Data Access

Windows Server Task Scheduler (called every hour):

- 3 – Data pulled to a location on the AAFC server for processing
- 4 – Sensor Measurement Calibration applied
- 5 – Soil Moisture Calibration Quality Control performed
- 6 – Data uploaded to WMS1 out-facing internet server
- 7 – Data pulled by “External Users” by building URLs from specified log file parameters



From: Patrick Rollin, AAFC

## Agriculture and Agri-Food Canada

### Real-time In-Situ Soil Monitoring for Agriculture (RISMA)

#### About

Soil moisture is a critical variable in agri-environmental monitoring as it often determines rates of crop growth and productivity, rates of soil biogeochemical processes that impact soil fertility and determines boundary layer conditions that drive meteorological processes. In 2010 and 2011, Agriculture and Agri-Food Canada (AAFC), with collaboration from Environment Canada, established three in situ monitoring networks near Kenaston SK, Carman MB and Casselman ON as part of the Sustainable Agriculture Environmental Systems (SAGES) project titled Earth Observation Information on Crops and Soils for Agri-



Environmental Monitoring in Canada. The near real time in situ soil moisture/temperature and precipitation data from these three networks are used to calibrate and validate remote sensing and modelled soil moisture products. By 2014, most of the in situ stations in the Saskatchewan and Manitoba networks will be equipped with additional meteorological sensors to complement the existing data with air temperature, relative humidity, wind speed and wind direction. For more information, [click here](#).

Acknowledgements: AAFC acknowledges the land owners for permission to use their land for stations and surveys; Environment Canada for site maintenance, site collaboration and technical support; University of Guelph and University of Manitoba for technical support; University of Saskatchewan for site collaboration; and University of Calgary for web site support.



#### Browse

Click on the Browse Button or the Browse Tab above for an interactive map of the network station locations and to view graphs of current and past data, click on the station of interest. Data can also be viewed and downloaded by clicking on the Data tab above. Sign up and log-in to download data series. For more detailed information about the data and the network stations, [click here](#).

[Goto Browser »](#)

#### Explore Networks

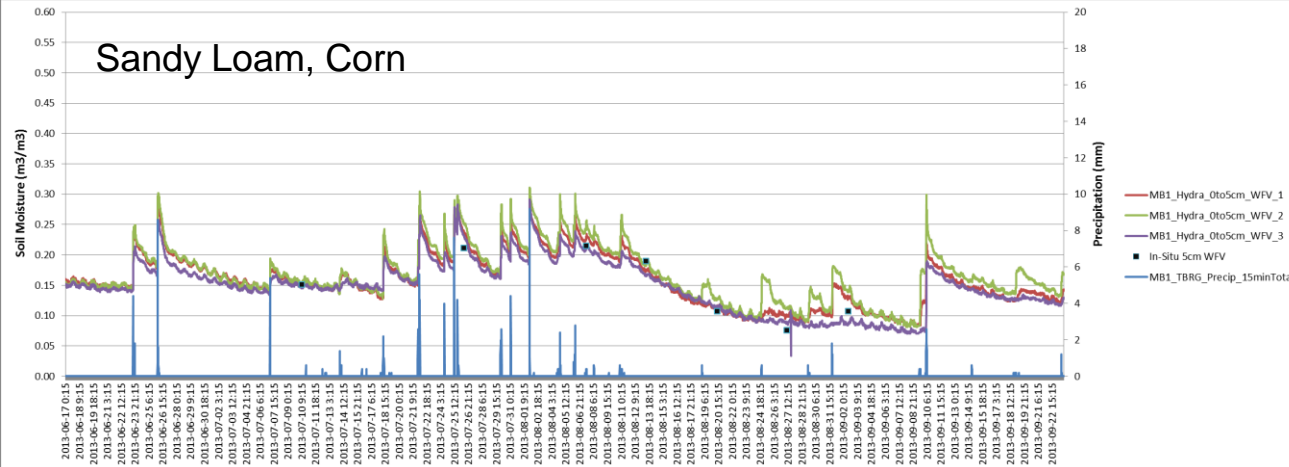
In-situ monitoring networks with near-real time soil moisture, soil temperature and meteorological data have been established in Saskatchewan, Manitoba and Ontario to capture conditions for the main agricultural crop types, soil textures and ecozones in Canada. The data can be used by local producers for day to day operational decisions or for scientific verification and calibration of remote sensing products, modelling, flood forecasting and drought monitoring.

[View Networks »](#)



# Sample Data

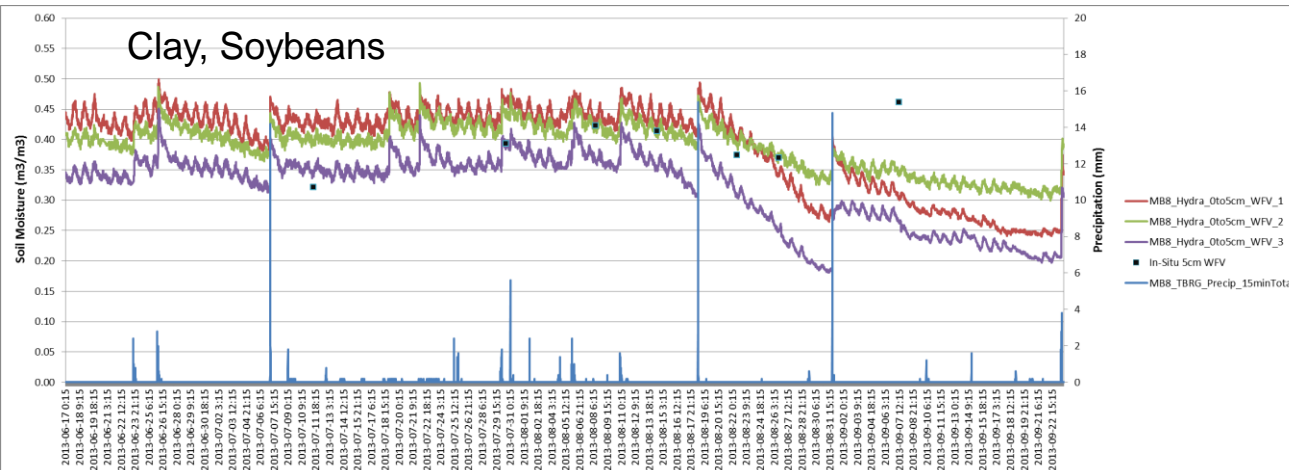
## Sandy Loam, Corn



### Issues encountered

- heavy clays (up to 70%) and suspected high salinity causing noise especially at depth (are large part of landscape and must be addressed)
- sensor malfunction, but with 3 sensors have redundancy

## Clay, Soybeans



- variability among sensors (is this representative of site variability; sunlight and shaded soils due to crop; uptake of water by crops)
- some sensors get “stuck” not responding to rain events; others affected by large cracks?