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Calibration of soil moisture-monitoring networks for use as validation for remotely sensed soil moisture products

Environment Canada and University of Guelph support of CanEx-SM10

Aaron Berg, University of Guelph

Brenda Toth, Al Pietroniro of HAL MSC Environment Canada

Craig Smith, Anne Walker of CRD, S&T Environment Canada

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National Laboratory for Hydrometeorology and Arctic Meteorology (Edmonton, AB Saskatoon SK and Winnipeg MB)

The major focus of the Hydrometerology and Arctic Lab (HAL) is on research and development of tools to assist in hydrological prediction.

To better describe water availability in arid regions of Canada the HAL is using both

- ***modelling*** **and**
- ***remote sensing*** **tools**

to more effectively assess soil moisture as one of the major controls on the hydrological cycle.

Very successful partnerships with the Universities of Guelph and Sherbrooke in remote sensing campaigns during 2007, 2008, 2009

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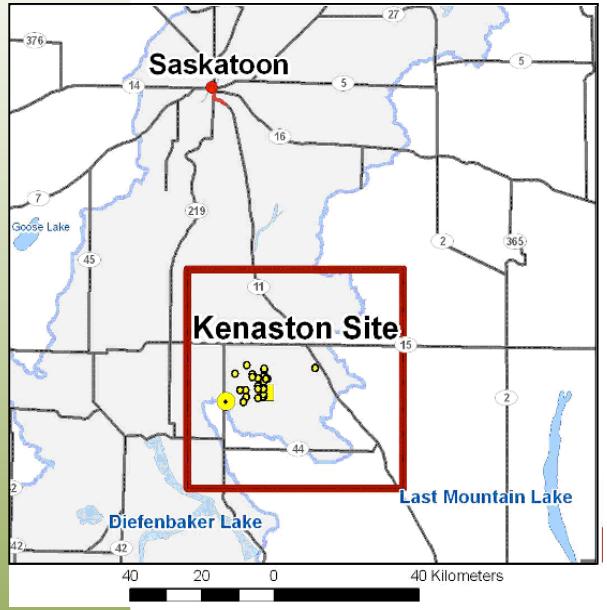
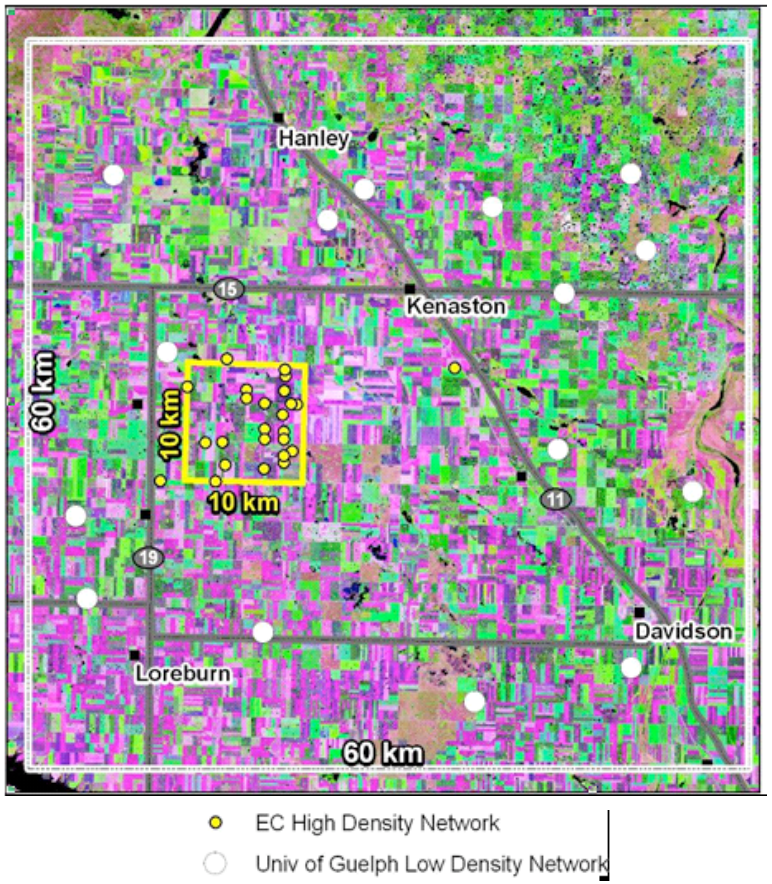
Study site – Kenaston/Brightwater Creek





- 24 sites (EC)
- 10 x 10 km grid

- Additional 16 sites (U of Guelph)
- 60 x 60 km grid

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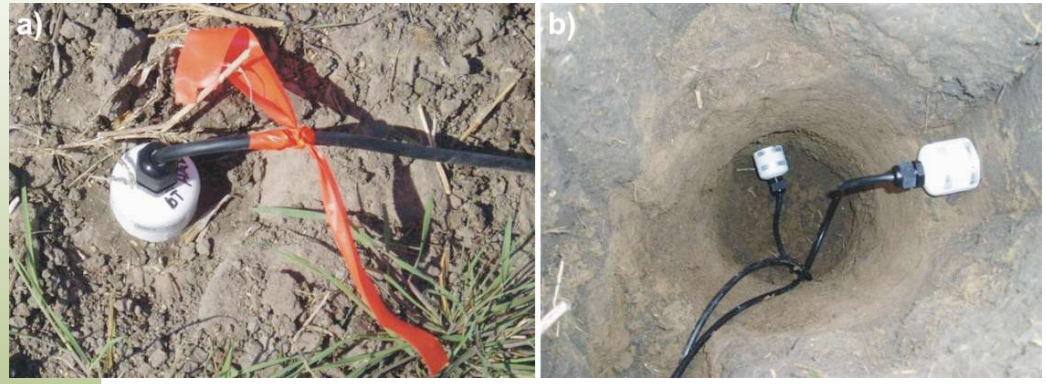
Typical Soil Moisture/Precip site

