



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Towards a standardized ground soil moisture network over Italy based on cosmic-ray neutron sensors

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Outline

1. About soil moisture **measurements** or how we call it
2. About ground soil water content (SWC) **network**
3. On the use of cosmic-ray neutron sensing - **CRNS**
4. CRNS **networks** on the Earth
5. Towards an **Italian** CRNS network
6. Towards a **standardized** network: the project SoMMet



About soil moisture measurements or how we call it

- Soil moisture **measurements** (or better (?) defined soil water content - SWC) is destructive and conducted in the lab
- In the field generally SWC is **estimated** by means of geophysical methods at a certain distance from the target

Point-scale invasive



Proximal sensing: intermediate scale



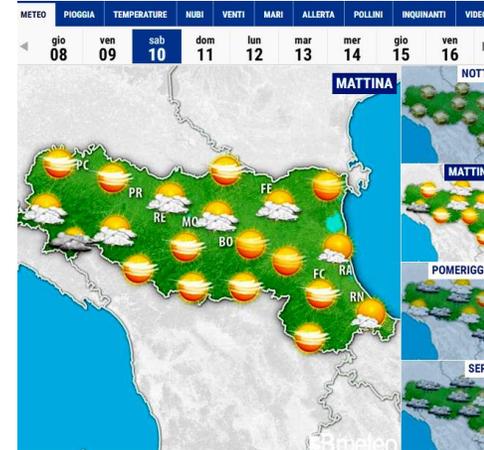
Remote sensing: large-scale



About ground soil water content (SWC) network

Valuable to establish a network for monitoring spatial and temporal variability of SWC, e.g.:

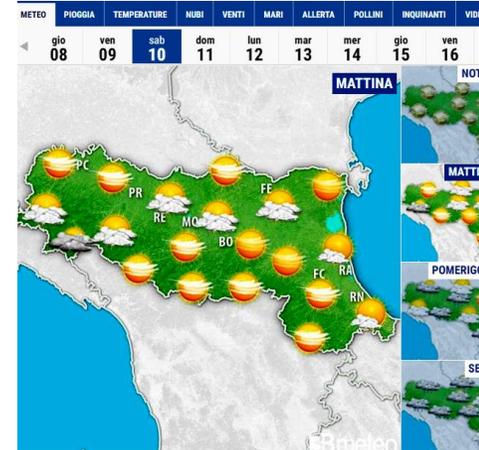
- weather, flood, fire and landslide prediction
- Agriculture and irrigation
- ...



