Laboratory, field and airborne spectroscopy for monitoring organic carbon content in agricultural soils

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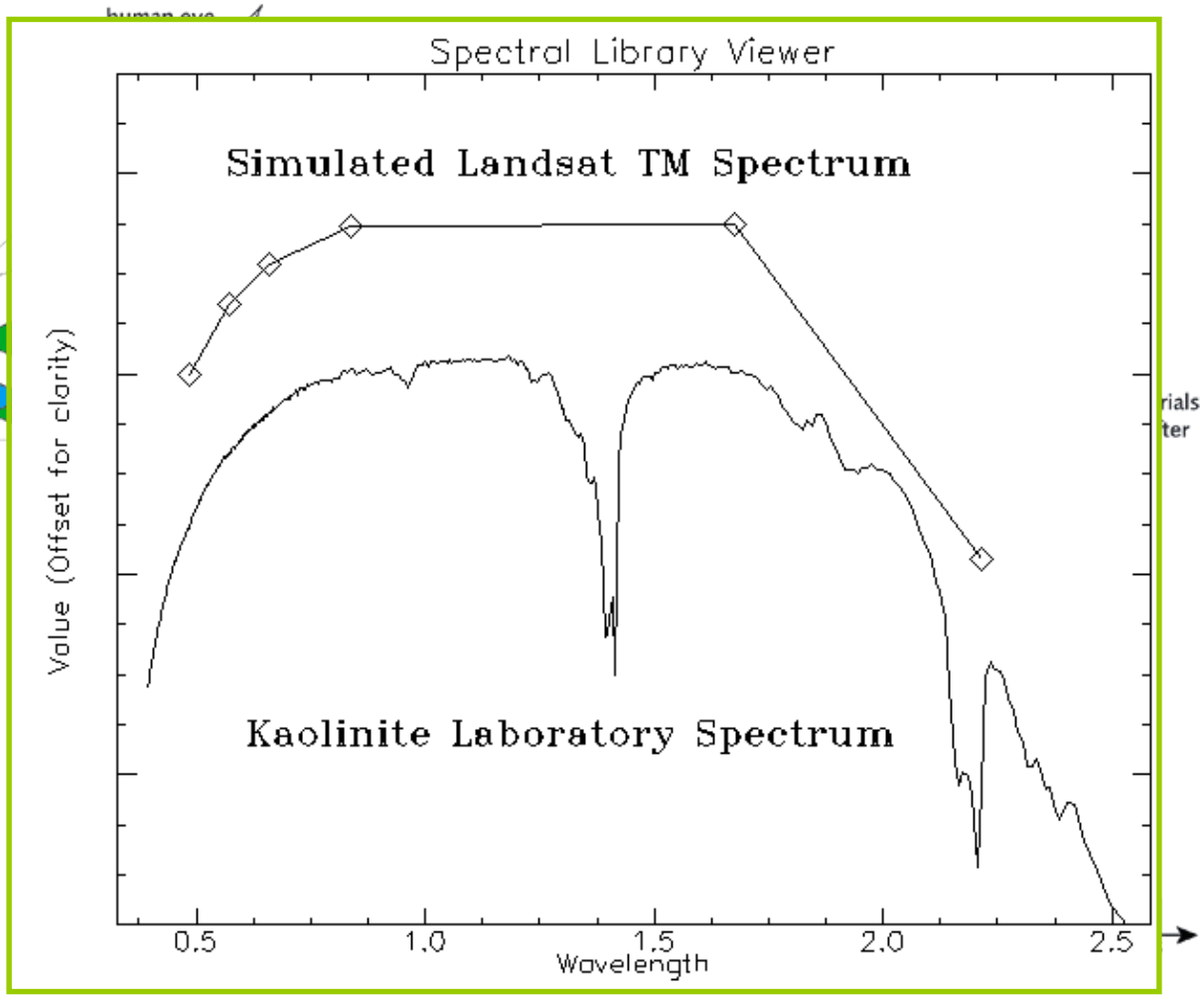
- Introduction
- Why SOC monitoring ?
- Why using reflectance spectroscopy ?
  - High spatial variability of SOC → high sampling density required
  - Traditional sampling techniques are time consuming
  - High potential for rapid in situ measurements and SOC mapping