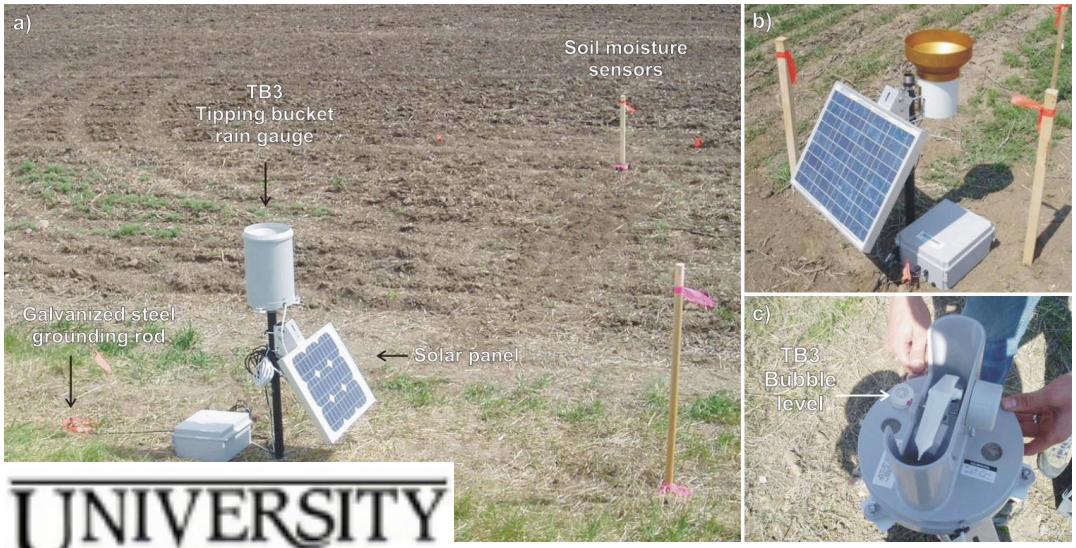


3 depths/orientation
•5 cm vertical (EC), horizontal (EC and U of G)
•20 cm horizontal
•50 cm horizontal
Stevens Hydra Probe II
Site specific calibration

EC 24 sites
U of G 16 sites

Temporal Frequency :
Hourly

Variables Observed:
Soil temperature
Soil Moisture
Precipitation



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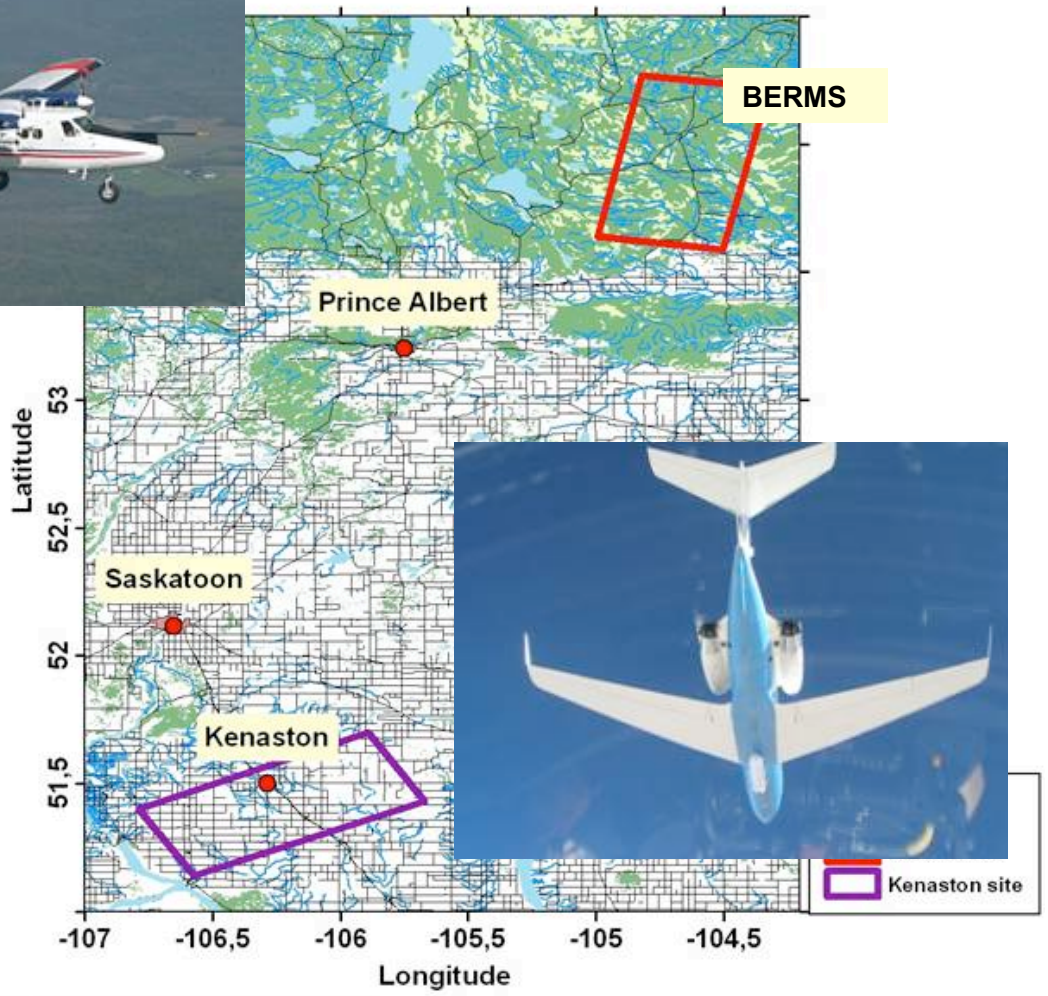
Collaboration – CanEx-SM10

SMOS validation
SMAP pre-launch algorithm development



Partners
EC, NASA, AAFC, CSA, U of Guelph, U of Sherbrooke

Kenaston
40 times series sites+ 20 additional ground truth sites

BERMS
20 time series sites + temporary time series sites + additional ground truth sites

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KENaston campaign

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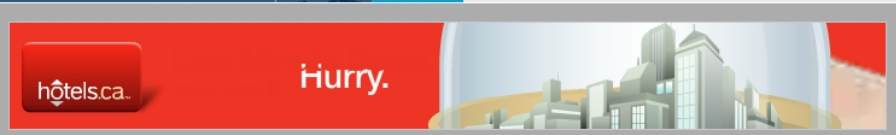
NASA502
(all flights) (photos)
National Aeronautics And Space Administration "NASA"
Houston, TX

Get notified of this flight's activity.

