

Coupling an Agent-Based Model of forest dynamics and soil production to sediment transport models in Landlab

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MOTIVATION

Patterns in **bedrock exposure** and topographic roughness correlate with metrics of **forest productivity** (i.e., tree canopy height, tree density).

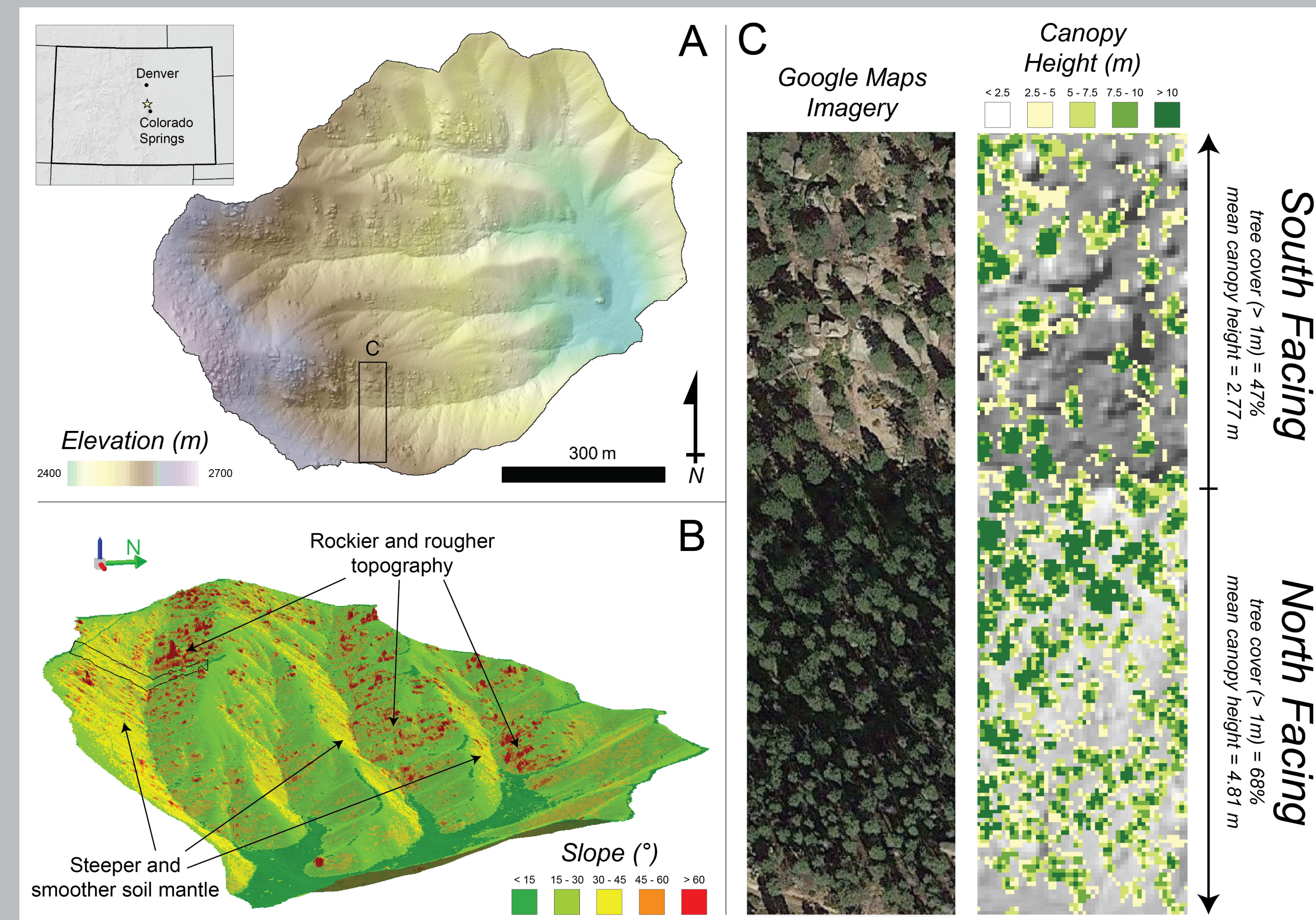
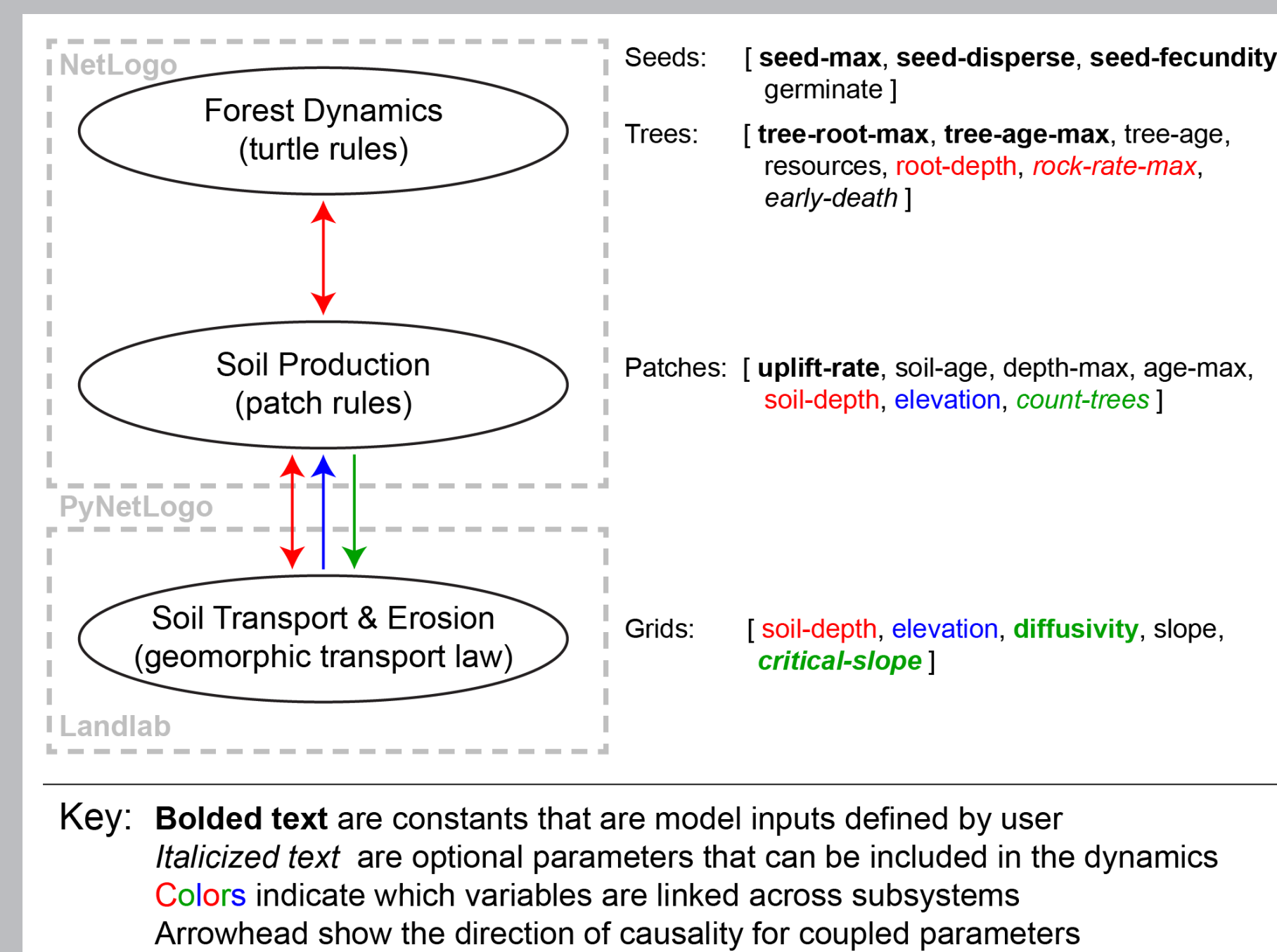


Figure 1: Example hillsides from the Rampart Range, CO. (A) Shaded relief map (1-m lidar) of small catchment in the range. (B) Perspective view of slope map for the same catchment. (C) Swath images from Google Maps and the associated canopy height model from lidar.

