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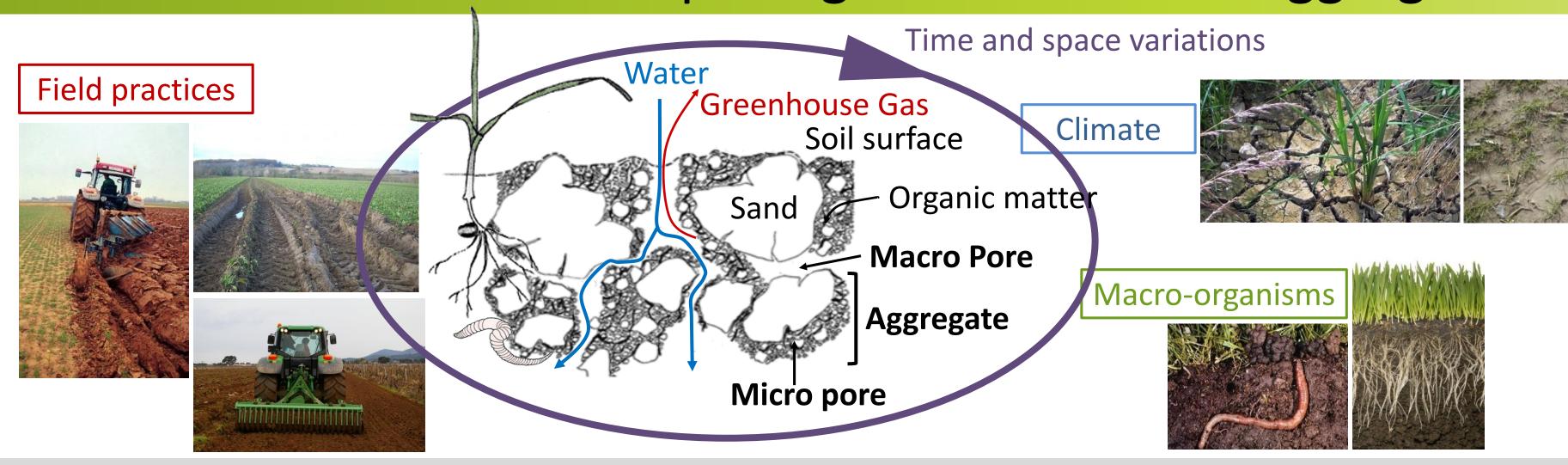


# Passive acoustic emission in soils: a new way to apprehend soil structure and monitor its dynamics?

**Marine LACOSTE** 

5<sup>th</sup> AgreenSkills Annual meeting 11-14 June 2018 - Edinburgh <u>AgSk hosting Lab</u>: Soil and Terrestrial Environmental Physics, Institute of Biogeochemistry and Pollutant Dynamics, ETH, Zürich, Switzerland <u>Work contributors</u>: Siul Ruiz, Dani Or (STEP Group, ETH Zürich, Switzerland)
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## 1. Soil structure: macroscopic organisation of soil aggregates and pores (Dexter, 1988)



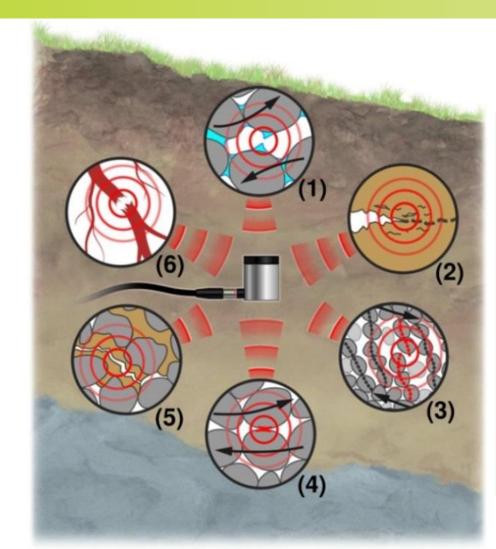
#### Control water and gas flows and storage in soils:

- Control physical and chemical environment for soil organisms
- Example: soil structure impacts on N<sup>2</sup>O emissions by soils (Rabot et al., 2015)
- ➤ Soil structure dynamics description and modelling = challenge in soil science