Aircraft	Gulfstream Aerospace Gulfstream 3 (twin-jet) (GLF3/ - track or photos)
Origin	Saskatoon Int'l (CYXE - track or info)
Destination	Saskatoon Int'l (CYXE - track or info)
	Other flights between these airports
Route	YPA111072 YXE182047 YXE102064 YXE180049 YXE194063 YXE119053 YXE104066 YXE178051 YXE192065 YXE120055 YXE105068 YXE176053 YXE192065 YXE120055 YXE106070 YXE174055 YXE108072 YXE173058 YXE109074 YXE172060
Date	Wednesday, Jun 09, 2010
Duration	Unknown
Status	*result unknown (?)* (track log and graph)

	Scheduled	Actual/*Estimated*
Departure	01:40PM UTC	01:25PM UTC
Arrival	01:40PM UTC	*result unknown (?)* (track log and graph)
Speed	440 kts	
Altitude	41000 feet	



Remark on this Aircraft (NASA502) » | Remark on this Flight (CYXE-CYXE) »

ACTIVITY LOG — Want a full history search for NASA502 dating back to 2005? Buy now. Get it within one hour.

Date	Type	Origin	Destination	Departure	Arrival	Duration
09-Jun-2010	GLF3	Saskatoon Int'l (CYXE)	Saskatoon Int'l (CYXE)	01:25PM UTC	*result unknown (?)*	n/a
06-Jun-2010	GLF3/Q	Saskatoon Int'l (CYXE)	Saskatoon Int'l (CYXE)	01:25PM UTC	05:28PM UTC	4:03
05-Jun-2010	GLF3/Q	Saskatoon Int'l (CYXE)	Saskatoon Int'l (CYXE)	01:40PM UTC	01:21PM UTC	n/a
02-Jun-2010	GLF3/Q	Saskatoon Int'l (CYXE)	Saskatoon Int'l (CYXE)	01:55PM UTC	06:00PM UTC	4:05
01-Jun-2010	GLF3/Q	(R2508)	Saskatoon Int'l (CYXE)	04:29PM GMT	07:21PM UTC	2:52
01-Jun-2010	GLF3/Q	Edwards Afb (KEDW)	Saskatoon Int'l (CYXE)	09:29AM PDT	07:15PM UTC	2:46
26-May-2010	GLF3/Q	Palmdale Regional (KPMD)	Palmdale Regional (KPMD)	09:51AM PDT	12:33PM PDT	2:42

...on't worry, it's free and easy.)

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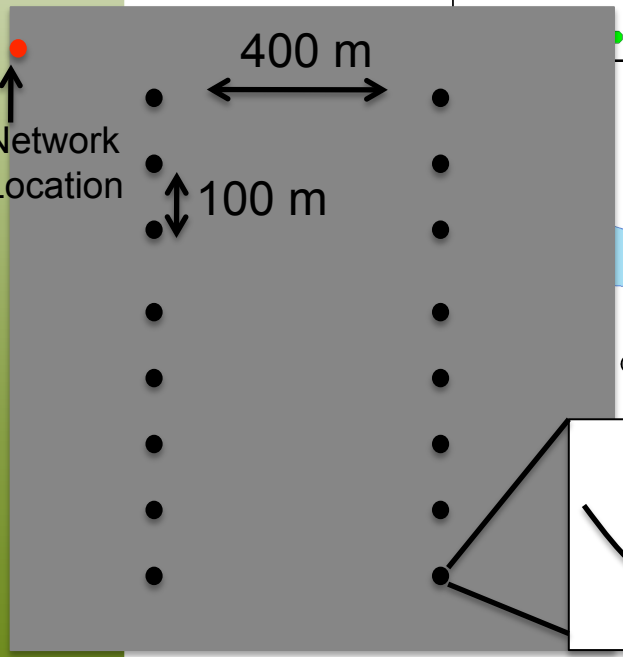
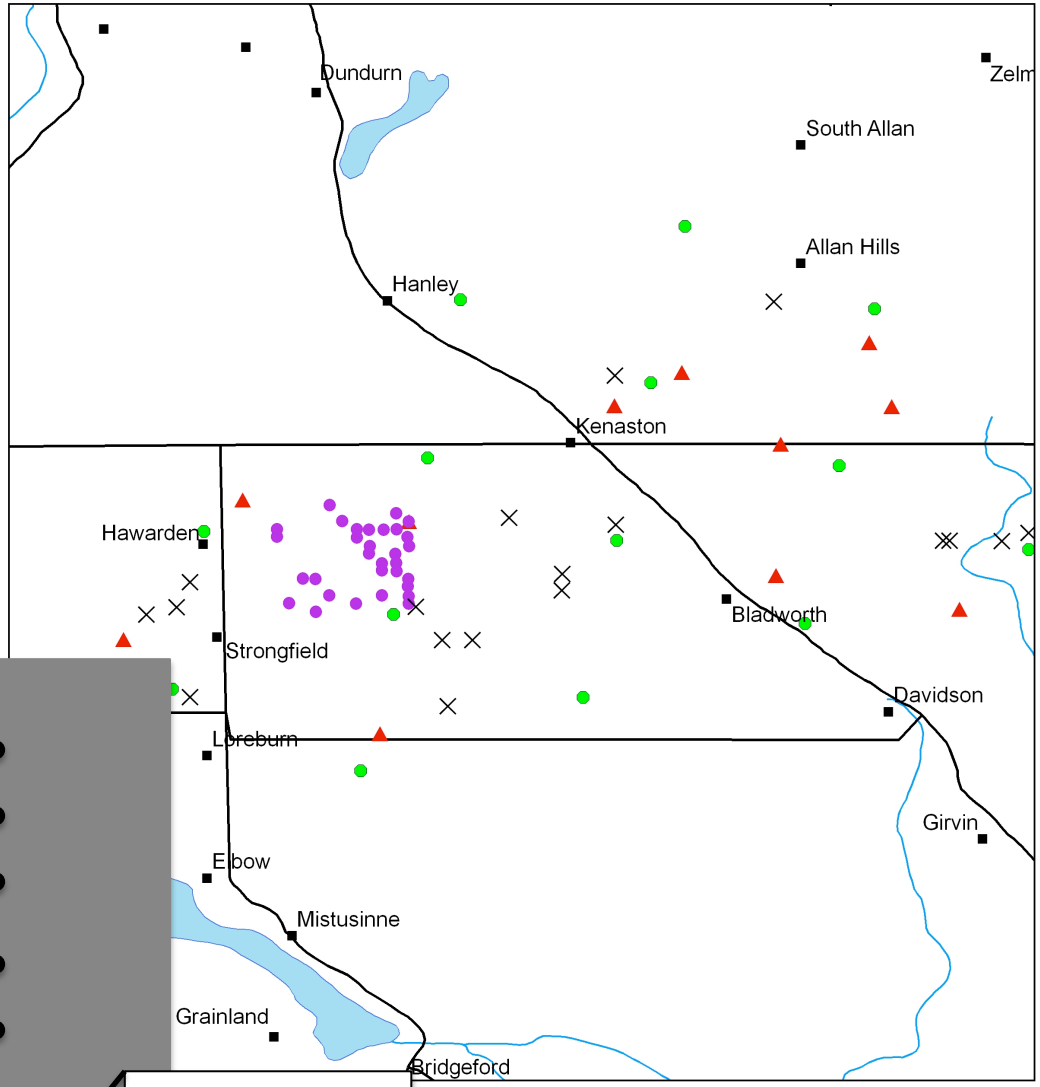
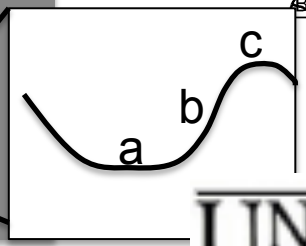
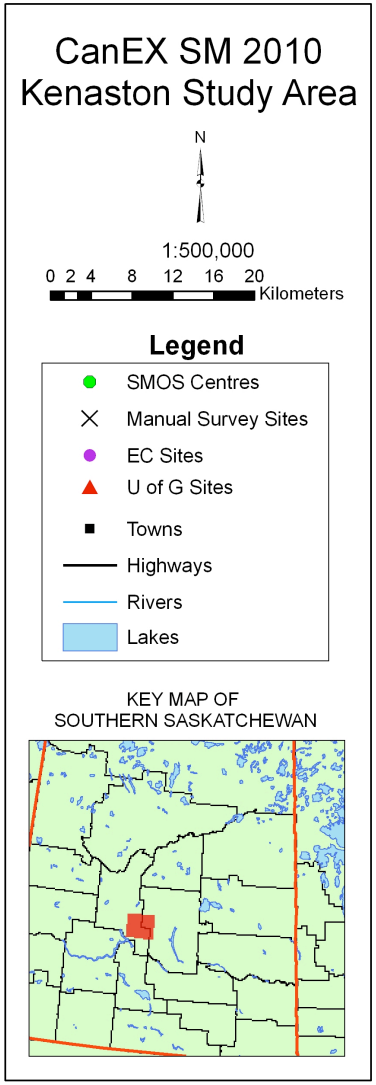
Networks sensors are at only one location