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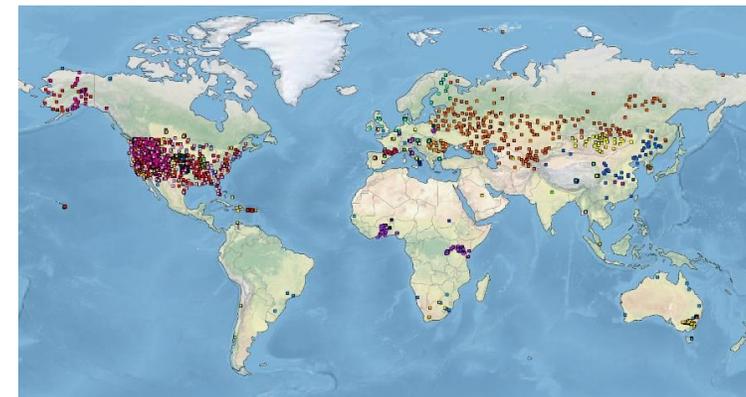
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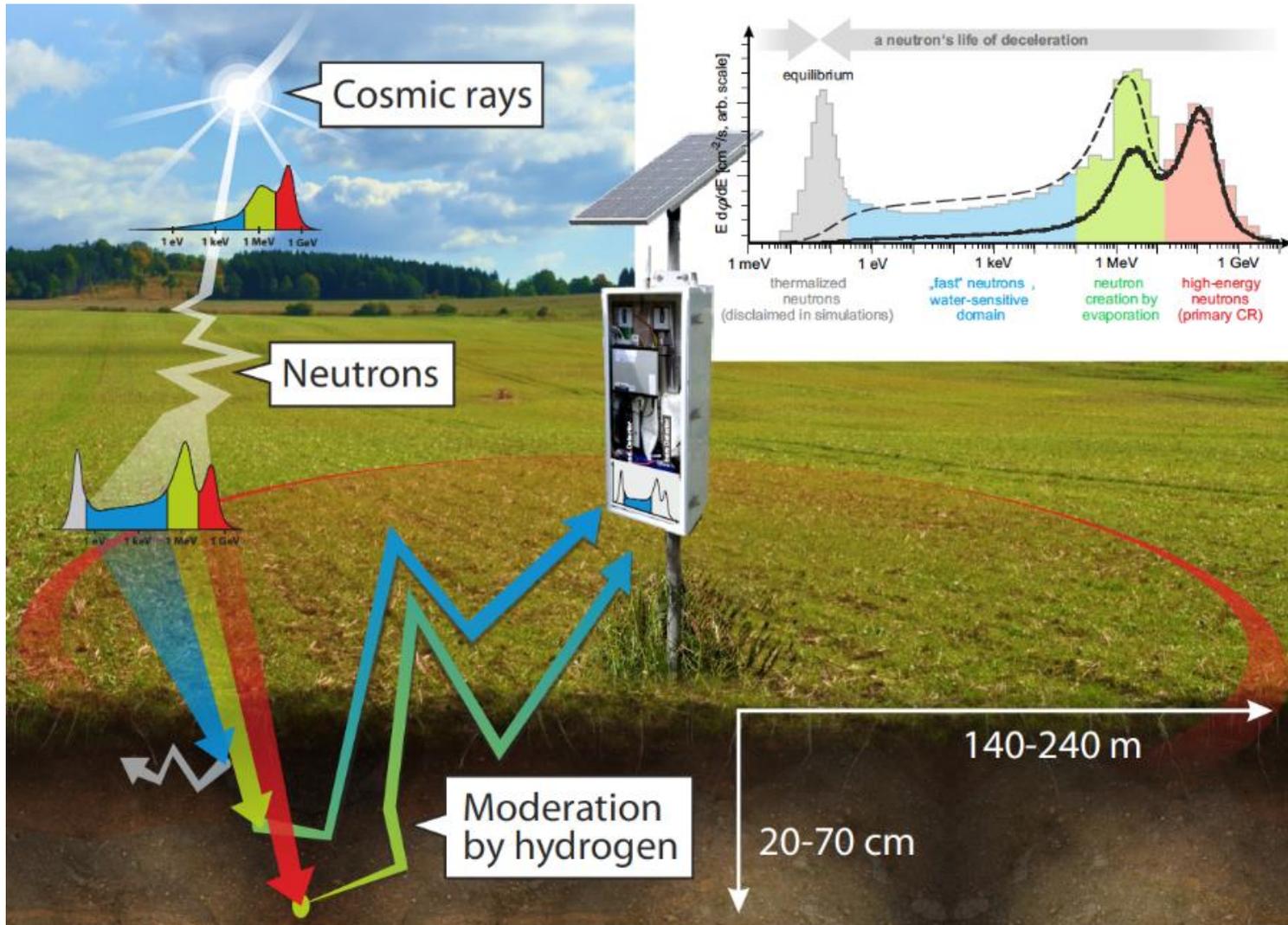
Difficulties with invasive point-scale sensors

- Several manufactures
- Difficulties of calibration and intercalibration
- Very sensitive to installation and location
- Maintenance and long-term monitoring

Dorigo et al. “The International Soil Moisture Network: Serving Earth System Science for over a Decade.” *HESS* 25, no. 11 2021. <https://doi.org/10.5194/hess-25-5749-2021>.



On the use of cosmic-ray neutron sensing - CRNS



Non invasive
Large footprint
(5 ha, 50 cm depth)



