# Soil moisture retrieval and Freeze/Thaw analysis

## U of Sherbrooke research plan

Ramata Magagi and Kalifa Goïta

2nd Canadian SMAP Workshop, 16-17 November, 2010

UNIVERSITÉ DE SHERBROOKE

Cartel Centre d'applications et de recherches en télédétection

# Soil moisture retrieval and Freeze/Thaw analysis

- Current research
  - → agricultural areas in Saskatchewan and Quebec
- Research plan in the context of SMAP
- Benefits

# Current research (1)

- **Soil moisture**

| Soil Moisture | |
|---|---|
| **Objectives** | **Methods** |
| **Estimation of soil moisture over the Mackenzie Basin (Robert Leconte)** | **Inversion of RTM** |
| **Potential of Radarsat-2 linear polarizations data for soil moisture estimation over agricultural fields** | **Inversion of RTM** |
| **Aggregation method of soil moisture to the spatial resolutions of Radarsat-2** | **Geostatistical approach** |

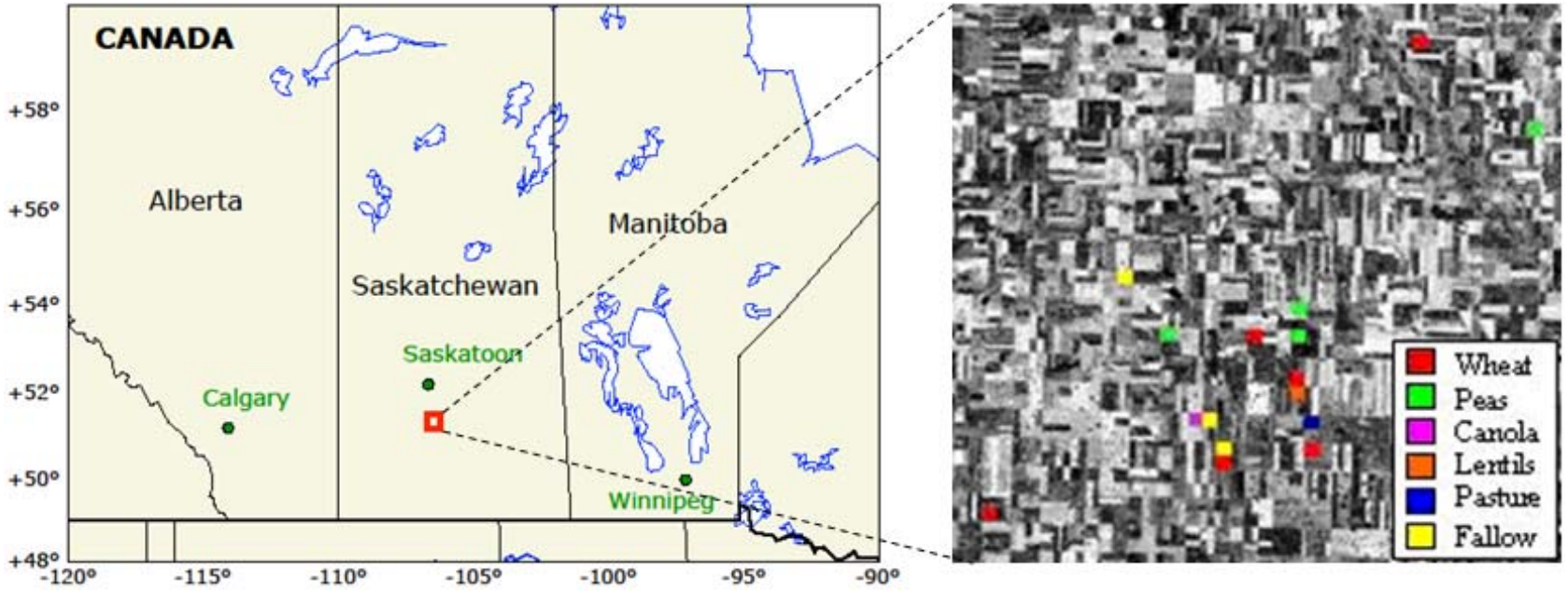
# Current research (2)

