Campistrous - Geophysics and Soil analysis

SOIL type/ composition - Soil resistivity/Conductivity

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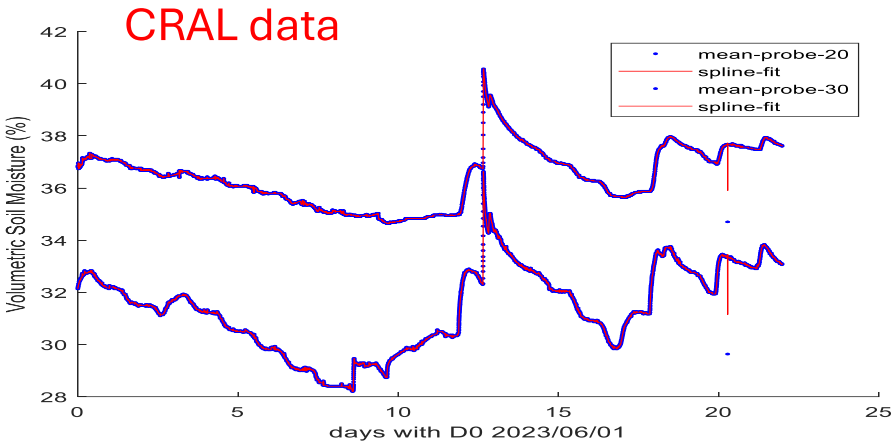
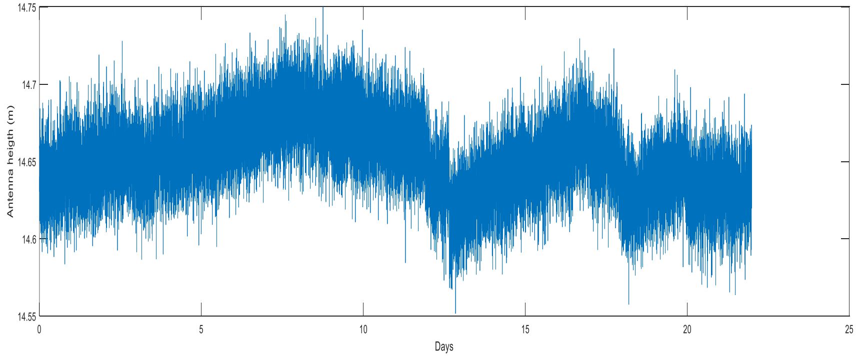
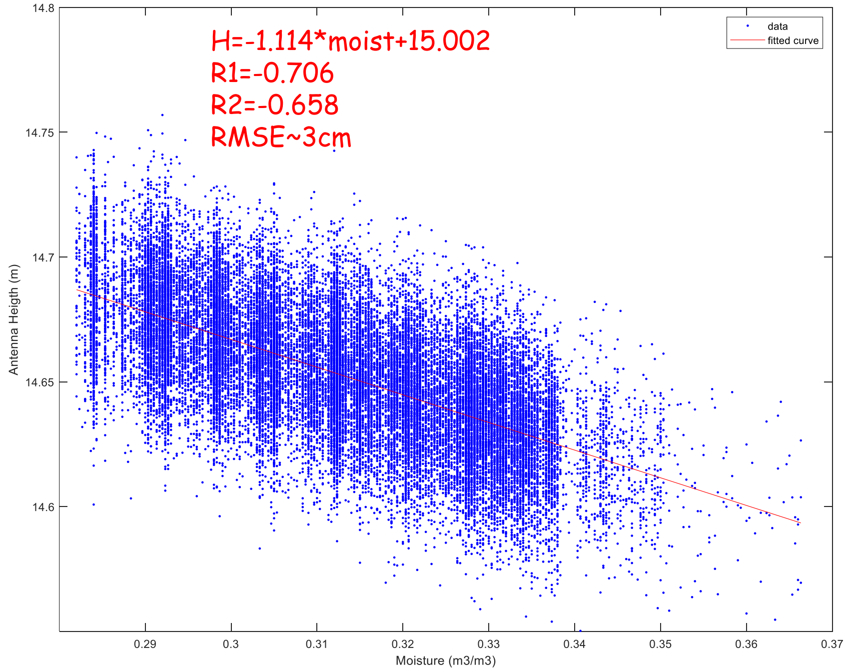
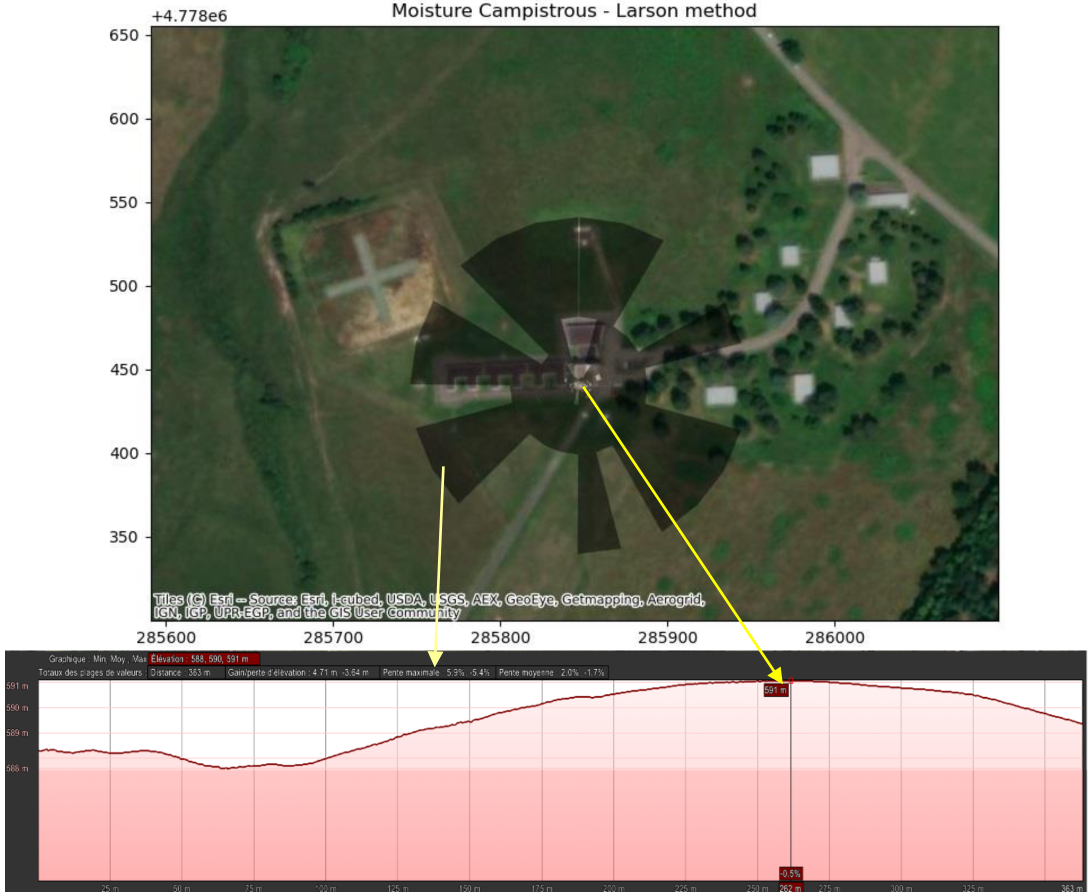
SINGLE ANTENNA - SOIL MOISTURE TIME SERIES





