FEDERAL SCIENCE POLICY

RAPAS
CLOSE RANGE AERIAL SENSING OF SOILS FOR IMPROVED REMOTE SENSING PRODUCTS

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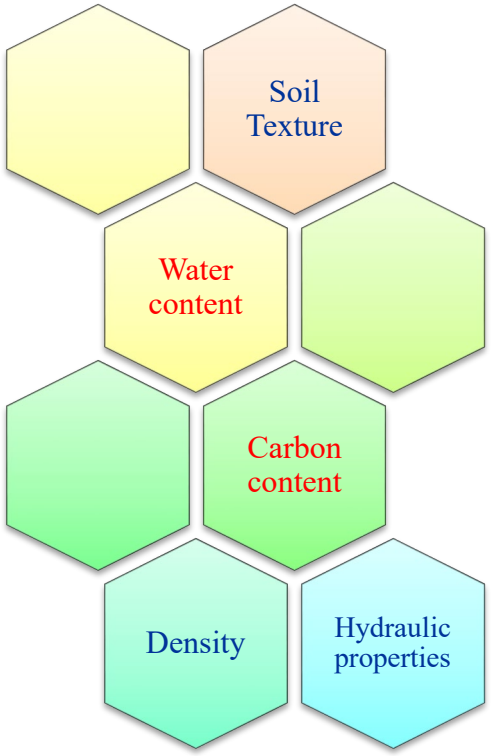
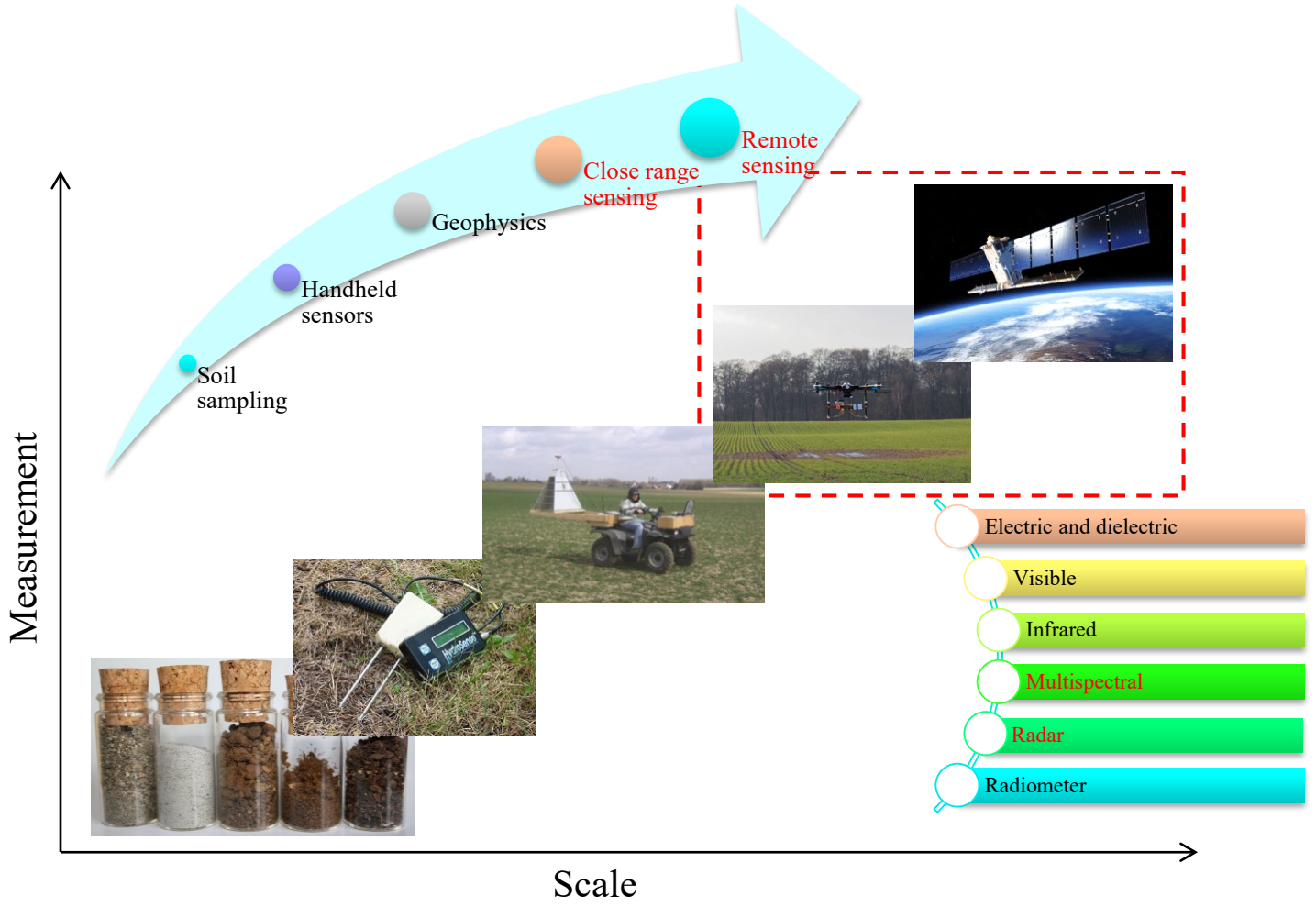
UCLouvain

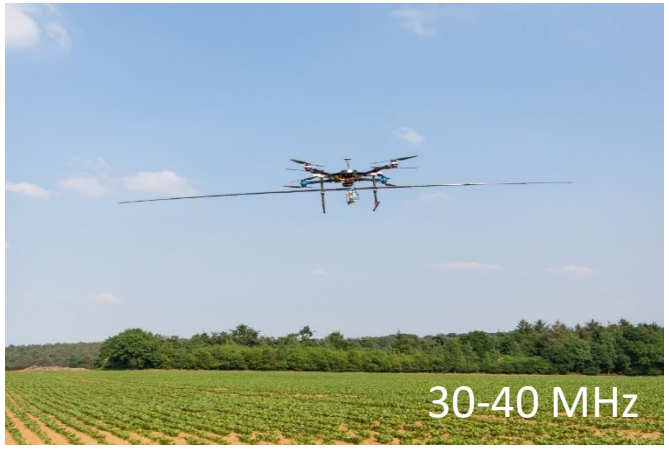
GPRLouvain

To develop drone-based ground-penetrating radar and multispectral spectrometer technologies for high-resolution digital soil mapping and calibrating satellite soil moisture products





Lightweight ground-penetrating radar and full-wave inversion

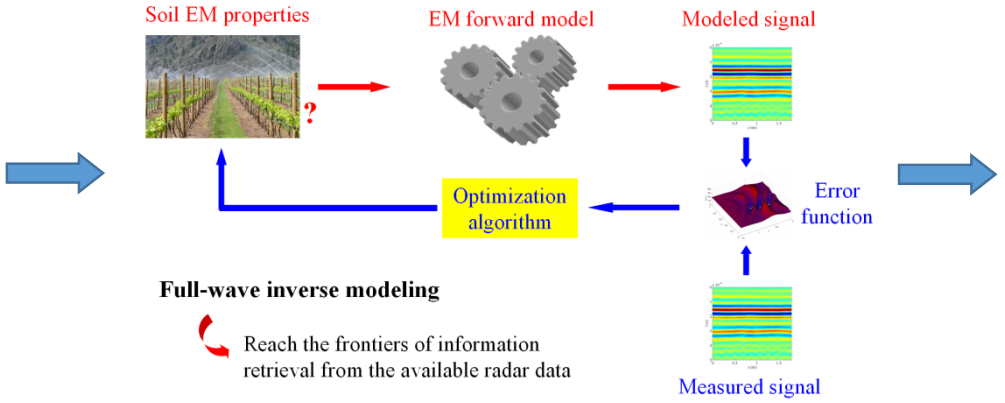


System design

$$S(\omega) = \frac{b(\omega)}{a(\omega)} = T_0(\omega) + \mathbf{T_s}\left(\mathbf{I_N} - \mathbf{G^0 R_s}\right)^{-1}\mathbf{G T_i}$$

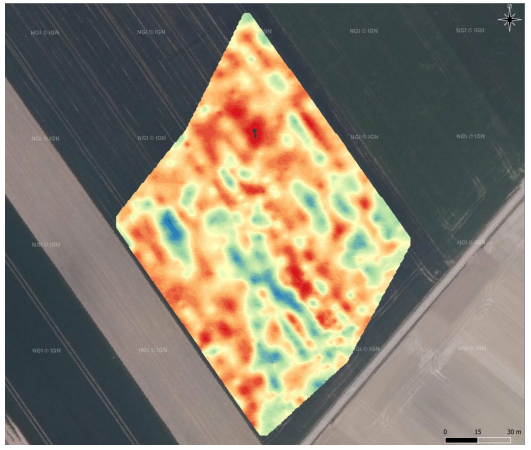
with

$$\mathbf{T_i} = \left[T_{i,1}(\omega)\ T_{i,2}(\omega)\ \cdots\ T_{i,N}(\omega)\right]^T$$
$$\mathbf{T_s} = \left[T_{s,1}(\omega)\ T_{s,2}(\omega)\ \cdots\ T_{s,N}(\omega)\right]$$
$$\mathbf{R_s} = \mathrm{diag}\left(\left[R_{s,1}(\omega)\ R_{s,2}(\omega)\ \cdots\ R_{s,N}(\omega)\right]\right)$$