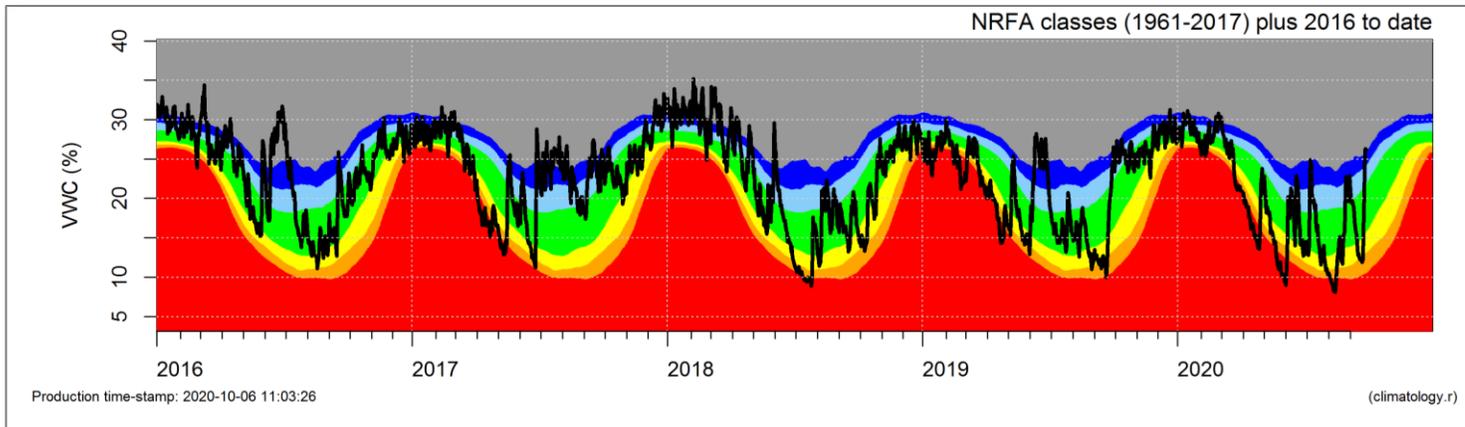
less sensitive to
installation/location

More suitable for long-term
standardized observations



CRNS networks on the Earth

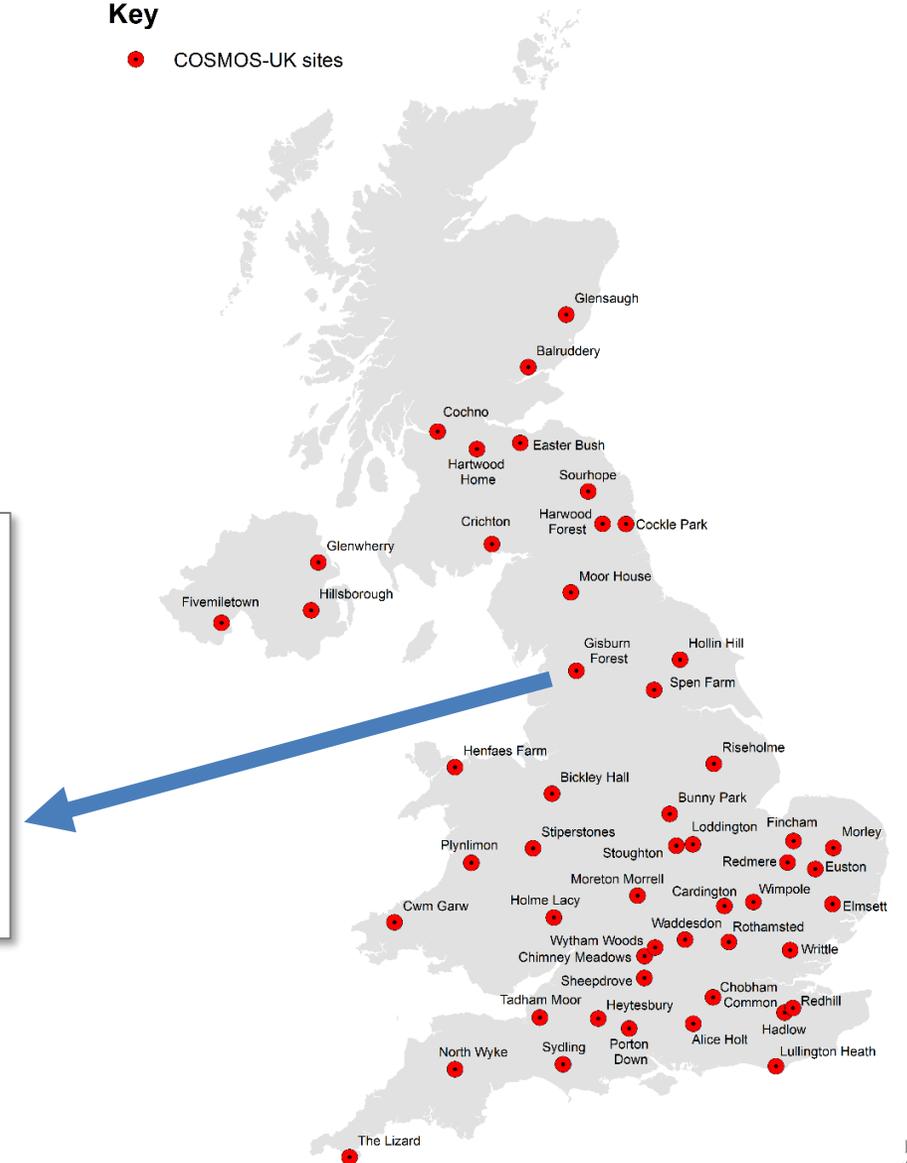
- COSMO-US (USA)
- COMSOz (CSIRO - Australia)
- COMSO-UK (CEH - UK)
- ...