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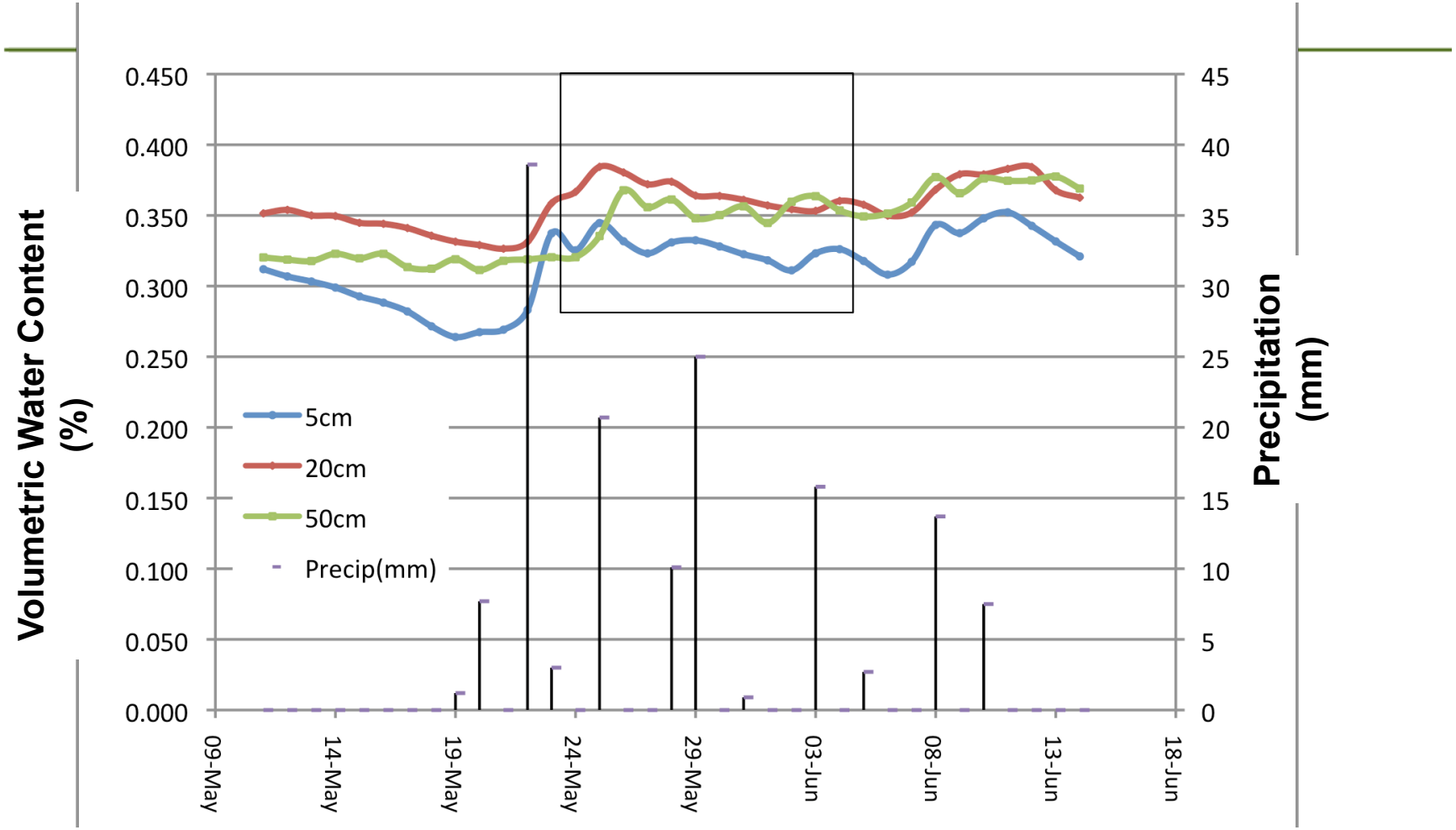
How representative is an *in situ* network compared to measurements taken over the field?