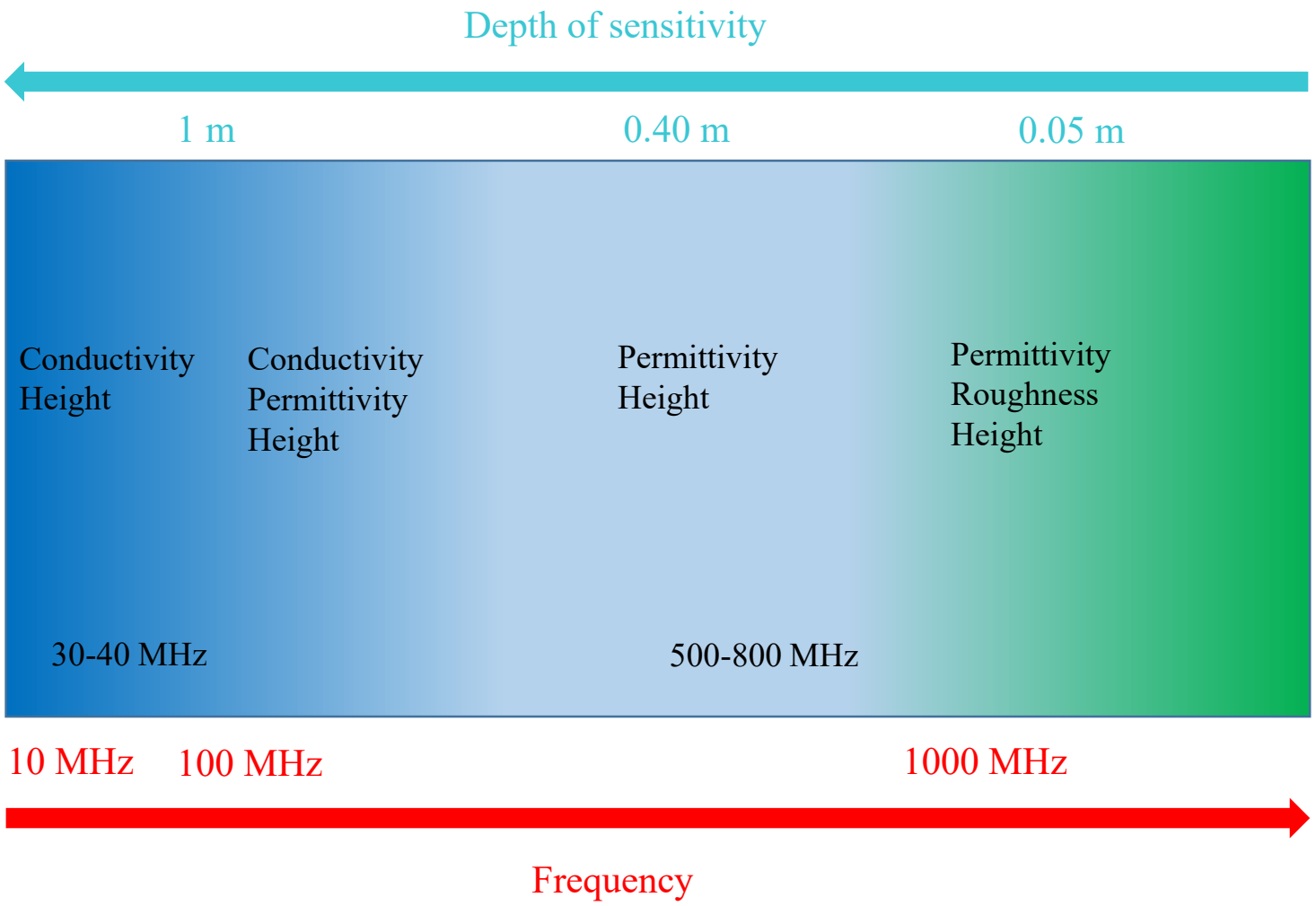
Signal inversion

Adapted with source drift correction and LUT-based inversion

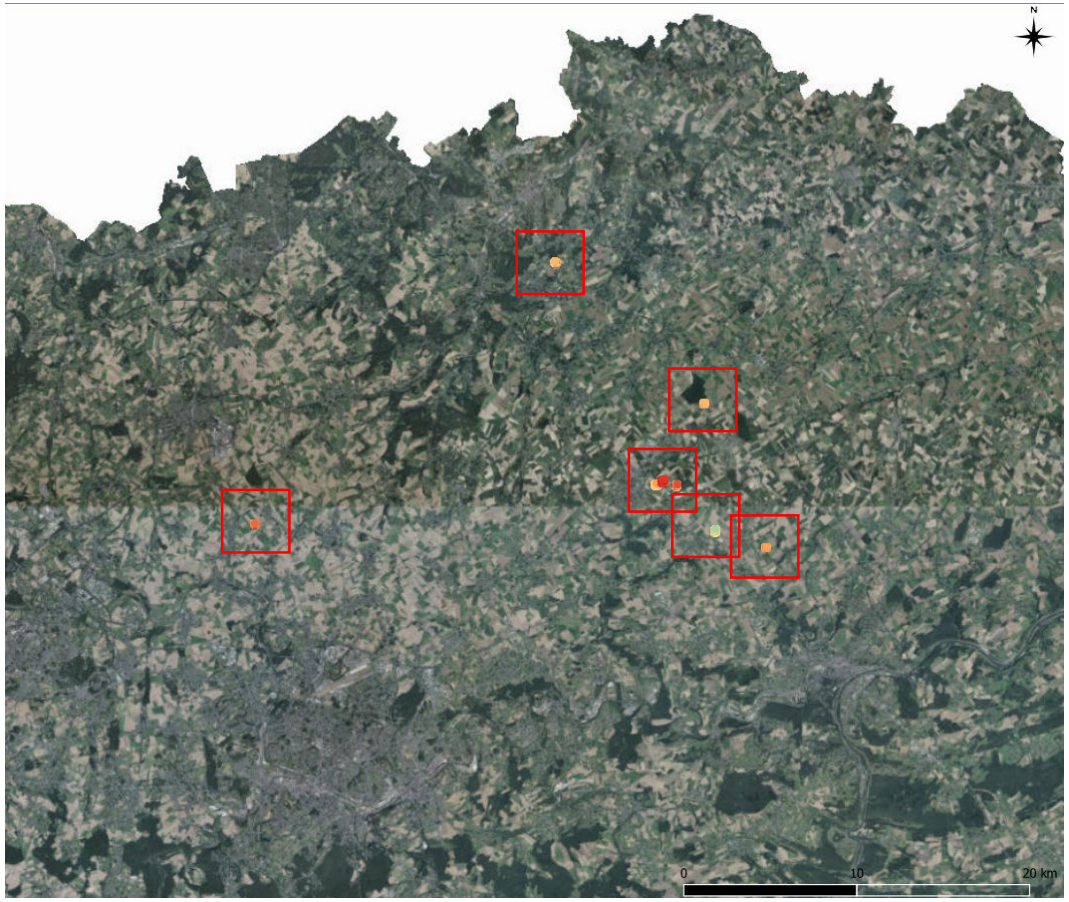


Soil moisture map

Radar sensitivities with respect to frequency



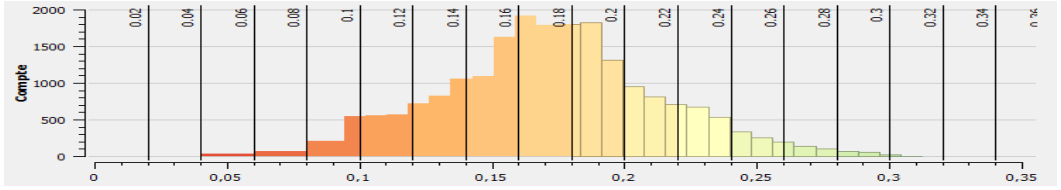
GPR field validations in 2018



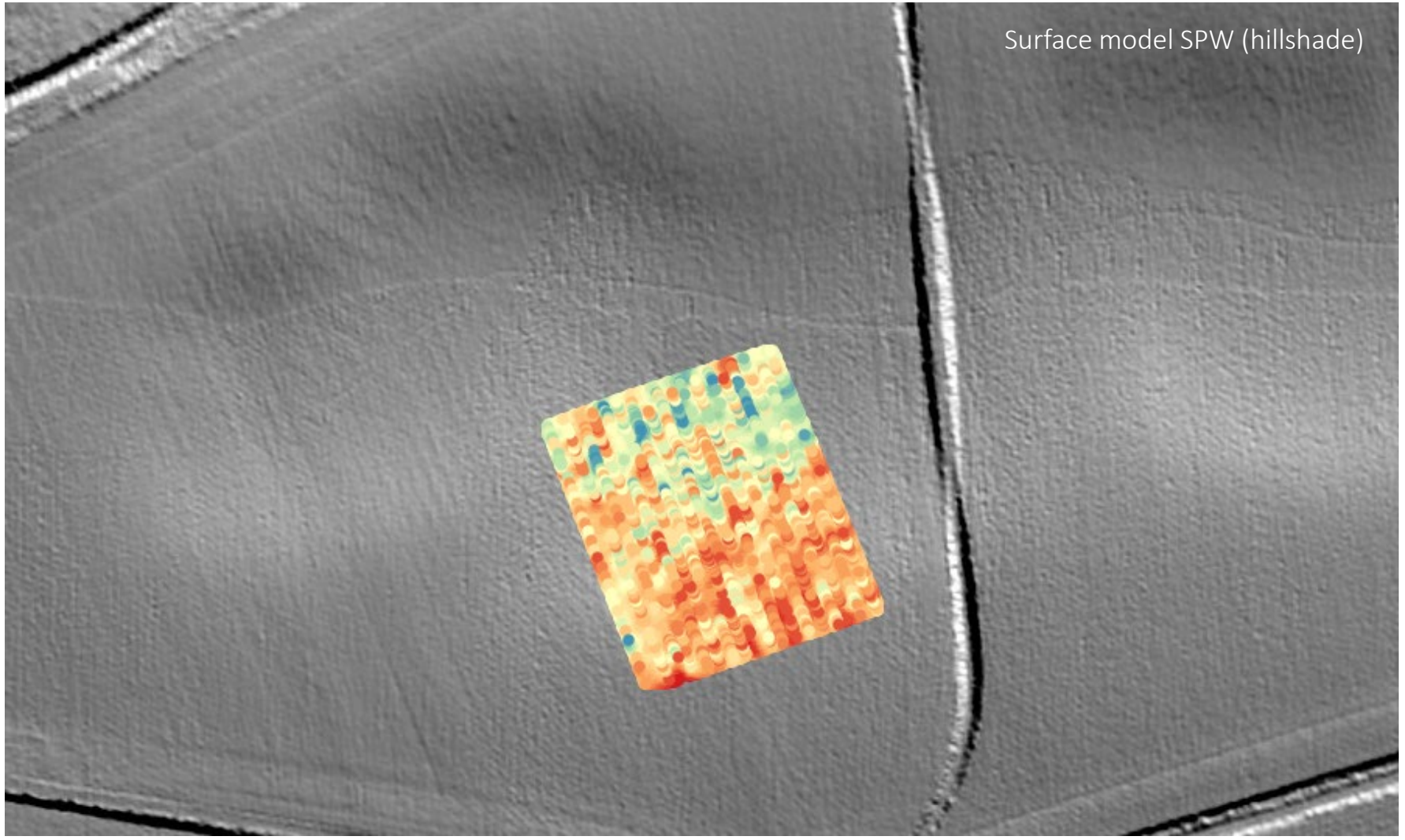
Orthophoto SPW

- 8 fields (collaboration with the CRA-W)
- 17 campaigns
- A part of the GPR acquisitions was synchronized with the multispectral and Sentinel-1 acquisitions