NUMERICAL MODEL

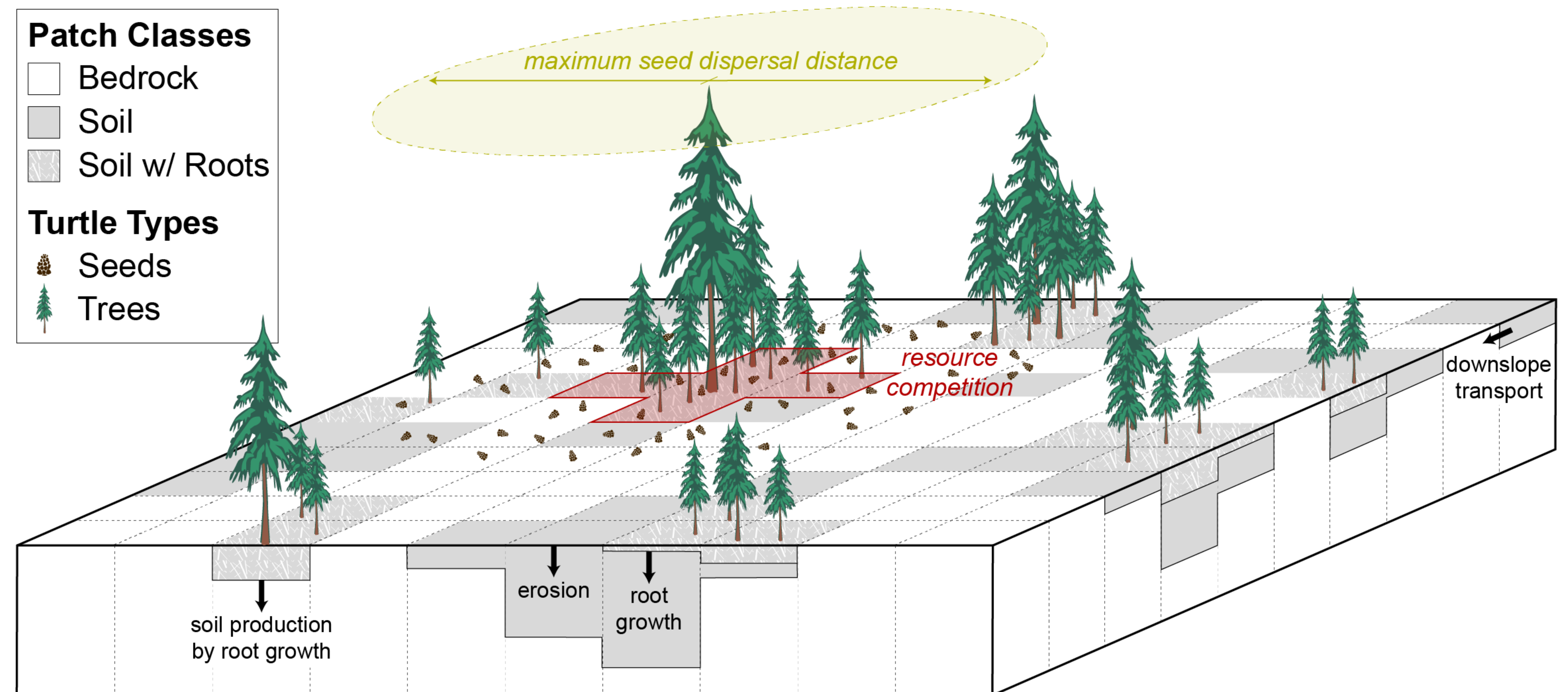
NetLogo⁴ Agent-Based Model (ABM) coupled to Landlab^{1,2} using the pyNetLogo³ library.

Figure 2: Model includes three subsystems that represent forest dynamics, soil production, and sediment transport. The first two components are dealt with in NetLogo and the last one in Landlab. Variables in each subsystem are shown inside square brackets. Font styles and colors highlight variable properties and the nature of interactions.



Patchy bedrock exposure and soil depth distributions are **emergent features** of the model even when soil production monotonically decreases with increasing soil depth.

Long-term soil production rates are **functionally linked** to plant parameters for reproduction, growth, and death, albeit in a highly nonlinear way.



