

THE SOIL CARBON CO₂ FERTILIZATION FACTOR: THE MEASURE OF AN ECOSYSTEM'S CAPACITY TO INCREASE SOIL CARBON STORAGE IN RESPONSE TO ELEVATED CO₂ LEVELS

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ABSTRACT

This research introduces the concept of a “CO₂ fertilization factor for soil carbon” (SigmaCF). The SigmaCF is a measure of an ecosystem's capacity to increase soil carbon storage in response to elevated carbon dioxide levels. This research describes the mathematical derivation of SigmaCF and illustrates how SigmaCF can be determined experimentally, using data from three different CO₂ enrichment experiments. I have developed this concept to compare the results of carbon dioxide enrichment experiments having different soil carbon turnover times, different levels of CO₂ enrichment, and different lengths of exposure to elevated carbon dioxide levels. The SigmaCF can also be used to estimate increases in soil carbon uptake due to observed contemporary increases in atmospheric carbon dioxide levels. This approach approximates the extent to which elevated carbon dioxide levels increase soil carbon storage. I calculated SigmaCF for three experimental settings—a mixed forest, and stands of loblolly pine and white oak trees—by measuring changes in carbon inventories and radiocarbon ratios. The forest had a SigmaCF of 1.8, which would imply a global sequestration of 5.5 billion tons C/year during the 1990's (in the highly-unlikely event that all terrestrial vegetation shows this same response to elevated carbon dioxide levels). The loblolly pine stand had a SigmaCF of 0.9 (2.8 billion tons C/year) and the white oak stand had a SigmaCF of 1.18 (3.5 billion tons C/year). These results show that elevated carbon dioxide levels in the atmosphere are increasing the flux of carbon from the atmosphere to soil.