## Which tools to monitor soil structure dynamics?

## 2. Acoustic Emissions (EA)

- **Characteristics of measured AE:**
- > Passive AE: signal spontaneously produced by the material
- > In-situ and dynamic monitoring
- Method sensible to movements (physical and biological)
- Applications:
  - ➤ AE used in civil engineering to study damages occurrence in infrastructures (bridges , etc.)
  - >Ground movements and avalanche monitoring
  - > AE not used in soil science > methodological innovation



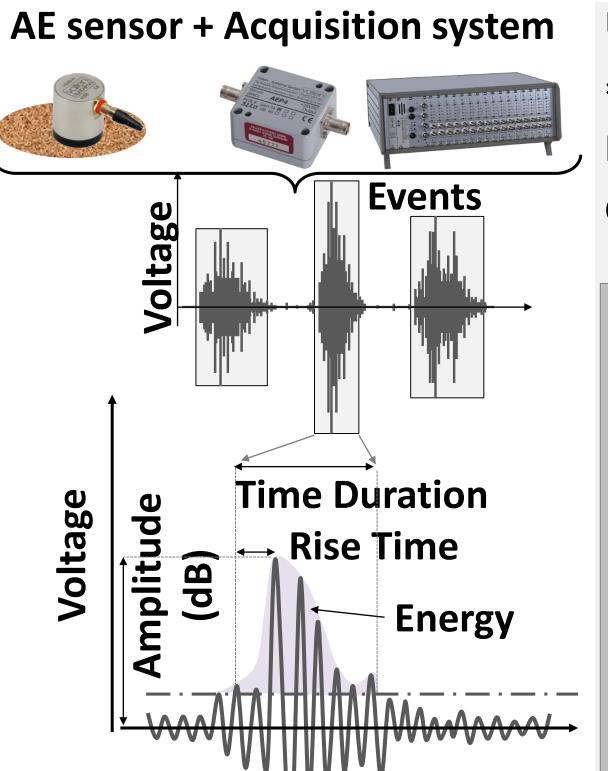
#### **AE** source mechanisms in soils

- 1. Liquid bridge rupture
- 2. Crack development
- 3. Release of force chains
- 4. Grain friction
- 5. Grain cementation fracture
- 6. Rupture of soil fibres

(Michlmayr, et al., 2012)

## Can AE monitoring in soils characterize the dynamics of soil structure?

# 3. Materials & Methods: three lab experiments



**Uetliberg soil:** 11% clay, 50% loam, 39% sand  $\approx$  34% water content, bulk density = 1.1 g.cm<sup>-3</sup> ≈ 30% water content