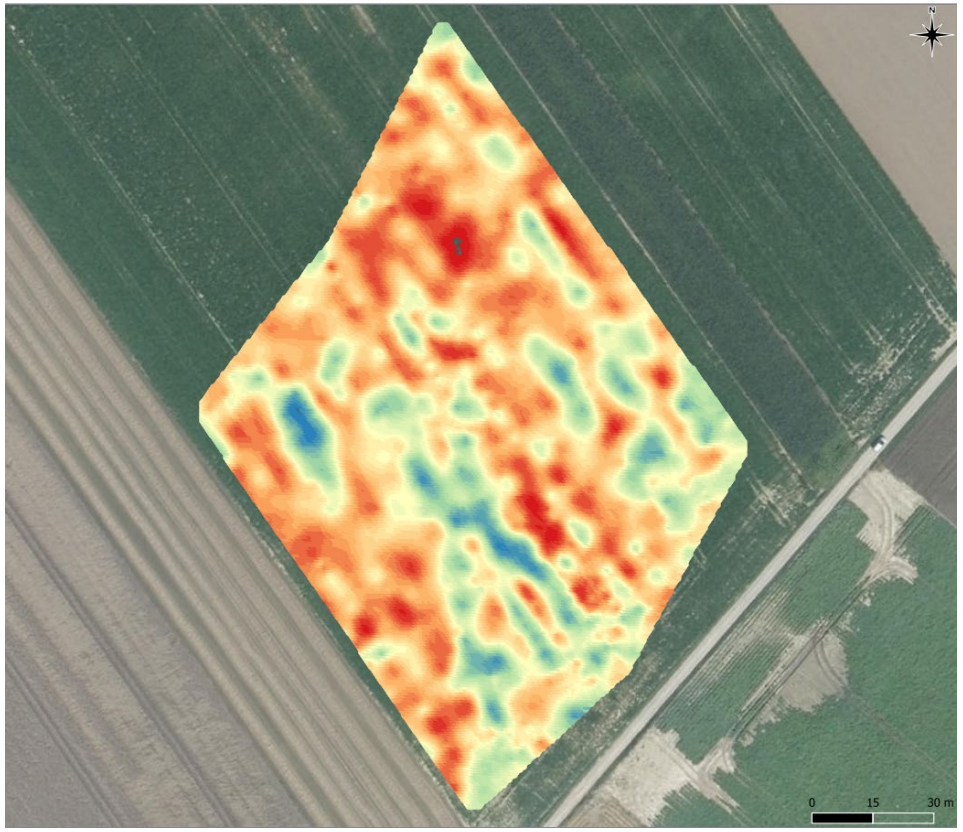
The drone-georadar soil moisture maps: example in Dion-Valmont



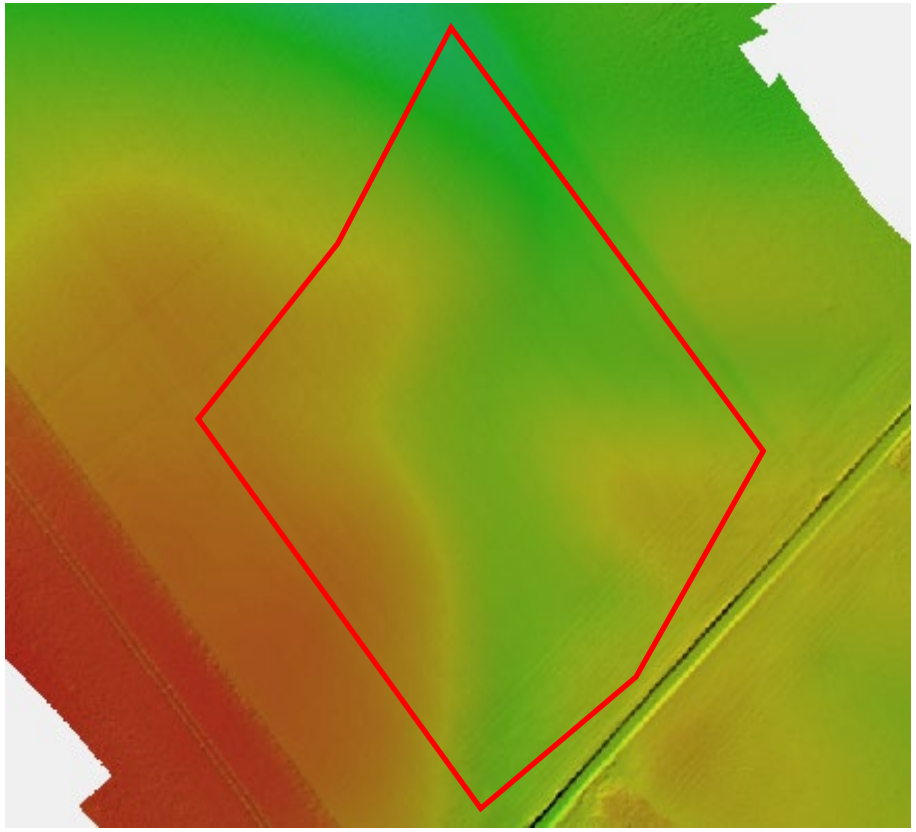
The drone-georadar soil moisture maps: example in Cinq Etoile



The drone-georadar soil moisture maps: example in Saint-Denis



Orthophoto SPW



MNS from drone photogrammetry

Drone-GPR conclusions

Progress

- Low- and high frequency radars designed and setup
- Full-wave electromagnetic model
- Consistent soil moisture maps
- Significant noise in the estimates

Perspectives

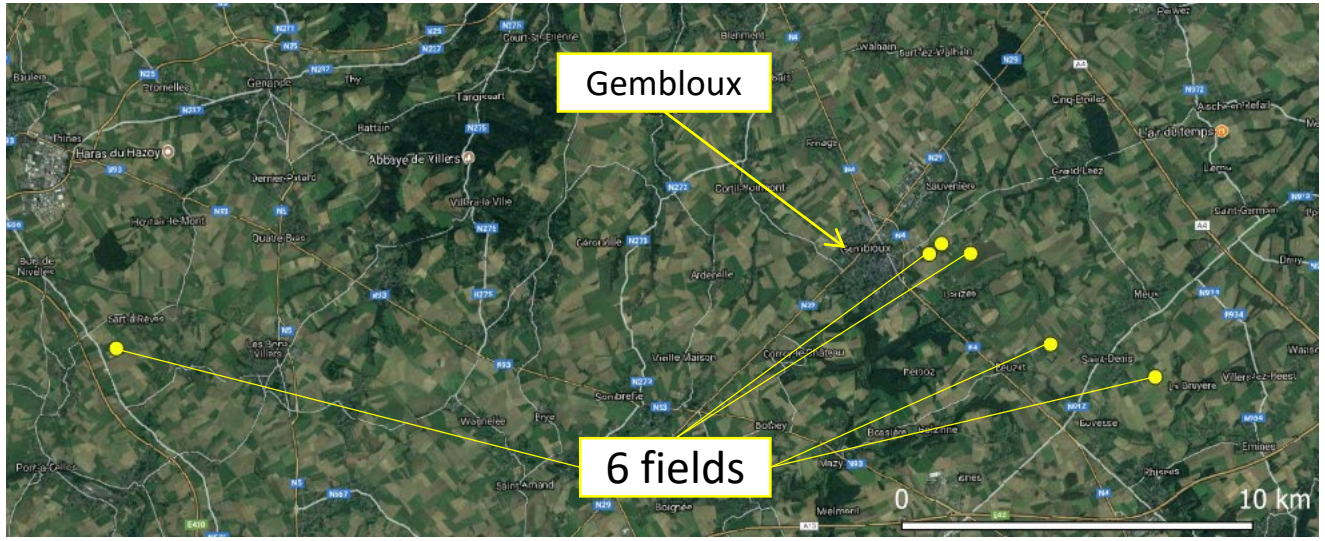
- Improve the radar-drone setup
- Improve the EM model for variable incidence angles
- Quantitative validations

Multispectral acquisitions: equipment and study area

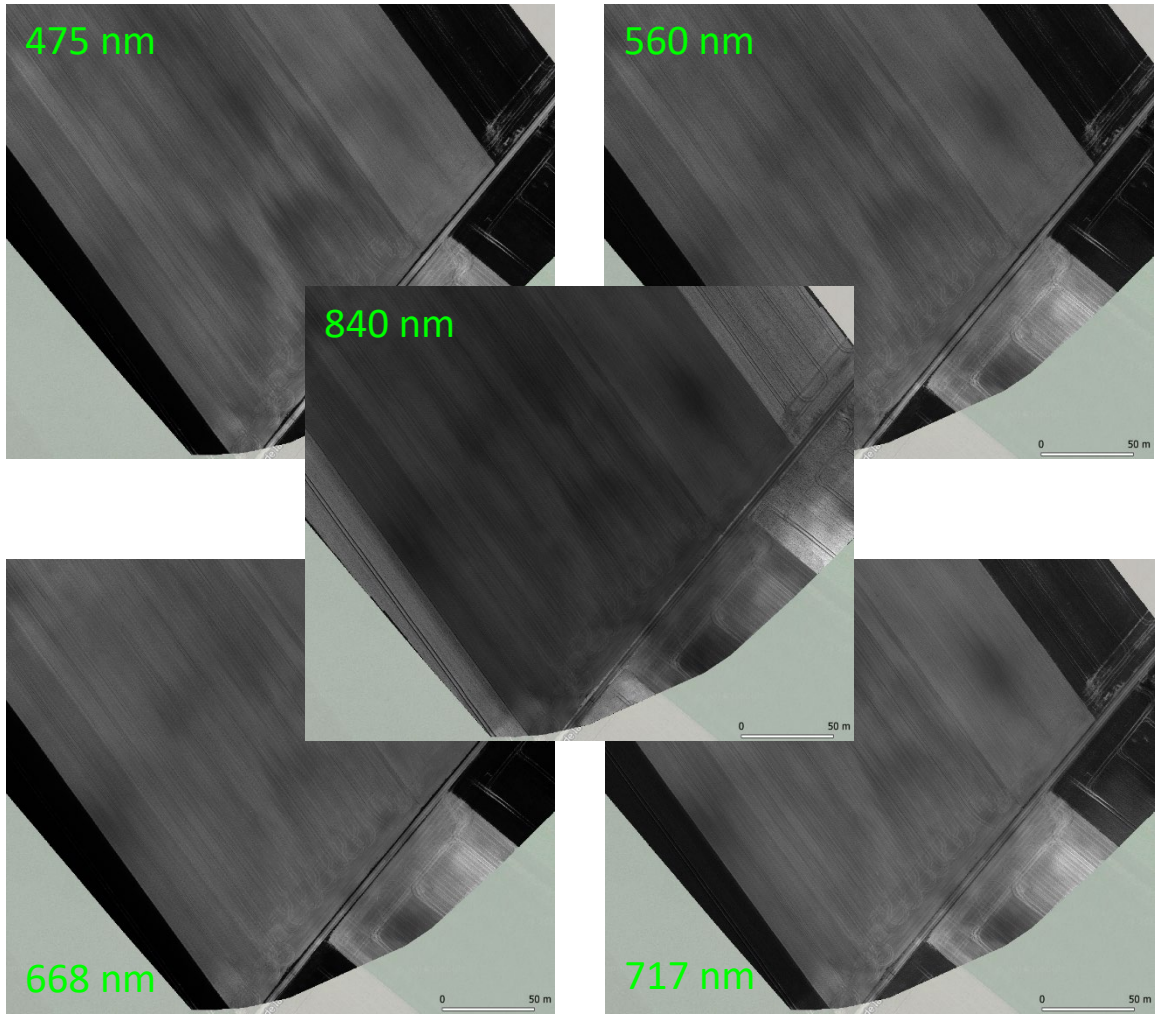
Micasense Rededge-M + Incident light sensor