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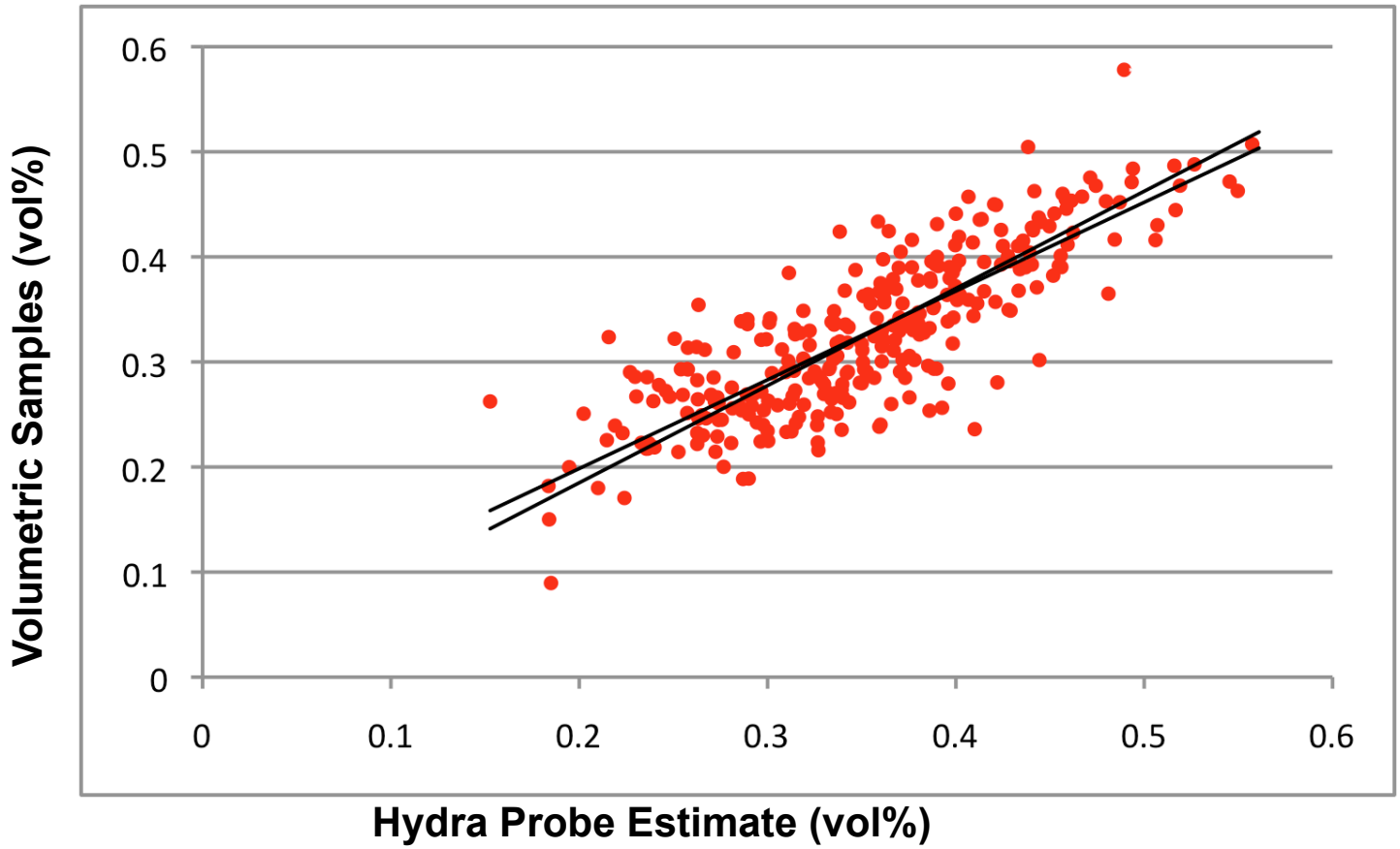
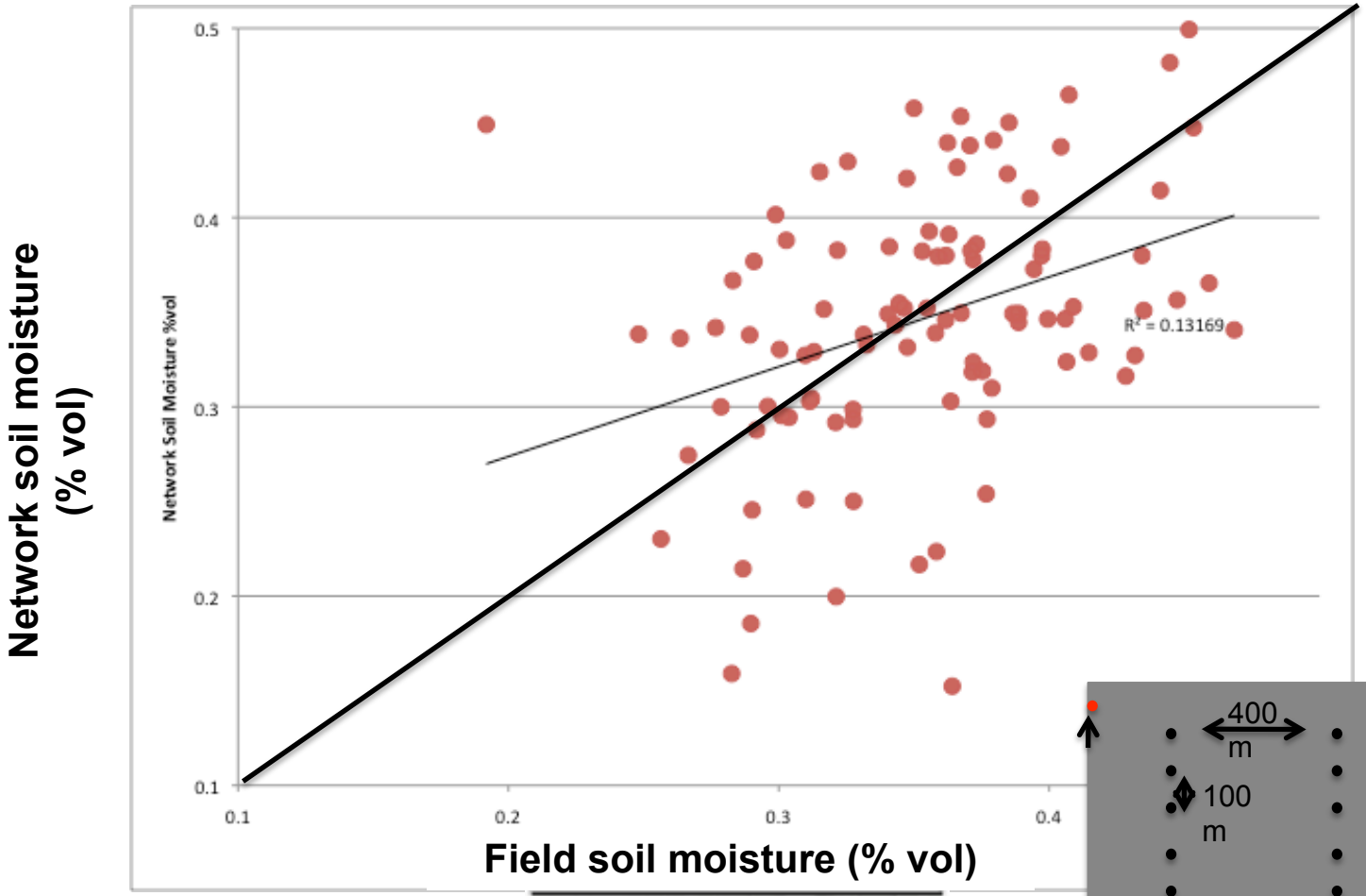
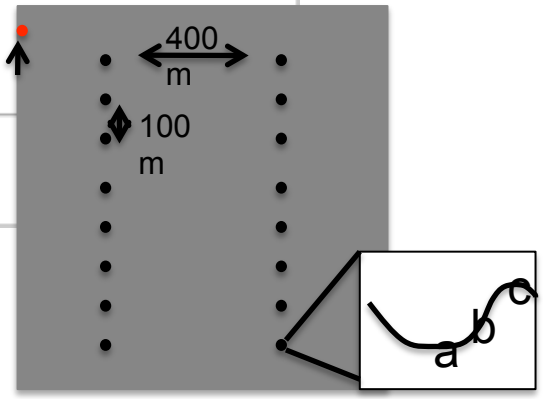
Calibration of Portable *in situ* Sensors