- Introduction

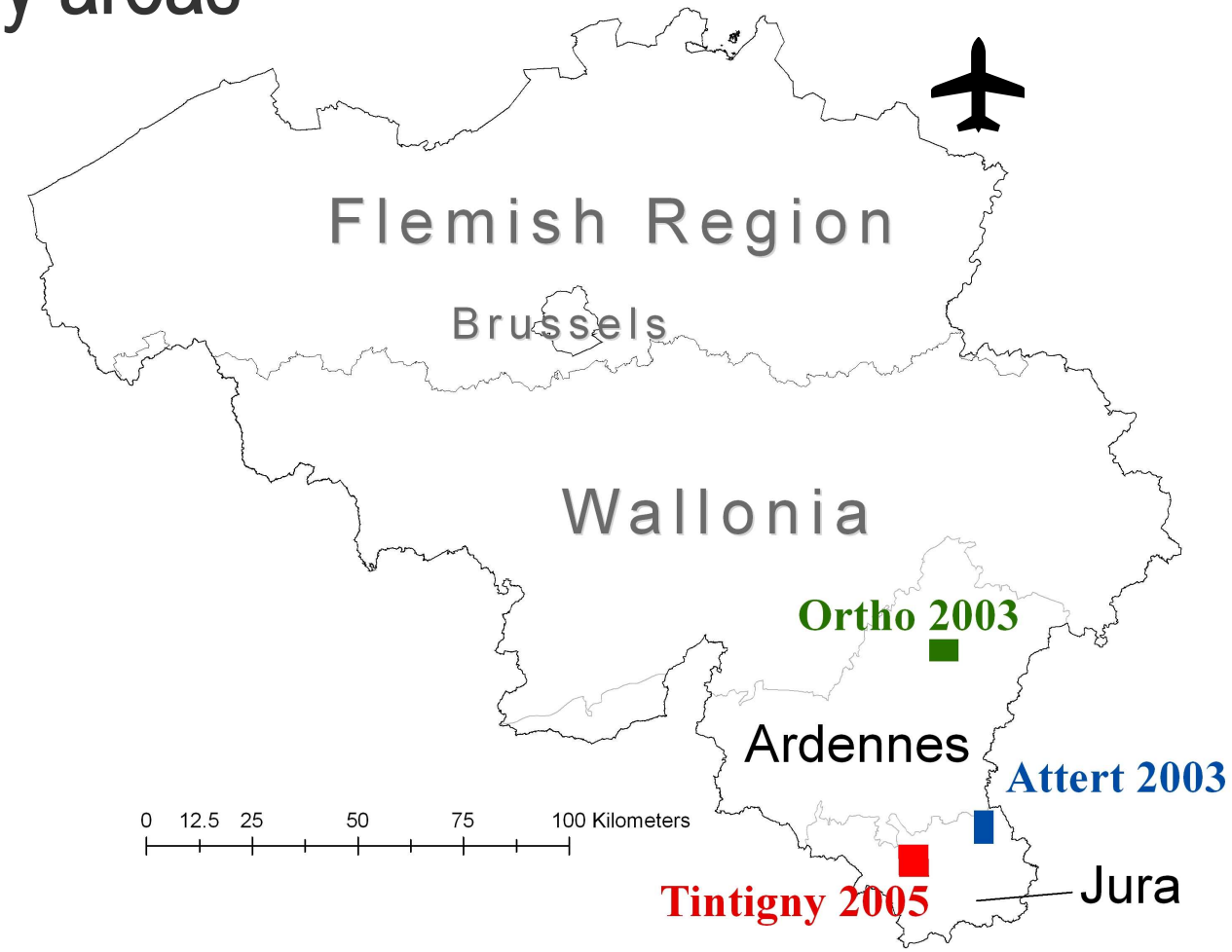
Introduction



- Introduction
  - Objectives
    - Compare the predictive ability of these three types of sensors for SOC determination using Partial Least Square Regressions
    - Evaluate the stability of calibrations
    - Evaluate the potentialities for SOC monitoring and mapping