DJI Phanotm 3

Pix4D software



Reflectance maps in 5 spectral broad-bands



Sensor tests for drone applications on soil properties*

ASD FieldSpec 3

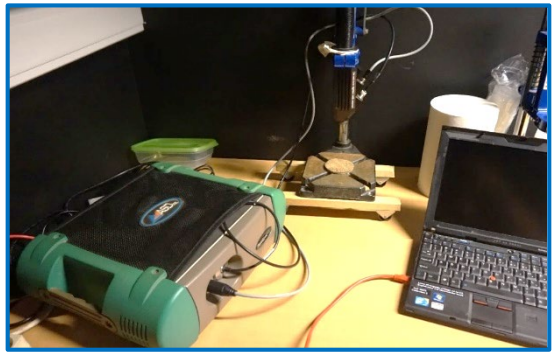
OceanOptics STS-VIS

OceanOptics STS-NIR

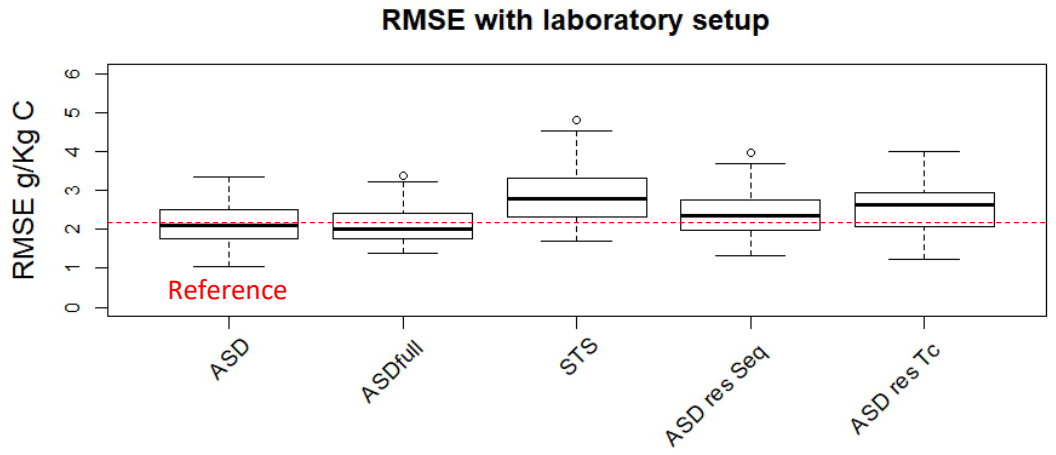
Parrot Sequoia

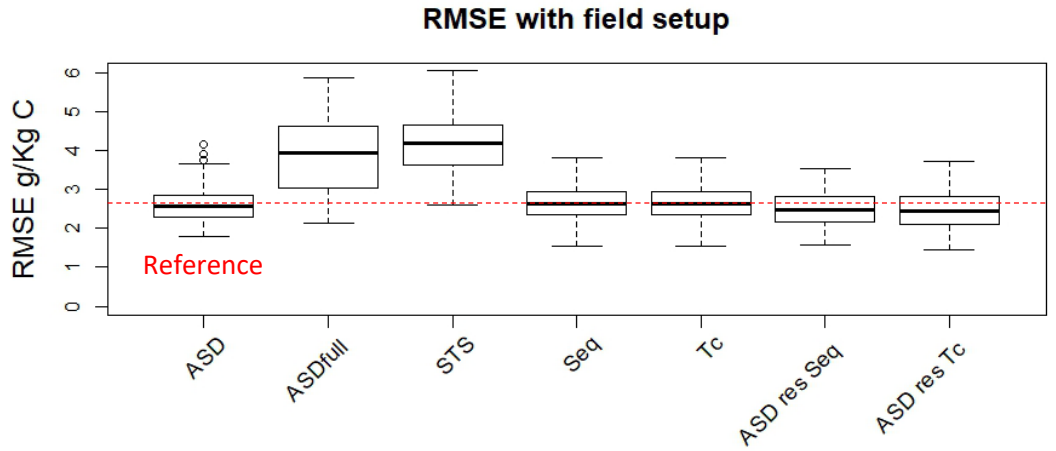
Tetracam Mini-MCA6

Laboratory setup



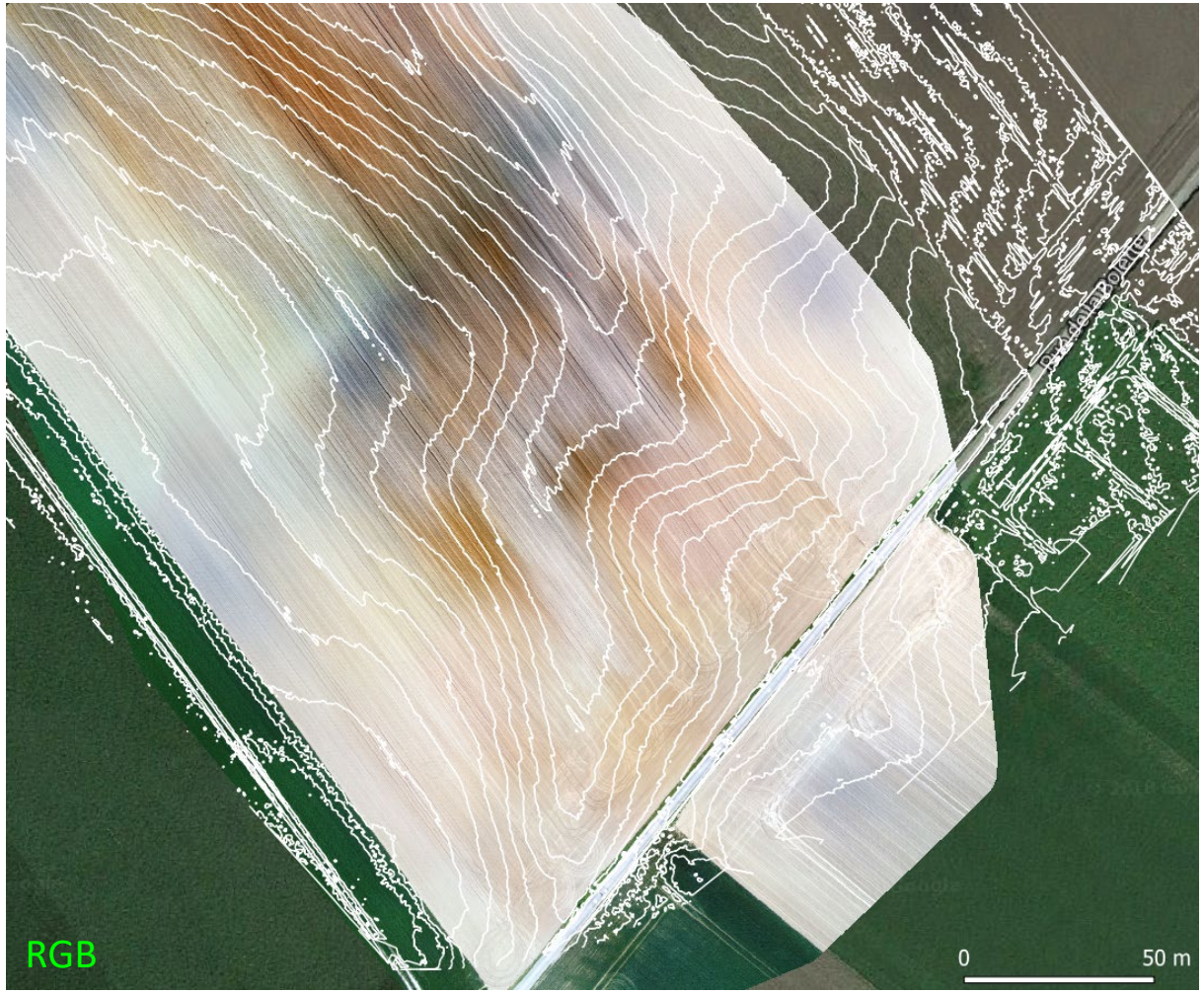