From presentation of David Boorman, COSMOS workshop
(Hidelberg, Germany, 2020)

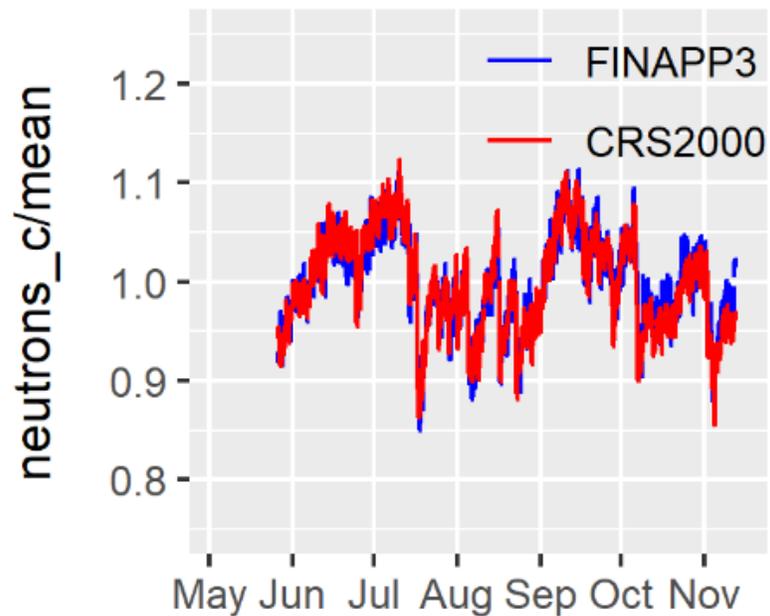
Key

- COSMOS-UK sites

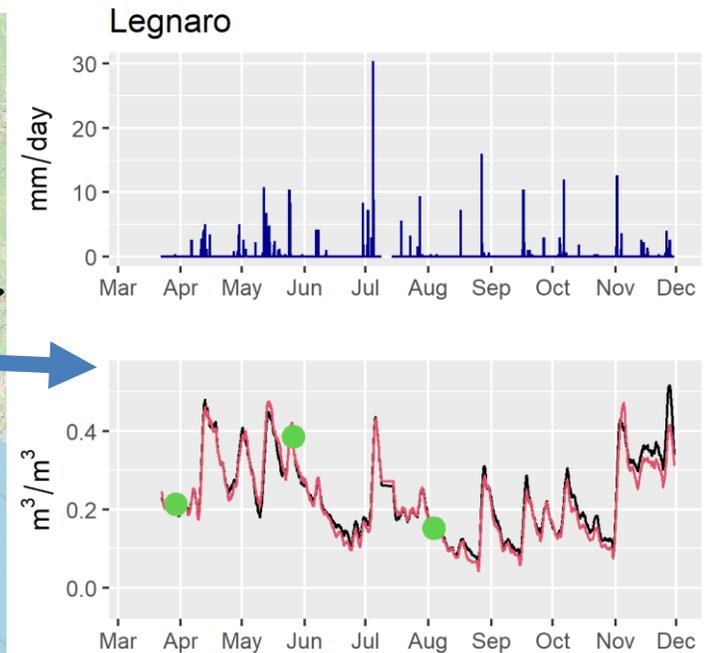
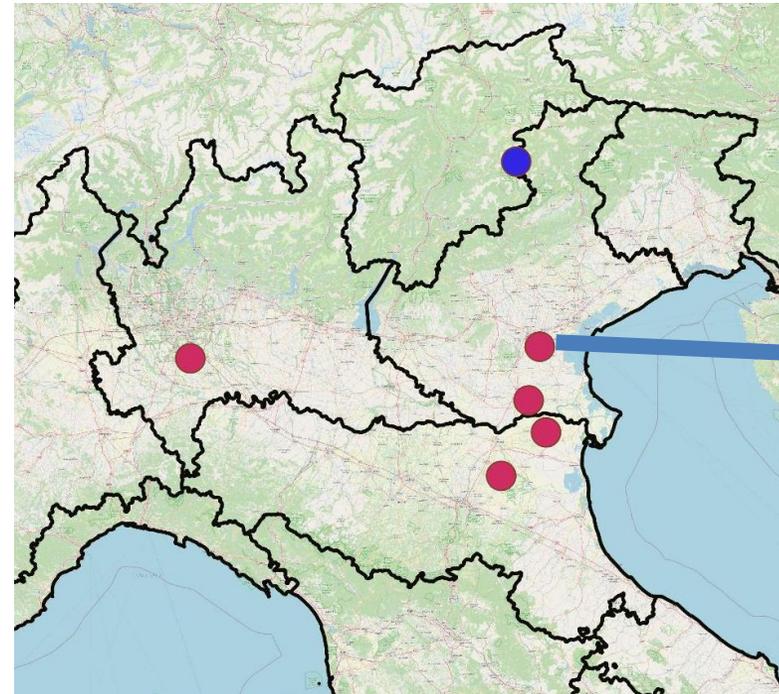