Methodology

- Study areas

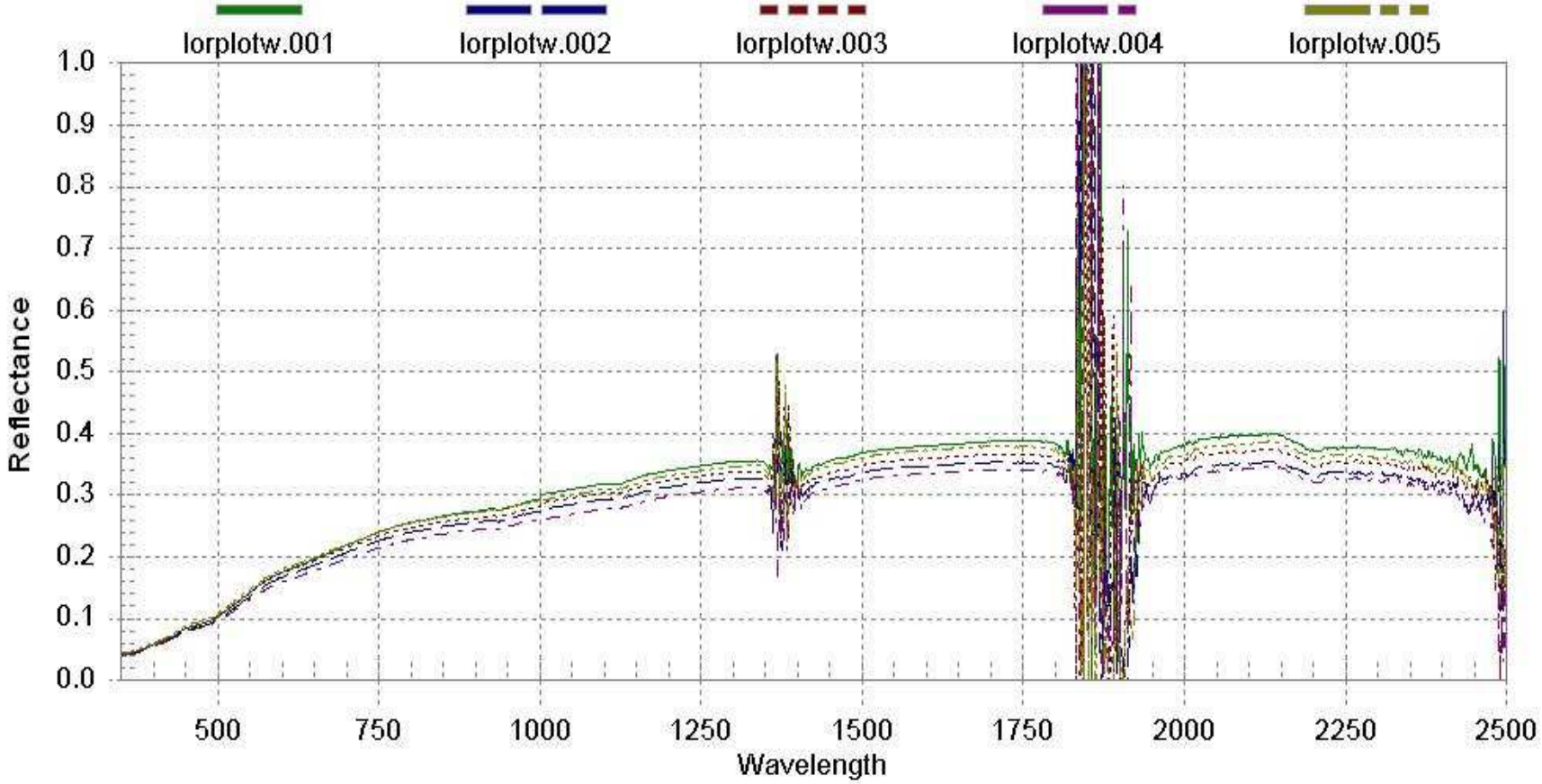


Methodology

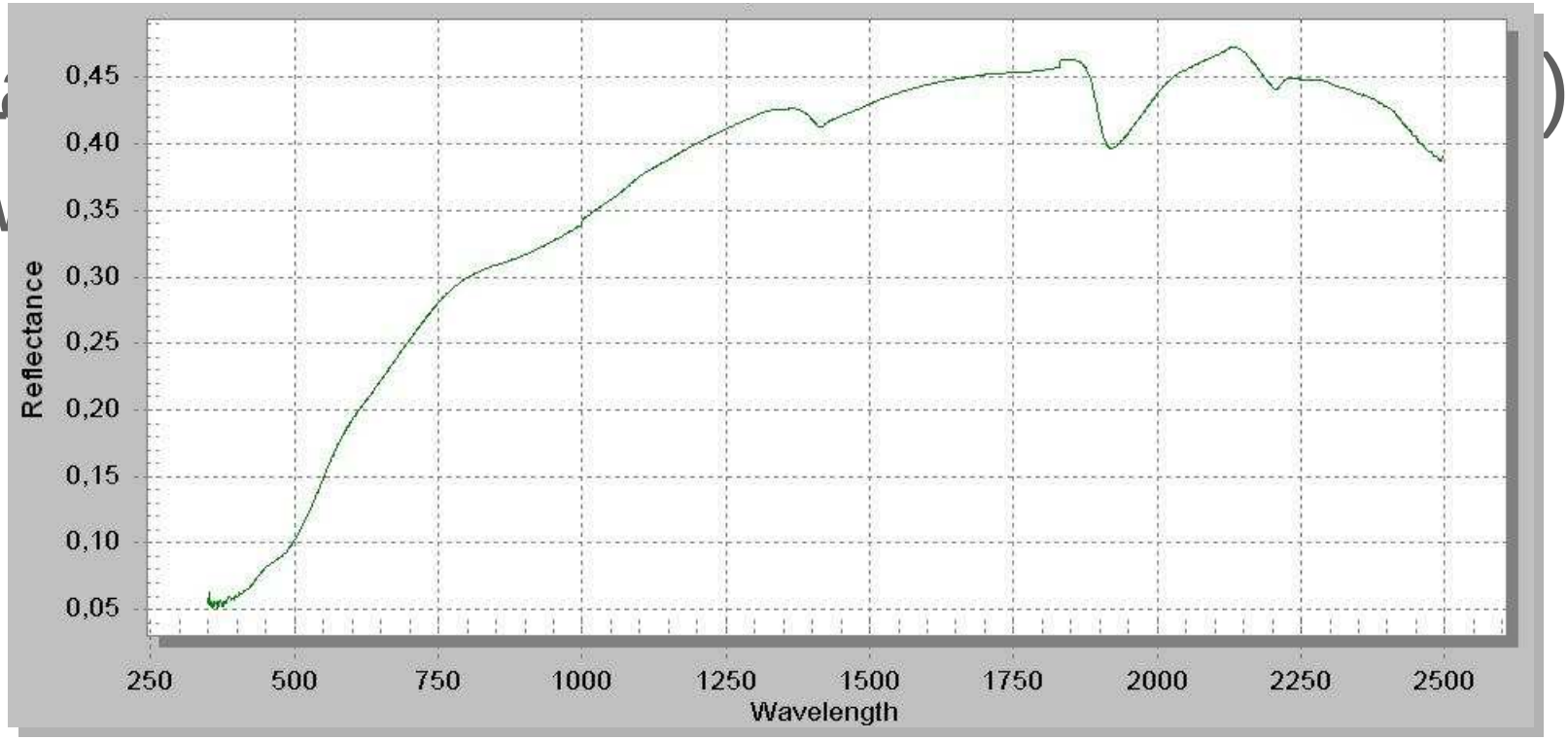
- Spectral measurements

Methodology

- Portable Spectroscopy: Analytical Spectral Device (ASD: 350-2500 nm)

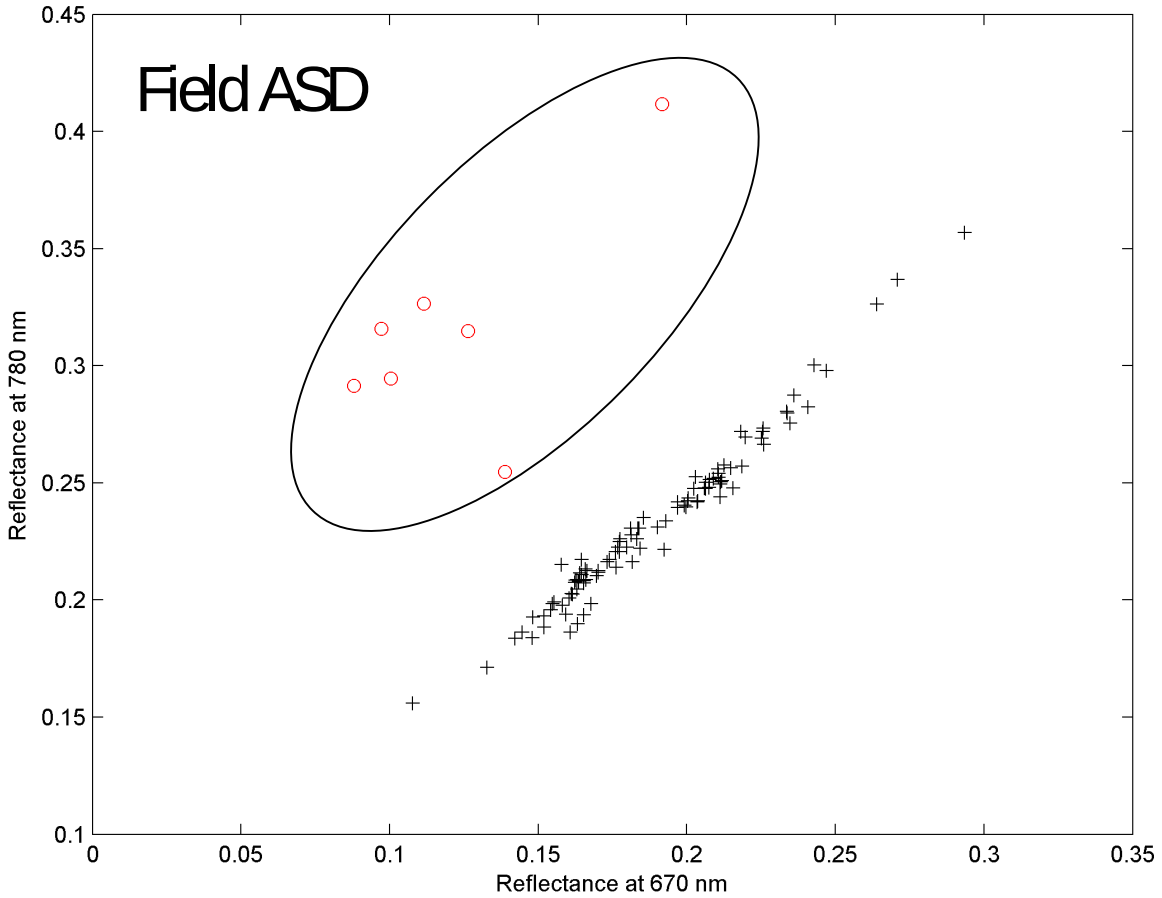


- Methodology
  - Laboratory spectroscopy: spectral measurement of sieved (2 mm) and air-dried soil samples with the ASD contact probe
  - L… W…