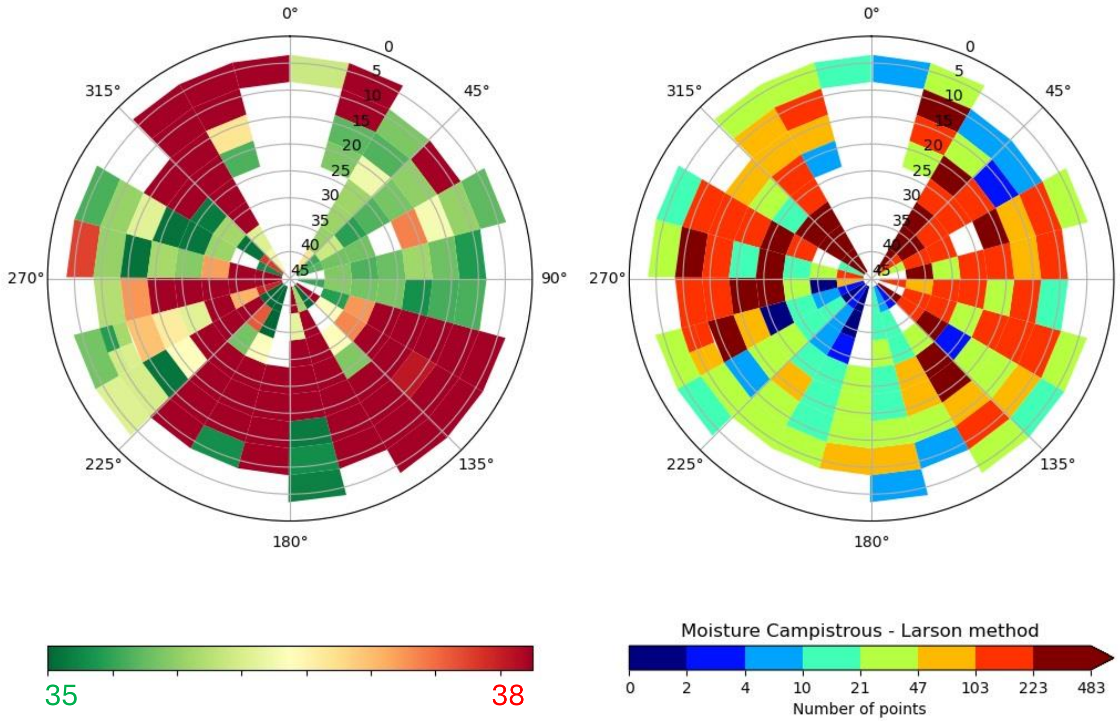


SINGLE ANTENNA - SOIL MOISTURE MAPPING



Coverage using 3 satellites G1, R22, R24

The time window of the map presented here covers the first 12 hrs.



Moisture map using 9 satellites G1, G2, G3, G4, G5, G6, R22, R24,

The time window of the map presented here covers the first 6 days.