Towards an Italian network: phase 1 (2021)

Intercomparison of new sensores developed by FINAPP
(<https://www.finapptech.com/en>)

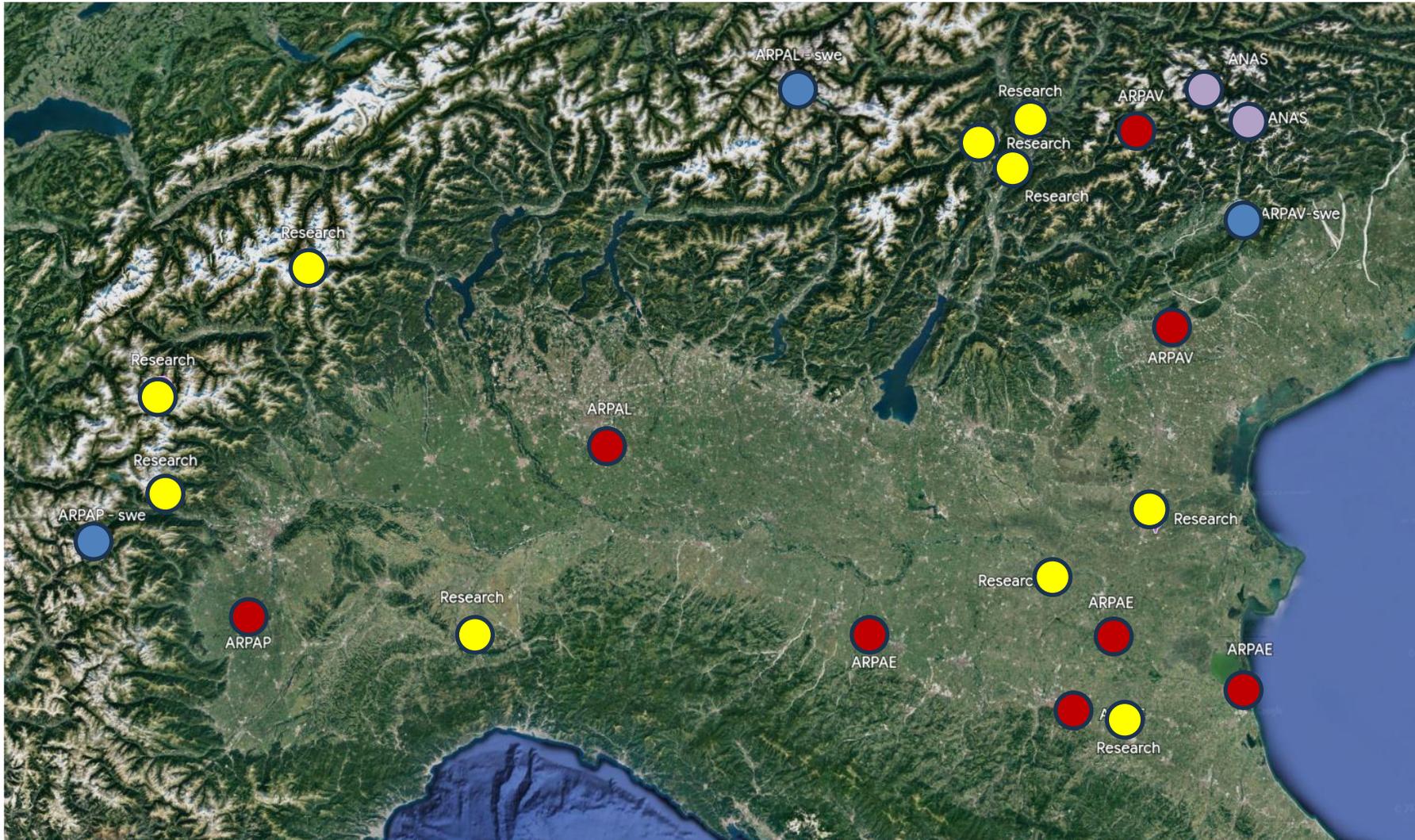


Field tests in collaboration with Regional environmental agencies (ARPA)