- **Freeeze/thaw**

| Freeze Thaw | |
|---|---|
| **Objectives** | **Methods** |
| **Potential of Radarsat-2 polarimetric information for FT analysis** | **Polarimetric target decomposition** |
| **Potential of AMSR-E low frequency data for FT analysis** | **Spectral gradient algorithm +** |
| **Characterisation of frozen agricultural soils over snow-covered areas** | **Assimilation of TerraSAR-X and Radarsat-2 data** |

# Study site (1)

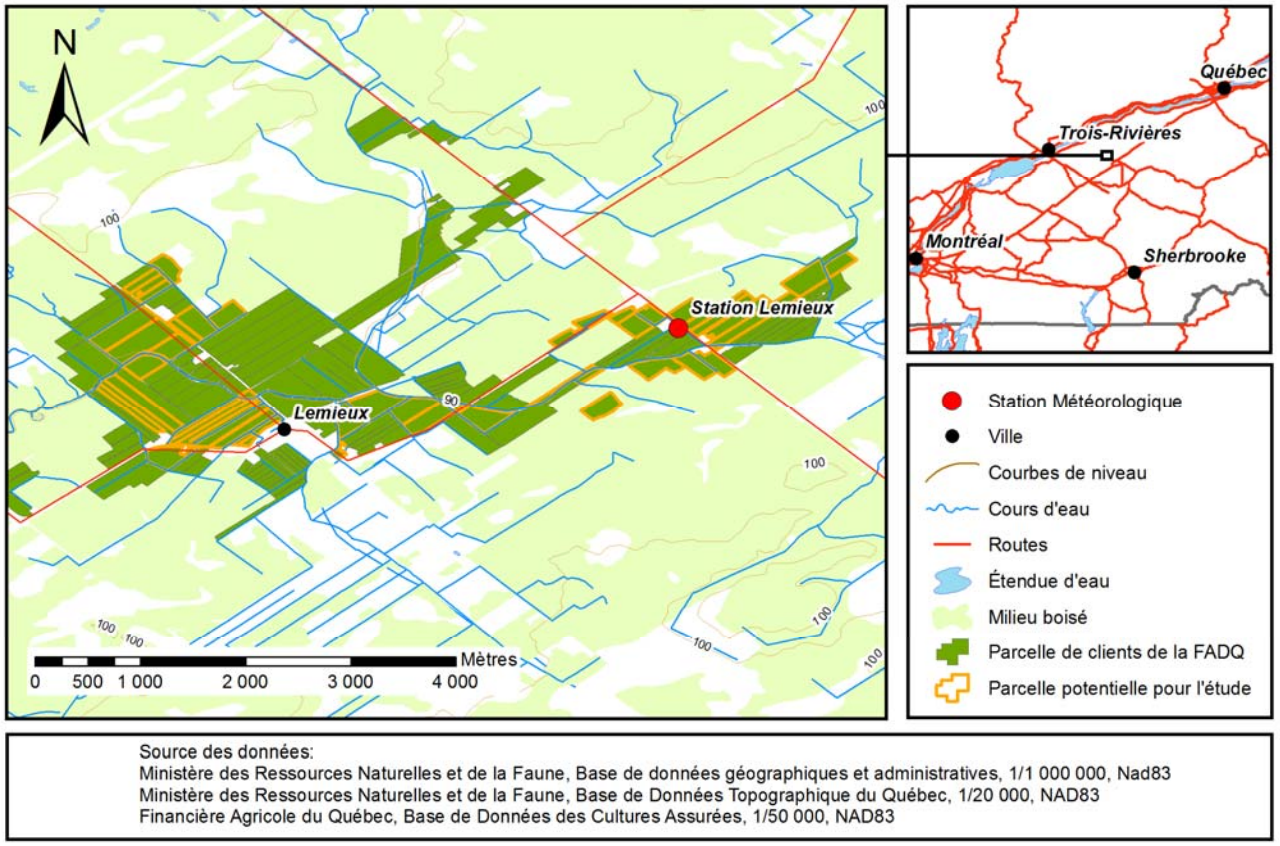
- **Agricultural area in Saskatoon**




→ Field campaign in the summer 2008

# Study site (2)

- **Agricultural area located near Trois-Rivières (Quebec)**



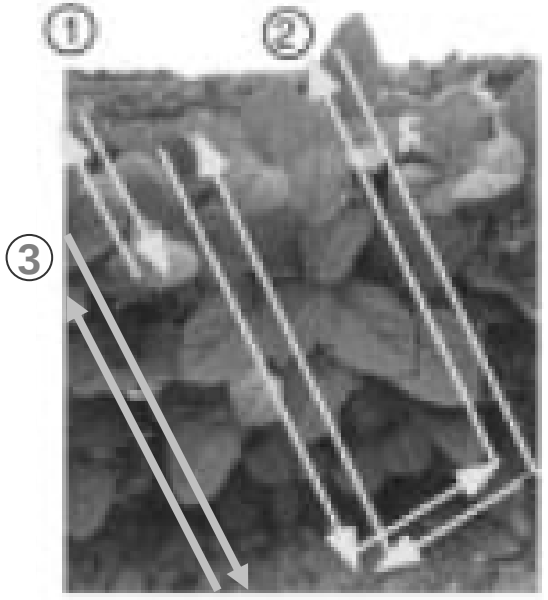
# Research plan

# Research plan (1)

- Results obtained from RADARSAT-2 images

| Parameters | RMSE | Average relative errors |
|---|---|---|
| Crop height | 13.65 cm | 19% |
| Vegetation water content | 1.01 Kg/m2 | 25.5% |
| Soil surface roughness | 0.22 cm | 10% |
| Soil moisture | 5.65 % vol. | 32% |

$$\frac{1}{N}\sum_{i=1}^{N}\frac{\left|Measured_i - \mathrm{Re}\,trieved_i\right|}{Measured_i}$$




- Improvement of SM estimation by combining RADARSAT-2 and SMAP radar (+ interaction term)

# Research plan (2)

- Up-scaling of soil moisture from RADARSAT-2, SMOS and SMAP data } **Geostatistics**

1st step : Ground data to RADARSAT-2 resolutions (almost completed)

2nd step : Application of the method to SMOS and SMAP

Ground → RADARSAT-2 → SMAP → SMOS, SMAP

SMAP: Radar

SMOS, SMAP: Passive microwave

**Few ten meters** **1-3 km** **40 km**

# Research plan (3)

- Use of CanEx-SM10 data
  - SMOS soil moisture downscaling
  - Soil moisture retrieval based on Environment Canada and NASA airbornes data

