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Accessibility, searchability, transparency and engagement of soil carbon data: The International Soil Carbon Network

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Soils are capacitors for carbon and water entering and exiting through land-atmosphere exchange. Capturing the spatiotemporal variations in soil C exchange through monitoring and modeling is difficult in part because data are reported unevenly across spatial, temporal, and management scales and in part because the unit of measure generally involves destructive harvest or non-recurrent measurements. In order to improve our fundamental basis for understanding soil C exchange, a multi-user, open source, searchable database and network of scientists has been formed. The International Soil Carbon Network (ISCN) is a self-chartered, member-based and member-owned network of scientists dedicated to soil carbon science. Attributes of the ISCN include 1) Targeted ISCN Action Groups which represent teams of motivated researchers that propose and pursue specific soil C research questions with the aim of synthesizing seminal articles regarding soil C fate. 2) Datasets to date contributed by institutions and individuals to a comprehensive, searchable open-access database that currently includes over 70,000 geolocated profiles for which soil C and other soil properties. 3) Derivative products resulting from the database, including depth attenuation attributes for C concentration and storage; C storage maps; and model-based assessments of emission/sequestration for future climate scenarios.

Several examples illustrate the power of such a database and its engagement with the science community. First, a simplified, data-constrained global ecosystem model estimated a global sensitivity of permafrost soil carbon to climate change (g sensitivity) of -14 to -19 Pg C °C-1 of warming on a 100 years time scale. Second, using mathematical characterizations of depth profiles for organic carbon storage, C at the soil surface reflects Net Primary Production (NPP) and its allotment as moss or litter, while e-folding depths are correlated to rooting depth. Third, storage of deep C is highly correlated with bulk density and porosity of the rock/sediment matrix. Thus C storage is most stable at depth, yet is susceptible to changes in tillage, rooting depths, and erosion/sedimentation. Fourth, current ESMs likely overestimate the turnover time of soil organic carbon and subsequently overestimate soil carbon sequestration, thus datasets combined with other soil properties will help constrain the ESM predictions. Last, analysis of soil horizon and carbon data showed that soils with a history of tillage had significantly lower carbon concentrations in both near-surface and deep layers, and that the effect persisted even in reforested areas. In addition to the opportunities for empirical science using a large database, the database has great promise for evaluation of biogeochemical and earth system models. The preservation of individual soil core measurements avoids issues with spatial averaging while facilitating evaluation of advanced model processes such as depth distributions of soil carbon, land use impacts, and spatial heterogeneity.