Network to Field Comparisons





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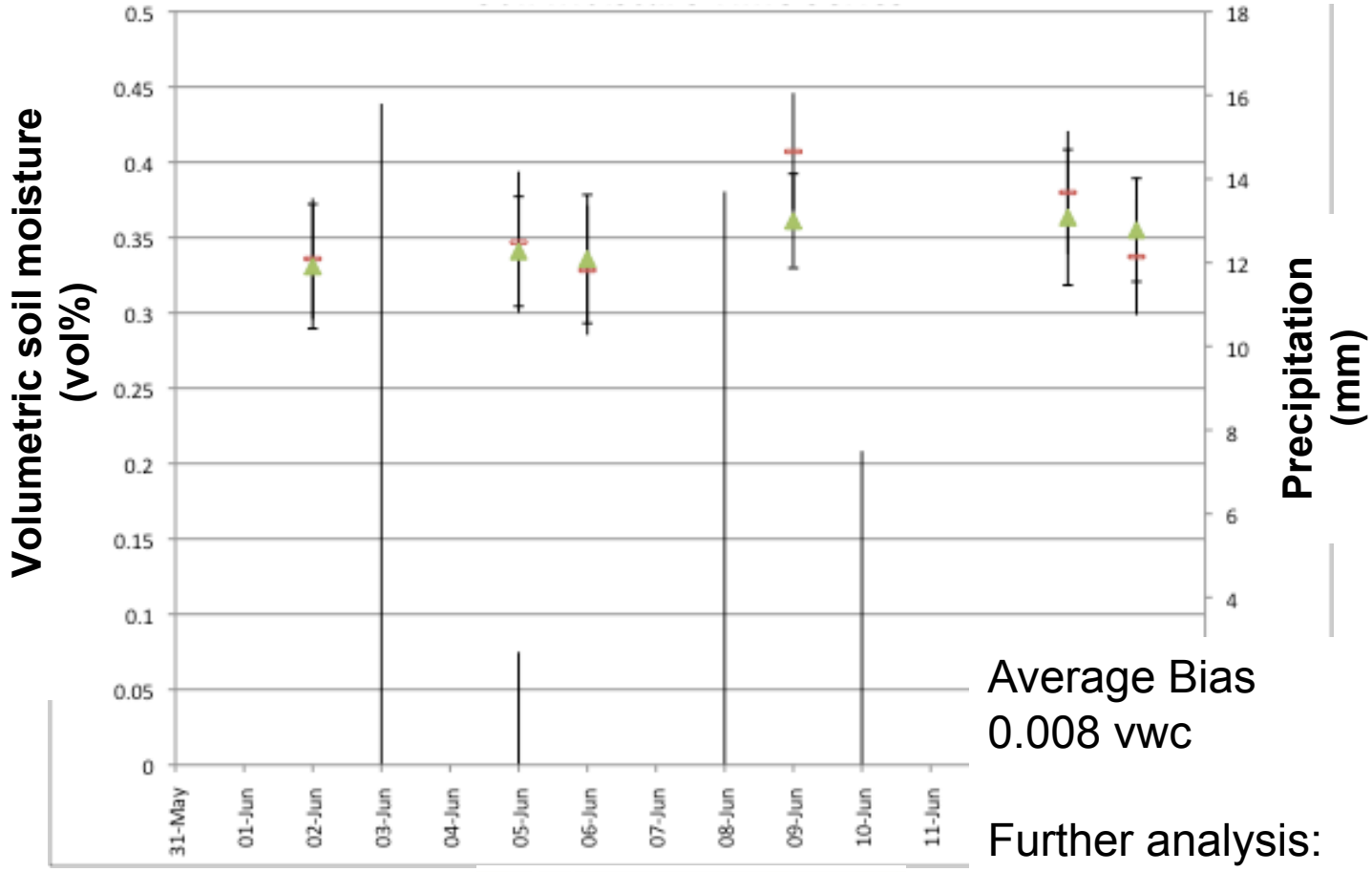
Network and *In Situ* Time Series



Average Bias
0.008 vwc

Further analysis:
Disaggregate to texture
Sensor orientation
Field/edge of field sensors

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Datasets – CanEx-SM10

- **Satellite acquisition**
  - SMOS, Radarsat-2, ALOS PALSAR, SPOT
- **Completed Flights**
  - EC Twin Otter, UAVSAR
- **Summary of Data - Kenaston**
  - Time series data – U of G sites and EC sites
    - Precipitation, soil moisture, soil temperature
  - Manual Surveys
    - Soil moisture
      - Surveys and field calibration data
        - » volumetric soil moisture, soil bulk density, soil texture
    - Surface roughness, Vegetative water content, LAI, MSR, Soil temperature data
- **Summary of Data – BERMS**
  - BERMS permanent sites - long term time series data
  - BERMS temporary sites - short term time series data
    - Bulk density and soil texture
  - BERMS ground data collection during the campaign
    - Vegetation, soil moisture
- **Summary of Data – ancillary data**
  - Flux tower data, Geologic weighing lysimeter
  - 24 accumulated precipitation radar
  - crop identification