Field setup

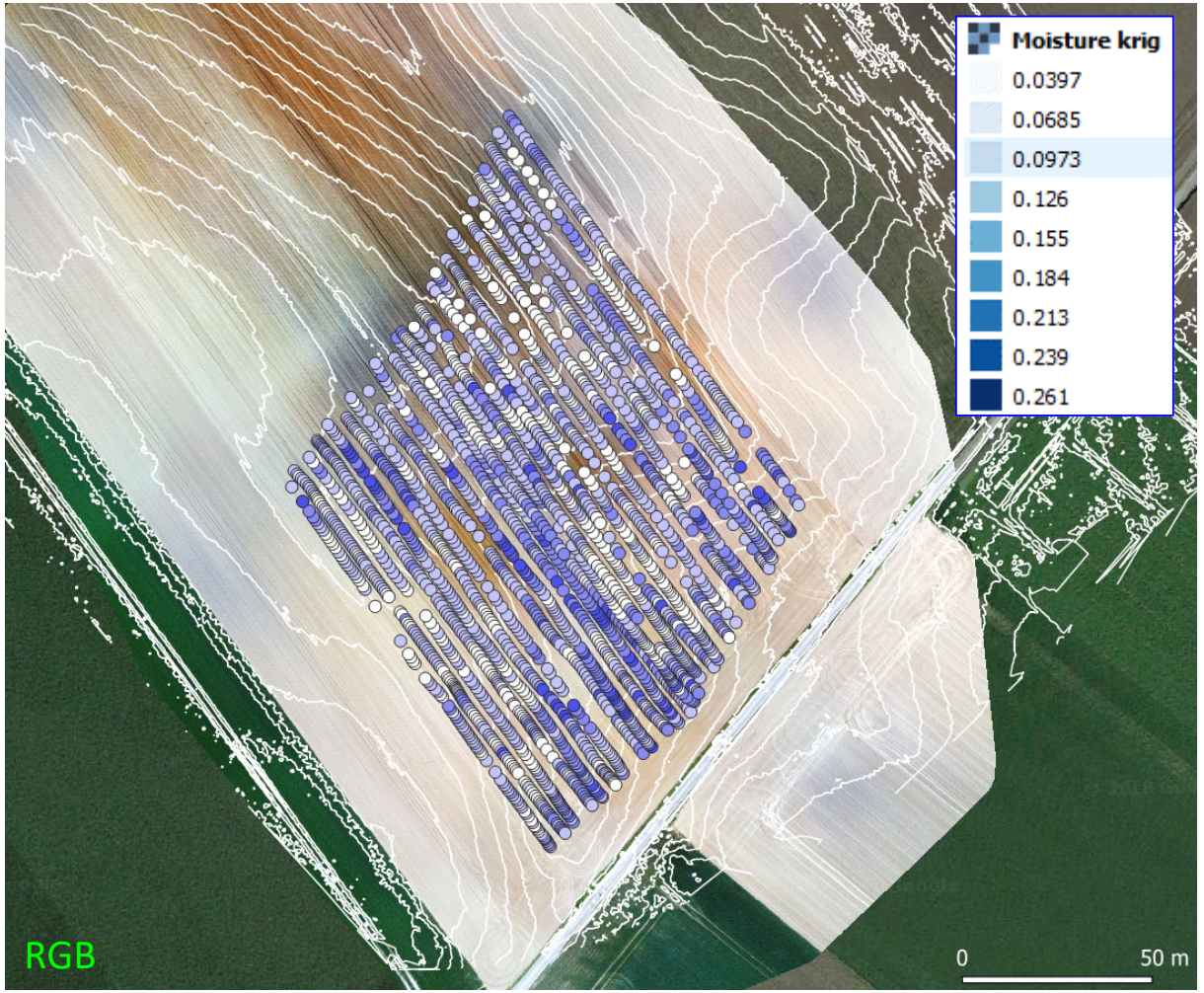




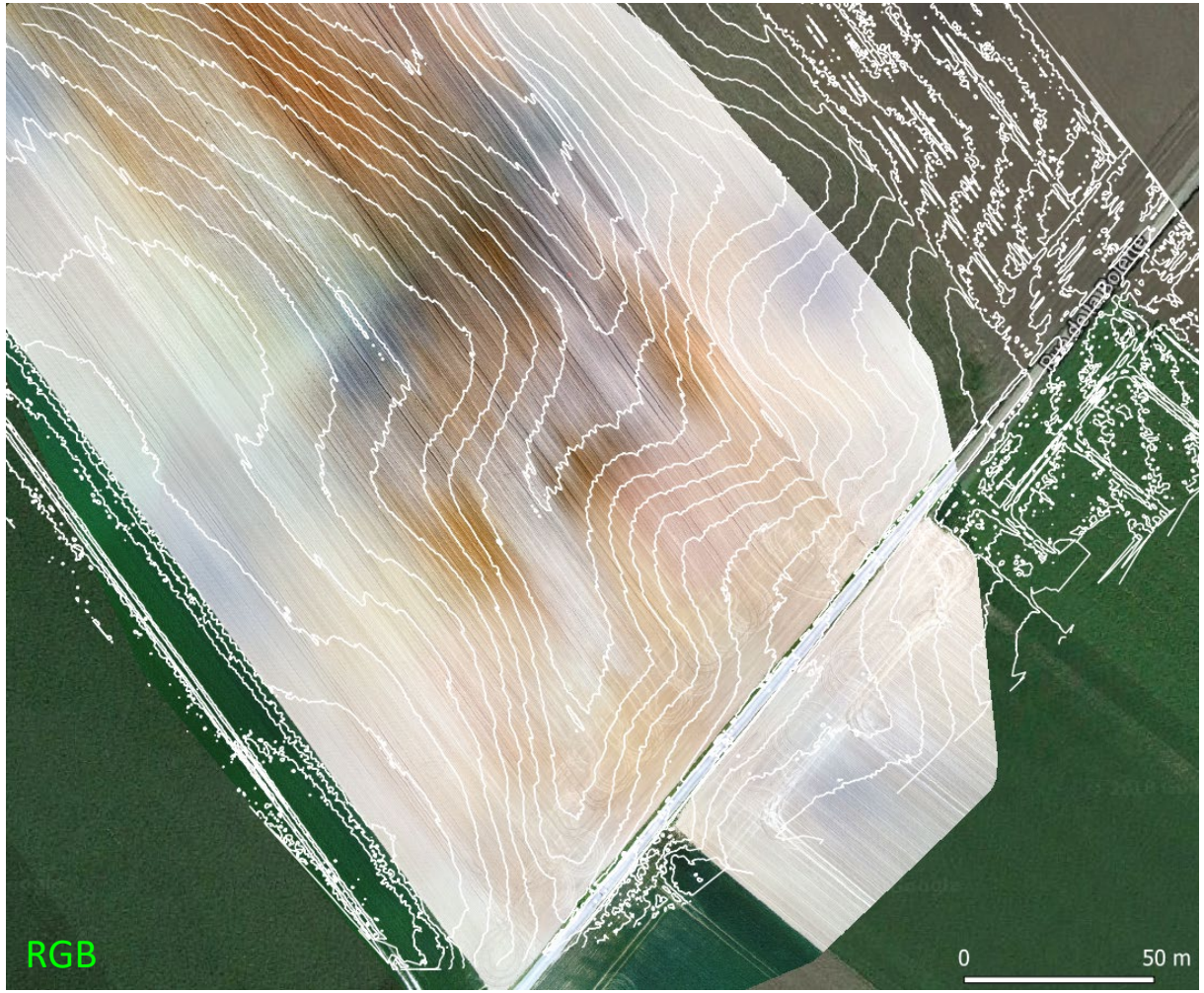
**Crucil G. et al. (2018) - Assessing the performance of UAS-compatible multispectral and hyperspectral sensors for soil organic carbon prediction (submitted to Remote Sensing)*

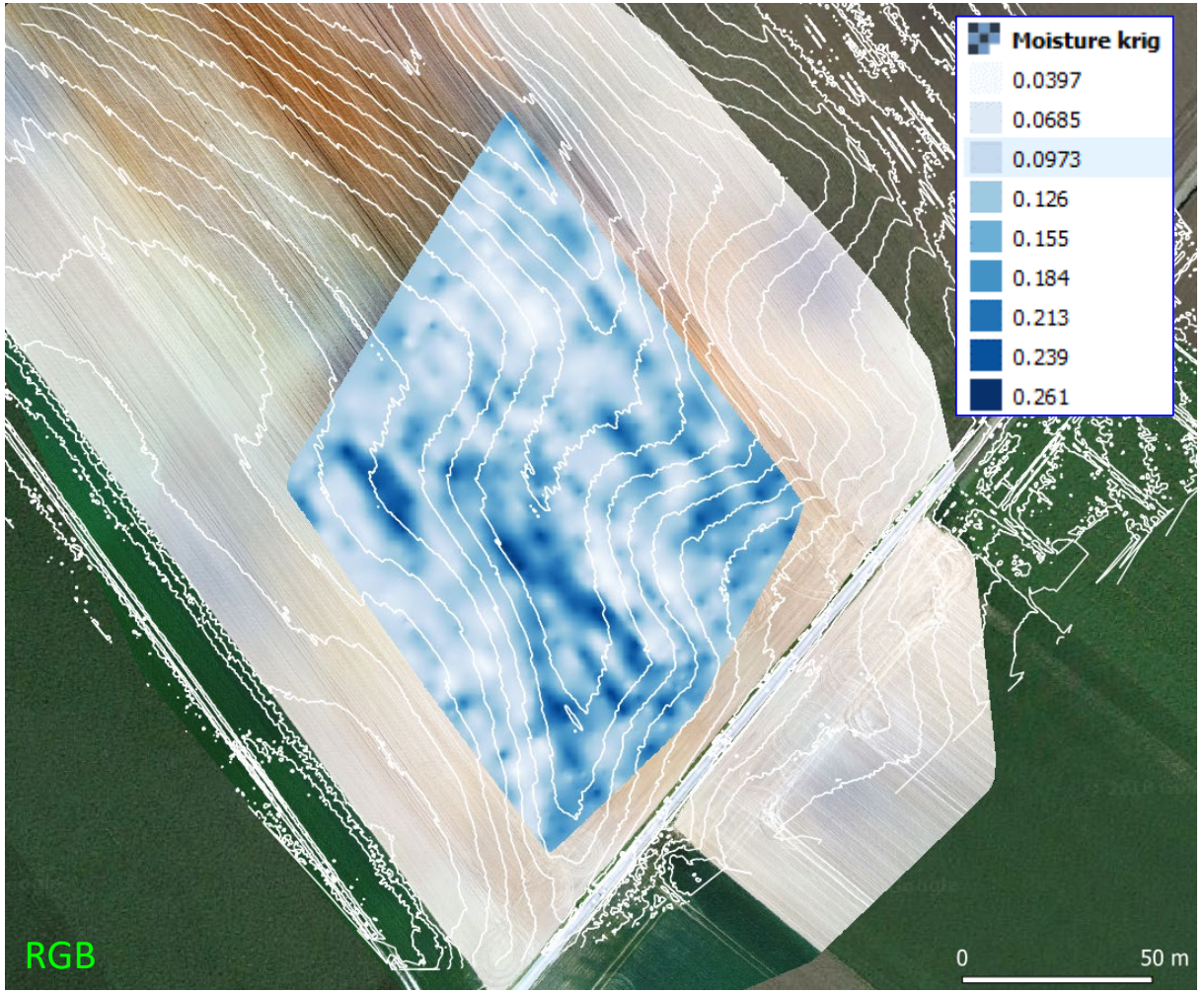
Joint multispectral and GPR acquisitions : Saint-Denis case study