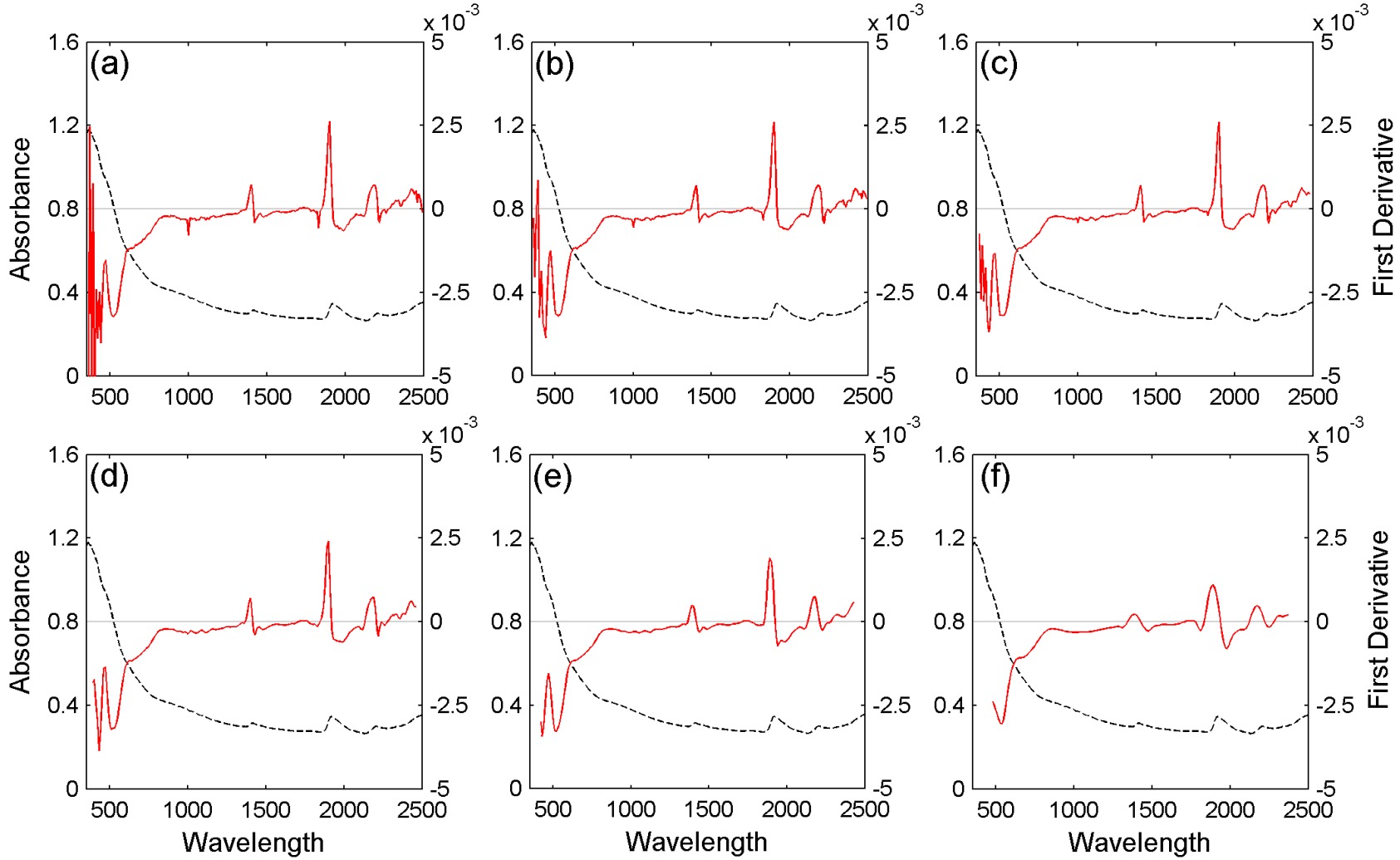
Data transformation before statistical analysis

- Removing vegetation influence (spectra having a NDVI > 0.3)



Methodology

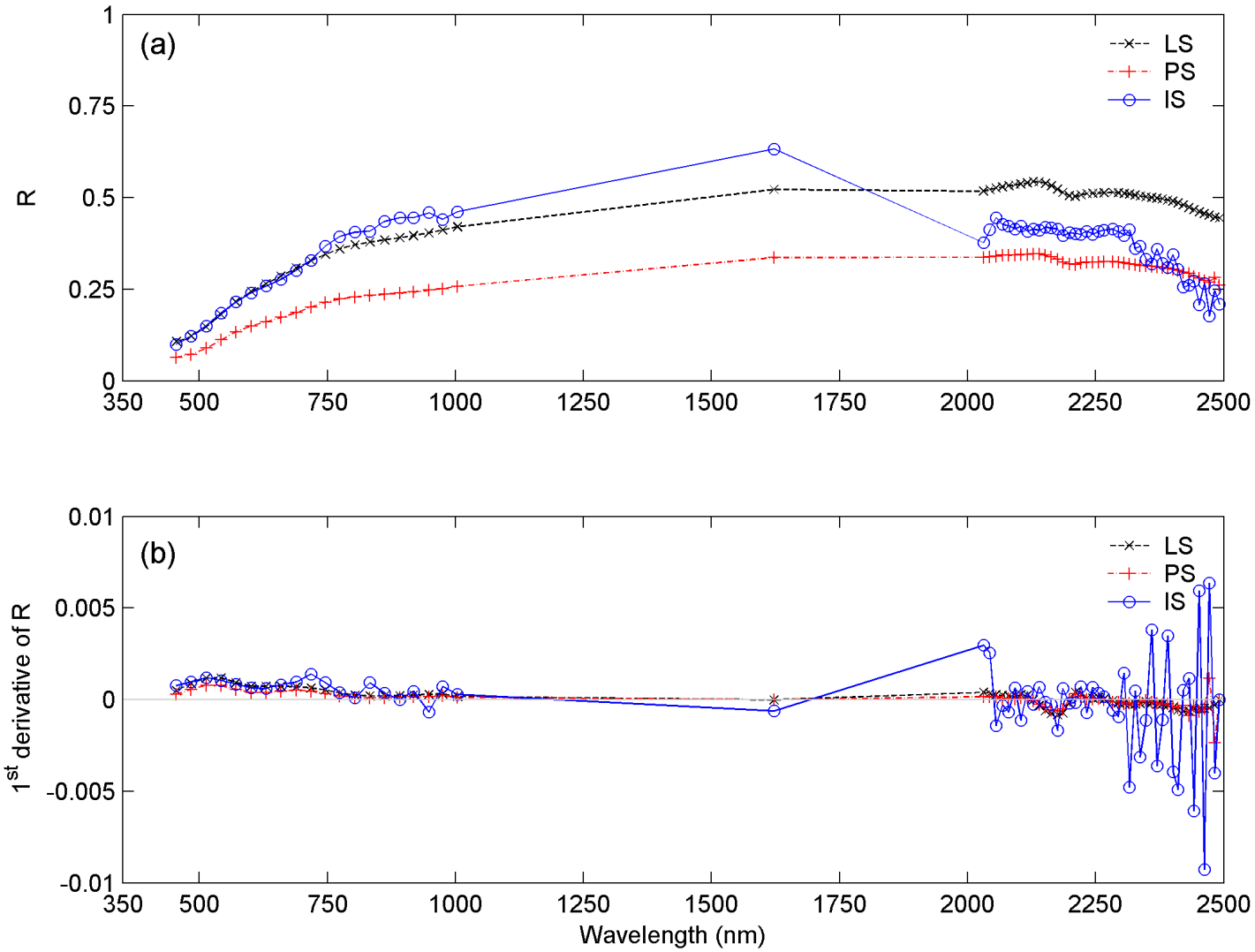
Data transformation before statistical analysis



