BIOME-BGC (BioGeochemical Cycles) is a daily, process-level, simulation model that calculates the cycling of carbon, water and nitrogen through ecosystems (Hunt and Running, 1992; Running and Hunt, 1993). The model requires the definition of several key climate (temperature, humidity, radiation, precipitation), vegetation (leaf area index, ecosystem type) and site (soil texture, atmospheric CO2) conditions. Ecosystem physiology is defined according to the ecosystem type, including ecosystems composed of mixtures of vegetation types. Allometric relationships are used to initialize plant and soil carbon (C) and nitrogen (N) pools based on the leaf pools.

As a brief summary, BIOME-BGC routes daily precipitation to snowpack or soil water after removing a portion for canopy interception based on leaf area index. Transpiration is calculated through an implementation of the Penman-Monteith equation, incorporating radiation, temperature, humidity, and soil moisture drivers for evaporation. Photosynthesis is based on the methods of Farquhar et. al. (1980) and Leuning (1990), where the maximum rate of CO2 fixation (Amax) is calculated within a Michaelis-Menton framework using estimates of leaf conductance, leaf nitrogen, and intercellular CO2 concentration. Amax is then reduced for non-optimal air temperature, and an average canopy photosynthetic rate is determined based on incident solar radiation and leaf area index. Net primary production is calculated by reducing total canopy photosynthesis for growth and maintenance respiration, assuming a Q10 of 2.0. Plant litterfall is deposited into the litter compartment for decomposition, where C and N are released by a water-, temperature-, and lignin-controlled decomposition algorithm.

GESSys simulations were executed for 2 years for each cell, the first year was used to initialize soil moisture conditions at the beginning of year 2, while the second year was used to simulate the actual ecosystem water, carbon, and nitrogen dynamics for each cell. Within BIOME-BGC, variations in climate primarily feedback to control rates of transpiration, photosynthesis, respiration, and decomposition. Variations in atmospheric CO2 directly control intercellular CO2 and leaf conductance (thereby influencing transpiration and photosynthesis) and indirectly control leaf and litterfall C:N ratios (thereby influencing decomposition). Components of BIOME-BGC have previously undergone testing and validation, including the hydrologic (Nemani and Running 1989, and carbon cycle (McLeod and Running 1988, Korol et al. 1991, Pierce 1993, Running 1994).

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