Joint multispectral and GPR acquisitions : Saint-Denis case study





Joint multispectral and GPR acquisitions : Results

GPR data

kriging

MS extraction at kriged cells

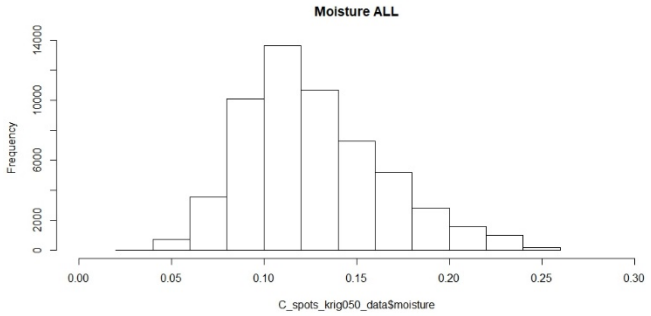
regression matrix

calibration/validation

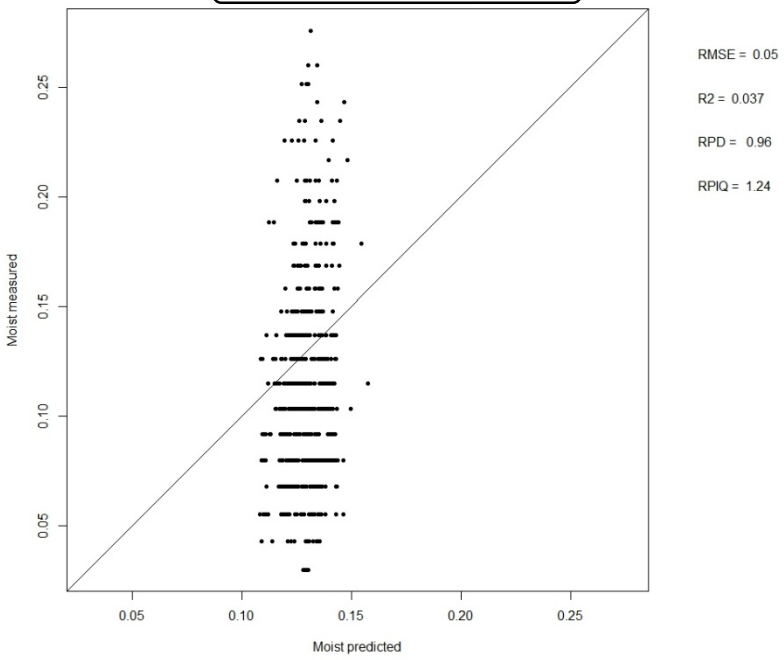
PLSR

RMSE, R^2, RPD, RPIQ

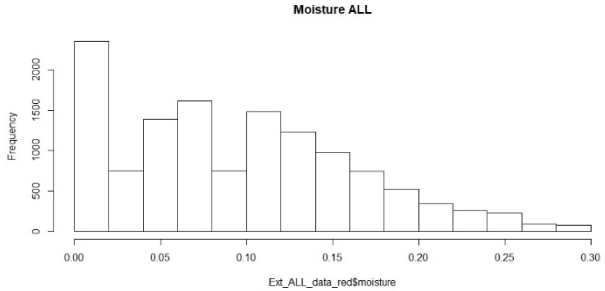
Saint-Denis



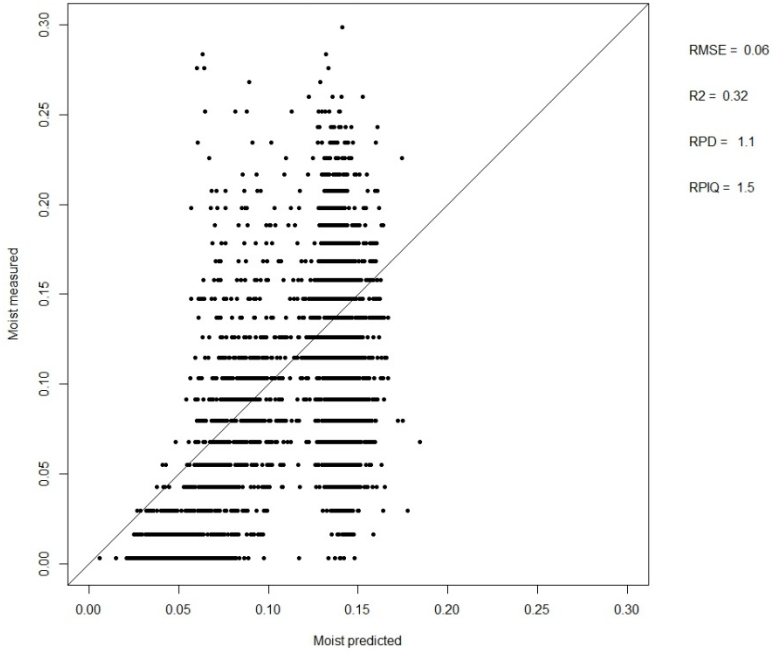
PLSR model fit



ALL fields



PLSR model fit



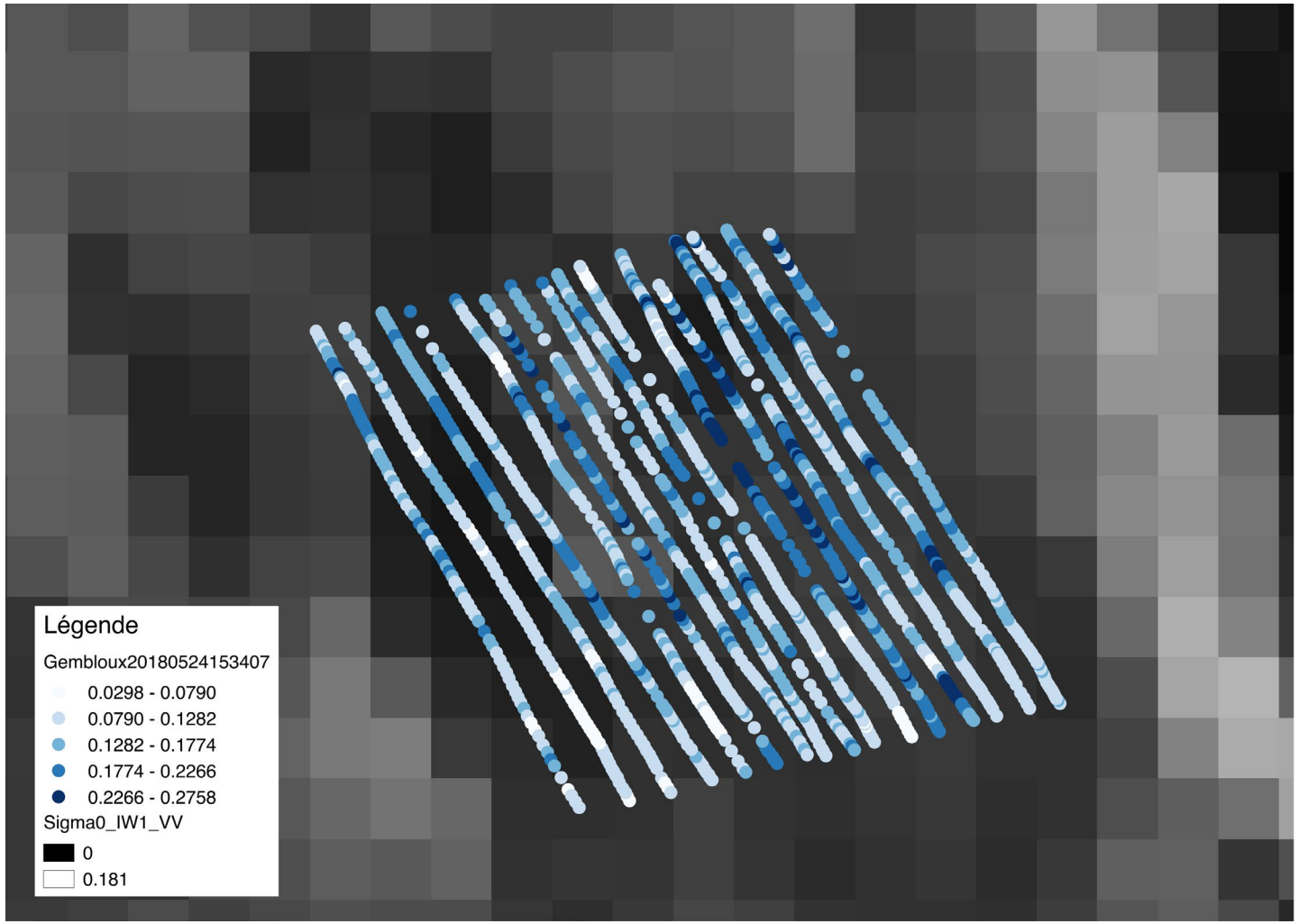
Relation between backscatter and surface soil moisture
Scattering coefficient

$$\sigma^0 = f(\varepsilon, s, \theta, \nu, \lambda)$$

05 24 2018 15:34 - Gembloux

Sentinel 05 23 17:24 (UT) (19:24 BE)