From Gianessi et al., "Testing a Novel Sensor Design to Jointly Measure Cosmic-Ray Neutrons, Muons and Gamma Rays for Non-Invasive Soil Moisture Estimation." <https://doi.org/10.5194/gi-2022-20>.

Towards an Italian network: phase 2 (since 2023)

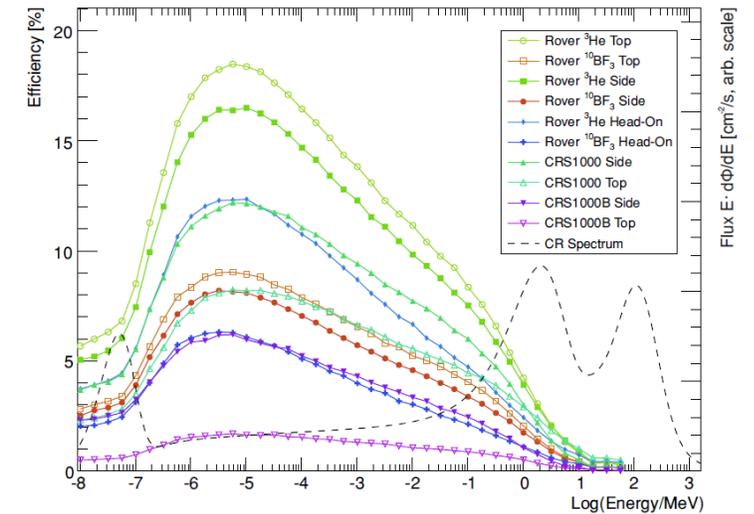


- ARPA -SM
- ARPA - SWE
- ANAS
- Research groups
- ND Private owners



Towards a standardized CRNS network

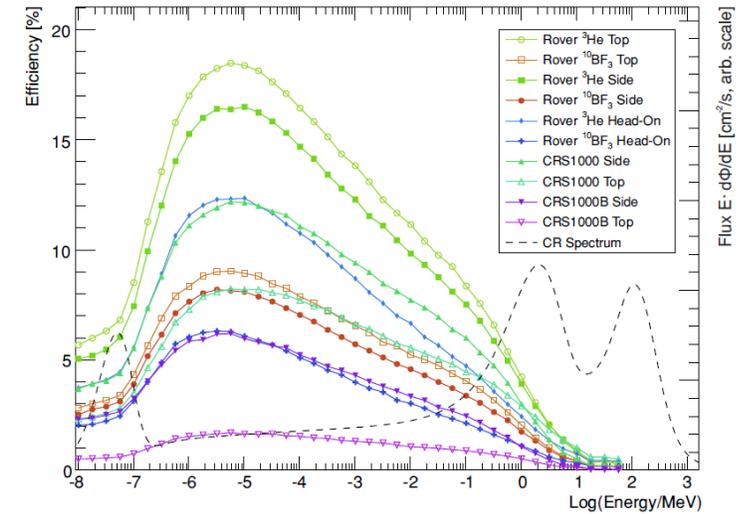
- Lab activities to characterize the **response functions** of the sensors (WP1). Z.Vykydal Czech Metrology Institute (Czech Republic)