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EC and U of G Networks as validation tools; lessons learned for core cal/val sites during CanEx-SM10

- Time series data, long term ***calibrated*** soil moisture for 24 sites over 10 x 10 km area, additional 16 sites over 60 x 60 km
  - Network data will be most valuable for correlation analysis
  - Questions of root mean square or bias require a calibrated network
- Ground campaign support
  - Survey for additional 20 suitable fields (KEN) and temporary sites (BERMS)
  - Participation in drafting protocols and support documentation
  - Extensive solicitation for field support staff
  - Availability of suitable facilities (labs, meeting spaces, drying ovens, computers, data storage)
  - Field training
  - Procurement (accommodations, vehicles and fuel, telecommunications, probes, cameras)

EC and U of G roles in CanEx-SM10 and lessons learned for core cal/val

- Ground support (continued)
  - Occupational Health and Safety considerations
  - Communications plan (possibly specific to federal government)
  - 24 hour access to weather support
  - Resources for post campaign data coordination, data entry and data analysis.

- Ancillary data and products are useful
  - Web post of past soil moisture
  - Soil texture
  - Meterological data
  - Radar data products
  - Weighing lysimetric data
  - Crop identification

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Acknowledgements

Planning and Execution

- Ramata Magagi (U of Sherbrooke)
- Stephane Belair (EC)
- Heather McNairn (Ag Canada)
- Anne Walker (EC)
- Tom Jackson, Mike Cosh
- Peggy O'Neill, Andreas Colliander

Funding for the ground campaign

- Canadian Space Agency
- above plus University of Guelph

Ground campaign

- 34 volunteers, students, technicians researchers, scientists
- Over 50 with inclusion of flight crews and other contributors

In-situ Network support

- Environment Canada
- University of Guelph
- National Snow and Ice Data Center
- Agriculture and Agriculture and Agri-Food Canada
- National Science and Engineering Research Council
- Ontario Ministry of Agriculture Food and Rural Affairs
- Canadian Foundation for Innovation
- Ontario Research Trust
- Canadian Foundation for Climate and Atmospheric Science

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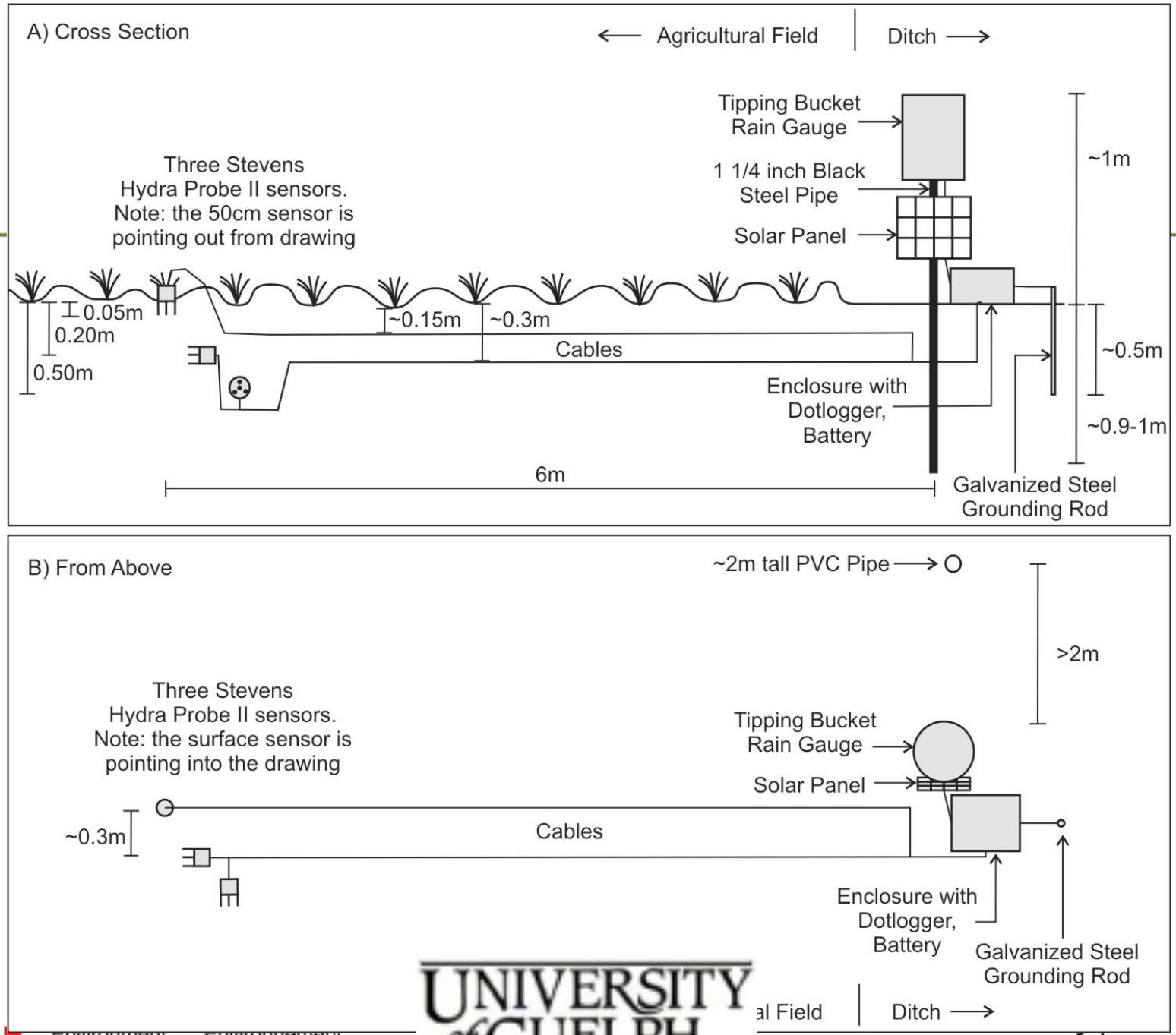

