Background

A significant portion of uncertainty related to climate change is attributed to the terrestrial system feedback upon the climate. The Ecosystem Demography Model (ED2), a terrestrial biosphere model (TBM), is uniquely suited to help diagnose, quantify and predict the net exchange of carbon between the atmosphere and land, thereby specifying the sign and magnitude of the climate feedback. ED2 uses size and age structured vegetation equations to capture the competition that a single tree experiences for light and nutrients. This gap-level competition is important for simulating successful growth and long term carbon dynamics that other ‘big-leaf’ models may miss.

Our goal is to identify the most significant sources of parametric uncertainty within ED2 by performing a 100 year simulation at Willow Creek, Wisconsin (1901-2010). To that end, we intend to perform a sensitivity analysis to identify the most significant sources of uncertainty and then incorporate both existing and synthetic observations that best reduce the uncertainty.

Initial Vegetation Conditions

The Willow Creek site is located within the Chequamegon National Forest of northern Wisconsin. The present day tree stand (70-80 years old) within a 0.5 km radius of the flux tower consists primarily of sugar maple/basswood (75%) and green ash/red oak (20%). However, the surrounding area (see WISCLAND land cover map to right) is composed of aspen, elm and fir species. This region is ideal for study because it is part of an Ameriflux network of sites within the Chequamegon Ecosystem-Atmosphere Study, and has experienced both climate change and disturbance.

The vegetation conditions are estimated for the year 1900 from witness tree data that provides the species, tree diameter and aggregate stem density for two trees at each location. Eleven locations within 16 km² of the site coordinates were used to initialize the model. We assume that the site is composed of 11 patches populated by 2 cohorts each consisting of the type and stem density observed.

Meteoerology

CRU-NCEP meteorology data (1901-2010) was used to drive atmospheric conditions within ED2. A 1 degree grid cell with 6 hour temporal resolution corresponding to the site coordinates, was adapted to drive the 13 variables: radiation (S), temp, precip, mixing ratio, pressure, wind (2), CO₂, and elevation.

Despite a full overstory canopy (LAI=5.3, left figure) a surge in early DBF sapling growth occurs almost immediately (middle figure). The overstory mid and late DBF species die off within the first 40 years. The understory sapling growth matures and merges with the existing canopy by 2010 (right figure). Unrealistic understory stem density coupled with low carbon balance indicates mortality and/or seedling growth parameters require additional tuning.

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