Towards a standardized CRNS network

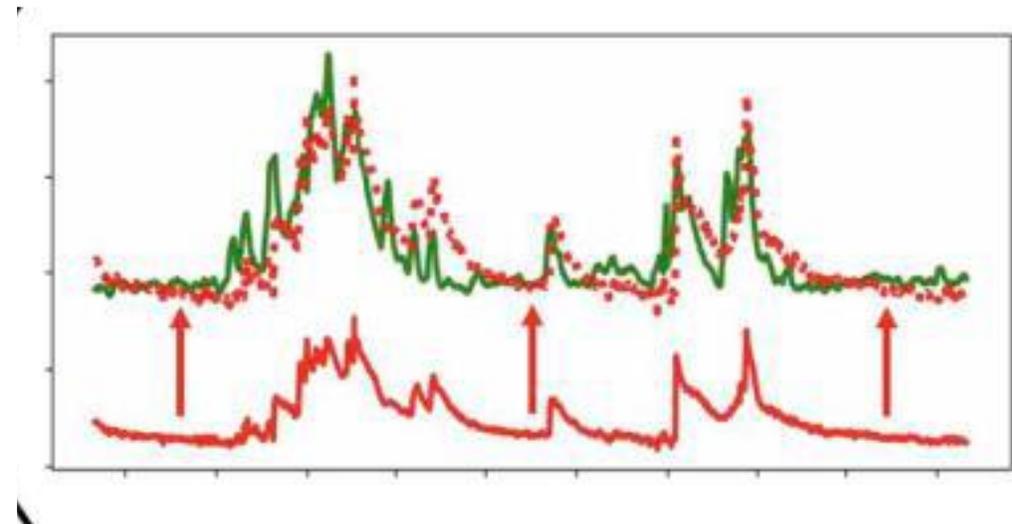
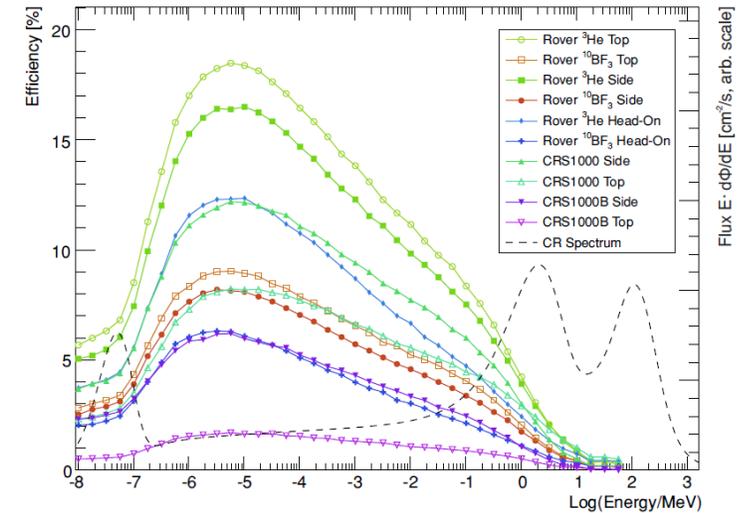


- Lab activities to characterize the **response functions** of the sensors (WP1). Z.Vykydal Czech Metrology Institute (Czech Republic)
- Field calibration protocol (WP2)