Methodology

- Relate SOC and spectra using Partial Least Square Regressions (PLSR)
- Select the best model (pretreatment) on the basis of their Ratio of Performance to Deviation (= RMSEP / SD)
- To test the stability of the calibrations, we joined current ASD field measurements with those of previous campaigns (CASI 2003) producing a dataset of 201 samples with varying carbon content, texture, soil surface condition and soil types

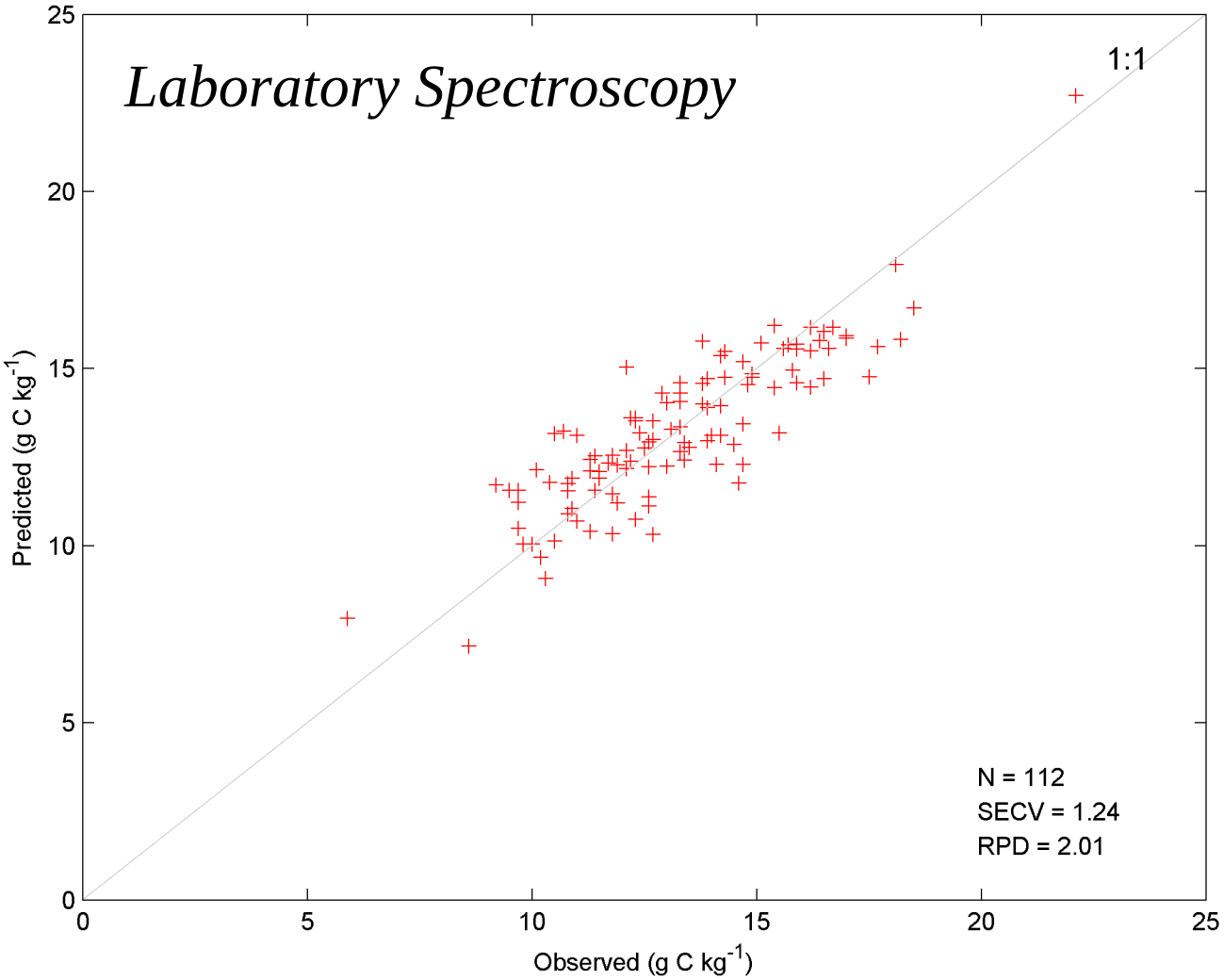
Results


(a)
LS
PS
IS
R
1
0.75
0.5
0.25
0
350
500
750
1000
1250
1500
1750
2000
2250
2500
(b)
LS
PS
IS
1st derivative of R
0.01
0.005
0
-0.005
-0.01
Wavelength (nm)

