Global soil respiration: patterns, challenges and network opportunities

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Soil respiration (Rs) is the soil-to-atmosphere CO\textsubscript{2} efflux produced by microbes and plant roots and is a critical component for the global carbon budget. We present state-of-the-art approaches to estimate global soil respiration at 1 km spatial resolution using the global Soil Respiration Database (GSRD) and machine learning techniques. Patterns of Rs are evident at the global scale and we report an annual estimate of 87.9 Pg C/year with an associated global uncertainty of 18.6 (mean absolute error) and 40.4 (root mean square error) Pg C/year. Global heterotrophic respiration (Rh), the microbial decomposition of soil organic matter, could be derived from empirical relationships with Rs with a global estimate of 49.7 Pg C/year. We discuss how these global estimates and patterns are influenced by adding new measurements as we compared the GSRD version 3 with version 4. This comparison raises challenges about how adding new information, within a multivariate space, influence model uncertainty and regional-to-global estimates. Finally, we discuss future approaches to estimate global Rs, network opportunities for expanding the GSRD, and where new measurements are needed across the world.