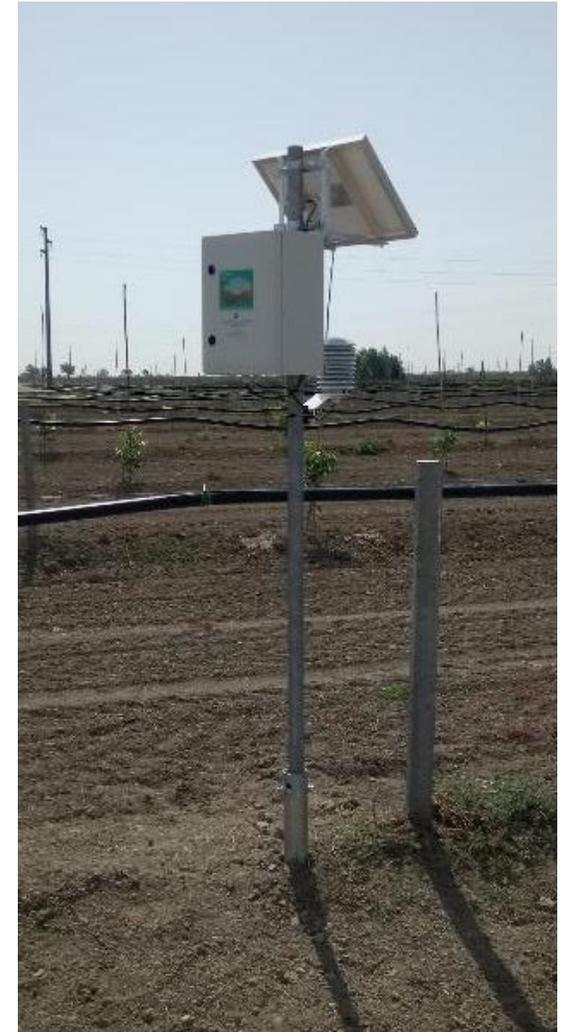
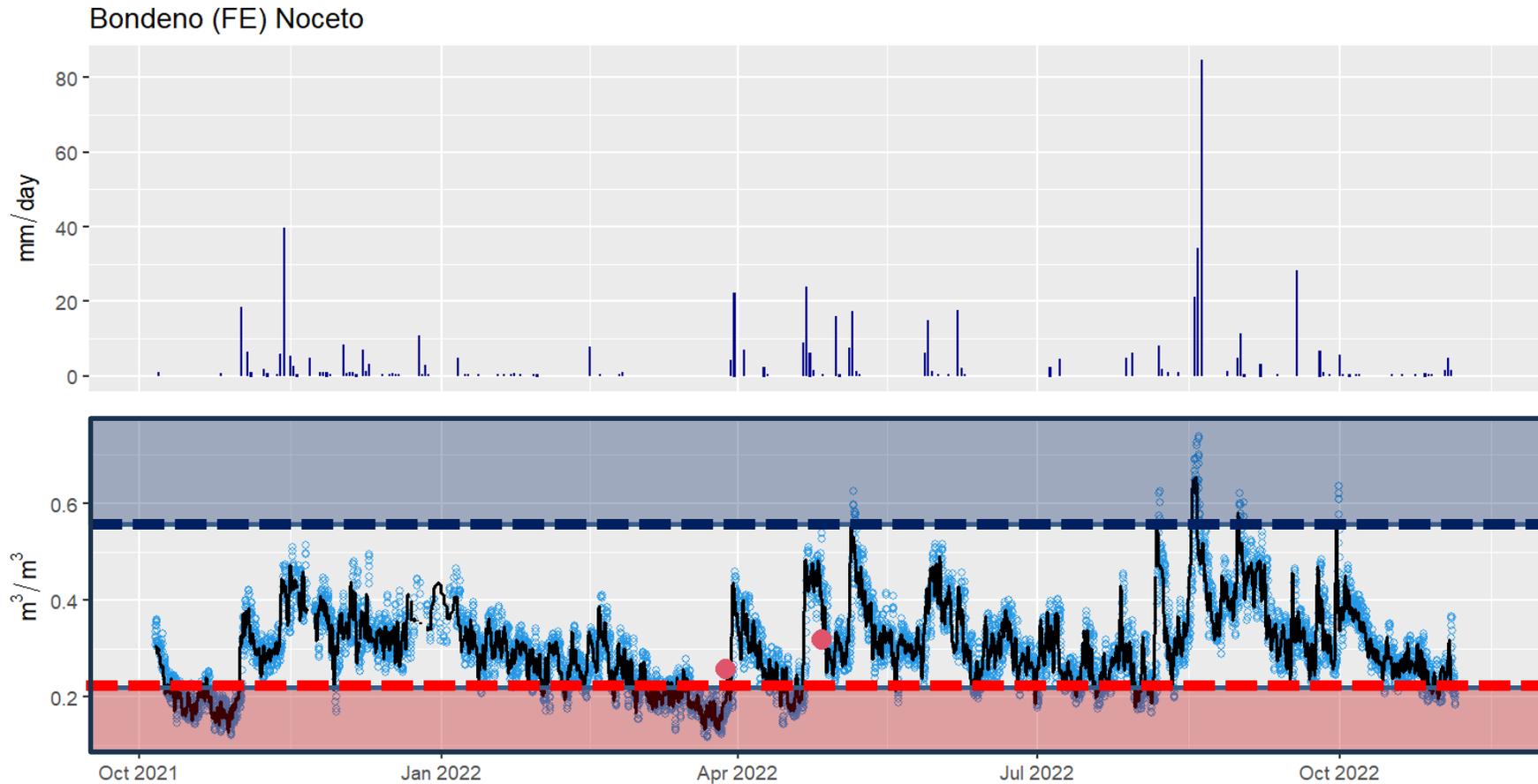
Towards a standardized CRNS network

- Lab activities to characterize the **response functions** of the sensors (WP1). Z.Vykydal Czech Metrology Institute (Czech Republic)
- Field calibration protocol (WP2)
- Quality check and post-processing (WP3)



Example of application: irrigation scheduling

Walnut field in collaboration with Agronoceto Aretè (Bondeno, Ferrara)



THANK YOU FOR THE ATTENTION

Aknowledgments

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- Collaboration with Aretè (Agronoceto – Bondeno, Ferrara)
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European Partnership

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**METROLOGY
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