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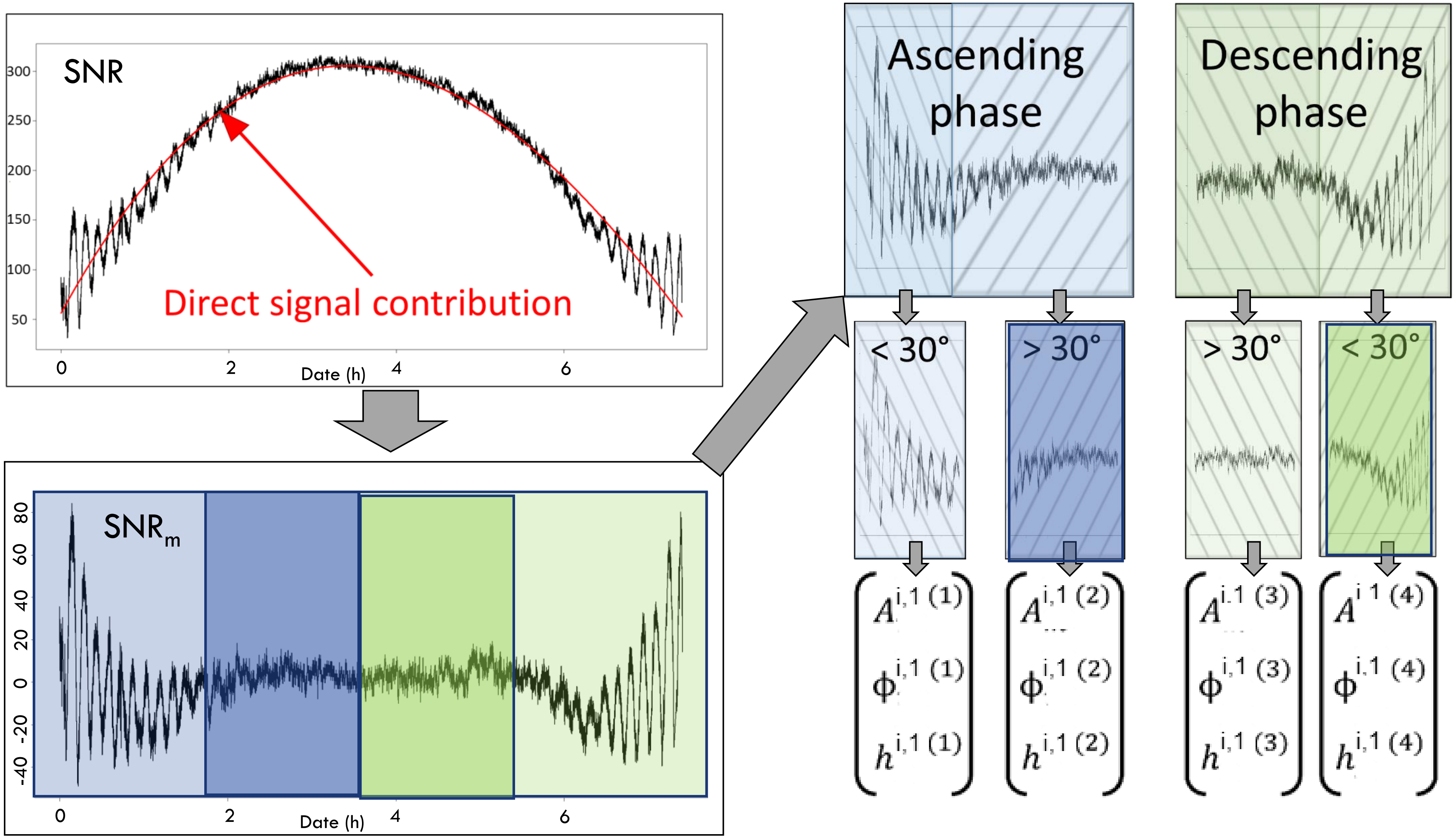
April – may 2024 Geophysical measurement campaigns + soil cores.

Receiver installed on the 30m mast ⇔ better quality measurements
better coverage
Comparison of the vapor c

Analysis of the vegetation (time serie and Map)



Least Square Inversion

$$f_{i=1}(t)=U_{i=1}\dot{h}(t)+V_{i=1}h(t)$$
$$f_{i=2}(t)=U_{i=2}\dot{h}(t)+V_{i=2}h(t)$$
.
.
$$f_{i=n}(t)=U_{i=n}\dot{h}(t)+V_{i=n}h(t)$$

Matrix representation

$$F=U\dot{h}(t)+Vh(t)=AX$$

with $A=(U\ \ V)$ and $X=\begin{pmatrix}\dot{h}(t)\\ h(t)\end{pmatrix}$

$$X=(A^tA)^{-1}(A^tF)$$

Kalman filter

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E state vector
A transition matrix
Q gaussian noise (covairance matrix)

$E_t = \begin{pmatrix} X \\ Y \\ H \\ Hdot \end{pmatrix} = A . E_{t-1} + q_{t-1}$

$X_t = X_{t-1} + H_{t-1} * dt$
$Y_t = Y_{t-1} + H_{dot\,t-1} * dt$

$A = \begin{matrix} 1 & 0 & dt & 0 \\ 0 & 1 & 0 & dt \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{matrix}$

Prediction can be used when you have **outlier**
$E_{t+1} = A . E_t + q_t$
$P_{t+1} = A_t . P_t A_t \text{(transpose)} + Q_t$

