Carbon input and residence times determine ecosystem carbon storage capacity

Objective:

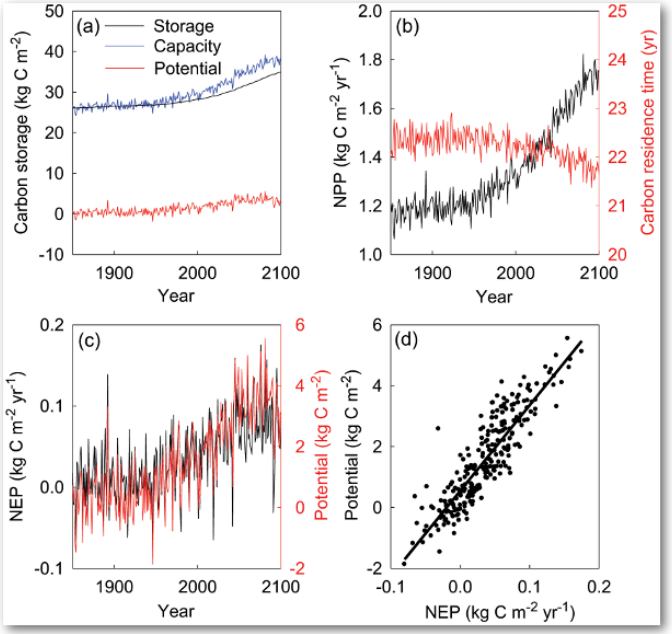
Develop a mathematical framework for understanding and predicting the transient dynamics of terrestrial carbon (C) storage

Approach:

- We applied a complex terrestrial ecosystem model to formulate a generalized system of equations for estimating transient C storage dynamics in terrestrial ecosystems
- The Terrestrial ECOsystem (TECO) model was emulated for numerical experiments simulating global change

Results/Impacts:

- Analysis indicated that C storage capacity is determined by ecosystem C input (e.g., net primary production, NPP) and C residence times, which vary with time
- Time-dependent C storage capacity acts as a moving attractor that is chased by actual C storage; C storage potential is the difference between actual C storage and C storage capacity
- One matrix equation replicated simulations of most land C cycle models, allowing model outputs to be reformulated to a common basis for C cycle diagnosis and evaluation



Modeled transient dynamics of ecosystem C storage in response to global change in Harvard Forest. Trajectories of (a) ecosystem C storage capacity, ecosystem C storage potential, and ecosystem C storage (i.e., C stock); (b) net primary production (NPP) and C residence time; and (c) correlated change in C storage potential and net ecosystem production (NEP) from 1850 to 2100. Panel (d) shows the regression between C storage potential and NEP.

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