Carbon stocks and fluxes across ecosystem and climate types

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Abstract

Global changes impact different aspects of ecosystem functioning, such as biomass, or fluxes and rates of ecological processes, that likely cascade on each other. To understand how ecosystem state might move within a multifunctional space, we conducted a global quantitative synthesis of a wide range of ecosystem functioning metrics related to carbon stocks and fluxes. We gathered a total of about 4000 values from the literature of metrics including biomass and detritus stock, biomass production, ecosystem respiration, and decomposition rate across eight major ecosystem types (e.g., forest, grassland, stream) and five broad climatic zones (e.g., arctic, boreal, tropical). We analysed the global relationships among variables emerging from the variations of stocks, fluxes and rates across ecosystems and climates. Within this three-dimension space, average ecosystems align along a gradient from fast rates-low flux and stocks (freshwater and pelagic marine ecosystems) to low rates-high fluxes and stocks (forest). Moreover, fluxes and rates decrease from warm to colder climates, consistently with the metabolic theory of ecology. However, the strength of climatic effects differs among variables and ecosystem types, resulting, for instance, in reversed effects on net ecosystem production between terrestrial and freshwater ecosystems (positive versus negative effects). This large-scale synthesis provides new insights on ecosystem multi-functionality and useful information to eventually predict the inter-dependence among ecosystem stocks, fluxes, and rates, and their sensitivity to global change.

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