Results

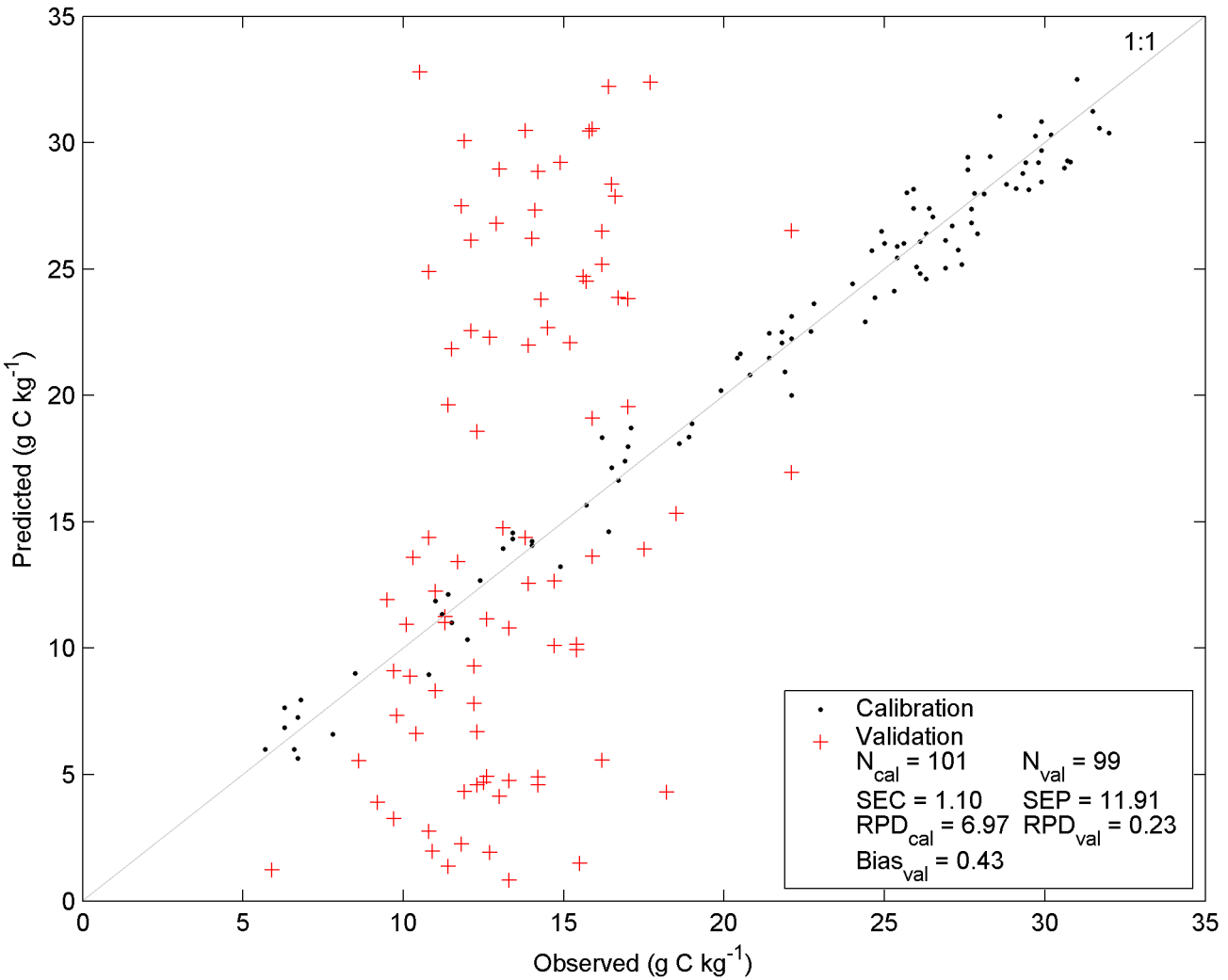
- Predi
spec

NIR



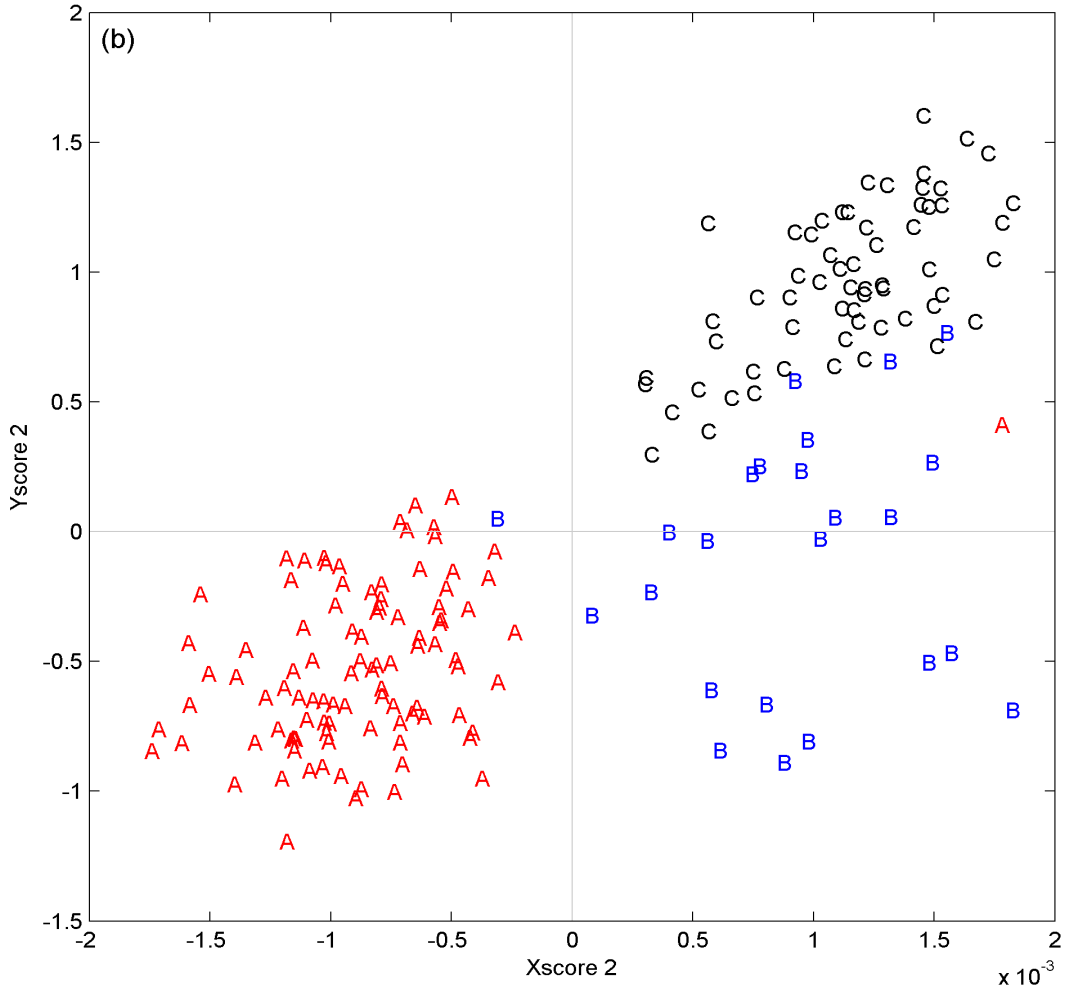
Results

Stab



Results

- Stability across time and space: cross validation



Results

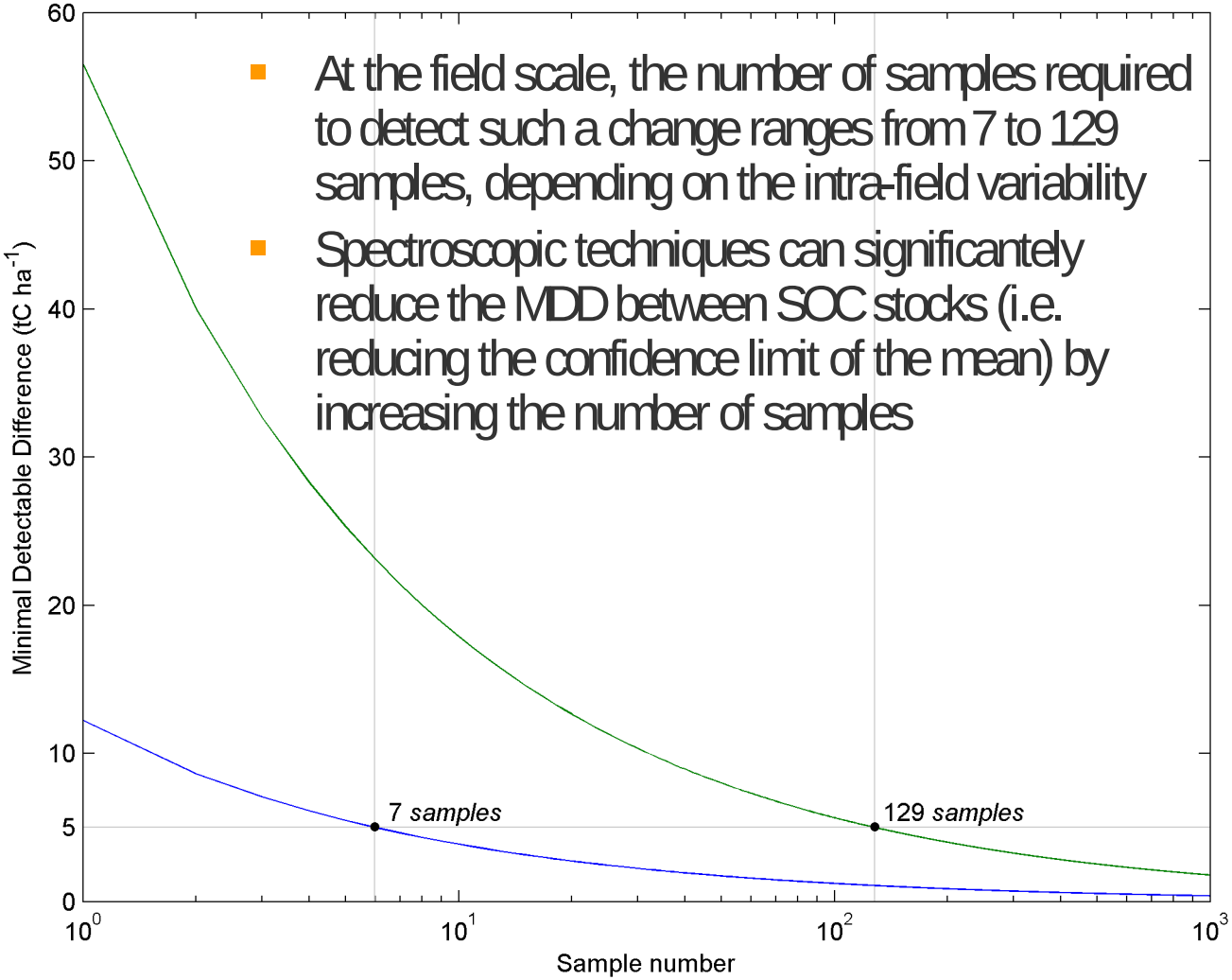
- Summary of results
  - There is a decrease in predictive ability from laboratory spectroscopy to remote-sensing due to :
    - Difference in sensor characteristics (number of spectral bands);
    - Uncontrolled measuring conditions (light source quality, soil surface conditions)
  - The ASD gives accuracies (± 0.1%C) that are similar to a routine analytical method (Walkley&Black)
  - Calibrations are currently site-specific and partly fail to predict, under a proper independent validation, samples belonging to another study area

Results

- Summary of results
  - Further needs:
    - More measurements (spectral libraries) !
    - Standard spectral measurement protocols in the field (surface conditions required,etc.)