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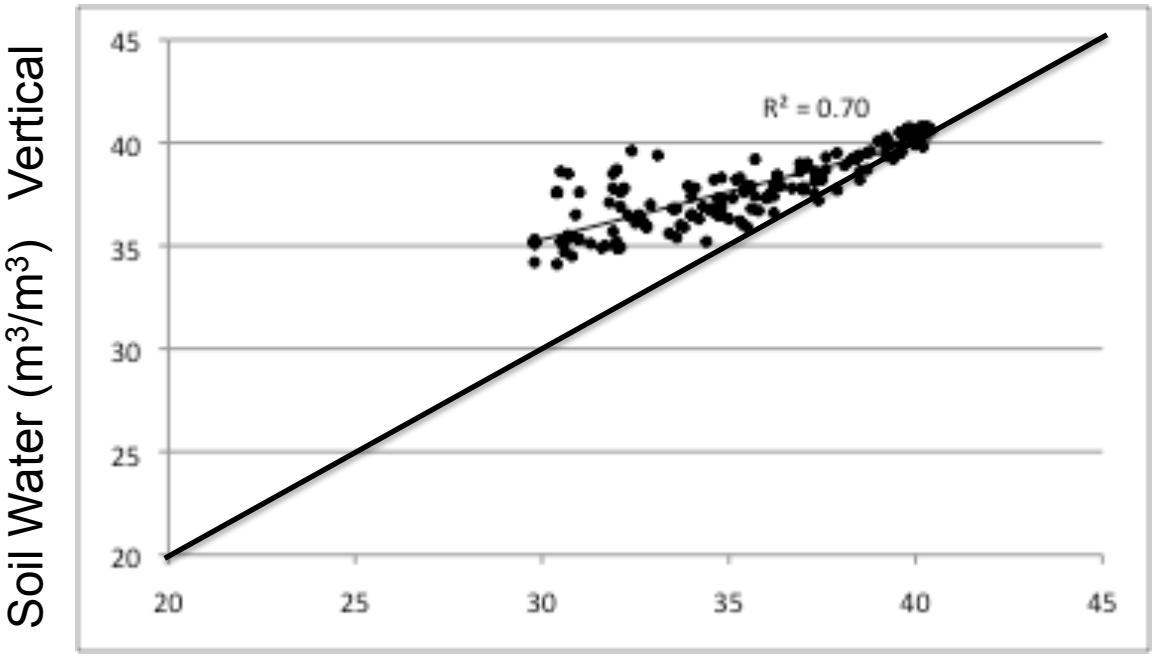
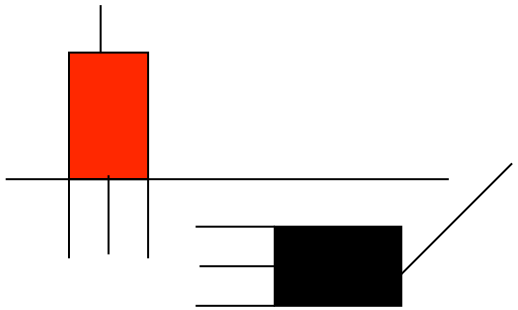
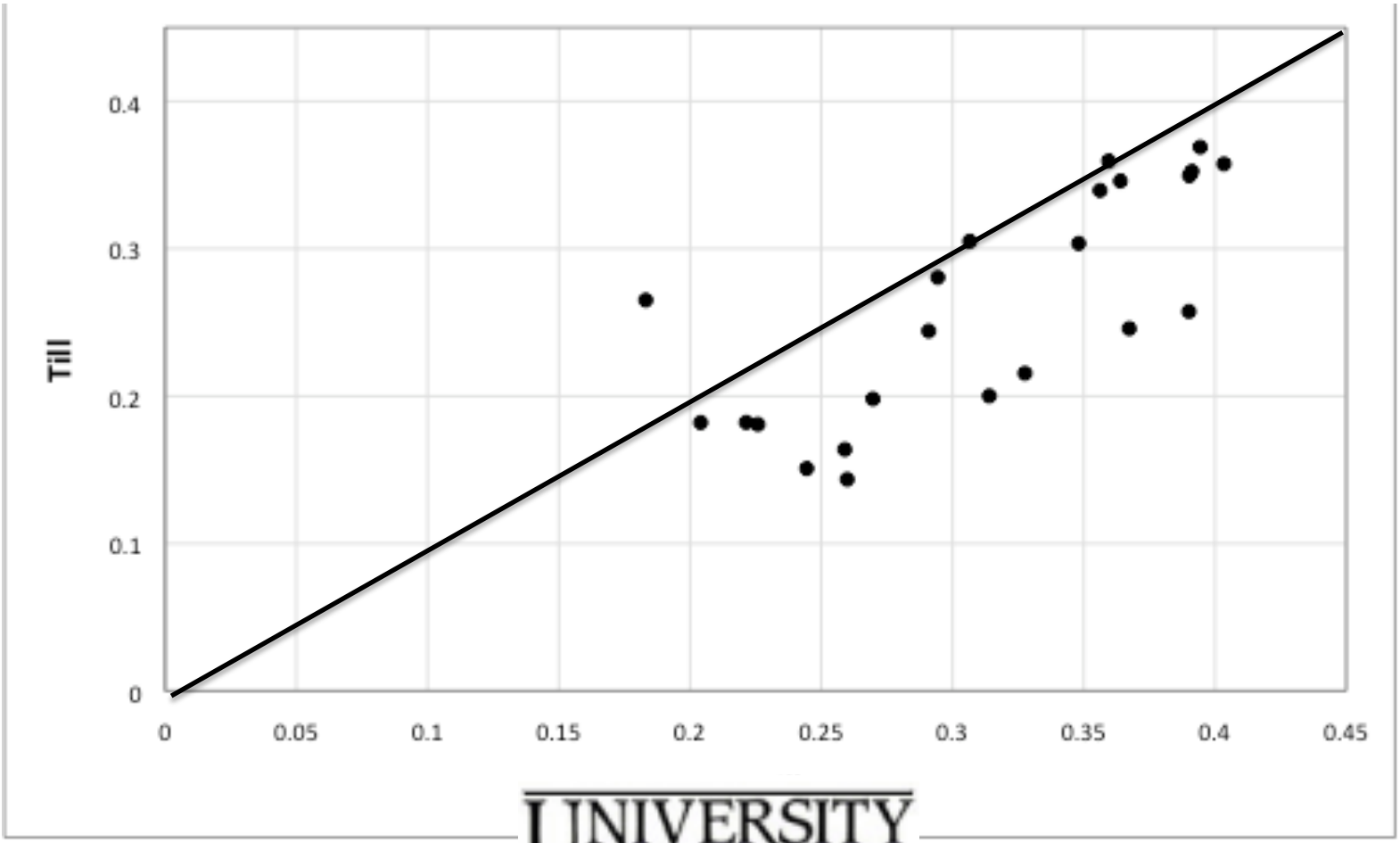
Impacts of Sensor Orientation?





Impacts of Land-use Practices
Tillage



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