Humid day

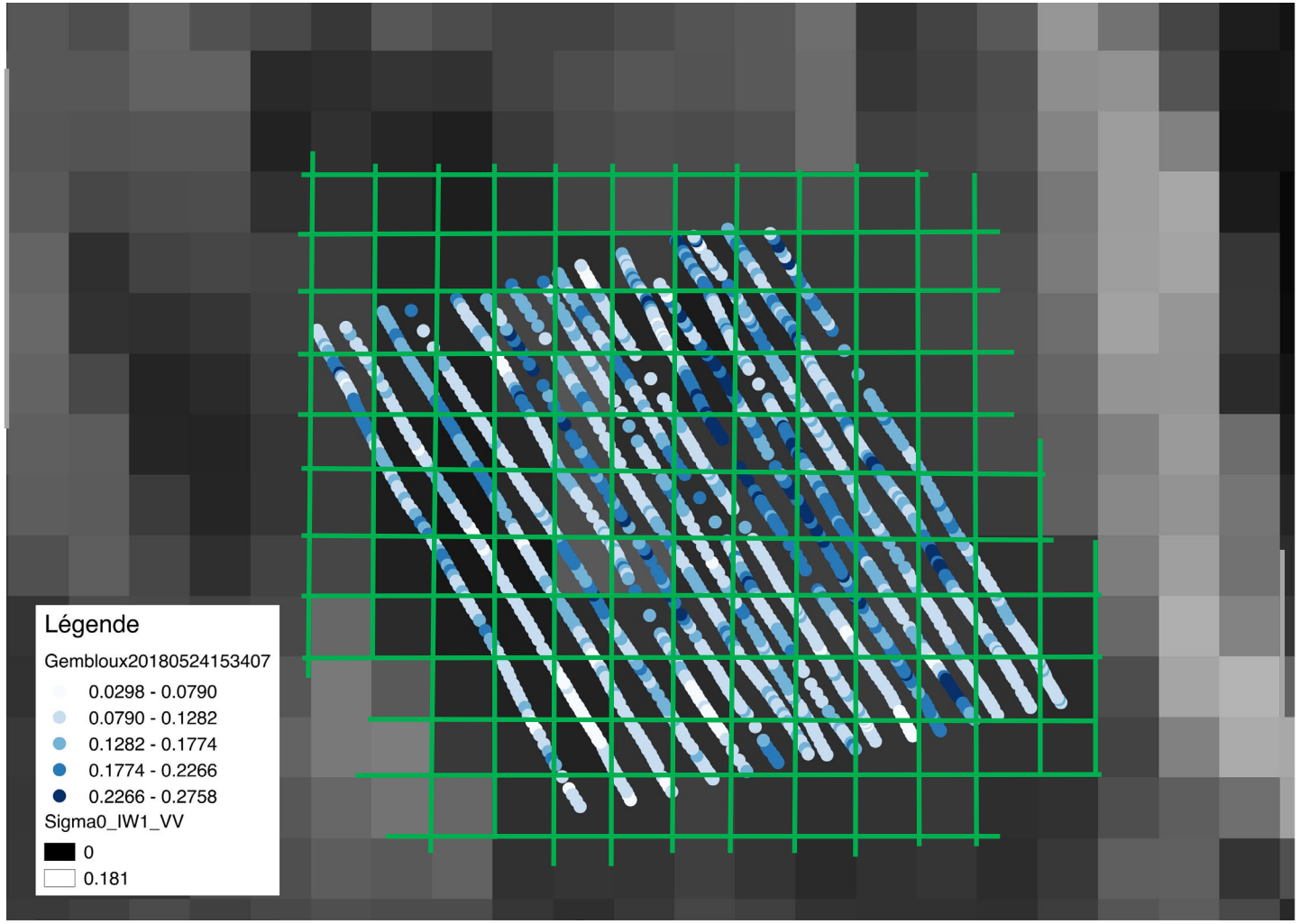


A. Radioti

05 24 2018 15:34 - Gembloux

Sentinel 05 23 17:24 (UT) (19:24 BE)

Humid day



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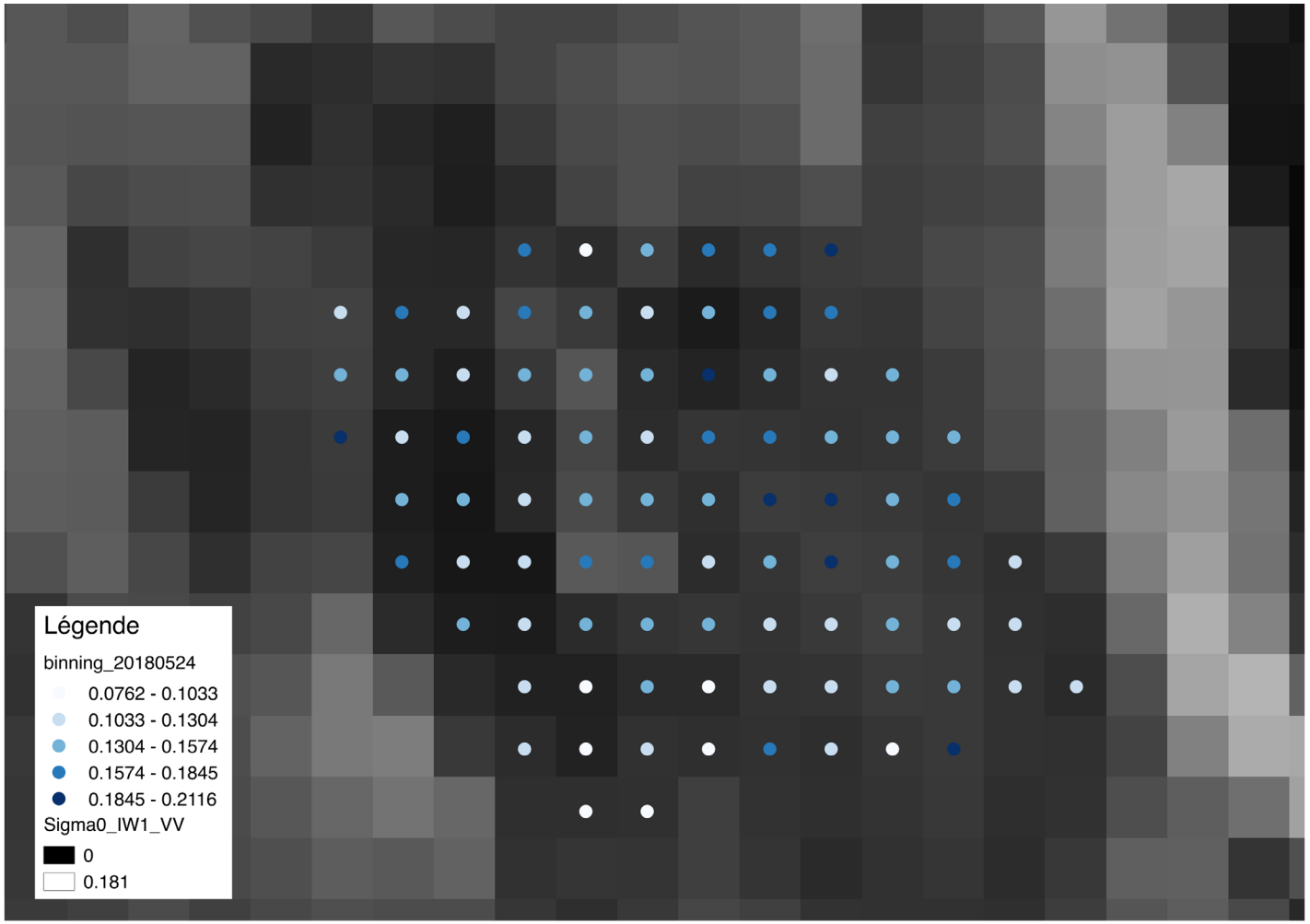

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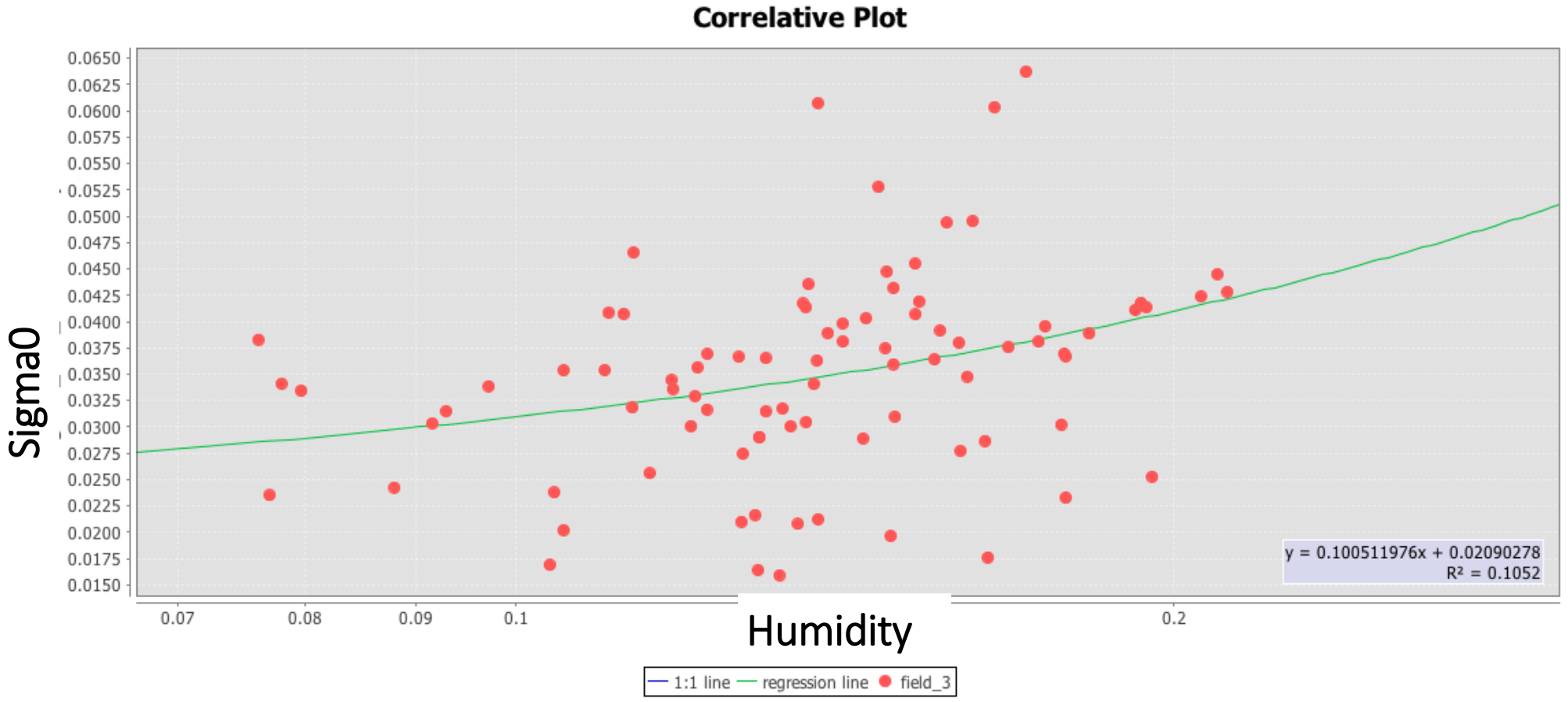
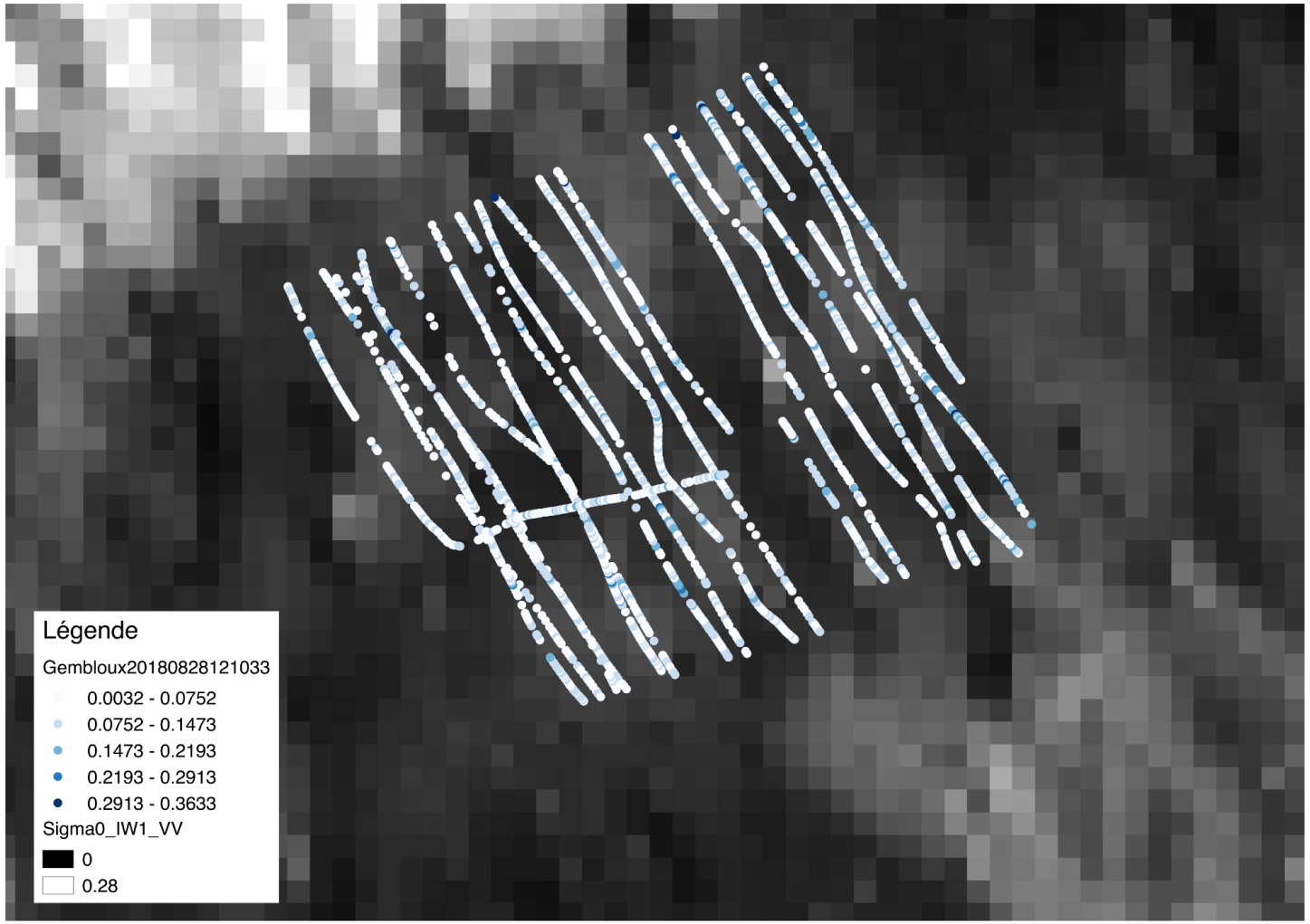