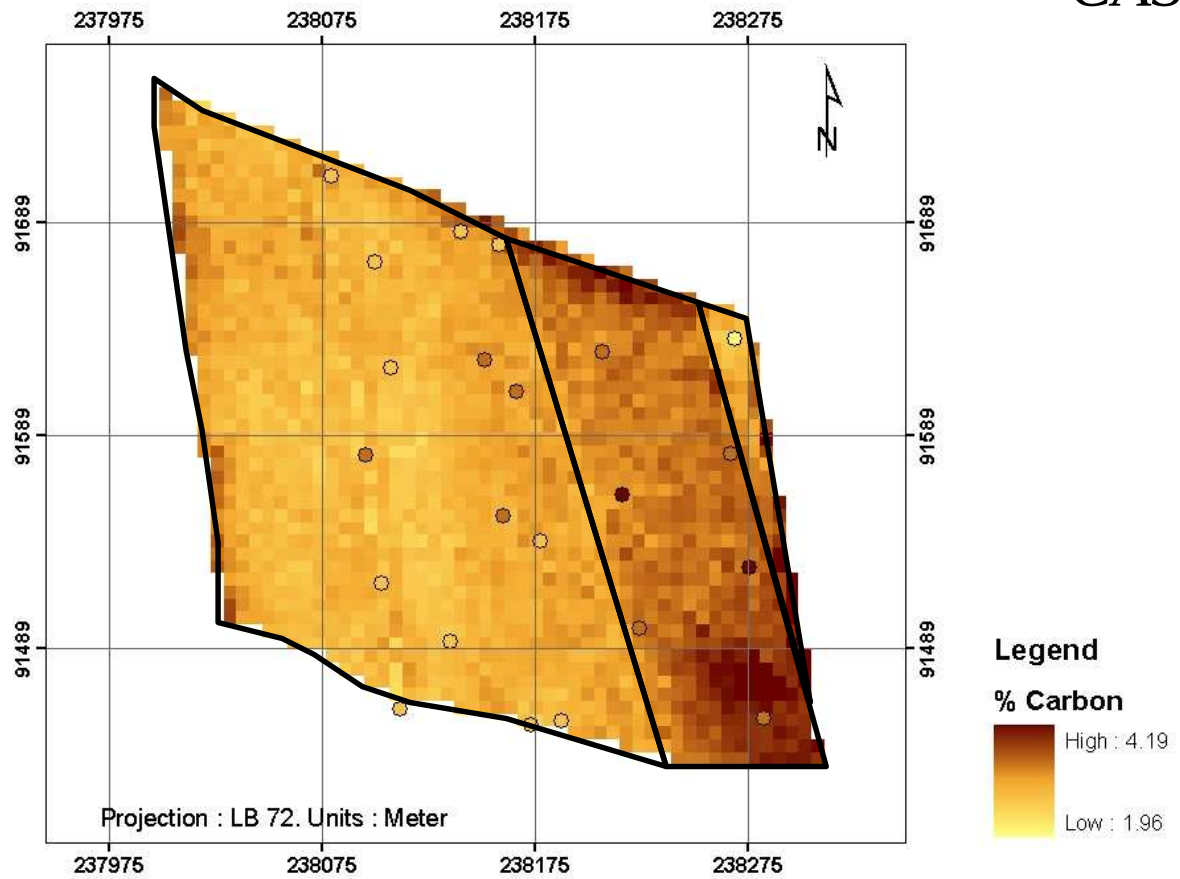
- Monitoring of soil carbon
  - Why VNIR spectroscopy offers a great potential in the context of soil monitoring ?
  - Minimal Detectable Difference (MDD) : How many samples are required to demonstrate a given change in SOC stocks?
    - SOC stock change after management change are <= 2tC $ha^{-1}y^{-1}$ (Freibauer et al., 2004)
    - After 3-5 year, it corresponds to + or - 5 tC ha^{-1}

Soil Monitoring



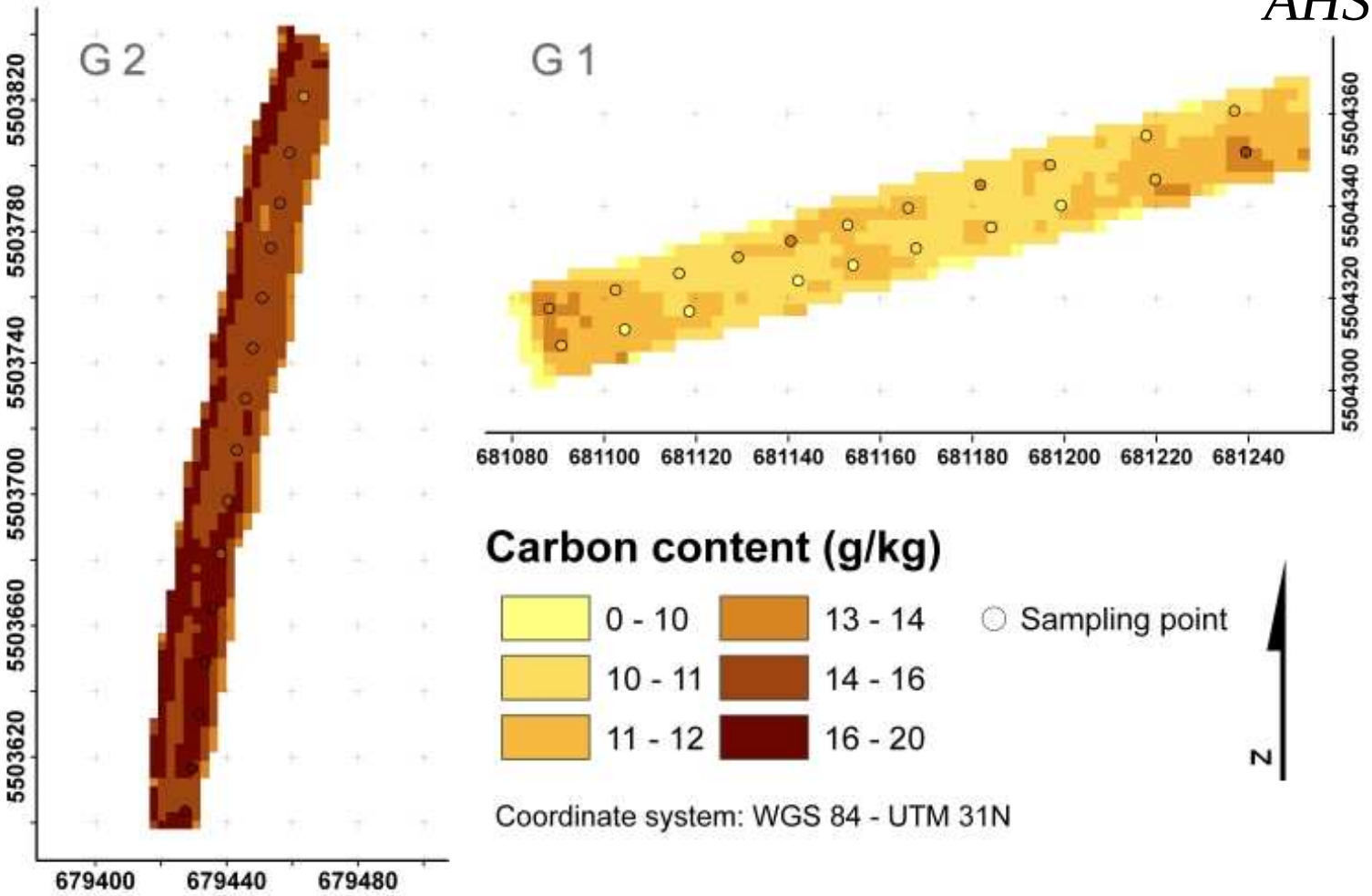
Soil Mapping

CASI



Soil Mapping

AHS



Conclusion

- Accuracies achieved by the ground measurements (Laboratory and Portable Spectroscopy) are comparable to the one of a standard analytical method (Walkley-Black) and they can thus be used for monitoring studies where their speed is a valuable advantage.
- Imaging spectroscopy, appears, for the time being, not able to predict SOC with an acceptable accuracy due to its low SNR and problem to achieve true spectral information. Nevertheless, the greater potential lies in this technique and more efforts have to be put in spectrum calibration

Merci pour votre attention !