SOIL PRODUCTION SENSITIVITY

Soil depth and cover differ in sensitivity to tree reproduction, growth, and death parameters.

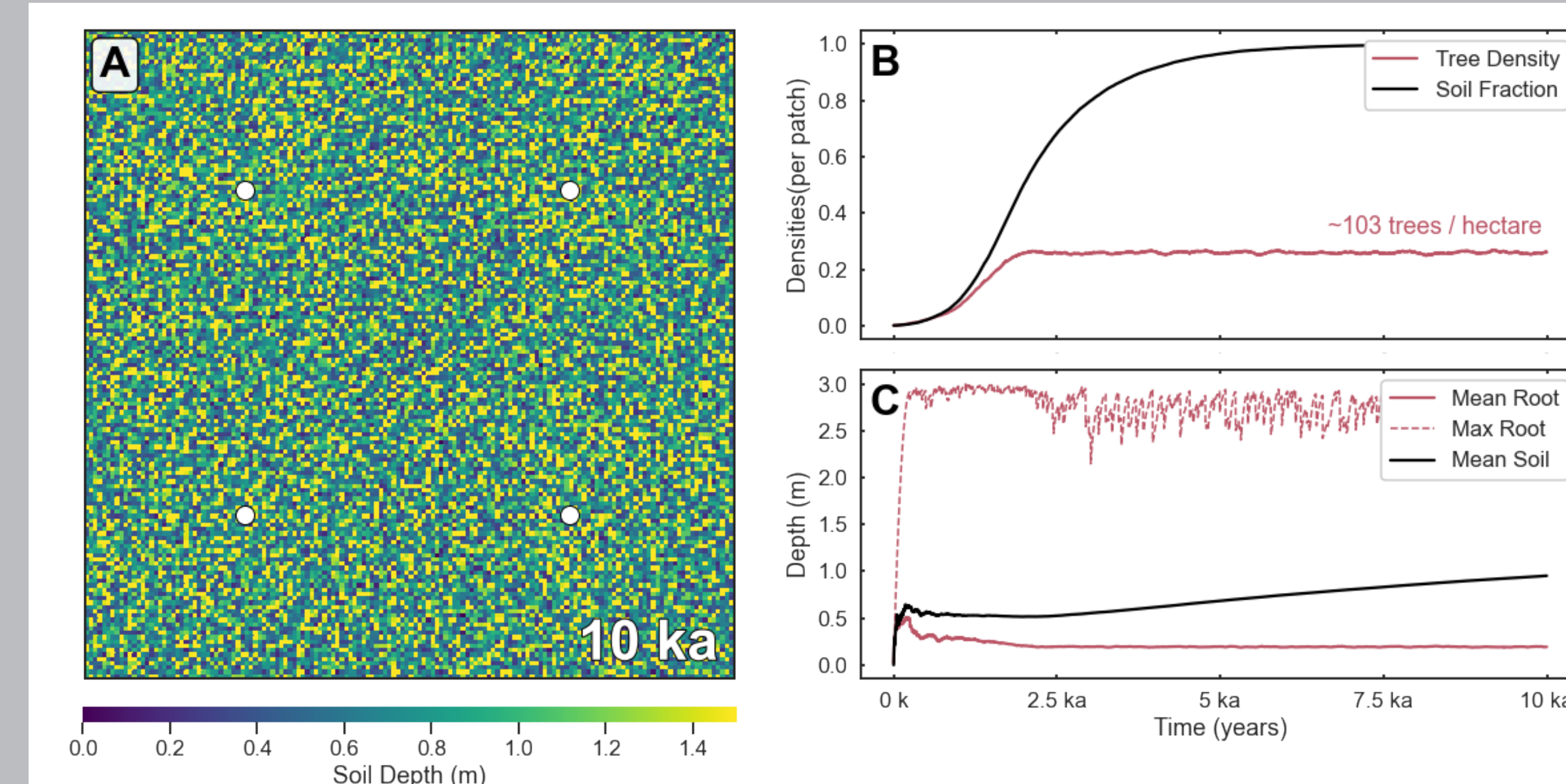


Figure 3: Model response of forest seeded with four individuals (white dots): (A) Soil depths at 10 ka; (B) tree and soil density; (C) root and soil depths.