We take a measurement at t

$Z_t = O . E_t + r_t$

Z measurement vector
O observation matrix
R :gaussian noise

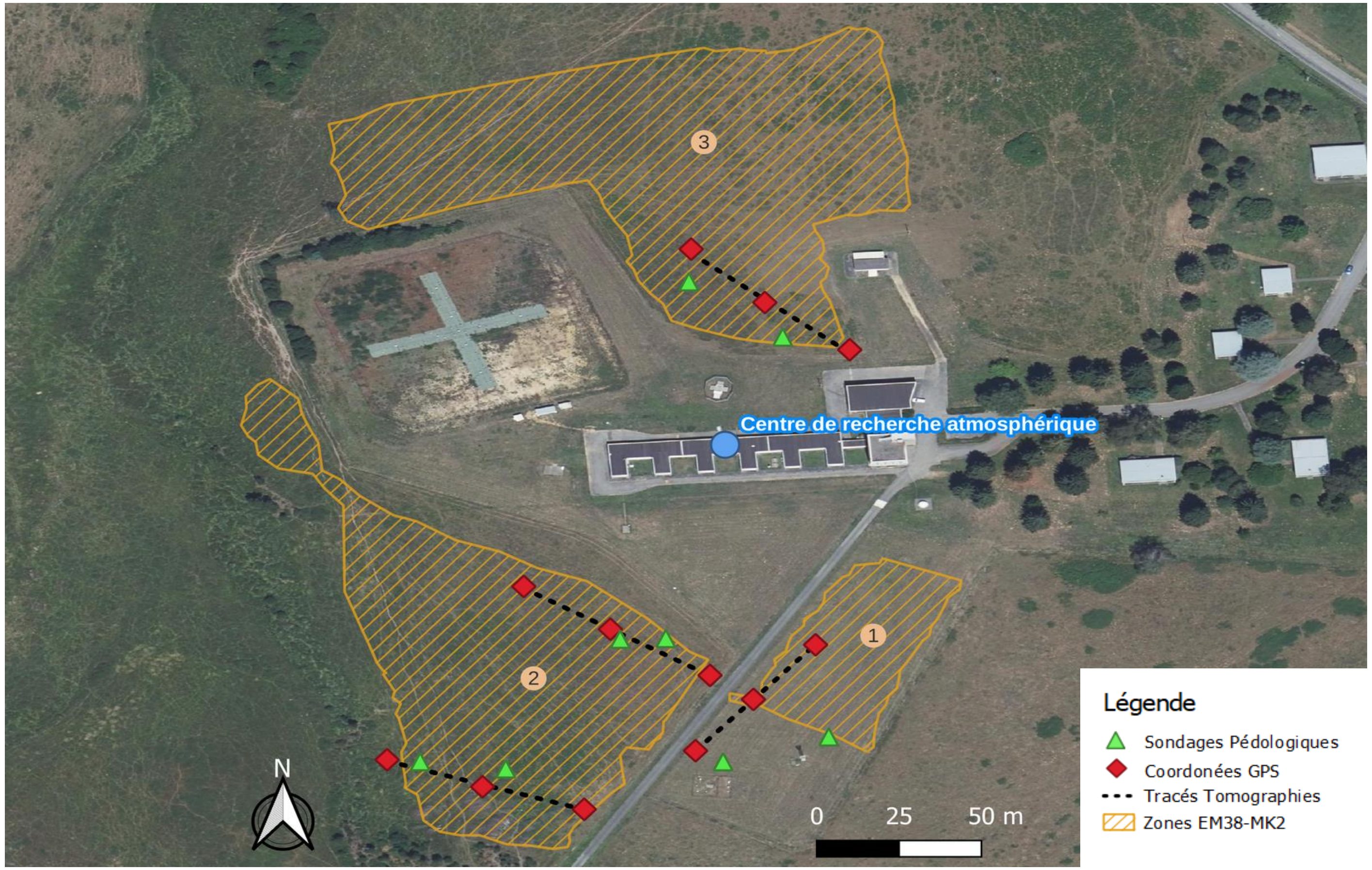
GNSS gives X,Y but not H and H_{dot} so

Observation matrix O ⇔ 2 observables X, Y

$H = \begin{matrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{matrix}$

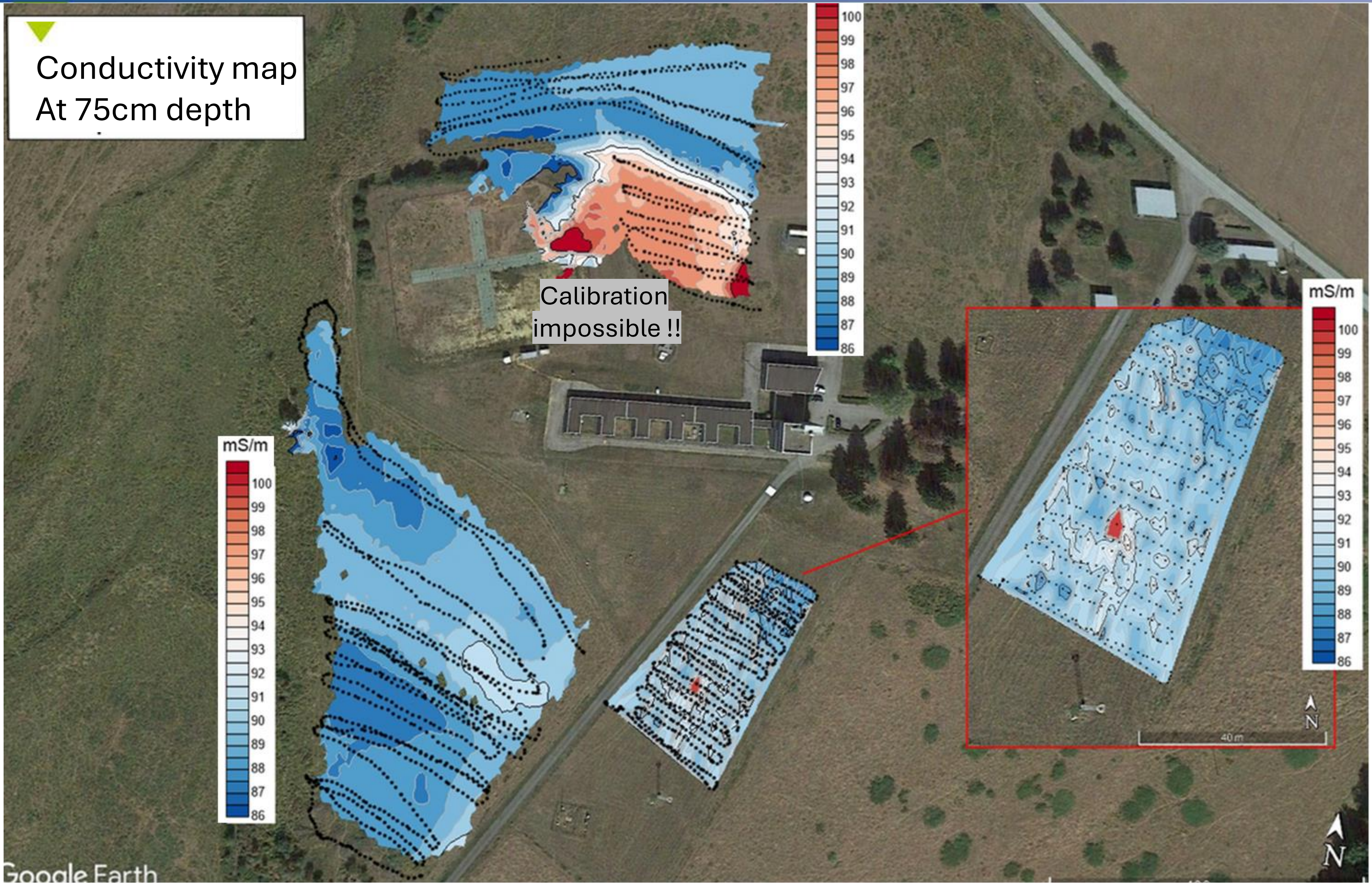
The advantage of this calculation is that we work with small matrices and simply update the covariance matrix, Z, O which minimizes the use of memory space and avoids crashes linked to the huge matrix obtained for least squares inversion over the entire period.