A. Radioti

08 28 2018 12:10 - Gembloux

Sentinel 08 27 17:25 (UT) (19:25 BE)

Dry day



A. Radioti

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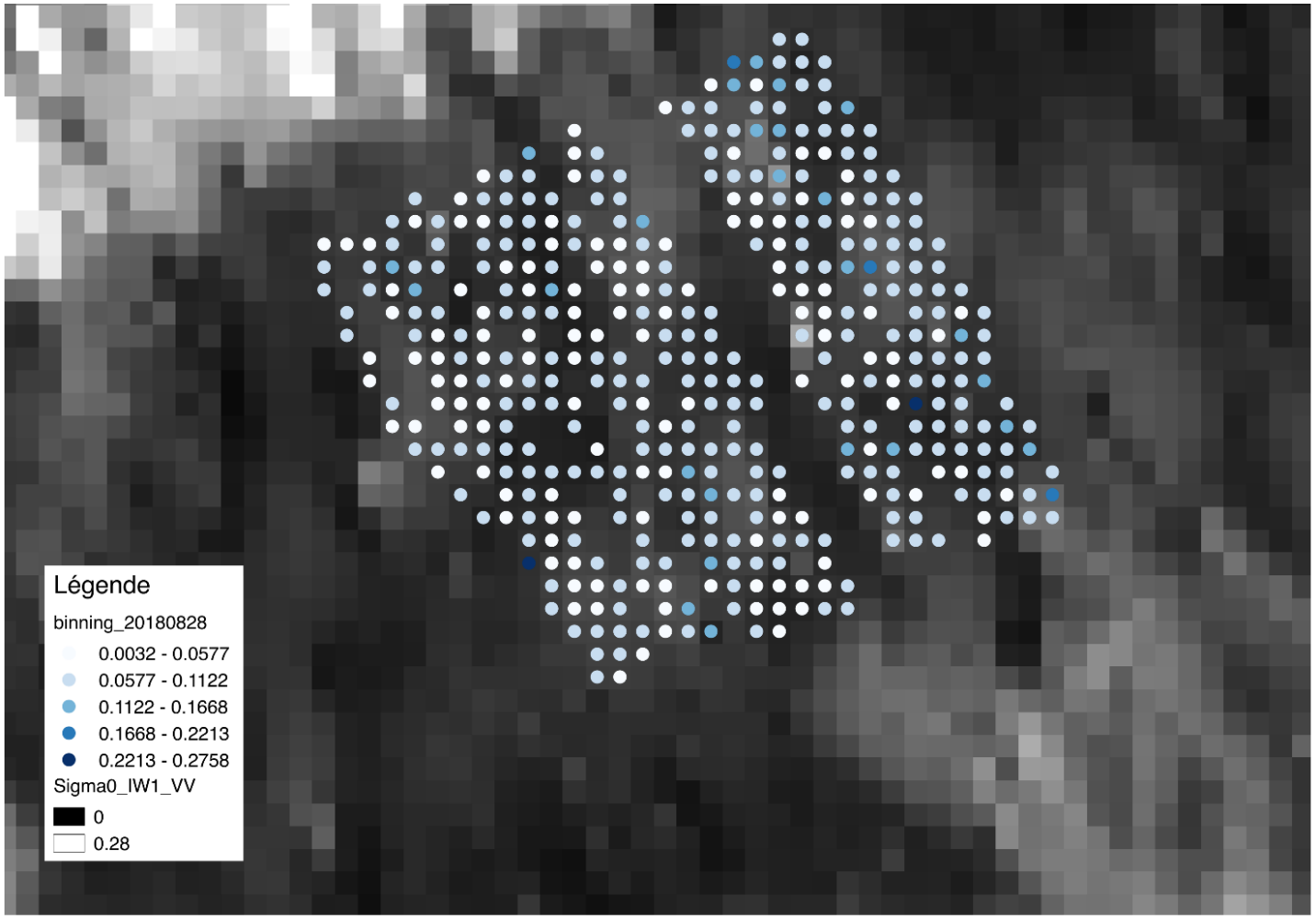
Dry day



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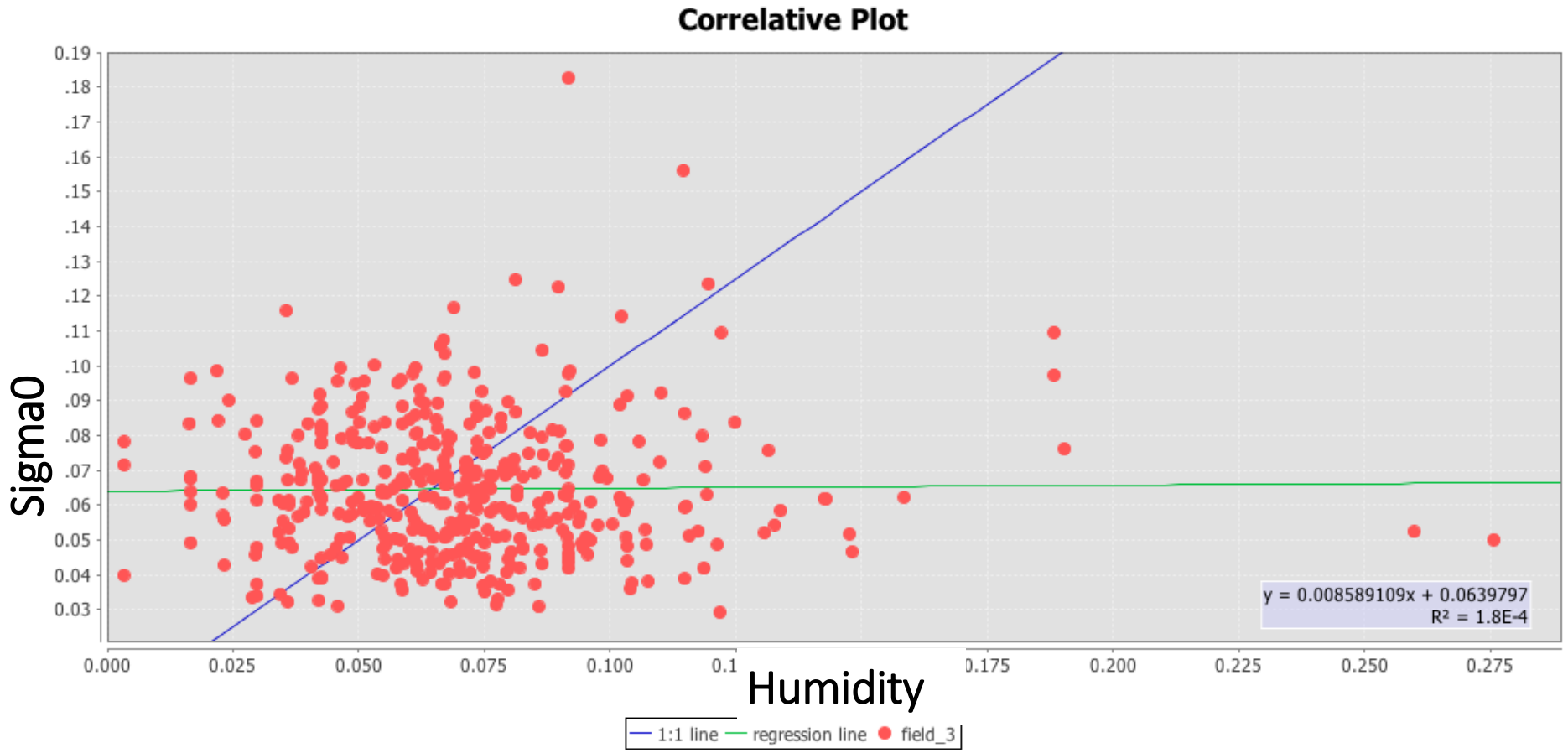
08 28 2018 12:10

Sentinel 08 27 17:25 (UT) (19:25 BE)

Dry day



Correlation between sigma0 and humidity

A correlation is more evident for humid days (1st example, 24/05)

- Humid days: wide range of humidity
- The values of humidity are better distributed
- Better correlation

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