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Mapping large-scale deep soil moisture variation using ambient seismic noise

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Soil moisture is a key metric to assess soil health. Water held in the shallow subsurface between soil particles enables various biogeochemical and hydrological processes indispensable to soil functions. Potential soil moisture deficit may raise the irrigation demands, which further exacerbates the stress on the water supply. The changes in soil moisture can impact climate, further amplifying the climatic anomalies and intensifying extreme weather events. Thus, understanding soil moisture and its dynamics over time are of broad scientific interest and practical implications.

Despite the vital importance of soil moisture, it still lacks sufficient means to properly assess the parameter at a regional scale, which is an essential research dimension for addressing practical issues in the agricultural and environmental sectors.

Ambient noise seismology provides new possibilities to infer subsurface changes in a real-time, non-intrusive, and costless manner.
In this study, we map the temporal variations in soil moisture for Central-Southern Europe with ambient seismic noise. It is the first time that the seismic method has been applied to map soil moisture at a regional scale using an ordinary seismic network setup. The method helps in bridging the resolution gap between current pointwise (e.g., tensio-, electrical- and neutron-meter) and global (e.g., satellite-based remote sensing) investigations, providing complementary information for both scientific research and public decision-making.