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New approaches of monitoring spatio-temporal soil organic carbon dynamics in agricultural systems

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Soil organic carbon (SOC) dynamics affect atmospheric CO2 concentration and climatic variation, soil quality and agricultural productivity. Despite the need for spatial assessments of SOC content over time, reliable estimates are limited by data availability; where measurements are often made at discrete point locations with coarse spatial support. Remote sensing (RS) is in a strong position to provide spatially distributed, reproducible, scale-appropriate and resource-efficient
measurements of SOC content and fluxes at field, landscape and regional scales. This paper provides a critical review of optical RS techniques for such applications. The first part of the paper reviews the
methods, instruments and techniques used for developing predictive models for monitoring spatial
SOC content. Secondly, sources of spatio-temporal SOC variations are examined, including the lateral
transfer of SOC by erosion, soil structural breakdown and land management practices, in the context of RS data and techniques. The key challenges of using RS to monitor SOC contents are discussed along with opportunities for improving SOC predictions within a RS framework. Such opportunities include the use of ancillary data, scale-specific methods, improved development of spectral libraries and better integration of RS technologies into empirical and simulation SOC models. This paper aims to provide a transparent assessment and practical guide to RS techniques and products in order to further advance and better incorporate the use of RS methods within soil science.