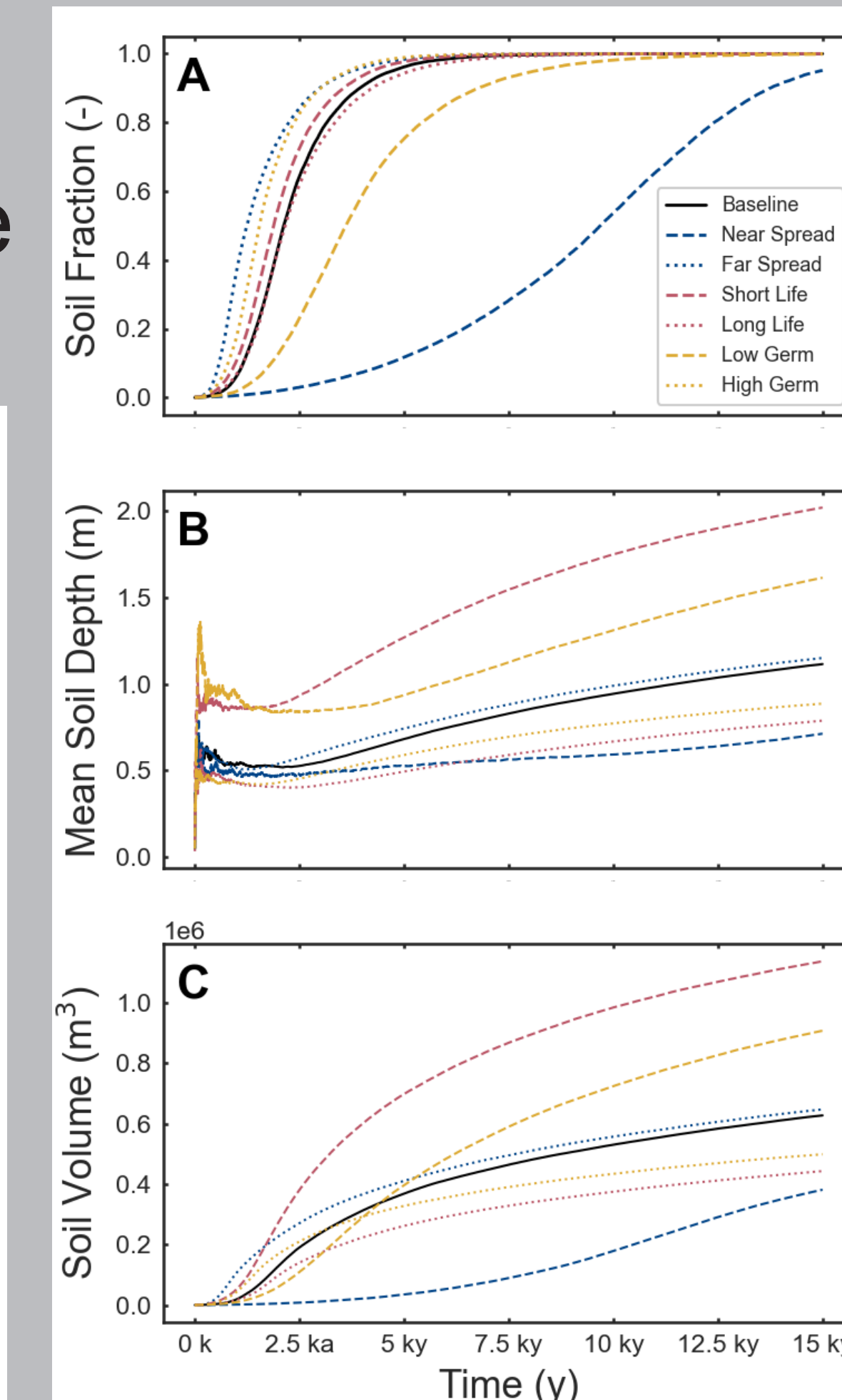


Figure 4: Sensitivity of ABM to plant parameters.

Check out new results for the fully coupled model:

[[link](#)]

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