GEOPHYSICAL DATA ACQUISITIONS



Location of map of geophysical data

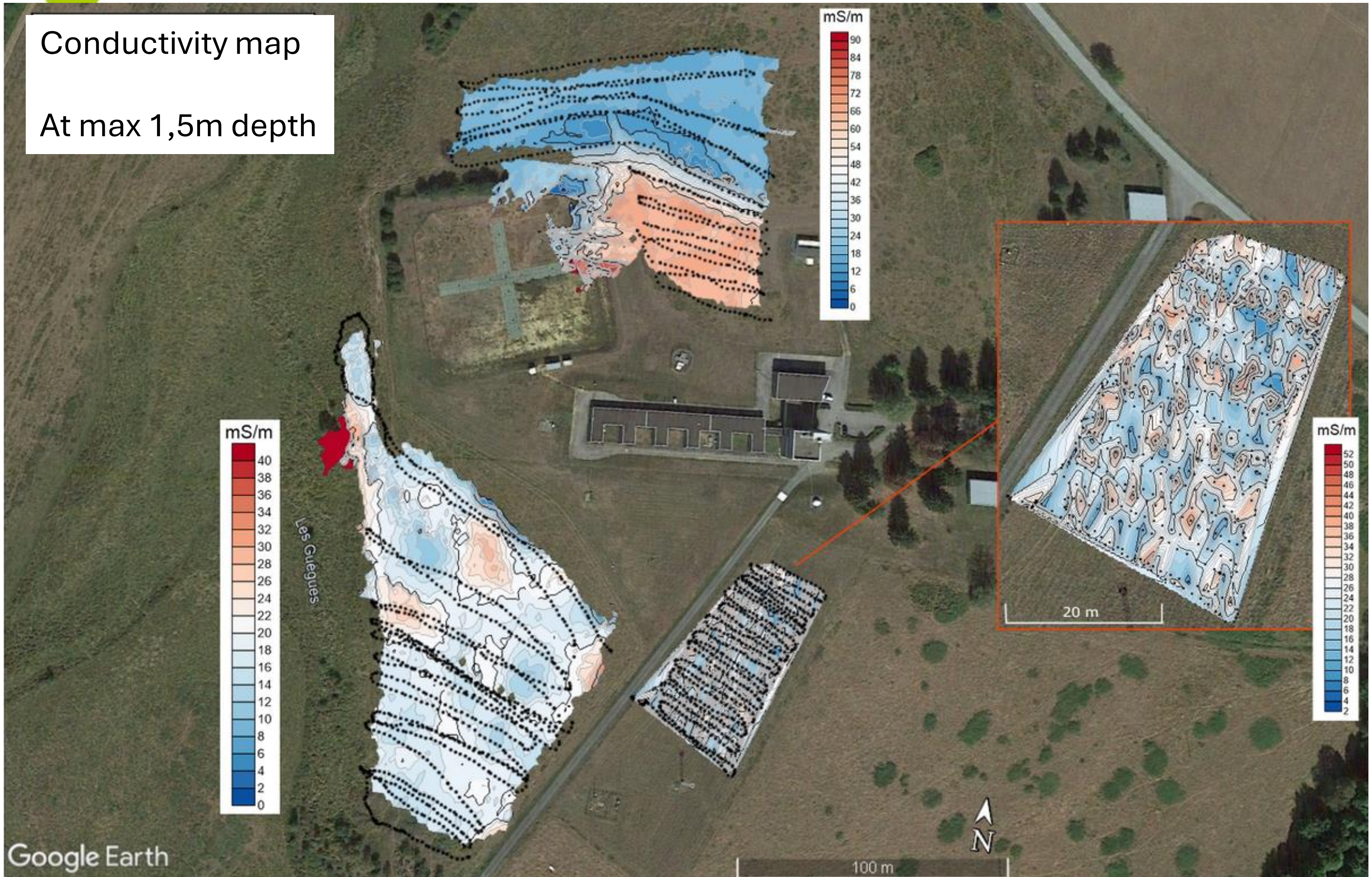
DATA ACQUISITIONS - EM38 MAP



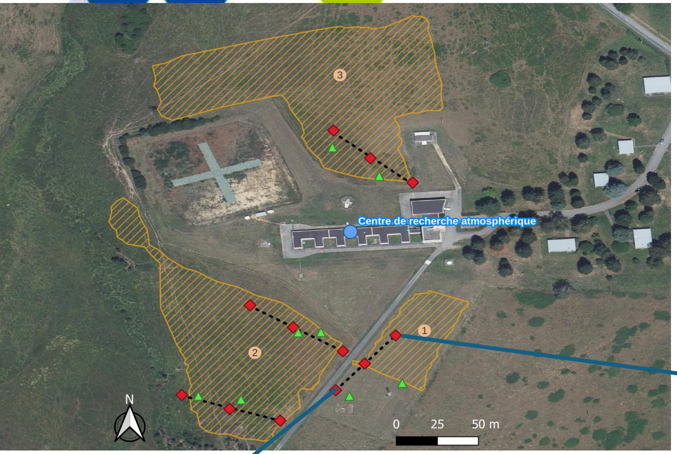
DATA ACQUISITIONS - EM38 MAP

Conductivity map

At max 1,5m depth



DATA ACQUISITIONS - ERT PROFILES



- Soil profile
- GPS point
- electrical resistivity tomography
- EM38 maps

$\rho_{apparent} = R \times S/L$ Ohm.m

measured resistance R (Ohm)

conductor length L (m)

