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The role of soil research, databases, and soil indices in the drawdown of CO_2

Jennifer W Harden (1), Ben Sulman (2), Gustaf Hugelius (3), Julie Loisel (4), Olga Vinduskova (1), Avni Malhotra (1), Katerina Georgiou (1), Anders Ahlstrom (1), and Robert B. Jackson (1)

(1) Stanford University, Earth System Science, Half Moon Bay, United States (82soiljen@gmail.com), (2) Oak Ridge National Laboratory, Oak Ridge TN, (3) Stockholm University, Sweden, (4) TAMU, College Station, TX, (5) Lund University

The conviction that strategic soil management practices can improve the resilience and productivity of our landscapes while also sequestering carbon is well grounded in agronomic and biogeochemical research. The scalability, timing, and political will to implement such methods, however are significant barriers to actionable, timely practice. By targeting data and datatools as a bridge between research and practice, we have the potential to increase the pace of information transfer and the adoption of climate-smart practices. For example, recognizing that research is driven by “what is unknown” whereas practice is driven by “what is known”, we can cultivate probability models and statements into data analysis without interrupting the progress toward improved knowledge and better practice.

Three types of scientific information are needed to build upon our spatial and temporal knowledge about carbon-sequestration practices: (i) inputs to soil; (ii) capacity to retain and store carbon (C); and (iii) timing of C retention. Dynamic processes and static landscape attributes determine spatial distributions of input, capacity, and timing. Interaction and feedbacks among input, capacity, and timing overlap because of the complexity of the system. The role of management practices can affect both processes and attributes, and, therefore, analyses must always include management information.

Using large datasets from the International Soil Carbon Network, the International Soil Reference and Information Center, and the International Soil Radiocarbon Database, we illustrate examples for the potential of C-degraded soils to recover their C content and their function as healthy, biotic systems. The capacity for C storage at various depth intervals was derived from profile datasets with information on location, clay, C content, depth distributions, and cultivation history. The potential for recovery from degradation can then be communicated as a probability density function for a given climate space and soil order. Next, the transfer of information to practitioners is illustrated as a index of soil service and soil health. For this index, which can be expanded to other properties, C data are normalized to the maximum C potential for a given climate-soil order-land-use space. Strategic management practices can then be prioritized for specific lands, regions, or soil types. These approaches are meant to encourage discussions about: potential new datasets to evaluate soils, key questions emerging from analyses of large datasets that might guide future research priorities and next data ingests, and the types of data needed for dynamic models to represent local to regional scale C budgets and soil health assessments.