    → Combination of SMAP radar and radiometer data

# Research plan (3)

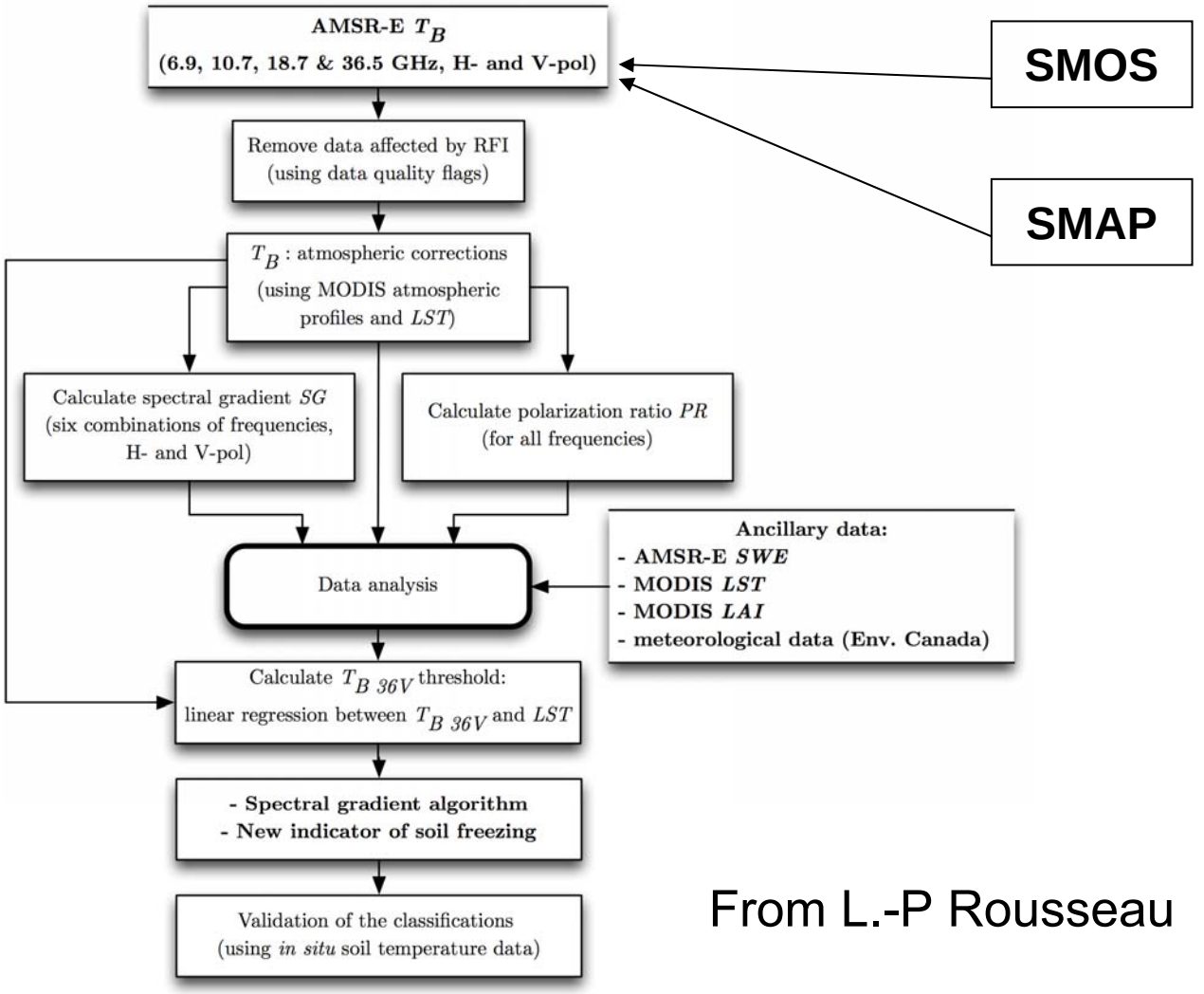
- Field campaign in the summer 2011
  - → Complement CanEx-Sm10 data
    - Impact of vegetation in the validation process of SMOS
    - Pre-launch field campaign for SMAP

U of Sherbrooke, U of Guelph,

Environment Canada

# Research plan (4)

- Freeze/Thaw




From L.-P Rousseau

# Research plan (5)

- Ground-based validation of SMAP radar


New life!

