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Air pollution monitoring through magnetic topsoil measurements in different land use classes

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Robust and high quality monitoring of particulate matter (PM) is needed to assess, understand and remediate its detrimental impact on human health and ecosystem functioning. Currently, PM concentrations are mostly assessed through gravimetric measurements using high volume samplers. However, the spatial distribution of these samplers is often insufficient because of high investment and maintenance costs. Therefore, the use of proxy methods that monitor PM pollution indirectly has risen over the past years. One method is based on the magnetic properties of combustion-related PM. After combustion, magnetically enhanced PM is deposited on soil, and as metals are incorporated into its crystal lattices, topsoil magnetic properties can be used as a proxy for both combustion-derived PM deposition and metal pollution. Topsoil magnetic properties have already been mapped in several regions, revealing enhanced soil magnetization in urban and industrial zones which are marked by household, traffic and industrial combustion. Furthermore, a clear correlation was often found between magnetic properties and metal contamination in the soil. When carrying out topsoil magnetic measurements, most authors use a standardized measurement protocol containing some general recommendations such as sampling density. However, to date the effect of the soil's geological settings and the prevailing land use on the three-dimensional distribution of the overall soil magnetic signal has not been taken into account yet. The topsoil magnetic record might not entirely reflect the three-dimensional distribution of the soil magnetic signal and its concomitant pollution status. Therefore we evaluated the feasibility of using topsoil magnetic records for air pollution monitoring in areas with different land uses. Based on the vertical and lateral variability observed in the magnetic response of the subsurface, the current survey protocol is updated to obtain robust and reproducible magnetic records, enabling to accurately determine the impact of atmospheric PM pollution through magnetic topsoil measurements in large study areas that include different land use classes.