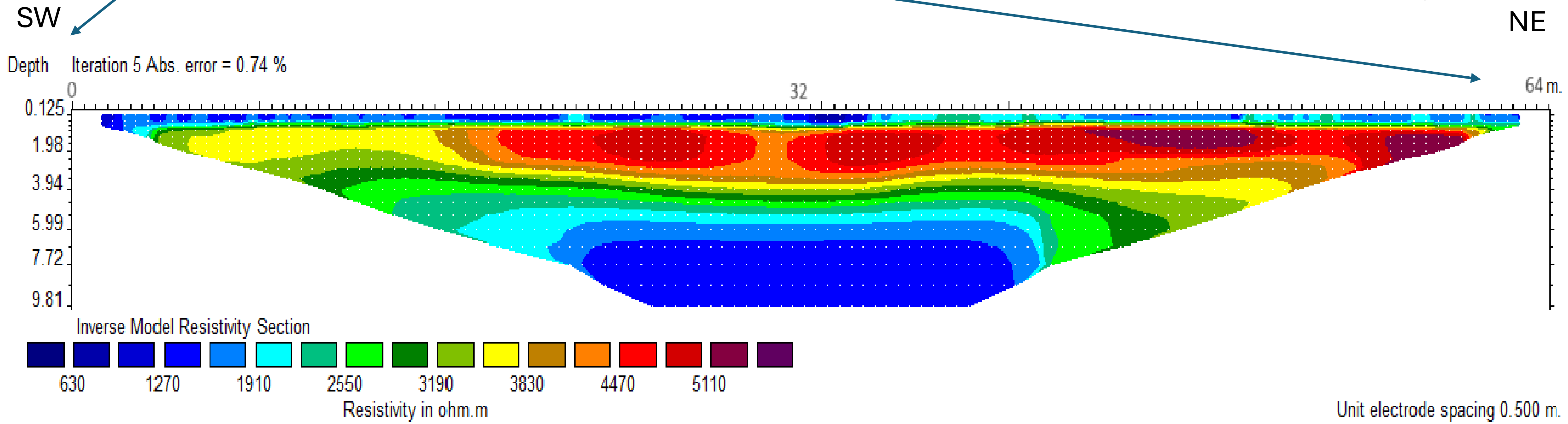
conductor cross-section S (m^2)

SOIL STRUCTURE

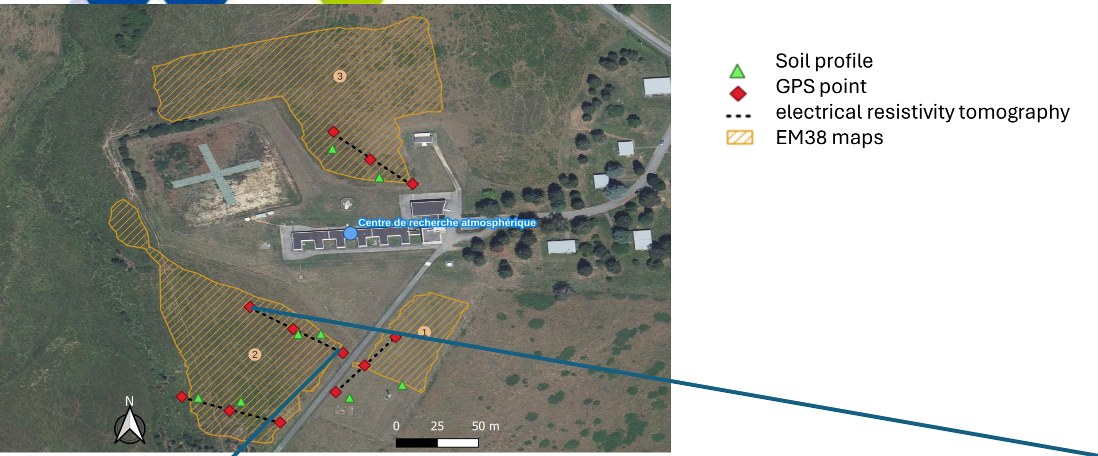
surface ⇔ saturated soil

at 1m until 5m a resistant layer (~4400-5200 Ohm.m)

In depth (> 6m) resistivity is not so high ⇔ mixed sand/clay or sand/water layer ?