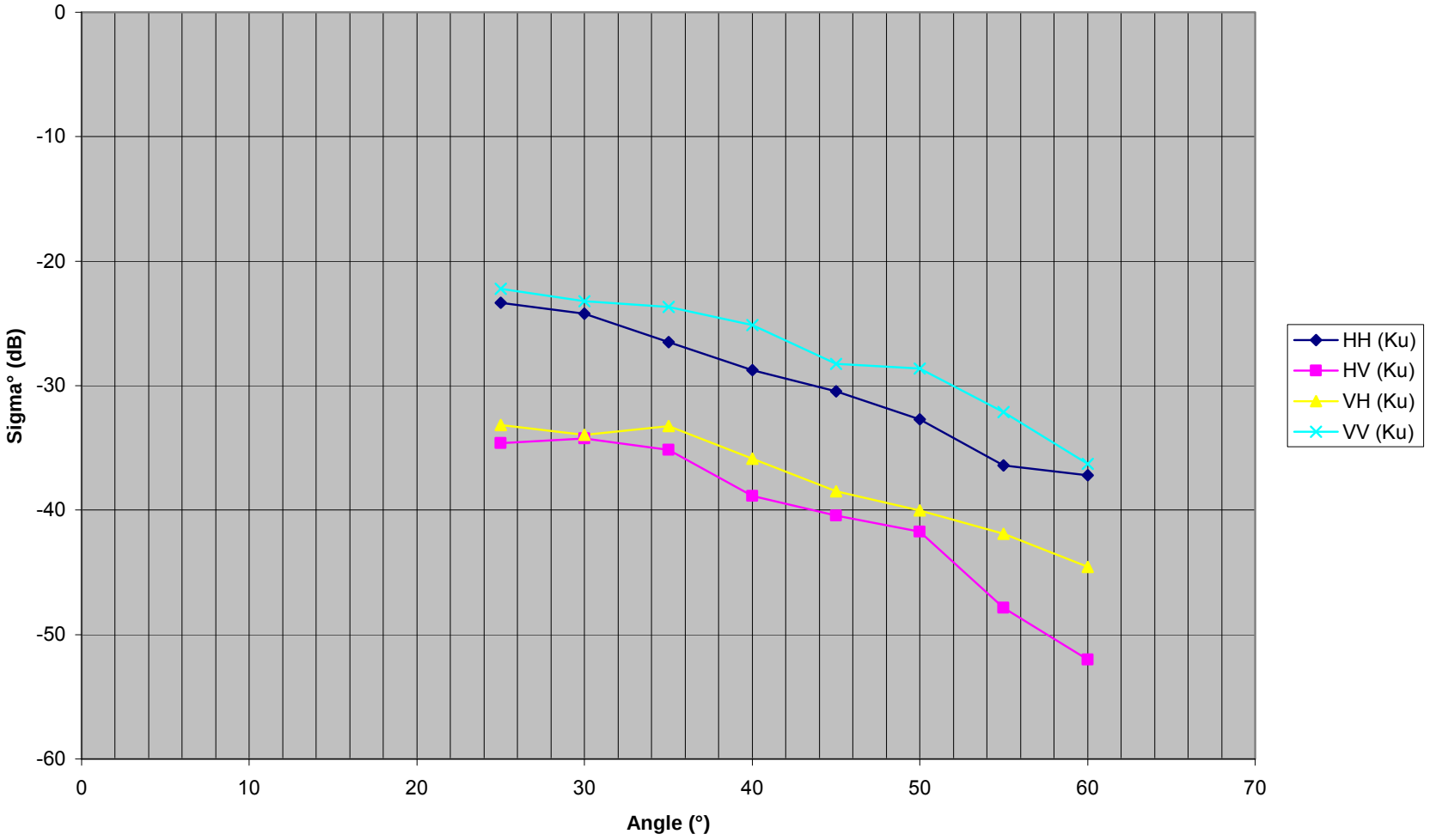
Co-Supervision of
Francois Charbonneau (CCRS)
Patrick Cliche (UdeS)
Philippe Mabilleau (UdeS)
François Boone (UdeS)

But, needs works

(calibration, measurements over extended area, ….)

# Research plan (5)

- Measurement tests Over Gravel, Ku-Band



# Additionnal sites

- Plans are ongoing for the establishment of a forest site near Drommundville (80 km from Sherbrooke)
- A local site is a being set at the Ferme Expérimentale de Lennoxville for fine scale experiments using ground-based radiometers and scatterometers.

# Summary

Research plan

- Improvement of RADARSAT-2 SM estimation algorithm using SMAP radar
- Up-scaling of SM
- Use of CanEx-SM10 data

  SM retrieval, downscaling of SM, field campaign in the summer 2011
- Freeze/Thaw : New indicator of frozen soils
- Ground-based validation of SMAP radar

# Training

| HQP/Projects | Timetable |
|---|---|
| 1 PDF/downscaling of soil moisture | 2 years |
| 1 PDF/ Works on the scatterometer and SMAP pre-launch validation activities | 2 years |
| 1 Ph. D/Soil moisture retrieval algorithm | 3 years |
| 1 M. Sc/upscaling of soil moisture | 2 years |
| 1 M. Sc/Freeze Thaw algorithm | 2 years |

# Benefits

| Research activities | Benefits |
|---|---|
| Soil moisture retrieval | Detect fields suffering from dryness or faulty drainage, and thus to predict crop production |
| Downscaling method of coarse resolution soil moisture (SMOS, SMAP) | Provide temporally frequent soil moisture values (in contrast to radar observations) at scales suitable for agricultural applications |
| Freeze/Thaw | Prediction of damages to hay crops;<br>Helpful for assessing the insurances caused by frozen soils and/or plant asphyxia. |
| All | Impacts on the use of present and future satellite data and on the management of water resources, agricultural production, agricultural crop water |

Thanks!