Real-time In-Situ Soil Monitoring for Agriculture (RISMA)
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)
- 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 hydra probe into the core to get RDC reading.
Approach to Up-scaling

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

\[
\text{In-situ Mv (SMAP pixel)} = (C_{inv} \times 47.55) + (L_{inv} \times 32.32) + (CL_{inv} \times 8.93) + (S_{inv} \times 11.20),
\]

where \(C_{inv}, L_{inv}, CL_{inv},\) and \(S_{inv}\) are the averages of the in-situ soil moisture for the clayey, loamy, coarse loamy, and sandy in-situ stations, respectively.

<table>
<thead>
<tr>
<th>Soil Texture Type</th>
<th>Soil Moisture Average Equation Symbol</th>
<th>In-situ Stations</th>
<th>Percent Area Equation Symbol</th>
<th>Re-calibrated Percent Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclassified</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Rock</td>
<td></td>
<td></td>
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<tr>
<td>Clayey</td>
<td>(C_{inv})</td>
<td>5-6-8</td>
<td>(C_a)</td>
<td>47.55</td>
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<tr>
<td>Loamy</td>
<td>(L_{inv})</td>
<td>2-3</td>
<td>(L_a)</td>
<td>32.32</td>
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<tr>
<td>Coarse Loamy</td>
<td>(CL_{inv})</td>
<td>1-4</td>
<td>(CL_a)</td>
<td>8.93</td>
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<tr>
<td>Sands</td>
<td>(S_{inv})</td>
<td>7-9</td>
<td>(S_a)</td>
<td>11.20</td>
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<tr>
<td>Organic</td>
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</tbody>
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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
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
- 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?