DATA ACQUISITIONS - ERT PROFILES

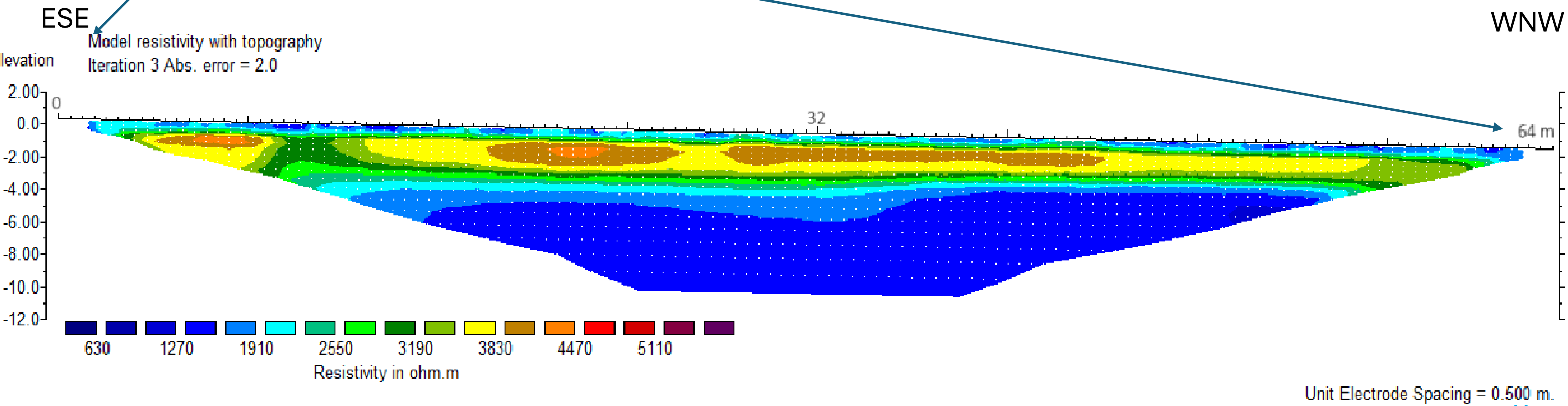


SOIL STRUCTURE IS CLOSED THAN previous ERT profile

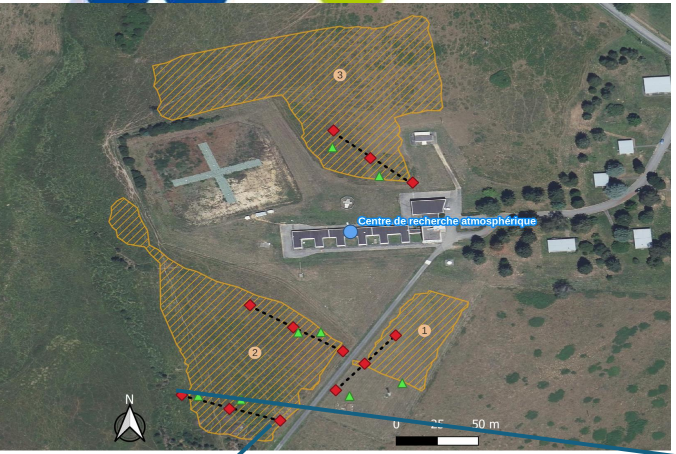
surface ⇔ saturated soil

at 1m until 6m a resistant layer (~3800-4200 Ohm.m)

In depth (> 6m) resistivity is not so high ⇔ mixed sand/clay or sand/water layer ?



DATA ACQUISITIONS - ERT PROFILES



Soil profile
GPS point
electrical resistivity tomography
EM38 maps

SOIL STRUCTURE IS CLOSED THAN OTHER ERT profiles

surface ⇔ saturated soil

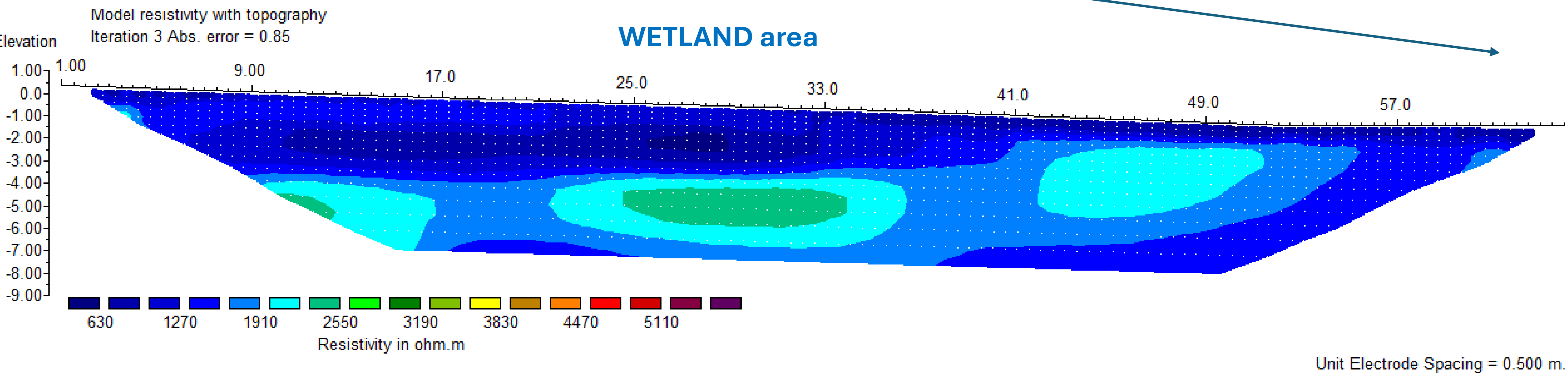
at 1m until 6m a resistant layer (~3000 Ohm.m)

In depth (> 8m) resistivity is very low ⇔ mixed sand/clay or sand/water layer ?

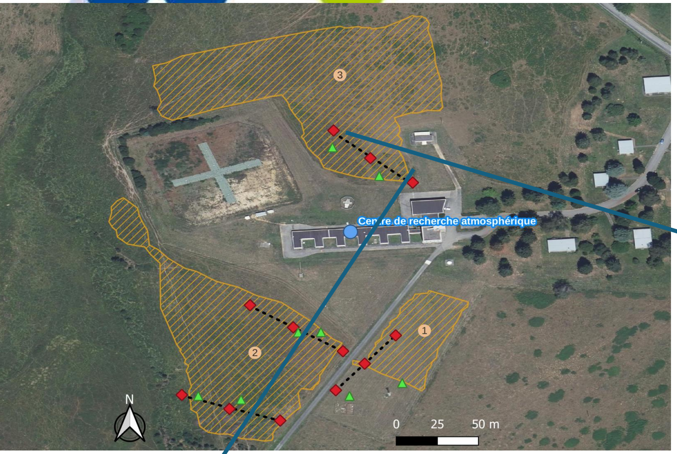
ESE

WNW

WETLAND area



DATA ACQUISITIONS - ERT PROFILES



gas tank (> 10000 Ohm.m) ? It mask ground resistivity constrast ⬄ SOIL STRUCTURE IS CLOSED THAN OTHER SITES

surface saturated soil

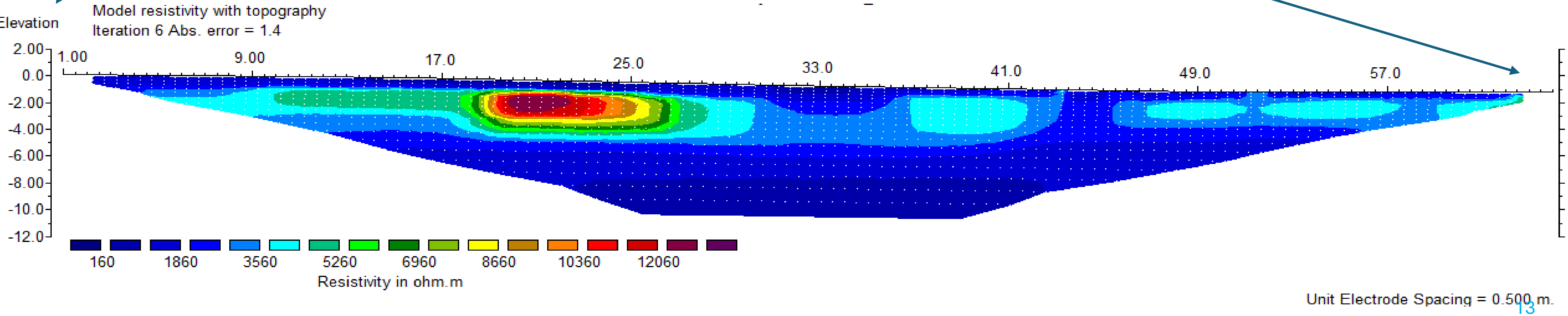
at 1m until 6m a resistant layer (~4000 Ohm.m)