Earthworm: Octolasium cyaneum (endogeic)
Glass cells: 0.8 cm thick

Soil control

Soil + Empty cell control

Winzlerboden soil: 9% clay, 9% loam, 82% sand

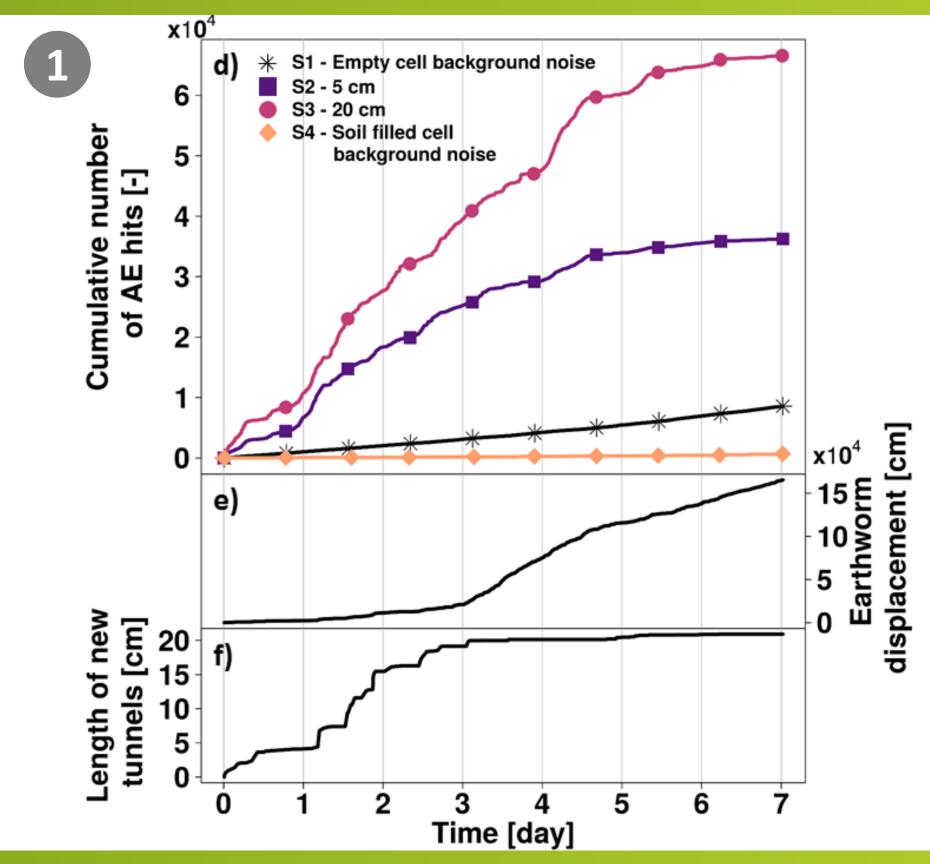
bulk density = 1.4 g.cm<sup>-3</sup>

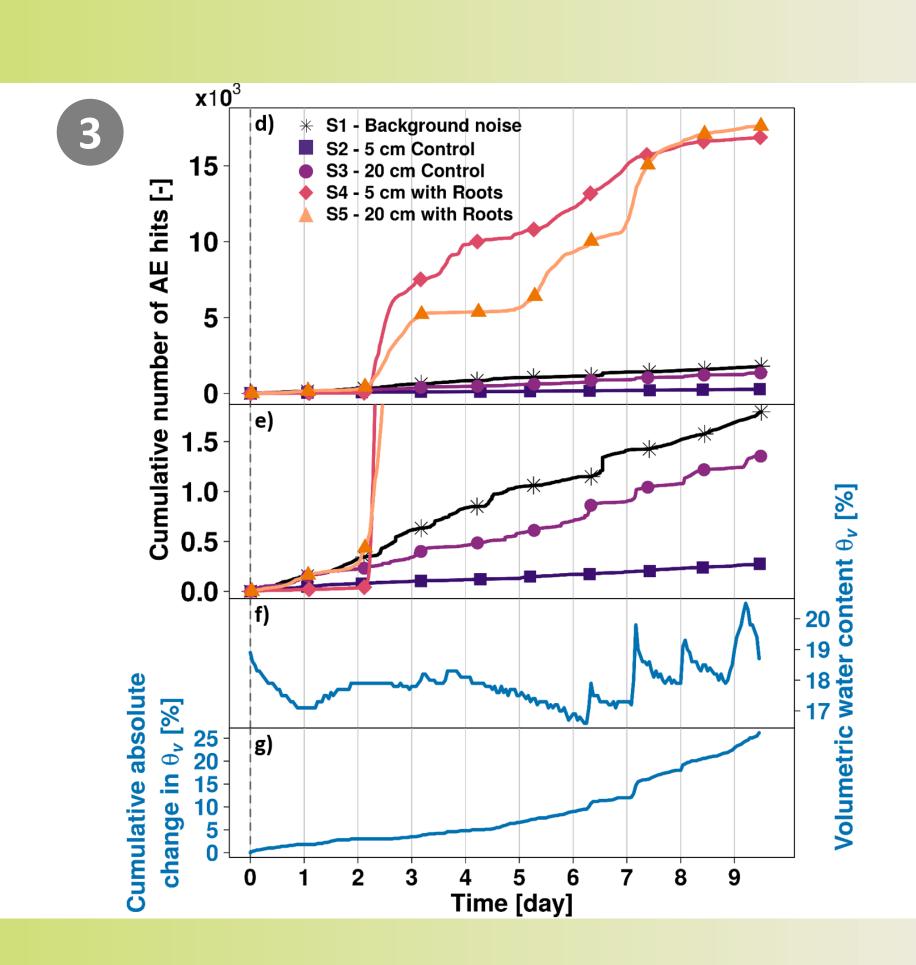
Glass cell: 1.2 cm thick

≈ 18% water content
bulk density = 1.2 g.cm<sup>-3</sup>
Soil column: 15 x 15 x 20 cm



## 4. Results





## 5. Conclusions and perspectives

### **Promising results**

- > AE signals correlate with earthworm burrow lengths and with root growth.
- ➤ AE from the soil columns: several orders of magnitude larger than AE emanating from bare soil under similar conditions.

### **AE** monitoring

- A window into largely unobservable biomechanical processes important for soil structure formation
- Insight into root development and earthworm ecology

Results still exploratory: the method requires further development and refinement.

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