In depth (> 8m) resistivity is very low ⬄ mixed sand/clay or sand/water

saturated layer ?

ESE

WNW



ANR

DATA ACQUISITIONS - SOIL MOISTURE

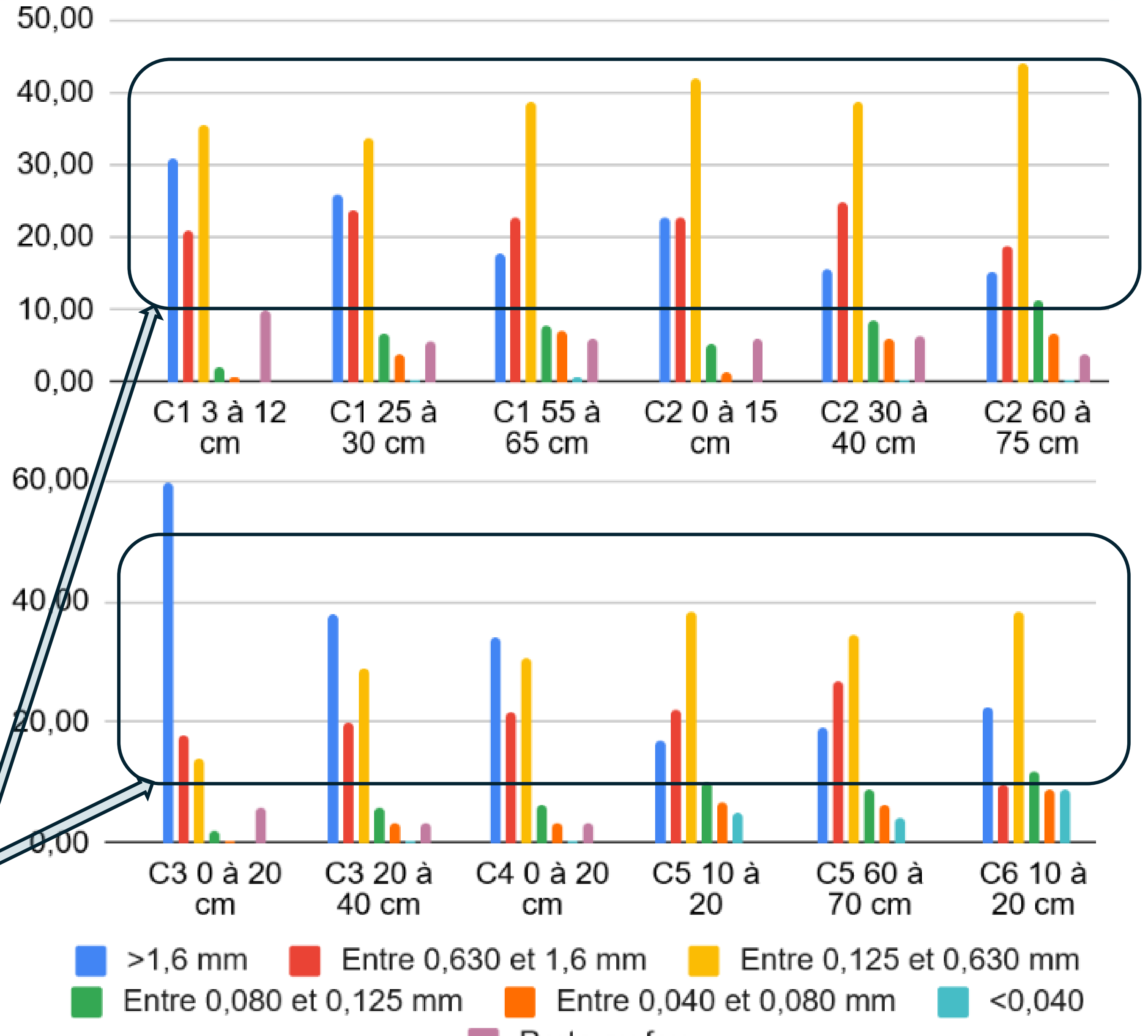
Géosciences Environnement Toulouse

Saturated to 7% topsoil first centimeters

Champ	Carottes	Profondeur	% Humidité	Humidité moyenne carottage (%)	Humidité moyenne champ (%)
Champ 1	C1	3 à 12 cm	7,04	8,43	8,61
		25 à 30 cm	5,60		
		55 à 65 cm	12,64		
	C2	0 à 15 cm	7,71	8,80	
		30 à 40 cm	8,53		
		60 à 75 cm	10,16		
Champ 2b	C3	0 à 20 cm	14,58	13,87	20,26
		20 à 40 cm	13,16		
	C4	0 à 20 cm	11,83	11,83	
Champ 2a	C5	10 à 20 cm	27,43	27,87	
		60 à 70 cm	28,31		
	C6	10 à 20 cm	26,25	26,25	

For C6 below 20cm ⬄ groundwater ⬄ impossible to obtain a core (no cohesion)

DATA ACQUISITIONS - SOIL MOISTURE



>1,6mm Pebbles; 1,6 mm > coarse sands > 0,2 mm
0,2 mm ≥ fine sands > 0,05 mm
0,05 mm ≥ coarse limons < 0,04 mm < fine limons/clay